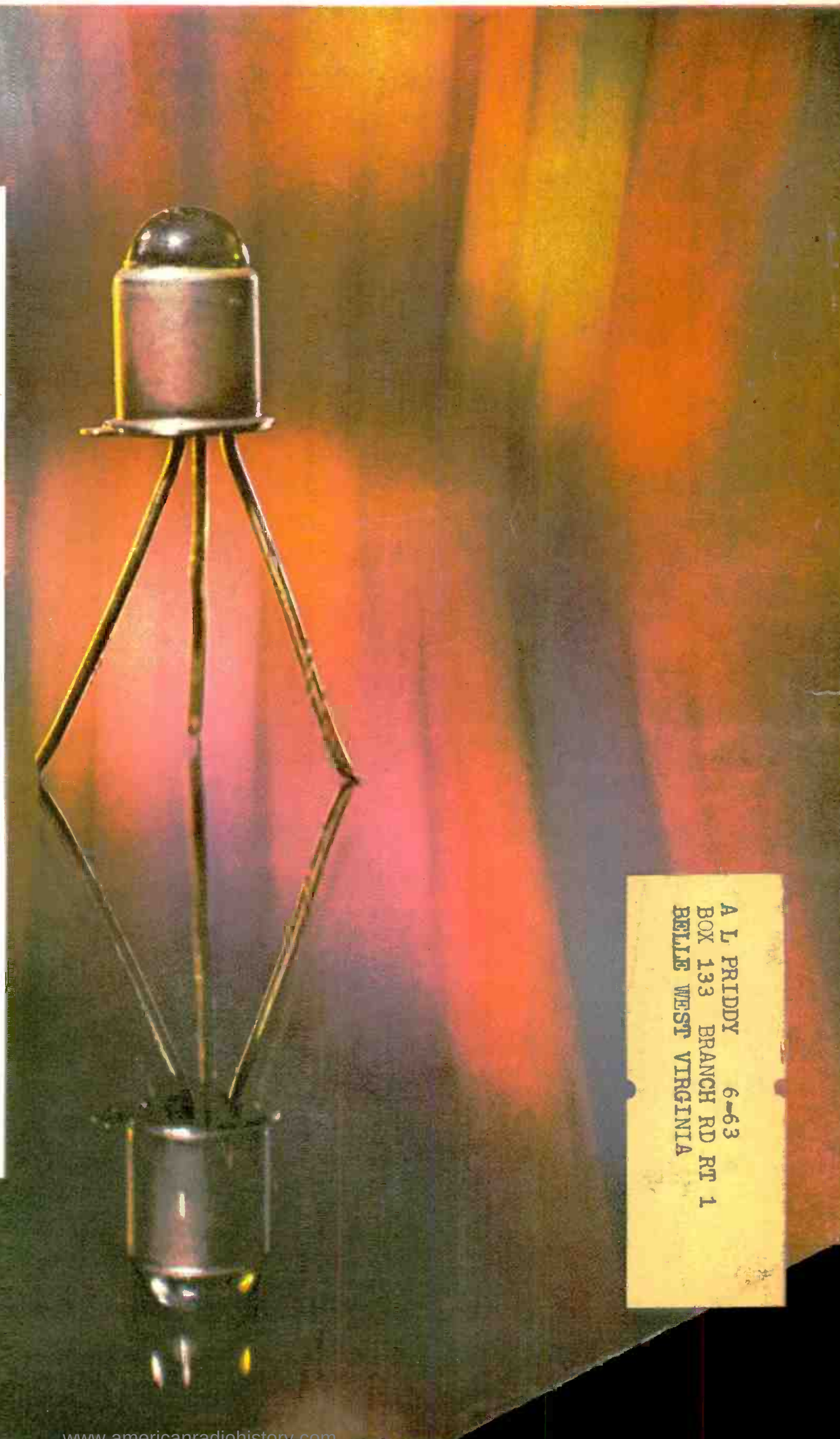
AUGUST

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor-in-chief



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OPTICAL TRANSISTOR OPENS NEW VISTAS

See page 50

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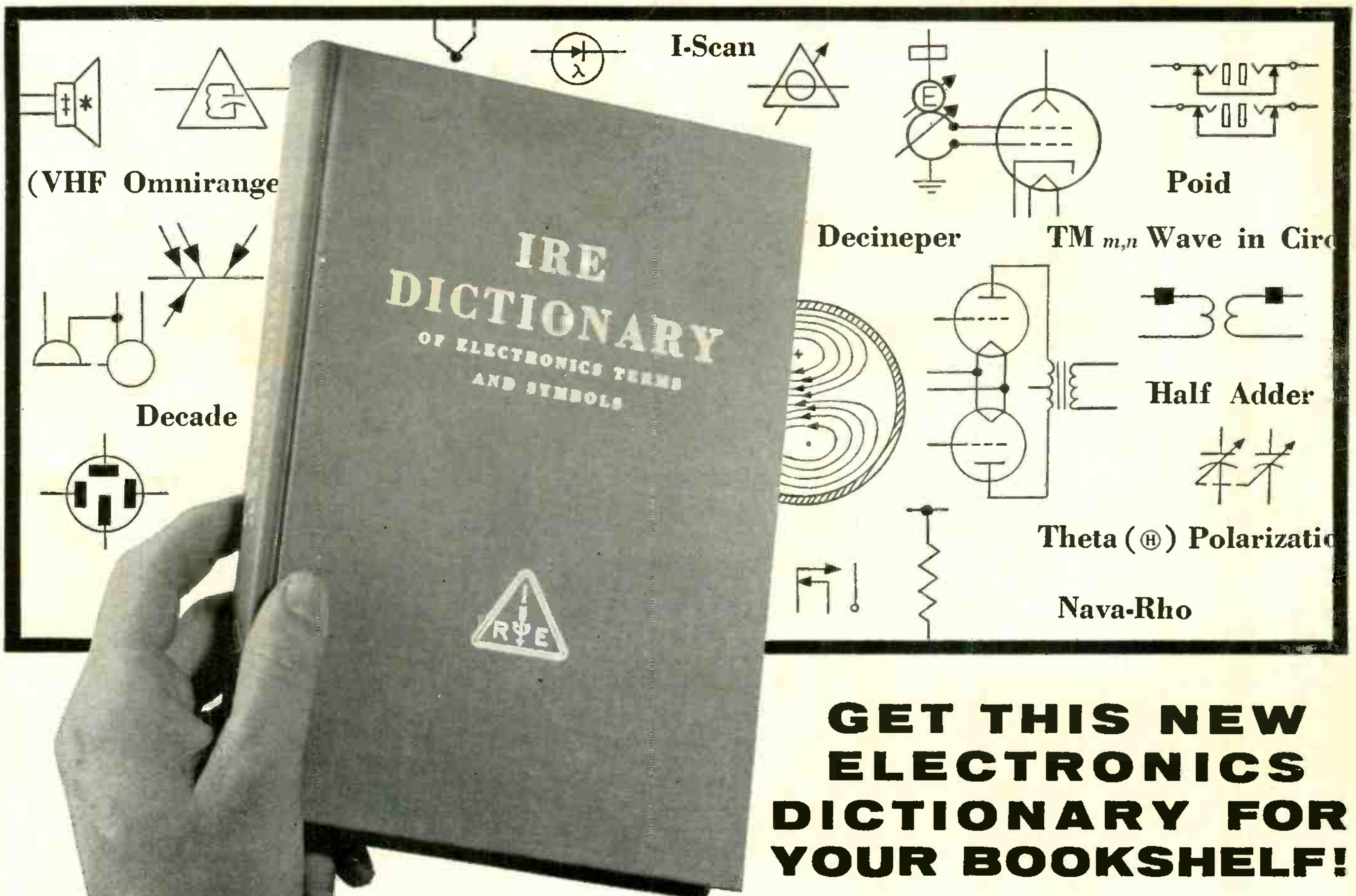

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AUGUST 1962
VOL. XXXIII No. 8

Formerly RADIO CRAFT—Incorporating SHORT WAVE CRAFT—TELEVISION NEWS—RADIO & TELEVISION*

—on the cover—

(Story on page 50)

With the hemispherical lens and conventional base connection, this transistor can operate with light or electrical signals, or both.

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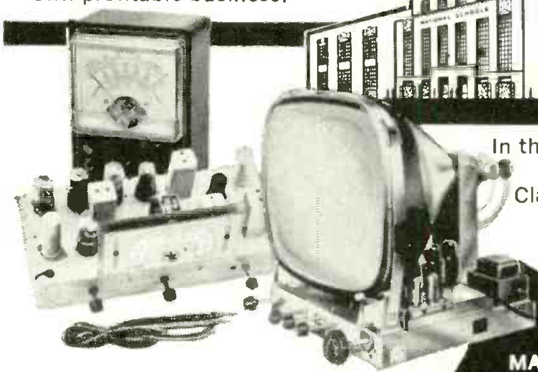

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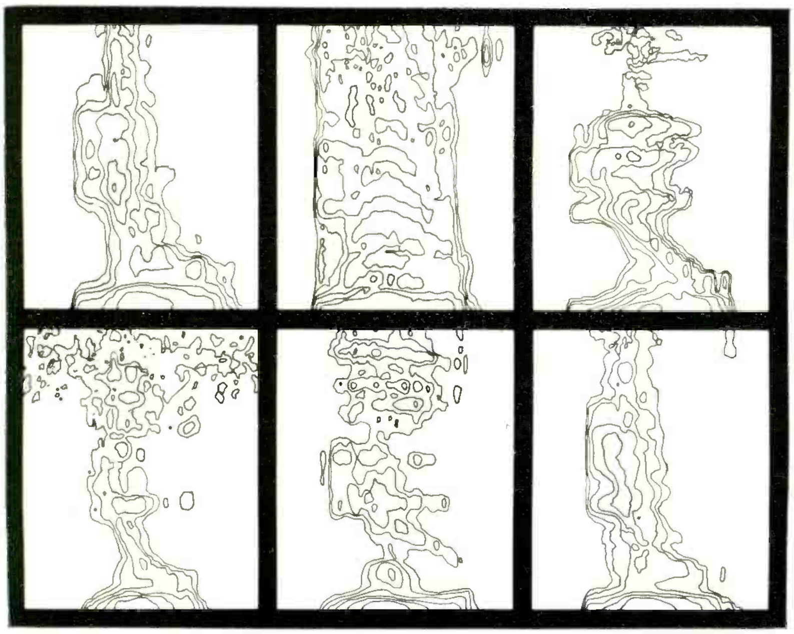
News Briefs

New Radar Has 500-Foot Range

Designed for automobile obstacle detection at ranges up to 500 feet, a new and simple radar method is capable of working at ranges down to a few inches, according to Wesley D. Boyer of the Ford Scientific Laboratory. The equipment, described by Mr. Boyer in a paper read at the latest IRE convention, is a single microwave transmitter, using one tube. It is switched (diplexed) alternately between two frequencies. The receiver compares the phases of the two alternately produced Doppler frequency waves to obtain the range of the obstacle reflecting the wave. The device might also be useful, said Mr. Boyer, as an aircraft altimeter.

"Voiceprinting" Suggested by Bell Labs Scientists

Your voice is so distinctly your own that it may someday identify you, just as your fingerprints do today, says Lawrence G. Kersta of the Bell Telephone Laboratories. While the difference in voices is a matter of common experience, Mr. Kersta points out that voice spectrograms disclose fundamental sound patterns that are more distinctive to the eye than the ear. Tests indicate that trained persons can pick out the voiceprints of the same person from among a large number, with an accuracy greater than 97%.



Six voiceprints of the word "you" were made by five different persons. The two prints by the same person are unmistakable.

82 Channels on All TV's

Similar bills, passed by both houses of Congress, require that all future television sets shipped in interstate commerce be constructed to receive all vhf and uhf TV channels. Receivers imported from foreign countries are also included. The bill leaves it to the FCC to set up regulations to bring about the shift to all-channel operation, and to establish a time schedule. The present estimate is that it will take about two years before the majority of manufacturers can produce all-channel sets.

New Acoustic Features in Concert Hall

A cannon was fired in the Philharmonic Hall of Lincoln Center for the Performing Arts, New York City, as part of a program of "tuning up" the new hall for best acoustics. The cannon was used to check reverberation time in the hall. The most striking of the measures for improving hall acoustics are several rows of "clouds"—reflectors—hanging from the ceiling. These clouds can be lowered or raised as required, and the angle of some of them changed to reflect sound to where it is wanted. A gold-anodized aluminum-mesh screen around the sides and back of the stage forms a 4-foot corridor with the outer walls. Engineers expect to place absorbing or reflecting materials in this corridor to control the sound.

WWVH Makes Minor Changes

The National Bureau of Standards proposes minor changes in the schedule of radio WWVH at Maui, Hawaii, becoming effective July 1. Four 3-minute silent periods each hour will no longer be observed, and are being replaced by one hourly silent period, from 15 minutes to 19 minutes past each hour. The 34-minute silent period at 1900 hours GMT (Greenwich Mean Time) will be retained as at present. One of the objects for the change was to make it possible to receive the time signals of either WWV or WWVH, without interference from the other. In the past, WWVH was silent at all times when WWV was. Now, WWVH will transmit during WWV's silent period, from 45 to 49 minutes past each hour.

Coherent Light Receiver Announced by Philco Lansdale

Engineers at Philco's Lansdale Div. have introduced a solid-state photomixer diode that can demodulate laser outputs. The new device, L-4500, is a silicon planar epitaxial

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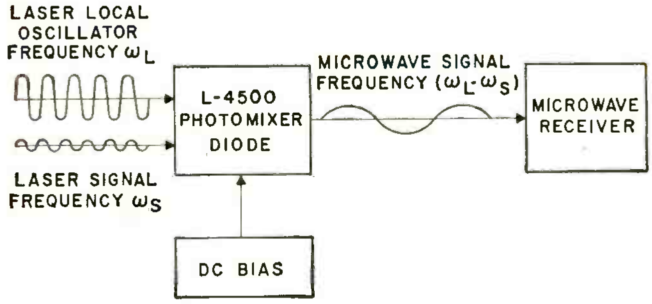

diode that detects the difference frequency between two closely spaced optical laser frequencies.

The mixing principle is the same as that of the radio superheterodyne, where the difference between two radio frequency signals is detected. Unlike the conventional crystal, the photomixer need not respond electrically to either a signal or a local oscillator frequency. It merely detects the difference frequency. The L-4500 provides high quantum efficiency, and operates for information bandwidths up to 5 kmc. At 7,000 angstroms, its quantum efficiency is estimated at a minimum of 65%, typical performance 85%. The output is to a 50-ohm coaxial line.

Japanese Production Up

Japanese electronics production increased roughly 20% in value in 1961, as over 1960. The figures, based on the first 9 months of each year, were released by the Dept. of Commerce. Television and radio receivers accounted for 48% of the 1961 production. TV receivers alone, for the 9-month 1961 period, amounted to 3,195,000 units, compared to 2,583,000 in the 1960 9-month period. Transistor receivers were up from 8,101,000 to 8,899,000. All semiconductors showed a significant increase, with transistors going from 104,377,000 to 129,947,000. Significantly, the value in thousands of dollars decreased during the same period, from $53,847,000 to $39,929,000, reflecting a sharp drop in transistor prices.

Calendar of Events

Turkey Run VHF Picnic, July 29, Wabash Valley Amateur Radio Association, Terre Haute, Ind.

Western Electronic Show and Convention (Wescon), Aug. 21–24; Sports Arena, Los Angeles, Calif.

World's Fair of Music & Sound, Aug. 31–Sept. 9; McCormick Place, Chicago, Ill.

International Symposium on Information Theory, Sept. 3-7; Brussels, Belgium.

National Symposium on Engineering Writing & Speech, Sept. 13–15; Mayflower Hotel, Washington, D.C.

Lithium Doping Improves Synthetic Quartz

Adding a small amount of lithium to the solution in which synthetic quartz crystals are grown (RADIO-ELECTRONICS, July 1959) may lead to the rapid production of crystals with a Q virtually equal to that of natural quartz, according to Dr. James King of Bell Telephone Labs. High-Q crystals can be grown synthetically at present, but only at such a slow rate as to make their production very expensive.

Electronic Refrigerator Readied for Market

The Norge Div. of Borg-Warner demonstrated a two-cubic-foot electronic refrigerator early in the summer, and expects to have it on the market by Sept. 1. The retail price has not been set, but is expected to be considerably higher than that of conventional refrigerators. An electronic air conditioner was shown at the same time. Estimated to cost "three to five times as much as con-

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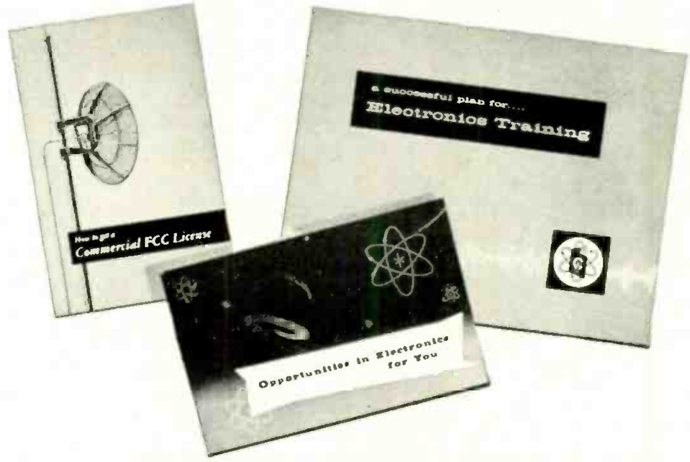

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ventional models," it has the great advantage that it can be turned from a cooler into a heater, simply by reversing the supply polarity.

Hugo Gernsback Award

Seymour Popovitz has been granted the 1962–63 Hugo Gernsback scholarship award, a $1,000 grant presented yearly to the student chosen by New York University's College of Engineering faculty.

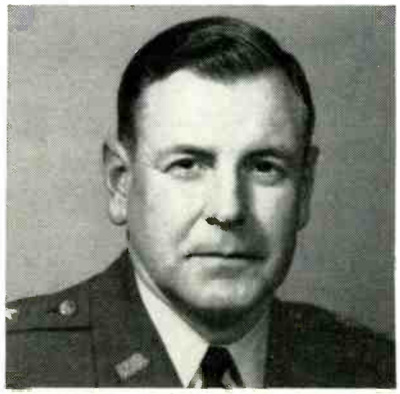
After graduation next June, Mr. Popovitz hopes to enter medical school to study instrumentation, neurology, cardiology and radiology. Ranking first in his class, he is president of Eta Kappa Nu, electrical engineering honor association, and member of Tau Beta Pi, engineering honor society. His summer months

are used for circuit design and experiment. The binary sequential switching circuit and logic demonstrator, which he designed, built and tested last summer, is now used at Bell Labs as a teaching aid.

Born in New York City in 1941, Mr. Popovitz became fascinated with electronics at ten. He later attended the Bronx High School of Science, where he helped to coordinate school science shows. His hobbies include physics, math, biology and photography.

Maj. Gen. Earle F. Cook Named Chief Signal Officer

Following the retirement of Maj. Gen. Ralph T. Nelson, effective June 30, Maj. Gen. Earle F. Cook, deputy Chief Signal Officer, Washington, D. C., was named the Chief Signal Officer of the Army. His association with the Signal Corps dates back to June 1935, when he was assigned to the First Signal Company at Fort Monmouth, N. J. During the war, he was staff officer with the Signal Intelligence Division, European Theatre of Operations, becoming director of the division in August 1945. After a number of other appointments, he went back to Fort Monmouth in June 1955, as Commanding Officer, Army Signal Research and Development Laboratory, and in May 1958, he became Chief, Research and Develop-



ment Div., Office of the Chief Signal Officer, in Washington, D. C., which post he held until appointment as Deputy Chief Signal Officer.

In his leisure hours, General Cook is an amateur radio enthusiast, and one of the few licensed "hams" among officers of general rank.

Sigmund Loewe Passes

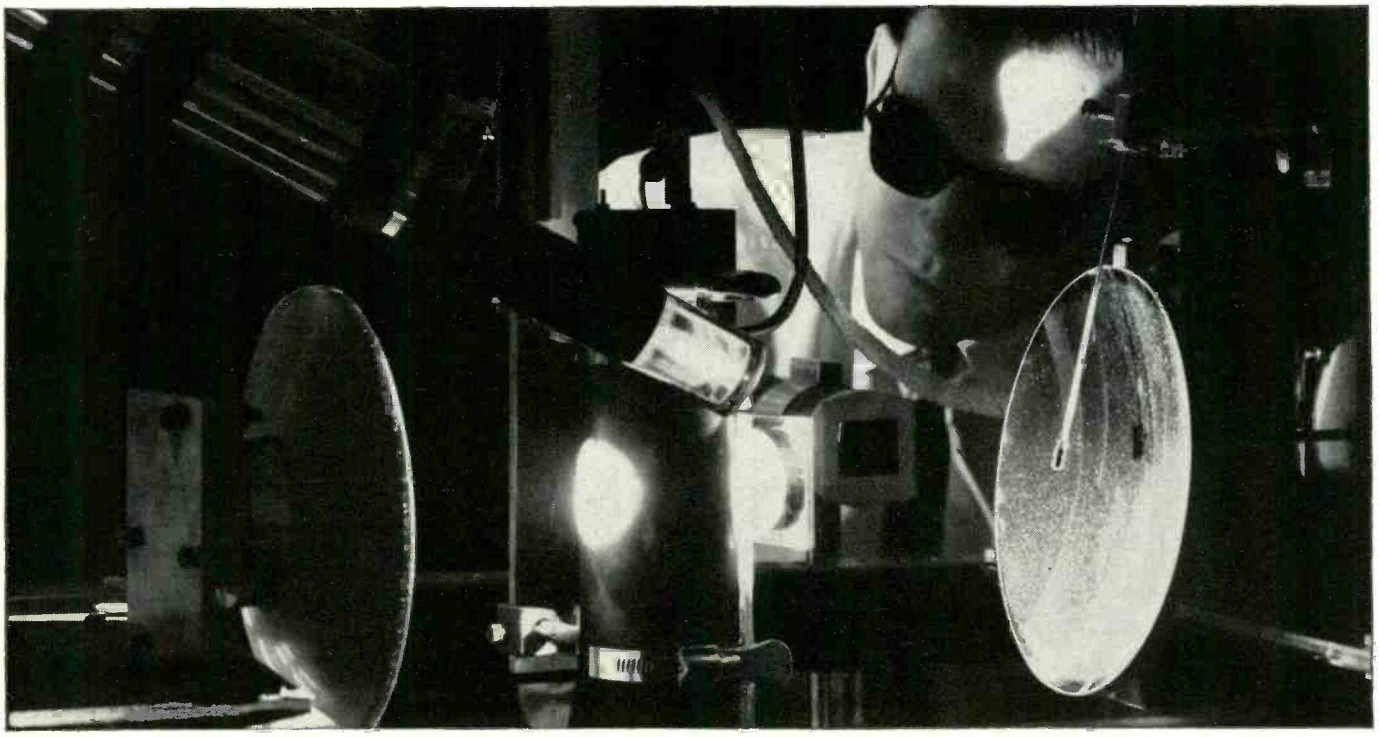
Dr. Sigmund Loewe, radio and television engineer and inventor, died May 2 in Sarasota, Fla. Dr. Loewe was one of the earliest experimenters with television, and in connection with these early experiments, Dr. Loewe invented (in the late '20's) the first multiple tube, combining three tubes as well as coupling resistors and capacitors in a single envelope. This

was done in connection with the search for a low-noise, wide-band amplifier for video signals.

At the time of his death, Dr. Loewe was president of the Loewe Radio Co. of New York, the Andromeda Co. of Switzerland and Loewe Radio Ltd. of London. His age was 76.

Brief brief

New Counter is needle size. Recently developed subminiature Geiger counter, designed for medical and cancer research, is so small it may be inserted in a tumor or placed in a vein through an ordinary hypodermic needle. Made by Eon Corp. of Brooklyn, the counter tubes range in size from .040 inch in diameter by 0.25 inch long to 0.125 inch diameter by 1 inch long. END



Exploring the possibilities in Coherent Light

At Bell Laboratories, Donald F. Nelson studies a beam of coherent red light produced by a continuously operating ruby optical maser. The heart of the device is a uniquely shaped ruby crystal immersed in liquid nitrogen in the tubular glass dewar extending from upper left to center. Light from the mercury arc lamp (lower center) is reflected by round mirror at left to mirror at right and then is focused on the ruby crystal to produce maser action. Coherent light emerging from end of dewar is picked up by a detector.

Is it feasible to take advantage of the enormous bandwidth available at optical frequencies? Could coherent light, for example, be sent through protecting pipes to provide high-capacity communication channels between cities?

To study such possibilities it is, first of all, necessary to have a source of continuous coherent radiation at optical frequencies. Such a source was first produced when Bell Laboratories scientists developed the gaseous optical maser.

Recently, our scientists demonstrated the generation of continuous coherent light by solid materials. Using a crystal of neodymium-doped calcium tungstate, a material developed at Bell Laboratories, continuous optical maser action was obtained in the near infrared. It has also been attained with visible light, using a new optical "pumping" arrangement to excite a ruby crystal. (See illustration above.)

Multichannel light highways for communications are still far from realization. But with continuous sources of coherent light available, it becomes possible to explore the problems of modulating, transmitting, detecting, amplifying and, in general, controlling light for possible communications applications.

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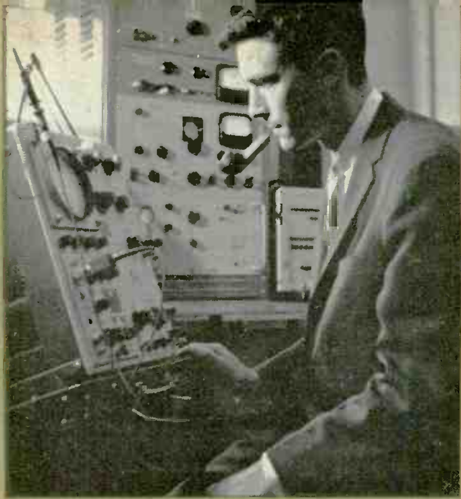

"THROUGH A CREI HOME STUDY PROGRAM I learned the practical theory and technology I needed to become a fully-qualified engineer—not a 'handbook' engineer, either—and I did it while I was on the job," says Robert T. Blanks. Today thousands of electronics personnel—engineering technicians, engineers, administrators, executives—attribute present high salaries and positions to home study of CREI Programs in Electronic Engineering Technology.

DEMAND FOR CREI-PREPARED MEN today far exceeds the supply—has exceeded the supply for many years. Designed to prepare you for responsible positions in electronics, CREI Home Study Programs are the product of 35 years of experience in advanced technical education. Aiding in their development are leading engineers and scientists from industry, government agencies and institutions of higher learning. Here Robert T. Blanks discusses CREI with Director Wayne G. Shaffer of Vitro Labs.

WHEN YOU ENROLL IN A CREI Home Study Program, you join more than 20,500 students working in electronics in all 50 states and most countries of the free world. One CREI Program helped Robert Blanks become an Electronics Engineer. Another helped Robert I. Trunnell become an Electronics Technician. While John H. Scofield—a Mathematician—is enrolled in still a different CREI Program relating mathematics to electronics. All work at Vitro Laboratories.

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Correspondence

Unfounded Fears

Dear Editor:

Mr. Melvin Cohen, a former officer of ESFETA, wrote a letter which appeared in the February issue of RADIO-ELECTRONICS, in which he expressed certain fears which I feel are groundless and should be laid to rest:

The Secretary of the State of New York makes the appointments to the licensing board, and may or may not consult with ESFETA, or any other interested organization. Furthermore, the bill stipulates the academic, professional and practical requirements of the men to be appointed. These men, as well as the lay citizens appointed, are paid for every day they serve at the proposed rate of $25 a day. The Secretary of State may remove any member for incompetence or dishonesty, and replace him.

No law which discriminates or places unfair burdens upon those already in practice would be constitutional. This is the reason for the famous "grandfather clause." Every license bill must have this proviso.

The Empire State Federation of Electronic Technicians Associates, Inc. (ESFETA) is interested in anything or anyone who can make the path to success in the television service field easier. Its chapters throughout the State of New York are represented in a truly democratic fashion. Any interested groups may join by contacting me. We welcome the views of anyone interested in securing a better place in the business sun for all TV technicians, and extend a hand to everyone to help us help you. Only by cooperation, one with the other, will the TV service technician ever succeed.

D. W. COOK

Corresponding Secretary
ESFETA

Bugs in the Power Supply?

Dear Editor:

I liked the idea of the power supply on pages 30-32 of the February issue, and put the issue aside to look into later. When I picked it up again a while back, it fell to pieces on close examination. It's as full of holes as good Swiss cheese.

1. Page 30—subtitle states "0.5 to 30 volts, 2- to 3-ampere output, 0.5%

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses – commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams" – people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelephone license after from 300 to 350 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally required to complete the course and get your license is as follows:

In the M thru F DAY course, you should get your first class radiotelephone license at the end of the 12th week of classes.

In the M-W-F EVENING course, you should get your first class radiotelephone license at the end of the 20th week of classes.

In the Tu-Th EVENING course, you should get your first class radiotelephone license at the end of the 30th week of classes.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand – choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

Advanced Resident Training

The Grantham F.C.C. License Course is Section I of our Electronics Series. Successful completion of this course is a prerequisite for enrollment in Section II which deals with more advanced material. However, it is not necessary for the student to take Section II unless he wishes to advance beyond the level of a first class F.C.C. License.

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24-M

Name ________________ Age ______

Address ________________

City ________________ State ______

I am interested in: ☐ Home Study, ☐ Resident Classes regulation." I hope nobody tried this. Drawing 3 amps at 1 volt would cause $3 \times 29 = 87$ watts dissipation in V5. It is rated 100 watts at 25°C case and 28 watts at 75°C case. If 87 watts were dissipated, it would rapidly rise above 75°C case, particularly with power being dissipated in V1 and the rectifiers—30 watts in V1 and 4 or 5 watts in the rectifier. Man, that chassis'll smoke! Two 60-watt lamps inside it effectively.

2. It ain't regulated, and has a source impedance (with the pot at mid-range) of $\frac{2,500}{50 \times 25} = 2$ ohms. Beta of V4 = 50; beta of V5 = 25.

3. It is short circuit-protected, but *not* overload-protected. You could draw 10 amps very nicely until it blew up.

I think you should go back to your "tested in our laboratory" labeling that you used for a while.

ED PREDMAN

North Babylon, N. Y.

Not quite!

Prior to my submitting the article on the regulated power supply, careful heat measurements on the chassis and transistors were made to assure proper operation. Results follow:

Thermal resistance of the chassis is 0.15°C/w, with an effective radiating area of approximately 400 square inches. (with components mounted). The chassis can dissipate 140 watts with a 21°C heat rise, maximum continuous peak dissipation of all transistors and components is 130 watts, which occurs only under very adverse conditions. Average peak dissipation rarely exceeds 100 watts. Assuming a T_A of 30°C and 130 watts dissipation, the resulting chassis temperature is 49.50°C. This is not hot!

Heat characteristics for the DA3F3 are: T_J (junction temperature) 100°C; θ_{JC} 0.4°C/w. Maximum dissipation at a T_M of 25°C is 187 watts, and at 67°C (which is the operating T_M) is 90 watts. Therefore, the transistors are being operated within their limits, as are the remaining devices.

I have yet to see a high-power transistorized power supply that operates cool, unless the heat sink is 10,000 square inches and a fan is used for cooling. Even then. . . .

As for regulation and output impedance, the following formulas should be used:

(1) Regulation:

$$\frac{\Delta V_O}{\Delta R_L}\left(\frac{R_L}{V_O}\right) \text{ with } V_I \text{ constant}$$

(2) Output impedance:

$$\frac{-\Delta V_O}{\Delta I_L} \text{ with } V_I \text{ constant}$$

where V_O is output voltage, V_I is input voltage, R_L is load resistance, and I_l is load current.

Also, the circuit is definitely overload-protected. Three amperes is the maximum current that can be drawn from the regulator. Any current above this will cause V3 to cut off, which in turn disables the entire regulator.

LEONARD J. D'AIRO

References

Motorola *Power Transistor Handbook*, pages 20 to 27.

Minneapolis-Honeywell, Semiconductor Products Div., *Application Lab Report ALR-3*.

Licensing Not a Cure-All

Dear Editor:

The attached clipping from the April 22, 1962, issue of *Parade* (*Long Island Sunday Press* magazine section) I consider the best proof that TV licensing will stop nothing but competition and the "on-the-job training" obtained by part-time servicing.

NEW YORK. The medical profession here is saying nothing about it, but some 1,500 MDs -- approximately one doctor out of every 12 in New York City -- have been implicated in an insurance claims racket. "We have evidence," says August J. Bardo, Jr., director of the State Education Department's division of professional conduct, "of doctors conspiring with lawyers to submit false claims, exaggerating medical reports, submitting bills for treatment not administered and listing X-rays that were never taken." The impending scandal constitutes another reason why medicine is getting a bad public image.

If these well educated professional groups, that command remuneration many times that of technicians with years of experience, cannot be completely above unethical practices with their licenses and tradition-steeped associations, how can TV licensing be expected to accomplish more?

If licensing were such a cure-all, there would be no need for traffic courts. No matter what the profession, trade or product, it is still *caveat emptor*—let the buyer beware.

CARL REMEL

Queens, N. Y.

Vote for Crowhurst

Dear Editor:

I must agree with Robert G. Vaughan (May 1962, page 22) concerning Norman Crowhurst. He *does* have a considerable amount of pride in his work. Also, I might add that I *learn* from Norman Crowhurst. This justifies a substantial amount of pride, from my point of view.

VERNON LEE CHAPPELL

San Diego, Calif.

Nature Recording

Dear Editor:

Bouquets and bravos for the fine feature story on nature recording by Professor Kellogg of Cornell, February 1962. To every RADIO-ELECTRONICS reader who has never heard his truly wonderful recordings of birds, frogs and many other of nature's timid crea-

tures, my suggestion is to go right out and buy some. For those who have heard some broadcast original tapes, slowed down to lower and lower fractions of the recording speed, I need say no further word. One fairly gasps at their marvelous sonic beauty.

Professor Kellogg has tramped all over our country to capture the wondrous sounds of nature's own aviators. But I have a prologue to his story:

In 1919, at the beginning of many extensive and later (1920's) researches in electrophonography for the Brunswick Co. in Chicago, I was employed by a radio engineering company in New York. A fellow engineer who was familiar with my work there on recording trans-Atlantic, high-speed, radio telegraph transmissions, with electromagnetic cutter heads, came to me one day with this story:

His brother-in-law was retiring from active business in quite another field. A bird-watcher and nature-lover generally, he wanted to make recordings of bird songs. Would I, my friend asked, give him some help in realizing his new ambitions? Of course I would. So Ben Liebowitz brought his sister's husband around one day, and we had a nice long chat about appropriate recording apparatus.

The first thing he needed, I said, was a sizable but still portable parabolic sound reflector. The next was the highest possible quality microphone. For this I suggested an anti-noise type of high directivity, with a sensitive diaphragm of much higher than usual natural frequency and well damped. It would feed a high-gain af amplifier that would drive the balanced armature type of cutter head. A cylindrical-record, Edison type dictating machine would complete the recording system.

The years rolled by, on and on, until March 1954, when I heard a broadcast of bird-song records made by Drs. Kellogg and Allen (then his associate) under the auspices of the Albert R. Brand Bird Song Foundation and the Laboratory of Ornithology of Cornell University. I was thrilled beyond description, and wrote a letter at once to them, reciting my 1919 contacts with Albert Brand in the development of his retirement hobby.

Dr. Kellogg's answer followed, with details of the Brand Foundation, and the sad news that Albert Brand had passed away in 1940. Shortly thereafter, Dr. Kellogg sent me a collection of their recordings, which have been enjoyed greatly, not alone by my family and our friends, but also by our parakeet-budgie and our outdoor friends at our bird cafeteria-style feeding and bathing stations.

BENJAMIN MIESSNER
Miami Shores, Fla.

END

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*

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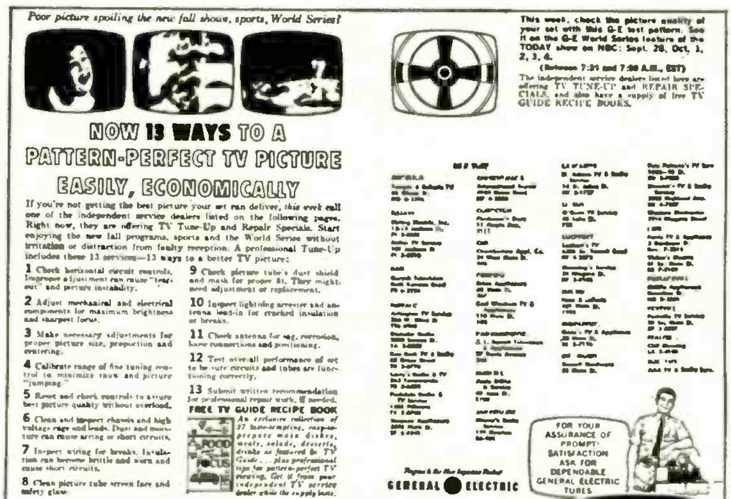

Poor picture spoiling the new fall shows, sports, World Series?

NOW 13 WAYS TO A PATTERN-PERFECT TV PICTURE EASILY, ECONOMICALLY

If you're not getting the best picture your set can deliver, *this week* call one of the independent service dealers listed on the following pages. Right now, they are offering TV Tune-Up and Repair Specials. Start enjoying the new fall programs, sports and the World Series without irritation or distraction from faulty reception. A professional Tune-Up includes these 13 services—13 ways to a better TV picture:

1 Check horizontal circuit controls. Improper adjustment can cause "tear-out" and picture instability.

2 Adjust mechanical and electrical components for maximum brightness and sharpest focus.

3 Make necessary adjustments for proper picture size, proportion and centering.

4 Calibrate range of fine tuning control to minimize snow and picture "jumping."

5 Reset and check controls to assure best picture quality without overload.

6 Clean and inspect chassis and high voltage cage and leads. Dust and moisture can cause arcing or short circuits.

7 Inspect wiring for breaks. Insulation can become brittle and worn and cause short circuits.

8 Clean picture tube screen face and safety glass.

9 Check picture tube's dust shield and mask for proper fit. They might need adjustment or replacement.

10 Inspect lightning arrester and antenna lead-in for cracked insulation or breaks.

11 Check antenna for sag, corrosion, loose connections and positioning.

12 Test over-all performance of set to be sure circuits and tubes are functioning correctly.

13 Submit written recommendation for professional repair work, if needed.

FREE TV GUIDE RECIPE BOOK

An exclusive collection of 57 taste-tempting, easy-to-prepare main dishes, meats, salads, desserts, drinks as featured in TV Guide . . . plus professional tips for pattern-perfect TV viewing. Get it from your independent TV service dealer while the supply lasts.

This week, check the picture quality of your set with this G-E test pattern. See it on the G-E World Series feature of the TODAY show on NBC: Sept. 28, Oct. 1, 2, 3, 4.

(Between 7:35 and 7:50 A.M., EDT)

The independent service dealers listed here are offering TV TUNE-UP and REPAIR SPECIALS, and also have a supply of free TV GUIDE RECIPE BOOKS.

[illegible]

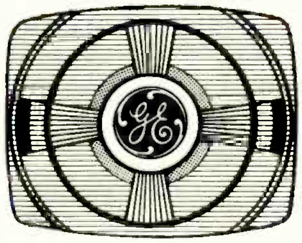
FOR YOUR ASSURANCE OF PROMPT SATISFACTION ASK FOR DEPENDABLE GENERAL ELECTRIC TUBES

GENERAL ELECTRIC

TV GUIDE

This hard-hitting ad sells your professional repair and maintenance service . . . refers to local TV Tune-Up Commercials on TODAY show . . . directs customers to you through your name and address listing *in your local edition.*

EMBER



3-part program sells immediate need for your service before & during World Series*

ULAR!!!

*

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G-E reporter, Roland Kempton, tells how September Tune-Up Spectacular

BUILDS BUSINESS FOR YOU 3 WAYS

1. Your customers prove to themselves the need for a tune-up and repair.

2. Through local television, local TV Guide and promotion materials.

3. In your city, your neighborhood, with your customers and prospects, you cash in on this TV TUNE-UP SPECTACULAR.

SEPTEMBER TUNE-UP SPECTACULAR is your campaign. It's easy to tie in. Proven effective. No red tape. Get full details from your G-E tube distributor, now. Names of participating dealers must be in by August 27. General Electric Company, Distributor Sales, Electronic Components Division, Room 1748C, Owensboro, Ky.

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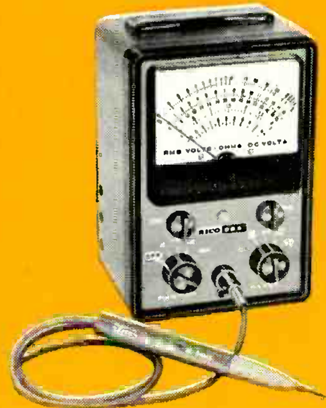
Highly sensitive, reliable AC VTVM & wideband amplifier. Measures 100 microvolts to 300V in 12 ranges; 10c-600kc ±0db response, 10 megohms input impedance, ±3% accuracy. Wide-band amplifier switch-controlled for external use: 8c-800kc response, 5VRMS output, 5K ohms output impedance, gain control, noise —40db. Frame-grid triode cathode follower input circuit, freq.-compensated input attenuator, cathode circuit attenuator. Regulated power supply.

AC VTVM #255 Kit $44.95 Wired $72.95
All the precise VTVM facilities of the **#250 less** external use of the wide-band amplifier.

** formerly designated as #260.*

AC VOLT-WATT METER #261*
Kit $49.95 Wired $79.95

AC voltmeter & load-compensated audio watt-meter of unique quality. Measures AC voltages from 1mv to 1000V in 11 ranges, power from .015mw to 150W in 7 ranges, across standard loads from 4 to 600 ohms. Tapped power resistor load (4, 8, 16 and 600 ohms) handles up to 80W on 8 ohms and 40W on other taps. Switch to external load up to 150W. Meter automatically compensated for any load selected, internal or external, to provide single watt scale.



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Entirely electronic, direct reading measurement of resistance, and AC & DC to 1500V in 5 ranges. May be calibrated without removal from cabinet. Complete electronic overload protection, plus fuse. 1% precision ceramic resistors. Exclusive AC/DC Uni-Probe® selects DC or AC-Ohms. DC voltmeter input impedance 11 megohms, accuracy ±3%. AC voltmeter input impedance 1 megohm, accuracy ±5%. Ohmmeter 0.2 ohms to 1000 megohms in 5 ranges.

IN-CIRCUIT CAPACITOR TESTER #955
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Tests capacitors in the circuit without unsoldering. Checks for shorts, (even in the presence of as little as 1 ohm shunt resistance). Checks open units (as little as 5MMF in the circuit). Measures capacitance with ±10% accuracy between 0.1mf and 50mf. Measures RC product, convertible into dissipation or power factor. Utilizes electron-ray tube EM84/6BGG with sharp bar pattern. Line adjust control permits maximum sensitivity regardless of line voltage variations.

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Measures ICEO, ICBO & DCβ directly, ACβ indirectly, without charts or special settings—plus all dc volts, currents & resistances needed to service transistor equipment. Battery powered. 50μA, 3½" face meter movement provides sensitivity & scale length necessary for accuracy. Built-in 20,000Ω/V VOM facilities frees your other test equipment.

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Heavy-duty 2-ranges for operating any mobile radio & transceiver including transistor or "hybrid" types. Also usable as charger for either 6 or 12 volt batteries. Variable transformer provides continuous output adjustment. 2 meters simultaneously observe output voltage and current. Ratings: 0-8V: 10A continuous, 20A intermittent; 0-16V: 6A cont., 10A interm. AC ripple: 0-16V range: 0.3% @ 2A, 1% @ 6A. Heavy-duty selenium rectifiers, & automatic reset overload relay.

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Radio-Electronics

Hugo Gernsback, Editor-in-Chief

ARE *THINKING* COMPUTERS POSSIBLE?

. . . What Computers Can and Cannot Do . . .

FREQUENTLY, nowadays, people compare computers to the animal or human brain. There is, however, little connection between the two. Chiefly, there are two types of computers: the *digital*—which deals with digits from 0 to 9—and the *analog* computer—which dissects a problem, then analyzes it. A computer, as its name implies, is merely—so far—a very sophisticated calculating machine that can make as many as 500,000 logic decisions per second; 250,000 subtractions per second; 250,000 additions per second; 100-000 multiplications per second; 62,500 divisions per second. One computer (the IBM 7094) takes 2 microseconds to get a bit of data out of its memory. Such a performance is an impossible task for a human brain.

Yet none of these machines can actually think for themselves, even if they are equipped with present-day magnetic "memories." Such memories essentially store "yes" and "no" information, used in all calculations.

Recently, Dr. Bernard Widrow of Stanford University disclosed a new device called MADALINE, which, when connected to a regulation computer, gave it a rudimentary learning capacity. Thus the computer could be taught to recognize a few geometric patterns.

As of now, all computers must be "programmed" by humans. The problem given to the computer must be elaborately stated, usually via punched cards. This means that ALL the thinking is done by humans *before* the machine can start. Then the latter takes over as a miraculously fast calculating robot which does in minutes the work that would take a man many years. Says Dr. Philip M. Morse, Professor of Physics of the Computation Center of the Massachusetts Institute of Technology: "The computer is not going to take over our thinking for us, but it will take over the *mental* drudgery, as other machines have taken over the *muscular* work."

