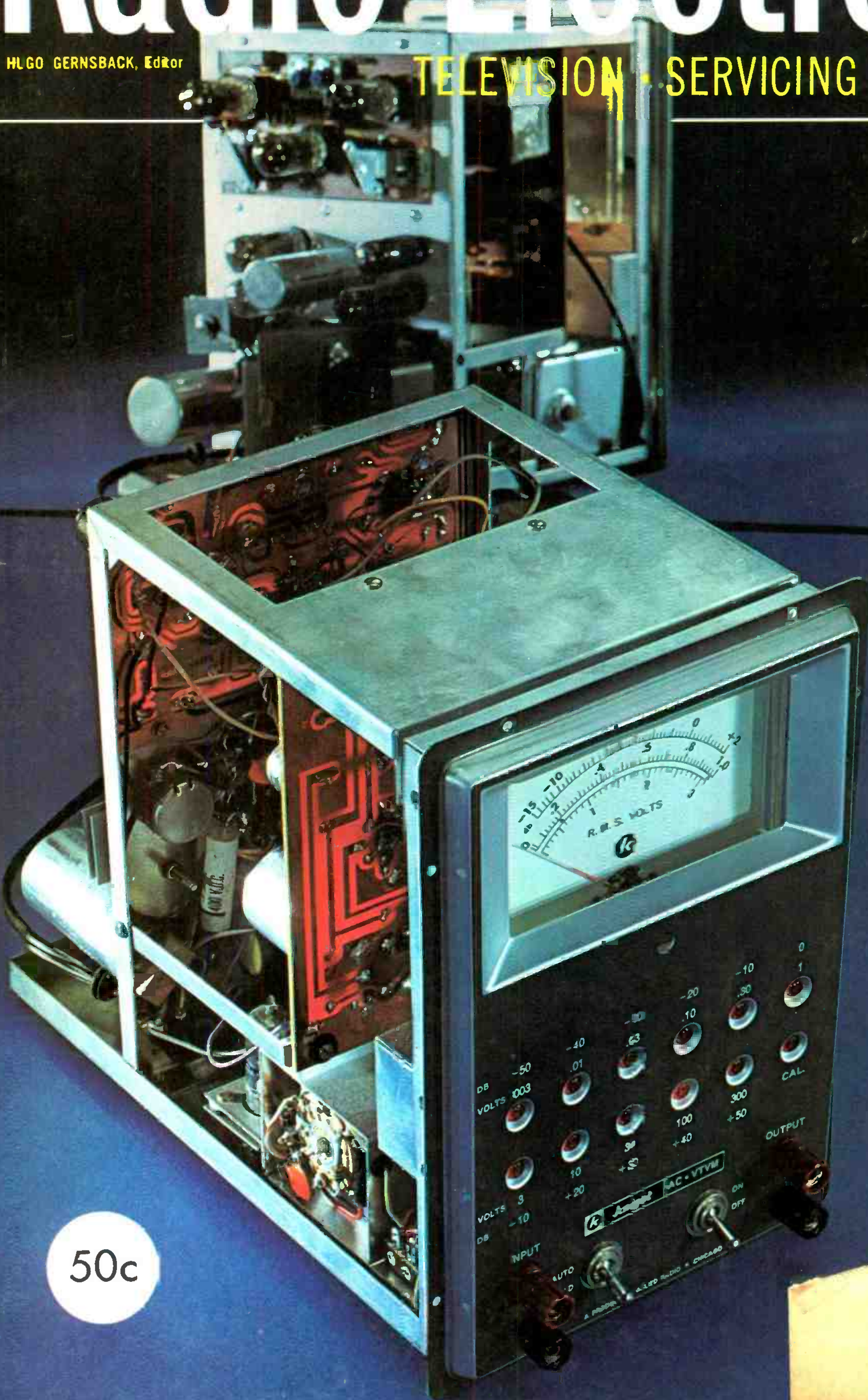
Build the Super-8 Transistor Radio

AUGUST 1960

Radio-Electronics

HUGO GERNSBACK, Editor

TELEVISION · SERVICING · HIGH FIDELITY



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Handy Transceiver For Citizens Band

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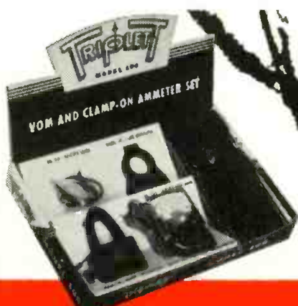

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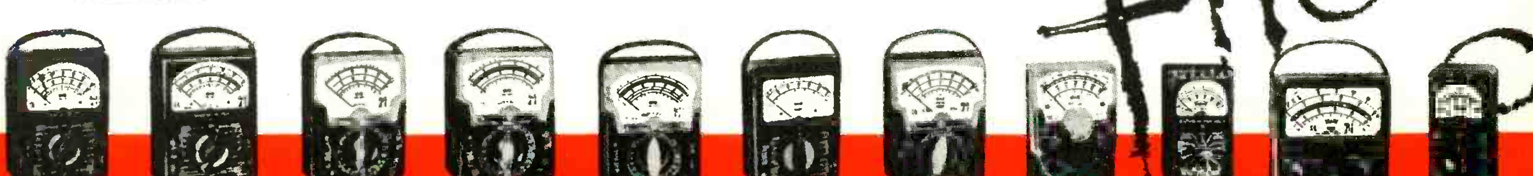

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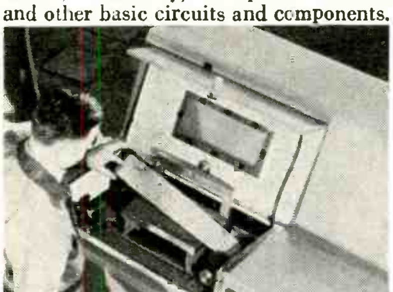

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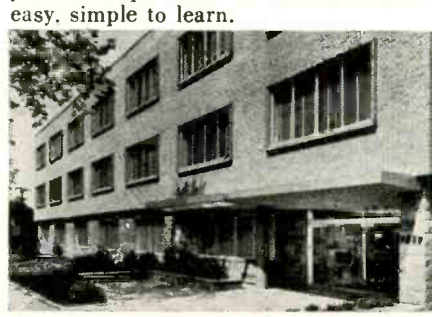

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AUGUST, 1960

Radio-Electronics

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ON THE COVER

(story on page 26)

The Knight-Kit ac vtvm out of its case—from the front and from the rear. When an unknown voltage is applied, a motor-driven range switch selects the correct range automatically.
Color original by Habershaw Studios

Average Paid Circulation Over 174,000

RADIO-ELECTRONICS is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

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SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscriber Service, 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.
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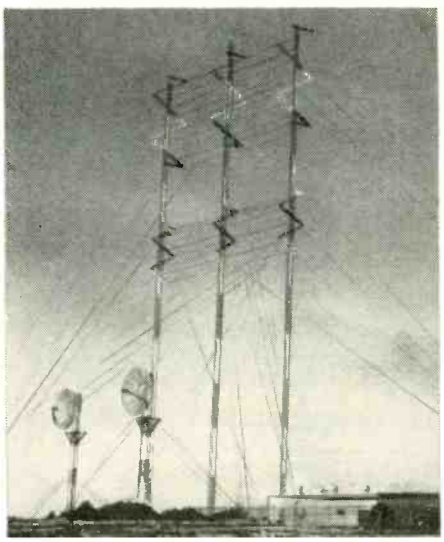
News Briefs

Scatter Communications For Armed Forces

A 6500-mile communications system designed to give the Pacific area virtually troublefree communications has gone into operation. Built for use by the Armed Forces, the Pacific Scatter Communications System uses advanced ionospheric and tropospheric scatter propagation to give better than 99% reliability. Unlike most scatter systems, parabolic antennas are not used. Instead, 200- and



400-foot antenna arrays composed of stacked dual-frequency corner reflectors handle the signals rather than the more usual dishes. The ones shown in the photo are at the Wake Island station.

The scatter technique beams radio signals at the ionosphere or the troposphere, to bounce back to earth in a scattered fashion. The signals are not broken up. They are only scattered. Diversity reception is used. One receiver will pick up the clearest signal. If it should fade, another receiver will pick up another "branch" of the same signal without a lapse. In this way a steady flow of intelligible troublefree information is insured.

The system, which was built by the Army and Page Communications Engineers, permits reliable communications between a transmitter and receiver 600 to 1,200 miles apart, even under conditions which disrupt normal long-distance radio signals.

Pushbutton Censorship

Advertisers were warned by Ross D. Siragusa, president of Admiral Corp., to keep their commercials on a high plane or risk having their messages turned off by viewers from their easy chairs. He said: "No longer must a viewer go to his TV set to turn it off or change stations. He can do this in a split second with a simple remote control."

Speaking at a meeting of 1,200 Eastern TV dealers at Miami Beach, Fla., Siragusa estimated that 10% of sets being sold today have remote controls. He said: "Advertising men and advertisers on TV can no longer ignore the threat held by an estimated 3,000,000 homes having TV receivers with remote controls. Television is too costly a medium for advertisers to risk pushbutton censorship."

Solid-State Transducer

A solid-state transducer using silicon wire has been developed by Statham Instruments, Inc., Calif.

The newly developed transducer has thermal characteristics equal to those of a standard strain gauge. Thermal coefficient of sensitivity is around .015% per Fahrenheit degree with a thermal zero shift of less than .01% of full scale per Fahrenheit degree.

The output level is high—about 30 to 40 times that of a conventional strain gauge. This makes the semiconductor transducer fully compatible with existing telemetry equipment without the need for the amplifiers used to raise the conventional gauge's output level.

It is expected to be on the market in about 5 months.

Recording Standards for Tape

The Magnetic Recording Association has adopted terminology standards on the use of the words channel and track. The most important point in the standards is one that affects the stereo man. It states: "In a multichannel system, the number of channels cannot exceed the number of tracks." In other words, if a particular stereo program is recorded on two tracks you cannot have three-channel playback—the sound that comes from a fill-in speaker that eliminates the hole-in-the-middle does not qualify as a third channel.

Some of the specific definitions:

A *channel* is a single complete electronic transmission path for sound; it must include one or more separate microphones, an amplifier, one or more loudspeakers. It may have a recorder and reproducer interposed as a time storage device. In a multi-channel system the number of channels is equal to the number of main transmission paths.

A *track* is a path which contains reproducible information left on a medium by recording means energized from a single channel.

When a time storage device is used, the channel may be divided into two parts: the recording channel and playback channel.

A *recording channel* includes the means by which sound is prepared for storage on a single track.

A *playback channel* includes the means by which the recorded sound on a single track is reproduced.

Electronic Highways Come A Step Closer

A full-size electronic highway has had its first public showing. Demonstrated by RCA in cooperation with General Motors, two specially equipped cars were guided automatically around a test track at RCA's David Sarnoff Research Center in Princeton, N. J. Acceleration, braking and maintaining a safe distance between vehicles were all automatically controlled by electronic signals from the road. (RADIO-ELECTRONICS described this system in an article by Vladimir K. Zworykin, "Electronics Guides Your Car". This story in the April, 1959, issue was one of a series on electronic highways.)

During the tests, circuits built into the road were used to inform the cars' "drivers" of simulated road inter-

men 17-55

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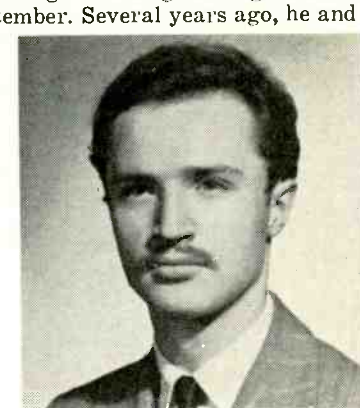
Hugo Gernsback Award

Leonid Garder of Nyack, N. Y., has been presented a 1-year scholarship for 1960–61. This annual Hugo Gernsback Award goes to an electrical engineering student of outstanding ability and promise of success in electronics. Mr. Garder will be a senior at New York University College of Engineering next September. Several years ago, he and his



mother escaped from Russia. They lived in Paris, France, for 7 years but never took out citizenship papers as both Leonid and his mother had always hoped to settle in the US. Today this dream has come true. In Leonid's own words, "I think the man who can appreciate freedom and prosperity most greatly is one who has lived under tyranny, hunger and fear. It is for this reason that I feel especially grateful, to you and to this country for this opportunity."

Winner of the annual $1,000 award is selected by the faculty of the College of Engineering.

Speedy Switching Transistor

A new production technique makes it possible to build switching transistors that work 10 times faster than existing ones. Units made by the new process are called epitaxial diffused transistors. This process forms an extremely thin, lightly doped collector region which is grown on a heavily doped low-resistance layer. The lightly doped area has a high resistance and, by keeping this layer thin, collector resistance is reduced and switching time with it. Epitaxial diffusion makes possible a high-resistance collector layer that is as much as 30 times as thin as usual.

The epitaxial techniques, developed

(*Continued on page* 12)

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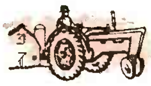

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Ultra-selective, highly sensitive dual-conversion superhet receiver features built-in adjustable squelch and noise limiter. Sensitivity (manual) is better than 1 μv for 10 db S/N; crystal, ½ μv. Includes built-in AC power supply. Easy to assemble; has dependable printed circuitry and pre-aligned IF transformers. With distinctively styled high-impact case, 5 x 12 x 12". Complete with all parts, wire-type doublet antenna, and one transmitting crystal (available for any channel from 1 to 22—specify preference). FCC application form is included (license is available to any citizen over 18—no exams to take). See below for DC mobile supply, vertical antenna, etc. Wt., 20 lbs.

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INSULATION RESISTANCE: 50 megohms to 20,000 megohms. Only 25v d-c is applied, permitting measurements on low-voltage ceramic, paper, mica, and film capacitors. For ceramics rated below 25 volts, IR may be calculated from leakage current measurements at exact rated voltage.

POWER FACTOR: Measured by Wien Bridge from 0 to 50%.

LEAKAGE CURRENT: 0.6μa to 600μa in 7 ranges. Measured directly on meter at exact rated d-c voltage of capacitor. No guessing on eye-width or counting lamp blinks!

A-C BRIDGE VOLTAGE: Only 0.5v is applied to the bridge. The voltage across the capacitor is less than this applied voltage, the amplitude depending upon capacitance being measured. No danger of overheating and ruining even a 1-volt electrolytic or a 3-volt ceramic.

POLARIZING VOLTAGE: Continuously adjustable, 0 to 150v.

STABILITY: Dual regulation of the power supply assures short-time reliability, while specially processed etched circuits and complete encapsulation of the critical meter amplifier insure long-time stability.

MAGIC-EYE TUBE: Simplifies bridge balancing for capacitance and power factor measurements.

HIGH GAIN AMPLIFIER: Sensitivity control for magic-eye null detector permits accurate measurements of small capacitances.

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NEWS BRIEFS *(Continued from p. 8)*

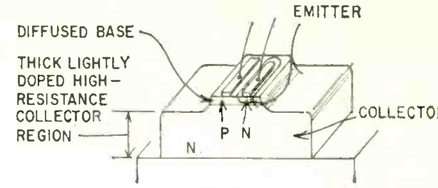

Fig.1

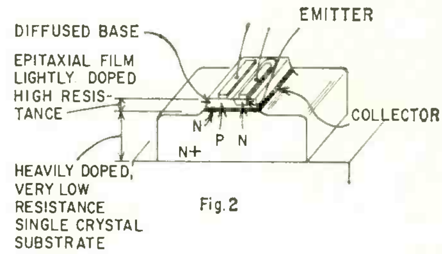

Fig.2

by Bell Telephone Laboratories, can be added to existing diffused-base transistor production lines with little trouble. The process is simple. Single crystal wafers of heavily doped material are cut and polished. Then a thin film (about 0.1 mil) of a lightly doped material is deposited on the wafer to provide the desired collector region. From this point on, standard diffused base techniques are used. The diagrams show the difference in the construction of standard (Fig. 1) and epitaxial (Fig. 2) switching transistors.

Frieda Hennock Passes

The only woman ever to become a member of the Federal Communications Commission died June 20 at the age of 55, following brain surgery.

Appointed to the FCC in 1948, Miss Hennock soon became the most active and controversial member of that body. Her activities were usually directed toward the listener–viewer interest and against those entrepreneurs who considered the TV channels exclusively a means of making money. A ceaseless and untiring campaigner for her ideas, her own remark that she "did the work of five men" was never challenged. Miss Hennock served until the expiration of her term of office in 1955.

Want Pay Raise—Miss TV

A report comes from London that the National Union of Mineworkers in England has requested a pay raise for miners on the nightshift. The reason—they don't get to see any evening TV shows.

Do-It Yourself Kit Not Cheap

A do-it-yourself kit designed to enable engineers to design and fabricate micromodules and electronic circuits that put several hundred thousand parts in a cubic foot of space may be one of the most expensive do-it-yourself projects in the US.

According to Dr. Alan M. Glover, vice president and general manager for RCA's Semiconductor and Materials Div. (they make and sell the kit), the Micromodule Laboratory *(Continued on page 16)*

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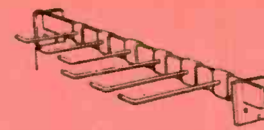
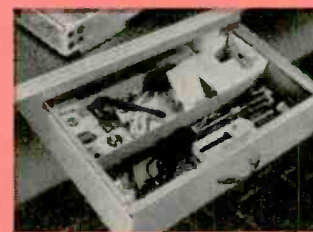


NEW RCA Accessory Bar Kit attaches to wall or shelf-unit standards. Movable hooks support anything from wire spools and tools to test instruments.



NEW RCA Special Drawer Unit provides a three-way benefit. Attaches under counter as utility drawer in service shop, cash drawer in sales area; or several drawers can be stacked together as a separate stand-up unit.

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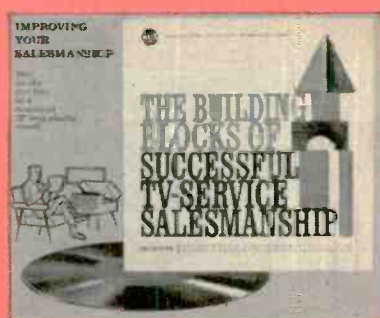
Here for the first time on a convenient 12" LP record are proven ideas on how to sell your services more effectively. Just sit and listen. Discover how you can apply successful selling techniques to the every-day aspects of your business.



Down-to-earth tips on: • Your Store • Handling Store Customers • Telephone Techniques • Home Service Calls • Advertising—and much more.

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Profitable new business awaits you in COLOR TV SERVICING—provided you're ready to take advantage of it. Now RCA—world's foremost color TV authority—offers you a FULL 11-LESSON HOME STUDY COURSE to make you the color TV expert of your community. Prepared by RCA Institutes, it's a complete education in principles and practices of color TV servicing. ACT NOW: the course is a limited-time offer through your RCA Tube Distributor.

And to supplement the course, the famous RCA COLOR TV PICT-O-GUIDE makes an ideal refresher and quick reference on color-TV problems and how to correct them.

speed YOUR SERVICE

Make your home service calls faster, easier. This new lightweight, compact "Quick Call" Tube Caddy has a rugged wooden construction with two-color leatherette covering. This perfect mate to the big RCA "Treasure Chest" is just the thing for service calls that don't require a full tube complement.

New Lightweight "Quick Call" Tube Caddy

Standard "Treasure Chest" Tube Caddy

NEWS BRIEFS *(Continued from page 12)*

Kit will enable engineers and manufacturers to experiment with micromodules in their own laboratories, reducing design time drastically. With the kit an engineer needs only 10 feet of workbench and a tank of nitrogen to go into the miniaturized-circuitry business.

A micromodule kit starts with the completed wafers and includes all equipment needed to build and test up to 10 modules for the exact values and configurations which the design engineer wants. It will sell, Dr. Glover says, for "less than $8,000."

Transparent Semiconductor

Methods of growing single crystals of gallium phosphide, a transparent semiconductor material, are being developed at Bell Telephone Laboratories. The properties of this substance are also being investigated. Since the material is transparent, it is possible to observe visually the differences which take place under varying conditions of doping and electron density. The largest single crystals produced so far measure ¾ inch long by ¼ inch square. The experimental work is aimed at a general understanding of semiconductors and junctions.

Motels Like TV

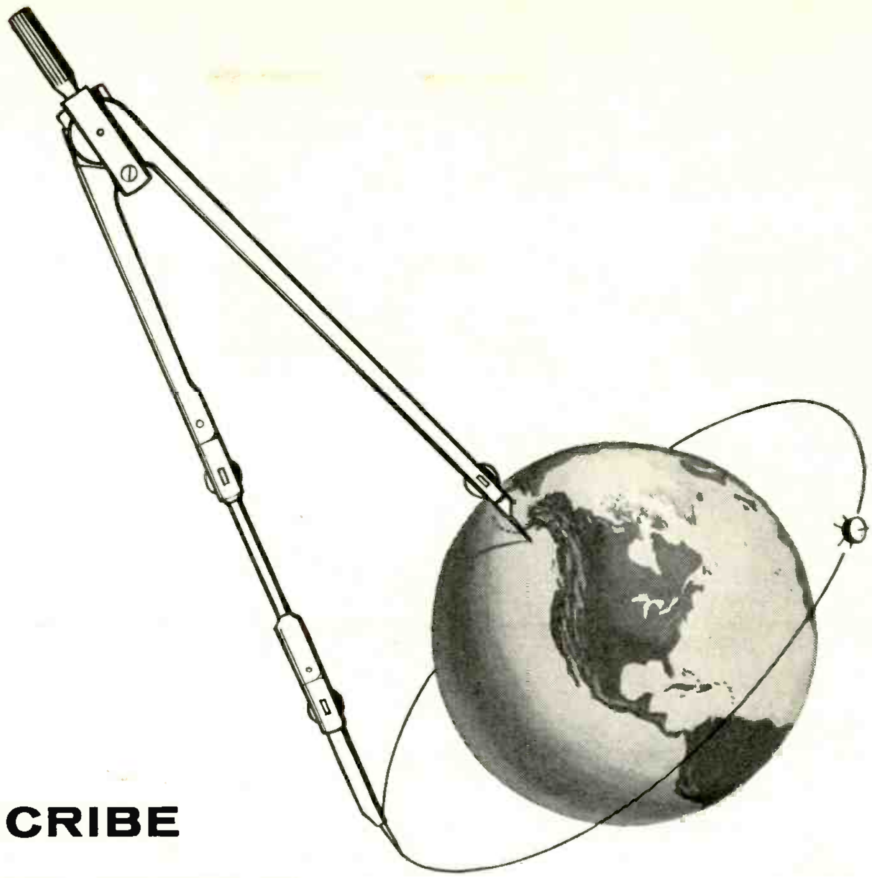
A nation-wide survey of TV sets, antennas and service revealed that 15,660 out of 19,337 motel rooms have TV sets, according to *American Motel Magazine*. Most of those who do not have sets installed plan to get them within the next year.

Motel owners indicated that the greatest problem related to room TV installations is not reception or servicing, but instead is the misuse, mishandling and tampering with sets by guests. They rated sturdiness as one of the lesser problems along with theft and antenna trouble. The owners also showed a marked preference for master antenna systems over indoor antennas and individual room systems.

Piezoelectric Compounds

The discovery of two strong new piezoelectric compounds—zinc oxide and cadmium sulfide—has been reported by Dr. A. R. Hutson of Bell Telephone Laboratories. The degree of piezoelectricity of zinc oxide is about four times as great as that of quartz while that of cadmium sulfide is about twice as great.

Both zinc oxide (ZnO) and cadmium sulfide are n-type semiconductors with the ZnO having a room-temperature resistivity of less than 10^3 ohm-cm. This relatively low resistivity effectively shorts out all experimental evidence of piezoelectricity unless the ZnO is first doped with an impurity (lithium) that accepts the excess electrons (which contribute to the conductivity). After doping, the resistivity of the ZnO was raised to 10^{12} ohm-cm.



HOW TO SCRIBE A "PERFECT" CIRCLE IN OUTER SPACE

Bell Laboratories guidance system achieves unprecedented accuracy in steering Tiros weather satellite into orbit

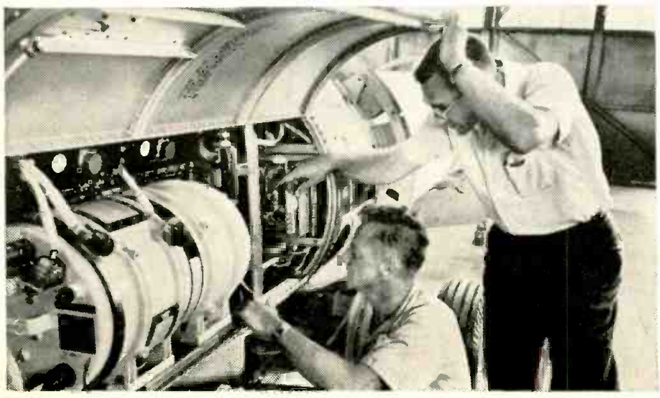
Equipped with TV cameras, tape recorders, solar cells and antennas, the world's most advanced weather satellite, the NASA Tiros I, had to be placed in a precisely circular orbit at a specified altitude to do its job well.

The "shot" was a virtual bull's-eye. The mean altitude was within *one mile* of that planned. And the deviation from this mean was less than ½ per cent, making it the most-nearly-perfect circular orbit ever achieved with a space vehicle by either the United States or Russia.

The dependability and accuracy of Bell Laboratories' ground-controlled Command Guidance System has been proven before—in the successful test flights of the Air Force Titan intercontinental ballistic missile, and in last year's Air Force Thor-Able re-entry test shots from which the first nose-cone recoveries were made at ICBM distance. Now, with Tiros, the system contributes to a dramatic *non*-military project. Other uses are in the offing.

This achievement in precise guidance again illustrates the versatility of Bell Laboratories' research and development capabilities—directed primarily toward improving your Bell telephone service.

Two Bell Laboratories engineers, T. J. Grieser and D. R. Hagner, look over the second-stage section of the Air Force Thor-Able missile used to launch the NASA Tiros weather satellite.



BELL TELEPHONE LABORATORIES

World center of communications research and development

Dr. Hutson predicted that the compounds would be put to use as ultrasonic transducers for certain applications.

Calendar of Events

Global Communications Symposium, Aug. 1–3, Statler Hotel, Washington, D. C.

National Audio-Visual Association Convention and Exhibit, Aug. 6–9, Morrison Hotel, Chicago.

Electronic Packaging Symposium, University of Colorado, Boulder, Colo., Aug. 18–19.

National Alliance of Television & Electronic Service Associations Convention, (NATESA) Aug. 18–21, Congress Hotel, Chicago, Ill.

Western Electronic Show & Convention, (WESCON) Aug. 23–26, Memorial Sports Arena, Los Angeles, Calif.

British Radio & Television Exhibition, Aug. 24–Sept. 3, Earls Court, London, England.

International Conference on Semiconductor Physics, Aug. 29–Sept. 2, Prague, Czechoslovakia.

International Symposium on Information Theory, Aug. 29–Sept. 3, London, England.

Joint Automatic Control Conference, Sept. 6–8, M.I.T., Cambridge, Mass.

New York High Fidelity Music Show, Sept. 6–11, New York Trade Show Bldg., New York, N.Y. (RADIO-ELECTRONICS and GERNSBACK LIBRARY will exhibit in Room 525).

2nd EIA Conference on Value Engineering, Sept. 7–8, Disneyland Hotel, Anaheim, Calif.

Joint Military Industrial Electronic Test Equipment Symposium, Sept. 14–15, Museum of Science & Industry, Chicago, Ill.

Eighth Annual Engineering Management Conference, Sept. 15–16, Morrison Hotel, Chicago, Ill.

Upper Midwest Electronic Trade Conference, Sept. 15–17, Minneapolis Auditorium, Minneapolis, Minn.

New England High Fidelity Show, Sept. 16–18, Boston, Mass.

ERA Business Management Institute, Sept. 18–23, Urbana, Ill.

International Symposium on Data Transmission, Sept. 19–21, Technische Hogeschool, Delft, Netherlands.

National Symposium on Space Electronics and Telemetry, Sept. 19–22, Shoreham Hotel, Washington, D. C.

Industrial Electronics Symposium, Sept. 21–22, Sheraton-Cleveland, Cleveland, Ohio.

High Fidelity Show, Sept. 23–25, Palmer House, Chicago, Ill.

ISA Fall Instrument-Automation Conference & Exhibit and 15th Annual Meeting of Society, Sept. 26–30, Coliseum, New York, N. Y.

Subsidiary Rule Eased

The Federal Communications Commission has decided to allow a limited increase in FM subsidiary communications activities. FM broadcasters will be permitted to use multiplex subchannels for transmitting material "of a broadcast nature expressly designed for business, professional, educational, religious, and other special groups of subscribers." Examples of this are "doctor-casting" and remote cueing and order circuits. END

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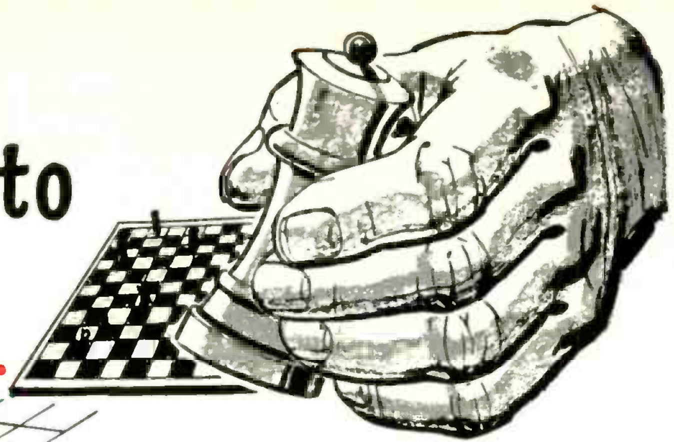

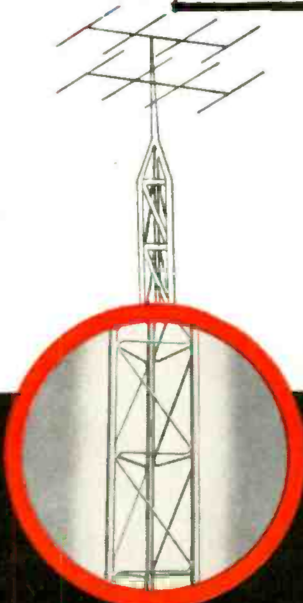

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From every standpoint, ROHN Towers offer you MORE . . . more quality, more variety, more advanced design, more sales features, more service, more total sales and more PROFITS! Move forward with these ROHN items!

ROHN TV TOWERS

ROHN makes the finest towers available for television reception! Illustrated is the No. 25 with amazing "zig-zag" cross bracing design. The entire tower is rated 33% stronger than other similar sized towers. Yes, sell and install the No. 25 up to 50 feet self-supporting or, properly guyed, up to 360 feet!

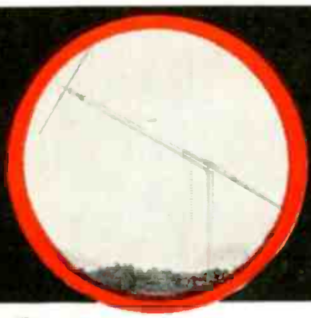
Or if you prefer, sell the popular ROHN No. 6 tower with the famous "Magic Triangle" cross-bracing. Both are fully HOT DIPPED GALVANIZED AFTER FABRICATION! Sections in easy-to-handle 10 ft. lengths.

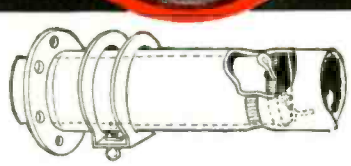
ROHN COMMUNICATION TOWERS

Here you have FIVE complete lines of heavy-duty, FULLY ENGINEERED communications towers to fulfill any communications requirement. Shown is the ROHN "SS" tower which is self-supporting up to 130 feet. Other models —(30-40-50-60) are available in heights up to 630 feet when guyed! Handle these towers for the demand in your area. There's a complete NEW catalog on this line. Get a copy so you'll have it on hand.

AMATEUR "FOLD-OVER" TOWERS

Specially designed "fold-over" towers are the best ever designed for amateur radio and experimentation. They are the most desired because they "fold-over" completely so you work on the ground for ease and safety. Three sizes, including heavy-duty type to handle any needs. All hot dipped galvanized.





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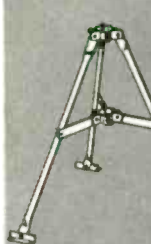

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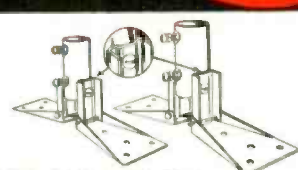
in 10, 5, 3, and 2½ feet heights — very popular — easily shipped — ideal in use — the best ever designed — in hot-dipped galvanized finish — truly a big profit item for you!



BASES AND MOUNTS

Wide variety of bases and mounts. Special features include "locking" device—also cast aluminum roof mounts—and a host of other installation items . . . get full details.

TV SERVICE TABLE

For holding TV sets while servicing, or storing, or for mobile use of set in such places as motels, hospitals, etc. Ideal for dozens of uses —thousands sold. Large casters—a real work-saver.

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Correspondence

CLASS IN ELECTRONICS

Dear Editor:

I have enclosed a photograph of my class of boys aged 11 to 15 whom I have been teaching basic electronics.

The class was started in February, 1960, with 24 boys. So far 17 of them have stayed with it. The class ends in June with each of the boys having built a three-tube radio (rf stage, regenerative detector and audio stage).

The only charge to the boys is for parts used. I have donated the time and space needed for the classes.

The class has been so well received by both the boys and their parents that I intend to hold another class this fall in which the boys will build hi-fi amplifiers with about a 5-watt output.

WILLIAM PORTER

Vale, Ore.

[To the rear of the photo are helper and co-instructor Marlowe Trick (left) and William Porter.—*Editor*]

EXPERIENCE WANTED

Dear Editor:

Mr. Read (Correspondence June, page 26) certainly hit the nail on the head when he said it was nearly impossible to get a job as a TV technician.

I have the same problem. I spent 2 years in a technical school (and have a diploma), still if I ask for a job in a shop, I get the same answer: "Sorry, but you don't have any experience."

Where in the world does a man get that experience? How does a man get to be a so-called "top bench man"? If you can't get a job in a shop and work every day repairing TV's and radios, how *can* you get job experience?

I spent several hundred dollars learning a trade, but it looks as if it will only be an expensive hobby.

FRANK NELSON

Portland, Ore.

[There is a two-fold comment to be made on this problem. One is to the individual, the other is to the industry.

Contact your local service association; some have employment services.

It is very possible that men with a problem like this will eventually become the so-called "illegitimate part-timers". Why not set up an employment service if your association does not have one? You may be doing your members a favor in more ways than one.—*Editor*]

MANUFACTURERS WANTED

Dear Editor:

Since you started the Industrial Electronics section in R-E, I have noticed (several times) that manufacturers are looking for service representatives. Our organization is looking for manufacturers to represent.

We have the best of equipment (Tektronix, Hewlett-Packard, etc.) and are sticking strictly to industrial electronics (no radio or TV). At present, we represent two

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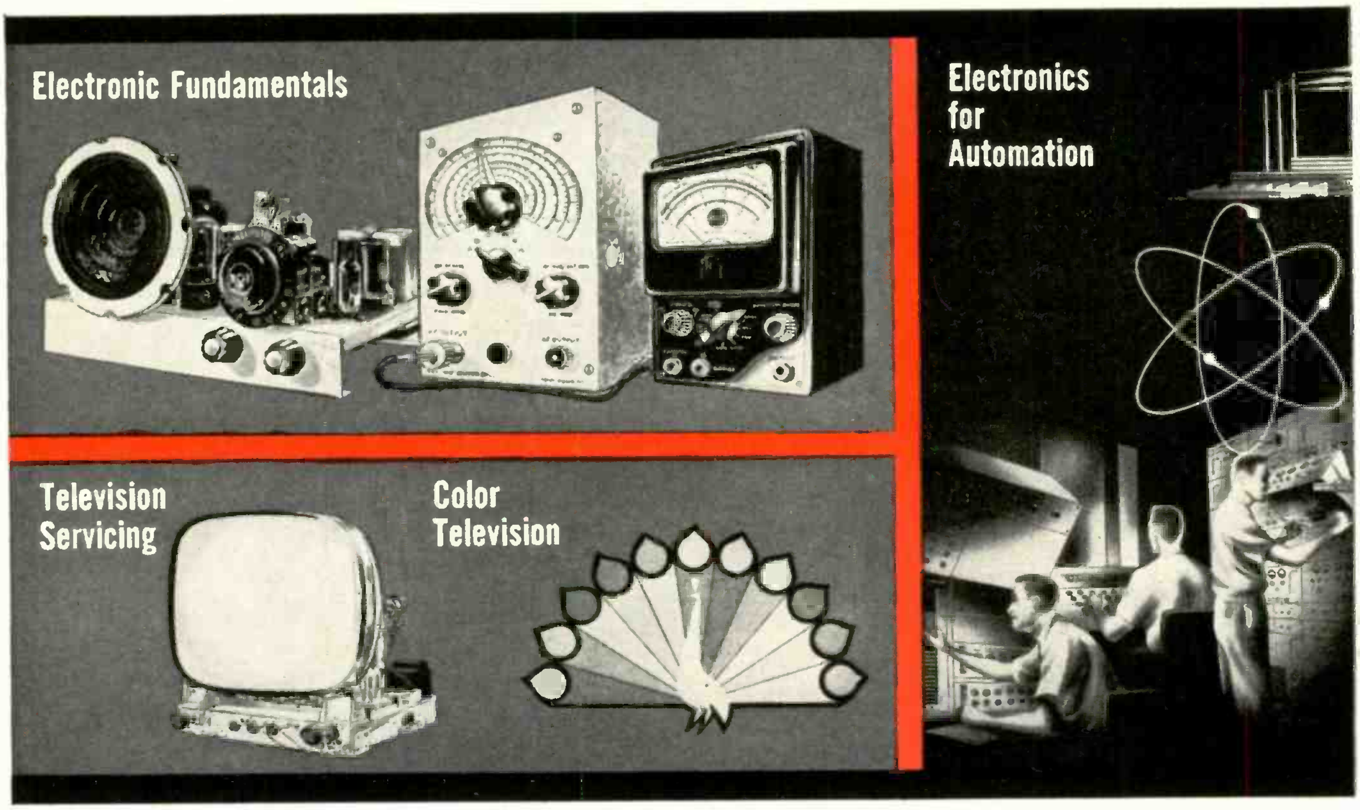

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manufacturers and are negotiating with several others, but are looking for more.

THOMAS BARTHOLOMEW
P.O. Box 68
Kensington, Md.

WORKING ON PROBLEM

Dear Editor:

Thank you for the copy of June RADIO-ELECTRONICS and your letter in which you invite my attention to your editorial "Recording the Invisible." I certainly support your plea for extensive research on new techniques to observe clear-air turbulence. As a result of the Tell City crash in which clear-air turbulence is alleged to have been a contributory cause, we received a number of suggestions from various people. These included measurements of stellar scintillations (my colleague, F. A. Gifford, a few years ago showed a rough correlation with jet-stream location) and the use of 1-centimeter radar using Doppler technique to detect discontinuities in the dielectric constant which might be associated with strong moisture, temperature and wind gradients.

During the past few years, the Weather Bureau has been attempting to observe tornadoes by radar operating on the Doppler principle, using equipment developed by the Cornell Aeronautic Laboratory. We are assigning a group of radar specialists to our Evansville, Ind., office, which is near the area of maximum frequency and intensity of jet stream occurrence. They will investigate jet-stream detection by use of our new WSR-57 weather radar (when that radar becomes fully operational) and by our Doppler radar. The project will include testing of a new device called an "R-meter" which is attached to the WSR-57 radar and which, we believe, will give us a useful measure of turbulence in clouds. The Evansville project will have the following purposes:

1. Further investigation of the suitability of a Doppler radar as a tornado identifier.
2. Basic research into the spectrum of particle velocity, both vertical and horizontal, in clouds and precipitating echoes.
3. Applied research into the suitability of Doppler radar as an identifier of turbulence, both clear-air and in cloud.
4. Studies relating measurements made during simultaneous operation of the WSR-57 radar, the R-meter and the Doppler radar.

The Air Weather Service has installed an automatic sferics detector in our Kansas City Severe Local Storms office. Many sferics reports are received from areas where there is no precipitation. We are examining these reports to see if they are associated with large temperature, moisture and wind gradients.

HARRY WEXLER
Director of Meteorological Research,
Weather Bureau

END

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HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass and treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. **"Excellent"**— SATURDAY REVIEW. **"Outstanding . . . extremely versatile."** — ELECTRONICS WORLD. **Kit $69.95. Wired $109.95.** Incl. cover.

HF85 Stereo Preamplifier: Complete master stereo preamplifier-control unit, self-powered. Distortion borders on unmeasurable. Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. **"Extreme flexibility . . . a bargain."** — HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Incl. cover.

New HF89 100-Watt Stereo Power Amplifier: Dual 50W highest quality power amplifiers. 200W peak power output. Uses superlative ultra-linear connected output transformers for undistorted response across the entire audio range **at full power**, assuring utmost clarity on full orchestra & organ. 60 db channel separation. IM distortion 0.5% at 100W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 100W. **Kit $99.50. Wired $139.50.**

HF87 70-Watt Stereo Power Amplifier. Dual 35W power amplifiers identical circuit-wise to the superb HF89, differing **only** in rating of the output transformers. IM distortion 1% at 70W; harmonic distortion less than 1% from 20-20,000 cps within 1 db of 70W. **Kit $74.95. Wired $114.95.**

HF86 28-Watt Stereo Power Amp. Flawless reproduction at modest price. **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision **eye-tronic®** traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. **"One of the best buys in high fidelity kits."** — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*.** Cover $3.95. *Less cover, F.E.T. incl.

AM Tuner HFT94: Matches HFT 90. Selects "hi-fi" wide (20-9000 cps @ −3 db) or weak-station narrow (20-5000 cps @ −3 db) bandpass. Tuned RF stage for high selectivity & sensitivity. Precision **eye-tronic®** tuning. **"One of the best available."** —HI-FI SYSTEMS. **Kit $39.95. Wired $65.95.** Incl. cover & F.E.T.

New FM/AM Tuner HFT92 combines renowned EICO HFT90 FM Tuner with excellent AM tuning facilities. **Kit $59.95. Wired $94.95.** Incl. cover & F.E.T.

New AF-4 Economy Stereo Integrated Amplifier provides clean 4W per channel or 8W total output. **Kit $38.95. Wired $64.95.** Incl. cover & F.E.T.

HF12 Mono Integrated Amplifier (not illus.): Complete "front end" facilities & true hi-fi performance. 12W continuous, 25W peak. **Kit $34.95. Wired $57.95.** Incl. cover.

New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.) 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26½", 13⅞", 14⅜". Unfinished birch. Kit $72.50. Wired $84.50. Walnut or mahogany. Kit $87.50. Wired $99.50.

New HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, ⅝" excursion, 8" woofer (45 cps. res.), & 3½" cone tweeter. 1¼" cu. ft. ducted-port enclosure. System Q of ½ for smoothest freq. & best transient resp. 45-14,000 cps clean, useful resp. 16 ohms. HWD: 24", 12½", 10½". Unfinished birch. Kit $47.50. Wired $56.50. Walnut or mahogany. Kit $59.50. Wired $69.50

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range, 8 ohms. HWD: 23" x 11" x 9". **Kit $39.95. Wired $47.95**

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36", 15¼", 11½". "Fine for stereo" — MODERN HI-FI. Completely factory-built. Mahogany or walnut $139.95. Blond $144.95.

New Stereo Automatic Changer/Player: Jam-proof 4-speed, all record sizes, automatic changer and auto/manual player. **New** extremely smooth, low distortion moisture-proof stereo crystal cartridge designed integrally with tonearm to eliminate mid-range resonances. **Constant** 4½ grams stylus force is **optimum** to prevent groove flutter distortion. **No** hum, turntable attractions, acoustic feedback, center-hole enlargement. Only 10¾" x 13". **Model 1007D:** 0.7 mil diamond, 3 mil sapphire dual styli, **$59.75. 1007S:** 0.7 mil, 3 mil sapphire, $49.75. Incl. **FET.**

†Shown in optional Furniture Wood Cabinet **WE71:** Unfinished Birch, **$9.95;** Walnut or Mahogany, **$13.95.**

††Shown in optional Furniture Wood Cabinet **WE70:** Unfinished Birch, **$8.95;** Walnut or Mahogany, **$12.50.**

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Radio-Electronics
Hugo Gernsback, Editor

MICROTELEVISION

. . . A New and Important Development Looms . . .

MICROELECTRONICS, the new and coming art,* is due to branch out into many new directions in the very near future. One of these is microtelevision, or miniature TV.

Why, one might ask, is such a development necessary or even desirable? A simple answer is to extend direct sight into inaccessible regions into which we cannot look today. In industry, in biology and medicine, in surveillance and intelligence, in missiles and spacecraft, there exists an urgent demand for micro or miniature TV to bring clear vision via the smallest possible dimension to the human eye or to a recording instrument.

Thus an airplane pilot cannot see the underside of his plane, the landing gear, the tail, the wing undersides, etc. Strategically located miniature TV cameras could tell him instantly of any misfunction at a glance on a mini-screen.

Medical researchers at the University of Melbourne, Australia, have recently designed a TV camera so small it can be swallowed. It is supposed to bring direct sight into the stomach at work. They are using a ¼-ounce TV picture tube developed by scientists in Germany. They hope to project clear pictures, magnified 30 to 40 times, of the various digestion processes and dysfunctions of the stomach onto a standard TV screen.

While this is a good beginning, we cannot hope soon to insert tiny TV cameras into such inaccessible parts of the human anatomy as the bladder, various sinuses, the arteries into the heart and other organs.

Nor need we do so. We can use standard iconoscopes by attaching the recently developed *optical cables* to them. Made of flexible glass fibers, these stranded cables can be less than ⅛ inch in diameter and conduct light readily. Each glass fiber, the thickness of a thread, transmits its own quota of light. When they are fashioned into a supple cable of hundreds of glass fibers, a strong light can be conducted around curves and corners.

Thus we can mount a powerful yet tiny electric light bulb directly behind the end of the light cable and illuminate the inside of an artery, look into the ear or other organ at will, via TV. Urologists urgently need such a tool which, inserted through the ureter, can view the kidney for lesions, stones or similar disorders.

For other purposes we also require mini-TV transmitters. For surveillance at a distance, optical cables are useless—here inconspicuous tiny cameras are needed that can be readily concealed.

In missiles and spacecraft such as satellites, the weight of 1 ounce and the space of 1 square inch are often extravagant, and frequently not permissible. Hence micro-TV transmitters are vital here. How small can a TV camera shrink? No one knows.

A fly's compound eyes see exceedingly well; so do those of other much smaller insects. Suppose for the sake of illustration, we build a TV camera with an aperture 1/16 inch in diameter. Can we scan in such a small dimension, say 1/16 inch by 1/16 inch? Theoretically, yes. (10,000 lines in 2¼ inches is equal to about 525 lines on a screen about 1/10 inch square.) Such small cathode-ray deflection—if we use cathode rays—requires less power, less voltage. Cutting down the spot size uses fewer electrons to paint the picture, but the latter is proportionately smaller, too. Then, at the receiving end, the tiny picture can be enlarged and thrown on a standard screen. Certainly all this will not be accomplished free of all faults, tomorrow. Yet electronic engineering has solved more difficult problems in the past. We may be certain that minitelevision will be an accomplished fact in the foreseeable future.

The special TV applications cited above will also have their counterparts in the public domain during the present decade.

Twenty-four years ago the present writer first spoke of minitelevision.** In an article entitled "The Future of Short Waves," we described television eyeglasses. They comprised an eyeglass frame on which were built two separate miniature TV receivers weighing but a few ounces. The images on the two tiny screens were to be postage-stamp size, but as the screens were only a fraction of an inch from the eyes, the small size would not matter. The dual images, though tiny, would be sharp and clear, exactly like the view one has through binoculars. In addition, it was foreseen that the images would also be stereoptical (three-dimensional). The TV eyeglasses were to be a completely self-contained TV receiver; tiny earphones were to convey the sound directly into the ears.

Today, or in the near future, there is no reason why sound cannot be added to the TV eyeglasses. It can be via bone conduction—hearing-aid glasses are in existence right now. As a *personal* TV receiver that does not disturb others in the same room, to view TV in bed, at home or in hospitals, the self-contained TV eyeglasses are an ideal adjunct. With recent transistor developments, TV eyeglasses should be here soon.

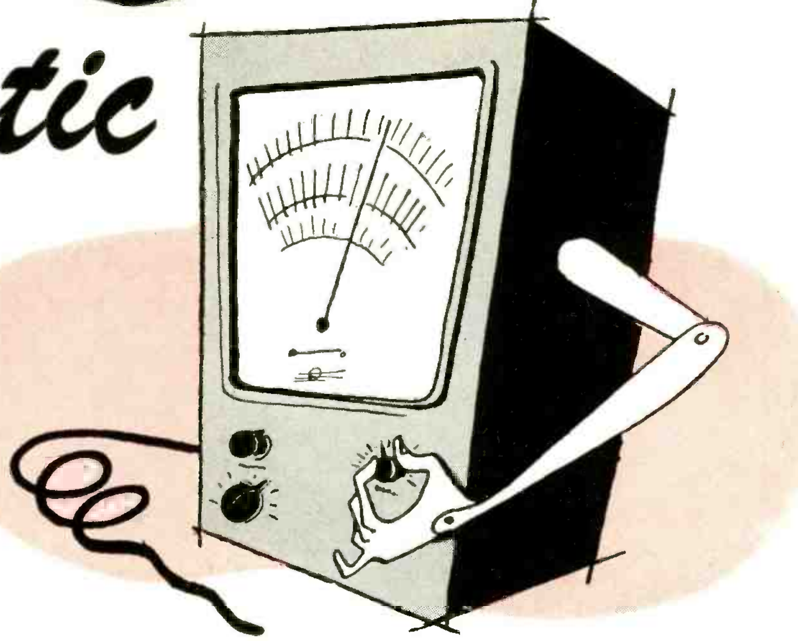
Pocket TV receivers also should make their appearance during the next few years. It would not surprise us if they were first made in Japan. They will have a 2- to 3-inch screen and give sharp definition. There will be a collapsible blind for viewing even in strong outdoor light. Completely transistorized with a flat picture tube, the set should be very light and compact. It probably will be energized by atomic type batteries. —*H.G.*

*"Microelectronics," RADIO-ELECTRONICS, February 1960, page 33.

**October, 1936, *Short-Wave Craft* magazine.

COVER FEATURE

Automatic Ac Vtvm



No hands! The meter picks the range itself, then lights a light to show you which one you're on!

By JOE MARSHALL

ELECTRONICS is basic to industrial automation. Yet, it is paradoxical but true that there has been little automation in the basic tools of electronics—particularly in the measuring and test instruments so essential to both development and maintenance of electronic devices. Punched-card tube testers and some very expensive digital voltmeters are the only examples of general-purpose automatic instruments that come to my mind. Now Allied Radio presents its Knight-Kit ac vtvm, a very clever example of automation in electronic instrumentation.

The instrument, an ac vtvm, measures ac voltages from 20 cycles to 2.5 mc with an accuracy of 1 db or better. It has exceptionally high sensitivity. The full-scale reading is 3 millivolts on the lowest range (this permits reading voltages as low as 200 microvolts) and 300 volts on the high range. It is unique in providing automatic or "self-seeking" switching between the 11 ranges.

When the probes are applied to a circuit, the voltage to be measured actuates a sensing and control circuit that seeks out the meter range that provides an approximate mid-scale reading. A red pilot light indicates which range is in use. There is no need for manual switching, either to choose the initial range or to adjust the range to a rising or falling voltage. The entire switching cycle takes place in less than 3 seconds.

Some of the advantages of automatic switching are immediately obvious, but there are some that may not be apparent to a casual glance. For example, the most useful scale for audio measurements is the db scale. But this scale is not linear. The most exact readings are obtained in the range between +2 db and −5 db. In this range, the scale is divided into divisions of 0.2 db. From −5 to −10, the graduations are in 0.5 db, and from −10 to −15 in 1 db intervals. Clearly, the most accurate reading can be obtained when the meter range is adjusted so the indication falls between −10 and +2 db. The automatic switching of the vtvm tends to keep the reading at this point.

Automatic switching is a particular convenience when working with an impedance bridge or in measuring the response of equalizers, tone controls, etc. with a steep response slope (where the response, for example at 20 cycles may be 40 db below or above the response at 10,000 cycles). In these applications, the range switch of a conventional vtvm might have to be changed as many as half a dozen times.

Trigger circuit

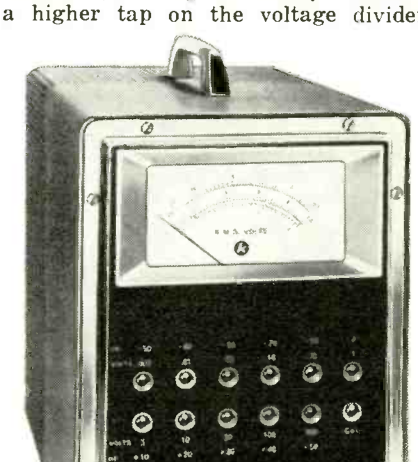
The heart of the Knight-Kit automatic ac vtvm is a trigger circuit which energizes a small reversible electric motor that drives an indexing rotary switch. It works like this:

The output of a three-stage amplifier is applied to a bridge rectifier circuit. The rectifier provides a positive voltage at one corner, and a negative voltage at the opposite one. The meter is connected to read this difference in voltage. A rectifier in shunt with the meter bypasses any voltage in excess of the fundamental range of the meter.

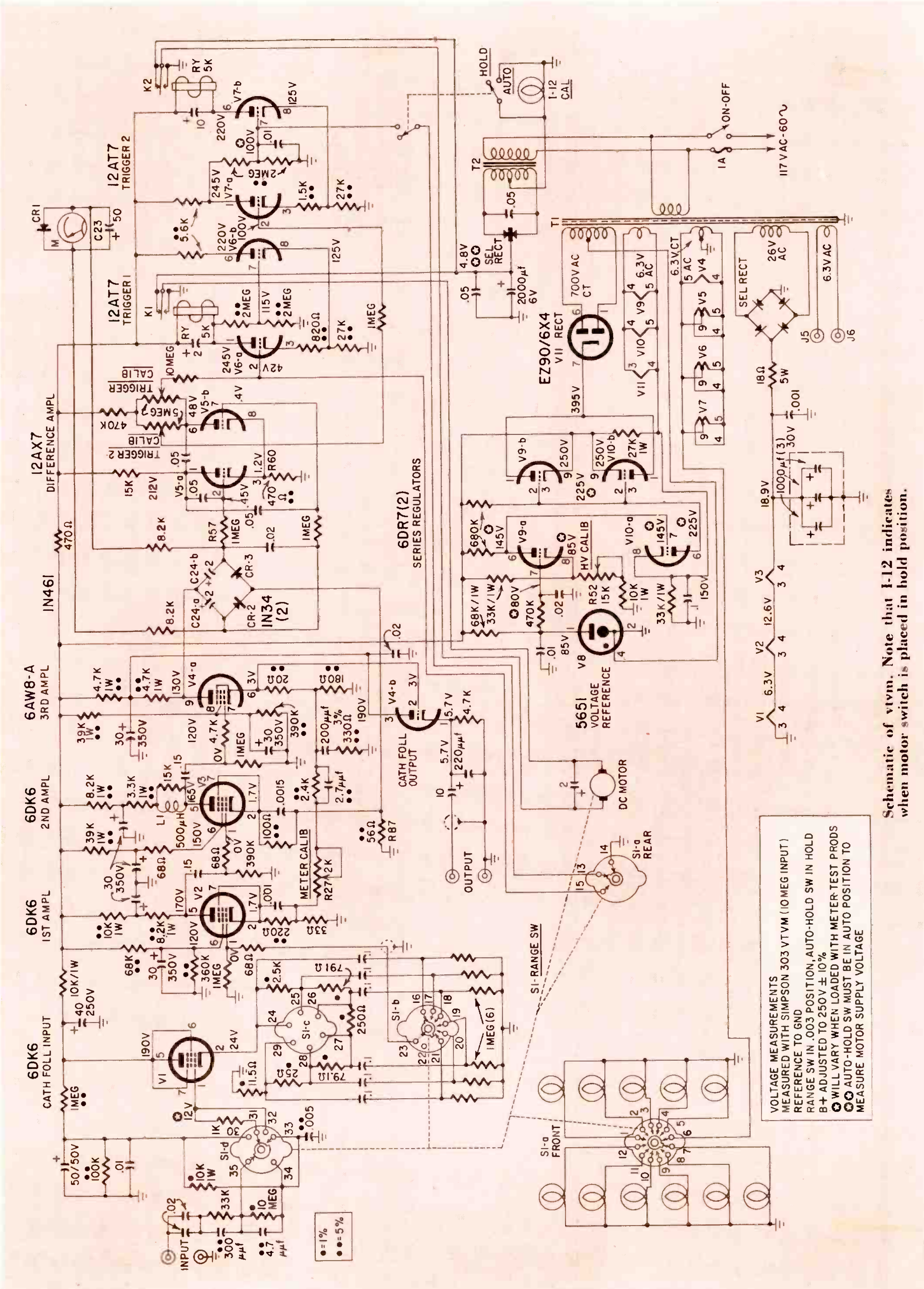
A difference amplifier consisting of the two sections of a 12AX7 is also connected to the bridge so that the positive side goes to one grid, and the negative side to the other grid. The output of this difference amplifier is connected to the grids of two trigger circuits comprised of the two sections of a 12AT7 connected as a cathode-coupled flip-flop trigger. One trigger operates when the output of the bridge rectifier is greater than a certain maximum voltage; the other when the rectifier output falls below a certain minimum voltage.

