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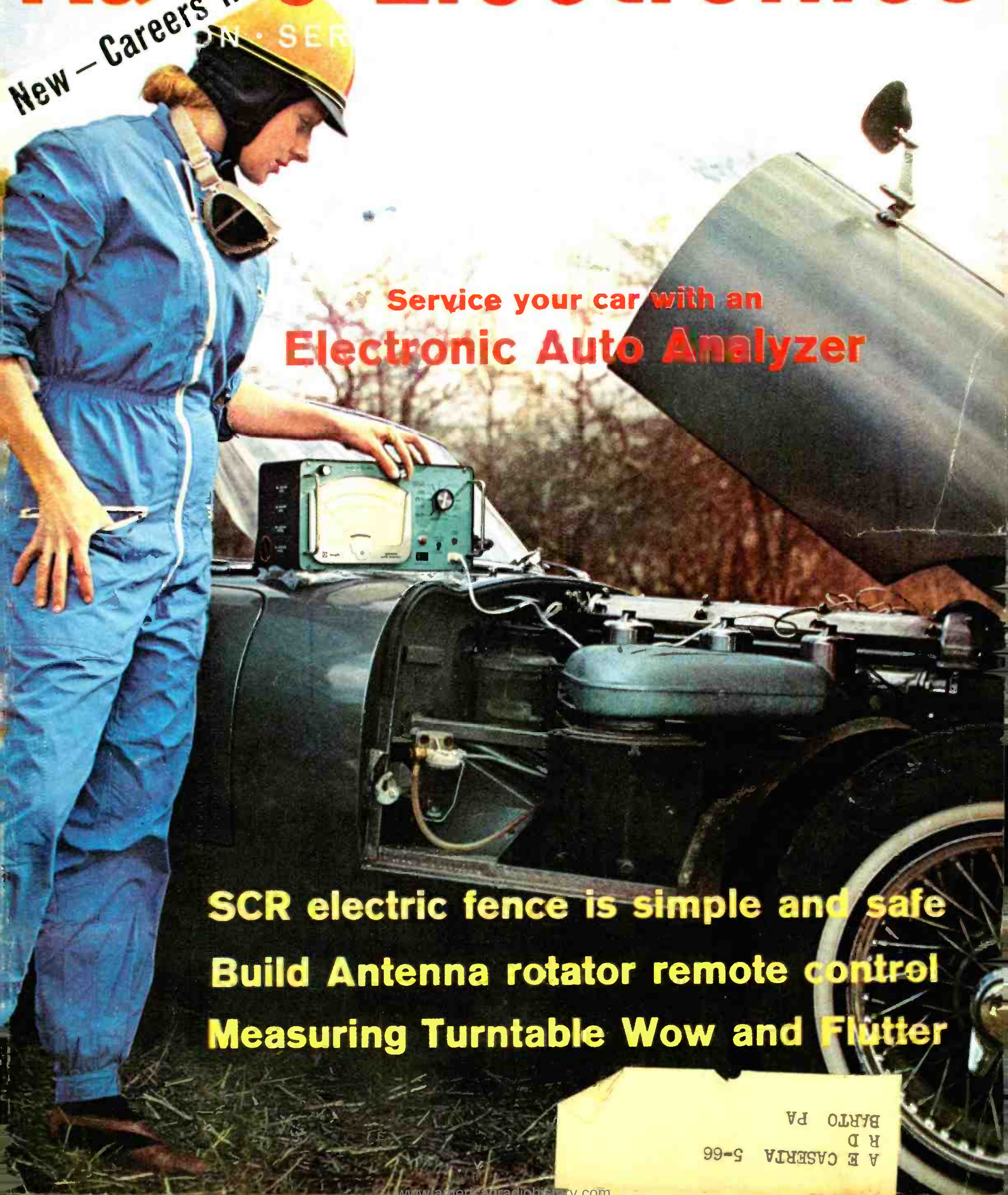

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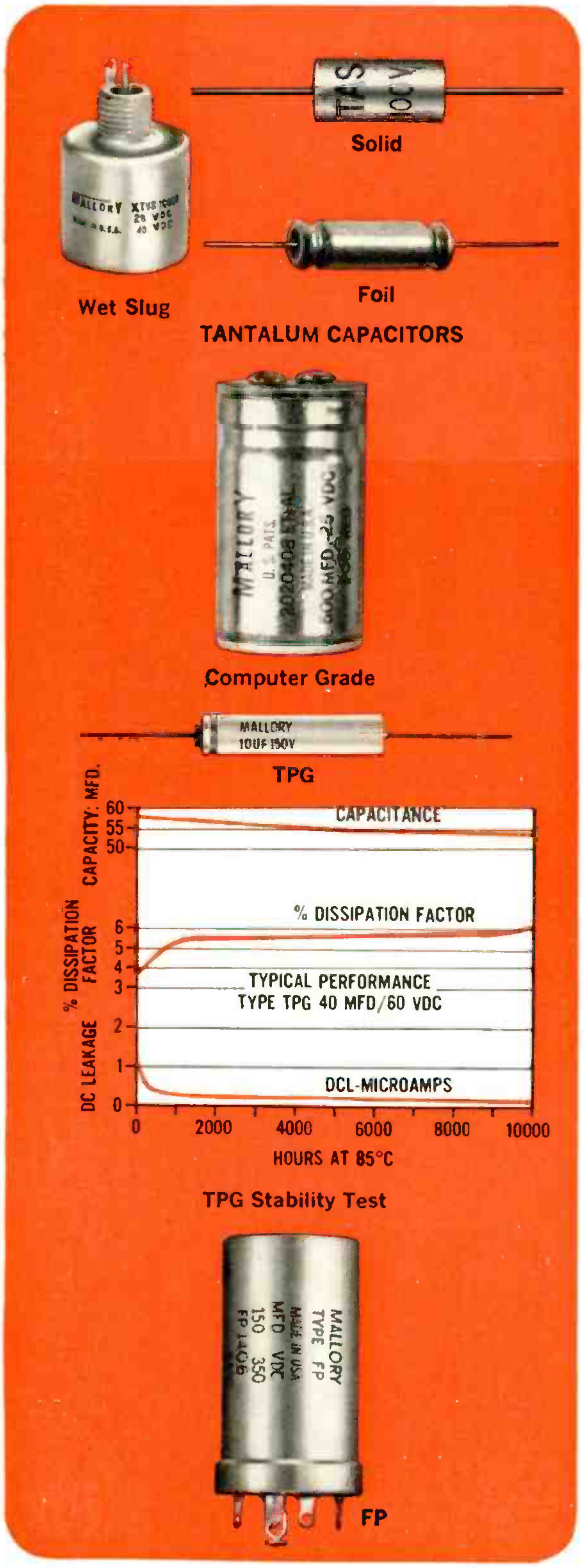
MALLORY Tips for Technicians

About reliability in electrolytic capacitors



Reliability has become a big, important word in electronics today. Makers of military equipment demand it—and get it—because today's intricate weapons and warning systems can't risk failure of even the smallest component. But a lot of other electronic manufacturers are setting requirements for reliability that often come close to the military.

When it comes to electrolytic capacitors, you can have just about any level of reliability you want—and are willing to pay for. Highest reliability usually means highest price, because it takes a lot of costly testing to verify reliability. We make 'em all, so we can be unbiased.

The highest reliability comes in tantalum capacitors—wet slug, foil and solid electrolyte. The best of these have a "mean time between failure" in the tens of thousands of hours. Or putting it another way, their failure rate level is around 0.01% per 1000 hours. Although they are used mostly in military gear, tantalum capacitors have become increasingly popular for industrial circuits where you need maximum assurance against failure. And they give you an unbeatably high amount of capacity in small size.

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Radio-Electronics

JULY 1965 VOL. XXXVI No. 7

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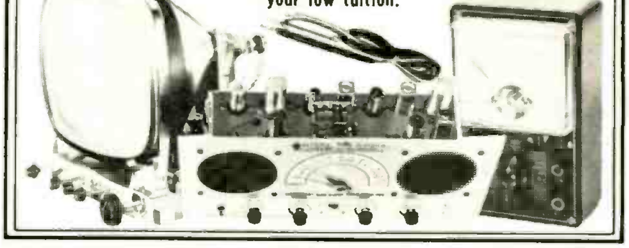

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NEWS BRIEFS

TV PREVENTS SUBWAY CRIME

The closed-circuit TV scanning system of Milan, Italy's new subway line (R-E, *What's New*, Feb. 1965, p. 43) has had an unexpected byproduct. There has not been a single purse-snatching, mugging or other violent act in the first 5 months of operation in any of the 21 stations of the line. Since every part of each station is directly under the eye of the station-master—who can switch from a long-range view to a closeup—crime indeed becomes difficult. Subway guards can be rushed immediately to any position and a fleeing thief reported on constantly by the speakers in the station.

CLOSED-CIRCUIT TV HAS A COMPETITOR

Five schools in Fulton County, N. Y. are linked together through a communications system that transmits the instructor's voice and "blackboard" handwriting through conventional telephone circuits.

The electronic writing unit. Paul Reed of Gloversville High School is conducting a Greek literature course.

The system, developed by General Telephone and Electronics Corp., transmits handwriting produced on a master unit over ordinary telephone circuits in the form of voice-frequency electrical tones to a receiving unit at the remote classroom where it is projected on a screen. At the same time, the instructor carries on two-way discussions with all the students.

A course in Greek literature is being transmitted from Gloversville High School, and briefhand, a form of shorthand, is being taught from Northville Central School. The other schools taking part in the program are Johnstown High School, Mayfield Central School and Broadalbin Central School.

ELECTRICAL RECORDING IS 40 YEARS OLD

Some 40 years ago this summer, the first audiences heard the "new sound" of phonograph records made electronically, an improvement so great over the old acoustical method of recording that listeners today will hardly believe that people listened to the old acoustic records for entertainment.

The files are incomplete, but it appears that Columbia signed a contract for electrical recording with Western Electric early in 1925, a few days or weeks earlier than did Victor. The first electrical recording Columbia made was on March 31, 1925, by the Associated Glee Clubs on the stage of the Metropolitan Opera House. The record carried on one side "John Peel," on the other, "Adeste Fideles." Exactly when the record reached the market is not known, but it was definitely within the next three months.

The first electronic phonograph for home use was put on the market by Brunswick in September 1925.

VACUUM TUBE'S DAY NOT YET OVER?

Vacuum tubes still have a bright future, but not in receiving equipment. This was the opinion of Prof. Glen Wade of Cornell University, speaking before the IEEE session on "State-of-the-tube-art." The receiving tube will be eliminated in a few years, he said. But there are fields in which the vacuum tube is unlikely to be replaced, such as satellite applications and ion engines for space travel. Wireless transmission of power, equipment for food processing and preservation are other areas in which tubes may long predominate. Dr. Wade also called attention to the possibility of new developments in tube design and materials which might make the tube more important in the future than now expected.

ACHIEVES FOUR FELLOWSHIPS

Dr. Victor Twersky, who directs research at the Western operation of Sylvania Electronic Systems, was recently elected a Fellow of the Acoustical Society of America. This made him the first to hold fellowships in four major scientific groups (the other three being American Physical Society, the Institute of Electrical and Electronics Engineers, and the Optical Society of America).

MASTER FM ANTENNA GOING UP ON EMPIRE STATE

What is said to be the nations' first master FM transmitting antenna will be erected at the very tip of the Empire State Building (1,250 feet up). It will be able to broadcast the signals of 17 FM stations simultaneously. The transmitters will be located on the 81st floor.

The setup will give greater FM coverage and stronger signals than before in the New York metropolitan area. Three stations, WQXR-FM, WHOM-FM and WLIB-FM, have already signed an agreement to transmit their FM signals beginning next fall.

NEW TRENDS IN TV AND TYPESETTING SEEN BY RCA HEAD

Thin-screen wall-mounted color television receivers and battery-operated portables whose bright colors can be viewed in any outdoor location were predicted by Elmer W. Engstrom, president of RCA, at the company's annual meeting on May 4.

Dr. Engstrom also dwelt on the formation of the Graphic Systems Division, to develop, manufacture and market new electronic equipment and

NEWS BRIEFS continued

systems for handling all types of printed information. He stated that ". . . it is our conviction that the graphic arts field, and particularly the printing industry, offers a major opportunity for new electronics technology . . .", and pointed out that the new division could draw extensively on RCA's long experience in such areas as facsimile transmission and reproduction, electronic printing, and computerized typesetting.

The shareholders' meeting was, like last year's, held in two cities. Chairman Sarnoff and the other officials in the Chicago Opera House were linked by closed-circuit television to shareholders in the NBC studio in New York City. Questions were asked and answered, and motions put with equal ease whether the participants were in one meeting place or the other.

FRENCH CLASSROOM TV IS DONE WITH MIRRORS

A new approach to classroom TV has been taken by the Ecole Nationale de Radiotechnique et d'Electricité at Clichy, France. The receivers for the classroom television system of that school are installed in the ceiling. The image is reversed, and the student has a mirror on his desk. Looking down at the mirror he sees a correct reflected picture. Thus the student can see the television screen without looking up from his desk to a TV set across the room. Both teachers and students approve the system.

IEEE GERNSBACK AWARD

Thomas L. Wilson, of Del Rio, Texas, a student at Rice University, was awarded the Hugo Gernsback Award at the Southwestern IEEE Conference in Dallas. The $500 award, anonymously donated to the IEEE, is for the best and most imaginative paper by an undergraduate predicting the future in science and engineering. Mr. Wilson's paper was titled "A Priori Tomorrow."

NEW FOG DETECTOR USES LASER BEAM

A new fog detector, developed by the Hoffman Science Center, beams an intense ray from a radiating diode through the air to determine the presence and amount of fog.

The diode is mounted in a cylindrical beam-projecting light pipe and beamed toward a spherical mirror which focuses and directs the rays into the fog. The density of the fog can be recorded most conveniently either by reflecting the beam from a mirror in the beam path, or simply by measuring


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NEWS BRIEFS continued

the backscatter (the amount of light reflected from the fog itself).

Frank Nickl, head of the Hoffman research team, explained that the present experimental diode equipment has about one-tenth of the output of the final version, which will be ready next January. Four detecting units are slated by the Science Center, a division of Hoffman Electronics Corp., for delivery to the Coast Guard, Air Force, Bureau of Standards and Weather Bureau for testing and evaluation.

2-MILE LASER BEAM GENERATED BY MULTIPLE REFLECTIONS

A laser beam more than 2 miles long has been generated in a 10-foot space by scientists of the Bell Laboratories. The experiment, conducted by Donald Herriott and Harry Schulte, was performed by reflecting the beam more than a thousand times between two mirrors. Because the points of reflection on the mirrors do not overlap, information can be modulated onto the light beam, stored and retrieved 10 μsec later. This opens the way for optical delay lines that could be used as high-speed, sequential computer memories.

Because light waves are dispersionless (all component frequencies travel at the same velocity), information modulated onto the laser beam is not distorted in the delay line.

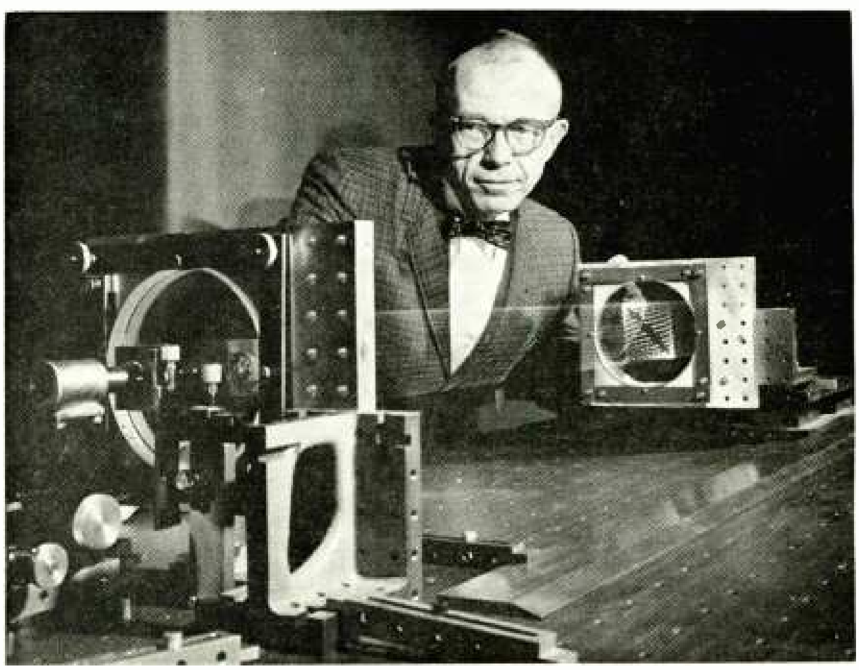
To get the maximum number of reflections without interference, Herriott and Schulte bent two spherical mirrors into slightly cylindrical shapes. This caused the horizontal radius of curvature of the mirrors to differ slightly from the vertical. As a result, the light spot—the point where a beam hits the mirror—moves with each reflection to form a Lissajous pattern.

The maximum number of beam reflections is limited by the area and the scattering loss of the mirrors. During 1,000 reflections (10 microseconds delay) the beam's power is reduced only 20 db by scattering. This would indicate that two or three thousand reflections (delays of 20 to 30 microseconds) are feasible.

WORLD'S LONGEST ANTENNA BUILT IN ANTARCTIC

A 21-mile-long, plastic-coated ¾-inch copper-cable antenna has been laid on the Antarctic icecap to study radio conditions in space. The National Science Foundation reports that it is twice as long as any built before.

The antenna radiates very-low-frequency waves of the kind generated by lightning. These are expected to travel far out into space along lines of force in the earth's magnetic field, and follow the lines as they curve back to the globe in the opposite hemisphere. Scientists have heard low frequencies called "whistlers", supposed to be generated by lightning strokes, and they expect somewhat similar effects from the waves radiated from the 21-mile antenna.



Harry Schulte of Bell Labs demonstrates the equipment by moving the mirrors closer together and reflecting the beam about 400 times, thus making it possible to see the points of light on the screen.

NOW—TELEVISION PICTURES ON PHONOGRAPH RECORDS

An electronic system that plays television pictures from a phonograph record has been developed by Westinghouse. The same long-play disc carries the sound track.

The recording is not a live television picture, but a series of stills produced every 6 seconds. The equipment contains two storage tubes. A scan converter builds up a complete television picture which is then read out and recorded on tape or disc in 6 seconds. The second storage tube then supplies information for the next recorded picture. In playback the process is reversed, and a slow-to-fast scan conversion displays the picture on the TV screen. One picture is read out repeatedly and displayed during the time that the next one is being formed on the storage tube from the video information in the groove of the recording.

Westinghouse promises equipment that will permit a user of the system, called *Phonovid*, to prepare his own sight-and-sound programs. The pictures would, in this case, be recorded on tape, and could be played back directly through the Phonovid system—or, if a number of copies were required, used to make a master phonograph record. The equipment is expected to be especially useful in educational work, and is more flexible than educational-TV movies or classroom films.

Up to 400 TV pictures and 40 minutes of sound can be recorded by Phonovid on the two sides of a 12-inch long-play record. All the electronic circuitry is housed in the small compartment under the fold-out turntable. Price will be around $10,000.

ST. LOUIS TESA OFFERS REWARD FOR TIPS ON VANDALS

The St. Louis Television & Electronic Service Association is offering $1,000 total in rewards for information leading to the arrest and conviction of whoever has been breaking TV service-shop windows and damaging service trucks.

Windows have been broken with pellet guns. Other apparently deliberate damage has been inflicted on stores and vehicles for several months. The motive for the attacks is apparently not robbery.

Anyone who has such information is asked to write TESA—St. Louis, 4933 Delmar Blvd., St. Louis, Mo., or to call 314 PR 3-0587.

TROUBLE WITH PORTABLES IS, THEY CAN BE CARRIED ... OFF

Milwaukee TV shops have been victimized by thieves who apparently are masters of a blitz technique. A recent report in the Wisconsin *TESA News* notes: "Six new 19-inch portable TV's were stolen so quickly that the thieves were not seen by residents living in the upstairs apartments."

NEWS BRIEFS continued

In boldface type at the end of the article is this: "Police suggested that TV shops do not display portables in their store windows. It is too easy to steal them quickly."

CALENDAR OF EVENTS

73rd Annual Meeting, American Society for Engineering Education, June 21–24; Illinois Institute of Technology, Chicago, Ill.

San Diego Symposium for Biomedical Engineering, July 6–8; US Naval Hospital, San Diego, Calif.

14th Annual Convention, National Community Television Association, July 18–23; Denver Hilton Hotel, Denver, Colo.

Annual IEEE Conference on Nuclear & Space Radiation Effects, July 12–15; University of Michigan, Ann Arbor, Mich.

6th International Conference on Medical Electronics & Biological Engineering, Aug. 23–27; Tokyo, Japan

SEARCH TUNING FEATURED IN TRANSISTOR PORTABLES

Signal-seeking tuners—long an adjunct of top-of-the-line automobile radios—are now being featured in some of the better Japanese transistor portables. The heart of the tuning mechanism is a tuning capacitor, capable of continuous rotation, driven by a spring motor.

Pressing the "search-tune" button energizes a relay and starts the motor. Electronic circuits sample the i.f. signal and stop the motor when the carrier of the next station is centered in the i.f. passband.

BRIEF BRIEFS

General Electric will soon begin manufacturing color tubes, which, they say, will be an improved version of the industry's standard "three-gun" type, and will incorporate the brighter rare-earth phosphors similar to those introduced by Sylvania. The announcement was made at the annual shareholders' meeting by Fred J. Borch, president.

General Electric has announced a new 11-inch color TV receiver, using a picture tube of G-E's own manufacture. The set will be on the market sometime in the late fall, "in time for the Christmas trade," it is expected. A feature of the new set is a marking system which optimizes color reception when the marks on the control knobs point straight up.

Dr. Elmer W. Engstrom, president of the Radio Corporation of America, received the Charles Proteus Steinmetz Centennial Medal of the National Academy of Engineering at the first annual meeting of the academy in Washington, D.C. END

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Correspondence

AUTO RADIO CONVERSION HINTS

Dear Editor:

Please extend my congratulations to Mr. Alex Burr on his excellent article about converting old auto radios. I have converted several, and all have worked well.

Some readers may have trouble with hum. Save for possible heater–cathode leakage (check all tubes), hum is usually caused by insufficient filtering. The original supply frequency from the vibrator was about 115 cycles (230-cycle ripple), and the original filtering will usually not be enough to remove 120-cycle ripple. Replace all filter capacitors with 40-μf 350-volt units, or shunt additional capacitance across the original filters.

If that doesn't help—or isn't enough—shield all heater and pilot-lamp leads.

You can get better bass by removing all cathode bypass capacitors in rf, i.f. and audio stages except the output stage. To improve high-frequency response, remove or reduce the audio plate bypass capacitors. In push-pull stages, reduce the value of the capacitor connected between the plates and insert a resistor in series with it. The value will have to be determined by experiment. Choose the value that gives best highs without whistle or squeal.

Connecting 6-volt 60-cycle ac to half of the power transformer primary, as suggested by the editor in the article, works better than any other method suggested. A particularly attractive feature of this method is that you can use the heater winding of an old TV power transformer, which many people have lying around, or which you can buy for a couple of dollars.

Be sure to use a fuse just greater than the current drain of the set, in series with the 6-volt lead to the set. (A fuse of the original rating will do.) To eliminate noise, replace 0Z4 rectifiers with 6X5-GT—the only necessary change is to ground pin 7 and connect a 6-volt lead to pin 2. Many radios are wired for direct substitution of a 6X5 for an 0Z4.

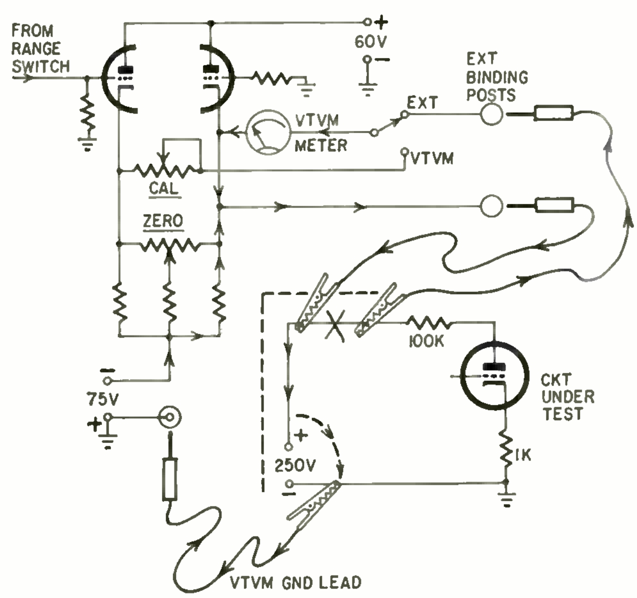
DENNIS C. SMITH
Detroit, Mich.

CHANCE OF METER DAMAGE

Dear Editor:

In the November 1964 RADIO-ELECTRONICS, page 106, appears an item by Albert Koehler called "Meter Borrowing Saves Expense." In this circuit, an spdt switch disconnects the meter from the rest of the vtvm circuitry [making it possible to "borrow" the meter alone for use in experimental circuits—*Editor*]. Unless a dpdt switch is used, to separate the meter *completely* from the vtvm, there is a possibility of damage to vtvm, meter movement and the equipment under test. The diagram shows a simplified circuit of a typical vtvm.

Note the extraneous circuit paths if the ground connection from the vtvm to the circuit under test is completed, which would be a likely condition if the vtvm had just been used for voltage or resistance checks. Also, the vtvm circuit's resistance and capacitance could



load the circuit under test if it is a high-impedance circuit.

F. W. CHESSON

Waterbury, Conn.

TV CONVERSION HEADACHE

Dear Editor:

The reader who requested advice on getting the sound carrier on West German TV (Service Clinic of January, 1965) may run into difficulty if he merely replaces his sound i.f. transformers with 5.5-mc ones as suggested by Mr. Darr.

The trouble is that the video i.f. bandwidth on US sets may not be wide enough to have enough 5.5-mc sound carrier available at the sound i.f. input. One alternative is to broad-band the video i.f. stages, a rather tedious task. Another is to split the sound carrier off at the mixer output as in the older US sets. The latter would require new sound i.f. transformers in the vicinity of 40 mc, or another converter to drop the sound carrier to 4.5 mc.

When I was stationed in Paris, I had a similar (only worse) problem with the French TV. The French channel is 11.25 mc wide and the sound is AM. I finally ended up with the sound carrier split off at the mixer and going through a crystal-controlled converter to 4.5 mc. I changed the ratio detector to an AM detector. Also, with 819 lines, a 4-mc video bandwidth will not give as good horizontal resolution as with the US, 525 lines, so I also broad-banded the video i.f. and the video, too. The whole job required about 200 hours of work, and I'd never do it again. It's much simpler to go out and buy a French TV set!

JAMES E. DUPREE
Colonel, USA, Ret.

San Antonio, Tex.

ON CLEANING RELAYS

Dear Editor:

Read your interesting and humorous article "Launching the Boat's Electronics" in the February 1965 issue of RADIO-ELECTRONICS, page 34.

I cannot agree with the use of bond paper for cleaning relay contacts. From my experience, bond paper will leave a film and has a tendency to create trouble, especially on contacts that carry low current.

May I suggest that when it is necessary to clean contacts that a burnisher (cleaned with a lint-free cloth) dampened with trichloroethylene be used. The desired result is usually obtained by rubbing the burnisher between the contacts two or three times while applying light pressure.

W. A. McDERMID

Cooksville, Ont.

Mr. Robberson Replies

Although Mr. McDermid prefers another method of contact cleaning, I have been using bond paper to burnish transmitter and receiver relay contacts for 35 years and have not yet suffered the trouble he reports. He must have used linty paper, or else tried to use paper on contacts so rough they needed more than simple film removal.

Because lint-free cloth and trichloroethylene are scarce along my waterfront, I'm going to stick to my method. Oh, yes—if you should rub a fiber off the paper, take a breath, purse your lips, and blow some $CO_2 + N_2 + O_2$ + Ar + Ne, etc. on the contacts. A few forceful applications of this mixture should do the trick.

ELBERT ROBBERSON

Setauket, N.Y.

OTHER MODIFICATIONS TO OLD AUTO RADIO

Dear Editor:

Thank you for the article "New Life for Old Auto Radios" in the April issue of RADIO-ELECTRONICS.

I rewired my conversion so the switch on the volume control turns the primary of the transformer on and off. I also found space to add a 12AU7 as a cathode-follower output to drive a

30-watt amplifier and two 15-inch speakers.

This works very well in a large metal garage with an auto antenna on the roof and a long shielded lead to the radio. This, plus the radio's metal case, eliminates static from fluorescent lights and other nearby equipment.

Sensitivity and selectivity are excellent—some of the old car radios are just built that way!

A word of caution: some of the older sets use a 6-volt field coil on the speaker. The speaker should be replaced with a permanent-magnet type.

ALEX SEED

Casa Grande, Ariz.

NOMO IS EVEN MORE USEFUL

Dear Editor:

In my "Do-It-Yourself Parallel-R, Series-C Nomogram" (Feb. 1965 R-E, page 97), I think it should have been pointed out that it can be used for more than two components at a time. It can be used to find the combined parallel value of any number of resistors, or the combined series value of any number of capacitors.

It also makes easy the job of selecting two lower-wattage resistors to be used in parallel for a high-watt dissipation. Start with R_T and work backward.

MELVIN T. HYATT

Prairie Village, Kan.

RECORDER CONVERSION DATA

Dear Editor:

Jack Darr's Service Clinic for March 1965 carried some bad news for the owner of a Grundig TK-30 purchased in Germany who wished information about its conversion from 50- to 60-cycle current.

We think there is hope for the owner of that tape recorder. Our shop has converted a number of TK-30's by merely replacing the flywheel/capstan.

Our shop has been servicing German audio equipment for many years and would be happy to supply information regarding proper use and repair.

JOHN REILICH

Eurotech Service Co.
66-44 Forest Ave.
Ridgewood, N.Y. 11327

END

40-WATT "SWITCHING-MODE" AMPLIFIER YOU CAN BUILD!

Rumors of a radically new kind of transistor audio amplifier have been circulating on both sides of the Atlantic for some time. In August RADIO ELECTRONICS: the first such amplifier designed especially for home construction! A 40-watt public-address amplifier of fantastic efficiency—smaller than a cigar box, it weighs only 40 ounces, works from a 12-volt battery. (Principle underlying this breakthrough is discussed on page 54 of this issue.)

COMING IN AUGUST
RADIO-ELECTRONICS

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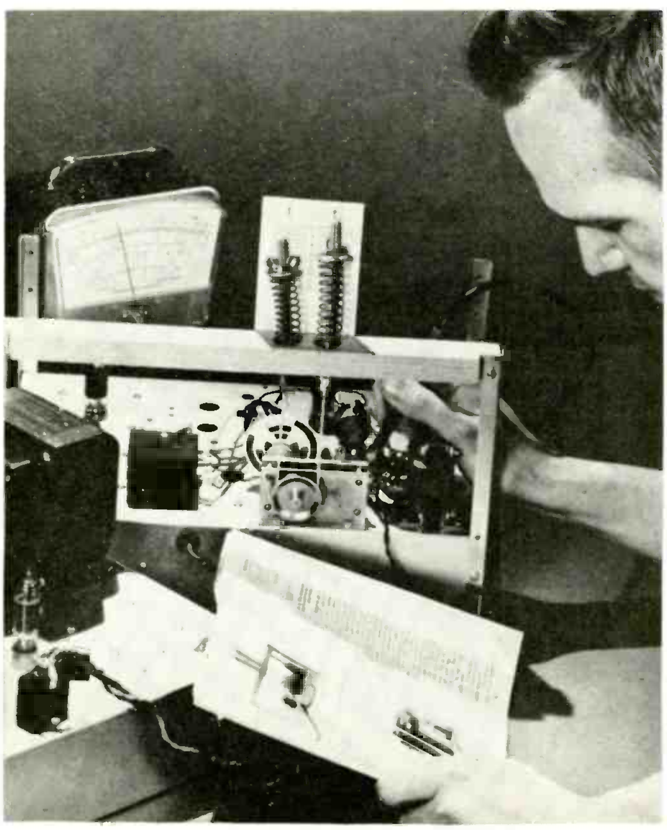
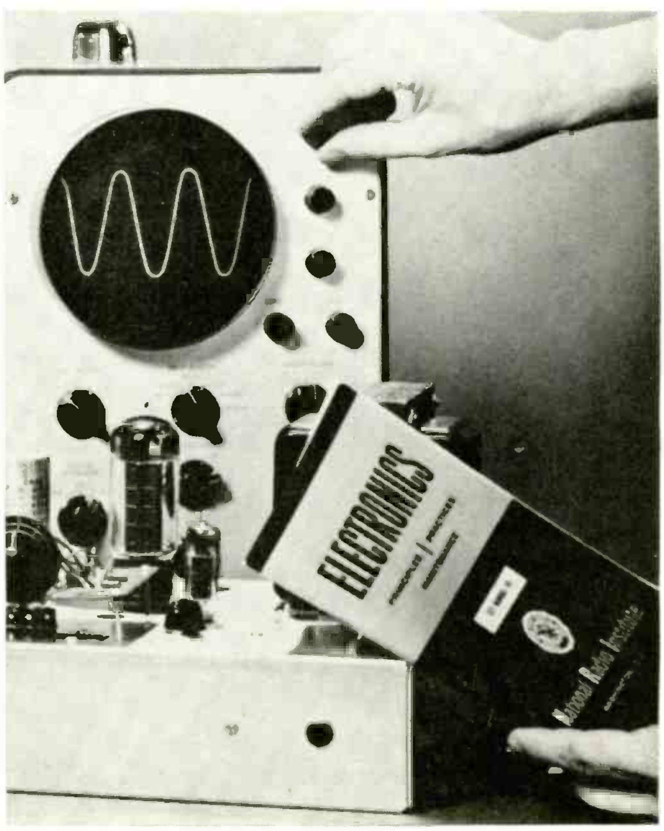




SERVICE CLINIC

By JACK DARR Service Editor

High-Voltage Regulators

One circuit is common to all color TV sets: the high-voltage regulator. Only minor variations are found between the earliest models and this year's. The addition of an adjustable control is about all! They all use the same tube, a 6BK4. Let's see what it is and what it does.

It's a beam triode, with a top-cap plate connection. Its maximum plate voltage rating is 27,000! But maximum plate *current* is only 1.6 ma. With 25,000 volts on the plate, it takes only − 15 volts to cut the plate current off completely. The 6BK4-A, the latest type, is exactly like the original but will handle 30 watts plate dissipation instead of 25 as does the 6BK4; they're interchangeable, of course, but I'd use an "-A" for a plain 6BK4, instead of vice versa.

How does it work? We connect the 25,000-volt high-voltage circuit of a color TV direct to its plate, and return its cathode to ground (eventually). So, any plate current this tube takes must come from the HV supply. It acts as a *shunt* or load across the high voltage. Now, if we can control the tube's plate current, we can change the loading on the HV supply and regulate it.

What we need is a control signal that indicates the output of the *flyback;* this includes the horizontal output tube, damper, yoke, etc. If this changes, so does the high voltage, boost voltage and everything else. So, if we feed the boost voltage to the regulator tube as grid bias, we can make the tube's plate current follow any change. Fig. 1 shows a typical circuit. This is from an RCA CTC 15, but they're all alike, since they do the same thing with the same tube.

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.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

Applied voltages will differ, but the actual grid–to–cathode voltage will be almost the same in every case. The amount of bias depends on whether the designer wanted a high or low regulator current. We might see an operating bias of − 10 volts (according to Sams Photofact data), so the tube would be drawing about 0.5 ma, at 25,000 volts. In the CTC 5 chassis, which had no adjustable control, the bias was − 15 volts, which is very close to cutoff, and on some recent RCA schematics it is − 5 volts.

Our main control signal for the grid comes from the boost voltage. If the flyback output goes up, the boost (and the HV, too) go up with it, quite naturally. So, the control grid is returned to the boost, through a matched pair of 1.5-meg resistors. (This is the "unboosted boost" here, not the 1,150-volt "boosted boost." Something like 750–800 volts, although it isn't given.

Now, if the boost voltage rises—goes more positive—the grid bias of the regulator tube goes more positive, too. Then the tube draws more plate cur-

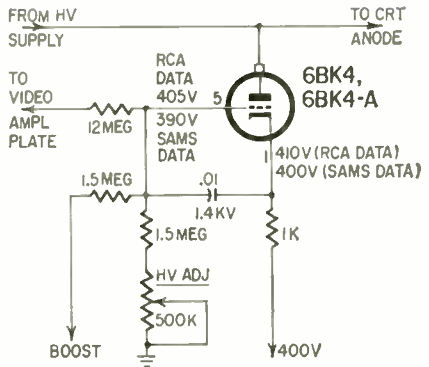


Fig. 1—High-voltage regulator circuit in an RCA CTC 15 color set. It's a variable shunt load on the high-voltage supply.

rent: this puts an additional load on the HV supply, which has increased with the boost, and loads it down enough to hold the voltage to the normal 25,000.

If the boost voltage falls, or heads in a negative direction, the opposite happens. The grid bias of the regulator becomes more negative: this reduces its plate current and takes some of the load off the HV supply. This lets the HV go up slightly, enough to compensate for the drop in supply, and once again we hold the rated 25 kv.

How do we check such a circuit? We measure the voltage and current. Most color sets have provision for opening the regulator cathode to read the current directly. In sets without, just unsolder one wire and hook up your milliammeter. I like the current measurement, for it is a direct one. If the thing isn't drawing the right current, it isn't working. Also, no matter what the applied voltages are (or seem to be), if the tube *is* drawing the right current, it *is* working!

Use a 1-ma meter. The normal operating current will be about 700 to

Follow that "beep!"

The inside story about the new PLUTO—an electronic marker that runs "eternally" on only negligible power. Called a Perpetual Low-power Unattended Transistor Oscillator—it's highly effective as an electronic marker for personal property—or a terrific object for a treasure-hunt. Fiendishly clever pulsed operation extends battery life to shelf life, yet each pulse contains a whole of a lot of energy. Track the signal on your transistor portable.

Coming in August
RADIO-ELECTRONICS.

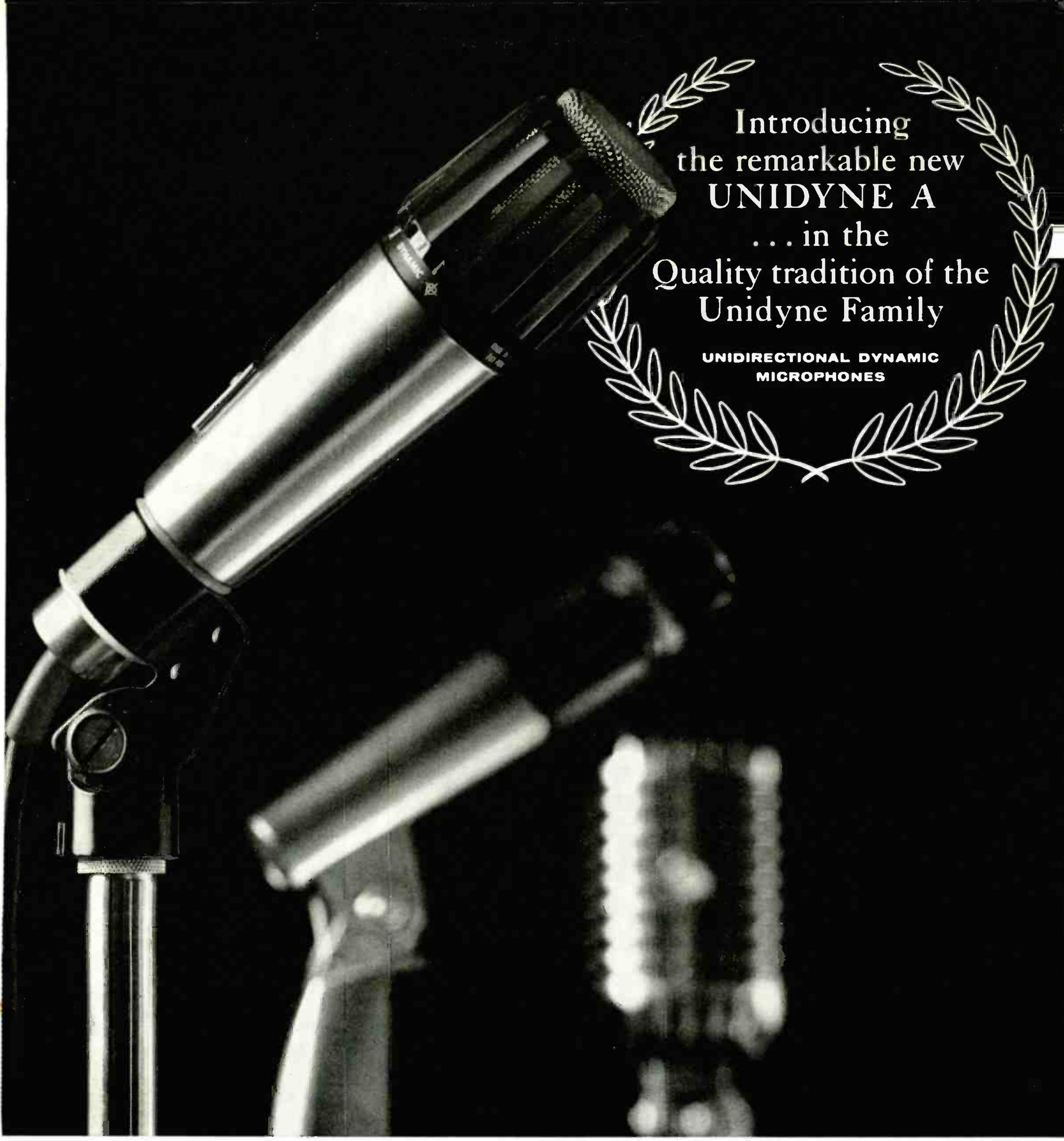
900 *micro*amperes (0.7–0.9 ma). Move the HV ADJUST control and check its effect: the current should change above and below the normal value. If, as I found in one set, you have *voltage* on the tube, but read no *current*, check some voltages. In this case, I read + 325 on the grid and + 385 on the cathode. A −60-volt bias! This is enough to cut off a tube with a much less steep slope than the 6BK4! It takes only −15 volts to stop *all* plate current, remember.

Some late sets use a connection to the video output plate circuit. When a very-high-brightness (almost white) scene is shown, it calls for a heavy beam current in the CRT, with a resulting heavy load on the HV. So, the HV would normally fall. However, the HV regulator's grid is connected to the video output through a very large resistor (12–15 meg) so that a bright scene causes the grid voltage to go negative. This reduces the plate current in the regulator and its loading on the HV, so that regulator action is improved. The opposite happens with a dark scene. This means very little beam current and less loading on the HV supply. So, the regulator grid goes more positive and the loading is increased, holding the HV steadier.

Troubles in this circuit? Resistors changing value and capacitors leaking. There are only a few resistors, but they're critical! Since a change of only 1 volt makes a great difference in the 6BK4 plate current, you can see that these big resistors must be right on the button all the time. Some circuits use bypass capacitors. Needless to say, *any* dc leakage in these will really foul things up. To make a reliable test, take the capacitors out completely. Hook one end to the dc-volts probe of a vtvm, then touch the other end to the highest voltage you can get: the boost is fine for this. If you get any "permanent" volatge reading, after the first charging kick, throw the capacitor out, quick! Even 1 volt of leakage is too much! Use good high-voltage types for replacements, and test *them* the same way before you put them in.

Quick-check for regulator trouble: pull the 6BK4 tube and turn the set on. If you now get high voltage, then there *is* trouble in the regulator circuit. Don't leave the set on too long: you might get flashovers. I've seen the HV go up to 30,000 without the regulator tube in place! Measure the voltage on grid and cathode, preferably between grid and cathode, and make sure that it is within limits.

This is basically a simple circuit, but it can give you some fine headaches if you don't use the proper test methods on it. Good luck, and watch that boost voltage: it bites!



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Admiral 16L1C: hash in B-plus; agc trouble

I've got an Admiral 16L1C in the shop. Good pix and sound for about 1 minute. Then both go at once. I get a normal waveform at W-1 (in Sams 394-1) while it's working. When it quits this jumps all over the place, and the B-plus waveform W14 goes crazy, too. I've substituted tubes, but nothing helps. What's wrong?—O.C., Bushton, Ill.