In short, we are still at the *very beginning* of a humanoid computer technique. Computers today "can only do what we tell them to do"—left to themselves they are as helpless as the most elaborate driverless automobile.

It took the human race nearly a billion years of evolution, heredity, instinct and learning through countless ages and experience to evolve the modern human brain. This is probably the most intricate *biological* evolvement on this planet. How then can we expect to implant all this intricacy in a mere machine in the foreseeable future?

With all our so-called wisdom, we still have only the vaguest ideas as to the functioning and operation of the living brain. Let us take only one facet. The human brain is estimated to have 1,000 billion memory units, composed of nerve cells, or neurons. Many of these parallel each other, so that, on call, information can be drawn from other cerebral centers almost instantly.

How soon can we build such a multibillion-unit electronic-neuron-memory brain? Not for centuries, unless there is a breakthrough in a near-biologic imitation of a neuron or something that parallels it closely.

Even with such an epoch-making invention, we would still be far away from a *thinking* machine.

Take our five chief senses of sight, hearing, scent, touch and taste—and there are, of course, others.

The brain also remembers and stores visual impulses in all primary colors and myriads of combinations over the entire chromatic scale. It recognizes faces, shapes *in depth*, patterns, objects in motion and countless other items. *How soon will a computer be able to recognize a black-and-white print of the Mona Lisa from the original color painting which has been remembered and stored by the machine?*

The brain hears and stores a vast array of sounds, overtones, timbres; it recognizes voices, melodies, compositions in endless tempos and cadenzas. *Could a computer whistle or hum or play the remembered score of any one of thousands of compositions on demand?*

Our brain stores and remembers countless scents and odors in myriads of nuances, pleasant as well as obnoxious. *Could the computer distinguish between the remembered scents of Chanel No. 5 and a live gardenia?*

The brain distinguishes tactile differences in texture and in temperature, pressure, sharp or blunt objects, cloth, wood, metal, etc., sticky or smooth surfaces, oily or talcum materials. *Could a computer distinguish between sheets of the same thickness of glossy paper and aluminum foil?*

The brain remembers and stores thousands of tastes in food and liquids—which often also are smelled simultaneously for additional recognition. The brain also stores safeguards in that it immediately telegraphs the tongue to reject and expel certain decaying or other harmful foods. *Could a computer be made to distinguish within seconds between a glass of champagne and beer?*

Yes, it is within the realm of possibility that in the distant future—with new electronic and technical developments—computer machines could successfully duplicate *all* the human senses. But, it will take a long and painful road of evolution to accomplish it.

Yet, even such a fantastic development would still only be a beginning. An electronic-mechanical brain—one that imitates successfully all the human five senses—would still only be a machine that imitates man's physical senses. *It could not think or reason by itself*. It would have no will of its own—*no intellect*.

Could an electronic brain or the most elaborate computer ever turn out new and important inventions? Could it invent like Edison? Could it make great discoveries like a Faraday? a Nikola Tesla? Could it evolve Newton's law of gravitation or Einstein's theory of relativity?

Could it write Shakespeare's dramas—or Jules Verne's or H. G. Wells' technical forecasts of the future? Or could it compose Verdi's or Wagner's operas? Probably not for at least 500 years to come, or longer.

What do some of our best scientists say on this subject?

Dr. Donald O. Smith, of MIT's Lincoln Laboratory, and Dr. Marshall C. Yovitz of the Office of Naval Research recently stated that "the much-publicized systems, allegedly capable of learning or recognizing, must be taken with a grain of salt."

To sum up: The human brain should not be compared to a present-day computer or similar machines. Computers are ultra-modern tools that solve man's mathematical, symbolic-logic and technological figure problems in a small fraction of time compared to that of man's capacity.* —*H.G.*

*See also "Electronic Brains," August 1952, and "Brain an Electric Computer," March 1960, *Radio-Electronics*.

measure atomic radiation

Building and using photometers and dosimeters

By CARL L. HENRY

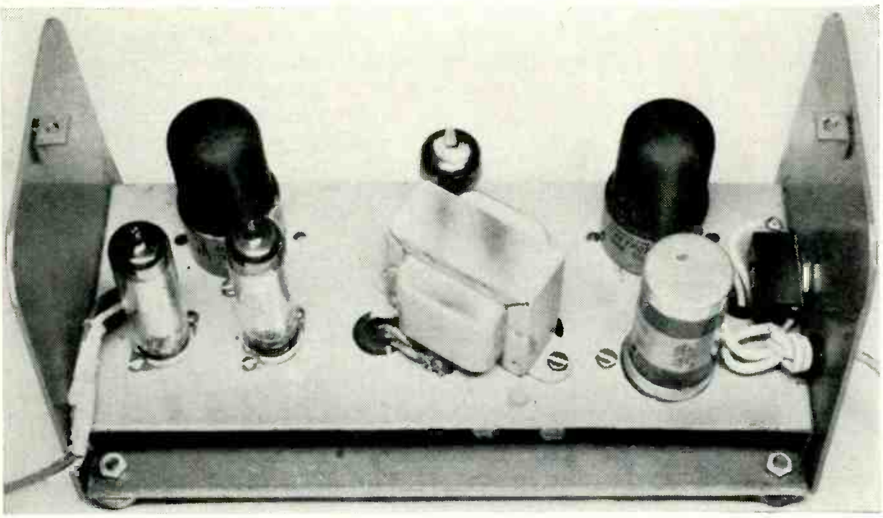
I find most electronic technicians vague about nuclear electronics or "nucleonics". This is not as it should be. Electronics and the atomic industry mesh together so thoroughly that all electronic technicians need a basic understanding of the electronic instrumentation in use in this field.

With so much talk about fallout from a possible war and, on the immediate side, so many new nuclear applications, a knowledge of basic nuclear electronics uses is valuable to us all. This article shows how you can measure radiation and tells you how to build several measuring instruments.

All authorities agree that the single most important type of emergency equipment to have on hand is a device to measure radiation. There are many methods for doing this. some very simple and reliable *if you understand what you are doing.* Using anything from photographic film to laboratory type ionization chambers is feasible, but unless you understand how to use the instrument or method, your measurements are useless.

In working with radioactive isotopes, X-ray machines and other sources of nuclear radiation in the servicing industry, you must know how to tell when radiation is dangerous, and when it isn't. You might ask at this point, "Just how much radiation is dangerous?" The table answers this question. All these values have been determined by the Atomic Energy Commission, to the best of its experience. However, a considerable variation between individuals can be expected for the doses that cause sickness and death.

After looking at this chart you are probably asking, "What *is* a Roentgen?"



Parts layout on top of photometer chassis.

The roentgen (pronounced "rent-kin") is officially defined as: "That amount of X-ray or gamma radiation that produces one electrostatic unit of electricity of either polarity in one cubic centimeter of air at standard temperature and pressure." In other words, the roentgen is a measurement of the field established by a radioactive substance or X-ray machine. A meter that measures this is similar in use to a radio field-strength meter. (See RADIO-ELECTRONICS, Feb. 1962, page 39.)

One drawback appears immediately in this measurement. Radiation is accumulative in the animal or human body. So, we must specify *roentgens per hour* in our measurement.

Use photographic film

The cheapest and possibly simplest method for measuring radiation is with photographic film. Its one drawback is that you are measuring the absorbed instead of the effective dose. In other words, if the film indicates a dose of 1 roentgen, you have absorbed 1 roentgen. Where the approximate effective dose is known to be low and variable, as in the case of radiation workers, this is valuable. It gives an accurate record of the actual absorbed dose of radiation. In measuring fallout, however, you might develop the film and find yourself dead.

If you know the radiation in the area to be high, leave the film in the area one hour (but leave the area yourself). Reclaim the film, develop it and check its density. This will tell you the number of roentgens absorbed by the film in an hour. Nuclear radiation, like any other radiation, follows the "square law": the intensity of the radiation de-

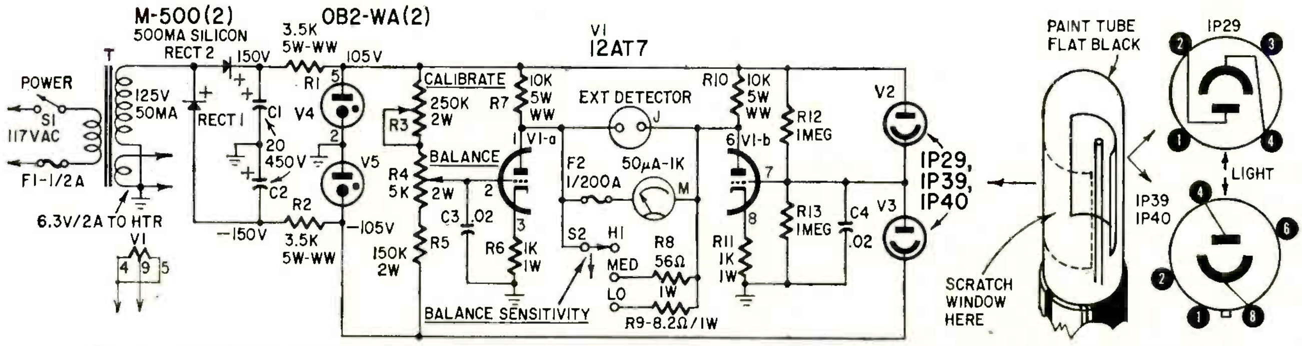


Fig. 1—Circuit of simple, accurate, photometer you can make.

R1, R2—3,500 ohms, 5 watts, wirewound
R3—pot, 250,000 ohms, 2 watts, linear taper
R4—pot, 5,000 ohms, 2 watts, linear taper
R5—150,000 ohms, 2 watts
R6, R11—1,000 ohms, 1 watt
R7, R10—10,000 ohms, 5 watts, wirewound
R8—56 ohms, 1 watt
R9—8.2 ohms, 1 watt
R12, R13—1 megohm, ½ watt
C1—20 μf, 450 volts, electrolytic
C2—20 μf 450 volts electrolytic
C3, C4—.02 μf, 600 volts, ceramic
F1—0.5 amp, 8AG
F2—1/200 amp, 8AG
J—microphone jack, female (Amphenol 80PC2F or equivalent)
M—microammeter, 0–50, 1,000 ohms (Lafayette TM-200 or equivalent)
RECT 1, RECT 2—silicon, 500 ma (Sarkes Tarzian M-500 or equivalent
S1—spst toggle
S2—single-pole 5-position rotary, shorting type
T—power transformer: primary, 117 volts; secondary, 125 volts, 50 ma; 6.3 volts, 2 amps (Stancor PA-8421 or equivalent)
V1—12AT7
V2, V3—1P39, 1P40, 1P29 (as required)
V4, V5—OB2-WA regulator
Vernier dial, 0-100.
Case to suit
Miscellaneous hardware

creases with the square of the distance. If you measured 100 r/hr at 1 foot distant from a source of radiation, the field would be 1 r/hr at 10 feet.

You can use a common photographic film to measure nuclear radiation if you have some type of density-measuring instrument. You *cannot* measure this density with your eye. Fig. 1 shows a home-built densimeter or photometer you can build. The meter is a 50-μa type, modified to work as a zero-center device. To do this, open the meter case and move the bottom hairspring adjustment until the pointer is at the center of the scale. Make a red mark at the center point of the scale, to aid in the nulling operation.

There are three controls: BALANCE SENSITIVITY, which shunts the meter to vary the sensitivity; CALIBRATE, which nulls the instrument before measurement is begun, and BALANCE, which has a 5-to-1 vernier dial. Construction is not critical. The two phototubes are mounted on either end of the chassis. The bridge triode is mounted between them. The rectifiers are silicon types and are mounted under the chassis.

Paint the outside of the phototubes with several coats of flat black paint. Then, when dry, scratch a 1-inch square on the front of each tube (Fig. 1). Brass tubes are mounted on the side of the cover to act as shades for the phototubes and prevent extraneous light from affecting their response. These tubes and the photometer case should be painted flat black inside.

The case is an old industrial relay housing, and not commercially available. I suggest that if you use the same circuit, build it into a small metal utility cabinet. The case I used was a tight fit, and I had to outboard the vernier balance control.

Phototubes V2 and V3 normally pass the same amount of current, and the bridge is balanced with BALANCE control R4 in its center position, and CALIBRATE control R3 at 150,000 ohms. A slight variation of R3 will compensate for slightly different phototube characteristics or regulated voltages. If both phototubes are exposed to the same amount of light, the bridge is still in balance. Of course, when one phototube receives more light than the other, the bridge is unbalanced. The vernier can then be used to restore the balance and the variation noted, or a variable density film can be put in front of one tube and balance restored. The latter method is extremely accurate, but the vernier method is close enough for film-density measurements. Any light source is OK as long the light is approximately equal on each phototube. Minor variations between the outputs of the two phototubes can be compensated for with the CALIBRATE control. A fluorescent table or desk light makes a nice light source.

Obviously, to measure film density due to exposure to radiation, some standard must be used. To give you something concrete to go by, I have exposed a common photographic film (Kodak Verichrome Pan) for 1 hour to radiation from a radioactive isotope of iridium at intensities from 50 milliroentgens to 500 Roentgens. Fig. 2 is a graph of the results of this test. This graph takes in the response of the photometer circuit and the response of the film. The response curve becomes logarithmic at about 2 Roentgens, and continues to over 500 Roentgens before the slope changes. Levels below 1 roentgen are difficult to measure, because of the natural fog level of the film.

To check radiation with this method use the following method *very exactly*. First, cut a roll of Verichrome Pan film into square sections in a totally dark room or closet. Do not allow it to be exposed to even the slightest light. Put the film into previously prepared envelopes made of a double thickness of black paper, and seal the envelopes. Number each envelope, and select one to be used as a control. It should receive no radiation exposure. Now you are ready to check radiation.

Place one or several of the film pockets in the area to be surveyed. After 1 hour, reclaim the pockets. Develop the film for 12 minutes at 68° F, in Kodak D-76. You must, of course, fix and wash the film after it is developed.

Process the film selected as a control, too—preferably at the same time. After processing is completed and the film is dry, you are ready to check the density. Allow the photometer to warm up for at least 5 minutes. Then null the meter with the CALIBRATION control, having the vernier set to 50. Now put the control film in front of one phototube and the exposed film in front of the other. Again null the meter, this time with the vernier. Take the vernier variation and read the radiation from the

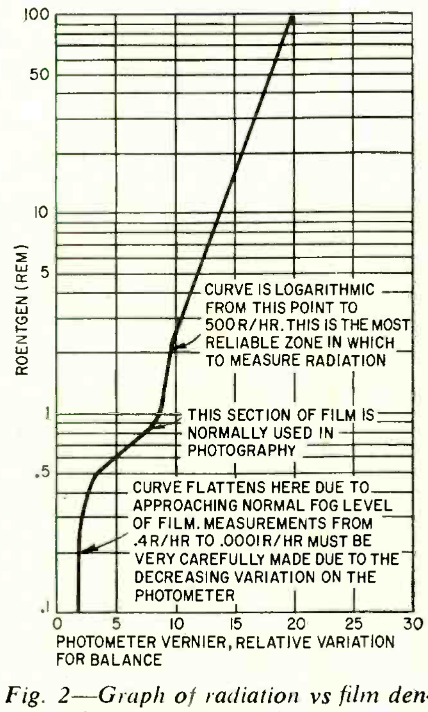


Fig. 2—Graph of radiation vs film density (relative reading on photometer) for Kodak Verichrome Pan film.

chart. For instance, if the vernier nulls the meter at 41, this is a variation of 9, and the chart shows the radiation to be 1.3 roentgens. This method of measuring radiation by its effect is tedious. However, it is very accurate.

Dosimeters

A somewhat simpler, but still highly accurate method of measuring the absorbed dose of radiation calls for measuring the ionization of a certain volume of air or gas in a chamber. This can be done using the simple electroscope principle—two gold leaves are charged to a certain fixed potential, and they repel each other. As the gas ionizes in the chamber, the potential leaks off, and the gold leaves come back together.

A device currently being produced by several manufacturers for about $25 works on this principle. It is generally referred to as a dosimeter (dō-sim′-e-ter). Although anything that measures dose rate is a dosimeter, in practice only this type of instrument commonly bears the name. Most dosimeters are of the self-indicating type; they have a reticule inside which can be read through the lens by pointing the instrument at a light source. Usually these dosimeters can be obtained in ranges from 100 milliroentgens to 200 roentgens, although each has only a single range. Some types are not self-indicating. They must be returned to the manufacturer for a dosage reading.

As you can see in Fig. 3, the gold leaves of the electroscope have been replaced with a gold bar and a movable quartz fiber. A capacitor is also included, so the dosimeter will maintain its charge over long periods of time. Such instruments are usually charged to 150 or 200 volts. This brings the quartz fiber into line with the zero on the reticule scale. As the charge is reduced by ionization in the chamber, the quartz fiber moves over the reticule scale, until it reads maximum.

Fig. 4 is the circuit for a dosimeter charger. Note that the charging contact of the dosimeter (Fig. 3) is normally open. The charging socket on the dosimeter charger is built to fit the bottom of the dosimeter. When the dosimeter is placed on the socket and pushed down, the internal contact closes, and the ZERO ADJ control is set to bring the quartz fiber in the dosimeter to zero on the recticule scale. The dosimeter will pass light through its entire length. The lamp and lamp battery are provided so that you can see the reticule when charging the dosimeter.

As said before, these instruments are very accurate. The only inaccuracy that can occur is the leaking off of the charge on the internal capacitor. Most dosimeters have a leakage factor that allows a 2-week period to elapse between charging without serious inaccuracies occurring.

These instruments, of course, are similar to the previously discussed film badge in that they measure the absorbed dose. They are primarily gamma detectors, and are insensitive to alpha and beta radiation. To use them to measure the exposure dose, in roentgens, we must adopt the same method that we used with film. That is, we must either put the dosimeter in a radiation area for a certain length of time and then reclaim it and read it, or can use a sensitive dosimeter and a watch to make our measurement.

The most sensitive dosimeter available must be used, preferably 50 or 100 milliroentgens maximum. Take the dosimeter into the radiation field, and keep it there for a specific time, say 5 or 10 minutes. Now, if after 10 minutes the dosimeter reads 50 milliroentgens, you know that the field you are in is in the neighborhood of 300 milliroentgens per hour. If you were in a field in which the dosimeter read 100 milliroentgens at the end of 1 minute, you would leave the area immediately, since you would know the field was about 6 roentgens per hour.

Remember, whatever the dosimeter indicates is the amount of exposure you have *already* had. If a dosimeter with a full-scale reading of 100 roentgens is used, you would have to get a 10- or 20-roentgen dose while making this measurement. So use a low-range *sensitive* dosimeter.

Next month we will continue with a discussion of ion-chamber meters and Geiger counters. A complete circuit for a G-M counter, with parts list, will be included.

TO BE CONTINUED

guide to emergency exposure to atomic radiation

Civil Defense Administration

Dose (Roentgens)	Time of dose accumulation	Immediate effect	Late effect
75	1 day to 3 months	none	probably none
100	1 day	sickness in 1% or 2%	probably none
100	3 days to 3 months	none	probably none
150	1 day	sickness in 25%	very slight
150	3 days or more	sickness in less than 25%	very slight
300	1 day	sickness in 100%; 20% fatalities	possible cancer and cataracts
300	3 days	much less than results for 1 day	possible cancer and cataracts
300	1 week	sickness in 50%; no fatalities	possible cancer and cataracts
300	1 to 3 months	probably no sickness	possible cancer and cataracts
650	1 day	100% fatalities	
650	3 to 7 days	100% sickness; high fatalities	pronounced and serious
650	1 to 3 months	sickness not high; 10% fatalities	pronounced and serious

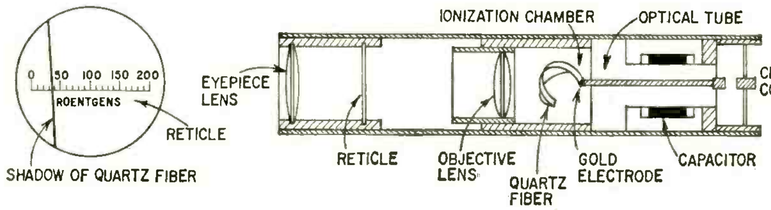


Fig. 3—Detail of a typical dosimeter.

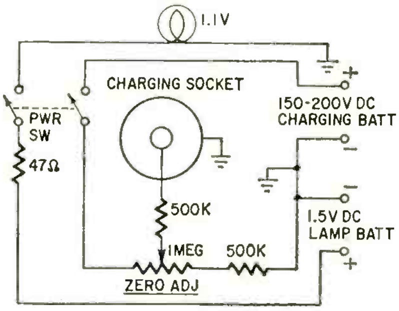
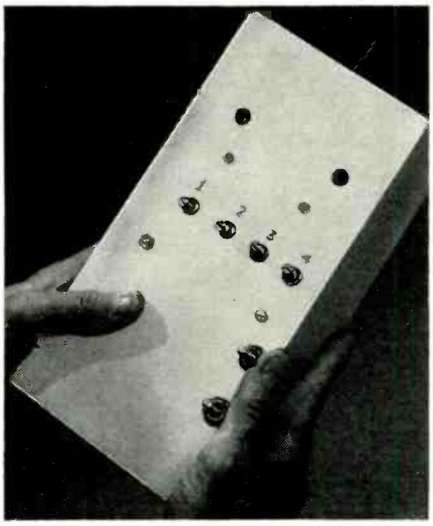


Fig. 4—Dosimeter charger circuit.

versatile

R-C TRANSMITTER

Four-tube unit provides 4 or more control channels



Two switches, located convenient to the thumb, provide 4-channel control.

By E. L. SAFFORD, JR.*

This completely self-contained unit uses standard, easy-to-get parts; will transmit on any one of the five radio-control spot frequencies. It will operate three of the four kinds of radio-control receivers—carrier, single-tone, and reed types just as it is. It will operate the fourth, which uses bandpass filters, if the tuned (L-C) parts in the audio oscillator section are changed to smaller values to resonate at the higher frequencies used by this kind of receiver.

The transmitter's rf section consists of a crystal-controlled master oscillator followed by a power amplifier (Fig. 1). With the crystal frequency shown, the output of the oscillator stage is 13.6275 mc. This is doubled in the final stage to 27.255 mc and also amplified. The signal is then sent into space through a quarter-wave antenna coupled to the final tank with a two-turn loop.

The oscillator–modulator section uses a 3A5 in a tuned multivibrator circuit to produce the tones and a 3A4 as a modulator. The 3A4 plate modulates the final rf stage. Four audio tones are available, each completely adjustable between 100 to 500 cycles. Tones are selected for transmission with two dpdt spring-loaded-to-center toggle switches. These switches are located on the lower right-hand side of the case for quick and easy operation. The pots that adjust the tones are located in the center of the case. You can add more potentiometers, capacitors and switches if you want to use this tone transmitter with an 8- or 10-channel reed type receiver.

*Author of *Model Radio Control* and *Radio Control Manual*, both Gernsback Library.

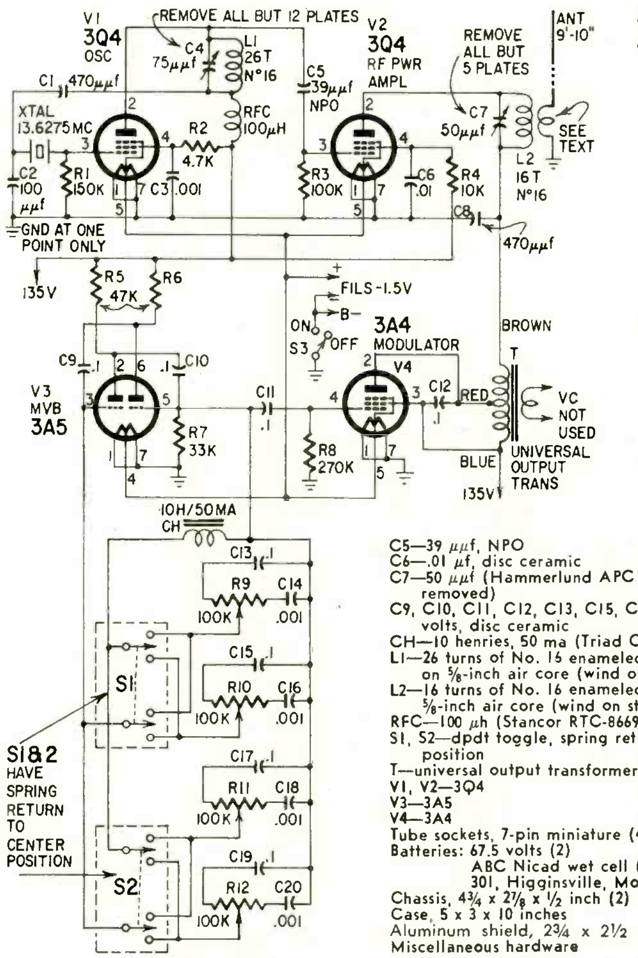


Fig. 1—Circuit of 4-tube transmitter.

R1—150,000 ohms
R2—4,700 ohms
R3—100,000 ohms
R4—10,000 ohms
R5, R6—47,000 ohms
37—33,000 ohms
R8—270,000 ohms
R9, R10, R11, R12—pot, 100,000 ohms, linear taper
All resistors ½-watt 10%
C1, C8—470 μμf, disc ceramic
C2—100 μμf, disc ceramic
C3, C14, C16, C18, C20—.001 μf, disc ceramic
C4—75 μμf (Hammarlund APC with all but 12 plates removed)
C5—39 μμf, NPO
C6—.01 μf, disc ceramic
C7—50 μμf (Hammerlund APC with all but 5 plates removed)
C9, C10, C11, C12, C13, C15, C17, C19—0.1 μf, 100 volts, disc ceramic
CH—10 henries, 50 ma (Triad C3X or equivalent)
L1—26 turns of No. 16 enameled wire closewound on ⅝-inch air core (wind on standard pencil)
L2—16 turns of No. 16 enameled wire closewound on ⅝-inch air core (wind on standard pencil)
RFC—100 μh (Stancor RTC-8669 or equivalent
S1, S2—dpdt toggle, spring return to open center position
T—universal output transformer (Triad S51-X)
V1, V2—3Q4
V3—3A5
V4—3A4
Tube sockets, 7-pin miniature (4)
Batteries: 67.5 volts (2)
ABC Nicad wet cell (Ace Radio Co., Box 301, Higginsville, Mo.)
Chassis, 4¾ x 2⅞ x ½ inch (2)
Case, 5 x 3 x 10 inches
Aluminum shield, 2¾ x 2½ inches
Miscellaneous hardware

Rf section

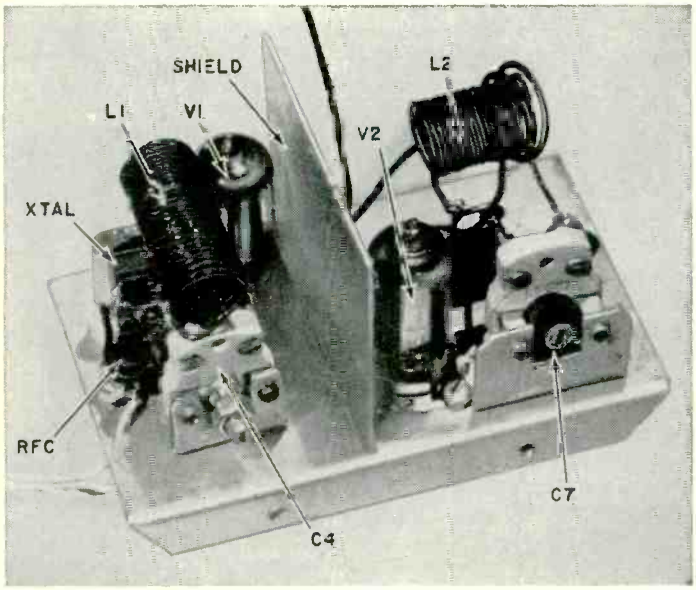
The rf section is built on a 4¾ x 2⅞-inch chassis made from 1/16-inch sheet aluminum. The chassis has a ½-inch front and back lip. The cabinet is a 5 x 10 x 3-inch aluminum chassis. Use a similar chassis for the oscillator–modulator section.

Mount the rf tuning capacitors to the chassis with small U-shaped brackets made from the sheet aluminum. Make sure that both sides of the capacitors are insulated from the chassis. A small 2¾ x 2½-inch aluminum shield is mounted 2¼ inches from the left edge between the two sections (see photos). Make certain the capacitor tuning shafts are at least ¼ inch back from the front of the chassis so they will not ground to the front panel.

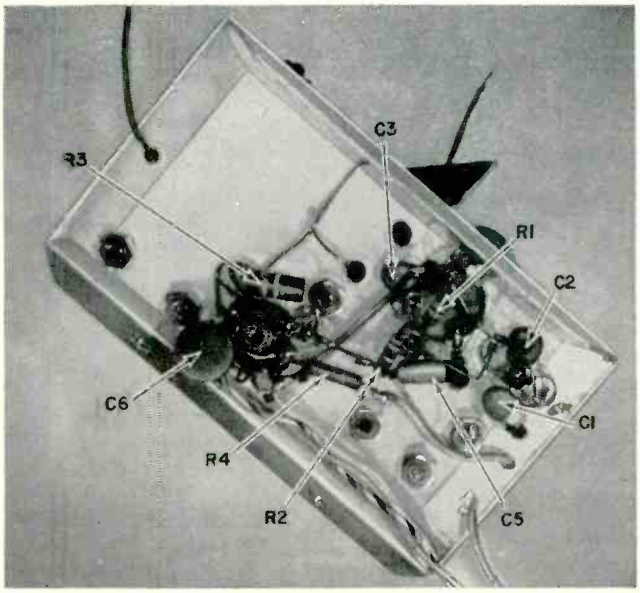
Locate V1's socket so its filament pins, 1 and 7, are nearest the rear chassis lip. Mount V2's socket with pins 1 and 7 nearest the chassis front lip. In front of the crystal socket, on top of the chassis, mount an insulated two-lug terminal strip.

Place L1 directly over its tuning capacitor and solder directly to it. A lead from each end of the coil then goes to each of the two insulated lugs of the strip. Connect one end of the 100-μh rf choke and one end of the 470-μμf disc ceramic to one lug. Bring a lead from V1's plate up through a ¼-inch hole in the chassis and connect it to the second lug.

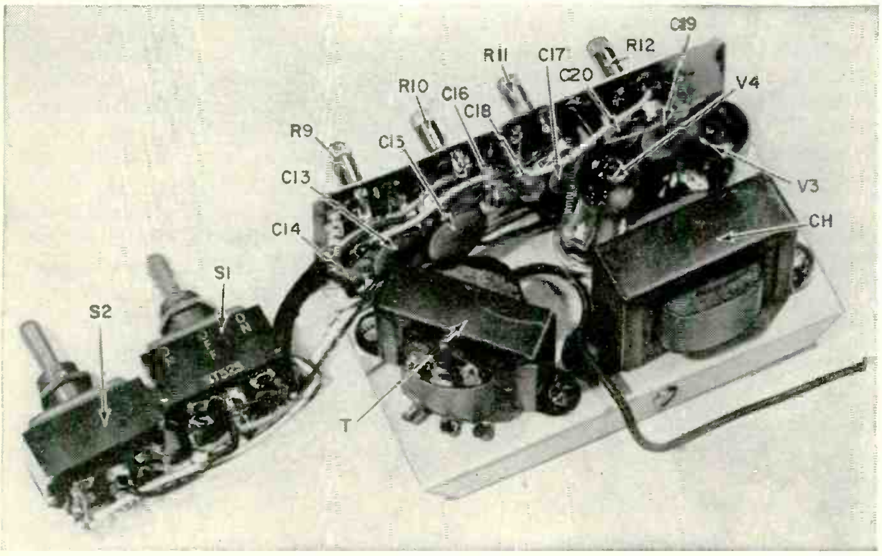
Also solder L2 directly to its capacitor. Bring the plate lead from



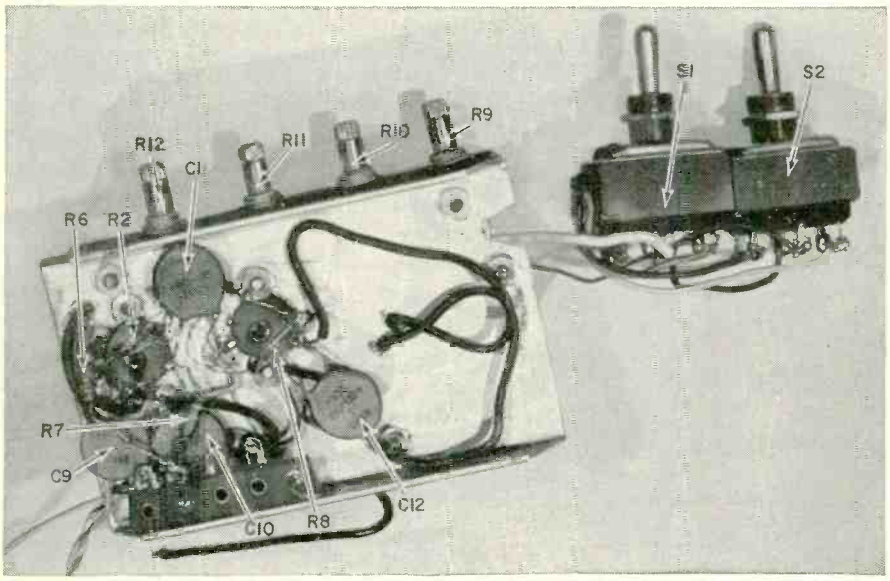
Top view of the rf section.



Rf section underchassis is relatively uncluttered.



Top view of the modulator–amplifier chassis.



A look under the modulator–amplifier chassis.

V2 to its coil through a ¼-inch hole in the chassis. Make this hole as close to V2's plate pin as possible. Now take a length of bare No. 18 hookup wire, solder it to all ground points and wrap it around one chassis mounting bolt to connect it to the chassis. A flexible lead soldered to this ground bus serves as B-minus and filament return. All other parts are mounted as close to each tube sockets as possible.

Oscillator–modulator

This section requires no special care except to locate the parts for each tube as near its socket as possible. Also use a ground bus as you did in the rf section. Mount the audio oscillator tuning pots on a small aluminum panel set ¼ inch back from the front lip.

This method of construction, using the two complete subchassis, permits us to completely tune and adjust each unit before it is mounted in the cabinet. It makes neater bug-free set.

Rf section adjustments

With V2 removed from its socket, connect a 0–50-ma meter in series with the oscillator B-plus lead. The meter should read about 10 ma. Use a nonmetallic screwdriver and tune C4 for a dip of about 7 ma. C4's plates should be about half meshed when the dip is found.

Adjust C4 so the meter reading is a little off the lowest dip point on the gradual-rise side. Now make a 1-inch diameter loop out of two turns of insulated hookup wire and connect a 150-ma brown-bead 6-volt pilot lamp to the ends. You should be able to place this loop near or over the end of L1 and have the lamp glow. If it doesn't, retune till it does.

Remove the light and place it on the B-plus end of L2. Insert V2 and connect the meter in the final plate B-plus lead. Use the insulated screwdriver and tune the final for dip. Final plates should be about half meshed at this point and the meter will read about 8 ma. If you don't get a dip, retune the oscillator capacitor a little and try again. With some juggling, you will get a good dip in the "final" meter reading, and the lamp will glow. The meter reading will drop to about 4 ma when the loop is removed and the final stage retuned for lowest dip.

There are several ways to hook up the antenna. The simplest is to use a two-turn loop of insulated hookup wire wrapped around the B-plus end of L2. Connect one end to the ground bus and the other directly to a 9-foot 10-inch antenna. If you'd like to use a shorter antenna, put a loading coil in series with the antenna. Use one with the same number of turns and size as the oscillator coil. Connect the loop to one end of it and an adjustable whip type antenna to the other. Watching the meter in the final stage, slowly extend the whip till you get the highest meter reading. The antenna will be 4 or 5 feet long.

Troubleshoot in a step sequence. First use a voltmeter and measure from the plates of the tuning capacitors to ground. You should read at least 100 volts. Loss of B-plus normally indicates an open rf choke, shorted bypass or grounded tuning capacitor. Next measure filament voltage at the tube sockets. You need at least 1.25 volts.

Third, recheck your wiring and look for bad solder joints or places where solder has run down and touches the chassis or wires it shouldn't. Then check each part for correct value and examine the tuning capacitors to make sure plates aren't shorted. Finally check the tubes and crystal. The crystal **must be a "doubler type."** Tripler type crystals **will not** work in this circuit. You have to replace the crystal to check it. Also check to be sure the crystal pins fit tightly into its socket. Suspect everything. In one case when the meter dipped but the light didn't glow a bad pilot light was the cause.

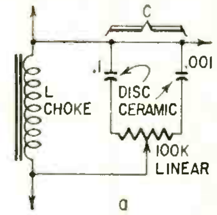


Fig. 2 a—(right) Basic audio tuned circuit. b—Audio tuning capacitors are mounted directly to pot.

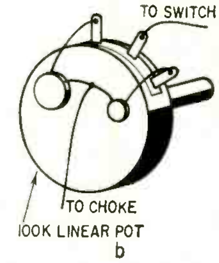
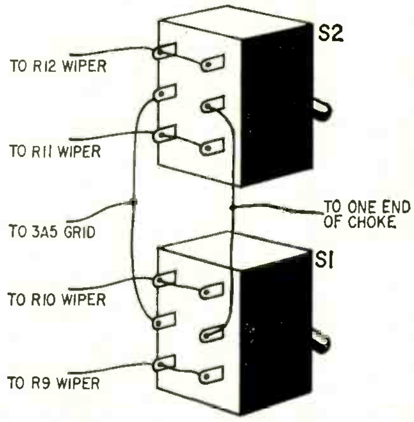


Fig. 3 (below)—Wiring and rear view to tone selector switches.



Modulator–oscillator setup

Complete the 3A5 section first. Then connect a pair of phones to one plate through a .01-μf capacitor and to ground. You should be able to hear the tone and, when you vary a pot, hear it change. Connect only one pot for this test and do not use the switches; use clip leads. Once you know this part of the circuit is all right, then wire in the other pots and switches.

If you hear a tone, about 700 cycles, and cannot change it, suspect the pot or see if the audio tuning capacitors are properly connected. The choke resonates at about 700 cycles, so it is probably connected and the ceramic tuning capacitors are not. Fig. 2 shows the basic audio tuned circuit.

The dpdt selector switches are necessary because we must connect both the grid and one end of the choke to the pot tuning circuit for each tone. We cannot connect the choke directly to the grids and switch from grid to pots without having the 700-cycle tone generated when the control switches are off. Connecting the switches is easy and shown in Fig. 3.

If you use a scope and audio oscillator to check the ton frequencies, you may worry about the small distortion on the 3A5 output. Don't worry. The 0.1-μf capacitor across the output transformer tunes this and smoothes out the wave.

Make a final check with phones by connecting them across the output lugs of the output transformer. Use the switches and vary each pot to determine that all is working properly.

Cabinet mounting

Cut away some of the base lip as shown in the photos. Slide the rf section in first, determine where to drill the tuning holes, then mount with two bolts through the front chassis lip. The modulator is mounted just below in the same manner.

Final wiring

Connect the flexible ground leads from each chassis together. Also connect the hot filament leads. Connect the rf oscillator and modulator B-plus leads together and to the 135-volt supply. The B-plus lead from the rf chassis final stage goes to the brown lead of the modulator output transformer. Put a switch in the ground lead between the B-minus and filament and chassis grounds.

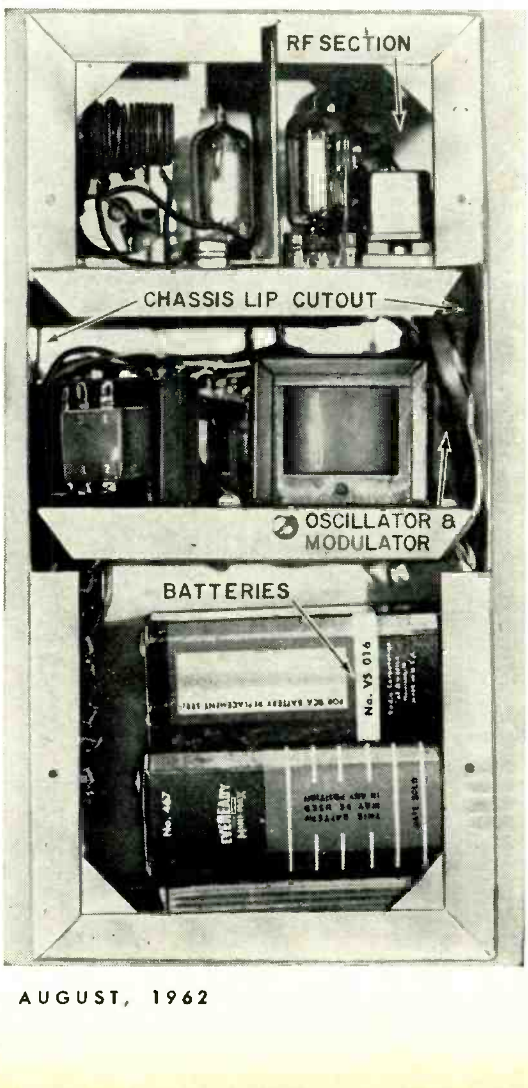
Adjusting for reed receivers

With the receiver on and reeds exposed, tune the receiver to the transmitter by listening to the receiver. Superregenerative types are tuned when the hiss vanishes. Superhet types are tuned when the tone is loudest. Now, if you haven't already, depress a tone switch and very slowly adjust the pot controlling this tone. You will see the reed suddenly start to vibrate. Adjust for maximum vibration. Stop sending the tone, then send it again. If the reed does not vibrate, readjust slightly. Stop tone, then send tone. Keep doing this till each reed vibrates when the proper switch is depressed.

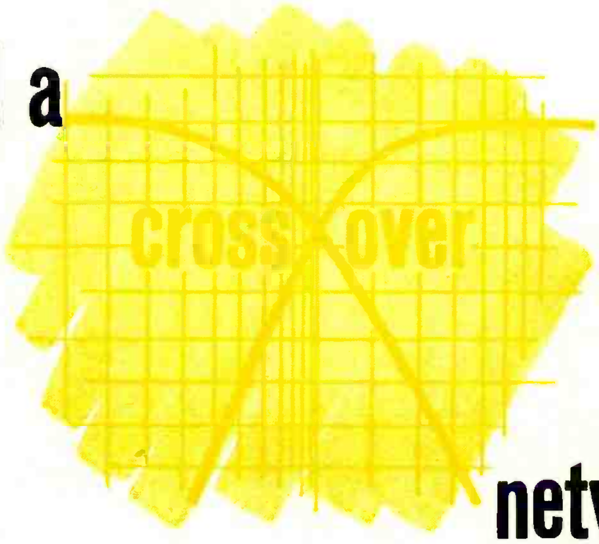
Be sure and check the reed tuning each time you are ready to use your system and before you get a plane, car or boat in operation. If you are operating a single-channel tone receiver, adjust one channel for the highest tone (500 cycles) and use it. To operate carrier receivers, put a keying switch in the B-minus lead and disconnect the modulator.

END

How various sections are mounted.



Let's build a crossover network



High-quality units are easy to design and construct

By BASIL BARBEE

Need a crossover network for your hi-fi speaker system? Here's one you can build that will meet your needs. It is inexpensive, reasonably attractive and not inordinately bulky.

First let's examine a typical crossover, the popular "constant-resistance" network of Fig. 1. It consists of a low-pass (L1, C1) and a high-pass filter section (L2, C2). Each is designed to feed a particular section of the audio spectrum to a particular speaker.

The crossover frequency of this network, the point at which the output of each section is down 3 db so each speaker receives half the total power, is set by the lowest frequency the tweeter can safely handle at its rated power level. Manufacturer's specs will give you this information.

The surge impedance or characteristic resistance of the network—they are the same for the ideal loss-less network—is approached closely by a well designed crossover. It is determined by the voice-coil impedance of the speakers the crossover will be used with.

The rate of attenuation for this network is 12 db an octave—an optimum figure for this circuit.

How were the values for the components in Fig. 1 calculated? I used two simple formulas:

$$L1 = L2 = \frac{\sqrt{2}\, R_o}{2\pi\, f_c}$$

and

$$C1 = C2 = \frac{1}{2\sqrt{2}\pi\, f_c\, R_o}$$

R_o is the voice-coil impedance of the speakers (assumed to be a pure resistance and equal for the two speakers), and f_c is the crossover frequency. The inductance for L1 and L2 is given in henries, and the capacitance for C1 and C2 in farads. If values for R_o and f_c are 8 ohms and 2,000 cycles, respectively, L1 and L2 turn out as .0009 henry (900 μh), and C1 and C2 as .000007 farad, or 7 μf.

Normally, coils L1 and L2 are hand-wound to the desired inductance, and C1 and C2 are purchased. Unfortunately, 7-μf oil-filled units are difficult to come by. But we can always use a combination of a 6-μf and a 1-μf unit. While this is OK electrically, the units are comparatively large and present mounting problems. Also the price is rather high.

To avoid the cost problem, some hi-fi people go to electrolytics although, as we will prove later, *they simply are not suitable as crossover elements.*

To get the neat, compact, economical result shown in the photos, let's try a slightly different approach.

R_o = 8 ohms is a standard fixed value of voice-coil impedance. C1 = C2 = a readily available value of capacitance. L1 = L2 = any reasonable value, (we are going to roll our own coils). f_c = any frequency reasonably near, but not lower than, the tweeter manufacturer's recommended minimum crossover frequency. The table lists the resultant crossover frequencies and coil inductances for several available capacitors.