Each of the triggers actuates a relay which applies a dc voltage to a motor which, in turn, revolves a multi-deck rotary switch. The switch moves the input of the three-stage amplifier to various taps on a voltage divider, thus reducing (or increasing) the voltage fed into the amplifier. The relay in trigger 1 applies a voltage to the motor which turns it in a counterclockwise direction. It thus switches the amplifier to a lower tap on the voltage divider. This reduces the voltage applied to the amplifier by 10 db (per step). If the reduced voltage at the output of the bridge rectifier is now below the peak value needed to actuate trigger 1, the relay opens, the driving voltage is removed from the motor and the proper range is established.

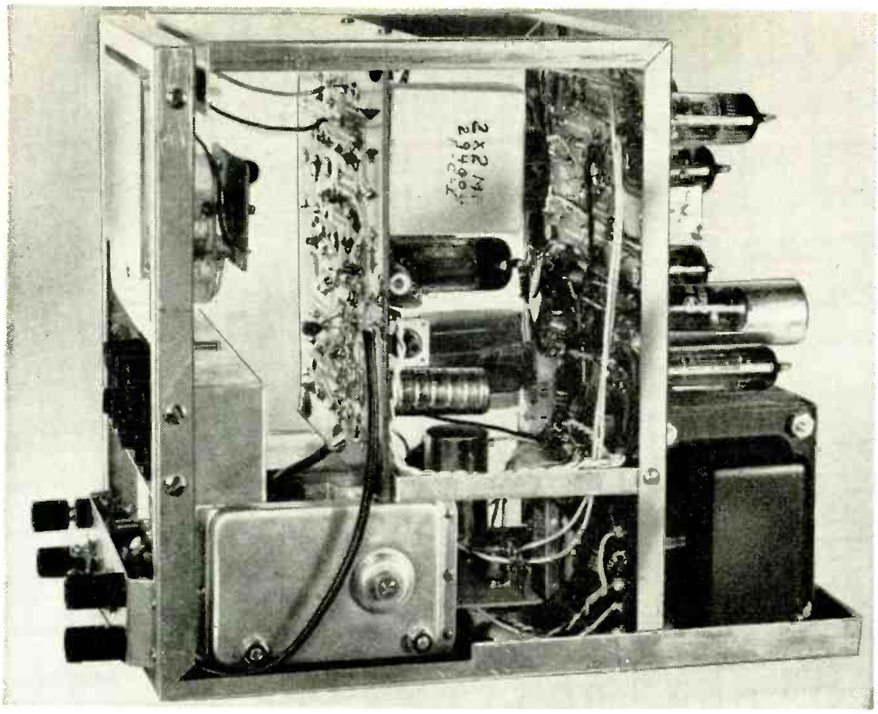
On the other hand, if the voltage delivered by the rectifier is below a certain value, the trigger 2 is actuated. Its relay applies a voltage of opposite polarity to the motor, which now turns clockwise, driving the rotary switch to a higher tap on the voltage divider.



Knight-Kit ac vtvm.



Schematic of vtvm. Note that I-12 indicates when motor switch is placed in hold position.



Side view of vtvm with cover removed.

This increases the input to the amplifier by 10 db. If the voltage delivered by the rectifier is now above the threshold, the trigger relay opens, the motor stops and again the range is established.

If the first step does not increase (or reduce) the voltage to the amplifier sufficiently, the trigger will remain on, the motor will continue to turn until a position on the divider is reached that delivers a voltage that falls between the two thresholds.

What happens

The alternating-current output from the amplifier is fed to the bridge (CR2, CR3, C24-a and C24-b). Part of the bridge output goes to the meter and part to the trigger circuit. As the output of the amplifier goes positive, current flows from ground through R87 and on through CR2. Here the current divides, part flowing through C24-a, the remainder through the meter and C24-b. When the output of the amplifier goes negative, part of the current flows through C24-a, the meter and CR3. The remainder flows through C24-b and CR3. A pulsating direct current (always of the same polarity) is therefore supplied to the meter.

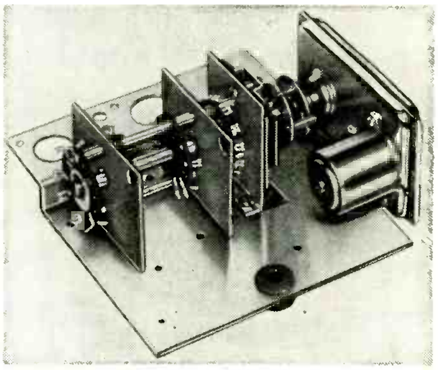
The trigger circuit input voltage is taken from the bridge rectifier circuit. The positive side of the bridge feeds through R57 into the grid of V5-a. Since the triggers operate in a similar manner, only trigger 2 will be described. As the output at the bridge circuit approaches the full-scale meter value, the bias on the grid of V5-a decreases, causing the tube to conduct more heavily. This increase in current results in a higher voltage drop across cathode resistor R60. Since R60 is common to both cathodes of V5, the voltage at the cathode of V5-b will also increase. At the same time that the cathode goes positive, a negative signal is applied to the grid of V5-b, causing less current to flow through the second half of the tube. As the current decreases, the voltage drop across the plate load resistor also decreases. This causes a more positive signal to be applied to the grids of V6-a and of V7-a. The bias on the grid of V6-a is such that the tube is normally held at cutoff. When a large enough signal is applied to this grid, the tube starts to conduct. The current flow energizes plate relay K1, which, in turn, actuates the range switch motor. The entire switching system is thus a feedback-controlled mechanical servo system.

So much for the automatic switching. The vtvm section starts with a cathode follower which feeds the first of three pentode amplifiers. The range is selected by switching the grid of the first amplifier tube (V2) up and down a voltage divider in the cathode circuit of the cathode follower. Each step in the divider produces 10 db of attenuation. Actually, though the meter has 11 range positions, the voltage divider has only 6 steps. When the input voltage is 1 or more, a 60-db attenuator is switched into the input of the cathode follower and the range switch starts again at the top of the voltage divider and goes down it again for the upper ranges. In other words, the divider is used twice, first, on the low ranges without the 60-db attenuator, and then on the high ranges with the 60-db attenuator.

The three-stage pentode amplifier is operated with low plate loads to widen the response. The second stage is peaked at the high end with inductor L1. There are two feedback loops. The first runs from the cathode of the third amplifier to the cathode of the first. The feedback control (R27) in this loop sets the circuit gain to provide the right reading for a known input voltage for calibration purposes. The second loop goes from the output of the bridge rectifier to the cathode circuit of the second amplifier. The two loops give a total of 30 db of feedback and result in the very flat response.

A cathode follower (the triode section of the 6AW8), fed from the cathode of the third amplifier, has its output connected to jacks on the panel so the output of the amplifier can be used for feeding a scope, etc. This gives the user a wide-band amplifier with a gain of approximately 34 db (when the range switch is in the lowest position) and a frequency response flat from 30 cycles to 300,000 cycles and within 1 db from 20 cycles to 1.5 mc.

Amplifier gain is kept constant by a rather elaborate regulated power supply using two 6DR7's and a 5651. The output voltage is adjusted with pot R52. When properly set, the regulation is within 1%.



Motor and range switch.

Dc is used on the heaters of the first three stages of the amplifier. There is also a separate 5-volt dc supply for the range-switch motor.

Included with the vtvm are components for a simple source of low voltages to calibrate the instrument and adjust the trigger circuits. It supplies .00065 (0.65 mv) and .0031 (3.1 mv) volt ac when fed by 6.3 volts from the heater chain. The vtvm has two jacks on the rear which supply this voltage.

A kit was bench-tested by the author. It took about 24 interrupted hours to assemble. The job could be done in less time. The calibration and adjustment procedure is simple and effective. An accurate dc voltmeter is helpful in properly adjusting power-supply voltage. If the line voltage falls between 115 and 120, calibration accuracy will be good enough for most applications. But if an accurately calibrated signal generator is used, the accuracy of the meter can be made to approach that of the signal source. The linearity is extremely good, both over the scale of a single range and from range to range.

The Knight-Kit automatic ac vtvm is a valuable and time-saving addition to the busy audio lab and represents a big value at its price of just under $100. END

That old charger that just sits around idle most of the time can save you most of the cost of a bench power supply

TRANSISTOR POWER SUPPLY for the SERVICE BENCH

By J. E. PUGH, JR.

AN adjustable, regulated power supply is often needed in checking and servicing transistor radios. The output of a battery charger is in the correct range, but its high ripple makes it unusable. This unit converts a battery charger into a regulated transistor power supply suitable for service-bench use, testing or checking, and for powering experimental transistor projects.

The voltage supplied by most chargers is either 6 or 12 volts or both. Current ratings run from 2 or 3 amperes for the smaller chargers to 10 or 12 amperes for the larger units.

The converter is a transistor filter and regulator that converts the rectified, unfiltered charger output into a well-regulated nearly pure dc output that is adjustable in level from 1.5 to 6 or 12 volts in 1.5-volt steps. The maximum current rating varies from about 0.7 to 1.8 amperes, depending on which output voltage step is used. The current rating can be increased to the maximum current rating of the charger by adding more power transistors in parallel with V1 and V2. Ripple percentage increases with loading and the maximum level is less than 0.25% at full load.

In addition to being used with battery chargers, this converter can also reduce ripple level and regulate battery eliminators with outputs up to about 20 volts. These units ordinarily use a large filter capacitor across their output, which makes it possible to eliminate C. This unit can also be used with any 6- or 12-volt ac filament supply by adding a rectifier in series with one of the converter input leads.

When compared with L-C filters, the converter has better regulation, lower ripple and an adjustable output. Its disadvantages are that it is more easily damaged by overload and that the batteries must be replaced annually.

Design

Before starting construction, it is advisable to see that your battery charger is suitable. Aside from having usable voltage and current ratings, the rectifiers must be able to take the maximum peak inverse voltage safely.

Most manufacturers rate rectifiers on a maximum rms input-voltage basis (generally either 13 or 26 volts) and give no peak inverse rating. The peak inverse voltage with the capacitor across the output is only about 7 volts greater than with a fully charged storage battery attached (for 6–volt systems, 3.5 volts). This difference becomes less as loading is increased and, if the manufacturer has provided a reasonable safety factor, it should be satisfactory. To determine this voltage for your charger, measure the rms voltage across each half of the secondary winding (or the entire winding for a half-wave rectifier) without load. Multiply by 1.41 to obtain the peak voltage and double it for the peak inverse with capacitor load.

If the charger is an inexpensive one, the transformer regulation may not be adequate and the voltage under no-load conditions may be too high. If so, it can be reduced somewhat by placing a resistor across the input of the converter—ahead of fuse F. This resistor should be of such value as to limit the voltage across C to 20 volts maximum with no load across the converter output. If a 6-volt charger is used, it should be no more than 10 volts.

The transistors are connected in parallel in a conventional emitter-follower regulator circuit. The resistor (R) between the bases is used to get equal emitter current so that each transistor does half the work. Check the emitter current through both transistors while under *full load.* Connect a low resistance in the base lead of the transistor having the greatest emitter current and adjust until these currents are equal. The resistor value is determined by the difference in transistor characteristics. In this case it was 22 ohms. If more transistors are added to increase the maximum output current, they should be connected in parallel with V1 and V2 and a similar resistor used in each of their bases to obtain equal emitter currents.

Four factors must be considered in determining maximum permissible out-

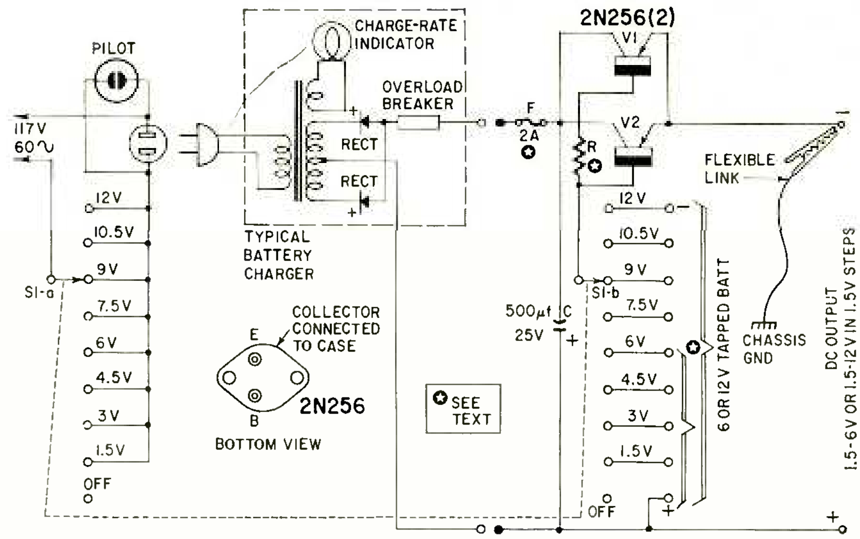
Bottom view of converter–regulator showing parts layout.

put current: maximum collector current, maximum collector-to-base voltage, maximum transistor dissipation and the point where the base current rises rapidly. The 2N256 transistor has a maximum collector-current rating of 3 amperes and a maximum collector-to-base rating of 30 volts. The table shows that neither rating is important in limiting the maximum output current. In all cases up to 9 volts output, it is the maximum transistor dissipation rating (6.25 watts per transistor) that is important and the output current must be limited so this value is not exceeded. In the 10.5- and 12-volt cases, both base current and ripple voltage increase rapidly at load currents above those shown in the chart and thus limit the load current before maximum dissipation is reached. After construction is completed, the maximum permissible load current for each output voltage should be determined for your converter, as it may vary for each unit.

Transistors are easily damaged by overloads and for this reason a fast-acting fuse rated just above the maximum permissible current of 1.8 amperes is used. This fuse will need to be a different value (1.5 amperes) for a 6-volt system or if more transistors are added. The charger overload breaker should not be relied upon for overload protection.

Maximum permissible load currents at various voltages (two transistors).

E_{out} (volts)	I_{load} (amperes)	V_{CB} (volts)	I_B (milliamperes)
1.5	0.7	17.5	12
3.0	0.8	15.0	15
4.5	1.0	12.5	20
6.0	1.2	10.5	25
7.5	1.4	9.0	30
9.0	1.8	7.0	50
10.5	1.5	6.0	50
12.0	1.1	5.0	40



R—½ watt, see text
C—500 μf, 25 volts, electrolytic
F—type 3AG fuse, see text
S1—2-pole, 9-position, nonshorting switch (Mallory 3229J or equivalent)
V1, 2—2N256 transistors
BATT—4 or 8 D cells
Neon pilot lamp (Drake 105 or equivalent)
Female receptacle
Chassis 2 x 7 x 11 inches
Plug to fit output socket on charger
Mica sheet
Line cord
Insulated terminals (2)
Hardware

Schematic of battery charger and regulator.

Type-D cells are used in the base circuit as the voltage-determining element to keep maintenance costs low. Mercury batteries can be used to maintain a more constant output voltage if desired. The batteries can also be replaced with voltage reference diodes, but their high cost rules them out in most cases. Smaller flashlight cells can be used, but if space is available, the larger ones should be used for economy. For 6-volt chargers, use four cells; 12-volt chargers need eight.

Construction

A large (2 x 7 x 11-inch) aluminum chassis was used to provide a good heat sink for the transistors, plenty of room for the batteries, and a convenient space for placing the charger. Connecting plugs allow it to be removed for battery charging duties.

A short length of ⅛-inch copper braid soldered to a spade type solder lug is used to connect either the positive or negative terminal to the chassis as desired. Check with an ohmmeter and see if the charger has either terminal grounded to the case. If so, insulate the feet so they will not touch the converter chassis.

Construction is simple and should cause no trouble if a few precautions are observed in mounting the transistors. Round off the edges of the transistor flange with a fine file and remove all sharp edges from around the mounting holes. Drill the base and emitter feedthrough holes just large enough to clear the pins comfortably (about ⅛-inch diameter) and deburr them and the mounting holes with a countersink or large drill. This is necessary because the mica mounting insulators are very thin and easily punctured.

Mica can be bought in small sheets of reasonably good quality at most hardware stores. First drill very small, accurately spaced holes in the mica for the base and emitter pins. Operate the drill with the fingers so as not to damage the mica. Then mark a light outline of the flange with a machinist's scribe. Make the outline about 1/32-inch larger than the flange and cut it out with sharp scissors. Most mica will be about .004 to .005 inch thick but can be separated into sheets about .002 inch thick, which is recommended for most power transistors. Do this after the insulator has been cut by easing a thin knifeblade into an edge where a slight separation has been started.

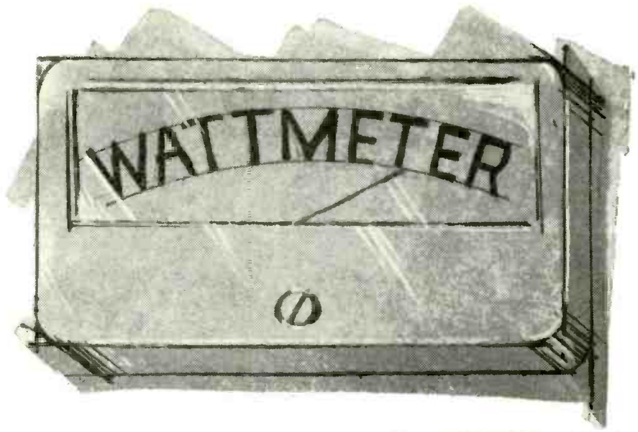
Now gently slide the knife into the insulator until it is completely separated into two sections. This may take several tries as the mica doesn't separate perfectly every time, but the imperfect insulators can be trimmed to remove the mounting-screw holes and used under the base and emitter connectors to keep them from touching the chassis.

Good base and emitter connectors can be obtained by removing the contacts from a seven-pin miniature wafer socket. The mounting screws are insulated from the chassis with extruded fiber washers. After mounting the transistors, check with an ohmmeter to be sure that none of their elements are making contact with the chassis.

All nine positions of S1 are used for a 12-volt system; on a 6-volt system, set the adjustable stop for five positions. After construction is completed, determine the maximum permissible load current for each switch position and mark with decals on the lower half of the switch dial circle. When using this power supply, keep in mind that, for a given load, the current will increase as the switch is set to a higher voltage. If working near the load-current limit of the unit, any such change should be made cautiously to avoid a blown fuse. END

Converter with charger in position.

MAKE AN AUDIO



from your VTVM

Add an external voltage divider and multiplier and draw a new scale, and your vtvm will measure audio watts

By **ROBERT G. CASEY**

THE essential difference between a vtvm and an "audio wattmeter" is that the vtvm reads voltage with respect to another point, usually ground, while the wattmeter reads voltage across a known impedance. By using the formula $W = E^2/R$ and a scale calibrated in watts, the meter reads directly in watts.

For example, if 2 volts appears across a 4-ohm speaker, wattage is $2^2/4$ or 1 watt. The same voltage across an 8-ohm speaker would be 0.5 watt. If the voltage across the speaker doubled, the wattage would be four times the original amount. Consequently, every impedance must have a different wattage scale, or a dividing network must change the voltage fed to the vtvm as the load impedance is changed. The latter method is the more common, and 4, 8, 16, and 600 ohms were selected as the most commonly used hi-fi speaker impedances.

To select the correct wattage scale to correspond to the voltage scale, let's consider $W = E^2/R$ or $E = \sqrt{RW}$. For any given wattage, the lowest resistance will have the lowest voltage developed across it. At 4 ohms, the vtvm's 3-volt range would be equal to 2.25 watts. By increasing this rating to 3 watts, the voltage across the load will be 3.464. By using a divider proportional to 3.464 to 3, the voltage to the vtvm will be 3 volts when the voltage across the divider is 3.464 volts and the vtvm reads directly in watts. Fig. 1 shows how this is done.

At 8 ohms, 3-watts would be 4.899 volts. So this time we need a voltage divider with a ratio of 4.899 to 3. This can be done in two ways, as shown in Fig. 2.

In a similar manner, the voltage to the 16- and 600-ohm impedances are calculated to be 6.932 and 44.272 volts, respectively. This means that the final meter shunts will look like one of the two circuits shown in Fig. 3.

The other vtvm ranges can also be used as wattmeter ranges. They translate as follows:

Vtvm Range (*volts*)	Wattmeter Range
.03	0.3 mw
0.1	3 mw
0.3	30 mw
1	300 mw
3	3 watts
10	30 watts
30	300 watts

Remember that the wattage varies as the square of the voltage, so the new range gets a log scale. The following group of markings will aid calibration:

Wattmeter Reading	Corresponds to Voltage
0	0
0.25	0.866
0.5	1.225
0.75	1.5
1	1.732
1.25	1.936
1.5	2.121
1.75	2.291
2	2.449
2.25	2.598
2.5	2.740
2.75	2.873
3	3

When making this unit, remember the load resistors must have a wattage rating higher than any wattage to be measured and should be noninductive types. END

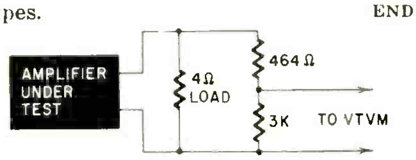


Fig. 1—To measure wattage across 4-ohm speaker, use this arrangement.

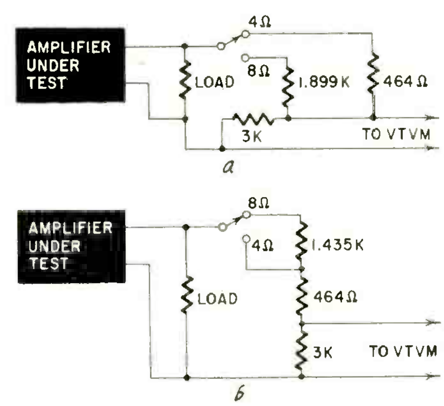


Fig. 2—Two ways of measuring wattage across 4- and 8-ohm loads: a—parallel divider; b—series divider.

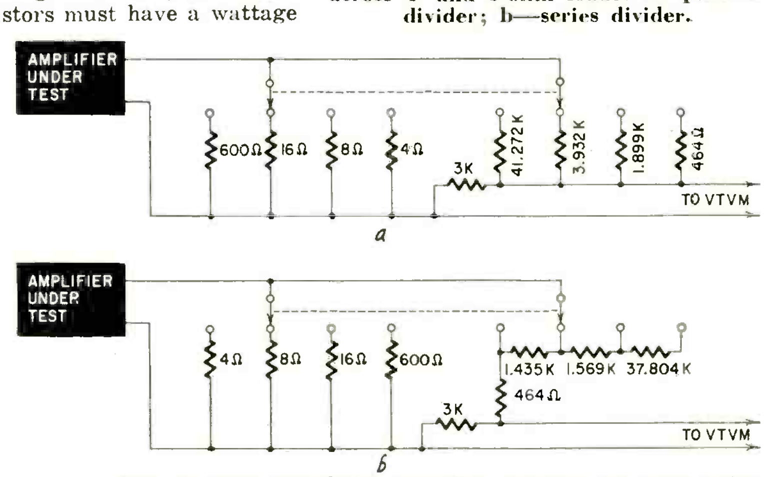
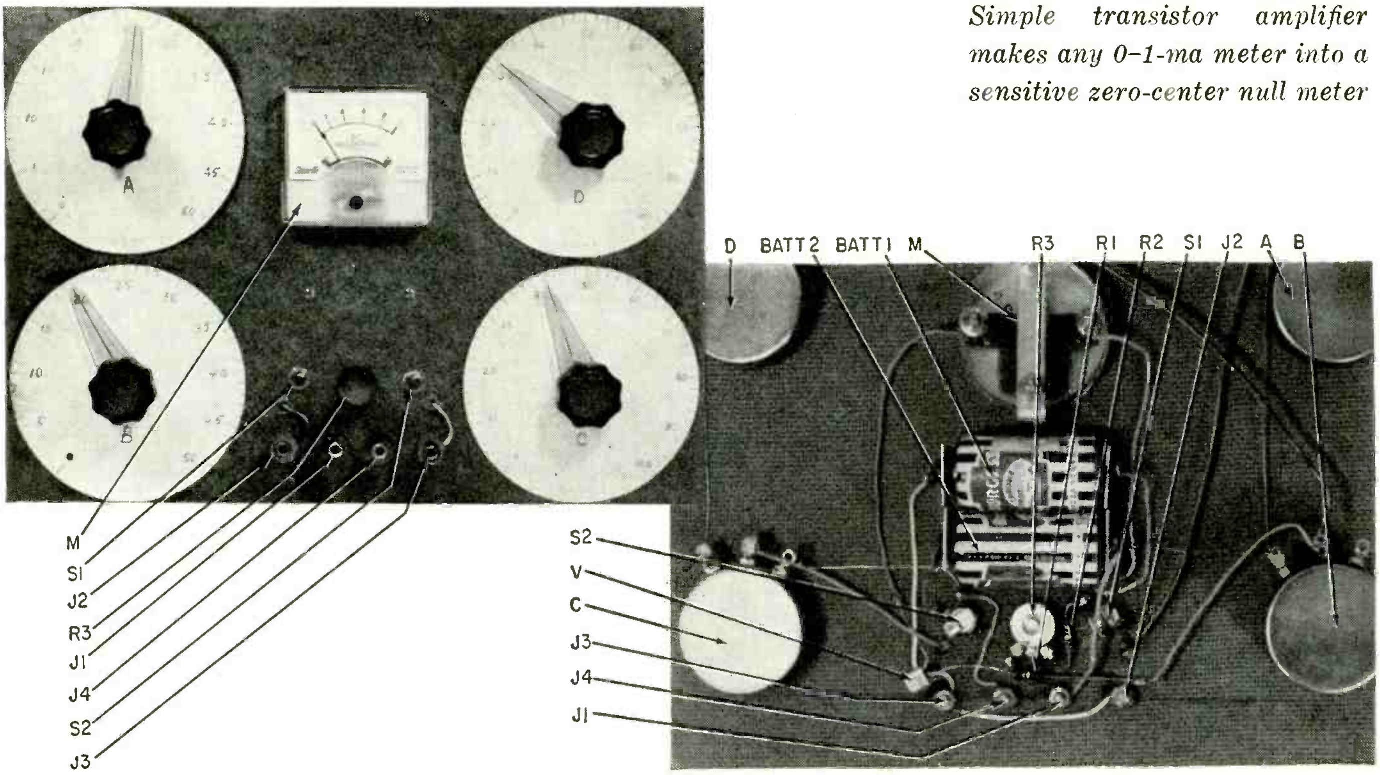


Fig. 3—The completed wattmeter section can take either of these two forms: a—parallel dividers; b—series dividers.

Simple transistor amplifier makes any 0–1-ma meter into a sensitive zero-center null meter



BOOST BRIDGE ACCURACY *with a null amplifier*

By FORREST H. FRANTZ, SR.

A SIMPLE Wheatstone-bridge calculator was described in "Divide and Multiply with a Wheatstone Bridge," in the June issue of RADIO-ELECTRONICS, page 48. That article showed how to build and use the calculator. This article describes a transistor null amplifier which can be used to increase the unit's sensitivity and extends its use to include measuring resistance.

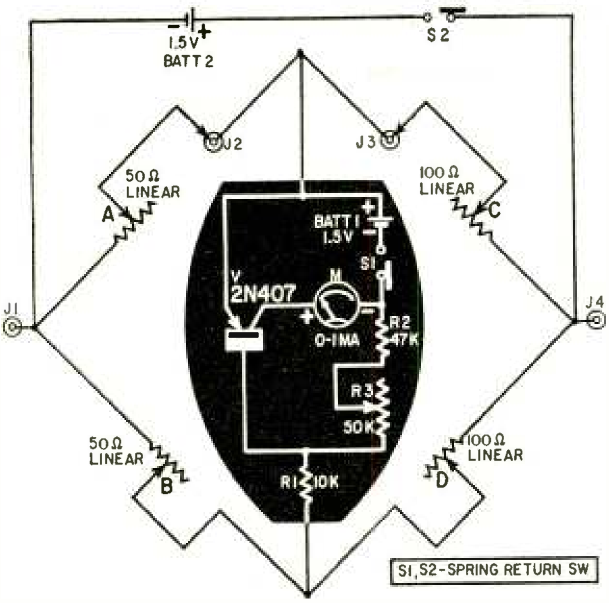
The increased null-meter sensitivity upgrades the unit's accuracy while the transistor circuit reduces battery drain. The null-amplifier circuit can also be used anywhere an extra-sensitive null meter is needed. The components required are not expensive and you can make the modification in an hour or two.

The unit's basic circuit is shown in the diagram. A 2N407 transistor amplifier drives the 0–1-ma meter in the modified unit. R2 and R3 bias the transistor base. R1 is the null-signal-input limiting resistor.

When S1 is depressed, BATT 1 feeds current to the transistor. R3 is adjusted for mid-scale (0.5 ma) meter deflection. This is the *meter* null setting. Such a null is considerably more convenient than the 0-ma meter null of the original circuit. To null the *bridge*, depress S1 and S2. Although the meter null can drift, it doesn't matter. If S1 is depressed and the meter reading does not change when S2 is alternately depressed and released, the *bridge* is nulled regardless of the meter reading. This feature lets the transistor amplifier work without an emitter stabilizing resistor that would reduce gain or require a higher battery voltage for equivalent gain.

To measure resistance

To modify the bridge for resistance measurements, pots A and C are taken



R1—10,000 oms, 1/2 watt
R2—47,000 ohms, 1/2 watt
R3—pot, 50,000 ohms
BATT 1—1.5 volts, flashlight cell, size D
J1 2, 3, 4—3-way binding posts
M—0-1 ma
S1—spst, pushbutton, spring return
V—2N407 transistor (Sylvania)

Circuit of the null amplifier added to a bridge-type electronic calculator.

out of the circuit and replaced by the unknown and standard resistors. This is done by connecting the arms of A and C to short lengths of insulated wire that pass through holes in the panel and plug into jacks J2 and J3. To measure resistance, pull out the wires and put the unknown between J1 and J2, and the standard between J3 and J4. Then A can be replaced by an unknown resistor. Its resistance, R_X, is CB/D where C, B and D are the respective bridge dial readings.

If R_X is more than about 200 ohms, replace C with a standard resistor, R_S, that approaches the value of R_X. This increases accuracy. For example, if R_X is 47,000 ohms, R_S should be 100,000 ohms. Then, $R_X = R_SB/D$ when the bridge is nulled. The preliminary rough measurement of R_X is made with the bridge, using pot C in the bridge circuit, or with an ohmmeter. This rough measurement quickly indicates the value of R_S to be used. R_S should have a tolerance of 1% or better.

The bridge measures resistance with an accuracy of several percent. This accuracy can be improved by measuring the total resistance of pots B and D on another bridge and computing a correction constant, $k = 2B_{total}/D_{total}$. Then $R_X = R_SkB/D$. If B_{total} equals 52 ohms and D_{total} 104 ohms, $k = 2(52)/104 = 104/104 = 1$. In this case you literally forget about the correction constant k. The Clarostat 58C1 pots have very good linearity (1%). But their total resistance may vary by 5%.

It's apparent that if B_{total} and D_{total} are both high or low in value, bridge error will be small even if the correction constant is omitted. The most extreme error would occur when B and D are off in opposite directions. For example, if B_{total} equals 52 ohms and D_{total} 96 ohms, $k = 2(52)/96 = 104/96 = 1.08$. In this relatively extreme case, the error is 8% if the correction factor is omitted.

The modifications are relatively simple. Drill a 3/16-inch-diameter hole on the center of a line connecting S1 and S2 for the meter centering control. Drill four holes of 1/8-inch diameter spaced 3/8 and 1 1/4 inches from each side of center and 1 inch from the bottom edge of the panel—these are for the binding posts.

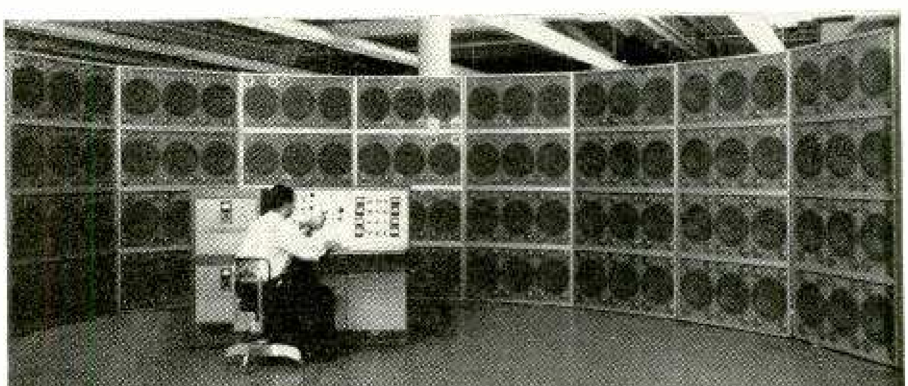
Drill two 1/8-inch holes 5/8 inch above the outer binding-post holes. Pass connecting wires from the sliders of pots A and C (center terminals) through these holes to the front side of the panel. Connect them to J1 and J4, respectively, when the unit is used as a computer. They are disconnected when the instrument is used as a measuring bridge. Cut R3's shaft to a length of 1/4 inch.

The photos can be used as wiring guides. Do not overheat the transistor when you solder it into the circuit. Grasp transistor leads with a pair of pliers between the transistor body and the connection ends during soldering. The pliers act as a heat sink.

The new null-detector circuit can be used in any instrument requiring a sensitive zero-center null meter. It may be used in instruments like "Mr. Math" (RADIO-ELECTRONICS, June 1958). The cost of the null-meter parts is considerably less than the cost of a sensitive zero-center microammeter. END

WALL of SOUND

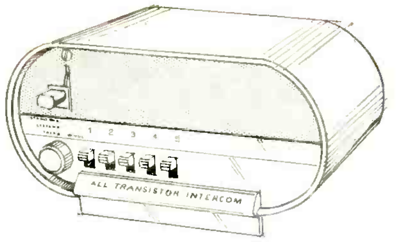
THIS bank of 480 speakers was not built for esthetic effects, as the title might suggest, but for the serious study of the physical effects of high-intensity sound. It will be used by the Wright Air Development Div., Wright-Patterson Air Force Base, Ohio, for whom it was designed and constructed by Stromberg-Carlson.



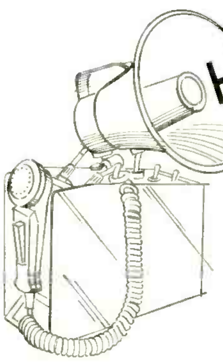
The system is flat from 20 through 20,000 cycles, at powers up to 14,000 watts. The speakers are arranged in 32 baffles of 15 speakers each—3 woofers and 12 tweeters, all specially built to deliver high fidelity sound at unusual acoustic power. Power is supplied from two 7,000-watt amplifiers. An alternate pair of 200-watt amplifiers is used for low-power work.

Four inputs are provided: sinewave; white noise; tape recordings of jet engines, missiles or other noise; and external. The four input sources can be mixed in any desired combination and supplied to the amplifiers at any required level indicated on a meter. A safety precaution makes it necessary for the operator to "turn down the volume" before energy can be applied to the high-power amplifiers.

INTERCOMS and BOAT HAILERS improved by Transistors



Semiconductors increase the efficiency, convenience and usefulness of the equipment in which they are used



By **ROBERT F. SCOTT**
TECHNICAL EDITOR

WITH the notable exception of their use in portable radios, consumer and home entertainment products have been slow to use transistors. The latest commercial adaptations to come to our attention are a combination foghorn, megaphone and public address system, and intercom systems.

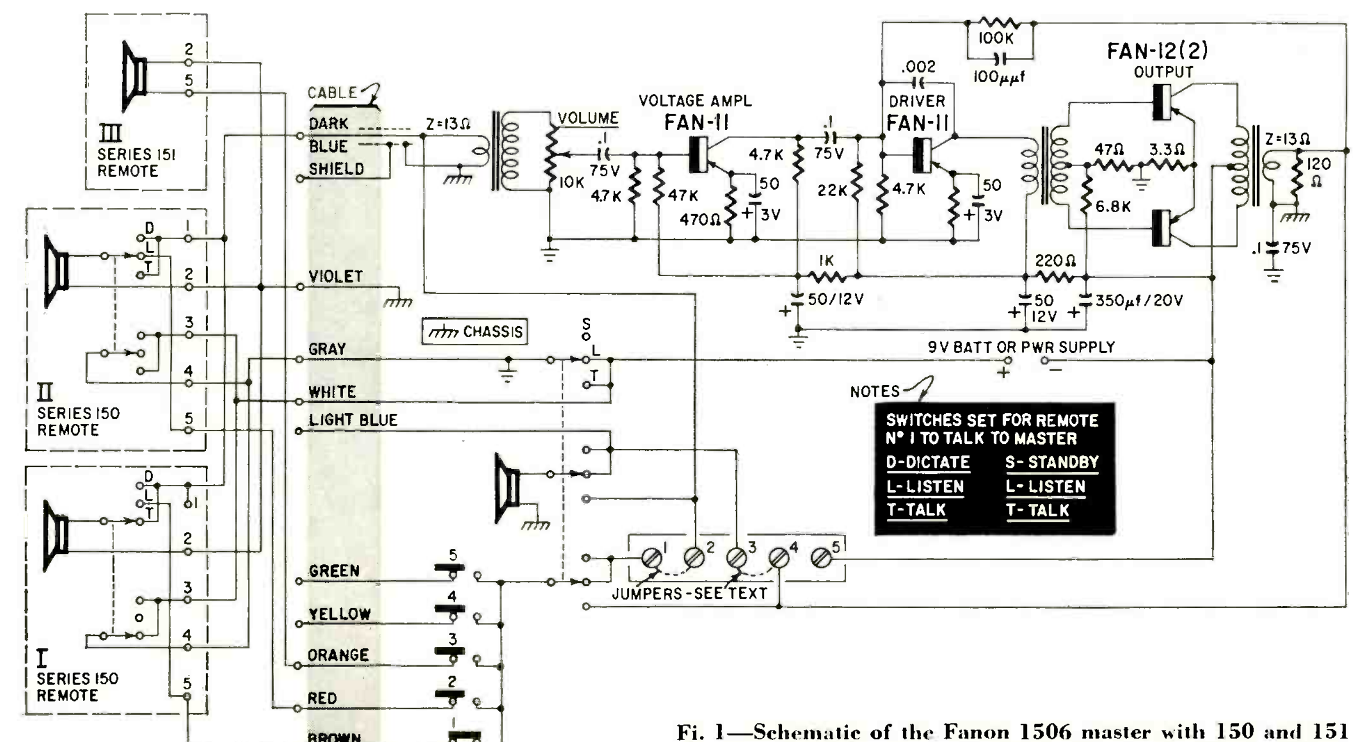
Transistor intercoms

Over the years, the popularity of intercom systems has been dimmed somewhat by complaints of hum, high heat radiation, shock hazard and high current consumption. Several firms have developed transistor intercom systems that eliminate all these disadvantages. The talk–listen switches turn the amplifier on and off so there is no standby current drain. Heat radiation is almost nonexistent and hum level is comparable to that of a good hi-fi audio amplifier. And, best of all, there is no shock danger from the battery or low-voltage power supply.

Typical of the transistor intercoms are the Fanfare systems made by Fanon Electric Co. The 1500 is a 2-station system with a master and remote. The 1506 is a 6-station unit for use in master-to-master, master-to-remote or any combination of master and remote units for up to 6 stations. The 1512 is a similar master unit designed for up to 12 remote stations of various types.

Three types of remotes are available. The model 150 is the common type with a three-position TALK–LISTEN–DICTATE switch. The 151 is a simple unit without switch. It is used for remote baby tending and in cases where it is not necessary to initiate a call to the master. The 156 has a six-station selector switch for calling any one of six masters in the system. The system may consist of a master and five remotes, all masters or an intermix circuit with two or more master with remotes. Thus, a variety of hookups become possible.

The amplifiers in the Fanfare series 1500 intercoms use four p-n-p transistors. Two type FAN-11's (Fanon type number) are used as voltage amplifier



Fi. 1—Schematic of the Fanon 1506 master with 150 and 151 remotes. Switches are set so remote No. 1 can talk to master.

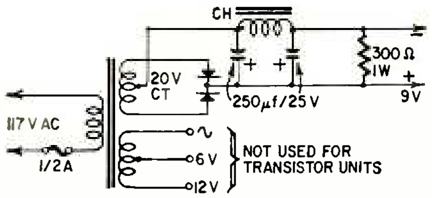
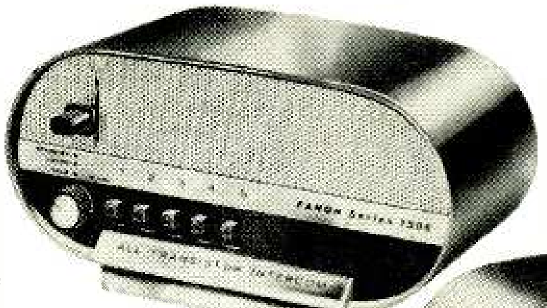
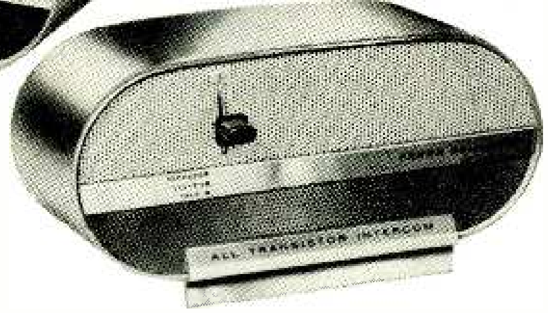


Fig. 2—Fanon PSA power supply.



Fanon 1506 six-station master.



Fanon model 150 remote.

and driver, and a pair of FAN-12's are used in the class-B power output stage. Fig. 1 is the circuit of the 1506 master with 150 and 151 remotes. The connections to the master terminate in a cable with ten insulated leads and a shielded conductor. Terminal boxes (not shown) are available for connecting this cable to the interconnecting cables of the other stations.

Five slide switches on the 1506 select the remote(s) to be contacted. The mode switch is left in the STANDBY position when the system is not in use. This disconnects the battery from the positive return lead in the amplifier. To initiate a call from the master, the caller selects the remote or remotes by closing the corresponding slide switches and then throwing the mode switch to TALK. This applies power to the amplifier, connects the master's speaker–mike unit to the input, and the hot side of the slide switches to the amplifier's output. When the mode switch is released, it automatically returns to the LISTEN position so the remote(s) is connected to the input and the master's speaker to the amplifier's output. When the conversation is over, the party at the master turns off the system by flipping the switch to STANDBY.

A party at a 150 (or 1506) remote initiates a call by throwing the switch to TALK or DICTATE. One section of the switch connects the remote to the amplifier's input. The other section turns on the amplifier by completing the circuit between the positive side of the battery and the positive return through the white and gray cable leads and terminals 3 and 4 on the remote.

The system can be set up for nonprivate operation (master can monitor remotes at will) by connecting a jumper between terminals 1 and 2 on the master. If the setup is for private operation, any remote can be made nonprivate by leaving its switch in the DICTATE position. This is useful for baby sitting or other instances where it is necessary to monitor activities from a distance. A jumper is required between terminals 3 and 4 on any master that talks to a remote but is not used in an all-master system. (The mode switches on the master and remotes are spring-loaded to return to LISTEN when released from the TALK position and have positive detents to lock in the DICTATE and STANDBY positions.)

The Fanon type PSA power supply (Fig. 2) may be used in place of batteries to power a system with up to four masters. The supply cable terminates in snap type connectors matching the battery connector in the master unit. When this supply is used, terminals No. 5 on each master must be connected together through an additional lead in the cable.

The Portahorn

RCA's Portahorn model CRM-S1A is a transistorized public-address system, intercom, signaling device, automatic foghorn and boat horn for all marine craft ranging from large commercial vessels to small pleasure craft. It may be used with a hydrophone to locate underwater sounds from schools of fish, divers, etc.

The Portahorn operates from two self-contained batteries and may be used ashore by fire, police and emergency departments, airport personnel, construction, railroad, surveying and civil defense crews and others requiring a portable sound system with a range of up to 2 miles. Its 12-volt supply consists of two RCA VS009 6-volt batteries in series.

Battery drain is around 70 ma with zero signal input and approximately 500 ma for full output. Standard equipment consists of the electronic unit, batteries, an 8¼-inch-diameter 15-watt re-entrant type horn loudspeaker and a pushbutton reluctance type microphone with a 65-inch coiled cord. Weight with batteries is 13½ pounds.

The speaker is mounted on top of the cabinet in a fitting permitting 360° horizontal rotation and 90° vertical swing. The speaker may be removed, located at a remote point and connected to the amplifier through an extension cord.

Basically, the Portahorn consists of an audio amplifier driving the speaker, an audio oscillator to supply the horn tone and a multivibrator to key the oscillator to sound the foghorn at regular intervals.

A somewhat simplified schematic of the versatile Portahorn is shown in Fig. 3. There are two audio input jacks. The AUXILIARY jack works into the base circuit of the preamplifier and is for the hydrophone, radio, tape recorder, phonograph or telephone pickup coil. The

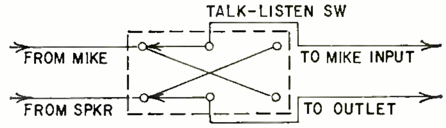
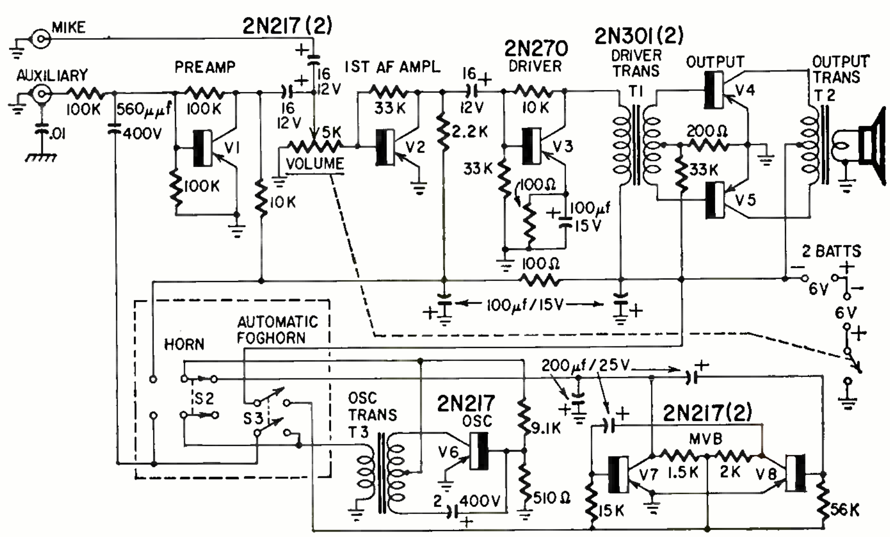


Fig. 4—Talk-listen switch for the Portahorn.

Fig. 3 (below)—RCA Portahorn.



MICROPHONE jack in the base circuit of the first af amplifier is for the mike supplied with the unit.

The 2N217 audio oscillator for the horn is a Hartley type operating in the range of 400 to 500 cycles and designed for high harmonic content to deliver a melodious, penetrating sound. The secondary of the oscillator transformer T3 is connected to sections of the HORN switch (S2) and AUTOMATIC FOGHORN switch (S3). S2 is a dpdt toggle switch shown in its normal position. When this switch is pressed for signalling, attracting attention or sounding a warning, T3's secondary is connected to the base of the preamplifier transistor and operating voltage is applied to the oscillator to sound the horn.

S3 is a dpst toggle switch that is normally open. When it is closed, the 1,500-ohm resistor in V7's collector circuit is put in series with the voltage supply to the oscillator. The transistors in the multivibrator conduct and cut off alternately. When V7 is cut off, the oscillator receives sufficient voltage to operate. When it is conducting, the voltage drop across the resistor is too great to allow the oscillator to operate and sound the foghorn. The mutivibrator is set so the foghorn sounds for 2 seconds and is off for 6 seconds.

The TALK–LISTEN switch (Fig. 4) converts the Portahorn into an intercom unit. In the TALK position, the instrument is used as a power megaphone, PA

RCA Portahorn

system, horn or foghorn. In the LISTEN position, the connections to the horn and reluctance microphone are reversed so the horn acts as a highly directional sensitive microphone and the mike acts as a reproducer used as an earpiece. END

(At this writing, RCA has taken the Portahorn off the market, but it will still be made and sold by Wightman Electronics, 9 West St., Easton, Md.—*Editor*)

low-cost starved-current Amplifier

Single-tube amplifier has cathode-follower output stage that delivers 1 mw

By PAUL S. LEDERER

IN 1950, a paper titled "Ultra-High Gain Direct-Coupled Amplifier Circuits" was presented by Dr. Walter K. Volkers at the IRE Convention in New York. The paper described how the amplification factor of a pentode may be greatly increased beyond conventional values by lowering the screen voltage below 10% of the plate supply voltage and by increasing the plate load resistance 10 or more times over conventional values. This type of operation results in extremely small plate currents, hence the descriptive term "starved-current" operation.

Based on this principle, a small amplifier was built some years ago (March, 1954, issue; page 45) using a 6AU6 as the "starved-current" amplifier and a 6V6 as power output tube. It performed well—it had a 92-db power gain and required 2-mv input for 100-mw output. However, its frequency response was limited—about 180 to 2,500 cycles.

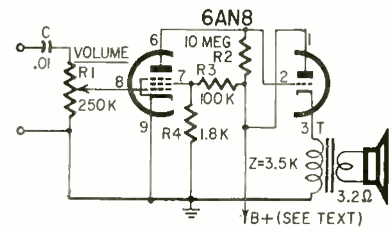
Further experiments produced another interesting starved-current audio amplifier with somewhat different characteristics. It uses even fewer parts and has a wider frequency response but lower gain. It uses a 6AN8 triode-pentode, with the triode acting as a cathode-follower power amplifier. In addition to the output transformer, only four resistors are required. In this amplifier a potentiometer volume control is substituted for one of the resistors and a dc blocking capacitor is added at the input. These features make the amplifier suitable for general experimentation.

With a plate supply of 140 volts, total current drawn is about 23 ma. With a 10-mv input (rms, 400 cycles) the power output into a 3.2-ohm speaker is a little less than 1 mw. This represents a power gain of 63 db. Frequency response is ±3 db from about 150 to 7,000 cycles and about 5 db down at 80 and 9,000 cycles.

The 1-mw power output certainly seems a far cry from high-fidelity amplifiers capable of putting out 20, 40 or even 100 watts. However, let's keep a few things in mind: These high-quality amplifiers are designed to give linear and distortion-free reproduction on transient sounds whose instantaneous power level may reach such values. The average level of power required is quite a bit lower. The actual power required depends on the size of the room, the efficiency of the speaker used and the personal tastes of the listener. In general, for listening at ordinary conversational level, about 200 mw seems to be sufficient. Furthermore, since the human ear responds logarithmically to sound amplitudes, a reduction of power output by a factor of 200 will seem to be about one-third the previous volume. Listening tests proved the output from a 5-inch PM speaker to be adequate with a 10-mv input. With 20-mv input, output is about 3 mw. The systems begin to overload near 30 mv—both tops and bottoms of the waves are clipped.

Since this amplifier is designed primarily for low input signals, no self-bias resistor was used. Contact potential between cathode and grid provides the necessary bias. With a 140-volt plate supply, the screen voltage is 2.6 and the total current drain is about 23 ma. This results in a triode plate dissipation of about 2.9 watts, a little greater than allowed by tube manufacturers' specifications.

Operation at a lower plate-supply voltage is possible too. With 110 volts at 10 ma, power output is about 0.4



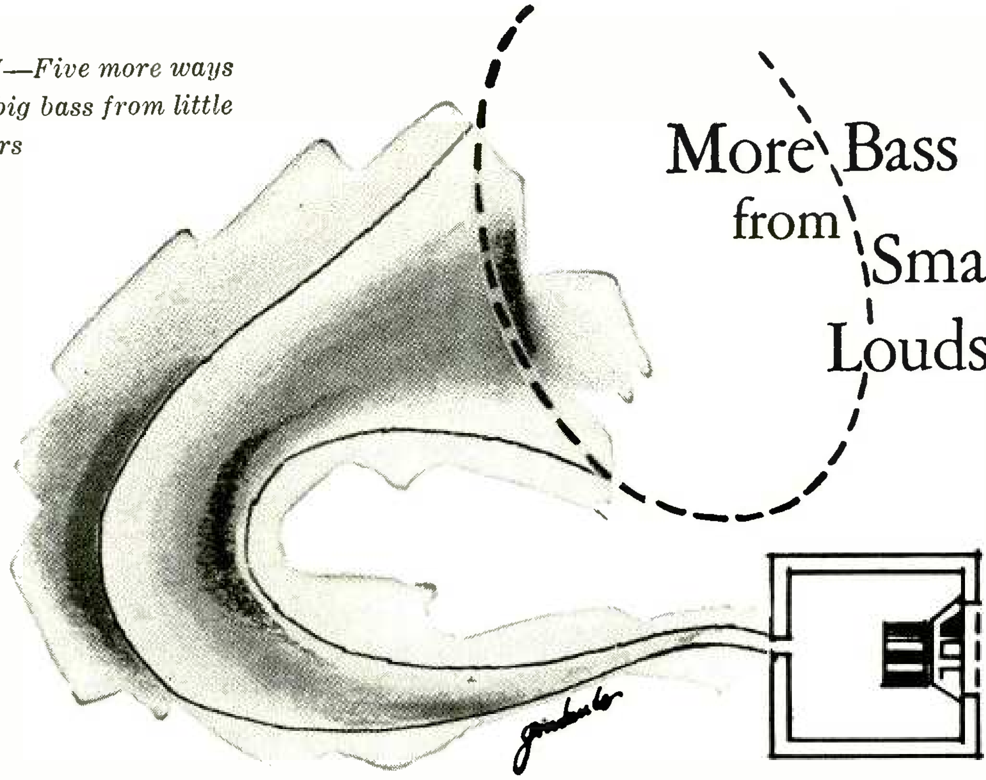
R1—pot, 250,000 ohms
R2—10 megohms, 1 watt
R3—100,000 ohms, 1 watt
R4—1,800 ohms, 1 watt
C—.01 μf, paper
T—universal output transformer
V—6AN8
Socket, 9-pin miniature for V
Chassis—3½ x 5 x 1 inch
Miscellaneous hardware

mw with 10-mv input. Plate dissipation is now about 1.9 watts. While building, the amplifier screen voltage was adjusted experimentally with a potentiometer (with 10 mv in and 140 volts B-plus) until the output voltage (as displayed on a scope) was greatest with least visible distortion and minimum plate supply current. This is not as complicated as it sounds. After a few tries, one gets the feel of the adjustments. When the optimum has been determined, replace the potentiometer with fixed resistors.

The whole amplifier is mounted on a 3½ x 5 x 1-inch aluminum chassis, but could be made even smaller. END

Part II—Five more ways to get big bass from little speakers

More Bass from Smaller Loudspeakers



By NORMAN H. CROWHURST

LAST month we looked at some popular types of enclosures. There were horns, infinite box baffles, the Boffle, bass reflexes and back-loaded horns. But in all these types the lowest frequency available is strictly proportional to the size of the speaker. The quest is for smaller units that give big bass.

Acoustic suspension

Trying for smaller speakers means that units utilizing propagation effects are out of the question because this method takes space. We have to live with types that depend on, use or take cognizance of the speaker's resonance. Making the enclosure smaller always tends to raise the resonant frequency. Lowering it again by artificial means tends to reduce efficiency.

First in this direction was the acoustic suspension unit. This is a variation of the infinite baffle, but with a change in proportions. Instead of using an ordinary speaker with a resonance around 50 to 100 cycles, the speaker's resonance is lowered "off the map" to around 10 cycles. Then the stiffness added by the box is the major control, bringing the resonance up again to 35 or 40 cycles.

