SERVICE DEALER & ELECTRONIC SERVICING

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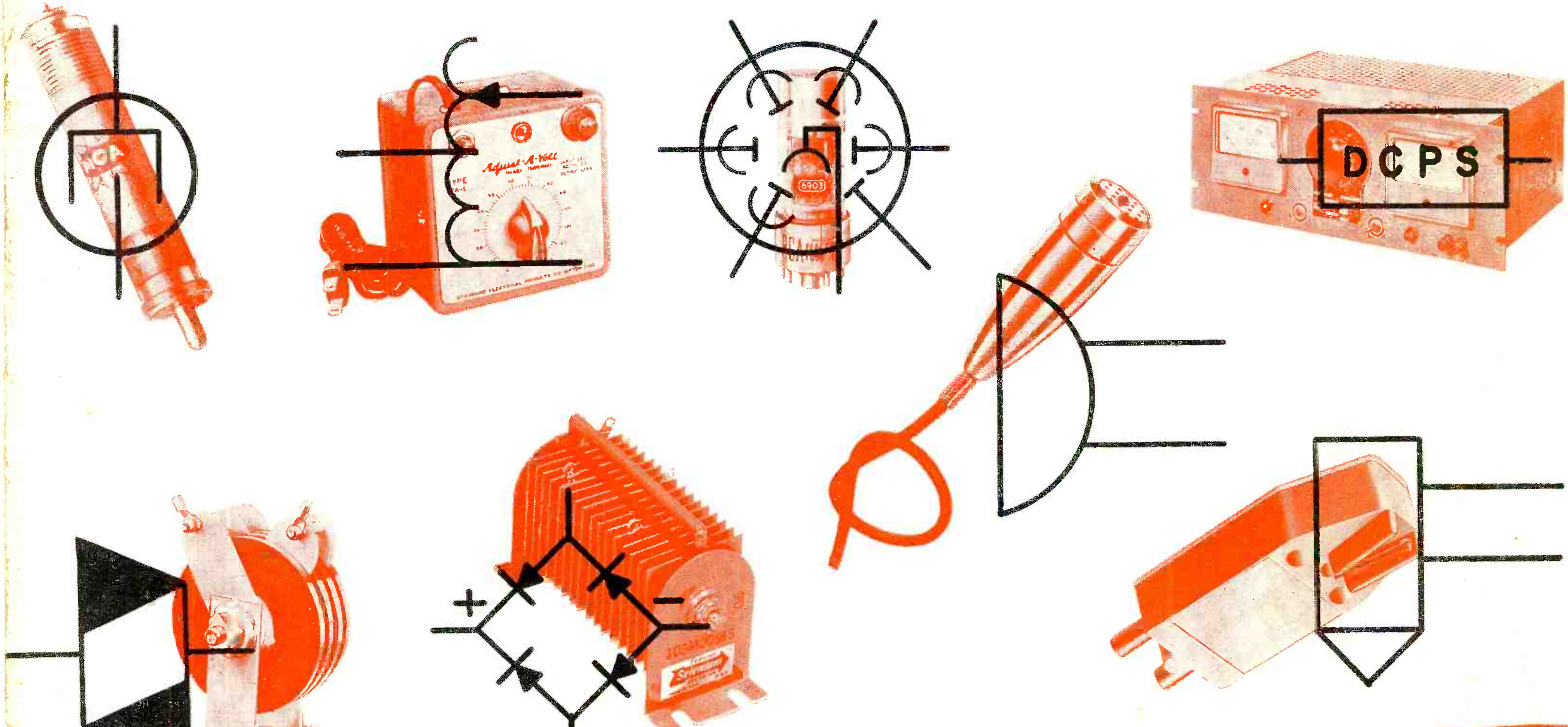

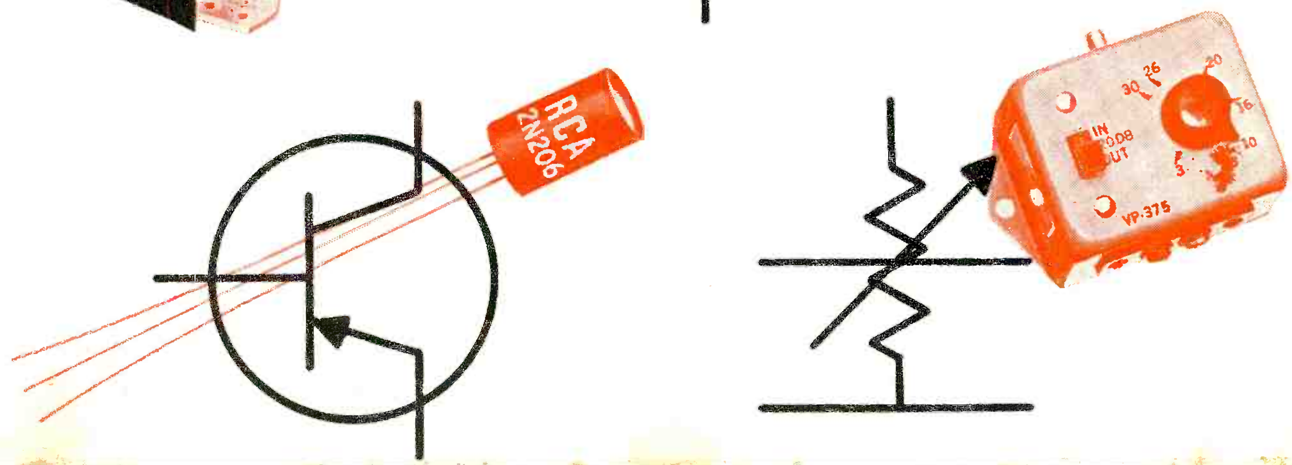

Capacohmeter

Marine Electronics

Color Killer Circuits

Understanding Tone Controls

Opportunities in Mobile Radio

Conversions and Modifications

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FEATURE ARTICLES

CIRCUIT AND SERVICE FORUM

DEPARTMENTS

THIS MONTH'S FRONT COVER

How well do you know your symbols? Shown from left to right and from top to bottom: Geiger tube—Nucleonic Corp.; Adjustable transformer—Standard Electric Products; Multiplier tube—RCA; D.C. power supply—Sola; Varistor—G.E.; Full-wave bridge-type metallic rectifier—Federal; Microphone—Ronette; Phono pickup—Astatic; Transistor—RCA; Attenuator—Entron.

COWAN PUBLISHING CORP., 300 West 43rd Street, New York 36, N.Y.

Conversions and Modifications

by ALLAN KINCKINER

The conversion or modification of a TV receiver often gives rise to concomitant defects. This article discusses some of these and their remedies.

ONE of the more difficult problems confronting the TV serviceman is that of straightening out the receiver which has been improperly modified. The modification may be in the form of a conversion to a larger picture tube, a conversion to intercarrier sound, a replacement of the tuner with a superior type, a modification for more stable horizontal *afc*, or perhaps the minor addition of vertical retrace blanking.

While all of these changes have been successfully accomplished many times with overall performance improved, in other instances changes made improving one phase of performance have led to sub par performance in another phase of set operation. While replacing a tuner, for example, with an improved type, may increase sensitivity and rid the set of tuner drift, distortion, etc., this replacement may also lead to poorer picture definition unless certain precautions are taken.

The conversions and modifications discussed here are those taken on the serviceman's own initiative, and not necessarily associated with set manufacturers' suggested changes, although similar defects many occur in these cases also. When making changes suggested by a manufacturer, be sure the change is suitable for the locale. For example, changes suggested for fringe area operation do not apply to strong signal areas. Before making a modification, be sure that some defective part is not erroneously indicating a need for the change.

In a recent case of poor sync, modifying the sync separator stage cleared up vertical hold but brought on picture bend. A defective part in the video section was the actual cause of the trouble. A final word on manufacturer's suggested changes — make *all* the part changes recommended in the modification.

This article discusses some of the more frequent conversions and modifications, defects which may result therefrom, and methods for correcting and improving overall performance.

Larger Picture Tube Conversions

Some of these conversions have been attempted by replacing only the yoke. This often results in too little brightness, blooming and poor focusing. To correct this condition it is necessary to change the horizontal output transformer to one capable of supplying higher anode voltage. It must also provide a proper impedance match for the yoke. Another defect which crops up in these conversions is vertical or horizontal jitter and buzz in the sound. This condition is frequently due to poor grounding of the yoke housing to the picture tube aquadag coating and to overlong or unshielded yoke leads. The remedies are obvious. A ground lead should be run from the set proper to the yoke housing and the spring ground applied to kinescope aquadag coating. Yoke leads should be shortened to minimum. Plug and socket connectors will render future servicing easier. Shielding the yoke leads is not often needed since lead dress is usually sufficient.

Another, though less frequent, defect is that of small picture, even though the set had full deflection when first converted. The tubes capable of causing the trouble were changed without effect. With the set in the shop, voltage and scope readings appeared normal enough. The yoke was bared by removing the cardboard cylinder around it and the fault became apparent. The ferromagnetic core pieces were loose around the windings. They had been held together originally with plastic tape. Assembling with a steel band from an old defective yoke finished that job.

A tough case of jitters occurred in a converted RCA using pulse width horizontal *afc*. This was definitely a job for scope tracing and with the scope it was found that the patterns were normal up to the final sync output. A transient pulse was suspected as the cause of the trouble and this

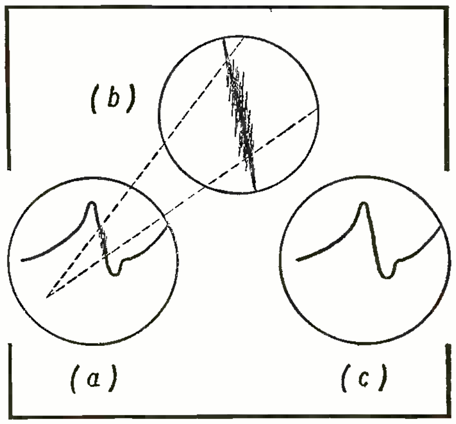

Fig. 1a—Distorted wave form at plate of sync amp; Fig. 1b shows an expanded view of the distortion. Fig. 1c shows the appearance of the normal wove form.

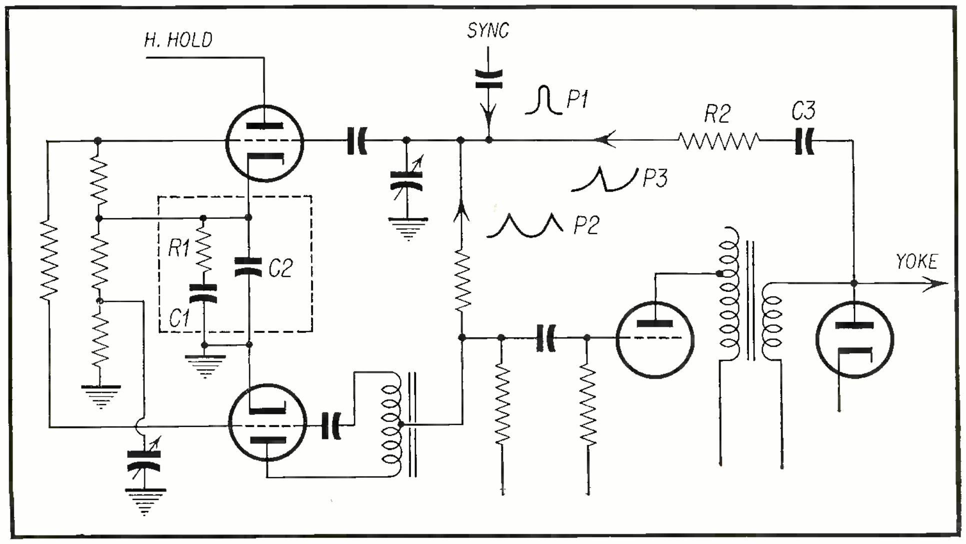

Fig. 2—Typical pulse width *afc* circuit. The component wave-forms used to produce the automatic control action are shown as P1, P2, and P3.

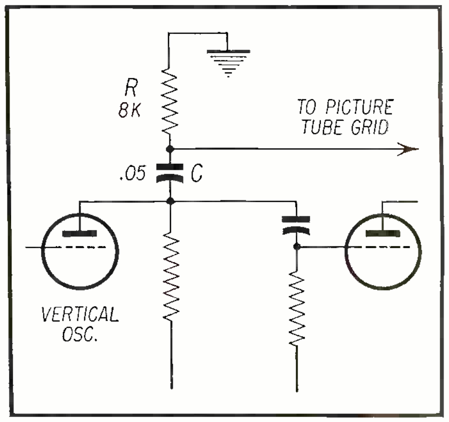

Fig. 3—A simple circuit which is commonly used to obtain vertical retrace blanking. The .05 μf condenser and the 8K resistor are the added components.

transient presented itself at the sync output plate and was noted, increased in amplitude on the grid of the controlling triode. These waveforms are shown in *Fig. 1a* and *1b*. The normal waveform is shown in *Fig. 1c*. Trouble was suspected in the anti-hunt portion of the circuit shown in the dotted box of the box pulse width *afc* schematic of *Fig. 2*. After each anti-hunt component was temporarily replaced without effect, the composite pulse was analyzed.

Referring again to *Fig. 2*, the composite pulse consists of the sync pulse *P1*, an integrated sawtooth pulse with slow decaying slope *P2*, and an integrated sawtooth pulse with rapid decay, *P3*. *P1* and *P2* appeared normal on the scope in both shape and amplitude, while *P3* appeared ragged and oversize. The pulses were displayed separately merely by disconnecting the other two pulses at their junction. The peak amplitude of these pulses should be, roughly, about 15 to 30 volts. In this set *P3* was almost 100 volts. This pulse turned out to be too great at its point of origin, due to the amplified deflection needed for the increased size. *P3* was removed by disconnecting the circuit completely. This conforms with later circuits of this design. The single sampling pulse *P2* working with sync pulse *P1* is capable of supplying stable horizontal *afc*.

Tuner Replacement

Another common modification is that of tuner replacement with an improved type. All too often such jobs are not followed through to the ultimate. The main defect which results as a byproduct is poor definition in the picture due to insufficient bandpass in the *if* amplifier. A basic requirement after tuner replacement is sweep alignment of the *if* ampilfier. Alignment of the tuner itself is rarely necessary if the replacement is new.

Another condition resulting in less than maximum improvement is the application of improper bias to the *rf* stage, particularly in cascode units. Reading this bias is mandatory on the finished job, with corrections made if necessary. Most sets will be operating with agc, and if the bias is too high the gain will suffer; if it is too low some

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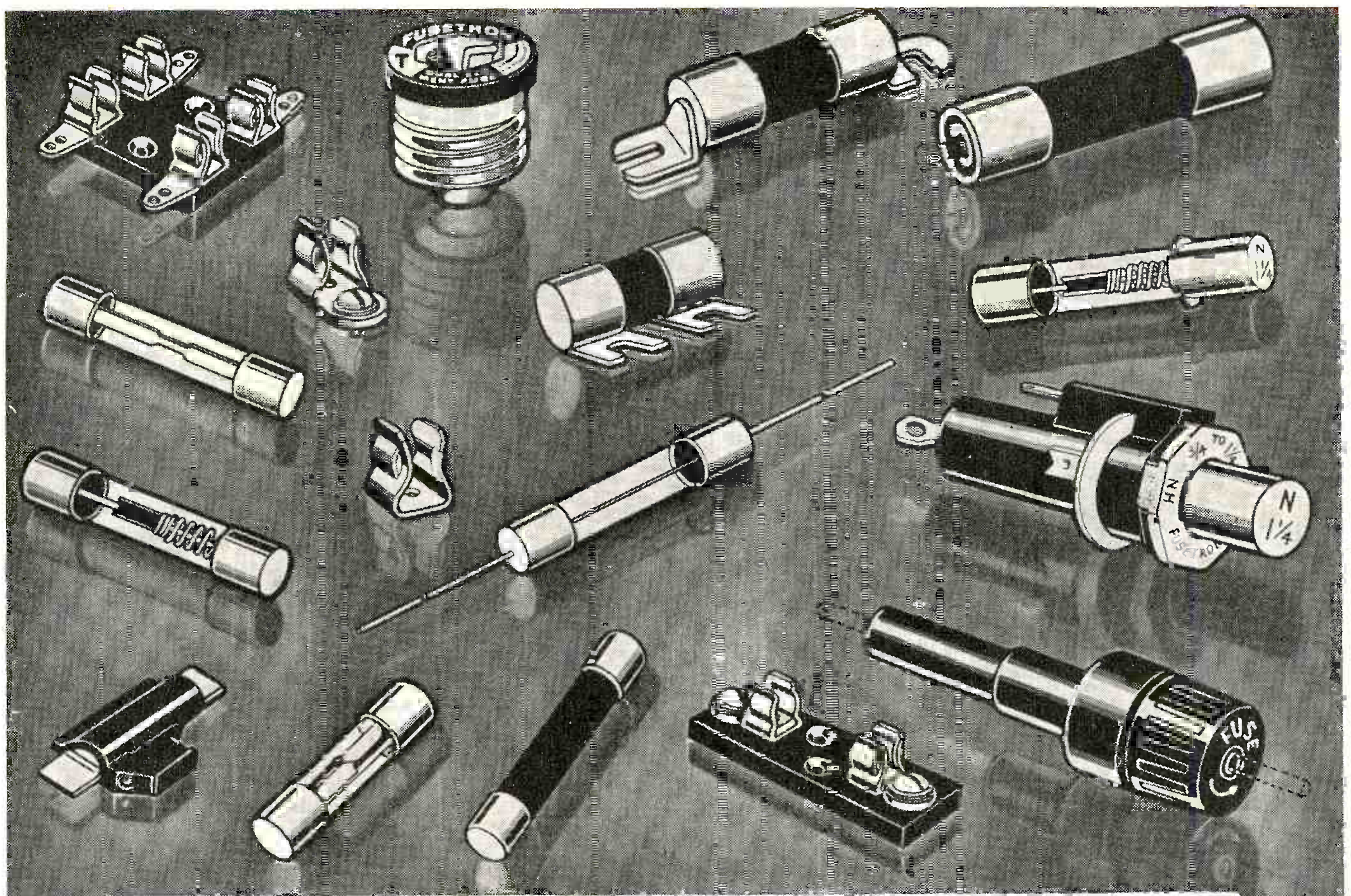
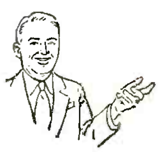
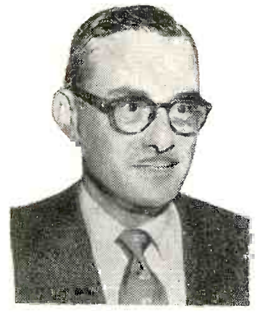






S. R. COWAN

Ad Libs

Towers Going Up

A tragic event occurred in early November. A small privately owned airplane, trying to reach its landing field, but flying in a heavy ground fog, crashed into the old, no longer used WOR tower situated just across the Hudson River close to New York City. This old tower, slightly less than 800 feet tall, became obsolete when WOR-TV began to use the 1,472 feet high facilities of the Empire State Building. Why the plane's operator failed to see the tower warning lights and avoid the tragedy is unknown.

At this writing there are under construction a 1,572 foot TV tower at Oklahoma Ctiy, Oklahoma; and a 1,610 foot TV tower about forty-three miles east of Roswell, New Mexico. Naturally these towers will embody every known safety and warning device. Further, there is a rumor that just west of Chicago, Illinois, it is proposed to build a tower that will stand close to 5,000 feet high. Imagine! Almost a mile!!

We advocate construction of the highest possible towers, however, with all necessary safeguards. The higher the tower the broader the range of television coverage. It is said the tower being built for KSWS-TV at Roswell will carry the station's signal over southeastern New Mexico and western Texas. Soon, if enough high towers are erected, they might even eliminate the need of certain proposed but not really wanted UHF stations. In any event, present-day towers and currently proposed towers are enabling transmitters to reach, with a TV signal, upwards of 87% of the homes in the USA. That nearly 70% of all USA homes now have one TV set (or more) is indicative of the fact that television is a very popular factor in our way of living.

