A HOWARD W. SAMS PUBLICATION

DECEMBER 1967 / 75¢

PF Reporter®

PHOTOFACT

the magazine of electronic servicing

SEASONS GREETINGS

The ring of the axe stings the cold silence as falling snow from shaking branches tingles against the cheek. When the tree is felled and loaded, we are homeward bound with snow crinkling beneath chilled steel and the foggy breath of spirited bays telling of their labor.

Circle 2 on literature card

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VOLUME 17, NO. 12 DECEMBER, 1967

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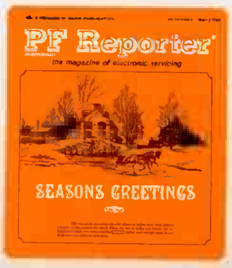
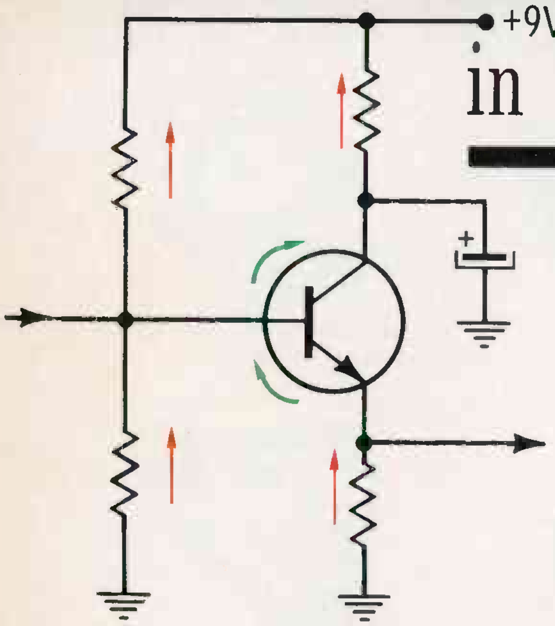
ABOUT THE COVER

The scene depicted on this month's cover represents one of many traditions associated with the holiday season. Although the mode of transportation has changed and the tree purchased from a super market or tree lot, the significance of this and most other Yule traditions has not diminished. The editor and staff of PF REPORTER wish to extend to each of our readers and to every member of the electronics industry a Merry Christmas and prosperous New Year.



UNDERSTANDING DC VOLTAGE DISTRIBUTION in TRANSISTOR CIRCUITRY



Defects within a transistor produce predictable changes in its electrode voltages. This fact, when combined with an understanding of transistor action and proper testing methods, makes transistor servicing almost easy.

by Robert G. Middleton

DC voltage values in transistor circuits often seem to disobey ohm's law. However, when the circuit action is fully evaluated, we find that the voltages do follow the usual rules. It is essential to understand DC voltage distribution in transistor circuitry, to avoid unnecessary occurrence of "tough dog" jobs.

When a transistor becomes defective, its electrode voltages change. This is the most practical way to pinpoint a defective transistor. For example, Fig. 1A shows a typical NPN transistor in an IF stage. Insofar as DC voltage distribution is concerned, we may consider the circuit to be simplified, as depicted in Fig. 1B. The DC voltage distribution may be tabulated as follows:

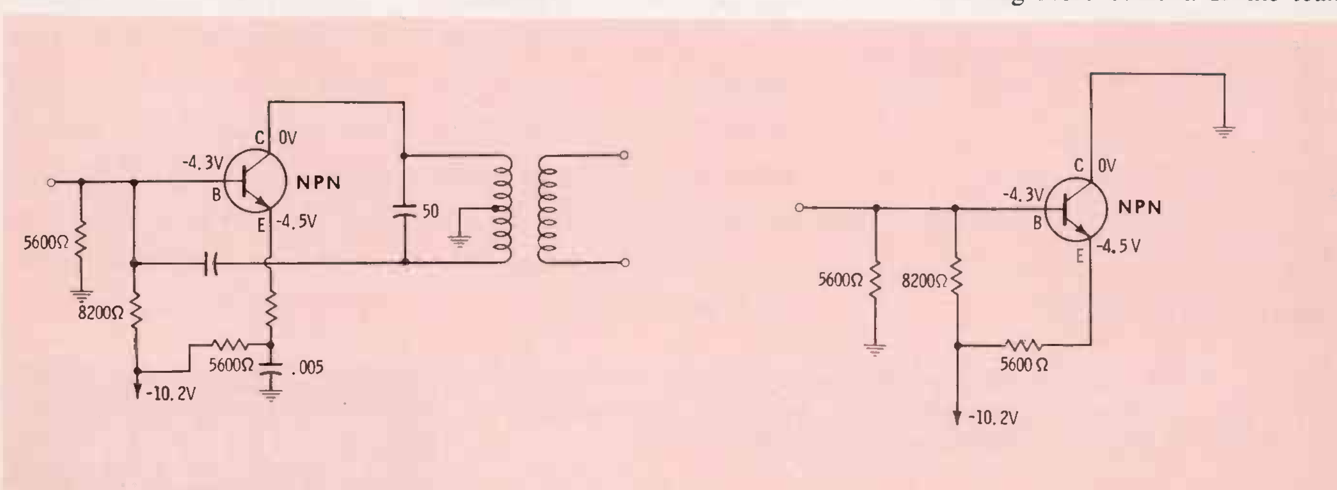
Emitter-Ground	−4.5 volts
Base-Ground	−4.3 volts
Collector-Ground	0 volts
Emitter-Base	−0.2 volts
Collector-Base	−4.3 volts

Collector Junction Leakage

One of the most common transistor defects is leakage from collector to base (leakage through the collector junction.) This leakage affects the circuit the same as if a resistor were connected between collector and base, as shown in Fig. 2. This leakage resistance draws current from the voltage divider that biases the base of the transistor, and the base voltage decreases. This base-voltage decrease also affects the emitter voltage as follows:

1. A decrease in base voltage increases the emitter-base bias voltage.
2. Increase in emitter-base bias voltage causes the collector current to increase.
3. Since the increased collector current flows through the emitter resistor, the drop across the emitter resistor increases.
4. Increased voltage drop across the emitter resistor causes the emitter voltage to decrease.

In the example of Fig. 2, the 100-k leakage between collector and base causes both the emitter voltage and the base voltage to decrease by 0.15 volt. Therefore, the emitter-base bias voltage has remained unchanged, although the transistor is drawing more current. If the leak-



(A) Typical circuit

(B) Equivalent DC circuit

Fig. 1. Transistor IF circuit.

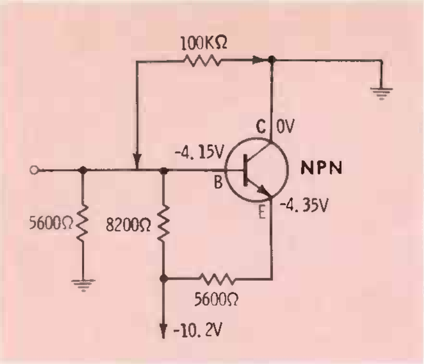


Fig. 2. The equivalent circuit with collector leakage.

age becomes excessive, the collector junction will overheat. The transistor then becomes open or shorted and the stage is dead. Moderate amounts of leakage usually cause gain reduction.

