Leakage Checker For Your VTVM

What Do I Need to Start TV Servicing?

Build a Better Short-wave Antenna

Is That Pix Tube Really Gone?

"PACKAGES OF GAIN" IN NEW TRANSISTOR STEREO PREAMP

See page 32
are you replacing top quality tubes with identical top quality tubes?

Now you can carry the identical tubes that you find designed into most of the quality TV sets you service. Chances are, you were not aware that these TV sets were designed around special Frame Grid tubes originated by Amperex and that even more tube types originated by Amperex are being designed into the sets you'll be handling in the future. Amperex frame grid tubes provide 55% higher gain-bandwidth, increase TV set reliability by simplifying circuits and speed up your servicing because their extraordinary uniformity virtually eliminates need for realignment when you replace tubes.

Tubes introduced by Amperex, currently used by major TV set makers include:

<table>
<thead>
<tr>
<th>Frame Grid</th>
<th>Others</th>
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<tbody>
<tr>
<td>2GK5</td>
<td>4GK5</td>
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<tr>
<td>2ER5</td>
<td>4EH7</td>
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<tr>
<td>3GK5</td>
<td>4EL7</td>
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<tr>
<td>3ER7</td>
<td>4ER8</td>
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</table>

For optimum satisfaction for your customers and a better profit operation for yourself, make room in your caddy now for these matchless-quality tubes. Next time you visit your distributor, look for the green and yellow boxes and enjoy confidence in your work such as you never have before. Amperex Electronic Corporation, Hicksville, L. I., New York.
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Watch Those Batteries!

Major Improvements for Short-Wave Reception
Vertical antennas for DX
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Superregenerative set uses 3 transistors
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[Image with text and pictures related to electronics training and equipment]

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Frequency-Modulated Lasers

A laser control technique that may lead to practical light-beam communications systems has been announced by Dr. James Hillier of RCA Labs. It uses magnetic fields to tune, modulate or pulse the light inside the laser crystal before it is emitted.

"This promises to make practical laser radars that can be pulsed 100,000 times a second, and new high-capacity communications systems that can be tuned over the widest spectral range ever received," reported Dr. Hillier.

"While lasers have existed since 1960 as sources of coherent light, their practical application has been limited by the lack of effective means for controlling the character of their output. In effect, we have had a high-frequency radio transmitter with no satisfactory means for broadcasting programs over it or tuning them in at the receiver."

"Other techniques for so doing have been developed recently, but they have all depended upon elaborate electro-optical systems outside the laser and have suffered from inefficiency, power loss and alignment problems. These are completely absent in the new approach that we have now developed."

Handicapped Inventor Honored by Iran

Emik Alexander Avakian, cerebral palsy victim whose inventions include a breath-operated typewriter, was decorated this spring by his native country, Iran. He received the Order of the Crown from the Shahanshah of Iran, less than a year after he was singled out by President Kennedy for the President's Trophy as the Handicapped American of the Year.

Robert C. Duncan of RCA Labs adjusts the focus of a solid-state receiver which detects the information-bearing laser beam generated by the device in the foreground and shot to the detector by the prism.

So severely handicapped that he cannot hold a pencil, Avakian has invented a knee-operated control panel for his electrical equipment and an automatic telephone arm.

A supervisory electronics engineer with the Telex Corp., Stamford, Conn., he has played a major role in the development of a class of solid-state data communications terminals, a signature-verification technique for banking systems, a microfilm information-retrieval system, and the automated voice-response system for the Televox computer.

His current project will use computer technology to control radiation beams directed at damaged portions of the brain that cause handicaps like his own. Described by Avakian as "bloodless surgery", the system will select the minute sections of the brain that are damaged and destroy them without side effects to healthy tissues. Computer technology not only con-
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JULY, 1963

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RR Scanner Works Fast

Railroad cars going 60 mph are identified and recorded by Sylvania Applied Research Lab's high-speed electronic scanning system. Dr. James E. Storer, ARL director, claims the system.

A prototype, being tested at Woburn, Mass., with the cooperation of the Boston & Maine Railroad, reads and prints out the directions and serial numbers of commuter cars passing to and from Boston. Each car bears a 6-inch-wide pattern of reflective color strips—one strip for each digit. An automatic scanner, installed at trackside, "reads" these colors; a decoder translates them into numbers, and they are printed on tape and sent to a central record hub.

TV-Radar in N.Y. Harbor

A new experimental RATAN (Radar and Television Aid to Navigation) station (Radio-Electronics, June 1962, p. 72) will be built by Raytheon Co. in Upper New York Bay. RATAN gives mariners a television picture of the harbor that can be received on any uhf TV receiver. Fixed objects appear as they would on a chart of the area, and moving ships have wakelike trails behind them. The 100-watt Raytheon 1605 radar transmitter will send out its signals from a 140-foot-high tower at Bayonne, giving it an ERP (Effective Radiated Power) of 750 watts.

Henry New FCC Chief

William Henry has been appointed chairman of the Federal Communications Commission, replacing Newton Minow, who resigned to return to the Encyclopaedia Britannica, where he will serve as vice president and general counsel.

Henry, a lawyer, is 34, the youngest chairman the FCC has ever had. He is expected by the industry to continue his predecessors' policy of pushing for the public interest as against overcommercialization. Though some predicted that the new commissioner would be even "tougher" than Minow, his own statements at a press conference held shortly after his appointment were moderate. "There are green shoots in the wasteland," he told the assembled reporters.

Brain Waves Cross Ocean

RELAY, the NASA communications satellite, was used this spring to send electroencephalograms (brain waves) from Bristol, England, to Minneapolis, Minn. The waves were sent from the Burden Neurological Institute in England via land line and

Part of New York Harbor, as seen on RATAN. Rows of double dots are channel buoys. Tadpole-like objects are moving ships.
Here's what they're saying about Sarkes Tarzian's free new booklet, "Lower the Cost of Fun with Tape Recording..."

"The vigor of this presentation proves that Tarzian is interested in getting this country (and tape recording) moving again...everyone should walk to their nearest tape store and request a copy...or walk to Bloomington"  
...(name withheld on request)

"Contains a modest but penetrating analysis of why Tarzian Tape is perhaps the least-known superior product in the United States today"  
...Committee for Truth in Tape Promotion

"A four-star ringer-dinger...understand three studios have been beating down the Tarzian doors seeking movie rights"  
...Hedda Winchell

"The chapter dealing with recording of short wave broadcasts blatantly lays bare more capitalistic tricks for spying on peaceful communications of our people's democracies"  
...Havana Times

"The chapter entitled 'Use Tape in Your Business' is a bold statement of Tarzian confidence in traditional American enterprise"  
...Hall Street Journal

"A four-star ringer-dinger...understand three studios have been beating down the Tarzian doors seeking movie rights"  
...Hedda Winchell

"I agree"...Harry Goldwater

"'Invite Tape to Your Party' is the chapter that puts the bright light of public inspection on those 'friendly get-togethers' in suburbia"  
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From SENCORE, designers of the famous Mighty Mite Tube Tester and other valuable time savers, comes another industry best. An all new method of testing and rejuvenating picture tubes. Although the method is new, the tests performed are standard, correlating directly with set-up information from the RCA and GE manuals.

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Checks all picture tubes thoroughly and carefully: checks for inter-element shorts, cathode emission, control grid cut-off capabilities, gas, and life test.

Automatic controlled rejuvenation. A Sencore first, preventing the operator from over-rejuvenating or damaging a tube. An RC timing circuit controls the rejuvenation time thus applying just the right amount of voltage for a regulated interval. With the flick of a switch, the RC timer converts to a capacity type welder for welding open cathodes. New rejuvenation or welding power can be re-applied only when the rejuvenate button is released and depressed again.

Uses DC on all tests. Unlike other CRT testers that use straight AC, the CR125 uses well filtered DC on all tests. This enables Sencore to use standard recommended checks and provide a more accurate check on control grid capabilities. This is very important in color.

No interpretation chart. Two "easy view" neon lights clearly indicate shorts between any element. A chart is included for interpretation of shorts, if desired. This chart is not necessary for normal testing on the CR125.

No adaptor sockets. One neat test cable with all six sockets for testing any CRT. No messy adaptors, reference charts or up-dating is required. The Sencore CR125 is the only tester with both color sockets. (Some have no color sockets, others have only the older type color socket.)

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the British transmission station at Goonhilly to RELAY, then back down to the receiving station at Nutley, N. J., and by land line to Minneapolis. There the signal was fed to a computer which printed out the data, and a diagnosis was made. Within 1 minute, the results were interpreted and sent back to England.

The process had never before been tried, but Dr. Reginald G. Bickford of the Mayo Clinic says the test may point the way to its widespread use. Long-distance diagnosis of brain disorders, showing which part of the brain is affected, can be helpful to underdeveloped countries, where diagnosis would otherwise require a trip by the patient.

UHF May Rescue Schools, Engineers Told

UHF-TV can avert a major school crisis in 1970, stated I. S. Blonder, chairman of Blonder-Tongue Labs, Inc., in a recent talk before the Newark (N.J.) College of Engineering. He said a vast number of UHF-trained electronic engineers will be needed to help in this effort.

"Without new teaching aids, our school system would require hundreds of thousands of new teachers by 1970, and a yearly budget of $20 billion to educate a swelling enrollment of 44 million students," he declared. "Faced with conditions such as these, educational TV is not just a convenience; it is a necessity."

The present VHF framework, overcrowded with its current 533 channels, leaves no room for ETV. But last year's all-channel TV legislation cleared the way for 1,500 new UHF allocations. If ETV gets its share of these, says Mr. Blonder, a severe teacher shortage can be avoided.

Telstar Rides Again

Experimental communications satellite Telstar II was launched early in May. The new Telstar's orbit takes it much farther from earth at apogee—6,713 miles as against the 3,531 miles Telstar I. Both have roughly the same perigee—604 miles for Telstar II and 592 for Telstar I. Telstar II orbits in 3 1/2 hours. Its higher apogee means that it will be visible between the United States and Europe for longer periods. Telstar I was mutually visible to the two continents for a little less than 2 hours under the very best conditions, and most of the time for much shorter periods. Telstar II will be visible from both Europe and the United States for more than 2 hours per orbit, from early June to the end of September, and for shorter periods for a month or so after that. Unfortunately, its orbit

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will be such that US-European communications will not be possible in mid-winter, and there will be no Christmas programs via Telstar.

UHF Picture Brightens

UHF stations now broadcasting number 116, according to TV Digest. Of these, 88 are commercial, 28 educational. There are 88 construction permits outstanding, and these stations may broadcast any time they wish, but are awaiting construction or financial aid. Some grantees may delay operation until all-channel set circulation builds up. For the 51 channels still to be granted, FCC has 67 applications—53 commercial, 14 educational.

Present leaders in UHF broadcasting are Fresno, Calif.; Youngstown, Ohio, and Scranton—Wilkes-Barre, Pa., each with four stations already broadcasting.

C-R Tube Has Two-Way View

A "trap-door" tube developed by the US Army Electronics Research & Development Lab, Fort Monmouth, N. J., allows photographing the tube's display from the rear, through the offset porthole, instead of obscuring the screen.

The tube is a modified version of a standard cathode-ray tube. A 2-inch transparent porthole in the normally opaque rear section allows a camera to take photos of the electronic display while the operator views the screen from the front. Previously, all such pictures were taken from the front, with the camera placed over the face of the tube. The operator had to watch the display through a small peephole.

In addition to easier and more efficient operation, the image from the back is two or three times brighter than from the front, and fine details of the picture show up more clearly.

Brief Briefs

FCC's Safety & Special Radio Services Bureau imposed a $100 fine on Morris J. Green, Mableton, Ga., licensee of Citizens radio station KDB-5712, for unauthorized communications.

Japan's radio-TV sales to US show a sharp increase during the first 2 months of this year, over the same period in 1962. The only exceptions are tube radios and "toy" radios with one or two transistors.

Explorer XVII satellite has sent back more than 8 hours of data on the helium girdle surrounding the earth, and on the actual makeup of the tenuous gases in the earth's atmosphere.

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Not only does the Grantham course cover all required subject matter completely; it grows and changes and expands in phase with change and expansion in the electronics field generally. With the Grantham course, you are assured of modern, up-to-the-minute instruction.

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The streamlined Grantham course is designed specifically to prepare you to pass FCC examinations and examinations given by electronics firms. What you need to know to achieve these goals, you are taught completely and in detail. The course is not “padded” with information you will not need.

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The weakness of the “coaching service” or “Q & A” method employed by some schools and individuals is that it presumes the student already has a knowledge of basic electronics.

The Grantham course is presented from the viewpoint that you have no prior knowledge of the subject; nothing is taken for granted where your training is concerned. We “begin at the beginning” and progress in a logical, step-by-step manner from one point to another, with the necessary math taught as an integral part of the course. Every subject is covered simply and in detail; the emphasis is on making the subject easy to understand.

With each lesson you receive an FCC-type test so that you can discover after each lesson just which points you do not understand and clear them up as you go along. In addition to the lesson tests, ten comprehensive Review Exams are given throughout the course.

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821 - 19th Street, N.W., Washington 6, D. C. (Phone: ST 3-3614)

JULY, 1963

Is the School Accredited?
Grantham School of Electronics is accredited by the Accrediting Commission of the National Home Study Council.

Is it a “Memory Course”?
Grantham School has never endorsed the “memory” or “learn by rote” approach to preparing for FCC license exams. This approach may have worked in the early days of broadcasting, to the extent that a man could get his license that way; but, Heaven help the employer who expected this man to be able to demonstrate abilities implied by possession of the license!
Fortunately for all concerned, it is no longer possible for a man to pass FCC exams by spilling out memorized information which is essentially meaningless to him. Advances in the field of electronics—and the desire of the FCC to have the license really mean something—have caused upgrading of the exams to the point where only the man who is able to understand and reason electronics can acquire the 1st class FCC license.

Learn to thoroughly understand basic electronics from the school whose graduates are successfully employed by virtually every major electronics firm in the United States. Why not join them through Grantham training?
At the Bottom

Dear Editor:

I have just read Joseph Marshall's "Improving the Hi-Fi Bottom" (May, page 49). I've been using a center-channel super-woofer system operating off the low-pass portion of the transistorized crossover (Radio-Electronics, June 1961, page 37) and a 50-watt amplifier. My speaker is a Bozak B-199-AL (not listed in their catalog, but available on special order). Used singly or in pairs, with 9 to 14 cubic feet of volume, these are unmatched below 40 cycles by most of the speakers you mentioned in the article.

Super-woofers do a phenomenal job of reproducing air-conditioning rumble in a large hall, and show up the noise in some of the "better" companies' records. Few are putting anything below 40 cycles on stereo records, and the low-frequency cutoffs on many current mono releases seem to have been shifted upward so they won't show up their stereo counterparts.

PAUL M. HINE, JR.
NAS, Patuxent River, Md.

Profusion of Tubes

Dear Editor:

For a couple of years I've been waiting for manufacturers to stop making new tube types. I figured the way they were going it wouldn't be long before they ran out of possible pin connection combinations. Now I realize I underestimated them. When they ran out of seven- and nine-pin combinations, they simply invented new tubes with 12 pins, under the pretext that they were superior to older types.

When sets with these new tubes break down and we are called on to repair them, it is very embarrassing to admit that we don't have the necessary tubes in stock. So the customer will often take his set back to the manufacturer, who will make still more profits by cutting out the service shop.

No one can tell me it was necessary to make 6AX3's and 17AX3's with 12 pins when there are only four element connections, and the new ones are little different from the older 6AX4 and 17AX4.

In 1962 alone, 63 new types were introduced. How many will there be this year?

Any technicians who feel as I do, please write me and let me know about it. Also, send a letter to the Federal Trade Commission about this situation. If they get enough letters, they will investigate.

If you send me the letter, I may use it to try to get a hearing with the FTC.

JAMES V. CAVASENO
111-20 124th St.
Ozone Park, New York

Watch Out for Transient Writers?

Dear Editor:

Mr. Leftwich ought to take a course in the use of test instruments (E. H. Leftwich, "Watch Out For Transients," April 1963, page 28). Burning out two meters and almost a third should be an insult to all electronics men. Anyone who did this once without finding out why it happened would not last long in any outfit I were head of.

There should be no trouble if a technician follows these steps in measuring high transformer voltages:
1. Separate the transformer leads.
2. Connect one meter lead to one side of the secondary being measured.
3. Turn on power.
4. Touch the other meter lead to the remaining secondary lead.
5. Read the voltage off the meter.

I've done this many times with no problems whatsoever.

THOMAS C. LAROY
Dearborn, Mich.

[Mr. LaRoy also brought to our attention the numerical error in Mr. Leftwich's peak-voltage computation. The correction was printed on page 96 of the June issue.—Editor]

Mr. Leftwich Replies

Dear Editor:

It is possible that I should take a course in test instruments, but I have been using them since 1924, and I find that generally it pays to read the manufacturer's instructions. I followed them to the letter in the case the article describes. Unfortunately, the manufacturer failed to note that "no-load" conditions could result in transients. Having used voms and vtvms for years without experiencing such difficulty, I felt that something was wrong with the
"Learn advanced electronics at home? Impossible!"

"Sure, I knew that home study programs were fine for a man who wanted to learn basic electronics. But, I needed to study advanced electronics to put myself in line for a better job. Thought I couldn't do it without quitting my job and going back to school. But then my supervisor told me about CREI. I've had two salary increases since I enrolled—and my company recognizes the value of this education."

This man is one of the thousands of men in every phase of electronics who are moving ahead with the help of CREI Home Study Programs. If you are employed in electronics, CREI can help you, too. For complete information, send for FREE book. Use coupon or write: CREI, Dept. 1407-A 3224 Sixteenth St., N.W., Washington 10, D.C.
most RELIABLE TRANSISTOR AMPLIFIER antenna

WINEGARD'S RED HEAD

Red Head is one transistor amplifier that does what it's supposed to do...boosts those weak signals right out of the snow, gives brighter contrast to your pictures without trouble and call-backs.

Red Head has a lightning-protected circuit—no transistor burnout due to lightning flashes, static precipitation or power line surges. Built-in high pass filter rejects interference from Citizen's Band, hams, etc. Unlike other transistor amplifiers, it can't cause smear or graininess in picture from phase distortion...has linear frequency response, no suck-outs or roll-offs at end of bands. You get clear, bright picture detail on color and black and white.

Other Advantages of Winegard's Red Head—has newest type four-lead transistor...is AC powered, no corrosion at terminals, no polarity problems—has built-in 2-set coupler in power supply—mounts easily on antenna, mast or wall—powerful enough to drive 6 sets, can be remoted up to 1500 feet using 300 ohm twin lead or ladder line. New eye-catching bright red amplifier housing—gives lasting product identity.

Red Head is your best transistor antenna amplifier buy. Try a few and see for yourself. Write for technical data or ask your Winegard distributor.

There's a Winegard Quality Antenna for Every Reception Needs

Low cost too

WINEGARD'S

RED HEAD

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RADIO-ELECTRONICS

first meter. I admit that I learned the hard way.

But it appears that very few electronic technicians know that surge voltages can be so high; that is exactly why I wrote the article. In the steps Mr. LaRoy outlined for safe testing, he merely repeated what I wrote in the article.

With reference to peak voltage, this is definitely an error. I can only say that my article was reviewed by one mathematician, three design specialists and four senior electronics engineers before I submitted it. They did not notice the error.

E. H. LEFTWICH
San Diego, Calif.
[Neither did four editors!—Editor.]

Against Licensing

Dear Editor:

I was surprised to see an article like "Is There an Answer?" (April, page 26) in your magazine. Once shops bind together into a strong organization, and the association becomes boss, they will be told when they can open, whom to hire, what to charge, and, unless they toe the mark, the association will close them down. The public will have no real choice of shops; they will all be run under the same flag, with the same policies.

At least four men I know today got started on their own reputations, without any associations. After completing an NRI course, they started service door-to-door and worked their ways up from there.

I have brought up this subject of association and state licensing at our local NRI alumni club. Not one man favored it. Wholesale parts houses represented at the meeting were also against licensing, which they felt would cut their business; they would be pressed into selling only to licensed shops. Their business depends also on the small shops and part-timers.

If I had to spend money on a license and on association dues, my magazine and service literature subscriptions might have to go out the window. Others might be forced to do the same, and surely this would have a bad effect on the business.

A. J. CIARROCCA
Coraopolis, Pa.

Kudos to Travis

Dear Editor:

I wish to thank you and Mr. Glen R. Travis for the excellent fixed-bias amplifier (April 1963, page 24). I have built amplifiers for many years, and this one really sounds better than any I have built in a long time. Very grateful for this contribution.

J. H. MORTON
Edwardsville, III.
Your FRK-300 Kit contains:

- 67 front controls covering 24 different values and tapers
- 50 rear controls covering 23 different values and tapers
- 212 shafts consisting of:
  - 8 types for single controls
  - 2 types for tandem twins
  - 13 types for push-pull dual concentrics
  - 30 types of front shafts for dual concentrics
  - 23 types of rear shafts for dual concentrics
  - 2 types for color TV
  - 15 KR Fastatch on-off switches
  - 10 KR push-pull line switches
  - 10 AK-38 twist-tab mounting plates
- Up-To-Date Current Guides and Cross-References

Centralab's FRK-300 Control Kit is a new giant-size kit designed to provide even the largest service organization with all the components needed to replace any popular 15/16" diameter control. This includes single, dual concentric, and twin models. 452 control components are packed in a heavy gauge, 18 drawer cabinet specially designed for Centralab.

Any control assembled with the FRK-300 is an exact replacement, electrically and dimensionally, for the manufacturer’s original control. Construction is a snap when you use the Fastatch II. Just plug in and snap together; no complicated alignment or twisting is necessary.
EICO 369 tv-fm sweep & post injection marker generator

With the 369, circuit response is not affected by markers and markers are not affected by circuit response. The 369 feeds only the required sweep signal to the input of the circuit being aligned or tested. At the output end, a demodulator cable picks off the signal and feeds it to a mixer stage inside the generator, where the markers are added. The combined signal is fed to the oscilloscope. This means that circuitry under test or alignment is not affected by the marker signal, and that traps in the circuitry will not reduce or eliminate the marker.

The EICO 369 has a controllable inductor sweep circuit—all electronic, with no mechanical parts to wear and give trouble later. The sweep generator is independent of the marker generator. It has five ranges: 1.5–5 mc, 7.5–19 mc, 16–40 mc, 32–85 mc and 75–216 mc. All five ranges are fundamentals; tuning to the desired center frequency is simplified by a 6:1 vernier dial and a 330 µ scale. Output impedance is 50 ohms. Retrace blanking is obtained by both direct and cut-off and indirect B+ cut-off (via the AGC chain) of the oscilloscope with a blanking tube that conducts during the negative excursion of the 60 cps sine sweep. A three-stage AGC circuit keeps the level of the swept signal constant over its entire frequency range, even when the widest sweep width of 20 mc is being used. A (biasing control) at the rear of the EICO 369 adjusts permanently the horizontal sweep signal fed to the scope.

The marker generator in the EICO 369 has 4 ranges covering 2–225 mc. The highest range, 60–225 mc, is the third harmonic of the next lower range. All other ranges are fundamentals. Frequency setting is simplified by a 6:1 vernier dial and a 330 µ scale. As a rapid check of marker generator alignment a 4.5 mc crystal is substituted with each generator. When plugged into a front panel socket it automatically turns on a fixed frequency marker oscillator. The 4.5 mc signal produced by this oscillator is mixed with the variable frequency marker. The 4.5 mc crystal is used also for alignment of sound circuitry in TV Receivers.

The demodulated wave form, with the post-injected marker is fed to the vertical input of the "scope", and the horizontal sweep to the horizontal input of the "scope" through one shielded two-conductor cable. Separate level controls for trace size and marker size on the front panel can be used independently. Kit $89.95; Wired $159.95.

www.americanradiohistory.com
BEYOND THE TRANSISTOR

...The Ideal Detecting Device Is Still in the Future...

It was Heinrich Hertz, the discoverer of electromagnetic (radio) waves, who also invented the first radio detector in 1888. Curiously enough, this detector was of the visual variety: A single metal wire loop with two small brass balls fixed less than a millimeter apart, which at the ends of the wire gave out tiny sparks when the wire loop was brought into the charged field of the transmitter. The visual sparks were the first demonstration of the new electromagnetic waves, now known as radio waves.

Hertz' waves, however, could not be detected outside of the laboratory. Other scientists took up his work to create more sensitive responders that would detect such waves over greater distances. Marconi, in 1896, invented his wireless transmitter and receiver with which signals could be transmitted over the English Channel—more than 30 miles. As his detector he used the coherer, first demonstrated by Prof. Edouard Branly of Paris in 1892 and Popoff of Russia in 1895.

Next came Gen. Gustave-Auguste Ferrié's and Prof. Reginald Fessenden's electrolytic detector in 1903, far more sensitive than the coherer. This in turn was eclipsed by the first crystal detector, invented and patented by Dr. Greenleaf W. Pickard in 1906.

There was also the unusual manmade-crystal detector, the Carborundum, invented by Gen. H. H. C. Dunwoody in 1906. Quite sensitive and stable, it required a 1.5-volt battery to function properly. It was a crystalline semiconductor composed of silicon carbide of a dark-blue-green color.

In 1904, John Ambrose Fleming invented the first two-element diode detector tube based upon Thomas A. Edison's 1883 "Edison effect."

