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SPRING-SUMMER 75c

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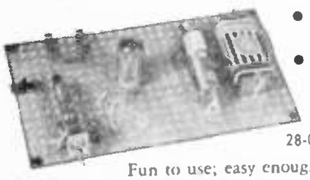

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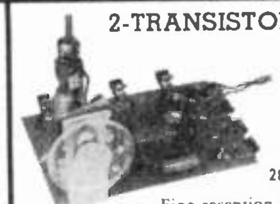

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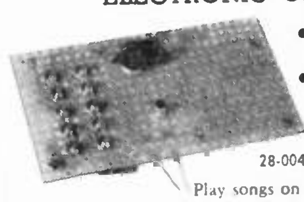

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Cover Photo by Leonard Heicklen

this issue's cover

■ **No one,** the story goes, ever realizes quite what a piece of electronic gear means in terms of pleasure and convenience when it's working the way it's supposed to. But comes the hour when TV images shrink to a single flat line across the screen, when stereo systems sound more leaden than golden, when kiddie phonos become more woeful than tuneful, when transistor sets garble rather than warble, and you'll sense only too keenly the pleasure you no longer have.

At this point you could call a serviceman, assuming, of course, that you are prepared to pay the price—the price in this instance involving the hours or days you must await his arrival, the bill you must pay for his call, and the unavoidable gamble you must take that he will be able to correct the particular fault at hand. But this is also the point where, in many cases, you could determine to fix the trouble yourself.

Often, a simple tune-up or adjustment rather than a full-fledged repair job may be all that is required. TV's, both black-and-white and color, must be properly adjusted if they are to function as intended. Similarly, small tube or transistor radios can frequently be returned to top operating condition by techniques straightforward enough to obviate need for a serviceman.

Fortunately, adjusting TV sets and tuning up small radios fall well within the capabilities of the do-it-yourself home repairman who follows the procedures outlined in this issue of TV REPAIR. For regardless of what it is that stands in need of attention—tape recorder, kiddie phono, TV set, FM tuner, stereo system, small radio—you will find this issue of value. ■

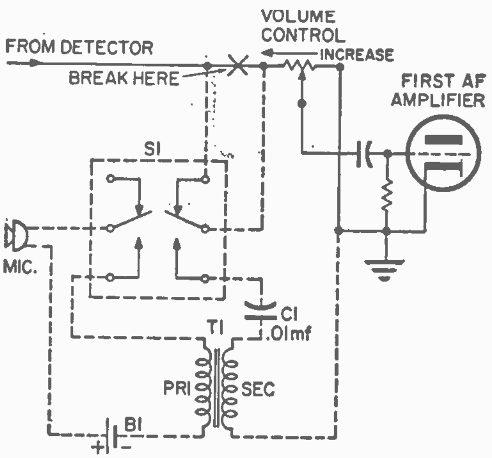
service shop tips

Radio Goes PA

How can I connect a microphone to an AC/DC radio so I can use its amplifier without using the radio circuit?

—A. S., Passaic, N. J.

Since the amplifier may not have enough gain for a crystal, dynamic or ceramic microphone, you can use a carbon microphone as



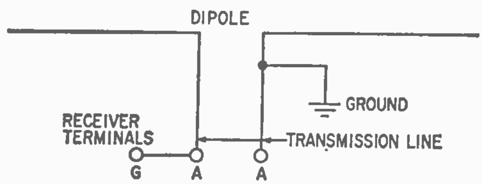
shown in the diagram. Install a d.p.d.t. toggle switch, S1, on the chassis or the set's rear cover. Mount microphone transformer T1, such as a Stancor A4705 on the chassis or rear cover, grounding transformer frame to chassis. Also install a battery holder (Lafayette 34G5005) on rear cover and slip a 1.5-volt battery (Burgess Z, Eveready 915, etc.) in the holder. Disconnect the "hot" volume control lead as indicated by "X" in the diagram. Wire the new parts into the circuit as shown, using the shortest possible leads (except microphone cord). Capacitor C1 may be an 0.01 mfd tubular.

Throw the switch one way for normal radio reception, the other way to use the mike. The volume control works for both. If there isn't enough mike volume add more batteries. Using a telephone type carbon mike, you should get lots of sound.

An alternative is to use a Philmore Junior Microphone (Cat. No. 500) which can be connected directly to the plate and cathode prongs of the first AF amplifier tube by means of clips furnished with the mike. These are sold in many radio parts stores. Still another, and the safest way is to get a wireless broadcaster (Knight, Lafayette, etc.) which does not have to be connected to the set and does away with the shock hazard.

Grounded

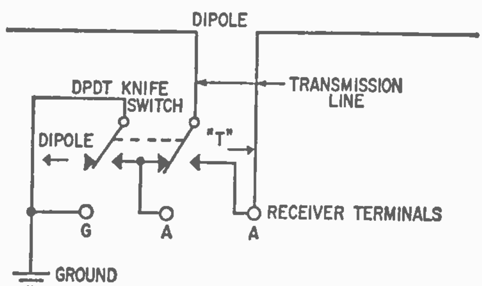
I have a shortwave receiver and a 40-meter band dipole antenna, connected as shown in the diagram. AM broadcast stations cover



the entire 160-meter band, except when I disconnect the ground. Is there anyway I can eliminate the BCI without removing the ground.

—R. A., Butte, Mont.

You've got the antenna hooked up wrong. Connect the dipole transmission line to the



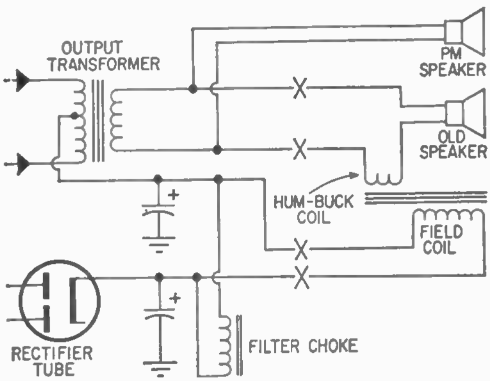
"A" and "A" terminal, and remove the shorting bar. Or, if you want more pick up on bands other than 40-meter, you can add a switch, as shown in the diagram, which will enable you to use the dipole as a "T" antenna. If you have been using coaxial transmission line, the shield should go to the center "A" connection.

Field Coils are Out

A radio I have has a field coil speaker. Is there any way I can replace it with a PM dynamic speaker?

—D. S., Hanover, Pa.

Use a filter choke in place of a low-resistance field coil, connected as shown in the diagram. The filter-choke inductance value is not critical, but it must be able to handle the receiver's total plate current. A



Stancor C-1002, for example, is rated at 15 henries and 75 milliamperes. Some sets used a high-resistance (5K to 10K ohms) field coil in parallel to the B-plus supply. It is generally not necessary to substitute a filter choke for this inductance. Many old auto radios do not need the choke either—it will only use extra battery current since it is connected in parallel to the filaments.

"I guess we forgot to call back—we fixed it ourselves this morning."

Service shop tips

Intercarrier Buzz

There is a buzz in the sound of my TV set. When I adjust the fine tuning control to eliminate the buzz, the picture is not right. How can I get clear sound and pictures together?
—N. T., New Orleans, La.

Chances are your TV set employs "intercarrier" sound and a gated beam sound detector. The usual cause of buzz in the sound channel is receiver misalignment. To align the whole receiver properly a sweep and marker generator and an oscilloscope are required. If you don't have these instruments available, try replacing the sound detector tube (6BN6, etc.). Also try tuning the gated beam detector "quadrature coil" for clear, buzz-free sound with the set tuned for the clearest picture. When tuning the coil by turning its ferrite core, use only a tuning wrench that fits. Some TV sets also have a potentiometer with which sound buzz can be minimized. Get a service manual for your set so you can locate these components.

Instant Radio

How can I modify an AC/DC radio so it will operate instantly when I turn it on like some TV sets I have seen advertised?
—S. R., Roosevelt Field, N. Y.

Connect a diode across the ON-OFF switch terminals of a typical AC/DC radio. With the switch turned OFF, the tubes should light but the set should not play. If it plays, reverse the polarity of the diode. Pick a diode that will handle at least 500 ma. and peak inverse voltage of at least 400 volts. They cost as little as 37 cents.

Tube Stretcher

I have heard of a gadget I can use with a TV set to increase tube life. What is it and where can I get one?
—E. D., Jackson Heights, N. Y.

The Wuerth TV Life Saver shown in the photograph should be available at radio parts stores. It is plugged into the electrical outlet and the TV set plug is inserted into the gadget. When the set is first turned on, a resistor is connected in series with the AC

line to cut the voltage reaching the set. After the resistor gets hot, a pair of contacts close and full voltage is applied to the set. It should greatly increase tube life.

It Ain't Easy

I would like to change my 30-50 mc band FM receiver to cover the 152-174 mc band. Can this be done?

W. C., East McKeesport, Pa.

It probably can be done by changing the RF, mixer and oscillator coils. Try coils with about one-fourth as many turns. You will need a good RF signal generator to permit adjusting the coils (number of turns and spacing of turns) and re-aligning the trimmers. You can set the tuning range limits with the signal generator.

Be a UHF Copycat

What type of antenna is best for reception of weak UHF translator TV stations?

F. B., Las Vegas, Nev.

A parabolic, Yagi or corner reflector antenna will give you considerable gain but must be accurately aimed at the station. Since these antennas have relatively narrow frequency range, they cannot be used to cover

service shop tips

the entire UHF TV band. These antennas are fairly inexpensive ($5 to $25).

Blame the Outlet

I often receive a broadcast station with good signal strength but with background static loud enough to be annoying. There are no electrical appliances operating. Is there any way to reduce this static?

—M. L., Fresno, Calif.

Try tuning in a strong local station. The noise should be greatly reduced. The noise could be coming over the power line. Try a line filter (Cornell-Dubilier IF-6, etc.) between the power outlet and the set's power plug. If the set has a loop antenna, rotate the set or the loop for minimum noise and maximum signal.

Hm mm mmm

I get a lot of hum on my AM-FM radio. Is there any way of getting rid of this hum? I do a lot of taping from the radio.

—A. S., Cleveland, Ohio

With the tape recorder disconnected, if the set still hums, chances are that it is due to dehydrated electrolytic filter capacitors or insufficient filter capacity. Try connecting a new filter capacitor across each section of the filter capacitor (one at a time) and note if there is any decrease in hum. On the other hand, if the hum is present only with the tape recorder connected, make sure that all of the cable shields are correctly grounded.

Dial Trouble

The dial of my short-wave set is inaccurate and far from the announced frequency. How can I improve it?

—P. J. Dett., Middletown, Pa.

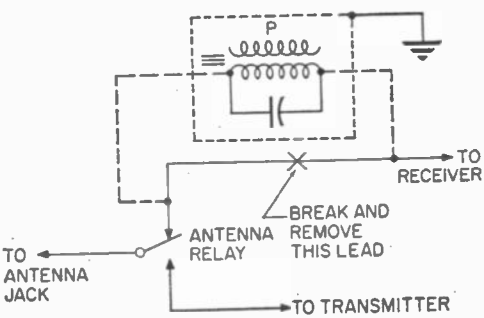
If the receiver has tuning trimmers, tune in a station at a known frequency. Then set the dial to indicate that frequency and adjust the trimmers until you get the same station. Or, tune in the station and disengage the tuning dial, set it to indicate the frequency of the station and then re-engage the dial. This is a cheap and dirty way out. If results are poor, you will need a signal generator alignment.

Trap It

On CB channels 9 and 19 I receive a local 1000-watt AM radio station about ¾ miles away which operates on 1400 kc. I use a ground plane antenna. How can I eliminate this interference?

—D. W. G., Lawrence, Mass.

Disconnect the lead from the antenna relay to the receiver antenna coil and connect



a wave trap in its place as shown in the diagram. You can use a shielded TRF coil such as a Miller A-320 RF with a 20 pf. capacitor connected across its secondary. Leave the primary disconnected. Mount the coil shield can to the chassis or rear cover of the set (if it is metal) and use the shortest possible leads. Tune the coil core until the interference is weakest or disappears. Try different values of capacity across the secondary if the suggested value doesn't do the trick. Make sure the coil shield can is securely grounded to the set chassis.

"Hey, Gladys, come cut a piece of wire about that long!"

service shop tips

Use a Sky Wire

I have a portable transistor radio which employs 12 transistors and 5 diodes. How can I improve its long distance, shortwave capability?

—J. T., Muskegon, Mich.

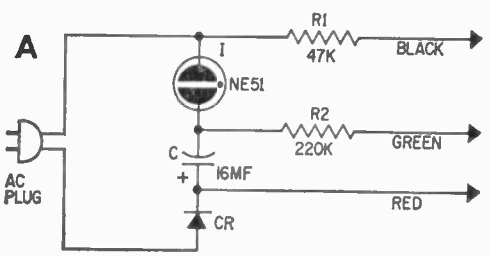
Connect an outdoor antenna to its whip antenna.

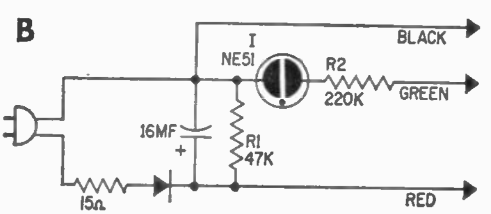
Cheap Tester

Over five years ago I built a tester using the circuit shown in the diagram. I have since forgotten what the instrument is called. I find that I can test a capacitor by connecting the red and black test leads to it. If the neon lamp flashes only once, the capacitor is O.K. But, what is the green lead for? (See diagram A below.)

—H. H., Menasha, Wis.

It is a combination continuity and capacitor tester. It looks like it is hooked up wrong. If you rewire it as shown in diagram B (below), it will work as a capacitor and continuity tester using the red and green test leads. You will also have a small DC power supply (about 150 volts) using the red and black leads. Resistor R1, shunted across filter capacitor C stabilizes the voltage and bleeds off the charge in C when the AC plug is disconnected.



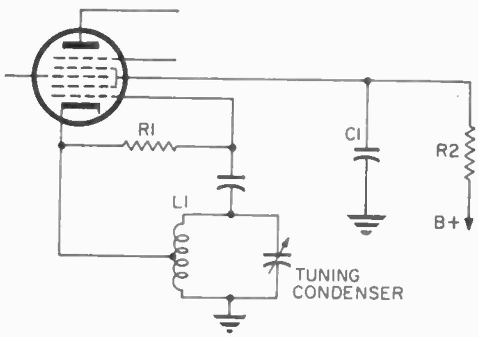


Local Oscillator Kaput!

My 5-tube AC-DC superheterodyne receiver will bring in stations near one end of the dial. The rest of the band is dead. What is the trouble?

—T. K., Long Island City, N. Y.

Either the tuning condenser plates are shorting or you probably are experiencing oscillator trouble. The oscillator may cease to function except over a limited frequency



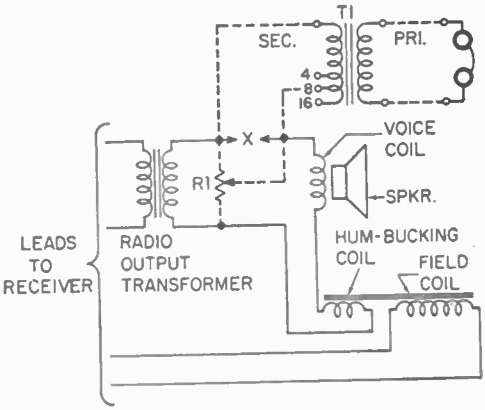
range. The trouble is usually due to a defective converter tube, change in the value of the oscillator grip leak (R1) or in the value of the screen voltage dropping resistor (R2). It could be that by-pass capacitor C1 may be leaky causing the screen voltage to drop. Try a new grid leak (R1) of the same value as the original. If that doesn't do it, change R2 and C1. Sometimes the oscillator coil (L1) absorbs moisture and its Q is lowered. Try drying it out by exposing it to an infrared lamp.

Headset Speaker Tie-up

My old radio has four speaker wires. How can I hook up earphones to it and cut out the speaker?

—D. W., Bay City, Michigan

Two of the wires undoubtedly go to the speaker's field coil. The other two go either directly to the voice coil or the primary of the output transformer, if the transformer is mounted on the speaker. Ignore the field leads. Disconnect the voice coil lead that goes to the output transformer (not to the hum bucking coil) as shown at "X" in the diagram. Add a 20-ohm potentiometer, R1, and connect it across the set's output transformer. Also add an extra output transformer, T1, such as a Stancor TA-44, connecting its secondary as shown in the sche-



matic diagram. Connect the headphones across its primary (high impedance side). The transformer type suggested has three taps. Try the 4, 8 and 16 ohm taps and use the one that gives best results. The purpose of the added transformer is to step up the audio voltage. To use the speaker, turn the potentiometer fully one way. Midway, both the headphones and speaker will operate (at reduced volume). When fully turned the other way, the speaker will be silent and the sound will be heard only in the headphones.

BCB Noise

Without moving out of the New York City metropolitan area is there any way to

"Sorry, Mr. Grump, I believe your interference problem is beyond my control."

service shop tips

get broadcast band reception? Using an HQ-100A and a 45-foot long wire I get good short wave but on the BC band I can't beat 300 miles.

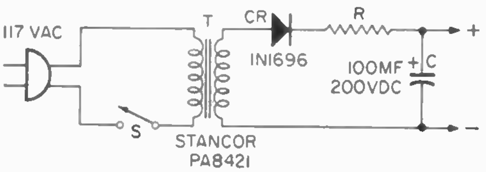
—P. F. A., Hewlett, N. Y.

Living near New York City can impose some hardships in regard to broadcast band DX because of the presence of so many stations in the area. Lengthening your antenna may compound your problems. Also, there are so few clear channel stations that you might have to stay up late to hear distant stations operating on the same frequencies which go off the air around midnight. Just before daybreak, you should be able to hear Cuban stations. Try 700 kc at night—you should be able to receive WLW in Cincinnati.

Take It From the Outlet

I have a miniature transmitter that uses a 90-volt battery which lasts only a week. What equipment should I use to get 90 volts DC from a regular house outlet?

—L. R., Detroit, Mich.



You can try a larger capacity battery or build a rectifier power supply as shown in the schematic diagram. The value (1000 to 5000 ohms) and power rating 1- or 2-watt) of resistance R depends upon the amount of current your transmitter draws. Try various values until you get 90 volts across capacitor C with the transmitter turned on and operating.

70-Volts of Audio

My amplifier has 4-, 8-, and 16-ohm and 70-volt output terminals. What is the 70-volt output used for?

—L. J. E., Everett, Wash.

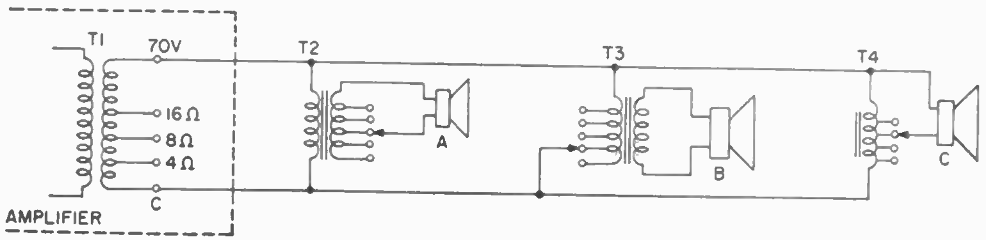
In a 70-volt sound system the amplifier gain is set so that the audio output voltage between the common and 70-volt output terminals is approximately 70 volts. The volume level is adjusted at the speakers by selecting line transformer taps as shown in the diagram. The line transformers may have a tapped secondary (T2), a tapped primary (T3), or it may be an autotransformer (T4).

The power fed to each speaker depends upon the voltage applied to it and its load impedance. For example, if Speaker A has an impedance of 4 ohms and is connected to the 2-volt tap on T2, it will consume one watt since power in watts is equal to E^2/R and here E^2 is 4 and R is 4. If set to the 6-volt tap, the speaker power will be 8 watts, and so on.

The three types of transformers shown perform the same function—they step down the 70-volt signal to the required level. The taps permit adjustment to the voltage ratio which is proportional to the turns ratio.

Speakers A, B and C may all be operated at different sound levels. The number of speakers that can be connected across the 70-volt line is limited by the power capability of the amplifier. For example, a 50-watt amplifier could feed 8 watts to speaker A, 10 watts to B, 2 watts to C and have 30 watts to spare for additional speakers.

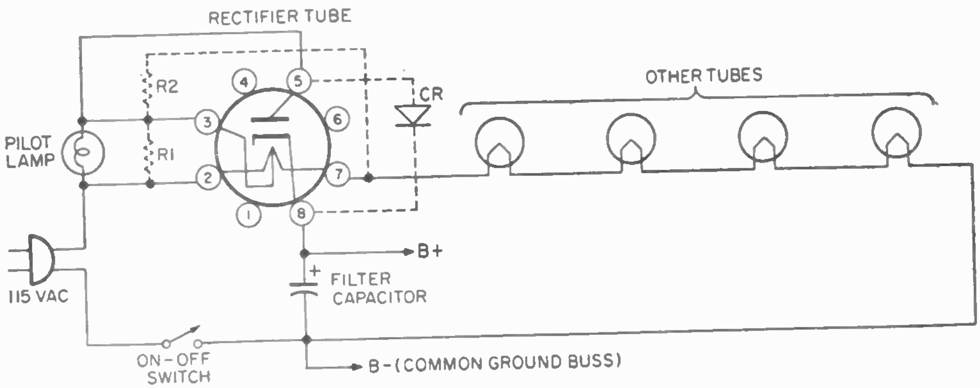
On some amplifiers the 70-volt output terminal is merely window dressing and is the equivalent of a 500-ohm line output. A true 70-volt amplifier has excellent output voltage regulation permitting removal or addition of a speaker without affecting the sound level of other speakers. It is easy to work with 70-volt sound systems since we deal with volts and watts without being concerned with impedance matching.



Bye Bye, 35Z5GT

Can I replace a 35Z5GT tube in an AC-DC radio with a silicon or selenium rectifier?
—G. L., San Carlos, Calif.

Yes! Just pull the tube out of its socket and leave it out. Connect the rectifier (CR) across socket terminals in 5 and 8 with polarity as shown in the diagram. Connect a 50-ohm, 5-watt resistor (R1) across 2 and 3, and a 200-ohm, 10-watt resistor (R2) across 3 and 7. The resistors take the place of the tapped tube heater. The resistors will run hot so be sure the set is well ventilated. You will obtain one added feature not bargained for and that is the surge resistance through the other heaters will be much less than previously. This is so because the cold resistance of the heater string will be higher with the resistors in the circuit in place of the 35Z5GT. However, the hot resistance of the heater string will be the same. The radio will take a few more seconds to warm up than previously. ■

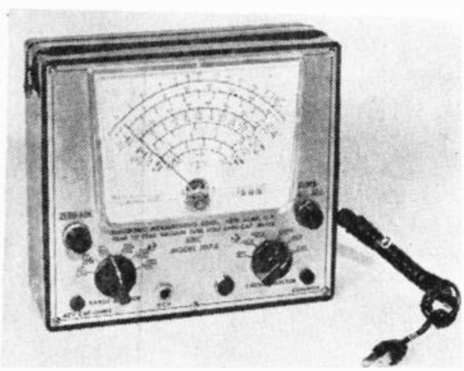


ACCESSORIES for the TEST BENCH

Handy gadgets and useful items that ease troubleshooting and repair of any electronic chassis.

VTVM Measures L & C

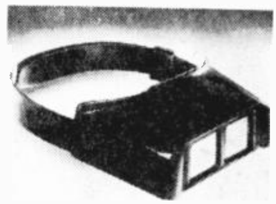
The new *EMC* Model 107A, a wide-range vacuum-tube voltmeter (VTVM) for DC, AC, and resistance measurements, also provides direct peak-to-peak readings on complex, asymmetrical voltage waveforms, direct capacitance readings, a zero-center scale, db scales, and indirect inductance measurement. Other features include a "wide screen" 6-inch meter faceplate for legibility and reading accuracy. This accuracy is furthered by 10 separately calibrated scales instead of combination scales. In addition to the capacitor test, the function switch includes separate positions for + or − DC. The meter movement is burnout-proof. Peak-to-peak voltage is measured in 6 ranges: 0 to 4, 28, 84, 280, 840 and 2800 volts. AC (rms) and DC, in 6 ranges: 0 to 1.5, 10, 30, 100, 300, and 1000 volts (up to 30,000 DC volts with accessory probe). Six resistance ranges cover from 0 to 1000 ohms (10 ohms center scale) up to 0 to 1000 megohms. Capacitance is measured in 6 ranges from 50 pf. to 5000 mf. Db is measured from −24 to +55 db in 6 ranges. Accuracy is 3 per cent on DC, 4 per cent on AC. Input resistance



is 16.5 megohms or 1⅔ megohms per volt on DC, 1.5 megohms on AC. A complete instruction manual for the *EMC* Model 107A VTVM includes conversion charts to obtain inductance readings in henrys and correct db readings for standards other than 0 db at 6 mw. in a 500-ohm line. Available accessories include an RF probe useful to 200 mc. and a high-voltage probe useful to 30 kv. Model 107A comes with instruction manual and test leads; in kit form, $36.50, or wired and tested, $51.40. *(Complete information is yours for the asking—write to Electronic Measurements Corporation, 625 Broadway, New York, N. Y. 10012.)*

3-D Sight Booster For Experimenter

With today's fast-paced, intricate technology and the importance of delicate, precise work, in one's business, profession or hobby, a sight-booster is often a vital necessity. Available now is a low-priced slip-on binocular magnifier that quickly returns its cost over and over. A quick, easy adjustment of



the head-band to accommodate head size, and Magna-Sighter is in place—and stays in place—even over regular glasses. To resume normal vision, just lift the head a little. No need to remove the Magna-Sighter. Like magic, lower the head and object enlargement is over 2½ times—leaving both hands free to work. Featuring the finest ground and polished prismatic lenses, Magna-Sighter has no moving parts, nothing to wear out, nothing to replace. Light in weight and heavy on performance, its enthusiastic acceptance by government agencies and famous names in industry testifies to its value and usefulness.

Offered on a 30-day money-back guarantee, Magna-Sighter is priced at just $9.95. *(To place an order or obtain more information write Fairchild Optical Company, Dept. TV31, 1555 West Howard Street, Chicago 26, Illinois.)* ■

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If there's one way to beat the high cost of boating, it's the "build-it-yourself" way. Nearly one-half million boat builders who have constructed their own boats from Boating Journal's Craft Prints would verify this fact.

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255–MINIMAX–Hydroplane
Materials cost: $20
Construction time: 1 day

8 ft. in length; 4 ft. beam and weighs 68 lbs. Will carry 2 people, take outboard motors ranging from 3 to 15 hp. Has a watertight air compartment that will support 900 lbs. even with the cockpit completely filled with water. Easy to build.

No. 255–Enlarged Plans, $3
No. 347–Full Sized Plans, $8

106–PETREL–Multi-Purpose Sloop
Materials cost: $163
Construction time: 85 hours

16 ft. sailer that can be built as an open cockpit racer or as a cabin sailer with accommodations for overnight trips. Can be adapted to outboard or air-cooled inboards from 1 to 6 hp. Seats 4. Wt. 650 lbs.

175–EAGER EYE–Outboard Cruiser

This 18 ft. cruiser carries four persons in the cockpit or sleeps 2. A cover hides the 25 hp outboard motor. Can be transported easily on a trailer and stored in a garage. Weight of hull is 600 lbs.

365–SNAPPER–Fishing Boat

11 ft. in length; 5 ft. beam; weight 125 lbs. One of the easiest boats to construct. With regular carpenter's tools, and average skill, this job should take about 15 hours and the cost of your materials should be less than $50. Ideal for use as a car-topper, this extremely rugged lightweight fishing boat is designed for use on sheltered waters. SNAPPER is a fascinating and inexpensive introduction to the pleasures of boat-building.

356–TABU–Sports Sailer

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343–MINIMOST–Sports Hydroplane
Materials cost: $15
Construction time: 1 day

An 8 ft. outboard. By using stressed-skin construction and advanced underhull design, speeds up to 30 mph can be attained with light-weight outboards in the 10 hp. class.

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270–SEA FLEA–Midget Sailer

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Construction time: 50 hours

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239–SEA ROVER–Cabin Cruiser
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Construction time: 65 hours

Can be built as a sports, utility or cabin model in either a 15 or 17 ft. length. Seats 3 in forward seat; 4 in cockpit on folding chairs.

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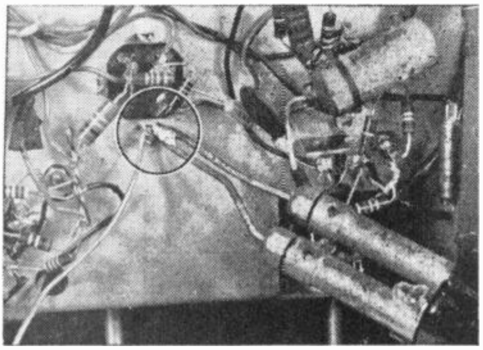
Workbench Tips

■ A frequent cause of hum (and sometimes even whistles from radios) is an improperly grounded can-type filter capacitor. Most can installations rely on their twist lock for con-



nection to ground. In time an oxide forms—a high resistance circuit occurs. To prevent trouble, always solder at least one lug to ground in kits and when replacing.

■ If your SW ear phones weigh heavy on your head, take a tip from the makers of hi-fi headsets and pad them with foam rubber. Foam rubber powder puffs are ideal for the purpose and are available at most cosmetic counters. To install, simply cut a ¾" hole in the puff's center, and cement in place as neatly as possible. Install puffs wherever headband meets top of your head.

"How do I plug this in?"

About Your Guarantee

We, the Editors, have the utmost faith in the procedures presented between these covers. They have been written by experienced authors who are active technicians—not just reporters, presenting happenings as they think they see them.

Over a period of time this book should save 10- to 100-times its purchase price—if you are lucky enough to have a set that only needs a tube now and then and a rear-chassis control adjustment at intervals. We cannot promise to teach you enough to cope with the expensive shop-repair problems in such a limited volume. We can teach you "first aid"—what to do before you call the service technician.

In this sense our authors are teachers—but all teachers cannot convey all of their thoughts to all of their students. Our readers are the students—wanting to learn how to do the easier things for themselves. Unfortunately, all students are not perfect students in that they cannot learn everything from all teachers. Here, the student is handicappec—he cannot ask questions to clear up a point that is hazy or something that is different from the teacher's example (because it is made by another manufacturer or it is a slightly different model).

The manufacturers of the actual devices do not have identical products—even though the products give similar services. All cars have wheels and an engine—they can use the same tires, oil and gasoline; you can even wash them with the same cleaner—but you can't switch mechanical parts from one to the other without making some form of compensation. Electronic equipment is the same—some items are interchangeable but some must be compensated for—instructions printed here are generalities and will cover most models manufactured.

Then, the symptoms of each electronic defect that occurs can have several solutions because many components are involved—not just one.

None of the normal procedures outlined here will cause additional damage, electrically, to the defective electronic instrument. Physical or mechanical damage can occur through accident or carelessness though.

GUARANTEE

If, after faithfully following instructions as set forth within this book on any mentioned repairs, adjustments, and installations you find instructions to be faulty and it becomes necessary to call a service repair man to repair your television set, we will reimburse you for the cost of this book. All you need do is send us a letter detailing what happened in as few words as possible, and return entire issue and we'll refund your purchase price.

—The Publisher

TV REPAIR
SPRING-SUMMER 1967

TUNE-UP TECHNIQUES for AM RADIOS...

...both tube and transistor!

By H. B. Morris

■ **As a radio signal** rides through an AM receiver—from antenna toward speaker—it may squeeze through a dozen tuned circuits. Up front, coils and capacitors slice one frequency away from the rest of the band. Further along the circuit, IF stages funnel the signal through sharply peaked transformers. But unless those tuned circuits hug their appointed frequencies, strong stations may slither through while weak ones trail into a quagmire of noise. Or receiver selectivity could topple and admit two stations simultaneously.

Keeping a receiver's circuits finely tuned and properly centered is the job of alignment. It's a task of turning, twisting, and touching up coils and capacitors until they resonate like a barber shop quartet. And it involves adjusting slugs, trimming padders, and "rocking" the oscillator.

Is This Twist Necessary? Whether you listen on grandfather's Atwater-Kent, or swing a solid-state transistor, be sure alignment will solve the problem. If the receiver was accurately lined up at the factory, it should remain that way for months or years. Therefore, be certain that a tube, a bad capacitor, or some other ailing component isn't the real cause of failing receiver performance before you start to align.

There are several reasons why receivers go out of alignment. An IF transformer could develop a shorted turn and veer off resonance. RF coils or their forms might absorb moisture and shift off frequency. Sometimes installation of a new component upsets alignment, especially if leads are disturbed. In older sets, corrosion may introduce resistance in mechanical joints which disturbs tuning. (One serviceman even claims a customer of his believed his radio suffered from "loose screws." The customer tightened every one of them—which aligned the radio on some frequency down in the audio range.)

Handy Items. Some old timers boast they can align an AM radio with one ear and a sharpened lollipop stick. But for best results, try to obtain a signal source and an output indicator (Fig. 1). An aligning tool that matches the slugs in IF transformer cans is strongly recommended. Using a regular metal screwdriver on powdered-iron cores often ruins the slot. For adjusting trimmer capacitors, use a non-metallic screwdriver. Then tuning won't waver as you bring the tool near the circuit.

Best signal source is the standard RF signal generator, an instrument that produces frequencies beginning far below the broadcast band (about 100 kHz) and extending to the TV region (220 mHz). Instruments of this type usually contain a built-in audio oscillator for tone-modulating the RF signal at 400 Hz. If you want to play it by ear, it's possible to perform some limited alignment with an off-the-air station. Trimmers in the IF stage or stages are adjusted until

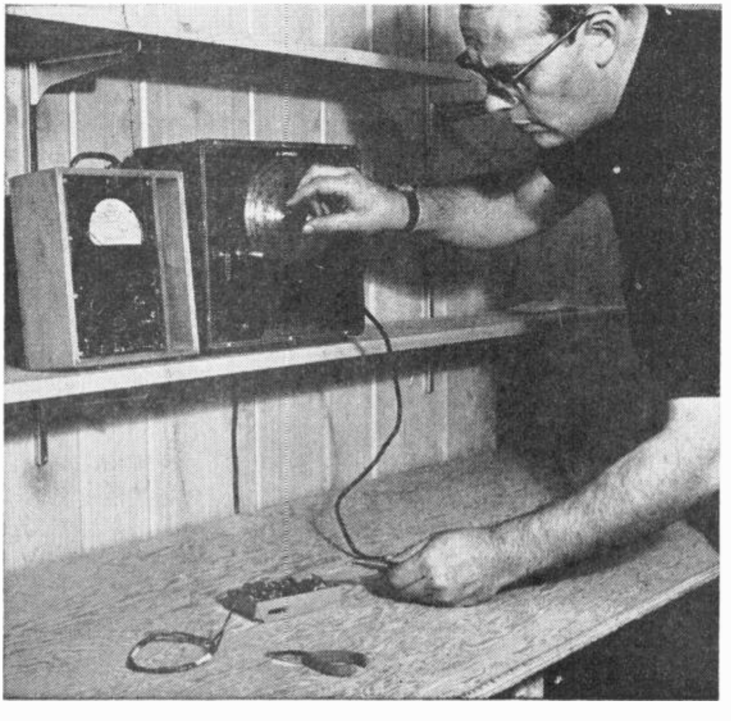


Fig. 1. Necessary instruments for AM radio alignment are seen on shelf—an RF signal generator (right) and an output meter, which can be either a VTVM or a VOM set up to read AC volts. On table, small transistor portable is in operation, awaiting alignment.

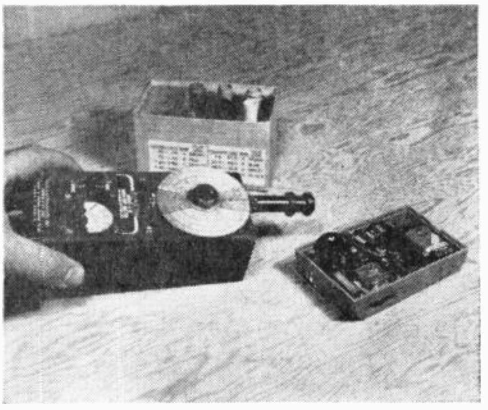


Fig. 2. A grid-dip oscillator can be used in lieu of an RF generator, but it must have coils for broadcast band and below.

loudest sound is heard in the speaker. (It's even possible to tune with no station at all simply by making adjustments until the strongest crackling noise is heard.)

The pitfalls of any informal tune-up technique are these: for one, the set may be so far out of alignment that it's insensitive to any received signals. Another is that strong signals produce AVC (automatic volume control) voltages. This condition does not produce optimum alignment for weak stations. And air signals aren't convenient for *tracking* alignment, a series of adjustments which cause tuning circuits to shift across the band in unison.

One trick for obtaining a free signal is to use another AM receiver. The local oscillator stage within an AM set often generates a frequency 455 kHz *above* its dial setting; e.g., tune to 570 kHz and the circuit radiates a 1025-kHz signal. Two shortcomings of this approach: the signal may be too weak to be picked up by a set which is considerably off alignment, and you can't obtain important IF frequencies below the standard broadcast band. Thus, a regular RF signal generator is recommended for maximum results. It produces strong, easily controlled signals on any desired frequency.

If you're a ham, and you own a grid-dip meter, it can serve as the signal source provided it has plug-in coils for all the alignment frequencies (Fig. 2). Frequency range of the GDO should begin at about 200 kHz. There's usually no tone modulation with these units, and thus it produces no tone in the speaker. But if you have an audio tone source you can usually jack it into the GDO and modulate the signal.

Consider the second major piece of equipment needed for the job: an output indicator. You can trust your ear just so far when attempting to judge an increase in speaker loudness as alignment progresses. Two limits should be known if you try the ear method. Good alignment technique says that *least signal* should be introduced to the receiver. This imposes a hardship on the ear which operates in logarithmic fashion; that is, about a doubling in output audio signal is needed for the ear to comfortably perceive an increase in loudness. A meter is far more precise. The instrument can be the AC voltmeter section found on a standard VOM or VTVM. It doesn't have to be supersensitive so long as it can indicate about 0.5 to 1 volt AC. It will be connected across the speaker voice coil.

Some authorities state that a useful output indicator is the tuning eye, or S-meter, built into some receivers. These indicators may work on well-designed receivers but may not produce best results on cheaper sets. They're based on measuring a receiver's AVC voltage, which varies with received signal strength. In the inexpensive receiver—and most AM sets fall into the economy class—highest AVC voltage may not correspond to maximum received signal. In fact, it has been found that aligning for maximum AVC in some inexpensive circuits might produce instability, feedback or "motorboating." *(Turn page.)*

Fig. 3. Alignment begins with IF strip where slugs are adjusted to IF frequency (usually 455 kHz). Slugs are accessible through holes at transformer top or bottom.

TV REPAIR TUNE-UP TECHNIQUES

Three Steps, Then Twist. If you're facing a transistor portable, an auto set or table AC/DC radio, the approach to alignment can be divided into three major steps. First the IF strip, containing several transformers, or cans, is adjusted so each element resonates at the specified IF frequency (Fig. 3). In the portables and AC/DC sets, this is almost always 455 kHz. Auto radios are usually at about 262 kHz. These frequencies are usually marked on the set's schematic, which should be on hand during alignment. It may contain some special tune-up quirk.

