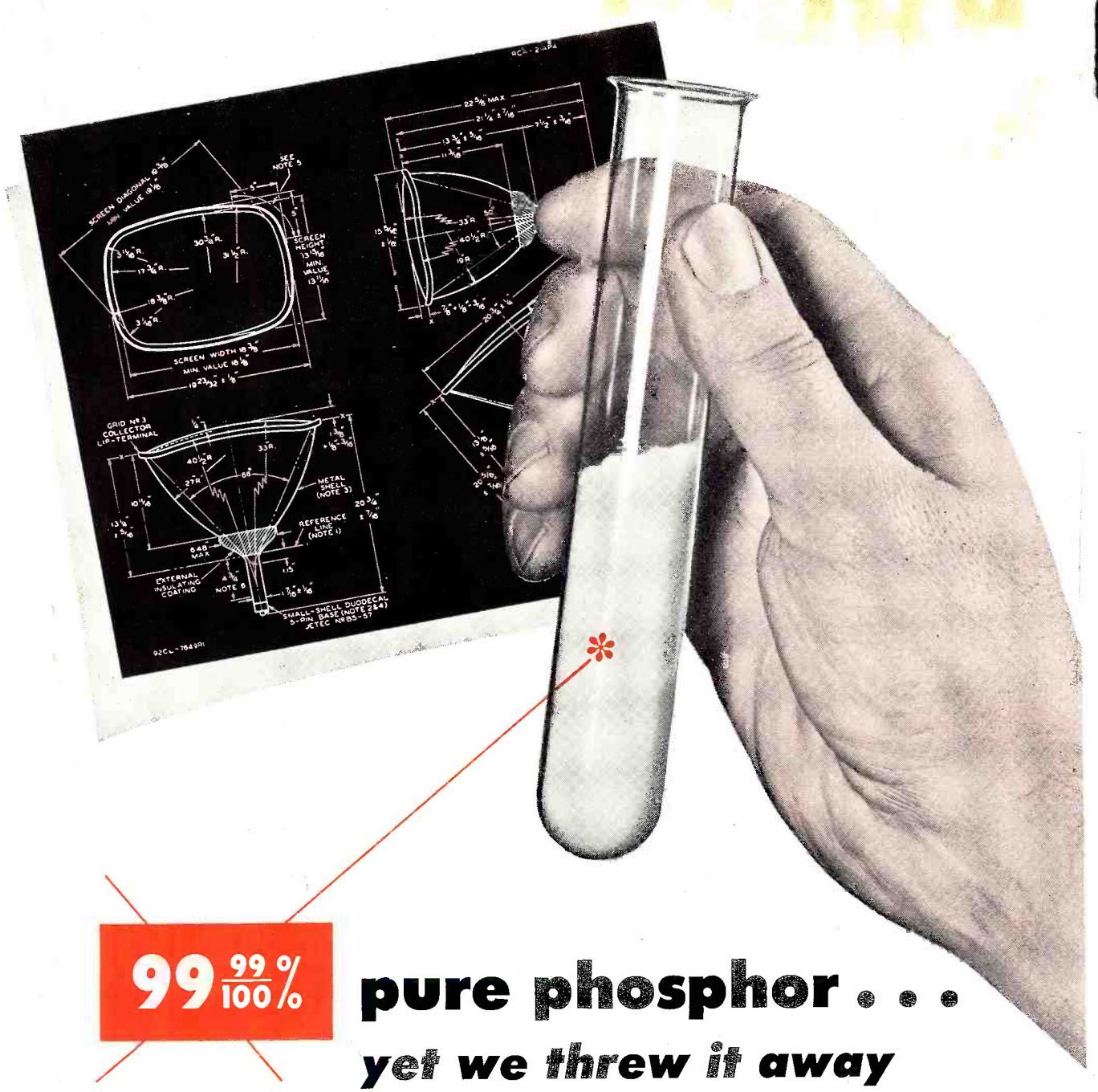

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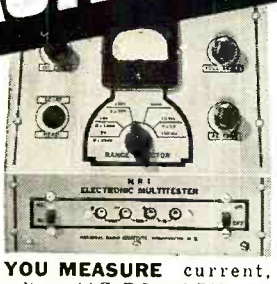

YOU MEASURE current, voltage (AC, DC and RF), resistance and impedance in circuits with Electronic Multitester you build. Shows how basic transmitter circuits behave; needed to maintain station operation.

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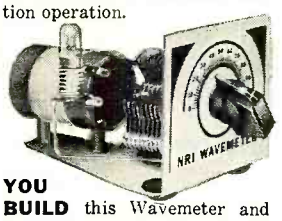

YOU BUILD this Wavemeter and use it to determine frequency of operation, make other tests on transmitter currents.

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Ever think HOW FAST Radio-Television Communications is changing, developing, growing? Have you considered what this amazing progress can mean to you?

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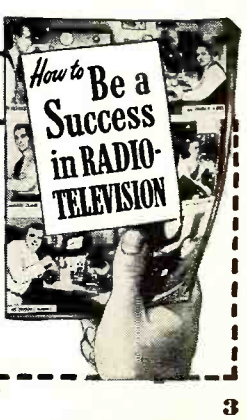

COVER PHOTO: A special TV tube test set, designed by Raytheon, plays an important role in maintaining the quality of production-run CR tubes. (Ektachrome by George E. Meyers)

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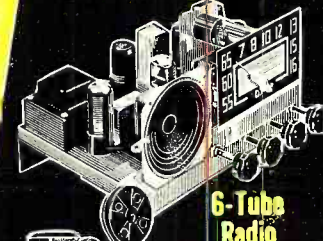
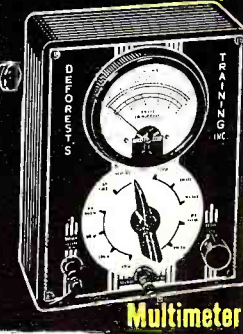


6-Tube Radio

Home Movies



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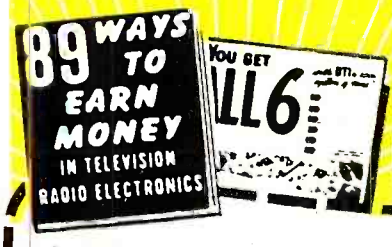

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For the RECORD

BY THE EDITOR

CONFUSED TV PUBLIC

THE television set owner continues to damn the TV industry for not fulfilling its claims of flawless performance. Newspaper ads, in particular, tend to oversell television. Glowing claims (24 hour service, etc.) have clinched many a sale to a gullible public which has been led to believe that the manufacturer and the dealer would rush a service technician to his home, day or night, at the customer's convenience.

The public has its most intimate contact with the technician—not the dealer, distributor, or manufacturer. The technician, accordingly, is the "fall guy" in the great majority of customer complaints. For example:

The evening meal is finished and Joe Doaks, proud new owner of a 17" TV console, hastens to his easy chair to watch the evening's programs. After the usual warmup period he hears his local station announcing a new booklet for only one dollar that shows the set owner exactly how to fix any television set, no matter what, right in his home, but—alas—no picture. Cursing the service technician who installed his set, he rushes for the telephone to call the dealer who sold him "the thing." No answer! Why, it's only eight o'clock and the salesman had promised service on his set any time it was required. Another call—no answer! Joe, his temper playing hard on his nerves, remembers the name of the technician and quickly checks the phone directory.

"Hello—is this Pete? This is Mr. Doaks on Lovers' Lane. My new television set's on the fritz. Can you come right over? I called your store but no one answered. You can't come tonight? Whaddaya mean you can't come tonight—your salesman said you would come anytime I needed service and I want this thing fixed now or you'll be out of a job tomorrow."

Slamming the receiver in its cradle, Joe storms into the living room and grabs one of the monthly science magazines from beneath Junior's funny paper. Joe remembers an article on fixing his television set—right in his own living room. He finds it on page 94 and scurries through to the part that tells what to do when no picture appears.

At this moment the doorbell rings. It's none other than Pete with his service kit and instruments. He makes excuses on behalf of the dealer and the salesman and proceeds with the job at hand. Joe watches the procedure, magazine in hand, to see if Pete tries to pull a fast one on him.

Out comes the v.t.v.m. and its high voltage probe. "This is ridiculous," mutters Mr. Doaks to himself. "This character is putting on an act to impress me that it's a complicated problem when it's just a simple matter of reaching in for that plastic wire and making it spark by touching the gizmal on the cup to the chassis."

After replacing the rectifier, Pete completes the job of readjusting all of the controls that Junior had been playing with after school and starts for the door. Joe, still doing a burn, points to the magazine article and sarcastically states, "It's about time you guys who sell television sets to the public are forced to stop charging we poor suckers for service when we buy a set. Who do you think you're fooling? Even the stations themselves advertise booklets on TV home servicing, so there can't be anything complicated about it. How come I'm forced to pay for something I can do myself? Crooks like you should be licensed to protect me against this racket."

The purpose of the above incident is to show how the public can be misled and confused. It's the old story of the three blind men and the elephant.

Service operators cannot afford to overlook the dangers inherent in this problem. As individuals they should make their sentiments known to their local newspapers and telecasters.

One large metropolis we know was faced with the singular problem of a local telecaster carrying an advertising message from the publisher of a book on "How to Fix Your Own Television Set." This town had a local contractor's association and their collective disapproval was immediately voiced to the station's manager. When he was made cognizant of the over-all effect, he pulled the ad off the air. The telecaster was made to realize that his sales story was dependent upon sets in use, and the local service operator was his best assurance of their optimum operation. After recognizing the complexities involved in TV servicing, the station manager pictured himself as the average non-technical consumer and came to the conclusion that the home service story was invalid.

The public has been placed in an unenviable position where it hears conflicting stories from different portions of the industry. There is apparently a need for a coordinated approach to the consumer by all facets of the television industry. The public expects, and is entitled to, an educational program designed to provide them with facts—not fancy.....O.R.

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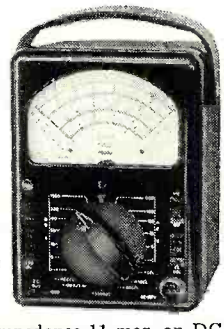

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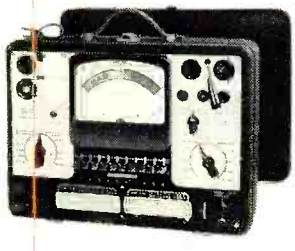

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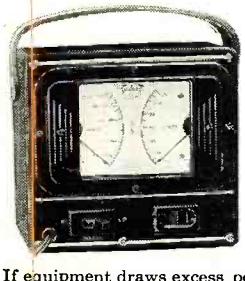

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BETTER in all ways! Gives better over-all focus—hair-line sharpness from edge-to-edge —with NO critical materials for focusing . . . and STAYS SHARP under considerable variation in line voltages.

REQUIRES NO re-engineering of present television chassis . . . NO added high voltage focus circuit . . . NO added receiver tubes . . . NO additional components except an inexpensive potentiometer or resistor.

FOCUSES by using D.C. voltage already available in the receiver.

ELIMINATES focusing coils and magnets . . . saves critically scarce copper and cobalt.

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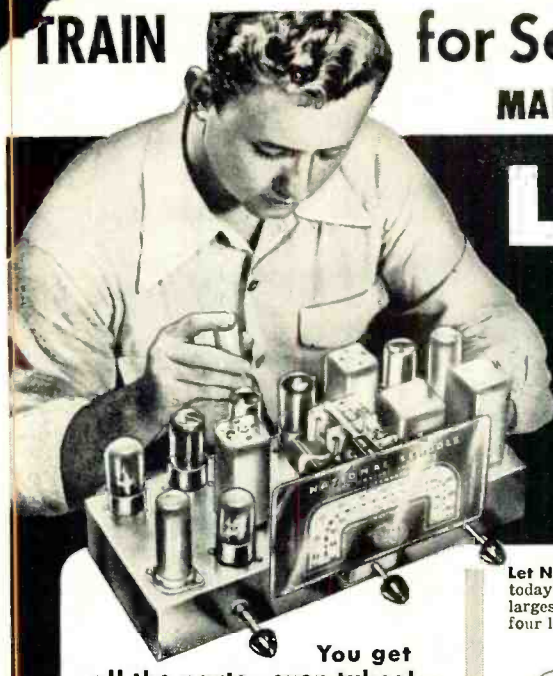

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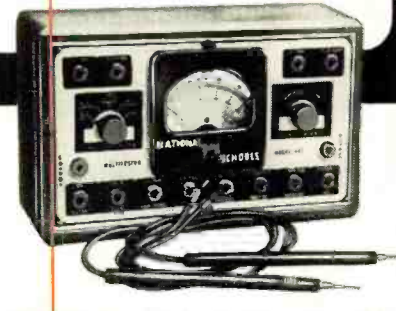

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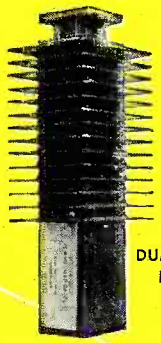

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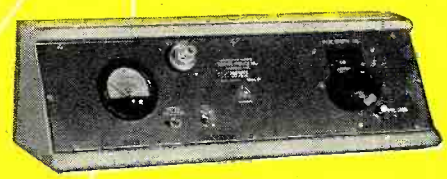

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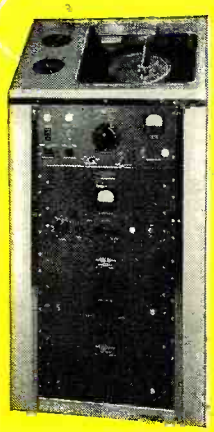

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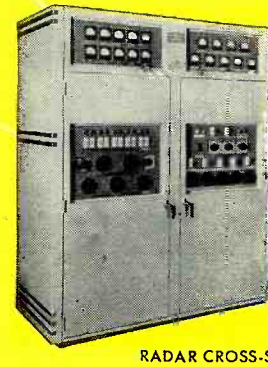

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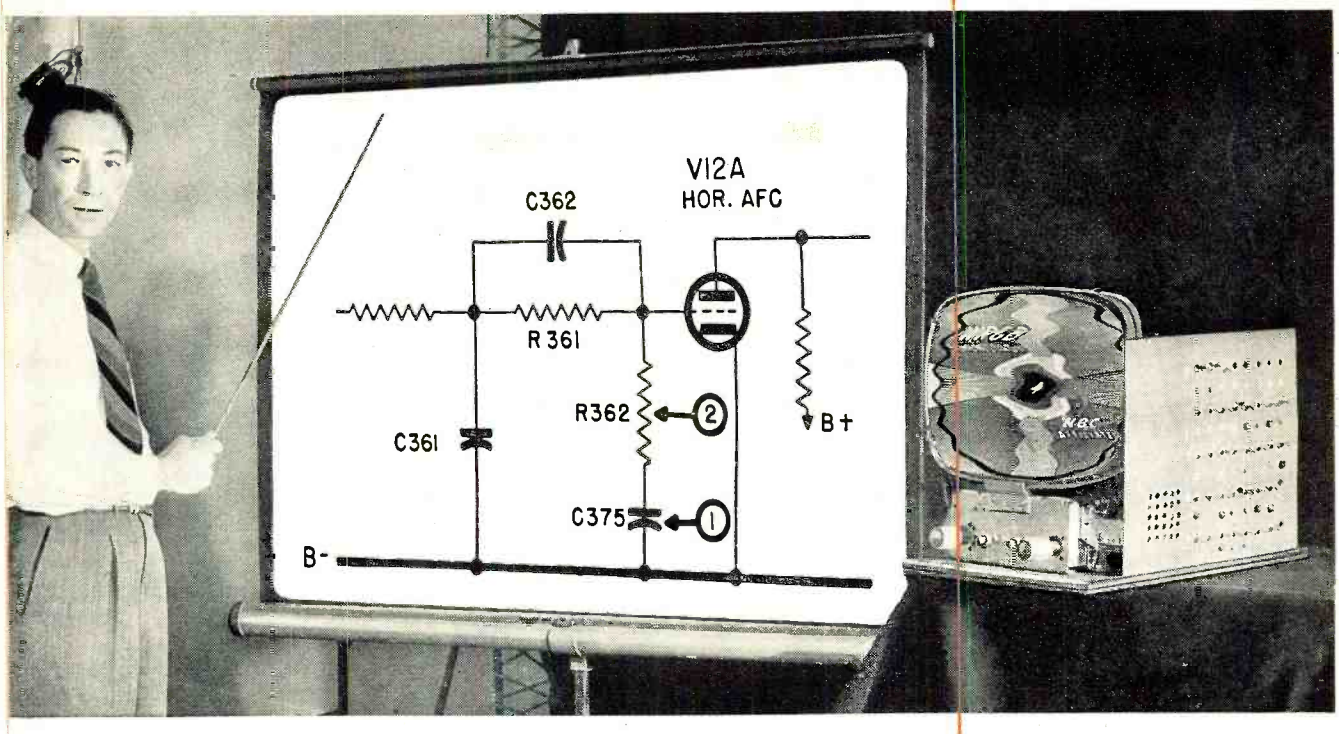

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Dramatic demonstrations of 33 different TV troubles that may occur in any set—and how to fix them—shown by resident G-E Field Engineers right in your own TV area—without charge.

WHAT you see in the picture above is the business end of a G-E field service meeting. By flicking one of the 33 toggle switches on the Dynamic Analyzer, the operator shows a typical example of sync trouble right on the screen. On the chart appears a diagram showing a portion of the horizontal AFC circuit—and the General Electric Field Engineer tells you how to fix it.

Meetings like this are being held all over the country by resident G-E Field Engineers to help service men and dealers diagnose any TV problems quickly and surely and know what to do to fix them.

Big service operators like Norm Liberman of San Fernando, Cal., and Sam Barriette of Garden City, L. I., say G-E television sets are better built—parts and replacements are easier to get—servicing is more profitable. *These men already know what you can learn at these field meetings!*

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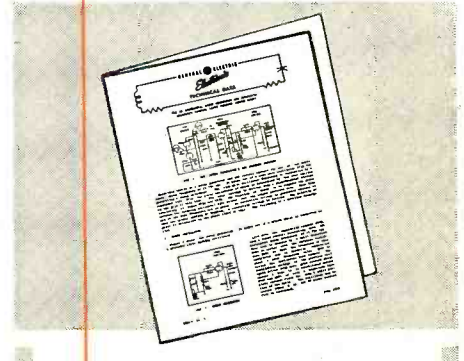

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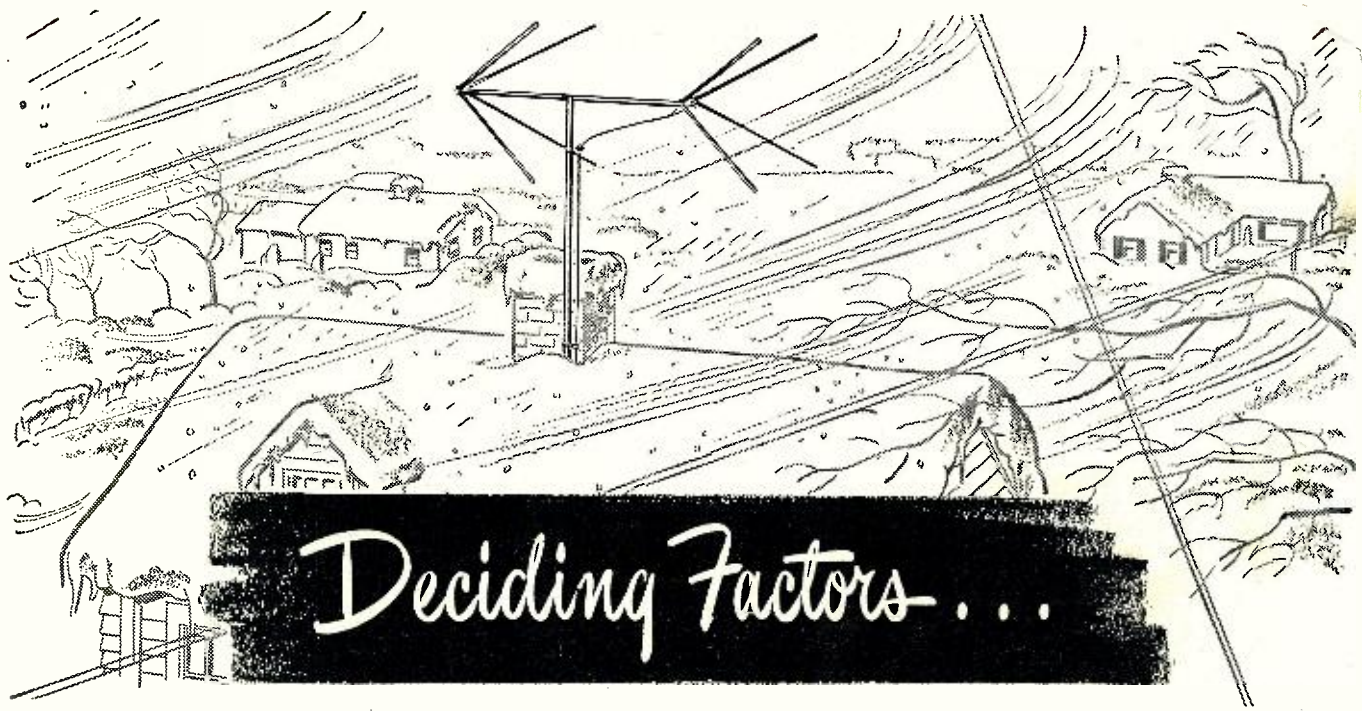
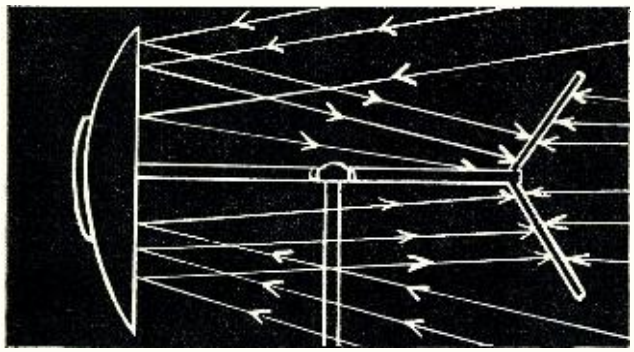


WITH WARD ANTENNAS INSTALLATIONS *Stay Put!*



Diagramatic sketch showing how parabolic reflectors gather in and concentrate energy on conical elements.

Ward mechanical superiority is a deciding factor weighing heavily with men in the field. Ward installations "stay put" . . . eliminate call-backs.

WARD PARA-CON* Antenna not only combines parabolic and conical principles to assure maximum picture clarity on all channels in most reception areas—but it features a material and structural strength that defies the elements, and assures a permanent installation. Aluminum tubing, molded plastic insulators, heavy duty crossarm and other construction features make for rugged strength and unsurpassed durability. Write for catalog. *T.M.

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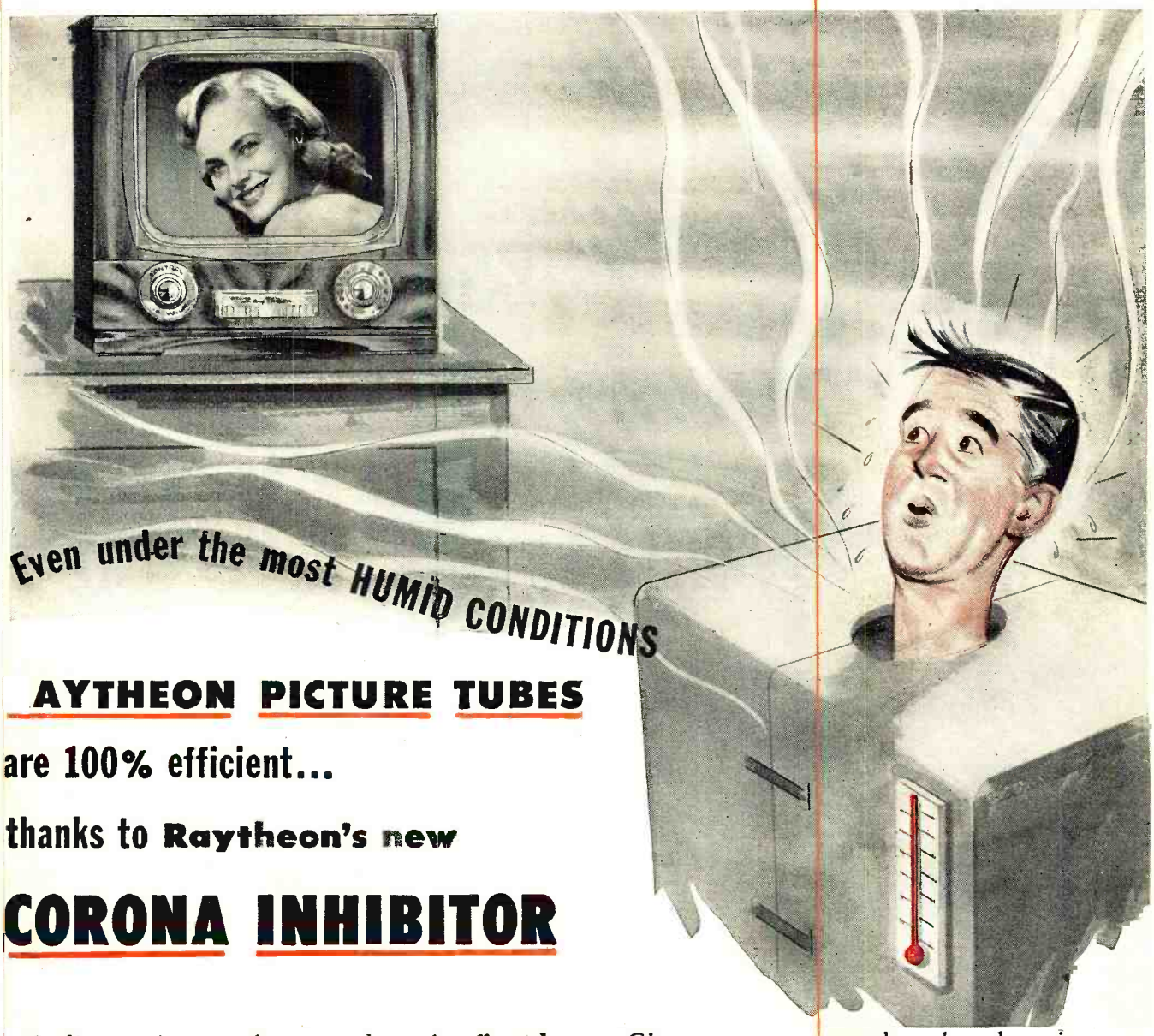

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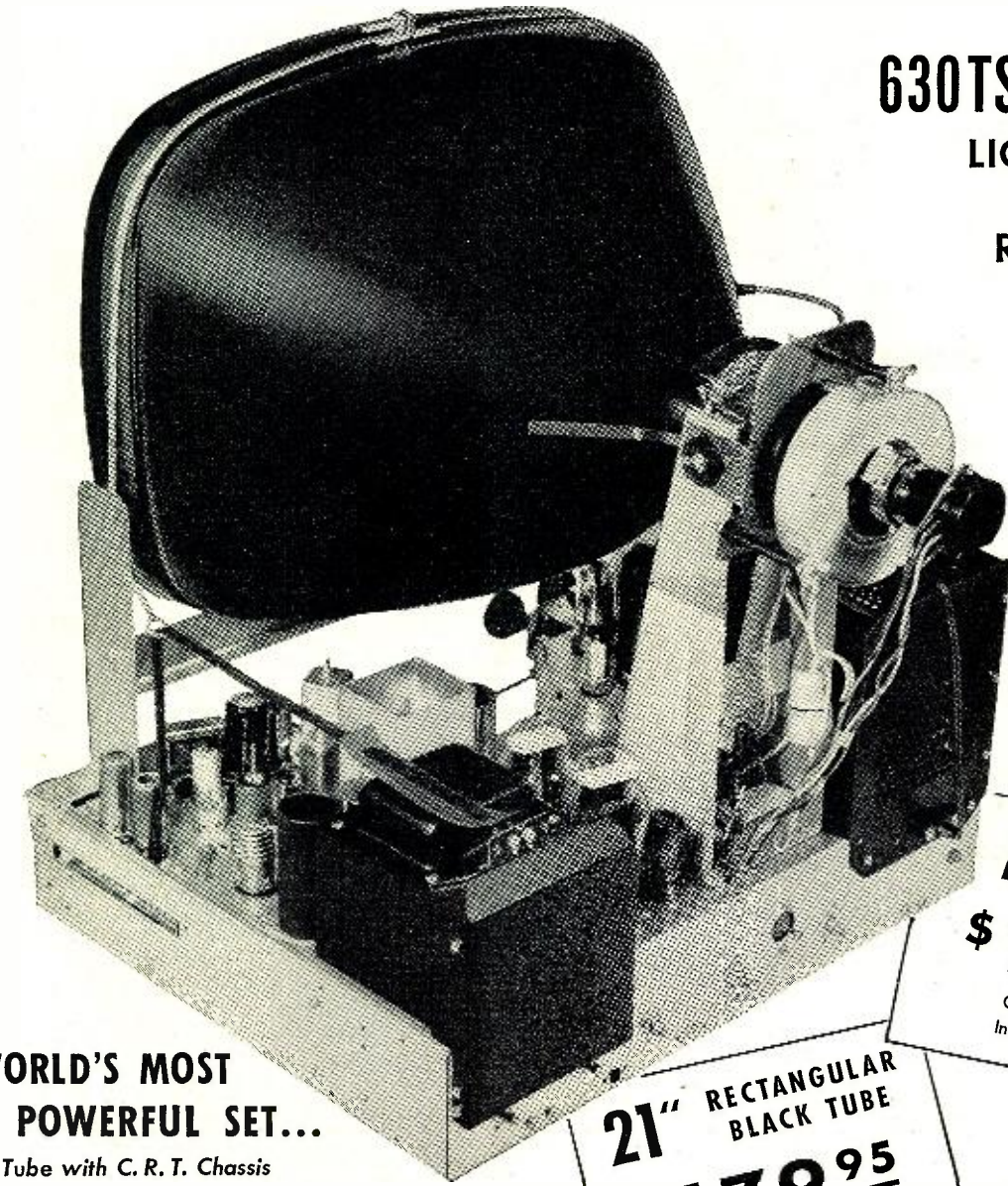

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NO EXTRA CHARGES
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IMMEDIATE DELIVERY—15% Down—Balance
C.O.D. Remit in full—save C.O.D. charges
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REMBER THESE CBS-HYTRON TV FIRSTS?

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original *studio-matched* rectangular picture tube.

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twin-triode sweep amplifier with superior efficiency.

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compact, high-voltage TV rectifier.

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Very-high-gain miniature pentode amplifier. Gives gains — within its power capabilities — equal to those of 6AG7. As video amplifier, provides better contrast in high-quality TV receivers. And in low-cost receivers, adequate amplification at low plate voltages.

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High-mu, 9-pin miniature dual triode. Especially designed for sync. separators and sync. amplifiers, high-gain audio amplifiers, and gating circuits.

Meet 4 more CBS-HYTRON TV Firsts!

NEW 12A4
High-efficiency, medium-mu, 9-pin miniature triode. Used as vertical amplifier, class C oscillator, or low-distortion audio output amplifier in push-pull.

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High-efficiency, low-mu triode with 6/12 volt heater. Designed for vertical amplifiers with limited B supply voltages. Gives more sweep than 6W6GT. In proper circuit, sweeps any 70° rectangular.

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Because these tubes are specifically designed for high-performance, low-cost TV for the mass market. Watch for them in new models of famous TV sets. When you buy these CBS-Hytron TV firsts, follow leading set manufacturers. Buy the original. Buy CBS-Hytron!

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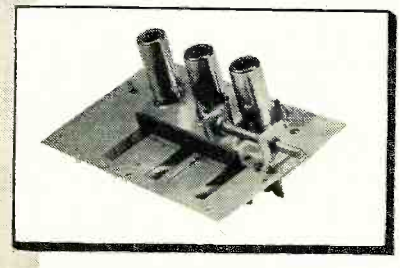
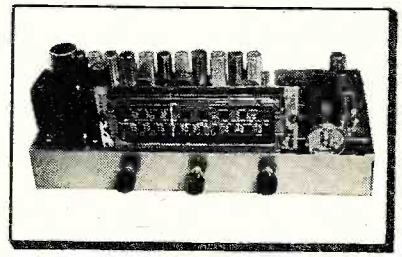


FM Tuning Unit **$15.25**



The Collins FM-AM Pre-Fab Tuner Assembled (Total Kit Cost **$69.00**)

AM Tuning Unit (Includes IF and Audio Amplifier) **$19.25**

FM IF Amplifier **$19.75**

Tuning Eye Kit Available At $2.85

UC-2 Universal Chassis Kit **$14.75**

The FM tuning unit employs 6J6 RF amp., 6AG5 converter, and 6C4 oscillator. Permeability tuned, stable, and drift-free. The IF amplifier for FM uses 6BA6, (4) 6AU6, and 6AL5 discriminator high gain, wide band for high fidelity reception. Distortion less than ½%. Frequency response 20 to 20,000 cycles at detector output.

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Tuner kit is supplied with AM/FM selector switch, volume control and AC switch, and tuning knob. Complete instruction manual with schematics and pictures included.

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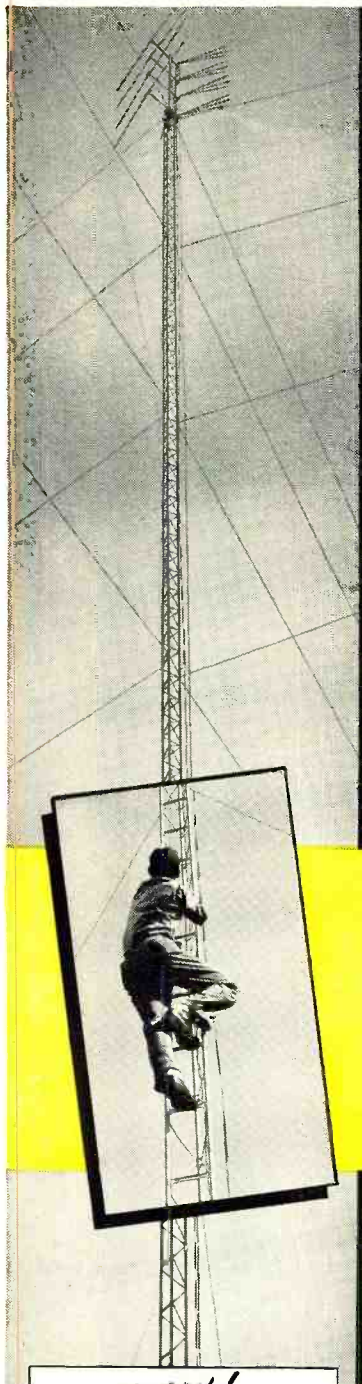
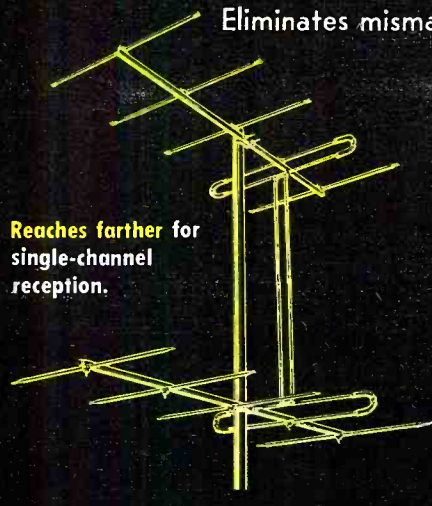


Eliminates mismatch! Outperforms standard Yagis!

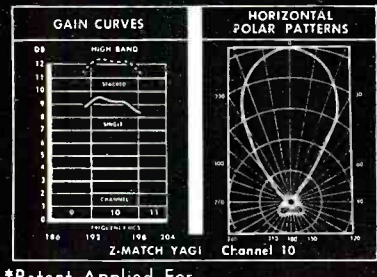
Z-MATCH YAGI*

600 Series



Reaches farther for single-channel reception.

- Perfect match to 300 ohm line, single or stacked.
- Wider spaced elements for higher gain.
- 100% gain in stacking!
- Completely preassembled.



*Patent Applied For

How The Z-Match Yagi Works

When antennas are stacked, the center feed bars of the folded dipoles are removed, automatically creating a perfect 300 ohm match for the entire stacked Yagi array. These same center bars are then used as half-wave connecting rods. This means

YOU DON'T PAY FOR STACKING BARS!

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CHANNEL MASTER

FIRST IN PREASSEMBLED ANTENNAS

For "Far Reaching" Results

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TOWERS

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- Steel tubular uprights.
- Built-in ladder with no obstructions.
- One standard interchangeable section which can be used as a top, middle or bottom section.
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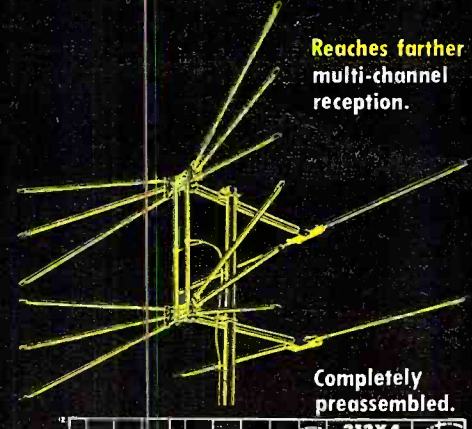
The most widely used antenna in the nation.

The highest gain broad-band antenna ever developed.

New reinforced fibreglas inserts in all elements and reflectors.



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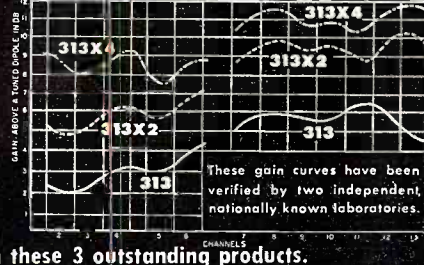

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Spot Radio News

Presenting latest information on the Radio Industry.

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

PRODUCTION PROPHESIES, the perennial favorite topic of newsdom during the last days of the year, which often do not create too much of an impression on those who have to live with the statistics, were not so blandly discounted during the '52 offerings, when presented by the experts in Washington, and industry. For, as in the early '40s, the figures were not gilded or resplendent with optimism. Instead, they represented rather frank and conservative estimates, predicated on the demands of the accelerated defense program.

While the crystal-ball seers did not indicate that manufacturing would dip to serious lows, it appeared as if the bulging warehouses would really begin to empty out, because of curtailments. Specifically, members of government declared that we'd have about 5,000,000 TV chassis coming off the line during the year. Some estimates of industry were not so hopeful, with a production rate of 3,000,000 presented in some quarters. One survey specialist declared that his private analysis disclosed that 4,300,000 sets would be made and 4,600,000 chassis would be sold. Substantially brighter guesses were issued on the home set-portable-auto radio production front. About 10,000,000 models in this category would be made, it was said.

Comparisons of '52's expected output with the shipments of '50 and '51, particularly during the first halves of the years, revealed graphically the effects of material allocations on production. During the first six months of '50, over 3,000,000 television sets were made, while in the January-April period of '51, over 2,000,000 chassis were fabricated. During the first quarter of the new year, the processing of only about a half-million sets is in the offing. Some believe that there will be considerably more units shipped, thanks to the conservation programs which have, in many instances, doubled and tripled inventories of essential components, accessories, and hardware parts. One manufacturer felt that industry ingenuity would permit at least another five to ten per-cent output. According to one of the country's leading set makers, industry's conservation efforts, which have resulted in such developments as the electrostatic type of picture tube and reduced substantially the amount of copper required, should permit production of over 800,000 sets during the first three months of the new year. Pacific Coast manufacturers indicated that in the first quarter they'll probably be able to produce about 75 per-cent of the output achieved in the October-December period of '51.

AS THE SET PRODUCTION FORECASTS appeared, the military were clamoring for more material and hammering away at the ODM office and, especially, Headman Charles E. Wilson. In their opinion, the civilian world was receiving too much of the essentials required by defense for guns and aircraft. During closed-door sessions, Wilson was told that it is important to race armament production, even at the risk of halting many types of civilian output. The production chief reported that the defense program was in full swing and that there were no lags anywhere. The three-year mobilization program was being followed as planned, he said, and the goal set will be reached as per schedule.

In one review of the preparedness effort, a Senate committee praised the mobilization authorities for following a middle-of-the-road approach in converting the nation to military production. If all-out requests had been issued, the Congressional group pointed out, an economic crisis would have been precipitated. In their opinion, it cannot be reasonably concluded that . . . "the nation has failed to maintain its minimum military strength in an effort to place butter before guns."

THE FREEZE ERA, which struck the telecasting world over three years ago, and a few months ago hit the color front with that edict from the defense officials to stop all red, green, and blue chassis making, entered the prophesy ring too, as the year '51 came to an end. Practically everyone in Washington released statements announcing that the ice blocks across broadcast road would start disappearing during the early spring. The most enthusiastic supporter of this belief was none other than the Commission's chief, Wayne Coy, who during several talks declared that by April 1 he hopes the FCC will begin issuing construction permits.

Speculating on the eventual construction pace that will prevail, Coy said that in five years . . . "we will have 1200 to 1500 stations on the air

Be Sure of Your Installations

Get the *Aptitude-Tested* RG/U TRANSMISSION LINE CABLES

FOR 50 YEARS *Wiremaker for Industry*

● You know what you are doing when you use Belden RG/U Transmission Line Cables—they're aptitude rated. They are designed to provide desirable electrical characteristics, and rigid control assures constant quality. Specify Belden Radio Wires.

Belden Manufacturing Co., 4681 W. Van Buren St., Chicago 44, Ill.

To You,

Belden's Golden Anniversary Means

—product performance that can come only from a "know-how" that has grown through actual service since the inception of Radio.

—an ability to co-operate in pioneering new wires to meet or anticipate industry's growing needs.

In the years that follow

This Belden Program Is—

—TO BE CONTINUED

APTITUDE RATING No. 8236		APTITUDE RATING No. 8237		APTITUDE RATING No. 8238		APTITUDE RATING No. 8239		APTITUDE RATING No. 8241		
Frequency (Mc)	Attenuation per 100 ft	Frequency (Mc)	Attenuation per 100 ft	Frequency (Mc)	Attenuation per 100 ft	Frequency (Mc)	Attenuation per 100 ft	Frequency (Mc)	Attenuation per 100 ft	
100.	2.65	100.	2.10	100.	1.90	100.	3.10	100.	3.75	
200.	3.85	200.	3.30	200.	2.85	200.	4.40	200.	5.60	2
300.	4.80	300.	4.10	300.	3.60	300.	5.70	300.	7.10	300
400.	5.60	400.	4.50	400.	4.35	400.	6.70	400.	8.30	400

Belden *Radio* **WIRE** The *Aptitude-Tested* **LINE**

and in ten years we may have 2500."

"Soon after the freeze is lifted, we expect to have some 1000 applications for construction permits," the communications headman reported. In his opinion, it appears as if . . . "almost a billion dollars has already been earmarked by various corporations and individuals to construct our new television stations."

THE FREEZE WORLD was also treated to an oddity in the form of a statement on color from NPA. Earlier industry had been asked to curtail production immediately and everyone agreed to comply. Shortly after this unanimous approval was received, the lawmakers began to worry. They found that the agreement among the set makers might be a violation of the Sherman and other anti-trust acts. So, it became necessary to legalize the desire to halt with an official ruling. Thus, Order M-90, officially banning color production, was issued and now it's perfectly proper not to make color sets. Technically, the ruling prescribes that . . . "no person shall . . . produce or assemble any television set designed to receive . . . color television, nor shall any person produce or assemble any product, attachment, or part designed solely to permit or facilitate . . . the reception of color television."

The official ban did not cover research or test programs. Neither did the ruling restrict the manufacture of color television equipment for closed circuit operations for industrial purpose or by hospitals and educational institutions for instructional applications.

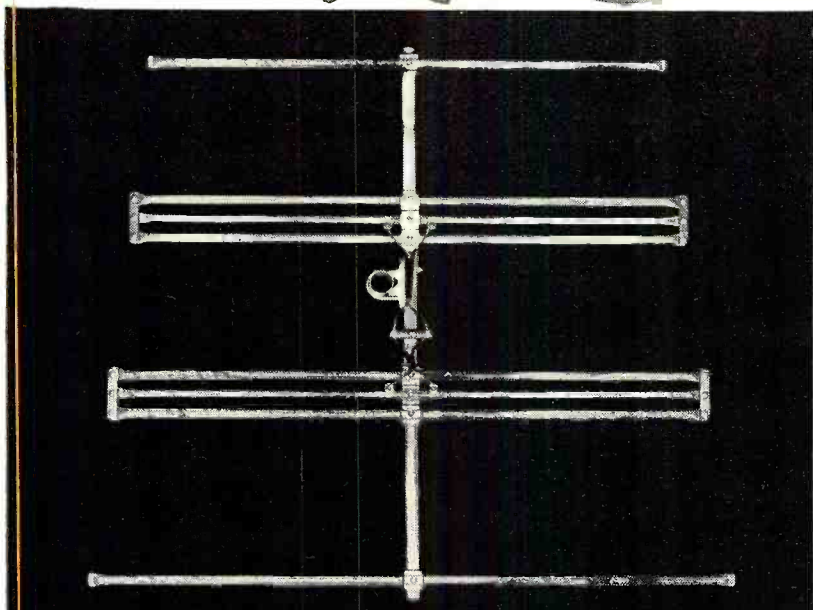
THE CLARIFICATION OF THE COLOR ban, which revealed that experimentation on color systems could continue, was greeted effusively by the proponents of the compatible techniques, since they could continue with their intensive industry study and submit a report which might reopen hearings on color and prompt the Commission to establish new standards.

As this column was being prepared a comprehensive on-the-air test survey of the electronic method, evolved by the various panels of the National Television Systems Committee, was under way. The tests, which were expected to last until the first days of spring, were being conducted in five cities: New York, Philadelphia, Chicago, Syracuse, and Washington. Among those transmitting color signals are *RCA* and *Du Mont* in New York, *Philco* in Philadelphia, *Zenith* in Chicago, *General Electric* in Syracuse, and *RCA-NBC* in Washington.

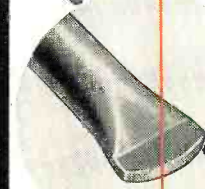
In a description of the characteristics of the signals being aired, NTSC said that the power of the aural-signal transmitter will be not less than 50 per-cent nor more than 150 per-cent of the peak power of the visual-signal transmitter. It was also noted that the color subcarrier frequency will be 3.898125 mc. ± .001 per-cent, with a

(*Continued on page* 134)

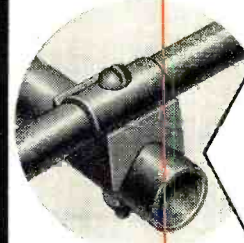
There's No Comparison!



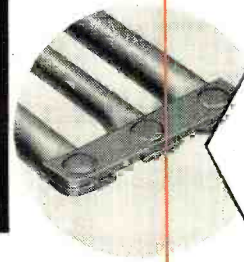
THE TRIO 2-CHANNEL YAGI FULL 10 DB GAIN ON TWO CHANNELS.
MODEL 445 FOR CHANNELS 4 AND 5
MODEL 479 FOR CHANNELS 7 AND 9
Patent pending — no licensing arrangements granted for duplicating principle of this antenna.



Yagi elements of .035" thick seamless aluminum, are full 5/8" in diameter. Ends are crimped for greater strength and to cut down vibration. Prevents entrance of dirt and moisture.



An extra clamping member permits taking up bolts tight without putting undue strain on element. Cast aluminum V block assures perfect right angle alignment. No detail of design or construction has been overlooked to make the TRIO 2-Channel Yagi the finest fringe area TV antenna available anywhere — at any price!



Double-folded dipole sections have heavy gauge aluminum brace bars securely riveted to element ends thus providing positive electrical connection and extreme rigidity. Workmanship throughout is of the highest order.

TRIO- the Original 2-CHANNEL YAGI

TOPS ALL IN DESIGN, CONSTRUCTION, PERFORMANCE

One of the most widely imitated antennas on the market today, the TRIO 2-Channel Yagi still stands alone in efficiency and strength.

TV buyers — and sellers — are discovering that "look alike" is not enough — that imitations are never as good as the original.

There is no secret to TRIO's marked superiority. The simple truth is that TRIO slights no construction detail, overlooks no design feature. This means unparalleled efficiency — rugged dependability for both installer and TV set owner.

Installers! Avoid profit eating call-backs caused by poorly made imitations! Set owners! Enjoy years of dependable, efficient TV reception! Compare the TRIO 2-Channel Yagi with any other TV antenna at any price. Yes, compare — then you, too, will insist on an original TRIO — the 2-Channel Yagi that set the standards.

TRIO the "Trouble-proof" TV Rotator

For years of dependable, unfailing service — in good weather and bad — you can't beat the new TRIO TV Rotator and Direction Indicator.

Sturdy and completely weatherproof, the TRIO Rotator will support the heaviest TV arrays — even in 80 MPH winds! Its sound design and construction has been proven by 3 years of extensive field testing under every extreme of weather. The TRIO Rotator will not freeze up!

2 HEAVY DUTY MOTORS

Two separate 24 volt motors are used — one for each direction of rotation. Thus, each motor operates just 50% of the time — cannot burn out. Positive acting electrical stops at both ends of 360° turn eliminates lead damage.

Housing is die-cast aluminum for greater strength, lighter weight and perfect alignment of parts. The TRIO Rotator is precision built throughout.

SMARTLY STYLED DIRECTION INDICATOR

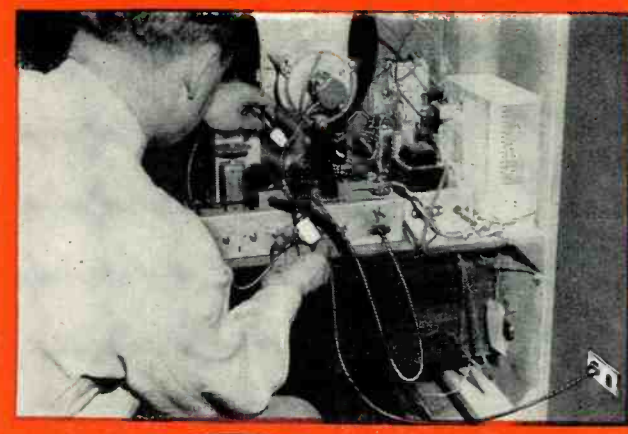
The TRIO Direction Indicator is housed in a sturdy plastic cabinet of graceful lines. It is a beautiful instrument that will blend harmoniously with any furniture style.

Utmost ease in selecting the desired antenna direction is provided by a new "finger-tip" control that operates at a light touch and the easy-to-read dial face that clearly and instantly indicates the exact antenna position.

Trio MANUFACTURING COMPANY
GRIGGSVILLE, ILLINOIS

available

from your Teletron distributor...



1

Tele-lead

Handiest TV servicing aid yet. Permits power connection to receiver chassis when safety interlocking switch is broken by opening protective back. At the same time, it provides a trouble light to see what's what.

2

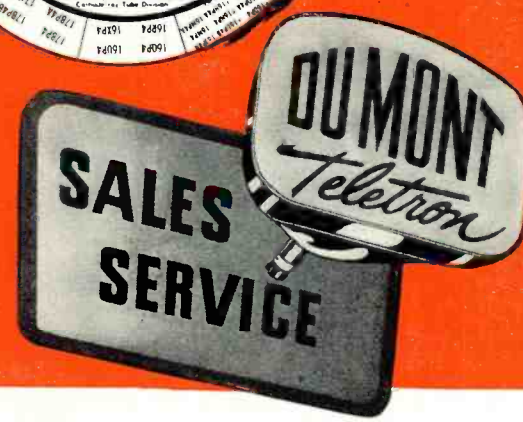
TV Picture Tube Selector

Replaces those bulky and seldom-at-hand charts and booklets formerly necessary to find correct replacements. Merely dial the type to be replaced—presto! there's the correct Teletron replacement. Also electrical and mechanical characteristics for those profitable conversion jobs!

3

Teletron Decal

Colorful decal easily transferred to store window, doors, inside displays, or on your truck or car. Immediately marks you as a quality-wise service organization. Ties right in with Du Mont fame!



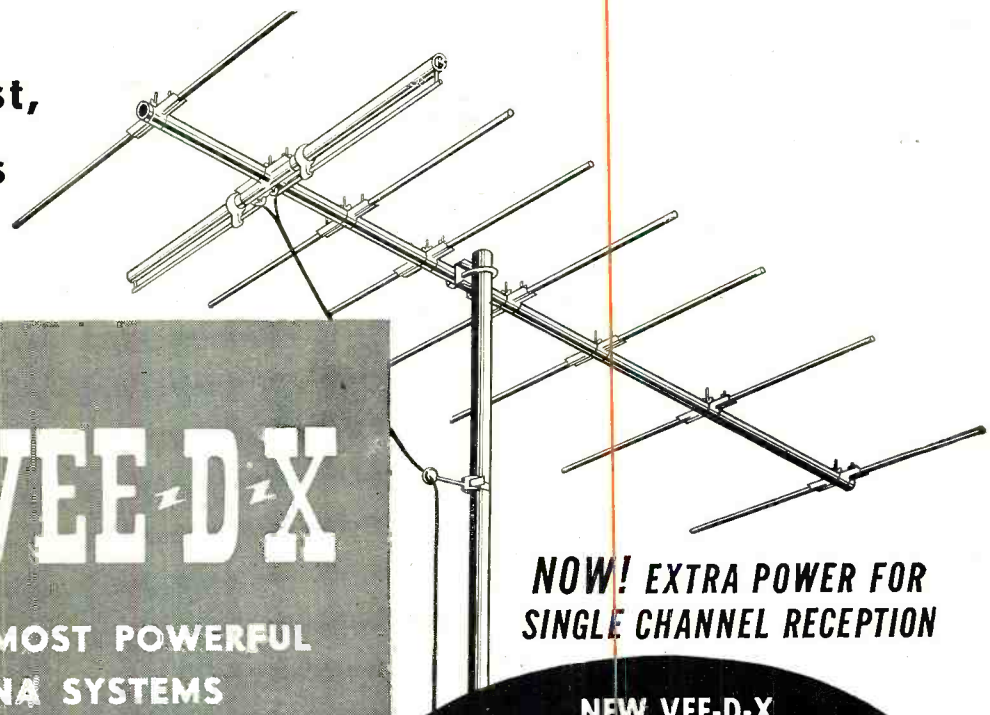
Geared to your TV servicing! It's up to you to get these aids from your Du Mont Teletron distributor. They represent *plus* values above and beyond that biggest bonus—Du Mont's reputation for *quality, progressive engineering* and *customer satisfaction*. Drop in on your Du Mont Teletron distributor today. Ask for the aids. And get in on the fastest road to more profitable TV servicing.

DU MONT

CATHODE-RAY TUBE DIVISION ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N.J.

*Trade-mark

For the sharpest, clearest pictures in television...



INSTALL

Genuine VEE-D-X

THE WORLD'S MOST POWERFUL TV ANTENNA SYSTEMS

NOW! EXTRA POWER FOR SINGLE CHANNEL RECEPTION

NEW VEE-D-X

Long John

8 Element Yagi

PROVIDES

41% MORE GAIN

Than The Best 5 Element Yagi

Gives Equal Gain To A Double Stacked 5 Element Yagi Array

VEE-D-X engineers have perfected this entirely new 8 element Yagi to meet the increasing demands throughout the trade for a single bay antenna that produces as much gain as a stacked Yagi array, yet lower in cost, easier to install, and better in appearance. Long John is the answer. Compare these time and money-saving features.

at lower cost! **$12.50 LIST**

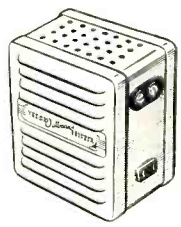
for Channels 7-13

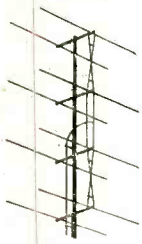
MODEL LJ—Ch. 2 or 3 ... $29.85 list
MODEL LJ—Ch. 4 or 5 ... $26.15 list
MODEL LJ—Channel 6 ..... $23.65 list
All Prices Less Mast

- **Faster, easier to install than stacked arrays**
- **Better roof-top appearance**
- **Higher front-to-back ratio eliminates co-channel interference**
- **Full 6 megacycle band width**
- **Rugged pre-assembled construction**

OUTBOARD BOOSTER

For single channel use. Delivers powerful 18 db gain with full 5 megacycle band width. Only $19.95



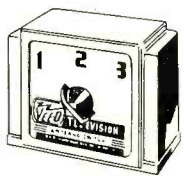


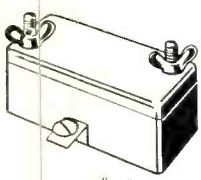
COLINEAR ARRAY

Lowest priced all-channel 4 bay array with pre-assembled construction. $23.75 less mast

ANTENNA SWITCH

3-way switch for stacked arrays or multiple antennas. Instant changeover to each antenna. Attractive ivory or mahogany plastic case. $4.95



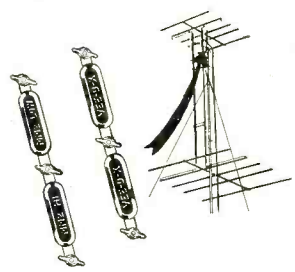


RW-200 ARRESTER

Positive protection against lightning. The full sized arrester that costs no more than a midget. Only $1.25

ROCKET BOOSTER (Patent Pending)

Powerful new single channel mast-mounted booster. Amplifies signal at antenna height where most favorable signal-to-noise ratio exists. List $34.95



MIGHTY MATCH

(Lic. A.A.K. Pats., 2,422,458; 2,282,292 others pending) Permits use of single transmission line between separate high and low antennas mounted on same mast. List $4.20

THE LaPOINTE-PLASCOMOLD CORPORATION
Windsor Locks, Connecticut

Gentlemen:
Send me information on the following: .....

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Name .....
Street .....
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Know "WHY" Ceramic Capacitors...

Here are the facts about Ceramic Capacitors — why they are the most permanent capacitors . . . why they do a better job . . . give a better performance . . .

Up until a few years ago, capacitor design was based on one idea — "the bigger the better." Paper and mica, etc., were cheap, readily available materials, and their use was the only known art for making commercial capacitors (or "condensers" as they used to be called).

Now don't misunderstand us . . . those old condensers were really OK as far as they went. *But today there's something more to talk about* . . . CERAMIC CAPACITORS.

Actually, the idea of ceramic capacitors isn't new. They've been used as electronic components for more than 20 years. We call them new because it's only in the last few years that service-engineers have paid any attention to them . . . and because some of these modern ceramic capacitors really are new . . . with *new* higher voltages, *new* and better physical characteristics. So if ceramic capacitors were overlooked by service-engineers during the last few years . . . we feel it's because you didn't know about just how *good* they really are—or because what you needed wasn't available.

Let's take a look at modern ceramic capacitors and the story behind them. It was in the early 1900's when German scientists discovered the dielectric properties of ceramic materials. In the U.S.A., we had an abundant supply of mica and other materials, so U.S. research men never bothered with ceramics. Then came World War I, and ceramics became mighty important in European radio manufacture. Ceramics were a long way from perfected but they did the job . . . and continual improvement made them increasingly important in the electronic field. Meanwhile, at Centralab, we had started to investigate these new materials. It was soon found that U.S.A. had a bigger source of raw ceramic materials and that our stocks were of vastly superior physical and electrical characteristics.

Then one of our foreign representatives supplied us with a complete set of foreign-made ceramic components. Result — Centralab developed a ceramic research program. The program was big and thorough . . . and it's still going on.

In a few years, Centralab put on the market its first ceramic capacitors. With World War II, came tremendous developments in electronics. Radio, radar and other electronic equipment demanded the finest in component parts . . . and ceramic capacitors came into their own. *In fact, independent research has shown that during World War II, in some classes of military equipment, there was not a single known instance of a failure of a ceramic capacitor!*

Thus, through the lessons learned over a period of 20 years of intensive research — Centralab Ceramic Capacitors have today become the best capacitor buy for safe guaranteed servicing. For when you use CRL ceramic capacitors, you're using the benefits of hundreds of thousands of man-hours of research—experiments with over 20,000 different ceramic compounds!

That's why any ceramic isn't the best ceramic for the job. Each of those 20,000 ceramic mixes had definite physical and electrical characteristics . . . and when we say that Centralab today uses only 250 of those 20,000 tested compounds, you can be sure that those discarded did not perform to the exacting requirements of sensitive electronic circuits.

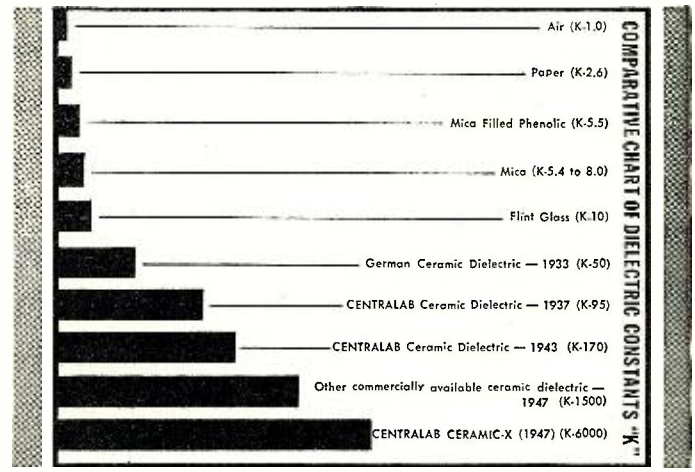
Yes, and if you compare the old-style paper and mica capacitors with modern ceramic capacitors . . . point for point, based on your own technical experience, you'll see why ceramics are vastly better . . . the safe, dependable way to assure a good service job.

For example, every serviceman is aware of the moisture absorbing quality of paper condensers . . . and how moisture can seep in along the leads on mica units. Compare these old designs with modern ceramic tubular and disc types . . . Centralab's Ceramic-X capacitor bodies are nonhygroscopic . . . moisture absorption being only .007% or less! That fact alone means Centralab Capacitors give you and your service customer the ultimate in reliability—even under severe tropically humid conditions.

Old-timers in the service field . . . yes, and young ones, too, will recall the bulky size . . . the difficulty of handling old-fashioned large size capacitors . . . when size seemed to be an important factor in design. Now, look at modern ceramic capacitors. They're less than 1/7 the size . . . you can fit them anywhere!

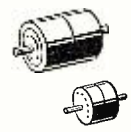
When you look at this chart of the development of capacitors using various materials . . . the tremendous improvement of the dielectric constant "K" with the entry of ceramics into the field is dramatically evident.

One of the most serious problems with old-time capacitors was that they broke down under high temperatures. Here again, ceramics have more than proven their superiority. 85° C. will not harm the modern ceramic capacitor. In fact, the ceramic body itself can easily withstand any temperature encountered in electrical apparatus. High capacity is



well maintained under wide temperature variation. What's more, the copper-silver electrodes are electro-bonded to the ceramic with a tensile strength of 30,000 lbs. per square inch — thus preventing any possible change of the relative position of the electrodes.

A typical example of the high degree of perfection and performance offered by ceramic capacitors is contained in CRL Hi-Vo-Kaps. These units are rated at 10 — 20 and 30 KV and are intended exclusively for TV. You'll find that practically the entire TV industry has standardized on these CRL units as original equipment for this most exacting application.



When it comes to low power factors—check ceramics against all others. With ceramics, initially it's .1% to .6%. After 100 hours at 95% humidity, it's .5% to 3% and they'll return to normal! That's ceramic high efficiency! If it's accuracy you want, ceramic capacitors can give you unusually close tolerances in wide range of values.

In r.f. circuits, where drift is critical, one of the likely causes is temperature change. Stabilization can be effected by capacitors which compensate for temperature variations. Centralab pioneered ceramic capacitors for this purpose. This important research resulted in Centralab's famous TC-Hi-Kaps Zero Temperature and Negative Temperature Compensating units. These are a Centralab exclusive "First". For service-engineers they are the industry's last word in accurate stabilizing capacitors.

Service-engineers today are called upon for more exacting work — more downright customer satisfaction. Every job that comes into your shop is a challenge to your reputation. Regardless of the care in workmanship, no service job is better than the components you put into it. To stay in business tomorrow — you can't take chances today.

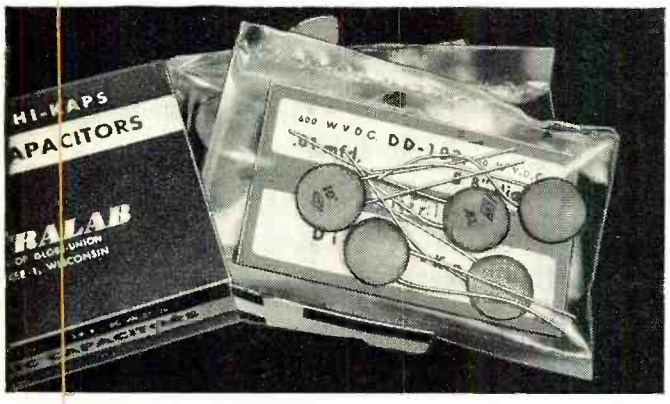
Field research shows that smart service-engineers everywhere *are replacing all old-fashioned or dangerously old capacitors with ceramic capacitors,* within the capacity ranges available. Particularly if there is any indication of possible failure within a reasonably short period. For by-pass and coupling applications . . . they're using Centralab BC Hi-Kaps. For tuning applications, they're using temperature compensating TC Hi-Kaps. It's their own assurance of a good job well done . . . and their customer's insurance of complete satisfaction. What's more, to the serviceman and customer alike . . . *there's little or no premium in price.*

* * *

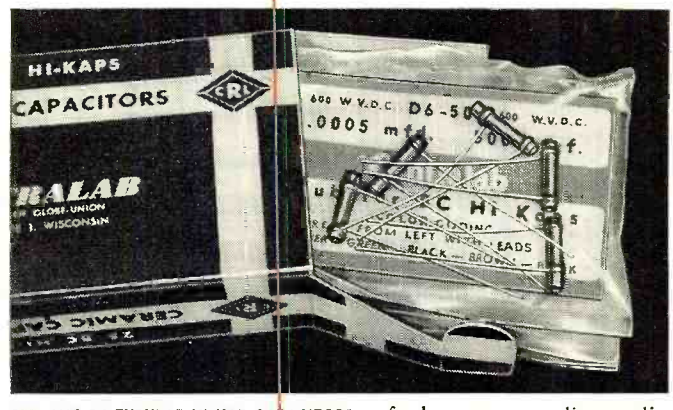
You'll find Centralab ceramic capacitors are available in a wide variety of capacities from any recognized better radio parts distributor. Ask him. And remember, Centralab is the pioneer in the field of electronic ceramics. That fact alone is your best assurance of engineering know-how, production know-how, and performance know-how that permits no compromise with quality.

and you'll Buy Ceramic Capacitors

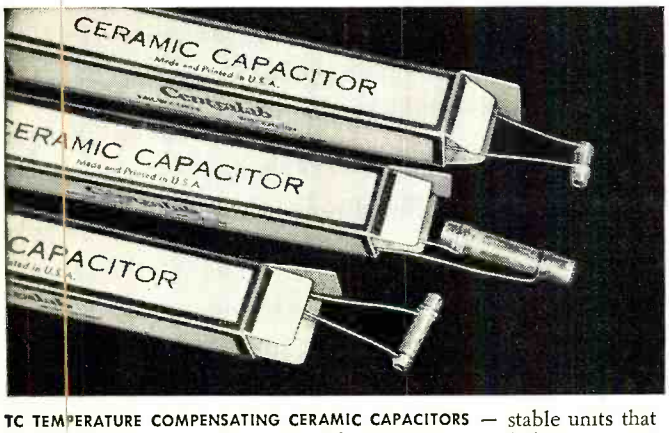
Choose the exact capacitors you need from the world's widest line of ceramic capacitors — for jobs that demand the best in guaranteed TV-AM-FM servicing . . .



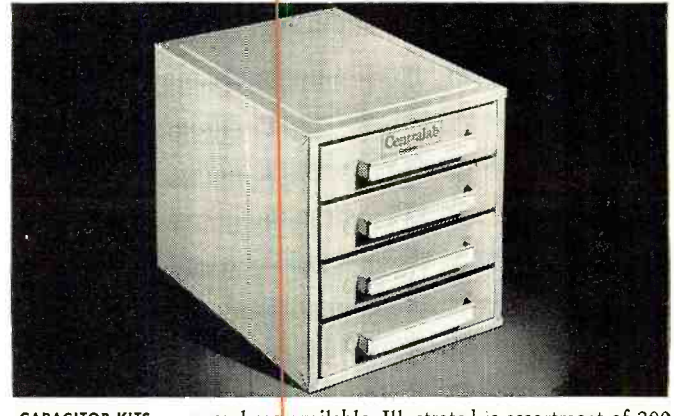
CERAMIC DISC HI-KAP CAPACITORS — provide very high capacity in extremely small size, with minimum thickness. For by-pass, coupling and general applications. Superior power factor and low inductance.



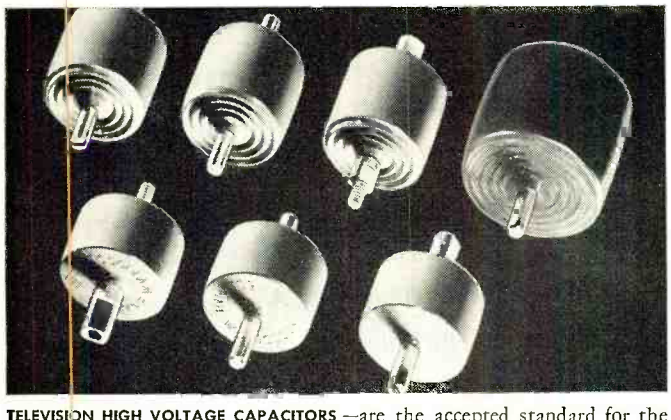
CERAMIC BC TUBULAR HI-KAP CAPACITORS — for by-pass or coupling applications and most general circuit work. Smallest size on the market. Remarkable stability under high temperatures or humidity.



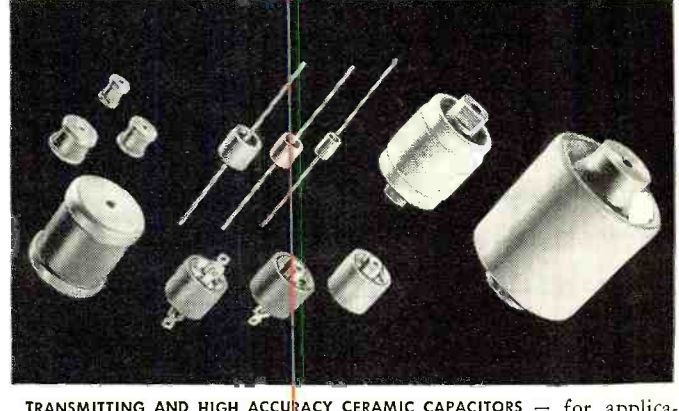
TC TEMPERATURE COMPENSATING CERAMIC CAPACITORS — stable units that do not change in capacity under wide temperature variations—or may be selected to correct for frequency drift in resonant circuits caused by temperature changes. Also superior replacement for close tolerance micas.



CAPACITOR KITS — several are available. Illustrated is assortment of 200 units of most generally used values, supplied in a four-drawer metal cabinet. Often assures required values will be on hand when needed in labs or for service. No charge for cabinet.



TELEVISION HIGH VOLTAGE CAPACITORS —are the accepted standard for the TV industry. Used for filter and by-pass in TV high voltage power supply and pulse filter for cathode ray tubes. Ask for Centralab Hi-Vo-kaps.



TRANSMITTING AND HIGH ACCURACY CERAMIC CAPACITORS — for applications involving rigid frequency control. Used for holding oscillator frequencies to close limits. Excellent as secondary Standards.

Yes, for the safest, quickest guaranteed servicing . . . standardize on Centralab Ceramic capacitors. You'll have the world's widest line to select from — as made by Centralab, *America's pioneer builder of ceramic capacitors.* You can get complete information on all the capacitors described here — plus other valuable service information from Centralab's Catalog 27 . . . available at your distributor's.

Centralab
CRL
Division of Globe-Union Inc.
910 E. Keefe Avenue • Milwaukee 1, Wis.

Within the INDUSTRY

LOUIS MARTIN is the new general sales manager of *Standard Coil Products Co. Inc.* of Chicago, Los Angeles, and Bangor, Michigan.

Mr. Martin brings to this newly-created post a wide knowledge of the radio, television, and electronic field as well as over 25 years of experience in the business.

He started his radio career in 1924 with *Colonial Radio Corporation* and subsequently became affiliated with *RCA* as manager of the Tube Department's equipment field force.

He comes to his new position from *General Instrument Corporation* where he was general sales manager of the Elizabeth and Sickles Divisions.

* * *

HERMON H. SCOTT received the John H. Potts Memorial Award for outstanding contributions to audio engineering in 1951 at the annual convention of the Audio Engineering Society held recently in New York.

The award was made by Dr. Harry F. Olson on behalf of the AES. Mr. Scott is president and director of engineering of *Hermon Hosmer Scott, Inc.* of Cambridge, Mass.

Presentation of the award was made in recognition of the work done by Mr. Scott and his organization in the reproduction and measurement of sound.

* * *

LARRY Le KASHMAN is the new vice-president of *Electro-Voice, Inc.*, Buchanan, Michigan, manufacturer of electronic equipment.

He was formerly associated with the Tube Department of *RCA* where he was the advertising and sales promotion manager for that department.

Mr. LeKashman is an enthusiastic ham, and during the war he served in the Naval Air Transport Command. Prior to that he was associated with a number of distributors in the electronics parts field. He is the author of many technical and popular radio articles and is the editor of several radio handbooks.

* * *

RTMA has launched a triple-pronged educational and information program designed to provide more trained service technicians and to improve service practices in the radio-television industry.

The program involves the recommendation of television servicing courses in the approximately 2500 vocational schools and in as many adult education schools as possible throughout the country.

To further this program, RTMA has engaged *RCA Institutes, Inc.* to write a three-year vocational high school syllabus on radio and television and a 10-12 month syllabus for adult educational institutions. The courses are being edited by Gilbert Weaver, training director of the New York State Board of Education.

A second phase of the project is the distribution of a booklet on the care of television receivers being sponsored jointly by the RTMA Service Committee and the National Better Business Bureau.

The third prong of the offensive involves cooperation by the RTMA with various service associations and other television technician groups which are also endeavoring to raise servicing standards.

* * *

ARTHUR RICHENTHAL, attorney, has been elected to the post of secretary of *Standard Coil Products Co. Inc.* of Chicago.

The appointment was made in recognition of Mr. Richenthal's services and his unusual contributions to the growth of this Midwestern television components firm.

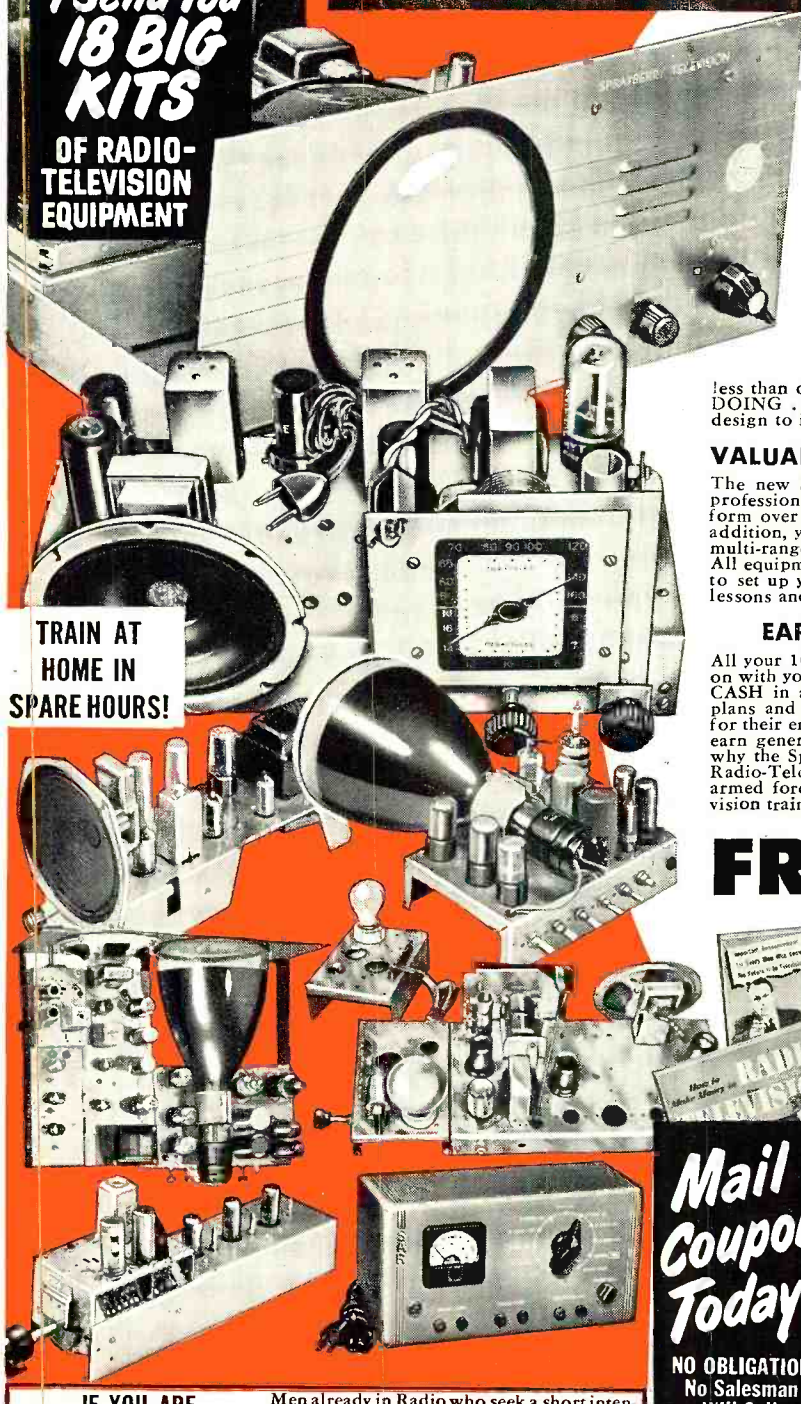
He is a graduate of Harvard Law School and at one time was an attorney for the Securities and Exchange Commission. He has been a director of *Standard Coil* for some time.

* * *

CBS-COLUMBIA, INC., has recently acquired a new plant in Long Island City, New York which will provide a total of 500,000 square feet of manufacturing space for civilian and military production requirements . . . Construction of a $5,500,000 defense production plant at Evendale, Ohio was begun recently by the **CROSLEY DIVISION** of **AVCO MANUFACTURING CORPORATION.** Limited production is expected to start in June . . . **SIMPSON ELECTRIC COMPANY** has recently completed a new addition to its Lac du Flambeau, Wisconsin branch . . . **HENRY & MILLER INDUSTRIES, INC.,** has announced the recent opening of a new metal fabricating and finishing plant in Jersey City, N. J. The company makes radar and television parts in addition to various military items . . . **INTERNATIONAL RECTIFIER CORP.** has purchased a new factory building located at 1521 E.

NOW—Be a Fully Trained, Qualified RADIO TELEVISION TECHNICIAN IN JUST 10 MONTHS OR LESS

I Send You 18 BIG KITS OF RADIO-TELEVISION EQUIPMENT



TRAIN AT HOME IN SPARE HOURS!

New "Package" Unit Training Plan
PAY AS YOU LEARN—YOU SET THE PACE!

No Monthly Payment Contract to Sign!

Now . . . be ready for Radio-Television's big pay opportunities in a few short MONTHS! Frank L. Sprayberry's completely new "Package" training unit plan prepares you in just 10 MONTHS . . . or even less! Equally important, there is 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. In just 10 months you may start your own profitable Radio-Television shop . . . or accept a good paying job in this fascinating expanding field at work you've always wanted to do. Mr. Sprayberry has trained hundreds of successful Radio-Television technicians—and stands ready to train you in less than one year, even if you have no previous experience. You learn by DOING . . . actually working with your hands with equipment of special design to illustrate basic theory instead of relying on books alone.

VALUABLE EQUIPMENT INCLUDED WITH TRAINING

The new Sprayberry "package" plan includes many big kits of genuine, professional Radio-Television equipment. While training you actually perform over 300 demonstrations, experiments and construction projects. In addition, you build a powerful 6-tube standard and short wave radio set, a multi-range test meter, a signal generator, signal tracer, many other projects. All equipment is *yours to keep* . . . you have practically everything you need to set up your own service shop. The interesting Sprayberry book-bound lessons and other training materials . . . all are yours to keep.

EARN EXTRA MONEY WHILE YOU LEARN!

All your 10 months of training is AT YOUR HOME in spare hours. Keep on with your present job and income while learning . . . and earn EXTRA CASH in addition. With each training "package" unit, you receive extra plans and ideas for spare time Radio-Television jobs. Many students pay for their entire training this way. You get priceless practical experience and earn generous service fees from grateful customers. Just one more reason why the Sprayberry new 10 MONTH-OR-LESS training plan is the best Radio-Television training in America today. If you expect to be in the armed forces later, there is no better preparation than good Radio-Television training.

FREE 3 BIG RADIO TELEVISION BOOKS

I want you to have ALL the facts about my new 10-MONTH Radio-Television Training—without cost! Act now! Rush the coupon for my three big Radio-Television books: "How to Make Money in Radio-Television," PLUS my new illustrated Television Bulletin PLUS an actual sample Sprayberry Lesson—all FREE with my compliments. No obligation and no salesman will call on you. Send the coupon in an envelope or paste on back of post card. I will rush all three books at once!

SPRAYBERRY ACADEMY OF RADIO
Dept. 25-F, 111 North Canal St., Chicago 6, Ill.

Mail Coupon Today!
NO OBLIGATION
No Salesman Will Call

SPRAYBERRY ACADEMY OF RADIO, Dept. 25-F
111 North Canal St., Chicago 6, Ill.

Please rush to me all information on your 10-MONTH Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me.

Name.....Age.....

Address.....

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

Please check Below About Your Experience

☐ Are You Experienced? ☐ No Experience

IF YOU ARE EXPERIENCED IN RADIO Men already in Radio who seek a short intensive 100% TELEVISION Training with FULL EQUIPMENT INCLUDED are invited to check and mail the coupon at the right.

Grand Ave., El Segundo, California. Its present facilities in Los Angeles will be used for research and development work . . . An application engineering office, designed to service Midwestern accounts, has been opened by **SPRAGUE ELECTRIC CO.** at 3 E. Second Street, Dayton, Ohio . . . **RAYTHEON MANUFACTURING COMPANY** has leased a new one-story brick plant on Seyon Street in Waltham, Massachusetts to house sections of its research, engineering, and manufacturing divisions . . . **HOFFMAN RADIO CORP.** has acquired a one-story fireproof building immediately adjacent to its No. 5 plant at 6200 S. Avalon Blvd. in Los Angeles . . . **SWEDLOW PLASTICS COMPANY** has begun construction on its third manufacturing facility in Los Angeles. The new plant, which will provide 36,000 square feet of floor space, will be used as general offices and for manufacturing.

* * *

E. W. MERRIAM has been named service manager of the Radio and Television Division of *Sylvania Electric Products Inc.*

He was recently affiliated with the Radio - Television Manufacturers Association as service manager, and for two years prior to that was chairman of the RTMA Service Committee. He was formerly associated with the *Allen B. Du Mont Laboratories* as service manager.

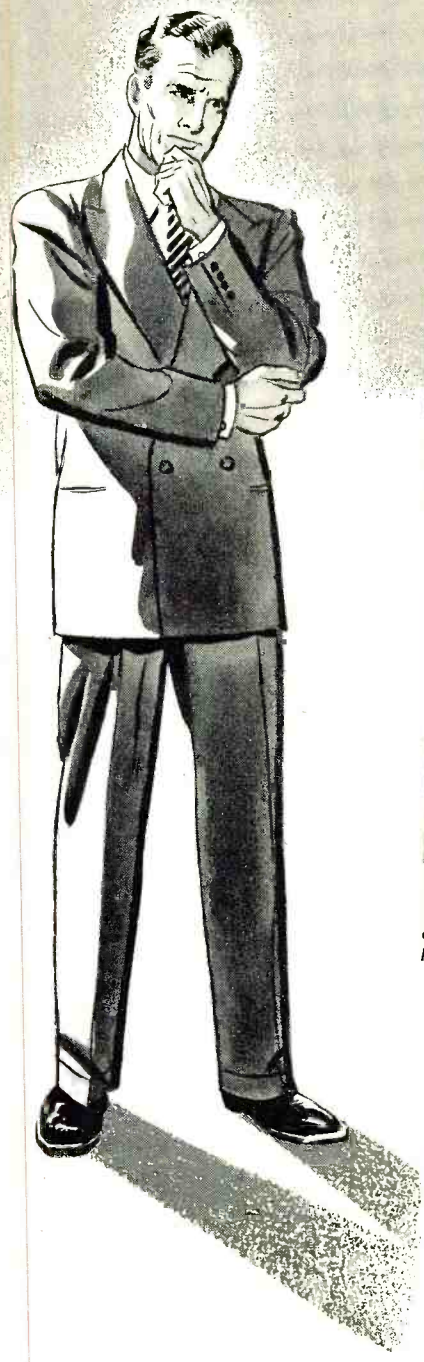
In his new capacity as service manager, he will be responsible for all service activities including the supervision of a nationwide organization of parts distributors and service contractors handling *Sylvania* products.

* * *

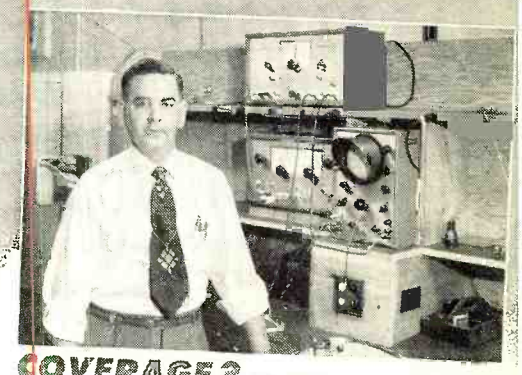
ROGER E. GAY, president of *The Bristol Brass Corporation,* has been elected president of the American Standards Association . . . *Hytron Radio & Electronics Co.* has recently promoted **GEORGE DETERS** to the post of sales manager in the Midwest section . . . **HERMAN S. SACKS** has been named to the newly-created post of assistant general sales manager of *Bendix Television and Radio* . . . The appointment of **PAUL HINES** as director of engineering for *The Workshop Associates* has been announced by the parent firm, *The Gabriel Company.* He will be in charge of the company's newly-announced laboratory now being built in Natick, Massachusetts . . . **GUS W. WALLIN** is the new vice-president in charge of engineering at *Webster-Chicago Corporation* . . . **FRANK H. EDELMAN,** formerly chief chemist for *International Resistance Co.,* has been named technical director of the Resistor Division of *Electronic Devices, Inc.* . . . **REAR ADMIRAL T. A. SOLBERG, USN** (Ret.) has been named general consultant to *Arma Corporation,* manufacturers of precision electronic and mechanical equipment for the Armed

(*Continued on page* 94)

WHAT DO YOU LOOK FOR IN TV TEST EQUIPMENT?



ECONOMY? "I look for long-range value. My 21 years in the electronics business have taught me that G-E instruments outperform them all." *Harold Robbins, Paramount Radio & TV Service, Des Moines.*

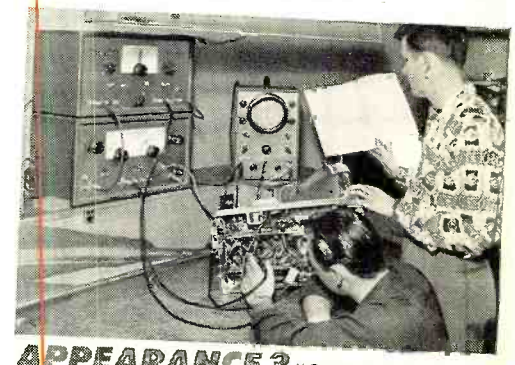


COVERAGE? "I don't have to buy new equipment to service UHF. These G-E units cover everything and cut my costs in half." *Ralph L. Crooks, Boulevard Radio & Television Co., Kansas City, Mo.*

RELIABILITY? "No guesswork, no rechecking with my General Electric Test Package. It does the job right the first time." *Warren Herbicek, Herbicek & Mathews, Newton Square, Pa.*

ACCURACY? "The combination of crystal controlled markers and variable permeability sweep gives us true alignments with fewer call-backs." *Tom Jacobs, Apex Radio Shop, Detroit, Mich.*

SIMPLICITY? "Easy to operate, these G-E units increase our work output per man, cut training problems and boost profits." *Charles Floring, Syracuse Electronics Corp., Syracuse, N.Y.*



APPEARANCE? "Customers have confidence in our clean, business-like shop. General Electric test equipment helps keep it that way." *J. H. Sampson, Sampson Television, Inc., Dayton, Ohio.*

YOU GET THEM ALL WITH GENERAL ELECTRIC

You can't afford to invest in TV test equipment that doesn't pay its way, with 15 million TV sets in use, and new UHF stations coming up. The successful businessmen shown above know the importance of this; read what they say.

