HUGO GERNSBACK, Editor-in-chief ■ MAY 50c

65

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

A GERNSBACK PUBLICATION

MASTER NIP 74

Easy-to build stereo speakers

Soup up your TV tuner

Make a musical horn for your car

FETs-P 49

Build this all-transistor FM multiplex generator

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Most of the quality TV sets you are presently servicing were designed around special Frame Grid tubes originated by Amperex. More and more tube types originated by Amperex are going into the sets you'll be handling in the future. Amperex Frame Grid tubes provide 55% higher gain-bandwidth, simplify TV circuitry and speed up your servicing because their extraordinary uniformity virtually eliminates need for realignment when you replace tubes.

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	6EH7	6EJ7	6ER5	6ES8	6FY5	6GJ7	6GK5	6HA5	6HG8	7HG8	8GJ7

If your distributor does not yet have all the Amperex types you need, please be patient—in some areas the demand keeps gaining on the supply.

Amperex Electronic Corporation, Hicksville, Long Island, New York 11802.

CATV Sí—CATV No: Twin Editorial, page 29

Radio-Electronics

MAY 1965 VOL. XXXVI No. 5

Over 55 Years of Electronic Publishing

Member, Institute of High Fidelity
Radio-Electronics is Indexed in Applied Science & Technology Index (Formerly Industrial Arts Index).

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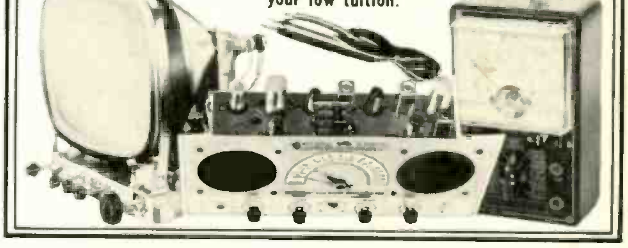

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NEWS BRIEFS

CW RUBY LASER WORKS AT ROOM TEMPERATURE

Scientists at Hughes Aircraft Co.'s Research Labs report continuous operation of a ruby laser at room temperatures. Previously, CW solid-state lasers could operate only at temperatures a little above absolute zero.

Dr. George F. Smith, associate director of Hughes Aircraft Company's Research Laboratories, demonstrates the new room temperature CW ruby laser.

Output is relatively low, according to Dr. George F. Smith, associate director of the Labs, but the technique shows promise of producing significant amounts of power—in the order of watts—at visible frequencies. The laser consists of an ordinary ruby rod, 2 mm in diameter and 2.54 cm long, pumped to threshold by a single mercury lamp operating at 1,000 watts in a specially designed elliptical cavity. The unit is water-cooled.

In a related experiment, Hughes scientists also suppressed all but one mode (one output frequency) from a small pulsed ruby laser. These simple mode-selection techniques are compatible with the CW configuration and therefore should open the way for solid-state lasers—with their much larger power capabilities—to qualify for many of the applications previously limited to gas lasers, Dr. Smith said.

HAMS SELDOM TO BLAME FOR TVI

The amateur radio operator is often the first to be accused in many complaints of radio or television interference. A report issued by Britain's Post Office Engineering Department—the equivalent of our FCC—points out that, of 15,134 cases of interference, only *82* were caused by amateurs.

Fifty-four cases of TVI on the vhf channels were traced to amateurs while 343 complaints were caused by radiation from the deflection circuits of other TV receivers. Among the other offenders were 1,585 contact devices (thermostats, switches, etc.), 824 sewing machines, 322 portable electric tools, 210 hair dryers, 149 filament type lamps and 366 neon signs. Overhead power lines accounted for 1,237 complaints. The greatest cause of complaints (6,160) was unsatisfactory conditions at the receiving location.

SHARK-REPELLER TO BE MARKETED

An electronic shark repeller that repels sharks 20 to 30 feet away without harming other fish or humans will be produced in various forms for skin divers, boats, rafts, fishing nets and beach equipment by Marine Industries Inc. of New York. The repeller includes a dipole antenna, a capacitor and a multivibrator that releases a pulse every second. It is battery-powered.

MORE TUBES THAN TUBS

According to *TV Guide* magazine, 93.5% of all homes in this country have a television set, whereas only 82% have bathtubs or showers. Furthermore, sets are tuned in an average of 5 hours and 25 minutes each day (or 82 full days a year). This, says *TV Guide*, means that television occupies 70% of a family's leisure time.

To sweeten these fulsome statistics, the article points out that all this pleasure costs only 13 cents a day for electricity and repairs.

FCC REAFFIRMS STAND ON CITIZENS-BAND ORDER

The FCC Report and Order of July 29, 1964, goes into effect April 26, the FCC announced. The Order, which aroused a storm of protest from equipment manufacturers, hobbyists, Citizens-band users and others, had been delayed to give a hearing to those who objected to it.

The document was intended to define more clearly some of the rules covering Citizens-band use. It limits communications between units of different stations to 7 channels out of the 23 allocated. If, for example, a TV service shop has a Citizens-band license, it can communicate only between base and mobile units of the shop operating as units of the same station, or between two of the shop's mobile units in the field, but not to other Citizens-band stations, except on channels from 9 to 14 and on channel 23.

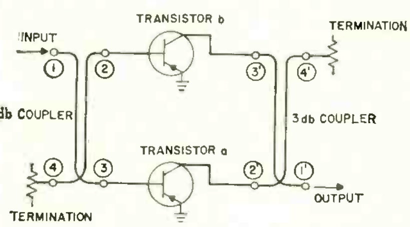
Use of the stations for hobby purposes or discussions of the performance of the licensees' equipment were also forbidden under the Order, as well as dx, which is defined as communication over a distance of more than 150 miles.

Objectors maintained that the amendments abridged licensees' freedom of speech, were in effect censorship and were generally not in the public interest.

The FCC considered these points and in a Memorandum and Order dated March 1, answered each one in full in considerable detail and, in many cases, with examples to illustrate the types of communication considered under the act. The Order concludes ". . . all other amendments to Part 95, Citizens Radio Service, adopted by the Report and Order on July 22, 1964, are affirmed; and it is further ordered that these rules shall become effective April 26, 1965."

THIN-FILM MICROWAVE AMPLIFIER HAS 1,000-MC BANDWIDTH

K. M. Eisele, R. S. Engelbrecht and K. Kurokawa of Bell Telephone Laboratories report an amplifier that operates at the highest frequency and the widest bandwidth ever achieved with integrated circuits. It operates from 500 to 3,000 mc (0.5 to 3 gc).



This simplified single-stage circuit diagram of the new integrated-circuit broad-band amplifier shows the balanced circuitry.

This is twice the frequency and bandwidth of the best transistor circuits, and equals or surpasses most traveling-wave tubes in its frequency range.

The wide-band performance was made possible by a balanced amplifier

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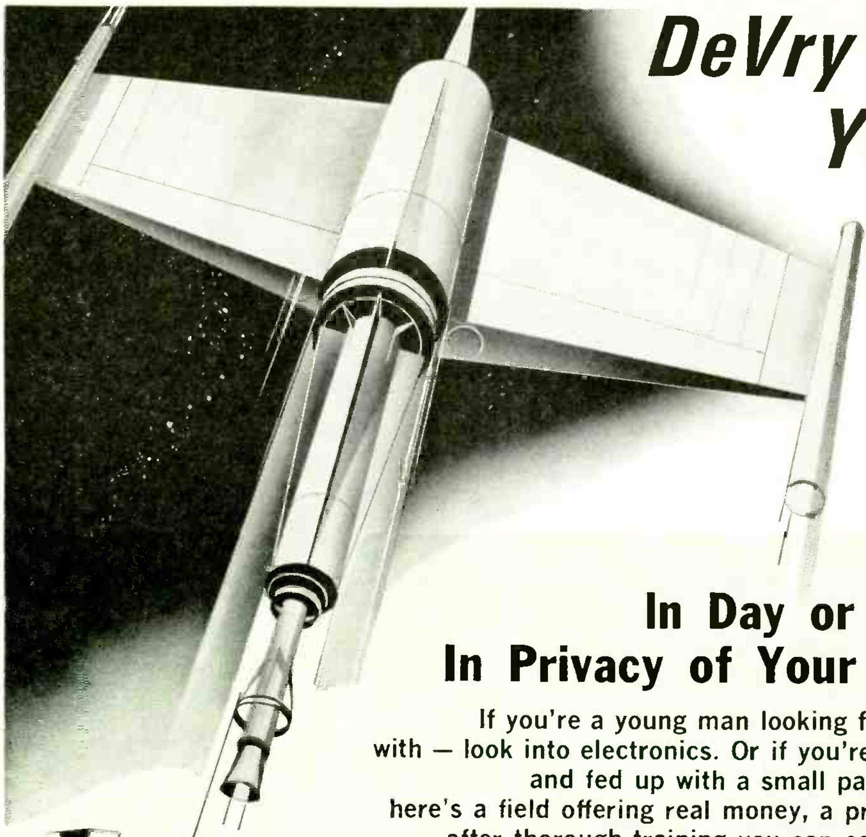

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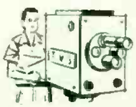

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design. The circuit consists of a pair of electrically similar transistors for each amplifier stage, with their input and output signals combined by a 3-db directional coupler. This design matches the impedances at the input, output and interstages, eliminating the need for tuning adjustments. It permits operation at lower noise figures and higher output powers than is possible with conventional designs.

Typical gains of 6 db per stage in the 1–2-gc range and 3 db per stage in the 2–3-gc range are obtained. The best noise figures, with production germanium transistors, are near 5 db at 1 gc and 8 db at 2.5 gc. This noise performance is comparable to noise figures typically obtained with traveling-wave tubes. With special experimental transistors, gains as high as 12 db in the 1-gc range and 6 db in the 2-gc range have been obtained, with further improvements in noise figures.

SEVEN TV STATIONS ON ONE LASER BEAM

The signals of all seven New York City TV stations were picked up and relayed over a single laser beam, the Army reports from Fort Monmouth, N. J., where the feat was accomplished. The signals were again picked off the laser beam and displayed on seven ordinary television sets.

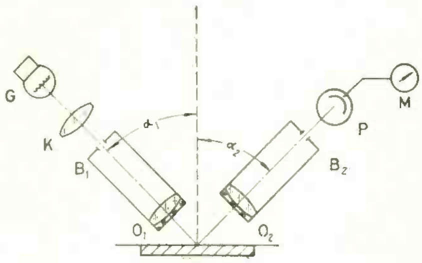
The signals of New York City's stations, from channel 2 to channel 13, were received on an antenna on the roof of The Hexagon at Fort Monmouth. They were amplified with a "off-the-shelf" broadband amplifier, and the entire spectrum, nearly 200 mc wide, was modulated onto the laser beam with a new type of modulator using a pair of matched potassium dihydrogen phosphate (KDP) crystals in a special 45° Z-cut.

The new modulator, developed by Texas Instruments, is the secret of the accomplishment. Signals from one TV station have been transmitted by laser, but heating of the modulation equipment prevented sending more than one station's signals on the beam. The Texas Instruments device operates at 20 volts rather than the 1,000 volts required by earlier modulators.

The demodulator is a silicon photodiode, operated in the "avalanche" condition, which greatly improves its sensitivity. The laser itself is a helium-neon type, operating on a wavelength of 6,328 Angstroms.

ELECTRONICS NOW MEASURES GLOSS

An instrument for measuring gloss electronically has been introduced into the United States by Carl Zeiss, Inc. It is expected to find applications in the paint, paper, ceramic, textile, plastic and metal industries. It will also be useful as a scientific research instrument in crystallography, metallography, histography and wherever else surface gloss is important.



Principles of the Zeiss GP 2. Gonio-photometer is supplied by lamp G and condenser lens K and is focused on the specimen through an illuminating collimator consisting of lens 0_1 and interchangeable stop B_1. Reflected light goes to photocell P through an identical collimator and current generated by the photocell is measured by meter M.

The device measures gloss at various angles—up to 150°—an important feature, since the reflectance of many glossy surfaces varies according to the angle of incidence.

3-D TELEVISION FROM CZECHOSLOVAKIA?

According to Edouard Hofman, director of the Czech television movie department, Czech television will start

continued on page 8

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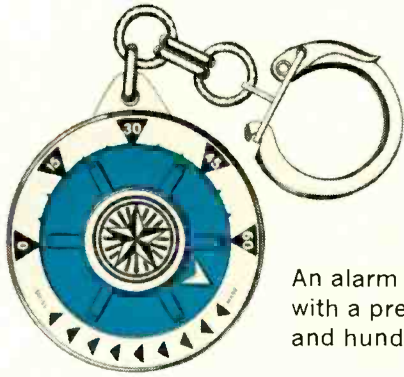

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NEWS BRIEFS continued

regular showings of three-dimensional TV this year. Anyone willing to put an inexpensive filter on his television set can view it, Hofman said. The first public trials of this *stereoplastic* television will be at the Festival of Prague, June 9–18. The principle is said to be somewhat similar to that used in 3-D movies.

INCREASE IN NUMBER OF WOMEN ENGINEERS

Mrs. Catherine Dryden Hock, reliability and quality assurance systems engineer at NASA Headquarters, told the New York section of the Society of Women Engineers that the interest in space programs appears to have reversed the declining trend in the number of women government engineers.

Between 1959 and 1963, Mrs. Hock said, the number of women in government grades of GS-12 and above in computer fields rose 790%, in mathematics and mathematical statistics 137%, in physical sciences 122%.

The decline in percentage of women in engineering jobs from 1.2% in 1950 to 0.9% in 1960 seems to have been reversed by the interest in space. NASA's engineering force is 3% women.

ITU CELEBRATES BIRTHDAY

The International Telecommunication Union—the intergovernmental organization that regulates world communications—is 100 years old May 17. It was founded in Paris in 1865 as the International Telegraph Union by the signing of the first International Telegraph Convention.

VLADIMIR K. ZWORYKIN HONORED BY BRITISH ENGINEERS ✓

Dr. Vladimir K. Zworykin, inventor of the iconoscope and the man who developed TV as we know it, has been awarded the Faraday Medal of the Institution of Electrical Engineers, London.

The medal is presented "for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science." Dr. Zworykin is the fifth American to receive the medal since the award was instituted in 1922. Earlier American recipients were Dr. D. W. Coolidge, Dr. Irving Langmuir, Dr. Ernest O. Lawrence and Dr. J. A. Stratton.

Dr. Zworykin was cited "for his notable scientific and industrial achievement in inventing the iconoscope and for his important role in medical electronics."

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CALENDAR OF EVENTS

Sencore Color TV Service Clinics: week of April 19, N. Dakota, S. Dakota, Minnesota; week of April 26; Michigan; week of May 3, Ohio, western Pennsylvania. Information on time and location from local parts distributors.

Symposium on System Theory, Apr. 20–22; Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

19th Annual Frequency Control Symposium, Apr. 20–22; Shelburne Hotel, Atlantic City, N. J.

B & K Instrument Seminars: Apr. 26–30, 203 Jackson Building, 220 Delaware Ave., Buffalo, N. Y.; May 10–14, 1605 Chatham Ave., Charlotte, N. C.; May 17–21, 1845 Temple Dr., Winter Park, Fla.

Southwestern IEEE Conference & Electronics Show (SWIEEECO), Apr. 21–23; Dallas Memorial Auditorium, Dallas, Tex.

NAECON (National Aerospace Electronics Conference), May 10–12; Dayton, Ohio

IFIP Congress '65, May 24–29; New York Hilton Hotel, New York, N. Y.

PROPOSES ANTENNA FARMS

Testifying before the House Commerce Committee against a bill that would ban new TV towers over 2,000 feet if they are shown to be a hazard to aircraft, Najeeb E. Halaby, head of the Federal Aviation Agency, said the best method of dealing with the problem was to create antenna "farms", where all towers in a community would be situated.

E. William Henry, chairman of the FCC, concurred and said the commission was making a formal proposal that such farms be established. END

"My TV set went dead over the weekend".
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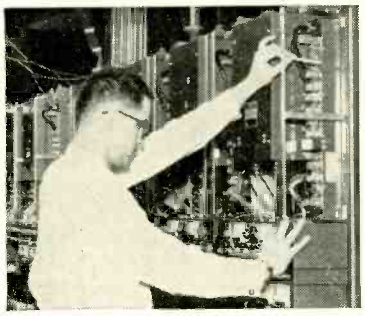

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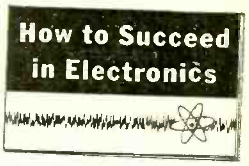

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Correspondence

TRANSISTOR IGNITION: THUMBS DOWN

Dear Editor:

Over a year ago I bought, by mail, a transistor ignition system, manufactured by a well known electronics company. Installed by a man who specializes in auto ignition, it gave satisfactory service for over a year. Note I say the performance was *satisfactory*—nothing more. Gas mileage was no different, nor was acceleration. True, the points may have lasted longer. I never had a chance to find out. Also, no condenser was required at the points (a condenser is not exactly an expensive item).

A few weeks ago, however, the car would not start. The engine turned over, but would not "catch". I took the air filter off to be sure the choke plate was open, found it was, and still could not get going. So I called a service station and had the car towed in. I had forgotten all about the transistor ignition. The service man installed new points in the hope this would do something. Before trying to start the car, he said there was no condenser in the distributor and he wanted to install one but could find no clamp to hold it. Then I remembered the transistor ignition and informed him about it—that was why the condenser had been removed. He tried again to start the car, without success. He then indicated right away that, with the transistor ignition, he could do no more. It was then that I began to realize that the old-fashioned coil and orthodox ignition had a great advantage even if the points did take a beating: Almost every mechanic worthy of the name could work on it.

So the car was towed again, this time to a garage with an excellent reputation. There I was told the trouble was in the transistor ignition, either in the coil or the transistor unit. They could not tell which was defective, and had no equipment to test the units. The only way they could get the car going again would be to disconnect the transistor ignition and put back the old coil. I made a trip back home to find it, but couldn't. (A day or so later, after the car had been repaired with a new coil, I located the old one.)

A **HOWARD W. SAMS** SPECIAL PUBLICATION

Color TV Guidebook

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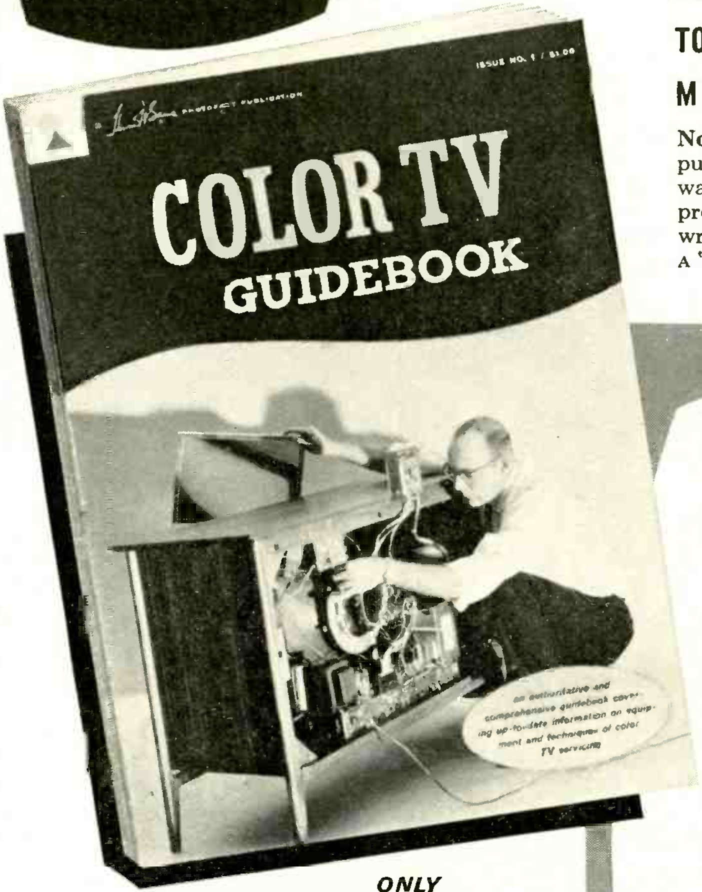

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- **A Color Broadcasting Center**—An interesting tour of the new CBS color broadcasting complex in New York.
- **Starting a Color TV Service Business**—What it takes and what you should know to realize the big profit potential in this field.
- **Using Your Head in Color Servicing**—Tells the technician how to think through the problems of color servicing—important for newcomers to the field.
- **Selling Color TV**—An informative discussion of how to turn those three basic colors into the "long green."
- **Are You Equipped for Color?**—A complete run-down on the instruments and tools required for successful color TV servicing.
- **Color Tube Stock Chart**—Invaluable information on the types and quantities of tubes required for practical stocking.
- **Color-Picture Symptoms**—A four-color picture story showing you how to make use of troubleshooting clues revealed by the screen of a malfunctioning color set.
- **The Facts About Color TV Antennas**—Full analysis of antennas and how to choose the right one for the job.
- **Color Waveform Analysis**—A picture story of waveforms encountered in color sets, providing basic information for making a true analysis of waveforms.
- **Quicker Checks with Color-Bar Patterns**—4-color picture story showing fast ways to test color sets by observing the effects of color-bar patterns on the TV set screen.
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After the ignition was hooked up in the orthodox manner, the engine started promptly.

The moral of this story is plain: transistor ignition offers no advantage over regular ignition and, if something fails, you are in real trouble!

Of course, my transistor equipment was out of warranty. Even if it had been in warranty, I would have had the problem of getting the car fixed and moving again.

If you are contemplating trying transistor ignition, go ahead, but keep your old ignition equipment in the trunk. You never can tell when you might need it again!

JAMES K. HALL, JR.
Richmond, Va.

TRANSISTOR IGNITION: THUMBS UP

Dear Editor:

There seems to be a lot of dissension among readers about which is the best type of transistor ignition. Everyone seems to agree that the transistor system is better than the conventional.

I built the Motorola version of what I now lovingly call "the old reliable" since it was one of the first around. I have run the very same ignition in different cars without ever having it fail. The cars included two older-model six-cylinder Chevrolets, a V-8 Mercury, a Volkswagen and a fuel-injection Stingray.

Except for the Volkswagen, which showed no increase in performance or gas mileage, every car showed an increase of 2 to 4 mpg. Due to the low rpm of the four- and six-cylinder engines, I don't feel they ever reach the operating range where the transistor ignition shows itself at its best.

The high-performance Corvette engine showed the most remarkable gains in both performance and mpg. The first time I took it for a test run, I noticed as I accelerated that, instead of a gradual decrease in acceleration as the engine rpm increased, there was a new burst of life at about 3,000 rpm. Several months later, when I removed the ignition, I verified that this was not an illusion, for I immediately noticed a great loss of power. I'm all for the guy who can "invent a better transistor ignition."

STEVE STUMPH
Lawndale, Calif.

IT WON'T WORK THAT WAY

Dear Editor:

I am surprised that you printed the letter from Mr. David C. Yeoman (Correspondence, January R-E, p. 27) with the criticism of my method of measuring high resistances. Mr. Yeoman does not understand the problem, did not read the item carefully and has never tried what he proposes. If he did, he would find that he will almost always get the same answer, about 11 megohms (input resistance of the meter). Since this is likely to be *100 times smaller* than the resistance to be measured, it will completely negate measurement of this resistance.

If he will read the item again, he will see that I never parallel the high resistance alone with a vtvm, but the entire supply. His method is patently wrong.

THOMAS JASKI
San Jose, Calif.

13

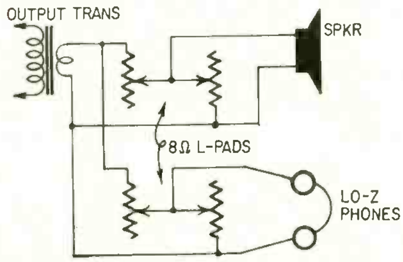
CORRESPONDENCE continued

THE L-SHAPED PAD ✓

Dear Editor:

After reading the item "Earphone Impedance Matching", pages 25 and 26 in the February *Service Clinic*, I feel compelled to show cause.

Impedance, power, resistance, ohms! Yes, each one is all-important. But have you ever heard of an L-pad? And secondly, why dwell on 2,000-ohm phones? The market is flooded with very good and not too expensive headphones advertised for stereo listening. They're still good for mono use when the plug is jumpered, and they are low-Z (8 to 16 ohms). Earphones from transistor radios are just as good for the purpose and less expensive.



The diagram shows the more desirable approach to the problem. Since we have a 4-ohm source, and 8 ohms in parallel with 8 ohms, we still have our 4-ohm match. Now we can have our cake and eat it too. That is to say, changing the volume control at either place has no effect on the other person's listening pleasure or temper. If you must use hi-Z phones, simply connect the output transformer mentioned in the February item in place of the phones, with the high-impedance phones across the high-impedance winding.

Above all, no switches, much less wiring, easier for all concerned.

CLINTON BROCKWAY
Niagara Falls, N.Y.

[The circuit shown is indeed an ideal one, although it may be considerably more expensive than either of the approaches in the February *Clinic*. Low-impedance stereo phones are still considerably more expensive than the high-impedance general-purpose type. The Allied catalog showed prices ranging from $15 to $40. High-impedance phones range from $2 to $4.50. (There is also a "professional type" at considerably higher prices.) The little phones from transistor radios, however, are cheap, and usually work well.—*Editor*]

A DOUBLE—IN NAME ONLY ✓ See FEB p30

Dear Editor:

Until we read your "Anonymous Speakers" article, we weren't aware that anyone else had a PRO-I speaker system.

Ours is completely different from the one described in the article. Its 10-inch woofer has a 2-pound Alnico V magnet and a 2-inch voice coil. The system has an extremely soft suspension and is mounted in a sealed enclosure. This model is called PRO, but there is a PRO-II in development. We're sure that there will be a natural tendency to call the present speaker the PRO-I.

We just wanted to be sure that everyone knows you weren't talking about our speaker!

AL ALTENHOF
Marketing Mgr.
Utah Electronics
Huntington, Ind.

EVEN FOOLPROOFER ✓

Dear Editor:

The circuit shown in Technotes (Aug., 1964) titled "Battery Polarity Warning Reduces Service Calls" may not be entirely foolproof.

If the lamp fails or the set happens to be on when the battery is connected backward, the wrong voltage polarity would get to the set.

An improvement would be to add a series diode D1 (see diagram) of

Continued on page 21

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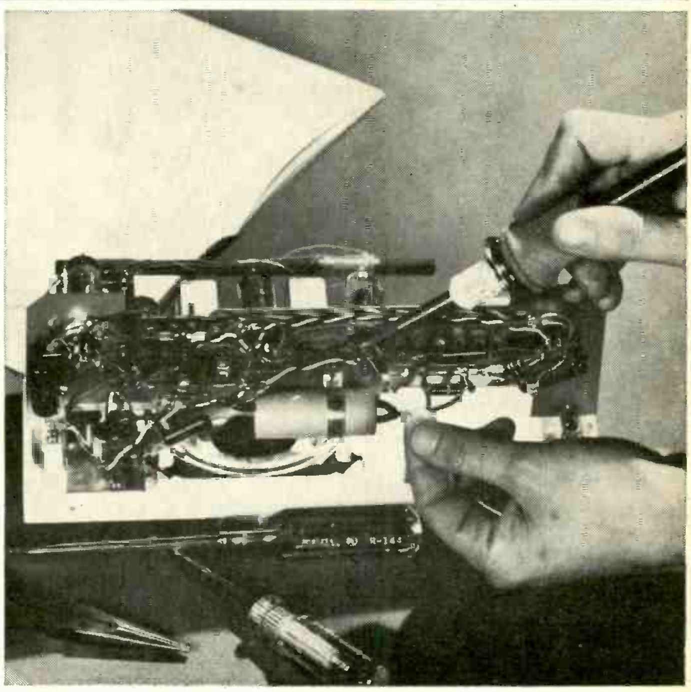
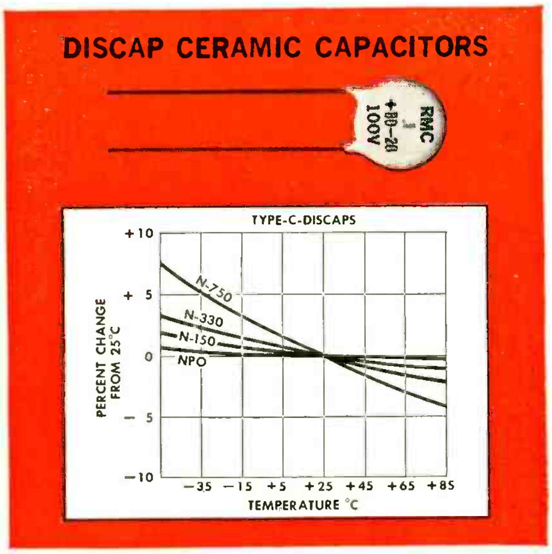
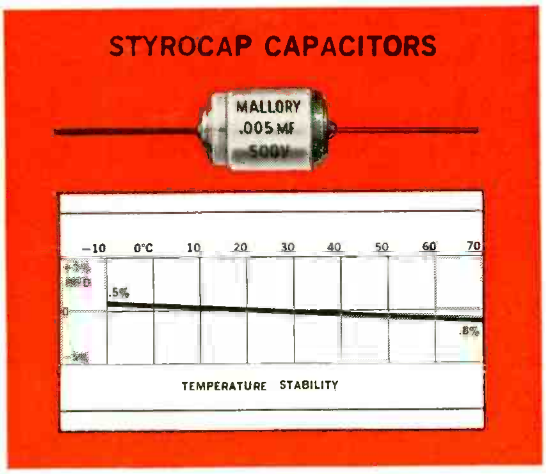
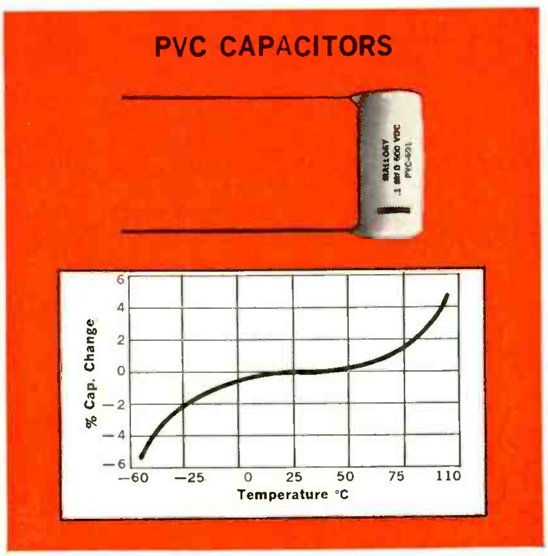


MALLORY Tips for Technicians

What you should know about capacitor stability







Why worry about capacitor stability? After all, aren't all capacitors pretty much alike? Well, as we all know, capacitors aren't "all alike". Matter of fact, there are many circuits where you wouldn't want capacitance to change with either temperature or time. For example, tuned circuits or RC timing networks. And this is especially true in color TV, because the eye notices even minor shifts that would pass unnoticed in black and white. Therefore, capacitor stability *is* important.

The trouble with most "static" capacitors is that capacitance increases as temperature increases. In other words, they have a *positive* temperature coefficient. And so do most inductance coils. Put these two creatures together and you'll see why frequency and timing can drift as the set warms up.

Now—what can you do about it? For small capacitance values, your best bet is a DISCAP® disc ceramic capacitor (made by Radio Materials Company, a Mallory division). DISCAPS are available in a vast array of temperature coefficients to exactly match circuit requirements. DISCAP temperature coefficients can be chosen so that they exactly offset the positive drift of coils (or other components). Thus, circuit characteristics stay constant regardless of temperature change. There are NPO (zero change) and up to N1500 (very sharp *negative* temperature coefficient) types. You'll find these listed in the 1965 Mallory General Catalog.

A brand new type of ultra-stable capacitor is now available. It's called the STYROCAP™. It's a new type of polystyrene capacitor that offers both temperature and time stability. The temperature coefficient is comparable to an N150 DISCAP. And capacitance change vs. time is practically zero. STYROCAPS are made from a unique form of stretched and fused polystyrene. They're transparent. You can look right through the clear plastic and actually *see* the aluminum foil! They're available from 5pF to .01 mfd. They're rated 500 WVDC and sizes and prices are right down there with comparable values in ceramics or molded film capacitors.

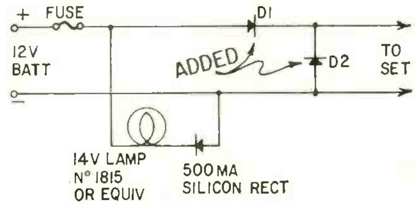
Styrocaps can be successfully substituted for all sorts of other capacitor types: mica, ceramic, paper, film, or anything else in their capacity and voltage range. But don't think of Styrocaps as substitutes. They're not. They're new. And they're better . . . especially where stability is downright important.

On the other hand you may really need a Mylar* type capacitor. When you do, take a look at the terrific Mallory PVC. These are available in a whole host of values and they're unbeatable in their class. The blue polyvinylchloride coating is just plain *moistureproof*.

And one more tip. Your Mallory distributor now has the new 1965 Mallory General Catalog. Ask him for your copy today. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

*Reg. Trademark E. I. du Pont de Nemours, Inc.

the proper rating. If the polarity is now reversed, the diode will be reverse-bi-



ased and will not conduct, protecting the set. (The diodes must be rated to carry more than the maximum operating current.)

D2 is added as an additional refinement. If D1 shorted and the polarity were wrong, the fuse would blow.

ALLEN A. GAULT

Baltimore, Md.

CORRECTION OF A TACHY ERROR

Dear Editor:

I wish to apologize to you and to your readers for an error in my article "Tachometer-Dwellmeter for Your Car" as published in RADIO-ELECTRONICS for March 1965, page 56. Diode D1, mistakenly identified as 1N474-B, should be 1N484-B.

This error was traced to the original manuscript and was discovered only as the result of an inquiry from one of your readers.

The 1N484-B is a very-high-back-resistance diode and is used to restrict the reverse current to a very low value even at high temperatures. It is available from parts houses for about 70 cents.

JOSEPH J. CONRADI

Wood River, Ill.

On Feb. 1, after our March issue was printed, Magnetics, Inc. adopted a minimum charge of $10.00 per order and refused single orders for their toroidal core specified by Mr. Conradi. We have asked them to make an exception in this case, since they had previously agreed to supply the coils. They agree to make the exception. Address orders attention of Mr. Wm. Irvine.—*Editor*

END

STABLE TRANSISTOR VOLTMETER!

Author Victor Laughter tells how to build highly practical, stable "tvm" with 200,000 ohm-per-volt input resistance and maximum full-scale sensitivity of 1 volt. Ideal for transistor circuitry measurements. Costs only $20 to $25 to build.

DON'T MISS IT IN . . .

June RADIO-ELECTRONICS

SERVICE CLINIC

By JACK DARR Service Editor

Reference Points

One thing that gets a lot of the young fellows (and a few of the older heads) into trouble in TV work is "reference points." In TV circuits, you're going to find voltages measured from chassis, voltages measured from a floating B-minus, and voltages measured from another tube's cathode! (This last, of course, in the stacked-B circuits.)

There are more of these than you'd think. Stacked video i.f.'s are common. The cascode rf amplifier is a "single-tube stack." The most common one, though, is the audio output/sync separator-plus-other-tubes stack, as in the diagram.

These can give you some really odd troubles. For example, the grid voltage on the audio output tube comes from voltage divider R1-R2 (Fig. 1) Let one of these open up or drift off value, and you may lose sync, video i.f. gain or something in a circuit not apparently connected with the audio output at all. The prize, to me, was the one that killed the raster: the 150-volt line fed the *brightness* control!

The audio output's bias voltage is the *difference* between the cathode and grid voltages measured from ground; −5 volts in the diagram. A change in bias causes a change in plate current, hence a change in the plate resistance of the tube, and so in the voltage on the 150-volt line. (The audio output tube's plate resistance is the "dropping resistor" between 300 and 150 volts.)

Leakage in the coupling capacitor between the first audio amplifier and the output tube can cause some funny effects. (Funny peculiar, not funny ha-ha.) There isn't a lot of difference in voltage between the two sides of the capacitor, but if it leaks, look out. Even a small leakage upsets the audio tube's bias, and can give you some very mysterious distortion, at least.

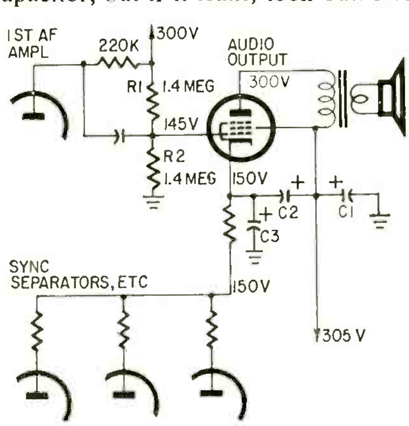


Fig. 1—Stacked-B-plus designs use audio output tube as dropping resistor for other stages.

Another cause of trouble is the filter capacitors, C1, C2 and C3—one from 300 volts to ground, another from 300 volts to cathode and the last from 150 volts to ground. A loss of capacitance, a leakage and especially a leakage *between units*, if they are in the same can, and you can really get some wild effects!

One of the most peculiar is an open C3 (150 volts to ground, usually about 40−60 μf). This will allow audio modulation to show up on the sync separator plate voltage supply line. This is a very common circuit, and you will find it in quite a few color sets. If this happens, you may find the sync appearing and disappearing in time with music or voice peaks! The voltage can vary enough to cause the sync separator plate voltage to drop and cut off the sync. The typical symptom of this is a wiggle or jumping in the picture. Many of us (me too) cut the sound off completely while we're working, to avoid disturbance; so, we may miss the connection between the wiggling picture and the sound. So, remember this, and turn the sound back up momentarily to check.

The scope, as usual, is the best cure for this. Look on the 150-volt line for any signs of hash, and turn the sound up to a high level to see if that causes trouble. One good check is feeding a 400-cycle audio signal into the first audio grid at a fairly high level; check the 150-volt line for any sign of 400-cycle sine wave. If you find some, start looking for a bad filter capacitor.

This kind of trouble can work the other way around, of course. Since the paralleled plate resistances of the tubes fed by the 150-volt line are actually in the cathode circuit of the audio output tube, any change in the total resistance will upset things. So, look for shorted tubes, or tubes in high-impedance circuits with grid emission. These can

> This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.
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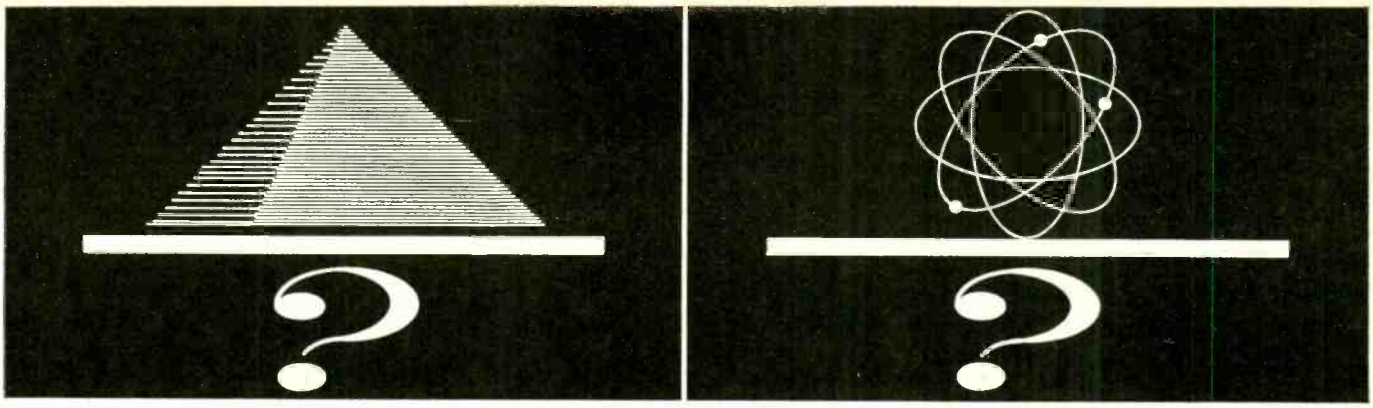


cause "trouble downstairs" to look like "trouble upstairs."

To get the *correct* (working) plate voltage on any tube in this circuit, or in any other, for that matter, *measure between plate and cathode*. This is the voltage that the tube works on, and this is the one you want.