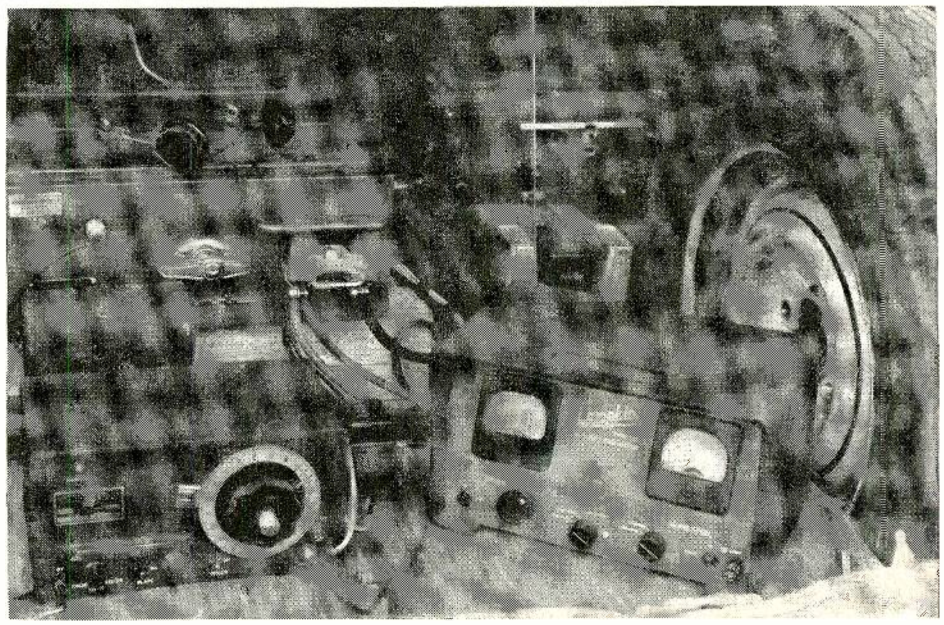
"Discount House" Evil

November 6th was Election Day. As you know, the big TV networks, with commercially sponsored programs gave minute-by-minute reports of developments. The commercials of one particular sponsor gave me "fits" and I can't understand why these tactics are tolerated by radio and appliance dealers who are franchised to sell their line. On station breaks here in New York this particular appliance and television set manufacturer had the temerity to urge listeners repeatedly to buy their products from a price-slashing, cut-throat "discount house." The objective, naturally, was to sell as many sets as possible merely because of price-cutting. No ordinary legitimate retail, department or furniture store, no legitimate radio or appliance store can possibly sell sets, furnishing delivery and token installation or even partial service in competition with the "discount house" in question because it got a price deal direct from this manufacturer, eliminating even the distributor.

That sort of almost - direct - from - manufacturer - to - public type of selling is one of the reasons why distributors of TV sets can't operate in the black purely from sales. Consequently, they find it necessary to become service firms in open competition with the retail firms and service dealers from

[*Continued on page* 45]

An accurate frequency meter is an essential piece of equipment for the mobile technician. One is shown here being packed in preparation for a service call.



A typical set-up of test equipment used in the checking of mobile equipment. This is a view of the interior of the trunk of a county sheriff's car.

Opportunities in Mobile Radio

BECAUSE mobile radio is such a time and money saver, it has been growing by leaps and bounds. The F.C.C.'s 19th Annual Report shows that there were 299,000 transmitters in service on January 1, 1952. The most recent report indicates that on January 1, 1955 there were over 44,000 fixed transmitters, and over 595,000 mobile transmitters for a total of over 640,000 transmitters. This is exclusive of fixed amateur transmitters. It is a safe assumption that there is at least one receiver (and probably more) for each transmitter. This tremendous rate of growth is expected to continue for years, and creates a wonderful opportunity for the wide-awake radio repairman, or service engineer. Each one of these mobile outfits must be installed, then re-installed each time the vehicle wears out or is replaced. Further, this equipment works best with "preventive maintenance," which means periodic inspection, alignment, and replacement of weak parts, before they blow. Finally, measurements of frequency, modulation, and power input must be made at least every 6 months.

Usually a home-radio and TV repairman is called upon only when some trouble is found in a set. Mobile-service engineers, on the other hand, are continuously needed since the equipment must be kept running, around the clock, 365 days a year. Some engineers take full-time, salaried jobs with the big operators of vehicular fleets; others, and by far the majority, operate as independent engineers and contract to maintain a number of smaller radio systems throughout their area.

Editor's Note: The information presented in this article appeared in a booklet published by Lampkin Laboratories, Inc. We feel that it is of interest and importance to all servicemen, and wish to express our thanks to the Lampkin Laboratories for their permission to reprint this material.

That is the way in which many progerssive radio-servicemen have climbed above the unrestricted cut-throat competition of regular radio and TV servicing —and established themselves as highly-paid professional mobile-service engineers; quite a few cover territories 300 or 400 miles wide, and some even fly to customers in emergencies.

What is Mobile Radio?

Mobile radio is two-way radio-telephone communication between a base station and a normally moving vehicle, and between vehicles themselves. Most of these vehicular telephones are in automobiles, taxis, trucks, etc., but many others are in boats and aircraft. All mobile-radio installations must operate according to regulations of the Federal Communications Commission, Washington, D. C. The F.C.C. classifies these installations as the Safety and Special Radio Services, which include such widely diversified users as:

Police Departments	Farmers
Fire Departments	Loggers
Gas Companies	Contractors
Doctors	Trucking Companies
Petroleum Companies	Geologists
Power Companies	REA Utilities
Railroads	Forestry Departments
Ambulances	Mining Companies
Highway Departments	Buses
Garages & Wreckers	Airlines
Taxis	Construction Companies
Fishing Boats	Private Aircraft
Agricultural Packers	Auto Clubs

The frequencies now used in mobile radio range all the way from 1610 kilocycles to 460 megacycles, with concentrated bands at 2.0 to 3.0 *mc.*, 30 to 47 *mc.*, 72 to 76 *mc.*, 152 to 175 *mc.*, and 450 to 460 *mc.* Besides the frequencies above, most of the services have allocations in the microwave region from 900 to

3,000 *mc*. However, at present there is very little activity in that part of the spectrum.

Each mobile-radio installation consists of a transmitter and a receiver; at the base station the transmitter usually operates from *ac* power, and is rated at 30 to 250 watts; the mobile transmitter averages 5 to 30 watts and runs on a 6-volt or 12-volt storage battery. The receivers are tuned for a single-frequency, are single or double-conversion superheterodynes, use crystal-control on the conversion oscillators, have a selectivity of 20-to-40-*kc*., sensitivity of 1 microvolt or less, and a squelch circuit to quiet the loudspeaker in absence of a signal.

The F.C.C. gives permission, through the medium of a radio-station license, for each transmitter to be used on a certain frequency. The license costs nothing, only the paper work on the application. In return, the licensee must check periodically to see that his station does not bother his neighbor, by wanderinng off the assigned frequency, by overmodulating, or by excessive power.

All adjustments, checks, and repairs on the transmitter which are made during installation, servicing, or tests must be made by, or under the direct supervision of a licensed radio operator, either first or second-class, radiotelephone or radiotelegraph grade. This is a commercial operator's license, as distinguished from an amateur license. The license likewise costs nothing, and is obtained by passing an examination at one of the F.C.C. offices.

For further information on the regulations, you can buy the following F.C.C. Rules from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.; Part 8 costs 15 cents, the others cost 10 cents each:

- Part 8, Rules Governing Stations on Shipboard
- Part 9, Rules Governing Aviation Services
- Part 10, Rules Governing Public Safety Radio Services
- Part 11, Rules Governing Industrial Radio Services
- Part 13, Rules Governing Commercial Radio Operators
- Part 16, Rules Governing Land Transportation Radio Services
- Part 18, Rules Governing Industrial, Scientific, and Medical Service
- Part 19, Rules Governing Citizens Radio Service

F.C.C. Maintenance Regulations

Here is a summary of the F.C.C. mobile-service maintenance requirements—requirements that mean a steady source of cash for the two-way radio technician.

A. Frequency Check—must be made when the transmitter is initially installed, whenever a transmitter change is made which would affect carrier frequency, and at intervals not to exceed 6 months when the transmitter is crystal-controlled or not to exceed 1 month when it is not crystal-controlled. This frequency check must determine if the frequency is within a tolerance of 0.01% if the carrier frequency is below 50 *mc.*, or within 0.005% if the carrier is above 50 *mc.* These figures apply to the majority of installations.

B. Modulation Check—at the same intervals as the frequency checks mentioned above, a modulation check must be made. This must determine that the modulation does not exceed the F.C.C. limits, which are: more than 70% but less than 100% (on negative peaks) for *am* transmitters; not to exceed 15 *kc.* swing, plus or minus, from the center frequency in *fm* transmitters.

C. Plate Power Input Check—this must be measured on the output tube of the transmitter at the intervals mentioned above, and must not exceed the licensed value.

D. The Name and Address of the Person Making the Checks Must Be Entered in the Station Log. This has two important ramifications for the mobile-service engineer. It means that he is guaranteed against competition from unlicensed persons—and it also puts a strong obligation upon him to make accurate measurements. It is a poor engineer who, having given a clean bill of health to a transmitter, a short time later gets a citation from the F.C.C.! Thus, in this field of service, you must have complete confidence in your measuring equipment.

RESULTS FROM SURVEY OF MOBILE-SERVICE ENGINEERS

Question	*Low*	*High*	*Average*
For how many *organizations* do you maintain two-way radio?	5	60	21
How many *frequencies* do you need to check?	4	52	23
How many *mobile* units do you maintain?	30	506	152
How many *fixed* units do you maintain?	6	128	28
What are the *lowest* and *highest* frequencies you measure?	290 KC	460 MC	—
How many *units* do you feel one man can maintain?	100	330	160
Labor charge, hourly rate	$ 3.75	$ 5.00	$ 4.35
Travel charge, cents per mile (added to hourly rate)	6¢	10¢	8.6¢
Travel charge, cents per mile (time & travel)	11¢	20¢	15.7¢
Retainer fee, base station, per month	$ 10.00	$ 27.50	$ 16.00
Retainer fee, mobile station per month	$ 5.00	$ 7.50	$ 5.50
Installation charge, base station, 60 to 250-watt	$ 50.00	$ 100.00	$ 75.00
Installation charge, mobile station	$ 20.00	$ 35.00	$ 28.50
Frequency & modulation check, one unit, no contract	$ 2.50	$ 10.00	$ 5.00

Turning These Opportunities Into Cash

These 9,000 new transmitters each month—and their need for continuous, high-grade maintenance by licensed commercial radio operators—mean a wonderful opportunity for men with ambition and foresight. Most home radio servicemen haven't the ambition to get the necessary license—so competition in the mobile-radio field will never be what it is today in receiver and TV repairing.

Yet while the necessity of getting a commercial ticket screens out much of your competition—probably because of the human inertia in most of us—it isn't a difficult obstacle. Actually, most who have taken it report that the second-class radio-telephone license examination is not much more difficult than the former Amateur Class A test. Hundreds of mobile-service technicians have prepared themselves right in their own homes for this exam.

You'll find several excellent correspondence courses advertised in the leading radio publications. Or, to save money, you may prefer to study one of the following books:

"Radio Operators License Question and Answer Manual," Milton Kaufman

"Radio Operating Questions and Answers," J. L. Hornung

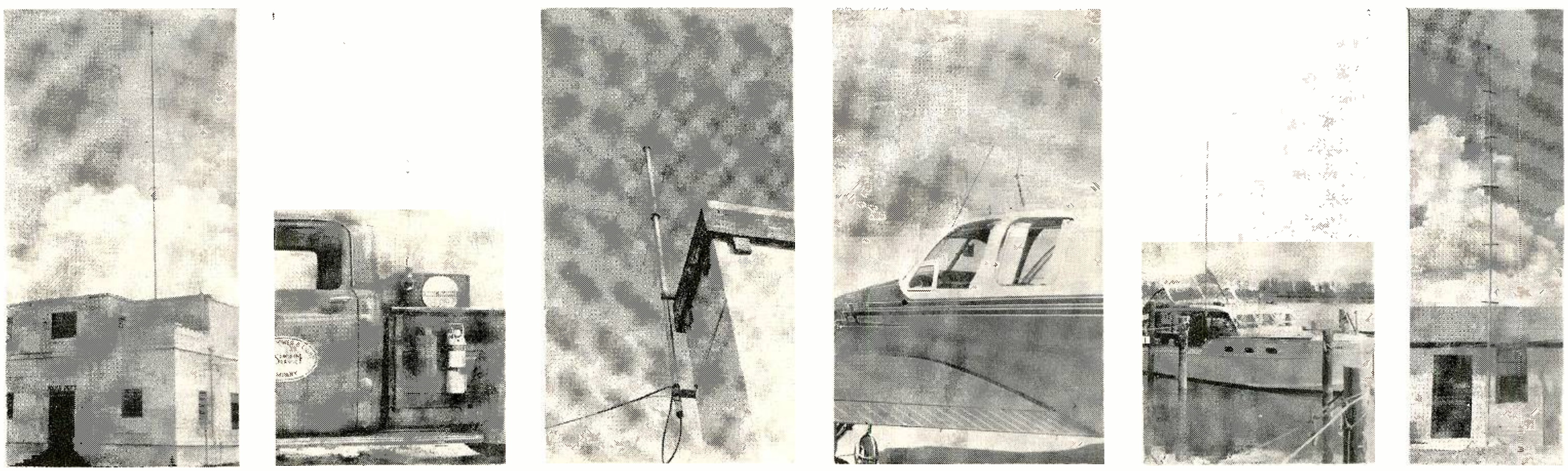
"How to Pass Radio License Examination," Charles E. Drew

After obtaining your operator's license, you are ready for customers. No doubt you know of mobile radio in your local police department—they pioneered the stuff some 25 years ago—and possibly know the electric power and taxicab systems. You could start with them. A neat way to locate customers is to be "antenna conscious." Keep your eye out for the tell-tale antennas on cars, trucks, boats, planes, road equipment, high buildings and water tanks—then start asking and find the boss. The very fact that some mobile-service engineers travel 300 miles to work on an installation must mean that there is no local, competent service technician.

Typical Mobile Service Arrangments

In general, there are two classes of arrangements between the service engineer and his client: (1) payment for service is made on a simple time-plus-material basis, as need for work arises; (2) payment for services is made on a contract basis.

The most frequently reported arrangement is an annual contract, between the technician and a number



Fixed stations serve mobile units in mobile communication system. These photographs illustrate antenna installations of both the fixed and the mobile variety. By keeping an eye out for such installations, the alert service technician can pick up leads for increasing his clientele.

of mobile-radio users, or licensees. By contract is meant a fixed fee, or retainer, paid periodically to the service technician by the licensee. This retainer can be figured at so much per radio unit per month, (a radio unit is a base station, a remote-control console, a relay-repeater station, a mobile station, a pack set, a handie-talkie, etc.) or it can simply be a certain sum per month for the entire radio system, with actual work charged for on a time and material basis. The contract can be written or verbal, depending mostly on local business customs. If written, it usually is on an annual, or a continuing basis with a clause permitting cancellation by either party on 30-day notice.

The contract must tell what work is covered by the fee, or retainer. Usually it calls for a periodic check, and correction as indicated, on each radio unit, at intervals of 30, 60, or 90 days; it includes the F.C.C. maintenance checks, and usually the F.C.C. paper work on license applications, construction permits, and renewals. It does not include installing, moving, or reinstalling equipment; nor does it ordinarily include parts which are furnished extra at regular retail prices.

There should be some understanding about the hours the service technician is to be on call. Twenty-four-hour call of course should be charged higher than 8-hour. On-call service also should depend on the degree of emergency—for instance, whether the outage is a main base transmitter, or only a single mobile unit—part of a fire or police system, or a farmer's field truck—in town, or 200 miles across the state. In urban areas the contract often includes service up to a 10 or 20-mile radius, with mileage to be charged outside. In other arrangements, the engineer makes a periodic swing around a 100 to 500 mile circuit, taking installations in sequence, and mileage is figured in the retainer. Very often, the latter engineer leaves a complete, spare chassis in working condition with the customer, to be substituted by him in case of trouble.

A contract is a beautiful way to finance some of the technician's test equipment. The licensee can advance the total price to the engineer, to be credited monthly against the retainer fee; or the engineer can take the contract to his bank, as basis for a loan to purchase the equipment.

Here are some other considerations regarding mobile-radio service rates and arrangements: if the equipment is all one make, you will through familiarity find the service work easier, and it will be easier to carry a good parts inventory. Further, you might hook up with one manufacturer as his area sales representative or area service representative, or both.

The amount of service work in a system depends on the age of the equipment—the older sets can come apart faster, or drop out of alignment more often. It also depends on the usage the equipment gets—a sheriff's car over mountain roads, or a 24-hour big-city taxi run will beat up the units much faster than an

[Continued on page 45]

Understanding Tone

This installment describes the operation of various treble-cut, bass boost circuits as found in popular amplifiers.

by LAWRENCE FIELDING

Part 2

A Popular Treble Cut Circuit

Figure 2 illustrates a simple means for obtaining treble cut only. With the 1 megohm control towards ground, nearly all the signal from the volume control is sent on to the next grid, because the voltage divider consists of *220K* in series with 1 megohm or more (depending upon frequency). With the 1 megohm treble control shorted out, however, low frequencies still see a high impedance from grid to ground because of the high impedance of series blocking capacitor (.001 mfd) at these frequencies, and are passed through the system unattenuated. High frequencies, however, see the .001 capacitor as a partial short circuit, and are therefore shunted to ground or attenuated. This, in effect, constitutes treble cut. About the only thing that can go wrong with this circuit is a short in the *.001 µf* capacitor, which would be evidenced by the treble cut control acting like a volume control instead of a tone control.

Universal Continuously Variable Tone Controls

Figure 3 is a schematic of one of the most popular types of tone control systems. In fact, it is safe to say that at least 75% of all high fidelity components manufactured in recent years utilize some form of this circuit. The component values shown in *Fig. 3* are those used by the General Electric Company in their Model A1-200 Pre-Amplifier and Control Unit. *Fig. 4* shows a similar circuit, with some different design parameters as used by Harmon-Kardon, Inc. in their Model C-100 Amplifier and Control Unit. *Fig. 5* is the schematic of the tone control section used by the Pilot Radio Corporation in their Model PA-913 Deluxe Control Center. For the purpose of this discussion, refer to *Fig. 3*. Following this analysis, you will find it simpler to extend the explanation to cover the other schematics of this basic type of tone control configuration.

The bass control portion of this circuit consists of resistors *R1, R2, R3*, and capacitors *C1* and *C2*, with *R2*, the *500K* potentiometer serving as the front panel tone control. In order to understand this tone control, it should be pointed out that even though flat response is achieved when the control is at its center of rotation, this point does not correspond to the half resistance point. These controls have a special logarithmic taper (sometimes known as an audio taper), so designed that when the control is at the center of its rotation, the arm actually picks up only 10% of the total resistance (in this case, *50K* of the total *500K*). This is especially important to note because many of your troubles with tone controls will involve changing the control itself when it has developed noise or an intermittent or open spot. Unless the replacement control has the taper prescribed for this operation, the action of the control will be completely incorrect.

With the arm of *R2* in the center, then, a voltage division of 10 to 1 occurs as far as the resistance is concerned and only one tenth of the available signal is transferred to the following grid circuit. It is for this reason that the circuit is sometimes referred to as a "losser" type of tone control. You will note that capacitors *C1* and *C2* also have a 10 to 1 relationship in capacitance (and hence a 10 to 1 relationship in impedance, regardless of frequency).

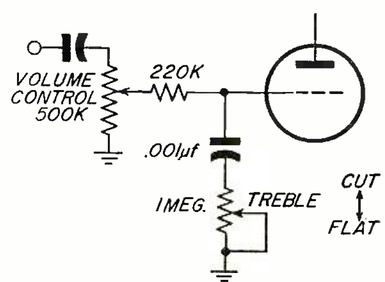


Fig. 2—A simple, basic, treble-cut tone control circuit.

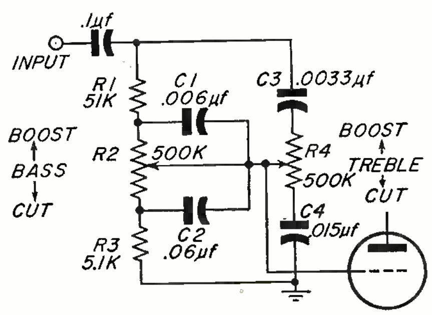


Fig. 3—Universal Losser circuit used in G.E. A1-200 preamplifier.

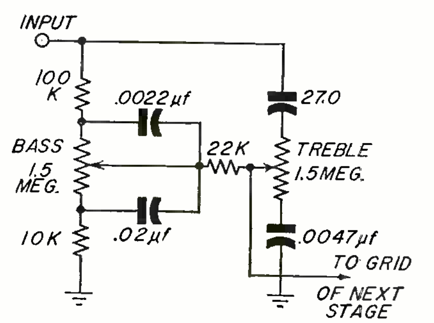


Fig. 4—Universal Losser circuit. Harmon-Kardon C-100 amplifier.

Controls

Thus, with the bass control arm in mid-position, a constant percentage of the input voltage is transferred to the next grid at all frequencies. Even at high frequencies, where both *C1* and *C2* effectively short out *R2*, the ten to one division is still maintained because of the value of the limiting resistors *R1* and *R3* which are respectively *51K* and *5.1K*.

Now, suppose the arm of *R2* is moved fully upward (clockwise, towards bass-boost). *C1* is then shorted out. At higher frequencies (above 800 cycles or so) *C2* is a short to the signal and 1/10th of the total signal is transmitted to the next grid. At low frequencies, however, *C2* presents a large impedance to the audio voltage. In the extreme case, it looks like an open circuit and voltage division is now changed so that about 9/10ths of the signal is across the following grid. (Actually *505.1K/556.1K*). This, of course constitutes a bass boost of as much as 10 times (or 20 *db*). When the arm of the bass control is fully counterclockwise (bass cut), *C2* is shorted out. Again, high frequencies are still divided in a 10 to 1 ratio, since *C1* now acts as a short circuit and volt-

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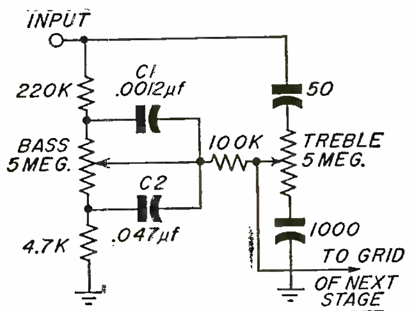

Fig. 5—Tone control circuit of the Pilot PA-913 control unit.