Open and Shorted Collector Junctions

Let us consider the DC voltage distribution in our basic circuit in case the collector-base junction is short-circuited. In this case, the base voltage will be zero. Since the emitter-base junction has a very low forward resistance, the emitter current flow is practically equal to the supply voltage divided by the emitter resistance, or 1.8 ma in accordance with Ohm's law. The emitter-base bias voltage will rise somewhat above its normal value of 0.2 volt, but the emitter-base junction will not be damaged.

On the other hand, suppose that the collector-base junction is open. In such case, the collector circuit does not load the bias circuit, and the emitter voltage rises to −6.5 volts, while the base voltage rises to −6.3 volts. Accordingly, the emitter-base bias voltage remains normal, and the emitter-base junction is not damaged.

In summary, collector leakage, or open or shorted collector junctions show up quite clearly as abnormal DC voltage distributions. As shown in the foregoing examples, when a collector-junction defect is present the emitter and base voltages may be either too high or too low.

Cutoff Test

The cutoff test is very informative when the normal operating voltages of the transistor are unknown. This is also a useful supplementary test, even when the normal operating voltages are known. The test consists simply in cutting off the base-current flow, and checking the voltage drop across the emitter resistor. For example, let us consider a cutoff test of the transistor depicted in our basic circuit Fig. 1. If the 8200-ohm base resistor is short-circuited, we will expect the voltage drop across the emitter resistor to be practically zero. The reason for this is that the base is reverse-biased by the short-circuit, which will normally cut off both the base current and the collector current.

Fig. 3 illustrates the cutoff test. Before the short-circuit is applied, the voltage drop across the emitter resistor reads 5.7 volts. With the 8200-ohm base resistor short-circuited, only the very small saturation current flows through the emitter resistor, and the voltmeter reads practically zero. This test result shows that the transistor has normal control action. On the other hand, if the voltmeter reading does

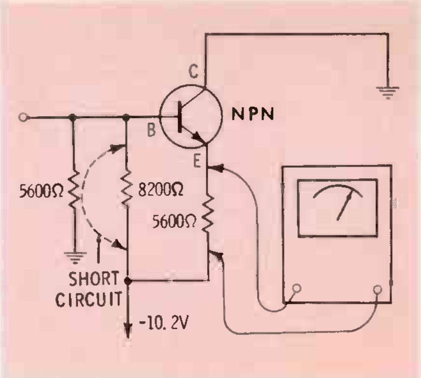


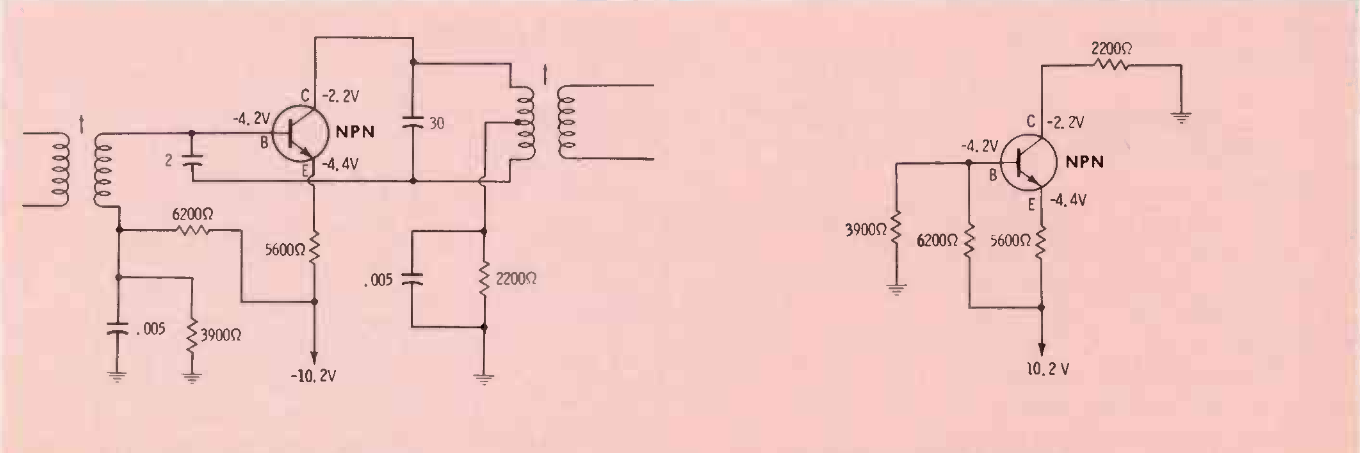
Fig. 3. The cutoff test.

not drop to zero, it indicates that the collector junction is leaky. Note that if the collector junction is leaky, the emitter will be less negative than the base in the short-circuit test—the emitter junction is therefore reverse-biased.

Resistors in Collector Circuit

The circuit in Fig. 4A differs from that in Fig. 1A in that the collector is not grounded, but returns to ground through a 2200-ohm resistor. Fig. 4B shows the DC equivalent circuit. Note that the collector is normally −2.2 volts with respect to ground; the emitter-base bias is 0.2 volt; the collector-to-emitter voltage is 2.2 volts. Suppose that there is collector-to-base leakage in the transistor (Fig. 4B); then both the emitter and base voltages decrease, and the collector voltage increases.

The reason for this changed DC voltage distribution is seen in Fig. 5. Suppose that there is 10,000 ohms leakage from collector to base. This is the same situation as if a 10-k resistor were connected between collector and base. Obviously,



(A) With collector load resistor

(B) Equivalent DC circuit

Fig. 4. Variation of the typical transistor IF circuit.

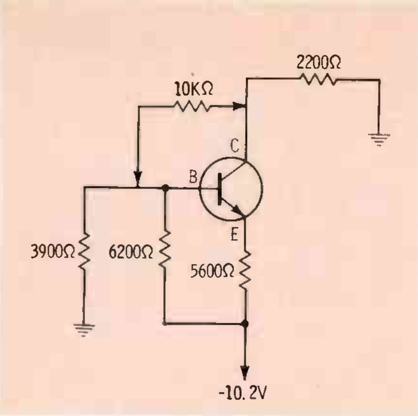


Fig. 5. Collector leakage upsets voltage on all resistors.

more current then flows through the 5600-, 6200-, and 2200-ohm resistors. Therefore, the voltage across each resistor increases. An increased voltage drop across the 2200-ohm resistor increases the collector voltage with respect to ground. Since the 10-K resistor increases the base-emitter current flow, we normally measure an increased voltage drop across the emitter resistor in this test.

Let us suppose that we wish to test for normal control action of the transistor in Fig. 4B, and for the presence of comparatively small leakage between collector and base. To do so, we connect a voltmeter across the collector resistor, and short-circuit the base to the emitter, as shown in Fig. 6. If the transistor is in good operating condition, the voltage drop across the collector resistor falls to practically zero. This action occurs because when the base and emitter are at the same voltage, the transistor is cut off; the only currents that flow through the collector resistor are the saturation current and the leakage current. Both of these currents are extremely small if the transistor is in normal condition.

Comparative Voltage Indications

Some tests require a voltmeter with a low first range such as 0.5 volt full scale. A value of 0.01 or 0.02 volt can then be clearly read. Let us consider the control-action test depicted in Fig. 3. If the transistor is in first-class condition, we can barely see the pointer move off zero when the short-circuit is applied and the voltmeter is switched to its 0.5-volt range. On the other hand, if there is objectionable collector-to-base leakage in the transistor, the voltmeter typically indicates 0.02 volt. This is two scale divisions on most meters. Thus, the up-scale deflection from zero is quite evident.