CROSSOVER VALUES

C (μf)	f_c (cycles)	L (μh)
2	7020	256
4	3510	512
6	2340	768
8	1755	1024

Since the minimum recommended frequency for the tweeter is 2,000 cycles, we choose the next higher frequency in the table (2340 cycles) for our crossover frequency. Then we can use single 6-μf capacitors for C1 and C2, and an inductance of 768 μh for L1 and L2.

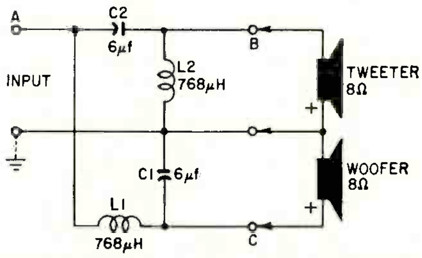


Fig. 1—Typical crossover network. Crossover frequency is 2,340 cycles.

These coils are wound on 1-inch diameter cores 1-inch long with 2-inch diameter ends. I used about 175 turns of No. 20 wire, then trimmed it down to resonate with the capacitors at the desired frequency. To calculate your own coils use the formula:

$$L_o = \frac{0.8\, a^2 n^2}{6a + 9b + 10c}$$

where a is the mean radius of the winding; b is the width of the winding; c is the depth of the winding; and n is the number of turns (see Fig. 2). L_o is the low-frequency inductance in microhenries. This formula comes from "Radio Engineers Handbook", Frederick E. Terman, First Edition, page 62.

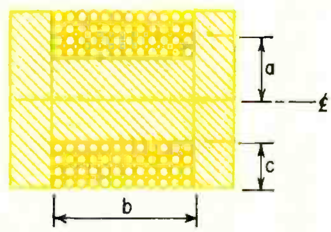
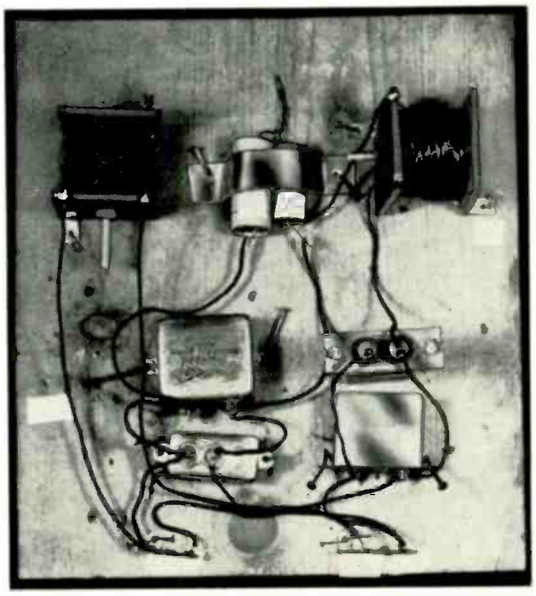
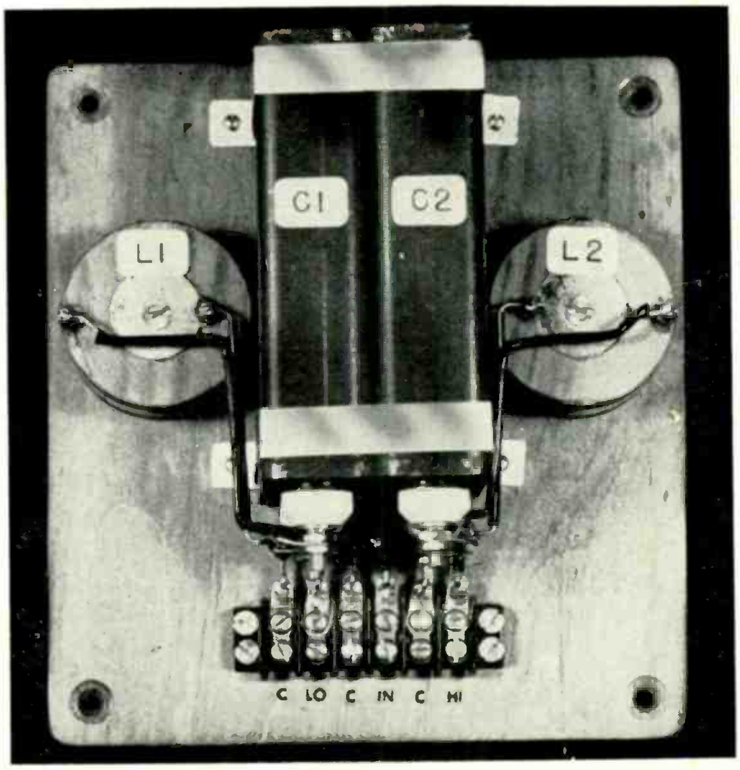


Fig. 2—Coil measurements for finding inductance.

Ordinary crossover (below) is sloppy, poorly designed and works poorly. Crossover network (right) was built following procedures outlined in this article. The differences are obvious.





Winding the coils

Winding one's own coils and ending up with a satisfactory attractive unit depends somewhat on the skill of the builder and the procedures he follows. If you want to be sure to do a good job, the following notes will be handy.

Masonite is excellent for the coil spool ends. Use a ¼-inch thick piece to insure sturdiness. It should have a smooth surface on both sides. If only one side is smooth, face it inward, toward the coil. It makes winding simpler. Otherwise use ¼-inch plywood or hardwood. Cut the ends with a circle cutter. You'll get a neat job and, when the form is assembled, you won't have square edges getting in the way when you wind your coil.

For the core of the form, a maple dowel is excellent. In the center of each of the end pieces, cut a hole the size of the dowel—actually a trifle smaller to insure a tight fit. Then cement the ends in place. This avoids running a metal bolt through the center to hold the form together and gives you a nonmetallic coil form.

The shape of the coil is the next factor to consider. For greatest efficiency—most inductance with the least resistance—wind the coil with the shortest possible length of wire. This means each turn must be close to every other one. The most efficient and practical shape for spool winding is a square cross-section—the winding is as wide as it is deep and the core diameter is half the outside diameter. Obviously, for compactness, it should be level wound, either by hand, chucked in a hand drill, or on a coil winder. Universal or jumble winding should not be used.

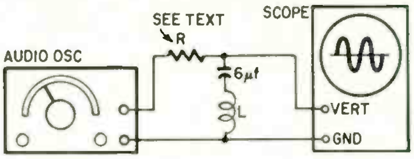


Fig. 3—Method of resonating crossover coils to capacitors.

Next—perhaps the most important part of coil winding—getting the proper inductance value. If you have an inductance bridge, you can wind on about 10% more turns than your calculation shows you need and peel them off a few at a time till you hit the correct inductance.

If you don't have a bridge, use an audio generator and ac vtvm or scope to do about the same thing. Set up your equipment as in Fig. 3. The capacitor shown is the one you are using in the crossover. Set the audio generator for the crossover and adjust the coil to resonate with the capacitor at that frequency. At resonance, the scope pattern or vtvm reading will show a sharp and pronounced dip. Resistor R is not critical; the internal resistance of the audio generator may even be adequate. Try values between 100 and 1,000 ohms. Use the one that gives the best dip at resonance.

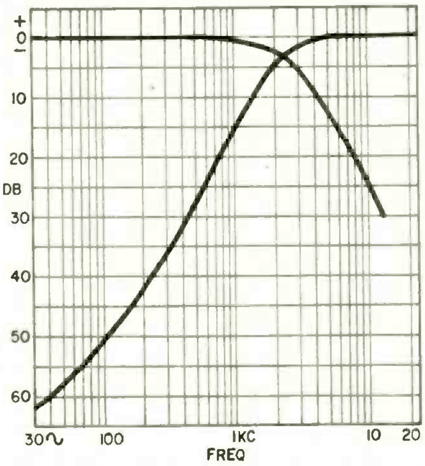


Fig. 4—Crossover response at any power level when oil-filled paper capacitors are used.

Mount the finished coils with No. 8 or smaller brass or aluminum screws. They have a negligible effect on the inductance and Q of the coils when the winding core is 1 inch in diameter or larger. Even No. 6 iron or steel screws will upset these characteristics as much as a ¼-inch brass screw.

Electrolytics in crossovers

Ideally, a crossover filter should have a low insertion loss. Also each output should be down 3 db at the crossover frequency. The high-frequency output should fall off at the rate of 12 db an octave for frequencies well below the crossover frequency, and the low-frequency output at the rate of 12 db an octave for frequencies well above the crossover frequency. Negligible distortion should be introduced by the filter. The crossover network we have been discussing, when fitted with oil-filled paper capacitors, meets all these specifications. (See the frequency-response curves in Fig. 4.) This does not hold true when electrolytics are used.

About 20 years ago a number of audio fans, this one included, hit upon the idea of replacing the then expensive paper capacitors in crossover net-

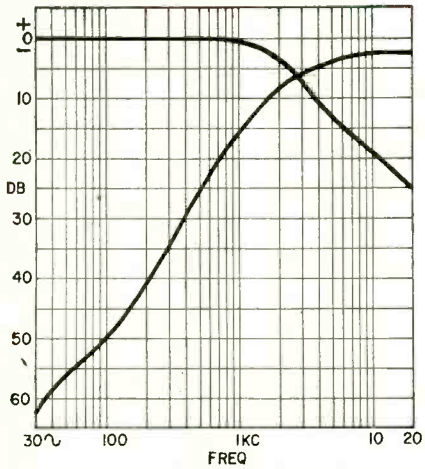


Fig. 5—Crossover response at 8 watts when back-to-back electrolytics are used.

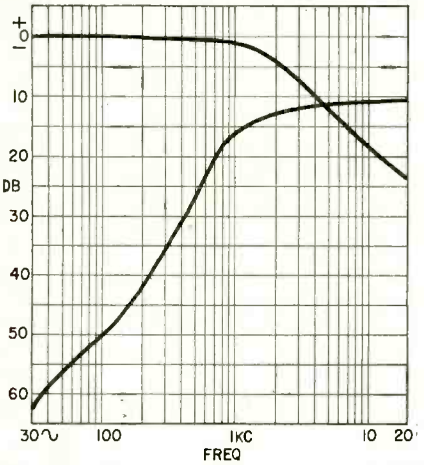


Fig. 6—Crossover response at 0.125 watts when back-to-back electrolytics are used.

works with electrolytics. I argued that, unless the electrolytics were polarized with some dc applied through isolating resistors, objectionable distortion would result*, especially at very low and very high power levels.

To prove my contention, I replaced the capacitors in the crossover of Fig. 1 with unpolarized electrolytics. Then I fed the network from an audio oscillator through a 10-watt amplifier, and terminated both outputs with non-inductive resistors capable of dissipating the full amplifier output. Frequency response and total harmonic distortion were measured at power levels of 8 and 0.125 watt for three conditions: (1) with 6-μf oil-filled paper capacitors; (2) with 6-μf (measured capacitance) electrolytics, consisting of two 10-μf 50-volt tubular electrolytics connected back to back, and (3) with them polarized with 25 volts through 10,000 ohms to each back-to-back junction.

Proof of the pudding

Surprisingly, this experiment proved that, while negligible distortion (on the order of 0.5% referred to full power) was introduced by the electrolytics regardless of power level, polarization or lack of it, their losses at high frequencies were intolerable. The curve in Fig. 4 was obtained with the oil-filled paper capacitors. Substituting the electrolytics produced the curves in Figs. 5 and 6. The curves for 8 watts were bad enough (Fig. 5), with each output down 8 db at crossover and a slope of only 6 db per octave for the low-frequency output beyond crossover, but the curves for 0.125 watt (Fig. 6) are far worse, showing a shift in the crossover frequency to 4,700 cycles and a loss of 11 db at all high frequencies. This sad performance was strangely unaccompanied by serious distortion at either power level.

Correct speaker phasing

Much confusion surrounds phasing speakers connected to crossover networks. When two or more identical speakers are simply connected in parallel or series as in PA work, phasing is obvious. When two dissimilar speakers, such as a woofer and a tweeter, are operated through a crossover network, the problem is how to connect their leads to provide *reinforcement* of sound waves rather than *cancellation.*

Uusually, we are told to tag the leads of the speakers according to which lead is positive when the diaphragm moves outward when a flashlight cell is momentarily connected to the leads. So far, so good. But from this point on, how the leads are connected to the terminals of the network is left to chance or intuition. If we connect them by chance, we'll be right half the time. If by intuition, we'll almost always go wrong because the natural thing is to connect both negative leads to ground or, if you have been fooling with p-n-p transistors, you might connect both positive leads to ground, with the same result.

Why is this wrong? Because voltages at the output terminals of the two sections of the network are 180° out of phase. Recently a few networks have been described in catalogs as "2,000-cycle 180° type." All networks of the type shown in Fig. 1 have this 180° phase difference between the outputs. It results from a 90° *lead* in the high-pass section and a 90° *lag* in the low-pass section.

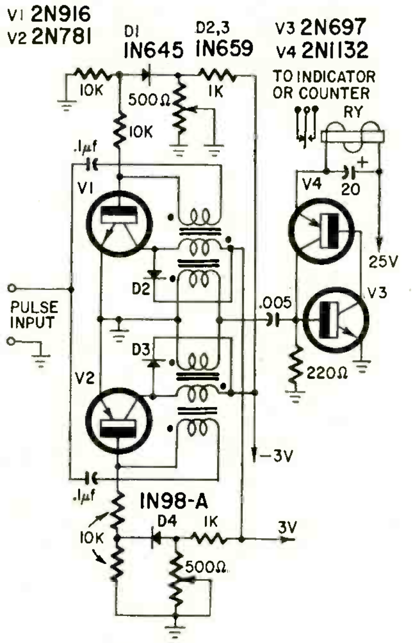
What this means in practical terms is that to phase our two speakers properly, we must first determine which lead polarity causes a push on the part of each diaphragm and then ground the *negative* lead of one speaker and the *positive* lead of the other. This method of phasing is much simpler and more foolproof than listening tests or microphone-and-vtvm measurements, both of which may prove confusing. END

*B. C. Barbee, W2MWX, "Electrolytics in A.F. Circuits," *QST*, January 1943.

Pulse-Amplitude Comparator

THIS TRANSISTORIZED PULSE COMPARATOR detects pulses whose negative or positive amplitudes exceed preset levels. It is especially useful in detecting and recording or counting voltage surges on signal or power lines. Designed by Owen B. Laug of the National Bureau of Standards, it was described in *NBS Technical News Bulletin*, January 1962.

The circuit consists of a pair of blocking oscillators (V1 and V2) that trigger a monostable switching circuit (V3 and V4) to operate a relay or counter in the 25-volt line. The blocking oscillators are regeneratively coupled



through paralleled tertiary windings so both are driven to saturation when either is triggered by a voltage exceeding its reference level. One transistor is triggered by negative pulses and the other by positive pulses.

The circuit can be arranged so the time constant of the relay keeps the relay energized for the period between periodically recurring pulses.

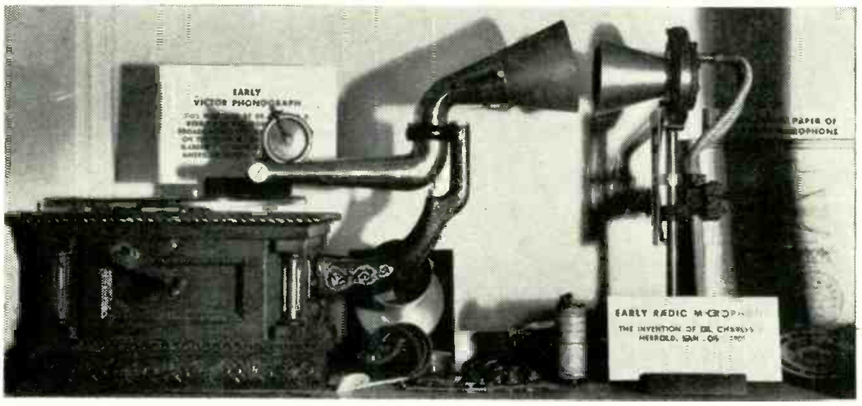
The input reference levels are adjustable from 0.5 to 1.0 volt with the two 500-ohm bias pots. Pulses as narrow as 50 nanoseconds can be detected. A voltage divider must be used ahead of the input when normal voltage amplitudes exceed the circuit's range.

END

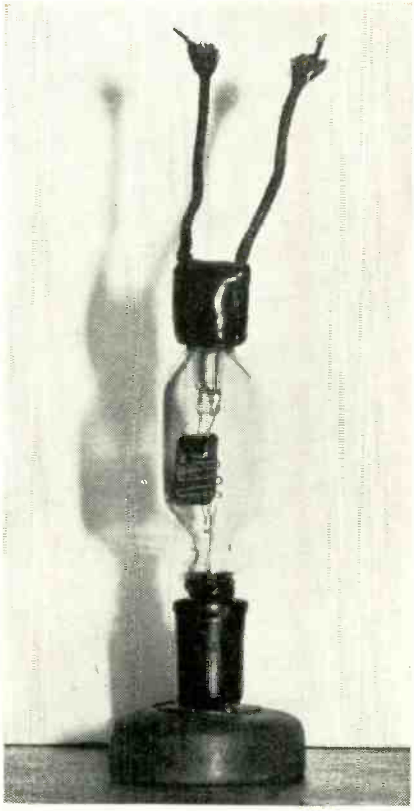
What's Old

By DICK BARRETT

All the items shown on this page are exhibits at the Cavalcade of Electronics, a collection of electronic equipment housed in one wing of the Perham Foundation's exhibit, a museum of early radio, at New Almaden, Calif.

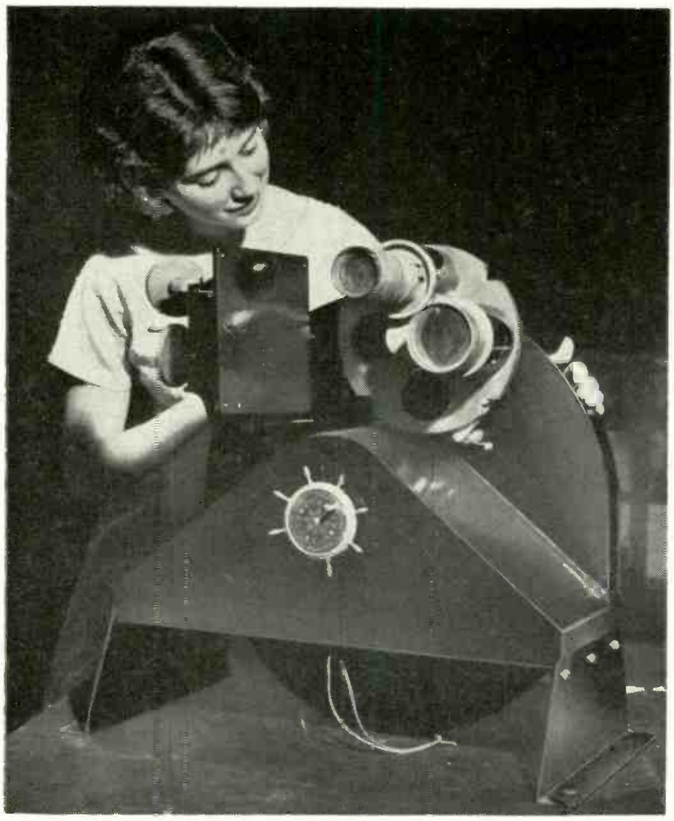


FIRST BROADCAST STATION was claimed by Charles D. Herrold in 1909. He used this microphone and phonograph to broadcast from a bank building in San Jose, Calif. Station call letters were FN.



AN ORIGINAL DE FOREST TRIODE made in 1906. These original three-electrode, cylindrical-shaped tubes with a screw base are now exceedingly rare. They were superseded by the more familiar globular Audion.

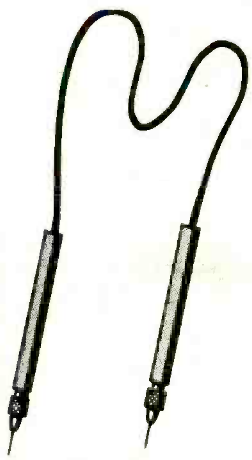
1928 TV CAMERA used a perforated scanning disc (behind the circular frame at the right rear). It was in use at station WAIT in Chicago in 1928. The disc system was used for TV transmission and reception in the US by Jenkins and in England by Baird.



POULSEN ARC made daylight communications between the West Coast and Hawaii possible for the first time. This one was assembled between 1916 and 1918.

10 TIPS speed transistor service

If you repair transistor radios, this article is must reading



Jumper wire with needle-tip test prods is used to check continuity of printed wiring.

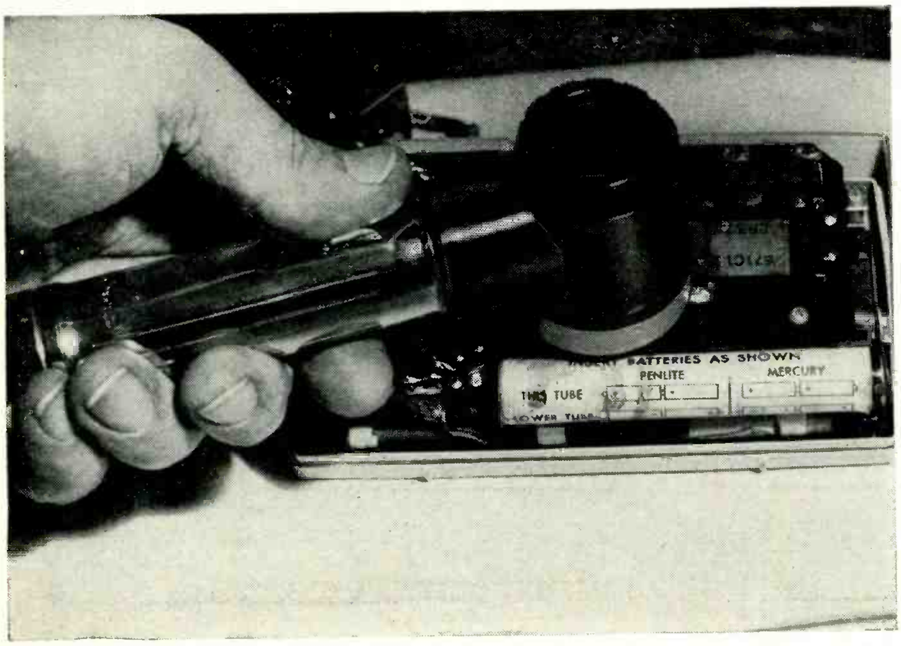
By WAYNE LEMONS

HERE ARE 10 PRACTICAL WAYS TO HELP you find transistor radio troubles faster. They are often obvious (though often forgotten) concepts that have been tried and proved advantageous.

1. Check battery voltage and current

This should be a regular habit. Test battery voltage with the set turned on. Check current drain with the volume turned down. Current drain can be checked by placing a milliammeter (most multimeters have a milliammeter position) across the radio switch terminals (set off). The average transistor radio will draw from 5 to 15 ma if class-B output stages are used, somewhat more if the output stage is class-A.

Excessive current drain can be caused by shorted or leaky bypass capacitors, improper biasing of one or more transistors or by a defective transistor.



Technician inspects transistor radio through magnifier lamp.

2. Look for obvious faults

More than any other thing, transistor radios suffer from broken wires and terminals, especially if they have been dropped (and they likely have been). Broken wiring can be difficult to analyze by either signal tracing or voltage readings so you can often save a lot of time by visual checking. An illuminated magnifier is ideal for spotting broken conductors (although it will miss on occasion).

Slight flexing of the printed board may bring the radio on intermittently so you can find the trouble easier. The small ¼- and ⅛-watt resistors are easily cracked and often open.

Heavy parts such as transformers often pull away from the printed board and break their connecting leads in the process. Move each component from side to side and listen for a pop in the speaker. Use a jumper wire with needle points to check whether a printed conductor is open.

3. Don't worry about transistors

Not a first anyway. It is not just a press agent's dream—bad transistors *do* account for only 2% to 3% of all transistor radio defects—check other things first!

4. Don't rely on transistor gain checks

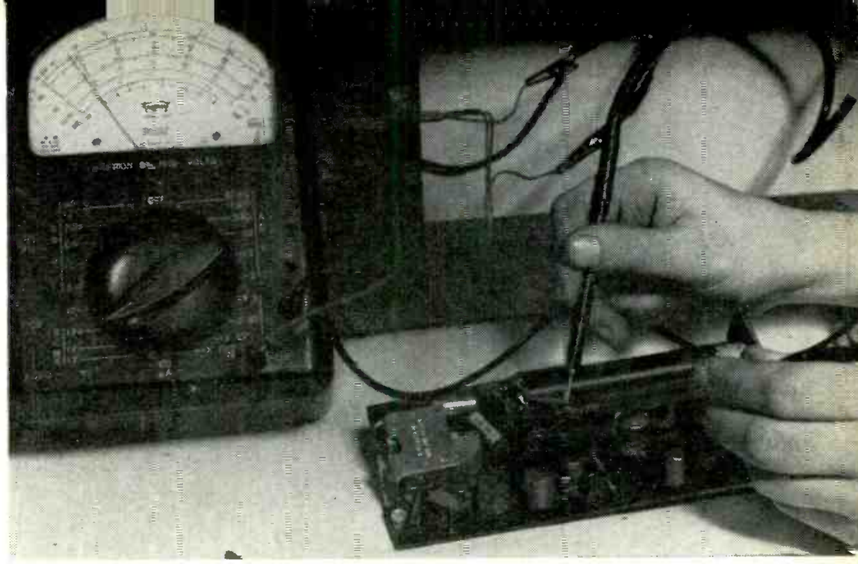
Unless you have laboratory equipment, the chances are you'll learn nothing from a gain check. Dc gain has almost nothing to do with the way a transistor will perform in a practical rf circuit. Too many other factors, such as input and output impedance, or biasing, are involved.

5. Check transistors in circuit

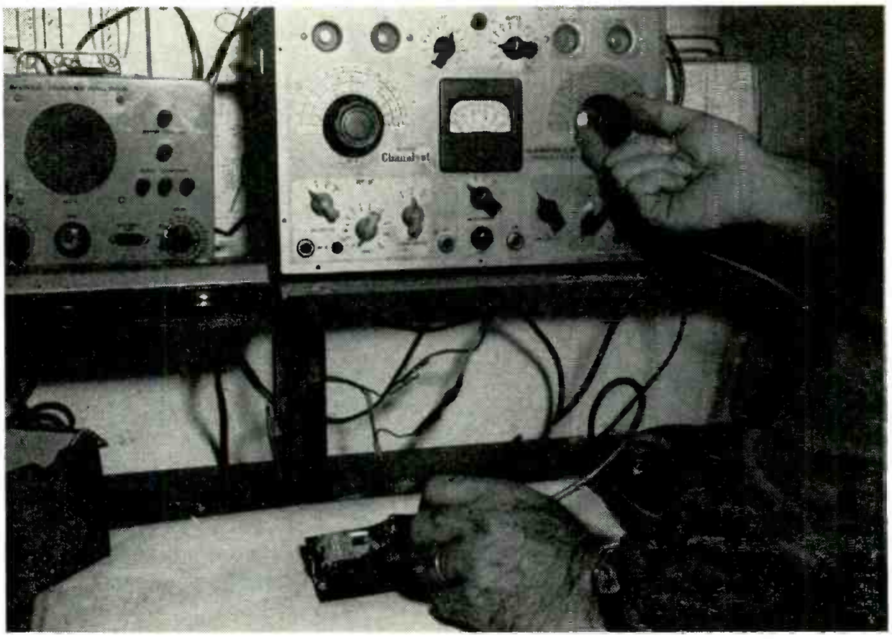
Since most transistors do not plug in, we must have some exploratory method of checking that doesn't involve unsoldering the transistor. With the radio off, place an ohmmeter (20,000 ohms-per-volt type) across the base and collector, then reverse the leads. There should be more resistance in one direction than in the other. Do the same from base to emitter. Typical readings may be 3,000 ohms in one direction and 20 ohms in the other. This usually indicates a good transistor, since there is evidence of diode action.

A transistor can also short from collector to emitter without affecting the apparent diode action of the base–collector, base–emitter paths.

Some have said that testing transistors this way can damage low-voltage electrolytics because of the reverse polarity voltage placed on them by the ohmmeter. We used the method long before we ever read this precaution and to our knowledge we have never damaged an electrolytic. [Of course it won't hurt to use a meter with a low-voltage battery.—*Editor*]



Measuring current drain of radio by connecting vom (milliammeter position) across open on–off switch terminals.



A Chanalyst is ideal for signal-tracing transistor radios. Here the technician is checking the transistor oscillator frequency. Modern versions of this instrument are available.

6. Signal-trace or signal-substitute

If you happen to have an old Rider Chanalyst or other radio analyzer, you have some fine equipment for signal-tracing the transistor set and for determining if the oscillator is working. There are some modern analyzers for transistor sets available, too. Otherwise, you can use a signal generator and starting with audio, successively trace back toward the front end. Don't be fooled, though, by the low-impedance base circuit. It will greatly attenuate the signal generator output. Inject the signal into the higher impedance collector circuit if possible.

7. Don't be fooled by gain of radio

A transistor radio may seem to be working normally, especially on strong stations, but refuse to operate when taken to a fringe area. If you work quite a lot on the same kind of radio, you can set up tests with an output meter and your signal generator to see if gain is up to par. If it isn't, check tuning and tracking as explained in step 10. Use a substitute capacitor and shunt each bypass and coupling capacitor in the radio.

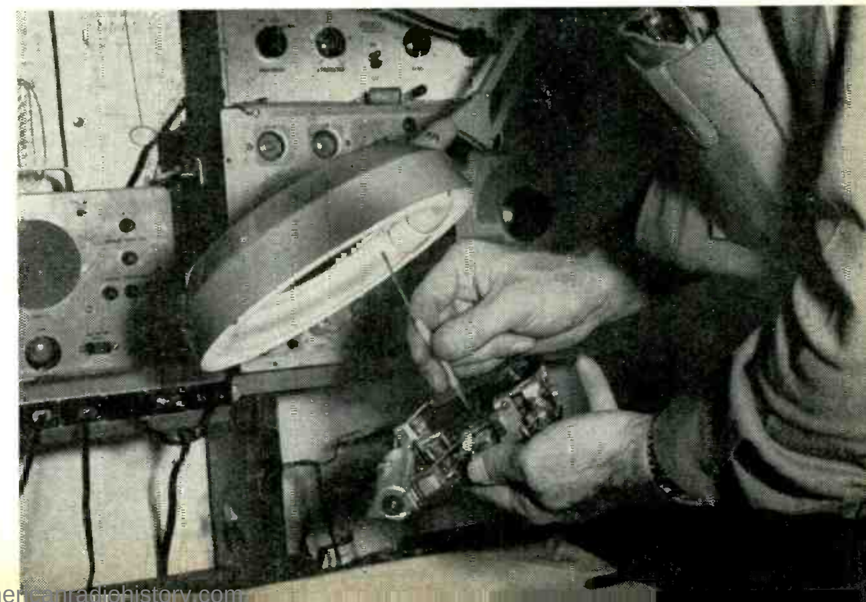
Capacitors and if transformers cause more weak radio troubles than anything else. Transistors usually short or open. To check if's try retuning them. If they can't be peaked, they are defective. If the tuning has to be changed drastically (unless the radio has been previously tampered with), it is likely the if transformer is defective and will have low gain even though it may appear to peak at some position of the slug.

8. Check oscillator with another radio

Place a working radio tuned to a station at the high end of the dial near the radio with a suspected oscillator stage. Sweep the defective radio through its tuning range. At some point a whistle or squeal will be heard in the good radio if the defective radio's oscillator is functioning. The whistle or squeal should be heard at approximately 455 kc below the station tuned in on the good radio if the good radio uses a 455-kc if. This lets you know that the oscillator tuning circuit on the defective radio is probably OK.

You can also use a peak-to-peak meter or a wide-band scope (even some

Holding radio near fluorescent lamp injects noise for adjustment of oscillator coil at low end of band and antenna trimmer at high end.



Moving parts gently will often disclose intermittents.

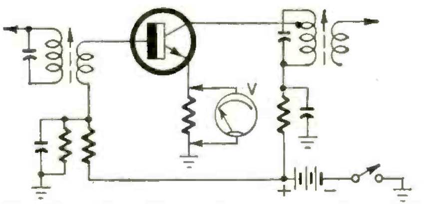


Fig. 1—No voltage drop across the emitter resistor indicates an open or cutoff transistor.

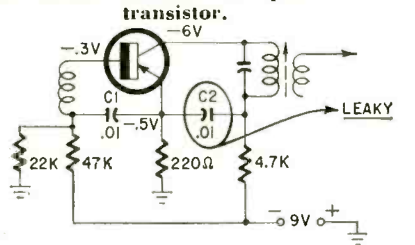


Fig. 2—If capacitor C2 is leaky, the transistor will be cut off.

narrow-band scopes) to check oscillator action. Most radios should develop about 0.2 to 0.8 volt peak-to-peak at the base of the transistor oscillator.

9. Make accurate voltage readings and analyze the trouble

Over half of the "dog" transistor radio troubles can be diagnosed by voltage readings. Remember, with respect to the emitter, the base is the *same* polarity as the collector. If the collector is positive then the base will be positive; if it is negative the base will be negative, unless there is trouble. The bias voltage between the emitter and base is often 0.2 volt or less, but the base must have the same polarity as the collector. A typical example is: base to emitter 0.2 volt, collector to emitter 3.5 volts. Another example: base to emitter −0.4 volt, collector to emitter −5.5 volts.

Let's suppose that these readings were found: base to emitter +0.2 volt, collector to emitter −6 volts. It's obvious that the base and collector are not the same polarity. The transistor cannot function; it is cut off. Fig. 1 shows how this might happen.

An open transistor can be spotted because there is no voltage drop across the emitter resistor. Of course bias must be checked first, since incorrect bias would also drop the emitter resistor voltage to zero. Fig. 2 shows how a leaky capacitor might cause this. A word of caution in bias readings. Some receivers have practically no (or even reverse dc bias on the converter stage when it is also used as an oscillator. You may think the transistor cannot function but it does because of the ac bias developed by the oscillatory circuit.

10. Use noise source to align oscillator and antenna circuits

First align the if's with an accurate signal generator to the specified frequency. Second, using a commercial noise generator, or almost as good, a fluorescent lamp, hold the radio close to the noise source, tune it to the low end of the band and adjust the oscillator coil for maximum noise. Now tune the radio to the high end of the band and adjust the antenna trimmer for maximum noise. If calibration is off somewhat, you may want to touch up the oscillator trimmer, then repeat the above procedure. This method of aligning eliminates the old "capacitor-rocking" method and is extremely accurate as well as fast. Do not worry too much about exact calibration since you'll find it often isn't too good at best.

Well, that's it—not all the answers of course—but if you follow these suggestions, we think you'll start getting more out of transistor servicing. END

"I believe he's just installed a stereo system."

Scope Astigmatism Control

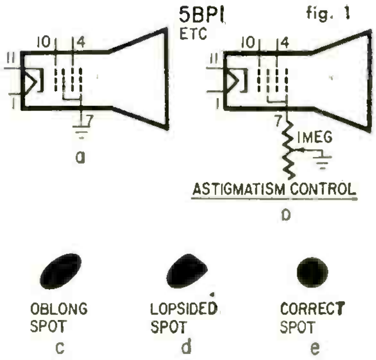
Inexpensive utility scopes such as the Eico 425 do not have an astigmatism control. However, such a control is desirable for optimum trace definition. Adding one is simple. Get screwdriver-set or short-shaft 1-megohm pot and mount it close to the base of the CRT.

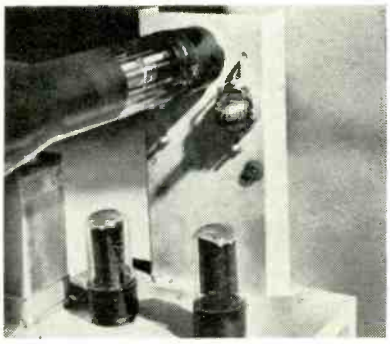
Remove the rear cover of the pot. Drill a 1/8-inch hole in the center of the cover and a corresponding hole near the CRT socket (see photo). Remove the CRT before drilling, to prevent breakage. Mount the cover with a 4-40 x 1/4-inch binder-head screw, lockwasher and nut, then reassemble the pot.

Fig. 1-a shows the original wiring with the second anode and G2 (pin 7 on a 5BP1) grounded. Disconnect pin 7 from ground and connect it to one end of the pot with a short piece of hookup wire through a grommet in a 1/4-inch hole. (Fig. 1-b and photo).

Circuit adjustment is simple. With a typical trace (60-cycle sine wave, etc.) on the oscilloscope, set the focus and the newly-added ASTIGMATISM controls for optimum pattern sharpness at normal viewing intensity level. Disconnect all sweeps. Reduce intensity until the spot is just visible in a darkened room and observe the spot through a magnifying glass. If it appears as in Fig 1-c or 1-d, adjust the astigmatism control for optimum as in Fig. 1-e. Apply the sweep and adjust focus for good trace resolution.—*Harold J. Weber*

[The astigmatism control adjusts the second anode to the same dc voltage as the deflection plates. If the plates are at a fairly high dc voltage, connect the control as a voltage divider between B-plus and ground.—*Editor*





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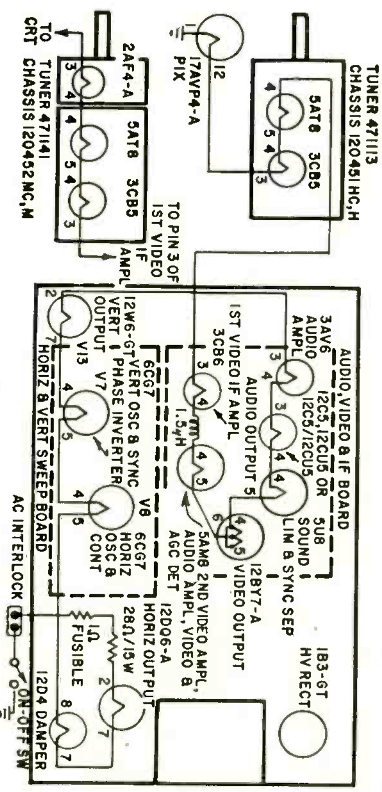
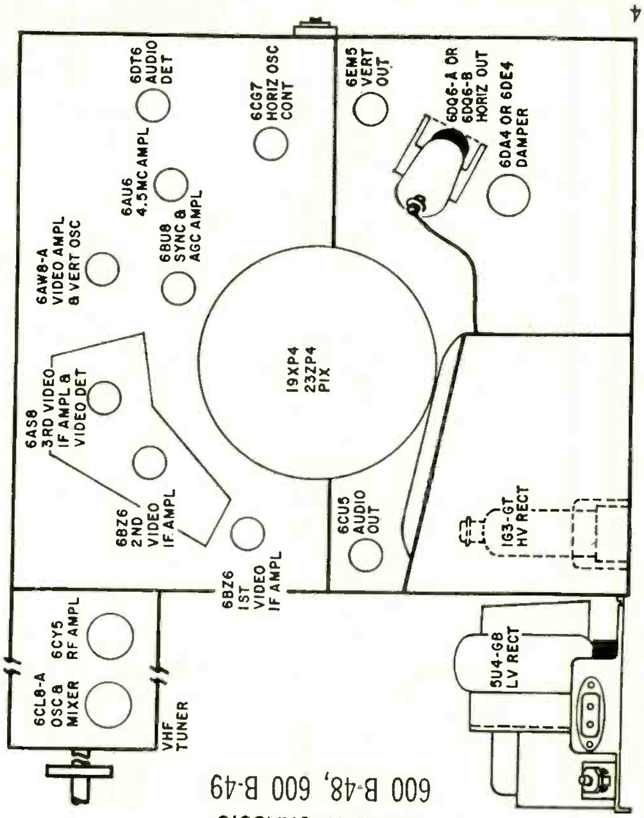


EMERSON CHASSIS
120451 HC(H), 120452 MC(M)



EMERSON CHASSIS 120530C, 549C, 550D, 551C,
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DUMONT CHASSIS
600 B-48, 600 B-49

TRIM HERE AFTER FOLDING

Radio-Electronics

TUBE LAYOUTS
IN TV SETS

Compiled by Larry Steckler, Associate Editor

DUMONT-EMERSON
1958-1962

HOW TO FOLD

Fold the top down and back, keeping the cover facing you. Then trim the right and left edges. Now staple the booklet along the vertical center fold, about ¾ inch from the top and bottom. Now fold from left to right, keeping the cover facing you. Trim a fraction of an inch off the top and trim the bottom to size and you're finished. You now have another useful piece of service data, exclusive with RADIO-ELECTRONICS.

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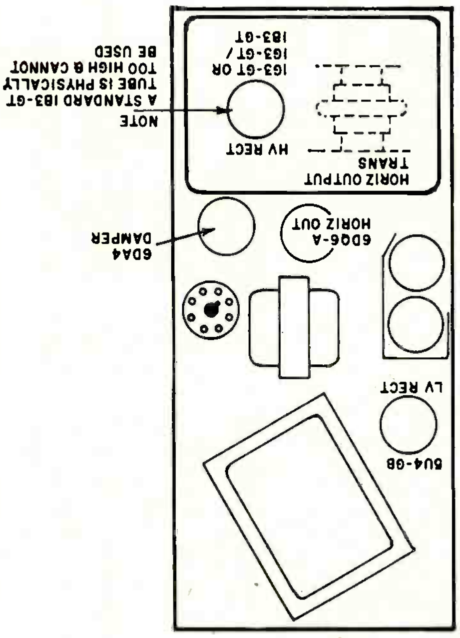
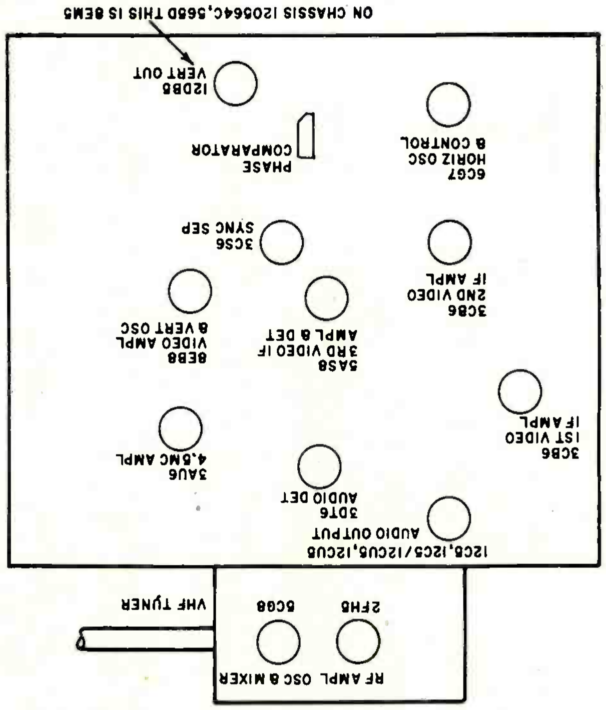


120424N, 425P, 434N, 435P



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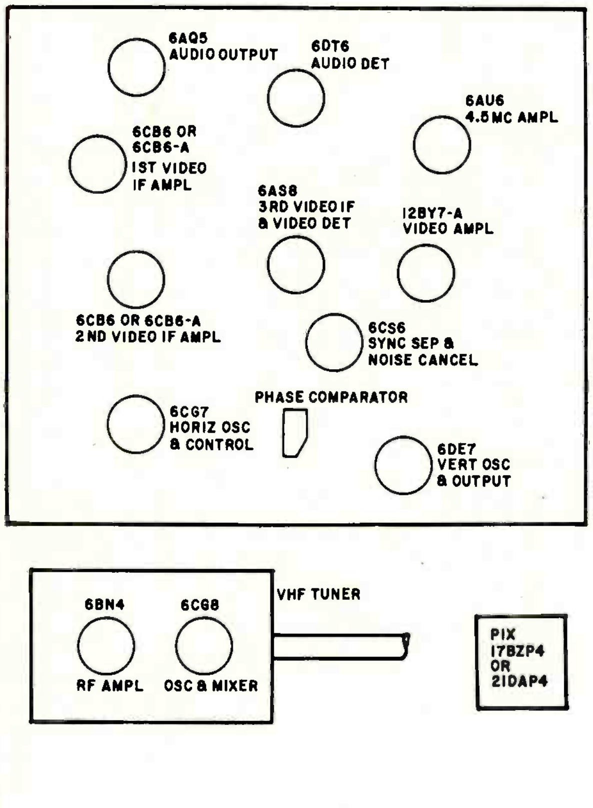
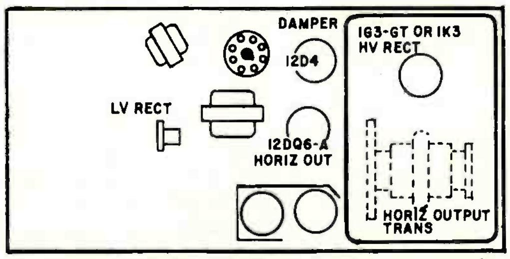
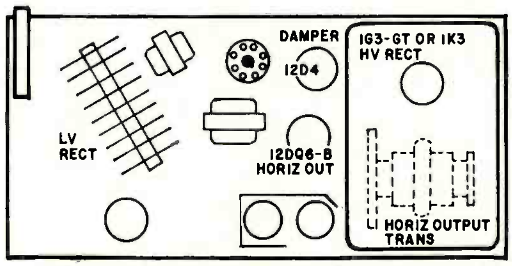
EMERSON CHASSIS 516-D, 541-C, 542-D, 564-C, 565-D





PWR SUPPLY, CHASSIS 120507A,508B,515C,516D,541C,542D USES SINGLE SILICON HALF-WAVE RECTIFIER



PWR SUPPLY, CHASSIS 120564,565D, USES VOLTAGE DOUBLER SELENIUM RECTIFIER ASSEMBLY

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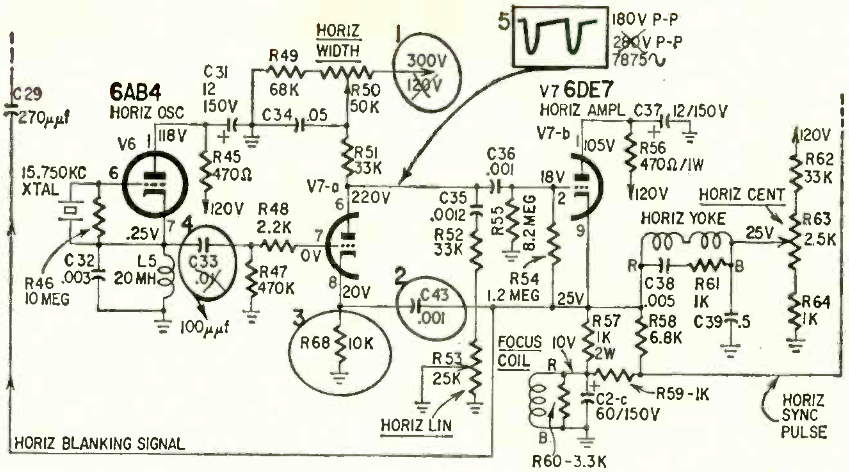
more on the TV camera



Revised schematic of the camera's horizontal deflection circuit. Terminal voltages simplify adjustments and troubleshooting.