After IF stages are lined up, you'll move on to the local oscillator. That's the tunable stage that generates a signal which always lies above an incoming station frequency. By mixing signals, a constant 455 kHz (or other IF frequency) is always produced for amplification in the IF strip. The alignment process will trim up the oscillator so it always shifts correctly as the receiver is tuned.

Final step is a trimming operation on the RF or antenna stage where the air signal initially arrives and is selected.

Vive La Difference! Just about any receiver you'll encounter will be a superhet and it's aligned according to this three-step approach. But there are bound to be small differences. The transistor portable and AC/DC set, for example, usually have no RF amplifier stage. This is easily determined by looking at the main tuning capacitor, the one that's rotated by the dial. If there are two sections, or groups, of plates, the circuit has no tuned RF amplifier. In the three-gang capacitor, the three groups of plates indicate that a tuned amplifier is present.

In the car receiver, you'll probably see no main tuning capacitor. These sets nearly always have *permeability* tuning; in this arrangement a group of slugs, rather than a variable capacitor, performs the tuning function. Most auto radios have an RF amplifier and one IF stage, but alignment is basically the same as for other circuits.

These and other receiver differences are shown throughout the accompanying photos and illustrations. You'll see that a transistor receiver usually has just one adjustment (single-tuned) at each IF transformer. This is in contrast to the double-tuned IF of the tube models, where there are top and bottom slugs (or trimmer capacitors in older sets). These differences should be apparent when the receiver's main tuning capacitor and IF cans are closely examined.

Warming Up. While you're giving the radio and test equipment a 15-minute warm-up for circuits to stabilize, let's consider some preliminary steps. One hazard in align-

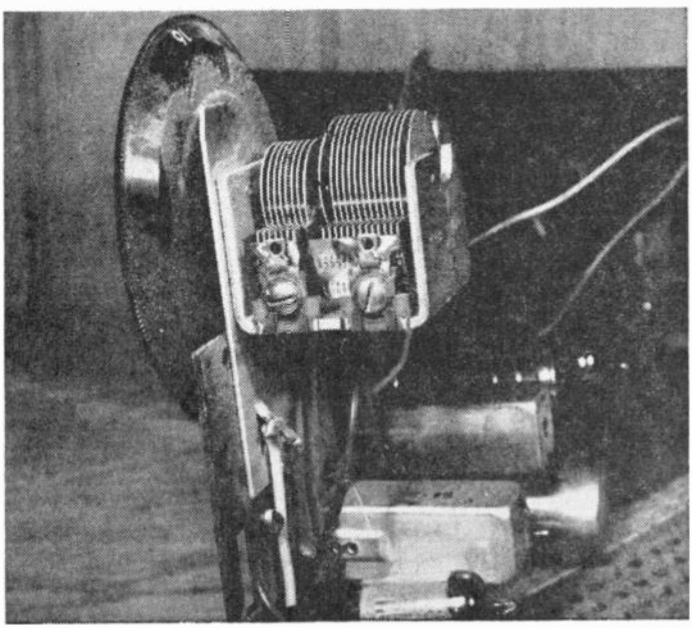


Fig. 4. Local oscillator on AC/DC sets is tuned with smaller section of two-gang capacitor, RF input with larger section. Trimmers for respective sections appear immediately below stator plates. Oscillator trimmer is tuned to specific frequency, RF trimmer set for peak response.

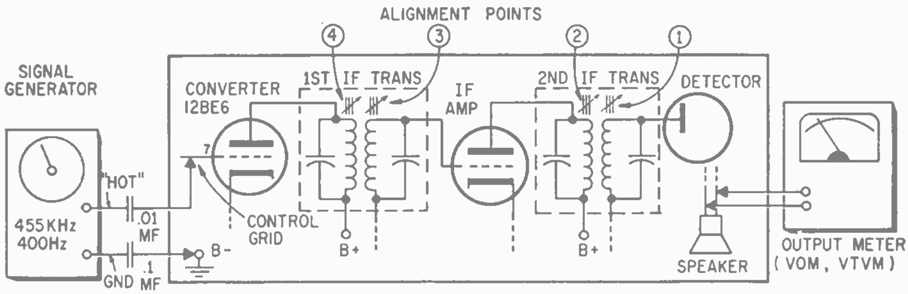


Fig. 5. IF alignment points in AC/DC tube receiver are numbered 1 through 4 and should be touched up in that order. Note use of isolation capacitor between B— and generator.

ment is possible shock from an AC/DC receiver. And usually the problem isn't from the "hot" chassis of the receiver itself (though there may be some danger here). Instead it emanates from the signal generator lead that is connected to the electrical ground of the receiver. It's possible for this connection to place AC line voltage on the metal cabinet of the generator.

One cure is to power the receiver through an isolation transformer. Another suggestion: while touching no part of the radio with your bare hands, plug it in and place one probe of an AC meter to the radio's electrical ground (usually the negative or black lead from the electrolytic filter capacitor) and the other meter probe to the building ground. (This is usually obtainable at the wall outlet: touch the probe to the screw that fastens the outlet's cover plate.) If you observe any voltage when the radio is turned on, reverse the radio plug in the wall. Of course, exercise precaution when working near any live, exposed electrical circuits. Another precaution is placing a 0.1 *uf* capacitor in series with the generator ground lead.

Another preliminary to alignment is turning the radio's volume control fully on. The reason is that the alignment process must operate with *least* RF signal. It's easy to submit to the temptation to pour on the signal since it produces a husky, easy-to-see swing of the output meter. But this causes the receiver's AVC to fight back. As you align for maximum output signal, AVC attempts to reduce receiver sensitivity (which is what AVC, after all, is intended to do during normal reception). Thus, AVC tends to smooth out signal changes.

Another problem is that AVC could vary the bandwidth of the receiver, causing it to grow broader during strong-signal reception. Tune up the receiver in this condition and adjustments may not be accurate for weak signals. So keep signal-generator output throttled down to where you can just see the needle rise on the output meter. And AVC voltage will never develop to upset the job.

Just before you start the first alignment steps (in the IF strip), the local oscillator stage of the receiver should be rendered inoperative. Otherwise signals from the signal generator and local oscillator could mix and produce annoying "birdies." A convenient method for doing this is shorting the main tuning capacitor section which controls the local oscillator. It's easy to locate since the capacitor plates are usually smaller than those for other section(s). A jumper is placed between the stator (fixed) and rotor (movable) plates of the capacitor. To be certain you won't short-circuit a transistor and possibly blow the semiconductor, use a blocking capacitor in the jumper lead (about .01 *uf* should kill the oscillator). Remember to remove the jumper for the other alignment steps.

Hooking Up. Fig. 5 shows the set-up for IF alignment of a typical tube-type receiver. Note that the signal generator's hot lead connects to the converter grid (pin 7 of the 12BE6, if the set is the common AC/DC type). This injects an alignment signal into the IF strip. A 0.01 *uf* capacitor is added to the hot lead to prevent DC shorts, and a 0.1 *uf* capacitor in series with the generator ground lead offers protection against a possible hot chassis. The generator is set to 455 kHz (or the approriate IF frequency) and the 400-Hz audio tone switched on for modulation.

The output indicator (the AC function of your VOM or VTVM) connects across the speaker terminals and responds to the 400-Hz audio tone. You'll probably have to set your meter to its lowest AC range to detect the signal. And reduce both RF and tone modulation from the signal generator for the smallest usable needle swing on the meter.

If you're aligning a transistor portable, an alternate method for injecting the signal is given in Fig. 6. Tiny circuitry and printed boards make it difficult to inject a signal directly into the converter stage, and, in most cases, it's possible to radiate the IF frequency through the air via a small homemade loop. It can be a few turns of hookup wire clipped to the hot and ground leads of the generator. Signal strength is adjusted either by manipulating the generator's attenuator control or by moving the loop away from the receiver.

Let's consider Fig. 7 for an IF circuit you're apt to encounter in a small transistor portable. One difference between this IF strip and the one in the tube circuit (Fig. 5) is that two IF amplifier stages occur instead of the usual one. This means there are three (not two) IF transformers to be aligned.

There is yet another difference. In most small portables, the IF transformers are *single-tuned;* they contain just one tuned circuit instead of the conventional two. The practical implication is that you'll be adjusting only one slug, at the top of the transformer. Though there are generally two coil windings in each IF transformer, the secondary serves as an untuned coil which matches the high impedance of the tuned winding to that of the following transistor base element. It can't be adjusted.

Our final IF strip is the typical circuit you'll encounter in the all-transistor car radio, shown in Fig. 8. It's characterized by just one IF amplifier stage, but the IF transformers are usually double-tuned. This means that you'll be adjusting two slugs on each IF can. The hookup for generator and output meter can be the same as that already shown for the transistor portable. The IF frequency will be approximately 262 kHz.

By referring to these IF strips you should be able to recognize the one you're going to align. There are other differences, to be sure, but they're mostly superficial. The number of IF stages may vary, or transformers might have small trimmer capacitors instead of the more modern powdered-iron slug. Too, the style of adjusting tool might vary. Most IF transformers require a screwdriver-type tool, some have hollow cores which take a hex-shaped tool. These items are readily available at radio supply sources.

Peaking The IF Strip. Assume the signal

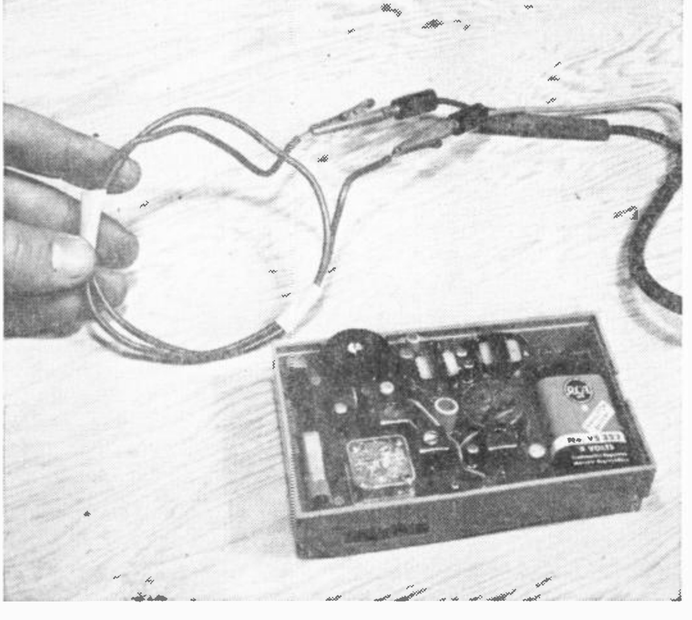


Fig. 6. Minuscule size and printed-circuit wiring of typical transistor set make signal injection difficult if not impossible. However, homemade wire loop connected to output of signal generator will ordinarily radiate sufficient signal to permit RF or IF alignment if placed near receiver.

generator and output meter are hooked up, with the modulated IF signal feeding the receiver. The volume control on the receiver is turned fully up, and local oscillator shorted. (If the local-oscillator capacitor is sealed or its connections difficult to locate, turn the radio's tuning dial to the highest frequency on the band. This is an alternative to shorting the oscillator. It will reduce, but not completely eliminate, the possibility of "birdies.")

Always adjust the final IF transformer—the one next to the detector—first. While watching the output meter, turn the transformer's slug or trimmer for highest indication on the needle. If there's no response on the meter, raise the signal level from the generator until a reading appears. The audio modulation control on the generator is set to about 30 percent and left at this level throughout alignment.

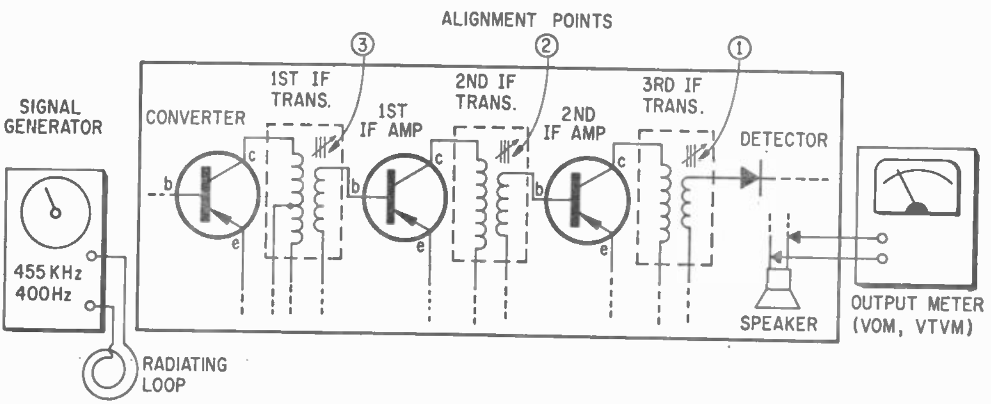
As soon as you peak the transformer (top and bottom, if it's double-tuned) reduce the generator RF signal. This is a rule during any alignment step: as soon as you obtain a signal increase on the meter, knock down the generator's signal strength until the needle returns to its lowest readable point. That way you'll avoid developing AVC as the receiver is pulled into alignment.

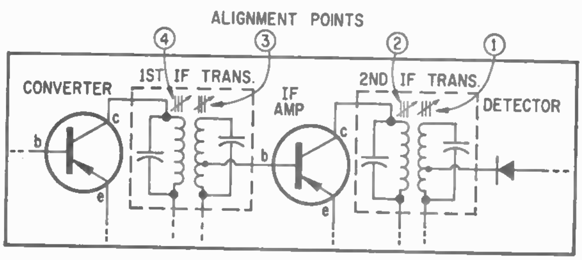
When you align a double-tuned transformer, you'll note some interaction between the top and bottom adjustments. This is cured by going back and forth between them until no further increase in output is evident.

Move on to the next IF transformer. As shown in our illustrations, the alignment sequence always begins with the last transformer and ends with the one nearest the receiver's converter stage. You can consider IF alignment complete when all adjustments—and weakest possible signal—produce no further peaking on the output meter.

Let's assume you cannot get a reading on the meter as you begin alignment, even with full signal generator output. This suggests that either the receiver is very badly out of alignment or some trouble exists in the IF strip. In this case, inject the signal at the grid of the last IF amplifier tube—or the base, if it's a transistor. If you still can't get an output reading, most likely there's a defective amplifier, transformer, or other component. This signal-injection technique can provide a stage-by-stage check for locating trouble.

Once the IF strip is behaving well and is resonating perfectly on the IF frequency, don't touch adjustments in this section for the remainder of the alignment process. It is possible, while aligning the receiver's front end, to return to the IF to build up a weak signal. But this is misleading; the radio might have good response at one end of the





Figs. 7 & 8. IF alignment of transistor portable (above) and car radio (right) are essentially the same, though IF transformers in portable may contain only one (as opposed to two) slugs. Numbers indicate preferred sequence, i.e., from detector stage, through IF amplifiers, to converter stage.

dial, but seriously drop off in sensitivity at another point if the IF strip is reworked.

Tracking Oscillator and Antenna. Next major step in alignment makes the local oscillator and antenna circuits tune over the correct range. Whether you're listening to a station at the low or high end of the band, the oscillator must always create a signal 455 kHz (or whatever the IF frequency happens to be) *above* an incoming station. Before starting, remove the short across the local oscillator, if one was used during IF alignment.

The front end of a typical AC/DC tube radio is shown in Fig. 9. Here you can find the large two-gang variable capacitor which controls the oscillator frequency and antenna tuning circuit. It is split into two sections—main RF tuning and main oscillator tuning, which are joined by a dotted line to indicate they move in unison on the same shaft. Mounted on each section are small trimmer capacitors which are adjusted during alignment: the oscillator trimmer and RF trimmer (Fig. 4). We can begin by adjusting the oscillator trimmer. It's usually the screw found next to the smaller group of main tuning plates.

A trimmer is almost always associated with tracking at the high end of the band. Thus the signal generator is adjusted to 1600 kHz (or to whatever frequency the

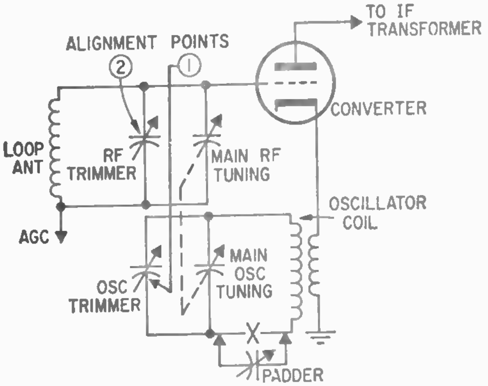


Fig. 9. Front-end alignment of tube-type receiver entails adjusting oscillator trimmer (point 1), then RF trimmer (point 2). Padder capacitor is also adjusted at this time.

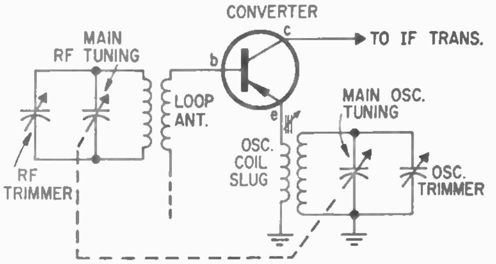


Fig. 10. Transistor set's front-end alignment is similar to that for tube-type set but slug in oscillator coil has replaced padder capacitor. See text for details.

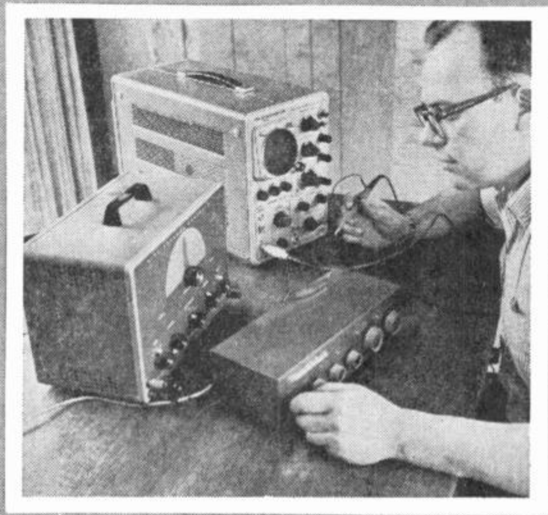
receiver maker recommends). A simple method for injecting the signal is via the radiating loop described earlier. The radio dial is also set to 1600 kHz or the point where the main tuning capacitor plates are fully open. Now the oscillator trimmer screw is adjusted until maximum signal indication is viewed on the output meter. Move your tuning tool to the RF trimmer and adjust it for peak reading. (If your receiver is a deluxe model and has an RF amplifier preceding the converter, adjust the RF trimmer located on the third group of main capacitor plates.)

In older receivers you may find an additional (small) variable capacitor known as a "padder," shown in Fig. 9. It usually appears when the main tuning capacitor has plate sections which are all the same size. To adjust the padder, tune both signal generator and receiver dial to 600 kHz, at the low end of the band. The next operation is a two-handed procedure known as "rocking." It's intended to secure the most efficient relationship between oscillator and antenna tuning. Grasp the receiver dial (which is set on 600 kHz) and slowly turn it back and forth over a small range. At the same time, adjust the oscillator padder. You should hit a combination of dial and padder setting that yields most output signal. Once you find it, you'll have to repeat trimmer adjustments at the high end of band, since they interact with the padding step. Go back and forth a few times until you cannot obtain further increases in output.

Transistor Front End. The low-cost tube radio usually has no tracking adjustment for the low end of the band. The transistor sets, both portable and table, however, often have this provision. If you check Fig. 10, you'll see that in addition to the regular RF and

(Continued on page 98)

SQUARE KEY TO HI-FI ILLS



■ Nothing lays bare an audio amplifier faster than a square wave. This lopped-off, stiff-sided test signal acts like it's got a built-in brain. Feed one into a hi-fi set and it'll come out reading "tilt" if the circuit isn't up to snuff. Tinker with a home-brew amplifier and square waves let you see what happens as you beef up bass or meddle with the treble. And as our pictures show, square waves can pinpoint a raft of symptoms that spell trouble in audio equipment.

Old Lang Sine. A conventional way to check out a hi-fi amplifier is using pure tone from an audio oscillator. Viewed on an oscilloscope, the signal appears like the one shown in Fig. 1; a simple sine wave. It's fine for signal tracing an amplifier that's suffered catastrophic failure—from a burned-out resistor or shorted capacitor, for example. But many troubles, like mushy sound, often won't show up. And examining an amplifier's frequency response is a tedious job with sine waves. Many tones must be fed in, then a graph plotted to reveal how the amplifier functions on each frequency. Even then many troubles fail to materialize.

Sine in the Square. But lash together a number of sine waves and the picture changes. It's possible to mix a brew of pure tones, each on a different frequency, and come up with a handy composite. That's the square wave. A single square wave may contain up to 30 different frequencies. Square waves are fat signals that ram within their shape a huge amount of frequency information. Let's see how they're born.

In Fig. 2(a) is shown the combining of two regular sine waves. One is the fundamental which we'll assume is a mid-range tone of 1,000 cps. Superimposed on it (dotted line) is a second tone exactly three times higher in frequency. It's the third harmonic on 3,000 cps. As the two sine waves mix, they cancel or reinforce each other at different points. For example, where both waves fall on the positive side of the base line, voltages add; but they buck each other when polarity is opposite. This produces the re-

TV REPAIR

SQUARE KEY

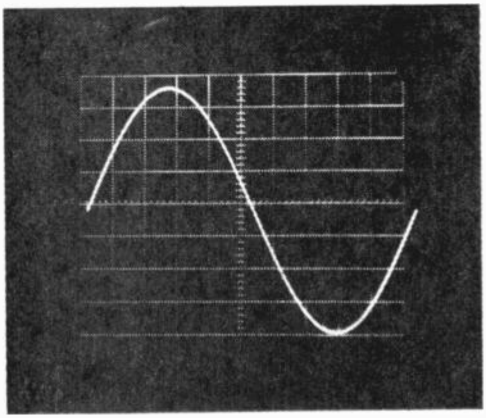


Fig. 1. A sine wave, as seen on the oscilloscope screen, represents a pure tone at a single frequency. Sine wave goes square by adding harmonics.

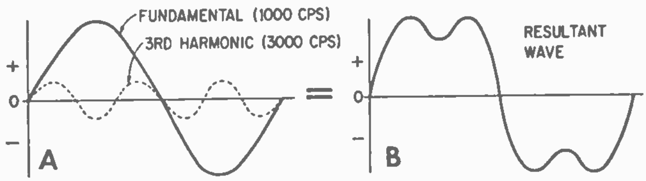
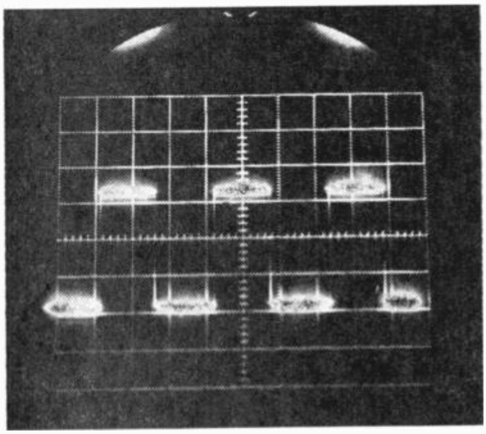


Fig. 2. In A at the left, two sine waves are combined. The resultant wave is shown in B. By adding more harmonic frequencies, squaring can be increased for desired shape.

Fig. 3. Square waves on the oscilloscope screen are at a frequency of about 1000 cycles per second. Look closely; these are square waves, although horizontal trace of the wave is brighter than the vertical part.



sultant shown in Fig. 2 (b); a double-humped wave that contains frequency information of *both* 1 and 3 kc, the original sine waves. That resultant, however, is not yet a square wave.

By piling on more sine waves, the resultant begins to acquire steeper sides and a flatter top. Soon it becomes a true square, like the actual scope photo in Fig. 3. This square wave contains harmonics as high as thirty times the fundamental (1000 cps). One requirement for producing square waves is that harmonics must be only odd-numbered ones; 1, 3, 5, 7, etc. Otherwise the shape will not be square, which is a convenient form for audio testing.

For the sake of comparison, we've shown a sine wave of 1000 cps in Fig. 4. If applied to a speaker it produces a flat, colorless tone since the wave is pure. An equivalent square wave (Fig. 3) sounds rich, almost musical. That's because it contains dozens of harmonics, or overtones.

Clipped or Triggered. The source of square waves is an audio oscillator. Although simple instruments produce only sine waves, many recent models, like Heathkit used here, include square-wave output. Principle in some models is simply to take a sine wave and severely clip its positive and negative peaks. The result is a square wave with desired harmonics. A slicker system in some audio oscillators is a trigger arrangement. Here a sine wave is used only to trip an electronic switch on and off. The result is a sharply angular square wave.

The Basic Test. If the square wave sounds like a complex signal, you're right. But that's also the reason it makes audio testing so easy. Since a square wave wraps so much information into one waveform, it applies a number of simultaneous tests to an amplifier. By observing on a scope how the amplifier treats the wave, you're given illustrated clues to what's wrong.

Another valuable feature of square-wave testing is that signals more closely resemble those of music. The smooth sine wave doesn't sock the amplifier, like a sudden cymbal crash or hefty drum beat. The steep-sided square wave does. Thus it yields information on how the amplifier treats transient, at random, signals.

Setting Up. The items needed for checking audio equipment with square waves are shown in Fig. 5. The signal source is the audio oscillator, at left, which feeds the in-

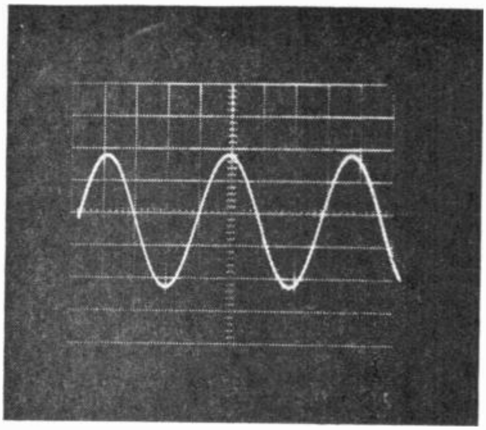
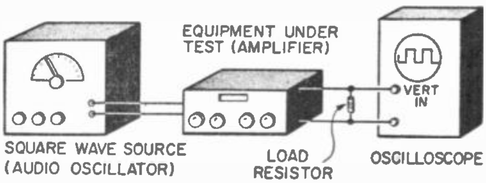


Fig. 4. Sine waves at 1000 cps are shown here for comparison with the square waves of the same frequency in Fig. 3. Note the sine waves are not just clipped.

Fig. 5. Pictorial of test setup for square wave testing shows load resistor connected in the circuit. Remember to set amplifier controls in "flat" position for test.



put of the amplifier under test. Instead of the usual speaker at the amplifier output, a load resistor is connected. (Its resistance can be, say, 8 ohms to agree with the amplifier output impedance. Power rating of the resistor should be sufficient to handle wattage output of the amplifier.) Using a load resistor eliminates false readings that might be introduced by voltages reflected back from a speaker voice coil.

To observe the waveform, an oscilloscope is connected across the load resistor. The scope need not be a lab type, but should be able to handle frequencies within the audio range, and somewhat higher. It's possible, when using high square wave frequencies, for some scopes to distort the wave shape. This should be checked by first feeding the wave from the audio oscillator directly into the scope. The scope or audio oscillator manual should provide required adjustments for initial squaring off of the wave, if necessary.

An actual test set-up is seen in Fig. 6. In Fig. 7 a load resistor is shown being connected across the output of the amplifier in place of a speaker. And in Fig. 8 a scope probe is being connected across the load resistor.

Fig. 6. Heathkit Model 1G-82 Sine-Square Generator and Tektronix 317 Oscilloscope being used to check output of CH-2133 Standard Transformer amplifier.

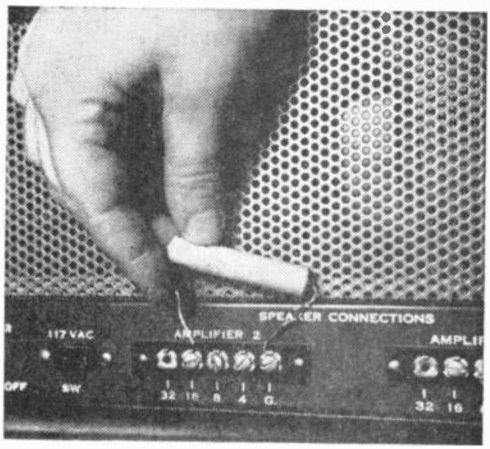


Fig. 7. A load resistor is placed across the output terminals of the amplifier and then the oscilloscope is connected. Leads go to vertical input terminals.

Feeding in Signals. There are some precautions to observe while testing with square waves. One is that amplifier tone controls must be set to their "flat" position. This is done by adjusting bass and treble controls, usually to their straight up position, as shown in Fig. 9. Otherwise the amplifier might seem to have poor bass response—for example, if the bass control happened to be turned down during the test.

Another factor is determining where to feed in the signal. Usually an "auxiliary" or "tuner" input is a good choice. If you apply the test signal to a phono input, you may see distortion on the scope. This is because phono inputs are equalized; that is, purposely designed with treble cut and bass boost to

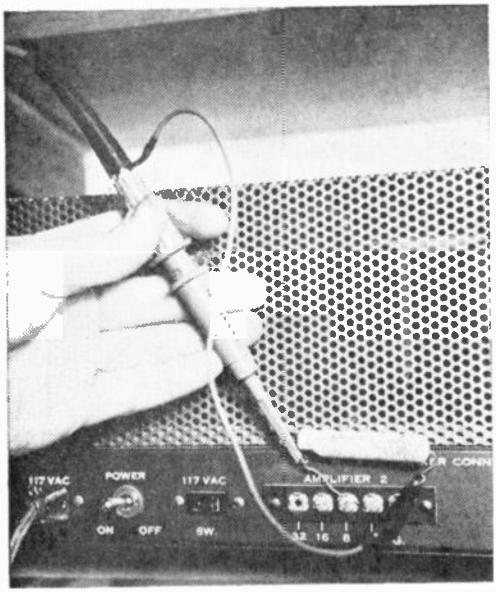


Fig. 8. Oscilloscope probe picks off signal from the speaker terminals of the amplifier. Ground lead from probe is connected to the "G" or ground terminal.

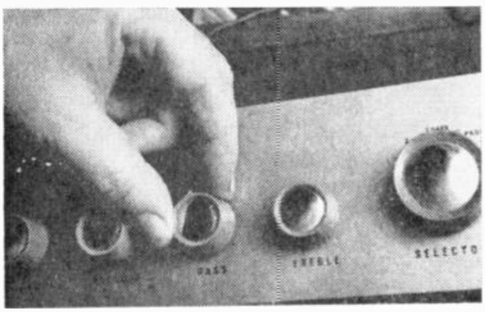


Fig. 9. Bass and treble amplifier controls are set to the "flat" position before testing. Rotating them during test shows effect of control on wave shape.

offset some frequency juggling introduced during the original disk recording. Phono and mike inputs should be avoided, too, since they provide extremely high amplification and may overload the amplifier. This matter of overload should be considered during any square wave tests. While feeding in test signals, be aware that an overloaded amplifier can also produce square waves due to signal clipping. They may resemble the square-wave signal from the audio oscillator. The problem, however, is usually simple to detect. If the scope picture in Fig. 10 is examined, you'll note that the wave is flat on top

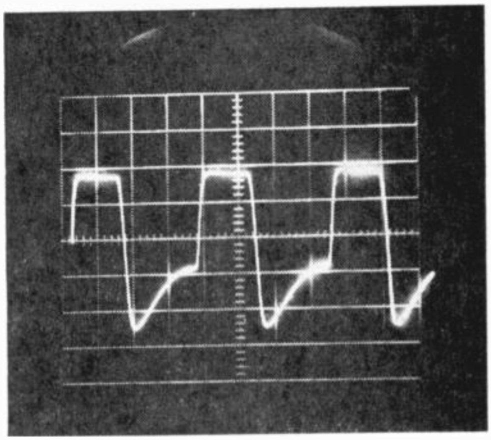


Fig. 10. A lack of symmetry between top and bottom of the square wave indicates possibility of excessive signal input. Reduce gain of audio oscillator.

and spiked at the bottom. Whenever the square wave does not appear symmetrical on top and bottom, as in Fig. 10, it probably means you're feeding excessive signal to the amplifier. Reduce output from the audio oscillator and the wave should equalize between top and bottom.

Test. Frequencies. Just two, possibly three, square wave frequencies can check the complete frequency response of the amplifier. This is because a single square wave frequency contains useful harmonics ranging up to some ten times the fundamental frequency. (We mentioned 30 times earlier, but anything much over ten times is too weak to be of value.) Thus the first test frequency can be at the lower limit of the amplifier's rated frequency response. Let's assume it is 50 cycles. This value is dialed on the audio oscillator. The 50-cycle fundamental square wave will check the amplifier from 50 to 500 cycles. Dial up 500 cycles and the amplifier is put through its paces on the 500 to 5,000-cycle portion of the audio spectrum. And a 5,000-cycle square wave extends the test beyond the level of audibility. Most high quality amplifiers, in fact, are designed for good performance beyond the range of human hearing and this can be observed during the tests. Now let's interpret the waveforms.

Low-Frequency Response. We'll assume that the audio oscillator is feeding the amplifier with a square wave and the result observed on the scope screen. First major waveform is shown in Fig. 11. It reveals poor low frequency response. This is seen by the slope of the wave across top and bottom. Note that low frequency refers to the

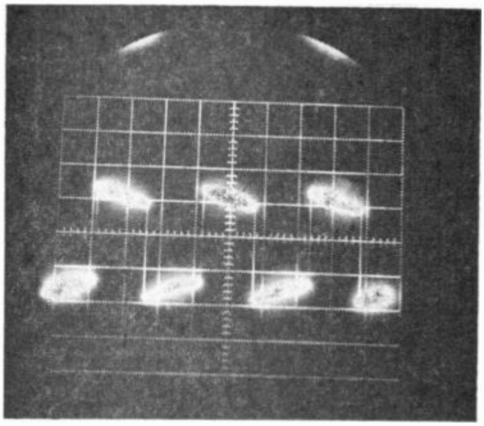


Fig. 11. Slope of square waves across top and bottom, as shown here, indicates amplifier under test has poor low frequency response. Text gives possible causes.

lowest square wave frequency being fed to the amplifier. This is the fundamental; the frequency dialed on the oscillator. If that frequency is, say, 500 cycles, nothing below that value will be seen. Thus if you wish to check low-frequency response of a hi-fi amplifier, use a very low square wave frequency, like 20 cps.

Some causes of poor low frequency response are coupling capacitors of inadequate capacity, defective bypass capacitors, or skimpy output transformer.

High-Frequency Response. The scope photo in Fig. 12 indicates an amplifier that's

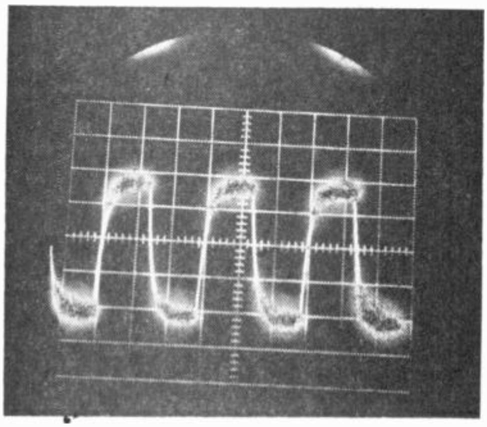


Fig. 12. This is how poor high frequency response will affect the shape of the square waves. Leading edges are softened at top and bottom parts of the waves.

losing its high tones. Note how the wave curves near top and bottom. This softening of the normally square shape indicates loss of higher harmonics from the square wave.

High and Low. The square wave in Fig. 13 shows not only an amplifier in sad shape, but points up the versatility of square-wave testing. That trace reveals that frequency response is sagging badly at both high and low ends. Note the rounding at top and bottom.

Overshoot. A small spike forming on the leading edge of the wave, like the one in Fig. 14, denotes *overshoot* in the amplifier. It

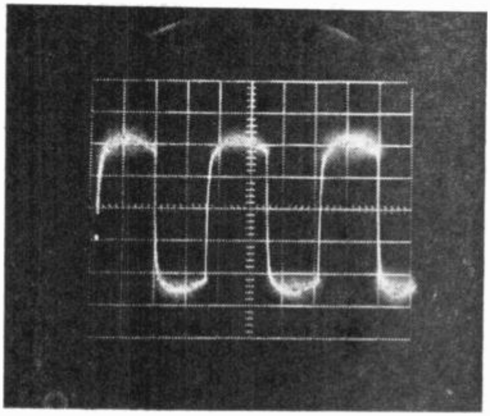


Fig. 13. An amplifier with poor high and low frequency response will pass a square wave rounded on the leading and trailing edges; compare with Figs. 11, 12.

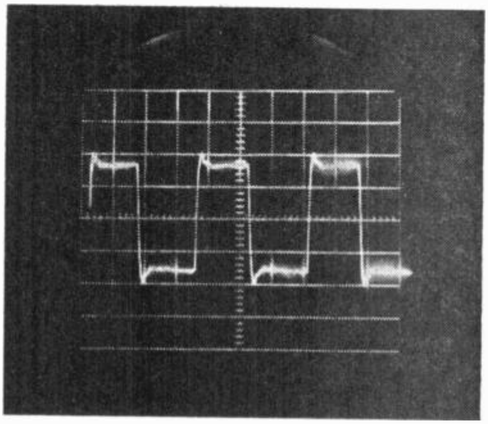


Fig. 14. Small spike visible on the leading edge of the square waves indicates overshoot or excessive high frequency response that fuzzes transient passages.

means the amplifier is overreacting to the sharp rise of the square wave. In practical terms, an amplifier with overshoot tends to fuzz musical passages of a transient nature; those which occur with fast attack. This problem, actually due to excessive high frequency response, is related to the next waveform.

Ringing. A close look at Fig. 15 reveals a small ripple along the top and bottom of the square wave. This means ringing, a condition where the amplifier is temporarily shocked into an oscillation. Both ringing and

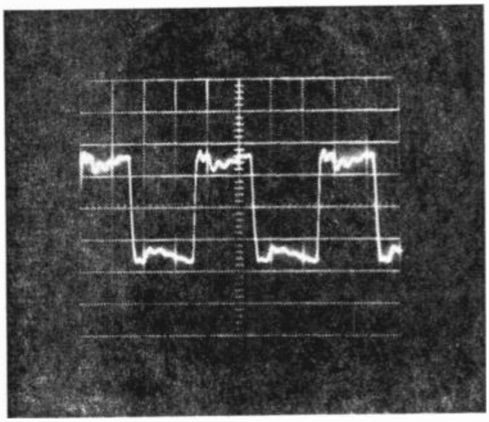
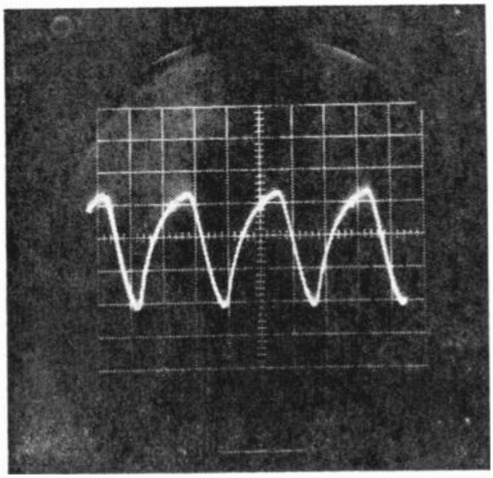


Fig. 15. A ringing condition is indicated by ripples across top of square wave. Ringing occurs when amplifier is shocked into oscillation by a sharp transient.