Width-coil problem, Firestone TV

While I was adjusting the width coil on a Firestone 13-G-54, the raster went out and the coil started to smoke. Now I have no high voltage, and nothing works.—B. G., Port Chester, N.Y.

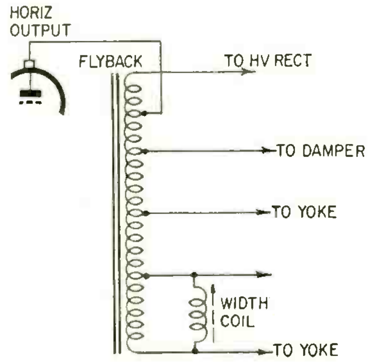


Fig. 2—Shorted width coil kills raster.

Looks as if the width coil shorted to ground. Take it off and recheck. Since the width coil is nothing but an "adjustable loss" across a section of the flyback, as you can see in Fig. 2, you can operate a set without it, at least for tests. In fact, if the set works OK, leave the thing off entirely. The iron core of the coil is grounded, and the winding sometimes shorts to it.

Air Castle Radio

I've got an old Air Castle radio, with a 25Z5, a 25L6, two 76's, a 6A7 and a 6D6 in it. Can't find any data on it. Also has a 6U5 tube for a tuning eye.—L. E. B., Greensboro, N. C.

Look in Rider's *Radio Trouble-shooter's Manual*, back about Vol. 7 or

8, for a set with a similar tube lineup. Air Castle is a trade name for radios built for Spiegel in Chicago, and there are many different "makes" under this name.

This is obviously an ac/dc set, with series heaters. You have about 80 volts of heater, so you'll need a ballast tube or resistor somewhere to "use up" the remaining 30 volts. (Design center then was 110 volts instead of the present 117.)

The 25Z5 is probably used as a voltage doubler. You can tell by checking the connections: if both plates and both cathodes are tied together, it's a halfwave; otherwise, it's a doubler. Check the filter capacitors, too—their voltage ratings will give you a clue.

Tuner trouble in RCA

I just made a service call on an RCA, and the tuner acts funny. Channels 6 and 4 are pretty good, 8 and 13 very poor. It looks as if someone has been at the tuner with a small screwdriver!—H. E., Kokomo, Ind.

It's happened before, and it'll happen again! However, there are a couple of things to check. You've changed the tubes? (A bad rf amplifier tube can cut out either high *or* low channels; so can a bad mixer-oscillator.)

Check the antenna balun coils. You can get this same effect from various combinations of open circuits there. If these are all OK, check the antenna lead-in. One side open gives funny effects.

"Extension" TV antennas

We moved to the country and evidently my TV picture fell off the truck! It didn't get here! Seriously, the nearest TV station is more than 100 miles away and we get pretty bad pictures. I have a good high-power all-channel antenna, and I've found a spot on top of a hill about 500 feet from the house, with a strong signal. Should I run a coaxial cable in an underground pipe, or 300-ohm

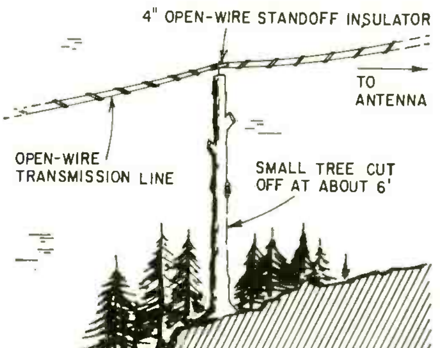


Fig. 3—Leave small trees in center of antenna-line right-of-way, to support line. Top them at about 6–8 feet.

lead-in through a buried plastic pipe, or what?—L. P., Bisbee, Ariz.

I wouldn't recommend coaxial cable *or* the buried 300-ohm lead, for the same reason: too much loss. The least lossy way is 300-ohm open-wire transmission line.

Cut about a 15-foot right-of-way to the top of the hill, to keep small trees from falling on the line in ice storms. Leave some trees in the center, at intervals of about 15–20 ft. Cut these off about 6 ft high, and run a 4-inch standoff insulator into the top, as in Fig. 3 This keeps the line from hanging low enough to be caught by people, cows, etc.

You shouldn't *need* a booster, if the signal is fairly good; the loss in this line is only 0.3 db per 100 ft. at 100 mc. However, you can use a booster at the antenna, with the power supply at the TV set. This is useful if you have a high-channel station; loss in these long lines are higher in the high band. We have one near here with over ¼ *mile* of lead-in like this—no booster and good pictures.

Intermittent loss of vertical sweep

In an RCA KCS-127 chassis, every so often the vertical sweep collapses, leaving a thin, bright horizontal line. If I move either the vertical height or linearity controls, the trouble stops. There is also quite a bad vertical jitter at times.—A. M., APO 19, N. Y.

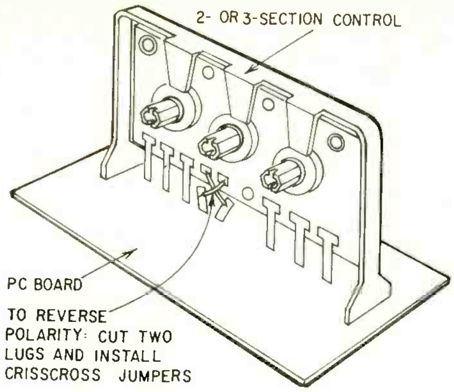


Fig. 4—Clip lugs and cross the connections to reverse direction of current through defective control.

This is caused by defective vertical controls: either the height or linearity control will do it. RCA recommends replacing this control unit with a modified type. However, overseas where you are, this might take a while to get. So try this: Clip the two lugs of the height control and cross-connect them by tacking two short pieces of solid wire to the lugs (Fig. 4). This reverses the direction of current flow through the control. If the controls are badly worn, so that you get a dropout every time the slider moves across a certain point, take the control apart very carefully and rub a very soft lead pencil over the bad place. This is an old radio trick, and will keep the thing going until you can get a replacement. A good contact cleaner will help if the controls aren't too "noisy".

Rebuilt CRT failure

This Emerson took a long time to warm up. The original CRT was replaced with a 21ALP4-B, which arced internally. This was replaced with a 21-CBP4, which lasted 2 months. Another 21ALP4 in here is acting up: loss of focus at top and lower right corner, and fuzzy images. The voltages are all OK, according to the diagram. What's happening? All of these CRT's were rebuilts, from the same company.—T. H., Port Chester, N.Y.

Change companies! From your description of the symptoms and failures, they could all be due to poorly rebuilt CRT's! Your loss of focus could be due to a "chewed-out" grid aperture in the gun—just old age, and the fuzzy picture on the other, from a bad screen.

CRT's rebuilt by one of the major tube manufacturers are usually OK. They carry a 1-year warranty, and things like this can be taken care of. Any real defect in a tube will show up within a year. END

The CATV question has produced a great deal of controversy, in which there has been more sound than light. Some look at CATV as a serious threat to independent TV servicing, and ultimately to our present system of free TV itself. Others consider it a legitimate extension of television reception service, and one that will give the TV listener more and better reception without notably increasing his costs.

To shed more light on the matter, RADIO-ELECTRONICS has gone to authorities on both sides of the question for a statement. Frederick W. Ford, the former FCC Commissioner, is president of the National Community Television Association. Morton Leslie is the president of the Television Accessory Manufacturers Institute, which champions the cause of free TV received directly over the air as opposed to the wire or cable systems, which they feel may ultimately lead to pay-TV.

CATV—Whether, Whither and Why

Guest editorial by MORTON LESLIE

FEW recall that when cable television made its first appearance about 15 years ago, the avowed purpose was to "bring television entertainment to communities previously denied it." In many cases it was represented to communities and city councils that the service was purely temporary—a stop-gap until local television should arrive. Today, with 1,500 systems operating or in the construction stage, and growth proceeding at the rate of 30 systems per month, less than half the systems are performing the functions of the original plan. RADIO-ELECTRONICS is correct in believing it highly appropriate to discuss some of the background, thinking and direction of CATV growth. Why especially appropriate just at this time? We can think of several reasons:

1. Television entertainment is no longer a luxury. It is a must in virtually every household. The householder will do without many other things before he will give up TV! When told he will receive "more TV" or "better TV", he is a profoundly susceptible buyer.
2. The general economy is at its highest. People are on a tremendous buying spree. We have an electric knife, an electric toothbrush, gold-plated bathroom plumbing—and one major company is test-marketing an electric whisk broom!
3. Risk capital is more plenteous than ever before. The profit and investment return of CATV is highly attractive. *Business Week* magazine refers to CATV as a *Money Machine* and quotes possible investment returns of up to 60%! In one small state 22 applicants are applying for 250 franchises!

Unlimited and unrestricted CATV growth poses many problems too often not immediately apparent to the unwary. Its uncontrolled growth directly affects the general

continued on page 71

CATV—A Natural Evolution

Guest editorial by FREDERICK W. FORD

IT has been said nothing is constant but change itself. Remember how long it took for some radio men to learn how to handle television? The tremendous resentment against printed circuits? The slowness to accept, become familiar with and profit by such developments as color TV, uhf and FM stereo? It is no wonder, then, that many TV technicians are suspicious of Community Antenna TV Systems (CATV).

While CATV is new to most of the country, it has been serving subscribers since 1950. There are now more than 1,600 systems, with new ones starting up every day.

But the impact of CATV is just beginning to be felt. It seems quite likely that within the near future almost every American city will be equipped for CATV.

The reason for its sudden prominence is simple. New equipment and techniques have made systems technically and economically feasible in even the largest of cities. The viewing public, in turn, is finding that CATV is the lowest-cost way of getting the programs it wants to watch. It is becoming apparent that the public has an almost insatiable appetite for program variety. While CATV systems originate no programs, they are able to bring in distant channels. Present CATV systems are offering as many as 12 channels.

The impact of the growth of CATV on the TV technician can hardly be overestimated. His business must evolve in step with the industry. Those who adapt will flourish; those who expend their energy trying to hold back change will wither.

Since there are so many systems in the country, we don't have to theorize about what happens when CATV comes to town. We can look at actual case histories.

In almost every instance, local TV dealers and tech-

continued on page 72

A SOLID STATE FM MULTIPLEX GENERATOR

Build this stable, accurate, versatile all-transistor FM stereo test generator.

All parts easily available **By EARL T. HANSEN**

This generator has all the flexibility and accuracy you could want for adjusting and repairing the multiplex portions of modern FM receivers. It is stable, portable, relatively inexpensive and easily constructed by the experienced technician. It runs cool and requires no warmup time. The cost of parts is about $90. By taking advantage of bargain sales, using imported parts and what you have on hand, cost can be reduced by half without compromising performance.

The generator was designed with transistors, mainly to get away from warmup drift and aging. This also made for a lighter, more compact, less expensive unit. The complete circuit of the generator appears on page 32.

The generator power supply is regulated and operated well below its capacity. It is relatively conventional. The regulator uses a Zener diode reference and two transistors. A unique circuit feature is the dc feedback provided by R54. It cancels the effect of line-voltage changes and reduces output ripple.

The pilot lamp is connected across one diode (D11) of the bridge. This energizes the lamp for only half the ac cycle, for longer life and less glare. The fuse is in the transformer secondary to be more responsive to overloads without the effect of transformer losses and energizing current. The power supply load current is less than 40 ma.

The heart of the generator is the 19-kc crystal oscillator. Its accuracy of .01% meets multiplex transmission standards. A multivibrator type circuit is used, with a resonant circuit (T1) as one collector load. A high resistance in series with the crystal limits the drive current to a safe and stable level. The 19-kc sine wave is fed through a phase-adjusting network, C38 and R58, and an emitter follower (Q6). It is then used as the variable pilot signal, and as an external signal for scope synchronization.

The 19-kc sine wave from T1 is also full-wave-rectified (by D9 and D10), which doubles the frequency to 38 kc, with the same basic crystal accuracy. This is amplified by Q3 and Q4. Double-tuned transformer T2 removes harmonics and provides a clean, balanced signal to the modulator bridges.

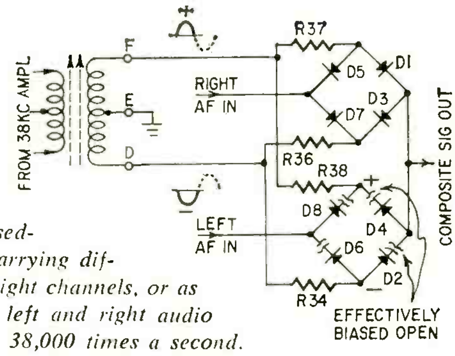


Fig. 1 — How multiplexing occurs. Bridges here can be viewed as balanced modulators, which produce a 38-kc suppressed-carrier AM signal carrying difference of left and right channels, or as switch that samples left and right audio channels alternately, 38,000 times a second.

The balanced modulators work much like a single-pole double-throw switch operating at a 38-kc rate, switching the output rapidly between left and right signal sources. This effectively time-shares a single channel to carry two channels of information—which, as you know, is the principle of multiplexed FM stereo transmission.

Fig. 1 is a simplified diagram of the balanced modulator and shows the conditions during the first half of the 38-kc cycle. With terminal F positive and terminal D negative with respect to ground, the four diodes D1, D3, D5, D7 in the right-channel bridge are forward-biased and conducting. A conducting diode has relatively low impedance, and the right input signal at that instant is conducted through the bridge. Most of the voltage across T2 is dropped by series resistors R36, R37. The left bridge is reverse-biased. A reverse-biased diode is effectively an open circuit (symbolized by the broken lines on D2, D4, D6, D8). The left input is isolated from the composite output. There is no drop across R34, R38.

During the second half cycle, the polarities are reversed, causing the right-channel bridge to be cut off and the left-channel bridge to conduct. Now the instantaneous value of the left signal appears as the composite output. One half of the 38-kc carrier cycle carries the left-channel information and the other half carries the right. This double-balanced bridge has a carrier output only when there is a difference in the left and right input signals. The 38-kc "sampling" from the bridges is almost a square wave, with many harmonics. L1, L2, L3 and associated components form a low-pass filter which removes the harmonics. L1 is tuned to the second harmonic, and L3 to the third. L2 and C37 attenuate higher-order harmonics. The 19-kc pilot signal is mixed in at the filter output load, R41, through R42. The resulting multiplex signal is available as a direct output, and is also fed to the 100-mc FM oscillator, Q13.

Q13 is a Colpitts oscillator, frequency-modulated by feeding a small amount of the composite signal to the base. The resulting small change in base current causes a change in the capacitance of the transistor, which in turn changes the resonant frequency of the oscillator tank, L5 and C18-

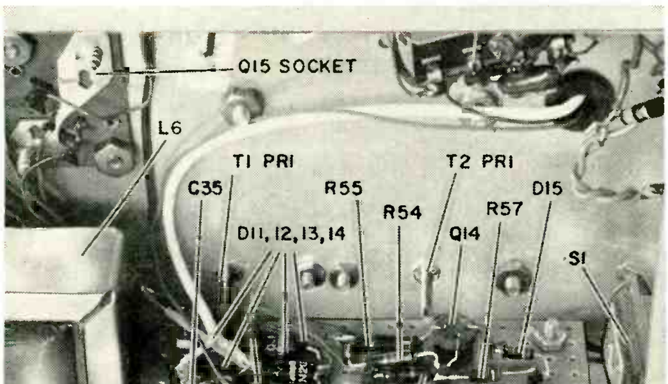
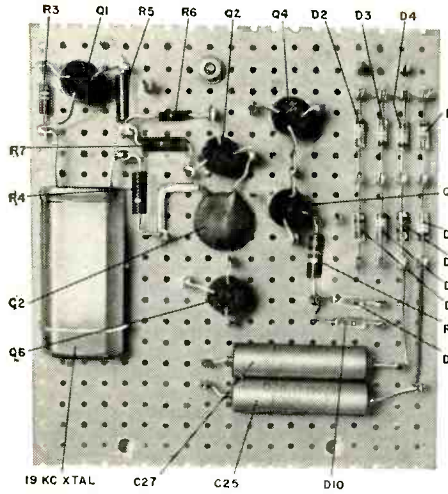


Fig. 2—The power supply components.



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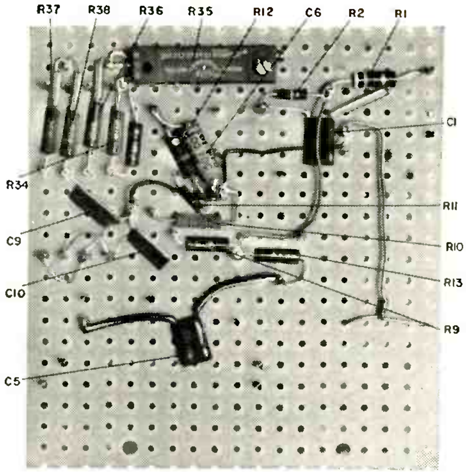

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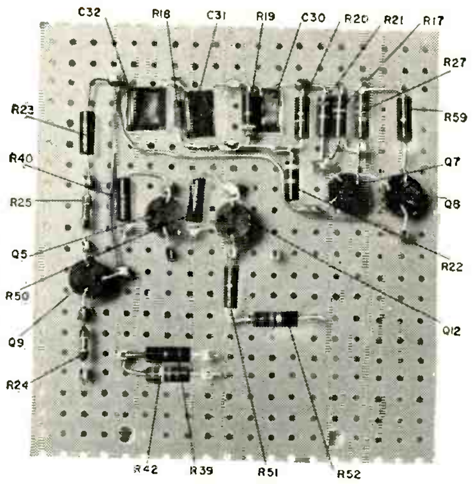

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C19. R44 and C22 filter the collector supply voltage to prevent hum modulation. The oscillator is capable of a much wider linear swing than the ±75-kc FM transmission standard.

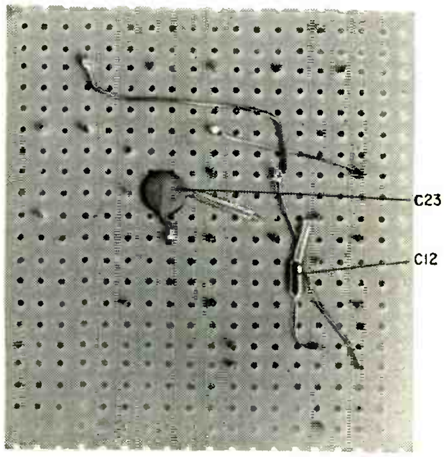
Q12 is a 67-kc Hartley oscillator controlled by S4. The multiplex signal is disabled when this oscillator is turned on. Q7 and Q8 form a 1,000-cycle phase-shift oscillator. Q9 is a phase splitter providing two equal-amplitude sine waves, 180° apart. A 120-cycle signal, available for channel modulation, is obtained from the power supply bridge. This signal is cleaned of harmonics and attenuated by R33 and C35. Q10 and Q11 are emitter followers providing a low-impedance signal source to drive the balanced modulators. Q10 also supplies the right-channel signal as an output, to be used for scope external synchronization.

Fig. 3—Side A of the 19-kc board.

Fig. 4—Side B of the 19-kc board.

Fig. 5—Side A of the 1-kc board.

Fig. 6—Side B of the 1-kc board.



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Construction and test

I found it most interesting to build and test the generator in sections. Start with the power supply (Fig. 2); then you will have a good dc source to test the other circuits. T3 can have a secondary rating from 22 to 30 volts at 100 ma or more. The one specified and used is rated at 1 ampere, because it is readily available, but is larger and heavier than desirable. Use a good insulated mount for Q15.

When the power supply section is completed, connect a 470-ohm load across C34. Turn the power on and measure the dc voltage across C33. It should be approximately 85% of the T3 secondary rms ac voltage. The voltage across the temporary load should be between 14 and 15 volts. The tolerance of the Zener diode (D15) will probably make adjustment necessary. Parallel R56 with additional resistance to lower the voltage, or parallel R57 to raise it.

Vary the input line voltage 20 volts either side of 117. (This is where a 0–140-volt variable transformer comes in handy.) The power supply output (across C34) should not vary more than 0.4 volt total swing. If it does, change R54 to a different value. If the output voltage *decreases* with an increase in line voltage, *raise* the value of R54, and vice versa. The peak-to-peak ripple across C34 should be less than 25 millivolts. Remove the temporary load resistor.

The small components of the 19-kc oscillator and most other circuits are mounted on perforated boards with push-through terminals. Build the 19-kc board as the next step—see Figs. 3 and 4. Mount the board on the chassis, with T1, T2 and associated wiring and components.

Connect a scope to terminal C on T1 (scope ground lead to chassis for all tests). *Caution—the 19-kc crystal has*

SPECIFICATIONS

Multiplex signal: 3 volts p-p
Rf signal: Internally adjustable over FM band. 10 to 1,000 microvolts. ±75-kc deviation
Residual noise: 50 db below mpx level at mpx output. 40 db below signal level through receiver
Crosstalk (separation): Better than 30 db
Modulation: 1 kc, −1 kc, 120 cycles and external, switched separately for each channel
Pilot tone: 19 kc, ±.01%, adjustable from 0 to 200% amplitude
Subsidiary Communications (SCA): 67 kc, internal source
Scope sync outputs: 19 kc, and the right-channel signal
Power consumption: 117 volts 60 cycles, less than 6 watts
Stability: Negligible drift. Unaffected by 20-volt line excursions
Semiconductors: 15 transistors, 15 diodes

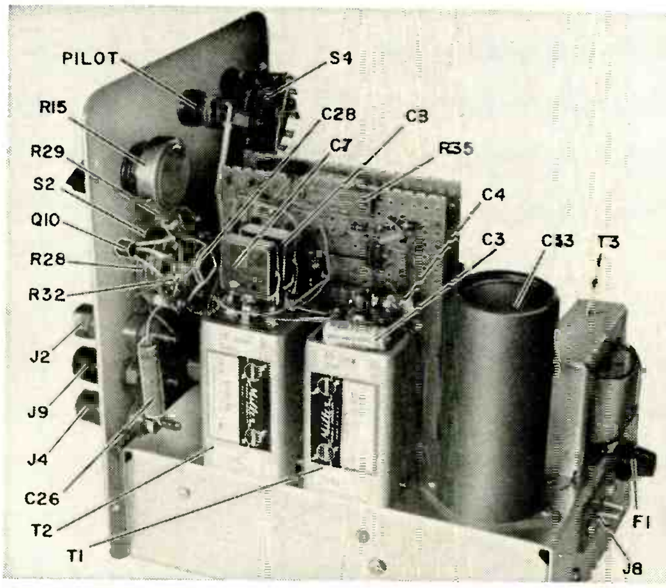
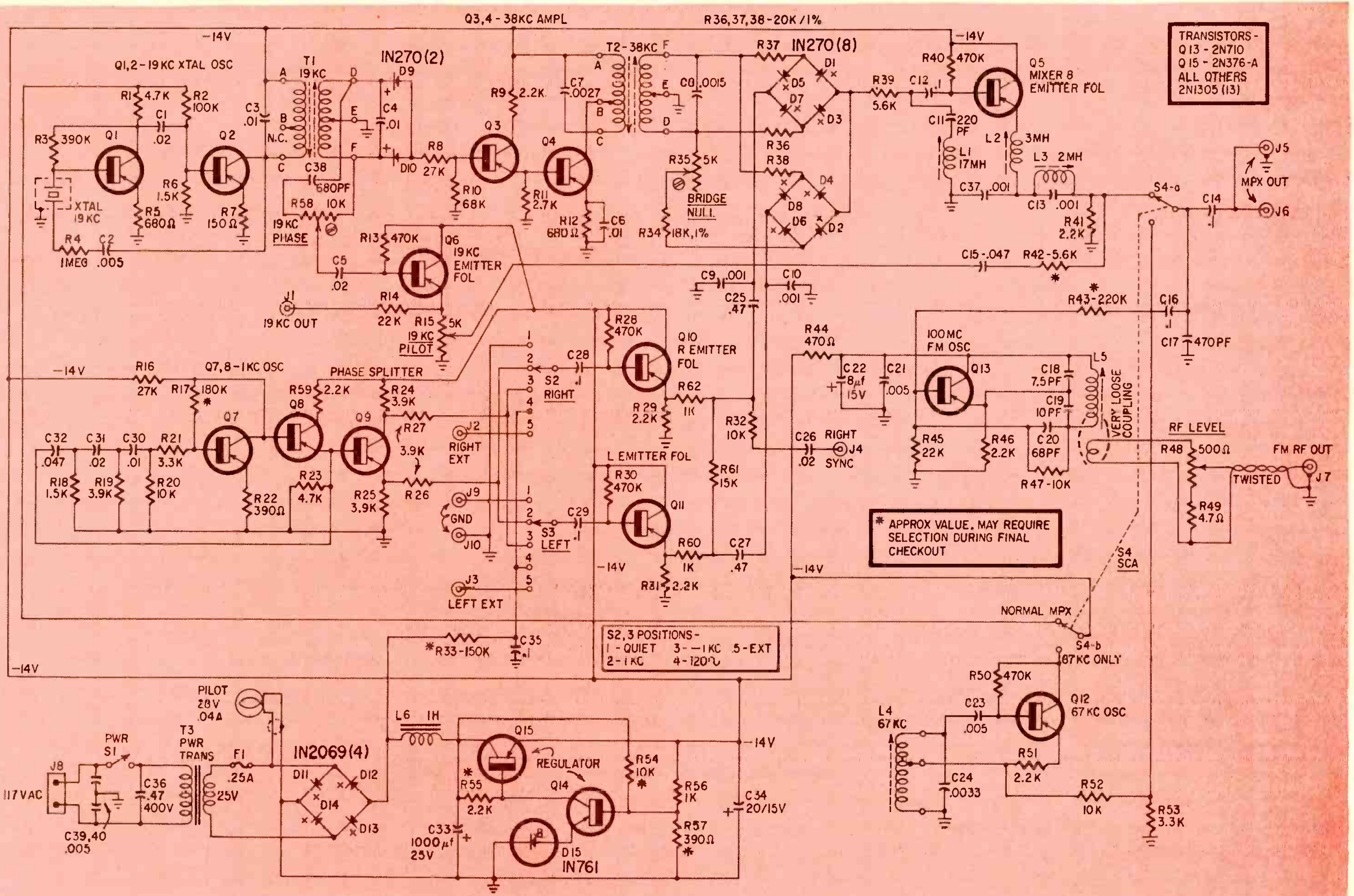


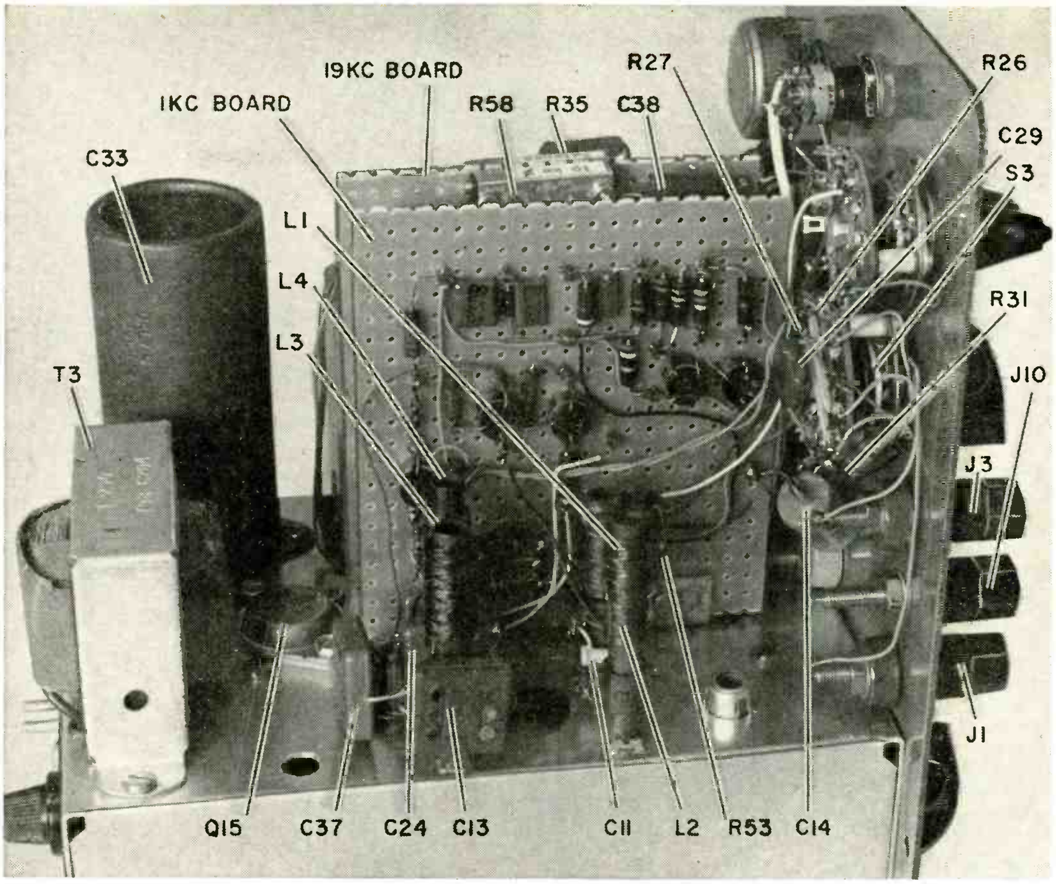
Fig. 7—Right side view of complete generator, showing panel wiring details.



Schematic of the multiplex generator. Channel separation was improved by the addition of three resistors, R60, R61 and R62. These do not appear in the component layout photos. With these resistors included in the circuit, the baseline of the waveform at J6 will appear more like scope photo 10 than photo 2, for the conditions specified in photo 2. It may be necessary to increase or decrease R61 slightly to obtain a flat baseline on the waveform.

This generator was rigorously tested by Leonard Feldman, who studied four commercial multiplex generators in preparation for his Radio-Electronics article "Roundup of Low-Cost FM Stereo Generators" in the November 1964 issue. He also worked with Murray Crosby in the early years of FM stereo development.

Mr. Feldman reported that "performance is generally as described" and that "the unit exhibits negligible drift, both in composite signal waveform and in rf output frequency." Initially, he found fault with the separation, as indicated by the wavy baseline in scope photos 2 and 5. Author Hansen ultimately added R60, R61 and R62 (page 32) to improve separation, which now meets specifications and equals that of the best commercial equipment.



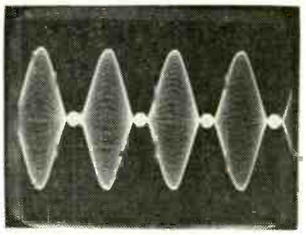
Left side of completed generator.

a maximum drive rating of 0.1 milliwatt. Do not reduce R4 to less than 470,000 ohms, and do not connect any test equipment to the crystal terminals. Also note that the crystal case is grounded.

Adjust the primary (bottom) of T1 to resonance, as indicated by maximum signal on the scope. Connect the scope to terminal D of T1. Adjust both T1 cores for maximum sine-wave amplitude. The peak-to-peak amplitude from D (and also F) to ground should be greater than 5 volts. With the scope on terminal C of T2, adjust the primary (bottom) for maximum signal. With the scope on terminal D of T2, adjust both cores for maximum sine-wave 38-kc signal. With the diode bridges connected, the peak-to-peak voltage should be greater than 9.

Build the 1-kc board (Figs. 5 and 6). Connect −14 volts and a ground return to the board. The scope should show a good 1-kc sine wave on the emitter and collector of phase splitter Q9. The amplitudes should be equal within 2%,

C1, C5, C26, C31—.02 μf
C2, C21, C23—.005 μf
C3, C4, C6, C30—.01 μf paper or mica
C7—.0027 μf silver mica
C8—.0015 μf silver mica
C9, C10, C13, C37—.001 μf paper or mica
C11—220 pf mica or zero-temp.-coeff. ceramic
C12, C14, C16, C28, C29, C35—0.1 μf
C15, C32—.047 μf
C17—470 pf
C18—7.5 pf 10% mica or zero-temp.-coeff. mica
C19—10 pf 10% mica or zero-temp.-coeff. mica
C20—68 pf 10% mica or zero-temp.-coeff. mica
C22—8 μf (or more) electrolytic, 15 volts
C24—.0033 μf mica or paper
C25, C27—0.47 μf
C33—1,000 μf electrolytic, 25 volts
C34—20 μf electrolytic, 15 volts
C36—0.47 μf, 400 volts
C38—680 pf mica
C39, C40—.005 μf, 400 volts
Capacitors may be paper or ceramic (GMV), rated at 25 volts or more, 20% tolerance, except as noted
D1–D10—1N270 (Sylvania) or equivalent high-conductance germanium diodes. (Use all same type.)
D11, D12, D13, D14—1N2069 (Texas Instruments) or equivalent 500-ma, 200-volt silicon diodes
D15—1N761 (Hughes, TRW or TI)
F—¼-amp fuse and holder
J1, J2, J3, J4, J6, J9, J10—5-way binding posts
J5—phono jack (RCA type)
J7—BNC or other coaxial connector
J8—Male TV ac-line interlock connector
L1—17-mh adjustable coil (J. W. Miller 6315 or equivalent)
L2—3-mh adjustable coil (J. W. Miller 6313 or equivalent)
L3—2-mh adjustable coil (J. W. Miller 6318 or equivalent)
L4—2-mh adjustable tapped coil (J. W. Miller 6323 or equivalent)
L5—5 turns No. 20 wire, wound 5/16 long on ¼-in. slug-tuned form (J. W. Miller 4500W or equiv.)
L6—1-henry, 300-ma choke, 50 ohms or less (Stancor C2336 or equivalent)
Q1 through Q13—2N1305 (G-E, TI or RCA)
Q14—2N710 (G-E, Motorola, RCA, Sylvania or TI)
Q15—2N376-A (Motorola, RCA)
R1, R23—4.700 ohms
R2—100,000 ohms
R3—390,000 ohms
R4—1 megohm
R5, R12—680 ohms
R6, R18—1,500 ohms
R7—150 ohms
R8, R16—27,000 ohms
R9, R29, R31, R41, R46, R51, R55, R59—2,200 ohms
R10—68,000 ohms
R11—2,700 ohms
R13, R28, R30, R40, R50—470,000 ohms
R14, R45—22,000 ohms
R15—pot, 5,000 ohms, linear
R17—180,000 ohms
R19, R26, R27—3,900 ohms
R20, R32, R47, R52, R54—10,000 ohms
R21, R53—3,300 ohms
R22, R57—390 ohms
R24, R25—3,900 ohms matched (see text)
R33—150,000 ohms
R34—18,000 ohms, 1%
R35—pot, 5,000 ohms linear (miniature—Bourns E-Z Trim or equivalent)
R36, R37, R38—20,000 ohms, 1%
R39, R42—5,600 ohms
R43—220,000 ohms
R44—470 ohms
R48—pot, 500 ohms, linear, carbon
R49—4.7 ohms
R56, R60, R62—1,000 ohms
R58—pot, 10.000 ohms linear (miniature—Bourns E-Z Trim or equivalent)
R61—15,000 ohms
All resistors ⅛ watt or more, 10% or better, except as noted
S1—spst rotary or toggle switch
S2, S3—1-pole, 5-position rotary switch
S4—2-pole, 2-position rotary switch
T1, T2—J. W. Miller 6194 horiz. osc. and discriminator transformers, or equivalent
T3—power transformer, primary 117 volts ac, secondary 25 volts, 100 ma or more (Stancor P6469 or equivalent)
XTAL—19.000-kc (±.01%) crystal, series-resonant, wire leads. Available from Northern Engineering Labs, 357 Beloit St., Burlington, Wis., for $20 postpaid if payment accompanies order. Alternate source: Texas Crystals, 1000 Crystal Dr., Ft. Myers, Fla. $19.95. (Address Mr. John Erasmus). Mention this **Radio-Electronics** article. **NOTE:** To use the Texas crystal, R4 must be reduced or eliminated completely. Use the highest value that gives stable **crystal-controlled** oscillation
Perforated boards, .062-in. holes, 0.2 in. between centers
Push-in terminals—Vector T-28 or equivalent
Chassis—aluminum, 5 x 7 x 2 in. (Bud AC-402 or equivalent)
Cabinet—Bud WA-1540
Miscellaneous hardware and knobs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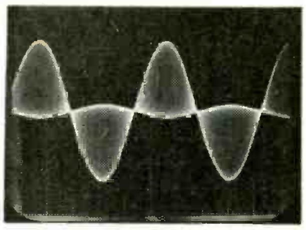
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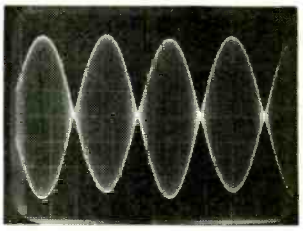
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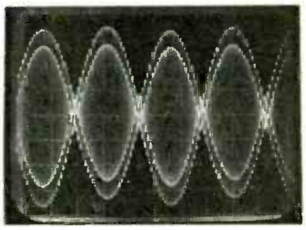
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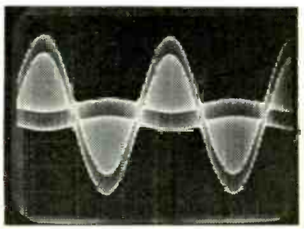
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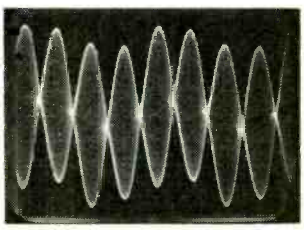
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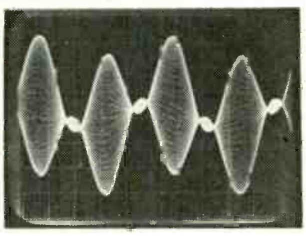
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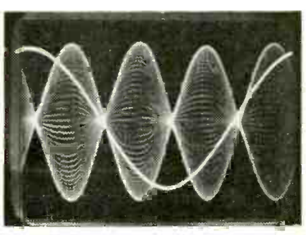
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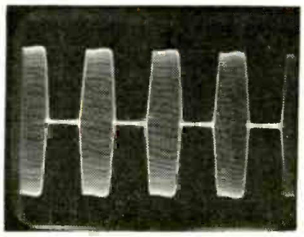
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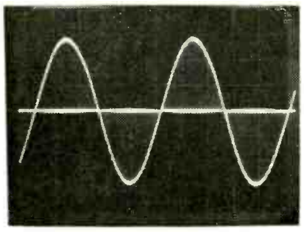
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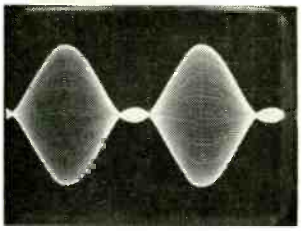
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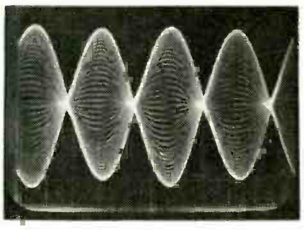
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otherwise it will be necessary to change R24 or R25 slightly by paralleling with a higher value. The peak-to-peak amplitude should be between 3.5 and 4 volts. The amplitude can be adjusted by changing R17.

Complete the front-panel circuitry. Q10, Q11 and associated components are mounted on the unused terminals of S2 and S3 (Figs. 7 and 8). L1, L2, L3 and L4 should be mounted away from the power transformer to avoid 60-cycle pickup. Complete Q12's circuitry. Note that the tap on L4 is nearest the *ungrounded* end of the coil. Set S4 to 67 KC ONLY, and connect a scope to J6. The signal amplitude should be approximately 3 volts peak to peak. Adjust L4 for 67 kc with an audio-frequency meter, a scope with a well calibrated time base or an accurate audio oscillator as a comparison. This adjustment is not critical but should be within 3%. Another method is to connect an AM radio to the emitter of Q12 through a 22-pf capacitor, and listen for the 10th harmonic at 670 kc, a 20th harmonic at 1340 kc, with nine others in between.

Short leads must be used in the 100-mc oscillator circuit (Fig. 9). Q13, C18, C19, C20 and R47 are mounted on the coil form terminals. Use an FM receiver to adjust L5 to 102 mc or any clear spot on the FM band.

Complete the remainder of the generator. Connect the scope to J4. Set S2 to position 4 (120 cycles). The amplitude should be within 10% of the 1 kc signal amplitude with the switch at position 2 or 3. If not, change R33 to correct it. With the scope on J6, S2 and S3 to QUIET, PILOT LEVEL OFF, and S4 to NORMAL MPX, adjust R35 for minimum 38-kc signal.