COLOR KILLER CIRCUIT ANALYSIS

Chroma amplifier circuits must be disabled during monochrome reception. General considerations and specific applications pertaining to Color Killer circuits are the subjects of this installment.

By BOB DARGAN and SAM MARSHALL

From a forthcoming book entitled "Fundamentals of Color Television"

During reception of *monochrome* signals (absence of burst) on a color receiver, it becomes necsssary to disable the chroma amplifier circuits, so that superfluous signals such as noise, which may appear at the chroma amplifier input for various reasons, are not present at the demodulator outputs. The presence of such signals would be translated as unwanted color information on the face of the color picture tube.

The simplest but least convenient method of accomplishing this disabling operation is to include an on-off switch in the chroma amplifier, so that the chroma amplifier is rendered inoperative during black and white reception. This technique was actually employed in early color sets as the only means of disabling the chroma amplifier during monochrome reception. However, the desirability of automatically accomplishing this function became evident in time and as a result, automatic circuits for disabling the chroma amplifier on monochrome transmissions are now employed in present color TV receivers. These circuits are called "Color Killers," their action depending on the presence or absence of the burst signal present in the received transmission. Thus, during the presence of a burst signal, the chroma amplifier is left in operation. During a monochrome transmission, however, there being no burst signal present, the chroma amplifier is disabled. In some receivers using automatic color killer circuits, an auxiliary switch is additionally provided to disable the chroma amplifier. This switch is used on weak monochrome reception where there is a strong possibility that noise entering the chroma channel might be accepted as a pseudo burst signal, thereby allowing spurious chroma information in the picture tube input circuits.

In effect therefore, a color killer circuit operates to disable the chroma amplifier *only* during reception of black and white signals. A basic color killer block diagram is shown in *Fig. 1*. In operation, a chroma signal from chroma takeoff transformer in the receiver is directed into the chroma amplifier. The output of this amplifier is fed into the section comprising the burst amplifier and automatic phase control (APC) loop. In this section the 3.58 *mc* burst, present in the chroma signal, is processed so that it controls the frequency and phase of the local 3.58 *mc* reference oscillator.

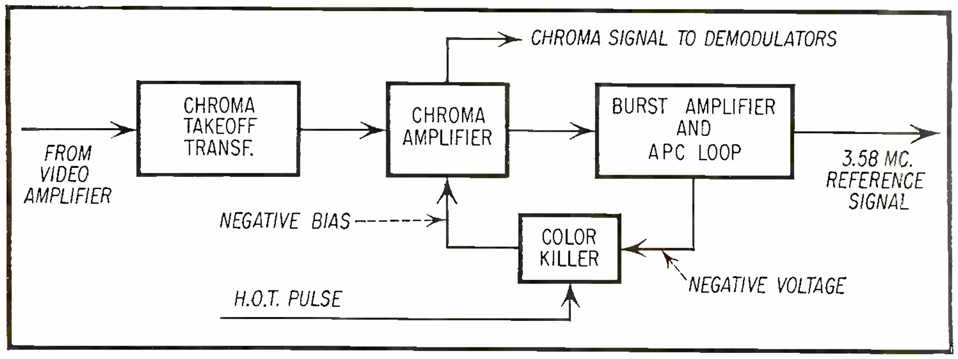

Fig. 1—Block diagram to illustrate the action in a typical color killer circuit.

Somewhere along the burst and APC loop chain, a negative voltage is developed during the presence of the burst signal. This negative voltage is made to bias a tube designated as the "color killer". Also fed into the color killer is a pulse from the horizontal output transformer.

During the presence of a color burst signal the color killer is biased to cutoff by the negative voltage developed in the burst-APC chain. However, during a black and white transmission this negative voltage is not present and therefore does not cut off the color killer. The latter is then free to amplify (or process in some other manner) the horizontal pulse from the H. O. T. This pulse is applied to input of the chroma amplifier where it develops a high value of grid bias due to grid-cathode conduction; a value high enough to cut off the chroma amplifier.

As a parting thought in this discussion, it might be pointed out that the cut-off bias, developed at the chroma amplifier, is developed in a fast-acting RC circuit. This action is rapid enough to switch the killer on and off during station breaks and commercials (when the latter is transmitted on a monochrome signal), thereby providing satisfactory operation during fast acting

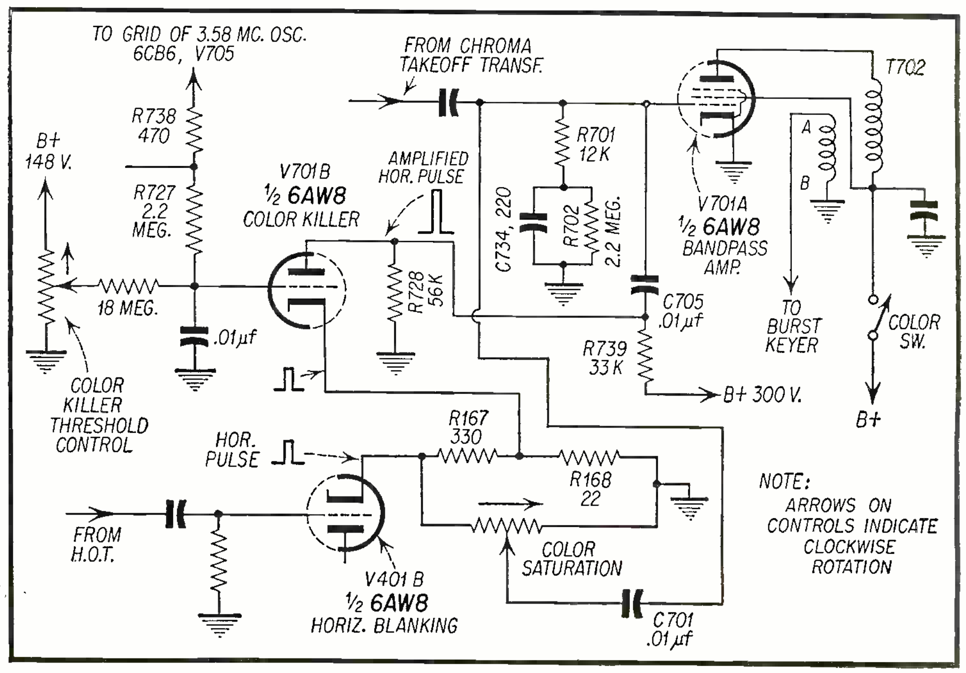

Fig. 2—Color killer circuit of the RCA CT5. Note the use of an auxilary switch.

transitions between monochrome and color transmissions.

RCA CTC5 Color Killer

One version of a color killer circuit using an auxiliary color switch is shown in *Fig. 2.* The operation of this circuit is as follows:

During reception of a burst signal on a color transmission an increased grid bias is present at the grid of the 3.58 *mc* reference oscillator, V705. This bias is transferred through *R738* and *R727* to the grid of the color killer V701 and cuts it off. Thus, the color killer plate, connected to the grid of V701-A through *C705,* develops no negative voltage and does not affect V701A.

Directing our attention now to V701, the bandpass amplifier, we observe that the bias on this tube is initially dependent on the grid-cathode conduction developed by the color saturation control setting. The latter provides a horizontal pulse from V401-B to the grid leak network comprising *R701, C734,* and *R702* through *C701.* The higher the pulse amplitude the greater the bias voltage applied to the bandpass amplifier.

When a monochrome signal is received, the bias at the output of V705, the 3.58 *mc* oscillator is reduced, there being no burst signal present. This reduced bias is transferred to the grid of V701-B, causing the tube to conduct.

In the meantime, a horizontal pulse signal from the horizontal blanking circuit, (*R167* and *R168*) is impressed on the cathode of V701-B, and appears as a positive amplified pulse in the plate circuit of this tube. This pulse applied to the grid of V701-A through *C705* grid biases the bandpass amplifier tube to cutoff, thereby preventing spurious signals developed in the chroma circuit from reaching the color picture tube inputs.

Notice that this circuit includes a color switch which is ganged to the color saturation control and which disconnects the B plus voltage from the bandpass amplifier when it is turned to the "Off" (counterclockwise) position. This switch is used on receiving weak black and white signals where the noise level is high, and where such

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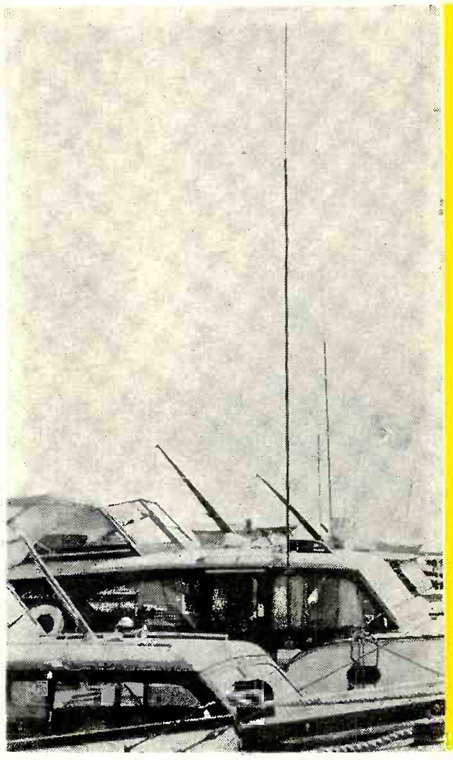


Line-up of small powerboats, showing radiotelephone antennas.

Marine Electronics

POWERBOAT ANTENNAS: Theoretical Consideration

Part Six

by ELBERT ROBBERSON

The most important single element in satisfactory marine radio performance is the antenna system which involves height, loading coils, losses, radiation resistance, etc.

THE antenna system is the most important single element in a radiotelephone installation, so it is imperative that the service agency be well acquainted with the theoretical kinks, as well as the practical ones.

For receiving, almost any kind of antenna will suffice, but for transmitting, rigid qualifications must be met. Except for VHF equipment, which will be dealt with later, marine radiotelephone equipment is designed to operate with a quarter-wave or Marconi type antenna. A Marconi antenna can be made up in a smaller form than other types of antennas. An ideal Marconi is represented by a vertical conductor connected at the bottom to the ground. It may be either series or shunt-fed, but the series connection is the one used in boat equipment.

Effect of Antenna Height

When the antenna has an effective height of one-quarter wave length, it appears as pure resistance to the transmitter, the bulk of this being radiation resistance with small values of ground and conductor resistance. The value of the total resistance in the ideal case is on the order of 30 ohms.

Now, here is the main complication. At the center of the band of marine frequencies, 2.5 *mc*, an equivalent quarter wave antenna would be 94 feet high (according to the expression $h = \frac{234}{f}$, where "h" is the height and "f" the frequency in *mc*). This is much too high an antenna to be practical for a small boat. In fact, mechanical considerations limit small powerboat-antenna heights to the neighborhood of 20-feet, and antennas as low as 12-feet are in common use. Thus, our powerboat antenna is nowhere near the desired quarter-wave length, but more on the order of one-twentieth of a wavelength.

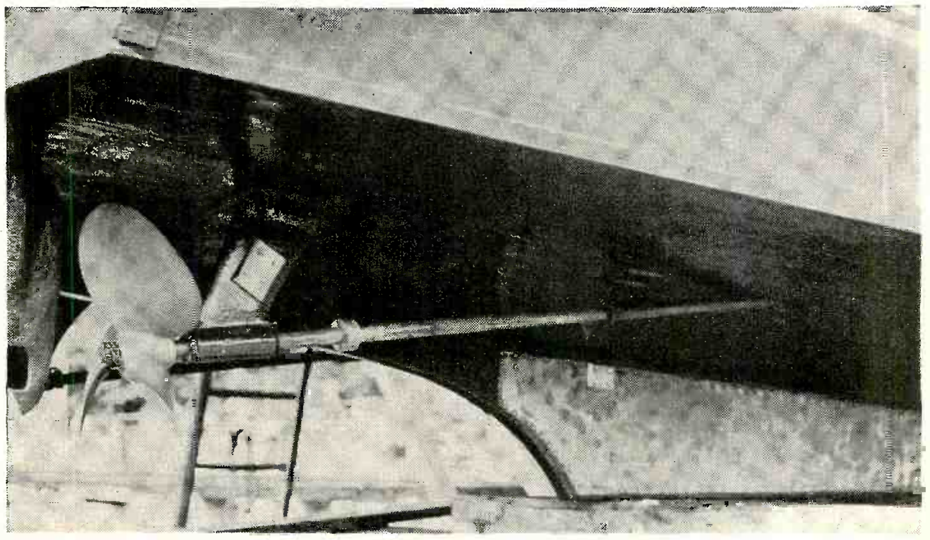
A conductor having a length less than one-quarter wave presents a capacitive reactance to the transmitter besides having radiation resistance. This capacitance must be balanced by the addition of inductance to the circuit to establish resonance, a function performed in the transmitter by a loading coil, with adjustments (usually coil taps) which are selected for the different frequencies by the channel switch.

Radiation Resistance

It hardly seems possible that so simple a system could be critical, but, indeed, it is. Comparison of the radiation resistance of antennas in the neighborhood of one-twentieth wave length, with the possible loss resistances, shows why this is so.

Radiation resistance in ohms can be computed roughly for a short antenna by the formula $R_r = \frac{h^2}{312}$, where "R_r" is the base radiation resistance in ohms, and "h" is the height of the antenna in electrical degrees. From this, we see that at the frequency 2.5 *mc*, a 12-foot antenna has a radiation resistance of approximately .4 ohms, an 18 footer approximately .9 ohms, and a 24 footer, 1.6 ohms. *Fig. 1* gives the radiation resistance for Marconi antennas having heights from 10 to 26 feet.

It would be very desirable for loss resistance to be much smaller than these values; however, they are usually much greater, and our primary aim must be, therefore, to keep loss resistances as low as possible. An understanding of the sources of loss and how they may be minimized is one of the most valuable tools of a marine electronics agency.



Practical method of installing ground plate on deadwood.

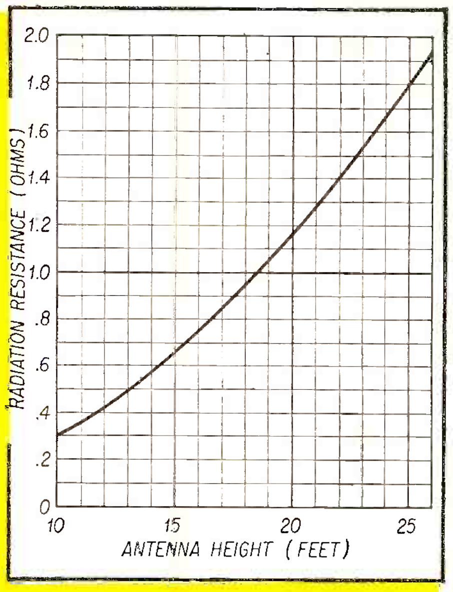


Fig. 1—The radiation resistance of Marconi antennas having heights that vary from 10 to 26 feet.

Conductor Resistance Loss

Basic loss is, of course, the *rf* resistance of the antenna conductors. This is made up of the ohmic *dc* resistance, with an added factor for skin effect.

First of all, it is important that conductors have the lowest possible *dc* resistance. Copper wire or tubing is best. Furthermore, the conductors should be as heavy as possible, within reason. If the conductor is one of comparatively high resistance, such as a piece of stainless-steel rigging wire being used as an antenna, the cross section of the rigging wire must be great to compensate (by additional skin area reducing loss due to skin effect) for its greater ohmic resistance.

For example, a piece of stainless-steel rigging wire may have several ohms more resistance than a copper wire of the same gage. But a larger gage stainless wire may have equal or lower resistance, due to the reduction of skin-effect loss.

Higher unit resistance should not be taken automatically to mean that stainless steel or other rigging may not be suitable for any antenna, since the numerical resistance per length is not as important as the ratio of this loss figure to the radiation resistance expected of the proposed antenna. A long antenna, one approaching one-quarter wave, would not be seriously degraded by the addition of a couple of ohms conductor resistance. However, it should be a rule to use wire of the highest conductivity and size possible in short antennas where loss resistances are significant compared to radiation resistance.

Ground Connection Loss

The next source of loss resistance is the antenna ground connection. A perfect connection to perfect earth would have zero resistance, and no power would be lost at that point. However, on a boat, the nearest ground of any kind is some distance away, and the circuit to it is through the water. Fortunately, salt water has a comparatively low resistance; however, fresh water is acknowledged to be very poor as a grounding medium. While we have no control over the medium, we can control the means of connecting to it, and this ground connection should be the very best it is possible to make.

The best ground is the hull of a metal boat, the bottom of a copper-sheathed boat, or a large copper ground plate on the hull in direct contact with the water. Installation of a ground plate requires that the boat be hauled out of the water, which sometimes may not be possible at the time of radiotelephone installation. As a temporary expedient, any available ground connection may be used, such as the engine, rudder, keel, or other metal fittings underwater.

Because an engine by itself is really inadequate for a ground, every available underwater metal fitting should be "bonded" with heavy wire to the engine, as well as tanks, piping, control rods, etc., in the bilge. Internal objects increase capacity to ground even if they do not actually contact the water and thus augment the engine somewhat as a "counterpoise." In fact, every large piece of "hardware" which can be bonded into the ground system should make some improvement.

Measurements on various installations have shown that ground resistance of metal-hull or sheathed boats may be on the order of a fraction of an ohm, while smaller ground connections have resistances in tens-of-ohms. It is obvious that in the latter case, since transmitter power divides among the various load resistances, much more power is devoted to the ground-loss resistance than to the comparatively insignificant radiation resistance of a short antenna. This fact makes the ground connection mainly responsible for the often observed phenomenon of transmitters of equal power having greatly different working ranges.

Another important part of the ground system is the ground lead itself, which, because it carries the heaviest current of any part of the antenna circuit, should be a conductor of as large a gage as possible. The use of #4 cable, and even larger, is entirely justified for this connection. Ground leads, should of course, be routed as directly as possible with the fewer possible number of kinks and bends. A long ground lead, or one which has its inductance increased by circuitous routing or bends, appears to the transmitter as a large enough portion of a wavelength to place the equipment several volts above ground as far as *rf* is concerned. *Rf* voltage present on the case of the equipment will, of course, leak off through the surrounding wood when it is damp, resulting in power loss. Cases have occurred where the transmitter chassis and cabinet were sufficiently above ground to give the operator an *rf* burn, and sparks could actually be drawn from the equipment cabinet. In extreme cases, difficulty may be encountered in tuning the transmitter's antenna circuit.

Loading Coil Loss

The next source of loss resistance is the loading coil used to resonate the antenna circuit. Part of the loading inductance is contained in, and is a part of, the radiotelephone itself, and hence, its losses are beyond your control. However, in the event that a transmitter has a loading coil which is suspected of having excessive loss, external loading inductance, either outside the set, or in the antenna itself, can be used to limit the amount of equipment coil which must be used to the value necessary for channel changing.

The magnitude of losses encountered in the inductor used to resonate the antenna can be considerable. For example, many coils have resistance values of about 5-ohms, and some even more. Accordingly, special care should be

[*Continued on page* 22]

Test Equipment

Simpson 383A Capacohmeter

by Robert G. Middleton

Chief Field Engineer, Simpson Elec. Co.

With the growing popularity of printed and plated circuits, it has become clearly evident that a different approach to locating faulty components is in order. Printed circuits are delicately fabricated devices and readily vulnerable to damage if not treated with considerable care. Unlike the point-to-point wired chassis, the printed-circuit chassis is not well adapted to frequent disconnection and reconnection of components during trouble-shooting procedures.

It is considerably more difficult, for example, to disconnect a capacitor from a printed circuit strip than from a soldering lug. Should the capacitor be disconnected from its printed circuit, and then found to be satisfactory by conventional tests, it is difficult to clean out the mounting holes and to reconnect the capacitor without damage to the printed circuit. When a half dozen or more such capacitors are so checked by obsolete methods, much valuable time is lost, and the printed circuit sometimes damaged beyond repair.

The instrument illustrated in *Fig. 1*, the Simpson Model 383A, provides three in-circuit tests which do not require disconnection of the capacitor from its circuit. These in-circuit tests are provided in addition to the more conventional out-of-circuit tests.

"In-Circuit" Measurement of Capacitance

When the shunt circuit resistance is higher than the minimum values listed in the following table, the capacitance value can be measured in-circuit.

Capacitance in μf	Minimum Shunt Resistance
0.01	3 megohms
0.02	2.5 "
0.05	1 "
0.1	500 K
0.22	450 K
0.47	350 K
1.0	250 K
2.2	200 K
5.0	150 K
10.0	100 K

An open capacitor measures either zero capacitance, or a very small value which immediately shows the presence of the fault.

In Circuit Testing of Leaky and Shorted Condensers

By far the most common fault encountered in paper, mica, and ceramic capacitors, is a leaky condition. When the leak has a very low value, it is termed a "shorted" condition. A pulse-voltage test can be utilized for checks of capacitors which are completely shunted by circuit resistance, as depicted in *Fig. 2*. Statistics show that, of all the capacitors which require replacement in the TV chassis, better than half can be picked out by this novel pulse test. The operation of the equipment in this test is based on the following principles.