The great breakthrough in radio detectors occurred in 1906 when Dr. Lee de Forest invented his Audion, the first three-element vacuum tube. But de Forest's vacuum tube did not long stay a simple detector; his vacuum tube connected in cascade became the first true radio amplifier. But not until 1914 did de Forest invent his oscillating vacuum tube, which also gave the world the radio transmitter and regeneration. Now radio waves could be detected 12,000 miles away—the distance limit of this planet! (Indeed, in the 1930's radio amateurs could communicate with the antipodes with only a small radio rig powered by a few dry cells.)

Still later, de Forest gave the Audion a voice: the modern radio telephone had been born. And that ushered in radio broadcasting circa 1920.

The triumphant march of the vacuum tube lasted uncontested for more than 40 years. Good as it was, it had one serious flaw: It required a hot filament or cathode to generate a steady flow of electrons. It also needed an A and a B battery or electric supply current to function.

In 1948, Drs. Shockley, Brattain and Bardeen of Bell Laboratories gave the world their transistor. It required no electrical power to speak of and did everything the vacuum tube did—and more. Already, thanks to miniaturization, the size of transistors has shrunk to the almost invisible. Even today excellent radio sets, the size of a cigarette pack, are commonplace.

Yet progress never stops. While the earth has shrunk to miniature size, galactic space has not—it never will. True, we already have sent our radio probes 40 million miles out into interplanetary space towards our nearest planet, Venus, and received intelligible signals back. But this is a mere beginning. It does not satisfy science.

The great difficulty with vacuum tubes and transistors lies in their inherent noise. When the incoming signal is weaker than the internal electron noise produced in the receiver, amplification becomes useless. The more you amplify, the more your noise increases.

So we come back to where we started: We need far quieter radio-wave detectors than those known at present.

Radio astronomers are particularly frustrated by our modern detecting and amplifying gear. They deal not in paltry millions of miles distances, but in billions of billions of miles. Thus one of the not too distant objects, the great nebula Andromeda (M31), is 1,600,000 light-years distant from us. Its natural radio signals intercepted by our radio astronomers take over 1.5 million years to reach us. To us these signals are only unintelligible loud hisses.

Yet scientists today know that we are not alone in the universe. Humans are not the only reasoning and intellectual creatures—it would be ludicrous to think so.

Sooner or later, with more sophisticated radio gear, we will intercept the intelligible signals for which we are waiting. These may come this year, 100 or 1,000 or 10,000 years hence. When will we be ready to decipher them?

The answer obviously lies in a super-low-noise detecting means. How will it be made? With our present-day knowledge, we can only guess.

Perhaps we require a cryogenic (cold near absolute zero) noncurrent-carrying device as a detector. Carrying no electric current inherently, it could not amplify internal electronic noises, only the incoming, fantastically weak micro-signals. An impossibility? Not necessarily. We have solved more difficult problems in the past.

— H.G.
A RECORD TOTAL OF LISTENERS ARE NOW ENJOYING INTERCONTINENTAL RADIO RECEPTION. THE SHORT-WAVE AUDIENCE HAS MORE THAN DOUBLED SINCE THE END OF WORLD WAR II. LISTENERS ARE USING JUST ABOUT EVERY TYPE OF RECEIVER FROM THE LATEST INNOVATION TO PRE-WAR MODELS.

FEW OF THESE LISTENERS REALIZE THAT A CAREFUL CHANGE IN THEIR RECEIVING SYSTEMS CAN IMPROVE THEIR RESULTS 5, 10 OR 15 TIMES. ONCE THAT CHANGE IS MADE, RARE-CATCH STATIONS ON THE FAR SIDE OF THE GLOBE WILL START APPEARING AND THOSE NORMALY LOGGED BANG IN WITH THE WALL OF CONTINENTAL US BROADCASTERS.

THE SINGLE MOST IMPORTANT ELEMENT IN REALLY GOOD TRANSCONTINENTAL RECEPTION IS THE VALUE CALLED DELTA (FROM THE GREEK LETTER, Δ). IT IS THE "VERTICAL ANGLE" AT WHICH A SIGNAL ARRIVES. THIS ANGLE VARIES WITH DISTANCE, CONDITIONS AND FREQUENCY, IN A SPECIFIC WAY. UNAWARE THAT DELTA IS AT WORK, THE LISTENER PUTS UP AN ANTENNA HE FEELS WILL DO THE JOB AND HOPES FOR THE BEST.

VERY LONG DISTANCE RADIO SIGNALS TRAVEL BY REFLECTION FROM THE IONOSPHERE. A RADIO SIGNAL SHOT FROM ONE CONTINENT TO ANOTHER MAY MAKE THE CIRCUIT VIA ONE BOUNCE, TWO OR EVEN THREE. WHAT HAPPENS ON ROUTE FIXES ITS ANGLE OF ARRIVAL AT A RECEIVER. IF YOU THINK ABOUT IT A MOMENT, IT'S ALL VERY LOGICAL. YOU CAN SEE IN THE HEAD ILLUSTRATION HOW THIS WORKS. NOTE THE SIGNAL FROM STATION A, SAY IN THE US, IS COMING IN TO THE LISTENER'S ANTENNA AT A FAR HIGHER ANGLE THAN REALLY DISTANT STATION B. LIKE THE CATCHER'S MITT, THE LISTENER'S ANTENNA MAY MISS ONE, AND SECURE THE OTHER. OR IT MAY PARTLY MUFF BOTH, AND THE NET RESULT IS MEDIOCRE TO POOR RECEPTION OF BOTH A AND B. THE LISTENER MAY EXPLAIN HIS RESULTS WITH: "OH, CONDITIONS JUST AREN'T GOOD." THE TRUTH IS, THE SIGNALS MAY BE WHIZZING BY HIS WIRE AS IF IT WERE NONEXISTENT, YET LAYING A SIZABLE SIGNAL INTO A COMPETITOR'S AERIAL.

ANGLES OF ARRIVAL

THREE FACTORS DECIDE THE INCOMING ANGLE OF A SHORT-WAVE SIGNAL — DISTANCE BETWEEN TRANSMITTER AND RECEIVER, FREQUENCY AND IONOSPHERIC BEHAVIOR BETWEEN THE TWO POINTS. THIS IS TRUE FOR DOMESTIC RECEPTION AND RARE-CATCH DX.


PUBLISHED FOR THE FIRST TIME IN THIS FORM IS THE CHART OF FIG. 1. IT ALLOWS A RAPID ESTIMATE OF INCOMING SIGNALS (VALUES OF DELTA) ON THE TRANS-ATLANTIC CIRCUIT BETWEEN EUROPE AND THE US EAST COAST. THESE ARE THE MEDIAN VALUES TO USE WHEN DESIGNING TOP-PERFORMANCE RECEIVING ANTENNAS.

AS TIME AND CONDITIONS CHANGE, EXACT ARRIVAL ANGLES VARY UP AND DOWN, BUT MEASUREMENTS SHOW THEY AGAIN RETURN TO THESE SPECIFIC VALUES AND COINCIDE WITH THEM MORE OFTEN THAN NOT. WE EVEN KNOW THE EXACT PERCENTAGE OF TIME THEY WILL VARY FROM THESE VALUES.

FIG. 1 shows us a lot about the typical trans-Atlantic circuit. Take New York to London, and it isn't too different from New York to Paris, Rome, Berlin or Madrid. The characteristic delta for 15 mc is about 9°. At the 7-mc end of the short-wave broadcast spectrum, 23°.

Let's see how the typical listener's dipole performs on a European band, say 7 mc. First, its vertical responsiveness. This is the balloon-like curve in Fig. 2. Right off, you see its major response is directly up. In other words, delta equals 90°. Strictly skyward. However, the arrow at the right shows that the 7-mc European band usually arrives at 22°. So it muffles this overseas band by a good 68°. Not too good by any standard. Works a bit, perhaps. But it's really marginal. Now let's try this typical setup at 18 mc. We cut it precisely to length to give it every ad-

1 NOTE: TO EUROPEAN READERS: IN GENERAL, THESE ANGLES HOLD WHEN LISTENING IN THE REVERSE DIRECTION. SAY, TO THE VOICE OF AMERICA.

![Fig. 1 — Incoming vertical angle of arrival of trans-Atlantic radio signals as received on the US East Coast.](image-url)

![Fig. 2 — Record of poor performance of a horizontal dipole one-quarter wavelength up. Note how receptivity is concentrated directly upward and is largely wasted for distance reception arriving at much lower angles.](image-url)
vantage there is. Without using space for another polar diagram, we find it is busily receiving at a delta of some 30°. Unhappily, Europe is arriving at 7° on this frequency. So it misses the ball again, this time by 23°. Conclusion: it isn't doing much of a job at this frequency, either.

At this point, the reader will say, "Well, my own dipole does pretty well with London and Moscow." But here the credit goes to superpower and top-flight engineering at the London and Moscow ends. Actually, the typical dipole abstracts only some 15% of the available European signal on a vertical-angle basis, and does it about 20% of the time. Small wonder far-side-of-the-world stations are rarities on the dial.

Dollars vs decibels

If a big percentage of any transoceanic signal goes whizzing by this average installation, how can more of it be captured? Going back to Fig. 1 again, you'll notice that the high end of the spectrum, where the superdistance usually lies, is the region of very low incoming angles. For example, 7° for 18 mc, 11° for 14 mc, and some 13° for 13 mc.

What's the best way to receive signals that come in at low, sizzling angles? There are several. One is genuinely costly: quadrupling the height of the dipole you are using and stacking and phasing counterparts under and beside it. Another approach uses knowledge instead of money, and can turn out first-rate results: switch the whole antenna concept to vertical polarization, and use a vertical wire working against ground radials.

Practical applications quickly

Perhaps the most interesting quarter-wave vertical developed to date is the one in Fig. 3. It is compared in Fig. 4 with the conventional doublet. It has a further advantage over the simple wire in that its performance broad-bands across any cluster of overseas stations, and receives them all about as well. A third advantage is that it can be fed by a standard 300-ohm TV line. Its length (height) in feet can be computed by 

\[ L_v = \frac{234}{f_v} \]

In supporting a vertical, the approach is the same as in stringing a horizontal wire, but your horizontal run now becomes fine rope or cord. It must not be wire, since the overhead metal disturbs the vertical's performance. Excellent support points are between sizable trees or adjacent buildings. The shorter the run, the tighter the line can be, and the more erect the antenna. By far and away the best supporting cord is No. 4, 1/8-inch 100% Nylon rope, breaking strength 450 lbs, and thin enough for a presentable appearance. A pulley-and-weight support system is best, but the Nylon itself has elasticity, so the two add.

For installations where no horizontal rope line can be erected (for instance, in a city or treeless development) excellent self-supporting verticals are available. Those manufactured by Hy-Gain, for example, include trap-loading coils and function on several bands. They have roof-top supports, also usable on the ground.

Space the three wires of the vertical 12 to 15 inches apart for SWL frequencies. Use hard-drawn copper or preferably brass tubing for spreaders. Solder the wires to the spreaders for good electrical connections.

One most important adjunct to the superior long-distance performance of this vertically-oriented antenna is the ground directly under it. Quite unlike the simple horizontal dipole, the vertical uses the ground as an electrical return path for signal currents. This interrelationship is responsible for its unique distance capability. For genuinely top-flight performance, the listener should lay a number of ground radial wires under the antenna, extending from it like the spokes of a wheel. At the center and directly under the antenna, drive a ground rod. Bond the radials to it. Then dig a circular trench around the rod and fill it with rock salt. Radials should be at least as long as the antenna, and preferably longer. For an apartment house installation, the radials can be laid on the roof, their center preferably bonded to the apartment house metal roof (some morning before the superintendent wakes up).

Still more gain

The next progression in long-distance reception appears in Fig. 5. This is the half-wave vertical dipole, and exceeds the quarter-wave in Fig. 3 because it has a still lower value of delta. It also has a degree of broad-banded response, and will successfully bridge a cluster of overseas stations. It can be directly fed by standard 300-ohm TV line, and the system very carefully balanced. A single-wire, half-wave dipole conventionally fed by coaxial line is not shown in this series. Though widely used, it attempts to marry a balanced antenna to an unbalanced line, with the result the coaxial's outer sheath or braid starts receiving what is usually noise. Like the three-wire vertical, this antenna should have radial wires underneath it for maximum performance.

Still one more step upward in long-distance gain is the antenna shown in Fig. 6. Never before appearing in published form, it was invented by a leading antenna engineer and is available in limited numbers to those interested in far-side-of-the-world reception. Its

Fig. 4—The balloonlike dashed curve represents the performance of a conventional dipole. The solid curve shows the low-angular performance of the vertical of Fig. 3.

Fig. 5—Folded vertical dipole also has broad-band characteristics.

Note to CB users and amateur mobile operators: park your car over the ground screen of a broadcast station (required by FCC), and you'll have the most remarkable results yet.

8 Dr. Dean G. Morgan, 927 Highgate, Alexandria, Va.

JULY, 1963
Variable height antennas

Of course the resonant frequency of the conventional tower is predetermined by its height, but there is a good chance it may lie close to an overseas broadcasting frequency. For example, an overall height of some 31 feet comes very close to optimum for the European 7.3-mc band. Then, too, the electrical length of a fixed tower may sometimes be increased to exactly the right value by adding an aluminum pole topmast.

But the most valuable of all TV towers for good short-wave reception is the crank-down type. Its owner has a tunable vertical that can be peaked on nearly any overseas band simply by raising and lowering its height (and therefore resonant length). The settings can be marked and the owner in effect has a calibrated mast which can be preset for any overseas band.

Your initial approach to the tower is made this way. Clip the TV lead-in at the tower base and insert a connector-disconnect plug. For short-wave use, wrap the lead-in around the tower. For TV reception, the lead-in is reconnected to the TV set. Guy wires, if any, should be insulated from the tower. Ground the tower base thoroughly via a ground-rod, driven in and rock-salt ed. For top results, lay radials around the tower base in spoke form, bonded at their hub to the tower base. Buried an inch deep, they are no hazard to walkers.

Next comes tentative calibration of the variable-height mast. Lower it to its minimum height, and if possible attach a tape measure to its highest point, or TV antenna. Then, with the tape measure secured, raise the tower to its greatest height. As you do so, attach tentative placed markers (indelible laundry ink on white adhesive tape) to the lifting cable. This is your first step in calibration. By the preceding formula, so many feet will be close to such-and-such a frequency. Use enough RG-58/U coaxial cable to allow a connection between the very bottom of the tower, and a point farther up, and the antenna terminals of the receiver.1 Sold about 3 feet of rather heavy,flexible insulated wire to the center wire of the coaxial line. At its end attach a battery clip large enough to fasten securely to a leg of the tower. Bond the outer braid of the coaxial line to the base of the tower, at the point where it is connected to the ground. Tentatively attach the battery clip to the tower, starting say, 1 foot from the base and moving progressively upward, later in final adjustment (Fig. 7).

The listener is now ready for more exact tower tuning and calibration.

Fig. 7—Hookup for using TV tower as antenna for distance reception.

Raise the tower to the point where the formula shows it is nearly resonant to a desired short-wave broadcast band. Then tune your receiver to this frequency, log a station and check signal strength on the S-meter. Now raise and lower the tower a bit for a maximum S-meter reading. Once tower height is set, start varying position of the clip connection, again looking for a point giving maximum reading. For peak results, both should be maximized once more, this time by small amounts, since their positions are slightly interrelated. When optimum positioning has been determined for each band of interest, record the tower elevation and battery-clip settings so they can be repeated.

The sometimes surprising performance of a vertical is illustrated by the experience of one East Coast listener who put up a sizable vertical Yagi pointed at Tokyo. His compass bearing was a perfect shot via the North Canada-Alaska-Petropavlovsk, USSR, circuit, a wild and uninhabited route to say the least. He snapped on his receiver as soon as the feedline was connected, and heard nothing except sporadic cracks of ignition noise.

Discouraged, he called a friend from a nearby research laboratory, who checked his general compass bearings, and then went to the receiver. The unmistakable snap of ignition again came in—soon identified as a farm tractor visible several fields away.

"Why, your antenna is as hot as a firecracker!" the engineer exclaimed. "Try it later, and be sure your receiver's on Tokyo's frequency." The vertical's constructor did as told, and suddenly there was a virtual thump as the Hammarlund's avc flashed on to Radio Tokyo, swamping everything else.

So if you're aware of slight ignition noise in your first listening, don't be concerned. It's more likely to be the sign of an asset, not a liability. Many veteran vertical listeners size up its appearance during off hours as a forerunner of later good reception. More often than not, it's advance proof the installation is superreceptive to the low-grazing angles that are the bearers of genuinely good long-distance reception. END

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1 Coaxial line is ideally suited here, since we have an unbalanced antenna feeding an unbalanced line.

---

Fig. 6—An added step in distance gain—two half-waves in phase. The upper and lower halves fire together.
Cathode Feedback Nomo

Little chart saves a lot of figuring

By JIM KYLE, K5JKX/6

Most technicians realize that an unbypassed cathode resistor introduces feedback into an amplifier circuit and thus reduces gain.

However, when you deliberately omit the cathode bypass to reduce distortion, you must ask, "How much gain is lost?"

Mathematical determination of the gain loss is a complicated procedure. As a result, most writers say to use the rule of thumb and assume that the stage gain will be cut in half. Unfortunately, this rule is frequently far from accurate.

The accompanying nomogram shows directly how much gain is lost in an unbypassed cathode resistor. Though the scales go only to gain of 60, they may be extended to any desired figure by multiplying both gain scales by the same amount.

To show how the chart works, let's go through an example: You have an amplifier stage with a gain of 20. Its dynamic plate load resistance is 220,000 ohms. Its cathode resistor is 22,000 ohms. What will the gain be if the cathode bypass capacitor is removed?

First, divide the dynamic load resistance value by the cathode resistor value to find the ratio $R_L/R_K$. Then connect the value of this ratio, on the chart, with the value of gain if the bypass is included. Read the resulting unbypassed gain—in this case, just over 7—from the "actual gain" scale.

Note that, in this example, the old rule-of-thumb formula would have given you a figure of 10, some 40% higher. On the other hand, had the ratio $R_L/R_K$ been larger, the rule-of-thumb result would have been too small.

JULY, 1963
Simple Transistor Ignition

Two transistors, two diodes and a few other parts make this reliable circuit.

By BRYCE SCHOLLMEYER

Electronic Ignition Systems have been talked about for many years, but they required high-voltage dc supplies, thyratrons and large capacitors. All this is inefficient and bulky. The trend toward less space for gadgets under the hood limits the size of the unit, and the warm-up time of tubes is a bother.

In the last few years transistor ignition systems have been developed, and a few months ago I decided to try one. Fig. 1 is the result. The transistors are 70-watt 2N277's and the diodes are Sarkes Tarzian M-500's (1N1084's). This system will work on 12-volt negative-ground cars only. It is constructed on a 4 x 9 x 1/8-inch aluminum panel. Q2 is mounted directly on the panel and Q1 is mounted with mica insulators. Any kind of chassis cover may be used, but it would be wise to have the sides

Underside of chassis. As shown here, unit has been modified (per Fig. 4) for Mallory F-12-T coil, at right.

Don't damage the cap. It must make an oil-tight seal when reassembled.

Two things have to be done: first, remove the primary winding and replace it with two layers of No. 16 enameled wire wound in the same direction, using the same space, as the old primary. Second, extend the braided wire from the secondary that is connected to one side of the primary and solder it to the case of the coil. This is so the high voltage does not return through the transistors.

The primary was rewound because the old winding had too much resistance for a transistor circuit. Normal resistance is about 1 to 1 1/2 ohms and the maximum allowable in a transistor circuit seems to be about 0.15 ohm. The new primary is about 0.12 ohm. After conversion, reassemble the coil in the case. The same oil is used again but, if any is spilled, it must be replaced with transformer oil. The oil is necessary for insulation and to conduct heat away from the windings. The top seal may now be peened back in place carefully—it must be oil-tight.

The main advantages of this circuit are low distributor-point current and better high-speed coil operation. Tests have shown that the high voltage at the plugs remains constant from idle to full throttle under load and in some cases (due to coil resonance) there is
an increase. This is in contrast to normal ignition, which falls off at high speed.

The diodes in the base circuits prevent reverse current at the time the coil field is collapsing. This inductive kick could pulse through the transistors. They have sufficient collector-to-base rating, but the emitter-to-base rating is close—hence the diodes. (If a diode should short, you could still get home.)

A note about the 0.25-ohm 25-watt resistor: it is a 1-ohm adjustable wirewound unit connected as in Fig. 2. Put the slider in the center.

In installing the unit, mount the chassis in the air path of the fan and away from the exhaust manifold. The coil should be mounted solidly to the engine and be well grounded. A wire is run from the +12-volt terminal to the ignition-switch wire of the old coil, provided no series resistor is used. If one is, connect to the switch side of the resistor. If the car has a resistor and a circuit to the starting switch to short out the resistor for starting (some GM's and others), this circuit can be used for a hotter spark for starting (Fig. 3).

It is not necessary to remove the capacitor from the distributor, but there is no inductive voltage at this point now, and the capacitor has no effect.

To reduce radio interference, make this check on your original system: Connect a 20,000-ohms-per-volt vom (250-volt dc range) in series with a 47,000-ohm resistor, and hook the combination across the coils high-voltage winding (meter negative to "frame" side of coil). Switch the ignition on and off, and observe the meter pointer direction when you switch off. Make the same test later with your transistor system installed. Reverse the coil primary connections (2 and 3) if necessary, to get the same polarity (pointer direction).

After installation and with the engine running, check with your finger the case temperature of the two transistors. If one is hotter than the other, adjust the 20-ohm resistor to insert more resistance in the base of the hotter one. Recheck after a few minutes. The collector-to-base and collector-to-emitter voltages and base current are poor indicators of transistor condition in this circuit unless you have completely balanced transistors. And that would be expensive!

The current through the diodes. If it is not balanced, adjust R3. (Turn off the power first.) The base currents should be balanced within 10 ma at 2 amps collector current. (Use a 0-500-ma meter.) This insures that the conducting and cutoff points of both transistors are the same, so the back emf of the coil is across both transistors in a nonconductive condition.

Many more things could be done to the circuit, including Zener diode protection for the transistors, but it works so well under extremes of temperature and voltage that I decided not to add expensive parts at random!

The Mallory coil can be obtained from E. A. Johnson Co., 1030 S.E. Water Ave., Portland, Ore., and presumably other Mallory distributors.

This gadget will not grind your valves or make your plugs last forever, but your points will last many times longer since they are switching only about 500 ma to a resistive load and the burning will be very slight. Top speed may not increase but you will have a better spark at high speed.

After more than 10,000 miles no problems have developed and I am quite happy with the unit. No point trouble, either!

**Electronics May Rank Fourth In US**

This year, electronics may become the fourth largest industry in the US, leaving only the food, transportation and chemical industries to top it. Total volume is expected to reach $15 billion, rising from about $13.1 billion in 1962.

Government products account for about 60% of the sales, and should grow from 1962's $7.6 billion to $9.0 billion, says the EIA. Consumer products will go up too, led by color TV, stereo phonographs and FM stereo receivers. RCA reports the highest dollar earnings from any quarter in its history during the first three months of 1963.

Long Island, N.Y., an important production center for electronic and space hardware, contributes about 20% of the entire US output.
IS THAT PIC TUBE REALLY GONE?

Picture-tube tester-reactivators work wonders on old picture tubes and new customers.

By JOHN FITZGIBBON

A GOOD PICTURE-TUBE TESTER IS A POTENT weapon for the technician. Properly used, it will bring a great percentage of unusable picture tubes back to life. At the same time, it can make friends and influence people. How? Applied industrial psychology! Let’s see, by following a typical case history.

You arrive at John Q. Public’s home in response to a call to “check the picture tube.” While many customers have a habit of anticipating the worst when a 1B3 goes out, this time the picture looks like Fig. 1. The customer is right, this time! The smearing of highlights, loss of brightness, and the “pearly” appearance of the picture tell you that this is definitely a bad CRT.

Now begins the application of psychology. Be gentle with him. He is now in about the same frame of mind as the guy who goes out to start his vacation and finds two flat tires on his car. So tell him, in a sympathetic tone of voice, “I’m afraid that the picture tube is bad.”

As soon as his face stops falling, then say, “Wait a minute. Let’s see if we can save it!” DON’T make any rash predictions! Get out the picture-tube tester and hook it up. Let him see the meter needle down in the BAD sector, where it will be with a tube that looks like Fig. 1.

Now, he’s really sick. He can see that sixty bucks floating away. This is the moment of truth. You say, carefully, “Well, sometimes we can save ’em. Let’s try, anyhow.” Now, he wants to know what you mean. A spark of hope reappears. Explain to him that this instrument will sometimes bring a dead picture tube back to life long enough so that he can get a few more months out of it. By phrasing this properly, you can get the impression across to him that you are not a heartless monster about to swindle him out of a large sum of money, but a Kindly Old Family Friend doing everything in your power and using all your technical skill to save him that expense!

Try to rejuvenate the tube. If it has gone weak from age and doesn’t have a brightener on it already, the chances are very good that you’ll be able to bring it back. From my experience, I’d say that at least 95% of tubes can be brought back, barring open heaters, cracked glass and such.

So, you shoot it, and the screen lights up again. He’s overjoyed, naturally. Now explain very carefully to him that this may be only temporary; that there is a chance that the tube will fade out again in two or three days. Being the just and fair-minded feller you are, you’re going to charge him for shooting it, but—if it goes bad again inside of — days (you pick the time limit, judging from the condition of the tube), you’ll come back and install a brightener on it without any extra service charge. (This is optional, of course. However, you can sell him the brightener on the next trip, and the public-relations gain is often worth the service call.)