Temporarily short terminals D and F on T2 together. Connect an audio signal generator to the junction of R39 and the diode bridges. Adjust it for about 2 volts output at 76 kc. Adjust L1 for minimum signal on the scope. Set the audio generator to 114 kc. Adjust L3 for minimum scope indication. Adjust L2 so the core is approximately two-thirds

CHECK FOR THESE WAVEFORMS

All photos taken with vertical sensitivity of 0.5 volt/cm, except photo 8. All signals are from the MPX output, J5 or J6, except photos 9 and 10. In each instance the scope is externally triggered from the 19-kc output, J1, or the right signal output, J4. The RIGHT selector, S2, is on 1 kc in every case.

Scope photo	Scope sync	Time base	Left channel	Notes
1	19 kc	10 μsec/cm	Quiet	19-kc pilot off
2	Right, 1 kc	200 μsec/cm	Quiet	19-kc pilot off*
3	Right, 1 kc	200 μsec/cm	—1 kc	19-kc pilot off
4	Right, 1 kc	200 μsec/cm	—1 kc	19-kc pilot 2×
5	Right, 1 kc	200 μsec/cm	Quiet	19-kc pilot 2×*
6	19 kc	10 μsec/cm	—1 kc	19-kc pilot 2×
7	19 kc	10 μsec/cm	Quiet	19-kc pilot 2×
8	19 kc	5 μsec/cm	—1 kc	Double exposure to show 19 kc pilot phase relationship. See text.
9	Same as Photo 1, except scope connected to output of bridge modulator—junction of D2 and R39.			
10	Same as Photo 2, at output of bridge modulator.			
11	19 kc	5 μsec/cm	Quiet	19-kc pilot off
12	19 kc	5 μsec/cm	—1 kc	19-kc pilot off

*Baseline should be nearly straight—not wavy as it is here. See page 32 caption.

NOTE: If you do not have access to a scope with triggered sweep calibrated in time units, an ordinary service scope with sweep marked in frequency will do. Adjust its sweep vernier until you get the patterns in the photographs. Synchronize the sweep with the signals listed under "Scope sync".

into the coil. Vary the audio generator from 10 through 40 kc. If the signal at 40 kc drops more than 15% under that at 10 kc, back the L2 core out slightly. Remove the audio generator and the jumper on T2. Readjust R35 for minimum signal on the scope. It should be less than 10 mv peak to peak.

Connect the scope to J1, and observe a clean 19-kc sine wave of about 4 volts peak to peak. Connect J1 to the external trigger input on the scope. With the scope vertical input connected to J6, set S2 (RIGHT) selector to 1 KC. The display should resemble scope photo 1, approximately 3 volts peak to peak. Set S3 to −1 KC. The pattern should resemble scope photo 2.

Set S2 and S3 to QUIET. Set pilot level control R15 full clockwise (2×). The 19-kc sine wave at J6 should be from 0.5 to 0.6 volt peak to peak. If not, change the value of R42 accordingly. Reduce the setting of R15 until the output is 0.27 volt peak to peak. This should be marked on the panel as the NORMAL position. The setting of the pilot level during use of the generator is not critical. Most multiplex circuits will perform well with less than normal pilot level. Return the control to full clockwise (200%). Retain this scope dispay. The phase relationship of the 19-kc pilot to the 38-kc difference signal is important. The pilot sine wave should cross the zero axis at the same time (point) as the L − R difference signal (1-kc and −1-kc channel modulation). Scope photo 8 is a double exposure, to illustrate this. The scope sensitivity was changed between exposures (0.1 v/cm for the 19 kc and 0.5 v/cm for the double 38 kc).

To make this adjustment, trigger the scope externally from J1 (19 kc). With the 19-kc signal displayed as above, note carefully the point on the scope face where the sine wave crosses the zero axis. The zero axis location may be determined, and centered if necsesary, by momentarily removing the 19 kc from the vertical input. Then turn the pilot signal off and S2 to 1 KC, and S3 to −1 KC. Decrease the vertical sensitivity on the scope. Adjust R58 until one of the crossover points on the scope trace coincides with the

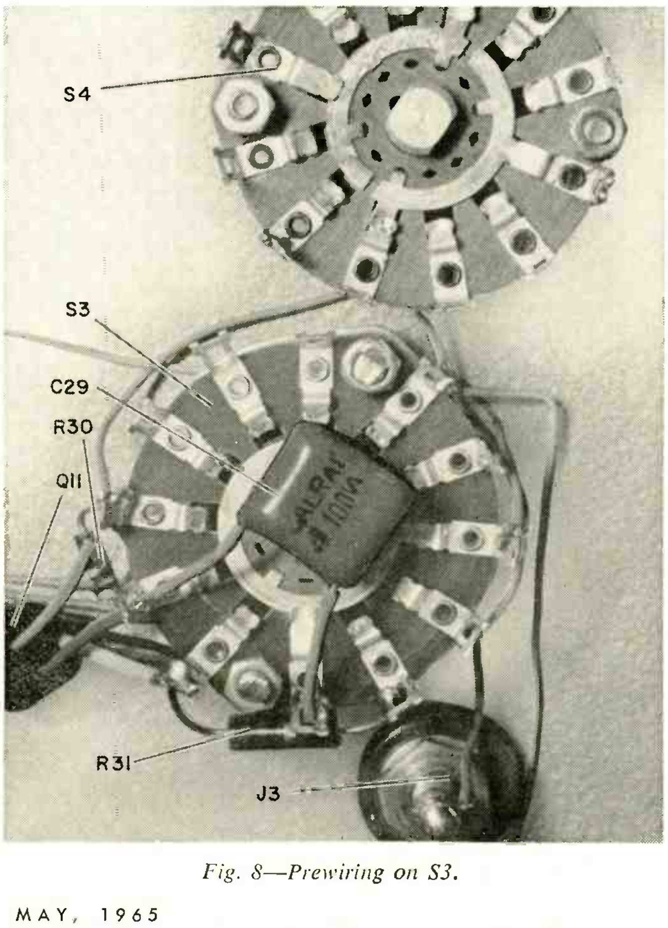


Fig. 8—Prewiring on S3.

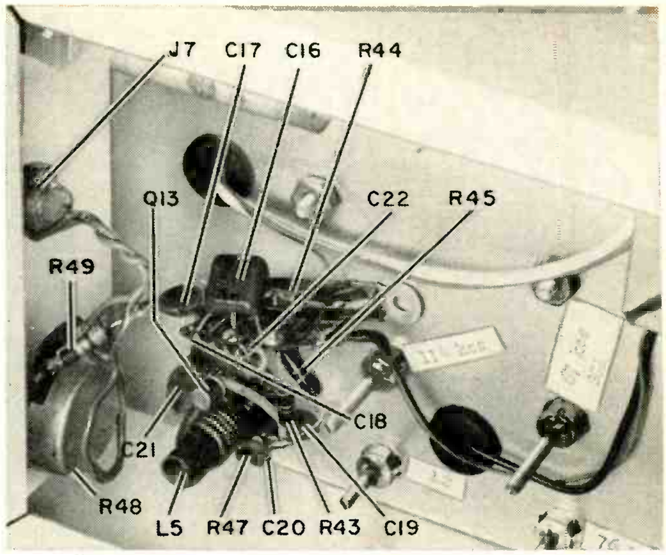


Fig. 9—Components of the 100-mc. FM oscillator.

point previously noted above. Repeat the procedure as a check. As a further check of phase adjustment, display the pattern shown in scope photo 6. Vary the 19-KC PILOT control between 0 and 200% (OFF and 2×). Alternate crossover points on the scope should remain stationary, while the others move up and down.

The next step is to check the frequency deviation of the 102-mc oscillator. A simple and satisfactory way is to tune it in on an FM receiver and compare the audio output of the generator signal with that of the average FM station. Use 1-kc modulation on both channels. When 1 kc is used on one channel and − 1 kc on the other, the sound will cancel out in a monaural receiver, if the receiver and generator are working properly. Change R43 if it is necessary to increase or decrease the deviation. Adjust the output coupling loop of L5 very loosely—about an inch away from L5.

As a final check of pilot frequency accuracy, display a Lissajous pattern of the 19-kc pilot (J1), and the signal from the 19-kc oscillator of a receiver properly receiving a multiplex transmission. The difference should be less than 5 beats per second.

I will not explain the use of the generator for receiver adjustment since there is already adequate information. Several books and articles have been written about it, and manufacturers usually supply detailed alignment data.

If the left and right channels appear to be reversed, reverse the wires on T2 terminals D and F. Then readjust the BRIDGE NULL control R35 for minimum output at J6 with the selectors on QUIET.

In using the generator, the variable pilot amplitude is especially useful in checking the lock-in range and initial adjustment of a receiver's 19-kc oscillator. Another proven valuable use for the generator is in a dealer's showroom. By feeding the external inputs with a taped stereo special effects program, a dealer may demonstrate the channel separation of his tuners with spectacular stereo effects not usually available from FM stations. In this application, the treble control on the preamplifier feeding the generator should be advanced to maximum. This will compensate for the lack of pre-emphasis in the generator. Pre-emphasis in the generator would require two additional transistors and circuitry, which would not be justified for this limited need.

The 10- to 1,000-μv range of the RF LEVEL control (R48) is only very approximate, and allows a range of rf control for checking limiter action. For very low-level sensitivity checks, an external attenuator on the receiver terminals will be needed.

The generator has been in use for several months and has proven to be accurate, stable and rugged. END

Get All the TV Channels

Adding "gimmick" trimmers to turret strips and aligning with a sweep generator brings in pictures like the ones on studio monitors

by LOUIS W. REINKEN

USUALLY, YOUR TV SET GETS ONLY A FEW channels really well. The others range from not quite so good to unreceivable. Changing antenna location or type may improve some channels but often makes others worse. The *real* trouble may be standing waves on the lead-in.

If changing the lead-in length by only a foot or less (which can easily occur with antenna revision) produces a marked change in picture quality on *any* channel, there are standing waves.

Standing waves can be eliminated by trimming the antenna circuit of each channel to exact resonance. If at the same time the remaining tuner circuits for each channel are accurately trimmed, reception will be good on all channels. One TV receiver, so modified, provides a choice of seven perfect local channels and three semi-distant channels previously hard to get.

Standing waves and mismatching

When both ends of the lead-in are mismatched, reflections travel in both directions. Response across the width of a TV channel will not be uniform—distortion will be like that produced by an i.f. amplifier with a tilted, bumpy response curve.

The intercarrier circuit in modern TV receivers permits the local oscillator frequency to be varied over a small range without losing the sound. Carefully adjusting this "fine tuning" control can compensate for the grosser distortions of standing waves and receiver mismatch.

Other mismatch troubles *cannot* be reduced by fine tuning. One of these is "wind flutter". With bad mismatch, the lead-in is very sensitive to small changes in capacitance to ground (especially the side of a wet building) and even a slight breeze will cause erratic flutter in the picture.

With correct matching, distant reception is greatly improved. Signal level at the receiver terminals is increased and, with better lead-in balance, noise is much reduced.

With proper match, only the directive antenna picks up signal. This reduces aircraft interference and Venetian-blind effect from distant transmitters on the same channel.

Turret type tuners, with separate strips for each channel, are equipped with trimmer capacitors, one each for "antenna", "rf" and "mixer input". It is usual to adjust these trimmers, with a sweep generator, for channel 9 or 10.

These can be set on the nose for *one* channel, but it is unlikely that the same setting will be best for all channels. This article explains how to trim up each strip for each channel to be received.

Standing-wave and mismatch troubles make proper antenna circuit tuning the number one improvement. Accurate alignment of the two other circuits is also very important. Tuning these accurately increases the level of weak signals (reducing snow) and provides *flat* response for locals. Uniform, flat response is as necessary in the tuner as in the i.f. amplifier.

To get the most from your tuner, there must be independent trimmers for *each* circuit in *each* channel.

Adding independent trimmers

Remove the external trimmers or simply set them to minimum capacitance by removing the trimmer screws. Each channel strip is then equipped with its own set of independent trimmers. This is easier than it sounds, because each trimmer is just a twisted-wire gimmick.

A pair of No. 20 plastic-covered wires, 3 inches long, has a capacitance of, very roughly, 10 pf, and is long enough.

As shown in Fig. 1, the gimmicks are soldered to the same lugs as those used for terminating the strip coils. (Note: *no* gimmick for the oscillator. The oscillator coil is equipped with a variable-inductance trimmer slug adjusted, usually, from the front.)

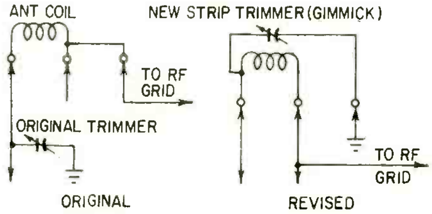


Fig. 2—Adding gimmicks doesn't really change circuit electrically—it merely provides a separate trimmer for each channel.

Study the tuner circuit to make sure that the gimmicks will be, electrically, in the same places as the original external trimmers. Usually, there will be no problem with the rf and mixer input circuits and the gimmicks may be shunted directly across the coils.

However, some tuners have antenna circuits requiring minor wiring changes in the tuner. A before-and-after example of such a circuit is shown in Fig. 2.

I.f. alignment

Initially, the i.f. section must be checked with the usual sweep generator and scope setup and, if needed, carefully realigned for a response curve as close to the textbook ideal as possible. This is essential because, with flat response from each channel in the tuner, picture quality will depend only on how well the i.f. has been aligned. Reminder: the video carrier i.f. must be located "50% down" from the flat top. This must be done carefully *before* the tuner gimmicks are adjusted.

Gimmick tool

Gimmicks are adjusted by twisting the two wires together to increase the

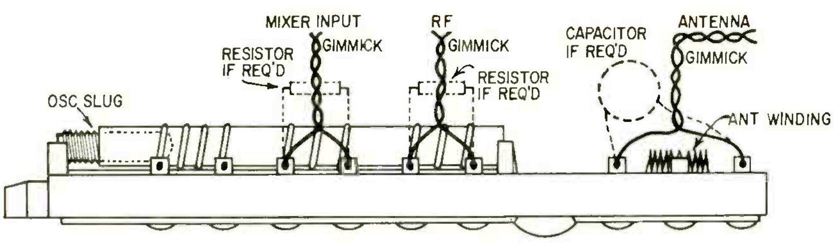
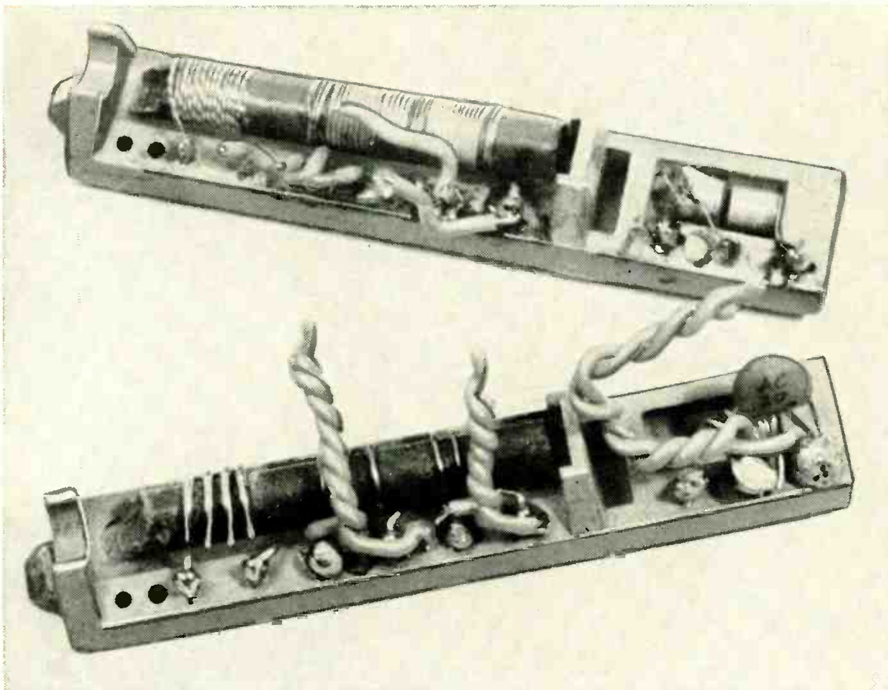


Fig. 1—A typical turret-tuner channel strip and how it is modified with gimmicks.

YOU'LL NEED . . .

Two ⅛ to ½-watt resistors per channel (see text for values).
One or two small capacitors per channel (see text for values).
About 15 feet of No. 20 plastic-covered hookup wire.
Sweep and marker generators, oscilloscope.
Plastic pliers or fuse puller.

See Sept P 12



Two turret-tuner strips modified with twisted-wire gimmicks for better set performance.

capacitance or untwisting to decrease it. Cut off excess length. This may require tightening the remaining twisted portion to compensate for the loss in capacitance when the excess is clipped off.

The ideal tool for adjusting the gimmicks is a pair of *plastic* pliers. Metal pliers cannot be used because of stray capacitance—even when insulated.

If plastic pliers are not available, an excellent substitute is a fiber or plastic "fuse puller". These pliers are notched inside the jaws to permit a standard cartridge fuse to be extracted from live fuse clips. They can be used as is or can easily be cut to approximate the shape of flat-nosed pliers. A pair of nonmetallic pliers has many uses.

Gimmick adjustment

With all the strips removed from the tuner and equipped with gimmicks, the soldering checked and the contacts cleaned (with De-Noiz or other contact fluid), gimmick adjustment can begin.

One of the strips is snapped back into the turret, at any location, for trimming. Set the sweep generator for the channel. *Accurate* rf marker signals must be available. (One way of insuring an absolutely accurate video carrier marker, for local channels, is to couple an antenna loosely to the tuner input and use the transmitter's video carrier as an rf marker.)

The scope input may be connected to the video detector to show the overall response including the i.f. amplifier, or to the mixer input (tuner test point). If the scope has enough sensitivity, connect it to the mixer input because this will show only the rf response and simplify adjustment.

With only one strip in the turret there will be plenty of room to insert the plastic pliers to twist or untwist the gimmicks while you observe scope. The rf and mixer input gimmicks should first be adjusted to approximately the "best" values as indicated by maximum output at resonance. *Do not clip these two gimmicks yet.*

Antenna gimmick

The antenna gimmick must be adjusted carefully and patiently. (If the antenna circuit is not properly tuned, mismatch and standing waves will wreck all other rf and i.f. alignment.) The adjustment is correct when increasing *or* decreasing the capacitance by a few pf reduces the pattern height—that is, tuner output level.

It may be necessary to supplement the gimmick capacitance with from 5 to 25 pf of fixed capacitance. Try different values until you are sure you are at resonance. Two or even three miniature disc capacitors may be paralleled to get the required amount. A *small* stock of different values, for instance 5, 10 and 20 pf, can then be used to provide any capacitance you need.

Because antenna circuit Q is low, resonance is not sharp and may be hard to locate. It may help to tap a fixed capacitor of several pf on and off (using the plastic pliers) to get a definite change in the CRO pattern. As you approach resonance (from the low-capacitance side), adding the test capacitance increases the pattern height; above resonance, adding capacitance decreases the height. And, especially on channels 2–6, hand capacitance near the tuner input leads has much less effect on the pattern at resonance.

Rf and mixer input gimmicks

After the antenna circuit has been aligned accurately, trim the remaining two gimmicks. Adjust them simultaneously, since a *small* amount of staggering between these two is permissible to get a flat response over the 6-mc bandwidth of the channel. The Q of these circuits is higher than that of the antenna circuit and it is easy to observe resonance on the scope. Q may be so great (particularly in the rf circuit) that resonant peaks make it hard to get flat response over the band when the circuits are tuned.

Usually, the rf circuit will have a sharp peak and the mixer input a broader, lower one. The peaks can be shifted by adjusting the gimmicks. *But,* the response *must not* be flattened just by detuning both circuits. This would simply sacrifice signal strength and increase adjacent-channel interference.

It is better to have the circuits resonate *within* the band, staggered if necessary, reducing and broadening the peaks as required to produce a response characteristic flat to $\pm10\%$. Peaks may be lowered and broadened by shunt resistors across the gimmicks. These should be small (1/8 to 1/2 watt) and have resistances of 3,000 to 10,000 ohms. Mount them as shown in Fig. 1. The best value is the *highest* that produces a response curve flat to about $\pm10\%$.

Overall response

When all three gimmicks have been trimmed, examine the overall response, including the i.f. amplifier, by shifting the scope input connection from the mixer input to the video detector. Because the local oscillator frequency is varied by rotating the fine-tuning control (or by screwing the oscillator slug in or out), you must make sure that the oscillator is at exactly the right frequency. Inject two marker frequencies (one rf and one i.f.) and shift the oscillator frequency until the markers coincide.

The i.f. marker, injected into the tuner test point through about 10,000 ohms, must correspond in frequency to that of the video carrier i.f. during alignment of the i.f. amplifier.

The rf marker corresponds to the video carrier frequency and is injected into the tuner input (along with the sweep input). As previously suggested, for local channels, this frequency may be picked up off the air.

With the fine-tuning control set midway, rotate the oscillator slug until the rf marker has been moved to the position of the i.f. marker. If the markers can be injected simultaneously—the rf from a loosely coupled antenna and the i.f. from a generator—they can be made to coincide precisely. If the scope pattern vibrates when this occurs, one of the markers may then be removed.

If the i.f. amplifier was correctly aligned and the rf response is flat over the band, the pattern should be like the solid curve in Fig. 3, with the video carrier "50% down". If it does not look like that (for example, if the flat portion is not wide enough or is tilted, or if the video carrier is not 50% down), perfect reproduction is impossible. The i.f. adjustments and tuner gimmicks should not be changed at random. Find out the *reason* for the incorrect pattern before you make any changes. This is the only way to get good results from all channels.

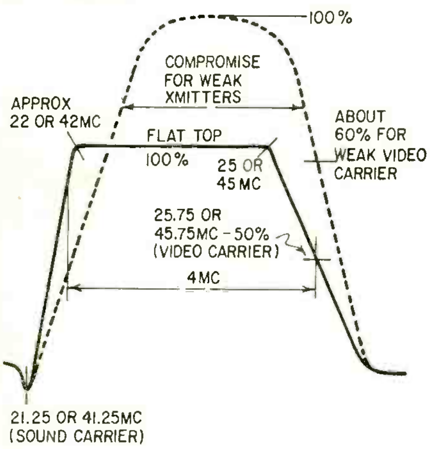


Fig. 3—Ideal response curve for any channel after adjustment. Dotted curve is compromise for weak stations—better contrast, less detail.

Distant stations

For more distant stations, it is worth swapping fine picture detail (which couldn't be seen anyway) for a stronger carrier. The overall response should be like the dotted curve in Fig. 3. To get it, increase the resistances across rf and mixer input gimmicks, or omit them.

Fig. 3 illustrates that the signal from a weak station may be doubled in level with slight loss of fine detail.

After all strips are back in the turret, give each channel one last overall check with the generators and scope. Channels for local stations should be like the solid curve (Fig. 3) and those for weaker stations like the dotted one. Errors caused by bending the gimmicks must be corrected with the pliers before closing the tuner.

When you switch channels, there may be a large difference between 6 and 7. This may be due to the sweep generator and not to the tuner. On the air there will be a noticeable increase in signal strength and *all* channels will be good. END

Your VTVM Checks Camera Shutters

Trust your shutter? Build this simple adapter and you can check it any time

By ELLIOTT A. McCREADY

ANYONE WHO DABBLES IN PHOTOGRAPHY has probably wondered just how accurately his shutter is calibrated, especially when he has just turned out a mediocre batch of pictures. At such times, I've sworn to build a device to check that camera shutter. Such circuits have been published, but have usually been rather complex.

Probably the simplest way to check the duration of any event is to use it to charge a capacitor through a resistor. The duration of the event can then be determined by simply measuring the charge across the capacitor. There's a predictable charge-time relationship for any combination of R and C.

Knowing that, look at Fig. 1. The camera shutter actuates switch S, which charges capacitor C through resistor R. The voltage across C is measured by meter M and indicates the length of time the circuit was activated.

Before this idealized setup can actually be used to measure camera shutter speeds, several changes must be made. First, as soon as M is connected across C, the capacitor begins to discharge. So a reasonably large capacitor and high-resistance meter must be used to get an accurate reading before the charge dissipates.

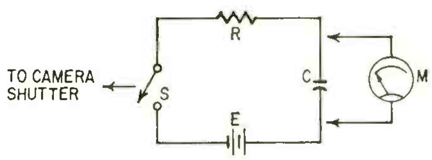
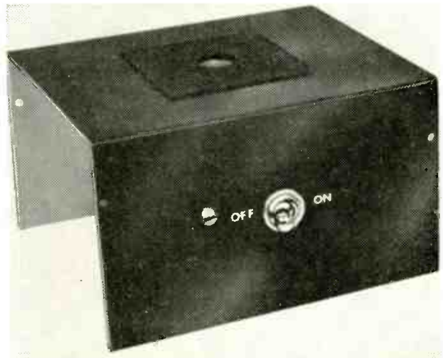


Fig. 1—Basic idea uses shutter-coupled switch to close capacitor-charging circuit. High-resistance voltmeter across capacitor measures voltage there, which is related to charging time.

Notice that R and M form a voltage divider across E, and that the maximum voltage across C will be that across M. At the instant the shutter opens, C will act as a short circuit, and no voltage will appear across M until C acquires a



Camera rests, lens down, on felt square surrounding hole on top of chassis. 100-watt bulb, shining through open camera back, is light source.

charge. At high shutter speeds, C will acquire a very small charge, and M will read a very low voltage. For this reason R must be kept low (compared to the resistance of M), and E fairly high for maximum voltage across C and usable readings at high shutter speeds.

The last and certainly the toughest change to the basic circuit is finding a switch to synchronize perfectly with the camera shutter. Obviously a photocell, actuated by light passing through the camera shutter, would be the perfect switch. We could use the photocell to drive a relay, but relays are much too slow for this particular job.

Before we go any further, let's define a switch. In part, the ideal switch has infinite open resistance and zero closed resistance. Real switches have a finite—but high—open resistance and a very low—but measurable—closed resistance. How far can we depart from the ideal and still have a usable switch for our shutter timer?

As the value of R determines the charging time of C, and hence the accuracy of the device, the closed resistance of the switch must not exceed a small percentage of R. The open resistance of the switch will determine the leakage or static current of the circuit and the voltage that will appear across

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C with S open. If the fastest shutter speed we plan to measure is 1/200 second, we can calculate the voltage that will appear across C. A quick check with Ohm's law shows that the open resistance of S must be not less than several thousand megohms.

Finding a photocell or photocell-actuated device that fulfills all these requirements turns out to be much simpler than it looks.

Circuit

Fig. 2 is the schematic of the shutter timer. The meter of Fig. 1 is replaced by an ordinary 11-megohm vacuum-tube voltmeter, which plugs into the circuit. The size of C, together with the fact that the vtvm is connected during the charge cycle, eliminates any problem due to meter lag.

The 1-megohm charging resistor is small in comparison with the resistance of the vtvm, and most of the voltage of the 22½-volt battery will appear across the vtvm.

Switch S of Fig. 1 is replaced by a modified n-p-n silicon transistor. Carefully file off the top of the transistor. The resulting unit is extremely photosensitive. I tried a cadmium sulfide photocell here, but its time constant was too long for all but the slowest shutter speeds. The time constant of silicon junction photo devices is less than 20 microseconds. Dark resistance of the modified transistor is many thousands of megohms; its resistance in moderate light drops to a few thousand ohms.

Switch S is a spdt unit that, in addition to disconnecting the battery, discharges C when it is in the OFF position.

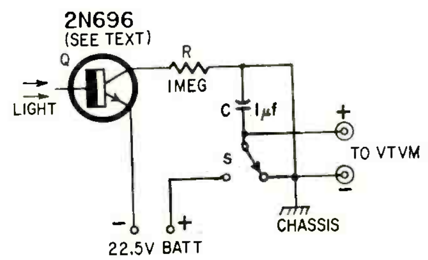
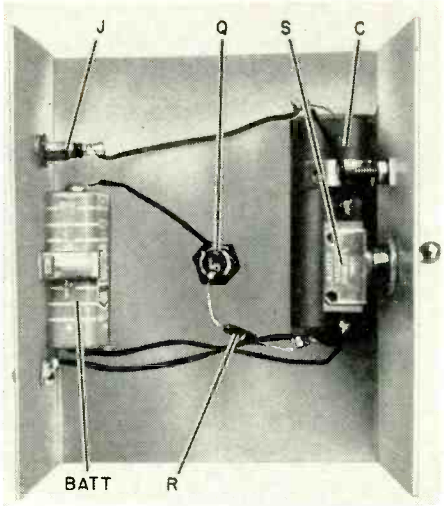


Fig. 2—Practical circuit is very much like ideal, except that opened-up silicon transistor is used as photosensitive switch.

Construction

The unit is constructed on the U-shaped half of a 3 x 4 x 5-inch box type chassis. A pin jack on the back of the chassis accepts the positive probe of the vtvm. The negative lead clips to a projecting 6-32 screw.

The photocell is constructed by carefully filing the top from a Texas Instruments 2N696 silicon transistor. Other silicon transistors would probably work equally well. However, I tried an



Underneath. Large capacitor and battery are held by metal clips.

BATT—22.5-volt hearing-aid battery (Eveready 412 or equivalent)
C—1 μf, 600 volts, 5%, paper
J—pin jack
Q—2N696 (TI), modified (see text)
R—1 megohm, ½ watt, 5%
S—spdt toggle switch
Aluminum box, 3 x 4 x 5 inches
Bakelite cap (see text)
Miscellaneous hardware

RCA 2N706-A which is smaller than the 2N696. The slab of silicon inside the transistor was also much smaller and the modified unit showed considerably less sensitivity than the 2N696.

The modified transistor is cemented inside a ⅜-inch length of lightproof bakelite or plastic cylinder. I used a ⅜-inch bakelite control protector cap with the closed end sawed off. The completed photocell is then cemented below a ⅜-inch hole in the top of the chassis. Glue a small piece of clear celluloid over the hole in the top of the chassis to protect the photocell, and cement a 2 x 2-inch piece of felt as shown in the photo to make a light seal between camera and chassis.

This remarkably uncomplicated black box offers a way to check your camera's shutter speed accurately enough for almost all photographic applications, without using stroboscopic techniques or film in the camera. A modified silicon transistor (which normally has extremely low leakage) is used as a light-sensitive switch to charge a capactitor for the length of time the shutter is open. A vtvm measures the voltage across the capacitor. Since the voltage depends precisely on the time the capacitor was allowed to charge, you can read the shutter-open period directly off a chart.

Works beautifully for shutter speeds from 1 second to 1/200 second, and for still higher speeds if your vtvm is sensitive enough.

Operation

Before using the shutter timer, check minimum voltage by connecting the vtvm (set at its lowest range), covering the photocell and switching the unit on. A properly operating unit should show no vtvm deflection. The manufacturer specifies a maximum leakage current of .002 μa for this transistor. A good transistor will show only a fraction of this leakage and should produce no observable voltage at the vtvm.

If the capacitor has just been charged (by exposing the photocell transistor to light, say), and then shorted, a small voltage will appear as soon as the short is removed, due to dielectric absorption. So, before you check the shutter timer initially (and for all checks of high shutter speeds) make sure the unit has been switched off (capacitor shorted) for a few minutes. That will completely dissipate the stored charge.

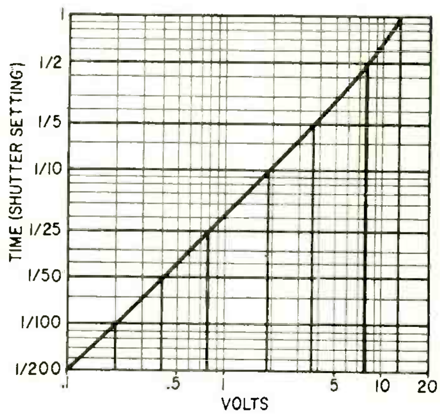


Fig. 3—Volts/time relationship you can use to relate vtvm reading to shutter speed. Chart can be extended down and left for higher speeds if you have access to dc millivoltmeter.

To check shutter speeds, connect the vtvm and set it to the proper range (consult Fig. 3). Open the back of the camera, open the lens fully, cock the shutter and place the camera, face down, over the photocell. As a light source, use a 100-watt bulb, placed a foot or less from the back of the camera. Now, turn the timer switch on, trip the camera shutter, note the peak voltage on the vtvm and use the graph of Fig. 3 to determine shutter speed.

If you own a vtvm that gives accurate readings at voltages less than 0.1, there is no reason why you can't measure shutter speeds faster than 1/200 second. The graph of Fig. 3 becomes a straight line below about 1/25 second. Simply add another section to the graph and extend the line to the left: 1/500 second becomes .04 volt; 1/1000 second, .02 volt.

After building this gadget, you will be truly amazed at the things you can accomplish with a minimum of parts and equipment! END

Low-Cost, Easy-to-Build Stereo Speaker Enclosures

This stereo pair—and a shelf to put them on—can be built and finished with a minimum of skills and tools

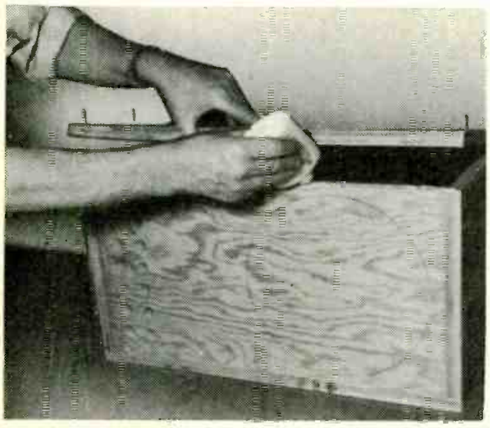
By **RICHARD G. LEMBURG**

THIS STEREO PAIR OF SPEAKER ENCLOSURES—AND A SHELF TO put them on—can be built and finished with a minimum of woodworking skills and tools, all for less than $22. Plastic covering material and solid construction result in good-looking units that deliver excellent stereo sound.

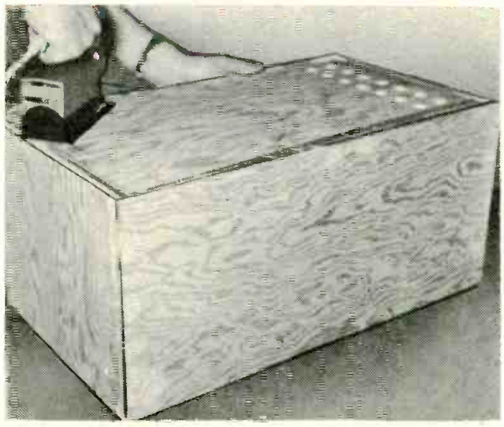
Both enclosures and shelf are cut from one 4 x 8 foot sheet of ¾-inch plywood (Fig. 1-a). Use a circular saw for

MATERIALS LIST (for two speakers and shelf)

- One 4 x 8-foot sheet ¾-in. fir plywood (AD grade)
- Two pcs ¼-in. plywood 13¾ x 23¼ in.
- 2 doz. 1½-in. flathead wood screws
- ¼ lb 3-penny finishing nails
- 8-oz bottle Elmer's Glue-All
- 4½ yd 16-in. Con-Tact
- 36 x 36-in. pc grille cloth (Lafayette 20 G 1212 or equivalent)
- 8 sq ft 1-in. thick glass-wool insulation (Lafayette 20 G 8001 or equivalent)
- Two 2-screw terminal strips
- Four 12-in. shelf brackets (Lafayette 99 G 9046 or equivalent)
- Four 12-in. wall standards (Lafayette 99 G 9055 or equivalent)
- Sandpaper, putty, staples or tacks



Apply glue liberally to each pair of surfaces to be joined. Top and bottom are glued in last. Nails will hold parts tight until glue hardens.



Speaker opening may be cut with sabre or keyhole saw after enclosure has been glued together.

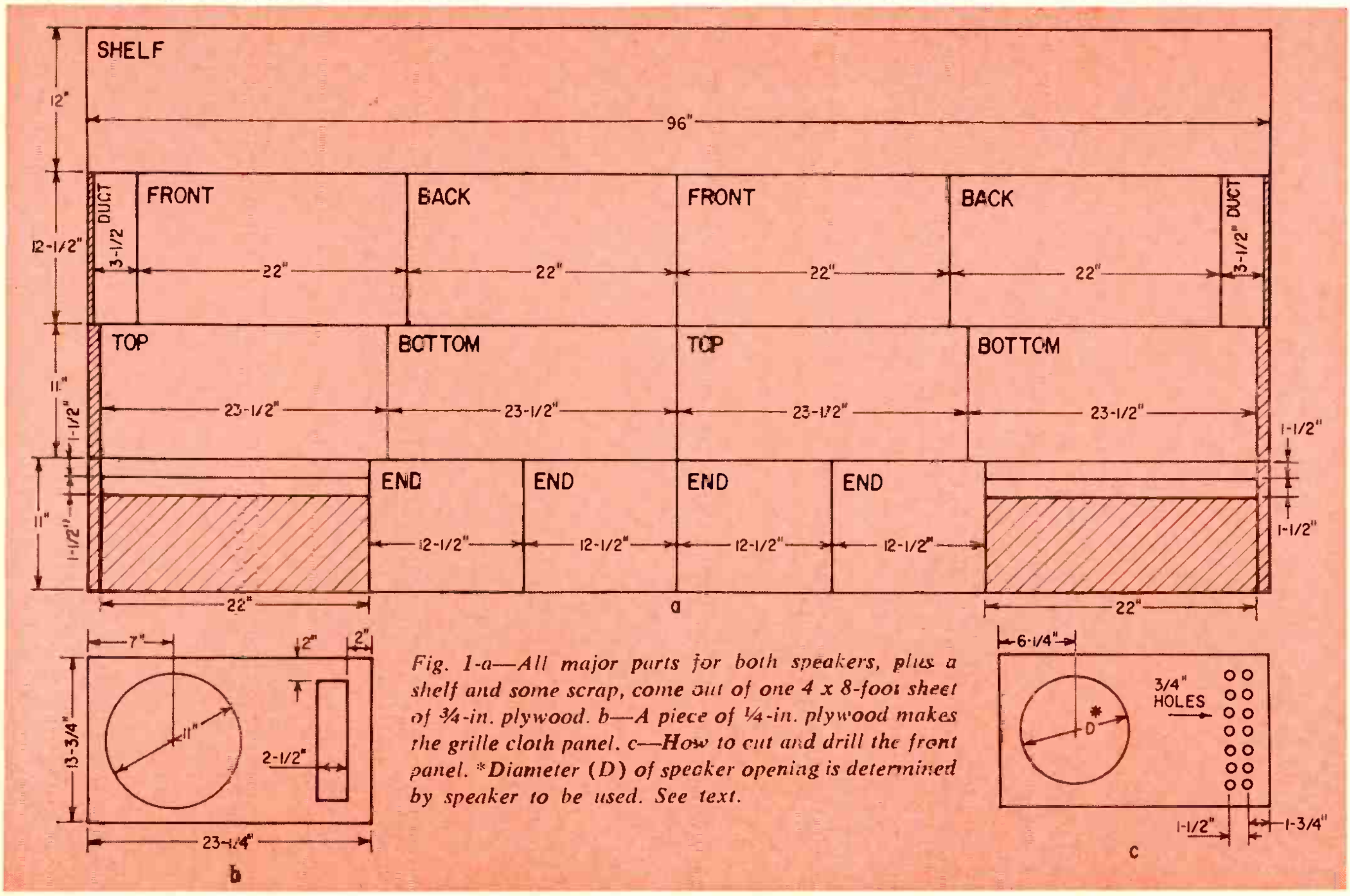
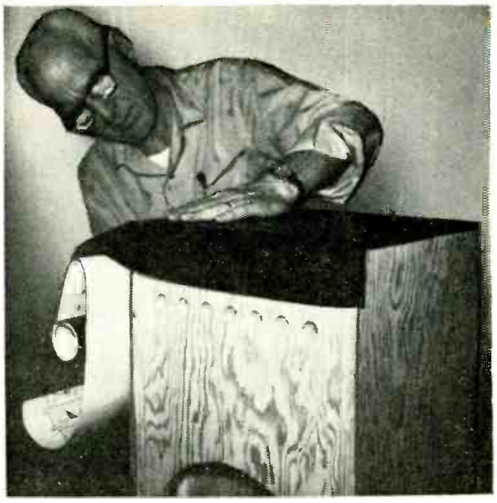
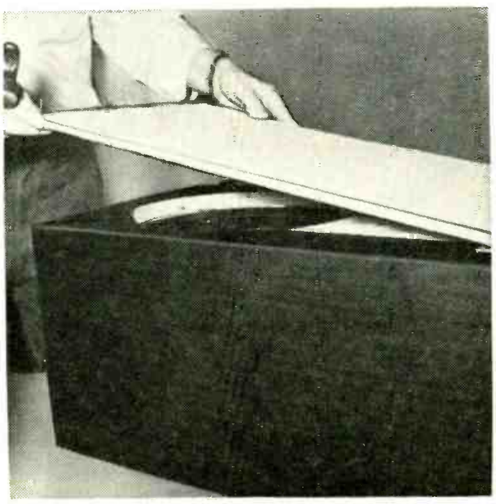


*Fig. 1-a—All major parts for both speakers, plus a shelf and some scrap, come out of one 4 x 8-foot sheet of ¾-in. plywood. b—A piece of ¼-in. plywood makes the grille cloth panel. c—How to cut and drill the front panel. *Diameter (D) of speaker opening is determined by speaker to be used. See text.*

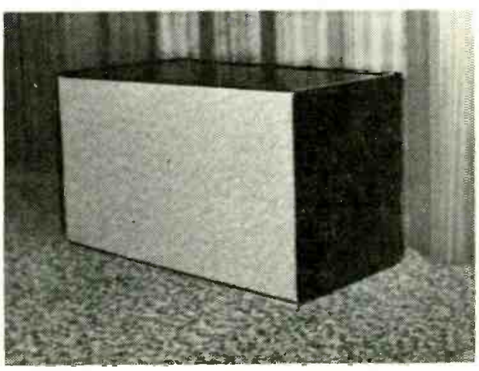


Sides, top and bottom are covered with self-stick plastic. Remove protective paper backing in short sections.