1. Leakage resistance usually varies with the applied voltage. In most instances as the voltage across the condenser increases, the leakage resistance decreases. This is indicated in *Fig. 3*. If the leakage resistance remained unchanged, the leakage current would follow the straight line (B). However, as indicated by (A), the leakage current exceeds the normally expected ohms law current by greater and greater amounts as the applied voltage decreases. This indicates a lower and lower value of leakage resistance as the applied voltage increases. Less frequently, the change is in the opposite direction, and the leakage resistance increases with increased voltage.

2. Leakage resistance is usually unstable. It frequently acquires a new value after the passage of a heavy current.

3. When the polarity of the voltage applied to a condenser reverses, the leakage resistance is often much greater (even infinite) for one polarity than it is for the reverse polarity.

4. Leakage resistance is often least stable when the applied voltage is in the form of sharp pulses.

The Model 383A utilizes these characteristics in the "in circuit" testing of capacitors. By employing a pulsed voltage across the condenser, two purposes are accomplished. First, a condenser may be charged to its rated breakdown value without injuring other circuit components in parallel with it. Thus a short duration 600 volt pulse with a comparatively long interval between pulses could be used to check a condenser for breakdown at 600 volts without overloading a parallel circuit as would be the case if a steady 600 volt *dc* source were used.

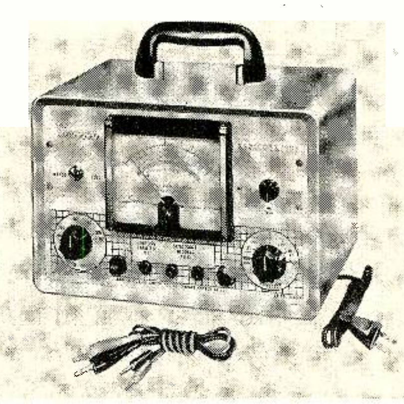


Fig. 1—Simpson Model 383A.

Secondly, a weak or intermittent condenser will break down more readily when a pulsed voltage is applied than when the voltage is steady.

Basically the instrument provides both a steady *dc* and a pulsed voltage to the condenser under test.

If the pulse voltage is considered independently, it may be represented graphically by *Fig. 4*. Notice that the average value of such a pulse is zero, since the short duration high level pulse in the positive direction is balanced by the long duration low level pulse in the negative direction. If such a pulse were fed into the resistive circuit of *Fig. 5*, the average current would be zero and the meter needle would not deflect. Of course the pulse repetition frequency would have to be high enough to prevent the needle from following the positive and negative excursions of each cycle.

Figure 6 shows similar circuit with a condenser taking the place of the resistor. If the condenser is good, the action is similar to that described for a resistor. If ordinary leakage resistance is present, however, the current flow

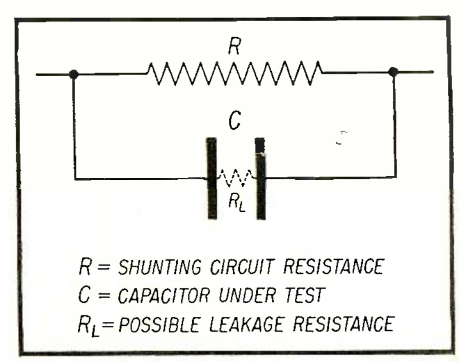


Fig. 2—The leakage condition (R_L) can be tested on an in-circuit condenser by the application of sharp amplitude adjustable pulses.

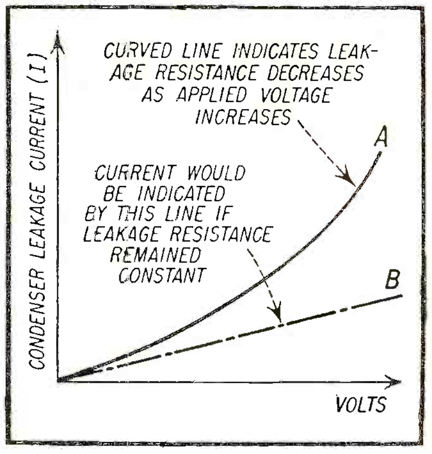


Fig. 3—The variation of leakage resistance with applied voltage is shown in the above illustration.

will be greater in one direction than the other because of the third characteristic of leakage resistance previously mentioned. The needle will now swing off the zero mark since the average current is no longer zero. Thus, a leaky condenser causes the needle to deflect

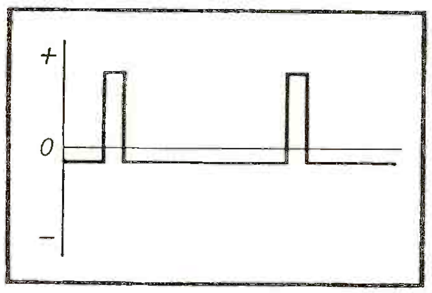


Fig. 4—The graphic presentation of the applied sharp test pulse.

to one side or the other when the pulse voltage is applied. If the condenser is good, the needle remains stationary.

The condenser may also be checked for breakdown by applying a pulse voltage 50% higher than the rated working voltage of the capacitor. If the needle remains stationary, the con-

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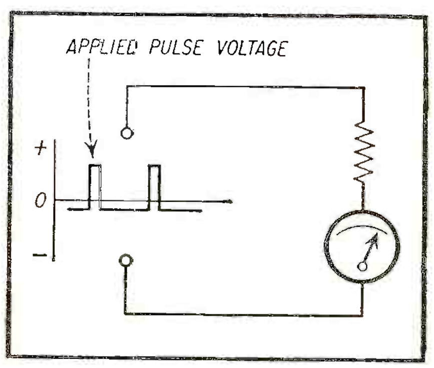

Fig. 5—The average current flow in resistor due to pulse is zero.

trade

Tremendous growth of the tape recording industry—360,000 recorders sold last year alone—has made magnetic tape easier for the recorder owner to select and buy. Minnesota Mining and Manufacturing Co.—makers of "Scotch" brand magnetic tape and pioneer in the field—has introduced three new self-service tape merchandisers which are now appearing in stores over the country. Daniel E. Denham, sales manager for the Magnetic Products division of the firm, pointed to the more than one million tape recorders in American homes today—by conservative estimate. "The American public is taking to tape recording just as it took to high fidelity music and equipment," Denham said. "Much of the interest in hi fi has now carried over into the tape field, since tape offers the best fidelity yet possible."

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A new concept in the method of teaching eletronics is contained in a series of basic laboratory manuals authored by the Radio-Electronics-Television Manufacturers Association—the second step in RETMA's program of instructional aids to vocational, trade, and technical schools throughout the country designed to produce skilled electronic technicians. In announcing the manuals' publication—"Basic Electricity," "Basic Electronics," "Basic Radio and Radio-Receiver Servicing." for radio and TV technicians, and accompanying "Instructor's Guide," W. L. Parkinson, of General Electric Co., and Chairman of the RETMA Service Committee's permanent subcommittee on Vocational Education said: "The availability of trained technicians required to install, maintain, and service electronic products may, in fact, determine the future progress of electronics."

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Officials of the Recoton Corp., phonograph needle, cartridge and accessory manufacturers in Long Island City, recently announced a drastic reduction in prices on their complete diamond needle line at the distributor level. In an announcement to the trade, Barney Edwards, Recoton Sales Manager, stated that their diamond styli are the very same fine quality that have always sold and are now selling under their famous brand name, "Recoton." He strongly suggested that Recoton distributors advise all their accounts to beware of diamond styli which do not bear the trade name of the manufacturer, since many of these are of inferior polish and radius and may ruin valuable recordings.

Nuclear-powered aircraft and other high-speed planes are expected to benefit by electronic developments described by enginers of Sylvania Elctric Products Inc. Electron tubes made of ceramics should be particularly useful in atomic-powered aircraft now being considered, according to W. R. Wheeler of Sylvania's product development laboratory at Kew Gardens, N.Y. Ceramic materials stand up better under intense nuclear bombardment than do the glass components of conventional tubes, he said, so considerable shielding weight can be eliminated for an atomic plane's electronic systems.

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Mr. Octave Blake, President of the Cornell-Dubilier Electric Corporation, announces the acquisition of the substantial majority stock control in the Tobe Deutschmann Corporation of Norwood, Massachusetts.

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America's electronic industry currently is an $11½ billion industry and within the next decade its sales and revenues probably will exceed $22 billion annually, an official of Sylvania Electric Products Inc. said recently.

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Harry G. Wahl is named field service engineer for the Sentinel Radio Company's Central Division with headquarters in Chicago according to an announcement by Ray J. Yeranko, National Service Director for Sentinel.

• • •

A tiny light-sensitive electronic device that may be used to guide missiles by sunlight, spot the flashes of distant artillery, or enable blind operators to find plug-in positions in a telephone switchboard was described by a scientist of the Radio Corporation of America. Development of the new device, a novel type of photocell no larger than the eraser on the end of a pencil, was disclosed by Dr. J. T. Wallmark, of the technical staff of RCA Laboratories, at a meeting of the Professional Group on Electron Devices, Institute of Radio Engineers. According to details given by Dr. Wallmark, the transistor-like cell is capable of sensing with a high degree of accuracy both the direction and intensity of a source of light. He pointed out that the compact device is capable of performing with improved accuracy and efficiency many functions which have been handled previously only with as many as four separate conventional photocells.

flashes

A receiver has been designed and engineered for ultimate simplicity by combining a complete plated circuit chassis with Packaged Electronic Circuits. The result is a decrease of chassis area by 20 per cent, the combining of 97 separate parts into 17 group units, and the reduction of conventional wiring by 90 per cent. This significant new development is the result of cooperative engineering effort between Motorola Inc., pioneer in plated circuitry techniques, and Centralab, originator of Packaged Electronic Circuits.

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The number of radio and television receivers sold through retail outlets to consumers in September increased over the August level, the Radio-Electronics-Television Manufacturers Association announced. Radio receiver sales increased over the comparable month of last year while TV sales declined. For the month of September, RETMA figures showed the sale of 763,881 television receivers and 756,345 radios through retail outlets compared with 566,158 TV sets and 681,152 radio receivers sold in August. A year earlier, RETMA reported the sale of 978,838 television receivers and 753,068 radio sets.

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Continuing its program to champion the cause of independent service-dealers, CBS-Hytron, a division of Columbia Broadcasting System, Inc., has introduced its Garry Moore Picture Tube Clean-Up Plan. Pointing out to housewives that they wouldn't believe that a Clean-Up could make the picture so much clearer, Garry asks them to "Pick up the phone and call an independent service-dealer. If you do not have a favorite service-dealer, look under Radio & Television Service in the yellow pages of the telephone book. Then call the service-dealer and tell him you want the Garry Moore Special Television Picture Tube Clean-Up."

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As part of an expansion program aimed to provide more comprehensive sales and application engineering service to instrument users, Weston Electrical Instrument Corp., Newark, N.J.—a subsidiary of Daystrom, Inc.—has announced the opening of the following district sales offices: Los Angeles, California, at 2001 So. Grand Ave.—Cincinnati, Ohio, at 7613 Reading Road—Philadelphia, Pa., at 101 North 33rd Street—Union, N.J., at Caldwell Ave. and route 22. In each office the staff of experienced and factory trained personnel has been expanded to meet the requirements in these highly industrial areas.

H. D. Johnson, Vice President of Sales of The Hickok Electrical Instrument Co., Cleveland announces that a new Service-Instruction Warranty Policy is now in effect to cover most of the company's electrical-electronic test instruments. Parts, materials and workmanship still carry the RETMA 90 day guarantee. In addition, however, Hickok has added, free of additional cost, a 1 year service-instruction warranty. This is the way it works: Upon purchase from a recognized Hickok distributor of one or more of the 26 instruments covered, a qualified Hickok Service Engineer will call on the purchaser and at no cost to the owner will check calibration and operation of the equipment. In addition, this service engineer will discuss operation function, rangers and uses of the tester. About 90 days thereafter, a second free-of-cost follow-up call will be made to again check calibration and operation of the equipment, as well as further discuss uses or functions of the equipment.

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A complete replacement line of TV transformers, flybacks, yokes and coils in hermetically sealed plastic containers is now available exclusively from Rogers Electronic Corp., 49 Bleecker St., New York 12, N.Y. This moisture-free, dirt-proof packaging extends shelf-life indefinitely, and minimizes failures and callbacks. The transformers also have built-in moisture protection. According to engineering director Fred Rogers, "As with many other electronic components, TV transformers also have a shelf life. The length of time a jobber or dealer may store them without introducing a risk of subsequent failure depends in great measure on the transformer's exposure to humidity and dust. This fact is recognized by designers of military electronic equipment; reliability is most important, so transformers are hermetically sealed. By hermetically sealing Rogers transformers in plastic bags, we expect to safeguard these units during storage in a similar manner."

• • •

Peter G. Buttacavoli has been promoted to the position of National Service Manager, it has been announced by William C. Scales, sales manager of the Receiver Division of Allen B. Du Mont Laboratories, Inc. Formerly manager of Du Mont Field Technical services, Mr. Buttacavoli is nationally known for his lectures on television receiver servicing both for black and white and color television receivers.

MARINE RADIO

[*from page* 17]

taken in selecting loading coils to make sure they have the highest attainable *Q*.

The most popular antennas today have a built-in resonating coil. The construction and materials must be of the best possible to minimize loss. Protection of the coil from weather and water is important, and the insulation and coil support should be low-loss and non-absorbent. For example, one early antenna was found to have a coil resistance of 5.4 ohms when dry, and 26 ohms when wet! This particular coil was wound directly on a wooden antenna pole, so such trouble could naturally be expected. Wrapped-pole antennas are still found today, but they are giving way to more efficient forms.

Another source of loss in a coil is a tight-fitting metal shield. There have been examples of this form of construction in marine antennas, but unless they are designed for minimum loss they should be avoided.

Loss Due to Insulation Leakage

The next loss resistance encountered is that due to the flow of current through shunt resistances—insulation leakage. This loss can be directly compared to the other series resistances by converting the shunt resistance to the series equivalent by the approximation: $R = \frac{X^2}{R_d}$, where "R" equals the equivalent series resistance, "X" equals the circuit reactance in ohms, and "R_d" equals the shunt resistance of the insulator.

Needless to say, no insulator is perfect. But measurements on a typical short antenna show that a shunt resistance of 1-megohm would have an equivalent series resistance of almost 2-ohms, which would be a very large loss resistance in comparison with the radiation resistance. The absorption of the slightest amount of moisture, especially from salt spray, will thus introduce a very serious loss.

It is extremely important that absolutely non-hygroscopic insulation be used for antenna systems, and that insulators be so placed as to avoid as much exposure to spray and water as possible.

Unglazed porcelain, or even glazed porcelain with bare spots which would allow the entry of water, turns into a low-grade resistor when wet. Wood is likewise a very poor insulator, and bakelite will hold up only as long as

[*Continued on page* 27]

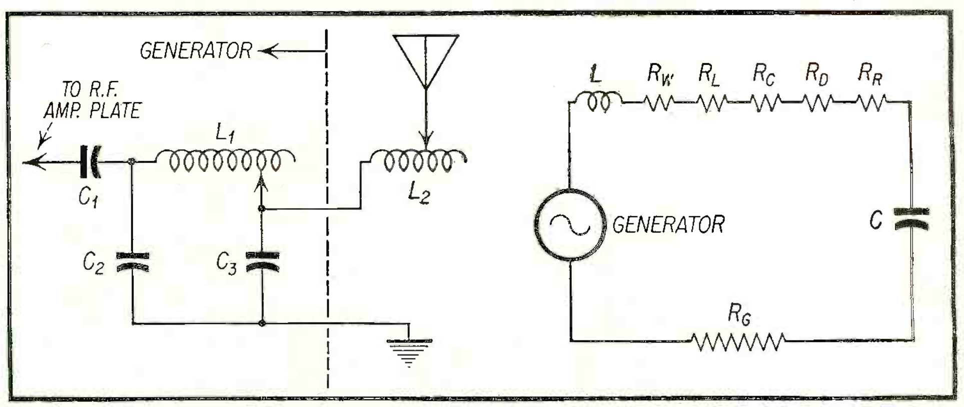


Fig. 2—The practical transmitting and equivalent circuits.

Left—Transmitting Practical Circuit
- C_1—Plate blocking
- C_2—Plate resonating
- C_3—Antenna Coupling
- L_1—Plate resonating
- L_2—Antenna resonating

Right—Equivalent Circuit
- L_1—Antenna Resonating Coil
- R_L—Coil Resistance
- R_c—Shunt Equivalent Capacitance
- R_d—Shunt Equivalent Resistance
- R_r—Radiation Resistance
- C_a—Antenna Capacitance
- R_g—Ground Resistance
- R_w—Conductor Resistance

ASSOCIATION NEWS

by SAMUEL L. MARSHALL

Radio and Television Guild of Long Island

At a recent business meeting, a motion was made from the floor and approved by a unanimous vote to appoint an Executive Secretary for the Radio and Television Guild of Long Island.

Currently, the Executive Secretary's most important project is to assist the Electronics Fair Committee in its efforts to publicize and organize this event for December 6th, 7th, and 8th.

Radio Television Technicians Association Pasadena

At a meeting held at the Venetian, Pasadena, the RTTA Pasadena heard a first reading of a proposed bill for licensing of technicians and service dealers. This bill is to be presented for enactment at the California State Legislature, under the auspices of the California State Electronics Association.

NATESA

The National Alliance of Television Electronics Service Associations (NATESA) have filed charges with the Justice Department alleging unfair trade practices by various TV set manufacturers in operating service branches, offering extended parts warranties, etc.

TESA, St. Louis

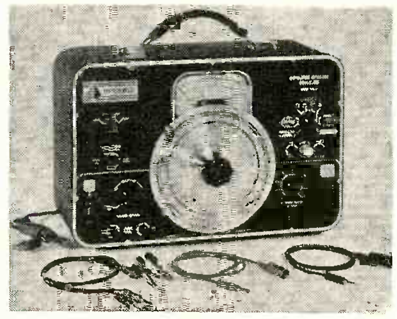
Recent uncovery by the Better Business Bureau of questionable activities by some T.V. service firms in the St. Louis area accents the need for some form of legislation to protect the public from the possibility of being victimized.

P.R.S.M.A., Philadelphia

An unusual alliance announced between organized TV servicemen and Philadelphia's up-coming Channel 35 promises easy, reasonable arrangements for area viewers to convert local sets to the UHF band before WHYY-TV gets on the air in November. ■■

SERVICE DEALER & ELECTRONIC SERVICING

NEW TEST EQUIPMENT



CAPACITOR-RESISTOR ANALYZER

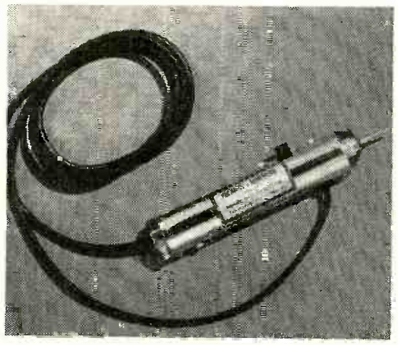
Pyramid Electric Company has introduced a highly versatile, moderately priced multi-purpose capacitor-resistor analyzer for the serviceman, technician and engineer, Model CRA-2. Ideal for use in industrial and military electronics, black and white and color television and all related fields, the CRA-2 helps remove the guesswork from circuit trouble shooting. Leakage current may be read directly while rated operating voltage is applied.

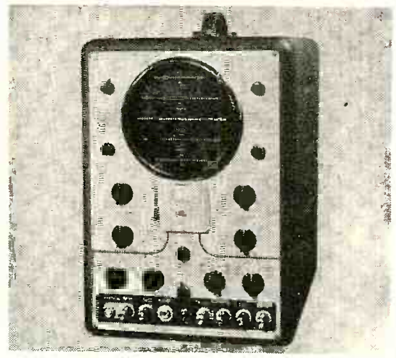
(Check 1215 on inquiry card for more information)

POLARITY-REVERSING PROBE

A polarity-reversing probe for volt-ohm-milliammeters is announced by the Futuramic Co. of Chicago. The new probe, Model 263, provides finger-tip control of signal polarity at the flip of a switch. The miniature switch, of slide construction is mounted in the probe housing, and feeds the signal to the V.O.M. via a high-flex small-diameter coax cable. The probe housing "floats" electrically to avoid shock.

(Check 1211 on inquiry card for more information)





TRIPLETT OSCILLOSCOPE

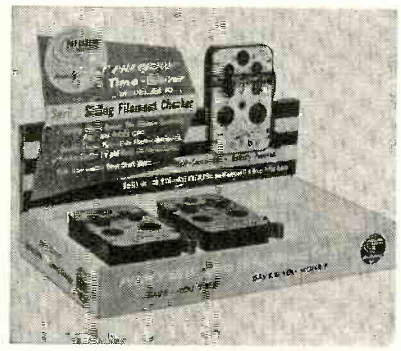
The Triplett Electrical Instrument Company has introduced a new cathode ray oscilloscope, Model 3441-A. An outstanding feature permits changing polarity to the vertical input amplifiers and thus reversing the waveform so as to be always able to present a signal in its conventional manner. Also provided is a calibrated meter for comparison peak to peak voltage measurements. A multi-vibrator type of sweep generator provides linear sweep.