In the infinite baffle, the major control is the diaphragm suspension, which is mechanical, and the box has to be big so the stiffness added by the air is relatively small. In the acoustic suspension, the stiffness due to air in the box is the major consideration, so the box can be small.

Getting the unit resonance down can be achieved by two methods: a—making the suspension more compliant or floppy; b—making the cone heavier.

If the first method is adopted, more latitude for movement is required, so a larger air gap to move in is also required. This means a bigger magnet or a loss in efficiency.

In the other method, the extra weight may be either in the coil or the cone itself. An average speaker cone weighs about 10 to 15 grams. A "heavy" one weighs 35 grams or more. Putting the extra weight in the coil means some of the efficiency lost by widening the gap is regained by using more of the extra width. Putting it in the cone helps the rigidity problem, but otherwise cuts down efficiency.

Associated with this choice is one of coil *length.* If the suspension is made more compliant or floppy, the cone can move a lot farther, even out of the gap. To avoid this causing nonlinearity in drive, some extend the voice coil beyond the gap (Fig. 1) so more coil comes in when the middle section moves out. But this means only a fraction of the coil is producing drive *at any instant.* The dead coil in series with the active part also reduces efficiency.

A popular compromise right now uses a cloth surround, suitably impregnated, which gets the free resonance down to a little below 30 cycles. Then the air in the box is used to bring up the resonance to its usual place, so that a low resonance of 40 to 60 cycles is possible, using half mechanical and half acoustical stiffness.

This approach is not strictly acoustic suspension but it retains good efficiency and achieves an acceptably small size (until next year maybe!). A look at the market today shows a variety of combinations in this area, each of which is supported by suitable arguments for that particular combination.

Another variant puts a division in the box, with holes in it (Fig. 2). This partially decouples part of the air spring through a mass and in this way lowers and spreads the resonant effect. The holes, by the way, are not small enough to make the second section a resonator in itself; they merely modify

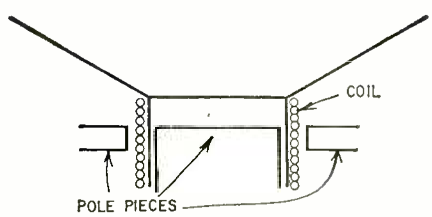


Fig. 1—The lengthened voice coil allows turns to be in the gap at all times (although not always the same turns).

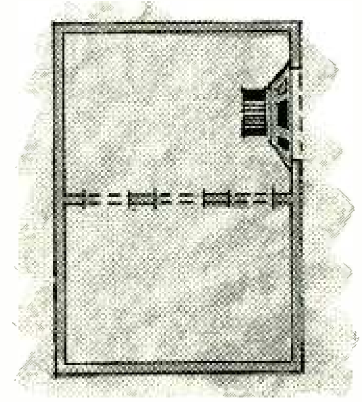


Fig. 2—A variation of the infinite baffle that makes the inside of the box effectively larger than it really is.

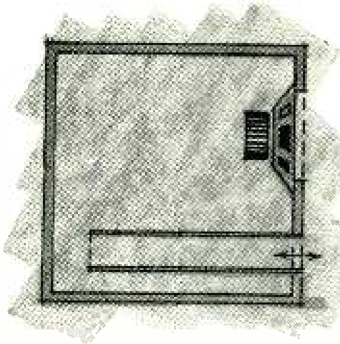


Fig. 3—The duct-loaded reflex radiates mostly from port at lowest frequencies.

the springiness contributed by the air on the other side.

Duct-loaded reflex

A pretty good variety of bass-reflex designs have been explored in the course of time, even to hanging a hinged door in the port! In the conventional reflex, at the lowest frequency before it starts into its 18-db-per-octave dive, the diaphragm pushes about equal power into both back and front, but the back wave gets reversed in phase so as to come out in phase with the front. This may be a kind of ideal matching arrangement, but it still ends up with a pretty bulky unit.

Various other combinations are possible, one of which is the duct-loaded reflex (Fig. 3). This uses a small box space with a tube vent to do something quite similar to the air coupler, but without using the propagation principle. Rather it uses what may be regarded as a resonant matching device. The acoustic L of the duct and the C of the box transform a large air movement in the duct into a back pressure on the cone, right at or near its resonance.

This cuts down cone movement considerably and transfers most of the radiation at this frequency to the duct. Proper choice of parameters seems to yield several advantages to this method. A smaller box is possible for response and efficiency comparable with an acoustic suspension or part-way acoustic-suspension type. The cone movement at the lowest frequency is restricted in a manner very similar to a horn or air coupler, reducing possibilities of distortion. And it is not necessary to bring the unit resonance to a frequency *below* the audio range decided upon.

The length of the duct makes the performance of the speaker reasonably independent of placement. However, it is a good idea to vent the duct into a restricted space, such as a wall behind the enclosure or the floor beneath it, the better to expand the almost point-source wave it emits. But failure to do this does not result in such deterioration in performance as does failure to put a horn in its corner.

Variable mass

While these past two represent older principles in which the proportions have been changed to get the desired effect, the last two we shall consider represent departures from established concepts. In the variable-mass idea, the starting point is the fact that, to keep resonance down to a low frequency with a small speaker, the cone mass has to be made larger, but this effectively prevents it from radiating at higher frequencies.

The variable-mass principle uses what is basically a light cone, but couples a somewhat flexible mass to it. At low frequencies, because of the relatively large movements involved, the relative flexibility of this coupling is poor and the whole mass moves with the cone, bringing down its resonance. At higher frequencies, the smaller, more rapid motion forces the flexibility of this coupling to "give" progressively more until only the cone moves.

It's a bit like having your cake and eating it too. By distributing the compliance throughout the mass—the whole piece is made of a special foam plastic—it does not suddenly leave off moving with the cone, but produces quite a smooth response over a wide range.

Bi-Phonic coupler

This latest innovation really starts from another point. The designer had noted that the bass-response problem with most speakers was making a satisfactory enclosure of one type or another. In many of them great pains are taken to prevent side panels from vibrating. In this design, he dispenses with the usual enclosure altogether, and uses a panel designed to vibrate as the radiating element, instead of the more conventional cone (see RADIO-ELECTRONICS, April 1960, page 94).

Most small loudspeakers use units with cones that are proportionately smaller than the enclosure. This is what makes the cone require large movement at low frequencies (with the exception of the ducted reflex). But this design uses a flat diaphragm, much larger than most woofers, *as a complete loudspeaker*.

Of course this makes the diaphragm much heavier than usual too. So we would not expect it to radiate much in the higher frequencies. This problem is overcome by using a material that is much stiffer as well as being heavier—a thin wood panel, specially treated.

So much for variations of the dynamic or moving-coil type.

Wide-range electrostatic

Just as everyone comes up with different variations on the old theme with the well-tried dynamic units, the wide-range electrostatic makes its appearance, and some are surprised to find it is not as big as they predicted it would have to be—"the whole wall of a room at least!" Since it is not unduly large and is sensibly flat, it can qualify for inclusion in a discussion of smaller speakers for bigger bass.

Can you imagine trying to make a dynamic speaker work using a miniature neon tube for the moving coil? It seems that earlier attempts at wide-range electrostatics were about that much off base. The diaphragm needs room to move, like a dynamic unit, and it needs commensurate driving voltages, which in turn require new insulation techniques. It's that simple.

But this does introduce a relatively new concept: the large-diaphragm loudspeaker. With this change in design, radiation resistance now becomes a considerable part of electrical input impedance, which helps.

However, this new field is only beginning. It seems that one way to use it is just to stand it by the wall, in which case the whole unit acts as its own air coupler, using the cavity behind it, which is quite uncritical.

Probably amplifiers should be designed specifically for driving this type unit, in view of its dramatically different impedance—high and capacitive. Its high-end response is very smooth, but something will probably have to be done about its directional effects. But that's another story.

But to get back to the small-speaker–big-bass aspect. It looks as if the people who used to tell us a unit had to be big to give real bass must be developing a taste for felt hats right now. True, all these approaches involve some loss of efficiency, due to the variety of reasons we have discussed. But proper choice of parameters results in a variety of products in which you would hardly know efficiency had been sacrificed. END

If everybody believed in the

GOLDEN RULE

we wouldn't have had to establish our mail-order tube sales policy. But since there are people in business who have been known to live up to only the first three words of that precept, we have found it necessary to insist that mail-order tube advertisers tell you either that their tubes are new and unused—or that they are seconds, rejects or imperfect if that's the case. Otherwise RADIO-ELECTRONICS will not accept their advertising.

	TYPE	UNIT REQUIREMENTS: Cone or Diaphragm: Size	UNIT REQUIREMENTS: Cone or Diaphragm: Mass	Surround Compliance	Unmounted Resonance	Cone Movement at Lowest Frequency	ENCLOSURE OPERATION: Acoustic Principle Used	Front Loading of Cone: Low Frequency	Front Loading of Cone: Medium Frequency	Back Loading of Cone: Low Frequency	Back Loading of Cone: Medium Frequency	Radiation of Lowest Frequency	SYSTEM FEATURES: Rate of Low Frequency Roll-off	Is Low Frequency Protection Needed?	Manufacturing Details to Look For	Special Care Needed in Use
LARGE	Horn	Unimportant				Small	Propagation	High acoustic resistance		Small compared to front		Large area horn mouth	Acoustically decouples suddenly	Yes	Accurate horn contour Rigid construction	Must be in corner with uninterrupted adjacent sides
	Back-loaded Horn	Normal for overall size	Light	Unimportant		Small	Propagation with acoustic crossover	Small compared to back	Normal radiation resistance	High acoustic resistance	Acoustic cavity reactance	Large area horn mouth	Acoustically decouples suddenly	Yes	Accurate horn contour Rigid construction	Must be in corner with uninterrupted adjacent sides
	Infinite Baffle	Normal for overall size	Light	Normal	Normal—raised by baffle	Normal for size	Suppressed radiation from back	Normal radiation resistance		Acoustic cavity reactance, higher than front resistance		Front of cone	12db/octave below system resonance	No	Well sealed interior Use of acoustic damping material	Should be against wall
	Boffle	Slightly smaller than average	Light	Normal	Normal	Slightly more than average	Radiation from back absorbed	Normal radiation resistance		Acoustic impedance lower than front		Front of cone	Depends on enclosure size and unit resonance	Yes	Not currently available	Should not be too close to wall
	Air Coupler	Suited to air column area	Medium	Normal	Low to normal	Small	Quarter wave acoustic transformer	High acoustic resistance	Succession of high & low loading alternately	Small compared to front	Constant (radiation) resistance	Mouth of tube	Acouctically decouples	Yes	Not currently available	Has to be built in Requires separate mid-range unit
	Bass Reflex	Normal for overall size	Light	Normal	Normal	About half average	Acoustic phase inversion	Normal radiation resistance		Equal to front	Acoustic cavity reactance	Equally from front of cone and port	18db/octave below system resonance	Yes	Correctly matched port Use of acoustic damping material	Should be against wall
SMALL	Acoustic Suspension	Normal—but in smaller enclosure	Medium to heavy	Very floppy	Very low	Large	Acoustically controlled resonance	Normal radiation resistance		High acoustic stiffness reactance		Front of cone	12db/octave below combined resonance	No	Well sealed and damped enclosure Large free movement with linear drive	Should be against wall, floor or ceiling Requires tweeter
	Duct-loaded Reflex	Normal—but in smaller enclosure	Medium	Higher than normal	Lower than normal	Small	Resonant acoustic impedance transformer	Small compared to back	Normal radiation resistance	High acoustic resistance	Acoustic cavity reactance	Mouth of duct	18db/octave below system resonance	Yes	Well sealed enclosure Duct should be spaced from floor or wall	Duct should point to floor or wall Requires tweeter
	Variable Mass	Small	Variable (see text)	Higher than normal	Lower than normal	Large	Distributed mechanical resonance	Normal radiation resistance		High acoustic stiffness resistance		Front of cone	12db/octave below complete mass resonance	No	Mass element well secured to cone Cavity well damped acoustically	Should be against wall or in bookcase
	Bi-Phonic Coupler	Much larger than usual	Heavy and stiff	Very stiff	—	Less than average	Large diaphragm open backed (dipole) radiator	Acoustic mass reactance	Normal radiation resistance	Acoustic mass reactance	Normal radiation resistance	Differential front and back	12db/octave size controlled turnover	No	Freedom from resonances in diaphragm panel	Requires at least small escape behind

SPECIAL EFFECTS with a TAPE RECORDER

By JOHN A. LARSON*

Want to have more fun with your tape recorder? Try the five stunts described here

ONE of the most versatile instruments in the world of sound is the magnetic tape recorder. Its unique ability to capture sound, store it on a thin piece of magnetic tape and then faithfully play it back again when desired and as often as desired, is the key to a practically infinite variety of applications. Many of these are well known: the playing of prerecorded music tapes, both stereo and monophonic; home recording of the family or of a party; recording from radio, TV or a disc player. These are the usual applications.

*Ampex Audio, Inc.

But let's go beyond the usual and look at some of the special effects possible with the tape recorder, effects that can bring a barrelfull of extra fun, entertainment and value to its user.

One of the easiest is adding reverberation. A recorder with separate record and playback heads is required so some of the playback signal, which is received by the playback head a fraction of a second after it is recorded, can be fed back into the original. This is done by jacking the output signal back into the line input signal (Fig. 1). The reverberation effect can be altered, using the playback level control, from that of a large hall to a large cathedral, or to a longer delay that becomes a distinctive echo of several words. Too high a level will cause immediate overloading—on a VU meter the needle will try frantically to ram itself through the right side of the scale. The best echo is obtained by keeping just below this overload level.

The lower the playback level position, the lower the echo effect. Earphones are a highly desirable aid to obtaining just the desired amount of reverberation. The 7.5-ips speed is best for cathedral effects and for a large-hall or slight echo effect. If a definite repeating echo is wanted, drop the speed to 3.75 ips. The echo will distinctly repeat over and over, gradually growing fainter. The speed and length of the repeat can be altered by the playback level control.

Sound-on-sound

One of the most discussed special effects is adding an additional sound to a previously recorded sound. There are various ways to do this, all dependent upon the kind of recorder you are using. For example, let's record a girl singer whom we want to sing a duet with herself—the first part soprano, the second part alto.

The prime requirement is a recorder that has separate record and playback heads (this is essential to almost all special effects). Of these, the easiest recorder to work with is one that can record stereo as well as half-track, and therefore has a split-erase head and a two-track record head. (The Ampex model 960 is an example of this kind of semiprofessional recorder.)

The first recording to be made is the master track. We'll have the girl sing her soprano part for this. Plug the mike into track 2 (usually the bottom track—most recorders when in the single record mode will record on the top track, which would be track 1). Record the girl's soprano part on track 2. Rewind the tape to the beginning. Jack the output of this master channel which is on track 2 into the input of track 1, and use earphones to monitor the master channel (Fig. 2). Plug the mike into track 1's mike input. Because of the recorder's split erase head, we can record on track 1 without erasing the master channel on track 2. Now, when the recorder is turned on, the playback head picks up the previously recorded master of the girl's soprano part on track 2 and feeds

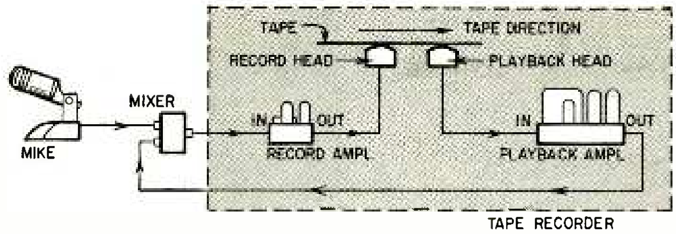


Fig. 1—Wiring arrangement for getting reverberation on tape.

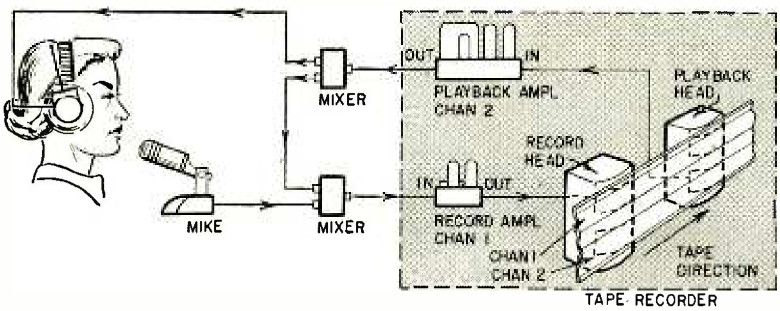


Fig. 2—Sound on sound calls for this setup.

it through the patch cord to the record-head input of track one. At the same time, the girl (listening through the earphones to the soprano part) sings her alto part in unison, and the two signals are combined on track one. The balance of the two signals is adjusted with the playback and recording level controls. Track 1 can be re-recorded again and again, until satisfactory, without erasing the master channel on track 2.

With recorders that record monophonic only, but can play stereo, the method is somewhat similar, except that because the recorder records only mono it will record on only track 1. Therefore a special step is necessary to get the master channel down to track 2, where it cannot be erased when adding the girl's alto part. Here's how to do it: Record the master channel of the girl singing soprano on track 1. When the recording is completed, do not rewind. Instead, turn the reels over, just as is done with half-track monophonic tapes when the other half is to be recorded, and jack the output of track 2 (which is where the master channel is now that you have turned the reels over) into the input of track 1. After adjusting playback and record levels, start recording. This records the master channel of the soprano part *in reverse* onto the new track 1.

When the "reverse" recording is finished, change the reels again back to normal. A copy of the original master channel is now on track 2, ready to play forward in the normal way. This copy is henceforth considered the master channel, as the original master on track 1 will be erased when adding the girl's alto part. Since your track 2 output is already jacked into track 1's input (and earphones are inserted into this circuit, as previously explained), recording can begin of the girl adding her alto part (and listening to the soprano part on track 2 through the earphones, as previously explained).

Another method for getting sound-on-sound, but involving considerable alteration and time, is to place the playback head of a recorder before the erase head. This is possible on some machines. In this case, the already recorded signal is heard by the girl through monitor earphones and at the same time the signal is routed to the high-impedance input of the record head. Right after this—a few milliseconds—the tape is erased by the erase head. The clean tape that reaches the record head receives the combination of the first signal plus the second signal (the girl's alto part) being added through the microphone.

Speed variation effects

We can get dramatic effects by altering the speed of a tape recording of a solo instrument—piano, electronic organ or guitar. A tape recorder with two speeds is required. Have the musician play a selection on his instrument at three-fourths the speed he normally plays it (a metronome may be necessary), and one octave lower than usual. Record this at 3.75 ips.

After the recording, rewind and play it back at 7.5 ips. This will make the music one octave higher than recorded, bringing it back to its correct key. Since the speed is one and one-half times as fast, the fingering technique sounds incredible and practically impossible for even the most accomplished musician.

Sound-on-sound can be added to this effect. For instance, first record the right hand only. Then add the left hand by following the technique outlined for sound-on-sound. If an electronic organ is used, another set of stops or pedal notes can be added. Or the solo guitarist could add a partner or several partners, by repeating the process several times (each time that you get further from the original master, however, more background noise is added, so there is a point of diminishing returns).

Tape with slide shows

A tape recorder can activate an automatic slide changer and at the same time be the sound track for the slide show, playing narration and music. The trick is that, when recording the narration and music on the sound track, a practically inaudible 25-cycle tone is recorded wherever a slide change is wanted. When playing the tape during the show, the 25-cycle tone activates a relay that will cause the automatic slide changer to change slides (see Fig. 3).

The tone does not have to be 25 cycles. As long as it is practically inaudible, yet within the capabilities of the recorder's preamp, it will work. A separate amplifier, tuned to the desired inaudible tone, operates the relay which changes the slide by triggering the mechanism of the automatic slide changer.

Another method is to splice strips of metal foil into appropriate places in the tape, which when running through a contact, would activate the relay.

There are many other ways too—a silence on the tape of so many seconds can activate a relay. One company markets a system in which a short slit is made horizontally in the middle of the tape, through which the relay-activating contact is made.

The simplest method, of course, although not automatic, is to record an

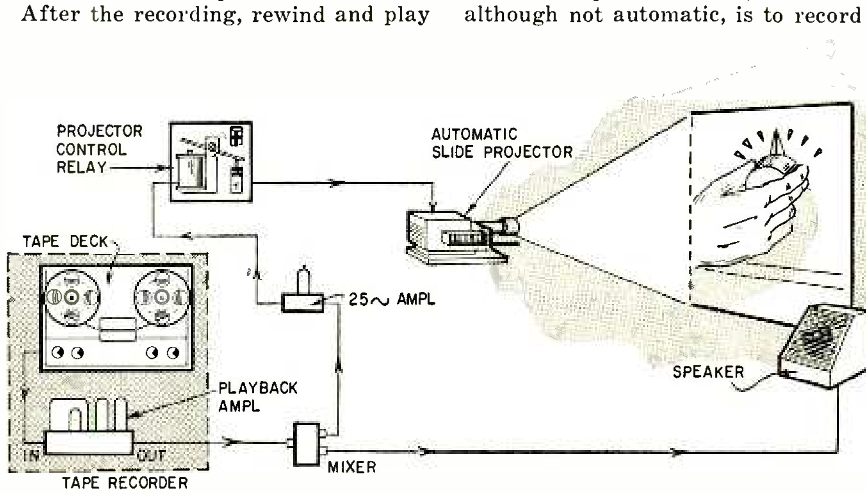


Fig. 3—A tape recorder can trigger an automatic slide projector. Use the simple arrangement shown here.

audible signal on the tape—snapping the fingers or clinking a glass—to cue the projector operator to change the slide. If the sound track is monophonic, this signal could be on the other track, with the output of this second track fed to earphones, so only the projector operator hears the cue signal.

Mary Had a Little Lamb

You can get an effect resulting in a hilarious game of tongue twisting if you have a tape recorder with separate heads for playback and recording. It is called Mary Had a Little Lamb or the speech testing game. The trick depends on being able to listen to the signal being recorded on the tape just a few instants after it is recorded.

Connect headphones to the amplifier's output. Set the recorder for normal record from a mike, and the record level for normal voice volume. Then turn up the playback level fairly high, so a loud signal reaches the contestant's (or victim's) ears. When everything is arranged, start the tape machine going and ask the contestant to recite Mary Had a Little Lamb fairly fast and with no pauses. The contestant will not be able to do it! Make sure the phones are fitted tightly over the listener's ears.

Here's what happens: After a signal is recorded it takes about 1/6 second for it to be played back through the headphones. When the contestant's voice reaches his ears 1/6 second after he spoke (and is louder than the voice "inside his head"), the normal speech-hearing process is interrupted and confused. It makes the victim stutter and pronounce words incorrectly or drawn out. In attempting to repeat the poem, he will usually say something like, "Mary had ah-ah-ahhhhh li-li-li-little laaaaammmmmmb." Ask the contestant to give his name and address and he won't be able to.

Remember, playback level must be high—loud enough to override a person's normal inner voice—but not so high that it will blast eardrums. Set up the level in advance, after a brief trial, to determine the best setting.

Actually, the game can be beat—by speaking very distinctly, clearly and fairly slowly. This makes the effect a valuable tool in speech improvement and correct word pronunciation.

Experiment yourself

The effects outlined here are, of course, only a few of those possible, but are those most often attempted. The actual method of producing them will vary between different makes of recorders and modifications may be necessary on some recorders. Likewise, the potential of other effects depends upon the particular make and type of recorder.

The only limit to the many special effects that can be achieved with the remarkably versatile magnetic tape recorder is one's own imagination. Start experimenting—that's how the effects mentioned came about. END

Zener Diodes *Prevent* Speaker Burnout

By RONALD L. IVES

SPEAKER burnouts caused by overdriving are common to some hi-fi systems. The reason—many amplifiers have an output that far exceeds the rating of the speaker it drives. Feeding 100 watts to a speaker rated at only 25 is not only acoustically unhappy, but usually causes financial distress too. And the system is out of service while the speaker is being repaired.

Thanks to semiconductor developments, this trouble can be eliminated at a cost somewhat less than one speaker repair: Simply shunt the speaker with a Zener diode voltage limiter.

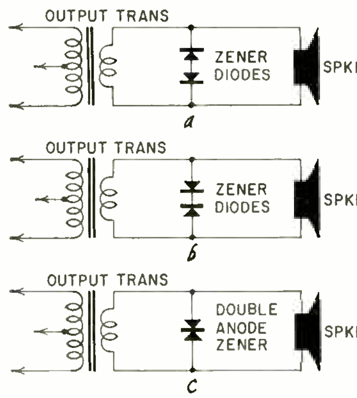


Fig. 1—Three ways of hooking up Zener diodes to protect speakers.

Zener diodes resemble ordinary rectifier diodes but have the property, when connected backward across the circuit, of conducting whenever the applied voltage exceeds a certain fixed and specific values.

A pair of Zener diodes connected across the speaker as in Fig 1-a or 1-b, or a single double-anode Zener, connected as in Fig. 1-c, will supply the required protection.

To determine what voltage rating the diodes you use should have use the formula:

$$E = \sqrt{2}\ \sqrt{WZ}$$

where E is the voltage rating of the Zener diodes; W is the speaker rating in watts; and Z is the speaker impedance in ohms. The factor $\sqrt{2}$ is introduced because the voltages which operate the Zener diode are peak volts while those in the speaker circuit are computed on an rms basis. Of course, both Zener diodes should have the same voltage rating.

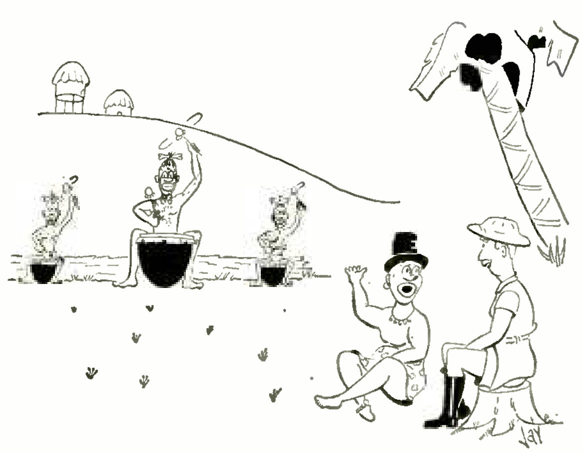
To determine the wattage rating of the Zeners use:

$$\text{Wattage} = \frac{\text{amplifier max power output} - \text{speaker watts}}{\text{number of Zener diodes in circuit}}$$

An ample margin of safety should be allowed here, as we have a divided load consisting of inductance (the speaker) and a pair of nonlinear resistors (Zener diodes).

In operation, the amplifier–speaker system works just as if the Zener diodes were not present as long as their voltage rating is not exceeded. When any peak voltages exceed the Zener rating, the diodes conduct, clipping the audio peaks at the Zener voltage level and dissipating the surplus power as heat.

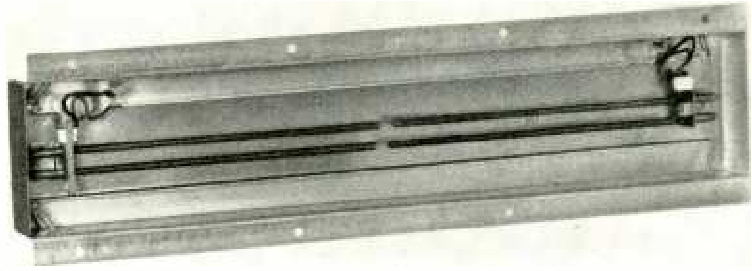
Present indications are that Zener diodes are almost immortal, if operated within their ratings. A more specific figure cannot be given at this time as many of the first Zener diodes are still working perfectly in continuous commercial service. END



"Stereo."

AND NOW . . . REVERBERATION

Delay lines add realism to hi-fi sound systems



Closeup view of delay lines used by Philco.

LITTLE by little high-fidelity sound reproduction has crept closer and closer to the original. Some people indeed feel that with a good hi-fi system matched against a good orchestra, the orchestra might come out second best. In that never-ending search to make sound reproduction at least as good as the real thing, something new —*reverberation*—has been added.

Reverberation is the term for short-time echoes that are produced by instruments, soloists or choruses performing in a concert hall. Some say that when it is used the living room does become a concert hall.

But how do you add reverberation to a hi-fi system? Philco, Westinghouse and Zenith have announced that they are adding reverberation to their new lines of hi-fi packages. The secret is a delay line made under license from the Hammond Organ Co. Let's see how they use it.

The basic diagram in Fig. 1 shows how Philco adds Reverbaphonic Sound to a stereo hi-fi amplifier. Instead of the right and left inputs being directly connected to their respective amplifiers, they go to a pair of 12AX7's. This signal then goes on to the proper amplifiers. However, a sampling of each channel is taken off the plate of each input triode, combined, amplified and fed to a pair of delay lines. At the other end of the delay lines, the signal is amplified again and inserted into both the left and the right channels. This gives the desired few microseconds' delay that produces reverberation.

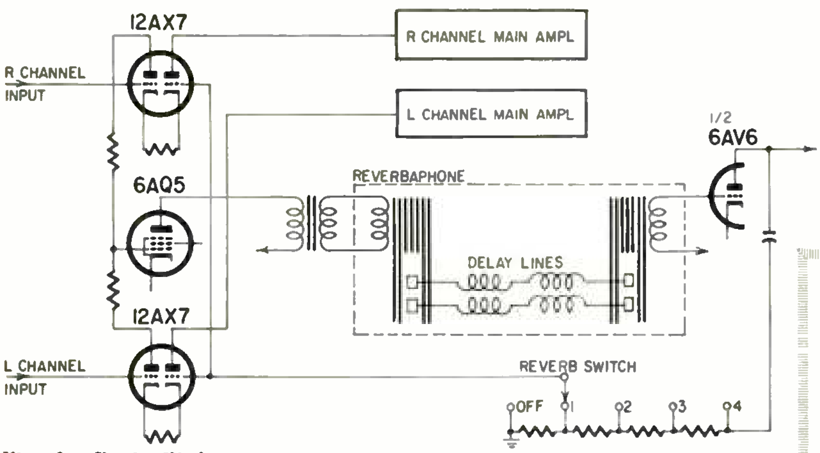


Fig. 1—Basic Philco arrangement.

The delay lines are the heart of the system. The reverberation input (at the plate of the 6AQ5 in Fig. 1) is fed to a field winding that activates two ferrite rotors. This causes each of the rotors to turn in proportion to the signal in the field winding. The greater the signal, the greater the rotation. Each rotor is connected to a mechanical delay line of discrete length, diameter and winding pitch (they look just like springs). The twisting motion applied to these lines takes a few milliseconds to travel from one end to the other. At the far end, this twisting force turns another rotor which induces a signal into another field winding, again in proportion to the amount of turning, but now delayed from the original signal.

The two lines produce delays of 29 and 37 milliseconds. Because the delay line is operated as an open-ended or unmatched system, some of the energy is reflected back over the line. These repeated reflections decay logarithmically and make the reverberation realistic. The amount of the reverberation is controlled by a simple four-position attenuator switch. [In the February, 1956, issue (page 52) and in the July, 1952, issue (page 51) RADIO-ELECTRONICS showed how to build similar reverberation devices called echo boxes.]

Zenith's method is called Sound Reverberation. Fig. 2 shows how it works. Part of the input signal is tapped off and fed to a 6CS7 sound-reverberation driver. It is amplified and then fed to two transducers that convert the signal into mechanical vibrations. These vibrations travel back and forth along their respective delay lines, gradually decaying until they are below an audible level.

Each time a vibration reaches an output transducer, a portion is picked off and converted into an electric signal and amplified by a 12AX7 sound-reverberation amplifier. At this point, the level of the reverberation can be adjusted with a reverberation control.

The reverberation signal then goes to the difference channel where it is amplified, fed to the matrix and combined with the original signal, and sent on to the speaker system.

The audiophile, by using either of these new systems, can bring the concert hall one step closer to his living-room. END

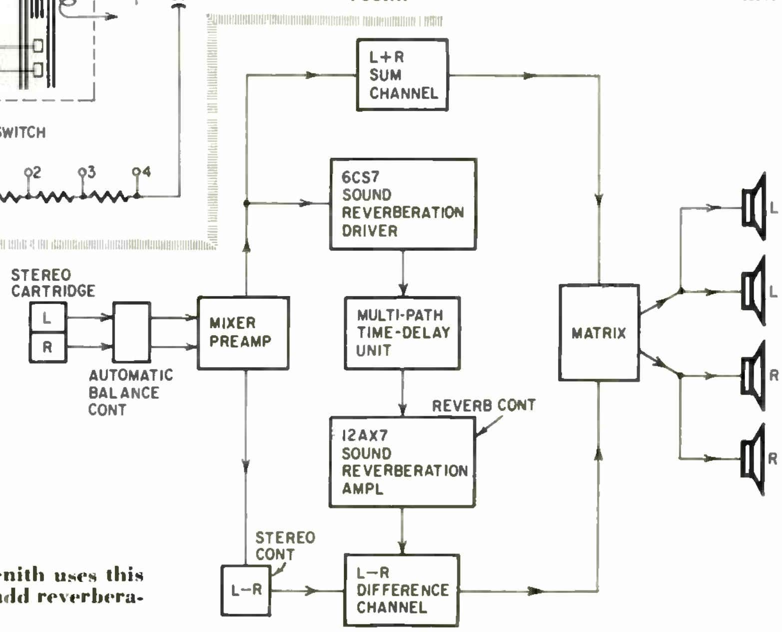
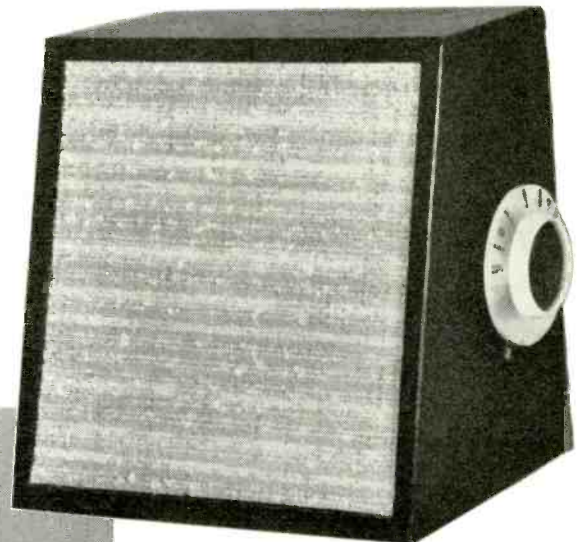


Fig. 2—Zenith uses this system to add reverberation.

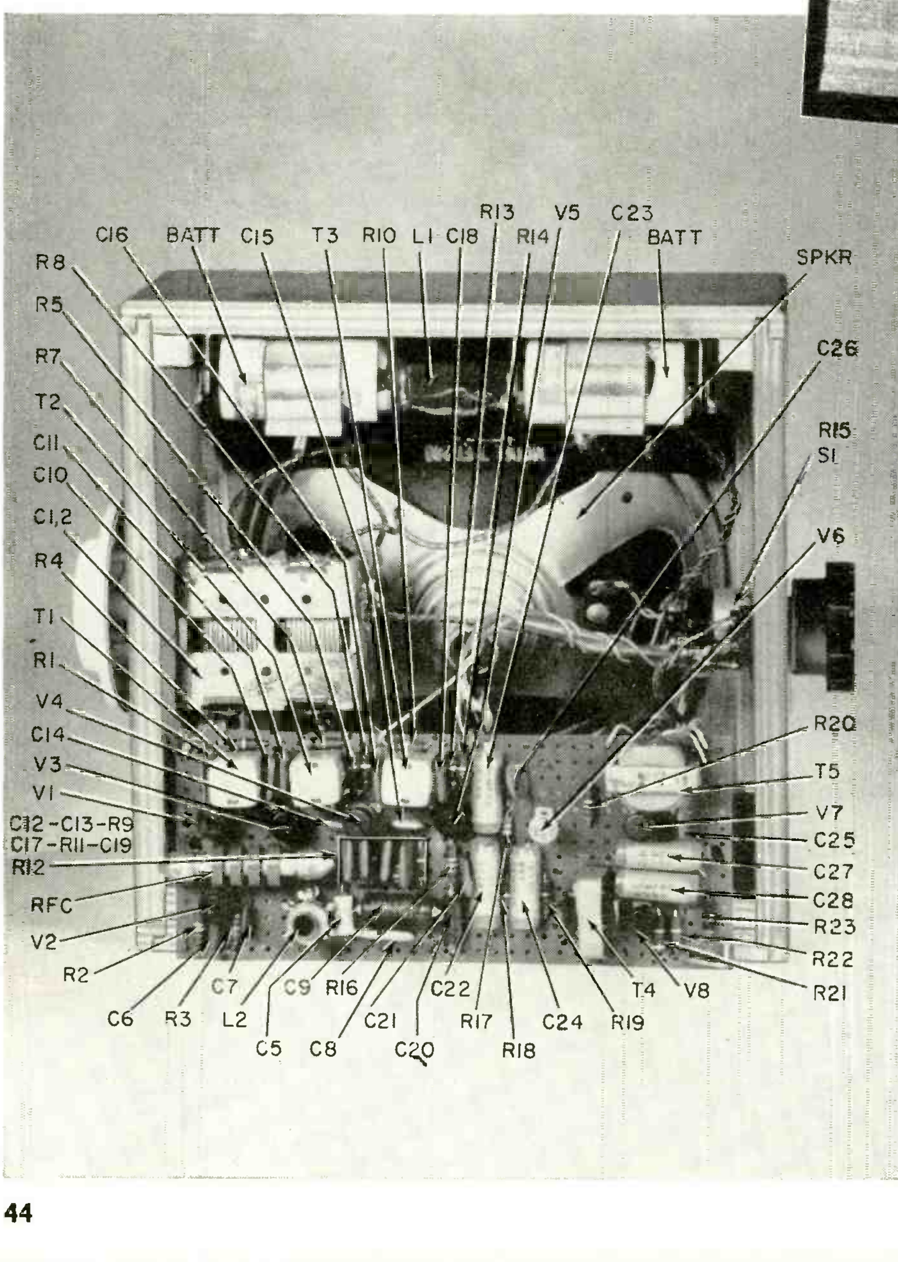
BUILD the Super-Eight

Sensitive eight-transistor circuit housed in a speaker baffle box results in improved audio quality



Front view of unit. Small hole below tuning knob is for access to C3.

By MARTIN KLEIN



Parts arrangement used by the author. Note the metal bracket holding driver transformer T4.

ARE you tired of making excuses for that little four- or six-transistor pocket radio, for its poor tone quality (from a 2 inch speaker) or its comparative lack of sensitivity and power? Have you ever taken it to a beach or picnic only to find that in the open it was audible only if held right up to the ear? If so, you will be interested in building this eight-transistor circuit into the back of a 6-inch speaker baffle. The extra room (in addition to accommodating the bigger speaker) allows for a 7-inch ferrite antenna for maximum sensitivity, a full-size tuning capacitor and volume control, and four flashlight (size C) cells for long life and economical replacement. The 6-inch baffle gives the set a solid plywood housing and looks good on a shelf, table, or even hung on the wall. Adding a handle makes the set a rugged portable.

The radio uses eight transistors in a superheterodyne circuit — a separate mixer and oscillator, two if transistors, a transistor detector (this provides more gain than the usual diode detector), a low-noise driver and two transistors in push-pull output.

The cost of buying all parts new should be in the neighborhood of $35, but a well stocked junkbox should be able to pare this figure considerably, especially if you have built a transistor set before and are leaving it idle because of the reasons mentioned above.

Construction details

The first step is to cut out a piece of bakelite board 6½ x 2¾ inches for the chassis. Perforated board has extra holes for later experimentation, but a solid sheet is just as good. Glue or tape a sheet of white paper onto the board and lay out a parts arrangement as in the photograph. Now drill holes for the leads on the components. A hand power drill will make short work of this hole-making. Cut and file holes for the transistor sockets, the if's, the oscillator coil and the transformers. If these holes are tight, you can just squeeze the parts into place, or, if they are loose, a drop of cement will hold them. The if and audio transformers can also be held with a small metal bracket.

After drilling the holes, peel the paper off the chassis and begin wiring. Start by tinning and fastening a piece of wire along each side of the board as shown to serve as ground and B-minus buses. Most of the parts are wired by their pigtail leads or by short lengths of insulated wire. Use spaghetti on any leads which need insulating.

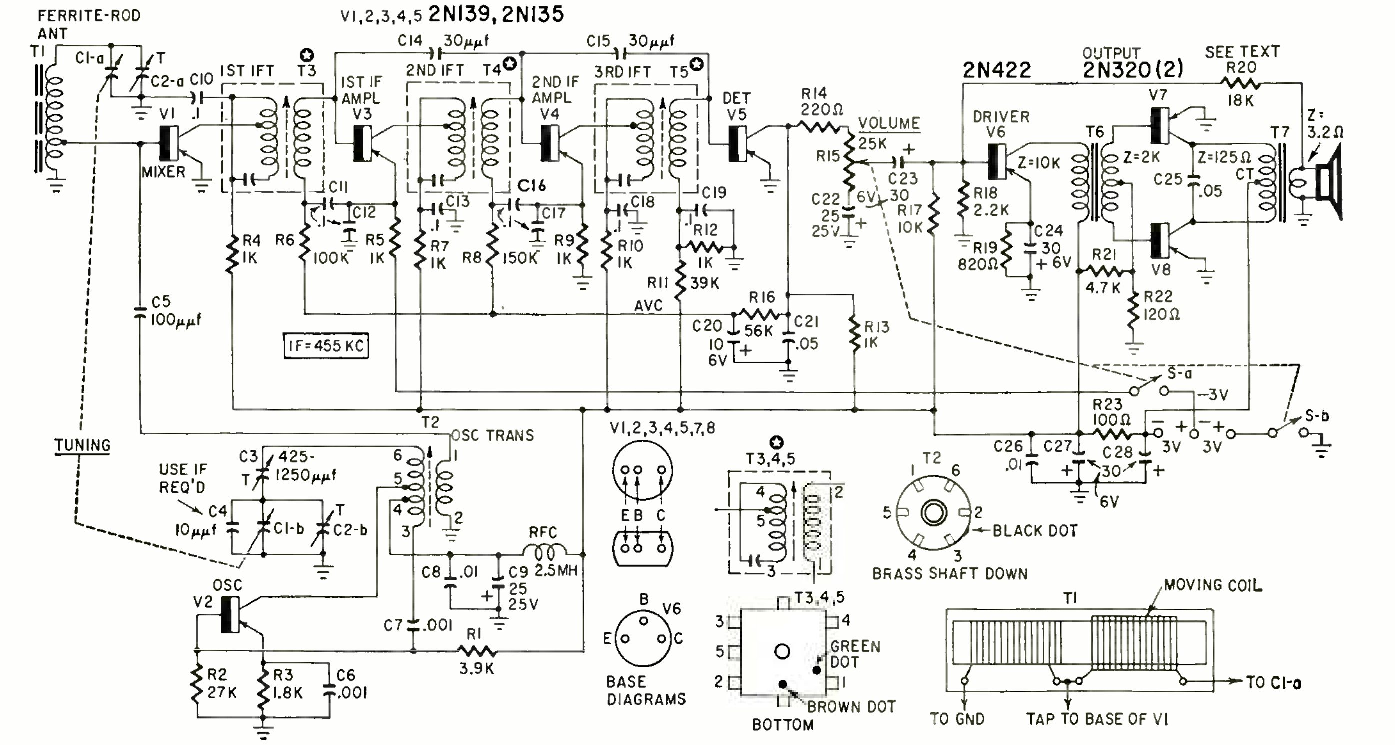
I found that the best wiring order was to start with the output stage and work backward to the driver, detector, if's and mixer and oscillator. In this way, it is possible to check each stage as you build it. If you do not want to do this at every stage, at least stop after wiring the driver transistor socket. At this point you can temporarily wire in the volume control, the speaker and the batteries and check out the entire audio section. An audio signal applied to the input should produce a clear loud tone in the loudspeaker.

Any oscillation or motorboating at this point is probably due to R20, the 18,000-ohm resistor, producing too much feedback. If this happens, either remove R20 entirely or try a higher value.

When you are sure the audio section is functioning properly, go on to complete the chassis wiring. Be very careful with electrolytic polarity, oscillator coil terminals (the diagram shows the coil with brass screw *down*) and if terminals (the diagram is a *bottom* view of the if). Follow the manufacturer's diagram for the color code of the output and driver transformers. Be sure to leave leads long enough to reach the larger components in the cabinet.

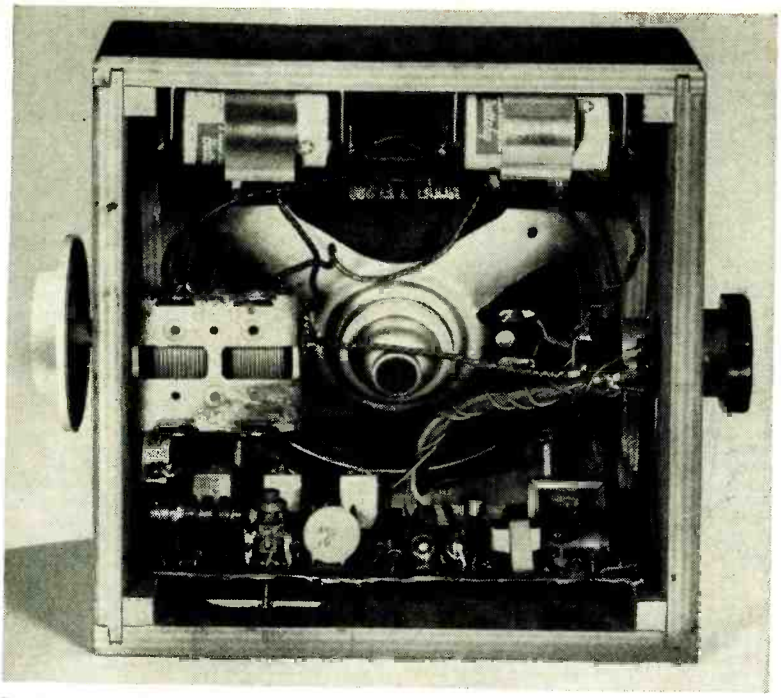
Mount the speaker after you have finished wiring the chassis. Drill holes and mount the tuning capacitor and volume control at either side of the cabinet. The trimmer, C3, is mounted just below the tuning capacitor with its shaft in a small hole in the cabinet. This allows it to be adjusted from the outside. Next screw in the battery clamps and wire them carefully, leaving a lead on the plus and minus sides and one between the two middle cells. You may have to scrape away some wood from inside the cabinet to fit in the loop or you can mount it at an angle if you prefer. It comes mounted on a fiber board which can be drilled for mounting on the screws holding in the loudspeaker, or it can be glued in place.

Now put the chassis in place and hold it with two small screws, one at each side. Wire in the final components. Shielded wire on the hot side of the volume control will reduce hum pickup,



R1—3,900 ohms
R2—27,000 ohms
R3—1,800 ohms
R4, 5, 7, 9, 10, 12, 13—1,000 ohms
R6—100,000 ohms
R8—150,000 ohms
R11—39,000 ohms
R14—220 ohms
R15—pot, 25,000 ohms, audio taper
R16—56,000 ohms
R17—10,000 ohms
R18—2,200 ohms
R19—820 ohms
R20—18,000 ohms (see text)
R21—4,700 ohms
R22—120 ohms
R23—100 ohms
All resistors ½ watt, 10%
C1—2-section variable capacitor, 365 μμf each section (Lafayette MS-142 or equivalent)
C2—trimmers on C1
C3—425-1,250 μμf, trimmer (Elmenco 308M)
C4—10 μμf, disc ceramic (if needed for good tracking)
C5—100 μμf, disc ceramic
C6, 7—.001 μf, disc ceramic
C8, 26—.01 μf, disc ceramic
C9, 22—25 μf, 25 volts electrolytic
C10, 11, 12, 13, 16, 17, 18, 19—0.1 μf disc ceramic
C14, 15—30 μμf, disc ceramic
C20—10 μf, 6 volts, electrolytic
C21, 25—.05 μf, disc ceramic
C23, 24, 27, 28—30 μf, 6 volts, electrolytic
All capacitors 15 volts or higher unless noted
S—dpst switch on R15
T1—7-inch ferrite-core antenna (Superex 7FT-240 or equivalent)
T2—oscillator coil (Lafayette MS-165)
T3, 4, 5—transistor if transformers, 455 kc; primary impedance 25,000 ohms, secondary 600 ohms. (Lafayette MS-268A or equivalent)
T6—driver transformer; primary 10,000 ohms, secondary 2,000 ohms ct (Lafayette TR-96 or equivalent)
T7—output transformer; primary 125 ohms ct, secondary 3.2 ohms (Argonne AR-174 or equivalent)
RFC—2.5 mh, rf choke
V1, 2, 3, 4, 5—2N139 or 2N135
V6—2N422
V7, 8—2N320
6-inch speaker baffle
6-inch speaker, 3.2 ohms
4 size-C cells
Bakelite board 6½ x 2¾ inches
Battery clips
Tuning knob, volume-control knob
Miscellaneous hardware

Schematic of the Super-Eight.



Back view of unit showing chassis in place. Leads are cabled for neater appearance.

but this is not absolutely necessary. Drill four holes in the bottom of the cabinet for access to the three if transformers and the oscillator coil. Check the battery leads again and then insert the eight transistors. If you have the patience, recheck all wiring. If not, hold your breath and turn the set on.

At this point one of three things can happen: you might get no sound; you might get a whine of oscillation or motorboating, or you might be thrilled to hear your favorite radio station blasting you with a loud commercial.

If you are greeted with silence, turn the set off immediately and check all wiring. Make sure the batteries are making contact in their holders with correct polarity. Check the if's and oscillator coil for opens or shorts. You can localize the trouble by injecting an audio signal at the base of the driver transistor, a 455-kc signal at the base of each if transistor and a 1,000-kc signal at the base of the mixer transistor. A good quick check of the local oscillator is to place the set near a known good receiver. Tune the good receiver to the high end of the dial. Rotating the tuning capacitor should at some point produce a whistle in the good set. This will occur when the Super-Eight is set 455 kc below the high-end setting of the good set.

If the radio oscillates on all stations, check the battery condition first. Try changing the value or completely removing R20. Check all electrolytics by bridging them with good units. If the set oscillates only on some settings of the dial, unaligned if's may be at fault.

Alignment

When you do get the set receiving stations, begin the alignment procedure. You will need an rf signal generator and a meter across the voice coil leads. Inject signals into the set by looping a few turns of wire from the signal generator output around the ferrite antenna coil. First set the generator at 455 kc with 400-cycle modulation. Adjust the if transformers, starting with the last one, T5, for maximum output. With the generator and the tuning gang set at 1400 kc, adjust trimmer C2-a for maximum output. Next set the generator and tuning gang to 600 kc and adjust the oscillator coil for maximum output. Adjust trimmer C3 to make sure the set tunes the entire broadcast band. When the other parts are aligned, tune the generator and tuning gang to 1000 kc and adjust the slide on the loop antenna for maximum output. Since there are so many adjustments, it is wise to go back and repeat the alignment procedure several times for best results.

If motorboating is still present on stronger signals after alignment, try detuning the if transformers slightly, changing the values of the neutralizing capacitors, C14 and C15, or simply rotate the set for less signal pickup.

When you have finished aligning the radio, screw on a back of wood or aluminum, add a nice tuning dial and, if you wish, a handle, and you are all set to enjoy your favorite radio programs.

As with most electronics items, you do not have to follow exactly the procedures outlined in this article. This circuit could be built in almost any nonmetal case (metal shields the antenna), and the parts arrangement is not very critical. You might even want to use a larger case for plenty of room to experiment. The transistors used don't have to be the ones specified. For instance, the popular CK722 or 2N107 might be used in the audio stages, with the CK760 being used for the rf applications. It is okay to experiment as long as you use p-n-p transistors and don't exceed any ratings. It is also a good idea to make a periodic check of new transistor listings for the appearance of higher-gain lower-noise transistors to use in your Super-Eight.

How it works

The Super-Eight has a superheterodyne circuit. The tuned circuit of C1-a, C2-a and T1 receives the incoming rf signal. Meanwhile C1-b, C2-b tunes the oscillator section to a frequency 455 kc above the incoming signal. The rf and oscillator signals are mixed by V1 to produce a resultant signal of 455 kc. This signal is amplified by V3 and V4, which are coupled by T3, T4 and T5. These transformers are tuned to 455 kc and also serve to match the output impedance of one transistor (approximately 20,000 ohms) to the input impedance of the next (about 600 ohms).

C14 and C15 provide a neutralizing network to prevent the if's from oscillating. Next V5 separates the audio component from the carrier signal and amplifies it. The dc voltage across R13 is filtered by C21, R16 and C20 to serve as an automatic gain control by biasing the if transistors for higher gain on weaker signals and lower gain, comparatively, on stronger signals. The audio component is then fed through the volume control and into the driver transistor which amplifies it further. The signal then is fed into T6 which acts as a phase splitter, providing V7 and V8 with signals which are 180° out of phase, so they can operate in push-pull fashion. The final signal goes into the output transformer which matches the output impedance of the push-pull stage to the loudspeaker voice-coil impedance. Resistor R20 is used to provide a bit of negative feedback to the base of the driver transistor to improve frequency response. It can cause oscillation if it feeds back too much signal to the driver. END

"I should have known better than to let you pick our wall paper!"

SINGLE-SIDEBAND Transmitter Adjustments

Eldico SSB-100F transmitter

Using a piece of commercial gear as an example, the author shows some of the adjustment techniques for SSB transmitters

By EDWARD M. NOLL

SINGLE-sideband transmission (SSB) has many attractive features. The best use can be made of these only if the transmitting equipment is aligned and working properly. For peak performance, the undesired sideband must be removed as effectively as possible and, in pure single-sideband transmission, the carrier must be suppressed completely.

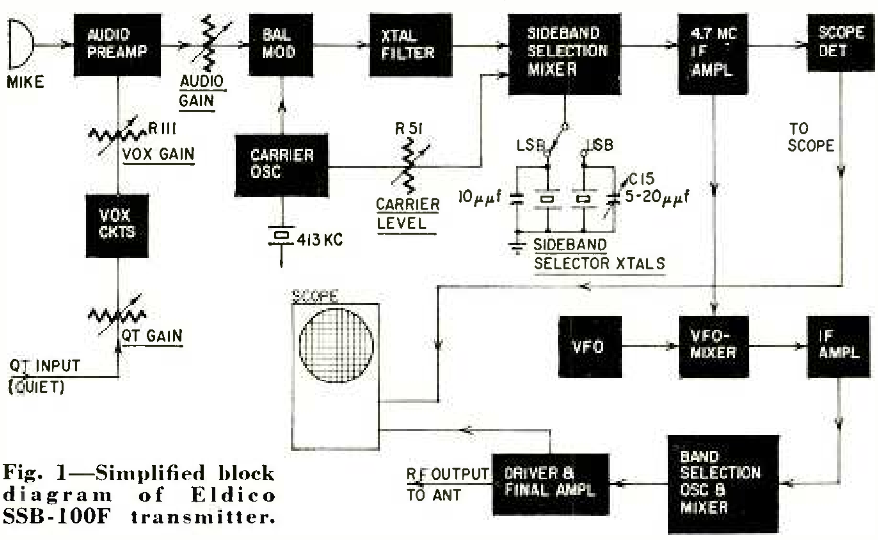


Fig. 1—Simplified block diagram of Eldico SSB-100F transmitter.

After the single-sideband signal is formed, it must be stepped up (heterodyned) to the operating frequency. Nonlinear defects must not be introduced in this mixing process. Proper tuning and correct adjustment of the linear amplifier that builds up the strength of the SSB signal is important. Mistuning contributes distortion or adds spurious signals that defeat the best features of single-sideband transmission.

To obtain a better knowledge of the techniques, let us consider some of the recommended service procedures for the Eldico SSB-100F transmitter, shown in the photograph. The single-sideband generating section is represented by the upper group of blocks in Fig. 1. The carrier oscillator operates at 413 kc. This signal is supplied to the balanced modulator, tube V2 (Fig. 2). The carrier is injected into the common-cathode circuits of the balanced modulator. Audio from the preamplifier is supplied through an audio gain control to the grid circuit of the balanced modulator.

Beneath the audio preamplifier (in the block diagram) is the voice-operated control circuit (VOX). The transmitter goes on the air automatically when the operator speaks and shuts off again as soon as he stops speaking.

The output of the balanced modulator is a double-sideband carrier-suppressed signal. The crystal filter that follows removes one of the sidebands to supply a single-sideband carrier-suppressed signal to the sideband selector stage that follows. This signal is mixed with the crystal-controlled injection signal to generate a 4.7-mc single-sideband signal which is supplied to the 4.7-mc if amplifier. The exciter output is derived from the cathode of this stage and fed to the vfc mixer.