Line top, bottom and ends with 1-in.-thick acoustic padding.



Separate grille-cloth-covered board is nailed over front. (Nails will not show.)



One of the finished stereo pair.

accuracy. (Most lumber dealers will cut the plywood to the required dimensions for a small fee.) Two pieces of ¼-inch plywood, each 13¾ x 23¼ inches, will be needed for mounting the grille cloth (Fig. 1-b).

When all panels and strips have been cut to size, locate and drill the ¾-inch port holes and cut the speaker opening in each of the two front panels (Fig. 1-c). Diameter of the speaker openings will, of course, be determined by the speakers used. Good quality 10- or 12-inch full-range speakers are recommended for optimum results.

Using a liberal amount of glue and two or three nails along each joint, assemble the enclosures as shown in the drawing. Begin by mounting the 3½ x 12½-inch port-duct strip on the front panel, 5 inches in from the end; then fasten the ends to the front panel and, before the glue sets, put on the top and bottom panels and the 1½ x 22-inch back mounting strips. Note that the back-panel mounting strips are glued ¾ inch *in* from the back edge of the top and bottom panels. (Use a piece of ¾-inch plywood as a guide.) All other joints are made flush. When the glue has dried, countersink the nails and fill the holes and the exposed ends of the top and bottom panels with water-mix putty. Sand the four sides of each enclosure, give them a coat of shellac, and sand again so they are smooth to the touch. (Use a sanding block.)

The next step is to cover the sides of the enclosures with *Con-Tact* or a similar covering material. A large variety of

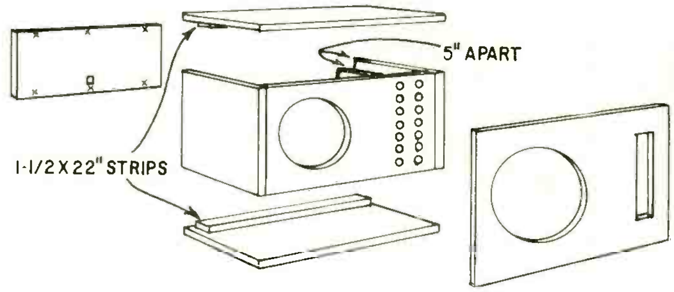


Fig. 2—Exploded view shows how parts go together.

wood-grain patterns and colors is available. Using a strip 6 feet, 4 inches long and 16 inches wide, start applying the plastic slightly over one edge (see photo). Wrap the plastic completely around the enclosure, carefully smoothing it as you go, and overlap the ends about ¼-inch where they meet. Now press the excess width of material over the front and back edges, making a 45° fold at each corner. Trim off any material that covers the speaker and port openings.

Install the speakers next, and line all four sides of each enclosure with acoustic padding (a 1-inch thickness of glass wool is good). Prepare the back panels by mounting a two-screw terminal strip on each, and drilling holes along the top and bottom edges for the six mounting screws. Wire the speakers to the terminal strip lugs, and fasten the back panels in place with 1½-inch screws.

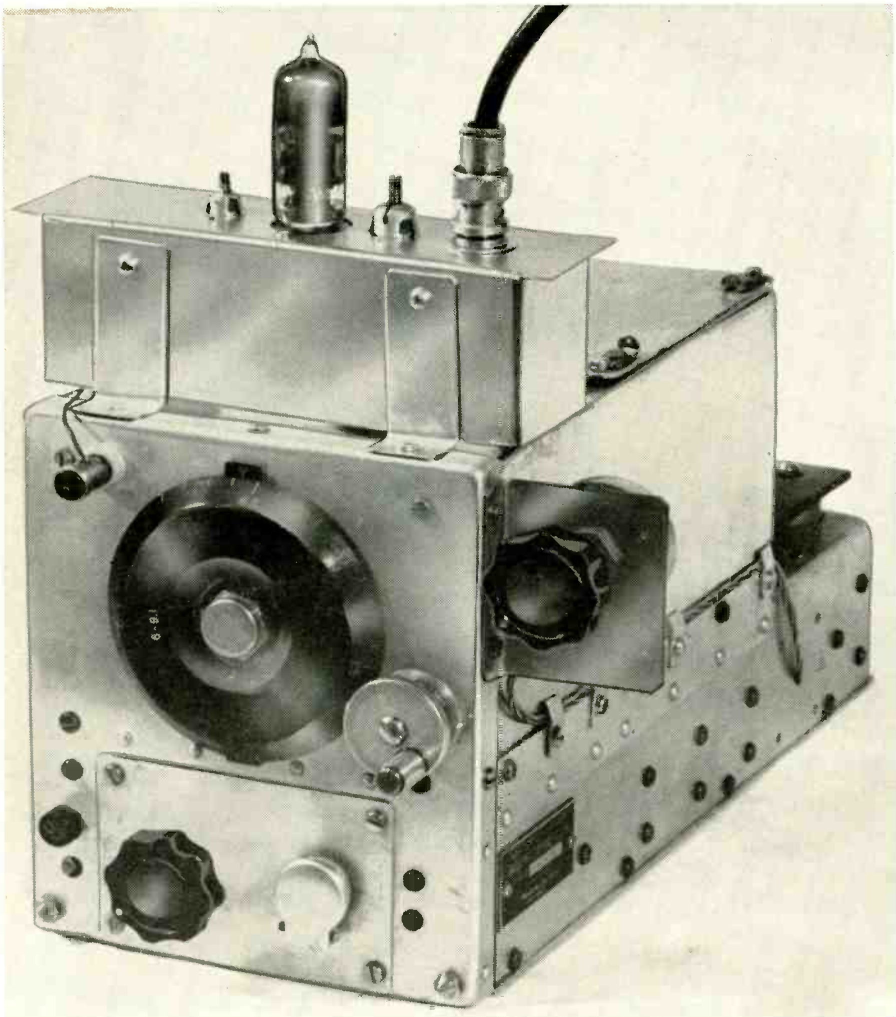
Mounting the grille cloth is the final step. After cutting out the two ¼-inch plywood boards as shown (Fig. 1-c), cover them with grille cloth, stapling it to the back of each board. (Lightweight, loose-weave flexible cloth is best.) Place the covered board over the front of the enclosure (be sure to line up the speaker opening with the speaker), and drive several 1-inch brads through the boards *from the front*. With a nail or nail set, countersink the brads below the surface of the grille cloth. They will not show.

[The author used 12-in. Norelco speakers. The enclosure design will suit almost any 12-in. speaker. Those who are familiar with bass-reflex cabinet tuning procedure will find it easy to change the resonant frequency of the enclosure by drilling more ¾-in. holes or by plugging some up, or by varying the duct length.—*Editor*] END

NO SQUELCH? DESIGN IT!

Two very simple circuits you can tailor-fit to almost any ham, CB or communications radio

By ARTHUR F. BLOCK



Author's BC-455-B surplus receiver, with squelch control on bracket at right. (Box with tube at top contains home-brew rf amplifier.)

IF YOU HAVE A COMMUNICATIONS OR CB receiver or a converter working into a standard broadcast receiver, and would like a simple and effective squelch, one of these circuits will fill the bill nicely. Squelch circuits are no more difficult than any other single stage in a radio. This is especially true of these basic units.

The simplest design (and the easiest to install because no additional tubes or diodes are required) is the *biased detector*. If your i.f. and rf tubes already have resistor-biased cathodes, the only additional parts needed are one fixed resistor and one potentiometer. (The necessity of cathode bias will be covered later.)

Fig. 1 shows that the only difference between the biased diode and a normal diode detector is that the cathode is returned to a small positive voltage instead of direct to ground. This means that the detector plate is more negative than the cathode. The diode will not conduct until the signal peaks override this bias. Thus, we have squelch.

Three volts positive at the top of R1 (Fig. 1-b) should give enough range for practically any receiver. With R1 a 1,000-ohm potentiometer, we need only 3 ma to get a 3-volt differential. Any power supply worth its salt can supply that much additional current without turning pink. R2 drops the voltage from the B-plus supply to the necessary amount for R1.

Determining the value of R2 is simple. It must supply 3 ma to R1 and at the same time drop all but 3 volts of the B-plus. Ohm's law is all we need. In figuring the wattage rating for R2, remember that it should be at least *twice* the calculated power dissipation.

C1 will probably not be necessary but, if you hear hum as R1 is advanced, the power supply hasn't enough filtering for this low-level use. Then add C1 as shown in Fig. 1-b. R2 and C1 then form another filtering section.

Before installing this squelch, check all tubes controlled by avc. If their cathodes are connect direct to ground, connect a resistor between each cathode and ground and bypass it with a disc capacitor of approximately .01 μf. With grounded cathodes, the tubes are normally biased only by the avc produced by stray noise pickup or by received signals. During squelch, this noise is not detected and there is no avc voltage. This leaves the tube with no bias. It may overload itself and the power supply. The cathode resistor restores normal bias with the squelch. For the newer miniature tubes approximately 150 or 200 ohms should do, and around 300 ohms for older octal tubes. A tube manual can provide more specific information. *Keep the leads short* and keep the ground connection close to the tube.

For those of you who have Eico transceivers of the 760, 761 or 762 design, this biased-detector squelch is a natural. Pin 1 of the V5-a (the 6FM8)

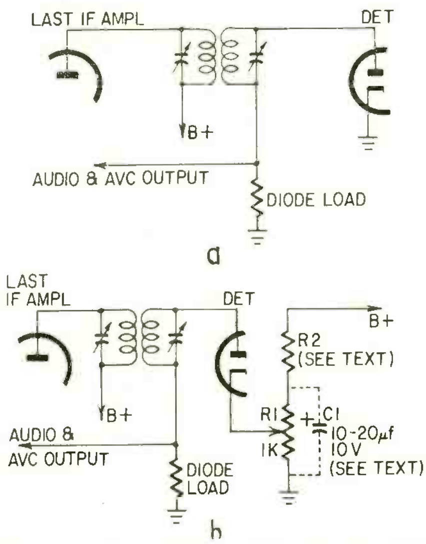


Fig. 1a—Basic diode detector. In (b), same basic circuit modified for squelch action by imposing positive threshold voltage on cathode.

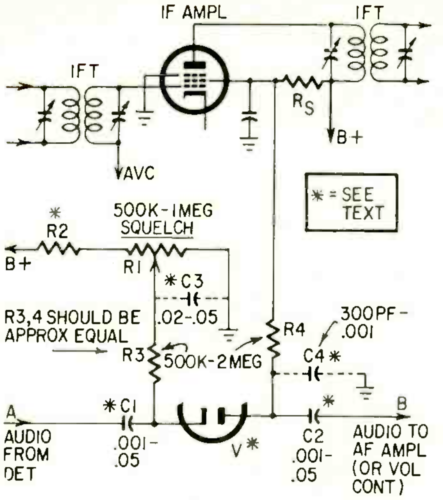


Fig. 2—Series back-biased diode squelch does not disrupt avc action. Incoming signal, amplified and detected, raises avc voltage, reducing screen current of i.f. amplifier and raising screen voltage. Increased voltage, transferred to diode plate, closes audio circuit and lets signal through to af stages.

is the cathode of the detector and would be removed from ground to the slider of R1 (Fig. 1-b). (If any other connections are made to pin 1, be sure to remove and ground them.) The size of R2 is determined as before. Cathode resistors and capacitors will have to be added to V1 (6BA6), and the pentode sections of V3 (6U8-A) and V4 (6U8-A) to restore grid bias.

As with any squelch control, do not advance R1 any more than necessary for squelch action. It operates best if a very small amount of noise is allowed to remain instead of trying for complete cutoff. Going beyond this point will decrease sensitivity. Impulse noise cannot be squelched completely. This is true of most squelch circuits.

One peculiarity of the biased-detector system may be true of other circuits also. It will not squelch if you have regeneration in the set. I tried it in a set with a regenerative i.f. (for selectivity) and squelch action was practically nil. Removing the regeneration permitted normal action. Regeneration appears to produce a spike type of noise which squelches only with the control advanced beyond the point where it will break with normal-strength signals.

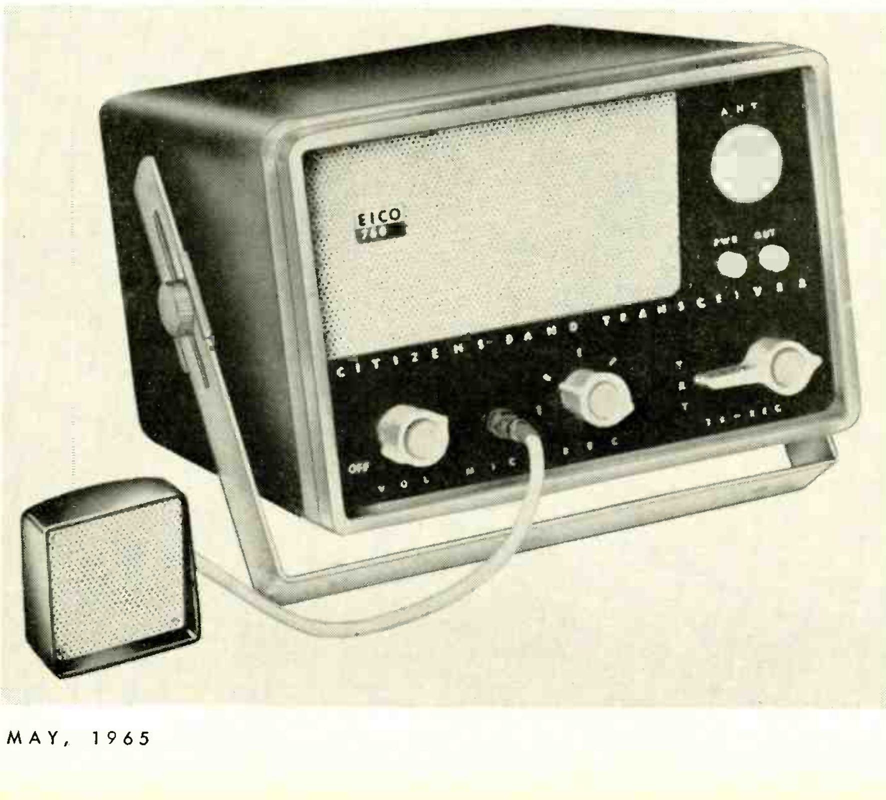
Another way

The second circuit is the series back-biased diode, found (with minor variations) in many CB transceivers. It is one of the most sensitive, cleanest-breaking, easiest-to-install squelch circuits I have encountered. A possible exception is the biased-detector circuit just mentioned, but the two circuits cannot be directly compared. Each has its particular characteristics.

Operation is simple (Fig. 2). V is in series with the audio signal and can allow it to pass or cut it off, depending on the relative voltage between plate and cathode. R3 and R4 allow the control voltages to be applied without shunting the audio to ground.

In operation, audio is blocked if the plate of V is negative with respect to the cathode, and allowed to pass if the plate becomes positive. Adjusting R1 to the correct point establishes the

Eico 760 CB transceiver—a cinch to modify for squelch as described in text.



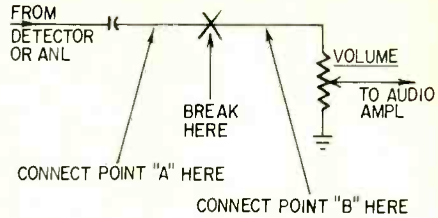


Fig. 3—Usual volume control circuit, showing where to break in and add circuit of Fig. 2.

operating potential. The plate of V is connected via R4 to the screen of a tube that is avc controlled. When a signal comes through, avc on the control grid of the i.f. tube drives the tube toward cutoff. There is less voltage drop through R_s and a rise of screen voltage. This rise also appears on the plate of V, allowing it to conduct. The audio then passes through to the audio amplifier.

Fig. 2 also shows how the squelch unit is connected to the radio to get the dc control voltage. Audio connections will be covered later. R4 should be placed directly at the socket of the i.f. tube to prevent rf currents from causing regeneration. The line between R4 and the plate of V1 can be any reasonable length, but keep it dressed close to the chassis to prevent stray pickup.

C1 and C2 are merely audio coupling capacitors and can be treated as such.

C3 and C4 may not be needed. C3 is of value if R1 happens to be noisy. C4 is an rf bypass; try it if instability appears. It should be connected close to R4. Use as small a size as will cure the instability. It also cuts higher audio frequencies, which may be needed for intelligibility. About 100 to 500 pf should do. Keep below .001 μf if possible.

R1 and R2 are chosen so that the voltage at the top of R1 is higher than the voltage on the screen grid of the tube to which R4 is connected. This allows the squelch point to occur within the rotation of R1. The value of R1 can be from 500,000 ohms to 1 megohm.

Choose R2 the same way as for the biased-detector system.

Although it is usually not necessary, R_s may be increased. This will increase squelch sensitivity somewhat, but it will also lower the screen voltage. Some receivers using this squelch have a value as high as 100,000 ohms for R_s. Be careful not to lower the screen voltage too far or you may cause a decrease in receiver sensitivity.

Although a regular diode of the 6AL5 or 6H6 type is the logical choice, a diode-connected triode may also be used for V1. It is best to stay away from older octal-based triodes, however, because of insufficient cathode-to-heater insulation. The newer miniature tubes are usually insulated for up to 200 volts between cathode and heater. If in doubt, consult any tube manual. In these circuits, the cathode will operate from 50 to perhaps 100 or more volts while the heater of the tube will usually have one side grounded.

The best place to make the audio connection to the radio is just ahead of the volume control (Fig. 3). Remove the wire from the "top" (ungrounded end) of the volume control and connect it to the input capacitor of the squelch unit. The output capacitor goes to the top of the volume control. Don't forget the ground connection if you make this an outboard unit. If the volume control also acted as the diode load resistor (Fig. 4), just replace it with a fixed resistor of equal value. This is designated as R_V in Fig. 4.

The precaution of a resistor-biased cathode in the rf and i.f. stages that was necessary in the biased-detector circuit is unnecessary here. We are dealing with audio and have in no way changed the detection system.

With normal undelayed avc, this squelch circuit will open with a signal so weak as to be scarcely readable, but the circuit will not work well with delayed

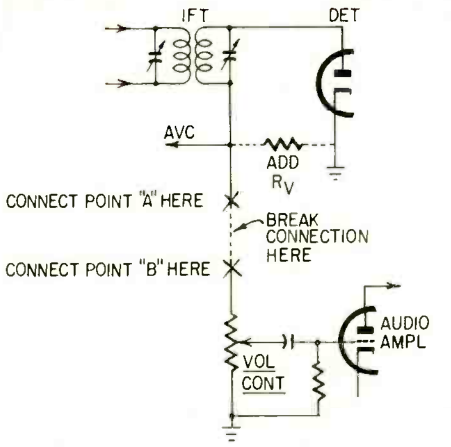


Fig. 4—Where volume control is diode load, use this circuit.

avc. The squelch-opening action depends upon the avc voltage changing the screen voltage, and with a delay circuit this cannot occur until the signal reaches a certain minimum level. Until this level is reached, no squelch break will occur. You can see from this the advisability of removing any delay circuits.

The easiest way to spot delayed avc is to measure the avc voltage with a vtvm and no signal. Then locate an extremely weak signal—one that you cannot even read—and see if the avc voltage rises slightly. If it does, you have nothing to worry about. If it doesn't, your receiver has delayed avc, and the best method of attack is to locate a diagram to determine which one of several circuits has been used in your particular receiver.

The squelch control should be set at the point where it is just sufficient to quiet the receiver. This point will be very sharply delineated. Any further advancement of the control will adversely affect sensitivity. If there is noise, you will have to decide for yourself the relative importance of silence as compared to the ability to receive weak signals. END

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Radiotron Designer's Handbook (4th Edition) (1952), Pp 1106, 1111-1114

The Radio Amateur's Handbook (31st Edition) (1954), Pp 90-91

Squelch Circuits

RADIO-ELECTRONICS, December 1959, p 57 (Globe squelch)

RADIO-ELECTRONICS, June 1960, p 50 (diode squelch)

RADIO-ELECTRONICS, September 1960, p 55 (Vocaline squelch)

RADIO-ELECTRONICS, April 1961, p 72 (transistorized squelch)

Nine-Volt Record Changer

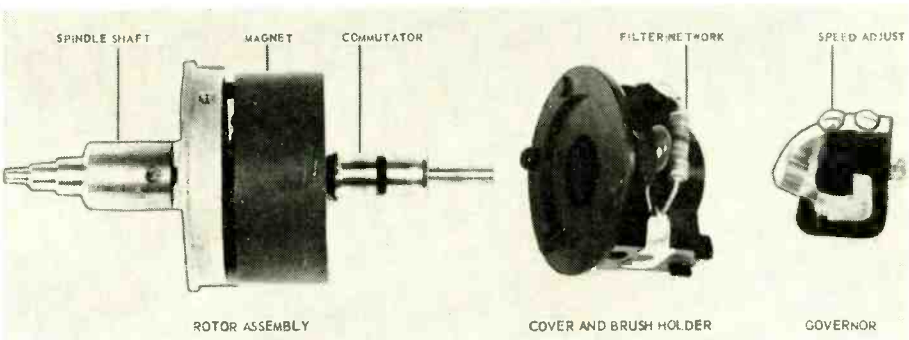
Dc motor with governor runs from 9-volt battery supply or stepped-down, rectified line voltage

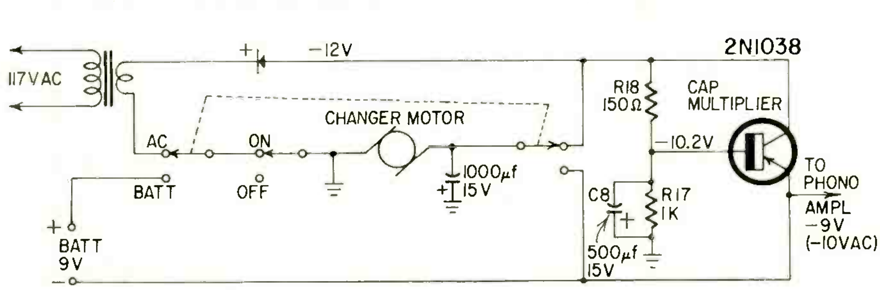
BATTERY-OPERATED PORTABLE PHONOGRAPHS with transistor amplifiers have been made for several years. The Westinghouse model H-99AC1/2 ac–battery phonograph contains a four-speed record changer that looks exactly like standard BSR 120-volt ac changers used in other models. A switch permits the phonograph to operate from 120 volts ac or six 1.5-volt batteries in series. The circuit of the motor and power supply is shown in the diagram.

When the phonograph is operated on ac, a stepdown transformer and silicon rectifier supply 12 volts dc. This voltage is filtered by the 1,000-μf capacitor and a transistor capacitance multiplier.

The capacitance multiplier is a fast-acting series voltage regulator that acts like a very large filter capacitor. Current drawn by the amplifier flows through the collector–emitter circuit. Current flowing in the voltage divider (R17–R18) charges C8 and biases the transistor base. On music peaks, the amplifier draws more current and the supply voltage tends to drop. The transistor base bias changes in the forward direction and more current flows in the collector – emitter circuit without appreciable voltage drop.

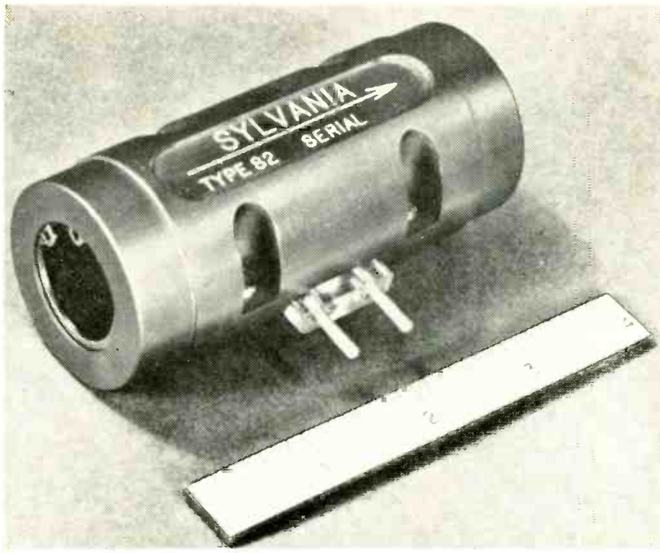
The 9-volt dc motor sets this changer apart from other BSR models used in many Westinghouse phonographs. (An exploded view is shown in the photo.) It is a conventional form of dc motor with a permanent-magnet field. One end of the armature carries a stepped spindle that drives the turntable through a rubber idler wheel. Voltage is delivered to the commutator on the other end of the armature shaft through two small replaceable brushes. A third brush, connected to a centrifugal governor, controls the motor speed. The governor has a simple adjustment screw for setting the speed of the motor. END



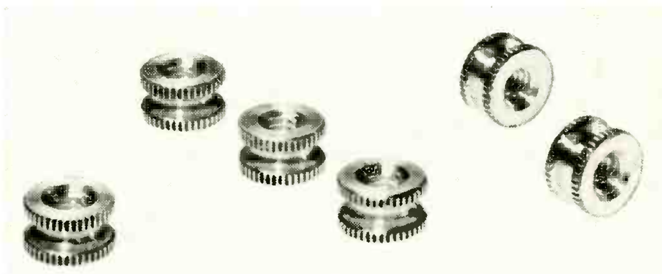


WHAT'S NEW

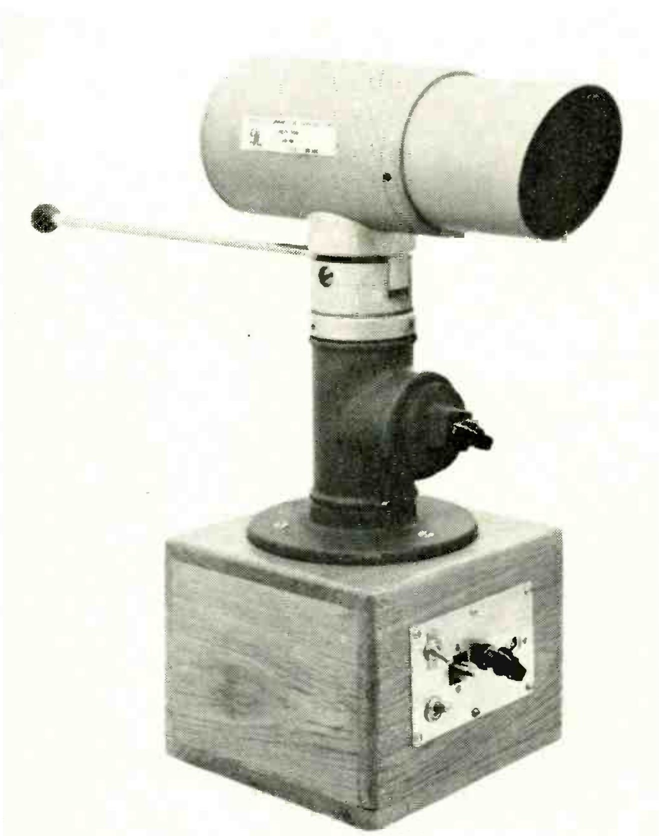
WORLD'S SHORTEST TV CAMERA (behind girl) is fixed onto giant telephoto lens (500-mm focal length, 24 inches long). Camera, one of Cohu Electronics' 2000 series, is only 7 inches long and 3 inches in diameter. It features all-solid-state construction (except for the vidicon, of course), 10-mc bandwidth, 700-line resolution. Camera is designed for every kind of coverage from golf tournaments to military troop movements, boat races to satellite and missile tracking.



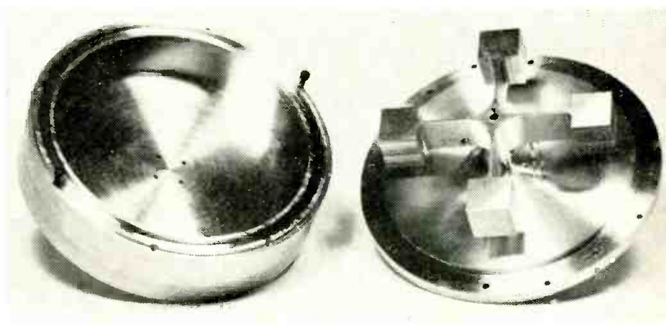
LOW-POWER AM—ON A LIGHT BEAM—is as practical as hooking up an audio modulator to a ham transmitter. This optical laser modulator from Sylvania's Electronic Systems division has a bandwidth from 0 to 20 mc and is suitable for audio, video, pulse or rf carrier modulation. To the low-power transistor amplifier used to drive it, it looks like a 20-pf capacitor, so there are no driving problems. The laser's beam shines through the modulator—along its axis.



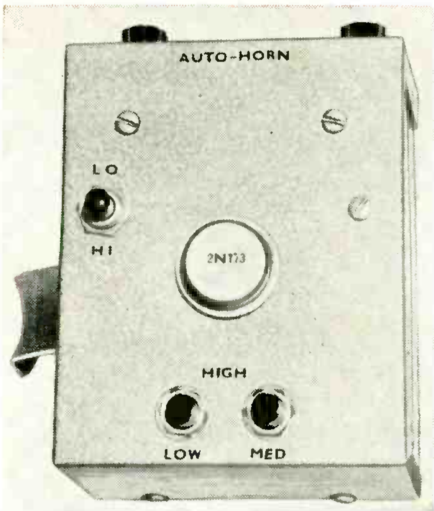
NOW WHY DIDN'T SOMEBODY THINK OF THIS BEFORE? Battery nuts knurled on both sides, of course! They are, as Cornell Manufacturing, Inc. points out, always right side up. This stroke is intended less for the user than for the manufacturer, though; the symmetry eliminates hand assembly. Automated assembly with hopper feeding is now possible, since as long as the nut lands flat, it's right side up.



VOICE AND MUSIC ON NARROW LIGHT BEAMS from this gallium arsenide laser, sent across rivers or canals or other hard-to-build-on features, are tough for unauthorized persons to intercept. Range is 3,200 feet minimum with narrow-band detection. Narrow-band, narrow-beam system can also be used for alarms, smoke or fog monitoring, surveying. It is made by a subsidiary of International Telephone & Telegraph Corp.



MEASURE MASS OF MOON from lunar orbiter—that's the goal of Hughes Aircraft research project that has so far come up with this unique mass sensor. Cross-shaped rotor of aluminum (right) spins in vacuum chamber (left). Gravitational pull affects rotation, which sets up vibrational modes detected by sensitive piezoelectric strain transducers. Output is translated into terms of the mass of object that causes the gravitational pull. "Noise" from electrical, mechanical, thermal and electronic sources, which would interfere with "dc" gravitational force, is reduced in effect by "chopping" action of rotor to convert normally dc gravitational force to ac signal.



Auto horn electronics mounts on dash or steering column.

Electronic Musical Horn for Your Car

Up to six loud musical notes with one transistor and a speaker

By LYMAN E. GREENLEE

REMEMBER THE MUSICAL HORNS OF THE Classic Era that could play tunes like "For He's a Jolly Good Fellow" or "Nobody Knows How Dry I Am"? Most of them could play three or four notes. This transistor version plays six notes with only three pushbuttons to manipulate. Cost is less than $20 for all parts. The sounds produced by it are unlike any you have ever heard from an auto horn. All sorts of novelty sound effects can be created. Battery drain is about 6 amps (72 watts) from the 12-volt car battery, and the sound is enough to wake the dead. If you want something that is really different to dress up your automobile, here it is.

How it works

A basic simplified diagram of the circuit is shown in Fig. 1. In this diagram, the multiple-contact switches of Fig. 2 have been eliminated, and a single tone is sounded when switch S1 is closed. Center-tapped output transformer T serves the dual purpose of oscillator coil and output transformer. Oscillation is maintained through feedback capacitor C1. By making this capacitor very large (500 µf) we can feed a powerful audio signal directly to the speaker. Emitter resistor R1 limits current through the transistor to a safe value and helps prevent runaway.

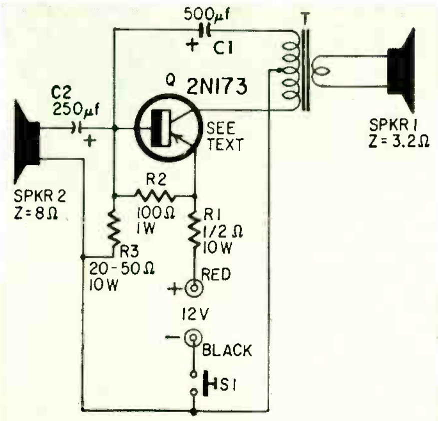


Fig. 1—Basic electronic auto horn is power oscillator. S1 is horn button. SPKR2 is optional (text explains).

Resistors R2 and R3 form a voltage divider that fixes the base voltage and also determines the frequency of oscillation. To change the tone, all we have to do is vary the resistance of R3. Actually, the tone depends on the characteristics of the output transformer, the size of C1 and the value of R3. Capacitor C2 and the second speaker will also have some effect on the frequency.

This second speaker deserves a word of explanation. Just what does it accomplish? Actually, two things. We get more sound, and the quality is different. The two speakers have different-size cones and different resonances. The sound output is a highly complex waveform with lots of overtones, like a square wave. In its simplest form, the circuit works well with C2 and the tweeter omitted. In this form, it will make a single-tone horn that is cheap to build and useful for all sorts of signaling. It may be operated from flashlight batteries for portable use.

The complete wiring diagram is shown in Fig. 2. All parts except the two speakers are mounted in an aluminum Minibox, and all connections are made to a terminal strip at the end of this box. The battery connections are left floating so either the positive or negative terminal may be grounded to the case, and the horn will work on cars with either a positive or negative ground.

All sounds are controlled with the three pushbutton switches. Switches S2 and S3 have a double function. First, they connect their respective resistors (R4 and R5) into the base circuit to generate the required tone; then, *only*

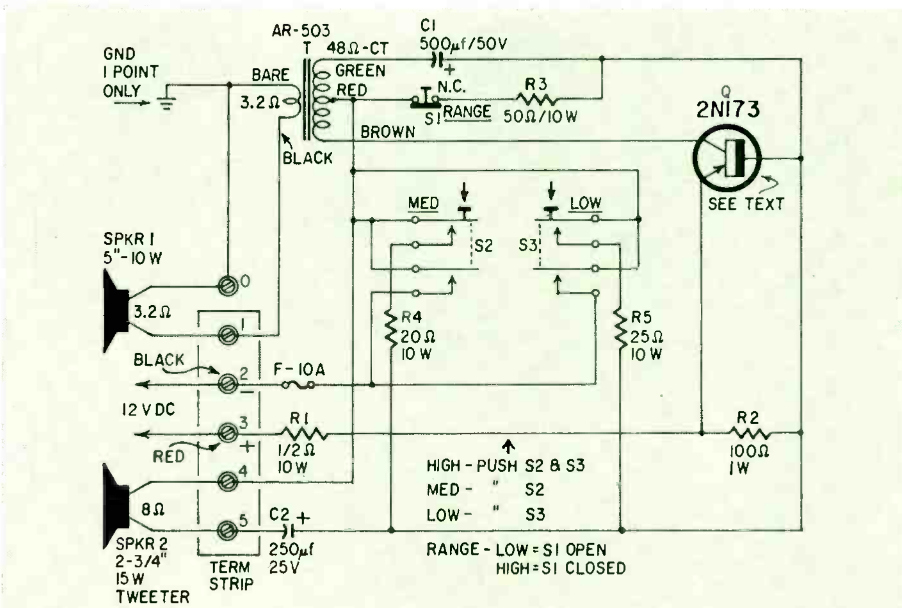


Fig. 2—More sophisticated six-note design.

C1—500 µf, 50 volts, electrolytic
C2—250 µf, 25 volts, electrolytic
R1—½ ohm, 10 watts (or two 1 ohm, 5 watt in parallel)
R2—100 ohms, 1 watt
R3—50 ohms, 10 watts
R4—20 ohms, 10 watts
R5—25 ohms, 10 watts
All resistors 10% tolerance
Q—15-amp power transistor (2N173 or similar)
S1—pushbutton spst, normally closed (Cutler-Hammer 8411-K8 or equivalent)
S2, S3—pushbutton dpst, normally open (Switchcraft 1004, modified, see text)
T—output transformer; primary 48 ohms ct, secondary 3.2 ohms (Argonne AR-503)
SPKR1—5¼-in. pincushion, 10 watts, 3.2 ohms (Quam 52C10)
SPKR2—cone tweeter, 8 ohms, 15 watts (Olson S-297)
Mica insulation (between transistor and case)
Case—aluminum box 3 x 4 x 5 inches (Bud CU-2105-A or equivalent)
10-ampere fuse
Terminal strips, miscellaneous hardware

after this connection has been made, the battery is connected as the switch button is fully depressed. To get this type of switch action, you must adjust the contacts to make sure that the resistor connection is completed *before* contact is made to the battery. This can be done by carefully bending the leaves of the switch with a pair of long-nose pliers.

Depressing S3 sounds a low tone. Depressing S2 sounds a medium tone. If both S2 and S3 are depressed simultaneously, both resistors are in parallel, and we get a much higher tone. This gives three notes with the two switches.

As long as S1 remains closed, R3 will be in the circuit and we can play three notes by manipulating S2 and S3. When we depress S1, R3 is disconnected. Now we can play three additional notes of a lower frequency by manipulating S2 and S3. Of course, S1 does nothing unless S2 or S3 are activated.

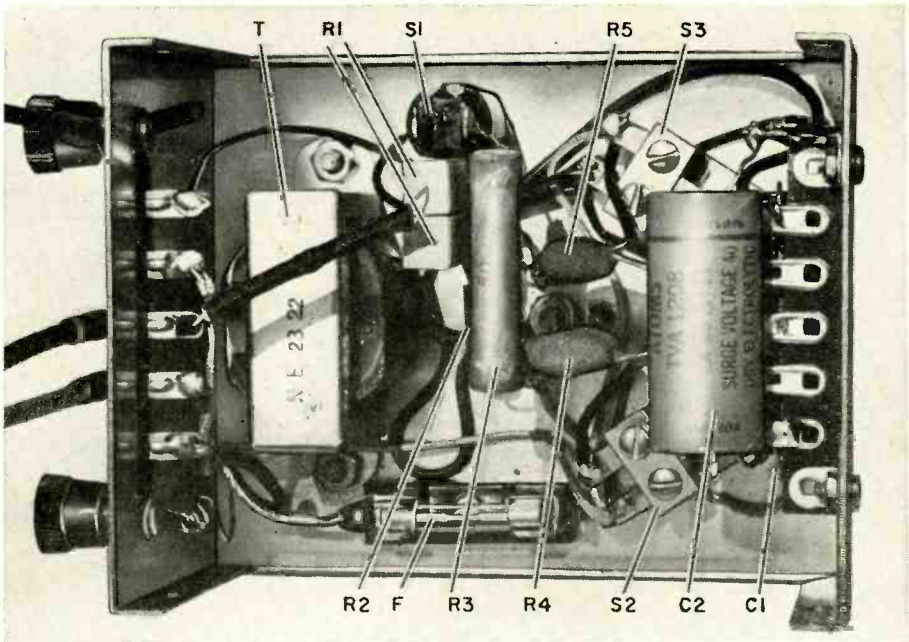
No attempt was made to tune the horn to any particular musical scale. The resistance values shown in the parts list are stock values, and tuning to any particular frequency would require special odd values of resistance. The following suggestion is made for those who might wish to experiment with tuning the horn to some particular frequency.