(Check 1216 on inquiry card for more information)

AUTOMATIC TUBE TESTER

The new American Scientific Development Company tube tester, model 400A, completely eliminates selector switches, knobs, load controls, and filament switches. Electrical contacts, made through the holes in a player-piano-type roll chart, automatically select proper filament voltage, load and other settings, when the rollchart is turned to the tube to be tested. The serviceman selects tube number on rollchart and plugs the tube into socket.

(Check 1212 on inquiry card for more information)



PRECISION FILAMENT CHECKER

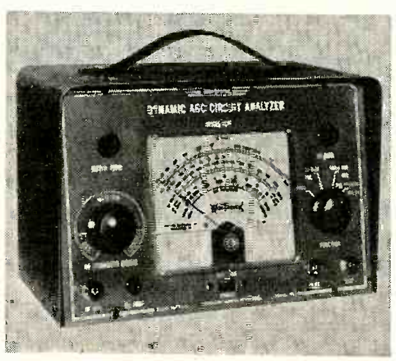
An all-new model SS-10 Series String Filament checker has been made available by the Precision Apparatus Co. in a striking counter display. The attractive merchandiser, with its brilliant poster-colors, displays two units horizontally while an actual unit in its standup background dramatizes the many selling points of the device . . . checks receiver tube filament continuity . . . picture tube continuity . . . and TV and radio set fuses.

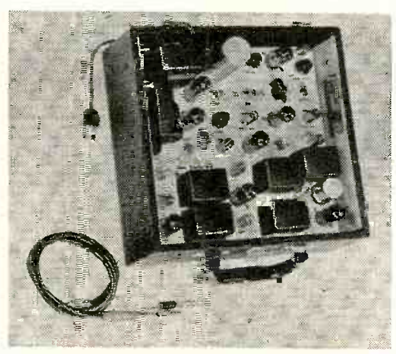
(Check 1217 on inquiry card for more information)

WIN-TRONIX AGC ANALYZER

The Win-Tronix Model 825 Dynamic AGC Circuit Analyzer provides a simple, systematic method for locating *agc* troubles. The instrument incorporates a standard *agc* test signal which is fed to the antenna of a TV receiver. Monitor circuits determine whether the trouble is due to *agc* troubles. The instrument checks *agc* action, substitutes *agc* bias, checks *agc* opens, shorts and ohms, tests gated *agc* circuits and measures *dc* and *agc* voltages.

(Check 1213 on inquiry card for more information)





HICKOK COLOR GENERATOR

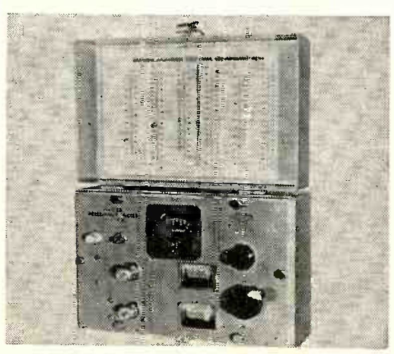
A new, small size portable white dot/bar generator, Model 660, is now available as an aid for home servicing of color TV sets. The unit permits easy on-location checks to determine the ability of a receiver to produce color in proper hue . . . even in the absence of a station signal. The instrument provides three patterns: White line crosshatch, white dot (small size), and crystal accurate color display patterns for color set adjustments.

(Check 1218 on inquiry card for more information)

NARDA FREQUENCY METER

A new highly accurate and readable frequency meter, Narda Model 802, covering the range of the most used microwave frequencies, 2,400 to 10,200 megacycles, has been developed by The Narda Corporation, Mineola, L. I. Over the entire band covered by this instrument, the loaded Q is in excess of 750 from 2,400 to 6,500 megacycles and in excess of 1,500 from 6,500 to 10,200 megacycles. The unit offers exceptional micrometer readability.

(Check 1214 on inquiry card for more information)



HEATHKIT ELECTRONIC SWITCH KIT

A completely redesigned version of the Model S-2, this new unit, Model S-3, allows simultaneous oscilloscope observation of two input signals by producing both signals, alternately, at its output. Four switching rates may be selected by a panel switch. The unit features a frequency response of 1 *db* from 0 to 100 *kc*. A sync output terminal is provided to permit scope sweep control. The unit is ideal for observing simultaneous amplifier signals.

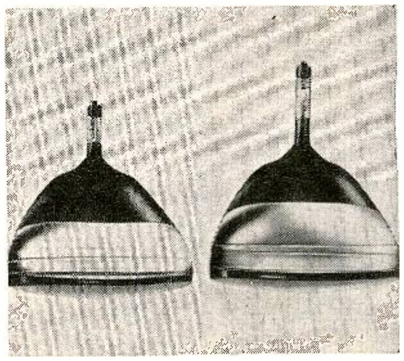
(Check 1219 on inquiry card for more information)

SERVICE DEALER & ELECTRONIC SERVICING
NEW TUBES

DUMONT PICTURE TUBES

The new short-length aluminized 90° television picture tube (left) of Allen B. Du Mont Laboratories, Inc., is compared with a conventional aluminized tube (right). Tubes pictured are the 21-inch diagonal size. These tubes are two inches shorter in length, while relative savings in length are made in 24-inch, 17-inch and 14-inch tube types, and feature a compact, single unit straight electron gun with the need for an ion trap eliminated.

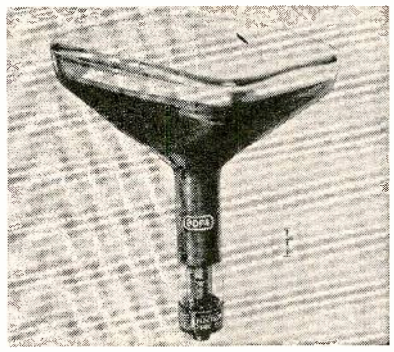
(Check 1221 on inquiry card for more information)



RCA 8DP4 PICTURE TUBE

The RCA 8DP4 is a small, compact, directly viewed, rectangular, glass picture tube of the low-voltage electrostatic-focus and magnetic-deflection type. Intended primarily for low-cost, lightweight, compact applications the 8DP4 has a spherical Filter-glass faceplate, a screen 7 3/16" x 5⅜" with slightly curved sides, round corners, a minimum projected screen area of 35.5 square inches and a length of 10¾". The tube employs 90° deflection.

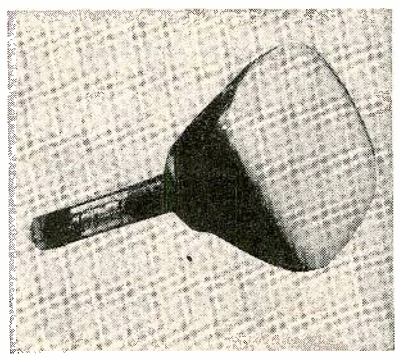
(Check 1222 on inquiry card for more information)



G.E. NINE INCH TUBE

The nine inch rectangular picture tube used in the personal television receiver announced by General Electric represents a radical departure from standard cathode ray tube design practices. Some of the pertinent data are: screen size 6" x 7½", screen area—40 sq. in., weight—2 lbs., overall length—13 1/16", magnetic deflection, electrostatic focus, anode voltage 6800 volts design center, 5500 volts recommended operating voltage, and 7 pin base.

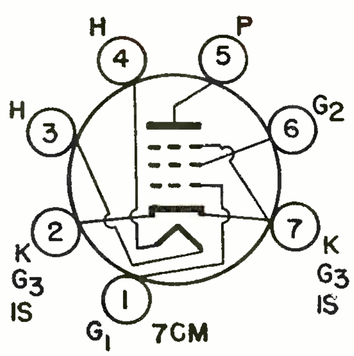
(Check 1223 on inquiry card for more information)



CBS 3CE5 AND 6CE5 PENTODES

A further improvement in the performance of the pentode *rf* amplifier in inexpensive *vhf* television tuners is now possible with the newly developed CBS 3CE5 and 6CE5 miniature receiving tubes. These tubes are high-transconductance, sharp-cutoff pentodes for *vhf* tuners and *if* amplifiers. They are manufactured to a narrow cutoff range characteristic limit which permits closer tolerances in the *agc* circuit, eliminating the need for tube selection.

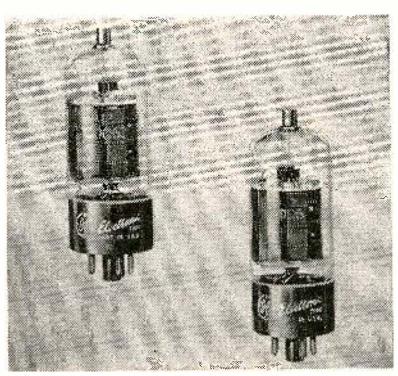
(Check 1224 on inquiry card for more information)

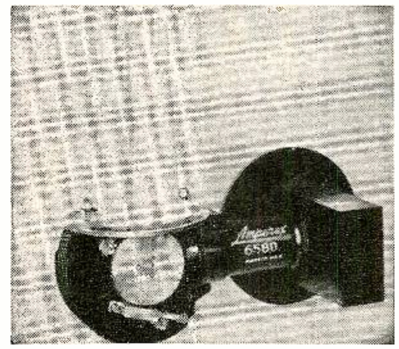


G.E. DEFLECTION AMPLIFIERS

A new horizontal deflection amplifier tube, the 12DQ6, has been added to the General Electric tube department's line of 600-milliampere controlled warm-up tubes. Also available is the 6 volt version, the 6DQ6. Both tubes have extremely high perveance, permitting the design of high efficiency 90° deflection system without the necessity of expensive deflection tubes. They incorporate a 6000 volt pulse capability and a 15 watt dissipation rating.

(Check 1225 on inquiry card for more information)

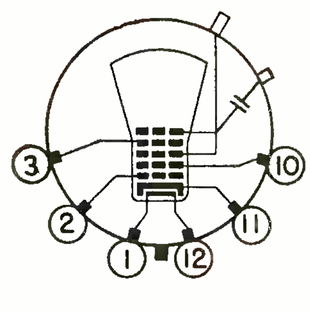




AMPEREX MAGNETRON

Amperex Electronic Corporation has announced the addition of a new type to their line of magnetrons. Designated as type 6589, the new magnetron is a non-packaged, high-power, pulsed, tunable oscillator, operating in the 10 centimeter region. It features a "one-piece" anode which assures low losses and long life performance. It is used with an external magnet having a field density of 2700 gauss and a pulsed power output of 500 kilowatts.

(Check 1226 on inquiry card for more information)

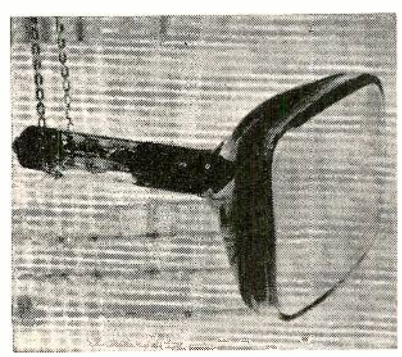


BOTTOM VIEW

RAYTHEON 8DP4 TUBE

The Raytheon 8DP4 picture tube is a direct view electrostatic focus and magnetic deflection tube for television receivers. It employs a spherical rectangular filter-glass face plate for elimination of reflection and is designed to be used with an external ion-trap magnet of the single field type to prevent ion-spot blemishes. The external conductive coating, when grounded serves as a filter capacitor with approximately 350 $\mu\mu f$ capacitance.

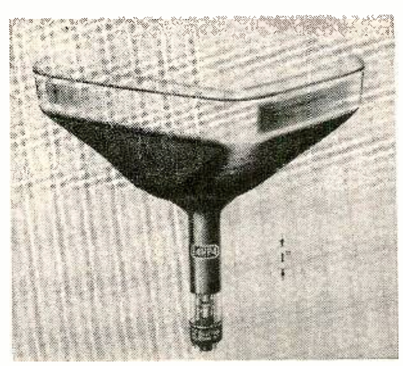
(Check 1227 on inquiry card for more information)



SYLVANIA 8XP4 PICTURE TUBE

A versatile new television receiver check tube which can be used to test virtually any television receiver or picture tube from 10 to 27 inches has been announced by Sylvania Electric Products Inc. Designated the 8XP4, the tube is an 8½ inch rectangular television picture tube featuring automatic self-focusing and parallel-mounted electron gun, thereby eliminating the need for an ion trap. The compact, lightweight design makes the tube easy to handle.

(Check 1228 on inquiry card for more information)



RCA 14RP4 PICTURE TUBE

The new picture tube 14RP4 is intended for use in lightweight, transportable TV receivers. It is a short, rectangular, glass type having electrostatic focus, magnetic deflection, spherical Filter-glass faceplate, a screen 12⅛" x 9⅝" with slightly curved sides and rounded corners, and a typical projected screen area of 108 square inches. Employing wide-angle (90°) deflection, the 14RP4 has a very short length and a weight of only 8½ pounds.

(Check 1229 on inquiry card for more information)

CONVERSIONS & MODIFICATIONS

[*from page* 3]

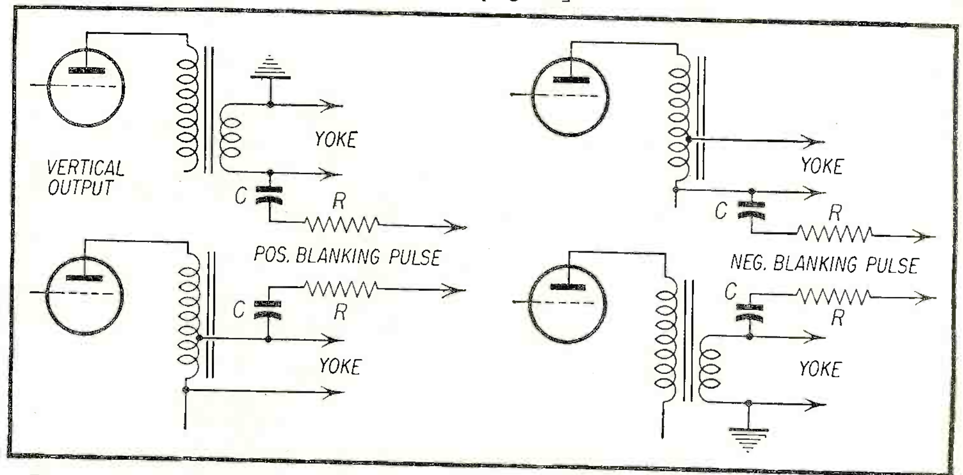


Fig. 4—Four commonly used circuits for supplying vertical retrace blanking. Note that two of these supply a positive blanking pulse and two a negative.

clipping will result causing critical sync.

Vertical Retrace Blanking

The addition of vertical retrace blanking is still another common modification. The circuit shown in *Fig. 3* is a common one and usually gives good results. The 8K resistor and the .05 *uf* cond are added as shown to provide the blanking pulse. With some picture tubes, however, it will cause striations following large black or white areas in the picture, shading, and/or vertical distortion when the contrast or brightness is set slightly high.

Shading of the raster from top to bottom, introduced by retrace blanking is most often found when the circuit is similar to one of those illustrated in *Fig. 4,* and less frequently with the circuit of *Fig. 3.* The waveform of the pulse produced by the circuit of *Fig. 3* is shown in *Fig. 5a.* The pulse produced by the circuits of *Fig. 4* is shown in *Fig. 5b.* A study of these pulses reveals that the sharp spike, which is the blanking portion, is accompanied by a sloping portion. It is this sloping portion which causes the shading.

The pulse found at the plate of the vertical output tube is easily attenuated to a usable value without causing this shading. In sets where the video is fed to the grid of the picture tube, this pulse is fed to the cathode as shown in *Fig. 6* In sets where the video is fed to the cathode of the picture tube, the pulse may also be applied to the cathode, by injecting it into the video amplifier plate load via *C* and *R* as in *Fig. 7.* This is done to prevent smearing of the picture. The component values shown in *Figs. 6* and *7*

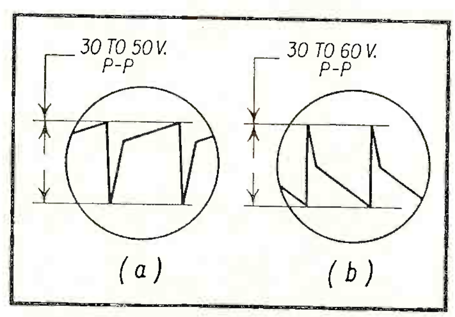


Fig. 5a—Negligible slope in the portion following the pulse.

Fig. 5b—Sloping portion following the pulse causes shading.

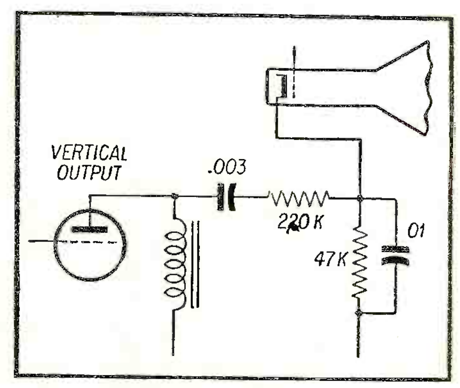


Fig. 6—Vertical blanking pulse being fed to cathode of the CRT.

have been found most practical in actual use in these circuits.

Care must be taken in either case that the added wiring be kept as short as possible. The condenser should be mounted directly at the plate of the vertical output tube, and in *Fig. 7* the resistor should be soldered as close as possible in the load circuit. If over four inches of wire are needed to connect the resistor and condenser it should be shielded to prevent spraying of the vertical pulse which would result in an audio buzz.

Fig. 8a shows the scope trace of this pulse as applied to the picture tube. Note that the sharp blanking spike is clean and wthout distortion. *Fig. 8b* illustrates the blanking pulse superimposed on the composite signal.

There are other more complex retrace blanking circuits, some using diodes and some a blanking tube. Those shown in *Figs.* 6 and 7 are easily added, low in cost and effective without creating incidental defects.

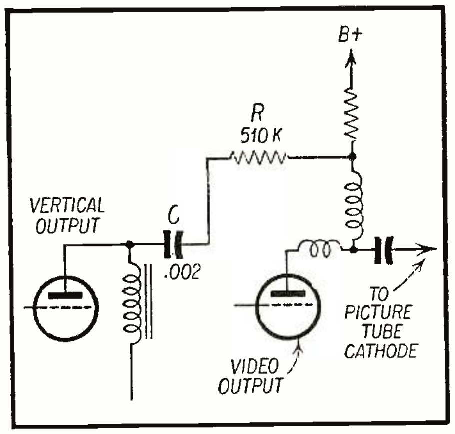


Fig. 7—Blanking pulse injected into video amplifier plate load.

Converting to Intercarrier Sound

Converting to intercarrier sound may be done without creating serious new troubles. One side effect is a 4.5 *mc* beat in picture which is easily removed by adding a trap in the video output circuit. Another defect is an audio buzz. This is generally corrected by picking off the sound at a point of lower video amplitude. If smear in the picture results when sound is picked off at the video detector, it can be removed by using a smaller pickoff condenser or reducing the size of the video detector filter by an amount equal to the capacity of the pickoff condenser. In any case careful dressing of leads involved is of prime importance.

When properly converted, whether the sound detector is of the discriminator, ratio detector, or gated beam type, the result should be improved tuning because of freedom from oscillator drift distortion. The gated beam type is preferred because of its lower cost, fewer parts, and fewer changes necessary for good results.

Recently an RCA using a KRK 5 tuner, had been converted to intercarrier sound with really fine results. These receivers produce considerable beat interference in the picture on channels 3 and 6 in the Philadelphia area. The interference is caused by harmonics generated in the sound discriminator and picked up by the tuner. Stage shielding and *if* shifting were unsuccessful. Converting to intercarrier sound in this set actually improved the picture.

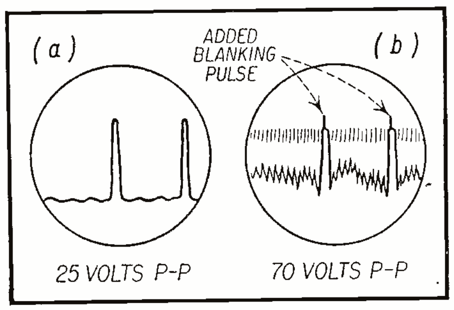


Fig. 8—Two views of the blanking pulse on the oscilloscope screen.

Since articles on intercarrier conversions have appeared in many of the service journals, no circuits are presented here.

[*Continued on page* 44]

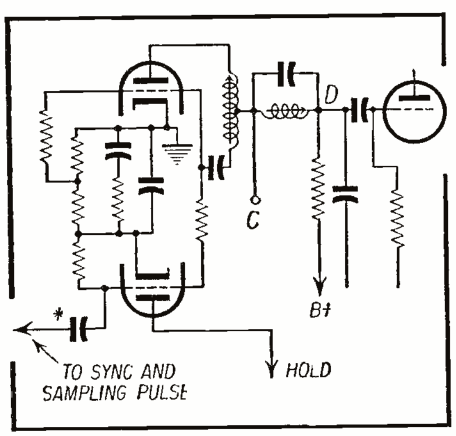
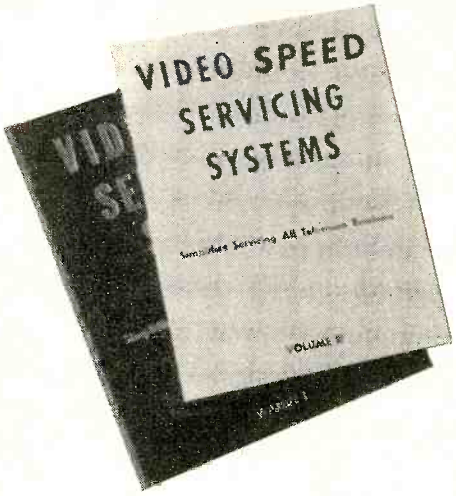
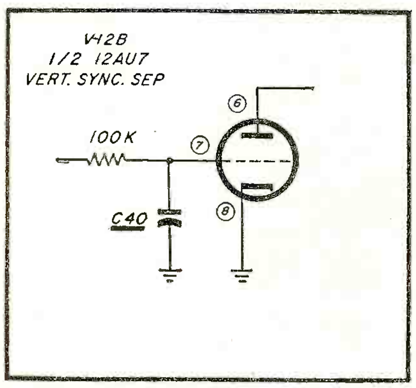


Fig. 9—Typical synchroguide circuit. B+ applied at point C caused the trouble in this case.





