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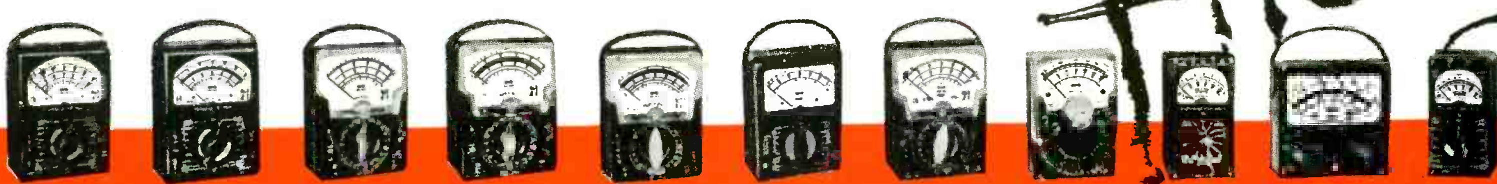

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(Story on page 34)

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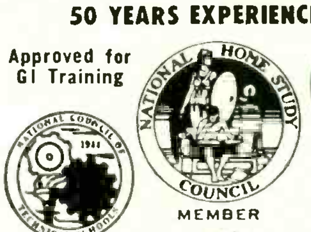

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News Briefs

Echo Satellite Opens Way To New Communications System

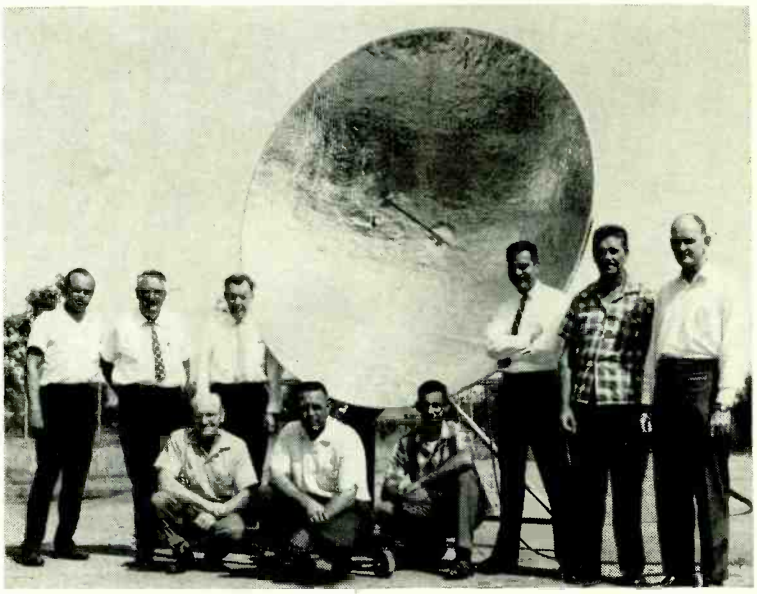
The successful transcontinental telephone conversations via the Echo satellite may be only the beginning of a complete system of telephone and TV relay communications via satellites. This is the opinion of scientists both of the National Aeronautics and Space Administration (NASA) and of the Bell Telephone Laboratories, who collaborated to put Echo into space.

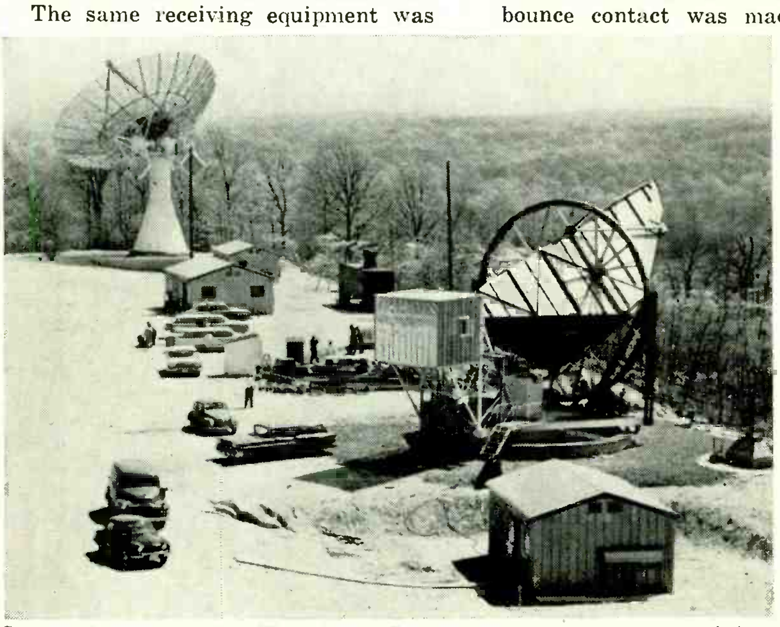
The first satellite is a sphere 100 feet in diameter, making a circuit around the earth in a little over 2 hours, and traveling roughly 1,000 miles above the earth on a course angled 47° from the equator. Two tiny transmitters 180° apart on the sphere's equator help the ground stations to track it. Otherwise Echo is a complete passive reflector.

A number of satellites, either three or four at great heights, as proposed by Hugo Gernsback in RADIO-ELECTRONICS, March, 1958, or a system of 50 traveling at about the same height as Echo, could carry a fantastic number of messages and provide reliable communication at all hours of the day.

As a rehearsal for Echo, phone messages were exchanged between Holmdel, N. J., and Goldstone, Calif., using the moon for a reflector. Reception, as witnessed by a large group of reporters, was completely intelligible, though much more noisy than the later Echo transmissions. The same receiving equipment was used later to track and receive Echo.

In transmissions between the Bell station at Holmdel and Jet Propulsion Laboratories at Goldstone, power in the order of 10 kw for the transmitters was used at both ends, the West Coast station operating at 2390 mc and the Bell Labs transmitter at Holmdel using 960 mc. The receiver is a ruby maser type, which, in conjunction with the special horn antenna, reduces noise to a negligible level.





Space-relay terminal at Holmdel, N.J. Transmitting antenna is at left, the receiving horn at the right of the photo. Receiving equipment is in shack at horn's end.

Hams Bounce Signals Off Moon

The first amateur radio moonbounce contact was made July 21 between the Eimac Radio Club in San Carlos, Calif., and Sam Harris of the Rhododendron Swamp VHF Society, Medfield, Mass. The frequency used was 1,296 mc. At both ends of the circuit, a 1,000-watt (maximum allowable power) klystron was used in the transmitter and a sensitive Microwave Associates MA2-1000 parametric amplifier in the receiver.

The contact took place between 7:30 and 8:00 am, PDT.

The photograph shows some of the members of the Eimac Radio Club who participated in the moon-bounce project. They are, left to right, standing: W6OUV, Robert Sutherland; W6HB, O. H. Brown; W6UF, Bill Eitel; W6RXW, George Badger; W6MUC, Al Clark; K6GJF, Bob Morwood; sitting, W6KEV, Ray Rinaudo; W6IVZ, Charles Anderson and K6GSO, Allan Beer. Not shown are Bill Orr, W6SAI, and Mike Krivohlavak, K6AXN.

Underground Radio

A teletyped radio message has been sent through 4½ miles of the earth's substrata by Developmental Engineering Corp. The message was sent on a frequency of 150 kc, but anything between 30 kc to 3 megacycles is suitable.

The transmitter was placed 1,000 feet below the surface in a mine near Carlsbad, N. M. The receiving equipment was in a second mine 4½ miles away.

The Lithocom system is not suitable for general broadcasting as the

(*Continued on page* 10)

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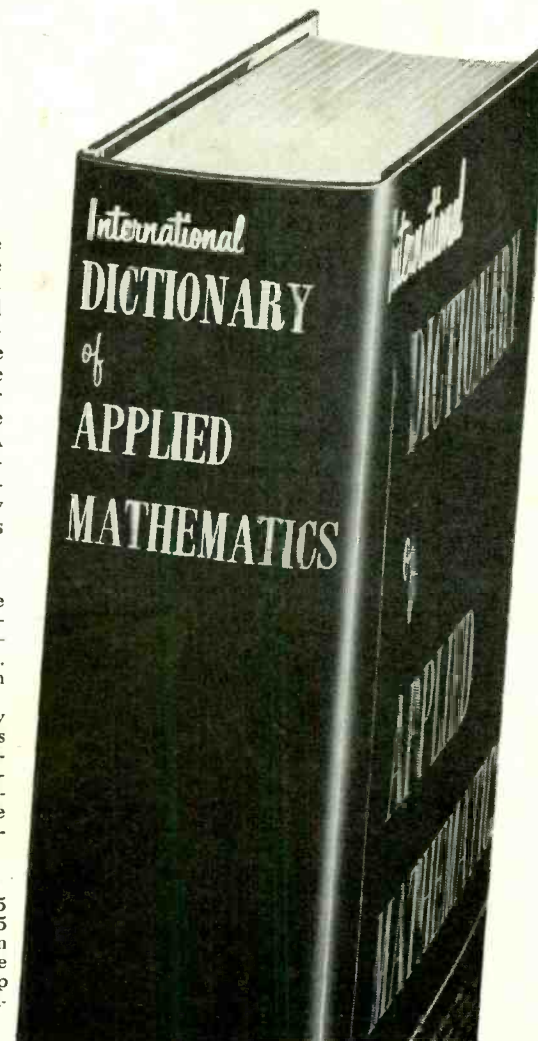

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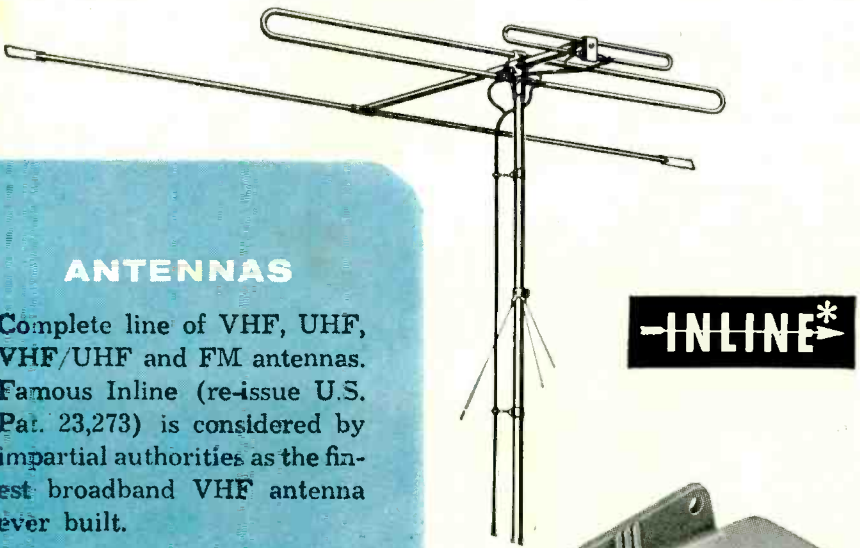

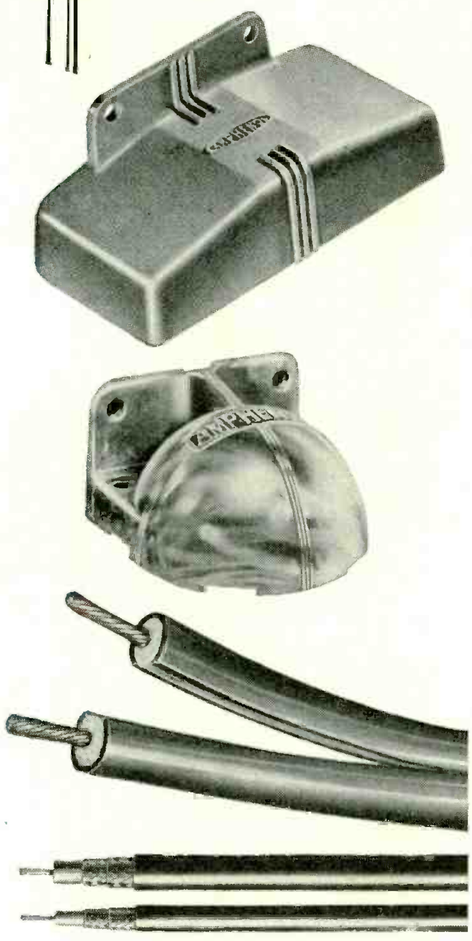

NEWS BRIEFS *(Continued from page 6)*

signals do not go above ground. The main value of the system lies in the fact that it is very difficult to jam. It can be used as an emergency means of communications. In a war, the enemy could not listen in (the expected maximum range is 100 miles).

Russian Artificial Hand

A man with an artificial hand "powered by bioelectricity generated in his own arm muscles" was presented to delegates of the First International Congress for Automatic Control, held in Moscow. The man wrote: "Welcome Congress Delegates" on a conference room blackboard in legible handwriting.

A paper presented on the subject by Soviet Professor Abram Kobrinski gave credit to Professor Norbert Wiener's work on bioelectrics 12 years ago. Dr. Wiener, of the Massachusetts Institute of Technology, said he was pleased that the Russians had developed "a bioelectrical artificial limb based on transistorized amplification of currents generated by the human body."

Reflecting Ring to Orbit Earth?

A plan to ring the earth with billions of tiny antennas is to be tested by the Air Force. Each antenna will be about half as thick as a human hair. Their length will depend on the frequencies to be used.

The ring will be used to relay signals from point to point by reflecting them off the ring in a manner similar to bouncing signals off the Project Echo balloon.

It is planned to place a small number of antennas in orbit by a vehicle with a different main mission. The vehicle may be launched within a month or two.

One objection to the plan is that the ring might block signals used in other space projects.

The ring would not be as likely to be damaged by meteorites or space debris as would balloons or "active" (receiver–amplifier) satellites.

Electronic Elevators Direct Passengers

"Talking elevators" installed at the Hess department store in Allentown, Pa., not only tell customers what they may find on the various floors, but also give instructions to help the passengers preserve their own safety and improve elevator service.

Completely electronic in operation, down to the pushbutton that summons the car, the elevators have a capacitance-operated door-safety device that detects a person in the way and opens the doors again to let him get in. If the passenger lingers, the elevator addresses him: "Kindly step back in the car, so that service may continue." After repeating the message a few times, if the passenger is still obstructing the entrance,

the elevator registers mild annoyance by starting a buzzer while continuing to urge the obstructor out of the way, and the doors close slowly but politely, nudging the customer into (or out of) the car. This capacitance system is considered superior to photocell methods of controlling doors, since it acts only if the customer is close to the door's edge. It also protects the smallest child, since the whole edge of the door, from ankle to shoulder height, forms part of the sensing element.

FM Increasing

FM stations are developing faster than AM stations, according to the latest count. Of course, AM stations still outnumber the FM's (3,484 AM's, 741 FM's), but percentage-wise, FM is ahead.

From 1958 to 1959, the number of operating FM stations increased from 571 to 677 (19% based on 1958 figures), while in the same period AM stations increased from 3,318 to 3,456 (4%).

In the period from Jan. 1 to June 30 of this year, 64 new FM stations went on the air (an increase of approximately 10% in just half a year), while 28 AM stations went on the air (approximately 1% in half a year).

And Now—Underwater Stereo

Submerged stereo in a swimming pool was heard for what is believed the first time in a joint demonstration by three audio companies at the famed Grossinger resort in New York State. Records were played through a dual 65-watt stereo amplifier to two specially designed underwater speakers. Bathers reported that the sound could be heard underwater across the whole pool.

Three companies took part in the demonstration of stereo sound, which was also carried on in more conventional style in a special listening room at the resort. Bogen-Presto supplied the amplifiers, University the special MM2-UW underwater speakers and United Audio the Dual stereo record changer.

Underwater Distance Record

Underwater explosions set off near Australia were picked up by Columbia University's Seismic and SOFAR (*S*ound *F*ixing *A*nd *R*anging) station in Bermuda. The sound waves traveled 12,000 miles in 3 hours and 43 minutes.

The shots—weighing 50 pounds—were fired in a deep channel off southern Australia by the Vema, Columbia's research vessel. There were three of them, spaced 5 minutes apart.

John I. Ewing (staff member and brother of Dr. Maurice Ewing, director of Columbia's Lamont Geological Observatory, Palisades, N. Y.) said recording the shots was remarkable

(Continued on page 16)

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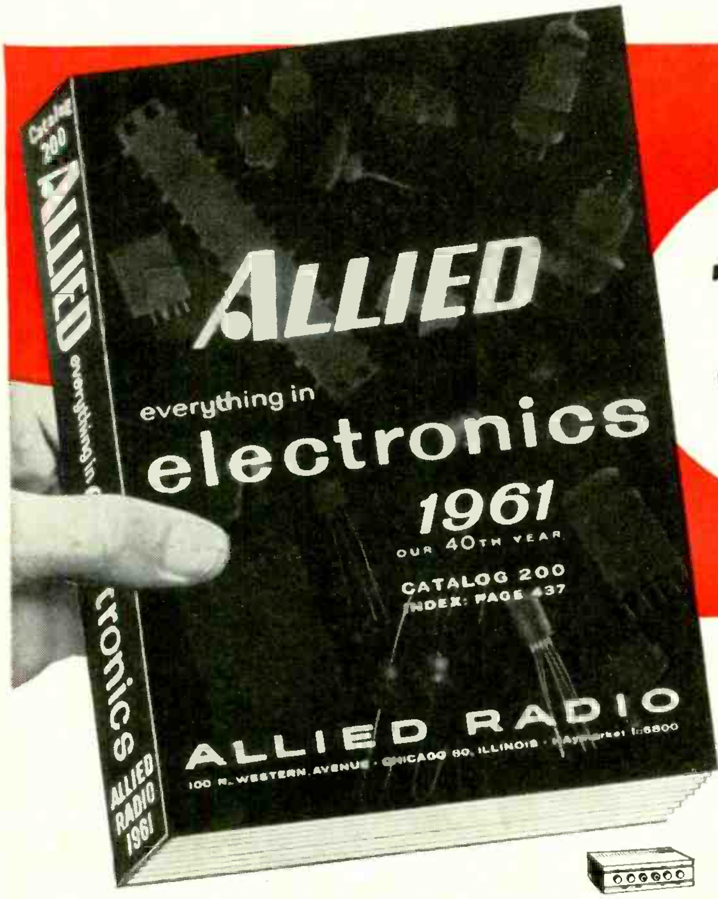

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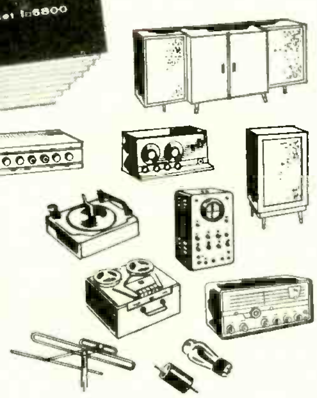

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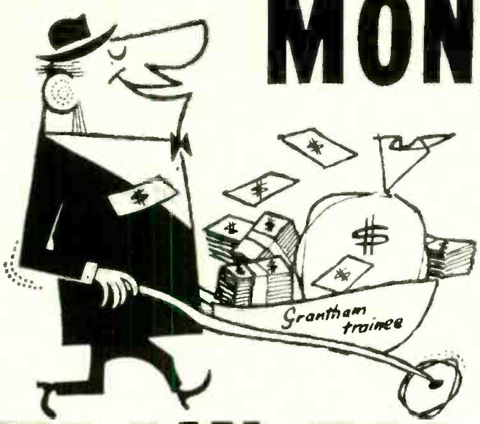

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NEWS BRIEFS (Continued from page 12)

both because of the distance and the small probability that there is a clear path between the firing point and Bermuda.

"Sound waves traveling through the water between those two points may have to feel their way around islands and through shallow areas," he said. The sound traveled near the surface in the south and then dropped to depths of around 2,600 feet near the Equator. It followed a Great-Circle path past the Cape of Good Hope.

The instruments in Bermuda are located in water about 2,600 feet deep. Scientists believe that an underwater atomic blast could be picked up if it was fired near the sound channel.

Party Lines Next?

Two widely separated computers can now exchange information with each other over a telephone system at the rate of 150 characters or numbers per second, the International Business Machines Corp. reported recently. The system requires a pair of IBM 1009 data-transmission units, one at each end of the line.

Information from a core storage unit, punched cards or magnetic tape may be sent.

Language Labs for Schools

The Board of Education plans to install language laboratories in 38 schools in New York City beginning this fall. The labs will be placed in 27 high schools, 7 junior high schools and 4 elementary schools.

In a language laboratory, the student listens to model speech through a pair of headphones and replies to or imitates it. His reply (and the master) are recorded on tape. By playing back the tape, the student can compare his answers with the master and see how well he is doing. Each student is in an acoustically treated booth. The instructor can monitor any of the booths (for more details, see "Electronic Labs Help Teach Languages," RADIO-ELECTRONICS, June, 1960, page 33).

Telephone Service Expanded

Two-way air-to-ground telephone service is now available in the New York, Washington and Pittsburgh areas. The service was previously available only on an experimental basis in the air corridor between Chicago and Detroit.

In making an air-to-ground call, a passenger pushes a button on the phone. An "aviation" switchboard operator answers via the nearest base station. The customer gives the operator the number he wants and she makes the connection.

Ground-to-air calls are made by dialing the telephone company and asking for the aviation operator in the area where the plane is known to be flying.

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ASR-8•80 Stereo Amplifier

When your amplifier adds or subtracts not one nuance of sound . . . you enjoy Integrity in Music. This concept of pure, unadulterated reproduction has been manifested most recently in Stromberg-Carlson's 8•80 stereo amplifier. Its combination of features, performance and price—its control versatility and listening quality—make it the most unusual value ever offered in high fidelity.

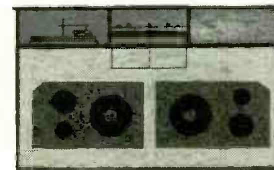
ASR-8•80 Specifications: *Power:* 64 watts (2—32-watt channels); *Response:* 20-20,000 cps ±0.9 db; *Distortion:* Harmonic: less than 0.6% at full output; IM: less than 1% at program level; Hum & Noise: down 70 db. A plus B output for center speaker system; *Price:* $199.95, Zone 1, gold and white finish, top cover extra.

Another amplifier featuring Stromberg-Carlson integrity is the dual channel ASR-433. Each channel provides 12 watts of exceptionally clean, balanced power. The control and performance are excellent.

The deliberately conservative specifications include: frequency response 20-20,000 cps; harmonic distortion less than 1% at full output; IM distortion less than 1% at program level; hum and noise 63 db down. Top cover available in gold and white or black and brushed chrome. ASR-433 . . . $129.95.*

Stromberg-Carlson now offers 16 equipment cabinets in a wide variety of styles and finishes. They are designed to house complete Stromberg-Carlson stereo component systems and are factory assembled. They reproduce as faithfully as separately mounted components because of a unique mounting method that isolates the speaker systems from the other sensitive components.

See your dealer (in Yellow Pages) or write for a complete component and cabinet catalog to: 1478-010 North Goodman St., Rochester 3, New York.



**Prices audiophile net, Zone 1, less base, subject to change.*

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private planes and airlines by the participating telephone companies. The 450-mc band will be used.

Ground stations, antennas and other equipment are operated by the New York Telephone Co., Chesapeake & Potomac Telephone Co., Bell Telephone Co. of Pennsylvania, Michigan Bell Telephone Co. and Illinois Bell Telephone Co.

Calendar of Events—October 1960

National Communication Symposium, Oct. 3–5, Hotel Utica and Utica Municipal Auditorium, Utica, N.Y.

Conference on Radio-Interference Reduction, Oct. 4–6, Chicago, Ill.

EIA Conference on Value Engineering, Oct. 5–6, Disneyland Hotel, Anaheim, Calif.

National Electronics Conference, Oct. 10–12, Hotel Sherman, Chicago.

The Southwest Area Reliability Training Conference, Oct. 10–15, Lake Texoma Lodge, Kingston, Okla.

Audio Engineering Society 1960 Convention and Exhibit, Hotel New Yorker, New York City, Oct. 11–14.

More than 80 papers, on subjects ranging from psychoacoustics to public address, will be read and discussed in the 13 technical sessions of the Audio Engineering Society convention at the Hotel New Yorker, Oct. 11–14. An exhibit of audio equipment will be included.

Engineering Writing and Speech Symposium, Oct. 13–14, Bismarck Hotel, Chicago, Ill.

Symposium on Adaptive Control Systems, Oct. 17–19, Garden City Hotel, Garden City, N.Y.

Symposium on Space Navigation, Oct. 19–21, Deshler-Hilton Hotel, Columbus, Ohio.

International Congress & Exhibition for Instrumentation and Automation, Oct. 19–26, Dusseldorf, Germany.

East Coast Aeronautical and Navigational Electronics Conference, Oct. 24–26, Lord Baltimore Hotel, Baltimore, Md.

Conference on Non-Linear Magnetics and Magnetic Amplifiers, Oct. 26–28, Bellvue-Stratford Hotel, Philadelphia, Pa.

1960 Electron Devices Meeting, Oct 27–28, Shoreham Hotel, Wash. D.C.

Conference on Electronic Techniques in Medicine and Biology, Oct. 31–Nov. 2, Sheraton Park Hotel, Washington, D.C.

IRE-EIA Radio Fall Meeting, Oct. 31–Nov. 2, Syracuse Hotel, Syracuse, N.Y.

Conference on Magnetism & Magnetic Materials, Nov. 14–17, New Yorker Hotel, New York, N. Y.

Mid-America Electronics Conference (MAECON), Nov. 15–16, Muehlebach Hotel, Kansas City, Mo.

Northeast Research & Engineering Meeting (NEREM), Nov. 15–17, Commonwealth Armory and Sheraton Plaza Hotel, Boston, Mass.

Northwest Hi-Fi Show, Nov. 25–27, Leamington Hotel, Minneapolis, Minn.

EIA Winter Conference, Nov. 29–Dec. 1, Fairmont Hotel, San Francisco, Calif.

US Cites Inventor

Dr. Otto Halpern was awarded the Department of Defense medal for distinguished public service for an invention that helps ships and planes evade enemy radar detection.

Last year, Dr. Halpern accepted $340,000 from the Government in settlement of his 18-year fight for a patent. The Government had refused a patent, saying that it would make public the details of an invention that was still a military secret.

The invention is a rubberlike material containing metallic flakes that absorb radar waves. END

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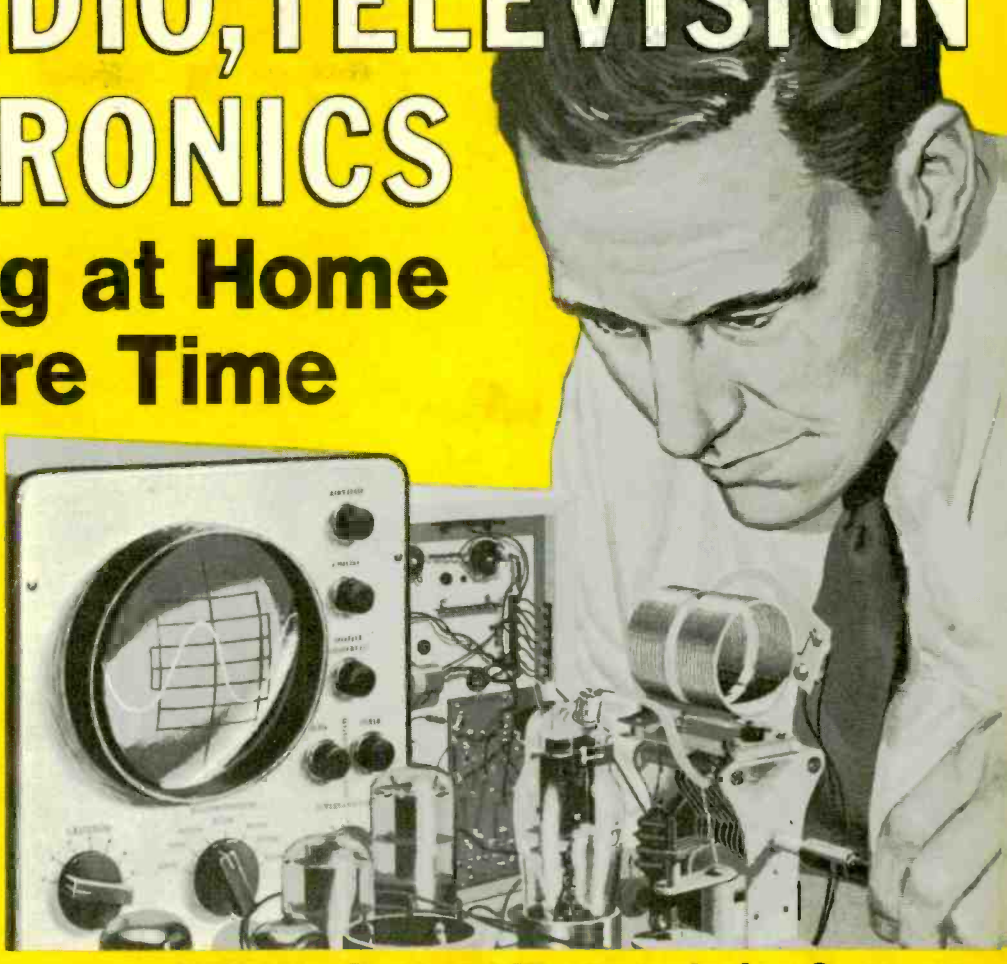

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"I started with station CJIC, now in charge of sound effects for CBC. NRI opened doors to greater opportunity for me." F. TUDOR, Toronto, Ontario

"Averaged $150 a month spare time before I graduated. Now have my own full time business and employ 2 men." F. W. COX, Hollywood, Cal.

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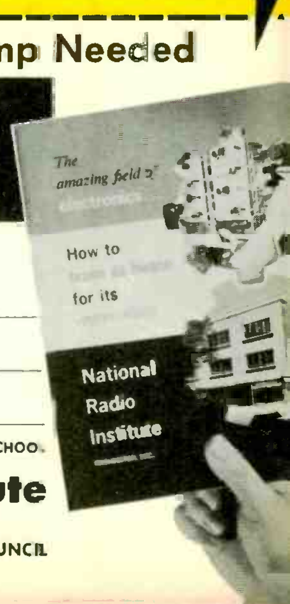

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Correspondence

SUPPRESSORS NEEDED

Dear Editor:

With regard to the article by F. H. Frantz, "Interference—Causes, Remedies and Locations," in the July issue, several points should be clarified.

The reactance alone of a capacitor at a given frequency will not establish its attenuation characteristics. The degree of attenuation can be made to vary 12 to 15 db by adjusting the capacitor's lead length.

With regard to automotive suppression, it will almost invariably be necessary to install 10,000-ohm suppressors in series with each spark plug. Further, it should be noted that the generator can be suppressed at the armature. Bypassing the field coil may prove quite costly. L. G. JAKUBEC, JR.
Reseda, Calif.

WHERE TO GET THEM

Dear Editor:

In at least two issues of RADIO-ELECTRONICS within the past year, the question has been raised as to the availability of spare parts for Natco projectors. Parts are available from several sources: First of all, Natco, 4401 W. North Ave., Chicago 39, Ill. Also parts for some models are available from Sears, Roebuck. Some models were marketed under the Sears Tower brand.

If the drive chain needs replacing, it is available from DeVry Corp., 4141 Belmont Ave., Chicago 41, Ill. DeVry's projector uses a drive chain that is almost identical with Natco's. If gears are needed, they can be cast or ground by Boston Gear Works, Quincy 71, Mass. LaVezzi Machine Works, 4635 W. Lake St., Chicago 44, Ill., is a good bet for reproduction of parts for almost all projectors.

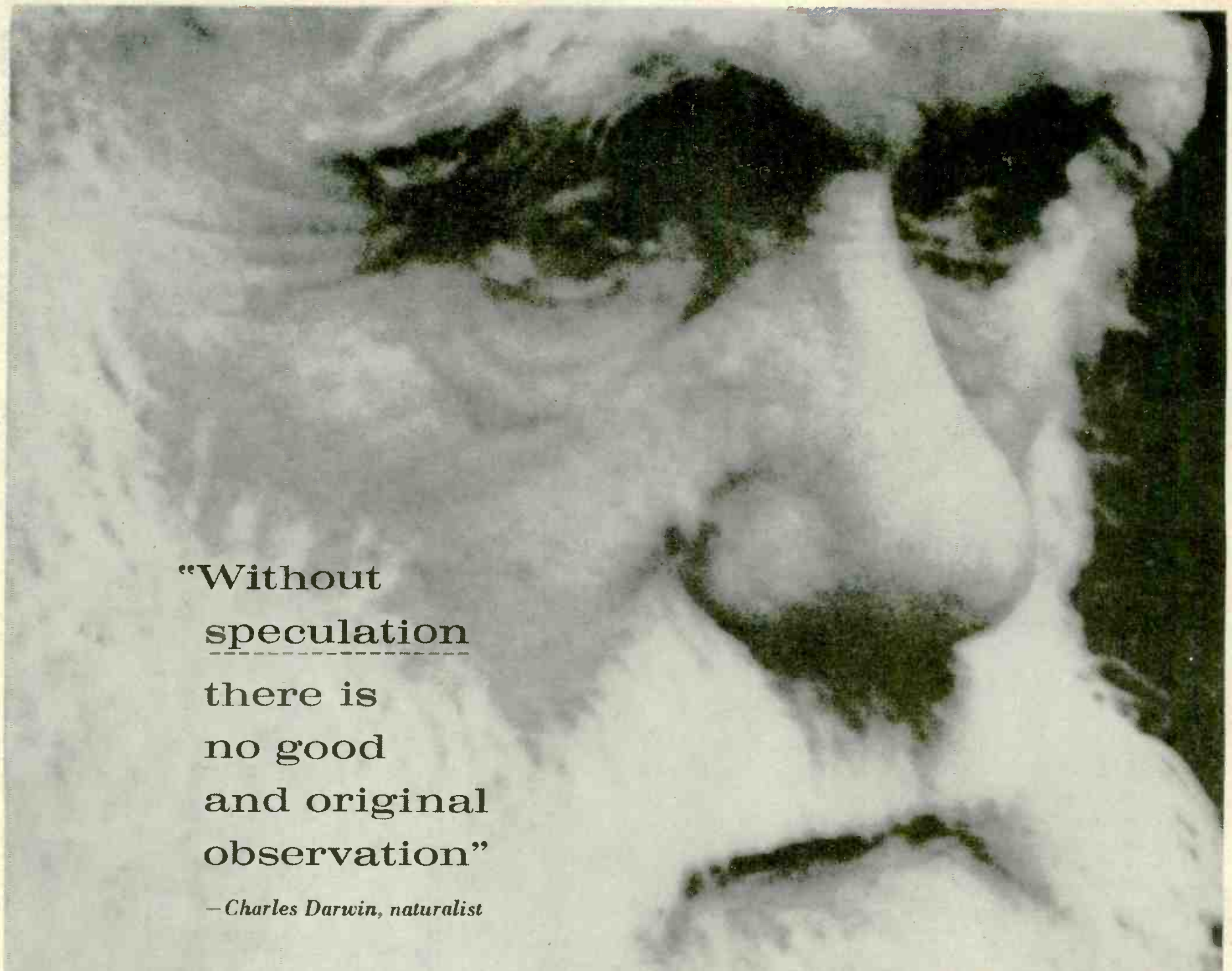
The only electrical trouble that is likely to occur would be the 6V6 oscillator coil (for the excitor lamp) burning out. Simply use a universal oscillator coil available from most parts houses. HERSHEL D. PARKER
Gadsden, Ala.

IMPROVING DETECTOR

Dear Editor:

Looking over the July issue of RADIO-ELECTRONICS, I came across the article "Underwater Metal Detector" by Mr. Richardson. This looks like a good thing for the small-boat people. It seems to me that R2 could be eliminated and, at the same time, increase the sensitivity. Since R2 is in parallel with the battery, it is also an extra drain. Remove R2

(*Continued on page* 26)



"THE CITATION SOUND" "...FOR THE SAKE

"Over and above the details of design and performance, we felt that the Citation group bore eloquent witness to the one vital aspect of audio that for so many of us has elevated high fidelity from a casual hobby to a lifelong interest: the earnest attempt to reach an ideal—not for the sake of technical showmanship—but *for the sake of music and our demanding love of it.*"

A truly remarkable commentary about a truly remarkable group of products—the Citation Kits by Harman-Kardon.

Mr. Reid's eloquent tribute to Citation is one of many extraordinary reviews of these magnificent instruments. We are proud to present a brief collection of excerpts from Citation reviews written by outstanding audio critics.

"When we first heard the Citations our immediate reaction was that one listened through the amplifier system clear back to the original performance, and that the finer nuances of tone shading stood out clearly and distinctly for the first time . . . bass is clear and firm, and for the first time we noted that the low frequency end appeared to be present even at low volumes without the need for the usual bass boost . . . The kit is a joy to construct." **C. G. McProud, Editor, Audio Magazine**

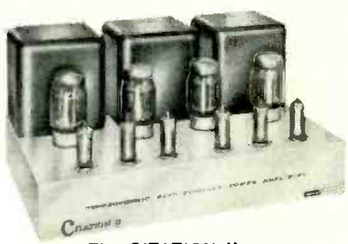
"The unit which we checked after having built the kit, is the best of all power amplifiers that we have tested over the past years . . . none have had distortion that was quite as low as we found in this new Citation II . . . the amplifier should provide the very finest in hi-fi stereo reproduction . . ."
William Stocklin, Editor, Electronics World

PRESENTING THE 1961 CITATION LINE FEATURING

The CITATION I
Stereophonic Preamplifier
Control Center

Here is the first brilliant expression of the advanced design concepts which sparked the new Citation Kit line—the incomparable Citation I, Stereophonic Preamplifier Control Center. The Citation I consists essentially of a group of circuit blocks termed "active" and "passive" networks. The "active" networks are treated as one or two stage amplification units, flat over an extremely wide frequency range and each is surrounded with a feedback loop. This results in levels of distortion so low as to prove unmeasurable. The "passive" networks provide precise equalization with no phase shift.

The use of professional step type tone controls overcome the limitations of continuously variable potentiometers. Each position on a step control is engineered to perform a specific function—which is absolutely repeatable when necessary. The many professional features and philosophy of design expressed in Citation I permit the development of a preamplifier that provides absolute control over any program material without imparting any coloration of its own. **Citation I—$159.95. Factory Wired—$249.95. Walnut Enclosure, Model WCI, $29.95.**



The CITATION II
120 Watt Stereophonic
Power Amplifier

This remarkable instrument has a peak power output of 260 watts and will reproduce frequencies as low as 5 cycles virtually without phase shift, and frequencies as high as 100,000 cycles without any evidence of instability or ringing. At **normal listening levels the only measurable distortion comes from the laboratory test equipment.**

Video output pentodes are used in all low level stages for exceptional wide frequency response and low distortion. Multiple feedback loops for increased degree of usable feedback (30 db overall) result in lower distortion without sacrificing stability. The power supply consists of four silicon diode rectifiers, choke, heavy duty electrolytics and potted power transformer for precise regulation and long life. The use of rigid component boards, heavy duty components, special Cable Harness assure the kit builder that the unit he constructs will be the exact duplicate of the factory built instrument. Because of its absolute reliability and exceptional specifications the Citation II has gained widespread acceptance among professionals as a laboratory standard. **The Citation II—$159.95. Factory Wired—$229.95. Metal Enclosure, Model ACII—$7.95.**

The CITATION III
Professional FM Tuner

Citation III is the world's most sensitive tuner. But more important—it offers sound quality never before achieved in an FM tuner. Now, for the first time Harman-Kardon has made it possible for the kit builder to construct a completely professional tuner without reliance upon external equipment. To meet the special requirements of Citation III, a new FM cartridge was developed which embodies most of the critical tuner elements in one compact unit. The cartridge is completely assembled at the factory, totally shielded and perfectly aligned — eliminating the difficult problems of IF alignment, oscillator adjustment and lead definition.

The Citation III's front end employs the revolutionary Nuvister tube which furnishes the lowest noise figure and highest sensitivity permitted by the state of the art. A two-stage audio circuit patterned after the Citation II is employed. By utilizing a high degree of feedback and providing a frequency response three octaves above and below the range of normal hearing, the Citation sound quality is maintained and phase shift is eliminated. The Citation III is styled in charcoal brown and gold to match all the other Citation instruments. **Citation III— $149.95. Factory Wired — $229.95. Walnut Enclosure, Model WCI—$29.95.**

OF MUSIC AND OUR DEMANDING LOVE OF IT."

"Its listening quality is superb, and not easily described in terms of laboratory measurements. Listening is the ultimate test and a required one for full appreciation of Citation ... there is a solidity, combined with a total ease and lack of irritation which sets this amplifier apart ... The more one listens to the Citation II, the more pleasing its sound becomes ... Anyone who will settle for nothing less than the finest will be well advised to look into the Citation II."

Hirsch-Houck Labs, High Fidelity Magazine

"At this writing, the most impressive of amplifier kits is without doubt the new Citation line of Harman-Kardon ... their design, circuitry, acoustic results and even the manner of their packaging set a new high in amplifier construction and performance, kit or no."

Norman Eisenberg, Saturday Review

"Specifications published by the manufacturer are so astonishing that our sister publication, Electronics World, has subjected them to critical examination and found performance wholly consistent with claims ... Nothing can faze it ... we have heard this particular amplifier loaded with four big speaker systems glide over the steepest orchestral hurdles without the slightest trace of strain ... The realism of the virtually distortion-free music was nothing less than startling. Our initial amazement soon gave way to an easy, relaxed enjoyment that was sustained for hours without a trace of that tension known as "listening fatigue." Here was a sound system that fulfilled the most difficult of all high fidelity requirements: to provide an awareness only of music, and oblivion of technicalities."

Herbert Reid—Hi Fi Stereo Review

THE NEW CITATION III PROFESSIONAL FM TUNER

The CITATION IV
Stereophonic Preamplifier
Control Center

The new Citation IV is a compact stereophonic preamplifier designed in the best Citation tradition. It offers performance and features rivaled only by Citation I. Square wave tracings at 20 and 20,000 cycles reveal no difference between the response of the Citation IV and the signal generator.

The Citation IV provides separate bass and treble tone controls for each channel which may be switched out of the circuit completely to eliminate phase shift and transient distortion inherent in all tone controls. D.C. on all heaters and the use of low noise resistors in critical places reduce thermal agitation and hum. A zero to infinity balance control allows complete cut-off for either speaker. Military type terminal boards make for rigid, professional appearance and facilitate construction. The control over program material provided by the new Citation IV enables the user to perfectly recreate every characteristic of the original performance. The Citation IV is handsomely styled in charcoal brown and brushed gold. **The Citation IV — $119.95. Factory Wired — $189.95. Walnut Enclosure, WCI—$29.95.**

The CITATION V
80 Watt Stereophonic
Power Amplifier

The Citation V is a compact version of the powerful Citation II. Designed with the same lavish hand, it is conservatively rated at 40 watts RMS per channel with 95 watt peaks at less than 0.5% distortion.

The availability of rated power at the extreme ends of the frequency range enables the amplifier to effortlessly drive any of today's most inefficient speakers. It clips clean without breakup. The output stage consists of two 7581's per channel operating conservatively in a fixed bias, ultrabalance circuit. A bias meter is provided to statically and dynamically adjust each pair of output tubes. The power supply consists of four silicon diodes (hermetically sealed) and heavy duty electrolytics for excellent B+ regulation and long life. This results in instantaneous recovery time and superb transient response.

Here is an all new power amplifier which truly reflects The Citation approach to audio design: no compromise in quality regardless of cost. The Citation V is styled in charcoal brown and brushed gold. **The Citation V — $119.95. Factory Wired — $179.95. Metal Enclosure, ACV—$7.95.**

CITATION KITS *by*

harman kardon

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PLAINVIEW, NEW YORK

For complete information on the new Citation Kits, including reprints of independent laboratory test reports, write to: Dept. 100, Citation Kit Division, Harman-Kardon Inc., Plainview, New York.

All prices slightly higher in the West.

CORRESPONDENCE (*Continued from p. 21*)

and connect the meter lead to the slider of R1.

On page 18 of the same issue, "Wanted: Less Confusion," Mr. Greenberg is *sooooo* right.

THOMAS L. BARTHOLOMEW
Washington, D. C.

METER LIMITATIONS

Dear Editor:

In the August issue, Robert G. Casey described a method of making an audio wattmeter from a vtvm. His method appears simple, but there are two limitations to be kept in mind when using the meter.

First, the method is good when working with sine waves only. This is a rarely encountered waveform in audio work (except when using a sine-wave generator for testing). Most vtvm's respond to either peak-to-peak voltage or to the average value of the waveform. The indicated rms voltage is correct only when the waveform is sinusoidal. For all other waveforms, the meter reading will probably be too high or too low. When the erroneous reading is squared to get the power, the error becomes relatively much greater.

Second, the suggested circuit makes use of the meter's 0-to-3-volt range. Here, most of the simple peak-responding meters become relatively inaccurate. For example, two Heath V-7A meters were calibrated to read correctly on sine waves above 6 volts. Both read about 14% low on a 1.4-volt rms sine wave and 14% high on a 2-volt (peak-to-peak) square wave.

Considering the above points, Mr. Casey's system will be quite satisfactory if it is restricted to sine-wave measurements and if a vtvm that is accurate on the low ranges is used. (The latter restriction will eliminate most of the simple peak-responding meters.)

KENNETH E. STONE
Iselin, N. J.

ELECTROSTATICS

Dear Editor:

In Norman Crowhurst's article "More Bass From Smaller Loudspeakers" (August, 1960), he makes certain statements concerning wide-range electrostatics which I believe are not completely fair.

"this new field is only beginning."

The truth of the matter is that Quad full-range units have been publicly demonstrated for more than 5 years and have been available for more than 3. It is true, of course, that competitive units will be introduced only this fall, but that does not subtract from the fact that the Quad has been available for some time.

"one way to use it is to just stand it by the wall, in which case the whole unit acts as its own air coupler."

Actually, the Quad works best away from walls and other room divisions which tend to upset frequency relationships, no matter what kind of speaker is used. The walls are no part of the

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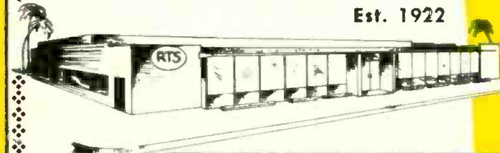

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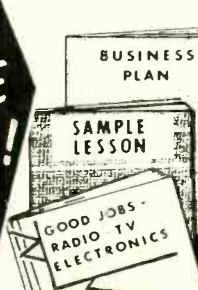

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Quad transmission system. Indeed, the response, out of doors and hung in the air, is flat to at least 40 cycles—the only known speaker that does not require room reinforcement for flat bass.

"dramatically different impedance—high and capacitive."

The Quad impedance curve is essentially resistive—actually lying between 15 and 30 ohms between 40 and 8,000 cycles (falling above that frequency).

"something will have to be done about its directional effects."

If you will read Mr. Briggs' chapters on electrostatic loudspeakers (in *Loudspeakers*, the most recent edition), he points out that directionality is the same problem with electrostatics as with dynamics, no more, no less. The following generalizations must apply (no matter what kind the speaker) and may mean that the electrostatic is the answer.

An electrostatic can be designed with any dispersion angle required. Design parameters are infinitely variable. Any design is completely predictable, whereas the design of dynamic spakers must be a bit more empirical since masses and interactions are much less precise.

More important than the actual dispersion angle (theorists vary on the requirements) is what speaker engineers call "acoustic ratio"—the congruence of dispersion angles at all frequencies from deep bass to high treble. It can be shown, analytically, that only a full-range electrostatic can be designed for a "proper" loudspeaker-room relationship.

Interested parties can read about these matters in Mr. Peter Walker's articles on electrostatics in *Wireless World*, 1955. IRVING M. FRIED, *president*
Lectronics of City Line Center, Inc.
Philadelphia, Pa.

Mr. Crowhurst Comments

Mr. Crowhurst was asked to comment on the above. His remarks follow:

When I wrote the article, I anticipated that some manufacturer might write in and complain that I had not been fair. After all, one cannot find good reason to pronounce every competitive product better than the rest! But Mr. Fried's letter, about the *wide-range electrostatic* came as a surprise.

He complains of my remark that this is a new field, just beginning, yet acknowledges that there has been only the QUAD so far. The rest of my remarks, about change in proportions, as compared with dynamic, about different impedance (where he quotes only part of my sentence—the rest of it refers to adaptation to integration techniques, for which the electrostatic is basically well suited) and about tailoring the directional response, only serve to confirm this first remark to which he takes exception.

On placement, I did *not* recommend placing it against a wall. I am well aware that an open-backed unit such as the electrostatic is least likely to suffer interference effects if it is away from walls. But if Mr. Fried insists on his customers hanging QUADS in the air or leaving them in the middle of the room, I don't think he'll sell many. Far more people need to place the speaker against a wall. My comment was that it *can* be used that way.

Unfortunately some makers of dynamic units act as if wide-range electrostatics are a joke—they'll never work! It seems as if Mr. Fried adopts the reverse attitude and ignores any comparison with dynamics. Trying to convey the impression that his speaker—of whichever type—is the only one that works, does not help anyone. Articles like mine try to put things in perspective to enable the purchaser to judge realistically.

There is no disagreement between Mr. Briggs and myself on this subject. In particular, Mr. Briggs conducts thorough investigations and makes realistic observations, letting "the chips fall where they may." Doubtless Mr. Briggs, too, gets accused occasionally of being "unfair."—*Norman H. Crowhurst*

END

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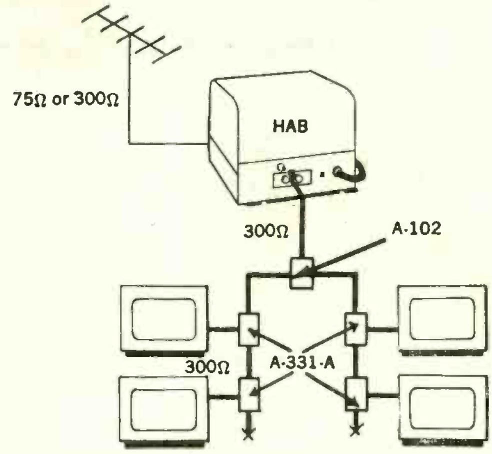

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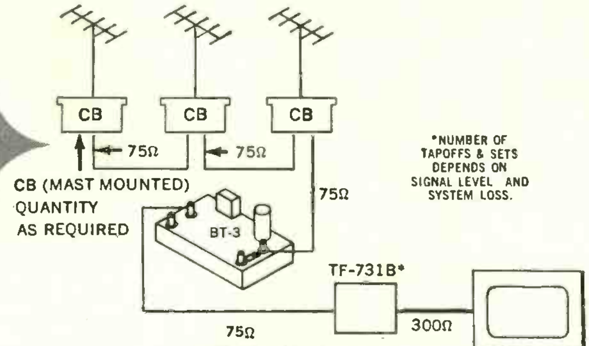

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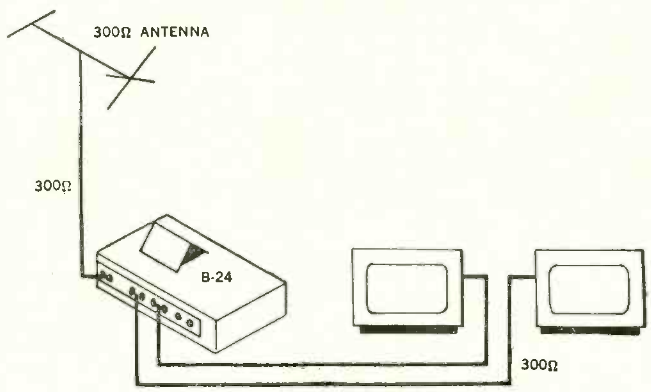

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INSTRUCTIVE ELECTRONIC DEVICES

. . . There Is a Big Market for Educational Devices Today . . .

IN an age when our survival as a nation depends upon the electronic progress of our next generation, the thoughtful observer is being continually shocked to note how little is being done today to strike a responsive spark in our youngsters and to awaken them to present-day electronic-scientific wonders.

Make no mistake, electronic engineers don't fall from the sky ready made. In some way they all are indoctrinated at a very early age, usually before they are 6. Some magnetic or electric toy usually catches the child's fancy, lighting the flame of scientific knowledge. Thereafter the youngster slowly progresses to more interesting devices, learning and absorbing the mysteries of the various branches of physics, few of which he ever forgets as he grows up.