Next, let us consider the control-action test depicted in Fig. 6. If the transistor is in first-class condition, we must observe closely to see that the pointer moves off zero when the short-circuit is applied, and the voltmeter is operated on its 0.5-volt range. On the other hand, if there is objectionable collector-to-base leakage in the transistor, the pointer typically moves up to 0.25 volt. Thus, a voltmeter with a first range of 2.5 volts full scale could be used in this situation.

The basic difference between the indications obtained in Fig. 3 and Fig. 6 is that there is only one path for leakage-current flow in Fig. 6; that is, all the leakage current flows through the collector resistor. On the other hand, there are two paths in parallel for the leakage-current measurement shown in Fig. 3. Part of the leakage current passes through the base resistance into the short-circuit path; the other part of the leakage current passes out of the emitter into the emitter resistor. In an approximate analysis, the transistor can be represented by an equivalent T circuit, as shown in Fig. 7. Observe that there are two paths for leakage-current flow.

In the equivalent circuit of Fig. 7, the collector junction ideally passes no current. However, with collector-junction leakage present, we may replace the junction by a high resistance; this resistance may

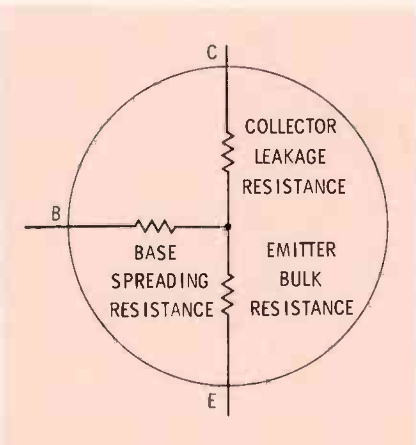


Fig. 7. Equivalent circuit for a transistor with collector-junction leakage.

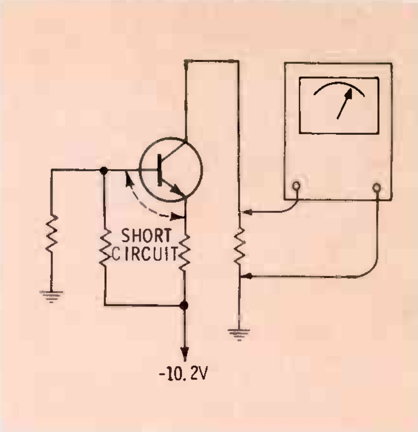


Fig. 6. The control-action test.

pass up to 1 ma of current in a very bad leakage situation. In effect, the base is connected to the lower end of this leakage resistance. The base has a certain resistance from this point to the base terminal, which is usually called the base spreading resistance. The emitter material also has resistance. Thus, neglecting some secondary semiconductor actions, the equivalent T circuit is as shown within the circle of Fig. 7.

Note carefully that the change in meter indication produced by collector-junction leakage in Fig. 3 is proportional to the change in meter indication produced by collector-junction leakage in Fig. 6. The basic distinction is that the meters are measuring a much lower voltage range in Fig. 3 than in Fig. 6. In other words, the control-action test depicted in Fig. 3 is just as sensitive as the control-action test depicted in Fig. 6, although we are working with a much smaller voltage value.

Common-Base Circuits

Although less widely used than the common-emitter configuration, the common-base arrangement is often found in electronic circuitry. The resistive portion of a typical common-base amplifier is shown in Fig. 8. If the collector junction is leaky, both the emitter and base voltages increase. The collector voltage also increases because of the leakage current. Note that the base voltage increases when leakage is present because collector voltage is then bled into the base circuit. An increase in base voltage causes increased current flow in the emitter-base circuit. This produces more

• *Please turn to page 56*

LETTERS to the editor

Dear Editor:

The latest PF REPORTER just arrived and I thought I would pass on my method of removing pages that I want to save, such as the Tube Substitution Supplement. I spray a little lighter fluid on the glue line and, within seconds, I can lift out the desired pages. By removing pages, I can make a very convenient data service for servicing some of the "dogs."

I have been a subscriber to PF REPORTER since it's inception and have a complete run of the publication. I locate many interesting articles in previous issues, and it is fun to examine the older issues.

H. D. WESTBROOK

Griffin, Ga.

Dear Editor:

I am writing in regard to a Capehart Model P4 AS 38 stereophonic record player I am repairing. Now that the company is no longer productive I have a tube problem. The set uses one 12AX7, one 35A3, and two 35D5's, and I have been unable to locate the last two types at any of the local distributors. I would like for you to determine substitutes for the 35A3 and 35D5 or send me information on where I may obtain original replacements. A stamped, self-addressed envelope is enclosed for your reply.

W. W. SMITH

Baltimore, Md.

The 35A3 and 35D5 were introduced by Marconi of Italy and, so far as we can determine, are not stocked by the leading parts houses or distributors. You may be able to obtain them from a supplier specializing in imports, such as Euro Electronics, Inc., 4329 N. Western Ave., Chicago, Ill. 60618. We do have the specifications for these tubes and have determined that there are no suitable substitutes.

▲

THE ELECTRONIC SCANNER

news of the servicing industry

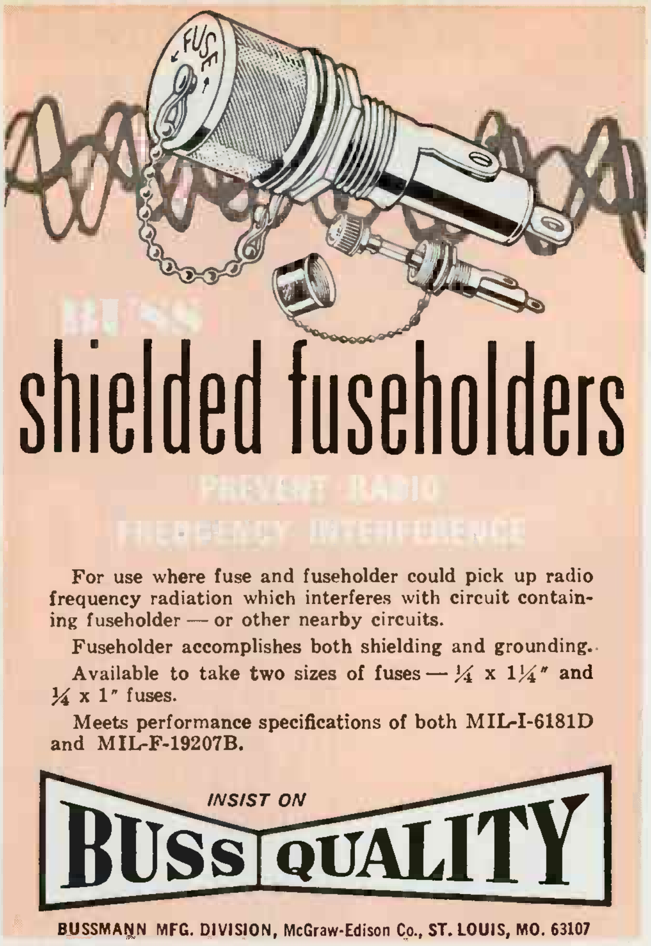
Service Technician Program Announced by EIA

The Consumer Products Division of the **Electronic Industries Association** at its annual fall meeting approved a far-ranging program aimed at increasing the number of qualified service technicians for consumer electronic products. It was stated that the budget for the Service Technician Development Program will amount to $100,000 in the 1967-68 fiscal year and over a half-million dollars over the next five years. The program follows a six-month exploratory effort, will encompass all phases of electronics service technician development, and will involve career guidance, teacher and student training, curricula upgrading, job placement and public relations.