REMEMBER: General Electric makes TV Test Equipment that covers *both* VHF and UHF. Hence, you have only *one* investment when you buy G-E.

GENERAL ELECTRIC

General Electric Company, Section 922
Electronics Park, Syracuse, N.Y.

Please send me the latest bulletins on General Electric Test Equipment.

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ADDRESS_____

CITY_____ STATE_____

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new communications "TOOL" for industry!

the *littlefone*®

2-WAY FM RADIO-TELEPHONE

10 lb. lower powered models also available

A new Hallicrafters product—the "*littlefone*"—is now ready for thousands of important uses in hundreds of industries.

This light, rugged, dependable radio-phone will be offered through Hallicrafters distribution organization—by the men who know communications best.

HAND CARRY

HT-21 (25-50 Mc.)
HT-22 (150-174 Mc.)

- FULL TWO-WATT ANTENNA OUTPUT*
- Weighs only 14 pounds!
- Complete, self-contained 2-way radio-telephone station!
- Powered by Dry, or Wet Rechargeable Batteries (can be recharged from car battery or 117 Volts AC)
- Rugged, weatherproof
- 22 sub-miniature tubes!

*On 25-50 Mc. • One-Watt output on 150-174 Mc.

CENTRAL STATION

HT-23 (25-50 Mc.) HT-24 (150-174 Mc.)

Same performance and specifications as the "Littlefone" Hand Carry.

- AC-operated Central Station
- Audio-amplifier, providing one watt of audio for loudspeaker
- Power consumption is 35 watts
- Plugs in any AC outlet (117 Volts)

Where one or more extra stationary receiving stations are desired, Hallicrafters economical S-81 receivers may be added.

USES OF "LITTLEFONE" CHALLENGE YOUR IMAGINATION!

There are literally thousands of industrial uses for the "*littlefone*" radio—anywhere where powerful, dependable, "on the move" contact is required.

AMONG THE MORE IMPORTANT PRESENT USES ARE:

- RAILROADING
- FREIGHT HANDLING
- WAREHOUSE OPERATIONS
- RANCHING & LARGE FARMS
- MINING (Above & Below Ground)
- PIPE LINE INSPECTION
- ROAD BUILDING
- SHIPPING (Dock Operations)
- CONSTRUCTION
- LUMBERING

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"The Radio Man's Radio"

World's Leading Manufacturer of *Precision* Radio and Television — Chicago 24

AVOID
RESISTOR BREAKDOWNS

OHMITE
LITTLE DEVIL RESISTORS

Provide EXTRA MARGIN of SAFETY

Where dependability is of the utmost importance, play safe with Ohmite Little Devil molded composition resistors. While they are tiny in size, these units have exceptional ruggedness, stability, and current carrying capacity. Little Devils are completely sealed and insulated by molded plastic. Under continuous full load for 1000 hours, their resistance change is less than 5%.

Ohmite Little Devils are available in ½, 1, and 2-watt sizes, in ± 5% or ± 10% tolerance. Standard RTMA values, 10 ohms to 22 megohms are furnished. In the 1-watt size, ± 10% tolerance, values as low as 2.7 ohms are provided.

AVAILABLE ONLY FROM YOUR DISTRIBUTOR

OHMITE MANUFACTURING CO.
4883 Flournoy Street, Chicago 44, Ill.

- **RATED AT 70C**— Little Devils have a wide margin of safety—being rated at 70C instead of 40C.
- **WITHSTAND TEMPERATURE, HUMIDITY**— Meet all JAN-R-11 requirements, including salt water immersion and humidity tests.
- **RESISTANCE AND WATTAGE CLEARLY MARKED**— In addition to color coding, the resistance value and wattage are marked on every unit.
- **TEMPERED LEADS**— Tinned copper leads are differentially tempered to prevent sharp bends.

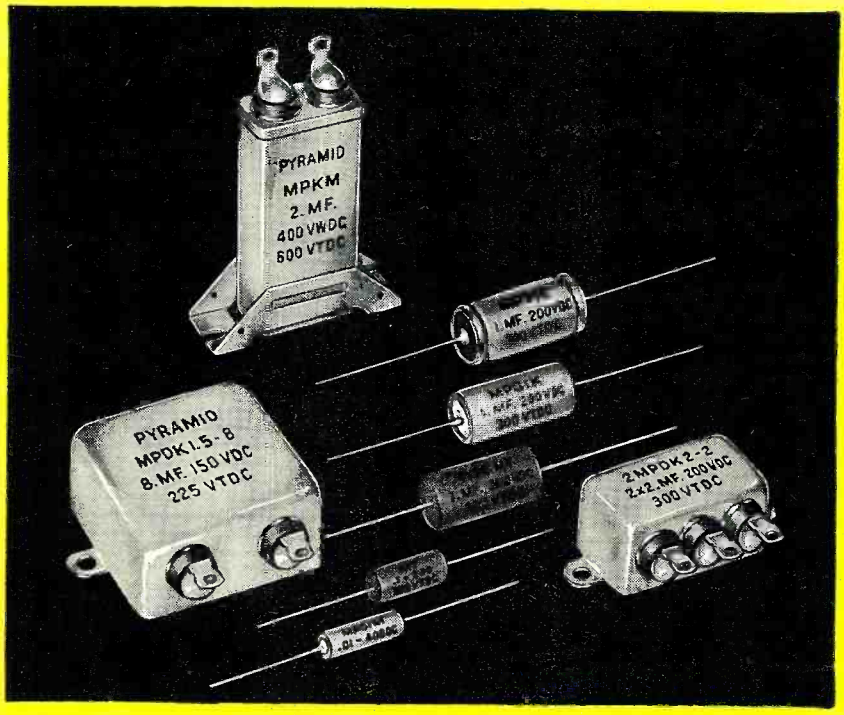
Be Right with **OHMITE**®

RHEOSTATS
RESISTORS
TAP SWITCHES

Now in **MASS PRODUCTION...**

PYRAMID ULTRA-COMPACT

metallized paper capacitors



PYRAMID Series M CAPACITORS use a specially-prepared metallized paper, providing all-important savings in size and weight.... Pyramid now produces large quantities of these capacitors in a wide variety of cardboard or hermetically sealed metal containers.

Your letterhead inquiries are invited

PYRAMID ELECTRIC COMPANY • 1445 HUDSON BLVD., North Bergen, N. J.

A PROFESSIONAL TYPE GEIGER COUNTER

By
LOREN C. WATKINS, Jr.
W5JXO

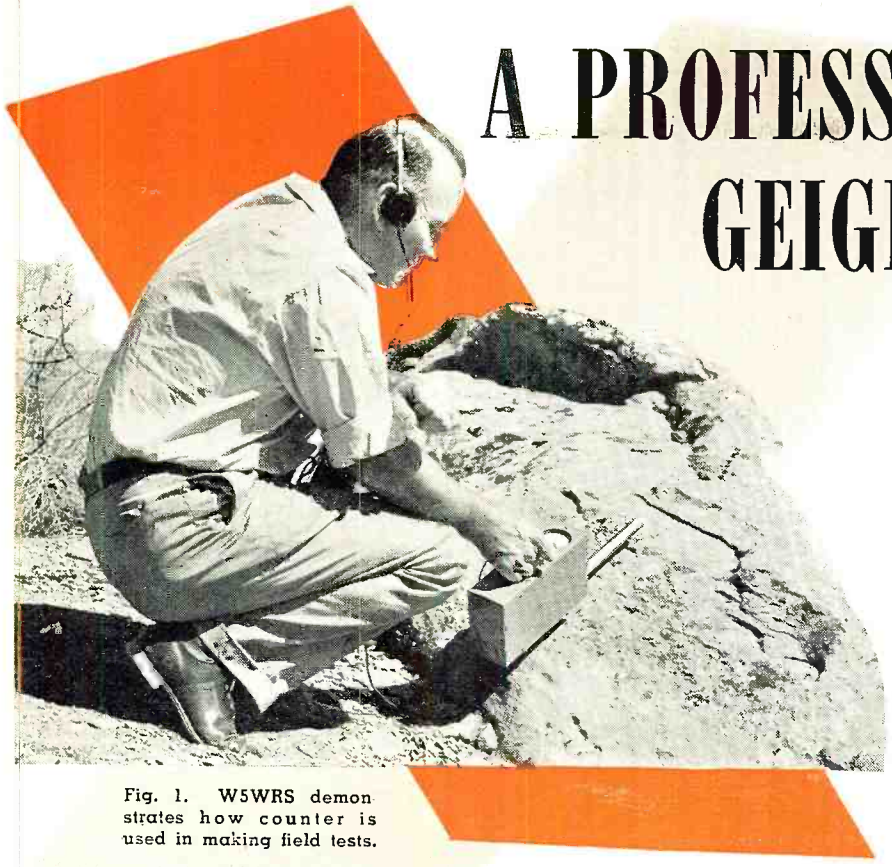


Fig. 1. W5WRS demonstrates how counter is used in making field tests.

Construction details on a thoroughly tested and practical low-cost counter which is easy to build.

INTEREST continues at a high level in the matter of prospecting for uranium deposits. The $10,000 bonus, and other attractions, offered by the Atomic Energy Commission has been enough to awaken the gambling instinct in large numbers of us. The amateur or professional electronics engineer, or technician, is in an excellent position to construct the necessary Geiger-Mueller detector unit.

Field experience has established several points for consideration. The counter should be as small and lightweight as possible. The layout of operating controls and physical construction of the unit should be such that the maximum of convenience is enjoyed in its use, and the chance of physical damage slight.

A direct and fairly accurate indication of the G-M tube high voltage is most useful, so that the voltage may be checked with the data furnished by the tube manufacturer, and the operating point of the tube kept on the Geiger plateau. In this same respect, and to compensate for battery aging, a variable control should be included for adjusting the high-voltage output of the power supply.

Headphones, of course, should be provided as they will normally be used when searching with the instrument. Their response to an increased count is immediate and the indication unmistakable. A meter should be included for indicating the integrated counting rate, and switched to act as a high-voltage indicator.

Several types of portable high-voltage power supplies have been devised and exploited commercially for G-M counter use. Each circuit has its particular advantages and disadvantages; however, it appears that two of the more successful arrangements to date are the vibrator type and the neon-oscillator type. Either circuit is good and will perform in an excellent manner.

ORE SAMPLES

Radioactive ore samples, suitable for testing purposes, may be obtained from Earle E. Fletcher, 2908 N. Sandia Dr., Albuquerque, N. M., for 25 cents postpaid.

The present article will be confined to a description of the construction of a neon-controlled type counter and the reader is referred to the bibliography for sources of additional information relating to the use of G-M counters in prospecting and circuits in general.

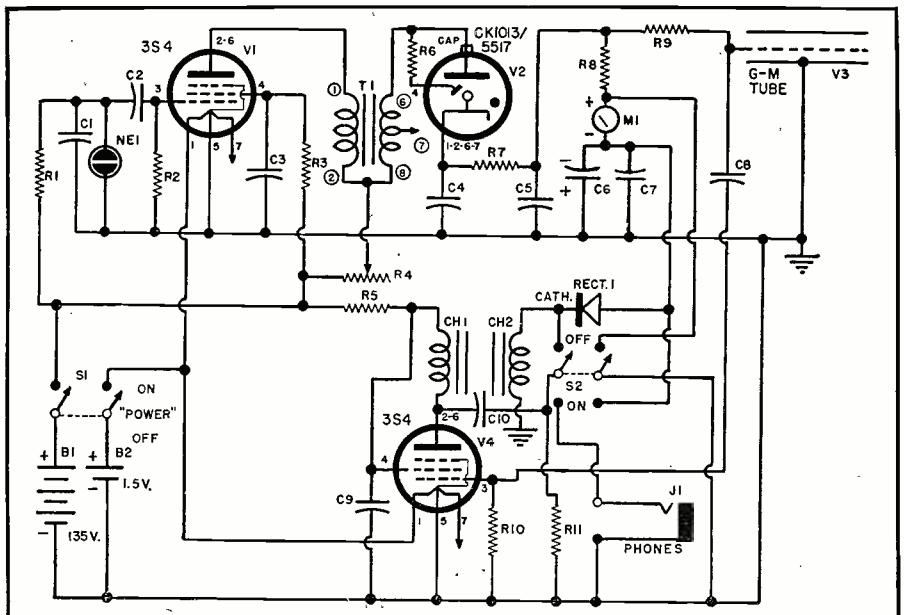
The particular counter described here, and shown in the photographs, is the handiwork of Earle Fletcher, W5WRS, who doubles as an electronics engineer and amateur prospector. The unit contains no special, hard-to-get components and is easily duplicated by the average technician. The batteries are of the type commonly used in personal-type radios and are readily available at low cost in nearly any locality. They consist of two series-connected 67½ volt "B" batteries and three parallel-connected standard flashlight cells.

Reference to the circuit diagram of Fig. 2 will show that voltage is applied to only one-half of the filament in V_1 and V_4. The battery drain is thereby cut in half and no decrease in performance is detectable in this circuit application.

V_1 and associated components form the oscillator stage. "B" battery voltage is supplied to the type NE-2 neon lamp through R_1, and C_1 is the neon lamp shunt condenser. The saw-tooth grid signal for V_1 is generated by the voltage rise across C_1 and the sudden drop when this voltage reaches the ionization potential of the gas in the NE-2 lamp. The complete cycle is repetitive at a rapid frequency rate, on the order of 800 cps in this instance.

The saw-tooth voltage applied to the grid of V_1 causes a rapid change in its plate current, which induces large voltages across the winding of the high inductance choke, T_1. In this particular case, the choke is actually an audio interstage transformer with the primary and secondary connected in series aiding. This induced fluctuating voltage is then rectified by the cold-cathode gas rectifier tube, V_2, and smoothed by the resistance-capacity network, C_4, R_7, and C_5, which reduces the ripple to an insignificant value.

The variable resistor, R_4, controls the high voltage output of the power supply over a range of about 500 to 1250 volts, with new batteries in use. This resistance in the plate circuit of V_2 acts to vary the efficiency of the circuit. As the batteries age, the control is adjusted to insert less resistance in the circuit, thereby increasing the efficiency, and permitting operation at 900 volts output until the batteries are expended. This point will have been reached when the battery voltage drops from its original 135 volt value to about 95 volts. The output voltage changes slightly with aging of the filament batteries, until they have dropped from the original 1.5 volts to about 0.8



R_1—6.8 megohm, ½ w. res.
R_2—22 megohm, ½ w. res.
R_3—47,000 ohm, ½ w. res.
R_4—50,000 ohm pot
R_5—100,000 ohm, ½ w. res.
R_6, R_9, R_{10}—10 megohm, ½ w. res.
R_7—470,000 ohm, ½ w. res.
R_8—30 megohm, ½ w. res. (two 15 megohm res. in series)
R_{11}—1 megohm, ½ w. res.
C_1—400 μμfd. mica cond.
C_2—.001 μfd. mica cond.
C_3—.002 μfd. mica cond.
C_4—.002 μfd., 2000 v. cond. (Condenser Products Co. "Glassmike" Type LSG202)
C_5—.05 μfd., 2000 v. cond. (Condenser Products Co. "Glassmike" Type ASG17)
C_6, C_7—500 μfd., 12 v. elec. cond.
C_8—500 μμfd., 2000 v. cond. (Condenser Products Co. "Glassmike" Type LSG501)
C_9—.01 μfd., 400 v. cond.
C_{10}—.005 μfd. mica cond.
S_1—D.p.s.t. toggle sw.
S_2—D.p.d.t. toggle sw.
T_1—Interstage trans. (UTC "Ouncer" Type O-7)
CH_1, CH_2—Reactor (UTC "Ouncer" Type O-13)
M_1—0-100 microammeter
J_1—Midget open circuit phone jack
$Rect._1$—1N34 crystal diode
NE_1—NE-2 neon lamp
B_1—Two 67½ v. "B" batteries (Eveready No. 467 or equiv.)
B_2—Three 1½ v. standard flashlight cells, 1 5/16" dia.
V_1, V_4—3S4 tube
V_2—CK1013/5517 tube
V_3—Victoreen Type 1B85 or equiv.

Fig. 2. Complete circuit diagram and parts list for the professional type counter.

volt. The output voltage regulation, as a function of the external load, is quite adequate for a G-M tube having a normal flat-plateau characteristic. If the tube does not have a flat characteristic, and at unusually high counting rates, the voltage is readjusted to the proper operating potential by varying the output control, R_4, slightly.

The amplifier stage, V_4, has a switch in its output circuit so that either headphones or the meter, M_1, may be used to monitor the count. The signal pulses from the G-M tube are coupled into the signal grid of V_4 via C_8. The amplified pulses appear across the plate circuit inductance, CH_1, where they are capacitively coupled to the indicating circuit. The "phones" switch, S_2, is connected so that in its "on" position the headphone jack, J_1, is connected across the output of V_4, allowing individual pulses to be counted. Stray circuit capacity from the neon oscillator and associated circuits provides a weak audio tone in the V_4 amplifier output, serving nicely as an indication that the instrument is operating, and that the batteries are not expended.

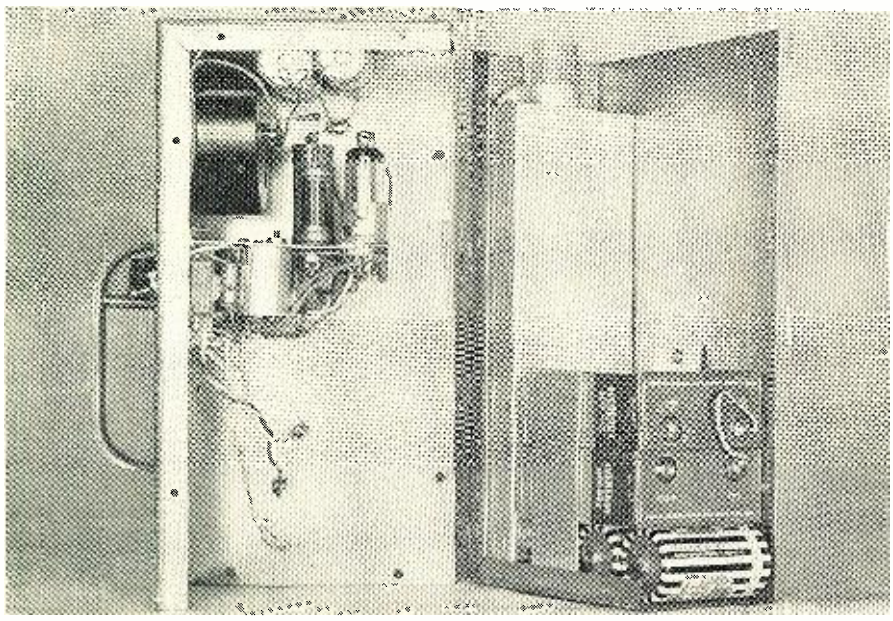
In the same switch position, the negative terminal of M_1 is returned directly to ground. The meter, therefore, is effectively connected in series with the bottom end of the high voltage bleeder resistor, R_8, to ground, and provides an accurate indication of the power supply output voltage. This assumes that the bleeder resistance value is accurately known. For example, if the bleeder resistance is 30 megohms, an indicated current of 30 microamperes requires the presence of 900 volts at the top of the bleeder, according to Ohm's Law. Other current values are interpreted accordingly, as the voltage output control is varied.

When S_2 is thrown to its "off" position, the headphones are disconnected and the amplifier output is connected into the 1N34 rectifier circuit. The rectified pulses are fed to the integrating condensers, C_6 and C_7, which allows the meter to indicate the average counting rate. The other side of S_2 has now connected the positive terminal of the meter and the bottom of the bleeder resistance, directly to ground, thereby removing the meter from the bleeder circuit.

It is unnecessary to provide a scale on the meter other than its original calibration, as the instrument is used mainly in a relative sense, with the background count as the reference.

The high voltage adjustment control should not be advanced to a position where the voltage applied to the G-M tube is great enough to cause it to "spill" or discharge continuously. A reduced G-M tube life will be the result.

Fig. 3. Completed assembly view showing sub-chassis and battery mounting details.



Construction

Figs. 1, 6, and 7 show the over-all appearance of the counter. When the unit is not in use the search probe is pushed down into the case. The probe is pulled about three-quarters of its length from the case for normal use, and is removed completely for exploring otherwise inaccessible areas. The probe is a 10-inch length of thin wall brass tubing, ⅞-inch outside diameter. Seven ½-inch diameter holes are drilled in a straight line through one side of the brass tube. The delicate G-M tube is floated inside the brass shell by wrapping several layers of *Elastoplast,* an elastic adhesive bandage material, around the tube at each end so that it is a snug sliding fit for the inside of the shell. Rubber corks are then forced tightly into each end of the tube and trimmed off flush. The cork that goes into the cable end of the probe should be of the type that has a center hole in it, so that the cable is

grasped firmly when the cork is pushed into place, thereby relieving any strain on the G-M tube connections when the probe is moved about. The cable is made about four feet in length and should be of the small lightweight type, single conductor and shield braid, with an outer insulating cover. It is pushed down into the case when the probe is not completely removed.

As partially seen in Fig. 3, the probe housing in the case is a 5-inch length of lucite tubing, with an inside diameter very slightly greater than the outside diameter of the brass probe, for a free sliding fit. The lucite tube is held to the rear of the case by two U-shaped brackets. The bracket mounting bolts are tightened sufficiently to deform the lucite tubing just very slightly so that enough friction is maintained against the probe to prevent its accidentally slipping out of the case. A hole is cut in the end of the metal case to permit insertion of the probe.

The case itself may be easily fabricated from a standard 10x12x3 inch aluminum chassis. Refer to Fig. 5 and cut the chassis as indicated. The result will be two pieces, 10 inches long and 5 inches wide, as seen in Fig. 3. In the same photograph, if the two halves of the cabinet are thought of as the pages of an open book, and then merely folded together, the case will appear in its final form. Two holes, for self-tapping metal screws, are drilled in each lip of the two halves. An aluminum tray, 8x2¾x1 inches, is bent up from sheet stock to provide a battery platform over the probe housing. The batteries are held in place by a single strap, as shown in Fig. 3. The "B" batteries are already provided with snap connectors, and connecting wires are merely soldered to the three paralleled flashlight batteries. Spring clips are out of the question in the available space, and are very liable to develop high resistance contacts.

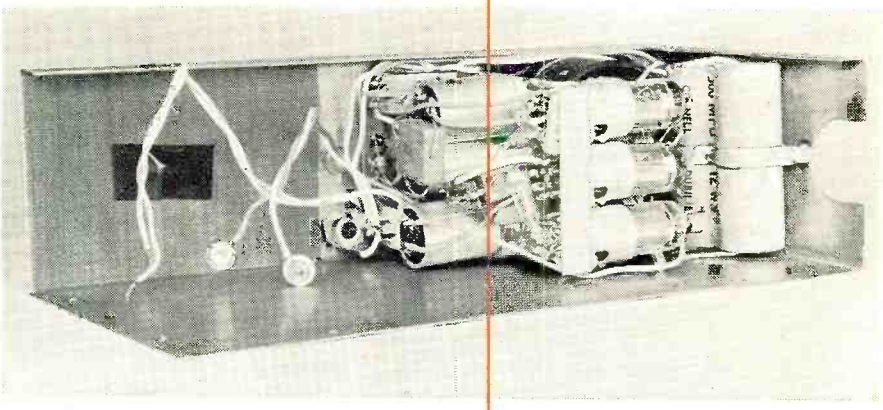


Fig. 4. Rear view of instrument. Construction is compact but easy to service.

Thin strips of insulating board are slid in behind each end of the flashlight cells for protection against accidental short-circuiting. A third strip, approximately 4¼x2¾ inches, is cut for a snug fit in the opposite half of the case, as seen in Fig. 4, to prevent short-circuiting the exposed "B" battery terminals when the case is finally assembled. The mounting screw for the lower end of the handle passes through the strip, and the exposed nut is covered by a piece of electrical insulating tape.

A hole is punched in the probe end of the case to accommodate the outer diameter of the lucite probe-sleeve, which projects through the case about ⅛-inch. A 2⅜-inch hole is cut in the top face of the case for the meter. The round 3-inch meter had to have its mounting flange sawed off on two sides so that it would fit into the case. A piece of lucite 2¾x3½ inches, and 3/16-inch thick, is placed between the glass meter face and the case, to provide protection against accidental breakage of the meter glass. A hole is drilled in the lucite to allow access to the meter zero-adjustment screw. The machine screw which passes through the upper

(*Continued on page* 160)

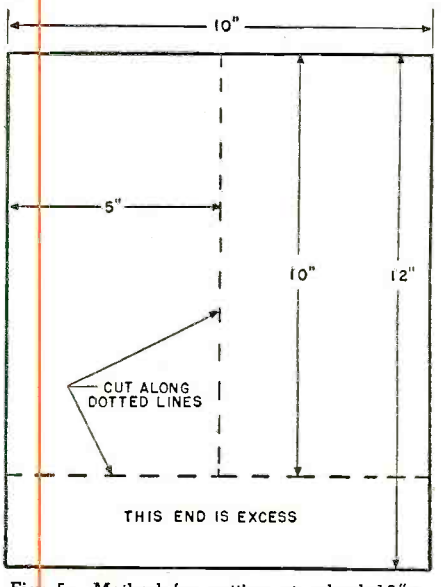
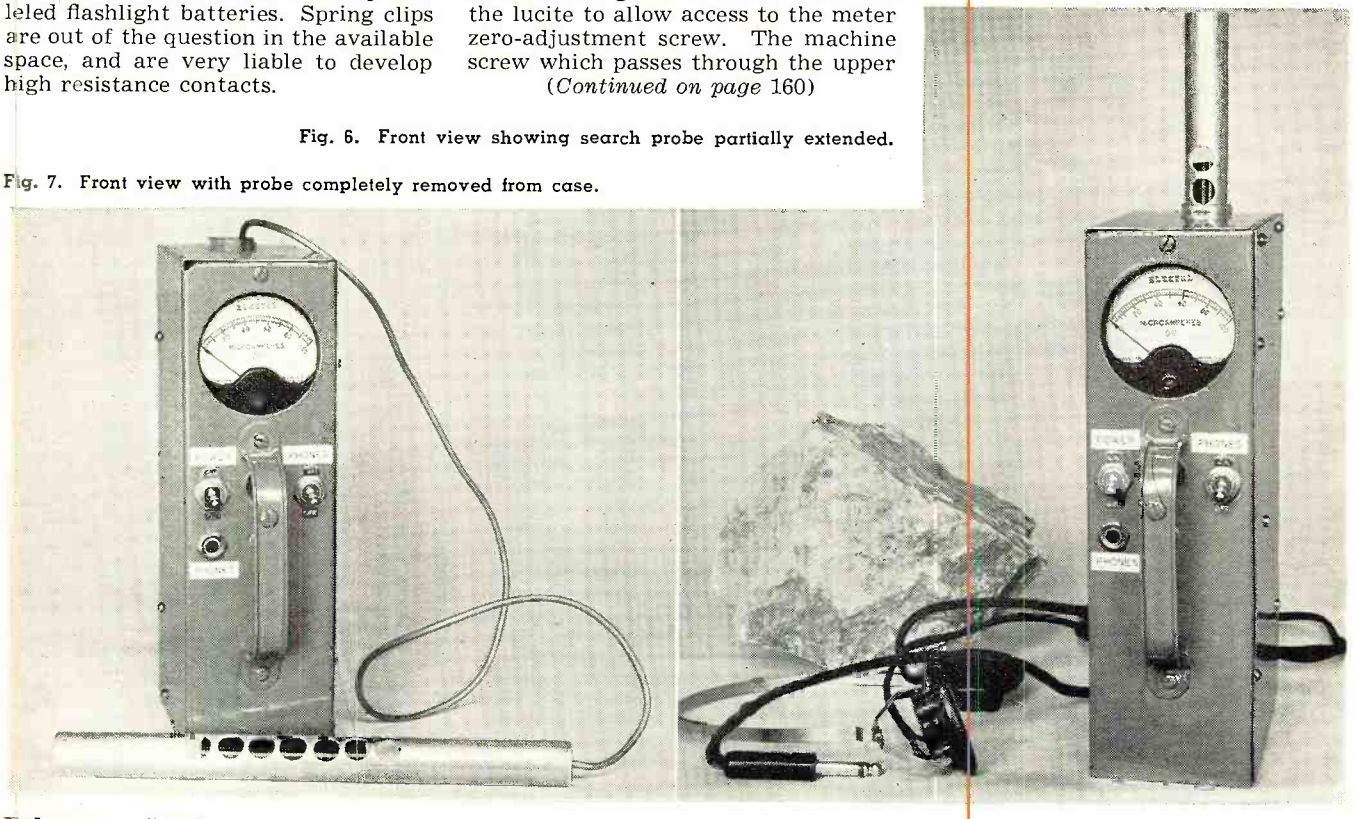


Fig. 5. Method for cutting standard 10"x 12"x2" chassis to provide case for counter.

Fig. 6. Front view showing search probe partially extended.

Fig. 7. Front view with probe completely removed from case.



A High-Quality AUDIO AMPLIFIER

Commercial version of the Williamson amplifier, the Radio Craftsmen Model 500.

By
EDW. S. MILLER
Chief Engr., The Radio Craftsmen, Inc.

Complete data on a commercially built Williamson amplifier which uses special low-distortion tubes.

ALTHOUGH the now-famous Williamson all-triode amplifier circuit, originally described in 1947, has been reproduced in the literature many times with various modifications, only recently has a complete amplifier based on this circuit been manufactured commercially. This chassis, known as the Craftsmen 500, was designed by *The Radio Craftsmen, Inc.*, Chicago. In the design, particular emphasis was placed on a unit that not only provided good operation over the range from 20 to 20,000 cps but also could be manufactured with consistent performance characteristics. Some of the many factors considered in this design are described.

Circuit Modifications

The Williamson all-triode circuit, which includes a direct-coupled, split-load phase inverter feeding triode drivers and class A operated triode output tubes, is notable for its basic simplicity. Even without feedback, this amplifier provides the characteristics of an extremely high-fidelity amplifier.

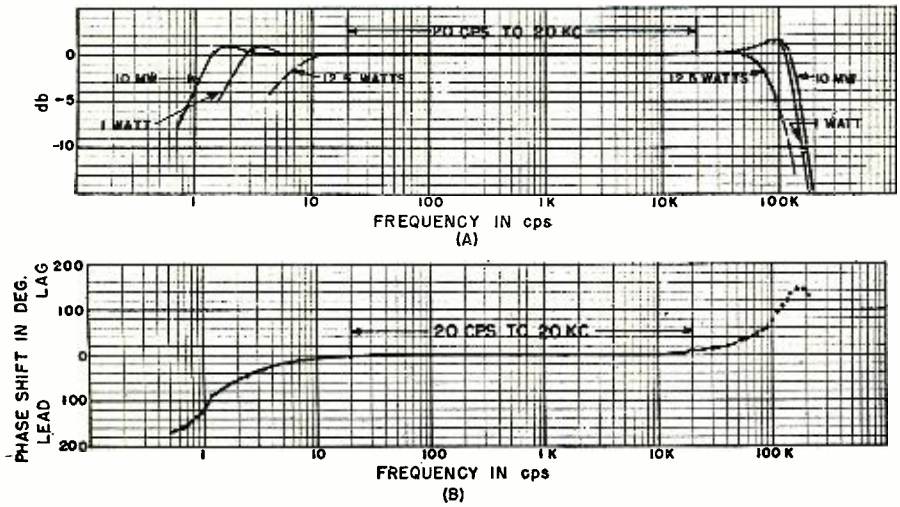
It was found desirable to make modifications in the original circuit in order to obtain optimum performance and increase manufacturing margins to insure meeting specified characteristics on all units.

In one modification of the circuit, the center tap of the heater string is returned to the positive voltage appearing at the output tube cathodes. In this way the application of positive bias to the heater of the first 6SN7GTA reduces the flow of heater-cathode or heater-grid "hum" currents so that a hum and noise level of 90 db or more below rated output is maintained for the amplifier.

By referring to the schematic diagram (Fig. 2) it will be noted that the output tube cathode resistance has been split into two matched 400 ohm resistors connected at the cathodes with a removable link. Use of this linked resistor pair not only greatly simplifies the adjustment of the bias and balance of the power output tubes but also increases the accuracy of the operation with commonly available metering equipment. In making the adjustment, the link is temporarily opened while a voltmeter is connected between the two output-tube cathodes. R_{16} is now adjusted for a zero reading on the meter. Now with the meter across either 400 ohm resistor, R_{20} is adjusted for a 25 volt reading. The link is now replaced for normal operation. *Each* KT66 is now operating with the correct bias for exactly 62½ ma. plate current, which with 400 volts d.c. from plate to cathode, represents a plate dissipation of 25 watts.

Further modifications were also made to improve performance near the extremes of the operating range. They are described below.

Fig. 1. (A) Gain-frequency and (B) phase-frequency characteristics of amplifier.



KT66 Output Tube

The unusually low-distortion and excellent damping action obtained with this amplifier can be attributed to the use of class A operated triodes throughout the circuit along with the application of 20 db inverse feedback around the entire amplifier. For the output stage, beam tetrode type power output tubes are used connected as push-pull triodes and matched to 10,000 ohms plate-to-plate for a very low distortion class A operation. An additional advantage is obtained with the use of this type tube in that only a relatively low grid voltage is required to drive the tubes to full output; this amount of driving voltage is easily obtainable from a resistance-coupled 6SN7GTA.

Various tube types have been used for this stage and the resulting operating performance of some typical tubes are given in tabular form for the convenience of the reader. The higher power output and adequate ratings, as shown in the chart, confirmed the choice of the KT66 for the output stage as used in the original design.

In any feedback amplifier, one of the

most important measurements of the amplifier's performance is its margin of stability. In order to eliminate variations in amplifier performance throughout its operating frequency range, this margin must be as great as possible for the amount of inverse feedback being used. Of course, the most important component determining this margin of stability is the output transformer. Out of numerous transformer designs tested, the design finally selected had interleaved windings, 120 hy. primary inductance, 25 mhy. leakage inductance, and full power output from 10 to 50,000 cps. The other circuit components determining the degree of stability margin are investigated by considering first the low frequency range operation, and then operation through the higher frequencies.

Low Frequency Operation

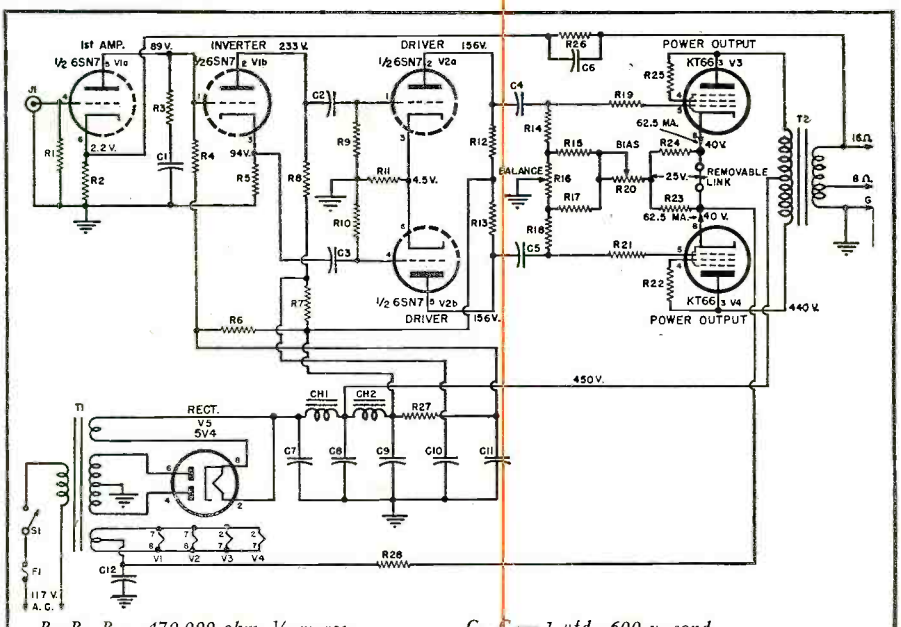
Because of the unusually flat gain characteristic and low phase shift required throughout the frequency range of 20 to 20,000 cps. the amplifier operation necessarily should be checked over the entire range of ½ cps to 2 mc. to insure conservative stability margins.

Components determining the low frequency performance are, besides the transformer primary inductance, the four interstage coupling condensers and their associated grid input resistances, and the power supply filtering or decoupling components. The power supply component values do not appreciably affect the amplifier operation in any frequency range except for a 20° phase correction furnished by R_{27}, C_{11} and R_7, C_{10} at 2 cps.

The greatest stability margin in any feedback amplifier design is obtained by staggering the time-constants of the interstage coupling networks. Thus, improved low frequency stability was accomplished by altering the values of these interstage coupling components from those found in the original design: R_9, C_2 and R_{10}, C_3 in the schematic each has the same time constant of 0.2 sec., R_{14}, $C_4 = R_{18}$, $C_5 = .01$ sec., and L_p (120 hy.)/R_p (2500 ohms in parallel with 10,000 ohms = 2000 ohms) = .06 sec. The first amplifier stage, being d.c. coupled, is not a factor to be considered because of its infinite time constant.

Low frequency performance is further complicated by the fact that the primary inductance, L_p, is not constant but varies with both signal level and d.c. saturation, according to the characteristics of the transformer core. In order to minimize this effect, the transformer was designed with a large core utilizing high-permeability laminations, stacked to provide a higher than normal air gap. The result of these precautions was a considerable increase in the margin of stability throughout the low-frequency range as compared to previous designs based on the Williamson circuit.

On the high end of the operating frequency range, the transformer characteristics again are the most important



R_1, R_9, R_{10}—470,000 ohm, ½ w. res.
R_2—470 ohm, 1 w. wirewound res.
R_3—2700 ohm, ½ w. res.
R_4—47,000 ohm, 1 w. res.
R_5, R_7, R_8, R_{28}—22,000 ohm, 1 w. res.
R_6, R_{27}—33,000 ohm, 1 w. res.
R_{11}—390 ohm, ½ w. res.
R_{12}, R_{13}—47,000 ohm, 2 w. res.
R_{14}, R_{18}—100,000 ohm, ½ w. res.
R_{15}, R_{17}—100 ohm, 1 w. res.
R_{16}, R_{20}—100 ohm, 2 w. wirewound pot
R_{19}, R_{21}—1000 ohm, ½ w. res.
R_{22}, R_{25}—100 ohm, ½ w. res.
R_{23}, R_{24}—400 ohm, 5 w. wirewound res. ± 2%
R_{26}—4700 ohm, ½ w. res.
C_1—560 μμfd. mica cond.
C_2, C_3—.5 μfd., 600 v. cond.
C_4, C_5—.1 μfd., 600 v. cond.
C_6—68 μμfd. mica cond.
C_7—4 μfd., 600 v. oil-filled cond.
C_8, C_9, C_{10}, C_{11}—40/40/8/8 μfd., 600 v. elec. cond.
C_{12}—.25 μfd., 200 v. cond.
J_1—Input jack
S_1—S.p.s.t. toggle sw.
F_1—117 v., 3 amp. line fuse
T_1—Power trans. 425-0-425 v. @ 150 ma.; 5 v. @ 2 amps.; 6.3 v. @ 3 amps.
T_2—Output trans. 10,000 ohms plate-to-plate to voice coil, 15 w. minimum
CH_1—4 hy., 150 ma. filter choke
CH_2—30 hy., 150 ma. filter choke
V_1, V_2—6SN7 tube
V_3, V_4—KT66 tube
V_5—5V4 tube

Fig. 2. Schematic diagram of amplifier. The KT66's specified on diagram are British tubes and may be difficult to obtain locally. Suitable substitutes are given below.

factors in determining the stability margins. Considerable care was used in selecting the transformer from numerous high-fidelity designs, considering both stability and frequency range.

Analysis of the circuit operation for this range is not as simple as at low frequencies. Although the 25 mhy. leakage inductance of the output transformer determines the frequency above which the amplifier gain begins to fall, the many, seldom-measured interwinding capacities and leakage inductances

(*Continued on page 95*)

Comparative ratings and operation of popular tubes used in the Williamson circuit.

	KT66	5881	6L6	1614	6AR6	807
Description	British tube with ratings higher than 6L6 and different characteristics	Tung-Sol improved 6L6 with higher ratings		Single-ended 807 but lower ratings	Radar power tube	Transmitting tube requiring plate cap
Socket Arrangement	Single-ended like 6L6	Single-ended like 6L6	Single-ended	Single-ended like 6L6	Single-ended but different	Plate cap
Manufacturers' Ratings:						
Plate Voltage (max.)	400 v.	400 v.	270 v. (screen rating)	375 v.	300 v. (screen rating)	400 v.
Plate Dissipation (max.)	25 w.	26 w.	19 w. (Triode Ratings	19 w.	21 w. controversial)	25 w.
G. O. L. Output†	10 w.	8 w.	8 w.*	8 w.*	10 w.*	8 w.

*Voltage and dissipation ratings inadequate for commercial dependability.
†G. O. L. (grid overload) is level where grids just begin to draw current. With resistance coupling, distortion increases markedly beyond this point. Above readings are as operated in Williamson circuit: 400 v. plate; 25 w. dissipation; 10,000 p.p. load.

A LOW COST EXCITER UNIT

Author's operating desk. An NC-100X receiver is flanked by a 150-watt amplifier and two exciters (one covering ten meters and the other the 3-band unit described). A single sideband adaptor is also used with this equipment on 75 and 20 meters.

Front view of exciter. Frequency dial, a bandswitch (lower knob), and output trimmer (upper knob) are only controls used. Power supply is through shielded cable.

By
JOHN F. CLEMENS
W9ERN

This v.f.o. exciter gives one watt of output on 80, 40 and 20 meters with crystal-like stability. It features small size, low power consumption, and bandswitching with simple construction.

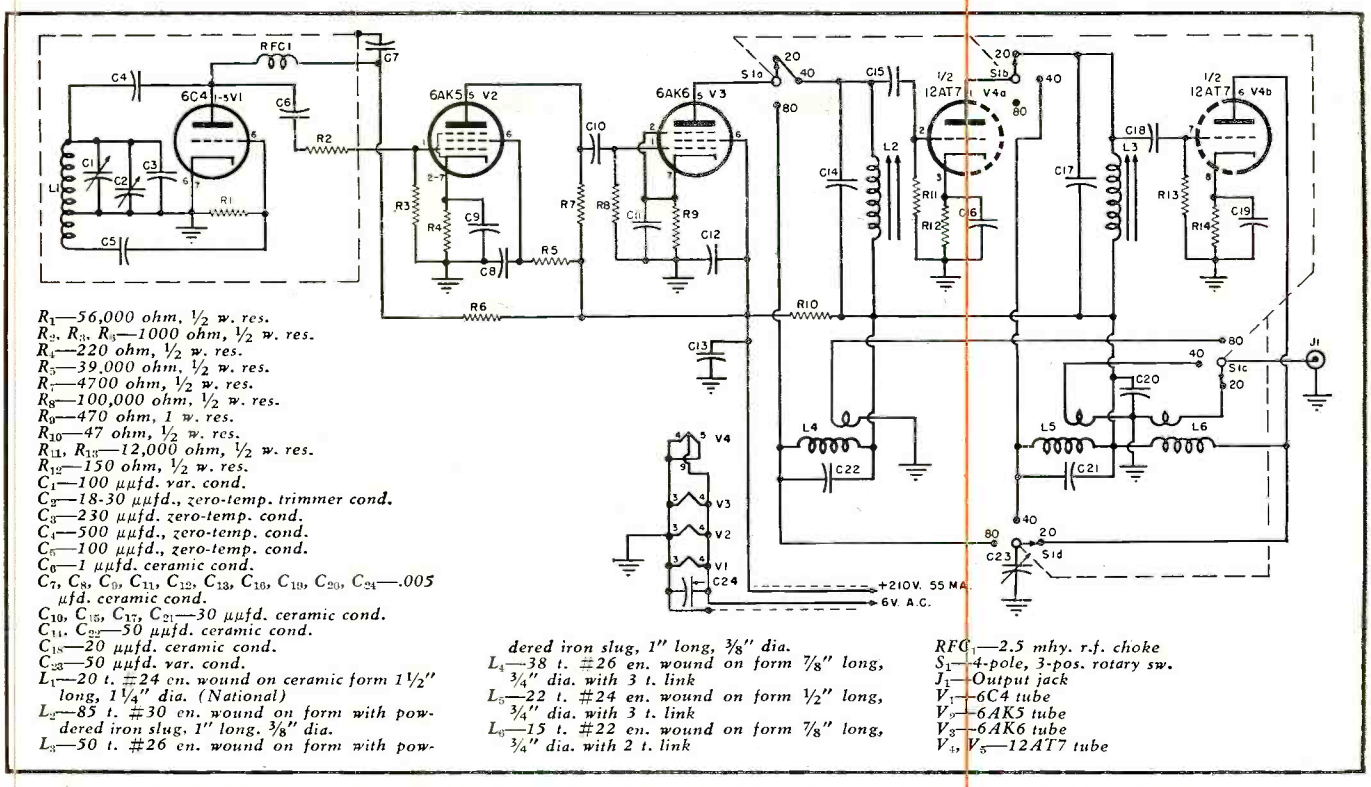
THE first requisite for a good radio signal is a good exciter. Variable frequency operation has now become accepted as a necessity by all avid amateurs and at the same time modern transmitting techniques, like single sideband, have set new standards of performance for the exciter. Many excellent commercial transmitters have achieved a degree of stability and flexibility which has frightened many hams out of the competition. It is the purpose of this article to show that equal results are not too difficult to obtain from equipment that anyone can duplicate with simple hand tools. The final result is an exciter which is simple to operate and should be free of instability, drift, TVI, and any of the other ills which have plagued all of us at one time or another.

If you would like to know before building the unit what kind of stability you can obtain from this design, here is a simple test to make on your present exciter as a comparison: Tune in your own signal with the receiver r.f. gain reduced to prevent overload and the b.f.o. switched on. Now alternately open and short circuit the r.f. output circuit of your exciter. Is there any frequency change shown by a change in the pitch of the signal? If so, your signal could stand some improvement. This exciter shows no change in the beat note. An exciter such as the popular BC-459A is likely to give a poor account of itself with such a test since the isolation between output circuit and frequency determining circuit is quite small.

Drift is another problem due to temperature variations of the constants of the tuned circuits which control frequency. This problem can be attacked several ways but possibly the best way is to prevent the temperature variations rather than try to compensate for them. The first step in preventing temperature rise is the selection of tubes which have low heater power consumption since the heater wattage will often be the largest component of the total heat generated. The 6C4 triode is an excellent choice for the oscillator in this respect and it has other advantages as well. It has a large plate well spaced from the other electrodes. Wide interelectrode spacing is desirable to minimize microphonic effects which are due to vibration of the tube elements and the resultant capacity variations. All other tubes used in the exciter compartment are similarly chosen to provide the most gain and power-handling capability with the smallest possible heater drain. Tubes such as the 6F6, 6AG7, and 6V6 should be avoided in the design of a compact unit since the heater of any of these tubes consumes enough power to cause temperature rises of twenty degrees or more in a small cabinet. Leave the power generation to the stages in the transmitter and let the v.f.o. concentrate on the job of controlling frequency—that's the easy way to stability.

Since every ham is not a "Village Smithy" we cannot all turn out those custom designed cabinets which are often essential to the electrical performance of high-grade commercial rigs. This exciter is constructed in a standard 9 x 5 x 6 inch steel utility box with a 7 x 5 x 2 inch aluminum chassis. Both of these items are inexpensive and generally available at radio stores. The oscillator shield compartment is built up of small pieces of 1/16 inch aluminum, each part being small enough so that the necessary bends can be made easily in a vise. This compartment is 3 inches higher than the chassis, 3 inches deep, and 3¾ inches wide. Number 4 self-tapping screws are used to fasten all metal parts together, providing a good electrical bond between parts of the shield as well as a very rigid mechanical assembly.

The circuit diagram and the photograph of the oscillator compartment will reveal a few of the more important constructional points which contribute to the over-all stability. The oscillator tube, first selected to generate the minimum amount of heat, is



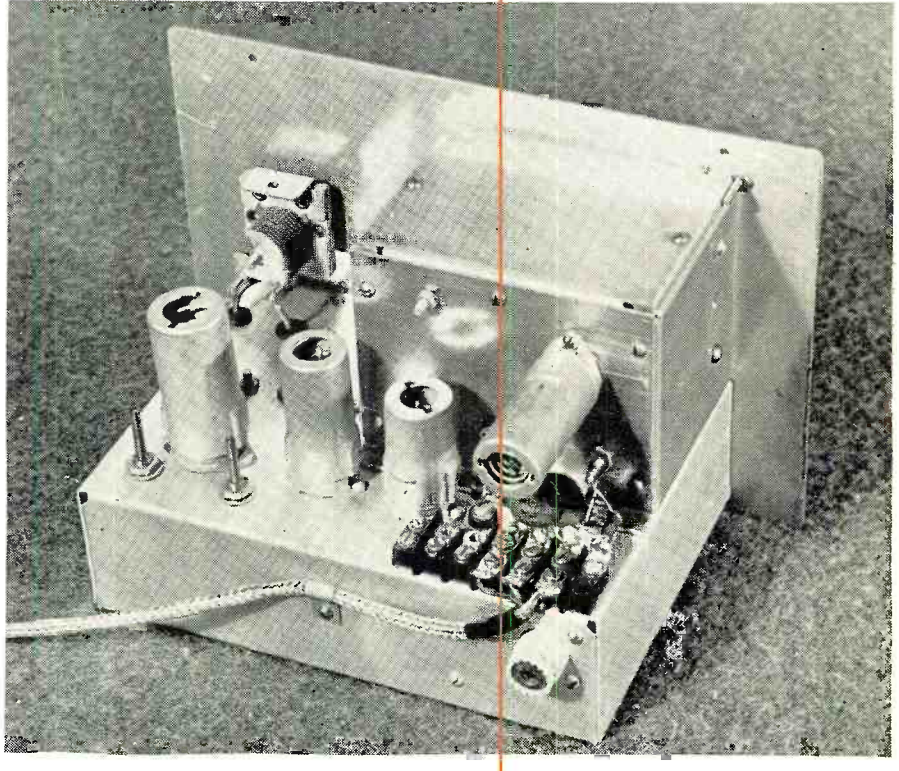
R_1—56,000 ohm, ½ w. res.
R_2, R_3, R_4—1000 ohm, ½ w. res.
R_4—220 ohm, ½ w. res.
R_5—39,000 ohm, ½ w. res.
R_7—4700 ohm, ½ w. res.
R_8—100,000 ohm, ½ w. res.
R_9—470 ohm, 1 w. res.
R_{10}—47 ohm, ½ w. res.
R_{11}, R_{13}—12,000 ohm, ½ w. res.
R_{12}—150 ohm, ½ w. res.
C_1—100 μμfd. var. cond.
C_2—18-30 μμfd., zero-temp. trimmer cond.
C_3—230 μμfd. zero-temp. cond.
C_4—500 μμfd., zero-temp. cond.
C_5—100 μμfd., zero-temp. cond.
C_6—1 μμfd. ceramic cond.
C_7, C_8, C_9, C_{11}, C_{12}, C_{13}, C_{16}, C_{19}, C_{20}, C_{24}—.005 μfd. ceramic cond.
C_{10}, C_{15}, C_{17}, C_{21}—30 μμfd. ceramic cond.
C_{14}, C_{22}—50 μμfd. ceramic cond.
C_{18}—20 μμfd. ceramic cond.
C_{23}—50 μμfd. var. cond.
L_1—20 t. #24 en. wound on ceramic form 1½" long, 1¼" dia. (National)
L_2—85 t. #30 en. wound on form with powdered iron slug, 1" long, ⅜" dia.
L_3—50 t. #26 en. wound on form with powdered iron slug, 1" long, ⅜" dia.
L_4—38 t. #26 en. wound on form ⅞" long, ¾" dia. with 3 t. link
L_5—22 t. #24 en. wound on form ½" long, ¾" dia. with 3 t. link
L_6—15 t. #22 en. wound on form ⅞" long, ¾" dia. with 2 t. link
RFC_1—2.5 mhy. r.f. choke
S_1—4-pole, 3-pos. rotary sw.
J_1—Output jack
V_1—6C4 tube
V_2—6AK5 tube
V_3—6AK6 tube
V_4, V_5—12AT7 tube

Circuit diagram of the exciter which provides output on 80, 40, and 20 meters with unusually high stability.

mounted outside the oscillator shield so that it is well ventilated to the back of the oscillator cabinet which is operated with the back open. Heat from the tube does not, therefore, reach the oscillator tuning condenser and coil which are completely shielded for r.f. A coil form should be used which has the best possible thermal stability and no other materials equal the ceramics in this respect. Plastic coil forms are to be avoided. After the coil is tightly wound, a thin coat of coil dope or cement should be applied to hold the wire in place. This procedure also provides a measure of protection against humidity effects on the coil, although there is not too much that can be done in simple equipment of this type to make the oscillator completely impervious to humidity changes. Complete shielding prevents rapid changes in the air inside the compartment so that frequency jumps or drifts are not noticeable. A seasonal change in calibration, due to humidity variations, is to be expected, however, although this is a rather fine point.

Zero-temperature coefficient ceramic condensers are used across the oscillator coil and the trimmer condenser is also of the zero-temperature type. The tuning condenser is ceramic insulated and must have a double bearing if smooth tuning and good reset accuracy of the calibration is expected. It is also important to mount the tuning condenser with an insulated shaft extension so that the metal shaft of the condenser does not protrude from the shield compartment. This is necessary to prevent radiation of the oscillator output, particularly the very high frequency harmonics, as well as to prevent pickup of r.f. currents from the strong fields of the output stages of the transmitter which can wreck the stability of the v.f.o. by feedback. For the same reason the frame of the tuning condenser is mounted on the chassis by means of insulating washers and only a single ground point is used between the oscillator circuits and the shield compartment, right at the tube socket. The theory here is that higher power transmitter stages will cause currents to flow in the shield walls due to the strong local fields from antenna and tank circuits. These currents must be prevented from interlocking with oscillator currents by flow through common paths. By avoiding this situation, where feedback currents reach

Rear view of exciter. Tube line-up, from left to right, includes 6C4 oscillator, 6AK5 buffer, 6AK6 80 meter output, and 12AT7 40 and 20 meter output. The r.f. output is to the coaxial connection visible on the leading edge of the chassis.



the oscillator, a major source of v.f.o. instability is avoided. "B-plus," filament, and r.f. output leads are brought out through the rear wall of the oscillator compartment with feedthrough insulators, in this case made of number 4 machine screws through fiber grommets.

The tuning range of the oscillator is 3490 to 4040 kc. so that when operating on the 80 meter band no doubling is necessary. It is desirable to operate the v.f.o. on the highest frequency possible to avoid TVI since there will be less trouble from harmonics if there is one possible harmonic every 3.5 mc. throughout the television spectrum than if there are two harmonics, as would be the case with operation of the oscillator on the 160 meter band. Output is taken from the oscillator through an attenuator made up of C_6, R_2, and R_3. This method of taking off the oscillator signal results in a virtually constant load on the oscillator, regardless of fluctuations in the impedance of the grid circuit of the following stage. Both plate voltage and heater voltage leads are bypassed at the feedthrough connections with .005 μfd. ceramic disc type condensers. This measure is further insurance against the entry of r.f. feedback currents via these leads. The r.f. feedback of this type is often responsible for roughening of the note and variations in the oscillator frequency as subsequent stages are tuned through resonance. The output attenuator provides a large measure of protection against feedback currents, also, because of the very high reactance of C_6 which has a capacity of only 1 μμfd.

Only voltage amplification is required in the second stage—a 6AK5, resistance coupled. The low input and output capacity of this tube permits substantial amplifications at 3 or 4 mc. without tuned plate circuits. Resistance coupling in this stage is also permissible since the following stage runs class A so that the 6AK5 is not required to deliver any power to the following grid circuit. With only resistors in the plate and grid leads, it is practically impossible for the 6AK5 to give any trouble from parasitics or self oscillation.

The 80 meter power output stage is a 6AK6, selected for its low heater drain as well as its high gain and adequate power rating. This stage easily develops over one watt of r.f. output with a plate current of under 20 ma. The output coil for this stage is under the chassis, as are all the output tank coils, to afford maximum spacing and isolation from the oscillator.

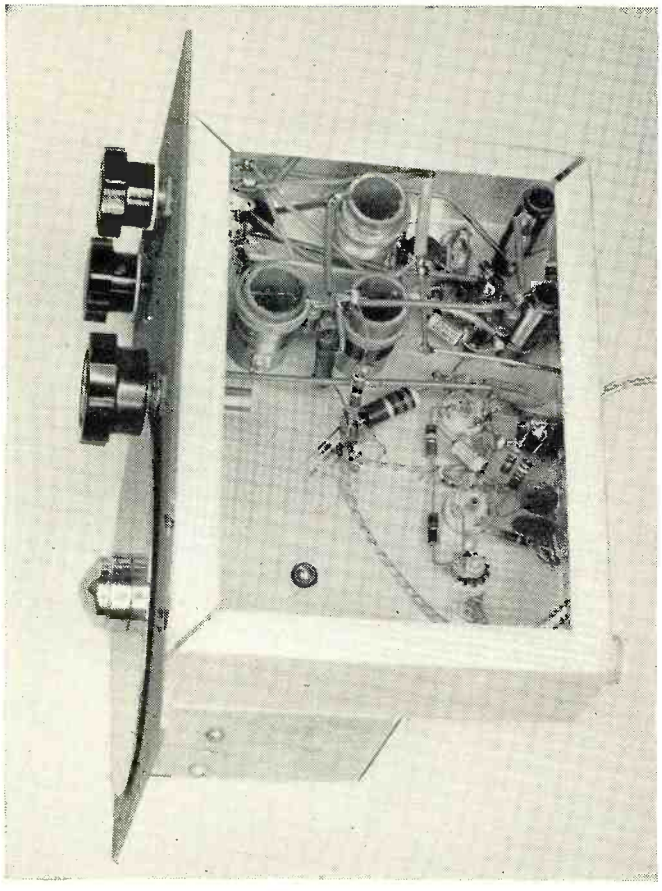
A rather novel bandswitching circuit has been designed especially to use an inexpensive and standard single-deck bandswitch—a *Mallory* type J. This switch is listed in any catalog, a fact that will be appreciated by anyone who has tried to duplicate one of the elaborate bandswitching transmitters current in the literature. The switch has four poles and three positions. One section transfers the panel controlled output tuning condenser, C_{23}, to the output coil in use. The second section selects the proper output link, connecting it to the output coax connector on the rear of the chassis. The third and fourth sections select the proper plate circuits for the 6AK6 80 meter power amplifier and the 40 meter doubler section of the 12AT7.

This same bandswitching section may be extended to add a 10 meter output stage if desired. In this case a 5 circuit, 4 position switch would be necessary. Such a switch is available from *Mallory,* slightly larger in diameter but of similar construction to the switch shown. A 6AB4, which is equivalent to one section of the 12AT7, is suggested as the 10 meter doubler, with circuit values equivalent to the values used in the 20 meter section of the 12AT7. An output coil would be required for the 10 meter stage and an additional slug-tuned 20 meter coil, similar to L_2 and L_3, may be required. No ten meter stage has been incorporated in the unit shown because a separate ten meter FM exciter is used at W9ERN.

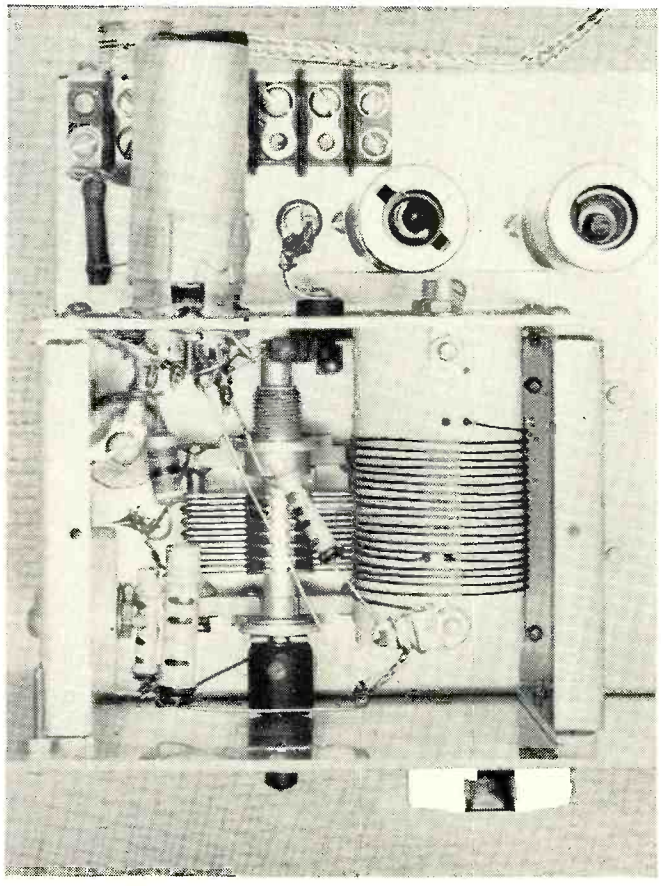
On 80 meters the 12AT7 is not used. The plate voltage is disconnected from the 40 meter doubler section with the bandswitch in the 80 meter position and the plate current of the 20 meter section of the 12AT7 is limited to a few ma. by cathode bias. As part of the bandswitching system, slug-tuned coils

(*Continued on page* 104)

Under view of chassis. The two slug-tuned coils are near rear of chassis. Output coils are grouped around bandswitch. Bus wiring and spaghetti are used freely in bandswitch wiring.



Internal view of oscillator compartment. A ceramic coil form is used for stability. Trimmer C_2, used to set oscillator tuning range, is adjusted through hole in side of compartment.



An "Extra" SUPERHET

By
LEON WICKFIELD

Construction details on a 5-tube superhet broadcast receiver. Its compact size, good performance, and versatility are outstanding.

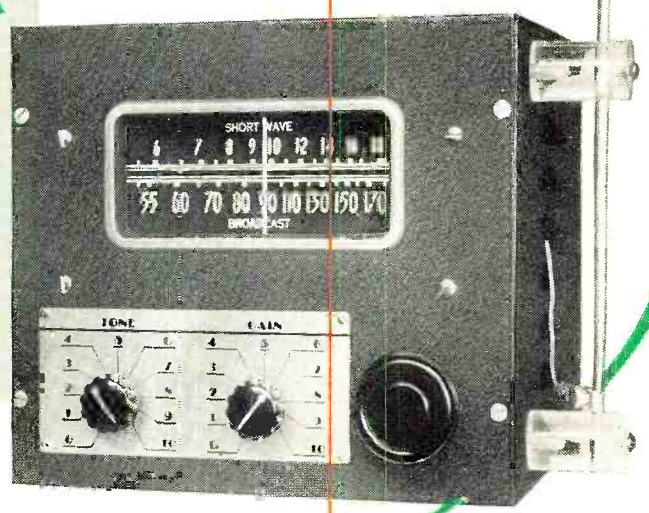


Fig. 1. Front view of completed receiver. The whip antenna shown in photo is an optional accessory.

THE "extra" standard broadcast receiver is still much in demand, television notwithstanding. Here is a rugged pint-sized set with giant-sized performance, whose continued reason for existence is to have something easily movable around the house that will make companionable noises when called upon (with apologies to the XYL). It fills a definite need for that extra set in the bedroom, kitchen, workshop, guest room, children's room, or for vacation or weekend trips. The finished product is attractive enough to grace the top of a bass reflex speaker enclosure in the living room upon occasion.

That great bugaboo of "home brewed" radio receivers, mistracking of the tuned circuits, is virtually eliminated by the use of adjustable iron core coils and a manufactured dial assembly. An alignment procedure that gets the most performance from the set and a lack of "corner-cutting" circuitry provides a degree of performance not often found in present-day mass produced receivers of the five tube variety.

Good selectivity and sensitivity were of more concern in the design of the set than was super high fidelity and audio power output. However, an oversize output transformer and the incorporation of inverse feedback in the audio stages provides excellent low and high frequency response with ample power to drive a large external speaker. Plug-in connections for this purpose are provided at the rear of the receiver, as well as a toggle switch to allow convenient changeover from the internal speaker to the external speaker.

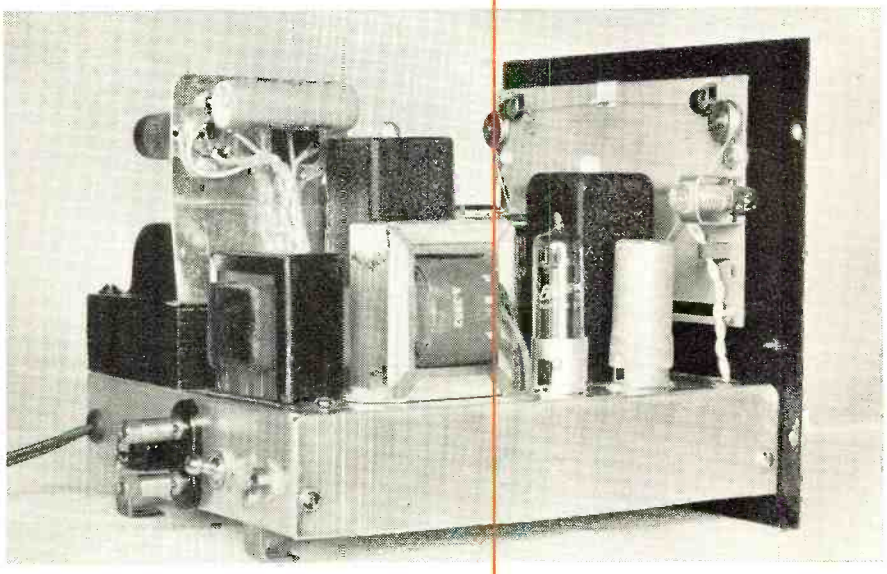
The output of the first audio stage (Fig. 3) is also available at the rear of the receiver for feeding an external higher powered amplifier or for using headphones. After the receiver was completed it became desirable to utilize the capabilities of the audio system as a phonograph amplifier. Another midget phone jack, not shown in the photographs, was installed at the rear of the receiver between the toggle switch and the headphone jack. The receiver volume and tone controls may be used with the external crystal pickup, and over three watts of power is available at the secondary of the output transformer with 0.8 volt input to the phono jack. The amplifier is perfectly hum free and the inverse feedback arrangement provides excellent speaker damping.

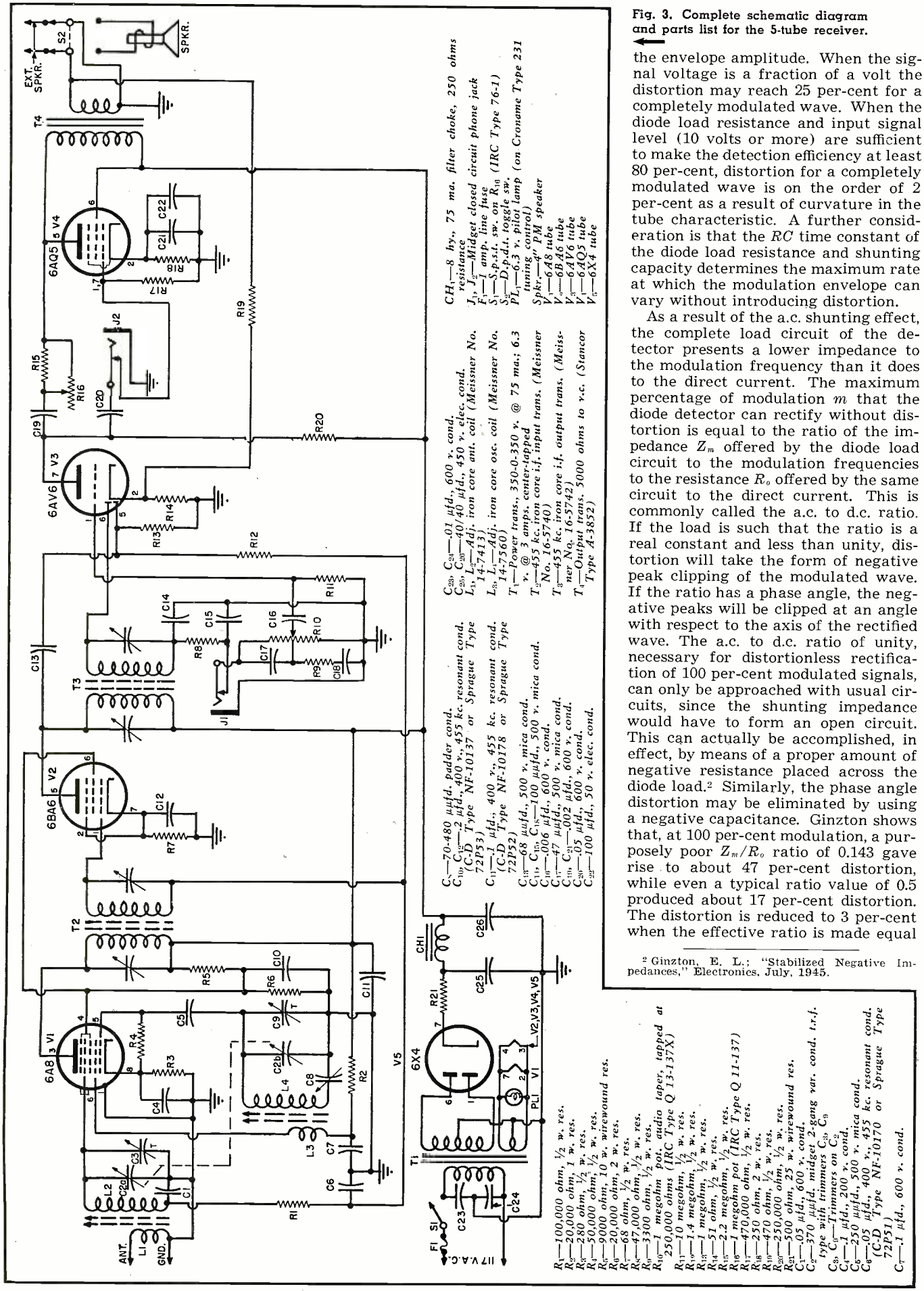
A total of four resonant bypass condensers contribute greatly to the final stability and performance of the set. Now commonly available the country over, these condensers are actually inexpensive series-resonant 455 kc. filters. They are of the same sizes as conventional tubular condensers having the same voltage and capacitance ratings. An increase of 3 to 4 times in bypassing efficiency is obtained in circuits operated at the resonant frequency of the condenser, as compared to the usual paper condenser of the same capacity value.

One V_3 diode unit (Fig. 3) is the automatic volume control rectifier and the other diode is the detector. The diode linear detector represents one of the simplest and most widely used detection methods. It is also probably the least understood circuit of those that make up a "conventional" broadcast receiver. Reference to Terman[1] indicates that diode detector distortion may result due to curvature in the tube characteristic, causing the rectification efficiency to vary according to

[1] Terman, F. E.: "Radio Engineering," 2nd ed., McGraw-Hill Book Co., Inc., New York, 1937, p. 425-434.

Fig. 2. Side view. Note angle pieces bolted to rear chassis drop to support weight.





C_{22}, C_{24}—.01 μfd., 600 v. cond.
C_{23}, C_{26}—40/40 μfd., 450 v. elec. cond.
L_{12}, L_{13}—Adj. iron core ant. coil (Meissner No. 14-7413)
L_{14}, L_{15}—Adj. iron core osc. coil (Meissner No. 14-7560)
T_1—Power trans., 350-0-350 v. @ 75 ma.; 6.3 v. @ 3 amps. center-tapped
T_2—455 kc. iron core i.f. input trans. (Meissner No. 16-5740)
T_3—455 kc. iron core i.f. output trans. (Meissner No. 16-5742)
T_4—Output trans. 5000 ohms to v.c. (Stancor Type A-3852)

CH_1—8 hy., 75 ma. filter choke, 250 ohms resistance
J_1, J_2—Midget closed circuit phone jack
F_1—1 amp. line fuse
S_1—S.p.s.t. sw. on R_{12} (IRC Type 76-1)
S_2—D.p.d.t. toggle sw.
PL_1—6.3 v. pilot lamp (on Croname Type 231 tuning control)
Spkr.—4" PM speaker
V_1—6A8 tube
V_2—6BA6 tube
V_3—6AV6 tube
V_4—6AQ5 tube
V_5—6X4 tube

C_1—70-480 μμfd. padder cond.
C_2, C_{19}—.2 μfd., 400 v., 455 kc. resonant cond. (C-D Type NF-10137 or Sprague Type 72P53)
C_3, C_{20}—.1 μfd., 400 v., 455 kc. resonant cond. (C-D Type NF-10178 or Sprague Type 72P52)
C_4, C_{18}—68 μμfd., 500 v. mica cond.
C_5, C_{15}, C_{16}—100 μμfd., 500 v. mica cond.
C_6—.006 μfd., 600 v. cond.
C_7—47 μμfd., 500 v. mica cond.
C_8, C_{21}—.002 μfd., 600 v. cond.
C_9—.05 μfd., 600 v. cond.
C_{10}—100 μfd., 50 v. elec. cond.

R_1—100,000 ohm, ½ w. res.
R_2—20,000 ohm, 1 w. res.
R_3—280 ohm, ½ w. res.
R_4—50,000 ohm, ½ w. res.
R_5—9000 ohm, 10 w. wirewound res.
R_6—20,000 ohm, 2 w. res.
R_7—68 ohm, ½ w. res.
R_8—47,000 ohm, ½ w. res.
R_9—3300 ohm, ½ w. res.
R_{10}—1 megohm pot. audio taper, tapped at 250,000 ohms (IRC Type Q 13-137X)
R_{11}—10 megohm, ½ w. res.
R_{12}—1.4 megohm, ½ w. res.
R_{13}—1 megohm, ½ w. res.
R_{14}—51 ohm, ½ w. res.
R_{15}—2.2 megohm, ½ w. res.
R_{16}—1 megohm pot (IRC Type Q 11-137)
R_{17}—470,000 ohm, ½ w. res.
R_{18}—250 ohm, 2 w. res.
R_{19}—470 ohm, ½ w. res.
R_{20}—250,000 ohm, ½ w. res.
R_{21}—500 ohm, 25 w. wirewound res.
C_1—.05 μfd., 600 v. cond.
C_2—370 μμfd. midget 2-gang var. cond. t.r.f. type with trimmers C_{2a}, C_{2b}
C_{2a}, C_{2b}—Trimmers on C_2
C_4—.1 μfd., 200 v. cond.
C_5—250 μμfd., 500 v. mica cond.
C_6—.05 μfd., 400 v., 455 kc. resonant cond. (C-D Type NF-10170 or Sprague Type 72P51)
C_7—.1 μfd., 600 v. cond.

Fig. 3. Complete schematic diagram and parts list for the 5-tube receiver.

the envelope amplitude. When the signal voltage is a fraction of a volt the distortion may reach 25 per-cent for a completely modulated wave. When the diode load resistance and input signal level (10 volts or more) are sufficient to make the detection efficiency at least 80 per-cent, distortion for a completely modulated wave is on the order of 2 per-cent as a result of curvature in the tube characteristic. A further consideration is that the *RC* time constant of the diode load resistance and shunting capacity determines the maximum rate at which the modulation envelope can vary without introducing distortion.

As a result of the a.c. shunting effect, the complete load circuit of the detector presents a lower impedance to the modulation frequency than it does to the direct current. The maximum percentage of modulation m that the diode detector can rectify without distortion is equal to the ratio of the impedance Z_m offered by the diode load circuit to the modulation frequencies to the resistance R_o offered by the same circuit to the direct current. This is commonly called the a.c. to d.c. ratio. If the load is such that the ratio is a real constant and less than unity, distortion will take the form of negative peak clipping of the modulated wave. If the ratio has a phase angle, the negative peaks will be clipped at an angle with respect to the axis of the rectified wave. The a.c. to d.c. ratio of unity, necessary for distortionless rectification of 100 per-cent modulated signals, can only be approached with usual circuits, since the shunting impedance would have to form an open circuit. This can actually be accomplished, in effect, by means of a proper amount of negative resistance placed across the diode load.[2] Similarly, the phase angle distortion may be eliminated by using a negative capacitance. Ginzton shows that, at 100 per-cent modulation, a purposely poor Z_m/R_o ratio of 0.143 gave rise to about 47 per-cent distortion, while even a typical ratio value of 0.5 produced about 17 per-cent distortion. The distortion is reduced to 3 per-cent when the effective ratio is made equal

[2] Ginzton, E. L.: "Stabilized Negative Impedances," Electronics, July, 1945.

to unity by means of negative resistance.

For the sake of simplicity the diode detector in the receiver of Fig. 3 does not utilize negative resistance or negative capacitance. However, an acceptable Z_m/R_o ratio is obtained by reducing the a.c. shunting to a minimum, accomplished in two ways. The a.v.c. voltage is derived from a separate diode, fed through a small condenser from the primary side of the last i.f. transformer. Thus the a.v.c. filter is not shunted across the detector load. An additional advantage is that the a.v.c. diode receives a greater signal voltage from the i.f. transformer primary than it would from the secondary, and the result is a larger a.v.c. voltage. Zero bias operation of V_3 allows the use of a 10 megohm grid resistor, R_{11}, thereby reducing the shunting effect from this source to a relatively low figure. The detector distortion is thus reduced to a value sufficiently low to satisfy all but the most critical requirements. J_1 is the phono input jack, and J_2 is the output jack for headphone use.

The tapped volume control, R_{10}, along with C_{17}, R_9, and C_{18}, provides a certain amount of high and low frequency boost at low settings of the volume control, in order to compensate somewhat for the normal deficiencies of the human ear. The tone control circuit, R_{15}, R_{16}, and C_{19}, operates by degenerating the higher audio frequencies. The individual constructor may change the values of these components to obtain a different tone control characteristic for a particular installation.

A portion of the circuit that should not be eliminated is the over-all feedback loop from the secondary of the output transformer to the cathode of V_3. Resistors R_{13} and R_{14} form the feedback voltage divider. If the amplifier oscillates when turned on initially, reverse the connections of R_{13} and ground to the secondary of T_4. The transformer should have a generous power rating if a falling off in power output and distortion at the lower frequencies is to be avoided.

The power supply output voltage is dropped to 250 volts by R_{21}. The common return circuit for C_{23}, C_{24}, C_{25}, C_{26}, and the T_1 secondary center taps should be made with insulated wire and grounded at only one spot on the chassis, to avoid hum-inducing circulating current in the chassis. This requires the can of C_{25}-C_{26} to be insulated from the chassis with a bakelite insulating mount.

Construction

The receiver is housed in a standard lid-type cabinet, 7 inches high and 8 inches in width and depth. A special chassis was made of sheet aluminum to fill the available cabinet space more completely than a commercial chassis. The dimensions are 7 x 7¾ x 1½ inches. A *Croname* double dial plate for the tone and gain controls is available as a stock item. A *Croname* Type 231 tuning control just fits into the available panel space and the edge-lighted glass scale is quite attractive. The scale furnished with the tuner has a combination short-wave-broadcast calibration, as seen in Fig. 1. For a few cents additional, an extra scale is available calibrated for the broadcast band only.

Referring to Fig. 5, the antenna coil is mounted nearest the tuning knob. The oscillator coil is adjacent to it, near the power transformer. Next is the 6A8 mixer tube, between the oscillator coil and input i.f. transformer. Then comes the 6BA6 tube and the output i.f. transformer. The 6AV6, 6AQ5, and audio output transformer are mounted along the left side of the chassis, with the filter choke at the rear. V_2 and V_3 should be shielded. The r.f. transformer and tube layout is such, that by suitable orientation of the tube sockets, very short and direct leads from stage-to-stage are obtained. The oscillator padding condenser is mounted on a bracket fastened to the side of the chassis, directly under the oscillator coil. The padder is adjusted through a hole drilled in the side of the chassis. Shielded wire should be used for the leads going to the two jacks at the rear of the chassis. The 6X4 rectifier tube, the dual filter condenser can, and R_{21} are mounted on a metal bracket fastened to the top of the power transformer. The cabinet lid has several holes drilled for the 4-inch speaker, and a protective grille of wire mesh. When the lid is closed the rear of the speaker fits into the space between the two i.f. transformers. A 58 inch chrome plated collapsible whip antenna, cut down from a regular automobile type, was mounted on the cabinet of our receiver. The two supporting insulators are polystyrene ⅞-inch diameter rod, 1½ inches long. The antenna lead from L_1 is brought through a grommet lined hole drilled in the side of the coil shield can, then fed through a side louver in the cabinet and attached to a small spring clip. The antenna lead is thus available for clipping to the whip antenna, if used, or to a longer antenna. The receiver regularly provides excellent long distance reception on nothing but the whip antenna.

Alignment

The first adjustment is to align the i.f. amplifier at 455 kc. Connect an output meter from the plate of the 6AQ5 to ground, and connect the signal generator to the cap of the 6A8 mixer tube through a small condenser. Temporarily short circuit the oscillator section of the two-gang tuning con-

(*Continued on page* 148)

Fig. 4. Under chassis view. Note the chassis cutouts to accommodate the dial mechanism and the tuning condenser lead wiring.

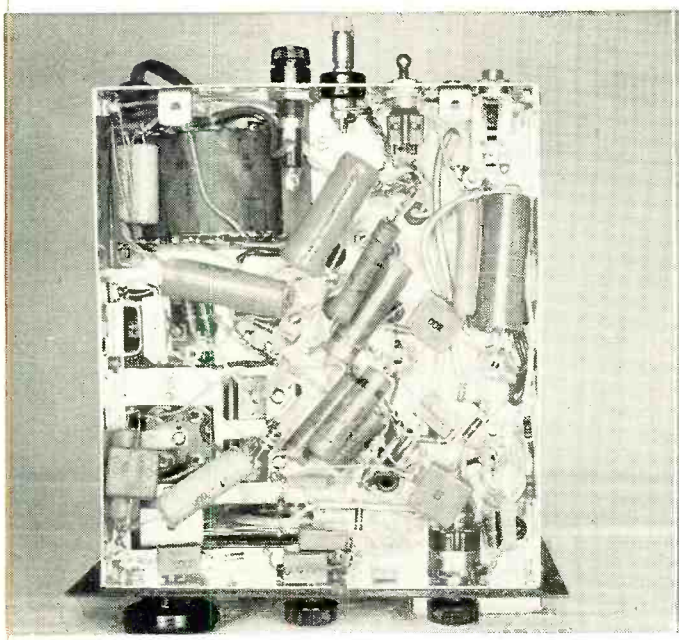
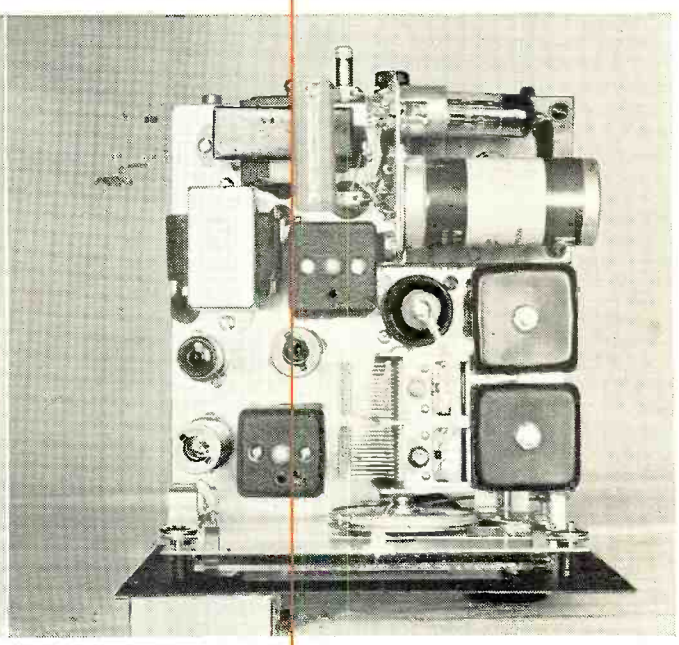
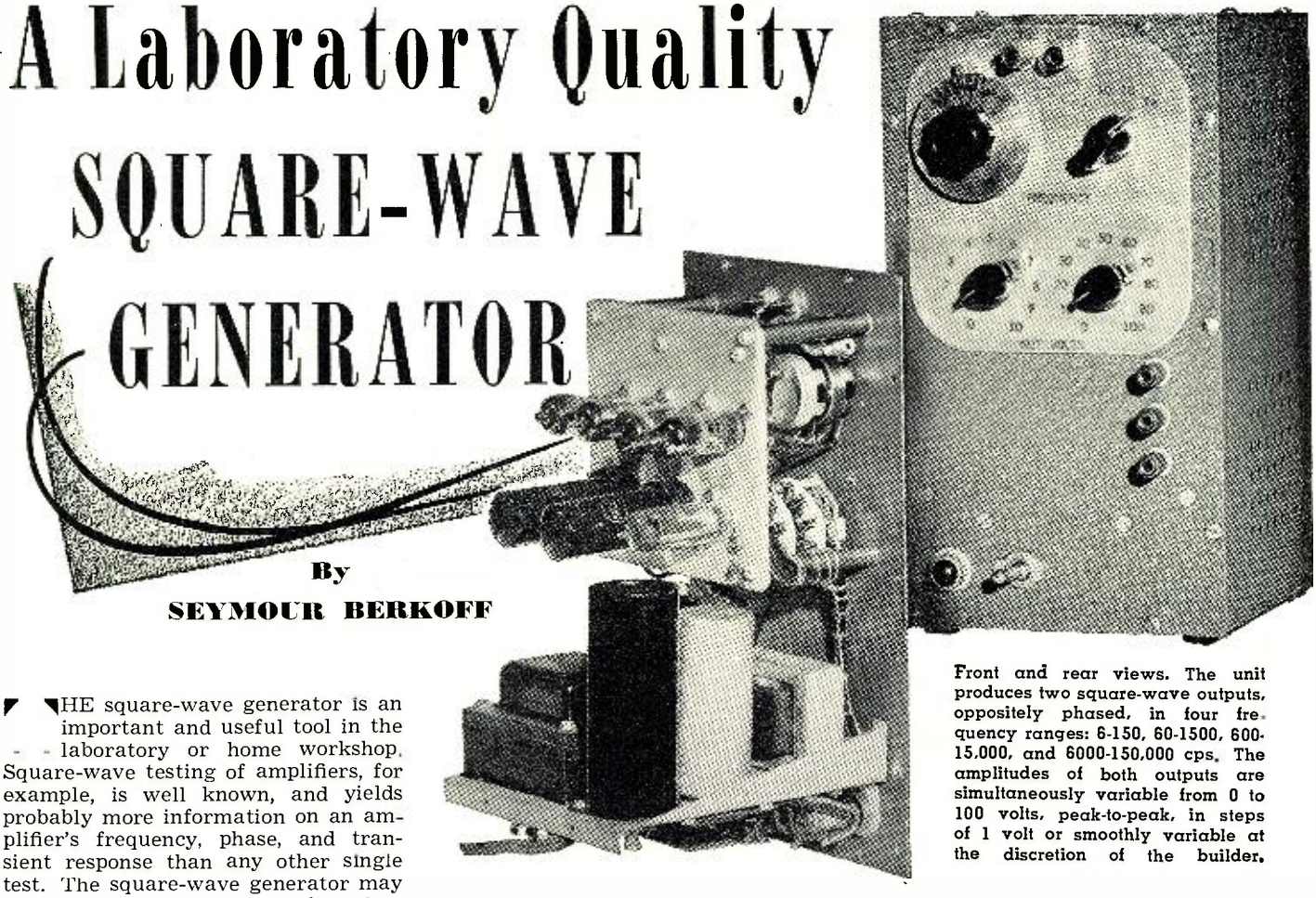


Fig. 5. Top chassis view of the completed receiver showing the location of components. Careful parts placement is required.