The despair of the average father nowadays is how little is offered on the market to start off a youngster on the road to electronic adventures. Outside of a few interesting magnetic toys in our stores, there is a vast vacuum when it comes to simple, low-priced, electric instructive devices.

At the turn of the century, the present writer was responsible for bringing to a previously nonexisting market dozens of simple, low-priced items, all of which found ready acceptance. Many were imported from Europe; others were made by his pioneering firm, the Electro Importing Co. (E. I. Co.); still others were manufactured at his behest by enterprising farseeing manufacturers.

Let us name only a few: telephone receivers (50¢); sturdy electric motors (from 60¢ up); household medical coils (weak electric induction shocking machine) (90¢); electric whistle ($1); electric luminous scarf pins (to operate from pocket battery) (45¢); 6-volt dynamo ($3.80); spark coils, giving a ¼-inch spark ($2.20); dozens of types of fascinating colorful Geissler tubes to work from spark coils (from 38¢ up); static-electric machine (3-inch spark) ($3.50); 4-inch X-Ray tubes* ($4.30) that worked well with a fluoroscope ($3.75); Fun With Electricity set (static) (50¢); microvolt meter (compass with coil winding) mounted with binding posts (50¢); rheostats (50¢)—just a few items from a long list.

Where can you buy such devices today? Particularly educational devices that a young boy can operate himself *before he can read*—the critical age.

More important, some of the few items that can be bought in stores today are all too often shoddy and a goodly percentage do not work.

Item: For two of our grandsons, below age 6, we bought a set of hand telephones (intercommunicating). Made of red plastic, the set looked attractive. It had, however, no binding posts or any device for clamping the connecting wires. Each handset instead had two metal strips with a tiny hole into which you stuck the wires—impossible to obtain a good contact. Upon testing the phones, they were found to be inoperative—dead. Since it was electromagnetic, no batteries were required to work the set, but there was an open circuit, so we returned the outfit. What about the complete frustration to the children? The less said the better. A week later, a new set arrived—also dead! Then the factory in New Jersey closed for vacation. Finally, a month later, an operable outfit arrived, but the functioning was so poor that the voices came through in whispers. Yet the shoddy set's cost was close to $8!

It has been our experience over the past 15 years that a large percentage of present-day instructive electronic devices sold in toy stores are so skimpy, so poorly engineered that it is a wonder they work at all. Mass-produced, they are often not properly tested or, if they are, they fall apart during shipping.

This usually is not the case with most of the similar European devices, which are much better made and far sturdier, a necessity for inquisitive and impatient little fingers.

In a number of cases, after ransacking toy stores to no purpose, we had to design and make a number of devices ourselves for the youngsters. One—a combination electric set mounted on a block of wood 8½ x 5½ inches—included: a sturdy standard buzzer, a small neon bulb, several colored flashlight bulbs, a few pushbuttons, two metal handles and several binding posts. The buzzer had its vibrator "blocked" in such a way that it became a high-frequency type. Its self-inductance built up sufficient voltage to light a neon bulb that normally required at least 40 volts, although we used only a 3-volt battery. The buzzer also had sufficient electric "kick" to operate as a miniature shocking coil when the metallic handles were connected to it. Everything worked by means of pushbuttons, all wiring being concealed under the base.

We constructed a number of other projects—all simple for youngsters to operate. One with a few electromagnets, springs and half-inch steel balls proved very successful. These examples are mentioned only to give some idea of the hundreds of devices that can be evolved with a bit of ingenuity and planning nor is a large capital investment necessary.

When mass-produced, with correct engineering and good workmanship, such devices can satisfy a huge market. The sales prices can be kept surprisingly low, even today. Plastics in countless shapes, electro- and permanent magnets, when produced in large quantities are still not expensive per unit, due to recent advances in mass production and automated machinery. Hence there is no reason why many instructive electronic devices should be out of reach of any youngster, even the ones in the most modest circumstances.

Parents, too, should learn that it is not always the most elaborate or costly outfit that makes the greatest hit with a given child. Often the very complexity proves frustrating because it's over his head—he's too young for it and cannot read and digest the technical instructions.

For example, such an outfit costing over $20 was given a 6-year-old boy. He turned away from it dejectedly after a few useless attempts to make some of the pieces work. He then played for hours with a device costing less than $2, which we assembled for his birthday: a small toy electric motor mounted vertically on a board. On top of the rotating shaft, you could place a number of specially colored disks, which were constantly changed into surprising color combinations if you interleaved them with other disks.

Another variety of devices, which are also mostly inexpensive and comparatively easy to make, can be created for older youngsters. They are *electronic games and puzzles*. Practically none of these are on the market. Yet none of them need to contain expensive parts—they use neither vacuum tubes nor transistors. Many of these devices are begging to be launched on the market by enterprising manufacturers looking for a steady, lucrative market.†

We were happy to learn that for youngsters, age 8–14, one of our great electronic kit manufacturers is launching a new line this fall in the country's *toy stores*. The list includes broadcast wireless mikes, experimental board, transistor kits and others. —*H.G.*

*In 1907, it wasn't known that they were dangerous.

†For further information on this subject, see *Electronic Puzzles and Games* (Gernsback Library).

COVER STORY

HIGH POWER FOR THE TWIN-COUPLED AMPLIFIER

Design a twin-coupled amplifier for tubes you like to use or build this 35-watt unit using EL34's

By NORMAN H. CROWHURST

MANY readers have asked, "How can we design a twin-coupled amplifier around the output tubes we like using?" This article answers that question by showing a high-power twin-coupled circuit you can build and how to design one to suit your own tubes, ideas or requirements.

The original twin-coupled circuit was designed to give high fidelity at low cost.* It used EL84's in its output, and inexpensive output transformers wound in the simplest possible manner to get adequate performance. This, unfortunately, resulted in unequal resistance for the primary halves. While the inequality is not important in the plate–screen-coupled transformer, it does result in slightly different bias on each of the output tubes—because of the different dc drop across the cathode-connected primary.

* "High Fidelity at Low Cost With Twin-Coupled Amplifier," November, 1957. "Updating the R-E Twin-Coupled Amplifier," June, 1960.

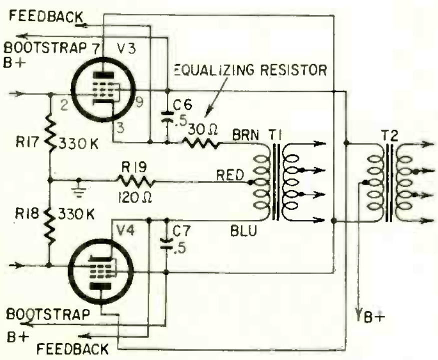


Fig. 1—A variation that equalizes cathode circuit resistance in the output tubes.

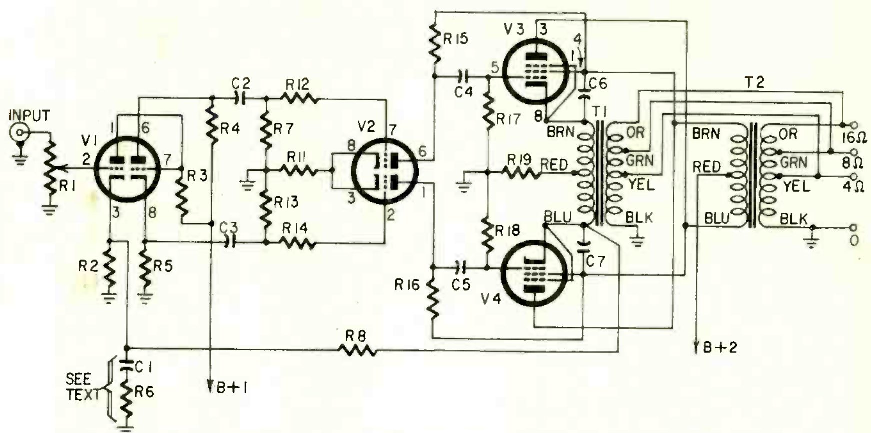


Fig. 2—Basic circuit of a more powerful twin-coupled amplifier.

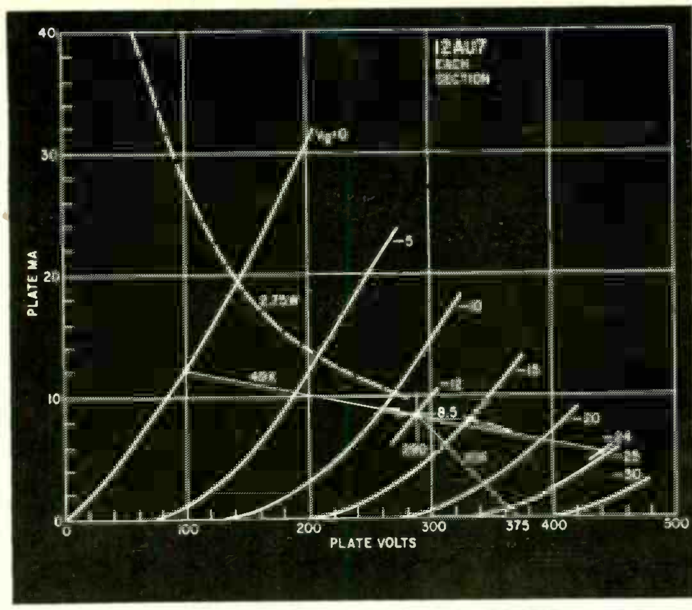
Some readers have rectified this difference and increased output 1 or 2 watts, by inserting a 30-ohm equalizing resistance in series with the half primary that measures only 70 ohms, to make its total resistance equal to the other half (Fig. 1).

To design your own circuit, use the same configuration as the original, or the variation shown in Fig. 2. As far as possible, the same component numbering is used on both to avoid confusion. But don't look for R9 or R10 in Fig. 2, because they aren't there. Whichever circuit you use, keep the arrangement and wiring of V2, V3, V4, R15, R16, C4, C5, R17, R18, C6 and C7 physically compact. They carry high audio voltages that should be kept away from the input circuits.

To go about the design, first decide what output tubes (V3, V4) you want to use and the operating conditions. If you want to go to more than 20 watts, you should use the larger transformer —Chicago Standard A-8098. It has balanced primary halves, more handling capacity and better mixing for high-frequency response. Its primary impedance is 2,000 ohms center-tapped, intended for use with tubes having a normal plate-to-plate load requirement of 4,000 ohms.

With slight variations, almost any output tubes can be used, with the suitable output transformer. To show how to figure circuit values, we will take EL34's as an example. The Mullard tube manual lists a condition using 375 volts B-plus with cathode bias, to give 35 watts output. The plate-to-plate load is given as 3,500 ohms for this condition. With a 4,000-ohm plate-to-plate load (using two A-8098 output transformers), these tubes should give better than 30 watts, assuming we get the same voltage swing with the higher load value.

To deduce the available output volt-



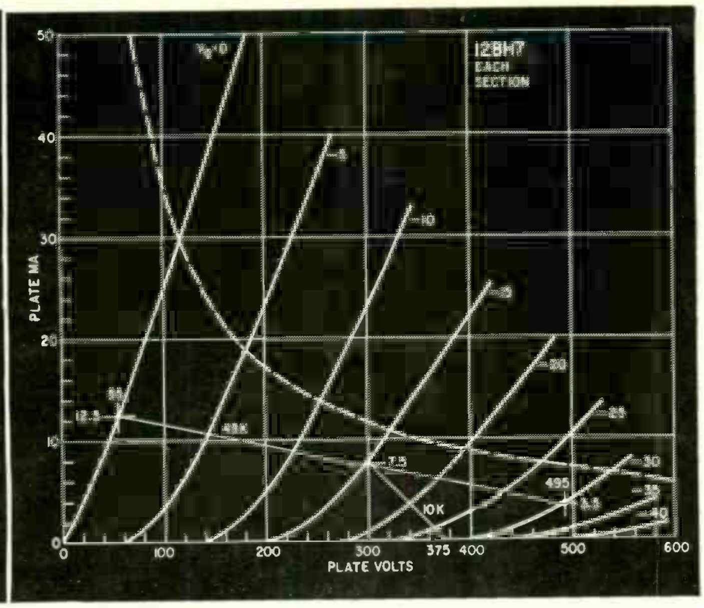


Fig. 3—Construction showing operation of a 12AU7 as a driver. Swing does not have sufficient margin.

Fig. 4—12BH7-A gives plenty of swing as a driver.

age swing in the plate circuit, from which we work out all the other swings, use the condition indicated in the Mullard tube manual tables: 35 watts output with a 3,500-ohm plate-to-plate load. This works out to 350 volts rms, using the formula $V = \sqrt{WR}$. We are interested in swing. Peak voltage will be 500, and peak-to-peak, which is swing, will be 1,000. Of this, 500 volts will appear across each primary, and 250 volts across each half primary.

Don't forget, while we figure out operation in terms of swing or peak-to-peak, a meter measures rms (on a sine-wave test signal). So when you check operation, divide the swing value by 2.83 to get the reading you should expect on an audio voltmeter.

To get the output swing we have just figured, the tube manual says the grids need an input of 40 volts rms, grid to grid. This will be 20 volts rms per grid, or 56 volts swing per grid. But this 56-volt swing is required from grid to cathode, and the cathode swings 250 volts because of the output voltage. So each driver stage has to deliver $250 + 56 = 306$ volts swing to its output tube grid.

The driver stage

Now we look for a driver stage. First let's try a 12AU7. The only way is by drawing the load line on the curves. First we put in the maximum voltage and dissipation (Fig. 3).

If we use 10,000-ohm resistors in the plates (R15 and R16) and about 12 volts bias, the operating point is about 290 volts, 8.5 ma (from the 375-volt supply). For a 56-volt swing, measured grid to cathode of the output stage, the grid swings 306 volts. So this 10,000-ohm resistor has only 56 volts (audio) across it, although the plate is delivering 306 volts audio. This means the effective value of the 10,000-ohm resistor for plate coupling, in the dynamic sense, is multiplied by $\frac{306}{56}$ or about 5.5, which makes it look like 55,000 ohms.

The grid resistors (R17, R18), which should not be higher than 470,000 ohms to satisfy operating requirements of the output tubes, do not get multiplied in this way because they have to be returned to ground. So the effective ac plate load is 55,000 ohms in parallel with 470,000 ohms, or about 49,000 ohms.

Laying a 49,000-ohm load line through the operating point and estimating a 24-volt swing (twice the bias voltage), plate swing is from 100 to 440, or 340 volts. To use this dynamic operating point, one tube passes 12 ma (at 100 volts) while the other passes 5 ma (at 440 volts). The total current is 17 ma on dynamic swing, or 18 ma in quiescent condition, and we require 12 volts bias. So the cathode resistor (unbypassed) must be 680 ohms.

This is just enough, but it allows too little margin for comfort. To be sure of getting enough swing, let's try a 12BH7-A (Fig. 4). Again using a 10,000-ohm plate resistor (R15, R16), this time with 15 volts dynamic bias, we get an operating point of 300 volts, 7.5 ma, which is within the rating of the tube.

With the same 49,000-ohm dynamic plate load, the swing is now from 55 volts, 12.5 ma to 495 volts, 3.5 ma. The voltage swing is much more adequate: $495 - 55 = 440$ volts. The cathode resistor (R11) needs to give 15 volts bias with a total current of $12.5 + 3.5 = 16$ ma. Probably 1,000 ohms is close enough, in view of the reserve. This will give close to the same quiescent operating point, because each tube passes 7.5 ma with 15 volts bias.

For the EL34 bias, the Mullard tube manual lists 260 ohms per tube. Each half primary of the A-8098 transformer measures 55 ohms, so an additional 205 ohms per tube is needed. For two tubes, this value is halved. A 100-ohm resistor (R19) is close enough. Total maximum signal plate and screen current is 227 ma ($2 \times 94 + 2 \times 19.5$), which will give a 22.7-volt drop and dissipate $22.7 \times 0.227 = 5.15$ watts. A 10-watt resistor should be used.

The driver plate resistors (R15 and R16) drop 75 volts with 7.5 ma, a dissipation of a little more than ½ watt, so at least 1-watt resistors should be used here. A ½-watt resistor is plenty for the driver bias (R11) and other resistors in these stages.

Phase splitter and voltage amplifier

The driver stage will need 30 volts swing on each grid (twice the bias voltage). This a 12AX7 will do easily with either circuit (Fig. 5). Using the arrangement of Fig. 2, with 100,000 ohms in both cathode and plate of the phase-splitter section (R4, R5), the load line is 200,000 ohms. Supplying 300 volts B-plus to this point, the minimum tube drop is about 60 volts. With the dynamic load line, due to paralleling the following-stage grid resistors (R7, R13), the minimum tube drop is somewhat greater, so allow 75 volts. This will be the minimum bottom swing from the operating point, with 15 volts in each load, plate and cathode. So the tube operating voltage should be 105.

PRINTED CIRCUIT AVAILABLE

RADIO-ELECTRONICS is pleased to announce that the printed-circuit board used in the Twin-Coupled Amplifier can be purchased by the constructor. By special arrangement, you can get a Twin-Coupled Amplifier circuit board for $2, postpaid, from RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N.Y., or Electro-Technik Co., 19456 Meyers Rd., Detroit 35, Mich. Both sides of the board you will receive are shown in Fig. 9 of this article. In future issues, printed-circuit boards for other construction projects will also be made available.

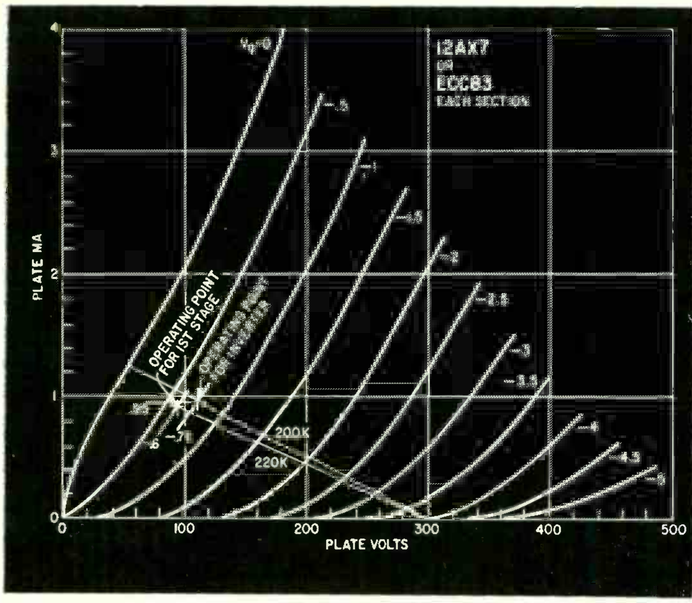


Fig. 5—Finding values for circuit in Fig. 2 using a 12AX7 or ECC83 voltage amplifier and phase inverter.

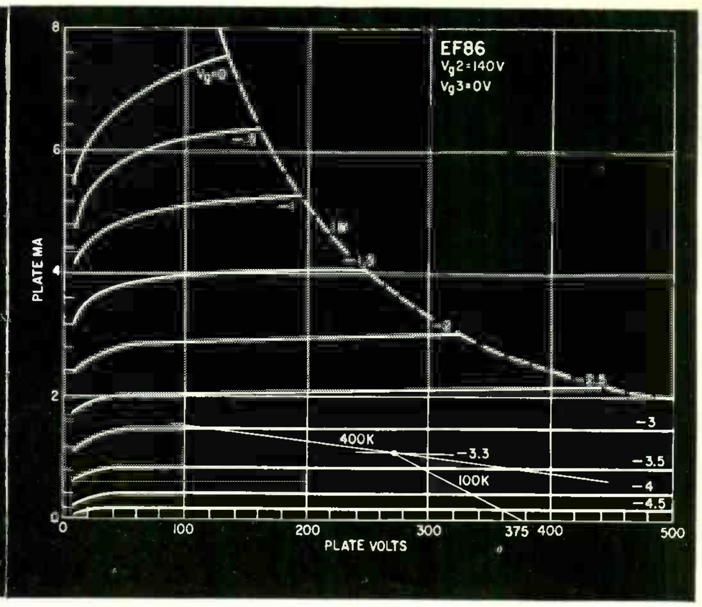


Fig. 7—Characteristics of an EF86 showing operation as a bootstrapped driver with a gain of about 500.

Make it 110 volts to give a slight margin. This leaves a 190-volt drop to the dc load resistor, 95 volts in the cathode and 95 in the plate.

Now the other half of the tube has to provide a direct-coupled grid voltage of 95 positive (strictly this should be less the bias of the second stage, which would make it 94.3 volts). Using a 220,000-ohm plate resistor (R3), this needs a bias of 0.6 volt with 0.9-ma plate current. So the input stage bias resistor (R2) must be about 680 ohms. This is also the bottom leg of the feedback network.

The phase splitter and voltage amplifier operate from a 300-volt source (B+ 1) so a series resistor is needed to reduce the available voltage (B+ 2) to this level. A 39,000-ohm ½-watt resistor passing 1.85 ma will develop the required 75-volt drop.

The stage has a gain of about 70, so the 30-volt output swing needed for the phase-inverter input (the phase-inverter gain is very nearly unity from input to each output) is obtained with about 0.43 volt input. If we use 14 db of feedback, the input has to be about 5 times this, or 2.15 volts swing, which is 0.76 volt rms. To get this feedback, the voltage across R2 has to be about 4 × 0.43, or 1.72 volts swing. The swing on V4's cathode, from which this is derived, is 250 volts. So resistor R8 must be $680 \times \frac{250}{1.72} = 100{,}000$.

Coupling capacitor values follow the original circuit. Also R12, R14 and R13 (with R7 made the same—270,000 ohms). If a 400–0–400-volt power transformer is used, total current is 227 ma for output tubes, 15 ma for the driver stage and almost 2 ma for the input stages: a total of 244 ma. A 5U4 with capacitor input filter will take care of power requirements. Using a 10-μf input capacitor, the output voltage is about 470. So the smoothing resistor must drop about 95 volts at 244 ma, requiring 370 ohms at 23 watts. A 350-ohm 25-watt resistor will serve. C8 must be rated at 500 volts.

Those are the calculations. But after building the amplifier, check the operating voltages, both quiescent and with power. The plate voltage of the 12BH7 should be 300 (assuming the B-supply ends of R15 and R16 get 375 volts). The cathode and plate of the second half of the 12AX7 should be 95 and 205 volts, respectively (again assuming the supply point is 300 volts). If not, the bias resistors (R11 or R2) need changing to get the voltages right. Don't forget, if you change R2, R8 needs changing in the same ratio to maintain correct feedback.

Network C1–R6, from V-1a's cathode to ground, levels off the response to around 20 kc when working into an open circuit or a resistive load. If the speaker system includes an electrostatic tweeter, this R-C network produces a 6- to 8-db boost at around 20 kc. This boost can be minimized by eliminating C1 and R6 when using an electrostatic tweeter.

If you use the original first-stage circuit (See RADIO-ELECTRONICS, June, 1960, for full schematic, or November, 1957, for original article), adjust R9 and R10 with signal passing and feedback connected, until signal voltage on both driver grids is equal. This is more easily done experimentally than by calculation.

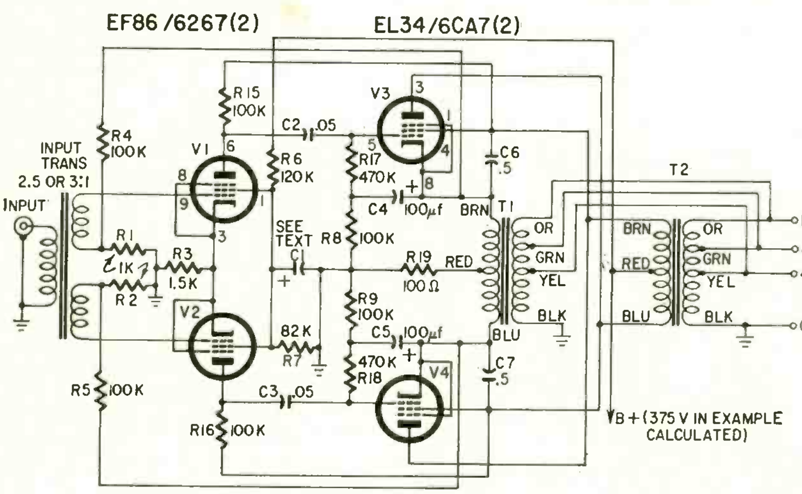


Fig. 6—Circuit using bootstrapped pentodes for drivers.

Transformer input

Another variation requested was a surprise to me—a circuit to use transformer input. To do this effectively, much more gain is needed from the driver stage, so two stages (drive and output) are sufficient. This is done by using a pentode driver and taking the bootstrap feedback a little further, to include the output stage grid resistors. Fig. 6 shows the circuit.

The output stage is the same as the one we have just worked through and requires a 306-volt swing per grid, of which 250 volts appears at the cathode. The driver uses two pentodes, which can be EF86's. Using a 100,000-ohm plate resistor (R15, R16), coupled to a 470,000-ohm following grid resistor (R17, R18), and 3.3 volts bias, the gain is approximately 500 (using a dynamic

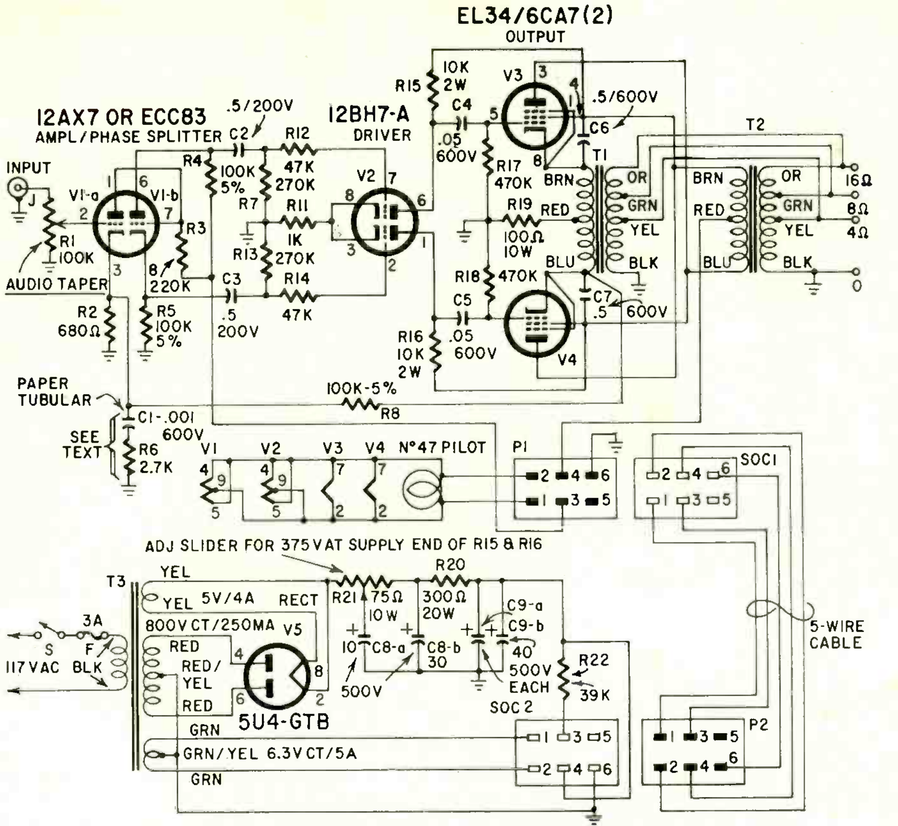


Fig. 8—Schematic of the complete 35-watt twin-coupled. B-plus voltage is adjusted by varying R21's slider.

R1—pot, 100,000 ohms, audio taper
R2—680 ohms
R3—220,000 ohms
R4, 5, 8—100,000 ohms, 5%
R6—2,700 ohms
R7, 13—270,000 ohms
R9, 10—not used, see text
R11—1,000 ohms
R12, 14—47,000 ohms
R15, 16—10,000 ohms, 2 watts
R17, 18—470,000 ohms
R19—100 ohms, 10 watts
R20—300 ohms, 20 watts
R21—75 ohms, 10 watts, adjustable
R22—39,000 ohms
All resistors ½-watt 10% unless noted
C1—.001 μf, 600 volts, paper tubular
C2, 3—0.5 μf, 200 volts, paper tubular
C4, 5—.05 μf, 600 volts, paper tubular
C6, 7—0.5 μf, 600 volts, paper tubular
C8—30, 10 μf, electrolytic, 500 volts minimum
C9—40, 40 μf, electrolytic, 500 volts minimum
F—fuse, 3 amps
J—phono jack
SOC1—connector, female, 6 prongs, cable type
SOC2—connector, female, 6 prongs, chassis type
P1—connector, male, 6 prongs, chassis type
P2—connector, male, 6 prongs, cable type
S—spst
T1, 2—output transformers: see text
T3—power transformer: primary 117 volts; secondaries 800 volts, ct, 250 ma; 5 volts, 4 amp; 6.3 volts, 5 amp (Stancor PC8413 or equivalent)
V1—12AX7 or ECC83
V2—12BH7-A
V3, 4—EL34/6CA7
V5—5U4-GTB
Chassis—see text
Sockets, (2) 9-pin shielded top-mounting type for printed circuits
Sockets, (2) top-mounting octal type for printed circuits
Fuse extractor post
Barrier strip, 4 terminals
Tie strips (3), lug-type; 3 terminals
Grommets, miscellaneous hardware

load line of 5.5 × 80,000, or 440,000 ohms (Fig. 7).

This means the grid input swing for the EF86's must be about $\frac{306}{500} = 0.6$ volt. Inserting 2.4 volts (4 × 0.6) in the return of the input transformer's grid windings gives 14-db feedback. The input swing per grid winding must be 3 volts, or about 1.06 volts rms. One of the stock line/plate to push-pull grid transformers, with a stepup ratio of 2.5 or 3 overall, will permit driving this amplifier from a cathode follower output delivering 1 volt rms.

The feedback resistors can be 1,000 ohms (R1, R2) and 100,000 ohms (R4, R5), to provide the 100-to-1 reduction from 250 volts to 2.4 (approximate). The only remaining details are the bias and screen voltage arrangements and the output-stage grid decoupling, to permit bootstrapping the grid resistors.

The EF86's need 3.3 volts bias with a total plate current of 2 ma, plus about one-sixth of this as screen current. A 1,500-ohm resistor should be right for this. Screen voltage must be 140, to use the operating point the curves were based on. Estimating screen current (two tubes) as 0.3 ma (one-sixth plate current) and swamping it five times with the potentiometer feed, the top part (R6) has to drop 375 − 140 = 235 volts with 1.8 ma, requiring a resistance of 130,000 ohms. The bottom part (R7) needs to drop 140 volts with 1.5 ma, requiring 93,000 ohms. Preferred values of 120,000 and either 91,000 or 82,000 ohms should serve.

A large capacitor (C1) is needed to decouple the screen because of the high stage gain, which means the screen will be susceptible to the amplification of any hum voltage fed to it. Try a 100-μf 150-volt electrolytic.

The output-stage grid decoupling requires full cathode swing voltage to be coupled to the bottom end of the grid resistors. There is a dc voltage across the capacitors used for this (C4, C5) equal to the bias of the output stage (22.7 volts). So a 50-volt electrolytic can be used, say 100 μf. The resistors

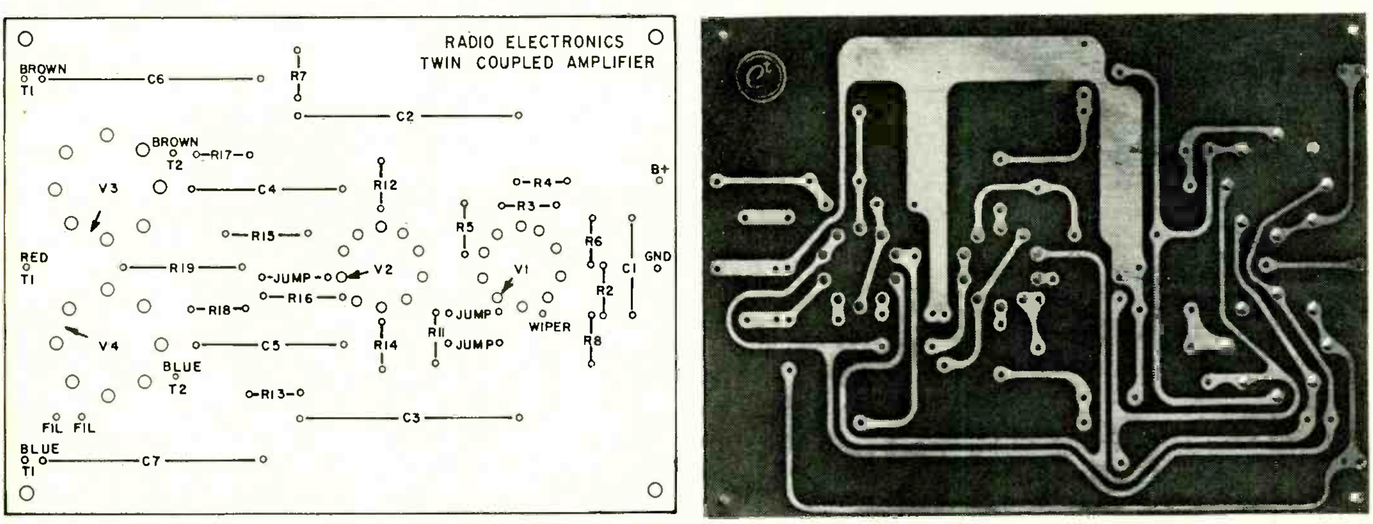


Fig. 9—Top and bottom views of the printed-circuit board. Drawing and photo are almost exactly half size. Board used measures 7⅛ x 5¼ inches. If you make your own, add about ¼ inch along each side to simplify mounting. Drill an additional mounting hole in the center of each long side to reduce flexing.

(R8, R9) absorb a small portion of the output power (as do feedback resistors R4 and R5, which at each cathode "see" a 1,000-ohm load resistance (one-fourth the total plate to plate). Making them 100,000 ohms means that only 1% of the proportion of power coupled by the cathodes will be fed to these resistors. The total grid-circuit resistance is now about 600,000 ohms (470,-000 + 100,000).

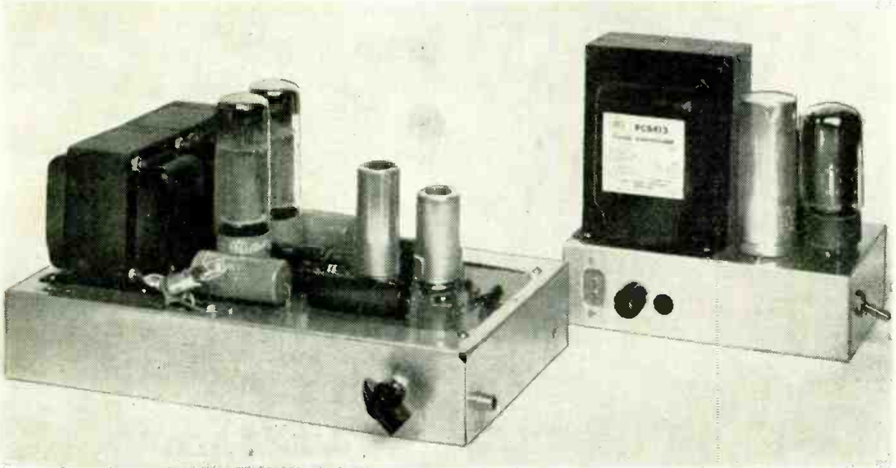
In setting this circuit up, as with the others, check all dc voltages and then see that the signal voltages are also what they should be.

A practical circuit

Following the design procedures outlined in this article, the staff of RADIO-ELECTRONICS developed the 35-watt twin-coupled amplifier shown in Fig. 8 must be oriented carefully before mounting. Mount sockets for V3 and V4 so the arrows on the mounting fall between pins 1 and 8. Mount V1 and V2 sockets so the arrows point to the space between pins 1 and 9. The arrows on the V1 and V2 mounting locations point to extra holes used for ground leads for the tube shields.

The prototype audio section of the amplifier was built on a 7 x 11 x 2-inch chassis. But, since B-plus voltage appears on some points on the top of the printed-circuit board, we recommend that you build this section on an amplifier foundation kit (a chassis with a matching ventilated cover) such as the Bud CA-1751 or ICA 3966.

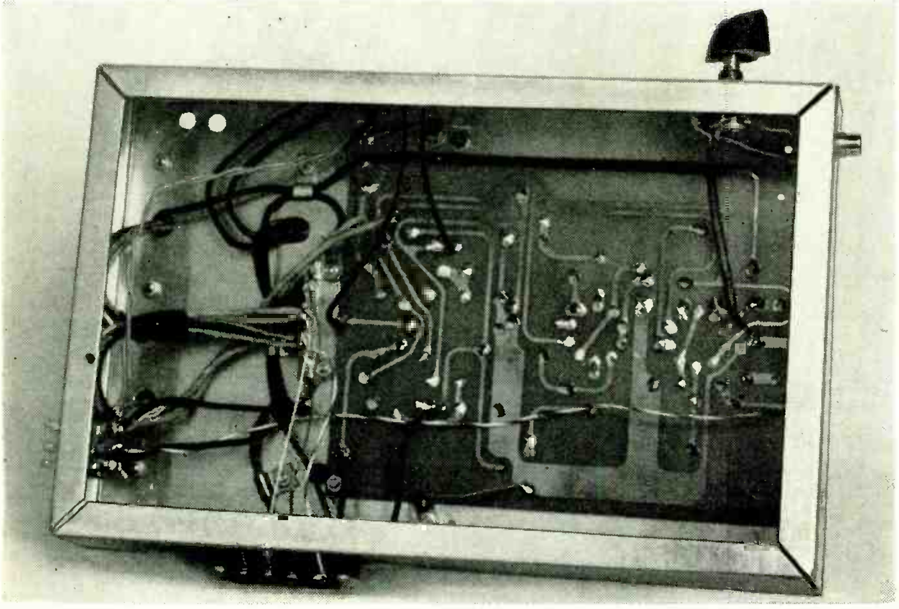
The power supply, connected to the audio chassis through a five-wire cable, fits nicely on a 5 x 7 x 2-inch chassis.



Top of the twin-coupled amplifier. Printed-circuit board makes all parts readily accessible.

and the photographs. The amplifier was constructed as a two-chassis unit with printed-circuit wiring in the audio section.

The sockets for V1, V2, V3 and V4 Input filter resistor R21 has its adjustable slider connected to the positive end of C8-a. The slider is adjusted for 375 volts at the B-plus ends of R15 and R16 (blue and brown leads of T2). END



Under-chassis view of the 35-watt twin-coupled amplifier.

HOW LIVE IS YOUR NICKEL-CADMIUM BATTERY?

By NATHANIEL RHITA

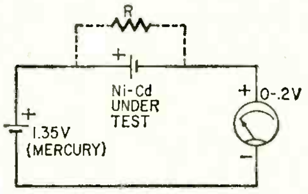
THE voltage of a mercury or nickel–cadmium cell remains nearly constant throughout its life span; then the cell goes dead suddenly. At normal discharge rates, for example, NiCd cell voltage varies as follows:

discharge	*voltage*
10%	1.28
40%	1.24
70%	1.19
95%	1.15

Thereafter, the voltage drops sharply. The small voltage variations during its useful life are not easy to measure on a 3- or even a 1.5-volt scale.

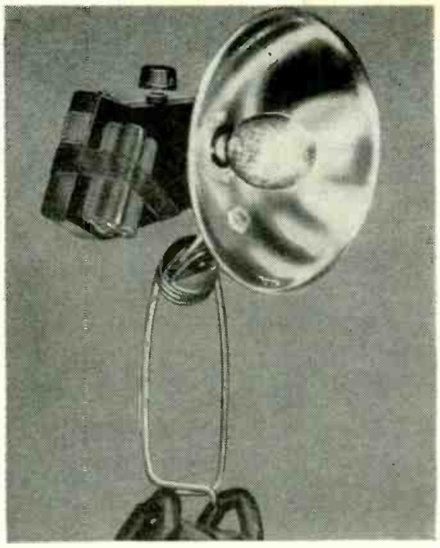
A better method is shown in the diagram. The NiCd cell under test is connected in series (opposing) with a mercury cell. The latter voltage is about 1.35. Thus the voltage difference between cells will vary between approximately zero and 0.2 volt.

Sensitive dc meters generally measure about 0.2 volt without multipliers.



For example, a 100-μa meter may have an internal resistance of 2,000 ohms, and thus measure 0.2 volt. My own meter is a 40-μa instrument with resistance of 5,000 ohms. When connected as shown, such a meter measures the voltage between the 1.35 volts of the mercury cell and 1.14 volts from the NiCd cell. To simulate actual conditions, add a load (R) across the measured battery. Select R to have about the same current drain as the equipment on which the cell is used.

This method can indicate whether a cell is fully charged, half-charged or exhausted so it can be put back on charge. It may prevent the embarrassment of trying to operate from a cell that has little life left. END



The finished unit. A clamp stand is attached to the reflector so the remote unit can be mounted almost anywhere.

Better Photos with a Transistor Slave Flash

By FRANKLIN T. MERKLER

EACH year thousands of flash bulbs are fired to produce thousands of flat portraits to paste into the family album. The villain is the flash bulb anchored to the top, side or bottom of the camera. It is needed to provide enough light for a proper exposure, but the direction and quality of this light never varies—it is always head-on.

Twenty years ago, I went through this critical phase of picture taking and soon tired of the flat prints, the glassy-eyed look, the ash-white faces. The flash gun was taken off the camera and two or more flash bulbs were set off at the ends of extension cords. These pictures were excellent, but the dangling wires which would sometimes appear in the picture and the nuisance of carrying some 20 feet of wire soon ended this experiment. Slowly the camera fell into disuse, except for the usual birthday and Christmas shots.

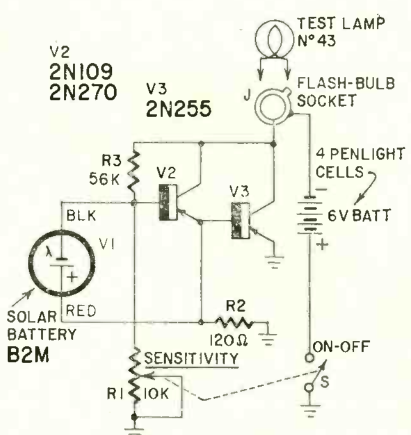
What I needed was an extension flash synchronized with the flash bulb on the camera. Such units could be made with the help of vacuum- and photo-tube circuits, but the disadvantages of providing a high-voltage supply ruled them out. I needed a unit that would be small, mobile, self-contained and keyed by the flash of light originating at the camera-mounted gun. Transistors could make such a unit possible.

Circuit requirements

Before a design could be worked out, I had to find out how much voltage and current a flash bulb requires. A typical M-class bulb (No. 5, Press 25, etc.) could be fired with 3 volts or more, but the current requirement was critical—300 to 350 ma minimum. To do the job, I designed a transistor switch that applies 6 volts at 500 ma to the flash bulb. The sensing unit is an International Rectifier Co. solar battery. Its output is too low to trigger the transistor switch directly, so some dc amplification is needed.

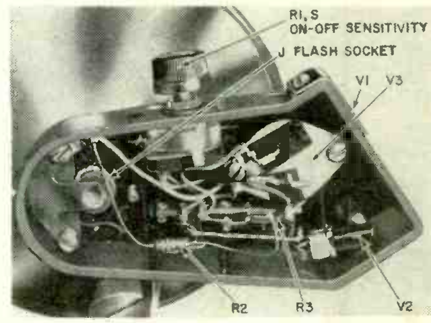
The circuit worked, but stray light would key the unit and flash the bulb. To make the unit more reliable, I added a 10,000-ohm potentiometer to the dc amplifier's base circuit and made up a test light to fit the flash socket. When the added pot is set so the test lamp does not light, it is safe to plug in the flash lamp. Any setting that lights the test lamp will fire a flash bulb. So when room lighting is bright enough to light the test lamp, the pot is turned down until the test light goes out.

Now I had a practical circuit (see schematic), but would it fire a flash bulb in sync with the one on the camera? At this stage, a professional photographer friend, Mr. Dale Watson, was asked to test the unit. He used a Speed Graphic with a Compur Synchro shutter. My slave flash was set up 12 feet away and aimed directly at the camera. The shutter was set at 1/25 second for the first exposure, subsequent tests were made at 1/100 to 1/400 second. Each time the slave flash unit keyed and fired its bulb when the camera bulb fired.



R1—pot, 10,000 ohms, with spst switch S
R2—120 ohms, 1/2 watt
R3—56,000 ohms, 1/2 watt
BATT—6 volts (4 penlight cells in series)
J—flash-bulb socket
S—spst on R1
V1—B2M solar battery (International Rectifier)
V2—2N109 or 2N270
V3—2N255
Chassis to suit (surplus flash unit)
Miscellaneous hardware

Circuit of the 2-transistor unit.



Parts layout inside the slave-flash case.

The breadboard setup was run through its paces in other ways too. One test had the flash bulb at the camera completely shielded from the subject. The light from the camera-mounted flash could only hit the slave-flash unit which was aimed to light the subject. This test was a complete success, the picture was perfectly exposed.

Building and using the unit

The finished unit (see photos) was built around a surplus flash unit. The reflector, socket and plastic body were used, but all internal wiring and the mounting shoe were discarded. Four penlight cells were needed to power the slave unit and they wouldn't fit into the case. Instead they are wired in series to provide 6 volts and are taped to the plastic case under the reflector. The 10,000-ohm potentiometer and its ganged switch are mounted in a hole drilled in the side of the case. Parts layout is not critical. The only vital point is to make sure all components are fastened securely in place.

The slave flash makes an effective portrait light when placed off to one side and above the subject so its light falls at about a 45° angle on the subject. Use the electronic slave flash to light your way to lively color slides and flash pictures with quality and punch. END

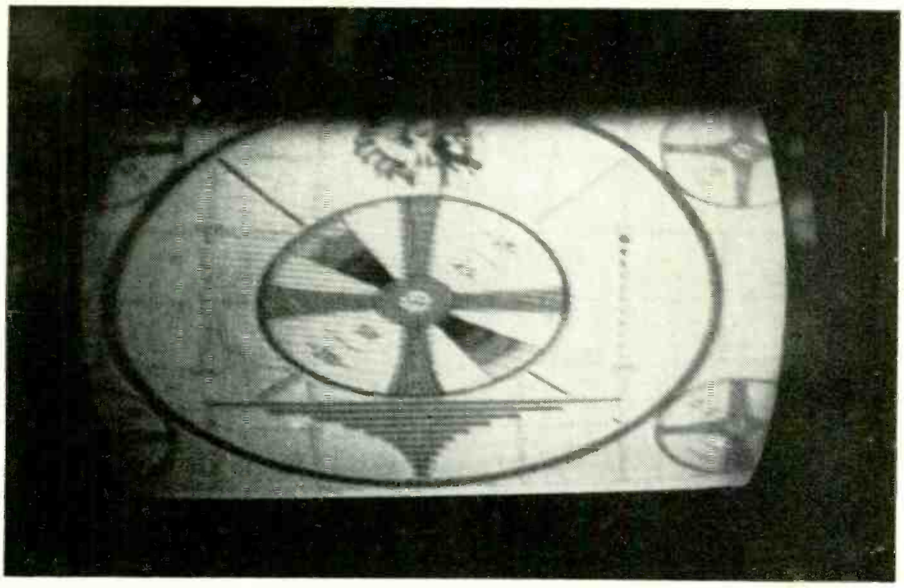


Fig. 1—Picture set up for vertical adjustments. Height and linearity controls turned down to leave 1 to 2 inches of space at top and bottom.

Much can be learned about the condition of the vertical stages just by observing the picture

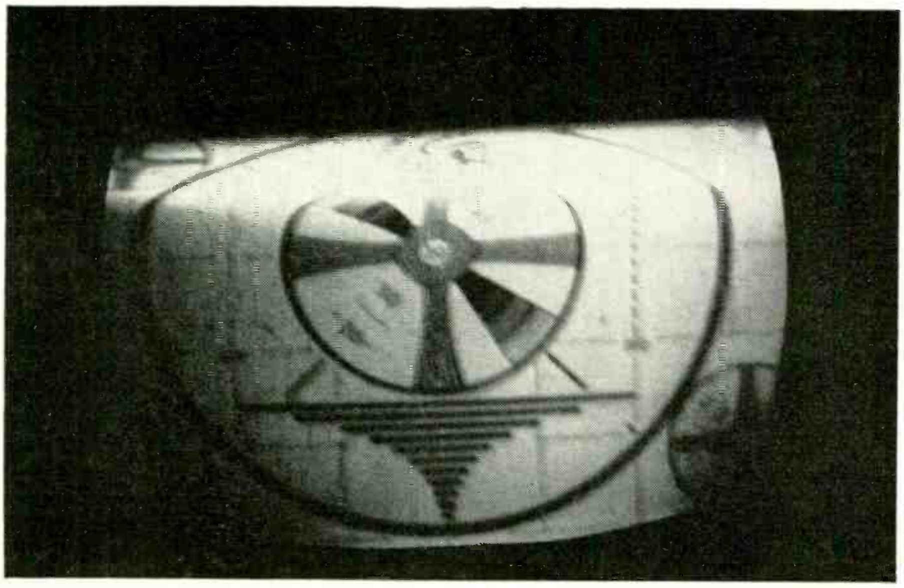


Fig. 2—Compression at top of picture is example of nonlinearity.

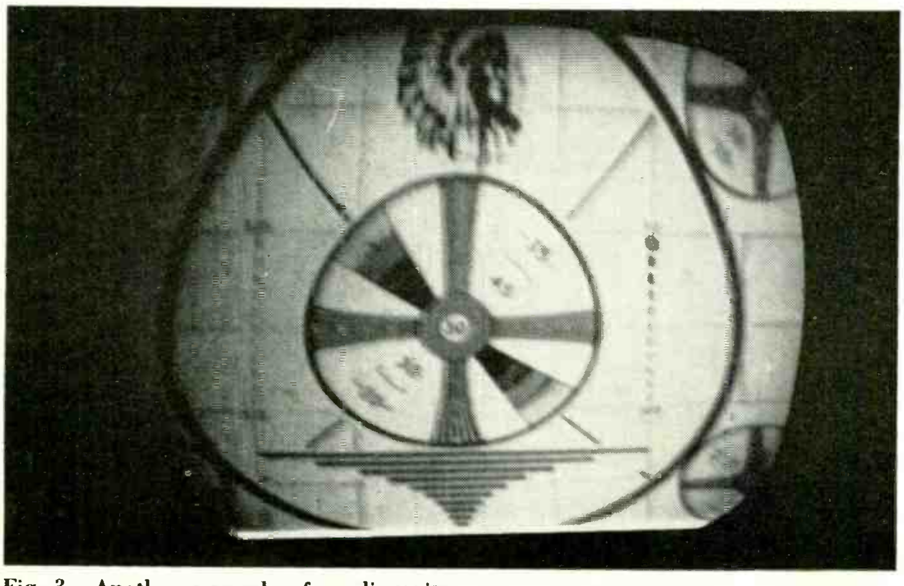


Fig. 3—Another example of nonlinearity is stretching of picture top.

THE vertical oscillator and output stages of a modern TV set shouldn't be too hard to troubleshoot. You can get a good idea of what shape they are in just by looking at the picture! A test pattern is always helpful (either off the air or from a pattern generator). And you can use a scope in one place (checking vertical sync), but even here you can find out what's going on just by watching the way the picture acts when you move the vertical hold control. You can get a pretty good idea of the condition of the whole circuit, in fact, by just checking the picture and raster (actually, you don't even need the picture, but it's easier!).

There are three things to check about the vertical circuit: height, linearity and "holding ability." The first two can be checked out pretty quickly by looking at the picture. If it doesn't fill the screen, find out why.

Height and linearity controls are used to compensate for tube aging. The first step should be to set up the picture correctly. Turn height and linearity controls down until you have a linear picture that lacks about an inch of filling the screen (top and bottom, as in Fig. 1). Center it with the centering magnets on the yoke until it is the same distance from both top and bottom edge. Now, using both controls, see if you can pull it up (and down) until it fills the screen with about a ½-inch overscan at top and bottom. If the picture will not cover the screen or isn't linear (crowded or stretched at the top), then you've found the first trouble.

Height lack is usually due to a weak tube or low B-plus voltage. In most cases, low B-plus will cause a narrow picture too. A weak tube in either oscillator or output stage will usually result in the picture being nonlinear at the same time. In any case, if the picture is too small, replace the tubes first; it's the easiest! (Note:

TROUBLESHOOTING the VERTICAL OSCILLATOR AND OUTPUT STAGES

By R. D. JACQUES

you'll find a few cases where the picture *will* have enough height, but will be stubborn about being linear. Change the tubes first; this is often the cause!)