Richard W. Tinnell, new director of education and training for the division, will be in charge of initiating the program. Mr. Tinnell outlined the career guidance effort which would be implemented by films, brochures and by working closely with career guidance teachers throughout the nation.

Production will start immediately on a 15-minute color film which is expected to be viewed by over a quarter of a million interested high school students each year. An effective brochure on the benefits of electronic servicing will be completed this year. Displays and seminars on a future in electronic servicing will be held at many vocational education conventions. The first of these seminars is scheduled to take place at the 61st annual American Vocational Association Convention in Cleveland in December.

Public image development will also be an important part of the program, and a good portion of the annual



BUSS: The Complete Line of Fuses and . . . .

program expenditure will be utilized on this important sector. Radio and television spots, news articles depicting the enormity of the problem of keeping over 500 million televisions, radios, phonographs and tape recorders and players in repair will be prepared and the good record of the industry in this area will be shown.

National Manpower Survey

During July and August, the **N.E.A.** Apprenticeship and Training Committee conducted a survey of independent TV-Electronic Service Dealers to determine present manpower needs.

Response from 618 dealers, in 18 states contacted, who presently employ 1,664 technicians, showed a need for 503 new employees.

Extension of survey results brings the following conclusions:

1. Total manpower needs of present Independent Electronic Service Dealers is approximately 15,600 (figures do not include manufacturer service companies or electric set distributor service departments).
2. Total number (advertising, registered, licensed, etc.,) full time dealers: 38,200.
3. Number of one-man operators included in total, approximately 50%: 19,100.
4. 19,100 shops with over one technician employ 52,000 total techs and perform 75-80% of the service work.
5. 19,100 one-man operators perform 12%-16% of the service work.
6. Fringe operators, hobbyists, factory technicians, non-business perform 4-8.5% of the service work.
7. Approximately 25% of the dealers hire additional part time technicians sporadically.
8. Of 19,100 multiple-technician shops, approximately 80% also sell one or more brands of TV-Radio.
9. Of 19,100 one-man operators, approximately 20% also sell one brand of Radio-TV.

$20/Hr To Test New Meter

Amphenol Distributor Division wants to show TV service technicians how a new, solid state voltmeter can make them "keymen" in their areas for servicing transistorized equipment. And, the division is willing to pay the electronic technician for his time in testing the unit just to prove its worth.

Under a new Fall promotion employing the "keyman" theme, technicians purchasing an Amphenol Model 870 Millivolt Commander from their local distributor will receive a $5 Keyman certificate redeemable at face value for any products carried by the distributor. Since the voltmeter can be checked out in about 15 minutes the $5 figure represents compensation for the technician's quarter-hour of time.

Circle 8 on literature card

The revised acquisition agreement is subject to approval by the directors of the two companies and of Ling-Temco-Vought and by the shareholders of LTV Ling Altec and Allied Radio, as well as to other legal requirements.

A new research and development center that will permit expansion of technical services to customers has been announced by **Belden.**

President Robert W. Hawkinson announced that Belden has purchased a 22,000-sq. ft. building near Geneva, Ill. "All research and development activities now being conducted at both our Chicago and Richmond, Ind., plants will be centralized in this modern new location," he said.

Westinghouse announced major expansions of its semiconductor production facilities on two continents. At the company's semiconductor division in Pennsylvania, a new building—the fifth expansion since 1956—has added 72,000 square feet of manufacturing capability to the existing plant.

And at Le Mans', France, site of the world-famous automobile race near Paris, a new manufacturing facility has been acquired by the division. The new organization is known as Compagnie des Dispositifs Semiconducteurs Westinghouse (CDSW). ▲

Holiday Gifts

General Electric's Tube Department has "fired up" its boilers to get the fall promotion for GE receiving tube distributors rolling. Termed the "GE Tube Holiday Gift Express", the campaign will offer valuable family gifts for tube purchases.

Premium coupons will be awarded to dealer customers for tube purchases, which will entitle the participants to select from an impressive array of valuable gifts. After accumulating the proper number of coupons, the customer will forward his order to the "Holiday Gift Express Depot" to receive his gifts. Gifts include items ranging from toys for the children to household and hobby items for mom and dad.

Mergers and Expansions

Agreement in principle on revised terms for the acquisition of **Allied Radio** by **LTV Ling Altec** was announced by both companies.

Under terms of the revised agreement, LTV Ling Altec will buy all of the assets and business of Allied Radio in exchange for 992,830 shares of LTV Ling Altec common stock and the assumption of substantially all liabilities of Allied. Allied would then distribute to its shareholders approximately nine-tenths of a share of LTV Ling Altec common for each of the 1,103,145 shares of Allied Radio common stock outstanding.

Circle 8 on literature card

KNOW YOUR 68 COLOR CIRCUITS
PART 2

by J. W. Phipps

CRT Control Circuits

The CRT control circuits employed in Motorola's all-transistor chassis are shown in Fig. 13. Since the color and Y signals are combined and fed to the cathodes, there is no signal applied to the G1, or control, grids. Instead, they are tied together and furnished a common voltage. The G2 (screen) controls determine the cutoff of each gun and are supplied approximately 600 volts DC from the focus voltage supply. Voltage for the green G2 control is supplied through a fixed 2.2-megohm resistor, while the voltage for the red and blue G2 controls is supplied through a potentiometer which serves as the tint control. Adjusting the tint control splits the supply voltage between the two controls so that the CRT screen can be tinted according to individual preference. Note that the 5-kv focus voltage is obtained by dividing the second anode voltage through a bleeder network. This configuration provides a fixed ratio between the high voltage and focus voltage at any brightness setting.