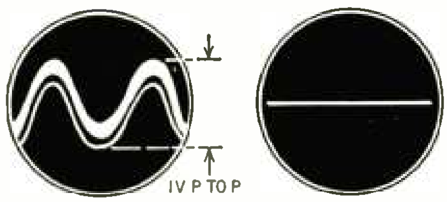

Fig. 2—Normal waveform at output of filter in this Admiral chassis shouldn't exceed 1 volt peak-to-peak. Anywhere else along the B-plus line, after other filters, you should get a straight line. Any ripple indicates a defective filter capacitor.

An intermittent filter capacitor. Your normal B-plus wave, W14 (Fig. 2), should remain steady at the ripple value shown, about 1 volt peak to peak. If it doesn't, or if a scope reading on your B-plus supply lines anywhere else in the circuit shows *anything* except a nice flat dc line, look out!

The filter capacitors are supposed to take out all fluctuations like that; that's what they're for. If you get fluctuations, try bridging filters.

Interference in antenna system

We have an amplified signal distribution system in our showroom. We had some troubles with it, so we added an antenna-mounted preamplifier. We have a good all-channel antenna, aimed at a channel-12 station 85 miles in one direction. Channels 3, 10 and 13 are 27 miles in the other, all maximum-power transmitters.

We have very bad windshield-wiper interference on 10 and 13, sound interference on unused channel 9, and so on! Where is the defective part in this system?—A. S., Sacramento, Calif.

You haven't got one. Just the opposite. Everything is working *too well!* You're using a very high-gain, deep fringe antenna, plus a high-gain antenna-booster, plus a high-gain broad-band amplifier. You are simply overloading the input of the broad-band amplifier!

The "interference" is actually what the CATV technicians call *splatter*, and is due to trying to get the signals through the amplifier at too high a level. Also, if any single channel in such a system is more than 6 db higher than the others, you'll get the same trouble. Such stations must be padded down to the same level as the rest.

Get a good field-strength meter and check the rf signal level at the input of the broad-band amplifier. If this is more than about 1,200–1,500 μv per channel, it will have to be reduced. I believe I'd try this without the antenna booster; try reorienting the antenna to see if you can't improve the situation in that way. If you use the booster, I'd put it on a separate channel-12 antenna, to bring that station up.

"Self-Changing Contrast"

I'm having problems with a Zenith 16D25 chassis. About twice a month, the picture fades to varying degrees of black and stays that way for a day or two, although once or twice the picture will come back to normal.

Contrast and brightness controls have their normal effect, but won't bring the picture up "out of the black". If I pull the CRT socket and then put it back, it works normally! (Confound it!) What to do?—P.H., Lakewood, Ohio

I know the first thing *I'd* do: clean that CRT socket! I've seen some very funny (funny-unusual, not funny-ha-ha) effects from corroded contacts in tube sockets: including rectification of strong rf signal from a nearby AM broadcasting station.

Also, this could be a defective video amplifier tube. Even if it tests perfectly good, replace it. Also, check *all* the resistors and capacitors in the video output circuit for leakage, change of value, etc. Heat the plate-load and other resistors, with an ohmmeter across them, to see if you're getting a thermal drift. Check the peaking coils for intermittent connections.

The video output in this set is "semi-dc-coupled", so even a leaky coupling capacitor in the *grid* circuit of the video amplifier tube could cause the change in CRT cathode voltage that you have. I don't think it's the CRT, but I could be mistaken. Should be some part that is affecting the bias voltage. Check 'em all.

Transistorized Stethoscope Amplifier

Do you have a circuit for an inexpensive transistorized amplifier that I can use as an electronic stethoscope? Also, what kind of a microphone will I need for this?—P.M., Tucson, Ariz.

We have had several requests for this circuit. Our editors have tried to find or design such a circuit, without any luck.

There are two problems. One, it is very difficult to get the required low-frequency gain. The energy in heart sounds is very weak to begin with, and is all concentrated in a very small band around 80 to 110 cycles. It's almost impossible to get sufficient gain at these frequencies. It *can* be done, but the price and complexity of the resulting amplifier puts it far out of the ordinary home constructor's reach.

Microphones are equally difficult. No standard pickup will do the job; we've tried everything. The only thing I found that gave good results was a specially designed stethoscope mike, and its price was $95 net!

I'm afraid that the response on this query is very negative, and we'll have to go back to the simple but highly efficient stethoscope in its original form, cold or not!

Identifying "Stacked-B" Stages

I'm new at this business. How can you positively identify a "stacked" B+ circuit?—E.C., St. Romuald, Que.

Look at the voltages on the control grid and the cathode. If the grid, for example, is shown with 125 volts positive on it, the stage *must* be "stacked." Also, in this case, the *cathode* will usually have a high voltage, near that of the grid.

Sams Photofact diagrams use a drafting convention which indicates stacked voltages. A small triangle beside the indicated voltage means "measured from ——", usually the cathode of the tube itself, or from the cathode of the following tube. To get the effective operating voltage on *any* tube, measure from the *tube's own cathode*.

Instant-On Rectifier Reversed?

I've hooked up an "instant-on" circuit (RADIO-ELECTRONICS, Jan. '62) to a Muntz 624T. On "standby" it radiates a hum-modulated signal that seems to peak at around 1010 kc! I can hear it plainly over the whole broadcast band. What's going on here and how do I stop it?—J.T., San Rafael, Calif.

It looks to me as if you could have only one thing that would cause such a condition: the instant-on rectifier is reversed! The basic idea of the original circuit was to insert the rectifier in series with heater strings, to that it gave them only a half-wave-rectified ac. This works out to about half of the normal current.

The rectifier must be hooked up so that its output is *negative* with respect to the normal B+ voltage of the set. In fact, it ought to be hooked up so that it is only in the heater string but, on some switches, you can't do this. Try reversing your rectifier. You must be getting some positive B+ in this set somewhere, to get rf output. Something is oscillating, with raw ac or pulsating dc on its plate!

Short Tube Life in Muntz Vertical Output

The 12L6 tube in a Muntz 721STP lasts about 2 weeks. When it's new, all scope patterns look OK, and it works. After a while, the vertical jitters begin, and it goes haywire. When you test the 12L6, it's dead-shorted. Help!—W. E., Sullivan, Mo.

The 12L6 is not, as I thought, a "12-volt 6L6". It's a 12-volt 50L6! There's a great difference, like between a 50-ma maximum plate current rating and a 100-ma max.! So, hook a milliammeter in the cathode circuit of this poor little tube and see what the current is. In this "one-pentode vertical-oscillator-and-output" circuit, it's working pretty hard! It won't take much of a drift in voltages or resistance values to put it out of commission in a short time.

Check the grid bias, and check for leaky coupling capacitors. Even a little bit of positive grid voltage here will overload the tube and probably cause it to short out. Check the heater voltage, too. END

"Guess what the actors do after you turn off the TV."

CONSUMERS' CHOICE

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	BRIGHTEST COLOR PICTURE	BEST OVERALL COLOR PERFORMANCE	CLEAREST COLOR PICTURE TO WATCH	BRIGHTEST BLACK AND WHITE PICTURES
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Picture Tube A	6.9	9.8	8.9	7.4
Picture Tube B	9.5	13.7	13.4	7.1
Picture Tube C	7.5	9.9	9.7	7.8

Test made under supervision of John J. Henderson and Associates, N. Y. Note: Not all people answered all questions—votes tabulated for 100% of answers to each.

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The *color bright 85* tube is available to you now for today's growing color TV market. It is a product of Sylvania Electronic Tube Division, Electronic Components Group, Seneca Falls, N. Y.

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JOSEPH R. HIXSON
SCIENCE REPORTER
THE NEW YORK
HERALD TRIBUNE

Electromedicine: End of the Wonder-Drug Era?

Guest editorial by JOSEPH R. HIXSON

IN Cleveland, a young man paralyzed from the neck down eats his meals with the aid of an arm brace wired to a computer. In Rochester, the blood pressure of a hypertensive woman drops to near normal levels at the behest of an electronic pulse device implanted in her neck. And in Brooklyn, a victim of heart failure turns the dial on a tiny transmitter held next to his chest when he needs to climb a flight of stairs.

The list of such electronic substitutes for failing bodily functions grows longer every day. The transistor hearing aid is a crude piece of hardware by today's medical electronic standards. It has one enormous advantage over the devices now being tested in the nation's medical centers: if the battery goes dead, the deaf person simply unsnaps his device and buys a new one. If a circuit fails, he takes the device in for repairs or buys a new one.

But if the tiny nerve center in a human heart has ceased to send impulses to the cardiac muscle, battery failure or the breakdown of a Pacemaker component can mean death within minutes. The level of reliability required of today's electronic life savers is of the same order as that specified by the National Aeronautics & Space Administration for parts in the Gemini and Apollo spaceships and for the probes sent to the moon, Mars and Venus.

But the components of even a Mariner spacecraft sent to Mars need work for only about 8 months. A cardiac Pacemaker must jab the heart electronically almost 40 million times a year for an indefinite number of years. Replacing such a device involves surgery on a patient whom doctors would classify as a "high risk."

Mr. Hixson has been a science writer for the Herald Tribune since November 1962, and has written medical books and articles for 16 years.

Such are the considerations to be kept in mind when one reads the rosy-hued predictions of a billion-dollar market for medical instruments and equipment by 1970.

A doctor misread an X-ray in Brooklyn the other day and sent an elderly auto accident victim home with a fractured pelvis. The man died within hours of internal bleeding. And in Seattle, a plastic shunt connecting an artery and a vein of a victim of kidney failure came apart while the patient slept. He was dead within minutes as his artery pulsed blood into his bed. The same shunt that saved his life by making possible artificial kidney treatments to cleanse his blood of wastes also killed him when it came apart.

Computers that read X-rays or electrocardiographs will be making and are today making life-and-death decisions. They must work every time. Thus quality control in the electronics industry is facing a crucial test. Recognizing this fact, the Federal Government is now seeking to obtain for the Food & Drug Administration the power to approve all devices for human medical use just as it must now OK the marketing of a drug.

But there is another facet of the problem. Meticulous care in routine matters can handle, to a large extent, the reliability crisis. But only brains, supplemented by big transfusions of money, can narrow what might be called the knowledge gap. The case of the paralyzed young man in Cleveland is a good example:

At the Highland Valley Hospital in suburban Warrensville, researchers from Western Reserve University and the Case Institute of Technology mounted a powered metal splint on Edward Rosak's right arm and hand. They attached the prosthesis (artificial limb) to a computer that had been programmed with arm and hand movements required to bring a fork or spoon from plate to mouth.

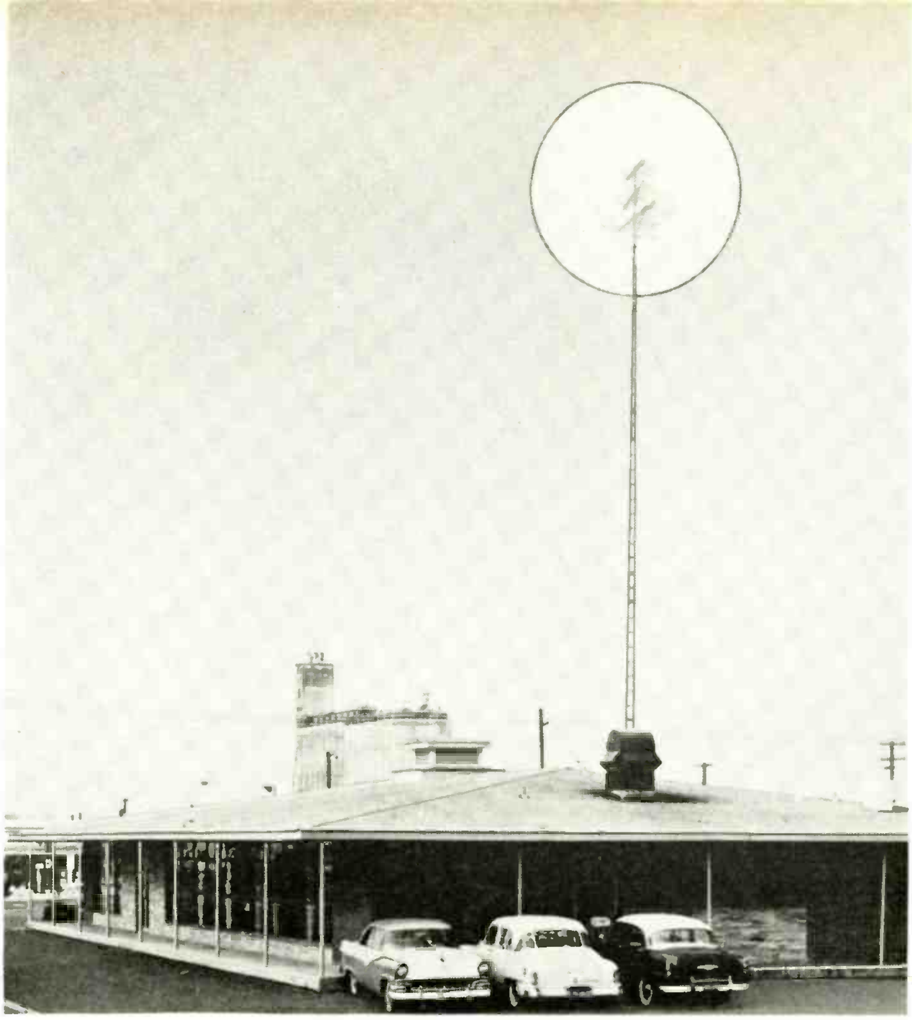
The doctors also installed a small, infrared light source on the man's eyeglasses. Now, when he wants to eat, the youthful paraplegic simply turns his head to aim the light beam at one of three photoelectric cells on his bed table. By so doing he activates one of the eating programs in the computer, which then moves his arm and hand. The doctors have also managed to pick up with tiny electrodes some of the residual nerve impulses in the young man's shoulder. These are amplified and transmitted to activate his finger muscles.

Yes, the boy does eat without human assistance. And of course the project is teaching the researchers on the elementary "how to" level. But the technology required is far, far removed from that required to replace lost nerve function. It resembles recent operations in which doctors have transplanted lungs, heart and livers from the dead to replace similar diseased organs in the living. The operations, thus far, have simply showed that the surgery is possible. But all the beneficiaries of the transplanted organs have quickly died.

The way that nerve fibers transmit their vital messages —their action thresholds, their frequency and the electrochemistry of their action, has been revealed in brilliant physiological research. But scientists are still unable to duplicate their subtle communication.

A patient whose nerve cells have been damaged by a polio virus or a stroke or an accident is in the same plight medically that he would have been in the Middle Ages. And that is why three out of four operations to restore severed arms and legs turn out failures.

continued on page 78



PLUG IN TO MATV

Master-Antenna TV installations for hotels, motels, showrooms—even homes—are easy and profitable

By LON CANTOR*

IT TAKES A LOT LESS KNOW-HOW TO plan and install an MATV system than to repair a TV receiver. And there's a lot more money in it! Yet technicians have left this lucrative market almost untapped.

Who needs an MATV system? Almost everybody. Most homeowners today own two or more TV sets. While they may not have a set in every room, they do have a portable they would like to move from room to room.

Many bars and bowling alleys are putting in TV sets. In motels, an MATV system is a must, and even apartment-house owners are beginning to realize that good TV reception raises the value of their apartments.

Two recent developments have increased the demand for MATV systems: the growth of color and the coming of age of educational TV. Color TV requires stronger signals for good pictures. This makes an MATV system in every TV showroom a virtual necessity. The growth of educational TV means that soon every school in the country must be equipped for it. More than 90% of the schools now being built will include some form of educational TV.

It's easy to get started in MATV. If you've had successful experience with single-antenna installations, you already know most of the fundamentals.

Moreover, equipment manufacturers are eager to help in planning systems. The major MATV equipment makers, Blonder-Tongue and Jerrold, maintain application engineering departments whose sole job is to help you design and install systems. Send them a description of the building and prevailing local signed conditions, and they will design the system for you. A typical system design prepared by an applications engineer and sent to a TV technician looks a lot like Fig. 1.

How to plan your MATV system

What would happen if you tried to connect 20 TV receivers directly to a single antenna? In the first place, you'd

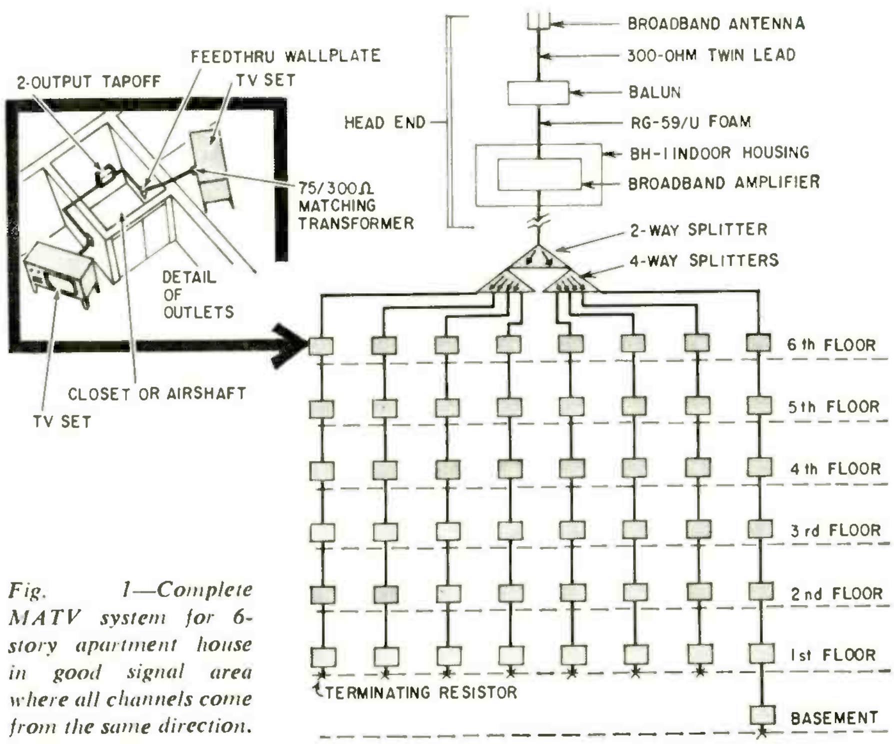


Fig. 1—Complete MATV system for 6-story apartment house in good signal area where all channels come from the same direction.

*Jerrold Electronics Corp., Philadelphia, Pa.

have an impossible mismatch. Twenty 300-ohm impedances (the TV receivers) would be connected in parallel across the 300-ohm antenna. Also, the TV sets would be connected direct to each other, with no isolation. This would almost surely cause interference. Finally, in most cases the antenna signal would not be strong enough for all twenty sets.

It is the job of the master TV antenna system to overcome these problems. An MATV system is divided into two basic parts: the head end and the distribution system. The head end makes the signals strong enough to provide good pictures on every TV set in the system. The distribution system isolates the receivers and provides the proper impedance match.

Typical broadband, all-channel amplifier with 40 db gain: Blonder-Tongue MLA-x

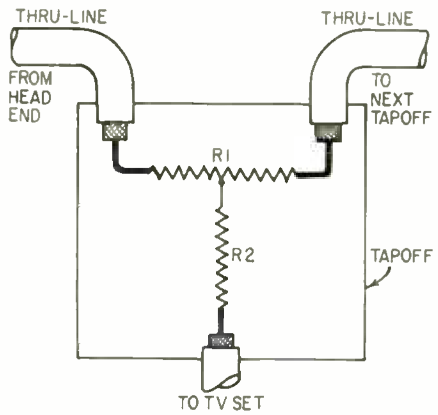


Fig. 2—Equivalent resistances of tapoff. R1 represents through-line loss, R2 is isolation loss.

Distribution-system design

Before we can determine how much signal we'll need at the head end, we must first find out how much signal will be lost in the distribution system. Therefore, the first step in designing an MATV system is to lay out the distribution system.

Let's take a typical six-floor apartment house. The complete distribution system for such a building is shown in Fig. 1. The first thing we must determine is how to run the cable. Since this building is taller than it is wide, we run the cable vertically, from the top floor to the basement. Next we'll have to decide how many cable runs to use. The house has 16 rooms per floor. We find that the most convenient place to run the cable is through the closets. Since the apartments are back to back, one line can serve two apartments. Therefore, we need eight through lines.

Now, the question is, how do we get eight through lines? The answer is *splitters*. A splitter is something like a Y-hose (Siamese). It makes one line into two or more. The job of the splitter is to maintain the signal match and to isolate the lines from each other.

Splitters divide the signals into equal parts. In a two-way splitter, half the signal power goes into one branch and half into the other. However, it is signal voltage rather than signal power we are concerned with in MATV work. Each branch line gets about 70% of signal voltage (70% of signal voltage × 70% of signal current = 50% of signal power). Quality splitters are of the hybrid type. In other words, they can be used not only to split signals, but to combine them.

To get the eight through lines we need for the apartment building in Fig. 1, we will need one two-way splitter, followed by two four-way splitters.

Here's how you string coax through closets:

1. Drill holes in floors and ceilings of closets. Two types of floors are in general use:
   a. *Concrete*. To drill through this, you need a carbide or a masonry bit. A ½-inch slow-speed drill is recommended.
   b. *Double floors*, found mostly in old buildings. If there is a big hollow space between the two layers, you will have to drill from the floor down and then from the ceiling up. Coax will have to be "snaked" through.
2. Pull cable through, from top down. Secure it to the inside wall of the closet with a heavy-duty staple gun or No. 4 Tinnerman clamps.
3. Cut the cable at the point where the tapoff is to be installed. Feed it into and out of the tapoff.

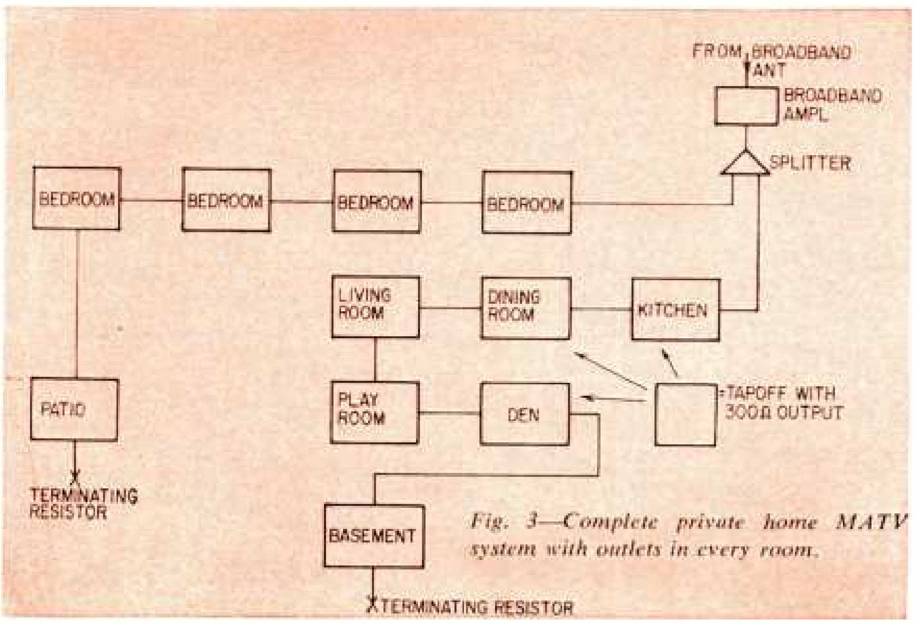


Fig. 3—Complete private home MATV system with outlets in every room.

Ordinary TV ribbon lead is not suitable for MATV systems because it is not shielded. Hundreds of feet of ribbon line strung through a building would pick up signals directly, resulting in ghosts. Ribbon lead also picks up interference, and two close together are inductively coupled. For this reason, 75-ohm coaxial cable is recommended for MATV systems. In general, RG-11/U is used outdoors and RG-59/U indoors. Both are now available with foam dielectric, allowing larger center conductors and, therefore, lower signal losses.

All cable causes some signal attenuation, varying with conductor resistance and dielectric heating. Cable attenuation increases in direct proportion to frequency. The table shows the attenuation of MATV cables.

Now that we have through lines for each apartment in Fig. 1, we must provide *tapoff*. A tapoff takes a portion of the signal from the through lines and feeds it to the TV set. It also isolates the set from the through line.

Fig. 2 is a representative schematic of a tapoff. Resistor R1 represents the signal loss in the trunk line caused by inserting the tapoff. Manufacturers generally specify this as "through-line loss," and it seldom exceeds 1 db.

Resistor R2 represents the isolation between the TV receiver and the through line. This is specified as "isolation loss." The most common isolation is 17 db (12 db and 23 db are sometimes used in very large systems). In our typical apartment house, we need tapoffs with two outputs to serve two apartments per floor from a single through line.

The 75-ohm coaxial distribution cable must be matched to 300-ohm TV sets. This is the job of a matching transformer. Many tapoffs have built-in matching transformers. That is, input to these tapoffs is the 75-ohm through line, and output is 300-ohm ribbon.

These tapoffs eliminate the need for separate matching transformers, but they are not always practical. In our building, for example, we are using one tapoff with two outputs to serve two apartments. Since the tapoff is not located in the same room as the TV set, a separate wall-mounted matching transformer is used in each apartment.

Separate matching transformers are also required in all strong-signal-area installations. In these areas, even the short length of flat ribbon lead from the wall to the set will pick up enough signal to cause ghosts. A separate matching transformer must be mounted right on the TV set or even inside it.

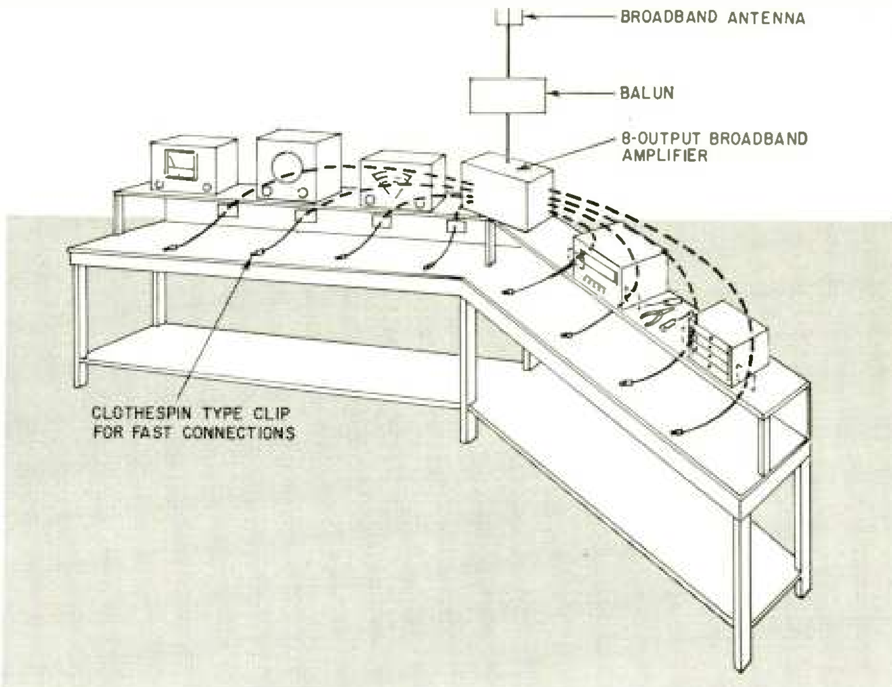


Fig. 4—Simple TV service bench system.

All 75-ohm through lines in a master TV system must be terminated with a 75-ohm resistor. This is important. Unterminated lines result in standing waves, which cause ghosts.

Now that the distribution system has been laid out, we must calculate the distribution-system losses. Actually, "losses" is a misnomer. Most of the signal is not "lost"—it is merely distributed. Only in the sense that all of the signal that doesn't get to a specific set in the system is "lost" to that set is the term "losses" correct.

How much signal does a receiver need to display a good picture? The answer depends on the particular receiver, together with the subjective standards of the viewer, but we ignore this in MATV work. Instead, we arbitrarily set a minimum standard of 1,000 microvolts, across 75 ohms, of combined picture and sound carrier voltages. This minimum assumes that the picture carrier is as strong as or stronger than the sound carrier. The 1,000 μv gives us a comfortable margin of safety.

Our concern, therefore, is to make sure that each TV receiver in the system gets at least 1,000 microvolts of signal. If the last set on the longest line gets enough signal, all others in the system will, too.

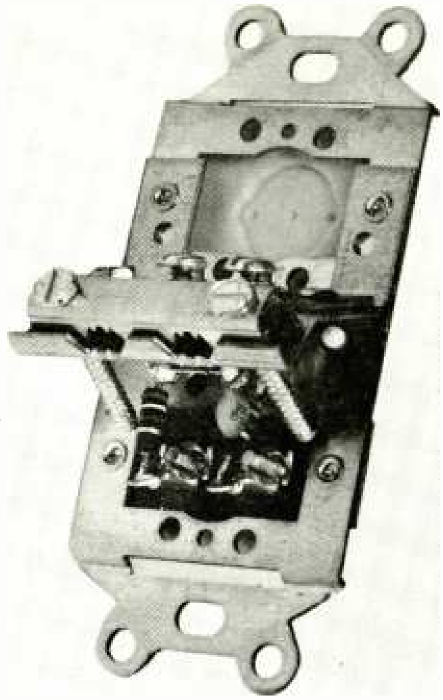
In our apartment building, we start at the basement TV set (since this is the longest line), and calculate the losses to the head end of the system.

There are three types of losses in a distribution system:

1. Cable loss. In the system shown in Fig. 1, there are about 150 feet of RG-59/U (foam dielectric) between the head end and the basement set. The table shows that RG-59/U foam cable causes a loss of 4.2 db per 100 feet at

CHARACTERISTICS OF CABLES USED IN MATV SYSTEMS

Cable	Interference rejection	Signal loss in db per 100 Feet				Effect of weather
		Ch 2	Ch 6	Ch 7	Ch 13	
RG-11/U	Excellent	1.4	1.7	2.7	3.2	Loss unaffected by heat or rain
RG-11/U Foam	Excellent	1.1	1.4	2.1	2.3	
RG-59/U	Excellent	2.7	3.5	5.1	5.8	
RG-59/U Foam	Excellent	2.1	2.7	3.9	4.2	
300-ohm ribbon	Fair	.75	1.1	1.5	1.8	Loss increases 6 times when wet



An MATV tapoff junction.

channel 13. (Losses are always figured at the highest channel in the system. In this case, we'll assume that channel 13 is to be included). Cable loss, therefore, is 6.3 db (1.5 × 4.2).

2. Splitter loss. A two-way splitter causes about 3 db loss, while a four-way splitter causes 6 db loss. Notice that, to get to the basement TV set, you go through one two-way splitter and then one four-way splitter. Splitter loss, then, is 9 db (3 db + 6 db).

3. Tapoff loss. There are two types of tapoff losses—through-line and isolation. To get to the basement set, we must go through the through-line loss of seven TO-2-75 tapoffs. According to the manufacturer's specifications, the through-line loss of these units is 0.7 db per tapoff. Total through-line loss is equal to seven tapoffs times 0.7 db per tapoff, or 4.9 db. Isolation loss of the TO-2-75 tapoff (17 db) is calculated only once—not multiplied by seven—because the signal goes through only one isolating resistor on its journey from the head end to the basement set.

Adding all these losses together, we find that the total distribution-system losses are:

150 ft of RG-59/UF @ channel 13	6.3 db
(1) two-way splitter	3
(1) four-way splitter	6
Tapoff through loss (7 × 0.7 db)	4.9
Tapoff isolation loss	17
Total distribution system loss	37.2 db

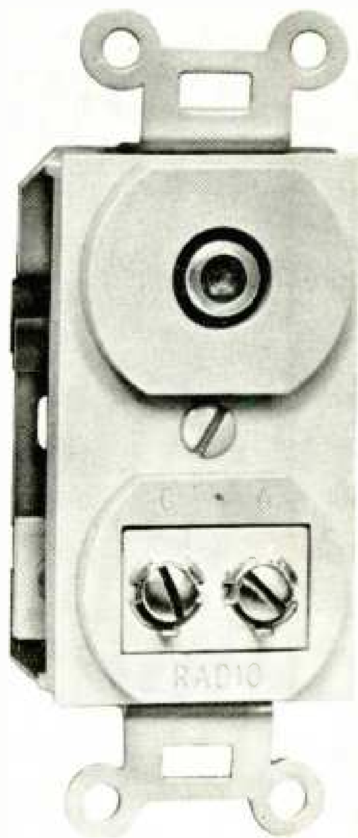
In other words, between the head end and the basement TV set, 37.2 db of signal will be lost. There is no need to compute the losses in any of the other through lines. The 37.2 db is called the total distribution-system loss. It is this loss that must be overcome by the head-end amplifier of the MATV system.

Now we know the total distribution-system loss, we can choose a head end for our system. Suppose the apartment house is located in an area about 20 miles from the transmitting stations and that all channels come from the same direction. The first thing is to put up an antenna. That's easy. It's exactly like a single-home installation, except that you can afford to use a better antenna and install it more securely. (A future article will deal more thoroughly with MATV antennas and head ends, and how to solve specific reception problems.) In an area this close to TV transmitters, you should receive between 2,000 and 5,000 μv per channel, using a good broad-band Yagi.

These signals will then have to be amplified to overcome the distribution-system losses. How much amplification will be needed? Since total distribution-system losses are 37.2 db, we should use an amplifier with about 40 db gain, such as the Blonder-Tongue model MLA-c or the Jerrold model 2300.

Most MATV amplifiers have an input impedance of 75 ohms, to match coaxial cable. Since the antenna impedance is 300 ohms, a matching transformer, called a *balun*, is required.

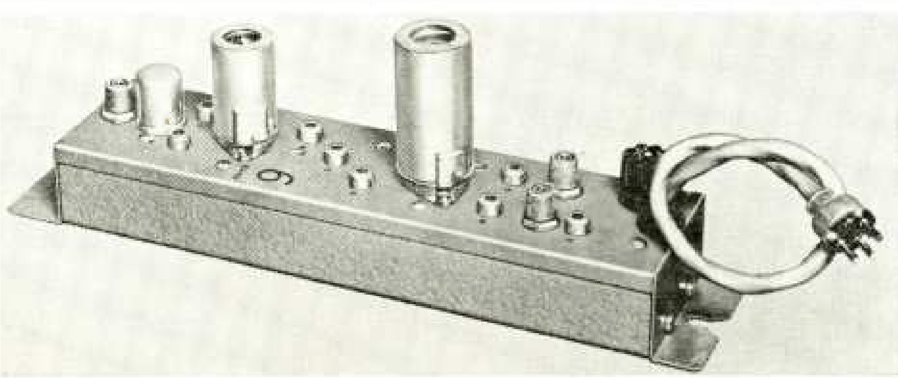
The principles explained for this typical system can be used for all MATV systems, large and small. A subsequent article will explain MATV installation and service techniques, as well as how to eliminate various types of interference.



Jerrold combination TV and FM tapoff.

To get started in the MATV business, begin with the simplest of systems. Next time you install an antenna in a home, try to sell the idea of a complete home system, with an outlet in every room. Such a system is shown in Fig. 3. You can install a similar small system in a TV showroom, a bowling alley or a small apartment house.

In fact, a TV service-bench system such as that shown in Fig. 4 might be a good jumping-off point. Once you have had experience with these small systems, it's relatively easy to handle large MATV systems in motels, schools and apartment houses. And remember, almost every MATV system you sell will also include a service policy. When a customer connected to an MATV system has trouble, he almost invariably blames the system and calls you. This can add a substantial number of TV service customers to your business. END



Jerrold model PMA Positive Matched Amplifier, for channel 6.

Measuring Turntable Wow and Flutter

Equipment and test records available to almost anyone offer a quick, precise way to measure turntable speed and speed variations

By EDGAR VILLCHUR*

The March issue of RADIO-ELECTRONICS *carried the first of this pair of articles*—"Measuring Turntable Rumble." *This second part discusses wow, flutter and speed regulation, and explains how to measure them simply and accurately.*

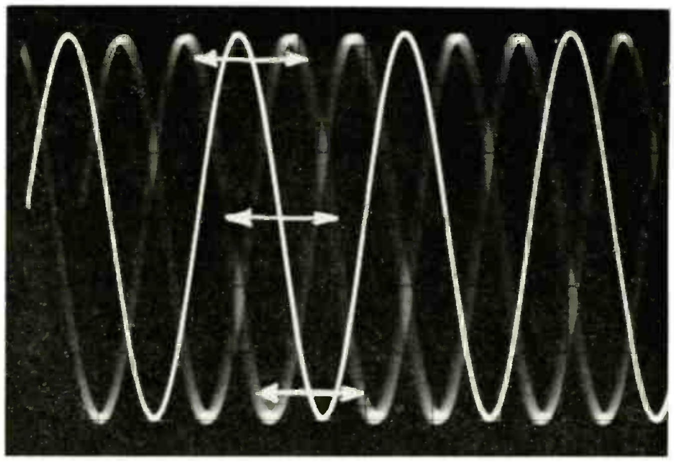


Fig. 1—Scope trace of 3,000-cycle flutter test tone. Horizontal movement to left and right represents frequency variation caused by turntable flutter. Do not confuse this with a constant drift in either direction which may be controlled or minimized by adjusting the scope's frequency control.

FLUTTER IS THE GENERAL TERM FOR speed variations in a reproducing mechanism that cause variations of pitch. *Wow* is a colloquial designation for these pitch variations when they occur at a slow rate. The wavering, sick-sounding background music sometimes heard in old movie films on TV represents an extreme case of wow.

Several brands of flutter meters are available, costing in the neighborhood of a few hundred dollars. These flutter meters measure the frequency variation of a standard 3,000-cycle tone played from a test record or tape, in percent.

Unfortunately the raw flutter percentage, taken without considering the *rate* of flutter, has limited significance. It has been established that flutter at the slow rate of 2–3 cycles per second (two or three up-and-down frequency variations a second) can be perceived much more readily than flutter at other rates. Low-frequency flutter in the 0.5-cycle range is about half as perceptible, and flutter at higher rates—10 cycles and above—is only about one-fourth as perceptible for the same percent of frequency deviation.

The flutter meter used in AR's test chamber gives weighted readings to compensate for these differences in perception. Weighted flutter meters are not available commercially, but it is possible with experience to make a weighted subjective evaluation of turntable flutter by ear, or by ear and oscilloscope, using the following procedure:

1. Play the 3,000-cycle flutter test tone. The only reliable flutter test record that I know, aside from AR's specially made one, is the Varo 37-1002 ($10.95 postpaid, Varo, Inc., Electrokinetics Div., 402 E. Gutierrez St., Santa Barbara, Calif.). There are other records with flutter test tones, but I have found them to be either erratic or to contain too much built-in flutter.

2. Turn the bass control all the way down to isolate the effects of rumble and of random groove irregularities, and adjust the volume control for a comfortable level.

3. Connect an oscilloscope (one with facilities for completely disabling horizontal lock with the input signal) across the highest-impedance amplifier output tap of one channel. Put the scope on "free run"; that is, turn off the horizontal sync.

Adjust the scope frequency control to display four or five sine waves of the 3,000-cycle tone and make the trace as stationary as possible. You will

Tester on AR production line checks mechanical regulation with "nickel test".

* *Acoustic Research, Inc., Cambridge, Mass.*

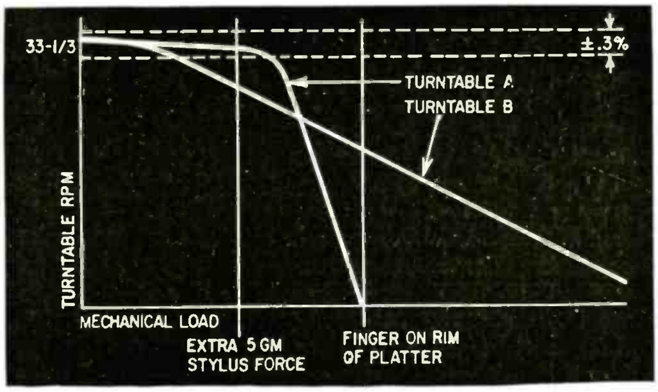


Fig. 2—Turntable A keeps within the NAB limit for speed accuracy over the range of mechanical load encountered in practice, and then stalls under heavier loads. Turntable B drops below the NAB limit in the operating load range, but turns at low speed under heavy load. (See text.)

not be able to stop the oscillation to left and right illustrated in Fig. 1—this is the flutter—but with care you should be able to stop drift in any one direction. Do not apply horizontal sync to stop the trace. If you cannot stop the drift entirely by the scope frequency control, you will have to discount the drift in your evaluation.

4. The rate at which the trace oscillates left and right is the flutter rate. The maximum speed at which the trace moves in any one direction represents the instantaneous percent of flutter. (The distance that the trace moves is also an index of flutter percentage, but only at a given flutter rate, since for the same percentage the trace will move farther at low flutter rates than at high ones.)

One should not expect a steady oscillation that can be counted easily. However, the speed and duration of even a single motion of the trace is significant, since it represents a half-cycle of the instantaneous frequency deviation from 3,000 cycles.

The least desirable trace movements are those that are fast (high flutter percentage) and that oscillate back-and-forth two or three times a second (the most audible flutter rate). Skill in interpreting the trace movements will come from comparing different turntables and correlating the visual display with the sound from the speakers.

You will not hear a perfectly steady tone, even from the best of turntables. The test conditions were purposely designed for maximum sensitivity, and the perception of pitch variation in the test tone far exceeds the perception of flutter in reproduced music. The audible wavering of pitch and the oscillation of the scope trace on a first-class reproducing turntable are at least as low as on a professional tape recorder.

It should be remembered that in listening to the flutter test tone, the weighting for flutter rate is automatic. While flutter cannot be evaluated on a quantitative or absolute basis by the method described here, an experienced operator can make a relative evaluation of turntables that probably has more validity than flutter meter readings.

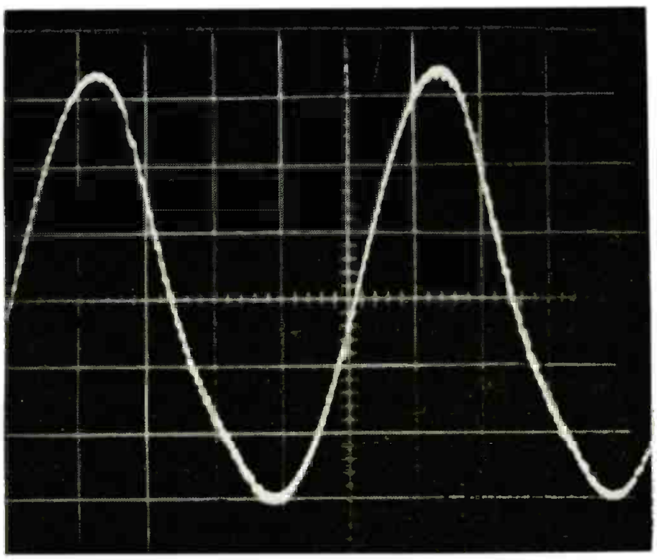
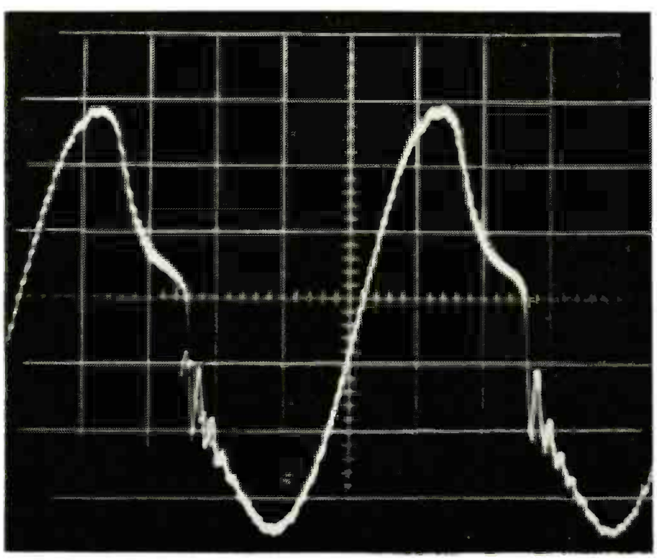
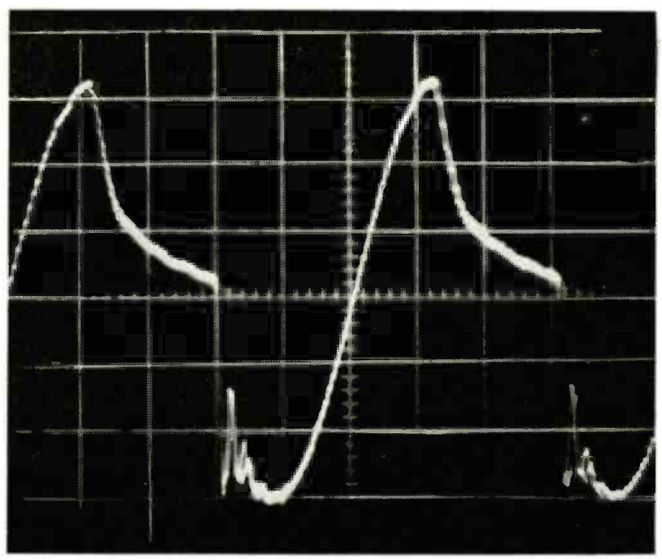


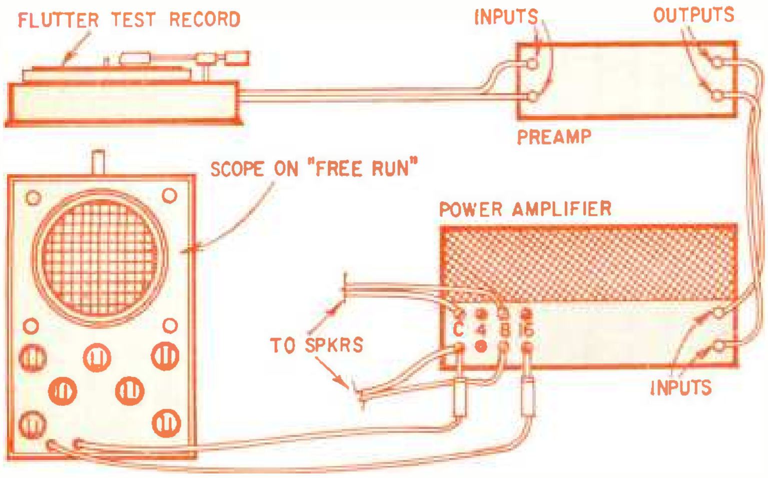
Fig. 3—Cartridge output on 6-cm/sec 300-cycle tracing test. Left—1¼-gram stylus force; below, left—1-gram force; below, right—¾-gram force.