While adjusting the height and linearity controls, check them for noise and roughness. Carbon controls will develop dirty or worn spots and cause trouble. These carry some dc in most circuits and are prone to troubles like this. You may find that the picture suddenly disappears as you move either control, leaving a thin white line across the screen. If this happens, the control is bad; replace it before going any further.

Linearity check

To check the linearity of the picture, look at the scanning lines. If they're evenly spaced all the way from top to bottom, fine. If not, the linearity is bad. A quick check for linearity is to roll the picture slowly downward with the vertical hold control. Watch the blanking bar as it travels down the screen. If it stays the same width all the way, good; if it comes into view very wide, then shrinks as it comes down, bad linearity. The opposite is also true: if it comes into sight narrow, then widens or if it changes in width at all as it goes down, the linearity is off and must be adjusted. Poor linearity will also show up in the picture: Fig. 2 shows compression at the top; Fig. 3, excessive stretch at the top.

Vertical oscillator

Now let's look at a typical vertical oscillator output stage used in many TV receivers (Fig. 4). The older sets used blocking oscillators with a separate output stage, usually a pentode. However, the multivibrator has about taken over in sets made in the last few years. The first versions used two tubes (sometimes) as in one series of Bendix chassis, half of a 6SN7 and a 6W6. Later sets use a single specially designed triode. These tubes are double triodes, but the two "halves" are different. The oscillator section is a voltage-amplifying type with a fairly high mu; the output half is a power amplifier. The 6CM7, 6CY7 and 6DR7 are typical of this class.

The two tubes are connected as a simple multivibrator. There are variations of this circuit, of course, but each version can be traced out as a multivibrator. Note the feedback paths from the plate of each section to the grid of the other. These R-C networks determine the time constants of the circuit, so that it will operate near the correct frequency of 60 cycles per second when free-wheeling.

The height control (sometimes labeled VERT SIZE) is usually found in the plate supply of the oscillator section. It will be a large resistor, common values being from 3 to 8 megohms. The vertical linearity control is most often found in the cathode of the output section. It will be a smaller control, running from 250 to 2,000 ohms. In this location, it regulates the output-stage bias so that the tube operates on the most linear (straightest) portion of its curve. A variation of this is used in Westinghouse and other sets with the linearity control connected in the grid-return circuit of the first and second stages. It is part of the grid leaks of both and also part of the coupling network. A higher resistance control is used here, around 500,000 ohms (Fig. 4).

In almost all circuits, the vertical hold control will be found in the grid circuit of the oscillator section where it will be a part of the R-C network. By varying the resistance in the grid cir-

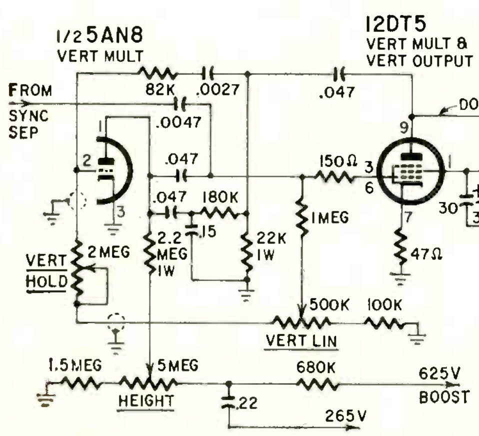


Fig. 4—Typical vertical multivibrator. Notice that sync is fed to plate of the first section of the oscillator and the control is in the common grid return.

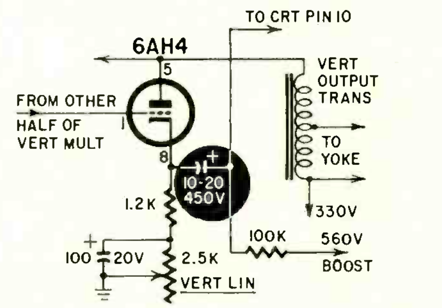


Fig. 5—When cathode-to-B-boost capacitor (circled) is leaky or open, linearity troubles may develop.

cuit, we alter the time constants and change the operating frequency of the oscillator.

There is a sort of general rule that applies to these circuits: The height control affects the bottom half of the picture, while the linearity control works mainly on the top half. Like all generalizations, this one is false, as it won't work in all cases. But it is pretty close.

Common troubles

The most common defect is loss of height or linearity. Weak tubes cause most of the trouble (as in all other circuits), and low operating voltages are next. As you can see from the schematics, some multivibrators are supplied from B-plus, while some are fed from the boost voltage. A few feed the oscillator from B-plus and the output stage from B-boost. Check the schematic for the set you're working on to see just what comes from where.

You'll find some high-value resistors in the supply circuits. These should always be checked carefully. If the trouble seems to be thermal (showing up only after the set is thoroughly heated up) you can suspect a shift in the value of one of the resistors in the B-plus circuits. Connect an ohmmeter across the resistor (after disconnecting one end) and hold the tip of a soldering iron close to the resistor. Watch for any resistance rise. If it changes more than 5%, replace it. Incidentally, while we seldom suspect variable resistors—such as height controls—of varying in total resistance, this *has happened!* So, don't overlook them when you're hunting for the cause of a height loss.

If the oscillator is fed from the B-boost voltage, a drop in boost voltage (due to a weak damper tube and so on) can cause trouble. Check the boost voltage first to make sure it's up to snuff. If the boost voltage is OK but the voltage at the output tube's plate is suspiciously low, check the output transformer for a high-resistance joint in the winding. A leaky coupling capacitor between oscillator and output stage can also cause this trouble although this will usually upset the linearity badly, causing foldover at the bottom of the screen.

Linearity troubles

Linearity troubles are almost always found in the output stage. While it is theoretically possible for it to originate in the oscillator circuit, in practice it is seldom found there. If the VERTICAL LINEARITY control is in the cathode of the output stage, it will always be bypassed with a large low-voltage electrolytic capacitor, 100 µf or more. If this value falls off or the capacitor opens entirely, linearity will be very bad.

High power factor in this capacitor is usually the cause of the mysterious "wrinkle" that shows up about a quarter of the way down from the top of the screen. The best test for this is to disconnect the original and substitute a known good unit of equal or larger size. You can use a larger capacitor but never a smaller one than that shown in the schematic.

Electrolytic capacitors elsewhere in the power supply can be responsible for vertical troubles. Some sets use an electrolytic of about 10 to 20 µf connected from the boost voltage to the vertical output tube's cathode. Obviously trouble in this unit can give you all kinds of assorted headaches! Leakage through it upsets the output tube bias; an open will allow all sorts of wild waveforms to float around the circuit and so on. So, if all of the "standard" parts seem to be OK, look for a capacitor connected in this manner (Fig. 5).

In a few cases, the last filter capacitor in the boost circuit will cause the same kind of trouble. This will be connected from B-boost line to chassis and may be far removed, physically, from the vertical circuits. If it opens up, it may allow high-level horizontal pulses to leak into the vertical output circuits where they will cause trouble.

The last common cause of vertical nonlinearity is found in the output transformer. Short of substituting a new one, these transformers are hard to test unless a winding happens to be completely open, in which case even I could find the trouble pretty easily! However, if everything else in the circuit is OK as far as you can tell and the picture still refuses to be linear (or have sufficient height), then there is room for a logical suspicion that the output transformer has a shorted turn(s) somewhere. Substitution is about the only quick check for this.

A lot of technicians have a tendency to suspect the vertical section of the yoke when this happens. However, you'll find that very few of these troubles are actually caused by defective yokes. There is one sure sign of vertical yoke trouble: that well-known trapezoidal raster (much narrower at top than bottom, or vice versa) which you'll find in every book. If you see this, there is only one thing that can cause it, and that's a bad yoke. In case of doubt, reduce picture width and look at the edges of the raster. If they are trapezoidal, you'll see it then. (There *is* one more possibility: If the vertical output transformer is *not* the original part, check up on the part number, just to be sure that whoever replaced it put in the right one. It *has* happened!)

Instability, sync troubles

Poor vertical stability is about the most common customer complaint, it seems. (It's rolling!) This can be due to two things: weak vertical sync or trouble in the oscillator. A weak oscil-

Fig. 6—Vertical oscillator waveform with sync pulse. Picture must be rolling slowly downward to make pulse visible.

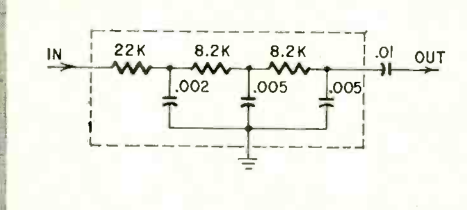


Fig. 7—Typical vertical-integrator network.

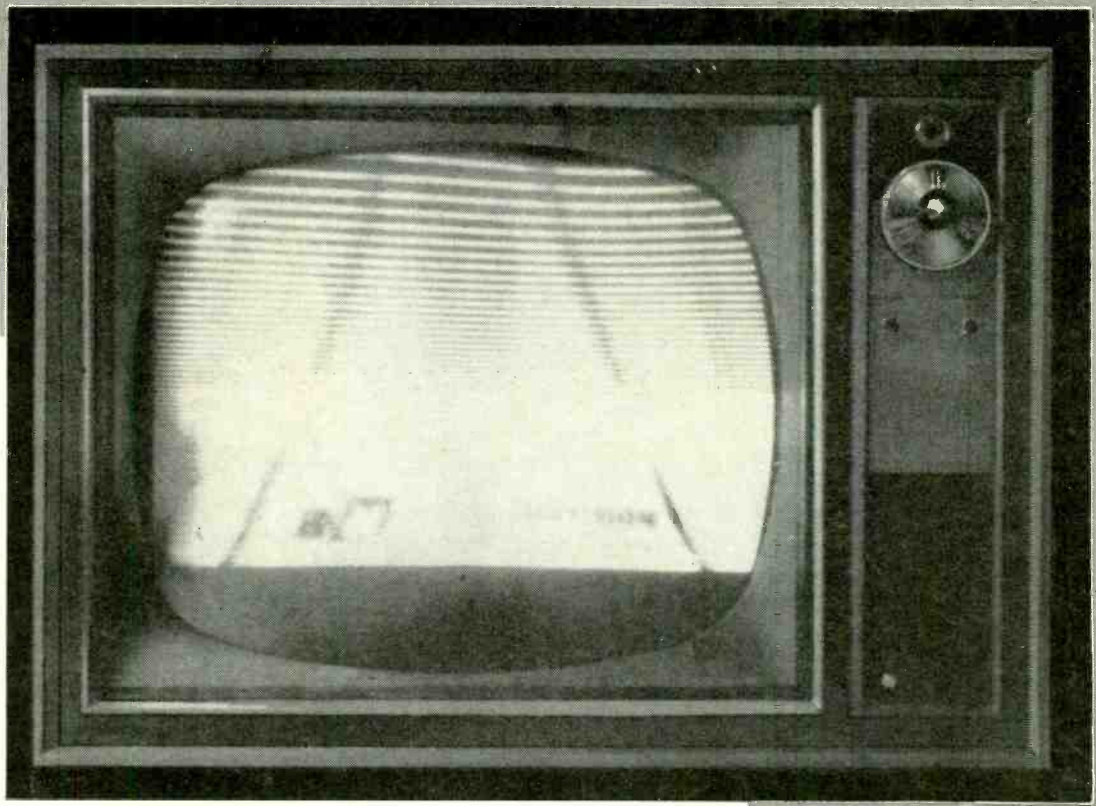


Fig. 8—Heater-to-cathode leakage in oscillator produces extreme nonlinearity.

lator tube can account for a lot of it so always change it first. If replacing the oscillator tube doesn't help, then change the sync tube immediately preceding it, just to find out.

A good check of the sync or holding action can be made from the front of the set. Simply roll the picture downward by turning the vertical hold control. This control can tell you a lot about the condition of the vertical stages. The picture should roll *slowly downward* when the control is turned one way, with the blanking bar rolling smoothly down until it gets to a point about 3 to 5 inches from the bottom in a large-screen set. It should then suddenly snap out of sight and the picture lock momentarily in place. When the control is turned in the other direction, the picture should remain stationary, then "break out," rolling *upward very rapidly!* If you can roll a picture *slowly upward* by turning the hold control, then there's something very definitely wrong with the sync or oscillator circuits!

The snap at the bottom of the picture is the point where the vertical sync pulse grabs the oscillator and forces it to lock in. On a scope, this looks like Fig. 6. Here, the picture has been rolled part way down so that the vertical sync pulse may be seen. It is the tiny notch just below the top of the waveform. This is about the minimum amplitude for the sync pulse. If it is smaller than the one shown, it won't be able to control the oscillator as it should. Low sync is usually caused by weak sync tubes, incorrect plate voltage on sync tubes or leaky capacitors in the vertical integrator network (Fig. 7). This is often a printed-circuit type (the parts values shown are the ones most commonly used) although there are others found in some sets that will differ from these. Zenith, for example, uses a small Rescap network which is actually only a single capacitor and resistor.

This is the one place where a scope can be used to real advantage. Connect it (through a low-capacitance probe) to the sync input of the vertical oscillator, roll the picture slowly down with the hold control and check the amplitude of the sync pulse. If you have hold trouble, the sync pulse may be so small that you can't see it at all or show up as a mere wiggle on the oscillator waveform. If there is any doubt, kill the vertical oscillator by removing the tube or grounding the grid (turn the brightness down to prevent burning the picture-tube screen) and check the amplitude of the sync pulse all by itself. In the multivibrator circuit of Fig. 4, the sync is fed into the plate of the vertical oscillator. This may appear strange to some hardheaded old-timers who insist that sync should always be applied to the grid.

Before checking for holding action, be sure that the picture is adjusted to normal height and linearity with the proper controls. If the picture is not set up right, there will be a change in the waveshape which may make sync action improper. Too much stretch at the top, for instance, can flatten the top of the wave so much that the sync pulses will have a hard time locking the oscillator at the right instant.

Foldover

Foldover at the bottom of the picture is caused by the oscillator running too fast. The beam has reached the bottom of the screen and started back up again before the whole picture has been scanned. Therefore, the bottom part of the picture is folded up over itself, making a wide white line (customer's description) at the bottom. This is usually caused by leaky coupling capacitors, defective grid resistors or improper bias on the oscillator tube.

Another cause of foldover, this one quite different, is heater–cathode leakage in the oscillator tube. This results in a 60-cycle sinusoidal voltage being applied, in effect, to the grid instead of the sawtooth and results in a picture looking like that of Fig. 8. This is easy to cure; just replace the tube. Characteristic symptoms: very bad nonlinearity and severe foldover so that the picture covers only about half the screen.

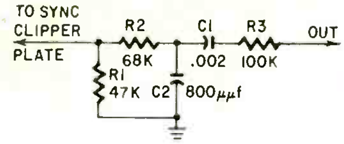


Fig. 9—Vertical integrator used in some General Electric sets.

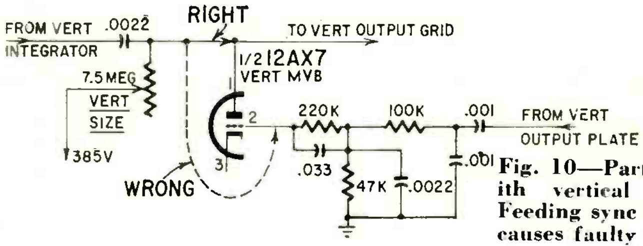


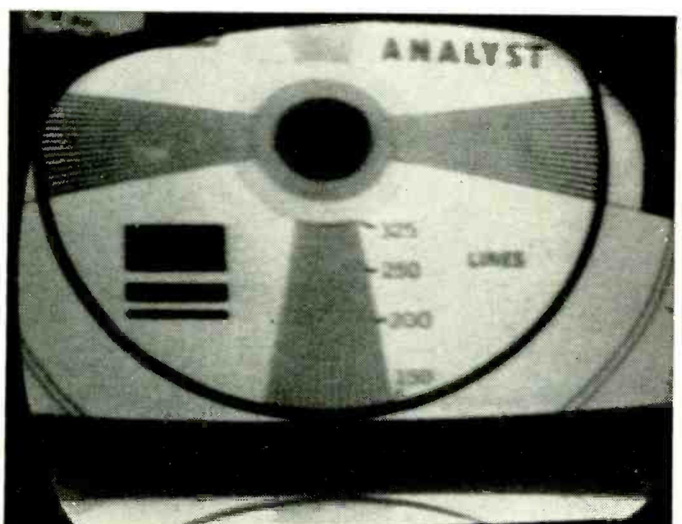
Fig. 10—Partial schematic of a Zenith vertical multivibrator circuit. Feeding sync to grid instead of plate causes faulty vertical lock.

Some odd troubles crop up as in all other stages. If there are two full pictures on the screen and the hold control has very little effect, look for a shorted capacitor in one of the time-constant R-C networks. For instance a shorted capacitor may change the time constant to only half of what it should be, and you will be able to get a double picture on the set. For a reliable test, one end of the capacitor must be disconnected. You can see the numerous parallel paths in the circuit which would foul up any resistance measurements taken with parts still connected.

Some tubes will give trouble, even though they test OK. For example, the 12B4 used as vertical output amplifier in certain Zenith TV sets will cause poor linearity, even though the screen is completely filled. Replace the tube for a quick test. In a Bendix T17 (with half of a 6SN7 and 6W6), the picture would hold fairly well. The "stop" action was almost normal. But, as the picture stopped, it would bounce up and down with a peculiar, slow rubbery bounce, almost as if it were suspended on springs! The cure? Replace the 6W6 output: apparently this tube had a wee gas content.

In some sync circuits you'll find parts values which might seem a bit strange, especially in a circuit handling 60-cycle pulses. An example of this is seen in Fig. 9. If you find vertical sync troubles in sets with similar values, try rebuilding the integrator. Reduce R3 to about 27,000 ohms and increase C1 to about .01 to .02 μf. This will increase the amplitude of the sync pulses applied to the oscillator and improve the hold action tremendously. Do not use too small a resistor for R3, or too large capacitor for C1. This will upset the time constant of the vertical oscillator, making the action jerky.

One final case history before we go. This was in a Zenith TV, using a multivibrator similar to Fig. 4. After replacing a leaky sync-coupling capacitor, the picture would roll up normally, lock in beautifully and was most exceedingly linear. There was only one small hitch: the point at which the picture locked so firmly in place was slightly off center (photo below). Try as we would, it would not lock where it was supposed to! (Remember, we just said that to some hard-headed old-timers all sync must be fed to the *grid* of a tube?) In desperation, we checked the circuit we should have checked first: the one we were working on. Sure enough, there was the sync-coupling capacitor, firmly soldered to the *grid!* (Fig. 10—Should have been on the plate!) Moral: when in doubt, always check the job *you just did*, before searching for more obscure troubles! END



Feeding sync pulses to the grid instead of the plate (Fig. 10) locked in the picture with the blanking bar visible.

two business primers

Both Sylvania and General Electric have recognized that the average TV service dealer is not likely to appear among the 10 best businessmen of the year. Mainly concerned with the electronics end of the business, he rarely pays as much attention as he might to the dollars-and-cents part.

For this reason the two electronics companies have decided to sponsor home-study courses in business management for the TV service technician. When combined with the fix-it knowledge the technician has already learned, these courses can help get more work and more dollars into the shop.

General Electric offers a three-piece kit, consisting of a 33⅓-rpm record and two bound texts—*Sound Business Practices* and *Selling Electronic Service*. Sylvania uses a two-volume set titled *Complete Business Practices*.

Both courses include questionnaires designed to test the technician on what he has learned. The answers are graded and returned.

The texts cover everything from taxes and business records to customer relations. They show how to handle and collect on bad debts, set up a result-getting advertising campaign (within the means of the shop), and how to make your business grow.

The General Electric course is listed at \$22.50, the Sylvania at \$25. END

"Charlie says these speaker plans almost have him baffled."

By HERMAN BURSTEIN

add a THIRD SPEAKER the easy way

A few minutes will show you whether a third speaker will make your stereo system sound better

THREE-speaker stereo is gaining in popularity. A center speaker, driven by the combined signal of the left and right channels, is added to the left and right speakers. This is in contrast to *three-channel* stereo, not yet available for the home, in which the center speaker is fed by a separate channel.

Several reasons have been advanced in favor of a center speaker:

- If the left and right speakers are angled wide to the listener's left and right, the center speaker tends to fill the hole in the middle.
- Center sound is a combination of the left and right channels. Combining them and feeding them to a center speaker serves to re-create center sound.
- The listener's position has less effect upon the stereo illusion when a center speaker is used. That is, he may sit closer to or farther from the speakers, or he may sit more distant from the center line between the end speakers, without losing the stereo illusion, as contrasted with the optimum position when only two speakers are used.

Whether these arguments are good or not, the fact remains that many stereophiles are incorporating or at least experimenting with center speakers. To save the cost of a third power amplifier, they often connect the center speaker across the stereo power amplifier as in Fig. 1.

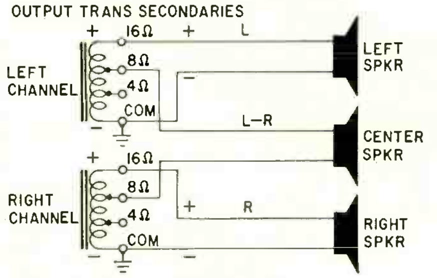


Fig. 1—Connecting center speaker to conventional power amplifiers can result in difference signal.

Unfortunately, this setup feeds a *difference* signal instead of a *sum* signal to the center speaker. Sometimes the difference signal produces results just as satisfactory as those we get from a sum signal. Often, however, the difference signal is unsatisfactory. This is apt to happen when a center microphone is used in recording and its output is fed in equal amounts to the left and right channels. Then the difference signal cancels the center sound.

To circumvent this problem, a number of stereo power amplifiers are now wired as in Fig. 2. The 4-ohm tap of each output transformer is connected to ground. Electrically, the 4-ohm terminal is the center tap of the secondary winding, so the output transformer is operated as a push-pull device. By connecting the center speaker to the 16-ohm tap of one output transformer and the common tap of the other, we get a sum signal.

It is possible to rewire conventional power amplifiers to operate as in Fig. 2. However, the values of the feedback network have to be adjusted to maintain the same amount of feedback as before the rewiring. This must be done on the basis of keeping the amplifier's gain

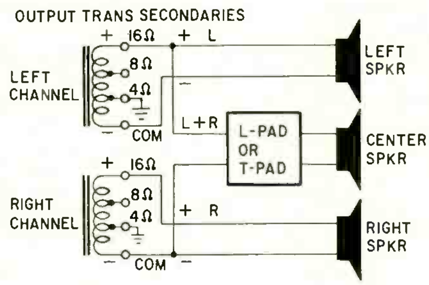


Fig. 2—Wiring a stereo power amplifier to produce a sum signal for the center speaker.

the same as it was prior to the changes. An audio oscillator and a vtvm are needed to measure gain.

For those using conventional power amplifiers for stereo, there is a much easier solution than rewiring the amplifiers, if their stereo preamplifier has a phase-reversal switch, as many do nowadays. This solution is illustrated in Fig. 3.

The phase reversal is only in one channel, let us assume the right one. When the phase switch is in its reverse position, the output of the right power amplifier is out of phase with that of the left. Therefore a sum signal is obtained when the center speaker is connected to like terminals on the two power amplifiers (for example, to the 8-ohm taps).

Because the right amplifier is out of phase, the leads to the right speaker must be reversed, as shown in Fig. 3.

If the left and right speakers are connected to the 16-ohm terminals, it is advisable to connect the center speaker to the 8-ohm taps to get reduced output from the center speaker. If all three speakers have the same efficiency, the center one will have 3 db less output than the others, which is just about right for three-speaker operation. Operating the center speaker at a slightly lower level than the end ones maintains sound at the left and at the right, instead of tending to focus it all toward the center.

In a similar fashion, if the end speakers are operated from the 8-ohm taps, connect the center speaker across the 4-ohm taps.

If the center speaker's efficiency is not the same as that of the end speaker's, adjust the relative volume of the center speaker by operating it through an L-pad or T-pad.

The "easy solution" presented here requires only a few minutes to hook up a center speaker. Quite possibly you have an extra speaker in the house. Or you may be able to borrow a bookshelf type speaker for several hours from a friend. With this speaker, a few feet of wire and an investment of a little time, you can find out for yourself whether three-speaker stereo enhances your enjoyment. END

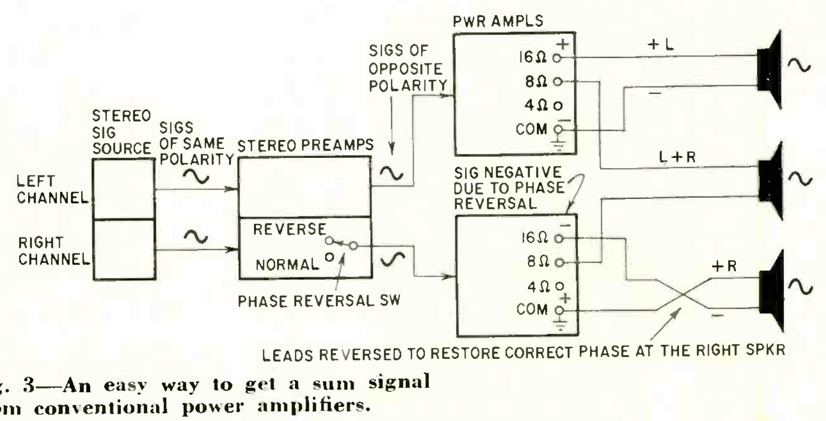


Fig. 3—An easy way to get a sum signal from conventional power amplifiers.

A practical tester FOR ELECTROLYTICS

By
H. B. CONANT *

THE best test for any product is one which evaluates its ability to do the job for which it was intended. Therefore any good test method must simulate some typical operating condition of the product under test.

In its most common function as a power supply filter, the electrolytic capacitor receives current pulses from a rectifier. It stores these for delivery to the dc load circuits during the intervals between rectifier pulses. The rectified ac is thus smoothed to a continuous direct current—if the capacitance is large enough, or if several filter sections are used.

If there is too little capacitance, some of the rectifier pulses remain superimposed upon the dc output of the filter and produce what is known as "ripple." (Ripple is proportional to current drawn by the dc load and inversely proportional to the capacitance of the filter capacitors.)

The test circuit shown places the capacitor under test in typical service where it receives current pulses through the 1N2069 silicon rectifier. Between pulses it partly discharges through the 30,000-ohm load resistor or through about 1,400 ohms when the 1,500-ohm resistor is switched in parallel. With no capacitance connected to the test terminals, ripple voltage is 100% so the meter is set to 100% or full scale with potentiometer R4.

Any capacitance across the test terminals will tend to filter the rectifier output, thereby reducing the ripple voltage and the meter reading.

* Conant Laboratories, Lincoln, Neb.

The 30,000-ohm load resistance provides a range of .03 to 6 μf and with the 1,500-ohm load in parallel, the range is 0.3 to 60 μf. Obviously, an open capacitor will not drop the meter reading; with a shorted capacitor, the meter will read zero. The reading will also be zero if an electrolytic is connected backward. The capacitor can also be damaged. Therefore mark the test terminals prominently to indicate polarity.

Circuit considerations

The meter circuit shown is a full-wave bridge rectifier type ac voltmeter fed through a .04-μf capacitor so that it reads only the ripple voltage. A 100-μa meter was used although any meter up to 1 ma can be used by changing values of capacitance and resistance to suit. The meter rectifier is a Conant catalog No. 1101 selenium bridge, selected both for economy and relative freedom from temperature effects, plus its suitability to this kind of circuit.

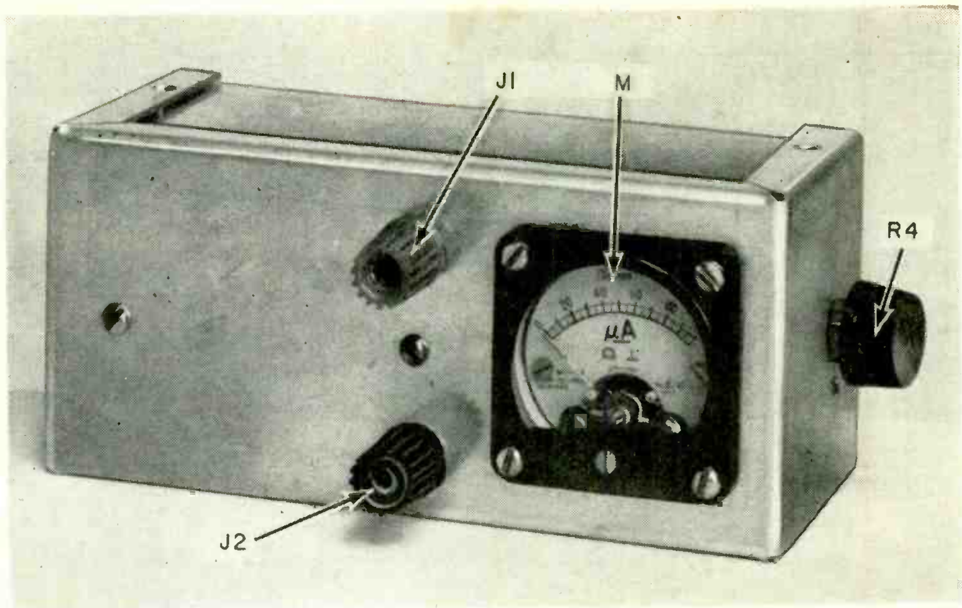
Transformer T is principally used for isolation from the line to avoid "fireworks." It is a small power transformer, rated at 117 volt primary and 125 or 150 volts secondary, and is attached with the secondary to the line. Its secondary (original primary) may deliver anything between 75 and 125 volts and should be rated 50 ma or more. If secondary voltage is greater than 75, the silicon rectifier should be a 1N2070.

Control R4 should be of the lowest resistance which in combination with fixed resistor R5 will permit setting the meter to full-scale on either range and on all line voltages likely to be present. As a suggestion, a 1,000-ohm control may be tried, with 1,000 ohms for the value of R5. If the meter won't come up to full scale, increase the value of R5. Reduce it if the meter can't be brought down to full scale. [Note that .01 μf was used for C and 470 ohms for R5 in making the measurements for the table shown here.—*Editor*]

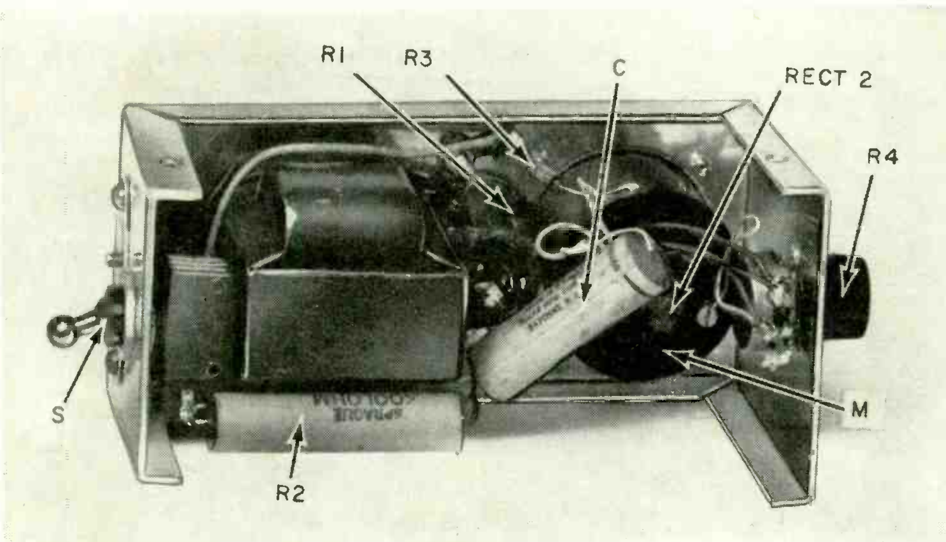
Calibrating the meter

Calibration will be simplified if the meter scale is calibrated 0–100, representing for calibration purposes 0–100% ripple. As there is a broad capacitance tolerance in commercial electrolytic capacitors, they cannot be used to give precise calibration, but may be close enough for practical use. Exact percentage of ripple depends upon the exact values of the load resistors.

After the tester is built, if possible borrow a pair of precision capacitance standards, say 1 and 10 μf, and find where they read on the two respective ranges. Assuming that each reads 30%

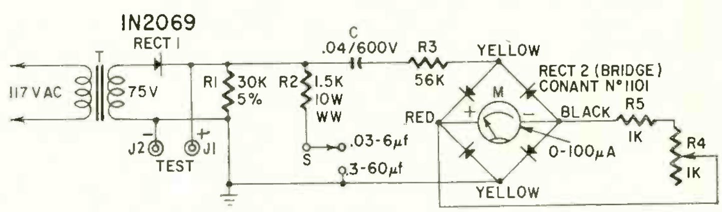


The practical capacitor tester.



Capacitor checker, internal view.

The tester measures ripple voltages. Thus the larger capacitances read lower on the meter scale.



METER READING vs CAPACITANCE

High Range		Low Range	
Meter	*μf*	*Meter*	*μf*
4	60	6	8
12	20	10	4
25	10	33	1
70	4	58	0.5
88	2	72	0.25
95	1		

The above readings were made by Mr. Queen of the *Radio-Electronics* staff. C was .01 μf and R5 470 ohms in his setup.

R1—30,000 ohms, 5%, ½ watt
R2—1,500 ohms, 10 watts, wirewound
R3—56,000 ohms, ½ watt
R4—1,000 ohms, pot (see text)
R5—1,000 ohms, ½ watt (see text)
C—.04 μf, 600 volts paper (see text)
RECT1—1N2069 or equivalent, see text
RECT2—meter rectifier, bridge type (Conant No. 1101, or equivalent)
S—spdt toggle switch
M—meter, 0–100μa, see text
T—transformer, see text (Stancor PA-8241 or similar type)
J1, 2—jacks or binding posts
Case, cord, miscellaneous hardware.

ripple on their respective ranges, then 0.5 μf and 5 μf will read 60%, 4 and 40 μf will read 7½%. Doubling the capacitance halves the ripple voltage. The response of the ac meter is essentially linear except at the extreme low end of the scale, so calibrations at the very low end will be only approximate.

Quality control

While this tester measures capacitance in terms of ripple voltage, its indications do tell whether a given capacitor is good or bad. For example, let us say an 8-μf capacitor reads 4 μf. Obviously it does not reduce the ripple voltage as well as 8 μf should, so it should be replaced.

Subject to small errors introduced by associated circuitry, this tester is practical for in-circuit testing. But don't try testing capacitors rated at less than 150 volts. And don't put it into transistor gear unless you want to ruin low-voltage components. END

BENCH TESTED

Specifications: Checks all capacitors from approximately .05 to 60 μf. Can be used for in-circuit testing in many circuits.
Performance data: Tested by a RADIO-ELECTRONICS staff member, this capacitance checker was found to work reliably, and to be a simple, accurate and useful instrument.

NEW stereo PICKUPS

Part II—The Grado Master, Neumann DST Dynaco TA-12, G-E VR-22, London-Scott 1000

By JULIAN D. HIRSCH

IN pre-stereo days, many of the finest phonograph cartridges used a moving coil as their generating element. Although moving-coil cartridges in general have lower output voltages and tend to be more fragile than other types, their lower impedance makes them relatively immune to induced hum (from nearby phono motors or power transformers) as well as to the shunting effects of cable capacitance at high frequencies.

At present, there are few moving-coil stereo cartridges. Two of these, both of very high quality, are the Grado and the Neumann.

Grado

The original Grado stereo cartridge (now called the Master) was described in RADIO-ELECTRONICS (November, 1958, page 88). Current production models of the Grado Master, though similar in construction to the unit described in the earlier article, have been further refined. The two coils, each of 1,000 turns of extremely fine wire, are wound on a hollow plastic cube approximately 1/16 inch square, which is molded in one piece with the stylus arm (Fig. 1). The coil assembly is mounted in a special rubber grommet which provides uniform compliance in all planes.

The coils are located in a uniform field supplied by a powerful permanent magnet. When the coil structure rotates, a voltage is generated in each coil (proportional to the recorded velocity in the corresponding channel).

The new Master cartridge has an output of 6 mv at 10 cm/sec. The effective stylus mass has been cut in half, from 0.8 to 0.4 milligram, which, in turn, extends the high-frequency response of the cartridge. The manufacturer's specifications for frequency response are 10–50,000 cycles (with no tolerance specified).

In other respects, the present Grado Master cartridge is identical to the earlier models. The two outputs are balanced to within 0.5 db over the audio range. Recommended tracking force is 3 grams and the load resistance is noncritical so long as it is greater than 5,000 ohms. Channel separation is greater than 25 db. A tiny radioactive element embedded in the case of the cartridge behind the stylus ionizes the air in the vicinity of the record surface. Static charges are reduced and so is the amount of dust that accumulates on the record.

The Grado Custom stereo cartridge is a less expensive version of the Master for use in record changers. Its coils are wound with more turns of slightly heavier wire. The output, therefore, is greater than that of the Master series —approximately 7 mv at 10 cm/sec.

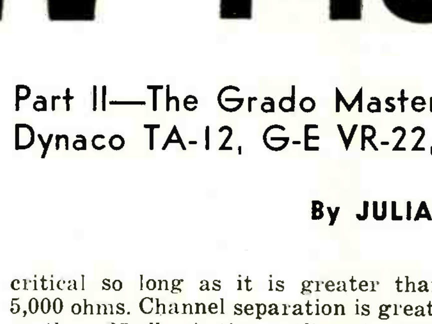


Fig. 1—The coil bobbin and stylus arm of the Grado Master are one piece.

The effective mass at the stylus is 0.6 milligram (reducing the claimed upper limit of frequency response to 40,000 cycles). Channel separation is in excess of 20 db. In all other respects, the Grado Master and Custom cartridges are similar.

The Grado Master cartridge is priced at $49.50 and the Custom at $32.50.

Neumann DST

The Neumann DST stereo cartridge is the product of a West German manufacturer of professional-quality microphones (sold in this country under the names of Telefunken and Neumann). It is imported by Gotham Audio Sales Co., 2 W. 46 St., New York 36, N. Y.

The Neumann cartridge is a moving-coil type with a tubular torsion bar mounting the stylus at one end and the two generating coils at the other end. The entire stylus bar is covered by a thin rubber membrane (visible in the photo). This membrane serves a triple purpose: It keeps dust and foreign matter from entering the cartridge, protects the delicate moving system from damage and provides a slight amount of stylus damping. Only the stylus jewel protrudes from the rubber membrane.

The impedance of the DST cartridge is extremely low—about 18 ohms—and it will work satisfactorily into any load impedance greater than 50 ohms. The output is correspondingly low, 1.05 mv at 7 cm/sec. This makes a stepup input transformer a virtual necessity. Gotham offers the Beyer TR147C transformer which has a 15-to-1 stepup ratio and a response from 30 to 20,000 cycles within 1 db. Two are needed for stereo operation.

The frequency response of the Neumann DST cartridge is 30 to 15,000 cycles ±2 db. Channel separation exceeds 30 db at mid-frequencies (1,000 to 3,000 cycles) and is better than 12 db at 10 kc. The stylus-system compliance is 3.6×10^{-6} cm/dyne. The recommended tracking force is 4 grams and the stylus is a diamond with a 0.6-mil tip radius.

The DST is designed to fit arms having the plug-in connection used on some professional European equipment. Typical arms are the Neumann TA-2 or the Danish Ortofon (known in this country as the ESL Professional).

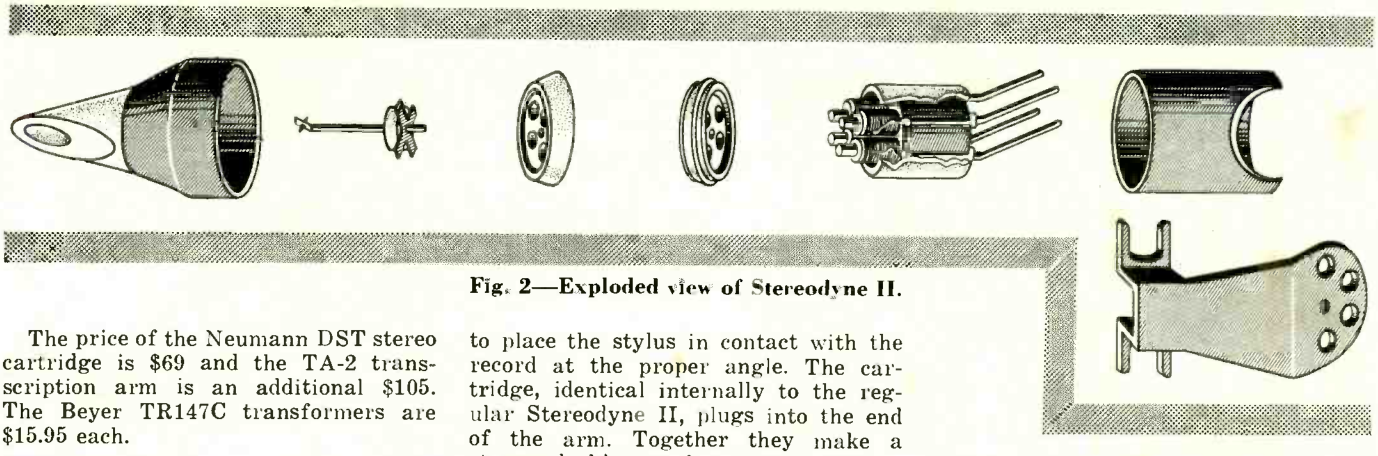


Fig. 2—Exploded view of Stereodyne II.

The price of the Neumann DST stereo cartridge is $69 and the TA-2 transcription arm is an additional $105. The Beyer TR147C transformers are $15.95 each.

Variable reluctance

The variable-reluctance principle (pioneered by General Electric in its early monophonic pickups) is still widely used in stereo cartridges. In a variable-reluctance cartridge, a fixed magnet supplies a magnetic field which links two or more fixed coils (in a stereo cartridge). An air gap is built into the magnetic circuit and the stylus moves an iron armature to vary gap width. This causes a change in *reluctance* (the magnetic equivalent of electrical resistance). The flux variation through the coils generates a voltage proportional to the stylus velocity. Thus, the name—variable reluctance.

Dynaco TA-12

The Dynaco B&O Stereodyne II cartridge is virtually identical to the one described in RADIO-ELECTRONICS, March, 1959, page 83. It has four coils and four pole pieces arranged to form a square (Fig. 2). The stylus moves an X-shaped armature, varying the flux to the two coil sets.

The chief changes in the present Stereodyne models have been to improve the stylus-system damping. The same basic cartridge, however, has been incorporated into an interesting integrated pickup design known as the TA-12.

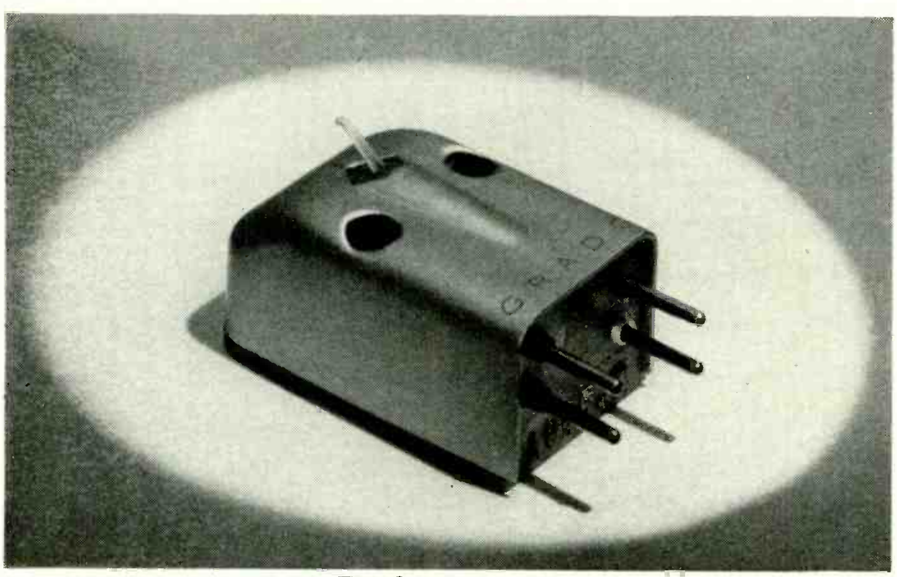
The arm is tubular with the front portion angled downward and inward to place the stylus in contact with the record at the proper angle. The cartridge, identical internally to the regular Stereodyne II, plugs into the end of the arm. Together they make a strange-looking combination.

The pivot design of the Dynaco arm resembles the gimbals used to support the rotor of a gyroscope. The inner ring is pivoted at top and bottom to allow lateral arm motion while the arm itself is pivoted from the sides of the inner ring for vertical motion.

The counterweight at the rear of the arm exactly balances the cartridge and is offset to the side opposite to the head offset. As a result, the arm (being fully balanced) is not affected by a turntable that is jarred or is not level. The downward tracking force is derived from a spring whose tension is adjusted by sliding a plastic collar along the arm. Calibration lines indicate stylus force (from 1 to 4 grams). The manufacturer recommends a force of 2 to 3 grams, which is enough for most installations.

The cartridge leads run through the pillar supporting the pivot assembly and are fully shielded. Since the cartridge is encased in Mu-metal, the result is a very low hum level.

The frequency response of the Dynaco TA-12 is rated at 30 to 15,000 cycles ±3 db. The output voltage is 7 mv per channel at 5 cm/sec. The compliance is 5×10^{-6} cm/dyne in all directions due to the symmetrical design of the cartridge. The moving mass is less than 3 milligrams. Recommended load resistance is 47,000 ohms.



The Grado Custom.

Price of the Dynaco TA-12 integrated stereo pickup is $49.95.

G-E VR-22

The VR-22 is the improved version of the G-E model GC-5 and GC-7 stereo pickups (RADIO-ELECTRONICS, October, 1958, page 49). In all fundamental respects, the new cartridge is identical to the original version.

The VR-22 series is available in two models, the VR-225 with a 0.5-mil diamond stylus for quality pickup arms and the VR-227 with a 0.7-mil stylus for record-changer operation.

The stylus assembly of the VR-22 cartridge has been improved—a new damping-block design improves tracking of high-level passages. Mu-metal shields around the top and front of the cartridge, as well as the coil assembly, minimize hum pickup.

Most of the performance specifications of the VR-22 are identical to those of the original Golden Classic cartridges. A notable improvement has been made in channel separation (which is as great as 30 db at mid-frequencies) and in channel balance. The outputs of the two channels are within 1 db of each other at 1,000 cycles and are closely matched over the entire frequency range.

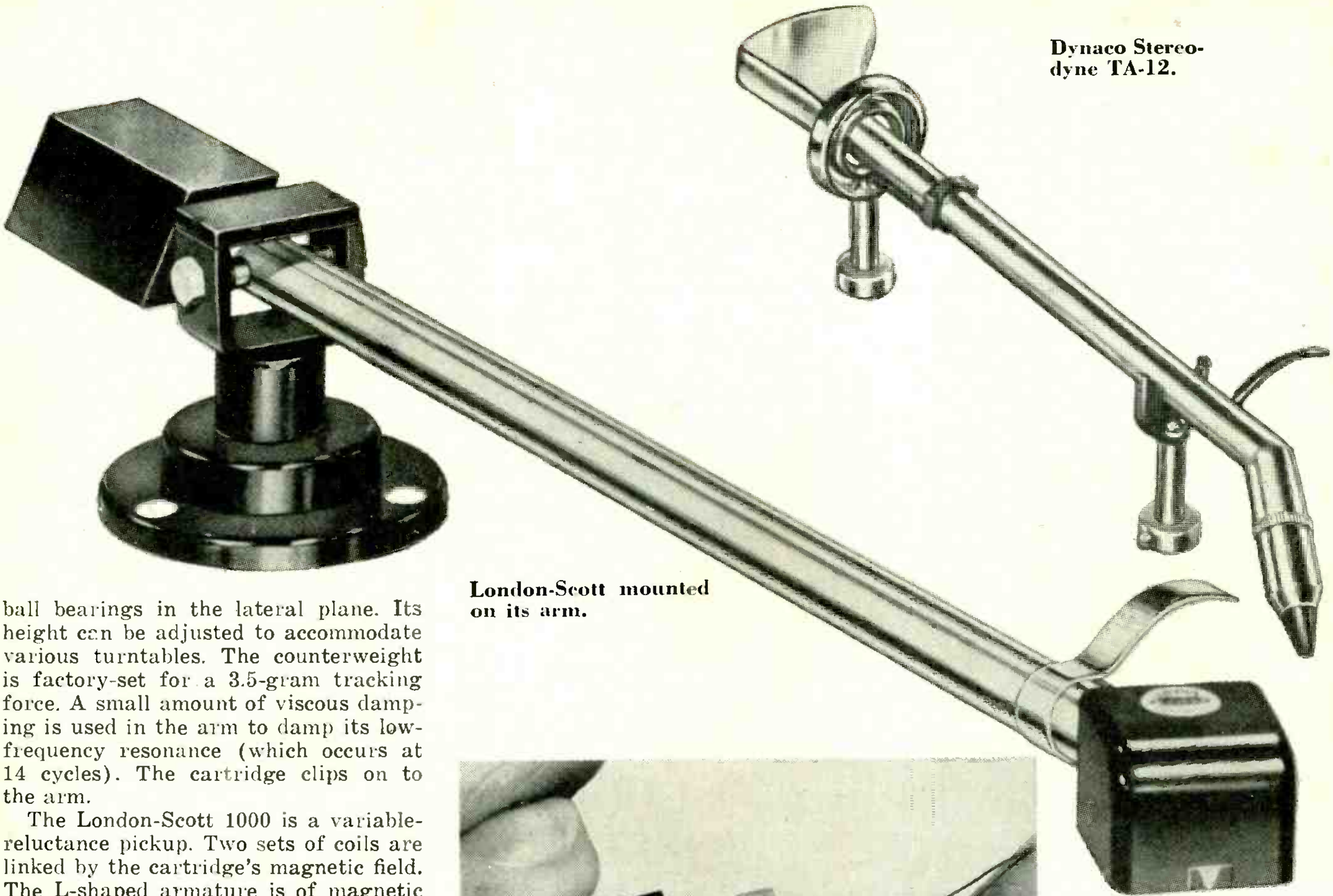
The response of the VR-225 is rated at 20 to 20,000 cycles ±3db, and the VR-227 at 20 to 17,000 cycles ±3 db. The output of both cartridges is 6 mv per channel at 5 cm/sec. The lateral and vertical compliances of the VR-225 are 4×10^{-6} cm/dyne and 2.5×10^{-6} cm/dyne respectively. For the VR-227, the compliances are 3×10^{-6} cm/dyne and 2×10^{-6} cm/dyne. Recommended tracking forces are 2 to 4 grams for the VR-225, and 5 to 7 grams for the VR-227.

The price of the VR-225 is $27.95; the VR-227, $24.95.

London-Scott 1000

In an earlier article (RADIO-ELECTRONICS, November, 1958, page 83), the London-Scott 1000 integrated pickup was described briefly. It had just been introduced and only sketchy information was available. This British unit is unique in being a true vertical–lateral pickup instead of the 45-45 type we are accustomed to.

The arm is anodized aluminum with needle type pivots in the vertical and



Dynaco Stereo-dyne TA-12.

London-Scott mounted on its arm.

ball bearings in the lateral plane. Its height can be adjusted to accommodate various turntables. The counterweight is factory-set for a 3.5-gram tracking force. A small amount of viscous damping is used in the arm to damp its low-frequency resonance (which occurs at 14 cycles). The cartridge clips on to the arm.

The London-Scott 1000 is a variable-reluctance pickup. Two sets of coils are linked by the cartridge's magnetic field. The L-shaped armature is of magnetic material and forms a part of the magnetic circuit for both sets of coils.