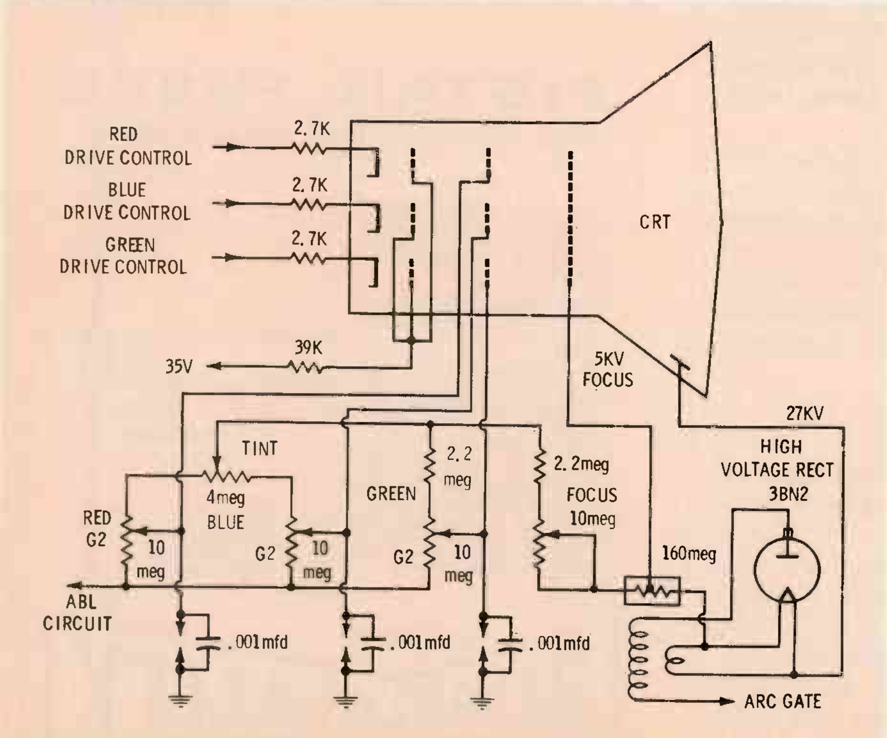


Fig. 13. CRT circuits employed in Motorola's all-transistor chassis.

An automatic brightness limiter circuit (ABL) is employed in conjunction with the CRT input circuitry and video drivers. The primary function of this circuit (Fig. 14) is to limit the maximum CRT beam current to a value that can be safely delivered by the horizontal output and high-voltage circuits. This is accomplished by monitoring the focus voltage which decreases with an increase in CRT beam current and using the resultant reference voltage to control the two common-emitter DC amplifiers. As the CRT beam current increases, the focus voltage drops, decreasing the reference voltage applied as forward bias to the ABL driver. The resultant decrease in the conduction of the ABL driver reduces its emitter voltage which, in turn, lowers the forward bias on the brightness control amplifier and reduces its conduction. With the output from the emitter of the brightness control applied as forward bias to the three video driver stages, the conduction of these sta-

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283 ***Here are the PHOTOFACT sets with Color TV coverage from the beginning in 1954 through 1967:***

1	31	61	91	121	151	181	211	241	271	301	331	361	391	421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871	901
2	32	62	92	122	152	182	212	242	272	302	332	362	392	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872	902
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19	49	79	109	139	169	199	229	259	289	319	349	379	409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859	889	919 Nov.
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27	57	87	117	147	177	207	237	267	297	327	357	387	417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867	897	927 Dec.
28	58	88	118	148	178	208	238	268	298	328	358	388	418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868	898	928 Dec.
29	59	89	119	149	179	209	239	269	299	329	359	389	419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869	899	929 Dec.
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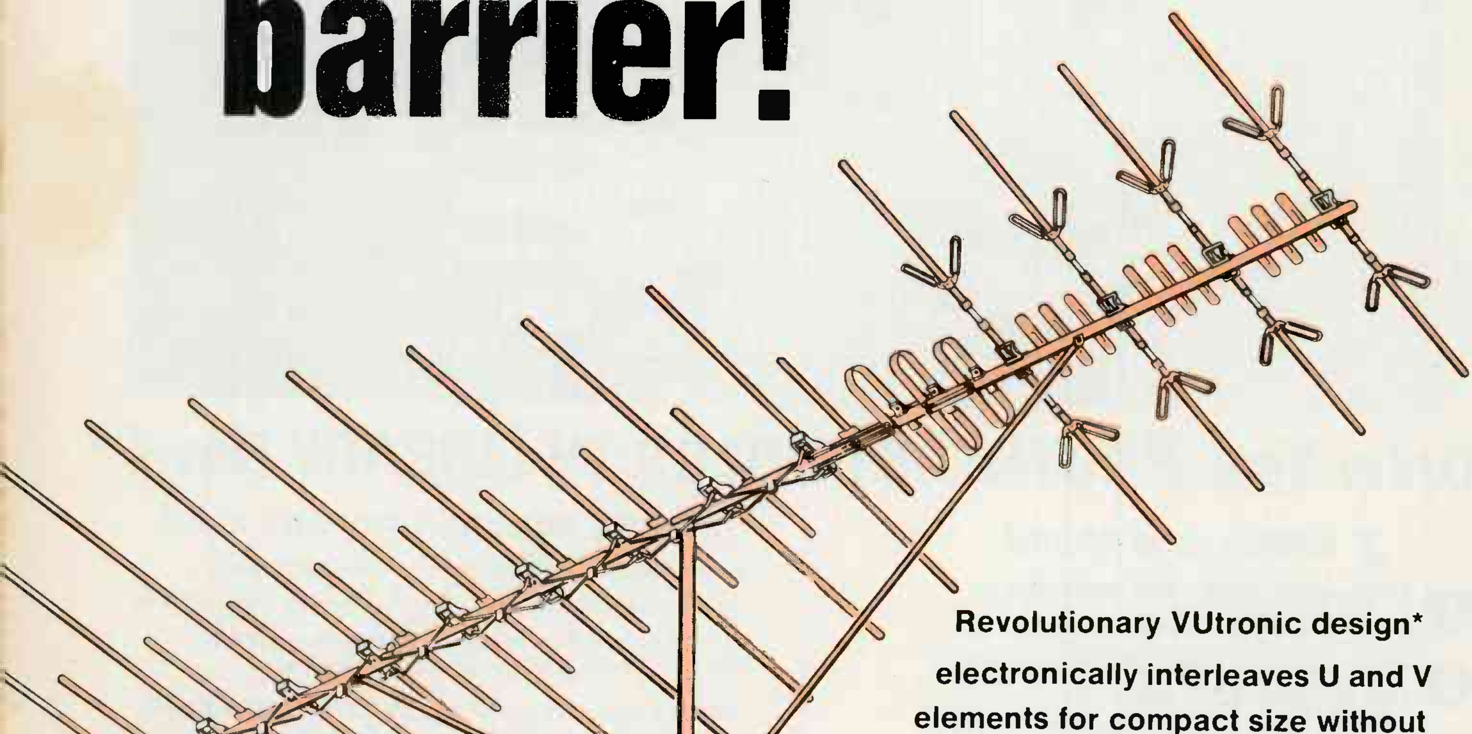

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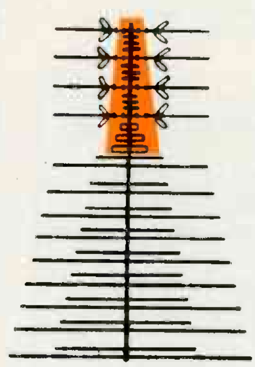
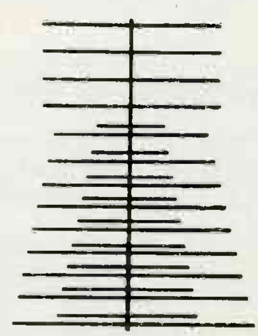
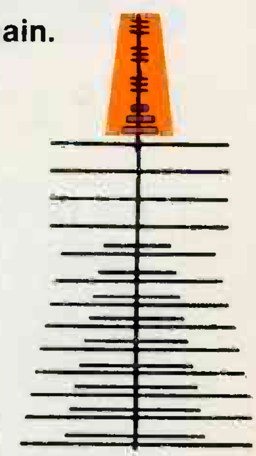


Fringe area Model 3661G has **all** UHF elements contained **within** the over-all length of the VHF section



A VHF only antenna with exactly the same VHF gain as the 82-channel Model 3661G is also practically the same size.