The sideband-selector mixer employs two crystals and a switch. This permits transmitting either the upper or lower sideband. For lower-sideband output, the single-sideband input signal is mixed with a signal from a 4.287-mc crystal. For upper-sideband output, the crystal frequency is 5.113 mc. Notice that a trimmer is connected across one crystal. It is adjusted to produce an exact 4.7-mc single-sideband output, regardless of which sideband is chosen for transmission.

The sideband-selector mixer is tuned by attaching an rf indicator to the if amplifier's output. A typical indicator circuit for this observation is shown in Fig. 3. It is a simple diode detector that supplies dc to a high-resistance dc meter. The 4.7-mc if amplifier transformer is first peaked with the sideband-selector switch set on the lower-sideband position. A changeover is then made to the upper-sideband position and the small trimmer capacitor C15 adjusted for an output peak.

Carrier suppression

One of the operations performed by a single-sideband modulator is to remove the carrier completely. Doing this reduces interference problems on crowded channels because carrier interference beats are avoided. The balanced modulator must be adjusted carefully to provide exact carrier cancellation. Potentiometer R13 in the cathode–grid

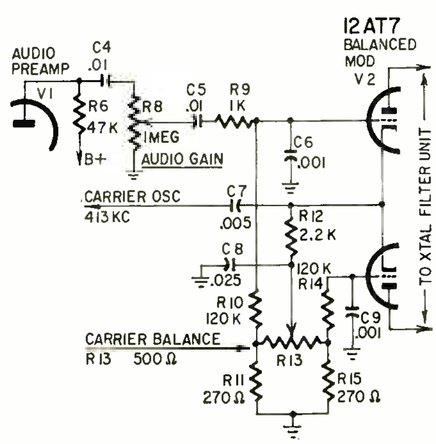


Fig. 2—Balanced modulator circuit used in the Eldico unit.

circuit of the balanced modulator, tube V2, provides a carrier-balance adjustment. R13, with resistors R11 and R15, injects a certain level of carrier into each grid circuit. The amount of carrier injected can be controlled precisely with this potentiometer (to correct for slight variations in tube and circuit characteristics) to obtain exact cancellation in the output.

A receiver or other type of output indicator can be used to check and adjust carrier balance. Unmodulated carrier from the oscillator is applied to the sideband-selector mixer through R51. The receiver is then tuned to the

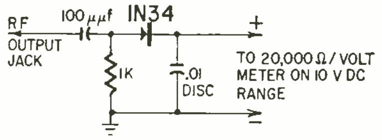


Fig. 3—Rf detector circuit for use in tuning the sideband selector mixer. Any high-resistance volt-ohmmeter set on a low-voltage (0–10) dc range can be used as an indicator.

output signal. Turn R51 until the arm is at the ground side. There should now be no noticeable output. If a carrier is still present, R13 should be adjusted until it disappears or a minimum of carrier is audible from the receiver.

In the Eldico transmitter, it should be mentioned that an AM signal can be transmitted. An AM signal is formed when the carrier is reinserted at the grid of the sideband-selector mixer. The source of this carrier is the carrier oscillator itself. The amount of carrier added can be controlled with potentiometer R51. At times in SSB transmission it is helpful to convey a weak carrier as well as the sideband. This can be accomplished by injecting a very-low-amplitude carrier via potentiometer R51.

Undesired sideband removal

The crystal sideband filter of this transmitter is factory preset and does not require adjustment. In case of filter failure, it is recommended that it be returned to the factory for adjustment.

A reasonably good check of the performance of a sideband removal filter can be made with a receiver and an audio oscillator that delivers a pure sine wave to the input of the transmitter. With the transmitter modulated by a pure 1,000-cycle tone, for example, it should be possible to tune the receiver through the undesired sideband-frequency spectrum without hearing any signal. In other words, when tuning, across the frequency spectrum only one signal should be noted, the desired single sideband.

An accurate signal generator, such as a BC-221 (military surplus), and a sensitive output indicator can be used in checking and aligning single-sideband filters. Whatever signal generator is used, it must have wide bandspread and accurate calibration in the filter spectrum to be checked. Spot frequency checks can be made and an approximate curve of the filter can be plotted.

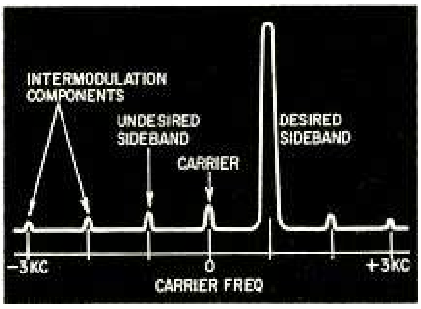


Fig. 4—Typical panoramic display. Note that although attenuated, the carrier and undesired sideband are still present.

A very exacting method of measuring and checking the performance of a single-sideband system is to use a panoramic spectrum analyzer. Such an instrument (made by the Panoramic Radio Products, Inc.) displays the desired frequency range on a calibrated oscilloscope screen. It also includes a calibrated signal source for supplying the necessary test signal to the single-sideband transmitter. A typical display for such a test procedure is shown in Fig. 4. A very weak carrier is indicated as well as a slight trace of the undesired sideband (assuming modulation by a 1,000-cycle tone signal). Some intermodulation distortion is indicated 2,000 and 3,000 cycles from the carrier frequency. With the vertical scale calibrated accurately, the actual amount the undesired components are attenuated (with respect to the desired sideband) can be determined.

VOX circuit

The VOX circuit's job is to turn the transmitter on whenever a signal is picked up by the microphone. In the transmitter under discussion, a portion of the audio preamplifier output is supplied through VOX linear control R111 to the first VOX stage. The audio output of this stage goes to a diode rectifier, which places a dc bias on the grid of the relay control tube that causes it to conduct and actuate the VOX control relay.

When the relay is energized, it puts the transmitter on the air by closing the B-plus circuit. When there is no signal from the microphone, a high bias on the grid of the relay control tube shuts down the transmitter so as not to interfere with any incoming signal.

A problem that must be overcome by a VOX system is the sound from the receiver speaker causing the transmitter to go on the air. Cancellation is used to prevent this trouble. An audio signal from the receiver is supplied to one half of the VOX tube. At the same time, the audio signal from the preamp (from the microphone which is picking up sound from the speaker) goes to the first half of the VOX tube. The two signals are amplified and fed to the two halves of the relay control tube where they mix and cancel with the result that the relay which turns on the transmitter is not actuated.

When adjusting a VOX circuit, the VOX gain control is turned up until sufficient audio signal from the preamp is supplied to operate the relay. With speaker output at a normal listening level, the QT (anti-trip) control that regulates the receiver audio signal amplitude is adjusted until sufficient audio is added to prevent the speaker output from operating the VOX relay.

Linear conversion and amplification

After the single-sideband signal has been formed in the exciter, it must be stepped up in frequency and power by a linear system. The single-sideband signal is in the form of a modulation envelope and, if it is to pass undistorted, it must not encounter amplitude nonlinearity. Remember that after an AM signal is modulated, any succeeding amplifier must be linear. Generally, class-B linear rf amplifiers are used to increase the power of a modulated-rf signal.

The amplifier linearity must be especially good in a single-sideband modulation envelope to prevent distortion and introduction of spurious sideband components. Otherwise, intermodulation distortion components can be developed in the undesired sideband spectrum, in which case the careful removal of the undesired sideband in the exciter is to no avail. It is apparent then that the linear amplifiers used in single-sideband transmission must be tuned carefully to provide the very best straight-line performance.

This transmitter contains a built-in 1-inch waveform oscilloscope and associated circuits are incorporated to monitor the linearity and assist in the adjustment of the rf stages. The circuits of the waveform monitor are designed to show a trapezoidal modulation display (Fig. 5). The modulating signal for the oscilloscope's horizontal amplifier comes from the scope detector at the output of the exciter. This signal gets to the horizontal amplifier through the power and signal cabling to the exciter unit. Modulated rf is supplied to the vertical deflection plate through a

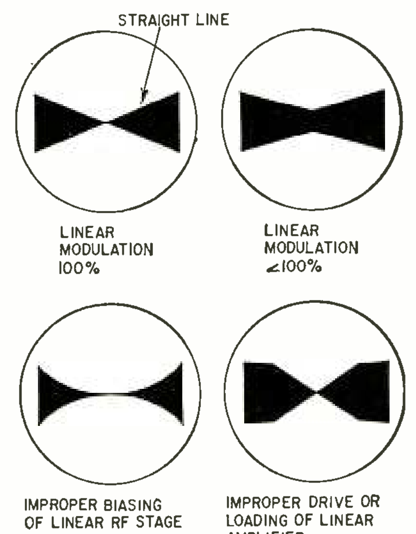


Fig. 5—Trapezoidal modulation patterns as seen on a scope.

capacitor from the tank circuit of the final amplifier.

Vfo and output stages

The output of the exciter is supplied to the vfo mixer section. This unit comprises a linear mixer and a class-A wide-band if amplifier. Vfo output goes to a band-selection section and the final power amplifiers of the transmitter. The driver amplifier is operated class-A with the final amplifier biased to class AB_1.

The final amplifier does the major part of amplifying the modulation envelope to a high power level. Its linearity is especially important. Inverse rf feedback is employed to minimize any amplitude distortion of the emitted envelope. The feedback path is from the plate of the final amplifier to the cathode circuit of the driver.

To insure the necessary linearity for single-sideband transmission, the amplifier stages must be tuned to resonance exactly and must also be neutralized very carefully. Finally the final amplifier must be properly excited and correctly loaded. The influence of improper drive or incorrect loading is demonstrated by the nonlinearity of the trapezoidal pattern displayed on the scope screen (Fig. 5.) The final amplifier stage must also be biased correctly to have it operate correctly over the linear part of its characteristic.

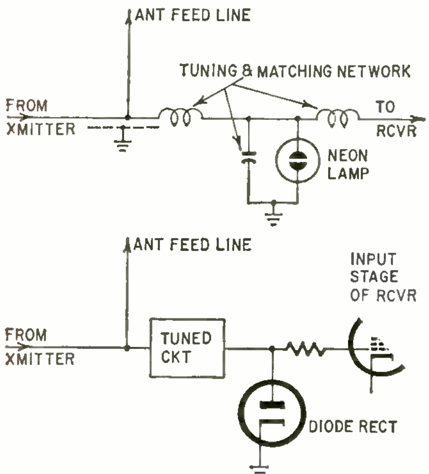


Fig. 6—Two simple TR switch circuits. More complicated circuits amplify the received signal in addition to simply protecting the receiver.

T-R switching

In single-sideband transmission systems, it is often convenient to use the same antenna for transmission and reception. The common form of antenna switching relay can be employed. However (and particularly in the case of VOX operation), some form of automatic switching is preferable. A simple TR arrangement as shown in Fig. 6 uses a neon bulb or some form of rectifier to shunt or bias off the input stages of the receiver when the transmitter is in operation.

In a neon-lamp circuit, the transmitter output is of sufficient amplitude to ignite the bulb. Consequently, it acts as a short circuit in the transmission line between the antenna and the receiver input. An alternative arrangement is to use a protective diode and series resistance in the input stage of the receiver. The rf power supplied to the transmission line when the transmitter is on causes the diode to conduct and places a shunt across the receiver input. If some signal does leak through to the grid, the series resistor acts as a limiter, the flow of grid current developing a high cutoff bias, effectively blocking signal entrance into the receiver.

Two-tone test signal

One common method used to adjust single-sideband transmitters is to use a two-tone input signal and oscilloscopic display. In the two-tone test procedure, two pure sine waves are passed through the system to produce the overlapping sinusoidal pattern indicated in Fig. 7. Such a two-tone signal can be formed by applying a pure sine wave audio input (a 1,000-cycle tone, for example) and reinserting some of the carrier to the same amplitude as the single-sideband tone generated. In the case of the Eldico transmitter, a two-tone signal can be developed at the grid of the sideband-selection mixer. The 1,000-cycle audio tone can be applied to the phone-patch input of the audio amplifier. This would produce a single sideband separated by 1,000 cycles from the carrier at the sideband-selector stage grid. To form the two-tone test signal, the carrier amplitude is now increased until it has the same amplitude as the sideband signal.

The two-tone modulation envelope so formed can be picked up with a coupling loop at the output of the transmitter and conveyed directly to the vertical deflection plates of a test oscilloscope. If the two-tone signal is not distorted with the transmitter operated at rated output, it indicates that the linearity of the system is good. When the two-tone sine waves are compressed or misshapen there are nonlinearity defects in the transmitter. END

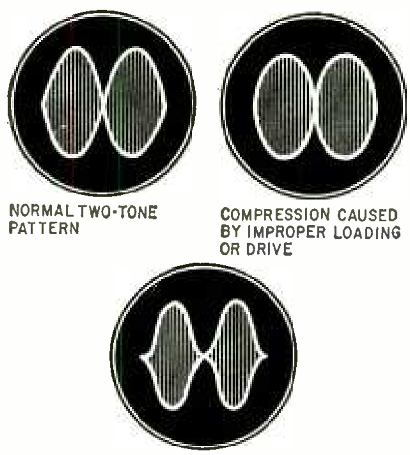
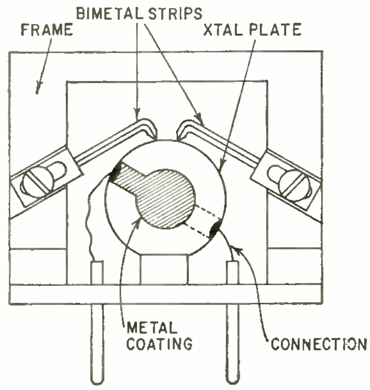


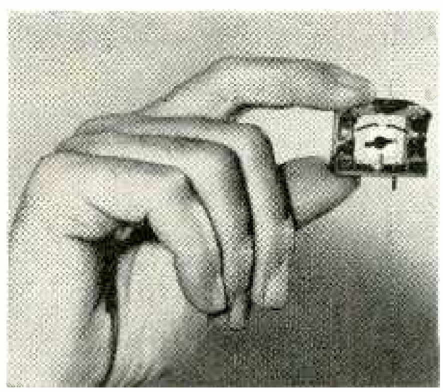
Fig. 7—Typical two-tone test patterns show circuit adjustment.

No More Ovens!

CRYSTAL ovens in radio transmitters may be on their way out. A new development from the Army Signal Research and Development Laboratory at Fort Monmouth, N. J., uses two or more temperature-sensitive bi-metal strips to



adjust the operating frequency of a quartz crystal to compensate for temperature effects (see diagram). The bimetal fingers act like thermostats and are arranged so they press against se-



lected spots on the edge of the crystal. These fingers apply a varying amount of pressure (dependent on temperature) to the crystal, changing its characteristics enough to keep it operating on frequency. The number of fingers used depends on the particular application. By eliminating the crystal oven, power is saved and space requirements are reduced. In battery-powered equipment, including satellite systems, these space and weight savings are significant, especially when we consider the possibility of reducing battery size and weight, thanks to reduced power requirements. END

"little handful" CITIZENS-BAND TRANSCEIVER

Efficient, easily constructed all-transistor unit has 25-mw output and a range of a half mile

By I. QUEEN
EDITORIAL ASSOCIATE

BENCH TESTED

Tests showed that the compact unit provides dependable two-way communications over a line-of-sight range up to 1/2 mile. On occasion, a greater range is possible but cannot be counted on. The printed-circuit transmitter insures frequency stability and meets FCC requirements.

MANY readers were interested in the Citizens-band transceiver described in October, 1959. This low-power set is completely transistorized and remarkably efficient. However, any home-built crystal oscillator may be off frequency because of the *crystal*, the *circuit* or the *tuning*. Since tolerance is only .005% in the Citizens band, it was recommended that a licensed radio technician make the necessary frequency adjustments and tests. Now the FCC requires that the oscillator be a ready-built unit or a manufacturer's kit. Home-built units are out! [FCC Rules & Regulations, Part 19.71 (c).]

A new rf unit made by International Crystal Manufacturing Co. solves this problem. Known as the TRT-1, it combines a crystal oscillator and an rf amplifier. The unit comes completely wired and is factory-tuned to your specific channel (or in the 10-meter ham band, if desired). Its oscillator coil is precisely tuned and sealed to maintain accurate frequency. *This stage must not be tampered with.*

The TRT-1 uses crystals with a .0025% tolerance! Compare this with .005% crystals which leave no room for circuit and tuning errors.

A compact Citizens-band transceiver based on the TRT-1 has been constructed, tested and found satisfactory. The set consists of the TRT-1, audio amplifier, battery, speaker and antenna. A two-position spring-return switch is normally in the receive position. Depressing a lever type knob switches the unit to transmit. This energizes the TRT-1, changes the amplifier into a modulator and connects the speaker as a microphone. Fig. 1 is a block diagram of the transceiver.

The detector and audio stages (Fig. 2-a) are assembled on a 3¾ x 2¼-

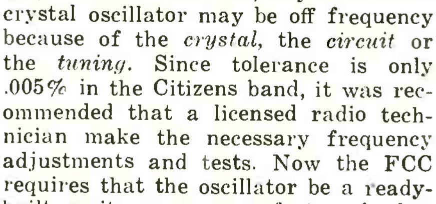
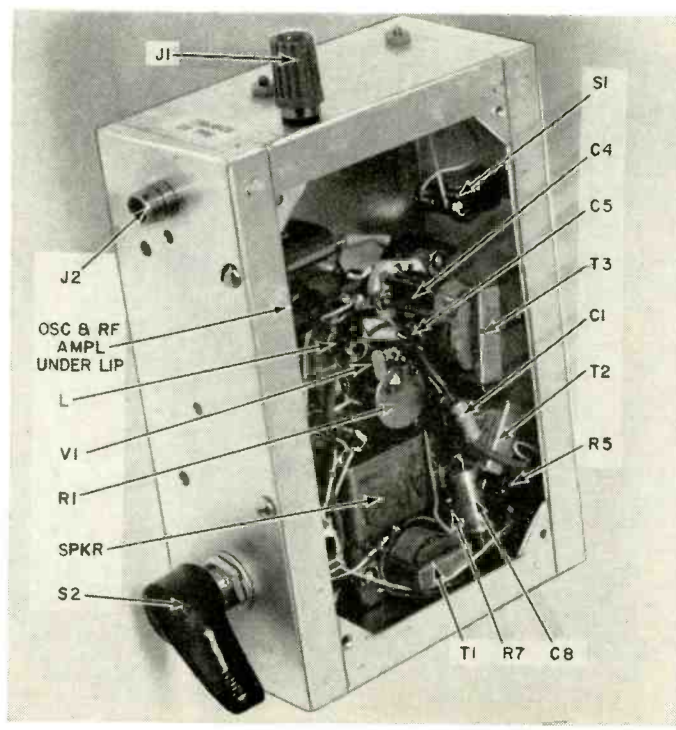
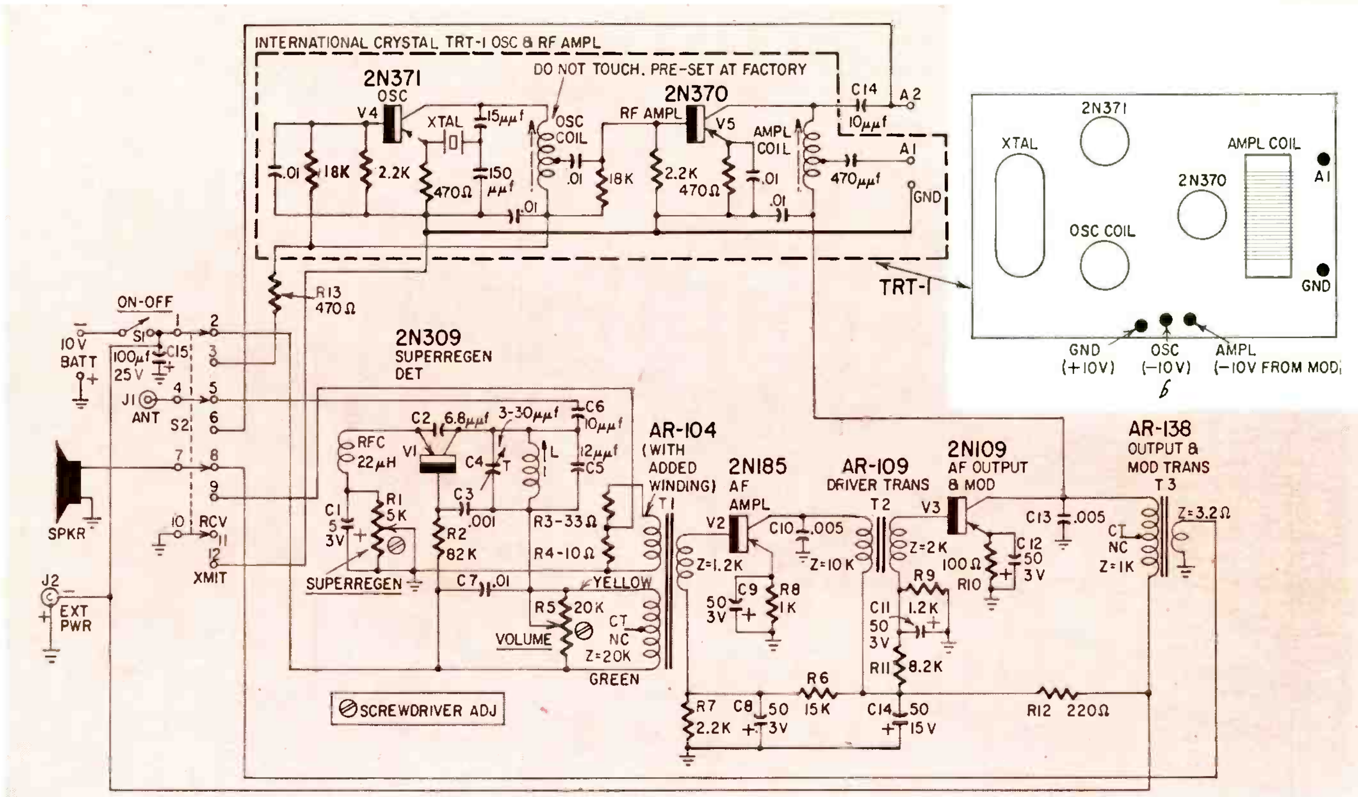


Fig. 1—Block diagram of the transceiver. Fourth section of switch, not shown, cuts off power to receiver when transmitting.



Transistors and miniature parts make possible the small size of this portable unit.



R1—pot, 5,000 ohms, screwdriver adjust
R2—82,000 ohms
R3—33 ohms
R4—10 ohms
R5—pot, 20,000 ohms, linear taper
R6—15,000 ohms
R7—2,200 ohms
R8—1,000 ohms
R9—1,200 ohms
R10—100 ohms
R11—8,200 ohms
R12—220 ohms
R13—470 ohms
All resistors, ½-watt 10%
C1—5 μf, 3 volts, electrolytic, miniature
C2—6.8 μμf, ceramic
C3—.001 μf, ceramic
C4—3-30 μμf, air variable
C5—12 μμf, ceramic
C6, 14—10 μμf, ceramic
C7—.01 μf, ceramic
C8, 9, 11, 12—50 μf, 3 volts, electrolytic, miniature
C10—.005 μf, ceramic
C15—100 μf, 25 volts, electrolytic, miniature
BATT—10 volts, two 5-volt cells in series (Mallory TR134 or equivalent)
J1—banana jack
J2—phono jack
L—15 turns No. 28 enamelled wire on ¼-inch slug-tuned core
S1—4-pole 2 position rotary switch, spring return
S2—spst toggle
T1—input transformer: primary, 20,000 ohms; secondary, 1,200 ohms; add one winding as per text (Argonne AR-104 or equivalent)
T2—driver transformer: primary, 10,000 ohms; secondary, 2,000 ohms (Argonne AR-109 or equivalent)
T3—output and modulation transformer: primary, 1,000 ohms ct; secondary 3.2 ohms (Argonne AR-138 or equivalent)
TRT-1—see text
V1—2N309
V2—2N185
V3—2N109
Transistor sockets (3)
Battery holder
Speaker, 3.2 ohms, miniature
Case, 6 x 4 x 2 inches
Whip antenna
Miscellaneous hardware

Fig. 2-a—Circuit of the transceiver. Note that the transmitter is an assembled, ready-to-use unit; b (upper right corner)—location of major parts on oscillator-rf circuit board.

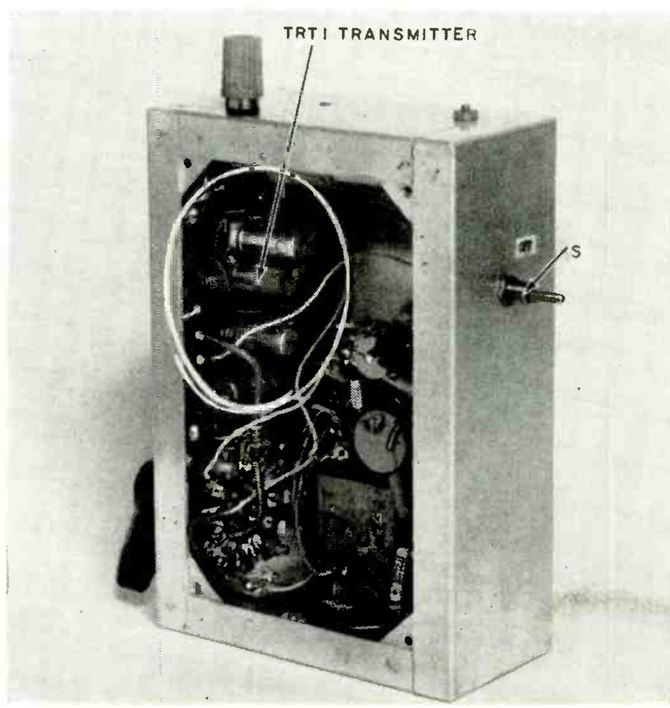
inch perforated board. There is a cutout for the rear of the speaker. This unit can be tested as a receiver before being put into the metal box.

R1, the SUPERREGEN control, is set only once, so it is not a panel adjustment. Volume control R5, a screwdriver adjustment through the panel, controls amplifier gain. Be sure it is set below the point where the modulator distorts or overloads during transmission, or where the receiver howls.

Coil L consists of 15 turns of No. 28 enameled wire on a ¼-inch slug-tuned core. This is not critical since C4 does the actual tuning. It has a screwdriver setting. Or you can use a conventional knob-tuned capacitor for C4.

T1 is an Argonne AR-104 transformer with an added winding. To make the new winding, remove the mounting bracket and core by prying or knocking out laminations one at a time. Also remove some insulating paper to make room. Then wind on about 40 turns of No. 38 enameled wire. Next, replace the core and bracket. Don't worry if one or two laminations don't seem to go back on when you are finished.

Note the voltage divider across the



This interior view shows the printed-circuit transmitter section.

new winding (Fig. 2). It reduces the signal from the microphone (speaker). If the signal is weak (modulation is low), connect terminal 9 on the rotary switch (Fig. 2) directly to the upper end of the new winding rather than the tap.

With the receiver performing correctly, you will hear a loud hiss from the speaker. This noise is reduced when a signal comes in.

The transmitter

The TRT-1 strip measures 2⅝ x 1⅜ inches. Its circuit is shown in Fig. 2. Two changes (shown as dotted lines) were made.

Antenna terminal A1 is not used. Instead, I added a 10-μμf capacitor directly to V5's collector and used A2 as the antenna terminal. This gave me a higher output from my 3-foot whip antenna. If your antenna is much longer, A1 will work better and you won't need the capacitor and A2. Tests show no perceptible frequency change when A2 is used instead of A1.

A 470-ohm resistor is added to reduce voltage to the oscillator. I use 10 volts (two 5-volt batteries in series). The resistor reduces oscillator voltage to 9 (the value specified by the manufacturer).

The amplifier's slug-tuned coil should be adjusted for maximum output (with antenna connected) with the aid of a field-strength meter. Don't touch the oscillator coil; it has been set at the factory. Fig. 2-b shows the parts layout and terminal arrangement for the TRT-1.

The three-pole two-position rotary switch is mounted on the side of the metal box. It is normally in receive position, held there by a spring return. Depressing the knob rotates the switch to its transmit position. The switch is mounted so leads to the amplifier, TRT-1 strip and speaker are kept short.

The transceiver case measures 6 x 4 x 2 inches. The antenna plugs into the banana jack mounted on top. A phono jack on the side of the transceiver is for an external power supply when the transceiver is used at home. This conserves battery life.

The unit has been tested under many conditions. When used to communicate with a second set at street level, it is effective for more than 1,000 feet. It can maintain contact with a mobile transceiver for at least ½ mile. These distances hold over territory with few obstructions; not in cities, where effective range may be severely restricted (even for 5-watt base stations). In a suburban area, this transceiver produced a signal-strength reading of S6 in a communications receiver three or four blocks away.

Batteries last a long time, however, it is best to save them for outdoor work only. When used indoors I connect the set to a 9-volt power supply through phone jack J2. END

Transistor-powered FM Auto Radio

FM RADIO in the family car is rapidly moving out of the electronic curio class and is about to become a standard accessory. European FM–AM auto radios such as the Blaupunkt, Becker and Philips have been available and distributed in limited quantities. Tuners designed as accessories for the car's AM radio are made by Gonset (see "Converter Puts FM in Your Car," RADIO-ELECTRONICS, August, 1959), Bendix ("FM Tuner For Your Car," RADIO-ELECTRONICS, January, 1959), Kinematix Inc., Granco and a few other small manufacturers.

A universal type FM-only auto radio that can be installed in any automobile with a 12-volt negative-ground electrical system has just been introduced by Motorola. Called the FM-900, it is designed for underdash installation and operates from the car's AM radio antenna. It has connections for a rear-seat speaker and an FM–AM radio switch to permit operating the car's AM radio through a common 3.2-ohm speaker system.

The receiver has seven tubes, three transistors and a selenium rectifier. The lineup consists of a 12DT8 rf amplifier and converter, two 12AU6 if amplifiers, two 12AU6 cascade limiters, a 12AL5 ratio detector, a 12AU7 af amplifier and driver and a pair of 2N176's in a push-pull output stage.

The receiver's front end is the popular one-tube type employing a 12DT8. The rf amplifier is a grounded-grid type whose low input impedance provides a good match for the antenna. This circuit also provides low-noise operation and effectively isolates the oscillator section from the antenna, thus minimizing radiation. The antenna connects through an L-C type high-pass filter that acts as an isolating network that prevents interaction between the receiver's input circuits. Agc voltage is tapped off the grid-leak resistor of the first limiter and applied to the rf amplifier grid to prevent overloading the converter.

The converter is an autodyne type using the remaining triode section of the 12DT8. The rf amplifier plate and converter grid circuits are slug-tuned. A special voltage-variable capacitor is used across the converter grid coil for automatic frequency control (afc). The value of this capacitor and the resulting oscillator frequency are controlled by the level of the dc bias voltage derived from the ratio detector output.

The if system consists of two if amplifiers and two limiters using seven 10.7-mc tuned circuits. The limiters use grid-leak bias and low screen and plate voltages for good AM rejection. When the grid voltage rises above a predetermined level (limiting threshold), the grids draw current and increase the average negative grid bias. This limits the plate voltage swing so there is no corresponding increase in if output when the input signal exceeds the minimum value.

A ratio detector is used to increase the AM rejection beyond that provided by the dual limiters. The dc component of the detector output is applied to the afc diode.

The audio amplifier uses a 12AU7 af amplifier and driver and class-B 2N176's in a push-pull output stage. Power output is 9 watts undistorted, 15 watts peak. A negative-feedback loop provides a response that rises in amplitude with increasing frequency. The arrangement is balanced so that with the standard FM de-emphasis, the overall response is flat from 50 to 10,000 cycles.

The circuit features a combination bass and treble control working in conjunction with a tapped volume control. At the extreme clockwise setting of the tone control, the response is flat at the low end and rises on the high end. Backing off approximately 15° produces a response curve with some bass boost. As the control setting is further reduced, the highs are attenuated with a further increase in bass boost.

The FM-900 has a built-in fader control for use with a dual-speaker system. An auxiliary switch is provided for switching the speaker or speakers to either the FM radio or the AM radio. The combination of switch and fader control makes possible a number of interesting speaker and radio combinations. END

Regulated low-voltage Power Supply

Two Zener diodes and four silicon rectifiers combined with a few resistors and capacitors produce a 22- or 44-volt supply with a high current capacity

By LAWRENCE J. MURPHY*

BOTH silicon and Zener diodes have characteristics that make them very useful in many practical circuits. Regulated power supplies with voltage and current ranges suitable for most transistor circuits are easily designed with such diodes.

In the very near future, diodes will be used widely in every phase of radio, television and electronic design. They have completely changed concepts of dc power supply design. It had previously been impractical in many cases to use voltage multiplier circuits because of filament power requirements. Semiconductor diodes completely solve that problem. They eliminate the need for power transformers and rectifier tubes. Diode rectifiers operate efficiently, keep cool and lend themselves to compact, lightweight designs. These characteristics should lead to their use in all types of electronic equipment.

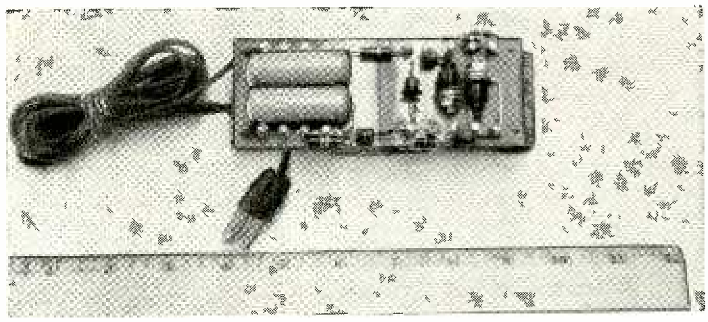
The simplest single-phase low-voltage regulated power supply (see diagram) requires a minimum of diodes for rectification and regulation. Since the rectifier in this circuit conducts only when the upper ac input terminal is positive, the first filter capacitor, C3, is charged only once during each cycle of the supply voltage. The same thing is true for filter capacitor C4, which charges only during the negative portion of the cycle. The ripple frequency, therefore, is equal to the supply voltage frequency. When RECT 1 conducts during the half-cycle the upper ac terminal is positive, filter capacitor C3 is charged instantaneously to the peak of the ac input voltage (less the conducting voltage drop through the diode) and maintains the dc voltage during the negative cycle.

R1 (R2) minimizes the large surge currents in half-wave circuits. Current flowing through R1 causes a voltage drop which is greatest when the surge current reaches its peak and which assumes a steady value when, after the first few cycles, the capacitors become fully charged. Resistor R1 also acts as a fuse and protects relatively expensive components against a short circuit across the load.

Unusually low values were used for C1 and C2 so that their reactance could be used to drop the voltage fed to the rectifiers. Do not use larger values without increasing the voltage ratings of C3, C4, C5 and C6 and selecting Zener diodes with a higher dissipation rating.

The functions of RECT 2, R2, C4 and C6 in the negative section of the rectifier are the same as those of the positive section.

Voltage regulation is provided by Zener diodes D1 and D2. These are connected across the power supply's load. This combination is fed from the unregulated supply voltage, E1, through series dropping resistors R3 and R4. The flat voltage characteristic of the Zener holds the load voltage essentially constant on the load current or supply voltage changes. A change in load current results in a corresponding change in Zener current. Therefore, the voltage drop across resistors R3 and R4 remains unchanged with variations in load current. A change in input voltage E1 produces a corresponding change in Zener current which causes the change in voltage drop across resistor R3 and R4 necessary to cancel the change in input voltage, thus holding the load voltage constant.



The completed unit. It must be mounted in an insulated box for safety.

Characteristics of the supply are:

Voltage Range

Input: 80–120 ac

Output: ±22 volts, can be increased or decreased with selection of Zener diodes for required voltage.

Current Range

Maximum set by Zener diode ratings. Can be increased by using high-current-capacity diodes.

Voltage Regulation: ±0.5%

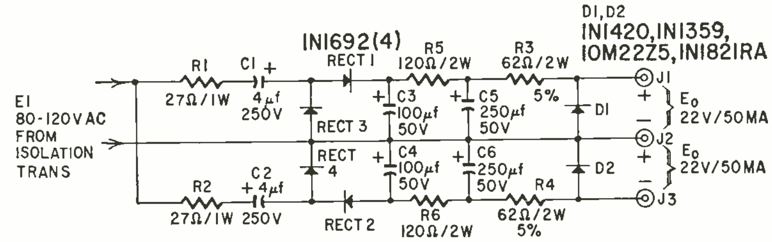
Advantages

A low-cost transformerless power supply.

Reference

General Electric Transistor Manual, third edition, "Power Supplies," page 105.

END



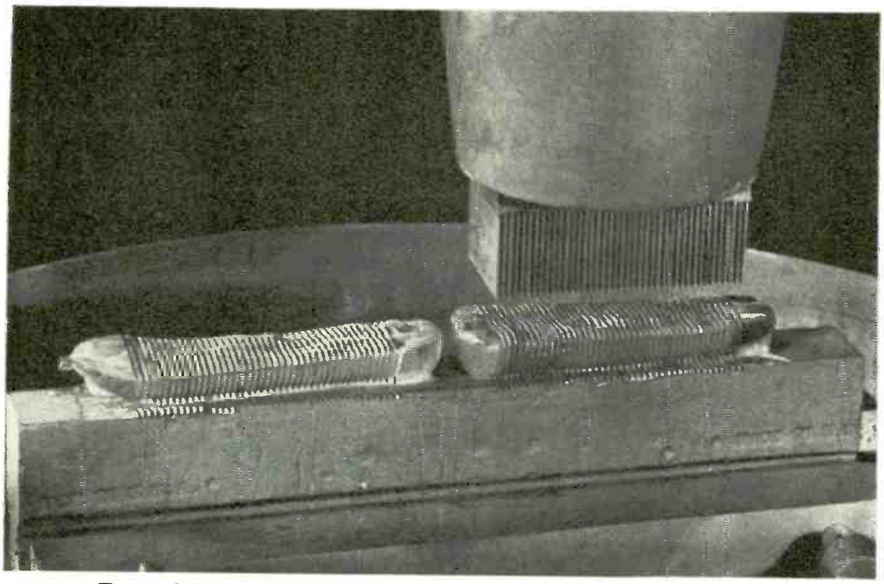
R1, 2—27 ohms, 1 watt
R3, 4—62 ohms, 5%, 2 watts
R5, 6—120 ohms, 2 watts
C1, 2—4 μf, 250 volts, electrolytic
C3, 4—100 μf, 50 volts, electrolytic
C5, 6—250 μf, 50 volts, electrolytic
D1, 2—Zener diodes, 22 volts, 100 ma or higher:
1N1420 (Western Electric),
1N1359 (Hoffman), 10M22Z5 (Motorola),
1N1821RA (Texas Instruments) or equivalent
J1, 2, 3, 4, 5—banana jacks
RECT 1, 2, 3, 4—1N1692 (General Electric or equivalent)
Chassis to suit
Miscellaneous hardware

Circuit of the regulated supply.

*Engineer of Shops, Western Electric Co., N.Y.C.

Introduction to ULTRASONICS

Sound waves, too high in frequency for the human ears to hear, are vital to modern industry. They are used to shake, break, weld, boil, cut, grind and clean



Forty slices of sapphire with one pass of this ultrasonic cutter.

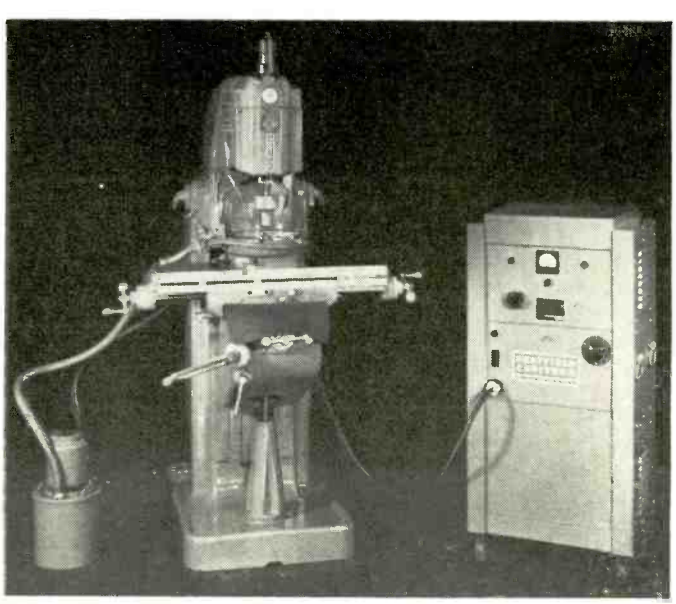
By TOM JASKI

ELECTRONICS has given modern industry one of the most versatile and most powerful tools invented by man. It slams molecules of matter against each other to shake, break, weld, boil, cut, grind and clean. It detects minute flaws or measures the thickness of an ultrathin sheet of steel with extreme precision. It combines solids and liquids which nature had never intended as mixtures. It kills germs, cuts through brain tissue with great precision, sets off burglar alarms and controls television sets. All this with but one tool, *ultrasonic waves*.

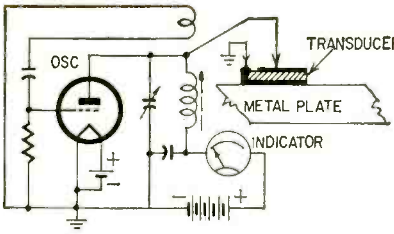
We have mentioned only a few of its applications. The future will bring many others, including amplification, detection and communication that will stagger the imagination.

What are ultrasonic waves? They are waves like sound waves that cause periodic rarification and densification

Ultrasonic flaw detection in machine stock. Indentation in scope baseline indicates a flaw.



Ultrasonic milling machine.



Basic circuit for an ultrasonic thickness gauge.

we identify in a very limited range as sound, but they are beyond the range of sound—beyond the normal range of human hearing. Any soundlike wave above 20,000 cycles qualifies as ultrasonics, including vibrations up to a frequency of 25,000,000,000 cycles per second (25 kmc) in solid material and liquids!

Experiments with ultrasonics have been carried out for a long time. The versatile and fantastic genius Sir Francis Galton invented one of the first useful tools for ultrasonic experiments 100 years ago. He made a Galton whistle, now better known as a dog whistle. It produces sound waves above human hearing which a dog can perceive. Of course nature preceded us in our endeavors as usual and provided bats with an ultrasonic "radar" system so accurate that they can fly in the dark between thin wires strung only a few inches apart without ever touching them!

How is this tool used in industry? Let us first look into why it is such a powerful tool. Matter, in spite of what our senses tell us, is mostly space. The molecules of even the hardest steel are separated by enormous distances compared to the size of the molecules. And in this space the molecules are in constant random motion. When we heat a substance, this motion increases, and the hotter we make it the more the molecules move. If we manage to push some of these molecules around, they will in turn push on other molecules. It is this transferred push that allows a sound wave to travel through a substance. The distance between molecules is shorter for solids than for air and the chance of the molecules colliding with each other is much greater. This explains why sound travels faster through solids than liquids and faster through liquids than gases. If we find a frequency which is a submultiple of the natural frequency of the molecules of the material and shake them up with it, there is a resonance. The molecules are flung together in some places and torn apart in others. This is called cavitation. If you have ever seen ultrasonics impinging on a water bath, you may remember the violent action it evokes!

This wild shaking of molecules can be used in many ways. If we want to mix different molecules, we just shake them together in lumps and they are soon intermingled thoroughly. This is emulsification. If the molecules tend to stick together in clusters and we want to spread them evenly through a solution, we shake them and call the process homogenizing. If we use an abrasive powder and slam it fast and hard against a piece of metal, again and again, it eventually chews through the hardest surface. This is used in ultrasonic grinding and machining. In similar ways we use ultrasonics for cold welding, cleaning, foaming beer and what have you.

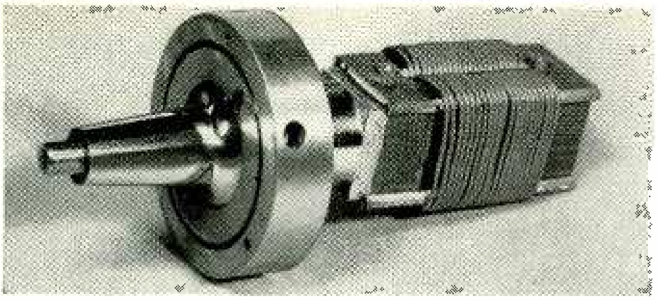
Gauging and measurement is a little different. When the moving molecules in a dense piece of matter reach the end of that material and find a vacuum or just air, few of them find gas molecules to push so they bounce back against other molecules in the solid and start a wave back from the bound-

Ultrasonic gauge tests thickness of nose cones for Nike-Hercules missiles.

Ultrasonic setup for cleaning miscellaneous metal parts.

Branson Ultrasonics Inc. photos

Cleaning small watch parts with ultrasonics.



Magnetostriction transducer made by Sheffield.

ary layer. If we adjust the frequency of the original wave so the time it takes for it to travel out and back is exactly half a cycle or a multiple of it, we have a 180° phase shift for regeneration. Any deviation from this precise dimension would immediately show up as an improper phase shift. The diagram shows the basic circuit of this kind of gauging apparatus.

Flaw detection also uses the backward-traveling energy. If we receive the echo and display it on a scope, flaws show up as extra echoes. Sometimes flaws too minute to appear clearly in X-rays can be detected with ultrasonics.

When the cavitation we mentioned earlier occurs in living organisms, it literally tears them apart. Ultrasonic physical therapy does not do similar damage because the power used is kept low—just high enough to increase the temperature within the tissue. But the brute force of cavitation tears the most persistent gum and dirt from parts and equipment in ultrasonic cleaning.

How do we get the energy from the oscillator into the material? It is done with a variety of transducers. Early equipment used magnetrostriction transducers exclusively. They depend on the fact that a nickel or nickel-alloy rod, when magnetized and subjected to an ac magnetic field expands and contracts minutely in the field. The expansions and contractions take place at the rate the magnetostriction rod is resonant to, determined by its length and material. Magnetostriction transducers are still widely used, particularly in high-power applications such as machining.

Piezoelectric transducers, such as quartz crystals, have also been used extensively but they are expensive and limited to relatively low-power applications. But new ceramic transducers (barium titanate) not only handle more power but are made in all kinds of useful shapes. One such is a paraboloid which can form the entire bottom of a cleaning vessel, concentrating maximum energy in one spot, the focus. For unlike the longer sound waves, ultrasonic waves can be focused easily, and the higher the frequency the sharper the focus.

Frequency varies all over the lot. The spectacular 25,000 mc cited earlier was generated by General Electric scientists in their laboratory. They expect to use it to investigate subatomic forces. Practical industrial frequencies range from 20 kc to 25 mc, with the majority of applications in the 20–100-kc region. This is where most of the cleaning, homogenization, emulsification, pasteurization, etc. takes place. However, cleaning small parts is done at frequencies up to several megacycles. Frequencies lower than 20 kc are rarely used. Most human hearing is limited to 16 kc, but a few individuals, particularly young women, can hear 20-kc signals. To be in the vicinity of an 18-kc ultrasonic cleaning bath would be sheer torture to such a person.

What are the advantages of ultrasonics over other methods? In cleaning, the answer is obvious. Only very thorough and repeated mechanical scrubbing plus highly potent solvents could do as good a job. Ultrasonics makes rapid, automatic cleaning lines possible. Flaw detection allows a measure of certainty unheard of by other methods except X-rays, and is much safer and much more economical to use. Ultrasonic gauging, depending on resonance as it does, can be far more accurate than mechanical gauging, and has the advantage over other electronic gauging methods that it can be used with just about any material.

In machining, ultrasonics can do things that cannot be done any other way. It can handle materials no other machining methods can touch. For example, ultrasonic equipment can machine and emboss glass and gem stones, ceramics and hard metals. It can drill holes through materials which withstand any other attempts at penetration. In many instances the ultrasonic tool can chew its way through materials in a fraction of the time that would be required by more conventional tools.

In medicine, ultrasonic waves can reach inaccessible places and be focused with pin-point accuracy on tiny spots in the brain or other parts of the human body to perform minute knifelike operations. Delicate, complex and precise shapes that open up new discoveries, new scientific instrumentation physically impossible before, can be fashioned with ultrasonic tools.

And we have only seen the beginning. Ultrasonic burglar alarms are in use in banks. Ultrasonic washing machines for the home are feasible, though not yet economical. The future will bring a great many new applications for this versatile tool which is already making a substantial contribution to industrial technology and scientific development today. END

FLUID AMPLIFIER

A TINY nonelectronic amplifying device—it measures about ¼ inch across and .003 inch deep—has been announced by the Army's Diamond Ordnance Fuze Laboratory. Three scientists working together developed the unit which uses either liquid or gas under pressure as the source of power and operates at frequencies up to 20 kc.

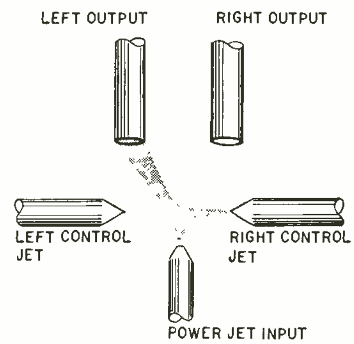


Fig. I

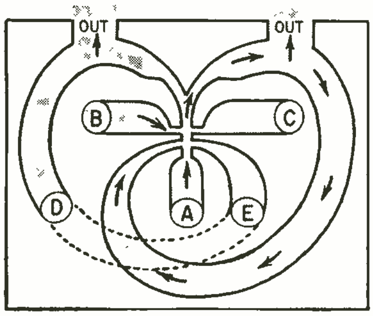


Fig. 2

The basic principle of the device is simple (Fig. 1). Liquid or gas under pressure is fed to the power jet input. A lower-power stream fed through either the right or left control jet directs the power jet to either the right or left output. Since the power stream is controlled by a much lower powered jet, the device is an amplifier.

When properly arranged, a simple fluid multivibrator can be made (Fig. 2). Here, the power jet input is at A. A control jet (B) directs the power jet to the right (if the control jet was at C the power jet would be deflected to the left). The fluid (or gas) flows around back to the input. Now control is switched to C and the jet moves around to the left. Periodically switching control jets produces a flow at each output in the best multivibrator fashion.

Intended uses for the device include powering pistons and air motors. (Audio amplifiers for liquid notes are not foreseen in the near future.) To send signals over a distance, pressure switches would convert fluid pressure outputs into electric impulses. END

INFRARED • in INDUSTRY

This rapidly growing field will continue to increase in importance

By BARRON KEMP

EVERY object whose temperature is above absolute zero (approximately −273°C) radiates energy in all wavelengths of the electromagnetic spectrum. Most of this radiation is in the infrared portion. Thus, every object from heavenly bodies to human ones is a natural radiator of invisible infrared energy.

Infrared is the portion of the electromagnetic spectrum starting at the deep red and extending to the microwave radar region. It is measured in terms of a wavelength unit—the micron—which is one-millionth of a meter; symbolized by the Greek letter μ (mu). The infrared energy emitted by an object is radiant power which may be expressed in lumens, lumen-seconds, watts, ergs or any of these quantities per unit area of radiating surface.

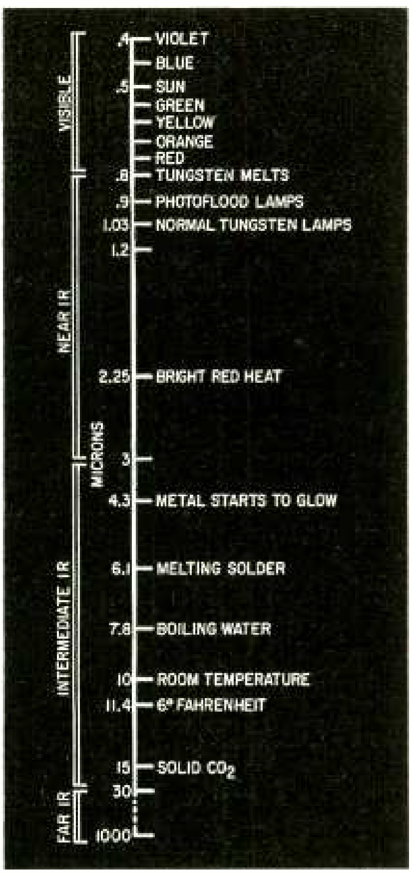


Fig. 1—Infrared spectrum. Radiation peaks for commonplace objects are given.

The infrared spectrum

The visible portion of the electromagnetic spectrum starts with the violet (about 0.4 μ) and extends to the deep red (about 0.75 μ), which is the lower limit of the eye's sensitivity. Infrared energy starts at the deep red (hence its name—"beyond the red"), extending from about 0.75 to about 1,000 μ. Infrared thus bridges the gap between visible light and the microwaves used for high-definition radar; from about 500,000,000 down to 1,000,000 mc.

The infrared spectrum is divided into three regions (Fig. 1). The near infrared is just beyond the long wavelength threshold of the human eye (about 0.75 μ) and extends to about 3.0 μ. The intermediate infrared region starts at about 3.0 and extends to about 30 μ; the far infrared, from about 30 to 1,000 μ, completes the spectrum.

Infrared characteristics

Some of the characteristics of infrared are like those of visible light; others more closely resemble radar waves. Parabolic mirrors and lenses can be used to collect and focus infrared energy (as with visible light); yet infrared radiation passses through materials—such as silicon and germanium—which are opaque to visible light.

The radiation emitted by an object is directly related to its temperature. All substances are composed of atoms whose electrons are constantly undergoing energy changes due to thermal action. These energy changes generate the radiated electromagnetic energy.

Barnes Engineering

A "thermograph" or "heat" picture of a man in a completely darkened room. Notice that pipe, chin and throat are warmest (lightest) while glasses, ears, hair and fingertips are coolest.

Radiation characteristics from several sources are shown in Fig. 1. This chart shows that the sun's 2,500°C radiation peaks at approximately 0.5 μ. Another significant peak is that of bright red heat (about 1,000°C), a temperature just a little higher than that of a jet exhaust. Boiling water (100°C) has a peak at 7.8 μ. Finally, room temperature (20°C) peaks at about 10 μ.

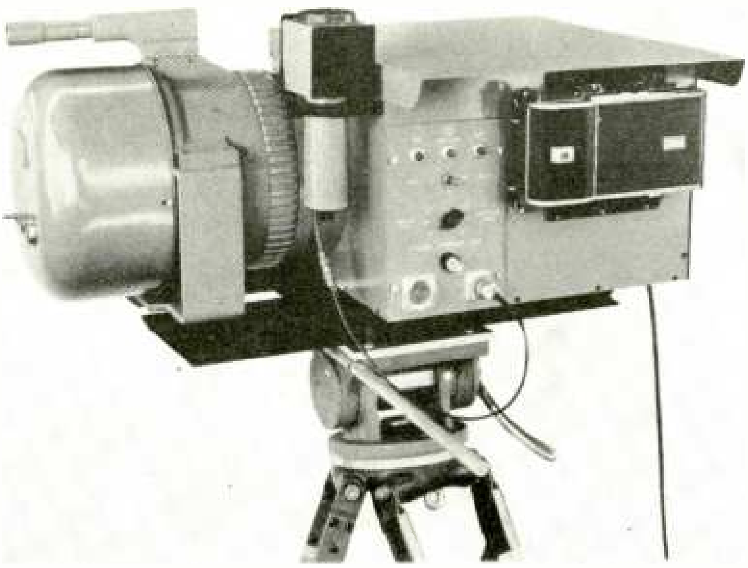
Infrared energy should not be confused with the transfer of thermal energy by conduction or convection. Thermal transfer requires a physical medium, such as air, through which the heat can travel; infrared propagates through a vacuum as well.

Infrared radiation is sometimes incorrectly called "heat radiation" because all warm objects emit the radiation and objects which absorb the radiation are warmed. A notable example of this is in baking or toasting bread. However infrared radiation itself is not "heat."

Black-body radiation

In their simplest form, the laws predicting infrared characteristics are written for a "black body." This is defined as an object which would, (if it existed), *absorb all* and *reflect none* of the radiation falling upon it. Such a black body would, when illuminated, appear perfectly black and would be invisible except when its outline might be revealed by obscuring an object beyond it.

The *rate* of emissivity of radiant



Infrared camera made by Barnes Engineering, Stamford, Conn. It can measure temperatures from remote position, or take "heat" pictures of radiating object.

energy from a black body is expressed by the Stefan-Boltzman law. The *distribution* of the radiant energy is described by Wien's displacement law. Black-body radiators (perfect emitters which obey these laws) have the spectral distribution shown in Fig. 2. The emissivity of a black body is unity (1). Other bodies (gray bodies) which do not have this perfect quality have emissivities less than 1. Gray bodies obey the same theoretical laws as black bodies, but energy radiated is proportionately less.