By W. E. PARKER

FIVE REVISIONS SHOULD BE MADE IN the horizontal deflection circuit of my TV camera in the May and June issues. They are keyed to points on the revised diagram.

1. Connect the width control to plus 300 volts instead of plus 120.

2. A .001-μf capacitor (C43) must be connected as shown. If not, the bias on V7-a will be about 45 volts. The correct bias on pins 8 and 9 is 20 and 25 volts, respectively.

3. Connect a 10,000-ohm resistor (R68) from pin 8 to ground. This establishes the correct bias for V7-a.

4. Capacitor C33 should be 100 μμf. If the .01-μf unit is used, V7-a will be overdriven. This causes insufficient width and a bias of around minus 25 volts to appear on the grid (pin 7).

5. The waveform at V7-a's plate is 180 volts peak to peak, *not* 280.

I've received a number of inquiries from readers who have not been able to duplicate all the parts specified. In many cases, the component tolerances are not critical, and substitutions are simple.

As mentioned in the text, the case was made from aluminum sheet metal formed around the 8 x 10-inch chassis (chassis is 2½ inches deep). If you don't want to tackle a job of this type, a local tinsmith or sheet-metal shop will do it at a nominal charge.

A number of readers have inquired about the ceramic trimmer visible in the upper left corner of the cover photo. This is a 1-7-μμf unit used for C18. It was later replaced by a 1.8-μμf unit. Don't be tempted to stick in any odd value here. The trimmer, when fully closed, had too much capacitance (around 7 μμf).

Some constructors are having trouble finding the inductors in their catalogs. Here is the dope:

L1—410 μh. (Use 420 μh Merit TV-202, Stancor RTC-8579) or 400 μh (Thordarson-Meissner 19-4400.)

L2—35 μh. Use 36 μh, Merit TV-180, Stancor RTC-8593 or Thordarson-Meissner 19-3036.

L3—200 μh on 33,000-ohm resistor. Use Merit TV-197, Stancor RTC-8586 or Thordarson-Meissner 19-4201. Shunt with 33K, ½ watt.

L5—20 mh, 110 ohms, pi-wound. The inductance, resistance and type of construction are not particularly critical in this circuit.

The choke was originally a 25-mh unit that was unwound to 20 mh for an earlier project. The shield or can is not needed. I potted the choke to improve its appearance. Any combination of values for L5-C32 within 20% will work, as long as the correct waveform is obtained. The little notch in the waveform comes from the grid of V7-a.

The filter choke's inductance is not too critical, but we want low resistance to minimize voltage drop. Use 2.3 henries, 150 ma, 60 ohms (Stancor C-2304 or Knight 61-G-482) or 4 henries, 90 ma, 100 ohms (Triad C-9X).

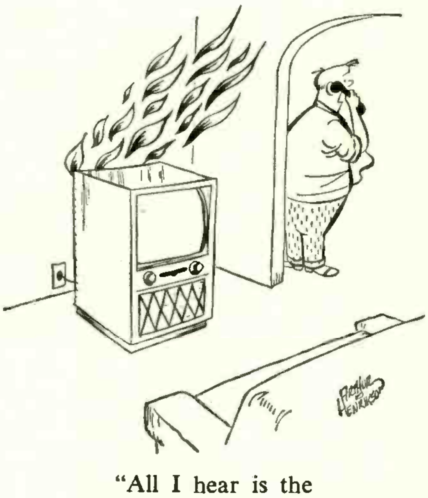
The vertical and horizontal deflectional coils overlap when placed around the tube that the vidicon slips into. The vertical coils overlap the horizontal coils and are placed last. The iron wire overwrap was obtained from an *old* TV deflection yoke. Newer vintage yokes have molded cores.

The resistance of the focus coil will vary between techniques used to wind it. The wire I used was obtained from an old TV set focus coil. Closer examination revealed that the wire size was nearer No. 30 than 32. Therefore the focus coil resistance will be approximately 100 ohms *more* than the value stated in the coil winding table. This will have little or negligible effect on the operation of the camera.

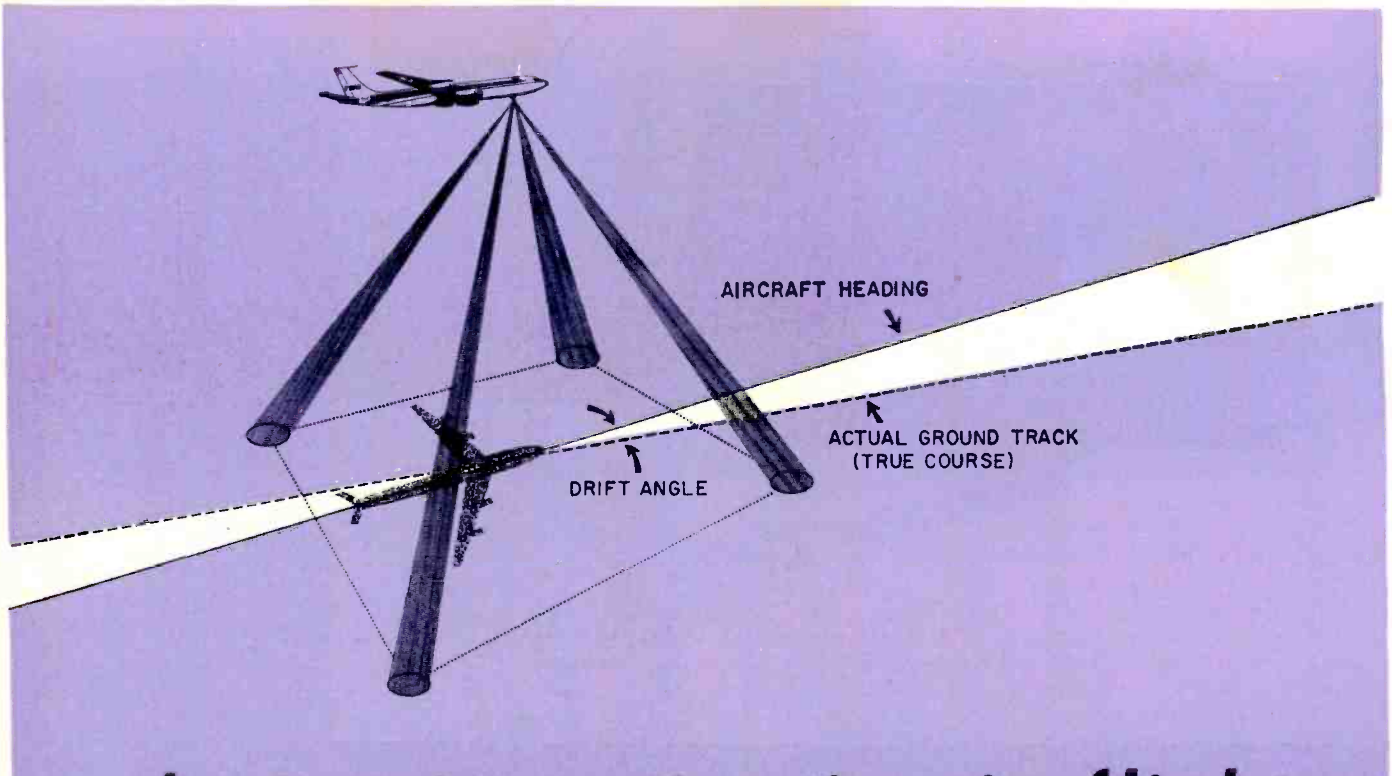
The power transformer has a 240-volt center-tapped high-voltage winding. One half is rated at 20 ma and the other at 100 ma. The Dage unit specified runs around $41.00. By allowing a little more space for the power supply, you can use two 125-volt half-wave power transformers with their primaries in parallel and secondaries in series-aiding. The 20-ma section may be a Knight 61-G-411 or Stancor PA-8421 and the 100-ma section a Triad R-73B or equivalent.

All major components for the camera, including power transformer, deflection yoke and focus assemblies, vidicon, case, lens and lens mount are available from Spera Electronics, 37-10 33rd St., Long Island City, N. Y. They have prepared a parts list with order numbers and prices. Write for your copy.

[The Dage power transformer specified in the parts list retails for $41. They have just informed us that their type 742262-01 is a less expensive substitute ($18.45). It is an open-frame model with separate 130-volt secondaries rated at 10 and 95 ma. Connect the BLUE/YELLOW lead to the RED lead for correct phasing. The heater winding is 6.3 volts at 3.6 amps.—*Editors*]



"All I hear is the funniest crackling noise."



electronic navigation in flight

Doppler radar keeps trans-Atlantic airliners on course

By VICTOR A. DAMORA

AIRBORNE ELECTRONIC NAVIGATION SYSTEMS that determine continuously the speed and position of an aircraft, automatically and without the aid of information from ground stations, make it possible for today's long-range high-speed aircraft to fly anywhere over the surface of the earth any time and under any conditions.

In one type of guidance system, Doppler navigation radar reads drift angle and ground speed. The results are fed to a velocity triangle computer to obtain the aircraft track—the actual path of the aircraft over the surface of the earth.

A representative type of Doppler navigation radar is discussed in this article. First, however, let's review a few factors that were once the exclusive problem of the navigator, and must now be familiar to the aircraft electronic technician.

We all know of the steering corrections that must be made when rowing a boat across a moving stream. The boat must be headed upstream in relation to the intended course to reach a desired destination. The faster the stream and the slower the boat, the greater the correction required. Aircraft navigation problems with respect to wind are much the same.

Fig. 1 shows a triangle of velocities that governs the true course of the aircraft through the air and over the ground. There are six factors to consider:

1. Wind direction.
2. Wind velocity.
3. True course or desired track of the aircraft.
4. Ground speed.
5. True heading.
6. True airspeed.

The *ground speed* of the aircraft, as shown in Fig. 1, is the resultant of the

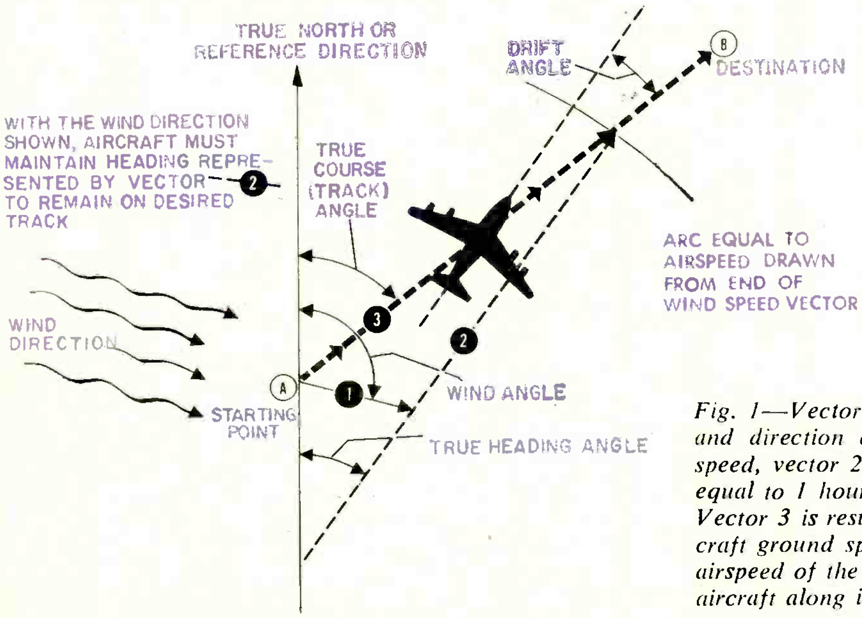


Fig. 1—Vector triangle for aircraft in flight. Wind speed and direction are represented by vector 1. Aircraft airspeed, vector 2, drawn from end of wind-speed vector, is equal to 1 hour of flight. It becomes aircraft true heading. Vector 3 is resultant of vectors 1 and 2. It is equal to aircraft ground speed which, in this case, is greater than the airspeed of the aircraft. This is because the wind helps the aircraft along its intended course.

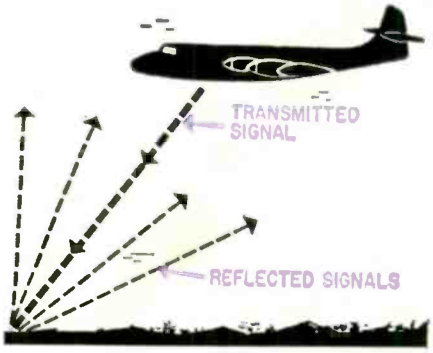


Fig. 2—Radar signal is transmitted ahead of plane. Part of signal is reflected to plane. Its frequency will be changed because of Doppler effect.

true airspeed and the *wind speed*. The track is the angle between the aircraft's actual *course* over the surface of the earth and a *reference direction* such as true North. The *true heading* of the aircraft is the angle between the longitudinal axis of the aircraft and the reference direction. The *drift angle* is the angle between the aircraft *true heading* and the *track*. If certain combinations of these factors are known, it is possible to determine the remaining ones.

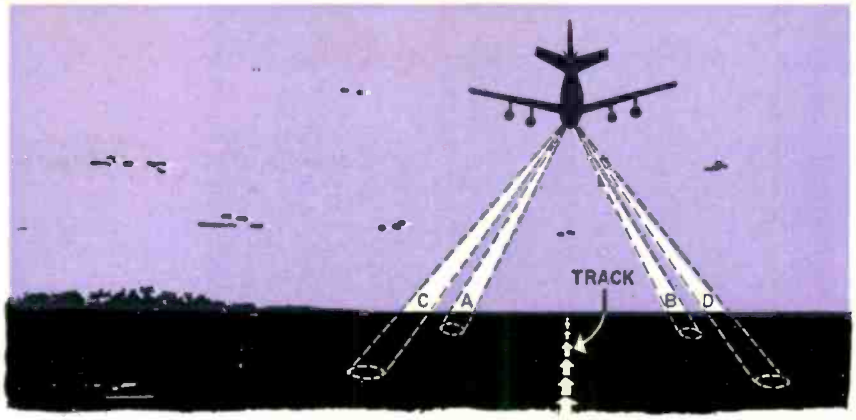
Doppler radar system

The outputs from a Doppler radar navigation system indicate the drift angle and ground speed. Therefore, only the true heading and true airspeed are required to solve the triangle of velocities. The true heading may be obtained from conventional cockpit instrumentation or from a simple inertial heading reference (directional gyro). True airspeed may also be obtained from conventional cockpit instruments such as the airspeed indicator (corrected for temperature and pressure).

Doppler radar operation is, of course, based upon the Doppler effect. This effect causes an apparent change in frequency when a transmitter moves either toward or away from the receiver or when the receiver moves either toward or away from the transmitter. If a transmitter and receiver are moving toward one another, the effect is an increase in frequency. Conversely, if the transmitter and receiver are moving away from one another, the effect is a decrease in frequency.

If a single pencil beam of microwave energy is transmitted forward from the aircraft, as shown in Fig. 2, some of the energy will be reflected back to the aircraft, but at a higher frequency. The frequency change is determined by comparing the received frequency to the transmitted frequency. The change is proportional to the speed of the aircraft. This simple system is all we need to obtain ground speed. However, to learn the aircraft drift angle, more than one beam is required. In most Doppler navigation systems in use today an antenna array having three or four beams, is employed.

Fig. 3 shows the four beams of a practical Janus type Doppler navigation radar. (Janus was a two-faced Roman god that could look in both front and rear directions.) The forward beam (A) and the diagonally opposite rear beam (D) are paired. The other forward beam (B) is similarly paired with the diagonally opposite rear beam (C). The two pairs of beams time-share the radar transmit-



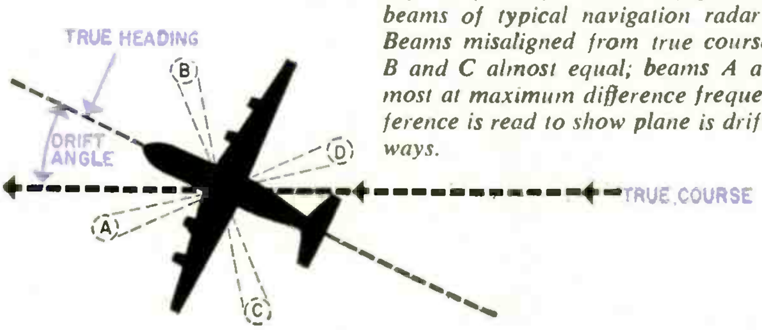
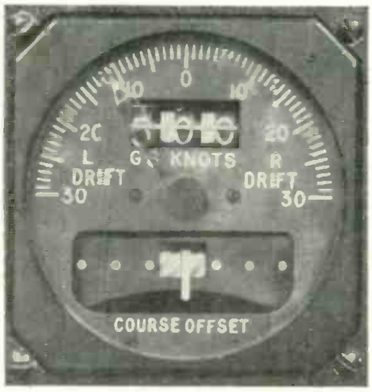


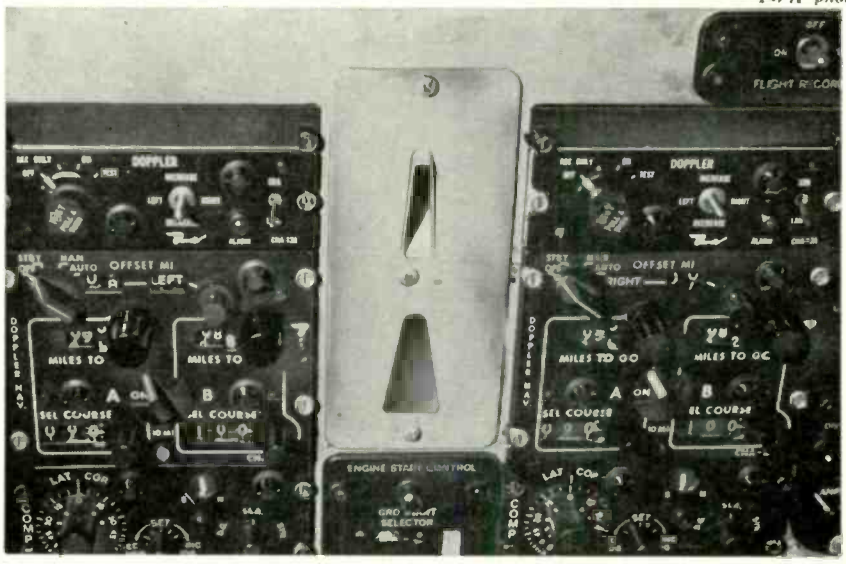
Fig. 3—(above) On-course flight shows four beams of typical navigation radar. (below) Beams misaligned from true course. Beams B and C almost equal; beams A and D almost at maximum difference frequency. Difference is read to show plane is drifting sideways.



Doppler indicator (right) Gives two readings—ground speed in knots and drift angle in degrees.

Overhead panel (below) gives pilot selected course readings, deviation left or right, and miles to go to a preselected point.

TWA photos



ter and receiver. Time is shared by switching the antenna feed electronically or mechanically.

Some of the microwave energy transmitted to the ground from a pair of beams is reflected to the radar receiver through the same beam pair. Since the aircraft is moving, the energy received in the forward beam (A, Fig. 3) will be higher in frequency than the transmitted energy and the energy received from the diagonally opposite rear beam (D, Fig. 3) will be lower. This is caused by the Doppler shift. The reflected signals received from a pair of beams are mixed to produce a difference frequency. The process is repeated, using the other pair of beams, and the two difference frequencies are compared.

The difference frequency of the two beam pairs are alike only when the beams are aligned symetrically along the aircraft track. Aircraft heading derived from cockpit instruments and the error signals developed from any detected difference between the beam pair differences is used to compute aircraft drift angles. In some systems the error signals are fed to a synchro system to keep the steerable antenna aligned with the aircraft track. The angular difference between the antenna alignment and the longitudinal axis of the aircraft is the drift angle.

The difference signal produced from a single pair of beams is also used to control a frequency generator whose signal is proportional to the ground speed. Fig. 4 is a simplified block diagram of one type Doppler navigation radar. The equipment used by TWA, the first American airline to experiment with the system, is made by Bendix. General Precision Labs also makes a system, and there may be others.

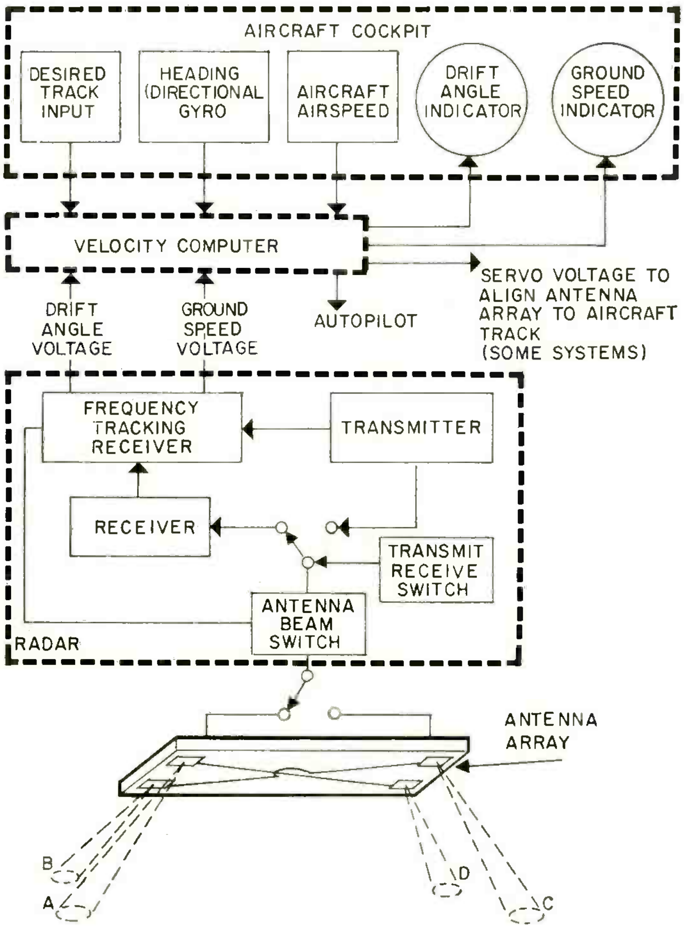


Fig. 4—Block diagram of typical navigation system.

The Doppler navigation radar, compass system, controls and cockpit displays form a simple reliable airborne navigation system which is completely independent of ground aids. Such systems are used in many of today's commercial jet aircraft. They are tied in with the autopilot, making it possible to fly long distances under autopilot control without the aid of ground navigational devices, yet arrive right at the desired destination. END

You know how most of these circuits work—or maybe you don't! But—

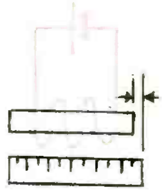
Can you name these strange electronic effects?

Score yourself:

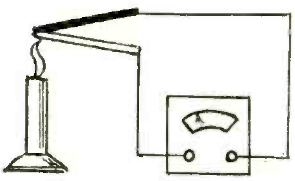
10 correct answers	Excellent
9 correct answers	Superior
8 correct answers	Good
7 correct answers	Average

The answers are on page 54.

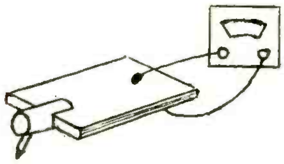
By ROBERT P. BALIN*
(Instructor in electronics, Arizona State University)



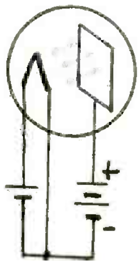
1. When a nickel rod is magnetized, it becomes shorter in length. Ultrasonic transducers for sonar employ this principle based upon the .... effect.



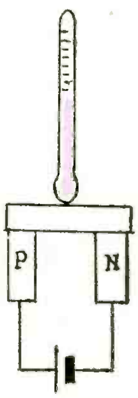
2. When the junction of an iron wire and a constantan wire is heated, a voltage appears between the free ends. Thermocouples use this principle originally called the .... effect.



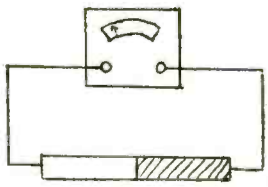
3. When a Rochelle salt crystal is twisted, voltage is generated between its faces. Phonograph cartridges use this .... effect.



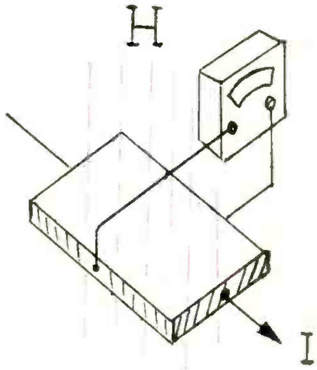
4. When the plate in this tube is made positive with respect to the filament, a current flows through the vacuum which will not flow if the voltage is reversed. This principle upon which the diode vacuum tube is based employs the .... effect.



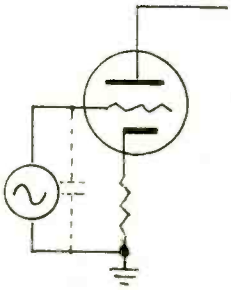
5. If a current is sent through the junction of a p-type and an n-type semiconductor such as bismuth telluride, the temperature of the junction changes. It becomes warmer or cooler depending upon current direction. This principle, now applied to the manufacture of cooling modules (such as Westinghouse WX816) for power transistors, is known as .... effect.



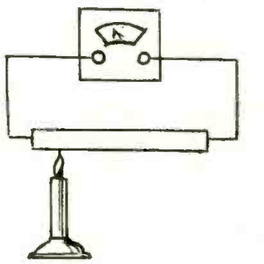
6. If two dissimilar metals are placed in contact with each other a voltage appears between the free ends. This phenomenon is known as the .... effect.



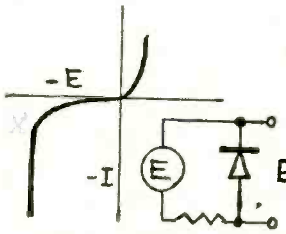
7. When a current is sent through a crystal of indium arsenide held in a magnetic field, a voltage is developed between the edges of the crystal which lie parallel to the current direction. This output voltage is proportional to the product of the field H and current I. Magnetic fields can be measured with a probe using this .... effect.



8. When input signal to this tube is increased, input capacitance also increases with the result that frequency response of this stage is reduced. An unbypassed resistor in the cathode circuit helps to minimize the changes in frequency response caused by the .... effect.



9. If a bar of metal is heated at one end, a voltage appears between the hot and cold ends. Important in the application of themocouples, it is known as the .... effect.



10. As the reverse voltage $-E$ applied to this silicon crystal diode is increased, a point X is reached at which the current increases greatly in value, with the result that it is difficult to increase the voltage E_o across the diode. Semiconductor voltage regulators employ the .... effect.

understanding the Microphone

Part I—This "simple" device is a vital part of many electronic communications systems

By ROBERT W. CARR[1]

THE MICROPHONE IS A *transducer*—IT transforms one form of energy into another. Like many of its larger relatives used in such fields as conversion or production of motive and electrical power, it has taken many forms.

These forms have been due to many factors: technological limitations and advances, economic considerations, adaptability to special uses, new applications and new requirements. Many earlier varieties are still used widely, though not always for the purposes for which they were designed.

This bewildering and sometimes not too easily understood variety may be simplified by classifying the commoner microphones according to type of generating element. All present types may be grouped loosely into two classes—the completely self-contained mike that requires no external power source (self-generating) and the type that needs an external power supply (modulating). These groups may be further subdivided.

I. Modulating Types

(require external energy source)

A. Carbon

1. *Principle*

   Carbon granules are enclosed in a chamber with one fixed and one movable electrode. The moving electrode is fastened to the diaphragm[2] so that diaphragm motion varies the pressure on the carbon particles. As the pressure varies, so does resistance between the electrodes, modulating direct current flowing through the carbon chamber. (Single- and double-button carbon mike construction is shown in Figs. 1 and 2.)

2. *Advantages*

   Availability of electrical power externally supplied, relative simplicity of the moving system, a diaphragm that is usually stiff and sturdy, and absence of the fine wires required in some types combine to form several useful features:

   a. High electrical output.
   b. Ruggedness.
   c. Insensitivity to extreme environmental conditions.
   d. Ease and inexpensiveness of manufacture.

3. *Limitations*

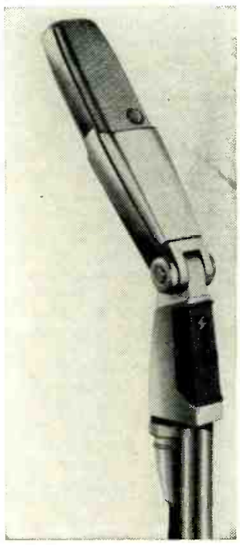
   Some of the very factors that contribute to the advantages tend to limit usefuluess:

   a. Need of an external power source.
   b. Tendency toward distortion (caused by the non-linear resistance change characteristic).
   c. Often relatively high internal noise.
   d. Rather limited high-frequency response.

4. *Applications*

   Despite its limitations the carbon microphone is still the most widely used, primarily because of the first of the following:

   a. Commercial telephone systems.
   b. Military and mobile communications.
   c. Applications where extremely hard usage is common. (For many exacting military



Example of modern bi-directional microphone.

Shure

[1] Manager of microphone development, Shure Brothers Inc., Evanston, Ill.

[2] The diaphragm of a microphone is the flexible member which collects sound energy and converts it to force for driving the rest of the moving system. It may be described as the converse of the loudspeaker cone.

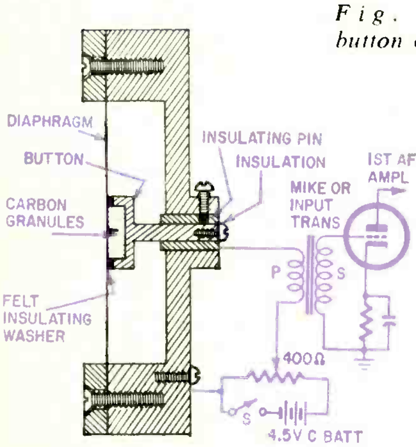


Fig. 1—Single-button carbon mike.

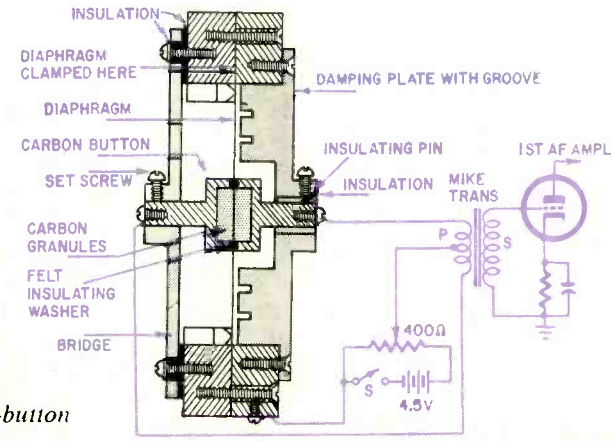


Fig. 2—Double-button carbon mike.

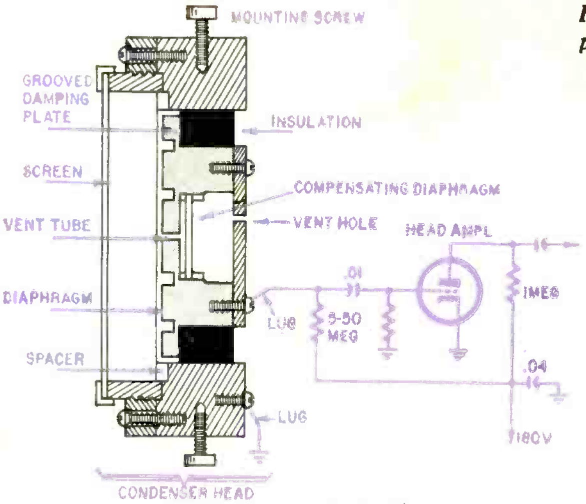


Fig. 3 — Capacitor mike.

A small general-purpose ceramic mike.
Sonotone

and communications uses, the balanced armature and some dynamic types rival the carbon microphone in stamina.)

B. Capacitor (Condenser)

1. *Principle*

This device is generally comprised of two electrodes separated by a very thin dielectric, commonly air. One electrode is the diaphragm itself, the other a rigid plate comparable to the diaphragm in area. Diaphragm motion changes the spacing between the two electrodes, varying the capacitance. If a dc voltage is impressed across this combination, the changing spacing produces a change in charge which may be picked off as an ac voltage (Fig. 3). If the device is used as a capacitance in the tuning circuit of an oscillator, capacitance variations produce an FM signal which may be reduced to an audio signal by a FM detector.

2. *Advantages*

a. Very linear, wide-range frequency response—(since the diaphragm is the only moving element, it may be independently "tuned" for optimum frequency response without the limitations imposed on other diaphragms by attached coils, contacts or driving mechanisms).

b. High output—(again made possible by supply of external power).

c. Insensitivity to mechanical noise—(due to the relatively high stiffness to weight ratio of the very thin diaphragm).

d. Choice of output impedances —(the circuitry necessary for operation determines the ultimate output impedance).

3. *Limitations*

a. Requires external power source.

b. Is relatively costly—(dictated by necessity for accessory detection equipment and extreme precision of manufacture).

c. Is sometimes adversely affected by high or changing humidity.

4. *Applications*

a. Professional recording.

b. Sound measurement standards and instrumentation.

II. Self-generating

(requires no external power source).

A. Balanced Armature (magnetic)

1. *Principle*

Operation depends on a magnetically conducting armature driven between two poles of a magnet by diaphragm motion (Fig. 4). As the armature is moved back and forth between the poles, direction and amount of magnetic flux in the armature changes. This changing field induces a varying current in a coil supported around the armature.

2. *Advantages*

The relatively sturdy and light moving system, a coil which remains stationary and a relatively high efficiency combine to form many favorable features as:

A. Can be made very rugged.

b. Has wide range of impedances without necessity for transformer.

c. Has high output.

d. Potentially has wide frequency range.

e. Is unaffected by extremes of environment.

f. Can be made small with relatively high output.

3. *Limitations*

Although potential frequency response is not particularly limited, extremely wide frequency ranges do require somewhat lighter moving systems with consequent sacrifice in ruggedness.

a. Not supplied in directional types.

b. Somewhat sensitive to induced magnetic fields—internal shielding generally prevents this limitation from being serious.

c. Usually not supplied with extremely wide frequency range (as explained above).

4. *Applications*

a. Communications equipment.

b. Home recording.

c. Hearing aids.

d. Public address.

e. Language laboratories.

f. Good general-purpose microphones.

B. Dynamic

1. *Principle*

This type (Fig. 5) is similar in operation to a common fixed-field generator, or to a loud-

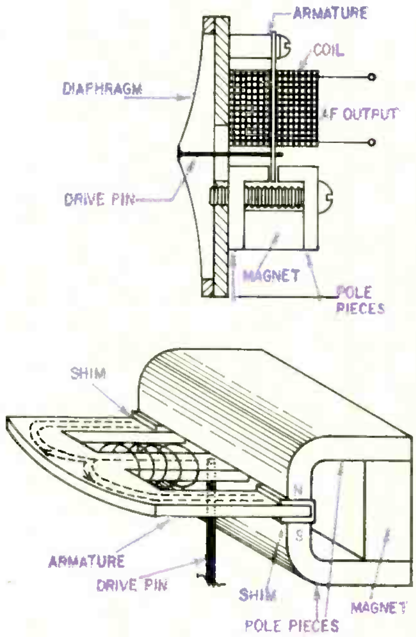
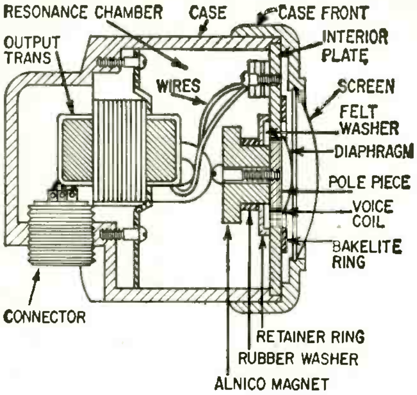


Fig. 4—Balanced-armature mike.



Turner Microphone

Fig. 5—Dynamic mike.

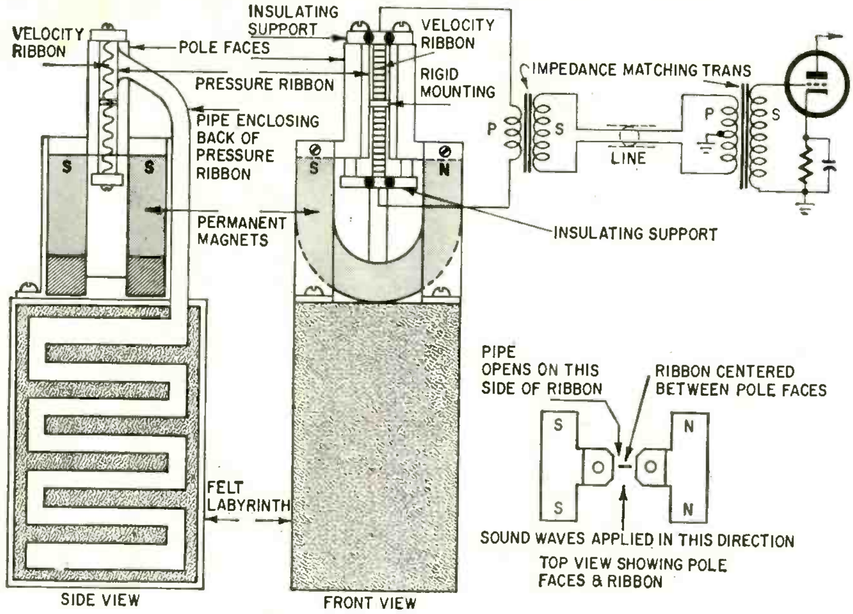


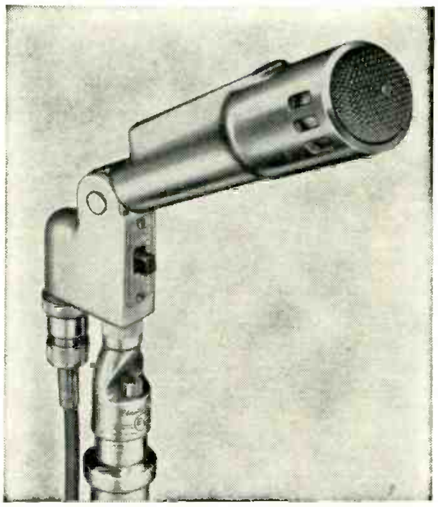
Fig. 6—Ribbon mike.

speaker (which is often used as a dynamic mike in intercoms). A coil of fine wire is attached to the diaphragm and moves in a strong magnetic field (air gap) as the diaphragm moves. When the coil moves in the air gap, a current is induced in the wire and conducted to the microphone terminals or transformer.

2. *Advantages*
   - *a.* Capable of wide-range frequency response.
   - *b.* Relatively insensitive to environmental conditions.
   - c. Potentially rugged (especially with new plastic diaphragm materials).
   - *d.* Available in low and high impedances (with transformer).
3. *Limitations*
   - *a.* Basically low impedance—requires a transformer for most practical impedances.
   - *b.* Somewhat sensitive to mechanical noise—slightly more than many other types, since moving the system tends to be relatively heavy for its stiffness.
4. *Applications*
   - *a.* Public address—probably most widely used type.
   - *b.* Home recording.
   - *c.* Communications microphones.
   - *d.* Broadcast and professional recording.
   - *e.* Dictating equipment.
   - *f.* Good general-purpose microphone.

C. Ribbon

1. *Principle*
   The only commonly used microphone without a diaphragm as such (Fig. 6). Operation is similar to the dynamic, the difference being that the diaphragm and coil are combined in a light, small, very thin metallic ribbon suspended between magnetic poles. Differences in pressure in the sound wave cause the ribbon to move, inducing a corresponding current flow in the ribbon itself.
2. *Advantages*
   The extremely light and simple moving system contributes to its desirable features:
   - *a.* Potentially flat, smooth and wide-range frequency response.
   - *b.* Relatively insensitivity to mechanical noise.
   - *c.* Relatively immunity to damage from mechanical shock.
   - *d.* Natural adaptability to bidirectional usage—the only type in which the construction is inherently symmetrical front and back.
   - *e.* Suitability for unidirectional operation.
   - *f.* Available in low and high impedances.
3. *Limitations*
   - *a.* Generally susceptible to wind noise—due in part to the extreme compliance of the ribbon itself. This tendency is largely eliminated in several modern versions.
   - *b.* Inherently very low impedance—built-in transformers make a variety of impedances possible.
   - *c.* Somewhat susceptible to damage by wind or breath blast. Some modern versions, however, are designed to sustain no damage from a 60-mile-an-hour wind.
   - *d.* Not generally available in lower-cost versions.
4. *Applications*
   Despite its now more or less historic limitations, the ribbon microphone is one of the most



Electro-Voice

This is a cardioid mike of the dynamic type.

Knight

Typical high-impedance dynamic unit.

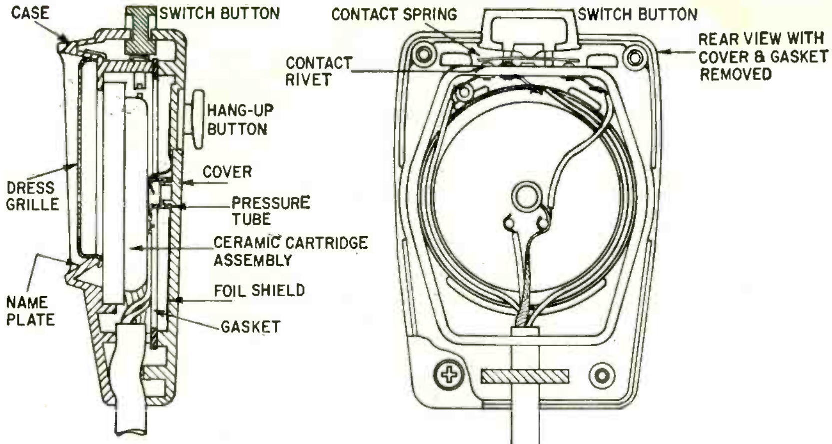
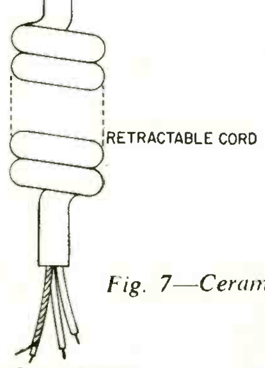



Fig. 7—Ceramic mike.

popular types for many exacting applications:

a. Professional recording
b. Film recording.
c. Broadcasting.
d. High-quality public address.
e. Semi-professional recordings.

D. Ceramic

1. *Principle*

These devices rely on a peculiar property of some materials that produces a voltage between two faces of the material as it is stressed (or bent). This *piezo-electric effect* occurs in some kinds of quartz, Rochelle salt and properly treated ceramic materials. The voltage produced across the element is proportional to the amount and direction of bending. Fig. 7 is a construction diagram of this type microphone.

2. *Advantages*

a. Potentially wide frequency response with a flat low-frequency characteristic.
b. Low cost.
c. Insensitivity to mechanical noise.
d. Unaffected by extreme environmental conditions.
e. Availability in unidirectional versions.


American Microphone
Mobile communications dynamic mike.

3. *Limitations*

a. Extremely high impedance—the element is almost a pure capacitance, which precludes use of long cables without an appreciable overall level loss due to the shunting effect of the cable.
b. Requires high input impedances to realize flat low-frequency characteristic. (This effectively precludes use of transformers for reducing impedance.)

4. *Applications*

a. Home recording.
b. Low cost public address.
c. Amateur and Citizens band radio.
d. General applications where good performance and low cost are desired, and long cables are not required.