RIDER SPEAKS

IT WOULD be grand if problems relating to business could be solved as easily as certain bacteria are killed off by an antibiotic. The business problem we're speaking of is the growing conflict between the servicing industry and factory service. It is our feeling that the servicing dealers of the nation as well as the independent service shops, can wage a successful fight, but it isn't about fights that we wish to speak at the moment.

We don't think anyone can deny that the existence of the servicing industry did help the receiver manufacturers achieve the widespread sale of television receivers. Of course, the sale of receivers was the reason for the creation of a servicing industry, but no matter how good the planning and manufacture everlasting operating life just cannot be worked into a commercial product made on a competitive basis. Hence the need for servicing facilities.

If we look back upon the growth of the home electronics industry, we can see that it is the result of money, brains, skill, ingenuity, imagination, sales ability and the courage to gamble on public acceptance. But those who have been successful in this business (and even those who were not so fortunate) never lost sight of the need for servicing facilities to keep the product sold. And it was the availability of service facilities wherever and whenever the public wanted them that helped the electronic industry get where it is. This service was independent service—Joe and Harry and Mike in all the towns and cities and counties.

Maybe the service was not always the best, but by and large it was good enough to keep the radio and television receivers owned by the vast majority of the public in operating condition, and it improved year by year. Is there any service that does not have its incompetents and malpractitioners?

And there were many years during which the servicing industry paid for the entertainment of the American public. These were the days of radio and they lasted twenty years; they were the days when "midget" radio receivers produced on vast production lines and priced at $6.95 or $10 or $12 just couldn't be serviced for less than one-quarter or one-half the purchase price. And the public screamed to high heaven! Radio receivers still are being made in great quantities each year, but with living expenses what they are many members of the servicing industry have

[*Continued on page* 41]

Mfr. G.E. **Chassis No.** "S" Line

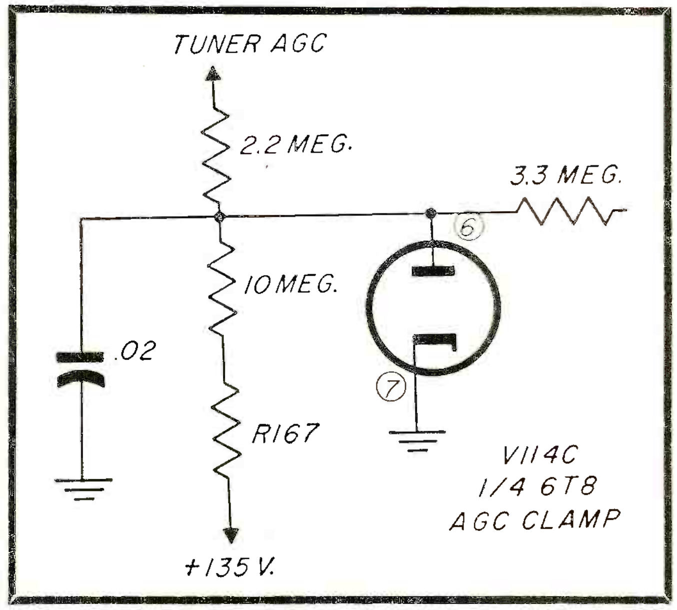
Card No. GE-S-1

Section Affected: Pix

Symptoms: Excessive noise voltage in picture.

Cause: Incorrect *agc* bias on the *rf* amplifier tube caused by too high a value of resistance in one of the B plus voltage divider network resistors. Resistor *R167* (2.2 megohm) reduces the positive voltage too much, and allows an excessively negative *agc* bias to be developed and applied to the *rf* amplifier.

What To Do:
Replace *R167* (2.2 Megohm) with two parallel 3.3 megohm resistors.
Note: If *overload* should occur on a particularly strong channel one of these parallel resistors should be removed.



Mfr. G.E. **Chassis No.** "S" Line

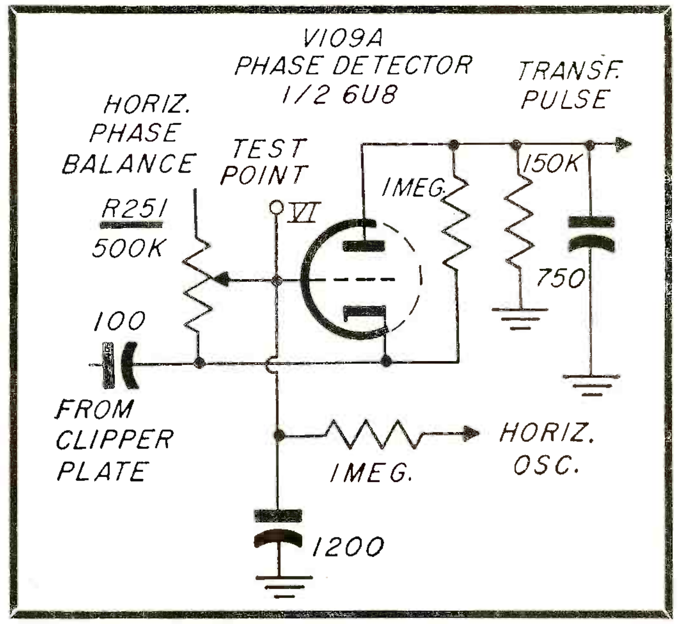
Card No. GE-S-2

Section Affected: Picture

Symptoms: Horizontal instability, such as picture top curling and pulling.

Cause: Misadjusted Horizontal Phase Detector Balance Control. This condition can also result from changing the horizontal phase detector tube, ½6U8.

What To Do:
Adjust: Horizontal Stabilizer Coil *L250* counterclockwise until picture is out of sync by approximately 20 bars. (The exact number is not important.)
Connect: VTVM to test point V1.
Adjust: Horizontal Phase Balance Control *R251* for a VTVM reading of minus nine-tenths (–.9) volt.
Readjust: Horizontal Stabilizer coil *L250*.



Mfr. G.E. **Chassis No.** "S" Line

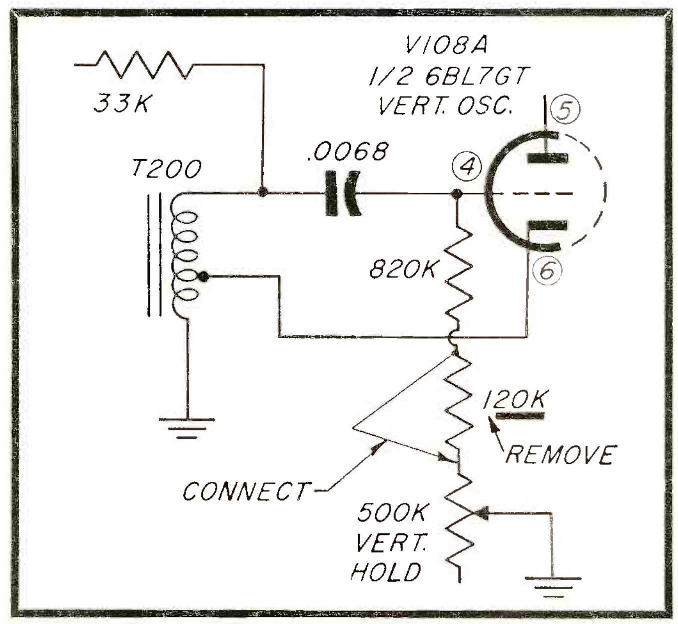
Card No. GE-S-3

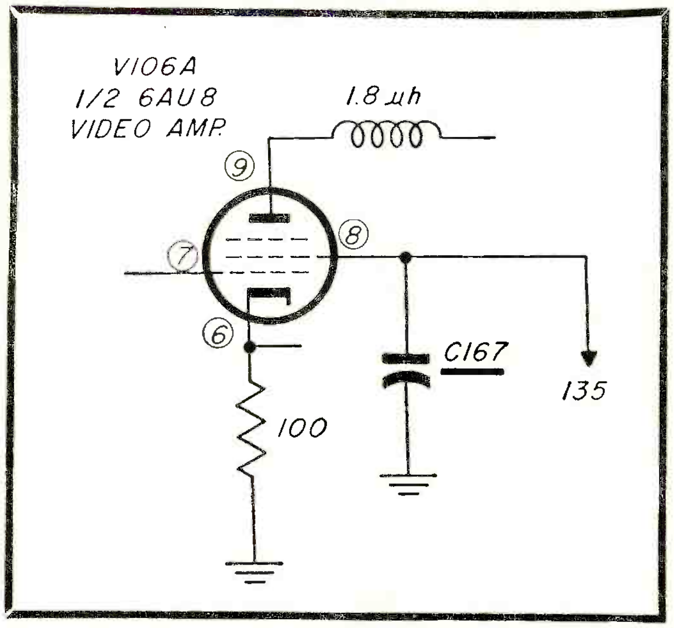
Section Affected: Pix

Symptoms: Vertical hold action is not centered in the vertical hold control range.

Cause: In changing the 6BL7 tube this trouble may result.

What To Do:
Remove: 120K ohm resistor in series with the vertical hold control, and connect lower end of 820K resistor to top end of vertical hold control.





Mfr. G.E. **Chassis No.** "S" Line

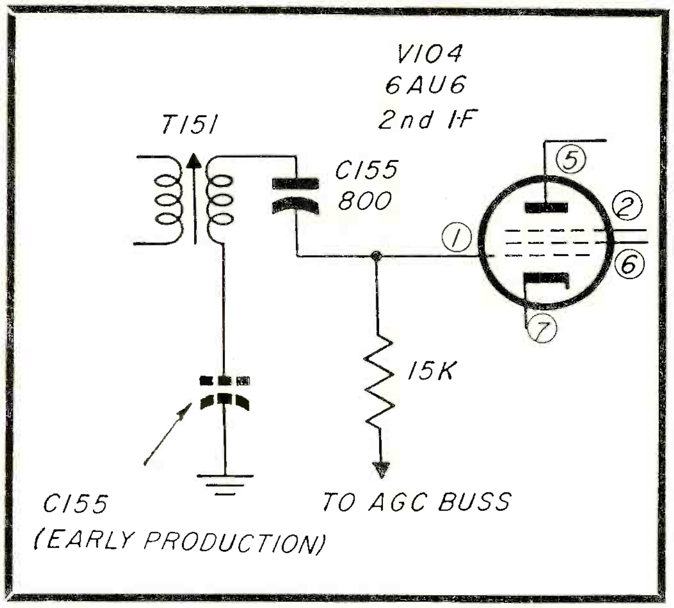
Card No. GE-S-4

Section Affected: Pix

Symptoms: Ringing in the picture information.

Cause: The screen grid circuit of the video amplifier tube V106A has insufficient bypassing.

What To Do:
Replace: *C167* (5000 *μμf*) with a 10,000 *μμf* condenser.



Mfr. G.E. **Chassis No.** "S" Line

Card No. GE-S-5

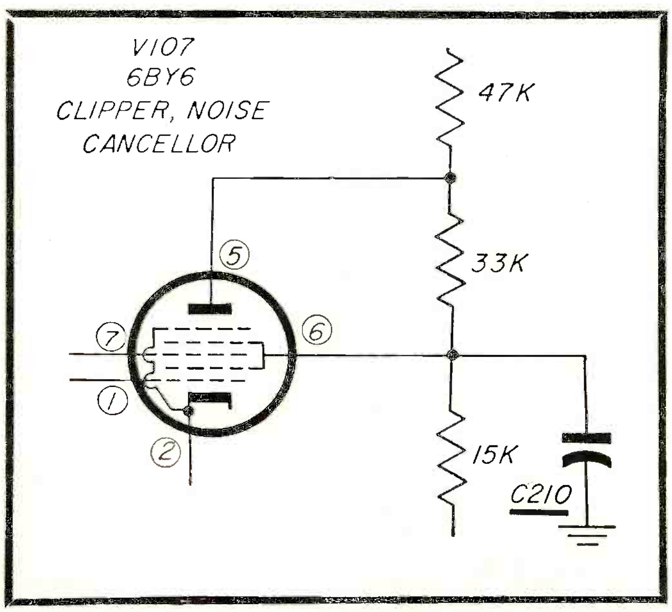
Section Affected: Pix

Symptoms: Picture is negative or overdriven.

Cause: Loss of *agc* negative bias has occurred because of short or leakage between windings of T151.

What To Do:
Replace: T151, *if* transformer in the plate circuit of 1st *if* stage.

Note: C155 is reconnected from bottom lead of secondary of T151 to top lead. This prevents bleeding off of *agc* voltage in the event of minute leakage between windings.



Mfr. G.E. **Chassis No.** "S" Line

Card No. GE-S-6

Section Affected: Pix

Symptoms: Poor horizontal and vertical sync.

Cause: The condenser bypassing the screens of the Sync Clipper tube is shorted to ground, reducing the plate voltage to the tube, and thus the sync signal amplitude.

What To Do:
Replace: *C210* (.1 *μf*).

Mfr. Sylvania **Chassis No.** 1-532-3, -4

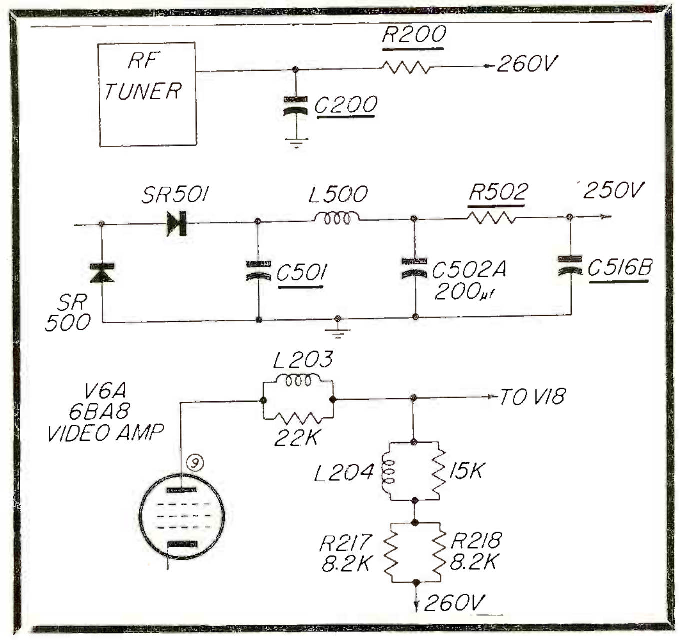
Card No. Syl 532-1

Section Affected: Pix

Symptoms: Hum in picture.

Reason For Change: Circuit improvement. Filtering of B plus voltage for the tuner and video amplifier stage has been improved.

What To Do:
Delete: *R200* (470 ohms), *C200* (.1 μf), *C501* (150 μf).
Add: *R502* (330 ohms).
C516A (150 μf) to replace *C501*.
C516B (30 μf).
Change: Parallel *R217* and *R218* resistors from 260 volt feed point to new 250 volt point.



Mfr. Sylvania **Chassis No.** 1-532-3, -4

Card No. Syl 532-2

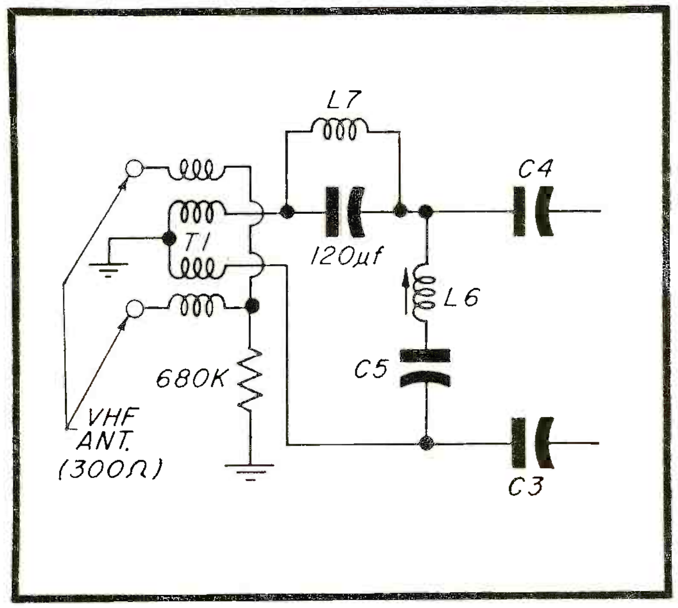
Section Affected: Pix

Symptoms: Interference in picture.

Cause: Signals of *if* frequency (45 mc) are passing through *rf* stage.

What To Do:
Adjust: *L6*, *if* trap for minimum interference in picture.
Check: Channel 2 and 3 for possible deterioration.

Note: Improper adjustment of *L6* may alter overall response for channel 2 and 3 with little effect on other channels.



Mfr. Sylvania **Chassis No.** 1-532-3, -4

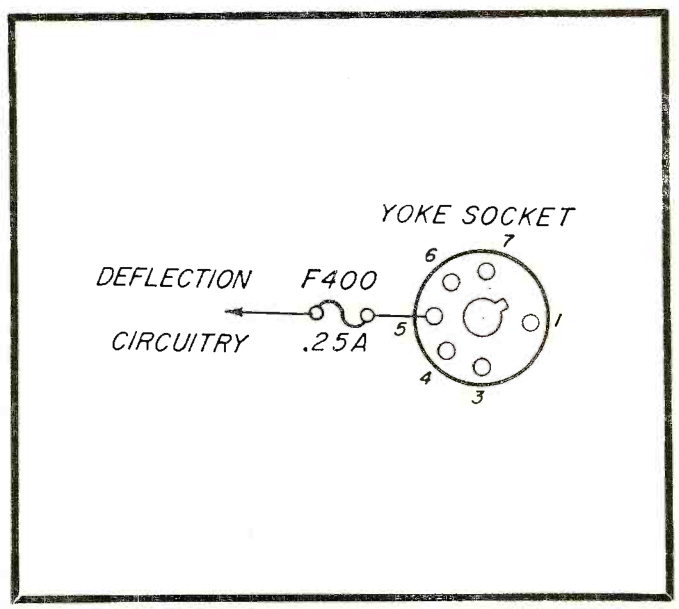
Card No. Syl 532-3

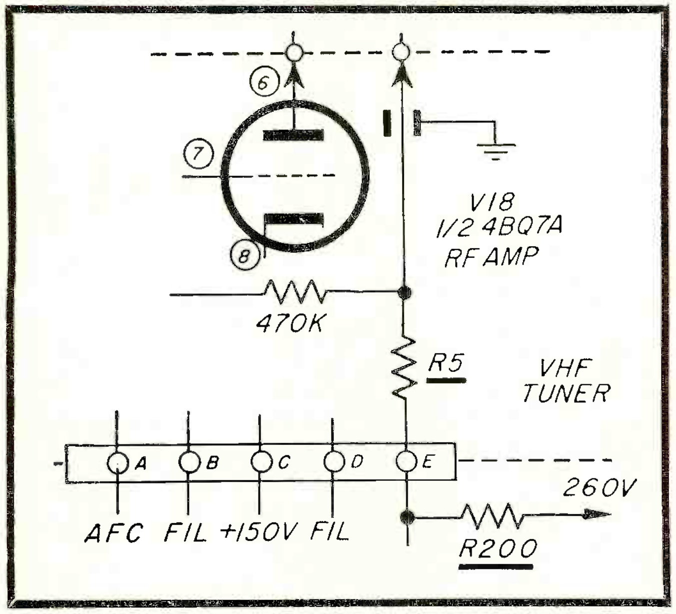
Section Affected: Pix

Symptoms: Repeated failure of fuse in deflection system.

Reason For Change: To provide more tolerance in the fuse rating and still render sufficient protection to circuit components.

What To Do:
Replace: *F400* (.25 ampere) fuse with a ⅜ ampere slow-blow type.