A Laboratory Quality SQUARE-WAVE GENERATOR

By
SEYMOUR BERKOFF



Front and rear views. The unit produces two square-wave outputs, oppositely phased, in four frequency ranges: 6-150, 60-1500, 600-15,000, and 6000-150,000 cps. The amplitudes of both outputs are simultaneously variable from 0 to 100 volts, peak-to-peak, in steps of 1 volt or smoothly variable at the discretion of the builder.

Construction details on a useful test instrument which covers from 6 to 150,000 cps in four ranges.

THE square-wave generator is an important and useful tool in the laboratory or home workshop. Square-wave testing of amplifiers, for example, is well known, and yields probably more information on an amplifier's frequency, phase, and transient response than any other single test. The square-wave generator may also be used as a basic part of an electronic switch for simultaneous observation of two waveforms on an oscilloscope, or to operate relays in repetitious switching circuits. Other waveforms, such as exponential, triangular, or variable width pulse shapes may be readily derived from square waves by simple resistance-capacitance circuits, and may be used in a variety of experiments. Square waves may even be applied for amplitude calibration of a.c. vacuum tube voltmeters or oscilloscopes. Many other uses will undoubtedly suggest themselves to the user.

The purpose of this article is to present detailed information on a carefully designed square-wave generator which fulfills basic requirements for a variety of laboratory and home workshop uses. In addition to a circuit description of the generator, the writer feels that it would be helpful to the reader to discuss some general circuit techniques governing the production of square waves.

The ideal square-wave generator should produce signals resembling those of Fig. 1A. The waveshape has flat tops and bottoms and very steep vertical sides. The reasons for producing this exact shape may be understood by considering the type of distortion that may be produced at the output of an amplifier under test with a square wave. For example, an amplifier having deficient or excessive low frequency response will impart a slope to the tops and bottoms of the wave, as shown in Figs. 1B and C. On the other hand, an amplifier having poor high frequency response will slow up the rate of rise and fall of the vertical sides and round off the corners, as shown in Fig. 1D. Still further, the shape shown in Fig. 1E represents distortion produced by an amplifier's tendency to regenerate in the high frequency region. This condition, incidentally, is not always readily revealed by testing the sine-wave response of an amplifier.

It is evident from these examples that the square-wave generator itself must not produce distorted waveshapes like these in order to provide a meaningful test of the performance characteristics of an amplifier.

The generator pictured produces two square-wave outputs, oppositely phased, in four frequency ranges: 6-150, 60-1500, 600-15,000, and 6000-150,000 cycles-per-second. The amplitudes of both square-wave outputs are simultaneously variable from 0 to 100 volts, peak-to-peak, in steps of 1 volt (or smoothly variable, at the discretion of the individual builder). Tops and bottoms of the wave output are flat within 0.5% of the peak-to-peak amplitude. The time of rise and fall of the vertical edges varies with output voltage from .03 to .17 microsecond. Both of these characteristics are independent of the generated frequency. In addition, synchronizing means are provided by which the generated wave may be locked in at the same frequency, or submultiple, of any other signal within the range of the generator.

The physical arrangement of the generator shown in the photographs was adopted with the object of conserving bench space. The unit is only 6 inches wide, 10 inches high, and 5½ inches deep, which was found to be very convenient on a crowded workbench. The physical layout is not at all critical, however, and many other arrangements are possible without detriment to the performance.

Generation of Square Waves

Two methods are in common use for generating square waves—the sine-wave-clipper type, and the relaxation oscillator, such as the multivibrator. In the first method, a sine-wave oscillator generates the fundamental frequency and feeds several cascaded clipper circuits. The clippers are merely amplifier tubes operating between plate current saturation and cut-off to lop off the tops and bottoms of the sine-wave, and with proper de-

sign will amplify sufficiently to steepen the sides.

The sine-wave-clipper type has two desirable characteristics. First, the frequency of the sine-wave oscillator can be accurately calibrated, independent of tube replacements or power supply voltage variations. Secondly, the generator as a whole can be used to produce both sine and square-wave outputs, thus combining two functions in one unit.

There are several disadvantages to this method, however. First, the rate of rise and fall of the vertical edges of the output square-wave varies with frequency, unless a large number of clippers is used, being slowest at low frequencies and more rapid as the frequency is raised. This is evident when it is remembered that the resultant square-wave is merely an amplified portion of a sine-wave, whose own rate of rise and fall varies with frequency. A second disadvantage lies in the expense and complication of the sine-wave oscillator itself. Ordinary Hartley or Colpitts oscillators are impractical for wide range audio frequency work, owing to the restricted tuning range of *LC* tuning circuits and the large physical size of these elements required to produce low audio frequencies. Beat-frequency oscillators can be used, but require much shielding and are subject to frequency drift to a large degree. The popular resistance-tuned Wien bridge oscillator is practical, but is large and expensive if the frequency calibration is to be made accurate.

The second method of generating square-waves, which is used in the present unit, is the multivibrator. A multivibrator is a two-stage resistance-coupled amplifier in which the output of the second stage is fed back to the input of the first stage in the correct phase to produce oscillations. The oscillation frequency is determined principally by the *RC* time constants of the coupling circuits. With proper design, the waveform produced resembles a square-wave in that it has approximately equal half cycles, with extremely steep sides and roughly flat tops and bottoms.

The multivibrator has the advantage over the sine-wave-clipper circuit in simplicity, compactness, ease of frequency control and synchronization, and quality of waveform, the latter being substantially independent of generated frequency. The principal disadvantage of the multivibrator, like other relaxation oscillators, lies in the dependence of its frequency upon power supply variations and tube replacements. Calibration of its frequency control is therefore not as precise as that of a sine-wave oscillator, although it can be held within about 5%. Fortunately, it is seldom necessary to know the square-wave frequency with exactness, and in the rare exceptions, the generator may be readily synchronized with an accurate frequency source.

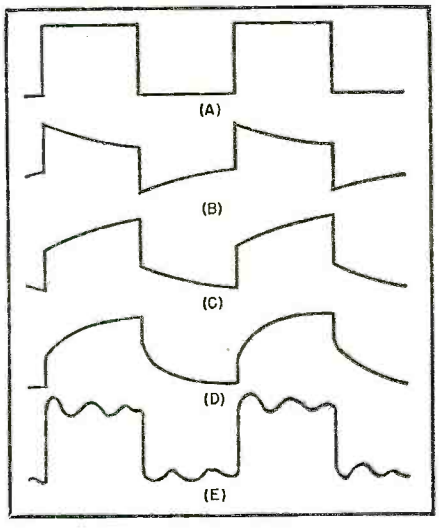
Fig. 2 shows the schematic of the complete square-wave generator. Tube V_4, 12AU7, is the multivibrator, whose frequency is controlled by the variable *RC* elements in its two grid circuits. Four frequency ranges, in steps of 10, are provided by the two-gang *Frequency Range* switch S_{1a} and S_{1b}, which changes the condenser elements in the circuit. The frequency is also made smoothly variable through the use of a two-gang potentiometer, R_7 and R_{13}. These, incidentally, have a standard logarithmic resistance taper to avoid crowded calibration at the low frequency end of the dial. Only the middle terminal and one end terminal on each potentiometer are wired into the circuit; the proper end terminal to use is the one which gives the most rapid resistance variation with rotation at the high frequency end.

The "B" supply to the multivibrator is regulated at 150 volts by the 0A2 voltage regulator tube in order to prevent line voltage variations from affecting the square-wave frequency.

The multivibrator will readily lock in at the same frequency as another signal by applying that signal to almost any point in its circuit. A simple way of doing this is to inject the synchronizing signal through a small condenser to one grid or plate of the multivibrator. This method is in fairly common use, but is undesirable for certain applications because a component of the square wave itself is fed out to the *Sync* terminal of the generator as an unwanted signal, which then appears as part of the synchronizing signal and causes difficulty in making certain kinds of experiments.

A better way of synchronizing the multivibrator, to eliminate this condition, is to isolate the *Sync* terminal from the multivibrator by means of an extra tube. The circuit of V_3-6J6 is arranged to provide symmetrical synchronization, that is, both halves of the multivibrator receive equal and oppositely phased sync signals. The multivibrator normally produces a symmetrical square-wave in which the time duration of the positive and negative halves of the cycle are approximately equal. With asymmetrical sync, either half of the wave will generally shorten with respect to the other half; further, the multivibrator will not lock in with equal ease and stability on positive *vs* negative going signals, such as pulses. On the other hand, the use of the V_3 circuit will allow the multivibrator to synchronize without instability on any signal, irrespective of the latter's waveshape, principal polarity, or amplitude; further, the shape of the multivibrator output will be undisturbed by symmetrical sync waveforms, such as sine-waves.

Fig. 1. Types of square-wave distortion produced by amplifiers having non-uniform frequency response. (A) Original square wave. (B) Amplifier deficient in low frequency response. (C) Amplifier with excessive low frequency response. (D) Amplifier deficient in high frequency response. (E) Unit with tendency to regenerate at high frequency.



Output Circuits

In addition to frequency stability and ease of synchronization, the major design requirement of the square-wave generator is to produce a waveshape with steep vertical sides and flat tops and bottoms. Capacitive effects in the circuit, which would impart a slope to the vertical edges of the wave, must therefore be minimized as far as possible, and this can be done by extracting the output waveform from small load resistances. Small resistances are introduced into the cathode circuits of the multivibrator, and the voltages formed across them are used to feed the output circuits of the generator. The waveshape across resistors R_{10} and R_{11} has extremely steep sides and flat bottoms, but the tops have an appreciable slope. It is necessary to flatten the tops and then to feed the signals to the output terminals of the generator through a power amplifier. Several basic considerations govern the design of a square-wave power amplifier, and these will be discussed here briefly.

The first problem that presents itself is the method of feeding the multivibrator signals to the power amplifier. Using ordinary resistance-capacitance coupling circuits is very impractical, for at low square-wave frequencies these circuits will impart a distortion to the waveshape like that shown in Fig. 1B. Extremely large *RC* time constants in the coupling circuits would be needed in order to avoid this distortion, or as an alternative, large square-wave amplitudes must be fed to the power amplifier grid in order to enable the latter to clip off the sloping tops and bottoms. From the standpoint of simplicity, cost, space, and quality of waveform, another method, namely d.c. coupling, is much to be preferred.

A second major problem in the design of the output circuits lies in the effect of the power amplifier on the power supply. The plate current of a square-wave power amplifier swings alternately between low and high values; the power supply is therefore required to furnish large pulses of current (as contrasted with steady d.c. current) in accordance with the frequency of the square-wave. At very

low square-wave frequencies, this effect would cause a large saw-tooth voltage to be superimposed on the d.c. voltage of the power supply, for the output filter condenser of the supply, unless prohibitively large in size, would be incapable of smoothing out the modulation produced by the power amplifier. The saw-tooth voltage on the supply, in turn, would modulate the power amplifier to produce a tilt on the tops and bottoms of the square-wave exactly like that of Fig. 1C.

The simplest way of avoiding this effect is to employ a push-pull square-wave power amplifier. Thus, two tubes draw pulses of current, but being in push-pull they do so alternately, with the result that the power supply is required to furnish only a steady d.c. current.

The foregoing methods are generally adequate to preserve the flat tops and bottoms of the waveshape at low frequencies. At high frequencies on the other hand, the principal consideration must be given toward maintaining the speed of rise and fall of the vertical edges. Practically, the only solution here is to make the power stage a good video amplifier, with a frequency response well into the megacycles. Cathode followers can be used, but they do not maintain their speed of response at large signal outputs. Push-pull pentode power amplifiers feeding small plate load resistors generally provide the best and most economical performance.

The power amplifier in the present square-wave generator meets the requirements outlined. Tubes V_1 and V_2 (6AG7's) are operated as direct-coupled push-pull stages, with the output square-wave signals developed across low values of load resistors. Plate current swing in each tube is from 0 to 50 ma., and a 2000 ohm load resistor in each plate will thus develop 100 volts peak-to-peak square-wave amplitude. In order to adjust the output amplitude, the plate load resistors of both 6AG7's are made variable. Plate current swings in the tubes are substantially unaffected by the load resistor settings.

It is necessary to use non-inductive load resistors, for excessive inductance will produce unwanted pulses in the output waveform. Several different non-inductive variable resistor schemes may be used at the discretion of the individual builder. One of them which suited the writer's purpose is shown in detail in the inset of Fig. 2. Here, a number of fixed resistors, carbon or composition type (not wirewound) are wired onto two switches so that the plate load resistance is varied in discrete steps. Switch S_3 produces 1 volt output increments, and switch S_4, 10 volt steps. Each switch is a two-gang arrangement operating on both 6AG7 plates at the same time. Thus both square-wave outputs are equal and simultaneously variable.

A second scheme, which is less expensive, is to use the variable arrangement on only one 6AG7 plate, leaving a fixed resistor of a 2 watt rating and any value up to 2000 ohms on the other plate. Only one of the square-wave outputs is then adjustable in amplitude.

If desired, the outputs may be made smoothly variable by substituting a two-gang, 200 ohm carbon or composition potentiometer for R_{43} to R_{52} on the 6AG7 plates in the schematic, keeping the switching arrangement for R_{23} to R_{42}. In general it is not advisable to use ordinary composition potentiometers for R_{23} to R_{42} owing to the relatively large power dissipation in this circuit, and wirewounds are also objectionable because of their self inductance.

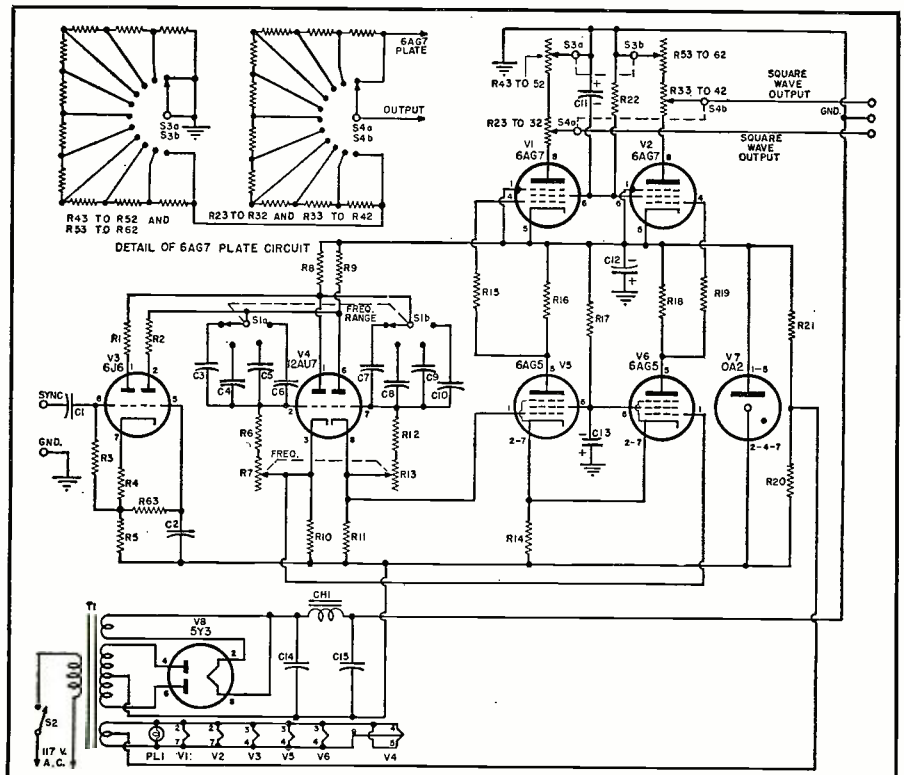
The two 6AG5 tubes, V_5 and V_6, are used as part of the over-all scheme to obtain flat tops and bottoms on the square wave. As mentioned previously, the signals at the multivibrator cathodes do not have flat tops. These signals are inverted by the 6AG5's and amplified sufficiently to cut off the 6AG7 plate currents during the negative-going 6AG5 plate swing. The 6AG7's clip off the sloping bottoms, leaving the desired waveshape at the output.

It will be noted that direct coupling is employed throughout. The 6AG5 grids are connected directly to the 12AU7 cathodes without coupling condensers. Each 12AU7 cathode swings positive with respect to "B–," so it is necessary to place a positive bias on the 6AG5 cathodes to maintain their grids in the negative region. The use of a common unbypassed cathode resistor for the 6AG5's is a simple and effective way of maintaining a steady d.c. voltage there, for both tubes conduct plate current alternately. Similarly, a common screen resistor is used for both tubes, being bypassed only for high frequencies with a .1 μfd. condenser; this helps maintain steep edges on the output waveform.

Direct coupling is again used from 6AG5 plates to 6AG7 grids through 100 ohm anti-parasitic resistors. These resistors are ordinary carbon or composition types, and should be wired directly on the 6AG7 sockets with the shortest possible leads. Tubes having a high transconductance are prone to oscillate at very high r.f. frequencies

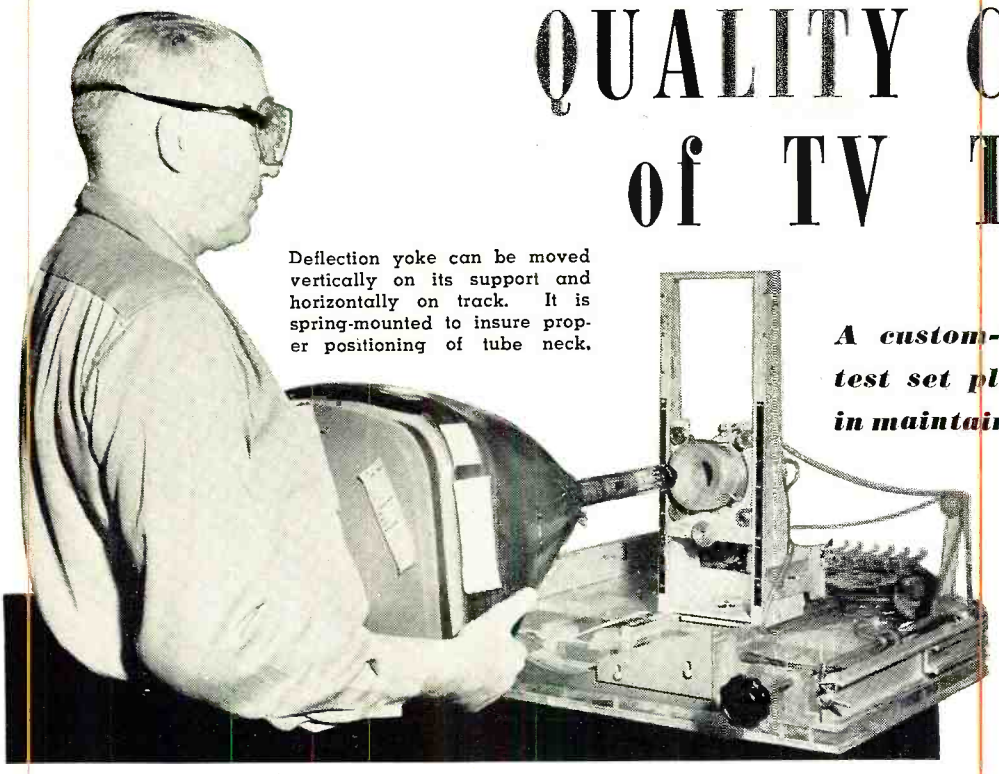
(*Continued on page* 119)

Fig. 2. Complete schematic of square-wave generator. Switch details are also given.



R_1, R_2—100,000 ohm, ½ w. res.
R_3, R_{63}—1 megohm, ½ w. res.
R_4, R_{16}, R_{18}—1000 ohm, ½ w. res. ± 10%
R_5—27,000 ohm, ½ w. res.
R_6, R_{12}—68,000 ohm, ½ w. res. ± 5%
R_7, R_{13}—2 megohm, 2-gang pot.
R_8, R_9—2200 ohm, ½ w. res. ± 5%
R_{10}, R_{11}—820 ohm, ½ w. res. ± 5%
R_{14}—470 ohm, ½ w. res. ± 10%
R_{15}, R_{19}—100 ohm, ½ w. res
R_{17}—3900 ohm, ½ w. res. ± 10%
R_{20}, R_{21}—33,000 ohm, 1 w. res. ± 10%
R_{22}—3300 ohm, 1 w. res. ± 10%
R_{23} to R_{32}, R_{33} to R_{42}—200 ohm ½ w. res. ± 5%
R_{43} to R_{52}, R_{53} to R_{62}—20 ohm, ½ w. res. ± 5%
C_1—.005 μfd., 600 v. cond.
C_2—.02 μfd., 200 v. cond.
C_3, C_7—100 μμfd. mica cond. ± 5%
C_4, C_8—.001 μfd. mica cond. ± 5%
C_5, C_9—.01 μfd., 200 v. cond. ± 5%
C_6, C_{10}—.1 μfd., 200 v. cond. ± 5%
C_{11}, C_{12}, C_{13}—.1 μfd., 600 v. paper bathtub cond.
C_{14}, C_{15}—40 μfd., 450 v. elec. cond.
S_1—2-pole, 4-pos. wafer sw.
S_2—S.p.s.t. toggle sw.
S_3, S_4—2-pole, 11-pos. wafer sw.
T_1—Power trans. 340-0-340 v. @ 70 ma.; 5 v. @ 2 amps.; 6.3. v. c. t. @ 2.5 amps. (Stancor PM-8408 or equiv.)
CH_1—13 hy., 65 ma. filter choke, 500 ohms (Stancor C-1708 or equiv.)
PL_1—6.3 v. pilot light (Mazda #44)
V_1, V_2—6AG7 tube
V_3—6J6 tube
V_4—12AU7 tube
V_5, V_6—6AG5 tube
V_7—0A2 tube
V_8—5Y3G tube

QUALITY CONTROL of TV TUBES



Deflection yoke can be moved vertically on its support and horizontally on track. It is spring-mounted to insure proper positioning of tube neck.

A custom-designed picture tube test set plays an important role in maintaining CR tube standards.

By
BERTRAND W. SQUIER, JR.

Chief Eng., Cathode-Ray Tube Dept.
Raytheon Manufacturing Company

THE mass production of cathode-ray tubes has necessitated a streamlining of test procedures. In regular production, five major characteristics are checked on each tube. They are grid cut-off voltage, screen appearance, gas, emission, and voltage breakdown. By the use of preset voltages switched by a series of push-buttons, these five characteristics can be checked in less than 30 seconds.

Such modern test procedures can only be justified when backed up by sound engineering, uniform production methods, and by the use of statistical quality control data. When a new tube type goes into production, the engineers involved decide which characteristics must be checked on every tube and which can be "controlled" by engineering analysis. The prime consideration in making these decisions is—Would a tube with this defect be inoperative in, or damage, a customer's set?

The engineering test set, pictured on this month's cover, is used to control the quality level of the outgoing product. This set is designed to read current and voltage in every circuit used to operate a television picture tube. Its meters are sensitive and calibrated weekly. In other words, this set is designed for extreme accuracy.

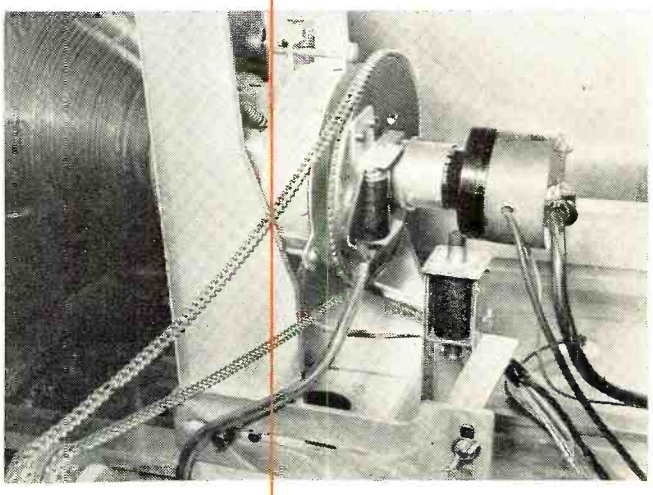
Each day a certain percentage of the day's production is selected from the five-hour hold conveyer and tested on the engineering test set. These tubes are given "the works"—a total of 22 separate tests. These tubes are then held for a week and tested a second time for changes in gas readings, emission, and leakages. The changes, as well as the initial readings, are plotted and the average is closely followed. For instance, if the average cut-off increases several volts a day for two or three days, an adjustment is made in the mounting operation to compensate for this change. Any tendency of a characteristic to stray from the bogie is reversed *before any actual scrap occurs.*

The engineering test set has several features which are unique and ingenious in design. One of these is the tap tester shown in the picture. The tap tester is operated by a push-button on the front of the test set. The unit can be moved to accommodate the various tube types. In the proper position, the core of the small solenoid raps the tube base below the brass sleeve. When testing for a loose cathode weld, a small spot on the screen is used. This spot will vary in intensity when the tube is tapped if the cathode structure is defective. Such a microphonics test has proved useful in judging new cathode structures and in the development of electrostatic focus tube types.

Since an engineering set must be versatile, this unit has been designed for quick changeovers between tube types and for easy loading. The lucite platform rolls out so that the front and side of the mounting unit are readily accessible. The machine will handle all tubes up to 30" in diameter. The accompanying photograph shows the platform in the loading position. The deflection yoke is enclosed in a thin, brass case for protection. This yoke has been wound to industry specifications and costs about 100 times the price of a standard television deflection yoke. Quick mounting is obtained by using a fixed support for the face of the tube and by changing the yoke height and yoke distance from the face. When the platform has been rolled out, it locks into position and all voltage lead wires make contact with electrical ground by means of roller switches. Thus, even though the operator is fully protected by interlocks, all residual charges are removed by the ground contacts. The ion trap is wound to standard specifications and is controlled by varying the current through it and by physical rotation of the trap by means of a chain drive. The tube socket is on flexible leads and is mounted by hand. A wire brush serves to ground external conductive coatings.

(*Continued on page* 165)

Close-up of the base tapping mechanism. The ion trap, which rotates on a thin brass sleeve, can also be seen in photo.



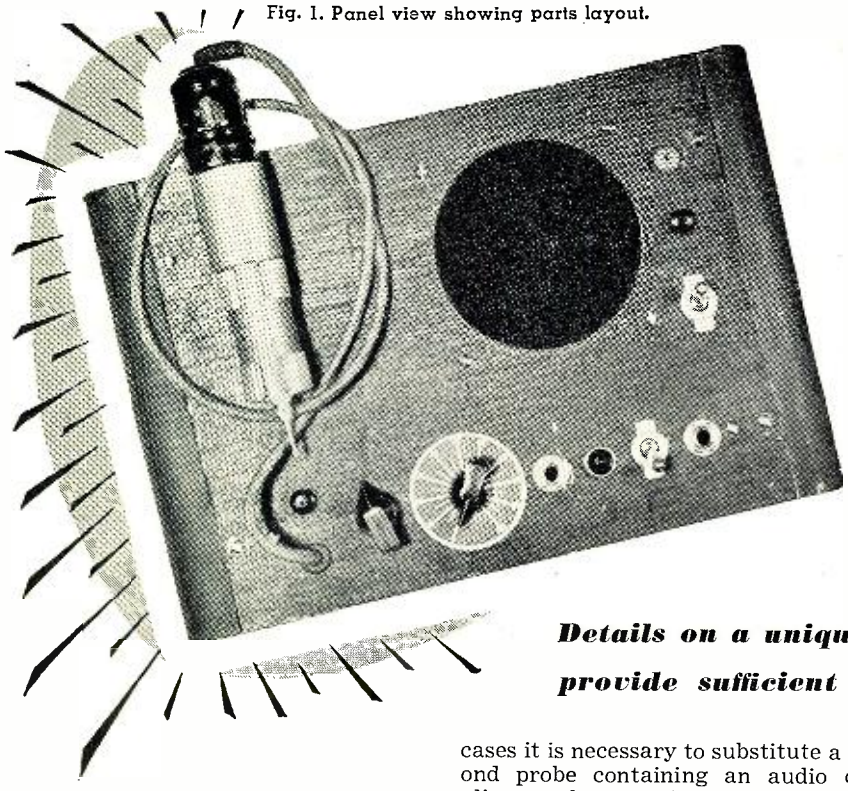


Fig. 1. Panel view showing parts layout.

A High Gain SIGNAL TRACER-AMPLIFIER

Details on a unique test unit which is designed to provide sufficient sensitivity for rural servicing.

By

ROBERT H. DELLER

W8ALV

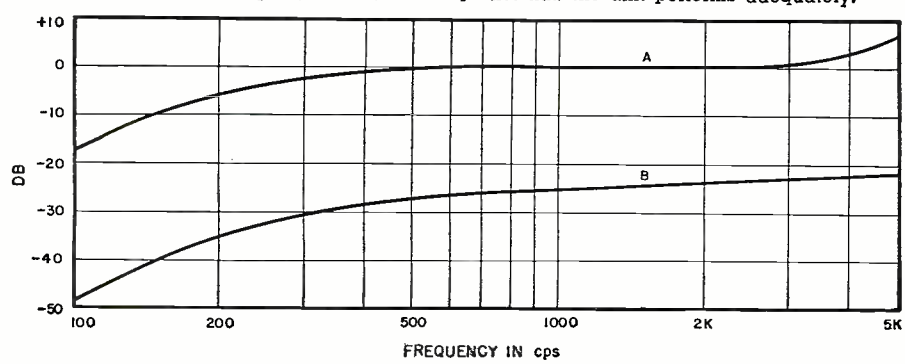
THE signal tracer method of radio servicing has gained increasing popularity during the past several years as exemplified by the many articles on the subject which have appeared in this and other technical magazines. Probably the greatest single factor that has contributed the most to the popularity of signal tracing devices has been the application of crystal diodes, such as the type 1N34, as the rectifying element in small, compact tracer probes. So versatile are these units that perhaps one loses sight of the fact that these diodes are, after all, simply rectifiers and contribute nothing toward the amplification of the signal. Since these diodes rectify indiscriminately from low audio to upwards of 100 mc., they cannot be used satisfactorily as probes in the audio circuit of a receiver or amplifier without introducing considerable distortion to the audible signal. In such cases it is necessary to substitute a second probe containing an audio coupling condenser. A properly designed vacuum tube probe, on the other hand, suffers from none of these disadvantages. It detects the audio component with facility from the very low frequency to the very high r.f.; it introduces no distortion to audio, produces only slight loading effect to tuned circuits, and at the same time provides a high degree of amplification.

Many of the signal tracers now in general use, using either diode or vacuum tube probes, seem to suffer from one common defect—lack of sufficient voltage gain. This condition is not detrimental to the technician living in a metropolitan area since his shop is practically saturated with strong signals from nearby stations. For the rural technician, however, whose shop may be located 50 miles or more from the nearest broadcast station, this lack of voltage gain could constitute a serious problem, particularly when attempting to detect a signal at the front end of a weak or misaligned receiver.

The signal tracer described in this article has been designed with the rural technician in mind. It is an extremely sensitive device devoid of unnecessary extras such as built-in r.f. meters, output meters, substitution speaker, or multiple circuits. It is simply a signal tracer that does nothing but trace signals. It is assumed that the technician already has the proper test equipment for making the usual voltage and continuity checks and therefore there is no need to increase the expense of the tracer by duplicating this equipment. However, provision is made so that an output meter may be connected to the tracer when necessary. The tracer may also be used for testing crystal and dynamic microphones and can serve efficiently as a phonograph amplifier or small p.a. system.

The extremely high voltage gain (more than 70 db) depends on the use of two high mu triodes operated at zero bias. This method of operation permits the use of high input and output circuit impedances in order to realize a voltage gain comparable to that obtained from high mu pentodes. Two distinct advantages result from this use of triodes rather than pentodes: an economy of parts through the elimination of cathode resistors and bypass condensers and the fact that the inherent tube noise is much lower in triodes. The result is a higher signal-to-noise ratio than could be realized from the use of pentodes. The problem of feedback or unwanted interstage coupling is eliminated due to the complete isolation of the probe tube from the rest of the circuit. Further decoupling is provided through the use of isolating resistors R_3 and R_7 and condensers C_2 and C_5. A somewhat unconventional method of coupling the probe tube plate circuit to the grid of the 6SF5 is also used. It will be noted that the volume control, R_4, is isolated from both the plate load resistor, R_2, and the grid resistor, R_5, by means of condensers C_3 and C_4. With this arrangement no d.c. voltage appears on the

Fig. 2. Comparative response at audio frequencies of the probe (curve A) and the microphone-phono input (curve B). Although not flat, the unit performs adequately.



control, resulting in noise-free operation and at the same time the input impedance of the 6SF5 grid is maintained constant regardless of volume control setting. Shunt capacity represented by the 2 foot shielded plate lead in the probe cable effectively bypasses to ground any r.f. voltage which might otherwise appear at the grid of the 6SF5.

The front panel layout is shown in Fig. 1. To the left of the 4 inch speaker grille is located the probe tube held securely in a clip bolted to the panel. The clip was originally intended to hold a flashlight and can be obtained in any hardware or auto supply store. Directly below the probe is pin jack J_2, which provides a ground connection to equipment under test. The entrance hole for the probe cable is located just under the pin jack. Immediately to the right is switch S_1 which disconnects the probe tube when the amplifier is used for testing microphones or record players. Volume control R_4 is next with input jack J_1 just to the right of the control. The pilot light, power switch S_3 and the output phone jack J_5 are shown next in the order named. Output pin jacks J_3 and J_4 just to the right of the speaker grille, provide a convenient connection when an a.c. voltmeter or output meter is used. Switch S_2 is located just below the pin jacks and is used to disable the speaker when using earphones or when an output meter is used and it is unnecessary to listen to the ear-splitting screech of a test oscillator during receiver alignment.

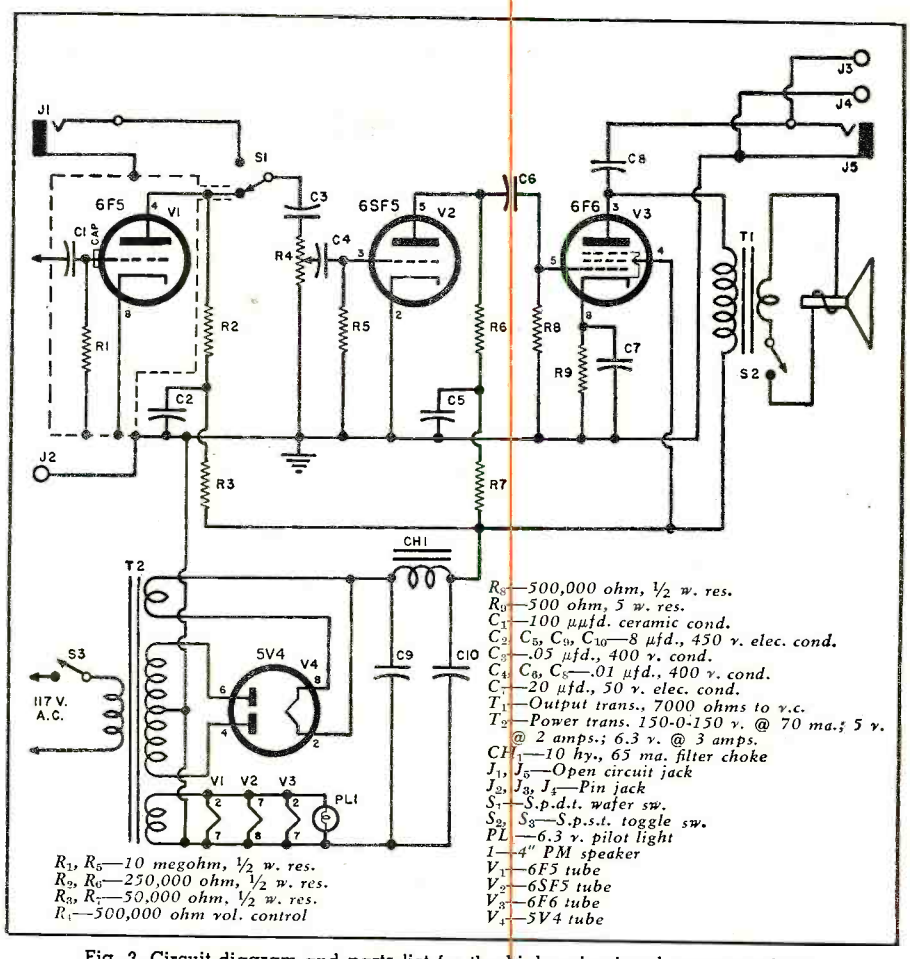


Fig. 3. Circuit diagram and parts list for the high gain signal tracer-amplifier.

As shown in Fig. 4, the probe consists of a metal 6F5, a tube base connector and cable, and a brass shield fitted with a probe tip. The 2 foot connecting cable requires one shielded plate lead and one heater wire. Ground return for both cathode and heater is made by way of the shield. A cable containing an extra wire is desirable since it can be paralleled with the heater wire to prevent a possible voltage drop. The cable is wired permanently into the circuit through a hole in the front panel. Grid resistor R_1 is mounted directly on top of the 6F5 with one end soldered to the grid cap and the other end to the tube shell adjacent to the grid cap insulating disc. The small coupling condenser, C_1, is likewise soldered to the grid cap with the free end fished through the probe tip when assembly is completed. The probe shield is made from a piece of brass bearing stock turned down on a lathe with an inside diameter to provide a tight fit when the 6F5 is forced into the shield. The probe tip mounted on a bakelite disc and fitted into the end of the shield completes the assembly. Possibly the reader may desire to construct the probe in some manner other than that described, using perhaps a section of a 6L6 tube shell or other metal tubing of suitable diameter. Any method will be satisfactory as long as the grid resistor and coupling condenser are contained within the shield. A small spot on the 6F5 shell should be scraped free of paint and wiped with solder to insure a good electrical connection between the shell and shield.

The under chassis layout is shown in Fig. 5. Arrangement of parts on the 7" x 9" x 2" chassis is not critical; how-

(*Continued on page* 149)

Fig. 4. The 100 μμfd. ceramic condenser and the 10 megohm grid resistor can be seen soldered to the 6F5 grid cap. The brass shield housing and probe tip assembly are shown in lower photo.

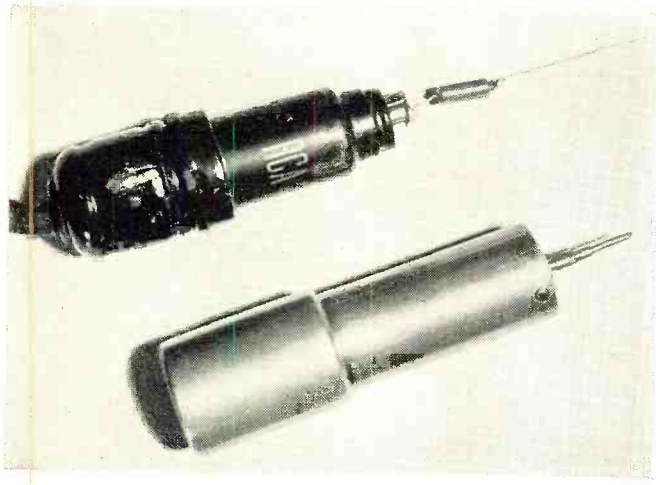
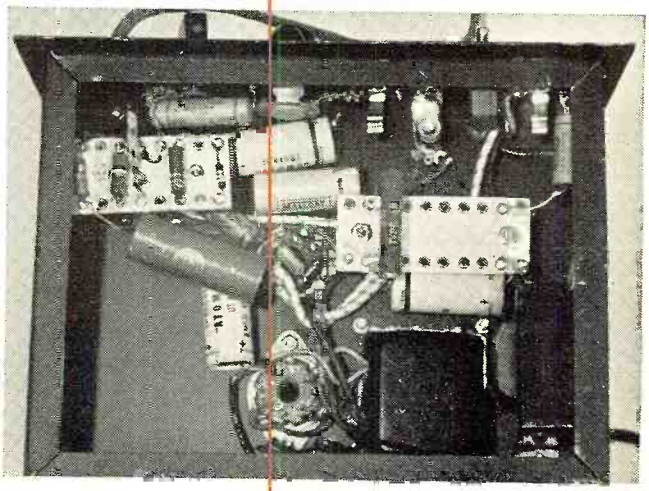
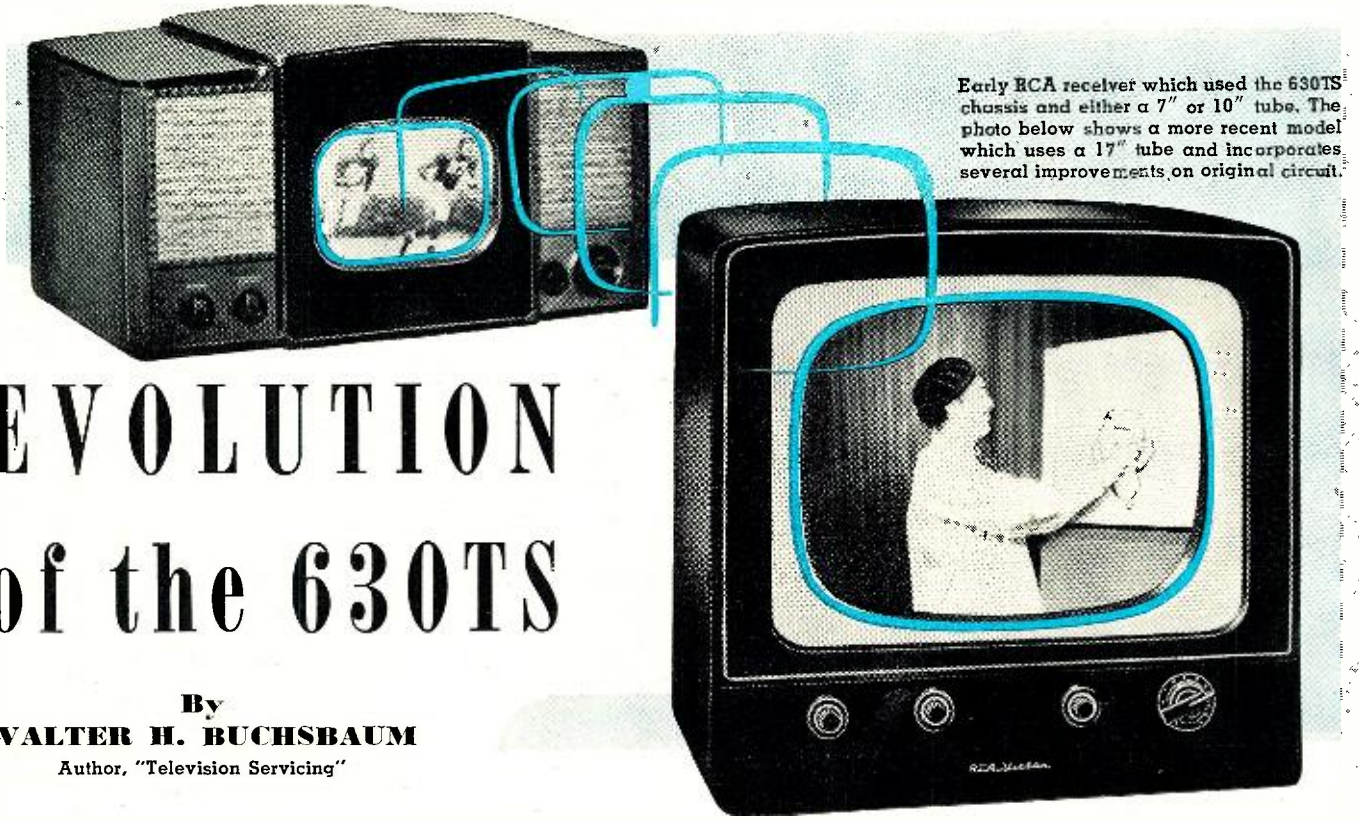


Fig. 5. Underchassis view. The 6SF5 tube socket is under terminal strip in upper left-hand corner. The 6F6 tube socket is at center with the rectifier tube socket visible just below.





Early RCA receiver which used the 630TS chassis and either a 7" or 10" tube. The photo below shows a more recent model which uses a 17" tube and incorporates several improvements on original circuit.

EVOLUTION of the 630TS

By
WALTER H. BUCHSBAUM
Author, "Television Servicing"

Data on a popular television chassis which appeared in 1946 and has since been revised and improved.

IN THE fall of 1946 *RCA* delivered the first mass produced television receiver in this country. Two models were offered, a 7-inch set and a "large screen" 10 inch table model or console. The 10 inch set was designated chassis model number 630, and had 30 tubes including the picture tube. Since that time more 630 type TV receivers have been sold than any other single model.

The model 630 quickly became a standard of performance and was copied in its essential features by many TV manufacturers, large and small. *RCA*'s patent licensing service enabled other manufacturers to use the identical tubes and components in their TV models. After *RCA* discontinued the 630, smaller manufacturers bought up chassis and parts and continued to use the original circuit and layout. Even today the 630 is being sold in kit form, finished chassis, and as complete TV sets for custom installations and private label merchandise. Its model number has become a symbol of reliable performance, extra sensitivity, and stability. Even the lay public knows that the 630 is a very well designed TV receiver.

The outstanding features of the 630 were its good sound and picture sensitivity, its extremely stable synchronizing system, and its sharp detail picture. Resistors and condensers were rated very conservatively, minimizing failure of these components. Unfortunately the 10 inch picture tube was the largest size available in quantity at the time the 630 was designed. To operate with present-day picture tubes drastic changes had to be made in the original version.

Fig. 3 is a block diagram of the original 630 set with the number and tube types shown in each section. Those sections marked with a star have been subject to considerable modification since 1946. The ion traps on the first receivers were of the electromagnetic type, having two small coils with part of the bleeder current going through them. Only a year after the 630 came out these coils were replaced by a permanent magnet type ion trap. The 10BP4 picture tube was superseded by a 12 inch or, in a few custom installations, by a round 15 inch tube. The original loudspeaker for the 630 table model was a 5 inch speaker of the electromagnetic type with the field acting as "B plus" choke. Most competing manufacturers replaced this with a larger speaker, usually of the PM type, and a choke coil. The single 6K6 audio output tube was often replaced by a push-pull audio amplifier, sometimes by part of a combination radio-TV set. These changes did not require too many new components and were all done during the first few years the 630 was on the market.

Three other major modifications have been added during the past three years and they have greatly extended the utility of the original 630 design. A new tuner, an automatically biased i.f. system, and a really large screen picture tube bring the 630 completely up-to-date. Many articles have appeared in this and other magazines on the mechanics of converting a 630, but little has been said on the circuit theory of the new *versus* the old circuits. To clarify the theory behind these three major changes, we shall briefly touch on the operation of both the original and the present circuits.

Tuner Change

The original 630 offered a thirteen-channel, switch-type tuner using three 6J6 double triodes. One 6J6 operated as a push-pull r.f. amplifier with an untuned input (300 ohms), the second 6J6 as a push-pull oscillator, and the third as the mixer. The tuned elements consisted of a tapped tuned line mounted on a wafer switch with the moving arm acting as a shorting bar. Alignment of this tuner, the KRK2, was tricky for the technician, to say the least.

Present-day tuners, such as the *Standard Coil* tuner—the one most widely used in recent years, usually feature two tubes, a pentode r.f. amplifier and a double triode as oscillator and mixer. The tuning is provided by a separate set of coils which is switched in for each channel. This permits the design of a tuned, impedance matched input circuit and individual, replaceable coil plates for each channel. Other types of tuners such as the *DuMont-Mallory* "Inductuner" or the *Sarkes Tarzian* switch tuner, all feature tuned input, pentode r.f. amplifiers, and much simpler alignment. In late 1951 a new "cascode" r.f. amplifier appeared which greatly reduces snow in extreme

fringe areas. The major advantages of present-day tuners are: increased r.f. gain, better signal-to-noise ratio, and better rejection of images and various types of interference. Reduced oscillator radiation is another feature, but this is of benefit to the neighbors rather than the individual set owner.

So widespread is the use of the 630 that most of the new tuners can be mounted in the original chassis pan with only minor alterations in the tuner cut-out. Electrically any tuner having an i.f. range between 21 and 26 mc. and a separate coil for the sound i.f. can be used in the 630 chassis. The "B plus," filament, and bias connections on most commercial tuners are so similar as to present no special problem.

Automatic Gain Control

One of the major complaints on the original 630 concerned the tricky adjustment of the contrast control. On a weak station a good picture would be received and on a strong station the picture disappeared or was distorted until the contrast and brightness controls were very accurately reset. This was due to the circuit of the contrast control. A fixed negative voltage was applied across the contrast potentiometer and a divider network in such a way that the contrast control varied the grid bias on the r.f. amplifier and the first three i.f. tubes. The i.f. and r.f. gain was thus varied by adjusting the fixed bias. On a strong signal the correct bias to prevent overload might be 4 volts while on a weak signal only 0.5 volt might be desired.

The first modification of the contrast circuit was the addition of a peak detection type a.g.c. system (Fig. 1). This required an additional diode, connected to the i.f. side of the second detector and furnishing a negative voltage output. This negative voltage is then applied through proper filters to the grids of the i.f. amplifier and the first three i.f. tubes. On a strong signal the diode will receive a larger i.f. signal and produce more negative voltage. A rise in negative voltage will reduce the gain of the i.f. and r.f. sections and thus overcome the increased signal strength. This action is basically the same as the a.v.c circuit found in most modern radio receivers. To obtain the additional diode section many designers removed the d.c. restorer network and used half of the 6AL5 double-diode as a.g.c. tube. A better approach is to add a crystal diode such as the IN34 or some of the more recent types. Since this eliminates the contrast control, another spot must be found for this function. In many instances a circuit was provided to maintain a fixed negative voltage across the contrast potentiometer and apply the variable bias from the contrast control in series with the bias supplied by the a.g.c. bias. Varying the screen voltage of the 6AU6 first video amplifier is another possible method of varying the contrast.

The most widely used type of a.g.c. in today's 630 models is a special keyed type. First described by the author in the December 1949 issue of RADIO & TELEVISION NEWS, this keyed a.g.c. system is being used in many other television models today. See Fig. 2.

The principle of this circuit is the keying action by the horizontal output section. The a.g.c. tube can conduct only during the horizontal retrace time, the exact period during which the sync pulse appears at the video amplifier. As a result, the a.g.c. bias voltage is dependent only on the sync pulse level, and noise occurring during the long picture period cannot affect the a.g.c. Furthermore, since only the 15,750 cps pulses can affect the a.g.c. bias, the a.g.c. filter can have a much shorter time constant. This, in turn, enables the a.g.c. to follow rapid changes in signal strength and thus compensate for fading due to airplanes or antenna sway.

Keyed a.g.c. has been in use for over two years now and many modifications of the original circuit have been made. The main features, however, are still the same. The 6AU6 is invariably used as the a.g.c. tube, and in the 630 model this requires an additional chassis hole and a socket. In some 630 kits the a.g.c. tube is mounted on a small bracket underneath the chassis. The keying pulse is invariably obtained from a special coil wound over the regular width coil. The contrast control is disconnected from the negative bleeder and the a.g.c. bias is connected to the grid of the r.f. and the first three i.f. amplifiers. To vary the contrast, some manufacturers use the old contrast control on the screen of the first video amplifier or else in the cathode of the a.g.c. tube. In the latter system the contrast control will determine the level of the a.g.c. bias and this provides a smooth and wide range of control. A further modification of the video amplifier circuit consists of a direct connection from the second detector to the first video amplifier which is then coupled directly to the a.g.c. tube. This assures a constant level for the sync pulses.

Most of the deluxe 630 models of the past year feature keyed a.g.c. and, in addition, new and better video i.f.

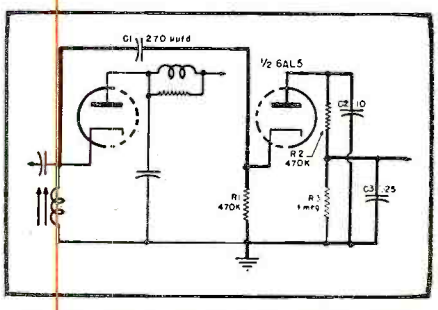


Fig. 1. Simple diode a.g.c. for the 630.

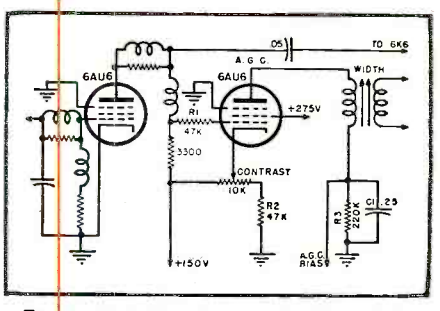


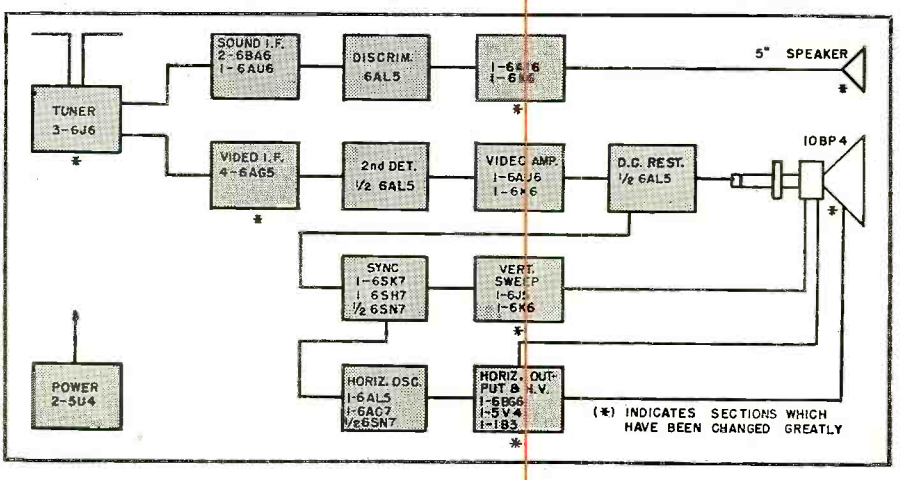
Fig. 2. Basic keyed a.g.c. for 630 model.

tubes are used. In the original design the i.f. amplifiers used four 6AG5 tubes which, at the time, were the best miniature pentodes for this application. Now the 6AG5 is becoming obsolete and its successor is the 6CB6. This miniature pentode has 20% greater transconductance than the 6AG5 and therefore greater gain. The suppressor grid is brought out independent of the cathode. The suppressor grid in the 6CB6 is pin 7 which is invariably grounded. Pin 2, the cathode of the 6CB6 usually has a small resistor, 39 ohms in the 630, going to ground. In the original 630 either pin 2 or 7 was used for the cathode since the suppressor in the 6AG5 was internally connected to the cathode. When servicing a late model 630 it is important to know whether a 6CB6 or a 6AG5 is used in the i.f. so that repairs can be made accordingly.

Large Screen Picture Tubes

The original 630 was designed with ample sweep for the 45 degree 10BP4 and with a high voltage of about 9000 volts. When a 52 degree tube, such as

Fig. 3. Block diagram of the original RCA 630TS television receiver chassis.



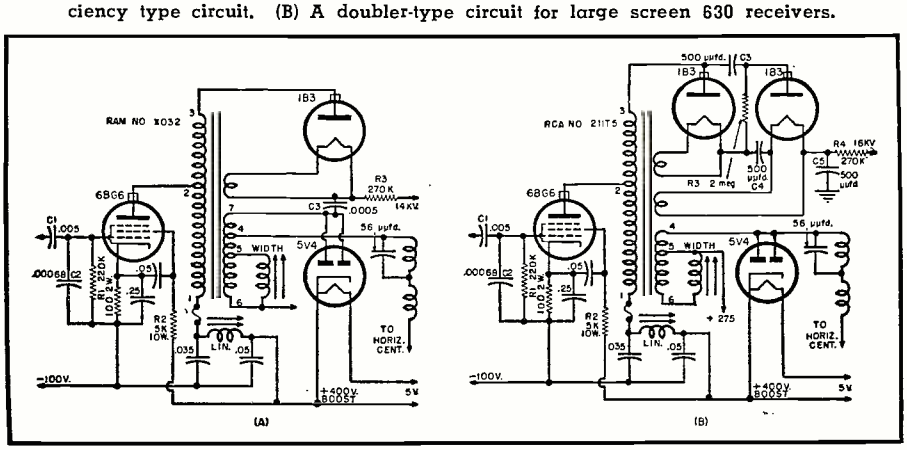
the 15CP4, was used the deflection and high-voltage were barely sufficient, but with 63 and 70 degree tubes, the old 630 was not usable. Two separate deficiencies appeared. First, the deflection angle became so wide that the old deflection yoke gave neck shadow as well as insufficient sweep. Secondly, the required voltage for the second anode was higher than the maximum available from the 630. The remedy for both defects consists of a completely new horizontal flyback system. Here again several different systems are in use today. The first *RCA*-developed sweep system for wide angle, large screen tubes involves the use of a high-voltage doubler to achieve the higher second anode voltage and a powdered iron core flyback transformer. This system is used in such well-known 630 models as the *Regal, Philmore,* and many others. The flyback transformer is the *RCA* #211T5, which has two high-voltage filament loops for the two 1B3 high-voltage rectifiers used in the doubler circuit. The ouput of this system ranges up to 16 kv. which is sufficient even for a 24 inch picture tube. This type of system is shown schematically in the diagram of Fig. 4B. In some models the original 6BG6 is retained, in others a 6CD6 is substituted. The latter tube draws more "B plus" and more filament current, which is sometimes supplied by using a higher rating power transformer than was originally used with the 630. Circuit modifications are also made in the horizontal oscillator and discharge networks to obtain more drive and thereby more sweep and high-voltage.

The second system used for large screen picture tubes involves the original, single 1B3 high-voltage rectifier, but a new, high efficiency flyback transformer is used. Instead of a large powdered iron core, a relatively small ferrite core is used which reduces the losses and greatly improves the *"Q"* of the entire circuit. To get full efficiency from this circuit the deflection yoke must be of special design, usually featuring, in addition, a ferrite core. Again, circuit changes in the oscillator and discharge networks are necessary to drive the flyback section hard enough. Although most models use the original 6BG6 output tube, some have substituted a 6BQ6 or a 6CD6 to get better results with a particular type of flyback transformer. It is important to note that many ferrite flybacks, such as the *G-E* 77J1, require a special width and linearity coil. In the case of a keyed a.g.c. system, the a.g.c. winding must be wound on the special width coil. Both the voltage doubler and the high efficiency flyback circuit have certain advantages and disadvantages. In the case of the doubler a second 1B3 and two additional high-voltage condensers are required. This cramps the already limited space in the high-voltage compartment and often leads to arcing and corona which may be very difficult to eliminate. The high efficiency flyback has a longer retrace time than the powdered iron type. Too long a retrace time results in horizontal foldover. This foldover can be minimized by adjusting the phasing slug on the "Synchrolok" transformer or by shunting the .015 μfd. condenser across the phasing winding of this transformer with an additional .002 μfd. Another scheme blanks out the foldover by connecting the first anode of the picture tube to a portion of the horizontal flyback pulse, thus cutting the tube off during the period of the retrace and foldover.

Some of the circuit details of the 630 circuit using a high efficiency flyback transformer are given in the diagram of Fig. 4A.

In both types of high-voltage flyback a wide angle deflection yoke must be used to avoid neck shadow and insure adequate sweep. Most of these yokes have a smaller vertical winding than the original 630. The vertical deflection for a 10 or even 15 inch tube which the 630 provided is not sufficient for the wide angle picture tubes with the smaller vertical yoke winding. To inincrease the vertical sweep, many 630 models simply raise the voltage to the vertical oscillator and output tube by connecting them to the boost voltage from the horizontal flyback transformer. In some cases the 6J5 oscillator is changed for a 6SN7 which permits using one half of the tube as the oscillator like the 6J5 and using the second half as a discharge tube, thus getting more vertical drive for the output amplifier. The 6K6 ouput amplifier in the original 630 was connected as a triode, and in some later versions, a triode like the miniature 6S4 or the 6SN7 connected in parallel, is used instead. New ouput transformers designed to match the ouput tube to the new vertical deflection yoke also help in getting sufficient vertical sweep.

Fig. 4. Two flyback circuits designed for use in the 630 circuit. (A) A high-efficiency type circuit. (B) A doubler-type circuit for large screen 630 receivers.



Other Changes

Many minor electrical changes are found in the new 630 versions. For example, in the old 630 the filaments for all 6AL5 tubes were heated through a resistor providing less than the 6.3 volts rated. The reason for this was the concern of the designers for the performance of the 6AL5 under rated voltage, since this was a relatively new tube. Now the 6AL5 has been considerably improved and the filament dropping resistor is eliminated in most late 630 versions. Substitution of a 6W4 for the 5V4 damper is another minor change. The 6W4 requires no separate filament and does the job just as well as the 5V4. In the original version a pilot light was used in the high-voltage cage as fuse for the flyback transformer. In many newer 630 sets this is either omitted or a fuse is wired into the circuit. Some of the condensers and resistors have been changed slightly to get better performance with large screen picture tubes, but these are all minor electrical changes.

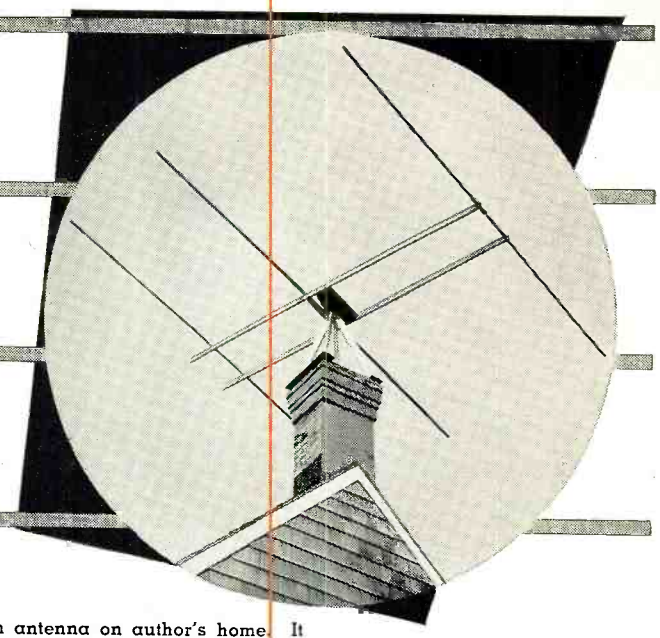
Mechanically the only major change has been in the mounting brackets used for the picture tube, deflection yoke, and focus coil. In the original 10 inch version, the picture tube is mounted on the chassis between the front controls. As the picture tubes gained in diameter, they had to be mounted higher above the chassis. The rectangular picture tubes are usually mounted entirely above the chassis on both front and rear supporting brackets. In many late versions the picture tube is mounted in the cabinet and cables and plugs connect the deflection yoke and focus coil to the main chassis.

Reviewing the past five years, it is indeed remarkable how one particular design has been maintained in its essentials yet is still an up-to-date TV model. With the additional improvement of better tuners, a.g.c., and large screen picture tubes, the 630 is today considered a high quality receiver with exceptional fringe performance, good resolution, and consistent trouble free operation.

While we have pointed out the important changes that have taken place in the past in the design of this particular receiver, new refinements are being added all the time.

In addition to circuit changes, the next few years will see many new developments in picture tube design, including the popularization of the electrostatic focus type tube which not only permits drastic savings in critical materials but allows important simplification of television receiver circuits. An article on this topic will be included in next month's issue. —30—

THE ALUMINUM FOIL BEAM



Beam antenna on author's home. It has withstood several hard storms.

By

MAJOR HARRY L. ULYAT,
W3PTW

Details on a priority-free antenna for operation in the 10 meter band. Only hand tools are needed.

THERE are a lot of us fellows who have thought about building a 10 meter beam but the trouble and expense have been big factors in making us decide against it. If it could be made of something we already had in the shack or in the kitchen, we wouldn't mind getting started on the thing.

The author had come to this "dead end" state of affairs when one day his wife was fixing dinner and started unrolling some long sheets of aluminum foil. A duck was to be wrapped in this foil and placed in the oven.

But about that time an idea was born and the wife was told to hold everything. Quickly getting out the yardstick the remaining length of foil was measured. Yep; it would do. My 10 meter beam was as good as made!

Leaving the duck to get along the best way it could (also the wife) the tool shed was ransacked and brought forth three long wooden poles 1½ inches in diameter. I had all I needed!

But would it work? Hastily looking through some articles for ideas on 10 meter beams I came across just what I wanted. Experiments had been made with some 1½ inch aluminum tubing and the results had been tabulated giving the element spacing and lengths.

Cutting the poles the lengths suggested, they were first painted with a good grade of wood filler. Strips of aluminum foil 5 inches wide were cut the same length as the poles and wrapped around them lengthwise while the poles were still wet, the edges lapping and held down with more wood filler. The filler proved to be a very good glue as well as serving to make the wood waterproof.

These aluminum covered poles were then temporarily mounted on the edge of a couple of pieces of 1 x 4, sixteen feet long. A "T" match was made on the driven element and the thing was hoisted to the roof and placed on the chimney to see what it would do. A piece of 300 ohm twin-lead connected the antenna to the transmitter.

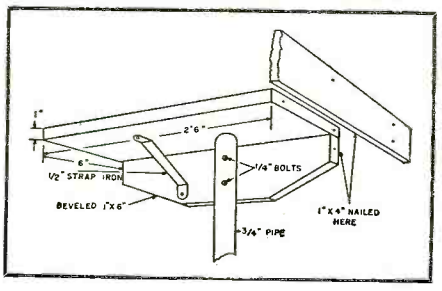
A test was arranged with another ham who lived about a half mile away. On the first test the transmitter seemed to load nicely but he reported that my signals were very weak. There was no noticeable reading on his "S" meter. Of course I was only running 50 watts but surely the signal ought to be stronger than that. He had thought it might work too so we were both quite disappointed. It had looked like a swell idea but I now had to admit that it was a failure.

But just for the fun of it, I suggested that we try once more and turn the beam a little bit. Perhaps it had not been pointing exactly towards his house. Reluctantly he agreed. So once more a test was made, this time checking the exact direction with a map.

To his surprise (as well as mine when he told me) his "S" meter showed an "off scale" reading and my signals were coming in like a ton of bricks! Other tests were made and it proved to have a very good gain and also a high front-to-back ratio.

Since the aluminum foil comes in 25 foot lengths, 12 inches wide, two rolls are more than enough to make a three element beam. Enough will be left over to bake several ducks. The elements should be handled with care during the process of construction as the aluminum foil can be easily torn.

Mechanical details of the aluminum foil beam. Unit is fairly simple to construct.



It is quite evident that beam elements made in this way behave the same as the regular aluminum tubing of the same length and diameter. Any formulas for aluminum tube beams can therefore be used if the wooden poles are the same diameter as the tubes.

After making sure that the beam was really working, certain tests were made with the aid of a field strength meter to determine the exact spacing of the elements. As no holes are bored in the 1 x 4 support, the outside elements may be rolled back and forth on this support while the beam is in the operating position on the roof.

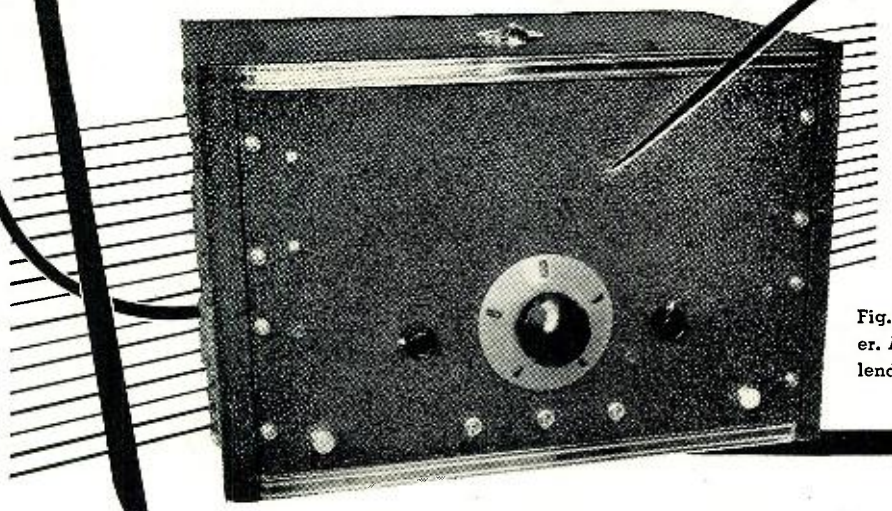
No experiments were made involving changing the length of the elements as this was not as practical as in the case of aluminum tube type beams. It was found that the original spacings, set according to the formula, were practically identical with those that gave maximum readings on the field strength meter.

The measurements used in my particular case were designed to operate best at a frequency of 28.6 mc. The director length was 15 feet, 10 inches; the driven element length was 16 feet, 6 inches; the reflector length was also 16 feet, 6 inches. The spacing of the director from the driven element was 4 feet, 11 inches. The spacing of the reflector from the driven element was 6 feet, 7 inches.

Round wooden poles may be purchased from many lumber companies. So-called 16 foot lengths will usually

(*Continued on page* 111)

STABILITY PLUS



A serviceable v.f.o. exciter which insures stability in amateur radio transmissions.

Fig. 1. Panel view of v.f.o. exciter. A minimum number of controls lends a professional appearance.

...with the Franklin Oscillator

By

MERRITT KIRCHHOFF*
W2FAR

and

DAVID D. BULKLEY**
W2QUJ

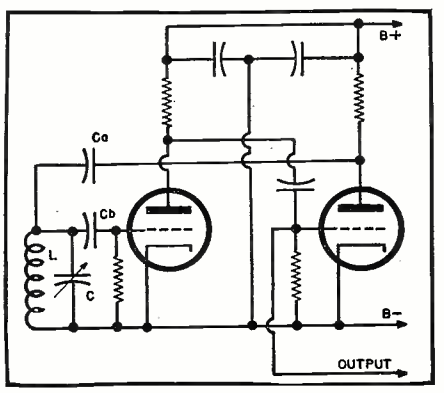
GREAT strides have been made in recent years in the improvement of amateur radio equipment. Receivers with greater sensitivity, greater selectivity, and greater frequency coverage today provide unsurpassed reception facilities for amateur communications. There are available vacuum tubes of such versatility that transmitters have become streamlined wizardries of the amateur art. However, it is evident that much may be done to enable the some 80,000 American hams to carry on with their hobby with a minimum of interference.

Frequency stability has become increasingly important with the adoption of variable frequency oscillators, for the FCC is exercising greater vigilance than ever before. The ham today is more and more conscious of "how his signal *sounds*" and "where his signal *is*." The many plaudits heaped on the *Clapp* variable frequency oscillator are well-earned, for the *Clapp* approaches the epitome of flexible amateur transmitter frequency control. However, the ingenuity of C. S. Franklin of the *Marconi Company* of England has given us a variable frequency control circuit with stability equivalent to that of the finest crystal-controlled circuits. The Franklin oscillator has found application in many laboratory devices in recent years. It is most often used in precision frequency meters and audio oscillators.

The Franklin oscillator differs from the conventional oscillator circuits in that it makes use of two cascaded tubes to obtain the "negative resistance" effect to sustain oscillation. Fig. 2 is a representative circuit wherein it may be seen that the second tube acts as a phase inverter to provide a very high effective transconductance. If the tuned circuit *LC* were replaced by an *RC* circuit, the oscillator would become a multivibrator.

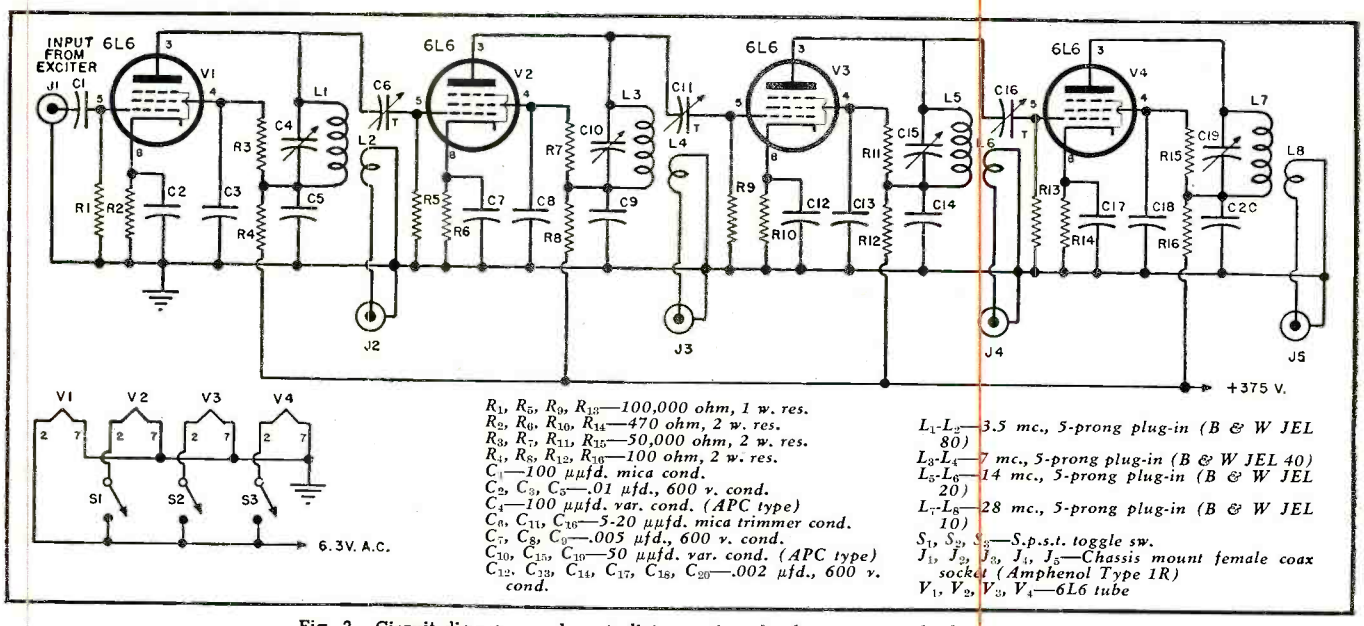
The stability of the Franklin oscillator depends on two factors: first the quality or "*Q*" of the tank circuit and second, the *degree of loose coupling* between the circuit and the tubes. In most forms of conventional oscillator circuits, the resonant circuit is quite tightly coupled to the tube and, as a consequence, is heavily loaded. Irrespective of circuit "*Q*" when measured alone, the "*Q*" will be considerably lower when measured in a "working" circuit. In the basic circuit of the Franklin oscillator, as shown in Fig. 2, C_a and C_b are extremely small—on the order of 1 to 2 $\mu\mu$fd. This effectively reduces tube loading to a negligible value. As a result, the isolation of the circuit *LC* from tube effects is quite complete. Since the interelectrode capacities of the two tubes can only act across the circuit in series with C_a and C_b, no changes of any kind in the tube circuits can alter *C* by more than 1 $\mu\mu$fd. or so. Thus, it is possible to exchange the tube for another of a different type, alter the plate or filament voltages widely, and even allow tube heating to occur. The resonant circuit *LC* cannot possibly be changed in effective capacity by more than approximately 0.2 per-cent (assuming a total tank capacity of 500 $\mu\mu$fd.) Of course, in practice, such drastic changes do not ordinarily occur, so the effect upon the frequency would be considerably smaller than even 0.2 percent. It is this singular immunity to tube and voltage variations and from the effects of tube heating and consequent drift that makes the Franklin such a useful circuit.

Fig. 2. The basic Franklin oscillator circuit. A separate phase-inverter tube is used to feed a portion of the output into the input circuit in the correct phase to insure sustaining the oscillation.



The Franklin lends itself to practical construction for it is tuned with a simple tank circuit with one end grounded, thus, the variable condenser may be mounted directly on the chassis. Should bandchanging be required, it is effected by providing several coils all joined together at one end and ground-

* Columbia Broadcasting System.
** International Telephone and Telegraph Corp.



R_1, R_5, R_9, R_{13}—100,000 ohm, 1 w. res.
R_2, R_6, R_{10}, R_{14}—470 ohm, 2 w. res.
R_3, R_7, R_{11}, R_{15}—50,000 ohm, 2 w. res.
R_4, R_8, R_{12}, R_{16}—100 ohm, 2 w. res.
C_1—100 μμfd. mica cond.
C_2, C_3, C_5—.01 μfd., 600 v. cond.
C_4—100 μμfd. var. cond. (APC type)
C_6, C_{11}, C_{16}—5-20 μμfd. mica trimmer cond.
C_7, C_8, C_9—.005 μfd., 600 v. cond.
C_{10}, C_{15}, C_{19}—50 μμfd. var. cond. (APC type)
C_{12}, C_{13}, C_{14}, C_{17}, C_{18}, C_{20}—.002 μfd., 600 v. cond.

L_1-L_2—3.5 mc., 5-prong plug-in (B & W JEL 80)
L_3-L_4—7 mc., 5-prong plug-in (B & W JEL 40)
L_5-L_6—14 mc., 5-prong plug-in (B & W JEL 20)
L_7-L_8—28 mc., 5-prong plug-in (B & W JEL 10)
S_1, S_2, S_3—S.p.s.t. toggle sw.
J_1, J_2, J_3, J_4, J_5—Chassis mount female coax socket (Amphenol Type 1R)
V_1, V_2, V_3, V_4—6L6 tube

Fig. 3. Circuit diagram and parts list covering the frequency multiplier section.

ed. It is a simple matter to switch them with a single-pole selector switch. It is for this reason that the Franklin circuit is frequently referred to as a "Single Terminal" oscillator.

By merely substituting a crystal for the tank circuit *LC* it is possible to convert the Franklin circuit into a crystal oscillator. Owing to the high amplification of the two-tube arrangement, oscillation is very readily obtained from "difficult" crystals, particularly at low frequencies. It may be applied, for example, to 100 kc. bars and will oscillate quite satisfactorily with resonator crystals (such as those designed for i.f. bandpass filters), which seldom perform in conventional single-tube circuits.

Now, with a thumb-nail sketch of the operation of the Franklin oscillator, we may proceed to the construction of a sensationally stable variable frequency exciter delivering a minimum output of 15 watts in every amateur band from 3.5 to 28 megacycles. Output on 1.7 and 50 to 54 megacycles is possible with very minor changes, which will be discussed.

General. The photograph in Fig. 1 shows the functional, simple, and attractive layout of the front panel of the exciter. To the left of the HRO type main tuning dial is the v.f.o. buffer/doubler tuning control. There is very little need to adjust this control except when endeavoring to get the last milliwatt of drive from the v.f.o. The control knob to the right of the main tuning dial is merely a dummy knob to balance the front panel for appearance sake. The filament indicator light is found in the lower left-hand corner of the panel while the plate-voltage indicator light is in the lower right-hand corner. The left-hand toggle switch controls "on-off" of all filaments in the exciter. The center switch applies plate voltage to the v.f.o. unit alone, so that "spotting" of a frequency may be accomplished without transmitting a signal on the air. The right-hand switch applies plate voltage to the frequency multiplier cascade. This switch might also be used to relay-control the remainder of the transmitter.

Variable Frequency Oscillator Unit. Referring to Fig. 7, we see a top view of the Franklin oscillator and v.f.o. amplifier unit with its cover removed. Although the authors chose to mount the oscillator in a war-surplus cast-aluminum case formerly used in the RAK-RAL Navy receivers, it is not necessary to go to such extremes of construction.

The left-hand compartment, as seen in the photograph, contains the tank circuit section of the oscillator circuit. The 6SN7GT/G oscillator tube (V_1 of Fig. 6), with its allied components, is mounted in the center compartment. This arrangement prevents heating of the tank circuit with possible frequency changes due to mechanical distortion.

As the output of the Franklin oscillator is extremely low, it is followed by a direct-coupled 6AG5 voltage amplifier stage (V_2, Fig. 6). The use of this stage also prevents any possible reaction on the oscillator when low-level modulation is employed in one of the

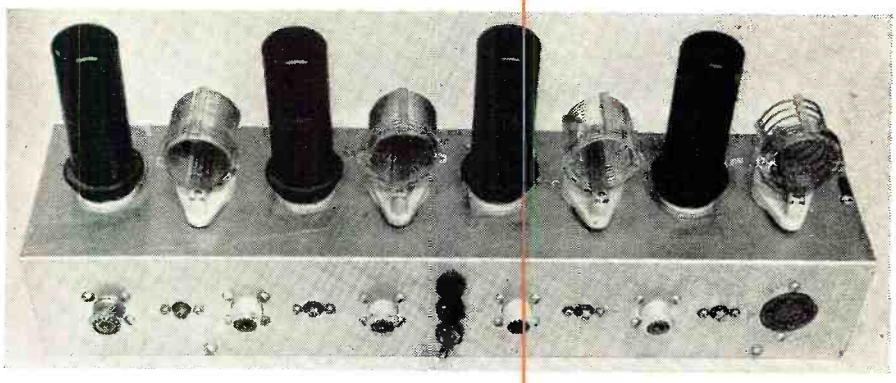
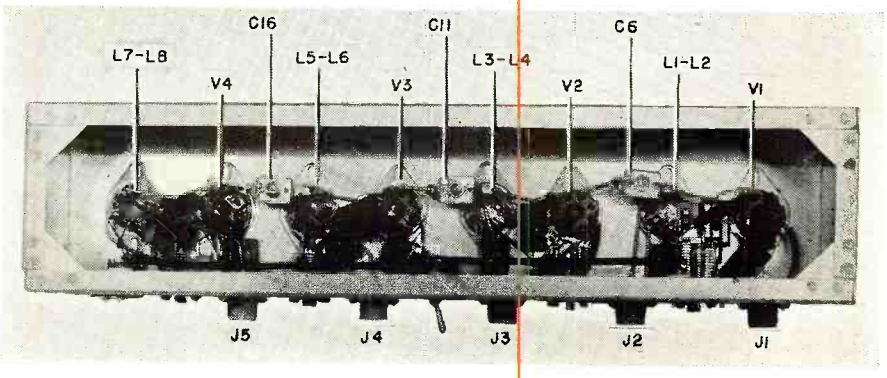
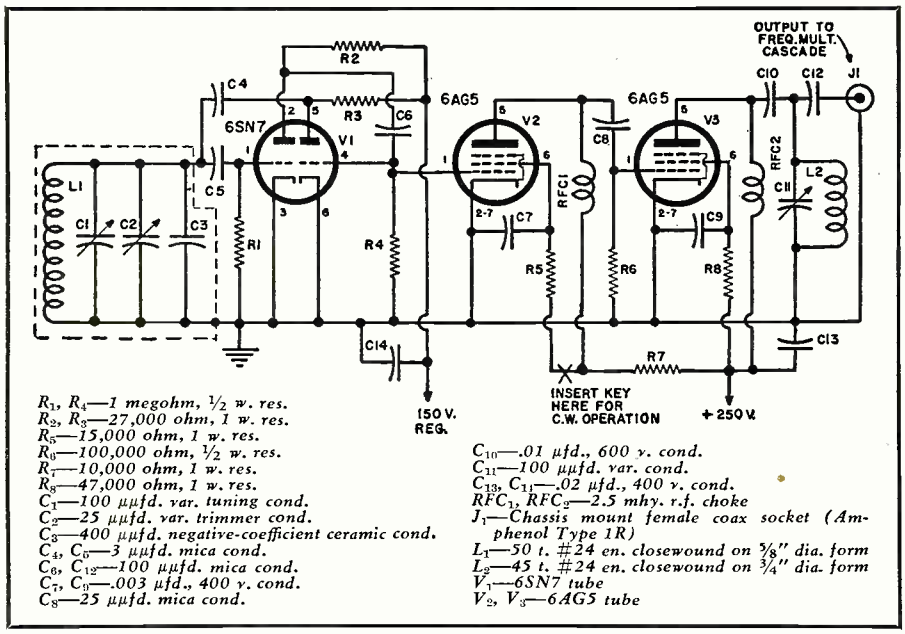


Fig. 4. The frequency multiplier cascade. This layout insures trouble-free operation.

Fig. 5. Bottom view of unit in Fig. 4. Adjustable trimmers are used with flexible drive.





R_1, R_4—*1 megohm, ½ w. res.*
R_2, R_3—*27,000 ohm, 1 w. res.*
R_5—*15,000 ohm, 1 w. res.*
R_6—*100,000 ohm, ½ w. res.*
R_7—*10,000 ohm, 1 w. res.*
R_8—*47,000 ohm, 1 w. res.*
C_1—*100 μμfd. var. tuning cond.*
C_2—*25 μμfd. var. trimmer cond.*
C_3—*400 μμfd. negative-coefficient ceramic cond.*
C_4, C_6—*3 μμfd. mica cond.*
C_6, C_{12}—*100 μμfd. mica cond.*
C_7, C_9—*.003 μfd., 400 v. cond.*
C_8—*25 μμfd. mica cond.*
C_{10}—*.01 μfd., 600 v. cond.*
C_{11}—*100 μμfd. var. cond.*
C_{13}, C_{14}—*.02 μfd., 400 v. cond.*
RFC_1, RFC_2—*2.5 mhy. r.f. choke*
J_1—*Chassis mount female coax socket (Amphenol Type 1R)*
L_1—*50 t. #24 en. closewound on ⅜" dia. form*
L_2—*45 t. #24 en. closewound on ¾" dia. form*
V_1—*6SN7 tube*
V_2, V_3—*6AG5 tube*

Fig. 6. Complete circuit diagram and parts list of the v.f.o. section of unit.

succeeding buffer or amplifier stages. Following the voltage amplifier is a buffer/doubler stage (V_3, Fig. 6) employing another 6AG5. The voltage amplifier and the buffer/doubler stages are contained in the right-hand compartment of Fig. 7.

If it is desired to key the exciter, it may easily be done by inserting a closed-circuit jack (insulated from the chassis) in the screen lead of the 6AG5 voltage amplifier stage (V_2, Fig. 6) of the v.f.o. This arrangement is noted on the circuit diagram of Fig. 6.

Frequency Multiplier Cascade. Fig. 4 is a top view of the four-stage frequency multiplier cascade utilizing 6L6's throughout. Any reasonable combination of frequency multiplying functions may be performed, but for the sake of simplicity, it was decided to drive each 6L6 as a doubler, except in the case of the 21 megacycle band, which will be discussed later.

The first 6L6 doubler (V_1, Fig. 3) receives a 3.5 megacycle signal from the v.f.o. and provides 3.5 or 7.0 megacycle output at J_2. Therefore, it is possible to obtain outputs from the succeeding stages as follows: 7 or 14.0 megacycle output from V_2 and J_3, 14 or 28 megacycle output from V_3 and J_4 and 28 or 50 megacycle output from V_4 and J_5. For 21 megacycle output, V_3 would be used as a tripler with output from J_4.

It is therefore a simple matter to obtain r.f. to drive the intermediate or final amplifier of any transmitter by merely choosing the coaxial output delivering the desired frequency. This simple and efficient system eliminates complicated switching circuits with their attendant losses and radiation.

Auxiliary filament switches are provided which allow V_2, V_3, and V_4 to be turned off when they are not needed; the three toggle switches in Fig. 4 are: S_1, the auxiliary filament switch for V_2, S_2 for V_3, and S_3 for V_4.

As shown in Fig. 4, the tuning condensers for each frequency multiplier tank circuit are screwdriver adjusted as these stages tune broadly enough to provide adequate drive to the succeeding stage.

Fig. 5 is the bottom view of the frequency multiplier cascade. With rigid construction throughout, components are mounted to facilitate assembly and servicing. It should be noted that variable trimmers are used for interstage coupling to permit drive changes to be made if necessary. No metering circuits are embodied as the non-critical drive requirements of the tubes are adequately attained using the components specified in the circuit diagram.

The plate and screen voltages supplied to the frequency multiplier tubes are below the maximum ratings of the tubes. Ample output is obtained to drive the average medium- to high-power amplifier, and is more than enough to drive any of the beam power tubes used by amateurs. If greater output is required, or if it is desired to operate this exciter as a low-power transmitter, the plate and screen voltages may very safely be raised to the full value prescribed for ICAS operation. With full voltages applied, the power output approaches 25 watts.

Power Supplies. Two separate power supplies are used; one for the v.f.o. and one for the frequency multiplier cascade. Although surplus components were used in the original power supply chassis, comparable commercial components are specified in the parts list accompanying Fig. 10.