E. Crystal

The crystal microphone is almost identical to the ceramic, differing only in its response to environmental conditions (2-d, above). While the ceramic microphone can be used under extreme conditions of temperature and humidity, the crystal microphone cannot. Its piezo-electric element of Rochelle salts is readily damaged by high humidity (or lower humidity over long periods) and temperatures of 120°F or higher.

There we have it. A complete rundown on all the common types of microphones, how they work and where you might use them. Next month we'll take a look at *microphone characteristics*—impedance, directivity and frequency response. TO BE CONTINUED

Better Nomenclature

IT SEEMS THAT ANY TYPE OF AUDIO equipment on the market these days, as long as it contains more than one loudspeaker or has a coax speaker, is labeled "Hi Fi". I hereby propose that the "Hi Fi" name be expanded, as listed below, and all equipment be categorically listed as such.

Category		*Minimum Response*	*Example or Definition*
Hi Fi	±½	db 20 - 20,000	Top-grade components
Hi Fo	±3	db 20 - 20,000	Brand X (the better kinds)
Hi Fum	±4	db 80 - 15,000	Good public address
Hi Hum	+4	db 55 - 65	Cathode-heater short
Ho Hum	±4	db 150 - 10,000	Public address, portable stereo
Lo Hum	+1	db 55 - 65	Pickup
Lo Fum	±3	db 40 - 10,000	AM radio
Lo Fi	±3	db 300 - 3,000	Telephone
Lo Fo	±2	db 400 - 5,000	Military radio
No Fo	±1/10	db 55 - 65	Full-wave rectifiers
No Go		0	Dead amplifier, open circuit

—*Fred M. Kehrle*

[Mr. Kehrle's scholarly contribution will probably be noted in the world of audio. He has, however, omitted one definition. British Overseas Airways Corp. has just announced that trans-Atlantic passengers on its 707's will receive programs from two separate tape recordings,

transmitted from within the liner to small individual receiving sets, so passengers who so desire can be entertained without disturbing seat-mates who do not care for music. This BOAC calls, of course, "Hi-Fli".—*Editor*]

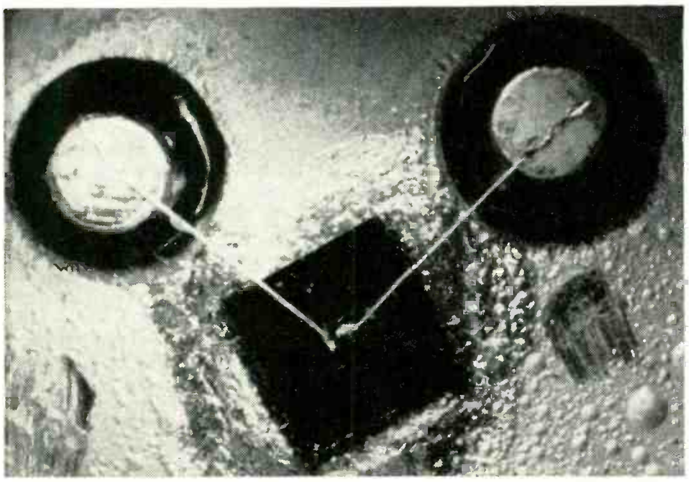
COVER STORY

optical transistors speed up computers

By ERIC LESLIE

New unit is sensitive to electrical or light input; may be used for communications inside computers.

Transistors compared in size with the handles of a pair of scissors.



(Tony Karp)

Silicon wafer enlarged about 32 diameters, showing active portion beneath collector and emitter leads.

THE OPTICAL TRANSISTOR SHOWN ON OUR COVER IS EXPECTED to solve many problems of efficient and rapid light-to-electrical-energy conversion, and lead to a solution of the problem of high-speed communications inside computers. It combines light sensitivity an order of magnitude greater than that of available phototransistors with the speed of ultra-fast switching transistors. Built into a standard TO-18 transistor envelope, the new transistor responds to both light and electrical signals with an overall propagation time of less than 0.1 microsecond. The active region of the device—.025 mm^2 is placed within a few microns of the semiconductor surface, insuring high sensitivity. The contacts are made as small as possible, to provide a clear path for the light.

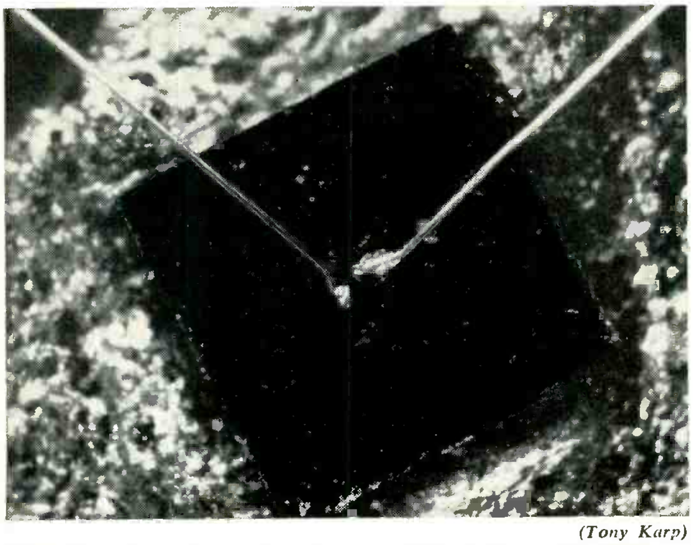
"No ordinary lenses were efficient enough in conveying light to the semiconductor element," states Dr. Thornton, director of the Semiconductor Research & Development Laboratories, Lansdale Div., Philco Corp., under whose guidance the new transistor was developed. "We therefore designed a spherical lens and selected the glass on the basis of refractive index and thermal coefficient of expansion, with a focal length precisely tailored to the TO-18 package."

Computer applications

One of the most serious limiters of computer speed is the problem of communication inside the machine itself. As the frequency increases, radiative losses and unwanted cross-couplings due to the wiring increase, and the length of time taken to transmit signals from point to point becomes significant. Thus, while it is relatively easy to build a high-speed memory, it is far from easy to put information in or to take it out of it without loss of speed. With light-path "wiring", there is virtually no interaction between channels, and communications paths can be packed within a square millimeter. The speed is necessarily that of light, with extremely small transmission losses. The highly directional nature of the light beam and the fact that two can even cross each other without interference makes "optical wiring" even more attractive.

As a transducer

The great speed and sensitivity of the optical transistor can be used to good effect where older transducers have been used, as in card readers, punched-tape readers, rotational counters, light choppers, position indicators and applications in the guided missile field.



(Tony Karp)

Greatly enlarged top view shows a little more of transistor.

Another possible application of the optical transistor is that of light amplification. Light can be changed to an electrical signal by the transducer, amplified through a conventional amplifier, and converted to light at the output. Where multistage amplification is required, the light could again be amplified through another optical transistor and conventional amplifier. Since coupling is through a light beam, there would be no problem of feedback, voltages between chassis, floating grounds, etc.

The highly directional qualities of the transistor can also make it extremely useful in position-sensing devices, Philco scientists believe. Four isolated optical transistor elements can be arranged under a single lens. A very slight displacement of the light beam would lead to a different illumination of the separate sensing elements. The resulting output could be used to actuate a servo mechanism, which would either bring the spot of light back to the center position, or would indicate the amount of displacement. END

Teaching Machines Win

Telephone technicians who learned basic electricity from teaching machines or programmed books did significantly better than a similar group taught the same material by conventional classroom methods, according to a recent report from Bell Laboratories.

Sixty-four New Jersey Bell Telephone Co. trainees were divided into two groups, each with the same average IQ, time spent with the company and background in math and electricity. One group was taught by an instructor for a total of 44 hours; the other taught itself from programmed books and machines, taking from 30 to 60 hours to complete the course. Both groups averaged the same total study time.

Final exams showed a markedly better score for the self-taught group than for the lecture group. Six months later, when exams were repeated, some data had been forgotten by all students. The self-taught group, however, still surpassed even the other group's original score.

In this particular course, non-electronic "programmed books" played an important part. However, the large part electronic machines play in machine teaching has caused the attention of electronic workers to be focused on all examples of such instruction.

SW PROPAGATION FORECAST

July 15–Aug. 15 — **By STANLEY LEINWOLL**

The combination of normally lower summer daytime MUF's (*M*aximum *U*sable *F*requencies) and continued decrease in solar activity will result in the lowest usable daytime frequencies since the mid-1950's, the 14- to 16-mc range being optimum for most areas from shortly after sunrise to around sunset.

During the evening and night, 8 to 10 mc should be best, except for communications into the southern hemisphere, where frequencies several megacycles higher will be optimum.

The tables show optimum frequency in mc for propagation of shortwave signals between locations shown during indicated time periods.

Select the table most suitable for your location, read down the left side to the region in which you are interested, follow the line to the right until you are under the appropriate time. (Time is given in 2-hour intervals from midnight to 10 pm, in local standard time.) This figure is the optimum working frequency, in mc. The best band for the service in which you are interested is the one nearest the optimum working frequency.

For example, a Chicago resident would use the Central USA tables. At noon, CST, signals to and from Western Europe would be optimum in the 13-mc band. Therefore, a radio amateur would be most likely to communicate in the 20-meter band, while someone operating a communications circuit would schedule a frequency in the 12- or 13-mc band. The listener would try the 15-mc broadcast band first, then the 11-mc band.

These tables are designed primarily as a guide; day to day variations in receiving conditions can be considerable. At certain hours, propagation over some paths given may be extremely difficult, or impossible. This will depend on the type of service, antenna characteristics, transmitter power, etc. The curves from which data in the tables are derived are based on an effective radiated power of 10 kw. These curves are representative for the paths given. Thus, the data over the Eastern USA/Western Europe path was taken from a propagation curve over the Washington, D.C.-Bern, Switzerland, circuit. On circuits further north, such as Bangor, Me., to Brussels, Belgium, frequencies will be somewhat lower than those shown, while a Miami, Fla., to Rome, Italy, path will use frequencies 1 or 2 mc higher than those in the tables.

EASTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	8	6	6	10	10	11	14	15	16	16	14	10
East Europe	8	6	8	10	10	11	13	14	15	11	10	8
Central America	13	10	11	15	16	17	18	19	19	18	16	13
South America	14	11	10	12	14	15	15	15	15	15	15	15
Near East	8	6	8	10	10	11	13	14	15	15	11	10
North Africa	8	6	8	10	10	11	13	14	16	16	14	10
South & Central Africa	6	8	8	13	14	15	15	15	11	8	6	6
Far East	10	8	8	9	10	10	11	11	13	14	14	10
Australia & New Zealand	10	10	10	8	8	8	6	13	15	16	16	16

CENTRAL US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	8	6	8	10	10	11	13	13	14	10	10	8
East Europe	8	8	8	10	10	11	14	14	11	11	10	10
Central America	13	11	10	15	17	18	18	18	18	18	15	13
South America	10	8	8	13	15	15	15	15	15	15	15	13
Near East	8	8	10	10	10	11	14	14	14	11	10	10
North Africa	8	6	6	9	10	14	14	14	15	15	11	8
South & Central Africa	8	8	10	14	14	14	15	15	16	16	11	10
Far East	10	8	6	6	10	10	11	13	14	14	15	16
Australia & New Zealand	11	10	8	7	6	6	10	20	20	20	20	16

WESTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	8	8	8	10	10	11	12	13	14	11	10	10
East Europe	8	8	8	10	10	11	13	11	10	10	10	10
Central America	10	9	9	12	14	14	14	14	14	15	12	11
South America	10	8	8	12	14	15	15	15	15	15	15	13
North Africa	8	6	8	10	10	11	13	14	14	11	10	10
South & Central Africa	8	6	8	12	13	14	14	11	8	6	6	8
Far East	10	10	8	8	10	13	13	14	14	14	15	16
South Asia	8	8	8	8	10	13	14	14	14	14	15	15
Australia & New Zealand	10	14	10	8	6	7	15	17	19	19	19	14

sweep generator report

Here are the facts and figures on sweep generators for TV alignment. No lab-type units not used by the average technician or experimenter are listed. Also included is one unit for FM tuner alignment. We've picked out the most important specs and lined them up in a chart for easy comparison. To select the unit you think best for you, go over the chart and pick out the unit that meets your requirements best.

	SWEEP GENERATOR											MARKER GENERATOR						
MANUFACTURER	Model	Type Sweep	Sweep Freq. Range	No. of Bands	Sweep Width (mc)	Output Voltage	Accuracy	Time Base	Distortion and Amplitude Variation During Sweep	Frequency Calibration Method	Retrace Blanking	Can Blanking Be Switched Out	Built-in Marker Gen.	Frequency Range	No. of Bands	Can It Be Switched Out?	Marker Adder Type
ELECTRONIC INSTRUMENT CO. Eico 3300 Northern Blvd. Long Island City 1, N. Y.	368 [2]	Increductor	3–216 mc	5	0–30	0.1–0.4	—	60 ∾	±0.5 db	—	Yes	No	Yes	2–225 mc	4	Yes	No
HEATH CO. Hilltop Rd. Benton Harbor, Mich.	TS-4A	Increductor	3.6–220 mc	4	0–40	0.1	—	60 ∾	±1 db	Crystal	Yes	No	Yes	19–180 mc	2	Yes	No
	FMO-1 [1]	Electronic	10.7 mc	1	200 kc–1 mc +	.05	1%	60 ∾	±1 db per mc	Crystal	Yes	No	Yes	1.07 & 100 kc	2	Yes	No
HICKOK ELECTRICAL INST. CO. 10514 DuPont Ave. Cleveland 8, Ohio	615	Electronic	0–220 mc	3	0–15	0.1	5%	60 ∾	0.1 db per mc	Crystal	Yes	Yes	Yes	2.5–220 mc	4	Yes	No
KNIGHT ELECTRONICS CORP. 2200 W. Maywood Ave. Maywood, Ill.	TV-FM [2]	Electro Mech Reactance	300 kc–250 mc	4	0–13	0.15	—	—	less than 1 db	TV Rcvr	Yes	No	Yes	Crystal		No	Yes
PACO ELECTRONICS CO. INC. 70-31 84th St. Glendale 27, N. Y.	G-32 [2]	Increductor	3–213 mc	5	0–30	0.25	—	60 ∾	Negligible	Crystal	Yes	No	Yes	Crystal		Yes	Yes
PRECISION APPARATUS CO. INC. 70-31 84th St. Glendale 27, N. Y.	E-410 [2]	Increductor	3–213 mc	5	0–30	0.25	—	60 ∾	Negligible	Crystal	Yes	No	Yes	Crystal		Yes	Yes
RCA Electron Tube Div. 415 S. Fifth St. Harrison, N. J.	WR–69A [5]	Electro Mech	50 kc–50 mc & Chan 2–13 and FM [4]	15	50 kc–20 mc vidio i.f. and FM 0–12 mc TV channels	0.1	—	—	0.1 db per mc	—	Yes	Yes	No	NA	NA	NA	NA
SIMPSON ELECTRIC CO. 5200 W. Kinzie St. Chicago 44, Ill.	479	Electro Mech	2–260 mc	2	0–15	1	0.1%	60 ∾	±0.1 db per mc	Crystal	Yes	Yes	Yes	3.3–250 mc	3	Yes	Yes

[1] Delivers 90–, 100– and 107–mc signals for oscillator tuning. 400–cycle audio output
[2] Output is agc-controlled.
[3] Supplies two bias voltages, each variable from 0 to –15 v.
[4] TV channel and 2 FM frequencies are switch-selected.
NA—Not applicable.

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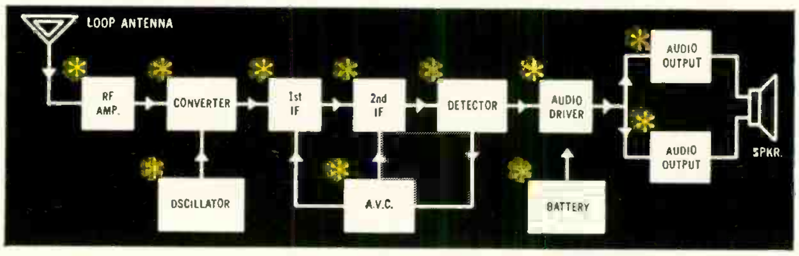

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The ANALYST gives you a complete signal-generating source for point-to-point signal injection. Easily enables you to trouble-shoot any transistor radio—check all circuits stage-by-stage—isolate and pinpoint the exact trouble in minutes.

Supplies modulated signals, with adjustable control, to check r.f., i.f., converter, and detector. Supplies audio signal to check audio driver and audio output. Provides unmodulated signal to test local oscillator. Provides separate audio low-impedance output for signal injection into loudspeaker voice coils to check speaker performance.

BUILT-IN METERED POWER SUPPLY FOR EASY SERVICING

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SIMPLIFIES IN-CIRCUIT TRANSISTOR TEST WITH NEW DYNA-TRACE SINGLE-POINT PROBE

Unique single-point probe needs only the one contact to transistor under test. No longer are three wires required to connect to emitter, base, and collector. Gives fast, positive meter indication. Saves time. Makes trouble-shooting simple and easy.

BUILT-IN VTVM

Includes high-input-impedance vacuum-tube voltmeter, which is so necessary for transistor radio servicing.

TESTS ALL TRANSISTORS OUT-OF-CIRCUIT

Meter has "Good-Bad" scale for *both* leakage and beta. Also has direct-reading Beta scale, calibrated 0-150. Assures quick, accurate test. Also automatically determines whether transistor is NPN or PNP. Meter is protected against accidental overload and burn-out.

Model 960. Net, **$99.95**

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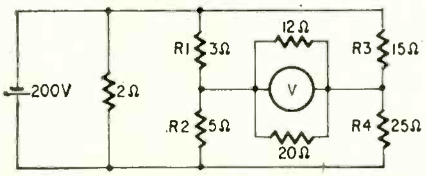
What's Your EQ?

July Solutions

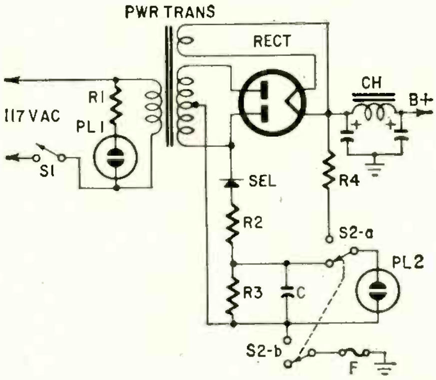
Resistance Network



The voltmeter reads zero—the circuit is actually a balanced bridge, as can be seen in the drawing. The terminals of the voltmeter are at equal voltage points, and the 12-and 20-ohm resistors are simply shunted across the meter.

Delayed Switching

When S1 is switched on, PL1 lights. S2 is shown in standby position. R2, R3 and C (a high-quality paper capacitor) are chosen so that the time taken to charge C to the firing voltage of PL2 is that necessary to warm the amplifier's filments. After that, PL2



will keep on flashing, indicating standby ready. When S2 is switched on, PL2 is placed across the B-plus supply and will stay lit continuously, indicating "amplifier on." (If expedient, the auxiliary rectifier network can be used as negative bias source.)

A Series Circuit

Since the vtvm does not load the circuit, the rating of 66 volts indicates that R1 is four times larger than R2. The 10-ohm resistance of the ammeter loads the circuit so a series parallel circuit is formed.

Then the 3 amperes through the 10-ohm meter indicates a drop of 30 volts across the meter and the parallel resistor R2. The current through R2 could be written as $\frac{30}{R2}$. The 300-volt drop across R1 can be written $\frac{300}{R1}$ or $\frac{300}{4R2}$, since R1 equals 4R2. The current through R1 is also equal to the sum of the current through R2 and the meter, so we have the equation: $\frac{300}{4R2} = 30R2 + 3$. Putting the right side over a common denominator, we have:

$$\frac{300}{4R2} = \frac{30 + 3R2}{R2}$$

Reducing the left side gives us:

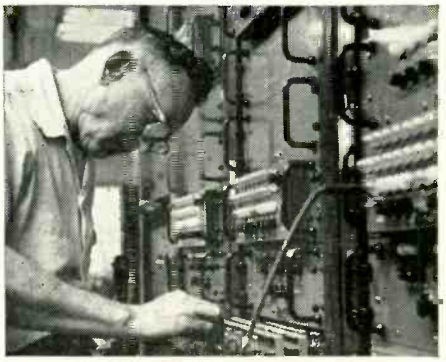
$$\frac{75}{R2} = \frac{30 + 3R2}{R2}$$

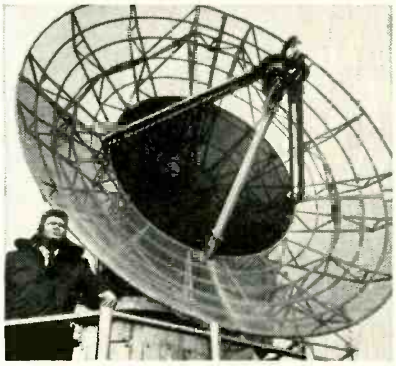
Multiplying both sides by R2, we have $75 = 30 + 3R2$, or $3R2 = 45$. R2 = 15 ohms, and R1 = 60 ohms.

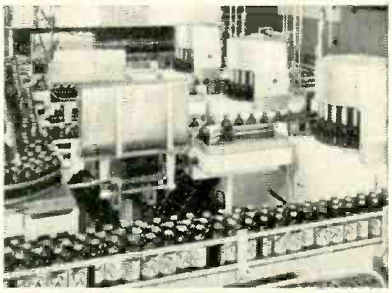
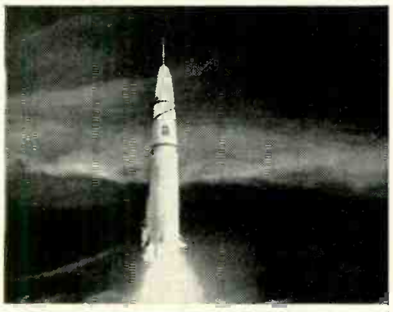
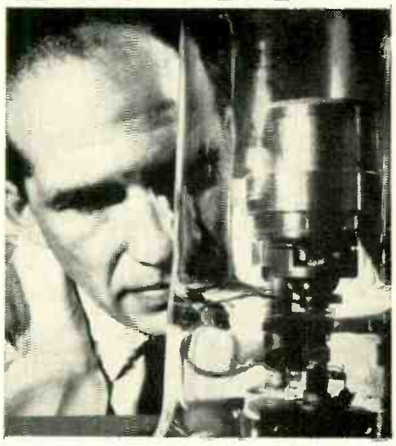
August Solutions

Strange Electronic Effects

1. Magnetostrictive effect
2. Seebeck effect
3. Piezoelectric effect
4. Edison effect
5. Peltier effect
6. Volta effect or contact potential
7. Hall effect
8. Miller effect
9. Thomson effect
10. Zener effect



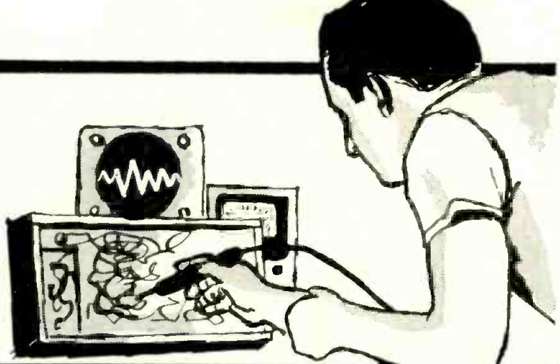



Your career in Electronics

SERVICE CLINIC

By JACK DARR
SERVICE EDITOR



This column is for your service questions. We answer them free of charge and your name and address will be kept confidential if you wish. The main purpose is to help those working in electronics with their problems.
We've changed our target a little and are no longer restricted to TV. Radio, audio and industrial electronics problems are also grist for the mill. All letters get a prompt individual answer and the more interesting ones will be printed here. So if you have a service problem, send it here. We'll do our very best to help you solve it.

VERTICAL BARS IN A TV PICTURE CAN originate in three different places. Key clue: the placement of the bars and their appearance. If the bar is in the left half of the screen, it's caused by ringing in the yoke, or by radiation of a spike from the yoke leads into the tuner input. Why? Because the left half of the screen is swept by the first half of the sweep sawtooth (Fig. 1). So, if we get ringing in the yoke, it's going to affect

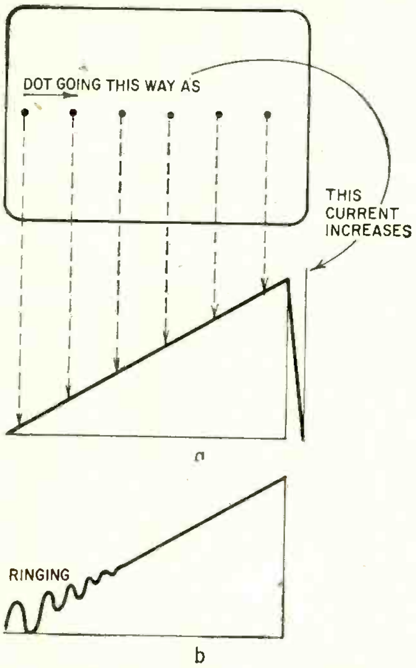


Fig 1—Electron beam scans from left to right across screen as sawtooth amplitude increases (a). Fluctuations in beginning of sawtooth (b), therefore, always cause distortion in left-hand side of screen.

the beginning of the sweep—the left side of the screen.

This happens because the left (beginning) half of the sweep stroke is actually furnished by the flyback pulse and the damper circuit, which includes the yoke. You all remember the familiar waveform of Fig. 2. It shows which part of the sweep is furnished by each stage. The horizontal output tube is cut off by the input signal waveform until

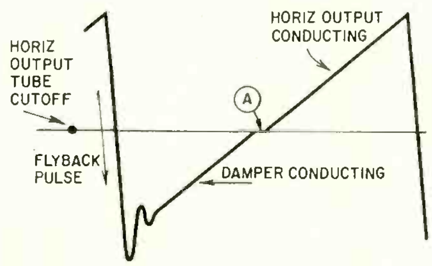


Fig. 2—Half of sweep sawtooth comes from the dampers, the other half from the horizontal output tube.

the voltage reaches point A. So kinks in the scanning lines caused by ringing yoke or damper circuits will show up on the left half of the screen. Any disturbance caused by something in the horizontal output tube *or* flyback transformer, that distorts the sawtooth, will appear on the right half of the pix tube.

For instance, false ringing caused by a spike radiating from a flyback with the shielding cage left off would fall on the right side. Radiation of a spike from the leads going to the yoke would fall on the left half.

How to tell them apart? If the scanning lines are bent, the trouble is yoke ringing. If the scanning lines are thinner at the point the bars show up, the CRT is partially cut off at that point, because a spike is getting into the video signal (Fig. 3). To quick-check, pull the rf amplifier tube. Yoke ringing stays in a blank raster, rf pickup goes away.

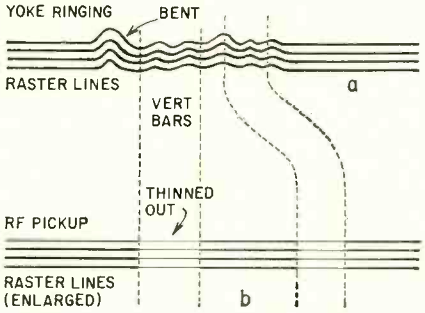


Fig. 3—Yoke ringing (a) puts a bend or kink in the rasterlines. Rf pickup (b) shows up as thinned-out raster lines.

Cure: Shield yoke leads by wrapping metal foil around them. Ground each end by wrapping a few turns of bare wire around it and fastening the loose end under a nearby screw. If the shielding cage is missing from the fly-

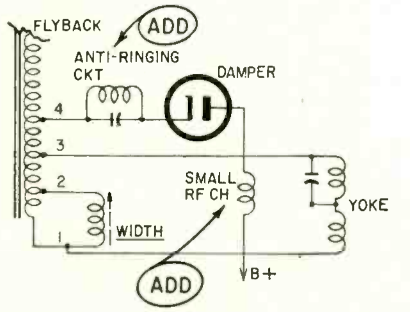


Fig. 4—In those last-resort circuits where usual aids don't eliminate ringing, add an anti-ringing circuit to damper stage.

back, replace it, even if you are forced to make one up out of copper screen wire, or some similar material.

Yoke ringing can be cured by replacing defective capacitors or resistors in the anti-ringing network in the yoke. If the CRT has been recently replaced, check these before replacing the yoke. In some older sets, the capacitors aged and went bad, due to moisture absorption. Severe cases may require an anti-ringing circuit installed in the yoke circuit (Fig. 4). Even very small rf chokes can be used in this application if properly insulated and spaced from the chassis. Don't install such extras until you have checked out *all* the original parts. Remember, it did work once, and you should be able to make it work again!

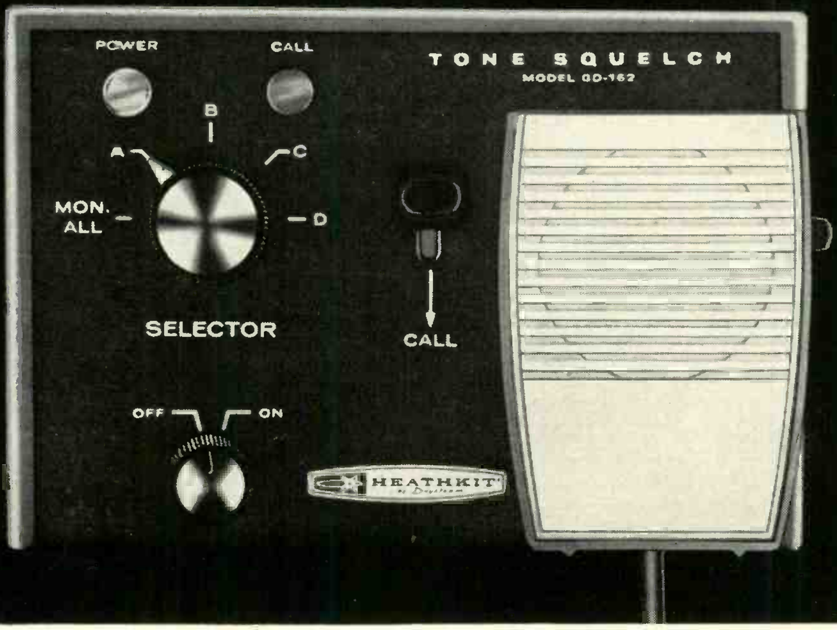
Sweep gen terminations

We have a Jackson TVG-2 sweep generator with a characteristic output impedance of 97 ohms on all attenuator settings, except the 10× position, which has 300 ohms. Alignment instructions for most TV sets specify a 50-ohm output. Can you tell me how to reduce this to 50 ohms?—H. Z., Bremerton, Wash.

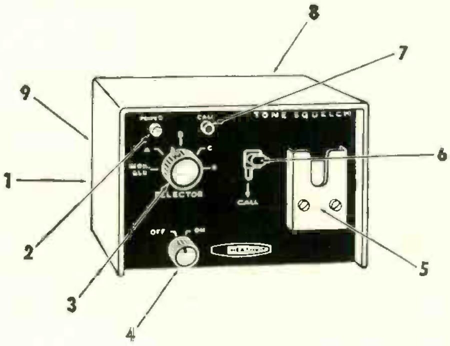
You won't have too much trouble using the Jackson for general alignment work as it is. Most often the sweep signal is very loosely coupled to the input of the stage. For example, in video if alignment, the signal is fed into the input by clipping the sweep generator to a floating tube shield on the mixer tube. In other stages, clipping the output lead to the insulation of a wire provides ample signal.

The reason for terminating a sweep generator properly (or any other signal generator, for that matter) is to avoid the possibility of reflections due to

First new concept in citizen's band equipment in two years! . . . Heathkit 4-Position Selective-Call kit



an exclusive with Heath, this inexpensive unit converts your CB station from "party line" confusion to "private line" calling convenience



FEATURES

(1) squelch time-delay control, **(2)** power indicator, **(3)** tone selector switch (4 tones plus "monitor all" position), **(4)** tone squelch "defeat" switch for normal operation **(5)** "lift-to-operate" microphone bracket, **(6)** "call" lever **(7)** "call" indicator, **(8)** external alarm contacts to signal received call, **(9)** input and output level controls.

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Using a unique new method, Heath's Selective-Call Kit features an *exclusive* 4-position rotary selected resonant-reed relay which responds only to calls transmitted by similarly equipped units using the same tone frequency. Upon receipt of the proper tone, your unit will automatically "come to life" permitting you to hear the call letters transmitted . . . you reply by merely lifting the microphone and acknowledging. At all other times, your station is peacefully quiet, allowing you to perform your job without one ear "cocked", for this unit does your listening for you.

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an impedance mismatch. These can (and will) upset your response curve. Standing waves will form on the output cable and distort the curve.

Fig. 5 shows resistive pads for

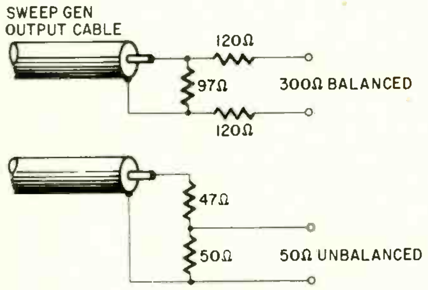

Fig. 5—Resistive pads for connecting a sweep generators output direct to the TV tuner input.

feeding your sweep generator output direct to the tuner input, or whatever circuit you want to feed. However, for best results and a minimum of curve distortion, I'd still recommend the loose-coupling method.

Brightness troubles

I've got brightness troubles in an RCA 21CS7815 color TV set. With both brightness and contrast controls turned down, I can't extinguish the raster. The contrast control also acts like a brightness control. The picture tube checks OK.—R. P., Clio, S. C.

Both the brightness and contrast controls in this set, and in many other color TV chassis, are in an entirely different location from the standard control positions used on monochrome TV sets (Fig. 6).

Because of the circuit connections used on the three-gun color tube, the video output stage is dc-coupled to the cathodes of the 21AXP22-A. So they regulate the beam current of the tube by controlling the bias of the video output tube (Fig. 7). You'll find some variation here but, in the later models, it will be brightness control in the grid and contrast control in the cathode circuit.

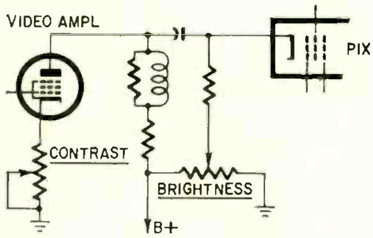

Fig. 6—Brightness and contrast controls in a conventional black-and-white set.

So look for a gassy video output tube, a leaky coupling capacitor, open grid resistor or similar troubles in the video output stage when you have this kind of defect.

If you'll trace the circuit as we have in Fig. 7, you'll see that the video output grid circuit goes back to the horizontal output tube grid, through the R-C filter shown. This is done to get a negative voltage for biasing the video output. So, if the 470,000-ohm resistor is increased or decreased in value, or the 0.22-μf filter capacitor is open or leaky, you will have troubles showing up, not in the horizontal output, but in the video output, because of improper bias. Check all voltages around the 12BY7 video output and see if they are OK, and, if not, why not.

Pix-tube conversion

I want to convert a Philco T-1403 TV to a larger tube (the set now uses a 12LP4). I have about 9,000 volts of high voltage now, with plenty of brightness. Could I use either a 16LP4 or a 16TP4 for this conversion?—P. H. J., Denver, Colo.

I see no reason why this conversion couldn't be made with either of the tubes you mention. The high-voltage supply in the set should be ample. Philco gives its nominal value at 11,000 volts. If brightness is insufficient after the conversion, a careful tuneup of the horizontal output system (new tubes, adjustments) should give you plenty of high voltage.

The deflection angle of the 16LP4 is the same as the original 12LP4–52° The 16TP4 is a 70° tube, but could probably be swept with your present yoke and flyback, even if it meant adding a bit of capacitance across the damper or some of the other tricks used to obtain that last bit of width. Basing on both tubes is identical, so you won't have to make any changes there. Both are magnetic-focus types, so the original focus coil can be used.

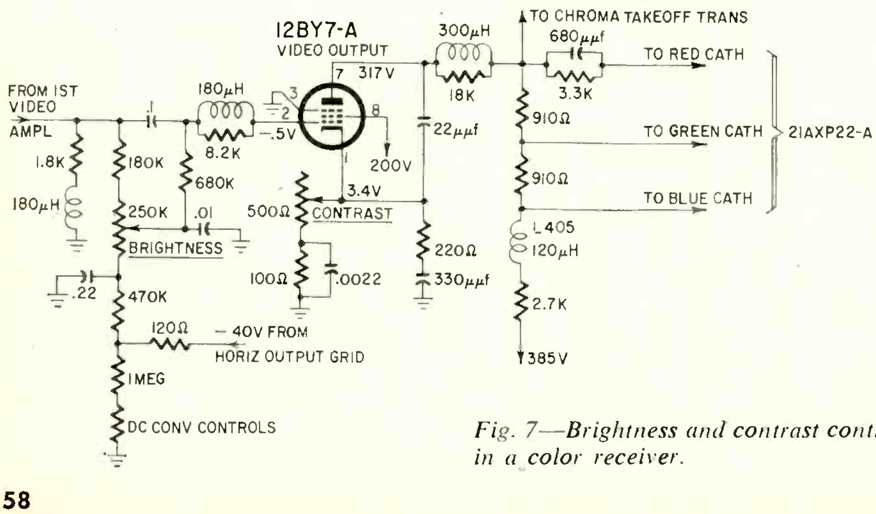

Fig. 7—Brightness and contrast controls in a color receiver.

The 16LP4 and 12LP4 both use double-field ion-trap magnets, and the 16TP4 uses a single-magnet beam bender, so be sure to get the right one after the conversion is completed!

Tuner adjustments

I'm faced with tuner trouble in a G-E 21T4. We have channels 3, 5 and 8 here. Channel 8 comes in OK, but 3 is on 2 and 5 is on 4! We've tried to adjust oscillator coils, but got nowhere.—J. J., Cleveland, Ohio.

This is an incremental inductance tuner. The frequency-determining element is a single coil (Fig. 8). In operation, the selector switch shorts out turns on this coil, beginning with the high channels (all but the last turn shorted out) and goes to the lowest channel (all of the inductance in the circuit).

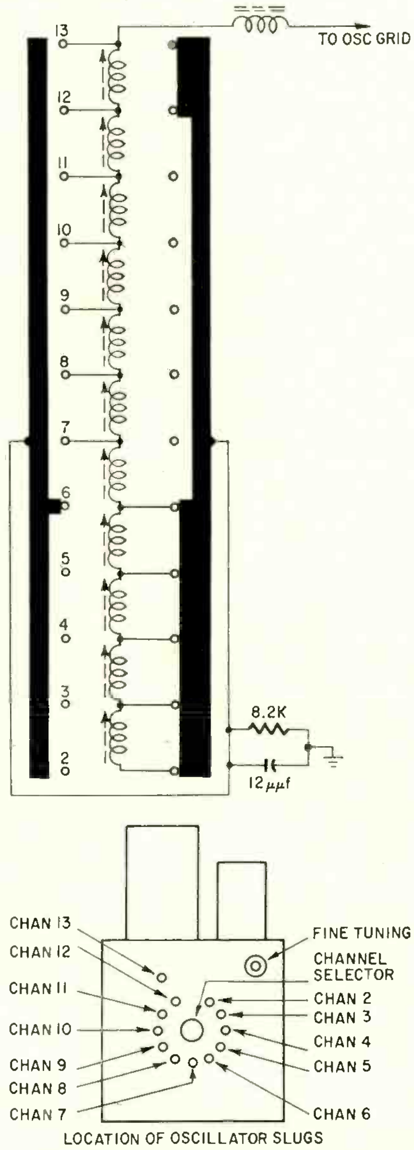

Fig. 8—Incremental tuners must be adjusted starting with the highest channel and working down to the lowest.

Like all tuners of this type, oscillator slugs must be adjusted starting with channel 13. This is necessary since each channel adjustment will affect all channels below the one being set. In

MALLORY P. R. MALLORY & CO. Inc.

Tips for Technicians

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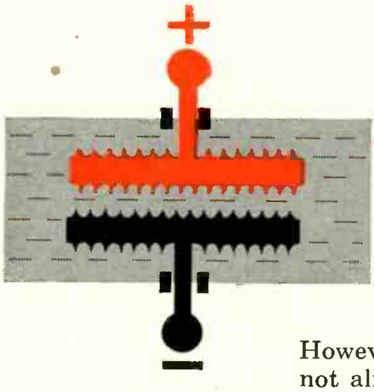
Why some filter capacitors develop hum... and some don't



Aluminum electrolytic capacitors are widely used as filters in DC Power Supplies. This is because of their large capacitance in relatively small size. All in all, they do an efficient job of reducing ripple (hum) to acceptable levels.

However, all electrolytic capacitors are not alike. This is often why some types seem to allow hum to rise to objectionable levels more quickly than do others. In order to understand why, we must investigate actual construction methods.

As you know, electrolytics are basically made by depositing a film of aluminum oxide on aluminum foil to form the positive anode. The oxide is the dielectric. A semi-liquid electrolyte surrounds the anode and is actually the negative cathode. In order to connect this semi-liquid cathode to a terminal, a second piece of aluminum foil is used. This is often *called* the cathode, but it is not. It is actually only the *cathodic connection*. (The preceding describes a "polarized" electrolytic capacitor.)

When high ripple currents are applied to polarized electrolytics, a thin oxide film forms on the so-called "cathode". It begins to assume the characteristics of a second anode. This in turn, has the same effect as placing two capacitors in series. Consequently, overall capacitance is reduced. Inevitably hum increases.

This action is especially noticeable in electrolytics which use plain foil as the "cathode". This is simply because the oxide builds up over a relatively small area.

Mallory avoids this problem by etching the "cathode" on electrolytics. As a result, oxide build-up is spread over a vastly increased area. Therefore, ripple currents are maintained at very low levels for very long time periods.

Of course etched "cathodes" cost a lot more to make. But you get them from Mallory at *no extra cost*. There's much more to the Mallory capacitor story, but we'll leave that to another TIP.

Meanwhile, see your local Franchised Mallory Distributor for capacitors, resistors, controls, switches, semiconductors, and batteries. In fact, he's the man to see for *all* of your electronic component requirements.

this particular case your highs are OK, but your lows are off. Take your alignment tool and adjust the slug in channel 6. Turn it a quarter-turn to the right. Now switch to channel 5 and see if there is any change. If the station is starting to come in go back to 6 and continue adjusting the slug by turning it to the right. If the station is drifting farther down, away from channel 5, switch back to channel 6 and turn the slug to the left a quarter-turn at a time until you have channel 5 tuned in on channel 5.

Poor pix and sound

A G-E 21T045 chassis has a very pale picture and weak sound. The brightness control won't darken the picture below what you might call normal viewing level. The voltage on the 135-volt line reads only 40.—P. R., Cincinnati, Ohio

You've got trouble somewhere around the audio output stage (Fig. 9). The brightness control in this series is fed dc from the 135-volt line. If this voltage is off, the control won't act as it should. With it this low, you won't be able to cut off the CRT and you'll have the condition you describe. Check the 680-, 750- and 800-μμf capacitors and the 60-μf electrolytic. Any leaky capacitors or shorted tubes can cause this.

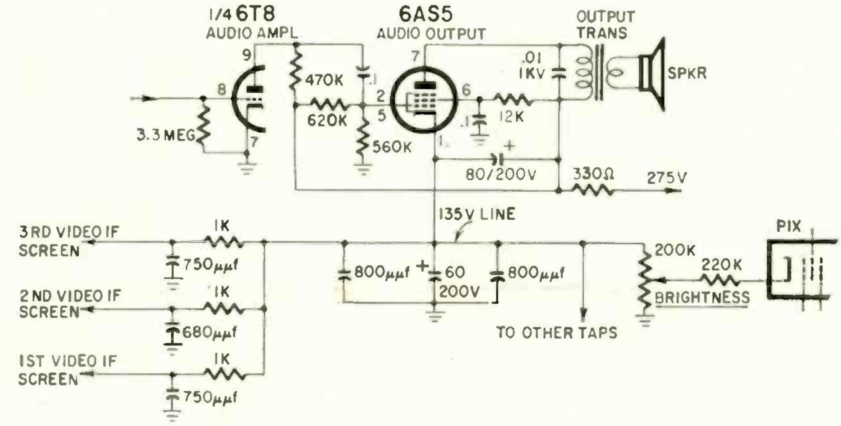


Fig. 9—Low voltage on 135-volt line can be caused by leakage in indicated capacitors or shorted tubes feeding off line.

Conversion

I am about to replace a 16GP4 picture tube with a 21EP4-B aluminized type (RCA chassis KCS-47A). I have some doubts whether existing high voltage is enough, especially for an aluminized tube.—J. M., Monessen, Pa.

I believe this is a practical conversion. The 21EP4 picture tube is the converter's friend, because of its comparatively low high-voltage requirements, only 12 kv on the regular tube and 16 kv for the aluminized type. The deflection angles are the same for both tubes, 70°.

Your KCS-47 chassis has a pretty hefty horizontal sweep circuit with that 6BG6, and if in good shape it should give you all the high voltage you need. Tune up the horizontal output stage very carefully. Be sure to get the horizontal linearity and width controls set up exactly right (they're a little critical in this chassis) and be sure you have ample drive.

If you have any trouble with the width, try the old tricks of shunting a low-value high-voltage capacitor across the damper from plate to cathode, etc.

Color-tube conversion

A Motorola color TV (chassis TS-902) has a bad 19VP22. Can I replace this color picture tube with the newer all-glass 21CYP22-A?—O. F. H., St. Louis, Mo.