No. 2 gimmick, just as good, is to offer to refund him the charge for shooting the old tube if it goes bad again and you have to install a new one within — days. This is a powerful sales pitch to get you the sale of the new tube.

There is nothing unethical, dishonest, immoral or even fattening in this! It is simply the application of psychology to customer relations. If you check the tube and say, “Yep. Dead as a hammer! You’ll have to fork over sixty bucks for a new one!” you’ll get an instinctive resentment reaction. He is quite likely to say, “Well, we’ll have to wait a while

Fig. 1—Typical symptom of a weak picture tube: “pearly” highlights, low brightness. Note that scanning lines are still visible, so this isn’t just an out-of-focus condition.
until I can get the money", and call another service technician to recheck your diagnosis! If the next one turns out to be a kind, sympathetic type, he's the one who sells the new tube!

Picture-tube testers

The modern picture-tube tester is an ingenious instrument. Some are simply short-and-emission testers. Others are capable of testing for shorts, continuity of elements and emission, and can also "rejuvenate" weak tubes. This isn't a very appropriate word. Nothing will bring back the "lost youth" of an old picture tube.

Fig. 2 shows the complete schematic of a typical instrument. A most ingenious short-continuity test circuit is used. Incidentally, this is used in one form or another in most of them. It will check for shorts between elements and, at the same time, indicate whether an element is open. Three NE-48 neon lamps are used. With the selector switch in the continuity-short position, ac voltage is applied between heater and cathode, cathode and G1, and cathode and G2. Each lamp is shunted by a resistor.

When the cathode is heated, each element of the tube becomes a diode with respect to the cathode. For instance, if G2 is connected, the ac voltage on it will be rectified. The current through the shunt resistor will develop a voltage drop and the lamp lights on one plate. This shows that G2 does have continuity; same for other elements, except the heater-cathode lamp. A short between any two elements results in ac being applied to the neon lamp, and both plates light up. Fig. 3 shows the possible combinations of lights and what they mean. So, in one quick test, two different things have been checked.

If none of the lamps light, although the CRT heater does, this can indicate that the tube is very weak or old. The cathode simply won't supply enough current to light even the little neon lamp!

Emission and cutoff testing

The tube is tested for emission by connecting a meter in the cathode or "plate" (G2) circuit (Fig. 4). A small ac voltage is applied to G2. The tube rectifies it and reads it on the meter as dc. Normal emission of a picture tube is from 300 to 550 µa, so we don't need a very high voltage on the "plate". The grid (G1) is returned to the cathode through a 47,000-ohm resistor.

The contrast range of a picture tube depends directly on its cutoff characteristic: the smaller the voltage needed for cutoff, the greater the contrast range. To check cutoff, S1 (Fig. 2) is in position 3 (cutoff), and the circuitry is pretty much the same as for the emission test, with one exception. Now V, the 6X4, supplies a negative bias, varied by R4, the cutoff control, to the cathode-

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JULY 1963

Fig. 2—Schematic of a CRT checker-rejuvenator (B & K model 440).
The cutoff control is calibrated qualitatively in terms of cutoff voltage. All you need to do is to throw the selector to cutoff, turn R4 until the meter pointer hits the "cutoff" line, and then look at R4 and its scale. If the knob pointer is within the good range, the cutoff characteristic is OK.

**Rejuvenation**

Loss of emission is due to exhaustion of the active material on the cathode. A CRT cathode is a 1/8-inch metal cylinder, with a heater coiled inside. The active material is a small spot of goop on the end of the cathode. After a few years of use, the electron-emitting ability of this coating becomes pretty low, the beam gets thin and less light is produced on the screen. Also, the weak beam is easy to defocus. This produces the smearing of highlights seen in Fig. 1. To increase the electron output, we'll have to do something to get rid of the deactivated crust that has formed on the end of the cathode.

Electron guns are pretty rugged pieces of furniture, but there are still a few precautions we must take. Since G1, the control grid, is a mere 4-thousandths of an inch from the cathode when cold, and about 2-thousandths when hot, we can't apply too much voltage between them, or we'll get the grandfather of all flashovers. What we need to do is pull a very heavy momentary current from the cathode. This will "boil" the active material, and bring some of the lower layers to the surface. You old-timers will remember this process: it's the one we used on our weak 201As! Remember the old "Sterling rejuvenators"?

Sometimes this can be done by simply applying the voltage to the cathode. Fig. 5 shows the "reactivator" circuit of a typical unit. The ac voltage from the power transformer is applied to the plates of a rectifier tube through pushbutton switch S2. A tapped filament voltage switch provides for three heater voltages to be applied: low, the regular 6.3 volts ac; medium, 8.5 volts, and high, 12.0 volts.

Some circuits leave the meter in the "plate" circuit during this process; others disconnect it by the switching.

**Testing the newer picture tubes**

As we said, all tubes built before 1958 used the same voltages. This, of course, was too good to last. Now we have tubes with 2.35-volt heaters, 2.68-volt heaters, etc. There is an adapter made for use with the older picture-tube testers, to accommodate these lower voltages. It will also check individual guns of color picture tubes.

Changes in gun design resulted in G2 voltages of 50, 450 and 500 volts, instead of the 200-300 volts used almost universally in the original CRTs. Now, we can get into two kinds of trouble. (Only two kinds? Hmmm!) Anyhow, if we check a tube with a 500-volt G2, and our tester applies only about 250 volts to it, it may read "weak" when it really isn't. So always make your final diagnosis from the appearance of the picture on the screen. After using a CRT tester only a short while, you'll be able to tell what is going on. Weak cathodes in these newer tubes can be reactivated, just as in the rest. Suggestion:
check a few tubes of this type, known good, and note the readings. You can make up a list and stick it to the lid of the tester for reference.

Going to the other extreme, we find the tubes with 50-volt G2's. If we slap about 300 volts on this tube, it'd read good if the heater was open! All joking aside, it is possible to damage these tubes by applying too much voltage. Also you get a false reading of "good" when the tube is actually weak. So, we run continuity-short tests as before. Then, in the tester of Fig. 2, for example, turn the cutoff or bias control fully counterclockwise. Increase the bias as much as possible. Now make the emission test, but do not push the EMISSION button, which would apply zero bias to the tube. If the meter reads well upscale, the tube is good.

If the tube never reads over about half-scale, even with the cutoff or bias control turned all the way up, the tube is weak, and may be reactivated carefully. When testing emission after reactivation, turn the bias control full off (maximum bias again).

Tubes in this last group are the 14AU4, 17CRP4, 21CX4, 24APJ4, etc. Type up a list of these tube numbers in red, and paste this too in the lid of the tester. Keep up with the latest editions of picture-tube manuals and, every time a new low-G2 type comes out, add it to the list. All these tubes will be in the 90-110° group.

Last-resort department: If the tube shows a heater-cathode short you can't burn out by the reactivation process, install a transformer type brightener. These are fully isolated transformers, as shown in Fig. 6-a. This type can be set by a selector-plug device so that it will isolate a short, but not boost the filament voltage. It ungrounds the cathode and the tube will now work very well, if it has enough emission. Incidentally, weak tubes with heater-cathode shorts can also be reactivated and used! Watch out for the auto-transformer type brighteners (Fig. 6-b). These will increase heater voltage, when necessary, but they will not isolate shorts between heater and cathode.

So, here's your chance to be a hero! This instrument can make money for you and be a real diplomatic tool at the same time. Use the CRT rejuvanator-tester with good will and common sense and it will help you build up an impressive list of trusting, devoted clients.

Equipment for testing picture tubes ranges from simple adapters for specific makes and models of standard tube testers to specialized CRT testers and tester-rejuvanators. The adapters range from about $19 to $70. Among the tester-rejuvanators are:

- Autronic Corp., 2712 W. Montrose, Chicago 18, Ill.
- B & K Mfg. Co., Div. of Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago 13, III.
- EICO Electronic Instruments Co., 3300 Northern Blvd., Long Island City 1, N.Y.
- Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.
- Lafayette Radio Electronics, 119 Jericho Turnpike, Syosset, N.Y.
- Precision Apparatus Co., 80-00 Cooper Ave., Bldg. 3, Glendale 27, N.Y.
- Sencore, 426 S. Westgate Drive, Addison, Ill.

Lafayette's TE-19 CRT Rejuvenator-Tester.

**STEREO BALANCE INDICATOR**

**Fig. 6—(a) Transformer type brightener; used to boost heater voltage or isolate heater-cathode short. (b) Autotransformer type; boosts heater voltage but does not provide isolation.**

The two calibrating pots must be adjusted when the indicator is first installed. Switch the amplifier to monaural and feed in a tone from a test record or audio generator. Use a vtm or output meter to measure the signal voltage at the output plates or across the output transformers' secondaries. Adjust the volume controls for equal signals in both channels at normal listening levels. Set the calibrating pots in the indicator grid circuits so both beams are the same length.

The EMM801 (Telefunken) indicator is relatively new in this country but is rapidly being adopted as an AM-FM tuning indicator, recording-level indicator and for similar applications. If your dealer doesn't stock it, try a local hi-fi or recorder service agency or your mail-order radio parts house.—H. O. Maxwell
8-channel radio-control receiver

With this 3-transistor receiver you can make your favorite model do just about anything

This 3-transistor remote-control superregenerative receiver has good sensitivity and excellent temperature stability. The original design was aimed at multi-channel operation, using reeds for 8 channels, but with few changes the receiver can be used as a single-channel job.

The superregenerative stage is unique since it employs the phantom Colpitts circuit and uses a high-frequency germanium p-n-p tetrode, the 3N25. The tetrode’s base 2 is connected to the emitter for circuit stability. Slight gain is sacrificed this way, but sensitivity remains more than adequate. Selectivity is fair and depends on the number of turns and position of the antenna link with respect to the tank coil. (A less expensive transistor, which works almost as well, is the 2N248. No wiring changes are required. The 2N248 simply doesn’t have a base 2.)

Incoming signals are fed from a 30-inch antenna to a two-turn link wrapped over the center portion of the tank coil. The signal is detected in V1’s base-to-emitter diode, and the audio portion fed to the second stage through matching transformer T. The choke keeps the rf in the first stage and capacitor C4 tunes the transformer primary for maximum audio transfer. R2 and C1 form a quench circuit, which determines to a degree the maximum sensitivity and operating quench frequency. These values may be adjusted for optimum performance. C2 and L2 form the tank circuit and may be tuned from about 26 to 29 mc. R1 in the antenna circuit is used for decoupling and impedance matching. The diode, since it will conduct at 0.2 volt, limits the rf signal in case of receiver blocking at close range. Most superregenerative receivers have a tendency to block if the receiver is turned on in the vicinity of high rf power. If receiver blocking is evident at some sensitivity below the 0.2-volt value (highly unlikely), the diode will have to be biased. R3 and C3 are used to supply proper collector voltage to the tetrode, about 8-12 volts.

Except for a few tricks, the audio stages are conventional. V2 is a 2N185 that is reverse-biased for greater voltage amplification and a better impedance match to the second audio stage. R5 is the emitter load and C6 the emitter bypass. Small solid tantalum electrolytic capacitors, manufactured by Texas Instruments, C5 and C7, couple the audio stages.

The power stage also uses a 2N185 and is emitter-biased by R8 for temperature stability.

The complete receiver has two stacked printed-circuit boards.

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Fig. 1 — Circuit of the 3-transistor receiver. Each reed of the reed relay operates at a different frequency and triggers a different control circuit.

The author suggests a few newer transistors that he has tried: 2N2188 or 2N2189 for V1 and 2N1273, 2N1274, 2N1370 or 2N1371 for V2 and V3.

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*Texas Instruments Inc.

1 See Fig. 1 caption for later transistor types.

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R1 = 330 ohms
R2 = 1 megohm
R3 = 47,000 ohms
R4 = 330,000 ohms
R5 = 83,000 ohms
R6 = 10,000 ohms
R7 = 3.5 megohms
R8 = 95, R9, R10, R11, R12, R13, R14, R15 = 47 ohms
All resistors 1/2 watt 10%
C1 = 100 µµf, mica
C2 = 2 µµf, tabular ceramic
C3, C5, C7, C8, C11 = 4.7 µf, 35 volts, tantalum (Texas Instruments 475BFC10A4 or equivalent)
C4, C9 = 0.02 µµf, disc ceramic
C10 = 0.035 µµf, disc ceramic
C16 = 470 µµf, disc ceramic
C17, C18, C19 = 3.9 µµf, 35 volts, tantalum (Texas Instruments T1M8BC35A2 or equivalent)
D-1N495
L1 = 2 turns of No. 26 plastic-covered wire over center portion of L2
L2 = 22 turns of No. 26 enamelled wire, ct, on
t706-LS6 form with ground
RFC = 750 µµf (National R33 or equivalent)
f - audio transformer-primary, 20,000 ohms;
secondary, 1,000 ohms (Telco 8642) (Available from Telco Inc., Telco Park, St. Paul, Minn. Approx. $1.50)
V1 = 3N25 or 2N248 (see Fig. 1 caption)
V2, V3 = 2N185 (see Fig. 1 caption)
C10 = 470 µµf, mica
V3 = 30 volts
R8, R9 = 100 ohms
R18 = 350 ohms
V1 & V2 same value through following 7 stages, noted as
R9 to R15 & C15 to C19
Fig. 17 = 30 volts
R8 & C12 same value through following 7 stages, noted as
R9 to R15 & C15 to C19
Printed-circuit boards
Miscellaneous hardware
ature stability. This resistor is bypassed by C8 to reduce audio degeneration. R4 provides negative feedback and agc. Adjust base bias resistor R7 for maximum gain. C9 peaks the reed bank's response and may vary from .02 to .04 mf. The reed bank called for is manufactured by W. S. Deans of California. It is a small and very well constructed unit. Maximum reed driving voltage is 15 volts rms, which the receiver supplies at full 80 volts input. Capacitor C11 keeps battery output impedance constant.

Make the receiver case of either aluminum or wood. The prototype is balsa, covered with silk and thoroughly doped. Two plywood runners glued to the inside of the case keep the receiver from moving about and also permit easy removal. One end of the case is open, with the lid held on with rubber bands. A pad of plastic foam is glued between a plywood mounting board and receiver to damp vibrations and reduce possible damage due to sudden impacts.

This receiver has been flown in a 7-pound multi-channel radio-control airplane for about a year. Many flights were put in during the hot Texas summer with temperatures often running well above 100° F. Receiver operation has been dependable with no ill effects from temperature.

Overall power gain is dependent on the dc beta of the output transistor. Values between 80 and 110 are suitable.

Capacitor C10 is used in series with a pair of headphones for receiver alignment. Tuning is simple. Plug in the phones and tune the tank-coil slug for maximum sound. To determine the best position of the antenna link, substitute a vtvm for the phones and adjust for maximum reading.

Miniature split Jaico relays are used for dependability in this application. A damping circuit consisting of R8 and C12 prevents relay chatter. These components determine the R-C time constant and are responsible for the maximum relay current change.

Receiver current drain is very low: about 1.5 ma with no signal, 1 ma with a modulated rf signal, and 4.5 ma with a modulated rf signal and 4.5 ma with reed vibrating and relay energized. END

Fig. 2—The receiver printed-circuit board reproduced exactly full size (top left). Parts are mounted on top of the board as shown (above). Receiver and relay boards mount together to form the complete receiver.

Fig. 3—The relay circuit board (a). Terminals on control relays go through board and are soldered to printed wiring on underside. Connections to relay 1 are shown (b). Other relay circuits are identical.

The receiver printed-circuit board.
Packages of gain and equalization make up the Citation A—

a stereo preamp and control center

THE TRANSISTOR HAS MADE IT POSSIBLE for the engineer actually to see his design concepts crystallized in pieces of mechanical apparatus. In sketching out a design, the engineer thinks in terms of so much gain here, this much equalization, so much more gain, etc., rather than in terms of what devices are to be used to realize such gain and equalization.

Vacuum-tube devices have not lent themselves to this "package of gain" concept, not only because of bulk, but because of the relatively high impedance of the circuitry.

The transistor solves both bulk and impedance problems and led us to consider a preamplifier—control unit design using building-block or modular approach similar to techniques that have been so successful in military and computer applications.

It seemed possible to develop a series of building blocks applicable not just to a single unit, but to a whole family of products. This would conserve engineering effort both in circuit work and in mechanical design. Further benefits of modular construction could be realized if a number of identical modules could be used, increasing production volume and providing interchangeability for servicing. Thus the "flat gain" module was developed.

The "package of gain"

The requirements for a universal building block of amplification are relatively severe. Not only must it have the high input impedance and low noise level required to operate properly from a phonograph cartridge or tape head, it must also be able to deliver a high output voltage at negligible distortion to drive the power amplifier of the high-fidelity system adequately. It must also have enough gain so that the number of modules can be kept to a minimum.

A further requirement—dictated by the wide-band concept of our Citation program—is that the unit pass 20-kc square waves with a rise time of less than 1 μsec, and pass 20-cycle square waves with no visible tilt. This sets 1-cycle and 1-megacycle limits for the passband of the module.

A final requirement (peculiarly a semiconductor function) is to maintain all operating parameters over a reasonably wide variation in ambient temperature. (A transistor can be made into an excellent thermometer.) Early in our work with experimental preamplifiers we found that precise temperature stabilization was required to maintain a distortion specification over even a small variation in operating temperature. Although not a heat producer by itself, the module must work under normal room ambient and also in reasonably ventilated cabinets near heat-producing vacuum-tube tuners and power amplifiers. We chose 10°—60°C (50°—140°F).

Having to compensate only a single amplifier circuit instead of each portion of a conventionally designed amplifier was a great advantage.

After developing a circuit to do the job in the laboratory, it was necessary to find and specify devices that would permit quantity production. The task was more difficult than we had expected.

A historical problem

Vacuum tubes were originally developed and used primarily for linear amplification. When switching and pulse techniques first came into the picture, tube types already in existence were redesigned for these special applications. Transistor art progressed the opposite way—they were first developed and used primarily as switches. Fewer applications have been found for transistors in amplifier type circuitry, and consequently there is little background of measurement and specification of devices for this application. Without the complete cooperation of a number of transistor manufacturers, we might have had an impossible task. As it was, it took a number of passes and some large samplings to finally zero in on a
set of device specifications that would avoid factory selection.

A module design was worked out to meet our basic objectives (Fig. 1) and the Citation A design was laid out as shown in Fig. 2.

Although the overall gain is 60 db at 1,000 cycles, NARTB equalization for tape heads combined with the bass boost increases the gain to 90 db at low frequencies. Even the regulated power supply does not have a small enough value of common impedance to provide complete low-frequency stability. It was found necessary to vary the time constants from module to module in the chain. Circuit layouts are identical.

The resulting three module variations, types I, II and III, cause no problems in fabrication since produc-

**Technical Specifications and Special Features**

- **Frequency Response:** +0.3 db from 1 to 1,000,000 cycles per second.
- **Square-Wave Response:** Better than 1 μsec in all function positions. Less than 5% tilt at 5 cycles per second.
- **Harmonic Distortion:** Unmeasurable at 2 volts output from 20–20,000 cycles per second.
- **Intermodulation Distortion:** Less than 0.05% from 40 Hz to 140 kHz.
- **Noise:** Low level: 50 db below rated output at 5-mv input reference. High level: 85 db below rated output.
- **Sensitivity:** High-level input: 0.25 volt. Low-level input: 1.5 mv.
- **Rated Output:** 2 volts. 6 volts maximum.
- **AC Convenience Outlets:** One individually switched for basic amplifier only. Three switched with preamplifier.
- **On-off Switches:** Two individual power switches. One controls power for basic amplifier only; the other, power for preamplifer and associated equipment.
- **Function Selection:** Six positions: auxiliary, tape amplifier, tuner, phonograph 1, phonograph 2, tape head.
- **Mode Selector:** Five positions: stereo, blend, A + B, monitor A, monitor B.
- **Blend Control:** Introduces variable amount of cross-feed between channels A and B. Rear section of control acts as center-channel gain control.
- **Equalization Control:** Separate turnover and rolloff to set equalization of low and high frequencies individually. Turnover: Tape Adjust, NARTB, 800/600, RCA, RIAA, L.P., AES, 78.
- **Rolloff:** 0/78, 4/FFPR, 10.5/OLD LON, 12/AES, 14/RTEA, 15/LP.
- **Tone Control:** Professional step-type controls for each channel. Electrically out of circuit in flat position.
- **Balance Control:** 0-to-infinity type; frequency insensitive.
- **Contour Switch:** Compensates for Fletcher-Munson effect at low listening levels.
- **Channel-Reverse Switch:** Interchanges channels A and B for proper listening orientation.
- **Low Cut Filter:** Two positions: Flat; 75-cycle cut.
- **High-Frequency Filter:** Five positions incorporated into treble tone controls. Special circuit nonringing type.
- **Tape Monitor Switch:** Permits tape monitoring while recording.
- **Output Receptacles:** Two main preamplifier outputs. One center channel output. Two tape outputs for recording.
- **Total Transistors:** 33
- **Special Features:** Pushbutton selector switch, stereo headphone receptacle, special front panel tape head controls to trim equalization for any tape head regardless of age or tape speed. Cabinet installation from front with escutcheon remaining fastened to preamplifier. Simple locking to mounting board.
- **Dimensions:** 14-7/8" wide x 5-1/4" high x 8-7/16" deep.

![Fig. 1](image1.png)

**Fig. 1**—One of the universal modules. This is a type II. Type III has a 200-pF input capacitor. Type I omits the 200-pF output capacitor and combines the two 47,000-ohm resistors into one 22,000-ohm unit.

![Fig. 2](image2.png)

**Fig. 2**—Line diagram of the Citation A control unit. Triangles are amplifiers; circuitry in the blocks adds no gain.
tion facilities and procedures are the same for all.

Our 6 years experience with experimental transistor preamplifiers bears out the prediction of increased reliability and longer operating life over vacuum-tube products.

Seven gain modules are used, three in each channel and one for an A + B derived center channel. Four other modules complete the design. Two contain complementary emitter followers (Fig. 3) for matching to the low-impedance tone control circuits and the signal output. One contains the transistor and phono equalizer, and the last one (Fig. 4) contains a two-transistor time-delay relay circuit to short the output jacks when power is applied until the power supply and the modules have stabilized at their operating points. This prevents "warmup" noise and distortion from being fed to the power amplifier and speakers.

The mechanical layout is simple. The regulated power supply and module rack occupy the rear half of the unit with the controls in the front. Each printed-circuit module is wired with a service loop to allow sliding it from the rack for inspecting, checking and easy replacement.

This layout makes a kit highly feasible. Fabrication and testing of the modules at the factory keep the relatively inexpert hands of the kit builder from damaging heat-sensitive transistors, and guarantee optimum performance in service.

Many inventions have a way of becoming forgotten, when later improvements supersede the original.

In American literature, Samuel F. B. Morse is universally acknowledged as the inventor of the telegraph, as of the year 1837. He deserves credit for the idea of tracing on a moving paper tape a zig-zag type of code, for which he was responsible. The telegraphic tracings could be made with an ordinary pencil or pen. The "Morse Code" came many years later.

Much less known is the fact that long before Morse, John Redman Coxe of Philadelphia was probably the first inventor of any electrical telegraph (1810). Coxe's telegraph was a chemical one. Papers which we know today under the name of litmus and other similar test papers, have been around for more than 150 years. Coxe used a wet band of chemical paper which recorded signals in color when a battery was connected to the recording stylus.

A similar chemical telegraph was invented in 1846 by Alexander Bain, a Scottish electrician and inventor.

For many reasons, today we can make good and practical use of chemical test papers, particularly in testing polarity, which otherwise requires instruments such as voltmeters. For a few pennies, experimenters can make an excellent polarity indicator which the present writer used more than 60 years ago and which still works well for anyone who wants to try it.

Several lines printed electrically from linotype slug on the special test paper. The two last lines were made with the negative wire touching the test paper.

Ordinary linotype slug used in the electrical printing experiment.

First you require the type of paper known as Turmeric Test Paper. This can be obtained from large drug stores or directly from the Fisher Scientific Co., which has offices in many large cities.

This paper usually comes in yellow strips about 2 inches long and about 1/4 inch wide. It must first be made conductive by dipping it in an ordinary salt solution. Then place the paper on a metal plate or thick tinfoil and connect one wire—the positive—to the plate. Use a 6- to 9-volt battery. The positive pole makes no impression. The negative wire, however, gives a brilliant red color.

Samples shown in the photographs here show how this is done. The one imprinted RADIO-ELECTRONICS was made by obtaining a metal linotype slug with the words RADIO-ELECTRONICS on it, to which was connected the negative pole. It imprinted the entire name excellently, as will be noted. If you want a permanent record, you need about 6 to 9 volts and the contact should last for a few seconds. This will make it indelible. The imprint will vary depending on the voltage used as well as the duration of the contact. Experimenters will find a good use for this Turmeric paper, which is cheap and has many other uses, such as testing chemicals, as well. Thus for instance a solution of ordinary borax stains the yellow paper red.
1.2-MEGAWATT TUBE TESTER—possibly the most powerful of its kind—tests high-frequency power tubes for broadcast and industrial use. It was made by Cheneutron Corp. for the Machlett Div. of Raytheon. Operating at 13.56 mc, the entire installation is carefully shielded to prevent interference. Dc power input to tubes under test can go from nearly zero to 30,000 volts, 40 amps. A cooling system built into the testing room can remove enough heat for 50 to 75 average homes on a cold winter day. The high-stability driver for these mammoth tubes puts out a cool 20,000 watts of rf.