As has been stressed in the circuit description, the Franklin oscillator is immune to voltage changes, so a regulated power supply is *not* necessary. Indeed, an unregulated selenium rectifier power supply would do just as well as the power supply shown in Fig. 10.

Interconnecting cables, for power supply voltages, are used in the interest of neatness. They are terminated in convenient power plugs. It is urged

(*Continued on page* 151)

Fig. 7. Top view of Franklin oscillator with its allied amplifier and buffer/doubler. Assembly is compact yet uncluttered.

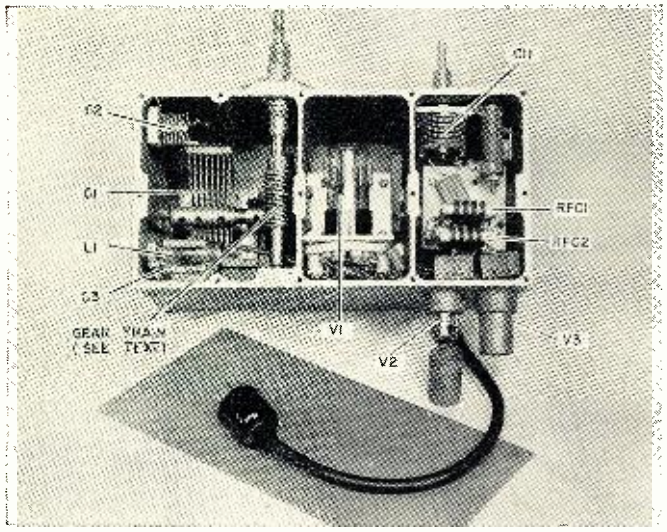
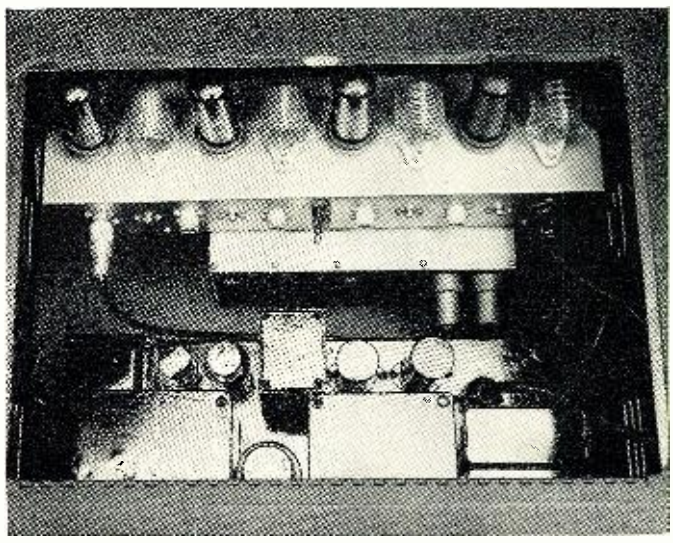
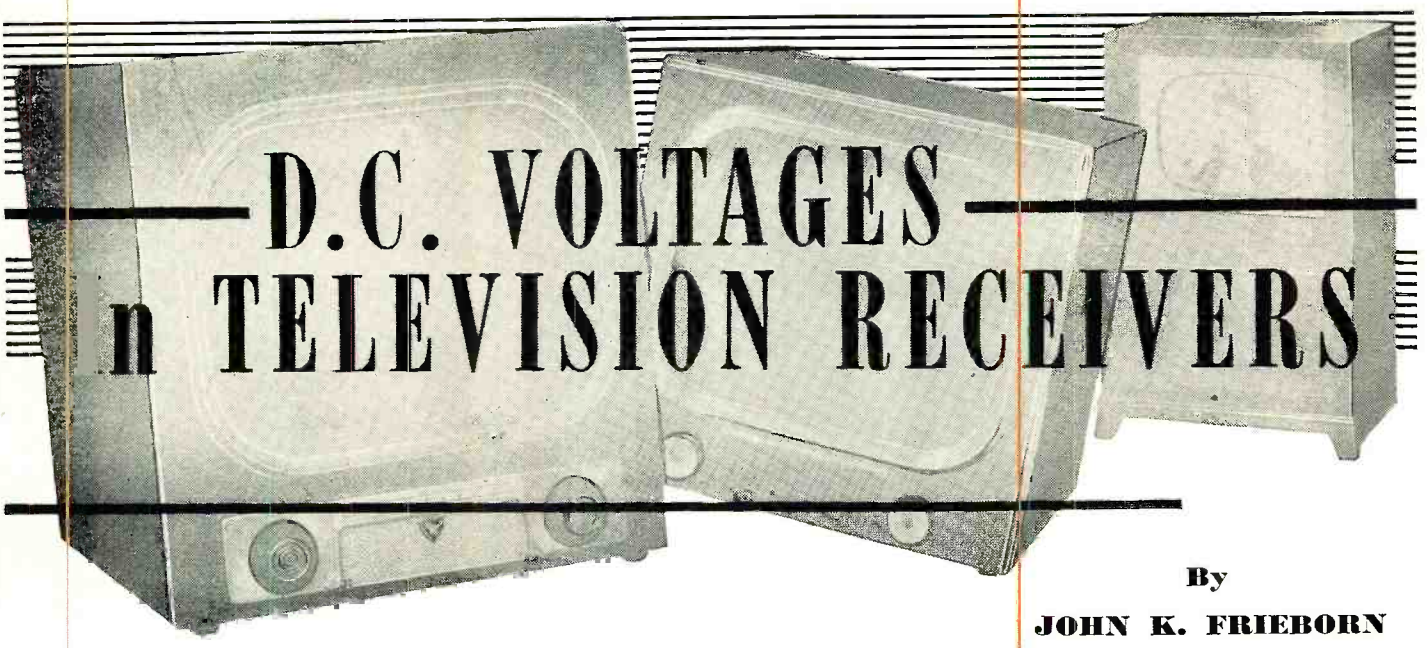


Fig. 8. Top view looking into cabinet. The unitized mounting system allows easy removal for servicing or modifications.





D.C. VOLTAGES in TELEVISION RECEIVERS

By
JOHN K. FRIEBORN

A discussion of TV sets having complicated voltage distribution circuits and how to troubleshoot them.

MEASURING voltages between chassis or "B minus" and the various electrodes of each tube is a standard method of troubleshooting radio and television receivers. In radio, it will not find all troubles, but when used with other simple checks, it will find most. In television, the method can be misleading or it can find troubles which are otherwise hard to figure, depending upon how the measurements are made and how they are interpreted. This method is based upon the fact that a fault which interferes with performance of a receiver's intended functions usually will also change d.c. or 60 cycle a.c. voltage measurements. If the technician has data to tell him what the readings should be, his only problem is interpretation, but it is often desirable or necessary to service without specific data for the receiver.

In dealing with radio receivers, an experienced technician can do this with reasonable confidence, because almost all radios have d.c. voltages within certain ranges, depending upon the tube type and its function in the set. He can save time by making all measurements with the meter common lead connected to chassis or "B minus." Of course, the effective grid, screen and plate voltages of a tube are those with respect to the cathode. However, the cathodes of most tubes in a radio receiver are at or only slightly above the potential of the reference point, so measurements of screen and plate voltage with respect to chassis or "B minus" are sufficiently accurate.

In television receivers, measurements from chassis or "B minus" to electrodes of the tubes vary too much between different makes and models of receivers for any range to be called typical for a certain tube and stage in the receiver. In some television receivers, conditions are similar to radio, the chassis is at "B minus" potential or approximately that, all cathodes are at or slightly above the potential of the chassis, and plates and screens, with a few exceptions, are positive from one hundred to three hundred volts. In other television receivers, the chassis may be one hundred volts or more positive with respect to "B minus," cathodes may be a similar amount positive or negative with respect to the chassis, and plates of some tubes may be less positive than cathodes of others. Voltage measurements with respect to chassis or "B minus" are found normally in some receivers which would indicate trouble in others.

One can avoid confusion, of course, by making all measurements with respect to individual tube cathodes, but this takes more time than the use of a common reference point. Another possibility is to subtract the potential of the cathode from the potentials of the other electrodes to get effective grid, screen, and plate voltages. A method which needs no mathematics and is accurate enough is to measure the potential of each cathode before other electrodes and, only in case of tubes whose cathodes are not near ground potential, shift the common lead of the meter to the cathode to measure screen and plate voltages.

The wider ranges of voltage readings in television receivers than in radios result from the greater variety of connections of tubes with respect to the power supply. In radio receivers, cathodes of all tubes are connected to "B minus," either directly or through bias resistors, while plates are connected to "B plus," usually through plate resistors or other loads and dropping or decoupling resistors. All of these combinations of cathode resistor, tube, plate load, and decoupling or dropping resistor are in parallel, just as tube heaters are in most transformer-type radios.

In television receivers, the available d.c. voltage from the power supply is considerably more than that required by many of the tubes. Tubes in deflection circuits usually require from 250 to 500 volts, so that amount must be available from the power supply. Tubes in r.f. and i.f. sections usually receive only 100 to 150 volts and other tubes may be operated with similar voltages. Reducing power supply voltage to such a value is accomplished by connecting tubes with dropping resistors in various series-parallel combinations, sometimes resulting in tube cathodes having potentials very different from those of the chassis. Some cathodes are considerably above ground in certain models of receivers made by *Admiral, Crosley, Garod (Majestic), Philco, Sentinel, Sparton, Stewart-Warner,* and *Westinghouse. Capehart, Du Mont, Emerson, Magnavox, Silvertone,* and *Sylvania* receivers have some cathodes very much below ground. *Arvin, Bendix, Hallicrafters, Motorola,* and *RCA Victor* have made receivers both ways.

In *RCA Victor* Model 8T241, cathodes of audio output, 1st and 2d video, and nearly all of the sync channel and deflection channel tubes are negative with respect to chassis. These cathodes are returned directly or through resistors to the negative lead of the low voltage power supply, which is 120 volts negative with respect to chassis. Fig. 1 shows that R_{193B} and R_{193C} are connected between the negative lead and chassis. Voltage drop

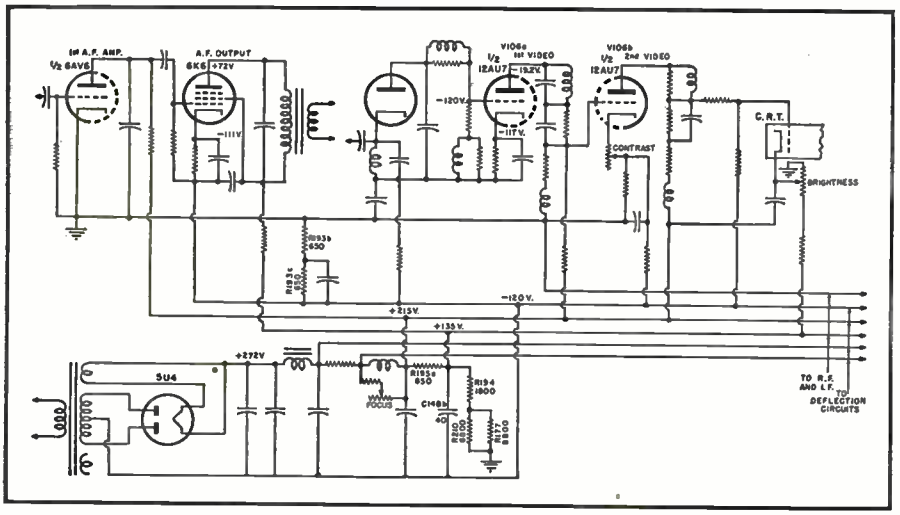


Fig. 1. Partial schematic diagram of the RCA Victor Model 8T241 television receiver.

across them is produced by current drawn not only by R_{193A}, R_{194}, R_{210}, and R_{177}, but also other tubes in the receiver whose cathodes are connected directly or through resistors to chassis. Tubes and other components which pass d.c. current are arranged in a rather complicated series-parallel fashion, but of course in such a way as to apply appropriate voltages to each tube. In the 1st video amplifier, the plate is marked —19.2 volts and the grid —120 volts, but the cathode is —117 volts, so the effective plate voltage is 97.8 volts less negative than the cathode, that is, 97.8 volts positive, while the grid is only 3 volts more negative than the cathode. The audio output plate is only 72 volts positive with respect to chassis, but since the cathode is —111 volts, the effective plate voltage is 183 volts positive.

From Fig. 1 we can see the effects of certain troubles. If R_{193C} should open, no current could flow through tubes whose cathodes are connected above it, so sound and video signals would disappear, but both horizontal and vertical deflection circuits and the high voltage supply would still function and produce a raster. However, voltages even on these stages would be changed. Since less current would be drawn from the power supply, its total output voltage would increase from the normal 392, but less current would also flow through components between the positive terminal and chassis, producing less voltage drop, so the filament of the rectifier would measure less than 272 volts positive, while the center tap of the low voltage power transformer would measure more than 120 volts negative. Less current would flow through the focus coil and none through the brightness control.

If the audio output tube heater should open, less current would flow through R_{193A} and voltages on all tubes whose plates are connected below it would increase, as would voltage across the brightness control. Current through the focus coil would also decrease, but by a smaller percentage.

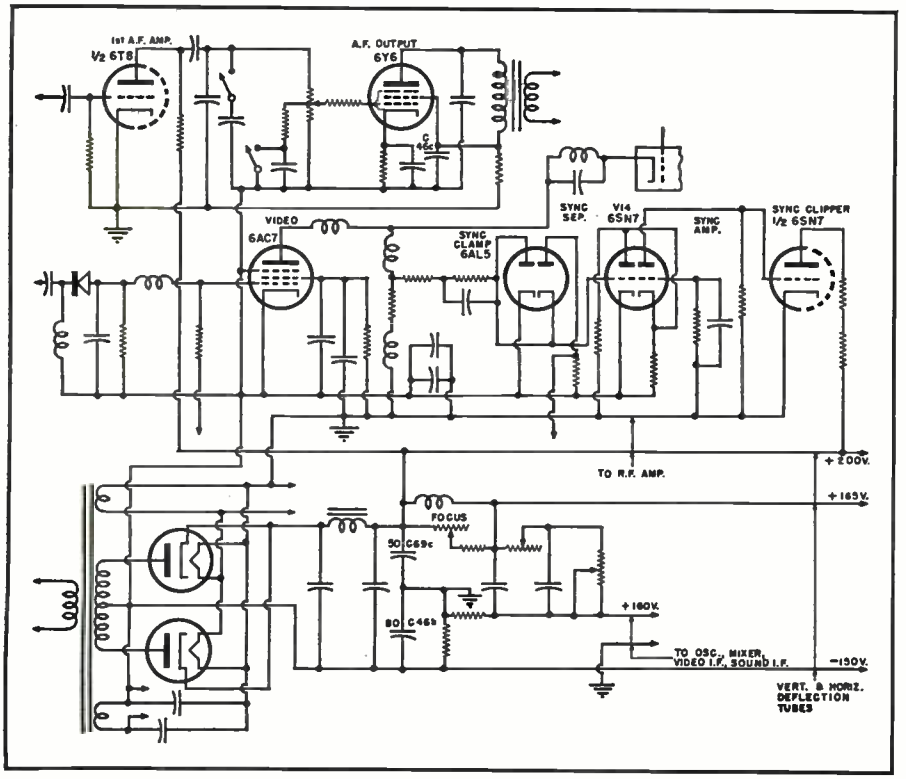
If C_{148B} should short, both the 135 volt positive lead and the 120 volt negative lead would assume ground potential and much more current would flow through R_{193A}.

A common method of tracing troubles in television receivers is: (1) to determine the section of the receiver at fault, by interpreting visible and audible symptoms; (2) to determine the stage at fault, by signal or function tracing of the section; (3) to determine the faulty component, by measurements or other checks in the stage. Troubles in receivers with complicated voltage distribution systems are often hard to find by this method, since one fault may affect several sections. Except in case of a very obvious trouble, the technician usually can save time by measuring a few key d.c. voltages before final interpretation of symptoms or signal tracing. In the *RCA Victor* Model 8T241, key voltages are those between chassis and various points on the low voltage power supply voltage divider.

While the *RCA Victor* Model 8T241 has tubes connected in series with various dropping resistors, more and more television receivers have tubes connected in series with each other for plate and screen voltage distribution, on the same principle as the series heater arrangement of transformerless receivers. Such an arrangement for plate and screen voltage reduces the amount of power lost in resistors. Thus it is unnecessary to use resistors of such high power rating and reduced heat radiation makes it possible to place parts in the receiver closer together and make the chassis and cabinet smaller.

Bendix Model 235M1 is a receiver in which some tubes are arranged in series-parallel with others. Total d.c. voltage available from the power supply is 350 volts, 200 volts positive with respect to chassis and 150 volts negative. Some tubes and associated components are connected across the entire 350 volts, some are connected between "B plus" and chassis, and others are connected between "B minus" and chassis. Fig. 2 shows d.c. voltage distribution. Plates and screens of audio output and video tubes are negative with respect to chassis, but their cathodes are more negative. A substantial part of the current for r.f. and i.f. tubes flows through the audio output tube; if it should become weak, the voltage drop across it would increase and the voltage and current for r.f. and i.f. tubes would decrease, result-

Fig. 2. A portion of the schematic covering the Bendix Model 235M1 video receiver.



ng in decreased picture contrast, among other things. If the audio output tube were gassy, voltages would be affected the opposite way.

Sync separator, amplifier, and clipper tubes are substantially in series. This arrangement can be used because little plate voltage is required for each stage and direct coupling is an advantage in this channel.

In this receiver, heaters of audio output, video, sync clamper, sync separator and amplifier, and vertical and horizontal deflection tubes are connected to a separate winding on the power transformer, which is connected to negative 150 volts. This is done to place the heaters and cathodes of these tubes at approximately the same potential and reduce heater-cathode leakage. Both sides of these heaters have the same high negative d.c. potential with respect to chassis, although the usual a.c. voltage is across each heater.

Key d.c. voltages to check are those between chassis and "B plus" and "B minus" for all troubles and, for synchronizing troubles, voltages at various points in the sync channel.

In any amplifier tube, plate current varies instantaneously with the signal. Where plate current of one tube flows through another tube in series with it, the signal in the first tube will affect the signal in the second. In this particular receiver, coupling would take place especially from the audio output stage to r.f. and i.f. sections. To reduce such coupling, C_{69C} and C_{46B} are connected across positive and negative parts of the d.c. voltage, respectively, while C_{46C} is connected across the audio output tube and its associated components. Thus, although the voltage across each load can change with the proper signal, the total voltage across each load and its tube is prevented from changing rapidly enough to follow any of the signals. If one or more of these condensers should open, voltages could change more rapidly and coupling from audio to r.f. and i.f. would increase.

In the *Admiral* 20X1, Fig. 3, audio and video output tubes are in parallel with each other and the combination is in series with r.f., i.f., and sync channel tubes, but audio and video cathodes are above ground. The same comments apply to faulty audio tubes and decoupling condensers in this receiver as in the *Bendix*.

Fig. 4 shows part of the circuit of *Westinghouse* Model H604T10. Audio output, damper, and horizontal output tubes are substantially in series. Most of the current through each tube flows through the other two. This arrangement makes use of part of the voltage developed by the damper to add to the audio output plate and screen voltages, as well as to the horizontal output plate voltage. It is conventional to use voltage produced by action of the damper in rectifying the horizontal deflection signal, to boost horizontal output plate voltage. This has the effect of salvaging some of the energy

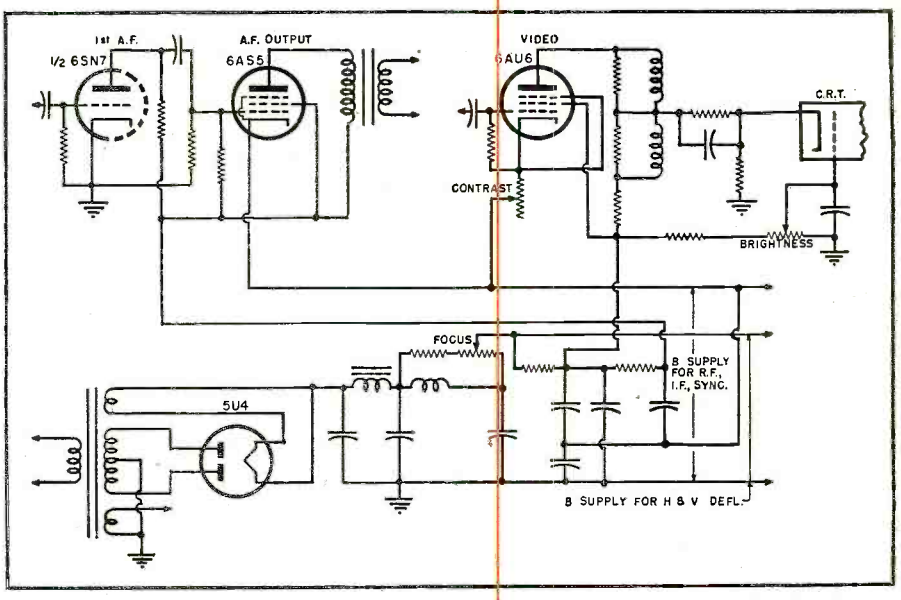


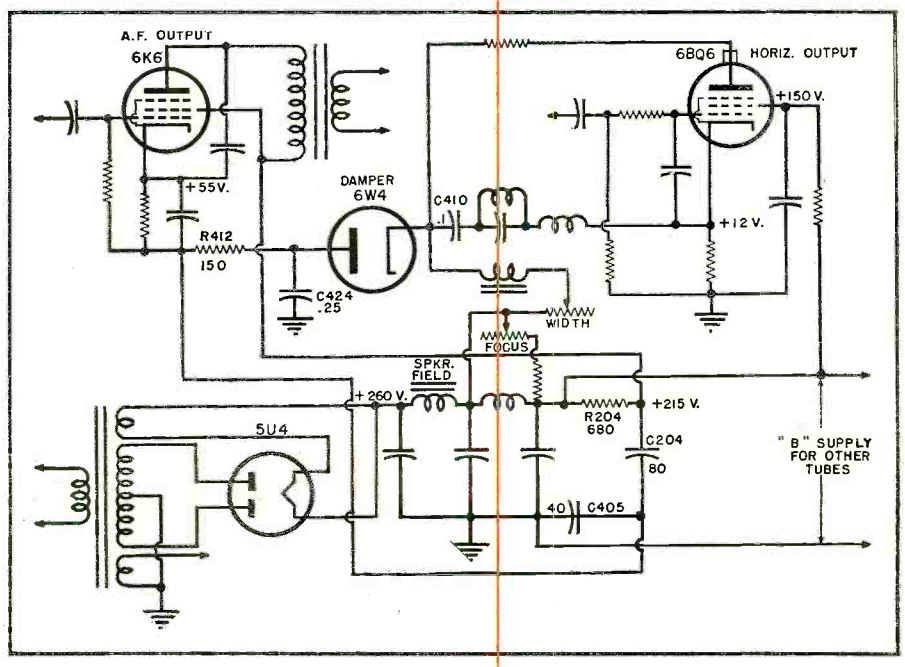
Fig. 3. One section of the Admiral Model 20X1 TV receiver. See text for details.

which must be dissipated when the field of the deflection coils collapses. Increased efficiency of the horizontal output stage is particularly useful in receivers using flyback type high voltage supplies, where high voltage as well as horizontal deflection pulses are obtained from this stage. In this *Westinghouse* receiver, the high voltage supply is of the separate r.f. oscillator type and the horizontal output stage does not need to furnish so much power. Some boost voltage is available for use elsewhere and it is applied where it will do the most good, to the audio output tube. The ratio between voltages supplied to horizontal and audio output tubes depends upon capacities of C_{410} and C_{424}, which are charged when the damper conducts, to voltages inversely proportional to their capacities. Decoupling networks, R_{412}-C_{405} and R_{204}-C_{204}, keep the audio signal from affecting horizontal deflection and *vice versa*.

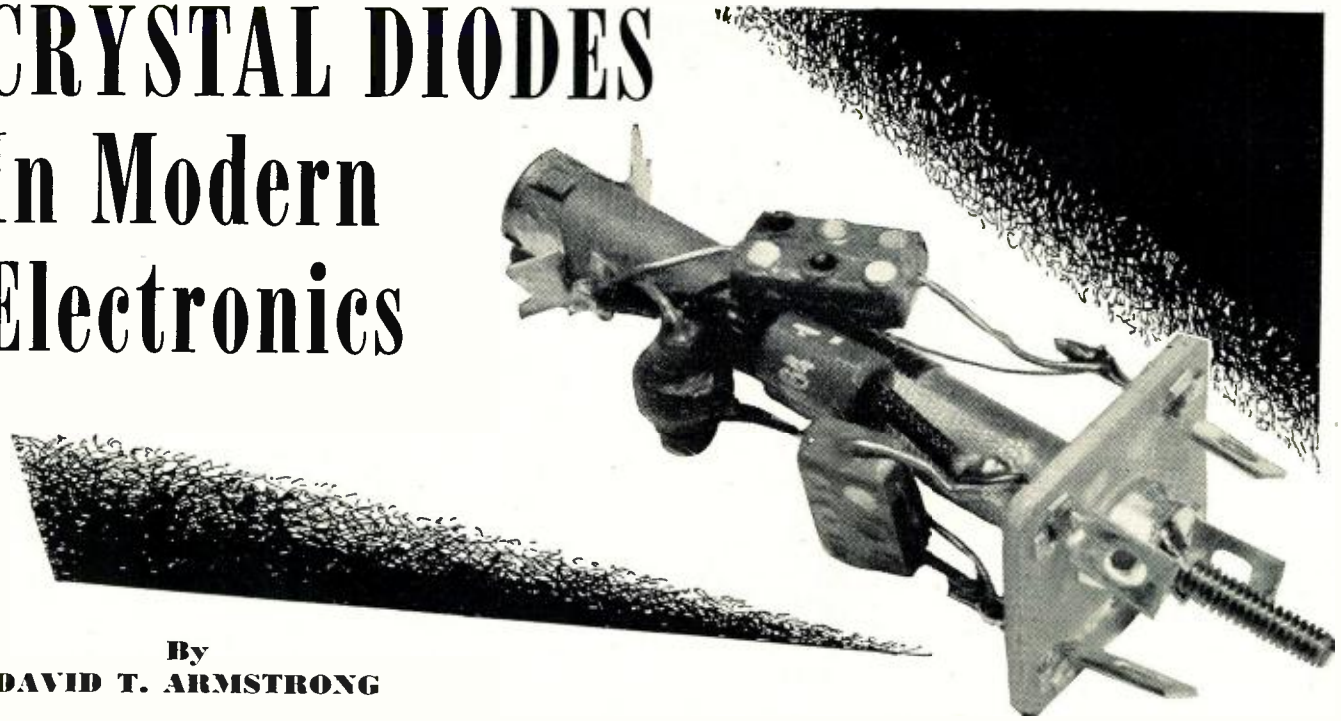
This receiver has the peculiarity that failure of any of the three tubes would eliminate both sound and horizontal deflection, although brightness and vertical deflection would still be present.

Key voltages are those across each of the tubes in series, but, because of the presence of large pulses, d.c. measurements ordinarily should not be made at the plate of the horizontal output tube or cathode of the damper. However, one may measure voltages between "B minus" and the cathode and plate of the audio output tube. Improper voltages in this receiver could be due not only to such usual things as faulty tubes, resistors of improper value, and leaky or shorted condensers, but also C_{410} or C_{424} being open or of improper capacity. —30—

Fig. 4. Partial schematic diagram of the Westinghouse Model H604T10 TV receiver.



CRYSTAL DIODES In Modern Electronics



By
DAVID T. ARMSTRONG

Part 5. A discussion of some of the applications of crystal diodes to television receiver circuits.

A conventional i.f. transformer assembly using a 1N64 germanium diode. G-E uses this unit in its TV receivers.

IN EARLIER articles of this series we discussed the uses of crystal diodes in AM and FM applications. In this and the next article we will consider several of their applications in modern television receiver circuits.

Fig. 3 shows several applications of crystals in TV receivers. As far as it is possible to discover, no manufacturer uses crystals at all these points, but some manufacturer uses crystals at each of these points. This block diagram indicates the possible applications of known germanium diode crystals in modern television receivers, based on present knowledge of circuitry and the performance characteristics of crystals. In general, the number of germanium diodes that may be used in a given television circuit is limited only by the number of diodes required.

To be quite optimistic, with the recent development of crystal triodes, which may be used in place of certain vacuum tube triodes, the future is bright with possibilities for small TV receivers that may become virtually tubeless!

Germanium diode type crystals have a definite place which they are now assuming on a large scale. It will be well for the experimenter and technician to know something about them for they are quite likely to supplant the 6H6's and the 6AL5's in many TV circuit designs.

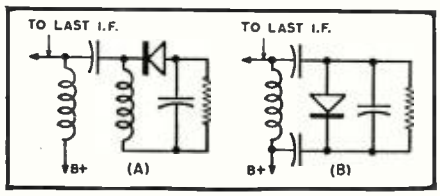
When color comes along the fellow who knows the fundamentals of the application of germanium crystals will be able to apply this knowledge to the uses of germanium and silicon crystals in the ultra-high frequency color spectrum. Be ready for it. That will be the day for germanium and silicon diodes! While eventually crystals are likely to displace tubes at high frequencies, even at low frequencies, certain types of crystals are proving more stable than presently available tube type diodes.

Basic Video Detector Circuits

At the present time the most widely accepted application of germanium diodes in television receivers is as video detectors. The chief function of a video detector is to demodulate the high frequency i.f. signal to obtain the video modulation. The most common component used for this purpose, until recently, has been half of a 6AL5. With but minor circuit changes a germanium diode may be substituted for the vacuum tube as a high quality detector element.

This substitution is not a simple problem, however. It is necessary to find ways and means of eliminating the other half of the 6AL5 vacuum tube diode in order to dispense entirely with the tube, socket, and associated wiring. This problem has been solved in various ways, such as using another germanium crystal as the diode d.c. restorer, sync clipper, or a.g.c. peak detector. Of course it is possible to design and use a full wave detector circuit using germanium diodes, but no manufacturer seems to have done this. It is possible to design a very fine full-wave video detector, but most design engineers feel that the improvement in greater output and higher efficiency would not be worth the cost nor the circuit complication.

Fig. 1. Basic TV detector circuits. (A) A series and (B) a shunt type of circuit.



In Part 2 (November 1951 issue) both series and shunt rectifier circuits were described. Both can be used in video detector applications. Consider the simple germanium diode TV detector circuits shown in Fig. 1. *A* is a series type circuit and *B* is a shunt type circuit. Both types of circuits are widely used and both will perform equally well in properly designed systems.

The shunt circuit shown at *B* in Fig. 1 is used primarily when a closely coupled i.f. transformer is used and capacitive coupling to the detector is desirable to prevent "B+" voltages from being impressed upon the diode crystal. With the diode crystal connected in such a shunt arrangement it provides its own d.c. return path; this path is normally restricted by the coupling condenser in the series hook-up.

For a shunt circuit the back resistance characteristic of the diode is important. It is necessary that the back resistance be at least ten times the load resistance to maintain the achieved gain. However, very high back resistance values may sharpen the "*Q*" of the tuned circuit; then bandwidth may have to be restored by a change in value of the coupling condenser or with a compensating choke.

For a series type circuit, such as that shown at *A* in Fig. 1, the forward dynamic resistance of the diode is im-

portant since it may be so large in comparison to the load as to form a voltage divider and reduce the output voltage. Because germanium diodes have lower dynamic resistance than vacuum tubes, additional gain may be realized in the crystal type video detector circuit. The "*Q*," or the sharpness of the resonance of the tuned circuit, will be broader as a result of the lower resistance of a germanium diode compared to that of a vacuum tube. While this may reduce the gain of the last i.f. stage, it can be restored by increasing the load resistance.

For both the series and the shunt circuit the load impedances are determined primarily by the video bandwidth requirements; therefore, these load impedances must necessarily be low values. The load condenser should be small enough to present a reasonably high impedance to the highest video frequency of 4 mc. and at the same time be sufficiently large to hold the charge from one peak to the next with a 24 mc. or 44 mc. i.f. signal. The load resistor must be large enough so as not to lower the impedance of the condenser and small enough to permit the condenser to discharge at video frequencies. Typical values are 5 to 10 $\mu\mu$fd. capacitance and 1500 to 5000 ohms resistance.

It should be realized that there are wider variations in the dynamic resistance of germanium diodes than there are in vacuum tubes. For this reason detector type germanium diodes are selected in the manufacturing process by test in an actual video detector circuit, see Fig. 2. This helps assure uniformity in actual performance. The design engineer attempts to select circuit values that minimize individual diode variations.

As a video second detector the germanium diode must convert an i.f. of 20 to 50 mc. into d.c., with the video signal and synchronizing pulses being passed on to the amplifier while the i.f. is rejected. This requires crystals capable of withstanding voltages higher than 1 or 2 volts; hence types like the 1N60 and 1N64 are used because these crystals are able to withstand voltages on the order of 5.0 to 10.0 volts.

Because both the dynamic resistance and the crystal capacitance of the germanium diode are very low, the crystal provides excellent demodulation in video detection circuits. The crystal provides exceptional linearity at low signal levels and is free from any undesirable contact potential effects. The excellent linearity characteristic of germanium diodes at low voltages and the absence of contact potential effects help achieve improved video output with reduction of distortion factors in low modulation regions. Hence the quality of the signal representing white is improved and the over-all picture presents more natural rendition of various shades from white to gray to black.

Since the picture carrier is amplitude modulated, a TV detector circuit is similar to the detector circuit found in AM receivers. In both instances the chief function of the detector is to demodulate the picture carrier. Crystals perform the detection function remarkably well at the AM broadcast frequency and crystals will perform the detection function better in TV since crystals operate better at higher frequency. The reason for this is that the efficiency of germanium diodes does not fall off as rapidly as the efficiency of tubes with an increase in frequency at which the circuit is operating. But a video detector imposes more severe requirements on the detector diode than an AM broadcast type detector or an FM receiver type detector is called upon to meet.

The trend in video detector design has been from the 6H6 to the 6AL5 to the germanium diodes. The input signal to the detector is such that current flows through the diode when the diode plate is positive with respect to the cathode. While the polarity of the picture signal is essentially a design problem and not a service problem, it must be remembered that whenever a germanium diode is replaced in a TV receiver the original polarity must be maintained, otherwise white and black objects will be reversed and synchronization will become extremely critical.

In general, picture phasing considerations are the same for a vacuum tube diode. It is necessary to achieve correct polarity of the crystal diode according to whether the blanking pulses are negative or positive and whether the signal injected to the CRT is to the grid or to the cathode. When the signal is to the grid it must end up with sync negative; when the signal is to the cathode, it must end up with sync positive. Whether the sync will be positive or negative depends upon the number of video amplifiers and the polarity of output of the detector; there is a phase shift of 180 degrees for each video amplifier.

Detector Circuit Considerations

Many modern TV receivers use a germanium diode as the video detector

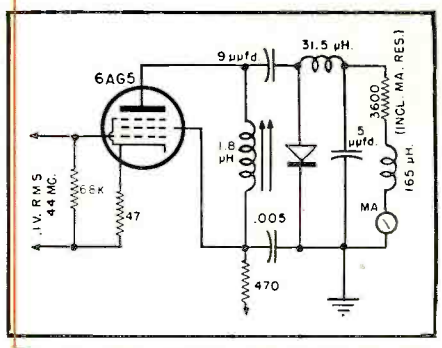


Fig. 2. The special test circuit for the 1N64 as used by General Electric Company.

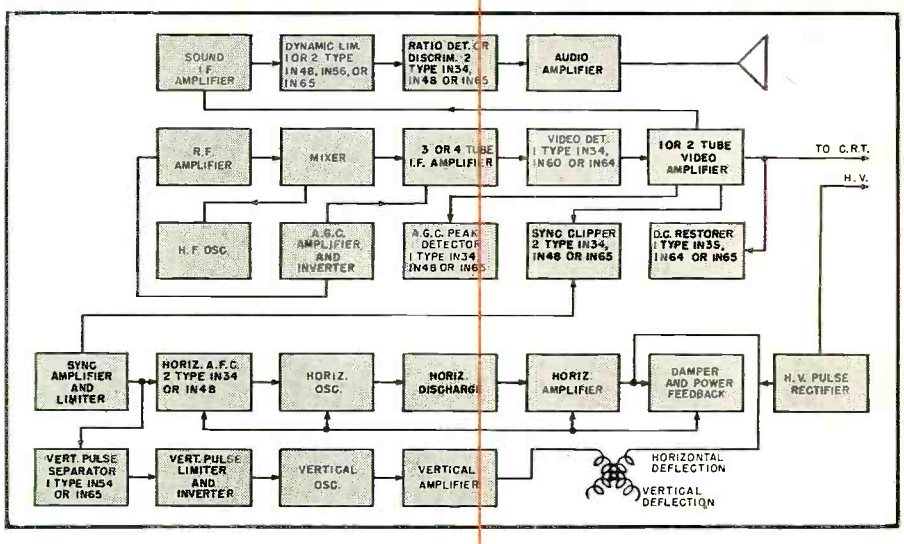
for various reasons as listed below:

1. Simplicity of design,
2. Ability to handle a large dynamic signal range,
3. Minimum amplitude distortion (not too important, but worth mentioning),
4. High degree of linearity,
5. Ability to shield the detector by mounting inside shield can.

One important requirement of a video detector is that the output level be approximately flat for frequencies from 30 cps to 4.0 mc.; the video amplifier should be designed to pass this range of signal without attenuation. Therefore, the value of each component in the detector circuit is usually the result of careful selection by the design engineer; if replacement of any component is necessary, a technician should be careful to use resistors, condensers, and coils of the same value. The coupling network may be of the peaking coil resistor type, or it may be a low pass filter type. Many receivers are now using a low pass filter type. It is worthy of note that no d.c. restoration is necessary with direct coupling from the video detector to the video amplifier because the d.c. component is preserved with direct coupling. But there must be direct coupling all the way from the detector circuit to the picture tube.

The signal at the output of a video detector is not quite strong enough to drive a picture tube. In this respect it

Fig. 3. Possible applications of germanium diodes in modern television receivers.



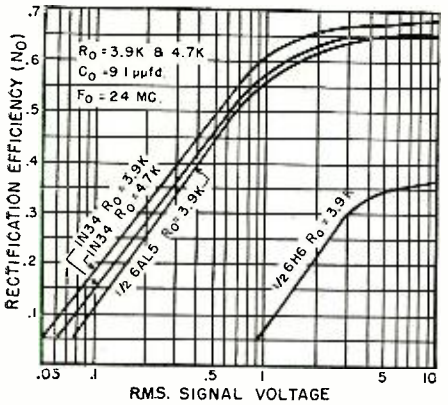


Fig. 4. Rectification efficiency vs. signal level. The curve for the 1N34 may be considered representative of the 1N60. These measurements were made with a fixed driving impedance and voltage which is not exactly the case in a video detector. In that particular instance the loading on the last i.f. coil is of most importance.

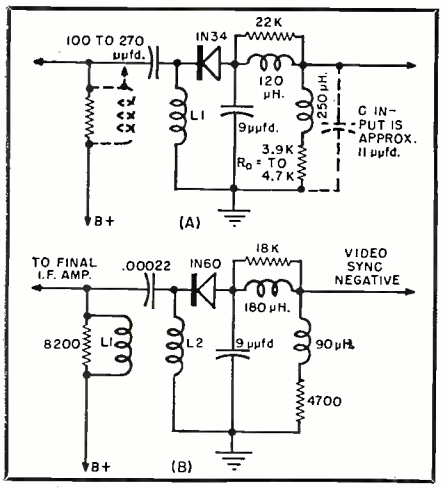
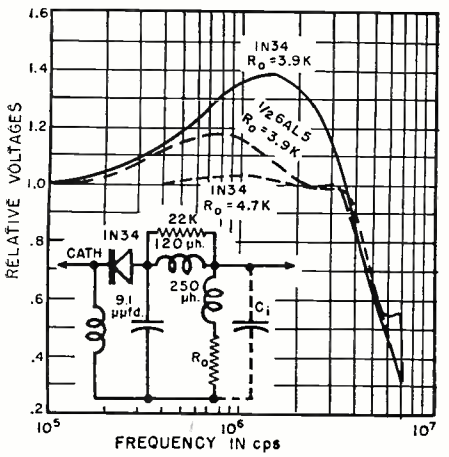


Fig. 5. Series type video detectors. (A) Using the 1N34. The inductance, L_1, is tuned to the i.f. frequency with the total shunt capacitance. If the tuning coil is on the plate side of the circuit, L_1 is a 10 μhy. r.f. choke. (B) Using a 1N60. Either L_1 or L_2 may be the tuning inductance. The value should be about .3 μhy. When tuning inductance L_1 is on plate side of tube, L_2 should be a 10 μhy. r.f. choke.

Fig. 6. Video bandpass curves. The curve for the 1N60 would be the same as that shown for the 1N34. The shape of the bandpass curves is more dependent on the load circuit values than on tube or diode used.



is similar to AM receiver detectors which require one or two stages of audio amplification for satisfactory sound. Video amplifiers following the detector are usually *RC* amplifiers similar to those found in AM receivers.

Signal amplification following the detector is generally small because most of the receiver video gain is obtained in the i.f. strip. While it is possible to have two stages of video amplification after the detector, it is common practice to simplify the circuit by using just one stage of d.c. coupled video amplification. This means that a detector must cover a wide range of signal amplitudes from 0.5 to 5.0 volts.

The 44 mc. i.f. frequencies may involve some reduction in pre-detection gain (although with tubes like the 6BC5 and the 6CB6, the gain at the higher frequencies is greater than was thought possible); thus, the detector may be called upon to work efficiently at low signal levels and high frequencies. The video detector for such a circuit would have to provide good linearity at low signal levels so that correct over-all highlight gamma (a numerical indication of the degree of contrast in a received television picture) may be maintained.

The video detector may be any of the usual types such as half-wave, full-wave, plate circuit, grid leak, or infinite impedance type. By virtue of simplicity the diode detector is so common that it is used almost exclusively; practically all are of the half-wave type. The additional circuit complication for full-wave detection does not warrant the expense involved.

Detector rectification efficiency of a typical half-wave diode tube type video detector circuit might be on the order of 35-40%, that is, with an i.f. input voltage of 1.4 r.m.s. to the diode the video output is on the order of about 1.5 volts peak-to-peak, or from maximum white to synchronizing pulse tip. The detection efficiency of a germanium diode type video detector circuit may approach about 52%. Small time constant load circuits involving small capacitances and low values of load resistance are necessary in order to preserve the high frequency video components in the detector output; these affect rectification and account for some loss in over-all efficiency.

Because these remarks may seem misleading to some engineers it should be understood that they are made with the following considerations in mind. The term "rectification efficiency" does not indicate whether or not more useful video output will be obtained by germanium diodes than by tubes. It is necessary to design the circuit specifically for crystals or tubes in order to maintain proper bandwidth as well as a.c. output. If two optimum circuits are compared there is likely to be little difference in ouput for crystals over tubes.

There seems to be no disagreement that the germanium diode has decided advantages over a vacuum tube where the detector is required to operate with signal levels on the order of 0.5 volt peak or less. For a bandwidth of 4.0 mc. the germanium crystal 1N34 shows a 5.5 db gain over a 6H6 and approximately a 0.5 db gain over a 6AL5 at a signal level of 5 volts. See Fig. 4. A 1N60 will show slightly better gain. Small signal rectification of the crystal diode for low values of load resistance is much better than for the 6AL5.

Fig. 5A shows a video detector circuit using a 1N34 type crystal. The resistor in series with the 250 μhy. coil and ground may vary from 3900 to 4700 ohms. The performance of the circuit is better when the resistor is 4700, as shown in the comparative sets of curves in Figs. 4 and 6. These curves are more dependent upon load circuit values than upon tubes or crystal diodes.

Because of the great interest in the use of germanium diodes in modern television circuits newer and better types of crystals are being designed and manufactured. Fig. 5B illustrates a *Sylvania* type video detector circuit designed especially for television applications. The type 1N60 was specifically designed and is tested for this type of service in the circuit shown in Fig. 8. This germanium diode provides high circuit efficiency and exceptionally good linearity at low signal levels. Low interelectrode and stray circuit capacitances make for improved video response. Increased over-all gain is obtained by virtue of reduced capacitive loading of the detector input circuit. When a circuit is designed with the component values specified, a full 4 mc. video bandwidth may be maintained at the output of the detector.

This circuit has high dynamic efficiency, low shunt capacitance, and excellent linearity at low signal levels of 0.5 volt peak or even less signal voltage.

For preservation of the high frequency video components in the demodulated picture carrier envelope the time constant of the vacuum tube detector load circuit should not exceed approximately 0.08 microsecond. This time constant should be observed even with elaborate types of high frequency compensation networks. To achieve this time constant the diode load resistance is generally 4000 ohms or less, and the load capacitances are correspondingly small. It is for these reasons that the efficiency of a vacuum tube detector circuit is generally low.

The dynamic impedance of the diode is an appreciable portion of the total circuit impedance. With the 1N60 germanium diode there is a substantial improvement in detection efficiency because the dynamic impedance of the crystal is materially lower than that of an equivalent vacuum tube diode of the 6H6 or 6AL5 type. Since with a crystal the shunting capacitance is substantially less it is possible to increase the effective load resistance without sacrificing bandwidth.

Increasing the diode load resistance results in material improvement of the

(*Continued on page* 120)

A Sharply Tuned A. F. AMPLIFIER

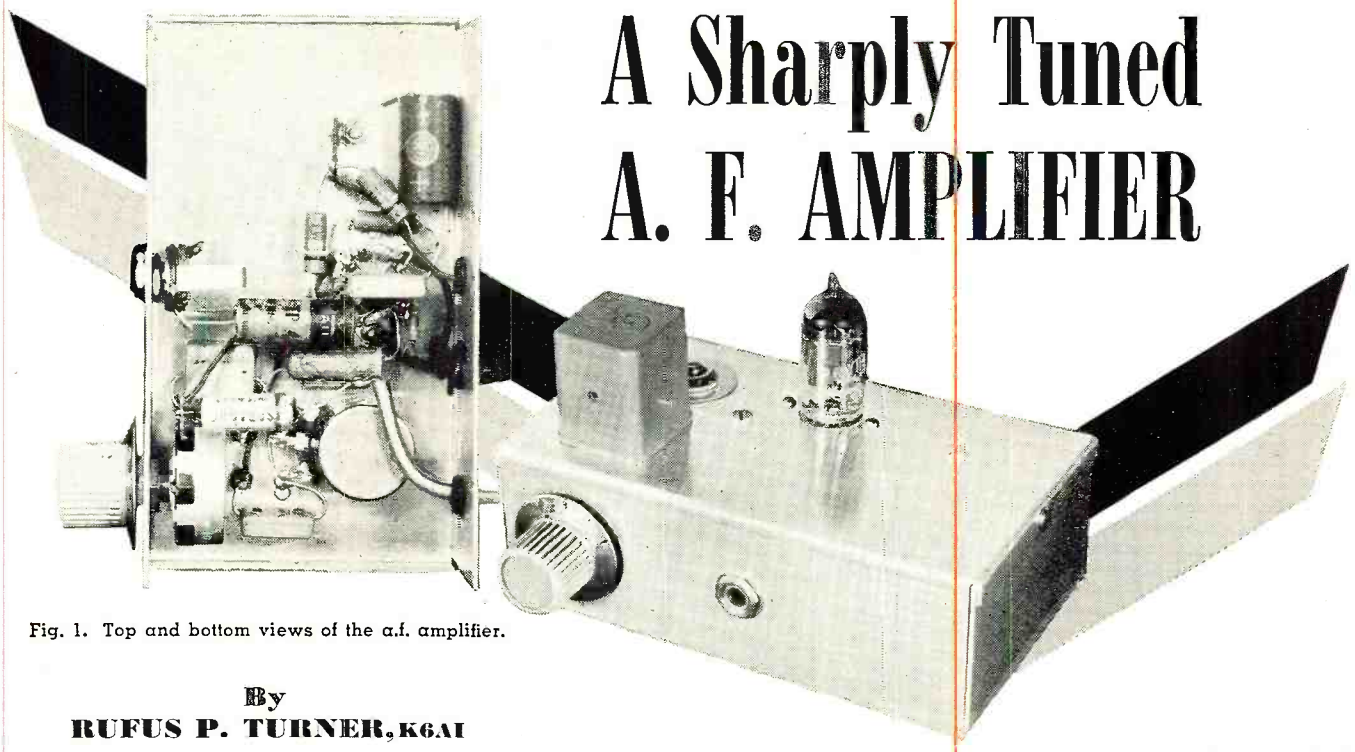


Fig. 1. Top and bottom views of the a.f. amplifier.

By
RUFUS P. TURNER, K6AI

A single-frequency amplifier of the bandpass type, having better than 50 decibel rejection at the second harmonic of the resonant frequency. At 1000 cycles, bandwidth is approximately 10 cycles.

SEVERAL feedback audio amplifier circuits of the resistance-capacitance tuned, bandpass type are in common use. These circuits find use where a selective amplifier is required. Common applications are bridge null detectors, peaked amplifiers for code reception, and tuned amplifiers for instrumentation and control.

RC-tuned amplifiers are not capable of providing large amounts of selectivity within a few stages. This is because of the relatively poor "*Q*" of *RC* circuits. It is common, for example, in a 2-stage *RC*-tuned amplifier for the output at half or twice the resonant frequency to be as much as 1/10 of the resonant output. In a 4-stage *RC*-tuned amplifier employing conventional components, the 2nd harmonic response rarely is better than 40 db (output voltage 1/100 of that at resonance). Thus, unless continuous tuning is a requirement, *LC* networks are more desirable.

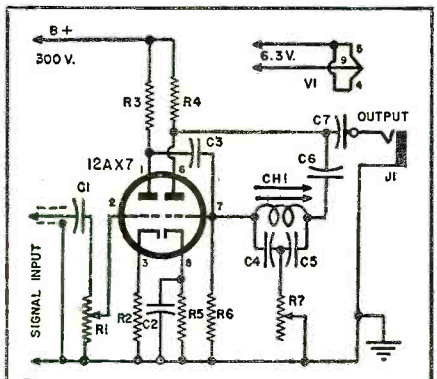
The amplifier shown in the accompanying illustrations employs an *LC*-type bridged-T network (CH_1, C_4, C_5 R_7 in Fig. 2) in its feedback circuit, and in two stages (one tube envelope) achieves a 2nd harmonic discrimination of more than 50 db. Components C_4, C_5, and R_7 have been selected for 1000 cycle operation, since the amplifier originally was designed for use as a null detector for a 1 kc. impedance bridge. Maximum voltage gain is 30; maximum output voltage 10 volts r. m. s. Sharpness of the amplifier is revealed by the following response figures: 1000 cycle output 10 volts, 500 cycle output 0.025 v., 2000 cycle output 0.025. At 7 volts' output (70% of maximum resonant output at 1000 cycles), bandwidth is 10 cycles (995 to 1005 cycles). Amplifier operating voltages are 300 volts d.c. at 2.8 milliamperes and 6.3 volts a.c. or d.c. at 0.3 ampere. These light power requirements enable the amplifier to be operated by the power supply of some other unit into which it may be built.

The first triode of the 12AX7 is used as an isolating input amplifier with degeneration obtained from the unbypassed cathode resistor, R_2. The second triode incorporates degeneration through the bridged-T network which effectively cancels the stage gain on all frequencies except the network null frequency. The latter accordingly is transmitted readily. For best selectivity choke CH_1 must have good "*Q*." This requirement, plus ability to tune the inductor closely to the desired frequency, has been met by employing a *UTC* Type VI-C tunable inductor.

Adjustment of the circuit is simple: (1) Feed a ¼-volt signal at 1000 cycles into the signal input terminals. (2) Connect an a.c. vacuum-tube voltmeter (set to its 10 volt range) to output jack J_1. (3) With an 8-32 *Allen* wrench, adjust the inductance of choke CH_1 for peak deflection of the meter. (4) Adjust network rheostat R_7 for further increase in the peak deflection of the meter. (5) Adjust gain control R_1 as may be required for meter reading near full scale. The amplifier may be tuned to frequencies other than 1000 cycles by changing the values of C_4, C_5, and R_7. Condensers C_4 and C_5 must be identical, each having twice the calculated capacitance for tuning choke CH_1 to resonance at the desired frequency. For the Type VI-C15 (CH_1) choke shown, rheostat should be 100,000 ohms maximum for frequencies between 20 and 800 cycles, 500,000 ohms from 800 to 3000 cycles, and 2 megohms from 3000 to 20,000 cycles.

High-impedance output is shown. This arrangement is entirely satisfactory for coupling into the high-impedance circuits of oscilloscopes, v. t. voltmeters, amplifiers, and the like. If low-impedance loads, such as headphones, normally will be employed; a cathode follower stage should be provided, in order to avoid adversely affecting the frequency and "*Q*" of the bridged-T network. —30—

Fig. 2. Complete circuit diagram and parts list for the tuned a.f. amplifier unit.



R_1—500,000 ohm pot
R_2—2000 ohm. ½ w. res.
R_3, R_4—100,000 ohm, 1 w. res.
R_5—1200 ohm, ½ w. res.
R_6—2.7 megohm, ½ w. res.
R_7—500,000 ohm pot (See text)
C_1—.1 μfd., 600 v. cond.
C_2—50 μfd., 50 v. midget elec. cond.
C_3, C_4, C_5, C_7—.01 μfd. mica cond.
C_6—.04 μfd., 400 v. cond.
CH_1—5 henry, tunable a.f. choke (UTC Type VI-C15)
J_1—Single-circuit, normally-open phone jack
1—12AX7 tube

BUILD THIS MIXER-EQUALIZER

By
LLOYD B. HUST

Over-all view of the mixer-equalizer shown with both high and low impedance mikes.

Features dual (high and low impedance) inputs and a built-in low frequency boost equalizer. The design is flexible in that it can be easily changed to meet your specific requirements.

THE versatility of many audio amplifiers now in use can be enhanced by providing additional input channels. Rarely will the single microphone input of many amplifiers be adequate for the different uses to which the owner desires to put his equipment, and even with the more modern amplifiers with multi-channel inputs, one can often find use for an extra input or two. Although most amplifiers have high-impedance microphone input circuits, it is often desirable to use these amplifiers with a low impedance source. Also, it is often the case that although two microphones are available, one may be of the high impedance type while the other is a low impedance microphone. In addition, it is often desirable to be able to equalize the output from certain microphones to compensate for certain acoustic conditions. This is often the case with crystal microphones, many of which have an extended high frequency characteristic. Such a set of conditions brought about the design of the unit to be described here.

This mixer-equalizer can be built for little more than the cost of a good input transformer and a couple of volume controls, but its usefulness makes it a most valuable addition to the audio system. It was particularly designed for use with an auditorium amplifier which had but one microphone input. Several instances occurred in which the usefulness of this amplifier was limited because of the fact that only one microphone input was available. It was not feasible to make actual circuit changes in the amplifier and for that reason this mixer was designed so that it could be plugged into the existing microphone channel without any other connections to the amplifier itself. Both high and low impedance microphones were available for use with this amplifier and it was decided that it would be a definite advantage to have the mixer handle a microphone of each type. Since its construction, this mixer has been used successfully with a low impedance *RCA* velocity mike and with a high impedance *American* dynamic mike as well as with a high impedance *Astatic* crystal mike. All microphones worked well with this unit and the mixing action was smooth and efficient.

Because an equalizer circuit is built into the device, the low impedance channel can accommodate the output from a modern low-impedance magnetic type phono pickup. A low impedance tape playback head can also be used satisfactorily in this channel, while a high impedance tape head can be used in the high impedance channel if desired.

The unit was built on a chassis taken from a war surplus relay box, but any chassis about 4" x 4" x 2" will do very nicely. The chassis used has a bottom plate which makes the unit entirely self-shielding. The input jacks used were standard single circuit jacks, chosen because the microphones on hand were equipped with plugs to fit jacks of this type. Naturally, the builder will want to use jacks to fit the equipment he possesses. Likewise, the output plug should be of the type to fit the amplifier with which this unit is to be used.

The actual construction of the mixer-equalizer presents few problems. The circuit is simple—the low impedance input is fed through the transformer and its volume control to R_2. Likewise, the high impedance input is fed from its control to R_4. These two resistors isolate the two controls of the separate circuits so that they will not short-circuit each other. The signal is then fed from the junction of these two resistors into the equalizing network and thence to the output which feeds the amplifier. It will be noted that when the switch S_1 is in position *D*, the equalizing network is switched out of the circuit entirely so that the unequalized output of the two microphones can be fed into the amplifier if desired.

Curves *A*, *B*, *C*, and *D* indicate the action of the equalizer for corresponding switch positions. The curve for position *D*, of course, shows no equalization, but it indicates the degree of output available when the equalizer has been switched out of the circuit. The various degrees of equalization indicated by curves *A*, *B*, and *C* were found to be satisfactory to compensate for acoustic conditions as well as to give various degrees of low boost when phono or tape pickups were fed through the device. If the builder wishes he can add other switch positions and can achieve other equalization curves to suit his own individual set of conditions. It will be seen from an examination of the circuit, as well as from the frequency response curves indicated in Fig. 2, that the equalizer gives low boost only. High boost equalizers were not added for several reasons. First, any equalizing circuit introduces

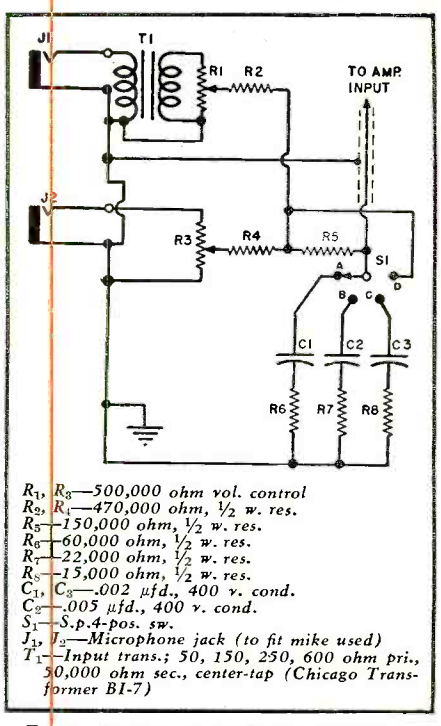
losses and it was felt that a high boost circuit in addition to the low boost circuit would bring the losses to a point which would greatly limit the degree of usefulness of the mixer. Second, practically all the equalization desired—the limiting of the extended high range of a crystal mike, the playback of tape recordings, and the use of a low impedance magnetic phonograph pickup—would be in the nature of bass boost.

In the construction of any apparatus which is to be used in connection with the input of a high gain amplifier, it is necessary that precautions be taken against the introduction of hum. The steps taken to eliminate the possibility of introducing hum into the amplifier by the use of this mixer are few, but important. First, and probably most important was the selection of the input transformer. The *Chicago* BI-7 unit was chosen, both for its hum rejection characteristic and for its excellent frequency response. When one considers that the hum rejection of this transformer is 70 db, and that its frequency response is flat within a fraction of one db from 30 to 20,000 cycles, he can be sure that here is one link in his chain of audio components which will be strong. He should take this into consideration when he is tempted to substitute an inferior unit. It should be noted that this transformer is rated as 50, 150, 250, or 600 ohms to grid, and in connecting it the builder should use those terminals which will suit the equipment he is to use. In the author's model, the 50 ohm input was used, and this will be found right for most applications unless one is planning to feed a line into the mixer.

Other steps that were taken to eliminate any possibility of hum were the connection of all grounds except those at the input jacks to one point on the chassis, the arrangement of the parts to assure short leads, and the placing of leads close to the chassis whenever possible. At first it had been planned to insulate the input jacks from the chassis so that the ground side could be connected to the common one-point chassis ground, but experiment showed that this was not necessary. The use of a bottom plate completes the shielding of the chassis proper, but experiments showed that fairly good results could be had in some instances without this bottom plate. Although no shielded wire was used within the chassis itself, it was, of course, necessary to use a shielded lead to the amplifier. The photographs of the unit show this lead to be of ordinary braid shielding, but it was found that the use of shielded wire of this type would, under certain conditions, cause hum if the shielding were allowed to touch the chassis or case of the amplifier. For that reason, the shielded lead as shown in the photographs was replaced with a length of high impedance microphone cable which is rubber covered. This change cleared up the only hum problem encountered with this unit.

It can easily be seen from an examination of the schematic diagram that a mixer of this type need not be limited to two channels. The same design can be used and as many channels as desired, either high or low impedance, can be used. Also, it should be apparent that the device will work very well without the use of equalizing circuits. However, since the components comprising the equalizer are low in price and readily obtainable, it would seem unwise to destroy the versatility of the unit by eliminating the equalizer. This is especially true inasmuch as the switching arrangement allows immediate switching out of the equalizer if desired.

It should be realized that when one uses any mixing and equalizing device in the input circuit of an amplifier, he cannot expect the output of that device to be equal in amplitude to that of a microphone plugged directly into the amplifier. However, this mixer was tried out with three different amplifiers—an *RCA* amplifier of such ancient vintage that the model number could not be determined, a relatively new *Bell and Howell* amplifier—the one used with the "Filmo" arc projector, and a home-made amplifier. In each case good results were obtained, and each amplifier had sufficient gain to more than make up for any losses within the mixing unit. The audio enthusiast or public address man will find that such a unit added to his equipment will do much to increase its usability. —30—



R_1, R_3—500,000 ohm vol. control
R_2, R_4—470,000 ohm, ½ w. res.
R_5—150,000 ohm, ½ w. res.
R_6—60,000 ohm, ½ w. res.
R_7—22,000 ohm, ½ w. res.
R_8—15,000 ohm, ½ w. res.
C_1, C_3—.002 µfd., 400 v. cond.
C_2—.005 µfd., 400 v. cond.
S_1—S.p.4-pos. sw.
J_1, J_2—Microphone jack (to fit mike used)
T_1—Input trans.; 50, 150, 250, 600 ohm pri., 50,000 ohm sec., center-tap (Chicago Transformer BI-7)

Fig. 1. The two-channel mixer-equalizer.

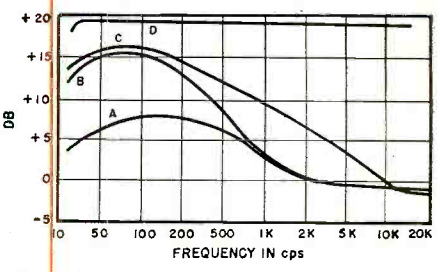
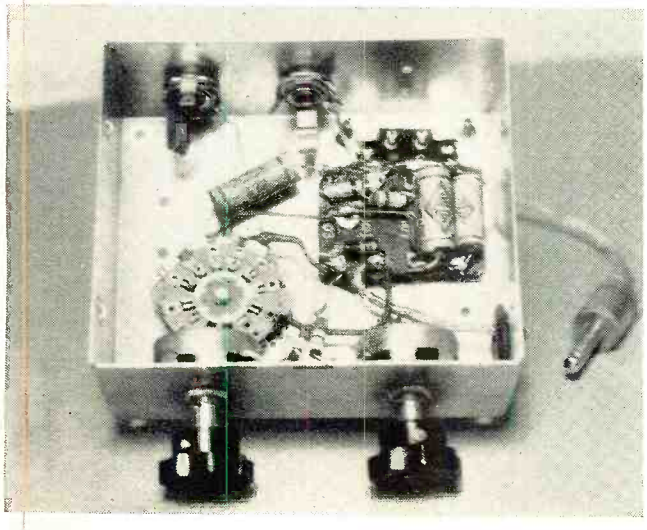
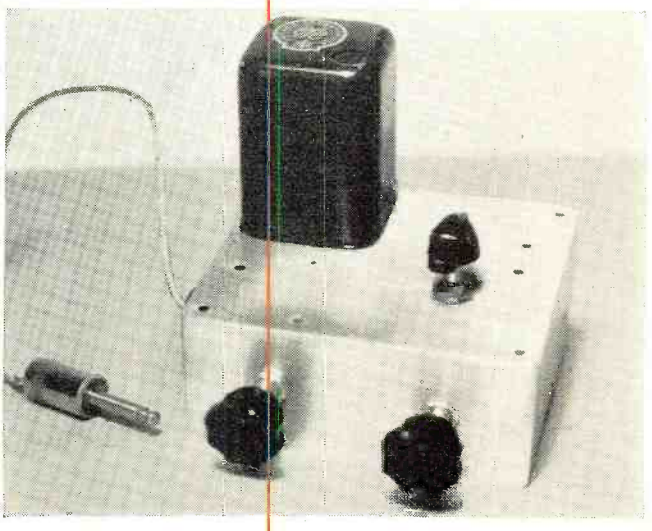


Fig. 2. Equalizer curves for various switch positions of the mixer-equalizer unit.

Underchassis view of the home-built mixer-equalizer unit.

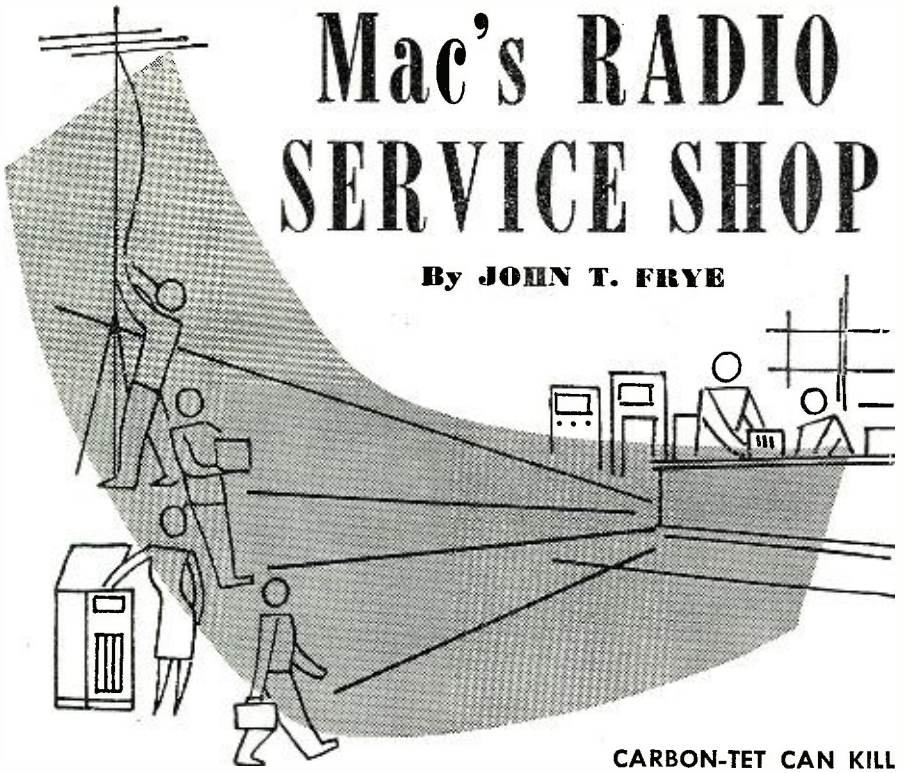


Over-all view of the compact (4" x 4" x 2") low-cost unit.



Mac's RADIO SERVICE SHOP

By JOHN T. FRYE



CARBON-TET CAN KILL

"HEY, Barney," Mac's muffled voice came from behind the closed door of the chassis-cleaning closet, "step outside and see if you can smell any carbon-tet fumes at this exhaust-fan port."

The apprentice technician of Mac's Radio Service Shop went out into the alley and sniffed cautiously at the strong current of air being pushed out by the fan. "Sure can," he called; "where's it coming from?"

"Come on back in here and see," Mac invited.

When Barney opened the door of the cleaning closet, he immediately noticed some changes. For one thing, a sort of metal funnel was mounted with its large opening pointing directly toward the exhaust fan and only a couple of inches away from it. From the smaller end of the funnel a piece of down-spouting went down along the wall and terminated in a ninety-degree elbow that rested on the floor. In front of the open mouth of this elbow was a piece of gauze that had been soaked in carbon tetrachloride. Replying to the boy's questioning look Mac explained:

"Carbon-tet fumes are five times as heavy as air; so I cooked up this arrangement to pull them right off the floor without interfering too much with the sucking out of dust from the top of the room. That fact that you could detect the carbon-tet vapor outside while I could smell none of it in here shows that the system is working."

"And that's good?"

"I'll say it's good. Just recently I've had my eyes opened to just how dangerous breathing carbon-tet fumes can be; and when I think of how carelessly we have been using the stuff in the past, I feel like a man who has just found out that the make-shift poker he has been using to stir the fire is really a stick of dynamite."

"How did you get hep to all this?"

"I had a little 'hint' published in RADIO & TELEVISION NEWS that involved the use of the cleaning fluid. That brought me a letter from an instructor at the Coast Guard Institute asking if I was aware of the very real danger that lurked in the improper use of the chemical—a danger that he had seen demonstrated very tragically. Naturally, I asked him for more information; and at the same time I wrote to the American Medical Association and to one of the country's largest manufacturers of carbon-tetrachloride for their opinions. I also mentioned what I was doing to Dick Rider, the operator down at the State Theater, and he promptly came up with some back issues of a trade magazine called *"International Projectionist"* that discussed the use of the cleaning agent in the operating booth. From all these sources came warnings that say substantially the same thing: carbon-tetrachloride can and will cause serious illness and death if proper precautions are not observed in its use."

"I've noticed that bottles of the stuff always carry warning labels saying you should not breathe the vapor," Barney mused; "but I never paid much attention to them. How does it get you?"

"It can do serious harm if the vapor is inhaled, if it is taken internally, if it is splashed into the eyes, or even if it is permitted to come into contact with the skin."

"Sounds like a lot of stuff to me," Barney said skeptically. "While I've never tried drinking it or splashed it into my eyes, I've inhaled a lot of vapor and have had it all over my hands lots of times, and I'm still kicking."

"You've been mighty lucky," Mac said. "One thing that has helped is that you have usually used the carbon-tet in here with the exhaust fan going, and that has kept the vapor concentration down. However, it does not take a heavy concentration to be dangerous. Doctors used to think that anything under 100 parts per million was safe, but now they think it is desirable to keep the vapor below 50 parts per million. You can get an idea of just how little this is when I tell you that a normal nose just begins to detect the odor at 79 parts per million."

"Maybe some people can take more of it than others can."

"That's quite true. In one case I read about, four men were working together using carbon-tet for cleaning purposes. The next day one of the men developed symptoms of carbon-tetrachloride poisoning. Three days later, since he was still not feeling well, he entered a hospital. Ten days later, in spite of proper medical care, he died. None of the other three men showed any ill effects."

"Then poisoning doesn't always show up right away," Barney observed.

"That's one of the treacherous things about it," Mac replied. "It is not unusual for symptoms to show up from two to eight days after exposure, and because of this the connection between the poisoning and the use of the chemical is often overlooked. But to get back to the subject of the varying reaction of people to carbon-tet, it has been discovered that certain groups of people are especially susceptible to poisoning. These groups include fat people, undernourished people, alcohol addicts, and people who suffer from diabetes, liver or kidney diseases, jaundice, pulmonary and heart disease, or peptic ulcers."

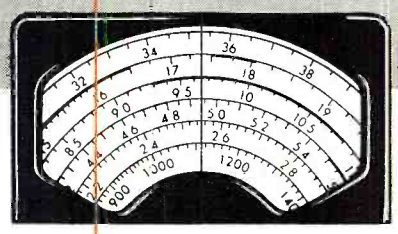
"So alcohol and carbon-tet don't mix, eh?" Barney said thoughtfully. "Boss, you had better clean the sets this afternoon. Mom hasn't noticed it yet, but her sweet cider is beginning to taste more interesting every day now, and I hit it up pretty hard after dinner. I know you wouldn't want me to take any chances."

"Well, you have already had a whiff of the vapor; so let's see if you have any of the typical symptoms of vapor-poisoning," Mac said with a grin. "The symptoms depend somewhat upon the concentration of the vapor and the duration of the exposure; but in general they are a feeling of fullness in the head, mental confusion, and headache; and then this is followed by nausea, stupor, and loss of consciousness. In severe cases there may be trouble with the vision and the coughing up of bloody mucus. If the person is not removed to a safe area promptly, death may occur because the person simply stops breathing."

"Suppose you should topple over while you were using the stuff here at the bench. What ought I to do?"

(*Continued on page* 139)

International SHORT-WAVE



***Compiled by* KENNETH R. BOORD**

IT IS a pleasure this month to dedicate the *ISW DEPARTMENT* to *Radio Monserrat,* HROW, in Tegucigalpa, capital of Honduras, Central America. Thanks go to David Dary, Kansas, for the following interesting data he received direct from the station:

Radio Monserrat, HROW, was founded May 22, 1949, and operates on a medium-wave channel of 850 kc.; short-wave frequencies are 6.020 and 6.675; schedule is 6:30 a.m. to 11 p.m. local time (0730-2130 *EST*). HROW is a commercial station owned and managed by Alfredo Leon Gomez. It employs *Western Electric* transmitters.

Sr. Gomez sent along this data about Honduras—population is 1,500,000; the capital city, Tegucigalpa, has 80,000 inhabitants; other principal cities are San Pedro Sula, La Ceiba, Tela, Puerto Crotez, Santa Rosa de Copan, and Yuscaran; is known for the famous ruins of Copan; products include bananas, gold and silver, timber, cotton, cereals, and cattle; the national tree is the pine.

Best wishes go to HROW for the future!

* * *

Club Notes

England—The International Short Wave League is no longer associated with *Short Wave News* published in London. It now is an independent organization with headquarters at 123, Sturla Road, Chatham, Kent, England, and is producing its own magazine called "Monitor." Membership fee for USA DX-ers will remain at 40 cents a year; the publication "Monitor" will cost $1.20 a year, according to Frank Baldwin, manager of ISWL. (Oskay, N. J.)

Information concerning the World Friendship Society of Radio Amateurs may be had by writing headquarters of this organization at 35, Bellwood Road, Waverley Park, Peckham Rye, London, S.E. 15, England. The club's publication, "Skywire," is currently carrying a series of articles written by members on such subjects as the elementary theory of radio; a reliable superhet receiver; design of a reliable frequency meter, and so on.

New Zealand—The New Zealand Radio DX League has chosen these new officers for the coming year—Arthur T. Cushen, president; Merv Branks, vice-president; Jim Martin, vice-president; Des Lynn, secretary. The "Times" Committee is composed of Merv Branks, editor; Arthur T. Cushen, short-wave editor; Keith Robinson, assistant broadcast editor; Bill Milne, assistant short-wave editor, and Alex Allen, circulation manager.

USA—Membership in the Minnesota Short Wave Listeners Association, recently organized club, is open to anyone anywhere; for details write to Meck Clark, 702 Cloquet Ave., Cloquet, Minnesota, who is secretary-treasurer of the group; Malfred Harnish is president of the club.

* * *

This Month's Schedules

Afghanistan—Radio Kabul was tuned 1140 when had request records in progress; announced "This is Kabul calling; we operate on 445.1 meters, 674 kc., and on 30 meters short-wave on a frequency of 9.975;" deteriorated badly around 1200, appeared to close down 1210A. (Pearce, England)

Andorra—Radio Andorra, 5.990, noted around 0700 with Latin American music, announcements in French and Spanish. (Catch, England)

Anglo-Egyptian Sudan—Radio Omdurman, 9.740A, noted recently with schedule extended to 1530 sign-off; uses no signature tune for native broadcasts. (Pearce, England) Bluman, Israel, says Omdurman has recently adjusted its 31-m. outlet to 9.737, presumably to get clear of Leopoldville on 9.745; still is badly QRM'd afternoons (*EST*) by Lisbon on 9.740, Bluman explains.

Omdurman, 17.94, now has "morning" Arabic session (heard Sundays) at 0345 to 0430A closedown. (Ridgeway, South Africa)

Angola—Pearce, England, recently has heard Radio Clube de Angola, Luanda, on 11.865A at 1515 and closing 1530; also heard by Bellington, N. Y., and by Ridgeway, South Africa. Ridgeways says the 11.865A channel closes 1530 but programs continue to 1630 over 9.64, 7.14.

Radio Clube do Huambo, 9.705, noted 1430-1500 with orchestral records, then varied popular music to 1530. (Pearce, England) *Radio Sweden* says CR6RJ, Radio Clube de Huila, Sa da Banderia, broadcasts on 9.755, with 1 kw., weekdays 0600-0700, 1300-1500, Sundays 0630-0745, 1230-1330, according to verification. Bluman, Israel, reports this one heard from 1300 onwards.

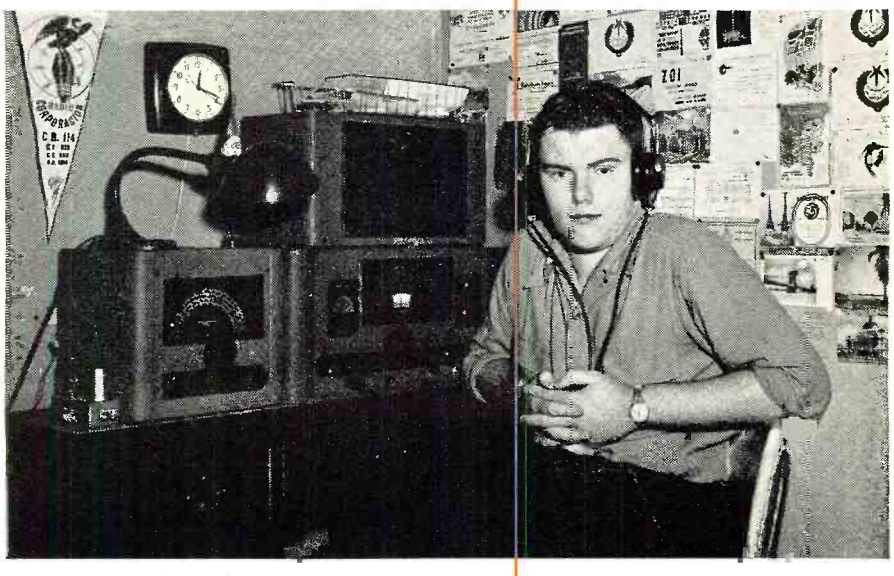
A *new* Angolan is noted on 7.790 at 1445-1525 when signs off with "A Portuguesa." (Radio Sweden)

Argentina—The SIRA programs from

(*Continued on page* 124)

(Note: Unless otherwise indicated, all time is expressed in American EST: add 5 hours for GCT. "News" refers to newscasts in the English language. In order to avoid confusion, the 24 hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 p.m. to midnight are shown as 1300 to 2400.) The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given. "A" means frequency is approximate.

David Dary, ISW Monitor, uses an RME-45 receiver and an RME DB-22A preselector.



AUDIO Simplified

By

DAVID FIDELMAN

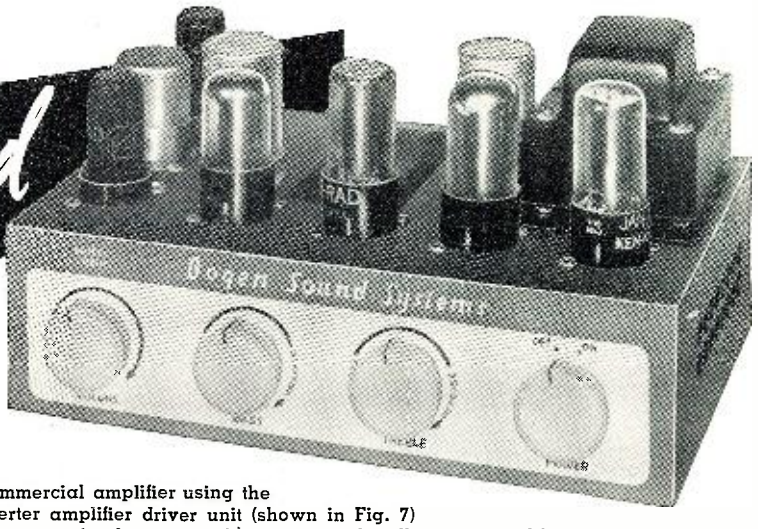


Fig. 1. Commercial amplifier using the phase-inverter amplifier driver unit (shown in Fig. 7) to couple output of voltage amplifier to the push-pull power amplifier.

Part 6. Covers practical design details on negative feedback circuits, transformer coupling, cathode followers, phase inverters, and driver amplifiers.

THE design and construction of voltage amplifiers has been discussed in previous articles of this series. The important characteristics of voltage amplifiers are: (1) overall gain, (2) input and output impedance, (3) input and output voltages, (4) frequency response, and (5) distortion. The gain, terminal impedances, and signal voltage levels are the amplifier design specifications, while the distortion and frequency response characteristics should always be the best that can be reasonably attained.

The required gain and output voltage can be obtained by using a sufficient number of amplifier stages, while the correct impedances can be obtained by resistance or transformer matching. However, it is more difficult to obtain the required good frequency response and distortion characteristics simply by use of basic, straightforward amplifier techniques. Bad frequency response can be corrected to a certain extent by equalizer circuits, but once distortion is present in the audio signal there is no way of removing it. The best method of obtaining good frequency response and low distortion is by using *negative feedback.*

Negative Feedback

A feedback amplifier is one in which a certain amount of voltage or current from the output is introduced back into a previous stage of the amplifier. The basic circuits for feedback in an amplifier are shown in the diagrams of Fig. 2. The arrangement in A shows the circuit for voltage feedback in which the amount of signal that is fed back is proportional to the voltage across the output load by means of the high resistance voltage divider. The arrangement in B shows the circuit for current feedback, in which the amount of signal that is fed back is proportional to the current through the output load by means of the resistor placed in series with the output load resistance.

The diagrams of Fig. 2 show that the voltage fed back from the output will add or subtract from the input signal, depending upon whether the two voltages are in-phase or out-of-phase. Suppose, for example, that the voltage fed back is in-phase so that it adds to the input signal to increase it. This has the effect of applying a greater signal to the input of the amplifier, and increasing the output voltage effectively increases the gain of the system. However, if the voltage which is fed back is out-of-phase so that it decreases the input signal, the output voltage is decreased and the gain of the system is effectively reduced. A feedback connection of the type in which the voltages add together is known as *positive feedback,* while the type of connection in which the voltages subtract is known as *negative feedback.*

The actual gain of an amplifier with feedback can be calculated if the feedback factor and the gain without feedback are known. If the fraction of the output voltage which is fed back is β, and the amplifier gain without feedback is A, then the output voltage with feedback is $A \times (E_{input} + \beta E_{output})$ and the gain of the amplifier with feedback is:

$$Gain_{feedback} = A' = \frac{E_{output}}{E_{input}} = \frac{A}{1 - \beta A}$$

The action of positive and negative feedback can be seen in more detail from the above formula by noting that when A is negative the gain with feedback is less than without feedback, and when A is positive the gain is greater than without feedback.

In a previous article it was shown that the gain of a single stage of amplification is negative, that is, the voltage in the plate circuit is 180° out-of-phase with the voltage in the grid circuit. Therefore, for any odd number of stages the output is out-of-phase with the input and can give negative feedback, while for an even number of stages the output is in-phase with the input and will give positive feedback.

The feedback equation also shows that if the amplification and feedback are such that the value of $A\beta$ is equal to $+1$ then the gain will be infinite and the circuit will oscillate. This condition is extremely important in the construction of oscillators, since a stable oscillator is obtained by the application of positive feedback at the desired frequency. Negative feedback reduces the amplification, and therefore also reduces the noise and distortions introduced within the feedback loop by the same amount. The percentage of distortion is decreased, and the frequency response curve is made more flat. In general, the following desirable effects are obtained by the use of negative feedback.

(1) Greater stability. The circuit characteristics will remain constant for wide changes in tube characteristics and applied voltages.

(2) Reduction of harmonic distortion and intermodulation distortion.

(3) Reduction of phase distortion.

(4) Improvement in the frequency response characteristics.

(5) Reduction of noise.

(6) Modification of the input and output impedances. In applying negative feedback to audio amplifiers, great care must be taken to apply the feedback in such a manner that phase shift does not cause it to become positive feedback at any frequency, because such positive feedback will tend to produce instability and increase distortion at these frequencies, and may even cause oscillation.

Transformer Coupling

In setting up audio systems it is often necessary to perform the functions of impedance transformation and phase

inversion. Impedance transformation is required whenever it is necessary to couple between circuits of different impedances, such as the plate of an amplifier stage to a transmission line or other low impedance load. Some type of circuit must be used which will match the two impedances properly. Phase inversion is required whenever it is necessary to couple from a single-ended to a push-pull circuit.

The simplest method of performing these functions is by the use of transformers, as shown in Fig. 3. Some transformer applications have already been shown, without further explanations, in previous articles in this series. A transformer consists of one or more windings placed on a single iron core, in such a manner that the electromagnetic field of the primary winding induces a signal in the secondary winding. If the two windings have different numbers of turns, then there will be an increase or a decrease in the voltage from one winding to the other, proportional to the ratio of the number of turns in each winding. When the secondary winding is loaded with a resistance, then this resistance appears in the primary circuit multiplied by the square of the turns ratio between the two windings. These basic characteristics of transformers are indicated by the formulas included in the diagram of Fig. 3.

For increased flexibility, the windings in a single transformer will often have taps brought out at various numbers of turns in order to give a wide variety of turns ratios. Different numbers of turns of the same winding can also be used as a transformer, as shown in *B* of Fig. 3, and such a transformer is called an auto-transformer.

Transformer coupling is used mainly between impedances ranging from a few ohms up to about 50,000 ohms, and is most useful in applications such as:

(1) Input coupling from low impedance sources to high impedance grid circuits,

(2) Interstage coupling from plate to grid circuits,

(3) Output coupling from plate circuits to low impedance lines or loudspeaker voice coils,

(4) Impedance matching between low impedance lines or from line to loudspeaker voice coil, as well as numerous other applications which will become evident upon further consideration of various audio systems.

One of the other important characteristics of transformers which can be seen from Fig. 3 is that the various windings are isolated from each other, since there is no direct connection between them, and transformers can, therefore, be used for d.c. and ground isolation between circuits. In coupling from the plate circuits of amplifiers, transformers are used mainly with general purpose triodes and pentode power amplifiers, since other types of tubes require too high an impedance.

Although they have a number of desirable features which make them quite convenient for use in audio circuits, transformers also have certain disadvantages which often make their use undesirable. One of the main disadvantages is their cost. A good quality transformer will cost considerably more than a single amplifier stage. Thus, if a tube can be made to perform the same function, it is obviously less expensive to use the tube instead of the transformer. The frequency range of transformers is limited by the practical considerations of maximum obtainable primary inductance and distributed capacity across the windings, so that when extremely wide frequency bands are required, transformers cannot always be used. The frequency response is very important when the feedback loop includes the transformer, since phase shift may cause the feedback to become positive at some frequency and cause instability. Care must also be taken that too large an unbalanced direct current does not flow through the windings—since such currents may saturate the iron core and cause distortion in the audio signal. One other factor which may make transformers undesirable for certain applications is their size, since the shielding or the size of the core may often cause high-quality transformers to be too large for applications where small size and compactness are required.

Considering the relative advantages and disadvantages of using transformers in audio circuits, it is evident that they should be used mainly in applications where their particular advantages are of value. A few typical examples are:

(1) To obtain high output voltage for limited supply voltage,

(2) To match to low impedance lines, particularly where isolation is required between primary and secondary circuits, and

(3) When a low d.c. resistance is essential in the grid circuit of the following stage, as well as other cases which may occur in the design and setup of specific audio systems.

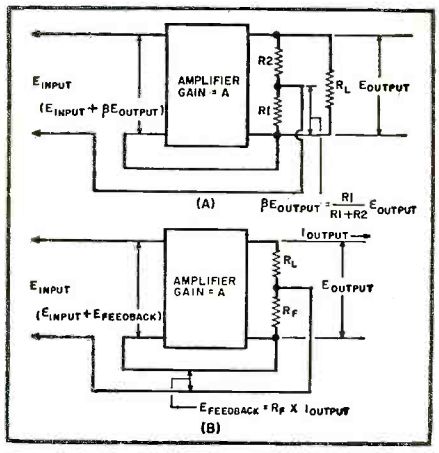


Fig. 2. Functional representation of the basic methods of voltage and current feedback. (A) Basic circuit for the application of voltage feedback to an amplifier by feeding a fraction of the output voltage back to the input. (B) Circuit for the application of current feedback to an amplifier by feeding back to the input a voltage proportional to output current.