Speed accuracy and regulation

Most technicians are familiar with the stroboscope card used for checking turntable speed accuracy. It is important to use an accurate card that will lie flat and that has a well centered mounting hole (such as Audiotex Strobe Disc 30-230). It is also important to know that a glance at the lines or dots to see whether they are drifting is not an adequate test for accuracy by professional standards.



Test setup for checking flutter. Fig. 1 is a typical scope trace produced by flutter.

The NAB standard for speed accuracy is ± 0.3% for reproducing turntables and ± 0.1% for recording turntables. Three-tenths of 1% speed error corresponds to a drift on a standard strobe card of 21 lines per minute, or only 1 line every 3 seconds. To measure such slow drift it is necessary to hold a pencil or similar marker over the strobe card and actually count the number of lines that pass the marker during a timed 60-second interval. Fluorescent illumination makes the count much easier, although ordinary ac incandescent light is adequate.

Speed *regulation* refers to the constancy of speed under different conditions—changed input voltage or changed mechanical load.

Electrical regulation is tested with a variable-voltage transformer. The input voltage to the turntable is varied over a range of 100 to 130 volts, and the speed is checked with a strobe card to see whether it stays within the NAB ± 0.3%. This test should be made under conditions of maximum mechanical load as described in the section following.

The test for mechanical regulation must be designed in terms of the differences of mechanical load that the platter is likely to encounter during operation. Whether or not the turntable uses a synchronous motor is of little moment here. Much of the turntable speed variation resulting from mechanical load changes is associated with the drive mechanism which couples the motor to the platter rather than with the motor itself. The platter may slow down beyond acceptable limits while the rpm of the motor armature remains rock-steady.

A tone arm imposes more drag when it is playing the outer grooves of a record than when it is playing the inner grooves. This difference in load is equivalent to adding about 2 grams of stylus force (often called, incorrectly, tracking pressure) to a cartridge playing the outside grooves. Another source of load variation is created by a heavily recorded passage, which is equivalent to 1 or 2 grams added to the stylus force. Dust cleaners that bear on the record as it turns create a drag equivalent to an extra 4 to 6 grams of stylus force.

These data were determined experimentally. They form the basis for the mechanical regulation test applied to AR turntables, which we call the "nickel test." Turntable speed is checked while the cartridge is playing the outside grooves of a record at 2.5 grams stylus force. The tester uses a foot-operated automatic timer. Speed must be within the NAB professional limit of 21 lines drift.

The stylus force is then increased to 7.5 grams by placing a US nickel—which makes a very accurate 5-gram weight—on the cartridge. Speed must stay within NAB limits. We impose the further condition that the extra 5 grams do not slow down the turntable more than 0.3%.

This may not seem to be a difficult test, but at least half of current record players will not pass it, and there are no turntables that do not show any speed change at all. In making the test, be sure to use a cartridge that can accept 7.5 grams without the needle bottoming.

There are two widely held misconceptions about testing turntables for mechanical regulation. One is that the speed of starting is an index of high power and therefore of good regulation. In fact, fast startup (necessary in cueing applications) is an index of high starting torque and of nothing else. Some motors, notably those of the induction type, have very high starting torque relative to their running torque. Others, like the synchronous permanent-magnet type, have very poor starting torque relative to their running torque.

The second misconception is that turntable regulation can be checked by placing a finger against the rim of the platter and seeing how much force it takes to stop it. This test may give some indication of the turntable's suitability for being harnessed to a buzz-saw, but not of its suitability for playing records at constant speed in the face of small changes in mechanical load.

Some turntables slow down beyond acceptable limits at very light changes of mechanical load encountered during operation, and yet will continue to rotate, at an unusably slow speed, under conditions of very heavy load. Other turntables keep within the very stringent NAB professional speed limits under all load conditions encountered in practice, and yet will stall out with the relatively light pressure of a finger. The speed vs load curves of these two types of turntable are illustrated in Fig. 2.

Arm-cartridge tracing

There is a test record on the market (model 211, $4.98, HiFi/Stereo Review, 1 Park Ave., New York, N.Y.) that puts an end to guesswork about how many grams of stylus force are needed for different cartridges mounted in different arms.

Two bands of heavily recorded 300-cycle tones (6 cm/sec peak velocity) are used, one for the left channel and one for the right. Stylus force is increased until each tone is reproduced without buzzing or breakup. It is very useful to monitor the test tones on an oscilloscope. Fig. 3 shows scope displays of successful and unsuccessful tracing.

The NAB Standard allows record warp as high as 1/16 inch, and many records show considerably more than this. The tracing test should, I believe, include playing the test tones with a 3/16-inch wedge under the rim of the test record to simulate a bad warp. This last test procedure takes into account tone-arm inertia and friction. Although the simulated record warp is exaggerated, a real and more shallow warp which covers a smaller arc of the record circumference may induce arm velocities as great.

I find that most cartridges require stylus forces in the range between 1¼ and 3 grams on this test when mounted in high-quality arms. The instruction booklet accompanying the model 211 record suggests an even higher range, but the booklet was written over a year ago. We found only two cartridges that will trace reliably as low as 1¼ grams. While many cartridges will play lightly recorded passages at a fraction of a gram, this is not a proper basis on which to recommend operating conditions.

AR's production test chamber used the *HiFi/Stereo Review* test record for the tracing test until we had our own record made, whose tracing test is in imitation of the model 211. We also use this test daily at our demonstration rooms. I consider it fundamental for setting stylus force correctly, and for checking the performance of the stylus, the cartridge, and the arm. END

SCR ELECTRIC FENCE CHARGER

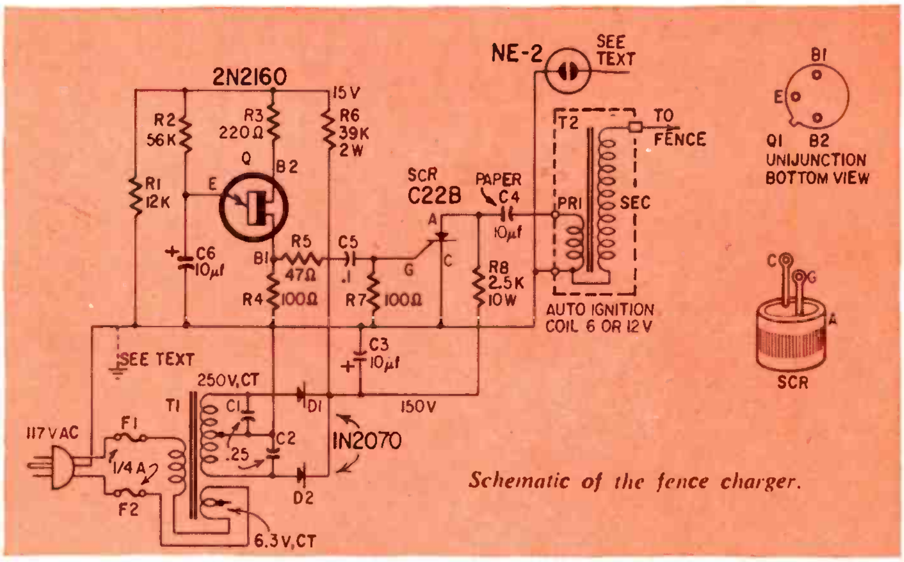
Safe, simple, reliable electric fence charger uses common parts.

By EARL T. HANSEN

AN ELECTRIC FENCE ENERGIZER MUST be effective, dependable, economical and, above all, safe. This unit is. The energy supplied to the fence is a high-voltage pulse from a standard automobile ignition coil. Dependability and long life are assured by all-solid-state design. Cost of parts is less than \$15, not including the ignition coil. Working from the ac line is far more economical than battery operation, so it is worth while to extend the fence wire to a sheltered power source.

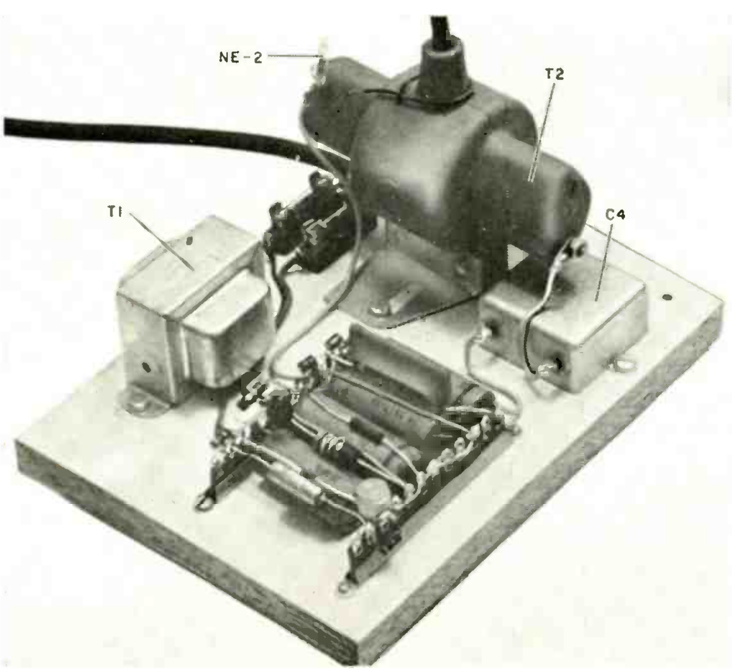
This system is safe for several reasons. The short-duration-pulse principle has been proved safe. Energy is present for only 1 millisecond during each second. This short duty cycle cannot cause a burn of any significance, or cause muscles to "freeze" to the wire. The short-circuit current and total energy are limited to a safe value by the characteristics of the coil and capacitor. Ac line voltage is prevented from reaching the fence in two ways: transformer isolation, and an earth ground on the ignition coil which would blow a fuse in the event of a shorted transformer or wiring error. Failure of one or more components would blow a fuse or stop the unit from working. In no case could a dangerous voltage be present at the output.

Transformer T1 and the associated circuitry form a 150-volt dc power supply. The 6.3-volt ac winding is connected in series-aiding with the primary, to reduce the secondary voltage slightly. C1 and C2 serve a dual purpose. Most important is to protect diodes D1 and D2 from transients which can occur in this type of equipment. The capacitors also reduce the primary current by improving the power factor. This is important if a long ac feed line is used. C4 is charged to 150 volts through R8. The SCR remains cut off and appears as an open circuit to the charge, until triggered on.



Schematic of the fence charger.

C1, C2—0.25 μf, 400 volts
C3, C6—10 μf, 150 volts
C4—10 μf, paper or oil-filled, 150 volts or more
C5—0.1 μf, 100 volts
D1, D2—1N2070, or equivalent 400-volt silicon rectifier
F1, F2—¼-amp slow-blow fuses and holders
NE-2 or equivalent small neon lamp (optional, see text)
Q—2N2160, 2N2646 or equivalent unijunction transistor
R1—12,000 ohms
R2—56,000 ohms
R3—220 ohms
R4, R7—100 ohms
R5—47 ohms
R6—39,000 ohms, 2 watts
R8—2,500 ohms, 10 watts
All resistors ½ watt 20% unless otherwise noted
SCR—G-E C22-B, or equivalent 200-volt silicon controlled rectifier, 3 amp or more
T1—Pri. 117 volts; sec. 250 vct, 25 ma. 6.3 volts, any current (Knight 62 G 008, Stancor PS-8416 or equivalent)
T2—Any good 6- or 12-volt automobile ignition coil
Ac cord and plug, wire, base and miscellaneous hardware



The SCR fence charger. The line cord has 3 wires with 3-prong plug. If your electrical system does not have 3-wire outlets or grounded conduit, be sure to use direct external ground.

Q is a unijunction transistor in a relaxation oscillator circuit. R6 and R1 form a voltage divider to supply 15 volts to the oscillator. C6 charges through R2. When the charge on C6 reaches the breakdown point, Q conducts hard and discharges C6 from emitter to base 1 through R4. The resulting pulse developed across R4 is applied to the SCR gate through R5 and C5. The triggered SCR discharges C4 through the primary of T2.

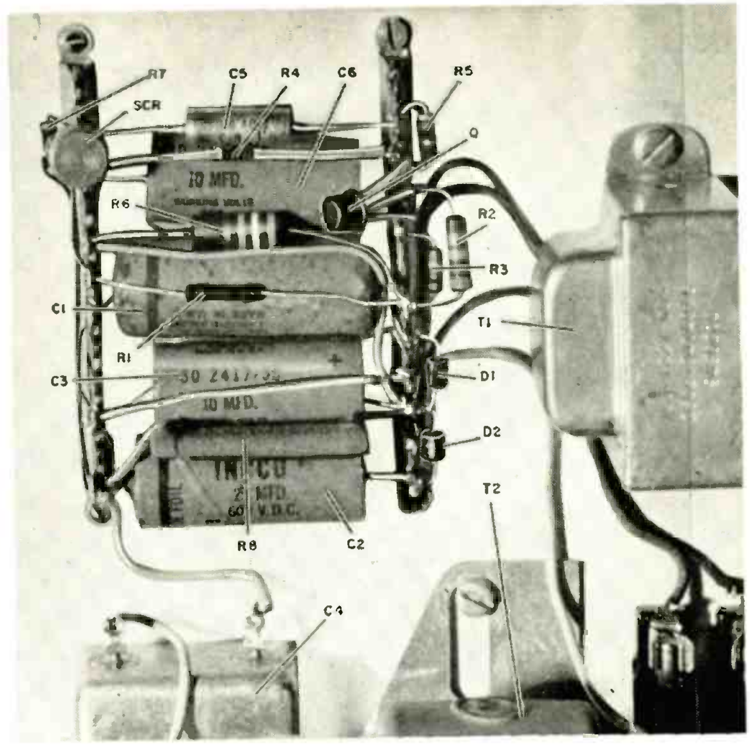
Since the turns ratio of T2 is approximately 100:1, a 15-kilovolt pulse appears on the secondary (when unloaded). The capacitive loading of the fence reduces this to half or less. As a part of the discharge cycle, the resonant characteristics of C4 and T2 cause the anode of the SCR to go negative, turning it off. C5 differentiates the initial pulse from Q. This assures a trigger pulse of shorter duration than the output pulse and allows a clean turnoff of the SCR. The peak short-circuit current is limited to approximately 50 ma. The pulse duration is about ½ millisecond. The repetition rate is about 2 per second.

Construction

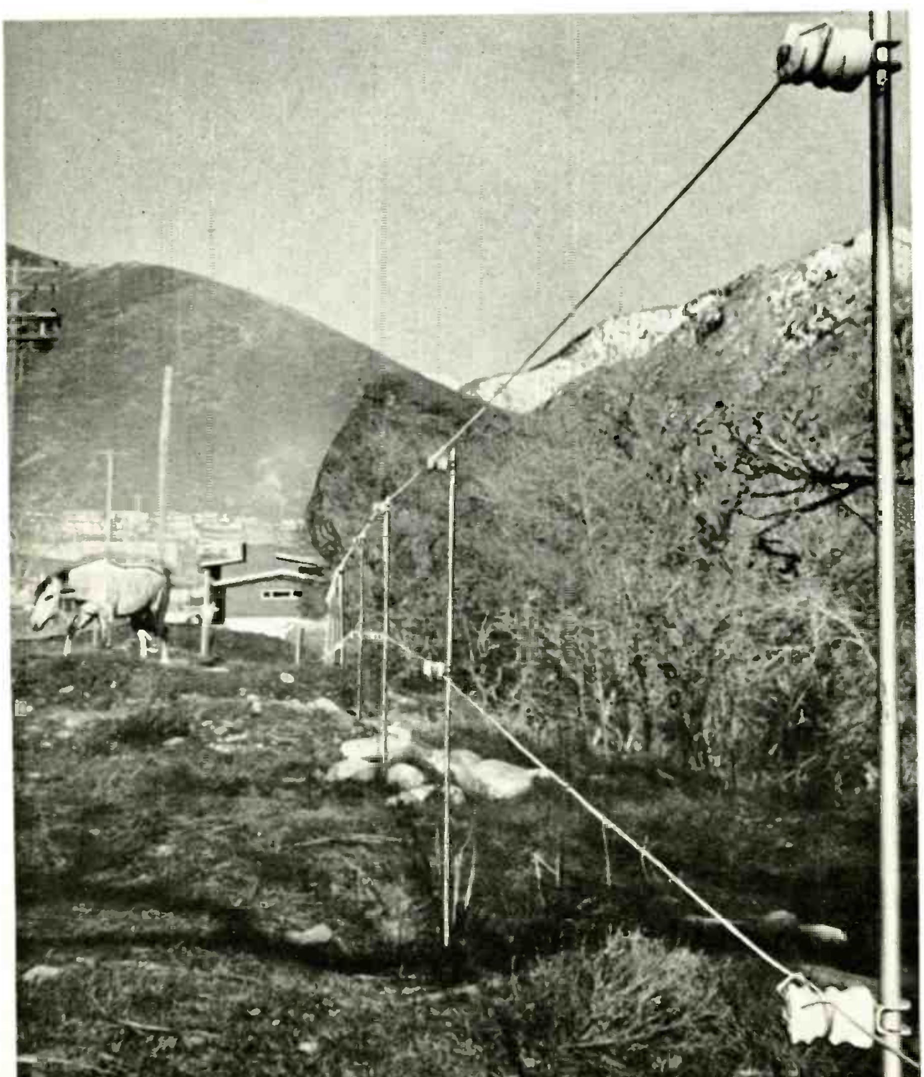
A wooden base simplifies construction and reduces cost, and is entirely adequate for sheltered use. None of the component values are critical, except to assure a high enough power and voltage rating. Parts layout is not critical and may be varied as desired. The phasing of the 6.3-volt winding must be tried to see that the secondary voltage is *reduced* slightly.

Three types of standard ignition coils were tried with equally good results. The new high-ratio transistor types were not tried, and are not recommended. The polarity of the primary is not important. However, if the terminal common to both primary and secondary is known, make it the ground connection.

Details of small-parts wiring. Two solder-lug strips support all the pigtail components and provide test-points at every junction. A paper capacitor is a must for C4. A bath-tub unit like that shown may not be readily available. Molded paper tubulars may be paralled to make a satisfactory substitute of the required capacitance.



Simple electric fence keeps horse inside his plot.



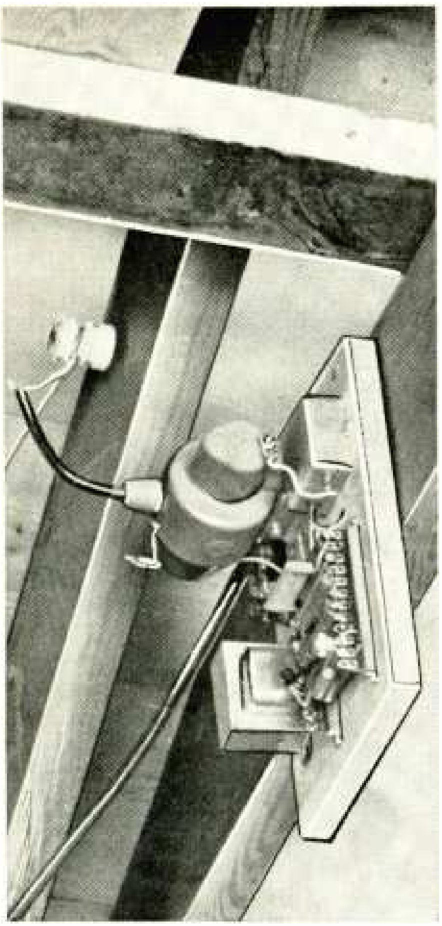
Electrolytic (polarized) capacitors are *not* satisfactory for use as C4; paper or oil-filled types are recommended. (Electrolytics were tried but the SCR would not always turn off after the discharge cycle when the output was shorted to ground.) Values less than 10 μf may be used, with a decrease in output energy.

The anode (case) of the SCR may be connected by clamping, or by soldering if you take care not to overheat it. Heat sinks are not required for either of the semiconductors. The short duty cycle causes no heating.

The neon bulb (NE-2) is an optional visual monitor. Its ungrounded lead is a few inches of wire positioned an inch or two away from T2's secondary output lead. The bulb flashes during normal operation but ceases if the fence becomes grounded.

If a three-prong grounded ac outlet is not available at the planned location of the unit, the internal ground circuit *must* be brought out separately and connected to a *good* earth or waterpipe ground.

When the completed unit is first turned on, it may not operate immediately. It may take a few minutes for C6 to "form" after a period of shelf idleness. During operation there is a slight ticking sound and the unloaded output should produce a ½-inch or longer



Fence charger installed on joist in barn. Insulated high-voltage lead can be seen coming from coil T2; it's soldered to fence wire suspended from knob insulator.

spark. The pulse rate may be increased up to 5 per second by decreasing R2. Faster rates will not allow C4 to charge fully and the output will be reduced.

Using the fence charger

Electric fence materials and practices are standard and will not be discussed here. The unit pictured has been in operation for several months, energizing a quarter mile of fence with no trouble. It controls a frisky horse very well. Operation is not affected by temperature extremes. The system is effective in the wettest weather. The maximum length of fence that can be energized effectively is not known. However, the output energy of this charger is equal to that of the best commercial line-powered units.

Radio and TV interference is negligible and cannot normally be detected 100 feet away on the broadcast-band or higher frequencies. However, there can be noticeable interference if poor fence insulation allows visible or audible sparking to occur. This of course should be repaired. Power consumption is less than 20 watts. Prolonged short circuit of the output will not damage the charger. END

What's a Keyed Circuit?

By JACK DARR
SERVICE EDITOR

Keyed circuits (or gated circuits—same thing) crop up more and more in today's electronics, and especially in TV. The best-known ones are used for agc, to pick the agc voltage only from the horizontal sync pulses for better noise rejection.

But there are other kinds, for other jobs. In a color set, you'll find one usually labeled "Burst Keyer" (Fig. 1). Here it controls the burst amplifier through the common 1,800-ohm cathode resistor. On the plate, there's burst and video from the video amplifier. How do we make the circuit react only to burst? Key it.

Notice the connection to pin 2 of the 6AN8 marked "flyback pulse". The burst is on the back porch of the horizontal sync pulse. Element voltages are arranged so that the burst keyer (triode section) keeps the burst amplifier (pentode section) cut off during sweep time, so that no video gets into the burst circuits. But during horizontal *retrace* time, the flyback pulse opens the gate and lets the burst amplifier amplify burst. (See Fig. 2.) Eventually the burst ends up controlling the 3.58-mc crystal reference oscillator through the phase detector circuit.

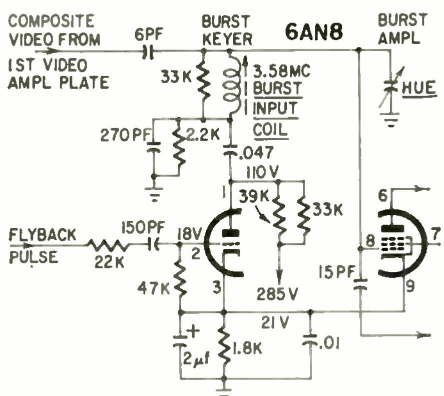


Fig. 1—This circuit separates color burst from rest of signal. Keyer turns amplifier on and off with flyback pulse.

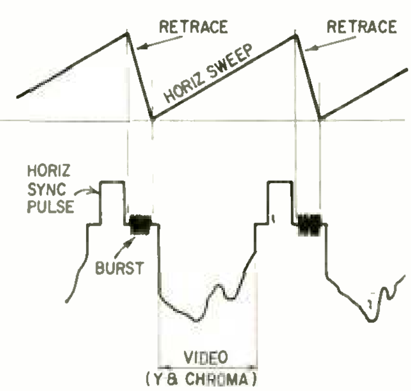


Fig. 2—Time sequence of events in composite video and sweep circuits. Gate opens just long enough to let burst through during horizontal retrace.

Now look at Fig. 3. These are color demodulators. At the input, from the bandpass amplifier, we have two signals mixed together at the transmitter, and we have to recover the separate signals.

To do it, we can use another gating circuit, but this time *phase* is the key, not amplitude, as it was with the burst circuit. The two signals, mixed though they may be, are in *quadrature*—90° apart in phase. Now see how the cathodes are connected: both to the same source (the 3.58-mc reference oscillator, through a transformer), but one goes direct and the other through a phase-shift network. The shift is exactly 90°.

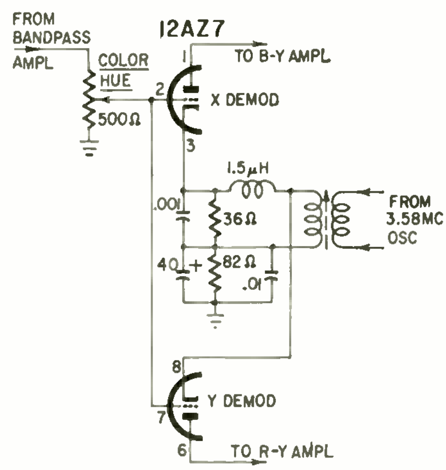


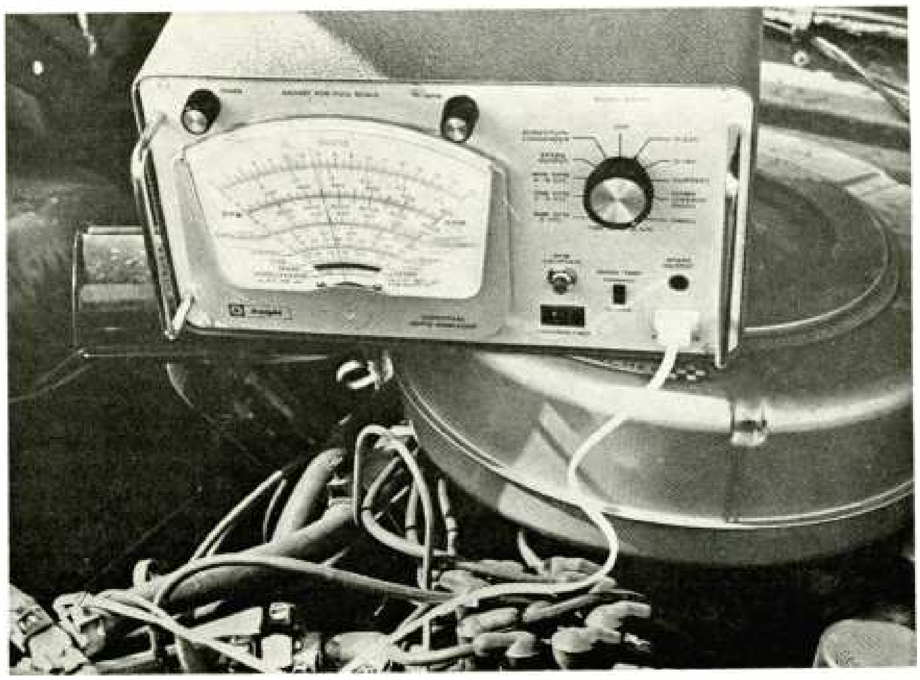
Fig. 3—A different kind of keying uses phase rather than amplitude to route components of composite color signal along proper paths.

Each tube conducts only when its grid and cathode voltages are in phase, not when they're 90° apart. So only that part of the grid signal which is at that moment in phase with the 3.58-mc reference at the cathodes gets through. In other words, the tubes are keyed by the phase of the reference oscillator voltage, and the B-Y and R-Y signals are sent along the right paths.

There! That's not so tough, is it? END

Service Your Car with an Electronic Auto Analyzer

COVER STORY



AMONG ELECTRONIC TECHNICIANS ARE many do-it-yourself auto enthusiasts who fool around with their own car maintenance, often for fun. Most of us understand the electrical system of a car, and many of us would service our own cars' "electrics" if we had the proper instrumentation.

This Auto Analyzer measures about 90% of the electrical functions of a car. It is primarily a dwell-angle meter, a tachometer and a vom with ranges specifically covering the electrical values found in a car. It also has some extra functions.

The entire unit is self-contained, operating from four size-D flashlight batteries, built in. It is housed in a steel case measuring 6½ inches high by 12½ wide and 5½ deep. A 12-position switch selects functions and ranges. The front panel includes an OHMS adjust control which sets the shorted-probes full-scale setting, an RPM control which, when the RPM CALIBRATE button is pressed, also sets full-scale meter deflection, a forward–reverse diode test switch, a spark-output neon flasher bulb, and two cable sockets. One is for current measurements and the other for all other tests. Solid metal handles on the front panel extend 1½ inches and are used for toting as well as for protecting the meter in case of rollover. A latched trap door in the rear is access to a storage compartment where the cables are kept when not in use. The battery compartment has a screw-on cap on the side of the case for easy replacement of batteries.

What it does

Dwell Angle. One important adjustment in an ignition system is the dwell angle of the breaker points. Dwell angle is the rotation period in degrees during which the points remain closed. The dwell-angle circuit is simply an ohmmeter, with the scale reading in degrees, which averages the time during which the points are closed. In the case of an 8-cylinder engine, for instance, a complete point action segment is ⅛th of 360°, or 45°. Thus 45 is the full-scale figure for checking dwell of an 8-cylinder engine. If points are closed half the time, the meter pointer would be at mid-scale: 22½°. A diode added to the circuit keeps the car battery voltage from affecting the readings.

Tachometer. The tachometer measures a pulse rate, which you read on the meter in terms of engine rpm. Three transistors and associated circuitry are a Schmitt trigger pulse counter. Two of the transistors are a pulsed square-wave generator. Pulses are taken from the primary of the ignition coil by merely clipping the test leads across the one primary terminal and ground. Four shunting variable resistors set calibration points for ranges of tachometer speed and engine cylinders.

Vom. The voltmeter has two ranges: a 3.2-volt range to check individual battery cells, and a 16-volt range for the entire 12-volt battery. An excellent way to check battery condition or capacity is to discharge the battery at three times the ampere-hour rating for 15 seconds. If the battery reads 9¼ volts after this test, it is good. A similar check can be made by cranking a warm engine for 30 seconds (with the distributor center wire pulled out), after which the battery should read 9½ volts or more.

Current measurements are made through an external heavy metal shunt strip. The meter reads the voltage drop across a portion of this shunt. With the shunt external, the instrument itself does not need to carry heavy currents. The shunt strip has one end slotted to fit under regulator or generator terminals. Approximate figures are provided with the instrument as a general guide to proper operation. They will vary from make to make; consult auto maintenance manuals for exact figures.

An ohmmeter position measures the resistance of the secondary winding on the distributor coil and of the ignition cable, and is an excellent continuity checker for many areas of the car's electrical system.

How you'll work with it

Dwell angle adjustment. Dwell angle is the total time in degrees during which the ignition breaker points on an engine remain closed during the explosion cycle of each cylinder. The explosion cycle is, as previously stated, 45° for an 8-cylinder engine (60° for 6 cylinders and 90° for 4 cylinders). If the points are closed during half the time of the explosion cycle, they are said to have a dwell angle of 22½° (half of 45). On the Knight-Kit Auto Analyzer, full-scale deflection for an 8-cylinder engine is the 45° mark (like shorting the prods of an ohmmeter), and is the equivalent reading of breaker points closed all the time—an impossible situation, of course. If the points are open half the time and closed half the time, the reading would be half-scale or 22½°.

To get best engine performance, dwell angle adjustment must be correct. The points need to close and stay closed long enough to saturate the core when current flows in the ignition coil primary. They need to open soon enough for the plug to finish firing during the rest of the 45° of rotation. When the points open, the magnetic field collapses fast and produces a high secondary voltage (20,000 to 30,000 volts). A counter-emf puts voltage in the capacitor across the points on the primary. On the capacitor's discharge, another shot of secondary voltage occurs, but lower in value. This continues as a damped oscillation.

Proper dwell angle is specified by the car manufacturer for a particular engine. Quoting from the shop manual for '65 Fords and Mercurys, the proper dwell angle for 8-cylinder engines is from 26 to 28½°; for 6-cylinder engines, 35 to 38°; transistor ignition systems, 22 to 24°. These figures are at idle speed.

To measure the dwell angle on your car, plug the white cable into the white receptacle (lower right corner) of the Auto Analyzer, set the function selector knob to DWELL, short the leads and adjust the OHMS knob to full scale. Open the hood of your car, set the Auto Analyzer on the fender, making sure the instrument won't fall off while the engine is running. Connect the black covered alligator clip to any chassis metal, and the red covered clip to the primary terminal of the ignition coil. Let the engine idle and read the meter. For 4-cylinder engines, read one-half the 8-cylinder scale. There is a separate scale for 6-cylinder engines.

If an adjustment is called for, turn the engine off, remove the distributor cap, remove the high-voltage lead from the center of the distributor cap and ground it. Removing the cap is not necessary for an adjustment on Chevies and possibly some other cars. They have an adjustment screw access from outside the distributor body. You might check your car for this. For cars requiring cap removal, loosen the screw of the stationary contact of the points and shift the stationary contact closer to the movable contact slightly if the dwell angle read low, or away from the movable points if the angle read high. If you are doing this work alone you will need a remote control starter cable to turn the engine over. In this case the ignition switch can be off. If you can get someone to assist you, have him turn the engine over with the ignition key starter switch. Crank the engine with the starter and read the meter again. You can adjust points while the engine is being cranked, if you stay clear of the fan blades or belts. With the secondary high-voltage lead grounded there is no danger of shock.

Adjusting idle rpm. Connect the instrument to the primary of the ignition coil in the same way you did for dwell angle measurement, but turn the selector knob to 1,200 RPM, 4–8 CYL., in the case of an 8-cylinder engine. Run the warmed-up engine at idle speed; press the red RPM CALIBRATE button and adjust the upper, middle knob for full scale reading. Release the button and the meter will read rpm.

The adjustment for proper rpm is made at the adjustable stop screw on the accelerator lever near the carburetor, not the idle needle valve on the carburetor. Again, proper idle speed should be obtained from the manufacturer's manual. 6-cylinder engines should idle at about 500 to 525 rpm, for manual-drive or automatic-transmission cars. Cars with automatic transmissions must be adjusted with the shift lever in DRIVE, but be sure the emergency brake is pulled up tight. 8-cylinder engines will idle at about 575 to 600 rpm for manual-transmission cars, and about 475 to 500 for automatics.

The tachometer function of the Knight-Kit Auto Analyzer may be used for a number of other adjustments—for example, to adjust the idle-adjust needle valve on the carburetor for top rpm.

Miscellaneous functions. There are several other valuable functions in the Knight-Kit Auto Analyzer. A spark output indicator shows spark energy on the meter and also flashes a neon light on the front panel. The spark pulse charges a 0.22-μf capacitor. The discharge reads on the meter. It is a relative indicator to assure that the sparks at each plug are equal. One position on the function switch connects an internal 0.22-μf capacitor to the test leads for breaker-point-capacitor (condenser) substitution. A polarity-reversing switch in the ohmmeter circuit is used to check silicon diodes in alternators. The relative forward and reverse resistance of the diodes are compared.

This instrument is available in kit form only. That's what makes the price of $49.95 possible. I found it easy to build. It took me 7¼ hours, and another 15 minutes for calibration. It uses three 13-terminal tiepoint strips lined up in parallel, and most of the components connect from one terminal on a strip across to the same terminal on the facing strip. No printed circuit boards are used; all wiring is point-to-point.

The front-panel handles form an excellent support base for working on assembly and wiring. Many of the parts are packed in separate vinyl bags with particular assembly sections. A nice feature, and a new trend with Knight-Kits, is the separate step-by-step assembly manual, and separate operating manual.

A separate cable with an ac plug and built-in limiting resistors is used for the internal tachometer calibration from the 60-cycle line. The four calibration pots for the tachometer ranges are reached through holes in the side of the case. These calibration adjustments are made only once for the life of the instrument.—*Louis M. Dezettel*

SPECIFICATIONS

(All specifications are the manufacturer's)
Dwell Angle: 0–45° for 8-cylinder engines; 0–60 for 6-cylinder engines; 0–90° for 4-cylinder engines
Tachometer: 0–1,200 rpm, 0–6,000 rpm; 4-, 6-, 8-cylinder engines
Voltage: 0–3.2, 0–16 volts dc
Current: 0–90 amps dc
Ohms: 0–20,000 ohms; 100 ohms center scale
Substitute capacitor: .22 μf
Meter: 7-inch with 10 scales
Power: four size-D flashlight cells
Knight Electronics Corp.
A subsidiary of Allied Radio
100 N. Western Ave. Chicago, Ill., 60680

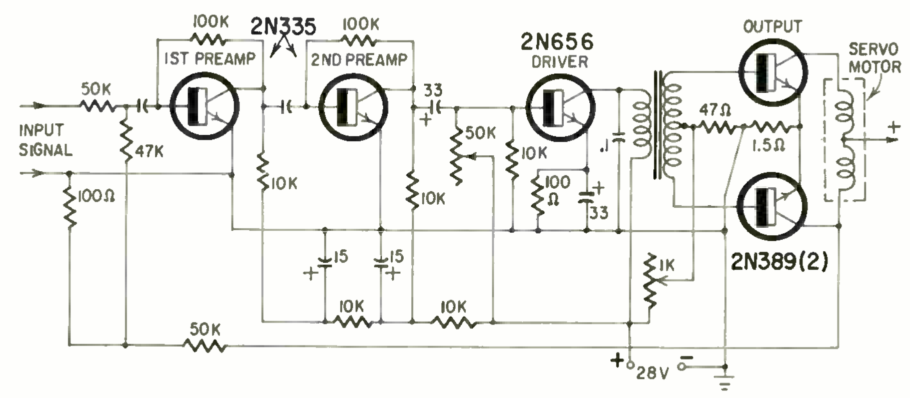
SERVO AMPLIFIER HAS HEAVY FEEDBACK

THIS CIRCUIT IS DESIGNED TO OPERATE A servo. Especially useful for controlling altimeters in an airplane, it is compact and unaffected by temperature extremes. For example, it can deliver 2.1 watts per cu. in., 1.5 watts per oz. Input is 50,000 ohms; power gain is 85 db.

All transistors are silicon. Feedback in the first two stages is provided by resistors between collector and base. The final stage has a resistor in series with its emitter. Overall feedback is obtained by tapping from the output to apply to signal to the input stage.

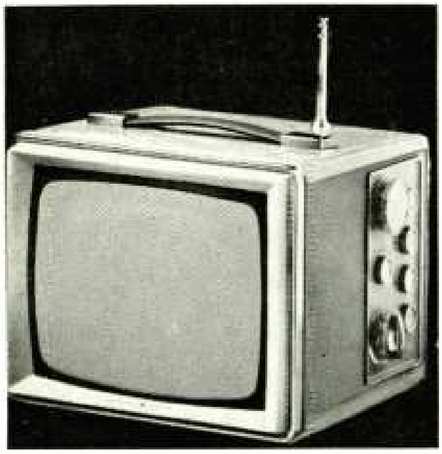
Output is delivered to the coils of the servo. The amplitude and phase of the amplified ac signal determine its speed and direction.

Further details may be obtained by consulting patent No. 3,105,199 awarded to Oscar Heller, assigned to Bulova Research & Development END



Sony Micro-TV 4-203UW

Philco N-1052BK



General Electric TR-803

Delmonic's 4T-40UHF

TRANSISTOR TV PORTABLES

A penetrating look at an all-transistor midget—particularly at the horizontal deflection circuits, where the greatest differences between tube & transistor practice appear.

ROBERT F. SCOTT
TECHNICAL EDITOR

AROUND THE BEGINNING OF 1964, THE one or two transistor television sets on the market were considered novelties. Few technicians expected to be called on to service any one of more than a dozen models within the next year. Well, there are at least 14 models on the market. You will have to service them and it is necessary to be familiar with their basic and specific circuits if you are to do the job rapidly and profitably.

Transistor sets use the same basic circuits as tube sets, but you'll find more stages in some sections. There will be a few more service controls; waveforms and signal polarity will vary from one model to the other. Diodes will be more numerous than in tube sets. You'll have to watch for the troubles they can cause when defective. Some of the diodes have conventional functions—afc phase comparators and ratio detectors. Others are used as transient suppressors, wave shapers, dampers, voltage multipliers and signal limiters.

Too, you may find p-n-p and n-p-n transistors in the same circuit. You'll have to be extra careful when measuring voltages. Taking measurements on an n-p-n stage and interpreting them as p-n-p or vice versa can really gum up your troubleshooting.

This article describes a typical transistor TV set. A detailed block diagram (Fig. 1) and a schematic (Fig. 2) of the horizontal deflection circuit will give you an idea about what you will be up against.

A typical transistor portable

The block diagram is of the Singer TV-6, a personal portable that uses 26 transistors, 14 germanium diodes and 6 silicon rectifiers. It uses a 6-inch (diagonal measurement) 90° rectangular picture tube with a 12-volt 150-ma heater and electrostatic focus. The i.f. circuitry is a conventional intercarrier type. The sound and video carrier i.f.'s are 22.25 and 26.75 mc, respectively. The video bandwidth is 3 mc. The cabinet is 6 inches wide, 7 inches high and 7 inches deep (8 inches with ac power supply). It weighs 5.7 lb (7.5 lb with ac supply).

The tuner is a turret type using three mesa transistors. The oscillator slugs can be adjusted through a hole in the fine tuning knob. The 75-ohm built-in antenna is normally connected and matched to the tuner. Two input jacks are provided for a 300-ohm external antenna. The DX jack is used in weak-signal areas. The LOCAL jack connects the antenna through a 15-db attenuator pad. This jack is used when overloading causes poor sync, tearing, negative pictures or crossmodulation. The built-in antenna is automatically disconnected when an external antenna is plugged in.

The video i.f. amplifier is a four-stage circuit using mesa transistors. D1 is connected in series with the emitter resistor in the first stage. It stabilizes the bias and minimizes crossmodulation. D2 is the overload diode connected across the primary of the second i.f. transformer. It is biased so it does not conduct on normal signals. Very strong signals override the bias. The diode conducts and reduces the gain by damping the i.f. transformer. Video detector D3 feeds the video and agc amplifiers.