Tuning

Replace R4 with a 10-watt rheostat. Adjust it for the desired pitch. Measure with an ohmmeter and make up a resistor for R4, either by winding one by hand or by connecting resistors in series or parallel to get approximately the correct value. Another way to get the correct resistance is to purchase a fixed resistor with an adjustable slide. Choose a value larger than the value you want, to give plenty of leeway for adjusting the slide. If you use adjustable resistors, do not buy them until you determine the correct values by using the rheostat in a temporary hookup. Follow a similar procedure to determine the correct values for R5 and R3. Choose R3 to move the tone up and down one octave.

Adjustable resistors are a lot more expensive, and I feel that most people will like the sound as is without going to the extra trouble of tuning.

Some towns and states have laws regulating the volume and tone of automobile warning devices. If you live in such a place, you may have to limit this horn to nonautomotive uses—a boat horn, a party noisemaker, a toy, an annunciator that sounds different tones for each doorbell button, telling you instantly where your visitor is waiting. Check your local regulations.



Wiring is noncritical—just keep the high-wattage resistors away from insulation, electrolytics. These resistors dissipate a lot of heat.

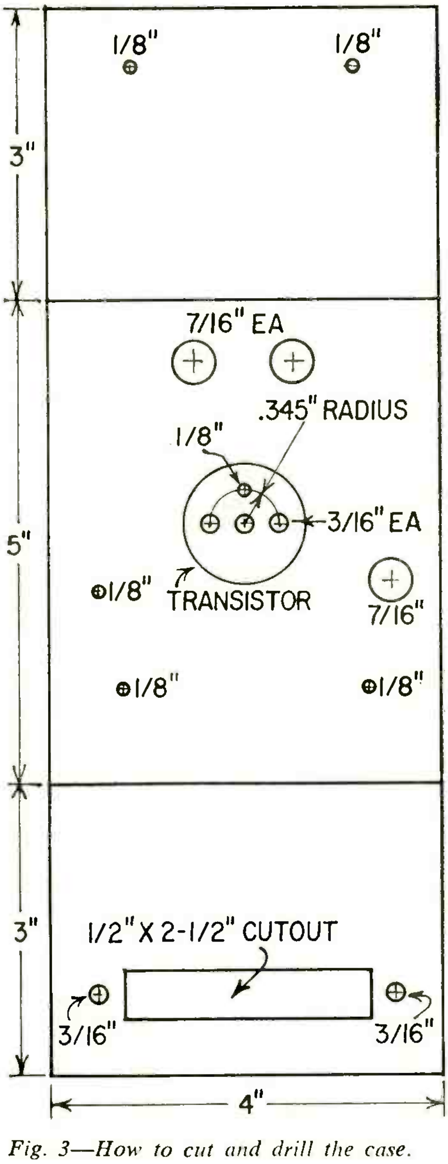


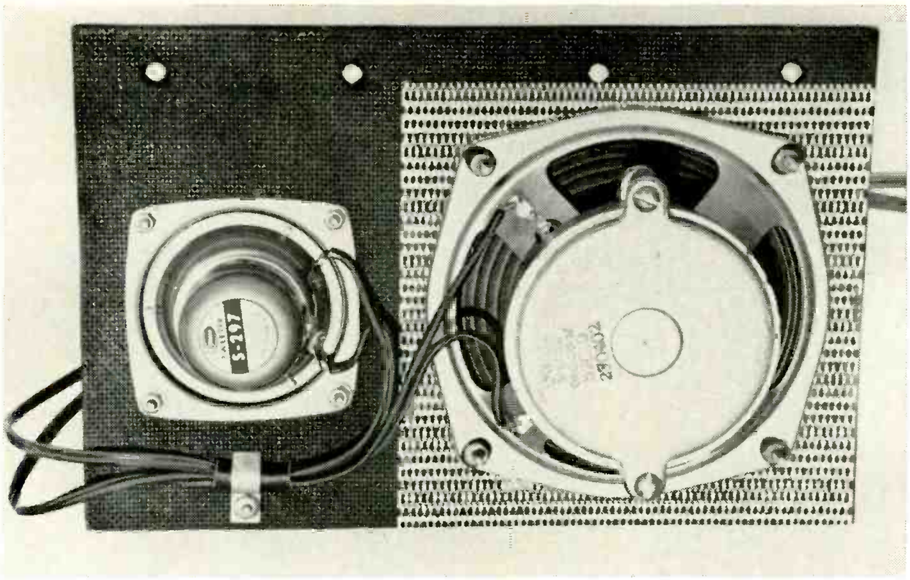
Fig. 3—How to cut and drill the case.

I tried several output transformers for T. The Argonne AR-503 was finally chosen because it was the least expensive one I tried that would oscillate properly with adequate power output. The transistor is a very inexpensive "bargain", similar to the 2N173. Quite a few types of power transistors worked. Any that will carry 15 amps should be adequate. A high-power ignition type works very well. It does not even have to be a very good transistor. One that is noisy and not good for audio use may work very well.

The two speakers specified in the parts list were chosen because of their combination of small size with large power-handling capabilities. Any speakers having similar impedances and power ratings would work equally well, but larger cone sizes may present a serious mounting problem when you try to fit them alongside an automobile radiator. A big speaker might cut the flow of air to the radiator. A large speaker cone is quite unnecessary because the frequencies being reproduced are all in the higher ranges, which are more efficiently generated by a small cone.

The resistors carry a heavy load and get quite warm. The values specified in the parts list are minimum wattage ratings for intermittent use. The Switchcraft pushbutton switches will handle 3 amperes, which is adequate because the load divides between the multiple contacts. Some other switches may not carry the heavy currents involved, so if you substitute, be sure the contacts will carry the load.

Everything fits neatly into the 3 × 4 × 5-inch Minibox. Fig. 3 shows the pattern for drilling the mounting holes. Carefully deburr the holes for the



Speakers are mounted on Masonite (or similar) panel, painted for protection. Mount speaker panel away from possible flying stones or sand, and out of path of radiator air.

transistor. I used a small piece of stove mica as an insulator for the transistor. (Available from your hardware store.)

Be sure to observe the correct polarity when installing capacitors C1 and C2. Resistors should be kept as far away from them as possible. The resistors will get quite hot, so do not let them touch either the transformer or the capacitors. Nothing else is at all critical about parts positioning; just keep those resistors to themselves.

Note that two binding posts are used, one at each end of the terminal strip. One is for the common (car battery) ground, and the other is for the grounded side of the speaker voice coil. Make up a short piece of wire with terminals on both ends. Use it to ground one battery connection. That is, if your car battery *negative* is grounded, run this wire from the case to terminal 2 on the strip; but if the *positive* of your car battery is grounded, run the wire from the case to terminal 3. Use No. 18 or heavier hookup wire for all internal connections.

Solder all joints carefully. They carry a large current.

I made up a small bracket to mount the case to the car steering column with a hose clamp. On some cars, it may be more convenient to attach the box to the dash or to the center control console with self-tapping screws. It should be placed so that the pushbuttons can conveniently be reached without interfering with any other driving controls.

Speaker mounting

The two speakers are mounted on a baffle cut from a piece of 1/4-inch hardboard. It is a good plan to mount this baffle on the car before you cut the holes and fit the speakers. On most cars, there will be ample room at one side of the radiator to mount the baffle and speakers. Use pieces of screen wire or metal speaker grille to protect the cones against damage from flying insects or stones that might be thrown up into this area while driving. It is a good idea to protect the speakers from rain with a sheet of plastic if they are in a direct line with the open grille of the car. Run two pairs of wires from the speakers back to the control box. Do not depend on the car chassis for a return connection. Use No. 18 wire for speakers, and No. 14 for the connections to the battery. The photographs should make clear the mounting of speakers and other parts. Give the speaker baffle a couple of coats of oil paint to protect it against moisture and to prevent warping. END

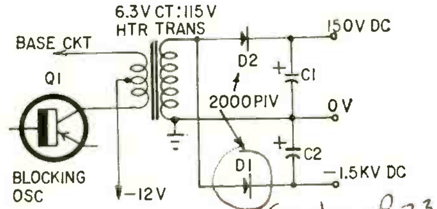
WHAT'S YOUR EQ?

Conducted by E. D. CLARK

Positive and Negative

This circuit generates both $-1{,}500$ and $+150$ dc volts. Note that both voltages are developed from the secondary of the same transformer whose primary is connected to a battery-operated transistor blocking oscillator.

I think the fact that I can get both the low and high voltages from the same secondary winding is pretty sneaky. Can you figure out how I do it? Hint: Note diodes' peak inverse rating.—*Bob Wisner*



See June P 73

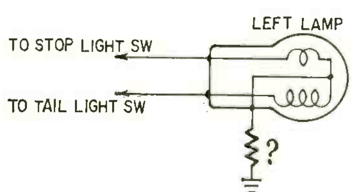
Two puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

Answers to this month's puzzle are on page 82.

Automotive Puzzler

Here's one that could happen to anyone—especially with an older car.



Both taillights and both stop lights lit when they were supposed to, but the left side, in each case, was dimmer than normal. Here's the joker—when the taillights were switched on *and* the brake depressed, both left-side lights went out leaving only the right-side lights burning.

I suspected a high-resistance ground on the left side, but couldn't reason (for a time) why both lights quit when they were supposed to be on together. Can you?—*Wesley S. Cole*

CORRECTION

We have discovered two more (minor) errors in the T-40/40 Transisor Stereo Amplifier in the March issue. (A correction note about the transposition of the R8 and R10 markings on the circuit board appeared on page 92 of the April issue.)

1. In the circuit diagram of the amplifier (page 33), R4 is shown connected to the junction of C6, R9 and R11. On the board, R4 is correctly connected instead to point H—the other side of R11. If you wire the amplifier from the schematic, connect R4 to point H rather than as shown. If you use the prepared boards, you have nothing to worry about.

2. Some boards may be supplied without a hole drilled for point E. You can correct this yourself by drilling an extra hole near the top of the largest irregular copper area on the board. (See the pattern in the upper right corner of page 35, in the original article.) END

See June P12

Tube Impedances With Transistors

The field-effect transistor, a have-your-cake-and-eat-it-too semiconductor: works like a tube, looks like a transistor.

By David L. Pippen

A NEW DEVICE IS BEING DEVELOPED (in fact, is in commercial use) that should fill the gap between the vacuum tube and the transistor. The device has been named the unipolar Field Effect Transistor (FET).

The vacuum tube has often been called a *voltage-actuated* device, while the transistor is *current-actuated*. The vacuum-tube input circuit requires a voltage but negligible current to operate properly. It is a normally "on" device and needs a voltage (of proper polarity) between its grid and cathode to turn it off—to stop electrons flowing from cathode to plate. Because of the polarity, the input circuit draws no current. The transistor is a normally "off" device, and must be "forward-biased" to turn it on. A small voltage applied to its input circuit causes a relatively large input current to flow. It follows, then, that the vacuum tube is a *high-input-impedance*, and the transistor a *low-input-impedance* device.

The FET combines almost all the advantages of the conventional transistor and of a vacuum tube. Like the tube, the FET has very high input impedance, and its output is isolated from its input. The FET is the size of a conventional transistor, requires no filament power, and is not as susceptible to nuclear radiation as are conventional transistors. A low-noise device, the FET produces negligible microphonics even under extreme shock. But it is sensitive to temperature variations.

*Project Engineer, Guidance & Control Lab, White Sands Missile Range.

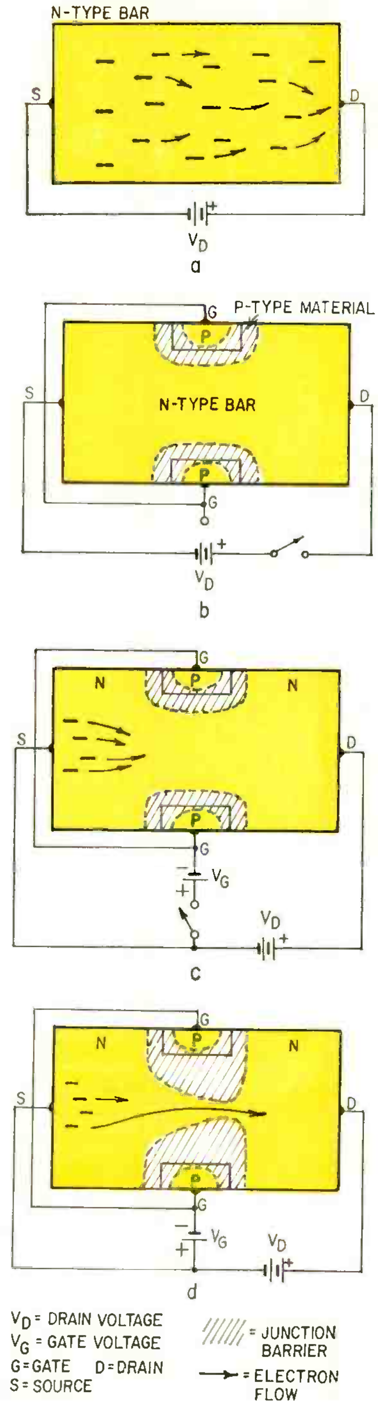


Fig. 2—Bar of n-type material freely conducts (a, above). When p-type material is diffused in (b), gate is formed and can control current flow. In (c), majority carriers (electrons, here) avoid barrier region at p-n junctions. Backward bias between gate and drain (d) constricts gate region further, thins out electron flow, reduces current.

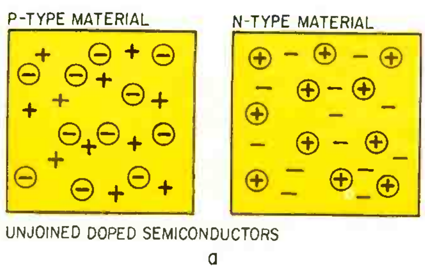
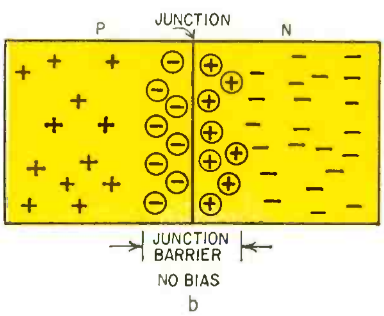
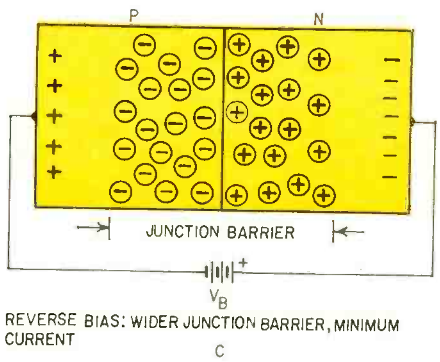
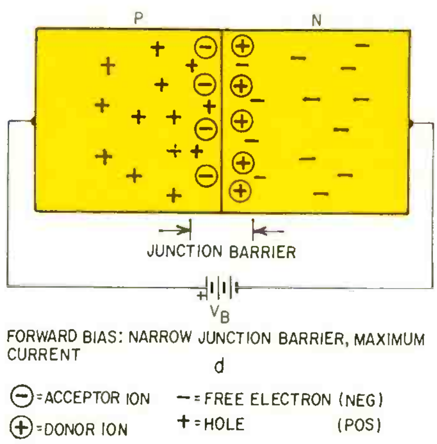


Fig. 1—Basic semiconductor junction principle. Pure germanium or silicon is doped with about 1 part in 10 million of donor impurity. Proportions of ions and carriers in these drawings shouldn't be taken literally.



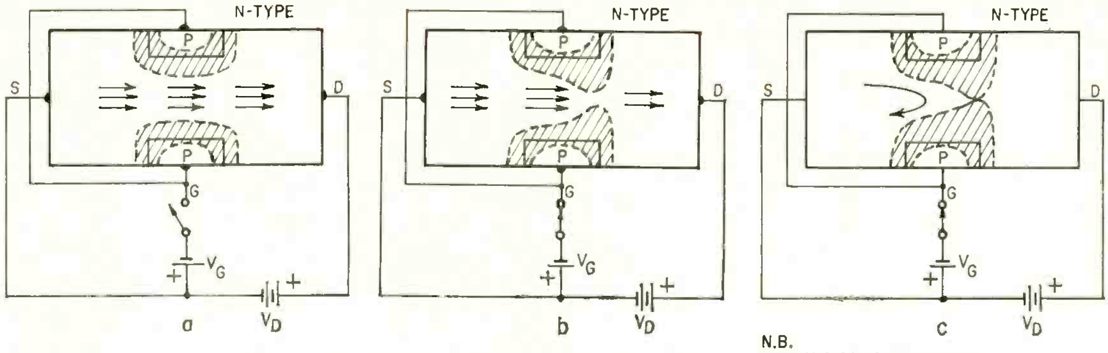




A conventional transistor operates as a bipolar device: two conditions must be present before it will operate properly. These are (1) that the base–emitter junction be forward-biased and (2) that the base–collector junction be reverse-biased. FET operation, radically different from a conventional transistor's, is unipolar: operation depends only on a reverse-biased p-n junction. No forward biasing is needed.

Let's backtrack a moment. You will recall that the *majority carrier* of a semiconductor material (that is, what carries most of the current) is determined by the impurity material (doping) added to the basic, pure semicon-

Fig. 3-a—Zero gate voltage. Device presents little impedance to current. In (b), sum of gate and drain voltages is less than pinchoff voltage, and in (c), greater. FET is now cut off, or "pinched off."



N.B.
SYMBOLS SAME AS IN Fig. 2

ductor material (Fig. 1-a). In p-type material, holes are the majority carriers (because there are more of them than of electrons). Free electrons are the minority carriers. In n-type material, the majority carriers are free electrons and the minority carriers are holes.

When p-type and n-type material are joined, the holes from the p-type material and the free electrons from the n-type material diffuse toward each other and combine. This action is shown in Fig. 1-b. Total recombination of all the holes and free electrons is prevented since each combination of a hole and electron forms an electron-pair bond. This leaves uncompensated *donor ions* (atoms that have "donated" a free electron) near the junction of the two materials. These ions build a barrier (also called a *depletion region*) which, due to their polarity of charge, prevents total recombination of the holes and electrons.

If a battery is connected across the p-n device so that the junction is reverse-biased, then the barrier is extended (Fig. 1-c), and no current flows through the circuit except for a very small amount of minority carrier current. If the battery is connected so as to forward-bias the p-n junction, then the barrier is compressed to an extent where hole and electron combination can occur again. The external battery then supplies the necesary electrons and holes to keep current flowing through the circuit to the junction (where the combination is taking place). This action is shown in Fig. 1-d.

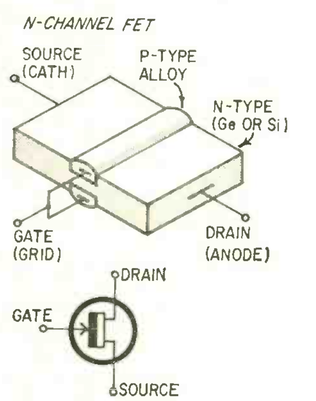
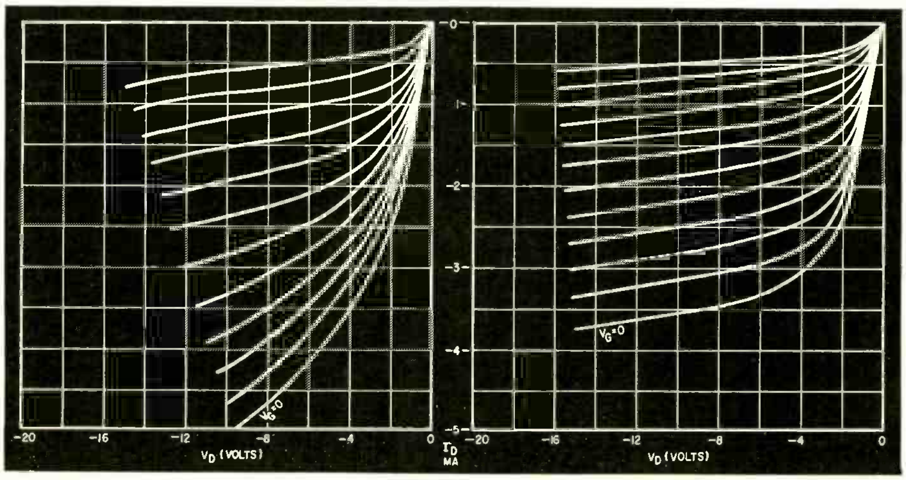


Fig. 4—N-channel FET and symbol.



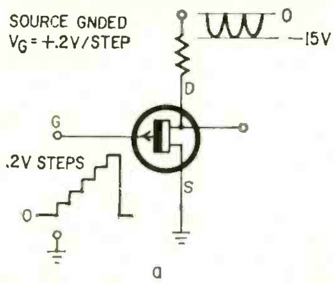
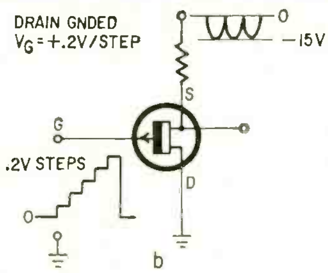


Fig. 5—Characteristic curves of Texas Instruments p-channel FET, type 2N2386. In (a), source is common to input and output; in (b), drain is common element.



Now let's connect a battery across a bar of n-type material (Fig. 2-a). Electrons, which are the majority current carriers in n-type material, would leave the negative terminal of the battery and diffuse through the bar toward the positive terminal. Note that there is no barrier to overcome along the electron's path. Maximum current will flow, for it is limited only by the resistivity of the material.

If the battery is disconnected and p-type material added on both sides of the n-type bar (Fig. 2-b), then a barrier is formed around the resulting p-n junction, as indicated by the cross-hatched area. This junction barrier is formed as explained previously. Now if we connect a battery across the n-type bar as shown in Fig. 2-c, electrons diffuse from the negative terminal to the positive terminal, but avoid the p-n junction region because of the barrier setup restriction presented by the junction-region barriers. This junction region is called the *gate*.

If a battery is added between gate and *source* (labeled S in Fig. 2) of such polarity as to back-bias (reverse-bias) the gate-source junction, then the barrier at this portion of the junction will widen and further restrict flow. Now consider the gate–*drain* (D) circuit.

As shown in Fig. 2-c, gate battery V_G and drain battery V_D are now in series across the portion of the p-n junction that extends between gate and drain. This back-biases that portion of the junction with a higher voltage than the portion that extends between gate and source. The result is the distorted junction barrier in Fig. 2-d. The majority current carriers now diffuse toward the positive terminal of the battery. As they approach the barrier set up by the gate, they are repelled by the polarity of the ions within the barrier. This tends to restrict the total current flow from the battery.

You can see now that as V_G is increased and the junction barrier widens, a point will soon be reached where no electrons will be able to diffuse through the bar because of the fields set up by the junction barriers. The value of V_G that causes the majority current carriers to cease flowing through the bar is appropriately named the "pinchoff" voltage. Fig. 3 shows an n-channel FET under various bias conditions. Since the junction barrier between the gate and the other two terminals *prevents* current flow between the gates and source or drain, the device acts much like a vacuum tube. As a result, the FET has a high input impedance (from 1 to 10 megohms) and is a normally "on" device.

The p-channel FET operates the same way, except that the operating voltages are reversed; that is, the drain-to-source voltage is negative and the device is cut off or "pinched off" by applying a positive voltage between gate and source. The bar is p-type material and the gate is n-type. Fig. 4 shows how the parts of an n-channel FET are arranged.

The drain voltage (V_D) versus drain current (I_D) curves are very similar to pentode vacuum-tube curves. Fig. 5-a shows the characteristic curves of a Texas Instruments 2N2386 p-channel FET. To show its possibilities as a bilateral switch, the source and drain were interchanged and Fig. 5-b obtained. The p-channel FET curves were made with a Tektronics transistor curve tracer which has a limited gate voltage supply (maximum of 0.2 volt per step). V_P cannot be determined on the p-channel 2N-2386 because of the curve-tracer V_G limitation.

As the voltage from drain to source is increased in a negative direction, a point is reached where the gate-to-drain back-biased p-n junction breaks down (avalanches). That shows up as the sharp increase of I_D at a V_D of about 20 volts. The breakdown occurs between gate and drain rather than between drain and source.

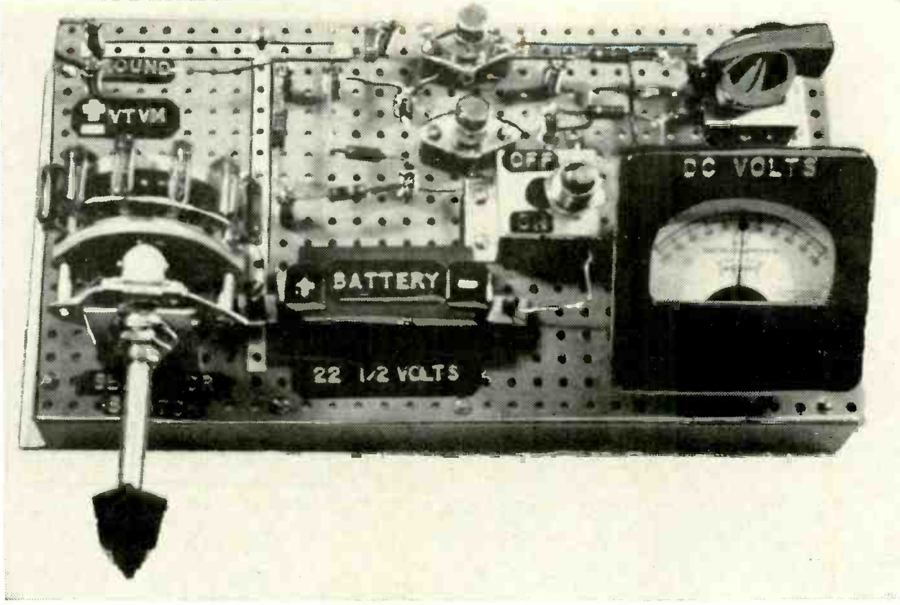
To get the feelings of the actual operation of an FET, the circuit shown in Fig. 6-a was constructed. Fig. 6-b shows the voltage gain to be about 20 db for the single stage. To show the linearity of the device, the output was attenuated and inverted to match the input. Fig. 8-c shows no visible distortion in the output.

This shows that the FET can be used effectively in amplifier, oscillator and switching circuits, much like the conventional and familiar vacuum tube.

The laboratory I work in needed a high-input-impedance voltmeter that was completely portable and required no external ac power source. Fig. 7 shows the schematic. The circuit uses two FET's as a differential amplifier with an input impedance greater than 18 megohms. It is accurate to within 2% of full scale. (Another FET voltmeter appeared November, 1964, page 36.)

FET's are already being used in missile systems and in commercial equipment. They are expensive compared to most transistors, ranging from \$7 for low-gain units to as much as \$75 for high-voltage, high-gain types.

The FET is not used extensively just now. But as we look at its potentialities, it seems likely that it will be used in entertainment type equipment as its popularity grows and its price drops. No matter what field you're in, you're going to see more of this versatile semiconductor—the FET. END



Breadboard version of FET voltmeter deescribed in Fig. 7.

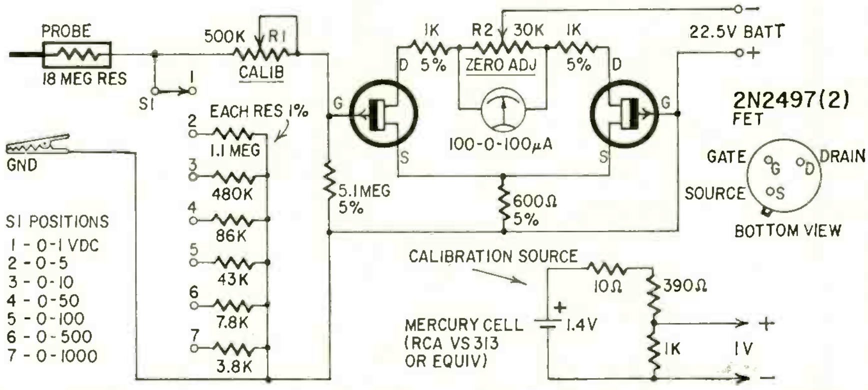


Fig. 7—FET differential voltmeter has about 18 megohms input impedance. S1 should be a shorting type switch. To calibrate, set switch to position 1, adjust ZERO ADJ for zero (center) meter reading. Apply exactly 1 volt between probe tip and ground (from calibration source) and adjust CALIB pot for full-scale deflection. Instrument can be used for voltages negative or positive with respect to ground, without switching.

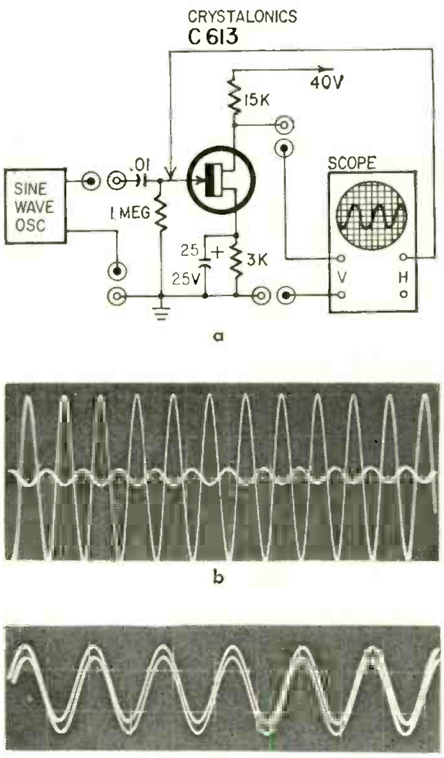
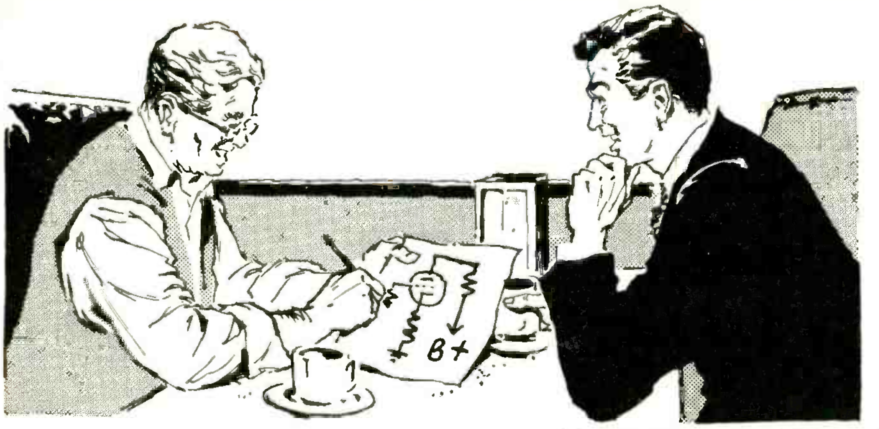


Fig. 6—Simple FET audio amplifier with 20-db gain and low distortion. Input (low-amplitude) sine wave in (b) was 2,100 cycles, .07 volt rms. Fig. 6-c compares input (lower trace) and output waveforms at 60 kc and .07-volt input.

See June 20



KEYED AGC ISN'T SO TOUGH

By JACK DARR
SERVICE EDITOR

"THE TROUBLE IN THIS LITTLE TV," exulted the Young Ham, "is that one of these tubes hasn't got any plate voltage at all!"

"Sure it ain't a 6AL5?" asked the Old-Timer with a sly grin, ambling down the long bench to peer over the boy's shoulder.

"Naaah! This is a 6AU6, and I think it's one of the video i.f.'s. That's what's causing the blank screen. Tubes all good, voltages OK, but I can't get sound or picture, just a white screen."

"Entirely possible," agreed the Old-Timer mildly. "Didja check the schematic to see what the voltage ought to be?"

"Not yet, but I will." The Young Ham scrabbled in the litter of paper on the bench. "Here it is. Lemme see. 6AU6, plate voltage—*HALF A VOLT NEGATIVE! Whaaat!*"

The Old-Timer grinned sympathetically. "Yep, that's what *I* said the first time I fell over one of the things! That's no i.f., it's a keyed agc stage."

"Keyed agc?"

"Yup. Ain't no plate voltage on it. No applied dc, that is. Plate's fed by a positive-going pulse from the horizontal sweep circuit."

"But, negative plate voltage! How do y' get that?" demanded the Young Ham in bewilderment.

"It ain't easy," said the Old-Timer. "All right, come on; we ain't been for at least a half an hour anyhow." And the two made the regular run out the back door, down the alley and into the back door of the drug store. Settled in the booth with their coffee steaming before them, the Old-Timer reached for the inevitable paper napkin and began to sketch rapidly.

How does it work?

"All right, give," said the Young Ham. "How does that deal work? You never told me."

"Tsk, tsk," demurred the Old-Timer, "your education has been sadly neglected!" Ignoring the muttered comment that *he* was the one who had neglected it, he drew a circuit on the napkin (Fig. 1). "Here, this tube, what happens if we apply the right voltages to it?"

"It conducts current," the Young Ham replied.

"Fine! Now, what if we put *ac* on one of the elements?"

"Which one?"

"I don't give a dern! Any one. As long as it's within the operating limits of th' tube. For instance, the plate ought to have 150 volts on it. What if we put 150 volts ac on it?"

"Well, lemme see. . . . Oh, yeah! The tube will conduct on the positive half-cycle just like a rectifier!" the Young Ham replied triumphantly.

"Hooray!" congratulated the Old-Timer. "Now, does it make any difference what *shape* this ac waveform has?"

"Well. . . . No. It wouldn't. As long as the plate goes positive, the tube's going to conduct. That is, if the positive part of the waveform swung far enough positive?" The Young Ham looked doubtful.

"Kee-rect! Go to the head of the class," said the Old-Timer, proudly. "Now you've got the basic idea of a keyed stage! What we want to do is make this stage conduct during certain *periods of time*, while some particular thing is happening. For example, your keyed agc stage over there conducts during horizontal retrace intervals. Why?"

"Well, I . . . " the Young Ham looked baffled.

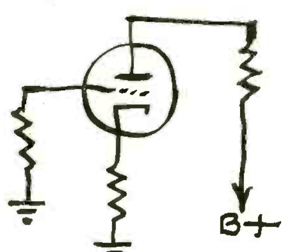


Fig. 1—Just a tube with the operating voltages on it.

What makes an agc voltage?

"Because we want it to," declared the Old-Timer. "We want an agc voltage out of it. So, what makes an agc voltage? We convert some part of the video signal into a nice useful dc voltage? What part? The video? Nope, that changes constantly. We gotta have something steady. So, since the horizontal sync pulses should always be the equivalent of at least 95% modulation of the TV transmitter, never changing, we use them. By keying the tube with pulses from the flyback, which in turn are controlled by the incoming horizontal sync pulses, we can chop out only the horizontal sync. We feed this into a filter, and wind up with a nice dc voltage. Since the dc is taken from the video signal, the amplitude of the dc is always proportional to the amplitude of the incoming signal! See?"

"Sure! That's just like avc in a radio, isn't it?" asked the Young Ham.

"Similar," replied the Old-Timer, "but not exactly the same. In a radio, we use the rf carrier. Here, we only use a part of the signal, the sync pulses."

"Why?" the Young Ham wanted to know.

"We take out only the horizontal sync pulses for our agc because we can get better noise immunity that way. Up in the high-frequency TV bands, we get lots of impulse noise—cars and so on. This is pretty well distributed over the whole signal. So if we take out only a very small part of the signal, we'll reduce the chances of random noise making our picture jump and jitter. We can do this if we 'key' the agc stage. Since we've still got that pulse from the flyback, and it's always in step with the incoming horizontal sync, we feed it back and use it as the keying pulse. Here." And he drew another sketch (Fig. 2).

"See? The keyer tube is conducting only during horizontal retrace time, so it just takes out the tops of the horizontal sync, like so," and he added some squiggles to another drawing (Fig. 3).

"How does it do that?" asked the Young Ham.

"It works that way, because we make it work that way. We set up the bias on the stage so it's cut off. That's why the grid goes back to B-plus and the cathode to a little higher B-plus point. See? Now, the tube is biased so high it can't conduct until it gets a positive-going sync tip on the grid. We set the level of these, on the grid, so that only the tips of the horizontal sync will cancel enough of the negative bias to let the tube conduct. So we get a series

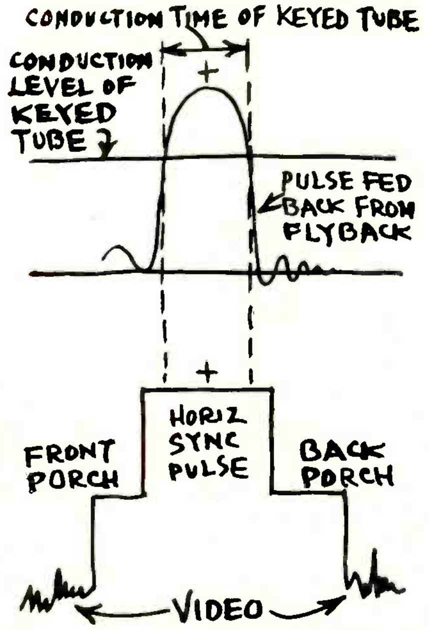


Fig. 2—Keyed stage conducts only during horizontal sync interval.

of cute li'l square-topped pulses in the plate circuit. Notice one other thing, too. Since the grid is negative, we've *got* to put on the video waveform so the sync tips are going *positive*. If we took 'em from a place where the sync was going negative, it wouldn't work. Usually, we get this video from the video amplifier plate circuit, where it's at a high amplitude. We can drop it down to whatever value we need by taking it off a voltage divider."

"So long as we got the right voltage, and the right polarity, huh?"

Where else can we key?

"Roger," replied the Old-Timer. "Now, tell me something else, from examining this diagram, even if it is a little soggy by now," rescuing it from a puddle of spilled coffee, "can you apply a keying pulse like this to any *other* element of the tube and come out with the same kind of results?"

"Why, I guess so," said the Young Ham, frowning at the slightly messy circuit. "I don't see why not."

"Right!" said the Old-Timer. "You

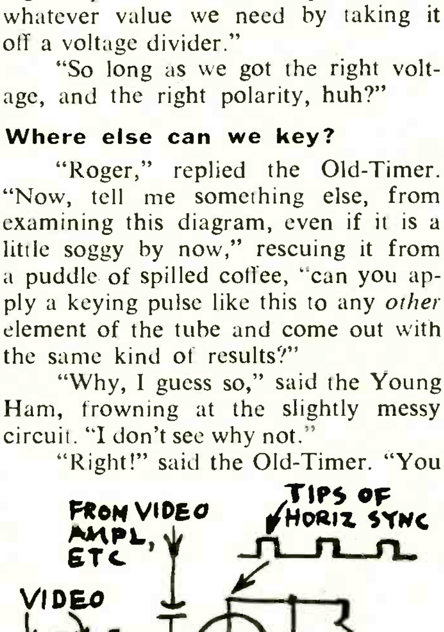


Fig. 3—Typical keyed agc stage. Grid and cathode are returned to B-plus, with the grid more negative than the cathode so that the tube is cut off.