Usual design 82-channel antenna would have to be 34% longer to provide the same UHF and VHF gain as Model 3661G Color Crossfire 82.

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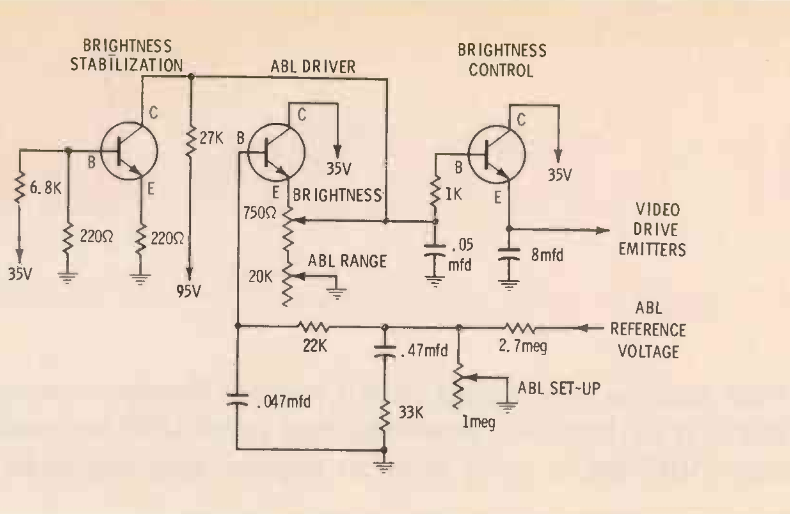

Fig. 14. Motorola's automatic brightness limiter circuit.

ges is reduced because of the decrease in the emitter voltage of the brightness control stage. Since the video drivers are DC coupled to the CRT cathodes via the video output stages, the decreased conduction of the video drivers reduces the drive to the CRT cathodes, thus decreasing the beam current. The brightness stabilization stage prevents variations in brightness resulting from changes in B+.

An additional advantage derived from the ABL circuit function is independent control of the contrast and brightness. This advantage is realized because the ABL circuit automatically adjusts the beam current in the direction needed to compensate for changes in brightness caused by adjustment of the contrast control.

CRT blanking in Motorola's TS-915 and TS-919 chassis is accomplished by the monostable multivibrator circuit shown in Fig. 15. The emitter of each video output transistor returns to ground through X2, which is normally saturated (maximum conduction). The application of either a vertical or horizontal positive pulse to X1 (normally cutoff) triggers it into conduction. Conduction of X1 decreases the positive potential at the base of X2, cutting it off and opening the emitter-to-ground path of all three video output stages. With no emitter return to ground, the video output stages are cut off and their collector voltages rise to the source voltage (255 volts). Since the video output stages are DC coupled to the CRT cathodes, the high positive source voltage is also applied to the cathodes, biasing them off. No DC restoration circuitry is required in the Motorola all-transistor chassis because 100% DC coupling exists between the video detector and CRT cathodes.

The use of the new red phosphor in RCA's color CRT's has made it necessary to add a red drive control. In previous CRT designs, red was the least efficient of the three phosphors, and the green and blue drive signals were reduced to compensate for this. However, with the increased efficiency of the new red phosphor, it may be necessary to reduce both the red and green drive controls with respect to the blue. The red drive control is utilized in all five of RCA's new color chassis.

Luminance Circuits

Emerson Chassis Group C-77, used in various 18", 20" and 23" models, employs a combination sync/AGC/chroma amplifier in the luminance channel. As shown in Fig. 16, the 1st video amplifier functions as a cathode follower with a separate output to both the combination amplifiers and the final video output stage. The sync, AGC, and chroma stages receive their respective input signals from the plate circuit of V1B. The chroma signal is fed to the burst amplifier and the chroma take-off coil in the grid circuit of the 1st bandpass amplifier. Voltage for the brightness control circuit is obtained from a separate half-wave rectifier.

Chassis group C-75A, used in the Dumont Custom Series and five 23" Emerson models, employs a new potentiometer-type video peaking coil in place of the slide switch found in earlier chassis. Chassis group C-75 continues to use the slide-type video peaking switch. Both types of controls are electrically located in the cathode circuit of the 3rd video amplifier.

The hybrid amplifier section introduced in General Electric's KC chassis is also found in the new KD chassis. NPN transistors are employed in the 1st and 2nd video amplifier stages, while the pentode half of a triode-pentode 6AG9 is used in the final video stage.

Philco's color line continues to use hybrid chassis with transistorized video IF, video driver, and AGC circuits. The only major change in this design involves the new 18QT86 chassis employed in two 23" models. The video driver

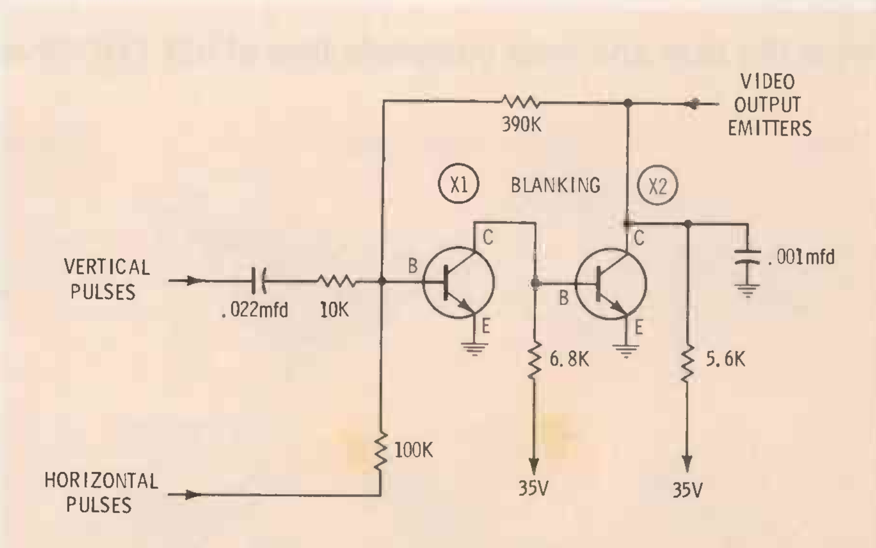

Fig. 15. Motorola's blanking system opens emitters of video output stages.

circuit in this chassis uses an integrated circuit in place of the NPN transistor found in the same stage in other Philco color chassis.

A new method of horizontal retrace blanking is utilized in RCA's CTC31 chassis. In previous chassis designs from this manufacturer, horizontal blanking was accomplished at the CRT control grids via the color difference amplifiers. However, a new chroma clamp diode is employed in the CRT grid circuit and precludes use of the grids for retrace blanking. Instead, both horizontal and vertical retrace blanking are now accomplished through the CRT cathodes via the video output stage. As shown in Fig. 17, both horizontal and vertical negative blanking pulses are applied to the grid of the output stage. During the normal scan time (no blanking pulse present), a positive voltage is applied to the anode of diode X1 through a 680K-ohm resistor. This causes X1 to conduct, passing the luminance information on to the grid of the output tube and through the tube to the CRT cathode. However, during horizontal retrace, the negative portions of the blanking waveforms bias off the blanking diode, video output stage and, consequently, the CRT cathodes. This action is accomplished regardless of the contrast or brightness control settings.