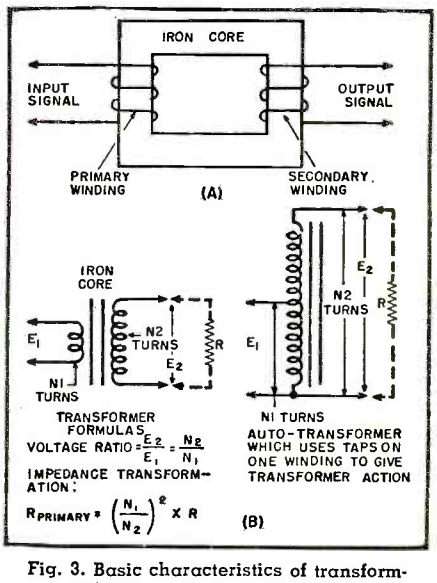


Fig. 3. Basic characteristics of transformers. (A) Basic physical construction of transformer. (B) Electrical representation.

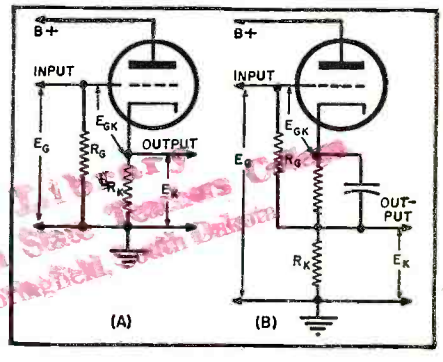
Cathode Followers and Phase Inverters

In many applications where it is not convenient or practical to use transformers, the functions of impedance transformation and of phase inversion can be performed by vacuum tubes. By using current feedback of the type shown in Fig. 2B, these functions can be performed by the *cathode follower* amplifier.

The cathode follower is a single-stage negative current feedback amplifier in which the output voltage is taken from across a load resistance in the cathode circuit. Typical circuits of cathode follower amplifiers are shown in Fig. 4. In these circuits the signal plate current flows through the load resistor as in the conventional amplifier stage, but this resistor is placed between cathode and ground instead of between plate and "B +." Since the input grid voltage is applied between grid and ground, while the control signal is the grid-cathode voltage, the grid-cathode signal is the output voltage subtracted from the input voltage.

The result of this type of connection is a considerable amount of negative

Fig. 4. Two often-used cathode-follower circuits. The output voltage is developed across the resistor in the cathode circuit.



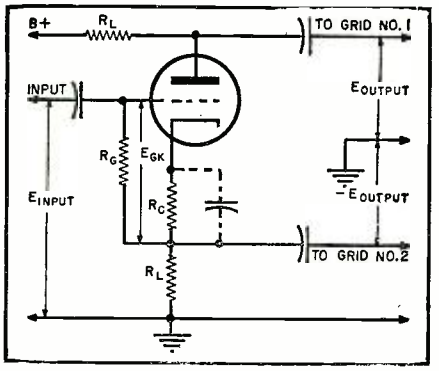


Fig. 5. How equal resistances are used in the cathode and plate circuits of a cathode follower to give a push-pull output from a single-ended input signal.

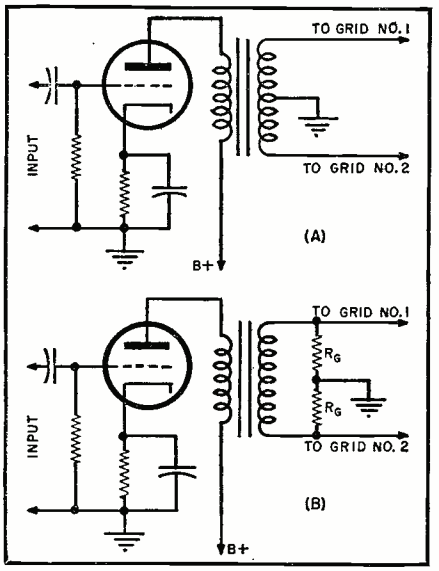


Fig. 6. Use of a transformer to give push-pull output from single-ended input signal.

feedback over the one stage, and the output signal across the cathode resistor must always be less than the input signal between grid and ground, since otherwise the tube would have to have an infinite amplification factor. The gain of the stage from the input grid signal voltage to the output cathode signal voltage is:

$$A' = \frac{E_k}{E_g} = \frac{\mu R_k}{(\mu + 1) R_k + R_p} = \frac{1}{1 + \frac{R_k + R_p}{\mu R_k}}$$

which is always less than one.

The cathode-follower amplifier connected in this manner has certain characteristics which are often very useful. The output impedance across the cathode resistor is very low because of the large amount of feedback, and is approximately equal to $1/g_m$ in parallel with R_k, which will almost always be well under 1000 ohms. The low output impedance is one of the most important characteristics of the cathode-follower, since it can be used to give a transformation from a high to a low impedance with no loss in signal level, over a very wide frequency band, without the use of a transformer. This circuit is particularly useful in feeding a low-impedance line from a high-impedance amplifier circuit. The input impedance is higher than for the same tube used in a conventional amplifier stage, and is equal to:

$$R_{input} = \frac{R_g}{1 - A'}$$

so that the closer the gain is to one, the higher is the input impedance. This high impedance is important in many cases where it is desirable to have the minimum amount of loading across some high impedance source, for example, in the preamplifier of a condenser microphone to obtain adequate bass response.

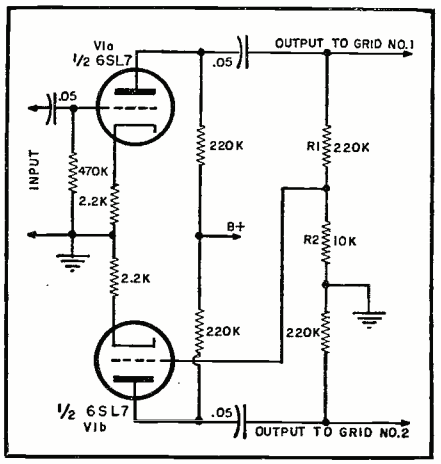
Because the cathode-follower has so much negative feedback, it introduces very little amplitude distortion, and is capable of handling a high input voltage without overloading.

Consideration of the basic cathode-follower circuit in Fig. 4 shows another extremely important characteristic. Suppose a positive voltage is applied to the grid—then the plate current increases and the cathode becomes more positive. This means that the output taken across the cathode load is in-phase with the input signal applied to the grid. However, in a conventional amplifier stage the output signal in the plate circuit is exactly opposite in phase with the grid input signal. Therefore the cathode output signal in a cathode-follower amplifier is exactly opposite in phase with the signal in the plate circuit, and this factor can be used to construct a phase inverter. The manner in which this can be done is shown in the circuit in Fig. 5. Equal resistances are placed in the cathode and in the plate circuit, and one output is taken from the cathode circuit and the other from the plate circuit. This gives two equal signals opposite in phase, which can then be applied to the two grids of a push-pull amplifier.

Driver Amplifiers

The driver amplifier couples the output of the voltage amplifier section to the input of the power amplifier. It must be able to supply enough voltage and power to the power amplifier grid to drive it to full output without overloading. When a push-pull power amplifier is used, the driver section should also contain a phase inverter to couple the output of a single-ended voltage amplifier to the push-pull grids of the power amplifier. Special techniques may also be used in the driver to minimize the effects of grid current in the power amplifier.

Fig. 7. Practical phase-inverter amplifier.



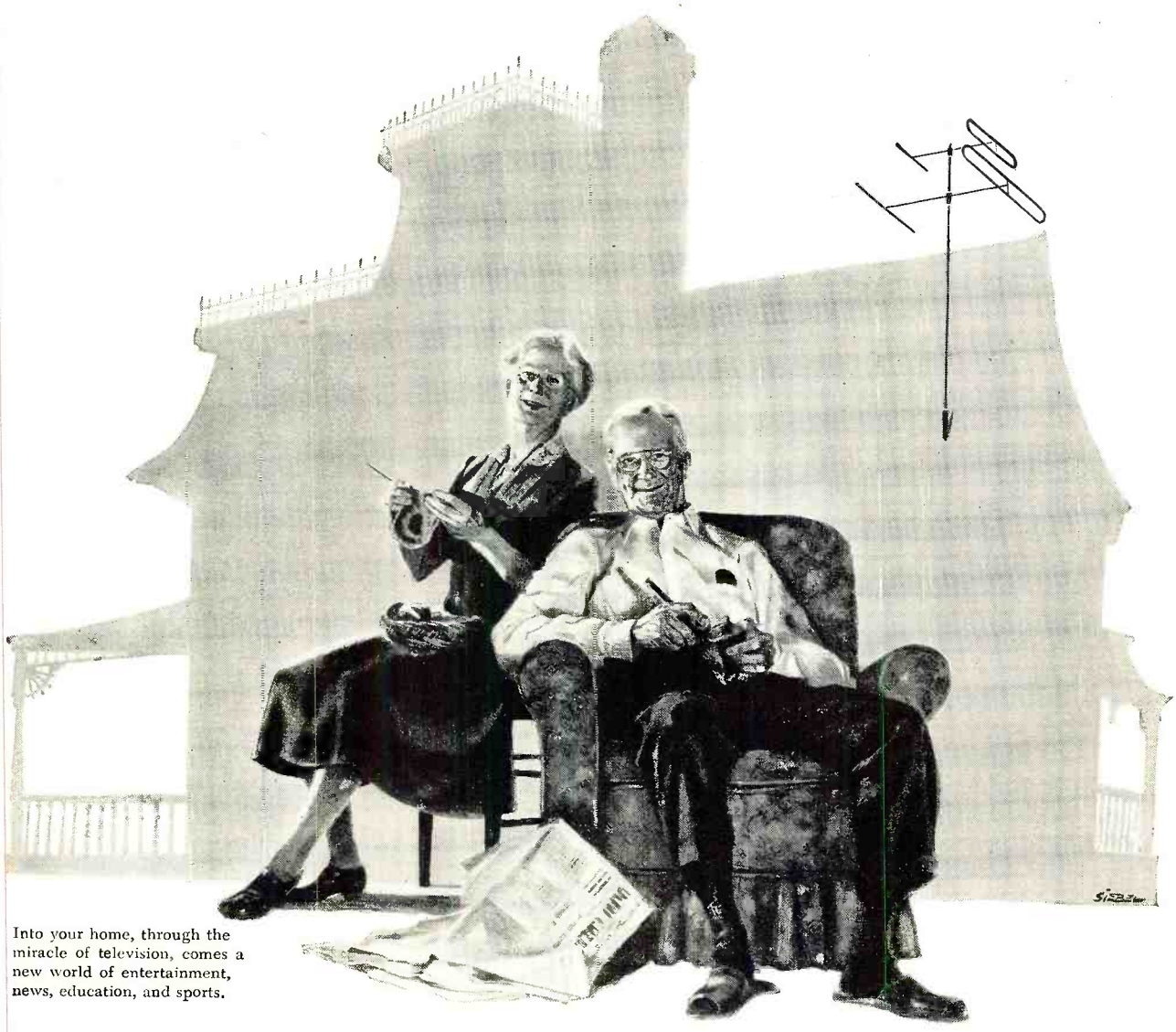
Because the amount of voltage required from the driver is determined by the power amplifier requirements, different circuits may often be required for different power amplifier tubes. Triodes in general are less sensitive and require higher grid signal voltages than pentodes and beam power tubes. Normally a general-purpose triode will furnish sufficient output voltage to drive most of the power tubes used in all except the very high power sound reproducing systems.

The circuits of several different driver amplifiers which are suitable for coupling the output of a single-ended voltage amplifier to a push-pull power amplifier are shown in Figs. 5, 6 and 7. The circuit of Fig. 6A shows the simplest and best known method of performing this function, *i.e.*, by use of a transformer having a center-tapped secondary winding. Since this provides two equal voltages 180 degrees out-of-phase, perfectly satisfactory results are obtained with properly designed transformers. If the transformer secondary is not center-tapped, it can still be used for push-pull operation by connecting a resistance voltage divider with its center grounded, as shown in Fig. 6B. The center-tapped winding is preferable because it introduces low resistance into the power amplifier grid circuit so that there is less distortion when grid current is drawn, and because it does not reflect any resistive load into the driver circuit on the primary side. However, because good transformers are expensive, they are not too widely used in most of the average-size sound reproducing systems.

For most applications, good results are obtained with the use of resistance-coupled amplifier stages. The simplest circuit which can be used for this purpose is the cathode-follower phase splitter circuit shown in Fig. 5. With equal load resistors in the plate and cathode circuits, two equal output voltages, opposite in phase, are obtained which are then applied to the two power amplifier grids. Since the gain to each side is approximately that of the cathode-follower with a maximum of 1, the total grid-to-grid output voltage gain of the phase inverter has a maximum value of 2. With this low gain, the tube does very little amplification, but takes the place of the transformer in coupling from the single-ended to the push-pull stages.

Another type of circuit which can be used for phase inversion is shown in Fig. 7. In this circuit the voltage amplifier drives one of the push-pull grids directly, while an additional amplifier stage is used to amplify a small part of this voltage with a 180-degree phase

(*Continued on page* 154)



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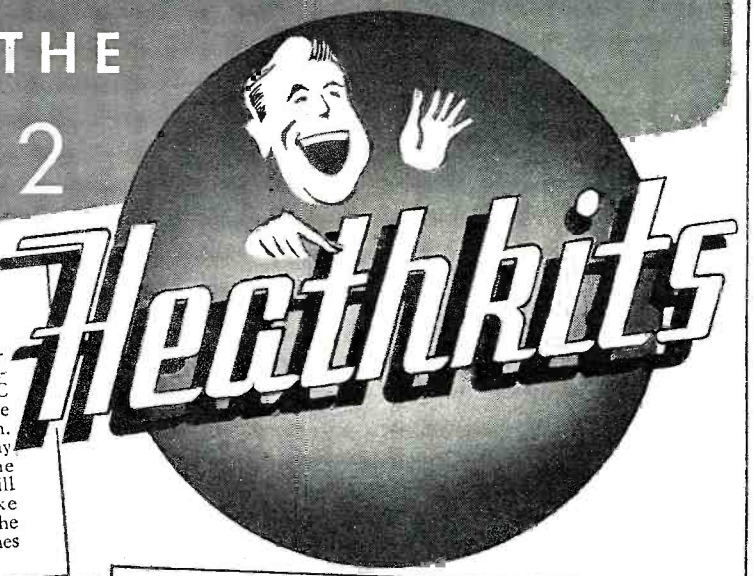
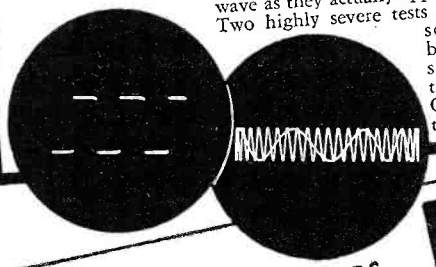
Features OF THE NEW 1952 Heathkits



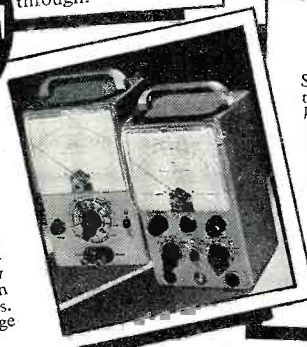
PROOF OF THE NEW O-7 OSCILLOSCOPE'S OUTSTANDING PERFORMANCE

Below are actual, unretouched photographs showing the outstanding frequency response characteristics of the NEW 1952 HEATHKIT OSCILLOSCOPE, MODEL O-7. To the left is a 10 KC square wave — to the right a 4 MC sine wave as they actually appear on the screen. Two highly severe tests to make on any scope (only the best of scopes will show traces like these) — and the O-7 really comes through.



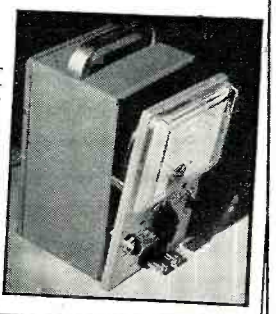
COMPANION VACUUM TUBE VOLTMETERS

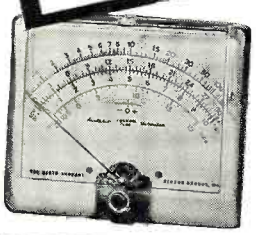
Here are the two NEW 1952 VACUUM TUBE VOLTMETER COMPANION PIECES. Matched instruments of new design to open up the whole field of DC, AC, and resistance measurements for you. The new greatly reduced size combines style, beauty, and compactness — The V-5 and AV-1 have the new panel and cabinet construction as shown on the right. A tremendous pair of voltmeters. Small in size but virtual giants in the range of measurements they make.



NEW STYLE AND BEAUTY

Style that's modern, yet functional — that's the trend of today — and Heathkits are right up to the minute. Note the cut showing the new V-5 and AV-1 cabinet and panel construction. The front panel and rear cover slide right over the recessed flange of the case thereby eliminating sharp edges and pointed corners. The voltmeter kits aren't "shelf", or "mounted" instruments — they're moved about on the bench a lot and thus the new compact size and specially designed cabinets — Another 1952 Heathkit feature.





A STATEMENT FROM SIMPSON ELECTRIC CO.

In choosing Simpson Meters for their Heathkit VTVM, the Heath Co. has set a new high standard of kit meter quality. The same high quality of material, workmanship and design that has given Simpson the reputation for building "Instruments That Stay Accurate" is found in the Heathkit Meter Movement.

SIGNED
SIMPSON ELECTRIC CO.

A STATEMENT FROM CHICAGO TRANSFORMER

It is indeed gratifying to note the outstanding sales records you are building with you Heathkits.

This sales success is readily understandable, since we are cognizant of the high quality standards you have established for your component suppliers.

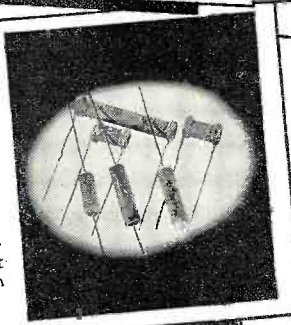
We at Chicago Transformer are proud that our product has contributed to the recognized quality and increasing popularity of Heathkits.

CHICAGO TRANSFORMER DIVISION
Essex Wire Corporation

L. S. RACINE
Vice-President and Sales Manager

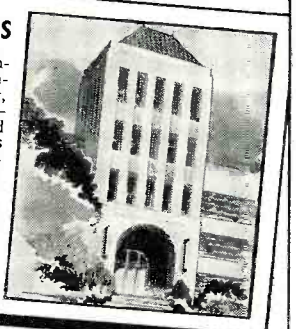
HEATHKIT PRECISION RESISTORS

Where exact resistance values are required for instrument accuracy, the Heath Co. has spared no effort in supplying the finest resistors available. Precision resistors as manufactured by Continental Carbon Inc., and Wilcor Corp., meet the rigorous JAN (Joint Army-Navy) specifications and are small in size, extremely non-inductive, highly stable, have a low temperature coefficient, and can be held to great accuracy. You'll find quality components in Heathkits.



COLLEGES USE HEATHKITS

Colleges and Universities throughout the country are using Heathkits in their electrical engineering, radio, and physics laboratories — Heathkits are the answer to good test equipment at low cost, plus being rugged, dependable, and accurate. Trade schools are having their students build Heathkits to obtain a first hand working knowledge of test equipment and to get the practical experience gained by construction. Heathkits fill school needs.



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New LABORATORY LINE HEATHKITS

NEW Heathkit A.C. VACUUM TUBE VOLTMETER KIT

MODEL AV-1
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Now — as a Heathkit — at a price anyone can afford, an AC VTVM. A new kit to make possible those sensitive AC measurements required by audio enthusiasts, laboratories, and experimentors. Here is the kit that the audio men have been looking for. Its tremendous range of coverage makes possible measurements of audio amplifier frequency response — gain or loss of audio stages — characteristics of audio filters and attenuators — hum investigation — and literally a multitude of others. Ten ranges consisting of full scale .01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts RMS assure easy and more accurate readings. Ten ranges on DB provide for measurements from −52 to +52 DB. Frequency response within 1 DB from 20 cycles to 50 KC.

The ingenious circuitry incorporates precision multiplier resistors for accuracy, two amplifier stages using miniature tubes, a unique bridge rectifier meter circuit, quality Simpson meter with 200 microampere movement, and a clean layout of parts for easy wiring. A high degree of inverse feedback provides for stability and linearity.

Simple operation is accomplished by the use of only one control, a range switch which changes the voltage ranges in multiples of 1 and 3, and DB ranges in steps of 10.

The instrument is extremely compact, cabinet size — 4⅛" deep x 4-11/16" wide x 7⅜" high, and the newly designed cabinet makes this the companion piece to the VTVM. For audio work, this kit is a natural.

NEW Heathkit AUDIO FREQUENCY METER KIT

MODEL AF-1
Shipping weight 12 lbs.

$34.50

A NEW Heathkit Audio Frequency Meter — the ideal instrument for determining frequencies from 20 cycles to 100 KC. Set the selector switch to the proper range — feed the signal into the input terminals — and read the frequency from the meter — completely simple to operate, and yet dependable results.

Quality Simpson 200 microampere meter has two plainly marked scales (0-100 0-300. These scales, read in conjunction with the seven position selector switch, give full scale readings of 100, 300, 1000, 3000, 10,000, 30,000, and 100,000 cycles. Convenient ranges for fast and easy readings.

For greatest accuracy, the 1-3-10 ratio of ranges is maintained and each range has individual calibrating control.

Input impedance is high (1 megohm) for negligible circuit loading. A signal voltage anywhere between 2 and 300V can be fed directly into the instrument and a change in signal voltage between these limits will not affect the meter reading. In addition, input wave shape is not critical (the unit will read the frequency of either sine wave or square wave input).

The tube complement consists of a 6SJ7 amplifier and clipper, 6V6 amplifier and clipper, 6H6 meter pulse rectifier, 6X5 power supply rectifier, and OD3/VR150 voltage regulator.

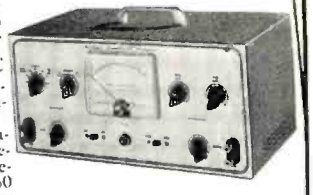
Construction is simple, and quality components are used throughout.

NEW Heathkit INTERMODULATION ANALYZER KIT

Intermodulation testing of audio equipment is rapidly being accepted by more and more engineers and audio experts as the best way to determine the characteristics of audio amplifiers, recording systems, networks, etc. — shows up those undesirable characteristics which contribute to listening fatigue when all other methods fail.

The Heathkit Intermodulation Analyzer supplies a choice of two high frequencies (3000 cycles and a higher frequency) and one low frequency (60 cycles). Both 1:1 or 4:1 ratios of low to high frequencies can be set up for IM testing, and the ratios are easily set by means of a panel control and the instrument's own VTVM. An output level control supplies the mixed signal at the desired level with an output impedance of two thousand ohms. The Analyzer section has input level control and proper filter circuits feeding the instrument's VTVM to read intermodulation directly on full scale ranges of 30%, 10% and 3%. Built-in power supply furnishes all necessary voltages for operating the instrument.

You won't want to be without this new and efficient means of testing



MODEL IM-1
Shipping wt. 18 lbs.

$39.50

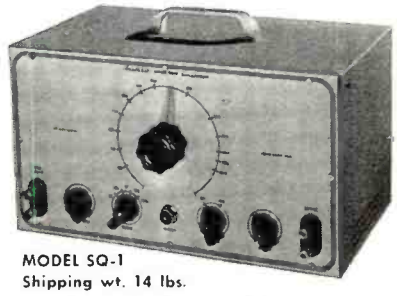
NEW Heathkit SQUARE WAVE GENERATOR KIT

The new Heathkit Square Wave Generator Kit with its 100 KC square wave opens an entirely new field of audio testing. Square wave testing over this wide range will quickly show high and low frequency response characteristics of circuits — permit easy adjustment of high frequency compensating networks used in vidio amplifiers — identify ringing in circuits — demonstrate transformer characteristics, etc.

The circuitry consists of a multivibrator stage, a clipping and squaring stage, and a cathode follower output stage. The power supply is transformer operated and utilizes a full wave rectifier tube with 2 sections of LC filtering.

As a multivibrator cannot be accurately calibrated, a provision is provided to allow the instrument to be accurately synchronized with an accurate external source when extreme accuracy is required.

The low impedance output is continuously variable between 0 and 25 volts and operation is simple. You'll really appreciate the wide range of this instrument, 10 cycles to 100 kilocycles — continuously variable. Kit is complete with all parts and instruction manual, and is easy to build.



MODEL SQ-1
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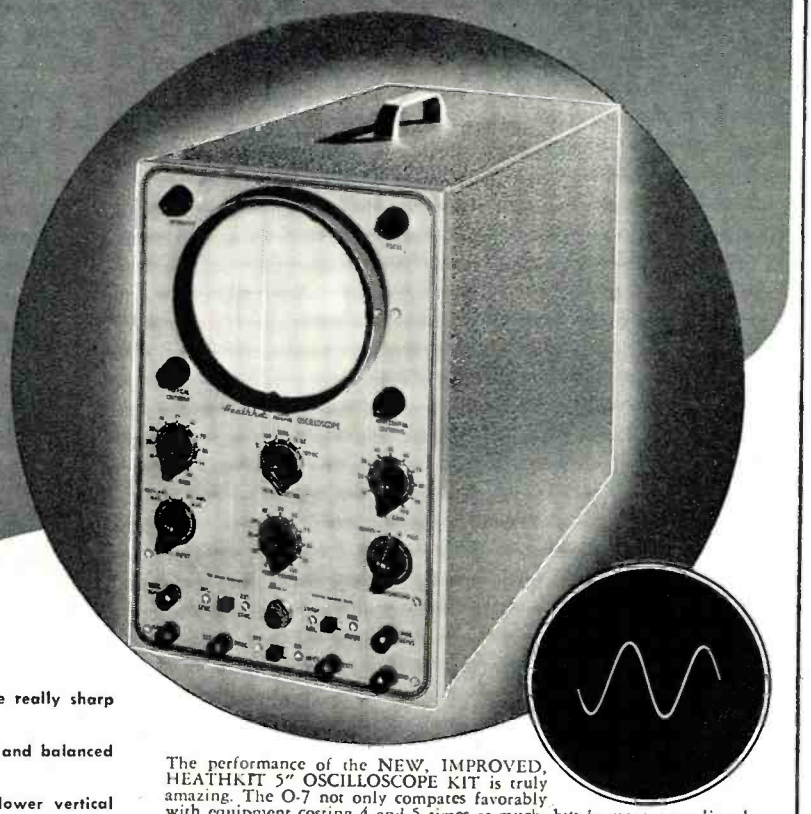
OSCILLOSCOPE KIT

MODEL O-7
SHIPPING WEIGHT 24 LBS.

$43.50



Features

- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 Mc.
- Tremendous sensitivity .03V RMS per inch Vertical — .6V RMS per inch Horizontal.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.

The performance of the NEW, IMPROVED, HEATHKIT 5" OSCILLOSCOPE KIT is truly amazing. The O-7 not only compares favorably with equipment costing 4 and 5 times as much, but in many cases literally surpasses the really expensive equipment. The new, and carefully engineered circuit incorporates the best in electronic design — and a multitude of excellent features all contribute to the outstanding performance of the new scope.

The VERTICAL CHANNEL has a step attenuated, frequency compensated vertical input which feeds a cathode follower stage — this accomplishes improved frequency response, presents a high impedance input, and places the vertical gain control in a low impedance circuit for minimum distortion. Following the cathode follower stage is a twin triode — cascaded amplifiers to contribute to the scope's extremely high sensitivity. Next comes a phase splitter stage which properly drives the push-pull, hi-gain, deflection amplifiers (whose plates are directly coupled to the vertical deflection plates). This fine tube lineup and circuitry give a sensitivity of .03V per inch RMS vertical and useful frequency response to 5 Mc.

The HORIZONTAL CHANNEL consists of a triode phase splitter with a dual potentiometer (horizontal gain control) in its plate and cathode circuits for smooth, proper driving of the push-pull horizontal deflection amplifiers. As in the vertical channel, horizontal deflection amplifier plates are direct coupled to the CR tube horizontal deflection plates (for improved frequency response).

The WIDE-RANGE SWEEP GENERATOR circuit incorporates a twin triode multivibrator stage for producing a good saw-tooth sweep frequency (with faster retrace time). Has both coarse and vernier sweep frequency controls.

And the scope has internal synchronization which operates on either positive or negative peaks of the input signal — both high and low voltage rectifiers — Z axis modulation (intensity modulation) — new spot shape (astigmatism) control for spot adjustment — provisions for external synchronization — vertical centering and horizontal centering controls, wide range focus control — and an intensity control for giving plenty of trace brilliance.

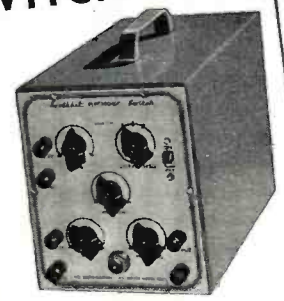
The Model O-7 EVEN HAS GREAT NEW MECHANICAL FEATURES — A special extra-wide CR tube mounting bracket is provided so that the vertical cascade amplifier, vertical phase splitter, vertical deflection amplifier, and horizontal deflection amplifier can mount near the base of the CR tube. This permits close connection between the above stages and to the deflection plates; distributed wiring capacity is greatly reduced, thereby affording increased high frequency response.

The power transformer is specially designed so as to keep its electrostatic and electromagnetic fields to a minimum — also has an internal shield with external ground lead.

You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis—nothing else to buy.

NEW INEXPENSIVE *Heathkit*

ELECTRONIC SWITCH KIT



The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls) and the traces can be superimposed for comparison or separated for individual study (position control).

Use the switch to see distortion, phase shift, clipping due to improper bias, both the input and output traces of an amplifier — as a square wave generator over limited range.

The kit is complete; all tubes, switches, cabinet, power transformer and all other parts, plus a clear detailed construction manual.

Model S-2
Shipping Wt. 11 lbs.

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The **HEATH COMPANY**

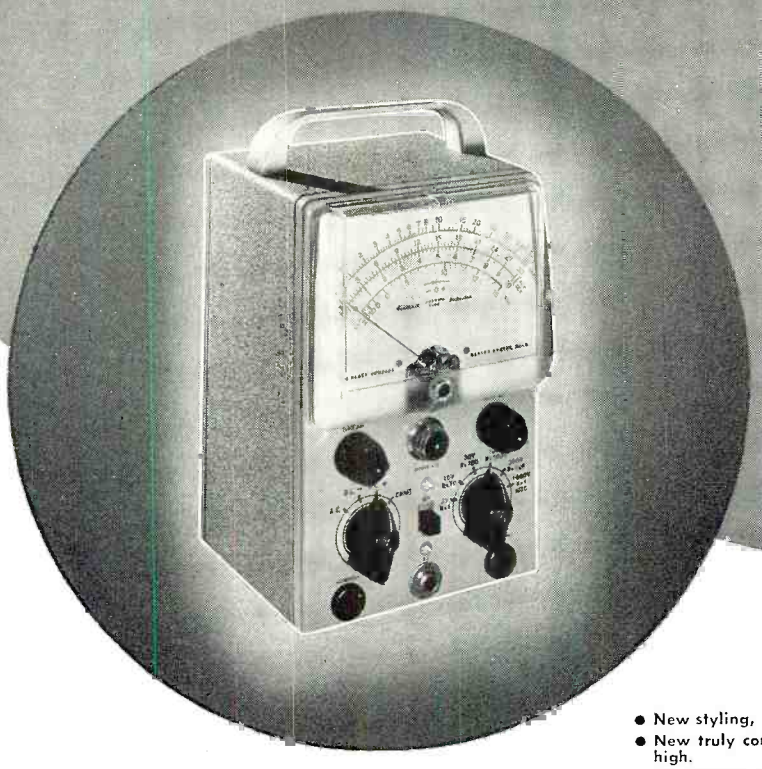
. . . BENTON HARBOR 15, MICHIGAN

THE *New* 1952

Heathkit VTVM KIT

MODEL V-5
SHIPPING WT. 5 LBS.

$24.50



Features

- New styling, — formed case for beauty.
- New truly compact size. Cabinet 4⅛" deep by 4-11/16" wide by 7⅜" high.
- Quality 200 microamp meter.
- New ohms battery holding clamp and spring clip — assurance of good electrical contact.
- Highest quality precision resistors in multiplier circuit.
- Calibrates on both AC and DC for maximum accuracy.
- Terrific coverage — reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
- Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.
- New styling presents attractive and professional appearance.

A real beauty — you'll have only highest praise for this NEW MODEL VACUUM TUBE VOLTMETER. Truly a beautiful little instrument — and it's more compact than any of our previous models. Note the new rounded edges on the front panel and rear cover. The size is greatly reduced to occupy a minimum of space on your workbench — yet the meter remains the same large size with plainly marked scales.

A set of specially designed control mounting brackets permit calibration to be performed with greatest ease — also makes for ease in wiring. New battery mounting clamp holds ohms battery tightly into place, and base spring clip insures a good connection to the ohms string of resistors.

The circuitry employs two vacuum tubes — A duo diode operating when AC voltage measurements are taken, and a twin triode in the circuit at all times. The cathode balancing circuit of the twin triode assures sensitive measurements, and yet offers complete protection to the meter movement. Makes the meter burn-out proof in a properly constructed instrument.

Quality components are used throughout —1% precision resistors in the multiplier circuit—conservatively rated power transformer—Simpson meter movement — excellent positive detent, smooth acting switches — sturdy cabinet, etc.

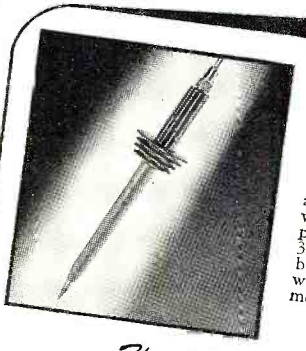
And you can make a tremendous range of measurements — ½V to 1000V AC, ½V to 1000V DC, .1 to over 1 billion ohms, and DB. Has mid-scale zero level marking for quick FM alignment. DB scale in red for easy identification — all other scales a sharp, crisp black for for easy reading.

A four position selector switch allows operator to rapidly set the instrument for type or reading desired—positions include ACV, DC+V, DC—V, and Ohms. DC— position allows negative voltage to be rapidly taken. Zero adjust and ohms adjust controls are conveniently located on front panel.

Enjoy the numerous advantages of using a VTVM. Its high input impedance doesn't "load" circuits under test — therefore, assures more accurate and dependable readings in high impedance circuits such as resistance coupled amplifiers, AVC circuits, etc. Note the 30,000 VDC probe kit and the RF probe kit — available at low extra cost and specially designed for use with this instrument. With these two probes, you can make DC voltage measurements up to 30,000V, or make RF measurements — added usefulness to an already highly useful instrument.

The instruction manual is absolutely complete — contains a host of figures, pictorials, schematic, detailed step-by-step instructions, and circuit description. These clear, detailed instructions make assembly a cinch.

And every part is included — meter, all controls, pilot light, switches, test leads, cabinet, instruction manual, etc.



Heathkit 30,000V DC
PROBE KIT

A new 30,000 V DC Probe Kit to handle high voltages with safety. For TV service work and all other high voltage applications. Sleek looking — Two color molded plastic — Red body and guard — jet black handle. Comes with connector, cable, and PL55 type plug. Plugs into Heathkit VTVM so that 300V scale is conveniently multiplied by 100. Can be used with any standard 11 megohm VTVM.

$5.50

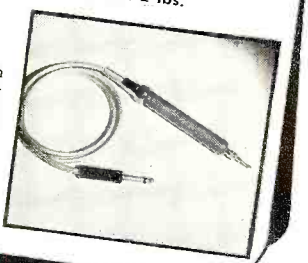
No. 336 High Voltage Probe Kit
Shipping Wt. 2 lbs.

Heathkit
RF PROBE KIT

This RF Probe Kit comes complete with probe housing, crystal diode detector, connector, lead and plug and all other parts plus clear assembly instructions. Extends range of Heathkit VTVM to 250 Mc. ± 10%. Works on any 11 megohm input VTVM. Specify No. 309 RF Probe Kit.

$5.50

Ship. Wt. 1 lb.



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Heathkit

SIGNAL GENERATOR KIT

Model SG-6
Shipping Wt. 7 lbs.

$19.50

The new Heathkit Signal Generator Kit has dozens of improvements. Covers the extended range of 160 Kc to 50 megacycles on fundamentals and up to 150 megacycles on useful calibrated harmonics; makes this Heathkit ideal as a marker oscillator for TV. Output level can be conveniently set by means of both step attenuator and continuously variable output controls. Instrument has new miniature HF tubes to easily handle the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The kit is transformer operated and a husky selenium rectifier is used in the power supply. All coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers. Comes complete, all tubes, cabinet, test leads, every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator.

Heathkit

CONDENSER CHECKER KIT

Only

$19.50

Model C-2
Shipping Wt. 6 lbs.

Checks all types of condensers — paper — mica — ceramic — electrolytic. All condenser scales are direct reading and require no charts or multipliers. Covers range of .00001 MFD to 1000 MFD. A Condenser Checker that anyone can read. A leakage test and polarizing voltage for 20 to 500 V provided. Measures power factor of electrolytics between 0% and 50% and reads resistance from 100 ohms to 5 megohms. The magic eye indicator makes testing easy.

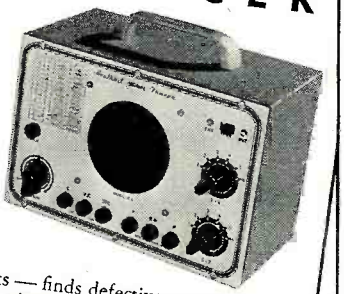
The kit is 110V 60 cycle transformer operated and comes complete with rectifier tube, magic eye tube, cabinet, calibrated panel and all other parts. Has clear detailed instructions for assembly and use.

NEW *Heathkit*

SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Model T-2
Shipping Wt. 7 lbs.



The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — finds defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast, FM, or TV receivers. The test speaker has an assortment of switching ranges to match either push-pull or single output impedances. Also tests microphones, pickups and PA systems. Comes complete: cabinet, 110V 60 cycle power transformer, tubes, test probe, all necessary parts, and detailed instructions for assembly and use.

Model TC-1
Shipping Wt. 12 lbs.

$29.50

Heathkit

TUBE CHECKER KIT

The Tube Checker is a MUST for radio repair men. Often customers want to SEE tubes checked, and a checker like this builds customer confidence. In your repairing, you will have a multitude of tubes to check — quickly. The Heathkit tube checker will serve all these functions — it's good looking (with a polished birch cabinet and an attractive two color panel) — checks 4, 5, 6, 7 prong Octals, Loctals, 7 prong miniatures, 9 prong miniatures, pilot lights, and the Hytron 5 prong types. AND IT'S FAST TO OPERATE — the gear driven, free-running roll chart lists hundreds of tubes, and the smooth acting, simplified switching arrangement gives really rapid set-ups.

The testing arrangement is designed so that you will be able to test new tubes of the future — without even waiting for factory data — protection against obsolescence.

You can give tubes a thorough testing — checks for opens, shorts, each element individually, emission, and for filament continuity. A large BAD-?-GOOD meter scale is in three colors for easy reading and also has a "line-set" mark.

You'll find this tube checker kit a good investment — and it's only $29.50.

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NEW 1952 *Heathkit*

BATTERY ELIMINATOR KIT

Model BE-3
Shipping Wt. 17 lbs.

- Can be used as battery charger.
- Continuously variable output 0 - 8 Volts — not switch type.
- Heavy duty Mallory 17 disk type magnesium copper sulfide rectifier.
- Automatic overload relay for maximum protection. Self-resetting type.
- Ideal for battery, aircraft and marine radios.
- Dual Volt and Ammeters read both voltage and amperage continually — no switching.

The new Heathkit Model BE-2 incorporates the best. Continuously variable output control is of the variable transformer type with smooth wiper type contacts.

There are no switches or steps and voltage between 0 and 8 Volts is available at 10 Amperes continuous and 15 Amperes intermittent. Maximum safety from overloads and shorts provided by automatic overload relay which resets itself when overload is removed.

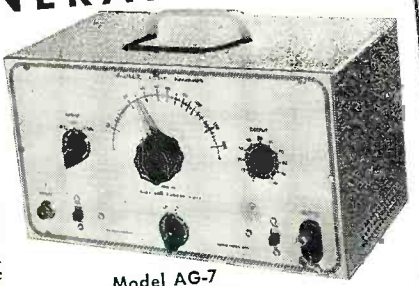
The new rectifier is a 17 plate Mallory magnesium copper sulfide type. This is the most rugged type available for long trouble-free use.

Output is continuously metered by both a 0 - 10 Volt Voltmeter and a 0 - 15 Amp Ammeter. Shorted vibrators indicated instantly by ammeter.

Equip now for all types of service — aircraft — marine — auto and battery radios — this inexpensive instrument vastly increases service possibilities — better be ready when the customer walks in.

NEW *Heathkit*

SINE AND SQUARE WAVE AUDIO GENERATOR KIT



Model AG-7
Shipping Wt. 15 lbs.

$34.50

Designed with versatility, usefulness, and dependability in mind, the AG-7 gives you the two most needed wave shapes right at your fingertips — the sine wave and the square wave.

The range switch and plainly calibrated frequency scale give rapid and easy frequency selection, and the output control permits setting the output to any desired level.

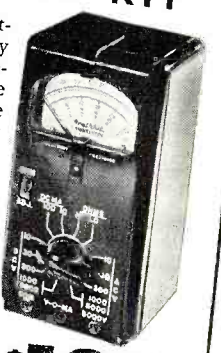
A high-low impedance switch sets the instrument for either high or low impedance output —on high to connect a high impedance load, and on low to work into a low impedance transformer with negligible DC resistance.

Coverage is from 20 to 20,000 cycles, and distortion is at a minimum — you can really trust the output wave shape.

Six tubes, quality 4 gang tuning condenser, power transformer, metal cased filter condenser, 1% precision resistors in the frequency determining circuit, and all other parts come with the kit —plus, a complete construction manual — A tremendous kit, and the price is truly low.

THE NEW *Heathkit*

HANDITESTER KIT



A precision portable volt-ohm milliammeter. Uses only high quality parts — All precision 1% resistors, three deck switch for trouble-free mounting of parts, specially designed battery mounting bracket, smooth acting ohm adjust control, beautiful molded bakelite case, 400 micro-amp meter movement, etc.

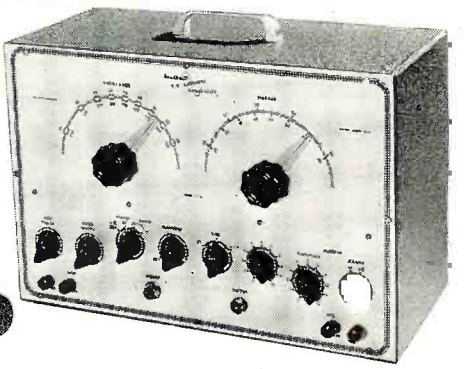
DC and AC voltage ranges 10 - 30 - 300 - 1000 - 5000V. Ohms range 0 - 3000 and 0 - 300,000. Range Milliamperes 0 - 10 Ma, 0 - 100 Ma. Easily assembled from complete instructions and pictorial diagrams.

$13.50

Model M-1
Shipping Wt. 3 lbs.

NEW *Heathkit*

T.V. ALIGNMENT GENERATOR KIT



Here is an excellent TV Alignment Generator designed to do TV service work quickly, easily, and properly. The Model TS-2 when used in conjunction with an oscilloscope provides a means of correctly aligning television receivers.

The instrument provides a frequency modulated signal covering, in two bands, the range of 10 to 90 Mc. and 150 to 230 Mc.— ALL ALLOCATED TV CHANNELS AS WELL AS IF FREQUENCIES ARE COVERED.

An absorption type frequency marker covers from 20 to 75 Mc. in two ranges—therefore, you have a simple, convenient means of frequency checking of IF's, independent of oscillator calibration.

Sweep width is controlled from the front panel and covers a sweep deviation of 0-12 Mc.—all the sweep you could possibly need or want.

And still other excellent features are: Horizontal sweep voltage available at the front panel (and controlled with a phasing control—both step and continuously variable attenuation for setting the output signal to the desired level—a convenient instrument stand-by position—vernier drive of both oscillator and marker tuning condensers—and blanking for establishing a single trace with base reference level. Make your work easier, save time, and repair with confidence—order your Heathkit TV Alignment Generator now!

Model TS-2
Shipping Wt. 20 lbs.

$39.50

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Heathkit IMPEDANCE BRIDGE KIT

Model 1B-1B
Shipping Wt. 15 lbs.

$69.50

This Impedance Bridge Kit is really a favorite with schools, industrial laboratories, and serious experimenters. An invaluable instrument for those doing electrical measurements work. Reads resistance from .01 Ohms to 10 meg., capacitance from .00001 to 100 MFD, inductance from 10 microhenries to 100 henries, dissipation factor from .002 to 1, and storage factor from 1 to 1000. And you don't have to worry about selecting the proper bridge circuit for the various measurements — the instrument automatically makes the correct circuit when you set up for taking the measurement you want. Bridge utilizes Wheatstone, Hay, Maxwell, and capacitance comparison circuits for the wide range and types of measurements possible. And it's self powered — has internal battery and 1000 cycle hummer. No external generator required — has provisions for external generator if measurements at other than 1000 cycles are desired. Kit utilizes only highest quality parts, General Radio main calibrated control. Mallory ceramic switches, excellent 200 microamp zero center galvanometer, laboratory type binding posts with standard ¾ inch centers, 1% precision ceramic-body type multiplier resistors, beautiful birch cabinet and ready calibrated panel. (Headphones not included.)

Take the guesswork out of electrical measurements — order your Heathkit Impedance Bridge kit today — you'll like it.

Heathkit LABORATORY RESISTANCE DECADE KIT

$ 9.50

Shipping Wt. 4 lbs.

An indispensable piece of laboratory equipment — the Heathkit Resistance Decade Kit gives you resistance settings from 1 to 99,999 ohms IN ONE OHM STEPS. For greatest accuracy, 1% precision ceramic-body type resistors and highest quality ceramic wafer switches are used.

Designed to match the Impedance Bridge above, the Resistance Decade Kit has a beautiful birch cabinet and attractive panel. It's easy to build, and comes complete with all parts and construction manual.

Heathkit LABORATORY POWER SUPPLY KITS

Limits:

No load	Variable 150-400V DC
25 MA	Variable 30-310V DC
50 MA	Variable 25-250V DC

Higher loads: Voltage drops off proportionally

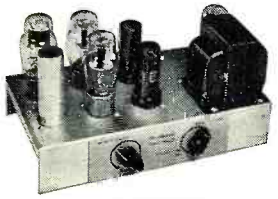
$29.50

Model PS-1.....Ship. Wt. 20 lbs.

Every experimenter needs a good power supply for electronic setups of all kinds. This unit has been expressly designed to act as a HV supply and a 6.3 V filament voltage source. Voltage control allows selection of HV output desired (continuously variable within limits outlined), and a Volts-Ma switch provides choice of output metering. A large plainly marked and direct reading meter scale indicates either DC voltage output in Volts or DC current output in Ma. (Range of meter 0-500V D.C., 0-200 Ma. D.C.). Instrument has convenient stand-by position and pilot light.

Comes with power transformer, filament transformer, meter, 5Y3 rectifier, two 1619 control tubes, completely punched and formed chassis, panel, cabinet, detailed construction manual, and all other parts to make the kit complete.

Heathkit ECONOMY . . . 6 WATT AMPLIFIER KIT



Model A-4
Ship. Wt. 8 lbs.

$12.50

No. 304 12 inch speaker . . . **$6.95**

This fine Heathkit Amplifier was designed to give quality reproduction and yet remain low in price. Has two preamp stages, phase inverter stage, and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watts output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at a low price. Better build one.

Heathkit HIGH FIDELITY . . . 20 WATT AMPLIFIER KIT

$33.50

Shipping Wt. 18 lbs.

Our latest and finest amplifier — the model A-6 (or A-6A) is capable of a full 20 Watts of high fidelity output — good faithful reproduction made possible through careful circuit design and the use of only highest quality components. Frequency response within ± 1 db from 20-20,000 cycles. Distortion at 3 db below maximum power output (at 1000 cycles) is only .8%. The power transformer is rugged and conservatively rated and will deliver full plate and filament supply with ease. The output transformer was selected because of its exceptionally good frequency response and wide range of output impedances (4-8-16-150-600 ohms). Both are Chicago Transformers in drawn steel case for shielding and maximum protection to windings. The unit has dual tone controls to set the output for the tonal quality desired — treble control attentuates up to 15 db at 10,000 cycles — bass control gives bass boost up to 10 db at 50 cycles.

Tube complement consists of 5U4G rectifier, 6SJ7 voltage amplifier, 6SN7 amplifier and phase splitter, and two 6L6's in push-pull output. Comes complete with all parts and detailed construction manual. (Speaker not included.)

MODEL A-6: For tuner and crystal phono inputs. Has two position selector switch for convenient switching to type of input desired.

MODEL A-6A: Features an added 6SJ7 stage (preamplifier) for operating from variable reluctance cartridge phono pickup, mike input, and either tuner or standard crystal phono pickup. A three position selector switch provides flexible switching.
Shipping Wt. 18 lbs. **$35.50**

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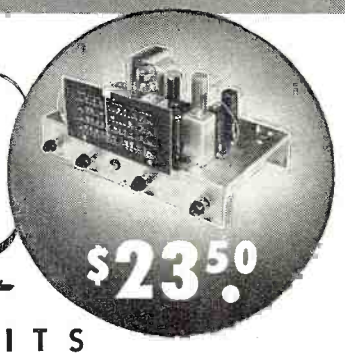
Heathkit RECEIVER & TUNER KITS for AM and FM

$19.50

Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt. 10 lbs.

Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt. 10 lbs.



$23.50

TWO HIGH QUALITY Heathkit SUPERHETERODYNE RECEIVER KITS

Two excellent Heathkits. Ideal for schools, replacement of worn out receivers, amateur and custom installations.

Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded. I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

Model FM-2
Ship. Wt. 9 lbs.

$22.50

TRUE FM FROM Heathkit FM TUNER KIT

The Heathkit FM Tuner Model FM-2 was designed for best tonal reproduction. The circuit incorporates the most desirable FM features — true FM.

Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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	Heathkit VTVM Kit — Model V-5			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit FM Tuner Kit — FM-2			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit Handitester Kit — Model M-1	
	Heathkit Three Band Receiver Kit—Model AR-1			Heathkit Power Supply Kit — Model PS-1	
	Heathkit Amplifier Kit — Model A-4			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Amplifier Kit — Model A-6 (or A-6A)			Heathkit Impedance Bridge Kit — Model IB-1B	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit A.C. VTVM-KIT — Model AV-1	
	Heathkit Audio Generator Kit — Model AG-7			Heathkit Intermodul. Analyzer Kit—Model IM-1	
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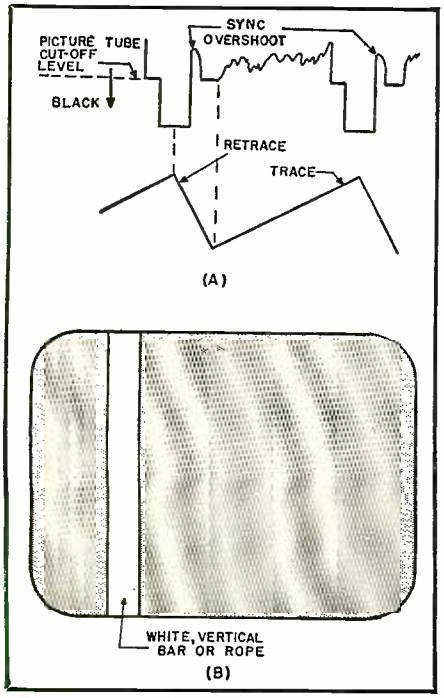
HORIZONTAL And VERTICAL SUPPRESSION CIRCUITS And THEIR USE

By
DAN LERNER
Supervisor, Television Service, Philco Corporation

One of the most difficult of all TV servicing problems. Here is how one group handles it.

RECENTLY a tough customer problem in a Midwestern city was represented by numerous complaints of a white line or rope on the left hand side of the picture tube. This so-called rope occurred only on one particular channel and its cause baffled many a technician. After numerous engineering checks it was found that the white rope was caused by a sync overshoot somewhere in the transmitter system. See Fig. 1. Many, many attempts at clearing up the trouble produced no results. Finally it was decided that perhaps some expedient would be found in the receiver which would solve the problem. Examination of the overshoot with an oscilloscope of a wide video bandpass revealed the overshoot to be of a relatively high frequency (approximately 3.6 mc.). It was also noticed that only on certain receivers would this white line appear. These particular receivers were those with a relatively wide video i.f. and video amplifier bandpass, 3.8 to 4.0 mc. On these receivers of the intercarrier sound type it was possible to tune the fine tuning controls so that the white line disappeared. However, picture definition was affected at the point the white line disappeared. The reason for this can be seen from Fig. 2. Notice that when the fine tuning control is rotated clockwise the video carrier is moved up on the response curve. As the carrier moves up on the curve, the high frequency response of the receiver is gradually reduced. In a receiver using a conventional sound i.f. system if the receiver is correctly aligned sound will be lost as the picture starts to lose definition; however, in an intercarrier receiver the sound is not lost since the sound depends upon the beat between the sound and video i.f. carriers.

Fig. 1.



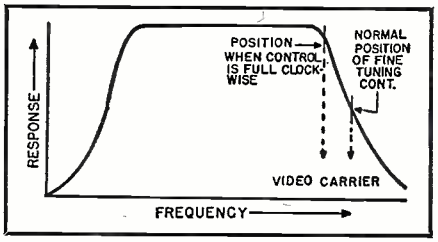


Fig. 2.

The first fix that was tried in order to get rid of the white line was to purposely degrade the high frequency picture information by increasing the value of the plate load resistor in the video output stage. See Fig. 3. However, this so-called fix not only removed the white line but also much of the high frequency picture detail. Since it was in the video section it degraded the picture quality on all the received television channels.

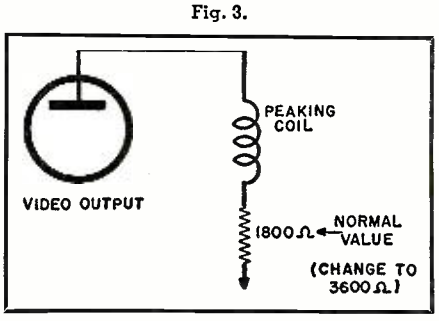
Horizontal Suppression

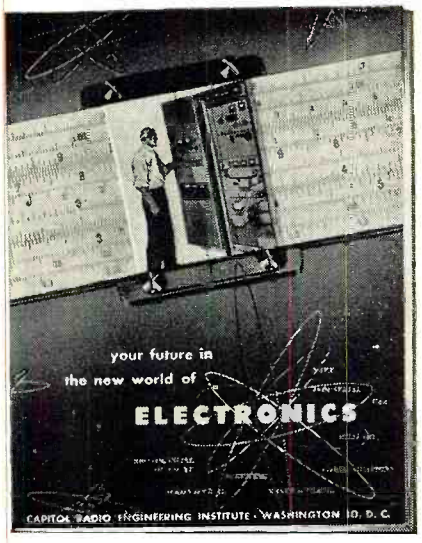
Finally it was decided to try some sort of horizontal suppression circuit. Since the overshoot occurred right after the horizontal sync pulse it was reasoned that the white line was caused by successive line CRT unblanking during horizontal retrace time. If this were so then a heavy negative or positive pulse to keep the picture tube from conducting during retrace time would do the trick.

At first the circuit shown in Fig. 7A was tried. This circuit used a heavy negative spike from the horizontal damper which was applied to the picture tube accelerating anode. The 47,000 ohm load resistor was used as the load across which the spike was applied to the accelerating anode. This circuit worked up to a point. That is, the high voltage involved, about 1500 volts, required the use of a high voltage condenser. The lead from the damper circuit to the anode produced some amount of harmful sweep radiation. Some of the left hand side of the picture was lost.

The next circuit that was tried is

Fig. 3.





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YOU CAN plod along for years, getting a paltry increase now and then, enjoying little security, finding your work dull and drab.

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"Luck," some may say.

"Contacts," others may suggest.

But in your heart, you will know the answer: "Training." And it all may have started the moment you filled out a coupon requesting a copy of a free booklet named "Your Future in the New World of Electronics." From this data you get knowledge of where you stand in Electronics. Tremendous expansion leaves this gigantic industry pleading for trained men. In the defense build-up alone, more than $7 billion in electronics contracts have been awarded. Top manufacturers sold about $3 billion worth of electronic merchandise in 1951. By 1960. the radio-electronics industry should do no less than 10 billion dollars per year, not counting military orders.

Today there are over 50,000 radio-equipped police cars; an even larger number of taxis are radio equipped (at least 65,000); 28,000 civilian planes have radio; 27,000 American ships have radio; there are 9,200 industrial radio network installations.

Within 5 years, says the Chairman of the FCC, there will be 1,500 TV stations, and in 10 years, 2,500 in operation. There are 14,496,000 TV sets and over 100,000,000 radios in operation. How these figures will increase in the next few years the most daring of experts are reluctant to predict. Countless positions must be filled—in development, research, design, production, testing and inspection, manufacture, broadcasting, telecasting and servicing. To fill these posts, trained men are needed—men who somewhere along the line take time to improve their knowledge, their skills. Men who. today, perhaps, take two minutes to send for a booklet.

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Now is the time of decision for you. Luck will not propel you forward unless it finds you trained. Contacts won't budge you an inch unless you have the skill to back them up. The answer is: Technical Training . . . and willingness to learn. Together they will bring you increased earnings in this new Age of Electronics. Fill out the coupon and mail it now. We'll promptly send you your free copy of "Your Future in the New World of Electronics." The rest—your future—is up to you.

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shown in Fig. 7B. In this case a positive pulse was applied from the last *"Sync Amp."* plate which, connected to the cathode, caused the tube to cut off during horizontal retrace. This circuit looked like it would be the answer for awhile, however other problems presented themselves. Tapping off from the plate of the *"Sync Amp."* would cause loading of the plate circuit and thus insufficient sync on some signals. On very weak stations bursts of noise amplified in the *"Sync Amp."* would cause black streaks and dots to appear on the screen.

The next circuit tried is shown in Fig. 7C. Again a positive pulse is applied to the picture tube cathode. However the pulse is obtained from the *"Horizontal Output"* plate by means of a gimmick coupler. This circuit also worked well up to a point, for any ringing in the horizontal system would be applied to the CRT cathode which would modulate the tube as shown in Fig. 5. Finally the circuit shown in Fig. 6 was used successfully. The 1N34 crystal allowed only the positive pulse to pass and thus the negative ringing excursions were eliminated.

Vertical Suppression

Many manufacturers use some kind of vertical retrace suppression circuit. All of them, in one way or another, prevent the picture tube from conducting during vertical retrace time. Such circuits have perhaps limited use to the average television consumer, however they are just another television refinement. Most present day television receivers have no d.c. restorer. Thus in scenes where very little studio lighting is used the white vertical retrace lines show through. Also in very weak signal areas the receiver contrast is usually insufficient to eliminate the white lines.

The circuit shown in Fig. 4 was used successfully to give vertical retrace suppression. To prevent any chance of loading, a series .003 μfd. condenser and 180,000 ohm resistor is used to tap off the positive vertical signal from the vertical output plate. This signal is applied to the picture tube cathode across a 47,000 ohm load resistor. —30—

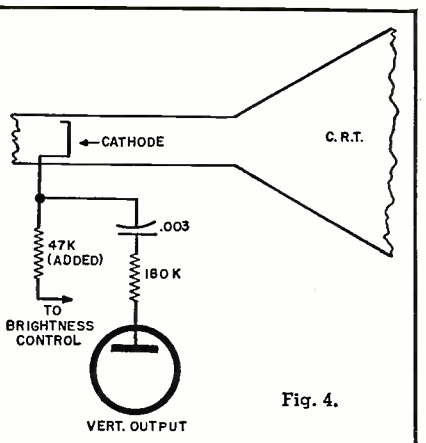


Fig. 4.

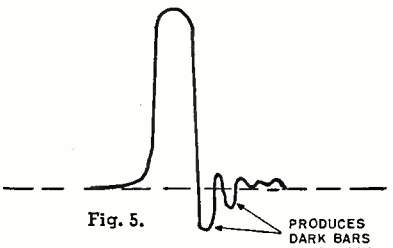


Fig. 5.

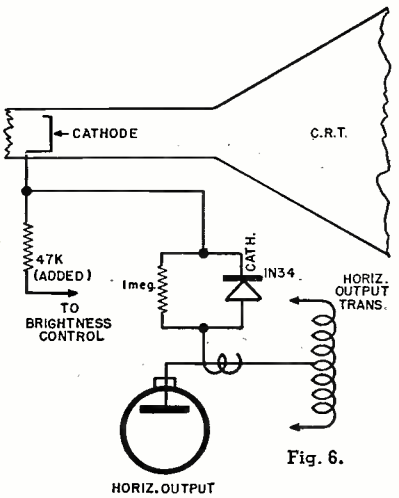


Fig. 6.

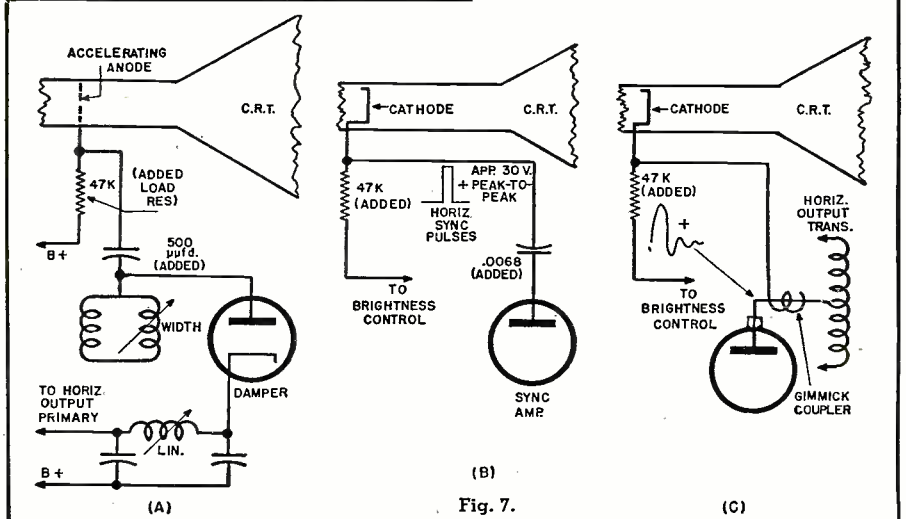


Fig. 7.

THE NEW "630" 30-TUBE CHASSIS WITH THE AMAZING CASCODE TUNER

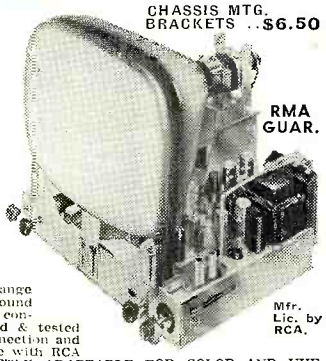
BRINGS IN RECEPTION . . . UP TO 200 MILES

4 Microvolt Sensitivity

This amazing new Super DX handles all tubes from 10" to 24" . . . will bring in better reception up to 200 miles without the use of boosters and will work where other sets have failed. The NEW STANDARD COIL CASCODE tuner gives you greater sensitivity with less snow. This tuner utilizes the newly developed 6BK7 tube with the gold plated grid . . . is fully shielded against radiation and has a newly designed converter circuit. Has new improved Mark flyback with built in Keyed AGC for better picture control; 15 KV output; 3 stage sync separator; 5 hour minimum heat run at factory. Moulded plastic condensers; synero lock; improved new Ferrite core width coil for greater range of width. Armstrong FM sound system; improved linearity control. Factory wired, aligned & tested before shipment. Phono connection and switch on chassis. Complete with RCA Hi-Fi 12" Speaker. DIRECTLY ADAPTABLE FOR COLOR AND UHF STATIONS.

$149.95
Complete with Fed. Tax. Less Picture Tube.

CHASSIS MTG. BRACKETS . . $6.50



RMA GUAR.

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SENSATIONAL INTRODUCTORY OFFER OF AIREX SUPER DX TV SETS. . . . The finest complete set value in its price class . . .

These outstanding sets were specially designed to meet our rigid specifications to assure you many pleasant hours of trouble free TV at an unequalled price. The mfr. is licensed by RCA. RMA guarantee. All you have to do is plug in and play.

24" CONSOLE
1 YEAR WARRANTEE ON TUBES AND PARTS
$299.95

17" $154.95
20" $179.95

17" $174.95
20" $199.95

CHECK THESE FEATURES

• Has standard coil Cascode tuner that brings in reception up to 200 miles • 22 tubes • Large HI-FI speaker • Hand rubbed, satin finished genuine mahogany cabinet • AGC • Moulded plastic condensers • Black, glareless picture tube, guaranteed for 6 months • Adaptable for UHF and color • Synchronized FM audio system • 5 hour heat run at factory • Factory wired, aligned and tested.

TV TUBE EXTRA

Standard Brands
Factory New—1st Quality

12½" Round	$22.50
14" Rectangular	23.95
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RESISTORS

100 asstd ½ to 2 watts $2.29

ESPEY FM-AM RADIO

12 TUBES Push Pull Output **$74.95**

300 OHM TV WIRE

2000 ft. spool **$17.95**
100 ft. spool **$2.00**

"630" KITS

Includes all parts & all small tubes Less Cathode Ray Tube.
$129.95

SPECIAL VALUES

• STANDARD COIL TUNER $22.95
• TV MASKS—16&17"—$4.95; 20"—$7.95; 24" 14.95
• REGENCY BOOSTER MODEL DB410 . . . . . 19.11
• BELL AMPLIFIER, extended control 54.95

We carry a complete line of 630 component parts.
We have a full line of RADIO TUBES. FROM 40% TO 60% OFF LIST

All merchandise is brand new, factory fresh & fully guaranteed. Mail & phone orders filled upon receipt of certified check or money order for $25 as deposit on TV chassis. 20% on other items. Balance C.O.D. F.O.B. N.Y. Prices subject to change without notice. No Fed. taxes to pay. Prices lower than OPS Regs.

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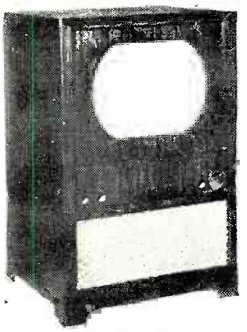
Beautiful, richly finished, hand rubbed mahogany cabinets to suit every taste. They are designed to house the "630" chassis, 12" speaker and up to 20" TV tube. The combination cabinets will hold up to a 20" TV tube, radio and Webster record changer, with ample record space. All cabinets are equipped with mask and mounting brackets. The perfect chassis deserves a perfect cabinet. It will be a focal point of beauty in your home. Other models in stock. When ordering chassis and cabinet, no chassis mounting brackets needed. Send for FREE circular.



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38x22x22—16" & 17" $49.95
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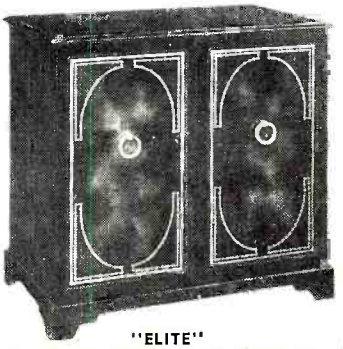
45x28x25—24" tube 74.95
Blonde $10 additional.

"STRATFORD"

40x28½x23½. Genuine crotch Mahogany doors $89.95



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Combination—39x40x23½. Red antique genuine leather. Gold leaf hand tooling $149.95
In limed oak, gold colored leather 159.95

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T-91	**Ion Trap** with 2 powerful Alnico 5 magnets. Bronze clamp keeps it firm.....	.98
X-263	**Ion Trap** single magnet type. Most popular in use. Order plenty.....	.49
T-94	**GE Type Universal Flyback Trans.** similar RTO-085, 77J1 for all 65°-70° Kinescopes. Ferrite core, supplies 14,000 volts. Single ea. $3.99. **Lots of 3, each**.	$3.49
T-93	**70° TV Yoke.** Similar to RCA 209D1. For use on Kinescopes up to 19" single ea. $3.49. **Lots of 3, each**.....	$2.99
T-82	**55° TV Flyback Trans.** Similar to RCA 211T1. For all 10" and 12" Kinescopes. Single, ea. $2.99. **Lots of 3, each**....	$1.99
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C-256	**500 MMFD 10KV** Ceramic TV Condenser. With threaded terminals. Single, ea. 79c. **Lots of 10, each**.....	.49
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BY-PASS KIT IN STEEL CABINET

LIMITED QUANTITY ONLY

Positively no more of these kits will be available when we run out of 4 drawer steel cabinets. **THIS IS REAL VALUE** — Kits contain the famous Olson Akrad "Super Sealed" By-Pass condensers. Cabinet size 4 1/4 x 6 5/8 x 6". Choice of 2 kits.

42 CONDENSER KIT

AS-36 ONLY

$6.95

You get the 4 drawer steel cabinet and the following 42 Olson Akrad "Super Sealed" By-Pass condensers.

Regular list $18.38

Qty.	Cap.	Volts
2	.001	600
2	.002	600
2	.005	600
5	.01	600
5	.02	600
10	.05	600
10	.1	600
2	.005	1600
2	.008	1600
2	.01	1600

100 CONDENSER KIT

AS-37 ONLY

$11.95

You get the 4-drawer steel cabinet and the following 100 Olson Akrad "Super Sealed" By-pass condensers.

Regular list $41.48

Qty.	Cap.	Volts
5	.001	600
5	.002	600
5	.005	600
10	.01	600
10	.02	600
25	.05	600
25	.1	600
5	.005	1600
5	.008	1600
5	.01	1600

FOR SALE BY OLSON—SOLID CARLOAD OF WIRE

Once a year Olson goes through his wire stock and closes out at cut prices millions of feet of brand new clean wire. Close-out time is here—and at a particularly good time for you. Right now while copper wire is tight you can buy yourself a good assortment of various types as listed below at CUT PRICES. All wire is number 20 or 22 unless otherwise shown. In addition you get at no cost an all steel forged pair of electrician pliers with serrated jaw and wire cutting edges. If you order 10 rolls of wire.

PACKED ON 50 FT. COILS

Stock No.	Number of Conductors	Type of Insulation	Suggested Uses	Close-out Price 50 Ft. Coil
W-80	1	Plastic	Hook-up, easy stripping	$ .49
W-81	1	Lacquered Braid	Hook-up or ground wire	.49
W-82	1	Waxed Cotton	Pushback hook-up	.59
W-83	1	Heavy Rubber	General use, extremely good	.69
W-84	1	Rubber and Lacquer Braid	Heavy duty, for rough use	.79
W-85	1	Rubber and Lacquer Braid	No. 16 wire for auto ignition and filaments	.99
W-86	2	Plastic	Twisted for extension speakers, intercoms	.89
W-87	3	Plastic	Twisted for intercoms & Telephones	1.29
W-91	4	Plastic & Cotton	For intercoms & speakers	1.59
W-92	5	Plastic & Cotton	For intercoms & Spec. Purpose	1.89
W-93	6	Plastic & Cotton	For intercoms & Spec. Purpose	2.19
W-96	7	Plastic & Cotton	For intercoms & Spec. Purpose	2.49
W-97	8	Plastic & Cotton	For intercoms & Spec. Purpose	2.89
W-95	9	Plastic & Cotton	For intercoms & Spec. Purpose	3.19
W-94	10	Plastic & Cotton	For intercoms & Spec. Purpose	3.49

Here's a bargain: Stock up on the multiple conductor cables shown above. The individual conductors or wire come apart easily. Thus, for instance, a 50 ft. coil of 10 conductor wire will give you actually 500 ft. of high grade wire!

SHIELDED WIRE

W-98	1	Plastic	For phono and amplifiers. Bare Shield	$1.39
W-88	1	Plastic	Has insulating cover over shield	1.49
W-89	2	Plastic	For intercoms—Bare Shield	1.69
W-90	2	Plastic	For intercoms, cotton cover over shield	1.89

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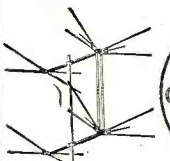
THESE PLIERS ARE YOURS AT NO EXTRA COST FROM OLSON'S.

PLIERS GIVEN FREE WITH EVERY ORDER FOR 10 ROLLS OF WIRE, SAME OR ASSORTED. GET TWO PAIRS OF PLIERS WITH 20 COILS, ETC.

Pliers are all steel, forged and have serrated gripping jaw as well as sharp wire cutting edges. Handles are fully insulated.



COMPLETE TV CONICAL ANTENNA KIT

—Nothing More to Buy

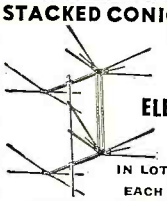
STOCK NO. AU-67

$17.99

Latest model. Genuine Aircraft Aluminum Tubing. Everything you need to erect a high-gain 20 element two-bay "X" type antenna. HERE'S WHAT YOU GET: 1 stacked deluxe 20 element conical antenna with high frequency stubs; 2 5-ft. steel mast sections; 1 UL approved twinline lightning arrester; 1 steel chimney mounting assembly with necessary strapping; 75-ft. 300 ohm twinline; 6 insulated screw-eye standoffs; and 2 insulated mast standoff insulators.

The antenna has a conical pattern providing high gain on ALL channels. All the necessary installation parts are packed with the antenna. Here's the economical way to buy. Have everything at hand for that installation. Order these kits NOW. This is real Olson Value. Shpg. wt. 25 lbs.

STACKED CONICALS FULL 20 ELEMENT



IN LOTS OF 3, EACH $8.66

With matching Q bars and High Frequency Stubs Genuine Aircraft Aluminum elements. High gain stacked conical. Will pull in those stations in "Fringe Areas." Works on all channels. Easily assembled.

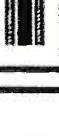
THIS IS A TERRIFIC VALUE!

Each Antenna consists of two conical bays plus a pair of matching Q bars. Less mast. Packed—3 Antennas to a carton. This gives you six bays and 3 pairs of Q bars.

Sold Only in Boxes of 3 Antennas AU-66. Carton of 3 ..... $25.98

Weight 25 lbs.

TWIN LINE



300 Ohm Poly Twinline

High quality, low loss. For all TV and FM installations. Shpg. wt. 2 lbs.

Stock No. W-73. 100 ft. coil.... **$2.99**

OPEN WIRE TV LINE

★ **Use in Place of 300 Ohm Line**

Ideal for fringe area installations. Not affected by moisture or sun. Made of #18 copperweld wire with genuine polystyrene insulators spaced 6" apart. Tensile strength 400 lbs.

Stock No. W-78. 100ft. coil. Shpg. wt. 4 lbs. **$5.95**

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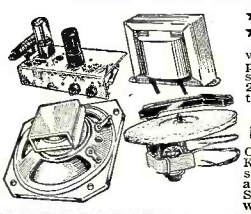

★ **Kits available now from Olson.**

★ **Choose from 2 Models.**

Each Kit contains a rim drive motor with velvet finish turntable, crystal pickup, all purpose needle, 4" PM speaker, matching output transformer, 2 tube AC-DC amplifier complete with tubes (35W4 and 50B5).

Single Speed Model 78 RPM		3 Speed Model 33 1/3-45-78 RPM	
Complete Kit as described above. Shpg. wt. 8 lb.	Stock No. AS-52 **$8.95**	Complete Kit as described above. Shpg. wt. 8 lb.	Stock No. AS-53 **$11.95**

Build a Receiver Set of Basic Components

Kit of 5 parts AS-38 $1.89

You get this kit of 5 basic parts to build an AC-DC set or portable:

Parts	Reg. List Price
Loop	$0.95
R. F. Coil	1.10
I.F. Transformer (456 KC)	
Input	1.60
Output	1.60
Oscillator Coil	.75
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Use any 365 mfd variable for tuning. Covers 535-1625 KC.

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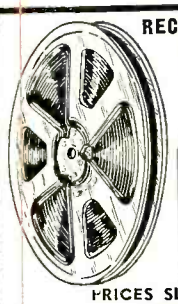

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PAPER BASE— 1200 ft. Stock No. X-248 Single, each $1.69 Lots of 10, each **$1.49**

PLASTIC BASE 1200 ft. Stock No. X-249 Single, each $2.19 Lots of 10, each **$1.99**

PRICES SLASHED ON EMPTY PLASTIC REELS
Finest Clear Plastic—Will Not Warp

5" Diameter—600' Size No. X-250 Single, ea. 39c. LOTS OF TEN, EA. ..... **29¢**

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MIKE

High output crystal mike for PA systems and recorders. Equipped with handle base and 7' shielded cable. Shpg. wt. 5 lbs.
M-67, each **$5.95**
M-66. same but with on-off switch built into handle.... **$6.95**

FAIRCHILD GRINDER

TL-3 **$9.98**

Every service shop needs one of these handy tools made by Fairchild, famous manufacturer of precision electric grinders. Regular nationally advertised price is $19.75. The set consists of 1—115 volt high speed, air cooled grinder, 6 assorted grinding wheels, 1 circular saw blade, 1 hardened steel reamer, 1 buffing brush, 1 abrasion stone and a natural finish wood case size 10"x5"x3" to house the grinder. Shipped in original factory sealed cartons.

30 WATT AMPLIFIER

- Factory Built
- Latest Design

Olson's Price less tubes. RA-23 ..... **$34.95**

A real commercial amplifier which looks good and performs well. Not a kit. Gain, mike, 130DB. phono 80DB. Has dual tone controls, one for bass and the other for treble tone. Output impedances 4, 8, 15 and 500 ohms. Input for two mikes and one crystal pickup. Shpg. wt. 20 lbs. Tubes required, 3—6SQ7, 1—6SC7, 2—6L6g, 1—5V4g.

3 SPEED PICK-UP ARM

M-64 **$4.95**

Cartridge flips by means of a lever. Dual cartridge, one side plays 33⅓ and 45 and other 78 RPM. Double needle.

4-DRAWER STEEL CABINET GIVEN WITH OLSON'S GIGANTIC, NEW AKRAD KIT

Olson's Price AS-20 **$16.95**

You get $51.60 list worth of "Akrad" Condensers plus the 4 drawer steel cabinet FREE, size 10"x 11½"x10". Shpg. wt. 11 lbs.

42 "AKRAD" By-Pass Condensers

Qty.	Cap.	Volts	List ea.	Total
2	.001	600	$.25	$.50
2	.002	600	.25	.50
2	.005	600	.25	.50
5	.01	600	.30	1.50
5	.02	600	.30	1.50
10	.05	600	.40	4.00
10	.1	600	.45	4.50
2	.005	1600	.55	1.10
2	.008	1600	.55	1.10
2	.01	1600	.60	1.20

Also 27 "AKRAD" Electrolytic Condensers

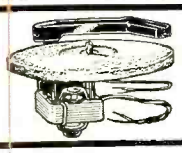
Qty.	Cap.	Volts	List ea.	Total
2	10	25	$1.00	$2.00
2	25	25	1.00	2.00
5	20	150	1.20	6.00
5	40	150	1.35	6.75
4	20-20	150	1.65	6.60
5	8	450	1.25	6.25
4	16	450	1.40	5.60
69	Value			$51.60

AS 46 KIT OF 20 $2.49

10 WATT RESISTOR KIT

We mean to move 80,000 fine 10 watt wire wound resistors during this sale. REGULAR LIST PRICE OF THIS KIT IS $15.00. Each kit contains 20 popular insulated resistors, with tinned copper leads. Shpg. wt. 2 lbs.

BIGGEST BARGAIN



Special while they last for the combination **$39.99** RA-91

COMBINATION OFFER—You get an Alliance Rim Drive 78 RPM Phono Motor with turntable PLUS a Pickup Arm with high Output Cartridge.

PHONO AMPLIFIER

RA-19. **$3.98** LESS TUBES

A real high efficiency 3-tube amplifier of modern design. Connect to any crystal phono arm and speaker. Has volume and tone controls 7"x 3¼"x2". Shpg. wt. 2 lbs.

SET OF TUBES FOR AMPLIFIER 12SQ7 50L6 35Z5 No. AS-22 ..... **$2.64**

RIM DRIVE PHONO MOTORS

Stock No. M-79

TOP QUALITY Single, each $2.19 lots of 3, ea. **$1.99**

Plays all 10" and 12" 78 RPM records. Quiet, velvet smooth friction drive motor with turntable. For 115 volts 60 cy AC.

3 SPEED M-63

Self starting, complete with turntable. Operates on 115 volt AC 60 cy. Shpg. wt. 5 lbs. **$5.99**

SEND FOR OLSON'S BRAND NEW BARGAIN CATALOG. GET NATIONALLY FAMOUS RADIO PARTS AND SUPPLIES AT BIG DISCOUNTS

CLEVELAND, OHIO

2020 Euclid Ave.

If you live in or near Cleveland visit our store, get these and many more bargains.

CHICAGO, ILLINOIS

623 W. Randolph Street

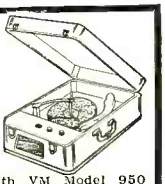
If you live in or near Chicago visit our store, get these and many more bargains.

IT'S OLSON FOR SPEAKERS

Don't hesitate—here's that opportunity to buy quality speakers at less than jobbers cost. Again Olson was Johnny-on-the-Spot. We had the cash and made the deal. Now you can get your share of the saving. All are PM with 3.2 ohm voice coils.

Stock No.	Size	Shpg. Wt.	Olson's Price
S-4	4"	2 lb	$1.69
S-5	5"	2 lb	1.79
S-7	6"	3 lb	2.29
S-96	7"	3 lb	3.39
S-123	8"	3 lb	2.99
S-97	10"	5 lb	3.95
S-167	12"	7 lb	4.95

3 SPEED AUTOMATIC CHANGER



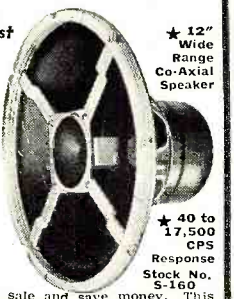
$42.95 RA-70 WHILE THEY LAST

COMPLETE with VM Model 950 Changer, Amplifier, Speaker and Case. A real Olson value if we ever saw one! Here is the latest VM Model 950 Automatic Changer built into a beautiful carrying case with speaker and fine Amplifier. Plays twelve 7" records (33⅓ or 45 RPM); twelve 10" or ten 12" (33⅓ or 78 RPM); 100% automatic in operation. Nothing more to buy when you order this fine player from OLSON. The cartridge is equipped with a long life needle. Motor shuts off after last record. Equipped with volume control and tone control. Speaker is Alnico V PM. Carrying case is beautifully covered. Size 15" x 17" x 8". For 115 volts 60 cy. AC. Regular list price $77.95.

CLOSING-OUT

Special close-out price while they last

$10.95



★ 12" Wide Range Co-Axial Speaker

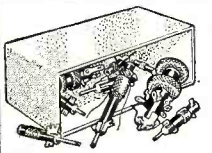
★ 40 to 17,500 CPS Response

Stock No. S-160

Make Way for New Model

Our regular $32.50 retail hi-fi speaker. 20 watts. We are closing out this speaker. Thousands sold at $13.95. We want to make room for the new model which will be coming in soon. Order one or more of these fine PM speakers during this sale and save money. This is the same type of speaker you will find in $300.00 combination radios. Each speaker consists of a 12" woofer section driven by a heavy 2 lb. magnet and this part delivers the bass notes. The 3" tweeter speaker is built into the center of the speaker and is driven by a 2.15 oz. Alnico 5 magnet. This part delivers the treble notes. The high pass filter is built into the speaker and the entire combination gives you tones you never dreamed possible. Only two wires to connect to any radio or amplifier and the speaker is ready to play. Voice coil impedance is 8 ohms. Shpg. wt. 10 lbs.

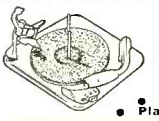
COIL KIT



79¢ Stock No. AS-51 Kit of 10 assorted

Each kit contains popular and hard to get coils all kinds for TV and radio. Width coils, linearity, RF, Ant., etc. A single coil is worth the cost of the whole Kit. Order several.

FAMOUS BRAND 3-SPEED AUTOMATIC RECORD CHANGER



$19.99 RA-69

- Sorry, we promised not to mention the manufacturer's name.
- Automatically Plays 7", 10" and 12" Records.
- Plays All Type Discs—All Speeds 33⅓, 45 and 78 RPM.

Completely automatic and what's more it's one of the most famous brands in changers. Precision built by experienced craftsmen. Every changer brand new in original factory packing. 100% guaranteed to please or your money back. Here is one of Olson's most sensational bargains. Believe us—you can't go wrong. Order one or more but we can't promise to repeat this offer. We have a limited quantity and when they are gone—no more.

The changer has a reject lever and a control for selecting 33⅓, 45 or 78 RPM speeds. Plays all 7", 10" and 12" records. Equipped with an Astatic Ceramic cartridge and a sapphire long life needle. Records drop gently and smoothly—just like velvet. Operates on 115 volts, 60 cycles AC. Base 12x12½". 5⅛" above plate and 3½" below. Shpg. wt. 15 lbs.

THIS COSTS YOU NOTHING—NOT A RED CENT

Just to get the ball rolling and to get your order coming our way—Olson is going to send you one of his valuable TUBE SOCKET KITS. The kit contains 20 popular assorted 6-7-8-9 pin sockets which can be used in AM-FM and TV work. To get this kit all you need do is make up an order for $10.00 or more from this ad—use the order blank below. We will ship your order at once and include the 20-piece socket kit—FREE.

IT'S EASY TO ORDER FROM OLSON'S

How to order: Order directly from this ad. For convenience use this order blank. Fill in columns below with quantity desired, stock number, description and price. You may send remittance with order (include enough for postage or parcel post shipment), or if you prefer SEND NO MONEY. Olson will ship C.O.D. and you may pay mail or expressman for merchandise and postage.

MONEY BACK GUARANTEE: *Everything you order from Olson is guaranteed as advertised. If you are not more than satisfied, you may return merchandise for cash refund.*

Please Minimum Order $3.00

QUANTITY	STOCK NUMBER	DESCRIPTION	PRICE EACH	TOTAL

NAME _____

ADDRESS _____

CITY _____ ZONE ___ STATE _____

RN 252

TOTAL	
ADD POSTAGE	
TOTAL AMOUNT	

MAIL ORDERS SHOULD BE SENT TO AKRON, OHIO

OLSON AKRAD RADIO WAREHOUSE • 275 E. Market St., Akron 8, Ohio

WHAT'S New in Radio

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

OUTPUT TRANSFORMERS

Quam-Nichols Company, 522 East 33rd Place, Chicago 16, Illinois has recently added a complete companion line of "Tru Match" output transformers designed to insure maximum tone quality of loudspeakers by exactly matching the voice coils of the original equipment.

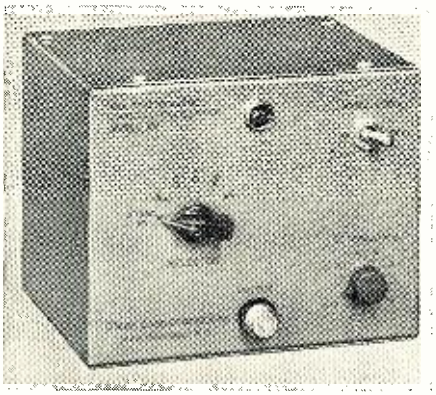
The new line consists of twenty-five output transformers and is intended to provide the distributor with a single source for both speaker and its component transformer.

The transformers are being individually packaged with complete information on the matching characteristics of all units in the line and suggestions on the selection of units for specific applications enclosed in each box.

CRYSTAL OSCILLATOR

Crest Laboratories, Whitehall Bldg., Far Rockaway, Long Island, New York has just announced a new multi-frequency high output signal generator.

The Model 50 is compact in size and



provides a convenient and inexpensive means of obtaining multiple outputs for spot frequency alignment of television and military receivers. It is available in a crystal-controlled range of 4.5 to 50 mc.

Additional details on this unit are available on request.