ELECTRON DIFFRACTION CAMERA (right) uses some 250,000 volts to examine atomic structure of matter. The camera, developed by Westinghouse, accelerates electrons to 90% of speed of light and beams them at sample to be studied. Passing through the material, electrons record its atomic arrangement on photographic film. Two mushroomlike objects are an electron gun and a 250-kv voltage divider. Gun directs beam down through specimen to photographic plate below. Aluminum "umbrella" at top is a radiation shield.

PLASTIC LASER may be the forerunner of a whole new family of low-cost lasers that can be mass-produced in any shape. Capable of generating intense flashes of crimson light, the device depends on a new physical mechanism which may be used eventually to generate coherent light from infrared to ultraviolet. Here RCA’s Dr. Nikolaus E. Wolff holds a spray of laser-plastic fibers. In the foreground are some shapes that future plastic lasers might take. Polymethyl methacrylate is the material, and traces of europium, a rare-earth element, produce laser action.

ELECTRONIC NURSE at the head of the bed is monitoring this young patient’s temperature, pulse, breathing rate and blood pressure, while a real live one makes her comfortable. The new system, developed by ITT, can monitor continuously up to 25 patients simultaneously from a central remote location. The equipment is fully transistorized.
new tricks with diodes

Use them to make everything from 2-way amplifiers to speech scramblers

By LEONARD E. GEISLER*

Crystal diodes, those simplest of all semiconductor devices, can handle a wide range of applications. In this article you'll see how to use diodes to make a two-way amplifier, an amplitude modulator, and a phono oscillator with a ring modulator and a speech scrambler. The circuits will need some working with as they are not intended to be more than basic guides for construction but, if followed, they will give the experimenter a sound foundation.

The circuit of Fig. 1 uses diodes as solid-state relay contacts that turn a one-way amplifier into a bilateral or two-way device. Circuit action is simple. The oscillator current alternately blocks (opens) the circuit to permit information coming from one direction through the amplifier while cutting off the other direction; then reverses to permit passage of information from the other direction. This switching is done so rapidly that the listener at either end does not notice any loss of information. It is extremely useful as a repeater for sound-powered telephones, and can increase the range of such instruments several times.

Amplitude modulators

To make a good simple amplitude modulator, wire two matched 1N34-A's or a 1N35-A duo-diode to a pair of center-tapped transformers (Fig. 2-a). I used a pair of three-winding transformers in my experimental model. Ohmmeter tests showed that they were within 1% of each other, so I felt they were suitable.

The circuit quickly illustrates how diodes can act as variable resistances. Simply connect an audio oscillator set at, say, 5 kc to T1's primary and a scope to T2's secondary (use the vertical input of course). Disconnect the leads connected to the center taps. You'll clearly see that there is no output until a dc bias is applied to the center taps of the transformer's balanced windings.

When you connect a 10,000-ohm pot in series with a 6-volt source and a 50-µa meter you will see how, at some particular level of forward bias, the diodes start to conduct. As bias current is increased, the amplitude of the pattern also increases. This continues until bias reaches a point where a further increase has little effect on the signal amplitude.

Make a simple graph of the upper and lower current levels—where there is no further gain and where a signal is just barely passed. It will be useful later. Note that your curve has a linear portion in the center. This is where you want to work the modulator to get undistorted linear amplitude modulation.

Fig. 2-b is a basic diode modulator and Fig. 3 shows a practical diode modulator and driver. Try a 1N35-A for the diodes (matched pair of 1N34's). The transistor can be a 2N255 or 2N185. Make sure you limit no-signal current to about 5-8 ma to prevent overheating the diodes.

The transformers are the same as in Fig. 2. If you have trouble getting them or find them too expensive, try using center-tapped filament transformers. Use the 117-volt primaries as the input and output windings and the center-tapped secondaries as the balanced windings. Either 6.3- or 12.6-volt units can be used; just make sure you use two identical transformers.

Now let's try a couple of experiments. Set your audio oscillator to about 10 kc. Connect a 2- or 3-inch 10-ohm transistor speaker to the transistor base through the capacitor. Connect your scope to T2's output terminals and the audio oscillator to T1's input winding. Speak into the mike (that 10-ohm speaker). Examine the waveform and you will see that you are amplitude-modulating the audio oscillator output.

Fig. 1—Diode-switched bilateral amplifier is ideal telephone repeater amplifier. Oscillator frequency should be about 10 to 30 kc. B-supply must be well filtered.

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*Technical writer, Spartron Electronics, Jackson, Mich.
If you disconnect the speaker and the base bias network from the modulator driver transistor, the output wave should drop to zero. (If it doesn't, reduce oscillator output until it does.) Now, by inserting a key between the bias network and the transistor base, we can key the carrier. Reduce the carrier frequency (audio oscillator) to about 1 kc and connect T2's secondary to a pair of phones. You will have a nice clickless CW practice set.

Want to monitor a remote phenomenon? Locate the audio oscillator and modulator at some remote point and connect the transducer to the modulator driver. Run a twisted pair line to the indicator panel where you can check on the transmitted data with an ac voltmeter. This is the basic method used in many industrial monitoring setups.

The basic modulator works both ways, that is either T1 or T2 may be used as input to the modulator, the other transformer acting as the output. The modulator will also function equally well as a demodulator, modulated information being fed into one transformer, demodulated information being recovered from the other transformer.

Want to generate high-frequency SSB signals? Take the circuit of Fig. 2 and add two more diodes in a lattice, or ring modulator (Fig. 4). This is actually a "folded" bridge and forms a simple DSB generator. Filter out the unwanted sideband and you have nice, clean SSB for modulating a ham transmitter.

Want to build a phono oscillator to supply one channel of a stereo phono signal to your radio? Use the circuit in Fig. 5. It is the same basic one shown in Fig. 3 and works the same way, but at radio frequencies. A ring modulator eliminates the carrier and leaves only the upper and lower sidebands available for transmission. To recover modulation, the oscillator frequency must be reinserted after modulation. With a breadboard hookup, reinsertion is automatic as oscillator radiation takes care of everything. I prefer the practical, two-diode circuit of Fig. 5 as it offers high-quality modulation with a minimum of parts. The completed unit must be checked out by an FCC-licensed radio technician and conform to FCC rules covering low-power communications devices in Part 15 of the FCC regulations.

Transformers T1 and T2 may be two identical "bar antenna" coils with about 10 turns per balanced secondary bifilar wound onto the end of each antenna bar. For best results, mount the bars at right angles to each other. Use a two-section broadcast-band tuning capacitor to tune the oscillator to a clear channel on your radio. Be sure each section of the tuning capacitor has the same capacitance. Otherwise, the circuits will not track and power output will fall off at the ends of the tuning range.

**Try a diode prankster**

Going back to Fig. 3, connect a microphone and amplifier to T1's primary and another microphone to the input of the driver transistor. Connect a pair of leads from T2's secondary to the input of a hi-fi system. Have a friend (or enemy), makes no difference speak into one microphone. You speak into the other. Have your third friend (or enemy) listen to the hi-fi system. If he doesn't die of fright, he'll kill himself laughing!

Tape-record the same "program" for future use as a conversation starter at a dally party. If your friend doesn't walk out in a body, they'll certainly want to know how you did it. A record of the output will consist of the queerest mixture of squeaks, oinks, clicks, growls, burps and bloinks you've ever heard. Possibly this is how sound tracks for nightmares are made.??

**Speech scrambler**

Imagine every reader has, at one time or another, wondered how military and civilian speech scramblers...
work. By taking the madcap system just described and applying speech input to T1's primary and a randomly varied frequency to the modulator driver input, the output will, when fed to a normal telephone system, be practically impossible to decipher unless the party listening has access to the varied frequency information and a demodulator identical to the scrambler. To make a complete system, two identical modulator-demodulators are required and some method of insuring complete synchronization of the scrambling carrier.

To build your own private scrambler system, use two diode modulators similar to Fig. 3, with an additional stage of amplification to make up for the losses incurred in scrambling, transmission, and unscrambling. Each end of the phone circuit requires two modulators. We have shown one complete circuit in Fig. 6. The other party requires an exact duplicate of this unit.

For the random variable frequency, try the output of a radio tuned to a musical program, preferably symmetric, as there is a time element involved. If the music should stop during your conversation you will be temporarily blocked off, or the scrambler's effectiveness will be reduced. You and the other party must tune your receivers to the same station.

Here is how the circuit works: When you talk into the microphone in the auxiliary (surplus) handset, your speech feeds through T3 and modulates the random-frequency carrier. This produces a scrambled signal that is fed from the telephone to the mike in the telephone handset. Scrambled speech coming in over the phone lines is picked up, amplified by the 2N217 and fed through T2 to the diode network where it mixes with the random carrier. The demodulated or unscrambled output is fed through T1 to the receiver in the handset you are using.

If you get a couple of spare telephone handsets, you can make a very professional "little black box" with all the works hidden inside, including the radio. The telephone pickup coil and the scrambler reproducer may be mounted at opposite ends of the "black box" so the regular telephone handset may be cradled atop the two transducers for perfect coupling.

Should you run into trouble when building any of the items described here, an analysis of the way the circuit works should show where the trouble lies. Matched diodes and transformers improve your chances of success. END

**Tricky Resistors**

In the circuit shown, R1 = R2 = R3 = R4. E1, E2 and E3 are input voltages to the circuit, and are measured with respect to ground. What is the output voltage, E4?—Earl H. Rogers

**Ventilation Problem**

A ventilating blower is used to vent two adjacent rooms. Each room has one light controlled by a wall switch. To comply with local building code rules, the electric circuit must be wired so that the blower will operate only when one or both lights are on. When both lights are off, the fan will not operate. Draw a circuit using the minimum number of switch contacts that will fulfill the code requirements.

—Kendall Collins

**Pot Position**

The ganged potentiometer is adjusted until the very sensitive ammeter reads zero. The battery and ammeter are then disconnected from the circuit, and the resistance measured between points A and C. What does the ohmmeter read?—Jack L. Shagena, Jr.
ADD A Leakage Checker TO YOUR VTVM

By WAYNE LEMONS

For just a few pennies and 30 minutes of time you can convert your present vtvm into an excellent leakage checker without affecting its normal functions.

Leaky capacitors are a major cause of electronic troubles, yet they are often missed in diagnosis for the lack of adequate leakage testing equipment. Leaky capacitors cannot be satisfactorily detected by an ohmmeter. The low voltage used in most ohmmeters just will not "drive" a leakage current through a capacitor with a high-resistance leak. Although many leakage testers are marketed that supply the 100 volts or more for making capacitor leakage tests, all too often the average technician fails to realize the absolute need for such equipment. Every day, though, the presence of a leaky capacitor, left undetected, is marring somebody's technical reputation. Leaky capacitors cause distortion in audio circuits, instability in sync circuits, overload in age circuits, smear in video circuits and numerous other elusive troubles.

Here's what to do

Open your vtvm and find the cathode of the rectifier supplying the positive dc voltage to the meter (Fig. 1). It may be a tube or a selenium rectifier. Measure the voltage to determine its value; it should be somewhere between 90 to 250 volts, depending on the make and model. Mount a leakage jack in a convenient place on the front panel. Calculate the size of resistors R1 and R2 so that the voltage at the leakage jack will be near the full-scale reading for a meter scale of 100 volts or more.

For example: suppose the voltage at the rectifier is 120 and the meter has a 100-volt dc scale. R1 should be 220,000 ohms or more to minimize any shock hazard. With R1 220,000 ohms, R2 should be about 1.2 megohms. This means the meter will read just about full scale with the dc test lead of the vtvm touching the leakage jack. If the next higher scale is, say, 150 volts, use R1 and omit R2 altogether.

Capacitors in circuit

Fig. 2 shows a typical coupling circuit used in numerous electronic devices. Capacitor C1 may be tested without removing either end from the circuit. Here's how. Connect the positive voltage from the leakage jack to the plate side, point A. (Device being tested must be turned off.) Connect the common lead from the vtvm to the circuit common, point B. Now connect the dc test lead to the grid, point C. Any meter reading, after the initial upward deflection, means the capacitor is leaky or shorted.

You can always trust this method to find a leaky coupling capacitor. Sometimes there may be an external dc path that would cause an erroneous reading; however. The best plan is to check all couplings for leakage in cir-

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**Fig. 1**—Adding resistors R1, R2 and a banana jack to the vtvm power supply are the only modifications necessary.

**Fig. 2**—Typical coupling circuit showing in-circuit leakage connections.
Leakage jack installed on my vtvm for testing capacitors in and out of circuit. After testing, then disconnect one end for a final check on those giving a meter reading.

Wrapup

This leakage checker will not only check capacitors but checks leakage in other devices and components as well, for instance, the small i.f. transformers in home and auto radios. They are notorious offenders. Be sure to disconnect one winding completely from the circuit so that there can be no external dc paths (Fig. 3).

A word of caution—this circuit will charge good capacitors, so to prevent a possible disagreeable shock, it’s a good idea to short the capacitor with a jumper after testing.

[It would be wise to check the capacitor’s voltage rating before you test, to make sure that the procedure for testing leaky capacitors doesn’t become one for making them leaky.—Editor]

Fig. 3—Checking for leakage in a radio i.f. transformer.

build a
Unijunction Metronome

Simple device has a count rate variable between 40 and 208 beats per minute

By PAUL S. LEDERER

My daughter’s piano practice next to my basement workshop and my recent reading of the chapter on unijunction transistor circuits in the General Electric Transistor Manual spurred me to build this metronome. A metronome—used by musicians for beating time—generally consists of a pivoted pendulum driven by a simple clockwork and produces loud ticks. The beat rate of the pendulum can be varied by altering the position of a weight that rides upon it. The range of such a mechanical metronome is from 40 to 200 beats per minute, or 0.67 to 3.46 cycles.

The problem in building an electronic metronome is that of building a variable-frequency oscillator covering a range from 0.67 to 3.46 cycles and producing audible signals. Since sharp, distinct signals are required, a pulse generator is indicated.

A possible approach to the problem was suggested by a device I built for laboratory use. It applied sharp blows to a small instrument at varying rates and consisted of a small electromagnetic shaker whose moving coil was in the cathode circuit of a thyratron sawtooth generator. Whenever the thyratron fired, a current pulse flowed through the shaker coil and moved it abruptly.

While considering a thyratron for the metronome I came across the reference to unijunction transistor circuits. A unijunction transistor has features

![Circuit of the simple device.](www.americanradiohistory.com)
not unlike those of a thyratron. Its very stable negative resistance characteristic makes it useful in oscillator and timing circuits such as sawtooth generators, multivibrators and trigger circuits. With a unijunction for these applications we get the usual advantages of transistors—reduction in size, weight, power requirements and heat generation and fewer circuit components.

Unijunction transistors are made of a small bar of n-type silicon. Connections at opposite ends of the bar are called base 1 and base 2. A p-n junction is formed near base 2 and called the emitter. When a positive voltage is applied from base 2 to base 1 (V_{bb}), the silicon bar acts as a voltage divider, with a fraction of the voltage appearing at the emitter. The emitter remains reverse-biased (no current flow) as long as any externally applied emitter voltage is less than the critical fraction of V_{bb}. If the emitter voltage becomes greater than the critical voltage, the junction is forward-biased and emitter current flows. As emitter current flows toward base 1, emitter voltage decreases and a negative-resistance characteristic results. The action is similar to breakdown in a thyratron.

The metronome is built into a 4 x 4 x 4-inch aluminum meter case. Its circuit is very simple. Two capacitors in parallel (C1 and C2) are charged through a resistor. The capacitors are connected to the emitter of the transistor and to ground. When the voltage across the capacitors reaches the critical value, they are discharged very rapidly through emitter and base 1 and through the speaker voice coil, producing a loud click. The cycle starts over again when the capacitors start charging again. Varying the setting of the linear potentiometer adjusts the pulse rate. The 47,000-ohm resistor restricts the highest pulsing rate to a little beyond the desired 208 beats per minute. Frequency is determined by the R-C constant of the charging circuit. Battery voltage has almost no effect on the pulse rate since the critical emitter voltage is a constant fraction of the voltage from base 2 to base 1 over wide ranges of voltage and temperature.

The loudness of the clicks (which also depends on the efficiency of the speaker) varies directly with the amount of charge on the capacitors. It can be increased, if desired, in two ways. One is to increase the charging voltage. The limit here is the maximum allowable V_{bb} of 35 volts for the 2N1671. The other way is by increasing the capacitance. The recommended maximum for this is 10,000 µf (no 2,000 volt oil-filled capacitors because they were on hand). Capacitors with a much lower voltage rating also work. Even electrolytics may be used but, because of their wide capacitance tolerances, it will take some experimenting to set the beat range.

Tests indicated that the sound produced by the small built-in speaker was not quite loud enough for some people. Attempts to add a simple, cheap and compact amplifier were not successful. However, I found that it was possible to use a pair of surplus low-impedance (600-ohm) headphones (high-impedance phones are not suitable) instead of the speaker. The sound level in the phones was actually louder than required and somewhat harsh. An iron core 8-mh choke in series with them softens the sound. A closed-circuit transfer jack is used to feed either the built-in speaker or the phone—choke combination. The use of phones will also prevent others from being annoyed by the metronome clicking in a quiet room.

The completed unit. Headphones are optional.

JULY, 1963

LIGHT-CONTROLLED BLINKER CIRCUIT

The diagram shows a simple photoelectric circuit with a neon-lamp indicator in place of the usual meter. The neon lamp blinks fastest when surrounding light is brightest. It can be made to generate audio frequency proportional to light intensity. The arrangement is a neon-lamp relaxation oscillator, whose frequency and rate of blinking follow the intensity of the light that falls on the photocell.

Operation is easily explained. Neglecting the dc supply voltage, the frequency is governed by the resistance and capacitance in the circuit. Part of the resistance is provided by the cadmium sulfide photocell. When this cell (an International Rectifier Corp. type CS-120-M6) is in darkness, its resistance is greater than 1 megohm; when its ex-

posed to bright light, the resistance drops to less than 1,000 ohms. This resistance change provides a large range of oscillation—so large, in fact, that the additional resistance of potentiometer R has been added to permit slowing the blinking rate to an easily countable figure.

To operate the circuit, (1) darken the photocell and adjust potentiometer R for a desirable low flashing rate (say, a flash now and then), (2) shine bright light on the cell and notice how the lamp blinks much faster. (When R is set to 900,000 ohms, for example, the lamp blinks once every 4 seconds when the cell is darkened, and once every second in bright light.) Through adjustment of the potentiometer, the rates may be increased or decreased at will. When R is set to a low value, bright light will develop an audio-frequency voltage across the lamp, and this signal may be applied to an amplifier whose input terminals are connected across the lamp.—Rufus P. Turner

www.americanradiohistory.com
Speed Color Setup and Service

How the CTC-12 can be set up in 20 minutes. Also some service tips on older color sets

By WALTER R. McCARTY

with nearly a thousand color sets in operation in Odessa, Tex., and sales averaging one a day, color service is already a large portion of our service department's work. Naturally, we look for ways to reduce our service call and set installation time.

On new set installations, we travel light and carry a special color caddy containing tools, tubes and parts used only in color sets. In addition, a dot-bar generator, degaussing coil and mirror are also required. Each technician using the caddy is required to keep it neat, restock it, and be familiar with its layout.

This leads to the second point in speeding up operations: don't fumble. Plan a definite procedure and follow it. Knowing where tools are, where adjustments are located and following a logical plan results in a smooth operation and a favorable customer reaction.

A ¼-inch nut driver, cheater cord, hex alignment tool and pocket screwdriver are the only tools needed for a color setup. These should be placed in the caddy within immediate grasp.

This is our abbreviated setup procedure for late-model RCA color sets (CTC-11 and CTC-12 chassis):

Preliminary

Remove the back, mount the convergence board on top, plug in the cheater cord, and turn the set on. Observing a black-and-white picture, make any necessary width, centering, height and linearity adjustments. On a new set, these will rarely be required.

Purity

Turn these controls fully counterclockwise: contrast, color, blue and green drives and screens. Turn the brightness and red screen fully clockwise and adjust kine bias for high-level red without blooming. Degauss, using a circular motion around the front of the screen—about 10 complete circles in each direction. Back off to 6 feet from the set, continuing the circular motion, turn the coil at right angles to the set and then switch it off.

Purity (total red across the screen) will in most cases now be correct. Any impurity will be seen as a purplish or yellowish area. Slight adjustment of the purity tabs or moving the yoke forward or to the rear should correct any impurity.

Once purity is OK, set the NORM-COLOR-SERVICE switch to SERVICE. Turn kine bias fully counterclockwise and then clockwise until a faint red line appears. Advance the green and then the blue screen controls until the blue and green lines are the same intensity as the red line. (Note: due to differences in screen phosphors, slightly different adjustments of the kine bias and screen controls may be necessary for best balance. Try to get all three screen adjustments so that the respective lines are equally bright at very low intensity.)

Return the switch to NORMAL and advance the green and blue drives for best black-and-white picture at a low brightness level.

Convergence

Connect the dot generator. Adjust the static convergence magnets on the CRT neck for correct center (white-dot) convergence. With Fig. 1 as a guide, observing the center vertical row of dots, adjust controls R811 and R812 to converge the dots at the bottom center of the screen. Then adjust R813 and R814 to converge them at the top center of the screen. Alternate bottom and top adjustments until the center vertical row of dots is in good convergence, top to bottom. If necessary, touch up with static magnets. R808 and R815 are blue adjustments and are seldom required. If necessary, alternate adjustment of these controls to bring blue dots as nearly in (or equally out of) convergence as pos-
possible. Then make final corrections with the static and lateral blue magnet on the CRT neck.

If blue adjustments are made, it may be necessary to touch up the other vertical adjustments as before.

Next, adjust L802, L801 and T801 to converge the horizontal center row of dots at the right edge of the screen, then adjust R804, R805 and R801 to converge them at the left edge. Alternate the right and left edge adjustments for best convergence.

Finally, recheck vertical convergence. Touch up with static magnets if necessary. Remove the dot generator, connect the antenna, and crank the brightness and contrast controls to the proper level and step back. You will be surprised how well converged the set is!

Another important point: Provided there is no serious color fringing, let well enough alone. If you continue to adjust, or try to go back through the procedure to correct a slight misconvergence or to “get it perfect,” your customer will get uneasy and you will be wasting your time. Slight misconvergence cannot be seen at normal viewing distances, so don’t even mention it.

When you are well experienced with the above procedure, you may be able to touch up slight misconvergence using a black-and-white picture. But, before you try this in a customer’s home, practice it in the shop. It is certain to save you time. It’s easy to memorize the location of each of the controls on the convergence board and the effect each has on a specific area of the screen.

**Screen temperature**

Proper screen temperature is particularly important. The customer will notice and complain about poor black-and-white balance and tracking more often than about misconvergence.

Follow the same procedure as in the preliminary temperature setup above, being more careful this time. Start with the brightness fully on, contrast and color controls fully off. Here in abbreviated form is the complete procedure:

**NORMAL-SERVICE switch to SERVICE.**

Green and blue drives fully counterclockwise.

Green and blue screens fully counterclockwise.

Red screen fully clockwise.

Kine bias for low-intensity red line.

Green and blue screens to match red line.

**NORMAL-SERVICE switch to NORMAL.**

Green and blue drives for low-level black and white.

**Color**

Remove the antenna, connect the bar generator, advance the contrast, color and tint controls to mid-range. Adjust color killer, inside vertical hold control, so that color:

a. saturates through complete range of tint control, and

b. cuts off (no confetti) when channel selector is switched to a channel not affected by generator, or with generator switched to standby.

That’s it. You should have taken (with practice, of course) from 15 to 20 minutes for the entire procedure. You now have an additional 10 to 15 minutes for customer instruction.

The foregoing setup procedure is just a procedure. A comparison with the RCA manual will show some departure from RCA’s established approach. You should, with practice and experience, develop your own. Do whatever is easiest and best for your own requirements and satisfaction—so long as it gets the job done right.

**Servicing color**

As with black-and-white, the majority of color TV troubles are with tubes. In the late models, the 6DQ5 horizontal output, 6DW4 damper, 3A3 high-voltage rectifier and 6B4K4 regulator all seem to have a high failure rate. The circuit breaker is another commonly encountered trouble. Over 90% of our service calls have been to replace one or more of these tubes or the circuit breaker.

In some late models, recurring circuit-breaker tripping, while often caused by circuit or tube defects, can occasionally indicate a defective circuit breaker. Replacing it in the home is simple. Just slip the chassis back a few inches, replace the breaker and solder the leads. Your color caddy should contain several new circuit breakers.

Another part which may fail for no apparent reason is the surge resistor. It, too, is easily replaced in the home, and several should be carried.

Other in-the-home repairs include replacing the 3.58-mc crystal and the .01-µf capacitors in the grid circuits of the demodulator tubes. The associated resistors in the plate and cathode circuits of the preceding stages, as well as the cathode resistor in the demodulator stages, should also be checked and replaced if necessary.

To date, troubles like these have accounted for about 99% of all service calls made on the late models.

There are a few deficiencies in the earlier color sets for which simple repairs or modifications can be made, and which do not seem to be generally known or published.

The first is vertical rolling, mainly in the CTC-5 series, thought to apply to later series as well. There are two different effects: One, an intermittent, generally appears as a tendency to roll after the set has been on for a while. It can be traced to a defective (usually open) 2-µf 350-volt capacitor in the screen grid circuit of the 6AQ8 video amplifier. Replace it with a quality 2-µf 450-volt type.