Emissivity is the ratio of the radiation emitted by an object to the radiation emitted by a black-body radiator at the same temperature and under similar conditions. The emissivity may be expressed for the total radiation of all wavelengths (total emissivity), as a function of wavelength (spectral emissivity) or for some very narrow band of wavelengths (monochromatic emissivity).

Wien's displacement law states that the peak wavelength varies inversely as the absolute temperature of the radiating object. The wavelength (at which peak radiation occurs) is equal to a constant (k) divided by the absolute temperature of the object. Absolute temperature equals the Celsius (Centigrade) temperature plus 273. The constant (k) for a black body has a value of 2,900. This constant has other values for various gray bodies.

The Stefan-Boltzman law states that the *radiance* (total energy radiated per unit area of radiating surface) is proportional to the product of the emissivity and the fourth power of the absolute temperature. The *total radiation* from an object is equal to the product of its area (in square centimeters), the fourth power of the absolute temperature, a constant which is equal to $5{,}672 \times 10^{-12}$ and the emissivity.

Infrared systems

Infrared systems are classified as passive where the natural radiation of an object is utilized. They are called active when the object must be illuminated by an external source of infrared energy (such as a searchlight). The infrared system may also be classified according to the type of detecting element as thermal or non-image-forming, when the change in temperature of the detector is utilized (such as the thermocouple or thermistor), or photo or image-forming when a photograph of some type results. Infrared photographic film or an infrared television camera tube may be used.

The simplest infrared system is the passive one which detects an object by its (the object's) own temperature. The basic units of such a system are the source of radiant energy (the object), the medium through which the infrared is transmitted (generally air), the optic (and scanning) system, the detector and the signal processing and presentation equipment (Fig. 3).

The radiation in a passive infrared system is generated by the object to be detected. The optical system may be either a lens or mirror arrangement for directing the radiation onto the detector element that converts the infrared radiation into an electrical signal. Unwanted background radiation is also received, but usually the target (or prime radiator) and background differ in spectral properties (wavelength) so that a filter can be placed in front of the detector to block undesired radiation. This method is used to enhance the ratio between primary radiation and background. The electrical output of the infrared detector is amplified and may be presented on any standard indicator or used to operate control circuits.

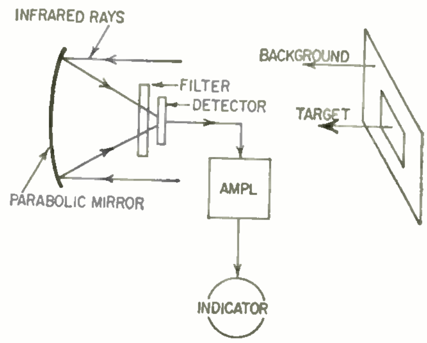


Fig. 3—Basic elements of a passive infrared system.

The active infrared system is similar to the passive system just described except that a source of radiation is provided to illuminate the target. The reflected radiation is received by the detector the same as in the passive system (Fig. 4).

An important use of the active infrared system is its application to communications. An infrared source is modulated by voice or code and the radiation transmitted through suitable optics and filters to remove the visible light. The receiver consists of a collecting optical system and an infrared-sensitive detecting element upon which the modulated radiation is focused. The signal is then amplified and fed either to a

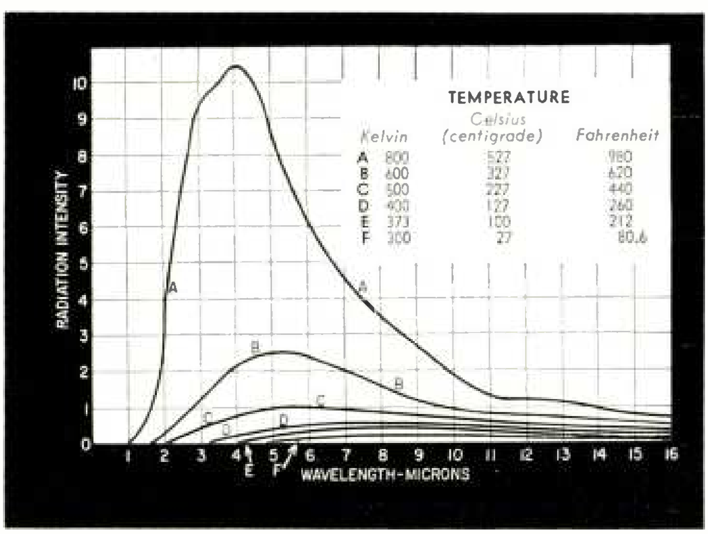


Fig. 2—Radiation curves for black bodies of different temperatures.

loudspeaker or to headphones (Fig. 5).

Applications

The development of new types of infrared detectors has led to an enormous growth in industrial applications of infrared energy. Several hundred industrial organizations have infrared research, development and production programs; several thousand use infrared devices in their operation.

Infrared energy is being used in automatic monitoring of chemical and biological processes; temperature measurement and control during manufacture of textiles, plastics and metals; fire and incipient-explosion detection. New applications are appearing in navigation and automatic-landing systems for aircraft, weather research and numerous outer-space projects.

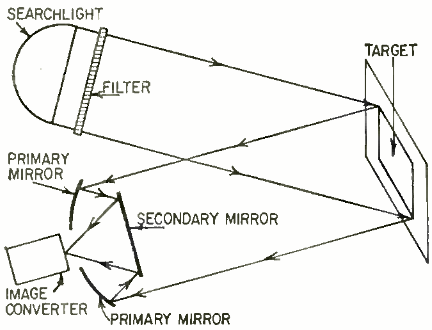


Fig. 4—Basic elements of an active infrared system.

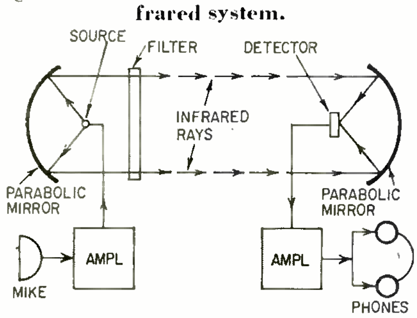


Fig. 5—An infrared communications system.

Other applications for infrared are found in photography, aerial mapping, communications and control techniques. There are, of course, many applications of infrared energy in heating, cooking and therapeutic treatment where the heating effects alone—due to absorbing the radiant energy—are important. From this we get infrared cooking, paint drying and the blistering off of tomato skins as a substitute for mechanical peeling.

Infrared energy is in use all around us. Infrared techniques have proved their worth in many industrial applications and are considered indispensable in many others. The possibilities of its application are limited only by the imagination and skill of the user.

Research and development projects are constantly working to advance the state of infrared technology as infrared takes its place among the tools of science. Whatever may be the ultimate goal of infrared, there is no doubt that it will play a prominent role in industrial electronics. END

Grid-Current Limiting Resistors

By DELLROYE D. DARLING

To most TV technicians "anode" is the name an industrial technician gives to the plate of a tube. However, anode is a correct name for *any* positive element. If you make a grid positive with respect to the cathode, it becomes an anode, and electrons will flow to it just as if it were the plate.

Grid current is nothing new to a TV man; it's used to develop bias, limiting action, etc. But in most radio and TV equipment grid current is so small it does no harm to the tube. In industrial controls, however, thyratrons often have their grids connected to sources that can supply considerable current. Something has to be done to keep the tube from passing enough grid current to destroy itself. The anode circuit of a 2050 thyratron, for example, can pass more than 100 ma continuously, but the control grid can't handle more than about 10 or 15 ma without damage. The second or "shield" grid has similar limitations.

Fig. 1 shows a simple photocell circuit in which grid current can be a real problem. A negative bias on the shield (grid 2) blocks tube conduction unless the phototube conducts (when light strikes it), allowing the control grid to go positive. Since the anode is supplied with 60-cycle ac, it is only necessary to make the shield grid negative when the anode is positive. (The tube can't fire on the negative half cycles.) For simplicity, ac is used on the shield grid, 180° out of phase with the anode supply. This means that half the time the shield is negative, which is OK; but the other half of the time it is positive, and grid current can flow.

The simplest way to control this grid current is with a series limiting resistor, as shown in Fig. 1. The value isn't critical; 20,000 ohms to 100,000 ohms will do. When the shield grid goes negative, no grid current will flow.

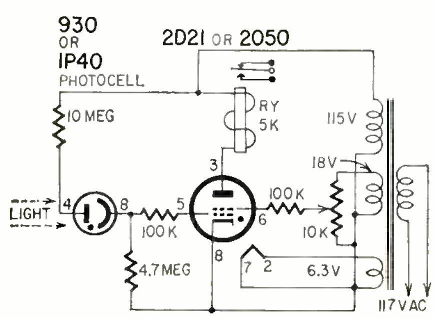


Fig. 1—Simple photocell circuit shows uses of current-limiting resistors.

When it goes positive, grid current will be limited to a safe value by the drop across the resistor, and the tube won't be damaged. The tube is now supplying itself with pulsating dc negative bias. Waveforms at various tube elements are shown in Fig. 2.

Control grid

When the phototube conducts, it supplies positive half-cycles to the control grid to "force" conduction. To protect this grid, a limiting resistor is placed in series with it.

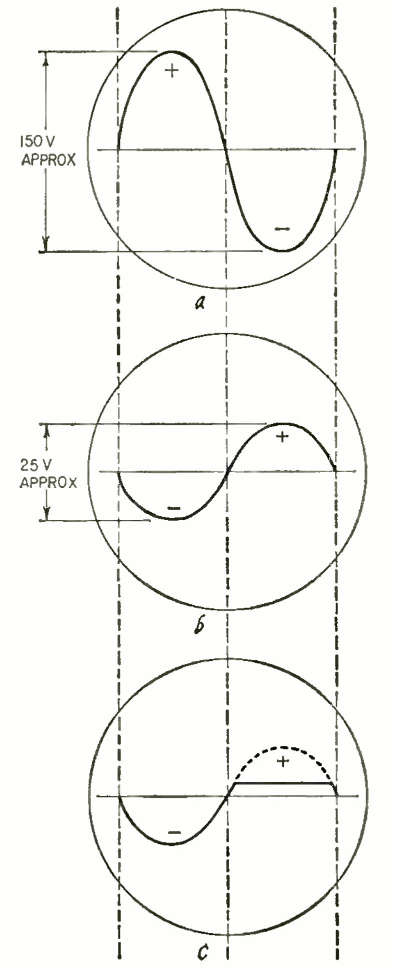


Fig. 2-a—Waveform of anode supply, b—waveform of shield-grid supply, c—actual voltage appearing on shield grid with series resistor.

This simple circuit was chosen as an example, but grid limiting resistors are a common feature of most thyratron circuits. END

MISSILE CONTROL AND GUIDANCE

Missile on target! Sounds simple, but it takes a complicated guidance system to make it true

By MARVIN HOBBS*

MISSILES take the form of either aircraft flying within the earth's atmosphere or rockets propelled within or outside the earth's atmosphere. Turbo- or ram-jet aircraft operating as missiles, are stabilized and guided by adjusting the position of the flight-control surfaces—rudder, elevator and ailerons. The three motions of a missile which the flight surfaces can affect are known as roll (when one wing becomes alternately higher and lower than the other), pitch (alternate nose-up, nose-down oscillations) and yaw (deviation to right and left of correct compass course (Fig. 1). In addition, the direction of the propelling thrust may be varied to change the course of rocket-driven missiles. This method is particularly applicable when rocket-powered missiles are traveling outside of the earth's atmosphere.

The direction-controlling elements of a missile are usually moved by either fluid-driven or air-driven pistonlike devices. In a typical hydraulic system, oil is the fluid and is brought to the required pressure by a hydraulic pump. A valve whose position is controlled by the amplified output of the guidance channel determines the direction and amount of fluid flow. This driving medium adjusts the position of the actuator piston, which is linked to and regulates the movement of the control element—whether it be the thrust control of a rocket or the rudder (or other (control surface) of a jet aircraft (Fig. 2).

Because of the high speeds of most missiles, the actuators must respond very rapidly to any corrective impulses as required. The guidance signals must be amplified sufficiently to insure positive servo-valve operation ahead of the actuators.

Stability control

The surface and thrust controls of pilotless aircraft and rockets must provide for flight stability as well as guidance. In other words, the missile can be guided into the desired trajectory only if it is in stable flight, not wobbling on and off course.

Before considering guidance-signal sources, let us examine the key component for achieving flight stabilization, the gyroscope. Since the early 1900's, engineers have been using the gyroscope to stabilize and direct the motion of torpedoes, ships and aircraft. Without the gyroscope, modern guided missiles would not exist in their present

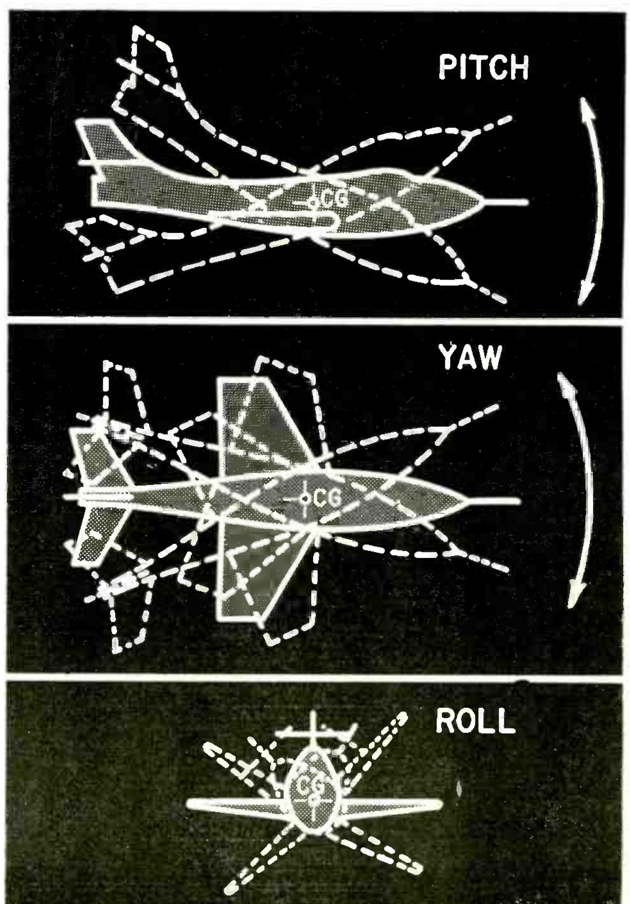


Fig. 1—Pitch, yaw and roll occur in missiles and aircraft. All movements are around the center of gravity (CG).

* Author: *Basics of Missile Guidance and Space Techniques* (John F. Rider, Publisher, Inc.)

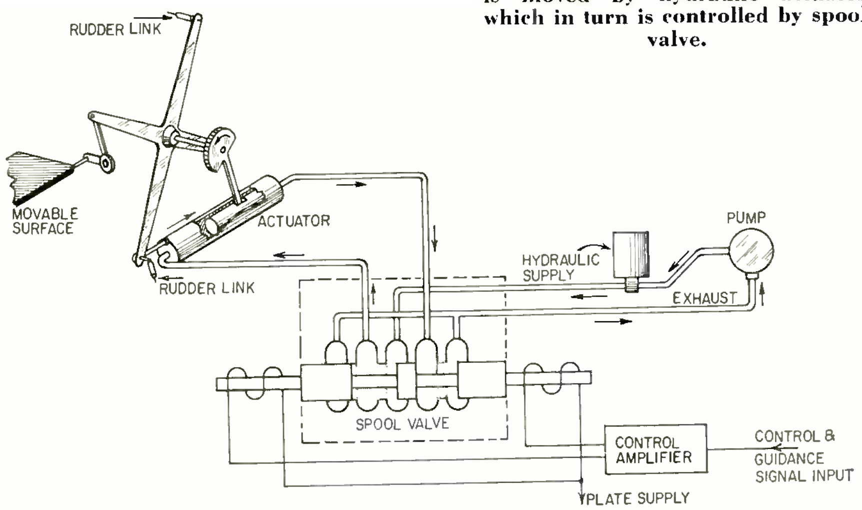


Fig. 2—Control surface (elevator) is moved by hydraulic actuator which in turn is controlled by spool valve.

form, if at all. Gyroscopes placed about the missile flight axes can help furnish signals to restore the missile to stable flight in its original direction.

Two basic characteristics of the gyroscope make it a very important tool in missile stabilization and guidance. One is its axial rigidity in space; the other is its tendency to *precess* when subjected to external forces.

When a gyro rotor is brought up to speed and aligned in a given direction in space, it can be used as a flight-axis reference for an aircraft or missile. By "picking signals" off the gimbals in which the rotor is mounted and amplifying and passing them through appropriate servo and actuator arrangements, the flight control surfaces can be moved to restore the missile to its desired course.

Another important consideration, the *rate* at which the missile is deviating from its course, can be measured by the precession of a rate gyro and also fed into the control system. A typical combination of a position gyro and a rate gyro to control the roll of a missile is shown in Fig. 3. Combinations of gyroscopes to provide flight stability around the three axes of flight motion have been known for some time as "autopilots."

Guidance

Such autopilots can give the missile flight stability, but guidance signals must be fed from radio, radar, accelerometer, programmed or additional gyroscopic sources to bring the missile into a desired flight path. Guidance systems vary somewhat, depending upon whether moving or fixed targets are being attacked. Typical moving targets are enemy aircraft, ships or tanks in motion. Fixed targets are cities, industrial centers and military installations.

A moving target presents a special problem. Information relative to its position, velocity and direction must be obtained and used to guide the missile to it. The faster the target moves the greater is the problem of catching it with an attacking missile. If several targets are to be intercepted at any given time, the problem becomes even more complex. A missile may strike close enough to a fixed target (with an atomic warhead) if it is simply aimed at the correct angle and given the necessary velocity.

Just as with guns firing at moving targets, it is necessary to use a computer to determine the angle at which the missile should be aimed. Calculations must take into account the speed of the target and the factors affecting the missile's direction and time of flight.

Whether inside the missile or outside, the computer is part of the automatic system (Fig. 4). In general, wherever a comparison must be made between the missile's position and the course which it should follow to intercept its target, a computer is a necessary system element.

Both analog and digital computers are used in a wide variety of missile applications. The allowable weight and volume of the computer vs the required accuracy are determining factors in the choice of type.

Passive systems

The simplest type of guidance system —and probably the most foolproof one— can be realized in attacking targets which radiate some form of energy that the missile can sense. Such radiation might be sound, light or heat. If the target radiates enough energy, the guidance may be completely passive, using only a receiver of the radiation. As far as is known, no modern missile operates on sound or light radiated from the target, but excellent ones have been developed to home on the heat of aircraft engines (or other targets). Examples are the US Sidewinder and the British Firestreak which home on infrared energy.[1]

Another type of passive guidance uses inertial navigation principles and has been applied successfully to ballistic missiles.[2]

Active and semi-active guidance

Any guidance system which requires the radiation of energy, either from the missile or another source, to select and track the target is an active or semi-active type. If the target-tracking signal is radiated from the missile, the guidance is active, if it is radiated from a source outside of the missile the guidance is said to be semi-active. Semi-active guidance is most widely used by defensive missiles which, before they are launched, preferably track incoming aircraft from a surface point, such as from the ground or from a ship. Command guidance, beam-riding and semi-active homing are in this category.

The basic concept of command guidance is this: Directing or commanding signals are sent to the missile from a control point instructing it as to the course it must take to intercept the target. In one rather well known form, one ground radar system tracks the aircraft and another tracks the missile. Taking into account the speed and direction of both target and missile, a ground-based computer determines the corrections in the missile's course to intercept the target. Commands can be sent to the missile over a separate radio channel or are modulated onto the missile-tracking radar and sent to the missile by that route. Certain versions of the Nike missile, designed to intercept high-flying aircraft over major populated or critical defense areas, are guided by a radar command system (Fig. 5).

Beam-riding guidance is another variation of the active technique. A

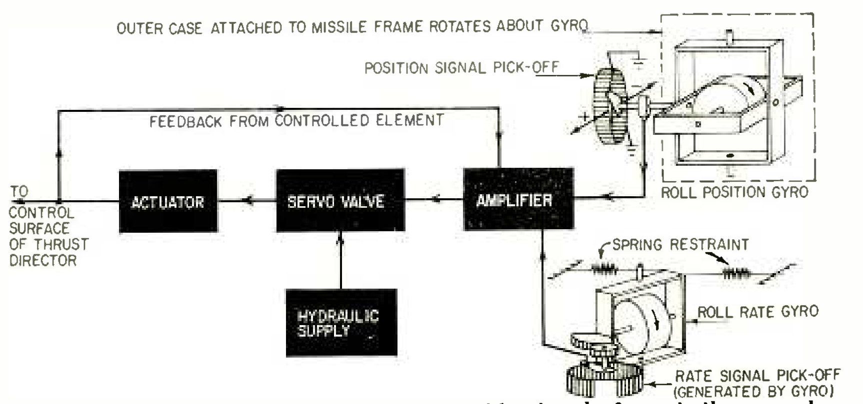


Fig. 3—Position and rate gyros can provide signals for missile control.

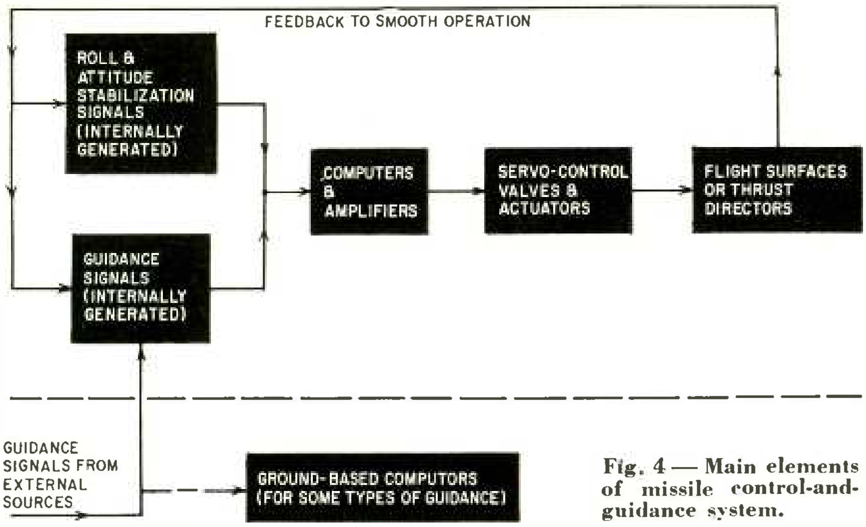
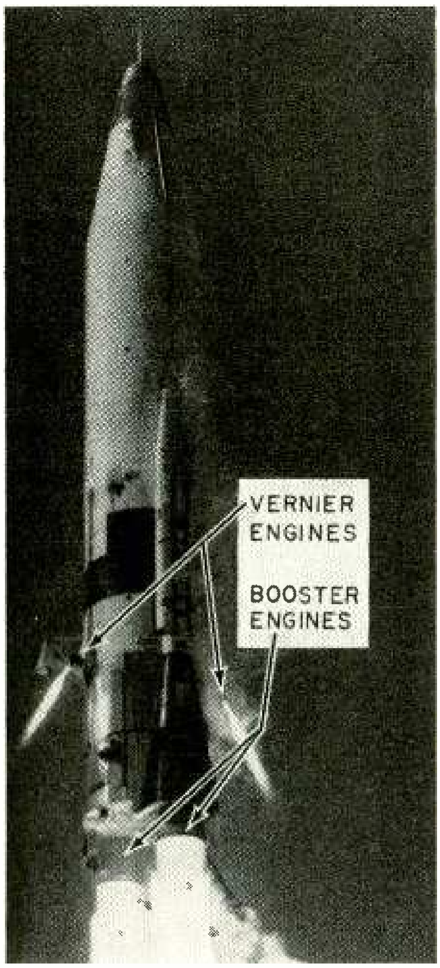


Fig. 4 — Main elements of missile control-and-guidance system.

single radar beam tracks the target and the missile travels up this beam to intercept it. As some have said, it makes the radar beam lethal. After a beam-riding missile is launched, its first flight phase is controlled by its autopilot. Then it travels through a so-called collecting beam radiated from the ground radar and is brought under ground control. From this phase, its receiver picks up signals from the central guidance beam and it follows this narrow cone of radiated energy to the target. Actually, the ground (or shipboard) radar sweeps out a conical beam around the target. Radar-beam modulation permits the missile's receiver to identify deviations of its course from the center of the conical scan. Signals developed within the missile as a result of any "off-course" modulation are fed to a computer which determines the corrections necessary to intercept the target (Fig. 6).



An Air-Force Atlas InterContinental Ballistic Missile (ICBM) thunders aloft from its launching pad at Cape Canaveral, Fla.

Homing methods

Both command and beam-riding guidance are semi-active systems. However, they are usually not specifically identified in this fashion. In another guidance method—homing (passive homing involving infrared seekers has already been mentioned), it is necessary to qualify the particular system as either active or semi-active. In active homing the missile carries the entire guidance system within itself. But, in semi-active homing, separate radar equipment tracks the target and is said to "illuminate" it and provide a reflected signal for the missile.

Since a complete radar system (transmitter and receiver) involves a substantial amount of equipment (even for short operational ranges), active homing has not been popular. Semi-active homing keeps equipment in the missile to a minimum just as in passive homing. Only the receiver and tracking antenna are required. It is an accepted guidance system for certain modern defense missiles.

The British Bloodhound, a semi-active homing missile, is one of the most widely used missiles produced outside of the USA. Made in England, it is used for defense against jet bombers by England, Sweden and Australia.

In operation, combined or separate early-warning and tactical-control radar pick up the target aircraft at some distance from the defense point. As the target approaches, a "target-illuminating" radar takes over the tracking and "illuminates" the incoming aircraft (Fig. 7).

Prior to missile launching, it provides accurate target position data to the launchers, so that the missile is pointed toward the target before launching. After launching, the missile's receiver extracts yaw and pitch information from the reflected radar signal so that its antenna can be pointed at the target (and the missile's wings moved to steer it into an interception course).

In the US, the Army missile known as the Hawk also depends upon semi-active homing. Its name is derived from "*H*oming *A*ll the *W*ay *K*iller." Its principal application is stated to be against high-speed, low-flying aircraft.

Ballistic missile control

The rocket exhaust of a long-range ballistic missile soon propels it beyond the earth's atmosphere, so that wings and aerodynamic surfaces are of little value in controlling its flight path. The only practical means of exercising control (and guidance) is by controlling the direction of the rocket engine's thrust. One system moves vanes in and out of the exhaust. Another moves a deflector ring—known as a "jetavator" —across the thrust stream.

However, a more widely used technique for large missiles, such as ICBM's and IRBM's uses one or more gimbaled engines. In this design, the entire combustion chamber of the rocket engine (with its exhaust nozzle) is moved in a gimbal mount to give the desired thrust direction. Small auxiliary thrust directors, called vernier engines, usually

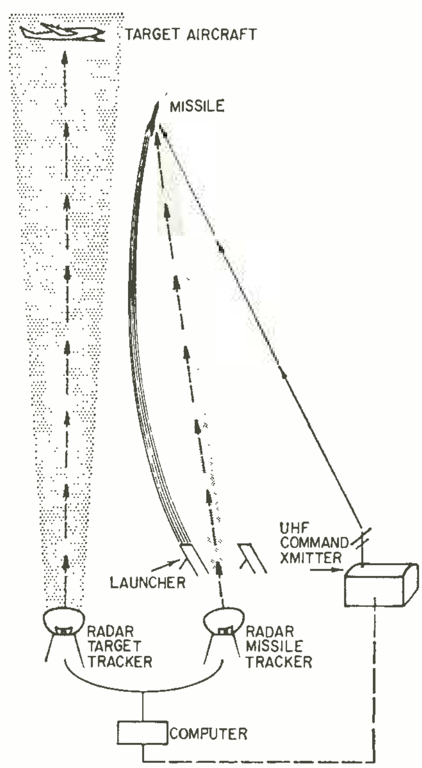
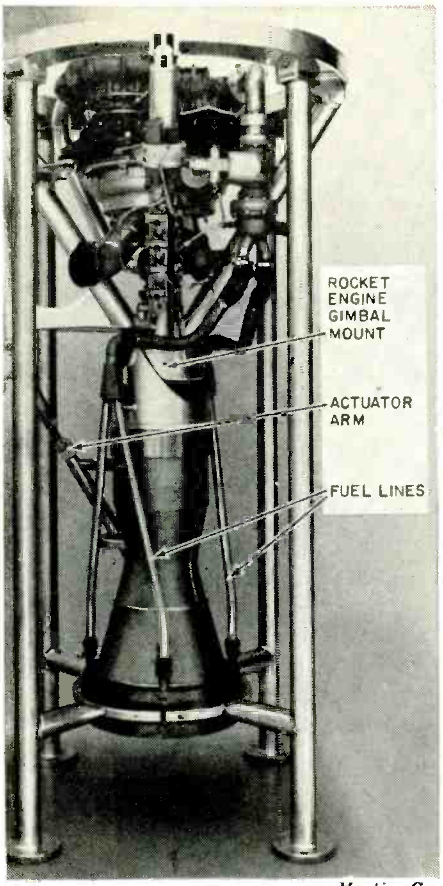


Fig. 5—Typical command guidance system. Signals may be transmitted to missile via uhf-radio link or along the missile-tracking radar.



Martin Co.

Liquid-fuel rocket engine in gimbal mount.

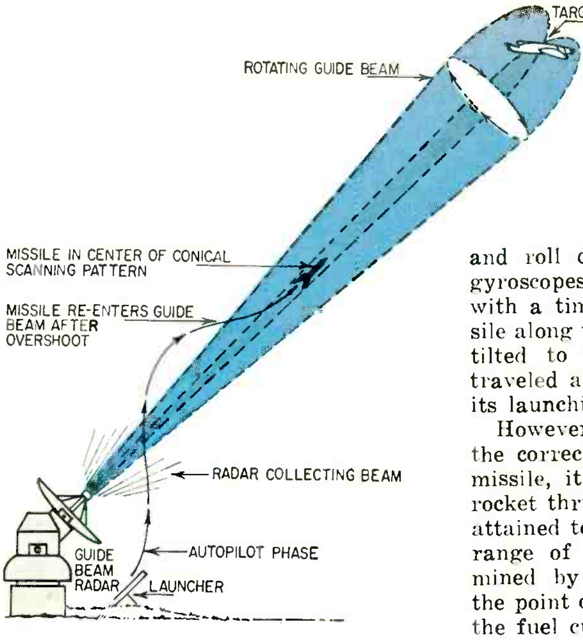


Fig. 6—In a beam-riding system, the missile follows the radar beam right up to the target.

supplement the main rocket engines. They are quite effective in controlling the roll of the missile as well as furnishing limited pitch and yaw corrections.

Ballistic missiles present a special problem when it comes to guidance—the target is not contacted by either self-generated or reflected radiation. Its position is established by geographic coordinates, and the missile's behavior is similar to that of a long range artillery shell. The principal difference is that the ballistic missile can be guided over a somewhat greater portion of its flight path than the shell. After the shell leaves the gun barrel, it receives no further guidance. However, the ballistic missile can be guided as long as there is enough fuel to power the rocket engines.

As mentioned above, long-range missiles are well beyond the earth's atmosphere (effectively) before their fuel is cut off and they begin their free fall to the target. By analogy, the guidance system for a ballistic missile establishes a hypothetical "gun-barrel" in space, which for long-range missiles, extends several hundred miles from the launching site.

The ballistic path

If a rocket is stabilized and launched in a vertical position, it will rise perpendicular to the earth's surface and fall back to a point near the launching site. It could be stabilized with an autopilot.

However, rockets with vertical trajectories are primarily for research purposes. Missiles must travel some distance from their launching site if they are to operate as military weapons. The missile must be tilted from the vertical position after it is launched.

One of the first practical applications of ballistic missiles was the historic German V-2. It was launched vertically and stabilized with an autopilot (consisting of gyroscopes to sense yaw, pitch and roll deviations). But, one of the gyroscopes was precessed in accordance with a timed program to tilt the missile along the pitch axis. Because it was tilted to the proper angle, the V-2 traveled approximately 200 miles from its launching site.

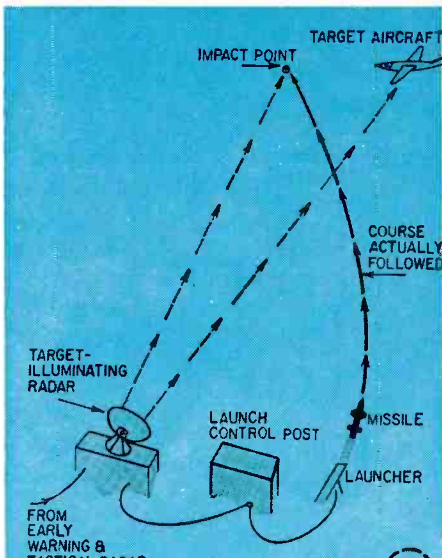


Fig. 7 — Missile follows (homes on) reflected radar signal from target.

However, in addition to establishing the correct pitch angle of the ballistic missile, it is important to cut off the rocket thrust when an exact velocity is attained to insure a desired range. The range of a ballistic missile is determined by its direction and speed at the point of thrust cutoff. To determine the fuel cutoff point, it is necessary to measure the velocity at which the missile is traveling in its flight path. One method for doing this uses the Doppler effect. A small transponder in the missile can indicate the Doppler frequency shift to a ground station, from which a command signal can be sent to cut off the fuel at the desired missile velocity. In another method, an integrating accelerometer measures the missile's velocity and establishes the correct point for shutting off the rocket engine.

To be accurate, a ballistic missile must also be on course from a lateral or yaw viewpoint. Modern missiles employ combinations of radar and inertial guidance or inertial guidance alone to establish correct pitch and yaw angles as well as the correct point for thrust cutoff.[2] A system using both radar and inertial techniques is known as radio-inertial guidance. The radar portion of the system operates like a command guidance type from ground to missile and adds computed corrections to supplement the accelerometer signals of the inertial portion. The goal of inertial-guidance designers—to obtain sufficiently accurate information from the accelerometers, without radar tracking—has been realized for some systems.

END

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[2]Philip Julian, "Inertial Guidance Directs Planes and Missiles," RADIO-ELECTRONICS, December, 1958.

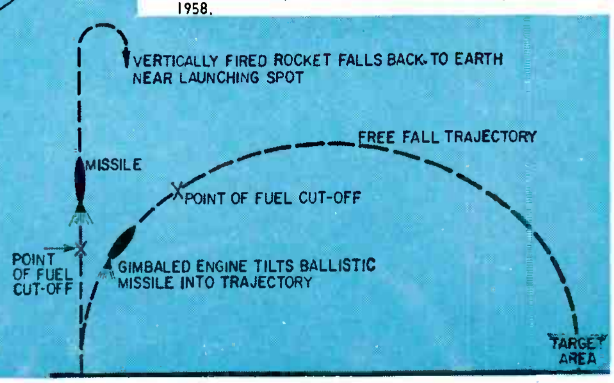

Fig. 8—Ballistic missile follows free-fall trajectory after point of fuel cutoff.

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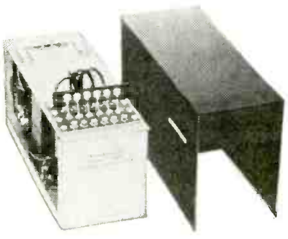

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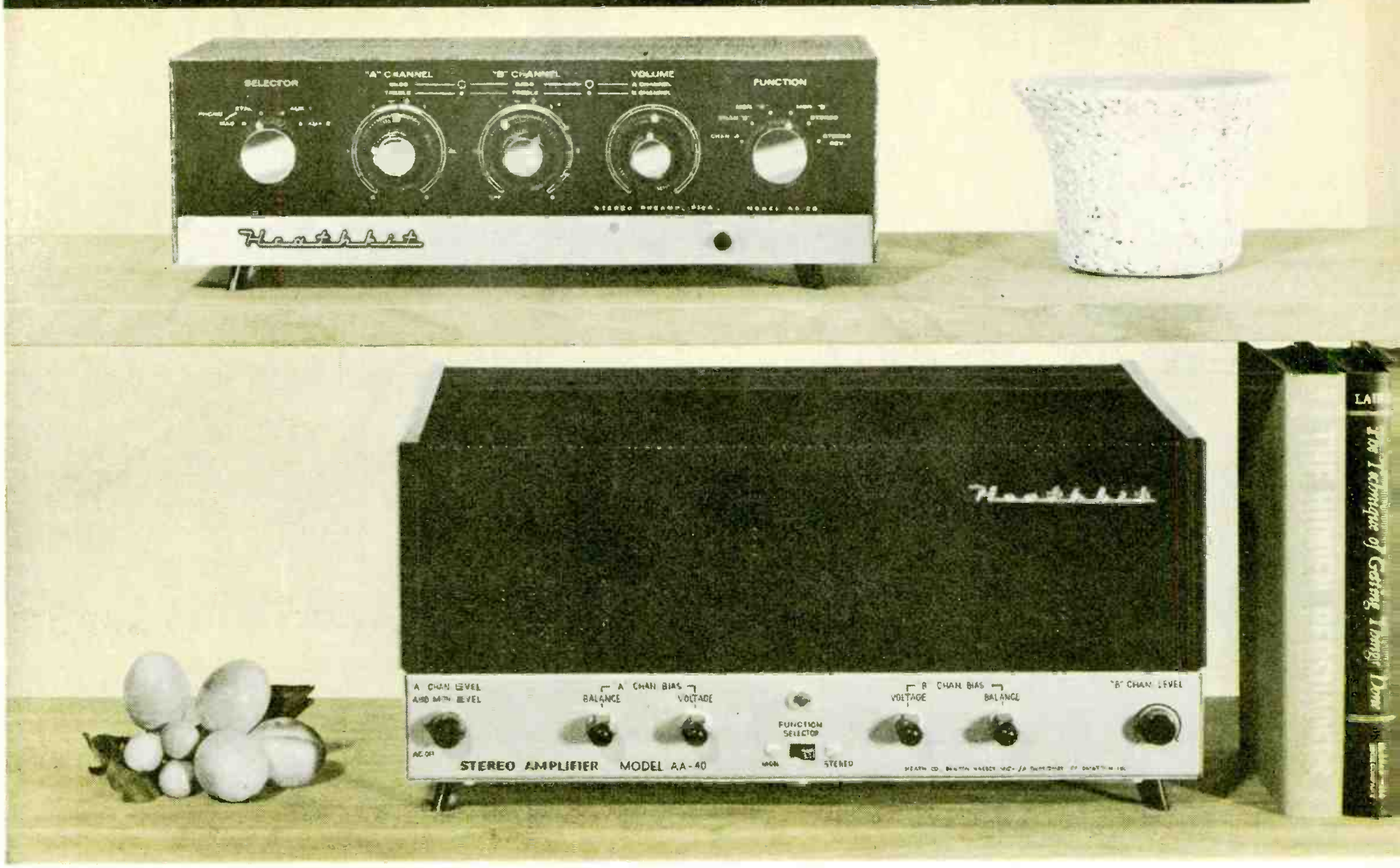

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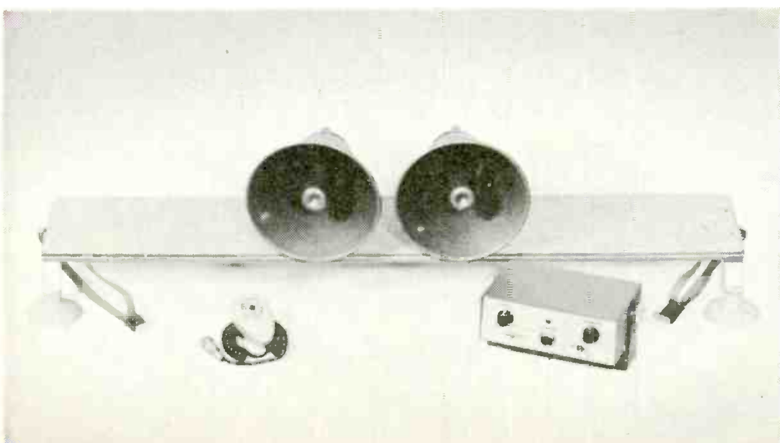

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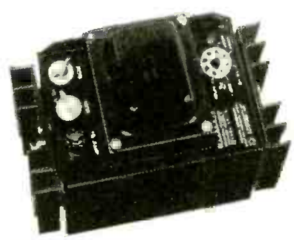

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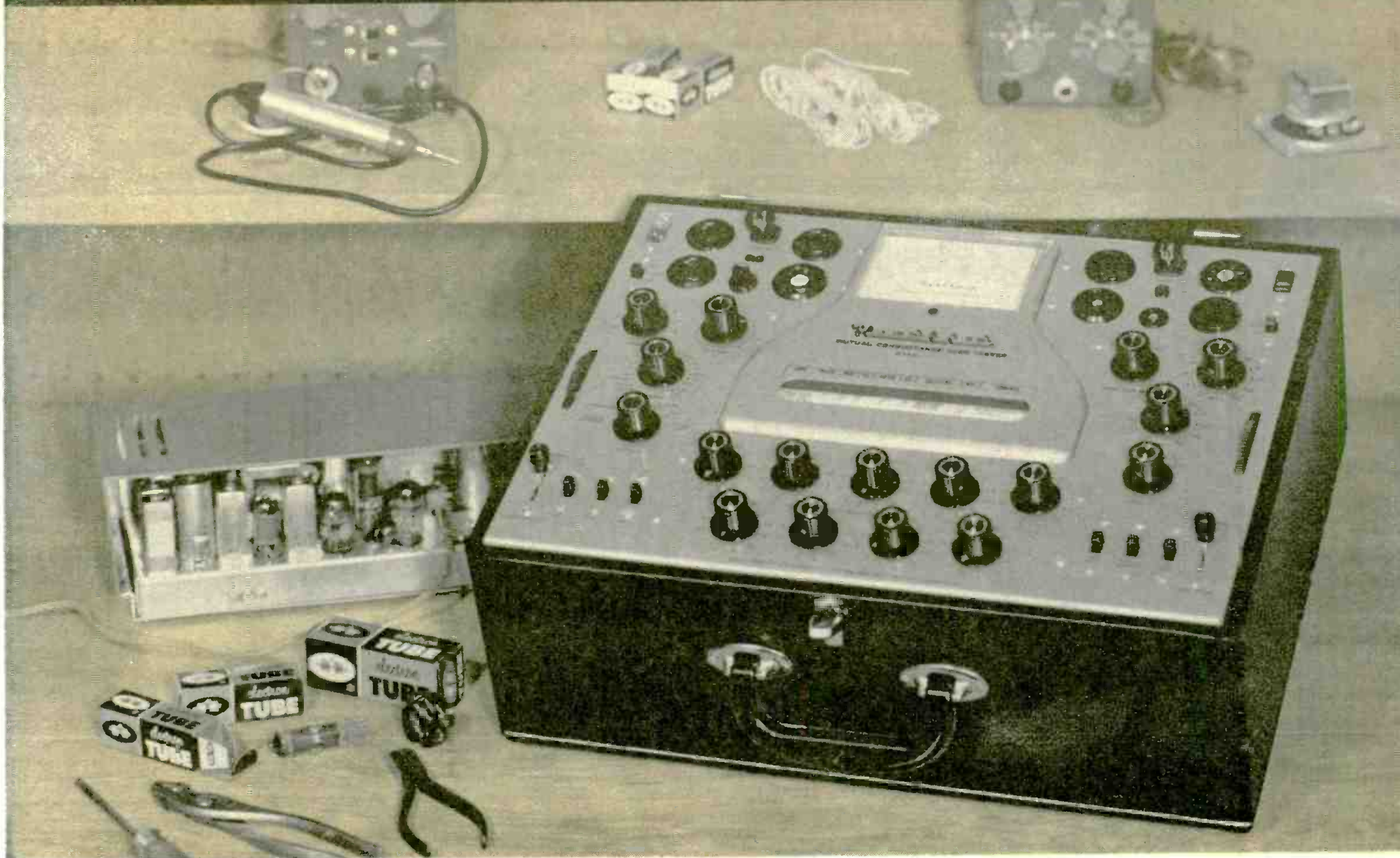

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NEW DEPARTURES in TUBES and SEMICONDUCTORS

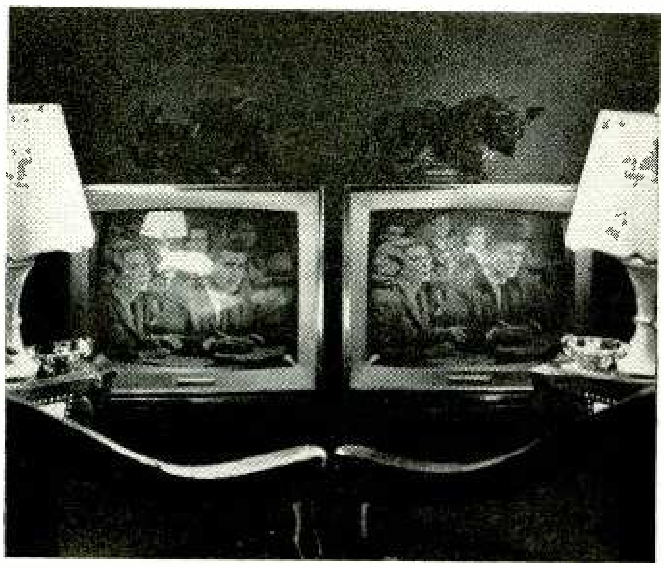
By LARRY STECKLER
ASSOCIATE EDITOR

Right out of the laboratory are these new, interesting devices that will soon be common in modern electronics

NEW and previously unheard-of tubes and semiconductor devices have been appearing in droves. Some you will see in this year's TV receivers—square-faced picture tubes, a nine-pin miniature envelope designed to replace many octal type tubes, and an etched picture-tube face that stops faceplate reflections. Others fit industrial applications—gallium arsenide tunnel diodes, Hall-effect devices, a high-power electron gun for radar, a method of aluminizing low-anode-voltage cathode-ray tubes, and multi-headed transistors.

Reflection-free TV

From Corning Glass comes a bonded-faceplate 19-inch picture tube that halts faceplate reflections. This square-

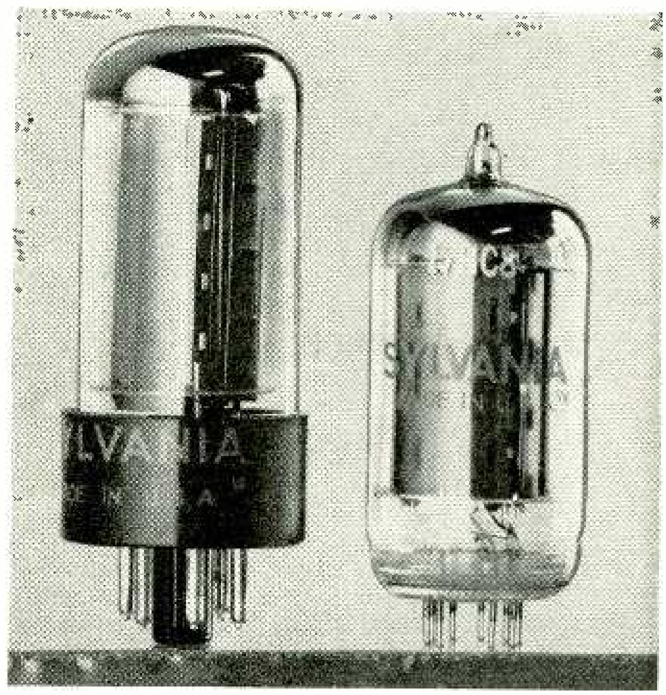


Two TV sets that are identical in all but the picture tube show the effectiveness of the reflection-free tube face introduced by the Corning Glass Works. Corning's new tube is on the right.

cornered tube with a bonded safety-glass face is used by Sylvania in their new line of TV receivers.

It is a 114° deflection tube carrying the type number 19AFP4. (Similar tubes will probably be made in other sizes in the near future.) The faceplate is etched to form a prismatic surface that traps and diffuses light from outside sources. The etched surface has no noticeable effect on the picture as seen on the screen. It is just as bright and clear as that on a standard picture tube.

Distorted or blocked-out TV screens caused by such things as reflected room lights or a burst of sunlight through a



Sylvania's 9-pin bantam tube and the octal type it supersedes.

venetian blind are prevented. The photo shows how effective the etched screen is.

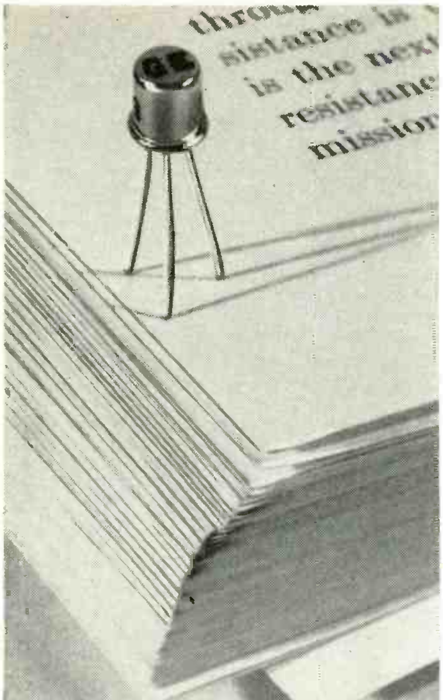
The bonded faceplates on these new tubes have another advantage too. There is no air gap between the picture tube and the safety glass to gather dust. The one outside surface can be cleaned easily. There is no safety glass to remove to get at the face of the picture tube. Corning says the bonded-glass face is so hard that it will not be damaged by ordinary household abrasives—even if applied with steel wool!

Bantam tube replaces octals

A new kind of tube construction puts the elements that now fit inside an octal tube into a miniature nine-pin envelope. The new tube makes for easier design of printed circuits by reducing component congestion. Some of the first tubes to feature this new Sylvania-developed construction are:

The 17HC8—a medium-mu triode-pentode for use as a vertical deflection oscillator and amplifier in TV.

The 6EW7—a double triode, one section for use as a



G-E's gallium arsenide tunnel diodes measure only a fraction of an inch in any direction.

Super-power electron gun. Intensity of electron beam is equivalent to concentration of 5 million 40-watt light bulbs.

vertical deflection oscillator, the other as a vertical deflection amplifier.

The 10EW7—identical to the 6EW7 except for its higher heater voltage requirement.

Aluminized low-voltage CRT's

Out of the laboratories of Thomas Electronics, Passaic, N. J., comes a development, using new processes, techniques and materials, that makes it possible to aluminize a cathode-ray tube that operates with anode potentials as low as 2 kv. Previously, they were aluminized only when operated at voltages greater than 5 or 6 kv.

Aluminized CRT's have several advantages over non-aluminized types. The main one is an increase in brightness —as much as 90%. The increased brightness makes it possible to reduce beam current. This reduces line width and therefore improves overall resolution.

In addition to precision oscilloscopes, aluminized tubes can be used for radar display screens and other systems that call for the ultimate in light output and screen stability. The new aluminizing techniques are, of course, applicable to TV picture tubes designed for use in transistor portable sets, where acceleration voltages are low.

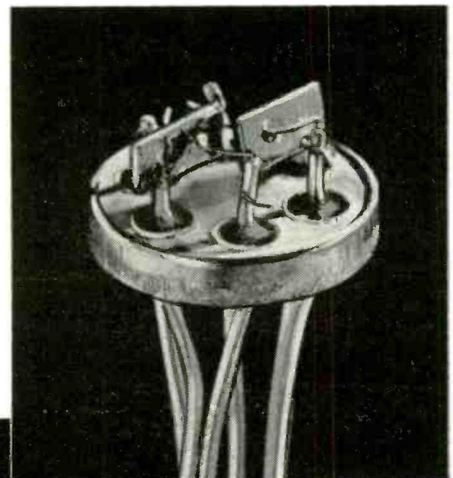
Gallium arsenide tunnel diodes

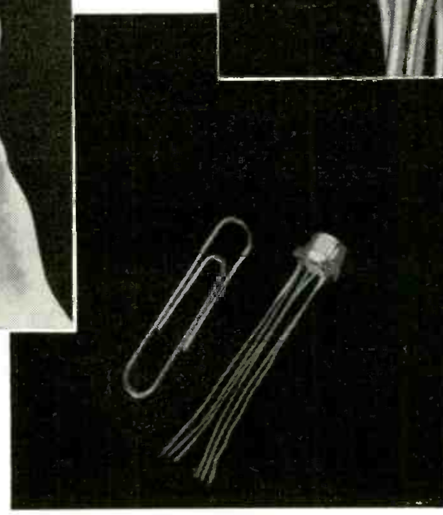
Gallium arsenide is a little known and rarely used semiconductor material. The more common germanium and silicon are extensively used for transistors and rectifiers. They are elements and are therefore much easier to purify and use. But because of its unique properties for electronic components, better in some cases than either those of germanium or silicon, gallium arsenide has been under intensive investigation for some time.

Now General Electric is offering tunnel diodes made from gallium arsenide. According to G-E, many performance characteristics of the device are better than those of germanium tunnel diodes. Ultimately gallium arsenide may be the principal material used for tunnel diodes. Tunnel diodes made from gallium arsenide on a mass-production basis are expected to sell for between $10 and $12.

Multi-headed transistors

Electronic Transistors Corp., North Bergen, N. J., has announced that it has developed and is now manufacturing





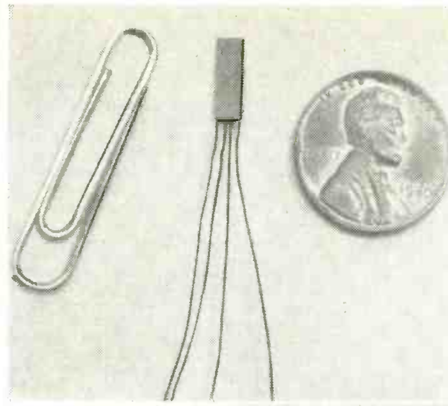
Construction is revealed when case of multi-headed transistor is removed. On left, assembled unit is shown in comparison with paper clip.

multi-headed transistors in an effort to reduce the size of transistor circuits.

The multi-headed transistor is a combination of any type or types of transistors. They can be put together in every variation and combination desired. Each multi-headed unit will contain the two individual transistors specified by the purchaser. The combination of individual transistors in the multi-headed package does not create any interference between transistors. The two units in the package are completely separate and do not contact each other.

1,000-ampere electron gun

A new electron gun that removes one of the basic obstacles to extending radar power and target detection has been



Two Hall-effect gaussmeter probes. The axial probe is on the right.

developed by the Electron Tube Div. of Sperry Gyroscope Corp. The new gun can project an electron beam five times as powerful as earlier devices. It increases the power capabilities of large missile-guidance radar and anti-missile systems.

The new electron gun can project electron beams of more than 200,000,000 watts power and 1,000 amperes current to operate large klystron amplifiers and other super-power electron tubes.

A basic factor in the development of the Sperry gun is a special technique for creating an ultra-clean operating environment inside the envelope of the tube. The special high-vacuum technique used creates a clean vacuum equal to space 200 miles above the earth. At that height an average electron would have to travel 6 miles before encountering a single atom of matter.

Hall-effect devices

Ohio Semiconductors, a pioneer in the field of Hall-effect devices, has two new units in production. One, their model HP-310, is especially suited for use as a gaussmeter probe and in other applications where small size and thin construction offer advantages over larger, more bulky devices. The HP-310 uses indium arsenide for its active element.

When used in magnetic circuits this small, thin unit gives increased current sensitivity and permits the use of smaller and more compact magnetic units. A similar unit made from the same material is the model HP-315. It is an axial field probe also intended for use as a gaussmeter probe. Both units produce an open-circuit output of 100 mv with a control current of 100 ma and a flux density of 10 kilgauss.