The video amplifier uses drift transistors. The first is a combined common-emitter amplifier and emitter follower. The 4.5-mc intercarrier sound signal is developed across a sound take-off transformer in the collector circuit. Composite video for the video output and sync circuits is taken off the contrast control in the emitter circuit. The emitter resistor (contrast control) is bypassed by a series-tuned 4.5-mc trap. The video output stage feeds the cathode of the picture tube.

The 4.5-mc sound i.f. amplifier uses drift transistors in conventional capacitance-neutralized circuits. The first stage is a straight amplifier. The second is an amplifier-limiter. D6 and D7 are ratio detector diodes.

The sync separator

Composite video from the detector is fed to the sync separator base. D8 removes any noise pulses riding on the sync pulses. The sync separator is a p-n-p alloy transistor biased to cutoff so it conducts only on the sync pulses. The amplified and inverted pulses are fed to the sync amplifier—an n-p-n transistor also biased to cutoff. Sync pulses are further clipped, shaped and fed to the vertical and horizontal deflection circuits.

Keyed agc

The composite video from the detector is fed to the base of the agc amplifier, a p-n-p transistor. A keying pulse, developed during the horizontal retrace time, is tapped off the flyback transformer and fed to the oscillator through D4. The amount of collector current that flows is determined by the height of the sync pulses. The resulting negative agc voltage is fed through D5 to the base of the second video i.f. amplifier. The first i.f. amplifier is controlled by returning its base to the second i.f. amplifier's emitter.

Singer TV-6 described in this article

On strong signals, the agc amplifier develops a higher negative agc voltage. This increases the bias on the i.f. amplifiers and reduces their gain. The AGC control, between collector and ground, sets the agc level.

Horizontal deflection circuit

If you want an idea of what you can expect in the way of circuitry, take a look at Fig. 2, the schematic of the horizontal deflection circuit. Impressive, isn't it?

Negative-going sync pulses from the sync amplifier are fed to the base of the sync splitter, a p-n-p alloy transistor. The sync pulses developed in the emitter and collector circuits are applied simultaneously to the afc phase-detectors, D10 and D11. A comparison signal is tapped off the horizontal deflection circuit. A correction voltage is developed and fed to the afc amplifier through an integrator network consisting of the .005-μf and .02-μf capacitors and the 6,800-ohm resistor. This signal is amplified and fed to the horizontal blocking oscillator. The ring-

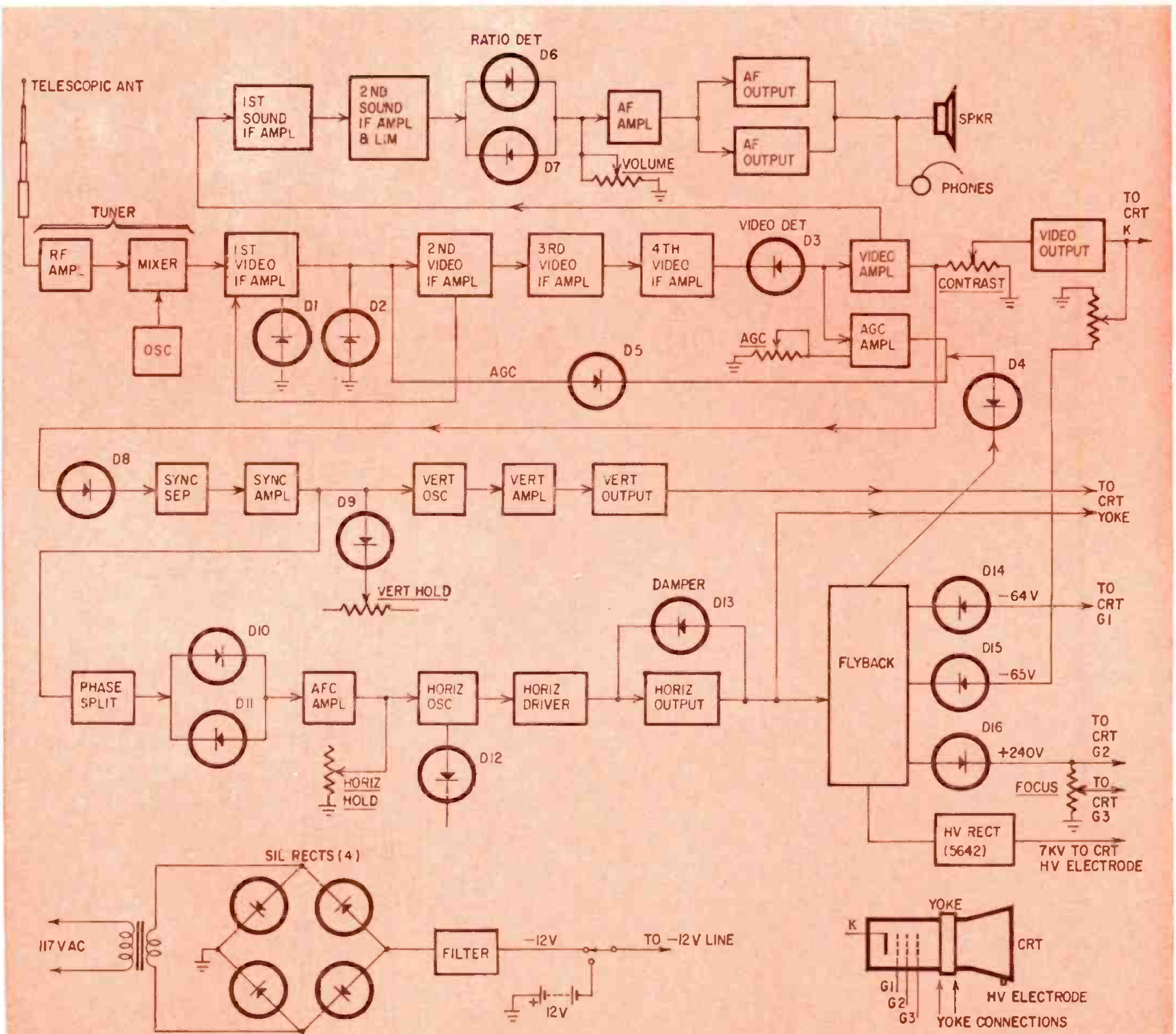


Fig 1—Block diagram of Singer TV-6.

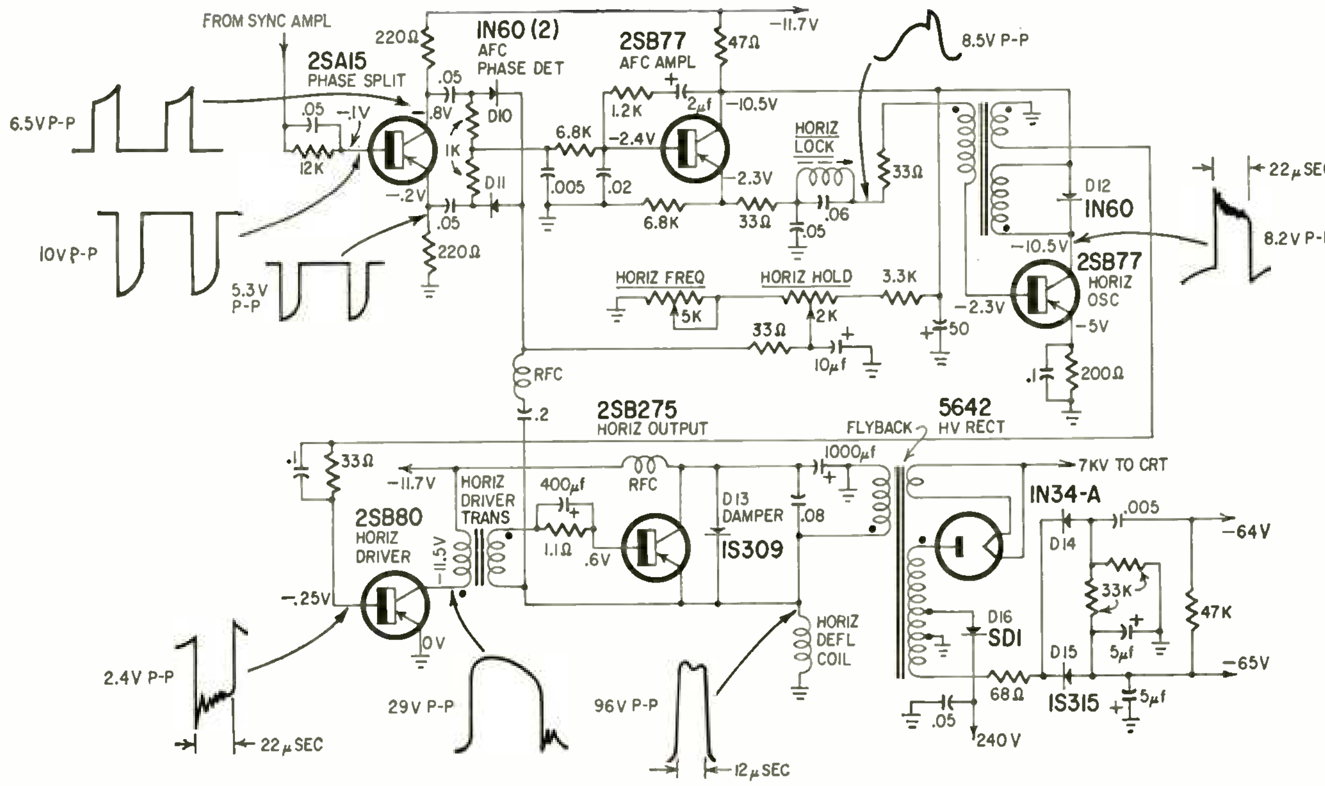


Fig. 2—Horizontal deflection circuit of the Singer TV-6.

Sharp Model TRP-601

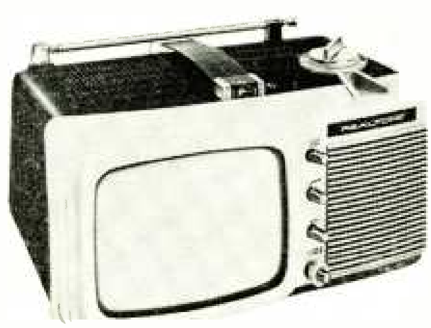
Channel Master's portable

ing coil in the emitter circuit is the horizontal lock control that provides precise sync.

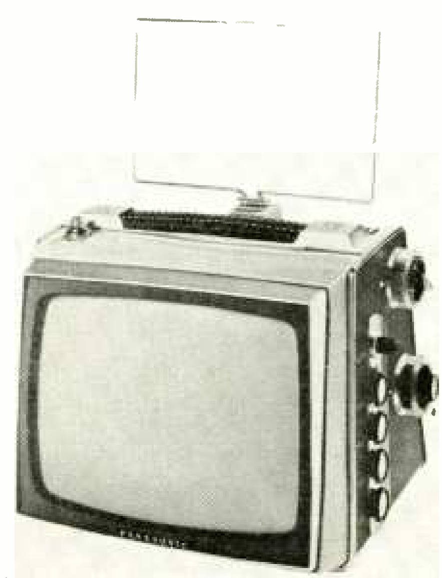
The horizontal driver is fed from an output winding on the oscillator transformer. The amplified drive signal is transformer-coupled to the horizontal output transistor. This stage produces high-current pulses at the emitter that feed the horizontal deflection coil in the yoke, producing a sawtooth current in the coil. Damper D13 conducts at the start of each sweep and damps out oscillations (ringing) in the deflection coil at the start of each trace.

The primary of the flyback transformer is in parallel with the horizontal deflection coil. The output emitter current is stepped up and rectified to produce 7,000 volts for the high-voltage anode of the picture tube. The high-voltage secondary is tapped to supply intermediate voltages. D14 and D15 supply approximately 65 volts to bias G1 in the CRT. D16 provides plus 240 volts for G2 and the focus electrode.

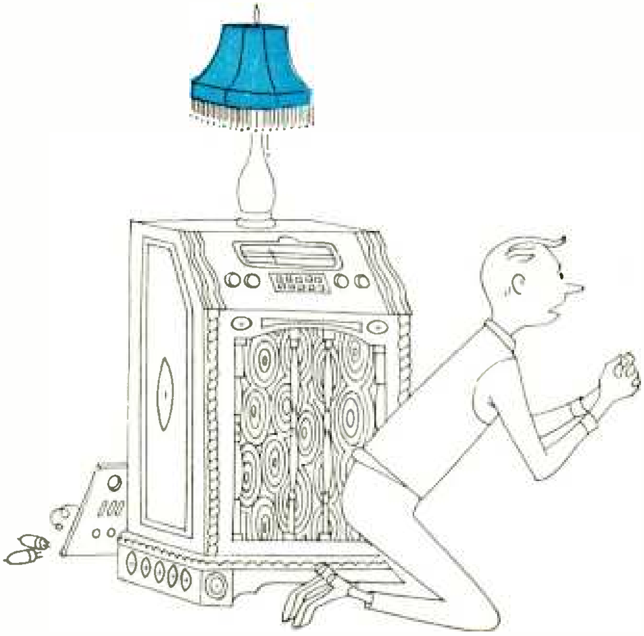
This has been a brief look at a typical transistor TV receiver. Future articles will analyze various sections of a number of similar receivers and will cover troubleshooting and circuit adjustment. Some of the sets to be covered are the Delmonico 4T-20U, Panasonic Mitey-9, Realtone TR-6867, Sony Micro TV 5-303W, Sharp TRP-601, Candle MT-510, General Electric TR805AEB and the Philco Nomad N1052. END



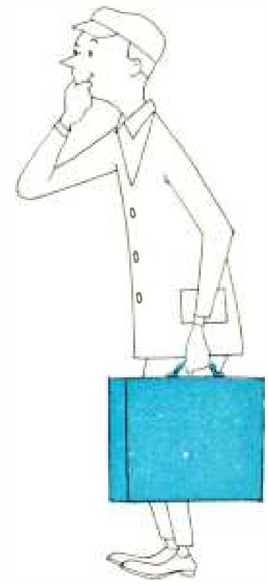
Realtone Transvision TR-6867



Panasonic Mitey 9U



RESTORING OLD RADIOS



Knowing how to get those old Stromberg-Carlsons and other quality receivers back in shape will endear you to many!

By JACK DARR SERVICE EDITOR

ALL OF US GET THIS QUESTION ONCE IN a while: "I've got an old radio at home. Beautiful cabinet, and my wife won't throw it away. It hasn't worked for a long time. Can you fix it?"

Truthfully, a lot of these jobs aren't too profitable, but they're almost always good "prestige" jobs: other men have probably tried to fix them, without results! If you can straighten them out and make them play again, you have made a friend. Of course, don't make any rash promises until you've *seen* the radio!

It will usually be one of the large console types, possibly FM–AM, with a record changer. Here is one possibility: after the radio is repaired, you have a good opportunity to sell him a modern 4-speed changer to replace the original 78-rpm unit.

Little radios usually aren't worth the effort. However, the old RCA's, Stromberg-Carlsons, Capeharts and so on, are very well designed chassis capable of amazingly good reproduction if they're in good shape.

We'll give you a list of all the things which cause trouble in these sets. By checking them out methodically, you can restore the sets to full performance in a very short time, and gain a reputation as an electronic whiz!

First, check all the tubes. As a rough guess, any that are more than 50% "down" will give trouble. However, you'll find that weak tubes have surprisingly little effect on performance in some circuits, because of the very conservative design of first audio amplifiers, some i.f. stages, etc. Some tubes have prohibitively high prices: the Loktal series, for example, and some of the older types. A well stocked junk box can be very helpful indeed! Some tubes may be so old that your distributor will give you a bargain, just to get rid of them! In a few cases, substitution will be possible. Sets using octal-base tubes will be the easiest to restore, since there are so *many* octals around.

Next, check the filters. Age is the worst enemy of electrolytic capacitors; they dry up. Electrolytics are universal, and you'll have no trouble at all in finding suitable single-unit replacements. You may even be able to find duplicates of the original multiple-unit filter capacitors. There will usually be ample room in the chassis to install separate-unit filters (Fig. 1).

Watch out for unusual (to us, that is) filter networks. A lot of these sets used a "floating B-minus" circuit, with a voltage divider in the negative return for bias voltages. This is always filtered, as in Fig. 2. If this capacitor is included in the original filter block, its polarity will be *reversed*. Standard practice: re-

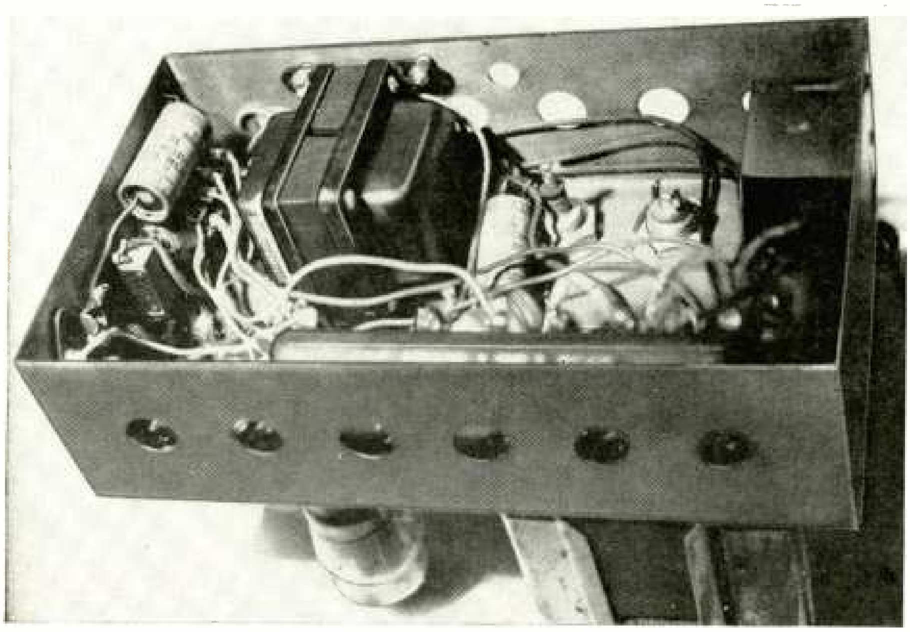


Fig. 1—Original wet electrolytics can be replaced with smaller modern dry units. Leave the old cans on the chassis for appearance's sake.

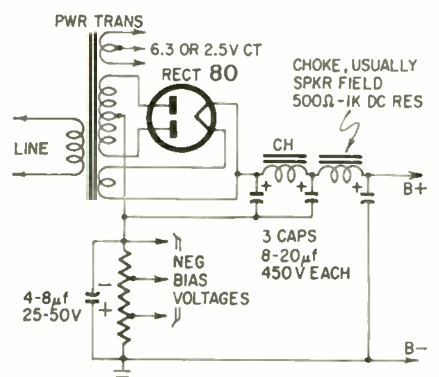


Fig. 2—Typical floating-negative power supply circuit common in older sets. Watch electrolytic polarity!

place main filters with an ordinary multiple unit, and the bias filter with a separate unit. Since these are always low-voltage, you can get a comparatively large capacitor in a small case, and there will be plenty of room for it. Omit this bias filter, and you'll get a "mysterious" hum that bridging the main filters won't affect at all!

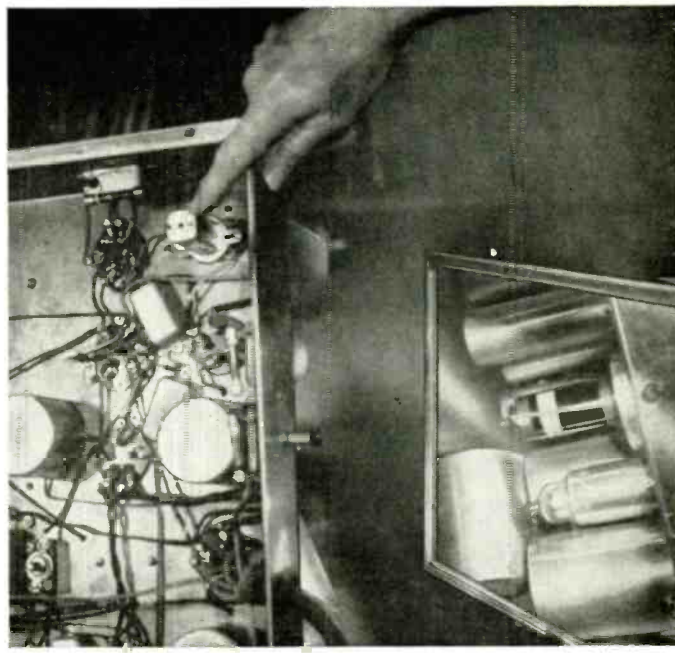
Notice in Fig. 2 that the negative connections of the main filter capacitors do *not* go to chassis, but to the center tap of the high-voltage winding on the power transformer! When making your initial checks on the radio, be sure that some technician unfamiliar with the circuit hasn't connected a replacement filter capacitor directly to ground! A quite common occurrence, and I've found that it often causes a severe hum.

After checking out the power supply, check out the resistors in the bias voltage divider. If these open, there will be no B-plus. If they should short to chassis, or be deliberately shorted to chassis by the aforementioned inexperienced technician, the bias voltages will be upset, and you'll probably have a mysterious distortion and hum. You'll need complete service data on all of these sets. Rider's old Radio Manuals, Beitman's Supreme manuals and factory service data are essential. Most of the sets we're talking about were built before Sams started printing Photofacts Folders! You need service data to check the value of the bias voltages.

Check the speaker and output transformer. Older transformers were prone to damage from electrolysis, which ate up the fine wire, causing an open circuit or high-resistance joint. A dc resistance check will catch it. The resistance of each half of push-pull transformers should be within 10% of the other, and speaker field coils should be within 10% of rated resistance.

Bad transformers must be replaced. Defective speaker field coils can sometimes be repaired, since the joint which causes most of the trouble is the connection between the fine-wire winding and the flexible lead on the outside of the coil. Carefully lift off the wrapping and look for the end of the lead; it will be sitting on a square of "empire cloth" (a yellow plastic-coated fabric) and will usually have a bright green spot at the end. This indicates corrosion. Clean away all traces of green, resolder the joint and check for correct dc resistance. If OK, spray clear plastic or coil dope on the winding, and replace the outer covering.

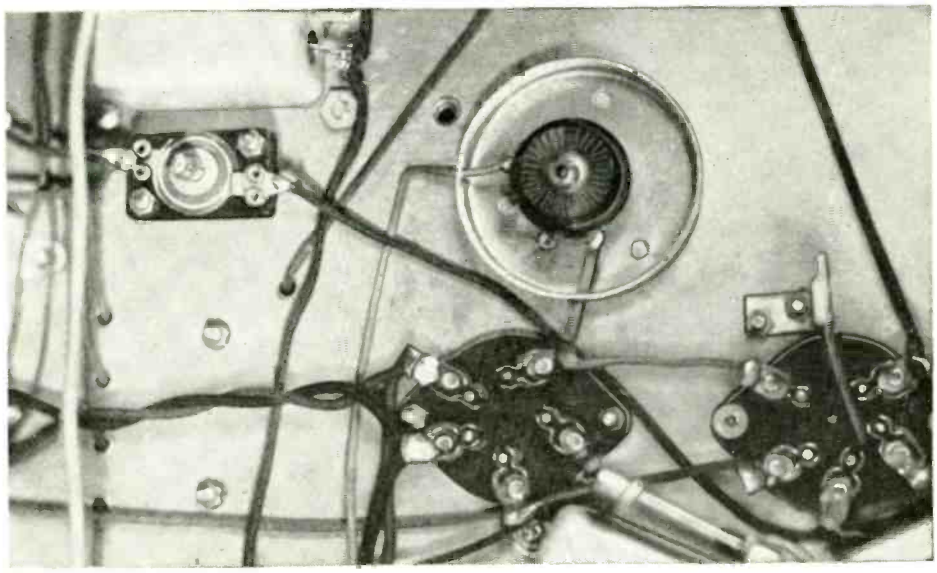
Check audio voltage-amplifier stages (there were often two or three), i.f. stages, mixer and oscillator for correct voltages. You will probably find dropping resistors changed in value, lowering the operating voltages. Check the screen-grid voltages especially, since



(Right) Original i.f. transformer can be replaced with modern small one. Mounting it below deck shortens leads, though top mounting would probably have done as well.

Mirror at right shows original transformer and shield can (removed) on top of chassis.

Underchassis view (below) of old radio. Round dish-like object is coil shield base. This one contains an rf choke. Wires corroded at point where they join terminals can often be repaired. Be sure to replace shields.



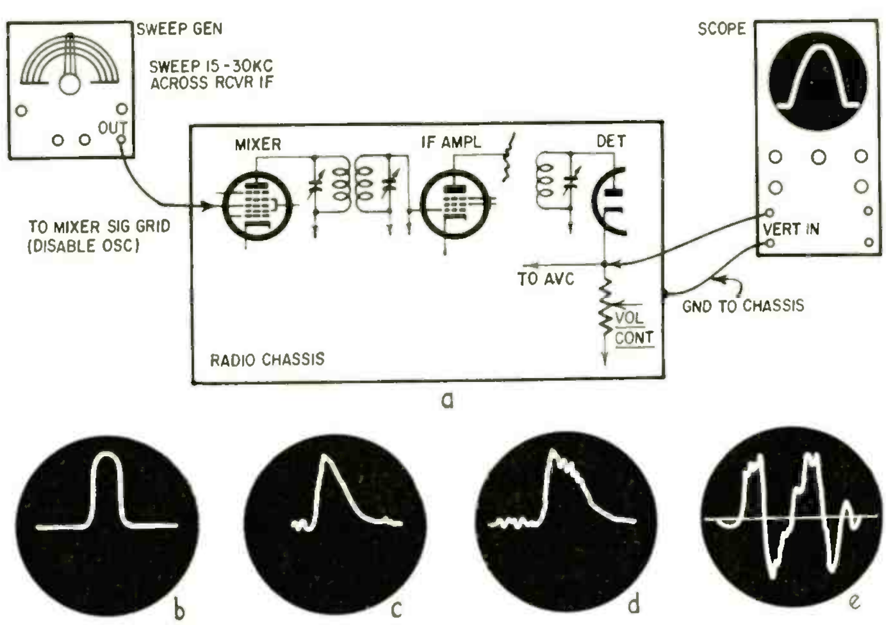


Fig. 3-a—Hookup for checking alignment and stability of i.f. stages. In b, an approximately normal response curve; c—incipient oscillation (note "triangular" shape); d—actual oscillation, squeals in audio; e—severe oscillation, probably enough to block receiver completely.

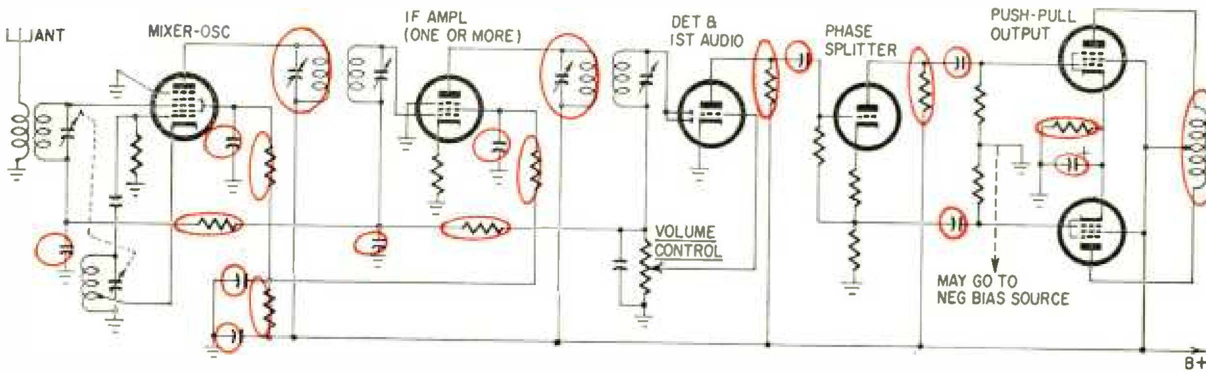


Fig. 4—Things to check, systematically, from speaker to antenna. This schematic is only a skeleton, showing basic parts.

low screen voltage will affect the gain of the stage a lot. You'll often find tetrodes or pentodes in first audio amplifier stages—watch out for low screen voltages here. Common practice was to use a 2.2-megohm or even larger resistor as a screen dropper, and a drift in this resistor can cause loss of screen voltage and a severe loss of gain, plus distortion.

Check mixer and oscillator supply voltages. Trouble with the signal-to-noise ratio can come from low oscillator injection voltage. Loss of sensitivity or selectivity or both can be due to low plate or screen voltages on rf or i.f. stages.

Watch out for leakage in coupling capacitors. Quick test: disconnect the grid end of the capacitor, or pull the tube, since these are all parallel-heater sets. Measure the dc voltage on the open end of the capacitor. If you find a steady positive voltage, replace the capacitor. Bypass capacitors in plate and screen supply circuits can leak and cause voltage loss there.

You may find i.f. transformers and oscillator coils open, too, from electrolytic corrosion. I.f. transformers can be replaced by the newer small ones. Watch out for too much gain in the transformer. If you run into oscillation, you may have to reduce the gain of the stage by reducing plate voltage, increasing bias, etc. Best check: hook up sweep generator and scope to make an i.f. response curve (Fig. 3). Look for traces of oscillation on the curve. If it's there, you'll be able to see it without any trouble at all. Fig. 4 is the basic circuit of a superhet with parts to be checked.

Novelty: I replaced an i.f. transformer in a very old chrome-plated-chassis job. To retain the appearance of the chassis, I put the original i.f. can (empty, of course) back over the new miniature transformer!

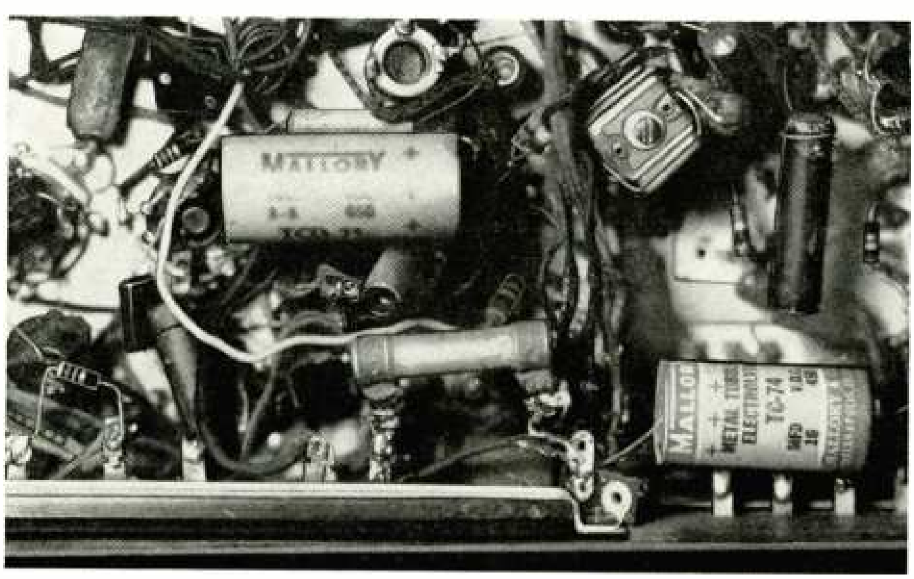
Band switches, volume controls, pushbutton tuners and any kind of control will probably be very dirty and noisy. A liberal application of spray cleaner will usually fix them up. Volume controls can be replaced by standard units, and band switches can be cleaned and the contacts tightened up by a careful working over with the slotted tip of a soldering aid, if they're worn too badly.

Hint: if the band switch is worn very badly, on a multiband set (one having several short-wave bands, as many of these did), the owner will probably allow you to cut out the short-wave parts, leaving only the broadcast band. Simply solder the band switch contacts together! Because of the complexity and time needed, I wouldn't recommend trying to *replace* a band switch, except in very unusual cases, and with the owner's knowledge that it's going to cost him *plenty!*

Wiring can be one of the worst problems. Rubber-covered wire deteriorates badly with age. So, don't *move any* of the wiring unless it is absolutely necessary. Cables that must be moved, speaker wiring, etc., should be replaced with new flexible wire. However, as long as the original wiring is left in place, it is usually safe enough. Sometimes you can lift one end of a wire, slip a piece of soft spaghetti over it and tack it back in place. This is a good way to cope with mouse damage. Mickey *loves* insulation!

This must be a "method" job: start at the power supply and work your way back toward the antenna, checking out every part as you go. It sounds like a two-week job, but it isn't. After a little practice, you'll be surprised how rapidly you can make a complete overhaul on one of these old crocks. I checked the time on my last one and it took just over 2 hours of actual bench time. I replaced four filter capacitors, seven resistors and 6 capacitors.

The final step should be a thorough cleanup of the chassis. Blow out the dust and wipe off wax, grease and less sanitary accumulations, and, most of all, clean up the dial glass until it shines! Also, be very sure that the dial cable, if any, is in good shape, not slipping. Clean up the cabinet, if it is not already clean (as many are), and you've got yourself a restoration all completed. END



Here's a set that's been worked on many times by many people, and shows its scars. Good idea to tie down large lead-mounting electrolytics. Flat "Candohm" divider resistor (bottom of photo) can be replaced in parts with 5-watt or bigger single resistors, if necessary.

Antenna Rotator Remote Control For TV, CB and Hams

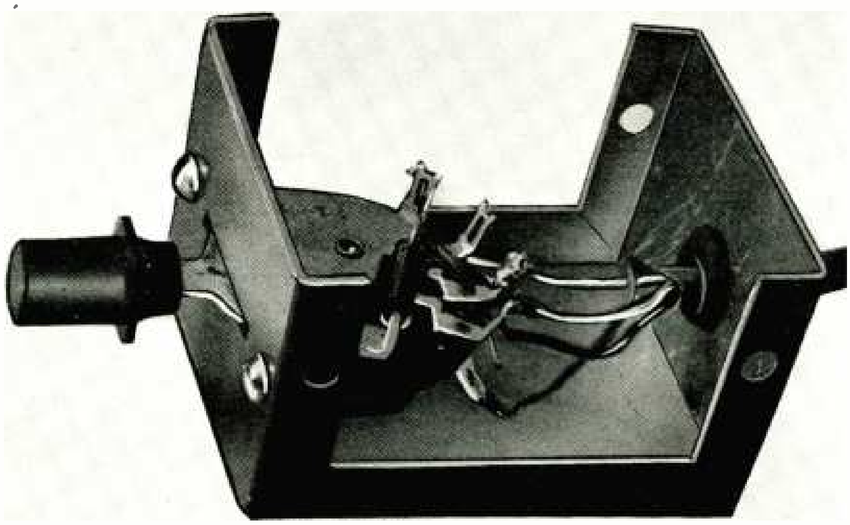
Simple lever-switch attachment gets direction-indicator and control-box off your operating desk. **By R. P. BINTLIFF**

FOR CONVENIENCE OF OPERATION IN A ham or CB station, the receiver, vfo, key, microphone and various control or accessory items are usually located within easy reach of the operator. The result is often an overcrowded operating table, with unoccupied space at a premium. My shack is no exception, but this modification of an antenna rotator control box has provided some relief.

The rotator in this case is an Alliance T-12, but the remote switching can be used with other rotators of similar design. The "stock" version is operated by a bar switch on the indicator control box close by.

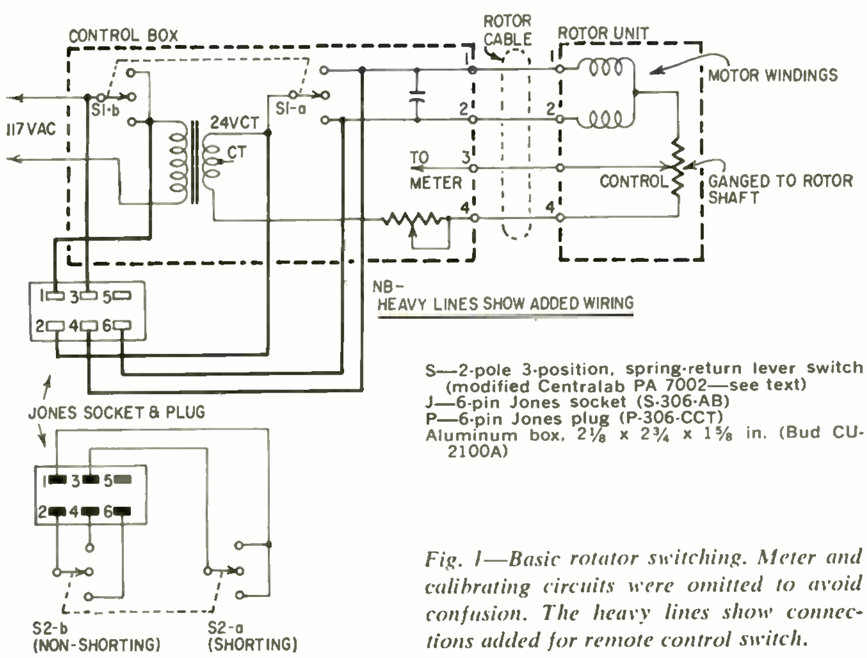
The remote-control unit shown in the photos permits relocating the indicator box to where you can see it without having it in the way. It consists of a two-pole three-position momentary-contact lever switch mounted in a 2⅛x2¾x1⅝-inch Mini-box. Instead of a Mini-box mounting, the switch can be installed on an existing control panel or at some other location, as you like.

A brief look at a simplified rotator schematic (Fig. 1) may be helpful.



It's only a switch in a box, and a 5-wire cable.

The rotator's reversible motor is operated by a dpdt center-off, spring-return switch (S1). The switch contacts are arranged so that S1-a first closes the 24-volt circuit and then S1-b applies primary power to the stepdown transformer. A remote-control unit must duplicate that switching sequence. The dashed lines show the added wiring connected to a Jones socket.

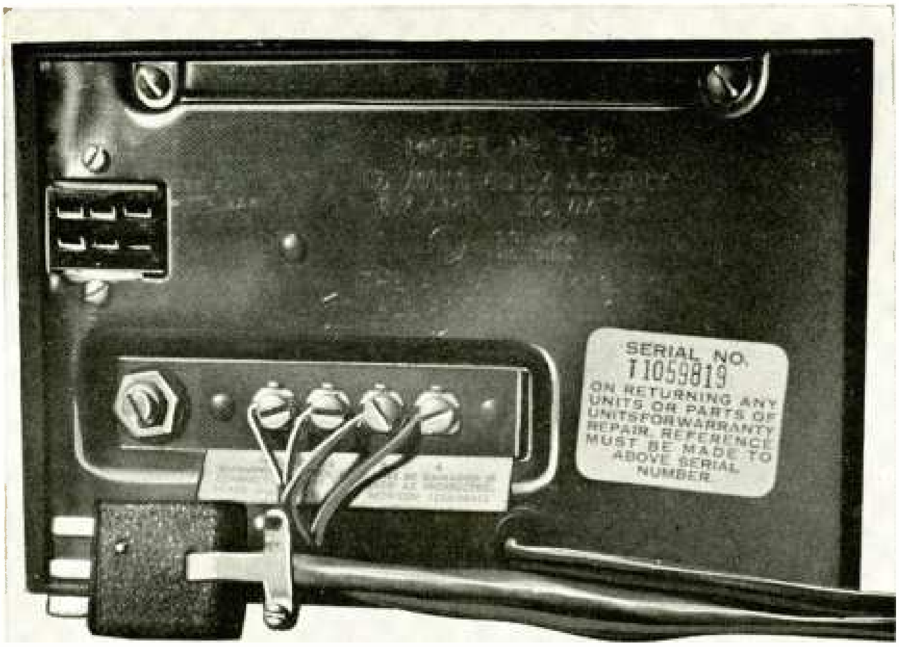


S—2-pole 3-position, spring-return lever switch (modified Centralab PA 7002—see text)
J—6-pin Jones socket (S-306-AB)
P—6-pin Jones plug (P-306-CCT)
Aluminum box, 2⅛ x 2¾ x 1⅝ in. (Bud CU-2100A)

Fig. 1—Basic rotator switching. Meter and calibrating circuits were omitted to avoid confusion. The heavy lines show connections added for remote control switch.

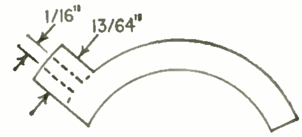
Lever switches are best suited for S2 in this application, since their switching sequence can be controlled. I tried bending the contacts of leaf-type lever switches, but switching was not completely reliable. So I used a wafer type of lever switch instead. The switch must be a momentary-contact one, because a positive-action switch can accidentally be left in either of the two energized positions. Continuing to apply power after the rotator's mechanical stop is reached may overheat the transformer and damage the rotator.

A Centralab PA7002 switch was selected because it is compact, has a positive spring action and is easy to modify. To alter the rotary contact of S1-b (for the switching sequence), straighten the bent-over tabs that fasten it to the wafer and carefully remove it. This shorting type contact must be filed down as shown in Fig. 2. An ignition or model-maker's file is useful here.



6-prong Jones plug shown at end of cable fits into mating female connector in new hole at upper left of control box back. Double-check connections before putting box into operation. Mistakes can do damage, and are a nuisance to track down later.

Fig. 2—How to file down rotary lever switch contact.



If you can scrounge a suitable non-shorting contact from your junkbox, you can save yourself some work. To install the new contact, stick its tabs into the correct wafer slots and bend them down tight.

A five-conductor cable and a six-pin Jones plug connect the control box to the indicator box. Install a mating socket as shown in the photo. The 1x¾-inch socket opening can be made with two cuts of a ¾-inch square chassis punch. Finally, wire the socket as shown in heavy lines in Fig. 1. Though the wiring is simple, check it out with an ohmmeter before you apply power.

Since the remote-control unit switch parallels the indicator/control-box switch contacts, either switch can be used to operate the rotator.

Without junkbox parts, this remote control unit cost me about $3. It has been very handy in contests.

Converting VHF To UHF For Tests And Demonstrations

TV TECHNICIANS IN VHF AREAS CAN simulate uhf signals with any single-tube uhf converter, according to a simple method devised by Blonder-Tongue Laboratories, Inc.

A technician merely takes an unamplified, single-tube converter and hooks it up backward. Instead of converting uhf to vhf, in the traditional manner, the converter changes a local vhf channel into uhf.

The backward hookup method is especially useful for technicians in vhf-only areas that have a new uhf channel due to go on the air.

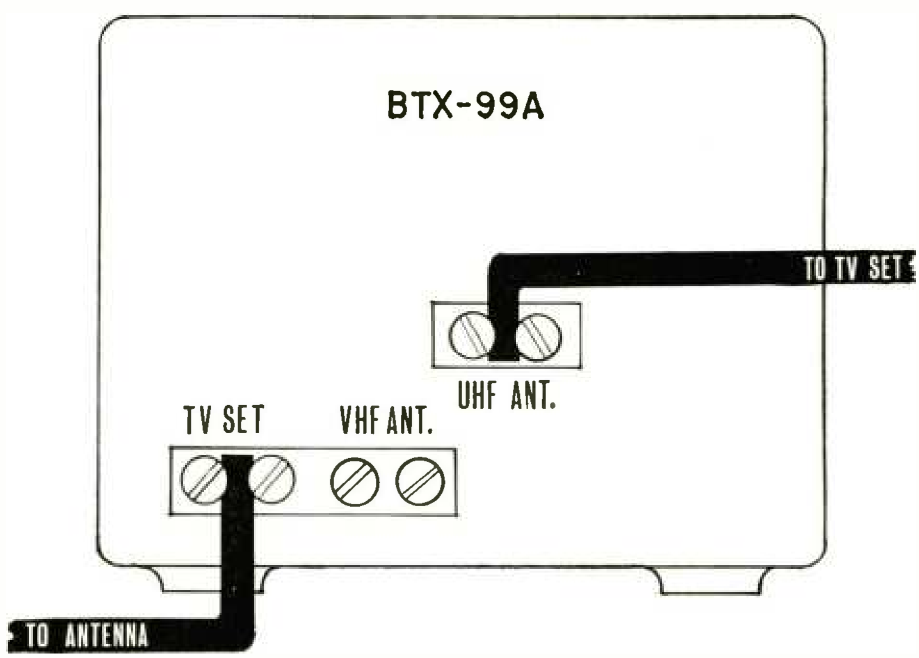
The diagram illustrates how Blonder-Tongue's model BTX-99A converter is hooked up to simulate uhf. The setup is most effective with an input from either channel 5 or 6, but any of the low channels will work if they are strong enough.