The other problem is in the vertical circuit of the CTC-5 series, and appears as general vertical instability. The hold range is very limited, critical and unstable. You can replace every part in the vertical circuit with little success. The best way we’ve found to stop the rolling is to clip out the .01-µf capacitor in the vertical integrating circuit. This is the one in the middle of the three capacitors that lie parallel to each other and adjacent to the 6CG7 tube on the vertical board. Clipping one lead is quick and usually satisfactory. You will
have to readjust both height and linearity and possibly touch up the convergence a bit.

Another problem easily solved in this chassis is the blooming that occurs when the brightness and contrast controls are turned up. This occurs because the contrast control varies the capacitance of the video amplifier stage (Fig. 2), affecting the overall brightness level. To modify this circuit, clip out the 22-µf capacitor in the plate circuit of the 12BY7 video amplifier. Remove the lead that connects to the cathode lug of the same tube and add a 68-ohm 1/2-watt resistor between the lug and the lead. Clip out the 100-ohm resistor and .0022-µf capacitor connected to the outside terminal of the contrast control. The terminal not formerly connected is now connected to the nearby ground lug. Remove the lead connected to the center terminal and connect it to the other outside terminal. Finally, connect a 50-µF 50-volt capacitor from the center terminal to a convenient ground.

The bias of the stage has now been made constant, while the gain of the stage is changed by increasing or decreasing degeneration.

The two neon lamps in the CTC-10 and early CTC-11 series have been a source of trouble. The common complaint is that the brightness level varies or that the picture gets dark. Make this modification on all sets that use the neon lamps. It requires only one resistor and can be done in the home. First, clip out the neon lamps. Solder one lead of a 220,000-ohm 1/2-watt resistor to the two outside lugs of the terminal strip (where the lamps were connected) and the other lead to the ground lug. Note that this shorts out a resistor on the strip (Fig. 3).

It is difficult to adjust the CRT temperature tracking on the CTC-7A series without winding up with a “green screen.” By replacing the two 910-ohm resistors (R118 and R119) and adding a 36-µh choke on the picture-tube socket board, CRT temperature adjustment is simplified and overall black-and-white quality improved (Fig. 4). It may be necessary to exchange positions of the two new resistors due to differences in screen phosphors.

In the CTC-10 series, the 3.3-megohm resistor (4.7-megohm in the CTC-11 series) located on a terminal strip on top of the chassis near the de-modulator tubes can be clipped to increase chroma gain. (There is no such resistor on earlier sets.) Adding a 330-000-ohm 1/2-watt resistor (Fig. 5) will increase the chroma gain, at a slight sacrifice in bandpass.

Insufficient vertical retrace blanking in the CTC-11 series can be corrected by shorting or bridging the 68,000-ohm resistor connected between lugs “N” and “R” on the PW400A board.

These are just a few of the little ways that can improve operation of both the old and new color sets, and may very well get you out of a bind on a “dog”. Many more ideas have been developed, and many more will be. Perhaps you already have some. Just remember, shortcuts are not meant to replace good service practice, so be absolutely certain you know exactly why you are making a certain modification.

Color TV is easy to service. With an effective, planned routine of setup and service, it can be fast too. Keep up with new developments, try new ideas, analyze the circuits and develop new and different ways to approach a service problem. This is the best way to satisfy your customers and insure your success.

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**Circuit Features Sought**

We're interested in publishing unusual and interesting circuit features in new manufactured equipment. While we describe many new circuits, it’s not always possible for our editors to review the schematic of every new piece of equipment. We know that many of you regularly work on new equipment, either as designers, testers or service technicians. If you run into any unusual circuit feature, we're interested. Give us a short description and a diagram of an unusual circuit feature, and the brand and model of the equipment. $15.00 will be paid for each item accepted.

—THE EDITOR
THE HICKOK FM MULTIPLEX SIGNAL Generator Model 725 is a very versatile instrument. It provides all the signals (except 10.7 mc) needed to test, troubleshoot, signal-trace and align any monophonic, stereo multiplex or SCA multiplex tuner or adapter:

1. An rf signal tunable from 92 to 104 mc, with or without modulation, output variable from about 50 to 1,000 µv.

2. Every variety of audio involved in monophonic or multiplex transmission: 400- or 1,200-cycle sine waves individually, the sum of both (L + R), the difference of both (L - R), composite audio (L + R and L - R), and some 20 additional combinations for specialized tests.

3. 19-kc pilot accurate to ±2 cycles with a choice of three phase relationships.

4. 38-kc subcarrier accurate to ±4 cycles.

5. 67-kc SCA subcarrier.

External mono or stereo signals can be fed into the generator to demonstrate FM stereo without actual radio transmissions.

As might be expected, it is a fairly complicated instrument. There are three rf generators: the main FM carrier generator, a 19-kc crystal-controlled pilot generator whose output is also doubled to produce a 38-kc signal, and a 67-kc signal which simulates the SCA subcarrier.

Two phase-shift oscillators generate 400-cycle and 1,200-cycle sine waves. These, or an external source of audio, are fed through cathode followers into the two channels which form the multiplex components.

The L + R component is formed by feeding the L and R channels into a matrixing network. The resulting sum signal goes through a network which delays the sum signal long enough to keep it in proper phase with the L - R component which has to undergo a more complex process.

To produce the L - R component, the R signal is inverted in phase by 180° and converted into a -R signal. This and the L signal are "added" in another carefully compensated matrixing network to produce the L - R signal.

A very stable crystal oscillator generates a 19-kc pilot. Its output is available from a cathode follower through networks which provide 5% or 10% phase relationships for normal adjustment, or a 45° delay for phase tests. In another channel the output is doubled to 38 kc, amplified and made available through another cathode follower.

The L - R audio and the 38-kc subcarrier are fed into a balanced modulator. The output is a double-sideband suppressed-carrier signal.

Now the L + R signal, from its delay network, and the double-sideband L - R signal, as well as the 19-kc pilot, are combined to produce the composite modulating signal. This is available either at the output jacks or for the FM carrier generator.

The carrier generator is the triode portion of a 6U8 in a Hartley oscillator. The pentode section is used as a reactance modulator fed by the output of the composite adder.

The 19-kc, 38-kc and 67-kc signals are available individually for signal tracing, signal substitution, circuit alignment, synchronizing locked oscillators, adjusting traps or filters, etc.

While all this versatility sounds complex, operation is quite simple and greatly aided by the arrangement of controls which is so logical that operation is almost self-explanatory. The user simply chooses the type of signal required by setting the switches in accordance with a table in the manual and adjusts the output attenuators to provide the desired signal level.

In most cases, the rf output of the generator will be used to feed the antenna input of the tuner. Without modulation this can be turned to peak i.f. and rf circuits. The 19-kc, 38-kc and 67-kc signals can be switched in to adjust bandpass or trap circuits.

Then the audio composite signal is switched in to modulate the rf carrier. The output of each tuner channel is monitored (preferably with a double-beam oscilloscope or with a single scope switched from one output to the other). The adjustments may involve balancing the individual channels, adjusting and checking for optimum separation, and adjusting the 38-kc subcarrier phase. Any type of circuit—matrixing, switching or envelope—can be adjusted.

A multiplex adapter is best aligned when connected to its tuner. However, the composite audio can be fed directly into the adapter, or the multiplex portion of a tuner.

The manual which comes with the generator details the test procedures with commendable clarity. It includes clear photos of scope traces illustrating "good and bad".

I found only one thing to criticize and this is easily corrected. The minimum rf output is 50 µv, which is rather strong and does not give a good idea of performance in fringe areas. A standard TV attenuator can be connected between generator and tuner to bring the level down to the 10-µv level.

In view of the $500 price tag (not high for this type of instrument), only an establishment which does (or expects to do) a considerable volume of multiplex servicing is likely to find the investment justifiable. Those who can justify it will find this an extremely versatile, easy-to-use instrument capable of dealing with just about any conceivable problem in servicing mono or multiplex FM receivers.—Joseph Marshall.

JULY, 1963
start service on a shoestring

By JACK DARR
SERVICE EDITOR

YOU WANT TO WHAT? OPEN A TELEVISION shop?” said the Old-Timer in a horrified voice. “Man, you’re out of your Government Issue skull! What would anybody that’d escaped from one into the nice soft easy life of the Army want to do a thing like that for?”

“Well, I do. My hitch’ll be up in a couple of months, and I want to get started on my own. If I know what I’ll need, I can get an idea of how much money I’ll have to have. Now, what would you think would be the absolute minimum I could get going on?”

“Well,” replied the Old-Timer, “I was really kiddin’. Fact is, I don’t know of a better business for a young feller. Of course, there’s one thing you gotta do, that you didn’t do too much of while you was workin’ for me. Work!”

“Aww!” protested the ex-Young Ham. “I know I didn’t sweep out very often, but . . .” The current Young Ham snorted in his coffee, and the Old-Timer glared at him.

“But that ain’t answerin’ your question. Here. Git a piece of paper an’ make a list.”

The ex-Young Ham produced a small notebook and pencil from the pocket of his blouse. “OK, let’s go.”

“Well, tell you what,” mused the Old-Timer, “there’s two things you’re gonna need to start with. This is about as little as you can go on. But if you use ‘em right, you can make a start, an’ get the rest as you go along.

“First, for general work, you need a good vvm. Git one with plenty of scales on it, like the ones in the shop. Most of the better ones have ac and dc volts, dc mils and a capacitance-tester scale that’s awful handy. Then, you can git a high-voltage probe to go with it, and you’re about fixed. Lots of ‘em have an ac probe that you can even use for signal tracin’.

“You can git factory-builts, or there’s some darn good kit instruments on th’ market now. Cost? Run from about $75 on up for good factory-wired ones, I’d say. Depends on which one you get. Matter of fact, you could even get one of the kits right now, and spend your spare time puttin’ it together. Keep you out of mischief?”

“OK,” said the young man. “Fine. That’s one. What’s the other thing?”

“Tube caddy,” declared the Old-Timer.

“Tube caddy?”

“Tube caddy. With a good vvm and a well stocked tube caddy, you can repair something like 85% of the TV sets you run into in everyday service work,” said the Old-Timer. “Tell me—if your memory goes back that far—what did we use on most sets when you was ridin’ around with me?”

“Yeah, I see what you mean now,” admitted the young soldier. “We very seldom had to take a set to the shop. The biggest percentage of ‘em were bad tubes, and small jobs. I remember.”

“Thought you would.” The Old-Timer grinned. “Especially when I think of how you used to growl when we didn’t have to lug one of them big consoles into the shop!”

“Anyhow, this has been proved many times, by statistics and other lies: the greatest percentage of your service jobs are goin’ to be bad tubes and small stuff. Lots of the sets we used to lug into the shop could have been fixed in the home—burnt resistors and things like that.

“So, you can use a well stocked tube caddy in place of a tube tester—to begin with, of course. Later on, get a tube tester, by all means.”

“Yeah. Now I begin to get the picture.” said the ex-Young Ham. “Hey! What kind of tubes would you recommend?”

“Fast movers, to begin with, of course,” said the Old-Timer. “Now, what tubes did we replace the most of? Percentages, again!”

“Well, horizontal output tubes, dampers, high-voltage rectifiers, low-voltage rectifiers—well, hadn’t rf amplifiers ought to go in there?” asked the young man, scribbling rapidly in the notebook.

“Don’t make a bit of difference,” the Old-Timer replied, “long as you git ‘em all in there. Now you got the idea. Stock up about five each of the fast movers that you just mentioned. Also, you’ll need the rest of ‘em: sync separators, video i.f. amplifiers, sound tubes and so on.”

“6BO6, 6AX4, 1B3, 1J3, 12AT7,” muttered the young man, writing away.

“Yeah, you got th’ idea now,” laughed the Old-Timer. “Tell you what, though. Believe it’d be a good idea to kinda take a look around the territory you propose to set up in. See what kind of sets you’re going to have. For instance, if they were all fairly old models, you’d carry 5U4’s and 6SN7’s pret-
few of those little boxes of hardware: back-cover screws, knob springs, line plugs, and stuff like that, even a little assortment of bypass capacitors and resistors, to fix little things without havin' to go to the shop."

"Well, now what do you think all this'll cost?" asked the young GI.

"Depends on how many tubes you git to start with," replied the Old-Timer. "You got the prices on the other stuff. Just as a darn rough guess, I'd say that your tubes would average something like $1.50 apiece, for the whole stack. Depend on how many new or old tubes you get, but that's close. So, if you had a hundred tubes, that'd be a hundred and fifty bucks, plus your tools, vom and vtvm and the other stuff. Probably figger out something like this," and he scribbled rapidly on the inevitable paper napkin. "There. That ought to do it." [A copy of the Old-Timer's "figgerin'" appears below.]

"Well, that's not too bad," admitted the ex-Young Ham. "I thought it would cost more than that."

"Will," warned the Old-Timer soberly. "You've got to figure your rent, utilities, transportation and other stuff. Too many 'variables' to even get a halfway useful answer on that now. What I gave you there was just the very minimum of tools and test equipment you need to get started on. You'll have to get the rest of your equipment a piece at a time. Next thing oughta be some substitution boxes and then a good scope, of course, with plenty of matched probes."

VOM (Pocket type) $2.00
SOFTWARE (solder gun, plyr, screwdrivers, etc.) 25.00
TUBE CADDY 10.00
TUBES,100 @ $1.50 ea. 150.00

"Yeah, I see, and I sure thank you," said the soldier, reaching for the list, which the Young Ham was studying intently. "Hey, gimme that."

"Wait a minute! I see something you forgot," said the current Young Ham, triumphantly. "How about sodler? You never said a word about any sodler in that tube caddy!"

"Yep," said the Old-Timer, with a straight face. "In all the years he worked for me, he was never known to leave any sodler in the tube caddy when I needed it! So, I left that out deliberately!"

New Facts On Television

Parents generally believe that the educational benefits of TV for children outweigh its bad effects on the young, reports a new book (The People Look At Television, Gary A. Steiner, Knopf). More than 64% of parents with a grade school education believed that TV was a factor in their children's education, while 89% of college-educated parents subscribed to that belief.

Some of the educational benefits were close to the fringe: one parent explained, "My kid has learned from watching Westerns that when you sit in a saloon you should face the door so you can see anyone who is coming to shoot you." TV viewers in general believe that TV watching is "lazy," though 12% believed it time well spent.

Another interesting fact discovered is that viewers in the higher education bracket, who are presumably the severest critics of low-level TV programs, do not pay more attention to higher level TV than those lower in the educational ranks. Viewers who had eight years or less of grade school education watched public affairs shows approximately 5% of the time, while those who had college- and beyond educations showed a figure of 8%. (Public affairs shows occupy about 50% of the time on major networks.

The number one objection was commercial interruptions at peak interest points in programs. Only 4% objected to "too loud" commercials.

Four-Way Switch

Three readers have pointed out that, though four-way (dpdt) switches might make a good puzzle (May EQ, page 34), in real life two three-way (spdt) switches and one four-way switch would be used, as shown in the sketch.
Three power transistors solve regulation and filtering problems in the Delco P-612

**low-cost transistor regulated power supply**

By P. R. Powell*

Transistor regulated power supplies are not new. But they have had one fault in common: good ones have been very expensive. Delco has begun producing a new transistor supply, the P-612, at a moderate price, designed especially to power the “Wonder Bar” signal-seeking auto radios.

Until now, these radios have been hard to bench-test because their tuner solenoids draw a heavy current. Whenever one of them is actuated, the terminal voltage of a normal unregulated supply drops substantially, causing the signal-seeking mechanism to “hang up.” This often resulted in a burned-out solenoid.

To compensate, service technicians were forced to run the tuner at about 16 volts, which shortened tube and transistor life in hybrid sets.

Fig. 1 shows the circuit of the new power supply. Up to the output of the full-wave rectifier portion, the circuit is fairly conventional. Two 18-ampere silicon diodes, D1 and D2, rectify the ac supplied by T, which has taps to provide two voltage ranges: 0–8 and 8–16. C1 and C2 help filter fluorescent-light hash, a common nuisance on service benches.

From this point, the P-612 differs quite a bit from the common pi-network choke-and-capacitor power supply often found in battery eliminators. There’s a good reason for that—the very reason for producing the new power supply in the first place. Let’s look at Fig. 2.

Suppose we represent the dc voltage source with a perfectly regulated supply. Current passes to the load (shown as a resistor) through a capacitor input pi filter. If the radio (load) draws 3 amps from the supply (and through the 0.5-ohm choke), we lose 1.5 volts across the choke—good old Ohm’s law.

To get the radio its rated 12 volts, we have to crank the supply up to 13.5 volts. This is not too bad. But now suppose the Wonder Bar solenoid is actuated. Our load suddenly becomes about 15 amperes! We now lose 7.5 volts across the choke—and 7.5 from our source of 13.5 leaves a puny 6 volts for the radio. The mechanism “hangs up” and overheats. Clearly, then, where the load varies 5 to 1, as it does here, a series choke is a serious disadvantage. And 0.5 ohm is a low-resistance choke.

**The better way**

Fig. 3 shows our way around this. You can still recognize the basic pi-net configuration, but the choke in the positive leg has been replaced with a transistor in the negative leg. (Two Delco DS501’s are used, but only one is shown, for clarity.) The transformer rectifier supplies a constant 20 volts (on the 8–16 volt range). If we need 12 volts across the load, the transistor drops the remaining 8; we must bias its base accordingly, so that it will conduct just enough. That’s the purpose of R1 and R2 in Fig. 3. Adjusting R2 turns out to be a very effective way of controlling the power supply’s output voltage.

**Ac regulation**

The method just mentioned is fine for controlling output voltage, but it does not regulate. What we need is a sensing device that can “feel” voltage changes and make them into suitable changes in forward bias on the series transistors.

* Delco Radio Div., General Motors Corp.
transistor, so that the transistor can compensate automatically for changes and hold the output constant even under varying loads.

One more thing: the simple circuit of Fig. 3 simply hasn't enough gain, or sensitivity, to compensate for small, rapid voltage variations—ripple.

We can solve both problems by using another transistor as an amplifier, or control transistor, as in Fig. 4. (In the actual power supply circuit, this is Q3, the DS520.) Referring to Fig. 4, as the arm of R is lowered, Q3's forward bias (and current flow) increases. This is passed on to Q1-Q2, whose resistance is lowered, and the terminal voltage goes up.

Now look at Fig. 5. All that's changed is that we've added a fat electrolytic, C (C3 in Fig. 1), between the common-plus line and Q3's base. Of course it blocks dc, so there is no change in static conditions. But it passes changes of dc; ripple. In other words, Q3's base bias will vary instantaneously and exactly with rapid fluctuations in the supply voltage. Suppose we have a positive ripple-pulse at A in Fig. 5. This is transferred through capacitor C to Q3's base, which also goes positive. This reduces Q3's forward bias current, and ultimately also reduces Q1-Q2's current. The result? Greater voltage drop across Q1-Q2. Or, to look at it another way, a negative pulse which matches and cancels the initial positive one. This instant electronic filtering produces only .01% ripple.

The regulating circuit assures that the P-612 can supply instantly the full current drawn by a Wonder Bar radio with a solenoid actuated.

**Circuit breaker**

Fig. 6 shows the P-612's circuit-breaker system. The breaker has two coils: one with only four turns of heavy wire in series with the supply line, the other a higher-resistance one in series with a 1,000-ohm resistor. The high-resistance circuit "biases" the breaker (magnetically speaking) so that it trips at the proper current point.

When a short occurs, the heavy current through the four-turn coil trips the breaker, throwing S1 and S2. S1 removes the forward bias from Q3, cutting it off and cutting off Q1-Q2 also. The transformer and rectifiers are still supplying 20 volts, but Q1 and Q2 are dropping all of it. The terminal voltage is zero.

Since the current flow in the supply line is now nearly zero, the relay would normally drop out and, if the short were still there, the breaker would begin to chatter as it cycled on and off.

To prevent that, S2 shorts out the 1,000-ohm resistance in series with the higher-resistance coil. Enough current flows through that coil now to hold the breaker in its tripped state. Turning the voltage control pot to off for about 8 seconds resets the breaker.

**Operating characteristics**

One unusual aspect of this supply is the fact that it can provide higher currents at high voltage output than at low. The reason is that, at high terminal voltages, Q1 and Q2 are low resistances and can pass considerable current without overheating. At low terminal voltages, their resistance goes up, and smaller amounts of current will heat the transistors.

On the 8-16-volt range, with the unit adjusted to 12 volts, 5 amperes is the continuous rating. At 6 volts on the same range, it is 2 amperes. But if you switch to the 0-8-volt range, the 6-volt continuous-current rating becomes 8 amperes. When the unit is switched to its 0-8 range, less voltage comes from the rectifiers and Q1 and Q2 drop less. They produce less heat that way, and hence more current can be drawn.

The maximum instantaneous current is 20 amps, and the supply's effective capacitance is 1.5 farads. It comes with voltmeter and ammeter for continuous monitoring of power. END
WEATHER IS PROBABLY THE MOST IMPORTANT factor in flying safety. A worldwide network of meteorological stations furnishes information on weather conditions continuously. But local weather conditions can change so rapidly that this information is not enough to keep a pilot informed of all weather conditions in the immediate vicinity. By using weather radar equipment, the pilot actually sees an accurate and continuous "picture" of weather conditions ahead of the aircraft—a weather map.

The weather map shows the location of weather fronts in terms of range and azimuth bearing, relative to the position of the aircraft. It identifies potentially dangerous areas such as thunderheads, hailstorms and turbulence. With this map as a guide, a pilot can navigate to avoid storms or turbulent areas, often by detours of less than 5 miles from the planned flight path.

**Radar weather observation**

To observe and interpret weather on a radar system, it is necessary to understand the display on the indicator screen. The radar information is presented on the face of a cathode-ray tube. The mask on the tube face is set up in terms of range and azimuth. The sweep trace on the tube rotates in synchronism with the radar antenna mounted in the nose of the aircraft. For both range and azimuth determination, bottom-center of the screen (upper portion of Fig. 1) represents the position of the aircraft. The 0° calibration represents the heading. All echo returns (reflected energy) appear as brightened areas on the screen, displayed to the left or right of the 0° reference, depending on the object's position—left or right, respectively, of the aircraft (Fig. 1).

Range marks (concentric circular traces at regular intervals on the screen) are set up as references in terms of distance from the aircraft.

**Fig. 1—Relative positions of aircraft and weather feature: actual (bottom) and as displayed (top). Bottom center of screen represents aircraft.**

Weather information detected and presented by the weather radar system is based on rainfall gradient: the variation of the rate of rainfall with distance. Radar pulses are reflected by precipitation, such as rainfall, wet hail or wet snow. Variations in rainfall gradient are detected by **contouring** (Fig. 2). When the radar is set up for contouring, areas of heavier rainfall appear as dark spots on the indicator screen, while the brighter display areas indicate lighter rainfall.

**Contouring**

The reason for this apparent paradox lies in the contouring system used. Since the brightness of the display depends on signal strength, age cannot be used in this system—it would level off most of the amplitude changes in the return signal. However, the absence of age seriously limits the "dynamic range" of the radar. For a particular screen-intensity setting, there is only a limited discernible range of brightness variation. A return below this range would produce no image, while a return above it would saturate either the display tube or the amplifier, producing a bright spot that would not get brighter no matter how much further the signal increased.

But since the return signal is a pulse whose amplitude is related to signal strength, we can solve the problem by reshaping the pulse. It is reshaped so that all returns below some predetermined level will be displayed in normal fashion (brightness directly proportional to strength of return), while all returns

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**By DONALD E. BOWEN**

C-band and X-band radar systems pinpoint storms and turbulences.
above this level will show as a “negative” of the area that causes the return (brightness inversely proportional to strength of return).

Thus, the weak returns (as from the perimeter of a turbulent area) show on the screen in the normal way—dim around the edges, brighter toward the center. But when the return exceeds the preset level (as it would in return from a turbulence with a steep gradient), the display is reversed so that it becomes darker as the reflected signal increases. That leads to the kind of display labeled CONTOUR in Fig. 2. The fringe of the storm appears as a bright area (moderate return) that encircles the violent core of the storm, shown as a “hole” (strong return).

Since contour presentation is not always desirable, the equipment has a switch to permit it to be used as normal radar.

How it’s used

Meteorological studies show that violent turbulence occurs near steep rainfall gradients (where the change from no rainfall to heavy rainfall occurs in the shortest distance). When the radar is set for contouring, steep gradients are displayed on the radar screen as relatively large “cores” (dark areas) surrounded by a narrow ring of bright returns. If there are no cores (or only very small ones) surrounded by large, bright rings, there is little or no turbulence. Thus, the inner and outer edges of the bright returns which surround the dark cores are contours that approximate the rainfall rate.

Obviously, the safest path for the aircraft is the path which avoids the dark storm cells indicated on the radar screen. A large thunderstorm area might contain not one but several individual storm cells, each in a different stage of development. The average life of a storm cell is about 1½ hours. (Because the several cells vary in stages of development, local weather information only minutes old is almost useless.)

One of the most significant features of thunderstorms is vertical development. Generally, a thunderstorm will develop at some altitude between 8,000 and 15,000 feet. If the top of the storm goes beyond 30,000 feet, turbulence is likely. If the top passes the 40,000-foot level, especially in temperate latitudes, damaging hail and severe turbulence are imminent. When the top reaches 50,000 feet, tornadoes are extremely likely. Hail (associated with updrafts or downdrafts) or dangerous tornadoes are indicated on the radar by fingers, hooked fingers, scalloped edges or U-shaped projections extending from intense echoes (contoured). These projections are very dangerous, as is an overhang from a thunderstorm.