Fig. 16. Almost-sawtooth wave form, representing extreme bass response, is obtained when the bass control is cranked up full and treble is backed all the way off.



overshoot rob sound of clarity, especially during transients.

Some possible causes in both cases are poor isolation between amplifier circuits (causing undesirable feedback, possibly through adjacent wires) or lack of shielding between circuits.

The waveform in Fig. 16 was obtained by turning the bass control fully up, and treble down. Thus the wave reveals extreme bass response. A trouble that could cause this is

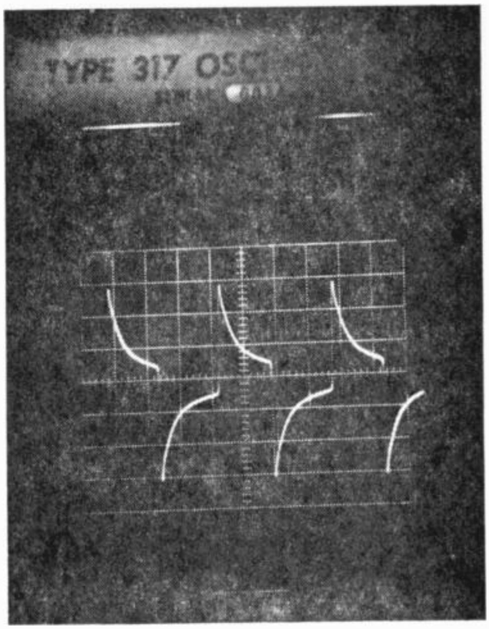
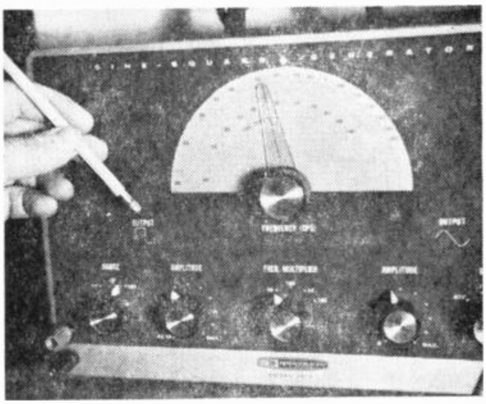


Fig. 17. An amplifier with extreme treble response passes square waves with sharply attenuated trailing edges; trace cuts diagonal across square waves.

On the Heathkit 1G-82 Sine-Square Generator front panel controls are marked with output wave form. Pencil points to square wave; sine wave is on right.



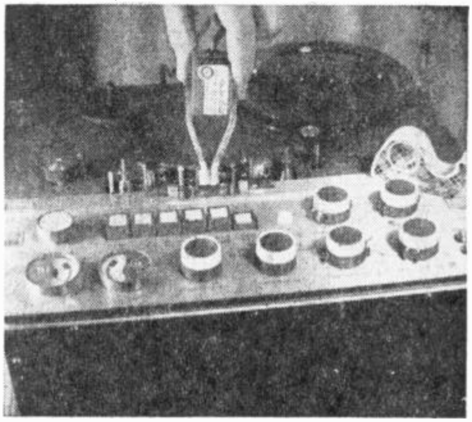
lack of negative feedback. Fig. 17 reverses the condition, and shows an extreme high-frequency condition.

Whether you're working with hi-fi, PA or any other kind of audio equipment, square waves can speed the job. The ability to put an amplifier through several tests simultaneously makes the square wave a natural for troubleshooting, signal tracing or circuit designing and adjustment. Just watch the scope trace; when it's square—you're there! ■

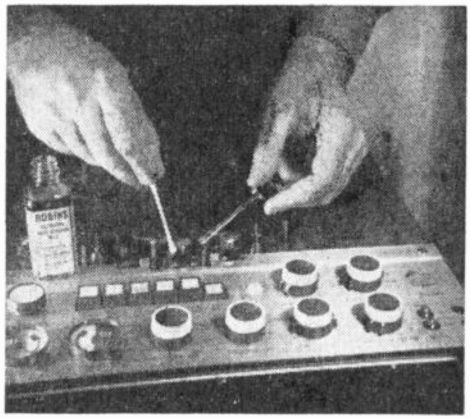
a primer on TAPE RECORDER REPAIR

What you should know about keeping your tape recorder in prime working condition

By Art Zuckerman



1 Use a demagnetizer such as this one from Audio Devices to remove unwanted residual magnetism from tape heads. Tape on pole pieces saves heads.



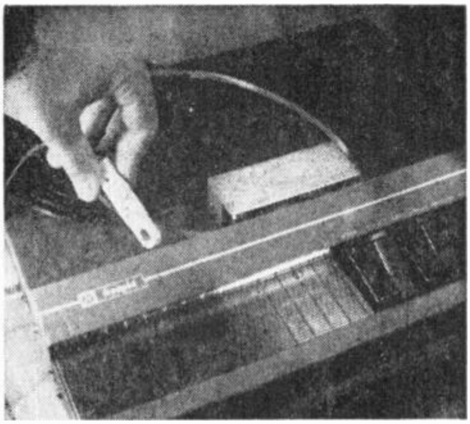
4 Clean heads periodically with commercial solvent such as Robins Industries head cleaner. Use soft cotton swab dampened with liquid. Do not drench.

WHEN it starts to get balky, all your pleasure in your recorder can quickly go straight down the drain—unless you can set things right.

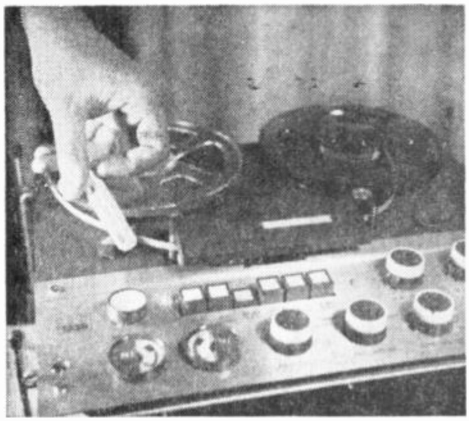
Like any other mechanical device, a tape machine will treat you only about as well as you treat it. So, just as you give your car periodic checkups and indulge it with preventive maintenance, you should give your recorder a good, regular once-over and catch minor problems before they become major ones.

Fortunately, some of the most annoying things likely to plague your unit are also the most easily fixed. Often, no more than a thorough cleaning job is required. As for a number of the more demanding problems, you can often correct them yourself, too, with just a little care and patience.

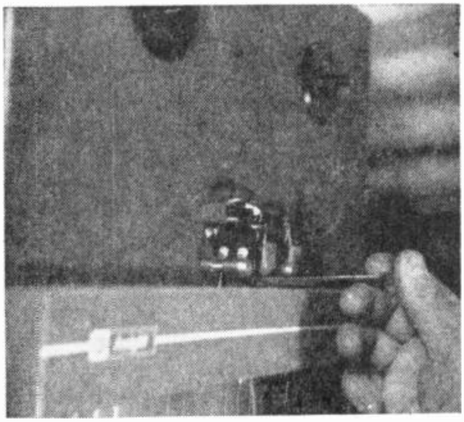
One of the commonest is too much tape hiss and background noise. This can generally be traced to a record head—sometimes a playback head, too—that has become permanently magnetized. A tape head, of course, is an electromagnet that should be pristine pure except when a signal is going through it. Residual magnetism is often left, however, when a particularly heavy surge of signal current is generated, especially if the machine is abruptly switched out of record mode before the signal subsides. Carelessly bringing magnetized tools near the heads can also do the damage.



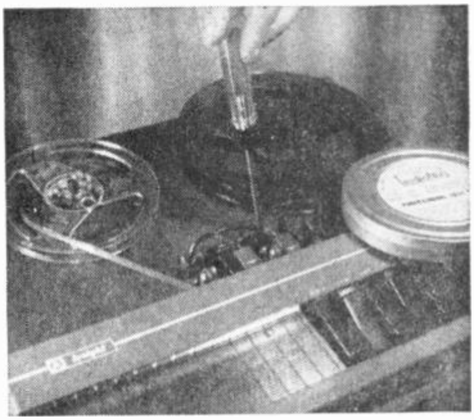
2 Stroboscope tape from Robins Industries appears to stand still when viewed under neon lamp provided speed is accurate. Speed changes also show.



3 For more stringent test, splice sections of the strobe tape into beginning, middle and end of a reel, so you can test speed under full-load conditions.



5 Use nail file with caution and you can fluff up a tired pressure pad. This treatment also takes oxide coat off pad surface. Do not scratch the heads.



6 Align playback head by using Audiotex alignment tape. Carefully rotate adjusting screw until level reaches peak. Use non-magnetic driver.

Such permanent magnetism impresses itself on the passing tape and is thenceforth inscribed as noise—and/or hiss. If head magnetization continues to build up, it can even erase the high frequencies from your tapes during playback!

The best way to fight this problem is to prevent it. If you must stop the tape just as a strong signal is being recorded, use the pause control and wait until the signal level drops appreciably before going into full "stop" mode. If you have no pause control, turn down the record level before going to stop. But if the damage has already been done, the services of a demagnetizer are in order.

Recorders are also subject to a pair of ills named wow and flutter. These are speed variations. Wow is a low-frequency speed shift that stretches sound out like taffy, and flutter is a rapid fluctuation that can put vibrato where it hadn't ought to be. There are times when you think you've got a case of these pests but aren't certain. Your doubts can be resolved with the aid of a handy little *Robins* strobe kit.

Wow is often caused by slippage, which can frequently be traced to a buildup of tape oxide and lubricant on the capstan assembly. This is the finely-machined post that revolves to pull the tape past the heads at exact speed, plus the rubber idler wheel that presses the tape to it.

Dirt buildup, this time on the heads and

TV REPAIR

RECORDER REPAIR

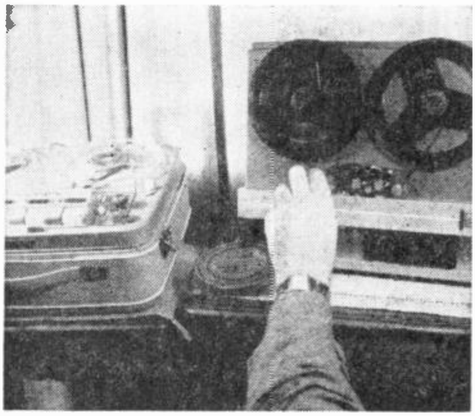
pressure pads, often produces friction that creates flutter.

A simple cleaning operation is the solution to either problem. For the purpose, Robins makes a special tape-head cleaning fluid that comes in an applicator-type bottle. On some machines, pure alcohol may serve, if the manufacturer's instructions so indicate.

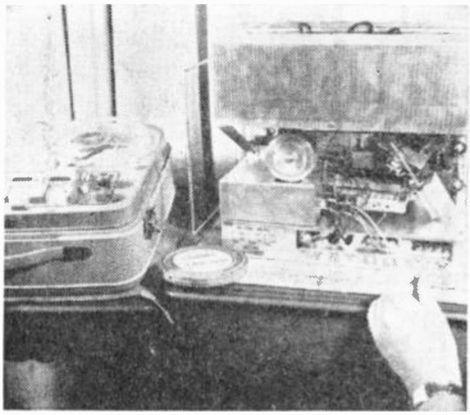
Cleansed parts should be allowed to dry before running tape through the machine.

Another cause of high-frequency loss is head misalignment. It is usually noticeable immediately on three-head machines but may only show up on two-head recorders when you play an old tape or one recorded on another unit. For proper recording and playback, the head gaps must be positioned precisely at right angles to the tape edge.

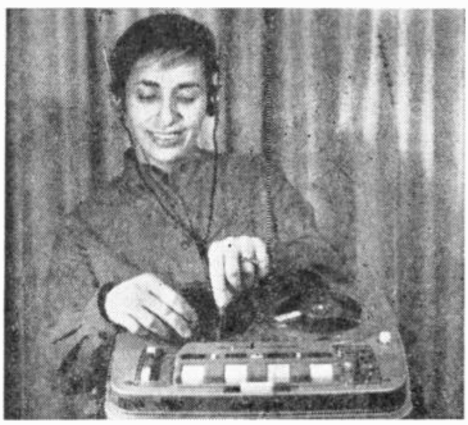
Alignment can readily be corrected on most recorders by a simple screw adjustment. The trick is to figure out how much to turn that screw. *Audio Devices* and *Audiotex* both offer alignment tapes for this purpose Recorded on a precisely-adjusted machine, they consist of a series of steady tone signals. All you do is adjust the playback head gingerly until the tone



7 While recording the alignment tape from another machine, adjust head for maximum while monitoring. Can be done with S.O.S.



8 Adjust recording bias by recording alignment tape as it is played from a second machine. Again for maximum volume level during monitor.



11 If unit fails to record, bridge terminals of record head with a pair of earphones to isolate the trouble. You should hear the program material.

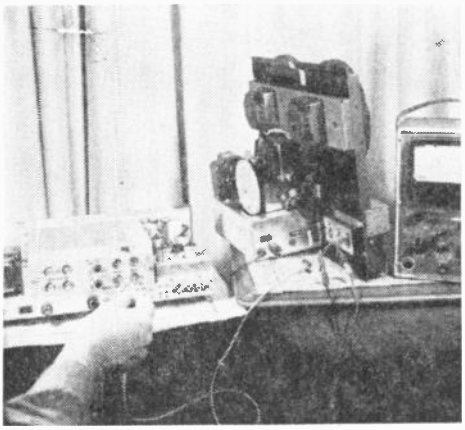
12 You can by-pass tape recorder's preamplifier and clip-lead connect directly to the phono input of your amplifier to check out tape preamp.

is at its loudest. Then you're on the nose. If you can get hold of a good volt-ohm-meter (VTVM), you can make this job easier by plugging it into the recorder's output and watching for maximum needle deflection.

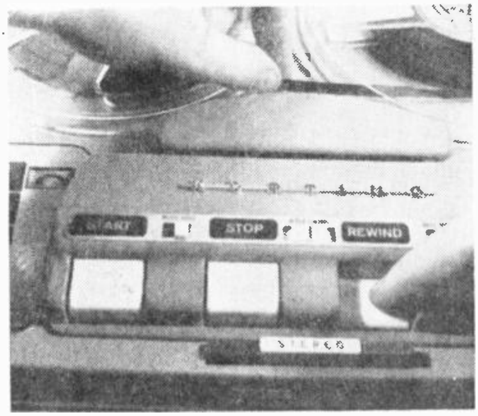
Suppose all your recently-made tapes sound badly distorted, but your erase head is working properly. Chances are that your bias oscillator, which provides current to the record head, is out of adjustment. As long as you can reach the bias-adjust trimming screw, you can rectify this situation. Incidentally, on stereo recorders there is an adjustment screw for each channel.

The setup is pretty much the same as for aligning heads. Using a borrowed machine as source, you should copy the continuous tone from an alignment tape. As you make the copy on a three-headed machine, you simply monitor the tape and very slowly turn the bias-adjust screw until the tone is at peak loudness. Once again, a VTVM attached to the recorder's output gives a much more reliable indication than your ears. But for this purpose, it must be able to read down to 0.01 volt or less.

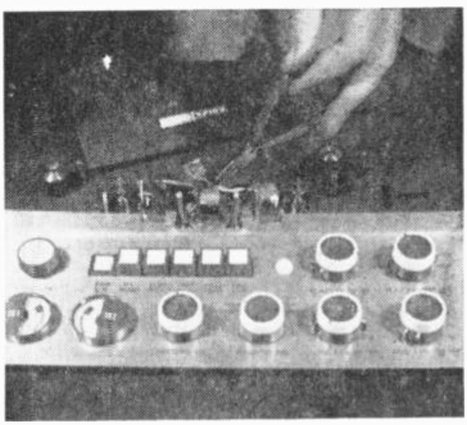
If you take the time to perform routine preventive maintenance on your tape recorder, you will have little trouble with it. Catch those little things before they require the aid of a professional (and expensive) serviceman. ■



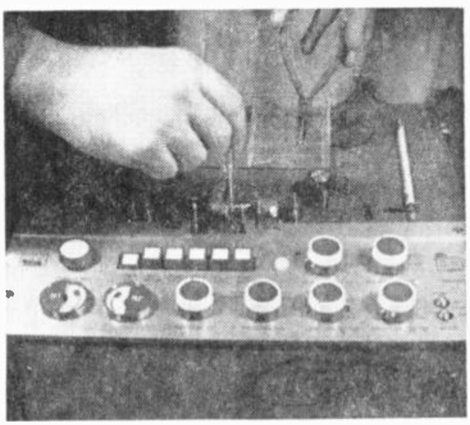
9 If you have a VTVM, you can connect a 100 ohm resistor in the ground leg and measure the voltage drop between the head and record amplifier.



10 Unless you have tape lifters, by-pass the slot during rapid wind and rewind to save wear and tear on your head surfaces. Trip end-of-tape lever.



13 If it becomes necessary to disconnect head leads, label leads with small strip of cellophane tape and numbers or letters to identify.



14 Fastener assemblies, those complex little parts and screws often become lost during service work. Place small parts in plastic boxes to save.

FOREIGN TUBE REPLACEMENT GUIDE

■ How many times have you been faced with the problem of replacing an obviously defective QA2408 vacuum tube in a European "von Schlock Super XB8" receiver not knowing that an ordinary 6SN7GTB will do the job? Don't fret! You will not be the last service technician or "do-it-yourselfer" who held up a simple repair job while waiting for a mail order package to arrive, when the exact or near exact replacement vacuum tube was in your tube caddy or resting in another receiver that was not in use. The interchangeability replacement guide for foreign tubes is given below to take care of such problems. The replacement types listed will give satisfactory performance in almost every case when used in home entertainment equipment. However, due to very unusual circuit design or a critical application, some replacement tubes may not give proper or usable operation.

In some very rare cases, damage to the circuit may occur. To avoid this, observe

(Continued on page 97)

Foreign	Replacement	Foreign	Replacement	Foreign	Replacement	Foreign	Replacement
B36	12SN7GTA	ECC32	6SN7GTB*	HABC80	19T8	QS1208	0B2
B65	6SN7GTB	ECC33	6SN7GTB*	HBC90	12AT6	QV03/12	5763
B152	12AT7	ECC35	6SL7GT*	HBC91	12AV6	QV06/20	6146,6146A
B309	12AT7	ECC81	12AT7	HCC85	17EW8	R19	1X2B
B329	12AU7	ECC82	12AU7	HD51	0A2	RE1	5Y3GT
B339	12AX7,7025	ECC83	12AX7,7025	HD52	0B2	S856	0A2
B719	6AQ8	ECC85	6AQ8	HF93	12BA6	S860	0B2
BPM04	6AQ5A	ECC86	6GM8	HF94	12AU6	T2M05	6J6A
D2M9	6AL5	ECC88	6DJ8	HK90	12BE6	U41	1B3-GT
D63	6H6	ECC91	6J6A	HL92	50C5	U50	5Y3GT
D77	6AL5	ECC180	6BQ7A	HM04	6BE6	U52	5U4GB
D152	6AL5	ECC189	6ES8	HY90	35W4	U70	6X5GT
DAF91	1S5	ECC801S	6201	KD21	0A3	U78	6X4
DAF92	1U5	ECC900	6HA5,6HM5	KD24	0C3	U147	6X5GT
DD6	6AL5	ECF80	6BL8	KD25	0D3	U149	7Y4
DF62	1AD4	ECF82	6U8	KT32	25L6GT	U709	6CA4
DF91	1T4	ECF86	6HG8	KT63	6F6GT	UL84	45B5
DF92	1L4	ECL82	6BM8	KT66	6L6GC	UU12	6CA4
DF904	1U4	ECL84	6DX8	KT71	50L6GT	V2M70	6X4
DH77	6AT6	ECL86	6GW8	KT88	6550	W17	1T4
DH149	7C6	ED2	6AL5	KTZ63	6J7	W63	6K7
DH719	6T8A	EF22	7B7*	L63	6J5	W76	12K7GT
DK32	1A7GT	EF36	6J7*	L77	6C4	W143	7B7*
DK91	1R5	EF37A	1620*	M8079	5726	W147	6K7*
DL33	3Q5GT	EF39	6K7*	M8080	6100	W149	7B7
DL91	1S4	EF72	5840	M8081	6J6	W727	6BA6
DL92	3S4	EF93	6BA6	M8100	5654	WT294	0D3
DL94	3V4	EF94	6AU6A	M8136	6189	X14	1A7GT
DL95	3Q4	EF95	6AK5	M8162	6201	X17	1R5
DP61	6AK5	EF96	6AG5	M8196	5725	X63	6A8
DY30	1B3GT	EF183	6EH7	M8204	5727	X65	6K8
DY80	1X2A/B	EF184	6EJ7	M8212	5726	X66	6K8
DY86	1S2A,1H2	EF731	5899	N15	3Q5GT	X77	6BE6
DY87	1S2A,1H2	EF732	5840	N16	3Q5GT	X727	6BE6
E81CC	6201	EH90	6CS6	N17	3S4	XC97	2FY5
E88CC	6922	EH900S	5915A	N18	3Q4	XCC82	7AU7
E90F	6661	EK90	6BE6	N19	3V4	XCC189	4ES8
E91AA	5726	EL34	6CA7	N709	6BQ5	XCF80	4BL8
E91H	5915A	EL35	6Y6GT*	N727	6AQ5	XF183	3EH7
E91N	5727	EL37	6L6GC	OBC3	12SQ7	XF184	3EJ7
E95F	5654	EL84	6BQ5	OM6	6K7*	XFR1	1AD4
E99F	6662	EL86	6CW5	PCF80	9A8	XL84	8BQ5
E180F	6688*	EL90	6AQ5A	PCF82	9U8A	XY88	16AQ3
E182CC	7044*	EL180	12BY7A,12BV7	PCF86	7HG8	YF183	4EH7
EAA91	6AL5	EM81	6DA5	PCL82	16A8	YF184	4EJ7
EAA901S	5726	EM84	6FG6	PCL84	15DQ8	Z63	6J7
EABC80	6T8A	EN91	2D21,5727	PF9	6K7	Z300T	0A4G
EB34	6H6	EN92	5696A	PH4	6A8	Z900T	5823
EB91	6AL5*	EN93	6D4	PL21	2D21,5727	ZD17	1S5
EBC90	6AT6	EY81	6AF3*	PL84	15CW5	1C1	1R5
EBC91	6AV6	EY88	6AL3	PL500	27GB5	1F3	1T4
EBF32	6B8*	EZ35	6X5GT	PM04	6BA6	1FD9	1S5
EBF89	6DC8	EZ80	6V4	PM05	6AK5	1P10	3S4
EC71	5718	EZ81	6CA4	QA2404	5726	1P11	3V4
EC90	6C4	EZ90	6X4	QA2406	6201	6D2	6AL5
EC92	6AB4	GZ32	5AR4	QA2407	6202	6L12	6AQ8
EC93	6AF4	GZ34	5AR4	QA2408	6SN7GTB	6L13	12AX7A,7025
EC94	6AF4	H52	5U4GB	QE06/50	807	6P15	6BQ5
EC95	6ER5	H63	6F5	QQV03/10	6360	6V4	6CA4
EC97	6FY5	HAA91	12AL5	QS1207	0A2	52KU	5V4GA

The TV Set's Controls

Operating, non-operating, and out-of-sight controls—what they are and how they work

By Joseph R. Griffin,
National Radio Institute

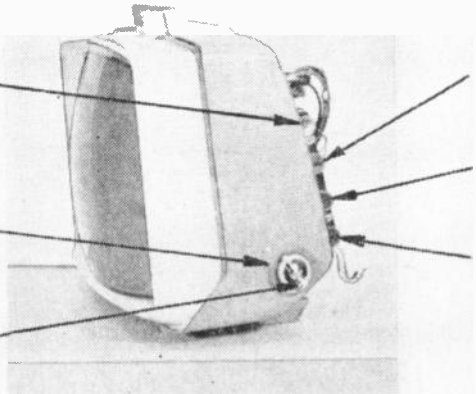


Fig. 1. These are the common controls found on the average TV receiver for normal adjustments.

TO MOST people a television receiver is a source of entertainment. Most everyone derives a great deal of pleasure from viewing a picture on a properly operating set. On the other hand, the user might consider a TV set on which the picture or sound is lacking in quality, a source of annoyance and frustration rather than entertainment.

Poor set performance is sometimes caused by defective components such as tubes, resistors or capacitors. In such cases the remedy is to call the TV serviceman. But in many instances poor reception is the result of incorrect adjustment rather than a defect in your TV set.

You already know that there are many controls you must properly adjust. There are also many hidden or rear controls. These "out of sight" controls are used to make adjustments to the various sections of your set to keep it in satisfactory operating condition. If you know what these service controls are supposed to do, you can correctly adjust them for the best possible picture and sound. By doing this you can often save yourself the expense of a service call, and eliminate unnecessary sub-standard reception.

Grouping of Controls. For convenience in discussing TV controls, we will group them according to their purpose. The first group will include those controls normally operated by the user. We will refer to these as operating controls. The second group, which we will call non-operating controls, includes those which usually require adjustment by a serviceman.

Operating Controls. Operating controls are those which are adjusted by the user in the normal operation of the set. These controls are located on the front, top or side of the set, and are readily accessible to the user. This group is generally made up of the on-off volume control, channel selector, fine tuning and contrast control. Sometimes the brightness, focus, vertical and horizontal hold controls will be included in this group.

Non-Operating Controls. Non-operating controls normally are not to be changed by

TV SET'S CONTROLS

the user after initial adjustment by the serviceman who installed the set. However, as tubes and component values change with age, these adjustments will require touching up from time to time. In this group we have the following: ion trap, deflection yoke, horizontal frequency control, sync stability control, width or horizontal size control, height or vertical size control, horizontal and vertical positioning and linearity controls, and automatic gain control (AGC).

Table I lists the controls that may be found on TV receivers. This chart includes controls that are used on all sets plus some that are found on only a few TV sets. It is doubtful that you will find all of the controls listed in the chart on any one TV receiver. Manufacturers have their own ideas as to where controls should be located, therefore a variety of arrangements for the location of controls are found on the many different model sets in use today. Fig. 1 shows typical arrangements for the location of controls on TV receivers.

Safety Measures. The high voltages required to operate the various parts of a television receiver present an extremely dangerous shock hazard. To protect the user from dangerous shocks, most TV sets have an interlock switch or special line cord attached to the back cover. When the back cover is removed, the interlock switch opens or the line cord is disconnected, opening the power supply circuit. A caution label containing this information is affixed to the back cover of most TV sets.

To gain access to such controls as the ion trap magnet, deflection yoke, and on many TV sets, the positioning and focus controls, you must remove the back cover. This means that you will either have to detach the line cord from the back cover, or use a separate line cord (cheater cord) to connect the set to the power outlet. On sets using an interlock switch, you will also have to secure the switch in the closed position, possibly with masking or friction tape.

In making adjustments you will be working in close quarters, relatively near parts having high voltage. The following precautions should be observed when making adjustments inside the cabinet while the set is operating. (1) Do not adjust the controls inside your set while standing on a concrete floor. (2) Make sure that there are no metal objects or wiring nearby through which you might make accidental contact to a good electrical ground. (3) Always keep one of your hands in your pocket when making your adjustments. This will prevent you from making a contact that could produce an unpleasant or dangerous shock. (4) Avoid contact with all parts having high voltage; especially the picture tube anode, or, in the case of a metal picture tube, any part of the metal shell of the tube. (5) In general, stay way from all tubes to avoid burns. A burn caused by a hot tube, or an electrical shock can result in cuts or bruises from striking other parts as your hand is withdrawn from the source of danger. (6) Use only moderate pressure to adjust any of the controls on the neck of the picture tube. Undue pressure or a jar can break the glass envelope causing the picture tube to explode.

If you follow these safety rules and use sound and careful judgment, you can safely

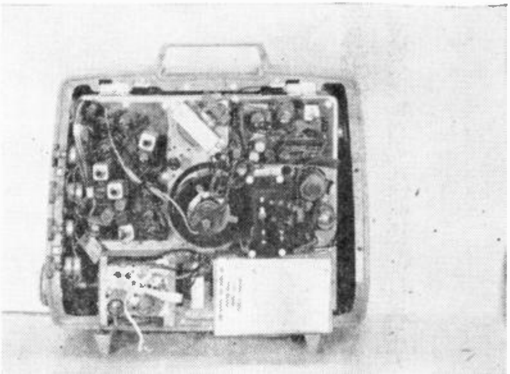


Fig. 2. With the back cover removed from the set, we can achieve access to some of the less frequently used but very important controls.

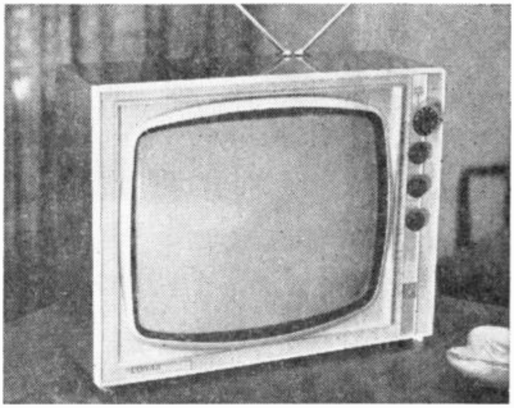


Fig. 3. Most of the often needed controls are on the front or side of television receivers; the others are on the back chassis of the set.

and correctly adjust your television set.

Test Patterns. Many TV stations transmit a test pattern for short periods before and after their regularly scheduled programs. Test patterns are a valuable servicing aid in making rapid checks of the performance and adjustment of a TV receiver. If no test pattern is available at the time you adjust your set, you can use the actual picture to check the adjustment of the various controls.

Normal Test Pattern. A mirror placed in front of the set will enable you to observe the picture on the screen while you make adjustments from the rear of the set. Fig. 3 shows the appearance of a typical test pattern with all controls properly adjusted, displayed on the CONAR CUSTOM 70 television receiver, sold in kit form by the Conar Division of National Radio Institute, Washington 16, D. C. Whenever the controls on any TV receiver are correctly adjusted, the test pattern should have the same general appearance as shown in Fig. 3. The concentric circles should be perfectly round and graduated in tones from the black dot in the center of the pattern to the white area surrounding the largest of the group of small circles. The outermost white circle should be flattened at the top and bottom to give the picture the standard 4:3 ratio of width to height.

Analyzing The Test Pattern. The elements of the test pattern are labeled in Fig. 3 and should conform to the following specifications: the light circle should appear just inside the edges of the mask when the horizontal and vertical size controls and the centering controls are properly adjusted. The dark circle and the edge of the black disc are perfectly round when the horizontal and vertical linearity controls are properly adjusted. Wedges are vertical and wedges are horizontal when the deflection yoke is properly positioned. The lines in the

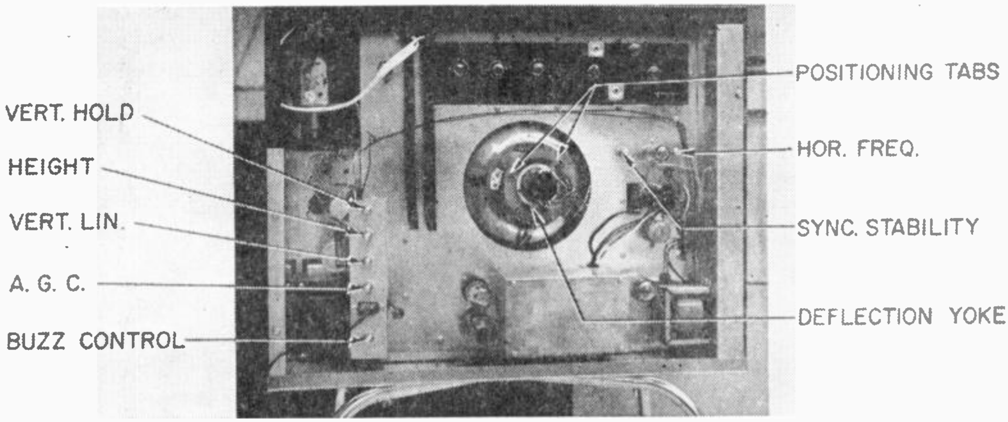


Fig. 4. These are the seldom-used controls. Each has its effect on the set's overall performance.

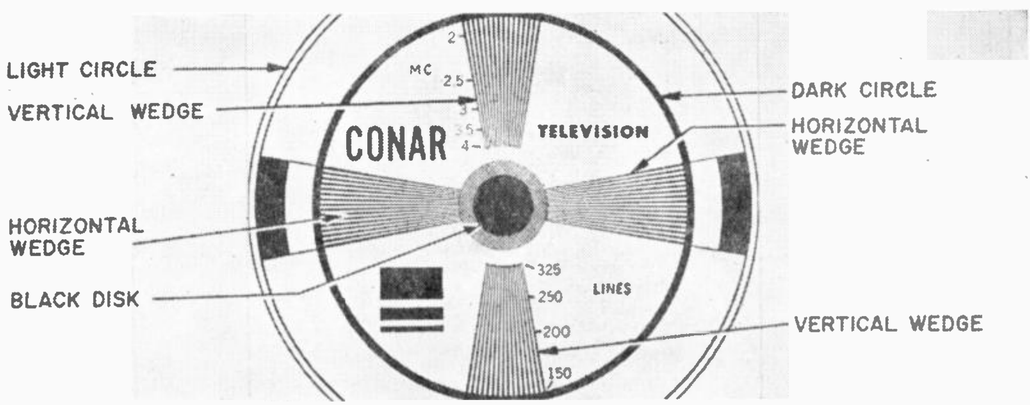


Fig. 5. The make-up of the familiar test pattern was designed to be an aid in diagnosing problems.

TV REPAIR — TV SET'S CONTROLS

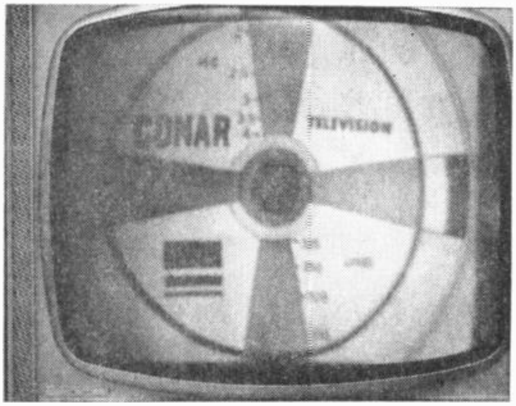


Fig. 6. This set with a misadjusted ion-trap shows a dark area on left side of the screen.

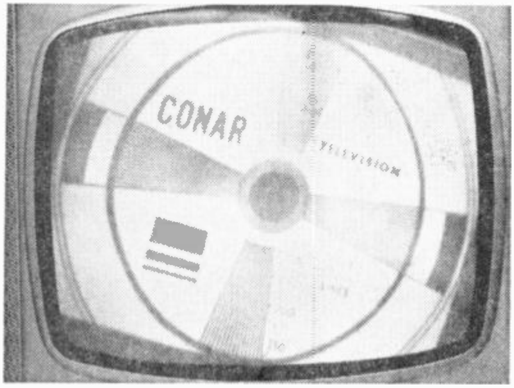


Fig. 7. With the deflection yoke set awry, you get a cockeyed picture. Just straighten yoke.

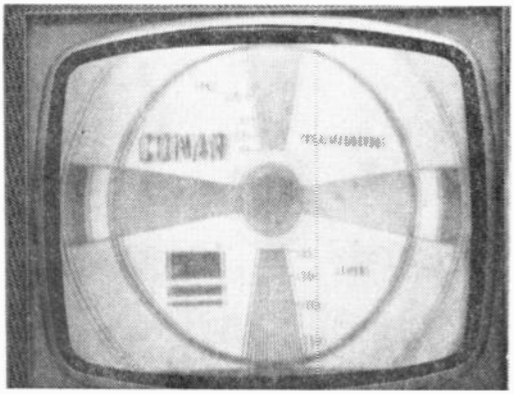


Fig. 8. Improperly adjusted focus control causes picture to smear, distort, and lose contrast.

wedges are sharp and distinct when the focus control and ion trap magnet are properly adjusted. The concentric circles are of different shades from light gray to black, when the brightness, contrast, and AGC controls are properly adjusted.

Adjustments. TV controls may conveniently be divided into four groups. The first group includes those controls which affect the operating conditions of the picture tube. The second group includes those controls which are adjusted to lock in step, or synchronize, the picture with the transmitted signal. The third category includes controls which adjust the size and positioning of the picture. The controls which are used to adjust the shape of the picture make up the fourth group.

We will now take up the adjustments of controls in each of the four groups. As we discuss specific controls, we will show how the picture will be affected by improper adjustment of that particular control.

Picture Tube Operating Conditions. The name ion trap magnet is a misnomer. It should actually be called an electron beam bending magnet.

In a picture tube electrons emitted by the cathode are focused by the electron gun assembly into a beam which is directed toward the phosphor coated screen of the tube. This electron beam also contains charged particles some 2000 times heavier than electrons, called ions. If these massive particles are permitted to strike the screen, they will destroy the phosphor coating wherever they strike, causing a brown spot to appear where no picture information can be produced.

In earlier picture tubes, several methods were devised to prevent ions from striking the phosphor coated screen. Two of these make use of the fact that ions are not appreciably deflected by magnetism. In one type picture tube the entire beam made up of both ions and electrons is deflected electrostatically within the gun assembly. The other type uses a bent electron gun assembly which directs the beam toward an anode located on one side of the tube. In the absence of the magnetic field which the ion trap magnet supplies, both ions and electrons are deflected to the anode, and the screen of the tube cannot be lighted because no electrons reach it. The ion trap magnet serves the same purpose in both type tubes; to deflect the electron beam, minus ions, toward the center of the screen. Fig. 6 shows the effects on the picture of an incorrectly adjusted ion trap magnet. Note the darkened area on the left side of the screen, and the lack of definition. Also note that the picture is positioned too far to the left of the screen.

To adjust the ion trap magnet, move it back and forth along the neck of the picture tube, rotating it slightly at the same time, until you obtain maximum brightness on the face of the picture tube. Next adjust the focus and positioning controls and readjust the ion trap magnet. You may have to adjust the ion trap magnet so that the brightness is decreased slightly in order to improve the focus.

Many modern TV sets do not use an ion trap magnet. The phosphorous coating on the face of the picture tube is backed with a thin layer of aluminum. Electrons readily pass through this aluminum layer to strike the phosphor coated screen, but the heavier ions are blocked by the aluminum layer. The aluminum layer also reflects the light back to the viewing side of the screen that normally would radiate into the back of the picture tube. This type tube will give a brighter picture than the type which does not have the aluminum layer. Since the ions do not have to be removed from the beam this type picture tube uses a straight electron gun which directs the beam to the center of the screen.

Deflection Yoke. The deflection yoke is located on the neck of the picture tube. Its purpose is to produce the varying magnetic field necessary to deflect the electron beam vertically and horizontally to produce the scanning raster on the screen of the picture tube. If the yoke is not correctly positioned, a tilted picture will result. To correct a tilted picture, first make certain the yoke is positioned as far forward on the neck of the picture tube as the bell will allow, and then rotate the yoke until the picture is level. When the yoke is properly positioned, it should be secured in position by a clamp or lock screw. A picture of the deflection yoke is shown in Fig. 4. The effect on the picture of an improperly mounted deflection yoke is shown in Fig. 7.