These are but a few of the many new developments in tubes and semiconductors to appear in the past few weeks. Still newer and more exciting devices are certain to come. Who can prophesy what will come out of the laboratory tomorrow? END

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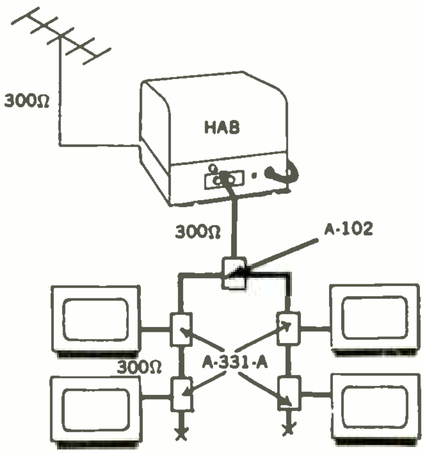

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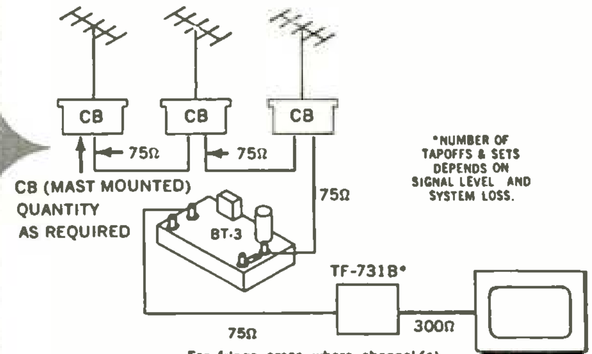

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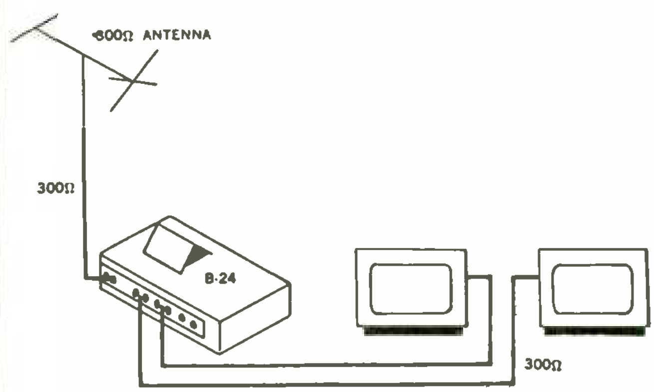

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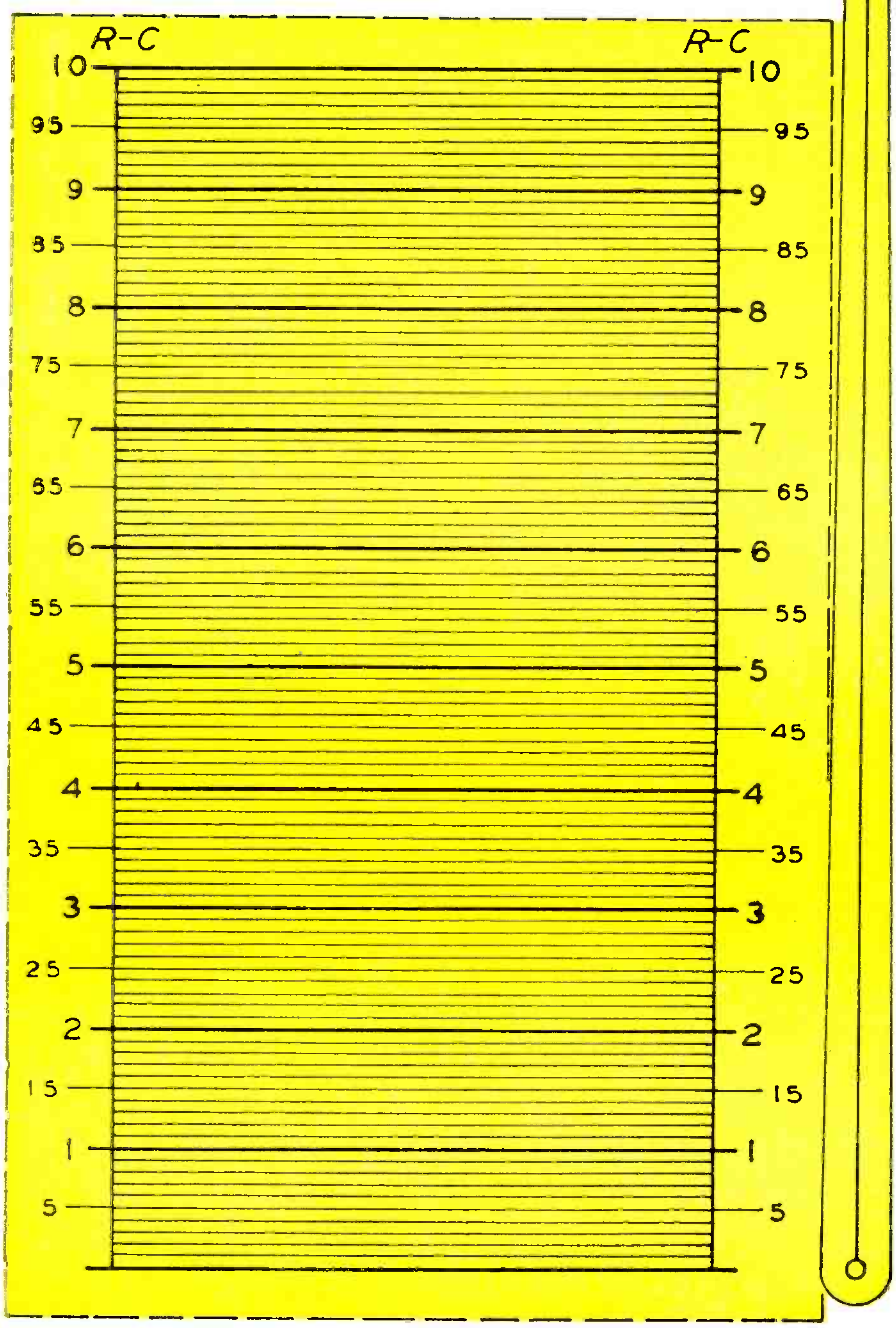
By S. J. SALVA

PARALLEL/SERIES RESISTANCE CALCULATOR



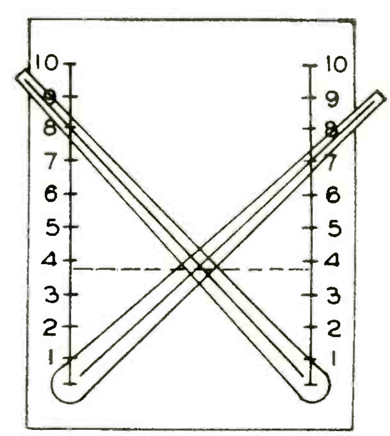
ONE of the biggest headaches in electronic work is having to break off in the middle of a job to figure values for parallel resistance or series capacitance. The calculator described here eliminates much of this pencil and paper work—thereby saving time and the aspirin supply.

The value of any two resistors in parallel or any two capacitors in series can be found by setting the first value on the left scale with the right indicator arm and the second value on the right scale with the left arm. The answer is read at the intersection of the two arms. By using standard multipliers, ×10, ×100, etc., the full range of values can be covered.

In Fig. 1, for example, to determine the value of an 800- and a 700-ohm resistor connected in parallel, we set the right arm to indicate 800 on the left scale. Then we set the left arm at 700 on the right scale, and the answer is read as 370 ohms.

The calculator is easily constructed. Simply cut any light sheet of material to the size of the chart—plastic, or even cardboard will do—and glue the chart (Fig. 2) in place. Using clear plastic or celluloid of thin stock, construct two arms similar to the one in the drawing. A straightedge and a sharp nail should be used to scribe a line down the center of each arm. Rub a bit of India ink into the scribed lines, wipe off the excess, and you have a couple of first-class indicators. The arms are attached to the board as shown in Fig. 1. Small rivets or eyelets will serve for this.

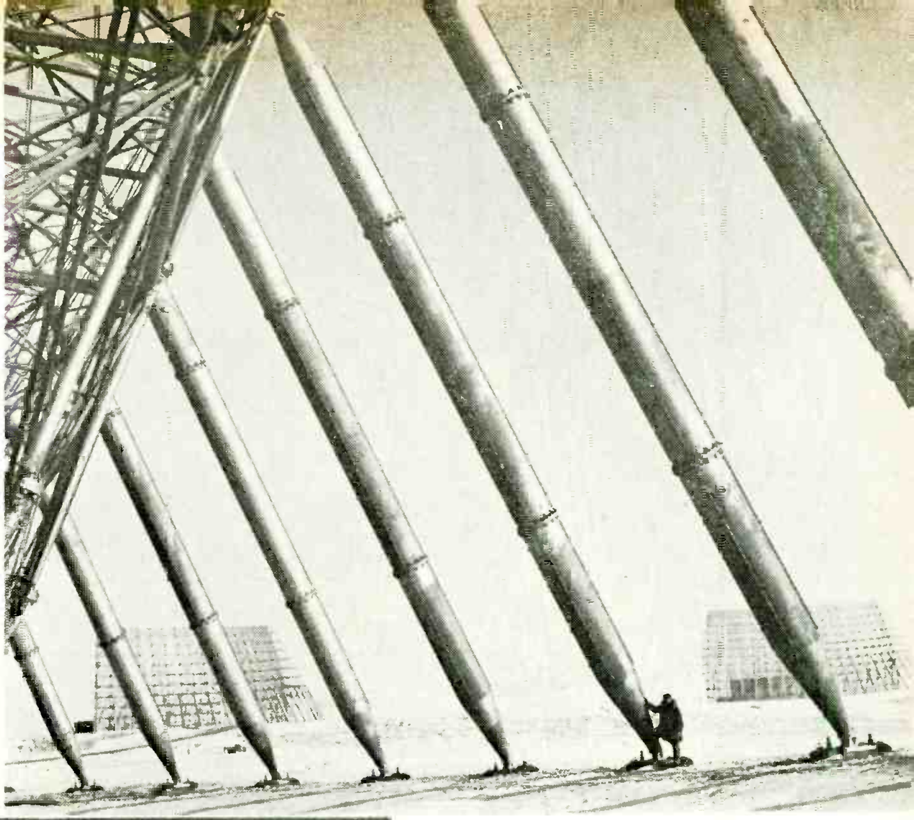
The calculator's size limits accuracy to about 2%. In circuits where greater accuracy is required, it will still be necessary to use the formulas, or make a bigger calculator! END



How to use the calculator.

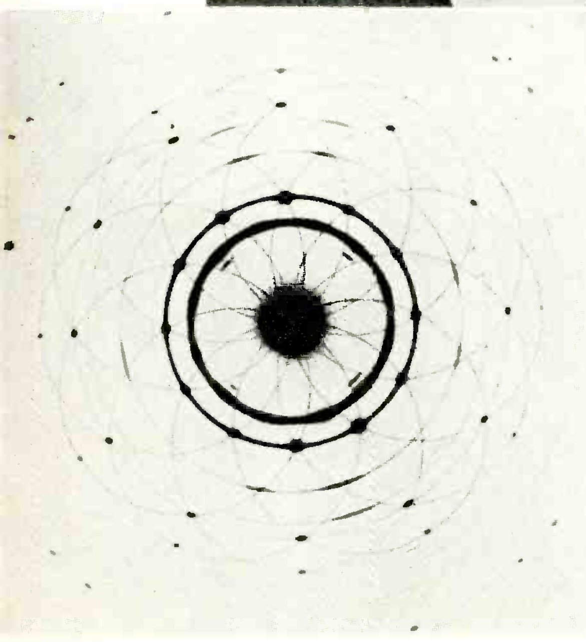
Full-size diagram you can cut out and mount to make your own calculator.

WHAT'S NEW



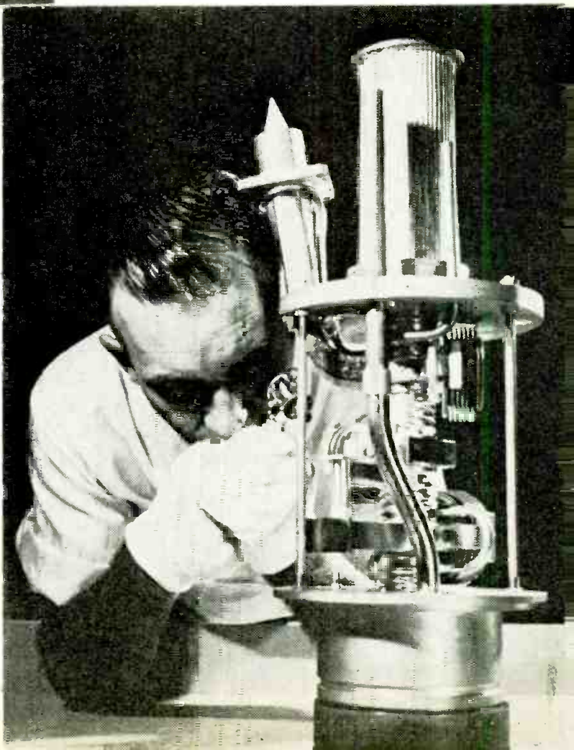
PONDEROUS PILLARS built by General Electric Co. dwarf workman. Each one is 60 feet long, 42 inches in diameter and weighs 7½ tons. Twenty of them are required to support each of four 1,500-ton radar reflectors, part of the Air Force's Ballistic Missile Early Warning System in Greenland.

WEATHER EYE is tiny RCA vidicon TV camera tube. For months, two of them have been orbiting the earth in weather satellite TIROS, taking more than 20,000 photographs. One of these cloud-formation pictures is shown in the background.



POWER BOOSTER by Sperry Gyroscope Co. uses 100-ampere electron beam to generate the megawatts of microwave power which allows military radars to "see" missiles at longer range. Pointed white cone (upper left) is ceramic window which is transparent to microwaves, yet maintains tube's high vacuum.

DIFFRACTION PATTERN of an electron beam is the result of passing the beam through 3 layers of tin and bismuth totaling 10^{-6} centimeter (.000,000,394 inch) thick. The strong inside ring is due to the tin; the second strong ring is produced by the bismuth. It is difficult to interpret the pattern as three separate ones are superimposed, but it does prove that the structure of matter is symmetrical. Photo made in conjunction with work done by Prof. Hans Richter, Stuttgart, Germany.



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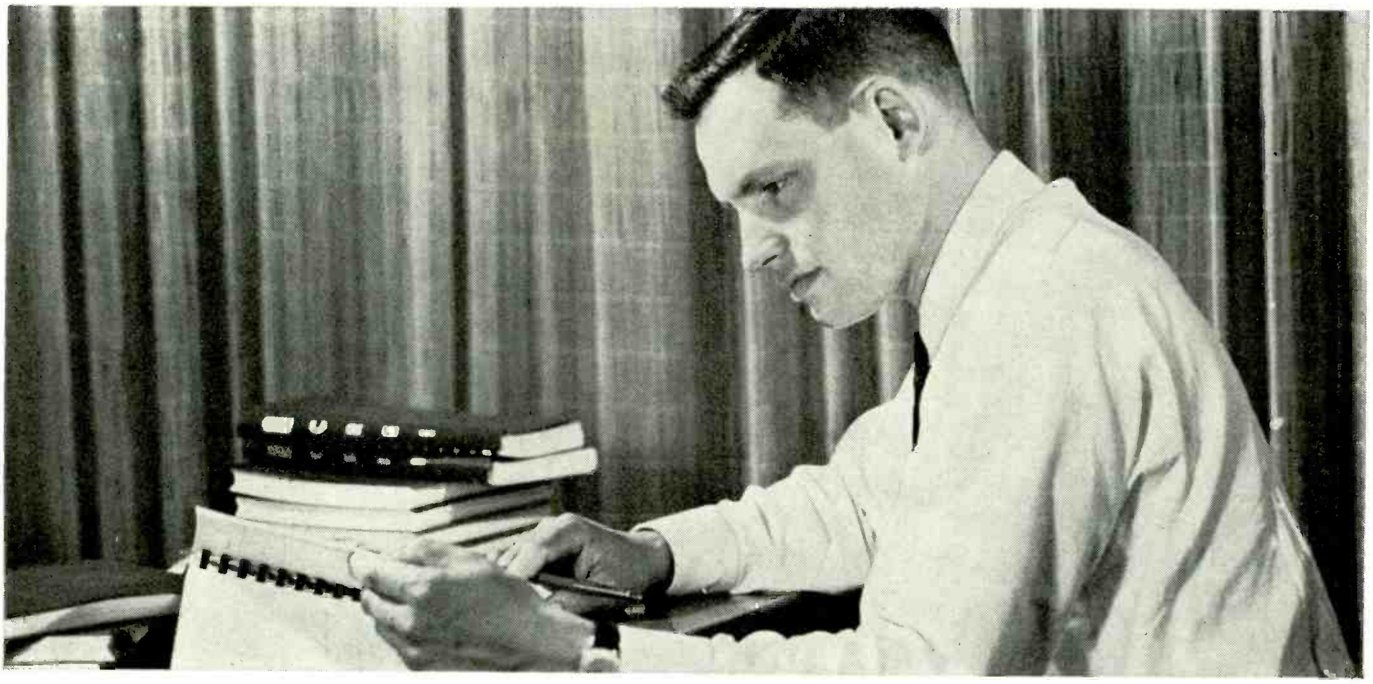

DYNAMIC EXPANSION OF ELECTRONICS INDUSTRY CREATES OUTSTANDING JOB OPPORTUNITIES. No other major field of engineering has enjoyed a more rapid growth or promises a more brilliant future than electronics. New developments in space exploration, guided missiles, automation, computers, and many other fields create new jobs daily, jobs which have to be filled by men with a modern advanced education in electronics. The shortage of competent electronic personnel will grow more acute over the next decade, and salaries and professional stature of technical men are expected to reach new highs.

The fact that new positions must be filled by men with an up-to-date education is evidenced by the experience of the CREI Placement Bureau, where the demand for graduates and advanced students has far exceeded the supply for several years. It is of interest to note that many leading companies regularly visit CREI strictly for the purpose of recruiting CREI graduates and students.

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FOLDOVER, HALOS and a CURE

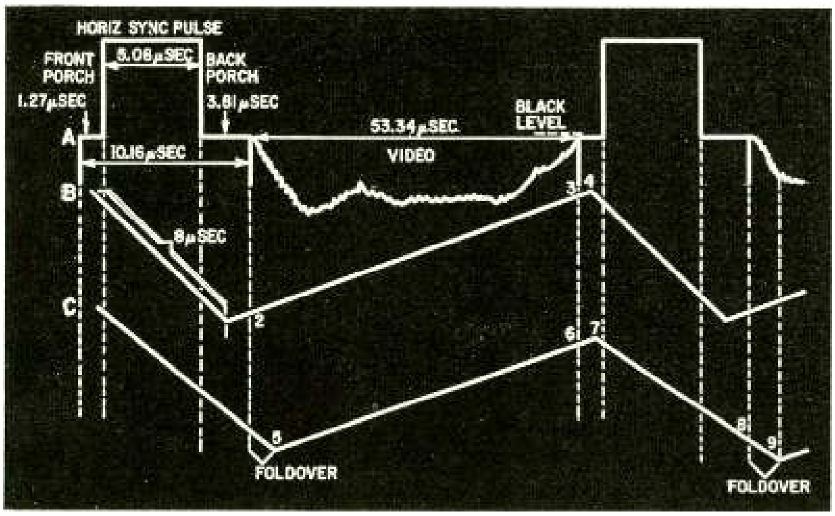


Fig. 1—Scanning and retrace vs video information. Line A is a line of video between two sync pulses. Line B is normal horizontal scanning waveform. Line C is horizontal scanning with excessive retrace time causing foldover.

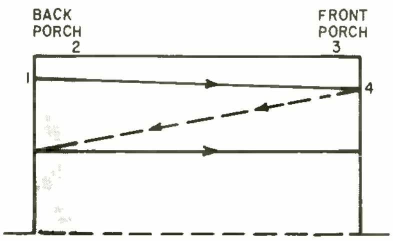


Fig. 2—Result of normal scanning (Numbers refer back to Fig. 1.)

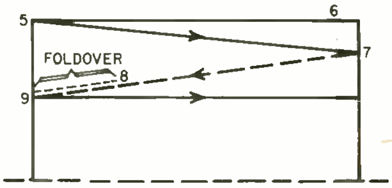
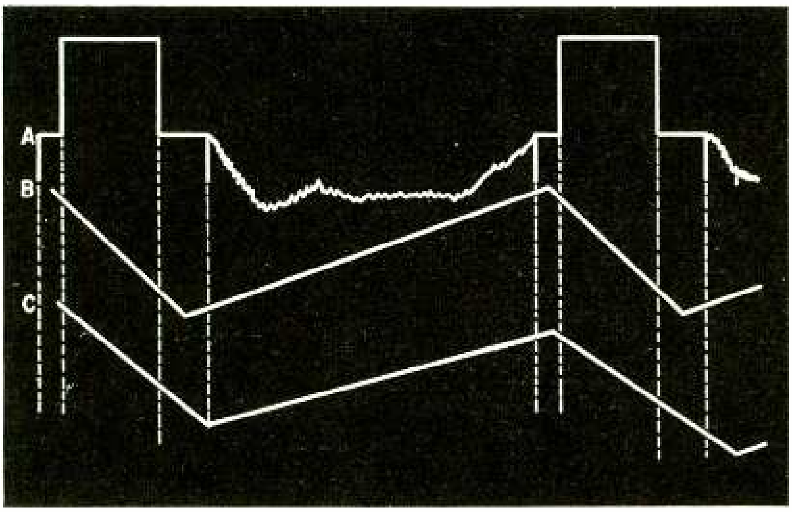


Fig. 3—Foldover caused by too long a retrace time. (Numbers refer to Fig. 1.)

Fig. 4—Scanning as in C causes halos on TV screen.



By **HECTOR O. ALGARRA** *

HORIZONTAL foldover is a common and annoying problem, yet few technicians know why or how it happens. To understand this problem better, let's begin by analyzing a case of foldover.

Line A in Fig. 1 shows one line of video information. The inactive portion between the end of one line of video information and the start of the next line has a 10.16-μsec duration. This is made up of a 1.27-μsec front porch, a 5.08-μsec horizontal sync pulse and a 3.81-μsec back porch.

Line B (Fig. 1) shows the sawtooth signal that is fed through the yoke to control the horizontal sweep. Naturally, we want a retrace time shorter than the inactive portion of the video information. An 8-μsec retrace is good and is easy to get when the horizontal stages are carefully designed.

At the start and end of the raster are the two porches. Therefore we get two small black stripes at each side of the picture (Fig. 2). Actually, these black bands are off the face of the TV picture tube and appear only if the picture is moved to the right or left by adjusting the centering controls.

However, if the retrace time is longer than usual (line C, Fig. 1), it extends into the video portion of the picture and the video information starts during the retrace period and appears on the screen as shown in Fig. 3. This type of foldover can appear on the right side of the screen too. When this happens, the retrace starts too soon and lasts too long.

Fig. 4 shows another type of retrace trouble. This one we run into on a number of American-built 110° deflection TV sets. Again lines A and B are correct. Line C shows a retrace time that is too long but does not run into the video information. It kills the back porch but, since the signal and active trace start at the same time, no serious harm is done. However, this can result in the porch level appearing during retrace as a halo on the screen (see photos) that overlaps the video information. This halo appears on light-contrast pictures and during camera changes when the screen is blank. It occurs because brightness is turned up and contrast decreased, making the inactive portion of the TV signal visible.

* Technical director, Tele-Royal, Buenos Aires, Argentina.

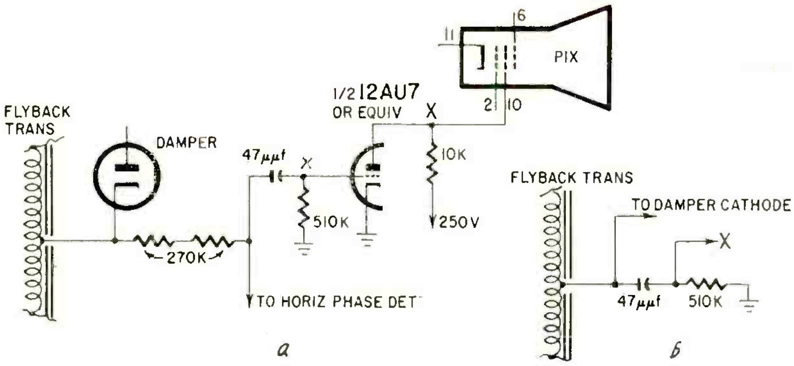


Fig. 5—Blanking circuit that eliminates halos and retrace lines. a—for use in phase-detector type horizontal circuits; b—for use in sets with Synchroguide horizontal circuit.

Halos caused by the porch level appearing during retrace.

The solution to the halo problem is to cut off the CRT during retrace. In this way, as long as the retrace time stays inside the front and back porches, there can be no halo, as the retrace can cause no video information.

Normally, we would keep a tube cut off by applying a pulse to its cathode. However, in the modern TV set, video is applied to the picture-tube cathode. Any sweep pulses fed to this cathode would reduce video output and affect the set's sync.

The control grid cannot be used either. Vertical blanking pulses are usually fed to this grid and horizontal pulses cannot be added without keeping electrode impedance high at 15,750 cycles. The result would be horizontal ringing in the picture.

Because of these problems we decided to apply negative pulses to the screen grid of the picture tube. Fig. 5 shows the circuit we use. It also eliminates retrace lines.

The 12AU7's plate connects to the CRT screen. Its grid is fed pulses from the flyback through a simple R-C network. These pulses keep it cut off during the normal scanning period. While it is cut off it has no effect and the CRT operates normally. However, during horizontal retrace the triode conducts, lowering the voltage applied to the CRT screen enough to cut off the tube. We used a 12AU7 since the other half of the tube was needed for another purpose. However, almost any medium-mu triode can be used with the same results. END

TV Service CLINIC

conducted by

JACK DARR

THERE is a drastic difference between *hum* and *buzz* in the sound section of a TV set, although the two might be confused at times. Hum, per se, is a smoother sound and should be familiar to all technicians. The basic hum waveform is a sine wave, as it originates in the power supply

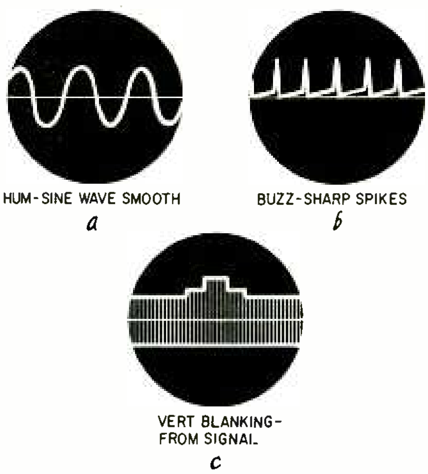


Fig. 1—Hum and buzz waveforms: a—hum, a sine wave; b—buzz, sharp spikes; c—sync buzz from an overloaded if stage.

or in heater–cathode leakage in some of the tubes. In either case, the root would be in the 60-cycle power supply voltage, and it would have the sine-wave form (Fig. 1-a).

Buzz, on the other hand, can come from quite a few places and assumes quite a few different shapes. The most familiar buzz is caused by overloading in the if amplifier (through some fault in the agc network or supply). It has a rough or raspy sound. The waveform (Fig. 1-b) shows why. There is a bit of a problem in differentiating, by ear alone, between buzz pulses originating in the sync or video if stages, and those coming from the vertical sweep circuits. It takes a scope to show exactly which is which.

If the trouble is sync buzz from an overloaded if stage (Fig. 1-c), it will quite obviously have the shape of the vertical blanking pulse from the TV signal, which it is! There are two quick checks for this: Remove the antenna connector. If the buzz stops, it was probably from the signal. If it is still there, it must be from the vertical oscillator. The second check is to move the vertical hold control while listening to the buzz or watching it on the scope. If the frequency of the buzz changes with the position of the hold control, it must be originating in the vertical output or oscillator stages. (Check those electrolytics!)

Another prevalent source of buzz is the vertical blanking signal at the picture tube which is related (though distantly) to the high voltage. Turn the brightness control up and down; if the buzz amplitude changes, the sound is coming from the stray fields around the picture tube and high-voltage supply. Shielding is the best cure for this, the buzz must be kept out of the signal circuits.

The origin of the buzz signals can be identified by their characteristic shape on a scope. Apply the scope to different stages of the audio circuit. Buzz pulses can even be found in the 4.5-mc sound if in the form of AM on the FM sound signal.

Agc trouble

I've recently purchased a junked TV set, an old Admiral 21Z1, in which the sound and picture will come on temporarily then go out. Removing the agc-keyer tube brings back the sound and picture. Measuring voltages, I found that with the keyer tube in, grid voltage on the first and second video if's goes to −20 volts, and the voltage on pin 5 of the keyer tube goes to about −45 volts. Resistance measurements on the tubes are normal. Pin 1 of the keyer tube is about 30 volts high. The raster is always present. I have substituted filter capacitors and decoupling capacitors in the agc circuit without results. Am I working in the right section? What would the cause of this trouble be?—W. L. B., Des Moines, Iowa.

You're certainly in the right section! This is undoubtedly agc trouble. You'll probably find the trouble in or around the 6AU6 agc-keyer tube. From the voltage readings given on the 6AU6, the tube is not operating correctly. The −45 volts on the plate should be about −0.3 volt. Check C316, the .001-μf capacitor between the keyer plate and the width coil, for leakage or open circuit; R331, the 270,000- or 220,000-ohm resistor between grid and screen of the 6AU6; R333, 150,000 ohms, on pin 5, and the 145 volts on pins 2 and 7, the cathode and suppressor. Defects in R319 and R338, the parallel combination of 7,500 and 3,000 ohms, at the 145-volt source, could also give trouble.

If you have a scope, check the keying pulse at the plate of the 6AU6. This should measure 320 volts peak to peak. There should also be 55 volts peak to peak of signal at the grid. If either of these is too far off, you will have this trouble. Clamp the agc line with a 3-volt battery, and check the signal at the grid.

Lack of detail

We have recently converted an RCA model 21T207 from a 21AP4 to a 21ZP4-B. No circuit changes were necessary although I did change the damper tube from a 6W4-GT to a 6AX4-GT. Brightness and contrast are OK, but the picture lacks detail. "Drive" lines are present when the brightness is at a comfortable viewing level. I would appreciate any hints or circuit changes which would be useful in remedying the conditions I have stated.—L. P. C., Spokane, Wash

I don't see anything in your conversion itself to cause this trouble, as the two picture tubes are electrically identical. Therefore, your trouble would lie in some part of the video circuits—tuner, video if, video detector, or video amplifier.

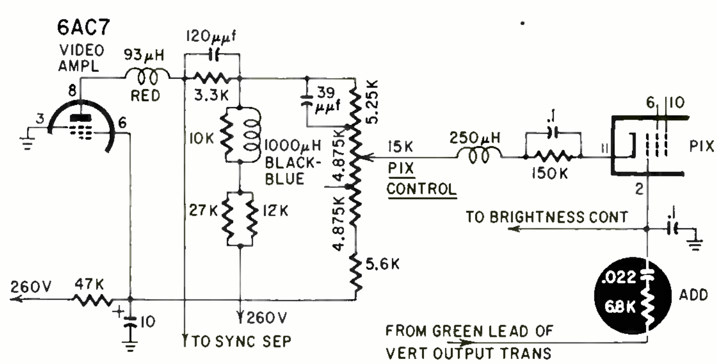


Fig. 2—Video amplifier circuit of RCA 21T207. Adding resistor and capacitor eliminates retrace. For loss of details in picture, check all parts shown, especially peaking coils.

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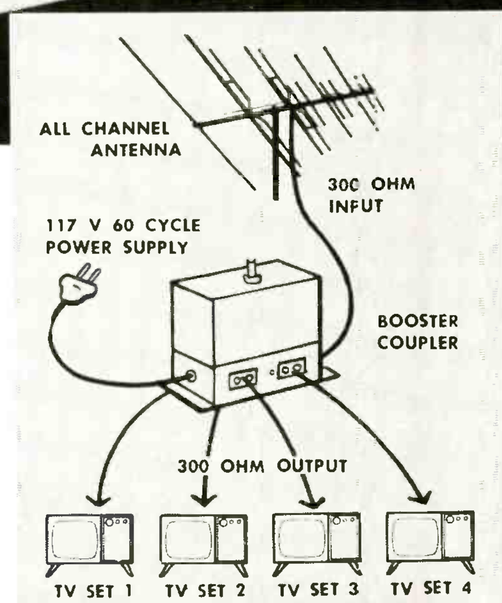

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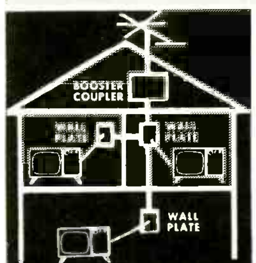

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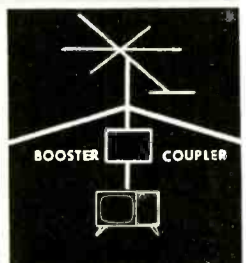

A 1-4 set signal amplifier—perfect set demonstrator for your store

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TELEVISION

This is quite common in the older series of TV chassis of all makes. If you'll check (preferably by substitution) *all* the tubes in that string, you'll very likely find some of the original ones! They are quite apt to be weak, leaky or shorted after years of use. Replace all that show less than 50% of normal transconductance and recheck the set.

Check the settings of the ion-trap magnet and the focus magnet until both are exactly right. Most of these chassis used PM focusing units and these will inevitably interact with the ion trap to a certain extent. Adjust both (also the picture centering magnet) until the scanning lines are at their brightest and best focus, on a blank raster.

If picture detail is poor, especially on thin vertical lines, check the peaking coils and resistors in the video amplifier plate circuit (Fig. 2). This series uses combination shunt-series peaking and an open or short in one of the peaking coils would cause a severe loss of fine detail. This will also result in upsetting the dc plate voltages on the video amplifier tube. Check the agc circuits for leaky capacitors, increased-value resistors and for proper agc action on a fairly strong signal.

If you have drive lines in the picture, back off the horizontal drive control until they just disappear. However, from the phrasing of your letter, I have a feeling that you are referring to vertical retrace lines (especially since this chassis does not use a vertical retrace eliminator and is prone to showing retrace lines if the picture controls are not set exactly right). To eliminate these permanently, connect a .022-μf capacitor in series with a 6,800-ohm resistor from the green wire on the yoke plug (the center of the vertical output transformer) to the grid of the picture tube, pin 2. This should take them out for good.

Marker generator trouble

My sweep and marker generator does not provide what I consider a usable marker. Perhaps it needs some adjustment that the average shop cannot handle.—R. C. S., Jr., Troy, N. Y.

A good way to check the marker output voltage is with a field-strength meter. Connect the generator output to the input terminals of the meter. Using the generator on marker output only, tune the generator and meter successively through the low and high channels. At least 20,000 μv is desirable for marking, and up to 100,000 μv is useful in tuner alignment. The generator output cable must be properly terminated to get flat output on all channels.

Hot flybacks

The flyback of a Silvertone 132.045-5 TV burns out about every month! This is the third one, and now it is burning up. Can you recommend a replacement that won't burn out?

Also, I can't find a replacement part

for a Sentinel 1U-1124, the first sound if coil. Can you give me the number of a replacement for this?—D. W., Medina, N. Y.

A Triad type D-19 will replace the flyback in the Silvertone. The original part number was N24989, wasn't it? But before making any further replacements, I would give this chassis a very careful cold check. Test the electrolytics, the output and damper tubes, the yoke and everything about that circuit. Such short life on the flyback indicates a severe overload, probably an intermittent condition.

If nothing shows up on the cold check, replace the flyback and measure the horizontal output tube (6BQ6) plate current. This should be slightly less than 100 ma. From the symptoms you give, I expect you'll find it slightly more than this value. If the flyback is running too hot, it will break down in a short time. Check your horizontal linearity adjustment and set it for the dip in plate current. Check the screen voltage of the horizontal output tube and reduce it, if necessary, to get that plate current down to normal.

I'm a bit confused about just which "sound if" coil you need. If it is the *sound takeoff coil*, in the video amplifier plate circuit, you can use a Miller 1469. If it is the interstage transformer, use a Miller 6203. These two coils can be used in any circuit of this type.

Vertical white line

I have an RCA KCS-68 chassis with no horizontal deflection at all. All I've got is just a vertical white line in the center of the screen. I checked the deflection yoke, linearity and width controls, and put in a new flyback transformer. Voltages check OK except for the two damper tubes, which have 340 volts on both plate and cathode. I'll appreciate any information.—H. J. S., York, Pa.

This trouble is in the yoke. You have at least three clues which point to this. First, the absence of horizontal deflection, although you do have enough high voltage to make the vertical line. (This is mildly unusual, as yoke troubles usually result in a complete extinction of the raster.) Second, the damper voltages. If the "flyback pulse" from the yoke was coming through as it should, you'd have boost voltage. Complete lack of boost shows trouble somewhere in the yoke. Third, you have replaced *everything else* that could be causing this trouble; ergo, there is only the yoke left. So, by a process of elimination, you have a defective yoke! Check the whole thing very closely before you replace it. I knew a technician (my wife's husband!) who once spent quite a while checking an obviously defective yoke, at the yoke terminals, only to find later a wire broken at the yoke plug! So, as this set has a yoke plug, look that over closely, as well as all other sources of trouble, R-C network, etc. before replacing.

Side-convergence troubles

Two RCA CTC7A color TV chassis on my bench have the same trouble. In making convergence adjustments with vertical bars, the blue tends to be on the right side of the bars on the left side of the screen, and on the left side of the right-hand bars. Purity is good. The blue amplitude and tilt controls move the blue dots up and down in the middle as they should, and the right and left blue controls move the lateral blue lines up and down as they should. The dynamic controls move the blue properly, and the blue moves up or down, but I can't get the sides of the screen converged. If it's OK on one side, it's out on the other!—T. M. D., Fort Lauderdale, Fla.

There were several changes in this chassis, as compared to the CTC5 series, especially in the convergence section. Several of the controls have been combined. The control RG-2, for example, moves both red and green at the sides of the screen.

Fig. 3 is a sketch of the convergence-board assembly. This is the proper convergence procedure:

After completing your vertical convergence adjustments, set the generator for a cross-hatch pattern with the finest lines obtainable. Recheck center convergence. Now adjust B-1 (L801) to make the blue lines at the right of the screen *straight*. Adjust control B-2 (R805) to make *straight* blue lines at the left side. If the lines cannot be straightened, move the clip between W and 4, on the back of the convergence board, to 4 and G.

Now adjust the coil RG-1 (L802), to converge the vertical lines at the right side. Check coil RG-2 (L803) to be sure that the horizontal lines at the right are converged properly. Check coil B-1, to make the blue fall on the red–green lines. Retouch RG-1, if necessary.

Adjust RG-3 (R806) to converge the vertical lines on the left. Adjust RG-4 to converge red–green horizontal lines, at the left. If you're unable to get full convergence on the left side with these adjustments, change the clips on the back of the convergence board: Move clip from 8 and G to 8 and V. Move clip from 12 and G to 12 and W. Now repeat the adjustment of RG-3 and RG-4, and you should have ample range to get the proper convergence.

The cause of the trouble here was not the blue lines themselves, but the fact that the red and green lines were not meeting them at the proper place.

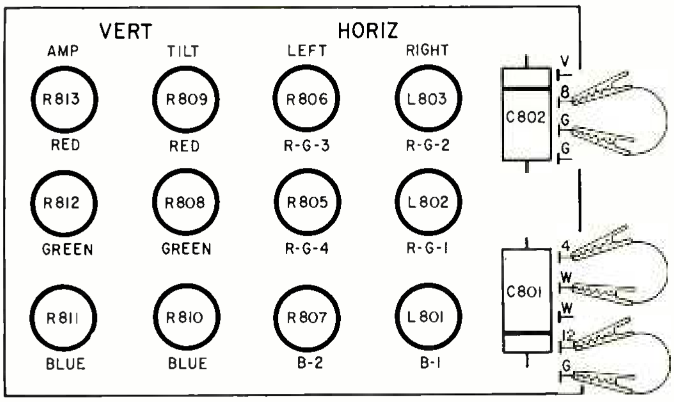


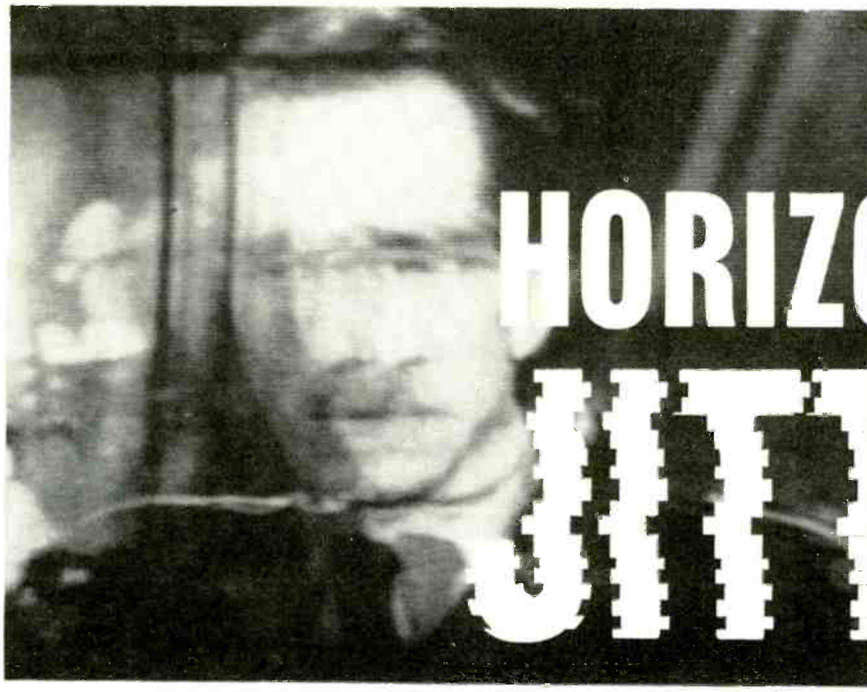
Fig. 3—Printed-circuit convergence assembly of CTC7A. Certain terminals on the right side of the board are interconnected by clips.

That's a pretty general rule for all convergence procedures: set up the blue, then move the rest to meet them. If any final touching up is needed, it can be done with the static adjustments.

Bad horizontal oscillator

On a Capehart 14F215 TV, the horizontal oscillator operates at a lower frequency after the set warms up. A white vertical line about 2 inches wide shows on the raster a little to the left of center, and a whistle is heard. Disconnecting the horizontal oscillator signal from the grid and applying an outside driving signal clears up the trouble, except for the loss of horizontal sync. The raster is OK. I have substituted several parts, including the ringing, width and keyer coils and the tubes. I removed the vertical sweep tubes and noticed the same horizontal waveform on the scope.—W. J. F., Baltimore, Md.

You had the clue in the horizontal waveforms which showed up with the vertical sweep disabled. This has shown up in several sets lately and puzzled several technicians until the cause was discovered. The trouble is probably a lack of decoupling in the B-plus supply. Check *all* electrolytics in the filter system, especially the output filters, for loss of capacitance or high power factor. You will probably have to disconnect each one and shunt it with a good one to make a conclusive test. If the power factor *has* gone bad on a filter, just bridging it with another one will not always clear up the trouble. The suspected unit must be completely out of the circuit and a good one in. Another possibility here would be leakage between two sections of a multiple electrolytic. Using the scope at a horizontal sweep frequency, check the B-plus supply lines for traces of horizontal pulse. Even at 60 cycles the horizontal sweep shows up as a distinct fuzz on the trace. END



STOP HORIZONTAL JITTER

Fig. 1—Jitter with long flutter rate. Displacement to right persists for several consecutive fields.

A common fault that careful trouble-shooting will make short shrift of

By LAWRENCE SHAW

SUDDEN sidewise shifts of a TV picture (or raster) are characteristic of horizontal jitter. The entire screen may be involved or only sections of horizontal lines. The second image may be equal in intensity but is usually weaker, resembling a ghost. Jitter is distinguished from ghosts by the back-and-forth jump or flutter.

The rate of shift can be rapid or very slow. A slow jitter may look like Fig. 1. Here the picture is displaced to the right for several fields and returns to its normal starting point on the left for a few fields. The intensity of the double image is proportional to the length of time spent in each of the two fields.

A rapid jitter may present only a confused jumble of lines. The horizontal shift can be seen only on close inspection. Such a picture closely resembles the multiple overlapping of images produced by too high a horizontal frequency.

Causes of jitter

Instability of the horizontal sweep is the underlying cause. Any part of the sync system from the transmitter to the horizontal output tube in the receiver can be at fault. As an example let's take one type of jitter which occurs frequently and see why it happens.

Ghosts from reflections, either transmitted-wave or lead-in, produce visible symptoms in the form of a second picture (or ghost). More important is the presence of a second sync pulse in the composite video signal (Fig. 2). The "ghost" pulse will try to trigger the horizontal oscillator just like the true pulse. Despite the afc system, the oscillator will often try to lock on to both pulses. If both pulses can make the horizontal oscillator waver between them, we get horizontal jitter.

When the horizontal oscillator is triggered by the true pulse, horizontal sweep starts farther to the left, as shown in Fig. 2. When the spurious second pulse takes control, the horizontal lines start farther to the right. The type of displacement shown by Fig. 2 causes tearout of sections of lines—not a complete tearout, but part of the picture is displaced to the right. If the horizontal oscillator locks onto the false pulse for half the time, we would get an effect similar to that in Fig. 1. A number of fields will start at the extreme left in response to the true sync pulse of the direct signal. Then some fields—not necessarily the same number, and usually less—will start farther to the right in response to the spurious or false pulse.

The vertical ghost pulse may not be strong enough to trip the vertical oscillator because the long time constants of the integrator network tend to prevent this condition. Therefore, vertical instability may or may not accompany horizontal jitter.

The ghost can be seen on the TV screen. The presence of the false sync pulse may be observed on a scope connected at the video detector. As a final check, switch the TV set to a channel which has no ghost or a much weaker one. If a ghost pulse was the trouble, jitter will either disappear or become less evident.

To cure horizontal jitter caused by ghosts, get rid of the ghost—try antenna orientation, a more directional antenna, matching the transmission line, etc. If the tuner picks up too much

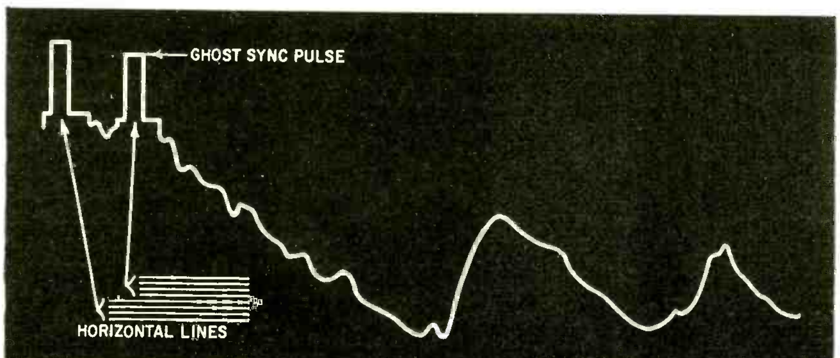
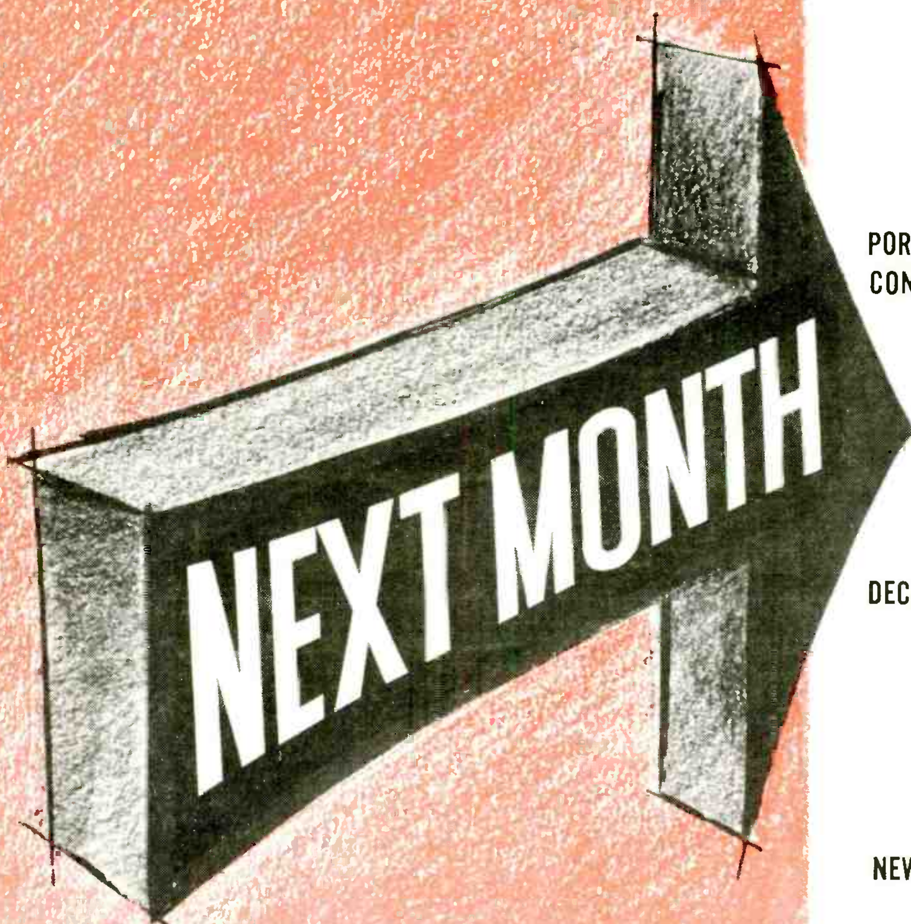


Fig. 2—Relation between spurious sync pulses and displacement of sections of horizontal lines.



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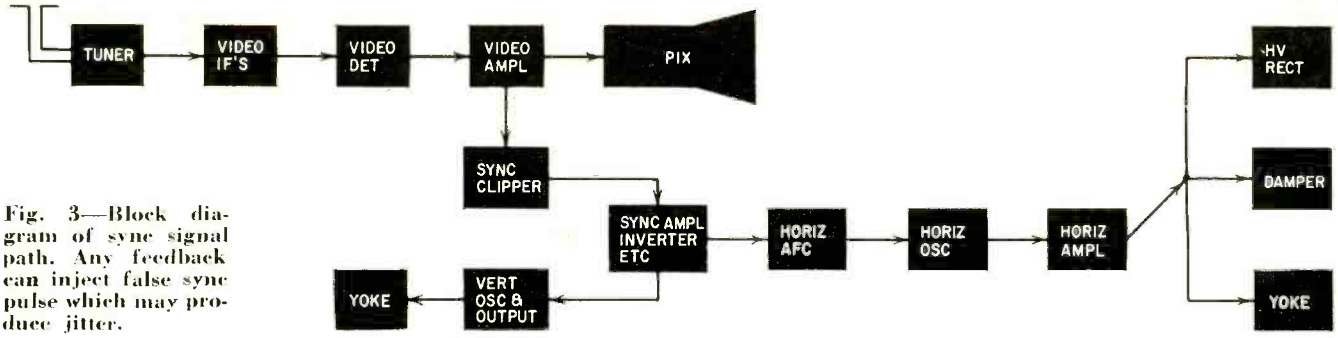


Fig. 3—Block diagram of sync signal path. Any feedback can inject false sync pulse which may produce jitter.

signal directly, it can cause a ghost. This kind of ghost pulse may lead the true pulse and the image will be displaced to the left rather than the right.

If the jitter from a ghost cannot be eliminated by getting rid of the ghost, careful adjustment of the horizontal oscillator's frequency and hold controls will help. Also check the afc circuit and put it in the best possible operating condition. Check the sync circuit for proper clipping action with a scope. A slight change in the clipping level will often clip more of the false pulse than the true one and the jitter may be removed. These ideas should be applied only if conventional methods fail to rid the set of the ghost pulse.

Internal false sync pulses

Closely allied to jitter caused by an external ghost is jitter caused by false horizontal sync pulses produced in the TV set. Such false pulses are produced in two ways:

- Injection of a false pulse back into the set at some earlier stage.
- Production of a spurious pulse by regeneration.

Other causes are pulses that are similar to false sync pulses—video information that has not been clipped properly in the sync clippers or strippers. Peaks of video information near the black level can act as such false sync pulses if they occur near the horizontal sync pulse. This trouble can be detected by noting that the jitter occurs only when black portions of the picture are at the extreme left or right edges. (Move the picture sidewise so you can check the edge.)

Adjust the sync stripping action to remove the picture information more completely to cure this type of jitter. A scope will reveal video information in the supposedly stripped sync.

Injection and regeneration can occur at any stage or over any number of stages wherever the sync signal is present in its normal passage from antenna to the horizontal sweep circuits. Fig. 3 is a block diagram showing these stages. A common cause of jitter is injection of the horizontal sweep into the antenna circuit, caused by dressing yoke leads too close to the transmission line or tuner. The remedy is obvious—move them away. The yoke–antenna path shows how the horizontal sweep—although on frequency—will produce a delayed pulse if injected back into the set. A similar trouble can arise if the yoke leads are too close to the first, and even the second, video if stages.

The lead to the driven element of the picture tube carries a high-amplitude composite video signal. Naturally, it contains high-amplitude sync pulses. And if this lead runs too close to the yoke leads or to earlier stages of the set, a false sync pulse and horizontal jitter may be produced.

Injecting sync pulses from a sync stage into an if stage can cause jitter. Fig. 4 is an interesting example. A sync screen bypass capacitor C1 and agc filter capacitor C2 are connected to the same ground lug. The solder was not applied to the lug, so only the ends of the capacitor leads were really soldered together. The contact resistance R_x of the leads to ground was often high and resulted in the circuit shown in Fig. 5. The sync fed directly through to the agc line and the grid of an if tube. Once this ground was resoldered, the set worked perfectly. The sync no longer modulated the composite if signal.

Regeneration in the video amplifier or in the if will produce a delayed pulse. The mixer can be considered an if amplifier in this sense. And the mixer acts like an rf amplifier as far as the previous rf tube is concerned. Regeneration anywhere along the line followed by the sync may produce a spurious pulse and jitter.

Frequency shifts

One kind of jitter results from changes in the horizontal frequency which are not caused by a false pulse. For example:

- A resistor that changes value.
- A capacitor that changes value and affects the horizontal frequency.
- A loose coil in a shielded can in some types of oscillator circuits.

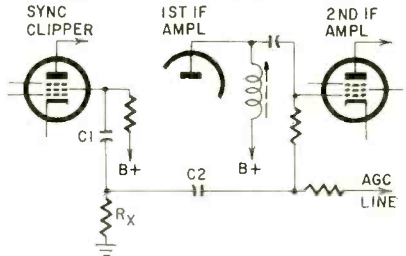


Fig. 5—Partial schematic shows what bad solder joint did.

- Partly shorted turns in a ringing coil (sometimes called a phasing coil) in a multivibrator plate circuit.

Troubleshooting external ghosts is simple—we can see the ghost on the picture and infer the presence of the false sync pulse. We get rid of the

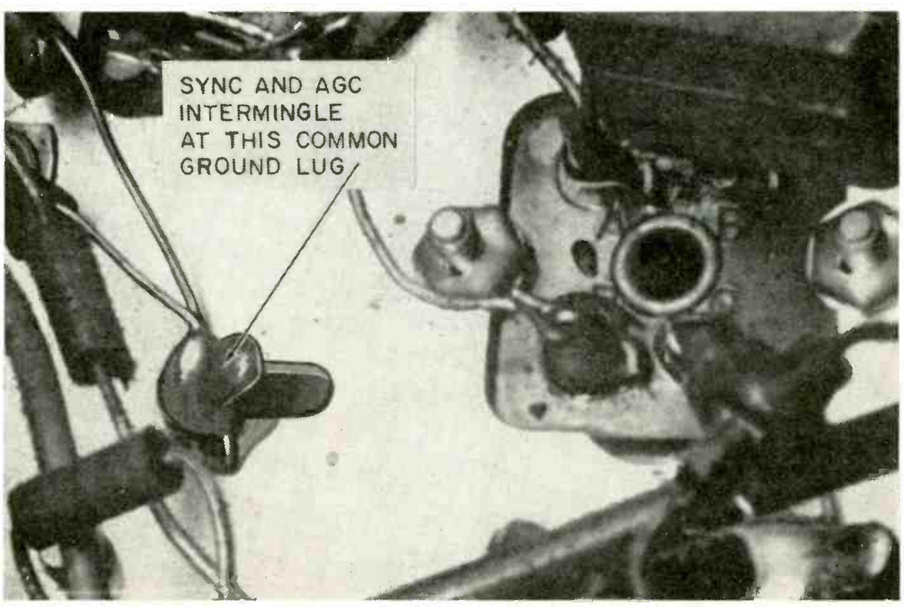


Fig. 4—Poorly soldered joint on common ground of a sync and an agc capacitor pair resulted in jitter. Sync fed into agc and if grids.

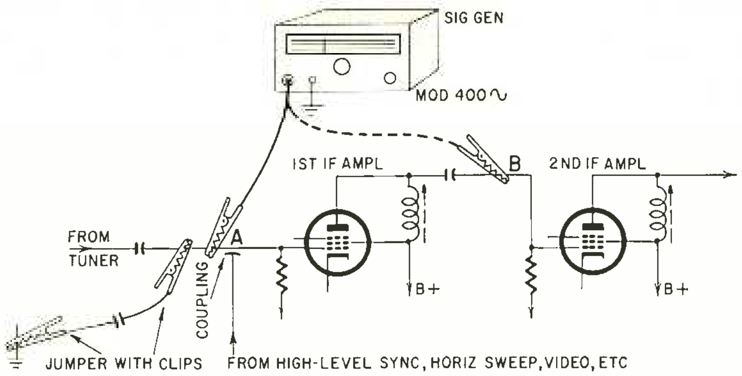


Fig. 6—Grounded-grid signal injection technique for localizing entry point of the spurious signal.

spook and the jitter at the same time.