The system

Weather radar is like any of the familiar radar systems in use, the principal difference being its application. Special lightweight systems have been developed specifically for small commercial and privately owned aircraft. These systems may be divided into C-band (5,400-mc) and X-band (9,400-mc) systems. The C-band radar system is larger and bulkier, a result of the lower frequency, which requires larger waveguides, cavities and antenna systems. But C-band frequencies permit deeper weather penetration.

Representative weather radar systems have three ranges: for example, 30, 60 and 150 miles. Markers for these ranges are typically 10, 15 and 25 miles. An antenna sweep of 60° either side of dead ahead is adequate. Systems are usually installed with the antenna in the nose of the aircraft, protected by a plastic radome which replaces the original nose section. (The radome is painted to match the finish of the aircraft.) To avoid long pieces of waveguide, the receiver-transmitter unit is frequently mounted near the antenna (Fig. 3).
The Collins weather radar system consists of a receiver-transmitter unit, a synchronizer unit, an indicator unit, an antenna and a cockpit control kit. The only operating power required is a source of 115 volts, 400 cycles ac, the standard aircraft electrical supply.

This system is a pulse-modulated radar device that operates at 9.375 mc (X-band). The narrow beam of rf energy radiated at X-band frequencies defines the targets sharply.

Short, high-powered pulses of rf energy generated by the transmitter are radiated in a narrow beam by the antenna located in the nose of the aircraft. The antenna sweeps from 60° left to 60° right, then back, 30 times per minute, taking a total of 60 scans per minute. When the rf energy strikes an object (such as a storm cell) within the 150-nautical mile range of the equipment, it is reflected to the antenna as an echo and applied to the radar receiver. The detected echo, a video signal, appears on the screen as a display of the object that caused the echo.

The synchronizer unit generates and controls the sweep trace and range circles. Indicator sweep trace and antenna sweep are locked together by the synchronizer to insure that echoes are displayed at the correct range and azimuth bearing.

The "rest" trace on the indicator is a bright line which sweeps back and forth across the screen, representing the scan of the antenna. When an echo is received, the sweep trace is brightened (or darkened) on the screen, showing the range and azimuth of the weather target.

A stabilized antenna system, together with the aircraft's gyros, compensates for pitch and roll. The weather-map presentation is in the same plane regardless of normal pitch and yaw of the aircraft. An additional feature of the stabilization system is variable antenna tilt, making it possible to map the terrain below and in the path of the aircraft (Fig. 4). Here, an aircraft is flying over a river at an altitude of 10,000 feet. The antenna is tilted to 6° below the horizon. Compare the indicator displays A, B and C with the river at scans P1, P2 and P3, respectively.

The Collins WP-103 is available with a 12-, 18- or 30-inch antenna, and either a conventional or bright-tube indicator. Increasing the size of the antenna improves intensity and definition. The conventional indicator provides the familiar yellow offset display. The bright-tube indicator provides a bright, longer-lasting display that enables the pilot to view the screen even in bright sunlight without a hood. An adjustable Polaroid filter dims the display for nighttime operation. The bright-tube presentation can also be varied from a normal yellow-green to red. Accuracy is not affected by the color change.

Weather radar has been extremely successful in adding to the comfort and safety of airlines flights. Because of this, more and more executive airplanes, too, are being equipped with weather radar systems. Small, lightweight, relatively inexpensive units ideal for executive aircraft are available. You can certainly expect to see more and more of these systems in the near future.

Of course, the cockpit control and indicator are mounted on the instrument panel, accessible to both pilot and copilot. Operating power and gyro signals for antenna stabilization are supplied from existing aircraft facilities.

**A complete system**

The Collins weather radar system was designed to be lightweight, relatively comfortable, and relatively inexpensive.

**Fig. 4—Relationship between terrain below aircraft, and display, when radar is used for ground observation. (Left), "actual" river, with position of aircraft and scanned sectors. (Above), how scene appears on indicator screen.**
THE HORIZONTAL SWEEP CIRCUIT OF A TV receiver is very much like a radio transmitter's "final" stage. In each, a power amplifier tube drives a load. To get maximum efficiency, this load resonate at the proper frequency. In fact, the energy in horizontal sweep circuits is often called rf.

In a transmitter, the transformer that couples the power amplifier to the antenna must be tuned to transfer maximum rf energy. This gives maximum efficiency. The horizontal sweep circuit is electrically identical. In this case, the tuning is done by adjusting the horizontal linearity control. (I am well aware that this is an oversimplification but it is the best analogy I can make.) In older models, adjustments are provided. In later models, the adjustable control is omitted for economy, but this quantity is always controlled. In later sets, the control is fixed by the design of the flyback, yoke and associated circuitry. Advances in component design and construction have made it possible to attain good linearity without variable adjustments. Defective components will cause loss of linearity in such circuitry.

Let's look at a representative sample. This month, we'll take the older chassis, a Stewart-Warner 9126, vintage 1950. This is one of the old "conservatively designed" sets. It has adjustments for almost everything. Tubes are not driven anywhere near their maximum output, so that you'll note some very low current readings compared to a few later types.

Fig. 1 shows a partial schematic of the horizontal output circuit. A 6CD6 is used as the horizontal output tube. Protective bias is developed by the 220-ohm resistor in the cathode. Horizontal linearity, drive and width controls are encircled. The normal drive signal here is 70 volts p-p, with a cathode current of 100 ma.

Fig. 2 shows a normal raster. Both circles are round, cathode current is 100 ma, and the high voltage measures about 16 kv.

Fig. 3 shows what happens when the drive is reduced, by setting the trimmer to maximum capacitance. The raster has pulled in at the left; linearity is bad, crowded left and slightly stretched right. However, the linearity control has not been moved—only the drive. This could be the result of tinkering by the owner or an unskilled technician. Cathode current up to 110 ma, high voltage down to 10.5 kv.

In Fig. 4, the drive has been returned to normal and the linearity adjustment thrown off slightly. Note slight stretch on left and compression at right. Cathode current is now back to normal 100 ma, but the shape of the circles shows that things aren't right. So, al-

---

**Fig. 1**—Horizontal amplifier of old Stewart-Warner 9126. Effects of adjustments are discussed in this Clinic.

**Fig. 2**—Normal test pattern and cathode current. Note roundness of both circles.

**Fig. 3**—What happens when drive is too high: current up, width bad, linearity poor.

**Fig. 4**—Here the horizontal linearity is slightly off. Current is normal, but picture is poor.
ways remember that cathode current alone is not a guarantee that the circuit is correctly adjusted. It is always possible to tune up a radio transmitter for correct meter readings, yet have practically no rf output at all!

Carrying this to extremes, we get a mess like Fig. 5. This results from misadjusting both horizontal linearity and drive at the same time. Once again, this can result from tinkering. It is shown here to keep you from leaping to the conclusion: "Leaky coupling capacitor in horizontal output tube grid circuit!" Always check the positions of linearity and drive controls. Even a small movement of either will start this pattern unfolding, and you can tell which is responsible. Cathode current is very low—only 80 ma. In this particular circuit, tuning the linearity control for the exact bottom of the dip gives this kind of pattern. In other variations, the bottom of the dip is the correct place! For a conclusive check, always check all other factors: hv, boost, etc. When you find the correct settings, hv and boost will be at a maximum, and the cathode current will be within safe operating limits for the tube type.

In Fig. 6, we see what happens when trouble in the oscillator circuit occurs. The oscillator here is far off-frequency, giving a semi-Christmas-tree effect. Now our secondary load circuit cannot reach resonance. Cathode current goes up to the highest point reached during this series of tests—a whopping 170 ma. Even for a stout-hearted old tube like the 6CD6, this is a strain. One of the smaller tubes like the 6BQ6 would be totally destroyed in about 10 minutes!

So there you have it. When setting up these circuits, after tube or part replacement, it's wise to check the setting of the linearity control. Cathode current should be measured, either with an adapter or by breaking the circuit and inserting a meter, as we have done here. A bias resistor in the cathode circuit will hold cathode-current to lower values. This automatically compensates (within limits) for low-drive conditions by increasing the bias on the grid. Set the linearity control for the lowest cathode current and the best linearity at the same time. In a lot of circuits, this will be a compromise setting. The drive should always be adjusted at the same time. Juggle the two adjustments back and forth until you get the best results. At this point, your circuit will give maximum efficiency, best performance and longest tube-life. In another clinic, we'll go into the same adjustments in chassis with fixed part values.

"Broadcasting" test patterns
I have just recently purchased a TV test pattern generator. Can you give me the schematic of a broad-band amplifier, so that I could cover about 4-5 blocks from my shop? This is so that I won't have to carry the instruments around to nearby houses.—L. S., Buffalo, N. Y.

I could, but I'm certainly not going to! Uncle Sugar very definitely frowns on such activities! If you did this, you would be operating a TV transmitting station without a license, and it wouldn't be long before the FCC came knocking at your door! Convenient as it would be, I'm afraid that you're going to have to go on carrying the generator with you on your service calls!

Tuner interchange
I've got a G-E 17T2 with a bad tuner. I also have a uhf tuner on an old Bendix TS17U. I want to use the uhf tuner, which is good, on the G-E. Can you tell me how to connect it up?—J. T., St. Petersburg, Fla.

Frankly, this would be a pretty hairy job! If you want to try it for fun, OK, but don't try to make any money out of it! The G-E is a series-heater set, while the Bendix is a parallel-heater job. You'd have to install a filament-transformer on the G-E chassis to light the tuner tubes, and put in a resistor to take care of the 24 volts you took out of the filament string in the original tuner.

Physically, also, you'll have troubles. The Bendix is a pretty good-sized tuner, as the uhf tuner is mounted on the side of the vhf tuner; the original G-E tuner is a long, narrow sort of gizmo. As far as connecting the tuner into the G-E circuit, this should be little trouble. Connect the i.f. output directly in to the grid circuit of the first 6AU6 video i.f. amp, and tune up the transformer to 42.0 mc. One thing that does match: they're both 40-mc i.f. tuners!

Horizontal bending
I have a bad case of horizontal bending in an Olympic CA-105 TV, chassis GAU. I've replaced the tubes, with no luck. What else could cause this?—F. K., S. Euclid, Ohio

Fig. 7—Olympic GAU chassis horizontal oscillator. Bad boost filter can cause horizontal bending.

Fig. 5—Everything out of adjustment. Low cathode current, severe foldover.
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available through most larger mail-order houses. But they are getting scarce, and you may as well convert now. A 35Z4 is a 35Z5 without the pilot-light tap in the heater (Fig. 8). Only precaution, check the socket to be sure that nothing is connected to pin 3. If there is, nip the whole lug off with diagonals and tape it up, or tack it to an empty lug nearby to keep it out of mischief.

Puzzle corner

A TV chassis just came in with no name, no labels, no model number, no nothing! Can you help in cases like this?—S. H. S., Crabtree, Ore.

If any of you run into this kind of problem, make us a rough sketch of the tube layout on top of the chassis, give us the type numbers of tubes used, and any part numbers you can see: the flyback, yoke, power transformer, etc. Look at the tubes and see if quite a few of them have a brand name. Most TV sets, unless they're awfully old, still have quite a few of the original tubes left in them. In other words, give us all the clues you can find (but not the serial number! That's meaningless!) and we'll see what we can come up with!

Flickering in Iceland TV

I live in Iceland. AC line voltage here is 220, at 50 cycles. I use a step-down transformer for my TV set, an American model. I get a good picture from the TV station at the airport, but it has a fast flicker. Could this be due to the difference between the 50-cycle supply and the 60-cycle sync?—P. A. C., Keflavik, Iceland.

Nobly resisting the temptation to say that the picture could be shivering from the extreme cold up there, I'd say that this is possible. The 10-cycle difference could conceivably be affecting your vertical oscillator slightly, causing it to pull against the sync, with a consequent flickering. Then, too, the lower power supply frequency means that your filter capacitors are not as effective as they are at 60 cycles. I'd suggest adding more capacitance to your power supply, temporarily, as a test. If this doesn't cure it, see if you can rig up some sort of belt-driven motor-generator set, which would give you 110 volts at 60 cycles. With your 50-cycle power, you'd have to modify the pulley sizes.

A TRANSISTORIZED AM BROADCAST TUNER

by Lafayette Radio, the PK-663, is nearly packed into 4 x 1 1/4 x 2 inch dimensions, including mounting brackets.

It features a three-transistor superheterodyne circuit completely wired on a printed-circuit board. Two stages of i.f. amplification provide good selectivity and sensitivity. A ferrite antenna is also used, eliminating the need for an external antenna, although one can be added (as will be explained later).

Performance is excellent and can be favorably compared to higher-priced transistor and vacuum-tube type AM tuners. Tests performed on this tuner produced amazing results.

Overall loop sensitivity is 100 µv at the high-frequency end, and 175 µv at the low end. Results of test performed are shown in the table.

Although originally designed to complement the series of transistor amplifiers produced by Lafayette Radio, the tuner operates equally well with any type amplifier. My experience (and tests performed) with this tuner show that, when used with an external antenna, it performed as well as an AM tuner of much higher price.

Complete with calibrated dial, this AM tuner is ready to mount horizontally in any custom cabinet.

Adequate age is obtained from this three-transistor-diode circuit even when receiving many of the weaker stations.

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electronic organ tuning MADE EASY

**TUNING CHART**

<table>
<thead>
<tr>
<th>FIXED LOW-FREQUENCY NOTE (CYCLES)</th>
<th>HIGH-FREQUENCY NOTE TO BE ADJUSTED (CYCLES)</th>
<th>NUMBER OF BEATS IN A 5-SECOND INTERVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 523.25</td>
<td>G 783.99</td>
<td>9</td>
</tr>
<tr>
<td>G 392.00</td>
<td>D 587.33</td>
<td>7</td>
</tr>
<tr>
<td>D 587.33</td>
<td>A 880.00</td>
<td>10</td>
</tr>
<tr>
<td>A 440.00</td>
<td>E 659.26</td>
<td>7</td>
</tr>
<tr>
<td>E 659.26</td>
<td>B 987.77</td>
<td>11</td>
</tr>
<tr>
<td>B 493.88</td>
<td>F# 739.99</td>
<td>8</td>
</tr>
<tr>
<td>F# 369.99</td>
<td>C# 554.37</td>
<td>6</td>
</tr>
<tr>
<td>C# 554.37</td>
<td>G# 830.61</td>
<td>9</td>
</tr>
<tr>
<td>G# 415.30</td>
<td>D# 622.25</td>
<td>7</td>
</tr>
<tr>
<td>D# 622.25</td>
<td>A# 932.33</td>
<td>10</td>
</tr>
<tr>
<td>A# 466.16</td>
<td>F# 698.46</td>
<td>8</td>
</tr>
<tr>
<td>F# 698.46</td>
<td>C#1046.50</td>
<td>12</td>
</tr>
</tbody>
</table>

Note: The beat frequency can be obtained by subtracting the second harmonic of the high-frequency note from the third harmonic of the low-frequency note. Then multiply this answer by 3 for the 5-second interval. Example—C above Middle C: 1569.75—1567.98=1.77 cycles per second, or about 9 beats per 5 seconds.

Tuning an electronic organ is easy when you follow the zero-beat method described here. No special apparatus is required, yet you can get accuracies of a fraction of a cycle per second. If one note has been repaired, it can be retuned to the other notes, which will not need to be disturbed.

By J. W. KORTE

YOU HAVE PROBABLY HAD SOME EXPERIENCE in zero-beating. This is the principle on which this method of tuning is based. For example, we can set a constant-frequency oscillator at 1,000 cycles and connect it to a speaker. Then we can connect a variable oscillator to another speaker. When we listen to the speakers, we can tell when the two oscillators have exactly the same frequency (1,000 cycles in this example) by adjusting for zero beat. If we want to set the adjustable oscillator to 1,001 cycles, we start with a higher frequency and lower it until the beat rate is reduced to 1 cycle per second. Similarly, 999 cycles on the adjustable oscillator will produce a 1-cycle beat or 998 cycles a 2-cycle beat and so on.

There are two common types of musical scales. In the natural scale, the do, mi, sol, do notes of the chords are in the ratios of 1.000, 1.250, 1.500, 2.000. But in organs or other fixed-pitch instruments, the tempered scale is used so that music can be played in various keys.
without retuning the whole instrument. Here the ratios are 1.000, 1.260, 1.498, 2.000. Note that the octaves are double frequency in either case, but that the other values given for the tempered scale are not an even 1⅓ and 1⅓ as with the natural scale.

If we analyze a single note produced by an electronic organ, we find that it contains more than just the fundamental frequency—there are smaller quantities of various harmonics too. (The organ stops that add octaves above or below or quints or overtones are not operated.) You will notice that the overtones of one note are near enough to certain others that a beat can be heard in an accurately tuned organ.

**ORGAN TUNING SUMMARY**

1. **Play two notes indicated on the chart. (Start anywhere). octave and vibrato tabs “off”**.

2. **Adjust the top note to the beat indicated on the chart. Be sure its frequency is flat or low by running the adjustment too far temporarily so it can be obviously heard.**

3. **Continue in sequence down the chart, adjusting each top note. Go past the first note tuned to check the accuracy of the whole octave.**

These could be set by zero-beating for the natural scale, but must be set for a certain beat frequency when tuning the tempered scale. The vibrato or revolving speakers should be off, of course.

Generally only one note will need to be retuned after it has been repaired, and the others merely checked or touched up slightly. The whole organ can be retuned upward or downward by adjusting any one note to zero-beat with a known accurate standard, and then using it as a base for tuning the other notes. Begin on the chart where this note appears as the fixed low-frequency note and continue in sequence through the octave. One of the best standards to begin with is a tuning fork. Music stores sell A-440-cycle forks for as low as about $2 and demonstrate how they should be held. Hold the tuning fork close to the ear and adjust organ volume to sound about as loud. This produces easily distinguishable beats, which are adjusted to a zero beat by tuning the organ note.

**Tune by the chart**

Tuning by this method may be started any place in the octave and continued on past the starting point to insure that no errors have been made. Depress two notes at a time in sequence as shown on the tuning chart. The key locations are indicated on the keyboard location chart. After the notes in the chart are tuned, the others should all be in step in such organs as the Baldwin, Lowery, Minshall and others that use frequency dividers. Organs that have separate frequency generators for each note can be adjusted by zero-beating the other octaves to the one tuned octave.

Actual oscillator tuning is made on the top note of the two being played. You will notice that the top note (and its harmonics) is slightly flat from the 1⅔ ratio of the natural scale. The amount of flat is very small and can be determined by the rate of the beat. It's a good idea to run the oscillator adjustment past the final spot and listen to make sure that the oscillator being adjusted is not above the zero-beat frequency, but below it as it should be. Each note is adjusted from the previous or adjacent note as such on the chart. Therefore, when the whole octave has been adjusted and the adjusting is continued past the starting point, any error will show up by the beat's being off when arriving at a note previously adjusted.

At these frequencies, the beat will average around 2 per second. If the beats are counted for a period of a few seconds, more accuracy is obtained. The last column in the chart indicates the number of beats to be counted in a 5-second interval. Various organ stops can be tried to obtain the best beat signal. The stop which takes the loudest or rawest part of the signal usually gives the best beats. Even though the beats are much lower in amplitude from the note played, they are easily discernible.

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JULY, 1963
**Automatic antenna matching system**

By ARTHUR L. MUNZIG

ONE COMMON WAY OF MATCHING A CENTER-FED, HALF-WAVE ANTENNA TO A TRANSMISSION LINE IS TO SHORTEN THE ANTENNA SO A CAPACITIVE IMPEDANCE IS PRESENTED AT ITS INPUT. THEN A TUNING STUB IS CONNECTED TO THE ANTENNA INPUT IN PARALLEL WITH THE TRANSMISSION LINE. THE STUB PRESENTS AN INDUCTIVE REACTANCE TO THE INPUT. THIS INDUCTIVE REACTANCE CAN BE VARIED WITH RELATION TO THE CAPACITIVE IMPEDANCE OF THE ANTENNA AT ITS INPUT SO THAT AN EFFECTIVE PURE RESISTANCE IS PRODUCED TO MATCH THE LINE IMPEDANCE. SUCH A MATCH, HOWEVER, IS NOT AUTOMATIC AND REQUIRES CONSIDERABLE EXPERIMENT AND STUB CUTTING TO TUNE THE STUB PROPERLY.

![Transmission Line Diagram](image1)

**Fig. 1** shows two methods of applying an automatic impedance-matching system to an antenna. They are covered by Patent No. 2,769,169 and were developed to match almost any balanced line to antennas having high or very low radiation resistances. The system is suitable for feeding rhombics, V-beams, folded dipoles, all-channel TV antennas, stacked arrays and many other types of antennas requiring two-wire feed lines.

In **Fig. 1**, D1 is equal to the spacing between conductors of the transmission line, and D2 is just enough spacing to prevent voltage breakdown. In receiving and low-power transmitting antennas, D2 may be the enamel insulation of two enamel-covered conductors twisted together in a twin line.

Referring to **Fig. 2**, the transmission line looks into an impedance transformation. The quarter-wavelength section becomes a matching transformer ($Z = \sqrt{Z_1 \times Z_2}$) and realizes $Z$ in the equation by summation, since the impedance rises and falls in opposite directions in the two stubs. Since $Z_2 = \sqrt{L/C}$ ohms and $Z_1 = Z_0$, a line can be terminated in $L$ and $C$ values that equal $Z_0$, a real quantity. ($Z_0$ is characteristic impedance and $L$ and $C$ are the inductance and capacitance, respectively, per unit length.) If the line has the same $Z_0$ through the quarter-wavelength stub, it will automatically seek out values of $L$ and $C$ to equal $Z_0$. The antenna quarter-wavelength stub will also seek out $Z_0$ and an impedance match will result, even though the antenna impedance is changed by adding reflectors or directors. Any change in $L$ and $C$ values reflected or coupled into either stub will automatically satisfy the equation for $Z_0$.

This matching system was tested by voltage measurements at the grid of the input tube, after the automatic gain control circuit had been disconnected. **Fig. 3** shows measured voltage gain in db, using the automatic impedance-matching system, compared with a reference antenna without the system.

I believe the theoretical explanation given is correct, for it will be seen that the $Z_0$ of a line can be matched to a load by selecting the correct $Z_0$ ($Z_0 = Z_1$) point on a resonant coil. The same thing can be done with a transformer and a resonant antenna. It is reasonable to believe the equation for $Z_0$ is satisfied, for the quarter-wavelength matching section contains both inductance and capacitance.

Details on a tri-band antenna for 80, 40, and 20 meters using automatic impedance matching are covered in my article "Automatic Antenna Matching" on page 75 of the July 1951 issue.
The silicon rectifier industry moves at such a rapid pace that you may not be aware of some recent developments. Take hermetic sealing for example. Many technicians feel that the "top hat" rectifier is the only safe one to use... probably because it's the original MIL type (1N538, etc.). This is the Mallory "H" type. It's a fine rectifier and we sell thousands of 'em. If you really need hermetic sealing, you should check the Mallory "D" series. It's smaller than the "H" and actually has better characteristics at a lower price.

But are you sure you really need hermetic sealing? The Mallory "A" series (axial leads) and "T" series (parallel leads) actually withstand four times the humidity cycling of the MIL test. They're both epoxy encapsulated and are available in all ratings up to 600 PRV at lower cost than either the "D" or "H". You shouldn't confuse the Mallory "A" or "T" rectifiers with those made by other people, though. No kidding, we use a superior encapsulating system. If you need quality, you'll be ahead with Mallory.

So, whenever you need 750 ma from 50 to 600 PRV, decide on the style and price that fit your requirements. Your Mallory Distributor has exactly the right rectifier for you.

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marker-adder
for your sweep generator

Get clear, sharp markers — feed them direct to your scope

By WILLARD WILES

When aligning TV or FM receivers it is often just as hard to supply the proper signals as to do the actual receiver adjustment. Here is a marker adder which provides all necessary marker frequencies simultaneously, with crystal accuracy, and feeds them directly to the scope. I have added it to a Heathkit sweep generator, but it will work as well with any other sweep generator.

When marker signals must pass through the receiver at the same time as the sweep signal, the response curve suffers from the injection process or the marker is hard to see at trap frequencies. When a marker adder is used, the marker generator signal does not pass through the receiver being calibrated at all. Instead it is detected, amplified and fed direct to the oscilloscope. The markers are independent of the receiver being calibrated.

The unit should be built into the sweep generator, rather than as a separate unit. It’s more convenient that way.

Low-frequency response in the 6AU6 pip amplifier has been purposely limited so a “sweep loop” due to rectification of the 60-cycle rf sweep does not appear on the scope. High-frequency response is also limited. This keeps the markers narrow and sharp. Thus, only the heterodyne audio frequencies, near zero beat, are seen as markers.

Sweep sample voltage is tapped off ahead of the sweep output attenuator so that marker size is unaffected by the sweep output controls. R1 (Fig. 1) is connected to the “top” side of the sweep fine attenuator. The original 270-ohm resistor, which connected the marker oscillator to the sweep attenuator, is disconnected and the marker signal lead is connected to R2, the 470-ohm resistor of the marker adder. Resistors R1 and R2 set the balance of the sweep and marker sample signals at the crystal heterodyne detector, provide isolation between the two generators and prevent trapping or standing-wave effects on the sweep output.

Locate the heterodyne detector

---

Fig. 1 — Circuit of the marker adder and a handy age bias supply.