Focus Control. There are three types of focus controls in use on TV sets. One type uses a magnet located on the neck of the picture tube. This can be adjusted by a shaft extending from the back of the set, or you may find it necessary to adjust several screws to correctly position the focusing magnet.

A second type of focus control uses a coil to electromagnetically focus the beam. The voltage across the coil is varied by a voltage divider potentiometer to give the best focus.

A third type focusing arrangement uses a series of taps or terminal connections to which the focusing electrode is attached to give the best possible focus. Fig. 8 shows the effect of an improperly adjusted focus control. Note the lack of definition in the image as compared with the normal test pattern. The focus control should be adjusted to give the sharpest, clearest picture possible.

Contrast Control. In Fig. 9 you see the effect of improper adjustment of the contrast control. In this case the contrast control is set too high. Note the effects; the picture is all black or white without shades of gray. On the other hand, when the contrast control is set too low, the picture will be all gray without sharp distinction between the black and white areas. The contrast control should be rotated to adjust for the most pleasing difference between light and dark areas.

Brightness Control. The brightness control adjusts the bias voltage between the control grid and cathode of the picture tube, to establish the correct blanking or black level. Fig. 10 shows the effect on the picture of an incorrect brightness control adjustment, (brightness too high). Note the faintness of the image and the general washed out appearance of the picture. The brightness control is adjusted together with the contrast control to give the best possible picture quality. If the brightness control is turned to the extreme counterclockwise position, the screen

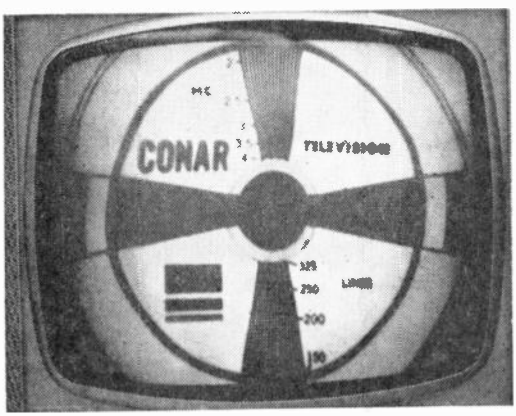


Fig. 9. Contrast control is set much too high. Gray shades wash out; picture is much too dark.

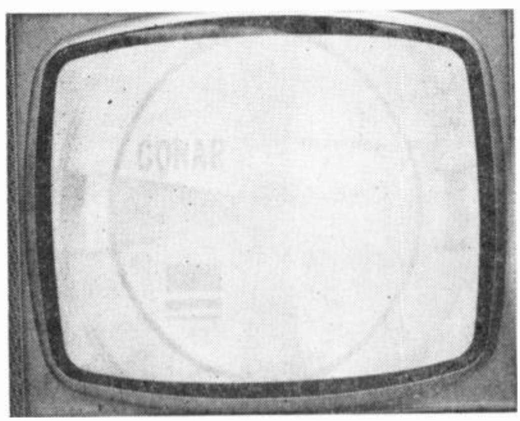


Fig. 10. With brightness control set too high, picture washes out and the image becomes faint.

TV REPAIR

TV SET'S CONTROLS

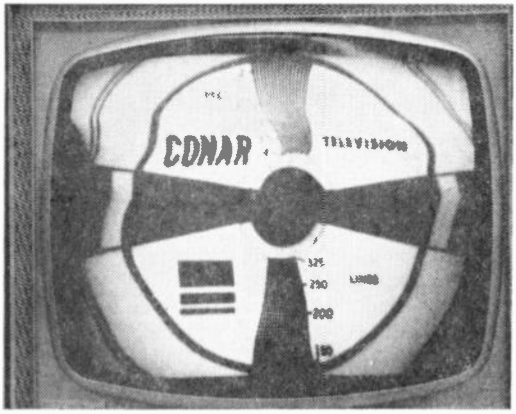


Fig. 11. AGC out of adjustment. The strong signal causes excessive contrast and audio hum.

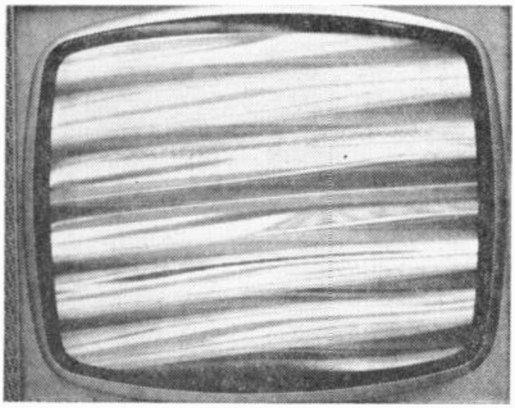


Fig. 12. Horizontal hold is out of kilter. The slanted lines indicate the need for adjustment.

will be completely dark—with no lines.

AGC (Automatic Gain Control). The AGC Control when properly adjusted enables you to tune to different channels having various signal strengths without requiring you to re-adjust the contrast or volume controls each time you change channels. If the AGC control is improperly adjusted, a strong signal will cause the picture to have excessive contrast, and a hum will be heard in the audio. Fig. 11 shows this condition. To adjust the AGC control, tune the receiver to the strongest channel in the area and rotate the AGC control clockwise until you notice excessive picture contrast, buzzing sound and pulling or tearing at the top of the picture. Then rotate the AGC control counterclockwise until the picture becomes normal once more. The control is then set to hold the gain of the receiver constant on all channels.

Horizontal Hold Control. The horizontal hold control is adjusted to change the frequency of the horizontal scanning oscillator. When this control is incorrectly adjusted, there will be a number of diagonal bars on the screen. Fig. 12 shows the effect of an incorrectly adjusted horizontal hold control. To adjust the control, rotate the shaft first in one direction to determine if the number of diagonal bars increases or decreases. If the number of bars decreases, continue turning the control in the original direction. If the number of bars increases, reverse the direction of rotation of the control and continue adjusting until the picture locks in.

Vertical Hold Control. The vertical hold control sets the frequency of the vertical scanning oscillator. When the control is improperly adjusted, the picture will generally appear as shown in Fig. 13. The image moves rather rapidly from the bottom to the top of the picture and several images may be seen at the same time. To adjust the vertical hold control, rotate the shaft or knob until the picture moves slowly upwards, and finally stops.

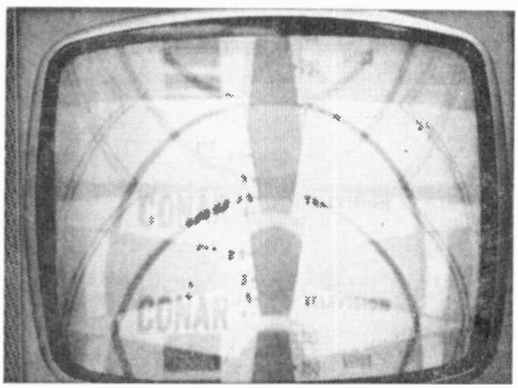


Fig. 13. Picture rolls or flops when the vertical hold control is not properly adjusted.

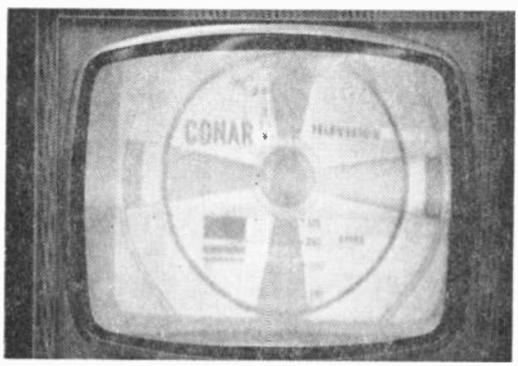


Fig. 14. This bending at the top is called "pulling." Sync stability is not properly adjusted.

TABLE I

CONTROL	LOCATION	TYPE
Channel Selector	Front	Electrical, Knob
Fine Tuning	Front	Electrical, Knob
Volume	Front	Electrical, Knob
Tone	Front	Electrical, Knob
Contrast or Picture	Front, Front (Under cover), Rear Chassis	Electrical, Knob or Shaft
Horizontal or Horizontal Hold	Front, Front (Under cover), or Rear Chassis	Electrical, Knob or Shaft
Vertical or Vertical Hold	Front (Under cover) Rear Chassis	Electrical, Knob or Shaft
Focus	Front (Under cover) Rear Chassis or Tube Neck	Electrical, Knob or Shaft Mechanical Focus Coil or Magnet
Brightness or Brilliance	Front, Front (Under cover), or Rear Chassis	Electrical, Knob or Shaft
RF Oscillator Adj.	Front (Under tuning knobs)	Electrical, Slug
Width or Horizontal Size	Rear Chassis	Electrical, Lever Electrical, Slug
Vertical Linearity	Front (Under cover), or Rear Chassis	Electrical, Shaft
Horizontal Linearity	Rear Chassis	Electrical, Slug or Lever
Horizontal Drive	Rear Chassis	Electrical, Shaft or Capacitor
Horizontal Lock or Horiz. Locking Range	Rear Chassis	Electrical, Capacitor
Horizontal Frequency	Rear Chassis	Electrical, Slug
Height or Vertical Size	Rear Chassis	Electrical, Shaft
Sync Stability or Noise Gate	Rear Chassis	Electrical, Shaft or Knob
AGC or Range Finder	Rear Chassis	Electrical Shaft, Knob, or Switch
Ion Trap	Tube Neck	Meehanical
Picture Positioning Lever (Focus Magnet or Coil)	Tube Neck	Mechanical
Pincushion Magnet	Tube Neck	Mechanical
Deflection Yoke (Tilt Correction)	Tube Neck	Mechanical

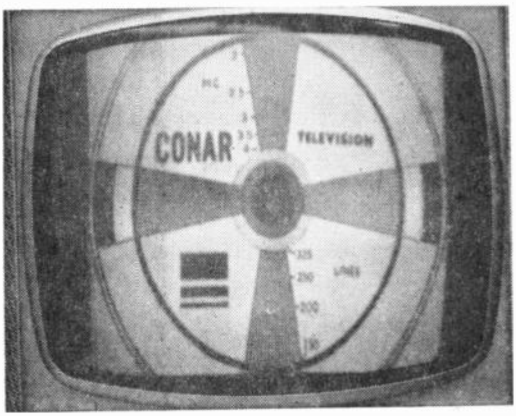


Fig. 15. The width of this picture is constricted. Check tubes if controls do not correct it.

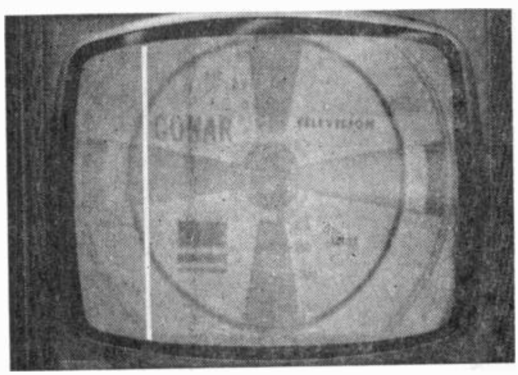


Fig. 16. Excessive drive causes white overdrive line to appear. To correct, back off the control.

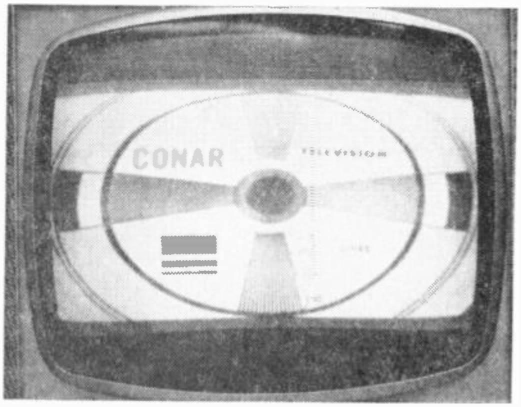


Fig. 17. Improper adjustment of height or vertical size control causes vertical shrinking.

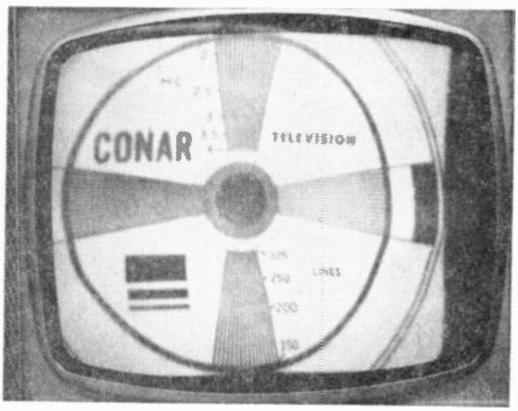


Fig. 18. If horizontal centering control is not set properly, picture will move off the screen.

Fig. 19. Vertical centering control misadjusted. Yoke adjustments can often pull into line.

Sync Stability Control. Fig. 14 shows the effect on the picture of improper adjustment of the sync stability control. Note the bending of the image in the top of the pattern. This control adjusts a noise rejection circuit so that noise in the picture signal will not upset the sync. To properly adjust the sync stability control, observe the picture on the strongest local station with the AGC control properly set, and rotate the sync stability control counterclockwise until the picture bends at the top. Then back off the adjustment until the bending stops. The control is now properly set.

Dimensions of the Picture. Controls are provided to adjust the picture to fit the viewing mask. These adjustments should be made with the set in the cabinet so that the picture fits the mask rather than the picture tube.

Width (horizontal size and drive) Control. In many instances there are two controls for adjusting the correct width of the picture. These are the width and horizontal drive controls. If the picture is too wide or too narrow, first adjust the width control until the picture approaches as near as possible the correct width. (Fig. 15 shows a picture that is too narrow.) Then adjust the drive control until the picture fits the mask. If the drive control is incorrectly adjusted to give excessive drive, a vertical white line (overdrive line) will appear on the screen. Fig. 16 shows the effects of excessive drive on the picture.

Height (or vertical size) Control. Fig. 17 shows the effect on the picture of an incorrect adjustment of the vertical size or height control. In this illustration the picture is too narrow from top to bottom, but symmetrical with respect to the center of the picture. Often the picture may be too high and off center. In such instances it is necessary to adjust both the vertical size and vertical linearity controls at the same time.

Horizontal Centering Control. The effects of misadjustment of the horizontal centering control on the picture may be seen in Fig. 18. To center the picture horizontally, move the metal rings on the yoke cover (see Fig. 4) until the picture assumes the desired position.

Vertical Centering Control. This control is accomplished in a similar manner to horizontal centering. Actually it is necessary to adjust for both vertical and horizontal centering at the same time. Fig. 19 shows a picture with the vertical centering control out of adjustment.

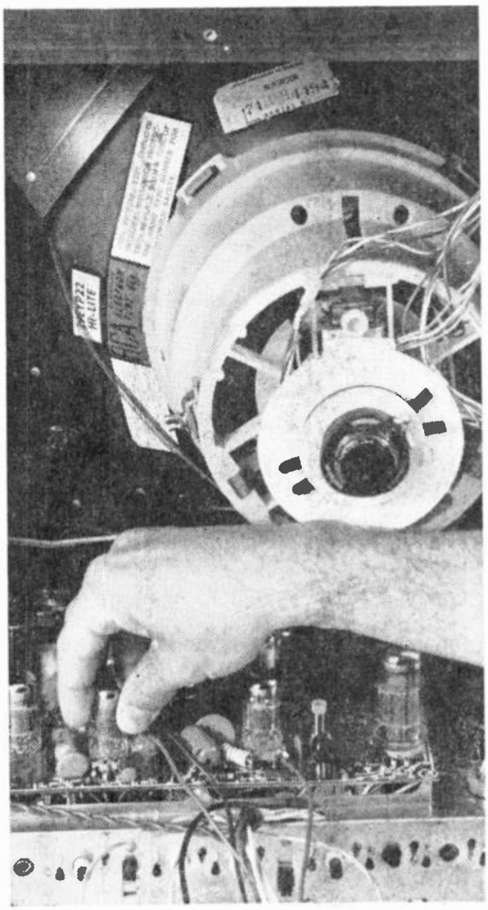
Circuits Which Determine Shape of Picture. The horizontal and vertical linearity controls provide a means for adjusting the shape of the picture.

Horizontal Linearity Control. The horizontal linearity control may be adjusted to change the horizontal radius of the picture

(Continued on page 97)

how to ADJUST your COLOR TV

No color TV can come through on all its promises unless each and every control is at its optimum setting / By **LEN BUCKWALTER**



Rear of color TV reveals chassis similar to that of B&W. However, color TV's are more complex.

Anyone who has switched from black-and-white TV to color viewing makes a disturbing discovery. No longer do little picture distortions—out-of-round circles or misshapen figures—sink into the background. Color permits less of a compromise. Misadjustments may spring out at the viewer to clutter the picture with a spectrum of colorful smears, nightmarish tints and ghoulish hues. We don't mean "fault"-type problems—outright failure of tubes, parts or antenna. These need servicing. Rather, it is the slow drifting that comes with time, or the intrusion of other factors which affect performance of an otherwise trouble-free set. The manufacturer anticipates such problems with a whole series of adjustments for correcting such error. Not just the user knobs on the front panel, but a complement of in-back controls that need an occasional touching up. They keep colors clean and the monochrome picture truly black and white.

Besides long-term drift, another significant force is at work. It is the stray magnetic field. So sensitive is the color receiver to magnetic forces that just moving the set around the room could deteriorate color, not to mention

TV REPAIR ADJUST COLOR TV

going from room to room or house to house. Even the earth's weak magnetic field has been singled out as a disruptive influence. Stray magnetism and inevitable drift, however, are readily corrected in the steps to follow.

It's probably occurred to some viewers that symptoms of misadjustment may really be signs of deeper trouble. In many instances this is true. But until you've developed a sharp eye for these differences, there's the trusty trial-and-error approach to provide the answer; if routine adjustments to be described won't restore performance, chances are the circuits need servicing. Adjustments can be performed without major chassis removal, often requiring little more than removing the back cover.

How difficult? It follows the old law: the beginner flounders around at first, the experienced adjuster breezes through the job in mere minutes. So don't expect push-button precision at first. It takes a little time to get the feel and effect of the various controls. One thing in your favor; the set, though uncomfortable to view, may be just slightly out of adjustment. This means you can avoid time-consuming confusion by not moving any controls more than just a slight amount while observing the desired result. And don't despair over two factors peculiar to color TV: (1) you rarely set a control once and leave it there. Interaction is the rule, so be prepared for much repetition and (2) aiming for utter perfection is not only impossible but often a waste of time. Color TV is still a miracle despite traces of color error, especially at screen edges, or some color fringing around some objects in the black-and-white program. The adjuster tends to see the screen with a far more critical eye than when he sits five or more feet away as a program viewer.

Required Equipment. Unlike the simpler black-and-white receiver, which usually can be adjusted by eye, the color set needs at least one test instrument. It's the color generator, a device which displays on the screen a pattern of dots, bars and other images which serve as a reference. Without such a unit, the adjustment job becomes hopelessly complex. At least one kit manufacturer markets a suitable generator in kit form for approximately $65. Commercially wired units begin at higher prices. Clipped to the antenna terminals of the TV receiver, the generator "transmits" the desired pattern selected by a knob on the front panel. Not only is the device needed for critical color adjustments but also serves for lining up certain black-and-white adjustments.

Next piece of equipment is the degaussing coil, the unit which demagnetizes stray pickup by the picture tube. Although such units are available, one may be inexpensively assembled by following the illustration in Fig. 1. You'll need about four pounds of No. 20 enamel-covered ("magnet") wire. This is wound around some temporary form of 12-

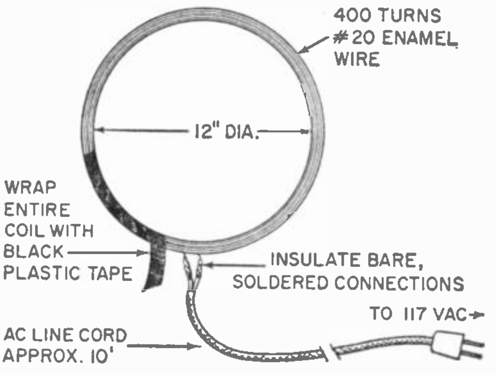


Fig. 1. For color TV receivers without automatic degaussing, a simple degaussing coil is needed.

inch diameter for 400 turns. After removal from the form, the coil is held together by a wrapping of black plastic tape. A long AC cord (with plug) is attached to the two free ends of the coil.

A handy accessory during adjustments is a mirror. It's awkward, if not impossible, to get a good view of the entire screen while manipulating certain controls from the rear of the set. The mirror should be large enough to give a total view of the screen when placed in front of the set. A chair provides a good support of approximately correct height. (Two additional items, "cheater" cord and hex tool, are described later.)

Finally, the set's service manual should be on hand. Now that numerous TV makers have entered the color field, there are apt to be variations in location and set-up of controls from one set to the next. The step-by-step discussion to follow applies generally, but the manufacturer's special comments should also be checked.

Major Steps. Adjusting the color set requires no grasp of complex theory, but a quick preview of major steps (see Fig. 2) and why each is performed could prove helpful. The job begins with:

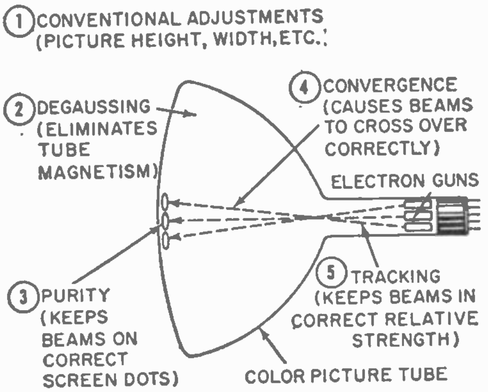


Fig. 2. The five major steps to accomplish in adjusting color TV for optimum performance.

1. Conventional Adjustments. These are the familiar controls found on all TV receivers, monochrome or color. They include height, width, focus and linearity (see Fig. 3). Unless preset for proper performance, adjustments which control color will be seriously affected. Even setting of horizontal and vertical hold controls should be done with care. Misadjustment of horizontal hold can cause fanning out at the top of the picture, while a vertical hold set improperly may produce slanting, retrace lines. (A suitable crosshatch pattern from the color generator can serve as a guide for these initial picture adjustments.)

2. Degaussing. This is the demagnetizing step mentioned earlier. It cancels out magnetism picked up by the metal shell of the picture tube and surrounding parts. The operating principle of the degaussing coil is similar to that of an erase head in a tape recorder: by applying a rapidly changing magnetic field (provided by 60-cycle house current), the magnetized object is returned to a neutral state. (Degaussing will not be required for the newly-announced receivers by RCA; it's done automatically by an internal circuit.)

3. Purity. If the color set cannot produce single, pure colors, it cannot be expected to properly render thousands of color mixtures required during a color program. This introduces purity—first major color adjustment. Done in two steps, it lines up three beams from the electron gun in the neck of the tube so they fall precisely on their respective screen color dots—red, blue and green. Actually, purity is accomplished by using the red beam only. The other two colors will automatically fall into place.

4. Convergence. Not only do the three beams have to center properly on the screen, they must also come to a point just before reaching their corresponding screen dots. The beams are magnetically squeezed together (converged), and form a point just before striking the screen. Travelling a slight distance further, they cross over, fan out slightly, then strike their corresponding dots. To achieve this focusing effect for the entire screen surface, convergence is done in two steps. The first sharpens the image at screen center, the second corrects the problem of variable distance between guns and screen. (The beams must travel farther to hit the edges of the screen.)

5. Tracking. Although the receiver is designed for color reception, its black-and-white performance is still critical. This final adjustment keeps color out of the monochrome image. Since the black-and-white picture is created by mixing red, blue and green in a fixed amount, any upset intro-

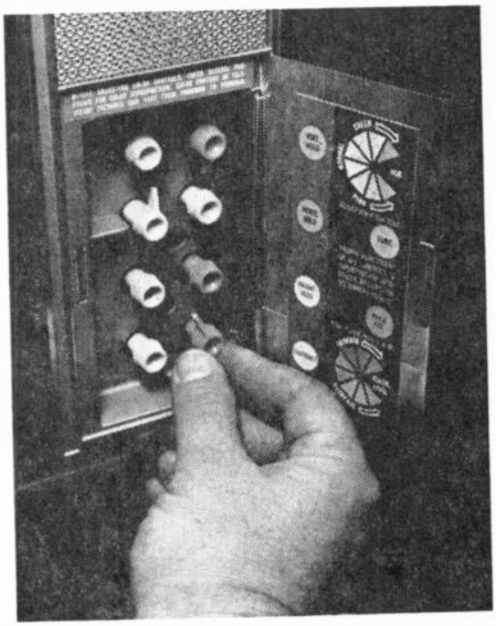


Fig. 3. All conventional controls—hold, width, linearity, etc. must be carefully adjusted first.

duces undesired color tinting. This is corrected by adjusting the beam strength of each electron gun for the proper gray shading.

Preliminary Set-Up. Decide now where the set is to be located in the room for normal viewing—and leave it there throughout the whole course of adjustments. Some of your work will be undone if the cabinet is moved to a convenient area for better access, then returned to its permanent place. Plumbing pipes, air vents or other masses of metal unpredictably warp the surrounding magnetic fields which influence purity and convergence.

Room lighting is another factor which may be considered. Is the set to be viewed as daylight enters the room, or under artificial illumination? Photo fans will see the analogy; outdoor color film is balanced against the blueness of natural light, while the indoor film type takes into account the yellowish hues of artificial light. In adjusting the color set, these lighting factors affect the outcome. A set adjusted during the day for a good black-and-white picture, for example, can assume a hue of color under lamplight. Adjustments, if possible, should be made under normal viewing conditions. Since most viewing is ordinarily done in the evening, it's helpful to adjust at that time or draw the shades and exclude natural light.

Other preparations. Turn on both set and test generator in advance. Both units should be allowed about 20 minutes to warm up and stabilize at operating temperature. Also, the back cover of the set is removed. There is some variation in interlocks here, devices which automatically kill dangerous voltages when the cover is removed. This safeguard is designed to protect against accidental shock. During adjustments, however, the set must be fully powered with the cover off. This usually requires the use of a special "cheater" cord to defeat the interlock. A suitable one for the particular set should be obtained, if necessary.

The matter of safety is even more critical for color than in the conventional black-and-white receiver. Voltages in color circuits run up to some 24,000 volts. While none of the adjustment points bear voltage, care should be exercised to avoid any accidental contact with nearby. exposed parts. There is no need to open the high-voltage cage or remove the cap plugged into the picture tube.

Some sets have removable top or side panels for access to certain internal controls. Others may have a springy wire which shorts the high voltage when the back cover is removed. These and other variations should be checked in the manufacturer's literature. Let's consider now, step-by-step, the various color adjustments. It's assumed that the conventional black-and-white settings (width, height, etc.) have been properly set.

Degaussing. (In this first step the receiver may be warming up, but it does not matter if the set is off during degaussing.) Degaussing is a simple procedure but one that requires careful technique. Don't be surprised if the coil warms up after plugging it into house current. It is designed solely to be powered for the short time required for the job. (Some sets may have "rim" or "field-neutralizing" magnets. If so, they must be retracted before turning on the degaussing coil.)

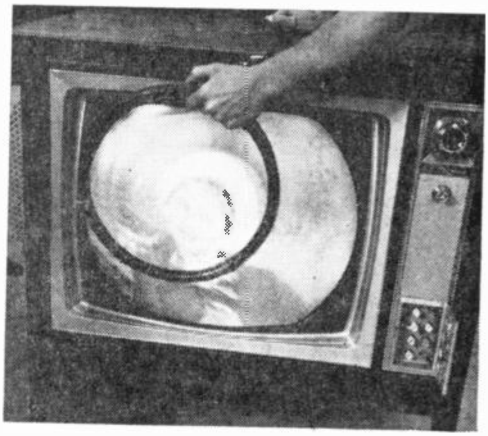


Fig. 4. Degaussing rids picture tube and other parts of stray magnetism that affects color.

As shown in Fig. 4, the coil is held with its flat side about an inch from the screen. Move it in circles over the whole area of the screen's face-plate and overlap into the bordering mask area to rid that region of possible magnetism. This part of the operation is done for about a minute. Now *slowly* back away with the coil, holding it in the same parallel position as before. When you've reached a distance of about six feet, turn the coil at right angles to the screen (narrow side points toward set). Now it's safe to pull the plug out of the wall. Another precaution: don't use a plug that is loose in the wall socket. Any make-break in AC power during degaussing can remagnetize the tube.

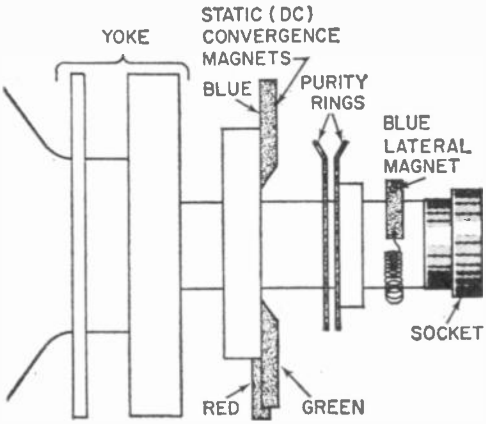
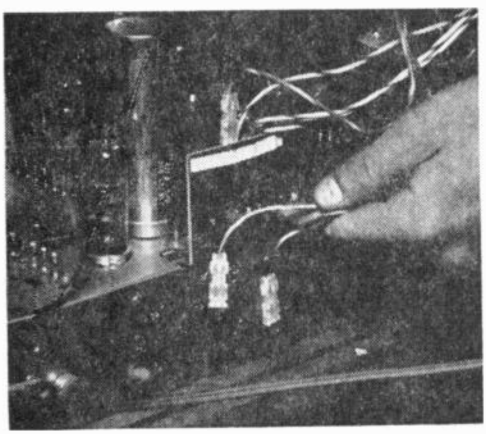


Fig. 5. Purity and static convergence adjustments are made on picture tube behind yoke.

Purity. This 2-step job (Fig. 5) begins by eliminating any possible source of interference on the screen, done simply by removing one of the receiver's I.F. tubes, or unplugging the I.F. cable running from tuner to chassis. (Don't forget to replace these after purity adjustments are completed.) Next is completely disabling blue and green electron guns in the picture tube. Only red will operate at this time. In the recent receiver illustrated in Fig. 6, note that blue and green guns are deactivated by removing two clip leads from a terminal strip. For other sets, a small commercial adapter is plugged into the picture-tube base. It has switches for disabling desired guns. (Such adaptors are often provided with the color dot-bar generator.) Some manufacturers specify clip leads for shortening out the guns.

Fig. 6. Before making purity adjustments, disable blue, green guns by method set provides.



Turn the set's contrast control fully off, brightness control to about halfway. The screen should now be essentially red. Locate the movable tabs (see Fig. 7) on the purity rings and make the red color move to the *center* area of the screen. Some back-and-forth adjusting might be necessary. Not only should the red area predominate at the center, but its color be as uniform as possible. Step 2 in the purity adjustment is sliding the yoke back and forth to cause the red area to fill the entire screen (see Figs. 8 and 9). (There's a screw clamp to loosen the yoke.) Note that the yoke does not nudge up against the bell-shape rear of the picture tube as in

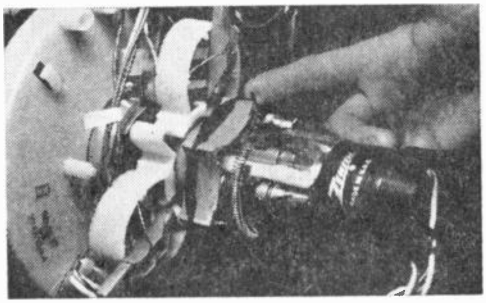


Fig. 7. The red area on the screen is moved to the center using the tabs on the purity rings.

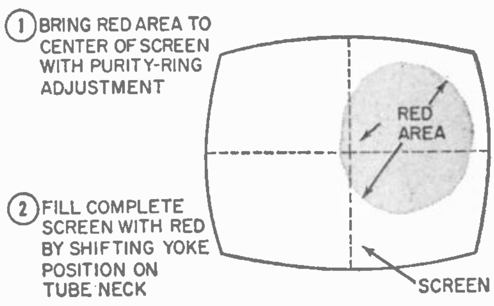


Fig. 8. The red area of the TV screen has to be centered and then expanded to fill the screen.

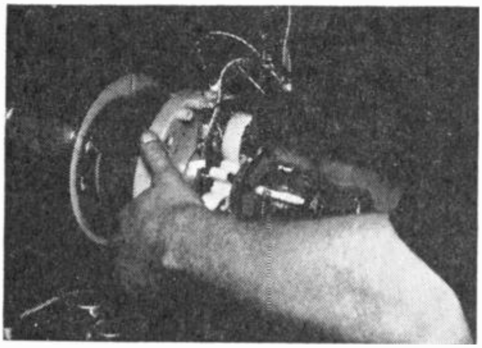


Fig. 9. Shifting the yoke along the tube axis causes a beam deflection that covers screen.

black-and-white sets. There is some play to permit purity adjustments.

The result of these steps should be uniform, uncontaminated red that slightly extends beyond (overscans) the borders of the picture-tube mask. In some sets, rim magnets around front the edges of the picture tube are adjusted for correcting color impurity existing out at the edges of the screen.

Convergence. For this step, the color generator is clipped to the antenna terminals in the set-up illustrated in Figs. 10 and 11. (Be sure the I.F. tube or plug removed earlier is back in place.)

The aim of convergence is a series of adjustments to produce pure white dots throughout the complete screen (see Fig. 12). Done in two major steps, static (or

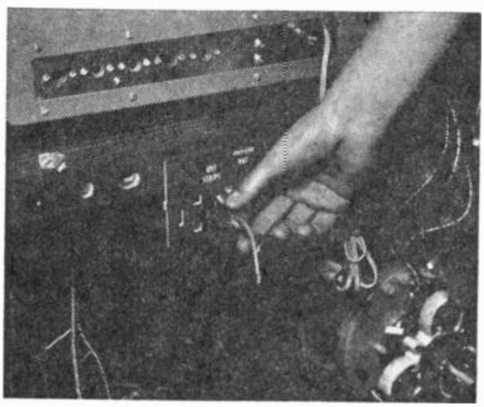


Fig. 10. The color generator output is coupled to the television receiver's antenna terminals.

Fig. 11. Color generator is tuned to frequency of an empty channel and set to generate dots.

DC), and dynamic convergence, it should be possible to apply the right amount of correction. Begin with static convergence, done with three movable magnets (see Fig. 13) which can be slid in and out of their holders. During this step kill the blue gun, but keep red and green guns active. By careful oper-

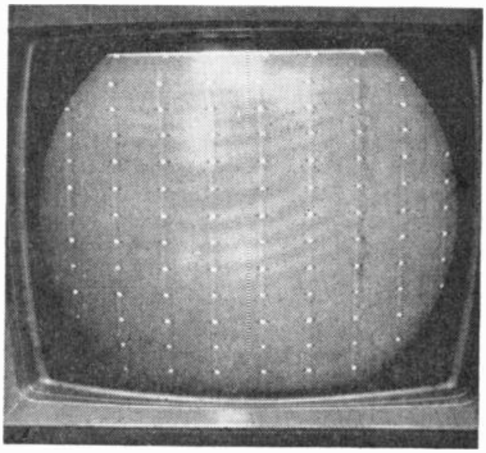


Fig. 12. Dot pattern is used during most color adjustments; is also used for conventional ones.

ation of red and green magnets it should be possible to bring together close-spaced red and green dots on the screen. As they merge, they form a single yellow dot. It's especially important that these static-convergence adjustments be made while viewing dots only at the *center* area of the screen, as shown in Fig. 14. Now activate the blue gun. Its magnet is slid to cause the blue dot to overlap the yellow dot. An additional control—the blue lateral magnet clipped on the tube neck near the base—permits side motion of the blue dot. As in other adjustments, static convergence requires some juggling back and forth among controls to achieve satisfactory results. The end product should be pure white dots in the central screen area.

Controls for dynamic convergence, which bring together dots lying outside screen center, are generally mounted on a separate "convergence board." In many instances (see Fig. 15) long cables to the board permit it to be mounted conveniently on the rear top edge of the cabinet. Note how it is temporarily fastened in place by two screws. Thus, controls are accessible while the screen is viewed directly (Fig. 16).

A typical convergence board layout appears in Fig. 17. The various controls are divided into two major screen areas; horizontal and vertical. With the color generator producing the same dot pattern used earlier, begin with vertical convergence, the six knobs on the board's left side. During these adjustments, it is important to view only the *middle vertical row* of dots, as pictured in Fig. 14. All others are ignored. Red-green controls can be adjusted first, and the blue gun turned off at this time. While watching the vertical column of dots, carefully turn Red Tilt, Red Amp, then Green Tilt and Green Amp in an effort to merge red and green dots so they form single yellow dots. Following this, the blue gun is restored and Blue Tilt and Blue Amp adjusted so the blue dot overlaps the yellow dot for the desired result; a pure white dot, more specifically, a complete vertical row of white dots.

This process is apt to be confounding at first due to interaction—turning of one control upsets the setting of another. And, in fact, when upper and lower dots appear to be perfect, *center* dots in the vertical row go out of whack. This is to be expected. The remedy is to go back and touch up the magnets used earlier for static convergence to re-align the center.

There's another approach to dynamic convergence which might prove helpful until more experience is gained. This is to leave the blue gun on, then adjust red and green controls to bring those dots into line with blue (which serves as a reference). Also, some technicians prefer not to use the dot pattern at all for convergence. They switch the generator for a crosshatch pattern (see Fig. 18). Here, only the vertical column or line at the center is viewed for vertical

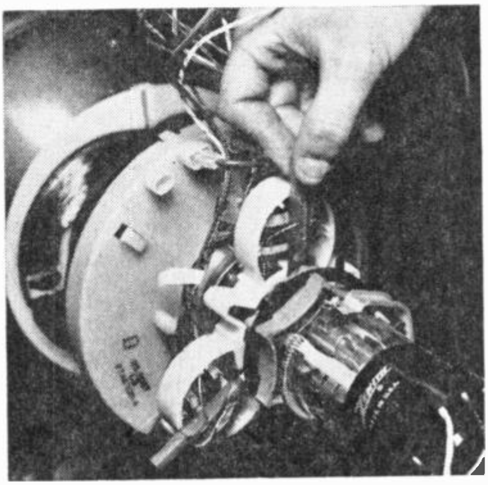


Fig. 13. Static convergence magnets are located in holders clamped around neck of tube.

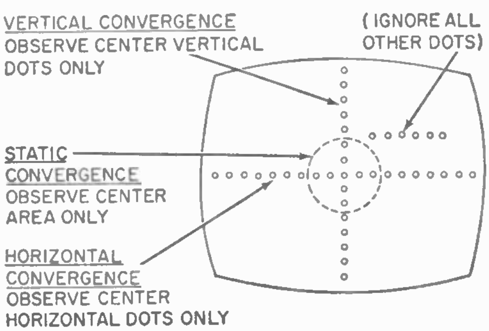


Fig. 14. In static convergence adjustments, observe only dot pattern in center area of screen.

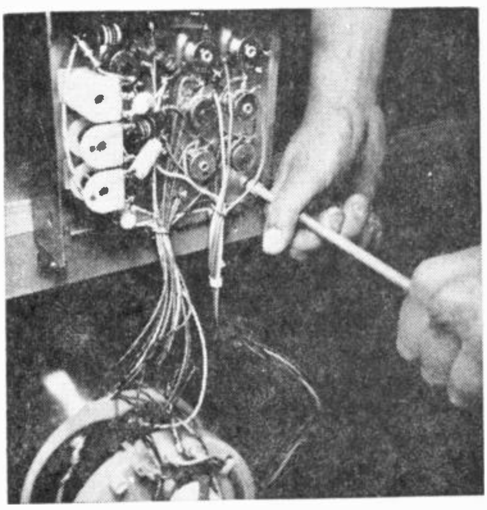


Fig. 15. For convenience, remove the dynamic convergence control board and secure where accessible for your tools and for visibility.