Mfr. Sylvania **Chassis No.** 1-532-3, -4

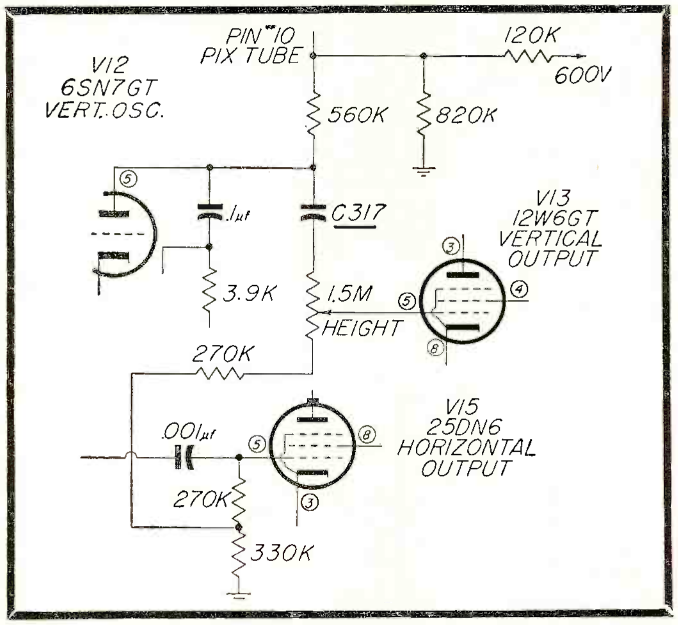
Card No. Syl 532-4

Section Affected: Pix and sound

Symptoms: Weak picture and sound.

Cause: A shorted 4BQ7A tube in tuner may burn resistors *R5* and *R200*, causing them to increase in value providing insufficient voltage to tube circuit.

What To Do:
Replace: *R200* (470 ohms).
R5 (1000 ohms).



Mfr. Sylvania **Chassis No.** 1-532-3, -4

Card No. Syl 532-5

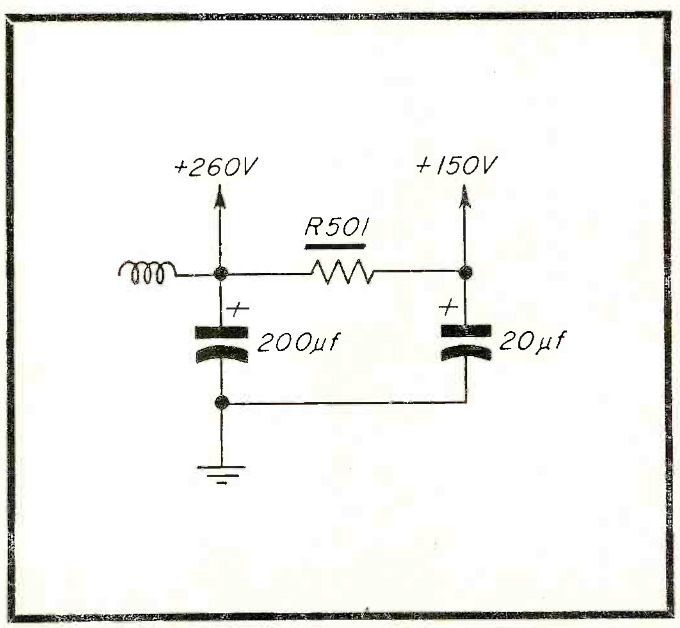
Section Affected: Pix and raster

Symptoms: Excessive height and poor vertical linearity.

Cause: A *dc* blocking condenser has developed a leak, reducing the negative bias on the vertical output tube.

What To Do:
Replace: Condenser *C317* (.22 µf).

Note: A low emission horizontal output tube can also introduce this condition by developing insufficient grid bias in its grid circuit.



Mfr. Sylvania **Chassis No.** 1-532-3, -4

Card No. Syl 532-6

Section Affected: Pix and sound

Symptoms: No picture, or possibly weak picture and weak sound.

Cause: B plus voltage divider resistor has overheated and increased in resistance supplying insufficient voltage to the 150 volt circuits.

What To Do:
Replace: *R501* (1.8K ohm).

THE WORK BENCH

Unusual Service Problems And Their Solutions

by **PAUL GOLDBERG**
Service Manager

This Month's Problem: Overload Conditions

Du Mont Model RA-164, -165

The receiver was turned on and it was observed that the video was overloaded. It must be mentioned at this point that the customer had stated that a friend had worked on the receiver but was unable to repair it. All tubes receiving *agc* voltage were replaced individually (V201, V202, V218, V102) but had no effect. The sound seemed to be okay except for a buzz due to the overload. The *agc* control, *R303* was varied but had no effect. (*Fig. 1*)

Knowing these facts, voltage checks were made at V218. The plate voltage measured about ½ volt negative which was insufficient. The screen voltage was correct at about 250 volts. The control grid measured about 50 volts positive instead of about 130 volts.

Knowing that this control grid voltage depended on the 12BY7 (video amplifier) plate current, the 12BY7 circuit was investigated. Its plate voltage also measured about 50 volts positive instead of 200 volts. The pulse supplied by the horizontal output transformer to the plate of the *agc* tube was measured on the scope and was found to be correct. Because of the 12BY7's low plate voltage, *R221* was resistance measured but was found to be correct at 5.5K. The 12BY7 screen voltage was also about right. The control grid however measured 2 volts positive. Here was a clue.

The 12BY7 was replaced but had no effect. The video detector crystal CR201 was checked with an ohmmeter and measured correctly at an approximate ratio of 1 meg. to 100 ohms. It was noted when checking CR201, that the polarities seemed to be opposite to what they should be in the circuit. Therefore, CR201 was reversed and connected into the circuit again. The receiver was turned on and immediately the video popped in back to normal. Thus it was obvious that the customer's friend was conspiring against TV servicemen.

When the crystal is reversed, current flows up from ground through the 4.7K (*R212*) resistor and causes a position voltage to appear on the 12BY7 control grid. This produces a high 12BY7 plate current which lowers its plate voltage. This low plate voltage is fed to the *agc* amplifier control grid and is too low to cause the *agc* amplifier to conduct. Thus there is little or no negative *agc* plate current flow and therefore no *agc* voltage drop across R222, 82K. Consequently, video overload is produced.

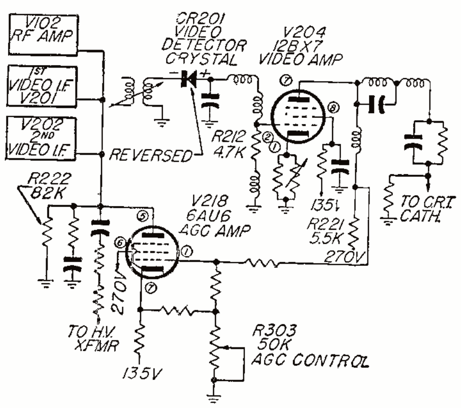


Fig. 1—Partial schematic of Du Mont RA-164, -165 chassis.

Sylvania Model 2140 B, Chassis 1-462

The receiver was turned on and the video was obviously overloaded. Tubes, V7-6AL5, V113-6SN7, V14-12AX7, were replaced individually but had no effect. The third and second *if* tubes, V5 and V4 and the *rf* amplifier were also replaced individually but had no effect.

The diagram was next studied. It was noted that in this receiver the positive going composite video signal is fed from the plate of V8, the video amplifier to the grid of V14A, sync separator and *agc* rectifier. Tube V14A is biased to allow only the sync pulse to cause this tube to conduct. When the tube conducts, a positive pulse appears at its cathode which is in turn fed to the control grid of V13A, the amplifier, and causes this tube to conduct producing the negative *agc* voltage at the plate. Variable bias is provided for the *agc* amplifier by *R179,* the *agc* control. Knowing these facts, the *agc* voltage was measured at Pin #5 of V13A to ground. Here the voltage measured zero. Pin #6 cathode of V13A was next measured and was found to measure zero volts instead of around 50 to 60 volts negative. (*Fig. 2*)

The diagram was again consulted and it was noted that V13A cathode was connected to a bleeder network. A resistance check was then made from Pin #6 to ground of V13A. The meter read 3.3K. Noting this, *R164,* 3.6K was clipped out of the circuit and was resistance checked. It was found to be open. A new 3.6K was therefore installed. The receiver was next turned on, the *agc* control *R179* was adjusted and now the receiver functioned normally. (When *R164* opened, V13A cathode was no longer at an approximate 50 volt negative potential.) The cathode was now at zero potential, through *R163* to ground. This kept V13A constantly at cut off. ■■

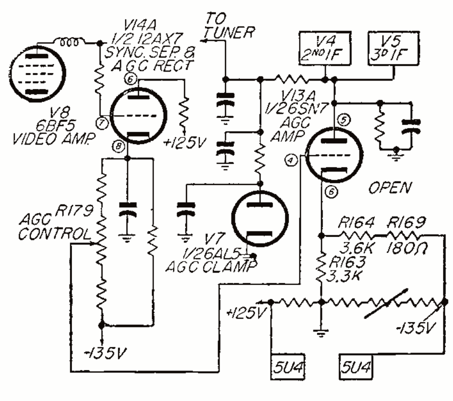


Fig. 2—Partial schematic of Sylvania 1-462 chassis.

THE ANSWERMAN

Inquiries Sent To The Answerman Will Be Acknowledged Only If Accompanied By Radio-TV Service Firm Letterheads Or Similar Identification.

BY SERVICE DEALER & ELECTRONIC SERVICING TECHNICAL STAFF

Dear Sir:

I have a G.E. "F" series chassis that is causing me difficulty in finding the faulty component.

Symptoms are no sound, no picture. I have found that by disconnecting the B plus from the tuner the voltages to the other stages in the set remain about normal or a little higher than normal. This led me to believe that the trouble is in the tuner. I then checked voltages on the oscillator and mixer tube and found them quite low. If I remove the 6J6 tube the voltages jump higher than normal on the tube such as the plate, pin 2, jumps up to about 160 volts. The trouble seems to be in the tuner but I can't put my finger on what is causing me to have low plate voltages. The oscillator circuit also does not functon because of the low voltage on the plate, around 48 volts.

What do you think is wrong?

F. P.
St. Louis, Mo.

Most likely one of the condensers associated with the 6J6 tuner has shorted. The procedure for servicing this type of trouble is first to remove the 6J6 tube from the socket. Now, the voltages can be measured at the grids, pins 6 and 5 of the 6J6. (See *Fig. 1*) Undoubtedly, you will find a positive voltage at one or the other of these grids. Suppose that the grid pin 6 has positive voltage. This indicates that either *C109* or *C110* has developed a leak. As can be realized, with the tube in the socket if a positive voltage should be applied to the either grid it will cause that grid to draw current just as though it was a plate. The positive voltage would be shorted out by the low resistance path in the tube, would not be measurable. This action causes the associated condensers not to be suspected. However, when the tube is removed from the socket the positive voltage is no longer shorted out. A voltmeter will show this up at once.

Continuing on with this problem, suppose grid pin 6 measures zero volts. Measure grid pin 5. Most likely a positive voltage will be found at this point. A positive voltage at this grid can be the result of *C106*, *C112* or *C124* leaking. It is then a matter of opening the grid side of these condensers and checking them for voltage at the open grid end. Of course a condenser checker will show immediately which condenser is faulty. More than likely it will be found that *C124* is the culprit.

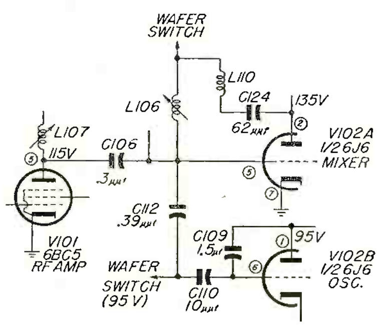


Fig. 1—Partial schematic of tuner circuit of GE "F" series chassis.

Dear Mr. Answerman:

I have a receiver in which there was no picture and no sound. I removed the *if* shield after a few checks and found that the screen and plate feed resistors for the *if* stages had burned open providing no B plus to the stages. The resistor was replaced and bypass condensers were checked. The *if* tubes were also checked. The receiver was turned on and picture and sound was restored. However, there existed a new problem in the receiver which seemed totally unrelated to the burned resistor.

This new problem is critical horizontal lock-in action. Since this problem was noticed immediately I went to work trying to correct it there on the bench. The horizontal oscillator circuit was thoroughly examined as were the sync and phase comparer stages. Nothing yielded the source of the trouble. The chassis is still on the bench.

There seems no solution to the poor horizontal sync problem. Can you offer me any help?

C. A.
Los Angeles, Cal.

What has happened to other technicians on occasion has evidently happened to you. In repairing the *if* circuitry and replacing the burned resistor you had to remove the shield over the *if* circuitry. In several cases personally witnessed when the shield for the *if* strip is not in position some receivers will exhibit critical horizontal sync action. This is particularly true when the layout of the different stages on the chassis is such that the pulses from the horizontal width coil or other deflection components are in close enough proximity to radiate energy into the first or second stages of the *if* system.

Therefore, perhaps the first step to be taken is to replace the removed *if* shield making sure that it is well grounded. More than likely this will remove the problem.

However, other failures that can cause this type of problem are filament to cathode leakage in the *rf* or *if* tubes, or open *agc* line filter condensers.

Another important source of this difficulty is due to poor *agc* line filtering as mentioned. If the filtering is borderline or insufficient it is quite possible that deflection pulses can be introduced into the grid circuits in strong comparative amplitude to the *if* signal via the *agc* feed line.

Dear Mr. Answerman:

We have been working on a "Signal Seeking" Delco auto radio. Our problem is that as soon as the station selector bar is depressed the signal seeking operation commences and doesn't stop until the on-off switch is turned off. The only thing we have found that appears to be wrong is that the coil that draws the plunger in becomes warm. We have not been able to find out why.

Unfortunately, we do not have any service information on these car radios. We have gone over the entire set and have come up with nothing, not having a diagram to compare it with.

If you can help us in this matter I would appreciate it.

W. T.
Santa Barbara, Calif.

It is normal for the plunger solenoid to become warm since the radio when in operation in this circumstance is sweeping continuously. It is only designed for station to station operation and not continual sweeping of the broadcast dial.

One of the most important points relative to signal seeking car radios is that there must be a broadcast station received to trigger the relay tube and cause the relay to release the arm and stop the paddle wheel. The basic trigger circuit of these signal seeking car radios is shown in *Fig. 2.* The triggering is accomplished by a pulse being applied to the grid circuit of the trigger tube due to a broadcast signal being received. The pulse causes plate current to be

[*Continued on page* 41]

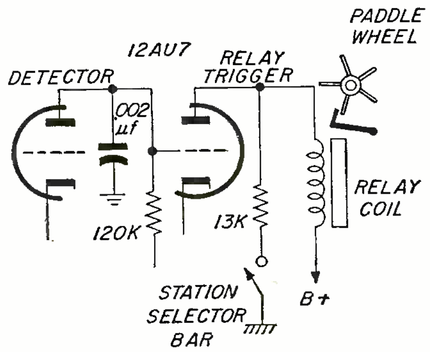


Fig. 2—Partial schematic of the Delco "Signal Seeking" auto radio with detector and trigger circuit.

CATALOGS CAN BE YOUR SALE-VATION!

BY GEORGE SIEGEL
Adv. Mgr.
United Catalogue Publishers, Inc.

A service technician from Rome,
Went into a young lady's home.
Completing his task,
He promptly did ask,
"Can I sell you some grillwork of chrome?"

THERE'S more sense than nonsense in this limerick. Too often the radio-TV service technician who enters a customer's home is content to be *just* a serviceman. He makes no attempt—or a feeble one—to sell additional items at the time of a service call.

Other dealers of services and products would jump at the chance to sell in a customer's home. But they lack the entree or do not have anything but "service" to sell. The radio-TV serviceman, on the other hand, has both the opportunity to work in a customer's home and the products to sell. He should take full advantage of this favorable position to add to his income. And he can do the job because the industry he is a part of gives him the products and the selling tools to do so. His main sales tool is a catalog.

For instance, while repairing a TV set, the serviceman can suggest a new antenna mentioning that the current models are engineered to improve reception. He can even sell a lightning arrester with the antenna. Upon questioning the customer as to the age and condition of the picture tube, the technician can recommend a picture tube brightener.

Car radio servicing also offers solid opportunities to sell. He can push a rear-seat speaker, battery charger or one of those new eye-catching colored auto antennas.

Still again, while repairing a record changer or tape recorder, a customer is receptive to buying needles and tape respectively.

Now here's where the catalog enters the picture. Of course, a serviceman can suggest any of the products mentioned here, and many more. But to give authority to his sales story he should produce a catalog—preferably an illustrated one. The catalog serves not only as a showcase, it also lends a feeling of reliability. Since the technician would not ordinarily take with him on a service call any of the products he could possibly sell, the catalog is an excellent substitute for promoting a sale.

The use of the catalog for selling in the home has been well established over the years. The Fuller Brush salesman proves this point conclusively. He carries a few representative samples with him, but in the main he sells from his catalog.

The electronic serviceman can use similar tactics. There are hundreds of radio-TV parts distributors throughout the country who are more than willing to supply catalogs to service technicians. Most catalogs are attractively presented so that the serviceman can show them to customers. Of the many catalogs available, the 1500-page industry-wide Radio-Electronic MASTER is one of the most popular with the servicing trade because list prices are shown. Since similar products are catalogued in a single section, it's easy for a technician to use the book without wasting time.

The very next time you are called on to do a service job in the home, take a catalog along with you. You'll be pleasantly surprised at the plus business you'll ring up in a very short time. ■■

RIDER SPEAKS

[*from page* 32]

given up trying to explain to the public why a radio repair job must cost what it does.

We realize that a business must expand. Standing still means going backward. But what possibility of expansion is there in the servicing industry when it is asked to sell tubes, and at the same time, self-service tube checkers and the tube sellers stocked with tubes are put into supermarkets and drugstores, thus bypassing the service shop. The discount houses slice into the servicing dealer's sales on one side and special service policies and factory service hack away at him on the other.

The overwhelming financial capabilities of the factories entering factory service give them numerous advantages in competition with the independent servicing industry, so we have been shocked on several occasions to see factory service business solicitation being carried on by disparaging the independent operator. Is this necessary? Should the small man, who has helped an industry grow be this kind of target? Is aggressiveness of this kind necessary? It is not surprising that it leads to behavior dictated by emotion rather than by reason.

The home receiver manufacturing industry has tried hard to persuade servicing people to spend time and money to dress windows; to buy goods, test equipment; to become more competent technically; to become business minded. Progress was slow, but progress was being made. Why then this present move which has been devastating in the extent to which it has discouraged servicing shops. It is surprising that it is resented so strongly?

We recall more than one report released to the press which stated that the caliber of service, especially for television sets, had improved tremendously. We recall television ads suggesting that when service was needed, the local independent should be called. We recall forecasts of tremendous service income in the years to come. Did the amount become too large to allow the independent to handle it? Did independent service deteriorate overnight? ■■

CONTACT

This section of SERVICE DEALER AND ELECTRONIC SERVICING serves as liason office between 1) Manufacturers of Electronic devices who seek qualified service firms capable of acting as their branch service depots, and 2) Technically qualified, financially sound Service Firms or Independent Radio-TV Servicemen who seek to be appointed as Factory-Trained Branch Service Agencies for Electronic Equipments Manufacturers in the areas where they are situated.
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For interview, write or phone Mr. Paul Kull.

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CAPACOHMETER

[*from page* 9]

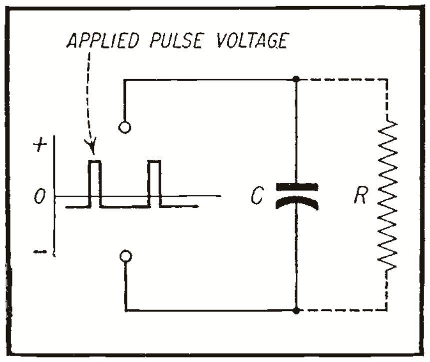


Fig. 6—If the condenser is good, action is same as with resistor.

denser is good. A kicking needle or an off scale deflection indicates that the condenser dielectric is breaking down. This is often accompanied by a crackling sound from within the condenser.

"In-Circuit" Checking of Coupling Capacitors

Coupling capacitors frequently cause trouble when leaking so slightly that they would perform satisfactorily in other applications. Hence, a highly sensitive test is desirable for coupling capacitors. This test is a "three-lead" test, which is made as depicted in *Fig. 7*. This in-circuit test for coupling capacitors only, permits the operator to pick out capacitors which may have up to 400 megohms leakage in typical coupling circuits. In the diagram, capacitor C is flanked by plate-load resistor R_p and by grid-leak resistor R_g. The coupling capacitor is shunted by leakage resistance R_L. The 3-lead test applies 300 volts *dc* on the plate side of the capacitor, and a sensitive microammeter indicates any voltage which develops across R_g. The 3-lead test is a sensitive in-circuit quick test. No disconnection of the capacitor from the circuit is necessary.

300 Volt Megohmmeter

The 383-A also has facilities for measuring the value of the leakage resistance of a capacitor out-of-circuit. Measurement is made with a 300-volt megohmmeter, so that the capacitor is tested under load conditions. In general, it will be found that the leakage of a capacitor is much higher at 300 volts, than at 1.5 volts, for example. That is, leakage resistance is non-linear. The megohmmeter scale is calibrated from ½ megohms to 1000 megohms.

Direct Reading Capacitance Meter

A direct reading capacitance meter provides for out-of-circuit measurement of capacitance values from 10 $\mu\mu$f to 10 μf. No bridge balancing is required which greatly speeds up capacitance measurements.

The tests noted in the foregoing discussion are principally applicable to capacitors of the paper, mica, and ceramic varieties. These are the types which dominate the chassis design, and which are responsible for the vast majority of circuit disturbances traceable to capacitor faults. However, the Model 383-A also has some facility in checking high-voltage titanium-dioxide capacitors, variable capacitors, and electrolytic capacitors.