PIN STRAIGHTENER

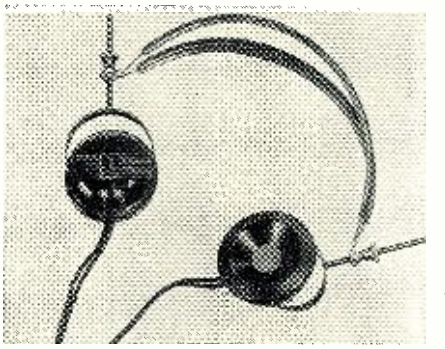
General Cement Manufacturing Company, 919 Taylor Avenue, Rockford, Illinois, is currently introducing a duplex tube pin straightener, the No. 8655.

This handy combination for straightening both miniature and jumbo miniatures of the 7 and 9 pin types, saves tubes that would otherwise be discarded because of bent pins.

When the tube is inserted in the proper receptacle, the precision steel die aligns and straightens the pins, making the tube reusable. The unit comes in colorful plastic and is small enough to fit in a tool box or be fastened to the work bench.

HEADPHONE RECEIVER

The Brush Development Company, 3405 Perkins Avenue, Cleveland 14, Ohio, is now in production on a new



headphone receiver that features high fidelity and smooth frequency response.

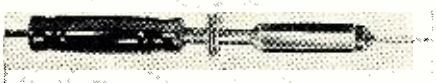
The new unit, which is available in three styles, is equipped with a "Metalseal Crystal" element to provide a new freedom from the problems caused by high or low humidity.

The double headset has been designated the BA-206, the single unit the BA-207, and the Lorgnette style the BA-208.

"SUPER-SPEED" IRON

Hexacon Electric Company, 119 W. Clay Avenue, Roselle Park, New Jersey, is currently marketing a new electric soldering iron for use on fast production lines.

The new Model P-154 iron is of the plug-tip type, rated at 150 watts, and has a ¼" diameter tip which reaches a soldering temperature considerably higher than that of the conventional iron. Special provisions have been made in the element construction to



withstand the unusually high temperature developed.

Elements and tips in the new iron are replaceable.

INSTRUMENT RECTIFIERS

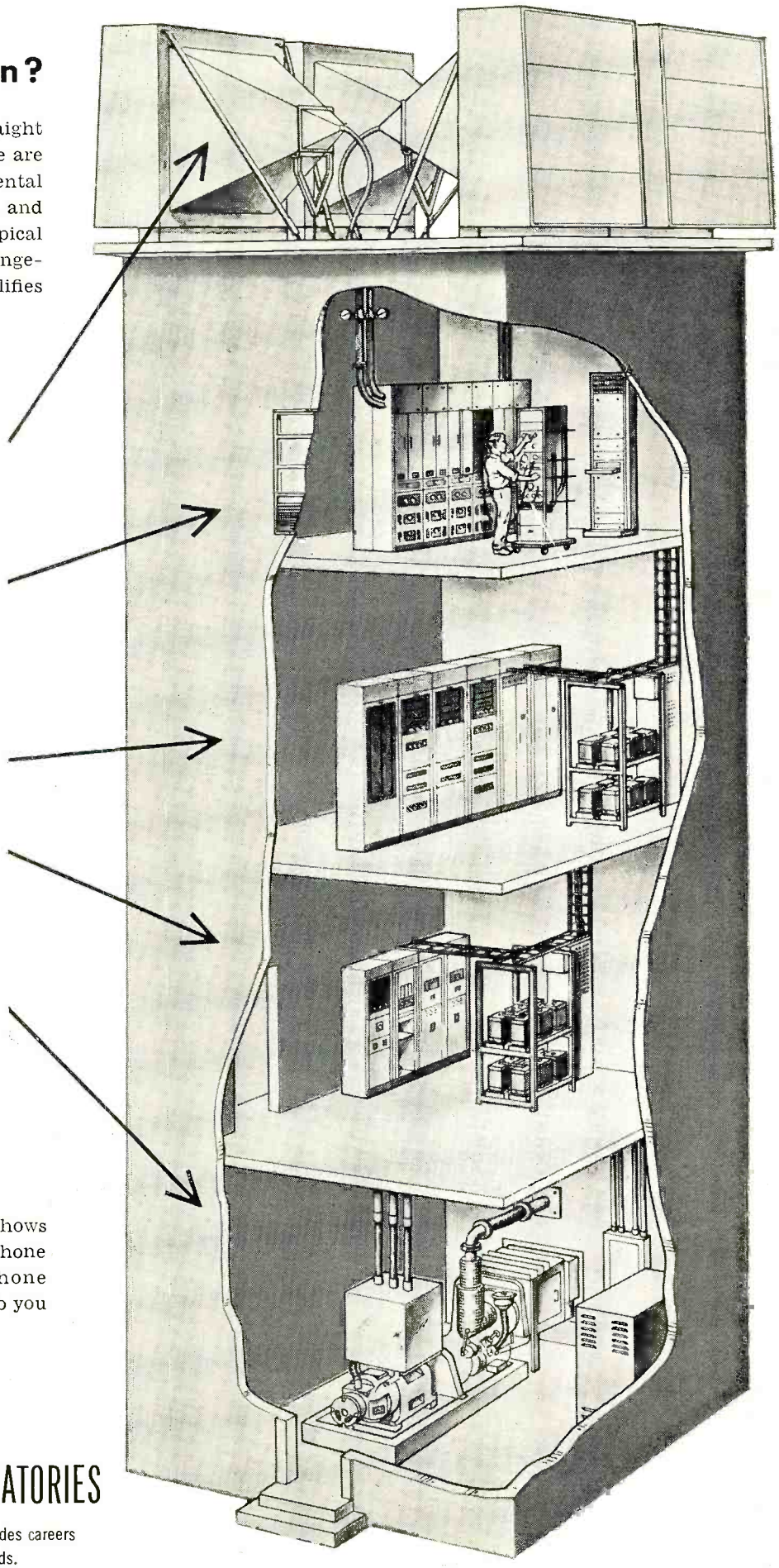
The *Precision Rectifier Division* of *Electronic Devices, Inc.,* 429 12th Street, Brooklyn, New York, has developed a new instrument rectifier which is unique in that it uses selenium rectifiers in its construction.

This feature is possible because of a

(*Continued on page* 112)

What's inside a *Radio-Relay* station?

Because microwaves travel in straight lines and the earth is round, there are 123 stations on the transcontinental television route between Boston and Los Angeles. This view of a typical unattended station shows the arrangement of the apparatus which amplifies the signal and sends it on.



ON THE ROOF are the lens antennas, each with its horn tapering into a waveguide which leads down to equipment

ON THE TOP FLOOR, where the signal is amplified, changed to a different carrier-channel and sent back to another antenna on the roof. Here are testing and switching facilities. Normally unattended, the station is visited periodically for maintenance.

ON THE THIRD FLOOR are the plate voltage power supplies for several score electron tubes.

ON THE SECOND FLOOR are filament power supplies. Storage batteries on both floors will operate the station in an emergency for several hours, but

ON THE GROUND FLOOR is an engine-driven generator which starts on anything more than a brief power failure.

Anything that happens—even an opened door — is reported to the nearest attended station instantly.

Coast-to-coast *Radio-Relay* shows again how scientists at Bell Telephone Laboratories help your telephone service to grow steadily in value to you and to the nation.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

IT'S HERE! McGee New 1952 Model 12 Inch Coaxial Speaker for $12.95

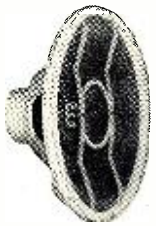
BUY YOUR WIDE-RANGE COAXIAL SPEAKER AT McGEE

NEW 1952 MODEL 12" COAXIAL P.M.

$12.95

WHY PAY MORE?

McGee offers its new 1952 model 12" coaxial PM speaker. The finest that we have ever offered. Quality you would put in your finest sets if you were a manufacturer. Genuine Alnico V magnet 6.8 oz. in the 12" woofer. The tweeter is coaxially suspended inside the 12" and has a metal diffusor attached. The high pass filter is concealed under the pot cover, leaving only two wires to connect to your radio or audio amplifier. Why buy an ordinary speaker, when you can have a 12" coaxial PM for only $12.95? Input 8 ohms with 18 watt peak and 10 watts average. Shipping weight 8 lbs. Response from 30 to 17,500 cps. McGee's finest speaker value. Stock No. CU-14Y. Sale price, **$12.95** each.



15" COAXIAL P.M. SPEAKER

$19.95

Only $19.95 buys a full 15" 20 watt coaxial PM speaker, with built-in high pass filter. Hook to any 8 ohm output on radio or amplifier. Response below 20 to above 17,500 CPS. Good bass response. A lucky purchase makes this price possible. Full 32 oz. magnet in the woofer, 5" tweeter. Model P15-9. Ship. wt. 11 lbs. Sale price, **$19.95.**

100 Molded Plastic Bypasses **$9.95**

100 molded plastic tubular by-pass condensers. All 600 volt. And all by the same nationally known mfgr. Regular dealers' net is over two and one-half times our 20th Anniversary sale price. You'll chuckle when you look these over. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 20—.02, 10—.05 and 10—.1. Our big deal No. RN-202. 100 plastic tubulars. Shipping weight 2 lbs. Net price, **$9.95.**

100 600 VOLT TUBULARS **$6.95**

100 top quality 600 volt tubular by-pass condensers. Made this year by a famous condenser factory. Don't confuse these with grab-bag surplus. McGee's deals are guaranteed to please you. Here's what you get: 10—.001, 10—.002, 20—.005, 20—.01, 10—.02, 20—.05 and 10—.1 600 volt condensers. Our big deal No. RN-203. Shipping weight 2 lbs. Net price, **$6.95.**

20 50 x 30 150 V. ELECTROLYTICS **$9.75**

Here's a red hot value. 20 of our XX quality replacement electrolytics. The most popular condensers in use today. Takes care of 90% of your AC-DC radio filter needs. Compact construction 1950 production. 1-year guarantee. 50-30 mfd. 150 volt, housed in a cardboard tube with common negative, has long flexible leads. 20th Anniversary, big deal No. RN-204. Sale price **$9.75.**

SELENIUM RECTIFIERS

65 mil Selenium Rectifier, net ..... **59c** each

100 mil Selenium Rectifier, net ..... **69c** each

150 mil Selenium Rectifier, net ..... **79c** each

200 mil Selenium Rectifier, net ..... **$1.19** each

250 mil Selenium Rectifier, net ..... **1.19** each

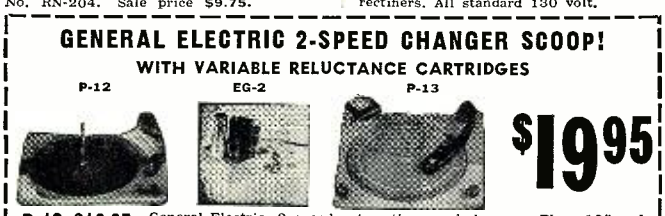
350 mil Selenium Rectifier, net. **1.59** each

450 mil Selenium Rectifier, net. **1.79** each

McGee offers you the finest in Selenium rectifiers. All standard 130 volt.

GENERAL ELECTRIC 2-SPEED CHANGER SCOOP!

WITH VARIABLE RELUCTANCE CARTRIDGES



$19.95

P-12 $19.95 General Electric, 2 speed automatic record changer. Plays 10" and 12" records of either 33⅓ or 78 rpm. Pickup arm equipped with separate plug-in heads. RPX-040 with 3 mil sapphire stylus for 78 rpm records RPX-041 with 1 mil sapphire stylus for 33⅓ rpm records. The two cartridges purchased separately are worth $11.70 alone. However, they are standard equipment with this deluxe changer. Changer base size, 10¾"x12½". Shipping weight 13 lbs. General Electric catalog No. P-12. A $60.00 list changer. On sale at terrific saving at McGee. Scoop price, with both General Electric, plug-in variable reluctance cartridges, for the low price of **$19.95.**

Eg-2 $8.95 AC self-powered preamplifier for General Electric variable reluctance pickup cartridges. This preamp is necessary if you use variable reluctance cartridges with any ordinary radio-phono connection. Some amplifiers are already equipped with the necessary gain for this type of pickup. Simply plug in any of the changers and plug preamp into the radio phono input. Stock No. EG-2 preamp. Net price **$8.95.**

P-13 $19.95 General Electric, 2 speed automatic record changer. Plays 10" and 12" records of either 33⅓ or 78 rpm. Pickup arm equipped with a G.E. RPX-050, turn about variable reluctance cartridge and twin sapphire needle. A simple twist of the knob selects the proper needle. The net cost of the cartridge, if purchased separately, is $8.20. This fine changer comes ready equipped with the cartridge. Changer base is 12x12½". General Electric catalog No. P-13 automatic record changer. Shipping weight 13 lbs. Brand new, factory cartoned. Offered at the low price of **$19.95.** (A self powered pre-amp for use with low gain inputs. Net price **$8.95** extra.)

3-SPEED CHANGERS ON SALE AT McGEE

WEBSTER CHICAGO 3-SPEED Regular $47.50 List Only **$24.95**

Webster Chicago Model 100-16 3 speed automatic record changer with crystal cartridge and all speed Sapphire needle. (1 needle changes all records). Base size 12x12¾". Shipping weight 14 lbs. This offer good only as long as our stock lasts. A special purchase makes this offer possible. Webster Chicago 3 speed changer, Model 100-16, Sale price **$24.95.**

WEBSTER CHICAGO MODEL 100-2 ONLY $26.95

For the first time we offer the world famous Webster-Chicago, model 100-2. Features a newly designed spindle, that drops the records flat; air-cushioned to the turntable. Pickup arm sets down automatically after the last record plays. Plays all records automatically, 33⅓, 78 and 45 rpm. New balanced tone arm with Electro-Voice Tilt-A-Matic cartridge with dual needles. Ordinarily cost over **$37.00.** McGee offers them for only **$26.95** each. Base size 12"x12¾". Shipping weight 14 lbs.

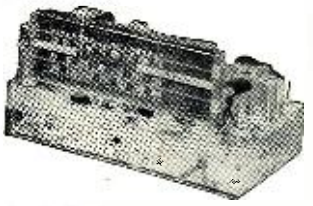
V.M. 3-SPEED MODEL 406 $22.95

VM model 406, deluxe 3 speed automatic record changer. Plays them all. Intermixes records of the same speed. Equipped with a flip over crystal pickup with twin needles. Base size, 12¼x13". Shipping weight 12 lbs. VM-406. Net price **$22.95.**

GENERAL INSTRUMENT 3-SPEED $19.95

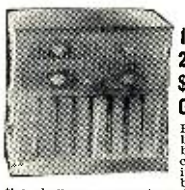
Another tremendous McGee record changer scoop. Only 500 to sell. General Instrument, 3 speed automatic record changer with standard crystal cartridge and all purpose permanent needle. Brand spanking new. Our first offering of a 3 speed changer at less than $20.00. We purchased a large quantity and pass our saving on to you. Stock No. GI-3384. Sale price **$19.95** each. Price to the small manufacturer in lots of 48 or more, **$19.50** each.

New Versatile Espey 12-TUBE FM-AM CHASSIS $64.50



★ BUILT IN PRE-AMPLIFIER FOR G.E. VARIABLE RELUCTANCE PICKUP
★ WIDE RANGE AUDIO
★ MAY BE USED WITH A CRYSTAL MIKE AS A HOME P.A. SYSTEM

McGee's new 1951 model 12 tube FM/AM chassis. Latest design with phono inputs for all types of record players, crystal or G.E. variable reluctance. Receives standard broadcast 550 to 1700 KC and FM 88 to 108 MC. Wide range audio response (push-pull 7C5) and bass boost tone control. Loop antenna for broadcast and 300 ohm line type antenna, may be stapled in cabinet. Attractive lighted slide rule dial. Chassis size, 13½x9" high and 9" deep. Shipping weight 20 lbs. **Stock No. 7-CX.** Made to sell at a much higher price. McGee's sale price is **$64.50,** less speaker (output matches 8 ohms). **7-CX** chassis with our 12" coaxial PM, CU-14X, both **$74.50.** Espey 7-C chassis, 12" coaxial PM speaker and 3 speed VM changer with G.E. variable reluctance cartridge, **$104.95.**



TERRIFIC RADIO-PHONO SALE

12-TUBE ESPEY CHASSIS
2—12" P.M. SPEAKERS
$200.00 VALUE WALNUT CABINET
GE 2-SPEED CHANGER

$179.95

Buy this combination offer and have a fine radio-phono combination for less than the value of the cabinet alone. This beautiful walnut cabinet was intended for a Capehart $800.00 combination and is the finest possible. furniture quality cabinet workmanship, 37" high, 40" wide and 21" front to back. Hinged top lifts in two sections. 25½" lid covers the changer compartment and 14½" covers the radio compartment. Changer mounting panel is furnished blank. Radio panel is shipped ready cut to fit the Espey 7-C chassis. Twin heavy duty 12" PM speakers are furnished. Espey 7-C chassis and a General Electric 3½, and 78 rpm, 2 speed automatic changer with two plug-in G.E. variable reluctance cartridges. Stock No. MED-375 cabinet, Espey 7-C chassis, 2 speed G.E. changer and 2 12" speakers. Sale price, **$179.95.**
2 speed VM automatic changer with G.E. variable reluctance turnabout cartridge furnished for $15.00 extra. Shipping weight 200 lbs. Shipped via truck, rail or express only.
Capehart cabinet described above, furnished cut to fit the Espey 7-C chassis, cabinet only **$79.95.**

MN-8.	8	mfd	450 volt	**35c**
MN-16.	16	mfd	450 volt	**45c**
MN-30.	30	mfd	450 volt	**55c**
MN-20.	20	mfd	150 volt	**35c**
MN-40.	40	mfd	150 volt	**45c**
MN-220.	20-20	mfd	150 volt	**45c**
MN-53.	50-30	mfd	150 volt	**49c**
MN-442.	40-40-20	mfd	150 volt	**69c**

All cond. guaranteed one year.

RED HOT SPEAKER VALUES

McGee has a tremendous stock of 100,000 speakers to fill your needs. Every speaker is fully guaranteed. Order your speakers now.

4 inch, square.....	1	oz. magnet	**$1.39**
5 inch, pincushion...	1	oz. magnet	**1.39**
6 inch, pincushion...	1.47	oz. magnet	**2.09**
4 x 6 inch.....	1	oz. magnet	**1.69**
5 x 7 inch. oval.....	1.47	oz. magnet	**2.19**
7 inch, pincushion...	2.15	oz. magnet	**3.19**
8 inch, pincushion...	2.15	oz. magnet	**3.29**
6 x 9 inch, oval.....	2.15	oz. magnet	**3.09**

50-W. OUTPUT TRANS.

ONLY $7.50 WHY PAY MORE

50-watt super quality high fidelity output transformer. Matches push-pull parallel or push-pull 6L6 tubes to 4/8/16-ohm voice coil, also 60 and 250 ohm line. Very efficient winding construction only 140 ohms, total resistance in primary, and 8-ohm voice coil tap only .2 of an ohm. This output transformer wastes a minimum amount of audio power due to heat loss within the transformer. Very ideal for public address amps. Stock No. 50-JB, net weight 5½ lbs. Bargain price **$7.50** ea., 2 for **$13.95.**

McGee's Super High Fidelity *Best Value in U. S. A.*

OUTPUT TRANS. 20-20,000 CPS. $7.95

Model A-403 High fidelity output transformer. Why pay $20 or $30 for an output, when our A-403 is available at $7.95? Impedance, 6600 ohms plate to plate (for PP 6L6 or 6V6), 10% feedback winding, 4-8-15-250 and 500 ohm secondary. Housed in a potted case. Net weight 6 lbs. Recommended for all amplifiers up to 34 watts.

SPEAKER AND BAFFLE SALE

8" SPEAKER AND BAFFLE $4.95

Stock No. 818, Tan leatherette covered, plywood slant type wall baffle; plus an 8" Oxford, 2.15 oz. Alnico V magnet PM speaker. A red hot McGee special for only **$4.95** each, or **$4.70** each in lots of 3 or more.

10" SPEAKER AND BAFFLE $6.95

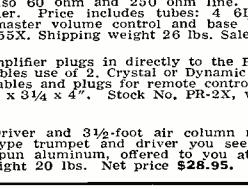
Stock No. CA-10, Tan leatherette covered plywood slant type wall baffle; plus 10" Permaflux, 3.16 oz. Alnico V PM speaker. Only a few hundred to sell at **$6.50** each, or **$6.25** each in lots of 3 or more.

12" SPEAKER AND BAFFLE $6.95

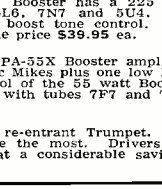
Stock No. CA-12, Tan leatherette covered plywood slant type wall baffle; plus a 12" Quam, 4.64 oz. Alnico V magnet PM speaker. (Popular Adjustacone model). A terrific McGee value for only **$6.95** each, or **$6.60** each in lots of 3 or more.

50-WATT BOOSTER AMPLIFIER—$39.95

25-Watt Horn $28.95



50-Watt Booster $39.95



2-Mike Pre-Amp. $10.00 Extra.

50-WATT BOOSTER A sensational value, 50 watt booster amplifier with push-pull parallel 6L6 output tubes. Connect to your present amplifier as a booster or use with the PR-2X Pre-amp to add the use of 2 mikes and one low level input. The booster amplifier has one input jack and with 1 volt input gives 50 watts of audio. Booster has a 6 lb. potted case high fidelity output transformer, matches speaker with 4-8-16 ohm voice coil, also 60 ohm and 250 ohm line. Booster has a 225 mill power supply with 5U4 rectifier. Price includes tubes: 4 6L6, 7N7 and 5U4. The two variable controls are for master volume control and base boost tone control. Size 8 x 6½ x 14½. Stock No. PA-55X. Shipping weight 26 lbs. Sale price **$39.95** ea.

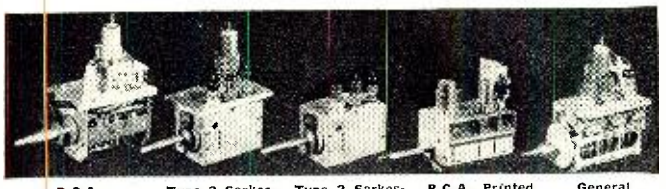
2-MIKE PRE-AMP. Pre-amplifier plugs in directly to the PA-55X Booster amplifier. It enables use of Crystal or Dynamic Mikes plus one low level input. Furnished with 4 foot cables and plugs for remote control of the 55 watt Booster Amplifier. Small chassis size 5 x 3¼ x 4". Stock No. PR-2X, with tubes 7F7 and 7N7. Net price **$10.00** ea.

25-WATT HORN 25-Watt Driver and 3½-foot air column re-entrant Trumpet. The standard type trumpet and driver you see the most. Drivers are 100% weatherproof, horn is satin aluminum, offered to you at a considerable savings. Stock No. MA-33. Shipping weight 20 lbs. Net price **$28.95.**

McGEE RADIO COMPANY Prices F.O.B. K.C. Send 25% Deposit with Order, Balance Sent C.O.D. With Parcel Post Orders, Include Postage

TELEPHONE VICTOR 9045. WRITE FOR FLYER 1422 GRAND AVE., KANSAS CITY, MISSOURI

McGEE OFFERS T.V. TUNERS — RADIO AND T.V. KITS



R.C.A. $9.95 | Type 3 Sarkes-Tarzian $9.95 | Type 2 Sarkes-Tarzian $7.95 | R.C.A. Printed Circuit $14.95 | General Inst. $2.95

RCA TV FRONT END WITH TUBES $9.95

Terrific buy on this RCA TV tuner. We have a limited quantity of the famous original 201E1, 13 channel completely wired and tested TV front end tuners. Ready to connect to your TV video I.F. strip. Offered at a sacrifice. Price was originally $44.00. Now only $9.95 each, with tubes. You'll save plenty on this item. No. RCA-13P TV front end tuner. Shaft length 3⅜" from base of tuner. Converter coil type for separate sound, as used in the famous 630 chassis. Net price **$9.95** each, **two for $19.00**, complete with 3-6J6 tubes.

SARKES-TARZIAN TYPE 3-TUNER WITH TUBES $9.95

This popular Sarkes-Tarzian TV front end is widely used today. 13 channel rotary type switch with individually tuned coils. Price includes a schematic diagram and 3 tubes, 6C4 osc., 6BH6 RF and 6AG5 mixer. Regular factory cost is twice our price. Each tuner and its own tube sockets are wired, ready to hook up to a video and sound IF strip. May be used with either inter-carrier or separate sound IF circuits. Built in fine frequency control. Shipping weight 3 lbs. Type 3 Sarkes-Tarzian TV tuner with tubes. Net price $9.95. Type 3 tuner and 205-XX video coil kit, **both for $16.95.**

SARKES-TARZIAN TYPE 2-TUNER WITH TUBES $7.95

Type 2 Sarkes-Tarzian TV tuner, same as Type 3 listed above, except does not have input IF coil built on. Complete with 3 tubes. Net price $7.95. Type 2 tuner and 205-XX video coil kit, **both for $14.95.**

RCA 12-CHANNEL PRINTED CIRCUIT TV TUNER $19.95

Latest design RCA 12 channel printed circuit TV tuner. Rotary switch with snap-in printed circuit strip principle. This popular tuner used by Hallicrafters in inter-carrier circuit sets. Shaft length 3⅜". Built in fine frequency control. Price includes tubes, 6J6 and 6CB6. A terrific value at $19.95 each.

GENERAL INSTRUMENT TV TUNER, LESS TUBES $2.95

Completely wired, 13 channel selector incorporating fixed inductance and variable capacitance. Converter output transformer is attached. To be coupled direct to separate sound and video IF's, 3 6J6 ttubes are required. Shaft length 2¼". Built in fine frequency control. Original cost over $20.00. Weight 4 lbs. Have been in sets, but guaranteed to be a good value. Stock No. GI-13PX, General Instrument TV tuner, less tubes. Net price $2.95 each.

2-TUBE SARKES-TARZIAN TUNER LESS TUBES $7.95

Sarkes-Tarzian new two tube model, type TT-3A, 12 channel television tuner. This is the new 2 tube model requiring a 6J6 plus 6AK5, or 6AG5, or 6CB6 or 6AU6 RF tube.

Pre-aligned by trained factory personnel. Input feeds 21 mc broad band. Fine tuning control is over the channel selector shaft. Power requirements 120 to 140 volts DC at 17 mills, plus 6.3 volts filament. This tuner is offered at a terrific saving to you. Stock No. TT-3A. Net price **$7.95**, **two for $15.00**, less tubes. Available with 2⅞", 5½" or 7½" shaft. Specify shaft length desired. 6J6 and 6AU6 tubes for above tuner, both for $2.39 extra.

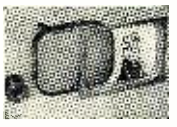
COMPLETE 17" TO 20" T.V. KIT

★ AC-TRANS-TYPE
★ CONVENTIONAL CIRCUIT
★ READY WIRED 12 CHANNEL T.V. FRONT END
★ 70° DEFLECTION ★ CERAMIC FLYBACK
★ KIT OF TUBES EXCEPT KINE $16.95 ★ 17BP4A $21.95 EXTRA

$59.95 LESS TUBES

A complete kit of parts to build an AC transformer operated television chassis for use with a 16, 17 or 20 inch rectangular picture tube. The 12 channel Sarkes Tarzian tuner is ready wired. The 4 tube video IF strip is also wired. Circuit is of the conventional accepted design, with latest ceramic type flyback high voltage supply. Chassis is ready punched. Warning: Do not buy this kit unless you understand Television and electronics. It is difficult to wire. We furnish schematic and photos. Kit model WH 20 ship weight 40 lbs., less all tubes **$59.95.** Kit of 19 tubes but less picture tube **$16.95** extra. 17 inch 17BP4A **$21.95** extra. 20CP4 inch rect. tube **$39.95** extra.

CONVERT YOUR T.V. TO A LARGER PICTURE TUBE



LOOK—16" RECTANGULAR CONVERSION KIT $28.95

With each conversion kit you get a plastic mask, 70 degree deflection yoke, 90 day guaranteed black face picture tube, plus our new 7741-X 14,000 Volt Universal fly-back and horizontal output transformer that works on any output tube and any single rectifier (1B3 or 1X2). A suggested diagram is furnished for use of the transformer with several different output tubes and rectifiers. We think this is the finest and best priced conversion kit in the country. Shipped Truck or Express, only.

Kit No. TCK-14, with 14BP4A 14" rectangular tube. Net price..... **$27.95**
Kit No. TCK-16, with 16RP4A 16" rectangular tube. Net price..... **28.95**
Kit No. TCK-17, with 17BP4A 17" rectangular tube. Net price..... **29.95**
Kit No. TCK-20, with 20CP4A 20" rectangular tube. Net price..... **49.95**

REGENCY T.V. BOOSTER $19.10

McGee has the famous Regency DB-410 TV booster. Order yours from McGee. Shipping weight 6 lbs. Sale price, **$19.10** each.

Video Coil Kit $7.95

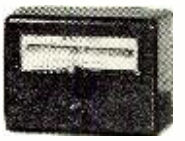
20 matched TV video and sound I.F. coils, intended for use with the RCA circuit. You get 6 peaking coils, 4—25.75 mc picture I.F.'s, 2—21.25 mc sound I.F.'s, discriminator and converter coil and 5 filament chokes. Stock No. 205-XX, weight 3 lbs. Net price, **$7.95. $6.95** if purchased with ANY TV tuner; all coils identified.

T.V. FRINGE AREA DEALERS—ATTENTION

FM AND TELEVISION BOOSTER SALE

ANOTHER McGEE SCOOP
WHY PAY MORE? NOT A KIT BUT A FACTORY-BUILT BOOSTER

$10.95 TWO FOR $20.00

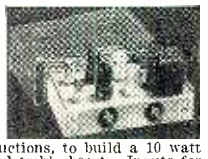


Sensational value. Continuously variable inductance type tuner, from channel 2, including the FM band, through channel 13. This booster is self powered for 110 volts AC operation. Incorporates a 6J6 tube. Input for 300 ohm TV line and 300 ohm output to the TV set. Single knob tuning. Attractive plastic case. McMurdo-Silver Super Sonic TV-FM booster, Stock No. GB-6B. Shipping weight 5 lbs. McGee's terrific sale price, **$10.95** each, **two for $20.00.**

SENSATIONAL NEW 2-BAND RADIO KIT ONLY $14.95

10-WATT HIGH FIDELITY AMPLIFIER KIT $14.95

★ MIKE INPUT ★ PHONO INPUT
★ BASE AND TREBLE BOOSTER



A complete kit of parts, including tubes, diagram and instructions, to build a 10 watt high fidelity twin tone control audio amplifier, with bass and treble boost. Inputs for radio tuner, crystal mike and crystal phono pickup. Output transformer matches 4-8-250 ohms. Use with our 12" coaxial PM speaker, or any good PM and have a beautiful sounding, yet low cost amplifier. Response form 50 to 15,000 cps. Chassis is ready punched and a ventilated cover is furnished. A straight forward circuit with twin triode gain stages and 2-50L6 tubes in push-pull. New twin 150 ma. selenium rectifier voltage doubler; television type power supply. Price includes tubes; 12AX7, 12AU7 and 2-50L6, plus rectifiers. A good quality kit with matched parts. Size, 5¼"x10"x5⅝" high, including cover. Stock No. AP-10R, shipping weight 8 lbs. Sale price $14.95 each. 12" coaxial PM speaker, $12.95. extra.

MODEL ME6-2 $14.95

NEW MODEL 6-TUBE, 2-BAND RADIO KIT
A FULL 2-GANG SUPERHET KIT
RECEIVES 550-1600 KC PLUS 6-18 M.C.

McGee's new 1951, 6 tube; AC-DC 2 band radio kit. Receives broadcast, 550 to 1600 kc and short wave, 6 to 18 mc. A straight forward superhet circuit with 2 gang tuning condenser, 456 kc I.F. transformers, etc. 5" speaker illuminated slide rule dial. Everything furnished, including tubes, 12SK7, R.F., 12K8 mixer, 12SK7 I.F., 12SQ7 detector, 1st audio, 35L6 output, 35Z5 rectifier, diagram and a photo showing view of underside of completely wired chassis. The chassis pan and dial parts are factory production. With this kit, you can build a commercial looking and factory quality 2 band radio, housed in a streamlined plastic cabinet. Size: 13 x 6¾ x 6¼". Stock No. ME6-2, shipping weight 10 lbs. Net $14.95.

SELF POWERED AC Broadcast Tuner Kit. 3-Gang Tuning. Complete Kit, $12.95

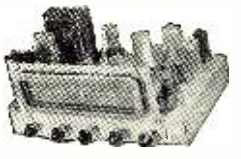
A self-powered, 3-gang superhet tuner kit with R.F. stage. When wired according to our diagram will make a top quality broadcast tuner (550 to 1650 kc) for use with any amplifier. Don't class this with ordinary tuners; this has its own power transformer. This complete kit is furnished with a diagram, photos and tubes, 6AU6 R.F., 6BE6 oscillator R.F., 6AU6 I.F. detector, 6AL5 diode, AVC, plus rectifier. Connect to any audio amplifier. Ideal for use with our S-2020, TM-16 or 7X5 amplifier kits. Chassis size, 9½x4x 4½" high. Shipping weight, 7 lbs. Broadcast tuner kit Model BT-38X. Net price, **$12.95.**

8-TUBE 22 WATT Wide Range Amp. Model 7x5 Kit Only $37.95

A complete kit, including tubes (3-7E5, 2-7F7, 2-6A3, plus rectifier), diagram and photos. All triode circuit makes for minimum harmonic distortion. Inputs for radio tuner any kind of phono pickup (crystal or G.E. variable reluctance) and either crystal or dynamic mike. Output transformer matches 8 ohm voice coil. Twin electronic tone controls, bass and treble with range selector switch for either juke box quality with heavy bass response or brilliant symphonic range. The best quality amplifier kit we know how to make. Has a very wide range output and heavy power transformer. Response 18 to 20,000 CPS. 8 tube all triode amplifier kit, complete with tubes. Weight 25 lbs. Net **$37.95.**

10-TUBE RADIO KIT $29.95

3-GANG TUNING
MIKE INPUT
12 WATT
HI-FI AUDIO
BASS-TREBLE
BOOST



A NEW 1951 ALL-PURPOSE RADIO KIT

10-Tube Broadcast (550 to 1700 kc) Radio Kit for custom builders. Features 3-gang superhet circuit with A.V.C., high gain IF circuit, 8" slide rule dial. Chassis size 12½" long, 10" front to back, 6½" high. Audio inputs for a crystal or dynamic mike, and record changer or player. Tone compensation for standard crystal pick-up or General Electric variable reluctance. Push-pull 6V6 output tubes, shielded high fidelity output transformer matches 8 ohm PM speaker, husky power transformer, 2 tone controls for separate bass and treble boost. A complete kit, including tubes 6SK7 R.F., 6SA7 mixer, 6SK7 I.F., 6H6 detector, AVC, 6SQ7 1st audio, 12AX7 variable reluctance and mike amplifier, 12AX7 phase invertor, 2-6V6 outputs, plus rectifier, diagram and instructions. Shipping weight 18 lbs. Stock No. BK-R10. Net price **$29.95.** 10" PM speaker, **$6.95** extra. Crystal mike and desk stand, **$4.95** extra. 12" coaxial speaker **$12.95** extra.

5-Tube Broadcast SUPERHET RADIO KIT $12.95

Model RS-5 tube AC-DC superheterodyne radio kit. Has loop antenna and 2 gang condenser, with lighted slide rule dial and attractive plastic cabinet. Receives broadcast, 550 to 1650 kc. Full size dynamic speaker, matched 456 I.F.'s, automatic volume control. This is a complete radio kit. Everything furnished, including diagram, photos and tubes: 12K8 mixer, 12SK7 I.F., 12SQ7 detector, 1st audio, 50L6 output, 35Z5 rectifier. Shipping weight 7 lbs. Stock No. RS-5. Net price **$12.95.**

Build Your Own Phono-Mike Broadcaster $7.95

Kit Model DE-6R. With this simple kit, you can build a 3-tube phono oscillator that also has a mike input. Will broadcast over any radio, within your home, (about 75 feet) from 1000 to 1500 kc. Inputs for crystal mike or crystal phono pickup. Fader control fades from mike to record. Ideal for a home P.A. system, baby listener and home entertainment. A complete kit of parts including tubes. Kit Model DE-6R. Net price, **$7.95.** DE-6RWT, wired and tested. Net price, **$9.95.** Crystal mike and desk stand, **$4.95** extra. Concealed microphone unit, only 1" in diameter and ¼" thick. Specify hidden mike when ordering. Stock No. T-001. Net, **$3.95** extra.

McGEE HAS EICO TEST EQUIPMENT KITS

Model 145-K, Multi-Signal tracer.	Net	$19.95
Model 221-K Vacuum Tube Voltmeter	Net	25.95
Model 315-K Signal Generator Kit	Net	39.95
Model 320-K Signal Generator Kit	Net	19.95
Model 425-K 5" Oscilloscope Kit	Net	44.95
Model 625-K Tube Tester Kit.	Net	34.95
Model 360-K Sweep Generator Kit	Net	34.95
Model 950-K Cond. Res. Comp. Bridge Kit	Net	19.95
Model 1040-K Battery Eliminator Kit	Net	25.95

Technical BOOKS

"FOUNDATIONS OF WIRELESS" by M. G. Scroggie. Published by *Iliffe & Sons, Ltd.,* Dorset House, Stamford Street, London, S.E. 1, England. 320 pages. Price 12 s./6d. (postage 8d.) Fifth Edition.

The fifth edition of this popular basic text has been completely rewritten to bring it up-to-date and in line with recent radio developments.

The text material covers the basic theory of radio, beginning with the most elementary concepts. The author has not assumed that the user of this text has had any previous experience with radio or radio terminology nor that he is familiar with mathematical manipulation.

The book is divided into twenty chapters and four appendices and covers elementary electrical concepts, capacitance, inductance, a.c. and d.c. circuits, tuned circuits, tubes, antennas, simple receivers, the superheterodyne, power supplies, CR tubes, transmission lines, a.f. circuits, etc. The appendices include a table of alternative technical terms (including American terminology for British terms used in the text), symbols and abbreviations, circuit symbols, and a decibel table.

The author's style is refreshingly simple and his use of analogies is unhackneyed. Aside from the vast amount of information to be gleaned from this book, the text makes interesting and lively reading.

* * *

"RECEIVING TUBE SUBSTITUTION GUIDE BOOK" by H. A. Middleton. Published by *John F. Rider Publisher, Inc.,* New York. 44 pages. Price $0.99. Paper bound. First Supplement.

In order to keep up with new tube developments, this first supplement to the "Receiving Tube Substitution Guide Book" has been published.

Included in this handy, paper bound book are nearly 750 new substitutions, among them older tube types that were omitted in the original publication. Most of the listings given apply to tubes used in television receiver circuits and, in addition, data on making such substitutions has been incorporated to facilitate servicing.

Like the original book, this supplement presents the required information in easy-to-use form. Television receivers are listed by make and model number and the proper substitutes and circuit changes given in tabular form.

In the case of receiving tubes, the tubes are listed by number, the substitute is given, performance of the substitute is evaluated, and the necessary circuit changes are explained.

Technicians will find this guide book a valuable addition to their service data shelves.

* * *

"TV AND ELECTRONICS AS A CAREER" by Ira Kamen & Richard H. Dorf. Published by *John F. Rider Publisher, Inc.,* New York. 319 pages. Price $4.95.

This book is an authoritative, graphically presented account of the workings of a greatly expanding field—electronics. Besides Mr. Kamen and Mr. Dorf, the other contributing authors are: W. Hollander Bohlke of the *RCA Service Co., Inc.,* who writes on "Television Servicing"; Raymond W. Peterson of *Admiral Corporation,* who writes on "Radio and Television Manufacturing" and "Electronic Engineering"; and J. R. Poppele of WOR-TV, who contributed the section on "Television Broadcasting." These men, who have gained their knowledge and experience directly from their work in radio and television broadcasting, communications, manufacturing, engineering, sales, and servicing, provide young people planning a career and those already in electronics, with factual information and guidance.

The chapters are clear and well-written, and give extensive descriptions of what various jobs in the industry consist, the work they entail, how to prepare for them, and how to go about getting them. The different salary scales are also given. —30—

130,000 qualified TV servicemen needed

Here is how you can be one of them

INDUSTRY EXPERTS HAVE ESTIMATED over 130,000 qualified TV technicians will be needed for the installation, trouble-shooting and repairing of the television receivers in use by 1955.

There are far fewer than 50,000 fully trained TV technicians available today. This means more jobs, unrivaled future for security, greater earning power for thousands and thousands of additional TRAINED and EXPERIENCED TV Servicemen. Will you be one of them?

OUTSTANDING FUTURE FOR QUALIFIED TV SERVICEMEN

Men now in radio servicing as well as men in the radio-electronics industry with no experience in TV servicing . . . here is your opportunity. The RCA Institutes Home Study Course in Television Servicing makes it possible for you to convert your skill in radio servicing, or interest in radio-electronics, to the important money-making field of TV servicing.

The RCA Institutes Course gives you a sound knowledge of television fundamentals . . . intensive practical instruction in the proper maintenance and servicing of complex TV receiver circuits—*including color TV and UHF* . . . teaches you the "short cuts" on TV installation and trouble-shooting, saving you many hours of on-the-job labor.

TRAINING MEETS MODERN REQUIREMENTS

This course is in step with the progress of the television industry. It is backed by RCA—pioneer in television development. It is based on the actual experience of the RCA Service Company in servicing thousands of home television receivers. The course is constantly being revised, improved and kept up-to-the-minute. It will help you to a more profitable and productive future in these ways:

PREPARE YOU to take the required technical examination with confidence, in those areas that require a license or permit to engage in TV servicing.

TRAIN YOU, if you are a serviceman in a non-TV area, to become a qualified TV technician by the time TV comes to your area. In TV areas, TV servicing has substantially replaced radio servicing as the chief source of income.

IF YOU ARE A QUALIFIED TV SERVICEMAN, it will keep you in step with the latest industry developments including color TV and UHF.

IT DEVELOPS the latent talents of installers into skilled trouble-shooting TV technicians.

TRAINS MEN in radio-electronics with no previous servicing experience to fill jobs as TV technicians, to win promotions and better pay.

RCA INSTITUTES HOME STUDY COURSE PLANNED TO YOUR NEEDS

You keep your present job in radio—television—electronics. In your spare time, you study at home. You learn "How-to-do-it" techniques with "How-it-works" information in easy-to-study lessons prepared in ten units. Cost of RCA Home Study Course in Television Servicing has been cut to a minimum—as a service to the industry. You pay for the course on a "pay-as-you-learn" unit lesson basis. You receive an RCA Institutes certificate upon completion of the course. The RCA Institutes Home Study Course in Television Servicing is approved by leading servicemen's associations.

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.*

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 Department, RN-252
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 INSTITUTE, INC.
A SERVICE OF RADIO CORPORATION of AMERICA
350 WEST FOURTH STREET, NEW YORK 14, N.Y.

Within the Industry

(*Continued from page 30*)

Forces . . . **JACK C. KEITH** has been elected vice-president in charge of sales for *Howard W. Sams & Co., Inc.* He has been with the firm since its inception . . . The Television Picture Tube Division of *Sylvania Electric Products Inc.* has appointed **RALPH R. SHIELDS,** former engineer for the company's test equipment merchandising, to the post of merchandising supervisor . . . **WARREN W. FREBEL** has been named vice-president in charge of purchasing by *Majestic Radio & Television Division* . . . **JOSEPH H. LANCOR, JR.** is the new director of the Transducer Division of *Consolidated Engineering Corporation* . . . **FRED H. GARCELON** has taken over the post of eastern sales manager for *Hytron Radio & Electronics Co.* . . . **BROOKS A. KAFKA** of Schenectady has been appointed supervisor of purchasing for the *General Electric Company's* cathode-ray tube operations . . . The Electrical Textile Sales Division of *Owens-Corning Fiberglas Corporation* is now being managed by **GEORGE H. SHERRARD** . . . **GEORGE I. LONG** has been named vice-president and general manager of *Ampex Electric Corporation* . . . *Sangamo Electric Company* of Springfield, Illinois has appointed **JOHN G. TWIST** to the post of sales manager of the company's Capacitor Division in Marion, Ill. . . . **LEIGH A. BRITE** is the new director of research and development for the *Transmitter Equipment Mfg. Co., Inc.* He was formerly chief electronics engineer of the U.S. Air Force Security Service at Brooks Field, Texas.

* * *

MILTON R. BENJAMIN has been appointed general sales manager of *Jewel Radio Corporation* of New York.

He was formerly vice-president and national sales manager of *Majestic Radio & Television.* In this capacity, he directed the sales of television and radio receivers as well as *Wilcox-Gay* recording equipment.

Prior to joining *Majestic,* he was associated with several outstanding companies in the radio industry in both sales and managerial capacities.

* * *

ANDREW CALIFORNIA CORPORATION has been set up in Simi to handle the California business of **ANDREW CORPORATION** of Chicago . . . The **CROSLEY DIVISION** has purchased the physical assets of **BRAND AND MILLEN LIMITED,** radio and television manufacturing firm of Long Branch, Ontario. The Canadian firm will be operated as a wholly-owned subsidiary and renamed **CROSLEY RADIO & TELEVISION, LIMITED** . . . **ARCO ELECTRONICS, INC.,** has opened a branch office, **ARCO CAPACITORS, INC.,** at 5281 W. Pico Blvd. in

Los Angeles to expedite distribution of the company's "Elmenco" line. Carl Drillick is in charge of the new West Coast operation . . . **TEL-O-TUBE CORPORATION OF AMERICA** has purchased the entire equipment and inventory of **VIDEO INDUSTRY PRODUCTS COMPANY** of Paterson, N. J., manufacturers of TV and CR tube test equipment and electronic instruments. The firm will be operated as the electronic division of the parent firm at 159-161 Marshall St., Paterson.

* * *

LLOYD A. HAMMARLUND, president of the *Hammarlund Mfg. Co., Inc.* recently celebrated his thirty-fifth anniversary with the communications firm.

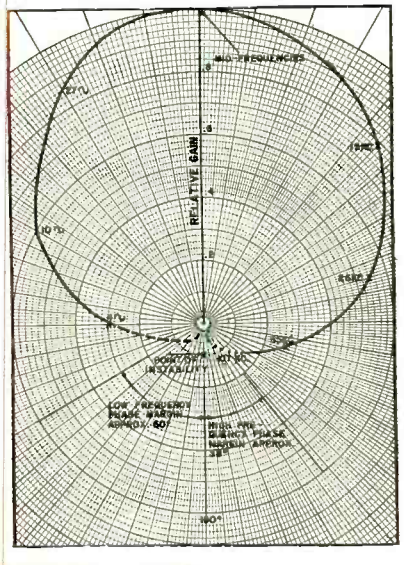
He has been with the company continuously since 1916, except for two years' leave for service in the Army during World War I. He has worked in every department of the company, taking over as president ten years ago.

The company was started in 1910 by Mr. Hammarlund's father, Oscar, and has grown steadily until it is now occupying 100,000 square feet at two locations in New York City. —30—

Audio Amplifier
(*Continued from page* 39)

are often more important in determining the exact margin of stability. Two phase-correcting networks have been utilized to improve this margin—R_3 and C_1 shunting the first amplifier plate and C_6 bypassing the feedback resistor. The resulting mode of high-frequency operation is further influenced by the load; and especially in the case of capacitive loads, the gain and phase characteristics must be watched for tendencies toward instability.

Fig. 3. The "Nyquist diagram." Measurements were made with the corrective network and without feedback. See text for full details.



The quickest analysis of an amplifier's operation with respect to its stability is accomplished by plotting the gain and phase response *without feedback* at all frequencies on a polar diagram. The resulting chart (see Fig. 3) is known as a Nyquist Diagram. The graphical measurement of the margin of stability then appears as the distance from the curve to a —20 db point (the amount of inverse feedback) at 180° phase shift. Oscillations would occur with the application of this amount of feedback, if the curve were to enclose this point. As shown in the graph (Fig. 3), both the low and high frequency stability margins are unusually wide.

Speaker Damping

One extremely important characteristic, resulting from the use of a triode output stage along with a large degree of inverse feedback, is a very low output source impedance. In the case of the *Craftsmen* 500 amplifier, this impedance, as seen by a speaker connected to the 16 ohm tap, is only 0.5 ohm. The amplifier can, therefore, be considered to have a 16/0.5 or 32:1 damping factor. Of even greater importance is the fact that this impedance is maintained near this value (see Fig. 4) throughout the audio range. The usefulness of such excellent speaker damping at very low frequencies has been readily demonstrated in reducing speaker "muddiness" and "one-note-boom." At higher frequencies, the effect of damping transient distortions in the speaker is often conveyed to the listener as a fresh sensation of clarity in reproduction.

Distortion

As can be seen by referring to the distortion *vs* power output diagram, both the harmonic and intermodulation distortions are remarkably low in this amplifier. At one watt, the intermodulation distortion (measured with 40 and 12,000 cps:4/1) is below 0.04%,

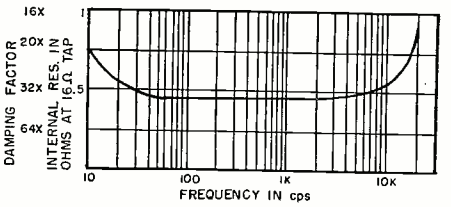


Fig. 4. Graph showing the output source impedance-frequency characteristic of unit.

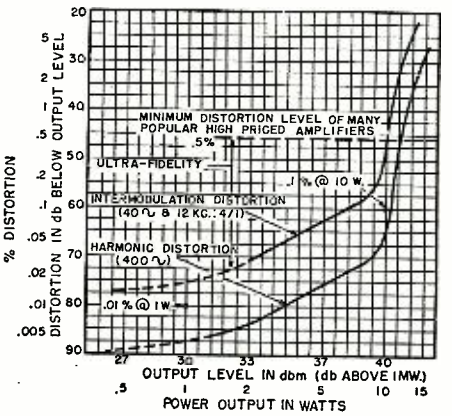


Fig. 5. Harmonic and intermodulation distortion vs power output of unit.

while the harmonic distortion is even less than 0.01%.

Because these very low magnitudes of distortion are maintained throughout the audio range, this amplifier has been described as being not only a high-fidelity amplifier but also capable of *ultra-fidelity*.

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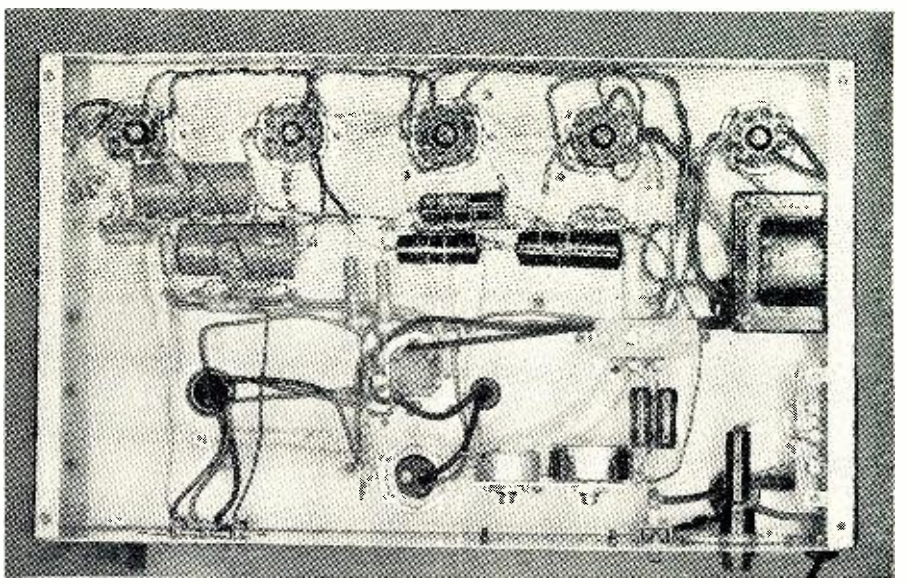
3. *Sarser, D and Sprinkle, M.C.: "Musician's Amplifier," Audio Engineering, November, 1949.*
4. *Cooper, G.F.: "Audio Feedback Design —Part 3—Analysis of the Williamson Amplifier," Radio-Electronics, December, 1950.*
5. *Keroes, H.I.: "Building the 'Williamson' Amplifier,"* RADIO & TELEVISION NEWS, *December, 1950.*

—30—

Under chassis view of the Craftsmen 500 amplifier using the Williamson principle.



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2J32	725-A
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DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
8D AR 93	28	3.25	375	.150	
23356	27	1.75	285	.075	APN-1
35CO458	28	1.2	250	.060	
ZA-085	12/24	4/2	500	.050	
ZA-056	12/24	8/4	12/275	3/110	
B-19 pack	12	9.4	275	.110	Mark II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 375
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
		9	1.12		
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			14.5	.5	

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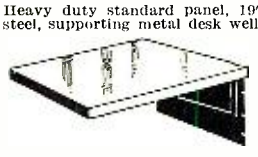

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75–84	110–	1.25
88–106	110–	1.50
107–129	110–	1.65
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PT-170	Auto: 156/146/137/128—.71A	3.29
PT-31A	2 x 300V 5 MA	.79
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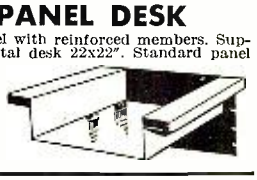

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Tube Substitutions for TV Receivers

As the tube situation gets tighter, technicians will be forced to improvise to keep TV sets in operation.

By
MEYER CHERTOCK
Delehanty Institute

THE necessity for developing substitutes for television components in short supply has already become acute. When prompt repairs are required to keep sets in operation, available materials must be used.

Since the shortage of tubes is one of the technician's greatest headaches at present, the techniques for substituting available types for hard-to-get numbers will be considered here.

R.F., I.F., and Video Amplifiers

In the r.f., i.f., and video amplifier family, we have such tubes as the 6AC7, 6AU6, 6BH6, 6AK5, 6AG5, 6CB6, 6BC5, and 6BA6. If the heater voltage is drawn from the 6.3 volt winding of the power transformer rather than a series filament connection, the differences in heater current may be disregarded. A small increase or decrease in heater current will not damage the power transformer. Aside from some differences in G_m, R_p, and interelectrode capacity, most 7 pin miniature triple grid amplifiers can be interchanged and will provide adequate operation if certain factors are taken into consideration.

In Fig. 1A, the plate, screen, grid, and heater pins are numbers 5, 6, 1, 3, and 4. These tubes differ only in the heater, suppressor, and cathode pin connections. A jumper may be connected from suppressor to cathode, between pins 7 and 2, if the grounding connection is removed from the suppressor. With this small change, it is now possible to insert any of the following tubes and, in most cases, reception will be possible. These tubes may operate in such a socket: 6AU6, 6AG5, 6CB6, 6AH6, 6BJ6, 6BA6, 6AK5, 6BC5, 6BH6, and 6AS6.

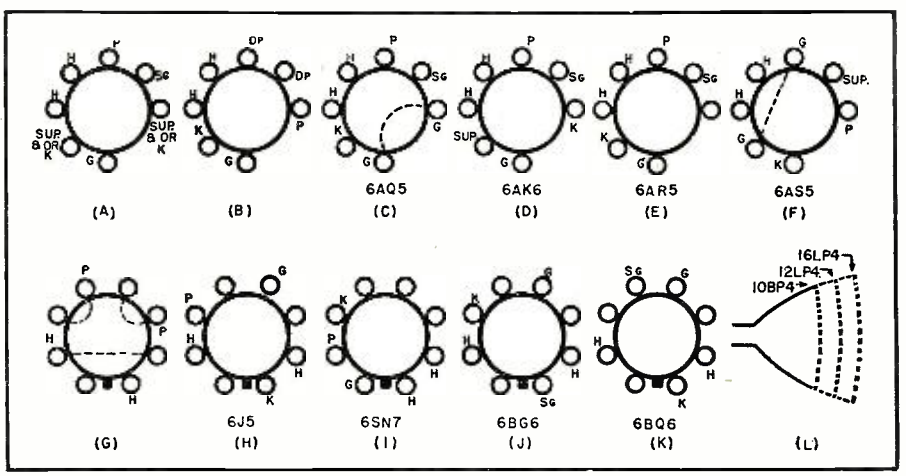
Since each of these tubes have slightly different characteristics, the i.f. or r.f. response curve may have to be altered. However, if the substitution provides the desired end result—a fair picture on the screen—the substitution may be considered successful.

To touch up the i.f. response curve, an r.f. sweep generator will have to be connected to the mixer grid, and an oscilloscope connected to the video detector load resistor. A slight adjustment of the i.f. transformers will then have to be made to correct any serious distortion of the response curve.

Audio Circuits

In the second section of TV receivers, we may find 6SH7 or 6SJ7 tubes and these may be interchanged. The 6SH7 has the suppressor connected to the cathode internally, and has two cathode leads. They function as FM limiters or sync clippers. Audio amplifiers such as 6AT6 and 6AV6 have similar characteristics. Newer additions to the duo-diode and triode family are the 6AQ6, 6BF6, 6BU6, and

Fig. 1.



6BK6. These tubes differ only in mu for the triodes, and rectification efficiency for the diodes.

In most cases, any of the duo-diodes or triodes listed will provide reception of audio signals. In Fig. 1B, the socket pin numbers are common to a large family of tubes—6AT6, 6AV6, 6AQ6, 6BU6, 6BF6, and 6BK6.

Audio power amplifiers provide a wealth of possibilities for interchanging. The 6V6, 6K6, 6F6, 6U6, and 6Y6 have similar base connections. Where the output circuit is not a push-pull, substitution of any of these tubes will, in most cases, provide reception. In push-pull circuits, identical tubes must be used, as the plate current unbalance will accentuate power supply hum. The plate current may be adjusted to the tube manufacturer's recommendations by changing the cathode bias resistor to provide more or less bias.

The miniature audio power amplifier family seems to suffer from a lack of uniformity as far as base pin connections are concerned. Reception of audio signals may be obtained by substituting any of the tubes shown in Figs. 1C, 1D, 1E, and 1F, if the tube socket is rewired. Adapters may be made permitting the use of octal base tubes in place of 7 pin miniatures, or, more easily, 7 pin miniatures in place of octals or loctals.

To use a miniature tube in place of a loctal or octal base tube, it is necessary to have a miniature socket and an octal or loctal tube base. Wires are connected to the miniature socket and pulled through the corresponding element pin of the octal tube base.

Some miniature tubes which can be interchanged with the octal or loctal type tubes are listed for audio only. In addition, a miniature for a 6 prong tube has been added:

6AT6	6AT6	6AT6	6AQ5	6AR5	6BF6
6SQ7	6Q7	75	6V6	6K6	6SR7
6BF6	6AT6	6AT6			
6R7	7B6	7C6			

Rectifiers (Low Voltage)

The 5U4 may be substituted for the 5Y3 low voltage rectifiers. A 5T4 or 5V4 may be substituted for the 5U4. A rectifier socket may be made to handle 5X4, 5U4, 5V4, and 5T4 by connecting the jumpers as shown in Fig. 1G. These same jumpers make it possible to substitute a 5Y3 for a 5Y4, or *vice versa*. A 5Y3 may be substituted for a 5W4 or 5Z4 without any rewiring.

By the use of adapters, various base type rectifiers may be interchanged. A four prong base rectifier may be used for either an octal or a loctal base. A miniature may be used for an octal or a five prong base tube. All that is necessary is the wiring of the same elements together between different bases. Some combinations are:

5V4	5Z3	80	6X4	6X4
5AZ4	5U4	5Y3	6X5	84

Single Triodes

A 6J5 vertical oscillator may be replaced by one-half of a 6SN7 if the socket is rewired for the 6SN7 triode

section, as in Figs. 1H and 1I. A 6C4 may be used in place of a 6J5 if a miniature-to-an-octal adapter is employed connecting the 6C4 elements to the proper octal pins. In some cases, 6AU6's have been rewired as triodes to replace some miniature triodes, and good results have been obtained.

Horizontal Dampers

The 5V4 damper may be replaced temporarily by a 5Y3 with some change in horizontal linearity, or the octal socket may be rewired for a 6W4. 6W4 and 6U4 have identical electrical characteristics and pin numbers. They serve primarily as horizontal dampers.

Readjustment of the horizontal drive and the horizontal linearity slug may correct the linearity to some degree. Expansion of the left half of the pattern may be corrected by a reduction in size of the damper resistor. If the 5V4 is replaced with a 6W4 in the *Philco* 48-1000, the socket is rewired, and the series resistor to the 5V4 heater may be shorted out.

Horizontal Amplifiers

A 6CD6 may be interchanged with a 6BG6 as a horizontal amplifier. The slight difference in bias is easily overcome by additional bias obtained from the rectification of the saw-tooth wave pulses in the grid circuit. Either of the above may be rewired to accommodate a 6BQ6 (see Figs. 1J and 1K).

The new 6BD5 as well as the old 807 offer some possibilities which the author has not as yet tried.

Vertical Amplifiers

A number of substitutions may be made in the vertical amplifier family. 6V6 and 6K6 may be interchanged. Parallel triodes of 6SN7 may be rewired for 6V6, or *vice versa*. Any of these may be replaced with a 6S4 with a 9-pin miniature socket, or *vice versa*.

Sync, Sweep, Etc.

A miniature, such as 12AU7, may be interchanged with an octal such as the 6SN7. A 12AU7 and 12BH7 may be interchanged in many applications.

A 6SN7 multivibrator whose cathodes are connected may be rewired for a 6N7. A 6SN7 may be rewired to accommodate a 6F8, since both are identical in characteristics. The 6SN7 is the modern single-ended edition of the 6F8, and the 12AU7 is the more modern 9-pin version of the 6SN7.

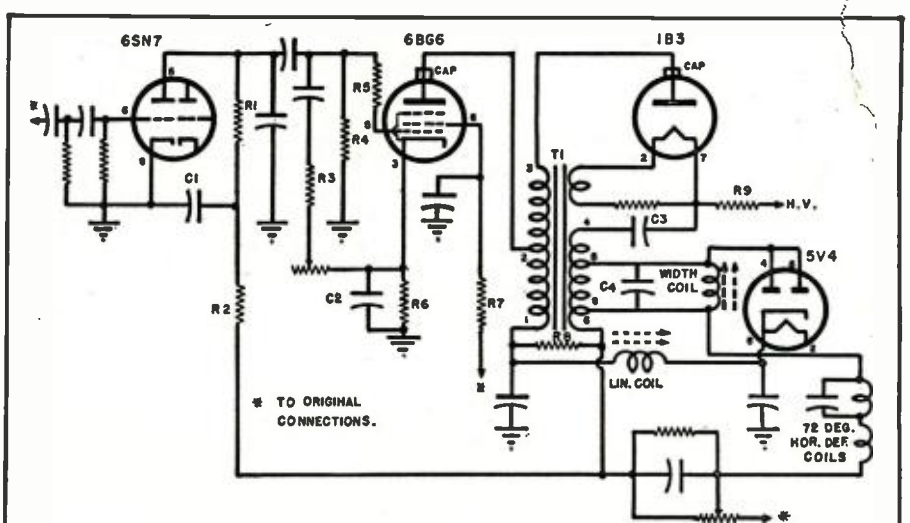
The 6SL7 is the modernized single-ended version of the 6C8, and the 12AX7 is the 9-pin version of the 6SL7.

CR Picture Tubes

Picture tubes are quite an expensive item. When there is doubt as to whether the picture tube or some component in the chassis is at fault, a temporary substitution of some other picture tube may be possible. A very simple substitution can be made by interchanging 10BP4. 12LP4, or 16LP4. The deflection angle of each of these tubes is the same. A receiver which provides a full size picture on a 10BP4 face will also provide a full size picture on a 12LP4 or 16LP4 face, and *vice versa*, as shown in Fig. 1L.

A simple precaution worthy of some note concerns the 16LP4. The neck surrounding the cathode-ray gun of the 16LP4 is one inch shorter than the neck surrounding the 10BP4. The bulky, old electromagnetic type of ion trap will not fit in this space. Either a single or a double permanent magnet type of ion trap beam bender must be employed with the 16LP4. —30—

From Leonard J. D'Airo comes another conversion diagram of considerable interest to television technicians. Mr. D'Airo has used this technique in converting Tele-King receivers to accommodate 16" and 19" CR tubes.



Change	To	Change	To
R_1—680,000 ohm	470,000 ohm, ½ w.	R_8—Add	10,000 ohm, 10 w.
R_2—Add	15,000 ohm, 1 w.	R_9—1 megohm	500,000 ohm, 2 w.
R_3—8200 ohm	15,000 ohm, ½ w.	C_1—Add	.05 µfd., 600 v.
R_4—470,000 ohm	1 megohm, ½ w.	C_2—.1 µfd.	.5 µfd., 600 v.
R_5—Add	100 ohm, ½ w.	C_3—500 µµfd., 10,000 v.	500 µµfd., 20,000 v.
R_6—280 ohm	100 ohm, 2 w.	C_4—Add	.005 µfd., 600 v.
R_7—10,000 ohm	5000 ohm, 1 w.	T_1—RCA 211T1	GE T7J1 and width coil

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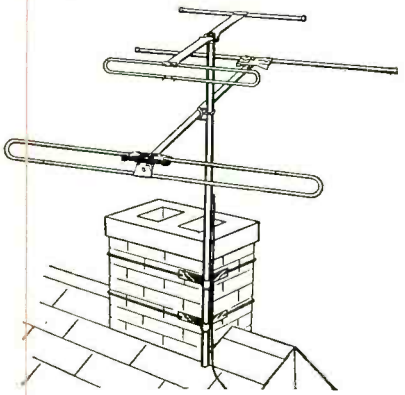

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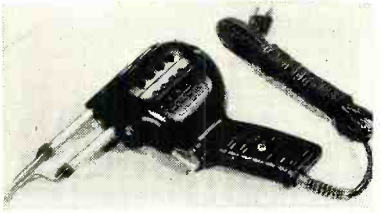

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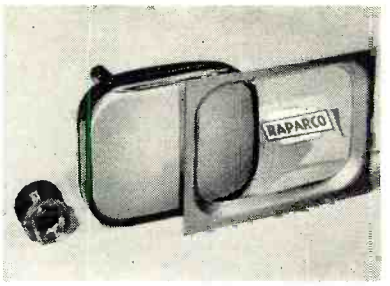

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BLINKING LIGHTS

Construction details on a simple relaxation oscillator circuit for use with neon lamps.

By
STANLEY SIENKIEWICZ
Industrial Electronics Dept.
DeForest's Training, Inc.

PROBABLY the oldest and most commonly used eye-catching device is the blinking light. Whether for ornamental purposes, for advertising, or in toys, flashing lights can always be counted upon to hold the center of attention. The manner in which the flashing of the light is achieved is very important, however, and flashing incandescent lamps fall considerably short of the best effect; they flash too slowly. This article will describe the use of neon bulbs in a simple relaxation oscillator circuit for the purposes mentioned above, or, for that matter, any other purpose suggested by the reader's own imagination.

The circuit, shown in Fig. 1A, is a relaxation oscillator of the simplest type operated from the a.c. line and shows the arrangement for two lights. The flashing rate will be determined by the values of resistance and capacity used in each branch. With values as shown, the neon bulbs will flash about five times per second. Increasing the resistance will cause them to flash more slowly and will also cut down the brightness of each flash. Since the brightness of the flash depends upon the current passed by the neon bulb, increasing capacity will also increase brightness besides increasing the time between flashes. The size of the electrolytic condenser in the power supply will determine how long the bulbs will continue to flash after the a.c. line has been disconnected. If the electrolytic condenser is made larger than 8 μfd., a small resistance should be connected in series with the selenium rectifier. This rectifier is of the 75 ma. type, although, since the current requirements of the device are very small, other types can be used. Fig. 1B shows the circuit diagram for the same setup using a dry cell battery source. Ionization potential of the *General Electric* NE-7 is about 60 volts, and since the current drain is very small, it is possible to operate the device on the smallest types of 67½ volt battery, such as the *Burgess* G-45. The writer used this device to provide blinking eyes in a stuffed Easter bunny. Although this device has been

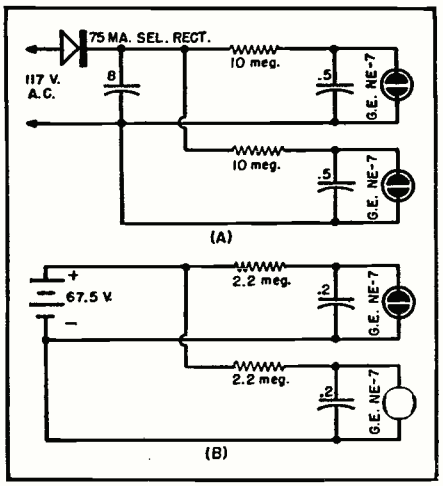
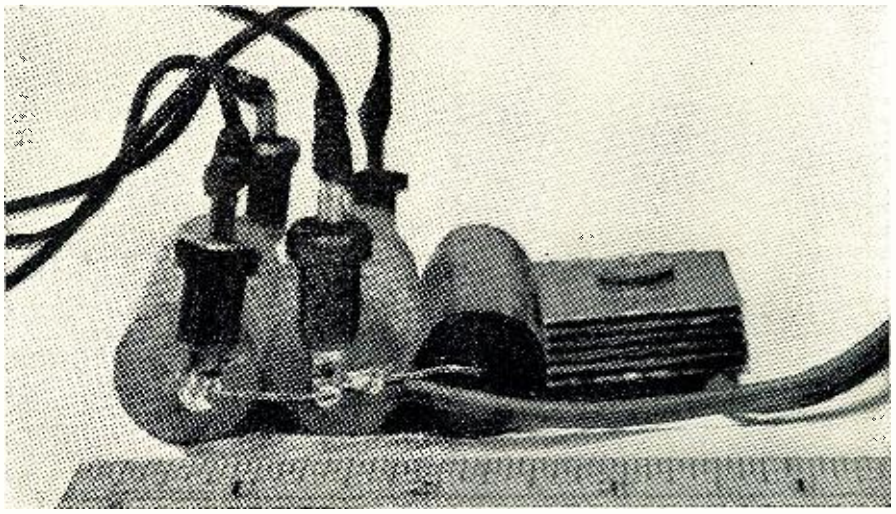


Fig. 1. (A) Simple relaxation oscillator operated from a.c. line and using two neon lamps. (B) Same circuit battery-operated.

Fig. 2. Oscillator unit is compact enough to be used inside fairly small toys, etc.



in operation since Easter of 1950, the bunny's eyes have been blinking continuously until the time of this writing and have not as yet decreased their flashing rate.

The writer found that the *G-E* NE-7 is the type best adapted for use as eyes. The elements consist of a circular wire and a solid metal piece in the center. If the bulb is connected into the circuit with the circular wire as cathode, the glow will appear as a red circle; if connected so that the center element is the cathode, it will glow as a red dot. Either effect is interesting.

In one application of this gadget the author installed the neons to serve as eyes for a plastic pig. With proper insulation of parts, the pig can still be used as a bank, which was its original purpose, besides which it is rather ornamental and is extremely intriguing to children and grownups alike. If the parts are installed in something that is relatively small, construction can be made fairly compact since none of the parts is large, as shown in Fig. 2. If the device is to be used as a toy, it is recommended that a battery be used to supply power.

The parts, whether for the a.c. or d.c. version, can easily be installed in any type of stuffed animal. The writer leans toward blinking eyes, but other imaginations may suggest other effects. One variation is to keep one light constant and allow the other to blink, producing the effect of winking. Operated from the a.c. line, any number of bulb circuits can be connected in parallel. The effect of a dozen or so on a Christmas tree is that of fireflies on the tree branches. For this application, the smallest types of neon bulbs can be used.

Variations of this device have been successfully used in seasonal advertising displays in retail store windows, where the blinking bulbs have been invaluable as an eye-catcher. The medium can be varied depending upon the season for which the display is made.

—30—

"Testing-n-ng, One, Two, Three!"

Low Cost Exciter

(*Continued from page* 42)

are used for the 80 and 40 meter interstage tanks when output is on 40 or 20. These coils are low-C circuits and quite broad enough to give plenty of grid excitation to their associated grid circuits without retuning over the entire bands. To adjust these coils, the exciter is switched to 20 meters and with a flashlight bulb load, the panel controlled trimmer is peaked for maximum brilliance. The two slugs are now adjusted for maximum brilliance of the light bulb and the adjustment is complete. On each band the panel trimmer, C_{23}, is peaked for maximum output near the center of each band. No retuning is necessary if working into a 50 ohm resistive load with this adjustment, except when changing frequency from one end of the 80 meter band to the other.

The three output coils are grouped around the bandswitch for short leads. From the photograph it is obvious that there is plenty of room left under the chassis and the unit is not difficult to wire.

Although keying the v.f.o. is not recommended, the 6AK6 cathode circuit may be satisfactorily keyed. Cathode bias on the following stages will prevent excessive plate current to the doublers in the key-up position. The keying leads should be well bypassed and an r.f. choke may be used to prevent feedback into the chassis via the key leads. Since keying provision was made in the 150 watt amplifier used with the exciter, no keying jack was provided.

A further refinement that could be added would be provision for switching of different tuning condensers across the oscillator tank to give complete bandspread on the three bands. This has not been tried, however, and is offered only as a suggestion for experiment.

Power consumption of the entire exciter is 55 ma. at 210 volts on 20 meters with slightly less plate current on 40 and 80. A measured output of slightly over 1 watt is obtained on each band into a 50 ohm resistive load. The total filament current drain is approximately ¾ ampere so that a power cable several feet long may be used without excessive filament voltage drop. This cable should preferably be shielded to prevent possible harmonic radiation and a two-wire shielded lead is quite satisfactory, using the two leads for the hot filament and "B-plus" conductors. Two VR-105's are used to regulate the plate voltage in the power supply.

A five inch *National* dial is inexpensive, smooth, and easy to install. This simple exciter is giving entirely satisfactory service for c.w., phone, and SSSC, using a 150 watt amplifier and an SSSC adapter to be described in later issues.

—30—

RADIO-TV Service Industry News

AS REPORTED BY THE TELEVISION TECHNICIANS LECTURE BUREAU

THE Federal Communications Commission's "freeze lifting" timetable for the renewal of television broadcasting station construction calls for the release of the new channel assignment tables for both u.h.f. and the revised v.h.f. television allocations to occur early in the year. Immediately following the release of the new tables, hearings will get underway on applications for channel assignments and it is expected that the first of the construction permits will be granted by April first. The areas that will receive priority for stations will be those that do not have telecasting stations and in which the applications for stations do not exceed the number of channels allocated to the area.

While attention has been focused primarily on u.h.f. television in connection with the lifting of the freeze, it is interesting to note that construction permits will be granted for a large number of new v.h.f. television stations. There still are a lot of v.h.f. channels available. It has been reported that there are a number of v.h.f. transmitters and towers already completed and stored in warehouses. With this equipment immediately available, it is probable that a number of new v.h.f. stations will be on the air with television programs by summer.

While it is impossible to foretell the probable speed of telecasting expansion after the freeze has been lifted because of the many unpredictable factors that have a vitally important bearing on the quantity of essential materials that will be available, there probably will be rapid progress made in the development of u.h.f. telecasting. Transmitter manufacturers have been working diligently for many months on production models of their successful experimental u.h.f. transmitting units. It is quite possible that u.h.f. transmitting equipment will become available rapidly which will pave the way for TV in many smaller communities that are now either completely outside of present television service areas or in the far fringe of their coverage.

New Service Opportunities

Since the first stations to be built after CP's are granted will be in areas that do not now have television broadcasting facilities, the first effect of the renewal of station construction will be to provide opportunities for many new TV installation and service businesses. Whenever a television transmitter goes on the air in a new area there is, of course, an immediate boom in receiver sales. Receiver manufacturers have developed special sales programs for the stimulation of consumer interest in the ownership of television receivers in new telecast areas. These sales programs are timed to reach their peak of effectiveness during the period commencing when the new station starts to put its test pattern on the air to the official opening of the station with its first regular television program.

Set retailers, as a rule, want to concentrate their entire facilities on the sale of receivers and they are content to assign the necessary installation, adjustment, maintenance, and servicing functions to an independent television servicing organization. The volume of service business that is immediately created in a new television area usually taxes the facilities of all of the radio and television service shops in the area that make a bid for the business.

An interesting development in television service started during the second year of television broadcasting which was stopped by the station construction freeze. As new television areas opened up, many men who had gained their practical experience in installing and servicing television receivers, in operating TV service businesses, and by working for TV installation and service contractors in the major cities moved in to the newly created television areas to establish their own installation and service businesses. These men held many decided advantages over the local radio service operators without practical TV experience who desired to expand their businesses to handle television servicing. Among these advantages were: 1. The "know-how" gained from practical experience regarding the best practices in installing and maintaining television receivers. 2. An understanding of the financial requirements necessary to set up and maintain an adequately equipped and staffed service organization. 3. Experience in organizing and directing the work of

installation and service technicians to get the best possible returns from their labor. 4. Knowledge of the normal replacement tube and parts stock requirements and exercise of caution to avoid over-buying. 5. A practical understanding of how to develop and maintain cooperative contacts with TV receiver retailers and thus maintain a satisfactory volume of installation and service work.

Experience has shown that the initial boom in television receiver sales in a new TV area lasts about six months. After that there is a continuing drop of receiver sales until it levels off to a norm for that particular section. After that it appears to follow a sales cycle similar to that of radio receivers.

It is during this "boom" period that properly financed and capably managed service businesses become firmly entrenched and thus develop a decided competitive advantage over less efficient shops after the days of easy-to-get business are over.

The local radio service operator in a new TV area who has had no previous television installation and servicing experience faces several serious problems in trying to get established in television servicing. In the first place, the television receiver sales boom moves too fast and does not allow him the necessary time to acquire wide practical experience through working with TV and to expand his facilities and personnel at the same time. He is faced with major problems in business management: (a) To secure additional capital to invest in the necessary equipment and supplies that even a minimum-sized TV service business requires, (b) to hire, train, and supervise the work of at least a few technicians, (c) maintaining constant dealer contacts in order to continue to receive the installation and service work on the receivers they sell.

The many service business failures that occur about a year after telecasting gets underway in a new area are usually due to the lack of adequate finances. Most of these service operators attempted to finance practically all of their capital equipment out of service income and they were unable to meet their obligations after the "boom" subsided and service revenue fell off.

It must be pointed out, however, that hundreds of experienced radio service shop operators have become very successful TV installation and service contractors. These men possessed unusual management skill and acumen which enabled them to build sound, financially successful businesses in television service.

Capital Requirements

A television installation and service business is not just a larger radio service business. It is an entirely new kind of a business. It has always been possible for a man who possessed both an exceptional ability to repair radios and a pleasant sales personality to

make a fair living out of a one-man radio service business. It would be possible, of course, for a good TV technician to operate a one-man television service shop. But it would be extremely difficult to get a fair return on his investment in the business and to take out an income for himself that would be comparable to the income his experience and abilities would provide him if he worked for a larger TV service business.

A study of successful television service businesses indicates that there is a certain minimum in personnel necessary for them to be profitable under normal conditions. The type of area in which the business is located will, of course, have an important bearing on the minimum personnel required for a successful business. This will vary from six to nine people in addition to the owner of the business.

These studies indicate that the capital requirement for a minimum-sized television installation and service business is about ten thousand dollars. This amount of capital would provide for the investment of $6500 in equipment, supplies, tools, etc., and allow $3500 as operating capital. More would be desirable.

The investment in equipment would include: Office furniture and mechanical equipment, $500; Shop furniture and tools, $1000; Shop test equipment, $1000; Technicians' equipment (for 4 men) $400; Installation equipment (for 1 truck) $200; truck and automobile (technicians use their own autos) $3400.

It should also be pointed out that u.h.f. television will probably demand a larger investment in shop test equipment for the efficient servicing of u.h.f. receivers and in particular, u.h.f. front end alignment. Since the investment mentioned is for but one test instrument position in the shop, it can readily be seen how capital requirements expand in order to handle a larger service business.

An important lesson that has been learned by TV installation and service contractors is that accurate financial and accounting records are indispensable. The editors of this department have interviewed a number of TV service contractors who were able to discount their bills during the serious business slump of last summer. In every case these service businessmen attributed their good financial positions to the fact that they followed the advice of the accountants and drastically curtailed purchasing and expenses while business was still good last Spring. The accountants' advice was based upon a knowledge of trends as indicated by accurate accounting reports.

NATESA Annual Convention

The National Alliance of Television and Electronic Service Associations held its first annual convention at the Conrad Hilton Hotel in Chicago recently. Organized about a year ago in Washington, D. C., NATESA now numbers sixteen member associations.

Associations which affiliated with NATESA during the convention included the following: Associated Radio & Television Service Dealers of Columbus, Ohio, represented by J. P. Graham; Television Service Engineers, Inc., of Kansas City, Mo., represented by Wade Williams, president, J. B. McDowell, secretary, Ray Crawford, treasurer, and members Donald Day, M. Thomason, Mac Metoyer, and Walter Niswonger; California TV Service Dealers Association, Inc., of Hollywood, Cal., represented by Joseph M. Robin, general manager; Certified Television Electronics Association of Baltimore, Md., represented by Selman M. Kremer, vice-president; Radio Service Dealers Association of Kansas, Inc., of Wichita, Kas., represented by Bill Nichols, chairman of the board, Ted Combs, president of the Wichita Chapter, and W. A. Rosenberg, executive state secretary; and the Radio Television Service Association of Minneapolis, Minn., represented by John W. Hemack.

In selecting their officers for the coming year, the Associations' delegates re-elected Frank J. Moch, president, James O. Hustad, secretary, and Bertram L. Lewis, treasurer. Regional officers elected included the following: Russell J. Cummings, eastern vice-president; Milton Klarsfield, eastern secretary; Joe McMillian, central vice-president; J. B. McDowell, central secretary, and Joseph M. Robin, western vice-president.

The following were selected by their own associations to serve as directors of NATESA: Arthur Rhine, New York, N. Y.; Joseph Lauinger, Brooklyn, N. Y.; Walter Ferry, East Orange, N. J.; J. Palmer Murphy, Paterson, N. J.; Don Kresge, Baltimore, Md.; William Nichols, Wichita, Kan.; John W. Hemack, Minneapolis, Minn.; J. P. Graham, Columbus, Ohio.

National headquarters for the National Alliance of Television and Electronic Service Associations is in Chicago, Ill. Information concerning its program may be obtained by writing to Frank J. Moch, President, NATESA, 5908 Troy Street, Chicago 29, Ill.

Progress of Philadelphia Committee

The Joint Electronics and Radio Committee on Service in Philadelphia —better known as the JERCS Committee—recently announced the formation of the sub-committee that is to study and recommend a technical educational program that will fulfill the requirements outlined by the sub-committee comprised of members of the Philadelphia radio and television service associations.

In its report, the service sub-committee made the following recommendation: "Prepare and make generally available a technical education program for the service industry, without regard to brand names, seeking only that all technicians, contractors, and servicing dealers have every opportunity to keep abreast of the new tech-

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Telegram, October 2, 1951, from Chief Engineer, Broadcast Station, Wyoming. "Please send latest list available first class operators. Have November 10th opening for two combo men."

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Edwin P. Healy, 264 E. 3rd St., London, Ky.

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Walter Koschik, 1442 Ridge Ave., N. Braddock, Pa.

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

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nical developments and employers are adequately supplied with trained personnel."

Members of the Technical Education Advisory Panel include the following: Bernard Bycer, of *Perfect TV Service;* J. C. Campbell, of *Edmar Communications;* Gene Castroville, of *Raymond Rosen & Co.;* Alvin H. Fisher, of *Motorola-Philadelphia;* Edwin T. Stark, of *Fairhill Products;* Herbert Carson, of *ABC Appliance Co.;* Sol Cutler, of *Sentinel Laboratories;* George Rincoe, of *Emerson Radio of Penna.;* Joseph Whalen, of *Inter-State Television;* Harry White, of *Louis J. Smith Co.;* William C. Hart, of *Ogontz Service Co.;* T. W. Hopson, of *Don Havens TV Service;* Thomas Jones, of *Bergdoll's, Inc.;* Joseph Margusity, of *Phillips Service;* and Albert Wilensky, of *Gevurtz-Stern Co.*

Detroit TCSA to Sponsor Program

The Television Contractors Service Association of Detroit, Michigan, has invited radio and television service groups throughout Michigan to join with them in initiating a program of industry cooperation along the lines of the JERCS plan in Philadelphia, according to J. J. Barton, President of the Detroit Association.

—30—

TV IN TURIN

By R. ZAMBRANO
Torino, Italy

WITHOUT fanfare, television transmissions have been going forward on an experimental basis at Turin, Italy during most of 1951.

The standard adopted, after the pattern set by the European C.N.T.T. Council, is 625 lines, 25 frames-per-second, interlaced, and with negative modulation. A slightly modified 6th channel was used with a video carrier frequency of 82.25 mc. and a sound carrier of 87.75 mc. The video bandwidth is 5 mc. The transmitter is a General Electric 5 kw. unit which has been installed on a hill in Turin. The superturnstile antenna is mounted atop a 240-foot steel tower which is 2000 feet above sea level.

Studios for RAI are located in Turin and are linked to the transmitter site by a u.h.f. relay operating at 2000 mc.

The photograph, Fig. 1, shows one of the pictures received on a Motorola "F" receiver. The picture was taken during an RAI transmission with a 35 mm camera, with an f 3.5 lens, at an exposure of 1/5 second. —30—

Fig. 1.

Aluminum Foil Beam

(*Continued from page* 55)

measure a little over 16 feet so that by picking out the longer ones they will be long enough for the driven element and the reflector. If they cannot be bought they may be made out of good 2 x 2 pine stock, rounding the corners with a draw knife and finishing up with a plane. Square elements might work just as well although this was not tried. There was very little sag in the elements as shown in the photograph.

After determining the exact spacing the poles may be nailed to the edge of the 1 x 4 supports. As an additional precaution they should also be tied to the supports with a piece of strong wire. Cross bracing between the 1 x 4 supports would give more rigidity to the structure but didn't seem to be needed in the writer's case. The braces, if used, should be 2½ feet apart.

There was some concern at first whether this type of construction would stand up in a strong wind but it has weathered one severe storm and came through without a mishap.

The 1 x 4 supports were nailed to a piece of 1 x 6, 2½ feet long, using 20 penny nails. Another piece of 1 x 6 the same length was beveled on the ends and nailed to the first piece at a 90 degree angle as shown in the diagram.

A piece of ¾ inch pipe was fastened to the beveled 1 x 6 by drilling holes in the pipe and running ¼ inch bolts through them. The end of the pipe fits in a hole in the top piece of 1 x 6. A metal brace made of ½ inch strap iron held the two pieces of 1 x 6 rigidly at right angles. In this way the pipe was very rigidly secured to the beam. All of the wood was painted with wood filler to make it waterproof.

A "T" match was made of the same pole material and covered with aluminum foil. It was about 2 feet long and lay between the 1 x 4 supports. Soft aluminum straps about 1½ inches wide were made to connect it to the driven element and keep the units about two inches apart. These straps may be moved to give a better impedance match and reduce the standing wave ratio. Two other straps of the same material were fastened near the center of the "T" match and spring type binding posts were mounted on them for connecting to the 300 ohm line.

Any of the conventional systems for supporting and turning the beam may, of course, be used. I happened to have a chimney that was no longer in use so the pipe was run down through the inside of it and turned in the fireplace. Sometimes the simplest method is to run the pipe through the roof of the shack.

With the present day scarcity of aluminum this aluminum foil beam may be able to solve your problem as it did mine, and if the XYL has a couple of rolls on hand in the kitchen and no ducks to bake you will not even need to make a trip to the dime store. —30—

What's New in Radio

(*Continued from page 88*)

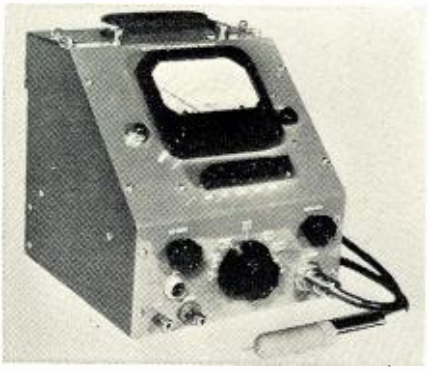
special plate stabilizing process and because the individual cells are matched to give uniformity within and between units. Tradenamed "Minisel," the new units are manufactured in all standard configurations, *i.e.*, half-wave, center-tap, doubler, three-quarter bridge, and bridge. The individual cells are rated at 10 volts a.c. input and 5 ma. d.c. output but can be obtained with input ratings up to 26 volts a.c. and output current ratings up to 10 ma. d.c. for special applications.