Fig. 3 is a simplified sketch of the pickup. The complete magnetic structure, including pole pieces, is not shown. The single lateral coil and two vertical coils are identical, so that a given

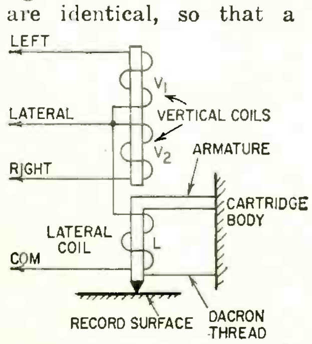
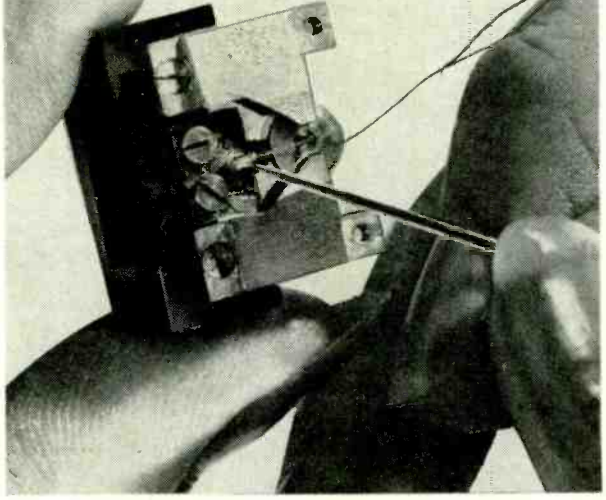


Fig. 3 — Interior of the London-Scott 1000 showing coil connections.

stylus velocity in the appropriate plane will generate the same voltage in its corresponding coil. The two vertical coils are connected in opposition with their junction connected to one side of the lateral coil. The other end of the lateral coil serves as a common output lead for all signals.

A purely lateral motion of the stylus will induce a voltage in the lateral coil, but not in the vertical coils. Under these conditions, the same output voltage will appear at all three output terminals (LEFT, RIGHT and LATERAL). On the other hand, a purely vertical stylus motion will not generate a voltage in the lateral coil, but will develop equal and opposite voltages in the two vertical coils.



Drop of cement is used to fasten the Dacron thread to the London-Scott cartridge body.

General Electric VR-22.

In stereo operation, with the 45-45 system of recording, modulation of one groove wall will generate equal voltages which may be called L, V_1 and V_2. Measured between the common lead and the left-channel output (assuming common and right-channel outputs will appear ($L - V_2$) or zero volts. This electrical matrixing converts the vertical–lateral coil outputs into equivalent channels of a 45-45 system.

In this type of cartridge, it is not necessary to parallel the left and right outputs to cancel vertical output when playing monophonic records. The output is taken from the lateral coil only and the vertical output is ignored.

Neumann DST showing membrane.

A Dacron thread is shown in Fig. 3. This is needed to restrain the stylus motion on the longitudinal axis (due to frictional drag on the record surface). It has no effect on the vertical or lateral motion of the stylus.

A bottom view of the cartridge, uncased, is shown in one of the photographs. The lateral coil is visible and the two vertical coils are hidden. The pole pieces direct the magnetic field through the coils, via the armature, which can be seen protruding (tip down) through the coil bobbin. The Dacron thread can also be seen.

The stylus-assembly compliance is in the order of 3.5×10^{-6} cm/dyne. The moving mass has been reduced to a very low value, less than one milligram. This places the high-frequency armature resonance well above the audio range and results in smooth response from 20 to 20,000 cycles. Output is 4 mv per channel. Channel separation is better than 25 db at mid-frequencies. The stylus has an 0.5-mil tip radius.

The London-Scott 1000 stereo pickup sells for $89.95 complete with arm rest, cables and hardware. TO BE CONTINUED

"TRIPLETS, MADAME"

Doctors can now say it will be triplets or twins, or just a single baby, if encephalographs are taken during the expectant mother's fifth, sixth or seventh month. Research described in the *Journal* of the American Medical Association revealed that accurate diagnosis of the number of tiny hearts beating can be made during that period, with less certain determination earlier. Naval doctors C. A. Novotny, W. K. Hass and D. A. Callagan did not say they could tell if the babies would be boys or girls!

DUO-JUNCTION

By I. QUEEN
EDITORIAL ASSOCIATE

IF you read Garner's article* on the G-E Unijunction transistor or other literature on this remarkable device, you know how useful and versatile it is. On the other hand, if you read the latest parts catalogs, you probably know that the Unijunction sells for about $15. Though well worth its price (it's made of silicon and dissipates nearly 500 mw), it is beyond the financial reach of many experimenters.

It is not generally known that 2 junction transistors can be directly coupled to show results like those of the Unijunction. For want of a better name, I have dubbed it the "duo-junction." For more theory and schematics on the two-transistor combination, consult *The Junction Transistor and Its Applications* (The Macmillan Co.), edited by E. Wolfendale, page 292. Also refer to the patent column, page 117 of this issue.

Fig. 1—Unijunction operating curve.

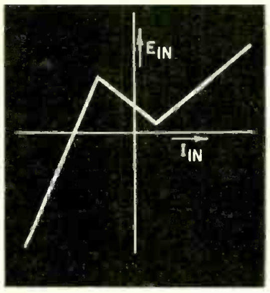
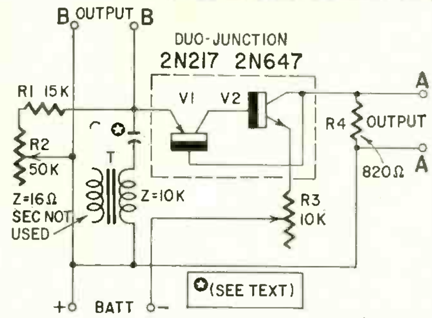


Fig. 2 (below)—Two-transistor duo-junction circuit.



R1—15,000 ohms
R2—pot, 50,000 ohms
R3—pot, 10,000 ohms
R4—820 ohms
All resistors ½-watt 10%
C—see text
BATT—1.5 or 3 volts
T—output transformer: primary 10,000 ohms; secondary, 16 ohms (UTC SSO-9, 6V6 output transformer or equivalent)
V1—2N217 or 2N109
V2—2N647 or 2N169
Battery holder
Plastic board
Miscellaneous hardware

Briefly, the Unijunction is a three-lead transistor with a negative-resistance N-shaped characteristic (Fig. 1). Thus it is a natural oscillator and requires few parts to generate pulse, sawtooth or square waves. Not having a Unijunction here, I set up the two-transistor "duo-junction" and found it gives excellent results.

The duo-junction requires a complementary pair of transistors—one p-n-p and the other n-p-n. A recently announced pair, the 2N217 and 2N647, is suitable. After considerable experiment, I found Fig. 2 an efficient circuit for square-wave generation. Waveform is excellent. With a .01 unit for C, the frequency is about 1,200 cycles. With a larger capacitor, the frequency drops. Use about 0.2 μf for 40 cycles.

For the transformer I used a tiny SSO-9 (UTC). A 6V6 output transformer also served well here.

In Fig. 2, R1 limits the emitter current. Potentiometer R2 adjusts the wave's symmetry and stability, and also varies frequency to some extent. R3 is variable and adjusts amplitude. If R3 is set too high or R2 too low, oscillations tend to cease abruptly. They resume when these controls are reset properly or if the battery circuit is opened and closed again.

For pulse generation, a simpler circuit is sufficient. The transformer may be shorted out since it is not needed. The same output terminals (A–A) are used as before. The waveform is now identical with that shown in Fig. 3. Pot R2 controls frequency over a very wide range.

For sawtooth generation, again short out T, but use the B–B output terminals. The resulting waveform will be identical with that shown in Fig. 4.

The experimental square-wave generator is assembled on a 2¼ by 4¾-inch baseboard of heavy perforated plastic (made by Vector). Both transistors are plugged into the same seven-pin in-line socket. The center pin is not used.

The duo-junction seems to be a good substitute for the Unijunction in many respects. Of course, it is not equal in power dissipation or temperature tolerance. Why not connect up one of these circuits and give it a try? END

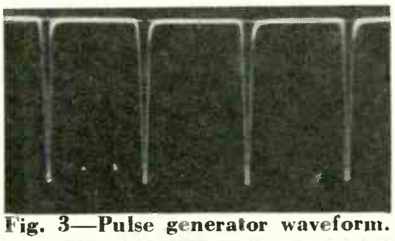


Fig. 3—Pulse generator waveform.

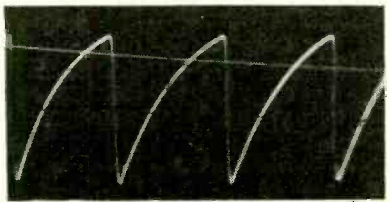
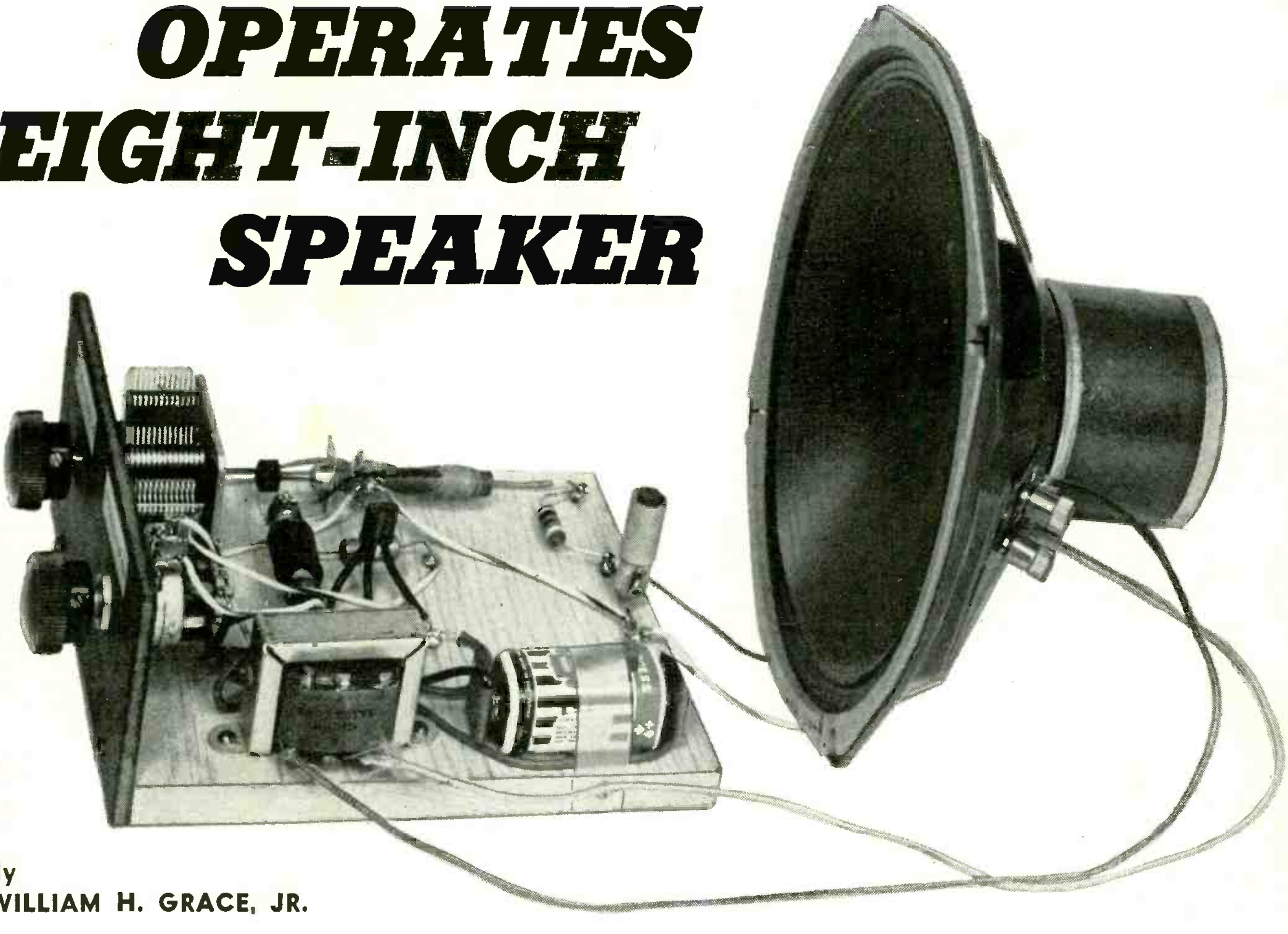


Fig. 4—Sawtooth generator waveform.

*July, 1957, page 91.

SINGLE TRANSISTOR

OPERATES EIGHT-INCH SPEAKER



By
WILLIAM H. GRACE, JR.

Breadboard model of receiver next to 8-inch speaker. Unit is quite small even though parts are spread out.

One transistor and a diode using Interflex principle result in good tone quality and volume

THERE is no gimmick in the title—this simple little single-transistor radio has been tested in various localities and has repeatedly given a good report of itself. Tone quality is excellent and volume is truly surprising for the few components employed.

An efficient outside antenna and a good low-resistance ground *must* be available for loudspeaker results as there is no provision for rf amplification in the circuit. An antenna about 75 to 100 feet long plus a waterpipe ground makes a combination that gives adequate volume for a large-sized room (within about 15 miles of local broadcasting stations). Actual antenna size will depend upon location and the field strength of signals in a given area. For example, 18 miles north of New York City, a 60-foot flattop brings in eight locals with fine quality and volume. In the uptown region of the city, a 45-foot length of lamp cord dropped out a window of a tall apartment house picked up 10 stations. Reports on the basic circuit from Richmond, Va., and the Chicago area were also favorable.

Circuit history

The schematic shows the two parts of the circuit. The first is the tuned or resonant section; the second is the detector–amplifier or output section. There is only a single connection, a small coupling capacitor, between them. No ground return is provided as none is required. While this system may appear unconventional to some readers, it is not a new idea and was often used in the days of spark in standard wavemeters and receiving circuits. It is a most effective method of coupling and was chosen in this case for simplicity.

The detector-diode is connected direct to the base of the transistor without any series capacitor. This is not a new idea either. The Interflex principle was introduced by Hugo Gernsback, the editor of this magazine, some 35 years ago. He suggested in 1925 that a crystal detector be substituted for the conventional grid-leak-and-capacitor combination used in De Forest tube circuitry for improved quality and superior gain over that of existing circuits. He developed the ingenious Interflex receiver which many of the old-timers will recall building in the early 20's. The writer himself built such a receiver in 1926 and was favorably impressed with the results obtained with a single tube.

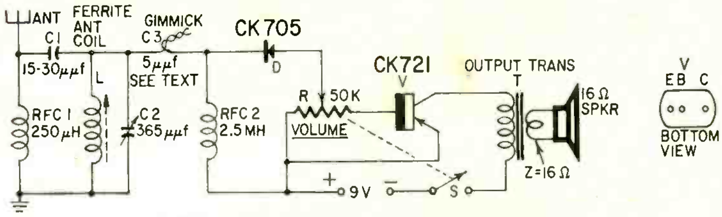
Shortly after the debut of transistors, the Interflex was adapted to use with both the point-contact and junction type transistors and the August, 1955, RADIO-ELECTRONICS (page 54) printed an article on it. The circuit became a popular one and is widely used today in various applications—receivers, field-strength meters and, in modified form, in certain TV video-detector–amplifier circuitry. All present transistor circuits in which a diode replaces the usual base series capacitor are, of course, merely transistor adaptations of the original Interflex idea.

Construction

The receiver may be assembled in any way the builder elects. The author has constructed both breadboard and miniature versions with equally good results. It is easy to house the small number of parts in a case whose dimensions are slightly less than those of a postcard. No socket is required for the transistor because the adjacent parts provide sufficient support. Wiring is done with No. 18 copper wire, either solid or stranded. The soldered joints must be made with care so that cold joints will not cause trouble later.

Parts assembly is not difficult; the order closely follows that shown in the circuit diagram. The front panel is drilled for mounting the volume control and tuning capacitor (and output jacks if desired). The first rf choke (RFC1) is soldered directly to the antenna and ground terminals. If the set tunes broadly after all other adjustments have been made, reverse RFC1's connections. On the breadboard model (shown in the photographs), the battery is held in place by a plastic strap and a piece of sponge rubber.

Try different values for C1 to find the best compromise between good volume and desired selectivity. Somewhere between 15 and 30 μμf would be a good working value to try out first. If you have a small air trimmer on hand, wire it into the circuit to give an approximate idea of the value required. Substitute a fixed capacitor of the same size in the finished rig. C3, also a very small capacitor, serves as the only coupling link between the resonant section of the receiver and the detector–amplifier section. The exact value is again a compromise between volume and selectivity—too large a value will broaden the tuning; too small a value will diminish volume. A starting value of about 5 to 10 μμf is a good beginning to work from. I solved the problem by twisting together about 2 inches of No. 18 solid enamel-covered wire and



Schematic of single-transistor receiver. A good external antenna is required.

R—pot, 50,000 ohms with switch
C1—15 to 30 μμf, ceramic, see text
C2—365 μμf, variable
C3—5 μμf (approximately), see text
L—loop antenna, ferrite core
RFC1—250 μh, see text
RFC2—2.5 mh
D—CK705 (or 1N34 or equivalent)
V—CK721
T—output transformer, see text
S—spst switch on R
BATT—9-volt battery (Burgess P6M or equivalent)
Speaker, 8 ohms, see text
Miscellaneous hardware, knobs (case or board and panel, depending on size desired)

then clipping off ¼-inch lengths until the best value was found. This completes the front end.

One end of the second choke RFC2, is connected to the lower end of the volume control; the other end to the junction of C3 and the diode. Various diodes were tried, but the CK705 did as good a job as any tested. A 1N34 is also suitable. The volume control may be of almost any value between 25,000 and 200,000 ohms, but be sure it has an attached switch to turn off the battery when the set is not in use. If you are in an area of low field strength, the volume control may not be needed. But, as this receiver is designed to function in areas of medium to high field strength, the volume control is an asset.

The transistor is a Raytheon p-n-p junction type, the CK721. Many others (2N106, 2N109 and 2N64) were found satisfactory with the exception of the CK722. An n-p-n transistor may also be employed in this circuit, but the polarity of the diode (and battery) must be reversed. If the diode polarity is not correct, the circuit will not function.

In the miniature version, the output transformer was mounted inside a separate speaker case to reduce the space needed in the receiver case.

Speaker selection

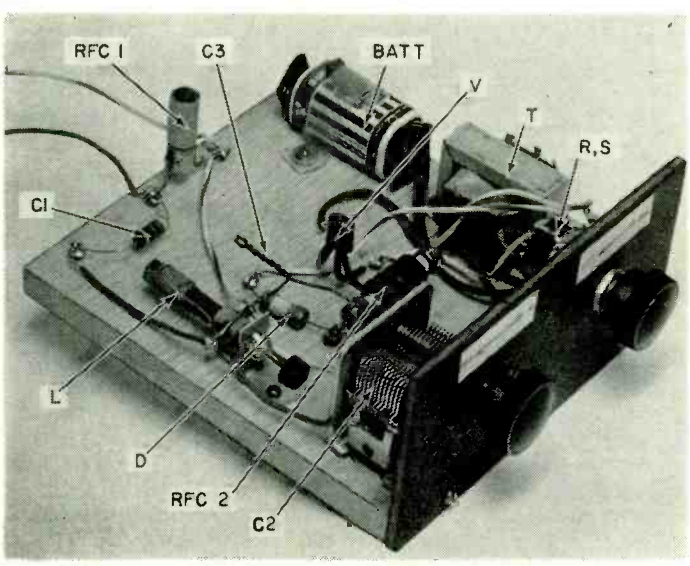
Naturally, the actual output of a single-transistor receiver is but a few milliamps. Therefore it is very important to use a good output transformer and sensitive PM speaker. The very small output transformers are not suitable for use with this circuit and much better results will be obtained from one of the universal types such as the Stancor A-3856 or the Lafayette TR-12.

Proper impedance matching is most important for both volume and voice quality. The speaker should have a heavy magnet and high efficiency in converting the available electrical energy into sound. Several high-quality units were tested with excellent results when installed in an acceptable enclosure, but good PM units and baffles are expensive. After a search for a combination that would deliver the goods without being too expensive, the Lafayette SK-130 was chosen. Mounted in a Karlson 8-inch enclosure, it gave results equal to some units costing several times as much. This is a British speaker with a magnetic flux density of 13,000 gauss and a 1-inch-diameter voice coil. Its impedance is 16 ohms and could be well matched with either output transformer mentioned above. The Karlson baffle is one of the better enclosures tried by this author. However, any good PM unit in a correctly designed baffle should produce good quality and volume with this tiny receiver.

It being a very simple circuit, not many things can go amiss, but any experienced builder knows that errors do creep in once in a while. It often takes as much know-how to get the most from a very simple receiver as it does from much more complicated rigs. A small loss of efficiency in complicated jobs is seldom apparent but, in receivers with low audio output, even a little loss is too much.

It is a wise move to place a meter in the collector circuit when a strong signal is being received and check the current drain. Readings of 10 to 20 ma are common, but it is desirable to limit the current to about 10 or 15 ma with the volume control under average operating conditions. The set has been run for periods well over an hour at better than 20 ma with no damage to the transistor.

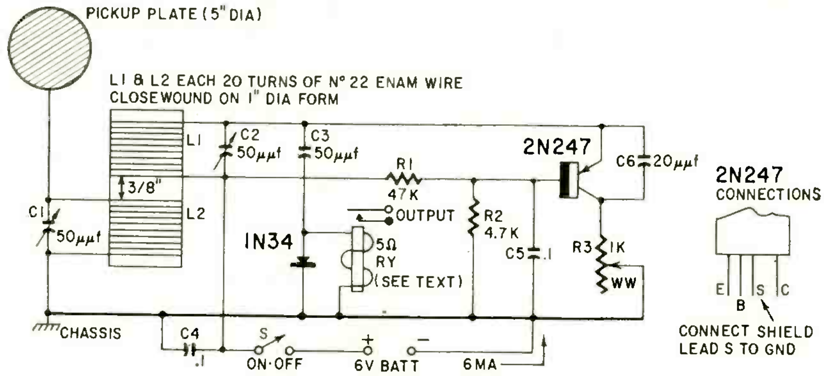
The constructor may experiment with voltages higher than the 9 volts used by the author as long as the transistor specifications are not violated. I used 15 volts in some tests with an increase in volume, but transistors can be ruined



Breadboard model of single-transistor unit. Notice the "gimmick" capacitor, C3.

TRANSISTOR CAPACITANCE RELAY

THE accompanying schematic shows a capacitance (proximity) relay employing a single transistor and operated from four flashlight cells. This device has sufficient sensitivity for use as a crowd stopper when the pickup plate is cemented inside a store window and a looker's hand is held opposite it on the outside of the glass.



One-transistor capacitance relay is easy to build.

The two coils, L1 and L2, are closewound on the same 1-inch-diameter form with ⅜-inch separation between coils. C1 and C2 may be either miniature variable air capacitors or compression type trimmers. C4 and C5 are paper, and C3 and C6 may be either mica or ceramic. R1 and R2 are ½-watt resistors, and R3 is a 1,000-ohm wirewound rheostat. The pickup plate may be cut from sheet metal or metal foil. The relay is a surplus 1-ma 5-ohm meter type unit (Triplett meter type sensitive relay) obtainable from Blan the Radio Man, 64 Dey St., New York, N. Y., for $7.90. The nearest commercial equivalent is Barber-Colman type AYLZ 4524S (13 ohms, 1.7 ma). Note: the Triplett unit's contacts are rated at only 50 ma and an additional relay may be needed.

To operate:

1. Close switch S.
2. Set C1 to minimum.
3. Set C2's plates about ¼ inch from minimum.
4. Adjust rheostat R3 to close the relay—do not have any part of your body near the pickup plate at this time.
5. Now tune C1 to open the relay completely. (C1 and L2 act as a wavetrap to absorb energy from the transistor oscillator tank, C2–L1.)
6. Now the device is ready for operation. If you bring your hand close to the pickup plate, the C1–L2 circuit will detune, oscillation will increase and the relay will close. When your hand is withdrawn, the trap again absorbs energy and the relay opens.—*Rufus P. Turner*

Single Transistor Operates 8-inch Speaker (continued)

if the ratings are exceeded so keep your meter at hand when conducting such tests.

Pseudo-stereo

One other item of interest with this receiver was the use of two PM units of different sizes spaced about 8 to 10 feet apart to get a pseudo-stereo effect. One unit was the SK-130 mentioned above and the other a 4-inch model with a fairly large magnet for its small diameter. It was mounted in a separate baffle box—a homemade affair from plywood, a la the Karlson design. As each unit has a noticably different frequency response, the highs seemed to be more evident from the smaller speaker and the lows from the larger. The sound was pleasant to listen to and gave the impression that horns and violins were on the left while the bull fiddles and drums were to the right.

Both speakers may be operated from a single output transformer, or separate transformers in series may be used. The actual sound output or volume seems to be somewhat more when two speakers are used, but this may be only an illusion.

If no suitable PM speaker (and well designed baffle) is at hand, the receiver may be constructed and then tested with a pair of high-impedance magnetic earphones instead. Insert phone tips in the output jacks or clip them across the output transformer secondary, turn the set to the ON switch position and check for proper operation and selectivity. If crosstalk is heard, it can be eliminated by reducing the value of C1 and C3. Remember that C3's capacitance may be lessened by snipping the open end with wire cutters.

If a PM speaker is added later, the values of C1 and C3 may have to be increased slightly over that found best for use on earphones to secure the best volume. Weak crosstalk is not heard on a speaker to the same degree as on phones.

Other factors that affect volume are the exact values of RFC1 and RFC2. The value of RFC1 will be found to be close to 250 microhenries for the antenna lengths suggested, but other values may well prove more effective for peaking the low-frequency end of the band with aerials of different length. If the builder wishes to get the maximum peaking action, a standard loop antenna may be substituted for RFC1. Set the tuning dial to a station in the vicinity of 550 kc, adjust the slug for best volume, then leave it alone.

The value of RFC2 was found to be between 2.5 and 5 millihenries for best results but lower values can be tried. Select the one that proves best. For some reason, not understood by the writer, certain rf chokes tested gave much better volume and selectivity than did others. Those with ceramic iron cores seemed somewhat superior. It may be due to differences in Q. Experimenting might prove advantageous.

The volume on earphones from a good local station should be on the uncomfortable side if the volume control is wide open when the set is working correctly. Such a signal on phones indicates that excellent loudspeaker results will be obtained. END

EDUCATIONAL TV ON TAPE

Fifty tape recorders is a lot of machines, and at almost $50,000 apiece, that's about $2,500,000. But 43 educational TV stations around the country will be getting video tape recorders from the Ford Foundation soon. The National Educational TV & Radio Center is presently checking recorders to decide what brand they'll use. Meanwhile Ampex reports that over 100 TV stations now have their video tape machines. There are also more than 100 Ampex video recorders overseas. Current production rate is two machines every day, and orders are stacked up for more than a hundred units ahead.

WINDING A TRANSISTOR-POWER-SUPPLY TRANSFORMER

By R. L. WINKLEPLECK

The high cost of special transformers need no longer stop you from building your own transistor power supply

TRANSISTOR converters of low-voltage dc to high-voltage ac (or dc) have many obvious advantages over the conventional vibrator type power supply. They're compact, have no moving parts and nothing to wear out. They introduce little or no noise into associated circuitry since the square-wave output is easy to filter, and they are very efficient when properly designed.

The wide selection of power transistors which combine relatively high alpha under load with comparatively low cost is rapidly sounding the death knell for vibrator power supplies.

The only serious drawback is the high cost of transistor power transformers, which must be correctly designed for high efficiency. This cost bottleneck can be eliminated by rewinding an old transformer from the junkbox. It is not claimed that such a rewound transformer is the full equal of the expensive commercial units. But it is possible to get fairly high efficiencies (with good design). This makes the home-rolled version very attractive if the thickness of your pocketbook is an important consideration.

Basic circuit

Fundamentally, a transistor power converter resembles a blocking oscillator or a multivibrator. The collectors of two transistors are connected to a center-tapped transformer primary. A feedback winding is connected to the two bases in such manner that the conducting transistor is biased forward and the nonconducting one cut off as long as current through half the primary winding continues to rise. This bias is maintained until the transformer saturates and can no longer supply the drive signal. At the instant of saturation, the base currents reverse. The conducting transistor now cuts off, and the other one is driven into conduction. This action is continuous and repetitive, producing an essentially square waveform. The secondary output voltage is proportional to the winding ratio. The frequency depends on the supply voltage, the primary inductance of the transformer and peak collector current. If the saturation flux of the transformer core material is known, it is possible to design for a specific frequency.

In the absence of this information, it is still possible to design an efficient power supply. It can be made to fit the transistors available and the input and output voltages and currents desired, but the frequency will "fall where it may." This is not too important if you plan to rectify the output.

Saturation test

First, an old transformer must be selected. The larger the transformer, the higher its potential power output. The frequency will be relatively high, however, and good results are possible

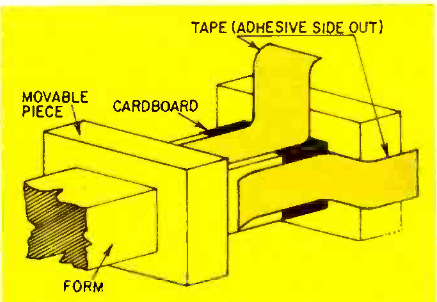


Fig. 1—Place strips of tape (sticky side out) on form before winding any coils.

with almost any old filament or audio transformer with a core area of at least ½ square inch. Dismantle the laminations, remove the old windings and make a matching winding form. This may consist of a 4- to 6-inch strip of wood with the same cross-section as the transformer core. A small square of thin wood is nailed across one end. Prepare a second piece with a square hole. This can be slid onto the core form and fastened in position to provide a winding area just the height of the window in the core (see photo). A strip of light cardboard (the width of the coil) is wrapped around the form and held in place with a piece of tape.

Three temporary coils wound on the form will be used to get information on core properties. Scramble-wind a 30-turn winding on each end of the form with enameled wire (which may be salvaged when the transformer is disassembled). The wire size used in these coils is not important. The center of the core area is wound with 30 turns of heavy enamel wire—No. 20 or larger is suitable. The completed three windings are now removed from the form and the transformer laminations reassembled around them. If a couple of strips of tape are laid across the form sticky side out (Fig. 1) and then folded across the completed windings, they will be much easier to handle.

Now for the tests! You'll need a storage battery (or other heavy-duty source) of the voltage which you plan to use with the power supply, a heavy-duty rheostat and a dc ammeter. These are connected in series to the heavy center test winding so the current to the winding can be varied and measured. A low, 60-cycle voltage is connected to one of the end windings. This should be 1 volt or less, otherwise it will confuse the reading. The 0.75-volt filament tap of a tube tester may be used or a suitable voltage divider may be temporarily hooked across the output of a spare filament transformer. The vertical leads from an oscilloscope are attached to the third coil and a horizontal scope lead is attached to either end of the ac winding (Fig. 2). Set the scope for horizontal input and apply the ac voltage.

Adjust the horizontal and vertical gain controls to produce a rectangular trace similar to Fig. 3-a. The figure may be reversed but this isn't important. This trace is the first cousin of the transformer's hysteresis loop. Now apply and gradually increase the dc. Notice that the height of the scope pattern shrinks as in Figs. 3-b and c. Increase the direct current until the almost-horizontal lines meet and cross as in Fig. 3-d. Note the meter reading. This is the current required to saturate the core. With this information it's time to start a little pencil work.

Calculating windings

Now we have to decide what transistors to use. When the switching capabilities of a transistor are not known, they can be assumed to be approximately five times their class-A amplifier ratings. The collector voltage should be rated at 2½ times the supply voltage you plan to use.

Divide the ampere-turns for saturation (determined by the test) by the collector-current rating of the transistor chosen. This gives the number of turns for each *half* of the collector winding since each transistor operates into half the winding. The wire size required may be determined from a reference source such as the wire table in the *ARRL Handbook*.

The center-tapped base-bias winding should consist of one-fifth the turns of the *total* collector winding. Very little current flows in this coil, so No. 26 or 28 wire may be used.

To get the number of turns for the output winding, multiply total collector turns by the desired output voltage, then divide by twice the supply voltage. This gives the open-circuit output voltage. The number of turns must be increased by from 20% to 50% if this voltage level is to be reached under heavy load. Wire size for the secondary may be quite small. In fact, it *must* be small if the windings are to fit the transformer window. You can determine the secondary wire size from the wire table. Pick out the smallest wire that will carry the load.

Winding the coils

The coils are wound on the wooden form which has first been prepared with the cardboard strip and the short lengths of binding tape placed adhesive-side out (Fig. 1). Enameled wire is used for all windings. It should be laid on in smooth layers; this way it will occupy far less space than if scramble-wound. The secondary goes on first. If some kind of winding jig can be fashioned from a hand drill or a lathe, winding the coils will be a lot easier. Leave plenty of wire for leads. Wrap the secondary with a layer of tape and then do the center-tapped base bias winding. The collector coil is wound last. The tape strips are then pulled tightly across the windings, a

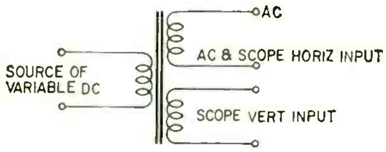


Fig. 2—Test circuit used to determine transformer's saturation point.

final protective layer of tape is applied and the completed winding is slid off the form. Reassemble the laminations around the new winding.

If you intend to experiment with the number of secondary turns (to find what is required to put out the needed secondary voltage *under load*), the secondary may be wound last. However, the efficiency is reduced somewhat by this arrangement.

When you take the trouble to prepare an accurate winding form and wind the coils neatly, there should be no difficulty in keeping the overall size of the windings small enough to fit the window of the transformer core. It's always a good idea, however, to use the smallest

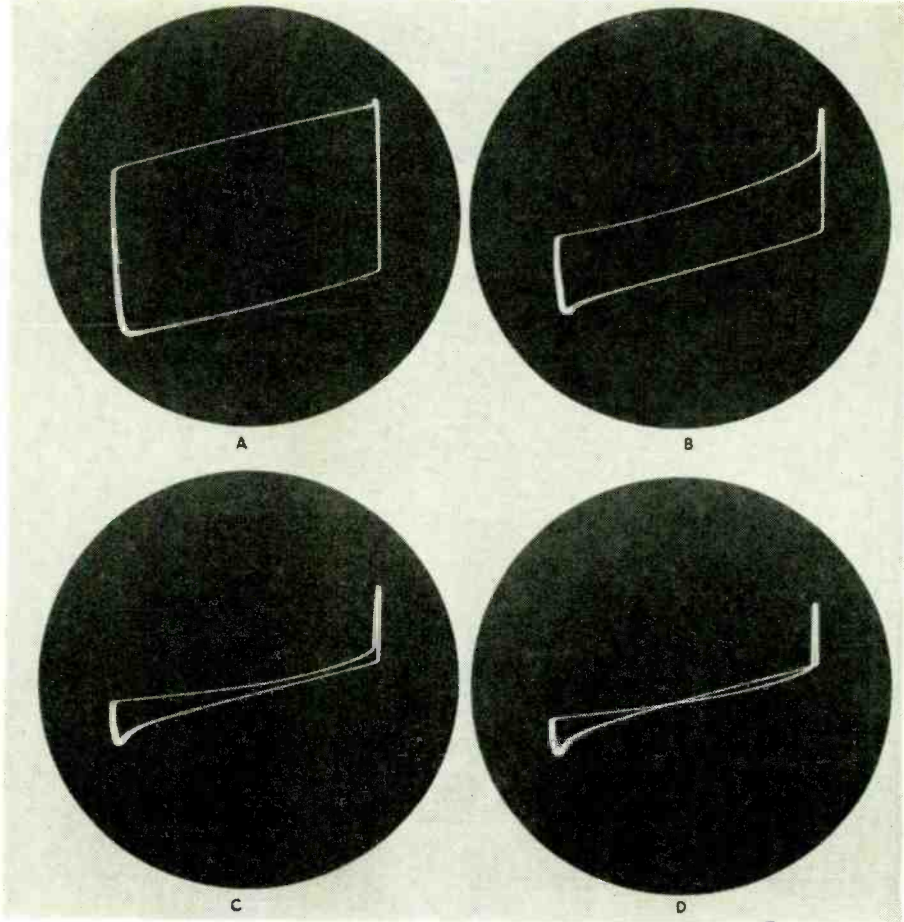


Fig. 3-a, b, c—scope patterns obtained as the transformer nears the saturation point; d—when lines cross, transformer is saturated.

wire which will carry the calculated current using the wire tables as your guide. Furthermore, place each turn tightly against its neighbor and keep the layers orderly.

Try it out

There are many transistor power supply circuits but the one shown in Fig. 4 is simple and dependable. It uses two resistors in a voltage-divider arrangement to assure easy starting under load. The high-voltage capacitor (C1) across the secondary is to reduce spikes which might damage the transistors. A high-capacitance low-voltage capacitor across the supply voltage will eliminate hash in associated equipment (if any is noted). The ratings of the rectifiers and the capacitors are determined by the output voltage and current.

Connect the transformer as shown and apply 1 or 2 volts. It should start to oscillate immediately. Use a scope or voltmeter across the secondary to check. If nothing happens, reverse the feedback leads (to the transistor bases), reapply power and you should be in business.

Examples

These directions have purposely been given without examples so that you might use them to build a power supply to fit exactly your needs with the materials at hand. A couple of "for-instances," however, are helpful: A

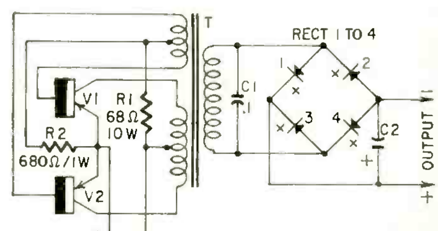


Fig. 4—Typical transistor power supply. The voltage and power rating of the supply will determine the ratings of the rectifiers and capacitors.

burned-out Stancor filament transformer is salvaged. A coil form is prepared to match its ¾-square-inch core area and the test coils are wound as described. With a 6-volt supply, 1.5 amperes are required to pull the scope trace together (indicating core saturation). This is 45 ampere-turns. Two CBS 2N256 transistors on hand are rated at 2 amperes (approximately) collector current in switching service. Dividing 45 by 2 indicates that each half of the collector winding should consist of 22½ turns. This winding will carry 2 amperes and the wire table suggests a size between Nos. 18 and 19. Either No. 18 or 20 will be satisfactory and the smaller size is used because the power supply won't be in steady use, current flows through each half of the winding alternately and a roll of No. 20 is on the shelf. The base-bias winding will have one-fifth the collector turns and there's some No. 28 wire available for it. Figuring a secondary voltage of 150 open-circuit, we multiply 45 (the collector turns) by 150 and divide by 12 (twice the supply voltage). This rounds out to 560 turns. While No. 40 or smaller would be OK, this isn't a big winding so a convenient spool of No. 32 is used. The coil form is chucked in the lathe and "away we go."

Even though a much larger secondary wire size was used than needed, the cross-sectional area of this winding is comfortably smaller than the window. If we'd decided on a much higher secondary voltage (requiring many more turns), it would then have been important to use the smaller wire so the windings would fit the window area.

When completed and hooked up in the multivibrator circuit, the output is 150 volts, no load, just as figured. A 60-milliampere load is applied which pulls the output down to 100 volts. This is an output of 6 watts. The 6-volt input is supplying 1.7 amperes (or a bit less) or 10 watts. Thus the efficiency is 60%.

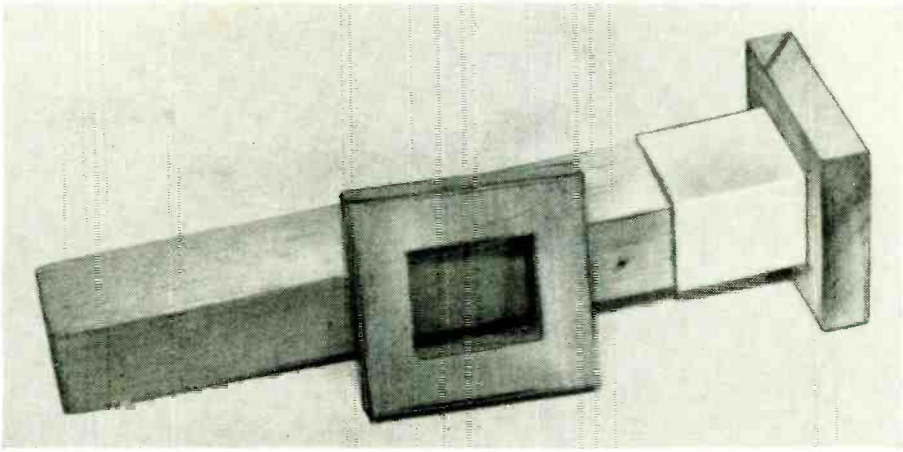
By reducing the size of R1 and 2, but still retaining their 10:1 ratio, the output can be raised to 10 watts or even more—still at 60% overall efficiency. With these transistors, however, the base current must not exceed 100 ma. Any adjustment of the resistors must keep base current within this value.

Next, a small audio output transformer with a core area of ½ square inch from a junked ac–dc radio was rebuilt. It required only 20 ampere-turns to close the hysteresis loop. It was decided to lower the battery drain, so a center-tapped 50-turn collector winding was calculated to produce only 0.8-ampere collector current. This and the 10-turn bias winding were applied on top of the original transformer high-impedance winding. A test showed that it pulled just under 1 ampere, about as expected. The no-load output was 500 volts. It charged a 500-μf photoflash capacitor to 450 volts in 25 seconds and would make a fine power supply for an electronic photoflash outfit. Incidentally, the laminations in some small audio transformers are placed all one direction. For power purposes these laminations, when reassembled, should be alternated.

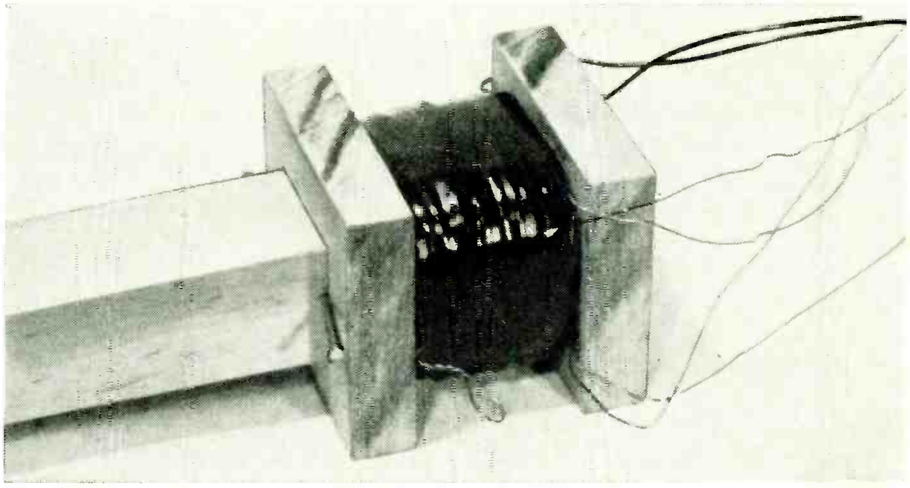
In instances where it is possible to salvage and use the old transformer secondary or primary intact, most of the work is eliminated. The collector and base windings go on fast and easily, occupying far less space than the original primary.

These two examples show the flexibility possible with this design procedure.

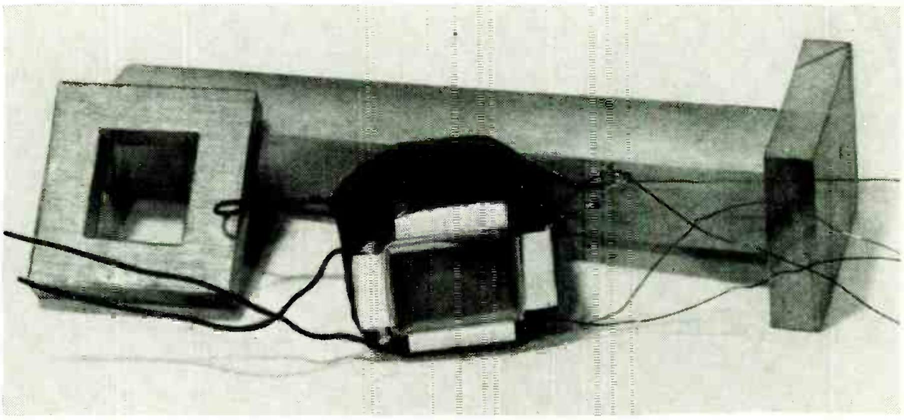
Your power supply can be designed for your car radio, for mobile equipment or for an electronic photoflash. Just remember that the transistors are working hard in some of these applications. They give off quite a bit of heat and must be mounted on a metal surface to help dissipate this heat. Check their operating temperature, if it goes over 150°F you'd better arrange a larger heat sink, a cooler location or perhaps a small fan to cool them. END



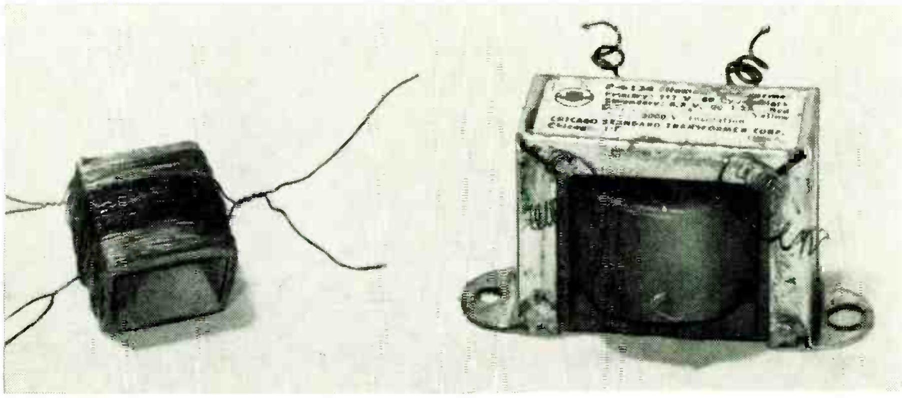
The winding form with cardboard collar mounted.



Completed windings are covered with protective layer of tape.

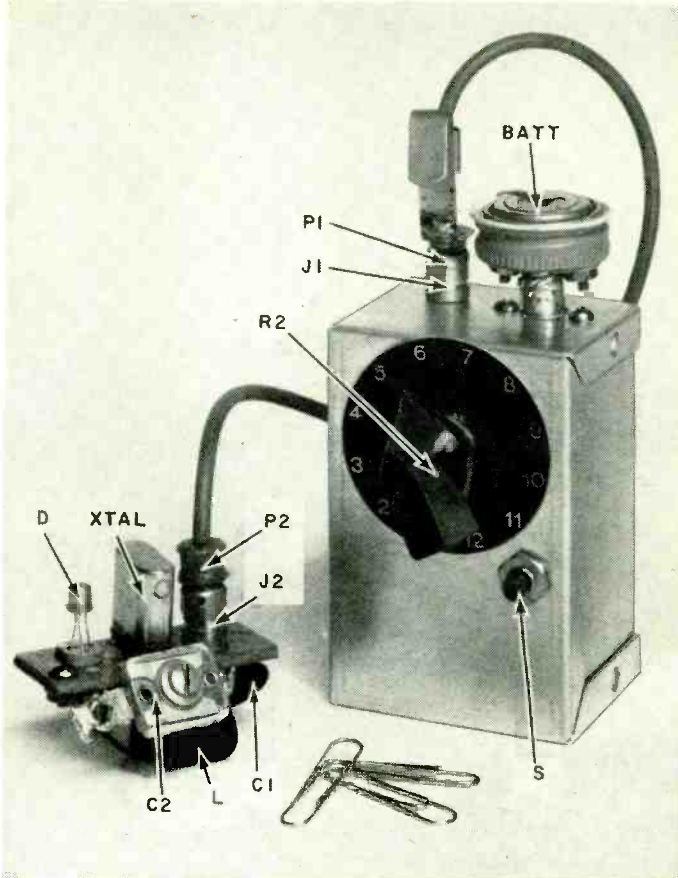


Windings removed from form and ready for assembly.



A completed transformer and the test coils.

THE TUNNEL DIODE REALLY WORKS



Simple tunnel-diode oscillator.

These two practical circuits can be duplicated by the average experimenter

By I. QUEEN

EDITORIAL ASSOCIATE

THE tunnel diode is an amazing semiconductor. Articles on it and its applications have appeared in periodicals, but have often been too theoretical for readers who like to experiment. Exact voltage and component values are often missing, making it hard to duplicate the stated results. (The operating bias for a tunnel diode is generally very critical.)

The July issue of this magazine, page 26, carried an excellent discussion of basic principles of the diode. It showed that this device has a *negative* resistance sandwiched between regions of *positive* resistance. Fig. 1 shows a highly simplified form of the familiar tunnel diode curve. Current increases as voltage is increased up to about 0.1 volt, then *decreases* as voltage increases from 0.1 to a little less than 0.5 volt, when it again starts to rise with increasing voltage. Voltage and current values are typical for a 1N653 (Texas Instruments). Circuit theory indicates that such a device must be an excellent *oscillator* and *switch*. This article will give full details on a crystal oscillator for 27–30 mc and a switch that is triggered by light.

The oscillator

The negative resistance region means that the tunnel diode is a ready oscillator. As explained in the July issue, the load line must intersect the region of negative resistance (Fig. 2). This load resistance is *smaller* than the negative resistance of the diode, specified as −40 ohms for a 1N653. E_1, the circuit voltage, is a small fraction of a volt.

No battery with such low voltage is generally available, so a divider is needed. Fig. 3 illustrates the crystal oscillator. Note the low value for R3 (which determines circuit resistance). Oscillations occur when the voltage across the diode is about 0.2. Start with a 100-ohm pot for R1. To set it, vary R1 (and R2 for fine adjustment) and listen for the signal on a nearby receiver tuned to the crystal frequency. Tune C2 for maximum output. For 27–30 mc, L is 16 turns of No. 18 wire, ¼-inch diameter, close-wound.

You may also adjust this oscillator and observe circuit operation by measuring voltages. Start with maximum resistance at R1 and R2, then raise the voltage across the diode. (R2, the 20-ohm pot, is rather critical. Use 10 ohms for ease of control.) At about 0.17 volt (as measured with a 20,000-ohms-per-volt meter) you will note a sudden jump (to about 0.2 volt) and oscillations will begin.

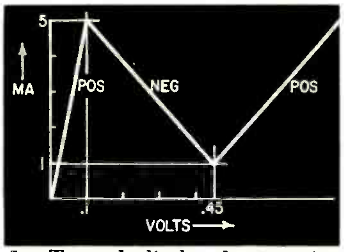


Fig. 1—Tunnel diode characteristic in an idealized—or cubist—form.

This circuit will work with any overtone crystal from 27 to 30 mc without retuning. This is hardly the upper frequency range of a tunnel diode. With smaller tanks you should have no trouble pushing the range higher. If you remove the crystal, the circuit will self-oscillate with a rough and unstable signal.

Once R1 has been determined for your particular diode and circuit, it may be replaced with a fixed resistor. A 47-ohm unit is just right for my oscillator.

For safety, limit diode current to a maximum of about 6 ma till you determine the current value for R1.

Construction is uncritical. In my unit, a battery and voltage-divider unit already on hand was used. That portion of the circuit could, of course, be mounted on the board with the other components.

Trigger switch

When the load line intersects the diode characteristic in three places (as load 1 does in Fig. 4) we have a switch. As an example, suppose the circuit voltage is E_2, about 1.2 volts. Load line 1 resistance is about 250 ohms. When the circuit is switched on, it stabilizes at point A.

Now if a weak positive pulse is applied to the diode, the operating point will rise over the peak. It will move along the downward slope quickly (due to negative resistance) and arrive at C. (Point B is an unstable position, and is of little importance in this explanation). All this takes place instantaneously. Thus even a very weak pulse will trigger the circuit from A to C. In a 1N653 these points correspond to about 5 and 2 ma, respectively. (This is terrific amplification, if you want to look at it that way.)

The triggering push may be an externally applied voltage or it may be just a reduction in circuit resistance. To show this, refer to Fig. 5. Starting with maximum R1, lower the resistance. At about 5 ma the meter will suddenly deflect *downward* to 2 ma, although we are *reducing* R1. The operating point

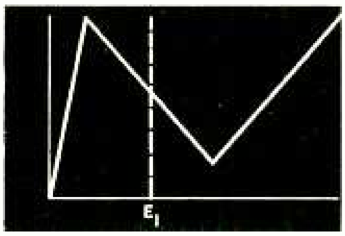


Fig. 2—Operating point for tunnel diode oscillator.

(Fig. 4) has moved up the curve till it reached the peak of the characteristic. At that instant (when it reaches the peak) it snaps to C. R2 (Fig. 5) is a limiting resistor.

Now increase R1. The slope of the load line becomes more horizontal until it coincides with load 2, at which instant the current will snap upward. For the 1N653 this occurs when the total series resistance is about 1,250 ohms. The current will snap from a low of 0.6 ma to 1.2 ma.