Ordinarily, the uhf antenna is connected to the converter terminals marked UHF ANT. The output connects to the set's antenna terminals. The desired uhf signal is preselected by the tuner and fed to the crystal mixer. The mixer diode combines the uhf input signal with the output of the oscillator. The *difference* between the oscillator signal and the input uhf signal is set by the tuner to be 82 mc, so the output is received on a TV set on channel 5 or 6.

When the converter is hooked up backward, as shown, the signal from the vhf antenna is mixed with the output of the uhf oscillator. The *sum* of these frequencies is equal to the uhf channel to which the converter is tuned. It passes through the uhf preselector to the UHF ANT terminals and then to the set.

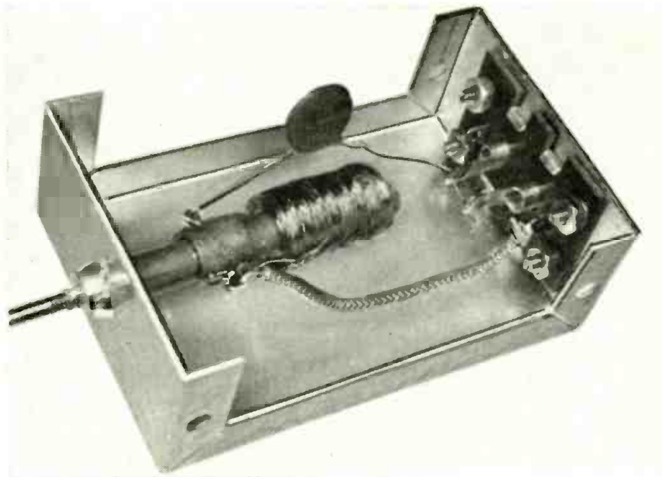
If the picture is snowy the input signal is not strong enough. Use a vhf booster between the antenna and the converter.

This method enables a technician to simulate any uhf channel by setting the converter's tuning knob to the desired position. END



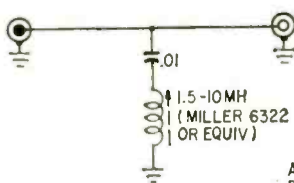
Plagued by rushing noises in all your taped FM programs? Could be "beats" from the 19-Kc stereo-multiplex pilot

by FRED BLECHMAN K6UGT



Simplest of all—19-kc tuned trap.

Filter for Recording FM Stereo



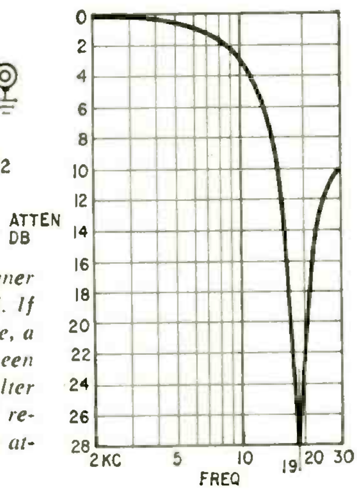
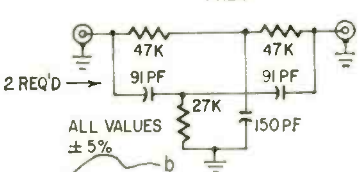
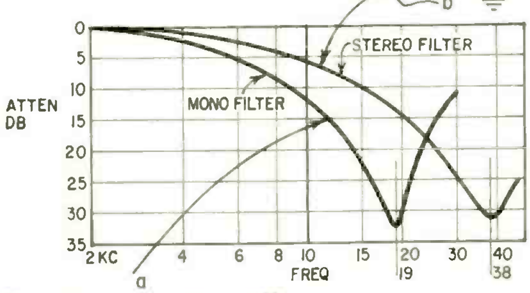


Fig. 1—Trap across FM tuner output may be all you need. If output is very low-impedance, a few thousand ohms between output jack and input of filter may improve rejection. The response curve at right shows attenuation.





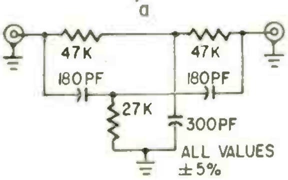


Fig. 2—19-kc parallel-T mono recording filter and its response curve; b—38-kc stereo filter and its curve. These work best from low impedance into high.

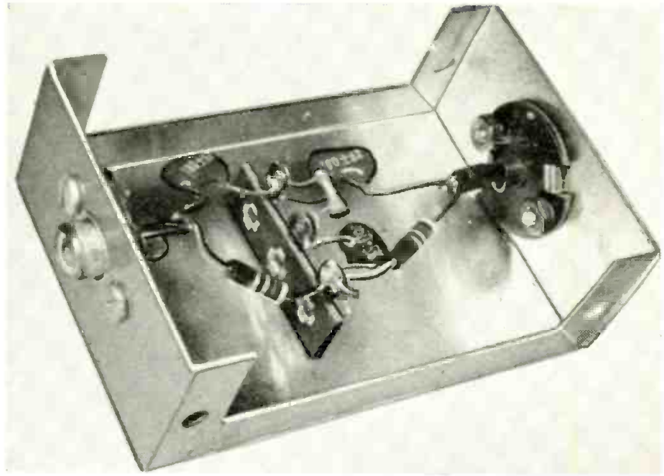
SINCE FM MULTIPLEX STEREO HAS COME ON THE SCENE, many tape recording enthusiasts have had difficulty recording FM music. There are whistles, squeals or buzzes on the recording, in monophonic as well as stereo tapes. If you're having this difficulty, the FM recording filters described here should help you.

Why the noises? When an FM station broadcasts multiplex stereo, a 19-kc "pilot carrier" is transmitted for synchronization and carrier regeneration in the multiplex receiving circuits. You can't hear it, since it's above the normal hearing range, but you can be sure it's there during stereocasts. If you are recording monophonically, this 19 kc can generate harmonics in the recorder circuitry which "beat" with the recorder's bias oscillator at an audio frequency—thence the whistles and squeals.

Even more sneakily, the 19-kc harmonics can get amplified and change your recording bias, with consequent distortion. The clue is simply this: if you get good recordings on a particular station when it broadcasts monophonically, but have distortion, whistles or squeals on your recordings when the same station is stereocasting, you can be sure you need a 19-kc filter. Two simple filters described later in this article suppress the 19 kc by about 30 db.

If you like to record FM multiplex broadcasts in stereo, you are even more likely to encounter problems. Why? Because your multiplex detecting circuitry *doubles* the 19-kc pilot carrier to 38 kc and increases its strength! Unless your multiplexer has a 38-kc attenuator at its output, you are probably going to have trouble getting "clean" stereo recordings. A simple outboard 30-db 38-kc attenuator can be added between your multiplexer and recorder.

One word of warning: You must be prepared to accept some loss of high frequencies when you add any of these filters to your system. They are not expensive, exotic circuits, and their attenuation curves extend into the audible range. The maximum attenuation, of course, is at the design frequency of either 19 or 38 kc. The attenuation-vs-frequency curves (Figs. 1 and 2) show some loss of highs, which appears more serious than listening tests indicate; the average listener can barely tell the difference. However, if you are a



A single parallel-T filter for 19 kc.

real discriminating audiophile and truly treasure every 15-kc overtone, you will want more elaborate filtering devices than these.

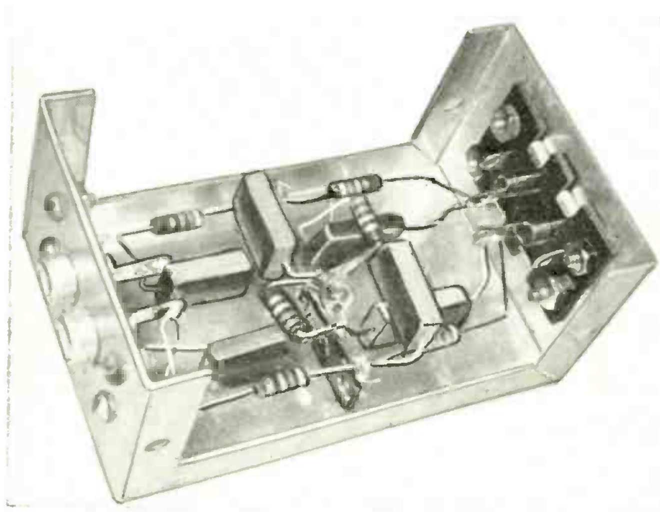
Your next decision depends on whether you intend to record mono or stereo. For mono recordings, the simplest, most effective method of "dumping" the 19 kc is to use an inductor and capacitor in series across the tuner audio output. Fig. 1 shows the circuit and the attenuation-vs-frequency curve. You get a 28-db reduction of the 19-kc pilot carrier at the recorder.

The parts are built into a 3¼ x 2⅛ x 1⅛-inch Minibox, using appropriate input and output jacks, as shown in the photos. The inductor is first slug-tuned to resonance at about 19 kc with an audio generator and vtvm or oscilloscope, then adjusted for minimum interference in use. Connect it between the tuner output and the recorder input with shielded cables.

An alternate design is shown in Fig. 2-a. This is a 19-kc-notch parallel-T network. No adjustment is required if the components are 5% tolerance. The maximum attenuation to 19 kc is 32 db. This unit is called "Model T" in the photos, and is also built in a 3¼ x 2⅛ x 1⅛-inch Minibox, with a three-lug terminal strip (center lug grounded) used for mounting the parts.

For recording stereo multiplex, just use two parallel-T circuits in the same box. Each T must have maximum attenuation at *38* kc in this case. The circuit and attenuation characteristic for each channel are shown in Fig. 2-b. My "box" had slightly over 30-db attenuation at 38 kc. Build *two* of these circuits in a 3½ x 2⅛ x 1⅝-inch Minibox, using a common chasis ground point for all components. This can be done easily with a five-lug terminal strip (center lug grounded), as shown in the photo. Four single jacks (or two dual jacks) will be required in this unit: input and output for each channel. The completed unit is connected in your system between the demultiplexed audio outputs and the recorder inputs, using shielded cables for the interconnections.

If you still have whistles or squeals even when using these filters, you are in big trouble! **END**



Dual parallel-T's for stereo (38 kc).

CAREER OPPORTUNITIES — first of a new series

Broadcast Engineering: Radio

By JACK DARR

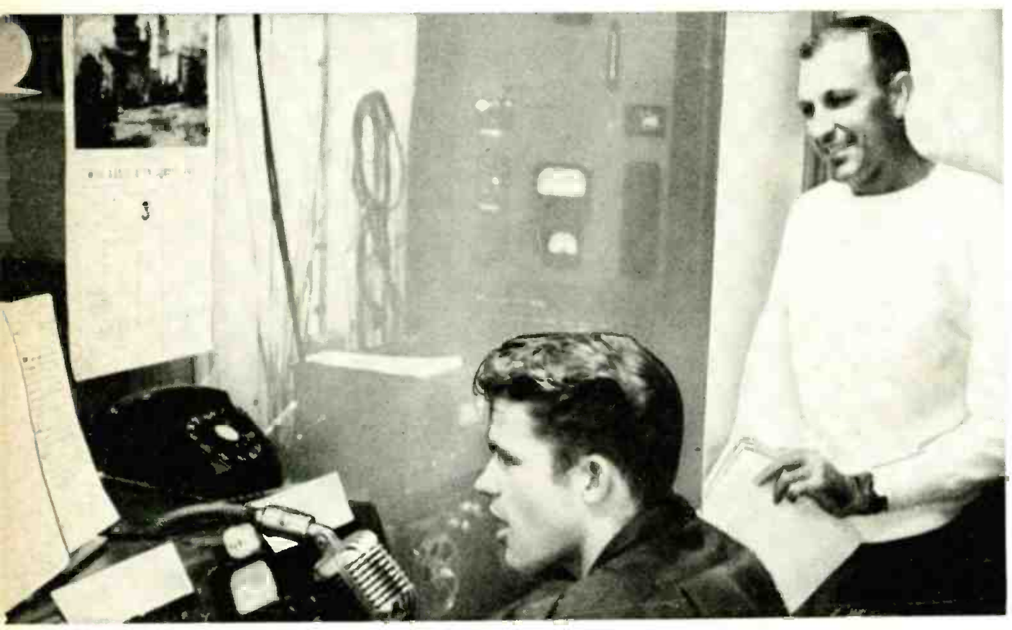
FROM ABBEVILLE, LA. (WARI), TO ZArephath, N. J. (WAWZ), there are thousands of AM radio stations, and more are being built every day. Most of these are small locals. Besides furnishing local news and entertainment, they provide a most fruitful market for young men wanting to get into radio engineering. There are *never* enough licensed engineers to go around! The graduate of a radio school, with the FCC's ink not yet dry on his First-Class Radiotelephone license, can get a job any time.

Pay scales vary between communities. Since most of these stations are in small towns, wages are usually ample, and above the local average. The budding engineer can have his choice: he can work in these stations for a year or two, getting invaluable experience and getting paid for it, then going on to better-paying jobs. Or, if he likes the leisurely pace of small-town living, he can stay as long as he wants. Many new men have become chief engineers of their stations a year or so after graduating from radio school! Turnover is often rapid, depending on the individual.

Let's see what the real engineers do, how they do it and how they like it.

Here's Jerry Hamby: 21, chunky, cheerful and just a wee bit ornery. Polio at the age of 5 left him with both legs in braces, but it didn't slow him down too much! After graduation from high school in Mena, Ark., his home town, he took a year and a half of college, majoring in English. His technical training was taken at the State Rehabilitation Center. After ten and a half months, he passed the tests and got the "ticket". He's been working at the station ever since—about a year and a half now.

He drives his own car, a white Ford Thunderbird, bought after going to work at the station. He rides horseback, chases girls and has a big time in general. A continual kidder, with an intermittent dimple, Jerry is a serious student of electronics, and he's made real progress in learning the ins and outs of real-life work on radio transmitters.



Jerry reads a spot while Wayne sorts out copy. Engineers in small stations often take shifts at the microphone. But even if you stutter in a falsetto, there are plenty of straight technical jobs in radio broadcasting.

Here's Wayne Ramsey, the chief engineer. A tall, rangy, 32-year-old Texan with a perpetual grin, he started as a musician. Deciding to get into radio, he took his training at the Elkins Radio School in Dallas. He got his ticket in 1958, and came here shortly afterward as second-shift engineer. He became chief in about a year, when the chief at the time left to work for the FAA. Single, he drives a Chevrolet Impala, plays a mean "swing guitar" or drums at local dances, and is a most popular fellow around town.

Now let's look at a typical working day at the station, and then talk to the men. Wayne opens the station up at 6:00 AM and works alone until 7:00. Jerry comes in just before 7:00, pulls the news from the teletype, and sorts it for the 7 o'clock news, first of many during the day. While this is going on, Wayne is being happy and cheerful over the air, playing records, mostly country and Western, which he loves dearly! Most of the work at a station of this size is playing records, and reading commercials ("spots"), although many live programs of local interest are broadcast from the little studio next to the control room.

Jerry now takes over at the console, and Wayne reads the early news from the studio. Jerry interrupts him at frequent intervals to read spots (and also make faces at him through the window, trying to make him laugh. This is old stuff for Wayne, though, and he reads calmly on.)

As each spot is read, the copy is moved from the top of the thick stack on the clipboard, or a page turned in the "repeater" book on top of the console. (The "repeater" book is a looseleaf binder of spots that are read without change for several days or weeks.) As each spot is broadcast, it is checked off on the detailed *program log*, the announcer initialing the proper place to show the bookkeeping department and the advertiser that his commercial was read as scheduled.

At 30-minute intervals, the engineer on duty takes the meter readings on the transmitter behind him and enters them in the *transmitter log*, which must be kept up to date at all times. It shows the frequency deviation, plate voltage and current of the final rf stage, and the rf line current to the antenna. As each engineer goes on or off duty, he must sign the log. By FCC rules, a licensed engineer must be on duty at all times when the station is on the air.

Between times, he selects records from the racks lining the walls, cues them up on the turntables on either side, cues up special tape-recorded spots, plays electrical transcriptions, and reads the typed spot copy. At times, this makes him wish he had three arms!

After about 8:00 AM, things get calmer. The early rush is over, most men have gone to work, and the spots are now less frequent, aimed at the housewife doing her daily work. Wayne officially goes off duty now, coming back before noon; a third man takes over then. The work shifts are broken up like this at most stations, so that the men work a few hours, then get a rest. This one, like many of the smaller stations, is "daytime only": it signs on at sunrise and signs off at sunset.

Now we can get a chance to talk to the boys and see what's going on. Jerry puts a long-playing record on a turntable, announces its title, and we sit down.

"Jerry, how do you like working here?"

"Fine! Wouldn't trade it for anything else!" he says enthusiastically.

"How about you, Wayne?"

"Me, too, I reckon," he drawls. "Gettin' along pretty good right now, I'd say."

"How did you come to get into radio?"

"Well," Wayne answered, "at the time, it looked like the best way to be sure of getting a job! Worked out that way, too. Never been out of work since I started in it."

"Jerry?"

"Yep. Same thing. I was always crazy about radio and electronics. Remember how I used to pester you when I was in high school? When I got the chance to go to radio school at the rehab center, I jumped at it."

"Tell me, what do you think is the hardest thing about getting into this kind of work?"

They both spoke at once. "That FCC test!" They laughed.

"Oh, come on, now. It wasn't that hard, was it?"

"You're dern right it was!" Jerry grinned. "I took it twice before I managed to pass it."

"Wouldn't a' passed it then if the FCC man hadn't been his uncle!" said Wayne, almost straight-faced. Jerry's dimple popped out again, and I said, "Now I know *that* isn't so! He can't be *Jerry's* uncle: he's mine! How do you think I got *my* ticket?"

"We've always wondered!" they said together.

"Seriously, though," Jerry said, "it isn't too hard, if you've really been studying like you ought to. If you want it bad enough to make a real effort, you can pass." Wayne nodded in agreement.

"All right. Now, what was the hardest part of it *after* you got the job?"

They both spoke at once: "Learning to talk!" "Talkin' "

Now I grinned: "Good old mike fright, huh?"

They both agreed, emphatically.

"Well, you got over it, I'd say," said I, for these two had very good 'chatter' on their disc-jockey shows. They seemed always at ease.

"It's hard to do, at first," Jerry said thoughtfully. "I was scared to death every time I opened that mike switch! Just don't let it get you down, though, and you'll get along fine. Worst trouble I had was talking too fast at first. I wanted to get through and get it over with."

"You know," said Wayne, "it looks to me as if the radio schools ought to put in a part on how to talk over the mike. A training course in announcing. Sure would help a lot of these boys."

"That's right," I agreed. "In fact, most of the engineers in these stations have to be combination men [combination engineer–announcers], don't they?"

"Darn right," he agreed. "All of 'em I've ever seen. Never worked at one where they *didn't*."

"OK, now, what would you say about this as a "career opportunity in electronics" as the ads say?"

"Good! About the best there is, I'd say," Wayne answered. "Why, do you know, I get three or four letters a month wanting to know if I know of a man with a ticket who'll go to work right away. My gosh, there ought to be a lot of jobs. Just look right around here: why, there's a little radio station every 40 miles in all directions! They're always looking for men."

"Yes, sir!" said Jerry, beaming up at the license in its frame on the wall. "If you've got that blue ticket, you can go to work almost anywhere you want to at any time!"

"Well, one more thing, Wayne. What about your technical duties? We've been talking about playing records, reading spots and so on. Now, how about the actual 'radio' part of it? What are your duties as chief engineer?"

"Just keep the thing on the air!" He grinned. "I keep the logs, file 'em, keep up the FCC reports and stuff. If we do have trouble, we all pitch in and get it fixed as soon as we can. I pull regular maintenance—that is, check up on the transmitter meter readings, clean switches and relays, change tubes and so on, and run a proof every so often [the *proof of performance* tests FCC requires]. Actually, by keeping up on the maintenance, we don't go off the air too often, outside of an emergency."

"Like the mouse, eh?" I said, remembering the time a mouse had got across the terminals of the high-voltage transformer and knocked the station off the air in a cloud of bad-smelling smoke.

"Well, what's the worst thing about it?" I asked.

"Staying up late for 'election parties'!" answered Wayne with a tremendous yawn. "I'm not caught up on my sleep yet after the last one. I had to get up and open the cotton-pickin' station the next morning, too! I believe I slept all the way through the 7:00 o'clock news, talkin' in my sleep! Oh, well, once every four years ain't too bad!"

Large metropolitan stations usually divide their duties. This engineer at New York's WQXR has his hands full keeping broadcast operations smooth and unobtrusive, while the announcer in the background does the talking.

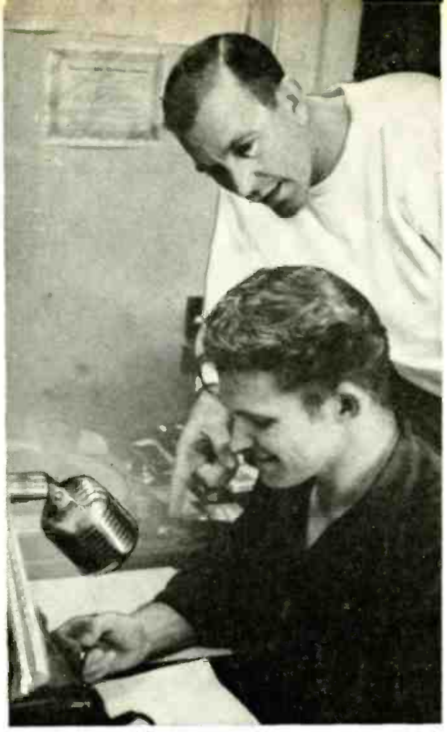
Summing up, I'd say that this is an excellent field for the young man who wants to get into electronics or radio. The technical education needed isn't *too* hard to get. With a reasonable amount of study, most men seem to be able to pass the tests in from 1 to 2 years. A good background of math is a big help, although all courses include math.

If you've been working with electronics—especially radio or audio—for some years, you may be able to pass the test with only a brief study of FCC laws and communications and broadcast practice (Elements I and II of the examination). Most of the technical material will be familiar to you, except for specialized broadcast practices.

The Government Printing office has available a study guide to FCC exams, for 75 cents; address Superintendent of Documents, Washington, D. C. 20025. Another helpful recent book is *Radio Operating Questions and Answers* (13th Edition), by Hornung and McKenzie, published in 1964 by McGraw-Hill ($8.25). Technical bookstores will be able to turn up other study guides and textbooks.

Both resident and correspondence school courses are available in all sections of the country. Rehabilitation and vocational training courses, with state help, are frequently available.

Cost of training varies. Resident schools are higher, of course, since the cost of living must be added to the tuition. Many resident schools have employment agencies, which help the student to get part-time work. Correspondence courses taken at home are the least expensive, with the advantage of staying home while training. Costs of many courses can be financed on a time-payment basis; get in touch with several schools and get the full details. If you are disabled, state programs often provide technical training or financial assistance, or both; student-loan plans are helpful, too.



The engineer may be working on the console while the announcer's on the air!

The work is pleasant, and the hours aren't bad. Although the job can get hectic at times, it's seldom monotonous.

Though even as a beginning radio broadcast engineer you'll have plenty of stimulating responsibility and room to grow, there is still more opportunity as you graduate to larger stations, particularly ones in cities. Chief engineers of 10-kw and 50-kw stations are often "upper management" as well as engineers: they may supervise a staff of half a dozen engineers and technicians and have responsibility for planning new studio, control and transmitter facilities, purchasing equipment and advising the station manager or owner on technical matters. Often there are public-relations duties, too—checking out listeners' complaints about reception, interference, blanketing and so on.

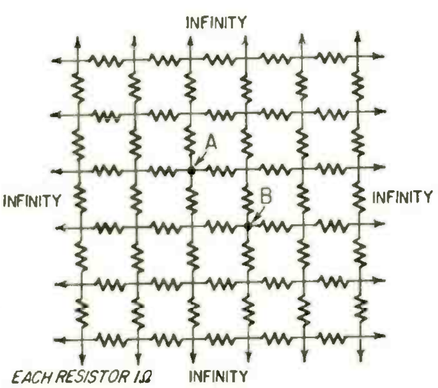
All in all, there's no better job assurance than that little blue sheet of paper in its frame, with your name and the words "First Class Radiotelephone Operator" on it! If you can't get a good job with one of these, you'd starve to death in a candy store! END

WHAT'S YOUR EQ?

Conducted by
E. D. CLARK

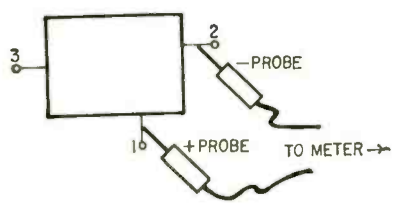
From Here To Infinity

Shown in the diagram is an infinite mesh of resistors interconnected so as to form a "screen".



If each resistor is 1 ohm, what is the *exact* resistance between points A and B?—*R. Shubert*

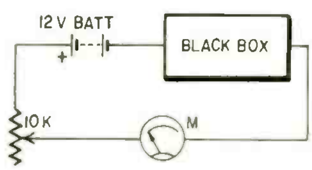
More Resistance



Observing polarities as shown, connect an ohmmeter to box terminals 1–2 and note reading. Short terminals 1–3, and reading *increases*. What's in the box? (Plus and minus markings on probes refer to actual ohmmeter voltage polarity and not necessarily to test jack markings on the instrument.)—*Alvin L. Hooper*

Steady Current

In this circuit, a 10,000-ohm potentiometer is connected in series with a milliammeter, a 12-volt battery and a



black box. The current in the circuit is about 1 ma regardless of the setting of the 10,000-ohm pot. What's in the black box?—*John C. Fakan*

Three 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 puzzles are on page 85.

Radio-Electronics
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Tell us what you want to see in it. Your suggestions may make it a better magazine for the rest of the readers as well as yourself. Write to the Editor, RADIO-ELECTRONICS, 154 West 14th St., New York, N. Y. 10011.

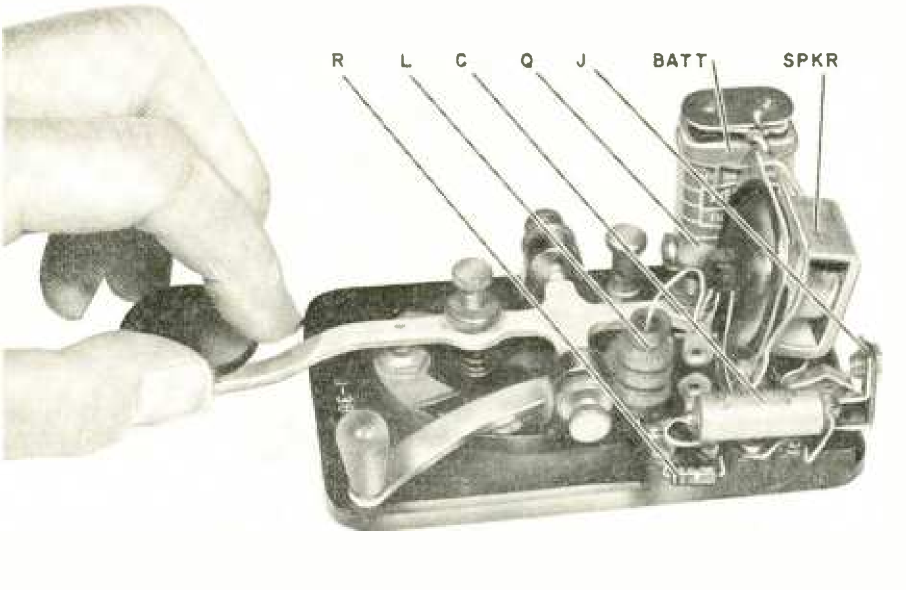
50 Years Ago

In Gernsback Publications
In July, 1915
Electrical Experimenter

Phonograph-Telephone Lecturer
Macrophone — Loud-Speaking Telephone
Build a Photophone
Talks 721 Miles by Wireless
The Goldschmidt Tone Wheel Detector
Locating Buried Pipes Electrically

Code-Practice Oscillator—On a Key

By **FREDERICK W. CHESSON**



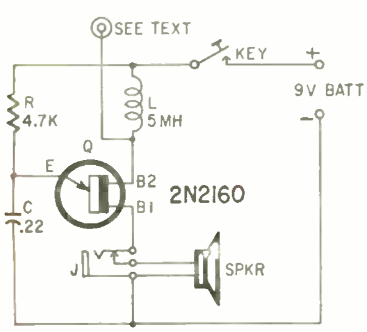
The unijunction code-practice oscillator. All parts, including the battery and miniature speaker, are mounted on a J-38-type telegraph key.

Here's an ultra-simple code-practice oscillator built right onto a key base—including battery and speaker! Using a single unijunction transistor as its only active part, the tiny oscillator can be used by itself or with several earphones for group practice. The pulses from the transistor contain enough harmonics so you can pick up the signal on a radio—to simulate real "short-wave code" reception!

The diagram and photo show all the details you'll need to build this unit. The same circuit also makes a good portable signal injector for radio and hi-fi checking.

Construction

A J-38 type key (still commonly sold as surplus) is the basis of the oscillator, though any similar key with a 3 x 5-inch base can be used. If you choose the J-38, remove the binding posts and contact strips at the rear of the base, but leave the brass screw eye. Most of the components are fastened to a four-terminal type 4-140 Jones strip, one end of which is sawed off to clear the key subbase. The miniature jack is mounted on an L-shaped bracket fastened by a screw at the other end of the Jones strip. The 1½-inch loudspeaker is mounted on a bracket tilted about 80°. The battery is held in place with thin wires through the screw eye and a hole in the speaker frame. A single-terminal solder lug strip connects the 5-mh choke (L) to the base-2 lead of the unijunction transistor and also provides a signal takeoff point.



Unijunction oscillator uses only eight parts, including key and battery.

VALUES OF R FOR VARIOUS FREQUENCIES

R (ohms)	Frequency (cycles)
4,110	1,000
5,600	850
6,800	600
8,200	500
10,000	400

Batt—9-volt battery (Eveready 216 or equivalent)
C—0.22 μf, 100 volts
J—miniature closed-circuit jack (Lafayette MS-282 or equivalent)
L—5-mh choke (Miller 6304 or equivalent)
Q—2N2160 unijunction (G-E)
R—4,700 ohms, 1/10 to ½ watt
Spkr—1½ inches, 10 ohms (Argonne AR-95 or equivalent)
Telegraph key

Applications

As a code oscillator, the little speaker gives an output loud enough to be heard clearly in a quiet room. The earphone from a transistor radio can be plugged into the jack, which can be connected either to cut out the speaker or to allow parallel operation of speaker and phones.

For group code practice with increased volume, connect a lead from the base-2-and-choke junction to the antenna terminal of a radio, with a .001-uf capacitor in series. Tune to the lower end of the broadcast band, avoiding strong stations, and operate the key. A very good solid tone, about the same as from the little built-in speaker, will come from the radio.

The oscillator also makes a highly portable test set. With the parts given in the schematic, a signal of 1,000 cycles with amplitude spikes of 2 volts appears across the speaker coil. This signal can be used to check radios through either rf, i.f. or audio stages. If the miniature jack is to be used for test signals, wire it for parallel operation with the speaker. The closed-circuit switch of the J-38 key lets you run the oscillator continuously without upsetting the key contact adjustments. END

"Watch what you say—Harold's rigged his hearing aid to get fringe reception."

THE TWO-STATE AMPLIFIER

Radically new system of audio amplification. Learn how it works—next month we'll tell you how to build a super-efficient 40-watt PA amplifier on this principle.

By NORMAN CROWHURST

WHEN TRANSISTORS CAME ALONG, MOST audio hobbyists waxed enthusiastic. But mainly, transistor audio resolved into a substitution which eventually proved to have *some* advantages over tubes, but nothing really exciting. We have the same old choice of class A or class B with its variations. Oh, yes, single-ended push-pull can have a few more modifications with the addition of complementary symmetry.

But we're still faced with power limitations: the part of the supply power that doesn't get turned into audio has to be burned up as heat in the output transistors. This is where we could use a breakthrough.

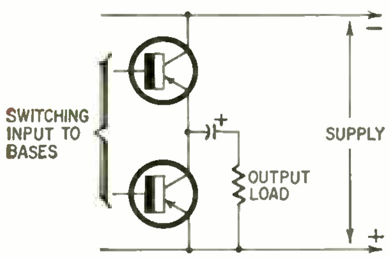


Fig. 1—Basic transformerless output, to illustrate two-state modulation.

Two-state modulation

Somewhat over a year ago, some of the more technical publications announced a new "two-state modulation" which uses transistors in the way they work best—as switches—with high-speed pulse modulation and filtering, to produce audio. This form was also called class D, because that was the next available unused letter of the alphabet. I prefer the term "two-state" because that really describes what it does.

Let's take a look to see how far two-state modulation helps. Without getting into details of drive circuits (we can make them do what we want, if we decide it's worth while). Fig. 1 shows an output circuit of the single-ended push-pull variety that can be converted to "two-state" or "class-D"—whichever name you prefer. All it entails is, instead of applying *audio* to the bases, you *switch* them as indicated in Fig. 2.

When no audio is present, the switching sequence will be as at (a). The average output across the load is half the supply voltage. The coupling capacitor stops direct current from flowing into the load, but the average current through the two transistors will be half what the supply voltage would drive through the load without that capacitor to stop it. At the transistors, the current flows first through one, then through the other; at the load, it flows back and forth.

When an audio signal equivalent to part of the maximum output voltage is applied, the time interval during which each alternate transistor conducts or is cut off will be changed from the equal parts of (a) to the unequal parts of (b). Now the average voltage at the junction of the two transistors is momentarily higher than at (a), so the pulse contains an element of the audio.

At (c) is shown the condition for peak audio signal in one direction: the top transistor conducts, momentarily, for the whole pulse duration, while the bottom one stays off.

Without filtering, the output would be very "raw"—a lot of the ultrasonic switching (pulse) frequency present. This can be removed by filtering (Fig. 3). Also feedback can be used to linearize amplification, just as in any audio amplifier.

This whole idea started from the fact that, when a transistor is cut off, it doesn't dissipate any power, and when it's all the way "on", so that full current flows with almost no voltage drop, it dissipates very little. By switching it rapidly so the "in-between" state lasts only a very short time, the dissipation normally associated with handling continuous audio waves is virtually eliminated.

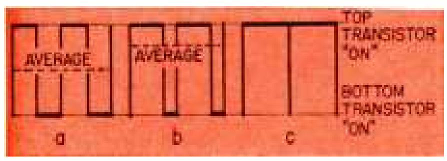


Fig. 2—Switching waveforms in two-state modulation.

That's a nice theory, until you stop to figure out what happens to the power you "save". Looking at Fig. 2, you see that with no audio present, switching at full voltage is occurring, with considerable high-frequency square-wave current being passed to the load, unless filtering is used. Only at an audio peak (Fig. 2-c) does the ultrasonic pulse momentarily disappear, so the current is momentarily "all audio."

Analyzing this step by step, with a sine wave as an example, Fig. 4 shows what happens. When the audio wave crosses the "zero line," the output is all ultrasonic power. At both peaks of the audio wave, all the power is momentarily audio. In between, there is always the same total power, but some of it is ultrasonic and some of it is audio.

So, we've made the transistors more

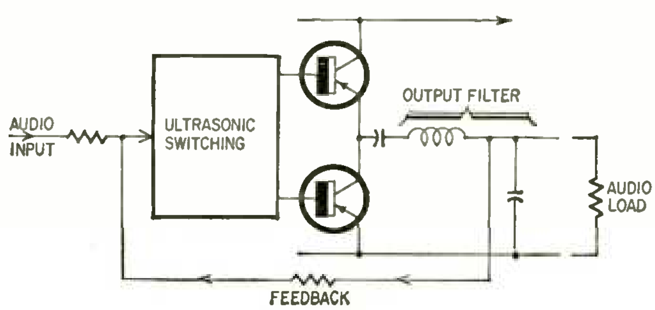


Fig. 3—Use of feedback around amplifier using two-state modulation.

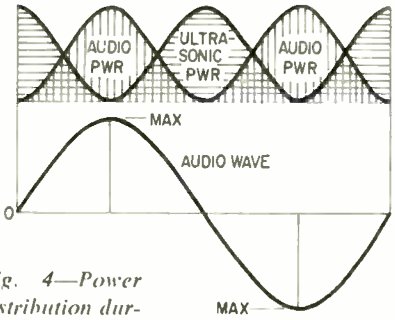


Fig. 4—Power distribution during the handling of a full-level audio sine wave by two-state modulation.

efficient and reduced their dissipation, but we're still taking the same power as a class-A circuit does from the supply. Instead of heating up the transistors with dc, we're heating up the load with ultrasonic power.

Of course, we don't do that. We filter out the ultrasonic. So where does that power go? You can deduce in some vague way that this must make the circuit behave more like class B, as far as its varying power demand goes. But the efficiency of the circuit now depends on a filter. And, to be efficient, the filter has to throw an inductive kick back to the transitors.

It's not turning out quite as easy as the announcement would have us believe. So I did some more thinking, to see what could be done to overcome this basic problem. What I came up with, after a few changes, was something that really is a breakthrough in power amplification with transistors. Finding it was quite exciting, so I'll take you through the steps that led to it, and in a later article give a construction piece that will enable you to make one for yourself.

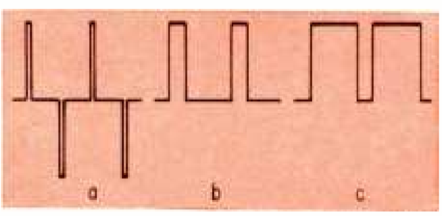


Fig. 5—Combining class-B with two-state modulation: (a) no audio; (b) about ¼ amplitude in one direction; (c) full amplitude in the same direction.

A double switching circuit

Fig. 5 illustrates the first step, in terms of waveform. Instead of switching the full voltage and current at quiescent, we switch only a very short pulse, alternately, in opposite directions. To introduce audio modulation, first we get rid of the pulse in the direction that is momentarily not needed, and then we make the pulse in the direction the audio momentarily takes grow in length (duration) until eventually it would fill the whole pulse period, as before.

Obviously there is much less power in the waveform at Fig. 5-a than in that at Fig. 2-a. And the power in the waveforms of Fig. 5-b and -c is proportional to, in fact is virtually equal to, the power needed in the audio waveform at those instants.

It didn't prove difficult to produce this result—we'll see how in a moment—but I ran up against a snag. When the pulse in the unwanted direction disappears it produces distortion in the audio that the filtering cannot remove. At one point on the audio waveform, the pulse is there, of minimum workable duration; at the next point, it has completely disappeared. This produces a notch in the waveform.

Nothing can get rid of this effect. You can change "bias" (the duration of the minimum pulse) just as you change dc bias in a class-B circuit, to get rid of crossover distortion. But this crossover distortion is obstinate—it won't go as easily.

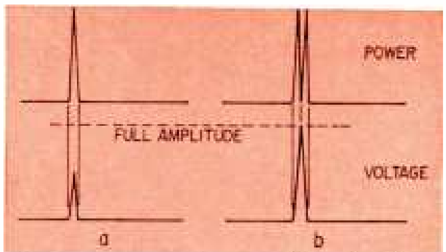


Fig. 6—Power relation with half-level and full-level pulse, each of minimum duration: (a) power makes one excursion to maximum; (b) with full level pulse, power makes two excursions to maximum, once during rise, once during fall.

Combined pulse modulation

Take another look at the pulses. That perfectly square front is really an idealized pulse. All real pulses take a finite time to rise and fall, even if it's only a fraction of a microsecond. So couldn't we let it come and go gradually, once we've got it down to minimum width (duration)? And, while we're about it, we can save a little power at quiescent, too.

Fig. 6 illustrates: (a) shows a voltage pulse stopped in its switch-on at the halfway point and switched off immediately. Halfway on is the maximum power the transistor can dissipate—half voltage at half current; (b) is a full-amplitude pulse. After it passes the halfway point during the switch-on, power falls back to zero for full current (or close to zero). Then, as it switches off again, it repeats the power pulse, going through maximum at the halfway point on the voltage or current waveform.

So we can see that a full-amplitude, minimum-width pulse dissipates just twice as much in the transistor as a half-amplitude pulse. This is true only of minimum-width pulses—ones that switch off immediately they're on. As soon as we increase the pulse width or duration, due to modulation, it must go to full amplitude to keep minimum dissipation.

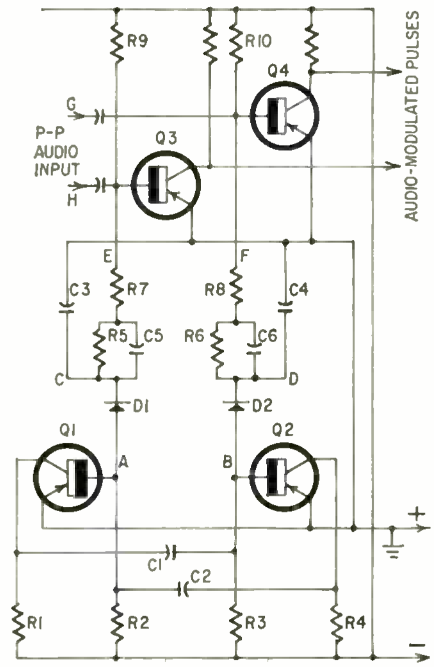


Fig. 7—Schematic to illustrate a way of achieving the modulation method shown in Fig. 5. This works, but with difficulties described in text.

Basic circuits

That's what we do, now how do we do it? Fig. 7 shows the drive circuit that produces the variable-width pulses. Transistors Q1 and Q2 are a multivibrator that produces the ultrasonic switching frequency. Resistors R1, R4 can be 100-ohm 2-watt (for a 12-volt supply), and Q1, Q2 can be 2N395's. With base resistors R2, R3 each 1,000 ohms, and C1, C2 each .05 μf, the switching frequency will be about 18 kc. Smaller capacitors will make the frequency correspondingly higher.

Interlaced sawteeth will be produced at points A and B (Fig. 8-a), but the slope finishes too soon to permit full period control to be used. This is overcome by using low-forward-resistance diodes D1, D2 (1N283's will serve here), which charge capacitors C3, C4 at each positive-going pulse, giving them time to discharge through R7, R8 and the base circuits of Q3, Q4. C3, C4 can be .01 μf, and R7 and R8, 2,700 ohms. We'll come back to R5, R6 and C5, C6 in a moment. For now imagine R7, R8 are connected directly to the diode cathodes.

Resistors R9, R10 are chosen (they too can be 2,700 ohms each) so that Q3 and Q4 are maintained normally con-

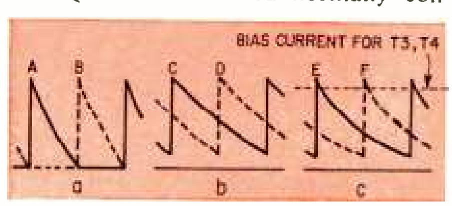


Fig. 8—Waveforms associated with multivibrator action (Fig. 7).

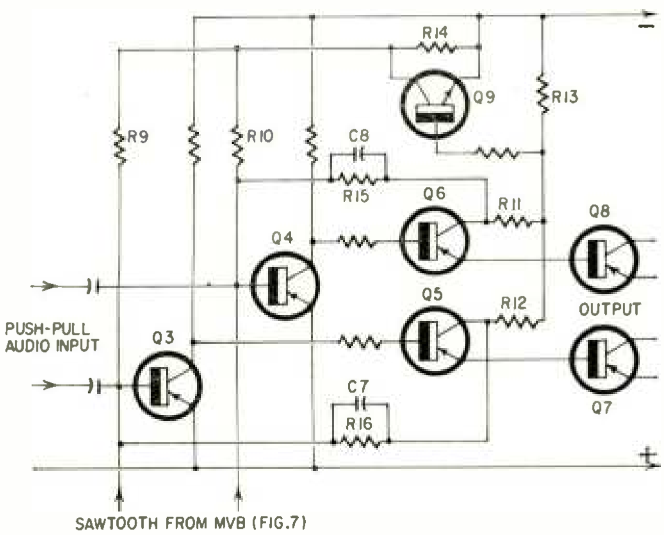


Fig. 9—Modification to circuit of Fig. 7 that overcomes all the problems.

ducting (for now the collector resistors can have any value to limit current to safe value for the transistors—which can be 2N323's), except for the very front edge of the pulse received through R7, R8. Now, if audio is applied at points G and H, push-pull, the duration of the pulses will be modulated, by varying the point at which transistors Q3, Q4 switch on again, after being switched off by the pulse.