ADJUST COLOR TV

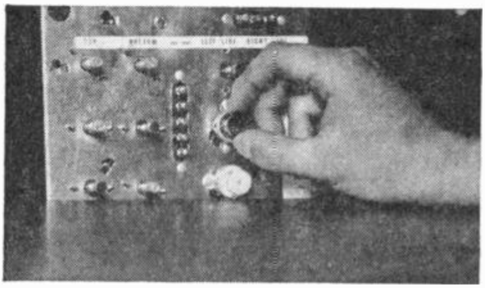


Fig. 16. When "board" is secured to top rear of set, it can be adjusted while viewing screen.

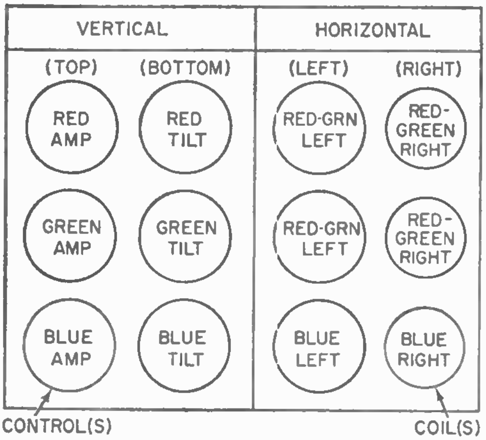


Fig. 17. The dynamic convergence board layout conveniently groups horizontal and vertical controls into logical position and color pattern.

convergence adjustments.

Horizontal convergence is next, a procedure not unlike the one above, only now the *middle horizontal row* of dots (or lines for crosshatch) comes under adjustment (see Fig. 14). There is a difference; red and green occur *together* on each of the two left and right controls. Thus, the red and green color dots will move at the same time. Blue, as shown, has its own individual controls. Also, the extreme right-hand controls are not usually provided with knobs, but require the insertion of a plastic hex-type aligning tool. After turning off the blue gun, the various red-green controls are used to produce single yellow dots on *right* and *left* halves of the screen over the entire middle horizontal row. When yellow dots are visible, activate the blue gun and adjust the two blue controls. As blue overlaps yellow the desired white dots should appear. Those blue controls only move the blue dots up and down. For side to side motion, it is necessary to return to the blue lateral magnet mentioned earlier. Again, static convergence (on screen center) may be affected by dynamic convergence, so some back-and-forth adjusting might be in order. It's a good idea, too, to make a final check of color purity, described in the preceding section.

Tracking. After purity and convergence are completed, output of red, blue and green electron guns is adjusted. This assures that a correct proportion of primary colors will be delivered for creating the black-and-white picture. The controls are usually at the rear.

Although tracking controls may differ in number and marking, the general idea is as follows: First tune to an unused channel and turn the set's contrast and front-panel color controls to minimum. This should fill the screen with white light (or raster). With the brightness control turned up (though not to maximum) adjust red, green and blue screen controls for best, color-free white light. If, for example, blue is apparent, back off slightly on that control.

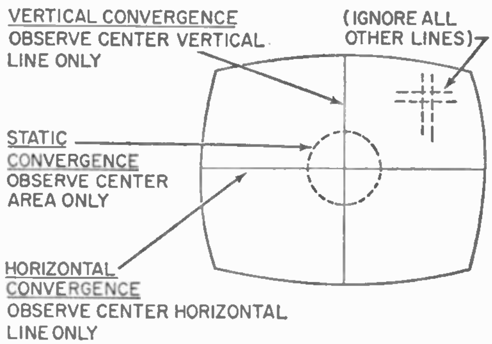


Fig. 18. Color generator can be set to give a crosshatch pattern for convergence adjustments rather than dot patterns discussed.

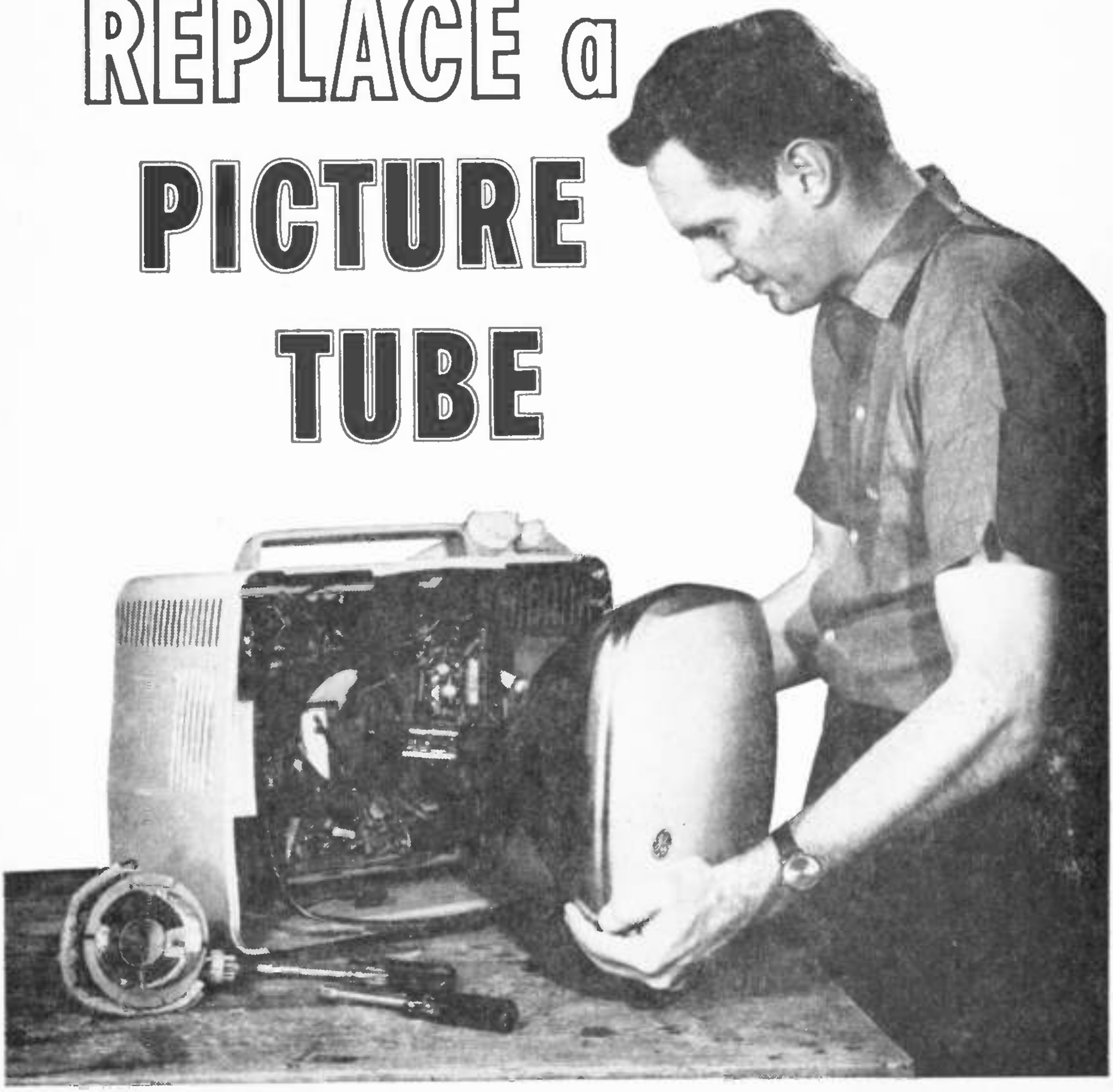
This completes the job. How well does the color set stay in adjustment? There is no set period, but you can expect that, with normal conditions, convergence remains fixed for fairly long periods, say upwards of two years or more. Any jostling, magnetizing or moving the set especially affects color purity. But knowing when to repeat the job is the easiest step of all. During day-to-day viewing, your eye will make that decision. ■

By Len Buckwalter

You can determine if your TV troubles are being caused by the picture tube, and if they are, You can do something about it

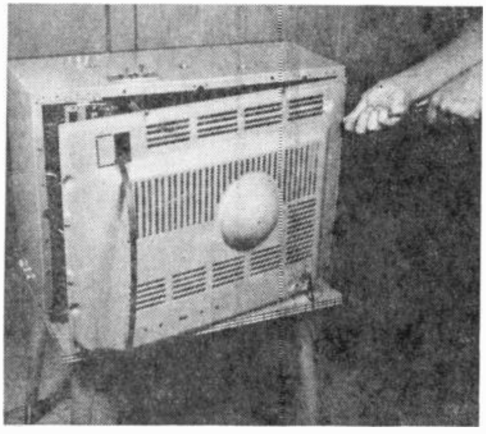
how to REPLACE a PICTURE TUBE

CAN anyone change a picture tube? Not the yank-'n-pull mechanic; he could fudge the job. The careful worker, however, can reap a double reward; a husky saving in cash and the satisfaction of restoring a good-as-new picture to an aging TV set. Success doesn't depend on an intimate knowledge of electronics. There are few mysteries surrounding the removal and re-installation of the picture tube. The big factor is a healthy respect an installer must have for the tube. Fragile glass construction can't tolerate rough handling. So, if you're willing to handle the TV picture tube with loving care—avoiding

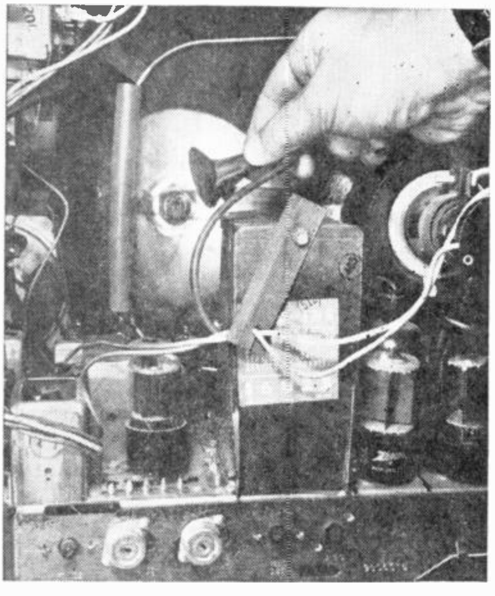


TV REPAIR

PICTURE TUBE



Removing back cover of TV is first step in replacing picture tube. AC cord, interlocked to back cover (lower right), comes off with it.



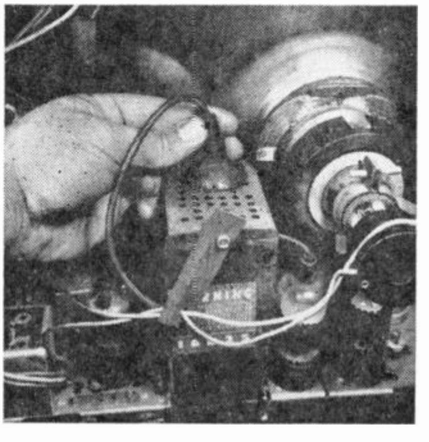
Carefully remove rubber anode cap plugged into the side of the picture tube by simply pulling or, if a clip type, by squeezing.

accidental strain, bumps or scratches—the job shouldn't prove too difficult.

Is the tube really at fault? This is a crucial first question. It's a crushing experience, as some have learned, to buy and install a picture tube—only to find the old trouble pop up on the new screen. Some faults give the exact same symptoms as a bad picture tube. So pinpoint the culprit.

Complete Loss of Brightness. The picture tube needs high voltage to produce brightness. Check for this voltage by finding the anode cap shown in the step-by-step photos. With power turned off, unplug the cap from the side of the tube (grasping only the rubber part). Now tape the cap so it sits about a quarter or half-inch away from its socket. Move away and turn on the power. If high voltage is present, you'll see and hear it; a blue spark should jump the gap and produce a sputtering, crackling sound. Some small chassis tubes which can kill high voltage are the horizontal oscillator, horizontal amplifier, high-voltage rectifier or damper. A blown high-voltage fuse is also a possibility. These items may be identified by the diagram pasted inside the set's cabinet or with the aid of a schematic. If these stages are causing high-voltage trouble, a new picture tube won't work.

Gradual Loss of Brightness. If this occurs over a long period, it's a good sign of a failing picture tube. You can milk additional months of service with a booster, but this is only a delaying action. Another possibility is the build-up of dirt on the screen (high voltage attracts dust like a magnet). In some sets, it can be cleaned from the front of the set if the manufacturer has provided a re-



Short circuit the anode cap against chassis several times to dissipate any charges that might be present.

movable safety glass. Otherwise, the tube must be removed to gain access to the screen surface. (If you have a late-model set with a bonded safety glass, usually stated in the advertising literature, dirt can't accumulate inside.) In any case, a good cleaning of the screen surface in older sets can yield a remarkable increase in brightness, especially if there's more than one year's accumulation.

The darkening screen, however, which inevitably occurs some two or more years after the set is purchased, spells decreasing emission from the tube's electron gun. A good clue to this condition is the length of time it takes for the set to warm up and produce a usable picture. Low-emission tubes take two or three times longer to heat than when the set was new.

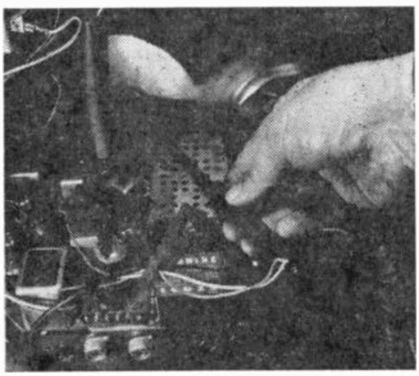
Other clues. Turning the brightness control has no effect; the picture stays bright. This is an excellent sign of a shorted grid in the picture tube. Such tubes deserve replacement, but there are two tricks for delaying the job. One is to purchase a special picture-tube booster which also can isolate the shorted grid. (It works only in some cases.) The other is a hit-or-miss method which might produce results, for a while anyway. Very gently tap the neck of the tube with the end of a pencil. This could dislodge the shorted element and unshort it.

Another valuable sign of a bad picture tube occurs when the picture goes negative; that is, blacks reverse to whites. This is caused by air seepage into the tube, molecule by molecule, over a long period of time. Such "gassy" tubes should be replaced. One misleading symptom is picture "blooming." As the brightness control is turned up to a normal position, the whole image expands like an inflated balloon. Image brightness dims as the picture grows in size. This is not caused by a bad picture tube. In nearly every case the reason is a bad high voltage rectifier, a small tube which is unable to keep high voltage up as electron-beam current rises to create more brightness.

Filament. Many people will tolerate a dimming image as the picture tube ages, but few will accept the condition which causes most outright failures. It is the burned-out filament. Investigating a dead filament should begin at the picture-tube neck. With the power on, a dull orange glow should be seen near the end of the neck, next to the socket. One exception may occur in the series-filament set, one without a power transformer. A burned-out filament in any of several small tubes could also cause the picture-tube filament to darken. Thus, dark or cold tubes in the series set must be checked individually before assuming that the trouble lies in the picture tube filament.

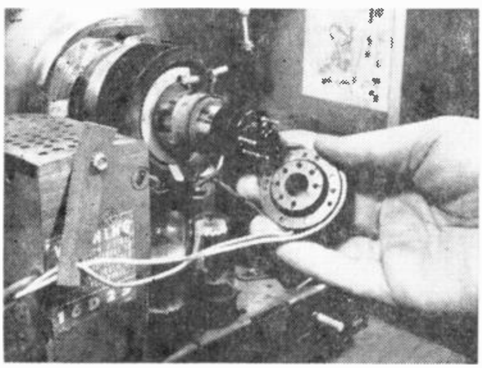
Occasionally, a picture-tube filament grows dark due to a mechanical fault in the socket, usually a loss of tension in the spring clips which grasp the tube pins. This may be detected by applying gently pressure to the socket, in all directions, and observing if the tube filament lights during any of these movements. If so, a new socket can be wired into place.

The professional installer usually makes a direct measurement of the filament to verify failure. One method is with an ohmmeter touched to the picture tube pins (after the socket is removed). An unbroken filament reads a few ohms resistance. Most tubes



Short circuit voltage stored in picture tube by touching insulated screwdriver to anode and chassis a few times.

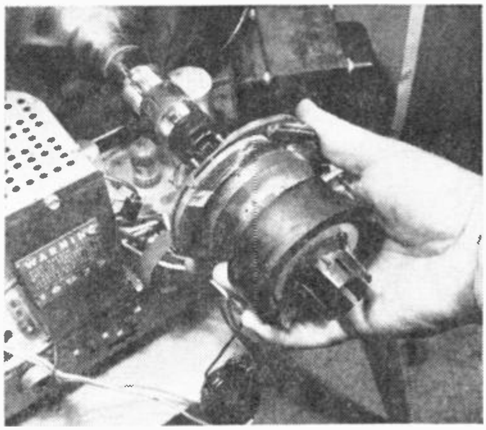
Now remove the picture tube socket from the tube pins at the base of the neck. A slight rocking action will probably be necessary.



TV REPAIR

PICTURE TUBE

First loosen wing nut, then slide off yoke clamp. (In many sets this will be ion-trap magnet held by a spring around tube neck.)

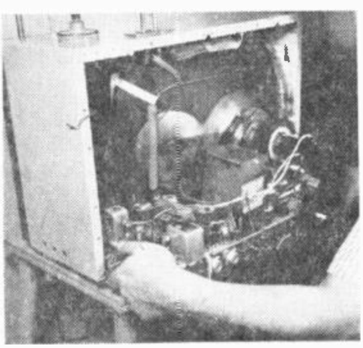


Slide off yoke and centering magnet assembly (usually in one piece). If a yoke clamp isn't used, loosen the wing nut on top of the yoke.

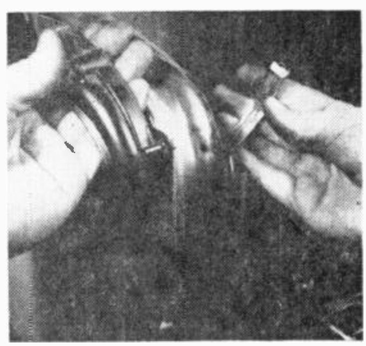
use one of the following filament-pin combinations: 1-8; 1-12; 3-4; or 4-5.

After you've determined that the picture tube is bad, the next consideration is the type of replacement to purchase. Unless you have a private pipeline to one of the big producers, you cannot get a *new* TV picture tube. All TV replacement tubes are rebuilt. This may imply a compromise in quality. Not so in most cases. Only the glass envelope is reused in the rebuilt tube; screen and electron gun are new. Yet, there is still a range in price. If a budget-priced rebuilt is purchased, it could run nearly half the cost of a rebuilt from a big-name producer—GE, RCA, etc. In this writer's experience, the budget-price rebuilts are economically attractive, but in numerous cases have failed to maintain proper emission (and therefore brightness) much beyond the 1-year guarantee period. It could be due to poor quality control by some small rebuilding houses. The choice is left to the buyer. Whatever the purchase, a replacement containing an aluminized screen, if available in your number, is highly recommended. The difference in tube performance is considerable; light is not wasted in the rear end of the tube, but reflected back to the viewer's eye.

Removal. The precautions shown for discharging high voltage retained by the tube

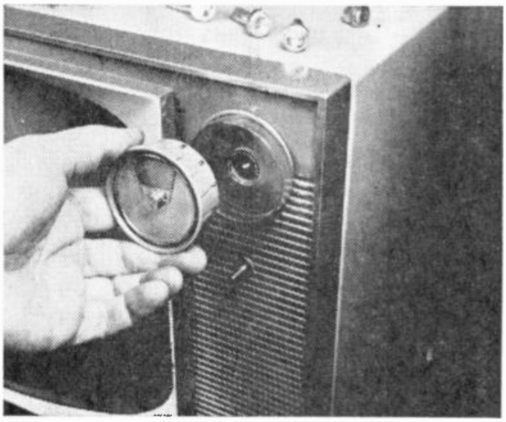


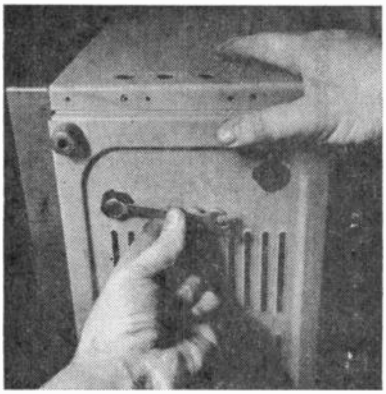
In this set, tube and chassis are removed together. When this is the case, make sure the tube face isn't held by cabinet.



Remove mounting hardware from all around the front rim of the tube. Be sure to retain all clamps, screws.

If it's necessary to remove chassis from cabinet (see text), remove all of the control knobs from the set first.

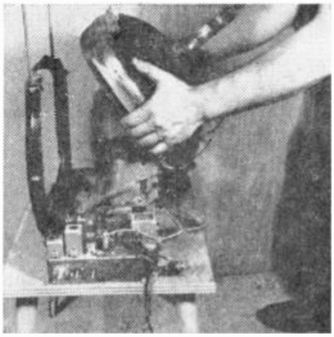




Chassis is usually secured to cabinet (shown here tilted) with bolts. Keep cabinet level when loosening.

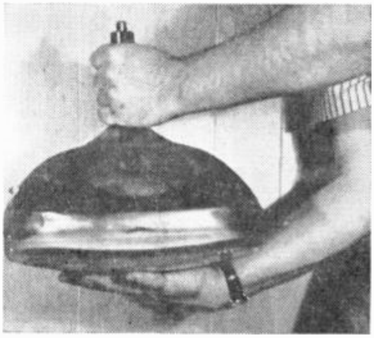
are mainly intended for protecting against breakage. The charge is not electrically dangerous. Rather, it may cause a person to jump back or jerk his arm while holding the tube, and thereby dropping it. Be sure to discharge the tube repeatedly for about a minute to get rid of the last tickle. Never hold the tube by its neck alone. It's the weakest part. Neck-holding may be done for balancing, but not for support of the tube weight. To further increase the safety factor, it's recommended that the installer wear a pair of safety goggles and apron, or other substantial piece of clothing. A fractured tube can implode and fling dangerous glass splinters.

Since the step-by-step photos show the general technique for removing the picture tube, let's consider variations from one set to the next. The first major consideration is observing how the tube is mounted, for this determines whether the chassis has to be removed from the cabinet. There are two principal systems: in the first, the tube is mounted directly to the front panel of the cabinet, true for many large, or 21-inch, sets; and, the second, where the tube is fastened directly to the chassis. (The model in the photos is of the latter type.) The system can usually be discovered by close observation of the tube. Frequently, a large tube will be seen fastened to a bracket around its forward rim. After items on the tube neck are removed (such as the deflection yoke) unbolting the forward tube support frequently permits the tube to be withdrawn while the chassis remains in place. That is, if the chassis presents no obstructions. Small tubes blocking the way may be temporarily removed, but if a transformer presents an obstacle, the chassis will at least have to be pulled out part way. In the chassis-mounted tube, both chassis and



The picture tube must be withdrawn very carefully to avoid disturbing the other components on receiver's chassis.

Carry picture tube by supporting all its weight with your hand under screen; grasp neck only for balance.

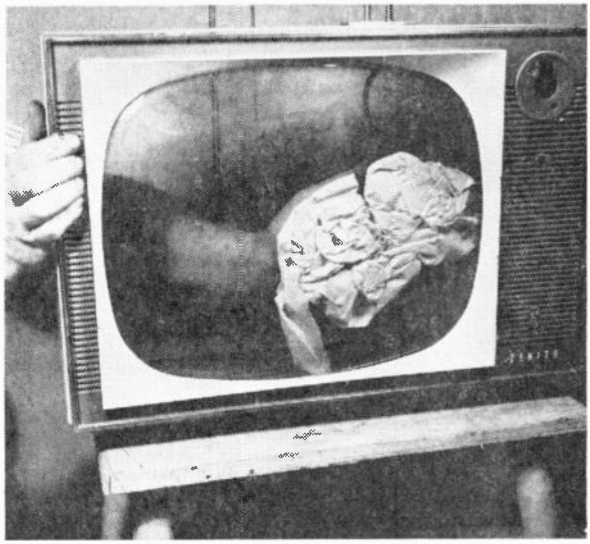


TV REPAIR PICTURE TUBE

Avoid scratching face of old tube by placing on soft surface. Scratches increase danger of implosion and could affect trade-in value.

tube emerge from the cabinet as one piece. Generally, this type requires the removal of screws which fasten the top rim of the tube to the front cabinet panel.

Some Differences. The sequence of removing components from around the tube neck is subject to some variation. If the chassis does not have to be removed, neck components must be dismounted before the tube is taken from the cabinet. In the tube-on-chassis type, it is simpler to slide off the neck parts after the chassis is out of the cabinet. The neck components vary considerably in different sets, but this should present little problem as long as they are replaced according to the original layout. The first part to be removed is the tube socket. In many older sets it will not easily pull off. Gently insert a screwdriver at several points around the socket rim and pry it away gradually. In some sets, the next item is the ion trap. It is a small, square magnet clipped around the tube neck and held by a spring. (The set in the photos uses no ion trap.) Since the trap presents the most critical adjustment after installing a new tube, it's advisable to carefully note its position on the neck of the tube. This, at least, will provide an approximate starting point later on. (Some ion traps have a small



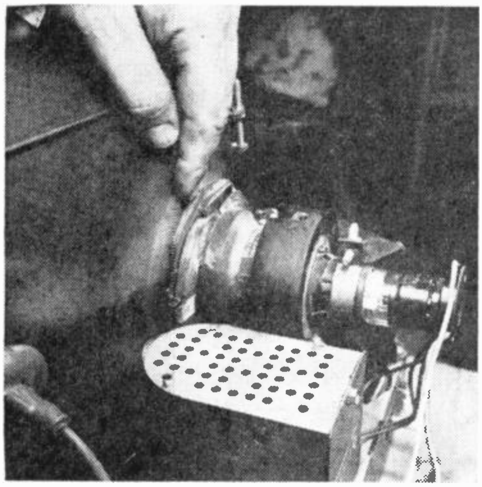
While picture tube is out of cabinet, take advantage and give safety glass a thorough cleaning with water and a drop of detergent.

arrow, which indicates the front of the set.)

Next on the tube neck is a focus coil or centering magnet assembly. It is unfastened and slid off. Finally, there is the deflection yoke which fits snugly against the flare, or bell-shape, portion of the tube. The usual fastening for this component is a wing nut, which is loosened. (Through age, the yoke may stick. Very gently work it loose.)

Installation. The new tube is inserted and mounted in the reverse order. Again, gentle handling is important. Just before the tube is strapped and bolted into its mounting, check the position of the anode socket. It should be on the correct side of the chassis to receive the anode cap. Also, check if the tube sits squarely in the mount; not slightly askew. One guide can be the marks indented by the old tube into the rubber or other soft material which retains the front rim of the tube.

The neck components are installed as closely as possible in their original locations. These positions, however will rarely be absolutely accurate, so don't give them a final tightening at this time. After you've checked everything for completeness, don't turn on the set. The following step applies if the tube uses an ion trap. Turn the brightness control about half-way up. Place a mirror in front of the set (if necessary) so the screen can be viewed while you're at the rear of the

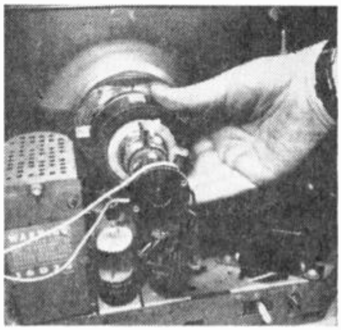


When replacing yoke on a new tube, make sure it seats against flare of tube, or picture won't fill screen.

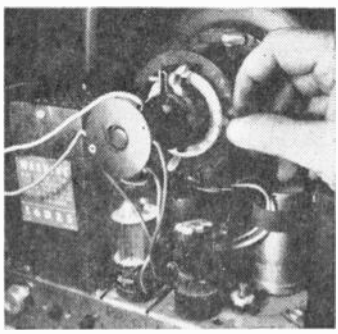
Before replacing the back cover, check the picture for alignment on the screen. If it isn't horizontal as here, the yoke must be rotated on the tube neck.

set with one hand on the ion trap. Now have someone turn on the power. Quickly rotate the trap about the neck, and move it back and forth, until brightness appears on the screen. If two positions provide light, use the brighter of the two. This position should be found within a minute to prevent heavy ions in the electron gun from bombarding the screen and causing possible damage. Now, move the trap slightly to find the point of maximum brightness. (If you're a photo fan, you can use this trick: an exposure meter placed in front of the screen makes the job easier; watch pin for highest indication.)

Back in Focus. Now get a picture on the screen. Are its fine horizontal lines slanting? If so, small rotation of the deflection yoke permits correction. Just be sure that the yoke remains snugly against the bell of the picture tube or the image may not fully fill the screen. When grasping the yoke, hold only its insulated portion. It may be difficult, while adjusting the yoke, to check the picture for its true horizontal position (unless words, for example, appear on the screen). A convenient method is to adjust the set's vertical hold control so a thick black bar appears on the middle of the screen. This serves a good horizontal reference. Corner shadows or incorrect picture position are corrected by moving the tabs on the centering assembly. Finally, touch up ion trap again; other adjustments may have thrown it off slightly. ■

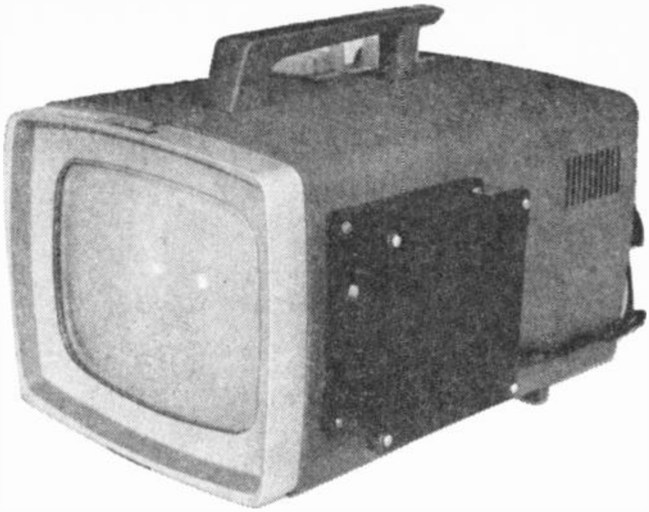


When rotating the yoke around the tube neck, grasp only the insulated cover of the yoke.



To center picture on screen adjust the two metal tabs on the centering of magnet assembly.

With a fan added to your TV set, cool air can be pushed into the front of the set, circulated around hot tubes, and vented out the rear louvers and grille.

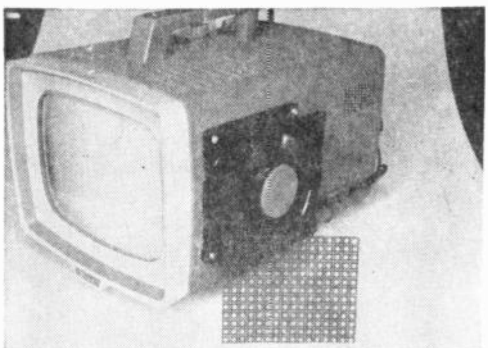


PLAN TO BEAT THE HEAT

It's like the Sahara in your TV set unless you fan it cool

By Fred Blechman, K6UGT

IF you own a portable television set, you may find the handle too hot to handle after a few hours of continuous use. Many of the sets on the market today are not adequately ventilated and the heat build up inside the set results in costly repairs and a shortened life for your TV set. Therefore, it will be wise to add an air circulating fan to the set to prolong its useful entertaining life.

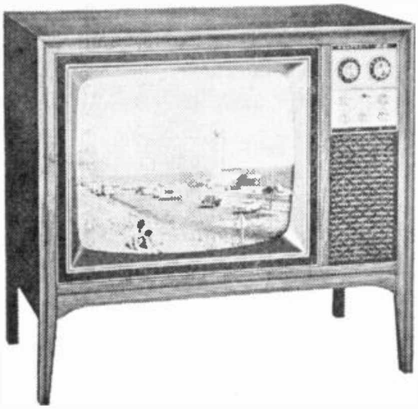


An aluminum grille panel cut to size mounts directly over the "Whisper Fan" input port to prevent accidental injuries and sucking up large particles and papers into the TV cabinet.

Originally designed for hi-fi installations, the Rotron "Whisper Fan" is engineered to operate at an inaudible sound level (minus 18 db speech interference) while delivering 65 cubic feet of air per minute. The 4¾" x 4¾" x 1½" unit draws 7 watts from the 115-volt power line. Pre-lubricated bearings and relatively low speed for a fan (2000 rpm) ensure long-life operation for the fan and the TV set. There are other fans on the market, both new and surplus. Be very careful when you buy. The fan must be able to work off the AC power line continuously without overheating and to operate at a very low noise level so as not to disturb your listening pleasure. Also, avoid fans with brushes—they may cause TV snow.

The fan can be installed directly over existing vent holes without cutting any holes as the author did. However, efficiency will be higher if you reduce back pressure on the fan by cutting or punching a larger hole. Secure the fan in place and connect the fan's leads to the TV set's circuitry so that it comes on when the set is turned on. To avoid broken or cut fingers, cut a piece of decorative aluminum grille to fit over the fan's input port. The grille will keep fingers out of harms way. The brackets, pressure-sensitive foam pad, vibration grommets, bolts and nuts come with the fan, however the author found the vibration isolation unnecessary. ■

Servicing is a snap when you...



BUILD YOUR OWN COLOR TV

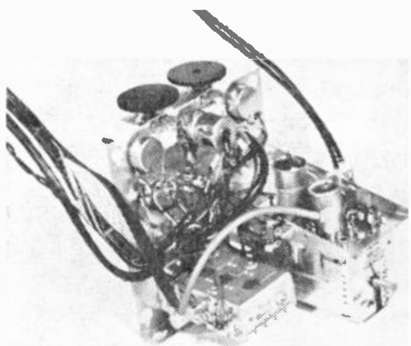
What makes the real difference between a good and a poor *color television* receiver? No, *a good picture* is not the answer as most modern color sets deliver an acceptable color picture. The real difference between what the consumer considers a good or bad color set is the number of service calls required to keep it going and the charges for those calls. Over the life of a color set, repair and service call costs can exceed $200. But, build the color set yourself and you will save several hundred dollars in repairs plus wind up with better color as you'll align the color reception to what *you*—not a serviceman—thinks is good to look at.

No, we haven't flipped our tri-color CRT, or our shadow mask either. If you build Heathkit's GR-25 Color TV Set you can do your own servicing because, firstly, the very process of building the kit will give you the confidence to do your own color alignment, and secondly, unlike other color receivers the Heath GR-25 has its own built-in *user oriented* service and alignment instructions. Absolutely no instruments are required to align the Heath; any test circuit you'll need is built into the GR-25.

For Example. Suppose a factory wired color receiver loses the color adjustments, or the set is moved to a new location and requires a degaussing. Obviously, this usually means a service call. But if you have a GR-25 you just lean on the speaker panel and the color dynamic convergence controls swing down in front of the set. What happens if you need a dot generator? Simple, you throw a switch on the back of the GR-25 and you get a dot pattern. Gun killers?—they're built in. As for degaussing, you do that with the supplied degausser when you build the kit so there's no big deal in doing it again. An automatic CRT degausser is built-in and works with the on-off switch.

It's Easy to Build. The actual kit construction is in a sense a *minor* assembly as the major components are supplied pre-wired—what's left for the user is the point to point wiring between the sub-assemblies and the non-critical circuitry. The combination VHF-UHF front-end is supplied pre-wired and pre-aligned. Similarly, the IF amplifiers are supplied pre-wired and pre-aligned on a printed circuit board. The user assembles the color, sound-sync, and convergence printed circuit boards. Wiring between the circuits is *via* a factory supplied wiring harness. Total construction time runs about 25 hours.

Color. When construction is completed you have an operating color receiver, just like your neighbors who have purchased theirs. The big difference is that *you* are able



Perfect for custom installations, Heath color set has VHF and UHF tuners, plus all user-operated controls, located on separate chassis.

to adjust *your* receiver for optimum color reception. To assist you in color adjustment the Heath service procedure is illustrated with 4-color pictures that show you exactly the results to be obtained.

Optimum color adjustment starts with the DC convergence adjustments (static alignment), and Heath's *service extras* start here. The static color gun adjustments snap into the plastic yoke and they are *knob* controlled; instead of pushing magnets around until the central dots on the screen turn white you simply *rotate* four knobs (two required for blue). The color-circuit board directly above the CRT has the dot generator on-off switch and the three gun-killers (no need to cut into the CRT wiring to kill any of the color guns for adjustment).

The dynamic convergence controls are mounted on a sub-panel behind the speaker. When the speaker is swung forward—it is hinged on the bottom—the dynamic convergence control panel swings into the position formerly occupied by the speaker. The panel contains 12 controls which adjust for convergence at the top, bottom and sides of the CRT in both the horizontal and vertical direction.

To correct for pincushion distortion, when the top, bottom and sides of the picture squeeze together on the *H* and *V* central axis, there is a *user adjusted* pincushion control that is used in conjunction with the dot generator. The controls are common to all rectangular CRT color TV receivers.

Final adjustment consists of adjusting the standard front panel *TINT* and *COLOR* controls, and the color burst phase transformer for normal flesh tones. A switch to a black and white picture indicates if the *color-killer control* needs adjustment—as evidenced by colored confetti flashing in the picture.

And that's it. As you can see, not only are the GR-25's adjustments specifically oriented towards the non-technical constructor, but the builder, even without a technical background becomes familiar with color set adjustments and can routinely tackle color circuit re-alignment any time he is not satisfied with the color reception. At no time is it necessary for the builder to make a technical decision as far as color alignment is concerned; the built-in dot generator takes care of the technical requirements and the user makes simple mechanical adjustments whose effects can be seen directly on the CRT.

Service. Of course, it is possible for a breakdown to occur, but 99% of possible breakdowns can be handled by the builder—

Bigger yoke, more controls are earmarks of any color set. But since you put set together, you should understand it from the inside out.

thanks in large measure to a very thorough service manual that indicates possible defects in 4-color photographs. In addition, there are two *signal flow* diagrams; the first showing the signal flow through individual circuits and the second indicating graphically the tubes, coils and transformers through which the individual signals pass.