The circuit may be triggered by light falling on a photocell (Fig. 6). A low-resistance Hoffman S1-A solar cell is shown in series with the winding of a relay RY to be energized. Light falling on the solar cell increases the circuit voltage and triggers the circuit. The higher voltage corresponds to changing the load line from 2 to 3 (Fig. 4). When

R1—47 ohms, see text
R2—20 ohms, pot (see text)
R3—10 ohms
All resistors ½-watt 10%
C1—.001, ceramic
C2—25—μμf trimmer
L—16 turns No. 18 enameled, ¼-inch diameter, closewound
XTAL—see text
S—push-button, normally open
D—tunnel diode, 1N653 or equivalent
BATT—1.2-volt, nickel-cadmium rechargeable. (The one shown was mounted in a metal screw cap with a phono plug.)
Miscellaneous hardware, jacks, boards or other housing as desired

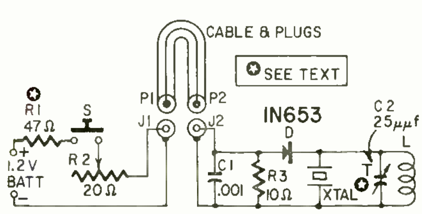
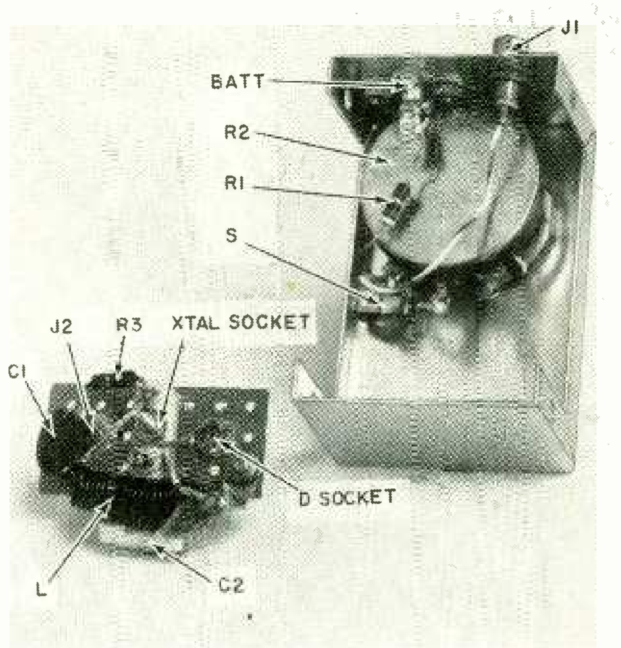
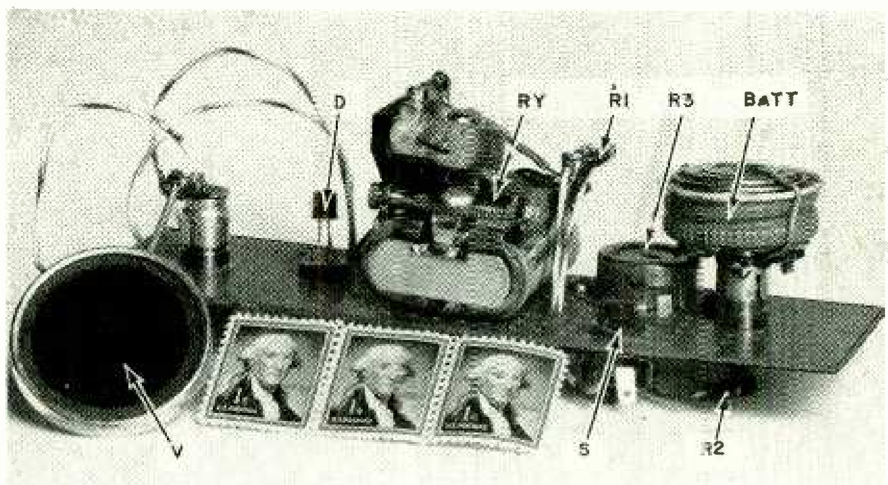


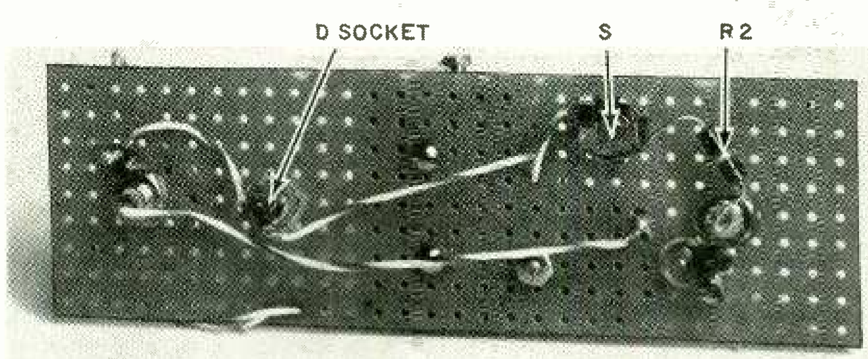
Fig. 3—The tunnel-diode oscillator on the right; power supply on the left.



A look inside the oscillator.



Switching circuit uses a tunnel diode.



One resistor sits under the chassis of the switching circuit.

the new line touches the peak point on the characteristic, the circuit triggers and the relay drops out.

The photo shows an actual switching circuit based on the above experiment. The relay must have a low-resistance winding. Being unable to find a suitable unit, I modified a Sigma 5F-1000, which has two coils in series, for a total of 1,000 ohms. They are reconnected in *parallel* to cut resistance to 250 ohms. Observe polarity of windings. The *yellow* lead of each coil is soldered to the *black* of the other. A 470-ohm resistor is shunted across the windings. This lowers the resistance and the sensitivity of the relay. Now the relay should be adjusted to pull in at 4.6 ma, release at 2.3 ma, approximately. Prime the circuit by pressing the RESET button, then lower R3 gradually until you are just below the trigger point. If triggering occurs, note the point and start over again, this time not advancing the control so far.

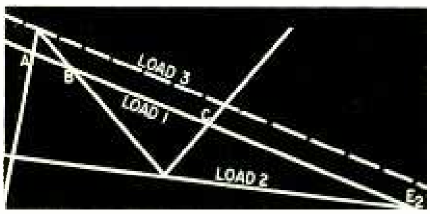


Fig. 4—How the tunnel-diode characteristic is used in switching.

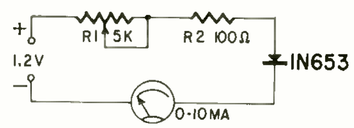


Fig. 5—Tunnel-diode switching circuit.

When properly set, the illumination from a 40-watt lamp at about 18 inches is sufficient to trigger the circuit and release the relay. Note that the solar cell is in series *aiding* with the battery.

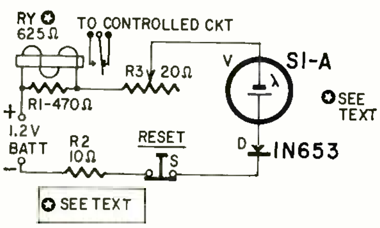


Fig. 6—Practical tunnel-diode switch.

R1—470 ohms
R2—10 ohms
R3—20-ohm pot
RY—Relay, Sigma 5F-1000, modified, see text
S—push-button, normally closed
D—tunnel diode, 1N653 or equivalent
V—photocell, Hoffman S1-A or equivalent
Miscellaneous hardware, perforated board, jacks, etc., as desired

This circuit may be made so sensitive that it can be triggered by switching on or off a nearby soldering iron or other appliance. The magnetic field of the ac does it.

If you reverse the polarity of the solar cell, you can prime the circuit with illumination *on* the cell. Then you can trigger the circuit by interrupting the light falling on the cell, even for a brief instant. END

TV Service Clinic

conducted by

JACK DARR

CONVERGENCE has been made a great deal easier in the later-model color sets, for which we are duly grateful. RCA, for example, has mounted all the convergence controls on a separate board which can be set up on bolts above the back of the set so that it is accessible from the front.

Control circuitry in this department has changed too. RCA and others have adopted a very useful device, the "combination" control (Fig. 1). These are the ones marked R-G-1, R-G-2, etc. They work on both red and green at the *edges* of the screen, the most difficult place to get good convergences.

Some of these are inductance controls, some resistive pad types. They are found mainly in the horizontal dynamic-convergence circuits and their operation is exactly the same as the older types. The details vary from manufacturer to manufacturer, of course, so go by the detailed setup instructions furnished with each set.

Before we leave this circuit, there's one point I'd like to mention: watch that contrast! We recently installed a late-model set. The color was beautiful, no fringing or contamination, and we were very pleased. A few days later, the owner called, complaining about fringing, impurity and several other things including loss of focus. We rushed over to the house in time to catch a color program.

Sure enough, there were all the symptoms she had mentioned.

It was quite by accident that I happened to turn the contrast control. Immediately, the picture cleared up and *all* the objectionable symptoms disappeared! The contrast control had been "opened wide." This gave us something of the same effect you'd get on a sensitive black-and-white set: smearing, loss of fine detail, excessive brightness, and, in this instance, slight misconvergence (probably due to a bit of blooming). In this particular set and in many others of the same vintage, I think you'll find that picture quality is best with the contrast control turned all the way down (counterclockwise).

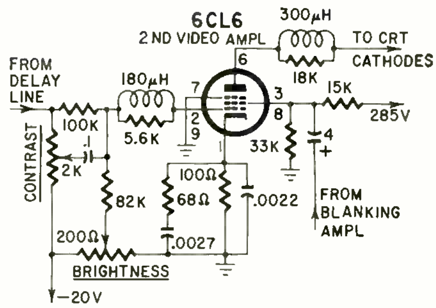


Fig. 2—Both the contrast and brightness controls are in the second video amplifier grid circuit.

While this may seem strange to those accustomed only to black-and-white circuitry, in the average color set it is quite normal. The controls labeled CONTRAST and BRIGHTNESS are found in quite a different place on color TV's. The contrast control on black-and-white receivers is usually located in the video amplifier cathode; in color sets it may be in any of several circuits. It is often located in or around the *grid* circuit of the second video amplifier (Fig. 2). However, in later chassis, you may find it back in the cathode (Fig. 3). Brightness controls are *not* found on the picture-tube grid or cathode, but in the

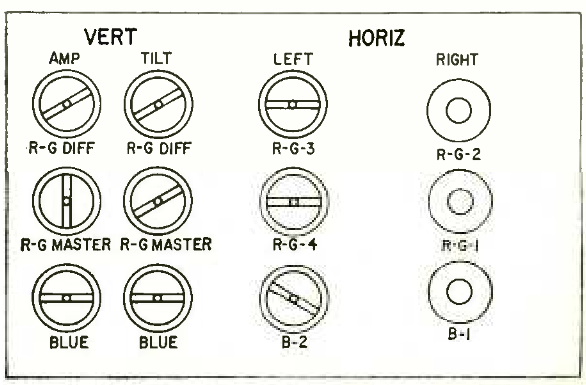


Fig. 1—Convergence board used by RCA in CTC10 sets. It is similar to the board in the August, 1960, issue, page 83.

grid circuit of the same second video amplifier (Fig. 3). These controls will have a slightly different effect than those we're used to. Check the installation instructions carefully and find out the control setting for correct operation. As a general rule, brightness should be set just below the blooming point and the contrast should be set as low as possible to avoid the slight blooming and excessive contrast that will mess up the color.

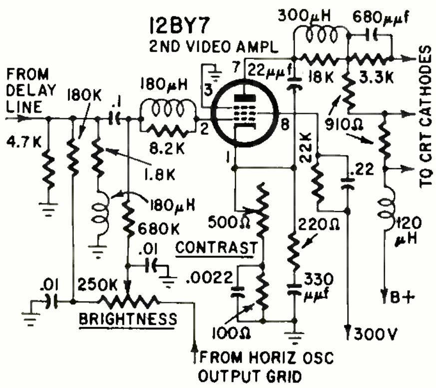


Fig. 3—The contrast control has returned to the cathods circuit.

Another point that many of us overlook is checking the high voltage before attempting *any* convergence or purity adjustments. I have run into several sets lately with convergence trouble that cleared up when the high voltage was returned to its normal value. If the convergence has been worked over with the high voltage below normal, there will be some readjusting to do!

Installation instructions (or service data) on all sets will give the proper procedure for high-voltage tests and adjustments.

Bad rectifier?

An Emerson 1184 needed a new picture tube. After replacement, the raster wouldn't fill the screen, so I paralleled the selenium rectifier with a new one and got a full raster (I let it play for about an hour). After I replaced the rectifier, the set would not work! There was no B-plus or boost.

We've replaced practically everything in the set including the flyback and oscillator coil. All capacitors and resistors in the horizontal section have been checked and double-checked. We're about ready to try building a separate high-voltage power supply!—R M. P., San Diego, Calif.

I hate to say this (and I wouldn't dare if I hadn't done the same thing myself so many times), but have you checked that *new rectifier* that you put in? If the set worked for an hour with the old rectifier shunted, then went out completely with the new one, there must be something wrong in or around that rectifier!

If this isn't the trouble, check the resistors in the B-plus circuit (the surge resistor, filter resistor, etc.). You might also check the capacitors while you're there. There is a definite possibility that your trouble is originating in the B-plus rather than in the high-voltage supply. In many cases, replacing a rectifier will raise the supply voltage enough so that marginal components (right on the verge of going bad) will fail when the B-plus is brought back to normal. Also check the hardware and connections at the high-voltage rectifier socket.

Vertical rolling

Have you any suggestions for eliminating a stubborn vertical roll that appears when an RCA KCS-92 is first turned on?—J. I., Newark, N. J.

Have I? Yes, sir! Like almost everything in television, this is a "single effect with many possible causes!" You must locate this trouble by a process of elimination, taking the most likely suspects first.

Therefore, replace the tubes first: the 12AU7 and 6AQ5 oscillator and output. Next, check the parts circled in Fig. 4. These all play a part in determining the operating frequency of the oscillator. If a resistor is off value when cold or a capacitor is leaky, the time constant of the circuit is changed and it runs off frequency until it reaches operating temperature. So measure all resistors in these R-C combinations very carefully and replace any that show signs of being too far off in value.

Clip an ohmmeter across the resistor, then hold the tip of a soldering iron near the resistor for 3 or 4 seconds. If the value changes more than 5%, replace the resistor.

Oscillator troubles

In a cathode-coupled multivibrator with a stabilizing or ringing coil, (horizontal oscillator), I've found that sometimes you can short out this coil without affecting oscillator operation and sometimes you can't. Furthermore, where a 6AL5 phase detector is used, the oscillator's control-grid voltage is normally zero. When you ground the control grid, the stabilizing coil can be shunted out and the picture made to "float" by adjusting the hold control.

I have recently received for service an Admiral 21F1 that goes so far out when the coil is shunted that a picture cannot be synced in. Is there a variation of this circuit which won't work with the coil shorted out? Or, does this mean trouble?—V. I. S., Canon City, Colo.

You're exactly right, up to a certain point. Normal voltage on the "input" grid of the horizontal oscillator is usually zero. The phase detector controls the frequency of the horizontal oscillator by varying this dc voltage. Therefore, we can ground this point and remove all "sync input", thus removing one possible source of trouble in the horizontal oscillator circuit. Please note that in this type of circuit, horizontal sync is *not* applied to the oscillator! It never gets any further than the phase comparer. There, it and the pulses from the flyback are compared (in phase) and transformed into small dc voltages. When both sync and pulse are in phase, the net output is zero.

Now, as to the oscillator circuit going far out of sync when the ringing coil is shunted: this is an R-C-coupled multivibrator and the ringing coil is *not primarily* one of the frequency-determining elements! Its only use is to stabilize circuit operation. Frequency-determining elements are the resistors and capacitors in the coupling networks.

The ringing coil and capacitor form a high-impedance path between the oscillator plate and B-plus. In effect, they are part of the plate load impedance for this half. Therefore, when the coil is shunted, only the plate load resistor is left in the circuit. As B-plus is always (or darn well should be!) at ground potential for ac, if we shunt the ringing coil in a circuit using a small plate resistor, like your Admiral, the plate of that section is "too close to ground." This cuts down the output and the multivibrator becomes badly unbalanced and gets very stubborn about working!

To cure this, simply increase the plate load resistor *temporarily*. Disconnect the plate resistor and raise it to about 15,000 to 20,000 ohms so that the plate impedance of this half of the multivibrator will have sufficient output to

(Continued on page 66)

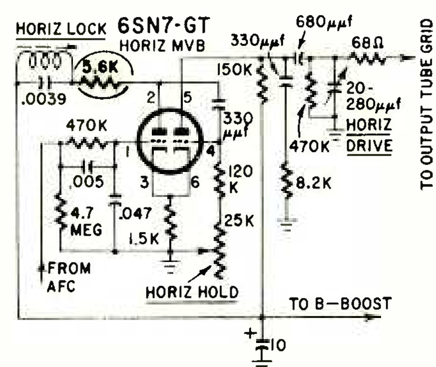


Fig. 5—The plate load resistor must be made larger temporarily to operate the multivibrator with the ringing (Horz. Lock) coil shunted.

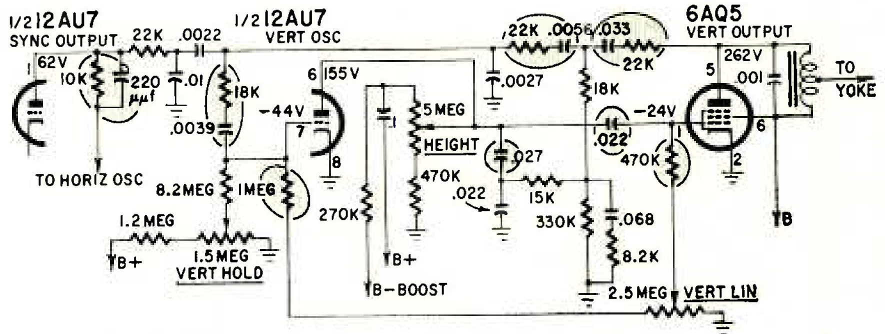


Fig. 4—All circled parts can affect vertical oscillator frequency.

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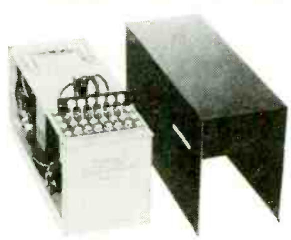

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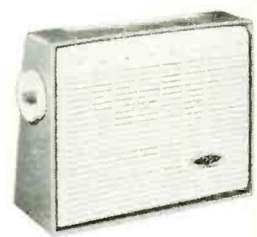

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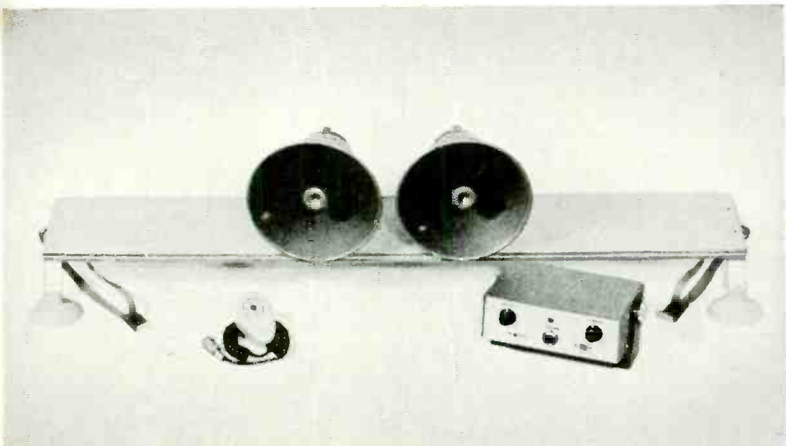

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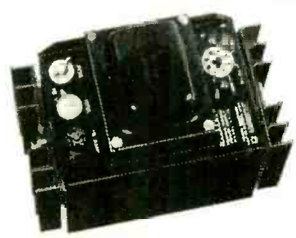

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(*Continued from page* 61)

work properly (Fig. 5). At this point, the horizontal oscillator should be able to float a picture across the screen, *if* all of the parts are good! If the oscillator will not work now, you have a defective part. A leaky capacitor or an off-value resistor will throw the time constant of the circuit far out of the correct range.

After getting the oscillator circuit to the point where it will work without the ringing coil, remove the shunt and replace the original plate resistor. Don't move the horizontal hold control. Turn the slug on the ringing coil until the picture locks in (perhaps not entirely steady, but much better than without it). (Remember, the sync input is still grounded.) Now remove the short from the grid. If the picture immediately goes far out of sync, there is trouble in the phase comparer.

Sound troubles

In a Philco E2006-11 portable TV the sound will not come on when the picture does. About 5 minutes later it comes in, or both show up at the same time, then the audio gradually dies away, to come back with a "pop" in about 5 minutes. After it's warmed up, nothing short of hitting it with a sledge hammer will make it cut out. Of course, out of the cabinet, it works beautifully.—C. S., Wilmington, Calif.

I hate to say this, but it looks as if you have a good case of printed-circuit trouble! It seems to be thermal in nature, from the description: the "loose wire" that is causing the trouble seems to be closing tightly once the set has heated up sufficiently.

There is one fairly good remedy for this. Using a medium to small iron, resolder *all* of the joints associated with the sound circuit, including the printed-circuit board!

If this drastic step fails, then replace the discriminator transformer. This trouble could also be caused by a defective base assembly, if one of the tiny built-in capacitors should be intermittent.

As you say, this set is used on shipboard quite a lot, you might check the 4.5-mc trap in the video output circuit. Salt-air corrosion could have caused one of the fine wires on this coil to be weakened. The same thing could account for the trouble in the discriminator transformer. After the trouble is located, spray the whole section with a good grade of acrylic plastic coating to prevent future corrosion.

Boost high voltage

Can the high voltage in a Transvision A41 be increased by using a 6CD6 instead of a 6BG6 in a flyback circuit that has a Merit HV-10 transformer and matching yoke? I would like to obtain about 1-kv increase.—H. H. G., Lansdowne, Pa.

There is more than one way to approach this problem. I would suggest checking the 6BG6's screen voltage. If it is less than 350 volts, the screen resistor can be reduced in value to obtain additional high voltage. Do not operate the screen over 350 volts, however, as tube life could be impaired. A high-voltage doubler will give a big stepup, which can in turn be reduced to desired value by using a suitable series resistance in the high-voltage lead. A 6CD6 output tube does give an advantage over a 6BG6. This requires circuit rewiring. In any case of raising the high voltage, the flyback transformer can become a limiting factor. If you are unable to scan the picture tube fully when the high voltage is increased, a larger flyback is required.

Agc–width coil

I have lost a lot of sleep over this one. In a Stromberg-Carlson TC-19, the width coil, (which also supplies the agc keying pulse) was defective. All the replacement coils I can find have proved ineffective. The pulse at the keyer tube plate is correct in polarity, but I can't get the agc line to go more than 2 volts negative. An external bias of 6 volts restores the set to normal operation. I haven't been able to obtain an exact duplicate replacement part for this anywhere. Can you help me out?—B. C., New York.

The coil you refer to is *not* the width coil with an agc winding, but a special transformer which supplies only the keying pulse for the agc tube. The width control is in another circuit.

This *is* a very special transformer; so special, in fact, that I have been unable to find it listed (as an exact replacement, that is) in any of the multitude of catalogues I have. However, I have located a coil which, I think, will do the job.

The original coil (T in Fig. 6) has an 0.2-ohm primary resistance and a

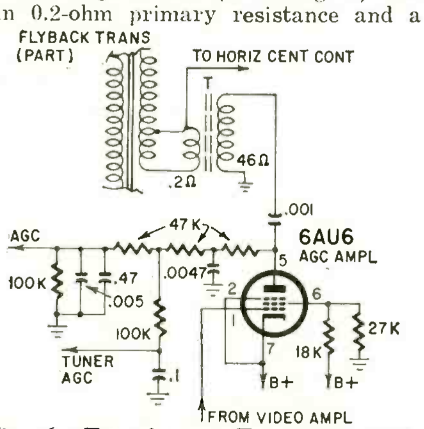
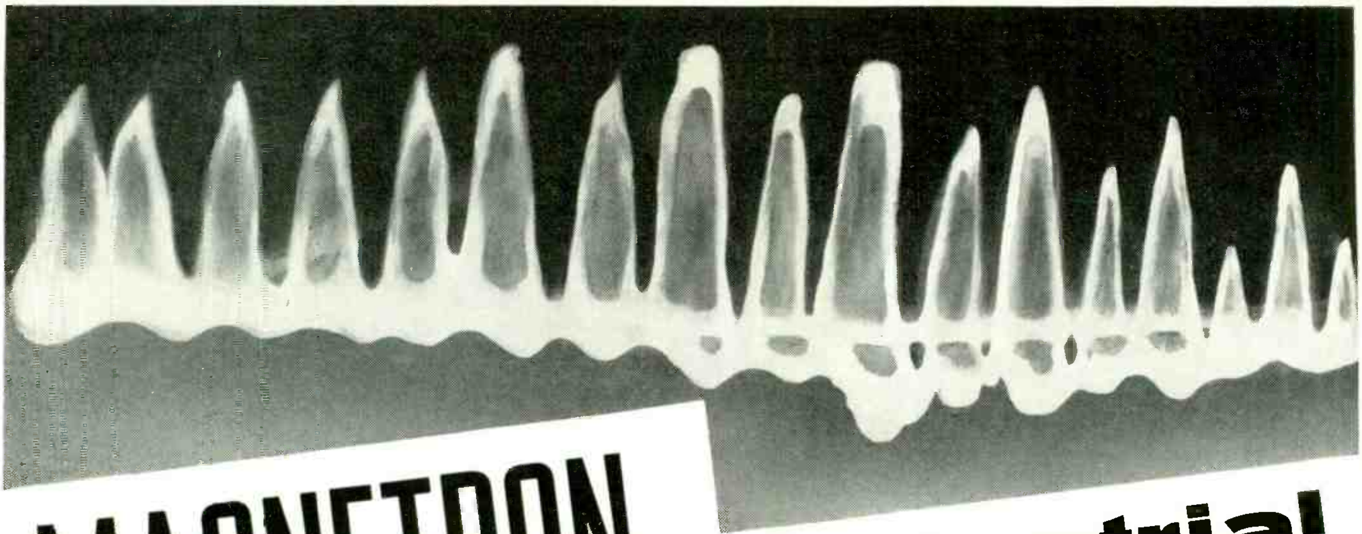


Fig. 6—Transformer T supplies high pulse voltage to agc amplifier's plate.

46-ohm secondary resistance. This would give it a tremendous stepup ratio.

Triad lists a coil which should do the trick: it is their WLC-29, with a primary inductance variable from 0.1 to 0.9 millihenry, and secondary from 4 to 28 millihenries. Because it has an adjustable core, you should be able to match the flyback tapping with the primary and get enough voltage out of the secondary to give you the correct pulse amplitude on your keyer tube.

As a precaution, you might check the signal level applied to the grid. Ordinarily this runs around 60 to 70 volts peak to peak. END



MAGNETRON industrial power generator

Able to supply great power for short periods at ultra-high frequencies, the magnetron's chief non-radar application at present is in cooking foods

By TOM JASKI

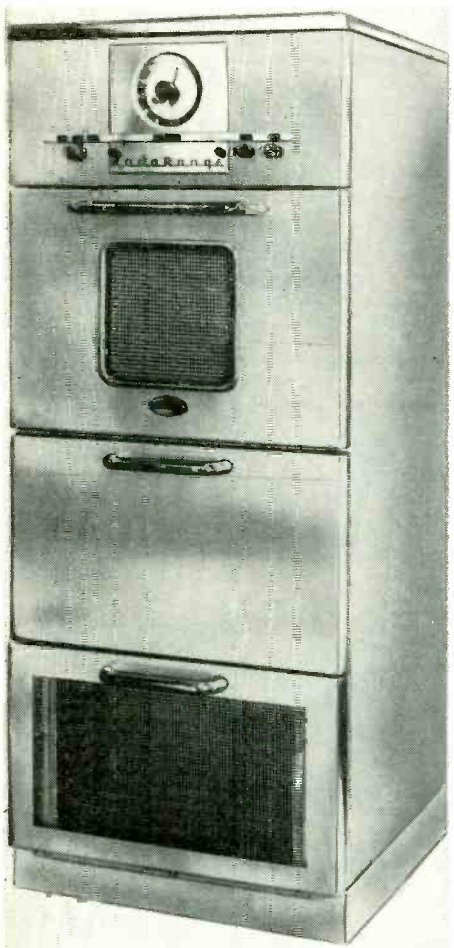


Fig. 1—The Raytheon Radarange, used in restaurants to cook food speedily.

YOU may not know it, but you have probably eaten food cooked by radio waves so thoroughly and rapidly that you couldn't tell it had been hard frozen *minutes* before. Modern electronic ranges can cook steaks in less than half a minute or turn out a piping hot frankfurter in seconds. The modern electronic way gives the restaurant diner foods that have been freshly cooked rather than wilted all day on a steam table, and it especially does away with hours of defrosting. One of the electronic marvels that can do this is the Raytheon Radarange, shown in Fig. 1.

Radio-frequency heating has been used in industry for many jobs during the past 30 years, but electronic cooking has not been around that long, and few are familiar with the equipment. While most industrial heating takes place at 13.8 mc, cooking ranges operate in the microwave regions. The frequency band of 2,400–2,500 mc has been assigned to industrial heating services by the FCC.

Heart of the Radarange and similar electronic cookstoves is the magnetron, powerful microwave generator, more familiar in radar installations. The magnetron in the range (Fig. 2) is mounted above the dish, and sprays high-energy radio waves with hundreds of watts of power directly at the food cooking it from the *inside out*.

The magnetron is a simple-looking tube, but the theory of its operation is rather complex. It can be understood if some very simple principles of electron motion are kept in mind. For example, an electron can be deflected in its flight by a magnetic field. Of course you know this, for the electron beam which lights the screen in your TV picture tube is deflected magnetically. Fig. 3 shows how an electron is deflected, a little by a weak magnetic field, and a great deal by a strong one. The amount of deflection depends, of course, on how long we leave the electron in the magnetic field and on how much momentum it has—in other words, how fast the electron moves. Since an electron always moves from a negative to a positively charged body (one with a shortage of electrons), the amount of positive charge (the potential) determines the speed of the electron, and thus the amount of deflection in a given magnetic field. To make the electron path curve more, we can either strengthen the magnetic field, slow down the electron, or do both at the same time!

Simple magnetron theory

An electron moving within a cylindrical anode with a cathode at the center and a magnetic field along its axis (Fig. 4) can be made to take different paths to the anode after leaving the cathode. The shape of the path depends on the strength of the magnetic field and the voltage on the anode. It

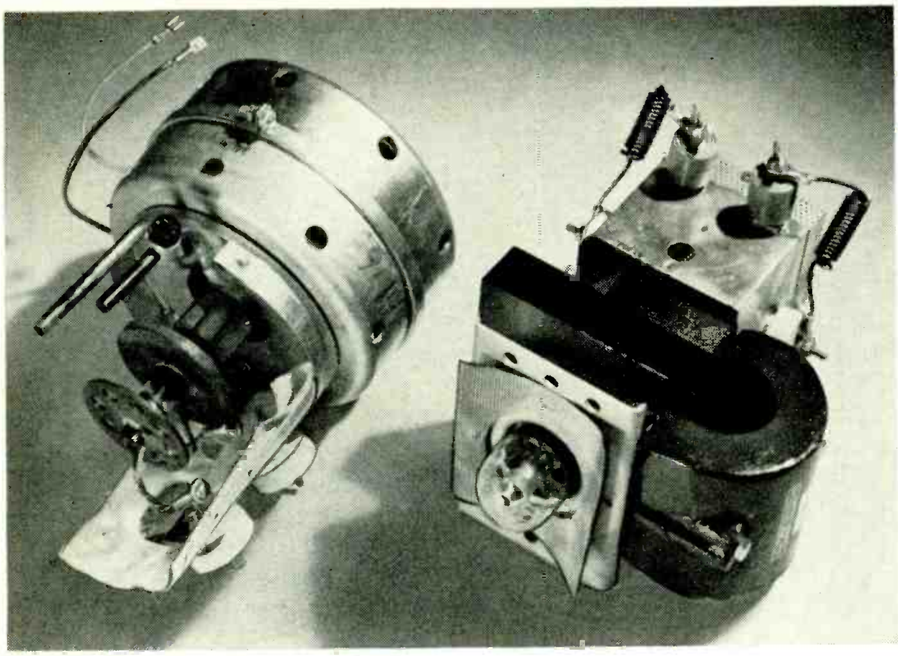


Fig. 2—Typical magnetrons. Left, a liquid cooled unit; right, air cooled type.

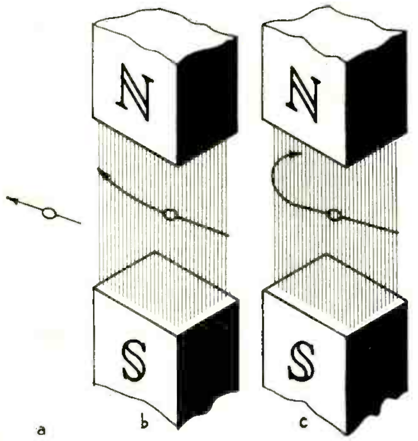


Fig. 3—How a magnetic field deflects electrons: a—no field, electron goes straight; b—weak field, path curves; c—strong field, path curves strongly.

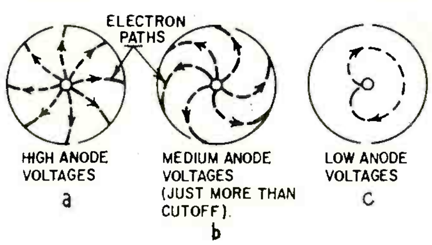


Fig. 4—How electron path varies in constant magnetic field: a—high anode voltage; b—medium voltage, just above cutoff; c—low voltage, cutoff condition.

will be almost straight if the field is weak and the potential high, curve more if the magnetic field becomes stronger or the potential lower, and so on, until we reach what is known as the "cutoff" condition, where a lot of electrons that leave the cathode will never get to the anode. Now cutoff is not an absolute condition, and a few electrons will travel to the anodes anyway, but very few. The great majority will travel around the cathode for a time in what we can call a rotating electron "cloud." We will need this rotating cloud later in our explanation, so keep it firmly in mind.

We can operate a magnetron in two ways. One is called *negative resistance* and the other *transist time* or *dynatron* operation. We will discuss the former first, although few magnetrons operate that way now. But understanding it is fundamental.

Fig. 5 shows a split-anode magnetron, with an external resonant circuit and the supplies needed. If the tube is not oscillating, we have here the situation which has been redrawn in Fig. 6-a, where the anodes have the same voltage. The magnetic field is perpendicular to the paper, with the North pole above and the South pole below the paper. If, in such a tube, we could measure the potential (voltage) between plate and cathode, we would find that there is a gradual decrease of potential as we approach the cathode. If we jot down the location of our measurements and the potential measured and then connect points with the same potential, we find that the "equipotential lines" as they are called form neat circles (Fig. 6-a). The number in each circle represents the potential at that "layer" of the cylinder.

If we send an electron from the cathode in Fig. 6-a and we have a fairly strong magnetic field, the path of the electron will be as shown. This is the cutoff condition. As the electron travels, it crosses regions of higher potential and is attracted to plate A. But before it can gain enough momentum to get to the plate, the magnetic field curves the electron away from plate A. It then crosses weaker field regions progressively, and the magnetic field keeps the path nearly circular.

But now let us see what happens if we reduce the voltage on one anode and increase it on the other. Now the equipotential lines no longer are nice circles but are badly distorted as shown

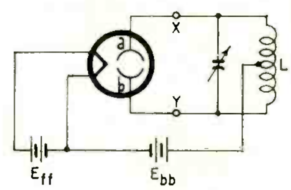


Fig. 5—Split-anode magnetron. Drawing is symbolic—filament is actually centered in the cylinder formed by the two anodes, and resonant circuit is composed of distributed instead of lumped elements.

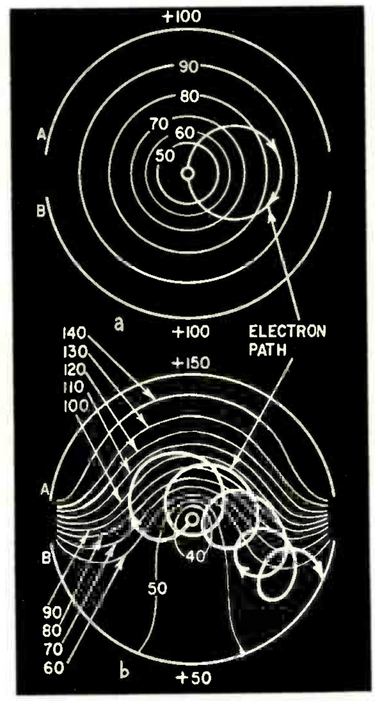


Fig. 6-a—Path of electron in cutoff condition, both anodes at same voltage; b—path with lower voltage on one anode. Lines show points of equal voltage.

in Fig. 6-b. What does this mean to the electron setting out from the cathode? As the electron starts out, it will meet conditions approximately like those in Fig. 6-a. But the change in potential region is much faster, and the electron gains somewhat more momentum from the field, but not enough to travel to plate A. Now it will curve back in a larger sweep, missing the cathode. And as it curves around the cathode, it will again pick up momentum in the rapidly differing field conditions encountered, and take another turn around. And again and again the field conditions the electron meets will cause it to take another turn (under the influence of the magnetic field) to travel the spiral path shown. Finally, after this long travel, the electron has lost a lot of its kinetic energy and is attracted to the nearest anode, which now is plate B. We have then the curious phenomenon that most of the electrons travel to anode B, the one with the *lower* voltage. Lowering the voltage on this plate has increased the current to it, and we have a clearly negative resistance characteristic.

How do we use this to oscillate? Well, look again at Fig. 5. If we already had a voltage across the resonant circuit, this would provide the plates with the difference in voltage we show in Fig. 6, wouldn't it? Suppose now that we start the tube by warming the filament and then suddenly turn on the plate power. Nothing is symmetrical and so, in the first instant, one of the plates will get a little more current than the other. This will lower the voltage on this plate a little (through the coil impedance) and thus it will first attract more electrons, and we're off. The capacitor will charge until the voltages are even. Then the voltages through the inductance-stored energy will reverse, beginning to raise the voltage on the other plate, as in any other resonant circuit, and the tube is oscillating.

Of course at this high frequency (in the microwaves), the resonant circuit will probably not be the coil and capacitor we show but instead a resonant cavity, with distributed capacitances and inductances instead of lumped ones.

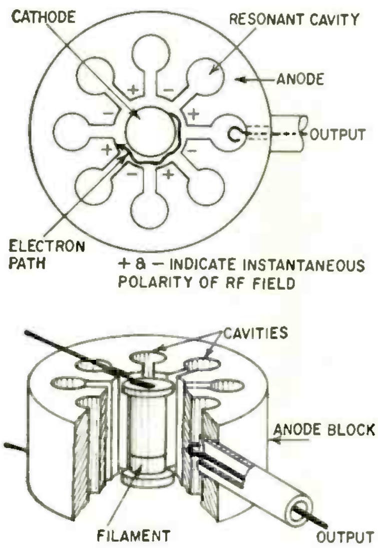


Fig. 7—Two views of multicavity magnetron, the type commonly used in industry.

This, basically, is negative-resistance operation of a magnetron, specifically the split-anode magnetron. Notice that essentially the magnetron was in the cutoff condition before it started to oscillate, but that the distortion introduced by the voltages on the plates did something to the field so that the electrons started flowing anyway and to the plate with the lower voltage.

Dynatron operation

Now remember the rotating cloud of electrons we could create in the magnetron in the cutoff condition. Assume we have created such a cloud. We will presently look at one of the electrons in it, but first let us look at an anode in which we have built cavities of the proper size for the microwave frequency at which we wish the magnetron to operate. Such a magnetron with cavities is shown in Fig. 7. (This is appropriately called a *multicavity* magnetron.) Notice that we have a coupling loop in one cavity to take the energy out. Now look at Fig. 8, where we have stretched out two cavities of the anode in an enlarged view to help us explain the action.

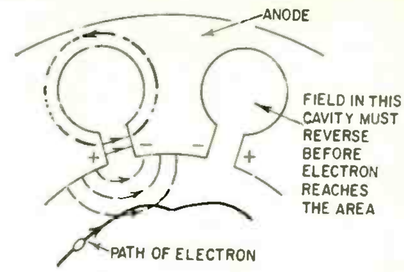


Fig. 8—Electron expends energy as it moves toward a negative point, absorbs energy when drawn toward a positive one.

When we have a cavity excited in some way by radio-frequency energy, we can have a difference of potential at the two walls of the cavity. This is indicated as "+" and "−" in Fig. 8. The arrows show (by convention) the direction in which an electron would be slowed down. Thus, an electron approaching the heel of the arrow is being decelerated, and an electron approaching the point of an arrow is being accelerated.

In Fig. 8 we have also drawn one of the electrons in the whirling cloud we spoke of before. This electron approaches the heel of an arrow—in other words enters a retarding field as it approaches the "−" segments, and loses some of its kinetic energy. This energy is imparted to the field in the cavity. How? Consider it in the following way: If the electron enters the field between the "+" and the "−", it will repel one electron *charge* from the field toward the "cathode" ("−") of that cavity. That charge will flow around the outside of the cavity to the "+", as indicated by the dashed lines. When the electron is past, the charge will flow back and re-establish the equilibrium in the field. The traveling electron loses kinetic energy and is then deflected from the cavity entrance by the magnetic field (which is here again perpendicular to the paper), and we show the path curved that way. The charges flowing back and forth on the inner surface of the cavity constitute an oscillatory current.

But the electron travels on past the next cavity. If we make sure now that the electron will also find a retarding field there, the action will be repeated as at the first cavity, and the electron will lose some kinetic energy again. Eventually, after passing a number of cavities, it will lose enough energy to be attracted to one of the anode segments between the cavities, because, you may remember, a stationary positive voltage is still applied to the entire anode.

This is the mechanism by which we obtain energy from the electron cloud in the dynatron operation of the magnetron. It is, as you can see, very similar to the method used in traveling-wave tubes (see RADIO-ELECTRONICS, December, 1959).

Between cavities, the electron obtains *some* energy from the positive voltage on the anode. If we now arrange our anodes and cavities and our electron speed so that the electron passes each cavity at the time when there is a retarding field, the electron will deliver energy to each cavity in turn. Since the cavities are adjacent, the field in these cavities will be 180° (half a cycle) out of phase. (The anode of one cannot be the cathode of the next one!) The time the electron must spend between cavities is exactly a half-cycle of the radio frequency. The path of such an electron is also indicated in Fig. 7. We have here, as in the traveling-wave tube, taken advantage of the transit time of the electron, which is the reason we also call this the *transit-time* method of operation.

Of course we must again get the thing started. But this is very easy, for once we get the cloud of electrons rotating by adjusting the plate voltage on the multi-cavity anode and the magnetic field (which most often is steady, supplied by a strong permanent magnet), the electrons passing the cavities will start to excite them and build up the rf field on them, which we had shown in Fig. 8 with the "+" and "−". These symbols of course indicate a momentary condition. We cannot keep the electron whirling around indefinitely; it would then begin to take up more energy than it would deliver. There is some optimum value for each type of magnetron.

Several other matters enter into magnetron operation. For example, there is the matter of *strapping*. The tendency of the cavities to get out of phase (because the electron which is losing energy might start to slow down) must be prevented. This we do by connecting each alternate anode segment with a heavy copper strap. This tends to equalize any voltage differences (rf, that is) on the anode segments, and the cavities are thus kept in phase. Obviously we must have an even number of cavities.

The magnetron can be made to deliver enormous power for very short periods of time. Even then the maggie must be cooled. As you saw in Fig. 2, air or liquid cooling can be used. But even so, the "duty cycle" of the magnetron (the portion of each second during which it is putting out power) must be short for maximum efficiency of radiated power without burning up the tube. So we *pulse* the magnetron—supply plate power to it 120 times per second in the Radarange. Fig. 9 shows the complete circuit of one of these ranges.

Most of the diagram is devoted to safety and control devices. T1 is the filament transformer and cathode connection. We bring this cathode to a high negative voltage 120 times per second (so that we can keep the plate nearest

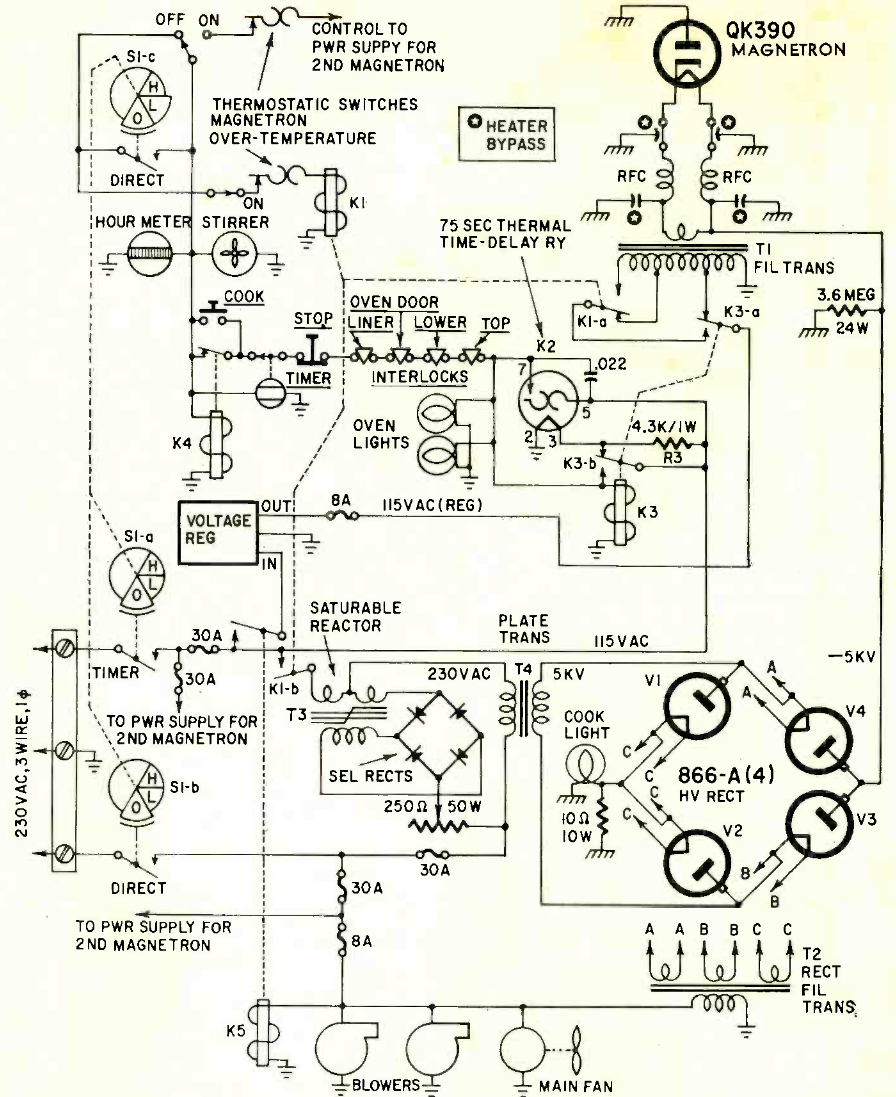


Fig. 9—Circuit of Raytheon Radarange. Not shown are a second magnetron and power supply, for full and half heat.

to the food grounded)*. This voltage is supplied by rectifiers V1, 2, 3, 4. These form an *unfiltered* full-wave bridge supply, providing the 120 pulses per second. The primary voltage of power transformer T4 is carefully regulated by magnetic amplifier T3. As you now know, the magnetron is very sensitive to voltage fluctuation.

Each Radarange contains two magnetrons. With switch S1 the operator can select OFF, LOW (one magnetron on) and HI (both on). He can preset the cooking time on the timer. Relays K2 and K3 provide a time delay, preventing the application of high voltage to the magnetrons until the filaments are warmed up. In the standby condition, when only the filaments are warm, they receive a *higher* voltage than when the plate power is on. As you will remember, some of the electrons return to the cathode, and these have additional heating effect.

To prevent the cathode from overheating, we must *reduce* the filament supply while the power is on. Relay K3 inserts R3 in series with the heater to apply a lower voltage to the thermal contacts of time-delay relay K2 after that relay has provided the necessary time delay. However enough current passes to keep K2 energized. At this point contacts K3-a of relay K3 switch the 115-volt line to a higher tap on T1 to reduce the voltage applied to the magnetron filament to 9. This voltage is again reduced by K1 when that relay is energized by the COOK button, and when it applies plate power to the magnetron.

The Radarange is the restaurant version. Industrial units are similar but some of them much larger. The 2,400–2,500-mc range of frequency is used because it is one of the most efficient *available* frequency bands for heating of foods. Actually 1,800 mc (10 cm) would be more efficient, but that frequency is occupied by other services.

This is the one industrial application of magnetrons, a microwave oscillator quite familiar from radar and other microwave applications. But you can be sure more and more of them will be used in industry as time goes by, particularly in the food industry, where they have the tremendous advantage that they can cook a large amount of food not only in a very short time, but also without discoloring it or changing its flavor. **END**

* For safety, in case an interlock should fail or food particles reach the plate, shorting it to ground.

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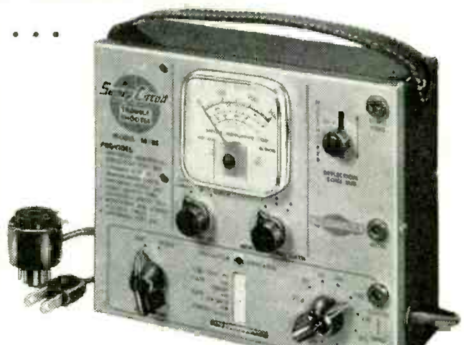
Ask any serviceman who owns one . . . or try one for just one day of servicing. You'll see for yourself how much time the LC3 can save you. Checks for leakage between all elements, whether caused by gas, grid emission or foreign particles. Also checks leakage on all capacitors with voltage applied — including electrolytics. Provides instant filament checks in "Fil-Check" position—no need for a second filament checker. One spare pre-heating socket and new roll chart prevent obsolescence. New charts provided free. For 110-120 volts, 60 cycle AC.

SENCORE SS105 SWEEP CIRCUIT TROUBLE SHOOTER

The Missing Link in TV Service . . .



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IT'S A . . .
UNIVERSAL HORIZONTAL OSCILLATOR. For direct substitution. No wires to disconnect in most cases. Traces trouble right down to the defective component. Variable output from 0-200 volts, peak-to-peak. Oscillator will sync to TV sync signal giving check on sync circuits.

HORIZONTAL OUTPUT CATHODE CURRENT CHECKER. A proven method that quickly checks the condition of the horizontal output tube and associated components. Adaptor socket prevents breaking wires. Easily replaceable Roll Chart gives all necessary pin, current and voltage data. New Roll Charts are Free.

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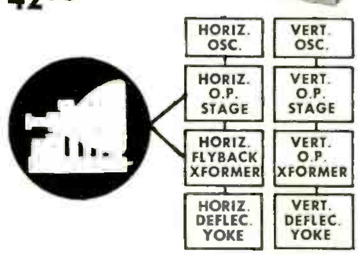
VOLTMETER. For testing bootstrap, screen and other voltages. Direct-reading voltmeter, 0-1000 volts.



UNIVERSAL VERTICAL OSCILLATOR. Checks oscillator, output transformer and yoke. Merely touch lead to component and check picture on screen.
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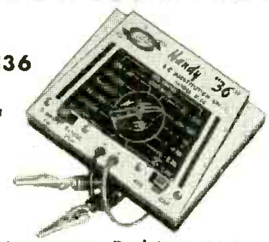

Substitute for Capacitors, Resistors . . . Provides the 36 most often needed resistors and capacitors for experimenting, substituting or testing. Eliminates searching for replacement components, unnecessary soldering and unsoldering and the mess it creates. Says goodbye to crumpled parts. Flick of a switch instantly selects any of: 24 Resistors from 10 ohms to 5.6 megohms, 10 Capacitors from 100 mfd to .5 mfd, 2 Electrolytics, 10 mfd and 40 mfd at 450 Volts. All components are standard American brand.