The current through points E and F decreases after the initial pulse, and it is this decrease that determines when base current starts again in transistor Q3 or Q4, terminating the pulse. With the waveform shown at C and D (Fig. 8-b) the width of pulse is not very easy to control. Slight changes can make it either disappear altogether, or get too wide to use as a minimum pulse.

Without R5, R6 and C5, C6, the current waveform at E and F is the same as the voltage waveform at C and D. But introducing these components (R5, R6 can be 1,000 ohms; C5, C6 can be .0033 μf) initial part of the trailing edges at E and F can be sharpened to the form shown at Fig. 8-c. This permits the minimum-width pulse to be controlled much more effectively.

That is the circuit that enables a pair of output push-pull transistors to be driven with a waveform of the type shown in Fig. 5. Now we have to introduce the amplitude control for minimum-width pulses. This is done with the additional circuitry of Fig. 9.

The negative-going pulses (switch-off of the transistors) at the collectors of Q3, Q4 are fed to the bases of drive transistors Q5, Q6 (these can be 2N-524's). To provide the needed current, collector resistors for the mixers (Q3, Q4), can be 150 ohms 1 watt, and the resistors from collector to base of Q5, Q6 can be 120 ohms. These make the "off" condition of Q5 and Q6 more definite.

Now the variable pulses passed by Q5, Q6 will cause them to conduct (collectors to go positive). In Fig. 9, part of the collector load for Q5, Q6 is separate (R11, R12) and part common (R13). This is so that resistor–capacitor combinations R15, C8 and R16, C7 can be used to sharpen the pulse wavefronts by positive feedback. Later I found that R11 and R12 are not needed.

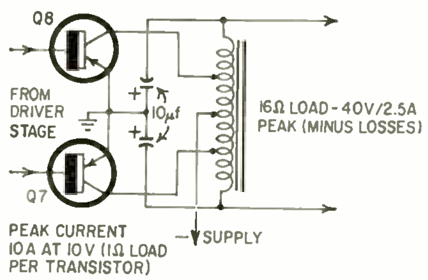


Fig. 10—How an autotransformer can be used in the output stage with this system. It transforms 16-ohm load to 1 ohm per side.

Common resistor R13, which later became the only one (R11 and R12 were eliminated), limits the drive current to output transistors Q7 and Q8. The voltage it develops is also used, through a suitable base resistor, to control n-p-n transistor Q9 (a 2N388), connected across a series resistor, R14, in series with bias resistors R9, R10. The value of this will be less than 1,000 ohms.

Normally, with no signal and no pulse, Q9 is nonconducting and a small voltage is dropped across R14. When a small pulse comes along, the negative voltage across R13 through the base resistor of Q9 causes it to conduct, momentarily increasing the bias current through R9 and R10, to the point where the pulse is terminated by causing Q3 or Q4 to conduct again.

Adding the n-p-n negative-pulse feedback not only allows a controlled pulse amplitude to be used (which the audio first offsets as amplitude modulation, until full height of one or the other is reached, so width modulation can begin), it also serves as an automatic "bias" for the output transistors, by controlling the quiescent pulse precisely.

To complete the picture of how the whole thing works, let's see how the output stage can be arranged (Fig. 10). Output transistors Q7, Q8 are fed by the drive stage working as an emitter follower. (That it has current-limiting resistors in its collector circuits does not alter its being an emitter follower from the output transistor's viewpoint.)

The output transistors are collector-coupled to the load by a push-pull autotransformer, in this case a stepup. The two electrolytic capacitors across the output side, with the leakage inductance between taps, filter out the ultrasonic pulses that remain, so the load receives only audio components.

That's what goes into the making of this new circuit. Next month, I'll deal with a few more problems, and give complete details on a 40-watt public address amplifier you can construct for yourself. END

700 VOLTS LIGHTS 80 WELL

Recently, a high-school boy brought in a radio he had built in a school project. "It won't work," he moaned.

The set used a type 80 rectifier which lit normally when the set was turned on. Before testing the voltages, I decided to check the wiring first—fortunately!

The boy had wired the 5-volt filament of the 80 directly across the 700-volt secondary of the power transformer.

This should have burned out the filament of the rectifier.

But it didn't. Why? Pencil and pad and a little computing with Ohm's law brought the answer.

The rated filament current of an 80 rectifier is 2 amperes. The dc resistance of the power transformer's secondary winding is about 350 ohms. The resistance of the rectifier's filament is about 3 ohms. Thus, this circuit with a potential of some 706 volts had a resistance of 350 plus 3, or a total of 353 ohms.

Using Ohm's law, we find that the most current that can flow is $I = E/R = 706/353 = 2$ amperes, the correct rated filament current of the 80. Thus, the tube lit normally.

Oddly, too, the voltage across the filament came to an approximate 6 volts, so, even though the wiring was awry, the rectifier tube received normal current and voltage.

I do not suggest that readers try this, because the filament wired across the power transformer's secondary amounts to a dead short, and if left connected for any time the winding will burn out.

Fortunately, this incorrectly wired receiver was not left on for long, so the power transformer was not damaged. When the filament of the rectifier was wired correctly and the secondary's high-voltage winding was hooked up as it should have been, the set worked perfectly.—*Joeseph D. Amorose*

WHAT, NO COLOR?

Trouble in the color section! Shouldn't be hard to find and fix

By HOMER L. DAVIDSON

THE TIME WAS 7:45 AM. I HAD JUST PUT my key in the front door of my shop when a dealer from a neighboring town pulled up with a color receiver. The boys helped unload the defective set, and symptoms were filled out on the service repair card. Brand-new color set, just out of the packing box, and no color. This was unusual; most color sets have been coming in with good purity and convergence. A little touch is all that is needed.

The color receiver was fired up with both uhf and channel 5 antennas tied on. A black-and-white picture tuned in on channel 5 was very good. There was no color telecast at that time, but a fellow can check a color set for color without a station, if he has a few tools and equipment. A good color bar generator works out fine.

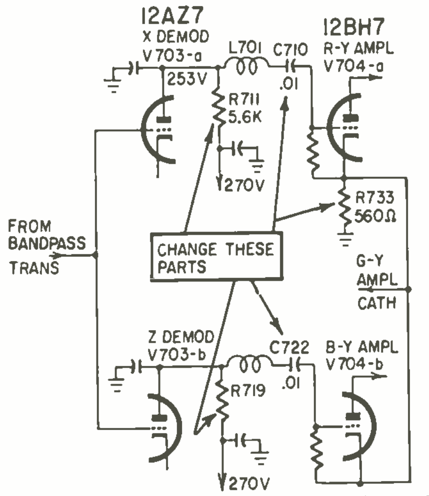
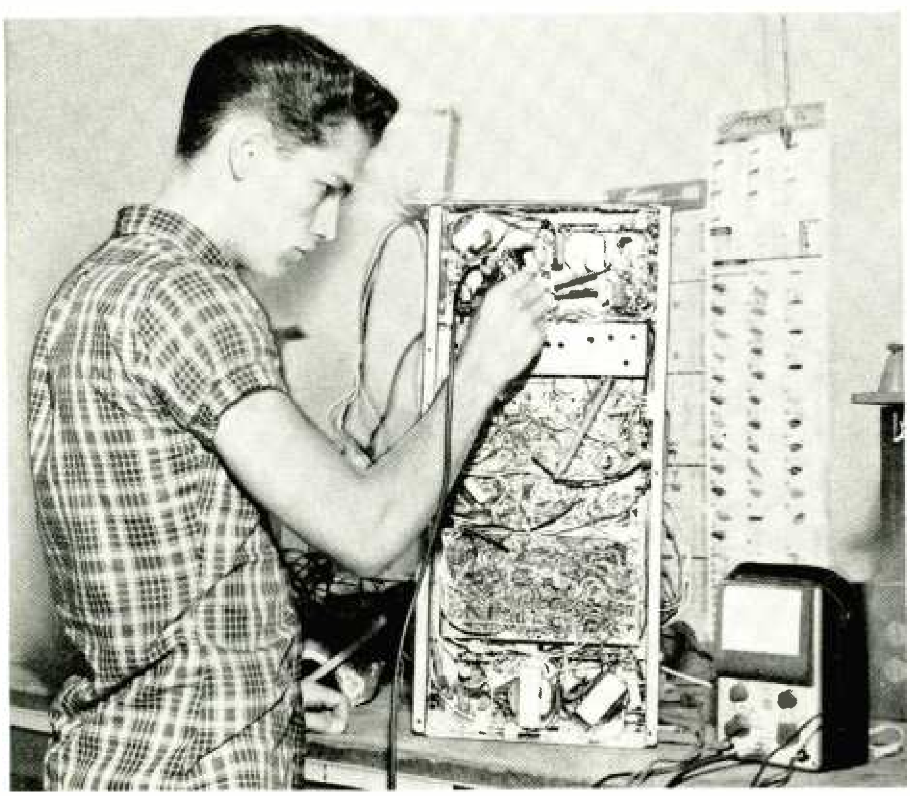


Fig. 1—Two very leaky capacitors burned up three resistors in this CTC 7.



Checking voltages in a color set. An 11-megohm-input-resistance vtvm is best for almost all checks.

From the front of the screen you can tell if the chroma section is performing by fine-tuning a black-and-white picture a little to one side. Notice the color fringing? Be sure the color killer control is up, and the color contrast control also. Color fringing or burst will appear next to the picture features, and show that the color section is working. Now turn the color contrast control down. The fringing disappears. When there is no color fringing, you know the color section is not working. This set had no color fringing.

You can also clip a color bar generator to the antenna terminals. If color bars show up on the screen, 9 times out of 10 the receiver is working. But the tenth time may get you. The signal from the generator is strong, and even if your defective receiver has too little color gain, the generator may make the color look real good. This also applies in a very-weak-signal area. Color receivers in fringe areas need all the gain they can get. In most fringe-area cases, the color killer control must be wide open.

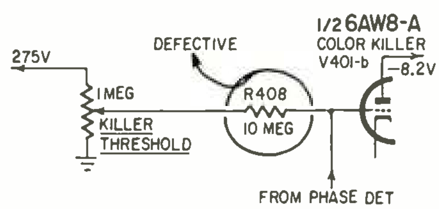


Fig. 2—When R408 increased, it kept the color amplifier partly cut off. Result: weak color.

(The color killer adjustment may be on the rear chassis apron, or inside [concentric with] another front control.)

I pulled the back off that new color set and took a peek inside. Of course there couldn't be *too* much wrong. Yes, it was just a crack in the side of a chroma oscillator tube (6GH8). The tube was white on top. The set must have had rough treatment in shipping.

Most color receivers follow much the same scheme. One tube may do two or three jobs, for there is often more than one section in the tube envelope.

Don't be frightened of color TV! Servicing color is no different from servicing black-and-white, except for the chroma section and color picture tube. Of course the high voltage is a little hotter, but the principles are the same.

One of the best ways to check out a chroma section or learn just how it works is to pull a few tubes and see what they do to the color picture. First, pull the color oscillator, a 6U8. In the old color sets this tube was quite critical. Then a new, more reliable type, a 6EA8, came out. When the 3.58-mc oscillator, first bandpass amplifier, second bandpass amplifier or phase detector is pulled, there is no color. Pulling the reactance tube and burst amplifier will throw the color out of sync or phase. These appear as shaded color lines. If you pull the X-demodulator or R — Y amplifier, you eliminate the red from the picture. The Z-demodulator or B — Y amplifier takes away the blue color, and the G — Y removes the green.

To see what might actually go wrong in a chroma section, let's take some case histories.

In the older RCA CTC7 chassis, the 6U8 oscillators are quite critical. You can select them for the best mutual conductance (g_m), or substitute a 6EA8 tube. In another chassis, a 12AZ7 X-demodulator had shorted. There wasn't any red in the picture. An open heater in this same tube, of course, will cause the same trouble.

A very common trouble in this chassis was leakage or shorting in coupling capacitors C710 and C722 between the demodulators and the R — Y, G — Y and B — Y amplifiers (Fig. 1). This placed a high B-plus voltage on the grids of these 12BH7 tubes, making them draw heavy current. The common cathode resistor R733 and plate loads R711 and R719 got hot and burned. All these parts had to be replaced. A vom would detect this trouble right away. After a while, when that chassis came to the shop for *any* repair, those two coupling capacitors were automatically replaced with 1,000-volt types.

Faulty B — Y, R — Y and G — Y amplifiers change the black-and-white

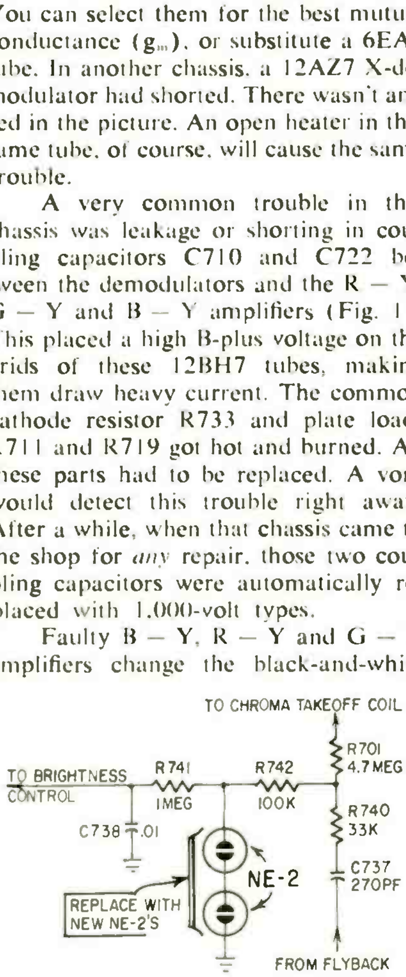
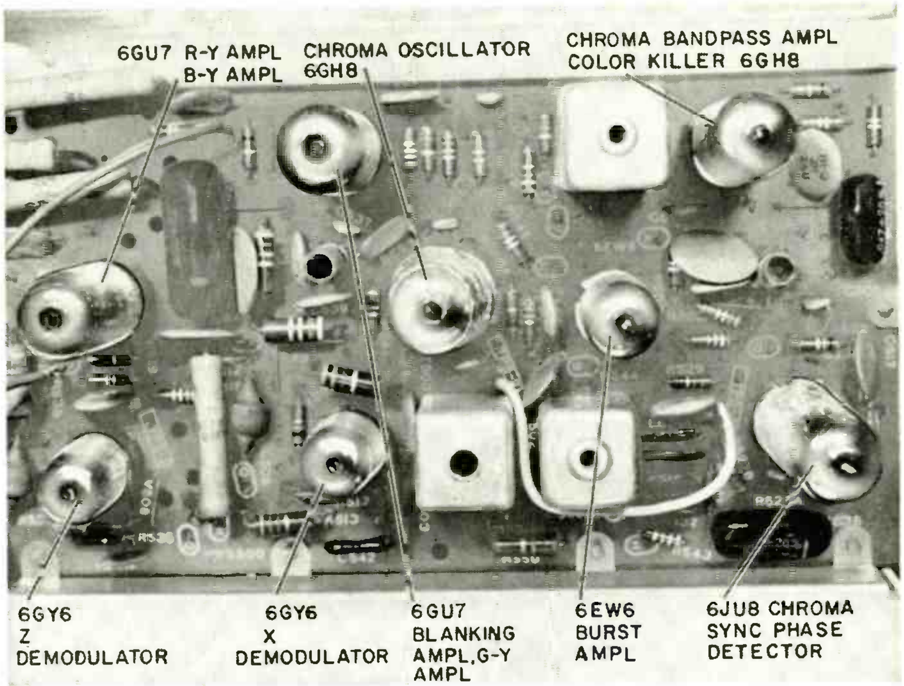


Fig. 3—Poor regulation (bad neons) in the brightness control circuit caused the picture to pull in when the control was advanced.



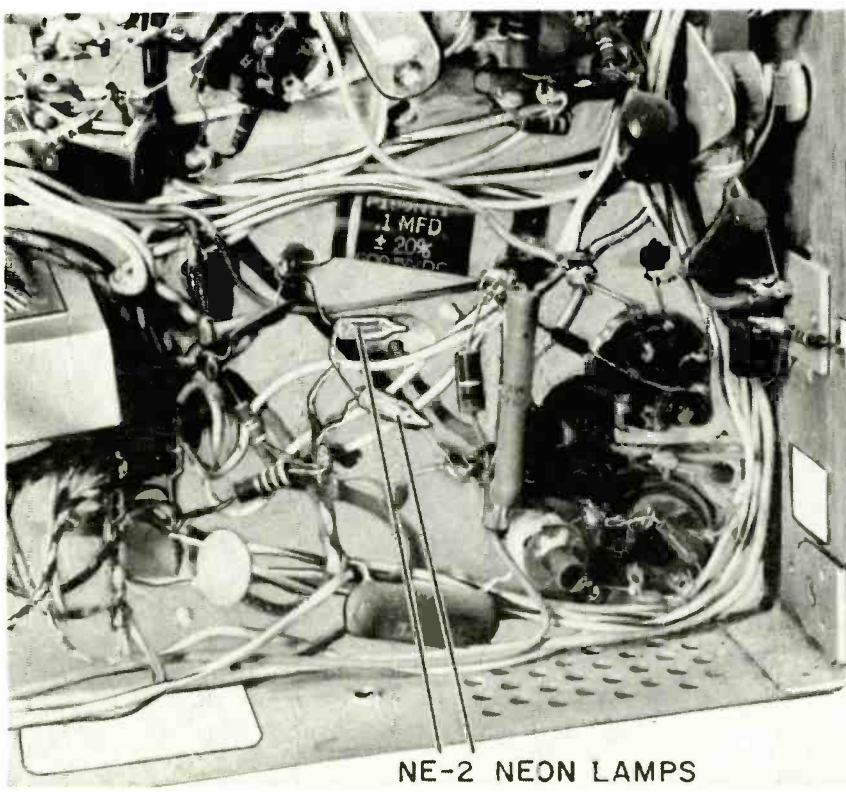
Color-circuits board from an RCA set, with all tubes and their functions called out.

color temperature on the screen. When one tube is replaced, it is best to put two known good ones in the set. These tubes and circuits are slightly heat-sensitive so let the set warm up before beginning black-and-white temperature adjustments.

In a RCA CTC10 chassis, only a small amount of color was visible. The chroma section was weak. Resistor R408 (Fig. 2) had increased in value and was cutting the color off. With the color bar generator on the antenna terminals, the color signal wasn't bad. But when a color broadcast came on, you could hardly see it.

This same CTC10 and also chassis CTC11 had a common trouble: loss of color, poor brightness, and picture sides that would pull in when the brightness control was advanced. All this was caused by two little old neon lamps in the brightness control circuit. These two NE-2 bulbs are in series. When one or both are bad, they get cherry red. Replace both.

The circuit also extends into the chroma takeoff coil section. It is always



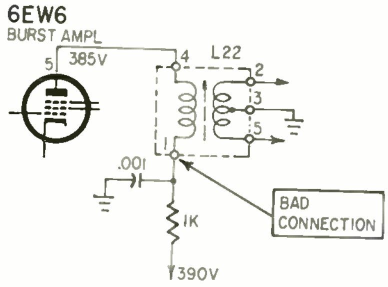


Fig. 4—More solder connections almost always mean more intermittents! This bad 'un in the burst amplifier caused on-and-off color.

wise to replace both these neon bulbs whenever the set is in for repair. Fig. 3 shows the location of these two neon bulbs.

If you are in a fringe color area, R701, a 3.3- or 4.7-megohm resistor, can be clipped out of the circuit. This is in one leg of the chroma takeoff coil and is located at the rear and on top of the chassis. Disconnecting it will give you more color gain.

Let's take the case of an Admiral 24E2 color chassis. The color would come and go intermittently. All color tubes were replaced but, if any color tube was wiggled, color still came and went. The chassis was pulled and turned over. When I pushed up and down on the color-section printed-circuit board, color was intermittent. Taking a closer look at the board, it seemed that around the burst amplifier the trouble really acted up.

I put a voltmeter on the plate of the 6EW6 burst amplifier (Fig. 4). The voltage rose and fell with the color. Coil terminal 1 was also dead. But just around it on the etched wiring, the voltmeter read 400 volts. A poor solder connection at pin 1 was corrected, clearing up the intermittent.

A farmer pulled in with his pickup truck and dropped off an RCA CTC11C color set. The symptoms were horizontal color bars, not in sync or in phase. I replaced the reactance tube and burst amplifier—to no avail. The chassis was pulled.

I knew the trouble was somewhere in the phase and sync sections. Then I checked voltages and found a shorted .01-μf postage-stamp capacitor was the trouble. It had shorted and R713 was warm. Both parts were replaced and the color picture was back to normal. To be on the safe side, I went through the color afpc (automatic frequency and phase control) alignment. Do this according to the set designer's instructions. The capacitor and resistor are shown in Fig. 5.

In the CTC11C, color gain can be increased by removing R701, a 4.7-megohm resistor.

On the RCA CTC15 and CTC16 chassis, uhf stations seemed to cause oscillations in the set when a color program was tuned in. Right at the point of color reception, as you turned the uhf dial, heavy black lines appeared. They would wander and the trouble proved to be oscillations in the agc circuit of the uhf tuner. A .047-μf capacitor was soldered to the green wire and to ground to eliminate them. This trouble appeared only on the uhf band. Before I deliver a new set, I always solder in a new capacitor.

The CTC16 chassis also suffered from intermittent contrast, which affected color reception. A 50-μf electrolytic capacitor in the contrast circuit (Fig. 6) was the culprit.

Only a few color cases have been mentioned here, but of course there are many others. We might start at the antenna. Never use one that is too sharp (too narrow in bandwidth) for color reception. Use a broad-band antenna. Especially on the uhf band, do not use Yagi type antennas for color. Several small stacked bow-tie translator antennas should be used for good bandwidth and gain.

As an example, a doctor in our town moved from a smaller house to a larger one down by the river. His color set worked fine at the old place but not at the new one. After several hours of checking I came to the conclusion that the set was OK. The uhf black-and-white picture was perfect, but there was no color. Yes, the station was transmitting color, but Doc wasn't getting it.

The uhf antenna was old and looked like an off-breed or a homemade affair. A new four-stacked bow-tie antenna was installed with a round polyethylene-filled lead. We now had plenty of good color.

Remember also that color reception cannot be any better than the black-and-white picture. If there is snow in the black-and white-picture, you will have colored snow in the color picture. The tuner, i.f. stages and video stages of the color receiver must be in tip-top shape. In a fringe area, a good antenna, lead-in and receiver are "musts."

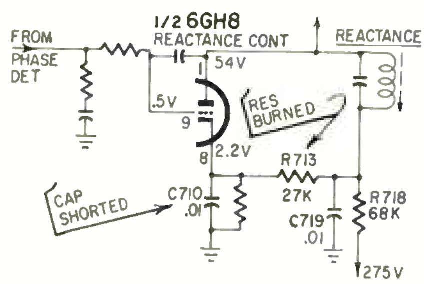
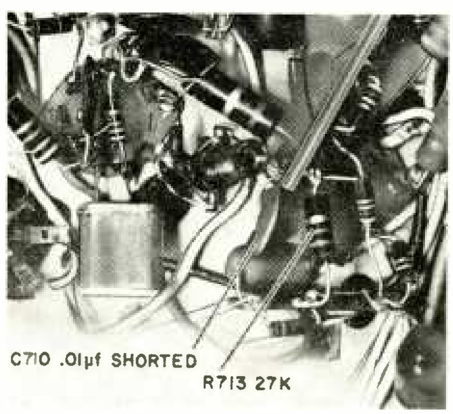


Fig. 5—Shorted C710 caused out-of-sync color bars.



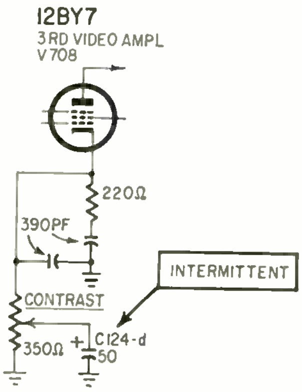


Fig. 6—Intermittent electrolytic here caused sudden contrast changes.

Of course, if the color picture tube is weak or one of the guns is out, color will be poor. The color picture tube acts just like a black-and-white tube when it goes bad. But you do have three guns instead of one. If red is gone or weak, check the picture tube. (Nine times out of ten, the red gun goes down before the other two.) A good color picture-tube checker is a must.

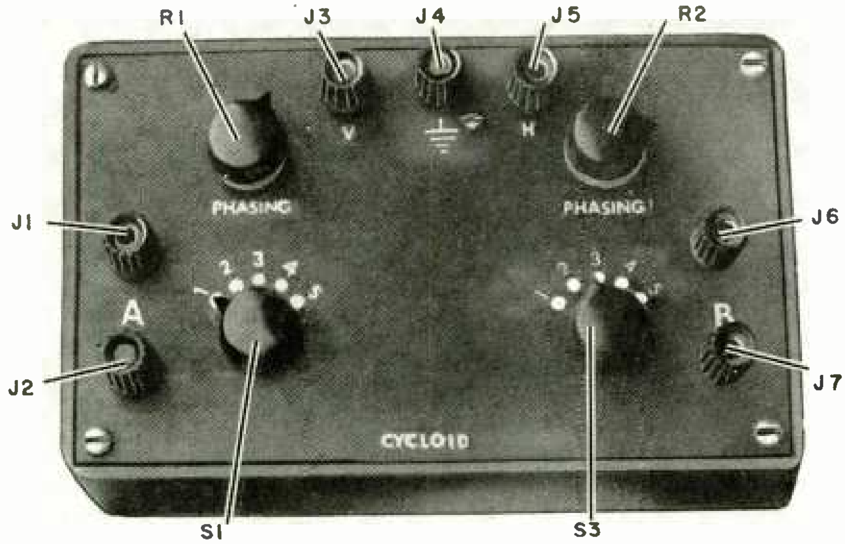
You can check the color picture tube for color in the home if you do not have a tester along. Take the convergence switch box and short out two of the guns at a time. With a little experience you can tell a weak gun from a good one. We might add that any of these colors will be missing also if the B – Y, G – Y, and R – Y amplifier tubes or components are defective.

When the color receiver repair is finished and the chassis is back in its cabinet, several adjustments have to be made. First, degauss the picture tube. Set the focus control and purity. Be sure the screen does not have a touch of red or green in the corners. Purity adjustments take only a few minutes. Hook up the color dot–bar generator and check convergence. Adjusting the convergence magnets may be all that is needed to touch up the black-and-white picture. Be sure to check the black-and-white temperature adjustment. Sometimes a slight blue tint is about right. Set the color killer and agc controls. Finally, check out the receiver on a color program. END

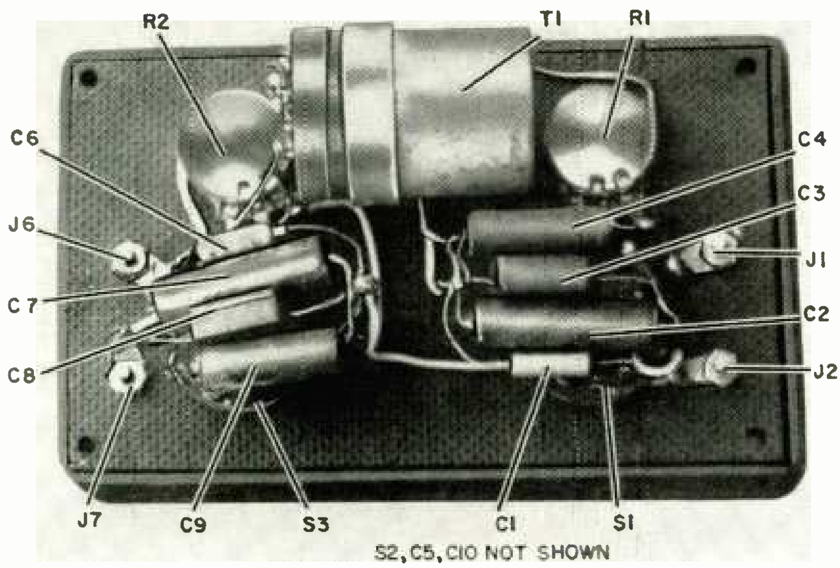
CYCLOIDS FOR FREQUENCY MEASUREMENT

They're more flexible and often more accurate than Lissajous figures

By **TOM JASKI**



The completed scope adapter.

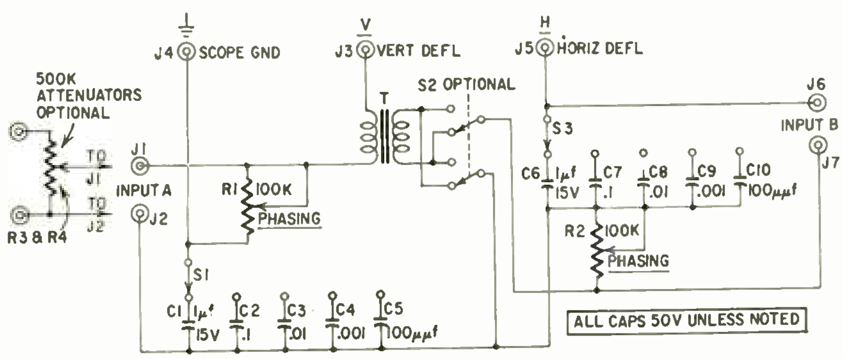


All components are mounted on the back of the front panel.

NEXT TO OBSERVING AND ANALYZING waveforms, the scope is most frequently used for frequency measurement, because it gives us an easy way of comparing an unknown with a known frequency. Several methods can be used, some of them thoroughly familiar to scope owners. There are Lissajous figures, intensity-modulated circles and ellipses, timing scales, and cycloids, the method to be discussed here.

To form a cycloid, we need two sets of voltages. Each set consists of two sine waves (or near sine waves) 90° out of phase. These can be provided with the equipment shown in Fig. 1 and the photos. Voltage A is applied to the phase-shifting network (R1 and capacitor selected by S1) and voltage B to the phase-shifting network consisting of R2 and capacitor selected by S3. Voltage A is also fed to the scope's vertical amplifier through one of the transformer windings. Voltage B goes direct to the scope's horizontal amplifier. The shifted portions of signals A and B are applied (through the transformer) to the vertical amplifier. They are added in the transformer. The result, a cycloid.

The shape of the cycloid depends on the relationship of the phases of the two voltages and on their frequency as



R1, R2—pot, 100,000 ohms
R3, R4—pot, 500,000 ohms (optional)
C1, C6—1 μf, 15 volts
C2, C7—0.1 μf
C3, C8—.01 μf
C4, C9—.001 μf
C5, C10—100 μμf
All capacitors 50 volts unless noted
J1, J2, J3, J4, J5, J6, J7—3-way binding posts
S1, S3—single-pole 5-position rotary switch
S2—dpdt toggle (optional)
T—audio transformer, high impedance, 1:1 up to 3:1 (ratio not critical)
Plastic box and cover, 3 1/16 x 6 x 2 inches
Miscellaneous hardware

Fig. 1—Circuit of simple scope adapter that will permit you to display cycloids.

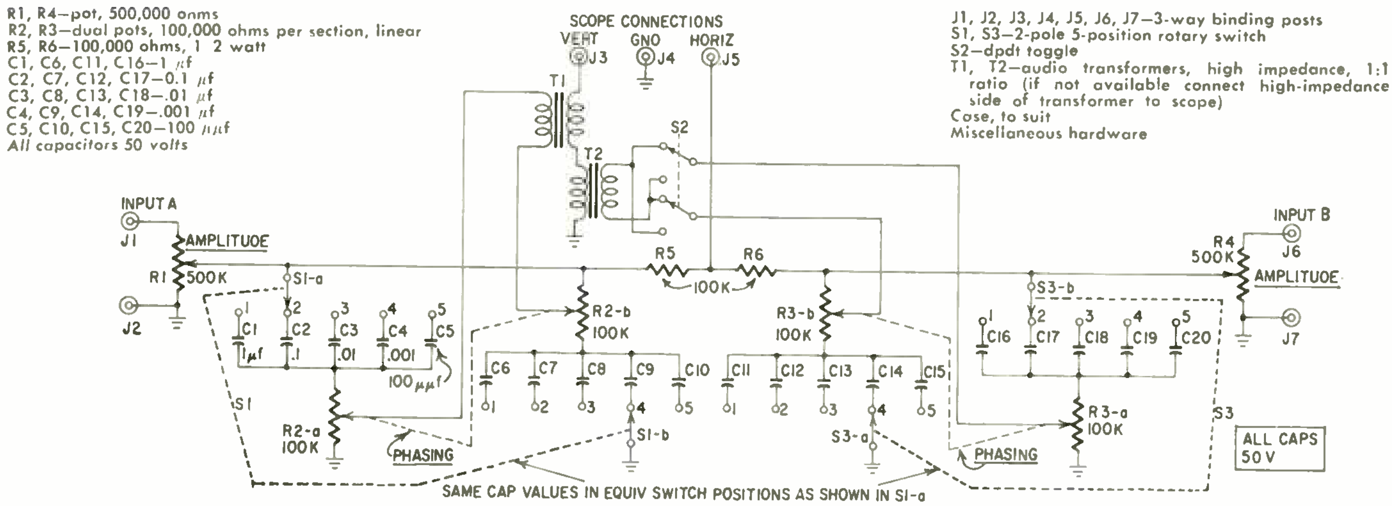


Fig. 2—A more refined version of the adapter shown in Fig. 1.

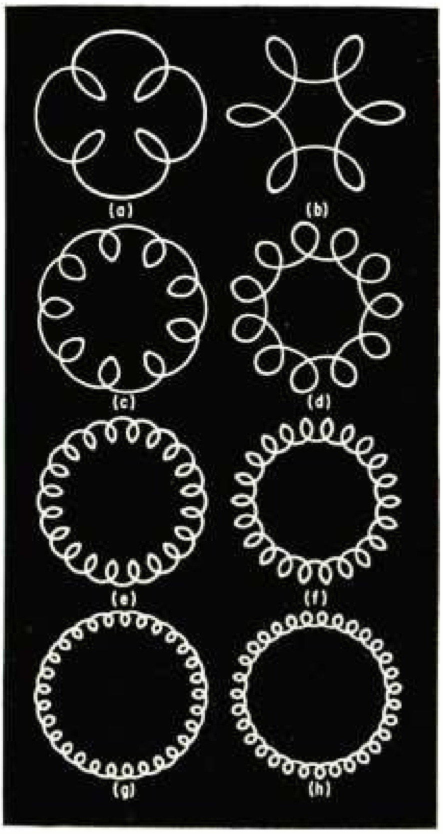


Fig. 3—Cycloid patterns of various frequency ratios. Outside and inside loop patterns are shown for each: a, b—5:1. c, d—10:1. e, f—21:1. g, h—30:1.

well as magnitude. The circuit in Fig. 1 has one unfortunate aspect. When we change the phase (with R1 or R2), we also change the magnitude. A much improved version of the circuit (also much more expensive) is shown in Fig. 2. Here phase shifting does not affect the magnitude of the signal. The two transformers are needed to isolate the A and B shifted portions, because the scope amplifiers have a common ground. A three-winding transformer could replace the two transformers. Winding ratios are not critical, but the closer you can get to 1:1:1, the better.

The equipment in Fig. 1 does not have attenuators, on the assumption that the sources will include these. If not, they must be added, as they were in Fig. 2.

If you expect to measure frequency often, the more elaborate circuit will pay its way in convenience. Compared to the cost of a frequency meter, it is inexpensive.

How to read cycloids

Before we can read cycloids we must create them. To make it easy on yourself, follow this simple procedure:

1. Select the lower frequency of the two and apply it to the scope amplifiers, keeping the other voltage at zero. Now adjust phase and amplitude of the low-frequency voltage until you get a satisfactory circle.

2. Turn the low-frequency voltage to zero and apply the high-frequency voltage. Adjust this for phase and amplitude until you get a very small circle.

3. Return the amplitude of the low-frequency voltage to its previous value. The result should be a cycloid, such as you see in Fig. 3. Whether you will get an epicycloid or a hypocycloid depends on the phase of the two voltages at the transformer. By throwing the reversing switch, you can change from one kind of cycloid to the other.

Reading cycloids is simple. For the kind shown in Fig. 3, you count the loops made by the small voltage. If the loops are inside the circle, add 1, for the number of loops plus 1 is the frequency ratio. If the loops are outside the circle, subtract 1. The number of loops minus 1 is the frequency ratio. Now as you can see, ratios of as much as 51 to 1 are duck soup with such cycloids. Ratios of 100 to 1 can be counted.

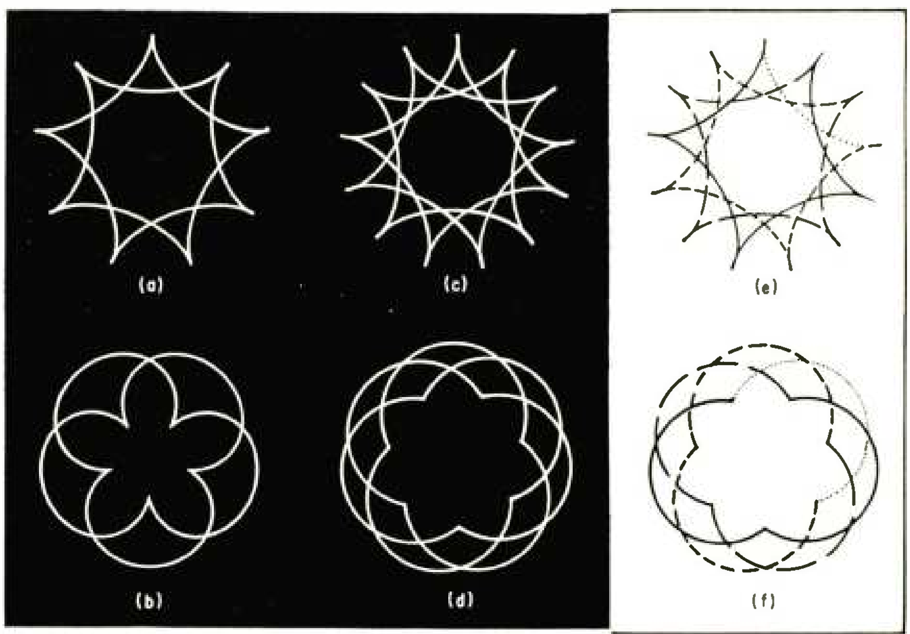


Fig. 4(a, b)—Outside- and inside-loop patterns for 3½:1 ratio; (c, d)—same for 3⅓:1 ratio; (e, f)—figures c and d redrawn to show number of overlaps. In each, start with short-dash line and go around, counterclockwise in e and clockwise in f. Count short-dash path as one lap; next, long-dash, then solid, totaling three. Dotted line completes figure and is not counted.

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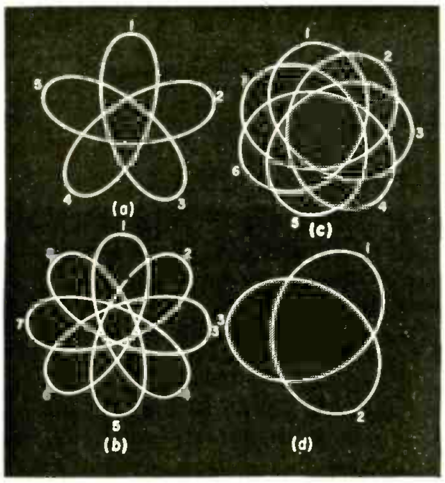


Fig. 5—Outside loop patterns showing ratios of less than 1. a—2:3. b—3:5. c—2:5. d—1:2.

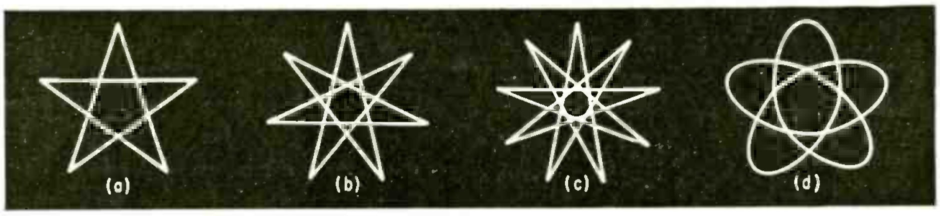


Fig. 6—Star figures formed by varying the phase and amplitude settings are also interesting.

Fractional ratios are not much more difficult. Here, you must count not only the cusps (loops) but also the number of overlapping similar figures made by the pattern. Sometimes these overlapping figures are easy to see, as in Fig. 4-a, where there are obviously two figures. Then the formulas for the frequency ratios are:

For loops inside circle,

$$\text{ratio} = \frac{\text{f (loops)} + \text{p (figures)}}{\text{p (figures)}}$$

For loops outside circle,

$$\text{ratio} = \frac{\text{f (loops)} - \text{p (figures)}}{\text{p (figures)}}$$

Let us examine some of these figures. In Fig. 4-e and f, the possible "figures" for both kinds of cycloids developed from Fig. 4-c and d have been drawn. Still other configurations are possible.

Ratios less than 1

When dealing with ratios of less than 1, outside loops are more easily read, but the technique of reading them is different. Take a look at the patterns in Fig. 5. All represent ratios of less than 1.

To get the ratio for Fig. 5-a, number all the loops as shown. Then follow the trace from loop 1 counterclockwise. It goes to loop 3, excluding loops 2, 4 and 5. Count the number of skipped loops between loops 1 and 3 in each direction. We skipped one at the right side (loop 2) and two at the left side (loops 5 and 4). As we are dealing with outside loops, we add 1 to our figures. This gives 1 plus 1, or 2 (going clockwise), and 2 plus 1, or 3 (going counterclockwise). Assembled into a ratio, we get 2 to 3. But it might also be read 3 to 2. How do we know which is correct?

It's easier than you might think. We simply increase the frequency of one of the input signals—for example the signal of known frequency. If it is the higher frequency the greater number of loops skipped (loops 4 and 5 in Fig. 5-a) will increase, but not the smaller. If it is the lower frequency the smaller number of loops (loop 2 in the example) will increase, but not the larger.

Now let's try again, this time with Fig. 5-b. Again number all the loops. Now follow the trace counterclockwise from loop 1. It goes to loop 4 excluding two loops going clockwise (right side) and four loops going counterclockwise (left side). Adding 1 to each figure gives us a 3 to 5 ratio. Now you figure the ratios for the other two figures. Remember to check to see which frequency is larger, so you know how to set up the ratio. You should count 2 to 5 for Fig. 5-c and 1 to 2 for Fig. 5-d.

Rotating figures

Like Lissajous figures, cycloids may also rotate a little. In that case the same rule applies. Count the number of cusps passing a given point per second. Then the frequency deviation from the exact ratio is given by the count. Whether these are to be subtracted or added you can find easily enough by changing one frequency a little. If increasing the frequency makes the figure rotate faster, the count must be added to the frequency you have changed (calculated from the other one and the ratio) or subtracted from the frequency you did not change to make the pattern rotate faster.

Thus if you find a figure that indicates a ratio of 5 to 1, and your known frequency is 60 cycles, the other one is near 300. If the pattern rotates so that 3 cusps per second pass the reference point (which is any arbitrary point outside the figure), and the pattern rotates faster if you increase the higher frequency, the actual frequency is 303 cycles.

Many interesting figures can be made with cycloids. They depend on the voltage and phase adjustments you use. Some examples are shown in Fig. 6. The same voltages could have caused daisy-like patterns with different voltage adjustments. Thus cycloids provide not only an accurate way of measuring relative frequency in very fine steps and over a large range, but also can provide hours of amusement if you like to create artistic patterns on the scope.

END

A TUBE WITH A SENSE OF TIME?

A swindle in stolen color television sets is reported to be operating in some areas. The swindlers manage to sell the same set many times over to different customers. The perpetrators allegedly net $100 on each "sale" of the set.

These "sharpies" contact an individual with whom they are acquainted and ask him if he is interested in purchasing a color TV set for $100, at the same time letting the prospective customer know that the set is stolen. The set need not be paid for until it is delivered to the home.

Upon delivery of the set to the home, the buyer is advised that if anything should go wrong with the set to call one of them (dispensers of the stolen sets) immediately, since they have to send one of their own repairmen so the theft will not be discovered.

The swindlers have a tube in the set that functions for approximately 48 hours, after which the set no longer works. The buyer contacts the swindlers for repair service, and they in turn send one of their own men to the home. After looking over the set, the alleged repairman states that he has to take it back to the shop to work on it. It is never returned, and the buyer is out $100.