We have concentrated on the service aspects of the Heath rectangular-CRT color receiver because color TV has meant a return to the service conditions of 1946-1947, when virtually everyone purchased a *black-&-white* receiver with a service contract costing in excess of $40. Whereas *black-&-white* TV has been improved to the point where many consumers can service their own set (it's generally a tube change), just a tube change or a minor component change can mean *complete servicing* for a color receiver. Therefore, the user who can service and adjust his own color receiver saves considerable monies over the life of the set as well as *always* enjoying excellent color reception. For further information on the Heathkit GR-25 Color TV Set write to Heath Co., Dept. EB, Benton Harbor, Michigan. ■

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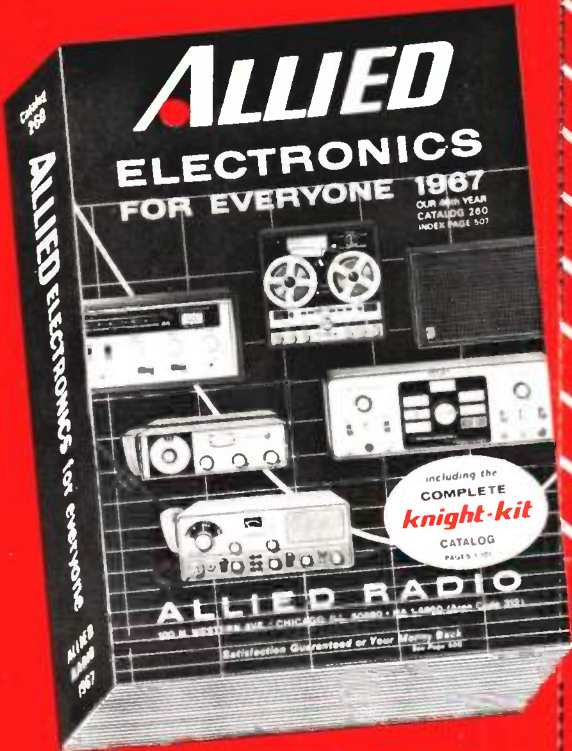

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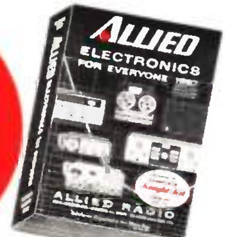

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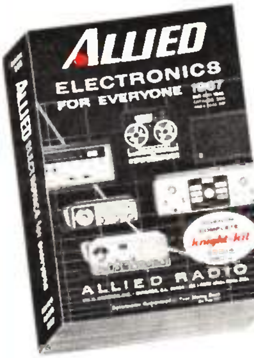

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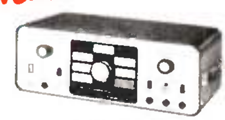

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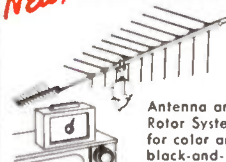

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OPERATION TUNER TOUCH-UP

■ To borrow a phrase from one old-time technician: "I'd rather fix a dead FM tuner than one that plays a little bit." It makes sense. Most inoperative sets have just one bad part. But a circuit that just won't sound right can make a repairman wish he'd stuck to plumbing. That kind of trouble can be general debility—not one bad part, but an adding up of many minor defects. If your tuner is more than three or four years old, chances are it's beginning to develop the symptoms. And you may not even hear it. The process is so slow that loss of quality is not immediately apparent. That is, until you go to a hi-fi show or dealer and hear once again what quality FM can really sound like.

Since the problem is a general one, the solution, too, is general. The tuner is probably ready for a good going-over. Some parts, in fact, can be renewed even when they

TV REPAIR

TUNER TOUCH-UP

seem trouble-free. Take the case of an aging RF amplifier.

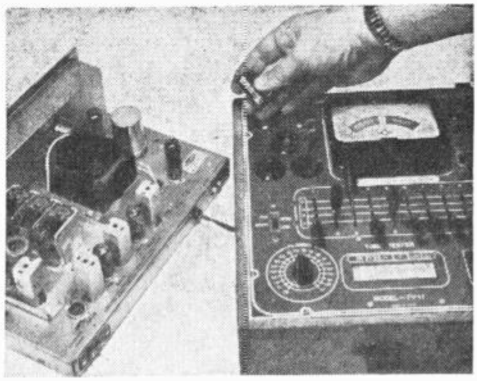
Vacuum Tubes. Most of the tuner's sensitivity—the ability to amplify a signal and not the noise—is determined in the front-end section. The big burden falls on the RF amplifier tube. When it ages, noise usually begins to creep up. Weaker stations are not received as well as when the tuner was new. And to compound the problem, such tubes usually check OK on a tube tester. So to head off problems in the front end, it's a good idea to replace the RF amplifier tube at least every two years, even though it seems to perform satisfactorily.

Another touchy tube also occurs in the front end. It's the local oscillator. One clue to a declining tube in this section is drift; the tuner requires returning one or more times after it's turned on. This could be caused by shifting element spacing within the tube and consequent changes in oscillator frequency. A fresh tube can eliminate this annoying inconvenience.

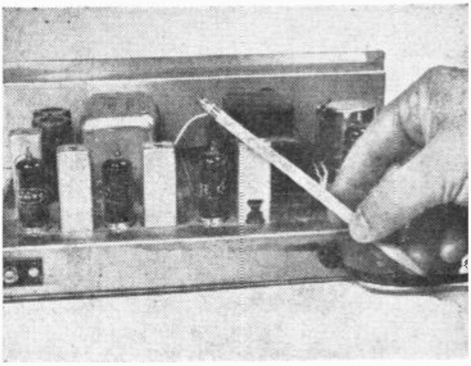
Other tubes in the FM tuner tend to be less critical since they handle lower frequencies. Yet they have their share of troubles. Consider IF tubes in the intermediate-frequency amplifier. They are especially subject to microphonics, a condition where loose tube elements vibrate and introduce false signals. You can check this by tapping the tube with an eraser and listening for a ringing sound in the loudspeaker. Another tube difficulty is a high-resistance short which develops between elements; this may not actually disable the tuner, but it may be troublesome enough to introduce hum or distortion.

These tube troubles may not show up on a tube checker—especially the corner drugstore type. Unless you have access to a high-quality checker (transconductance type) the most effective method is tube substitution. With a set of new tubes on hand, it is a simple matter to check each major stage in the receiver. Note carefully the difference in performance as each tube is replaced. You may detect small changes in hum level, hiss or sound quality. Vacuum tubes are responsible for more than about 80 percent of all tuner trouble.

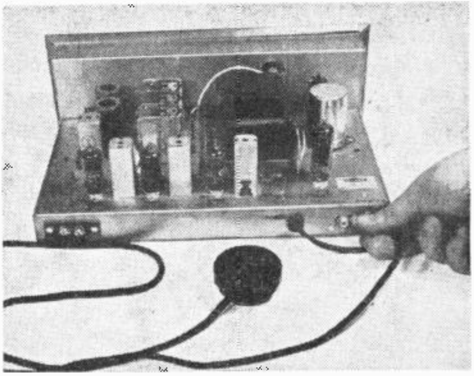
Mechanical. The tuner, essentially an electronic device, is also mechanical. Whenever



Always check out vacuum tubes before doing anything else. About 80-percent of tuner troubles can be attributed to vacuum tubes. As mentioned in text, vacuum tube trouble in the different stages is indicated by specific "pin-pointing" symptoms in quality of audio performance.



Loose elements in a tube cause microphonics, very odd sounds that make your rig sound as though you're tuned to a concert of electronic music when you tap the faulty tube sharply with the eraser at the end of your pencil.



If you don't have an amplifier and speaker handy on your workbench, just hook up a headphone set in the audio output jack to monitor the output audio signal.

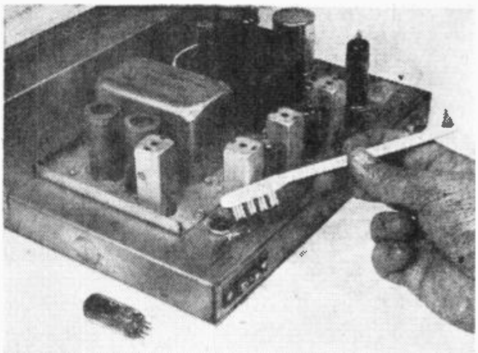
the two are mixed there's bound to be trouble. Mechanical failure produces scratching noise while changing stations, sizzling sounds when the volume control is adjusted . . . or strange cases of intermittent signals due to defective audio plugs and sockets. Here's a case history of what to expect from a tuner that's getting on in years.

One of the tuners shown in the photos developed a classic symptom: several stations could be tuned in smoothly, some signals seemed to pop into place, others just couldn't be latched in. A sputtering sound in the loudspeaker made the rig sound like it had sawdust in its transmission. Since this mainly happened as the tuning dial was rotated, it looked like a case of poor grounds in the tuning capacitor. If you closely examine a variable capacitor you'll see several pieces of springy brass (yellowish in color) soldered to the capacitor frame. They also push against the turning shaft of the capacitor. This insures that the moving plates of the capacitor are always firmly grounded. But spring action may wane, or dirt may work itself in. It sets up an electrical racket and tuning becomes tricky.

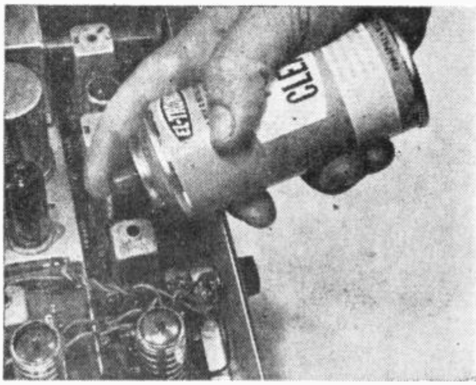
The remedy isn't difficult. Use a cleaner-lubricant (such as GC's Lube-Rex) and introduce a small amount into the various mating surfaces between the brass springs and shaft. Let it work in by rotating the tuning dial several times over its complete range. The result can be surprising, like-new smoothness in tuning. Some tuners, incidently, shield the tuning capacitor with a metal can. This is usually removable by a few screws. Just be careful not to bump the capacitor plates when working in this area.

Another candidate for cleanup is the volume control found on most tuners. After a few years, dirt enters and causes sizzling noise when the control is turned. It can cause some strange effects, too. Old volume controls have been known to change sound level as someone walks across the room. They can also cause hum. These effects usually occur as the sliding element within the control loses some tension or fails to make good contact. These troubles are almost always cured by squirting some cleaner spray into a hole on the body of the control or in the opening around the solder lugs. With these steps completed—all controls cleaned and lubricated—consider the next major step.

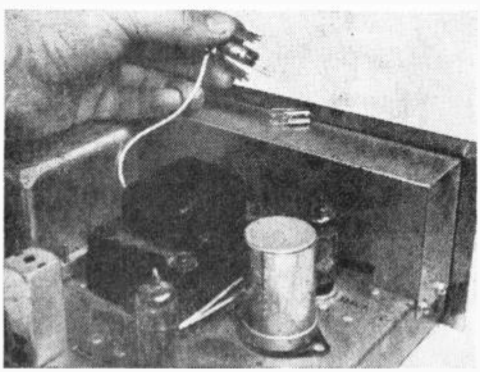
Visual Inspection. Peer into the wiring



You'll wonder where the electrical leakage went when you brush the tops and bottoms of your tube sockets with a commercially available tuner cleaner. Remember to clean that smudged tuning dial glass while tuner's apart



Spray tuner cleaner into switches and controls to renew surfaces and re-establish contact. Don't forget the tuning capacitor; very often movable plates lose contact to ground because of dirt, which results in erratic performance as you tune across dial. Remember, neatness counts.

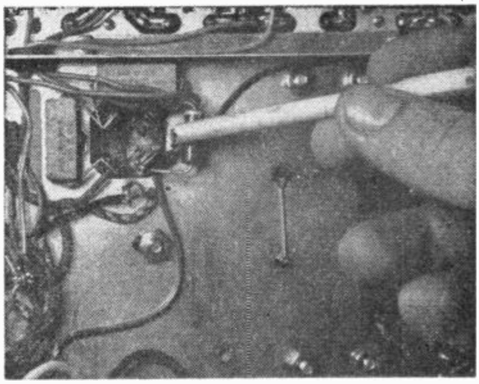


The job of replacing burned out dial illuminating lamps often prompts you to performing a complete overhaul of your tuner. Don't forget those lamps; it's easy to get carried away peaking up the low output of your tuner.

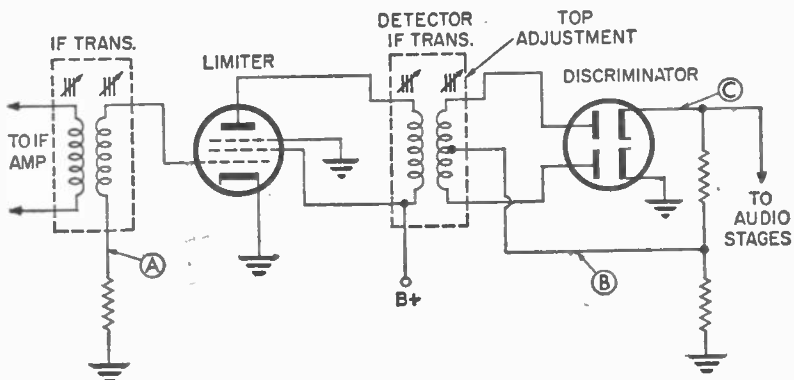
TV REPAIR

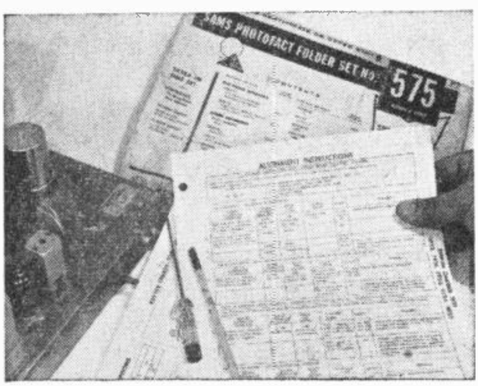
TUNER TOUCH-UP

under the tuner chassis and you may spot trouble, even with no other test instruments than your eye and nose. Use a bright light source, like a lamp next to the chassis. Examine all capacitors. Several might appear to be damaged; with large blobs of matter oozing from their insides. Don't be deceived by this symptom and automatically replace these parts. If the leaking material is ordinary wax, it is normal for this material to sag due to heat developed during tuner operation. The function of wax is to seal the capacitor against moisture. But despite some flow, there is no serious problem. Usually these capacitors are tubular or paper type

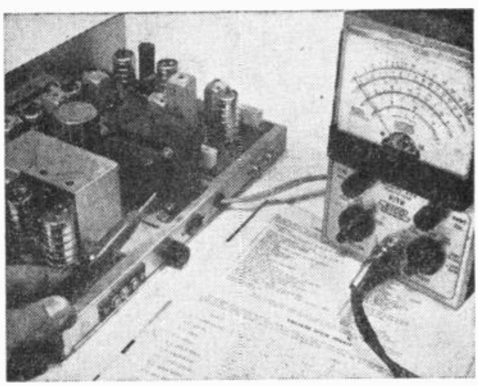


When visually checking the tuner chassis, inspect the lugs around the electrolytic capacitor for a powdery substance which collects if the capacitor has been leaking. Check a suspect electrolytic capacitor with vacuum tube voltmeter for correct voltage. Also, listen for hum.

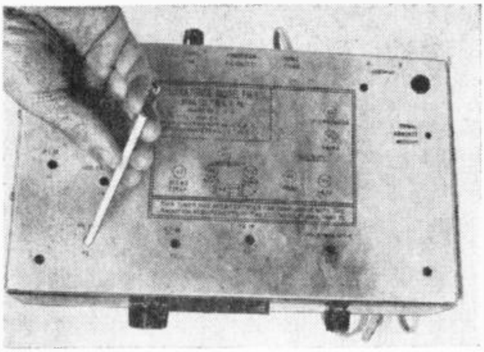




If your FM tuner was built from a kit, you have important alignment information in your booklet; otherwise get service literature such as *Photofact* folder shown here.



Your tuner voltage, resistance, and alignment measurements should be taken with a vacuum tube voltmeter. The VTVM shown here was built from a kit available from *Eico*.

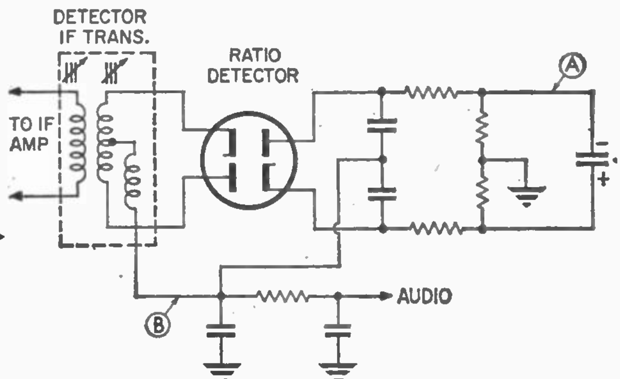


On most tuners the IF alignment is made from the tops of the IF cans, but on some tuners, such as the one shown here, alignment is made through the access holes in the bottom plate. If hole identification marks are beginning to fade, retouch with lacquer—add labels if needed.

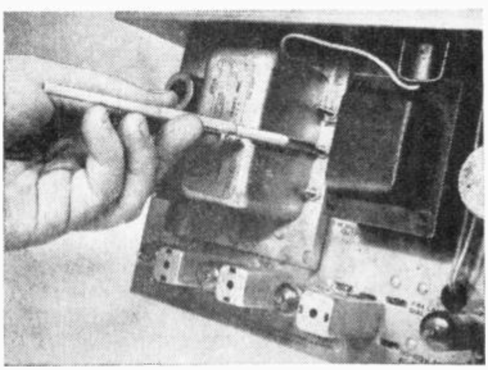
and may be left alone; the excess wax won't short-circuit other parts.

But if you're looking at a large electrolytic capacitor, especially the type mounted in a metal can, leakage could be a sign of trouble. Here the material pushed out of the capacitor appears powdery and collects around the solder lugs. Whether the capacitor needs replacement must be determined by checks described later. But if you're a purist—the kind who wants quality at any price—you can install a new electrolytic, say every three years. After tubes, these components tend to be the most cantankerous. In the aging process, their filtering action may drop somewhat and introduce increasing hum. Also they can cause motorboating; a slow kind of oscillation which produces a put-put sound, especially when the bass control is turned full on. Another

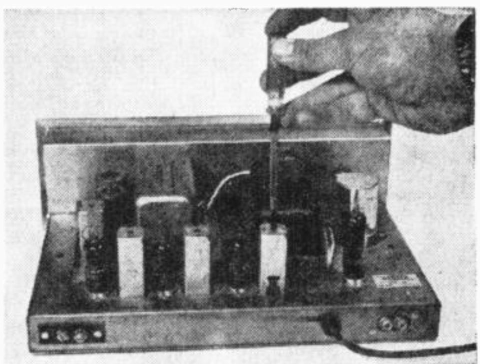
Drawing 1. The schematic diagram of a typical limiter-discriminator shows the alignment points at which voltage measurements are taken (left) VTVM makes IF alignment measurements



Drawing 2. The detector alignment points are given on this schematic diagram of a ratio detector (right). All IF transformers except top of detector transformer are tuned for a maximum negative DC at point A.



Front end alignment of RF amplifier, mixer and local oscillator is not normally required, but when necessary, it's almost a must to have an RF signal generator on hand.



Fragile transformer cores should be adjusted only with the proper alignment tool; it is designed to fit the core perfectly. Use of a screwdriver may cause damage.

problem of old electrolytics: their internal resistance may drop and impose a drain on the power supply, thereby lowering the B+ voltage supply to the rest of the tubes' plate circuits.

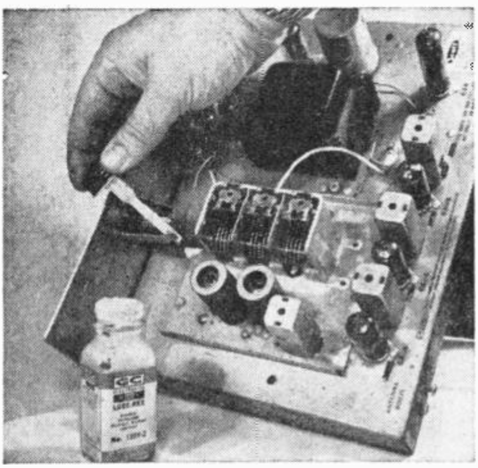
Your eye, with an assist from the nose, can spot charred or blackened components, usually resistors which have become overheated. Again don't be misled by the first glance. Underchassis parts frequently become blackened due to air currents set up by the hot tubes. As air is drawn into the chassis, air-borne grease and dust ride in too and coat the components. So before changing any blackened component, first wipe it off with a cloth. If the material is actually charred and flakes off, it requires replacement.

Circuit Checks. To continue the reviving process in an FM tuner more than human senses is needed. Required is a vacuum-tube voltmeter (VTVM). With this instrument, it is possible to run a fast check of all key test points in the circuit. This is a revealing step. You may run into circuit values which are completely wrong—but fail to produce a dead tuner. Rather, they rob the circuit of full performance capability. The few minutes spent making these measurements are well worth it.

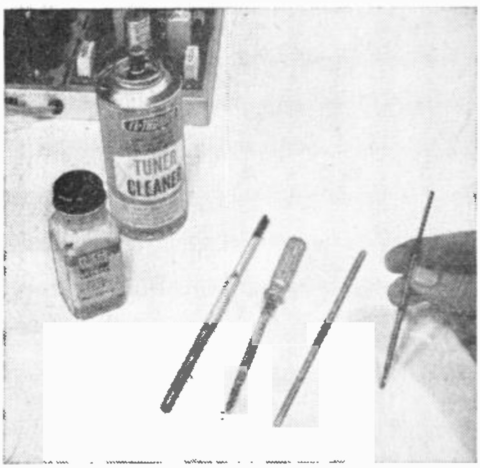
Virtually no significant meter readings can be taken without good service information. If yours is a kit-type tuner, chances are that such data is provided in the instruction manual. Some factory-wired tuners come with an operator's manual which may also contain technical information. Another possibility is writing to the manufacturer for the tuner's service manual. Finally, you can choose the route taken by a large number of servicemen; purchasing service literature designed for troubleshooting the particular tuner model. Such information, for example, is offered in *Photofact* folders, which provide a great amount of detail; parts identification, circuit values and alignment information. They are available through mail-order catalogs or at local electronic distributors.

Start with resistance checks at all tube-socket pins using the resistance chart provided. These readings are taken with the tuner off and unplugged from the AC wall outlet. Occasionally there will be a resistance reading which is considerably off the recommended value. This could be due to capacitors which retain their charge and influence the meter reading. The remedy is to take an insulated screwdriver and short the capacitor to ground.

If all resistances are OK, run a voltage check on all recommended test points. In some cases, voltages are supplied in chart form, in others they are marked directly on the schematic. Don't overlook special precautions to be observed during voltage checks. Some manufacturers, for example, state that voltages must be within 15%, how



GC Electronics' *Lube-Rex* is a specially formulated electronic contact lubricant that is being used here to re-establish contact between capacitor plates and ground.



Among the things you'll need before starting the job are a selection of alignment tools, contact lubricant, and tuner cleaner. Finish up job by waxing your enclosure.

the volume control is set, whether a station is tuned in, etc. These factors affect meter readings.

Alignment. In general, tuners tend to stay in alignment for long periods of time. Unless a coil or transformer has been changed, only slight touch-up of adjustments is in order. You'll need at least two items before attempting the job: the alignment procedure given in the service literature and appropriate tuning tools. These last items are important. The right tool not only speeds the job, but prevents damage to such fragile components as cores inside transformers (which usually powder when turned by a regular screwdriver). Depending on the specific tuner, you'll need either a hex-type plastic tuning rod or a broad-tip, insulated screwdriver made especially for IF transformers. These requirements are frequently given in service literature or you can shine a light into the transformer cans to see the shape of the core. Although specific instructions should be followed, let's consider some general aspects of alignment.

Part of the job can be done without instruments if the tuner has a tuning meter or magic eye. Tune in a station which is only moderately strong (one that doesn't deflect the tuning meter all the way or completely close the tuning eye. Many FM tuners have four or five IF transformers. Locate the one next to the detector stage (farthest from the front end, or tuning section, of the tuner). Adjust the *primary* core of the detector transformer—which is generally the *top* adjustment—for maximum signal on the tuning indicator. Then proceed to the top and bottom adjustments of all remaining transformers, working your way toward the front end of the set. Only slight adjustments should be necessary. It's also important not to touch the tuning dial during any of these adjustments.

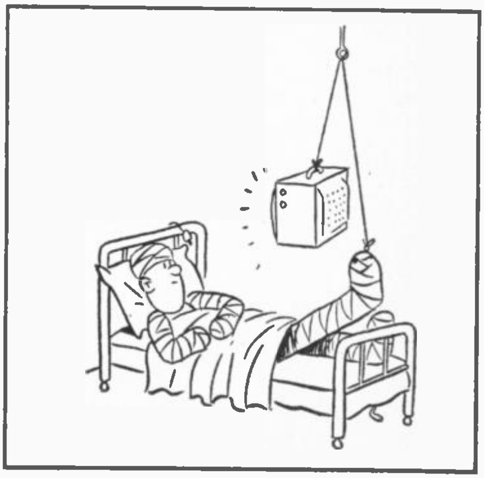
Now return to the detector transformer and its top, or secondary, adjustment. You'll have to connect an amplifier during this procedure so sound quality can be monitored by ear. Carefully adjust the top core for least distortion and hum.

If the tuner has no built-in tuning indicator, a VTVM is used for IF alignment. Shown in Drawing 1 is a simplified schematic diagram of a limiter stage used in FM receivers having a discriminator-type detector. The VTVM is set up to read low negative DC voltage at point A shown in the diagram. The IF transformer cores (except for the top and bottom of the detector transformer) are adjusted for maximum negative voltage. Next place a 1-megohm resistor in series with the negative probe and touch it to point B. The bottom of the detector transformer is tuned for maximum reading. The final step is adjusting the VTVM so it reads at zero-center (usually done by placing its function switch on negative and setting the needle at center scale with the zero adjust). Place the VTVM probe at point C. Adjust the top of the detector transformer for zero volts. It's important to observe the following during this adjustment: while the top core is adjusted, the meter needle must swing through positive and negative on either side of zero.

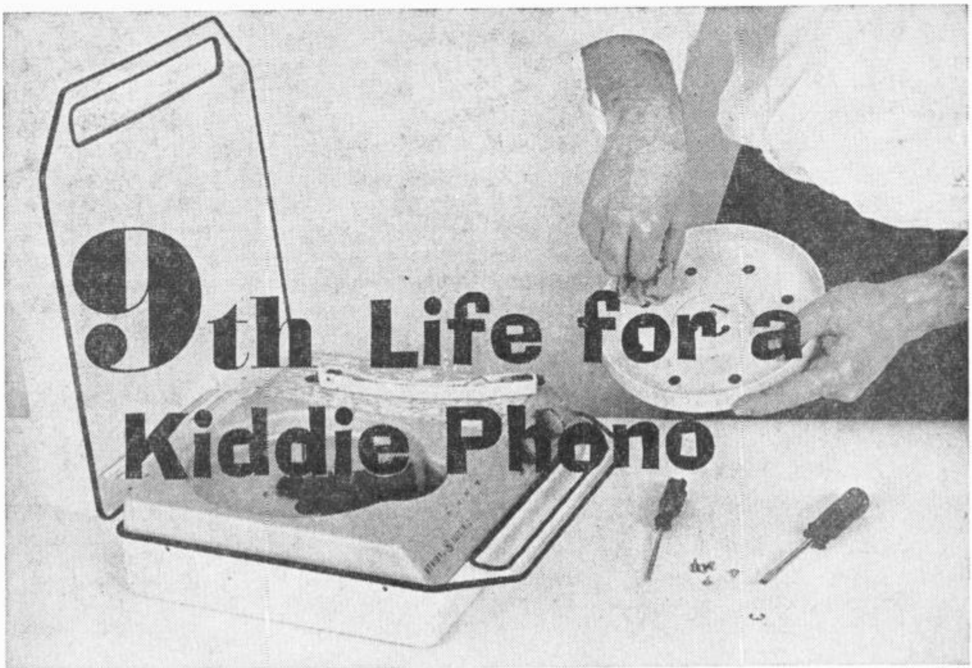
If your tuner has a ratio detector, like the circuit shown in Drawing 2, alignment points are slightly different. Tune all transformers for maximum negative DC at point A, except the top of the detector transformer. Shift the VTVM to point B and tune the top of the detector transformer for zero volts, using the zero-center technique described above for the discriminator circuit.

The only remaining area of alignment is the tuner front end; RF amplifier, mixer and local oscillator. Since they operate at extremely high frequencies it is best not to attempt alignment without a signal generator.

As a final step for reviving an FM tuner, recheck the antenna. Any improvement here can pay off handsomely. The antenna system should be in perfect condition from the tuner terminals to the top of the mast. If a separate FM antenna is not used, a coupling transformer tapped into the twinlead of a TV antenna can also produce good results; perhaps even pulling in a couple of more FM stations from distant points. ■



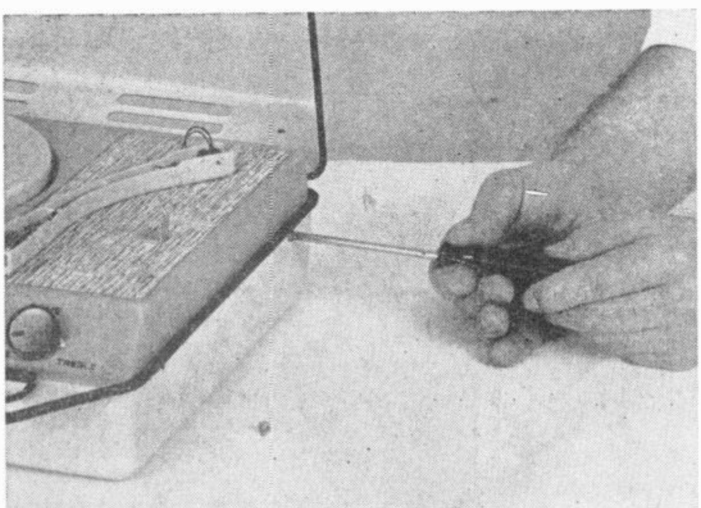
9th Life for a Kiddie Phono



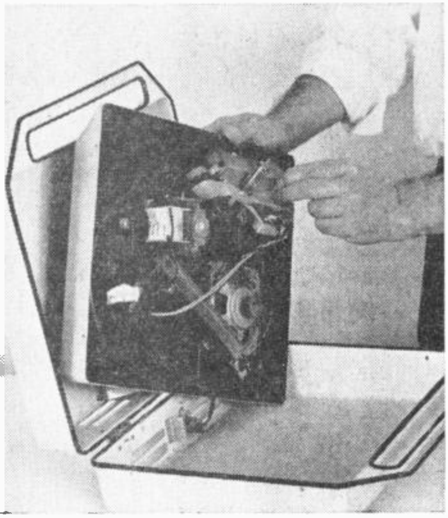
■ If your child's phonograph has given up the ghost for what you insist *has* to be the last time, think again. For a kiddie phono is so simple a gadget it's bound to have nine lives (perhaps even ninety-nine) before it ends in the trash can. And whether due for its ninth or its ninety-ninth life, any kiddie phono requires a minimum of skill to return to working order.

One of the reasons kiddie phonos are such a breeze to repair stems from the fact that there is really very little that can go wrong. Basically, any kiddie phono consists of a motor and turntable, a pickup and cartridge, an amplifier and speaker—plus a cabinet to house the lot. And aside from a broken cabinet, most repairs to kiddie phonos center around one of these three basic areas. In other words, it's either the motor and turntable, the pickup and cartridge, or the amplifier and speaker that are due for attention. Let's start with motor-turntable problems.

Unless the motor has conked out completely—in which case the entire assembly should be replaced, a general cleanup will probably put things back in the AOK cate-



Kiddie phonos vary widely in general mechanical layout and construction, but this General Electric player is not unlike several other brands that have been on the market at one time or another. Disassembling this unit required unplugging line cord from socket at rear, then removing series of Phillips-head screws with a screwdriver.



Amplifier/speaker section of kiddie phono generally contains one or two tubes in an AC/DC circuit. Inoperative amplifier usually stems from burned-out tube; damaged speaker often proves to be the cause of distorted sound.

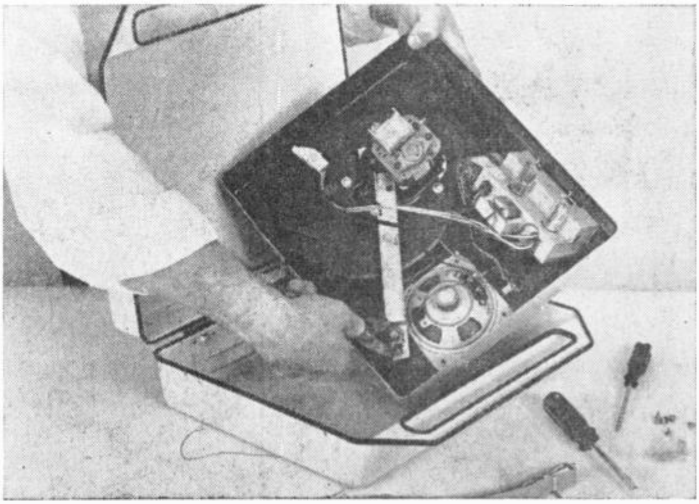
Cartridge and tone arm easily fall prey to injury (note absence of tone-arm base in player above). Needle should almost always be renewed with exact replacement, as should both tone arm and cartridge, if condition warrants.

gory. This can easily be accomplished by removing the pin or E-ring from the turntable, carefully pulling the turntable from the spindle, then cleaning the underside of the turntable as well as the motor shaft and idler assembly with a suitable solvent—a small bottle of GC carbon tetrachloride being a good choice. Use the cleaner sparingly on rubber parts, and be certain to clean the rim of the turntable thoroughly (see photo at top of facing page).

A new needle (now generally referred to as a *stylus*) should put the arm-and-cartridge combo back in like-new condition unless either or both has been damaged. If they have, it's usually best to replace both with a new arm-and-cartridge assembly as shown in the photos.

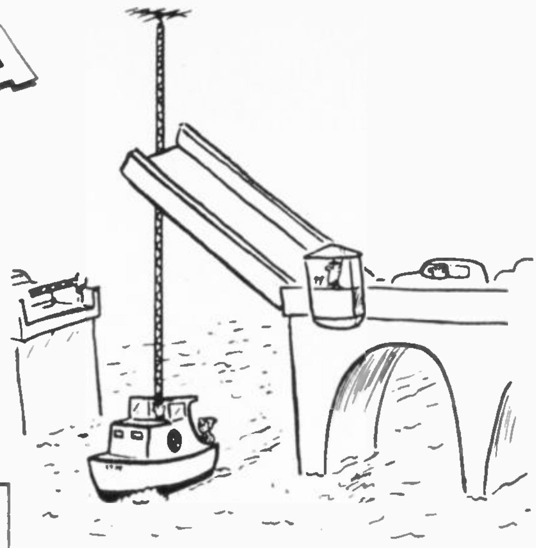
As for the amplifier and speaker, burned out tubes and punctured speaker cones account for something like 90% of kiddie phono troubles in this area. Effecting a cure is almost child's play—plug in a new tube or toss in a new speaker, and you'll have every reason to expect that the set will play like new again.—*Ron Mitchell* ■

After carefully noting wiring of leads running into amplifier from cartridge, leads were unsoldered, then single hex nut was unscrewed to permit removal of tone-arm assembly. Since new tone arm was virtual duplicate of damaged unit, fitting it in place called for little more than a reversal of disassembly procedure.

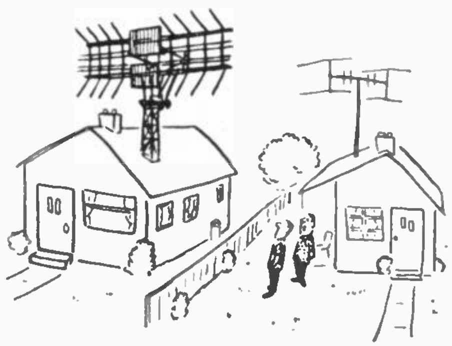


ANTENNA ANTICS

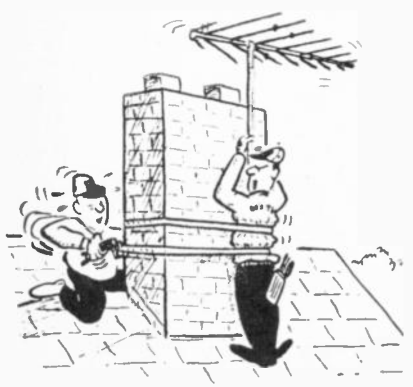
By Jack Schmidt



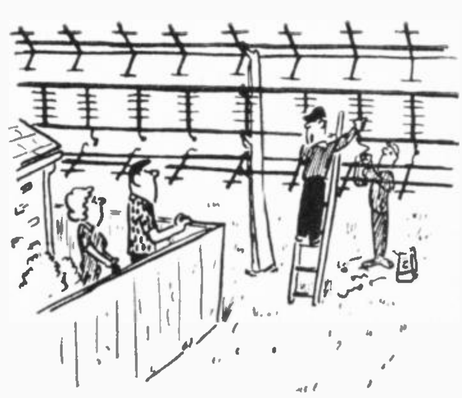
They finally got here to trim the trees!



It's a fake!
He doesn't even have a TV set.

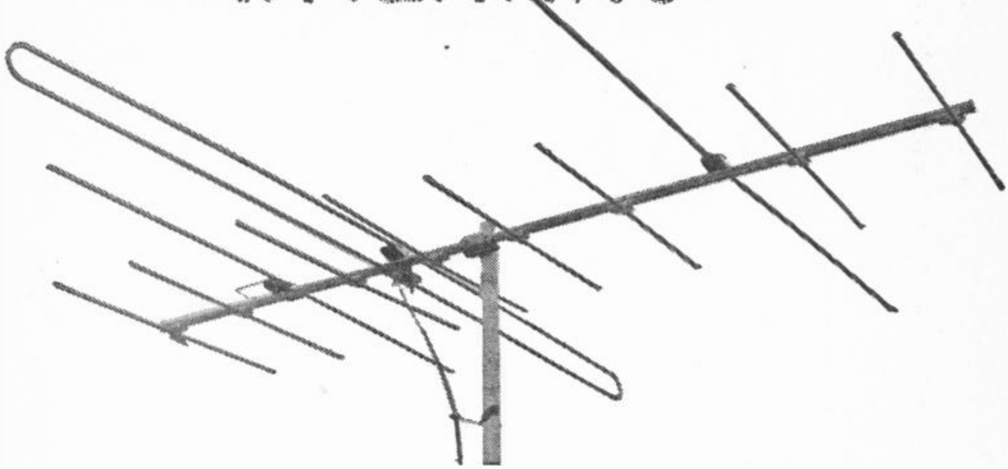


Hold it—hold it—hold it!!!



Relax Bud, this isn't mine! It's part of the instrument system for a new airport here!

ANTENNAS



. . . silent partners that can make or break the performance of any TV or FM set

■ There's no big mystery about TV and FM antennas—they are nothing more than the parts required to deliver a signal to your television set or FM receiver. It may be as simple as an indoor antenna and a short length of lead in. A more complex system could have several additional parts, such as a signal amplifier, multiset coupler, etc. The job of the antenna system is to deliver a strong, noise-free signal to every set connected to it. Here are some professional types to help you select and install the system that will provide the best possible reception, at the lowest cost.

Before we get into the practical side of selecting and installing an antenna system, let us indulge in some basic antenna theory.

Broadcasting. TV and FM signals are basically the same as those of AM radio, except they contain more information, and are higher in frequency. As in the case of AM, the TV and FM signals radiate from the transmitting tower in all directions to any antenna that may be within their range. The signal strength at any point depends upon how strong the signals were when they left the transmitting antenna and the distance they traveled. The terrain over which the signal travels is also important. Mountains and tall buildings will stop a signal dead, and leave a "shadow" on the other side. We'll discuss the shadow problem later. Over water or flat land, a TV or FM signal will go clear out to the horizon—getting weaker and weaker every foot of the way.