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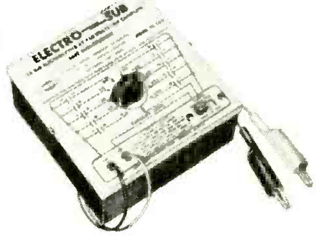
ELECTRO-SUB



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Locate faulty Rectifiers, Diodes . . . This unique substitution unit simplifies trouble shooting rectifiers and diodes, gives you a positive check every time. Substitute for suspected rectifier or diode, watch picture or listen to sound and you'll know in seconds whether or not the rectifier or diode should be replaced. No guess work, soldering mess or time lost. The RS106 costs less than having loose rectifiers and diodes in the shop for testing and is worth many times more. A must for servicing voltage doubler circuits. Protected by a ½ amp. Slow Blow Fuse.

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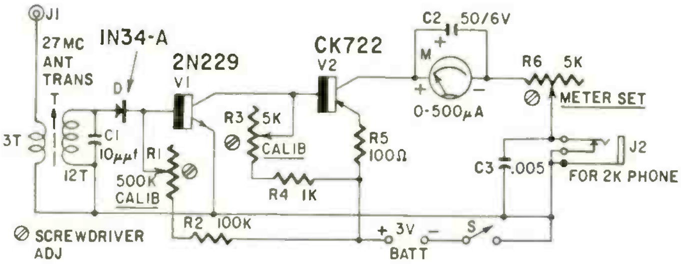
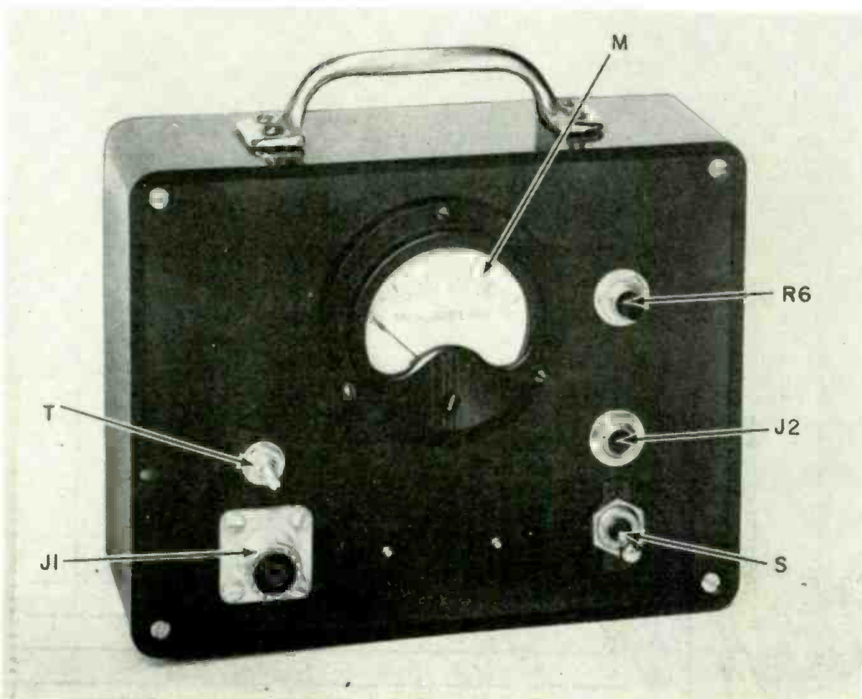
R2—100,000 ohms
R3, 6—pot, 5,000 ohms, linear
R4—1,000 ohms
R5—100 ohms
All resistors ½ watt 10% unless noted
C1—10 μμf, ceramic, NPO (Centralab TCZ-10 or equivalent)
C2—50 μf, 6 volts, electrolytic
C3—.005 μf, ceramic
BATT—3 volts (2 penlight cells in series)
D—1N34-A
J1—coaxial connector (to match antenna)
J2—closed circuit phone jack
M—0 500 μa
S—spst toggle
T—antenna transformer: secondary, 12 turns No. 28 enameled wire; primary, 3 turns plastic-covered hookup wire: both wound on CTC coil form PLS5B
V1—2N229
V2—CK722
Battery holder
Flea clips
Base-loaded whip antenna for 27-mc band
Miscellaneous hardware

By LYMAN E. GREENLEE



Circuit of the two-transistor field-strength meter.

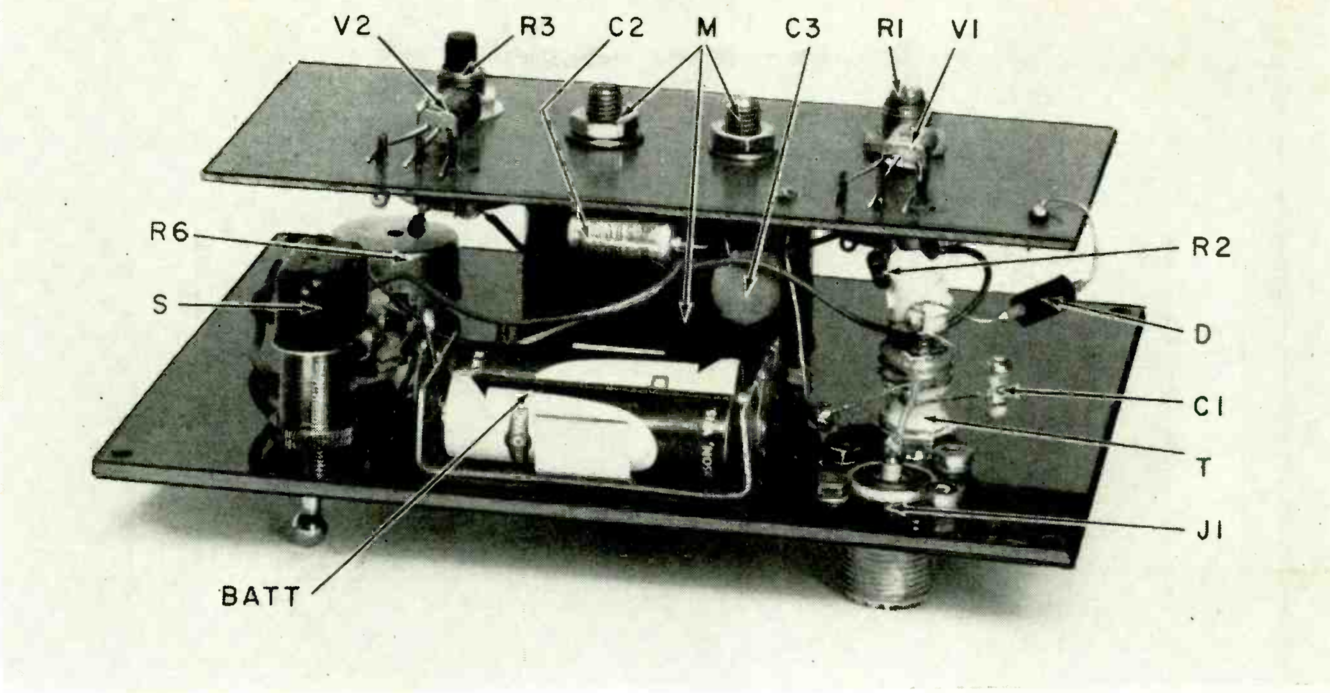


A bakelite case houses the unit.

MEASURING the field strength of a transmitter's radiated signal is an excellent way to evaluate the efficiency of any antenna or transmitter. The best way to do this is with a field-strength meter. Most Citizens-band transmitters are limited to 5 watts input. Therefore, they require the maximum antenna efficiency to make full use of the available power. The latest FCC rulings permit the operator to adjust the antenna tuning on Citizens-band transceivers. The only adjustments not allowed are those affecting the transmitted frequency, which must be held to within a tolerance of .005%. But without accurate equipment for measuring field strength, it is not easy to tell whether antenna or transmitter adjustments are for better or worse.

This direct-coupled two-transistor field-strength meter is simple and requires few parts (see schematic). A 27-mc base-loaded whip antenna feeds through a coaxial connector to antenna transformer T. A 10-μμf fixed capacitor (C1) and the slug in the coil form allow tuning over all 23 Citizens-band channels. The diode detector feeds V1's base. This n-p-n transistor is direct-coupled to V2, a p-n-p unit. The meter is any 0-500-μa unit and is bypassed by C2 to avoid sudden pointer swings on signal peaks. A pair of 2,000-ohm headphones can be plugged into the phone jack to monitor speech from the transmitter. This is a very convenient way to check speech quality. Power is furnished by two penlight cells.

Operating procedure is straightforward: Set R6 at half-scale (about 2,500 ohms) and adjust R3 (inside the meter case) for a full-scale meter reading. Make this adjustment with no signal.



The phenolic chassis is fastened to the meter. This gives firm yet simple mounting.

Now adjust T and R1 for maximum meter deflection with a 27-mc signal. The meter reads full scale with no rf signal, and R6 which is on the front panel is used to set the meter to full scale. R1 and R3 inside the case are adjusted once and left alone unless transistors are changed.

The circuit is temperature-sensitive (like all transistor circuits of this type) so R6 has to be adjusted each time the switch is turned on. If this full-scale meter adjustment is beyond the range of R6, reset R3 inside the case. In measuring field strength, we are primarily concerned with tuning the transmitter for maximum output, so we adjust for maximum meter *swing* regardless of the no-signal setting of the meter. Plugging in the phones will alter the meter reading, but this is of no consequence because field-strength measurements are normally made with the phones disconnected. The undistorted audio output is low, current through the phones being limited to 500 μa at 3 volts, but it is adequate for checking hum and modulation difficulties with a small transmitter. If the field-strength meter is being operated within 10 feet of the transmitter, the audio output will be distorted because of overloading. If it is necessary to work very close to the transmitter, remove the whip antenna. The easiest way to reduce the signal is to move away from the transmitter until a point is found where speech is clean and the circuit no longer overloads.

To evaluate different antennas, proceed as follows: Set up the field-strength meter at a known fixed distance from the antenna to be checked out. Set the meter to full scale with R6 and then turn on the transmitter, tune it to the antenna and take a field strength reading. In this way, various antennas, locations and transmitters can be compared. Use a tape measure and choose a convenient distance such as 25 or 30 feet for all measurements. By keeping the distance from the antenna constant, the relative meter reading will show antenna and transmitter efficiency and may be used as an accurate basis for comparing equipment. The rf output from the antenna can frequently be doubled or tripled with careful tuning and adjustment, and this is certainly worth while when we consider the low power and limited direct range of a Citizens-band transmitter.

The direct-coupled meter circuit has proved rugged and dependable in actual use. By reversing the polarity of the diode, the meter can be made to swing in the opposite direction with an rf signal and, if a transistor with low leakage is selected for V2, the no-signal "zero" reading on the meter will be small.

With diode polarity reversed, R1 and R3 should be adjusted for a low initial meter reading, rather than a full-scale reading. This field-strength meter will give a satisfactory indication either way; the one you use is a matter of choice. When the diode polarity is reversed, set R6 for a full-scale meter reading with the maximum signal normally encountered.

Any of several base-loaded whip antennas can be used with the field-strength meter. Listed in order of best performance for this unit they are:

International Crystal CRA 208
Lafayette HE17
Radio Shack 29D672 (I used this)
Allied Radio 83YX729
Philmore AA59

Mount the meter, S, J1, J2, T, the batteries and R6 on the front panel. The rest of the parts should be mounted on a small 1/8-inch linen bakelite subpanel which is held in place by the meter as shown in the photograph. Layout is not critical and all the parts to be used may be placed on the undrilled panels and outlined with pencil to locate the mounting holes. The transistors are mounted with six flea clips, three per transistor. Parts on the subpanel, including the flea clips, should be wired before it is attached to the meter. Be sure to observe correct polarity when connecting the transistors, diode, electrolytic capacitor, and battery. Be sure to install the transistors correctly and remember one of them is an n-p-n while the other is a p-n-p. If you install them the wrong way, both will be ruined. END

Specifications: Must for tuning up Citizens'-band transmitters • Completely portable • Very sensitive direct-coupled transistor circuit.

Performance Data: Tests conducted by a member of the staff of RADIO-ELECTRONICS showed operation substantially follows author's specifications. Unit is excellent for 27 mc, yet does not react to high power at 21 mc (50 watts). Sensitive enough to give a reading from a 250-mw transmitter. Components are comparatively inexpensive.

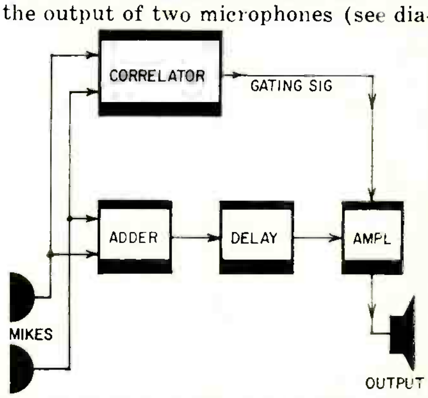
SOUND AT THE cocktail party

HUMAN hearing is amazing. Ever notice how you can be in a crowded room filled with people all talking at the same time and still be able to concentrate on a specific voice and separate it from all other sounds even though it may be no louder than the surrounding noise level?

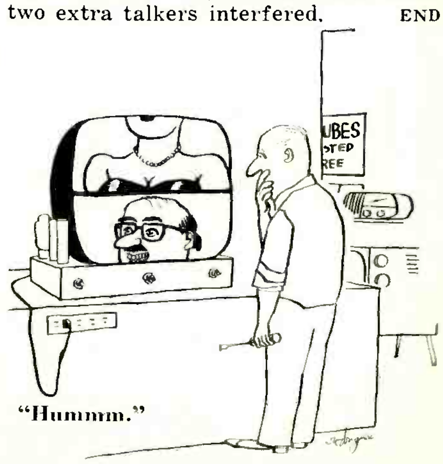
This "cocktail-party effect" works so well that any two-eared listener can enhance the effective intensity of the desired voice by 5 to 15 db simply by mentally suppressing the background noise level.

All this is well and good, but can it be duplicated electronically? Yes, it can and has been done. The way to do it was described by E. E. David, Jr. and J. F. Kaiser of the Bell Telephone Laboratories at a meeting of the Acoustical Society of America.

The device these scientists use takes the output of two microphones (see diagram), compares them and cross-correlates them to generate a gating signal which is applied to the combined output of the two mikes. The gating raises the intensity of the combined signal only when energy from the desired voice arrives simultaneously at both microphones. At all other times the gate suppresses the combined signal. Noise or interfering speech is passed through the gate only if it occurs at the same instant as the desired speech signal.



Subjective tests with a prototype unit showed enhancements of 9 db in effective signal levels against an interfering single-talker background. A smaller enhancement, 5 db, was measured when two extra talkers interfered. END



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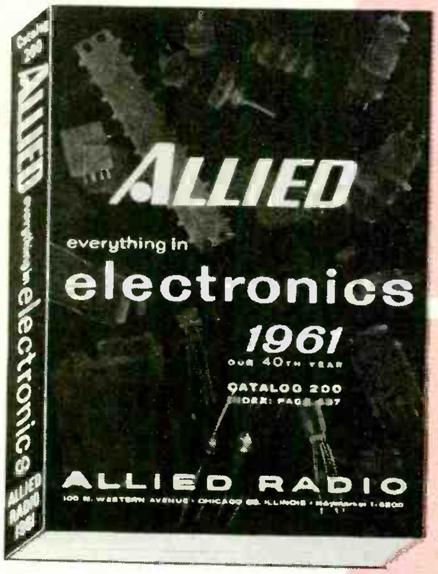

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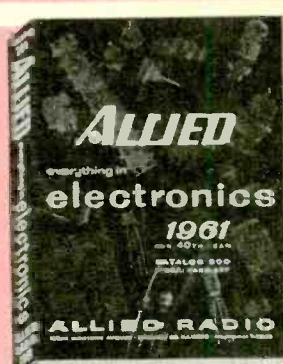

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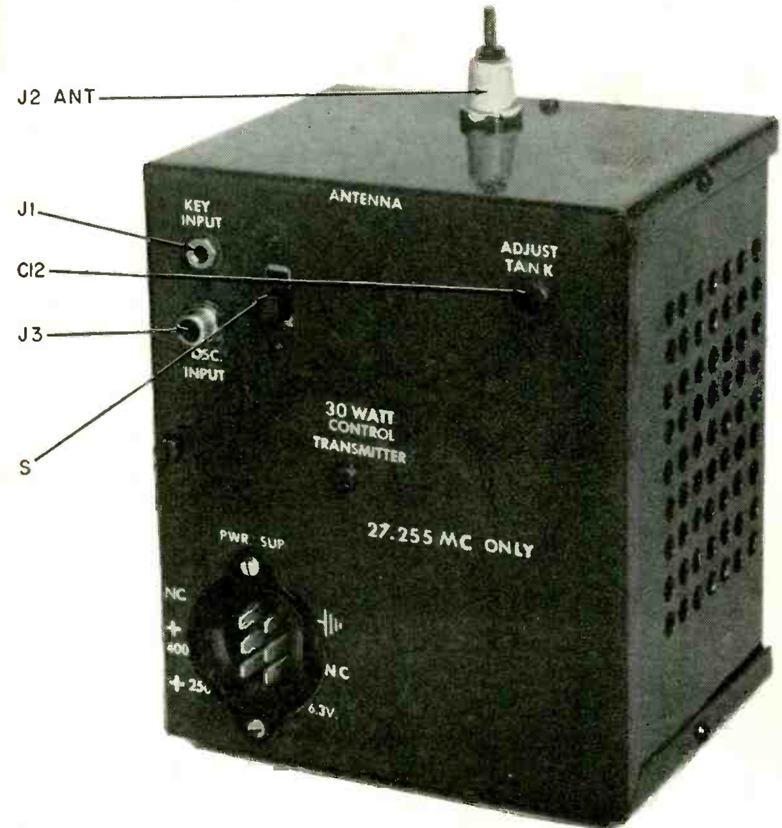


The completed unit. Author used a 6-terminal Jones plug to connect the separate power supply.

radio control with OOMPH

30 watts of remote-control power in a 4 x 5 x 6-inch package

By J. H. THOMAS

IN the excitement over the Citizens-band communications many may have overlooked the simultaneous change in the control channels, which allows 30 watts input on one of them, channel 23 (27.255 mc). Most radio control transmitters were designed for the earlier 5-watt maximum input. But here is a compact, powerful transmitter which can take advantage of the new regulations for class-C transmission.

The unit (Fig. 1) has a 30-watt input and can be keyed (for carrier control) or modulated for control by audio tones. The modulator is included in the unit, but the power supply (Fig. 2) is separate. Fig. 1 shows the complete schematic of the transmitter and modulator. Half of a 12AV7 is the crystal oscillator. Here you should note that for 30-watt input the FCC requires .005% frequency control (for less than 3-watt input .01% is permitted). Make sure that the crystal you buy has the proper frequency tolerance. The second 12AV7 section is an amplifier driving the 6BQ6 final.

The 6BQ6 final amplifier is screen-modulated. This is one of the most economical ways of modulating, but you can't use it and get 100% modulation—about 80% is the best that can be expected. This can be obtained with less than 1-volt signal at the modulator's input. (For 100% modulation, the screen would have to be driven negative.)

Switch S enables the operator to select modulated or unmodulated opera-

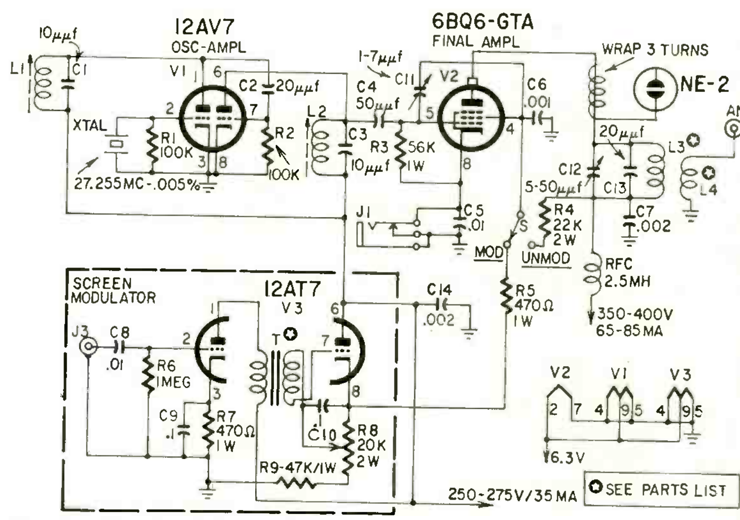
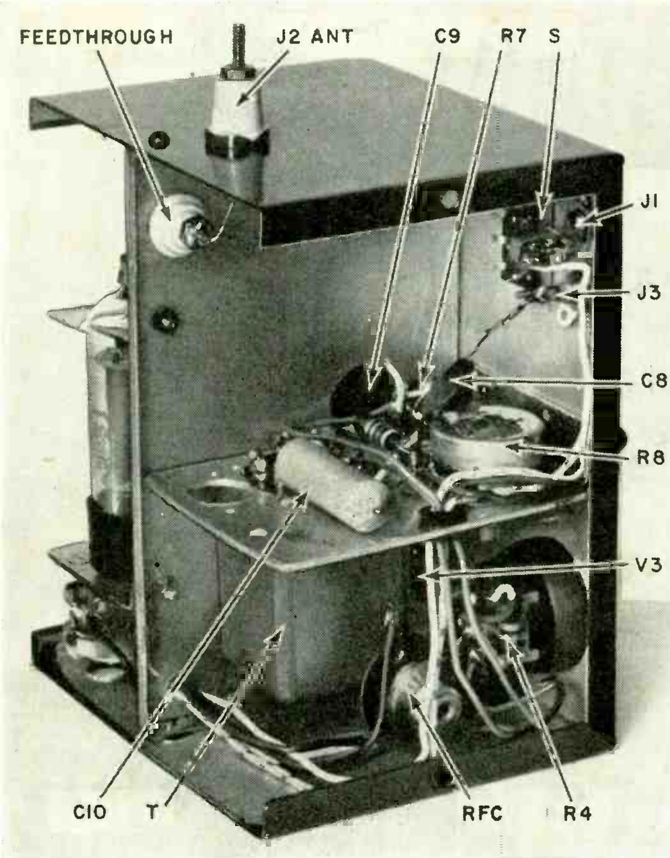
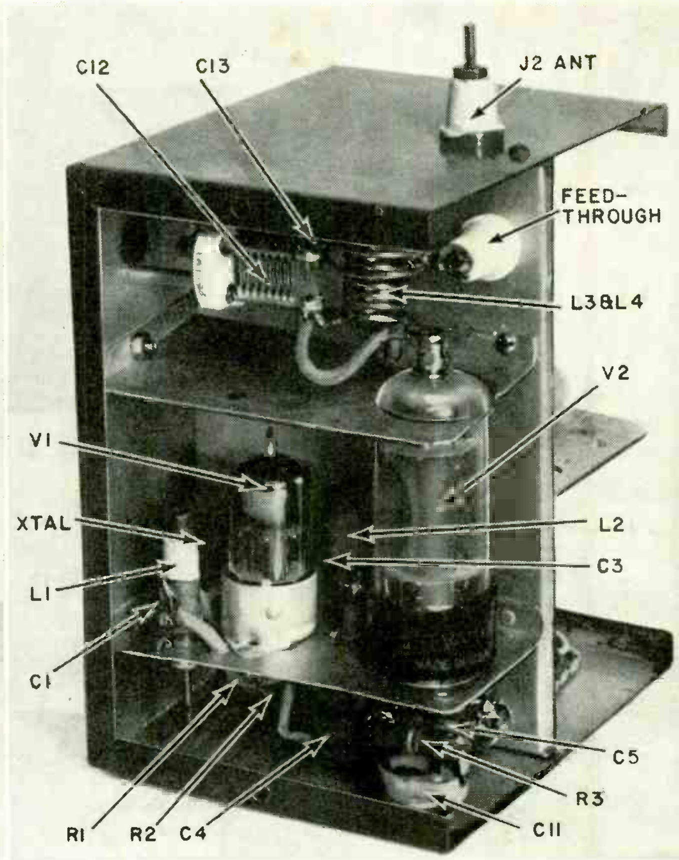


Fig. 1—Circuit of the radio control transmitter.

R1, 2—100,000 ohms, ¼ watt
R3—56,000 ohms, 1 watt
R4—22,000 ohms, 2 watts
R5, 7—470 ohms, 1 watt
R6—1 megohm, ¼ watt
R8—pot, 20,000 ohms, 2 watts or more, wirewound
R9—47,000 ohms, 1 watt
All resistors 10% tolerance
C1, 3—10 μμf, disc ceramic
C2, 13—20 μμf, disc ceramic
C4—50 μμf, disc ceramic or mica
C5, 8—.01 μf, disc ceramic
C6—.001 μf, disc ceramic
C7—.002 μf, disc ceramic
C9, 10—0.1 μf, paper
C11—1-7 μμf, trimmer
C12—5-50 μμf, trimmer
All capacitors 600 volts
J1—phone jack, normally closed
J2—standoff insulator
J3—phono jack
L1, 2—15 turns No. 24 DCC on ¼ inch slug-tuned coil form (Miller C-1 or equivalent)
L3—11 turns No. 14 bare copper wire. Wind into coil ½-inch ID, 1¼ inches long, supported on C12.
L4—2 turns No. 14 bare copper wire. Wind ¾ inch ID, supported on standoff insulator. Leave one end long enough to reach chassis ground. Mount surrounding cold end of L3.
S—spdt slide switch
T—4:1 audio interstage transformer
V1—12AV7
V2—6BQ6-GTA
V3—12AT7
Case, 4 x 5 x 6 inches
Socket, octal
Sockets, 9-pin miniature (2)
Neon lamp (NE-2)
Miscellaneous hardware



A look inside the transmitter's case.



Another view of the transmitter's interior.

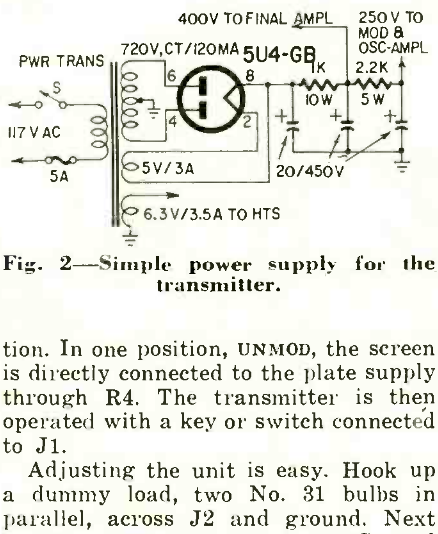


Fig. 2—Simple power supply for the transmitter.

tion. In one position, UNMOD, the screen is directly connected to the plate supply through R4. The transmitter is then operated with a key or switch connected to J1.

Adjusting the unit is easy. Hook up a dummy load, two No. 31 bulbs in parallel, across J2 and ground. Next tune the resonant circuits, L1–C1 and L2–C3, with a grid-dip oscillator to a frequency slightly higher than 27.255 mc. This must be done with the tubes in place since their input and output capacitances contribute to the total circuit capacitance. Then apply power and tune the bulbs in the dummy load for maximum brightness. Lack of signal will show up immediately as a sudden increase in plate current to the final. When the transmitter is lighting the bulbs, slowly increase the inductance of L1 and L2 a bit at a time, again increasing the bulb's brightness. Suddenly you will reach a point where no signal is generated. Back off a quarter of a turn on both L1 and L2, and turn the power off and on to shock the crystal into operation. If the bulbs light each time you turn on the power, L1 and L2 are properly tuned. A final tank adjustment is necessary to match to the antenna you'll be using.

This kind of power can effectively shut down communication on the upper Citizens-band channels for miles around, if the communicators are using broadly tuned superregenerative receivers. So use the transmitter sparingly. The FCC permits the radio control transmitter to be on only when actually controlling objects.

In the modulator, with no modulation applied, R8 is adjusted for an antenna current of about 30% of the UNMOD position. However, this is difficult to judge with only a lamp load. Using a grid-dip oscillator as a detector may help, and it should show a reduction of about 50% with the modulator in the circuit.

What can you do with such a powerful transmitter? Well, for one thing you can consider control operations which would have had no margin of safety with low-power transmitters. The usual reliable range of ½ mile can now be increased to many miles. If you are a rocket fan, you can control missiles with it. If you just want to open the garage door, you can now make sure that the door is fully open before you get there. Or you can use this transmitter to call people with a paging receiver. Voice transmission is not permitted, but calling is. In the words of the FCC (Part 19, paragraph 19.34c) "... for the remote control of objects or the remote actuation of devices used solely as a means of attracting attention."

Many other new uses will crop up. Controlling agricultural machines and devices over considerable distances and turning irrigation pumps on and off are a few farm applications. Industrial uses would include opening and closing doors, guiding carts and loading devices, etc. A friend of mine uses his to anchor his boat a considerable distance from the pier. A special pelican hook disconnects the mooring line from a buoy after a control impulse starts the engine. Control of engine and rudder then brings the boat alongside, saving the owner an arduous rowing trip.

The station must be licensed by the FCC. Such a license is not hard to get if the equipment is crystal-controlled and meets other specifications as set forth in part 19 of the rules. END

- Operates on Citizens band
- 30-watt input
- Long-range radio control
- Tone or carrier type operation

Unit meets author's specifications. Transmitter has high output and seems to show no signs of frequency drift. If unit is stable—and this one is—it can be tuned to proper frequency. Transmitter must be on frequency. (Allowable tolerance is .005%.)

BENCH TESTED

Tube-Changing The Tough Ones

By **JACK DARR**
RADIO-ELECTRONICS TELEVISION CONSULTANT

Changing a tube is often only the start of a repair job. It can indicate burnt-out resistors, shorted capacitors or other damaged components.

"THAT finishes Ozz-wald," said the Old-Timer, laying down his soldering gun. "Now we'll let him sit and cook for a while. Make sure his horizontal sweep is back in order. So, Junior, with the work out of the way for a while this looks like a good day for me to do a little lecturin', so get ready."

The Young Ham tore off a couple of pieces from the filthy cloth which was referred to as "the shop's clean rag" and pretended to stuff them in his ears. The Old-Timer made threatening motions at him and resumed.

"Well, sir, there's more to 'tube-changing' than just pluggin' in new tubes. F'rinstance, if you open up a set and find the B-plus fuse blown, you might just put a new fuse in and go on, but if you do, you'll probably be back pretty soon. You oughta check the damper tube. Here." He pointed to it in the set on the bench. "See? Better check it for shorts by flipping it pretty hard with your finger, like this." He snapped his middle finger against the tube base. "If there's any shorts in it you'll notice it arcin' and sparkin' right down here at the base of the elements. You may short it out and blow a fuse, but better blow it now than after you leave. Lots of guys replace the damper tube anyhow, whenever they find that fuse blown, just for luck."

"How about the high-voltage rectifiers?" asked the Young Ham. "They give a bit of trouble too, don't they?"

"Yes, but not as much," replied the Old-Timer. "They're pretty easy to spot. If you can draw a fairly good arc from the plate cap, but haven't got any high voltage on the picture tube, change the rectifier. But don't assume the rectifier's good if you can't get an arc; I've found several of 'em that must have been shorted. If they're weak you'll get 'blooming.' The picture will get a lot bigger when you turn up the brightness control. Generally goes out of focus at the same time."

"Can't you get the same symptoms from the horizontal output tube?" asked the Young Ham.

"Nope, just the opposite," said the Old-Timer. "Usual sign of that is a narrow picture. Weak tube don't have enough poop to swing the beam all the way across. Also, a weak oscillator tube will narrow the picture. Look out though; I found one once that bloomed just like a bad 1B3—turned out to be a bad 6SN7 in the horizontal oscillator! Those are pretty scarce though. Y' want to look out for two-tube troubles. If the oscillator gets weak and don't drive the output tube and it's run for some time, the output tube may get weak from being underdriven and drawing too much plate current."

Checking tube-element voltages from the top of the chassis. All it takes is a test-socket adapter.

"Oh," said the Young Ham, "just like the final in my transmitter!"

"Pree-cisely," said the Old-Timer. "Same identical thing, in fact. These horizontal output tubes operate just exactly like your finals. Horizontal linearity control works kinda like your plate tuning. It 'tunes' the output of the stage so it will work most efficiently. So if you lose the drive on one of these hard-workin' little tubes, the chances are you'll weaken it considerable. Now, then! Here's somethin' you've got to do every time you change the horizontal output tube or oscillator. Check to see that the output tube has the proper amount of drive on its grid. Unless you do that, the chances are the new tube won't last too long!"

"How you gonna check that without taking the set out of the box?" asked the Young Ham. "The grid's on the bottom, pin 5, isn't it?"

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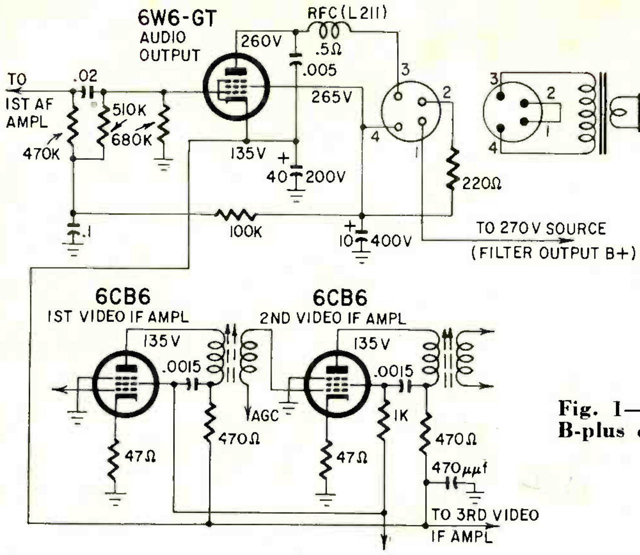


Fig. 1—Typical series B-plus circuit.

"On the 6BQ6, 6CU6 and some others it is," answered the Old-Timer. "Here's the answer to that problem." He reached a long arm up to a little shelf over the bench, and brought down an adapter. Turning the set off, he removed the 6BQ6, plugged it into the adapter and replaced it in the set. Turning the set on, he reached for a vom lying nearby. "See? The grid comes out to these little studs on the side here. Measure it with that little vom we keep in the tube caddy. There's one of these adapters in the tool kit too. See here? 28 volts negative. That's about what it should be. For this tube and this set, that is. There's some variation, but not too much. Now if that'd been down around 15 volts, we'd have had to check the oscillator, the setting of the horizontal drive, or something. If you don't get enough drive, you'll notice the plate showing a little color and that ain't right. Shouldn't run red-hot, like the tubes in your transmitter sometimes do."

"Aww, they were only a little pink," said the Young Ham. "That just means they're good tubes!"

"Yep, rf output and heat the ham shack, all for the same price, huh?" said the Old-Timer. "But we ain't interested in heatin' the house here; we just want a good picture."

"Yeah, and how about some of these tight-fitting doghouses? If you raised the tube that much, the plate cap would short to the shield or at least arc over!" argued the Young Ham.

"Simple. Use some of that amateur ingenuity. Looky," and the Old-Timer pulled the tube, removed the adapter and slipped a short piece of solid insulated wire over the grid pin, after bending a loop on both ends and sliding the insulation back a bit. Replacing the tube, he clipped the voltmeter lead to the loose end. "Verstehen sie das, kinder?" he grinned. The Old-Timer had worked in South St. Louis long enough to pick up a smattering of "commercial German" and never tired of showing it off.

"Jawohl, Grossvater!" said the Young Ham, who hadn't been listening to him all year for nothing.

"'Nother thing," continued the Old-Timer, "you always oughta check your horizontal hold for proper range. In the average set with a good strong signal, you should be able to hold the picture over the entire range of the hold control. Of course, this means only the standard carbon-pot type of hold control, not some of them sets like the RCA's and the Stewart-Warner 9126 where the hold control knob was actually the end of the slug in the horizontal oscillator coil and you could keep turning it as long as you wanted to, almost. If your picture falls out with only a little turn of the control, chances are you've got a weak oscillator tube. Change it and see if your hold range doesn't go back to normal."

Combination troubles

"Now you get to the combination troubles. Stuff that's caused by one tube, but shows up like it was another one! Look here," taking a schematic from the file and spreading it on the bench. "What's going to happen if you get a heater–cathode short in this audio tube?"

"I don't know. Let's see . . ." and the Young Ham bent over the schematic (Fig. 1).

"I'll give you a hint. Follow the cathode circuit and see where it goes."

"It goes to . . . *the if plate?*"

"Yep. That's a series-B-plus circuit. They've got around 300 volts in the power supply, so to save makin' a voltage divider they connect the audio output and the video if's in series, for their plate supply. If you'll check the voltages you'll see that each one runs about 150 volts from plate to cathode. Now, you see they show the audio plate 260 volts, the cathode 135 volts, and the if plates 135 volts. This is from ground, of course. Now, what happens if you get a heater–cathode short in that 6V6 audio output?"

"You'd have the 260 volts on the if plates," said the Young Ham.

"Hello? Where'd you get the 260 volts?" said the Old-Timer.

"Well, it'd go right through the audio stage and to . . . Oh! I see. You said *heater–cathode* short! You'd have 260 volts on the *audio* plate and no voltage on the if's at all!"

"Now you're gettin' better," approved the Old-Timer. "Wouldn't get much picture, would you? Nor much sound, on account of you'd lose the sound signal at the same time in the if's. So you might be lookin' for trouble there instead of in the sound tube where it actually was. If that audio tube gets too gassy or its coupling capacitor gets leaky, you got troubles too. That upsets the bias, also the current drain of the audio tube, and fouls up the plate voltages on the if stages."

"This gets more and more complicated as we go along," sighed the Young Ham.

"You ain't been anywhere yet," said the Old-Timer. "Another place where heater–cathode shorts'll really get you is in the series–heater TV sets (Fig. 2). Half your tubes will be lit, the other half dead. Whenever you see that condition, you can generally find a heater–cathode short somewhere. If you've only got three or four tubes burning, chances are they'll be burning real bright, on account of they're tryin' to use up all the current that should have supplied the whole string! Way to catch that is to look for the last tube in the string that's burning. Lot of people now are putting diagrams of the filament string inside the cabinets, bless their little hearts. Remember that Westinghouse we checked yesterday? Had a 3AL5 shorted out, and we looked on the diagram, traced it right down, and there it was. Sure appreciate the guy that put that there!"

"Yeah, that's helpful," agreed the Young Ham.

"And we can use all the help we can get!" said the Old-Timer fervently. "Here's another dandy. There's nothing these things would rather do than lead you up the garden path with a lot of false symptoms. You got a set with all the symptoms of agc trouble: weaving, buckling and, if you check the voltage at the agc test point, there ain't any. Ah ha! Agc trouble, you say. You

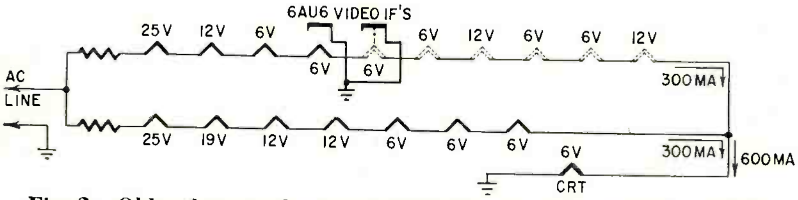


Fig. 2—Old-style series-heater circuit with two major branches. Each string carries 300 ma. If either 6AU6 in the upper string develops a heater-cathode short, the remainder of that string will go out.

change the agc tubes; no help. Finally you come up with a grid–cathode short in the second if tube! It's lowering the signal and shorting out the agc in the if stages, and there you are."

"That's what was the matter with that Philco last week, wasn't it? I remember what you called it!" laughed the Young Ham.

"All right, I'm ashamed of myself. Another case where you can get troubles, even after you replace the bad tube, is a tuner like the one we had last Tuesday. Remember? 6BZ7 shorted out, so we replaced it. Still had snow, so we had to take out the tuner and replace the two little resistors in the plate circuit that had burned to a crisp when the tube shorted. That's the one where the 'BZ7 plate was red-hot!

"Now you take color sets, you'll find all of the same symptoms in 'em, just like the black and white. Only thing, you've got a few more circuits in 'em. Now if you've got a good picture, but no color or the color won't hold, you start lookin' for some tube that handles the whole color signal—the burst amplifier, color killer, bandpass amplifier, and so on. Now if only one color was missin', say you didn't have any red in your picture, you'd start lookin' for a tube that handled only red signals —a dc restorer, or red amplifier, or somethin' like that. Simple, see?"

"Yeah, simple," agreed the Young Ham, dubiously. "I can imagine!"

"Now you can also get intermittents from tubes and lots of 'em! Take that set last week. Three other guys had worked on it without finding the trouble. I turned it on and the trouble showed up right away. I had to pull it out of the cabinet and check it with a scope, though, to be sure. It would play along perfectly and then blam! White-out! Scope showed no signal at the plate, but plenty at the grid. Nothin' between the two points except tube, so I replaced it. Took my high-power magnifyin' glass to the thing and, sure enough, you could see it then. The cathode ribbon was loose where it was welded to the tube pin! When she got hot, away she went, pulled loose. Like I say, I was just luckier than those other guys. It showed up for me."

"Aw, that wasn't luck, that was superior technical ability," said the Young Ham. "You're just smarter than they are. How about a raise?"

"I'll raise you, young squirt," said the Old-Timer. "Well, Ozz-wald," addressing the TV set which had been playing perfectly throughout all this discussion, "I reckon you're all right, so we can bundle you up and take you to your owner. Rain's stopped and it's about time to choose up sides an' go home." As he reached for the cheater cord, the picture gave a couple of wiggles, bowed in the center, and quietly faded out. The Old-Timer stared at it in amazement, while the Young Ham roared with laughter. Peering into the back of the set, the Old-Timer shrugged and reached for a 5U4. "Guess the dern thing musta been listenin'." He grinned. "Got a bad tube!" END

INJEC-CHECK

INDUSTRIAL TEST UNIT

One-transistor instrument is a measuring device, continuity checker, signal injector and audio generator

By WM. F. KERNIN

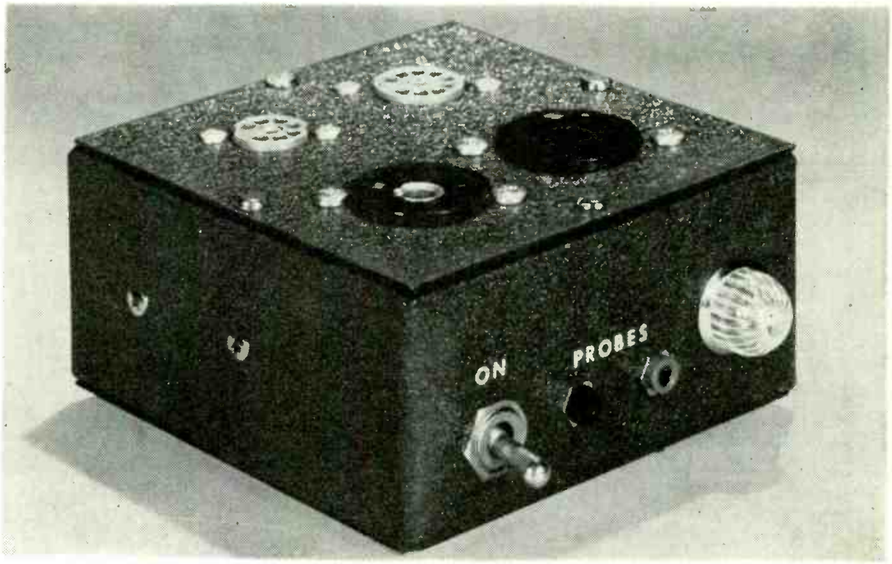
HERE is a device, originally designed to handle a measurement problem in industrial electronics, that proved to have numerous practical uses in the radio and TV service business as well as on the home experimenter's workbench. To list some of its uses to date: a preset level or temperature indicator, a tube filament checker, a continuity checker, an af–if–rf signal injector. It is simple and efficient—completely self-contained, battery-powered and compact enough to fit into your tool box.

Originally, an instrument to indicate when the solution in a tank had reached a given level was needed. Visual indication was desired. Cords from the electric line were taboo, for safety reasons; economical, long-life battery operation was required. For a sensing element, two probes were to be used, so that when the solution touched both at the set level, the indicator light would go on. One difficulty—any voltage on the probes must be ac. Direct current would decompose the solution. And this ac must present no shock hazard.

The schematic diagram shows the circuit that fulfilled all those needs. A transistor blocking-oscillator power supply provides the high voltage for the NE-51 indicator light. It is patterned after the high-voltage GM counter supply presented by Thomas G. Knight, RADIO-ELECTRONICS, September, 1956. Bias resistor R is much lower than normal to "beef up" the output of the generator. Capacitor C determines primarily the frequency or pulse repetition rate. The radio-frequency choke—RFC—is included to improve the efficiency of the oscillator by blocking the oscillator energy from the dc power supply. Jacks J1 and J2 are the input terminals for the sensing probes. An UTC H-1 miniature transformer was used because of its rugged construction, improved terminals and better mounting system. However, the less expensive O-1 or O-2 may be used.

The output potential in this unit lights the NE-51 to full brilliance when the probes are shorted. However, there is no shock hazard even if one should grab the bare probes in both hands.

Power for the unit is supplied by two inexpensive penlight cells. Current drain averages 4 ma.



The Injec-Check has sockets for quick filament checking

A level indicator

In operation, the probe tips are set at the desired height in the tank or vessel. Filling of the tank may begin as soon as the unit is turned on—no warmup time is needed. When the solution contacts the probes, NE-51 lights. When the level falls, the contact path between probes is broken—and the light goes out.

The unit may be used as a *minimum level* indicator. Here the light would stay lit until the solution fell below the preset level of the probes.

As a checkout feature for the unit, a momentary shorting switch may be connected between J1 and J2. To check the condition of the device when turned on, the switch is closed and, if all is well, the light should go on.

Proper operation depends upon a fair degree of conductivity of the solution. No attempt was made to use it with volatile or turbulent liquids.

Also a thermometer

As a set-temperature monitor, the unit is used with a mercury contact thermometer as the sensing element. This type of thermometer—particularly the delicate, precision ones—requires a low-potential low-current indicating device to avoid contaminating the mercury. The NE-51 draws only 90 microamperes to glow at full brilliance in this unit. Hence it works well with the mercury contact thermometer.

And a continuity checker

Now for the bonus. By adding the tube sockets shown by the broken lines in the diagram, the original unit can be used as a go–no-go tube filament and continuity checker.

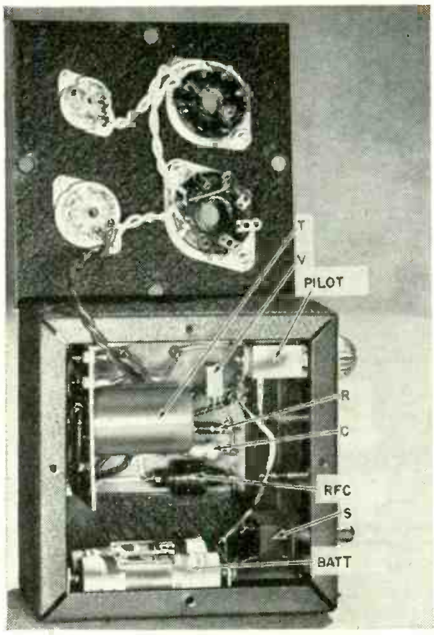
The NE-51 indicator light brilliance is not affected by normal filament resistance. Lowest current filament may be tested as surely as the highest.

The photographs show the layout used for a typical unit. A 4 x 4 x 2-inch utility box is the basic package. The choice of tube sockets shown covers most of the common tube types found in service work. To handle CRT and odd tubes as well as continuity checks, a pair of external test probes such as those used with the typical vom may be plugged into J1 and J2.

Operation as a filament continuity checker is simple. The unit is turned on; the tube is inserted in the proper socket. If the light lights, the filament is good. The same holds true using probes—continuity lights the light.

Or a signal injector

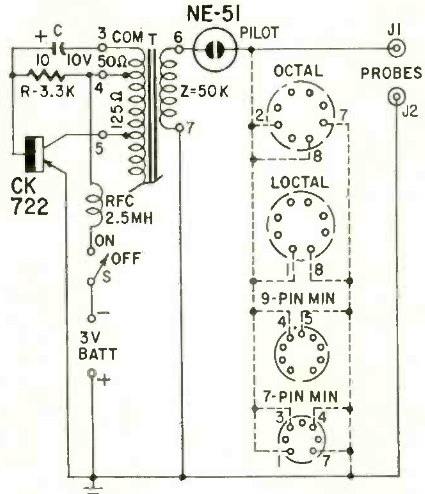
This device combines in one package



Inside view of Injec-Check

several features that are particularly handy in servicing the series-string ac–dc type of radio. Besides its use as a tube filament and continuity checker, it provides a signal source for injection into the radio under test. The waveform at jacks J1 and J2 is rich in harmonics, producing strong af, if and rf signals simultaneously. Thus, signal injection can begin right at the antenna and be applied to any and all stages. The output, or audio component, is heard as a distinctive "growl" or buzz from the set's speaker, if all is well.

The technique of signal substitution in servicing is fairly well known and need not be discussed here. To couple the signal into a set, one probe from the hot jack—J1—is all that is normally required. The ground return—J2—may be used for a stronger signal. END



The instrument is basically a transistor oscillator and neon-tube indicator

R—3,300 ohms, 1/2 watt
C—10 μf, 10 volts
T—transformer, UTC H-1, O-1, O-2 or equivalent
V—CK722
RFC—rf choke, 2.5 mh
S—spst switch
BATT—1.5-volt penlight cells (2)
PILOT—NE-51, bayonet socket, clear jewel
J1, 2—tip jacks (H. H. Smith 1505 or equivalent)
Tube sockets (octal, loctal, 9-pin miniature, 7-pin miniature), battery holder, 4 x 4 x 2-inch box
Miscellaneous hardware

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

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TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Subminiatures, Novals, Subminars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emisison-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-curent types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome, portable Saddle-Stitched Texon Case. Only **$47.50**

Model 80 — ALLMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Superior's New Model 80

20,000 OHMS PER VOLT ALLMETER

THE *ONLY* 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES *ALL* THE FOLLOWING FEATURES:

- **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- **CAPACITY RANGES** permit you to accurately measure *all* condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

- A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.
- Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
6 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms. 0-20 Megohms.
2 CAPACITY RANGES: .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: — 6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only.......... **$42.50 NET**

Model TV-50A—Genometer. Total price—$47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

GENOMETER

7 Signal Generators in One!

- *R.F. Signal Generator for A.M.*
- *R.F. Signal Generator for F.M.*
- *Audio Frequency Generator*
- *Bar Generator*
- *Cross Hatch Generator*
- *Color Dot Pattern Generator*
- *Marker Generator*

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency).

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

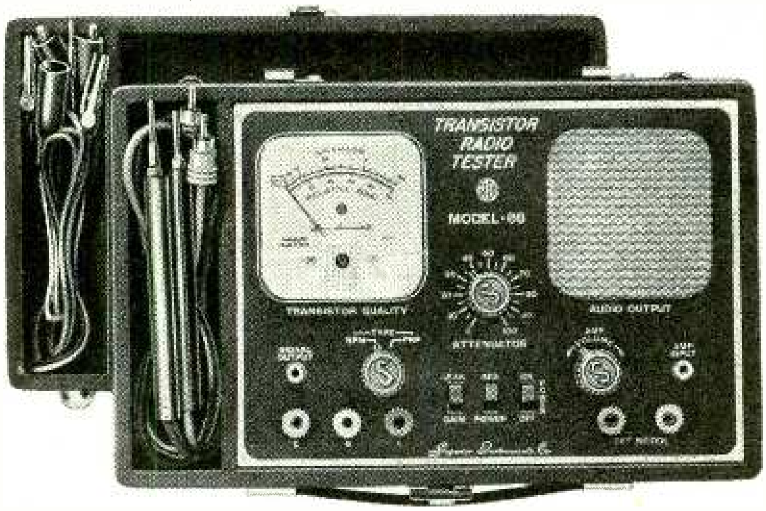
$47.50 NET

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

The Model 88....A New Combination

TRANSISTOR RADIO TESTER and DYNAMIC TRANSISTOR TESTER



The Model 88 is perhaps as important a development as was the invention of the transistor itself, for during the past 5 years, millions of transistor radios and other transistor operated devices have been imported and produced in this country with no *adequate* provision for servicing this ever increasing output.