When the customer contacts the swindlers to inquire when the set will be returned, he is told that the police have confiscated it and that he—the customer—is very fortunate in not being involved for having purchased the allegedly stolen set.

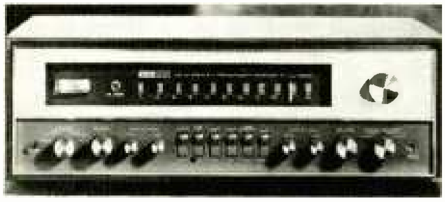
The swindlers keep repeating this method of operation as often as they can find someone to pay $100—always using the same TV set. —*From the FBI Law Enforcement Bulletin*

What we want to know is how to rig a tube (or any other part) to make it work for just 48 hours or thereabouts, rather than cut out after 8 or wobble along for a week. We welcome suggestions from our more devious readers. In fact, we'll print the best ideas.—Editor

EQUIPMENT REPORT

Harman-Kardon SR-900

WHEN MOST AUDIO MANUFACTURERS were still timidly clinging to tube design, Harman-Kardon was up to its neck in transistors. As far back as 1961, the Harman-Kardon engineering team—then headed by Stewart Hegeman—developed the Citation A all-transistor preamp, which still sets a high mark in sound reproduction. Now the firm's long experience in solid-state audio has been applied to all-in-one receivers. The result is the Stratophonic series.



The classic moniker is intended to signify "high-sounding," and the SR-900—top model of the series—fully justifies its name. Its performance places it clearly in the forefront of today's solid-state receivers. Surprisingly, its price of $469 is almost competitive with top-bracket tube units.

The first thing I expect from solid-state equipment—no matter what its other virtues—is a low hum level. In this respect, the SR-900 proved truly outstanding. Even with the volume control in maximum position, and with the selector switch on magnetic phono input, the background remains inaudible. The music emerges against virtual silence. In my test location—a country house in the Berkshire hills of Massachusetts, remote from traffic and other noises—this total absence of hum was really striking and added greatly to the dramatic impact of the music.

The backwoods test location also revealed the excellent sensitivity of the SR-900. With a six-element Yagi roof antenna, the tuner section provided full limiting on FM stations from New York City, more than a hundred air miles away. With just about every station between Boston and Philadelphia crowding the dial, I had no selectivity trouble.

Later I left the outer fringe and took the unit to New York City to try it under signal conditions typical of metropolitan areas. Most local stations came in fine without any antenna at all—further proof of the SR-900's sensitivity. And when an indoor antenna was connected and excessive signal strength tipped the tuning meter all the way to maximum, there were no audible signs of overloading. It would seem that Harman-Kardon has successfully solved the most obstinate problem of transistor tuner design: how to accommodate a wide range of incoming signal strengths without overloading rf stages.

When the adjustable interstation muting is switched in, the flywheel tuning rolls silently from one station to another without white noise between channels. The Stereologic circuit (selected by a special position on the program selector switch) senses when a station is broadcasting in stereo and automatically switches the receiver to stereo, lighting the stereo indicator. When a mono station is tuned in, the SR-900 automatically reverts to the mono mode. A control at the rear lets you select the response threshold for this kind of automation. If a stereo signal comes in too weak for satisfactory stereo reception, it is automatically reproduced in mono, so that noise and distortion are kept at a minimum.

The sound quality of the SR-900 is, for all practical purposes, limited only by the quality of the signal source. A live stereo broadcast or an exceptionally fine recording reproduced on the SR-900 is a striking demonstration of "transistor sound" at its best. The music comes through with startling clarity. Most important, there is no harshness in the strings or solo woodwinds at low volume. Evidently Harman-Kardon succeeded in eliminating the switching distortion in the class-B output stages responsible for the typical harshness of some earlier transistor amplifiers.

Thanks to superb damping, transients are crisp and sharp, and the bass in particular is well controlled. With the bass controls well advanced, the bass from our KLH speakers remained tight and solid, without a trace of boominess.

The discreetly elegant front panel is very sensibly laid out for convenience of operation. In addition to the customary controls, it displays several uncommon features. One is a switch that lets the signal bypass the tone controls, eliminating the phase lag inevitably introduced by the tone control circuits. Another eminently practical feature of the SR-900 is the provision for feeding the output to two separate pairs of stereo speakers, simultaneously or one pair at a time.

There are other thoughtful touches. Speaker terminals, for instance, are far enough apart to prevent shorting between neighboring leads, and a raised ridge between "hot" and ground terminals prevents accidental shorting.

Considering the exceptional performance of the tuner and the amplifier, these extra features are indeed gilding the lily. In short, the SR-900 sets new standards for an all-in-one unit. Frankly, I looked for flies in the ointment. I found one: the position markers on the knobs are hard to read.—*Hans Fantel*

MANUFACTURER'S SPECIFICATIONS

IHF music power: 75 watts, both channels
Frequency response: 5 to 60,000 cycles at full output
Harmonic distortion: less than 0.2%
Hum & noise suppression: 95 db
Damping factor: 40
Square-wave rise time: 2.5 μsec
FM usable sensitivity (IHF). 1.85 μv
Image rejection: better than 70 db
Spurious-response rejection: better than 85 db
Multiplex separation: 40 db
Price: $469
Harman-Kardon, Inc., 15th & Lehigh Ave., Philadelphia 32, Pa.

Viking VFS Frequency Standard

WITH THE ENORMOUS NUMBERS OF TWO-way radios in use today, more and more technicians find that it pays to get an FCC license and go full or part time into two-way servicing.

A must for this kind of work is a frequency standard and a method of checking modulation deviation.

The Viking VFS does these jobs extremely well and with a minimum of fuss—especially the frequency measurements.

It is reliably accurate to .0002% as a primary standard, and when calibrated against WWV and used as a secondary standard, it is correct to .00003%. Either way its accuracy exceeds considerably the required tolerance limits specified for all transmitters.

The heart of this standard is a 100-kc crystal installed in a thermostatically controlled crystal oven. In addition four locked oscillators of 50 kc, 25 kc, 20 kc and 5 kc may be selected individually. Harmonic amplifiers then provide output all the way to 500 mc.

This kind of standard makes it necessary only to select the proper oscillator so that a harmonic will fall exactly on the transmitter frequency. No math is necessary, however, since a calibration chart for all present two-way frequencies is firmly affixed to the lid. Often the same oscillator setting may be used for a number of transmitter frequencies. As an example, in the 30- to 50-mc range, you use the 20-kc position for any assigned frequency measurements. In the 450-mc band, the 50-kc oscillator is used for all measurements.

For frequencies that are not multiples of any of the oscillators, a deviation control on the 100-kc oscillator shifts

continued on page 70

its frequency approximately 10 cycles up or down. This control must be used for checking frequencies in the 150-mc range. Here again no mathematics is needed because the correct setting is indicated in the lid.

Each instrument is individually calibrated in deviation so that you may check any crystal-controlled frequency whether specifically assigned by the FCC or not.

The VFS does require that the frequency of the transmitter or receiver under test be known to within a few kc (that is, somewhere in the channel), which of course is always true with crystal-controlled apparatus. It is difficult to check frequencies of vfo's for example unless the dial calibration is known to be good within a few thousand cycles. However, using a closely calibrated receiver with the VFS, the frequency may be spotted to within a few cycles easily, even at high frequencies.

Another important point about the VFS is that it can be used for calibrating other frequency standards, such as crystal-controlled test sets.

I have used the Zero-Beat, as it used to be called, for almost a year now, calibrating transmitters on many frequencies. I have not seen any frequency standard easier to use for two-way radio, or one more tolerant of its power source. Power-line voltages from 90 to 130 do not change the calibration or accuracy.

A built-in modulation-frequency deviation device, using the Bessel null method, lets you check modulation. This is not quite so easy as metered deviation, but, used with care, is just as accurate—perhaps more so. A 2,083-cycle oscillator is fed to the audio input of the transmitter. The deviation control in the transmitter is turned from minimum until the first audio null occurs. This is exactly at 5-kc deviation. The disadvantage of this system is that the input amplitude must be known for each make and model of transmitter; this is usually supplied by the manufacturer. But on the plus side, this information *should* be known when using *any* deviation monitor.

The VFS sells for $695. I think it would be a good investment for anyone seriously interested in entering the two-way field, or for the service company that needs an additional frequency standard to make quick, precise checks.
—*Wayne Lemons*

Dimensions: 18⅞" wide, 11⅛" high, 6¼" deep
Weight: 21 lb
Power input: 50 watts
Frequency range: 5 kc to 500 mc
Accuracy: field service .0002%, Laboratory set-up .00003%, Stability, .0002% 30 days
Warmup time: 18 minutes
Accessories supplied: Coax cable, calibration chart.
Price: $695
Manufactured by Viking Instruments, Inc., Town Road, East Haddam, Conn.

END

NEW SEMICONDUCTORS AND TUBES

SILICON POWER TRANSISTORS FOR AUDIO

A whole new line of silicon n-p-n power transistors especially for use in audio amplifiers has been announced by RCA. There are 20 of them—numbered 40309 through 40328—and they can be adapted to a wide variety of PA, utility

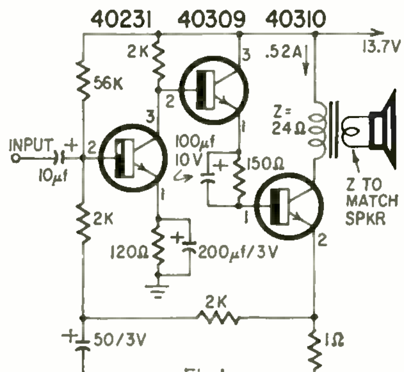


Fig.1

and hi-fi audio amplifier designs from 2 to 50 watts. Some of the amplifiers described in RCA design notes can be operated directly off the power line, like the 117-volt ac–dc table radio described in the June issue of RADIO-ELECTRONICS (page 39).

Twenty transistors is too many to describe fully in this column, so we'll have to limit the presentation to saying that the 20 form a family, members of which can be used singly or combined in various ways to produce a remarkable variety of useful amplifiers. Two are diagrammed here. The line even includes a p-n-p silicon transistor—a somewhat rare breed—as shown in the 10-watt amplifier on this page.

Now: the circuits. Fig. 1 is a modest but conservatively designed 2-watt amplifier billed as ideal for low-power mobile work or for other applications where temperature variations are large. Total harmonic distortion at 2 watts, 1 kc, is 2%; the circuit will produce up to 3 watts at mid-range before the distortion becomes serious. Since the amplifier is all class-A, it draws a more or less constant current (525 ma) from 13.7-volt supply (normal average voltage in a moving car with a 12-volt-nominal electrical system).

Another neat circuit (Fig. 2) is a 10-watt class-AB high-quality amplifier with a series-connected transformerless output stage. The design is conventional; it follows what has become known as "the G-E circuit," used in several commercial amplifiers as well as (in slightly modified form) in RADIO-ELECTRONICS' own T-40/40 amplifier in the March 1965 issue. Frequency response is claimed as flat from 15 cycles to 100 kc (3-db points, 0 db taken as 8 watts at 1 kc).

Harmonic distortion is claimed to remain well under 1% at 8 watts from 20 cycles to 20 kc. Quiescent power dissipation is less than 1 watt. The amplifier is said to be stable at all temperatures up to 71°C. The credit for that is shared by the silicon transistors, the two 1N3754 silicon diodes and the dc feedback around the amplifier through various loops. Input sensitivity is not stated specifically, but it is probably around 1 volt

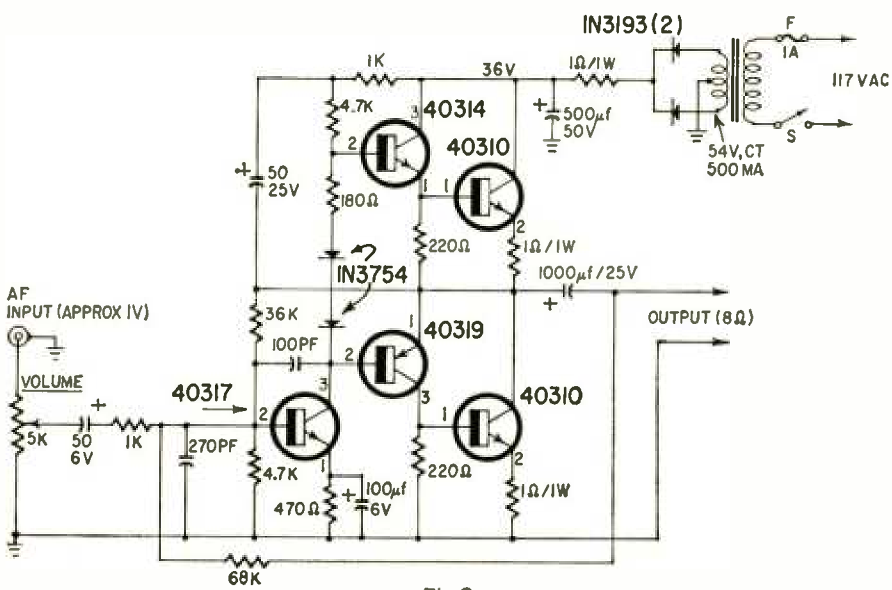


Fig.2

across the 5,000-ohm volume control for full output.

The line of transistors is somewhat more expensive than a comparable line of germanium transistors, but that's usual for silicon and usually justified by the greater design flexibility and wider operating-temperature range. One-apiece retail prices range from about $1.05 to $3.75 at RCA distributors. Data sheets and application notes are available from RCA Electronic Components & Devices, Harrison, N. J.

ELECTROSTATIC IMAGE ORTHICON

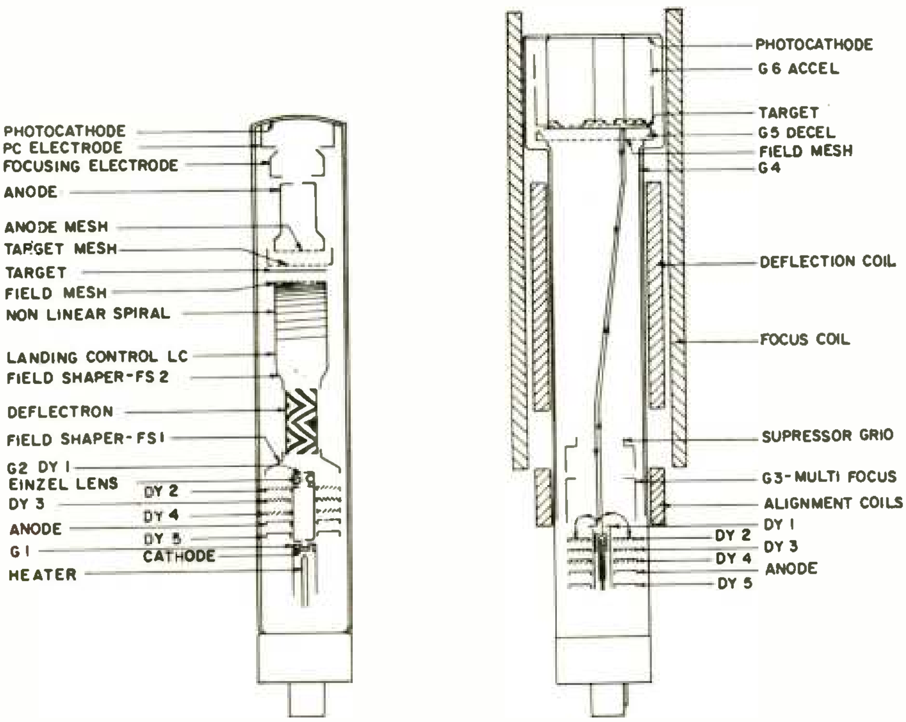
A highly sensitive "see-in-the-dark" image orthicon that uses electrostatic focusing and deflection was recently announced by General Electric. Called the Z-7804, the new tube is expected to weigh only about one-twentieth as much as a comparable electromagnetic tube with all its associated coils, draw some 30 times less power, and be about one fifth the size.

Electrostatic focusing and deflection has been used before on vidicons (a much less sensitive kind of tube), but never on image orthicons. The orthicon functions in starlight with high resolution, while the vidicon usually needs daylight. Satellite applications are obvious, but they were impractical until now because of the high power requirements of the heavy electromagnetically controlled orthicon.

The Z-7804 has a high-gain, thin-film magnesium oxide target with a sensitivity 10 to 20 times that of glass targets. The target can store a signal for a substantial time before readout, making low frame rates, or beam pulsing, possible. Variable scan-rate and frame-rate circuits are far simpler with this tube than with electromagnetic versions.

"Blooming" or halo caused by bright, shiny objects is less of a problem with G-E's new tube than with older types. Blooming caused by excessive subject brightness can mean losing the picture altogether for several seconds.

G-E admits readily that some electromagnetically focused and deflected orthicons will outperform the Z-7804 in very-high-resolution jobs, but the lower drain, lighter weight, smaller size and simpler circuitry are expected to outweigh many disadvantages. END



At left, cross-section of General Electric's new electrostatically focused and deflected image orthicon. At right, conventional, magnetically focused and deflected I.O. and its yokes and coils. New tube eliminates deflection, focus and alignment coils, eliminating more than 15 pounds of weight. Self-contained deflectron, Einzel lens and nonlinear spiral lens in new tube focus and deflect beam. Decreased length of new tube is also shown.

NEW PRODUCTS

30-WATT STEREO AMPLIFIER, *LA-224A*, has 3-position input selector; 4-position mode selector; independent bass and treble controls for each channel; concentric volume/balance control; pilot light; rumble filter switch; phase-reverse switch; speaker/headphone selector switch; power on–off switch; headphone jack. Power output: 15 watts per

channel—30 watts mono. Frequency response from 25 to 25,000 cycles ± 1.5 db. Harmonic distortion 1.25% at 15 watts. Hum and noise: magnetic phono, — 56 db; tuner, — 75 db. 8- or 16-ohm speaker impedance switch on rear, hum adjust and ac outlet. Ten tubes. For 105-125 volts, 50/60 cycles ac. 12¾ x 5⅛ x 8½ in., 20 lb.—**Lafayette Radio Corp.**, 111 Jericho Turnpike, Syosset, N. Y.

LAVALIER MICROPHONE, *model S-58*, has slide-type on–off switch. Response: 60–13,000 cycles. Output level —60 db. Impedance high and 150 ohms. 25-ft cable and assembly furnished. — **Turner Microphone Co.**, 909 17th St., N.E., Cedar Rapids, Iowa

TV/FM FIELD-STRENGTH METER, *model FS-2*: 3½ lb.; 2 bands for channels 2–6; FM channels 7–13; uhf adapter position; separate picture and

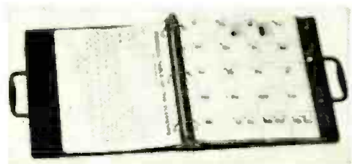
sound carriers. 4 db scales from —33 to +60. Performs with accuracy of ±1.75 db. 8¼ x 4½ x 3 in. with carrying case and two 9-volt batteries.—**Sadelco, Inc.**, 601 W. 26 St., New York, N. Y. 10001

VOICE-ACTUATED RECORDER CONVERTER, *KX-5000*. *Voice-matic*, works with all tape recorders. It starts when you speak, turns off when you stop. Has: ON–OFF switch; sensitivity control to determine degree of sound to operate unit from 2 to 20 feet away; pause control adjusts pause time between sentences; input/output jacks, standard ⅛-in. phone type; output switching jack to use with tape recorders with floor control switch or to switch on or off any battery-operated device; switching contacts, 2 amperes. 3½ x 2¼ x 1 in., 12 oz less batteries (uses 2 standard 9-volt batteries).—**Kinematix, Inc.**, 2040 W. Washington Blvd., Chicago, Ill. 60612

WIDE-BAND SWEEP GENERATOR, *model 890*, vhf and uhf, has sweep signal with center at any frequency from 500 kc to 1,000 mc, sweep widths from 100 kc to 200 mc. Rf output, monitored by matched crystal diodes feeding a 2-stage push-pull alc amplifier, is flat within ± .5 db up to 800 mc and ± 1.5 db from 800 to 1,200 mc (at maximum sweep width). Applications include circuit alignment, measurement of gain, loss and vswr.—**Jerrold Electronics Corp.**, 15th & Lehigh Ave., Philadelphia 32, Pa.

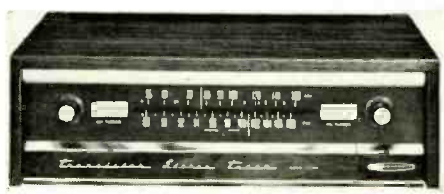
VHF–UHF FIELD-STRENGTH METER, the *Signal Commander*, has two linear scales, 0–100 μv and 20–40 db reference to 1 microvolt. Switched attenuators extend this range to 100,000 μv and 100 db. Plug-in tuning heads for vhf and uhf and uhf TV and for 25–900-mc coverage. Accepts both 50- and 72-ohm unbalanced systems without adapters. Small balun connects to uhf-type coaxial fitting to convert for 300-ohm balanced lines. Has silicon transistors; frequency measure-

ments accurate to 5%; signal-strength measurement accurate to within 1.5 db. Operates on two 8.4-volt mercury batteries. 9½ x 4¾ x 3¾ in., 3½ lb.—**Amphenol-Borg Distributor Div.**, 2875 S. 25 Ave., Broadview, Ill. 60155



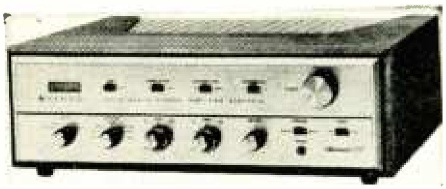
ELEMENT COLLECTING KIT has 36-page instruction manual, two books—*The Elements* and *Atoms, Crystals, Molecules*, periodic table of all known elements, 5 clear vinyl sheets with 20 pockets each for housing samples, all contained in 11½ x 10½-in. binder.—**Edmund Scientific Co.**, 106 E. Gloucester Pike, Barrington, N. J. 08007

AM/FM/FM STEREO TUNER KIT, *AJ-43C*, has 25-transistor, 9-diode circuitry; features automatic switching to stereo, stereo indicator light, afc on the FM band, individual AM and FM tuning me-



ters, slide-rule dial. Zener-regulated transformer-operated power supply. Walnut cabinet; factory-assembled and aligned FM front end and 5-stage FM i.f. circuit board.—**Heath Co.**, Benton Harbor, Mich. 49023

80-WATT STEREO AMPLIFIER KIT, *LK-60*, has light-bulb fail-safe circuit which glows warning to recheck wir-

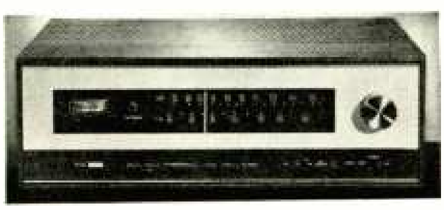


ing. Output circuit monitor facilitates bias and balance adjustment. Steady-state power: 30 watts per channel. Music power: 40 watts per channel. Harmonic distortion less than 0.8%; frequency response, 10–40,000 cycles. Tape input and output; bass and treble controls for each channel; front-panel stereo headset output.—**H. H. Scott, Inc.,** Dept. P., 111 Powdermill Rd., Maynard, Mass.

TRANSISTOR IGNITION SYSTEM, model *AM-275.* Power transistor is mounted on special heat-radiating aluminum case with cooling fins, operates on any 6- or 12-volt negative-ground system. Includes 400:1 ratio coil, transistor switching unit, ballast resistor, wire and instructions.—**Olson Electronics, Inc.,** 260 S. Forge St., Akron, Ohio 44308

PROFESSIONAL TAPE ACCESSORY KIT, model *ACI-100,* consists of bulk tape eraser, (which erases reeled tape in seconds), splicing and editing block with self-adhesive bottom for mounting on tape deck, splicing tape, spray head cleaner, marking pencil, and cutting tool.—**Artronics Co., Inc.,** 630 Cleveland Ave., River Vale, N.J.

SOLID-STATE AM/FM STEREO TUNER, the *ST-2000,* can handle strong input signals without overload or cross-



talk. Sensitivity: 2.9 microvolts IHF for FM and 50 μv per meter for AM. I.f. rejection is 55 db, image rejection better than 45 db and spurious response rejection exceeds 60 db. Flywheel tuning with d'Arsonval tuning indicator and meter. Three front-panel switches for AM/FM, stereo/monaural and on/off functions. Stereo indicator light and convenience outlet. 13¾ x 4¾ x 10½ in., 9 lb.—**Harman-Kardon, Inc.,** 15th & Lehigh Ave., Philadelphia 32, Pa.

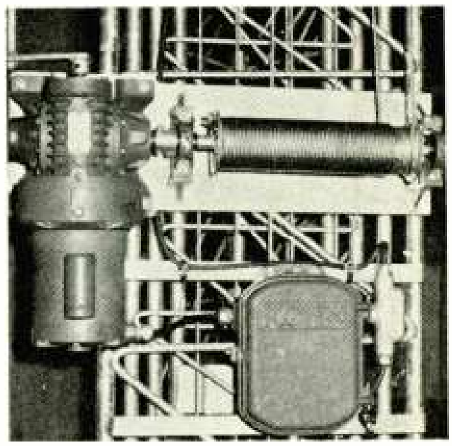
WIRE STRIPPER, *No-Nik.* Head of tool grips and centers wire—precision blade scores insulation without touching conductor, and conductor is drawn through its own insulation. Wire gauge stamped on centering device, handles are color-coded. Available for Nos. 18, 20, 22, 24, 26, 28, 30 and 32 size wire.—**Clauss Cutlery Co.,** Fremont, Ohio

UHF CONVERTER/ANTENNA. *Convertenna model 4003* combines *VU-82* indoor antenna with transistor uhf converter. 300-ohm output and input match set and antenna. Operates from 120 volts, 50–60 cycles ac outlet. Built-in diplexer reverses directivity 180° by switching. Butterfly dipole with 96-in. nontarnish elements. — **Channel Master Corp.,** Ellenville, N. Y.

DIPPED MYLAR CAPACITORS KIT, *Deal #150X,* includes free Xcelite *PS 120* nutdriver set (10 pieces). 150 capacitors of 10 most popular types

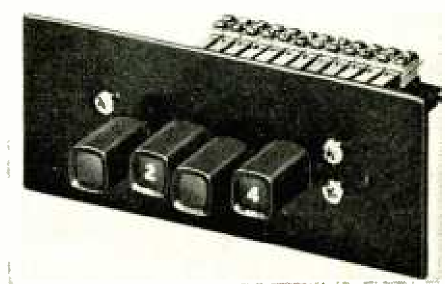
packed in plastic bags with capacitance value, working voltage and part number. —**Arco Electronics, Div. of Loral Corp.,** Community Dr., Great Neck, N. Y. 11022

TACHOMETER/DWELL-ANGLE METER, *model 100,* connected to ignition system of all 4-, 6-, 8-cylinder cars through single pair of external leads for all measurements of dwell angle or engine rpm. Has 2 rpm scales (0–1,200 and 0–6,000). Instruction book and cross-reference chart with settings for all popular cars since 1953. Operates on pair of internal flashlight cells.—**Electronic Measurement Corp.,** 625 Broadway, New York, N.Y. 10012

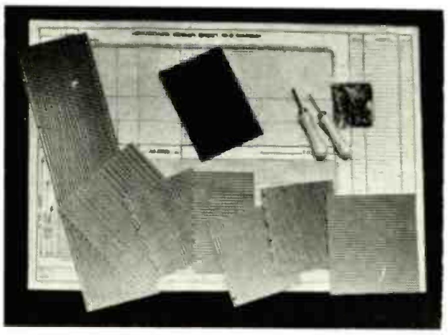


MOTORIZED WINCH UNIT, *model 100 Tower Controller* for *HD* series crank-up towers, consists of the winch, a heavy-duty weatherproof motor and gearbox and the controller. Factory-wired, supplied with 25 feet of 2-conductor power cable. Requires 2 connections to a 115-volt 60-cycle source. *Model 200* remote control unit optional.—**Rohn Mfg. Co.,** Peoria, Ill.

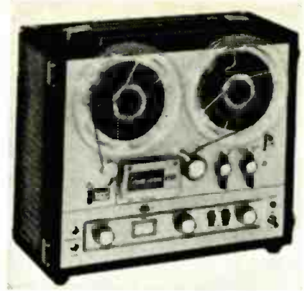
ILLUMINATED BUTTONS, *Glo-Button,* X Series, requires no bulb or electrical power. Button has translucent front screen with legend marked in opaque color; fluorescent illuminator is on pusher



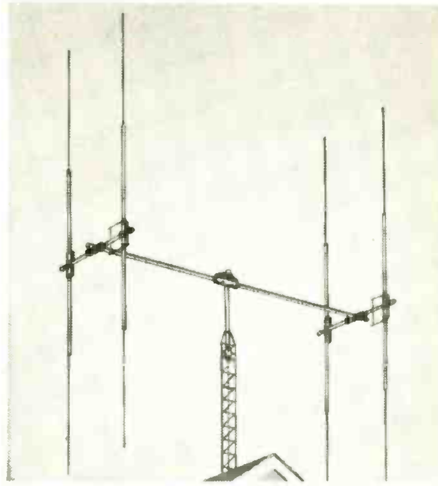
with 2 legs extending from rear. When button is pressed, these legs bring illuminator flush with screen and legend lights up due to reflected ambient light, projecting symbol that signals switch control status. *Glo-Buttons* mount on standard .050 x .187 plungers in two mounting planes to match horizontal or vertical panel layouts. Available legends: numerals 1-18 letters A–R, ON, OFF.—**Switchcraft, Inc.**, 5555 N. Elston Ave., Chicago, Ill. 60630



LABORATORY DEVELOPMENT KIT, *model VBK-7*, consists of 8 assorted Veroboards up to 18 in. long; plain Veroboard with staggered 0.1-in. grid, spot face cutter, terminal-pin insertion tool, 500 terminal pins, reproducible design sheet and instructions on Vero circuit concept.—**Vero Electronics, Inc.**, 48 Allen Blvd., Farmingdale, N. Y.



4-TRACK TAPE RECORDER, *model 3200*, includes sound-with-sound. Capable of adding a second track while playing a previously recorded track. Has VU meter, pause-edit control, 3-digit index counter, 2 extended-range 6-in. oval speakers, automatic shutoff, 3 tape speeds. 10 watts per channel output, 18,000 cycles response.—**Rheem Califone**, 5922 Bowcroft St., Los Angeles, Calif. 90016



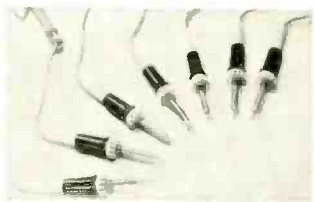
CITIZENS-BAND BEAM ANTENNAS. The *114DB* (shown) uses 2-element beams and multiplies effective radiated power of an efficient 5-watt CB transceiver to 42 watts. Model *116DB* uses 3-element beams, raises power of 5-watt transceiver to 93 watts, designed for use with heavy-duty TV rotator. Standard rotator for the *114DB*. Heavy-gauge aluminum, reliability in winds up to 100 mph.—**Hy-Gain Electronics Corp.**, 8700 N.E. Highway 6, Lincoln, Neb. 68501

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.



SOLDERING IRONS, pencil type, available in 7 temperatures ranging from 450°F to 1,000°F. Air-cooled handle; stainless-steel jacket on element. Various colors.—**Hunter Tools**, 9851 Alburtis Ave., Santa Fe Springs, Calif. END

All specifications from manufacturers data

NEW LITERATURE

PRETAX SALE CATALOG. *Olson Flag Days.* 32 pages of component bargains. Federal Excise Tax Ruling 56-8, due July 1, 1965, will raise most amplifier and speaker prices.—**Olson Electronics, Inc.,** 260 S. Forge St., Akron, Ohio 44308

1965 FULL-LINE CATALOG. 36 pages, many new products and new format, featuring new line of solid state products, such as FM multiplex stereo tuner/amplifier, FM stereo multiplex generator, color signal generator. Photographs of each item, plus specs and dealer list.—**Eico Electronic Instrument Co., Inc.,** 131-01 39th Ave., Flushing, N. Y. 11352

AUDIO EQUIPMENT CATALOG. *No. 100*, 36 pages with photos of cartridges, mikes, earphones, speakers, baffles, intercoms, jacks, capacitors, transistor AM-FM front ends, etc.—**Speco, Components Specialties Inc.,** 101 Buffalo Ave., Freeport, N.Y.

CATALOG. *Cameradio 65*, 384 pages, 5½ x 8½ in. All kinds of components (hardware, resistors, capacitors, transformers). Illustrated, with component index and manufacturer's index.—**Cameradio Co.,** 1121 Penn Ave., Pittsburgh, Pa. 15222

CAPTIVE SCREW CATALOG, 6 pages, engineering data, drawings and installation details on new line of captive screws with quad lead threads and mating quad lead nut-plates. Also retractable spring-loaded captive fastener which mates with any standard nut-plate or tapped hole.—**Calfax Inc.,** 2500 Compton Blvd., Redondo Beach, Calif.

APPLICATION GUIDE FOR RCA MEMORY PRODUCTS, *MP-315*, 24 pages, looseleaf punched. General information on RCA ferrite magnetic devices for memory applications, discussing magnetic fundamentals, hysteresis characteristics, operating principles of ferrite cores, design considerations for core selection and memory devices, transfluxors, typical memory system, and definitions.—**RCA, Electronic Components & Devices,** Harrison, N.J. **50¢.**

VACUUM AND GAS MEASURING INSTRUMENTS. 7 data sheets, 1 short-form catalog and price list. Photos, charts, diagrams, characteristics and specs on omegatron, ionization gauge tubes, standard sight port windows, Pyrex-Kovar seals, standard stems, helium diffusion cell.—**Electron Technology, Inc.,** 626 Schuyler Ave., Kearny, N.J. 07032

ETV BOOKLET & MATV PRODUCT CATALOG, 4 and 8 pages, respectively: the first telling why a master TV system is needed for educational TV; second, the catalog, has photos and specs of broadband amplifiers (uhf and vhf), single-channel amplifiers, converters, attenuators, outlets, filters and traps, housings, transformers, splitters, mixers, tapoffs.—**Blonder-Tongue,** 9 Alling St., Newark, N.J. 07102

ELECTRONIC MEASURING INSTRUMENTS, *1965 CATALOG*, 12 pages, photos and specs of vtvm's, decade amplifier, uhf millivoltmeter, ac/dc voltmeter-ohmmeter, precision calibrators, capacitance meter, ac/dc linear converter, micropotentiometer, and accessories.—**Ballantine Labs, Inc.,** PO Box 97, Boonton, N.J. 07005

PRECISION POT CORE BOOKLET, *Ferroxcube Bulletin 220*, 24 pages, looseleaf. Up-to-date data replacing *Bulletins 202* through *210, 212, 213* in company's catalog. Charts, curves, photos and text taking ferrites from scratchpad to wound inductor with inductance, Q, temperature coefficient and smallest package.—**Ferroxcube Corp. of America,** Saugerties, N.Y.

SYNCHRONOUS MOTORS AND TIMERS, *Condensed Catalog No. MT-200*, for special engineering applications with emphasis on high-torque output and reliability. 20 pages, looseleaf-punched; dimension drawings, photos. Series ranges from water softener actuator to advertising display color wheels.—**Controls Co. of America,** 2001 N. Janice Ave., Melrose Park, Ill. 60160

AUDIO PRODUCTS CATALOG, *SAH-76*, 16 pages photos, specs of line of ceramic and crystal phono cartridges, replacement needles, tone arms, ceramic mikes, learning-lab mike units, loudspeakers, high-compliance speaker systems.—**Electronic Applications Div., Sonotone Corp.,** Elmsford, N.Y. 10523

CAPACITOR CATALOG, 12 pages, illustrated, lists 88 types of standard variable air capacitors. 3-hole-punched.—**Hammarlund Mfg. Co.,** 73-88 Hammarlund Dr., Mars Hill, N.C. 28754

SOLDERING-IRON CATALOG, 12 pages, 5-hole-punched; describes features, applications and prices of 9 basic models rated 6 to 230 volts and 12 to 1,250 watts—tip sizes from 1/16 to 2 in.—**General Electric Co.,** Schenectady 5, N.Y.

COMPONENTS CATALOG, *No. 6F5*, 40 pages, looseleaf-punched, Large assortment of terminals, taper pins, hardware, cable clamps and ties, instrument dials, knobs and instrument cases, tube and transistor sockets, etc.—**Waldom Electronics, Inc.,** Chicago, Ill. 60632

FOLDER, 4 pages, looseleaf-punched, drawings, specs and curves on Octavium system: low-frequency sound reproducer (15–70 cycles) with 15-in. woofer and radiating wood-and-styrofoam enclosure.—**Aladdin Electronics, Inc.,** 1450 6th St., Berkeley, Calif. 94710

CATALOG, Q-65, 17 page, 3-hole-punched, on 1965 Q series digital circuit modules with drawings, specs, price list (21% reduction) for all 25-kc, 100-kc and 1-mc modules.—**Engineered Electronics Co.,** 1441 E. Chestnut Ave., Santa Ana, Calif. 92702

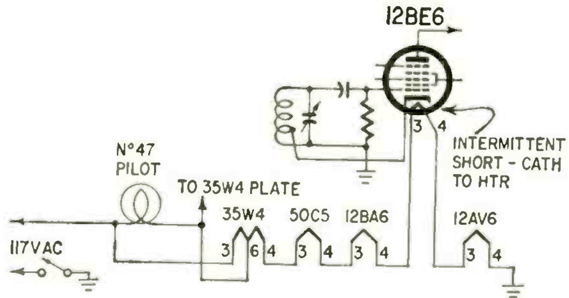
> Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.
> UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

TECHNOTES

ODD HEATER-STRING TROUBLE

Recently a small five-tube G-E radio came into my shop with the complaint of intermittent reception. Sometimes the set would come on and quit later, while at other times it wouldn't come on at all.

The set was playing but in a few minutes went dead. Voltage checks on the avc line showed it to be normal. (This particular model has a history of leaky capacitors in the i.f. transformers that puts a B+ voltage on the avc terminal of the transformer.) Plate voltage readings were normal except on the plate of the 12AV6 first audio, where the reading was 90 volts instead of the usual 55. This indicated that the tube was not drawing plate current.



All resistors and capacitors in this circuit measured good, so I substituted a new tube. The set now worked perfectly. The next evening I turned it on again and it was dead. I turned the set over to remove the new tube, and it wasn't even lit. Back in went the old tube, still no light. An ohmmeter test (with the set turned off) of the heater circuit showed the 12BE6 to have a cathode-to-heater short. The cathode of the 12BE6 is connected to a tap on the oscillator coil, which goes to ground. Thus when the heater shorted to the cathode, the heater string was grounded, bypassing the 12AV6 tube. This kept the tube from lighting, thus the plate drew no current.

Just because a tube isn't heated up is no sign that it is burned out!—*James A. Fred*

SPLIT PICTURE

The flyback in a Fleetwood 17-5 had shorted and been replaced with an exact duplicate by another technician. Now the set showed a horizontal blanking bar (picture split vertically). This trouble is usually caused by a defect in the phase detector or sampling circuit.

In this case, the leads of the sampling pulse winding on the flyback were transposed. After I reversed them, the picture was normal again.

Watch for this—the leads are usually not marked for proper polarity.—*E. L. Deschambault*

PRATT & WHITNEY TAPEOMATIC DRILL

Trouble: Position error in X or Y axis.

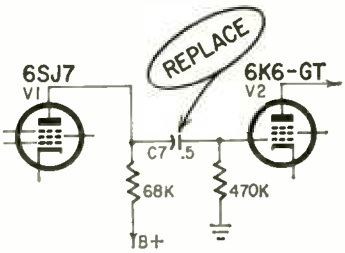
Cure: If trouble persists after photoelectric transducer phasing has been set to manufacturer's service instructions, check photocell currents. If unequal, balance by increasing the low value by adjusting the associated lamp resistor. Should this prove unsuccessful, increase the current through both photocells 5%. Repeat, if necessary, to a maximum increase of 20%. This will usually restore normal operation. —*R. C. Roetger*

WATCH THAT SOLVENT

When transistor radios develop noisy controls, don't squirt commercial solvents into the pots. Often the solvent leaks or drips onto surfaces visible from the outside of the case, marking them permanently. These compounds can be applied safely with an eyedropper by holding the set so that any excess fluid will drip harmlessly onto the bench.—*Steve P. Dow*

EICO 377: NO OSCILLATIONS

An Eico 377 audio generator would not oscillate. V2, a 6K6-GT, had a red-hot plate and screen. We checked voltages with a vtvm. The voltage on V2's control grid was 80—much too high. Replacing C7, the coupling capacitor, fixed the trouble.—*Pierre Cappaert*



TEMPORARY REPLACEMENT

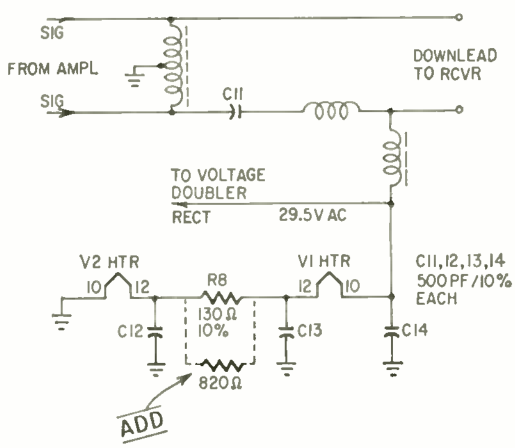
The 8CM7 vertical oscillator/amplifier in my customer's series-string receiver was defective. I had only a 6CM7 to replace it with, but its heater drew 0.6 ampere instead of the 0.45 of the 8CM7.

I heated the heater of the 6CM7 in my tube tester, bringing it to operating temperature. Then I quickly inserted the tube into the 8CM7 socket. It worked.

I explained to customer that I would be back the next day with the correct tube, and warned him meantime not to turn his set off, else he'd lose his picture when he tried to turn it on again.—*E. L. Deschambault*

WINEGARD COLORTRON AMPLIFIER

A few months after installation, the output of this amplifier fell. The signals at the receiver dropped from near 200μv to less than 100 (relative readings with the same field-strength meter).



Checks on the amplifier showed the input voltage to the amplifier to be 28 vac instead of 29.5 (117 vac to the power supply). This is only 5% off. R8 was 140 ohms. This is less than 8% off for a 10% resistor. This resistor was dropping

TECHNOTES Continued

17.6 volts with less than the normal tube current of 0.13 amp through it. This is 0.7 volt more than normal.

The 1.5-volt input difference, the 0.7-volt difference because of R8, and an unbalance in the tubes caused the heater voltage to be 5 volts on one tube and 5.4 on the other. Correcting this by shunting 820 ohms across R8 brought the field-strength readings back to their original values.—*James R. Giles*

END

Electromedicine: End of the Wonder-Drug Era?

continued from page 27

But there are problems whose solution doesn't require more knowledge than we now have. Unquestionably the most important of these is the development of an articial heart or—more specifically—devising a way to power it. The kind of energy required by a heart Pacemaker or by the blood-pressure device developed in Rochester is well within the capabilities of modern, long-life battery technology.

And technicians have had some success in recharging implanted batteries by induction from a charger held outside the skin. (Doctors don't like the battery to be outside the body because the wires that bring electricity to the device can also bring infection through the necessary holes in the skin.)

But to run a pump such as the human heart requires vastly more energy. One artificial heart, developed at the Cleveland Clinic Foundation, runs on compressed air, but the conduit is impractically large. There is talk now of compact atomic generators that could be implanted in the body, but the hazards of radiation pose a formidable obstacle.

Recently, engineers demonstrated power transmission by microwave beam. They flew a helicopter about as big as a man with the energy of a beam transmitted from the ground (RADIO ELECTRONICS, January 1965, p. 72). But the human biologist must worry about the heat generated in wave-power transmission. Perhaps a wavelength can be found that will not dissipate its energy by heating living tissue that lies in the path of its target.

But solving the power problem for an artificial heart is not going to end the problem. For the medical men do not yet know enough about the restrictions that human red blood cells place on dynamic fluid flow. You cannot handle blood as you would plasma substitutes or dextrose. You cannot send red blood cells into strong eddies or around sharp curves without damaging them irreparably. The unknowns of this problem are the real stumbling block in the path of replacing the human heart.