Variable capacitors can be checked for voltage breakdown up to 900 volts, and buffer capacitors can be similarly checked. A 900-volt pulse test of a buffer capacitor is generally regarded as a definitive test of merit. Electrolytic capacitors can be tested for shorts and leakage under a 300 volt load.

Leakage tests can be made of coil-to-coil and coil-to-core insulation in bifilar transformers, output transformers, and deflection yokes. "High-pot" checks can be similarly made of wiring harnesses, switches, sockets, etc. ■■

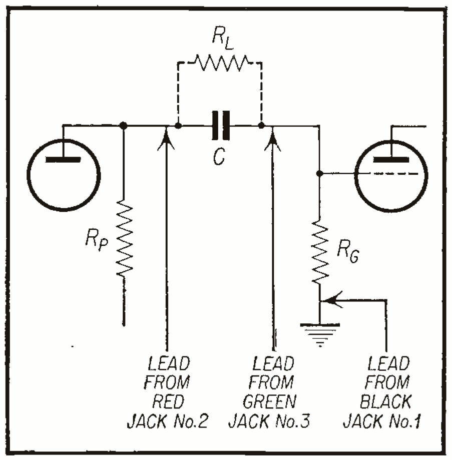


Fig. 7—Coupling capacitor leakage check with "three-lead" test.

THE ANSWERMAN [*from page 39*]

reduced below a level that will allow the relay to hold the arm. Thus, the arm is released to catch the paddle wheel.

From this it can be seen that to cause the signal seeking operation to cease, a station must be received to trigger the relay. If the antenna is disconnected or its leads broken the unit will continue to operate once the station selector bar is depressed. Anything that prevents normal reception such as a faulty *rf*, *if* or detector tube, a defective 12AU7 relay tube or a defective circuit in the signal path will cause the unit to continue to sweep. ■■

MARINE ELECTRONICS

[*from page 22*]

the finish is bright and unblemished. Applying a silicone coating to insulators will help them shed water and retain their insulating qualities. Naturally, antennas should be located so that wet lines, flag halliards, etc. cannot come in contact. In one case, after I had installed the antenna, the owner rigged a pulley on top of it with a very nautical flag on a halliard. As soon as the cotton line got wet his transmitter went off the air, resulting in an "unnecessary" service call.

Loss Due to Shunt Capacitance

Another source of loss is due to shunt capacitance, especially between the base insulator and ground. Stand-off insulators, of course, add to this effect, so that as a rule, the fewest number of insulators should be used which will give sufficient mechanical strength. Current will flow through this capacitance, just as it will through any other, and any current which does so will naturally never reach the antenna and cause radiation to take place.

Fig. 2 shows the actual circuit and the equivalent circuit which summarizes the sources of loss discussed above.

With the above factors in mind, the next installment will deal with practical points concerning the installation of various commercially available small-boat antennas. ■■

CONVERSIONS & MODIFICATIONS

[*from page 31*]

Horizontal *AFC*

Modifying the horizontal *afc* is very rarely attempted. We had an Olympic set in the shop recently which was originally designed with a pulse width *afc*. This particular circuit did not use a stabilizing coil. Someone had modified it to include this coil. The circuit is shown in *Fig. 9*. Since the set was in for horizontal tearout, a careful check was made of the modification and when an attempt was made to align the phasing winding with the scope at point *C* of *Fig. 9*, a sawtooth pulse was found, rather than the rounded and sharp pulse normal at this point. Further examination revealed that B plus was fed through the plate load resistor to point *C*, instead of at the normal position, point *D*. After wiring correctly and aligning the coil as prescribed, the set still had a tendency toward horizontal tearing. Further checking revealed the condenser indicated with an asterisk was leaky. Replacing the condenser cleared the trouble.

This case emphasizes two points. One is that incorrect wiring can nullify any modification for improvement, and the other that a defective part may mistakenly have indicated the need for the modification originally.

While the troubles encountered in improperly modified or converted sets may cause considerable headaches, consume much time and often are barely profitable, they also have the potential of creating customer respect. The fact that you could make his set straighten up and fly right when some other serviceman could not, is generally appreciated. The impact of this condition indicates to the set owner that he has found a technician of superior ability. Since this ability is your chief commodity, it can only work to your benefit and bring in more business. ■■

MOBILE RADIO

[*from page* 9]

ambulance or fire truck sitting in the house.

A survey of servicemen showed that about 70% for the retainer-fee arrangement, and 30% for the straight labor-and-material method of charging. The 30% group were chiefly in the rural or rough sections of the country.

Equipment You Will Need

If you are already in the radio and television repair business, chances are you have the following:

Tube tester
RF Signal Generator
Vacuum-tube voltmeter
AC-DC Multimeter
Signal tracer
Battery eliminator (6 and 12v).

In addition, for your two-way-radio maintenance work you will need:

1. Dummy R.F. load—with this you can operate the transmitter at normal input and output without transmitting a signal beyond your shop. (The F.C.C. requires that mobile units be measured under load conditions equivalent to actual operating conditions.) You can make this dummy load, or you can find several moderately priced ones (sometimes called "dummy antennas") at radio-parts distributors.

2. Grid-dip meter—very handy for checking the resonant frequency of tuned circuits without applying power to the equipment. Also convenient for determining the approximate output frequency of the multiplier and amplifier stages in transmitters, and for checking conversion oscillators in receivers.

3. FM modulation meter—this must measure *fm* deviation, plus or minus, from center frequency of the transmitter. FM transmitters in these services operate on frequencies from 25 to 500 *mc*. Since the F.C.C. says the *maximum* modulation deviation shall not exceed 15 *kc.*, the meter should respond to actual *voice* peaks, not just to average or sine-wave modulation.

4. Frequency meter—this instrument must show whether or not a transmitter frequency is within the 0.01% tolerance on assignments below 50 *mc* and within 0.005% above 50 *mc*. As noted previously you may have occasion to measure frequencies from as low as 290 kilocycles up to 460 megacycles.

5. AM modulation meter—actually, you may not need this piece of equipment, as the vast majority of transmitters in these services use frequency modulation. However, marine, aircraft, and some police transmitters below 30 *mc*. do use amplitude modulation.

AD LIBS

[*from page* 5]

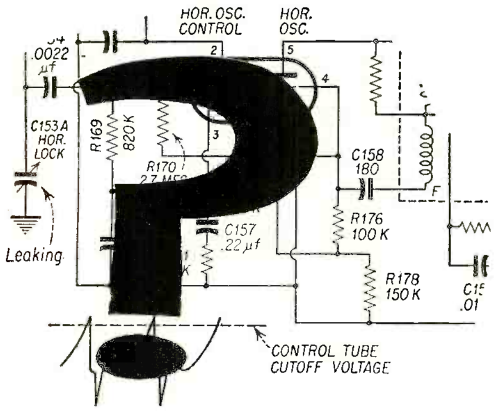
which they try to make a living. Stated another way, service firms should stick to servicing and sales; distributors should stick to selling at wholesale to service dealers; and manufacturers should stick to selling their legitimate service dealers only through their wholesale distribution outlets.

COLOR

[*from page* 13]

noise might be translated by the burst circuit as burst pulses.

Notice that the initial bias on the color killer is fixed by the setting of the color killer threshold control, and adjusts the level at which the color killer conducts. In making this adjustment the receiver is switched to a channel where no signal is received. The contrast control is then adjusted until noise



The Case of the Missing Video Signal

Once upon a time, in the hectic, hurried business section of an average American city, there was a small TV service shop with a large sign in the window. What was on the sign is unimportant, and, as a matter of fact, so is the shopowner's name, but for the sake of telling this story we'll call him Mike.

Mike was a very busy TV serviceman, averaging between 9 and 10 calls on a normal day. He was a fine technician, poor but honest, and his customers were rarely, if ever, dissatisfied.

One day, however, Mike got an excited phone call from a very excitable lady who spoke in a very excitable manner. "My set's not working, and I just paid you to fix it, and you're a crook, and you better get back here, and I want my money back," were a few of the phrases that Mike was able to catch in his phone receiver.

So, not wanting to leave a customer unhappy, our hero set out in his small panel truck to discover the cause of his customer's grief. On arriving at her home, the trouble was very clear: no picture, no raster, audio section working fine.

Well, Mike checked this and he checked that. He pulled tubes, he pulled condensers, he pulled transformers, and he pulled his hair out. Finally, after hours of frustrating labor, Mike was ready to give up. Then he noticed the strange tint on the face of the picture tube. The mystery was solved. The little girl of the family had left a Winky-Dink screen on the picture tube and had completely covered the screen with crayon.

Now, this story may seem fantastic, and in real life would probably never happen. But, you can be sure of one thing, if Mike had been a regular subscriber to SERVICE DEALER he never would have needed so much time to discover the trouble.

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is visible on the picture tube. Following this the color killer control is turned fully clockwise and color should be observed on the noise pattern of the picture tube. The killer threshold control is then adjusted counterclockwise until the color noise pattern disappears.

Notice that this circuit conforms to the block diagram of *Fig. 1* in the following three basic voltages developed and utilized:

1. A negative voltage developed at the grid of the 3.58 *mc* oscillator on a color burst signal, which biases the color killer to cutoff only on color signals.

2. A horizontal pulse fed from the horizontal output transformer to the color killer which provides color killer conduction on sync pulses only (provided, of course, a monochrome signal is being received.)

3. A negative voltage developed at the chroma circuit grid (connected to the color killer output) during a monochrome transmission (absence of burst).

RCA CTC5N — Color Killer Circuit

Recalling that the basic color killer grid gets its negative bias from some point on burst-APC chain during a color transmission, we now present *Fig. 3*, which is a partial schematic of RCA CTC5N color killer, and observe the unique manner in which the burst-APC chain makes available the negative bias for the color killer during burst. In this circuit a separate crystal rectifier (CR 701), in conjunction with the 3.58 *mc* crystal circuit, provides a voltage doubled rectified signal of negative polarity to the grid of the color killer (V701-B) through *R715*. This negative voltage is large when the burst is present and small when the burst is absent.

If no burst signal is present, as on a monochrome signal, a small negative bias will be developed at the grid of the color killer. Under these conditions, the color killer will conduct only during sync pulse intervals by virtue of the positive sync pulses applied at its plate. As a result of this conduction a negative voltage will be developed at the top end of *R711* which is applied to the control grid returns of the "X" and "Y" demodulators, cutting off their conduction and preventing superfluous signals present in the chroma section from reaching the color picture inputs.

It might be pointed out that although the H. O. T. pulse applied to the plate of the color killer is always present at point A it does not appear at point B (or the demodulator grids) because of the low pass nature of the RC filter consisting of *R713* and *C724*.

[*Continued on next page*]

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Emerson 120319-D, Color Killer

A color killer circuit which finds its counterpart in many color TV receivers, is shown in *Fig. 4,* which is a partial schematic of the Emerson 120319-D. In this circuit, a signal containing burst is fed into point A of V18, the phase detector of the APC loop (*see Fig. 4*). The action taking place manifests itself in an increased negative bias at point B. This bias is transferred to the color killer tube, driving it to cutoff. Under these conditions, the color killer tube does not affect the chroma amplifier grid (V11A).

Now consider the absence of burst, designated as NB (no burst). Point B will now decrease to —18 volts. The bias on the grid of the color killer now puts it into a conducting state. Notice that at all times a horizontal pulse (—10 volts) is applied to the grid of the color killer. During the conduction period of the tube this pulse will be amplified, and will appear in a positive direction at the plate with an amplitude of approximately 25 volts.

This pulse is coupled into the grid of V11A by means of *C86.* The pulse amplitude is high enough to drive the first chroma tube into grid-cathode conduction, thereby charging *C86* to a high negative potential, and keeping the chroma tube cutoff as long as the color killer tube conducts. During the no-burst period, *C86* discharges slowly through the circuit resistors. ■■

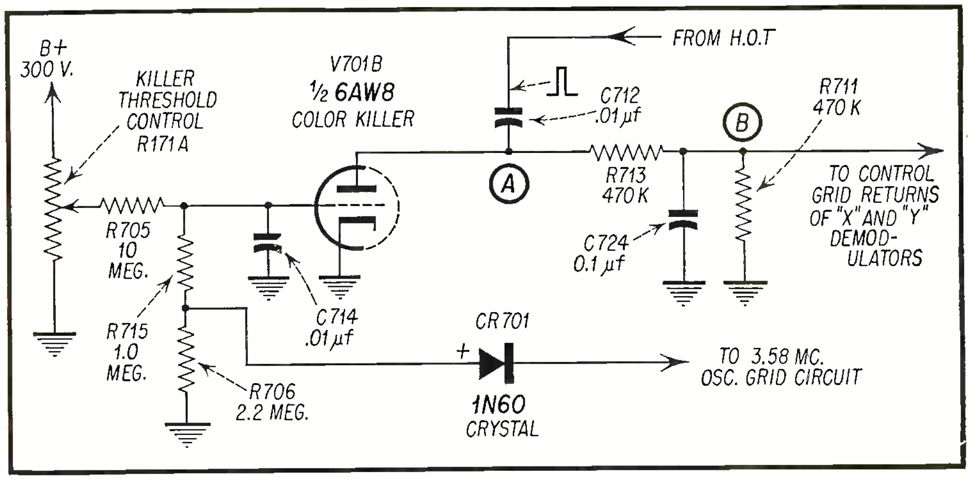


Fig. 3—Color killer circuit of the RCA CTC5N bias obtained from burst-APC chain.

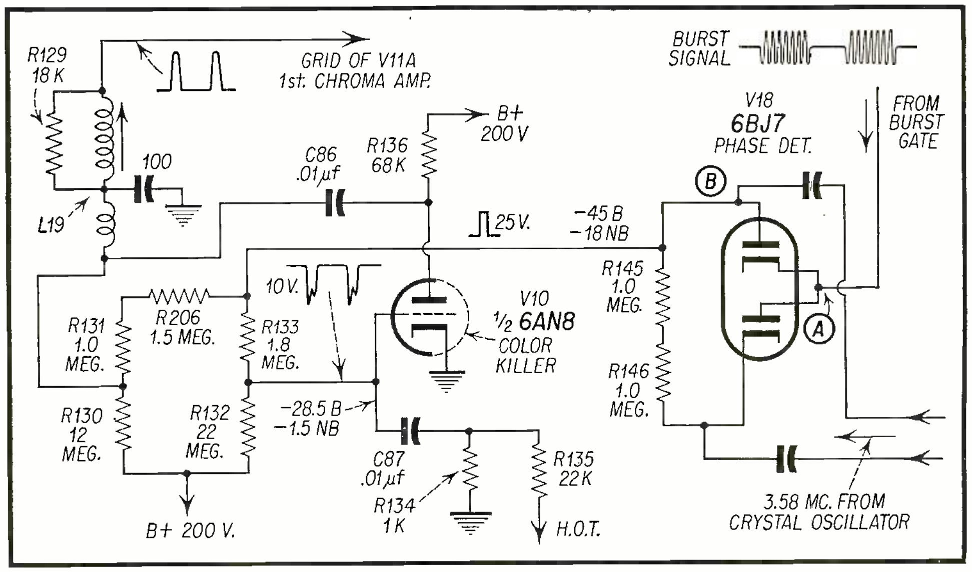


Fig. 4—Partial schematic showing color killer circuitry of the Emerson 120319-D.

UNDERSTANDING TONE CONTROLS

[*from page* 11]

age division is strictly a function of *R1* and *R3.* At low frequencies, however, *C1* approaches open circuit conditions and voltage division is now approximately 1/100th of the total voltage (*5.1K/556.1K*) or a reduction of bass frequencies of about 10 to 1 compared to the flat position.

The treble control circuit of *Fig. 3* consists of capacitor *C3, C4* and resistor *R4* with *R4* acting as the front panel Treble Control. In this case, as in the case of the bass control, *R4* is a specially tapered potentiometer whose arm engages only 10% of the total resistance from ground when the shaft is in mid-position. This circuit responds to treble tones only, because of the high impedance of the coupling capacitor *C3.* With the arm in the mid position (mechanically), 10% of all high frequencies (those which reach this potentiometer through *C3*) are sent on to the succeeding stage. With the arm of

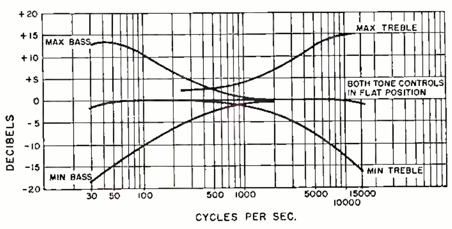


Fig. 6—Typical compensation curves showing range of control with universal losser.

R4 at the top, however (treble boost condition), a voltage divider consisting of *C3* and *R4* is established. Since *C3* looks like more and more of a direct short as the frequency increases, a greater percentage of the higher frequencies are fed to the next grid, resulting in treble boost. With the arm of *R4* fully counterclockwise, higher frequencies are effectively by-passed to ground through *C4,* which results in treble cut. The typical range of control available with this type of tone control circuit is shown in *Fig. 6.* The treble control circuit, like its bass counterpart, is virtually trouble free. Capacitor or resistor breakdown in these circuits is extremely rare, inasmuch as

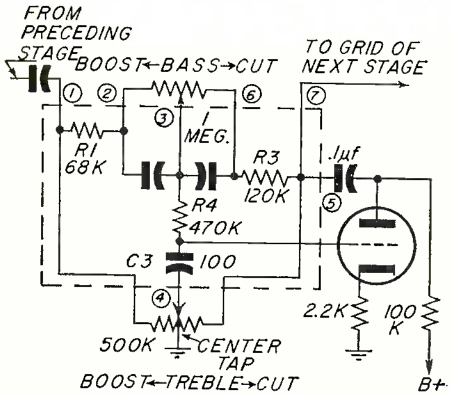
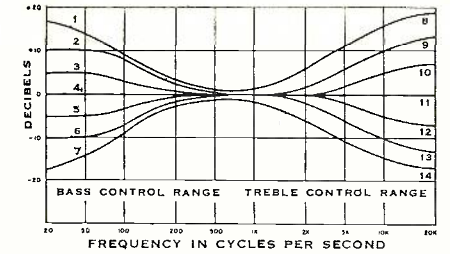


Fig. 7—Feedback tone control featuring variable cross-over.



BASS CONTROL	TREBLE CONTROL
1: MAXIMUM BOOST	8: MAXIMUM BOOST
2: 2/3 ROTATION CW	9: 2/3 ROTATION CW
3: 1/3 ROTATION CW	10: 1/3 ROTATION CW
4: UNIFORM RESPONSE	11: UNIFORM RESPONSE
5: 1/3 ROTATION CCW	12: 1/3 ROTATION CCW
6: 2/3 ROTATION CCW	13: 2/3 ROTATION CCW
7: MAXIMUM ATTENUATION	14: MAXIMUM ATTENUATION

Fig. 8—Range of tone control available with feedback circuit.

only minute audio voltages are impressed upon the components of the circuit. In replacing a noisy or intermittent potentiometer, however, remember that the ohmic value of the control is not enough to specify the part. Correct taper of the "pot" really determines the operation of the entire circuit, and as such should be carefully specified when ordering replacements.

Feedback Type of Tone Control

Figure 7 illustrates in schematic form a type of universal tone control system which has gained popularity recently because it has inherently less distortion at high levels and because the *frequency* at which boost or attenuation begins is also variable, unlike the previous circuit which "pivots" about 800 cycles or so. It is felt by some experts that this "variable crossover" action is desirable, since it enables the user to apply small amounts of correction at the extremes of the audible range, with virtually *no* shift in response towards the middle of the spectrum.

The available range of control with this type of system is shown in *Fig. 8*. A rigorous analysis of the method of operation of this circuit is beyond the scope of this discussion.* Suffice it to say that the bass part of the circuit is included in a negative feedback loop consisting of the plate circuit of the triode, *R3*, *R2*, (bass control) *R1*, *C1* and *C2*. The treble circuit comprises the plate circuit of the triode, *R5* (treble control), *C3* and isolating resistor *R4*. The action of the circuit depends upon changes in the amount of total feedback at different frequencies as determined by the circuit values and the setting of the bass and treble controls. These circuits use linear taper controls, making the replacement somewhat less of a problem than with the "losser" type described earlier.

You will note that certain points of the circuit (enclosed by a dotted line) are numbered (1 through 7). Many manufacturers utilizing this type of circuit (notably Harman-Kardon and Fisher Radio) have found it convenient to use a printed circuit slab which includes the elements contained in the dotted lines of *Fig. 7*. These manufacturers have also found it convenient to incorporate the Bass and Treble Controls as a dual, concentric shaft potentiometer arrangement, in which most of the printed circuit leads are wired directly to the potentiometers. The numbering shown in *Fig. 7* is standard with these manufacturers and should enable the serviceman to check out the printed circuit slab with the aid of an ohmmeter and capacitance checker. Replacement printed circuit slabs of this type are commercially available from The Centralab Corporation and are called the "Baxandall Printed Circuit Tone Control." Use care in resoldering such a printed circuit to the tone controls, for the leads, necessarily close to each other, are rather thin and fragile.

The next article of this series will cover the theory, installation and servicing of "Loudness-Controls." ■■

* Those seeking a complete analysis of this circuit will find it in the October 1952 issue of the magazine "Wireless World" in an article by P. J. Baxandall entitled "Negative Feedback Tone Control. . . ."

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