From the characteristics of the two tubes I would say that this would be a very practical conversion requiring only mechanical changes in the mounting, etc. The electrical characteristics of the two tubes are almost identical, and the 21-inch tube is slightly shorter than the 19-incher!

You might have to get a rim clamp and a set of purity magnets to go with the new tube if there aren't enough purity magnets on the Motorola to allow good purity adjustments. However, you might try the original one first. After all, there is only 1-inch difference in diameter between the two tubes: 19-9/16 inches for the "19", and 20-9/16 for the "21". END

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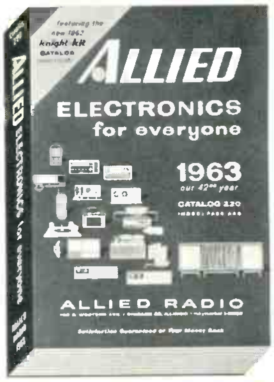

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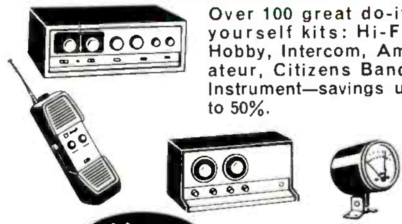

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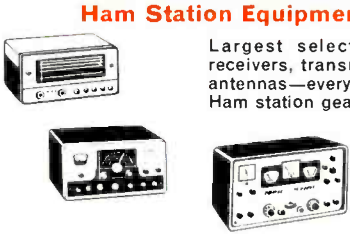

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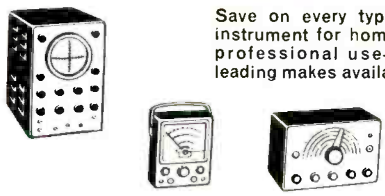

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get MORE from your LM and BC-221 frequency meters

The only thing different about modified LM is small hole in side to provide access to crystal trimmer.

By GEORGE JENNINGS III

THERE ARE TWO BASIC KINDS OF FREquency meters: the counter, (which we shall ignore because of its price tag) and the heterodyne frequency meter. Both the BC-221 and its Navy counterpart, the LM, are members of the latter group. The two instruments are much alike, both in operation and circuitry, and comments on one are usually applicable to the other. Basically, each consists of a vernier-driven vfo, a 1-mc crystal oscillator, a mixer and an audio amplifier stage.

I'll assume that most technicians are reasonably familiar with the BC-221 and will make no attempt to explain its operation any further than is necessary. For those not familiar with these gadgets, a very clear writeup on both the BC-221 and LM may be found in the series, "Surplus Radio Conversion" by R. C. Evenson and O. R. Beach, Vols. I and II (Editors and Engineers, Ltd., Summerland, Calif., 1948).

As is, these units are capable of ± .01% accuracy on the high range and ± .03% on the low. However, that ± .01% accuracy is not adequate for some measurements the technician is bound to encounter. Nor is ± .01% anywhere near the full capabilities of these instruments! With the radio communications bands becoming ever more crowded, and receivers becoming ever more selective, close transmitter tolerances must be maintained, or you spend all your time retuning the old receiver.

Both the BC-221 and LM are capable of accuracies better than ± 30 cycles over most of the 125-kc to 20-mc range. Further, in quite a number of special cases accuracy approaches to within a couple of *tenths of a cycle!*

There are three "tricks" you can use to improve these units. The first is to use them as **additive frequency meters.** The second is to linearize the calibration curve with the list of auxiliary **crystal check points.** The third and final step is to gain access to the crystal trimmer capacitor, which allows that worthy item to be set to within **0.1 cycle** with 1 mc (WWV).

Additive frequency meter

If an external rf signal (F_x) is fed to the mixer of the BC-221 and heterodyned against the harmonics of the crystal oscillator, the mixer circuit will produce all the sum and difference frequencies formed from the external signal and the crystal harmonics. For example, try 10.7 mc. This 10.7-mc signal will beat with the crystal fundamental (1 mc) to produce 11.7 and 9.7 mc. The 10.7-mc will also beat with the crystal second harmonic (2 mc) to produce 12.7 and 8.7 mc, etc.

Now, while I sit back and relax for a moment, follow that train of thought until you come to the tenth harmonic of the crystal. The resultant frequencies from 10 and 10.7 mc are 20.7 and 0.7 mc. Now hold on just one minute! Here we have a 700-kc signal in the mixer, which we can measure on the low range of the vfo. This 700 kc can be measured within ± .03% or within ± 210 cycles.

Just for the heck of it, let's see where we would have been, had we used the instrument as the manufacturer intended it: .01% of 10.7 mc is 1,070 cycles. But, we came out to better than 20% of that error. We have already improved the accuracy (at 10.7 mc, anyway) by a factor of 5, just by using the BC-221 as an additive frequency meter. If we had used a 20.7-mc external signal to start with, we would have still been able to measure it to within ± 210 cycles, but .01% turns out to be 2,070 cycles. In other words, at 20.7 mc we have improved the accuracy by almost 10 to 1.

That's fine at the high end of the range, but what happens down at the bottom? When we measure something below 1 mc, we don't profit much. There are, of course, some special cases. Take 800 kc, for example: 1 mc minus 800 kc gives 200 kc, which we can measure within a couple of tenths of a cycle, since it happens to be one of the crystal check points. But what about 700 or 653.580 kc? The above method gives an improvement of only 1.5 or 2 to 1. It seems that the additive method is best suited to frequencies above 1 mc or so. Up there we can knock off the megacycles with the crystal harmonics, and measure the kilocycles left over with the vfo. As things turn out, steps to improve the accuracy at the low end result in almost unbelievably low percentages of error when we apply the same techniques to the high end. Read on!

Auxiliary check points

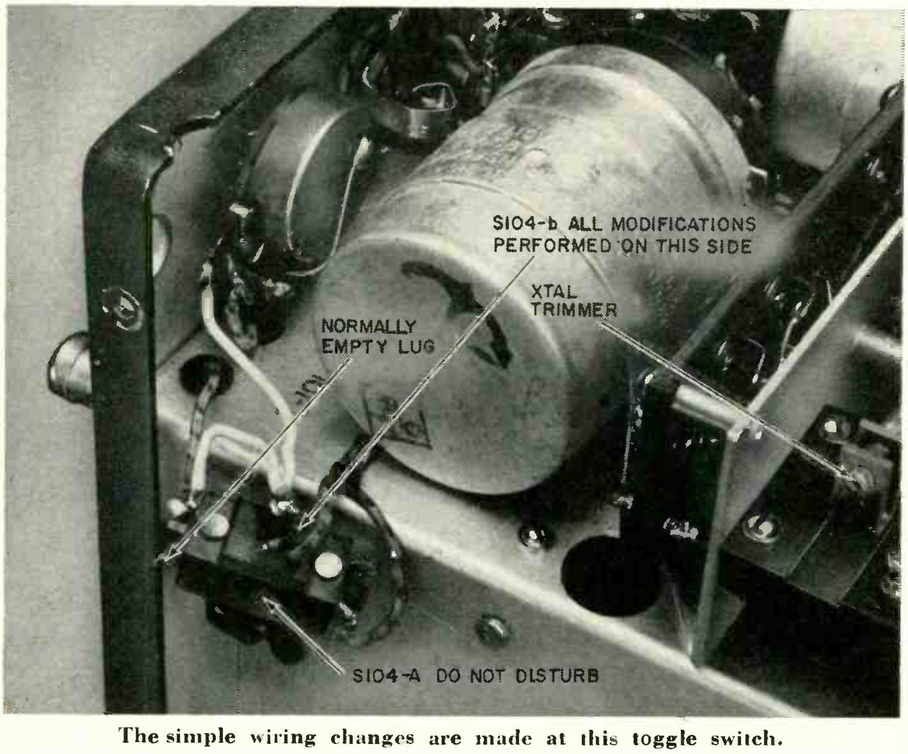
When the manufacturer built the LM and BC-221s, he also calibrated the units and supplied the user with a little book, serial-numbered to match its meter. This is the calibration manual and is accurate only when used with the particular instrument for which it was compiled. In this book are listed "crystal check points," which are merely dial settings at which the harmonics of the vfo will zero-beat with the harmonics of the crystal. The folks who built the gear established these points when they calibrated the instrument, and passed them along so the user could recalibrate his vfo whenever he wished. While the dial settings for these check points are peculiar to a particular instrument, the frequencies that they represent apply to *any* BC-221 or LM (or any other frequency meter with the same vfo range, for that matter).

The calibration book lists 10 crystal check points throughout the low range—125 to 250 kc. There must be (and there are) many more points at which the vfo harmonics will fall on a whole number of megacycles. If we can locate and identify more and more of these points, we can pinpoint the calibration more closely, and thereby improve the accuracy of the instrument.

The table is a list of all possible vfo frequencies (fundamentals only) which will zero-beat with 1-mc harmonics up through and including the 15th (15 mc). Obviously, if the eighth

Auxiliary Crystal Check Points

125.00000	139.2405	157.1428	180.55555	212.12121
126.05040	139.53488	157.30333	**181.81818**	212.7659
126.12612	140.00000	157.89473	182.9268	213.1147
126.21359	140.18691	158.5365	183.0985	**214.28571**
126.3157	140.35087	158.7301	183.33333	215.3846
126.4367	140.62500	159.09090	183.67346	215.6862
126.5822	140.8450	159.4202	184.21053	216.21621
126.76056	141.0256	159.5744	184.6153	216.66666
126.98412	141.1764	160.00000	185.18518	217.39130
127.11864	141.3043	160.4938	185.7142	218.18181
127.27272	141.41414	160.71428	186.1406	218.75000
127.45098	141.50943	160.9195	186.66666	219.51219
127.65957	**142.85714**	161.29032	187.50000	220.00000
127.9069	144.23076	161.7647	188.4057	220.3389
128.20512	144.3298	162.50000	188.6792	220.5882
128.44036	144.44444	162.79069	189.18918	**222.22222**
128.57142	144.5783	163.26530	189.6551	223.8805
128.71287	144.7368	163.63636	189.8734	224.4897
129.03225	144.9275	163.9344	190.47619	224.1379
129.31034	145.16129	164.1791	191.1764	225.00000
129.4117	145.45454	164.3835	191.48936	225.80645
129.62962	145.63106	164.5569	191.7808	226.4150
129.8701	145.83333	164.7058	192.30769	227.27272
130.00000	146.0674	164.8351	192.9824	228.0701
130.43478	146.34146	**166.66666**	194.0298	228.57142
130.84112	146.66666	168.5393	194.44444	229.16666
130.9523	147.05882	168.6746	194.8051	229.5081
131.14754	147.3684	168.8311	195.12195	**230.76923**
131.31313	147.54098	169.0140	195.65217	232.1428
131.57894	147.72727	169.2307	196.0764	232.5581
131.8681	148.14814	169.4915	196.4285	233.33333
132.07547	148.5148	170.2127	196.7213	234.0425
132.35294	148.6486	170.4545	196.96969	235.29411
132.5301	148.93617	170.73170	197.1830	236.36363
132.6530	149.2537	171.0526	197.3684	236.84210
132.74336	149.4252	171.42857	**200.00000**	237.2881
133.33333	150.00000	171.8750	203.3898	238.09523
134.0306	150.5376	172.41379	203.7037	240.00000
134.1463	150.6849	172.8395	204.0816	240.7407
134.35294	150.74339	173.07692	204.54545	241.37931
134.61538	151.1627	173.33333	205.12820	241.9354
134.8314	151.51515	173.91304	205.4794	242.42424
135 13513	151.8987	174.4186	205.88235	243.24324
135.4166	152.17391	174.6031	206.3492	244.44444
135.59332	152.54237	175.00000	206.89655	244.8979
135.8024	152.77777	175.4385	207.5471	245.2830
135.92233	152.9411	175.6756	208.33333	245.6140
136.36363	153.0612	176.47058	208.9552	245.9061
136.8421	**153.84615**	177.2151	209.30232	**250.00000**
136.9863	154.9295	177.4193	209.6774	
137.24590	155.17241	178.0821	210.52631	
137.50000	155.55555	178.57142	211.2676	
137.61467	155.8441	179.1044	211.5384	
137.93103	156.25000	179.48717		
138.2978	156.6225	180.00000		
138.46153	156.86274	180.3278		
138.61386				
138.88888				



The simple wiring changes are made at this toggle switch.

harmonic of 125 kc, and the fourth harmonic of 250 kc are both 1 mc, there must be *three* other frequencies between 125 and 250 kc whose 5th, 6th, and 7th harmonics also fall on 1 mc. Also, there must lie (between 125 and 250 kc) seven frequencies whose 9th through 15th harmonics fall on 2 mc.

The same reasoning holds for all the rest of the frequencies whose harmonics fall on a whole number of megacycles, and which lie between 125 and 250 kc. The chart lists only those up through 15 mc since the beat notes get pretty weak by the time we get looking for the beat between the 107th harmonic of 140.19691 kc with the 15th harmonic of 1 mc.

Referring to the table, note that there is at least one auxiliary check point every 1 kc (over most of the range), as contrasted with the mere 10 supplied by the manufacturer. Using these Auxiliary Check Points (hereafter ACP's), you can plot as coarse or as fine a calibration curve as you want. I use the frequency in kilocycles plotted against dial divisions.

The easiest way to plot a portion of the calibration curve is to locate two or three ACP's within the range to be covered. The next step is to interpolate the dial settings from the calibration manual (or from the ACP dial settings for better accuracy). This will allow you to spread the curve out over as wide a range as you wish, using the ACP's to pinpoint exact points on the curve.

Let's take another example, this time using the ACP's. Suppose it is required to set a Civil Air Patrol transmitter to within ± .01% of 4.4675 mc. To be suitable for this service, the standard must be at least twice as accurate as the allowable tolerance. This means, in this case, the BC-221 must be capable of at least ± .005%.

Careful!!! The **FREQUENCIES** in the following example are good for ANY BC-221. The DIAL SETTINGS apply to the author's **LM ONLY**. They are mentioned for the example only, and won't work with other meters! After a suitable warmup time (30 to 40 minutes) the actual measurement is started. You can spend that half hour going over the following: We are going to measure the desired frequency by getting the four megacycles (in 4.4675 mc) from our crystal using the fourth harmonic. The rest of the 4.4675 mc is obtained by using the harmonics of the vfo. In this case we can get 0.4675 mc in one of two ways. We can use the second harmonic of 233.75 kc or we can use the third harmonic of 155.83333 kc.

Consulting the ACP list, we find that there are more ACP's in the vicinity of 155.8333 kc — so we decide on that one. The closest ACP to 155.8333 kc is 155.8441, or only 11 cycles away from our target. We could figure that when we took the third harmonic of our ACP (155.8441 kc), we would have 0.4675333 kc or within 33.3 cycles of where we want to be. As 33.3 cycles is considerably better than ± .005% (it is actually ± .00072%) we have just accomplished our purpose. We just zero-beat the transmitter crystal with the ACP and

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• The PS120 provides features never before offered. Only two major controls make the PS120 as easy to use as a voltmeter. Even its smart good looks were designed for functional efficiency. New forward thrust design, creating its own shadow mask, and full width calibrated graph increase sharpness of wave form patterns. A permanent chromed steel carrying handle instead of untidy leather strap and a concealed compartment under panel for leads, jacks and AC line cord make the PS120 the first truly portable scope combining neatness with top efficiency.

• Electrical specifications and operational ease will surpass your fondest expectations. Imagine a wide band scope that accurately reproduces any waveform from 20 cycles to 12 megacycles. And the PS120 is as sensitive as narrow band scopes . . all the way. Vertical amplifier sensitivity is .035 volts RMS. The PS120 has no narrow band positions which cause other scopes to register erroneous waveforms unexpectably. Another Sencore first is the Automatic Range Indication on Vertical Input Control which enables the direct reading of peak-to-peak voltages. Simply adjust to one inch height and read P-to-P volts present. Standby position on power switch, another first, adds hours of life to CRT and other tubes. A sensitive wide band oscilloscope like the PS120 has become an absolute necessity for trouble shooting Color TV and other modern circuits and no other scope is as fast or easy to use.

SPECIFICATIONS

WIDE FREQUENCY RESPONSE:
Vertical Amplifier—flat within ½ DB from 20 cycles to 5.5 MC, down —3 DB at 7.5 MC, usable up to 12 MC.
Horizontal Amplifier—flat within —3 DB from 45 cycles to 330 KC, flat within —6 DB from 20 cycles to 500 KC.

HIGH DEFLECTION SENSITIVITY:

		RMS	P/P
Vertical Amplifier—	Vert. input cable	.035V/IN.	0.1V/IN.
	Aux. vert. jack	.035V/IN.	0.1V/IN.
	Through Lo-Cap probe	.35V/IN.	1.0V/IN.
Horizontal Amplifier—		.51V/IN.	1.44V/IN.

HIGH INPUT RESISTANCE AND LOW CAPACITY:

Vert. input cable	2.7 Meg. shunted by approx. 99 MMF
Aux. vert. input jack	2.7 Meg. shunted by approx. 25 MMF
Through low cap. probe	27 Meg. shunted by 9 MMF
Horiz. input jack	330 K to 4 Meg.

HORIZONTAL SWEEP OSCILLATOR:

Frequency range—	4 ranges, 15 cycles—150 KC
Sync Range—	15 cycles to 8 MC-usable to 12 MC

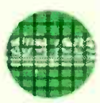
MAXIMUM AC INPUT VOLTAGE:

Vertical input cable— Aux. vert. jack— Lo-Cap probe—	1000 VPP (in presence of 600 VDC)
Horiz. input jack—	approx. 15 VPP (in presence of 400 VDC)

POWER REQUIREMENTS:

Voltage—	105-125 volts, 50-60 cycle
Power consumption—	On pos. 82 watts Stby. pos. 10 watts

SIZE: 7″ wide x 9″ high x 11¼″ deep—weight 12 lbs.



The PS120 is a must for color TV servicing. For example, with its extended vertical amplifier frequency response, 3.58 MC signals can be seen individually.

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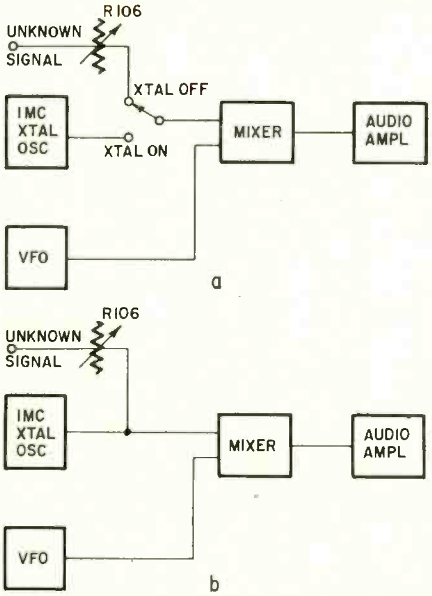


Fig. 1-a—Block diagram of LM before modification. b—Block diagram of LM after modification.

4th 1-mc crystal harmonic, and we are well within tolerance.

If we want to get even closer, we merely set the vfo dial at the ACP, zero-beat the ACP with the 1-mc crystal (having interpolated the dial setting for the ACP from the calibration manual), then interpolate the exact dial setting for 155.8333 kc and set the vfo to that point. Then we zero-beat the transmitter crystal trimmer, and we're right on.

On my LM, 155.8441 kc comes out to dial setting 1309.2, and 155.8333 comes out to 1308.8. As each vernier (at this region) corresponds to 3 cycles at the fundamental (and we are using the third ACP harmonic), the four vernier divisions between 1308.8 and 1309.2 come out to about 36 cycles, which is not too far from the 33.3 cycles we expected.

Theoretically, we should be right on the button. There are, however, errors to be considered. First, there is the question of how close we can zero-beat by ear. The answer lies in using a receiver with an S-meter. You can see the cyclic variation of the meter, and can read a beat to within a couple of tenths of a cycle.

The second question concerns the accuracy of the 1-mc crystal in the meter, on which we have piled such a burden. This item is very stable, and will hold within 2 or 3 cycles of WWV (at 5 mc) for several months, under normal room temperature. You can improve this by simply drilling a small hole in the instrument case (opposite the crystal trimmer capacitor) to let you adjust the crystal oscillator to within another couple of tenths of a cycle.

By far the largest error is due to two things. One is that the vernier is calibrated to only five significant figures. This makes it a little difficult to read anything less than one vernier division. Connected with this is an ugly little gremlin known as mechanical backlash. I was lucky — mine doesn't seem to have much (less than one vernier division). However, I've seen some that have several. One had as high as 12 vernier units of backlash. If we assume that ± 2 vernier units is a fairly good compromise, it leaves us with a total error in the above example of, at worst, ± 20 cycles. In terms of percentage, we have measured 4.4675 mc to within roughly ± .00043%, which isn't *too* bad, I guess.

When we just happen to have to measure a frequency that falls on a harmonic of one of the ACP's, we get even better. Take 960 kc. The 6th harmonic of 160 kc just happens to fall on 960 kc. The 25th harmonic of 160 falls on 4 mc. This means that 160 can be classified as an ACP. Since we don't use the dial on the vfo for actual measurement, it can't lend any error. We only identify the 160-kc ACP with the dial readings, and do the actual measurement by zero-beating. The error is less than 1 cycle, or ± .0001%. If we were measuring 10.960 mc, etc., we would

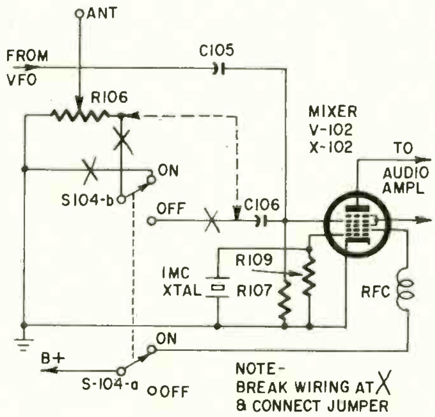


Fig. 2—Input mixer circuit showing where modification is made.

come out to somewhere near .00001%, which is getting pretty close for a heterodyne type meter.

Modifying the LM

Obviously, the whole basis of this technique hinges on being able to beat the unknown, the 1-mc crystal, and the vfo all together — simultaneously. This can be done in the BC-221 as is. The LM requires a slight modification which in no way hinders the use of the gadget in the normal manner. Figs. 1 and 2 give the pertinent details for the tinkering, and should be self-evident.

Basically, the modification consists of removing all wires on S104-b, tying the two *ungrounded* wires together on one of the now empty S104-b terminals, and clipping off the grounded wire so it doesn't go flapping in the breeze.

For most technicians and hobbyists able to afford the hundred or so dollars investment, the LM and BC-221 frequency meters are capable of performance far exceeding their original specifications. Further, since a good signal generator will usually run in the same price category, the investment is not as large as at first appears. If you care to spend a little extra time, you can have a frequency meter which will compare in accuracy with almost any commercial unit selling for upward of six or seven times the price. END

ultraviolet microscopy + closed-circuit TV

By BARRON KEMP

Combination has magnification exceeded only by the electron microscope, but lets you see live cells

SCIENTISTS HAVE LONG DREAMED OF A super microscope that could be used to view the basic processes of living cells. Conventional optical microscopes can't be used for this purpose because the wavelengths of visible light are too long —too near the size of the cell. The electron microscope can "see" cells, but the electrons kill them, so it can be used only for viewing dead cells.

Recent advances in medical electronics have produced a microscope that uses ultraviolet light in combination with closed-circuit TV. The wavelengths of ultraviolet light are short enough to give twice the resolution possible with visible light. With this microscope we can view and take motion pictures of living cells in the act of growing and dividing to reproduce. It is especially valuable to doctors studying cancer cells. These cells transmit visible light almost uniformly over their entire structure, making it impossible to distinguish details of cellular structure and its chemical constituents. But with the ultraviolet television microscope, we can take motion pictures of the living cancer cells (Fig. 1) to learn about chemical changes taking place *within* the cell, movements and activities of the tiny cell organs, and changes that occur when a cell is injured or dies.

Ultraviolet radiation, as we know, can be very damaging to living tissue. If the atmosphere did not shield us from the ultraviolet radiation of the sun, we would have to fear rather than welcome sunlight. Ultraviolet microscopy uses special electronic circuits that permit us to photograph cells for hours without killing them. This instrument actually turns the damaging effects of ultraviolet to advantage because we can damage cells purposely with ultraviolet radiation and watch what happens.

There are two types of ultraviolet television microscopes. The first, and oldest, uses the ultraviolet-sensitive surface of a television image tube, such as the ultraviolet vidicon, to view a specimen through a conventional ultraviolet optical microscope. The television signal from the vidicon is then amplified by conventional electronic circuitry and displayed on a CRT. The second type is much superior to the first. It uses the flying-spot television circuit which was applied to ultraviolet microscopy by Dr. P. O'B. Montgomery, Dr. F. F. Roberts and Mr. William A. Bonner of the Southwestern Medical School in Dallas, Tex.

Flying-spot ultraviolet microscope

The flying-spot ultraviolet microscope (Fig. 2) uses a minute flying spot of ultraviolet radiation to scan a specimen. The ultraviolet source is a special CRT which produces a very small and intense spot of ultraviolet on the tube face. The scanning techniques are very similar to those of a magnetic-deflection TV picture tube. A fine beam of electrons is swept across the face of the CRT. Unlike a conventional CRT, however, the face of this tube is coated with a phosphor that emits mostly ultraviolet radiation instead of visible light. The scanning electron beam traces out a rectangular raster on the face of the ultraviolet-emitting CRT. The raster then becomes the source of ultraviolet radiation and is projected through a compound microscope onto the cell being viewed. (TV technicians will note that this operates like the flying-spot scanner in the B&K TV Analyst.)

The compound microscope gives

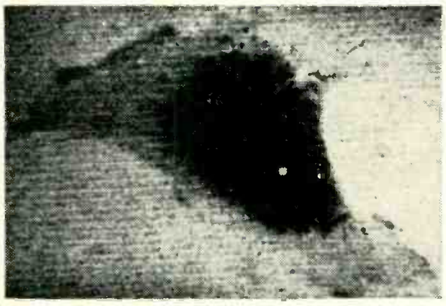


Fig. 1—Ultraviolet absorption image of living cancer cell. Brightened square in center of picture represents a 1-micron-square beam of ultraviolet centered over a nucleus of the cell to produce selective cellular damage.

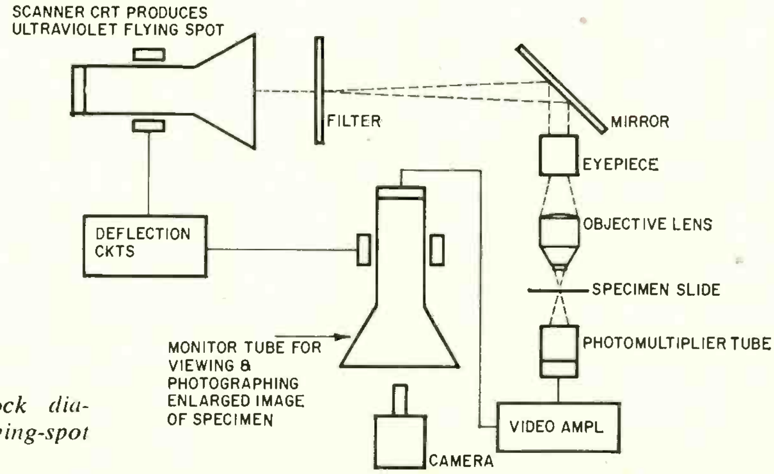


Fig. 2—Block diagram of flying-spot scanner.

double magnification. One lens gives a primary magnification of an object under observation, which is then picked up and further enlarged by a second lens operating as a magnifier. This is shown in Fig. 3.

The small and intense spot of ultraviolet that traces out the raster illuminates the microscope through a filter which passes only the desired band of wavelengths in the ultraviolet spectrum (Fig. 4). A mirror directs the radiation through the eyepiece and objective lens. The microscope is thus used in reverse, reducing rather than magnifying the image which is, in this case, the raster traced out by the flying spot. In this way we can reduce the size of the flying spot enough so that it can be used to trace out a raster in an object as tiny as a living cell.

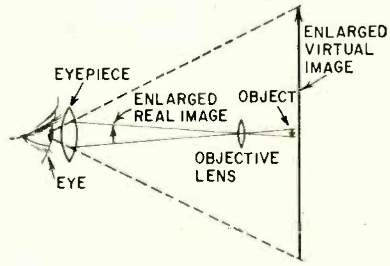
As the now greatly reduced image of the flying spot traces out the raster, the cells of the specimen pass ultraviolet radiation in varying amounts, depending upon their structure and chemical makeup. This radiation passing through the cell produces an image that is made up of points of varying brightness which depend upon how much ultraviolet radiation is absorbed by each minute area of the cell. The amount of radiation emerging from each area of the specimen is inversely proportional to the ultraviolet absorption of that point of the cell.

This radiation emerging from the cell is channeled through a grating monochrometer (selective wavelength filter) which is used to select the wavelength band that produces the best contrast of the displayed image. The ultraviolet image created by the cell is then converted into a pattern of electric pulses by an ultraviolet-sensitive photomultiplier tube. The output of this tube is amplified and used to drive conventional TV picture tubes whose deflection circuits are synchronized with those of the CRT which serves as the ultraviolet source. The electron-beam intensity (brightness) of the monitor tube is thus modulated to produce an enlarged image of the specimen. This image can then be inspected visually and recorded with a camera.

The ultraviolet raster

The raster is derived from sawtooth voltages applied to the vertical and horizontal plates of the ultraviolet-producing CRT. They determine the number of lines in the raster and the raster repetition rate. In practice, the raster consists of a rectangle approximately 1.25 inches high and 1.75 inches wide. In this area the flying spot traces 250 horizontal lines. The total raster buildup time may be varied from 1/20 second to 10 seconds. The repetition

Fig. 3—How the lens arrangement in a compound microscope works



rate may be varied from 1/20 second to several hours. Overall brightness of the raster can be varied by altering the grid-to-cathode potential of the CRT.

Selected areas of the raster can be intensified or extinguished by applying a rectanglar voltage pulse of suitable phase and amplitude between the grid and cathode of the scanner CRT. Two pulse generators are needed to do this. One is arranged to generate a pulse (variable width) when the horizontal sweep voltage reaches some predetermined level; the other to do the same thing when the vertical sawtooth sweep voltage reaches some predetermined level. The outputs of these pulse generators are applied to a coincidence circuit which conducts only when the two square-wave voltages from the pulse generators arrive at the tube simultaneously and in phase.

The coincidence circuit is a class-A amplifier using a pentode tube. Control and suppressor grids are biased to cutoff so the tube conducts only when the positive pulses from the pulse generators reach the grids simultaneously. The output from the coincidence circuit is a negative pulse which is amplified and applied to the control grid of the scanner CRT.

These amplified pulses are used to brighten the raster of the scanner CRT at the preselected time. Adjusting a horizontal-delay control circuit moves the spot to the right or left. Adjusting pulse width of the square-wave pulse generators will change the dimensions of the brightened area of the raster. This brightened area may be from one to several hundred picture elements in size, and its intensity is adjusted according to the need of the experiment. The spot may also be extinguished rather than intensified to produce an area in which no ultraviolet irradiation occurs.

At the end of each complete raster, a pulse is generated, differentiated and switched alternately to two preset counters. The counter outputs then control precisely the lengths of the photographic exposures and the intervals between exposures. In this manner, time-lapse motion pictures of the ultraviolet absorption images of living cells can be taken.

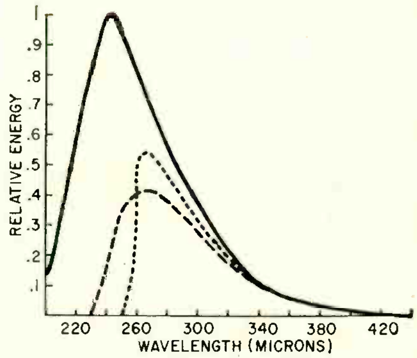


Fig. 4—Spectral distribution of scanner tube output (solid line) compared with output of two filter types (dashed lines).

The ultraviolet flying-spot scanner tube used in this system was developed by Philco. The equipment used by Dr. Montgomery at the Southwestern Medical School of the University of Texas employs a slow-scan TV system in which each field is scanned once every 2 seconds. This slow-scan equipment was designed by Dr. Roberts and Mr. Bonner of the Southwestern Medical School. Philco is presently working on a similar system employing different methods of scanning. Another system, developed by Dr. Vladimir K. Zworykin of the Rockefeller Institute, stains cells *electronically* with selected colors —red, green and blue.

The monitors

The flying-spot ultraviolet microscope system at the Southwestern Medical School (Fig. 5) uses a single monitor for visual observation and photography. Three monitors are used for the Philco system (Fig. 6)—one to present the picture for visual observation, one to record the same picture with a camera and the third to present a color image of the specimen. The visual tube is coated with a long-persistence orange phosphor similar to that used for radar PPI scopes. This long persistence permits us to view a complete picture in each frame even when the flying spot moves at a slow scanning speed. The monitor CRT for the camera uses a blue phosphor which has a shorter persistence and is more favorable for photography.

Biologists studying cellular anatomy with visible light must stain, or otherwise modify, the cells to make the structures more visible. This treatment not only kills the cells but may also alter their natural state. The color-translating microscope monitor is the first practical instrument to translate ultraviolet absorption data of living cells into colors by television methods.

Since different materials selectively absorb different wavelengths of the ultraviolet radiation, color-translating circuits can change these selective absorp-

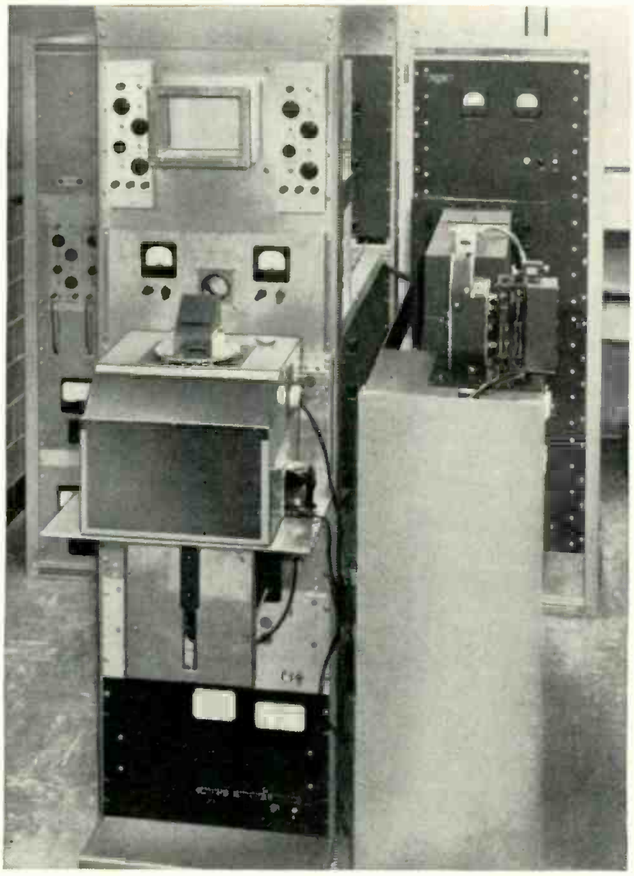
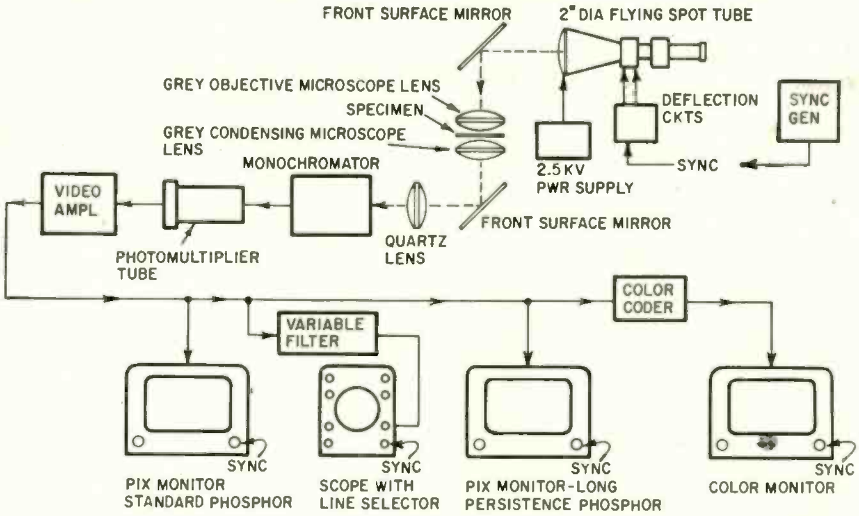


Fig. 5 — Ultraviolet flying-spot microscope used by the Southwestern Medical Shool of the University of Texas.

Fig. 6 (below)—Block diagram of Philco system using three TV monitor units and including the color monitor.



tions into color and thus aid in showing the location in the cell of various absorbing chemical constituents. The areas of the specimen having greatest absorption are displayed in red, for example, areas with less absorption are green, while areas with the greatest amount of ultraviolet transmission appear on the screen in blue.

A cathode-ray oscilloscope with a line selector is used to determine the amount of absorption of small areas along a single line of the specimen. With a single control, a horizontal white identifying line can be displayed across any selected part of the picture on the three monitors for identification.

The system constructed by Philco (Fig. 6) uses a high sweep rate and very bright spot to compensate for thermal noise of the photomultiplier. This provides a sufficiently high thermal signal-to-noise ratio in the picture when photographed. The intensity is such that the cells of the specimen will be damaged quickly if scanning is continuous. To reduce damage, the microscope has a pulsing system so that scanner-tube operation can be confined to one or more frames per cycle, synchronized to the shutter of a 16-mm movie camera. The specimen need be exposed to ultraviolet radiation only during the actual photographic exposure time and there is no irradiation during the time the camera is changing frames. END

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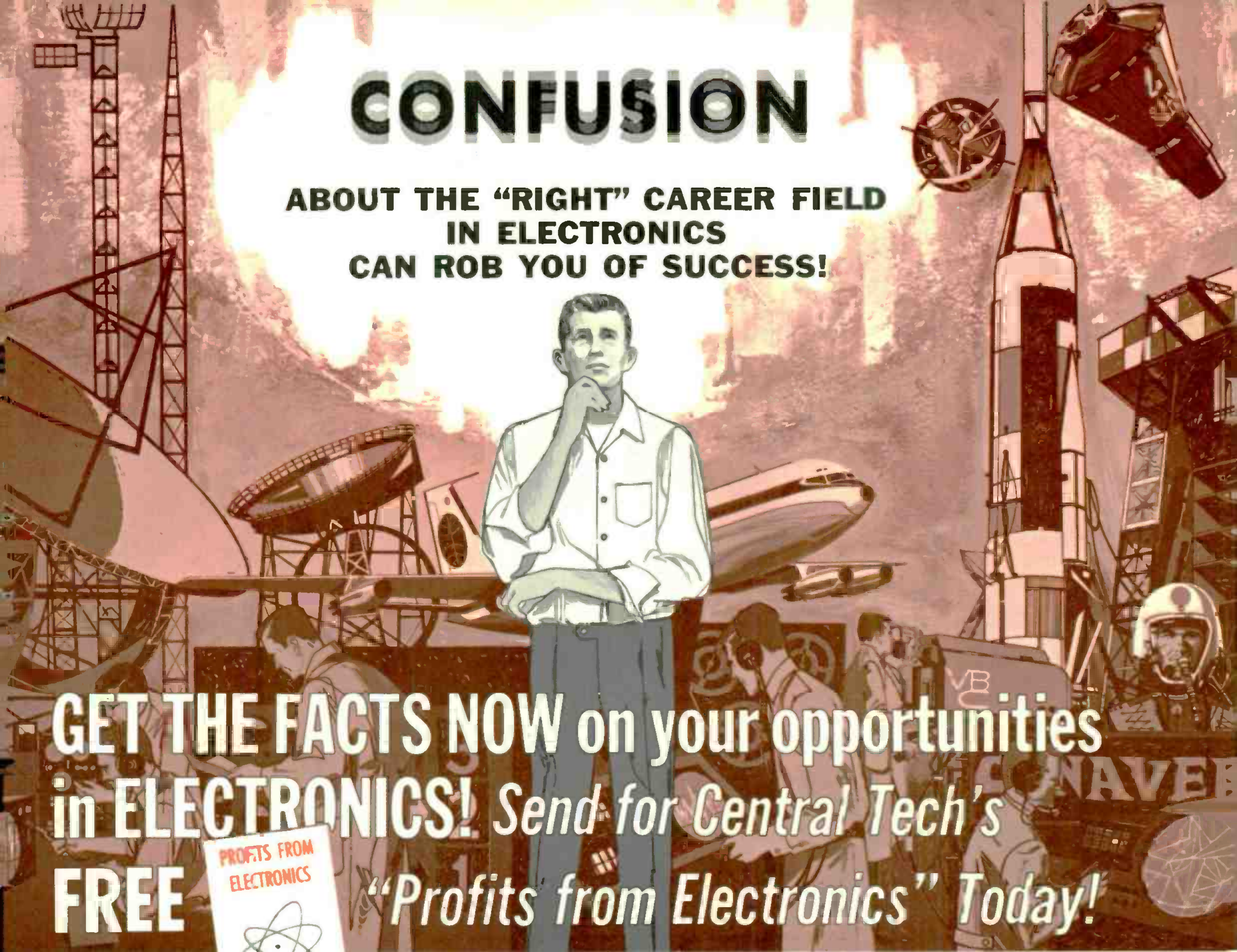

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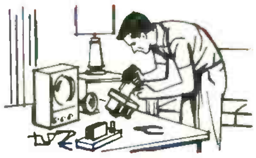

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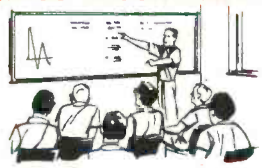

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This closing article of a series shows how to locate and repair trouble in this section of a tape recorder

Servicing the Bias Oscillator

By EARL E. SNADER*

ONE OF THE FIRST STEPS IN TROUBLE-shooting a tape recorder is to determine whether the audio section or the bias oscillator is at fault. As the first test, try playing back a commercially recorded tape known to be good. If playback is defective, check the audio section of the recorder. This should include a check of the playback head for both wear and alignment.

If playback appears normal, check the audio section of the amplifier with the controls set for recording.

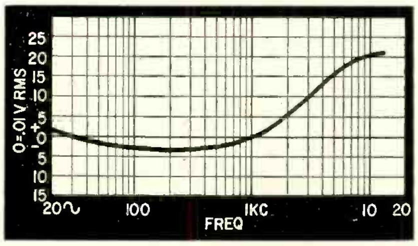
Disable the bias oscillator temporarily, either by removing the bias oscillator tube or by disconnecting its dc supply.

Using shielded leads, connect the input of a test audio amplifier across the terminals of the record head. You will probably have to turn the gain of the test audio amplifier down almost all the way to keep the relatively high output of the recording amplifier from overloading the test amplifier.

Feed a signal into the input of the recording amplifier the same as for recording. The output from the recording amplifier may sound shrill through the test amplifier, but it should not be distorted in any other way.

The reason for the shrillness is that the recording equalization commonly used in tape recording amplifiers boosts frequencies above about 6 kc by more than 15 db, based on the level at 1 kc. This compensates for the natural response characteristics of a tape recording head. The exact equalization has been standardized, to some degree as shown in Fig. 1.

If this test reveals obvious distortion in the recording amplifier, other than the shrill frequency response, the cause of such distortion should be determined and the distortion removed. The methods and procedures for doing this will be about the same as for any conventional audio equipment.



Viking of Minneapolis

Fig. 1—Recording amplifier response curve.

*Customer service, Viking of Minneapolis.

Bias oscillator checks

The next step is to check the bias oscillator to see if it is working. The simplest way of doing so is to check for negative voltage at the control grid of the bias oscillator tube.

Check the bias oscillator frequency next. The erase and recording heads are connected normally for this test because the heads on some recorders affect the operating frequency of the bias oscillator.

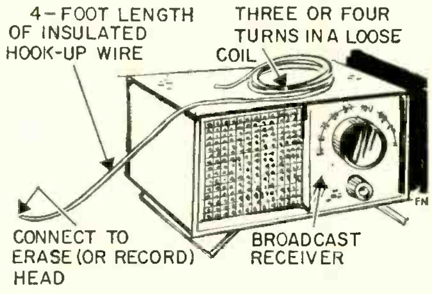


Fig. 2—Checking bias oscillator frequency with a broadcast receiver.

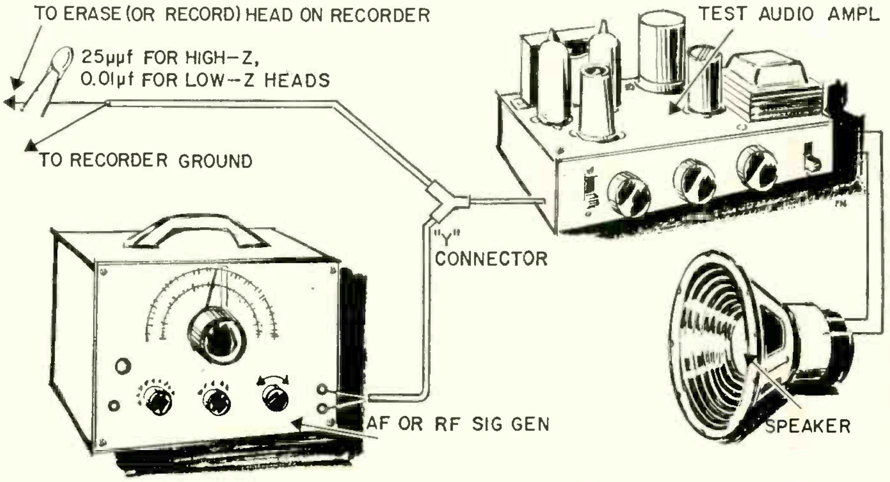


Fig. 3—Checking bias oscillator frequency with a signal generator, test audio amplifier and loudspeaker.