---

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near the sweep output attenuator so that R1 and R2 leads can be kept short. Their values may have to be changed somewhat to accommodate different signal levels if they are used with other signal generators. The values shown allow harmonics of the Heathkit 19- to 60-mc variable oscillator to be used to mark TV channels, and these harmonics have been marked on the dial as TV channels.

The very convenient and unique markers shown in the oscillogram depend on the type of marker oscillator used in the Heathkit sweep generator where the variable and crystal signals are available simultaneously to provide multiple markers. When a 4.5-mc crystal is used, picture and sound markers appear simultaneously, a requirement when TV tuner calibration is attempted.

When the 1.5-mc crystal is used, all the important points in the TV if passband are marked. These points include the adjacent-channel trap, the accompanying sound trap, the picture carrier and two points on the flat top. The Heathkit crystal oscillator modification for the 1.5-mc crystal, is shown in Fig. 2.

A selector switch was added for convenience in selecting crystals. As the variable oscillator dial is moved, the multiple sideband markers move along too, always at the same frequency spacing (1.5- or 4.5-mc, depending on the crystal in use) from the variable oscillator. As the variable oscillator tunes through a harmonic of the crystal in use, the scope indicates a beat pattern, instantly checking the variable oscillator for accuracy.

The output of the marker adder is fed directly to the scope's vertical amplifier, as well as the usual lead from the TV set's video detector. The capacitance of the marker adder and its output cable is negligible and does not affect the low-frequency response curve picked up from the TV receiver. No fancy mixing circuit is necessary here, but do not omit the 47,000-ohm resistor in the picture detector end of the pick-up cable. Otherwise markers will be weak and the response curve rough.

To prevent unwanted radiation from the bias output terminal bypass it with a .0015-mf mica capacitor, on the outside of the sweep generator panel, to the shield side of the rf sweep output jack. There was no radiation problem from the marker-pip output jack which was placed on the left side of the front panel, away from the sweep output attenuator.

The fundamental marker, or the marker produced by the vfo in the marker generator, will be somewhat larger than its accompanying sideband markers. For example, if the variable marker oscillator is set at the sound-carrier frequency of 41.25 mc and the 1.5-mc crystal is switched "on", the largest marker pip will be at 41.25 mc and smaller pips will occur at 39.75, 42.75, 44.25, 45.75 and 47.25 mc; all spaced at crystal controlled 1.5-mc intervals. The third pip from the 41.25-mc sound-carrier pip will be the 45.75-mc picture-carrier pip if you count in the direction of rising sweep frequency. This direction is determined by rotating the variable marker oscillator dial in an upward frequency direction and noting
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Marker generator in the Heathkit sweep generator does not go below 19 mc. However, 10.7-mc FM receiver if's can be marked by setting the variable oscillator at 21.4 mc, the second harmonic of 10.7 mc, if a 10.7-mc crystal is not at hand. Whenever the sweep generator is connected to the antenna posts of the TV or FM set, a special balanced termination should be used on the end of the sweep output cable. A 120-ohm carbon resistor in each lead will present a balanced signal to the receiver.

Build this useful addition for your calibration equipment. Those calibration jobs suddenly become much less dreadful when all of the necessary markers appear simultaneously and your full attention can be given to calibration without having to ferret out elusive pips.

### Battery Holder

While conventional side-loading holders are available for most battery types, there is often a real need for an end-loading holder, and they are just not available.

An end-loading battery holder is easy to construct and the parts cost only a few cents. The holder described here is for a single RM401R mercury battery, but the same design can be used for other types and combinations of batteries.

The parts needed are plastic tubing (inner diameter slightly larger than the battery diameter), plastic rod (outer diameter same as the inner diameter of the tubing), two solder lugs, one 6-32 round-head screw, one 6-32 flat-head screw, two 6-32 nuts, one coil spring, a paper clip and a short length of metal strap for mounting the holder.

To construct the battery holder, simply cut all parts as shown in Fig. 1 and assemble as shown in the photograph. Cement the 3/16-inch end plug in one end of the tubing with an appropriate cement—coil dope or polystyrene Q-dope thinner works nicely on polystyrene tubing and rod. The spring is from the General Cement assortment of large compression springs, item H441-F. Bend the first turn on one end into a small loop to fit the 6-32 round-head screw. Make the matching slots in the removable plug and housing with a fine-toothed hacksaw or a coping saw. Put the plug in place and lightly clamp in a vice, while sawing the slots. The U-shaped retaining clip is made by bending the paper clip as shown. Adjust its tension for a firm fit.

If a holder is needed for a different type battery, or for more than one, select tubing and rod that fit the battery best. The spring described will be satisfactory for most cells except the very largest ones. They may need a larger spring.

The length of the housing should be such that the spring is about halfway compressed when the battery and removable plug are in place. When tightening the mounting clamp, use only enough pressure to keep the holder in place.

---

**END**
Watch those batteries!

**DRY BATTERIES**—THOSE INERT, RELIABLE contrivances—can be sneaky and dangerous. We’re all aware that installing a battery backward in a transistor radio can damage the radio. But did you know that it can also damage the battery? Reversing one cell in a group of three or more can send enough reverse current through the cell to generate internal gas and (occasionally) cause an explosion. Though such dramatic results are rare, a “backward” cell being continually “charged” this way will begin to leak and damage the equipment it’s in.

Of course, most ordinary zinc-carbon cells will leak when discharged. That’s why you’re always told to remove discharged cells promptly, and to remove even good batteries from a device that’s expected to sit unused for some weeks or months. Inspect battery-operated equipment often, test the cells and replace any weak ones immediately. “No-leak” warranties usually apply only to flashlights damaged by leaking batteries. Don’t expect to get your eight-transistor portable replaced free if you forget about the batteries!

Pay special attention to mercury batteries: their polarity is reversed from that of zinc-carbon cells. Check before you install. Discard old mercury cells promptly. While they won’t leak, they have been known to explode spontaneously, especially at high temperatures. For that reason, too, don’t chuck old (or new!) mercury cells into a trash fire or incinerator.

Above all, never try to recharge a mercury battery (or any other primary cell, for that matter). It won’t work, and the cell may explode because of internal gas pressures.

---

**Urges Big-Screen TV For School Use**

Classrooms should have 29-inch TV sets, with more bandwidth and better audio, said Dr. William H. Hayt Jr., Purdue Electrical Engineering School director, at the Spring IEEE convention. Most classroom sets now made have 23-inch screens, and the only larger tube is 27 inches. The 29-inch sets, with better front-mounted speakers and increased bandwidth, would be less expensive and easier to see and hear, he said.

Dr. Hayt also asks exemption of educational sets from the all-channel law—a concession the FCC is expected to grant in the near future.

---

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Illustration at left shows the basic outlet, which adapts to flush or surface mounting and accepts either 75- or 300-ohm solderless plug-in connectors. ULTRA-TAP is compatible with any TV signal-distribution system. Write for complete information on Jerrold's wide line of antennas and antenna systems.

---

**JULY, 1963**
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AUGUST ISSUE (ON SALE JULY 18)

WHAT'S YOUR EQ?

These are the answers! Puzzles are on page 38.

Tricky Resistors

Using the superposition theorem, with E2 and E3 shorted to ground, the circuit that E1 sees is:

Note that R2, R3, and R4 in parallel equals 1/3R. Therefore E1 = 1/3 the input voltage. E1 is a result of E1, is -4 volts. When E3 is considered as the input, output 2, as a result of E2, is +4 volts. When E3 is considered as the input, output 3, as a result of E3, is -4 volts. Adding outputs 1, 2 and 3 algebraically, the actual total E, with all three inputs is -4 volts.

Ventilation Problem

Two double-pole single-throw switches, connected as shown, do the job.

Pot Position

Since no current flows through the ammeter, the voltages at A and B must be equal. We can calculate the voltage at B: 2.5 volts. If the voltage at A is also to be 2.5 (which is 1/4 of the total 10 volts), both sections of the ganged pot must divide it in half. The voltage at the 100-ohm pot's wiper must be 5, and at the 12-megohm pot's wiper, 2.5. This means the pots must be exactly at mid-position.

-4 Neglecting the very small effect of the 100-ohm section, we can see the resistance between points A and C consists of two 6-megohm resistors in parallel, so the resistance is 3 megohms.

(This is a problem that can most easily be solved "by running," or rather, by sliding.)
A piece of industrial electronic equipment that is being used more and more with each passing day

By ARTHUR S. KRAMER

PLOTTING AN ENTIRE FAMILY OF TUBE or transistor curves in less time than it takes to read this sentence is just one of the tasks performed by an X-Y recorder. Other duties include testing jet engine components, plotting magnetic amplifier characteristics and measuring variations in the machined surface of ship propulsion gears, to name a few.

In mathematics, the Cartesian or rectangular coordinate system is often used to plot curves which show the relationship between two variables. The independent variable is called X, and the dependent variable is called Y. If the curve were being plotted manually, X would be allowed to have a whole range of values as in Fig. 1, and the values of Y, which would depend on the values of X, would be calculated. This is done using the algebraic equation which expresses the basic relationship between X and Y. In Fig. 1, the equation is \( Y = X^2 \).

Instead of using X and Y as variables, suppose we varied the voltage applied to a transistor collector and plotted the resulting collector current. The curve of current vs voltage might look like Fig. 2. Here, voltage is the independent variable, and current the dependent one. The X-Y recorder automatically plots such two-variable curves, provided each variable is expressed as a voltage. It permits rapid, accurate plotting of curves, since it eliminates reading meters and laborious manual plotting of points.

An outgrowth of the X-Y recorder is the X-Y-Z recorder which shows several curves in three dimensions using an optical viewing system. The discussion in this article, however, is about X-Y recorders only.

Typical recorder operation

Among the photos is a front view of the Leeds & Northrup 69950 Speedomax X-Y recorder. The writing pen, attached to the pointer, is driven by the X-amplifier and moves upscale horizontally, in proportion to the amplitude of the input X signal at any particular instant. Since the pen on this recorder cannot move vertically, the Y-amplifier output causes the chart to move up or down, depending on the direction in which the Y-signal amplitude is changing. The photos show a view of this recorder with chart removed. The horizontal chassis at the bottom of the picture is the X-amplifier chassis, while the Y-amplifier chassis is mounted behind the vertical wall. The full-scale signal voltage on either channel is 10 mv dc.

Referring to Fig. 3, any deviation from initial balance at the X-input terminals is detected by the amplifier. This unbalance potential causes a current to flow through a synchronous converter whose contacts alternately reverse the direction of current through the center-tapped primary of the input transformer. This induces an ac voltage in the transformer secondary, which is amplified to energize the control winding of a two-phase balancing motor. This motor moves a contact along the measuring slidewire to the new balance position. The pen is mechanically coupled to move with the slidewire contact. As
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soon as the system is rebalanced, the motor is de-energized and the slide-wire contact stops moving until the input voltage again changes. An identical system operates the Y-axis or chart movement, permitting it to move up or down within a 10-inch span in proportion to the direction and magnitude of voltage unbalance.

Other X-Y recorders

The Loral Electronics UV (ultra-violet) X-Y plotter differs from most other models in that it uses an ultra-violet light beam and records on UV-sensitive film. Its writing speed is much greater than that of recorders using mechanical pens or stylus, and it is claimed to be several thousand inches a second in any direction. This makes it possible to record aircraft speeds up to Mach 5 (five times speed of sound, or about 3,700 miles per hour). It is very useful for plotting the paths of several aircraft simultaneously.

The Tally model 20J plotter gives a plotted result as a series of mechanically generated printed impressions. Resolution on the vertical and horizontal axes is such that it can plot 40 points an inch for a total of 10 inches. Four symbols are used for four different plots on the same piece of chart paper. In addition, the numerals 0 through 9 may be printed slightly below the 0 X-axis. The device may be considered a digital printing plotter, since it records discrete points on a curve but does not draw a smooth curve through them.

Operation of the Mosely model 2S is electrically similar to that of the recorders previously described. The pen in this model is arranged so that it can move both vertically and horizontally, with the paper chart fixed in position. The size of the recording surface is 11 x 17 inches. Each axis is con-

Moseley model 2S with a partially drawn curve on its graph.

**JULY, 1963**
trolled by an identical, self-balancing servomechanism, electrically independent and isolated from ground. Both axes have identical response, and about 1 second is required for full-scale travel.

Houston Instrument Corp. manufactures a model HR-92 X-Y recorder. It is a null-seeking servo type plotter designed to draw curves on regular 8\(\frac{1}{2}\) x 11-inch graph paper. Conventional chopper amplifiers, two-phase motors and potentiometer rebalance are employed. Reference voltages are furnished by mercury cells. Sensitivity is 10 mv per inch and pen speed is 7.5 inches per second.

**Where X-Y recorders are used**

The Allison Division of General Motors, makers of jet engines, have found the X-Y recorder a very useful instrument. One application has been in the dynamic testing of engine fuel controls. A method of simulating the engine's dynamic characteristics was worked out to evaluate the complete performance of the fuel control. A dc drive motor, fuel pump and photoelectric paper cam follower are used. For X-axis input, simulated engine speed is taken from the drive-motor gear box and converted to millivolts. Y-axis input is supplied by fuel flow, measured by a flow meter. The recorder will thus show fuel flow vs engine rpm. The effects of changes in temperature, altitude, humidity and other parameters can be easily studied.

Plotting characteristic curves of tubes and transistors with the X-Y recorder saves tremendous amounts of time and gives more accurate results than hand plotting. A setup for transistors is in Fig. 4. A similar setup for vacuum tubes is in Fig. 5.

Fig. 6 shows one method for plotting the control characteristics of a simple vacuum tube amplifier. By varying dc control current, and thus changing the inductance of the ac load windings, the ac voltage across R2 can be varied by a large amount. The voltage set up by the dc control current through R1 is fed to the recorder's X-amplifier, while the Y-voltage is obtained by rectifying, filtering and dropping down the ac voltage appearing across load resistor R2.

Other uses for X-Y recorders include soil research. A setup at the Virginia Agricultural Experimental Station uses a Leeds & Northrup Speedomax controller to govern water temperature rise while a Leeds & Northrup X-Y recorder plots temperature vs time difference.

Another X-Y recorder application is in testing simple wool fibers. The Bigelow-Sanford Carpet Co. checks the spring effect of the original crimp in the fiber as well as subsequent elastic and flow regions under straight tension.

**Future of X-Y recorders**

As our electronic technology grows more complex, as computers become larger and larger, and as trained manpower becomes scarcer and more expensive, X-Y recorders will find increasing acceptance. Wherever curves plotted on graphs are needed with any independent variable except time, the X-Y recorder can be put to good use. It is quite probable that miniaturized models will be taken along in space vehicles to expedite the collection of scientific data and speed measurements. These recorders will find a prominent place in underwater exploration vehicles of the future, for plotting water temperature against depth, sound propagation against depth, etc. They might even be in use today to keep a running record of the ship's location or to plot the course of a missile after it is fired.

The author wishes to acknowledge with gratitude the following people and companies, without whose assistance this article could not have been written:

- Loral Electronics Corp., New York, N.Y.
- Tally Register Co., Seattle, Wash.
- Mr. Bruce G. Hall, F. I. Moseley Co., Pasadena, Calif.
- Mr. G. H. More, Houston Instrument Corp., Bellaire, Tex.

END

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NEW PRODUCTS

3-WAY SPEAKER SYSTEM, Classic Dual-12. Two 12-inch speakers plus Sberticon super tweeter. Frequency response to 22,000 cycles, continuously variable brilliance control.—University Loudspeakers, 80 S. Kronosco, White Plains, N. Y.

HI-FI SPEAKER KIT, Jankit 31. Electrostatic mid- and high-frequency tweeter in single-radiator version. 11-inch model 350A dynamic cone tweeter with high-pass network filter. crossover at 4,000 cycles. Reference 75-16,000 cycles.—Rek-O-Kut Co., Inc., 38-19 108 St., Corona, N. Y.


12-INCH, 3-WAY SPEAKER, model S-600. Heavy-duty die-cast frame, ribbed-cone bass and midrange element. Independent compression horn tweeter. Electrochemical crossover 3,500 cycles; frequency response 30-16,000 cycles; power capacity 20 watts; impedance 8 ohms.—Olson Electronics, Inc., 260 S. Forge St., Akron 8, Ohio.


VHF-UHF INDOOR TV/FM ANTENNA, model TF955-M Astro-fet. Channels 2-8; all FM and FM stereo stations. 6-position switch, uhf radio-direction type loop. 4-section telescoping brass dipole, weighted tip-proo.; base.—JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y.

TRANSMISSION-LINE ASSEMBLY, G-Line. Single-conductor cable guides radio frequencies in transverse magnetic, radially symmetric, nonradiating modes. Single modified-surface wire coupled to coaxial line at each end with identical, conical-shaped field transformers. Housing contains mechanical mounting and electrical connecting devices for transmission line, coax feed line, guy assembly. Weather-proofed cone. Models for varying applications. Model LLD014-A, community TV feeder. Range 50-250 mc; loss 1.8 db at 1,000 ft. Other ranges up to 5500 mc, with losses from 0.5 to 1 db per 100 feet.—Surfae Conduction, Inc., 1501 Broadway, New York 36, N. Y.

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1-WATT WALKIE-TALKIE KIT, model GW-52. 10-transistor, 2-dial circuit, crystal-controlled transmit and receive channels. Built-in squelch and automatic noise limiter, rechargeable nickel-cadmium battery, battery condition meter. Battery charger recharges from 117 vac or 12 vdc.

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FM STEREO RECEIVER KIT, Award FA-204X, Stereo tuner, premade and power amp; delivers 30 watts. FM section: multiplex section frequency response ±1 db 15-15,000 cycles; 30-stereo separation. Afc, FM stereo indicator light.

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Manufacturer's stereo cartridges. Variety of needle-tip combinations.—Sonorex Corp., Elmhurst, N.Y.

CARDIOID MIKE, model 500. Response 40-15,000 cycles, output -53 db at high impedance. Length 6-13/16 in., dia. 1-17/32 in. 12 or less

Controls: 2 mike, dual auxiliary fader, bass, treble, anti-feedback, on-off. Response ± 2 db, 30-20,000 cycles. Gain: mike, 139 db; auxiliary 97 db. Hum and noise 70 db below rated output. Input voltage for rated output: mike, 0.028 volt; auxiliary 0.20 volt. Outputs: 8, 16, 22, 27 and 70.7 volts. Power consumption 160 watts at 120 vac. 4-speed phone top with cartridge, model KN-3201, attaches with screwdriver.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

30-WATT STEREO AMP, model AM-214. Standard headphone jack on front panel accommodates most stereo phones. Response ± 0.5 db, 30-25,000 cycles. Harmonic distortion less than 1%. 110-125 vac, 60 cycles.—Ovon Electronics, Inc., 260 S. Forge St., Akron 8, Ohio.

76-WATT FM STEREO TUNER-AMPLIFIER, model 340B. Side-rule tuning, front-panel earphone receptacle. Auto-Sensor circuitry automatically switches to stereo or mono. Stereo signal light, precision illuminated d'Arsonval meter. Powered third channel for direct connection of remote speakers or for 3-channel system. Tape and monitoring facilities; controls operate on playback. Tuner section: IFM sensitivity 2.2 µv; signal-to-noise ratio 60 db below 100% modulation; harmonic distortion 0.8%; response 20-20,000 cycles ± 1 db. Amplifier section: IFM power band-width 20-20,000 cycles ± 0.5; harmonic distortion 0.8%; IM distortion 0.6%; hum and noise —80 db.—H. H. Scott, Inc., 111 Powdermill Rd., Maynard, Mass.

FLEXIBLE NEEDLE, Sonora-Type. Rubber expansion joint between stylus and lever arm needle makes needle break-proof, bend-proof. Fits in manufacturer's stereo cartridges. Variety of needle-tip combinations.—Sonorex Corp., Elmhurst, N.Y.


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FLYBACK TRANSFORMERS. Exact replacements for 177 Silverstone, 123 Philco, 68 Admiral TV sets.—Sancor Electronics, Inc., 3501 W. Addison St., Chicago 18, Ill.

ALUMINUM ELECTROLYTIC CAPACITORS, type 6002D. Rated up to 150 vdc, operate —55 to +125°C. Meet MIL-C-3965 for tantalum capacitors. Maximum capacitance ratings in 34-in.

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THE HALL EFFECT AND ITS APPLICATIONS. 23-page booklet discusses theory, applications, existing devices and manufacturer’s Hall-Pak kit. Illustrated with line drawings.—Bell, Ingham & Co., Columbus 12, Ohio.


AMATEUR RADIO CATALOG. 16-page fold-up booklet shows photos and specs on manufacturer’s transmitter, amplifier, power supply, plus Miniatures, etc. 3-Cells, other hard-to-find items.—Barker & Williamson, Inc., Bristol, Pa.

63-64 CATALOG AND REPLACEMENT GUIDE. TV, hi-fi, auto and home radio component and modules. Illustrated with line drawings, manufacturers’ part numbers.—Merit Co. & Transformer Corp., Merit Plaza, Hollywood, Fla.


MASTER INDEX to Sams Photofact sets through February 1963. Bimonthly supplements give more recent data. Covers TV, radio, audio, auto radios, record changers and recorders.—Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind.

A NEW LOOK AT WORST-CASE. 12-page booklet, tells why tight design tolerances are helpful. Examples of resistors, transistor logic and diode logic circuits. 25 performance charts, schematics, block diagrams. Explains firm’s contest on best use of their devices. 21 space-prooes, 35 photos.—Cornite Electronics Corp., Corn ing Glass Works, Raleigh, N. C.

WHITE-NOISE MANUAL. 12-page booklet describes Sams Photofact white-noise diodes, with photos and circuit drawings. Negohm, new solid-state noise resistant device, presented in 4-page layout. Includes 32-diode white-noise diodes, high-voltage potted rectifier assemblies, listed in 8-page bulletin.—Soliton Devices, Inc., 500 Livingston St., Newark 6, N. J.

SEMICONDUCTORS. More than 3,500 types, listed in 24-page 1963 Short Form Catalog. Zener diodes and reference elements, silicon controlled rectifiers, photocells, silicon and selenium small-medium, high- and super-power rectifiers. Ratings, characteristics, descriptive data, plus list of JEDEC rectifier types, cross-referenced to device classification, rating and page. Request on company letterhead.—International Rectifier Corp., 233 Kansas St., Sunnyvale, Calif.


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MERCURY SERVOMATIC ANALYZER. Attractive 4-page brochure describes instrument dimensions and mounting details. Re- quest on company letterhead.—Schweber Electronics, Westbury, N. Y.

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Heathkit W-5M Amplifier

The owner of this amplifier appeared at my shop with the complaint that he had blown the voice coils on two very expensive tweeters. This rang a bell—high-frequency oscillation. This amplifier has an R-C network across the secondary of the output transformer to present a low-impedance load to the amplifier at these damaging high frequencies. The trouble was traced to the 0.1-µF capacitor—it was open.—Barry Atwood

Early Motorola TV

Early Motorola sets using a 6AH6 video amplifier sometimes have excessive gain in this stage, with poor high-frequency response. I find that reducing the value of the 6AH6 plate load resistor improves response and picture definition. The original value is usually 4,700 ohms. I generally use a 2,200-ohm resistor instead. The plate voltage goes up somewhat, but it is still well within the maximum rating for the 6AH6.—Charles Andrews

1957 Zenith TV Sets

There is a weak point in the vertical circuit of many 1957 Zenith chassis (17Z30-31 etc.). Feedback capacitor C39 (.0047 µF) often breaks down, causing first vertical roll and finally complete loss of height. The original capacitor is rated at 600 volts, which is too low to withstand the high pulse voltages on the output plate. For all replacements I use buffer capacitors rated at 1,600 volts.—Charles B. Randall

Oldsmobile 986131 Transportable

The set was very noisy on strong locals, but weak stations came through very well. The rf stage was being cut off by high avc bias. Further inspection showed an abnormally high voltage at the emitter of the ave amplifier. This transis-
tor, it turned out, was leaky. Since the circuit is a high-resistance one, the small collector-to-base leakage had a serious effect. Replacing the transistor with a low-leakage n-p-n unit restored normal operation.—Richard Rufer

**Motorola TS118**

**Trouble:** Poor focus.

**Idea:** Look for an open 400-ohm resistor across the focus coil. It may look good, but tests bad.—Charles Andrews

**RCA Color Model 21-CS-7815**

**Complaint:** Complete loss of color and black-and-white picture. Audio OK. Chroma tubes OK.

**Solution:** C723 (0.1 µf) in the PW700 chroma section was leaking wax and measured 750,000 ohms. M. L. Tortariello

**Emerson 888 Vanguard Radio**

Over about 2 months, the number of stations heard on this set dropped to one—a local, and even it was weak. Voltage checks back as far as Q3 gave no clue. But Q3’s base was —2.4 volts instead of —0.46. Q3’s emitter was also too negative. Q1’s base also read —2.4 volts. C7 was good. On a hunch, I measured the resistance between primary and secondary of T1. It was 15,000 ohms instead of something near infinite! A new transformer and a realignment put the set back in shape.—CWO Laddie F. Klancher

**Replacing 1N23-C in Radar**

When replacing the 1N23-C used in 2,455- or 10,525-mc radar, scrape both ends of the diode clean. There is a film on the 1N23-C that could cause low sensitivity or intermittent conditions when not cleaned off.—Don Dudley END
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**Model 600 Series**

- **Easy installation**
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### Type-Reading Device

**Patent No. 3,000,000**

**Ken E. Eldridge, Palo Alto, Calif. (Assigned to General Electric Co.)**

This device translates letters and numbers into machine language (pulses). Each letter or number is printed with ink containing magnetic particles. They are magnetized, then scanned by a reading head. Voltage is induced in the read coil in accordance with the magnetized area being scanned. Note the waveform generated by the numeral "4".