But those who are interested in the basic energy-producing mechanism of the body may yet find ways to substitute for failing heart action without supplying a new heart. At the University of Wisconsin, scientists are closing in on the chemical electronics of mitochondria, the units within muscle cells that supply the energy for contraction. These researchers have now isolated units called electron transfer particles. These particles take energy from the sugar in the blood and transfer it to the adenosine triphosphate molecules that serve as storage batteries for the cells.

This sort of biochemical investigation suggests by its very nomenclature its close relationship to concepts familiar to workers in electronics. There is no mystical difference. The processes are the same, only carried on by different molecular entities.

There are similar resemblances in problems of the transfer of oxygen and carbon dioxide across the remarkable membranes in the human lung and for the exchange of wastes and electrolytes that goes on in the tiny tubules of the human kidney. General Electric recently demonstrated a membrane that allowed a hamster to live completely surrounded by water. And several college engineering departments are working to replace the large, expensive and cumbersome artificial kidney machines.

Unfortunately, for every medical researcher who welcomes the help that physics and electronics can give him, there are dozens of doctors who argue that medicine is being "dehumanized", that the patient is actually suffering from the splintering of the kindly, lovable general practitioner into the coldly intellectual specialist.

The dean of the Harvard University Medical School was recently queried on this medical controversy which, in one form or another, emerges in practically every state and national medical meeting. He asked me whether I thought a patient would rather die with his hand comfortingly held by a gentle general practitioner or survive under the care of a more impersonal specialist.

In fact, automation is worrying organized medicine as much as it alarms industrial workers. But those who confidently expect to overcome our three major killers—heart disease, cancer and stroke—are banking heavily on computers and electronics to swing the balance in their favor.

Just in the past 2 years, doctors have seen the following examples of what electronics technology can do for medicine:

- At the Kaiser-Permanente Foundation in San Francisco, people coming in for annual health checkups now undergo more tests in 2 hours than were previously possible in a day spent at the clinic. Thanks to automatic blood testing machines and computer records of X-rays, electrocardiographs and other tests, examining doctors can examine the physical condition of a patient and question him with all needed current information at hand. There is no waiting period for test results to come in. And there need be no bulky filing cabinets from which earlier medical data must be laboriously retrieved.
- In two brain research centers, one in the United States and one in England, scientists are now able to see patterns in brain waves that they could never see without the aid of computers. In the US, the link of computer and electroencephalograph has enabled the researchers to tell by his brain waves what color a person is looking at. In England, doctors say they can distinguish a neurotic from a psychotic patient and both from a normal person by computer analysis of brain waves in a situation in which the subject must learn to respond to a stimulus.
- Recordings of patients' heart activity are now being sent over telephone lines to computers that know as much about what is normal and what is not as any competent heart specialist. Thus communications and computer electronics can make any doctor a reasonably good heart specialist if he has an electrocardiograph machine, a "black box" translater device and a telephone.
- Increased knowledge of the importance of the electric charge of body tissues has already produced an improved wound dressing made simply of gold leaf with an induced positive charge. Some research indicates that electrically charged air may benefit the victims of certain diseases.

Recently there occurred in Paris a typical scientific brou-ha-ha over a claim that some cancers in rats had been controlled by electromagnetic induction. The claim may well have been false, but few medical experts today would deride the idea that magnetic fields exert profound effects on the electrochemical processes of life.

In short, it seems that the era of "wonder drugs" is coming to an end and the age of medical electronics is here. A much closer working relationship between engineers and technicians on the one hand and physicians on the other will be required to obtain the full fruits of *electromedicine*.

The human race may well have a working mechanical heart before it sets foot on the moon! END

NOTEWORTHY CIRCUITS

MATCHING TRANSISTORS IN AUDIO OUTPUT STAGES

Matching the two transistors in the push-pull output stage of a radio or amplifier is usually important to prevent serious distortion, loss of power and early failure. But matched pairs are hard to come by commercially, and expensive, too. Matching them yourself is often time-consuming unless you have a transistor analyzer that can quickly compare leakage and small-signal current gain.

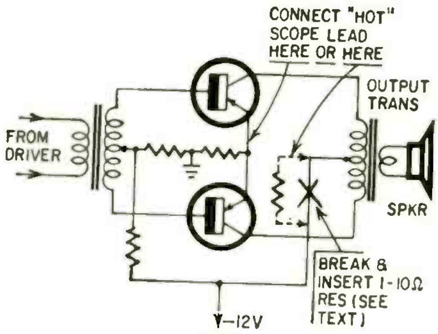


Fig.1

As in testing or matching tubes, it turns out that the best "test instrument" is the apparatus the transistors are to be used in. All you need besides the radio or amplifier you're working on is your oscilloscope and a single-frequency audio tone, 1 kc or lower. The 400-cycle signal from an rf signal generator is fine.

How you connect the scope depends on the circuit of the radio's output stage. In an ordinary transformer-coupled circuit, such as in Fig. 1, you can connect across the common-emitter resistor if there is one, or otherwise break the common-collector supply lead (output transformer center tap) and insert a resistor of 5 ohms or so. Connect the scope across that. (In high-powered amplifiers with husky power transistors in the output stage, the resistance may have to be less than 1 ohm to prevent disturbing the stage.)

Now feed in an audio signal at any convenient point (across the volume control, for example). You should see on the scope a pattern like Fig. 2-a or 2-b. Each upward "arch" represents a

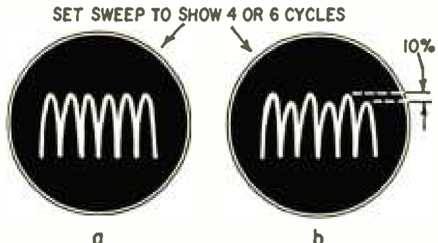


Fig.2

half-cycle of the audio signal, and the portion of the total sine wave handled by each transistor. Fig. 2-a is the ideal. If you get a pattern like that at all signal levels, consider yourself lucky and get to work on the next set! More likely you'll see something like Fig. 2-b. Keep the signal input low at first, to prevent misleading flat-topping, and get the pattern height you want by turning up the scope's gain control instead.

If the difference in height between adjacent half-cycles is 10% or less, the two transistors are matched closely enough for all practical purposes. The difference will not be the same at all signal levels unless the two transistors have the same ac gain (h_{FE}). Sometimes the difference will fall one way at low signal levels, be zero at moderate levels, and lean the other way at maximum signal. So raise the input signal gradually and watch what happens. If the difference exceeds 10% at some point between low level and clipping, replace one transistor. The change in the pattern will tell you whether you're working in the right direction.

It might be wise to keep on hand two transistor sockets with clip leads, which you can simply clip in in place of the original transistors. Then you can plug and unplug transistors to your heart's content without worrying about damaging them by too much soldering.
—*Siemens Werkstatt Praxis* END

40-WATT "SWITCHING-MODE" AMPLIFIER YOU CAN BUILD!

Rumors of a radically new kind of transistor audio amplifier have been circulating on both sides of the Atlantic for some time (see article on page 54). In August RADIO-ELECTRONICS: *the first such amplifier designed especially for home construction!* A 40-watt public-address amplifier of fantastic efficiency—smaller than a cigar box, works from a 12-volt battery.

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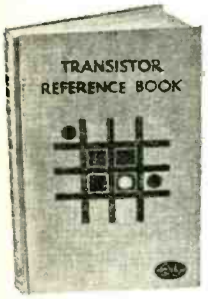

**26.
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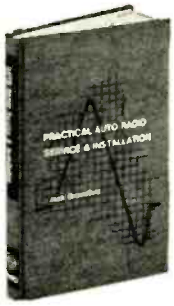
Lists all transistors, cross references them and supplies information on their operating characteristics. Clothbound – *Retail Price* $6.00



**87.
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How to handle bugs in these specialized sets. How to service power supplies, various tube types, hybrids. Time-saving hints on installations and removal. Clothbound –*Retail Price* $4.60

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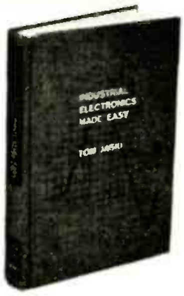

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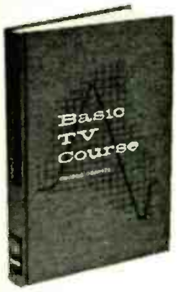

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BASIC TV COURSE
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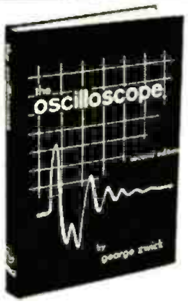

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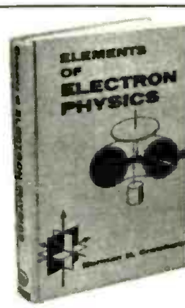

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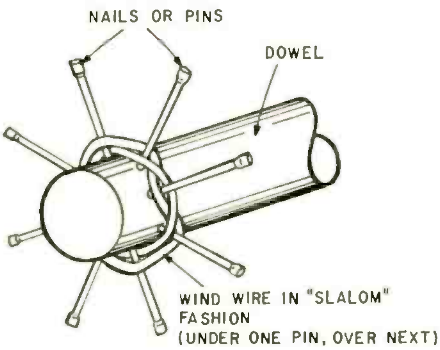
TRY THIS ONE

MAKING FLAT COILS

To make flat spiral coils for telephone pickups, and flat broadcast coils for miniaturized equipment, I start with an old-fashioned spiderweb coil. This is made by putting an *odd* number of pins or nails in a dowel rod and winding the wire as shown. When the coil is wound, one side is covered with vinyl cement.



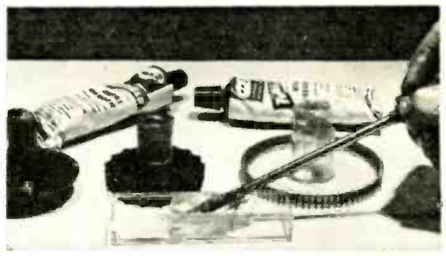
(The nails can be covered with a thin layer of paraffin to keep glue from sticking to them.) When the cement sets, remove the pins and coil. Squeeze the coil between two flat plastic or wood pieces in a vise or press. Now you have a flat spiral coil. The thinner the pins, the more successful the process. For very small coils of fine wire, use sewing needles.

Two such coils placed on either side of a plastic base make an excellent rf or i.f. transformer. By placing one coil on the plastic side of a copper laminate board, and connecting one end to a copper disc the size of the coil (after etching), the flat spiral coil can be provided with capacitance. Inductance of the spiral coil $L = .00194\ dn^2\mu$ where d = outside diameter of spiral, n = number of turns and μ = permeability, usually 1.—*Tom Jaski*

EPOXY RESIN COMPOUND REPAIRS BROKEN KNOBS

Have you ever repaired a TV set or radio, finished the job and found that a knob is broken off or gone altogether? You look into your $200 assortment of knobs and nothing matches the broken one. The local distributor says he has just sold the last one and it will take only 2 weeks to get a new one. *You* know that the last knob took 6 weeks, another knob 8 weeks. Here is your answer for those hard-to-get-knobs. Don't get me wrong—I like to sell knobs also, but there are times when a set will sit on the shelf for months with just a little old broken knob.

Some distributors stock a mending glue called Twin-Weld (also found at most hardware stores). Twin-Weld is a fiberglass–epoxy material. When the contents of the two tubes are mixed together, the resulting goop will bond most anything into one piece—metal to wood, ceramic, concrete, glass, bricks, anything. It is best to mix in a throw-away container; or be sure and clean the container up before the epoxy sets. (Twin-Weld epoxy is a product of Fybrglas Industries, Chicago, Ill.)



Mix just enough epoxy material for the knob to be repaired with. Take the broken piece and put it back into its original position. If a flat spring was in the broken piece, also place it in as originally manufactured. Spread glue on the joining surfaces and also all around the broken piece of the knob. Coat the surface well; the epoxy mixture will not run down the side of the knob. On very-long-shank knobs, it is best to coat the entire length with epoxy. Let the knobs set over night. The next morning the mixture will be very hard and can be filed or ground smooth. The photo shows the mending operation.

If a long-shank knob needs repair and a piece is missing, the shaft must be built up into its original shape. Place the small spring into position and lay a small piece of masking tape over it. Don't use too big a piece—leave enough room so that the epoxy will bond to the cracked side of the knob. Simply apply a lot of mixture where the piece is missing and go clear around the whole knob shank. Wrap a layer of masking tape around the mended knob and let set overnight. Tear the masking tape off the next morning and grind or file the patched part down into a decent looking knob.

This type of epoxy mixture is also very good for repairing radio cabinets. —*Homer L. Davidson*

PROTECTING SMALL DRILLS

Avoid premature breakage of small, delicate drills by pushing the drill through a cork, rubber ball, etc. before chucking in the drill press. The cork keeps the drill from bending in the middle while biting into the work.—*Ed Mayover* END

WHAT'S YOUR EQ?

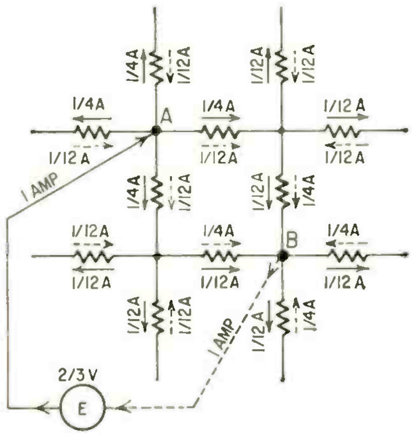
These are the answers. Puzzles are on page 52.

From Here To Infinity

The solution is not too difficult if the superposition principle is employed.

Let 1 amp from some source enter the mesh at node A, and leave the mesh at infinity. Because of symmetry, the current (shown in solid lines) divides evenly at each successive node. For example, at A, the current divides four ways into ¼-amp currents. These ¼-amp currents go on to divide into 1/12-amp currents, and so on.

Now, let 1 amp enter at infinity and leave the mesh at node B. The currents (dotted lines) leading to node B must add evenly, that is ¼ amp must come from each of the four branches leading to B, and so on.



If both of these effects are superposed, the combined effect is the same as if we had 1 amp flowing into A and out B by means of a battery connected to A and B. Adding the voltage drops along either path from A to B:

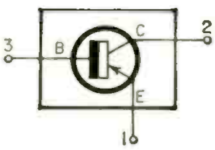
$$V_{AC} = (\tfrac{1}{4} + \tfrac{1}{12})\text{ amp} \times 1\text{ ohm} = \tfrac{1}{3}\text{ volt}$$

$$V_{CB} = (\tfrac{1}{4} + \tfrac{1}{12})\text{ amp} \times 1\text{ ohm} = \tfrac{1}{3}\text{ volt}$$

Total voltage between A and B is ⅔ volt. Therefore:

$$R = \frac{\tfrac{2}{3}\text{ volt}}{1\text{ amp}} = \tfrac{2}{3}\text{ ohm}$$

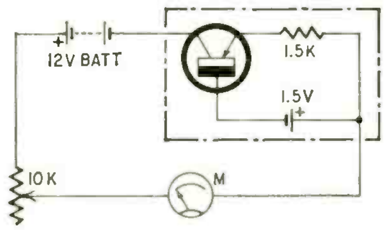
More Resistance



The box contains a p-n-p germanium power transistor connected to terminals as shown.

Steady Current

The black box contains three components—a transistor, a resistor and a 1.5-volt battery. In operation, the transistor base-emitter circuit is biased by the 1.5-volt battery, causing the transistor to conduct. As current flows through the external circuit via the 1,500-ohm resistor, a voltage drop is developed which bucks the 1.5-volt battery. The result is that the current is regulated to the point where the voltage drop across the 1,500-ohm resistor just equals the bias voltage minus the base-emitter voltage.



This very simple circuit is quite effective, and is the basis for most solid-state current regulators.

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NEW BOOKS

ELECTRONIC MOTOR CONTROL, by Allan Lytel. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 224 pp. Paper, $3.95*

Discusses all types: tubes, semiconductors. magnetic amplifiers, etc. Includes troubleshooting data and schematics of typical industrial controls.

WORLD MEDIUM WAVE GUIDE 1965, World Publications. *Obtainable from Gilfer Associates, Box 239, Park Ridge, N.J. 6¾ x 9 in., 58 pp. Paper, $1.95.*

Lists all medium-wave broadcast stations in the world, and all North American television stations. This is a supplement to the "World Radio-TV Handbook" which does not list the American broadcast stations. The listing is in two parts: North American countries, and countries outside North America. The listing is by frequencies, beginning with 520-kc stations (540 in North America) and continuing to the top of the broadcast band. There is also a North American list by states and provinces (Mexico, interestingly, is listed in the non-North American stations) and a list of American and Canadian television stations.

THE RADIO AMATEUR'S HANDBOOK, by Headquarters Staff of American Radio Relay League, *Newington 11, Conn. 6½ x 9½ in., 686 pp. Paper, $4.*

This is the latest edition of one of the world's most widely read and most often used technical manuals. It has been brought up to date to include the latest developments in theory, practice, circuitry and components. The section on vacuum-tube characteristics is the most comprehensive and useful that you will find anywhere. A must for progressive hams, experimenters and communications technicians and engineers.

SEMICONDUCTOR NETWORK ANALYSIS AND DESIGN, by Vasil Uzunoglu. *McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036. 6 x 9 in., 372 pp. $12.50.*

An advanced text that links theory with engineering solutions. Suitable for graduate students.

PHOTOCELL APPLICATIONS, by Rufus P. Turner. *Lafayette Publication No. 10-0102, 111 Jericho Turnpike, Syosset, N.Y. 11791 5½ x 8¼ in., 80 pp. Paper, $1.50*

Covers the whole subject concisely and compactly. Numerous schematics of experimental and practical circuits, with complete parts lists for the constructor.

PRINCIPLES AND APPLICATIONS OF BOOLEAN ALGEBRA, by Salvatore A. Adelfio and Christine F. Nolan. *Hayden Publishing Co., Inc., 850 3rd Ave., New York, N.Y. 10022. 6 x 9 in., 336 pp. Cloth, $8.*

In its purpose of explaining Boolean algebra and applying them to basic electronic circuits, the authors have been highly practical. Well over half the book is devoted to electronics applications of this branch of math so important to electronics.

ELECTRONIC PROJECTS FOR STUDENTS, BEGINNERS & HOBBYISTS (Vol 1, Parts 1 and 2). *Semitronics Corp., 265 Canal St., New York, N.Y. 10013 5½ x 8½ in., 96 pp. Paper, $1.95*

A book aimed at the student. beginner and hobbyist. After a brief introduction. designed to explain without terrorizing. some 50 projects are described, ranging from a simple diode crystal set to a sound-operated receiver for use in a garage-door opener or for similar applications. Complete parts lists are given and a master list of parts that covers all of the experiments appears at the end of the book.

2-WAY MOBILE RADIO HANDBOOK, by Jack Helmi. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 223 pp. Paper, $3.95*

A guide to equipment and systems used in the Citizens and business bands. with many schematics. Installation tips. operational theory, test and maintenance. and even how to set up a repair and sales business.

LES TECHNIQUES ULTRA-SONORES, by P. Hémardinquer. *Editions Chiron, 40 rue de Seine, Paris VIe, France. 5½ x 8½ in., 261 pp. Paper, 30 francs.*

Although this book has the handicap of being in French. the literature on ultrasonics is so sparse that many will welcome its rather complete coverage, which begins with generators and ends with applications in various fields. Old-time readers will remember Hémardinquer as an author in RADIO-ELECTRONICS and *Radio Craft.*

HI-FI TROUBLES . . . HOW YOU CAN AVOID THEM . . . HOW YOU CAN CURE THEM, by Herman Burnstein. *Gernsback Library No. 120, 154 W. 14 St., New York, N.Y. 10011. 5 x 8½ in., 160 pp. Paper, $3.95*

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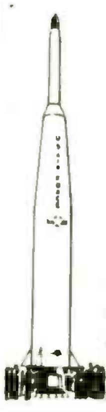

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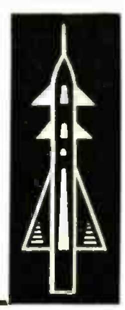

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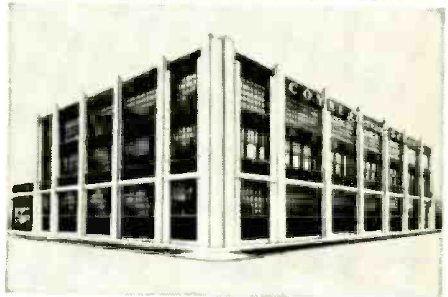

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LOW LOW QUOTES, DYNA. A.R. GARRARD E.V. HI-FI, Roslyn, Pa. 19001

CORRECTION

In the article "Low-Cost Strip-Chart Recorders" in the June issue (page 58) the Heath EUW-20A chart-recorder is erroneously referred to as available in kit form. This unit is referred to in the catalogs as a Heath-Built instrument, and is not offered in kit form.

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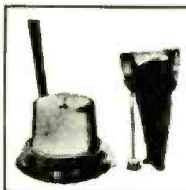

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TYPE	PRICE
0A2	.90
0A3	.90
0A4G	1.55
0B2	.80
0B3	1.20
0C3	.85
0D3	.75
0C3	2.75
0Y4	1.20
0Z4	.95
1A3	1.49
1A5	1.49
1A6	1.49
1A7	1.95
1AB5	.75
1AD4	1.75
1AE4	1.30
1AF4	1.45
1AG4	2.20
1AJ5	1.05
1AU3	1.25
1AX2	.95
1AY2	.98
1B3	.88
1B4P	2.00
1C5	1.00
1C6	.98
1D5GP	.98
1D7	1.25
1DN5	.53
1E5GP	.98
1E7	.99
1F4	.95
1F5	.95
1F6	1.20
1G3	.88
1G4	1.75
1G6	1.50
1H4	1.25
1H5	2.59
1H6	.98
1J3	.88
1J5	.98
1J6	.98
1K3	.88
1L4	.66
1L6	2.35
1LA4	1.30
1LA5	2.60
1LA6	1.49
1LB4	1.80
1LC5	1.05
1LC6	1.80
1LD5	1.95
1LE3	1.25
1LG5	1.98
1LH4	1.80
1LN5	1.25
1N5	1.75
1P5	2.00
1Q5	1.95
1R4	.80
1R5	.90
1S2A	1.90
1S4	1.45
1S5	.90
1T4	.79
1T5	.80
1U4	.70
1U5	.87
1V	1.05
1V2	.79
1X2B	.84
1Z2	3.25
2A3	2.50
2A5	1.95
2A6	3.75
2A7	1.50
2AF4A	1.10
2AH2	1.34
2AS2	1.30
2B3	2.70
2B7	.95
2BN4	.98
2CY5	.95
2D21	.75
2D24	1.95
2EA5	1.45
2EN5	.83
2ER5	1.60
2FH5	1.40
2FQ5	1.95
2FS5	2.55
2GK5	1.57
2GU5	1.65
2GW5	2.40
2HK5	.98
2X2	.60
2X2A	1.30
3A2	1.45
3A3	1.29
3A4	.74
3A5	1.10
3AF4	.99
3AL5	.87
3AT2	1.23
3AU6	.55
3AV6	.44
3AW3	1.31
3B2	3.35

TYPE	PRICE
3B7	1.35
3BA6	.95
3BC5	.61
3BE6	.85
3BN4	1.18
3BN6	.73
3BU8	.76
3BY6	.56
3BZ6	.54
3CB6	.54
3CE5	.90
3CF6	1.05
3CS6	.56
3CY5	1.18
3D6	1.48
3DG4	1.25
3DK6	.58
3DT6	.52
3DZ4	1.59
3EH7	1.00
3EJ7	1.00
3ER5	1.35
3FH5	.95
3FS5	1.18
3GK5	1.49
3GS8	1.21
3GW5	.98
3HA5	1.49
3HK5	1.23
3HS8	1.29
3Q4	1.35
3Q5	2.00
3S4	.75
3V4	.61
4AU6	.89
4AV6	.70
4BA6	.85
4BC5	.90
4BC8	1.02
4BL8	1.00
4BN6	1.45
4BQ7	.99
4BS8	.96
4BU8	1.20
4BZ6	.85
4BZ7	1.00
4CB6	.87
4CS6	.59
4CY5	1.10
4DE6	1.01
4DK6	.58
4DT6	.87
4EH7	1.47
4EJ7	1.47
4EM6	1.19
4ES8	1.79
4EW6	1.01
4GK5	1.59
4GM6	1.25
4GS8	1.19
4GZ5	.91
4GZ6	1.19
4HA5	1.85
4HC7	1.39
4HM6	.91
4HS8	1.18
4HT6	1.24
4JC6	1.35
4JD6	1.35
5AM8	.77
5AN8	.88
5AQ5	.52
5AR4	1.75
5AS8	1.75
5AT8	.81
5AU4	1.25
5AV8	.98
5AW4	1.00
5AZ4	1.98
5B8	2.09
5BC3	.89
5BE8	1.27
5BK7	.89
5BQ7	.99
5BR8	.81
5BT8	.79
5BW8	1.31
5CG8	1.20
5CL8	1.19
5CM8	1.47
5CQ8	1.45
5CZ5	1.70
5DE8	1.15
5DJ4	1.00
5EA8	1.21
5ES8	2.21
5EU8	1.29
5EW6	1.01
5FG7	1.07
5FV8	1.21
5GH8	1.53
5GJ7	1.62
5GM6	1.00
5GX6	.89
5HC7	1.49
5HG8	1.65
5J6	.72
5KE8	1.24
5T4	2.95
5T8	.96

TYPE	PRICE
5U4	.60
5U8	.84
5V3	1.59
5V4	1.45
5V6	.65
5W4	1.75
5X4	.99
5X8	.84
5Y3	.47
5Y4	1.45
5Z3	2.00
5Z4	1.90
6A3	2.75
6A4	2.20
6A6	1.75
6A7	2.65
6A8GT	.95
6A8M	1.75
6AB4	.52
6AB5	3.00
6AB7	1.00
6AC5	1.95
6AC7	.91
6AD7	3.25
6AE5	2.50
6AF3	1.10
6AF4	.99
6AF4A	.99
6AF6	2.65
6AF11	1.98
6AG5	.68
6AG7	1.75
6AH4	1.11
6AH6	1.25
6AJ5	2.25
6AJ8	1.73
6AK5	.90
6AK6	.94
6AL3	1.00
6AL5	.45
6AL7	1.95
6AL11	1.65
6AM8	.76
6AN4	2.59
6AN5	1.95
6AN6	2.45
6AN8	1.50
6AQ5	.52
6AQ6	1.05
6AQ7	1.55
6AQ8	1.20
6AR5	1.03
6AR6	1.50
6AR8	2.00
6AR11	1.65
6AS5	.79
6AS6	1.00
6AS7	2.85
6AS8	1.30
6AS11	1.95
6AT6	.49
6AT8	.84
6AU4	.95
6AU5	1.60
6AU6	.52
6AU7	.54
6AU8	.87
6AV5	1.45
6AV6	.44
6AV11	1.52
6AW8	.88
6AX3	1.05
6AX4	.64
6AX5	.74
6AX7	1.25
6AX8	1.34
6AY3	1.05
6AZ8	2.15
6B4	3.95
6B5	4.00
6B7	2.75
6B8	2.50
6B10	1.35
6BA3	1.05
6BA6	.49
6BA7	1.50
6BA8	1.48
6BA11	1.22
6BC4	2.10
6BC5	.62
6BC7	1.47
6BC8	1.49
6BD4	7.00
6BD5	1.20
6BD6	.94
6BE3	1.15
6BE6	.53
6BF5	.88
6BF6	.48
6BF8	1.65
6BG6	1.67
6BH6	1.00
6BH8	.94
6BJ6	.69
6BJ7	1.19
6BJ8	1.35
6BK4	3.15
6BK5	1.30
6BK7	.89
6BL7	1.19

TYPE	PRICE
6BL8	1.52
6BN4	.98
6BN6	.74
6BN8	1.18
6BQ5	.83
6BQ6/6CU6	1.08
6BQ7	.99
6BR8	1.34
6BS8	1.42
6BU8	.74
6BV8	1.19
6BW8	1.35
6BX7	1.46
6BY5	1.65
6BY6	.98
6BY8	1.01
6BZ6	.72
6BZ7	1.19
6BZ8	1.35
6C4	.54
6C5M	1.45
6C6	2.70
6C8G	2.95
6C10	1.53
6CA4	.77
6CA5	1.20
6CA7	1.95
6CB5	3.25
6CB6	.68
6CD6	1.65
6CF6	.95
6CG7	.63
6CG8	.85
6CH8	2.00
6CK4	1.00
6CL6	1.12
6CL8	.94
6CM6	1.29
6CM7	.95
6CM8	1.45
6CN7	.92
6CQ4	1.25
6CQ7	1.80
6CQ8	1.15
6CR6	.91
6CS6	.85
6CS7	.99
6CU5	.84
6CU6	1.10
6CU8	1.59
6CW4	1.69
6CW5	1.39
6CX8	1.49
6CY5	.99
6CY7	1.22
6CZ5	1.59
6CZ7	1.95
6D4	1.75
6D6	2.50
6D10	1.59
6DA4	1.05
6DA5	1.05
6DB5	1.99
6DB6	1.01
6DC6	1.29
6DC8	1.22
6DE4	1.03
6DE6	.93
6DE7	1.29
6DG6	.95
6DJ8	1.65
6DK6	.89
6DN6	2.74
6DN7	1.35
6DQ5	2.50
6DQ6	1.10
6DR7	1.29
6DS4	1.55
6DS5	.99
6DT5	.95
6DT6	.75
6DT8	1.35
6DV4	2.39
6DW4	1.39
6DW5	1.55
6DX8	1.19
6DZ4	1.53
6E5	1.89
6EA5	1.55
6EA7	1.47
6EA8	1.19
6EB5	1.75
6EB8	1.55
6EH5	1.10
6EH7	.79
6EH8	1.21
6EJ7	.79
6EM5	1.29
6EM7	1.79
6EQ7	1.49
6ER5	1.35
6ES5	1.15
6ES8	2.19
6ET7	1.40
6EU7	1.03
6EU8	1.25
6EV5	1.10
6EW6	.92
6EW7	1.50

TYPE	PRICE
6EY6	1.23
6EX6	2.79
6EZ5	1.39
6EZ8	1.41
6FA7	1.10
6FD7	1.42
6F4	3.95
6F5GT	1.50
6F5M	1.69
6F6G	1.95
6F6M	2.19
6F7	3.95
6F8	3.25
6FG5	1.99
6FG6	1.25
6FG7	1.12
6FG8	1.75
6FH5	.92
6FJ5	2.25
6FJ7	1.39
6FM7	1.31
6FQ7	.89
6FS5	1.19
6FV6	1.33
6FV8	1.15
6FW5	1.59
6FW8	1.49
6FY5	1.11
6G5	1.95
6GC5	1.55
6GC6	1.69
6GB5	1.81
6GC5	1.19
6GE5	1.59
6GE7	1.19
6GF5	1.42
6GF7	1.69
6GH8	1.15
6GJ5	1.69
6GJ7	1.37
6GK5	1.55
6GK6	.99
6GL7	1.99
6GM5	1.21
6GM6	.91
6GN8	1.35
6GQ7	1.89
6GS7	1.42
6GT5	1.49
6GV5	1.65
6GV8	1.85
6GW6	1.55
6GW8	1.21
6GX6	.88
6GY5	1.31
6GY6	1.89
6GZ5	.87
6H6	1.16
6HA5	1.45
6HB5	1.69
6HF5	2.79
6HF8	1.45
6HG8	1.80
6HJ8	1.25
6HK5	1.19
6HQ5	1.15
6HS8	1.21
6HT6	1.19
6HZ6	.99
[illegible]	[illegible]
6J4	2.95
6JB6	1.76
6JC8	1.15
6JE6	2.99
6JE8	1.49
6J5M	1.30
6J5GT	.72
6J6	.72
6J7	1.85
6J8	2.50
6J11	1.82
6JH6	.99
6JH8	1.69
6JK8	1.30
6JS6	2.95
6JT8	1.69
6JV8	1.49
6JZ8	1.44
6K6GT	.64
6K7	1.70
6K7G/GT	1.49
6K8GT	1.25
6K8M	2.50
6K11	1.49
6KD8	1.39
6KT8	1.23
6KU8	1.15
6L5B	1.49
6L5G	1.50
6L6C	.98
6L6GA	1.50
6L6GB	1.50
6L6GC	1.61
6L6M	3.25
6L7M	2.50
6L7G	1.75
6M11	1.81
6N7M	1.85

TYPE	PRICE
6N7GT	1.75
6Q7GT	1.95
6Q7M	2.00
6Q11	1.29
6R7	1.75
6S4	.56
6S7	1.95
6S8GT	1.50
6SA7GT	1.39
6SA7M	1.49
6SB7Y	2.20
6SC7	1.49
6SD7	1.49
6SF5	1.19
6SF5GT	1.05
6SF7	1.95
6SG7	1.65
6SH7	1.21
6SJ7GT	1.19
6SJ7M	1.49
6SK7GT	1.25
6SK7M	1.45
6SL7GT	1.10
6SN7GT	.75
6SQ7GT	1.25
6SQ7M	1.45
6SR7	1.25
6SS7M	1.95
6SS7GT	1.49
6SZ7	1.25
6T4	1.15
6T8	.85
6U5/6G5	1.95
6U8	1.29
6U8GT	1.10
6V3	1.42
6V4	.59
6V6GT	.66
6V6M	2.39
6W4	.89
6W6GT	.89
6X4	.60
6X5GT	.75
6X8	.82
6Y6	1.25
6Y10	.98
7A4	1.15
7A5	1.29
7A6	1.29
7A7	1.35
7A8	1.95
7AD7	1.25
7AF7	1.65
7AG7	1.75
7AH7	1.49
7AU7	.67
7B4	1.50
7B5	1.25
7B6	1.25
7B7	2.25
7B8	1.25
7C4	1.15
7C5	1.25
7C6	2.25
7C7	1.20
7E5	1.25
7E6	1.25
7E7	1.33
7EY6	.75
7F7	2.10
7F8	1.95
7G7	1.65
7H7	1.65
7HG8	1.29
7J7	2.50
7K7	2.45
7L7	1.99
7N7	2.25
7Q7	1.85
7R7	1.79
7S7	1.79
7V7	1.81
7W7	1.95
7X6	1.35
7X7	1.95
7Y4	1.79
7Z4	1.79
8AU8	.95
8AW8	.98
8BH8	.99
8BQ5	1.36
8CG7	.99
8CM7	.95
8CN7	1.07
8CS7	.99
8CX8	.98
8EB8	1.25
8EM5	1.25
8ET7	1.19
8FQ7	1.39
8GJ7	.95
8GN8	1.31
8JV8	1.27
8KA8	1.42
9A8	1.39
9AU7	1.29
9BR7	1.05
9CL8	1.32
[illegible]	1.10

TYPE	PRICE
9EA8	1.49
9U8	.99
10AL11	1.69
10BQ5	1.45
10C8	1.49
10DE7	1.29
10DX8	1.37
10EG7	1.49
10EM7	1.75
10EW7	1.45
10GN8	1.30
10HT8	1.21
10JA8	1.35
10JY8	1.49
10KU8	1.15
10Y	.95
11CY7	1.10
11JE8	1.49
11KV8	2.35
12A4	.95
12A5	1.25
12A6	.89
12A7	1.95
12A8	2.95
12A11	1.69
12AB5	.95
12AC6	.75
12AD6	.79
12AE6	.79
12AE7	1.25
12AF3	.95
12AF6	.98
12AG6	1.49
12AJ6	.94
12AL5	.69
12AL8	1.95
12AL11	1.69
12AQ5	.79
12AT6	.55
12AT7	.92
12AU6	.69
12AU7	.69
12AV5	1.50
12AV6	.53
12AV7	.89
12AW6	1.10
12AX3	1.03
12AX4	.75
12AX6	.91
12AX7	.79
12AY3	1.05
12AY7	1.55
12AZ7	.89
12B4	.89
12BA6	.60
12BA7	1.90
12BD6	.72
12BE3	.99
12BE6	.61
12BF6	.68
12BH7	.91
12BK5	1.22
12BL6	.89
12BN6	1.48
12BQ6/CU6	1.15
12BR7	.98
12BV7	1.19
12BW4	1.07
12BY7	.83
12BZ6	.76
12BZ7	.95
12C5/12CU5	.76
12CA5	.89
12CN5	.98
12CR6	.89
12CS6	.95
12CT8	1.60
12CU6/BQ6	1.11
12CX6	.95
12D4	1.05
12DB5	1.05
12DE5	.92
12DE8	1.19
12DK7	1.05
12DL8	1.95
12DQ6	1.15
12DQ7	1.29
12DS7	1.19
12DT5	1.15
12DT7	1.10
12DT8	1.25
12DW7	1.19
12DW8	1.25
12DY8	2.90
12DZ6	.98
12EA6	.99
12EC8	1.35
12ED5	.98
12EG6	1.03
12EK6	.98
12EL6	.71
12EL8	.95
12EM6	1.14
12EZ6	.83
12F5	1.60
12F8	.99

TYPE	PRICE
12FA6	.97
12FK6	.83
12FM6	.81
12FQ8	1.19
12FR8	1.48
12FX5	.96
12FX8	1.27
12GA6	.91
12GC6	1.15
12GE5	1.46
12GW6	1.15
12J5	1.21
12J8	1.21
12K5	1.19
12K8G	1.50
12K8M	2.95
12L6	.79
12L8	.50
12Q7GT	1.39
12Q7M	1.50
12R5	1.18
12SA7	1.49
12SA7GT	1.25
12SC7	1.50
12SF5GT	1.19
12SF5M	1.50
12SF7M	1.75
12SG7GT	1.20
12SG7M	1.39
12SH7	1.55
12SJ7GT	1.25
12SJ7M	1.39
12SK7GT	1.10
12SK7M	1.35
12SL7GT	1.15
12SN7	.89
12SQ7GT	1.15
12SR7	1.50
12U7	.93
12V6	.95
12W6	.89
12X4	.59
13DE7	1.12
13DR7	1.29
13EM7	1.83
13FD7	1.89
13FM7	1.15
13GF7	1.79
14A4	1.45
14A5	1.35
14A7	1.39
14AF7	1.65
14B6	1.69
14B8	1.95
14C5	1.75
14C7	2.19
14E6	1.39
14E7	1.39
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14F8	1.95
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16GY5	1.90
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17AX4	.89
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17BS3	1.15
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17DQ7	1.75
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17GV5	1.69
17GW6	1.49
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17JB6	1.95
17JM6	1.65
17JN6	1.70
17JZ8	1.19

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17LD8	1.35
17W6	1.15
18A5	1.55
18FW6	.75
18FX6	.79
18FY6	.69
18GD6	.81
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19BG6	1.95
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19CL8	1.25
19EA8	1.19
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25F5	1.29
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25W4	.83
25Z5	1.49
25Z6	.98
27GB5	1.49
32ET5	.89
32L7	.85
33GY7	1.95
34DG5	.95
34GD5	.83
35A5	2.19
35B5	1.10
35C5	.73
35EH5	.83
35L6	.87
35W4	.40
35Y4	1.63
35Z3	1.49
35Z5	.65
45Z3	.55
50A5	2.25
50B5	.89
50C5	.72
50DC4	.64
50EH5	.87
50FY8	1.50
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50HK6	.86
50L6	.95
50X6	1.95
50Y6	1.49
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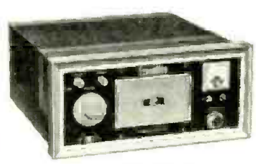

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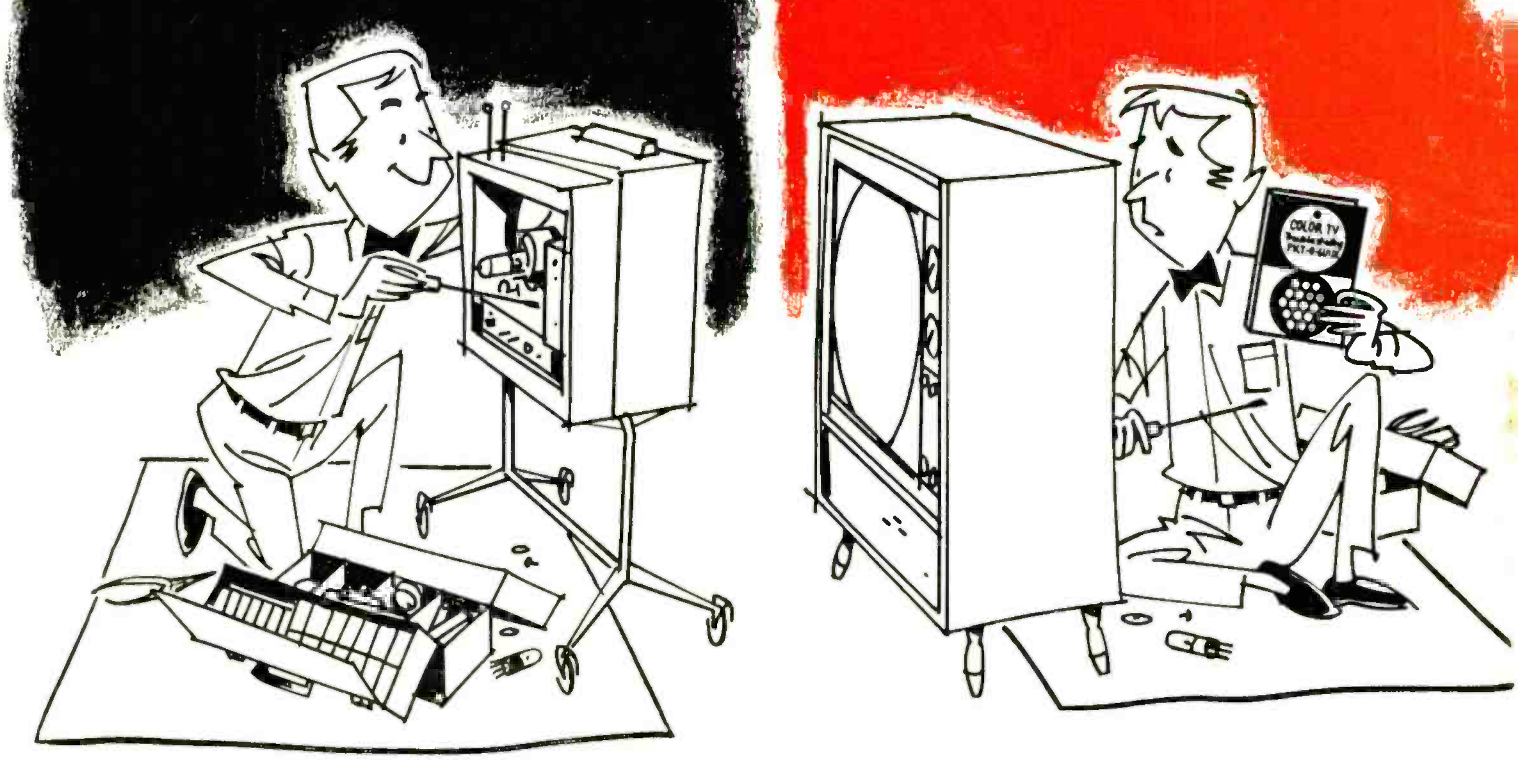

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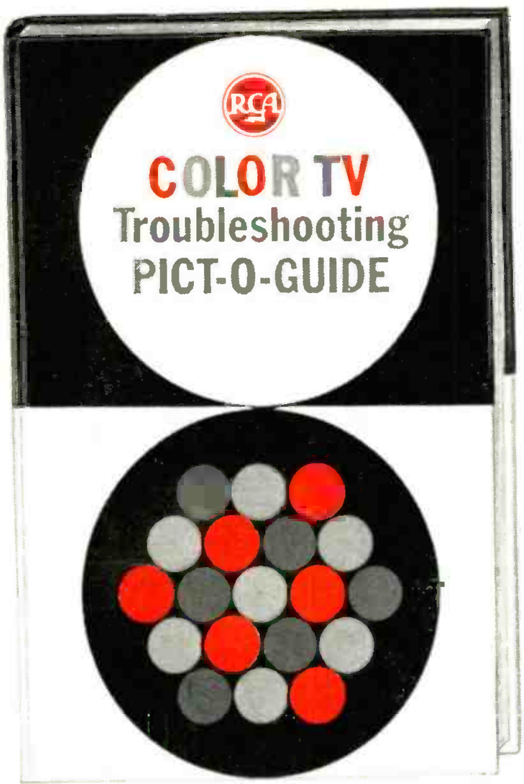

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