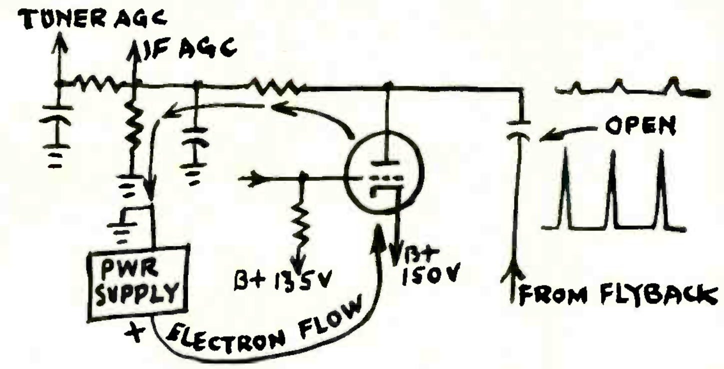


Fig. 4—Partial circuit of agc circuit showing where that negative plate voltage comes from.

can take any kind of tube, triode, pentode, dual-control pentode like the 6BE6's, or anything you want, set it up for cutoff operation, and then key it into operation by applying the right size and polarity of pulses to it. You can feed your pulses to the plate, control grid, screen grid, cathode—anywhere you want, just as long as they cause the tube to conduct when they hit. Your tube sets there doin' nothing until the pulse comes along and opens the gate. That's why they call these gated circuits, sometimes."

"Well, then, how-come keyed?" asked the Young Ham.

"What do you use to open a locked gate?" The Old-Timer grinned.

"A . . . Oh! I get it, now. They're the same thing!"

"Good! You got that an' I got th' coffee." The Old-Timer dropped a handful of pennies into the kitty which sat near the coffee-pot, under a large sign reading, "This coffee-pot is operated on the honor system. This means *you*, you crooks!" They galloped out the back door, ignoring the druggist, who was demanding loudly that they come back and count all those pennies. Back at the shop, the Old-Timer settled down on the stool, and turned the little TV on. When it warmed up, he picked up a scope probe and touched several places in the circuit. He grinned.

Here's the real trouble

"Here y'are, sonny." he said. "Look." He touched the probe to a tiny capacitor. Large spikes showed on the screen. Touching the other end of the capacitor, only a very small spike was seen. "There's your trouble. That capacitor's open."

The Young Ham removed the offending unit and replaced it. Turning the set back on, a very wiggly picture showed up. The Old-Timer turned the agc control down and it cleared up.

"See what happened there? This little capacitor was open, so the keying pulses couldn't get through to the plate. We did see some little ones, but they were just feeding through from stray capacitance. Tube didn't have enough voltage during the keying time to conduct. Like so, see?" and he traced out the circuit on the schematic (Fig. 4).

"Fine. Now, there's just one thing that puzzles me," said the Young Ham. "Why is the cotton-picking plate voltage negative?"

"I was wondering when you were going to ask that," laughed the Old-Timer. "That puzzled me for a long time, too! It's like this. Look at your circuit here. When you put a positive pulse on the plate, what happens?"

"Current flows," said the Young Ham.

"Right. Which direction?"

"Cathode to plate?"

"Now, if current flows from cathode to plate, where does it go from there? Just jump off into space?"

"No, it's gotta get back to B-plus through the power supply," said the Young Ham, with an air of 'I wish I hadn't said that!'

"Where's the B-plus, friend? I don't see any. Looks to me like any current that flows there is going to have to get back to the cathode through those two resistors, here and here (Fig. 4). Plate current *has* to have some direct path back to the cathode, so it's goin' through the power supply, all right, but it's goin' through between ground and the *cathode!* See? Now, what does it look like? Current's a stream of electrons, right? If a stream of electrons flows through a resistor, which end of the resistor assumes the negative potential, huh?"

"The end the electrons are flowing *into*. Ohh! I get it. That resistor going to ground in the plate circuit! The plate end of it is *negative!* To ground! And, the more plate current there is flowing, the more electrons, and the more negative that end of the resistor gets! I see it now."

"There's hope for you yet," said the Old-Timer kindly, patting the young man's crew-cut head. "With a little skilled help, you may in time grow up to be an idiot! By the way, remind me next coffee break to show you some keyed circuits that have nothing to do with agc." END

SCR POWER CONTROL

Basic firing circuit drives SCR's up to 100 amps, for heating and lighting control, motor speed control and other jobs in home, shop and factory

By LOUIS M. P. T. WIJSEN

A RELATIVE NEWCOMER TO ELECTRONICS, the SCR (silicon controlled rectifier) has already gained an excellent reputation for long life, compactness and maintenance-free operation. It has replaced thyratrons, rheostats and variable transformers in existing circuits, and has opened up a world of new possibilities as well.

SCR's are now available in current-carrying capacities up to 400 amperes. They can be switched off in about 10 microseconds. Power gains of billions are feasible.

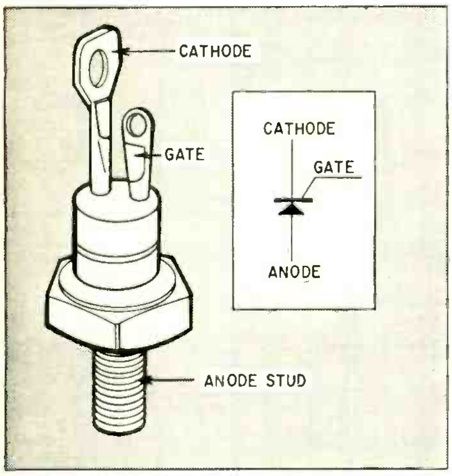


Fig. 1—Stud-mount SCR and general silicon controlled rectifier symbol.

High-current, high-voltage SCR's are not within the budget of the average hobbyist, but lower-rated units are. A 5-amp 400-piv SCR costs less than $5. A 25-amp 300-piv costs $8.40. (A 235-amp 400-piv SCR costs $224.) Prices vary according to operating temperature and gate characteristics.

Used within safe current and voltage limits, the SCR can perform well for many years. Greatest dangers are excessive peak inverse (or reverse) voltage, and excessive current. They will destroy the SCR almost at once. Excessive piv can usually be prevented easily, there is always danger of damaging currents. It is wise to use SCR's whose ratings exceed amply the expected current flow. Also, put a fast-blowing fuse in series with every SCR, with a rating well below that of the unit it protects.

Here is a simple single-phase ac power control device. It can be used for heater control, as a lighting dimmer, power tool controller, or for many other applications. It will work well with SCR's of up to 100 amperes, and can be built cheaply and fast.

You will select the proper SCR's for your particular use. For ordinary applications, the two main factors to reckon with are forward current and reverse voltage. Computations, apart from the trigger pulse amplitudes, are the same as for regular diodes, and are found in the several SCR handbooks now available.

Fig. 1 shows the symbol for the SCR, and identifies its corresponding parts. Note that the *stud* of the SCR is its *anode*. The gate may be compared with the grid of a thyratron. The triggering signal is applied between gate and cathode.

(Reverse-polarity SCR's—units in which the *cathode* is connected to the case or stud—are now being made. They are generally identified by the suffix "R" after the type number.—*Editor*)

Fig. 2-a shows how SCR's should be connected for ac control. Fig. 2-b shows how power can be controlled with one SCR, if it can carry the power demanded. The load gets pulsating dc in this case.

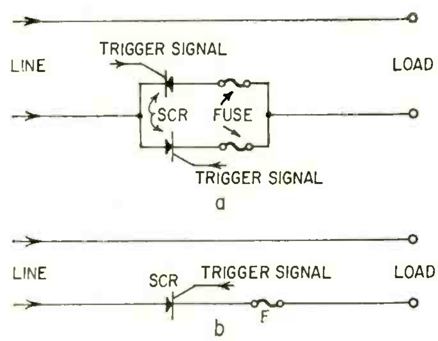
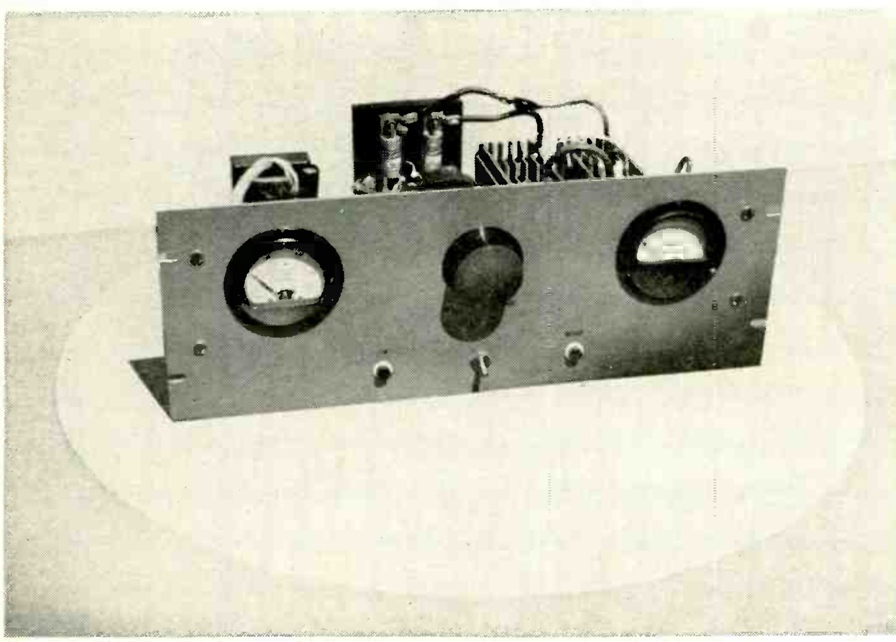


Fig. 2-a—Full-wave ac control with SCR's. b—Half-wave control.

When its anode is positive to its cathode the SCR will conduct from the instant we apply a positive pulse to its gate until the end of the half-cycle of line voltage, when anode voltage becomes zero and starts to go negative. By applying gate pulses at the proper time (or phase) with respect to the phase of our line voltage alternations, we can control the length of time that the SCR conducts, and thus the current through it and the load.

For this we need a firing circuit that allows us to control the SCR's from nonconduction (180°) to practically full



One SCR power control, with 70-amp SCR's, occupies considerably less space and is far lighter than variable transformer with similar capacity. This one has been used successfully for about 3 years by author's company.

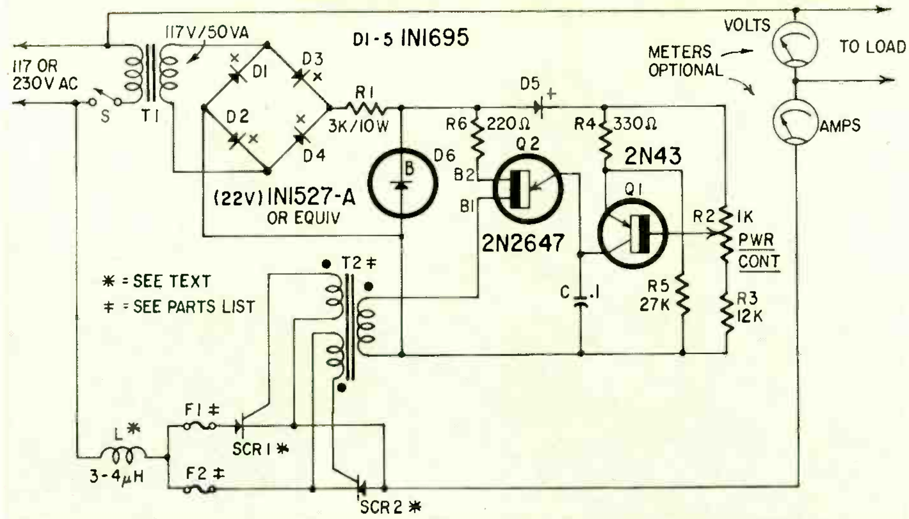


Fig. 3—Circuit of the power control. If only one SCR is used, as in Fig. 2-b, omit T2 and connect a 47-ohm ½-watt resistor between base 1 of Q2 and common (that is, where the primary of T2 is now). Connect the SCR gate to Q2 base 1.

C—0.1 μf, 50 volts or higher
D1, D2, D3, D4, D5—silicon rectifiers, 400 piv, 500 ma (1N1695, etc.)
D6—Zener diode, 22 volts, 1 watt (International Rectifier Corp. 1N1527-A or equivalent)
F1, F2—fuses; select according to SCR rating
L—inductance, optional (3–4 μh—see text)
Q1—2N43, 2N525, 2N1057, 2N1614, etc.
Q2—2N2647 (G-E)
R1—3,000 ohms, 10 watts, wirewound
R2—pot, 1,000 ohms
R3—12,000 ohms
R4—330 ohms
R5—27,000 ohms
R6—220 ohms
All resistors 10%, ½ watt except R1
SCR's—see text
T1—isolation transformer (230 to 117 or 117 to 117 volts, 50 va approx)
T2—pulse transformer (UTC H51) (see Fig. 3 caption)
Heat sinks (see text)
Hardware

conduction (0°). The circuit in Fig. 3 enables us to control the SCR from about 180° to 10°. (The 10° limit does not cause a serious loss of power.) This is a simple unijunction trigger circuit, with only few components, but performs reliably and well.

It works like this: ac from the secondary of the isolation transformer is rectified by a full-wave bridge. A 3,000-ohm resistor (R1) and a Zener diode clip the remaining voltage with its 120-cycle ripple to a waveform that resembles a square wave. This ripple is essential for synchronizing the pulse train. It gives us the required phase relationship between our pulses and the line voltage, to control the SCR's.

When the moving contact of control potentiometer R2 is brought up, toward D5, Q1 is biased off by the voltage across R4. By bringing the potentiometer arm down, toward R3, we forward-bias Q1 and throw it into conduction. By making the base more negative to the emitter, we increase conduction. The collector current of Q1 charges C. Q1 acts as a variable resistor, making a variable R-C time constant with C.

When the charge of C exceeds the emitter peak-point voltage of Q2, the unijunction transistor Q2 turns on, making a low-resistance path from base 1 to its emitter across the capacitor, which discharges rapidly through the primary of T2. A pulse appears on T2's secondaries and fires the SCR's.

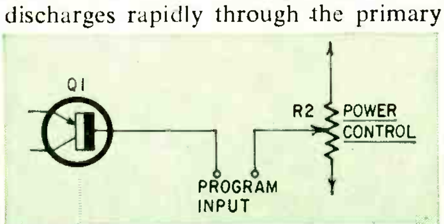


Fig. 4—Up to 2 volts across the PROGRAM INPUT *terminals can control power remotely.*

Automatic control

If you want to control the SCR's automatically, and you have a dc control voltage available (as with instruments such as certain pyrometers and vacuum meters), you can insert up to 2 volts between the arm of control potentiometer R2 and the base of Q1, as shown in Fig. 4. Depending on the polarity of the voltage and the position of the arm of the control pot, the pulse rate will be decreased, increased or reduced to zero, as desired, by changes in this controlling voltage from the instrument.

If the potentiometer control is not fine enough for applications that need small and exact charges of current, insert a 500-ohm and a 5,000-ohm variable resistor as in Fig. 5. For greater control over low currents, use all or part of the 5,000-ohm pot. That moves the bias of Q1 toward cutoff and reduces the voltage drop across R2, allowing more rotation for the same voltage change on Q1's base, and so more precise control of its bias. You then have better control over low currents, at the expense of maximum pulse repetition rate.

For better control of high currents, also use the 500-ohm variable resistor, or part of it, in the voltage-divider circuit.

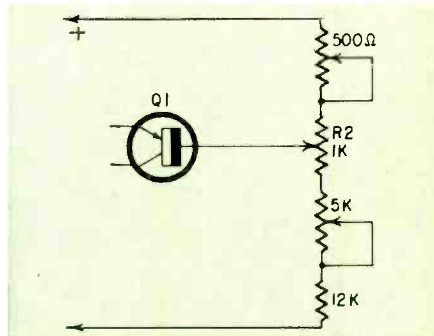


Fig. 5—Greater flexibility of adjustment with these extra variable resistances, as described in the text.

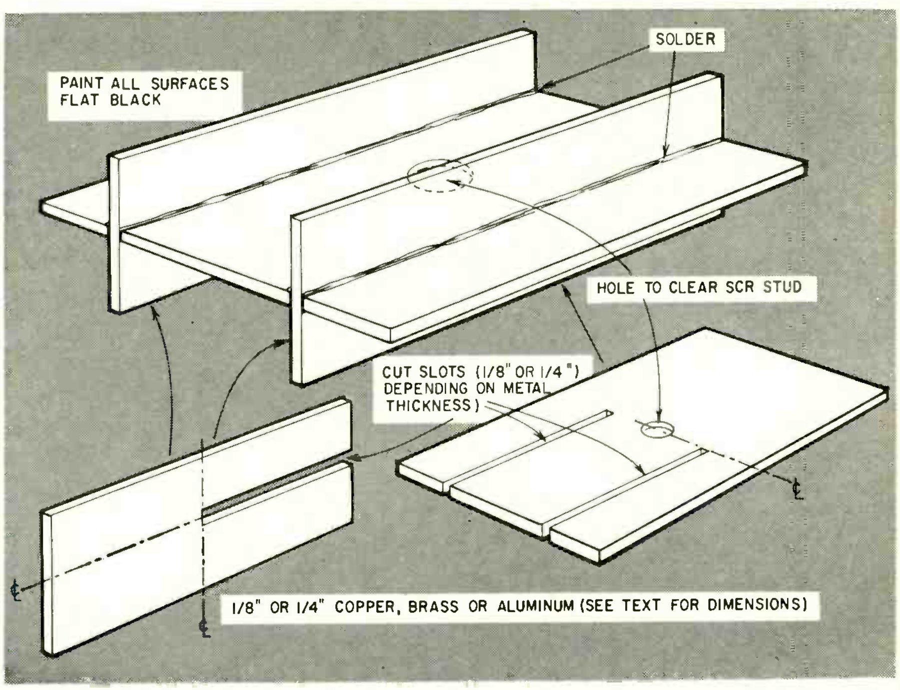


Fig. 6—How to make a heat sink for the SCR's. See text for full details.

This moves the bias in the direction of greater conductivity, to overcome the decreased voltage across R2. High currents can be reached again and controlled precisely.

Although not an absolute necessity, it is advisable to have some inductance between the SCR's and the input or output terminal. A choke of 3 or 4 μh is enough. This inductance resists the sudden current surge when the SCR's are fired, and if current is excessive, gives the fuses time to blow before the SCR's are damaged. These current surges can be impressive! If the SCR is triggered at 90°, for instance, the current increases instantaneously from zero to peak. Five to 10 turns of wire will be enough to limit the surge.

Construction

The pulse circuit can be placed on a 4 × 4-inch piece of ⅛-inch-thick fiberboard. R2, the control potentiometer, can be mounted on the front panel. Keep the pulse board close to the SCR's to conserve the pulses.

The SCR's have to be mounted on heat sinks. The size of the heat sink and its fins depends on the characteristics of the SCR, the application and the heat sink's material and construction. Ready-made heat sinks are relatively cheap.

If you wish to make your own sinks, use ⅛- to ¼-inch-thick copper, brass or aluminum. (These home-made heat sinks should not be used with SCR's that operate at or near maximum current for long periods.) For a 50-amp SCR, use a piece about 6 × 3½ inches, with two fins about 6 × 2½ inches. For a 25-amp SCR, a 4 × 2½-inch heat sink with 4 × 2-inch fins is satisfactory. In the center of the heat sink, drill a hole with a diameter slightly greater than that of the SCR stud. At one short side of the heat sink piece, at ½ inch from the edges, saw out slots ⅛ or ¼ inch wide, (depending on metal thickness), halfway through to the other end (Fig. 6). Then saw slots out of the fins, lengthwise, ⅛ or ¼ inch wide, starting in the center of one short side and stopping at the center.

The fins can now be pushed over the heat-sink piece, and the slot will mate. Solder or weld the fins to the heat sink. Paint the whole assembly flat black, except for a small, circular area around the hole, where the anode of the SCR will make contact with the metal.

Mount the SCR with a lockwasher and nut over its stud. The nut must be screwed on tightly, otherwise the heat sink will lose its effectiveness.

The sink, which is at anode potential, has to be insulated from the chassis. Holes in the chassis underneath will aid air circulation. The chassis can be kept small by placing the heat sinks vertically. END

Make Your Own Linear-Scale AC Meters

Ordinary dc meters with rectifiers are more useful than iron-vane ac jobs in variable ac supplies and such

By JOSEPH H. SUTTON

YOU CAN EASILY MAKE ACCURATE LINEAR-scale ac meters from 1-ma dc meters with the help of a simple trick. The application shown here is to a variable transformer box (Fig. 1), where ordinary iron-vane meters, unless carefully shielded, might be disturbed by the transformer field. (For example, General Radio advertises that, in their similar transformer box, the meters are carefully shielded.)

The necessary meter resistors and diodes are mounted on a clear plastic platform fastened to the meter terminals. Terminals on the platform are bent from small solder lugs, attached with 2-56 screws. There are six terminals on each side, enough for matched pairs or trios of resistors if required. The plastic will stand a *little* soldering without melting.

To the Fig. 2 circuit, at points A, B, attach the current meter calibrating system of Fig. 3. Ten volts across the 10 ohm resistor equals one ampere.

R1 in Fig. 2 is about 200 ohms (not critical), so R1 plus meter resistance is about 250 ohms. Initially, calibrating resistors R2, R3 are pots or decade boxes. Set R2 at about 10,000 ohms, R3 about 5,000. Then proceed as follows:

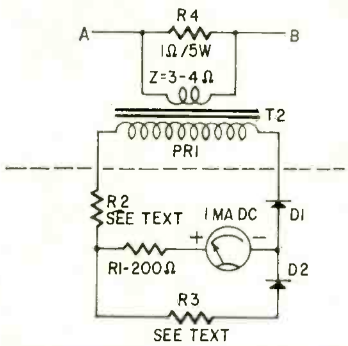


Fig. 2—Current transformer and half-wave rectifier for measuring alternating current. Connect between A and B in Fig. 1.

Step 1. With the Variac, gradually increase current to ½ ampere. With R2, keep 1-ma meter deflection below half scale.

Step 2. At ½ ampere current, adjust R2 for half-scale deflection.

Step 3. At 1 ampere current, adjust R3 for full scale deflection.

Step 4. Repeat steps 2 and 3 as necessary.

With your ohmmeter, match the values of R2, R3 with fixed resistors.

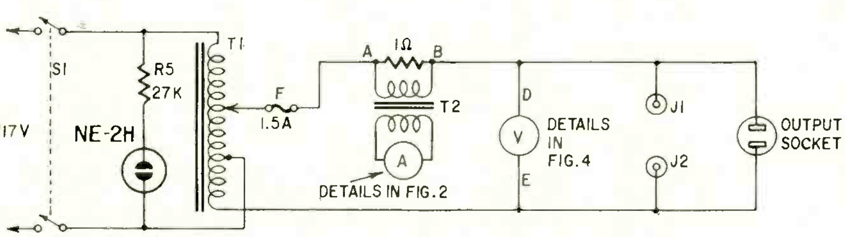
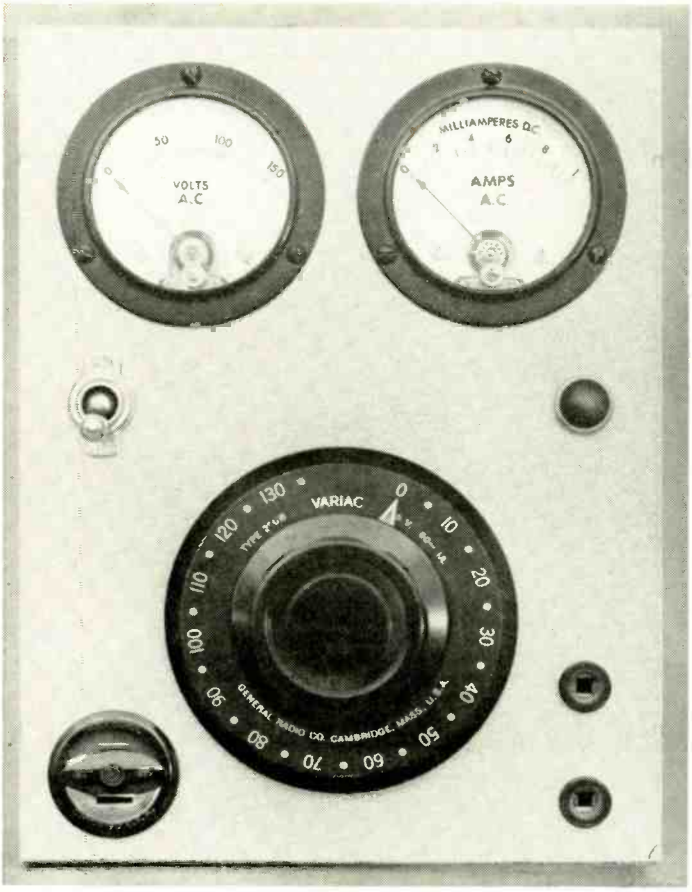
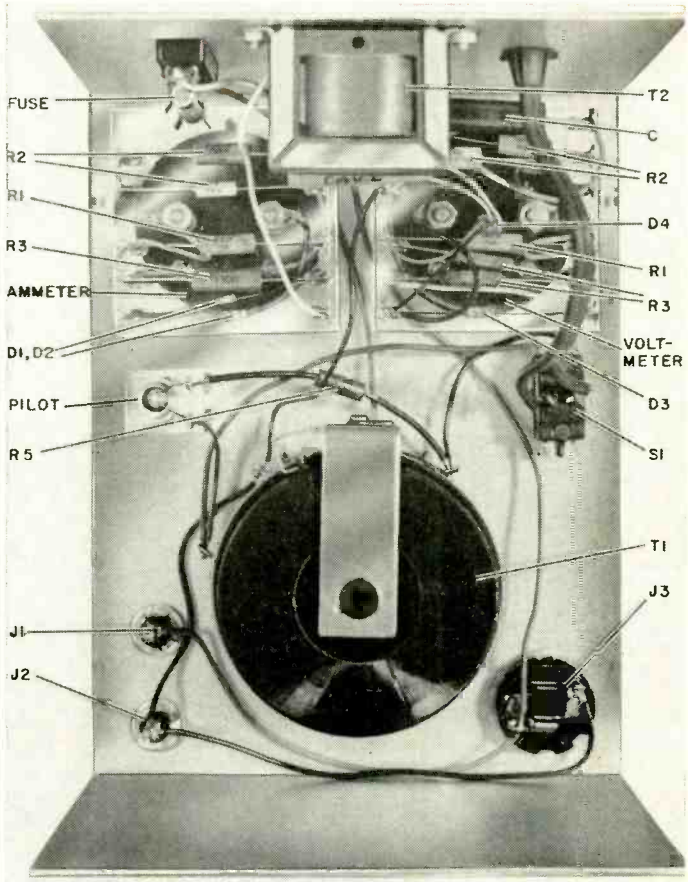


Fig. 1—A variable ac supply using the two metering arrangements described in the text.



Author's variable transformer box with converted meters.



Inside the variable transformer box.

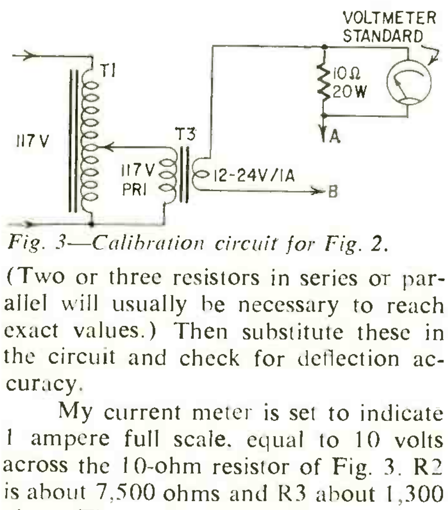


Fig. 3—Calibration circuit for Fig. 2.

(Two or three resistors in series or parallel will usually be necessary to reach exact values.) Then substitute these in the circuit and check for deflection accuracy.

My current meter is set to indicate 1 ampere full scale, equal to 10 volts across the 10-ohm resistor of Fig. 3. R2 is about 7,500 ohms and R3 about 1,300 ohms. The resistors are 1% types, purchased in a "by the pound" deal at a surplus dealer. Ordinary 10% carbons will do, but with age they drift more than precision types.

- C—.02 μf, 400 volts
- Chassis—LMB box 8 x 6 x 4½ inches
- D1, D2, D3—three 1N34-A diodes
- D4—meter rectifier, full-wave (Conant 1101, B-160 or equivalent)
- R1—about 200 ohms
- R2, R3—see text
- R4—1 ohm, 5 watts (see text)
- R5—27,000 ohms, ½ watt, 10%, carbon
- T1—variable autotransformer, 1 amp or more (General Radio Variac 200-B, Superior 10B, etc.)
- T2—small audio output transformer, 3- to 4-ohm secondary
- Two 1-ma dc meters, one with 0–150-volt scale
- Red-jewel NE-2H or NE-51H pilot lamp assembly, fuse holder, two output jacks, standard ac outlet socket, line cord, miscellaneous hardware

Fig. 4 shows the voltmeter circuit. The .02-μf capacitor blocks any dc that might be present in an experimental circuit connected to the box. The full-wave meter rectifier is a Conant 1101, but a Conant B-160 will work as well. Full-wave rectification had to be used here because of the .02-μf series capacitor.

To calibrate the voltmeter, you need a source of ac voltage and an *accurate* voltmeter standard. Connect two 700-ohm, 10-watt resistors in series across the 150 volts to give you a 75-volt center tap for midrange measurements. At 75 volts, adjust R2 for half-scale deflection, then adjust R3 for full scale at 150 volts (or for whatever your full-scale reading may be). (In my box, R3 is about 2,000 ohms and R2 is around 120,000 ohms to indicate 150 volts.) Since each adjustment affects the other, go back and adjust again till you read exactly 75 volts at half scale and 150 volts at full scale. Then measure R2 and R3 and substitute fixed resistors.

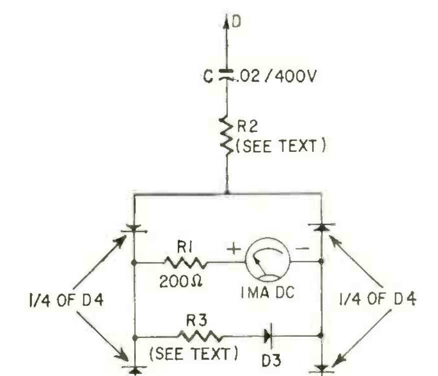


Fig. 4—Voltmeter circuit with full-wave rectification, to be connected between points D and E on Fig. 1.

To mark that the meters now indicate ac volts and current, I stuck black decals to the *outside* of the meter glass. The effect is just as good as if the face were changed, and there is no risk of damaging face or pointer. In cementing the decals, use lacquer thinner sparingly.

Output can be taken either from the Amphenol 78-1M tip jacks J1 and J2 (lower right corner of panel) or the standard ac outlet (lower left corner). Note that the on-off switch disconnects *both* sides of the ac line, an important safety feature when working with an autotransformer.

A larger variable transformer than my T1 can of course be used, if it will fit in the box. Two 1-ohm resistors can be paralleled across T2 to handle the larger current. END

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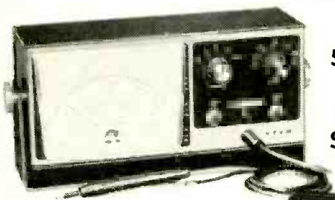

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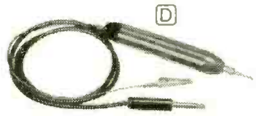
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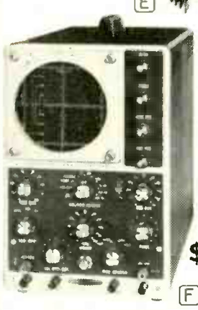
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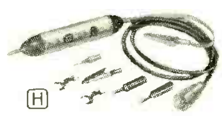
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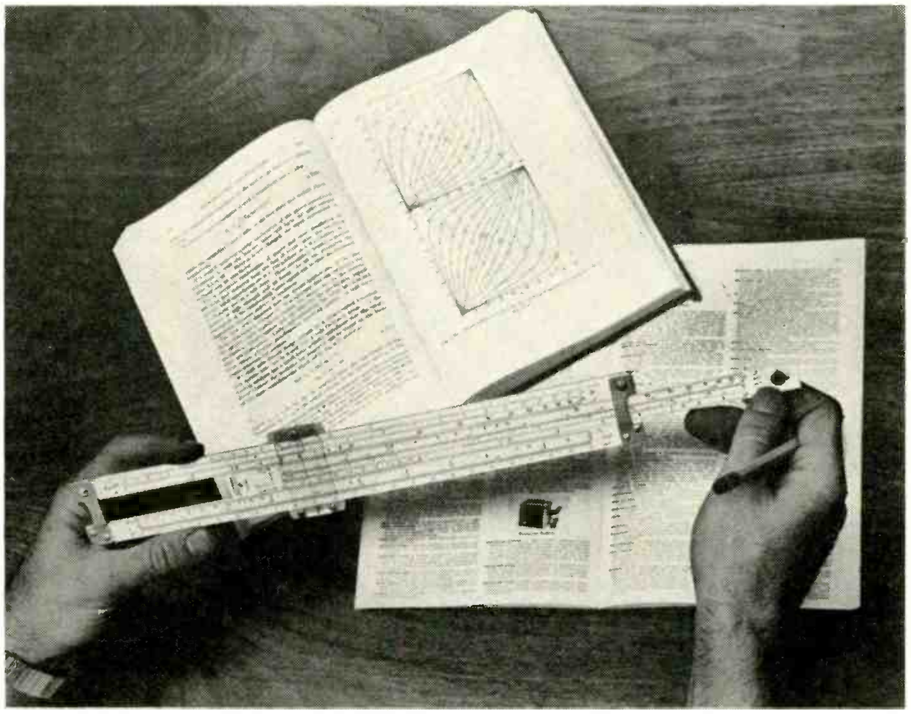
EQUIPMENT REPORT

Slide Rule for Electronics



THERE MUST BE THOUSANDS OF PEOPLE in electronics who have never had the marvelous adventure of calculating problems with a slide rule; other thousands have had to content themselves with a slide rule not specifically designed for electronics. For both groups, the new model N-515-T rule designed and marketed by Cleveland Institute of Electronics and built for them by Pickett will open a whole new era of quick calculations.

Even if you have never had a slide rule in your hand before, the 108-page manual that is included takes you by the hand and leads you from simple calculations right through resonance and reactance problems with hardly a hitch. If you already use a slide rule, you'll find the book a first-rate refresher course. And it explains in detail the shortcuts built into this new rule.

On the front of the rule you'll find the regular slide-rule scales: A, B, C, D, CI, S, T, L and Ln; but there is also an H scale and a 2π scale as well as markings on the other scales such as X_L, X_C, f (for frequency), to make it easy to select the correct scales.

One big benefit of the new rule is the "Decimal Point Locator" (DPL) on the reverse side. Here you can find exactly where the decimal point should be, and get a rough calculation of the answer to any reactance or resonance problem. This not only saves a lot of time but greatly reduces the chance for error as compared to finding the decimal point in the usual manner. For example, you can find that a 500-pf capacitor has a reactance of between 100 and 200 ohms at 2 mc in a matter of seconds with the DPL. This is accurate enough for many calculations, but when you need to be more precise, simply turn the rule over, set the frequency on the 2π scale and the capacitance on the C_X (which is the normal CI) scale and read 159 ohms on the C scale using the X_C (usual D) as index.

As another example, you can find from the DPL that the reactance of a 200-μh choke is about 500 ohms at 455 kc. For greater precision, again turn the rule over, set the frequency 455 on the 2π scale, move the slide under the hairline to 200 on the L_X (CI) scale and read 573 ohms under the X_L (C) index on the D scale.

In both these problems we know *nearly* what the answer is by reading it approximately on the DPL. This tells us that the answer to the first problem is not 15.9 ohms nor 1,590 ohms but 159, and that the answer to the last problem is not 57.3 nor 5,730 but 573 ohms. (Decimal points must normally be placed by using pencil and paper and rough calculations, with an ordinary slide rule.)

If, for example, you need to know what inductance would have 300 ohms reactance at 100 mc, just set the X_L indicator to 300, the hairline to 100 mc and read 0.5 μh from the μh scale, or you could find that a capacitance of 5 pf would have 300 ohms reactance at 100 mc, etc.

With the DPL you can make quick approximations of resonance. You could find, for example, that a 200-pf capacitor and a 500-μh coil resonate near 500 kc. Reading from the front of the rule, on the H scale, shows that the actual frequency is 504 kc. Here again you can solve for any unknown; if you know frequency and capacitance, you can solve for L; if you know frequency and inductance, you can solve for C, or if you know frequency only, you can solve for the L-C product, etc.

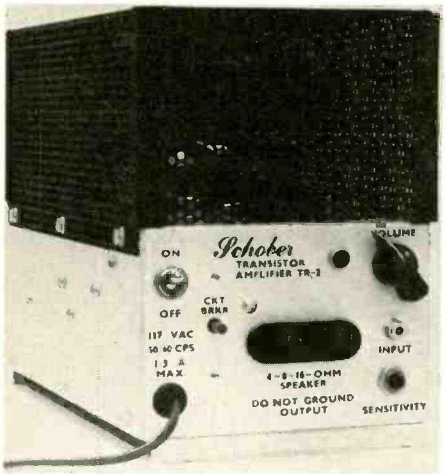
In addition to the Decimal Point Locator on the reverse side of the rule, there are more than 60 of the most-used electronics formulas and conversion factors—Ohm's law for dc circuits, Ohm's law for ac circuits, frequency and wavelength, reactance, resonance, decibels, power factor, transformer impedance ratios, parallel resistances, series and parallel impedances, coupled inductance, efficiency, temperature C to F and F to C and Kelvin, effective-to-average and effective-to-peak voltages, feet to meters, meters to miles, horsepower to watts, Q and many others.

The rule has all scales necessary for performing trigonometric functions and more than 30 pages of the instruction book are devoted to solving such problems. These examples are very helpful to users unfamiliar with slide rules.

The rule is all-aluminum, with adjustable slide tension, and comes in a handsome stitched leather case with a thick plastic insert to protect the rule. Every rule comes with a free four-lesson course that will be graded by instructors at CIE if you wish.

I introduced this rule to a group of high-school students studying electronics and struggling through various reactance and resonance problems. After a short course of instruction on the rule they really "came to life" and began solving all sorts of electronics problems for the sheer fun of it.—*Wayne Lemons*

The Schober TR-2 Transistor Power Amplifier



A COMMERCIALLY AVAILABLE MONOphonic amplifier is a rare beast today. And a *transistor* mono amplifier? In hi-fi, the word transistor has become linked forever with stereo!

Well, here's a transistor monophonic power amplifier—and one of the most unusual pieces of audio equipment I've seen. The Schober TR-2 is very nearly a black-box power amplifier. It will put out at least 40 watts into 8 ohms anywhere between 20 and 15,000 cycles seemingly forever, with a harmonic distortion well under 1% (verified). Though it is not much smaller than a comparable tube amplifier, it is certainly lighter (no output transformer) and far, far cooler.

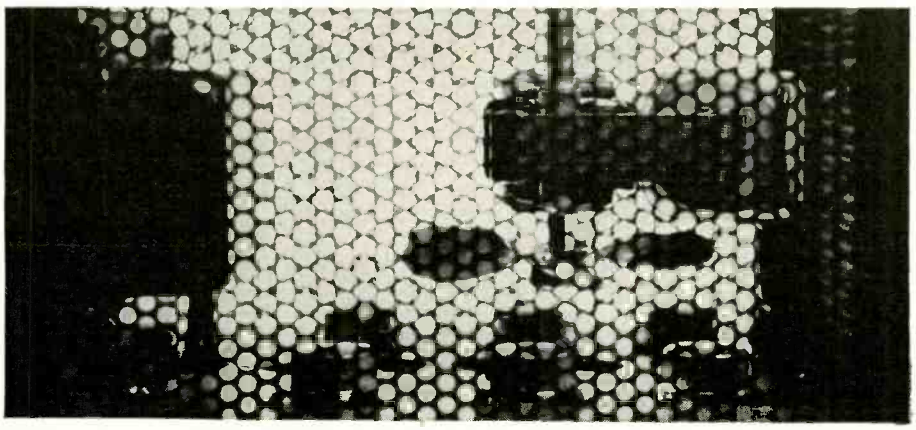
The most unusual feature of the Schober TR-2 is its "cooling system." Instead of the large, finned heat sinks that are almost universally used with power transistors, this amplifier has a chassis of unusually thick aluminum. The six power transistors (four output, one driver and a regulator) are mounted near the edges of the chassis top in two rows of three, with five round ¾-in. holes in a row between them. Inside the perforated cage is a small fan (see the photo) which draws air through holes in the chassis bottom plate, up around internal components, up through the five big holes near the power transistors, and out. A simple sort of forced-air cooling, in which the convection of a large volume of moving air replaces the cooling-by-radiation of heat sinks.