NEW V.T.V.M.

The Electronic Measurements Company of Red Bank, New Jersey, has come out with a new vacuum tube voltmeter, the Model 161-A.

This new test instrument incorporates seven d.c. voltage ranges, six a.c. voltage ranges, resistance coverage from .1 ohm to 1000 megohms, and a single power level scale which covers from −10 db to +10 db.

The unit is housed in a metal cabinet



finished in dark grey wrinkle. It measures approximately 8½" x 8" x 8", which includes a storage compartment for accessories. The Model 161-A weighs about 8½ pounds with accessories.

SERVICE LIGHT

Columbia Wire & Supply Company of 2850 W. Irving Park Road, Chicago 18, Illinois is now marketing a new TV service light which has been especially designed with the technician's needs in mind.

The unit features a 7 watt, 110 volt bulb, a non-breakable reflector, a 6 foot cord with plug, and a rubber suction cup which holds firmly on any flat surface.

The light takes very little room inside the TV cabinet and throws the light where needed, leaving both hands free to work.

Each light comes boxed in a lightweight and durable container which can be used to carry the unit on service calls.

Additional information on this unit is available from the company.

SOLDERING GUN

Wen Products Co., 5806 Northwest Highway, Chicago 31, Illinois, has announced the availability of a new low-cost soldering gun which has been designed to meet the needs of a wide range of users.

This transformer-type soldering device heats instantly when the trigger is pressed and cools when the trigger is released. A built-in spotlight illu-

minates the work, while a long tip permits reaching spots which would otherwise be inaccessible.

The unit is said to have ample reserve power for heavy duty or intermittent work in factories, repair shops, radio and television service establishments, or in home workshops.

INDUSTRIAL VIBRATORS

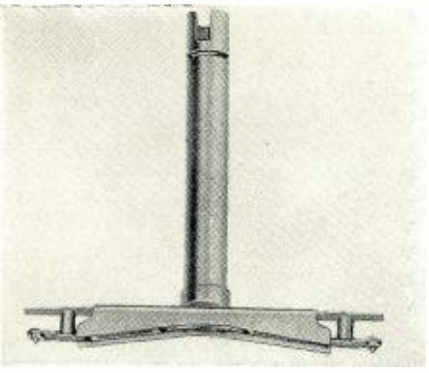
A complete new line of aircraft and industrial vibrator types has been recently introduced by the *James Vibrapowr Company* of 4036 North Rockwell Street, Chicago 18, Illinois.

The new line is said to cover most aircraft and industrial replacement requirements. These components will supplement the company's line of communications vibrators.

Specifications on these new units are given in a new supplement catalogue, Form F529. Further information and a copy of the new catalogue are obtainable from the company on request.

REVERSIBLE STYLUS

In response to the demand by record collectors, the engineers at *General Electric Company's* Syracuse laboratory have designed a dual reversible sapphire and diamond stylus to permit



the playing of all three record speeds with equal fidelity and without the necessity of changing cartridges.

Designated the Model RPJ 013, the new stylus employs the sapphire for standard and the diamond for 33⅓ and 45 rpm records. A simple twist of

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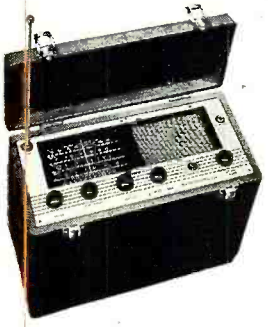

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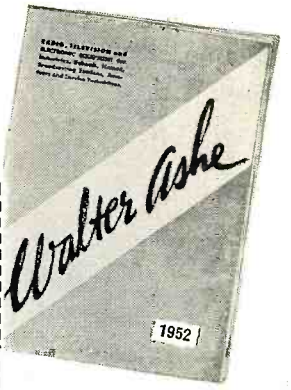

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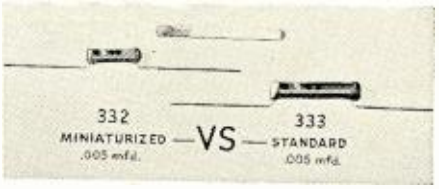
the readily-accessible positioning knob will place either the diamond or sapphire in playing position without moving the cartridge or arm.

The new unit is designed to be used with the *G-E* RPX 047 and RPX 050 variable reluctance cartridges. No weight adjustment or compensation is needed and the tracking pressure is constant at from six to eight grams.

MINIATURE CONDENSERS

Erie Resistor Corporation of Erie, Pennsylvania, has introduced a new



line of miniaturized ceramic condensers which have been tradenamed "GP3 ceramicons."

These units employ a high dielectric constant ceramic material which permits capacitance values as high as .002 μfd. on a basic ⅛" x ⅜" long tube and .005 μfd. on a ⅛" x ⅝" long tube. Baked enamel, clear lacquer, dipped phenolic insulation, or low-loss molded phenolic insulation are available.

A data sheet giving complete information on these units may be obtained from the company.

R.F. ATTENUATOR

A new r.f. attenuator which is suitable for use by radio and television engineers, technicians, and service personnel has been introduced by *Jerrold Electronics Corporation,* 26th and Dickinson Streets, Philadelphia 46, Pa.

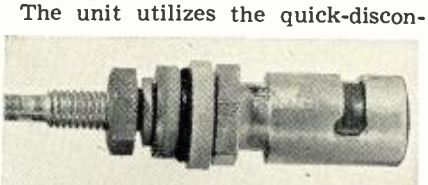
The new unit, designed for 72 ohm input and output matching over the 0-250 mc. range, provides attenuation in any value from 0 to 82 db by a simple "in" and "out" switching arrangement. The attenuator is accurate within 1% at the maximum attenuation, according to the company. The feed-through insertion loss is less than .5 db at 250 mc.

The instrument is currently available in two models, the A-72 for use with RG-59/U cable and the A-72X for use with RG-11/U cable. Both models are supplied with appropriate chassis connectors and two male cable connectors.

BINDING POST

Kings Electronics Company, Inc., 40 Marbledale Road, Tuckahoe, New York, is marketing a new and improved binding post, the Model K952.

The unit utilizes the quick-disconnect principle with spring loaded action and stainless steel locking jaws. "Teflon" insulation throughout provides low dielectric loss, no moisture absorbance, no carbon tracking, and



the maintenance of mechanical properties in the binding post temperature application range of 67 to 149 degrees F.

Complete moisture sealing is effected on the chassis itself by a special "Teflon" and rubber combination. Color coded removable rubber caps can be provided for identification and personnel protection. The unit is silver plated to the base, which is a chessman type for easy soldering.

R.F. PROBE

Precise Development Corporation, Oceanside, Long Island, New York, is now offering a new low-cost r.f. probe to the trade.

The Model 912 incorporates a time-tested circuit which is housed in a specially constructed, non-porous case and uses a germanium crystal rectifier for measurements through 250 mc. The probe handle is terminated in an *Am-*

phenol connector while the other end of the RG-59/U shielded cable may be ordered with an *Amphenol,* phone plug, or phone tip type of fitting.

Complete information on this new probe is available from the company direct.

TRAINING AID

Of interest to schools and organizations concerned with radio-electronic instruction is the new electronic visual training aid recently introduced by the *United Radio-Television Institute,* 237 Washington Street, Newark 2, New Jersey.

Known as the Model 101, the unit features a 17 x 22 inch display board on which a completely operating receiver is wired in such a way as to provide easy measurement of voltages, tracing of circuits, etc. It also incorporates a basic signal generator, condenser checker, test speaker, etc. to aid in the repair and troubleshooting of defective radio receivers.

The unit is available in kit form and comes complete with an illustrated instruction manual and a cable containing most connecting wires — color coded for easy assembly. The training aid is also available factory-wired at additional cost.

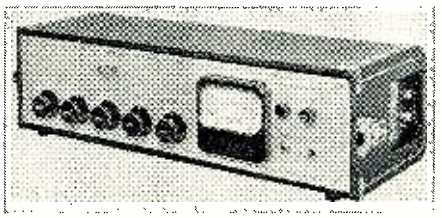
PORTABLE MIXER

Developed to meet the need for a quality broadcast mixer for field use in AM, FM, and TV remote pickup, the new Model 220A portable mixer just released by *Altec Lansing Corporation,* 9356 Santa Monica Boulevard, Beverly Hills, California, is also suitable for use with public address systems.

Designed for high fidelity mixing,

this compact unit incorporates two 1410A dual preamplifiers with individual volume controls for four microphone inputs, a 1440A line amplifier, a master volume control, a 30A power supply, and a large 4" vu meter.

It can be operated from a.c. power or external battery supply. Available in-



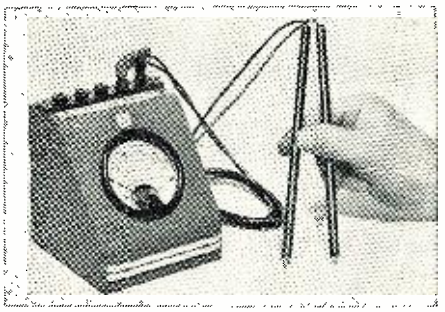
put impedances are 30, 150/250, or 500/600 ohms, and a selection of output impedances of either 125 or 600 ohms is provided through a selector switch. The gain of the system is 80 db, with a maximum output level of +18 dbm at less than 1% harmonic distortion.

The mixer is housed in a black luggage-type case which measures approximately 23" long, 6" wide, and 12" high and weighs 27 pounds.

TEST LEADS

Insuline Corporation of America, 3602 35th Avenue, Long Island City 1, New York, is in production on a new set of extra long-handled test leads which have been especially designed to speed up and simplify circuit probing in complicated radio and television chassis.

Eight inches long and made of polished hard rubber, the handles are fitted with short, sharp-pointed tips which minimize the possibility of short-circuiting adjacent connections. The flexible leads are of kinkless wire 48



inches long, have standard phone tips, and can be used with practically all types of test instruments.

Distribution of these leads, Catalogue Number 329, is being handled by regular jobbers.

PORTABLE TAPE RECORDER

Full-scale production is underway at *Amplifier Corp. of America*, 398 Broadway, New York 13, New York, on the company's new "Magnemite" battery-operated portable tape recorder-playback unit.

Weighing only 9¾ pounds and measuring 11½ x 8½ x 5½ inches, the new unit incorporates a high gain amplifier which requires no preliminary warm-up and will pick up a normal speaking voice 100 feet from the microphone.

The recorder operates from self-con-

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1B3GT		.95	6AG7		1.15	6K5GT		.87	7B5		.65	12F5GT		65c
1B5			6AH6		1.40	6K6GT		.59	7B6		.65	12H6		
1C7G		29c	6AK5			6K7GT		.79	7B7		.65	12J5GT		.54
1E7			6AK6		.87	6K8GT		.87	7B8		.65	12K7GT		.79
1H6			6AL5			6L5G		.95	7C4		1.15	12Q7GT		.65
1H5GT		.65	6AQ5		72c	6L7		.87	7C5			12S87GT		.95
1H6G		1.15	6AQ6		.65	6N6G		1.40	7C6		65c	12SA7GT		.72
1J5GT		.95	6AR5		.59	6N7GT			7C7			12SC7		.79
1L4		.29	6AT6		.54	6P5GT		87c	7E6		.79	12SF5GT		
1LA4			6AS5		.72	6Q7GT			7E7		.95	12SF7		72c
1LA6		95c	6AU5GT		.95	6R7GT			7F7		.79	12SH7GT		.79
1LC5			6AU6			6S4			7F8		1.15	16SJ7GT		.65
1LC6			6AV6		59c	6S7GT			7G7		.95	12SK7GT		.72
1LD5		.95	6B4G			6S8GT		1.15	7H7		.95	12SL7GT		.87
1LE3		.95	6B5			6SA7GT			7J7			12SN7GT		.79
1LH4		.95	6B6G		.79	6SC7			7K7		72c	12SQ7		.54
1LN5		.95	6B8GT		1.15	6SD7GT			7L7		1.04	12SQ7GT		.59
1N5GT		.72	6BA6		.65	6SF5			7N7		.59	12SR7GT		.79
1P5GT		95c	6BA7		.87	6SF5GT			7Q7		.65	12Z3		.95
1Q5GT			6BC5		.72	6SF7			7R7		.72	14A7		.79
1R5			6BC7		.79	6SH7GT			7S7		.79	14AF7		.87
1S5		72c	6BD5GT		1.15	6SJ7			7V7			14B6		79c
1T4			6BE6		.65	6SJ7GT		65c	7W7		95c	14B8		
1U4			6BF5		.79	6SK7GT			7X6		.79	14C5		.95
1U5		.65	6BF6		.59	6SL7GT			7X7		.95	14C7		.87
1X2A		.95	6BG6G		1.73	6SN7GT			7Y4			14F7		.79
2A3		1.15	6BH6			6SQ7		.54	7Z4		65c	14F8		1.15
2A5		.79	6BJ6		72c	6SQ7GT		.59	12A7			19BG6G		2.15
3LF4		.95	6BN6			6SR7GT		.65	12A8		1.15	19T8		1.04
3Q4		.79	6BQ6		1.15	6SS7		.72	12AH7		.79	20		1.40
3Q5GT		.87	6BQ7			6T7G			12AT6		.95	24A		.79
3S4			6C4		1.58	6T8		1.15	12AT7		.54	25AC5GT		1.04
3V4		72c	6C5GT			6U5			12AU6		1.04	25BQ6GT		1.15
5T4			6C6		59c	6U6GT			12AU7		.72	25L6GT		.59
5U4G		1.40	6C8G			6U7G		.79	12AV6		.65	25W4GT		.72
5V4G		.59	6CB6		1.15	6V6GT		79c	12AV7		.54	25X5		1.04
5W4		.87	6CD6G		.72	6W4GT			12AW6		1.15	25Z6GT		.79
5W4GT		59c	6D6		1.69	6X4			12AX7		.95	32L7GT		1.15
5X4G			6D8G		.79	6X5GT		54c	12BA6		.87	35A5		.59
5Y3GT		.65	6E5		1.15	6Y6G			12BA7		.65	35B5		.65
5Y4G		.45	6F5GT		.79	7A4		.87			.87	35C5		72c
5X4G		.54	6F6GT		59c	7A5		.72				35L6		.59
5Z3		65c	6F8G		1.15			.79				35W4		.45
6A3		1.15	6G6G		.95							35Y4		59c
6A8GT		.79	6H6		.59							35Z3		
6AB5		.95	6H6GT		.65							35Z4		54c
												35Z5		
												35Z6G		.95
												35/51		.79
												41		72c
												42		
												43		
												45		
												45Z5		.59
												46		1.04
												47		.79
												50A5		
												50B5		72c
												50C5		1.04
												50C6G		.59
												50L6		1.40
												70L7		.79
												50X6		.59
												50Y6		.72
												50Y7		.87
												71A		72c
												75		
												77		
												78		.45
												80		.79
												85		1.40
												117L7		
												117N7		
												117P7		.54
												117Z3		.87
												117Z6		1.95
												807		9.95
												813		29c
												1294		
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tained dry batteries which last 100 hours without replacement at an operating cost of less than 2½ cents an hour. At a tape speed of 1⅞ inches per second with a frequency response to 3000 cycles, two full hours of re-

cording time can be accommodated on a single 5 inch reel of standard ¼ inch sound recording tape.

Playback is accomplished through crystal earphones. An external power amplifier and speaker may also be connected to the output terminal. An auxiliary playback unit, complete with amplifier and speaker, is available separately.

TEST INSTRUMENT

Electronic Measurements Corp., 280 Lafayette St., New York 12, New York, has added a new test unit to its line of such instruments.

The Model 106 vacuum tube voltmeter is specially designed for field alignment of radio and television sets. It is completely electronic on all functions and ranges and has five a.c.-d.c. and ohms ranges. Featuring a 1½ volt range for both a.c.-d.c. volts, this instrument is housed in a molded bakelite case that measures 7¼ x 5¼ x 2⅞ inches, which weighs three pounds.

FM RECEIVERS

The Hallicrafters Company, Fifth and Kostner Avenues, Chicago 24, Illinois, has recently introduced two new civic patrol FM receivers, the Models S-81 and S-82.

Designed to cover police, fire, bus, truck, private telephone, forestry, and

other industrial bands operating either in the 30 to 50 mc. or the 152 to 173 mc. range, the new sets use a selenium rectifier and six tubes in a superheterodyne circuit. Both units can be operated either from 105 to 125 volt d.c.

or 50-60 cycle a.c. The dial is calibrated in frequency and type of service.

The S-81 operates in the 152 to 173 mc. range while the S-82 covers the 30 to 50 mc. band. —30—

Square-Wave Generator
(*Continued from page 48*)

somewhat unexpectedly if the wiring is carelessly arranged to include feedback loops between grid and plate, screen and plate, or grid and screen. This parasitic oscillation will be evidenced by a general instability of operation, and the tube output signal may change drastically, for example, if any of the tube socket terminals are touched by hand. Small resistors placed in series with the grid, screen, or plate circuits are generally sufficient to prevent such parasitics. The theory is simply that oscillation can occur only if the tube presents a negative resistance to its circuit as a result of regenerative feedback; the insertion of a positive resistance in series with the input circuit will cancel this effect. It should be borne in mind that this feedback may occur in the v.h.f. or u.h.f. region, where a small loop of wire together with tube interelectrode capacitances may constitute an *LC* tank circuit of an oscillator.

Power Supply

The arrangement of tube circuits with respect to the power supply is perhaps somewhat unconventional. It was desired to operate all of the tubes at low voltage—on the order of 150 volts—in order to diminish the heat dissipation in the unit and to minimize the size requirements of the components. This consideration, together with the requirement of d.c. coupling between stages, led to a series arrangement of tubes across the power supply. The "B" supply furnishes approximately 325 volts at 55 ma. The two 6AG7's, in series with the supply, provide 175 volts drop to the regulated 150 volt portion of the supply, which operates the remainder of the tubes. A d.c. current flows through the 6AG7's, since each carries full current half the time. It will also be noted that the push-pull arrangement is used in all circuits of the generator, which prevents modulation of any part of the power supply by the square-wave.

The positive output terminal of the power supply is grounded in preference to the conventional "B—" connection, since the generator output is taken from the 6AG7 plates and it was desired to avoid the use of large blocking condensers to keep hot "B+" off the output terminals. It will also be seen that the 6.3 volt heater winding of the power transformer is returned through its center-tap to a voltage divider across the 0A2 regulator tube. The purpose of this connection is to set the d.c. heater-to-cathode voltage on all tubes to less than 90 volts, which is the maximum rating specified in the tube handbook. —30—

Crystal Diodes

(*Continued from page 64*)

over-all detection efficiency. The circuit in Fig. 5B has been carefully designed to provide a bandwidth of not less than 4.0 mc. The component values have been chosen to work into an effective load capacitance of about 11 $\mu\mu$fd. The 9 to 10 $\mu\mu$fd. condenser should be a low tolerance component, or the tolerance should be on the low side rather than the high side so that the capacitance does not exceed 10 $\mu\mu$fd.; the additional 1 or 2 $\mu\mu$fd. is the shunt capacitance of the germanium crystal.

In this circuit the detector polarity is such that the demodulated video signal at the grid of the video amplifier is sync negative. There are good reasons for recommending this type circuit:

1. There is some noise limiting in the video amplifier by virtue of driving the tube to cut-off on the noise peaks.
2. The use of a d.c. coupled video amplifier between the detector and the picture tube preserves the d.c. component and eliminates the necessity for d.c. restoration. It is better to retain the d.c. than to block it with a condenser and then attempt to restore it.
3. This circuit presents a high quality picture with receiver simplification.
4. The use of the 1N60 provides improved response in the direction of white, better background illumination levels, excellent highlight detail, and improvement in the over-all gamma of the video system.

Fig. 7 shows static characteristics for the 6AL5, 1N34, and the 1N64 over a small voltage range near the origin of the curves. The following aspects of this graph are noteworthy:

1. The linear portion of the crystal curves extends to considerably lower voltage signal levels than the 6AL5 is able to achieve.
2. This improvement in linearity at low signal levels has the over-all effect of improving highlight detail.
3. The better the linearity the more

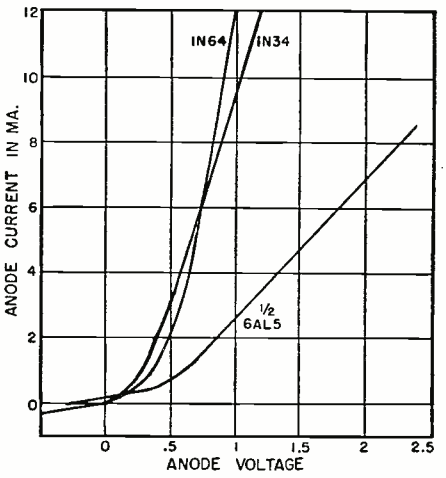


Fig. 7. Static diode characteristics graph. Note that the curve for the 1N34 and the one for the 1N64 go through the zero point for voltage and current on the graph and that the 6AL5 draws some current at the point of zero volts applied potential.

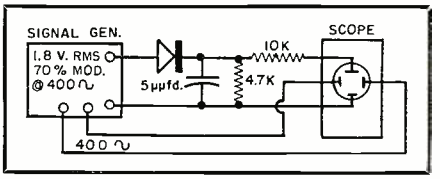


Fig. 8. Sylvania's test circuit for the 1N60.

reduction of amplitude compression in the direction of a white signal.

4. For small value signals, rectification efficiency of crystals is better with low values of load resistance than with any comparable 6AL5; it is possible to use higher load resistances with the crystal without sacrificing any element of picture quality.

Circuit Applications of the 1N64

General Electric has developed a special second detector diode, the 1N64. This was designed specifically for use as a second detector in television receivers. The physical characteristics of this diode are identical to those of the general purpose types. It is pri-

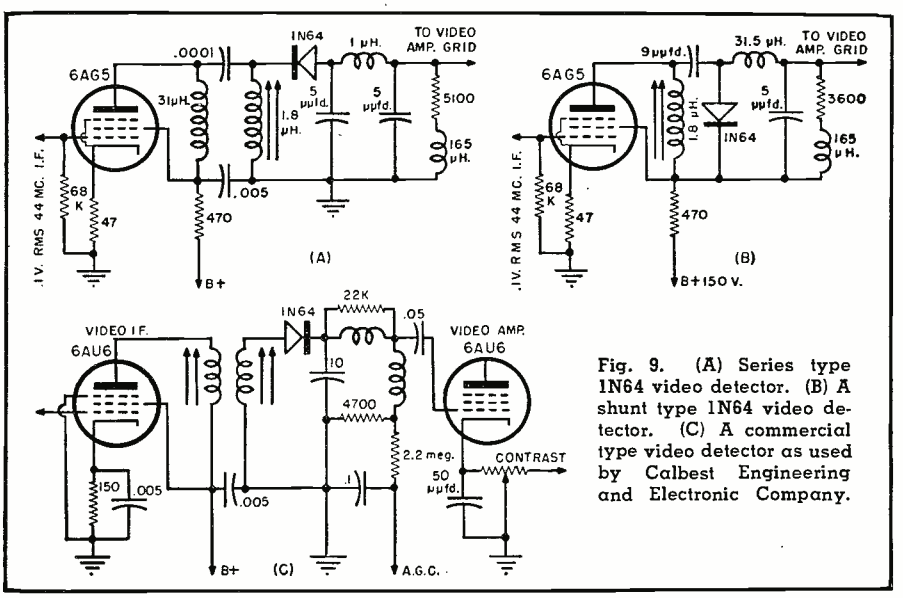
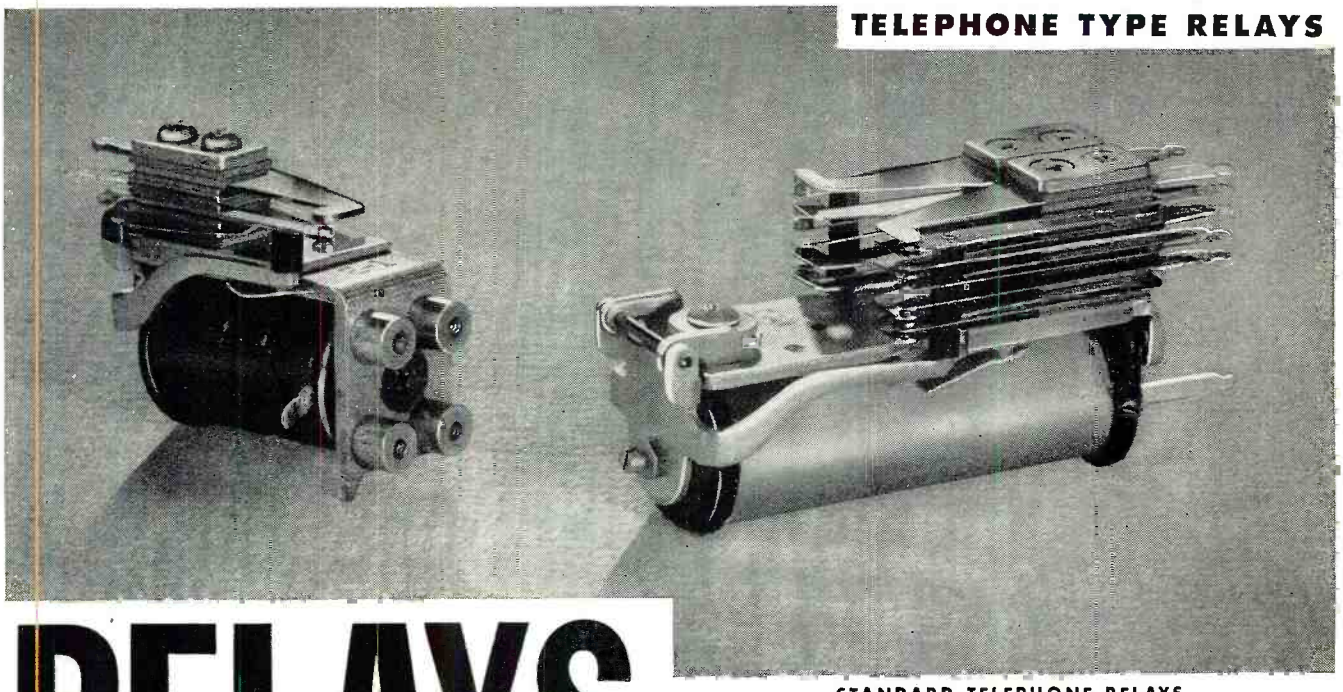


Fig. 9. (A) Series type 1N64 video detector. (B) A shunt type 1N64 video detector. (C) A commercial type video detector as used by Calbest Engineering and Electronic Company.



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R-343	12 VDC	100	1C	2.00
R-826	12 VDC	150	2C, 1B	1.55
R-770	24 VDC	150	1A/10 Amps	1.45
R-368	8/12 VDC	200	1B	1.40
R-771	24 VDC	200	1A/10 Amps	1.45
R-603	18/24 VDC	400	2A	1.55
R-575	24 VDC	500	2C	2.40
R-764	48 VDC	1000	1C&2A	2.00
R-417	5.5 ma	5800	2C	2.50
R-563	60/120 VDC	7500	1A	2/3.10
R-213	5/8 VAC 60 Cy.	.....	2A	2.50
R-801	115 VAC		NONE	1.45
R-589	12 VDC	125	2A	1.30
R-113	12 VDC	150	4A	1.55
R-689	12/24 VDC	255	1C	1.55
R-799	24 VDC	500	NONE	1.00
R-115	24 VDC	500	1C	1.70
R-110	24/32 VDC	3500	1C	2/3.45
R-121	150 VDC	5000	2A&1C	2.05
R-122	150 VDC	5000	2C/Octal Base	2.50
R-634	150/250 VDC	6000	1A&1B	2.45
R-569	8/12 VDC	150	2A, 2B	1.60
R-508	6 VDC	15	4A @ 4 Amps	1.50
R-800	12 VDC	150	2C&1A	1.55
R-537	12/24 VDC	150	2C&1B	2.00
R-750	24 VDC	400	1A	1.60
R-567	10/16 VDC	195	2C	2.50
R-335	20/30 VDC	700	2A, 1C	2.00
R-366	30/120 VDC	4850	1C	2.50

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R-873	6 VDC	12	3C-3A MICALEX	3.00
R-305	12 VDC	50	2A Split Cerm.	1.35
R-360	24 VDC	200	1C	1.50
R-484	24 VDC	200	2A, 1C	1.35
R-337	24/48 VDC	1200	1A, 2B Split	2.65
R-101	24 VDC	1300	2A	2.50
R-868	30/162 VDC	3300	1C	1.90
R-365	52/162 VDC	3300	4C	3.95
R-518	85/125 VDC	6500	1C	3.60
R-918	52/228 VDC	6500	1C	3.60
R-852	52/228 VDC	6500	1C, 1A	3.00
R-341	75/228 VDC	6500	4C @ 4 Amps	3.65
R-633	180/350 VDC	10,000	1C @ 5 Amps	2.90
R-344	72/300 VDC	11,300	3A, 1B	2.45
R-332	100/350 VDC	40,000	2A	3.50
R-664	110 VAC	..	2B&1A/OCT.SOCKET	2.45
R-667	6 VDC	.75	1B/10AMP. 1A/3AMP.	1.45
R-632	6 VDC	12	5A&1C	3.25
R-154	6/12 VDC	200	1A	1.50
R-517	12 VDC	250	2A	1.50
R-116	85 VDC	3000	1B	3.05
R-631	100/125 VDC	3300	2A	1.90
R-545	110/250 VDC	7000	1C	2.40
R-124	300 VDC	12,000	1A	1.55
R-511	24 VDC	200	W/MICRO N.O.	3.05
R-160	6 VDC	12	3C&3A	3.00
R-851	52/228 VDC	6500	1C, 1A	3.00
R-591	6 VDC	40	1B&1C	1.35
R-155	12 VDC	100	4A&4B	1.45
R-520	200/300 VDC	14,000	2C	3.45
R-159	6 VDC	50	2A	1.35
R-158	6 VDC	50	4A Cerm.	1.85
R-381	6/8 VDC	100	1A Split	2.50
R-382	6/12 VDC	200	1B Split	2.50
R-153	12 VDC	200	1C&1A	1.55
R-304	12 VDC	200	4A Split Cerm.	2.50
R-383	6/12 VDC	500	1A Split	2.50
R-385	6/12 VDC	500	1B Split	2.50
R-384	6/12 VDC	500	3A Split	3.00
R-576	12 VDC	200	2A	2.50
R-316	24 VDC	200	1C	1.50

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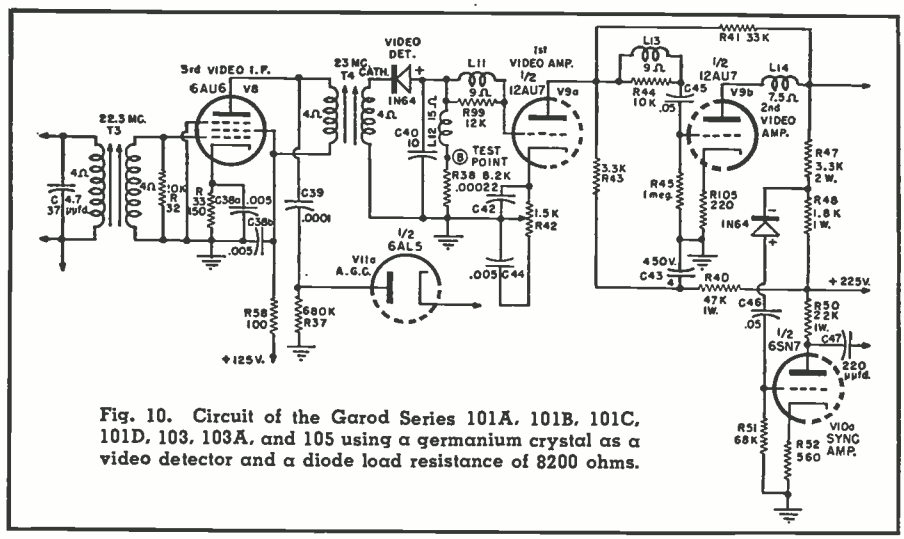

Fig. 10. Circuit of the Garod Series 101A, 101B, 101C, 101D, 103, 103A, and 105 using a germanium crystal as a video detector and a diode load resistance of 8200 ohms.

marily selected for maximum efficiency as a detector at high frequencies because only in this way can proper detection and uniformity be assured. The minimum d.c. output current in the circuit of Fig. 9B is 100 microamps, the peak inverse voltage is 20 volts, and the maximum shunt capacity is 2.0 μμfd. In addition, to assure uniformity of bandwidth, the diode is tested to have more than 50,000 ohms resistance at −1 volt and less than 4000 ohms resistance at +0.25 volt.

The schematic shown in Fig. 9B was designed to use a 1N64 germanium diode with the 44 mc. i.f., and this is the circuit used in most *G-E* model television receivers. The small size of the diode makes it possible to mount it inside the last i.f. can for maximum shielding. The 1N64 provides optimum efficiency in this shunt type detector circuit. The circuit components, 9 μμfd. condenser and the 31.5 microhenry coil, may be varied if it is desired to change the bandpass characteristic. Similarly, variations of the 5 μμfd. condenser and the 3600 ohm resistor will affect the video output as a function of the video frequencies.

Fig. 9A shows a series type detector circuit in which the low forward dynamic resistance of the 1N64 enables it

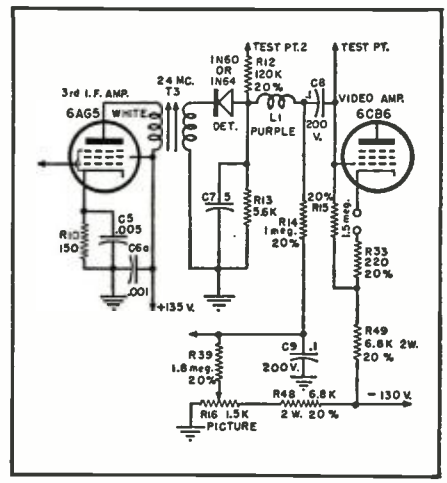

Fig. 11. The Teletone TAP-2-UL chassis.

to perform exceptionally well. Since any variation of the forward resistance of the diode will effect changes in the bandpass characteristic of the detector stage, the load resistance should be maintained relatively high with respect to the dynamic forward resistance of the diode for the purpose of minimizing variations in the bandpass. For this reason the components should be chosen with great care. Low tolerance

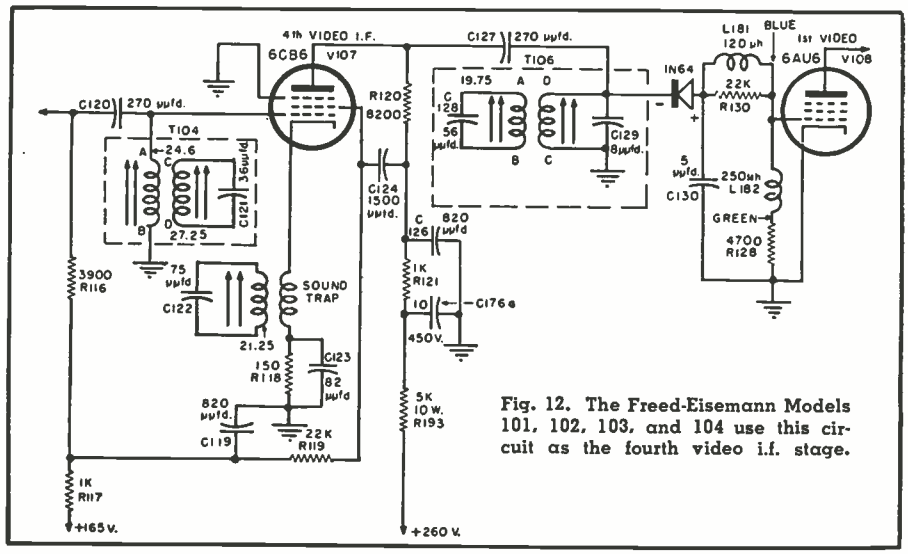

Fig. 12. The Freed-Eisemann Models 101, 102, 103, and 104 use this circuit as the fourth video i.f. stage.

values will stabilize any crystal diode detector circuit.

Because of the great interest in the use of germanium crystals as video detectors a number of commercial applications of the basic circuits discussed have been illustrated. Fig. 9C is an application of the 1N64 to a TV receiver by the *Calbest Engineering and Electronics Company*. For convenience, the associated circuitry, involving a.g.c., contrast, and a video amplifier is presented.

Teletone has been interested in TV receiver simplification because they are designing and manufacturing low price budget sets for a mass market. Fig. 11 shows a *Teletone* circuit using a crystal with an absolute minimum of associated components. The use of a resistor with a value of 5600 ohms would not be possible with a 6H6 or a 6AL5 because the bandpass would be unduly affected.

Gorod makes excellent use of a germanium crystal with a relatively high value diode load resistance of 8200 ohms. This is one of the highest values found in any of the commercial circuits available. This is also an excellent example of a video detector feeding a two-stage video amplifier with a single tube, see Fig. 10. Note also the use of the 1N64 between the second video amplifier stage and the picture tube. The 1N64 was selected for specific d.c. characteristics for this circuit; it helps eliminate hash in the sync circuit.

In the *Freed-Eisemann* circuit of Fig. 12 there is a complete schematic for the fourth picture i.f., the crystal video detector, and the first video amplifier. This is a quality circuit and it follows the standard recommendations for the choice of the component values, as indicated elsewhere in this article. While this circuit uses the 24 mc. i.f., it will work equally well with the 44 mc. i.f. and with a signal input voltage of 0.1 r.m.s.

(To be continued)

SOLDERING TO POLYSTYRENE

By OTTO WOOLLEY, WØSGG

SOLDERING to polystyrene coil forms and sockets presents a problem if damage to the unit is to be avoided. One method is to solder quickly, being careful to avoid overheating the socket or form. However this often results in an electrically poor joint.

In the case of coil forms, one thoroly satisfactory method is to use a holder for the form consisting of an inexpensive wafer type socket. Plug the coil form into the socket and the prongs extend through the bottom leaving plenty of room for soldering. Even though the form may be overheated the socket will maintain the prongs in the form in alignment and no damage will be done.

Soldering to sockets uses the same method in reverse, i.e., plugging a discarded tube into the socket. The tube prongs will not only hold the socket prongs in alignment but will also carry off excess heat that might damage the polystyrene. —30—

International Short-Wave

(*Continued from page* 69)

Buenos Aires continue to be heard well evenings (*EST*) over the 9.69 and 9.450 channels (carry separate programs in *English*). (Eccles, Minn.) LRS, 11.88, fine level 2215. (Niblack, Ind.) Serrano, Brazil, reports that SIRA now lists a *new* and at present *inactive* frequency 15.345. (ISWC, London) SIRA has reverted to individual calls; for a while was using LRA as call for all SIRA transmission; now uses LRU for 15.290; LRS, 11.880; LRA, 9.690; LRY, 9.450. (Cushen, N. Z.)

Australia—Perth, 9.610, noted with good signal around 0510-1030; Brisbane, 9.660, heard at good level 0600-0900. (Boggs, Mo.) VLI6, 6.09, Sydney, signs on 0215, at least weekdays. (Bellington, N. Y.)

Austria—Blue Danube Network, 9.617, Salzburg, noted 0400 with headline news, 0600 with newscast; sent QSL card listing s.w. channels of 6.055, 5.080, 9.617. *Radio Wien,* Vienna, noted with recordings 0150 in parallel on 7.245, 9.664; call 0200; news in German 0215, followed by orchestral music. (Pearce, England)

Azores—Ponta Delgada broadcasts daily on CSA93 at 1700-1900 using 4.845; the same program usually is repeated the following day over CSA92, 11.090, at 1500-1600 beamed to Portugal. The 4.845 broadcast is for the Azores. (*WRH Bulletin*)

Bechuanaland—ZNB, 8.242, Mafeking, heard 1200-1430 closedown by Swedes. (*Nattugglan*)

Belgian Congo—OTM, 9.38, noted with 18-note drum interval signal prior to opening 0000. (Bellington, N. Y.) This one heard afternoons to 1500 when closes with National Anthem after giving resumé (in French) of programs to be heard the following day. (Pearce, England) OTM2, 9.38, opens 1100, high level in South Africa; plays much music; in native from 1300; OTM1, 6.295, noted 1430 in French, closes 1500; OTH, 9.21, also opens now 1100 in French and Flemish and is *not* in parallel with OTM2; not certain of closing time on 9.21. (Ridgeway, South Africa)

Brazil—Radio Ministerio de Educacao, PRL4, 9.766, Rio de Janeiro, noted at fair level 1600 improves by 1615; Portuguese announcements, music. (Ridgeway, South Africa) Recife, 9.565, is heard with good level when presenting "Brazil Calling" (*English*) weekdays 2005-2030, Sundays 1725-1800. (Boggs, Mo.) PRB25, 15.135, Sao Paulo, *Radio Record,* is heard Sundays to 0100. (Cushen, N. Z.) ZYC8, 9.610, Rio de Janeiro, noted 1815 in Portuguese. (Patterson, Ga.) PRF6, 4.895.2, Manaos, *Radio Bares,* noted in language around 2000. (Russell, Calif.)

British Guiana—ZFY, 5.980, Georgetown, noted opening 0443 with music; fair level and no QRM. (Bellington, N. Y.)

British Honduras—Belize is reported by overseas sources as operating now

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0C3/VR105	1.49	3C31/C1B	3.49	249C	3.95	814	3.95	8012	3.95	WL677	34.50
0D3/VR150	1.29	3C45	19.95	250R	12.95	815	2.95	8013	2.95	WL681	22.50
1B22	3.45	3CP1	2.25	250TH	22.50	816	1.30	8014	29.95	OA2	1.55
1B23	12.50	3CP1S1	2.95	250TL	21.50	826	1.98	8020	1.29	OA4G	1.25
1B24	19.95	3DP1	4.95	274A	5.50	828	12.75	8025	5.95	OB2	1.65
1B26	3.95	3DP1A	6.95	274B	2.65	829	12.95	9001	2.25	OZ4	.75
1B27	24.50	3DP1-S2A	8.95	276A	9.95	829B	14.95	9002	2.25	O1A	.73
1B29	2.75	3D21A	1.98	293A	2.98	830B	3.25	9003	2.25	1A3	.73
1B32	14.95	3E29	5.75	304A	9.95	832	12.95	9004	.75	1A4P	1.30
1B36	24.96	3FP7	3.95	300B	9.95	832A	12.95	9005	2.95	1A5GT	.78
1B38	32.50	3GP1	4.75	304TH	14.95	833A	41.50	9006	.49	1A6	.85
1N21 Xtal	1.25	3HP7	3.95	304TL	14.95	836A	3.95	C1JA	9.95	1A7GT	.95
1N21A "	2.25	4-65A	14.21	305A	34.95	837	1.69	C6B	9.95	1AB5	.85
1N21B "	4.25	4-125A	26.95	307A/RK75	5.95	838	2.95	C6A	7.95	1B3/8016	1.25
1N22 "	1.35	4-250A	29.95	310A	8.95	841	.45	C6J	6.95	1B4	1.15
1N23 "	2.25	4AP10	4.95	316A	.65	843	.39	C100D	1.49	1B5/25S	.95
1N23A "	3.25	4B22/EL5B	9.95	323A/B	24.50	845	4.95	CK502AX	2.95	1B7GT	1.25
1N23B "	6.95	4B24/EL3C	7.95	327A/5C37	4.95	849	39.50	CK503AX	2.95	1C5GT	.85
1N26 "	5.95	4B25/6CF	8.95	328A	8.95	851	69.50	CK505AX	2.25	1C6	.73
1N27 "	1.69	4B26/2000	8.95	331A	12.95	852	29.95	CK506AX	2.25	1C7G	.73
1N34A "	1.40	4B28	4.95	350A	8.95	860	6.95	CK507AX	2.25	1D5GP	.73
1P23	3.95	4B32	9.95	350B	4.95	861	29.50	CK512AX	2.25	1D7G	.73
1P24	1.79	4C27/CV92	9.95	368AS	7.95	864	.39	CK517AX	8.45	1D8GT	.73
1P36	2.95	4C35	34.50	371A	1.49	865	1.45	CK1005	.89	1E5GT	.73
1S21	6.95	4E27/257B	17.95	371B	.98	866A	1.39	CK1006	3.25	1E7G	1.19
2AP1	11.95	5AP1	3.69	388A	2.75	866JR	1.29	E1148	.35	1F4	.77
2C21/RK33	.69	5AP4	3.69	393A	6.95	869B	45.00	EF50	.69	1F5G	.73
2C22/7193	.49	5BP1	5.95	394A	4.95	872A	2.95	F123A	8.75	1G4	.73
2C26A	.49	5BP4	5.95	417A	12.95	874	1.49	F127A	22.50	1G6GT	.73
2C34/RK34	.89	5CP1	4.95	434A	4.95	876	.59	F128A	89.50	1H4G	.89
2C39	24.50	5CP7	12.95	446A	4.95	878	2.25	F606	37.60	1H5GT	.75
2C40	12.95	5C22	55.00	446B	4.95	884	1.85	F660	79.50	1H6GT	1.05
2C43	14.95	5D21	24.50	450TH	47.50	885	1.49	FG17	3.95	1J6	.98
2C44	1.49	5FP7	3.25	450TL	47.50	905	3.59	FG27A	8.75	1L4	.73
2C46	7.50	5GP1	4.95	527	12.75	902A	10.95	FG32	7.95	1LA4	.89
2C51	6.95	5JP1	24.45	559	1.39	903	3.59	FG57	14.95	1LB3	1.15
2D21	1.79	5JP2	24.45	562	97.50	908	12.95	FG81A	3.95	1LB4	1.06
2E22	1.95	5JP4	24.45	575A	13.95	918	1.69	FG105	22.95	1LC5	.89
2E24	4.89	5J23	12.95	701A	5.95	919	2.79	FG172	34.50	1LC6	.98
2E26	3.69	5J29	12.95	702A	3.95	922	.95	FG146	8.95	1LD5	.98
2E30	2.29	5J30	49.50	703A	7.95	923	1.05	FG434A	4.95	1LE3	.85
2J21A	9.95	5J32	99.50	704A	1.05	927	1.59	FG451	.89	1LG5	.85
2J22	8.45	5LP1	15.95	705A	2.95	930	1.20	FG502A	1.85	1LH4	.89
2J26	29.50	5NP1	5.95	706BY	39.50	931A	4.95	FG562	97.50	1LN5	.95
2J27	29.50	6AS6	3.69	706CY	39.50	954	.39	FG592	14.95	1N5GT	.89
2J30	99.50	6C21	24.50	806FY	42.50	955	.45	GL502	1.85	1P5GT	.79
2J31	39.50	6F4	5.95	706GY	42.50	956	.45	HF125	14.95	1Q5GT	.73
2J32	39.50	6J4	6.95	707B	17.95	957	.45	HF300	19.95	1R4	.73
2J33	39.50	7BP7	8.95	708A	4.95	958	.45	HY114B	.79	1R5	.95
2J34	39.50	7DP4	17.95	709A	3.95	959	.69	HY115	.79	1S4	.73
2J36	97.50	9GP7	14.95	710A/8011	1.75	991/NE16	.39	HY615	.29	1S5	.85
2J37	12.75	9JP1	14.95	713	1.45	1603	5.25	KC4	37.50	1T4	.85
2J38	12.75	9LP1	19.95	714AY	6.95	1613	1.25	KU610	6.95	1T5GT	.73
2J39	39.50	9LP7	14.95	715A	7.95	1614	2.25	ML101	69.50	1U4	.89
2J40	39.50	10BP4	22.50	715B	9.75	1616	.98	REL21	3.95	1V	.72
2J46	39.50	10	.49	715C	29.95	1619	.35	RK20	9.95	1X2	1.18
2J48	29.50	12DP7	16.95	717A	1.69	1622	3.25	RK25	4.49	2A3	.95
2J49	39.50	12GP7	16.95	721A	2.59	1624	1.98	RK33	.69	2A5	.73
2J50	22.50	12HP7	16.95	722A	2.95	1625	.45	RK34	.89	2A6	.73
2J54B	39.50	12LP4	22.50	723A	14.95	1626	.45	RK48A	4.49	2A7	.75
2J55	97.50	15E	1.19	723A/B	22.50	1629	.35	RK59	1.49	2B7	.75
2J61	49.50	15R	.89	724B	3.89	1630	.98	RK60/1641	2.25	2V3G	.79
2J62	49.50	16AP4	42.50	725A	7.95	1631	1.29	RK65	24.50	2X2	.65
2K25/ 723AB	29.50	16CP4	42.50	726A	6.95	1632	.79	RK72	.59	2X2A	1.60
2K28	36.25	19T8	2.90	726B	29.50	1633	.75	RK73	.59	3A4	.65
2K29	24.50	23D4	.45	730A	30.50	1634	.75	RX21A	2.95	3A5	.90
2K33	310.00	28D7	1.35	750TL	79.50	1636	3.25	RX120	8.95	3B7/1291	.59
3AP1	12.95	30 Special	.59	800	1.95	1638	.39	V70D	6.95	3D6/1299	.59
3B22/Elic	7.95	45 Special	.39	801A	.49	1641	2.25	VR78	.59	3LF4	.95
3B23/RK22	4.85	53A	5.95	802	4.49	1644	.98	VR91	1.49	3Q4	.79
3B24	5.95	75TL	6.95	803	4.49	1654	2.39	VR92	.98	3Q5GT	.85
3B24W	7.95	100R	.89	804	9.95	1655	1.50	VT127A	3.95	3S4	.85
3B25	4.65	100TH	9.95	805	4.49	1751	1.50	VT158	14.95	3V4	.90
3B26	3.95	121A	2.98	806	29.95	1851	1.89	VU29	2.95	5R4GY	3.75
3B27	3.95	203A	8.95	807	1.98	1960	.79	VU111	1.49	5T4	1.25
3B28	8.95	204A	69.50	808	7.25	1961	4.99	WL468	12.95	5U4G	.73
3BP1	8.95	211	.69	809	2.45	2050	1.90	WL530	12.75	5V4G	1.12
3C22	64.50	212E	49.50	810	9.95	2051	1.45	WL531	12.75	5W4	.81
3C23	9.95	215A	.19	811	3.25	5670	8.95	WL532	2.95	5X4G	.89
				812	2.95	8005	5.95	WL578	1.29	5Y3GT	.63
										5Y4G	$0.73
										5Z3	.89
										5Z4	.89
										6A3	1.25
										6A4LA	1.35
										6A6	.92
										6A7	.99
										6A8	1.05
										6AB7	1.15
										6AC5GT	1.20
										6AC7	1.15
										6AD7GT	1.35
										6AE6G	.89
										6AF6G	.95
										6AG5	.89
										6AG7	1.55
										6AH6	1.40
										6AJ5	1.15
										6AK5	1.50
										6AK6	1.10
										6AL5	.82
										6AQ5	.82
										6AQ6	.87
										6AR5	.79
										6AT6	.73
										6AU5	1.25
										6AU6	.93
										6AV6	.72
										6B6G	.99
										6B7	.98
										6B8G	.85
										6BA6	.85
										6BC5	.98
										6BE6	.85
										6BF6	.79
										6BG6G	1.18
										6BH6	.97
										6BJ6	.97
										6BQ6	1.35
										6C4	.79
										6C5	.79
										6C6	.79
										6C8G	.98
										6CB6	.98
										6D6	.85
										6D8	.89
										6F5	.79
										6F6	.95
										6F7	.85
										6F8G	.95
										6G6G	1.15
										6H6	.95
										6H6GT	.79
										6J5	.75
										6J5GT	.69
										6J6	1.20
										6J7	.82
										6K6GT	.89
										6K6GT	.79
										6K7	.73
										6K8	.73
										6L5G	.87
										6L6	3.00
										6L6G	1.75
										6L6GA	1.75
										6L7	.98
										6L7G	.95
										6N7	.89
										6Q7	.95
										6R7	.85
										6S7G	.98
										6S8GT	1.05
										6SA7	.85
										6SC7	1.30
										6SD7GT	.98
										6SF5	.89
										6SF5GT	.89
										6SF7	.98
										6SG7	.98
										6SH7	.73
										6SJ7	.89
										6SK7	.89
										6SL7GT	$0.98
										6SN7GT	.98
										6SQ7	.75
										6SR7GT	.85
										6SS7	.95
										6ST7	1.10
										6SU7GTY	2.15
										6SV7	1.25
										6T7G	1.20
										6T8	1.18
										6U5G	.95
										6U6GT	.98
										6U7G	.95
										6V6	1.55
										6V6GT	.89
										6W4	.85
										6W7G	1.05
										6X4	.73
										6X5GT	.75
										6Y6G	.98
										6Y7G	1.25
										6AY3G	.89
										7A4/XXI	.79
										7A5	.89
										7A6	.85
										7A7	.85
										7A8	.89
										7AG7	1.05
										7B4	.85
										7B5	.85
										7B6	.85
										7B7	.85
										7C4	.79
										7C5	.85
										7C6	.85
										7C7	.85
										7E5	.75
										7E6	.59
										7E7	.89
										7F7	.85
										7H7	.85
										7K7	1.20
										7L7	.98
										7N7	.98
										7Q7	.83
										7R7	.95
										7S7	.98
										7V7	.95
										7W7	1.05
										7X7	1.10
										7Y4	.75
										7Z4	.85
										10A	.55
										12A6	.73
										12A7	1.05
										12A8GT	.79
										12AH7GT	1.27
										12AL5	.93
										12AT6	.73
										12AT7	1.25
										12AU6	.95
										12AU7	1.15
										12AV6	.73
										12BA6	.85
										12BE6	.87
										12C8	.79
										12F5GT	.79
										12H6	.82
										12J5GT	.55
										12J7GT	.82
										12K7GT	.79
										12K8	.89
										12Q7	.69
										12SA7GT	.93
										12SC7	.99
										12SF5	.89
										12SF7	.89
										12SG7	.79
										12SH7	.73
										12SJ7	.79
										12SK7	.98
										12SL7	$1.05
										12SN7	.98
										12SQ7	.85
										12SR7	.85
										12Z3	.85
										14A4	.98
										14A7	.95
										14B6	.95
										14F7	.95
										14F8	.95
										14H7	.95
										14J7	.95
										14S7	.95
										14Q7	.95
										14R7	.95
										19	.69
										24A	.75
										25L6GT	.85
										25Z5	.79
										25Z6GT	1.05
										26	.50
										27	.49
										28D7	1.95
										30	.45
										31	.85
										32	.95
										32L7GT	.89
										33	.93
										34	.89
										35/51	.83
										35A5	.89
										35B5	.89
										35C5	.98
										35L6GT	.85
										35W4	.69
										35Y4	.75
										35Z3	.85
										35Z4	.73
										35Z5	.69
										43Z3	.89
										43Z5	.80
										46	.82
										47	.89
										48	.98
										49	.95
										50A5	.95
										50B5	.95
										50C5	.95
										50L6GT	.85
										50Y6	.85
										53	.98
										56	.65
										57	.80
										58	.85
										59	.95
										70L7	.95
										71A	.75
										75	1.25
										76	.55
										77	.60
										78	.79
										80	.73
										82	.89
										83	1.15
										83V	1.15
										84/6Z4	.85
										85	.89
										89Y	.45
										117L7/M7	1.35
										117N7	1.35
										117P7	1.35
										117Z3	.89
										117Z6	.90

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Secret Transmission Receiver for reception of double modulated carrier. Will receive 235-258 mcs signals that have been modulated by a 600-750 KC signal. When carrier is heard on a standard receiver no modulation is heard on the carrier when actually speech is being transmitted. 12V DC input. Excellent condition.

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Lightweight Portable Search Radar for detection of aircraft, in the frequency range of 600 MCS. power input 115v 400 cyc. 1330 watts, 28V DC 400W. Complete installation. Excellent condition.

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in the 60-meter band (probably around 4.960) daily 1300-1400, 1900-2000. However, has not been found there recently by USA DX-ers. Formerly operated as ZIK2 on listed 10.600.

Bulgaria—Radio Sofia, 9.705, noted ending its *English* broadcast 2030 and asking for reports and comments. (Maurice, N. Y.) Carries own *English* programs 2000-2030, 2300-2315 on this channel and at other times during the evening (*EST*) takes relay of *Radio Moscow's* (*English*) North American beam. Measured 9.7043 at 2000 by Oskay N. J.

Noted 1500 with *English* for Europe on 6.070 and announced further *English* for same channel 1600-1630. (Pearce, England) Heard on this frequency 1645 in French news session. (Rodger, Scotland)

Canada—VED, 7.32, Edmonton, Alberta, noted daily 0100 with news. (Bellington, N. Y.) Confirmed move to this frequency. (Russell, Calif., others) CBFY, 11.704, Montreal, noted from 0700. (Ferguson, N. C.) Has religious service 0815, at least weekdays.

CBC's International Service is scheduled — *European Service* — 0905-1130, CKNC, CKCS; 1130-1330, CKNC, CKCS; 1330-1345, CKCS; 1345-1400, CKCS, CHOL; 1400-1420, CHOL; 1420-1545, CHOL, CHLR; 1545-1600, CHLR; 1600-1700, CHLR, CKRZ; 1700-1830, CKLO, CKRZ. *Australasian Service*—Sun. and Wed. *only* 0340-0450, CHOL, CKLO. *Caribbean and Latin American Service* — 1850-2240, CHOL, CKLO; *English* remains 2105-2135. *North West Territories Service* (Northern Messenger)—Sundays *only* 2315-0005 (approx.). Channels are CKNC, 17.82; CKCS, 15.32; CKCX, 15.19; CHOL, 11.72; CHLR, 9.71 (*new*); CKLO, 9.63; CKOB, 6.09; CKRZ, 6.06.

Canary Islands—Radio Clube de Tenerife, 7.518, noted on Sundays with varied recordings from 1330. (Pearce, England) Heard recently at good level 1700-1800 sign-off. (Saylor, Va.)

Cape Verde Islands—CR4AA, 5.8535 (measured by Oskay, N. J.), Praia, noted in Portuguese to closing with "A Portuguesa" at 1700; nice signal in New York. (Bellington)

Ceylon—Radio Ceylon noted in parallel on 9.52 and 11.975 at 1116; closed 1147. (Pearce, England) Also noted by Rosenauer, Calif.

The 15.120 outlet noted after 2130, fading badly by 2215 some days. (Balbi, Calif.) Carries BBC news relay 2100.

Chile—CE1174, 11.742, Santiago, noted with strong signal 2240 and announcing for "El Nuevo Mundo"; signed off 0001. CE960, 9.593, Santiago, noted 2130 to after 2230 in Spanish, mostly recordings. (Ferguson, N. C.)

China—Radio Peking heard on 10.360A at 0400-0445; has news 0400 followed 0415A by POW messages; announces 6.100, 10.260 (actually now 10.360A), 11.690, 15.060, and 15.170 in parallel; announces POW messages for all three English transmissions (has different POW's on each session) at 0400, 0830, 1700 (which would make POW schedule 0415A, 0845A, 1715A).

(Rosenauer, Calif., others) The 10.360A channel varies greatly at times; was measured recently 0625 as 10.3565 by Oskay, N. J.

When this was compiled, *Radio Peking* in its 1700-1730 *English* session was being heard widely with best signal on 10.36A (Home Service outlet) in parallel with 11.685A and 15.060A (Overseas Service outlets); the 11.685A and 15.060A channels remain in parallel to around 2130 closedown, while 10.36A carries a separate program to *after* 2200 (some say to 2400).

Colombia—HJBB, 4.815, Cucuta, is good level around 2100. (Catch, England) HJDE, 6.1455, Medellin, noted with native program 2000; HJFB, 6.2255, Manizales, heard signing off 2305. (Russell, Calif.)

Costa Rica—San Jose, 11.970V, noted 2230-2240 with Spanish commentary and Latin American music. (Lane, Wyo.)

Cuba—COBL seems to have settled down again on 9.833 where battles with Budapest evenings (*EST*). (Leary, Ind., others)

Curacao—PJC2, 5.010, noted 1825 with light QRM; had commercial in *English* 1915; QRA is "Curom," P.O. Box 31, Willemstad, Curacao. (Kroll, N. Y.) Commercials in both *English* and Spanish noted by Ferguson, N. C.

Cyprus—Limassol, 6.117A, noted with stringed instrument interval signal around 2254 prior to opening day's transmission. (Bellington, N. Y.) Heard signing on 2154 on 6.790. (Oskay, N. J.)

Czechoslovakia—Prague, 11.875, noted at nice level around 1935 when giving news; 9.550 is in parallel; both have strong signals at times. (Niblack, Ind.) Prague, 6.010, noted 0000-0030 with a program from Yugoslavia. (Krejny, Ohio)

Denmark—OZF, 9.52, Copenhagen, is good level in North American transmissions 2030-2130, 2200-2300. (Golden, Mass.)

Dutch New Guinea—D. Van Os, Program Director, Radio Omroep Nieuw Guinea, Hollandia, Dutch New Guinea, has advised Paul Dilg, Calif., that *the station would appreciate any phonograph records (presumably music) that anyone can send;* used but yet serviceable records will be welcomed. Present record library is quite limited. Hopes to have a *new* 3.5-to-5-kw. transmitter in operation soon; present output on 7.126 is 400 watts; schedule is 0430-0630 with an additional broadcast Saturdays 2100-2300. QSL cards and schedules are being printed. *Return postage is welcomed with reports.* New installations are still under construction; hopes to extend broadcasting hours when new transmitter is put on the air.

Ecuador—Hoffman, N. Y., says the big diesel motors and generators for the high-powered transmitter project of HCJB are now in Ecuador and that concrete bases for the power plant have been placed.

Officials of HCJB have informed me of recent changes made in the European Service. The two former releases for Britain in *English* have been

merged into a single period at 1600-1730 over 17.89, 15.115, 12.455; German, on these channels, has been changed to 1430 daily; French to 1500 daily; Portuguese has been added on Wed., Fri., and Sun. at 1830; this brings the total number of languages to ten.

Egypt—SUV, 9.985, Cairo, now has news 1130-1140 when closes; plays one request record each day. (Ridgeway, South Africa) SUX, 7.862, Cairo, heard with Arabic program around 1645. (Sanderson, Australia)

Several overseas sources report that The Egyptian Broadcasting Service is transmitting *test* programs from Cairo daily on 9.55 at 1345-1600; ISWC, London, says opens with the "Triumphal March" from *Aida* (Verdi), and that broadcasts in *English* and French—with news in *English* 1345 and in French 1400; announces "This is Cairo calling on an experimental short-wavelength of 9.555 megacycles" (in French as "Ici Le Cairo"). Reception reports and suggestions are requested to Egyptian Broadcasting Service, Cairo, Egypt.

El Salvador—Noted a San Salvador outlet *testing* recently on 11.95A around 1836 tune-in; played mostly Latin American music; good level but some fade and at times had bad CWQRM; call letters were given frequently by male announcer and sounded like YSAX; *new* station? (Bellington, N. Y.)

Ethiopia—Radio Addis Ababa, ETAA, 15.047, was heard on a recent Saturday until 1300 with a *special* program in native (Amharic). (Bluman, Israel) *May be used further irregularly; watch for it!*

Fiji—ISWC, London, and other overseas sources say a 500-watt transmitter will start operations from Suva some time this year.

Finland—Helsinki still has news weekdays 0715 and 2200 on 15.190, 17.800, 9.550. Heard on 6.120 with music at 1140 tune-in. (Pearce, England)

France — Paris, 5.954 (*measured*) noted in Portuguese when tuned 1640; announced in Portuguese and French 1645 and left the air. (Ferguson, N. C.) Paris heard on 9.680 with news in French 1500. (Rodger, Scotland) Heard on 15.24 signing off in French 1630; used "La Marseillaise" to close transmission. (Niblack, Ind.) Heard in Calif. on 7.24 at 0300-0315 in French; 0315-0330 in *English.* (Winch, Rosenauer) This outlet noted in Portuguese 1640 and signing off 1645. (Ferguson, N. C.)

French Equatorial Africa — Radio Brazzaville, 11.970, noted 1745 on a recent Sunday with a special (*English*) program called "Africa Today" instead of the usual *English* newscast. (Ferguson, N. C.; Rosenauer, Calif.) Noted signing off in French daily 1800 on 11.970, 9.440. (Golden, Mass.) Heard on these channels with news 0015. (Hoffman, N. Y.)

French Morocco—Radio Maroc, 6.006, Rabat, is fair from 0200 sign-on but has QRM from RIAS, 6.005, Berlin. (Saylor, Va.) Heard on this *measured* frequency in England 1800-1825 with

dance music, then short newscast in French to 1830 when closed with "La Marseillaise." (Catch)

French West Africa—Radio Dakar, 15.342, noted parallel with 11.896 at 1530 in French. (Ridgeway, South Africa)

Germany—RIAS, 6.005, Berlin, has nice signal to 0300 sign-off. (Saylor, Va.) OZF, 9.52, Copenhagen, in recent DX session said RIAS would move to another channel soon; no other details. (Bellington, N. Y.) In verifying, listed power of 20 kw., schedule as 2245-0245, 0400-2005 (Sat.-Sun. 2245-2045). (Cushen, N. Z.)

A station heard on 6.090 at 0145-0215 in European language with horn interval signal is believed to be *Radio Free Europe;* fair signal in Calif. (Balbi) Leipzig, 9.728, noted 0015 with news in German. (Sanderson, Australia)

Greece—Radio Athens noted on 7.300 (recently measured by Oskay, N. J., as 7.2985) with music around 2355 and 0000 with news. (Bellington, N. Y.) Greek Forces Station, 7.050, noted regularly afternoons (*EST*). Athens heard on 7.300 with news in *English* 1430, followed 1445 by news in French. (Pearce, England) The North American beam 2000-2100 appears to be on 7.300 now; news noted in progress 2043. (Bellington, N. Y.)

Larissa, 6.745, is good some days around 0100-0200 sign-off with Greek program. (Saylor, Va.) Edho Janina, 6.23, is still heard from *after* 0000, fair signal some days; plays all kinds of music; should sign on 0000 with Greek musical notes. (Bellington, N. Y.)

Greenland—Godthaabs Radio, 7.572, heard 1700-1845 closedown. (*Nattugglan,* Sweden) Noted by Oskay, N. J., on measured 7.5834 opening 1745.

Still heard on 7.09A to 1845 sign-off with march followed by Danish Anthem; has bad CWQRM at times. (Bellington, N. Y.)

Guatemala—TGLA, 6.29A, noted in Spanish around 1910 announcing as "La Voz de Centro America." (Bellington, N. Y.)

Haiti—4VRW at press time seemed to have settled down around 9.96. (Bellington, N. Y., others) Recently measured as 9.953 at 1745 when announced as *Radio Haiti* (in French); still good level 1934. (Ferguson, N. C.)

Honduras—HRP1, approximately 6.345, noted *testing* evenings to around 2300 or 2315; announces in both Spanish and *English* and asks for reports to Radio Station HRP1, San Pedro Sula, Honduras. (Bellington, N. Y.) This one has been noted also by de Leon, Mexico, announcing "El Eco de Honduras," and asking for reports on *test* transmissions.

Hong Kong—ZBW3, 9.525, heard with *English* from 0230 onwards; Chinese after 0500 when is weak and often with QRM. (Balbi, Calif.)

Hungary—English programs for North America are now beamed from Budapest over 6.247A, 9.833, 7.220 at 1700-1730, 1930-1950, 2330-0030. (ISWC, London)

Iceland—TFJ was recently *measured*

12.175V at 1120 on a Sunday; is scheduled Sundays *only* 1115-1145; previous measurement was 12.1798. (Oskay, N. J.)

India—AIR noted 0300 with news on 17.740, 15.190; at 0615 on 15.16 signing on in *English* on 15.16 with program for Burma (native); heard on 4.940 with news 1030, in Hindustani 1045, closing 1100, then reopening 1130 in native and running to 1330 closedown; on 3.495 at 1030 native music, at 1100 talk in *English*. VUC2, 4.880, Calcutta, noted with news 1030, off 1200; VUB2, 4.840, Bombay, at 1030 in native music; VUM2, 4.920, Madras, news 1030. The Delhi 4.940 outlet noted closing native program 1330; Arabic program near 7.123 closes 1430. Delhi noted on 5.990 (with severe QRM from *Radio Andorra*), 7.170, 7.190 in broadcast for Europe (*English*) 1400-1515. (Pearce, England) Madras has been heard on 3.490A around 0900-0930; Calcutta, 7.210, noted with news 0730. (Rosenauer, Calif.)

WRH says AIR is broadcasting Home News in *English* at 1030-1045 on Delhi channels of 3.435, 4.940, 5.970, 6.010, 9.590, 11.760, and over Bombay, 7.240; Calcutta, 4.880; Madras, 4.920, 6.085, and Mysore, 6.065.

Delhi, 11.85, noted 1930-1945 with news; 11.79 heard 2130-2145 with news. (Boggs, Mo.) The 11.85 outlet noted signing on 1830. (Russell, Calif.) I note India with news 0730 and 0830 on a frequency of 15.380; at 0730 is parallel on 17.760, 9.590.

Indo-China (Vietnam)—*"La Voix de Vietnam"* noted near 7.090 at 1759 tune-in; Eastern-type music; at 1800 call was repeated several times in French by woman followed by news in French. (Pearce, England) This channel noted in Calif. around 0400-0500 with poor to fair signal. (Winch) Has *English* news 0845-0905. (Cushen, N. Z.)

Radio France-Asie, Saigon, noted on 9.754 around 0800. (Bluman, Israel) The 11.83 channel is now heard as early as 0400. (Balbi, Calif.) Has news 0500. (Sanderson, Australia)

Radio Dalat has a daily program in Vietnamese on 7.265 with 1 kw. at 0515-0630 and a program in French is aired each Sat. 0630-0700. *Radio Hanoi* operates on 6.165, 1 kw., 1830-1930, 2300-0030, 0500-0830 in Vietnamese, French, *English,* and Chinese; news in *English* 0530-0545; news in French 1805-1820. 2345-2400, 0730-0755. (*WRH Bulletin*)

Iran—Radio Tabriz noted around 2315 in Persian or Arabic language on 6.085A; good signal but bad fade and QRM. (Bellington, N. Y.) *Nattugglan,* Sweden, says *Radio Tabriz* is scheduled 2130-2300, 0330-0600, 1030-1345; heard best in Sweden 1200-1300.

OTC, Belgian Congo, says *Radio Teheran* is now using 9.680 instead of 15.100 for news in Persian 1400; in German 1430; in French 1445; in *English* 1500, and in Russian 1515. (Robertson, Mass.)

Iraq—HNG, *measured* 11.724, Baghdad, heard 2325 in Arabic. Verification listed call of HNG for *Marconi* Type S.W.B. 10 Short-wave transmitter, 16

kw., high-level Class B modulation; aerials omni-directional; program times 2330-0100 (actually opens normally 2300), 0430-0600, and 0830-1500; Arabic and occasional European languages, music, and talks; interval signal is bird call; time signal is clock striking. (Ferguson, N. C.)

Ireland—Athlone, 17.84, noted yet with daily newscast around 1330-1345A. (Ferguson, N. C.)

Israel—Kol-Israel on 9.010 and 6.830 noted with news 1430; on 9.010 with "Voice of Zion" (*English*) program starting 1630 and closing down 1716A. (Pearce, England)

Bluman, Israel, says press reports say the *new* 50 kw. transmitter is not yet ready to go into operation but that the "Voice of Zion" hopes to have a second 7.5 kw. transmitter on the air shortly. Sent this winter schedule for Kol-Israel:

On 6.830, 1205 kc., 737 kc., 575 kc., 1330-1445 (also on 9.010); weekdays (Sun.-Thurs.) 2330-0130, 0300-0815, 0900-1605; Saturday 0030-0815, 0900-1605, and Saturday (Israel's Sunday) at 2330-0130 (Sun.), 0300-1605; *English* 0700, 1430; French 0800. Tel-Aviv II, 9.010 and 652 kc., scheduled 1130-1330, French at 1130-1215; "Voice of Zion" on 9.010 at 1445-1715 (*English* at 1630; French 1530). Forces Station (Galei-Zahal), 6.725, is scheduled 1130-1500 and is parallel on m.w. 1275 kc., 1304 kc., 1393 kc., and 1336 kc.

Italy—Rome noted again on 15.405 in broadcast (*English*) to Far East 0315; noted ending *English* 0615 recently on 11.905, followed by French for Middle East. Heard signing on 1150 in Serbo-Croat on 11.905 in parallel with 9.57; and signing on in *English* for British Isles 1350 on 6.010 (announced 11.81, 9.57 as parallel). Noted 1440 with anthem and call, followed by foreign language broadcast near 7.105; heard mornings (*EST*) on this channel also; heard in *English* 1505-1530 for South Africa on 9.630, 11.81. (Pearce, England) Rome noted on 9.575 in *English* news 1900 and 2145; transmission runs 1900-2200. (Robertson, Mass.) Heard opening 0400 on 11.905 in Italian at dictation speed. (Fargo, Ga.) Ridgeway, South Africa, reports Rome on 5.26 at 1415 in Spanish to 1445, then interval to 1500 when has further session.

Italian Somaliland—Bluman, Israel, says that a station in Italian Somaliland has been carrying out *tests* on 7.420 daily 1200-1300; programs consist of Italian light music (recordings), with news in Italian 1230.

Jamaica—Radio Jamaica, 4.950, has news 0730. (Saylor, Va.)

Japan—According to press reports from Tokyo, the Radio Corporation of Japan by this time should have resumed Overseas Service in various languages including *English*. Latest NHK schedules are JKH, 7.2575, 5 kw., 1530-0900; JKI, 4.910, 5 kw., 1530-1725; JKI-2, 9.655, 5 kw., 1725-0245; JKJ, 7.285, 5 kw., 1530-0900; JKM, 4.940, 5 kw., 1530-1715, 0310-0900; JKM-2, 9.695, 5 kw., 1725-0300; JBD, 9.505, 7.5 kw.,

1530-1905, 0255-1000; JBD-2, 5 kw., 0255-1000; JBD-3, 15.225, 7.5 kw., 1915-0245; JBD-4, 15.235, 5 kw., 2200-0245; JKI-4, 11.800; 5 kw., 1530-2145.

AFRS, Tokyo, 11.825, noted with strong signal when closing with *English* announcement 2159. (Winch, Calif.) BCOF, 6.105, Kure, noted with news 0400. (Sanderson, Australia)

Kenya Colony—Nairobi, 4.855A, noted 1320 with talk; 1330 classical records. (Pearce, England) *Measured* 4.8535 at 1500 closedown when played "God Save the King." (Catch, England)

Lebanon—Beirut, 8.026A, is heard some nights from around 2330 in Arabic. (Bellington, N. Y.) Noted 1000 opening hour's program in *English*. (Pearce, England)

Liberia—ELBC, Monrovia, is still operating on 6.023 (*measured*) daily to 1845 closedown, but now has bad QRM. (Oskay, N. J.)

Mauritius—Ridgeway, South Africa, finds that V3USE, Forest Side, has been wandering around the 19-m. band lately; at last report, Ridgeway found it on 15.100 to 1230 when closes with "God Save the King."

Mexico—XEMC-XESC sent letter verification and picture postcard views of Mexico, via airmail; listed XEMC, 1590 kc., m.w., 5 kw.; XESC, s.w., 15.205, 5 kw. Gave no schedules. (Pearce, England) Verification from XEWW, Mexico City, lists s.w. channels of 15.160 and 9.500 with 10 kw. output and XEW, m.w., on 900 kc. with 250 kw.; QRA is Cadena Radiodifusora Mexicana, S.A., Radiodifusora XEW, La Voz de La America Latina Desde Mexico, Calle Ayuntamiento 54, Apartado Postal 2516, Mexico, D.F. (Hoffman, N. Y.)

Monaco—Monte Carlo, 6.035, 9.785, now broadcasts an *English* program each Friday 1730-1800. (Radio Sweden) Bellington, N. Y., recently heard *English* religious program from Monte Carlo on a Friday evening 1803.

Noted on 9.785 in Texas to 0900 or later. (Stark)

(*Continued on page 141*)

Spot Radio News

(*Continued from page 22*)

maximum rate of change not to exceed ⅛ cycle per second, and the horizontal scanning frequency will be 2/495 times the color subcarrier frequency, which corresponds to 15,750 cps. The bandwidth assigned to the modulated color subcarrier will extend to at least 1 mc. at 6 db attenuation below the color subcarrier frequency and to at least .4 mc. at 6 db above the color subcarrier frequency. Signals outside the assigned channel, it was said, would be attenuated at least 60 db below the peak visual signal amplitude.

As in standard telecasting, sound will be frequency modulated, with a maximum deviation of ±25 kilocycles, and with preemphasis in accordance with a 75 microsecond time constant. In the main, slides are being used during the tests and color pickup will be on specially-built receivers located in the labs and, in some instances, in the homes of the engineers and management headmen involved in the tests. Of course, it will be possible to pick up the black and white images of these colored views on any standard receivers, in view of the compatible system employed. Everyone is being asked to report their findings on this portion of the test. Since the telecasts are experimental, they are being run during the morning or other off-periods when commercial broadcasting is not in progress.

CABLES FOR TELEPHONY AND TELEGRAPHY, always assumed to be a mainstay requirement, now have a mighty competitor to contend with: the very-high bands of radio.

In the Hawaiian Islands, the telephone company has found that submarine cables are very impractical since the heavy surf pounds the lines against the coral reefs and causes constant breaks. Accordingly, it has been decided to employ a radio system and the frequencies used for TV (Channels 5 and 6 or 76 to 88 mc.) and FM (channels 251-300 in the 98 to 108-megacycle bands).

In tests with the higher frequencies, normally used for this type of communications (3700, 4200, 5925-6425 and 10,700-11,700 megacycles), it was found that the long water paths between the many islands linked in the communications systems, interfered with transmission. Over water paths of 60 miles or more, signals on the higher channels were very unreliable, tests revealed.

Transmitters are expected to be located at sites about 42 to 92 miles apart.

The extensive repairs required for another cable system, connecting this country and the Far East, and the reliable services afforded by the easily-maintained radio systems, has also spelled doom for an oldtimer in the telegraph world. In this instance, the cables were laid in 1902 and 1906 and

have since broken down innumerable times. The damage in one line is so bad, company representatives have reported, that about $500,000 would have to be spent for repair. In addition, it was said, it would be necessary to purchase a new cable-repair ship to replace an antiquated vessel recently sold, which might cost over 1 million dollars. It would be wiser, the cable owners told the Commission recently, to discontinue completely the cable service and transfer operations to existing companies using radiotelephone circuits over the same routes.

It wasn't too long ago that cablemen had announced that radio circuits could never supplement or complement a wired service. Those views now appear to have become items for the pages of history, recording the progress of electronics.

IN AUSTRALIA, there is in operation a radio-communications system which has been described as one of the most unique in the world—a flying-doctor service relying on a network which links this sparsely settled land from coast to coast.

In that country, whose size is about the same as ours, there are many hundreds-of-thousands of square miles which have a population of less than two persons to the square mile. In these remote areas are sheep and cattle ranches which, in some instances, sprawl over 1000 square miles of land. The need to serve these large areas was always important, but impossible to meet, until radio came along. Today, there are eight bases at which are located transmitters, operators, and suitable aircraft with pilots and doctors. There are also outpost stations which use smaller transmitters and can contact the base posts. Through the facilities of this net, it has become possible to not only provide medical aid, but air ambulance service too, and over 1000-odd mile routes.

Describing this unusual communications setup in the *Proceedings of the Institution of Radio Engineers, Australia,* L. N. Schultz noted that the base transmitters use powers of from 20 to 300 watts, depending on the area to be served. In one instance, there are two 300-watt transmitters, operating on the 2, 4, or 6-megacycle bands. It is possible to adjust these transmitters so that they can operate simultaneously on a pair of frequencies modulated by one operator, or alternatively, the transmitters can operate on separate frequencies modulated by different ops. Pedal-driven generator power transceivers are used at the outpost stations, which have a power of about 3 watts. Many models use vibrators. All have three fixed crystal-controlled transmitting and receiving frequencies. Also provided is a variable tuning range to cover high-frequency bands. At the station, which uses a trio of frequencies on high power, horizontal doublets are used in the antenna system, arranged to be a quarter wavelength in height above ground.

According to Schultz, there are 600 outpost stations which are from 50 to 600 miles from the base posts. All are tied into a net which provides a continuing, reliable medical-aid service.

THE MORAL POWER OF TV which has been of deep concern to those in Congress, in government bureaus, and in industry, too, has rallied many to discuss its effect on our present and future living patterns.

During a dinner, tendered to Dr. Allen B. Du Mont recently, celebrating the pioneer's twentieth year in television, the important subject was sharply analyzed. The picture-tube specialist declared that TV has already affected the political fortunes of many. "Already the politicians, high and low . . . are wondering what television is going to do to them or for them next year," he declared.

Noting that the roving eye of the camera could distinguish the demagogue from the statesman, the eminent tube man declared that the politicians are planning to avoid or make use of this unerring ability.

Looking into the future, Dr. Du Mont said: "I cannot help but wonder what is in store for us next year and in succeeding years when the honesty of television is put to work in earnest, in the cause of good, clean, honest government. . . . It is conceivable . . . that in the working of that accomplishment, television at its efficient best could fill the halls of Congress with statesmen, and our state and local offices with men whose greatest desire is to serve the public interest and welfare by means of the application of honesty and sincerity. . . . If that dream could become a reality, television could move forward, unhampered, for fulfillment of its destiny in the full and complete service of mankind."

The dynamic code adopted by the broadcasters has also provoked discourse on the moral force of television. Commenting on the new code, during a meeting of the American Television Society, James L. Caddigan, director of programming and production of the *Du Mont* TV net, said that these standards represent . . . "television's declaration of independence . . . a declaration that points up the fact that the television industry is completely capable of handling its responsibilities to the community, the television audience."

IN '52, the famous Olympic games will be held, this time in Helsinki, Finland. And as in '48, broadcasting will play quite a role in covering this international event.

According to present plans, disclosed in the *EBU* bulletin, permanent trunk programs will be established between Helsinki and other areas in Western and Central Europe, and these will be extended as required from their distant terminals by cable or radiotelephone. In the trunk link the following cities will be connected: Stockholm, Oslo, Copenhagen, Berlin, Frankfurt, Co-

logne, Hilversum, Brussels, and Hamburg.

As in previous years, a broadcast center will be provided to coordinate the technical arrangements for all broadcasts, particularly those required by observers from other lands. This center will be located beneath one of the grandstands at the stadium, and will contain the control rooms, recording booths, studios, switching panels, results-announcement units, and maintenance facilities. A magnetic-tape recorder will be used exclusively.

A staff of about 250 is expected to be provided, many of which will be assigned to technical matters. A number of interpreters will also be on hand. No arrangements have as yet been made for television coverage. The possibilities of microwave circuits have been discussed and telecasts may be made through such facilities to receivers in Germany, France, and elsewhere. Undoubtedly there will be pools for TV film coverage and eventual distribution to our TV nets via a transoceanic plane-ferrying service.

RADIO'S FIVE DECADES of progress were celebrated, as '51 came to a close, with scores of unique programs in Washington and New York. In the nation's capital, the FCC issued a review which noted that the first radio signal was flashed across the Atlantic on December 12, 1901 by Marconi. Today, FCC said, there are 700,000 authorizations to individuals to operate transmitting equipment . . . quite a record of progress.

Commenting on the new era of TV, the Commission said that it is looking toward . . . "resolving the remaining problems which will permit removal of the freeze and blueprint operation of a nation-wide TV service for years to come." A bright promise for the years to come! . . . . . L.W.

POSITIONS OPEN

THE Signal Corps has announced that there is an urgent need for electronic equipment installer-repairmen for duty in the Army Communication Center at the Pentagon in Washington, D. C.

These Civil Service positions, paying from $1.47 to $2.27 an hour, require rotating shift duty.

No written test is required. Applicants are rated on the basis of their training and experience, as described in their applications. A certain amount of credit is allowed for advanced amateur radio operation.

Persons interested in these positions should file Application Form 57, Supplemental Experience Form CSC-206, and Card Form 5001 ABC with the Executive Secretary, Board of U. S. Civil Service Examiners, Military District of Washington, Room 2E-1030, Concourse, The Pentagon, Washington 25, D. C.

Complete information may be obtained from the Executive Secretary of the Board of Civil Service Examiners at the address given above or from the U. S. Civil Service Commission, Washington 25, D. C.

—30—

A TAPE RECORDER TAKEUP CLUTCH ASSEMBLY

By LLOYD B. HUST

ONE of the problems encountered in designing a tape recorder is that of obtaining a smooth variable speed for the takeup reel. This reel turns rapidly at first, but must turn progressively slower as the diameter of the roll of tape builds up. This problem is solved in many tape recorders by the use of a spring belt, similar to those used in 16 mm moving picture projectors.

This solution is satisfactory in many instances, but unless the pulleys are machined very smoothly, and unless the belt has exactly the right tension, the takeup reel may move in a series of small jerks. This is of little moment in the case of a movie projector, but in the case of a tape recorder, these small jerks are transmitted to the tape with a resulting annoying "flutter." Even with a spring belt which is perfectly adjusted, t me will cause a misadjustment which will cause noisy operation of the machine as well as the flutter.

The clutch diagrammed below solves the problem of variable takeup speed without these annoying complications. Furthermore, it is simple enough for the experimenter to build without trouble and with the tools ordinarily found in the home workshop. Although the sketch shows the complete spindle-clutch arrangement, existing spindle shafts can have the clutch added to them if they are of sufficient length.

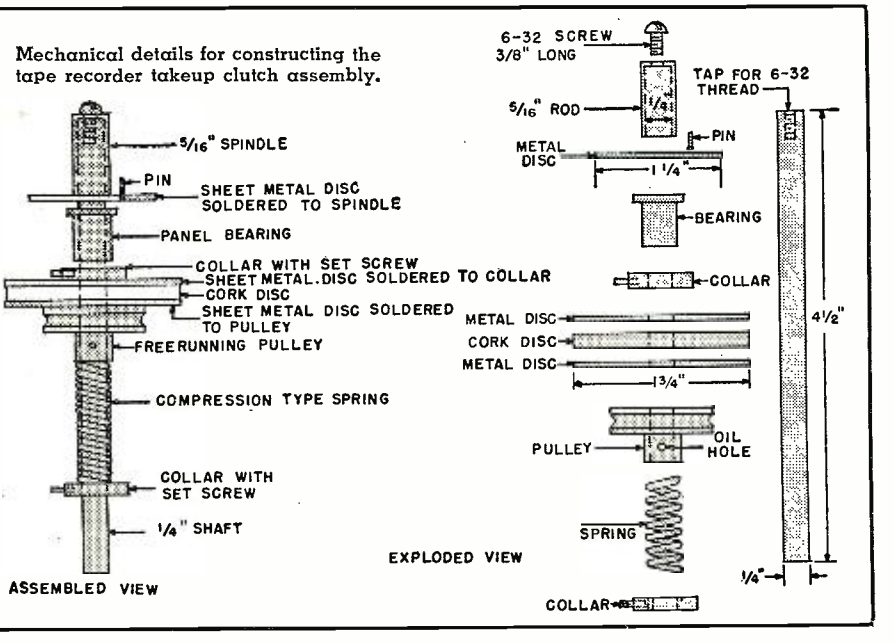
The clutch consists, primarily, of a free running pulley which is attached to a sheet metal disc 1¾" in diameter; a second similar disc is attached to a collar which is locked to the main shaft by means of a set-screw; a disc of ⅛ inch cork—available as gasket material from any auto supply store—and a compression type spring about 1 inch long and large enough in diameter to slip easily over the shaft. The spindle itself is made up of two pieces of shafting—a 5/16" piece, 1 inch long, and a ¼" piece about 4½" long. The 5/16" piece is drilled for most of its length to take the ¼ shaft. A small hole is drilled in the other end to pass a 6-32 screw, and the end of the ¼" piece is drilled and tapped to take a 6-32 screw. These two pieces are assembled as shown in the drawing, and are held together by the 6-32 screw. A heavy sheet metal disc about 1¼" in diameter and having a ¼" center hole is slipped over the ¼" shaft and fit up snug to the 5/16" piece and soldered in place. A small hole is drilled in this piece and a pin made from a small brad is soldered in place. This much of the assembly provides a riding surface and drive pin for the roll of tape. The clutch itself is then assembled. One of the 1¾" discs is centered with and soldered to the pulley. The other disc is soldered to one of the collars. The spindle is placed through the panel bearing, then the collar with the disc is fastened in place underneath the panel. The cork disc is coated on both sides with graphite (rubbing with a soft lead pencil will do the trick) and slipped over the shaft next to the disc which is in place. A drop of oil is placed inside the pulley and it is pushed up against the cork disc. The spring is then slipped on and the retaining collar fastened in place.