The region surrounding a TV transmitter is divided into different reception areas according to the strength of the signal in each area. Close in, we have the *local* area, then comes the *intermediate* or *suburban* followed by *fringe* and *ultra fringe* areas. No matter which area a receiver is in, it must obtain a certain minimum amount of clean signal before it will give a clear, stable picture, or good FM reception. For a few older sets, the minimum is about 50 microvolts per meter; for newer sets, it is less.

The phrase, *50 microvolts per meter* means that the signal passed from the receiving antenna to the receiver must be equivalent to what a field-strength meter with an antenna tuned to that signal would show as 50 microvolts for each meter of length of the antenna arms. When a TV set front-end receives at least this amount of signal, all of its circuits function normally and give a stable, contrasty picture.

Whether a receiver gets this minimum-signal strength depends upon its antenna and the area. In the local area of a particular TV-transmitting station, the signal may be as strong as 10,000 microvolts or more.

Where an indoor antenna is just not strong enough, it is necessary to go to an outdoor antenna, mounted so that it gets a clear view of the transmitting antenna. An outdoor antenna will also have more arms, or elements, than an indoor antenna. Generally speaking, the more you have to intercept the signal, the more signal you trap. However, the antenna design (configuration) is frequently more important than the number of elements.

To understand the basics of antenna design, we'll have to understand the common terms used by antenna engineers and manufacturers.

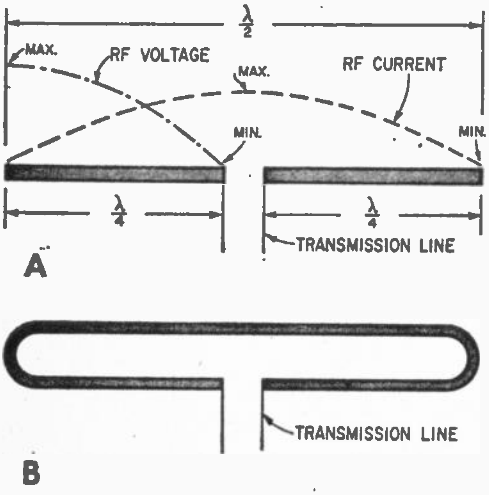


Fig. 1. The dipole antenna (A) is basic to communications by amateur (Ham) and commercial stations as well as FM and TV. RF voltage and current are easy to measure when connected to transmitter. Folded-dipole (B) matches 300-ohm impedance twin-line lead-in.

Dipole Antenna. A dipole antenna has one element—but two arms or legs—as shown in Fig. 1. A dipole is center fed and a half-wavelength long—a resonant circuit (an open-circuited, quarter-wave) with voltage maximums at the dipole ends, and a current maximum at the center. A dipole usually consists of aluminum tubing positioned in a straight line. If a single length of tubing is used, bent over double (as in Fig. 1B), it is called a *folded dipole.*

Parasitic Array. By itself, a dipole will receive signals equally well from front, back, top and bottom—which also picks up any interference, so parasitic arrays are used to give the basic dipole some measure of directivity. A parasitic array is a dipole antenna that has a passive or nondriven (parasitic) element in addition to the driven element. Both *reflectors* and *directors* may be used in parasitic arrays as in Fig. 2.

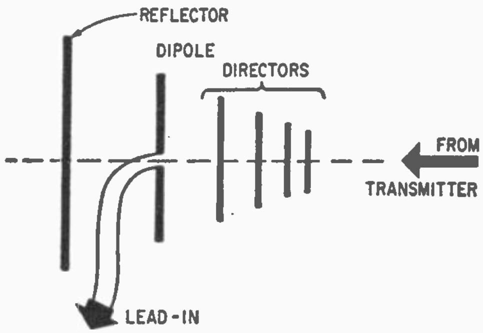


Fig. 2. Parasitic elements, those without physical connection to lead-in, lower antenna impedance and bandwidth. Length and spacing are very important.

Reflectors and Directors. A reflector is cut approximately 50% longer than the driven element (dipole), and a director is cut approximately 5% shorter. The director is placed on the signal side of the driven element, while the reflector is on the opposite side. The elements are spaced one-tenth to fifteen-hundredths of a full wavelength apart. Some of the longer parasitic arrays may have 16 or more elements.

All other factors being equal, the more elements an antenna has, the higher the gain and the greater the directivity (the narrower the beam width). This is not to be confused with frequency sharpness or bandwidth. Usually, frequency sharpness is dependent upon the thickness or diameter of the elements. The small-diameter elements (thin wire) will have maximum frequency sharpness. The bandwidth, or relative Q, will broaden out as the diameter of the elements increases. This is shown in Fig. 3.

An antenna with a sharp resonant peak at its operating frequency, such as a thin-wire dipole, is said to have a high Q (Fig. 3A). Antennas with a broad resonance curve (Fig. 3B) have a lower Q. It should be noted that a high-Q antenna is not necessarily the best for all purposes. A high-Q antennna will receive one frequency or a narrow band of frequencies quite well. A low-Q antenna will cover a wide range of frequencies.

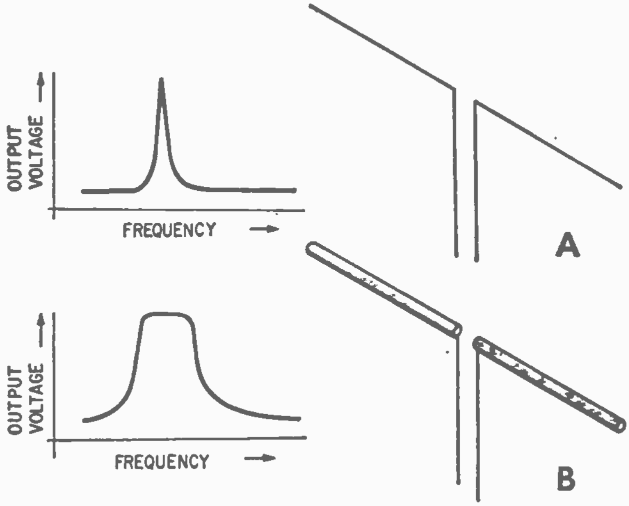
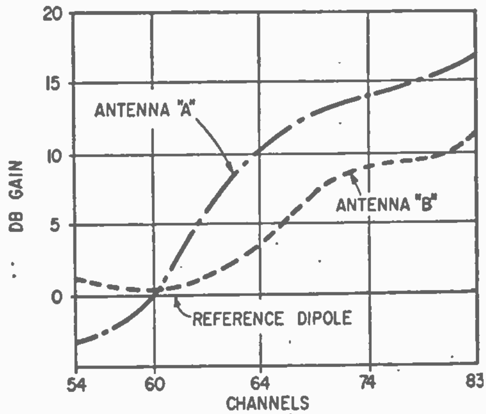


Fig. 3. Diameter of conductors used for dipole arms affects bandwidth of antenna. Antenna is actually a tuned circuit—tuned by length of dipole arms. Thin conductor (A) has sharp tuning but tubing (B) broadens response.

Fig. 4. Antennas are analyzed by receiving or transmitting signals through newly designed antenna and reference dipole. Transmission and reception characteristics are identical with any given antenna which makes tests simpler.



Antenna Gain. The gain of an antenna is measured by comparing the voltage produced at the terminals of the antenna with that of a thin-wire dipole of the same size, operating at the same frequency, in the same location. Antenna gain is normally expressed in decibels (db), since it is essentially a ratio. The equation is the same as for any other voltage ratio:

$$\text{Antenna gain} = 20 \log \frac{E_1}{E_2}$$

where: Antenna gain is in decibels

E_1 is the voltage induced in the unknown antenna, in microvolts

E_2 is the voltage induced in the reference antenna, in microvolts

Antenna gain is often shown in a gain curve or gain chart such as Fig. 4. Usually, the zero-db line indicates the gain of the thin-wire dipole to which the antenna is being compared.

Antenna Directivity. This is a measure of the antenna's ability to receive signals from one direction and reject those from other directions. Graphically, it is usually shown on horizontal directivity or polar patterns similar to that in Fig. 5. On such diagrams the antenna is considered as being at the center of the graph. The pattern surrounding this point show the relative sensitivity or response in any given direction. Theoretically, transmitters of equal power, located at any point on the curves shown, would produce equal voltages in a given antenna. The areas outlined by the curves are called *lobes*. Any area where there is a minimum response, or no response, is called a *null*.

The directivity pattern of an antenna will, of course, vary with the construction. Antenna engineers spend a good part of their time making directivity patterns to show that their particular antenna is more (or less) directive than all other antennas. In general, the more elaborate arrays have a sharper directivity pattern.

When studying directivity patterns in the brochures of antenna manufacturers, with the idea of making a comparison, here is one point to remember. The directivity pattern of an antenna will vary with the frequency, just as does the gain. To use patterns as a basis for comparison, make sure that they apply to the frequency range to be used.

Antenna Beam Width. The beam width of an antenna is an arbitrary measure of directivity. It is measured on the major lobe of the directivity patterns, and its horizontal limits are arbitrarily set at 70% of the maximum response or sensitivity point, as shown in Fig. 6. This corresponds to the practice of measuring the bandwidth of an amplifier.

ANTENNAS

Front-to-Back Ratio. The front-to-back ratio of an antenna is also a measure of directivity. It is a means of expressing directivity in terms of ratio, rather than in the graphic terms of a pattern. A front-to-back ratio of 10-to-1 (10:1) means that the antenna is 10 times as sensitive in one direction as it is in the opposite direction. Front-to-back ratio does not give as good a picture of an antenna's directivity as does a polar diagram, since it does not indicate side lobes, minor lobes, etc.

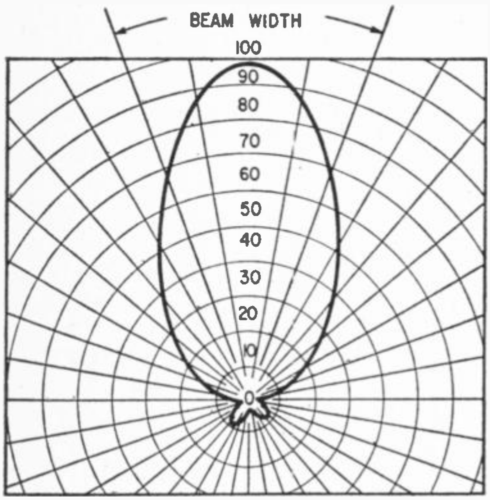


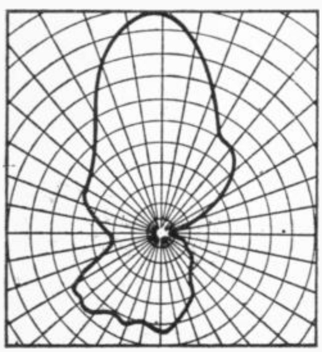
Fig. 6. Antenna beam width is measured at 70% (of maximum signal) points of main lobe. Improved designs have greatly improved fringe-area reception.

Antenna Impedance. Since an antenna is essentially a resonant circuit, it has an impedance. Most TV antennas are designed for a 300-ohm impedance to match a 300-ohm twin-lead antenna lead-in and the set input. However, some antennas have a 72-ohm impedance to match coaxial cable. Although antenna impedance is a problem for designers, it may be of interest to know that the impedance is determined primarily by the spacing between the center-feed points of the dipole, and by the number of parasitic elements.

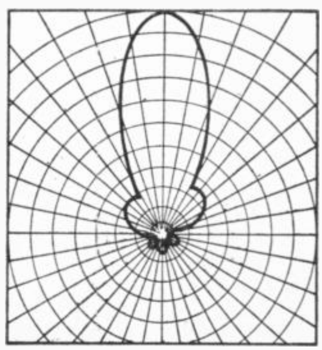
Antenna VSWR. The voltage standing-wave ratio (VSWR) of an antenna is actually a measure of match or mismatch between the antenna and the transmission line or lead-in. When an antenna and the lead-in are perfectly matched (as to impedance) all of the energy or signal will be transferred from the antenna to the lead-in, and there will be minimum signal loss. This is quite rare in actual practice. If a match should occur, it will only be at one specific frequency. At any other frequency, there will be a slight mismatch, and some of the energy will be reflected back into the line. This energy or signal will cancel part of the desired signal. If you could measure the voltage along the line, you would find that there were voltage maximums (where the reflected signal is in phase with the desired signal) and voltage minimums (where the reflected signal is out of phase, partially cancelling the desired signal).

These voltage maximums and minimums are called standing waves, and the ratio of the maximum to the minimum is the standing-wave ratio. A standing-wave ratio of 1:1 means that there are no maximums or minimums (the voltage is constant at any point along the line)—that there is a perfect match between antenna and lead-in. If you have a voltage maximum of 30 volts and a minimum of 10 volts, the VSWR is 1:3 (or 3:1).

Stacked Antennas. An antenna is said to be *stacked* when there are two or more



A



B

Fig. 5. Antenna directivity is diagramed on polar charts showing major and minor lobes of signal pick up. Antennas are rotated while test signals are received and transmitted by complex test equipment. Polar pattern varies from one TV channel to another. Large rear lobe (A) can pick up annoying ghosts. Small, side lobes (B) often must be taken into consideration when aiming antenna for best signal pick up. This is why ghosts may appear on one channel and not on others.

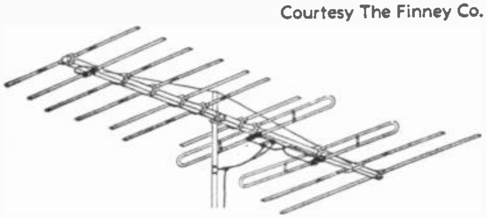
driven elements connected together; or when, in effect, two or more antennas are connected together. Each driven element, with its related reflectors and directors, is called a bay. Therefore, four dipoles with reflectors, all connected together to form an antenna, would be called a four-bay stacked antenna. The stacked antenna is used most often in UHF TV.

Antenna Types. The next step is to study the various antenna types. There are many (perhaps too many) types of antennas available for TV and FM use. Each of these has its own particular advantages and disadvantages. We'll describe some of the various types of antennas but we won't compare the antenna of one manufacturer against that of another or even compare one type against another.

It is obvious that the more elaborate arrays will give better directivity, gain, front-to-back ratio, VSWR, and will cost more money. An elaborate array is not necessary for all installations. It is a waste in strong signal areas and could overload the receiver.

Broad-band antennas (such as the flying arrow for VHF TV, or the bow-tie for UHF TV) will provide good gain over an entire band while narrow-band antennas (such as the Yagi) provide excellent gain over a small portion of the band—you can't have both at

Courtesy The Finney Co.



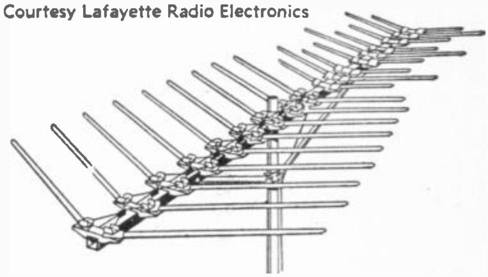
Some Yagis, like this Duo-Twin-Drive antenna, claim range up to 175 miles for color and black-and-white.

the same time. Highly directional antennas will eliminate ghosts and interference by a single lobe pointing directly at the station antenna. Don't expect this same antenna to pick up two stations equally well though, unless the station antennas are in line with each other from your location.

In short, no one antenna will do everything. You must select the antenna to meet the needs of the particular installation. If the signal is strong, any one of a dozen simple antennas (perhaps even an indoor antenna) will bring in a good picture. As the signal gets weaker, you must then use the high-gain antennas, and perhaps even add a booster or amplifier. If there is a particular ghost or interference problem, the narrow-beam antenna will give the best results. If you are concerned with only one frequency, it is possible that a special antenna will give the best results at that frequency.

VHF Antennas. The simplest of all VHF antennas is the *flying arrow*. It is basically a dipole with a single director element. The length is cut (usually) so that it will give maximum gain near the center of the VHF

Courtesy Lafayette Radio Electronics



This log-periodic swept-element antenna is for VHF-TV (chan. 2-13) and FM. 18 elements for 175-mi. range.

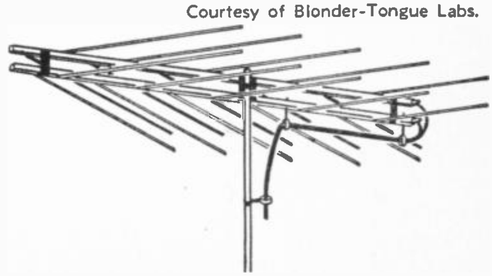
band (Channels 2 to 13), although it is basically a broadband antenna. The flying arrow is not highly directive since it has only one directive element and should be used where the signal is strong, from all stations to be received, and there are few (if any) ghost problems.

Next in line for VHF antennas is the *conical* array. This is similar to the flying arrow, except that it has two forward (or reverse) elements fanned out to simulate a cone-shape. This gives the antenna more interception area to pick up "hot" signal spots. (We will talk about "hot spots" later on under Parabolic Reflectors.)

The remaining VHF antennas can be divided into two major classifications—the Yagi and the Log-Periodic types.

Yagi Antennas. In its various forms, the Yagi is a popular narrow-band, highly directive version of the half-wave dipole. The high directivity of the Yagi is obtained by placing several director elements in front of the di-

Courtesy of Blonder-Tongue Labs.



Basic log-periodic design is modified for color-TV and gives appearance of an entirely different type.

pole. These elements are cut shorter than the dipole, but they are all of the same length. Therefore, all of the elements resonate at the same frequency, providing high gain at that frequency. Signals coming from directly in front of the elements will have maximum gain since they receive the benefit of all director elements, while signals from either side will have less gain since they receive benefit of only a few director elements. This accounts for the high directivity. Usually only one reflector is placed behind the dipole to eliminate the rear lobes. Any number of director elements may be used; more elements provide higher directivity and gain.

The narrow frequency response of the Yagi antenna has advantages and disadvantages. Its selectivity and gain are very useful for a single-channel where reflections produce ghosts that cannot be easily eliminated. If several channels are available, however, a simple Yagi may not be able to receive all of them. Various manufacturers have devised methods to eliminate this problem. The Yagi antenna shown in Fig. 7 covers a wider band than usual. It has dipoles of different lengths. Elements of different lengths provide more than one resonant point across the band—increasing overall frequency response.

Log Periodic. High directivity, with broad-band reception, is obtained by placing several swept-forward reflector elements behind the dipole. These elements are all cut longer than the dipole, but each is progressively or *period*ically longer than the next, increasing in a *log*arithmic progression. Signals directly in line with the dipole will have maximum gain since they receive the benefit of at least one reflector element. This provides the increased directivity. Broadband coverage occurs since at least one reflector is resonant at any point across the band.

UHF Antennas. Basically, UHF-TV antennas are the same as VHF-TV antennas, only they are smaller. The half-wave dipole is still the basic element. Many of the time-proven VHF-antenna designs (parasitic arrays, reflectors, Yagis, log periodics, etc.) are used without change for UHF. In strong signal areas, it is even possible to connect a VHF antenna to the UHF input terminals and get a satisfactory picture.

The significant difference between UHF and VHF antennas is the difference in size. Because UHF antennas are so much smaller, it is possible to manufacture an elaborate, high-gain, multi-element unit at a far lower cost. This means that UHF antennas generally have a higher gain and are more directive than those for VHF. Although the added directivity is not a problem in itself, it does require the UHF antennas be oriented with greater care.

Ghosts. A major problem with UHF-TV is that high-frequency radio waves can be reflected easily by solid objects as shown in Fig. 8. The reflected signal is delayed a few microseconds. The resulting double image, on the TV screen, occurs when a receiver picks up both a direct and a reflected signal. About the only solution to the problem is to use a highly directional antenna. Fortunately, most UHF antennas are more directional

Courtesy Winegard

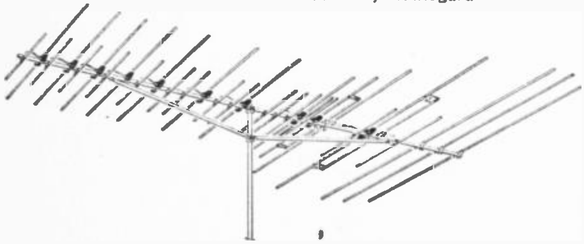


Fig. 7. In spite of the great number of elements, this Yagi antenna has broadband characteristics. Different lengths of elements stagger-tune response and improve pick up over a greater frequency range than is possible with fewer elements.

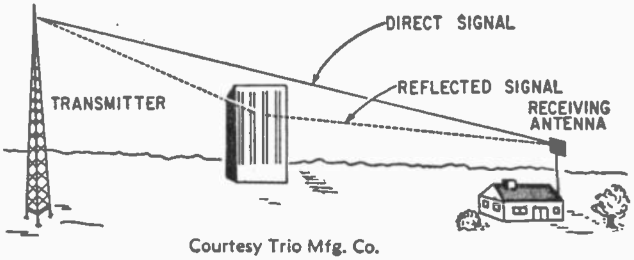


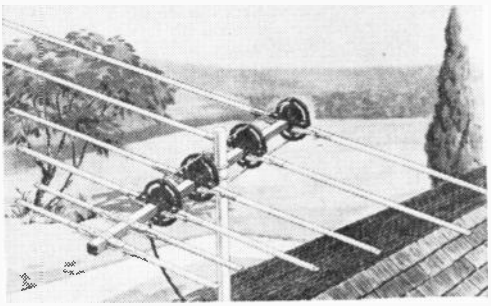
Fig. 8. Modern antennas have eliminated most of the reception problems common in early days of VHF-TV. Rushing to catch up, UHF-TV installation materials are constantly improving as production keeps up with technology.

Courtesy Trio Mfg. Co.

than VHF antennas. They can be oriented on the station's antenna, attenuating signals all other directions. However, this high directivity creates a problem in itself. If a UHF antenna is not *bang on target* considerable signal strength can be lost. The problem becomes more serious when more than one UHF channel is available. Unless the transmitting antennas of all the stations are close together, several receiving antennas or a rotating antenna may be needed.

There are other UHF transmission characteristics that make reception difficult. All other things being equal, a UHF transmitter requires greater power to cover a given broadcast area than a VHF transmitter. Fortunately, this is offset by the fact that the FCC allows more power for UHF stations.

Courtesy Jerrold Electronics Corp.



Another log-periodic antenna for color-TV seems more like Yagi—element interconnections makes the design.

One of the more annoying problems is the line-of-sight effect (Fig. 9). VHF and UHF transmissions differ from lower frequencies in that the VHF and UHF radio signals do not bounce off the ionosphere at these wavelengths; they pass straight through. Only the direct wave can be picked up by the receiving antennas. There is some refraction of VHF radio waves in the troposphere, so reception will occasionally occur at distances greater than the actual line of sight. However, reception of UHF signals is limited to points in a straight line from the transmitter. The ultimate distance of any UHF transmission is limited by the height of the transmitting and receiving antennas. This in itself is no great problem since it is possible to space UHF stations so that additional areas can be covered. However, because of the line-of-sight effect, any obstruction between the transmitting and receiving antennas will attenuate, if not completely block, the signal to the receiving antenna. This effect is known as a *shadow*.

Receivers in the shadow areas (Fig. 9) are blocked from receiving signals from one of the two transmitters. In metropolitan areas, tall buildings can create very effective shadows. Mountains, even low rolling hills, can produce the same condition in country areas. Very little can be done about shadows. The only practical solution is to raise the receiving antenna as high as possible, out of the shadow, so there will be a line-of-sight path between the transmitting and receiving antennas. In shadow areas where the signal is attenuated but not completely blocked, it is possible that a high-gain antenna will produce a strong enough signal for good reception. However, obstructions (tall buildings or mountains) will usually block the signal completely rather than attenuate its strength.

A true shadow area is one where the signal is blocked by an obstruction, even though the receiver is within the local-signal area of the transmitting station. This should not be confused with the fringe area where the signal is attenuated by distance from the transmitter.

The *bow-tie* antenna is a popular UHF broad-band version of the half-wave dipole. The triangular shape is chosen to provide maximum bandwidth. Since the frequency of an antenna is determined by its length, the bow-tie is, in effect, many dipoles cut to various lengths. Length A (Fig. 10) is equivalent to the dipole in Figs. 10b, 10d, and length B is equivalent to the one in Fig. 10c. The bow-tie antenna combines the dipoles of every length between A and B. The dipole at length A is resonant near the low end of the band, while the B length covers the high end of the band. The bow tie offers somewhat

Courtesy Trio Mfg. Co.

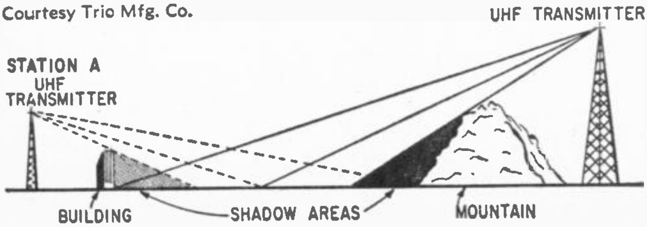


Fig. 9. Any electrical conductor will shadow or reflect VHF and UHF signals—just like radar. Even foliage on trees can affect reception, as can rain clouds or dust and smog. Signals are often stronger after rain.

more gain at the high end of the band than does a simple dipole. However, the principle use of the bow tie is to give broad-band coverage just as the conical antenna (10d) did in the earlier days of TV.

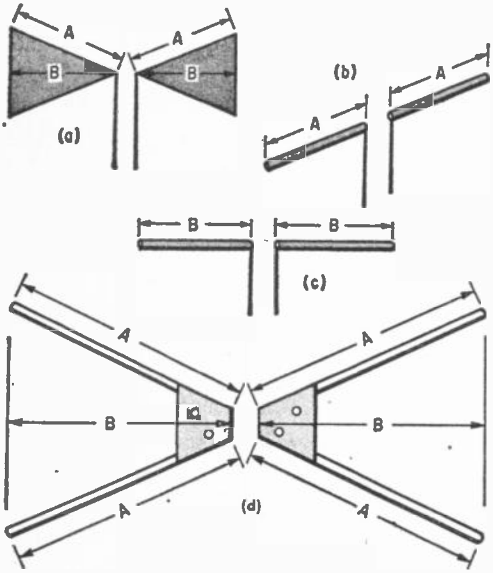


Fig. 10. Bow-tie antenna (a) is derived from the cone antenna. Reduced to its simplest form the outline of the cone, dimensions A and B, become dipoles of the same length in (b) and (c). Conical antenna (d) is easier to visualize as a cone or skeletonized bow-tie antenna of much larger dimensions needed for VHF-TV.

Like other simple dipoles, the horizontal directivity pattern of a bow tie is essentially a figure eight (Fig. 11). As the frequency increases toward the high end of the band, the second harmonic of the low end is approached (the UHF band is almost 2 to 1—470 to 890 megacycles) side lobes appear as shown in Fig. 11, bottom.

Additional gain will result when stacking bow-tie antennas—either vertically, horizontally, or both. The effect of stacking is shown graphically in Fig. 12. When bow-tie antennas are stacked, their feed points are tied together with bars or rods to a common 300-ohm impedance point. Bow-tie antennas can be made directive by adding a reflector to eliminate the rear lobe.

Corner Reflector. Basically a bow-tie antenna with a triangular reflector, it concentrates the signals to the dipole. The top

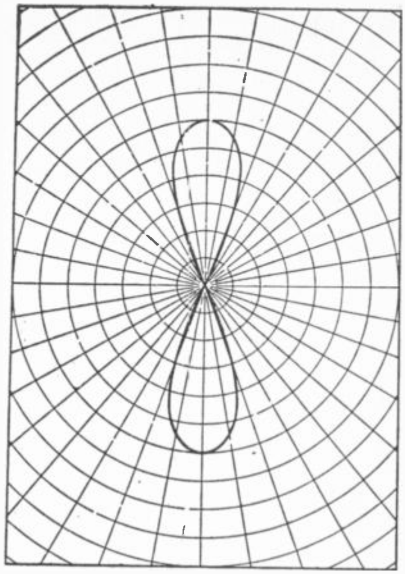
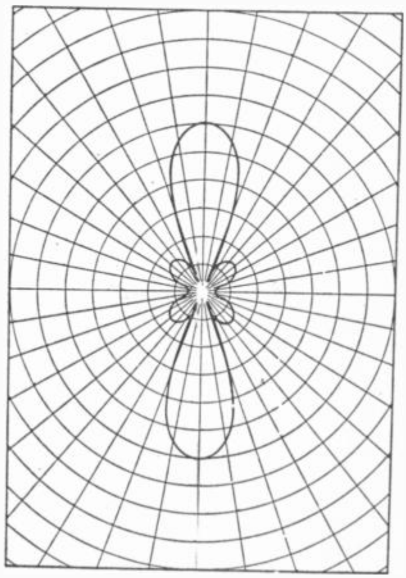
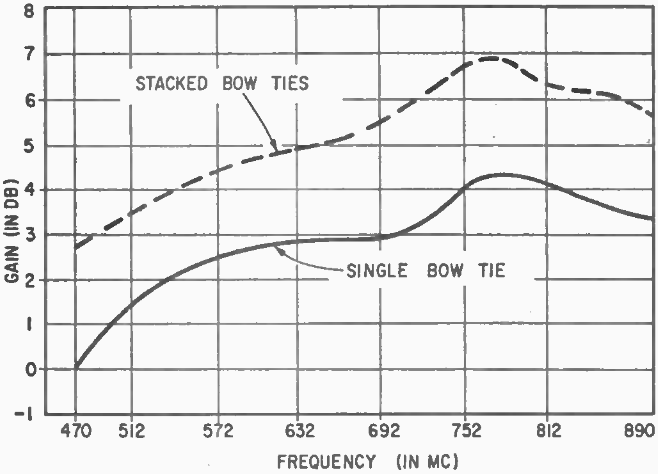


Fig. 11. Figure-8 pick-up pattern occurs at "cut" frequency of antenna elements (top) while minor lobes develop above and below the "cut" frequency. Changing dimensions of elements changes "cut" frequency and lobes (below) will be changed accordingly.



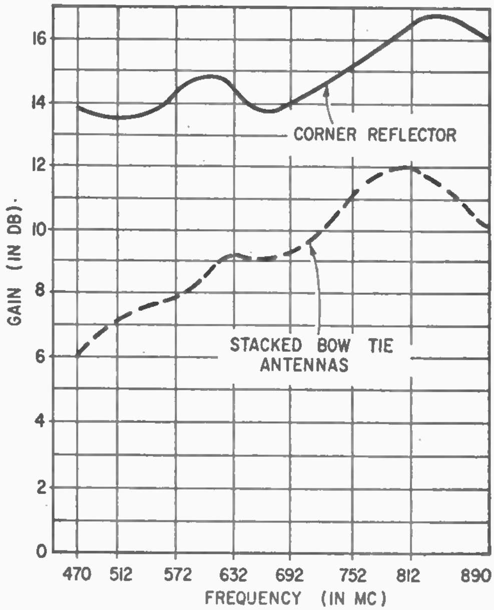
part of the reflector deflects the signals down to the dipole, while the bottom part deflects the signals up to the dipole. This provides additional gain over stacked bow ties, as shown in Fig. 13. However, the main reason for the corner reflector is to provide greater directivity than with stacked bow ties. This is particularly desirable where ghosts, from multiple reflections, make a bow-tie antenna



Courtesy Lafayette Radio Electronics

Fig. 12. Ability to pick up signals can be increased by stacking elements. Stacked (parallel connected) bow-tie antennas have nearly 3-db higher signal pick up over the single bow tie as reference.

Fig. 13. Adding corner reflector to stacked bow ties further increases pick up. Pick-up ability of one antenna over basic antenna is called gain and is indicated in decibels (db) or power.



unsatisfactory. As shown in Fig. 14, the rear lobes are almost eliminated.

Parabolic Reflector. The concentration of signals, from the curved surface to the driven element, provides more gain and makes the antenna more directive than would be possible with a flat reflector. However, this does not necessarily mean that a parabolic reflector with a single driven element will provide more gain than several stacked elements and a flat reflector. The main advantage of parabolic reflectors is their ability to bring in signals from *hot spots.* When you are installing any antenna, especially UHF TV, it is often necessary to probe at various heights because of the alternating *hot* and *dead spots,* as shown in Fig. 15. Such variations in strength are caused by the interaction of signals direct from the transmitter with signals reflected from other antennas, metal gutters, vehicles in the street, etc.

Even though you probe and find a hot-spot, there is no guarantee that it will remain hot. These good-signal spots tend to shift significantly. An antenna that has a small vertical interception area is most vulnerable to these shifts. It should be noted, however, that vertically stacked arrays share this same advantage in that at least one of the driven elements will remain in the hot spot.

The Yagi is quite popular for UHF TV. One problem with a Yagi is that the impedance is lowered as directive elements are added. This condition is compensated by using a high-impedance dipole. The antenna shown in Fig. 16 uses a special folded dipole (cut from one piece of aluminum) to increase the impedance.

Yagis are as vulnerable to the variation in signal strength, at different heights, as the

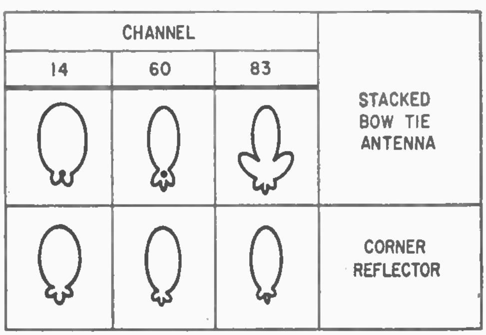


Fig. 14. Corner reflector affects pick-up pattern of stacked bow ties. Lobes are greatly affected by any change in element arrangement, interconnections or adjacent conductive surfaces—masonry, foliage. Anyone can experiment with antennas if they have the necessary metal-working tools. Lack of proper test facilities makes cut-and-try experimentation slow.

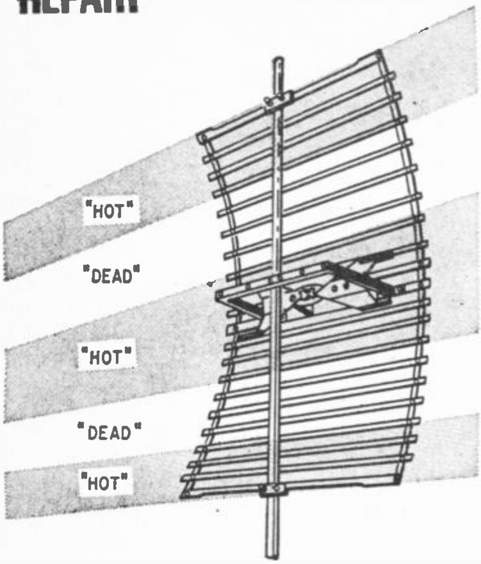


Fig. 15. Curved reflector catches signals and aims them at active antenna elements in some designs. A concentrated signal reduces static or snow at UHF.

bow-tie antennas. The Yagi shown in Fig. 17 has a corner reflector instead of the usual single reflector element. This corner reflector provides additional vertical interception.

Log Periodic. Another solution to the vertical interception problem is shown in Figs. 18 and 19. These log periodic antennas are flattened out versions of helical antennas and provide an almost constant frequency response over the entire band.

FM Antennas. FM radio requires the use of a VHF antenna just as television does. Once you get out of the immediate broadcast area, an outdoor antenna becomes necessary. Many people have used their TV antennas for FM with sometimes good results. But this may not be true for stereo FM reception. Every stereo tuner or receiver has a multiplex circuit which separates the received stereo signals into their left- and right-channel components. During the stereo separation process, 90% of the signal is lost —equivalent to being 50% further away from the station. This results in noisy reception and loss of stereo effect.

You say you have a perfectly satisfactory antenna fór TV at present, but need an antenna for FM? (You have, or are getting, an FM stereo receiver.) Should you replace your TV antenna with a combination TV-FM model? Well, not if you're satisfied with the TV reception you get—and the antenna is not so oxidized or deformed (bent or broken) that it needs to be replaced. What you can do is get a separate FM antenna which may be added to your TV mast.

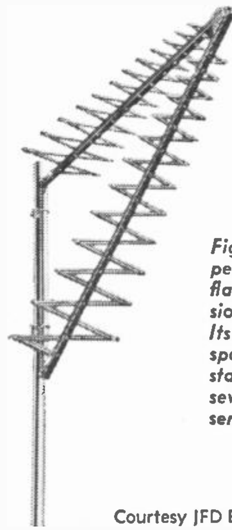


Fig. 18. This log-periodic antenna is a flattened-out version of helical antenna. Its wide-band response at UHF is an outstanding asset where several UHF stations are serving the area.

Courtesy JFD Electronics Corp.

Courtesy Channel Master Corp.

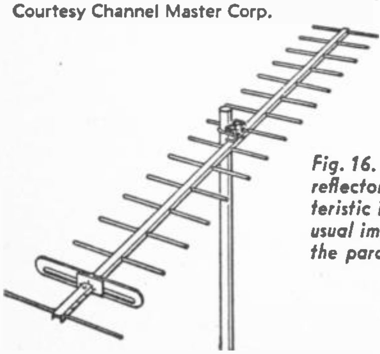


Fig. 16. Folded dipole ahead of reflector increases antenna's characteristic impedance to offset the usual impedance-lowering effects of the parasitic elements in array.

Courtesy The Finney Co.

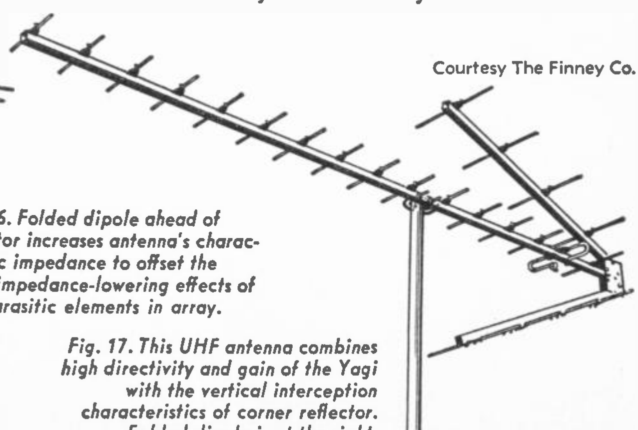


Fig. 17. This UHF antenna combines high directivity and gain of the Yagi with the vertical interception characteristics of corner reflector. Folded dipole is at the right.

Courtesy JFD Electronics Corp.

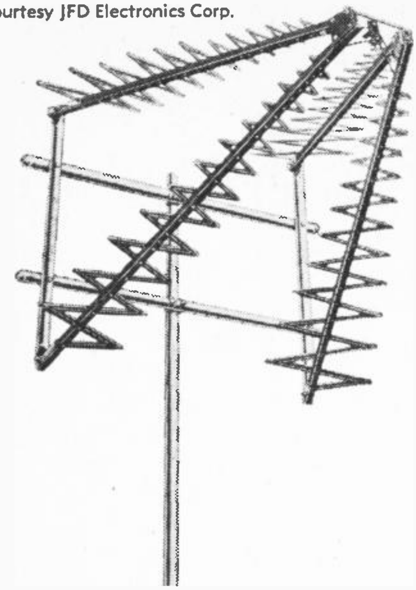


Fig. 19. Stacked log-periodic antenna is pyramid-shaped. Stacking increases directivity and gain—high front-to-back ratio reduces interference, ghosts.

In many areas there is almost no limit to the number of FM stations that can be received. To get "round the compass" FM reception you can use either an omnidirectional antenna or a directional type with a rotator. The directional antenna has more gain and will bring in stations from greater distances.