A bonus of the heavy aluminum chassis is its rigidity—an important thing with a big power transformer.

A sign of the versatility of the TR-2 is the fact that it has both a "volume" control and a "sensitivity" control. The first is a potentiometer at the input jack, fitted with a knob. The second is a rheostat in series between the emitter-follower input stage and the next stage. The sensitivity control is a level-set that makes it possible to set the full-power sensitivity of the TR-2 anywhere from .05 to 0.8 volt, giving the volume control a useful range.

To those who worry about the delicacy and temperament of transistor amplifiers—forget it (at least with this one). *Neither running it at full power (even at high frequencies) nor shorting the output terminals will harm it.* At most, the resettable circuit breaker will pop open. The only caution is this, quoted from the instruction sheet: "If the amplifier has been operated at a very high power level for a . . . time sufficient to make the chassis feel quite warm or even hot, you must avoid shorting the output . . ."

The major secret of this reliability is a 0.3-ohm 10-watt resistor in series with the speaker terminals, plus a bit of negative current feedback to the driver stage. A short across the output terminals is now not a dead short on the power supply through the transistors (which would destroy them in an instant), but a "0.3-ohm short" (plus the 0.24-ohm current-feedback resistor). That small resistance is enough to keep the transistors from being hit with full current at full voltage in case of a shorted output, and the increased signal current increases the negative feedback



Shot through cage shows cooling fan.

SPECIFICATIONS

(All specifications are the manufacturer's)

Power response: 40 watts ±1.5 db from 20 to 30,000 cycles
Rated power: 40 watts (into 8 ohms)
Harmonic distortion: less than 0.75% from 20 to 20,000 cycles at 40 watts output
Intermodulation: 1.4% at 40 watts equiv. sine-wave power, using 60 and 7,000 cycles mixed 4:1
Hum & noise: 83 db below 40 watts
Input impedance: approximately 100,000 ohms
Sensitivity: .05 volt rms for 40 watts output at extreme clockwise setting of sensitivity control
Dimensions: 11¼ (incl. mounting flanges) x 5½ x 7⅝ in.
Weight: 13 lb
Price: $75.90, kit, including Fed. excise tax

to the driver, cutting the drive power to the output transistors.

The circuit is basically a slight variation on the popular RCA-developed "totem-pole" single-ended push-pull class-B scheme, with four 2N2147 transistors driven by a 2N2148 through a split-secondary driver transformer. The supply to the driver and all previous stages is regulated.

Though I didn't build the kit, a study of the instructions and of the amplifier itself shows no pitfalls even for the first-time novice. The instruction booklet contains excellently written material on basic construction and tool-handling techniques that might be valuable even to seasoned kit builders. Most of the pigtail components are mounted on an etched circuit board with numbered holes. Almost anyone should be able to finish the job in 4 to 5 hours.

What can you use it for? The Schober people are makers of electronic organs; hence a major application of the TR-2 is to supplement or replace the small amplifiers in their lower-priced organs, or to extend large organ systems where multiple-speaker installations are desired. But because of its excellent performance and versatility, it should be useful as a recording or broadcast monitor amplifier, a utility power amplifier for labs and service shops, or as a driver for a center-channel speaker in three-channel stereo. And let's not forget the man who just isn't interested in stereo, has no use for two channels and simply wants 40 to 50 watts of clean, reliable power to feed to his one speaker.—*Peter E. Sutheim*

Western Reserve 300 Digital Passive Scaler

WHAT IS A "DIGITAL PASSIVE SCALER"? This unit, built by Western Reserve Electronics of Cleveland, Ohio, is a beautifully constructed volt-ohmmeter of high accuracy. It has both regular meter readout and digital readout from manually operated number drums. "Passive" in its name indicates that the instrument requires no external power for operation.

A front-panel switch labeled SEARCH MODE is for normal vom readings with the meter. When this switch is moved to DIGITAL MODE, the meter is used only to indicate a null. The number drums are rotated until the meter reaches its "target" area. On voltage readings this target area is at the center scale of the meter, on ohms measurements it is at the left or "0" side of the meter.

In search mode, the meter is used the same as any 10,000-ohm-per-volt

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meter. In the digital mode, the range switch is used normally; turning it moves the decimal point to the proper position for digital readout. The drums are then rotated with thumb wheels until the meter pointer exactly centers on target. The exact voltage or resistance is then read from the number drums.

The 1% accuracy of the digital readout on all ranges makes the Digital Passive Scaler suitable for many calibration applications in shop or factory. In fact, I found that my sample meter was within ½% of any reading compared to a laboratory standard voltage source, except on the 100-volt range, where it was within ¾%. In other words, more than enough accuracy for all but extremely demanding applications.

Other interesting features are built into this professional instrument. A solid-state meter protection circuit is used but, in addition, a sensitive relay disconnects the negative input lead on overloads. If you are reading 85 volts on the 100-volt range and inadvertently switch to the 10-volt range, the relay will open the test lead circuit. A red button on the front panel is used for reset. The 1.5-volt ohmmeter battery is "borrowed" to energize the relay coil during the reset function.

This instrument should be ideal where high accuracy, long-term stability and ruggedness, as well as professional appearance, are important.

The ohmmeter in the search mode and on any of the first four ranges (×1, 10, 100 or 1,000) has on the test leads less than the threshold voltage of silicon semiconductors, so that resistance measurements can be taken with no shunting error in circuits containing these devices. Voltage on any ohmmeter range is small and the current is limited, so that there is no possibility of damage to semiconductors of any kind.

Voltmeter ranges are from 0.1 to 1,000 volts, ac or dc. Current can be measured from 10 μa to 10 amperes dc, resistances from 1 ohm to 1 megohm. (In the search mode, resistance down to 0.2 ohm can be read without trouble.)

Owning the Digital Passive Scaler is comparable to having a good Wheatstone bridge and vom in one package. The instruction book, which is permanently fixed inside the lid, is one of the best written and most detailed I've come across in a long time. Also housed in the lid of the fiberglass case is an accessories panel for storing test-lead terminations.

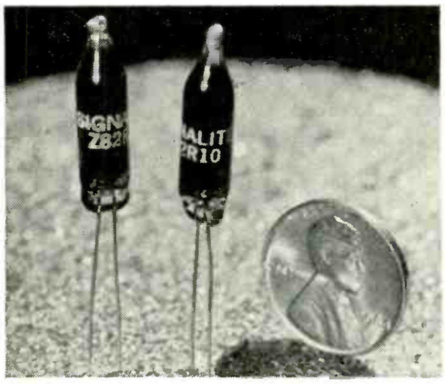
It is a nice instrument, one that should find its way into many professional service and industrial applications. —*Wayne Lemons.*

Western Reserve Electronics, Inc., 12430 Euclid Ave., Cleveland, Ohio 44106. **$350.** END

NEW SEMI-CONDUCTORS AND TUBES

SUBMINIATURE REFERENCE TUBES

A line of subminiature voltage reference tubes with extremely close tolerances and a low temperature coefficient has been released by Signalite, Inc. The tubes' working voltage is in the vicinity of 83 volts, depending on the particular type.



Life expectancy for all lamps in the series is 30,000 hours continuous operation. Operating temperature range is – 55° to 90° C.

Maximum current is specified as the point at which there will be less than 1 volt change from the reference voltage. One type in the 82-volt series, the Z82R7, handles up to 7 ma; the Z82R10, up to 10, etc. In the "10", there is less than 1-volt change between 0.3 and 10 ma, and less than 0.2 volt from 0.35 to 7 ma.

Breakdown voltages vary from 100 to 107 (dc), depending on type.

UHF REPLACEMENT TRANSISTOR

A universal replacement germanium p-n-p epitaxial transistor called the TV1000 has been announced by Semitronics Corp. It is an exact replacement, according to the manufacturer, for front-end and mixer/oscillator transistors in Blonder-Tongue, Jerrold, JFD Finco, Alliance, Channel Master, Winegard, Gavin and other TV antenna boosters and master antenna systems. It is said to be equally applicable in TV cameras, video amplifiers and CB and ham equipment.

The TV1000 has a straight-line four-lead design ("straight-line" refers to the fact that its four leads are all in a straight line). Leads are gold-plated. Dealer net price is just under $3.

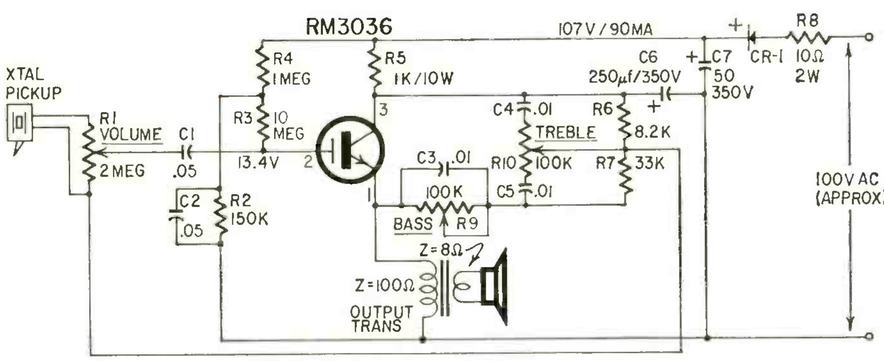
MORE ON THE MHO-AMP

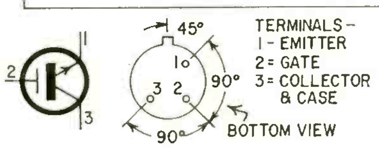
In February's column we introduced Raytheon's Mho-Amp, a two-stage amplifier with a high-impedance field-effect transistor input, all packaged in a single TO-5 transistor case. The device's input impedance is greater than 1 billion megohms (really) and has 150 db gain.

We mentioned that although it was not, of course, intended as an audio amplifier (its price is up around $100), it was being demonstrated in that capacity, producing 1 watt of audio at less than 5% distortion. We thought you might be interested in seeing the circuit—unusual in many ways. It is no more complex, certainly, than a two-tube phono amplifier, especially since it has separate volume, bass and treble controls.

The circuit shown here requires 400 mv (0.4 volt) across 2 megohms for full output.

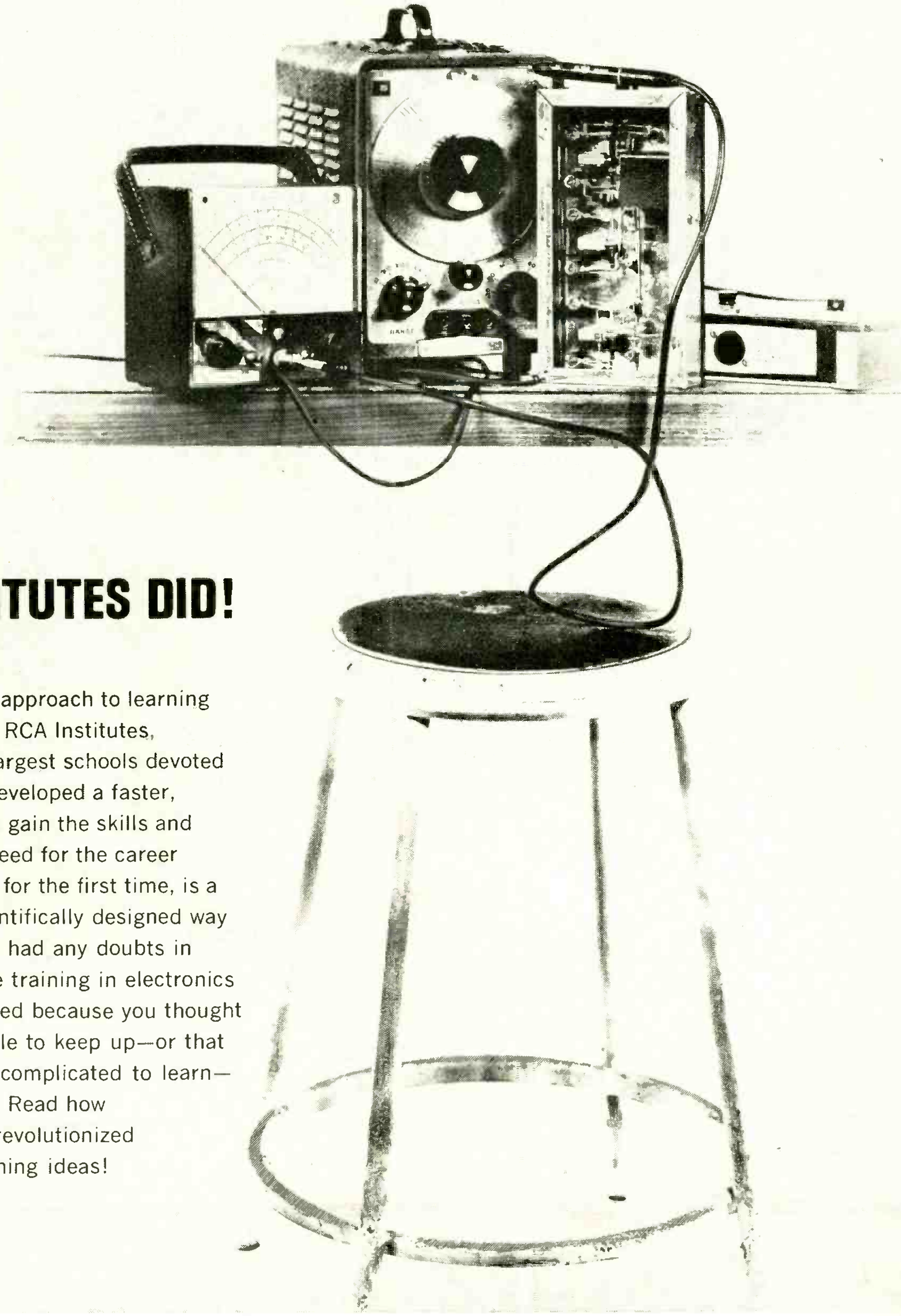
For those of you who have money to burn and want to buy an RM3036 Mho-Amp and try the circuit, one word of caution: spend an extra few bucks and buy a 10- or 15-watt isolation transformer. Transformerless circuits can be dangerous. END





Circuit of Mho-amp amplifier. Symbol is Raytheon's; device has what amounts to 2 stages even though symbol does not show them.

SOMEONE SHOULD DEVELOP AN EASY WAY TO LEARN ELECTRONICS AT HOME



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TECHNOTES

NORELCO/PHILIPS CONTINENTAL 400 STEREO RECORDER

Mono playback and recording OK on either track. Stereo recording and playback missing in right channel. Capacitor C108, .015 μf, 400 volts, interstage coupling in right-channel equalized amplifier, leaky. (Leakages as high as 750,000 ohms can block this stage. Triode following is self-biased with grid resistance of 40 meg.) Capacitor, connected between pins 2 and 6 of V103 (12AX7 ECC83), can be replaced by removing bottom plate over preamp section, input panel, and shield over radio phono jack.

AM INTERFERENCE ON FM

Recently I had a transistor AM–FM portable in for service with an odd complaint. A local AM station would break through and disturb the reception of an FM station. The customer lived very close to the 50-kw transmitter of the AM station. An overall check of the set showed no trouble.

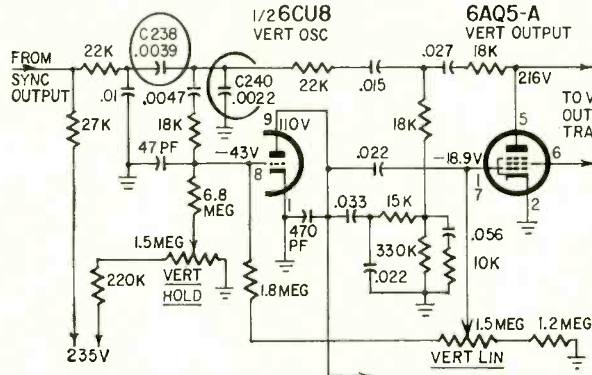
The set was an imported make with separate front-ends for AM and FM, a common i.f. system and a switch feeding power to the correct front end and changing the audio circuit to one detector or the other. The tuning capacitor was the combined type with four gangs, two for each section. I noted that the dial setting of the desired FM station corresponded with the setting of the AM station that was breaking through. Shorting the antenna tuning section of the AM front end removed the interference.

The high Q of the tuned circuit and the proximity to the transmitter caused a high resonant voltage across the plates of the tuning capacitor and a high current through the entire circuit. This was somehow modulating the FM oscillator and breaking through the afc's hold.

Since there are only two FM stations in our locality I decided to alter the frequency of the FM front end, placing the desired station about 1 megacycle lower on the dial than it had been, and about 50 kc off resonance for the AM station. This cured the trouble and did not interfere with the calibration of the FM dial too greatly. Since there was ample room at the ends of the dial, future stations will be receivable without change.—*Steve P. Dow*

VERTICAL DRIFT IN RCA PORTABLES CHASSIS KCS120-E, -F

One of these sets had a vertical frequency drift that depended on temperature. If the hold control was adjusted when the set was thoroughly warmed up, the picture would roll rapidly downward the next time the set was turned on after cooling off. All components checked good.



I sprayed a chilling chemical on ceramic capacitors C238 and C240 while the set was warm and in sync. At once it went into a downward roll. I replaced the ceramics with Mylar units—that cured the trouble.

A slow-heating 6AQ5 vertical output tube will cause the same trouble, though less serious.—*Charles Andrews*

CLEANING TAPE-RECORDER HEADS

To do a fast, efficient job cleaning heads on tape recorders without undue wear on the heads, use relay-cleaning tape K. S. 6528 manufactured by Hope Webbing Co., Inc., 350 5th Ave., New York, N.Y.

Run the tape past the head several times just the way the recording tape runs. If the cleaning tape comes out dirty, use another piece and repeat the process.—*George P. Oberto*

[Cleaning tapes especially for tape recorders are also available from Elpa Marketing Industries, Robins, Audiotex, Lafayette and possibly other sources.—*Editor*] END

CATV—WHETHER, WHITHER AND WHY

continued from page 29

public, the entertainment industry and the thousands of television dealers and service technicians throughout the country. No longer is CATV confined just to outlying and remote regions. It is now virtually in every type of market, large and small. At its present rate of growth, CATV will soon be in every city in the nation with a population of 2,500 or more. Such growth presents a number of dangers:

1. CATV can hurt local TV stations by making available distant big-city stations. By duplicating the big-city stations' programming, they are *diluting* available audiences, affecting ratings of local stations and possibly their advertising rates. Local stations *must* be allowed to continue their functions as a local service.
2. Uhf growth and CATV growth are incompatible. It is common thinking in the broadcasting field that no investor will apply for and build a uhf station where a local CATV system is making available big-city TV, uninterrupted FM music and weather channels. At present, more than 1,000 uhf stations are allocated but not yet on the air. They must be permitted and encouraged to proliferate as a true extension of *free* TV. Within 5 years, more than 20 million all-channel TV receivers will be sold *fully equipped* to receive those stations.
3. Many persons may find themselves paying for "more TV" but retaining their old viewing habits and watching their favorite stations. In such instances (and there could be hundreds of thousands of them), the set owner would be paying a permanent monthly charge for what he had been getting free. After he has discarded his antenna, worth up to $100, he is reluctant to incur a whole new set of installation expenses and goes on paying his "4, 5, or 6 bucks a month, ad infinitum." [1]
4. We know of no stated plans for utilizing or converting CATV systems into pay-TV facilities—*but it is possible*. The present cables which carry up to 12 channels of off-the-air program material can easily include a scrambled pay-TV channel. Billing can be done by meter or through a pair of telephone company wires.
5. Is it legally and morally right for CATV to take off-the-air material and retransmit it for a charge without the consent of, and with no compensation to, the owner?

[1] George B. Storer, Jr., president of Storer Broadcasting Co. in *Financial World*, July 29, 1964.

6. CATV can very easily and naturally become involved in set service—unless cable repair men are clearly barred from servicing.

The existence of an independent servicing industry is threatened. When the receiver fails to work normally, the fault may be in the cable or in the set. The set owner, not wanting to pay for a service call only to be told that the fault is in the CATV system over which he has no jurisdiction, will naturally call the CATV company. Under such circumstances the idea of a service department to handle customers' sets becomes very attractive—almost necessary. Such a situation can lead only to deterioration of the independent service industry on which we depend for the performance of our TV receivers as well as our radios and hi-fi equipment.

There is a truly simple way to bring order to this complex problem. As a legitimate business, CATV has every right to exist and provide whatever service it can bring to its subscribers. But it is too closely linked to broadcasting and the use of the radio spectrum not to be answerable to the same agency—the Federal Communications Commission. There are those who believe that the FCC has jurisdiction over CATV (referring to Titles II and III of the Communication Act). At least two briefs, one by the American Broadcasting Co., have been filed urging the commission to exercise this jurisdiction. The FCC has thus far failed to reply. The only other avenue for regulation is Federal legislation making CATV subject to the full provisions of the Communications Act.

Regulation and control over CATV by the FCC is desirable for a number of reasons. Here is an agency competently staffed with some of the nation's top engineers and attorneys who, with complete authority and absence of bias, can decide purely in the *public interest* whether CATV is a boon or bane to a community. Only they can weigh the effect of CATV upon local TV stations and the growth of uhf. They would have absolute power to grant a CATV *license*, establish technical standards, and if pay-TV must come, assure its having little if any effect upon free TV. And in the true American tradition, *hearings* would be held so that *all* sides of any CATV installation at issue could be heard and aired—and there would be opportunities for appeals where indicated. Local city councils are unequipped and unqualified to decide whether CATV belongs in their communities. END

CATV—A NATURAL EVOLUTION

continued from page 29

nicians are strongly opposed to CATV—*before the system goes in.* On the other hand, once operations begin, these people generally become its strongest supporters.

The reaction of Robert Schlosser, of Schlosser Radio Service, Pontiac, Ill., is typical: "Our biggest surprise," he wrote in a letter to the system manager, "was the increase in repair service. With steady signals and program variety, people became more critical of their reception. We have had many complete overhauls, including new picture tubes."

Mr. Schlosser pointed out that the cable system had eliminated the police radio interference that had plagued so much of the city of Pontiac. "Almost every set in our stock is now free of this interference in any location using cable."

Undeniably, the TV dealer does lose some antenna sales. This is more than offset by the fact that people in a CATV community rapidly become very TV conscious. They buy more sets and more accessories. They see just how good a picture can be, making them dissatisfied with anything but perfection. This leads to an increase in service business.

Another important factor is that CATV serves as a tremendous impetus to color TV sales. People who know that they can get excellent color reception consistently are willing to invest in a color set.

Mr. Schlosser says, "Color TV and remote-control sets are now selling. Very few color sets were in use before the cable came. Fading and interference could not be overcome even with expensive antenna installations."

And not even the antenna business is a total loss. In large cities and suburbs, the majority of residents never sign up for the CATV service. Yet the nonsubscribers have a new standard against which they can compare their reception. Not only do the nonsubscribers become more quality conscious, but they are more inclined to reach out for the distant channels being brought in by cable. This means that the aggressive dealer can promote bigger and better antenna installations. And he can often justify their cost by comparing it with the total monthly CATV subscription charges over a several-year period.

CATV has many enemies. These include:

1. Antenna manufacturers, who fear they will lose business.
2. Broadcasters, who feel that CATV competes with them.
3. Theater owners, who also think of CATV as competition.

Broadcasters often insist that CATV will drive them off the air. Fortunately, this is not true. Let's take a look at the record.

During hearings in 1958 and 1959, the FCC heard testimony from licensees of 12 television stations, who charged that CATV would destroy their economic base.

This never happened. All 12 stations survived. As a matter of fact, none of these stations decreased its rates and 9 of the 12 have increased them since 1959. Ranging from 11% to 66%, these rate increases average out to almost 30%

Similarly, CATV has been accused of preventing the proliferation of uhf. Again, this is not true. A lot of uhf channels did fail when the band was first opened, but this was due primarily to the lack of TV sets capable of receiving uhf. (The recently enacted all-channel law was designed specifically to remove this roadblock.) Of the 109 uhf stations that have gone off the air, only 18 operated simultaneously with CATV systems in the same community. Two of these stations wrote letters commending the local CATV system for helping them stay on the air as long as they did. And only one uhf station—which later returned to the air as vhf—ever claimed that CATV was a factor. The FCC found insufficient evidence to indicate that the impact of CATV was serious enough to threaten a station's continued existence.

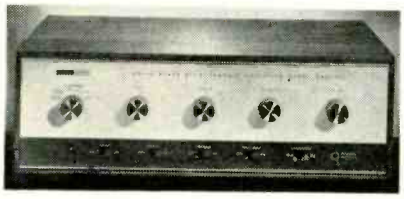
Of course, CATV is competition for other forms of home entertainment. But since when is competition a bad thing? What actually happens in a CATV area is that the local broadcasters are forced to improve their programming. This definitely benefits the public.

And, importantly, CATV is not pay-TV. It is simply a method of improving TV reception. All TV is wired TV, and there is no such thing as free TV. You pay for your TV set, your antenna and maintenance on both. You need a wire between the antenna and the TV set, whether it be 6 inches long or 6 miles long. CATV simply gives you an extra choice. You can buy an indoor antenna, an outdoor antenna or connect your set to the community antenna.

The unalterable fact is that many people want the choice offered by CATV. This is obvious, since many are willing to pay for it. It is good business to give the public what they want . . . and the business that does just that serves in the public's best interests. END

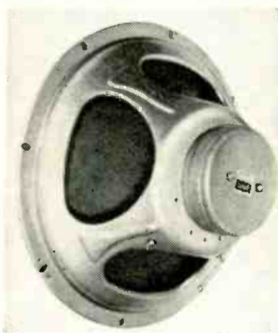
NEW PRODUCTS

SOLID-STATE STEREO AMPLIFIER, *model SA-2000,* provides 36 watts IHF music power (18 watts per channel). Reproduces all frequencies from 8 to 25,000 cycles with flat response within ±1 db at 1 watt; at full power 10 to 23,000 cycles with flatness of ±1 db. Damping factor 25:1; square-wave rise time 5 μsec; harmonic distortion less than 1%; hum and noise suppression at least 60 db. Controls: volume with power switch; balance; ganged bass and treble; contour switch; low-cut switch; high-cut switch; tape-monitor switch; speaker-defeat switch. 13¼ x 4⅝ x 8¾ in., 9 lb.—**Harman-Kardon, Inc.,** 15th & Lehigh Ave., Philadelphia 32, Pa.

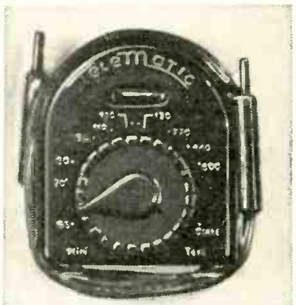


MICROPHONE, *model 500* (cardioid), now available with gold finish at no extra cost. —**Turner Microphone Co.,** 909 17th St. N.E., Cedar Rapids, Iowa 52402

CLOSED-CIRCUIT TV CAMERA, *type PK-301,* has 8134 electrostatic vidicon tube. Power: 117 volts, 50–400 cycles or 12 volts dc. Video output adjustable to 0.7 peak-to-peak noncomposite or 1.0 volt peak-to-peak composite. Horizontal resolution: 700 lines in center of picture, 500 lines in each corner. Video response uniform to 10 mc ± 1 db before high-peaking and aperture circuits added. Gamma correction: ratio of either 1.0 or 0.7 from remote point. Aperture correction variable from 0–12 db. 10 shades of gray from log-linear gray scale. Signal-to-noise: 38 db. Automatic light compensation.—**RCA,** 30 Rockefeller Plaza, New York, N.Y. 10020



SPEAKERS, *Cadence series,* 9 models in sizes from 6 x 9 in. through 15 in. Engineered to withstand pounding from bass guitars, accordions, electric guitars and organs, etc. Selection includes magnets from 10 to 32 oz with voice coil sizes of 1″, 1½″ or 2″ in diameter. Cone suspension for controlled cone travel, treated cone edges, 66-strand voice-coil lead wires, rf-cured epoxy bonds at points of strain.—Utah Electronics, 1124 E. Franklin St., Huntington, Ind.



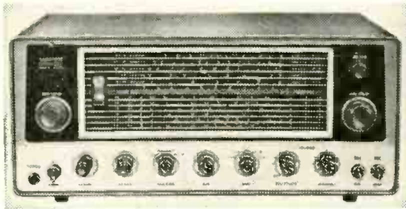
POCKET-SIZE VOLTMETER, the *Mini-Test, model VT-101*, measures 65 to 800 volts ac or dc.—**I. E. H. Mfg. Co., Inc.**, 102 Prince St., New York, N.Y.

ORGAN KIT, *model GD-983*, is kit version of Thomas' Coronado BL-3 all-transistor organ. 17 true organ voices; 2 full-size 44-note keyboards; 28 chime notes; 13-note heel-and-toe pedalboard with 1-octave range C through C; color-tone attack, repeat and sustain percussion; reverb. Built-in 2-speed Leslie rotating speaker plus 2-unit main speaker system using 12-in. speakers. Stereo chorus control; vibrato; treble accent; manual balance; pedal volume; expression pedal. Headset outlet; all-transistor 75-watt EIA peak music power amplifier. Factory-assembled walnut-finished hardwood cabinet and bench.—**Heath Co.**, Benton Harbor, Mich. 49023

15-WATT STEREO AMPLIFIER, *model AM-256*. Frequency response 80 to 20,000 cycles; output 15 watts (7.5 per channel); output impedance 4, 8 and 16 ohms. Controls: input selector, volume,

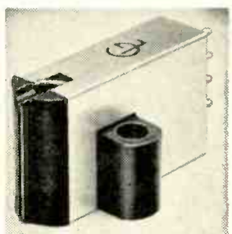
tone and balance. Stereo reverse switch. Inputs: crystal or ceramic phono. Ventilated metal cabinet. 10¼ x 6¾ x 4 in. Operates on 110-120 volts, ac 50-60 cycles.—**Olson Electronics, Inc.**, 260 S. Forge St., Akron 6, Ohio

AMATEUR COMMUNICATIONS RECEIVER, *HA-225*, has 14-tube superheterodyne circuit and dual conversion on 6 meters. Frequency coverage from 150 kc to 54 mc in 5 bands: 150–400 kc (Marine Beacon), 1.6–4.8 mc, 4.8–14 mc, 10.5–30 mc, 48–54 mc. Separate filament transformer for mixer and oscillator tubes; calibrated electrical bandspread on amateur bands 80 through 10 meters; 0–100 logging scale; sensitivity 0.5 μv for 10-db signal-to-noise ratio. Product detector SSB; BFO; Q-multiplier; crystal calibrator



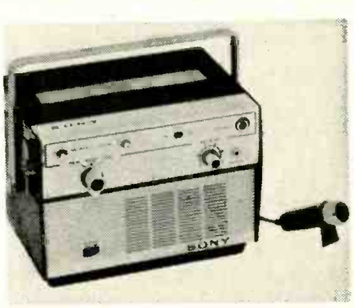
(crystal optional); ANL; S-meter; jack for tape recorder input; voltage-regulated power supply, 1.5-watt audio output into 8 and 500-ohm terminals (speaker optional). 17 x 7½ x 10 in.—**Lafayette Radio Corp.**, 111 Jericho Turnpike, Syosset, N.Y.

STEREO PICKUP CARTRIDGE *model A*. Manufacturer claims frequency response curves no longer significant; response is wide and flat, an incidental consequence of the extremely high compliance and low moving mass of stylus assembly (10×10^{-6} cm/dyne dynamic compliance;

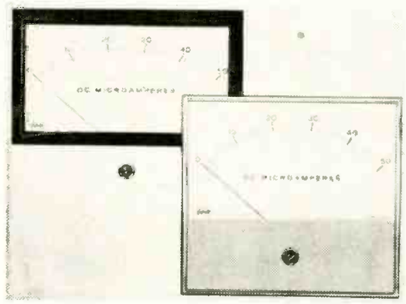


0.3 mg dynamic tip mass). Response 10 cycles to beyond 50 kc. Output (with transformer), 4 mv at 5 cm/sec recorded velocity, 6,000-ohm source impedance; without transformer, 1 mv at 5 cm/sec, 400-ohm source impedance. Recommended load resistance, 1 megohm. Tracking force, 1 to 2 grams. Stylus is manufacturer's Twin Tip design; vertical tracking angle, 15°.—**Grado Laboratories, Inc.**, 4614 Seventh Ave., Brooklyn, N. Y. 11220

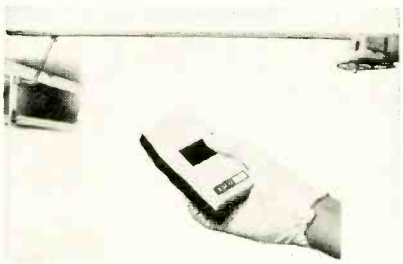
VOICE-ACTIVATED BATTERY RECORDER, *model 905*, features transistorized voice-activated mechanism and automatic gain control. Upper of the 2 units serves as portable recorder when detached; weighs 4½ lb. Placed on base amplifier/speaker, recorder will play back (base also has charger). Power requirements: recorder—4 AA batteries; speaker/



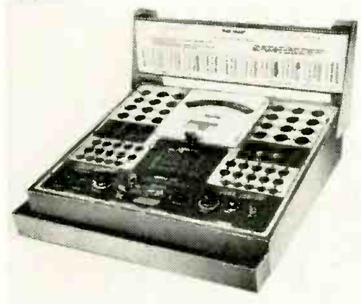
amplifier—115 volts 50-60 cycles. Tape speeds: 3¾ and 1⅞ ips. Frequency response: 90–5,000 cycles. Reel size: up to 3¼ in. Inputs: microphone and auxiliary. Outputs: monitor, external speaker. Both units together: 8⅜ x 6½ x 6½ in., 7⅞ lb.—**Sony Superscope, Inc.**, 8150 Vineland Ave., Sun Valley, Calif.



PANEL INSTRUMENTS, *G-Series*, 2½, 3½ or 4½ in., optional mounting bezel; Bar-Ring dc movements; long dominant scale with plenty of dial area; flat insert for masked portion of meter front for personalizing meter (special handling fees). Ac ranges from 10 ma, dc ranges from 5 μa. 2 mounting styles shown.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.



REMOTE GARAGE-DOOR OPENER, *Doormatic 4000* consists of door-opener mechanism, radio-control receiver, manual pushbutton wall switch, mounting hardware and small tone-modulated transistorized radio-control transmitter operating from self-contained battery. Factory-wired, complies with Part 15 of FCC regulations.—**EICO Electronic Instrument Co., Inc.**, 131-01 39th Ave., Flushing, N. Y. 11352



DUAL-PURPOSE TUBE TESTER, *model 202-E*, can be either professional bench tube tester or self-service tester. Tests virtually any tube for emission, shorts and gas; tests each section of multi-purpose tubes separately; tests 6- and 12-volt radio vibrators, fuses and lamps. 63 tube sockets; built-in 7- and 9-pin straighteners on panel; green finish. 11½ x 19 x 20½ in. Flip chart of 1,400 tube types.—**Mercury Electronics Corp.**, 111 Roosevelt Ave., Mineola, N. Y.

TWO NEW CONE TWEETERS under the *Tempo* label. *Model T 3C208* is 3 in. square, has frequency response of 1,800 to 17,000 cycles, power capacity of 6 watts. *Model T 5C208* is 5 in. square, frequency response of 1,000 to 17,000 cycles, power capacity of 6 watts. Recommended for use in combination with low-resonance woofers.—**Oxford Transducer Corp.**, 2331 N. Washtenaw Ave., Chicago, Ill. 60647

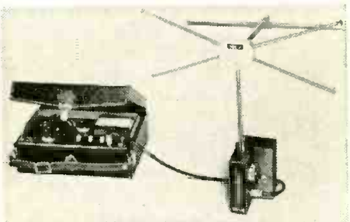
DEGAUSSING COIL, *Walsco 2592*, 7 in., molded in hi-impact plastic case. Extension cord and built-in switch with a clip for hanging on back of color TV set.—**GC Electronics Co.**, 400 S. Wyman St., Rockford, Ill.

INSULATING SPRAY, *NO ARC*, for protecting high-voltage components such as flyback transformers, yokes, eliminating arcing, corona and shorts plus coating against humidity and weather.—**Chemtronics, Inc.** 1260 Ralph Ave., Brooklyn, N. Y. 11236

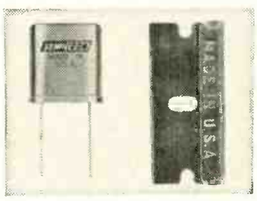
AUTOMATIC TURNTABLE, *Miracord 40*, pickup arm will track any car-

tridge at recommended stylus-force settings to less than 1 gram, has gram-calibrated dial, plays single records manually or automatically and stacks up to 10 records. Turntable is 1-piece casting, 12-in. diameter, 6 lb. Wow and flutter less than 0.1%, rumble better than 50 db below average signal level.—**Benjamin Electronic Sound Corp.**, 80 Swalm St., Westbury, N. Y.

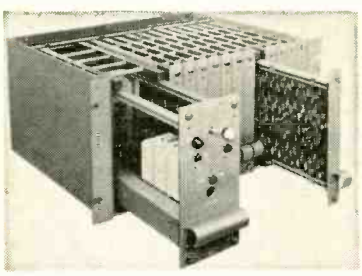
UHF TV FIELD-STRENGTH METER ADAPTER. The *UA-1* adapts any vhf TV field-strength meter for uhf TV measurements. Features: solid-state volt-



age regulator so batteries can be used down to 40% below rated voltage; level meter indicates when batteries are exhausted; backward-diode mixer and mesa transistor i.f. stage for low noise and wide dynamic range from below 5 μv to 0.1 volt.—**Sadelco Inc.**, 601 W. 26 St., New York, N. Y. 10001

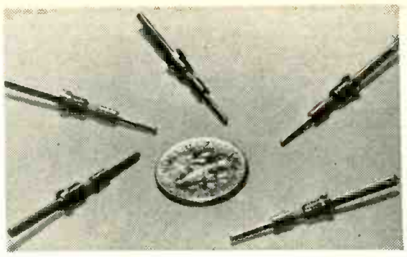


TV COLOR CONTROL CRYSTALS, *No. CTV358.* Supplied in HC 6/U hermetically sealed case with 2-in. leads, achieve perfect color control in color burst circuitry (3,579.54 kc). Exact replacements for color TV receivers of all leading makers.—**Semitronics Corp.**, 265 Canal St., New York, N. Y. 10013

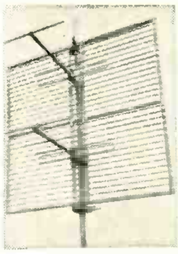


NEW MODULE RACK, 5¼ x 11 in., can be used with any combination of 1-, 2-, 4- or 8-in. modules; will accept printed-circuit cards in combination modules. 5¼-inch module rack makes it possible to package a power supply and circuit boards or memory unit and logic boards in one compact unit. Available from stock.—**Vero Electronics, Inc.**, 48 Allen Blvd., Farmingdale, N. Y.

SPECIAL-PURPOSE PICOFUSES designed for fusing terminal strips and connectors. Ampere ratings from ⅛ through 5 amps at 125 volts. Short-circuit



interrupting capacity of 300 amps at 130 vdc. Blowing time at minimum of 300% of rating. Fuse body, not including terminals, 8/32 x .078-in. diameter, weighs 1/5 gram.—**Littelfuse, Inc.**, 800 E. Northwest Highway, Des Plaines, Ill.



DUAL-ELEMENT SCREEN YAGI, *model SY-42-13*, 13 db, for TV service requiring high gain at 210 to 216 mc. Direct coaxial input for either 50 or 75 ohms; VSWR 1.5:1; power rating 2,040 watts. 60 x 60-in. reflector, frame of 1¼-in.-sq. aluminum, screening of ⅜-in. reinforcing sleeves.—**Technical Appliance Corp.**, Defense and Industrial Products Div., Sherburne, N. Y.

TRANSISTORIZED VIBRATOR ELIMINATOR, 12 volts, oscillates as low as 5 volts. Operates in temperature range of −50° to +180° F, is designed for CB mobiles and car radios. *No. 65-551* for positive-ground systems, *No. 65-552* for negative grounds.—**GC Electronics Co.**, 400 So. Wyman St., Rockford, Ill.