Localizing frequency shifts is simplified by observing the raster and comparing it with a picture. If the raster jumps—jitters—particularly if the set is shaken or jarred, the trouble is somewhere after the sync takeoff from the video stages. We may suspect a shift in horizontal frequency (unsynced) or feedback from a stage after the video into one ahead of it.

With a picture present, the presence of a false sync pulse is readily seen on a scope connected at the video detector. The picture may flutter, but the fluttering pulse is definitely established at this point. Since the contrast control is in the video section, it varies the video gain and the amplitude of the sync, if taken off after the stage controlled by the contrast control. Less sync amplitude means less feedback and this often furnishes a clue. If sync is removed prior to the stage which contains the contrast control, this test fails.

A trimmer capacitor can be installed from the sync line to ground temporarily. Some sets have such a trimmer as a sync lock range control. It works by bypassing some of the sync signal to ground or B-minus, reducing sync amplitude. If such a reduction (by varying the trimmer) makes the jitter disappear, some stage following it must be feeding energy back into an earlier stage. (Excessive sync input is another possibility. If so, just adjust the trimmer and leave it in the circuit as a permanent cure.)

Break the sync feed to the afc and sync the horizontal oscillator manually with the hold (or frequency) control. If jitter persists, on *either* raster or picture, the trouble is in the horizontal system somewhere after the point of the break. Feedback from the horizontal sweep circuits into preceding portions of the set can be uncovered by this method.

At this stage of troubleshooting, check the grid waveform of the horizontal amplifier. Sync the pix manually. No jitter of the wave should show if the trouble follows the horizontal amplifier. If present, search for the cause at the input (to the horizontal amplifier) or ahead of it.

This check will distinguish some cases of pseudo jitters caused by intermittent components in the horizontal output circuit. These are:

- Loose slug in linearity coil or width control.
- Defective yoke section
- Defects in the centering controls and circuits
- Loose flyback windings. Often, these jitters are excited by microphonic action caused by the speaker. The test may fail if the waveform is fed back to the horizontal afc for comparison and the oscillator is not held in sync manually.

If the trouble is likely to be found in the if or front end, we may go into these stages with an rf probe and scope. At some point we will find the injected or otherwise generated false pulse. By doing so, we localize the stage into which it is injected (or produced) and can give it a thorough going over.

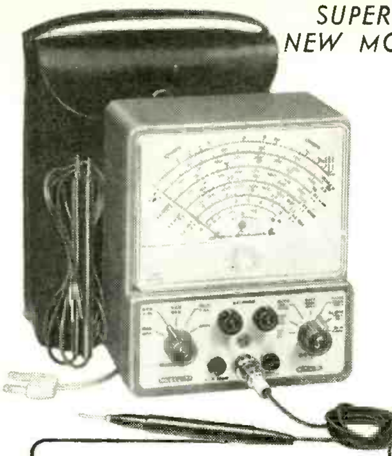
Alternatively, use a signal generator to inject a signal into each rf and if grid in turn. The generator is amplitude-modulated in this test—rf injection without modulation will not furnish a sync signal. The grid of the preceding stage is grounded with a jumper, or a large capacitor.

For example, suppose we are checking the circuit shown in Fig. 6. If jitter is produced with the signal generator's output at point A, but not at B (grid of first if grounded), we can assume trouble in this if stage. It might take the form of the gimmick coupling shown (a horizontal yoke lead too close to the grid of the first if, etc.).

Sometimes the feedback is along B-plus or avc lines. A quick test is to shunt each bypass capacitor to ground here. Use a 0.1-μf 600-volt capacitor.

Sometimes jitter is caused by too long a time constant in the anti-hook filter in the horizontal afc control lead to the horizontal oscillator. If so, suspect a change in value of the resistors. Shunt each one with a potentiometer and vary it. If the jitter disappears, you have localized the trouble. Do not use too low a value of resistance as a replacement unless a check is made to see that hook (pulling at top of picture) is not the result of this modification.

After removing the jitter, retune the horizontal oscillator and any stability controls associated with it. Check all channels after completing the job. END



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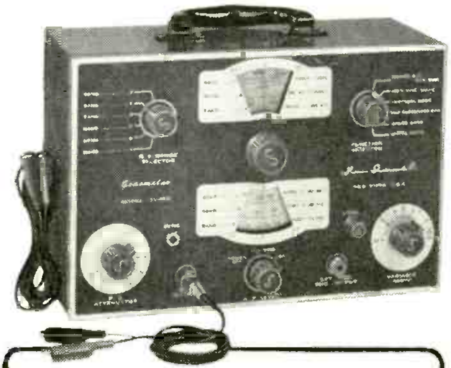

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MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc.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

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

$47.50 NET

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

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Model TW-11—Tube Tester
Total Price $47.50
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★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
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★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

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

EXTRAORDINARY FEATURE

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

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

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Multi-Socket Type TUBE TESTER

Model 82A—Tube Tester
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TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

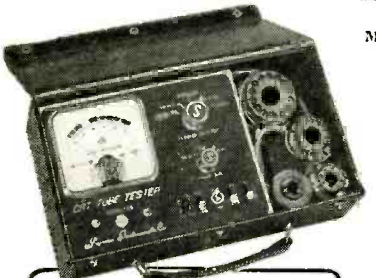
SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously

Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.
To test any tube, you simply insert it into a numbered socket as designated. turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only $36.50



SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES

Model 83—C.R.T. Tube Tester
Total Price $38.50
Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

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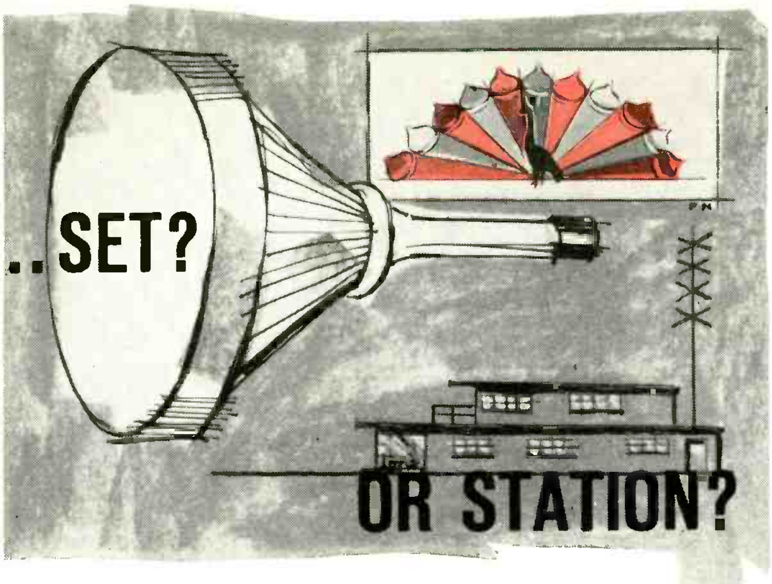


Causing your COLOR TV TROUBLES?

By JACK DARR

ALMOST all color TV troubles originate in the receiver. But something does go wrong at the transmitter every now and then. This can complicate spotting the fault, unless the technician recognizes the defect for what it is. Let me say right now that this *is not a criticism of transmitter engineers*. Most of them are highly skilled, conscientious men. But equipment does fail, as any operating engineer will testify.

I will describe and identify these troubles, by symptoms, so the service technician can recognize them and distinguish receiver faults from transmitter troubles. In addition, this may give TV technicians some idea of the tremendous amount of work it takes to deliver the almost perfect pictures we see every day. (It may help cut down on some of the nuisance calls to the control room, too!)

TV stations are checked continuously. The FCC demands regular records on the performance of every piece of equipment which could possibly affect signal quality. Most tests are made weekly, and a very thorough complete check of the entire installation (called the "Proof of Performance" tests) is made once a year. Hourly logs of all meter readings must be kept by the operators and be available for inspection by FCC field engineers at any time.

The competent chief engineer of a TV transmitter keeps this high standard of performance through constant maintenance work on his equipment and by making many tests, which will be described later. However, error will rear its ugly head occasionally, for miscalibrating even a minor piece of equipment can cause large errors, which may go unnoticed. For this reason, the chief engineer is always grateful for *genuine* trouble calls.

Color transmitter tests

Color TV demands the most exacting adherence to performance standards. Unless the TV transmitter and every piece of its associated equipment are absolutely perfect, color reproduction will be distorted. Even a very slight droop in the overall response curve, especially around 6 mc, can attenuate the color burst and ruin reception. As one engineer said, "Quite frankly, it is possible to get by with murder in black-and-white and still come up with pretty fair results. But a transmitter correctly adjusted for color must come up with a beautiful black-and-white picture!"

Here are a few of the tests and measurements made on color TV transmitters *in addition* to the standard frequency, power output, sync and modulation-percentage tests made on monochrome. They are: amplitude vs frequency response, differential gain or gamma, differential phase, and envelope

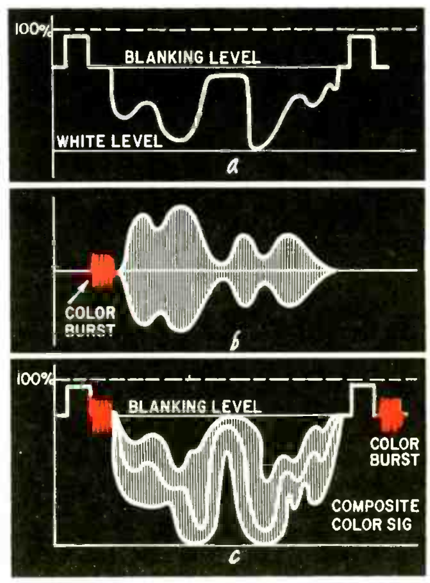


Fig. 2—Transmitter signals: a—standard monochrome video; b—color information corresponding to the modulation in a; c—completely modulated color TV signal with color bursts and amplitude variation.

delay. Each of these, if not exactly correct, can produce trouble.

Amplitude vs frequency response

The amplitude response of the transmitter must be absolutely uniform (flat) to all signals in the video range, up to and very definitely including the color subcarrier—beyond 6 mc, in fact. In other words, there must be no frequency-sensitive elements in the transmitter that could attenuate any frequency as the signals pass through.

This is tested by using a sweep generator and oscilloscope sideband analyzer. The scope produces a 60-cycle sweep display that shows the amplitude response of the visual transmitter. The range of the input sweep carries the signal from well below the video to well above the audio carrier.

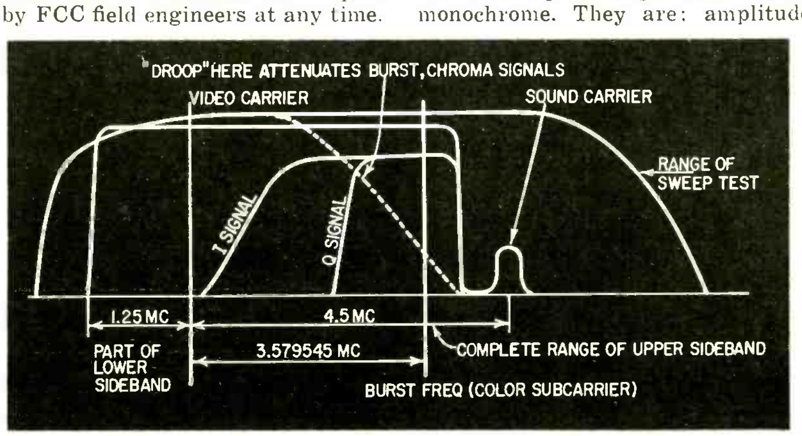


Fig. 1—Vestigial-sideband carrier produced by modern TV transmitter.

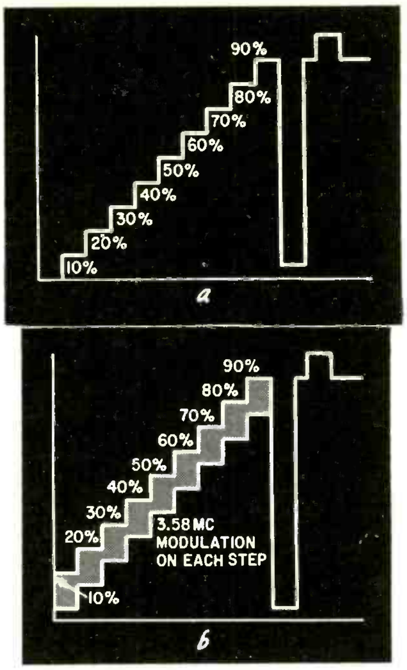


Fig. 3-a—Waveform from a staircase generator used to check transfer characteristics; b—same waveform with 3.58-mc burst signal.

The modern TV transmitter produces a vestigial-sideband type of carrier (Fig. 1). All video information is in the upper sideband. If the amplitude of this sideband is not uniform, the higher-order modulation product can be attenuated severely, resulting in a loss of the higher frequencies which contain the chroma information and the subcarrier burst.

Since the color subcarrier's amplitude determines the saturation of the color being transmitted, any amplitude nonlinearity causes trouble. For example, if the transmitter droops at the high end, colors whose carriers are in that vicinity will be paler and washed out compared to colors which lie in the lower-frequency regions. While color information is carried on both amplitude and phase relationships, trouble in either one causes improper color rendition.

Droop at the upper end (dashed line in Fig. 1) also attenuates the burst. The sharp spike at the right of the video carrier curve is the sound carrier and is furnished by a separate transmitter, so it does not affect the video transmitter. It is shown merely as a reference point. For best results, the video transmitter should be flat to a point well beyond the sound transmitter's frequency.

Differential gain—gamma

One absolutely necessary condition for perfect color transmission is that neither the amplitude nor phase of the chrominance signal be changed by the luminance signal. Also, the luminance (brightness) signal must not be changed in any way as it passes through the transmitter. This is known as the differential gain (or gamma) of the system and simply means the response (gain) of the transmitter to signals of differing levels passing through it. For example, if the transmitter had a gain of 50% for signals at a 50% amplitude level, and a gain of 70% for a signal of 90% of amplitude, the differential-gain factor would be very bad!

Poor differential-gain factors cause compression and stretch in monochrome transmitters. It affects color transmissions even more, because of the tremendous number of signals the equipment must carry simultaneously (Fig. 2). A standard monochrome video signal with sync pulses is shown in Fig. 2-a. Color information corresponding to the modulation in Fig. 2-a is shown in Fig. 2-b. Fig. 2-c is the corresponding waveform of a completely modulated color signal, with color bursts and the variation in amplitude drawn out. The central line of the modulated signal shows the average values of the Y, or brightness signal. This value is used by monochrome receivers to make a picture. As you can see, the average value of the rf modulation from the color signal at any given instance is approximately zero, compared to the amplitude of the brightness signal. Therefore, color signals do not affect monochrome sets.

Poor differential gain also causes saturation errors in color transmission. If the amplitude of a color signal is distorted in passing through the transmitter, its relationship to its hue and brightness signal is changed and the transfer characteristics are incorrect. It shows up on the receiver screen as pasty faces with no color or shading, bad flesh tones, etc. Even in black-and-white transmissions, it can cause wash-out of highlight areas such as faces.

A very interesting method of checking this is used by engineers. A staircase signal representing equally varying levels of modulation is passed through the transmitter (Fig. 3-a). Superimposed on each step is a 3.58-mc subcarrier frequency (Fig. 3-b). Each step represents a 10% increase in modulation for the transmitter. On the bottom step, the transmitter is 10% modulated, on the middle step 50%, and on the top step 90%. Thus, the system's response is measured at every practical level of modulation. Each step is carefully set for equal amplitude.

The resultant signal is picked off the rf transmission line to the antenna. It is demodulated (by a very linear detector!) and fed to an oscilloscope through a high-pass filter (Fig. 4). The filter takes out the low-frequency staircase component of the signal and leaves only the modulation (the 3.58-mc subcarrier frequency). The result should be a perfect rectangle on the scope screen (Fig. 5). Any nonlinearity of the modulation appears as a change in the long sides of the rectangle. A decrease in amplitude makes the figure trapezoidal and indicates compression somewhere in the system. Needless to say, all elements used in this test must be perfectly linear if the results are to be of any value.

Differential phase

This type of distortion can be measured with the same equipment as the preceding one, with the addition of a phase shifter. We compare the signal from the transmission line (through the high-pass filter) to a reference 3.58-mc signal which is 180° out of phase coming from the signal generator which produces the modulation. This reference phase is shifted to produce a null. The number of degrees needed to produce the null indicates the phase shift for that component level of the staircase. It must never be more than ±10° for any step.

This measurement is very important. The phase distortion it can cause affects the relationship of hue to burst, and green faces and purple people become a gruesome reality! It can be caused in transmitter systems by improper inductances in tuning circuits, excess or insufficient capacitance in others, stray wiring capacitance, improper tube operating voltages and several other things!

Another way to make the same measurement uses a 90° phase shifter and a phase detector. Over a reasonable operating range, the phase detector can compare the two signals, and its output is proportional to their difference. The display oscilloscope can be calibrated to be direct-reading, giving the amount of phase shift for each level tested.

Envelope delay

Here is a type of distortion caused by nonlinearity in the system's phase characteristics. It allows different components of the composite video signal to pass with varying amounts of time delay. This distorts the vital relationship between luminance and chromi-

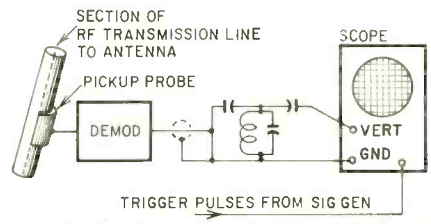


Fig. 4—Hookup for checking differential gain at the TV transmitter.

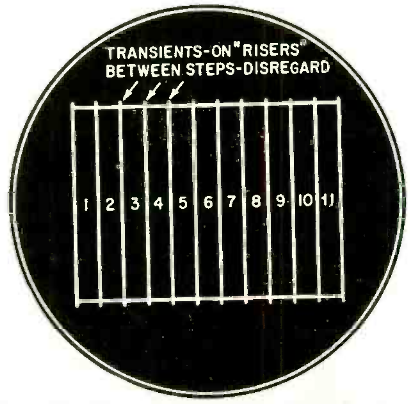


Fig. 5—Scope display with hookup shown in Fig. 4.

nance signals and causes color fringing and ringing.

The symptom is known among engineers as funny-paper effect because of the misregistered colors. The picture looks like a funny-paper whose colors have not been printed exactly where they should have been.

The causes are excessive vestigial-sideband attenuation of the transmitter, the lower sideband characteristics of the *receiver*, and excessive high-frequency rolloff in the region of the sound carrier in both receiver and transmitter. It can make trouble even in monochrome transmissions.

Corrections at the transmitter

At the TV transmitter, a correction is applied to the color signal to prevent overmodulation. (It has been discussed in every color TV textbook ever written, so we'll not go into detail here.) Briefly, it makes the resultant of the two curves, transmitter and receiver, come out to an ideal response curve and all frequencies are reproduced exactly alike.

One problem at the transmitter is chroma clipping. It occurs when high-level chrominance passes into the buffer region and is clipped out. The result is a loss of color in the clipped portion, usually a highlight such as a person's forehead—it turns white where it should be flesh-colored. It is similar to the white compression mentioned in the section on differential gain. It can also happen if the receiver's video amplifier is not quite up to snuff. A weak or gassy tube can cause a very similar symptom, even in monochrome pictures. Therefore, check everything in the video section first!

Troubles in receivers

There is one infallible method of finding out whether the trouble is in the receiver or the transmitter—tune to another station. If the same defect shows up, the fault is almost certainly in the receiver.

Sync–video difficulties

One ever-present possibility for transmitter trouble is in maintaining correct sync–video ratio (Fig. 6). This ratio is displayed on a monitor scope on every transmitter control console. If the station has a remote studio connected to the transmitter through a microwave link, the sync–video ratio is monitored at the studio and again at the transmitter. Despite these precautions, errors can still creep in. The major source is in the miscalibration of the monitor scopes on the console or in misreading by operating personnel. The correct ratio is 75% video, 25% sync.

It can be roughly checked by the technician, with a known good receiver. Just take a scope reading at the output of the video detector or video amplifier. The sync percentage (roughly!) should be about that stated. There is only one way to make this anything like a valid test—use at least three stations and compare their sync–video

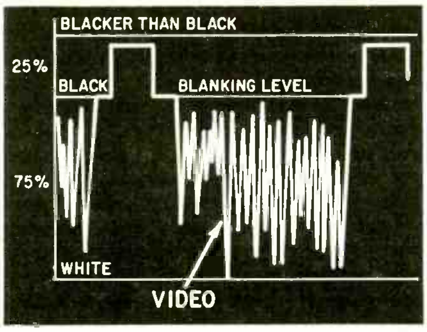


Fig. 6—Waveform used to check for proper sync–video ratio.

ratios. For best results, make the rf input level approximately equal on each station. This can be done by padding the strong stations down to the level of the weakest. Take a reading on the suspected station, then quickly tune to the others. If there is trouble in one station, the difference will be obvious.

If the set is used on a community antenna system or in an area that has several stations of approximately equal signal strength, the condition is easy to detect. The bad station's pictures will be very black (excessive contrast) and show a tendency to roll or fall out horizontally at the slightest disturbance. All other stations will display normal contrast and be much more stable. Adjust input signals to the same level and check the sync–video ratio on all stations with a scope.

Poor sync–video ratio almost always causes color troubles, even if it does not do much harm to black-and-white reception. This is due to attenuation of the color burst by severe compression of the back porch of the horizontal sync pulse where the color burst lives.

Color misregistration, as discussed above, is not too common, but several well-authenticated cases have been found. In one, all the reds in the picture were shifted slightly to the left.

[At this point, someone is sure to rise up in the back row and say, "But that would be a red lead! If there were differences in the delay time in some piece of equipment, wouldn't that cause a lag (shift to the right)? This would mean that the red signals were getting here before they leave the transmitter!"]

This is quite true, and the actual cause was never identified, although the piece of equipment causing it was—a terminating amplifier at the end of a 73-mile coaxial cable between two cities. The cable had been swept out several times, and pronounced "unfit for color; not over a 3-mc bandpass!" Since the amplifier has been replaced, the same cable has been carrying beautiful color for several years! Locating this defect required NBC specialists and the cooperation of nearly everyone in the whole state!

Transmitter engineers are human too. An operating engineer once connected a video cable to a multiple network outlet to get a signal to a workshop about 50 feet away. The network was not in use at the time and this looked like a good source of test signals. Unfortunately, he forgot to remove the piece of cable. When a color program came down the network, the result was horrible! Very low burst, no color and extremely bad ringing! The open end of the cable was producing reflections and fouling the whole network from that point on! (Since the guilty engineer happened to be on a coffee break at the time, the operating crew had a terrible time finding out what had gone wrong!)

Color and video tape

More and more color programs are being recorded on video tape. While the tape's average response is excellent, here again trouble can rear its ugly head! Several bad effects such as color phase-shift and hue-shift banding and color saturation banding can creep in. Since these defects originate in the tape recorders, they are easily recognized—each produces the characteristic pattern of horizontal bars, changing every 17–19 lines. Video tape is scanned in a very special way—by revolving heads mounted on a drum which actually travel across the tape which also moves like conventional tapes. One defective head on these machines will produce the characteristic pattern. It can always be identified by the horizontal bar structure.

Receiver checking

Needless to say, if the technician suspects a given transmitter of causing troubles, he must observe certain precautions before making any complaint. Be sure the receiver which shows the trouble is in perfect working order. Better still, check to be sure that identical symptoms are seen on a large number of receivers. In color troubles, be very sure that the color receiver is absolutely OK before making complaints. Again more than one set should be checked. Color temperature adjustments on the picture tube, both static and dynamic convergence, agc setting and most especially, the setting of the noise canceller control should be carefully checked.

A lot of possibilities

Signals traveling on a network must pass through maybe 1,000 to 2,000 miles of coaxial cable or microwave links. While doing this, they also pass through 100 to 250 repeater amplifiers. With about 40 tubes in each amplifier, there are something like 4,000 to 10,000 tubes. Each one must pass the color signal perfectly! As one engineer said, "There are about 10,000 reasons why the thing can't possibly work at all, but it does!"

I would like to express my sincere thanks to Mr. John Barth, chief engineer of KVOO-TV (channel 2, Tulsa, Okla.), for his very generous help in preparing this article. KVOO-TV is one of the nation's leading color TV stations and has received several commendations on the excellence of its maintenance! END

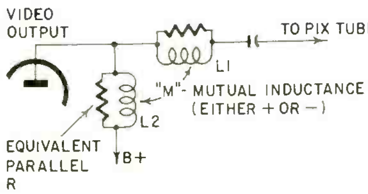
TELEVISION

WATCH THOSE PEAKING COILS!

By LAWRENCE SHAW

WHILE most TV service technicians know that improperly positioned peaking coils can cause oscillation in video amplifiers, few seem to realize that loss of fine detail can result from improper positioning.

In one particular case, two coils (L1 and L2 in the schematic) were placed parallel to each other. Even though the two were in the same video amplifier plate circuit, mutual inductance lowered the effective inductance of both coils and caused trouble. The primary function of a peaking coil in a video circuit is to form a highly damped reso-



nant circuit that builds up the response at about 3.5 to 4.0 mc. This boosts the amplitude of the higher video frequencies so these detail-carrying frequencies will satisfactorily reproduce the fine detail of the picture. Loss of inductance will cancel this desirable design and cause poor detail.

Loss of inductance increases the boost frequency. If the increase places the new bandpass above the video range, the effectiveness of the coils is nullified. Similarly, if the inductance is increased—by reversing the leads to one coil or physically turning a coil (of the pair) 180°—the resonant frequency is lowered and picture detail decreases. How much loss occurs depends on the mutual coupling and other factors.

The safe thing to do is to put the coils at right angles to each other. Then the self-inductance of the individual peaking coils is largely unaffected by mutual inductance—either aiding or opposing. At the same time, separate the coils as much as possible to reduce mutual inductance further. END

NEW TUBES and SEMI-CONDUCTORS

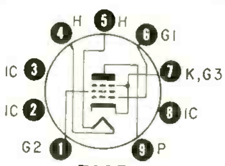
THERE is about an even break this month between tubes and semiconductors. All the tubes happen to fall in the entertainment type group and all the semiconductors in the industrial group.

Entertainment types

One new entry for hi-fi, a beam power pentode, appears this month. Also presented is some dope on shadow grids and a line of tubes that pays for labor if in-warranty replacement is required.

7695

The 7695 is a beam power pentode in a 9-pin miniature envelope. It features high power sensitivity as an audio power amplifier. In class-A1 operation it



7695

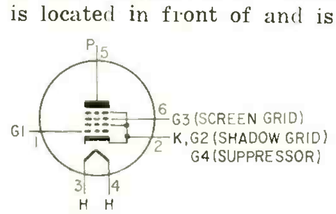
can deliver 4.5 watts with a 130-volt B-plus supply.

Characteristics of the Sylvania 7695 as a Class-A1 amplifier are:

V_P		130	140
V_{G2}		130	140
V_{G1}		−11	—
R_K	(ohms)	—	100
V_{G1}	(peak af)	11	11.3
I_P	(Zero sig) (ma)	100	100
	(max sig) (ma)	108	100
I_{G2}	(zero sig) (ma)	5	5
	(max sig) (ma)	15	14
g_m	(μmhos)	11,000	—
R_P	(approx) (ohms)	7,000	—
R_L	(ohms)	1,100	1,100
P_{out}	(max) (watts)	4.5	4.5
Dist.	(approx) (%)	11	11

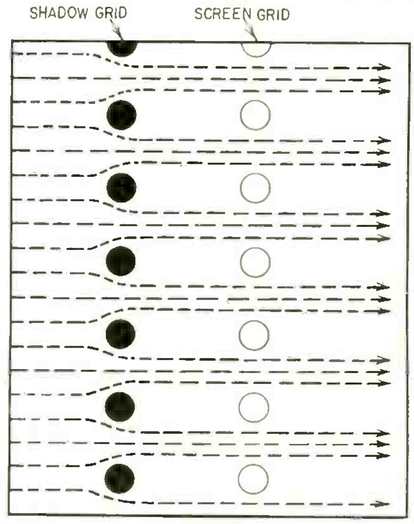
6FG5

The first General Electric receiving tube to use a "Shadow Grid". This extra grid is located in front of and is pre-



6FG5

cisely aligned with the screen grid. (see the diagram). It is grounded to the cathode and for this reason repels electrons flowing from the cathode to the plate. As a result, the electrons are steered around the wires of the screen grid. This keeps electrons from hitting the screen grid, reducing screen current and making possible a drastic reduction in screen dissipation. One practical advantage of the shadow grid is that the screen can be operated at the same voltage as the plate, eliminating the need for a dropping resistor and bypass capacitor. Another advantage is the exceptionally low noise figure. Also, higher



6FG5

transconductance is possible, making it possible in some designs to reduce a three-tube if strip to two tubes.

Average characteristics of the 6FG5 are:

V_P	250
V_{G2}	250
I_P (ma)	9
I_{G2} (ma)	0.42
g_m (μmhos)	9,500

New tube policy

A service technician who has to make a callback to replace any of the 10 tubes Raytheon has given their Uniline label gets a new tube from his dealer and $1 as a labor allowance. This covers any tube failures during the warranty period. The 10 Uniline tubes were selected

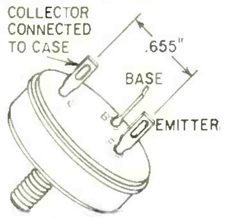
by service technicians throughout the US who were asked to list the 10 most troublesome tubes they encounter. These 10, which are now the Uniline 10, are: 1B3-GT, 1X2-A/B, 6CB6-A, 6CG7, 6AU4-GTA, 6X8, 6BQ6-GTA/B, 6SN7-GTB, 12AT7 and 6AX4-GT.

Industrial Types

On the heavy-duty end is a high-current high-power transistor, a group of four tunnel diodes and four very-high-current switching transistors.

DA3F3

Here is a high-current high-power germanium p-n-p transistor primarily intended for converting a 12-volt supply to either dc or square-wave ac at any output voltage. The DA3F3 has collector diode and reach-through voltage ratings of 60 volts. Its exceptionally low thermal resistance permits a steady-state power dissipation of 100 watts at a case temperature of 25°C or 28 watts at 75°C.



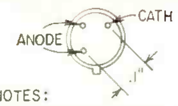
DA3F3

Performance specifications of the Minneapolis-Honeywell DA3F3 are:

h_{FE} (I_C=10 A, V_{CE}=2) (min)	25
V_S (I_C=10 A, I_B=2 A) (typ)	0.15
V_{CB} (max)	60
V_{CE} (max)	35
I_B (max) (rms) (amps)	2.5

1N650, 1N651, 1N652, 1N653

Four gallium arsenide tunnel diodes designed specifically for logic circuits, oscillators, amplifiers, memory units and other applications require a high voltage swing and high operating temperature. The units come in a welded case with glass-to-metal hermetic seal



1N650
1N651
1N652
1N653

NOTES:
CATH IS IN ELECTRICAL CONTACT WITH CASE
ANODE LEADS CONNECTED INTERNALLY

between the case and leads.

Absolute maximum ratings of this group of Texas Instruments tunnel diodes at 25°C are:

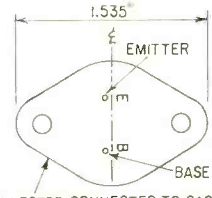
Forward current	(ma)	20
Reverse current	(ma)	20
Dissipation	(mw)	30

Typical electrical specifications at 25°C are:

	1N650	-51	-52	-53
I_P (peak current) (ma)	10	10	5	5
I_V (valley current) (ma)	0.5	0.5	0.5	0.5
V_P (voltage at peak)	0.1	0.1	0.1	0.1
V_V (voltage at valley)	0.45	0.45	0.45	0.45
V_f (fwd volts at typ peak current on diode characteristic)	1.1	1.1	0.98	0.98
L_S (total series inductance including leads) (mμh)	8	8	8	8
—R (negative resistance) (ohms)	20	20	40	40
C (total capacitance) (μμf)	40	40	40	60
R_S (series resistance) (ohms)	1	1	1	1

CTP-1552, -1544, 1545, 1553

A group of p-n-p very-high-current germanium switching transistors that are especially adaptable to use in high-power dc to dc converters with outputs in excess of 500 watts. Extremely low saturation voltage, guaranteed collector leakage current even at high temperatures and maximum applied voltages for good reliability, and controlled gain spread are a few of the advantages offered by the units.



CTP-1544
CTP-1545
CTP-1552
CTP-1553

Absolute maximum ratings of these Clevite transistors are:

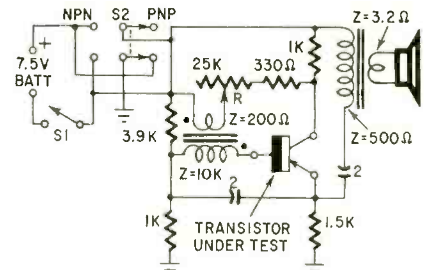
	CTP-1552	-1544	-1545	-1553
V_{CB}	40	60	80	100
V_{CE} (fwd-biased emitter)	20	30	40	50
(rev-biased emitter)	35	45	65	80
(rev-biased emitter) (for peak collector current of 500 ma)	38	58	78	98
V_{EB}	30	30	30	30
I_C (amps)	25	25	25	25
I_B (amps)	5	5	5	5
$P_{average\ total}$ (watts at 70°C)	25	25	25	25
(watts at 25°C)	75	75	75	75

END

NOTEWORTHY CIRCUITS

TRANSISTOR BETA TESTER

A simple instrument for measuring a transistor's beta (current gain), awarded US Patent No. 2,894,206, was developed by G. M. Montgomery of the National Bureau of Standards. To use

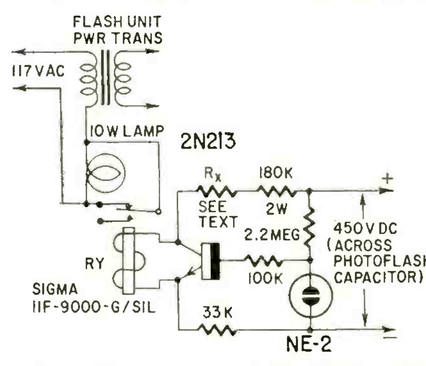


the unit, S2 is placed in the proper position for the transistor to be tested, and the transistor is plugged in. Then potentiometer R is adjusted until the circuit oscillates at an audio frequency and a tone is heard from the speaker. By calibrating the dial on the instrument, beta can be accurately measured over a range from 10 to 170.

The circuit is designed so the transistor adjusts itself to an operating point that is fixed at a collector voltage of 5 and collector current of 1 ma.

FLASH-UNIT CONTROL

This simple unit controls ac-powered electronic flash units and insures a proper flash each time you snap the shutter. The circuit is arranged so that when the flash capacitor charges to 450 volts, the relay puts a 10-watt lamp in



series with primary of the flash unit's power transformer. If the flash bulb isn't triggered, the voltage on the flash capacitor drops slowly. When it drops 12–14 volts, the transistor loses control of the relay and turns the unit back on. This cycle is repeated until the bulb is triggered. The 10-watt lamp reduces sparking at the relay contracts.

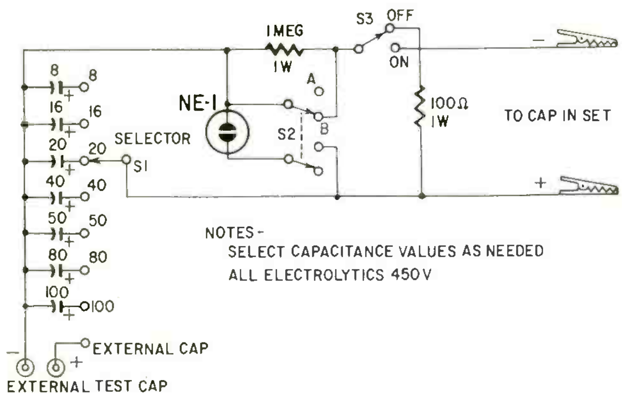
To set up the control unit, insert a

50,000-ohm potentiometer for R_X. Starting at zero resistance, adjust it until the relay pulls in at 450 volts. Remove the pot, measure its resistance and, insert a fixed ½-watt resistor in its place.

Note that one contact of the Sigma 11F-9000-G/SIL relay specified is connected to its frame. As the ac line is connected to the contacts, the relay is hot. It must be insulated from any metal case or chasis and kept completely enclosed to avoid accidental contact.—*R. B. Dodson*

IMPROVED SUBSTITUTION BOX

Most shops use at least a couple of substitution boxes. The type of box (resistance, capacitance, etc.) depends on the need, since with a little imagination, countless designs are possible. The electrolytic substitution box described here is a combination of several ideas.



Basically, a substitution box is a systematic arrangement of the parts to be substituted around a multiple contact switch. However, substituting electrolytics is different. A defective component in a power supply can blow (literally explode) electrolytics as fast as they are replaced. The cause—the capacitor was charged too fast with too much current. This box avoids the problem by using a high series resistance to extend charging time and a neon lamp to indicate full charge.

On the hazard side, how many times have you bridged a test capacitor across a faulty unit and later found that accidental contact with leads gave you an unexpected jolt? This doesn't happen here, because whenever a capacitor is switched out of a circuit it is shunted with a 100-ohm resistor to discharge it.

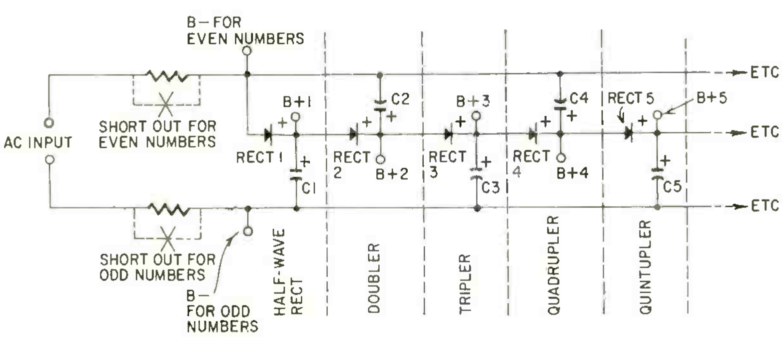
No exact construction details are given since the size of the electrolytics determines the cabinet size. However, there are two points that apply to all units:

Do not use "bargain" electrolytics in your substitution box. Choose only high-quality components. The extra cost will be repaid by dependable performance and long life. Don't make any connections to the substitution-box chassis, and use insulated binding posts and clips.

To use the device, S2 should be in position A. Then turn S3 ON. After the neon lamp lights, move S2 to position B. When disconnecting the device, place S3 in the off position to discharge the capacitors. The binding posts are for connecting an external test capacitor. By selecting the proper group of capacitors you will have a substitution box that meets your needs exactly.—*Ronald Wilensky*

SIMPLIFIED RECTIFIER STACK

Various types of rectifier stack circuits are shown in the diagram. By placing a blank piece of cardboard over the portion of the circuit to the right of the first dashed line, a half-wave rectifier is shown. As you move the cardboard to right, a voltage doubler, tripler, quadrupler, and quintupler are revealed in turn.



The voltage and current ratings of rectifiers RECT 1, 2, 3, etc. are alike. Capacitors are identical in capacitance but not voltage. C2 has double the rating of C1, C3 has three times the voltage rating of C1 and so on.—*Barr Jamison*

END

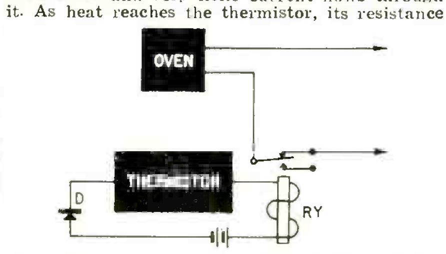
new PATENTS

ELECTRONIC THERMOSTAT

Patent No. 2,929,968

Heinz K. Henisch, Flushing, N.Y. (Assigned to Sylvania Electric Products, Inc., Wilmington, Del.)

Zener diode D is normally operated below breakdown and very little current flows through it. As heat reaches the thermistor, its resistance



drops. More current flows through D until the breakdown point is reached. At this point, sufficient current flows through the relay winding to energize it. This opens the contacts from the power line, permitting the oven to cool. The thermistor resistance rises again, forcing D below breakdown.

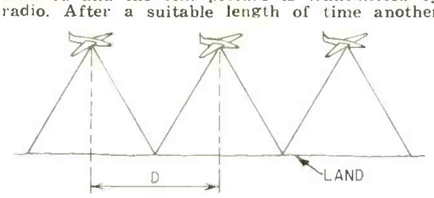
The feature of this invention is the sharp transition from breakdown to blocking conditions of the Zener. This gives a positive, high-speed switching action.

AUTOMATIC SKY SPY

Patent No. 2,931,857

John Hays Hammond, Jr., and Emory Leon Chaffee, Gloucester, Mass.

The specifications of this patent reveal mechanical and electronic details for an automatic TV camera in an airplane, which may be directed by remote or automatic means. The camera is exposed for an instant to the ground view. For a longer interval that follows the camera tube is scanned and the still picture is transmitted by radio. After a suitable length of time another



view is exposed, and so on. An oscillating mirror helps to minimize blur due to the speed of the plane.

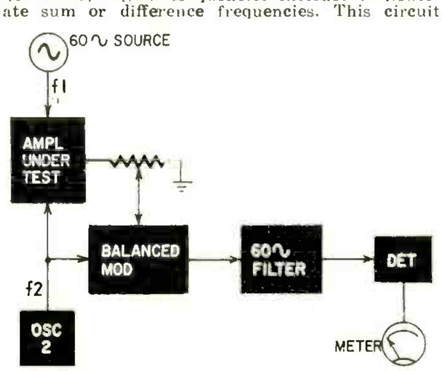
At the receiving station, the polarity of the output signal is set to negative. It is photographed directly on film to obtain a positive. After rapid processing and drying, the film is projected. If desired, the series of still pictures may be combined to form a continuous view of the ground.

INTERMODULATION INDICATOR

Patent No. 2,929,989

Hyman Hurvitz, Washington, D. C.

Intermodulation distortion occurs when two (or more) signal frequencies interact to generate sum or difference frequencies. This circuit



uses two test signals. One frequency (f1) is fixed at 60 cycles. The other (f2) is variable. Both are applied to the amplifier under test. When there is distortion, the amplifier output contains the beats (f2 − f1) and (f2 + f1).

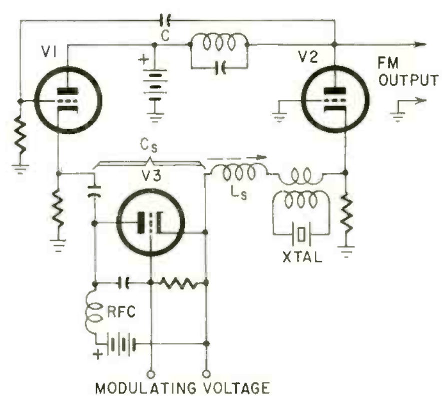
A balanced modulator receives two signals: the amplifier output and f2. These signals do not appear at the output, but their beats do. Therefore, if there *is* intermodulation in the amplifier, a 60-cycle output (f1) will pass through the 60-cycle filter [(f2 − f1) + f2 or (f2 + f1) − f2]. The meter can be calibrated in percent of distortion.

CRYSTAL OSCILLATOR FOR FM

Patent No. 2,913,677

David I. Kosowsky, West Newton, and Robert W. Luscher, Belmont, Mass. (Assigned to Hermes Electronics Co., Boston)

Conventional crystal oscillators are "stiff" in their control over frequency and do not permit frequency modulation to any extent. This rela-



tively simple crystal circuit produces wide-band stable FM.

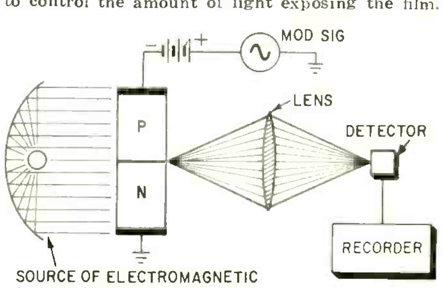
V1, V2 constitute the rf oscillator. Feedback occurs through C and through a series-tuned cathode network L_s, C_s. (C_s is actually a capacitive reactance tube, V3.) Its grid voltage, an af signal, controls the value of C_s and thus varies the oscillator's instantaneous frequency. The center frequency is maintained by a crystal which is loosely coupled into the network.

SEMICONDUCTOR GATE

Patent No. 2,929,923

Kurt Lehovec, Williamstown, Mass. (Assigned to Sprague Electric Co., No. Adams, Mass.)

In the usual method of optical recording on film, a narrow aperture passes a light beam while an audio signal varies the width of this opening to control the amount of light exposing the film.



In this invention, a different kind of gate is used to regulate electromagnetic radiation. A p-n junction replaces the mechanical slot. This provides a much narrower aperture and can use much higher frequencies than audio.

The semiconductor is reverse-biased. Its carriers absorb energy so none can pass through the crystal except at the *junction*, which is free of charges. In one case, the inventor notes, the crystal passed 50% of the impressed energy when the blocking potential was varied 10 volts. Modulation at several hundred mc is possible. END

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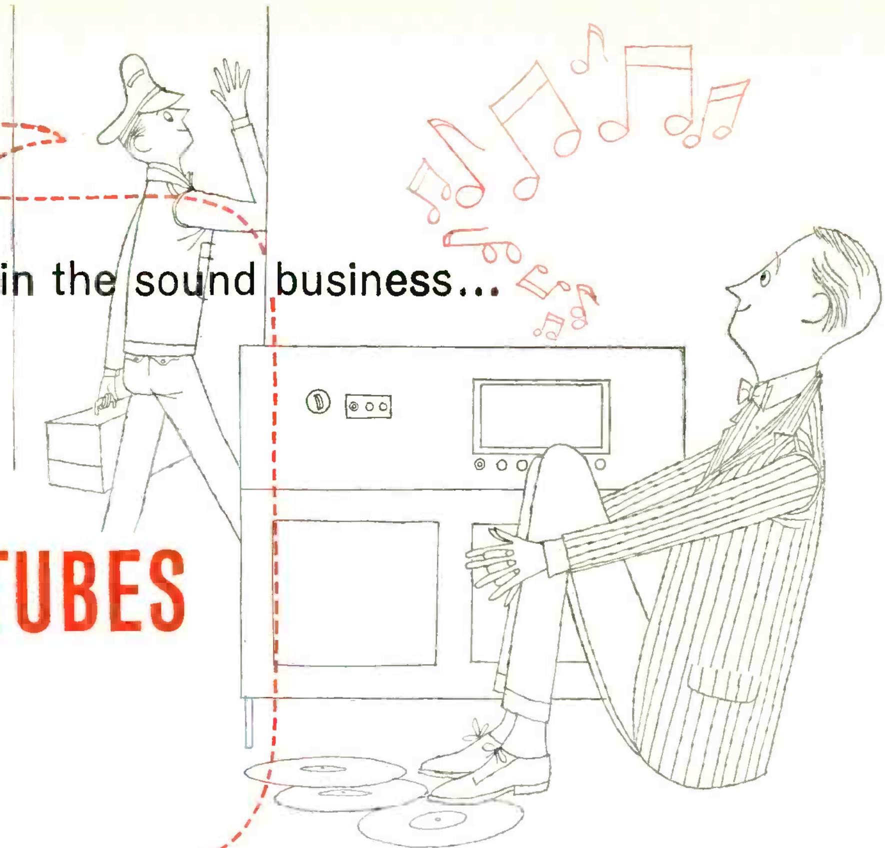

Hi-Fi set owners are a "finicky" lot. Won't compromise with audio quality. It's easy to help them get the fine sound reproduction they want. When the trouble is a tube, do what profit-minded dealers have been doing for years with radio and TV sets. Replace defective tubes with SYLVANIA superior-quality TUBES.

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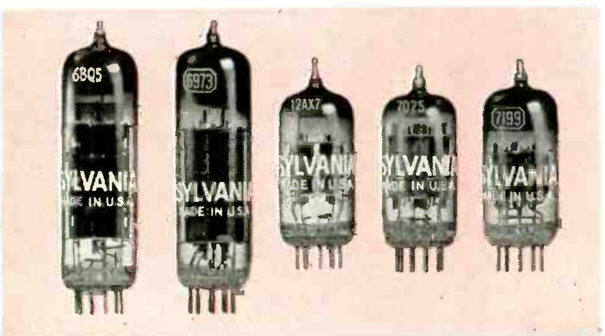

SYLVANIA 6BQ5 . . . power pentode used in many medium-to-high power output stages.

SYLVANIA 6973 . . . power pentode popular in medium-to-low power output stages.

SYLVANIA 12AX7 . . . high-mu twin triode used in many high-gain preamplifiers.

SYLVANIA 7025 . . . a "sophisticated" 12AX7, featuring exceptionally low noise and low microphonics.

SYLVANIA 7199 . . . triode-pentode, featuring low hum and low microphonics, used in high-gain preamplifier and phase inverter stages.

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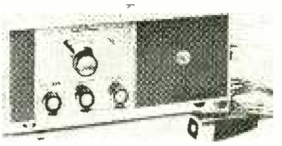
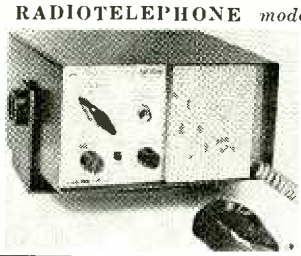


Mounting bracket. Microphone with push-to-talk switch. 2 *Mark VII* models: 117 volts ac and 6 volts dc; 117 volts ac and 12 volts dc.—**Radio Corp. of America,** 30 Rockefeller Plaza, New York 20, N. Y.

TRANSCEIVER, *Pocketphone,* for 27-mc Citizens band. Power input to final stage under 100 mw; no license is required unless used to contact licensed stations or equipment. Crystal-controlled receiver and transmitter. Built-

in speaker serves as mike. Battery life expectancy 1 year.—**Globe Electronics,** 22-30 S. 34 St., Council Bluffs, Iowa.

RADIOTELEPHONE *model*



Ray-Tel. 4-channel crystal-controlled Citizens-band transceiver. Squelch, avc, noise limiter. Push-to-talk switch on mike. 117 volts ac or 12 volts dc. Power input 5 watts.—**Raytheon Co.,** Waltham 54, Mass.

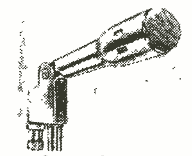
SINGLE-SIDEBAND microphones, *models* 440 and 440SL

(shown). Response 300 to 3,000 cycles with rising characteristic for maximum intelligibility. Identical except *440SL* has grip-to-talk switch and *440* standard microphone thread. High impedance. For use with amplifier with input impedance of 100,000 ohms or more. Open-circuit voltage −52.5 db.—**Shure Brothers, Inc.** 222 Hartrey Ave., Evanston, Ill.

MICROPHONE for industrial, mobile use (Citizens band, ham

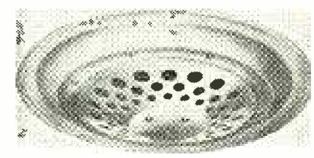
radio and ship-to-shore). *Model PA-77*: response 100 to 9,000 cycles. Impedance 500,000 ohms. Built-in slide switch operates relay for transmit–receive switching. 5-foot single-conductor shielded cable, 2 color-coded switching conductors in one jacket. Polystyrene impact-resistant case.—**Lafayette Radio Corp.,** 165-08 Liberty Ave., Jamaica 33, N. Y.

DYNAMIC CARDIOID microphone for recording and PA use. *Knight model KN-4550*: directional pickup pattern for high front-to-back ratio. Response 60 to 13,000 cycles, output level −57 db. Impedance either 150 ohms or hi-Z. On-off switch, 18-foot cable and stand-



ard thread to fit all floor and desk stands. Stock No. *93 S 479.* —**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

LOUDSPEAKER and integrated ceiling and wall metal



baffle *model SK-175* 2¼ inches deep. 12-oz magnet structure in front of speaker. Impedance 8 ohms, response 90 to 9,000 cycles. Voice-coil diameter 1 inch. —**Lafayette Radio Corp.,** 165-08 Liberty Ave., Jamaica 33, N. Y.

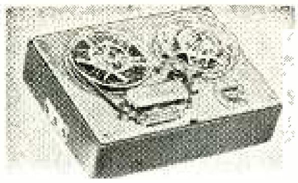
PICKUP ARM. 2 *Professional*

models: *M232* for 12-inch records; *M236* for 16-inch records. Ball bearings at all pivot points to reduce drag. Heads interchangeable. — **Shure Brothers, Inc.**, 222 Hartrey Ave., Evanston. Ill.

TURNTABLE. Hysteresis synchronous motor. 33⅓ and 45 rpm, single-speed motor. Speed-

change mechanism uses double-stepped cone on motor shaft. Shaft suspended in graphite nylon bearings. Dynamically balanced. Rumble down 50 db (referred to 7 cm/sec at 1,000 cycles). Wow 0.15%, flutter 0.1%. Turntable 12 inches in diameter, turned of nonferrous material. Neon indicator glows when power is on.—**Ercona Corp.**, 16 W. 46 St., New York 36, N. Y.

PORTABLE RECORDER *model TR-750*. 2½ x 7½ x 5½ inches. Amplifier uses 5 transistors, is powered by 9-volt 60-hour battery. Motor powered by 8 penlight cells. Built-in meter indicates recording level and battery condition. Two speeds: 3¾ and 1⅞ inches per second.



Reel size 3 inches. Response 200 to 5,000 cycles. Microphone, zippered carrying bag, batteries and tape reels supplied.—**Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.

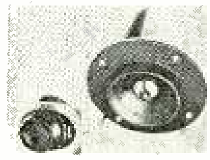
PORTABLE SOUND SYSTEM, *Rhythmaster*. Variable - speed (25–100-rpm) turntable, 20-watt amplifier, two 10-inch speakers in baffles. Use as high-fidelity phonograph, PA system

or high-fidelity radio (with AM-FM tuner). Magnetic cartridge. **—Rek-O-Kut Co., Inc.**, 38-19 108 St., Corona 68, N. Y.

HI-FI CONTROLS mount on speaker cabinet, wall or wood-

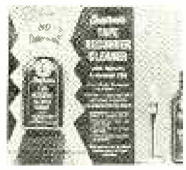
work. *No. 666*, L-pad speaker volume control rated at 5 watts peak, 8 ohms. *No. 667* speaker selector switch. *No. 668* stereo switch selects any of 3 stereo sources for amplifier input. *No. 669* (shown) 1-megohm matched stereo volume control.—**Switchcraft, Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.

SUPER TWEETER *Sphericon T-202*. Response to 40,000 cycles. Domed phenolic diaphragm acoustically loaded by conoidal



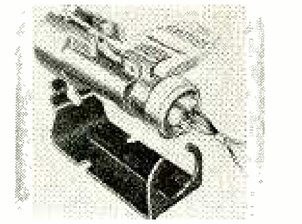
ring plus diffractor sphere to widen dispersion pattern to 120° in all directions. Response 3,000 to 22,000 cycles ±2 db. Built-in crossover network, brilliance control on 35-inch cable.—**University Loudspeakers, Inc.**, 80 So. Kensico Ave., White Plains, N. Y.

TAPE-HEAD CLEANER does not affect plastic parts of re-



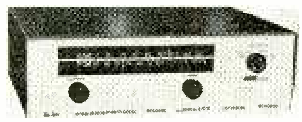
corders. Cleans heads, rollers and capstan. Packaged in 2-oz. bottle with felt applicator.—**Chemtronics Inc.**, 870 E. 52 St., Brooklyn 3, N. Y.

STEREO CARTRIDGE. All-plastic construction except for



crystal element, styli and mounting bracket. *Series 12* high-output cartridges designed to improve quality and reduce cost. *Model 12TL* output 1 volt; *12TH* output 2.5 volts. Recommended load 1 megohm, channel separation 15 db.—**Sonotone Corp.**, Elmsford, N. Y.

STEREO TUNER *Aria (model T220)*. FM response 30 to 15,000 cycles ±0.75 db. Distortion 1% or less on both AM and FM.



Sensitivity: AM, 120 μv per meter; FM, 2μv for 30-db-quieting. Afc and afc defeat, multiplex outlet. — **Harman-Kardon, Inc.**, 520 Main St., Westbury, N. Y.

LUBRICANT in 6-oz can. *Dry Lube* is nontoxic, greaseless, inert. Nonconductive, for

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DISCOUNTS UP TO 50% on Hi-Fi amplifiers, tuners, speakers, tape recorders, individual quotations only, no catalogs. CLASSIFIED HI-FI EXCHANGE, 2375 East 65th Street, Brooklyn 34, N.Y.

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ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT CO., 128 Liberty Street, New York, N.Y.