Also found in the same chassis is a brightness limiter control (Fig. 17). The limiter control supplies one end of the normal brightness control with a variable amount of positive voltage. The other end of the normal brightness control is supplied with a negative voltage from the grid of the horizontal oscillator via the filter network comprised of two resistors and a .047-mfd capacitor. The normal brightness control adjusts the bias on the video output grid, thus establishing the brightness level. Adjusting the limiter control varies the positive potential supplied to the brightness control and, therefore, determines the range of positive voltage supplied to the video output grid. When the limiter control is properly adjusted, the normal brightness control can be advanced fully clockwise (maximum brightness) without excessive blooming.

All new RCA color chassis, with the exception of the CTC22, employ a push-pull type normal/service/raster switch mounted on top of the chroma circuit board. In addition, the normal/service/raster switch circuitry in the CTC31 chassis is designed to provide approximately 20 volts of AC-coupled blanking to the CRT cathodes when the switch is in the service position. The 20-volt blanking signal is obtained from the plate of the video output stage and coupled to one side of the service switch through a 39K-ohm resistor and .01-mfd capacitor (R1 and C1). The service switch, in turn, applies the blanking signal to the CRT cathodes via the drive controls, as shown in Fig. 17. The necessity of this added blanking signal is a result of the previously described CTC31 blanking system, which cuts off the cathodes via the video output stage. If the service position of the normal/service/raster switch completely removed the video output from the CRT cathodes, as is done in other RCA chassis, no horizontal blanking signal would be applied to the cathodes during color temperature setup and the resultant visible retrace lines would interfere with the temperature adjustments.

Sylvania's new D10 series chassis, employed in various 23" models, features a hybrid design with the complete three-stage video IF and three-stage keyed AGC circuitry transistorized. In addition, the sync amplifier, noise gate, and first two video amplifiers are also transistorized. This manufacturer's DO6 and DO7 chassis (used in 20" and 18" models, respectively) employ tran-

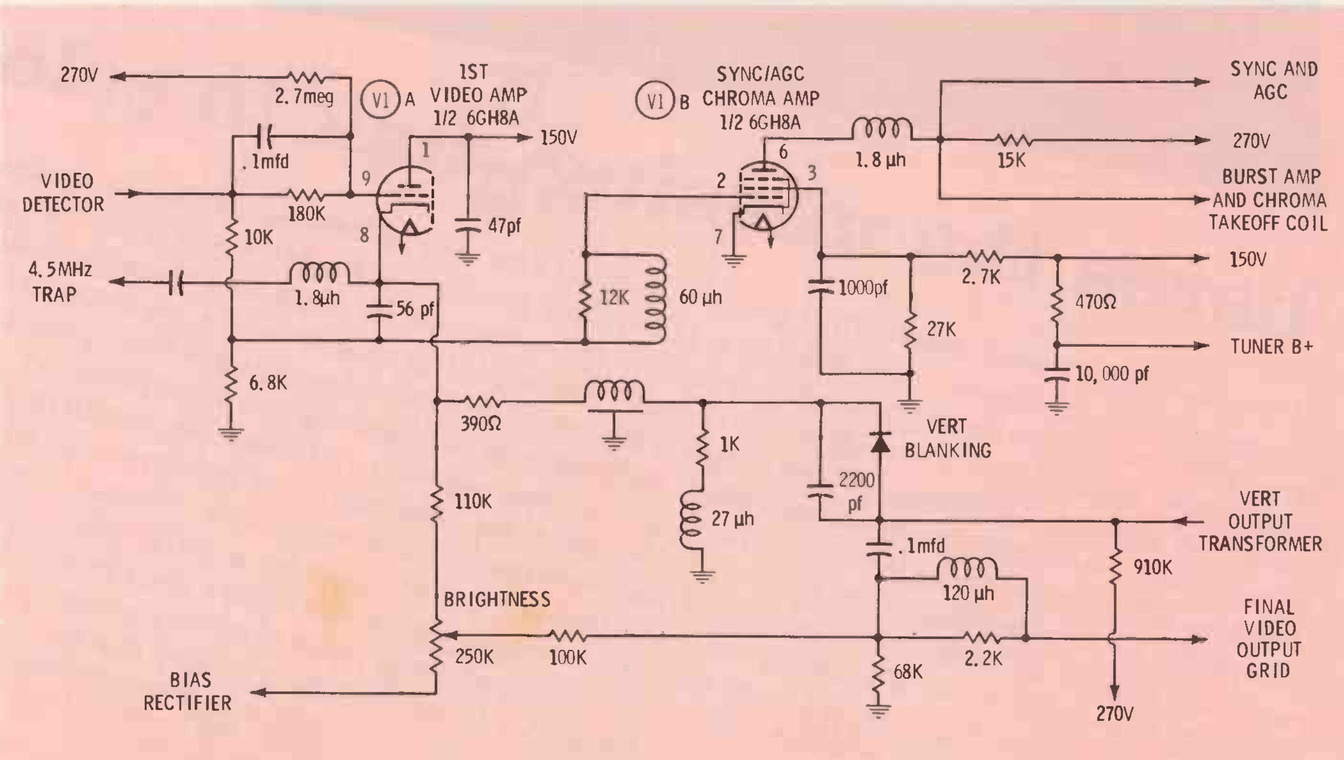

Fig. 16. Combination sync/AGC/chroma amplifier stage is employed in Emerson chassis.


mystery:
where did all the color GO?

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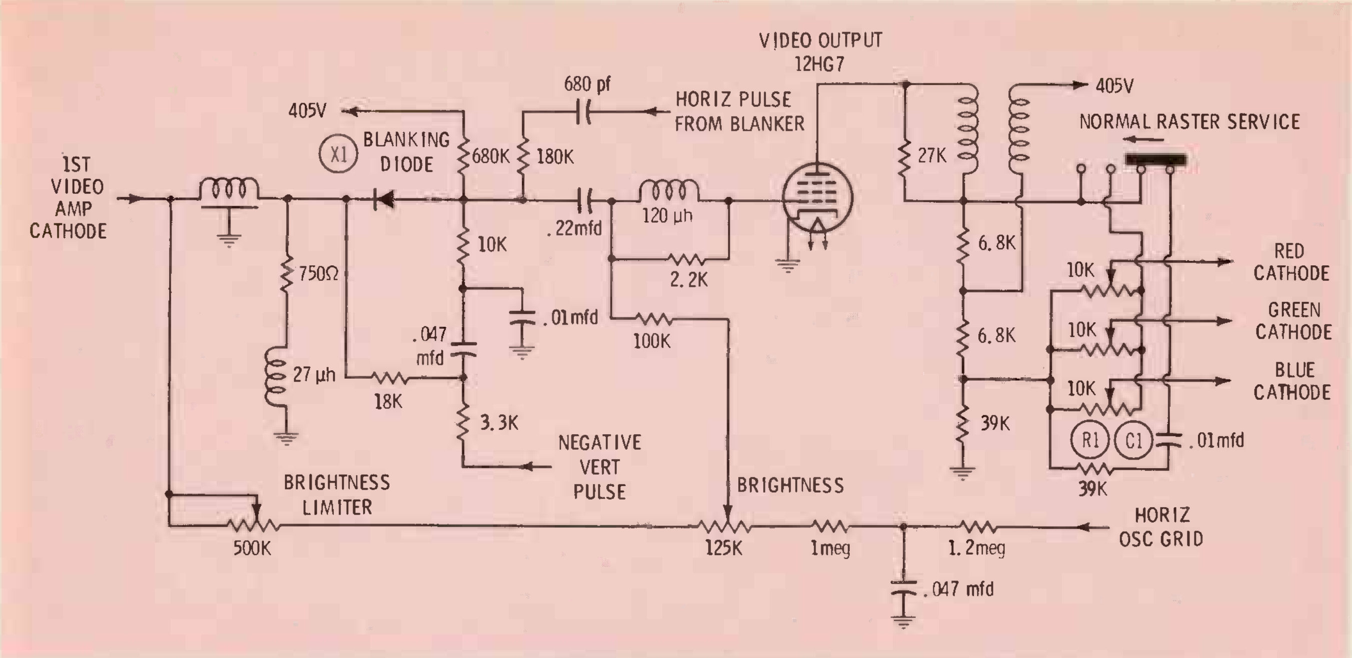