### Automatic Soldering Gun

**Patent No. 3,031,562**

**Arron J. Hongo, McNeel, Ariz.**

Solder 5, loaded into a tube T at the rear, is automatically fed to the tip as required. Pressing the trigger lightly switches on the gun and lights the lamp. Additional pressure moves a link L to drive T forward.

Upon releasing the trigger, T retracts, but two sets of jaws (not shown) hold the solder and prevent it from returning all the way.

### Odd-Harmonic Generator

**Patent No. 3,060,364**

**Don R. Holcomb, Los Angeles, Calif. [Assignor to Hughes Aircraft Co., Culver City, Calif.]**

This device is effective at all radio-frequencies—up to 500 kHz for Varicap diodes. The input is sinusoidal. During any half-cycle, one diode conducts with the output as a variable non-linear capacitor to distort the wave. The diode reverse rates during the other half-cycle. Thus the output wave is symmetrical and contains no even harmonics.

The tank is tuned to desired odd harmonic.
Muster Support for Pa. Licensing Bill

Harrisburg, Pa.—Plans to stress the theme of consumer welfare to generate interest among state lawmakers were approved by the Pennsylvania Federation of Television & Radio Service Associations.

Delegates also went on record to seek support for the bill from the Better Business Bureaus in the state, and issued a call for unity among service technicians to support licensed servicing. They were asked to get information on service complaints in their areas. Police and legal officials will be queried about the scope of such complaints.

The information will be compiled to show a pattern and presented to state legislators.

CSEA-Pasadena

Pasadena, Calif.—The Pasadena chapter of the California State Electronics Association was extended an invitation to attend Zenith's color seminar and demonstration program in the area.

The group recently raised its dues to $1.50 per month. As of March 1, according to a unanimously approved motion, all CSEA-Pasadena's technicians are classified as State Technician members.

Wisconsin News

Madison, Wis.—A bill before the Wisconsin legislature would create a state board to license technicians. The five-member board would be appointed by the governor, and TV repairmen would be required to take an examination.

A clause in the measure would exempt technicians already engaged in service work prior to the date of the new law.

TV shops would be barred from using the term "engineer" unless a repairman actually holds an engineering degree from a recognized school of engineering.

The bill also includes advertising restrictions designed to prevent misleading price claims, false "authorized" claims and similar unethical practices. Speaking at the state capital in favor of the bill were Richard Gordon, Ed Bruning, Larry Dorst, Ken Mueller and Will Piette of Milwaukee, and John Bruder of Sheboygan.

Marshfield—At the head of the Central Wisconsin TESA branch for the coming year are George Frank, Marshfield, president; Robert Braun, Wisconsin Rapids, vice president; Art Zag, Stevens Point, treasurer; Robert Wroblewski, Stevens Point, secretary.

Milwaukee—New officers of the Milwaukee TESA branch were installed by Frank Moch. NATESA executive director. As guest speaker, Moch stressed professionalism in the industry. "If each of us becomes a true professional and businessman, acts like one, dresses like one, and collects like one, we will prosper."

The new officers are Frank Schroeder, president (re-elected); Clarence Saatkamp, vice president; John Zaniewski, secretary; Ken Mueller, treasurer; Lee Cowen, NATESA director.

New Association Organizes

The National Electronic Association, a new international organization of television service technicians, was...
formally organized at a recent Chicago meeting.
NEA is composed of state technicians' associations only and plans to correlate state group activities. (See Technicians' News, RADIO-ELECTRONICS, April 1963, page 90.)

At the Chicago meeting, temporary officers were named. The next session was scheduled for Kansas City, Kan., June 23.

Officers elected are Gregory Barkoukis, Crest Electronics, Akron, Ohio (formerly president pro-tem), president, and Edward T. Carroll, Carroll's TV Service, Indianapolis, secretary-treasurer. Regional directors are: Keith Kirstein, executive director, California State Electronics Association, Sacramento; John Hemak, Northeast Radio-TV Service, Minneapolis, and Byron Moon, Des Moines.

Charter members are the California State Electronic Service Association, Indiana ESA, Iowa TESA, Kansas TESA, Michigan TSA, Minnesota Television Service Engineers, Ohio TESA, and Pennsylvania Electronic Service Dealers Association.

Committees were named to study elimination of bait advertising, definitions and standards and the possible close cooperation with National Appliance Retail Dealers Association.

ESFETA Meets
The Empire State Federation of Electronic Technicians Associations, Inc., met at Binghamton, N. Y., and elected new officers. The new president is Ben de Young, Ithaca; vice president, Warren Baker, Albany; treasurer, Harold Hazzard, Binghamton; corresponding secretary, O. Capitelli, New York City; sergeant-at-arms, Joe Marotta, Syracuse.

Warren Baker was also appointed chairman of the Standing License Committee. Max Leibowitz is chairman of Liaison and Publicity.

Topics discussed at the meeting were licensing, "captive" factory service, and nonavailability of replacement parts. Anyone with factual information about difficulty in obtaining replacement parts should write to Max Leibowitz, 24-09 41st St., Astoria 3, N. Y.

The group announced also that they will be guests of the Albany chapter at a clambake, to be held in Albany on Sunday, July 28.

Philco's Technirama '63
Attendance at Philco's Techniramais running as much as 600% above average 1962 attendance, said Richard Hershey, coordinator of Technirama and Philco's manager of electronics service publications and training, speaking of the "forums" designed to present new servicing techniques and circuit information.

Some representative figures around the country: San Antonio, 158 attending, up 630% from the 25 in 1962; Wichita, 135, up 600%; Hartford, 200, up 590%; Washington, D. C., 123, up 220%.

In Hartford, the manager of the place in which the Technirama was held had to blink the overhead lights at midnight to get the crowd out. The formal presentation ended at 10:30.

Why this great success? "Well," said Hershey, "the technician knows that the only commodities he has to sell are his time and his knowledge. We have geared Technirama '63 to the idea of making his time more productive.

"After all, there have been rapid changes...in circuitry, and Philco has developed new and easier service techniques. These...have been built on actual service records. We're not guessing.

"Literally dozens of men have told our people after the meeting that they have gotten more out of the meetings than any they have ever attended, bar none."

Canadian Licensing Law
An extremely comprehensive and clearly stated licensing law comes from Manitoba, Canada. As of June 1, 1963, all persons who repair and service radio and television equipment in Winnipeg, Portage la Prairie and Brandon must be licensed. Nonlicensed persons may do this type of work only under the direct personal supervision of a person who holds a valid license.

Two types of license are available: one for radio only, and one for radio

ESFETA's new officers. Seated, left to right, vice president Warren Baker, president Ben de Young. Standing, left to right, treasurer Harold Hazzard, sergeant-at-arms Joe Marotta, secretary O. Capitelli.

RADIO-ELECTRONICS
and TV repair. An applicant must qualify by examination, after having submitted letters of reference from persons who can attest to his competence. Proof of completed study courses must also be submitted with the application.

For alternative experience requirements have been set down by the Mechanical and Engineering Division of the Manitoba Department of Labour, administrator of the new law. An applicant can qualify under any one, provided he passes the exam and otherwise fulfills the requirements. His experience will be deemed sufficient if:

1. He holds the radio servicing license and has at least 1 year of practical experience servicing TV;
2. He holds the radio license, has completed an acceptable course, and has 6 months TV experience;
3. He has at least 3 years experience in radio-TV service, of which at least 1 year must be in TV; or
4. He has over 1½ years of general electronics experience, of which 6 months must be in TV, and has completed an acceptable course, for which the license board may give up to 1½ years experience credit.

If an applicant fails the exam, he may try again in 90 days. If he fails to qualify after three attempts, he must satisfy the board "that he has obtained further knowledge and experience" before he can try once more.

Seattle Technician Convicted

Seattle—"Guilty as charged," said Judge Evans O. Manolides to Larry Lee Allen, charged with attempted petty theft by trick, deceit and bunco. Evidence showed that he had charged for tubes not installed on a $50 home service call on a set less than a year old. (See Technicians' News, RADIO-ELECTRONICS, March and April 1963.) Manolides deferred sentencing of Allen for one year, contingent upon good behavior and payment of costs. The judge commented that, while the technician may have been misled by his employers, he was nevertheless old enough to know right from wrong.

"All-Channel" Committee Works on Uhf Clinics

New York City—Efforts to increase public interest in uhf TV are moving ahead strongly under the guidance of the FCC-sponsored Committee for Full Development of All-Channel Broadcasting.

Its technical and consumer information subcommittees agreed that clinics for dealers and service personnel should be held, and that immediate promotion of uhf is important.

The next clinic will be held in Chicago on July 22. The industry, the FCC and the EIA will work together in determining the agenda.

30 Years Ago

In Gernsback Publications

HUGO GERNBACK, Founder

<table>
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<td>Television News</td>
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Some larger libraries still have copies of Modern Electrics on file for interested readers.

In July, 1913, Electrical Experimenter

How to Select and Operate Wireless Tele-

graph Sets, by H. Winfield Secor.

How to Make Selenium Cells, by Samuel Wein.

New Wireless Instruments, by H. Gerns-

back.


New Method of Grounding, Polarized Relay.

Telephone for the Nose.
1962-63
TV Replacements
Lead Stancor's

PARADE of PARTS

Stancor exact replacement transformers for 1962 and 1963 television sets are now available from your distributor. For the first time in the history of the transformer replacement market, parts are in stock for sets the dealers are selling today. These brand-new units are among the more than 90 yokes, flybacks, powers, and vertical output transformers added to the Stancor line so far this year.

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3501 W. Addison, Chicago 18, Ill.

Q.

Where can you buy modern, handsomely clothbound books on servicing, test instruments, shop practice and electronic theory for less than 67 cents?

A.

ON PAGE 73

NEW SEMI-CONDUCTORS & TUBES

New hv silicon rectifiers
Five new lines of silicon rectifiers with piv ratings of 800 to 1,400 are available now from Power Components, Inc. A 500-ma 1,000-volt rectifier costs $1.40, single lot price; a 2-amp 1,000-volt job, $2.05.

All the rectifiers in the series have extremely sharp avalanche "knees", according to the manufacturer. In processing, boron and phosphorus are diffused into purified silicon wafers, which are then gold plated to permit soldering the silver leads to the wafer.

With these new units, rectifiers up to 1,000 piv cost less than two of half the piv rating. Eliminating series strings to get high-enough piv solves the problem of unequal reverse voltages and consequent breakdown, reduces space and soldering operations, requires less hardware—and so through a multitude of attractive advantages.

6JC6, 6JD6
Also available with 3.5- and 4.5-volt heaters, these two RCA sharp-cut-off pentodes are designed for TV i.f. amplifier service around 40 mc. The two types are quite similar and their inter-electrode capacitances and bases are identical. They may be interchangeable in some circuits.

The cathode has two separate terminals to reduce cathode-lead inductance and thus increase input impedance at high frequencies. An internal shield eliminates the need for an external one.

The tubes' characteristics are compared below:

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<td>G_m</td>
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<td>14,000 µmhos</td>
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Custom SCR stacks
Custom silicon controlled rectifier stacks, with rectifiers, gate excitation...
circuits and surge protection all built together (heat sinks, too) are available from International Rectifier Corporation. They cover a wide current range (3-, 5-, 10-, 16-, 70- and 150-amp devices) and, depending on circuitry, will work as single-phase bridges, three-phase bridges, and controlled rectifier inverse-parallel pairs for direct ac power control.

A low-power potentiometer provides continuous adjustment of output voltage from zero to full.

Recommended applications include adjustable-voltage dc power supplies for dc motor speed control, inverter service and battery charging. Price depends on individual requirements.

**2DX4, 3DX4, 6DX4**

These are 7-pin miniature triodes designed for local oscillator service in uhf TV. Both plate and grid have double pin connections to reduce internal lead inductance. The new triodes differ only in heater rating, the 2DX4 (2.4 v, 0.6 a) and the 3DX4 (3.0 v, 0.45 a) having controlled heater warmup time for series-string applications. Since the basis of the 'DX4 is the same as most other uhf oscillator tubes, it can often be substituted for earlier types for improved performance.

Typical operation at 1,000 mc

\[
\begin{align*}
E_p & = 85 \text{ volts} \\
I_p & = 10 \text{ ma} \\
R_1 & = 150 \text{ ohms} \\
G_m & = 11,000 \text{ umhos} \\
I_E & = 250 \mu a
\end{align*}
\]

The tubes are made by Westinghouse.

**MP721A, -B, -C**

These are high-power, high-speed, high-voltage switching transistors, claimed by Motorola, the manufacturer, as particularly useful for flyback (horizontal output) circuits in transistor TV sets.

The fall time in flyback applications...
THIS SALE IS "HOTTER THAN JULY"

10% OFF & FREE GIFT - ON PURCHASE OF $10 OR OVER (ON DOLLAR BUYS)

TV & RADIO "HANDY TOOLS JACKET" $1.97
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6 Tools mfd. by CBS, invaluable to builders, repairmen, experimenters, etc.
is 0.7 μsec at 8 amp collector current. The new transistors offer a choice of three breakdown voltages (hence the three types)—50, 75 and 100. Current gain at 10 amps is 25, minimum, and typical cutoff frequency is 100 kc.

The drawing shows the epitaxial base construction of the MP721 series, largely responsible for the fast switching and high cutoff frequency.

Other suggested applications include transistor ignition systems, ultrasonic oscillators, high-speed power-switching circuits, and class-C power amplifiers for a or low-frequency rf use.

High-power vhf transistors

Once in the "wouldn't-it-be-nice-if" category, all-transistor high-power vhf transmitters seem to be a practical reality now, with a new line of mass-produced vhf power transistors recently announced by Motorola. The new line consists of the MM719, a low-power oscillator-multiplier, the MM801, a medium-power driver of final, and the MM799 and MM800, high-power class-

C amplifiers. All are n-p-n. Of the last two, the MM800 has the higher ratings. It is guaranteed to produce 15 watts unmodulated rf output at 50 mc with a collector voltage of 25 and a driving power of 3 watts. It functions at junction temperatures to 175°C. The MM799 is similar, but rated at 10 watts output. The MM801 medium-power device can put out 3.5 watts at 50 mc.

In 50-mc FM or CW transmitters, two MM800's in parallel can produce 40 watts rf with 8 watts drive, from a 28-volt dc supply.

The diagram, adapted from a Motorola data sheet, shows the last two stages (driver and final) of a 20-watt (output) 30-mc AM transmitter.

At this writing, prices are still high: the OEM 100-up price of the MM800 is $44.50.
NEW 1963 TWO WAY RADIO 5 TRANSISTOR TRANSCEIVER

CITIZENS BAND
Hams, Hunters, Rangers, Construction, Farmers, Booting, Sportsmen. It's a genuine rugged 5 transistor factory-wired walkie-talkie at a pleasantly low price. Has sensitive super-regenerative receiver and crystal-controlled transmitter with maximum legal power citizens band transceivers, built in 21/2" speaker. Removable whip antenna sections extends to 30". Attractive durable steel case 6 x 2 1/4 x 1 1/4". Compact hand held unit. Fully guaranteed. No license required. Shipping weight 15 oz. Mfg. in U.S.A.

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Specially Priced at $10.75 Ea.
With 9V Battery, plus 75 cents for shipping and handling

Test-Lead Pin-Tip Repair

The pin tips on test leads will in time enlarge the pin-jack contact sleeves in a tester, causing poor contact and erratic readings.

Apply solder heavily to all sides of the original pin tip. File off the excess solder, to get the pin tip uniformly round, when it has cooled.

After filing try inserting the pin tip into the jack in the tester. Stop filing when the pin tip enters the contact sleeve with only slight pressure. — A. Von Zook

Shop Back-Savers

A turntable mounted on the service bench makes it easier to move the TV chassis just an inch or two to reach some control or see anything on the screen without scraping or scratching the bench top. It also reduces the possibility of straining connections to a choice CRT or cabinet-mounted CRT setup on the bench.

The turntable can be made from a wooden cable reel end (18 inches to 2 feet across) covered with hardboard trimmed to size. On the bottom, mount six or eight ball-type casters to make the table easy to turn. A pivot made from a thread spool, large dowel or roller-skate wheel attached to the bench keeps the turntable from accidently rolling off the bench.

Additional turntables can be used to trundle setup equipment or heavy chassis to an unused portion of the bench for "cooking".

With this turntable mounted in the corner of an L-shaped bench, most test equipment can be kept within arm's length with a minimum of movement for the technician. — Elmer C. Carlson

DEmagnetize Small Tools

My tweezers, small screwdrivers and other little steel tools are always getting magnetized. This is very annoying when I want to start a small steel screw in a tight place [though it can also be useful! — Editor]. To demagnetize them, I squeeze the trigger on my soldering gun, bring the tool slowly into the space surrounded by the tip element, and slowly remove it. Be sure to move the tool at least a few inches away before releasing the trigger; else the tool may be remagnetized. — J. Hagoood

Pin Plug to Mike Jack Adapters

Anybody who works with PA and hi-fi equipment will appreciate these simple shielded adapters for connecting phono pin plugs to standard and miniature screw-on mike connectors.

To make these two adapters you will need one Amphenol 75-MC1F (standard size) microphone connector; one Switchcraft 5501F (miniature size) microphone connector and two Switchcraft 3501FP single-hole-mounting phono pin jacks. These are available at the larger radio mail-order houses.

The photo shows the simple construction of these adapters. Remove the cord-protecting springs from the two microphone connectors, and remove the loose hardware from the two phono pin jacks. Solder a short length of bare copper wire to each pin jack lug. Insert a pin jack into the open end of the standard mike connector, letting the end of the wire pass through the...
eyelet in the mike connector. Solder the pin jack to the end of the mike connector where the two join together; then clip off the extra wire and solder the wire into the mike connector’s eyelet in the usual manner. Make the miniature adapter the same way, but file off a little of the threads on the remaining pin jack to allow it to slip into the end of the miniature mike connector.

The second photo shows the completed adapters.—Arthur Transfer

Relay Tip

Simple spdt relays are limited to controlling one or two circuits. Such relays can be salvaged from junkboxes and modified for more complex circuits. The cost of converting an old relay is often less that the price of a new relay with additional switching functions.

The “gimmick”, as shown in the photo, is a conventional light-pressure snap-action switch attached to the relay frame with a sheet-metal bracket. A short length of rod soldered to the relay armature extends over the leaf actuator of the switch. When the relay is energized, the armature is pulled down, actuating the switch in addition to the relay’s own contacts. The addition of one spdt switch converts the relay to dpdt action. Depending on the strength of the relay, additional switches could be added if desired.—William B. Rasmussen

Replacing Radio Trimmers

No matter how old the receiver, its performance will be improved when the tuning-capacitor trimmers work properly. When the screw threads are stripped or an adjusting screw gets lost, just bend back the old trimmer plates and solder a new trimmer to the remains of the old one. Often it is easier to replace both trimmers at the same time when the dual trimmer from an old capacitance-tuned i.f. transformer is available. These will usually bridge the space between the i.f. and oscillator section solder terminals on the variable capacitor. Being soldered at four points, the trimmer is now self-supporting.

After installation, follow normal alignment procedures or, if a signal generator is not handy, set the dial to some local station whose frequency is around mid-tuning range and adjust the oscillator trimmer until that station is heard. Next adjust the r.f. trimmer for maximum volume. Then return for a weak station around 1,500 kc and re-peal the r.f. trimmer. Now tune for a weak station near 1,400 kc and peak (tune) the i.f. transformer trimmers or slugs for maximum volume. The increase in performance will be noticed, and appreciated, by any customer.—E. C. Carlson

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- **10 PINS**
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- Tests over 1,000 tube types.
- Makes all necessary tests: Checks for shorts and leckages between all elements; tests for filament continuity; indicates the quality (emission) of all tubes.
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City Zone State...

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**JulY, 1963**
Amateurs and experimenters have developed various schemes to use relatively inexpensive TV power transformers or surplus units to deliver approximately twice the normal dc output voltage. Some use either a voltage doubler or bridge rectifier. Others use two identical power transformers with primaries in parallel and secondaries in series. The unusual power supply in the diagram is used by G3MHQ in his transmitter described in R.S.G.B. Bulletin, a ham magazine published by the Radio Society of Great Britain.

The supply delivers 1,200 volts dc. T1's secondary feeds the rectifier (816's, 866's, etc.) plates and T2's secondary is connected to the filaments. Two 1,200-volt center-tapped transformers are shown but you can use any combination of secondary voltages that will deliver the required B-plus voltage. For example, T1's secondary can be 900 volts center-tapped and T2's secondary may be rated at 1,500 volts center-tapped. When using dissimilar transformers, use the higher voltage unit for T2. S1 and S3 are power on-off and standby-operate switches, respectively. S2 connects the power line to T1's primary. When it is open, B-plus is reduced to 600 volts (or half T2's secondary voltage) for tuning up.

If there is no output from the completed supply, reverse the connections to the rectifier plates.

Simple Transistor Intercom

This circuit is a modification of the "Transformerless Intercom" described in the July 1961 issue of Radio Electronics. Current drain is reduced to a minimum with good voice response by using new bias conditions and high-impedance (45-ohm) speakers.

The signal developed by a speaker is amplified by Q1 and Q2 and then fed to the voice coil of the second speaker.

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Your Choice

**29¢ each**

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For every Rad-Tel quality Brand New Tube you buy, as advertised—Rad-Tel will give you your choice of a Brand New 5U4 or 6C6B tube for only 29¢ each!!

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**ONE DAY SERVICE—OVER 500 TYPES IN STOCK**

up to 75% OFF**

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| *Manufacturers Suggested List Price*

**FREE! Send For New Tube & Parts Catalog**

Send For Trouble Shooting Guide

Be your own TELEVISION REPAIRMAN

The Original NOW YOU CAN

**FIX YOUR OWN TV SET BOOK**

You can fix your own TV if you have TV First Book ... because 80% of troubles are caused by tubes. This book explains, illustrates trouble and what tubes cause this trouble. Pinpoints in over 3000 layouts by model number, position and type tube causing trouble.

$1.00

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- **6BM6**
- **6BN6**
- **6BU8**

**TUBES**

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four-pole double-throw switch interchanges the speaker connections for two-way communication. The two pots control the bias on the transistors and affect the quality and amplitude of the output signal. Adjust them for maximum volume and clarity.—Robert Kimber

**Novel See-Saw Circuit**

We needed to simulate electronically an split spring-return or momentary switch without using any reactive components. Our specific requirement was that an actuating pulse (not greater than +1.5 volts peak) shift a dc output voltage (again, not greater than 1.5 volts) from one output terminal to another. Normally, one output terminal (say, A) was to be 1.5 volts positive, and the other one (B) zero. The pulse was to make A zero and B +1.5 volts. On cessation of the pulse, B was to return automatically to zero, and A to +1.5 volts. Operation was to be anywhere between dc and a pulse repetition rate of several hundred kc, hence the requirement of no capacitors or coils.

We devised and tested a number of circuits, some active and some passive. The diagram shows our simplest arrangement, which also gives best economy and reliability. It requires only three 1/2-watt resistors, one transistor and one penlight cell.

Normally (no input pulse applied), because of the extremely low Ic of the silicon transistor, virtually the entire 1.5-volt potential of the battery appears across the transistor collector-emitter circuit and at OUTPUT 1. OUTPUT 1 now is zero. This is the condition of rest. When subsequently a 1.5-volt pulse (or steady control voltage of the same value) is applied, the resulting drop across resistor R due to collector current reduces the transistor voltage and OUTPUT 2 practically to zero. And the pulse voltage simultaneously appears at OUTPUT 1. This is the second state. When the pulse ceases, OUTPUT 1 falls back to zero, and OUTPUT 2 returns to maximum. In the "zero" state, OUTPUT 2 actually has a residual level of somewhat less than 0.1 volt. This was tolerable in our application; however, full zero may be attained, if desired, by applying a bucking voltage. Minimum load for the output terminals should be 100,000 ohms. Battery drain is approximately 0.3 ma.
The primary winding (L2) of an untuned rf transformer replaces the rf choke in a conventional shunt-fed plate circuit. The secondary (L1) is inserted in series with the screen supply. The transformer is wound on a 4-inch length of 1-inch-diameter polystyrene or equivalent tubing. L2 consists of No. 28 enameled wire closewound to a total length of 3 inches. L1 is No. 28 enameled wire closewound to a winding length of 1 inch over the B-plus end of L2. Wind both coils in the same direction. Connect the top end of L2 to the plate and the top end of L1 to the screen. Use polyethylene film or high-voltage tape between the windings. This final can be powered by the supply shown as the first item in this month's column.

**Ultra-Linear**

**Type RF Amplifier**

An 813 or similar pentode operated as a grounded-grid linear rf amplifier is generally run with around 3 kHz on the plate and 750 volts on the screen to obtain maximum plate-current swing without distortion. When operated at lower voltages, the plate voltage may drop below the screen. The screen current then increases and severe distortion develops. The tube may be ruined by excessive screen dissipation.

E. W. Holt (G3MHQ) operates his 813 linear with relatively low plate voltage (1200 volts) by using negative feedback from plate to screen to reduce distortion. The screen voltage drops with the plate, though by a lesser amount, thus making possible greater plate swings before the plate drops to the screen-grid level. The diagram shows a simplified diagram of the linear described in R.S.G.B. Bulletin (London, England).

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