One of the simplest ways to check the bias oscillator frequency is to use a broadcast receiver to pick up harmonics of its signal.

Connect a 3- or 4-foot length of insulated hookup wire either to the hot side of the erase head or to the plate of the bias oscillator tube. Wrap the other end of this wire in a loose coil with three or four turns 3 or 4 inches in diameter, and lay this coil on top of the broadcast receiver, or near its antenna (a receiver with a built-in antenna should be used), to couple the bias signal into the receiver.

Turn on the tape recording amplifier and the receiver, and tune across the lower end of the broadcast dial (500 to 800 kc). Harmonics of the tape recorder bias oscillator should be heard at different points on the dial. These can be positively identified by momentarily turning off the tape recorder and noting whether the signal disappears.

The distance in kilocycles between the points where harmonics of the bias oscillator signal are heard on the dial will be the same as the fundamental of the bias oscillator frequency. If, for instance, harmonics of the bias oscillator signal appear at 570, 600, 630, etc., on the broadcast receiver dial the bias oscillator frequency is 30 kc. If they appear at 560, 595, 630, etc., the bias oscillator frequency is 35 kc, and so on. The setup for this method is shown in Fig. 2.

A more accurate method of checking the bias oscillator frequency is to use a calibrated signal generator that operates at frequencies around what is supposed to be the bias oscillator frequency.

Feed the output of the generator

and that of the erase head into the input of a test audio amplifier, through a Y-connector as shown in Fig. 3. Use shielded leads.

Connect the center conductor of the second shielded lead to the hot side of the erase head through a capacitor. If the erase head is a high-impedance unit, use about 25 μμf. If it is low-impedance, use about .01 μf for this capacitor. Ground the shield of the lead to the chassis of the tape recorder.

Turn on the tape recorder, audio amplifier and signal generator. Adjust the generator to a frequency that heterodynes with the signals from the bias oscillator, as heard in the audio amplifier. Adjust the signal generator for the lowest pitch in this heterodyne (it should go down to zero cycles per second when the signal generator is set at the bias frequency). The bias frequency can then be read from the setting of the signal generator dial.

This procedure has the disadvantage that heterodynes will appear at harmonics of both the bias oscillator and signal generator fundamental frequencies. One way of identifying fundamentals is to pick the strongest heterodynes. Also, the setting of the signal generator should be checked against the published specifications concerning the tape recorder bias oscillator frequency.

Use your scope

If an oscilloscope is available, the bias oscillator frequency can be checked by using the scope, rather than an audio amplifier, to compare the frequencies from the bias oscillator and the signal generator.

Connect the shielded lead from the tape recorder to the scope's vertical input, and the shielded lead from the signal generator to the horizontal input. Set the sync control on the scope to external, and adjust the signal generator until a near-perfect circle appears on the screen. Vertical and horizontal gain controls will have to be adjusted to give the right proportions. The circle will appear on the screen only when the fundamental frequency of the signal generator is the same as the fundamental signal of the bias oscillator. This arrangement is shown in Fig. 4.

After the actual operating frequency of the bias oscillator has been determined, check it against the manufacturer's specifications. If there is a discrepancy of more than 10%, adjust the bias oscillator to operate at the right frequency. This may require changing capacitors in the bias oscillator circuit, adjusting the oscillator coil or, occasionally, replacing the bias oscillator tube or coil.

Do not overlook the possibility that a defective erase or record head could be affecting the operating frequency of the bias oscillator.

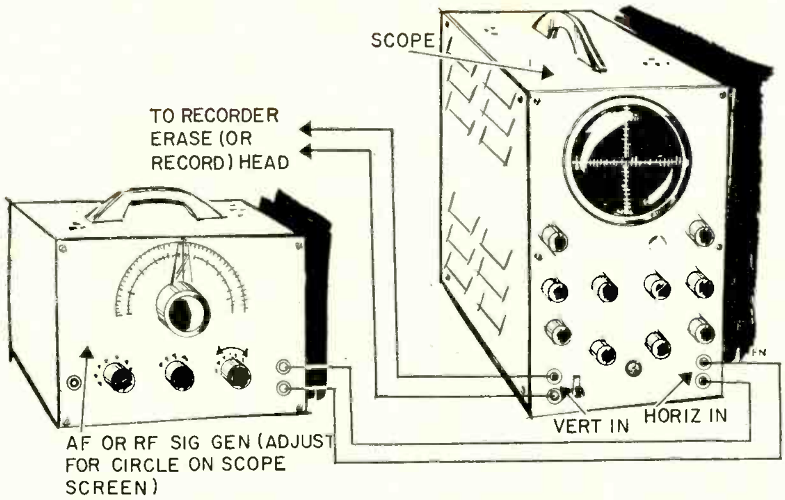


Fig. 4—Checking bias oscillator frequency with a signal generator and oscilloscope.

Check the output waveform

After the frequency of the bias oscillator has been checked, and adjusted if necessary, examine the bias oscillator output waveform for unbalance or any other type of distortion.

Connect the scope's vertical input across the erase head (or across the record head if there is no erase head). Set the sync control for internal sync and adjust the horizontal sweep so two or three cycles of the bias waveform appear on the screen. The trace should show a symmetrical waveform, evenly centered on the horizontal axis.

Any obvious lack of balance should be corrected, either by adjusting the oscillator balance control or replacing resistors or capacitors in the bias oscillator circuit which may have changed in value. All cathode, grid and plate voltages should be within 10% of those recommended by the manufacturer.

Persistent distortion or unbalance may mean that the oscillator coil is defective and should be replaced. The grid-to-plate capacitors in symmetrical oscillator circuits should be carefully matched.

Not all bias oscillators will be perfectly balanced, even when they are operating normally. It may be necessary just to get the waveform balanced as much as possible, without bothering too much about the slight unbalance that remains.

If an oscilloscope is not available, it may be necessary to assume that the oscillator is in a fairly well balanced condition without any actual checking. The voltages at the pins of a symmetrical oscillator may be some clue to an unbalanced condition, but are not as reliable as an oscilloscope check. Under certain circumstances an oscillator can be fairly well balanced as far as its output waveform is concerned even though there are noticeable differences in voltage readings at the pins of the oscillator tube.

The final check for oscillator balance, on tape recorders that have an oscillator balance adjustment, is to make several test blank recordings. Do not apply any signal to the input of the recording amplifier for this test. Make several blank recordings with the oscillator balance adjustment at different settings. Note the setting that corresponds with each test recording.

Then play the test tape back with a vtvm connected to the output of the playback amplifier to read the relative level of the background noise for each section of the test recording. Set the balance adjustment at the point where the lowest amount of background noise was recorded on the test tape.

The more common faults in the performance of a tape recorder traceable to trouble in the bias oscillator and adjustment of the bias in the record head are low output, poor high- or low-frequency response, and distortion. The conditions that might be associated with each symptom are listed in the table.

Check head currents

A final step in checking a tape recorder is to measure the exact amount of erase, recording bias and audio current at each tape head. If test points are provided, this is relatively simple *if* the original heads are being used or any new heads are exact replacements. If there are no designated test points in the recording amplifier, or if different heads are being used, measure the current to each individual head and adjust it if necessary.

One common way of ascertaining whether the correct current is being supplied to the heads is to measure the ac rms voltage across the head.

This method is not always reliable. Suppose, for instance, the head is resonant at the bias oscillator fre-

COMMON FAULTS CAUSED BY BIAS OSCILLATOR

Symptom	Possible Cause
Low output	Insufficient recording bias
Poor high-frequency response	Excessive bias
Poor low-frequency response	Insufficient bias
Distortion	Insufficient bias or too much recording (audio) current

quency. A rather high voltage may appear. This might be interpreted as meaning that plenty of current is flowing through the head windings to cause this voltage when actually, the head is at resonance and practically no current is flowing at all.

Evaluating performance by measuring voltage across the head is reliable only under controlled circumstances in which a specific head is being checked in connection with a specific recording amplifier and with the right kind of a voltmeter.

If the heads are low-impedance types, the voltage reading is a fairly reliable indication of the actual operating conditions, but only if definite values have been suggested as indicative of correct operation.

The amount of bias current flowing through an erase head is not critical, as long as the head seems to be erasing properly without showing signs of heating. Sometimes it may be necessary to adjust the amount of current in the erase head to get the right amount of bias current in the record head, because of the interaction of the two.

An excellent way of accurately measuring the amount of bias current in the record head is to connect a 100-ohm resistor in series with the ground side of the head and measure the voltage drop across this resistor. The current flowing in the circuit can then be calculated by using Ohm's law:

$$\text{Current passing through the head (ma)} = \text{Voltage across 100-ohm resistor} \times 10$$

Several specific requirements must be met in any voltmeter used for calculating the current to the tape head by this method. It should be an audio vtvm that can measure ac rms voltages as low as .001 volt accurately, at frequencies as high as the bias oscillator frequency in the tape recorder. A meter with shunts which may resonate at the bias frequency cannot be used. Such meters could give wild and completely unreliable readings under the circumstances.

Use the 100-ohm resistor

Typical values of bias current for high-impedance record heads will be 0.5 to 0.7 ma. These will cause drops of .05 to .07 volt, respectively, across the 100-ohm resistor.

You must insert the 100-ohm resistor in the ground side of the head circuit and as close to the head as possible. It is in the ground side so the meter can be grounded. Otherwise, stray capacitances between meter and ground could affect the accuracy of the reading.

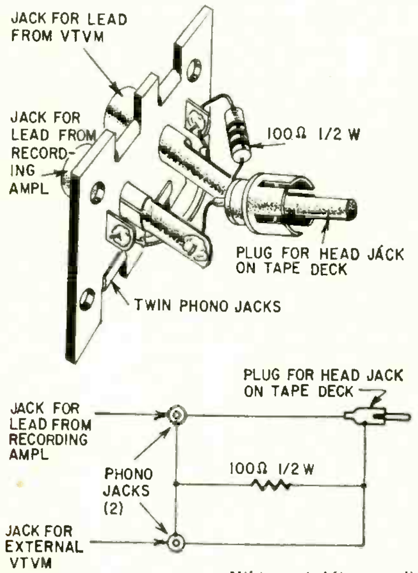
The resistor is inserted in the circuit as close to the head as possible so the voltage drop across it will be caused by current actually flowing through the head and not to losses in the leads between the resistor and the head.

The audio current fed to the head by the recording amplifier also can be measured by the 100-ohm resistor method. To measure the audio current, disable the bias oscillator and then feed a signal into the recording amplifier input. Adjust the level control for a normal indication at the record-level indicator and then measure the voltage drop across the 100-ohm resistor in the same way that it was measured to check the bias current. The normal audio level to the record head will be much lower than the level of the recording bias current, so the vtvm readings will be much lower. Some high-impedance heads may require only .03 or .04 ma audio recording current. These low-magnitude currents will produce voltage drops of .003 and .004 volt, respectively, across the 100-ohm resistor.

The leads to the erase and record heads on many tape recorders are connected through phono plugs and jacks. A gimmick can be prepared to facilitate checking the audio, bias and erase currents. This can be a plug and twin-jack assembly arranged so a 100-ohm resistor is automatically connected in series with the ground side of the head when the gimmick is plugged into the head jack and the leads from the recording amplifier and to the voltmeter are plugged into the twin jacks. Fig. 5 shows the details of such a gimmick.

If one side of the jack for the head being checked is grounded to the tape recorder chassis, you will have to break the ground connection temporarily to use the gimmick. Otherwise the ground connection at the jack will short the 100-ohm resistor in the gimmick and it will not be possible to get an accurate voltmeter reading.

A 100-ohm resistor may be too large to connect in series with a low-impedance head to measure the head currents. If so, use a smaller resistor. Its resistance should not be greater than 1/10, or better yet, 1/20 of the impedance of the head in ohms. The 10 in the formula given above should be changed accordingly, by dividing the resistor value into 1,000 and using the quotient. For a 50-ohm resistor, for example, it would be 20.



Viking of Minneapolis

Fig. 5—Setup for measuring current in erase and record heads.

A discussion of this kind might be expected to begin with a list of the test instruments that are necessary to follow through the procedures suggested. In this case, however, it will close with such a list, since most technicians will have all of them on hand.

Some basic tools for checking the bias oscillator in magnetic tape recorders are:

. . . A good, wide-range audio vtvm sensitive to ac rms levels as low as .001 volt.

. . . A signal generator that covers frequencies from about 20 cycles to 100 kc.

. . . A test audio amplifier.

. . . An oscilloscope—not absolutely necessary but very convenient.

Also, it is a good idea to have some spare erase and record heads around (both low- and high-impedance types), and maybe a spare bias oscillator coil or two for substitution. END

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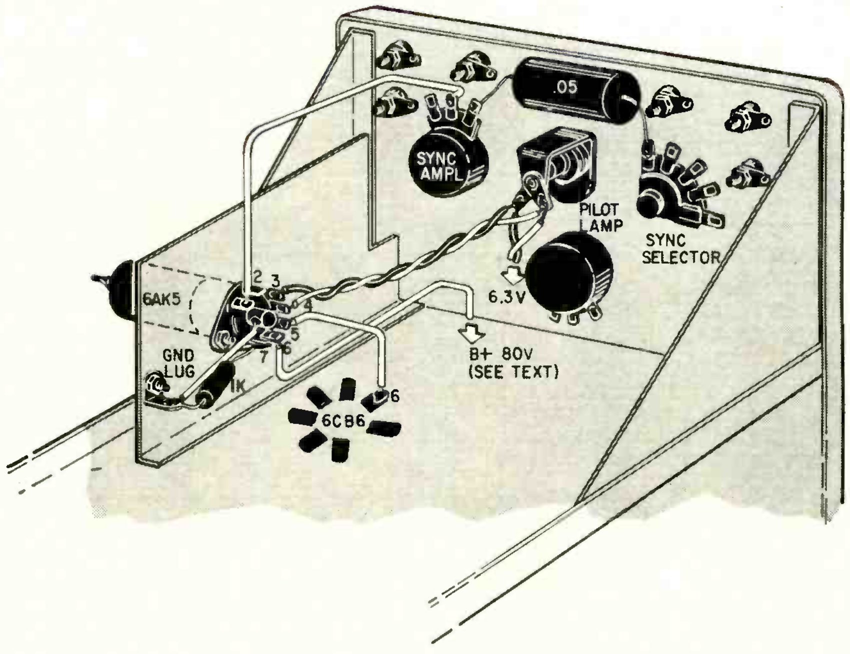

Modifying Heath Scope

Our Heathkit O-10 scope has given us excellent service since we bought it for our laboratory some years ago. For laboratory use, however, it was found desirable to modify the original unit to eliminate two difficulties:

- Lack of ability to lock the horizontal sweep with the wave to be viewed, under three conditions:
  - At frequencies below 100 cycles per second.
  - When the frequency of the wave to be observed is changing in frequency, such as the output of an electronic organ with vibrato.
  - When the voltage of the wave to be observed is small.
- Loading the circuits under test when connected to the external sync terminals.

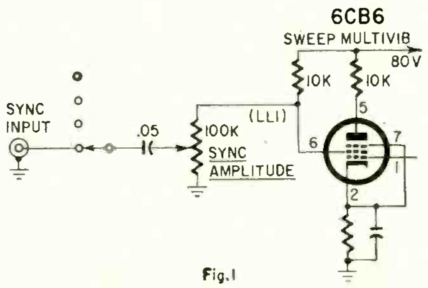

Fig. 1

The cause of these difficulties is shown in Fig. 1. The sync signal is fed from the SYNC INPUT through a .05-μf coupling capacitor to the SYNC AMPLITUDE control and then to the screen grid of the 6CB6 sweep multivibrator. Since the screen grid of this tube is inefficient as a "control grid," a relatively large sync voltage is necessary. The difficulty of obtaining this voltage is aggravated by the relatively low input resistance of this circuit caused by the 10,000-ohm screen dropping resistor. This low input resistance loads external circuits connected to the external sync input terminal. Feeding a low-resistance circuit makes the job of the coupling capacitor more difficult, and at 60 cycles per second approximately 80% of the sync voltage is lost in the .05-μf unit.

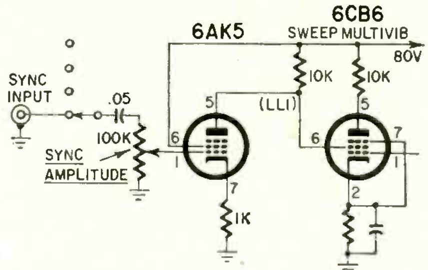

Fig. 2

All these conditions were corrected by adding a 6AK5 and a 1,000-ohm resistor. The new circuit is shown in Fig. 2. The 6AK5 is used as a sync amplifier so the screen grid can still be used as the control element, leaving the sweep multivibrator circuit intact. The existing 10,000-ohm resistor is now the screen dropping resistor for the 6CB6 and the plate load resistor for the 6AK5. Direct coupling between the sweep multivibrator screen and the sync amplifier plate eliminates the need for a coupling capacitor and its inherent low-frequency losses. The sync amplitude control is reconnected as a normal "level" control, thus providing a relatively constant, high input resistance of approximately 100,000 ohms.

The drawing above shows the modified wiring in the scope and the location of the added parts. The 6AK5 socket is mounted in hole punched in the shield. —*Edward J. Och*

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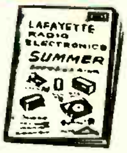

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experimenter's tandem amplifier

2-transistor unit converts high-impedance inputs to low-impedance outputs and provides a gain of 38 db

By LeROY MAHONEY

CATHODE-FOLLOWER AMPLIFIERS HAVE served many useful purposes for a long time and are still very much in demand. Perhaps their greatest use is to convert a low-level high-impedance source to a low-impedance output. The drawback is the lack of amplification.

The tandem amplifier is made up of two transistor stages. The first, V1, is an emitter follower that permits a high input impedance without transformer coupling. The second is a common-emitter amplifier which provides most of the gain and the low-impedance output.

The emitter-follower amplifier (using two transistors) has a low-impedance output and a high-impedance input, just like a cathode follower. However, unlike cathode followers, it delivers a voltage gain of 95. The circuit shown in the diagram is very stable when operating from input impedances ranging from 2.2 megohms to 360,000 ohms, and output impedances from 1,000 to 8,000 ohms. Extended tests proved the amplifier frequency response — when input and output circuits were loaded anywhere between these wide limits—was practically flat from 20 to near 500,000 cycles.

The amplifier uses 2N139 transistors, and can be built into almost any small space—the pickup arm of a record player or the base of a microphone. Simply use subminiature components.

Only standard, easily obtained parts were used to build the tandem amplifier. The large capacitors have a very low breakdown voltage and are thus inexpensive. To protect the transistors while soldering, as several circuit arrangements were tried, two subminiature tube sockets were used. The transistor leads were carefully cut to a length that allowed them to fit firmly into the sockets. During soldering to socket terminals, the transistors were removed, eliminating the danger of heat damage to the transistor.

The large-value capacitors in the input and output insure the passage of the lowest audio frequencies. The time constant of the input and output load impedances assures a flat response. The 25-μf capacitor across the emitter bias resistor causes enough degeneration to prevent oscillation over the audio range.

The input is almost unbelievably small. An input of 13.7 mv across a 360,000-ohm input load impedance produced only 50-$\mu\mu$watt input. The amplifier worked well at this level, and equally well with inputs up to 50 mv. Beyond this, response falls off rapidly and the output wave suffers. The amplifier's 1.3-volt output (peak to peak) is enough to drive the input tubes of an audio amplifier or power transistor stage. The output waveform (with 13.7 mv input) as seen on a dual oscilloscope is almost an exact duplicate of the input wave.

Because the amplifier is battery-powered, current drain must be watched. The greatest current flow is in the emitter follower or first transistor—0.98 ma. The output draws only 0.3 ma, making a total of 1.2 ma at 5.4 volts.

Unless the amplifier is operated continuously for long periods the battery will last about 2,000 hours without falling below 4 volts. This value appears to be the minimum necessary for a fairly good waveform and good response.

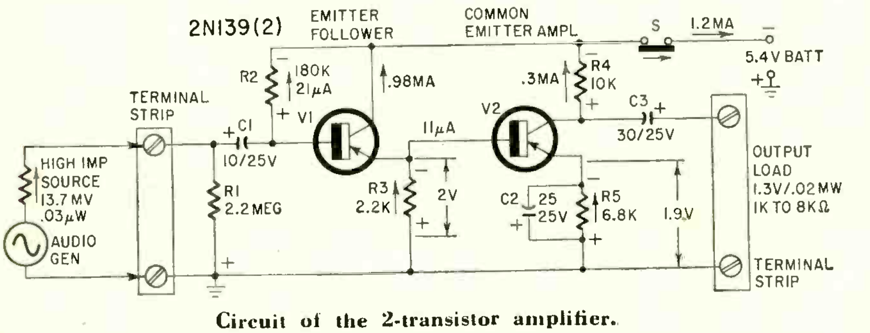
Rapidly changing the input and output impedances appeared to have little effect on the amplification and response characteristics. In test runs lasting for 40 hours or more, the frequency response remained constant at less than ½ db down at 300,000 cycles and 3 db down at 500,000 cycles. The low-frequency response was equally satisfactory, 4 db down at 20 cycles, then dropping swiftly as the impedance of the large output capacitor grew very large. The voltage gain was nearly flat between 50 and 300,000 cycles.

No special tricks were required to overcome phase shift. The 10-μf capacitor at 20 cycles offered less than 1,000 ohms impedance and, as frequency increased, this impedance decreased.

The open-circuit voltage of the test generator, with an internal impedance of 2.2 megohms (to match R1) was 0.7. When the generator was connected to the input, the voltage dropped to .0137 or 13.7 mv. The open-circuit output voltage was 1.3, indicating a gain of 95 for the unloaded amplifier. Connecting a 5,000-ohm load across the output drops the voltage to 0.5 or 500 mv. These values remained almost the same as the input and output impedances were varied from 2.2 megohms to 360,000 ohms, and from 8,000 to 1,000 ohms, respectively. As different load impedances were applied, the input frequency was varied over a wide range, extending far beyond the audio frequencies. Extreme stability and good waveform were observed.

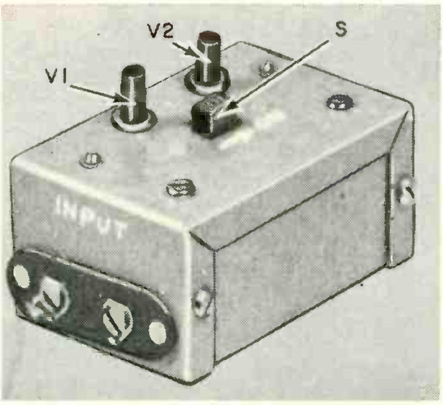
$$\text{db power gain} = 10 \log \frac{\text{power out}}{\text{power in}}$$

Since we have voltage and resistance



Circuit of the 2-transistor amplifier.

R1—2.2 megohms
R2—180,000 ohms
R3—2,200 ohms
R4—10,000 ohms
R5—6,800 ohms
All resistors ½-watt 10%
C1—10 μf, 25 volts, electrolytic
C2—25 μf, 25 volts, electrolytic
C3—30 μf, 25 volts, electrolytic
BATT—5.4 volts, mercury (Mallory TR134R or equivalent)
S—spst slide switch
V1, V2—2N139
Terminal strips, 2 lugs (2)
Case, to suit
Miscellaneous hardware



The completed unit makes a neat little package.

available, the power is calculated from the formula $W = E^2/R$. Power input is then:

$$W = \frac{.0137 \times .0137}{2{,}200{,}000} = .085 \text{ microwatt.}$$

Power output is:

$$W = E^2/R = W = \frac{0.5 \times .05}{5{,}000 \text{ ohms}}$$

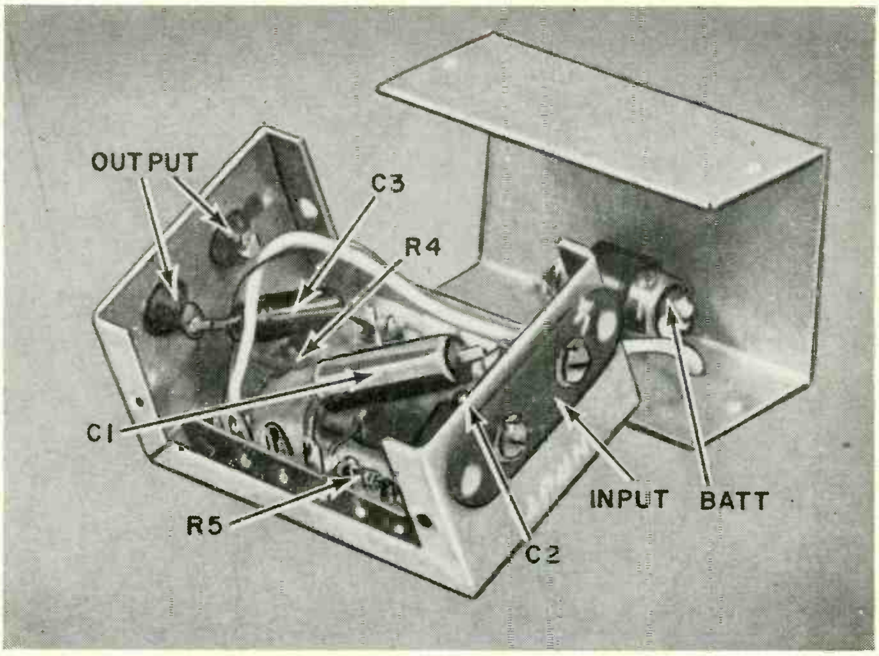
$$W = 50 \text{ microwatt.}$$

$$\text{db power gain} = 10 \log \frac{50}{.085}$$

$$= 10 \log 588 = 27.69$$

$$\text{db voltage gain} = 20 \log \frac{\text{voltage out}}{\text{voltage in}}$$

$$= 20 \log \frac{0.5}{.0137} = 20 \log 36.5 = 31.24$$



Parts arrangement for the tandem amplifier.

With a 2.2-megohm input impedance, the source impedance should not drop below 460,000 ohms. If the source impedance drops below 360,000 ohms, disconnect R1.

The tandem amplifier uses standard resistors and capacitors. A component tolerance of 10% is quite acceptable. Several types of transistors can be used with no appreciable change in operation. Try this yourself.

This amplifier may be used wherever very little signal power is available. It is ideal for portable equipment as a microphone amplifier. Once the circuit is set up, no changes are necessary except to replace the battery about every 8 months. END

R-E Project Wins at Science Fair

MELODY SWEARINGEN, 13, MIAMI SPRINGS, Fla., walked off with top honors at the South Florida Science Fair with a servomechanism from the pages of RADIO ELECTRONICS. The "Photomagnetic Toy, by H. Schreiber, (page 79 January 1962) was adapted by her into a "Best of Show" winner.

With a science fair coming up, and suggestions eagerly solicited, Melody's father, F. R. Swearingen called the article to the attention of his daughter and her science teacher. It was adopted as *the* project immediately, and work started.

It wasn't all easy. Melody couldn't get a 1N77-B, so a discarded photocell from an old camera was substituted. Housing and mask were built to fit. The "breakthrough" came when the 3/32-inch slot curved to match the contour of the shadow cast by the floating ball, was cut in the mask. This gave full control.

Another problem was that dark current ran a little high. This made static current through the electromagnet great enough to suck up the ball if someone bounced the globe a little too hard. It was licked by a 1.5-volt cell in the "eye" return making it more positive than the positive supply.

Right now, Melody is carefully reading RADIO-ELECTRONICS page by page, keeping an eye open for another winner.

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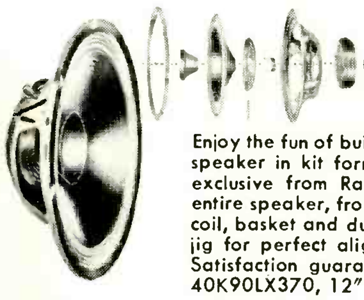

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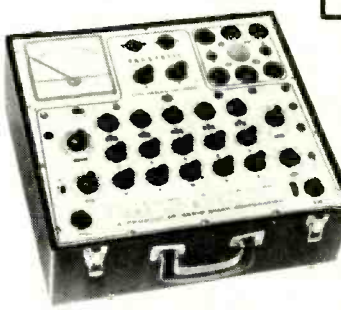

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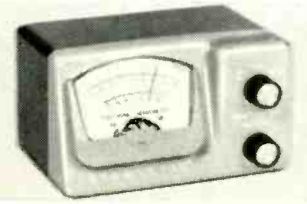

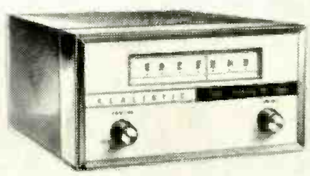

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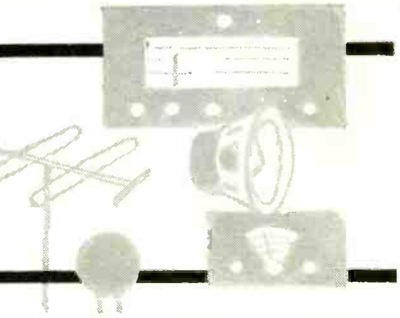


AMPLIFIER KIT, *DA-283*. Music power rating 16 watts, 2% harmonic distortion at 1,000 cycles. Hum and noise: magnetic phono 50 db, crystal phono tuner 60 db below full output. Response ±1 db, 30–15,000 cycles at full output. Tone controls: bass; 18-db boost, 17-db cut. 30 cycles: treble; 17-db boost, 15-db cut, 15,000 cy-

cles. IM distortion 2% max at full output. Input sensitivity: magnetic phono .004 volt at 1,000 cycles; crystal phono 0.2 volt at 1,000 cycles; tuner 0.25 volt at 1,000 cycles. Output impedance 4, 8, and 16 ohms. Damping factor 0.10.—**Daystrom Products Corp.,** PO Box 167, St. Joseph, Mich.

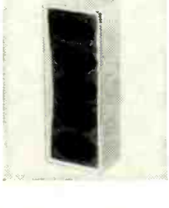
AM-FM TUNER, *model DA-286*. AM section: Usable sensitivy, normal position. 10 μv at 1,400 kc, 15 μv at 1,000 kc, 25 μv at 600 kc. 20-db quieting. Built-in antenna. Tuning range 550 to 1,600 kc. I.f. 455 kc. Hum and noise —30 db. FM

section: quieting sensitivity 20 db at 1 μv. 30 db at 1.5 μv, 48 db at 25 μv. Balanced input for external 300-ohm antenna. 88–108-mc tuning range, 10.7-mc. Image ratio—45 db, AM suppression 27 db, afc correction factor 100 kc per volt, i.f. rejection 65 db. Harmonic distortion less than 1%. output 1 volt. output impedence variable from 0 to 800 ohms.—**Daystrom Products Corp.,** PO Box 167, St. Joseph, Mich.

SPECIAL-DUTY SPEAKER, *model SPB-1*. Weatherproof; bell opening screen. *Versalock* omnidirectional mounting bracket. Power 25 watts at voice frequencies, impedance 8 ohms. frequency

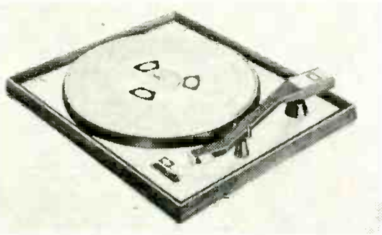
response 300–10,000 cycles. Bell diameter 7¼ in. 6⅛ in. overall.—**Atlas Sound Div.,** American Trading & Production Corp., 1419-51 39th St., Brooklyn 18, N. Y.

COLUMNETTE SPEAKER, *Realistic Nova 12*. For PA and stereo requiring maximum sound coverage, minimum number of speaker installa-



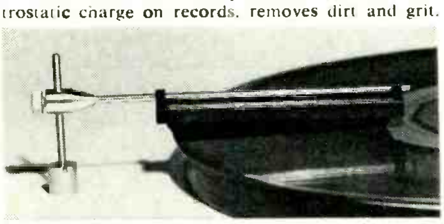
tions. Wide-angle 120° horizontal radiation, controlled vertical radiation. Five 3 x 5-in. oval speakers mounted in line. Response 170–12,000 cycles; power rating 15 watts, vertical dispersion under 60°.—**Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

LIGHTWEIGHT TURNTABLE, *model 66*. 2 precision hysteresis synchronous motors on opposite sides of deck; suspended on neoprene seismic platform. Accuracy within 1 rph. rumble



60 db, wow and flutter 0.5%. 2 inches including integrated base. 6 lb. Integrated viscous-damped arm or low-dynamic-mass pickup.—**Weathers Industries,** Div. TelePrompTer Corp., 50 W. 44 St., New York 36, N. Y.

RECORD CLEANER, *Dustat*. Reduces electrostatic charge on records. removes dirt and grit.

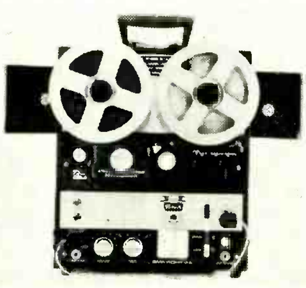


No radioactive materials. Adjustable for any turntable.—**Grado Labs, Inc.,** 4614 7th Ave., Brooklyn 20, N. Y.

MONO/STEREO CARTRIDGE, *model 880p*. Long-life unit. Dynamic mass less than 0.5 $\times 10^{-3}$ gms, compliance 30 x 10^{-6} cm/dyne, channel

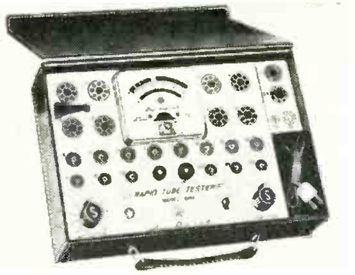
separation 30 db, tracking force ¼ gram. Range 6–30,000 cycles.—**Empire Scientific Corp.,** Garden City, N. Y.

STEREO TAPE RECORDER, *model 1040*, with Harmonizer Magi-Cable for multiple sound-on-sound recording plus sound-with-sound feature. Duplicates from one tape recorder to another.



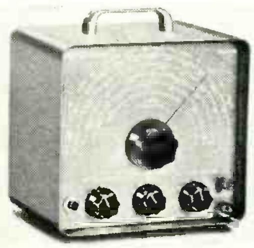
Stereo effect from radio or mono phonograph. Records FM multiplex; 2- and 4-track stero and mono record/play; dual self-contained power stereo amps and built-in extended-range stereo speakers. —**Roberts Electronics,** 5920 Bowcroft St., Los Angeles, Calif.

MULTISOCKET TUBE TESTER, *SICO model 820*. Tests more than 850 types, including



Novars. nuvistors, compactrons. 10 and 12-pin types, plus 0Z4. 4-inch meter. 26 sockets, dual scale meter, 7 and 9-pin straighteners mounted on panel. All sections of multi-element tubes tested simultaneously. Leakage test circuit shows leakage up to 5 megohms.—**Moss Electronic, Inc.,** 1849 10th Ave., New York 34, N. Y.

AUDIO OSCILLATOR, *model 95*, for servicing tone equipment. Frequency range. 600–2,600

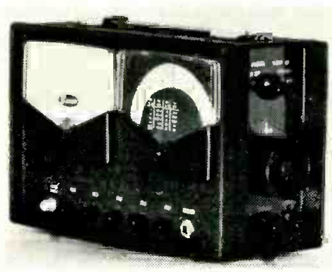


cycles. Resetability and frequency drift 0.1% or less.—**Plectron Corp.,** Overton, Neb.

CRT TESTER-REJUVENATOR, *model CR-60*, for black-and-white, color. Checks all tubes for proportionate screen brightness by qualitative measurement of electron beam. Checks cathode

and controlling action of first grid. Tests and rejuvenates color-tube elements (red, green and blue guns) separately. Other tests: hot cathode and interelectrode leakage; shorted elements and actual leakage; leakage paths or shorts in gun structure, etc.—**Precision Apparatus Co., Inc.,** 70-31 84th St., Glendale 27, N. Y.

FIELD STRENGTH/WATTMETER, *model FSP-3*. Portable, fully transistorized. Frequency 52–220 mc in one range. sensitivity 5 μv minimum readable signal; 60 μv full scale, sensitivity control maximum. Input impedance 75 ohms unbalanced, 300 ohms balanced; bandwidth 3 db at 0.5 mc.



Overall accuracy +2 db —1 db over ambient temperature range 0°-120°F. Spurious responses 80 db down. VSWR more than 1.2 on 100-μv meter range, more than 1.1 at other ranges. Percentage modulation measurable in 0–5% and 0–50% rangs. Powered by 8 Mercury penlight cells; 3 hours operation per week for 1 year or 180 hours continuous operation.—**Benco Television Assoc., Ltd.,** Blonder Tongue Labs Inc., 9 Alling St., Newark, N. J.

TRANSISTOR TESTER, *model 1885*. Measures beta and leakage with ±3% accuracy. Pulsed technique beta test, pulse width continuously variable from 0.1 to 1.66 μsec. Pulse repetition rate

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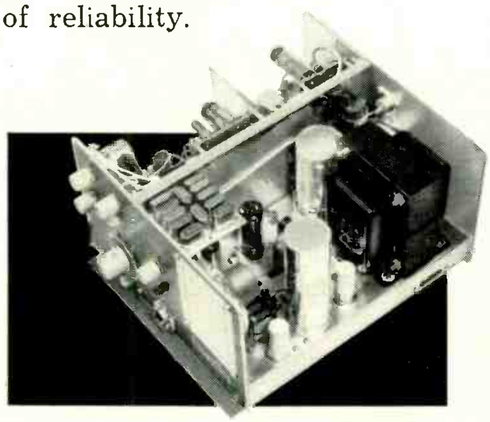

Crystal filter for minimizing adjacent channel interference. Built-in calibration circuit ● 12-position crystal controlled transmit channel selector ● Front panel microphone jack ● Provision for connecting external speaker and S/meter ● Tunable dual conversion superheterodyne receiver covering all 23 channels. ● Two crystal controlled receive positions ● Push-to-talk operation ● Three way power supply for 6/12 vdc and 115 vac ● Five watts plate input ● Certified tolerance ± .005% ● Brown cabinet with brown and silver panel ● Dimensions: 5½" H. x 8½" W. x 9" D.

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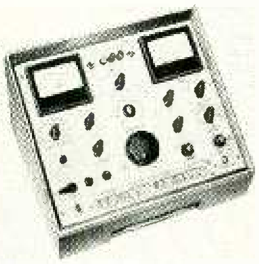
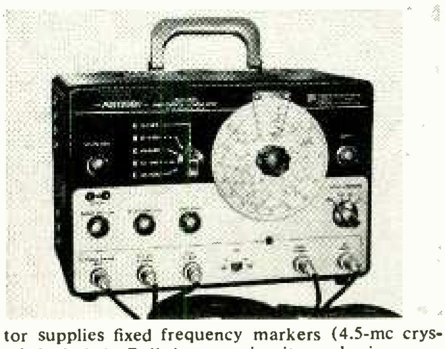


60 cycles, duty cycles .006 to 0.1. Tests diodes, Zener diodes, tunnel diodes, silicon controlled rectifiers, photodiodes. Collector voltage continuously variable 0-100, to 50 amp current. Base voltage continuously variable from 0-10, to 5-amp current. Built-in roll chart lists data for beta and leakage tests on 1550 transistors.—**RD Instruments,** Div. Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

3-IN-1 TESTER, *model 625 DYNA-TESTER.* Combination tube tester, vom, CRT rejuvenator. Tube tester checks new and commonly used tubes, including nuvistors. Novars, 10-pin tubes and 12-pin compactrons. Checks voltage regulators, thyratrons, auto radio hybrids. European hi-fi tubes, most industrial types. Checks for shorts, grid emission, leakage and gas. Adjustable grid-emission check, sensitivity over 100 megohms. Checks each section of multi-section tubes separately; checks

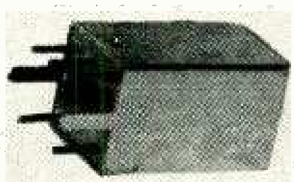
tube quality and cathode emission under current loads simulating actual operating conditions. Vom ranges: 0-10, 100, 1,000 volts dc; 0-10, 100, 1,000 volts ac; 3-ohm center scale, 1-ohm range. CRT section tests and rejuvenates picture tubes at correct filament voltages at 2, 6, 8 volts. Checks for leakage, shorts, emission. Removes interelement shorts and leakage. Restores emission and brightness.—**B & K Mfg. Co.,** 1801 W. Belle Plaine, Chicago 13, Ill.

SWEEP SIG GEN MARKER ADDER, *model E-410.* Sweep frequency coverage in 5 fundamental output ranges, 3 to 213 mc. Sweep width continuously variable to 30 mc. Built-in crystal oscilla-



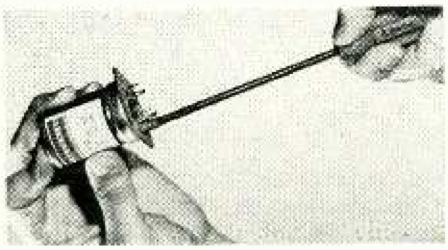
tor supplies fixed frequency markers (4.5-mc crystal included. Built-in agc circuitry, phasing control, dual attenuator, external marker input jack for use of external rf generator as marker generator.—**Precision Apparatus Co., Inc.,** 70-31 84th St. Glendale 27, N.Y.

MICROMINIATURE I.F. TRANSFORMERS. 9/32-in. square, 15/32-in. high. *RTC-9262,* input. *RTC-9263,* interstage. *RTC-9264,* output. All 455-kc frequency. *RTC-9261,* matching oscillator, tuning capacitance 78–110 $\mu\mu$f max. Threaded cup core engages threaded coil support for tuning.—



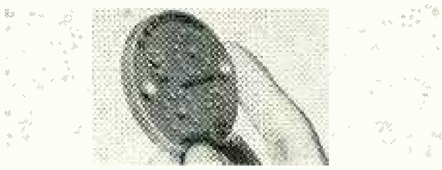
Stancor Electronics, Inc., 3501 W. Addison St., Chicago 18, Ill.

CAPACITOR TAB ADJUSTER, *model ETR-2968.* Slotted end fits over mounting tabs for ease



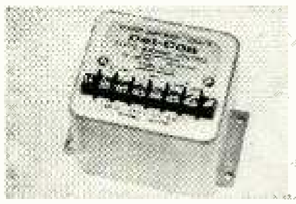
in removing and installing can type electrolytic capacitors.—**General Electric Co.,** Dept. B, 3800 N. Milwaukee Ave., Chicago 41, Ill.

PIN STRAIGHTENER. Hard plastic disc, ¼-in. thick x 2-½ in. diam., contains straightening-hole configurations for 7-, 9- and 10-pin mini-



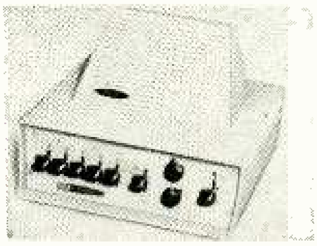
ature tubes, large-circle 9-pin tubes and 12-pin compactrons.—**General Electric Co,** Dept. B, 3800 N. Milwaukee Ave., Chicago 41, Ill.

CONTROL AMPLIFIER, *model CRA-5.* 500-volt-amp solid-state device switches power to ac or dc, controls resistive or inductive loads such as motors, solenoids, clutches, brakes, contacters, electric heaters, incandescent lamps, etc. Operates from manufacturer's static logic elements, or triggered by dc signal source. Supply voltage 25–125



ac, rms; supply transients 400 volts peak, 1-μsec duration. Supply frequency 50–500 cycles, typical. Load currents: ac—5.0 amps rms, 7.0 amps peak, continuous; dc—4.7 amps, average, continuous; surge 25 amps max. Input: signal voltage turn on, 10 vdc; signal current turn on, 5 ma dc max. Maximum allowable signal voltage 30 dc. Ambient temperature range —60°F to 150°F.—**Delco Radio,** General Motors Corp., Kokomo, Ind.

INTERCOM KITS. All-transistor. Built-in ac power supply. Provision for up to 5 stations. 1-watt output, separate level controls for talk and

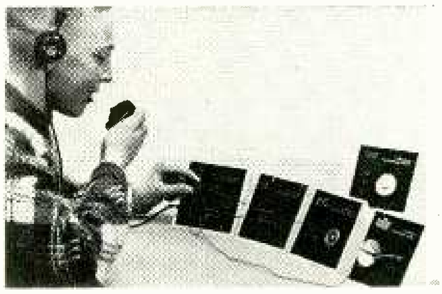


listen. Remotes callable singly. *Kit GD-121,* master station; *kit GD-131* indoor remote, *kit GD-141* outdoor remote.—**Heath Co.,** Benton Harbor, Mich.

SUPERHET CB TRANSCEIVER, *model HE-15B.* 8 crystal-controlled transmitting channels.