Adjustment of the unit is extremely simple. A takeup pull, exerted on the tape after it has left the capstan, should be between 3 and 9 ounces. However, this pull will vary as the build-up of the reel varies. Usually, correct tension on the tape is that which assures positive pull on the tape when the takeup reel is full. Any greater tension may have a tendency to stretch the tape. The tension is adjusted by adjusting the lower collar on the shaft. Pushing it up tightens tension on the spring and, hence, gives more pull to the spindle. Lowering the collar loosens the tension.

The pulley used may take a round or flat belt—even a spring belt will do as the belt is not required to slip. Belt tension should be sufficient to assure positive pull of the pulley at al times. The pulley should be lubricated lightly through the oil hole provided, but the hole should then be packed with felt so that oil will not run onto the surfaces of the clutch. A little care taken in the construction of this clutch will assure smoother operation of many types of tape recorders.

—30—

Mechanical details for constructing the tape recorder takeup clutch assembly.



Mac's Service Shop

(*Continued from page 68*)

"Drag me outside into the fresh air. If I quit breathing, administer artificial respiration at once and keep at it until I start to breathe naturally again. Keep me lying down and warm. After I regain consciousness, you can give me some hot tea or coffee to drink. Of course, a doctor should be summoned at the first opportunity and the treatment turned over to him."

"Is there anything I should be careful *not* to do?"

"Yes; *never* give alcohol, fats, oils, or epinephrine to a person who has been exposed to carbon tetrachloride."

"What's the best thing to do if you accidentally get some of it in your eyes?"

"Wash them at once with large quantities of water for a period of at least fifteen minutes."

"What would you do for a person who accidentally drank some of the liquid?"

"That would be particularly dangerous, for drinking only 3 or 4 cc of carbon-tetrachloride may cause death. The first thing to do is to cause vomiting by making the victim drink a glass of lukewarm salty or soapy water. This unpleasant but necessary procedure should be repeated at least three times to insure that all poison possible is removed from the stomach. Then a teaspoon of Epsom salts in water can be given. That is about all the layman can do outside of seeing to it that the victim is placed in the hands of a competent doctor as quickly as possible."

"What does it hurt to get carbon-tet on the skin?"

"For one thing it washes away the natural oil of the skin and results in redness, roughness, and chapping. This, in turn, impairs the skin's ability to keep out germs and microbes, and infection is likely to develop. It is especially important to keep the chemical away from cuts and burned areas on the skin, for, while it has not been definitely established, there is some evidence that the poison may be absorbed into the system through such places. Finally, some individuals display an allergy to the cleaning agent.

"If you do get some of it on the skin," Mac continued, "you should immediately wash with a mild soap and warm water. Then an ointment containing petrolatum or lanolin should be applied.

"You know, you're beginning to scare me," Barney admitted.

"You should be scared," Mac said emphatically. "Carbon-tet fumes are said to be more poisonous than chloroform. If the poisoning does not cause immediate death, it may result in permanent damage to the liver, kidneys, heart, adrenal glands, lungs, or digestive and nervous systems. There is an added danger when carbon tetrachloride is exposed to an open flame or intense heat, for then it decomposes and forms

the deadly phosgene gas of warfare."

"What kind of safety rules would you recommend?"

"Always keep carbon tetrachloride in tightly-stoppered bottles and keep the stoppers in those bottles except when you are actually extracting some of the liquid. Never use the chemical except out of doors or in a well-ventilated place, preferably one with downdraft ventilation. Never allow pads or cloths soaked with the liquid to lie around, but place them outside as soon as you are through with them. Take precautions to prevent getting the cleaner in your eyes. Avoid having the skin in contact with it for a prolonged length of time, such as would occur when carbon tetrachloride-soaked gloves are worn. Never place carbon-tet on an open flame or a hot surface. And, of course, never keep it in a medicine cabinet or with any other bottles whose contents are taken internally."

"Whew!" Barney gasped. "In view of all that, maybe it would be better just to quit using it altogether."

"Not at all," Mac denied. "Gasoline is dangerous, too, but that does not cause us to give up our automobiles and go back to the horse and buggy. Carbon-tet does a lot of jobs around a radio shop better than any other chemical agent. It is an excellent dry-cleaning fluid, metal degreaser, and rubber solvent. You can't beat it for cleaning turntable rims, wire and tape recorder heads, tuning condenser wiping contacts, or volume controls. It evaporates quickly and leaves practically no residue. Many manufacturers of turntables, recorders, TV tuners, etc., recommend its use; and there is no reason why their recommendations should not be followed; but just remember to observe common sense precautions when you are using it."

"I'll remember, Boss," Barney promised. "From now on, while I've got the cork out of that carbon-tet bottle, I'm only going to breathe *out!*" —30—

TV SERVICE TIP

ENGINEERS at Hytron Radio and Electronics Corporation have come up with a worthwhile tip for technicians which may help to solve a bothersome TV service problem.

The use of low-grade rubber anode caps on picture tubes, which gradually become conductive due to chemical decomposition of the rubber, are causing technicians to believe that the picture tube itself is defective.

The suggested cure is to remove the rubber cap and replace it with a new one of plastic or synthetic rubber which does not contain lamp black as a vulcanizing agent. If such a cap is not available, the elimination of the cap will not harm the set or the picture tube.

Cleaning the tube can be accomplished if ordinary water and a scouring compound are used along with a little "elbow grease." The area around the anode button should be so cleaned and then thoroughly dried and polished with a clean, dry cloth so that no residue remains.

—30—

International Short-Wave

(*Continued from page* 133)

Mozambique—Lourenco Marques noted on approximately 15.27 signing on in Portuguese 1100; swamped 1115 by VOA Relay Base at Tangiers which signs on then. (Pearce, England) Bluman, Israel, lists this as CR7BG on 15.273, good from 1100 onwards. Ridgeway, South Africa, says is parallel with 4.82 with all-Portuguese program. Noted in Calif. by Balbi signing off 1500.

New Zealand—Wellington noted with good signal in parallel around 0000-0030 on 15.280, 11.780. (Foerster, Ill.) Heard on 11.78 and 9.54 (weaker) around 0500-0545 sign-off. (Boggs, Mo.)

Nicaragua—YNVP, 6.76, noted with Spanish announcement 2030, giving slogan *"La Voz de Nicaragua."* Had popular Latin American tunes around 2020. (Bellington, N. Y.)

Nigeria—At the time this was compiled, Bellington, N. Y., received a letter from *Radio Nigeria,* Lagos, 7.255, that would shortly use a *new* wavelength; did not state what channel would be put into use, however. Bellington says the 7.255 outlet has readable signal some days around 1630 but with bad slop-over from Munich, 7.250; also is heard some days from 2330 sign-on, parallel with London, 6.110. Verified for Bellington and for Oskay, N. J.

Northern Rhodesia—The Northern Rhodesia Broadcasting System, Lusaka, heard on 7.220A at 1040-1130 fadeout recently; musical program including some American popular selections; announcements were in an African dialect; weak signal in Calif. (Rosenauer)

Norway—Radio Norway, LLG, 9.610, noted signing on 0600 for New Zealand-Australia-Far East; announced as operating in the 13-, 19-, 25-, and 31-m. bands; very weak in parallel on 15.17. On Sundays has "Norway This Week" (*English*) 0700-0715; other days closes 0700. (Pearce, England) Oslo noted opening 0800 on 15.170 with good level in Georgia. (Fargo) LLH, 9.645, noted in *English* at 1500. (Ridgeway, South Africa) The 11.735 channel is fine strength opening 2000 to North America. (Niblack, Ind.)

Pakistan—Radio Pakistan, 11.675, noted yet opening with good level 0830 with Burmese program for Burma. (Bellington, N. Y.) General Overseas Service noted lately near 9.480 signing on 1210 with news at dictation speed to 1230; news still heard 1015-1030 on 11.675; at 0200-0210 on 15.620 (for Bengal). Noted on 4.805 (Lahore?) at 1015-1030 in parallel with 11.675; news 1015; confirmed this channel as Karachi but may be Lahore. (Pearce, England) Rosenauer, Calif., others, have recently heard the 4.805A channel around 0900 onwards; had news 0930-0945; no location was given; signal fair.

Panama—HOLA, 9.504, Colon, signs off weekdays 2300 but on Saturdays

runs to 0200 (Sun.). (Bellington, N. Y.) Noted *in English* 2130. (Ferguson, N. C.)

Paraguay—Ridgeway, South Africa, says *Radio Encarnacion,* XPA5, 11.946, is noted with frequent relays of *Radio Belgrano* programs, around 1500 to well after 1630; has woman announcer on its own sessions; good level in South Africa.

Peru—Radio Colonial, 9.33, noted 0054 with music. (Bellington, N. Y.) OAX4Z (announced), 15.105, Lima, noted 2218 announcing for *Radio Nacional del Peru.* (Ferguson, N. C.) OAX4W, 9.405, Lima, continues to be heard in England around 1900, but at poor level. (Catch) OAX4X, *Radio El Sol,* Lima, is now heard on 15.105 until 0100. (Cushen, N. Z.)

Philippines—DZH9, 11.855, Manila, noted mornings (*EST*) but at times is covered by a VOA outlet on 11.86. (Balbi, Calif.) DZH8, 15.300, noted R5 at 1000. (Pearce, England) Heard opening with *English* announcement 1555; had program of religious music 1600-1630; good signal in Calif. (Rosenauer) Heard well in South Africa from around 0830 to 1200 closedown on DZH7, 9.73; DZH9, 11.855, and DZH8, 15.300; DZH6, 6.030, is also announced but not heard. (Ridgeway)

Radio Free Asia, 6.110, Manila, noted 1000 signing off with announcement is using DZI4, Manila, 10 kw. (Pearce, England) DYH3, 6.140, Cebu, noted 0340-0400, mostly in Filipino but with *English* identification 0400. (Rosenauer, Calif.)

Poland—Warsaw sent winter schedule for *English* broadcasts for Europe —1230-1300, 6.220, 7.205; 1315-1345, 6.115, 9.525; 1350-1420, 6.220; 1545-1615, 7.205; 1615-1645, 6.115, 9.525. (Pearce, England) Warsaw, 6.15, noted with *English* 2320; bad heterodyne but strong signal; talk closed 2335 and station signed off *English* at 2342 and continued in foreign language. Announced that this channel is being used four times daily for *English* broadcasts to North America. (Niblack, Ind.) These *English* sessions are 1700-1730, 1730-1800, 2315-2345, 0030-0100. (Bellington, N. Y.)

Portugal—Radio Free Europe noted over the Lisbon 9.604 relay outlet with interval 1057 and then signing on 1100 in Czech. (Pearce, England) Lisbon noted on 6.360 to 1900 when signed off with "A Portuguesa" after the Lisbon clock sequence. (Stark, Texas) CSA21, 6.374, Lisbon, heard at good level from 1315 onwards; announces in Portuguese as Home Service; music and talks. (Ridgeway, South Africa) This outlet noted signing off 1900. (Saylor, Va.)

Lisbon, 11.963A, noted 1730-1800 sign-off, good level; 9.745 is better in parallel. (Niblack, Ind.) Bishop, Ohio, reports Lisbon signing on 1330 on 11.996 with strong signal. Lisbon heard on *measured* 15.124 around 0700 to closedown 1130; all-Portuguese. (Catch, England)

Reunion Island—Radio Saint-Denis gives this schedule in letter—2145-2245,

0315-0410, 0900-1000 (Sat. to 1400) on 4.797, 7.170. (Radio Sweden)

Sao Tome—CR5SC, 4.808, noted regularly 1500-1600 closedown; has three-note gong; CR5SB, 17.698, heard Sundays 0700-0800. (Ridgeway, South Africa)

Saudi-Arabia—Djedda, *measured* 5.976, noted recently 2243 with interval prior to opening broadcast 2245 and to closedown 2331; must have changed schedule as formerly was heard 2300-2345A. (Ferguson, N. C.) Noted around 1150 on 11.95, 11.85, 5.975. (Pearce, England) Bluman, Israel, says the 5.975 outlet is now on the air also at 0600-0645.

South Africa—SABC calling Africa noted on 11.937 at 1200-1505 closedown; has news 1500, some days in *English,* others in Afrikaans; usually has news 1200 followed with weather report (*English*) at 1215. (Pearce, England)

Southern Rhodesia—Salisbury, 3.320, noted 1325 with recordings; call 1330. (Pearce, England)

Spain—Radio Juventud Escuela No. 17, 7.200, noted around 1726 with varied recordings. Sends fine QSL card promptly; QRA is Radio Juventud, Buenos Aires 4, Cadiz, Spain; gives frequency as 7.200 but sent no schedules. At 1500 note good signal from FED, Vallodolid, 7.005, *Radio Nacional de Espana en Malaga,* 7.025, *Radio Mediterraneo,* 7.037, Valencia, all of which take Spanish news relay from Madrid at 1545. Spanish-speaking station noted near 7.105 at 1430 announcing *"Radio Tullento Murcia."* (Pearce, England)

Bluman, Israel, says Madrid's *Radio SEU,* EDV-10, seems to have settled down now on 7.140 where it has a clear channel between *Radio Africa,* 7.128, Tangiers, and Berlin, 7.150, after having roamed the 42-m. band for quite some time.

Madrid, 9.363, continues to have strong signal during its "repeat" session for North America (*English*) 2215-2245. (Mesard, D. C.)

Spanish Morocco—Radio Tetuan, EA9AH, *measured* 6.0625, was logged recently 1745 with poor level; signed off 1802. (Oskay, N. J.)

Sweden—SDB2, 10.78, Stockholm, heard regularly from 1300; *English* 1345-1400; bad QRM at times. (Ridgeway, South Africa) This one usually is poor for *English* in North American session 2000-2015; 15.155 in parallel is much better signal in Ohio. (Bishop) Heard over SBP, 11.705, daily 0815 in *English* ("Sweden Today"). (Rodger, Scotland) The 15.155 channel is parallel.

Syria—Maurice, N. Y., recently received this schedule from Damascus—665 kc. and 719 kc., m.w., 50 kw., Arabic program 2330-0200, 0630-0800, 1000-1700; on 6.165, 20 kw., dipole antenna, Arabic 2330-0200, 0630-0800, 1000-1700; 7.145, 2 kw., dipole antenna, 0200-0230 Arabic; 0230-0430 French, 0830-0930 French, 0500-0600 *English;* 11.915, 20 kw., rhombic antenna, 1530-1630 French, and 1630-1730 *English;* 17.865, 20 kw., rhombic antenna, 0945-1045 Arabic and *English* for India-Pakistan;

QRA is General Administration of the Syrian Broadcast, Victory Street, Damascus, Syria.

Tahiti—Radio Tahiti, 6.135, Papeete, noted 0034 in French. (Winch, Calif.) With native music 2345-2355; French 0000; weak to fair level in Wyoming. (Lane) *English* announcement noted 0125. (Russell, Calif.)

Taiwan—Taipeh, 15.235, noted opening 2300 with news and commentaries in *English;* announced 11.735 in parallel; good on 15.235, very weak (barely readable) on 11.735; has Chinese after 2400, and is better level then. (Rosenauer, Calif.) Noted opening 0530 on 7.135A. (Bellington, N. Y.) "Voice of Free China," Taipeh, noted on 11.800 with *English* 1415 good strength; has Chinese after 1515. BED26 has moved to 10.050A where is well heard at 0500 and noted again 0900. (Cushen, N. Z.) The 6.095 and 7.02 Taipeh outlets sign on 0500, former is best level. (Balbi, Calif.)

Tangiers—Radio Africa, 7.125, noted with Spanish music afternoons (*EST*). (Pearce, England) Heard with announcement in French by male announcer at 1813 recently. (Bellington, N. Y.)

Thailand—HS8PD, 15.918, Bangkok, has a good signal (in native) in South Africa 0845; music 0900; signal deteriorates at 1015. (Ridgeway) The 6.24 outlet is heard faintly most days after 0500. (Balbi, Calif.)

Trinidad—VP4RD, 9.625, Port-of-Spain, noted 0700 and around 1700 at fair level; according to verification received, station has a 3.275 channel. (Gates, Conn.)

Turkey—ISWC, London, and other overseas sources, report a *new* station announcing as *"Burasi Ismir Radyosu,"* operating irregularly on 6.500A; is likely to be on the air Wed. and Sun. *only* around 1200 to approximately 1535; programs are relayed from the long-wave station of *Radio Ankara.*

TAS, 7.285, Ankara, good signal with *English* 1600-1645. (Foerster, Ill.) Often heard from 1330. (Simonian, Mass.) Announces TAP. 9.465, is parallel at 1600.

TAT, 9.515, noted recently 1100 in native language; TAP, 9.465, noted on the air at 1110 to tune-out 1135. TAV, 17.820, noted signing on in *English* 0730 for Australia-Far East with news, recorded music, Mail Bag. (Pearce, England) This one noted in Georgia with news 0730. (Fargo) TAP, 9.465, noted with news 1600. (Rodger, Scotland) TAT, 9.515, continues with "local-like" level in its 1815-1900 beam to North America (*English*). (Clapp, N. J.)

Uruguay—CSA21, 6.1612, Montevideo, noted at good level 2030. (Russell, Calif.)

USI—Padang, 7.24, noted from around 0440 to 0600 sign-off. Indonesian noted lately on 11.935A very weak with QRM at 1000; heard signing on 0430 on this channel announcing as *Radio Indonesia* in Djakarta. (Balbi, Calif.) YDC, 15.15, Djakarta, heard 1010. (Pearce, England) The Indonesian on 11.082 with Dutch announcements, music—heard 0800 to closing 0930 with Hawaiian tune—is believed YDQ3, Makassar, Celebes. (Ridgeway, South Africa) Overseas sources say the *new* 100 kw. transmitter at Kebajoran, Java, will use YDF6, 9.585, instead of YDF7, 11.770, for programs 1100-1500 daily beamed to Europe.

The Djakarta Forces transmitter has verified its 7.165 outlet for Cushen, N. Z. Transmitter is a *new* 7.5 kw. job

CONDENSER TIME DELAY RELAY

By JOSEPH HOULE

TIME delays between 1 and 10 seconds are easily obtained using parts that inhabit most junk-boxes—d.c. relays and electrolytic condensers. The circuit shown, Fig. 1, can be adapted to door openers, lamp flashers, voice-controlled transmitter switching, or whatever need may turn up. It has been used in a circuit for holding a magnetic door latch open for 5 seconds after a push-button is pressed.

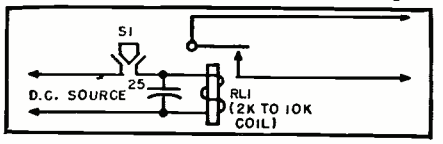
Momentary closing of the switch or push-button, S_1 will charge up the condenser from the d.c. source. After the switch is released, the condenser will discharge through the relay coil, holding it closed for a time depending on the coil resistance, the relay adjustment, the supply voltage, and the capacitance. The relay drop-out current and the capacitance are the most important factors. To get the longest hold-down time, adjust the relay for light spring pressure and a small gap between armature and pole face when the relay is closed. If the relay contacts will have to handle more than 1 or 2 amperes, don't make the spring pressure too light or the contacts will stick together. If necessary, use a second heavier relay, controlled by the sensitive relay, for handling heavy loads.

A selenium rectifier working off the 115-volt line makes a good d.c. source. If this voltage is too high for the relays on hand, it is OK to insert some resistance in series with the coil to limit the initial current; this will lengthen the hold-down time somewhat, too.

A relay with a pair of back contacts (normally closed contacts), and a condenser across the coil, will close and release continuously when the back contacts are connected in series with the d.c. line—making, in effect, a low-frequency square-wave generator. The frequencies obtainable are in the right range for sign flashers.

A good combination for a 5 to 6-second hold-down time is a 2000-ohm sensitive relay with about 5000 ohms in series with the coil, a 110-volt selenium rectifier supply, and a 160-μfd. condenser. —30—

Fig. 1. Wiring diagram. With a 50 μfd. condenser, 2000 ohm relay, and 110 volt d.c. source, delay is about 2 seconds. Up to 10 seconds is obtainable with larger condensers or with higher resistance relays.



and is directed towards Western Java and the Celebes; however, is currently using 11.940 (replacing 7.165) at 0430-0630 daily. (Radio Australia)

USSR—Station on 7.10 noted around 1740 with classical music, off 1757 with Russian Anthem; woman announcer; fair signal but CWQRM'd at times. (Bellington, N. Y.) Soviet on 6.825 noted 2300 with usual bells. (Leary, Ind.) Soviet noted in native 0745 on 7.175. (Stark, Texas) *Radio Tashkent,* 6.825, heard with *English* for India-Pakistan 1000. (Pearce, England) Moscow heard on 7.340 with talk and news around 1650-1700. (Rodger, Scotland) Ridgeway, South Africa, notes Tashkent, 6.825, also in *English* 1115-1130; begins language session 1130, sometimes has bad CWQRM.

Moscow, 15.36, noted with news 0930-0945 for India-Pakistan; good level in Calif. (Rosenauer) Noted on 7.245 with *English* 0045 and at 0245. (Hoffman, N. Y.) Komsomolsk, 9.7257, noted in *English* 0050. (Russell, Calif.)

Vatican—HVJ, 15.120, heard with *English* 1000-1010, then in Polish. (Pearce, England) Noted 1315-1330 in *English* on 9.644; often spoiled by bad jamming. (Ridgeway, South Africa).

Venezuela—YDKF, 4,880, noted with good level to 2300 sign-off. (Foerster, Ill.) YVMI, 3.370, Maracaibo, noted 1730-2200; QRA is YVMI, *La Voz de La Fe,* Maracaibo, Venezuela. (Kroll, N. Y.) YVMC, 3.350, noted at good level to 2200 sign-off. (Lane, Wyo.)

Western Samoa—Overseas sources say ZM2AP, Apia, is on the air 0030-0330 on Sat., Sun., Tues., Thurs.; 0103-0230 Mon., and 1500-1600 Mon., Tues., Wed., Fri.; *test* channels are 3.410, 6.040; has not been reported as heard in USA.

Yugoslavia—*Radio Yugoslavia* noted with call 0930 on 6.100. (Pearce, England) By this time, *Radio Yugoslavia* should have started an *English* session; no further details were available when this was compiled. A detailed list of programs beamed by this station can be had by writing to Yukovich George, 6 Mose Pijade, Belgrade 2, Yugoslavia. (*WRH Bulletin*)

* * *

Press Time Flashes

When this was compiled, Bellington, N. Y., was hearing a station in Arabic around 2330 on 6.165 which seemed to have same program as Beirut, Lebanon, on 8.026A.

The Yugoslav Emigrant Radio, 6.887, noted around 0030-0045 in European language. (Leary, Ind.) Noted in Britain on *measured* 6.888 at 1620 and closing 1635. (Catch)

The Forces Station, Djakarta, USI, is now on 11.940A until 0630 closedown; program is quite similar to that heard formerly on 7.165. (Radio Australia)

Ridgeway, South Africa, notes an Angolan station on 7.800 closing 1430 with "A Portuguesa" which he believes to be Radio Clube de Benguela; other channel used by Benguela is 7.080, closing 1430.

Congratulations go to John J. Oskay, New Jersey, who won the recent DX

contest sponsored by the International Short Wave League, London. John logged 98 countries during the brief period of the competition.

A station on 4.330 heard around 0830-0900 with oriental language may be *Radio Pyongyang,* North Korea. (Rosenauer, Calif.)

The *new* schedule for the *"Voice of America's"* Amateur Program is—Latin American Service on Saturday 2130 on 6.040, 6.060, 9.650, 11.890, 15.210, 15.350; Far Eastern and Pacific Service on Sundays 0745 and 0945 over 6.060, 6.075, 6.125, 6.185, 6.195, 9.515, 11.890, 15.245; European and Near Eastern Service on Sunday 1415 over 6.040, 6.170, 9.700, 11.775, 11.830, 15.270. (Graybill, Wash. State)

Guentzler, Ohio, has received these schedules from *Radio Moscow* for *English* periods—*North American Service* 0800-0830, 17.83, 15.12, 11.96, 11.91; 1820-1930, 15.23, 15.11, 9.70, 9.67, 9.57, 9.55, 7.24, 7.20; 1930-2030, 15.23, 15.11, 9.67, 7.24, 7.20; 2030-2300, 15.23, 15.11, 9.70, 9.67, 9.57, 9.55, 7.24, 7.20; 2300-0100, 11.88, 9.56, 7.24, 7.20. *To Far East and Europe*—0300-0330, 11.78, 11.75, 11.72; 0400-0500, 15.36, 11.82, 11.78, 11.75, 11.72, 9.68, 9.64; 0530-0600, 15.41, 15.36, 11.82, 11.78, 11.75, 11.72, 9.68.

YDG2, 2.310, Sourakarta, Java, USI, is heard in New Zealand with news in Indonesian to 0945 when closes down. (Cushen)

Bluman, Israel, says ZNR, Aden, 2 kw., reported operating on 6.085, 6.760, 12.115, is a radio telephone transmitter but at times may be used for special relays. At present there is no regular radio station at Aden. (*WRH Bulletin*)

QRA for the *"Voice of Free China"* outlet on 11.800 is New Park, Taipeh, Taiwan; is heard from 1400; asks for reports to Near East and European Division; appears to be American-operated (?); has Russian 1400-1420, then *English* 1420-1440 when fades out. (Cushen, N. Z.)

Radio Sweden says the Chinese station reported heard on 6.430 around 1900-2000 may be *Radio Hsin-Hua,* Harbin, Manchuria; that Istanbul, Turkey, has been heard 1430-1457 on 7.970 and on 7.775; Rome can be heard now on 9.780 from 1220 onwards; *Radio Africa,* 7.126, Tangiers, broadcasts a short financial bulletin in *English* 1630; a Swedish firm has just published "Dux DX-bok," containing a list of long-, medium-, and short-wave stations; DX-ers can get a copy by sending eight IRC's to DX Editor, Radio Sweden, Stockholm 7, Sweden.

Lisbon, 11.963, is fairly good signal 1700-1800. (Kessel, Canada) LRA, 9.69, Buenos Aires, is a fine signal in Seattle, Washington, evenings, regularly. (Oestreich) *Radio Indonesia,* 7.270, Djakarta, noted 0700-0730 with popular American recordings, announcements in Dutch; *Radio Nacional,* 15.145, Lima, Peru, noted 1845-2030; BED32, "Voice of the Chinese Air Force," 9.775, Taipeh, Taiwan, heard 0530-0600. (Rosenauer, Calif.) CR4AA, 5.900V, Cape Verde Islands, still noted 1530-1700 in Newfoundland. (Peddle) Prague, Czechoslovakia, noted around

6200 relaying Moscow after 1430; had own program 1400-1430.

Copenhagen Radio reports *Radio Yugoslavia* on a *new* outlet of 7.235 at 2000-2145 and 2300. (Golden, Mass.) Copenhagen, 9.52, is good level in Iowa 2030-2130. (Lund) *Radio Ceylon* has replaced 3.400 with 9.520 used parallel with 7.190, 11.975 at 0630-1145 (*English* from 0830); the "All-African Service" of SABC is now on "summer" schedule of 17.748 at 0330-0700, 0900-1045, and 11.927 at 1100-1510. (WRH) Haiti's 4VN, 6.013, is coming in well now 1800-2135 sign-off; 4VPL, 8.984, Petionville, is heard around 1600 but has bad CWQRM; 4V2S, 4.951, is heard 1500-1545 sign-off; all have French. (Saylor, Va.)

FBS, 7.220, Fayid, Suez Canal Zone, is heard 1630 with Arabic program of world news and native music; BED22, 7.010, Taipeh, Taiwan, noted 0600 with Western music; BED26, 10.080A, noted 0500 with Chinese news; BED7, 11.735, has news now 0700; Bangkok, 11.910, noted 0445 with news; North Shensi, 9.024, China, noted 0445 with Western music. (Sanderson, Australia)

4VEH, 9.71, Cap-Haitien, Haiti, has been off the air for about two months; two of its transformers have burned out and it is necessary to rebuild the transmitter; hopes to return to the air shortly with three times as much power as before. (Hoffman, N. Y.; Golden, Mass., others)

Port Moresby, Brt. New Guinea, is scheduled over VLT7, 7.280, Mon.-Fri., 0815-0745, 1545-1745; Sat. 0315-0800, 1545-1730; Sun. 0315-1200, 1645-2000. VLT9, 9.52, is on the air Sun.-Thur. 2100-2245, 0100-0300; Fri. 2100-0300, Sat. 2100-2300, 0100-0300. (Radio Australia)

Short Wave News, London. says by this time *Radio Goa*, Portuguese India, should again be using its 10 kw. transmitter on 9.260. The Newark News Radio Club reports a test was heard some time ago from Stockholm's new high-powered transmitter on 21.730 at 0500-0559; the new Stockholm super-powered jobs should now be in regular operation.

A flash from officials of HCJB, Quito, Ecuador, says HCJB will be going to 100 kw. shortly; more than 100 tons of new equipment have already arrived in Quito; new land has been purchased at a better site in the valley to take HCJB out of the shadow of Pichincha which should permit signals to get out across the Pacific better; new site is in direct line with old one and an FM link will be utilized from studios to transmitters; present plans call for two 50 kw. transmitters which can be sub-divided into four 25 kw. transmitters to be used for four frequencies or two—depending on the language being used and the time of day; new studios will be built, and already new curtain beam antennas are being erected.

* * *

Acknowledgement

Thanks for the splendid reports. Keep them coming to Kenneth R. Boord, 948 Stewartstown Road, Morgantown, West Virginia, USA....KRB

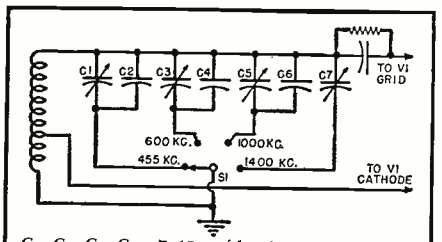
An "Extra" Superhet

(*Continued from page 45*)

denser. Starting with T_3, align the tuned circuits of both i.f. transformers for maximum output meter response, making sure that the receiver volume control is on full and that the signal generator output is kept reduced to the point where the output signal is clearly audible but not loud.

Remove the oscillator short circuit and connect the signal generator through a dummy antenna of 200 $\mu\mu$fd. to the antenna connection. It now becomes necessary to experimentally track the oscillator with the antenna circuit, using a systematic procedure. In following the steps given below, the antenna coil inductance and trimming capacity must be adjusted at the appropriate frequencies (600 kc. for the inductance, 1400 kc. for the trimmer) each time a change is made in the oscillator conditions.

Adjust the padding condenser to its minimum capacity setting. Set the receiver dial and signal generator to 600 kc. and adjust the oscillator inductance until a signal is heard. If no signal is heard within the range of the oscillator inductance adjustment, screw the inductance in as far as possible and increase the padding capacity until a signal is heard. Attempt to align the oscillator trimmer condenser to agree with the dial at 1400 kc. If the adjustment cannot be made, again increase the capacity of the padding condenser and reduce the oscillator inductance (by turning the screw out)



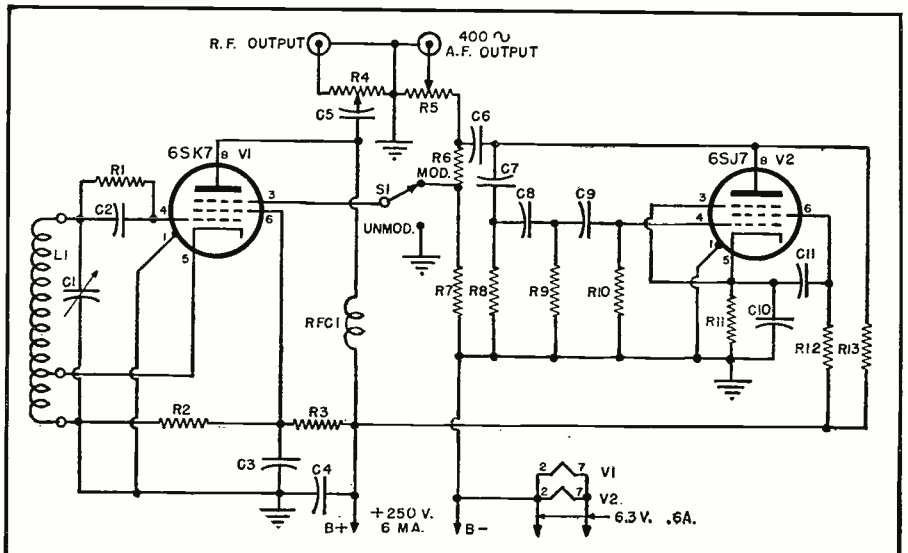
C_1, C_3, C_5, C_7—7-45 $\mu\mu$fd. trimmer cond.
C_2—570 $\mu\mu$fd. mica cond.
C_4—310 $\mu\mu$fd. mica cond.
C_6—75 $\mu\mu$fd. mica cond.
S_1—S.p.4-pos. ceramic rotary sw.
Other components same as in Fig. 7.

Fig. 6. The optional signal generator tank circuit for spot frequency use.

to obtain a new setting at 600 kc. Continue this process until both 600 and 1400 kc. are correctly indicated. Now tune the receiver and generator to 1000 kc. and make a sensitivity measurement, which should be written down. Increase the padding condenser capacity slightly, decrease the inductance to give a 600 kc. signal, align at 1400 kc., and again measure sensitivity at 1000 kc. If the sensitivity is better than it was before, repeat the last operation until the measurements show greatest sensitivity and then start falling off again. Return to the adjustment giving maximum 1000 kc. sensitivity. Throughout the alignment process it is important to obtain a definite peak in adjusting the antenna and oscillator trimmers.

Fig. 7 shows the circuit of a simple but highly practical signal generator that may be easily constructed at low cost from "junk box" parts, if access to a regular generator is inconvenient. Using the values specified for C_1 and

Fig. 7. Complete schematic diagram of a simple broadcast-band signal generator.



R_1—22,000 ohm, ½ w. res.
R_2, R_{13}—100,000 ohm, 1 w. res.
R_3—100,000 ohm, 2 w. res.
R_4—500 ohm carbon pot.
R_5—500,000 ohm pot.
R_6—470,000 ohm, ½ w. res.
R_7—47,000 ohm, ½ w. res.
R_8, R_9, R_{10}—1 megohm, ½ w. res.
R_{11}—560 ohm, ½ w. res.
R_{12}—390,000 ohm, ½ w. res.
C_1—2-gang var. cond., 498 $\mu\mu$fd. max. capacity per sec., both sections paralleled
C_2—100 $\mu\mu$fd., 500 v. mica cond.
C_3—.005 μfd., 500 v. mica cond.
C_4—.1 μfd., 600 v. cond.
C_5—500 $\mu\mu$fd., 500 v. mica cond.
C_6—.01 μfd., 600 v. cond.
C_7, C_8, C_9—150 $\mu\mu$fd., 500 v. mica cond.
C_{10}—10 μfd., 25 v. elec. cond.
C_{11}—.05 μfd., 600 v. cond.
S_1—S.p.d.t. toggle sw.
RFC_1—2.5 mh. r.f. choke
L_1—114 t. #26 en. on 1¼" dia. plug-in form. 215 μh. inductance. Cathode tap at 44 t. from gnd. end
V_1—6SK7 tube
V_2—6SJ7 tube

L_6, the generator will tune continuously from about 344 kc. to 2100 kc., a more than ample range for broadcast receiver alignment. If desired, the continuously variable frequency tank circuit may be replaced by the one shown in Fig. 6, in which case the spot frequencies of 455, 600, 1000, and 1400 kc. are available at the turn of a switch. This system is convenient and desirable for the experimental alignment process just described, as generator frequency reset errors are avoided. The signal generator r.f. output voltage may be modulated by the 400 cycle phase shift oscillator, V_2. The very pure sine wave voltage output of this oscillator is also available for audio test purposes, the output level being controlled by R_5.

The signal generator is quickly and accurately calibrated by zero-beating, in another receiver, standard broadcast stations of the desired frequencies. The 455 kc. frequency is calibrated by beating the second harmonic of the generator against a broadcast station operating on 910 kc. The generator may be powered temporarily directly from the receiver described in this article by removing the ground connection from the generator tube filament circuit. The receiver filament circuit is already center-tapped to ground. -30-

Tracer-Amplifier

(*Continued from page 51*)

ever, the volume control and associated components should be located as close as possible to the 6SF5 tube socket. The power supply should be located on the rear of the chassis and removed as far as possible from the grid circuit of the 6SF5 to reduce the possibility of hum pick-up. Further insurance against hum is provided by using shielded wire for grid circuit leads more than an inch or two long or where they may pass close to heater leads.

Fig. 2 shows the comparative response at audio frequencies of the probe (curve *A*) and the microphone/phone input (curve *B*). While the curves are far from what the high-fidelity man calls "flat" still they are good enough—and the results prove it—to provide good quality when the amplifier is used with a record player or when checking for distortion in receivers. It should be remembered that the tracer was designed with maximum gain as the primary consideration. Average gain with the probe is better than 70 db, more than adequate to detect a weak signal at the front end of a receiver in even the remotest locations (North and South Poles excepted)! Average gain at the microphone/phono input J_1 is better than 40 db, sufficient to handle crystal or dynamic microphones and phono pickups.

As mentioned before the probe produces only slight loading effect to tuned circuits. It can actually be made to produce none at all. In receiver cir-

cuits following the first stage, where some amplification has been given the signal, it is unnecessary to even touch the probe tip to the circuit under test. Response can be obtained merely by bringing the probe close to the circuit connection. Strong response can also be obtained by placing the probe tip on top of glass envelopes of tubes in the i.f. and audio stages.

It will be noted that with the gain control full on a slight hum can be heard from the tracer speaker. This hum originates entirely from free a.c. pickup by the short probe tip and can be eliminated by poking the probe inside a grounded metal can. The hum is of no consequence since under normal operation the volume control is seldom more than half on, and at this setting no hum whatsoever will be noticed.

One precaution should be observed in the construction of this instrument. All high voltage wiring in the plate circuit of the 6F6 power stage should be of the high voltage type or at least provided with adequate insulation to prevent breakdown under certain conditions of high frequency audio input. Actual measurements at 5000 cycles input to the probe have indicated an output voltage at this frequency of more than 600 volts developed at the plate of the 6F6. This is practically the overload point of the output stage and is obtained with the volume control full on. Since the control is seldom more than half on no trouble should be experienced from insulation breakdown. The point is mentioned only to acquaint the reader with the fact and perhaps prevent him from being knocked on his dorsal posterior if he should happen to accidentally become a part of the output circuit under the above conditions.

An interesting experiment to demonstrate the tracer's sensitivity may be performed by operating the signal tracer as a "wide-band" receiver. This may be done by connecting an ordinary 2.5 mhy. r.f. choke between a receiving antenna and ground. The ground side of the choke is connected to the tracer chassis and the probe touched to the antenna side of the choke. The result will be a bedlam of broadcast stations, police, hams, airlines, beacons, and everything else all bursting forth from the speaker at the same time. —30—

CONDENSER TESTERS

By C. D. CHANDLER, W4BO

HERE'S a kink on the use of condenser testers that I have found very useful in the measurement of small values in critical circuits (FM transmitter pulse, TV receivers, and equalizers) where two condensers must be of equal value.

Using a v.t.v.m., measure the voltage across the grid to cathode of the "eye" tube, use this voltage as the balance indicator rather than the "eye." In this manner the values can be measured very closely. I have been able to restore a circuit to normal with ease by "culling" my stock of condensers.

I hope that this hint will be of some use to fellow sufferers. —30—

Franklin Oscillator

(*Continued from page 58*)

that shielded cable be used to minimize possible radiation which might cause interference to television sets in the vicinity.

Construction

If the accompanying photographs are carefully studied, there is little that can be said regarding construction of this exciter. It is assembled in the conventional manner.

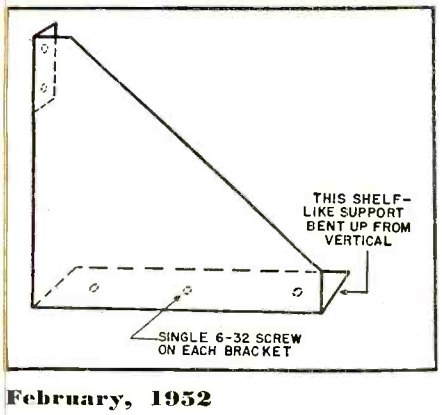
The v.f.o. unit may be mounted in the three-compartment war-surplus cast-aluminum box formerly housing the multi-gang tuning condensers for the RAK/RAL Navy receivers. With this arrangement it is possible to use the left-hand condenser and its worm-gear drive after the two unneeded sections of the condenser have been removed from the box. This particular arrangement for mounting the v.f.o. is not necessary, however, for any conventional means of v.f.o. assembly may be used. One point should be borne in mind. The tank circuit of the oscillator, as shown within the broken lines in Fig. 6, should be mounted in a compartment of its own, or at least mounted away from the vacuum tubes. This is to insure isolation from heat and attendant mechanical changes.

The v.f.o. is bolted directly to the front panel. The HRO type dial is specified to provide extremely accurate calibration facilities.

The frequency multiplier cascade is built on a standard 17 x 4 x 3 inch steel or aluminum chassis. This chassis is very easily mounted in the exciter cabinet by means of a pair of chassis mounting brackets modified as shown in Fig. 9. The bottoms of these brackets are bent up at right angles to the body of the bracket presenting a shelf-like support for the ends of the chassis. One 6-32 hole is drilled and tapped in each bracket and at either end of the chassis on the lip. As the unit is very light in weight, only one 6-32 screw is needed at each end of the chassis to secure it in place.

The power supply chassis is secured to the bottom rear of the cabinet by small angle brackets.

Fig. 9. Chassis bracket modifications to provide a secure and serviceable mounting for the frequency doubler cascade circuit.



A 72-ohm coaxial cable, such as RG-59/U, is used for feeding r.f. from the v.f.o. to the frequency multiplier cascade, and from the final doubler or multiplier stage to the succeeding amplifier stage of the transmitter.

Tuning and Operation

This exciter was designed with facility of operation and ease of construction foremost. Therefore, no complicated metering circuits were specified, as it was felt that they were not needed in equipment of this type. All that is actually needed to "tune up" is a screwdriver and an accurately calibrated wavemeter with a sensitive r.f. indicator, such as a meter with germanium rectifier circuit. Once initial tuning operations have been performed, the stages may be "peaked" with a ¼-watt neon lamp.

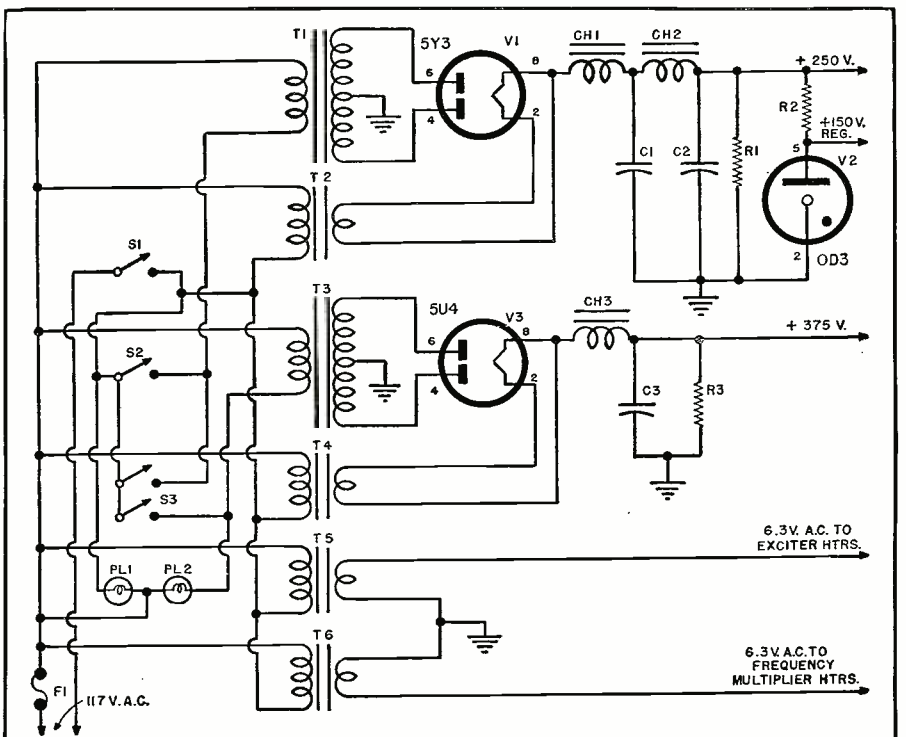
Having made certain that all connections have been properly made, plate voltage may be applied to the v.f.o. and the frequency doubler cascade. The wavemeter should be set at approximately 1.7 megacycles and placed near the output of the 6SN7GT/G oscillator tube (V_1 in Fig. 6). Then, the v.f.o. should be tuned until an indication is noted on the wavemeter r.f. indicating device. The wavemeter should then be tuned to 3.55 megacycles and placed near L_2 and C_{11} (Fig. 6) tuned for maximum output as indicated on the meter. The 6AG5 buffer/doubler (V_3, Fig. 6) is now tuned to 3.55 megacycles and is operating as a frequency doubler.

Before proceeding with the adjustment of the frequency doubler cascade, the interstage coupling condensers C_6, C_{11}, C_{16} (Fig. 3) should be adjusted for approximately half capacity. Now, with appropriate coils in their sockets, the frequency multiplier cascade may be tuned, progressing from one stage to the next, in a conventional manner. With the wavemeter tuned to 3.55 megacycles and placed near L_1-L_2, tune C_4 (Fig. 3) with a screwdriver until a maximum meter reading is noted on the wavemeter; with the wavemeter tuned to approximately 7.1 megacycles and placed near L_3-L_4, tune C_{10} for maximum meter reading; with the wavemeter tuned to approximately 14.2 megacycles and placed near L_5-L_6, tune C_{15} for maximum meter reading; with the wavemeter tuned to approximately 28.4 and placed near L_7-L_8, tune C_{19} for maximum meter reading.

If 21 mc. output is desired (when this frequency band is opened for amateur operation) V_3 (Fig. 3) may be used as a frequency tripler. In this case the wavemeter would be tuned to approximately 21.300 megacycles and placed near L_5-L_6. A commercially wound coil for 21 megacycles (such as the "*B & W* JEL 15") should then be substituted for the 14.0 megacycle coil. Then C_{15} should be tuned for a maximum meter reading on the wavemeter.

For 50 megacycle output from V_4 and

Fig. 10. Complete circuit details and parts list for the power supply section.



R_1—25,000 ohm, 10 w. wirewound res.
R_2—5000 ohm, 2 w. res.
R_3—35,000 ohm, 10 w. wirewound res.
C_1, C_2—125 μfd., 350 v. elec. cond.
C_3—20 μfd., (two 10 μfd.), 600 v. paper cond.
S_1, S_2—S.p.s.t. toggle sw.
S_3—D.p.s.t. toggle sw.
PL_1, PL_2—117 v. pilot light
F_1—5 amp. fuse in 3AG holder
T_1—Plate trans., 325-0-325 v. @ 40 ma.
T_2, T_4—Fil. trans., 5 v. @ 3 amps.
T_3—Plate trans., 400-0-400 v. @ 200 ma.
T_5—Fil. trans., 6.3 v. @ 1.2 amps.
T_6—Fil. trans., 6.3 v. @ 4 amps.
CH_1—Filter choke, 5 hy. @ 50 ma.
CH_2—Filter choke, 7 hy. @ 50 ma.
CH_3—Filter choke, 4.5 hy. @ 200 ma.
V_1—5Y3 tube
V_2—0D3 tube
V_3—5U4 tube

J_5 it will be necessary to use different coils than those specified in the parts list of Fig. 3. Coils should be substituted as follows: L_1-L_2 should be replaced by a 7.0 megacycle coil, L_3-L_4 should be replaced by a 14.0 megacycle coil, L_5-L_6 should be replaced by a 28.0 megacycle coil and L_7-L_8 should be replaced by a 50 megacycle coil. These coils may be the commercially wound variety; their exchange in this setup does not necessitate technical changes in the coils, or the circuit. In tuning the stages for 50 megacycles output, the v.f.o. should be tuned to approximately 1.6 megacycles with V_3 tuned to approximately 3.25 megacycles. Then V_1 (Fig. 3) should be tuned to 6.5 megacycles, V_2 to 13 megacycles, V_3 to 26 megacycles and finally V_4 to 52 megacycles. Great care should be exercised that output is not taken from any coaxial socket but that of V_4 (J_5). The 50 megacycle amateur band is not harmonically related to any other amateur band and therefore out-of-band operation will result if the foregoing suggestions are not followed.

It should be noted that 1.7 megacycle operation may be obtained by replacing L_2 (Fig. 6) and L_1-L_2 (Fig. 3) with appropriate 1.7 megacycle inductances. In this case V_3 (Fig. 6) and V_1 (Fig. 3) would act as r.f. amplifiers with 1.7 megacycle output obtained from J_2.

To take advantage of the extreme accuracy and stability of this exciter, it should be calibrated with the aid of a very accurate signal generator in conjunction with the station receiver. However, a "dial scale *versus* frequency" curve may be effectively plotted by obtaining frequency reports from stations contacted across each amateur band. If this procedure is used, the unit should only be operated well within the band edges to avoid receiving the not so welcome QSL from the FCC. An accurate frequency meter will allow operation close to the band edges, and relieve the operator of much mental strain.

Conclusion

Although many types of variable frequency oscillators have been introduced to the amateur world in the past few years, they all may be improved upon. In these days of congestion with the few hundred kilocycles allotted to the amateur service, it is more important than ever that we keep our signals "put" and to insure that our keying characteristics are the best that we are able to provide. This exciter embodying the Franklin oscillator provides a simple, clean, and dependable frequency control. When properly built, it is surpassed in stability only by a temperature-controlled crystal oscillator.

No effort has been made to keep the exciter down to "miniature" size, but there is no reason why the frequency doublers as well as the power supply could not be converted for miniature tubes. Then one would have extreme compactness in addition to the very desirable features already outlined.

-30-

Audio Simplified

(*Continued from page 72*)

reversal to drive the second push-pull grid with the proper voltage and phase. The driving voltage for this phase-inverter-amplifier tube is obtained from the voltage divider formed by the two resistors in the first push-pull grid. The resistances should be chosen so that

$$A = \frac{R_1 + R_2}{R_2}$$

where A is the gain of the phase inverter tube. The exact value of the resistor (now shown as 10,000 ohms) must be selected very carefully for satisfactory balance of the push-pull amplifier. A disadvantage of this circuit is that as the tubes age, the gain of the phase inverter stage may change and cause unbalance in the push-pull amplifier. Cathode degeneration by use of an unbypassed cathode resistor can help to stabilize the gain to reduce this effect, or the use of a variable instead of a fixed resistor for the 10,000 ohm unit permits periodic readjustment to maintain accurate balance.

Practical Circuits

All of the sound reproducing systems in use at the present time are based upon the circuits which have been described in this article. Push-pull power amplifiers are almost always used when good reproduction is required, and one of the various phase inverter circuits is used to couple a single-ended voltage amplifier to the power amplifier grids. Good amplifiers almost invariably use negative feedback to improve the distortion, frequency response, and stability, according to the negative feedback design equations which have been given in this article.

The circuits which have been described previously in this article are redrawn, with practical component values, in Fig. 8 for the benefit of those who may want to use one of these circuits in the construction of an amplifier. The tubes and components suggested in these schematics are suitable for most applications, and their specific

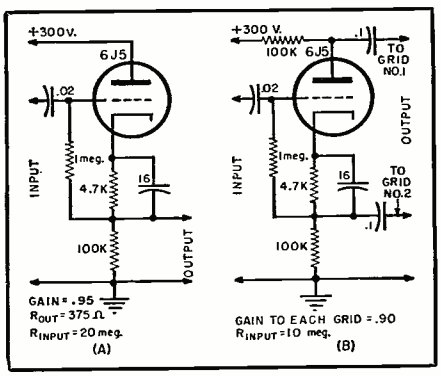


Fig. 8. Practical component values for circuits described herein. (A) Practical cathode-follower circuit based on Fig. 4B. (B) Cathode-follower phase inverter (Fig. 5).

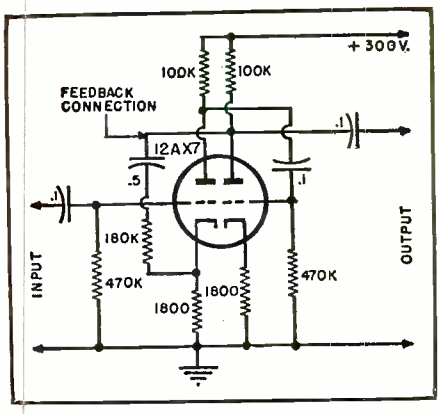


Fig. 9. Application of negative feedback to a two-stage dual-triode amplifier to provide a stable gain of 40 decibels.

requirements will be discussed in further detail in connection with power amplifiers in a later article in this series.

A typical use of negative feedback is shown in the schematic of Fig. 9, which shows the application of negative feedback to a two-stage dual-triode amplifier to give a stable amplifier with a fixed gain. The amplifier without feedback would have an amplification of about 70 db, but the application of feedback from the second plate to the first cathode reduces this gain to 40 db. The total amount of feedback is 30 db, and with this amount of feedback the gain will remain quite stable with aging of the tubes until they fail completely. In most audio amplifiers, the negative feedback is generally applied over the entire amplifier from the secondary of the output transformer to one of the first stages in the voltage amplifier. The manner in which this is accomplished, as well as the connection of the various circuits to form a complete audio amplifier, will be discussed later in this series.

(To be continued)

AMATEUR EXTRA CLASS LICENSE

THE FCC is currently considering a proposal to recognize amateurs of long experience by modifying the requirements for the Amateur Extra Class license in such cases.

Any applicant for Amateur Extra Class license will be given credit for examination elements 1(C) and 4(B) if he so requests and submits evidence of having held a valid amateur radio station or operator license issued by any agency of the United States Government during or prior to April, 1917.

—30—

TECHNICIANS NEEDED

MITCHELL Air Force Base, N. Y. has sent out a call for trained communications technicians to take part in its reserve training program.

Training takes place one weekend a month for which members are paid for four days inactive duty, according to grade.

Complete data on this program may be obtained by writing: Commanding Officer, 914th Air Reserve Training Wing, Mitchell Air Force Base, N. Y., Att: Recruiting Information. —30—

NEW TV PRODUCTS on the Market

SOUND AMPLIFIER

Vidaire Television Company, 576 W. Merrick Road, Lynbrook, New York has introduced a new push-pull sound amplifier for use with television receivers having a single tube for sound output.

In cases where the receiver has been designed without consideration being given to sound tone quality, by removing the 6K6, 6V6, or 6Y6 sound output tube and plugging in the company's A-130 amplifier, the over-all frequency response of the sound system is increased. The amplifier is flat within 1.5 db between 80 and 20,000 cycles.

TV BOOSTER

Blonder-Tongue Laboratories of 38 N. Second Avenue, Mt. Vernon, N. Y. is in production on an improved version of the company's "Home Antensifier".

Designated the Model HA-2-M, this unit covers all channels and is fully automatic. It has no knobs or controls and turns on and off with the TV set operation by means of an automatic, silent thermo-relay power switch.

Featuring an improved 4-tube chassis with 4-stage cascaded amplification

and a push-pull circuit, the new model has an average gain of 16 times (24 db) over all channels.

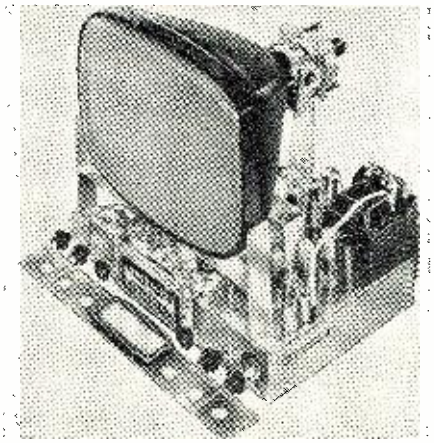
The unit is housed in a compact metal cabinet finished in mahogany hammertone. It may be installed in less than 1 minute, concealed or displayed.

TV CHASSIS

Regal Electronics Corporation of 605 W. 130th Street, New York, New York has just released a new television chassis which has been designed especially for fringe area applications.

The powerful 22-tube chassis, capable of driving 16", 17", 19", and 20" cathode-ray tubes, has a horizontal automatic frequency control which has been tradenamed "Regalok". It has a 70 degree yoke with ample sweep to cover a 20" television picture tube without shadows.

The set also includes a turret type tuner, a high gain video amplifier, four stages of i.f. amplification, a power line



filter, and sync clamping to insure absolute sync hold.

The new chassis are now available at parts jobbers and distributors.

CR TUBE EXTENSION

General Cement Manufacturing Company, 919 Taylor Avenue, Rockford, Illinois, has devised a new picture tube extension which is said to speed servicing work and facilitate custom installations.

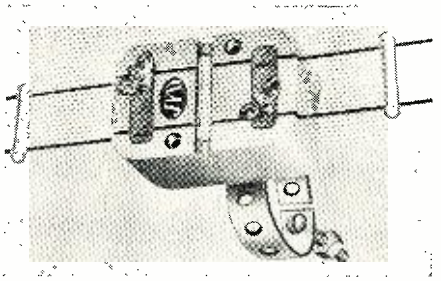
The No. 8689 permits the chassis to be removed without disturbing the picture tube, as the picture tube can be mounted away from the chassis, thus allowing flexibility in custom-built TV cabinets.

The extension measures four feet in length and is heavily insulated with positive contact receptacles.

OPEN LINE ARRESTER

JFD Manufacturing Company, Inc. 6101 Sixteenth Avenue, Brooklyn 4, N. Y., has developed an open line lightning arrester, the Model AT107.

The new arrester is constructed of high dielectric porcelain. Under its



clear polystyrene cover positive contact can actually be seen when in use. The unit is permanently sealed against temperature and humidity changes. Its nickel-plated brass hardware provides lasting corrosion resistance.

Packaged with four feet of ductile aluminum ground wire, the arrester is equipped with a perforated steel strap for wall, window sill, or grounded pipe mounting.

TV ATTENUATOR

International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa., has announced the availability of a new television attenuator which permits the quick reduction of undesirable effects on picture and sound caused by excessively strong signals.

Known as the QJ-3, the new unit provides signal attenuation from approximately 0 to 70 db. Easily installed, the attenuator permits the adjustment of signal level to overcome such undesirable effects as adjacent channel interference, background picture on weaker stations, horizontal or vertical patterns in picture, poor picture definition, annoying hum or buzz, and picture and sound breakover, when caused by excessive signal strength.

The unit may also be used in service work to duplicate fringe area signals when the shop is located near a strong local station.

MALLORY U.H.F. CONVERTER

A u.h.f. converter which is ready to be put on the market as soon as channels have been assigned for commercial telecasting in the u.h.f. region has

been announced by *P. R. Mallory & Co., Inc.,* Indianapolis 6, Indiana.

The new unit is entirely self-contained including the built-in u.h.f. antenna. No changes need be made in any part of the television receiver with which the converter is to operate. The converter cabinet design and slide-rule dial make it suitable for use with any v.h.f. receiver.

Two designs will be available, one having an i.f. of 127 mc. for use with v.h.f. receivers employing a *Mallory* six-turn "Inductuner," the second incorporating an i.f. output at v.h.f. Channel 5 or 6 for use with v.h.f. receivers employing switch-type tuners.

TUBE REACTIVATOR

Transvision Inc. of New Rochelle, N. Y., has just released a new cathode-ray tube reactivator which is portable, self-powered, and completely self-contained.

Because the unit weighs only 3 pounds, the reactivation of the CR tube can be performed in the customer's

home, if necessary, without removing the picture tube from the television set. In the majority of cases the reactivation is complete and permanent, amounting to a virtual rejuvenation.

The unit will not work on broken filaments, broken glass, or shorted components.

Further information on this unit is obtainable from Dept. DG of the company.

NEW 21" TUBES

The Cathode-Ray Tube Division of *Allen B. Du Mont Laboratories, Inc.,* Clifton, New Jersey has made available to the trade two new all-glass 21" rectangular TV picture tubes.

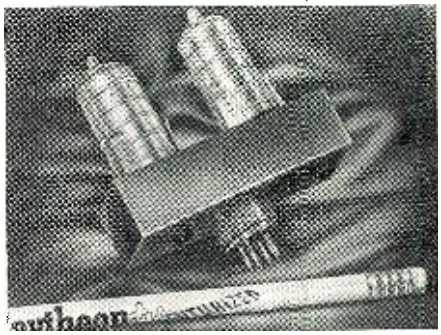
Designated the Types 21EP4A & 21KP4A, the new tubes employ the same all-glass bulb which results in a picture area of 242 square inches, larger than the previous metal-cone 21" tubes. The screen face is made of filter-glass for minimizing reflections and improving contrast.

The 21EP4A uses the company's bent gun for electromagnetic focusing. A single magnet ion trap is used. The 21KP4A is one of the new "Selfocus Teletrons" requiring no focus controls or circuity. It provides absolute focus at all times. This tube may be used as a replacement for either electromagnetic or electrostatic focusing type tubes.

FRINGE-POWER AMPLIFIER

Raytheon Manufacturing Company, Newton, Massachusetts, has developed a new fringe-power amplifier which has been designed to improve TV reception up to 38 per cent in rural areas.

The new amplifier unit may be in-



stalled by simply plugging it in. It is designed to provide added sound amplification where picture performance has outdistanced the receiver's ability to pick up the accompanying sound.

DEFLECTION YOKES

Standard Transformer Corporation, 3580 Elston Avenue, Chicago, Illinois,

has added two new deflection yokes to its line of TV replacement parts.

The DY-8 and DY-9, with cosine distributed windings designed to provide anti-astigmatic focusing over the entire picture tube area, are both 70 degree ferrite core units with coils wound on nylon bobbins.

The DY-8 has a horizontal inductance

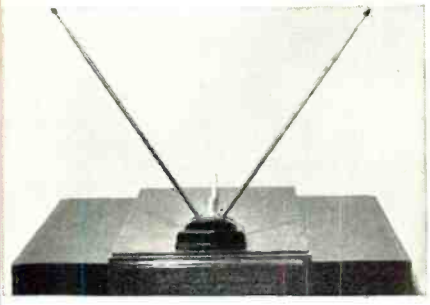
of 8.5 mhy. while the DY-9 has an inductance of 13.5 mhy.

Bulletin 387 describes these new *Stancor* units in some detail. A copy is available on request.

INDOOR ANTENNA

Insuline Corporation of America, 36-02 35th Avenue, Long Island City 1, New York, is currently distributing a new table-top antenna of simple design, rugged construction, and attractive appearance.

Tradenamed the "Meteor," the new unit has two nickel-plated arms which are adjustable in length from 15 to 38 inches and are hinged so that they can



be closed in completely or opened out flat. A weighted base with a padded bottom permits the antenna to be oriented quickly for best reception. A four-foot length of 300 ohm lead, fitted with spade lugs, is included.

SHELDON TUBE

The *Sheldon Electric Company* of Irvington, New Jersey has recently announced the availability of a new, all-glass 21" rectangular, low voltage, electrostatic focus TV picture tube which features a special no-glare cylindrical face.

Known as the 21FP4A, the new tube eliminates glare by using a cylindrical face by means of which annoying reflections are thrown below the level of the viewers' eyes by tilting the tube to an almost unnoticeable degree.

Volume production is expected to be reached on these tubes in the very near future.

—30—

Geiger Counter

(*Continued from page 37*)

mounting hole of the carrying handle also secures the bottom of the lucite block and the meter. One other screw at the top of the meter provides adequate fastening.

Condensers C_6 and C_7 are mounted in the top end of the case, adjacent to the meter, with their mounting strips spot soldered to the case. Flexible leads are first attached to the condensers to permit wiring them into the circuit at final assembly. Two condensers are used in parallel here to obtain sufficient capacity in the available space.

After all the metal work is completed, the finished case is spray painted with automobile enamel or hammertone lacquer and the result is an exceptionally sturdy and finished-appearing product.

All other components, except the phone jack, are mounted on a small sub-chassis, 2½ inches wide by 3¾ inches long, with a ½-inch lip at the rear and a 1½-inch lip at the front. The sub-chassis is held to the case by three holes in the front lip, through which pass the mounting bushings of the two toggle switches and the voltage-adjusting potentiometer. This potentiometer shaft is fitted with a small knob and is prevented from accidental turning by the guard formed by the upper end of the carrying handle and a piece of ¼-inch diameter metal rod. The rod is located so that it just clears the knob and is mounted to the handle by a machine screw, after first drilling and tapping one end of the rod.

Looking at the rear of the sub-chassis, Fig. 4, the three tubes are mounted in line across the rear, with V_4 at the top, V_1 in the center, and V_2 at the bottom. The three high voltage condensers, C_4, C_5, and C_8, are mounted in line between the tubes and the rear of the meter case. The particular condensers specified are conveniently mounted to the chassis by use of the screw terminals provided at either end of the units. It is necessary to use insulating washers when mounting C_8, as one end of it does not go directly to ground.

The transformer, T_1, and reactors, CH_1 and CH_2, are mounted in line on the bottom of the sub-chassis, as observed in the photographs. In Fig. 4, T_1 is at the extreme bottom, and is mounted on an insulating disc of lucite, 1-inch in diameter and ⅜-inch long. The method is to attach the disc to the transformer by two holes drilled through the disc and deeply countersunk for flathead machine screws, to provide electrical clearance from the screws to the chassis. The disc and transformer assembly is then held to the chassis by a hole drilled halfway through the disc and tapping the hole for a machine screw. The transformer operates with high peak voltages and the windings will break down to the case if it is not insulated from the chassis. The proper connections for T_1 are indicated in Fig. 2 by the encircled numerals, which refer to the numbered terminals on the actual transformer.

It is most important that well insulated hook-up wire be used when wiring the instrument. If the insulation is not adequate, undue leakages and voltage breakdowns will certainly occur. A plastic-insulated wire, such as *Belden* Type 8913, is recommended.

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13. *Leslie, E.; "The Geiger Counter—How Does it Work," Radio-Electronics, September 1949, p. 22.*

—30—

DRILLING LARGE HOLES

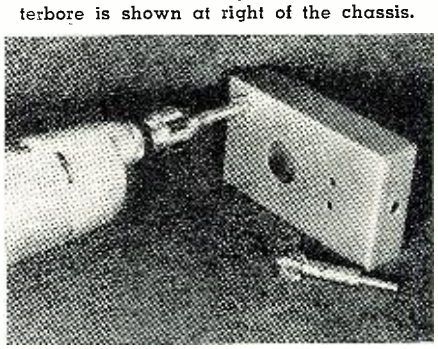
By RUFUS P. TURNER, K6AI

THE technician who must get along with a small electric drill will be interested to learn that clean, "drill press-type" large holes can be cut easily with counterbores operated in the electric drill. Counterbores require small pilot holes which keep them running true while doing the cutting. They never give egg-shaped or triangular holes, the woe of electric drill users, whether the stock is a thin chassis or ¼-inch panel.

The high-speed type counterbore should be used. Essential sizes for radio work are ⅜" for volume controls, rotary switches, pilot lights, and socket punches; ½" for toggle switches and binding post plates; and ¾" for 9-pin miniature sockets and large pilot lights.

—30—

Using a counterbore in an electric drill. A clean, ⅜" hole is being cut. A ¾" counterbore is shown at right of the chassis.



Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO & TELEVISION NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

CLAROSTAT CATALOGUE

Clarostat Mfg. Co., Inc., Dover, New Hampshire has issued a concise technical catalogue which has been designated No. 51.

Most of the space in the publication is devoted to extensive listings of types and values of resistors and controls. Items listed are standard and include carbon and wirewound controls of various types and sizes, attachable shafts and switches, rotary switches, constant-impedance controls and sound system attenuators, tube-type resistors and ballasts, line voltage regulators, fixed and adjustable power resistors, power rheostats, glass-insulated flexible resistors, TV beam benders, and the company's resistor decade box.

Copies are available from *Clarostat* distributors or from the company direct.

SERVICE HINTS

Readers of this magazine are being offered a free copy of a newly published booklet "How to Simplify Radio and TV Repairs" by *Feiler Engineering Co.*, 8026 N. Monticello Avenue, Skokie, Illinois.

The booklet, which normally sells for 25 cents a copy, contains helpful data on radio and TV servicing and outlines the advantages of signal tracing techniques.

When requesting copies of this publication, readers are asked to mention RADIO & TELEVISION NEWS.

RELAY CATALOGUE

Advance Electric & Relay Co., 2435 North Naomi Street, Burbank, California is currently offering a copy of its new relay catalogue to interested persons.

This two-color catalogue illustrates and describes the company's complete line of standard and special relays and includes detail data, dimensions, contact combinations, circuitry, and prices.

Among the units covered are circuit controls, radio and h.f. keying, midget, aircraft, coaxial, hermetically-sealed, and special purpose types.

RECTIFIER DATA

A booklet containing a reprint of the article "Metallic Rectifier Design and Application" is being offered by *Radio Receptor Company, Inc.*, Seletron Rectifier Division, 251 W. 19th Street, New York 11, N. Y. to interested persons.

Written by Julian Loebenstein, the article is thoroughly illustrated with application photographs, drawings, diagrams, and charts. It reviews the background of metallic rectifiers and clarifies the various factors in their application to electronic circuits.

Copies will be forwarded without charge to persons making their requests direct to the company.

TV-RADIO CATALOGUE

Star Electronics Distributors, Inc., 7736 S. Halsted Street, Chicago 20, Illinois, has announced a new 52-page "Winter-Spring Bargain Catalogue."

Designated Catalogue No. 12, the new publication lists a complete line of both standard and bargain merchandise. Thousands of items for service technicians, manufacturers, experimenters, amateurs, and engineers are listed.

Included are speakers, baffles, antennas and accessories, TV components, receivers, cabinets, record changers, and many other items.

TRANSFORMER CATALOGUE

The Halldorson Company, 4500 N. Ravenswood Avenue, Chicago 40, Illinois has issued a new and comprehensive catalogue-manual which includes not only a complete television and auto replacement guide but also other useful information to make it handy sales manual as well as a catalogue.

Items have been renumbered for quick selection and easy use. The publication features the latest developments, including an up-to-date listing of television replacements such as flyback transformers, deflection yokes, focus coils, and other components.

A copy of the new catalogue may be obtained from any of the company's authorized distributors or from the company direct.

TV SERVICE GUIDE

General Electric Company's new and comprehensive television service guide is currently available to service technicians, dealers, and distributors.

This 80-page publication is designed for easy "on-the-bench" reference, each page opening flat, the paper dirt and fingerprint-resistant.

The new guide contains schematic diagrams with circuit symbol numbers, tube locations, top and bottom chassis views and cabling diagrams on combination sets, accurate information on 102 *G-E* chassis, plus 10 r.f. tuners used in 86 TV chassis. A picture section identifies every postwar *G-E* television set made from 1945 through present production models including the 24 inch chassis, plus color code charts for resistors and condensers.

The guide is priced at $1.00 and is available from the company's distributors or from the company at Syracuse, New York.

COLOR CODE CHART

The first color chart to include all the color-coding requirements of the entire electronic industry has been

prepared by *Centralab Division* of *Globe-Union Inc.*, Milwaukee, Wisconsin.

Printed in eleven colors with over 3300 color dots or marks, the new color code chart is especially suited for use by electronic engineers, in research and educational laboratories, by purchasing and production men, by radio and TV service engineers, and by distributors of electronic equipment.

Color coding outlined on the new chart includes that of transformers, battery cables, antenna and ground leads, telephone switchboard cable, RTMA and JAN mica, paper, and ceramic condensers, standard values of fixed composition resistors, miscellaneous condensers and resistors, electrodynamic speakers, and radio and television chassis.

Initially, distribution will be made through the company's representatives and jobbers. Later it will be made available to anyone at a nominal charge. The chart measures 36 inches high and 30 inches wide.

RECTIFIER HANDBOOK

The Rectifier Division of *Sarkes Tarzian, Inc.*, Bloomington, Indiana has compiled a new "Selenium Rectifier Handbook" which has been designed for engineers, service technicians, hams, and experimenters.

The handbook contains 48 pages which cover radio-television type rectifiers, and schematic diagrams on how to use these units. Seven pages are devoted to replacement information, while 25 pages cover power and high voltage selenium rectifiers with isothermal, frequency, and reverse characteristics.

The booklet will be sent free to engineers but service technicians, amateurs, and experimenters may obtain a copy by sending in 50 cents with their requests.

ALLIED CATALOGUE

Of interest to service technicians and custom builders is the new special supplement No. 128 recently released by *Allied Radio* of 833 W. Jackson Blvd., Chicago 7, Illinois.

This 16-page booklet lists latest television and radio releases and includes tuners, boosters, tape recorders, converters, a.c.-d.c. receivers, record changers, phonograph components, television accessories, TV antennas, TV chassis, test equipment, communications equipment, tools, and cabinets.

POCKET REFERENCE BOOK

The Tube Department of *Radio Corporation of America* has again published its "Pocket Reference Book" which is issued annually for the benefit of dealers, service technicians, and industrial users.

Available at all *RCA* distributors, the new book has been completely revised and expanded to include information on *RCA* products introduced during the current year. The booklet also contains complete product listings and comprehensive data on the char-

acteristics, interchangeability, and socket requirements of more than 450 *RCA* receiving tubes, including kinescopes. It provides similar data on 75 dry batteries.

Fundamentals of television and some helpful hints on television trouble-shooting, compiled by John Meagher, are also included along with a 56-page daily diary for 1952, calendars for 1952 and 1953, and 16 pages of full-color maps.

WIRING DEVICES

Over 1000 individual electrical wiring devices are listed and described in the new 40-page catalogue just issued by *Rodale Manufacturing Co.* of Emmaus, Pa.

Known as "General Catalogue No. 51-1952," the new publication includes hundreds of items that are of particular interest to the radio and electronics industries.

A copy of the catalogue may be obtained from the company without charge.

"HIGH FIDELITY GUIDE"

Lafayette Radio, 100 Sixth Avenue, New York 13, New York is currently offering copies of its new 1951-1952 "High Fidelity Guide."

This new, fully-illustrated, 32-page manual and catalogue is one of the most complete publications of its kind. It lists high fidelity components of all the leading manufacturers, complete radio-phonograph and television systems, home installations, and finished cabinets. The booklet also carries a complete explanation of the term "high fidelity," the requirements of a high fidelity system and its components, and details on how to plan such a system for the home.

REPLACEMENT MANUAL

Sprague Products Company, North Adams, Massachusetts now has available for distribution the 4th edition of its "TV Replacement Capacitor Manual."

Containing accurate, up-to-the-minute condenser replacement data on a total of 1561 receiver models made by 63 companies, the new book is printed in dark brown ink to distinguish it from earlier editions.

The publication gives complete, set-by-set listings of original equipment condensers and their recommended *Sprague* replacements. Rating data and manufacturer's part numbers are listed for the original unit while the *Sprague* catalogue numbers and electrical specifications are given for the replacement unit.

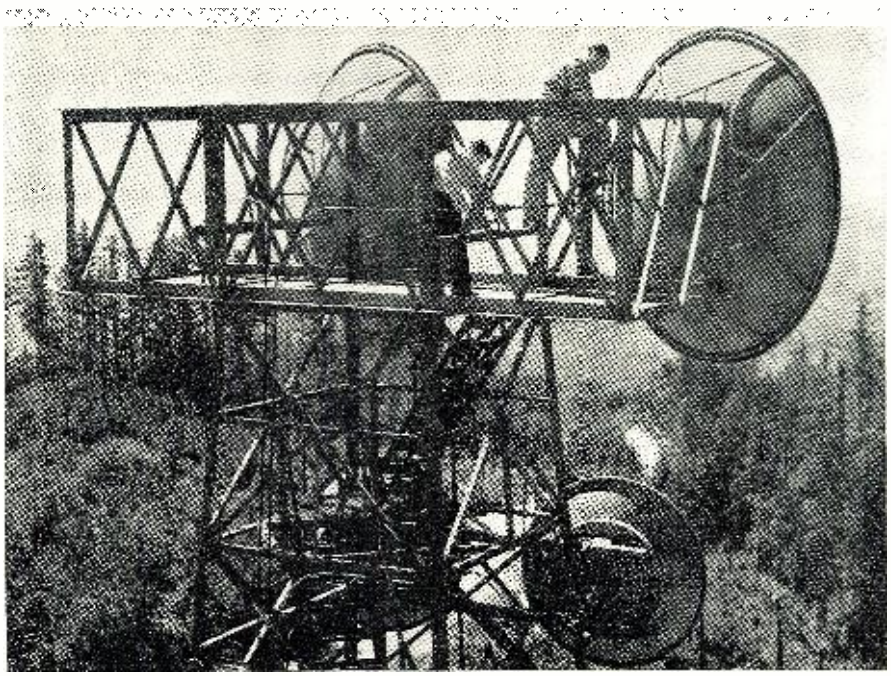
Free copies of the new manual, publication M-481, are available from local *Sprague* distributors or may be obtained from the company direct upon receipt of 10 cents to cover mailing and handling.

ANTENNA MOUNTS

South River Metal Products Co., Inc. of South River, New Jersey has published a comprehensive catalogue covering its line of antenna mounts and accessories.

Designed especially for dealers, service technicians, and jobbers, the new catalogue lists chimney mounts, wall brackets, adjustable wall brackets, a combination wall bracket, and a duo-pipe mount. Other types of hardware are also featured. —30—

Microwaves, in a vast communications system, span the rugged terrain of the Pacific Northwest for the Bonneville Power Administration. At the present time they have 200 miles of microwave circuits in operation and expect to have at least 1400 miles during the next five years. Workmen in the picture are shown completing installation of a giant parabolic antenna on microwave tower near Squak Mountain in northwest Washington. Like TV, microwaves are reflected and beamed from station to station.



Quality Control

(*Continued from page 49*)

The new electrostatic focus, magnetic deflection tubes can be tested fully in this test set. An Indian-head pattern generator supplies a uniform video picture for making quick resolution tests. Since electrostatic focus tubes such as the 17HP4A, 20HP4A, and 21FP4A, vary in focus voltage with the ion trap position, a uniform method of testing these tubes must be established. The procedure is to first set the brightness at a low level and adjust the ion trap for maximum light output. This operation assures the tester that the beam is clearing the gun apertures. If the ion trap is not adjusted for the maximum light condition, there is a possibility that the electron beam will actually melt a new "aperture" into the electron gun parts. When the ion trap has been set up, the focus anode voltage is then varied to achieve the best line structure (vertical resolution) and the best horizontal resolution as evidenced by the vertical wedge in the Indian-head pattern. The voltage for best over-all focus should occur within the limits specified. Focus voltage also varies slightly with grid No. 2 voltage and with anode voltage. In order that a complete engineering analysis can be made on the various types of electron guns, a variable width pulse generator and synchronizing unit are available.

Besides its use in development work, production recorded readings, and life test data, the engineering test set is also used to analyze all test rejects. Data on these rejects is supplied to the engineer concerned so that he may take immediate steps to correct the process or material at fault.

The use of such an engineering test set by engineers and production men results in an over-all increase of the product quality level. Every attempt is made to ensure its full use, and low scrap rates are proof of its benefits.

—30—

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38, 96	The Radio Craftsmen
49	Raytheon Manufacturing Company
52, 59 (right)	Radio Corporation of America
59 (left)	Majestic Radio & Television
59 (center)	Argos Products Co.
62	General Electric Company
70	David Bogen, Inc.

ERRATA

In the International Short-Wave Department appearing in the December, 1951 issue an error was made in the item "Stability of BBC Outlets." Mr. H. F. Smith, editor of "Wireless World," has pointed out that the BBC transmissions are maintained to within one part in one million (10^6) of their nominal values instead of the one part in ten as stated in the column. Our apologies to BBC and our thanks to Mr. Smith for calling this error to our attention.

* * *

In Fig. 3 (Page 49, November, 1951 issue) of the article "An Audio Amplifier with 'Presence,'" the pin numbers for the 6SD7 tube have been inadvertently interchanged. Pin 4 should be numbered 6 and vice versa.

* * *

In the article "A Combination Phonograph-Tape Recorder," the diagram of Fig. 3 appearing on Page 46 of the November, 1951 issue shows resistor R_{12} connected to ground. It should, of course, be connected to "B+."

Classified

Rate 50c per word. Minimum 10 words

RADIO ENGINEERING

RADIO Engineering Broadcasting, Aviation and Police Radio, Servicing, Marine Operating and Electronics taught thoroughly. Expenses low. Write for catalog. Valparaiso Technical Institute, Dept. N, Valparaiso, Ind.

SALE

WIRE recorder foundation mechanism, Webster Chicago 78,.$30.00. Wurlitzer Jute Box 16, record mechanism, $15.00. Henry H. Jensen, UGD, Ogden, Utah.

TOWERS: 100-foot galvanized steel, bolted, sectional, 12-foot square base, pyramidal. Ideal for long distance TV and FM antenna mounting, Penn Albert Hotel, Greensburg, Pa.

DIAGRAMS Radio, Record Changers, Recorders, 75c; Television with Service Data, $1.25 up. State manufacturer and model number. Kramer's Radio Service, Dept. N8, 36 Columbus Ave., New York 23, N. Y.

HOTTEST surplus list in the country. Electronics-Hydraulics, Aircraft-Gadgets. Dick Rose, Everett, Wash.

HEARING aids, used. Zeniths, less accessories, $7. One-piece Nationals, $10. One-piece overhauled, with accessories, $20.00. Shelby Instrument, 321 W. 7th St., Long Beach, Calif.

TUBES, surplus, bought-sold. Free list. Betz, 73 Caroline Ave., Yonkers, N. Y.

AMERICA'S favorite, "The Tuffy Tower," 20' television tower, easy to erect and safe to climb. May be made 40' by telescoping pipe through tower. Complete with peak roof saddle hinged mount. F.O.B. $25 net. Youngstown Steel Towers Co., 1825 Wilson Ave., Youngstown 8, Ohio.

TV and FM Antennas. Yagi, Conical, Bow-Tie. Mounts, accessories. Lowest prices. Wholesale Supply Co., Dept. H, Lunenburg, Mass.

WANTED

RG-8-U, RG-11-U or RG-59-U coaxial Cable, any lengths, any quantities. Write: Television Service Co., 249 N. 48th St., Lincoln, Nebr.

AN/APR-4, other "APR-," "ARR-," "TS-," "IE-" ARC-1, ARC-3, ART-13, everything surplus; Tubes, Manuals, Laboratory equipment. Describe, price in first letter. Littell, Farhills Box 26, Dayton 9, Ohio.

WANTED: The following sets, parts or equipment associated with: BC-611 handie-talkies; ARC-1; ARC-3; ARN-7; BC-342, 312; R-89B/ARN-5; T-47, 47A/ART-13 & dynamotor; F-21/ARA-9 audio filter; RT-7A/APN-1; APN-2; APN-9; BC-348; MG-149; BC-733D; BC-966A; DM-32A; BC-453B; CRT-3; SCR-522; plus all types test equipment. Top Dollar paid. Write: Robert Sanett, Dept. WC, 4668 Dockweiler, Los Angeles, Calif.

WANTED: ARC-1, ART-13, TCS-12, BC-348, BC-342, BC-312, BC-221, BC-654A, RA-34, PE-103A, PE-104A, manuals, Radar, tubes, test equipment. Arrow Appliance, 525 Union, Lynn, Mass.

HELP WANTED

RADIO Officers, $7,200-$10,000 annual earnings, top union conditions, 6 months Radio Operating experience U.S. Merchant ships on FCC License since Jan., 1935, can get emergency FCC License to sail at once. Also experienced U.S.N. Radiomen with 2nd class Radiotelegraph license & 6 months sea Radio time. Phone, write, wire American Radio Association, CIO, 5 Beekman St., New York. CO 7-6397.

CORRESPONDENCE COURSE

USED Correspondence Courses and Books sold and rented. Money back guarantee. Catalog free. (Courses bought.) Lee Mountain, Pisgah, Ala.

RADIO Servicing Course shows latest short cut methods. Lessons easy to follow. Only $3.00, postpaid in U.S.A. Buyers Syndicate, 30 Taylor St., Springfield, Mass.

MISCELLANEOUS

SPEAKERS repaired, wholesale prices, guaranteed workmanship. Amprite Speaker Service, 70 Vesey St., New York City 7.

RADIO Television, Trade Gazette; stamp please. Trowbridge, 655 W. 81st St., Chicago.

FEBRUARY 1952

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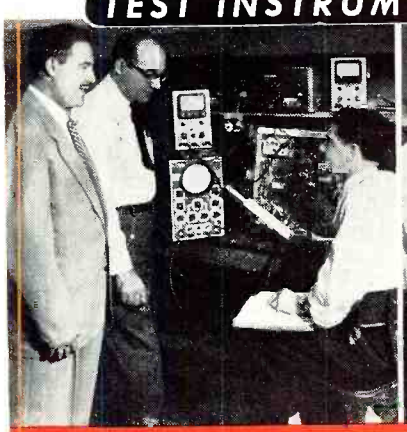
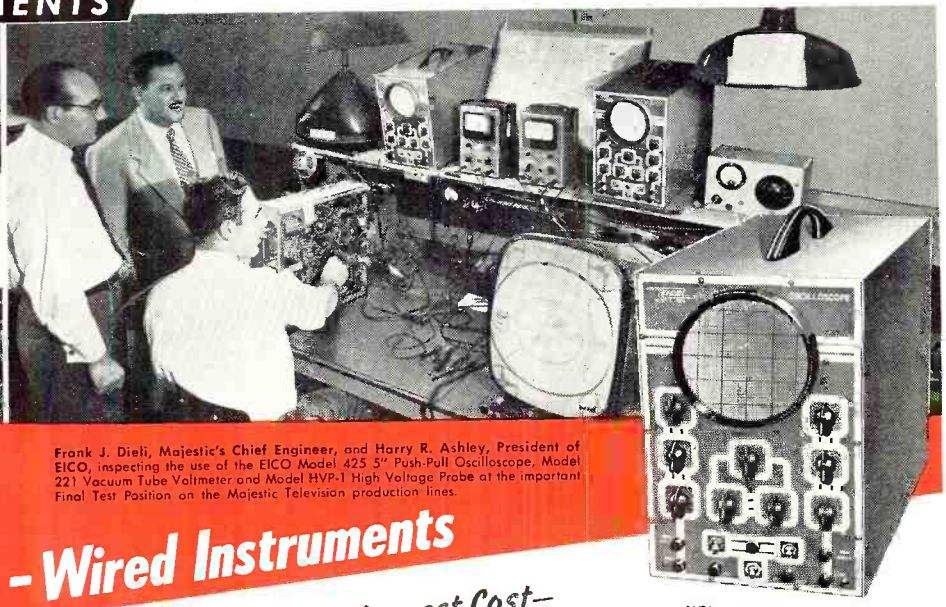


In the Majestic design laboratories, Frank J. Dieli and assistant, Paul Smith, discuss with Harry R. Ashley, some important prototype-circuit measurements just taken with the 425 Oscilloscope, #221 VTVM and #HVP-1 HV Probe.



Frank J. Dieli, Majestic's Chief Engineer, and Harry R. Ashley, President of EICO, inspecting the use of the EICO Model 425 5" Push-Pull Oscilloscope, Model 221 Vacuum Tube Voltmeter and Model HVP-1 High Voltage Probe at the important Final Test Position on the Majestic Television production lines.

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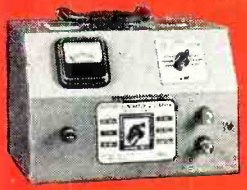

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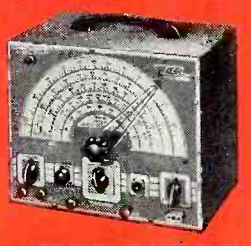

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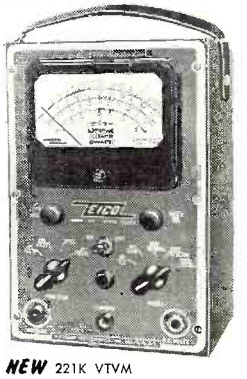

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