The Model 88 was designed specifically to test all transistors, transistor radios, transistor recorders, and other transistor devices *under dynamic conditions.*

AS A TRANSISTOR RADIO TESTER

We feel sure all servicemen will agree that the instruments and methods previously employed for servicing conventional tube radios and TV have proven to be impractical and time consuming when used for transistor radio servicing. The Model 88 provides a *new simplified rapid* procedure — a technique developed *specifically* for transistor radios and other transistor devices.

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble whether it be a transistor, some other component or even a break in the printed circuit is located and pinpointed. The injected signal is heard on the front panel speaker as it is followed through the various stages. Provision has also been made on the front panel for plugging in a V.O.M. for quantitative measurement of signal strength.

The Signal Tracing section may also be used less the signal injector for listening to the "quality" of the broadcast signal in the various stages.

AS A TRANSISTOR TESTER

The Model 88 will test all transistors incuding NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

SPECIFICATIONS:

✔ Model 88 operates on a self-contained 4½ volt battery and is always ready for instant use on the bench or in the field.

✔ ***Signal Injector:***

The signal injector used in the Model 88 is a new departure in signal source design. Previously, signal sources were provided by signal generators operating on a single frequency and requiring retuning. The Signal Injector of the Model 88 employs a transistor in a grounded emitter self-modulating blocking oscillator generating a low R.F. frequency providing stable harmonics to 30 megacycles. A power output of over 2.5 volts peak to peak is provided. An attenuator prevents overload of the receiver or the amplifier under test.

✔ ***Signal Tracer:***

Two high-gain grounded emitter transistors are utilized in a high gain amplifier with sufficient output to operate the built-in 4½" Alnico V Speaker. A diode is used as a "clamp" to prevent overloading of the output stage. A volume control permits attenuation of strong signals. Provision is also made on the front panel for the addition of a meter or an oscilloscope for quantitative evaluation of the signal strength.

✔ ***Transistor Tester:***

The transistor tester used in the Model 88 measures the two most important transistor characteristics needed for transistor servicing; leakage and gain (beta).

The leakage test measures the collector-emitter current with the base connection open circuited. A range from 50 ohms to 100,000 ohms covers all the leakage values usually found in both high and low power transistor types.

The gain test (beta) translates the change in collector current divided by the base current. Inasmuch as the base current is held to a fixed value of 50 micoamperes, the collector current calibrated in relative gain (beta), is read directly on the meter scale.

The Model 88 will test *all* transistor types, including NPN or PNP, germanium, silicon, gallium arsenide and the newer diffused junction and mesa types.

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-On Cables for Transistor Testing, an R.F. Diode Probe for R.F. and I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! Only **$38.50**

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Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC.
Dept. D-813, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligations.

☐ Model 88................Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.

☐ Model TW-11..........Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.

☐ Model TV-50A ....Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.

☐ Model 80................Total Price $42.50 — $12.50 within 10 days. Balance $6.00 monthly for 5 months.

Name..

Address..

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

All prices net, F.O.B., N. Y. C.

Export Division: Rocke International Corp., 13 East 40th St., New York 16, N.Y.

TV ANTENNAS INVITE *LIGHTNING* TO STRIKE

IF you're among the thousands who think that an ordinary television antenna atop the roof is safe from lightning, you're wrong, says the Lightning Protection Institute.

Studies of some 1,500 lightning-fire and damage losses, reported in newspapers during a 3-month period, reveal that upward of 4% of them involve television sets and their antennas. That's no small matter—$4,800,000 annually.

Those facts pointedly illustrate that an unprotected antenna *actually invites lightning to strike*. There are more than 40,000,000 television masts in this country, and it is inevitable that this forest of high-rising metal towers will help to increase the losses suffered from lightning strikes—unless the masts are protected.

Total annual lightning losses in the US are placed at 600 persons killed, more than 1,500 injured, along with $120,000,000 in property losses. Lightning is the biggest single cause of fires in rural and outlying suburban areas, being responsible for 37% of all such fires.

Tying the TV antenna into the home's lightning-protection system is one means of helping to reduce losses. Where a building does not have a complete lightning protection system, grounding the TV mast properly will only partially protect it. To ground a TV antenna adequately, in addition to a 10-foot ground rod, tie-in should be made to the water system, electrical and telephone grounds and any metallic bodies within 6 feet of the down conductor. Ordinary TV installations in themselves are inadequately grounded, and the antenna is not a lightning-protection device.

Basic information

Lightning will most likely strike the highest object in an area. Because of its height above surrounding objects, the antenna becomes this most likely lightning target.

A TV antenna, even though grounded according to most set manufacturers' recommendations (and with a lightning arrester), does not offer sure lightning protection for the set. It is not connected with a heavy enough cable nor does it provide the proper paths to earth to function as an efficient lightning rod.

Most antennas, contrary to popular belief, do not have lightning arresters. And an arrester is not full protection in itself—the mast must also be tied in with the correct conductor cable to a ground rod sunk 10 feet deep in moist earth.

When lightning does hit an ungrounded antenna, its path is most likely to be down through the house. It may leap over to the wiring system or water pipes, or follow the antenna lead. At the least, you can expect damage to whatever mechanical equipment the bolt passes through (Many TV sets have ended in a ruined tangle of wires) and at the worst, injury or death to occupants.

Scores of lightning losses involving TV antennas lead the Lightning Protection Institute to endorse strongly this requirement in the Underwriters' Laboratories code:

> **"Radio and television masts of metal, regardless of location on building, shall be bonded with standard conductor and fittings to the main conductor of the lightning protective system. It is also recommended that a lightning arrester be installed on the lead-in wire, tape, or cable."**

Where a television antenna is installed on a building provided with lightning protection (a lightning-rod system), the metal mast or supporting tower should be connected to the system. If the tower rises appreciably above the building, it should also have a down conductor connecting it directly to ground to conform to National Bureau of Standards requirements.

Alternate method

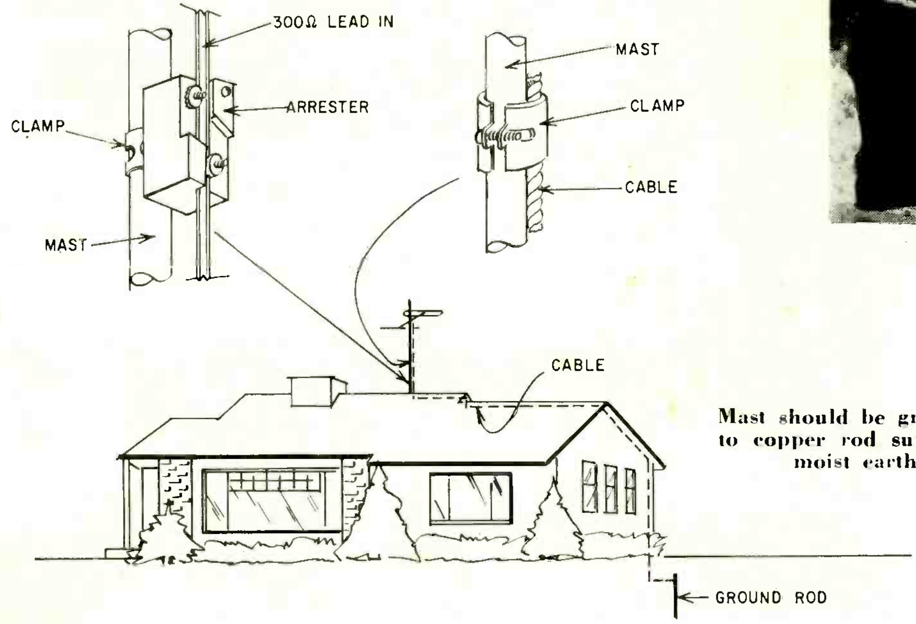
Where a building is not provided with a complete lightning protection system, and safety with economy is the watchword, the institute advises *full protection* of the TV antenna and set. This will partially protect the building proper. This is recommended on the premise that some protection is better than no protection at all.

If the TV antenna is centrally located, grounding the mast can be tied in with complete lightning protection for the home by continuing the cable in both directions (and adding terminals at 20-foot intervals if the building is 40 feet or longer) from the TV mast along the roof ridge and down to ground on two sides of the building. This is not a job for the usual TV installation man. Considering the danger to life and property, the importance of trained engineering skill becomes even more vital. Don't hesitate to seek professional help or advice in all instances, whether for protecting a TV set and antenna or for a complete lightning-protection system. However, if the antenna is at either end of the building, the TV mast alone is comparatively simple.

The drawing illustrates how the lightning arrester is connected to the TV lead-in and then fastened to the mast with an approved pipe clamp (which generally comes with the arrester). Many good arresters are on the market; the important thing to

An increasing number of TV-related lightning fires occur each year. Most could be prevented if proper grounding techniques were used

Lightning traveled "down" a TV lead-in and made a new entrance for this kitchen.



Mast should be grounded to copper rod sunk into moist earth.

watch for is the Underwriters' Laboratories label.

The drawing also illustrates how the ground cable is connected to the TV mast, using a UL-approved cable clamp.

The ground cable is run from the connection at the mast, along the roof ridge (hidden by placement along ridge rolls), down the gable side (hidden under eave), then down the building side.

There are several rules governing cable installation. The cable shall have no bends sharper than 90°. The radii of all curves should be at least 8 inches. Lightning, with its sudden rise time, will not travel through a cable that has sharp bends if it can find a shorter path to ground (a jump across several feet to a water pipe is not uncommon). The cable is to be supported every 3 feet on open-air runs, and maintain a horizontal or downward course, free from down and up (V or U) pockets.

The cable is connected to an approved ground rod with a standard ground-rod clamp. The ground rod is driven 10 feet into permanently moist soil, at least 2 feet away from the house foundation.

Standard materials

Copper and aluminum are acceptable materials for lightning-protection systems, but should never be used together without special connectors. Aluminum parts must be larger than equivalent copper parts for equal conductivity.

The copper cable should weigh at least 187.5 pounds per 1,000 feet (individual wires making up the cable should be at least of No. 17 gauge). This cable is three times the size of a No. 6 cable which most manufacturers and installers recommend. Aluminum cable should weigh at least 95 pounds for the same length.

Ground rods, solid copper or copper-clad, should be at least ½ inch in diameter and 10 feet long.

Connectors and fasteners must be of the same material as the cable. Galvanized or plated-steel nails, screws or bolts are not acceptable on copper or aluminum installations.

Service available

The Lightning Protection Institute, a non-profit Chicago organization, offers its help whenever it is needed by anyone—home owners, plant engineers, organizations or individuals. Sponsored by reputable, long-established lightning-equipment manufacturers, the institute was set up to promote the science and improve the methods of lightning protection (and to advise and give information).

Another of its purposes is to formulate and press for the practice of ethical standards in all phases of the lightning-protection industry. In this role, it works toward the goal of full inspection and official approval of all lightning-protection systems, new or old.

While the institute does not take any part in actual equipment testing or field inspections of installers and their work, the group works closely with Underwriters' Laboratories.

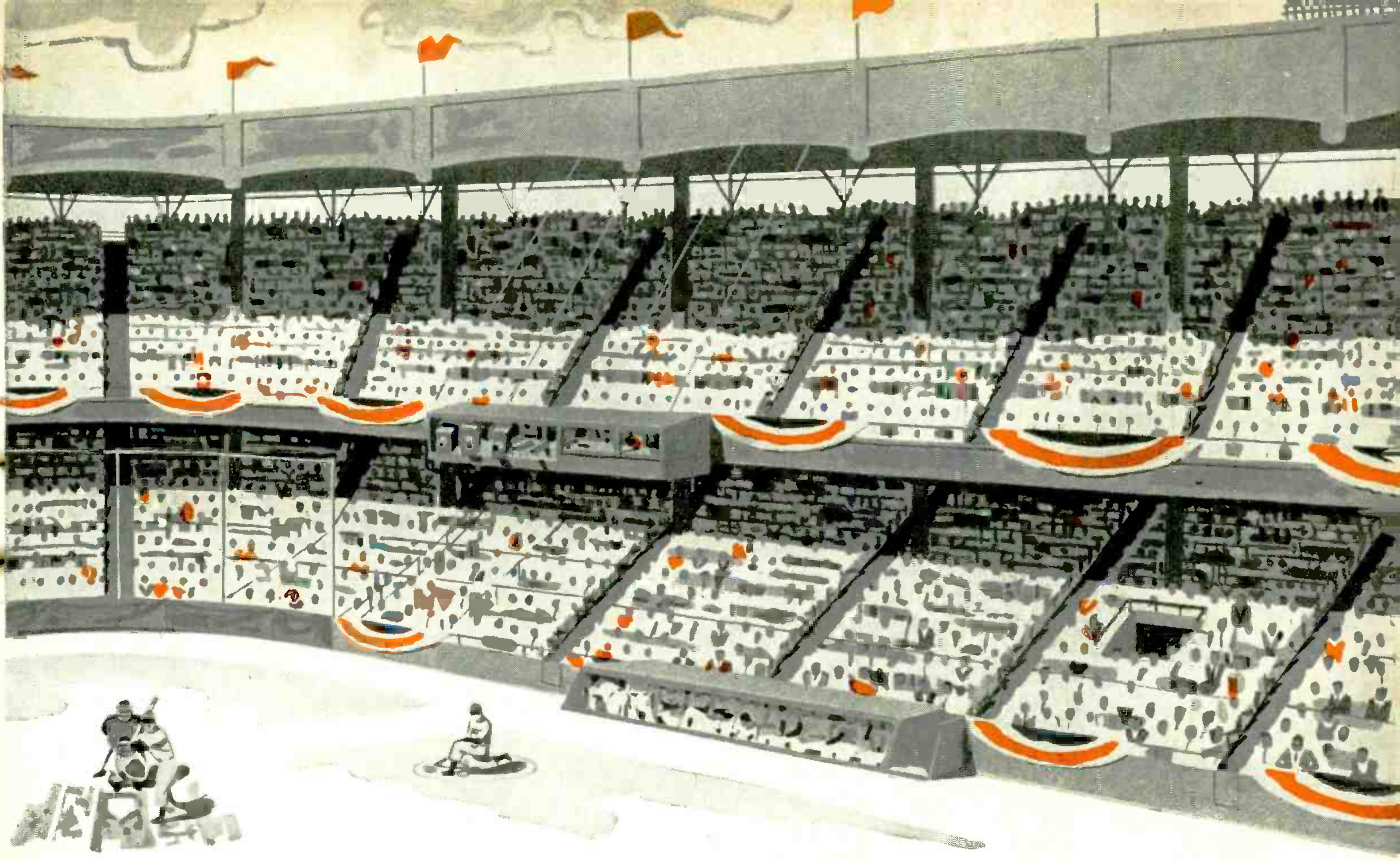
If you plan to protect your TV antenna and set, entire home or plant against lightning and there is any question regarding materials or installation, the best way to get the answer is to write to the Lightning Protection Institute, 53 W. Jackson Blvd., Chicago 4, Illinois, for *Lightning Facts and Figures*. END

YOU WILL SCORE G-E WORLD SERIES

Spotlights you for quality TV service right when demand hits its peak! The year's top business, profit-builder for technicians!

All 55 million TV owners will want their sets to be in first-class condition when the umpire calls "Play ball!" The neighborhood technician whom owners know best will be the one to benefit. Don't miss this profit opportunity! General Electric is going all-out to help you—by telling World Series fans whom to call, where to go for fast, reliable TV check-up. *To the technician who installs G-E tubes! He's the best! And just around the corner!*

Long before the first day's pitchers have been named, G-E displays and promotions will be pulling customers into your shop. Once play starts, fans in most large cities will receive frequent radio reminders that you are ready to serve them fast and well. Go World Series with General Electric! Get ready for a B-I-G two weeks of business! See your G-E tube distributor! *Distributor Sales, Electronic Components Div., General Electric Company, Owensboro, Ky.*



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Timely, high-impact display items like these will draw more customers to your shop, pay off in stepped-up income. General Electric has ready for you many other World Series displays, advertising helps, and novelties, all new and exciting. See them today at your General Electric tube distributor's!

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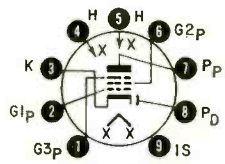
311-403

NEW TUBES and SEMI-CONDUCTORS

THERE was a slight letdown this month. Release of new tubes and transistors slacked off to a minimum. However, several interesting types were announced, one with a circuit diagram showing how it is used.

6EQ7, 12EQ7

Two multi-unit 9-pin miniature tubes made up of a diode and a remote-cutoff pentode. They are designed for use as combined if-amplifier and AM-detector in AM and AM-FM receivers. The pentode can also be used as an rf amplifier; the diode for automatic volume control. The only difference between the two tubes is in their heater ratings. The 6EQ7's heater is rated at 6.3 volts, 300 ma. The 12EQ7 at 12.6 volts, 150 ma.



6EQ7,12EQ7

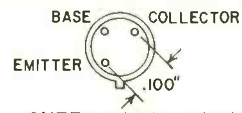
Maximum ratings of the pentode section of these RCA tubes when used as a class A1 amplifier are:

V_P	300
V_{G3} (positive value)	300
(negative value)	300
V_{G1} (pos bias value)	0
(neg bias value)	50
V_{G2}	300
P_P (watts)	3
$G3_{input}$ (mw)	200
$G2_{input}$ (for G2 voltages up to 150) (mw)	600

The diode section of the 'EQ7 is rated at 1-ma maximum plate current.

2N734, 2N735, 2N736

A group of general-purpose, n-p-n double-diffused silicon mesa transistors



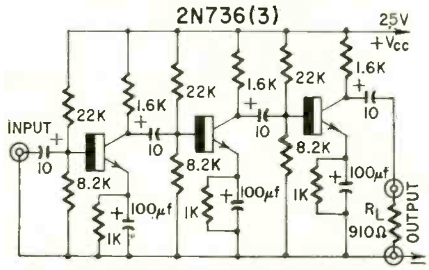
2N734,2N735,2N736

with a beta range that starts at 20 (minimum for the 2N734) and goes on up to 200 (maximum for the 2N736). All have a free-air dissipation rating of 500 mw and a high breakdown voltage.

Maximum ratings for these Texas Instruments transistors are:

	2N734	-735	-736
V_{CE}	60	60	60
V_{EB}	5	5	5
h_{fe} (V_{CE}=5, I_E=5 ma, f=1 kc)	50	100	200

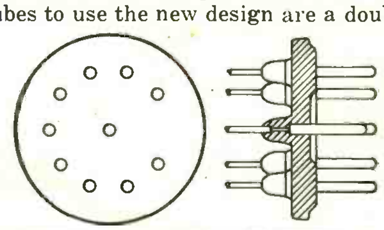
The diagram shows a simple cascaded



audio amplifier using the 2N736. It has a typical current gain of 92 db at 1 kc.

10-Pin Tubes

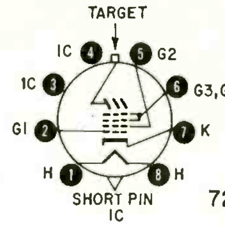
A new construction in miniature receiving tubes is the 10-pin envelope announced by Sylvania. The unit uses the regular 9-pin arrangement (like the 12AX7 or 12AU7) with an additional pin centered in the pin circle. The first tubes to use the new design are a double



tetrode for use as an rf amplifier, oscillator–mixer in FM tuners and receivers. Another unit will be a triple triode for use as an rf amplifier, oscillator–mixer and afc.

7262-A

A 1-inch camera tube (vidicon) intended for use in small, compact, transistorized television cameras. It can be used for televising black-and-white or color scenes in industrial and other closed-circuit TV applications. The high sensitivity of the tube makes possible high-quality pictures under normal room lighting conditions. The sensitivity of the 7262-A can be expressed as equivalent to a photographic film with an ASA exposure index of 600.



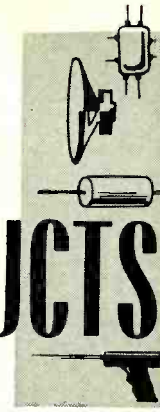
7262-A

Characteristics under typical operating conditions for this RCA tube are:

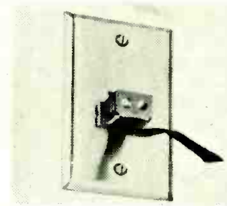
V_{G4} (decelerator) & V_{G3} (beam-focus)	300
V_{G2} (accelerator)	300
V_{G1} (for picture cutoff)	−45 to −100
Visual equiv signal-to-noise ratio	300:1
$V_{blanking}$ (min peak-to-peak)	
(when applied to G1)	75
(when applied to cathode)	20

END

new PRODUCTS

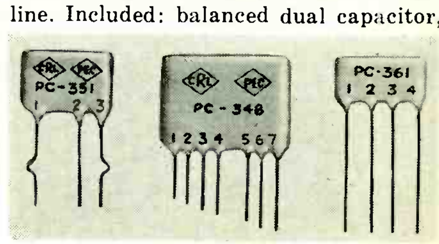


WALL OUTLETS for TV antenna systems. Flush-mount (shown) and surface-mount styles. Come with plugs



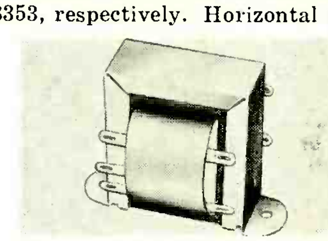
with no-strip terminals. 300 ohms. Flush-mount type in brass, ivory, chrome. Surface-mount type in ivory.—**Winegard Co.**, Burlington, Iowa.

PACKAGED CIRCUITS (27) for TV and hi-fi use have been added to *PEC* line. Included: balanced dual capacitor,



loudness contour networks, phase detector, diode-triode *Couplate.* — **Centralab**, 900 E. Keefe Ave., Milwaukee 1, Wis.

REPLACEMENT PARTS for TV. Deflection yokes *DY-35A*, *DY-36A* replace Philco 76-9173-13/14 and Emerson 708353, respectively. Horizontal output



transformers *HO-312*, *HO-313*, *HO-314* replace Emerson 738160, 738162, 738169, respectively. Filter choke *C-2343* (0.75 henry at 300 ma). 70.7-volt output transformers (shown); A-8080 (1—5 watts), A-8081 (6—10 watts), A-8082 (11—15 watts). All have five power ranges in 1-watt steps. 8- and 16-ohm secondaries.—**Chicago Standard Transformer Corp.**, 3501 Addison, Chicago 18, Ill.

TRANSCEIVER *model GW-30* for low-power unlicensed or licensed Citizens band use or 10-meter ham band. Fixed-tuned superregenerative receiver, crystal-controlled transmitter. Volume

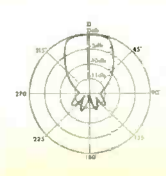
UP TO FOUR TIMES THE WORKING DISTANCE OF CARDIOID TYPES* with the Electro-Voice model 644 sound spot

Of all the audio problems confronting sound engineers, one of the most difficult to overcome is the use of microphones in spacious areas. Churches, auditoriums and amphitheaters present formidable problems in room acoustics and reverberation which degrade audio quality. Consequently, microphones cannot be placed at conventional distances from the source of sound. Under such conditions, loss of level and "presence" further add to the enigma of proper pick-up. The Model 644 Sound Spot is the answer. Here is a microphone providing acceptance within an included angle of 90° at high frequencies, high axial sensitivity, wide frequency response extending from 40 to 12,000 cps and excellent wind noise cancelling characteristics. Its highly directional feature permits unusual microphone working distances as well as startling flexibility in loudspeaker placement. Effective cancellation of sound at the rear and sides for unparalleled rejection of random noise, reverberation and feedback without frequency response loss. See Polar Pattern. Stop at your Electro-Voice distributor today and let him demonstrate the Model 644.

*Depending on Acoustical conditions.

Other features: Output level—53 db. 150 ohm and high impedance. Impedance changed by moving one connection to connector. Low impedance only: line balanced to ground and phased. Acoustalloy diaphragm, shielded from dust and magnetic particles. Non-welded circuit with Alnico V and Armco magnetic iron. Pressure cast case. 5/8"-27 thread. Satin chrome finish. 18 ft. cable with MC4M connector. ON-OFF switch. Size: 2 3/16" diam. 16" length. Net Wt.: 2 lb. 9 oz. less cable. List Price $110.00. Desk stand available (extra).

Polar Pattern



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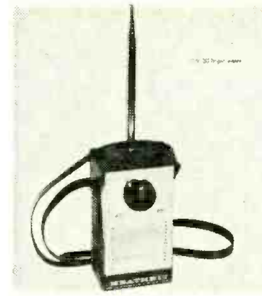
ELECTRO-VOICE, INC.
Dept. 90T Buchanan, Michigan



control, push-to-talk button, telescoping antenna. Kit or wired, carrying case and shoulder strap. — **Heath Co.,** Benton Harbor, Mich.

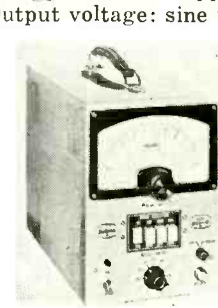
TRANSCEIVER for 27-mc Citizens band. 22-channel transmitter and receiver. Pretuned sealed oscillator. Up to

5 watts input. 5 tubes. Supplied with tubes, crystal, antenna, microphone.— **Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

ALL-CHANNEL TUNER for crystal-controlled Citizens-band receivers. Plugs into receiver in place of crystal.

No batteries or power source needed. 2-inch vernier dial. 2 x 4 x 4 inches— **Crown Electric Products Co.,** PO Box 171, Orange, N. J.

AUDIO-GENERATOR, *model 605.* Sine-, square-wave output. 20 to 200,000 cycles. Pushbutton range selection. Schmitt trigger circuit supplies square wave. Output voltage: sine wave 0 to 5



(rms), square wave 20 mv to 7 (peak to peak). Less than 1% distortion on sine wave. Square-wave rise time 0.2 μsec.— **Jackson Electrical Instrument Co.,** 124 McDonough St., Dayton, Ohio.

AC VTVM *model 715,* 10 ranges up to

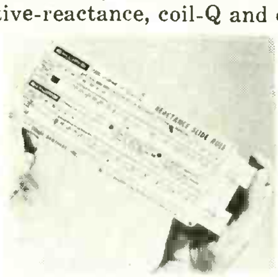
300 volts full scale. Low range 10 mv full scale. Accuracy 5% of full scale.

Response 10 to 400,000 cycles ±1 db. Db markings on scale, range switch.—Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

CAPACITOR ANALYZER, *Transcap model TCA-1*, for low-voltage low-leakage tantalum and aluminum electrolytic capacitors as well as other low-voltage units. 5 ranges cover 1 $\mu\mu$f to 2,000 μf.

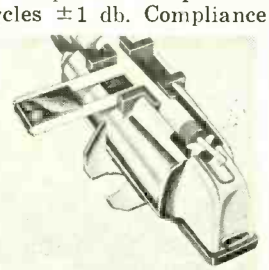
Meter reads insulation resistance from 50 to 20,000 megohms and leakage current down to fractional microamps. Power factors measured by Wien bridge from 0 to 50%—**Sprague Products Co.**, 335 Marshall St., North Adams, Mass.

REACTANCE RULE solves resonant-frequency, inductive-reactance, capacitive-reactance, coil-Q and dissipa-



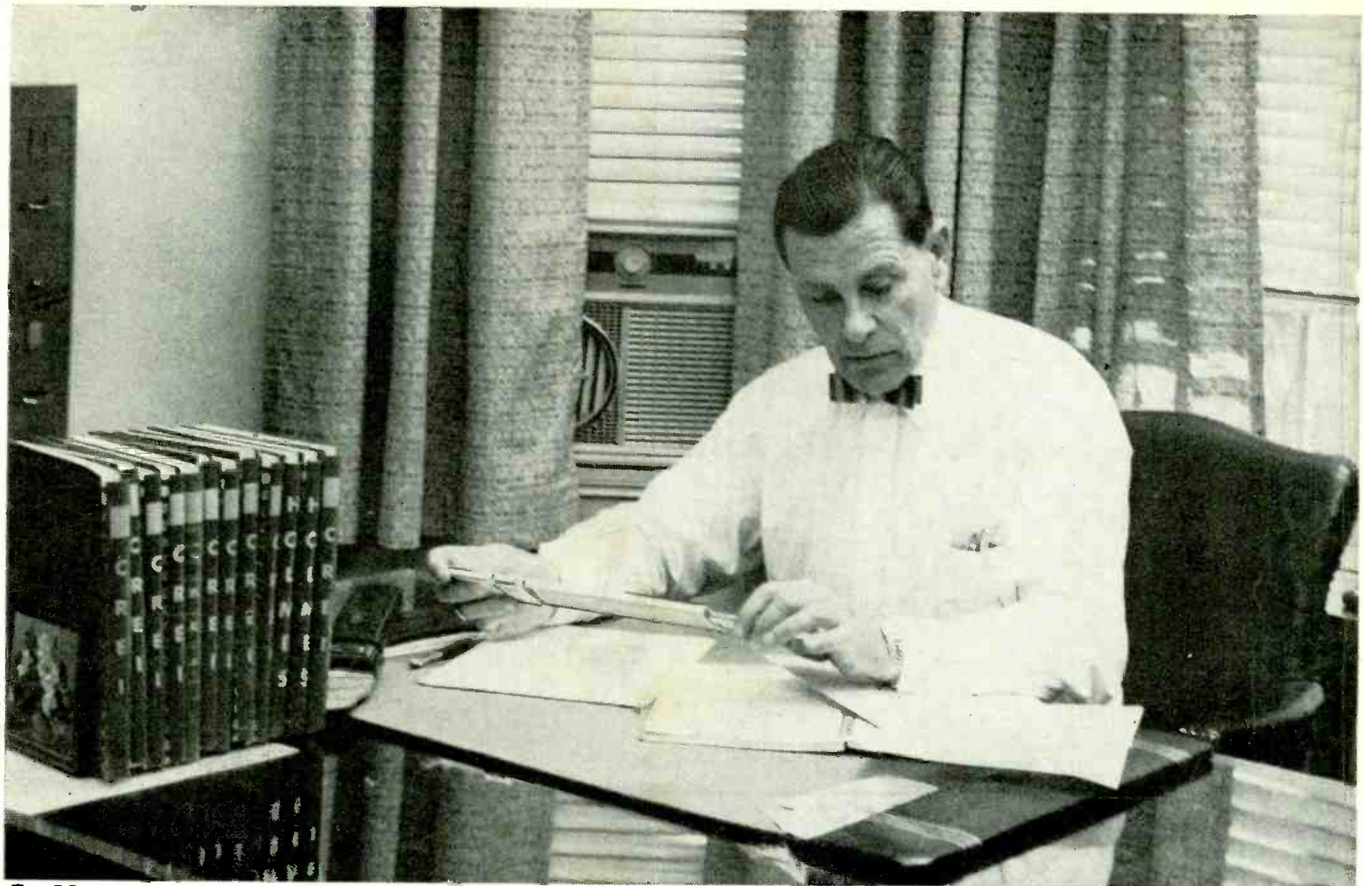
tion-factor problems. Frequency range 5 cycles to 10,000 mc. Re-issued.—**Shure Brothers, Inc.**, 222 Hartrey Ave., Evanston, Ill.

STEREO CARTRIDGE *model 9T*. Turnover ceramic type. Smooth distortion-free response. Response 20 to 17,000 cycles ±1 db. Compliance 3.5 x



10^{-6} cm/dyne. Low tracking force (2 grams for pickup arms, 3 grams for changers) reduces stylus wear, in-

(*Continued on page* 106)



A Home Study Program for Engineering Technicians and Professional Engineers Comparable in Technological Content to College-Level Electronics Residence Courses.

CREI's Extension Division offers combinations of courses in advanced electronics engineering technology to meet present or future employment requirements, and step up your earning power.

A CREI program, the product of 33 years experience, is neither short-cut nor magic formula. It is an accredited home study curriculum which may take as little as 18 months, or as much as 3 years, depending upon the course selected and amount of stick-to-itiveness brought to bear. The program is designed specifically for men employed in a technical capacity in the electronics industry, where a shortage of manpower with advanced technical education not only exists, but shows every likelihood of increasing.

Now fifth in volume among American industries, the electronics industry offers almost unlimited employment and advancement opportunities. Applications of new electronic developments in automation, instrumentation, industrial electronics, aeronautical electronics, guided missiles, servomechanisms, computers, astronautics and telemetering create new jobs every day. Yet, paradoxically, industry growth does not always mean individual growth. Companies actively seeking men with modern, advanced technological knowledge are simultaneously firing mediocre men who lack this knowledge.

CREI students (more than 20,400 are currently enrolled) keep pace with the needs of the ever-advancing electronics industry and are eagerly sought by employers who offer solid opportunities for rapid promotion.

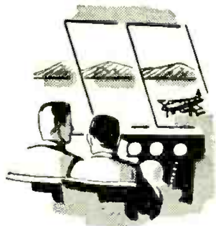
Since 1927 we have directed the technical education of students in advanced electronics engineering technology. We developed the prototype civilian electronics course for the Army Signal Corps in 1941, supplied 300,000 texts to the U. S. Navy in a special course for radio technicians in the South Pacific in 1943, trained hundreds of technicians during World War II for the Signal Corps. We co-founded the National Council of Technical Schools, which first established scholastic and business standards for the technical school field. We were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. In 1946 we instituted the group training programs used by companies representing the cream of the electronics and aviation industries. CREI courses are widely employed today in company-sponsored educational plans by companies throughout the U. S. and Canada.

What does this record of achievement mean to you as a CREI student? It means that industry and the Armed Services alike respect CREI men. It means that your CREI diploma is a door-opener. Significantly, Help Wanted ads often specify "CREI education or equivalent required." Our Placement Bureau, which helps graduates and advanced students find more desirable positions, is always available to CREI men. While no placement guarantees will be made by CREI or any other reputable institution, for many years the demand for CREI graduates and advanced students has far exceeded the supply.

CREI HOME STUDY ADVANTAGES.

This advanced technical education is accomplished on your own time, during hours chosen by you. You waste no time in travel. You have plenty of time to do your best. Your work is under the supervision of a regular staff instructor who guides your progress step by step. Courses are prepared and taught by men experienced both in teaching and in electronics, presented in easy-to-understand form, kept up to date by periodic revision. Experience in more than three decades of home-study teaching, during which time we have corrected and commented on many hundreds of thousands of examinations, enables us to anticipate questions in our lesson material.

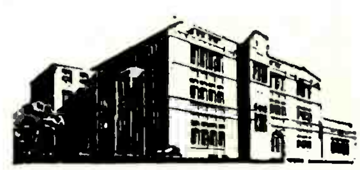
CREI STUDENTS are professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. In 1958 they devoted approximately 1,572,400 hours to 104,831 lesson texts, answered and were individually graded upon 1,048,310 searching questions and engineering problems. They studied **advanced** electronics engineering technology associated with transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of Vandenburg AF Base and Cape Canaveral. They are at Alamagordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines, and Trans-Canada Air Lines. They share in electronics at All America Cables and Radio, Inc., and The Martin Co. They work for USIA (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI education under company sponsorship. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world and across the street. They're men you'll compete with—to gain or hold your place in the electronics profession.



If ambition is part of your make-up—if you want to convert interest and energy into dollars of income—if you want to convert your spare evening hours into material benefit and the personal satisfaction that comes with advancement and respect of your associates—then CREI's home study education assures you of:

1. A solid foundation of college-level, advanced technical electronic engineering knowledge.
2. A means of keeping abreast of the complex developments in electronics.
3. The ability to communicate intelligently with your engineering associates and superiors.
4. The best preparation for professional advancement in electronics as the industry demands more qualified personnel.

QUALIFICATIONS FOR CREI. College degree is not essential. If you have had basic electronic education, practical experience in electronics and a high school education, you can probably qualify. A good way to find out: Use the postage-paid card. It will bring you the free 54-page book which has launched thousands on their advanced careers: "Insurance for Your Future in the New World of Electronics." Tuition is reasonable and may be paid monthly. It takes just one $10-a-week raise to repay your investment in CREI education and leave you a substantial bonus the first year. Available to veterans under GI bill.



RESIDENCE SCHOOL in Washington, D. C. for those who can attend classes. Day and evening classes start at regular intervals. Qualified graduates earn AAS degree in approximately 27 months. Electronics experience not required for admission.

CAPITOL RADIO ENGINEERING INSTITUTE

ECPD Accredited Technical Institute Curricula. Founded 1927

Dept. 1410-G **EE**
3224 16TH ST., N.W.
WASHINGTON 10, D. C.

 (Continued from page 101)

creases record life.—**Sonotone Corp.**, Elmsford, N. Y.

STEREO AMPLIFIER *model 299B* improved version of *299*. Monitoring for recording. Power increase to 50 watts

(IHFM standards). Extra-high-level input for electronic organs.—**H. H. Scott, Inc.**, Dept. P., 111 Powdermill Rd., Maynard, Mass.

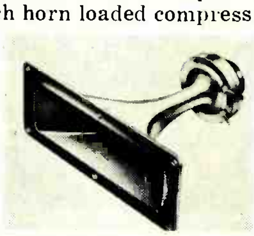
ORGAN TUNER uses spinning stroboscopic disc. *Autotuner* tunes most elec-

tronic organs in minutes. 6¾ x 5¼ x 2¼ inches. Microphone included.—**Schober Organ Corp.**, 43 W. 61 St., New York 23, N. Y.

SUPER TWEETER *T-202*. Response 3,000 to 40,000 cycles (to 22,000 cycles ±2 db). Dispersion 120° in all direc-

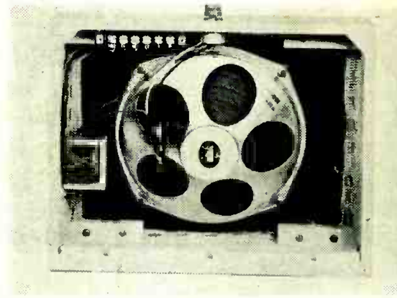
tions. Power 30 watts. Built-in crossover and brilliance control. Impedance 8 ohms.—**University Loudspeakers, Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

HORN TWEETER, *Tempo High Note*. 2 x 6-inch horn loaded compression type.



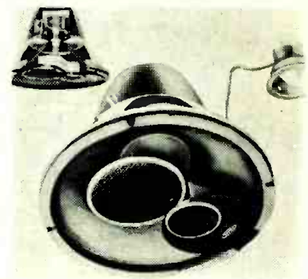
Shielded magnetic circuit, wide-angle sound dispersion.—**Oxford Components**, 556 W. Monroe St., Chicago 6, Ill.

SPEAKER - BAFFLE combination uses *Magni-Magic* inverted speaker. 4 series: (1) speaker and baffle; (2) speaker, baffle, volume control; (3) speaker, baffle, control, 70-volt transformer; (4) speaker, baffle, transformer. Blond, mahogany, walnut. 8-inch, 5-watt, 8-ohm speaker. Screw ter-



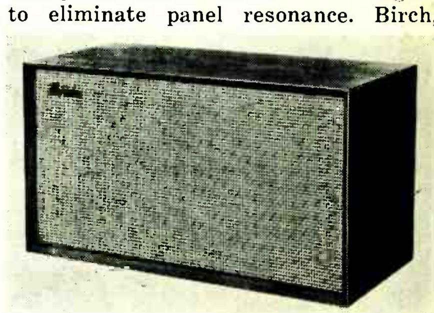
minals.—**Utah Radio & Electronic Corp.**, 1124 E. Franklin St., Huntington, Ind.

TRIHELIX SPEAKER *SK-180*. 3 independent speakers on single frame. To minimize interaction, smaller speakers mounted off center. Built-in crossover network with brilliance control. Overall response 20 to 20,000 cycles (30 to 12,-



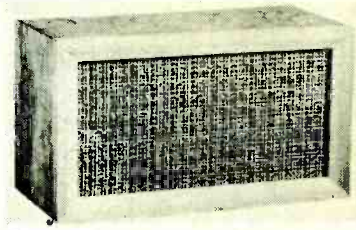
000 cycles ±3 db).—**Lafayette Radio Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

SPEAKER SYSTEM *model XP-2*. Two 8-inch woofers, 5-inch tweeter. Response 35 to 15,000 cycles. Built-in crossover network. 22 x 12 x 11¼ inches. High compliance plus high efficiency. Enclosure filled with Acoustiglas to eliminate panel resonance. Birch,



cherry, walnut, mahogany. — **Fisher Radio Corp.**, 21-21 44th Dr., Long Island City 1, N. Y.

SPEAKER ENCLOSURE *model 6*. Unfinished. Cutout for 8-inch speaker, sound-reinforcing ports. 10 x 16 x 9

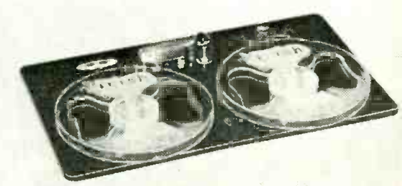


inches. ½-inch plywood, sanded on top and sides. Damping material installed. —**Homewood Industries**, 26 Court St., Brooklyn, N. Y.

TAPE RECORDERS, *model 101* (shown) plays, records half-track monophonic. Response 50 to 12,000 cycles at 7½ ips. 5 transistors, 2 tubes. *Model 262-SL* plays 4-, 2-track stereo; records ¼-track monophonic. Response 30 to

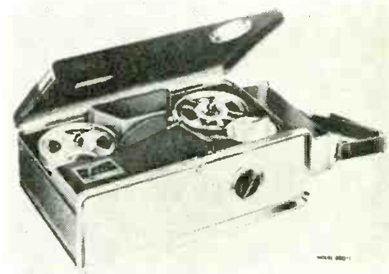
18,000 cycles at 7½ ips. *Model 262-D* deck same specifications as *262-SL*. All 117 volts, ac-operated. — **Superscope, Inc.**, 8150 Vineland Ave., Sun Valley, Calif.

TAPE-PLAYER KIT *model AD-70* for prerecorded 4-track stereo tapes. For use with separate stereo preamplifier. Single control selects stop, play,



rewind, fast-forward. Mounts vertically or horizontally. Flutter and wow below 0.35%, harmonic distortion less than 2%. Finished, unfinished bases available.—**Heath Co.**, Benton Harbor, Mich.

PORTABLE RECORDER *model MR511* works on 7 AA-size cells, house current or 12-volt auto systems. Plays 1⅓ hours at 1⅞ ips. 3-inch reels. Tran-



sistorized. 7 pounds, 3 x 6⅛ x 10¾ inches. '61 line ranges from stereo recorder-players to monophonic models for home use.—**Telectrosonic Corp.**, 35-18 37 St., Long Island City 1, N.Y.

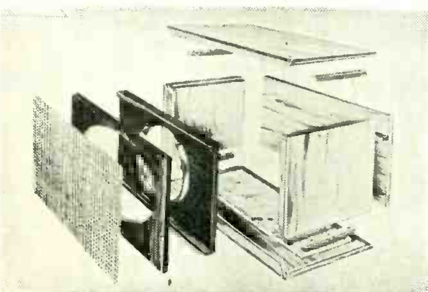
TURNTABLE AND ARM *Realistic*

Mark VIIIa. Hysteresis motor, 4 speeds. Noise level 50 db below average record level. Stereo pickup arm pivot-mounted with ball-bearing races to minimize friction. Mounting board, two 3-foot cables supplied.—**Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

HIGH-FIDELITY pickup arms and turntables. *ST-33* turntable (shown): hysteresis-synchronous motor, 4 live-

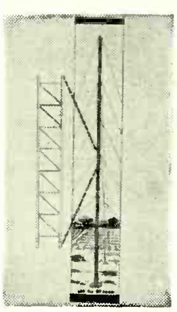
rubber shock absorbers, polyurethane drive belt. ⅛-inch steel mounting plate has hole for pickup arms. *PK-33* turntable similar in kit form. *212 series* arms dual-viscous-damped. Kits available. — **Gray Manufacturing Co.,** 16 Arbor St., Hartford 1, Conn.

CABINET KIT *model CK-14.* Elliptical port broadens frequency response.



No source separation between high, middle, low frequencies. — **Lafayette Radio Corp.,** 165-08 Liberty Ave., Jamaica 33, N. Y.

ANTENNA TOWER *No. 55.* Rigidity and strength in heights up to 450 feet. 10-foot hot-dipped galvanized sections



constructed on 18½-inch triangular pattern.—**Rohn Manufacturing Co.,** 6718 W. Plank Rd., Peoria, Ill. END

All specifications are from manufacturer's data

Technotes

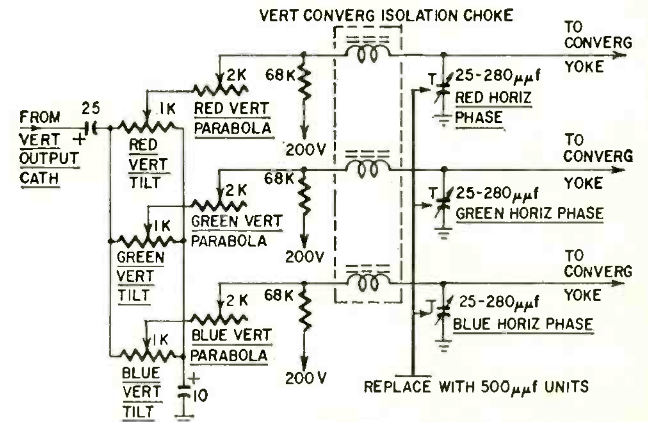
SILVERTONE 7140-A

Complaint was color fringing obviously caused by poor horizontal dynamic convergence. When an attempt was made to adjust convergence, no response was obtained from the red or green horizontal phasing controls. The control circuit is shown in the diagram.

A scope check showed drive voltage was being applied to the circuit, but that very little voltage was developed across the coils and trimmer capacitor. There was evidently a short or open in the circuit.

An ohmmeter check indicated no shorts or opens. Yet the 900-volt sine waveform refused to appear when the receiver was turned on. After a bit of wasted time, we discovered that the 25–280-μμf trimmer would short under the applied ac voltage, though it checked out OK at the 1.5 volts applied by an ohmmeter.

The faulty trimmers were replaced, using units having a top range of 500 μμf. This corrected the difficulty. We found that the top value of 280 μμf in the original trimmers necessitated turning the adjusting screw down tightly to set



the phase correctly. Because of the high compression force, the trimmers failed to hold up under stress of the high ac voltage.

Using replacement trimmers with a top value of 500 μμf permitted correct phase adjustment without excessive compression.—*Robert G. Middleton*

PIX STREAKS AND FLASHES

Streaks and flashes in a television picture are often caused by a minor defect in the tuner—a dirty switch contact or wiper. This can usually be cured by spraying the contacts and wipers with a contact cleaner. Use a perfume atomizer to get a fine penetrating spray or try one of the new spray cans.—*W. C. Warren*

PHILCO MODEL UG3052-BL

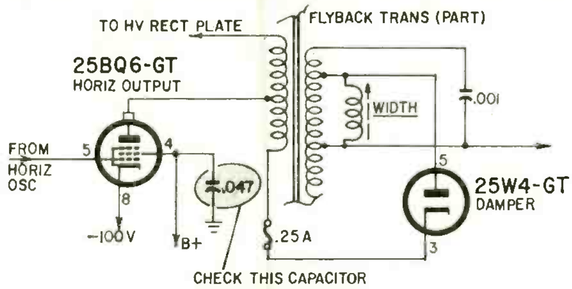
This model often has a very noisy and defective tuner. The channels will not hold on station, sound is intermittent and, in extreme cases, there is no picture. A cursory examination of the tuner may lead the technician to diagnose the trouble as contact oxidation, or just plain dirty contacts and springs—but beware. Close inspection reveals that the tuner will not be repaired so easily. In fact, several jobs that crossed the bench led me to believe that the tuner was ready to fall apart. Anything in it you touched caused the set to cut out, with loss of most of the sound, and snow. You decide the tubes are defective or that a portion of the printed circuit, down underneath, is unsoldered but, regardless of the steps taken to find the trouble, as soon as these receivers are plugged in and the station selector is turned to one of the local channels—the same old trouble!

In every case checked, the trouble turned out to be in the contact rivets on the shaft discs. Apparently the strain on these contacts, caused by turning from channel to channel, breaks the solder joint where they are solder-dipped to the thin printed wiring on the back side of the disc. The break cannot be seen and will not appear to be at this point. But, by very carefully touching up these soldered spots with a small iron, the trouble usually will be corrected. This condition, if not isolated at once and corrected, may cause several discouraging callbacks. If the job is approached with deliberation along the lines mentioned here, it should take no longer than a few minutes to satisfy the customer completely.—*George D. Philpott*

CORONADO 15TV4

Complaint: No raster.

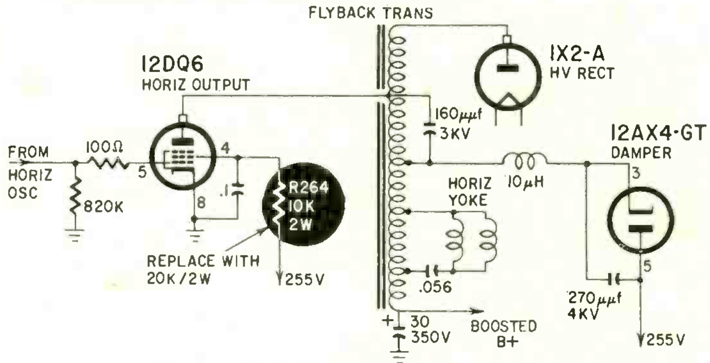
Cure: Check B-plus at pin 3 of the 25W4 damper. If it reads about 220 volts instead of the recommended 280, check for an open .047-μf capacitor from the screen grid of the



25BQ6 (the horizontal output tube) to ground. In one set with this trouble, both the horizontal oscillator and output transformers were singing and would have been suspect. However, a quick check showed normal voltages and waveforms in their circuits.—*John B. Ledbetter*

G-E 17P1329

Complaint: Too much width. The sides of the picture extend past the edges of the picture tube.



This problem can be cured by increasing the value of R264 from 10,000 ohms to 20,000 ohms. Use a 2-watt resistor.
—*George Warren*

FORD 74BF

A stubborn case of distortion in this auto radio hybrid was solved when we discovered the transistor bias control was set at maximum resistance. As emitter current was normal at this setting, it indicated an unusually sensitive transistor. When a more normal transistor was substituted and the bias readjusted, the distortion disappeared.—*Chase Bass* END

NOTEWORTHY CIRCUITS

TWO POWER MEGAPHONES

Of the circuits shown, the 1-watt unit (Fig. 1) will be adequate in most uses. The input load impedance is the primary of an output transformer. The 4–8-ohm secondary is not used. The 6-watt megaphone (Fig 2) is very powerful and can be considered a deluxe model. Wiring and parts layout are not critical and both amplifiers are de-

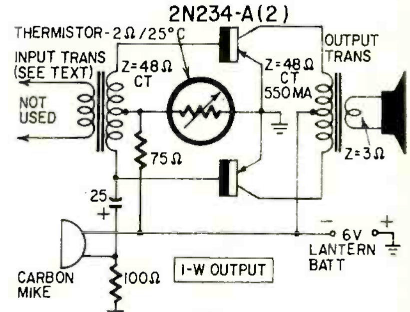
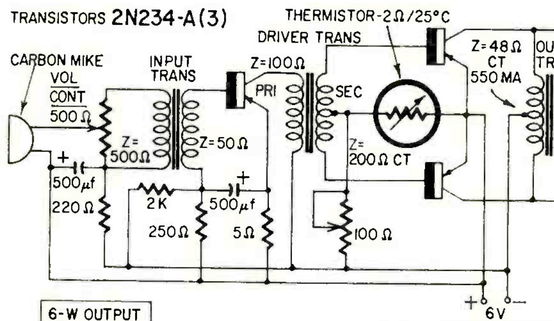


Fig.1



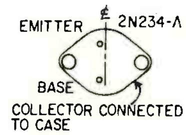
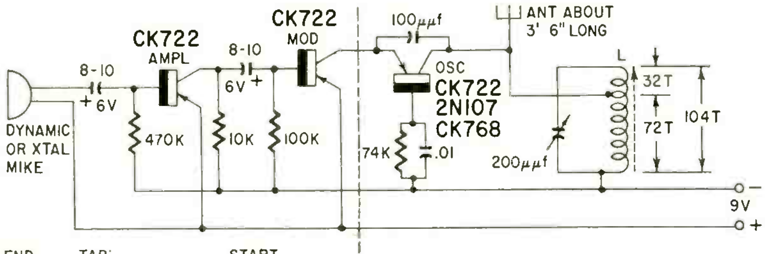


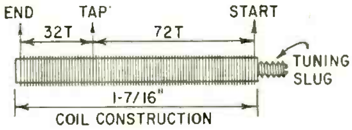
Fig.2

signed for use with standard 6-volt lantern batteries. The transistors in the 6-watt version must be mounted on a heat sink.—*Bendix Semiconductors*

MORE ON THE SNITCHER

After building the Snitcher described in the November 1959 issue (page 35), I decided to make a couple of changes. First I substituted a simplified amplifier–modulator unit. Then I decreased the value of R3, the oscillator base resistor, to 74,000 ohms. This increased output considerably. I also wound a new coil with 104 turns of No. 36 cotton-covered wire close-wound on a ¼-inch form (Superex C-1 or equivalent). The coil's tap is connected to the antenna and V3's collector. This increases stability and reduces the effect of body capacitance.