The most common omnidirectional antennas for FM are the Sigma (S-shape) and the turnstile. For fringe areas there are FM Yagi antennas, from 3- to 10-element models. Because of their directional characteristics, the Yagi must be used with a rotator unless you are interested in only one station.

If you have an FM antenna now for monophonic reception, but plan to get a stereo receiver, you may require a more powerful antenna. First, try to use the antenna you have. If reception is not satisfactory, that is, if the stereo separation is not apparent and if there appears to be some distortion and noise, or if you can't tune in stereo stations clearly, then the trouble may very well be in the antenna. In that case, you will probably need to get a higher-gain model. In practical terms this means:

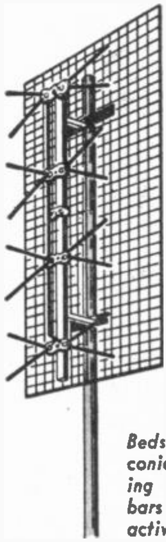
If you are now using a built-in or indoor antenna for monophonic FM you may need an S-shape or turnstile outdoor antenna for satisfactory stereo reception,

If you are now using a turnstile or S-shape antenna, you may need a 5-element Yagi with a rotator,

If you are now using a five-element Yagi you may need a 10-element Yagi (or stack 5-element Yagis) and, perhaps, add an antenna-mounted booster.

Another solution to the problem is the use of *intermixed* antennas. Such antennas will cover VHF, UHF, and FM. However, the directivity problem will remain.

Transmission Line (Lead-In). While a transmission line (lead-in) is any device that will conduct electrical energy from a source to a load the term *lead-in* is usually applied to the conductors between the antenna and receiver. (*Transmission line* usually means the line between a transmitter and antenna.) Since the same types of wire are used in both applications, the terms are actually interchangeable.



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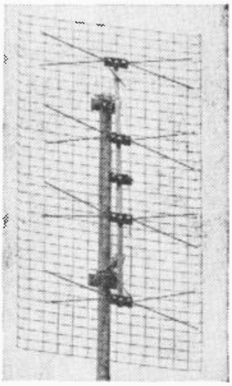


Bedspring-like reflectors back up the conical-type stacked antennas. Spacing is critical but special stacking bars assure accurate positioning of active elements for optimum pick up.

In TV or FM, two wires are required since the antennas are dipoles. Two basic types of lead-in are *parallel-wire* lines and *coaxial* lines. To break it down further, parallel-wire lines can be of the open-wire type where there is no material between the conductors except widely separated spacers. More likely it will be flat ribbon (twin-lead) or possibly tubular line. Coaxial lines are those where a center conductor is completely surrounded by the outer conductor.

Line Losses. All transmission lines have some losses. That is, part of the energy or signal will be lost in the transfer from the source to the load. There are four basic reasons for such losses. *(Turn page)*

ANTENNAS

Since a transmission line is carrying an RF signal, a portion of that signal is radiated from the line (Fig. 20). This is known as radiation loss. It is present on VHF lead-in to a limited extent, but it becomes a real problem for UHF. Because the outer conductor of a coaxial line also serves as a shield, coaxial lines have a minimum radiation loss.

When a transmission line is routed near another conductor, part of the radiated energy is transferred to the adjacent conductor by induction. These induction losses occur where lead-in wire is routed near metal gutters, drain pipes, etc. (Fig. 21). Since induction loss is a result of radiation, it will be at a minimum when coaxial lines are used.

The insulating material between the two transmission wires is a dielectric which acts as a high resistance shunt. A portion of the energy or signal is lost across this shunt (Fig. 22). This is known as *dielectric loss*. Fortunately, dielectric losses are not too great under normal circumstances. Although dry air is the dielectric which offers the most resistance (and the least losses), moist air has very high dielectric losses. Likewise, flat-ribbon lines normally have low loss except when they are wet or dirty.

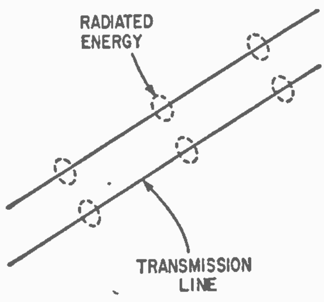


Fig. 20. Parallel wires used for lead-in reradiates some signal—loss is greater than with coaxial cable.

All conductors have some resistance which will cause loss (voltage drop) as the currents flow through them (Fig. 23).

Line Attenuation. The combination of the four types of line losses results in a net attenuation of the signal. This is usually expressed in db (decibels) per 100 feet, or in percentages of efficiency. Attenuation increases with length. However, to be of real value, the attenuation factor of a lead-in should be related to the entire frequency range used, as well as the surrounding conditions.

Line Impedance. Since any conductor has inductance (along its length), capacitance (between leads), and resistance, a transmission line has a characteristic impedance which accounts for all of these (Fig. 24). The most common impedance of flat-ribbon lines is 300 ohms, while the impedance of most TV coaxial lines is 75 ohms. The open wire used in the early days of UHF had an impedance of about 450 ohms, but now it is manufactured with an impedance near 300 ohms. The actual impedance of a line is not as important as the impedance match with the antenna and the receiver input. Most antennas and receivers are now designed to be used with 300-ohm transmission lines.

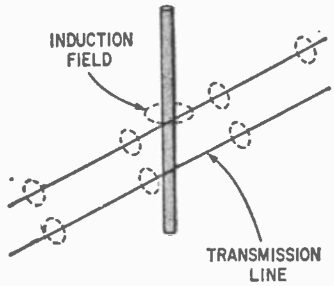


Fig. 21. A conductor adjacent to one lead of pair will unbalance transmission line, weakening signals.

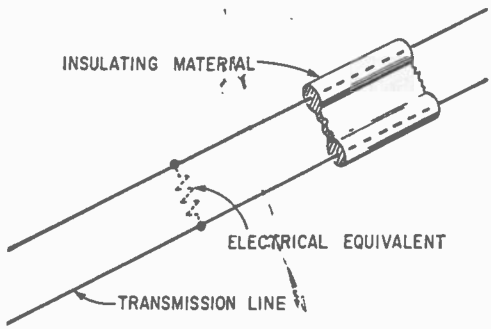


Fig. 22. Shunt signal loss may be in form of a low resistance or a capacitance across transmission line.

Transmission Lines. There are four basic transmission line types (or lead-ins) available for TV and FM antennas. Each has its own particular advantages and disadvantages.

Open Wire Line. The open wire line has the least loss, because the dielectric is mostly air. The two conductors are separated at intervals by polethylene spacers that vary in shape. There is little chance for dirt or mois-

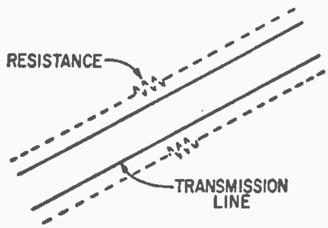


Fig. 23. Resistance would be main consideration if lead-in carried DC—effects at VHF, UHF are severe.

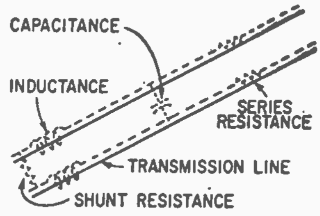


Fig. 24. Series resistance and inductance and shunt resistance and capacitance affect line's impedance.

ture to build up across the open leads, so an open-wire line is a good choice for very long runs where losses must be kept to a minimum. However, open wire is difficult to install, and it deteriorates from exposure to the elements faster than other types of line. Open-wire line is almost never used for anything but UHF-TV antenna systems.

Coaxial Cable. Because of its shielding, coaxial cable is the best bet where there are radiation or pick up problems (routing near metal surfaces or wires), or where exposure to the elements is a problem. This cable consists of an inner conductor (embedded in the polyethylene dielectric) enclosed in a copper-braided shield and a vinyl jacket for weather and abrasion protection. Coaxial line is virtually unaffected by moisture and dirt on the outside jacket of the line. Also, nearby conductors will not absorb energy from the line, nor will interference signals enter the line. Coaxial line is fairly simple to install, but it does require a hole at the feed-through point. (Flat ribbon line can usually be slipped under a window.) Coaxial-line impedance varies from 50 to 75 ohms, which does not match the normal antenna impedance of 300 ohms, so a matching transformer is required. A matching transformer is also needed when you are connecting to a 300-ohm input on the TV set.

Flat Ribbon Line. Flat ribbon or twin-lead is the most popular TV and FM lead-in. One of the reasons for this is that it can usually be routed into the house without drilling holes. It is readily available from a number of sources, including most variety stores. Its impedance is normally 300 ohms so it will match most TV and FM antennas. Not popular now is the narrower 150- and 72-ohm twin lead.

In addition to the conventional flat ribbon, twin-lead is available in a punched or slotted ribbon (a form of open wire line) where a large percentage of the insulating material between the leads has been removed—this reduces losses.

Another version of the ribbon line has a polyethylene covering or sheath placed over the line. This keeps the line protected from the elements, and it has considerably lower losses than other types of twin-lead when the lines are wet.

Tubular Line. One of the best all-weather lead-ins is the tubular line which was designed to keep losses down when the lead-in is wet, or covered with dirt and snow. As shown in Fig. 25, the energy fields between the two conductors of a transmission line are essentially circular. These energy fields are outside the insulation with conventional flat line. When moisture is present, it acts as a high-resistance shunt between the conductors, causing additional losses. On tubular line, the moisture remains outside the field of energy. *The exposed ends of tubular line must be sealed against moisture* when it is installed. This is done by heating the end of the line and pinching the tubular sides together with pliers. Or the tube-like line can be sealed with a plug. Usually, the manufacturers recommend that a small hole be punched at the bottom of the drip loop to remove moisture that may accumulate inside the hollow tubular line. Tubular line has a drawback in that a fairly large hole must be drilled at the feed-thru point into the house.

Reception Aids. There are a number of accessories and reception aids available for TV and FM antennas. These include amplifiers (or boosters), antenna couplers, splitters, matching transformers, and antenna rotators.

Couplers and Splitters. The terms *coupler* and *splitter* are used interchangeably, although technically a coupler is used to join two or more sets to one antenna, while a splitter is used to combine the signals from two or more antennas so that they can use a single lead-in. The term coupler usually means joining two units of the same type or frequency, while splitter implies separation of two different frequencies, or bands.

Splitters usually combine a low-pass filter and a high-pass filter in a single unit. A splitter would be used, for example, where a VHF antenna and a UHF antenna are mounted together on the same mast or other-

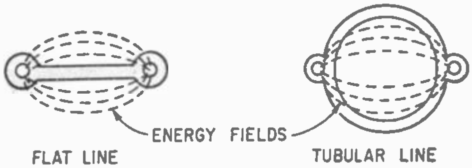


Fig. 25. Tubular line (right) keeps dust, soot deposits and water film (from rain, dew) out of field.

wise near each other, and there is no room for separate lead-ins. A splitter is connected to the two antennas and to the lead-in. A second splitter is then connected between the lead-in and the UHF/VHF antenna terminals. Such a splitter is shown in Fig. 26. A typical schematic is shown in Fig. 27. With this arrangement, high-pass filters are connected to the UHF antenna and the UHF terminals on the set, while low-pass filters are connected to the VHF antenna and the terminals. UHF signals go through the high-pass filters—to the lead-in from the UHF antenna, and from the lead-in to the UHF-antenna terminals, but they are blocked from the VHF antenna and VHF-antenna terminals by the low-pass filters. VHF signals are passed by the low-pass filters, but they are blocked by the high-pass filters.

Instead of being designed to pass (or reject) an entire band of frequencies, some splitters pass one specific frequency or channel through one set of terminals, and all other channels through another set of terminals. In this case, a separate splitter must be used for each specific channel. Such splitters consist of a passband (or band pass) filter and a channel trap (sometimes known as a stop-band filter). The channel trap permits the specific channel to pass, while rejecting all other channels. The passband filter permits a wide range of frequencies to pass.

Typical connections are shown in Fig. 28. Here, a VHF antenna is included with UHF antennas. A channel-19 splitter connects the two UHF antennas, and then a UHF/VHF splitter adds the VHF antenna to the system.

Matching Transformers. A matching transformer is used between a 300-ohm antenna and a 75-ohm coaxial lead-in. Most antennas are designed for 300-ohm impedance. However, the 300-ohm antenna can be matched to 75-ohm coaxial cable with one matching transformer at the antenna end. Then, the coaxial lead-in can be matched to the 300-ohm input of the set, with another matching transformer at the set end. Some antennas are designed for 75-ohm impedance, so the matching transformer is required at the set end only when coaxial lead-in is used. Some TV sets have provisions for 75-ohm antenna inputs.

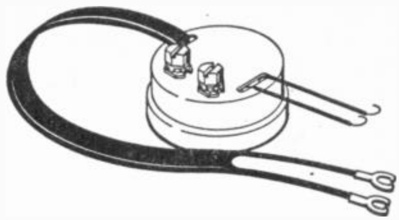


Fig. 26. Splitter or coupler should be used when VHF and UHF antennas share a single lead-in and roof mast.

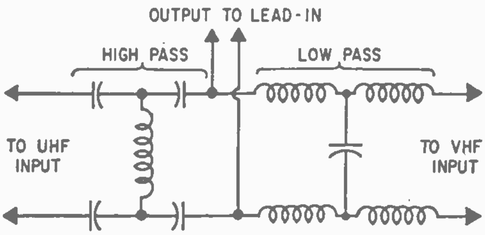


Fig. 27. Coupler circuitry divides into low-pass and high-pass filters used to isolate UHF from VHF.

Amplifier or Booster. The terms *amplifier* and *booster* are interchangeable. These units amplify weak antenna signals before they arrive at the set. There are two basic designs.

The *indoor amplifier* is a single unit mounted on or near the set. The antenna lead-in is routed to the amplifier input, and the amplifier output is connected to the UHF input terminals of the set. The amplifier is plugged into an AC outlet. Once placed in operation, the amplifier performs its function automatically; there are no operating controls or adjustments. In fact, because of their low power drain (usually 2 or 3 watts), these amplifiers normally remain turned *on* at all times.

The *outdoor amplifier* is divided into two units: an amplifier (Fig. 29) mounted on the antenna mast and a power supply mounted on or near the set. The antenna is connected to the input terminals on the amplifier. The amplifier is connected to its power supply through the lead-in, attached to its output terminals and the power supply is connected to the input terminals of the set. The power supply requires 115 volts AC, and provides

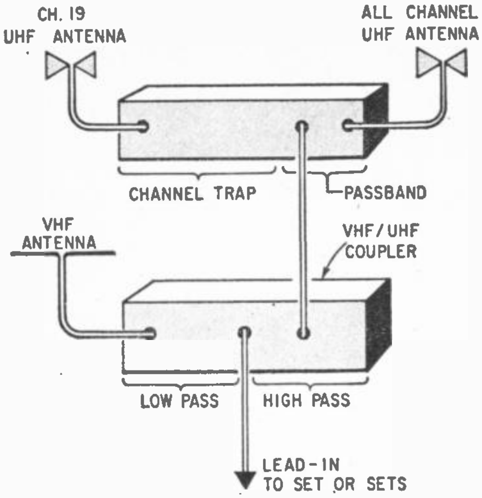


Fig. 28. Some signal strength may be lost in the splitters and couplers—you may need a booster, or separate lead-ins, to take care of signal losses.

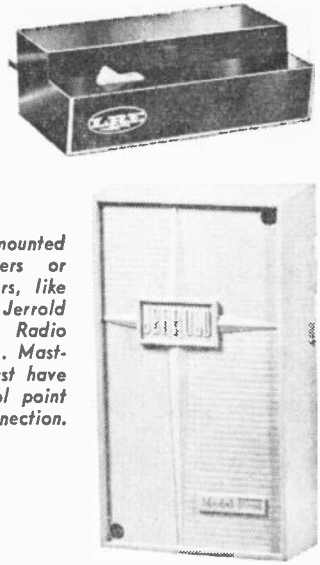


Fig. 29. Mast-mounted outdoor amplifiers or amplified couplers, like these units by Jerrold and Lafayette Radio Electronics (top). Mast-mounted unit must have an indoor control point and power connection.

the mast amplifier with reduced-voltage AC (15 to 30 volts) through the lead-in. The outdoor amplifier functions automatically, without operating or adjustment controls. The power supply remains *on* all the time.

In general, mast-mounted amplifiers provide more gain and have less of a noise problem than the indoor type. With either one, any noise or interference picked up before amplification will increase along with the desired channel signals. Since the lead-in from the antenna to the outdoor amplifier is much shorter, the chance of noise being picked up and amplified is lessened. Some amplifiers serve the dual purpose of amplifier and splitter, or amplifier and coupler.

There are many areas where the signal strength is sufficient to drive a single set from an antenna, but not two sets. Here an amplifier-coupler combination will work nicely. Where VHF and UHF signals both require amplification the signals can be split in the amplifier instead of using a separate unit.

Antenna Rotators. Rotators have long been a popular antenna accessory in fringe and deep fringe areas where the viewer had to direct his antenna toward widely scattered TV stations. With an increase in FM listening and need of exact antenna orientation for FM stereo, and with the increasing number of UHF stations, suburbanites are using rotators to great advantage. There are basic types of rotators—automatic and manual.

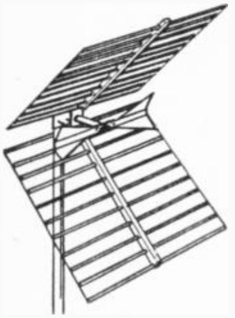
The *automatic rotator* is very convenient: set it to the channel you want and forget it. The antenna will slowly and smoothly turn to face the desired station and stop. The *manual rotator* demands your constant attention: you must keep your finger pressed down on the control all the while the antenna is turning. When the antenna is facing in the desired direction, as indicated by a pointer on the scale, you lift your finger and the rotator stops. Some manual rotators do not have direction indicators, and must be kept going until the TV picture is clearest.

Oxidation Problem. Bare aluminum, exposed to the air, quickly oxidizes. Over a long period of time this grows into a thick coat of aluminum oxide (an insulator), which doesn't permit all of the signal to be pulled out of the air (by the antenna) to pass down to the FM or TV receiver. Old, oxidized antennas should be replaced. Oxidation is a particularly acute problem along the seacoast where the moist air has a high salt content. Dust, as from cement and steel factories, is also bad for antennas. And so is soot from on-the-chimney installations.

There is no sure cure for oxidation. If you have a particular problem in your area, the best bet is to use an antenna where the bare aluminum has been treated. The subject of antenna metal finishes is highly controversial—especially with the manufacturers. But certain facts are clear. Any finish is better than bare aluminum. Basically, there are two finishes. One type makes the metal surface nonconducting, while with the other finish the aluminum remains a conductor. With the nonconducting finish the area around the terminals must be cleaned (by scraping) to make a good metal-to-metal connection.

Selecting An Antenna. Here are some final tips on selecting an antenna. The kind of antenna system you want depends upon the stations in your area. Many areas have both VHF (Channels 2-13) and UHF (Channels 14-83) stations at this time Other locales have only UHF or VHF stations.

Courtesy Allied Radio Corp.



Corner reflector and bow-tie are popular UHF antenna—sturdy and fairly easy to manufacture.

However, many additional stations will shortly be on the air, so it is important to consider both your present and future needs.

If you use FM extensively, it is well to remember that superior FM reception, using the outdoor TV antenna, is a bonus of a good home antenna system. This is particularly true of FM stereo.

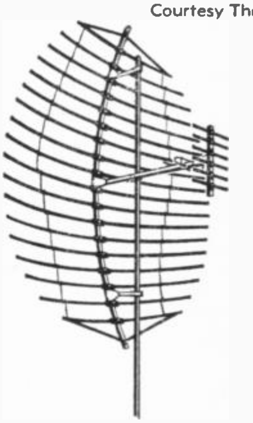
If you intend adding color TV to your home system, you *must* have a good antenna system that will provide strong signals. And the antenna system must provide broad enough frequency coverage to cover the *entire* channel, as well as all channels. Some antennas reject (or absorb) portions of a TV signal. This may not be noticeable with black-and-white signals, but it can kill color TV. Color-TV signals are carried at the main frequency and at another frequency—called the color subcarrier. If both frequencies are not delivered to the receiver with equal strength, some colors may come in stronger than others or worse still, you may lose a color entirely. The results may range from unreal colors to only partial color, in either case not what you bargained for when you bought your color-TV set. A carefully designed color-TV antenna will pull in all frequencies at full strength (flat response) for better black-and-white and color reception.

The Economics. As with any purchase you make, you get the best system for your TV or FM dollar by paying for only those features which are needed. A good example of this is with lead-in wire. Coaxial cable has excellent noise shielding properties; is less prone to pick up undesired signals; and maintains its electrical characteristics better when wet or near metal. However, these features are only important in areas where signals are weak, where electrical noise is high or where cables are run near large metal objects. Weigh these facts against the nearly two-times-as-high cost of coaxial cable and required matching transformers before you decide on the type of cable you want.

"How many sets must my antenna system supply?" This is an important question because it is almost always possible to connect all TV and FM sets in a home to a single antenna system. In metropolitan and suburban areas, this is often as simple as connecting a multiset coupler between antenna and sets. In fringe areas, an amplifier may also be required.

Do you need an amplifier? If your antenna doesn't deliver enough signal, TV pictures will be snowy, lack contrast, or exhibit other reception problems. An amplifier will eliminate this problem by increasing the signal's strength before it reaches the set. An amplifier may also be required to provide enough for several sets, even though the signal from the antenna is adequate for one set. Many amplifiers have built-in multiset couplers which can provide signals for up to four sets.

Courtesy The Finney Co.

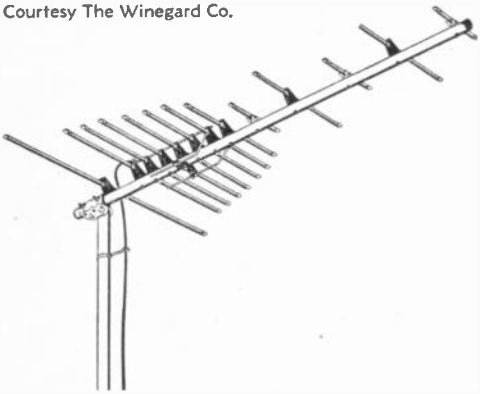


Double reflection, from parabola to flat reflector, assures maximum pick up area to catch UHF signals.

Installation. The following installation tips will aid you in making an installation of professional quality.

1. Wherever possible, the antenna should be mounted above all local obstacles, such as buildings or nearby trees. Use the height of your neighbors' antennas as a guide. The antenna can be raised with special masts—aluminum or steel tubing in five- and ten-foot lengths which may be jammed together to make as tall a tower as desired, but not to exceed fifty feet, safely. High carbon steel is stronger than aluminum and the new acrylic-coated "dura-lube" steel is strongest yet. Aluminum will do for short masts five or ten feet high, carrying suburban size antennas. For high wind areas and heavy antennas, steel is safer. Tubing comes in different thicknesses or gauge, i.e., 18 gauge is thicker than 16 and is recommended for heavy loads. Pre-telescoped lengths with hardware attached, that can pull out from 20 to 50 feet, are widely used.

Courtesy The Winegard Co.



Grouped "active" elements, in front of reflector, all feed signals to lead-in with this log-periodic unit.

2. The antenna should be mounted away from power lines. Mount the antenna where tree branches will not blow into it.

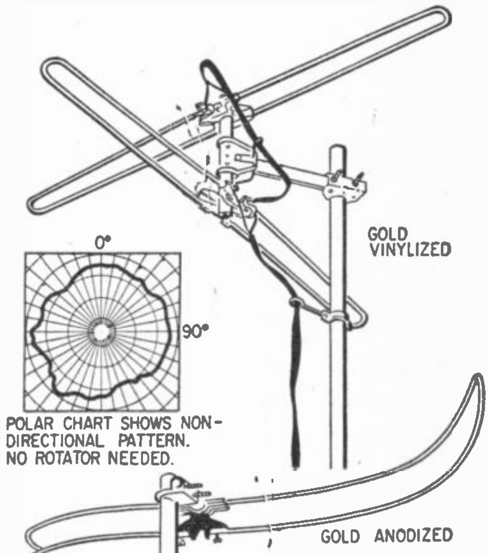
3. Check your local electrical code. Many codes require that the antenna mast be grounded.

4. One of the most popular, but not necessarily the most convenient method of mounting an antenna is to strap it to a chimney. There are a wide variety of chimney strap mounts into which the antenna mast fits. If you do not have a chimney, do not despair, there are special brackets for ridge roofs, peak roofs, and flat roofs; for mounting an antenna directly to the wall of a building or under the eaves of a roof. Most of these methods are gradually giving way to mounting the antenna mast on a vent pipe that extends through the roof. (Make sure that the pipe is solidly attached to the house.)

5. Support the antenna mast at a minimum of two points. As a rule of thumb, at least a quarter of the total mast length should lie between the two supporting points. Masts over 10-15 feet require guy lines. Very tall masts need double guying. That is, two complete sets of guy wires from different positions along the mast to anchor points on the roof or ground. One end of each guy wire is fastened to a hole in a ring that fits around the mast and is fastened to the mast with a clamp. The bottom end of each guy wire is anchored with an eyebolt or hooks. At least three wires are needed to maintain equal tension completely around the mast.

6. Guying is only as effective as the condition of the guy wires and anchor points. Rusted or kinked guy wires are no protection at all. Among the best types of guy wires are galvanized steel, alcad coated aluminum and vinyl-coated galvanized steel. The galvanized coating protects the wire against corrosion, while the vinyl coating adds weather protection and also prevents kinking and the formation of "fishhooks" and scales.

Courtesy The Winegard Co.



Turnstile FM antenna (top) has a nearly circular pick-up pattern —shown in polar chart. S-shaped folded dipole has omni-directional pickup too.

7. Be sure to use standoffs for the lead-in. If the lead-in flaps excessively, the wires inside the cable will break. In an apartment building, the simplest way to run a cable is

next to the line of windows. Since other cables may also be mounted in this manner, try to place standoffs so that your cable is a minimum of six inches away from any others.

8. Wherever possible, keep lead-in away from metal surfaces, to reduce signal losses, and the possibility of getting ghosts. Never staple cables to the outside of buildings. Use standoffs every 4 to 5 feet apart. Put a twist in the wire every 3 to 5 feet for reduced noise pickup. Keep the cable reasonably taut, to prevent damage from abrasion (with the building) and collision with other objects. In areas near broadcast transmitters, use the shortest possible horizontal cable runs. The cable may be brought into the house by drilling a hole and inserting a plastic form designed for the purpose, or by filling the hole with putty. Indoors use plastic cable clamps.

9. A simple lightning arrester should be fastened to the downlead where it enters the house. The arrester is then connected, with solid aluminum ground wire, to a stake or rod driven into the ground.

10. Raising an antenna ten feet can be as effective as stacking an additional antenna into an installation, particularly if the viewer is located in a hilly area. That is why so many ultra-fringe area viewers use towers for their antennas. Stock towers are available for heights up to about 60 feet.

11. When installing an antenna, there are a few things you should do before you scramble up onto the roof. First of course, make sure you have all the parts and tools you need. A screwdriver and pliers with wire cutting jaws are all the tools you will need, although a hammer and adjustable open-end wrench may come in handy, as will an electric drill (¼-inch) for making the entrance hole into the house for the lead-in. A brace and extra long bit may be needed to make a hole through thick walls or window jambs.

12. Splices, even soldered ones on lead-in, increase its resistance to signal flow, so it's best to buy a little more wire than a rough measurement indicated you will need from antenna to set. If there is excess, you should cut it off; don't let it lie around in a coil behind the TV set.

13. Start by assembling the antenna on the ground. In most cases when you remove the antenna from the box it will be folded up like a collapsed umbrella. Just follow the directions packed with the antenna.

14. When using a chimney mount, separate both straps so that one is near the top of the chimney and the other is near the bottom. Set up the eyebolts in the mount first with the nut practically at the end of each bolt, giving you lots of bolt to take up. Then fit the strapping around, making sure that there are no kinks in the strap and that each strap follows the same row of brick all the way around. Tighten the strap lock to hold the free end of the strap—cut off excess.

15. Make certain to tighten all fastenings on a flat or ridge roof mount. Loose fastenings can lead to water leaks. It's best to pour sealer around the fastenings; any type of flexible caulking will do.

16. With the mounts in place, fasten the transmission line to the antenna terminals, slip the mast with the antenna into the mount, and tighten the mount's U-bolts, but leave some play so that the antenna can be turned to face the TV stations.

17. To orient the antenna, fasten the lead-in temporarily to the TV set and then turn the antenna slowly until your helper (you better have a helper) at the TV set tells you that the picture is best. Lock the mast in this position. Reception will probably be best with the front of the antenna, the end with the shorter elements, facing the station.

18. Make certain that the base of the mast is not sitting directly on the roof, leave room for the rain water going down inside the base to escape at the bottom.

19. Snap a standoff insulator onto the mast and fit the lead-in through it. Make certain the lead-in is twisted a couple of turns per foot. Crimp the head of the standoff insulator to hold the lead-in. When the antenna is mounted on a rotator, enough play will have to be left in the lead-in to account for a 360° turn on the antenna. Use as many standoff insulators as required to control the lead-in so that it will not whip about in the wind.

20. Make sure that the lead-in does not run alongside or in signal-robbing gutters or downspouts; when crossing such obstructions use screw-in type standoffs to keep the wire away from the metal. Where the lead-in enters the house (through a hole in a window jamb, masonry or a shingle wall), be sure to leave a rain loop in the wire so that water coming down the wire will drip off outside the house and not enter. ■

TV Set's Controls

Continued from page 48

from the center to the left or right side. Fig. 20 shows the effect of a misadjusted horizontal linearity control. Note the elongated left side of the picture compared with the right side. To adjust the horizontal linearity control, rotate the shaft until the horizontal radius of the picture from the center to the left side is equal to the radius from the center to the right side. In most cases it is necessary to adjust the horizontal size control along with the horizontal linearity control.

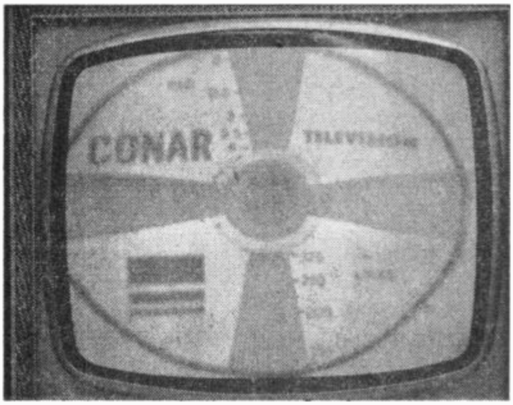


Fig. 20. If right side of picture is squashed, left side elongated, horizontal linearity is out.

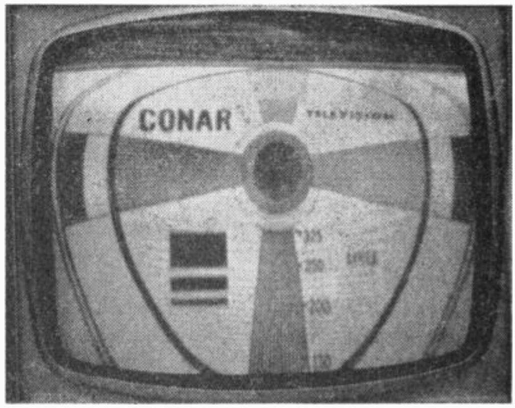


Fig. 21. This egg-shape distortion occurs when the vertical linearity is out of adjustment.

Vertical Linearity Control. Fig. 21 shows a picture in which the vertical linearity control is misadjusted. In this case the picture is cramped from top to center while the bottom half is elongated. To adjust the vertical linearity control, rotate the shaft until the picture dimensions from top to center and from bottom to center are the same. To do this it is usually necessary to adjust the vertical linearity and vertical size controls alternately until the picture is linear and fits the screen.

Buzz Control. Some late model, quality TV receivers, such as the Conar Custom 70, have a buzz control. This control is adjusted to the position at which hum, or buzz, in the sound is minimum.

Correct adjustment of the fine tuning control, the AGC, and Contrast Controls also help eliminate buzz. These controls should be checked first for proper adjustment, then the buzz control should be adjusted for minimum buzz.

You know now the controls found on a TV receiver and what they are supposed to do. You also know where to look for various controls and have seen how the picture is affected by improper adjustment of each control. With this information you should now be able to adjust your set for the best possible picture and sound. By doing this you can save both money and wear and tear on the nerves. You also will probably bring added enjoyment to your whole family by enabling them to view television without experiencing the annoyance and frustration that is often caused by an improperly adjusted set. ■

Replacement Guide

Continued from page 40

the unit's operation after replacement has been made. If the unit works properly without circuit parts overheating (cathode, plate and screen resistors in particular) all is well. However, if the unit does not function as it should, shows signs of overheating, or pops fuses, forget the substitution and obtain the exact replacement.

Note that some replacement parts are starred(*). These tubes have different heater currents than those they replace. Do not use these tube types in sets that have series connected filament circuits unless you have added compensating resistors. In the case of a tube drawing less filament current than the one it is replacing, a resistor would have to be placed in parallel with its filament to make up the difference. And in the case of a tube drawing more current than the one it is replacing, suitable resistors would have to be placed across the filaments of all other tubes in the chain. ■

Tune-Up Techniques

Continued from page 26

oscillator trimmer capacitors, there is an oscillator coil slug. The alignment procedure is the same as before—the trimmers are adjusted for best signal at the high end of the band. However, the "rocking" operation just described for a padder can also be done. The generator and receiver are tuned to 600 kHz and the coil slug tuned for the operation. Again, the trimmers should always be rechecked and touched up (Fig. 11).

Auto Radio. Whether a car radio is tube transistor, its front-end alignment follows the same general steps. A notable feature of the circuit is the absence of a large main tuning capacitor. Since car radios operate under tougher signal conditions, tuning is most often achieved by slugs moving in and out of coils. Known as permeability tuning, the technique is superior to the variable capacitor method in that better sensitivity and selectivity are attained throughout the band.

A typical car radio front-end appears in Fig. 12. The three slugs (cores) L1 through L3 are the variable tuning elements; they move in and out of the antenna, RF, and oscillator coils as the dial is tuned (or pushbuttons depressed). Each coil is fitted with a trimmer capacitor for alignment and these are adjusted for the high end of the band. Tracking at the low end of the band is achieved by adjusting the slugs. Though they are moved by the tuning knob, it is also possible to make small alignment adjustments by inserting a tool into access holes provided on the chassis.

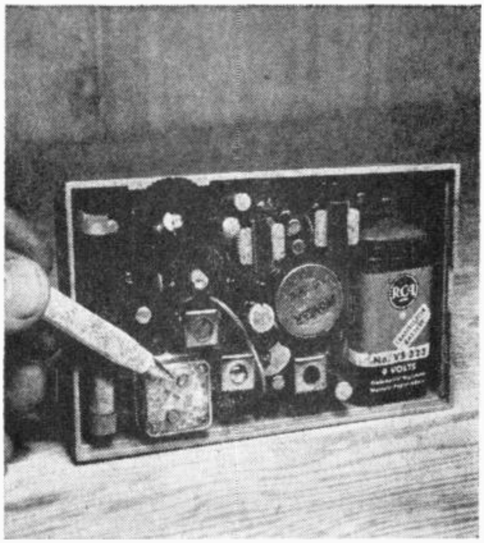


Fig. 11. RF and oscillator trimmers on transistor sets are occasionally hard to find, but they must be sought out and adjusted. Trimmers (indicated by pointer) for this set appear on main tuning capacitor.

Roll Your Own. Some familiarity with these basic alignment circuits and techniques, coupled with practical experience, proves that tuning a superhet can be done quickly. Since no general outline can cover all special cases, it's best to secure the manufacturer's schematic of the particular set you are about to tackle. It should summarize the recommended alignment steps and it should also point out any peculiarities of his receiver. ■

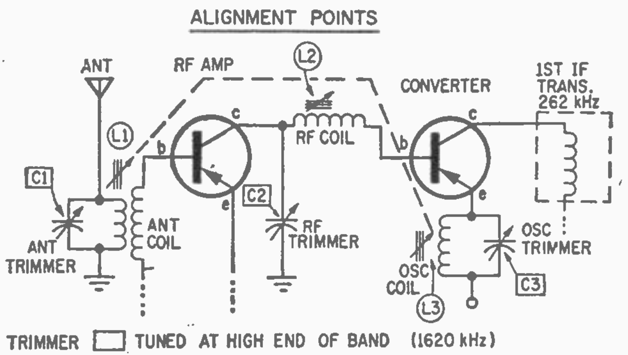


Fig. 12. Front-end alignment of a car radio requires only two generator frequencies—600 kHz and 1620 kHz. However, antenna trimmer (C1) is ideally adjusted for maximum signal with radio installed, antenna connected, and dial tuned to any station near 1400 kHz.

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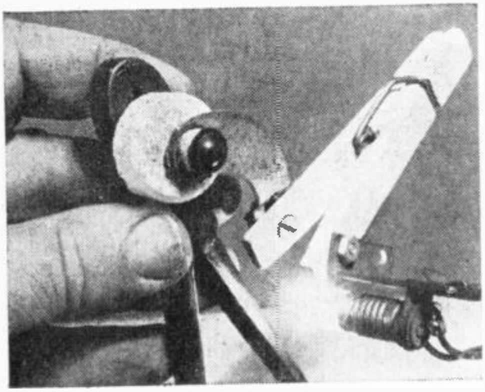


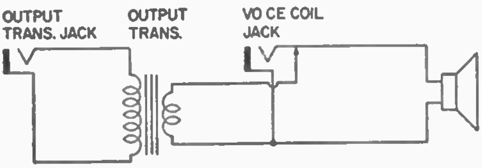
■ Almost daily there is a need for a tiny extension light for seeing in close quarters. Such a light can be easily made that will be self-supporting in two ways if this is desirable. Fasten a miniature lamp socket to one side of a spring-type clothespin. To the other side of the clothespin attach the magnet element from an automatic can opener. The light is complete for connecting to a battery power source. Connect alligator clips to the long lamp leads so they may connect to battery or 6.3-volt AC filament transformer. The magnet will cling to iron tools for extra reach.

EMERGENCY COUPLER HAS ZERO BACKLASH

■ A one-inch length of automobile windshield wiper hose can be used as a quick, inexpensive ¼"-to-¼" shaft coupler for radio and other electronic gadgets. While not intended to replace conventional couplers which employ set screws, the hose does grip the shafts with surprising tenacity, making it handy in an emergency or in experimental breadboards. A 3- to 4-inch length of hose makes a good flexible coupler for connecting the shaft of a variable component to a knob shaft when the two shafts are out of line up to 45 degrees from each other—backlash is practically nil.

Other uses for the hose include couplers for small electric motors, Veeder-Root counters—in fact, anywhere ¼-inch shafts are used, and the load requirements are moderate.

DISCARDED PORTABLE BECOMES TEST SPEAKER



■ If you own an old tube-type radio portable that's ready for the garbage can, you're in for a windfall by simply converting it to a portable test speaker. Scrap all of the set's guts except the PM speaker and output transformer. Now scrounge up open-circuit and closed circuit phone jacks (see schematic diagram), phone plug, wire, and two alligator clips with rubber sleeve insulators. Wire up the portable case as shown in the schematic diagram and label the cabinet's front panel so you will know which jack is which. Now wire up a patch cord using 3 feet of rubber test lead lengths to the phone jack and install the alligator clips to the wire's free ends. Now you can connect the test set to speaker terminals or into audio plate circuits. ■

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