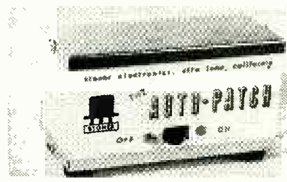
Tunable over full 23-channel band. 3 watts audio output, avc, front-panel rf jack. Power input 5 watts to transmitter final amplifier. Controls: 3-position function switch, planetary vernier tuning, variable noise limiter. Output impedance matches 52- and 72-ohm antennas with coax connector. Built-in PM speaker, input jack for crystal or ceramic mike. Power receptacle for 117-volt ac line, connection for 6- or 12-vdc external power supply. Supplied with channel-9 transmitting crystal ceramic microphone and mounting brackets.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N. Y.

BASIC COMMUNICATION KITS for instruction in communication techniques. Assembly instructions, communication experiments, description of components and functions. *Starter Kit:* 2



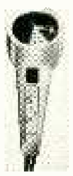
mikes, 2 headphones, all components to build 2 power supplies, 2 control boxes, 2 transistorized speech amplifiers and transistorized voltmeter. 2 *Add-On Kits* may be purchased separately.—**Scientific Development Corp.,** 372 Main St., Watertown, Mass.

CB PHONE PATCH, *Auto-Patch.* Connects phone line to CB system. Fully automatic. Push-



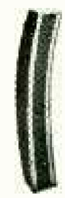
to-talk switch transfers phone-line connection. Gain control on rear apron, plus cable jacks for microphone, speaker and phone line.—**Stoner Electronics,** Baseline and Hellman, Alta Loma, Calif.

MOBILE CERAMIC MIKE for CB and other applications. Hand-held. Push-button operation.



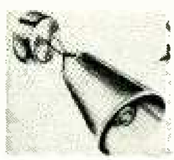
Shielded against pickup from stray fields. Output —52 db below 1 volt/dyne/cm². Ceramic element withstands temperatures —40°F to +300°F.—**Astatic Corp.,** 250 Harbor St., Conneaut, Ohio

RADIATOR PA SPEAKER, *model LR 7.* Nine 5 x 7-in loudspeakers, 2 vhf drivers. Response 100–20,000 cycles. Diffraction horn on driver eliminates beaming of high frequencies. Full half-



section crossover at 3,500 cycles. Horizontal coverage 160°, vertical coverage 45°. Power handling capacity 50 watts, impedance 8 ohms. Universal mounting brackets. 60 x 11 x 14 ins.—**Electro-Voice, Inc.,** Buchanan, Mich.

2-WAY PA SPEAKER, *LIL-8.* Frequency



New Heavy Duty RFI Suppression Kit For Mobile Radio

RADIO HAMS, fleet owners, and CB operators can now enjoy clearer, more readable, less tiring mobile communications at longer effective ranges.

Sprague's new Type SK-1 SUPPRESSIKIT provides effective R-F Interference suppression—at moderate cost—up through 400 megacycles. Designed for easy installation on automobile, truck, or boat engines with either 6-volt or 12-volt generators, the Suppressikit makes possible high frequency interference control by means of Sprague's new, extended range, Thru-pass® capacitors.

The components in the SK-1 Suppressikit are neatly marked and packaged, complete with easy-to-follow installation instructions. All capacitors are especially designed for quick, simple installation.

The generator capacitor is a heavy-duty unit rated at 60 amperes, and will operate at temperatures to 125°C (257°F). This means you'll have no trouble with an SK-1 installation in the terrific temperatures found "under the hood" on a hot summer's day. There's no chance of generator failures from capacitor "short outs," as with general purpose capacitors. The Thru-pass capacitors for use on voltage regulators are also rated at a full 60 amperes.

The Deluxe Suppressikit is furnished complete with an 8-foot shielded lead on the generator capacitor which can be trimmed to necessary length for any car or small truck, preventing R-F radiation from armature and field leads.

Containing only 5 easy-to-install capacitors, the Deluxe Suppressikit is a well-engineered kit. The net price is a little higher than that of many thrown-together kits, but it saves you so much time and aggravation it's well worth the slight extra cost.

For additional information on the Type SK-1 Suppressikit, see your Sprague Electronic Parts Distributor.

65-341 R2

response 300–10,000 cycles; power rating 15 watts; impedance 8 ohms. Dispersion 110°, sound pressure level 119 db; mike sensitivity —27 dm. 15¾ x 6⅛ in.—**University Loudspeakers, Inc.,** 80 S. Kensico Ave., White Plains, N.Y.

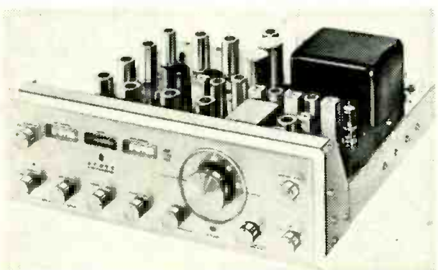
MULTIPLEX RECEIVER, *model MX-7.* FM multiplex stereo tuner. AM tuner. *Master Control* 30-watt stereo amplifier. Multiplex demodulation system, FM tuner with nuvistor rf amplifier tuner, temperature-sensitive line-current limiting resistor.

Master Control: touch lever controls, dual volume controls, bass and treble controls; preset on–off functions, afc, tape input and monitor, phono input, impedance matching, auxiliary input, optional remote unit.—**RCA Electron Tube Div.,** Merchandizing Dept. Harrison, N. J.

STEREO MULTIPLEX RECEIVER, *model TA 3000X. Audio section:* music power output 15 watts per channel; response ±1 db 15–70,000 cycles at normal listening level. Input sensitivities: phono low, 2.0 mv; phono high, 115 mv; tuner, 125 mv. *FM section:* Sensitivity 3.2 μv IHFM, 0.95 μv for 20-db quieting; image rejection 50 db; response

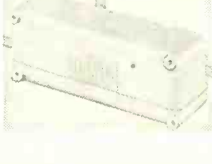
±1 db 10–35,000 cycles. Multiplex adapter frequency response ±1 db 15–15,000 cycles. Distortion unmeasurable at 30% modulation, less than 0.1% at 100% modulation. Hum 60 db below 100% modulation. Output level 1 volt at 100% modulation. *AM section:* Sensitivity 80 μv per meter, terminal sensitivity 7 mv. Selectivity: 10-kc bandwidth, 6 db down. Image rejection 40 db. Distortion 1% harmonic. Response ±2.5 db 20–5,000 cycles. Hum 45 db below 80% modulation.—**Harman-Kardon, Inc.,** Ames Court, Plainview, N. Y.

FM STEREO TUNER, *model 4310.* Built-in electronic brain senses FM multiplex broadcast, switches to stereo operation automatically. 10 front-panel controls. seperate level controls. sep-



arate VU meters. Automatic interstation noise-suppressor, 22 tubes. cascode front end. IHFM sensitivity 1.9 μv; capture ratio 2.2 db; signal-to-noise ratio 60 db; harmonic distortion 0.5%; frequency response 30–15,000 cycles ±1 db; selectivity 50 db. Rack-mounted model available.—**H. H. Scott Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

ANTENNA SPLITTER, *model TX-FM.* Permits reception from common antenna for both TV and FM sets. Separates FM from TV frequencies, filters FM (88–108 mc) through to FM set. Used with ordinary broad-band vhf TV antenna. Placed



anywhere between antenna down lead and FM set. —**Jerrold Electronics Corp.,** 15th & Lehigh Ave., Philadelphia 32, Pa.

INDOOR TV ANTENNAS. *Jet series: model TA707,* aluminum dipole; *TA720* brass; *TA880*

chrome. *Astro-Jet series:* model *TA900* aluminum dipole; *TA990* brass. Both with electronic channel-selector switch and phasing stub. Packed in full-color poly bags.—**JFD Electronics,** 6101 16th Ave., Brooklyn 4, N. Y.

All specifications are from manufacturers' data

NEW BUSINESS GETTERS

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.

STYLUS/CARTRIDGE DISPLAYS. Point-of-purchase materials include "window-blind" wall charts, cartridge dispensers, storage bins in 2

sizes, mobiles, wall banners and plastic tray merchandisers.—**Electro-Voice, Inc.** Buchanan, Mich.

INDUSTRIAL BATTERY SELECTOR eliminates look-up time. Gives battery class, type

number, dimensions. weight terminal connections, plus number of service hours for 3 current drains and end-point voltages.—**RCA,** Electron Tube Div., Harrison, N. J.

ELECTRONIC PARTS—more than 50,000 items from 260 manufacturers—offered in 337-page *1962 Electronic Buyers Guide.* Complete specs. many illustrations.—**Arrow Electronics, Inc.,** 525 Jericho Turnpike, Mineola, L. I., N. Y.

ELECTRONIC PRODUCTS displayed in 180-page *Catalog FR-61-GED.* Includes chemical equipment, knobs and resistors, test instruments, communications and CB products. TV antennas and hardware, audio equipment, mikes and mike accessories. Many photos, complete specs.—**GC Electronics,** 400 S. Wyman St., Rockford, Ill.

SILICON TRANSISTORS, p-n-p fusion alloy, detailed in 28-page *Designers Handbook.* Describes types 2N327A-2N329A, 2N1034-2N1037, 2N1275, 2N1263, 2N1654-2N1656. Fifty graphs and curves show breakdown voltages, large signal characteristics, transconductance values, collector and emitter voltages, noise figures, collector capacitance and switching times. Write on business letterhead. —**Raytheon Co.,** Semiconductor Div., 900 Chelmsford St., Lowell, Mass.

RIGID PLASTIC BOXES, approximately 200 assorted sizes and shapes, pictured in 19-page *Prestige Plastic Showcase Packaging.*—**Bradley Industries, Inc.,** 1650-57 N. Damen Ave., Chicago 47, Ill.

ELECTRON TUBES, 33-page catalog, is reference guide for design and replacement. Contains numerical index plus full specs on manufacturer's complete tube line. Requests on company letterhead honored free of charge. others **50¢.—Amperex Electronic Corp.,** Advertising Dept., 230 Duffy Ave., Hicksville, N. Y.

SPRAY PAINTS AND COATINGS, with 64 color chips, offered in 16-page buying guide. Pictured and described are manufacturer's aerosol finishes, protective coatings. cleaners and industrial lubricants. New products include heat-resistant engine enamel sprays, silicone mold release and electric motor cleaner.—**Krylon, Inc.,** Norristown, Pa.

INSTRUMENT RECTIFIERS described in 4-page leaflet. Multicolor chart shown manufacturer's color code; details on standard types given in spec chart with illustrations.—**Conant Labs,** Box 3997, Bethany Station, Lincoln 5. Neb.

INDUSTRIAL DISTRIBUTOR COMPONENTS shown in new 19-page illustrated catalog. Entire precision potentiometer line listed. including upgraded industrial potentiometers. precision deposited carbon resistors, vitreous enameled resistor and military type resistance devices. Complete specs, many graphs and photos.—**Clarostat Manufacturing Co., Inc.,** Distributor Sales Div., Dover, N. H.

ELECTRONIC COMPONENTS presented in 32-page *Catalog 62.* Products include sockets and shields, plugs and connectors. terminal strips. tip-jacks, binding posts. TV accessories and others. Cross-index, many photos.—**Eby Sales Co.,** 148-05 Archer Ave., Jamaica 35, N. Y.

METAL FILM RESISTORS offered in 2-color brochure. Contains specs, performance characteristics, complete curves, application data. charts and photos.—**Daven,** Div. General Mills Inc., Livingston, N. J.

DYNAMIC HEADPHONES, stereo and mono, described in 4-page illustrated brochure. Includes 19 models, plus replacement parts and microphones.—**Permoflux,** PO Box 1449, Glendale, Calif.

TONE MULTIPLEX BROCHURE. CT-42. 16 illustrated pages describe manufacturer's new solid-state tone multiplex equipment. Detailed data on equipment applications. frequency allocations, component diagrams, transmitter and receiver options plus complete system specifications.—**RCA,** Microwave Dept., Bldg. 15-4. Camden 2, N. J.

HEAT SINKS explained in 4-page Technical Application Data leaflet TA-201.—**Thermalloy Co.,** 4417 N. Central Expressway, Dallas 5, Tex.

BARRY'S GREEN SHEET, Summer Edition, features electronic tubes. semiconductors, transformers, chokes, meters. wire. test equipment, industrial equipment. 45-page illustrated brochure includes many hard-to-find items.—**Barry Electronics Corp.,** 512 Broadway, New York 12, N. Y. **25¢.**

CONTROLLED POWER PRODUCTS described and illustrated in 32-page 1962 Power Supply Catalog. Over 40 new models.—**Raytheon Co.,** Sorensen Products, Richards Ave., So. Norwalk, Conn.

ELECTRONIC PARTS covered in revised 94-page Catalog AD-3964. Sections include: capacitors; resistors and rc networks; antennas and antenna accessories; auto radio. antennas and accessories; fuses, switches. lamps and controls; rectifiers. diodes and transistors. plus cross-reference guide. Covers 55,000 parts.—**Philco Corp.,** Consumer Products Div., Tioga and C Sts., Philadelphia 34, Pa. END

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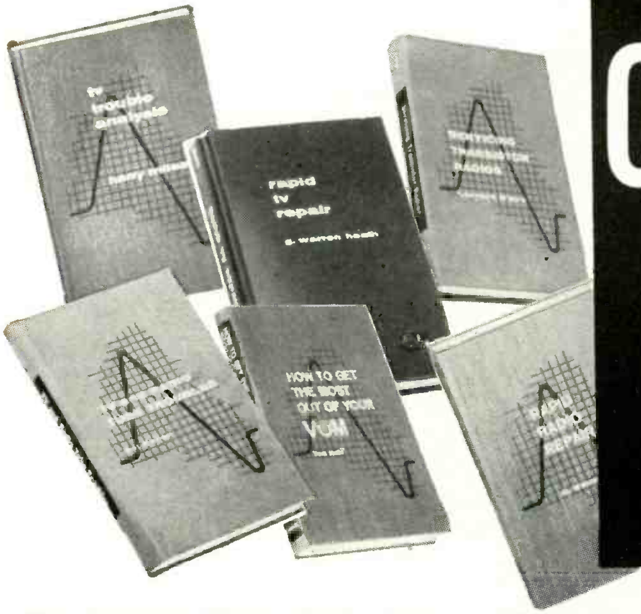

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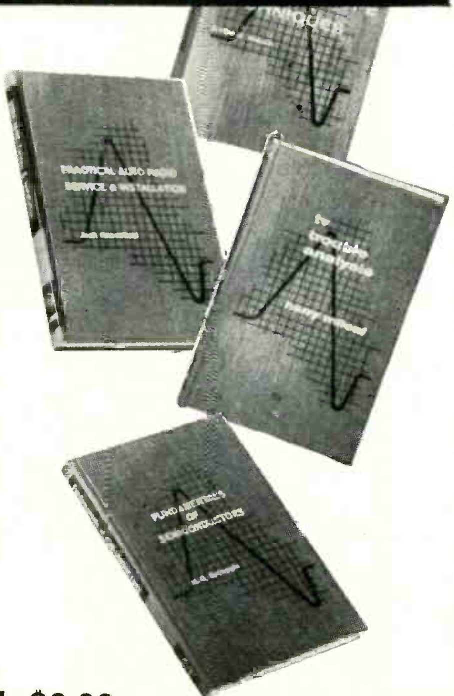

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☐ **PRACTICAL AUTO RADIO SERVICE. By Jack Greenfield**—Covers transistor, hybrid FM and AM models. Compares auto with home radio servicing. Covers removal, installation, troubleshooting, power supplies, interference, suppression, tuner theory, etc.

☐ **FUNDAMENTALS OF SEMICONDUCTORS. By M. G. Scroggie**—Thorough rundown on theory and practical applications of all kinds of semiconductors—transistors, diodes, photocells, solar generators, Hall effect devices, and others. Application of principles in practical devices.

☐ **SERVICING TRANSISTOR RADIOS. By Leonard D'Airo**—Ins and outs of the specialized knowledge needed to handle these tricky sets. Theory, instruments to use, pitfalls to avoid, alignment, hints on how to handle transistors.

☐ **RAPID RADIO REPAIR. By G. Warren Heath**—An alphabetized "instant" guide to finding tough troubles in FM, transistor, hybrid auto sets and other modern receivers.

☐ **SERVICING COLOR TV. By Robert G. Middleton**—Get ready for the color breakthrough! This book answers all your questions about chroma circuits, matrix testing, the flyback system test equipment. Contains numerous troubleshooting charts.

☐ **HOW TO GET THE MOST OUT OF YOUR VOM. By Tom Jaski**—Get more mileage out of this versatile instrument. How to choose, build, work with and extend the use of the VOM.

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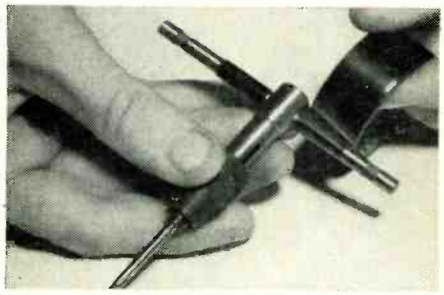
TRY THIS ONE

Encapsulating Electrolytic Capacitors

Next time you build an experimental transistor circuit with those little metal-cased electrolytics, use some Alphex shrinkable tubing to insulate them. Slip a piece of tubing a little bit longer than the capacitor over the unit. Then shrink it down to a tight fit with heat from your soldering iron or over a candle flame. Once it's shrunk down, it won't slip off like an ordinary piece of spaghetti.—*Warren Roy*

Taped Handle Reduces Tap Breakage

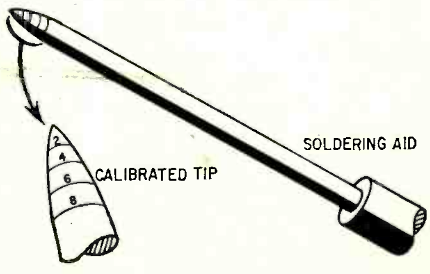
The T-handle of a tap wrench will often slip off center and allow too much pressure to be applied to one side of the tap. Having the handle slip off center



this way sometimes causes the tap to break. Save taps, time and temper by first centering the handle, then wrapping electrician's plastic tape around it as shown.—*Scott Mock*

Measure Nuts and Bolts With a Soldering Aid

Most TV shops have a large box full of unassorted hardware—nuts, bolts, clips, etc. A technician usually spends a lot of time finding matching screws and nuts from this selection.



With my simple gage it is easy to size up a nut or screw. The gage is made in a few minutes from a Hytron soldering aid by sliding different (known) size nuts onto the slim pointed end of the tool. The spot where each nut is stopped is carefully marked with an engraving tool or scriber, or by other means.

Nuts are picked up with the tip of the calibrated tool. Let the nut slide down the tool until it stops. If it's the wrong size, it is dumped in less time than it takes to look at a nut and decide whether to try it. A screw can be gaged by holding it in front of the tool.

There are some variations due to different threads and wear, but overall it is surprisingly accurate. If you have ever been frustrated by nut hunting in the junk box, here is the answer.—*Leonard Prince*

Spray-Can Safety

Accidental pressure on a spray can may make a mess in the caddy. To prevent this, save the protective cap. Carefully mark the location of the spray tube and make a small hole with a scribe or icepick. Enlarge the hole with a tapered rod or punch. This will make a hole with all the rough edges on the inside.

When storing, the spray tube does not have to be removed. It protrudes through the hole.

If you punch or ream a hole in the top of the protective cap and cover the sharp edges with a grommet, the top need not be removed at all.—*Elmer Carlson*

Electric Drill Cuts Control Shafts

The next time you have to cut a volume control or rotary switch shaft, try this time- and labor-saving method. Chuck the end of the shaft in an electric drill, hold the drill steady, and hold a hacksaw against the shaft at the point where you want it cut. A small notch cut into the shaft at the point of the cut sometimes facilitates starting. In addition to the time and work saved, the shaft comes out neater, with the burr in the center instead of the outside. This makes the knob fit straighter. Vibration has not damaged a single switch or control out of about 75 that were cut this way. This method also works well for bolts, as the threads are not damaged.
—*Matthew Fichtenbaum*

TECHNICIANS' NEWS

NATESA Gets Resignations

According to *Home Furnishings Daily*, NATESA (National Alliance of Television Electronic Service Associations) has received resignations from three of its affiliates: the Indianapolis Television Technicians Association; the Television Bureau of Elkhart, Ind., and the Fort Wayne Electronic Service Association, Fort Wayne, Ind.

Multiplex Meeting

Philadelphia, Pa.—FM stereo is no longer a problem to technician members of TSA-Delaware Valley. They attended a technical meeting conducted by E. J. Kob, Zenith's stereo and FM technical training specialist. The meeting was co-sponsored by the association and Pierce-Phelps.

Election Up North

Detroit, Mich.—TSA Hall was the site. The event was the TSA-Michigan annual election of officers. Those elected: Edward J. Brown, president; Charles Nutting, vice president; John Kippinger, secretary; Michael Dallen, treasurer.

Servicing Practices

St. Louis, Mo.—Use of instruments in troubleshooting color-TV was the subject of the technical session held for members of TESA-St Louis at the Ambassador-Kingsway Hotel. The meeting was sponsored by Olive Electronics and the Hickok Electrical Instrument Co. Thomas Clements of Hickok conducted the meeting and demonstrated servicing practices. He followed up with a discussion on color TV.

TSA-Seattle Elects

Seattle, Wash.—After a week's delay (bad weather), the annual election was held. Results showed that the new president was Paul Messer; vice president, Clyde Ellis; secretary, Clinton Cox; treasurer, Hal Hjelte; and new to the board of trustees Connie Jenkins, Ronald Jin and Raymond Howard. Holdover trustees are Art Kessler, Harold Hart and Enos Rice.

California News Front

Tulare—New addition to the California State Electronics Association has been chartered. President of the new Tularie chapter is George Morgan. (Welcome from us too.—*Editor*)

San Diego—Local CSEA chapter reports its color course highly successful with 2 TV stations and 65 shops represented. Moreover, 104 technicians attended the course.

CSEA-Pasadena Meets

Pasadena, Calif.—Dinner and meeting were at the Westward Ho, but the subject was a travel film of the Far East (Japan). A business meeting held later in the month for members of the Pasadena area chapter of the California State Electronics Association featured a talk on servicing tape recorders. It was presented by Vic Short, service manager for Roberts Tape Recorders.

Color Troubleshooting Class

Buffalo, N. Y.—TESA-Buffalo invited all members to a color class at the Continental Inn. Subjects included troubleshooting color TV, shortcuts in servicing color, interpretation of scope patterns, practical demonstration in equipment use, what equipment is really needed. Free schematics of all new color sets were handed out to all who attended. The "instructors" were Carl Meyer, A to Z TV, and Pete Milosevich, Hallmark TV. As expected, it was a big success with members calling for more of the same in the future.

(We welcome TESA-Buffalo's publication to the technician's reading list. TESA *Vision* is a lively, attractive issue every month.—*Editor*)

Two Sets Mean Double Business

Remember the promotion of not too long ago when certain auto manufacturers came out with the slogan, "Two cars for every garage?", one for him and one for her. Then there is the telephone company which has the well-known record of promoting the extension phone idea. We could take a hint from these extremely successful promotion schemes.

Most readers are primarily interested in service with sales as a sideline. Here is a chance to kill two birds with one stone. First, sell the second set, then service it. Generally, a second set is not a new one. Most people will settle for a good rebuilt one, and most of them will prefer to buy it from a service dealer to whom they have been going for regular service.

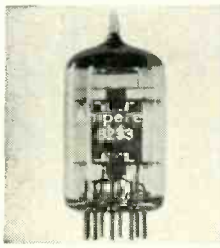
Theoretically, here is a way to double your service business. This sort of a promotion should be going on constantly in one's operation. The average customer, thereby, will be made to at least think of owning a second set. And when he does buy, you have, in effect, added another customer to your list.—*Bob Ebel in The Supreme Effort, TESA-Kansas City, Mo.* END

NEW TUBES and SEMI-CONDUCTORS

PICKINGS WERE SLIM, THOUGH INTERESTING, this month. We've a communications tube with two frame grids, a line of Trinistor controlled rectifiers, 13 "universal" semiconductors, and a twin-triode for mobile communications gear.

8233

A wide-band high-power miniature pentode with a transconductance of 45,000 μmhos at 50-ma plate current and a plate dissipation of 10 watts. A high-power version of the 7788, this tube uses a frame-grid control grid and a frame-grid screen. The control-grid construction gives the high transconductance and the screen-grid construction results in a high ratio of plate-to-screen current.



The Amperex 8233 is designed for military and industrial applications in wide-band pulse circuits, microwave links, radar i.f.'s, video amplifiers and cathode followers.

Trinistor controlled rectifiers

These units (2N1842 through 2N1848), are medium-power devices. They will carry a 16-amp rms forward current. Forward blocking voltage is 25 through 300 volts, depending on the unit. Repetitive peak reverse voltage is

30 to 360. Average forward current is 10 amps at a 180° conducting angle. One-cycle peak surge current is 125 amps and maximum forward voltage drop is 2.3 volts peak at a forward current of 10 amperes.

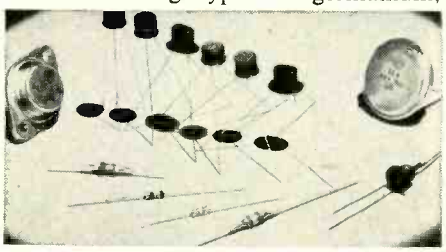
Typical applications for these Westinghouse semiconductors include light dimmers, heater controls, pulse generators, frequency changers and motor controls.

"Universal" semiconductors

As an addition to their line of "universal" replacement parts, G-E has announced 13 semiconductors, said to replace several thousand types now in use.

There are 8 transistors in the group labeled GE-1 through GE-8. Four are p-n-p types and four n-p-n's. They are intended for use as mixer-oscillator converters, and as audio, high-power audio and i.f. amplifiers.

Number nine on the list is a GE-504 power rectifier with a 45-ampere surge rating. It needs no limiting resistor and is designed as a replacement for all existing types of germanium,

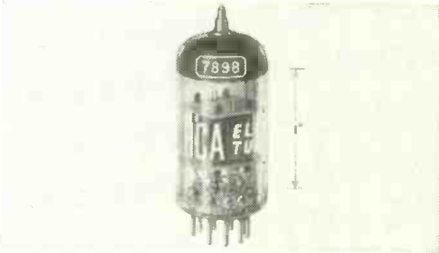


silicon and selenium rectifiers in TV receivers.

The last four units are crystal diodes: 1N34-AS, general-purpose; 1N60, video detector; 1N82-A, silicon uhf mixer, and 1N295, 50-mc detector. These types are said to replace 98% of the crystal diodes now in use in entertainment equipment.

7898

A twin-triode in a miniature 9-pin envelope, this tube is designed for mobile communications equipment as an oscillator, mixer, limiter or dc amplifier. The RCA 7898's heater will withstand voltage variations of 12 to 15 volts and momentary excursions from 11 to 16.

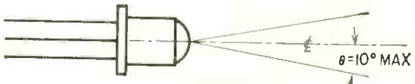


There is a separate pin connection for each cathode.

L-9000 optical transistor

Here's the technical dope for the unit shown on this month's cover.

The Philco L-9000 is an electro-optical transistor designed to respond to both light and electrical signals. It is a silicon, n-p-n, double-diffused epitaxial planar device with its collector electrically connected to its case.



L-9000

Maximum ratings for the L-9000 are:

V_{CBO}	35
V_{CES}	30
V_{CEO}	15
V_{EBO}	5
P_{total} (watts at 25°C)	1.15

When used as a switch (with electrical input), maximum turn-on time is 25 nsec and maximum turn-off time is 75 nsec. With optical input turn-on time is 0.1, and turn-off time 2.5 μsec. 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
Practical Electrics	1921
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 August, 1912, *Modern Electrics*

Wireless Telegraphy, by Guglielmo Marconi.

Selenium Cells, by Samuel Wein.

Resistances of Rectifying Detectors, by Stanley E. Hyde.

A Galena Detector, by Linas Worden, Jr.

A Compact Receiving Set, by Alex T. McCone.

Wireless Clubs, (list of 90).

Modern Wireless Instruments, by R. E. Stark.

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- ☐ 40—ASST. PRECISION RESISTORS in 1 percenters $1
- ☐ 20 — ASS'TED WIREWOUND RESISTORS 5, 10, 20 watt .. $1
- ☐ 10 — ASST. RADIO ELECTROLYTIC CONDENSERS ... $1
- ☐ 5—ASST. TV ELECTROLYTIC CONDENSERS $1
- ☐ 2 — ELECTROLYTIC CONDENSERS 40/40-450v $1
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- ☐ 250—ASST. SOLDERING LUGS best types and sizes $1
- ☐ 1—LB SPOOL ROSIN-CORE SOLDER 40/60 .... $1
- ☐ 1000—ASST. HARDWARE KIT screws, nuts, washers, rivets, etc. $1
- ☐ 100—ASST. RUBBER FEET FOR CABINETS best sizes $1
- ☐ 150—ASST. 6/32 SCREWS & 150 6/32 HEX NUTS $1
- ☐ 150—ASST. 8/32 SCREWS & 150—8/32 HEX NUTS $1
- ☐ 150—6/32 HEX NUTS & 150—8/32 HEX NUTS $1
- ☐ 8—ASST. LUCITE CASES hinged cover, handy for parts $1
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- ☐ 10—ASSORTED TUBES Radio, TV, Industrial $1
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- ☐ 25—FUSE-OHM WIREWOUND RESISTORS 4.7 ohm $1
- ☐ 25—FUSE-OHM WIREWOUND RESISTORS 5.6 ohm $1
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- ☐ 10—DIODE CRYSTALS 1N34 . $1
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- ☐ 3—SILICON RECTIFIERS Top Hat 500ma-400v $1
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Technotes

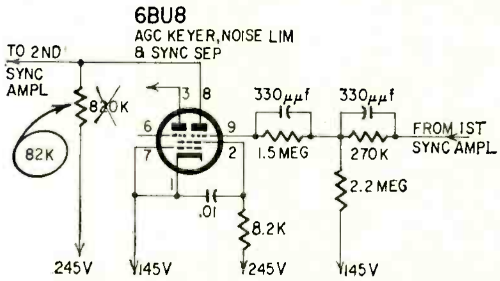
Printed-Circuit Parts Removal

When removing i.f. transformers, filter capacitors and other printed-circuit parts, save yourself a lot of work by first thoroughly heating each individual soldered connection with a hot soldering iron or gun. Once the solder is good and hot, draw or suck it up with a tank type vacuum cleaner. Clean the bag after each job.—*George P. Oberto*

RCA KCS-122BPM1

Several of these sets had poor vertical sync, and when I, the RCA dealer in this locality, complained to the RCA representative in this country (El Salvador), he said he suspected something wrong in their design. I decided to tackle the problem and compared the 6BU8 sync separator circuit constants with those used in other makes and models. Much to my surprise, I found there really seemed to be an error.

The remedy was replacing the 820,000-ohm plate load resistor off pin 8 of the 6BU8 with a 82,000-ohm unit. This immediately stabilized the vertical sync.—*Oscar A. Batres, Jr.*



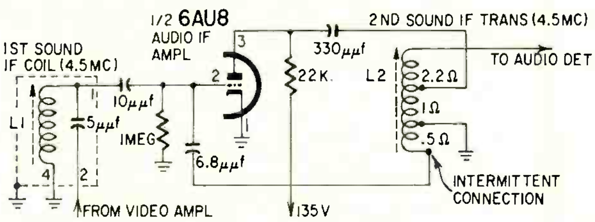
Eastern Industries Speed Radar

When servicing Eastern Industries 2455-mc speed radars, it is good practice to replace the 1N21-B crystal diode detector as a routine if it has been in service any length of time. Frequently, it is the major cause when low sensitivity (reduced range) is the complaint. Front-to-back resistance measurements are not always conclusive at these high frequencies. Incidentally, the 1N21-B can be replaced by the more efficient 1N23-B.

Another item sometimes overlooked because of the inconvenience involved, yet one that will help restore sensitivity, is the antenna. If the unit has been in use several years, remove the antenna protective covers, exposing the eight-bay antenna array. Carefully clean the brass elements and ground reflecting plate.—*Domenic Ripani*

Olympic 14TT91, U; 14TT92, U; 17TU93

The complaint was intermittent oscillation resulting in a dark band across the picture plus distorted sound. We tried everything in the turner and video i.f. until we noticed



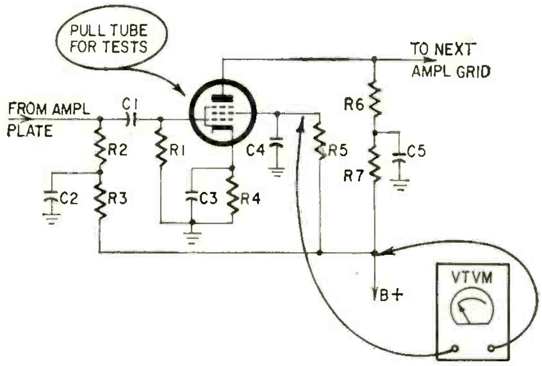
that the oscillation would change frequency as the sound i.f. slugs were adjusted.

The cure was to replace coil L2. An ohmmeter check revealed it had an intermittent connection in the neutralizing winding, resulting in the 6AU8 triode sound i.f. taking off intermittently.—*George P. Oberto*

Locating Leaky Capacitors

The typical amplifier stage shown has five capacitors, any of which may be leaky. Unsoldering each one to test for leakage takes a lot of time and may give your customer the impression that you are a bit uncertain in your trouble-shooting tactics. But you can find the leaky capacitor with a vtvm, isolated from the line and ungrounded.

First unplug the tube from the stage in question. If this kills the B-plus, run a pair of B-plus leads to the amplifier



from your adjustable bench supply. No filament (heater) power is needed. To check C1, connect the vtvm from ground to the grid pin on the socket. With the tube removed, the grid-to-cathode diode effect no longer acts like a clamper, and leakage is detected easily. To check C3, use the vtvm on its ohmmeter range, and measure R4. If the reading is correct, then C3 is not leaking enough to cause trouble.

The other capacitors (C2, C4 and C5) are readily tested by flipping the polarity reversal switch on the vtvm and connecting the negative vtvm lead to B-plus and measuring to the capacitors with the usual probe. With the tube pulled, any indication on the meter again indicates a leaky capacitor. Any leakage too low to show up is definitely not going to affect the operation of the amplifier, unless one of the resistors has opened. This would have been spotted by routine voltage measurements with the tube in the socket.—*Roy A. McCarthy*

Trouble on the Ground Level

Radios can be as "doggie" as recalcitrant TV sets—like this old table model, for example. It crackled and popped louder and oftener than breakfast cereal. All tubes and components tested OK. Routine flexing and tapping produced nothing since any movement at all generated noise. For lack of anything better to do. I began a routine tightening of machine screws and nuts. The tuning capacitor was fastened and grounded to the chassis by three screws. Two of them were too tight to even budge. The third was about a quarter-turn loose. When it was snugged down, the radio's trouble vanished, taking mine along with it. Maybe you can explain it to me!—*E. W. Fisk*

Lazy-man's Radio Alignment

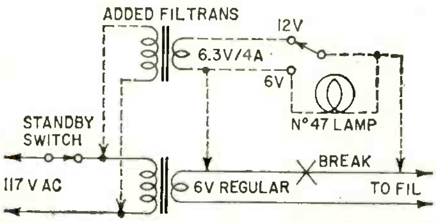
Want to eliminate all that signal generator dial twisting when aligning an AM radio? If so, try this: Set the generator to 540 kc and radiate a signal into the set's antenna. Move the radio dial to 1620 kc (the generator's third harmonic) and set the oscillator trimmer. Then move the dial to 1080 kc (the second harmonic of 540 kc) and align the antenna trimmer. After that, finish up by going down to the lower end for padder adjustments. Using harmonics this way saves much time and effort.—*John A. Comstock* END

NOTEWORTHY CIRCUITS

6- or 12-Volt Power Supply

The simple addition of a 6-volt filament transformer and an spdt switch will greatly increase the usefulness of the Heath PS-4 power supply for either 6- or 12-volt needs. The circuit change is indicated in the diagram.

A 6-volt filament transformer winding is added in series with the regular filament supply to give a total of 12 volts when selected by the spdt switch. To prevent accidental application of 12 volts when a 6-volt supply is required, a red-jeweled pilot lamp can be added. The wiring shown connects

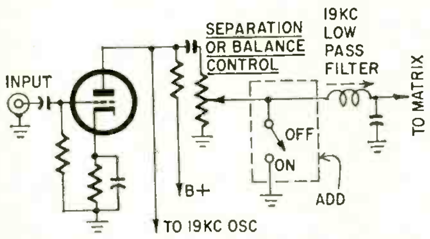


the warning lamp to the added 6-volt winding only when the 12-volt source is used.

I mounted the new pilot lamp to the left and slightly below the original indicator. The switch was installed on a line with it to the right of the original indicator.—*W. C. Cloninger, W4NX*

Search Control for FM Stereo

If your multiplex adapter does not have an automatic stereo indicator, you must listen pretty carefully to tell if a station is broadcasting FM stereo. Here is a simple modification that makes it easy to tell when a station is broadcasting stereo. The modification can be added



to Crosby, Heath and other matrix type adapters.

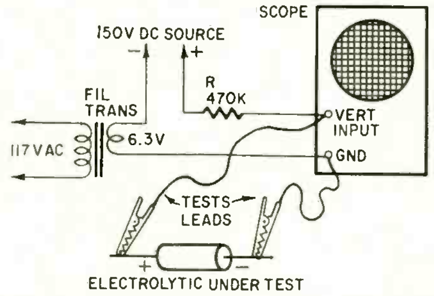
Connect a spst switch between ground and the L + R line, on either side of the 19-kc filter as in the diagram. Now, it is easy to identify a stereo broadcast. Throw the switch to ON to ground the L + R line. There will be no output from the speakers on a monaural program. If you hear anything, it is the L − R difference signal that is present only during a stereo broadcast. Throw the switch to OFF and enjoy full FM stereo.—*Bennett C. Goldberg*

[Or, if you have a separation control on the adapter, simply turn it "off" as far as it will go. That will kill the L + R, allowing you to hear only difference signals—and various types of interstation hash—as you tune across the band looking for stereo stations.—*Editor*]

Checking Electrolytics

The diagram shows a simple means for checking electrolytic capacitors to determine whether they will be noisy if used as filters in dc supplies of 100 volts and upward.

Some days ago my son brought in his record player. As soon as the set warmed up, a 60-cycle hum was produced loud enough to be heard around the block. All normal checks showed no trouble, the plate circuits showing infinite resistance to ground. I finally re-



sorted to substituting part by part. When the electrolytic capacitors on the filter circuit were replaced, all the noise disappeared.

I then tried out several ways of testing the defective capacitors and finally hit upon the method shown in the sketch. While this may be a commonly used test, I have yet to come across a description of it.

Once I had the instruments set up, I tested all the spare electrolytics I had in the shop. I found two more showing a positive result and, as they were of about the same rated capacitance as the defective electrolytics, I tried them out on the record player. Sure enough, the 60-cycle hum reappeared.

Referring to the sketch, I used

both 5Y3 and 6AX5 tubes in the 150-volt dc source and found no difference in the results. With an acceptable capacitor under test and with maximum vertical gain on the oscilloscope, I could not obtain a 60-cycle pattern of greater than one or two minor divisions on the vertical scale. With defective capacitors, readings of 15 to 20 on the vertical scale were obtained. Incidentally, the two defective capacitors which I found among my spares were both new!

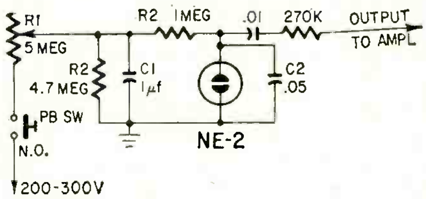
I tried substituting a vtvm or a multimeter for the oscilloscope and found either would give satisfactory results. More significant readings were obtained my reducing R to 150,000 ohms when using either of the voltmeters. With the vtvm I obtained readings of 0.15 volt with defective capacitors, while good capacitors showed no voltage. Readings could be obtained most easily by observing the voltmeter scale while connecting and disconnecting the 117-volt ac source. The multimeter was used in much the same manner with a 1.5-volt setting and the DB OUTPUT. Defective capacitors gave a reading of 0.1-volt with the multimeter.

Although, with but little elaboration, this setup could be used to obtain approximate quantitative results, the simple layout shown will effectively allow defective electrolytic capacitors in this voltage range to be weeded out quickly.—*Robert W. Gausmann*

Electronic Siren

At the request of a customer, I designed this electronic siren and added to his intercom system. The siren was supplemented by several additional speakers installed in stragetic locations.

When the pushbutton switch is closed, voltage is applied to C1 through



R1. As C1 charges, the voltage across it rises gradually toward the supply voltage level. This rising voltage is applied to the relaxation oscillator consisting of R2, C2 and the neon lamp. The circuit starts to oscillate at around 1,000 cycles. The rising causes a progressive decrease in frequency and volume, thus simulating the characteristic siren tone.

The parts were assembled on two five-lug mounting strips mounted on the amplifier chassis close to the volume control. The output lead goes to the hot terminal on the volume control.—*L. M. Dilley.* END

new PATENTS

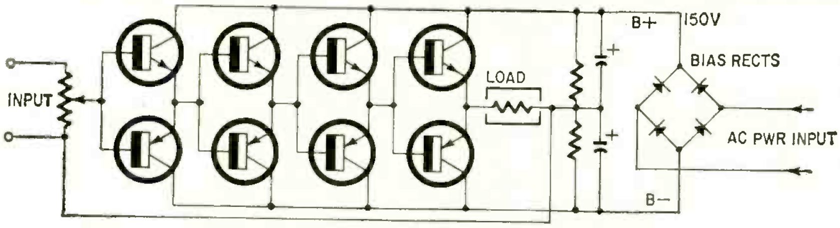
MULTISTAGE AMPLIFIER

Patent No. 2,994,834

Edward M. Jones, Cincinnati, Ohio (Assigned to Baldwin Piano Co., Cincinnati)

Each stage is comprised of a complementary pair of transistors, connected as emitter followers. Therefore, the input impedance of this amplifier is very high and the output impedance is very low. If each stage is correctly balanced, as much current flows *into* one transistor as flows *out* of its mate, leaving zero output current.

Signal input increases the internal resistance of one transistor, while decreasing the resistance of its mate. This unbalance current becomes the input for the next stage, and so on. The sum of all unbalance currents flows into the load. An input of a few milliwatts can produce as much as 70 watts output in a typical chain.



Since each stage handles greater current than the preceding one, the inventor suggests making each pair of transistors slightly larger than the preceding pair.

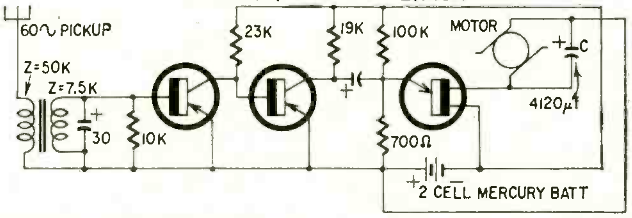
The power supply is a conventional center-tapped circuit using a bridge network.

BATTERY-OPERATED SYNCHRONOUS CLOCK

Patent No. 3,001,114

Lee N. Hermann, St. Charles, Ill., and Richard P. Landgraf, Chicago, Ill.

An electric clock is as accurate as the frequency that controls it. This one runs from batteries, but is controlled by stray 60-cycle hum generated by power lines in the walls. Positive half-cycles break it down, putting the synchronous motor across the mercury battery during these intervals. This occurs 60 times each second, of course.



A probe or antenna picks up hum voltage which is amplified by two transistors, both in common-emitter circuits. The third transistor is a Unijunction, which acts like a thyratron.

A large capacitor, C, smooths the abrupt on–off voltage supplied to the motor, making it more nearly sinusoidal.

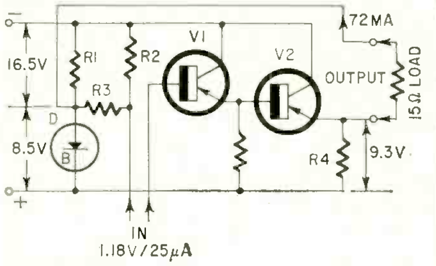
CURRENT AMPLIFIER

Patent No. 3,005,957

Earl W. Grant, Los Angeles, Calif. (Assigned to Stratham Instruments, Inc., Los Angeles)

This is a bridge whose arms are R1, D (a Zener), V2 and R4. At balance, no current flows through the load. Divider R2, R3 determines a point with the same potential as V1's base. Therefore the input terminals may be shorted without affecting balance.

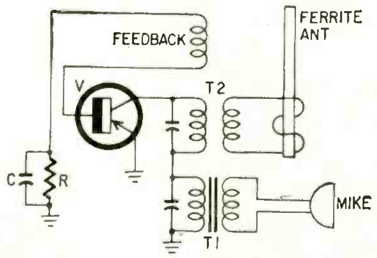
The input signal varies V1's bias. In turn, this emitter follower controls a second follower V2, which unbalances the bridge. Due to transistor gain, sensitivity is very high. A signal of 1.18 volts at 25 μa gave an output of 72 ma. Typical voltages were as shown. Both ac and dc may be amplified.



RADIO TRANSMITTER

Patent No. 2,999,926

Dietrich A. Jenny, Princeton, N. J. (Assigned to Radio Corp. of America)



The transistor in this circuit has three functions: it amplifies af from a microphone; rectifies the af to provide bias, and oscillates at rf. T1 is the audio transformer. The rf transformer, T2, has a feedback winding. R-C is the filter which smooths the audio. The modulated rf is coupled to a ferrite-core antenna which radiates the signal.

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