CB TRANSCEIVER TESTER, *No. 42-0126*, measures rf power output, relative field strength, standing-wave ratio, percent modulation, relative crystal activity. Modulated crystal-controlled rf signal, 1-kc audio signal. D'Arsonval meter measures up to 6 watts. SO-239 sockets take standard PL-259 connectors. 7⅝ x 5⅜ x 2⅞ in., 9-volt battery and 30-in. telescoping antenna.—**Lafayette Radio Corp.**, 111 Jericho Turnpike, Syosset, N. Y. END

All specifications from manufacturers data

END

NEW LITERATURE

MOTOR TEST MANUAL, 10 pages, describes all popular motor operating tests performed with absorption dynamometer using an electrical hysteresis brake; also automated instruments used in 100% production testing; includes brochure on line of absorption dynamometers.—**John Chatillon & Sons,** 85-93 Cliff St., New York, N.Y. 10038

COMMUNICATION ANTENNA SYSTEMS, *Catalog No. 664,* 64 pages with photos. specs, directivity patterns and technical data section (expanded beyond scope of earlier catalogs).—**Communication Products Co., Phelps Dodge Electronic Products Corp.,** Marlboro, N.J. 07746

DATA SHEETS, *Bulletin 201964,* on model 504 electrostatic charge amplifier. 7 sheets. Specs, photos, applications, characteristics.—**Kistler Instrument Corp.,** 8989 Sheridan Dr., Clarence, N.Y.

CARTOONED FOLDER on alpha-numeric display tubes line, with brochure and bulletin sources on each.—**Burroughs Corp., Electronic Components Div.,** Plainfield, N.J.

"NOTHING BUT NOISE?", 24-page pocket book, illustrated, describes problems and solutions of radio frequency interference in mobile rigs. Question-and-answer style.—**Hallett Manufacturing Co.,** 5910 Bowcroft St., Los Angeles, Calif. 90016

"VACO NEWS" is a monthly publication which lists and illustrates firm's new product literature, with box for checking catalogs desired. 4 pages.—**Vaco Products Co.,** 317 E. Ontario St., Chicago, Ill. 60611

"CAREERS IN ELECTRONICS," 44-page booklet, giving explanations and choices of either home training or classroom courses for school with branches in Hollywood, Seattle, Kansas City, Mo., and Washington, D.C. Gives table of contents of books used in courses.—**Grantham School of Electronics,** 1505 N. Western Ave., Hollywood, Calif. 90027

ALTERNATORS BROCHURE, *"There Is No Such Thing as an All-Purpose Alternator,"* illustrates 40-, 53-, 60-, 100- and 175-amp sizes, and shows method of calculating electrical requirements, alternator output, and comparing to be sure alternator matches load. With curves and photos. —**Leece-Neville Co.,** 1374 E. 51 St., Cleveland 3, Ohio

PRECISION SWITCHES CATALOG, 12 pages, looseleaf punched, on Klikswitch snap-action switches—pin-, leaf-, plunger-, roller-actuated switches, slide switches, high-current switches, foot-operated switches and actuators. Photos and specs. —Request on letterhead from Sales Promotion Dept., **ITT General Controls, Inc.,** 801 Allen Ave., Glendale, Calif. 91201

CAPACITORS BROCHURE, 4-pages on capacitors called VacCaps. Photos, diagrams, and specifications.—**Eitel-McCullough, Inc.,** 301 Industrial Way, San Carlos, Calif.

1965 MICROPHONE CATALOG, 16-page, 4-color, photos, specs of microphones for CB, broadcasting, amateur, professional and home recording, etc.—**Turner Microphone Co.,** 909 17 St. N.E., Cedar Rapids, Iowa 52402

BULLETIN A105 describes the Alpha solder and flux research and development kit, which contains 36 solder-chemical materials.—**Alpha Metals, Inc.,** 56 Water St., Jersey City, N.J. 07304

BOOKLET, "Sound Reinforcement and the New Liturgy," explains to the clergy sound system revisions required with the addition of English to the Mass. 14 pages, illustrated.—**Electro-Voice, Inc.,** Buchanan, Mich.

BROCHURE ON BOOKS describes 8 publications, most of them revised editions, including two new titles: "Short Wave Antennas—Theory and Practice" and "How to Build TV Antennas for All Channels and Systems." **World Publications,** 1, Lindorffsallé, Hallerup, Denmark.

CONDENSED SEMICONDUCTOR CATALOG, 42 pages plus foldout, looseleaf punched, with chapters containing a quality-control flow chart, reference list for new design types, how to choose a photosensitive device, circuits utilizing Amperex semiconductors (i.e. chopper, differential amplifier, AM-FM receiver, Sonobuoy transmitter) and a list of available Amperex application reports. Write on company letterhead to **Amperex Electronic Corp.,** Slatersville, R.I. 02876 END

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.

ELECTRONIC MUSIC . . .
Way-out? Or will it graduate to the concert hall! Is the science-fiction sound gimmick attracting interest in the world of serious music? Can the do-it-yourselfer compose and play electronic numbers? James Seawright, technical director, Columbia University Electronic Music Center, authors this full up-to-date report.

"MUST" READING IN . . .
June RADIO-ELECTRONICS

Non-Commercial Classified Ads

RADIO-ELECTRONICS now has a new Non-Commercial rate of 30¢ per word for *individuals.* (Our commercial rate remains at 55¢ per word.)

Readers interested in buying or selling personal items or equipment can now do so at little cost.

See the classified section for details and order form.

TECHNICIANS' NEWS

NEA UNDER WAY

The recently formed National Electronics Association has begun issuing a monthly bulletin. The first issue, dated January, was bannered "N.E.A. What?" and its editors announced that they were searching for a title (reader contributions invited).

The second (February) issue arrived with "N.E.A. Mirror" as its name, and carried a report of the board of directors' meeting in Des Moines. Particularly interesting business transacted at the meeting was the allocation of funds and authority to "pursue and clarify the uncertainty . . . in cases of dual distribution as it applies to the electronic sales and service trade."

An NEA Technical Information Committee was initiated to collect and dispense manufacturers' information not normally easily obtained by service technicians.

The NEA's position on CATV seems at the moment to be neutral. Its CATV Committee will prepare and distribute a fact sheet to be used by "local and state associations, intelligently and legally, in supporting or opposing [CATV] activity."

ON HOW TO GO BROKE

A recent issue of the *TSA Service News*, monthly publication of the King County TV Service Association, centered in Seattle, Wash., carried some very persuasive thoughts on the usually fatal risks of price-cutting on service calls. What follows is an innocent rewrite of the article.

The writer declares that he is always saddened to hear of a failing service shop or of one that couldn't make enough to support its owner's family. He is even sadder when he finds that the shop has been charging far below average rates with the excuse that people "just won't pay a fair price for good service."

The absurdity of this excuse, says the author, is clear from the fact that other shops in the same neighborhood charge from 25% to 50% higher rates than the "sick" shop does.

"*Anybody* can get business by charging a below-cost rate. The consumer just loves to find such a shop, and the shop can get a lot of business just from those looking for a bargain, and from those who want something for nothing. But what benefit does such business bring, if the owner can't make wages . . . and leaves his family to exist on a substandard level?"

A shop does not make money when service rates are too low. "Low rates attract the something-for-nothing type of customer, who not only seeks cheap service, but often objects even to paying . . . for the service he gets. This customer is *not* loyal—he will go anywhere he thinks he can save a few pennies." If he hears of another shop willing to charge even less, he runs there, and tells his friends "how *you took him* by charging more."

"Most small businessmen scare themselves into taking this road to eventual oblivion. They care a little too much about what the other shop charges, and fail to build their business on *good* service at a *fair* price. The shop that does good work seldom needs to worry whether its price is too high. It is too busy making money."

The writer refers to a survey which showed that, in 2 months, only 22 price-cutters advertised in newspapers in all of the State of Washington. Seventeen of them were in Seattle. "Now if the price is such a factor, why is it that almost 800 shops operate in the state and over 300 in the city? How come the 22 shops don't get *all* the business? After all, $1.50 service calls should be a lot more attractive . . . than the $6.95 to $7.95 charged by the majority of service shops. And we cannot help but wonder what the difference is between a $1.50 call and a $3 call. Is the $3 call worth twice as much? Or does the $1.50-call shop just go broke twice as fast?"

G-E OPENS APPLIANCE OUTLETS

Fulfilling rumors of the past several months, General Electric early this year opened four new appliance centers in Cleveland, Ohio, at which they sell, among other things, color television sets at prices that some observers believe are below what smaller, independent dealers can manage. The Cleveland stores advertise G-E Provincial fruitwood console color TV's for $518. A G-E Danish modern console goes for $498.

According to an article by Gene Love in the January St. Louis *TESA News*, small G-E dealers who have complained have been told they must go along with it. Two fears expressed in the article are that other manufacturers will soon follow G-E's lead to meet the competition, and that G-E (and eventually others) will begin servicing sets as well, depriving the independent service shop of business.

TESA WISCONSIN TO REINTRODUCE LICENSING BILL

Members of the Television & Electronic Service Association of Wisconsin are moving forward with plans to push their long-hoped-for licensing bill through the state legislature this year.

Briefly, the bill calls for licensing of all television service technicians. Any person now in the business can be licensed merely by applying, until Jan. 1, 1966. After that date, applicants must have 2 years apprenticeship or the equivalent in vocational school courses. Apprentices are licensed without examination, but all their work must be supervised by a licensed technician.

A "Wisconsin Board of Television Technicians" will be created, with seven members appointed by the Governor, all "knowledgeable in the field of television"; at least four must have been full-time technicians for at least 5 years immediately before their appointment. The board will prepare suitable examinations, and is given the power to revoke or suspend licenses for infractions.

The bill would also cover advertising: "No person shall advertise television repairs unless he is or has in his employ a licensed television technician."

Penalties would run to $100 or 60 days in jail for each infraction.

Members of TESA are being urged to write their lawmakers in support of the bill.

G-E OFFERS TRANSISTOR-SET TROUBLESHOOTING COURSE

A "programmed instruction" course in three volumes, covering all types of transistor troubleshooting, is being sold to technicians by General Electric.

Available through G-E radio receiver department field-service representatives and TV and phono distributors, the course covers diagnosis and repair in transistor television sets, phonographs and radios. It uses the "programmed instruction" technique, which allows individuals to set their own learning pace and test their understanding as they read new material.

The three-volume course may be ordered for $14.25. END

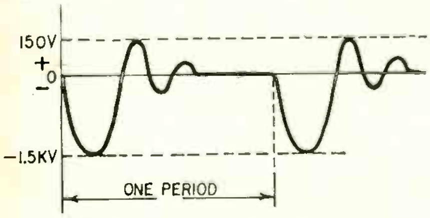
Technicians! Get your groups into print! Send news to Technicians' News, Radio-Electronics, 154 W. 14 Street, New York, New York 10011.

WHAT'S YOUR EQ?

These are the answers. Puzzles are on page 48.

Positive and Negative

The trick lies in the waveform across the transformer's secondary. The output is a negative pulse with a slight positive ring. Diode (D1) conducts during the negative portion of the pulse and charges C1 to −1,500 volts. D2 conducts only during the positive portion of the pulse, and hence charges D2 to +150 volts.



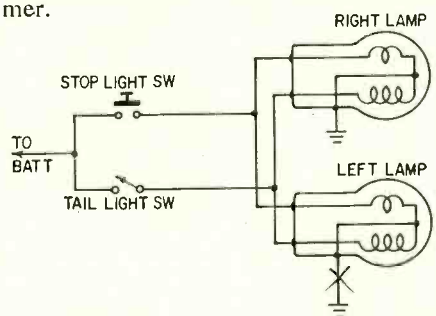
Both diodes need to have the same peak inverse rating in this peak-charging circuit.

Automotive Puzzler

The left light bracket proved to be completely ungrounded! The lamps used are dual-filament type with common ground, and taillight has lower candlepower but higher resistance than the stop light.

When taillights *only* were on, the left side was in series with both stop lights and, having much higher resistance, got the lion's share of the voltage. As a result, the left side was a bit dimmer.

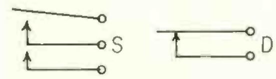
When stop lights *only* were turned on, the left side was in series with both taillights, resulting in both taillights burning at about half voltage plus the right stop light at full voltage. This made the left side appear considerably dimmer.



When *both* tail and stop lights were turned on, the left side went completely out because both filaments were pegged at full voltage and there was no series circuit to ground. END

Wrong Switch

There was an error in the Answers column concerning the "Dialing" puzzler in the March 1965 issue. The sequence



of operation (Fig. 2) starts with closing switch S instead of D (which is already closed). In the Question column, switch D should have been shown normally closed.

50 Years Ago

In Gernsback Publications

In May, 1915

Electrical Experimenter

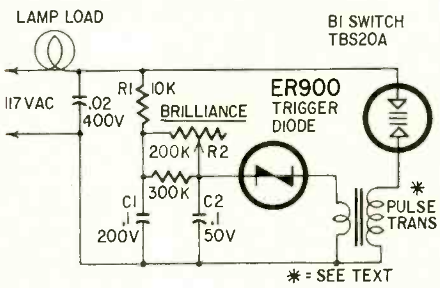
Radio Receiver Protective Gap
Wireless Telegraphy & Telephony on Union Pacific Railroad
The D. C. Arc for Wireless
Improved Conical Tuning Coil
Universal Crystal Detector

NOTEWORTHY CIRCUITS

NEW LIGHT-DIMMER CIRCUITS

Semiconductor light dimmers and motor speed controls are increasingly popular. Several SCR circuits have been abstracted from manufacturers' application notes and published in this magazine. The better circuits use two SCR's and a number of other semiconductor components.

Transitron Electronic Corp. has developed two semiconductor elements —a *BiSwitch* and a special trigger diode —that greatly simplify electronic light dimmers and motor speed controls. A basic dimmer circuit is shown. The *BiSwitch* is a bilateral switching device comparable to two SCR's connected in parallel back to back. It can be turned on in either direction by applying a voltage pulse whose amplitude is higher than the breakover voltage.



The pulses are developed by a ER900 silicon trigger diode. This is a symmetrical multi-layer avalanche switching diode that develops a pulse each time its breakover voltage is exceeded in either direction. In this circuit, the ER900 produces bipolar pulses; one pulse for each half-cycle of the input voltage. The two-section R-C phase shifter (R1-C1 and R2-C2) permits the BiSwitch to be controlled over a range of 0° to 140° of each half-cycle. R2 controls motor speed and lamp brilliance.

The circuit shown can handle lamps and motors up to 750 watts. The trigger or pulse transformer used with it may consist of a primary with 2 turns of No. 24 wire and a secondary of 60 turns of No. 20 wire on a ferrite core. It's construction is rather critical. Transitron recommends the type 12759 transformer available for $1.85 from Torotel, Inc., 5512 E. 110th St., Kansas City 37, Mo.

The ER900 trigger diode is $1.75 and the TBS20A $5 at Transitron distributors.

VOX FOR TAPE RECORDERS

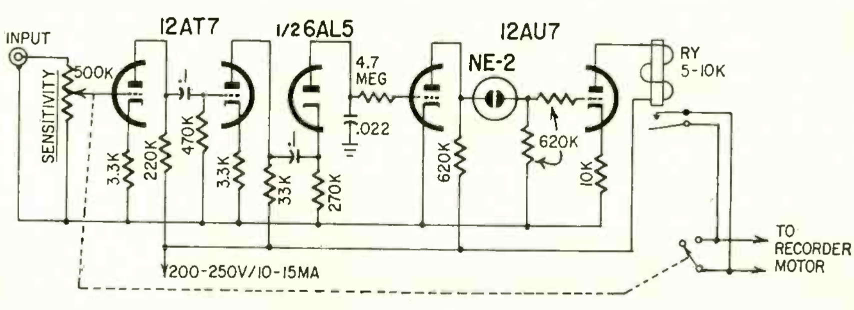
Voice-operated or voice-controlled break-in, commonly called VOX, is widely used in amateur phone transmitters. A portion of the audio modulating voltage is rectified and used to turn on the transmitter. A similar device is a valuable accessory for tape recorders—particularly when recording speech or dictation.

The tape recorder VOX circuit in the diagram was published in *Radio, Television & Hobbies* (Sydney, Australia). The input signal is tapped off the plate of the recorder's first af amplifier ahead of the volume control.

This signal is amplified in the 12AT7 and rectified by the 6AL5 to develop a negative voltage on the grid of the first section of the 12AU7. This triode is biased toward cutoff, and its plate voltage rises until it reaches the striking voltage of the NE-2.

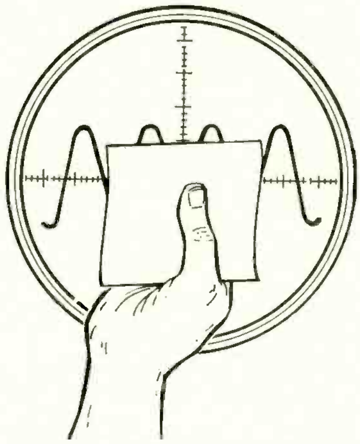
The relay control stage is biased close to cutoff by the large cathode resistor. When the NE-2 fires, a large positive voltage is applied to the output grid. This tube saturates and closes the relay. The VOX closes the relay and starts the recorder within 1 millisecond after the initial sound strikes the mike.

The author recommends operating the recorder at its lowest speed to provide rapid starting and to minimize tape spilling when the relay opens. The relay contacts should be able to handle the motor's surge currents. If it cannot, then it should be used to control an auxiliary power relay. Connect a capacitor of around 0.1 μf from the chassis to one of the relay contacts to suppress the arc that occurs when the relay opens. When the recorder has separate drive and takeup motors, the relay should break both circuits simultaneously. END



TRY THIS ONE

GAGING SMALL SCOPE-TRACE CHANGES

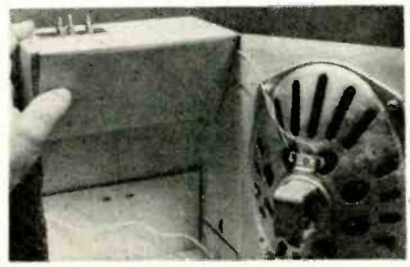


To read small changes in the height of a scope trace, cover all but a small portion of the signal with a piece of paper. The *relative* changes will then be greater and more easily seen.—*Tom Jaski*

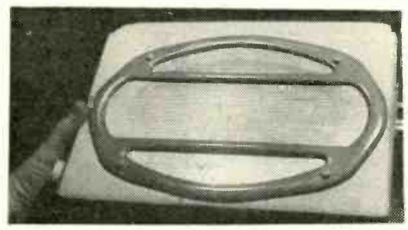
CARTONS MAKE QUICK SPEAKER ENCLOSURES

Excellent "no-cost" speaker enclosures can be made quickly from ordinary corrugated cardboard shipping cartons. Auto radio extension (rear-

seat) speakers or emergency PA jobs are two uses that come to mind right away. These cartons eliminate time-consuming work in making a suitable enclosure. They are ideal for protecting test speakers, and a little paint, a grill cloth framed by (perhaps) a discarded picture frame makes an attractive enclosure for permanent installation.



Speakers are often shipped in cardboard cartons of ideal proportions for quick conversion into a permanent enclosure. The only tools needed are screwdrivers, a nail to punch holes and a safety razor blade to cut the grille opening. The corners of the carton can be reinforced with wooden blocks, but this is usually unnecessary since the cellular construction of corrugated cardboard enables it to withstand almost as much weight as thin plywood. It can readily be shaped without woodworking tools.



Experiment with the depth of the enclosure until you like the tone quality. In one installation, a large carton was used and reinforced inside with pieces of Masonite. Experimenting with extra strips of corrugated cardboard made a "sound chamber." Usually, however, the speaker shipping carton is suitable as it is for the enclosure, and it needs only slight reinforcement to make it as sturdy as a wooden cabinet.—*Glen F. Stillwell*

HI-FI SALES AID: PRE-MARKED CONNECTIONS

When I sell hi-fi components to customers who wish to do their own installation, I have spared much time and trouble by numbering the wires. Then speaker phasing and input connections require no time-consuming technical explanations.

Assign numbers to each connection that must be made by the customer. Wires to speakers are numbered at both ends on both conductors, and corresponding numbers are placed on the speakers and on the amplifier. By doing this, the technician "presets" the impedance and phasing correctly. All the user has to do is place plugs in their sockets and wires on their screws. Numerals can be attached easily by folding cellulose or masking tape over the lead and writing on it with a good ballpoint pen.—*Steve P. Dow* END

NEW PATENTS

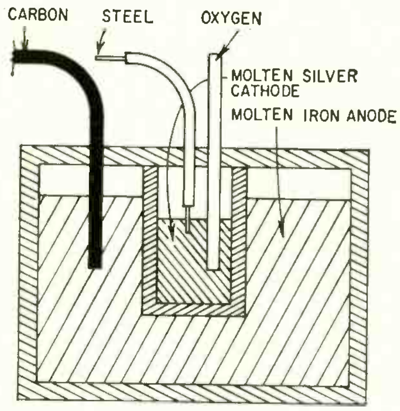
FUEL CELL

PATENT NO. 3,138,490

William E. Tragert, Scotia, Robert L. Fullman, Schenectady, and Ralph E. Carter, Colonie, N.Y. (Assigned to General Electric Co.)

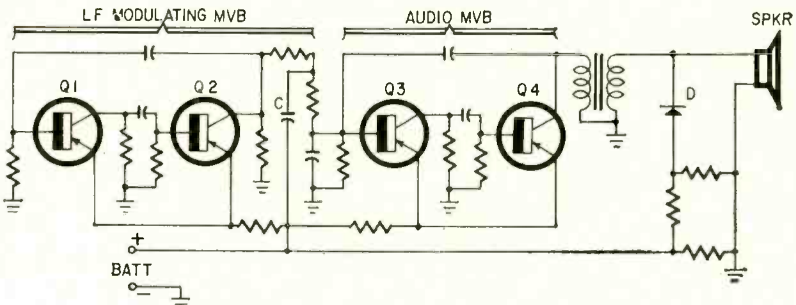
This source of low-voltage dc utilizes heat that might be wasted otherwise. The cell has two electrodes, both liquid at the high operating temperature (approximately 1,700°C). The electrodes are in separate containers.

One electrode is iron saturated with carbon, and it is in contact with a carbon conductor. The other electrode, silver, is contacted by a stainless steel conductor. As electricity is generated, the carbon conductor dissolves. The silver is kept saturated with oxygen, supplied through a tube. The voltage under load is approximately 0.75.



ELECTRONIC SIREN

Patent No. 3,137,846



Harold G. Keeling, N. Tonawanda, N. Y. (Assigned to Kenneth Tower, Tonawanda, N. Y.)

There are two multivibrators in this circuit: Q1, Q2, and Q3, Q4. The first pair generates a frequency of only a few cycles per second, while the second pair oscillates in the audio raange.

Q3 of the audio multivibrator receives its bias from voltage across C, which is charged and discharged by Q2. Transistor Q2 switches abruptly from conduction to nonconduction, but C smooths the transition. The periodic voltage fluctuations across C vary the freqency of the audio multivibrator and produce the sirenlike sound. It is fed through a matching transformer to the speaker.

The audio tone is originally a sawtooth, but D clips the peaks. Therefore the output is more nearly a square wave, which produces a piercing alarm. END

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NEW BOOKS

AC CARRIER CONTROL SYSTEMS, by Keith A. Ivey. *John Wiley & Sons, 605 Third Ave., New York, N.Y. 10016. 6 x 9 in., 349 pp. Cloth, $12.*

Advanced and broad coverage of the analysis and design of systems. Also describes components for these systems.

ELECTRONICS ASSEMBLY METHODS, by S. R. Duarte and R. L. Duarte. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 7 x 10 in., 242 pp. Paper, $5.95*

Requires no previous technical background. It covers use of tools, theory of radio circuits and components, troubleshooting and test procedures. Written especially for assemblers and wiremen.

AN INTRODUCTION TO PATENTS FOR INVENTORS AND ENGINEERS, by C. D. Tuska. *Dover Publications, 180 Varick St., New York, N.Y. 10014. 5¼ x 8½ in., 192 pp. Paper, $1.50*

A Dover edition of the book previously entitled "Patent Notes for Engineers," a standard work now offered at popular prices. The author is a pioneer radio amateur, inventor of the Superdyne circuit and former director of the Patent Department of RCA. The book is excellently illustrated with drawings of inventions. Explains patent theory, law and practical approaches to applying for a patent.

ADVANCED SERVICING TECHNIQUES (Vol. II). *John F. Rider Publisher, 116 W. 14 St., New York, N.Y. 10011. 8½ x 11 in., 178 pp. Cloth, $5.95*

The second volume of what was originally a purely TV service course is devoted to servicing non-TV electronics, and is divided into a number of subjects, covered by different authors: Stereo Amplifiers, FM and FM Multiplex, by Orville Neely; Record Changers, by Lawrence Massaro and Robert S. Harris; Tape Recorders, by M. P. Rosenthal; Home Intercoms, by William P. Kist, and Combination Receivers, also by William P. Kist.

WORLD RADIO TV HANDBOOK, edited by J. M. Frost. *Available from Gilfer Associates, PO Box 239, Park Ridge, N.J. 07656. 6½ x 8½ in., 302 pp. Paper, $4.95.*

The 19th edition of the short-wave listener's Bible, "the only book available to short-wave listeners, broadcast-station operators, hams, etc. that contain details on every short-wave and TV station throughout the world," is up to 302 pages. It also contains a listing of long-wave stations, and all the medium-wave broadcast stations of the world, except those of the United States (only US stations of more than 10 kw are listed).

STANDARD ELECTRONICS QUESTIONS AND ANSWERS (Vols. 1 and 2), by Steve Elonka and Julian L. Bernstein. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 5¼ x 8 in., Total pages 452 pp. Cloth, $8.50 per vol., $15.95 for set*

Vol. 1 covers basic electronics, Vol. 2 goes on to industrial applications. Both written in nontechnical language without math. They cover a wide range of topics, from simple dc and ac circuits to color TV and test equipment.

TAPE RECORDERS (2d Edition), by Charles G. Westcott and Richard F. Dubbe. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 224 pp. Paper, $3.95*

The theory, construction and operation of recorders are described for service technicians and hi-fi listeners. Testing, special applications and typical schematics are included.

ELECTRONICS GADGETS FOR YOUR CAR, by Len Buckwalter. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 126 pp. Paper, $2.95*

All information for constructing an emergency flashlight, dwell indicator, directional-light beeper, trunk alarm and 6 other useful items.

LIGHTNING IN HIS HAND, THE LIFE STORY OF NIKOLA TESLA, by Inez Hunt and Wanetta W. Draper. *Sage Books, 2679 S. York St., Denver, Colo. 80210. 5½ x 8½ in., 269 pp. Cloth, $5*

Although over-sentimental in places, this book contains more detail than most biographies of Tesla, and includes a number of facts not noted in recent biographies.

RADIO SERVICING PROBLEMS, by W. A. L. Smith. *Norman Price, Ltd., distributed by Sim-Tech Book Co., P.O. Box 69, Agincourt, Ont., Canada. 5½ x 8½ in., 64-pp. Paper, $1*

A book of simple mathematics exercises all applied to actual radio service problems.

COMMUNICATIONS IN SPACE, by Orrin E. Dunlap, Jr. *Harper & Row, Inc., 307 Ash St., Scranton, Penn. 5½ x 8½ in., 260 pp. Cloth, $5.95*

A fascinating history that revives memories and fires the imagination. From wireless to countdowns, it tells the stories behind the Titanic, KDKA, World War II radar, Marconi, deForest, Armstrong, Popov and all the others.

TECHNICAL WRITER'S & EDITOR'S STYLEBOOK, by Rufus P. Turner. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 202 pp. Paper, $3.95*

One of RADIO-ELECTRONICS' best writers, who now teaches English at California State College in addition to his work as a professional electronic engineer, lays down some rules and gives advice to other authors or would-be authors. Turner's clear English style is maintained throughout the book. An especially interesting feature is Chapter 12, a 50-page Glossary of Usage.

SOUND AND TV BROADCASTING, by K. R. Sturley. *Iliffe Books, Ltd., Dorset House, Stamford St., London S.E. 1, England. 5 x 8½ in., 382 pp. Cloth, 45s*

Training manual used by BBC engineers. Principles and operation of TV cameras, recorders and transmitters. END

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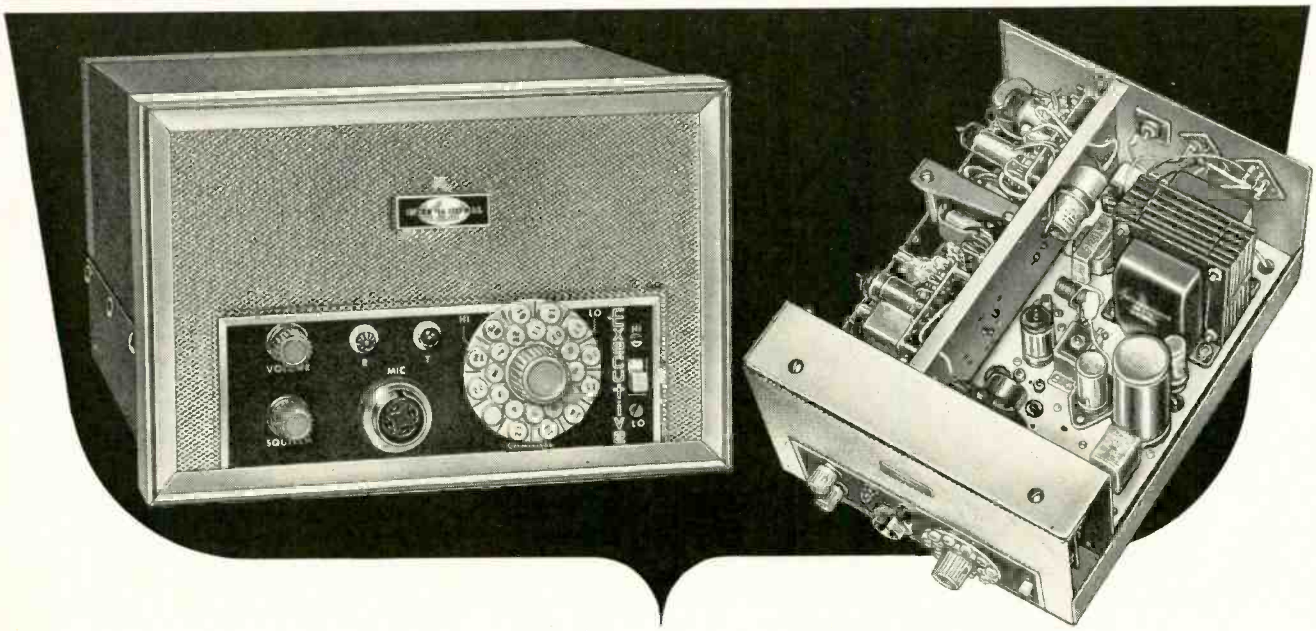

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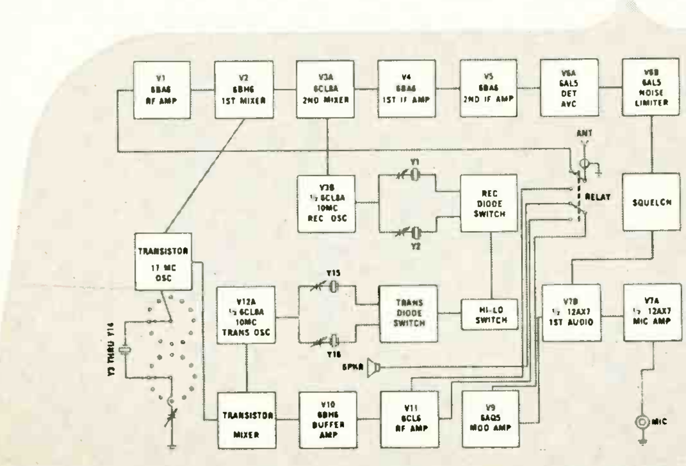

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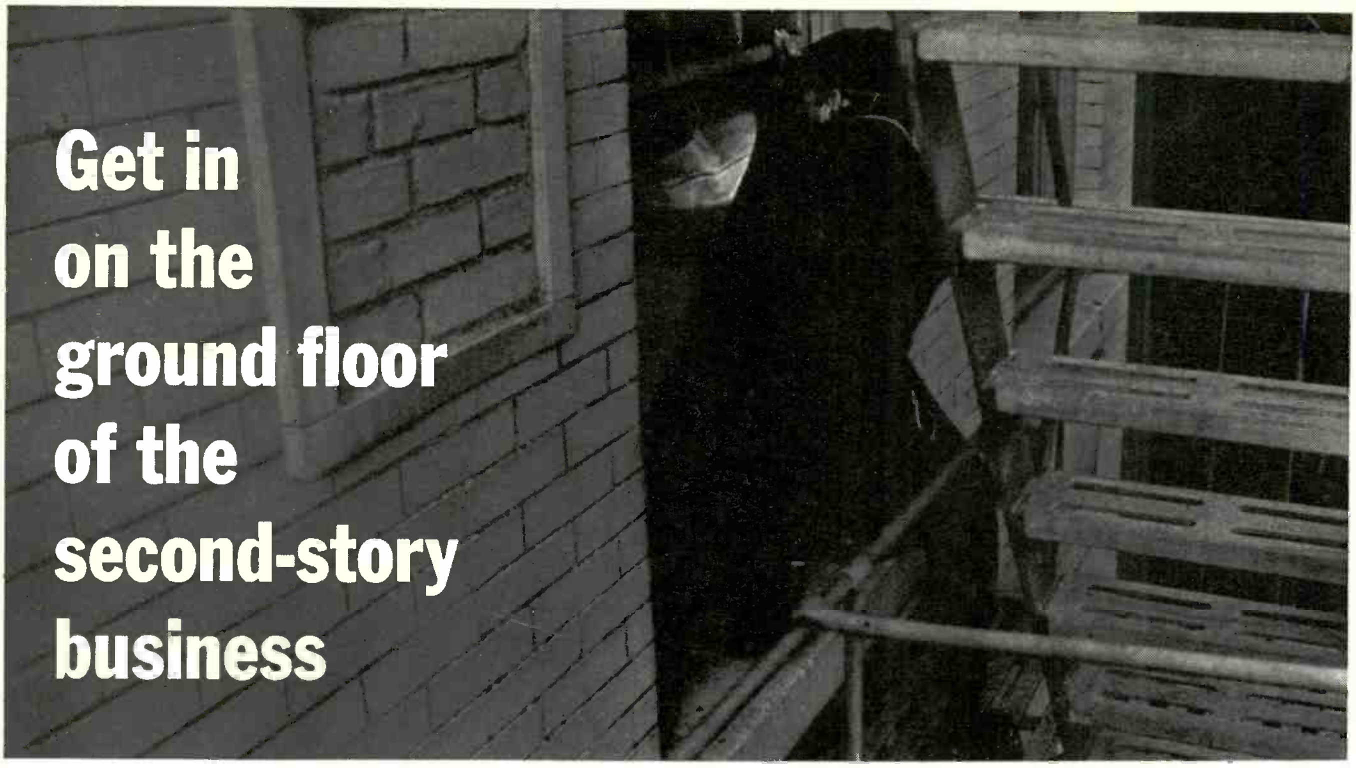

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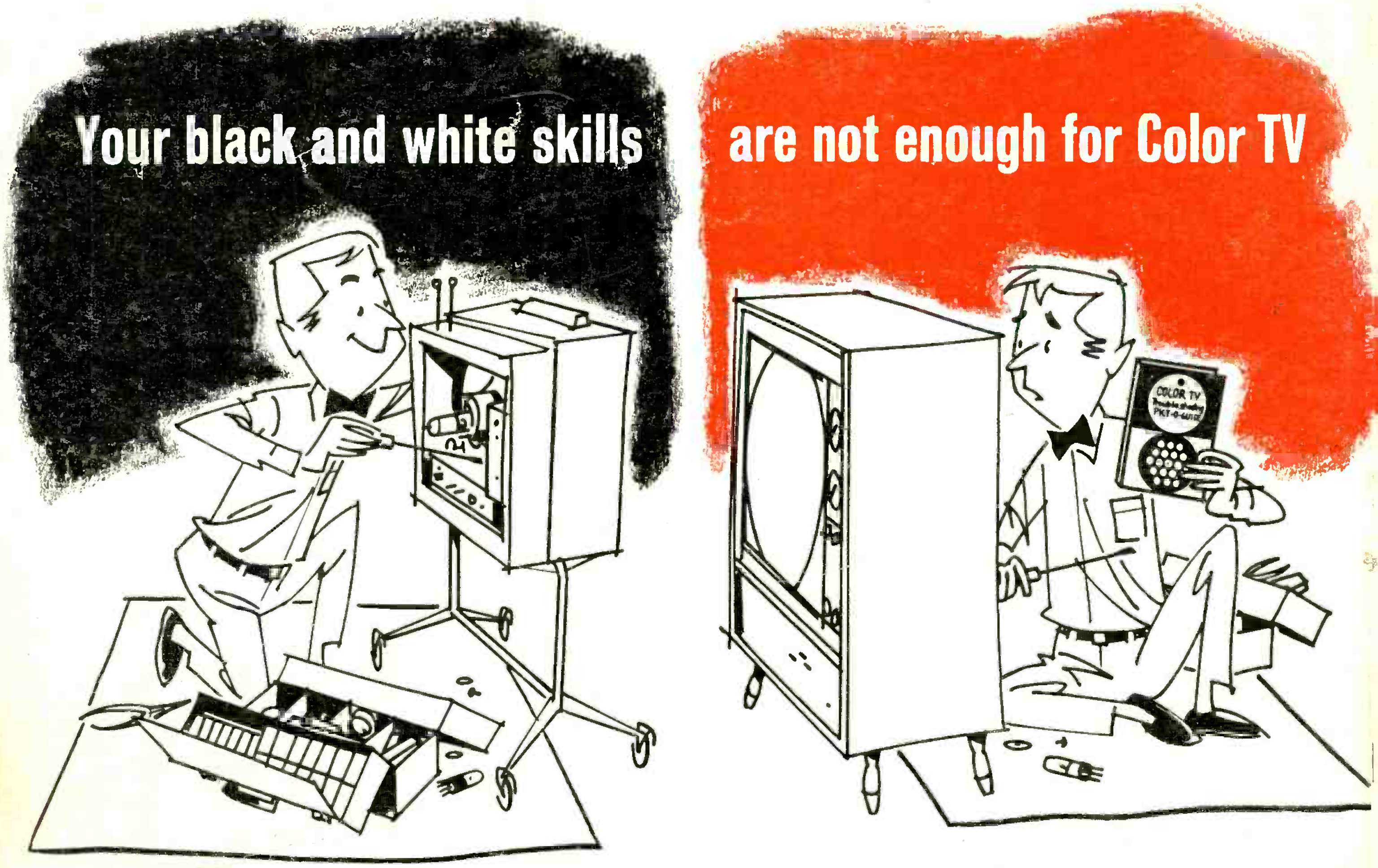

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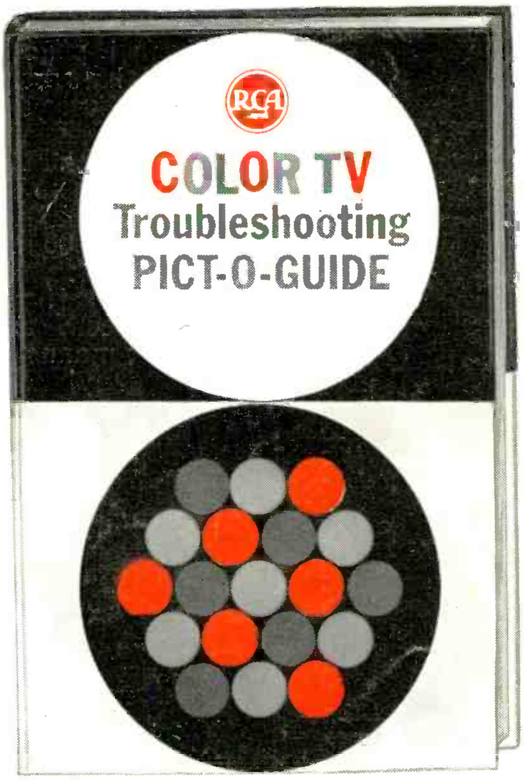

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