ROCKET FUEL CHEMICALS. Model Missle Kits, Parts. Catalog 25c. CENTRAL ROCKET COMPANY, Waupaca, Wisconsin.

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RADIO & TELEVISION RECEIVING TUBES, brand new, first line name brands only. No rejects, no pulls. Discounts up to 66⅔% off list. EDISON TUBE CO., Menlo Park, N.J.

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PROFESSIONAL ELECTRONIC PROJECTS — Organs, Timers, Computers, etc.—$1 each. List Free. PARKS, Box 1665, Lake City Station, Seattle 55, Wash.

SONGPOEMS and LYRICS WANTED! Mail to: TIN PAN ALLEY, INC. 1650 Broadway, New York 19, N. Y.

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RADIO & TV TUBES at Manufacturers' Prices! 100% Guaranteed! Brand New! No re-brands or pulls! UNITED RADIO, Box 1000-R, Newark, N.J.

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Tubes—TV and Radio tubes—Guaranteed. Save up to 80%. Brand new, no pullouts, some factory seconds. Write: EMKAY ELECTRONICS, P.O. Box 142, Blythebourne Station, Brooklyn 19, N. Y.

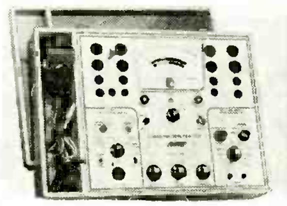
relays, switches, pots, dials and solonoids. Also for drawers, zippers and locks.—**Strauss Photo Technical Service, Inc.,** 930 F St. N. W., Washington, D. C.

MULTITURN POT *model 1R-150.* Infinite resolution. Continuous slide-wire element. Resistance tolerance ±10%. Linearity tolerance 0.5%. Power rating 5 watts. Available from 2 to 35 ohms. — **International Resistance Co.,** 401 N. Broad St., Philadelphia 8, Pa.

CODE OSCILLATOR *model 706.* Built-in 3-inch speaker. Pitch continously variable from 500 to 2,000 cycles. Panel switch

selects tone alone, tone and light or light alone. Panel light usable for signaling after dark. Panel jack for headphones. Temporary key of formed metal and solder lug removable for connecting standard key. Kit or wired.—**Electronic Instrument Co., Inc.,** 33-00 Northern Blvd., Long Island City 1, N. Y.

COMBINATION TESTER, *model 300,* combines multiple-socket tube tester, CRT tester-reactivator and volt-ohm-capacitance meter. Tube tester



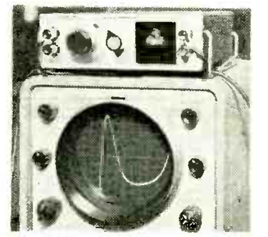
checks emission of more than 700 tubes; checks for shorts, leakage, gas. CRT tester-reactivator checks black-and-white and color tubes. Meter controls reactivation, eliminates danger of stripping CRT cathode. Indicates life expectancy. Vocm: 0 and 7,500 volts dc in 7 ranges; from 0 to 1,500 volts ac in 6 ranges. 5 current ranges 0 to 15 amps. 2 capacitance ranges .001 µf to 80 µf. 3 ohms ranges 0.5 ohms to 10 megohms.—**Mercury Electronics Corp.,** 77 Searing Avenue, Mineola, N. Y.

TV ANTENNA designed to blend with new TV set styling.

Models H6M (mahogany) and *H6B* (blond.) 4-section telescoping dipoles extend to 36 inches. Weighted base has felt bottom.—**Clear Beam Antenna Corp.,** 21341 Roscoe Blvd., Canoga Park, Calif.

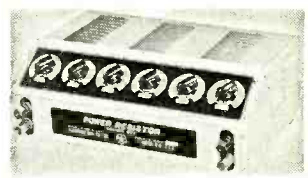
FM ANTENNA for indoor installation. Can be concealed behind cabinet or under rug. Standard 300-ohm ribbon transmission line.—**Robbins Industries Corp.,** 36-27 Prince St., Flushing 54, N.Y.

CURVE TRACER for tunnel diodes. Usable with any sensitive scope. Checks diodes from



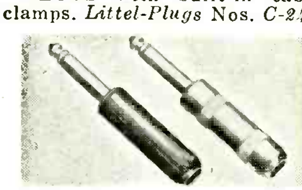
all manufacturers. With optional shunt, reads negative resistance at any point on curve. —**Texas Instruments, Inc.,** 3609 Buffalo Speedway, Houston 6, Texas.

DECADE BOX of power resistors, *model 240C,* allows any value from 1 to 999,999 ohms, to be selected in 1-ohm steps. Maximum power 225 watts. Resistance may be changed in working circuit without resist-



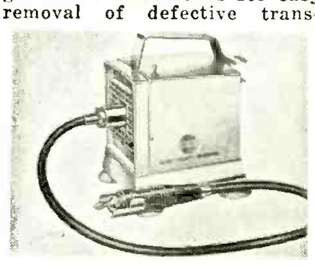
ance breakdown between steps, protecting meters or other instruments.—**Clarostat Mfg. Co., Inc.,** Dover, N. H.

PLUGS with built-in cable clamps. *Littel-Plugs* Nos. *C-240,*



C-245 and *C-270* come with black plastic, red plastic and shielded handles, respectively. —**Switchcraft, Inc.,** 5555 N. Elston Ave., Chicago 30, Ill.

FLEXIBLE-SHAFT TOOL grinds off rivet heads for easy removal of defective trans-



formers, tube sockets and capacitors. Faster than drilling rivets out with ¼-inch drill. Eliminates rivet spinning. *Flex-O-Tool* has 40-inch shaft. Accessories available for grinding, polishing or engraving.—**Dremel Manufacturing Co.,** Racine, Wis. END

All specifications on these pages are from manufacturer's data.

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—UNIVERSAL UTILITY TESTER......with $\$20^{00}$ ORDER*
—SURPRISE GIFT....with every ORDER of $\$5^{00}$ or over

PLUS . . . 1 DOLLAR BUY FREE with every 10 you buy

*ORDERS from $20.00 to $100.00 will receive GIFTS in proportionate values

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- ☐ 5 – SELENIUM RECTIFIERS 65ma list $1.50 ea . $1
- ☐ 4 – SELENIUM RECTIFIERS 75ma $1
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- ☐ 2 – SELENIUM RECTIFIERS 300ma $1
- ☐ 2 – SELENIUM RECTIFIERS 1—150ma 1—65ma $1
- ☐ 3 – TRANS. RADIO BATTERIES as Eveready 216. $1
- ☐ 4 – DIODE CRYSTALS 1N34A $1
- ☐ 300 – RUBBER GROMMETS OD 1/2" ID 3/16" . $1
- ☐ 100 – ASST. CERAMIC CONDS. best types . . . $1
- ☐ 100 – TOP BRAND TUB. CONDS. .0022-200v . . $1
- ☐ 100 – TOP BRAND Mica Conds. 10000mmf-500v $1
- ☐ 100 – CERAMIC CONDENSERS 1500 mmf-500v. $1

RC-121 STEREO GARRARD CHANGER 4-spd. $29.97
RC-88 STEREO GARRARD CHANGER 4-speed . 44.62
C-98 STEREO GARRARD CHANGER 4 speed . . 53.24
G.E. STEREO DIAMOND CARTRIDGE #GC7. . 11.97
110° TV CONVERSION KIT all Essential Parts 17.42
90° TV CONVERSION KIT all Essential Parts . 15.98
70° TV CONVERSION KIT all Essential Parts . 13.97
UNIVERSAL 70° FLYBACK TRANSFORMER 4.86

UNIVERSAL 90° FLYBACK TRANSFORMER $5.24
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17" TV MASK gray 13 3/4" x 17 1/4" 1.49
21" TV MASK gray 18" x 22 1/2" 2.38
23" TV MASK gray 18" x 22 1/2" 3.78
21" or 23" TV SAFETY GLASS 18" x 22 1/2" . . 5.16
24" or 27" TV MASK gray 21" x 26" 4.93
24" or 27" TV SAFETY GLASS 21" x 26" . . . 5.87

TECH-MASTER for 1960 ★ "GOLD MEDAL" #2430-B
WORLD'S MOST POWERFUL TV CHASSIS

COMPLETE ready to operate (less CRT) 90° $175.85 • 110° $182.60 *Catalog on request*

TUBULAR CONDENSERS—85°C TOP QUALITY—Equally as good for Radio or TV work
.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v, .03-600v 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .0047-1000v, .01-1000v, 8¢ ea.
.039-1000v, .047-1000v, .1-1000v, .007-1600v, .03-1600v, .05-1600v, .005-3000v, .001-6000v, 14¢ ea.

ELECTROLYTIC CONDENSERS—85°C 1-50v, 1-150v, 2-350v, 25-50v, 8-150v 19¢ ea.
20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v......34¢ ea.

CARBON RESISTORS—Regular factory stock in Stackpole, Speer, etc.
1/2 WATT 10% 10, 39, 47, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800Ω.... 2¢ ea.
1/2 WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33kΩ.... 2¢ ea.
1/2 WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ.... 2¢ ea.
1/2 WATT 10% 390k, 470k, 560k, 680k, 820k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ..... 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω.. 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
2 WATT 10% 18, 22, 82, 100, 180, 2200, 3900, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ.... 4¢ ea.

WIREWOUND RESISTORS 5-5w, 16-10w, 20-10w, 47-5w, 100-5w, 140-5w, 220-5w. 16¢ ea.
280-10w, 390-5w, 470-5w, 500-10w, 680-10w, 820-5w, 1K-5w, 1K-10w, 1500-5w, 2K-10w....16¢ ea.
2500-5w, 3K-10w, 4700-5w, 5K-10w, 6K-10w, 7K-10w, 8200-5w, 10K-5w, 15K-5w, 22.5K-12w...16¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 150 mmf .. 3¢ ea.
CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 10k mmf .... 3¢ ea.
MICA CONDENSERS 5, 25, 50, 60, 68, 75, 100, 120, 150, 220, 270, 330, 470, 510 mmf .... 3¢ ea.
MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf .. 3¢ ea.

DX-16 Super Deluxe TV KIT
70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES

Dimensions 17 1/2" W x 16" D
Shipping weight 40 lbs.

- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
- ★ All Video and I.F. Coils factory pre-aligned and tuned.
- ★ Large 250ma Power Transformer for dependable service.
- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.

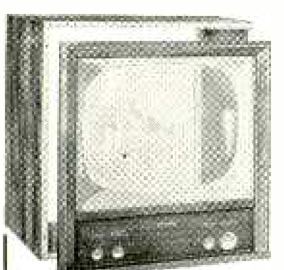
Includes ***LIFE-SIZE*** step-by-step Building Instructions
Most Up-To-Date and Practical Course in Television

COMPLETE KIT
with SET of WESTINGHOUSE TUBES $93.49

4—6CB6, 6U8, 6T8, 6C4, 12BH7, 6SN7, 6BQ6, 6W4, 6K6, 1X2B, 5U4. 6BN4, 6GC8, incl. in the Tuner (less CRT)

Also sold on EASY-PAYMENT-PLAN Buy LIFE-SIZE Instructions—$2.49—and buy Parts as you build.

BUILD YOUR OWN CABINET FOR ANY TV CHASSIS



Comparable to the type that Top Mfrs. use on high priced TV sets.

CABINET KIT with 90% of the job done, includes—
FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. **TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.**
And EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26"H, 25"W, 22"D $26.97

23" TV Cabinet Kit . . $28.47 24" or 27" TV Cabinet Kit . . $38.47 24" or 27" Front Panel Assembly . . $24.97

"ONE DOLLAR" Buys

- ☐ 1—3" PM SPEAKER alnico #5 magnet $1
- ☐ 1—4" PM SPEAKER alnico #5 magnet $1
- ☐ 1—5" PM SPEAKER alnico #5 magnet $1
- ☐ 1—3 1/2" TWEETER SPEAKER for HI-FI $1
- ☐ 3—AUDIO OUTPUT TRANS. 50L6 type $1
- ☐ 3—AUDIO OUTPUT TRANS. 6K6 or 6V6 $1
- ☐ 15—ASST. TV COILS sync. peaking, width $1
- ☐ 3—I.F. COIL TRANSFORMERS 456 kc $1
- ☐ 3—I.F. COIL TRANSFORMERS 10.7 mc FM $1
- ☐ 3—I.F. COIL TRANSFORMERS 262kc(auto) $1
- ☐ 4—OVAL LOOP ANTENNAS ass't hi-gain $1
- ☐ 3—LOOPSTICK ANT. new ferrite adjustable $1
- ☐ 3—VARIABLE COND. super 420/162 mfd $1
- ☐ 3—ASST. SIZES RADIO CHASSIS PANS $1
- ☐ 600—ASST. HDWARE screws, nuts, riv., etc. $1
- ☐ 3—1/2 MEG. VOLUME CONTROLS w/switch $1
- ☐ 5—50K VOLUME CONTROLS less switch $1
- ☐ 5—ASS'T. 4 WATT WIREW'D CONTROLS $1
- ☐ 10—ASST. VOLUME CONTROLS less switch $1
- ☐ 5—ASST. VOLUME CONTROLS w/switch $1
- ☐ 100—VOLUME CONTROL HEX NUTS $1
- ☐ 1—GOLO GRILLE CLOTH 14x14or12x18 $1
- ☐ 5—SETS SPEAKER PLUGS wired $1
- ☐ 10—SETS PHONO PLUGS and PINJACKS $1
- ☐ 2—$2.50 SAPPHIRE NEEDLES 5000 plays $1
- ☐ 20—ASST. PILOT LIGHTS popular types $1
- ☐ 10—PILOT LT. SKTS. bayonet type, wired $1
- ☐ 50—ASST. TERMINAL STRIPS 1, 2, 3, 4 lug $1
- ☐ 20—ASSORTED TUBE SHIELDS best sizes $1
- ☐ 35—ASST. RADIO KNOBS. screw & push $1
- ☐ 100—ASSORTED KNOB SET-SCREWS $1
- ☐ 25—ASS'TED RADIO DIAL POINTERS $1
- ☐ 25—ASS'TED CLOCK RADIO KNOBS $1
- ☐ 15—ASST. ROTARY SWITCHES $15 worth $1
- ☐ 3—TOGGLE SWITCHES spst, dpdt, etc. $1
- ☐ 6—SLIDE SWITCHES spst, dpdt, etc. $1
- ☐ 50—ASST. SOCKETS octal, nov. & m'ature $1
- ☐ 5—TV CRT. SOCKETS with 18" leads $1
- ☐ 5—TV ANODE LEADS with 18" leads $1
- ☐ 3—TV CARTWHEEL CONDENSERS 20 kv $1
- ☐ 2—TV CARTWHEEL CONDENSERS 30 kv $1
- ☐ 3—HV RECTIFIER SOCKETS 1B3 m'ntd $1
- ☐ 3—HV RECTIFIER SOCKETS 1X2 m'nted $1
- ☐ 20—ASST. TV KNOBS, ESCUTCHEONS, etc. $1
- ☐ 25—ASST. PEAKING COILS popular types $1
- ☐ 1—RCA SYNCHROGUIDE COIL #205R1 $1
- ☐ 1—RCA SYNCHROLOC COIL #208T8 $1
- ☐ 1—STANDARD AGC COIL 1R4AG $1
- ☐ 1—RATIO DETECTOR COIL 4.5 mc $1
- ☐ 1—RATIO DETECTOR COIL 10.7 mc $1
- ☐ 200—SELF TAPPING SCREWS #8 x 1/2" $1
- ☐ 50 — TERM'L STRIPS best type, 10 lugs $1
- ☐ 1—SILICON RECTIFIER 750 ma 500v $1
- ☐ 5—DIODE CRYSTALS 2—1N21 2—1N22 1—1N64 $1
- ☐ 3—DIODE CRYSTALS 1—IN60, 1—IN64; 1—IN69 $1
- ☐ 3—SELENIUM RECT. 2—75ma & 1—150 ma $1
- ☐ 100—ASST. 1/2 WATT RESISTORS some 5% $1
- ☐ 70—ASS'TED 1 WATT RESISTORS some 5% $1
- ☐ 35—ASS'TED 2 WATT RESISTORS some 5% $1
- ☐ 25—ASST. PRINTED CIRCUIT SOCKETS $1
- ☐ 50—ASST. TUBULAR CONDENSERS $1
- ☐ 20—TUBULAR CONDENSERS .047-600v $1
- ☐ 15—TUBULAR CONDENSERS .47-400V $1
- ☐ 20-TUBULAR CONDENSERS .001-1000v $1
- ☐ 20—TUBULAR CONDENSERS .005-600v $1
- ☐ 20—TUBULAR CONDENSERS .01-600v $1
- ☐ 15—TUBULAR CONDENSERS .25-600v $1
- ☐ 10—HV TUB. CONDENSERS .007-1600v $1
- ☐ 10—ASST. RADIO ELECTROLYTIC COND $1
- ☐ 5—ASST. TV ELECTROLYTIC COND $1
- ☐ 2—ELECTROLYTIC COND. 40/40—450v $1
- ☐ 3—ELECTROLYTIC COND. 80-450v $1
- ☐ 3—ELECTROLYTIC COND. 50/30-150v $1
- ☐ 100—ASST. MICA COND. some in 5% $1
- ☐ 50—ASSORTED FUSES popular sizes $1
- ☐ 10—SURE GRIP ALLIGATOR CLIPS $1
- ☐ 50—100KΩ 1/2 WATT RESISTORS 5% $1
- ☐ 50—470KΩ 1/2 WATT RESISTORS 10% $1
- ☐ 50—2.2 MEGΩ 1/2 W. RESISTORS 10% $1
- ☐ 10—ASST. WIREW'ND RES. 5, 10, 20 watt $1
- ☐ 40—ASST. PRECISION RESISTORS best sizes $1
- ☐ 35—ASST. DISC CERAMICS best numbers $1
- ☐ 25—ASSORTED MICA TRIMMER COND. $1
- ☐ 10—6' ELECTRIC LINE CORDS w/plugs $1
- ☐ 5—TV CHEATER CORDS w/both plugs $1
- ☐ 4—50' SPOOLS HOOK-UP WIRE 4 colors $1
- ☐ 50—STRIPS ASS'TED SPAGHETTI best sizes $1
- ☐ 100'—TWIN LEAD-IN WIRE 300Ω heav.duty $1
- ☐ 50'—FLAT 4-COND. WIRE many purposes $1
- ☐ 35—MICA COND. 20-5mmf & 15-25 mmf $1
- ☐ 35—MICA COND. 20-50 mmf & 15-68mmf $1
- ☐ 35—MICA COND. 20-100mmf, 15-270mmf $1
- ☐ 35—MICA COND. 20-470mmf, 15-680mmf $1
- ☐ 35—MICA COND. 20-820mmf 15-1000mmf $1
- ☐ 35—MICA COND. 20-2200, 15-2400mmf $1
- ☐ 35—MICA COND. 20-3300, 15-4700 mmf $1
- ☐ 35—MICA COND. 20-6800, 15-10,000 mmf $1
- ☐ 35—CERAMIC COND. 20-5mmf, 15-10mmf $1
- ☐ 35—CERAMIC COND. 20-25mmf, 15-47mmf $1
- ☐ 35—CERAMIC COND. 20-56mmf, 15-82mmf $1
- ☐ 35—CERAMIC COND. 20-100, 15-150 mmf $1
- ☐ 35—CERAMIC COND. 20-270, 15-470 mmf $1
- ☐ 35—CERAMIC COND. 20-1000, 15-1500mmf $1
- ☐ 35—CERAMIC COND. 20-2000, 15-5000mmf $1
- TOP BRAND TUBES—1B3, 1X2B, OZ4, 5U4, 6SN7, 6CB6, 6U8, 6J6, 6V6, 6K6, 6X8, 6AX4, 12AU7 Each $1
- ☐ 3—SELENIUM RECTIFIERS 100 ma $1
- ☐ 1—LB. SPOOL ROSIN CORE SOLDER 40/60 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #1 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #2 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #3 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #4 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #5 $1

EACH ALIGNMENT TOOL is different & valued at over $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.
TELEPHONE COrtland 7-2359

TECHNICIANS' NEWS

TV CLINIC

Texas Electronics Association Inc. will hold its eighth annual TV Clinic in Houston this year. The dates are Aug. 5, 6 and 7. There will be speakers on all phases of management and technical know-how. The management program will be conducted by specialists from the Business Administration School of the University of Texas.

The latest in test equipment, components, TV sets, radios, tape and hi-fi gear will be exhibited.

The sessions will be held at the Shamrock Hilton Hotel, which has set aside more than 200 rooms at special convention rates. A program of entertainment has been planned for the ladies, and baby sitters will be available.

SEE YOUR AGENT!

On Jan. 7, 1960, one of the member firms of Television Service Engineers (Kansas City, Mo.) was burglarized to the extent of $1,400, according to *The Supreme Effort*, the TSE magazine. While this in itself is not unusual, the point worth noting is that the owner of the shop is still trying to settle with his insurance company.

TSE checked into the matter by contacting the insurance-company adjusters. They were told that there is no doubt that a loss occurred and that the policy is *supposed* to cover such a loss. TSE was also told that they were unable to arrive at a settlement that would satisfy the terms of the policy relating to "proof of loss."

According to the adjuster it is necessary to prove (through invoices) that each item covered was purchased and then prove (through sales records) that the item was not sold.

He stated specifically that *inventory records are not considered adequate to prove possession, even when reconciled with purchase and sales records since the inventory.* In many instances, the proof would have to consist of a complete audit of all business transactions since the company was founded (and even then there could be certain items not covered).

The Supreme Effort comments that the cost of such an audit might be greater than the loss involved. It recommends that all technicians go over their insurance policies with their agent and attorney. You may not have the coverage you think you have.

TRAINING PROGRAM

A 5-day refresher course in meter repairs has been announced by Weston

Instruments Division of Daystrom Inc. The course, keyed for experienced instrument repair technicians, will take place in regular plant production areas. It will involve intensive training in assembly and casing of small instruments, assembly calibration, checking and calibration of large instruments. Information on special tools and equipment will be supplied. Instruction is free, but the technician must pay for all other personal charges. Those interested are asked to write to Daystrom Inc., Weston Instruments Div., 2530 Polk St., Union, N. J.

HAVE YOU APPEARED?

RADIO-ELECTRONICS is publishing a list of known service associations in North America. Areas covered so far (in the order they appeared) are: Pennsylvania, New York, Ohio, Iowa, North Carolina, Kansas, Arizona, Michigan, California, Ontario (Canada), Massachusetts, Missouri, Minnesota, Florida, Montana and Oregon. The listings started in the August, 1959, issue. *If you belong to an association that has not been listed, let us know about it.* We have no way of knowing that your organization exists, unless you tell us.

States that seem reluctant to admit they have any activity are: Arkansas, Connecticut, New Hampshire, Oklahoma, Rhode Island and especially Texas. We have heard nothing from Alaska and Hawaii.

To list an association or to find out the name of the one nearest you, write to: Associations Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

OREGON

SOUTHWESTERN OREGON TV & RADIO SERVICE ASSOCIATION
Clyde DuPuis, secretary
333 S. Broadway
Coos Bay

NORTHWEST ELECTRONIC TECHNICAL ASSOCIATION
John C. Whitesides
1233 S. E. 44 St.
Portland 15

OREGON TELEVISION SERVICE ASSOCIATION
Cliff Kadell, secretary
219 N. Evans St.
McMinnville

RADIO TV SERVICE ASSOCIATION OF COTTAGE GROVE
Edward J. Copple
1117 E. Main St.
Cottage Grove

TELEVISION & RADIO ASSOCIATION OF KLAMATH FALLS
Rolfe Lungreen
509 Commercial
Klamath Falls

RADIO & TELEVISION DEALERS ASSOCIATION
James W. Fletcher
1351 Willamette
Eugene

TELEVISION APPLIANCE ASSOCIATION
Roscoe E. Watts
424 Failing Building
Portland

TELEVISION TECHNICIANS ASSOCIATION OF TILLAMOOK
B. L. Greeson
2108 8th St.
Tillamook

TUALATIN VALLEY TELEVISION ASSOCIATION (TVTVA)
Norn Herman
P.O. Box 91
Aloha

WEST END ELECTRONICS ASSOCIATION OF EASTERN OREGON
P.O. Box 178
Umatilla

YAMHILL COUNTY TV ASSOCIATION
210 N. Evans
McMinnville

MINNESOTA (added)

We have been informed that the secretary of CENTRAL MINNESOTA RADIO & TELEVISION SERVICE ASSOCIATION is:

Lee C. Meemken
Sauk Rapids Admiral
23 N. Broadway
Sauk Rapids

OHIO

reports another addition:

SCIOTO VALLEY ELECTRIC ASSOCIATION
Harvey McGlothlin, president
1329 Galena Park
Portsmouth

CONVENTION REMINDER

The annual NATESA convention will be held Aug. 19 to 21 at the Sheraton Towers Hotel in Chicago, Ill.

TEAM'S NEW OFFICERS

The Electronic Association of Missouri has elected Art Mayer their president; Robert Lucas, vice president; Herman Wolfe, secretary-treasurer; Tom Dooly, recording secretary, and A. Payne, sergeant at arms. A. Payne, "Beaver" Beeson, W. C. Pecht (editor, *TEAM News*), and C. W. Omohundro were elected directors.

BONUS, TRAINING PLANS

Montgomery Ward & Co. has expanded its service program to include a bonus plan for TV and appliance technicians. The company has developed a time-allowance system for different types of repair jobs. Each job is allotted a certain number of "performance credits," with each credit being equal to 1 hour's work. The figures used to set up these allotments were obtained from company repair-service records. Any technician who earns more than his assigned number of credits (a 40-hour week represents 40 credits) receives a bonus. A 40-hour-per-week man with 50 credits gets $10 bonus.

The plan takes into account cancelled calls, excess travel time, wrong addresses and two-man calls.

In addition to the bonus plan, the company has instituted a training program that will cover eight major mechanical and electrical lines representing about 95% of all serviceable items. These include television; refrigeration, laundry, radio and hi-fi equipment; heating and cooking equipment, water systems, gas engines and electric housewares.

Every Ward technician will receive at least 1 week's training during 1960.

WCATT ELECTS

The Worcester County Association of Television Technicians (Mass.) has elected as president Clem Daigneault, former secretary. Other officers include: Dave Ballou, vice president; Ed Sulkoski, secretary, Art St. Pierre, treasurer, and Al Stark, business agent.

ESFETA MEETS AUG. 7

The next ESFETA meeting will be held on Aug. 7 at Buffalo. It will convene at 10:00 a.m. For the exact location, write to Melvin Cohen, corresponding secretary, Rural Delivery 1, Hudsons Falls, N. Y.

TECHS, DISTRIBUTORS AGREE

Independent service dealers and 14 parts distributors in the Philadelphia (Pa.) area have come to an agreement on handling the problem of wholesalers selling to the general public. The distributors have agreed to the following:

Discourage retail sales by charging retail prices to nontechnician customers and crediting the technician nearest the customer's address with the price difference.

All cash-purchase slips will now contain the name and address of the purchaser.

Part-time servicers are encouraged to

obtain and use tax numbers from the state.

High-fidelity users will pay retail prices for replacement parts and supplies.

All advertising literature mailed to service dealers will be in sealed envelopes, not open flyers.

Distributors will discontinue Yellow-page advertisements and use only boldface listings.

Morris Green, president of Almo Radio Co., Inc., said: "We recognize the problems faced by the servicemen, and feel we just can't turn our head away. We feel we've come up with a pretty good tentative solution. We hope the retail customers will begin to realize they can get the same price breaks at service dealers as they can . . . by us. This will not be accomplished overnight, but we feel we have a good start. We also hope the agreement sets a pattern for the industry at large to follow . . ."

HEADS LICENSE COMMITTEE

Daniel Hurley has been appointed to head the Empire State Federation of Electronic Technicians Associations Inc. License Committee by Irving Toner, ESFETA president. All unaffiliated technicians in New York State are urged to contact Mr. Hurley at 410 Florida Road, Syracuse, N. Y. He will be glad to receive your suggestions and will keep you informed on the license bill's progress.

TESA TO EDUCATE PUBLIC

The Television & Electronic Service Association of Greater Buffalo, Inc. (N. Y.) has launched a campaign to educate the public on "what to look for in fair and honest treatment" by technicians.

"Not all television repairmen are gyps, and we want people to know the protection they can receive by dealing with a member of the association," said Edward J. Danaher, vice president.

During the past year, 2,000 complaints against technicians in the Buffalo area were made to the Better Business Bureau.

A BBB spokesman said the association has been helping to adjust complaints. He also said: "Many of our calls are from people with older TV sets. Their repair bills run up to $50."

INTERFERENCE SOURCES

Two of the major sources of television and radio interference are defective (or forgotten) heating pads and electric blankets, according to Herb Pinkham and Bob Campbell, troubleshooters for Puget Power and City Light, respectively. *TSA Service News* (TSA King County, Washington) reports that the interference can take several forms, but generally is pulses of buzz type noise.

The offending article is usually in the house, but may be as far as a block away. Occasional cases may be found where a person uses a heating pad and then puts it away, plugged in. END

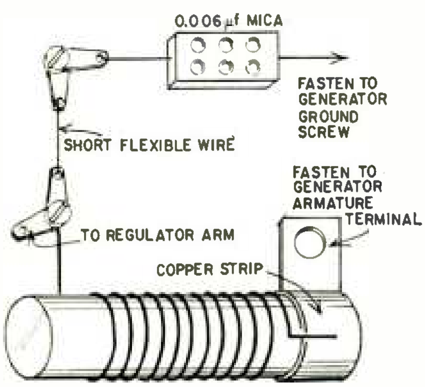
Technotes

PLASTIC CUP CURES CORONA

In some sets (particularly Admirals), strong corona discharge between the high-voltage rectifier's cap and nearby areas of the high-voltage cage is difficult to correct. A simple solution to the problem is to invert a plastic drinking cup over the tube. This trick works where corona dope fails. Any plastic drinking cup that fits can be used. Fasten it to the chassis near the base of the tube with plastic tape.—*John A. Comstock*

AUTO GENERATOR NOISE

When uhf receivers (part of a communications system operating on the public service frequencies) are installed in late-model cars, one of the



most frequent causes of noise is the car's generator. The ordinary 0.5-μf generator capacitor is seldom any help since this type filter is not effective at uhf.

The filter shown in the diagram eliminates this trouble. It consists of a choke coil wound on a 6-inch length of 1-inch dowel. It is made up of 18 turns of No. 12 wire. A .006-μf mica capacitor is used as the bypass.

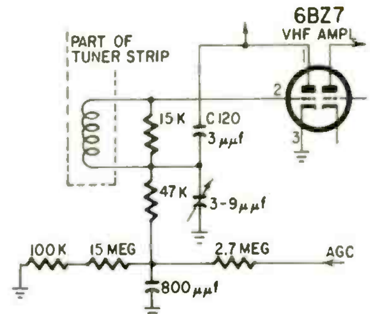
The choke will handle the output of the ordinary generator. Its winding spacing should be about the diameter of the No. 12 wire.—*A. G. Sydnor*

ADMIRAL 122DX12

A bowling-alley proprietor thought his TV set was a silver lining to the damp, rainy day clouds that kept a few patrons around. But when the picture on the set developed a silver lining on damp days he was quite understandably perturbed. The outside technician changed all tubes in the tuner, if and pix detector stages to no avail. Then he pulled the chassis.

In the shop the set proved a dog to service. A perfume atomizer was used to dampen various sections under the chassis to produce the symptom.

The silvery picture was caused by



video overload produced by low agc voltage. The agc at the tuner showed as much as 2 volts positive. The grid lead to the 6BZ7 was connected to the vtvm through a 47,000-ohm isolating resistor. The grid was 3.2 volts positive. A new 6BZ7 gave approximately the same reading.

The tuner's side plate was removed and the interior searched with a dentist's mirror and flashlight beam. Considerable grime was noticed, particularly on neutralizing capacitor C120 (3.0 μμf). Resistance readings between socket pins 1 and 2 confirmed the suspicion of a leak from plate to grid. The capacitor was cleaned with rubbing alcohol on the end of a pipe cleaner. Resistance between pins 1 and 2 disappeared. The symptom was cured. So, on a humidity-caused symptom, do not forget to humidify the tuner!—*Lawrence Shaw*

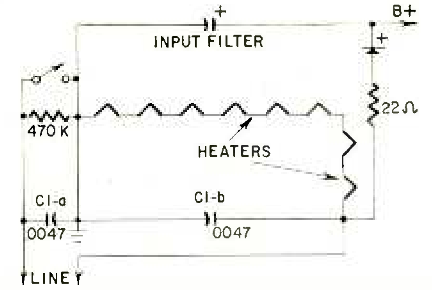
FORD 74BF

This hybrid had weak sound with only locals being received. On the bench, a signal tracer picked off normal reception at the transistor base, but not beyond that point. A voltage check showed zero potential between ground and the transistor's collector. Closer examination revealed a break, held intact by insulation, where the output transformer lead enters a terminal lug attached to the collector. This lug was removed and a new one soldered to the lead *before* attaching it to the collector, as excessive heat can ruin a transistor. This repair restored the set to normal operation.

Transistor life after a breakdown in one of its circuits is often short, and always difficult to estimate. To avoid callbacks and customer ill-will, replace when in doubt. Because I didn't, this one was back dead the following week.—*Chase Bass*

ZENITH 7T04

This AM-FM receiver was brought in one morning by the owner, who said something about a thunderstorm or lightning. I plugged it in cautiously after checking the resistance across the plug with the switch on. To my surprise it played perfectly. Some other work needed doing so this set was left to cook. It played for several hours and I had almost decided that there was nothing wrong with it when I decided to turn it off and on a few times to shock it electrically and pos-



sibly cause any failing components to act up. When the set was turned off the speaker continued to hum. A look at the tubes showed that the 35C5 heater continued to glow dimly and, suddenly, from down under the chassis came the glow of a tiny campfire. Hastily the plug was pulled and the cheery glow under the chassis died out. The reason for this strange behavior was a small two-section disc capacitor (C1) which has one section across the switch and one between the chassis and the other side of the line. The section across the switch had broken down and had a leakage resistance which was in series with the set when the switch was turned off. This current caused the defective capacitor to overheat and burn when the switch was in the OFF position (see C1-a in the diagram). This was one rare set which worked normally until it was turned off.—*Alfred L. Hollinden*

CBS-COLUMBIA U3T602

Whenever line voltage would fluctuate, the raster would momentarily collapse vertically.

The trouble was eliminated by placing a 100-ohm resistor in series with the grid lead of the vertical output tube. The resistor suppresses parasitic oscillation set up in the grid circuit because of changes in line voltage.—*J. R. Vought*

END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In August, 1910, *Modern Electrics*

The Oscillation Transformer, by M. A. Deviny.
Wireless Communication As Applied to Railroad Lines, by Dr. Lee de Forest.
Returns From Fight Sent By Wireless, by Ellery W. Stone.
Measuring Box For Condenser Capacities, by A. C. Marlowe.
Automatic Key and Aerial Switch, by J. P. Davenport.
Double Detector, by Edward B. Duvall.
Non-Inductive Potentiometer, by H. W. Secor.
New Wireless Telephone.
New Marconi Connection.

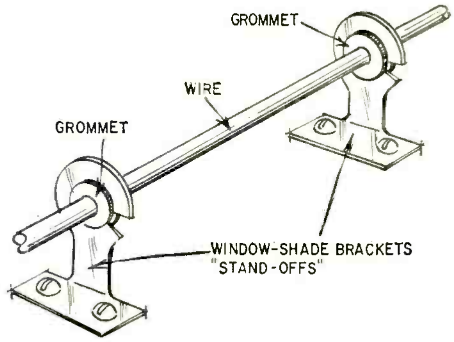
CRT COATING

Occasionally a service technician will discover a TV set whose picture tube has a defective aquadag coating. A CRT in this condition offers a poor ground connection to the ground return spring, sometimes resulting in arcing that disturbs vertical sync, causes noise specks in the picture, and a noisy discharge when the voltage builds up enough to arc to the chassis. This is not uncommon, but does present an evasive type of fault that is often overlooked. Often, this trouble occurs only on particularly damp days, when the moisture content of the air permits a high-voltage discharge through the air at the surface of the tube, between the coating and chassis.

To remedy this situation, simply paint the peeled surface of the picture tube with one or more coatings of *Carbon X*, a liquid solution commonly used to touch-up noisy volume controls. In a matter of minutes the *Carbon X* dries into a thin conductive coating around the ground spring and eliminates the arcing. This solution can even be used to completely renew the conductive coating on the outside of the CRT.—*George D. Philpott*

HINT FOR EXPERIMENTERS

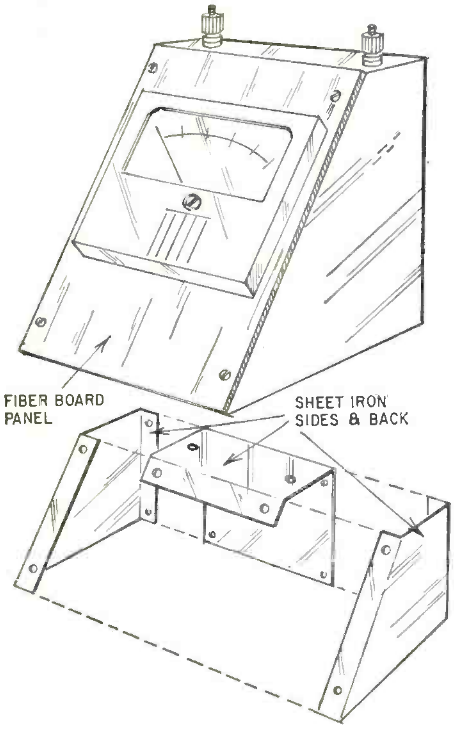
Electronic experimenters will find that ordinary window-shade brackets can have several useful applications. For example, in building experimental circuits they can be used as mounting



brackets for controls and as standoff insulators for wires. If bare wire is used, a small rubber grommet is snapped into the "eye" of the bracket. In most cases, the eye will have to be enlarged slightly by reaming or drilling.—*Scott Mock*

NONMAGNETIC METER CASE

Mounting meters in iron cases for bench use can cause errors unless the instrument is specially calibrated. As much as 10% error may be noted between readings in and out of an iron case, because of magnetic shunting.



Satisfactory meter cases can be made with sheet-iron sides and backs if the front panel is nonmagnetic. A piece of fiberboard attached to the metal frame with screws or rivets will make an ideal mount.—*Hugh Lineback*

UNUSUAL ANTENNA JOB

The customer reported his antenna was blown down during a wind storm, so immediately upon arrival I climbed to the roof to reinstall the torn-out roof mount.

"Hey, don't do that!" the excited customer called out from below, as I lifted the antenna to set it back into its mount.

"Why not?" I shouted back.

"Because I get better pictures with the antenna lying on the roof. All I want you to do is install the antenna in that position," was the immediate answer.

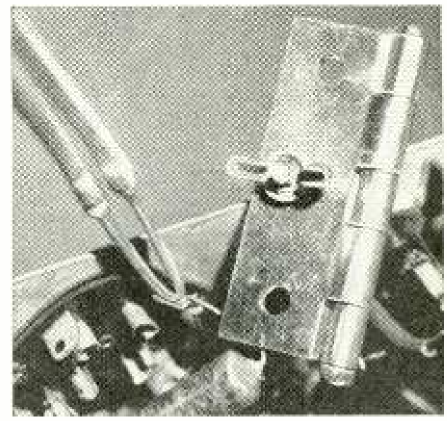
What a request! Before attempting to do anything more, I put the antenna back where it had fallen and climbed down from the roof to have a ground-level talk with the customer, and a look at the set.

Sure enough, reception *was* much better with the antenna on the roof than with it in the roof mount! Remembering that old business motto "The customer is always right" (and he *was* this time), I reinstalled the antenna in a lower position that gave reception equal to the antenna lying on the roof.

Moral: If the customer's house happens to have aluminum-foil insulation, try several *low* positions when you install that TV antenna. It may mean a signal difference of several microvolts or more!—*John A. Comstock*

HANDY HEAT SINK

An ordinary metal hinge with a small machine screw and wing nut through a pair of its mounting holes makes a dandy heat sink when you have to solder or unsolder a heat-sensi-



tive component from a circuit. Just unscrew the wing nut a little way, slip the sink over the component's lead and tighten the nut again. This is much easier than using pliers—particularly if the soldering job happens to be a three-handed one.—*Jerome A. Carlson*

HOLE SHRINKING

After tightening and loosening a self-tapping screw several times, the threads on the tapped metal become loose. This also happens when machine screws are used with tapped holes in sheet metal. To make the hole tight again, just shrink it!

Sheet metal can be compressed into the hole by center punching. Six or so sharp punches with a prick punch around the hole and about ⅛ inch away does for most cases. Hold a hammer against the other side so that the metal does not bend if it is thin. If six punches do not do the job, try more or punch the same holes again.—*Robert James*

STICKY RELAY CURE

If the moving armature of a relay touches the pole piece after it has pulled in, the relay may not release the armature at the prescribed dropout current or voltage across it.

The cure is *smooth* insulating material cemented to either the pole piece or the armature. Use varnished cambric, Mylar, etc. Cellophane tape is good in an emergency but crinkles with age.

Be sure to remove any surplus adhesive as the relay may be even more sticky if the surface is not smooth.—*James Alan*

COMPOUND FILLS HOLES

When installing antennas on roofs, I find it handy to carry a tube of calking compound in my toolkit to fill holes made by guy-wire anchors, and in window sills where a lead-in feeds through. The compound is more convenient to carry than tar since it comes in a tube like toothpaste and just one squeeze fills most holes.—*Joe C. Allen*

BUSINESS and PEOPLE

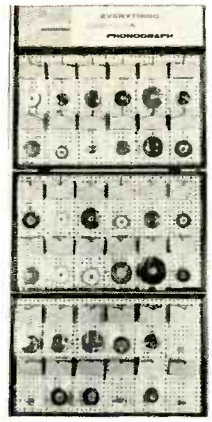
W. S. Parsons was re-elected vice president of Globe-Union, Inc., Milwaukee, Wis., parent company of Centralab, in an administrative reorganization resulting in increased divisional autonomy. He was also appointed president of Centralab Electronics Div. **Walter E.**

Peek (left) was elected vice president, marketing, of Centralab, a new position created in line with the reorganization. He had been general sales manager. **Bruce E. Vinkemulder**, former assistant general sales manager advanced to marketing manager. **G. C. French, Jr.** was appointed vice president, manufacturing; and **R. L. Wolff**, vice president, engineering.

Herbert W. Clough, vice president, marketing, of Belden Manufacturing Co., Chicago, was elected to the board of directors.

William Djinis is now chief engineer in charge of all scientific activities of Electro - Sonic Laboratories, Inc., Long Island City, N.Y. An author and physicist, he had been head of the Physics Research Department of General Bronze Electronics Corp.

Sprague Products Co., North Adams, Mass., is merchandising a special selection of electrolytic capacitors for radio-television technicians in a plastic job tray holding 15 tubular electrolytic capacitors in the 12 most frequently used ratings. It is known as the EK-3 Atom Assortment.



Jensen Industries, Forest Park, Ill., is merchandising its new line of phonograph drive wheels, idlers, pulleys, tires and belts in a new Wheel Deal display rack. The new line includes 75 wheels that may be used in phonographs made by 29 leading manufacturers.

L. Edward Cotsen, formerly distributor sales manager of Tung-Sol Electric Inc., Newark, N. J., was advanced to assistant to the vice president in charge of sales. **Richard L. Jandl** (left), previ-

ously regional original equipment markets sales manager succeeds him. **Harold F. Cook** (right), becomes manager of marketing services, directing the advertising, sales promotion, market research and sales planning departments.

Jerrold Electronics Corp., Philadelphia, Rep of the Year Award went to

Ray R. Hutmacher Associates, Chicago. Walter Goodman (left), division manager, is shown making the presentation to Ray Hutmacher as Lou Waelterman, (right) Jerrold Midwest regional manager, looks on.

Raytheon Co., Waltham, Mass., presented the grand prize in its treasure hunt for industrial electronics salesmen to Joseph Donahue, Wholesale Radio &

Parts Co., Baltimore, Md. John Hickey (left center), industrial products manager of Raytheon's Distributor Products Div., is shown presenting $500 and tickets for a 15-day tour of Europe to the winner. John T. Thompson (left), general manager of the division, and Paul Cunningham (right), Baltimore area sales manager, look on.

Triplett Electrical Instrument Co., Bluffton, Ohio, is breaking ground for a new addition to its plant—the second major expansion in 3 years. R. L. Triplett, (center) chairman of the board and founder, looks on as his two sons, M. M. Triplett (left), vice president, and W. R. Triplett (right), president, prepare to dig in. Municipal officials and civic leaders look on.

Sencore, Addison, Ill., has been holding a series of time-saving clinics sponsored by local distributors throughout the United States and Canada. Photo shows a group on Long Island sponsored by Gem Electronics. Ed Flaxman, Sencore vice president, and Steve Fisher, New York representative, were on hand to answer technical questions and to introduce the company's new tube tester, the Mighty Mite.

Switchcraft, Inc., Chicago, Ill., developed a low-cost, practical language laboratory system which it states will help revolutionize language training libraries. Tom Dowell, distributor sales manager, demonstrates the equipment to a group of language students.

Hickok - Electrical Instrument Co., Cleveland, Ohio, celebrated its 50th anniversary at a dinner attended by civic and industrial leaders. Mrs. Robert D. Hickok, Sr., widow of the company's founder, was presented with a bronze plaque authorized by the board of directors. She is shown with R. D. Hickok, Jr., president of the company. END

new LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

GENERAL CATALOG *No. 61* is actually four books in one. First section describes nearly 1,500 coils and coil products. Second section cross-references TV manufacturer's parts numbers with Miller numbers. Third section does the same with auto radios while the fourth covers home radios.—**J. W. Miller Co.**, 5917 S. Main St., Los Angeles 3, Calif.

TUNERS and high-fidelity amplifiers are described in several catalog sheets. —**Harman-Kardon, Inc.**, 520 Main St., Westbury, N.Y.

COMMERCIAL SOUND products are described in *Catalog No. 132*. Specifications and graphs are given on microphones, PA loudspeakers and transformers. Included in this 32-page book is a guide for selecting the right microphone for a given job.—**Electro-Voice Inc.**, Buchanan, Mich.

PHONOGRAPH NEEDLES and accessories are described in a 48-page catalog. Duotone needles are cross-referenced to other manufacturers' needles and phonograph models. Each needle is illustrated so customers will have less trouble identifying the replacement needle for their phonograph.—**Duotone Co., Inc.**, Keyport, N. J.

TV TRANSFORMERS are cross-referenced to set manufacturer's numbers in 52-page *TV Transformer Replacement Guide*. Specifications of the replacement units are given. Available from distributors or manufacturer. — **Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

PEC GUIDE *No. 6* describes in detail over 150 packaged electronic circuits. Test information, circuit diagrams and component values are given. Also included is a cross-reference to other manufacturers' packaged circuits. — **Centralab, Div. of Globe-Union, Inc.**, 900 E. Keefe Ave., Milwaukee 1, Wis.

CATALOG of electronic supplies describes and illustrates transformers, coils, tubes, test equipment, hi-fi equipment, etc. Special emphasis is given to ham gear.—**World Radio Laboratories,**

3415 W. Broadway, Council Bluffs, Iowa.

AUTOMATION is the subject of 16-page *Bulletin GED-3908*. Process control, computing, instrumentation, numerical control of machines, sensing and communications—the six key functions of automation—are discussed.—**General Electric Co.**, Schenectady 5, N. Y.

PICTURE-TUBE MANUFACTURE is the subject of *Six Miles Of Sylvania Craftsmanship*. This 24-page, fully illustrated booklet describes the techniques and facilities used in making TV picture tubes. Available from distributors or manufacturer.—**Sylvania Electric Products, Inc.**, 1100 Main St., Buffalo 9, N. Y. **10¢**

TOOLS are described and illustrated in 24-page *Catalog No. 103A*. Pliers of all types, wire-skinning and other special knives and tool kits and pouches are covered.—**Mathias Klein & Sons**, 7200 McCormick Rd., Chicago 45, Ill.

LOUDSPEAKERS are covered in an 8-page catalog *Crescent Speakers*. High-fidelity, automotive and public-address units are described.—**Federated Industries, Inc.**, 4477 Elston Ave., Chicago 30, Ill.

RESISTORS and electronic hardware are covered in *Catalog No. 62*. Couplings, binding posts, handles, knobs, shaft locks, washers, precision resistors, tapped resistors and standoffs are but a few of the items described and illustrated.—**Sterling Precision Corp., Instrument Div.**, 17 Matinecock Ave., Port Washington, N. Y.

CITIZENS BAND posters are available for marinas and boat landings which continuously monitor Citizens band channel 13 (unofficially selected as a national calling frequency). Qualified marinas or landings should send letter or card to manufacturer stating that they continuously monitor channel 13. —**Kaar Engineering Corp.**, 2995 Middlefield Road, Palo Alto, Calif.

COMMUNICATIONS EQUIPMENT for amateur, aircraft and broadcast use is listed in 94-page *1960 General Catalog*. Transmitters, receivers, radars, transponders, antennas and a spectrum analyzer are among the many items covered.—**Collins Radio Co., Cedar Rapids Div.**, Cedar Rapids, Iowa.

CIRCUIT HANDBOOK has 30 battery-powered transistor circuits. *Transistor Circuit Handbook for the Hobbyist* shows schematics for audio and entertainment equipment, transmitter modulators, preamps and rain alarms. Available from distributors or from manufacturer.—**Sylvania Electric Products, Inc.**, P. O. Box 37, Buffalo 9, N. Y. **50¢**.

SMALL PANEL METERS are described in *Bulletin GEA-7034*, 12 pages of specifications, features, ordering instructions and prices. A description of custom features for special applications is included.—**General Electric Co.**, Schenectady 5, N. Y. END

new BOOKS

ZENER HANDBOOK. International Rectifier Corp., El Segunda, Calif. 100 pp. $2.

The Zener diode has become an important and useful member of the semiconductor family. This handbook discusses theory and design considerations. Applications include dc and ac, af and rf circuits, computers and circuit protection.—*IQ*

ELECTRONIC GUIDE. References for Research Div., Electronic Guide Publishing Co., Burbank, California. 7 x 10 in. 191 pp. $7.50.

This directory lists all the electronic articles that have appeared in close to 50 periodicals of seven nations. It covers the year 1959. The articles listed are arranged by title under appropriate category headings.

DIGITAL COUNTERS AND COMPUTERS, by E. Bukstein. Rinehart & Co., 232 Madison Ave., New York 16, N. Y. 6¼ x 9¼ in. 248 pp. $7.

As presented on its jacket, this text contains "a complete description of the theory, design and application of digital counters and computers, including the interpretation and use of their output." Though written for the student or practicing electronic engineer, the text is not too difficult for the electronic experimenter. Twelve chapters take the reader from nonsinusoidal waveforms to analog and digital converters. Of course, there are stops along the route to cover binary and decade counters, readout indicators and circuits, number systems, storage devices and other important topics.—*LS*

BASIC ULTRASONICS, by Cyrus Glickstein. John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y. 6 x 9 in. 144 pp. Soft cover $3.50. Cloth cover $4.60.

Handled in the modern picture-book style, this work gives the beginner in ultrasonics a clear idea of the subject. It is divided in three sections. The first, "General Theory", explains exactly what ultrasonics is. The second, "Equipment", shows chiefly how it is generated. The third gives the applications of ultrasonics to a large number of measuring, therapeutic and other uses.

The author, Cyrus Glickstein, is well-known to our readers, having had a number of articles published in this magazine.—*FS*

FUNDAMENTALS OF SEMICONDUCTORS, by M. G. Scroggie. Gernsback Library, Inc., 154 W. 14th St., New York 11, N. Y. 5½ x 8½ in. 160 pp. $2.95.

If you don't understand the Hall effect, electroluminescence, masers, Zeners or thermistors, you need this book. Of course, transistors also receive considerable attention.

Written for electronic technicians, it

is highly informative and easy to follow. The first few chapters discuss atomic systems, energy, junctions and other physical concepts. From this theory you will be able to understand the function and use of special devices like Spacistors, Unijunctions, solar generators and tunnel diodes, to mention only a few of the many semiconductors described here.—*IQ*

A GUIDE TO STEREO SOUND, by David Tardy. Popular Mechanics Press, 200 E. Ontario St., Chicago 11, Ill. 9½ x 6¾ in. 192 pp. $4.95.

An explanation for the beginner who gets confused by long-winded theoretical explanations of what stereo is and how it works. Here, written in simple, uncomplicated language is the story of stereo, starting with "Why Stereo" touching on "Sound & Location, Amplifiers for Stereo" and ending with "Stereo Stored."—*LS*

CLASS-D CITIZENS RADIO, by Leo G. Sands. Ziff-Davis Publishing Co., 1 Park Avenue, New York 16, N. Y. 9¼ x 6 in. 181 pp. $4.95.

A basic introduction to Citizens radio for all who are interested in Citizens radio equipment or want to know more about this rapidly expanding field. Its nine chapters and three appendices cover the many aspects of Citizens radio.—*LS*

101 WAYS TO USE HAM TEST EQUIPMENT, by Robert G. Middleton. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 168 pp. $2.50.

The grid-dip meter, antenna impedance meter, bridge, voltmeter and scope are the instruments most often mentioned in this book. The author shows how to use them to test, measure and adjust receivers, transmitters, filters, amplifiers, antennas, etc. All procedures are given in detail, making it easy for any ham to keep his shack in first-class operating condition.—*IQ*

MASERS by J. R. Singer. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 6 x 9 in. 147 pp. $6.50.

The maser is a relatively new instrument of modern science. It is useful at very high frequencies as an oscillator, amplifier or frequency standard. Though expensive and complex, it has the important advantage of low noise. The author discusses solid and gaseous types, two-level and three-level, and shows how they are used. No advanced math is required, but the author does rely on equations to explain the theory.

TWO-WAY RADIO, by Allan Lytel. McGraw-Hill Book Co., 330 W. 42nd St., N. Y. 36, N. Y. 6 x 9 in. 289 pp. $9.50

Besides being a valuable introduction to two-way radio, this book is a useful text on FM. Since that system of modulation is almost exclusively used in two-way radio, the author has gone into it in considerable detail. He devotes his first four chapters to an introduction

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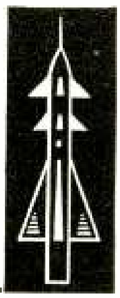

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to FM—modulation, transmitters and receivers. A chapter is, however, given to AM transmitters and receivers, and the rest of the book covers installation, antennas, selective calling systems and servicing.—*FS*

UNDERSTANDING MICROWAVES, by Victor J. Young. (Abridged Reprint) John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11, N.Y. 5½ x 8½ in. 292 pp. $3.50.

It isn't an easy task to write a good book on microwaves without resorting to deep math. This author has done it. He explains the mysteries of transmission lines, waveguides, antennas and oscillators from a physical standpoint. Vectors are introduced to pave the way for Poynting's formula and Maxwell's equations, but most of the math is left for footnotes.

The book begins with the elements of fields, charges and electromagnetics. It ends with discussions of microwave tubes, radar and communications.—*IQ*

EXPERIMENTS IN ELECTRONICS, by W. H. Evans. Prentice-Hall Inc., 70 Fifth Ave., New York 11, N. Y. 6 x 9 in. 374 pp. $6.95.

This is a lab course for college electronics students. Experiments cover the use of test equipment, operation of circuits, tests and measurements. Both tube and transistor circuits are included. Among them are amplifiers, flip-flops, multivibrators, modulators, sweeps, etc.

Readers need a good knowledge of theory and math to gain full benefit from this book. It is not for beginners.

RADIO CONTROL FOR MODEL BUILDERS, by William Winter. John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11, N.Y. 5½ x 8½ in. 220 pp. $4.25.

You too, can join in the fun. This book tells about radio, remote control, models and how they go together. It contains chapters on receivers, transmitters, batteries, actuators and relays. Simple and complex units are discussed. You will also find the latest FCC regulations as they apply to control. END

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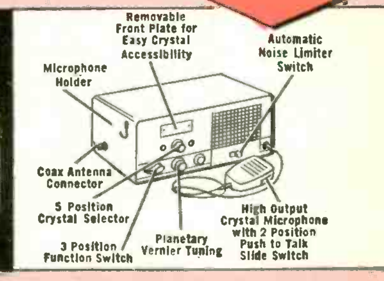

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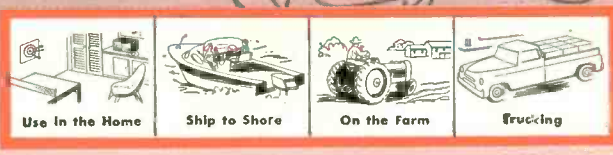

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