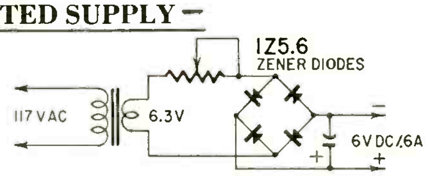


COIL CONSTRUCTION

The hookup is shown in the diagram, and the operating frequency is in the upper part of the broadcast band.—*Karl Sperber*

– VOLTAGE-LIMITED SUPPLY –

The diagram shows a simple regulated dc supply. The Zener diodes both rectify and limit the supply's output voltage. They are selected to act as clippers in combination with the potentiometer. This limits the voltage to which the capacitor can be charged. The arrangement provides control of more power than could ordinarily be handled by these Zeners and can be used wherever extreme regulation is not vital.—*International Rectifier News*



END

TECHNICIANS' NEWS

NEW KC LICENSE LAW

The City Council of Kansas City (Mo.) passed a new ordinance regulating TV and radio servicing after the old one had been declared void in a suit brought against the city by The Electronic Association of Missouri (TEAM). The Honorable Tom J. Stubbs, presiding judge, had ruled that the old law was altogether too broad and unreasonable.

Judge Stubbs also said: "I think the ordinance is bad for a further reason . . . the Board of Examiners are directed to take into account the character and reputation of the applicant for a license and, as I construe the ordinance, may refuse to recommend an applicant for a license if the board concludes that his character is such that he shouldn't have a license." The new ordinance makes no mention of character.

The old law applied to all electronic devices containing tubes, transistors or both. The new law pertains to "radio and/or TV receiving apparatus and associated components."

Service dealers and technicians are divided into three groups—Class One for both radio and TV servicing, Class Two for TV only and Class Three for radio alone. License fees are $10 annually for a technician and $25 for a service dealer.

The law also provides that customers must receive a copy of a bill showing the date(s) when work was performed; make, model and serial number of the set; full name and serial number of the licensee; name and address of the customer and the charge computation. The computation must specify what work was done and the amount charged for each part replaced. The dealer must keep his copy of the bill for 2 years.

WANT ASSOCIATION?

Those interested in forming a service association in Great Falls, Mont., are asked to contact LeRoy Peck, Peck's Radio-TV, 1010 First Ave. South, Great Falls.

OFFICERS RE-ELECTED

Raymond G. Tuszynski was re-elected president of the Electronic Service Association of Butte, Montana. Harry Carroll was re-elected recording secretary; Kenneth Venner, treasurer; and Al Laurick, trustee. New officers are Mrs. Eileen Giese, corresponding secretary and Bjarne Johnson, trustee.

CLOSED-CIRCUIT INSTRUCTION

Closed-circuit TV was used by General Electric Co. for instructing a class of television technicians at Buffalo,

N. Y. One camera was used to bring into view intricate assembly operations and to scan meters, charts and oscilloscopes. One 17-inch set was used as a monitor and six 21-inch sets were used for the technicians. All service technicians in the Buffalo, N. Y., area (independent and G-E) had been invited to attend.

Audience reaction was very favorable, according to Steven R. Mihalic, television service manager. "Giving each person a closeup view, even of waveforms and meter readings, established a close relationship between student and instructor and greatly facilitated an exchange of information," he said.

HESTER INJURED

Robert W. Hester, past president of NATESA, was seriously injured in a fall from a ladder while installing an air conditioner, according to *The Hoosier Test Probe.* His shop is located in Mission, Kan.

LICENSING CAMPAIGN

The California State Electronics Association is behind a massive signature campaign for state licensing. The program centers around a dummy ballot which is offered to technicians around the state. They are asked to indicate that they would vote for a state license bill and then sign their names. The

6810 **BALLOT**

PROPOSITION NO. 1		
To license radio and television technicians in the STATE OF CALIFORNIA	YES	
	NO	

As a registered voter of the STATE OF CALIF.I would support with my vote, the licensing of radio and television technicians in the STATE OF CALIFORNIA"

NAME________

ADDRESS________

CITY________

ballots are then forwarded to State Legislators.

The ballot has the statement "As a registered voter of .... county I would support with my vote, the licensing of radio and television technicians in the State of California" printed on it. Extra copies are available for technicians to give to their customers.

IOWA OFFICERS

The Television Electronic Service Association of Iowa (TESA) elected Henry Gulliver as its new president, states the *T.E.S.A. Beacon.* Bob Norman was elected vice president; Don Price, secretary; Ed Vilimek, treasurer. Members of the Board of Directors are Howard L. Bonar, Gene Wierson, George Rizzio, Jim Yordy, George Miller, Leland Scott, J. R. Jackson and Jack Betz.

PUBLICATIONS LIST

Below is a list of most of the magazines, folders and newsletters published by service associations around the country. A complete list of associations is planned for a forthcoming issue.

One of the most important things an association needs is publicity. If you make the public aware of you and what you stand for, you have taken the first step toward eliminating the doubt with which much of the profession is regarded. We do not make this statement lightly. Association publications from all over the country agree that a major problem to the industry is the fringe group of dishonest operators. What good does it do to set high standards of ethics, conduct, etc., unless the public knows about it? Publicity is a powerful weapon in the fight to upgrade the profession!

Yet some associations seem to be almost ashamed to admit they exist. Many groups have not answered our letters inquiring as to the name of the secretary or president. Some associations will not even reveal their address. We get letters and cards from individuals wanting to know the name of their nearest association. We send what information we have, but often we do not know the name of an officer to contact or even if the association is still active.

For information, write to: Associations Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

ARTSD NEWS
Don Hamill, editor
Associated Radio & TV Service Dealers
2552 N. High St.
Columbus 2, Ohio

CINTI TESA NEWS
Harold J. Gruber, editor
TESA of Cincinnati
4365 Kalama Ct.
Cincinnati 36, Ohio

CSEA DIGEST
Chet Spink, editor
California State Electronics Association
Orbit Publications
Rm. 467A Porter Bldg.
San Jose 13, Calif.

ETAT NEWS
Vern LaPlante, editor
Electronic Technicians Association of Toledo, Inc.
1952 Sylvania Ave.
Toledo 13, Ohio

E. T. G. NEWS
Donald A. Cicolini, editor
Electronic Technicians Guild, Greater Boston Chapter
PO Box 124
W. Somerville 44, Mass.

GUILD NEWS, THE
Jack Wheaton, editor
Radio TV Guild of Long Island, Inc.
464 Sagamore Ave.
E. Williston, N. Y.

HOOSIER TEST PROBE, THE
Frank J. Teskey, editor
Indiana Electronic Service Association
PO Box 23125
Indianapolis 23, Ind.

IPET
(for the Independent Electronics Technician)
Arnold J. Meyer, editor
Society of Radio & TV Technicians, Inc.
PO Box 126
Van Nuys, Calif.

NATESA SCOPE
Albert C. W. Saunders, president
National Alliance of TV & Electronic Service Associations
5908 S. Troy St.
Chicago 29, Ill.

PRINTED CIRCUIT, THE
Jim Hornaday, editor
North Carolina Federation of Electronic Associations, Inc.
1228 Montlieu Ave.
High Point, N. C.

RASTER, THE
Benton Linder, editor
Electronic Service Council of the Ozarks
854 S. Glenstone
Springfield, Mo.

RTA MAGAZINE
Chet Spink, editor
Santa Clara Valley and Santa Cruz Chapter—CSEA (Old RTA)
Orbit Publications
Rm. 467A Porter Bldg.
San Jose 13, Calif.

SUPREME EFFORT, THE
Harry H. Moore, editor
TV Service Engineers, Inc.
2114 E. 39 St.
Kansas City 9, Mo.

T. E. A. TIMES
Leonard R. Smith, editor
Texas Electronics Association, Inc.
1105 May St.
Fort Worth 4, Texas

TEAM NEWS
W. C. Pecht, editor
The Electronic Association of Missouri
718 Goodfellow
St. Louis, Mo.

TESA BEACON
Frank Gronert, editor
TV Electronic Service Association of Iowa
5000 Urbandale Ave.
Des Moines, Iowa

TESA MIAMI NEWS
A. Edward Stevens, editor
TESA-Miami
35 Almeria Ave.
Coral Gables 34, Fla.

TESA NEWS, DAYTON AREA
Harry Hansen, editor
TESA-Dayton Area
6855 N. Dixie Dr.
Dayton 14, Ohio

TESA NEWS
Ken Garthe, editor
TESA-St. Louis, Inc.
5609 Riverview
St. Louis 20, Mo.

TESA NEWS
Helen S. Bessort, editor
TESA of Wisconsin
PO Box 6091
Milwaukee 9, Wis.

TSA-DV NEWS
Ray Fink, editor
TV Service Association of Delaware Valley
7819 Rugby St.
Philadelphia 50, Pa.

TSA NEWS
Harold Chase, editor
TV Service Association of Mich., Inc.
8225 Woodward Ave.
Detroit 2, Mich.

TSA SERVICE NEWS
Clinton W. Cox, president
King County TV Service Association, Inc.
500 E. Pine
Seattle 22, Wash.

TV SERVICE NEWSLETTER
Jack Massecar, editor
Independent TV Service Dealers Association of Los Angeles County, Inc.
213 S. Coronado St.
Los Angeles 57, Calif.

VANGUARD, THE
Tony DeFranco, editor
Tri-State Council of TV Service Associations
4616 Westfield Ave.
Camden, N. J.

ADVICE TO SET OWNERS

TV owners can save themselves trouble by carefully studying repair contracts before signing them, Attorney General Louis J. Lefkowitz of New York State believes. Mr. Lefkowitz, in an article in *TV Guide* magazine said that America has the finest technicians in the world, but there will always be "business sharpshooters." He advised set owners to do the following:

Don't permit your set to be taken from your home for repairs without receiving a written estimate of the repair cost.

Obtain written assurance that no additional repairs will be made unless you agree and that, if you do not wish the extra repairs, the set will be returned immediately.

Never sign a contract without reading it carefully.

Never sign a repair contract which contains blank spaces. Hundreds of people are victimized in this way every day.

Never sign a statement that work is done when it is not. You may have to pay for an unfinished job.

When dealing with an unknown repair service, check with your Chamber of Commerce, Better Business Bureau or technicians' association.

Mr. Lefkowitz cites one New York firm that victimized set owners of more than $1,000,000 before being driven out of business. The company advertised that TV repair costs could be paid for with as little as 50 cents per week. Once the sets were in the shop, however, the customer was notified that a new picture tube was needed and a down payment of at least $35 was required. The customer had no choice but to pay, without knowing if the tubes were really needed.

REFUSED MEMBERSHIP

The Electronic Service Association of Butte, Mont., voted to deny membership to a probationary member, Stuart A. Mayo. Grounds were price advertising in violation of the association's code of ethics, and violation of a membership resolution establishing a minimum service charge for house calls.

AD GIMMICK

TESA News of Wisconsin reports an interesting advertising gimmick being tried in Kansas City. The shop buys standby time from a local station. Whenever the station goes off the air because of technical troubles, it says (or words to this effect): "Don't call Ace TV, it's just TV station trouble." The shop has a flat rate, no matter how many times the station goes out.

[How much trouble does this station have?—*Editor*] END

new PATENTS

REGENERATIVE TRANSISTOR PAIR

Patent No. 2,864,062

Johannes S. Schaffner, Syracuse, N.Y. (Assigned to General Electric Co.)

This invention is a way of making a pair of junction transistors behave like a point-contact transistor. Readers probably know that the point-contact is an easy oscillator and can generate sine, square, pulse and sawtooth waves. A junction type is more rugged, efficient and easier to manufacture than the point-contact.

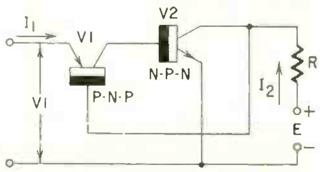


Fig.1

Fig. 1 shows a p-n-p transistor (V1) directly coupled to an n-p-n unit (V2). Its input characteristic is drawn in Fig. 2. This idealized "curve" has three distinct regions.

With negative input current (I_1) V1 blocks and no current flows into V2's base. The input *resistance* is that of a reverse-biased diode (V1 emitter–base) which is positive and large. See region I.

Both transistors conduct when I_1 is positive. Note that V2's collector current (I_2) is greater than I_1 and is opposite in direction. V1, which is

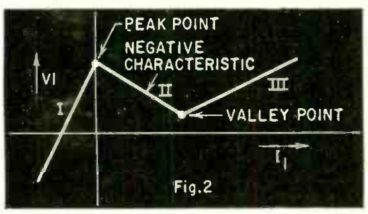


Fig.2

equal to $E - I_2R$, goes down as I_1 rises. This is negative resistance as shown in region II.

Very large I_1 results in a large voltage drop across R. Due to the low potential difference between V2's collector–emitter, this transistor ceases to function. The input *resistance* is now

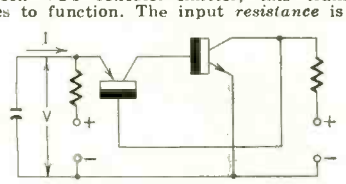


Fig.3

that of a positive biased diode (V1 emitter–base) and is positive and small. Refer to region III.

Fig. 3 shows a free-running oscillator. The operating point is chosen so that the negative-resistance region corresponds to zero input current. For more data see story on page 51.

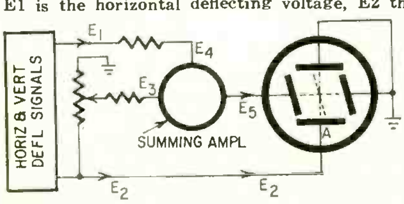
DEFLECTION CORRECTION

Patent No. 2,936,400

Thomas H. Tatham, Jr., San Diego, Calif. (Assigned to General Dynamics Corp., Rochester, N.Y.

When an oscilloscope is used for precise measurement or display, its deflecting plates must be positioned accurately. If they slant (see diagram), the resulting display will slant likewise. If the plates are distorted, the error may be corrected by this external circuit.

E1 is the horizontal deflecting voltage, E2 the



vertical. A fraction of E2 is combined with E4 at the amplifier. E5 is the *corrected* horizontal deflection voltage.

Consider the display of a vertical line which, due to plate misalignment, will slant. When the trace is at the top, plate A must be negative with respect to ground. Therefore E3 is also negative, and E5 must be more negative than E1. Thus the beam is repelled toward the right.

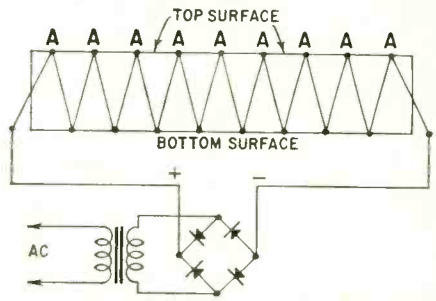
When the trace is at the bottom, A is positive. This means that E5 will be more positive than E1, and the beam will be attracted more to the left. It is obvious from this discussion that the display will be more vertical than it would otherwise be. R is adjusted as required for complete correction.

ELECTRIC BLANKET COOLS

Patent No. 2,938,356

Howard O. McMahon, Lexington, Mass. (Assigned to Arthur D. Little, Inc., Cambridge, Mass.)

According to this invention, blankets, flying suits, apparel or bedding can be used to *cool* the body. It utilizes junctions of dissimilar metals or semiconductors passing direct current. These junctions are *cooled* when current flows



in one direction, *heated* when the current is reversed. The principle is known as the Peltier effect.

The diagram shows how junctions (A) terminate at an upper surface made of nonconducting material such as fiber. This surface will be cooled. The other surface, contacted by the remaining junctions, will be heated.

The inventor recommends that the junction be made of a metal and a semiconductor, and he lists several suggested junctions in the patent.

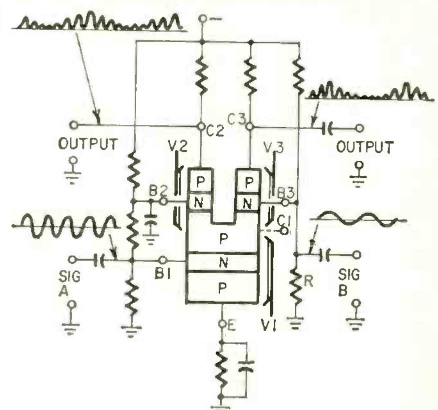
TRIPLE TRANSISTOR

Patent No. 2,936,384

John R. White, Westbury, N. Y. (Assigned to Hazeltine Research, Inc.)

Here are three transistors formed of a single crystal. There are five layers, with a slot cut across the top. The lower p-n-p transistor is labeled V1. V2 is at the upper left, V3 at the upper right. V1's collector is also emitter for V2 and V3, for direct coupling.

A modulator using this unit is shown. The bases of V1, V2 are biased from a voltage divider. V3's base returns to ground through R. Output may be taken from the collector of V2 or V3.



Assume that the output is taken from V3. The output frequency is that of signal A, while signal B controls its amplitude. As B goes negative, it biases V3 for *greater* conduction and output. V3's emitter potential follows the potential of its base. Since V2's base voltage is held constant and its emitter has gone more negative, it is evident that V2's output goes *down* when B goes negative.

The inventor likens this device to a 6AR8 double-plate sheet-beam tube. Both are suitable for various switching and gating applications and permit push-pull output. END

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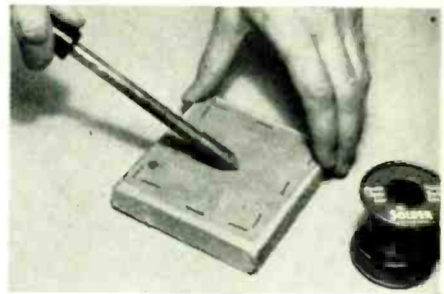
LOOP OILER

A small narrow loop of thin wire makes an excellent oiler for carrying a small amount of oil into a tight spot and not elsewhere. Such a device may be made from a strand of stranded wire soldered to a heavier piece of wire. The loop should be rather small—not more than about five wire diameters across or the oil will not form a film.

In practice, the loop picks up a drop of oil from the nozzle of an oil can. It is touched to the point to be lubricated and twisted slightly so the oil flows on the part from the loop.—*L. Shaw*

SOLDERING-IRON CLEANER

A piece of fine screening tacked to a scrap piece of wood makes a fine scratchboard for a soldering iron. Wiping the iron's tip across the screen occasionally removes excess drops of



solder and crust from the tip efficiently.
—*Charles A. Cunningham*

TESTING AT TOP OF SOCKET

The tips of ordinary test prods won't fit into the pin holes of miniature tube sockets. This is a definite handicap when you want to check voltages from the top of the chassis rather than from underneath. To overcome this handicap, file or grind the ends of your prods to fit. You'll have to make them smaller and more pointed.—*Albert Mason*

NEW FLOCK FOR TURNTABLE

Have you ever tried to pry the C washer off the spindle on a record player only to have the screwdriver slip and run a gash across the face of the turntable? With a little time and patience such an accident can be remedied with no one the wiser.

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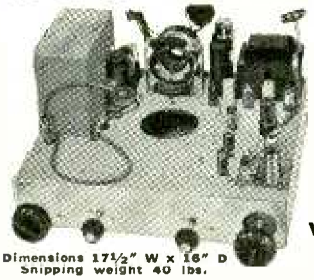

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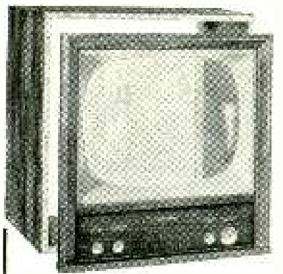

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½ WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ.... 2¢ ea.
½ WATT 10% 390k, 470k, 560k, 680k, 820k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ...... 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω.. 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
2 WATT 10% 18, 22, 82, 100, 180, 2200, 3900, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ.... 4¢ ea.

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- ☐ 50 – ASST. MICA CONDENSERS some in 5% .$1
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- ☐ 4 – BAKELITE KNIFE SWITCHES dpdt $1
- ☐ 3 – ASST. TOGGLE SWITCHES spst, dpdt, etc.$1
- ☐ 15 – ASST. ROTARY SWITCHES $15 worth...$1
- ☐ 100' – FINEST NYLON DIAL CORD best size ..$1
- ☐ 200 – SELF TAPPING SCREWS #8 x ½" $1
- ☐ 35 – ASST. RADIO KNOBS screw and push-on ..$1
- ☐ 100 – ASSORTED KNOB SET-SCREWS $1
- ☐ 25 – ASSORTED CLOCK RADIO KNOBS $1
- ☐ 600 – ASST. H'DWARE screws, nuts, rivets, etc.$1
- ☐ 35 – ASST. SOCKETS octal, noval and miniature .$1
- ☐ 25 – ASST. PRINTED CIRCUIT SOCKETS ...$1
- ☐ 10 – ASST. VOLUME CONTROLS less switch...$1
- ☐ 5 – ASST. VOLUME CONTROLS with switch...$1
- ☐ 20 – ASST. PILOT LIGHTS popular types......$1
- ☐ 10 – PILOT LIGHT SKTS. bayonet type, wired..$1
- ☐ 50 – ASST. TERMINAL STRIPS 1, 2, 3, 4 lug .$1
- ☐ 10 – ASST. RADIO ELECTRO. CONDENSERS.$1
- ☐ 5 – ASST. TV ELECTROLYTIC CONDENSERS.$1
- ☐ 25 – ASST. MICA TRIMMER CONDENSERS..$1
- ☐ 15 – TUBULAR CONDENSERS .47-400v $1
- ☐ 15 – TUBULAR CONDENSERS .1-600v $1
- ☐ 6 – TV ION TRAPS standard for all CRT's.....$1
- ☐ 15 – TUBULAR CONDENSERS .047-600v $1
- ☐ 2 – ELECTROLYTIC COND. 40/40-450v........$1
- ☐ 3 – ELECTROYLITIC COND. 50/30-150v......$1
- ☐ 25 – ASST. PEAKING COILS popular types ...$1
- ☐ 1 – ELECTRIC PHONO MOTOR 78rpm 110v..$1
- ☐ 1 – RCA FLYBACK TRANSFORMER #211T1.$1
- ☐ 300 – ASST. ½W RESISTORS short leads.....$1
- ☐ 4 – TV CENTERING RINGS $1
- ☐ 35 – DISC. CERAMIC CONDENSERS 5000mmf $1
- ☐ 25 – ASST. RADIO DIAL POINTERS $1
- ☐ 8 – ASST. LUCITE CASES handy for parts.....$1
- ☐ 100 – MICA CONDENSERS 820mmf-500v $1
- ☐ 3 – ASST. SIZES RADIO CHASSIS PANS...$1
- ☐ 3 – VARIABLE CONDENSERS super 420/162mfd.$1
- ☐ 4 – OVAL LOOP ANTENNAS ass't hi-gain types $1
- ☐ 3 – LOOPSTICK ANT. new ferrite adjustable ...$1
- ☐ 3 – ½ MEG VOLUME CONTROLS with switch.$1
- ☐ 5 – 50K VOLUME CONTROLS less switch $1
- ☐ 5 – ASST. 4 WATT WIREWOUND CONTROLS $1
- ☐ 5 – ½ MEG VOLUME CONTROLS ss switch .$1
- ☐ 5 – 1 or 2 MEG VOLUME CONTROLS 1/switch .$1
- ☐ 100 – VOLUME CONTROL HEX NUTS $1
- ☐ 10 – SURE GRIP ALLIGATOR CLIPS $1
- ☐ 1 – GOLD GRILLE CLOTH 14"x14" or 12"x18".$1
- ☐ 5 – SETS SPEAKER PLUGS wired $1
- ☐ 10 – SETS PHONO PLUGS and PIN JACKS..$1
- ☐ 2 – $2.50 SAPPHIRE NEEDLES 4000 playings.$1
- ☐ 5 – DIODE CRYSTALS 2—1N21 2—1N22 1—1N64 $1
- ☐ 3 – DIODE CRYSTALS 1—1N60 1—1N64 1—1N69.$1
- ☐ 4 – DIODE CRYSTALS 1N34A...............$1
- ☐ 35 – MICA COND. 20—50 mmf & 15—68 mmf $1
- ☐ 35 – MICA COND. 20—100 mmf & 15—270 mmf $1
- ☐ 35 – MICA COND. 20—470 mmf & 15—680 mmf $1
- ☐ 35 – MICA COND. 20—820 mmf & 15—1000 mmf $1
- ☐ 35 – MICA COND. 20—2200 mmf & 15—2400 mmf....$1
- ☐ 35 – MICA COND. 20—6800 mmf & 15—10000 mmf ...$1
- ☐ 35 – CERAMIC COND. 20—5 mmf & 15—10 mmf...$1
- ☐ 35 – CERAMIC COND. 20—25 mmf & 15—47 mmf ..$1
- ☐ 35 – CERAMIC COND. 20—56 mmf & 15—82 mmf ..$1
- ☐ 35 – CERAMIC COND. 20—100 mmf & 15—150 mmf .$1
- ☐ 35 – CERAMIC COND. 20—270 mmf & 15—470 mmf .$1
- ☐ 35 – CERAMIC COND. 20—1000 mmf & 15—1500 mmf $1
- ☐ 35 – CERAMIC COND. 20—200 mmf & 15—5000 mmf $1
- ☐ 4 – KENRAD TUBES #6SH7...............$1
- ☐ 2 – TOP NAME #6SQ7 TUBES $1
- ☐ 2 – TOP BRAND TUBES #35W4............$1

TOP NAME TUBES OZ4, 1B3, 1X2B, 5U4, 6AC7, 6AX4, 6CB6, 6J6, 6K6, 6U8, 6V6, 6SN7, 6X8, 12AU7, 12AX7, 50L6 ....Each $1

- ☐ 3 – TV ALIGNMENT TOOLS assortment #1...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #2...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #3...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #4...$1
- ☐ 3 – TV ALIGNMENT TOOLS assortment #5...$1

EACH ALIGNMENT TOOL is different and valued at over $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

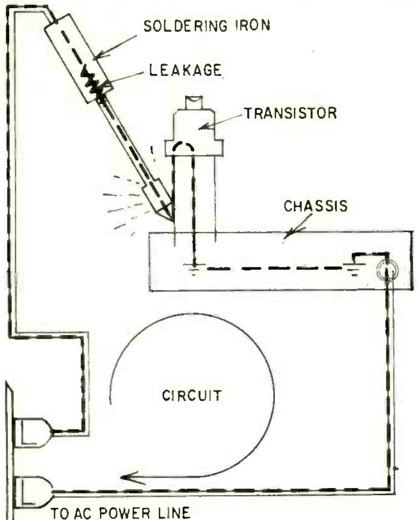
BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

First scrape some flocking off the rim of the turntable with a penknife. In most cases the turntable is set down in a well and the rim is out of view. Next, carefully apply some general-purpose cement to the gash and brush on some of the flocking. If this is done neatly, once the cement is set you will never know the difference.—*Frank A. Salerno*

TRANSISTOR LIFE SAVER

Before you start to solder a transistor into a radio–TV or other electronic device, disconnect the set's power cord.

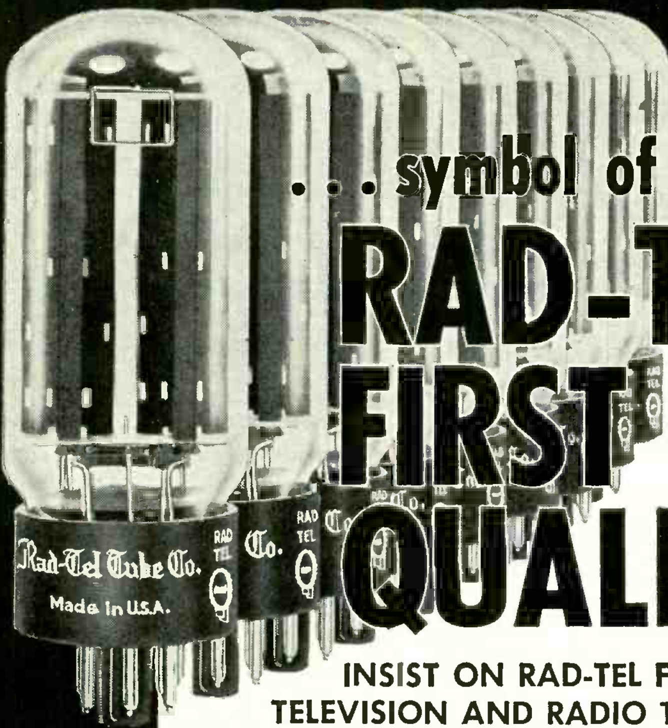


If the set is connected when you touch the tip of your iron to the transistor lead, you may ruin the component. This happens if there is leakage from the tip to the power line inside the iron or gun. The current path is from the power line, through the iron's tip, through the transistor, to chassis ground, and back to the power line. Though the diagram shows an ac–dc set, the same type of thing can also ruin transistors in sets that have a power transformer.—*J. C. Alexander*

PLASTIC TV KNOBS

The TV technician installing a chassis in the cabinet after an initial repair job often finds the plastic knobs so worn that they refuse to stay on the knurled shafts. Attempts to shrink the plastic with a soldering gun usually result in a messy, loose knob. At best, some technicians jam the knobs on the shafts, using wood or plastic tape to provide the necessary grip. These methods are sometimes effective, but not very permanent. An alternative method that *works* calls for simply slipping the proper type of insulating spaghetti tubing into the oversize knob hole, using a little cement to hold it in place, then fitting the knob on the shaft.

Walsco Flexitube spaghetti, a polyethlene type, or Alphlex PVC-105 seem best for this purpose. Either may be purchased in various sizes.—*George D. Philpott*



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Not Used — Not Pulled Out Of Old Sets • Each Tube Individually and Attractively Boxed!

Qty. Type	Price
0Z4M	.79
1AX2	.62
1B3GT	.79
1DN5	.55
1G3	.73
1J3	.73
1K3	.73
1L6	1.05
1LN5	.59
1R5	.62
1S5	.51
1T4	.58
1U4	.57
1U5	.50
1X2B	.82
2AF4	.96
3AL5	.42
3AU6	.51
3AV6	.41
3BA6	.51
3BC5	.54
3BE6	.52
3BN6	.75
3BU8	.78
3BY6	.55
3BZ6	.55
3CB6	.54
3CF6	.60
3CS6	.52
3CY5	.71
3DK6	.60

Qty. Type	Price
3DT6	.50
3Q5	.80
3S4	.61
3V4	.58
4BC5	.56
4BC8	.96
4BN6	.75
4BQ7	.96
4BS8	.98
4BU8	.71
4BZ6	.58
4BZ7	.96
4CS6	.61
4DE6	.62
4DK6	.60
4DT6	.55
5AM8	.79
5AN8	.86
5AQ5	.52
5AT8	.80
5BK7A	.82
5BQ7	.97
5BR8	.79
5CG8	.76
5CL8	.76
5EA8	.80
5EU8	.80
5J6	.68
5T8	.81
5U4	.60
5U8	.81
5V6	.56
5X8	.78
5Y3	.46

Qty. Type	Price
6AB4	.46
6AC7	.96
6AF3	.73
6AF4	.97
6AG5	.65
6AH6	.99
6AK5	.95
6AL5	.47
6AM8	.78
6AN4	.95
6AN8	.85
6AQ5	.50
6AR5	.55
6AS5	.60
6AT6	.43
6AT8	.79
6AU4	.82
6AU6	.50
6AU7	.61
6AU8	.87
6AV6	.40
6AW8	.89
6AX4	.65
6AX7	.64
6BA6	.49
6BC5	.54
6BC7	.94
6BC8	.97
6BD6	.58
6BE6	.55
6BF6	.44
6BG6	1.66
6BH6	.65
6BH8	.87

Qty. Type	Price
6BJ6	.62
6BK7	.85
6BL7	1.00
6BN4	.57
6BN6	.74
6BQ5	.65
6BQ6GT	1.05
6BQ7	.95
6BR8	.78
6BU8	.70
6BY6	.54
6BZ6	.54
6BZ7	.97
6C4	.43
6CB6	.54
6CD6	1.42
6CF6	.64
6CG7	.60
6CG8	.77
6CM7	.66
6CN7	.65
6CR6	.51
6CS6	.57
6CU5	.58
6CU6	1.08
6CY5	.70
6CY7	.71
6DA4	.68
6DB5	.69
6DE6	.58
6DG6	.59
6DQ6	1.10
6DT5	.66
6DT6	.53

Qty. Type	Price
6EU8	.79
6EA8	.79
6H6GT	.58
6J5GT	.51
6J6	.67
6K6	.63
6S4	.48
6SA7GT	.76
6SK7	.74
6SL7	.80
6SN7	.65
6SQ7	.73
6T4	.99
6U8	.78
6V6GT	.54
6W4	.57
6W6	.69
6X4	.39
6X5GT	.53
6X8	.77
7AU7	.61
7A8	.68
7B6	.69
7Y4	.69
8AU8	.83
8AW8	.93
8BQ5	.60
8CG7	.62
8CM7	.68
8CN7	.97
8CX8	.93
8EB8	.94
10DA7	.71
11CY7	.75

Qty. Type	Price
12A4	.60
12AB5	.55
12AC6	.49
12AD6	.57
12AE6	.43
12AF3	.73
12AF6	.49
12AJ6	.46
12AL5	.45
12AL8	.95
12AQ5	.52
12AT6	.43
12AT7	.76
12AU6	.50
12AU7	.60
12AV5	.97
12AV6	.41
12AV7	.75
12AX4	.67
12AX7	.63
12AZ7	.86
12B4	.63
12BA6	.50

Qty. Type	Price
12BD6	.50
12BE6	.53
12BF6	.44
12BH7	.73
12BL6	.56
12BQ6	1.06
12BY7	.74
12BZ7	.75
12C5	.56
12CA5	.59
12CN5	.56
12CR6	.54
12CU5	.58
12CU6	1.06
12CX6	.54
12DB5	.69
12DE8	.75
12DL8	.85
12DM7	.67
12DQ6	1.04
12DS7	.79
12DZ6	.56
12EL6	.50

Qty. Type	Price
12EG6	.54
12EZ6	.53
12F5	.66
12F8	.66
12FM6	.45
12K5	.65
12SA7M	.86
12SK7GT	.74
12SN7	.67
12SQ7M	.73
12U7	.62
12V6GT	.53
12W6	.69
12X4	.38
17AX4	.67
17BQ6	1.09
17C5	.58
17CA5	.62
17D4	.69
17DQ6	1.06
17L6	.58
17W6	.70
19AU4	.83

Qty. Type	Price
19BG6	1.39
19T8	.80
21EX6	1.49
25BQ6	1.11
25C5	.53
25CA5	.59
25CD6	1.44
25CU6	1.11
25DN6	1.42
25EH5	.55
25L6	.57
25W4	.68
25Z6	.66
35C5	.51
35L6	.57
35W4	.52
35Z5GT	.60
50B5	.60
50C5	.53
50DC4	.37
50EH5	.55
50L6	.61
117Z3	.61

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STEREO AMPLIFIER CHASSIS $4.95

Lots of 3 ea.

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☐ Set of tubes: 2-35C5; 1-12AX7; 1-35W4 $1.15
☐ Set of 3 grey ½" knobs 30c

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TERMS: 25% deposit must accompany all orders — balance C.O.D.
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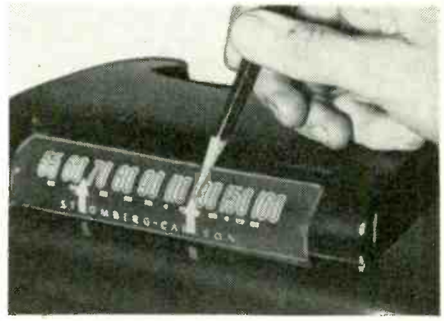
TRY THIS ONE *(Continued)*

GOODWILL KINK

As an extra service to the customers that bring older model radios to our



shop for repair, we mark the set's dial at 640- and 1240-kc (Conelrad alert frequencies) with arrows cut from red plastic tape. Customers seem to appreciate the interest we show in their welfare. To determine the exact location of each arrow, we just set up the signal generator to each frequency, calibrate the set's dial and stick the arrows in place.—*Allen C. Johnson* END

50 Years Ago

In Gernsback Publications

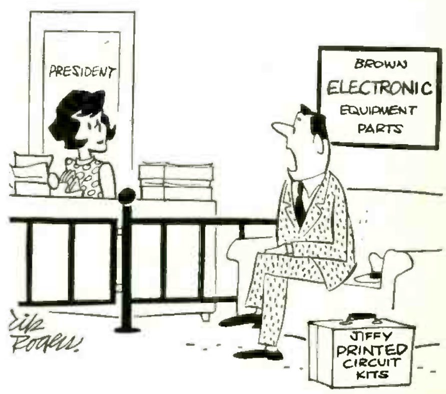
HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In October, 1910, *Modern Electrics*

Radiotelephony, by Wm. E. Smith.
A Variable Slide-Plate Condenser, by Richard Baker.
New Electrolytic Detector.
Helices, by D. E. McKisson.
90 Miles With a One-Inch Coil, by Chas. D. Herrold, E.E.
How to Construct a Non-Inductive Potentiometer, by William Klaus.
Construction of a Hot Wire Ammeter, by Donald R. Johnson.



"Pardon me, do you have a scrap of paper? There's a radio program I don't want to miss."

BUSINESS and PEOPLE

RCA Electron Tube Div., Harrison, N. J., launched a new advertising and sales promotion campaign, the biggest of its kind in its history, for its all-new

premium Silverama TV picture tube. Newspapers, trade and consumer magazines, radio and TV, direct mail and outdoor advertising will be used.

Electronic Instrument Co., Inc., Long Island City, New York, is offering distributors of its line of Eico hi-fi equip-

ment, test instruments and other electronic equipment, in kit or wired form, colorful neon and clock neon signs for window and interior display.

CBS Electronics, Danvers, Mass., again received an award from NATESA for outstanding service in creating better customer relations. A. L. Chapman, CBS Electronics president

(center) accepts the award from Mac Metoyer, NATESA president. J. H. Hauser, CBS Electronics sales manager; Frank J. Moch, executive director of NATESA, and R. V. Bontecou, CBS Electronics vice president of marketing, look on (left to right).

H. H. Scott, Inc., Maynard, Mass., has

PHOTOGRAPHS RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic devices. We will pay $7.50 each for good professional photos or equivalent, suitable for reproduction. Full information on subject photographed will increase their acceptability.

The Editor, RADIO-ELECTRONICS
154 West 14th St. New York 11, N. Y.

offered to replace any original London-Scott 1000 stereo cartridges with the new ruggedized version. The company has also announced that it had received a Certificate of Merit for excellence of design and execution from the Art Directors Club of Boston for its booklet "How to Use Stereo High Fidelity Components in Your Decorating Plans."

Raytheon Co.'s Distributor Products Div.'s Unicenter in Westwood, Mass., has installed a new machine which

automatically bonds clear-plastic contour blisters to cardboard merchandiser panels so that 10 transistors can be shipped and displayed together.

Rek-O-Kut Co., New York, played host to 94 winners of its Tropical Holiday dealer-incentive promotion on a

week-long trip to Nassau in the Bahamas. Dealers and their wives are shown boarding the chartered plane for the return trip.

Vaco Products Co., Chicago, is offering purchasers of its Crimcut cutting and crimping tool a dollar book, "Shop Kinks," for 25c.

Kenneth B. Shaffer (left) was promoted to manager, distributor sales, of the RCA Electron Tube Div., Harrison, N. J., succeeding **D. M. Branigan,** who was recently appointed manager, electronic components marketing, of RCA's International Div. Shaffer had been distributor field sales manager. **John R. Meagher** (right) was appointed man-

ager of electronic instruments merchandising of the Distributor Products Dept. of the division. He has been a technical editor, field engineer and author and lecturer on test equipment for the company.

Francis J. Chamberlin was appointed vice president of sales of Clarostat Mfg. Co., Dover, N. H. He has been with the company since 1945, most recently as general sales manager.

The acquisition by Electro-Voice, Inc., Buchanan, Mich., of the Featheride Phono Pickup & Cartridge Div. of Webster Electric Co. of Racine was announced by **Al Kahn**, president of Electro-Voice. The newly acquired products will be marketed as Electro-Voice Featheride cartridges and tone arms and will be manufactured in the firm's new Eureka, Ill., plant.

Boyd B. Barrick, former central zone manager for Raytheon Co.'s Distributor Products Div., Westwood, Mass., was promoted to the position of general sales manager of the division.

Ralph H. G. Mathews joined Blonder-Tongue Labs., Newark, N. J., as director of marketing. He comes from Westinghouse Electric Corp., TV-Radio Div. He held the position of manager of national accounts and sales training at Westinghouse.

Alvin Grad has been named national sales manager for Mercury Electronics Corp., Mineola, N. Y. He is a veteran sales executive and was with such companies as Fada Radio, Admiral and Rytel.

Clyde J. Schultz was appointed sales promotion manager of Switchcraft, Inc., Chicago. He will be responsible for all phases of the advertising and sales promotion program of the Industrial and Distributor Sales Divisions. He comes to the company from Admiral Sales Corp. where he was sales promotion manager. END

new LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

NEEDLE CATALOG has illustrations of needles and how they are mounted in cartridges. Cross-references are given to several needle manufacturers as well as phonograph manufacturers. Tables list needle numbers, tip sizes, prices, cartridge numbers and old manufacturer's numbers. — **Astatic Corp.**, Conneaut, Ohio.

PARTS AND ACCESSORIES are listed in a 375-page loose-leaf manual. Information and photographs are given on batteries, tubes, tuners, wrenches, knobs, antennas, etc. Available from manufacturer's distributors.—**Zenith Sales Corp.**, 6001 W. Dickens Ave., Chicago 39, Ill. $4.

GUIDE TO INDUSTRIAL PRODUCTS gives specifications on voltage regulators, special-purpose tubes, semiconductors; describes and illustrates knobs, and includes a cross-reference to competitors' tube types. Several sections in one folder.—**Raytheon Co., Dist. Products Div.**, 411 Providence Turnpike, Westwood, Mass.

INDICATOR LAMPS and sockets are described in a 4-page folder. Bulbs are flat-topped with special construction for smaller size, longer life, stronger bases and higher light output. A colored nylon cap fits the bulb end. A matching line of sockets is available.—**Sylvania Lighting Products, Div. Sylvania Electric Products, Inc.**, 60 Boston St., Salem, Mass.

MICROPHONE FACTS discusses operation principles of the parabolic-reflector microphone, the "machine-gun" microphone and the model 642, an extreme-directivity, wide-range, high-output instrument.—**Electro-Voice, Inc.**, Buchanan, Mich.

CATALOG of stock panel meters lists more than 1068 models and sizes. 8-page *Bulletin No. 2061* has photographs and dimensional drawings.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

REPLACEMENT TV KNOBS are pictured

and listed for 12 makes of sets. This 8½ x 14½-inch chart has 12 pages.—**GC Electronics Co., Div. Textron Electronics, 400 S. Wyman St., Rockford, Ill.**

COMPRESSOR–LIMITER amplifier and control unit are described in a 4-page folder. — **Westrex Corp., Recording Equipment Dept.,** 6601 Romaine St., Hollywood 38, Calif.

REPLACEMENT GUIDE lists ceramic-base printed circuits used in radios since January, 1950. *Manual K-352* lists manufacturers in alphabetical order. Schematics of entire line of 179 replacement printed circuits are shown along with capacitance and resistance ratings. Available from distributors or send **10c** to manufacturer.—**Sprague Products Co.,** 81 Marshall St., North Adams, Mass.

CATALOG of stereo and test equipment, radio and TV components, Citizens-band equipment, tools, books, public-address systems, cameras, etc. *Catalog 310* is largest (320 pages) and most comprehensive offered in firm's history.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

REFERENCE DATA for TV-antenna systems. *Booklet JP-1* lists cable data, frequency data for the different channels, information on manufacturer's tapoffs and a chart to simplify db calculations.—**Jerrold Electronics Corp.,** 15 St. and Lehigh Ave., Philadelphia 32, Pa.

MICROPHONES are listed in *Catalog M10*. There are 12 pages of specifications, photographs, applications and prices. 8½ x 11 inches.—**Astatic Corp.,** Conneaut, Ohio.

POWER SUPPLY HANDBOOK lists variable-frequency ac supplies, variable-voltage dc supplies (up to 600,000 volts) and voltage regulators. Seven pages of technical data cover such subjects as ripple, ac regulators and frequency changers.—**Sorensen & Co., Inc.,** Richards Ave., S. Norwalk, Conn.

MULTICONDUCTOR cables in round and ribbon styles are listed in an 18-page catalog. Conductors and insulating materials (including Teflon) are discussed.—**Times Wire & Cable Div., International Silver Co.,** Wallingford, Conn.

CLOSED CIRCUIT TV and its uses are covered in the 14-page booklet *How to Use Direct-Wire TV*. Some of the subjects discussed are medical uses, student training, pilferage protection and interdepartmental communication. — **Argus A-V Systems Dept., Argus Cameras, Inc.,** 405 Fourth St., Ann Arbor, Mich.

TERMINAL BLOCKS and switches are described and illustrated in 32-page *catalog No. 16*. Blocks are barrier and pressure-contact (setscrew) types. Toggle switches meet military specifications.—**Kulka Electric Corp.,** 633-643 S. Fulton Ave., Mount Vernon, N. Y. END

new BOOKS

FUNDAMENTALS OF NUCLEAR ENERGY AND POWER REACTORS, by Henry Jacobowitz. John F. Rider, Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 6 x 9 in., 118 pp. $2.95.

Written for technicians and students of physics, this begins with atomic theory, which is explained clearly with the aid of illustrations. The second chapter discusses fission and shows how energy is released. The last two chapters (most of the book) deal with types of reactors and power plants. Large sketches, cutaway drawings and photos show details of actual reactors. Specifications, control systems, cost and output are given.

TRANSISTORS. Saedi, Unlimited, 626 S. Federal St., Chicago, Ill. 8½ x 11 in. 30 pp. $1.25.

In a brief and elementary manner, this book explains transistor operation. It compares basic transistor circuits with those using tubes and discusses certain types of amplifiers and oscillators. A few pages give servicing hints.—*IQ*

2-WAY MOBILE RADIO HANDBOOK, by Jack Helmi. Howard W. Sams & Co., Indianapolis and Bobbs-Merrill Co., New York. 5½ x 8½ in. 207 pp. $3.95.

More than a million vehicles are equipped for radio communication. This book discusses and explains the theory and practice of mobile transmitters and receivers, their alignment and repair. Topics include selective calling, afc, squelch, antennas and power supplies. The book is directed to those who are already familiar with basic radio. The final chapter tells how to set up shop for servicing two-way radio sets and gives a rundown on the latest test equipment.—*IQ*

EXPLORATORY ELECTRICITY, by Joseph P. Arnold and Kenneth L. Schank. McKnight & McKnight Publishing Co., Bloomington, Ill. 8½ x 10 in. 104 pp. $1.25.

This book is written at the level of the junior high student. It begins with an interesting discussion of the work done by electricians, technicians and engineers, then proceeds to a study of electricity and its everyday uses. Experiments with batteries, motors, circuits and radio sets are described. A continuity tester and tube checker are among make-it-yourself items.

A 22-page manual, supplied free to teachers, discusses tools, shop layout, activity boards for experiments, and answers the questions given in the text.

MOON BASE, by T. C. Helvey. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 5½ x 8½ in. 72 pp. $1.95

Before attempting anything as hazardous as a manned expedition to the moon, scientists must know conditions

SCHOOL DIRECTORY

NEW BOOKS *(Continued)*

in space and on the moon, and how humans will probably react to them. This authority presents a factual, frank discussion of the technical and psychological aspects. He makes recommendations as to food, air, equipment, medical care, etc. He concludes that the optimum crew would consist of two men and a woman.—*IQ*

RCA RECEIVING TUBE MANUAL. RCA, Electron Tube Div., Harrison, N. J. 5½ x 8¼ in. 432 pp. $1.

The useful data crammed into this latest edition make it a big dollar's worth. It describes uses, tests and installations of tubes and the design of circuits. About 60 pages at the beginning describe the use of tubes in basic circuits. About 20 more at the end are devoted to practical schematics of amplifiers, radios, power supplies, etc. Detailed characteristics are listed for recommended type tubes. Discontinued and renewal types are identified by being listed in smaller type.—*IQ*

INTRODUCTION TO ELECTRIC CIRCUITS, by Herbert W. Jackson. Prentice-Hall, Englewood, N.J. 6 x 9 in. 479 pp. $8.75.

INTRODUCTION TO ELECTRIC ENGINEERING, (3rd ed.), by Robert P. Ward. Prentice-Hall, Englewood, N. J. 6 x 9 in. 372 pp. $8.50.

Both volumes are highly recommendable for their clarity and coverage. Both discuss fundamentals of magnetic circuits, dc and ac networks and measurements.

The first volume is written at the level of technical schools and is well suited for self-study. A chapter on vector analysis prepares the student for chapters on impedance and resonance. There are many numerical examples with answers.

The volume by Ward is more advanced and is directed to majors in electrical engineering. The author uses calculus. Topics include ferromagnetism, magnetic fields and transients. Problems and study questions are included. END

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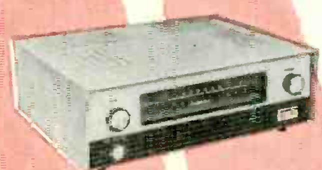

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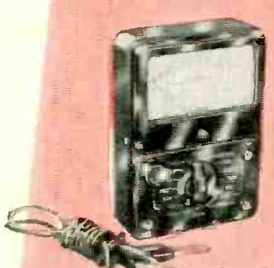

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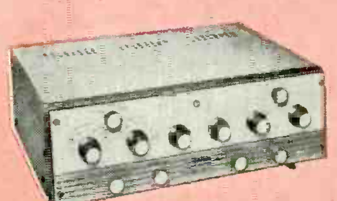

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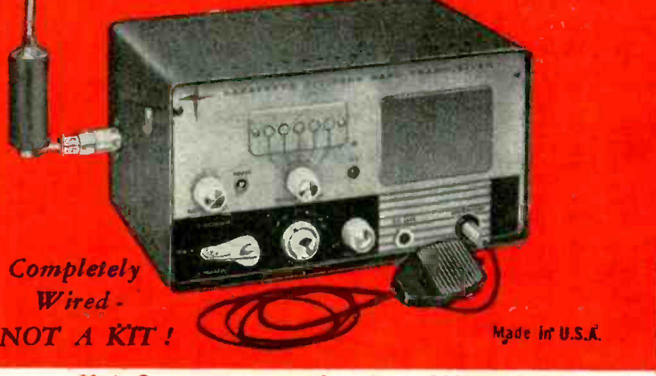

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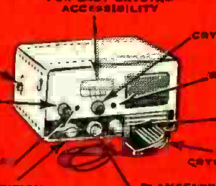

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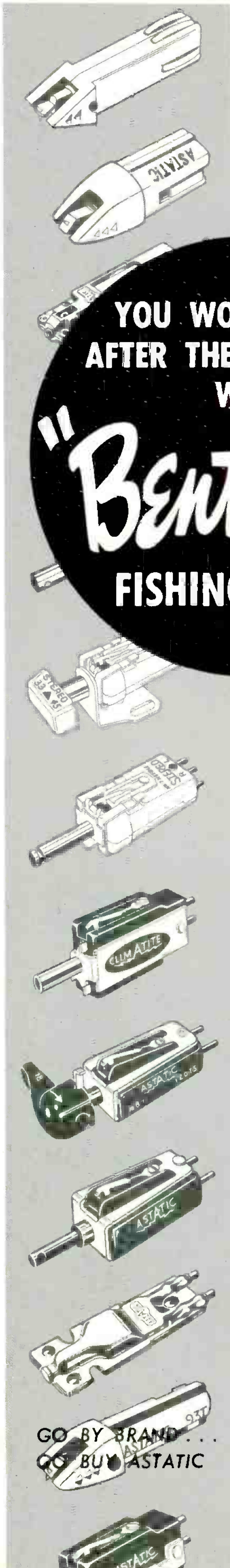

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