Fig. 17. Negative blanking pulses cut off video output stage in RCA CTC27 and CTC31 chassis.

sistors in three luminance channel stages: the noise gate, noise amplifier, and 2nd video amplifier.

The luminance channel of Westinghouse's color chassis utilizes an NPN transistor in the 1st video amplifier stage (Q1 in Fig. 18). Five separate outputs are obtained from Q1: The collector supplies an amplified composite video to the 2nd video (via the delay line) and sync amplifier, while the emitter functions as a cathode follower, supplying inputs to the tuning indicator section, AGC keyer, and chroma amplifier stage.

Collector voltage for Q1 is obtained from series voltage regulator V1A. The bias on the grid of V1A is set at +22 volts by a voltage divider network consisting of R1 and R2. Although the composite video input to Q1 produces current variations in its collector circuit, these variations are filtered out of the cathode of V1A by C1, the cathode bypass capacitator. Thus, with a fixed bias at its grid and no AC signal component on its cathode, the conduction of V1A is consistent, producing a stable 25 volts at its cathode.

Sweep and High Voltage

The 4H12 chassis used in Admiral's 23" models employs the familiar 6BK4B triode high-voltage regulator circuit and a 2BA2 or 2AV2 tube-type focus rectifier. However, chassis 6H1O, 7H1O, and 9H10, used in this manufacturer's 18" and 20" receivers, employs the solid-state feedback regulator system introduced in the spring of 1965. In this system, pulses fed back from the horizontal output transformer are rectified by a solid-state diode and used to supplement the 6KG6 pentode horizontal output tube bias. Operation of this system is as follows: An increase in CRT brightness (more current) produces an increase in flyback loading, which results in less feedback. Consequently, less bias is applied to the horizontal output tube grid and the output current of this stage is increased to compensate for the increased current demand of the CRT.

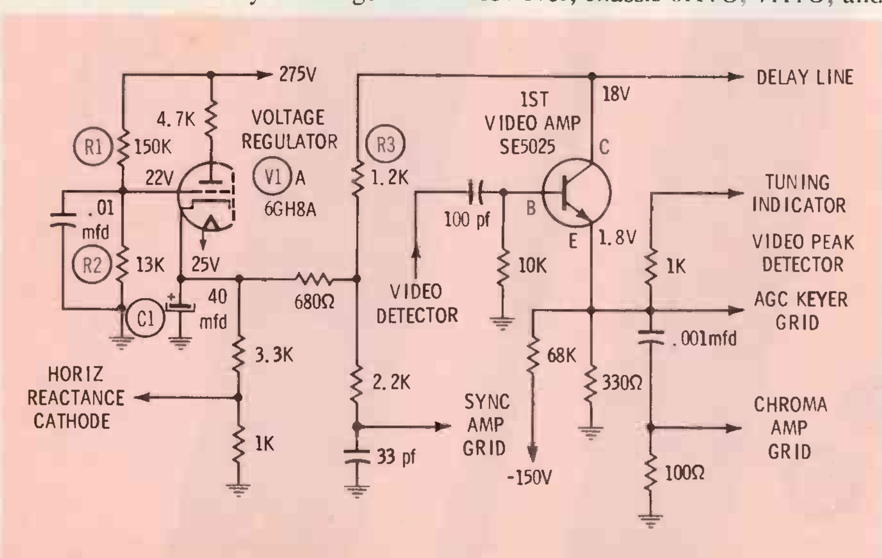

Fig. 18. Video amplifier collector voltage is regulated in Westinghouse chassis.

The focus circuit used in conjunction with the feedback regulator system employs a solid-state diode in place of the tube-type rectifier found in the 4H12 chassis. This solid-state focus circuit also employs an automatic focus tracking circuit consisting of two 500K-ohm resistors connected in series with the high-voltage winding of the flyback. With an increase in CRT current (increased brightness), more voltage is dropped across the focus tracking resistors. This increased voltage is added to the focus rectifier output, automatically adjusting the focus in response to changes in CRT current.

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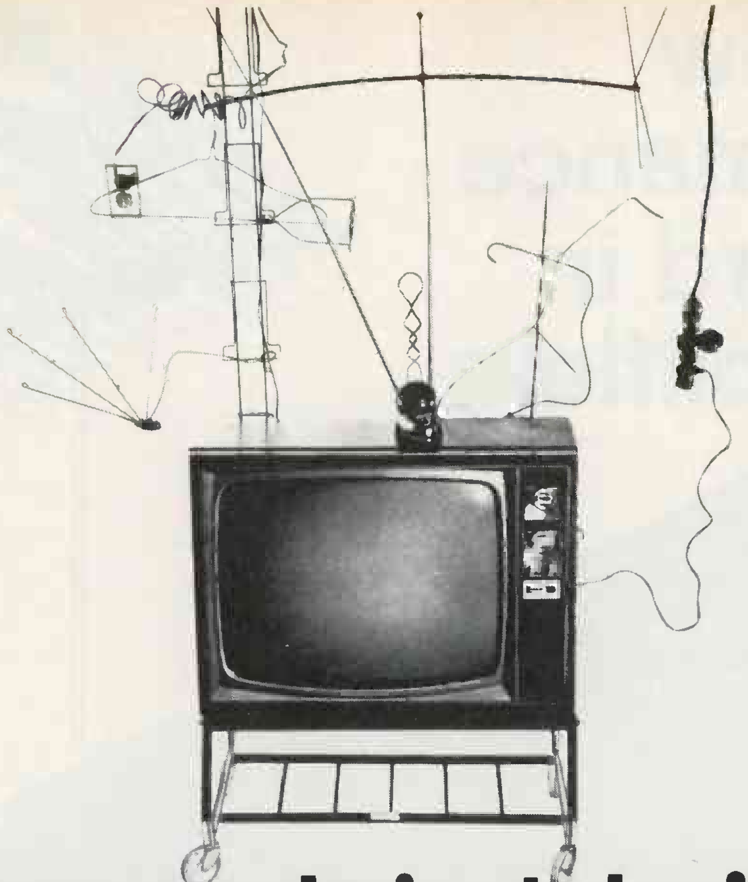

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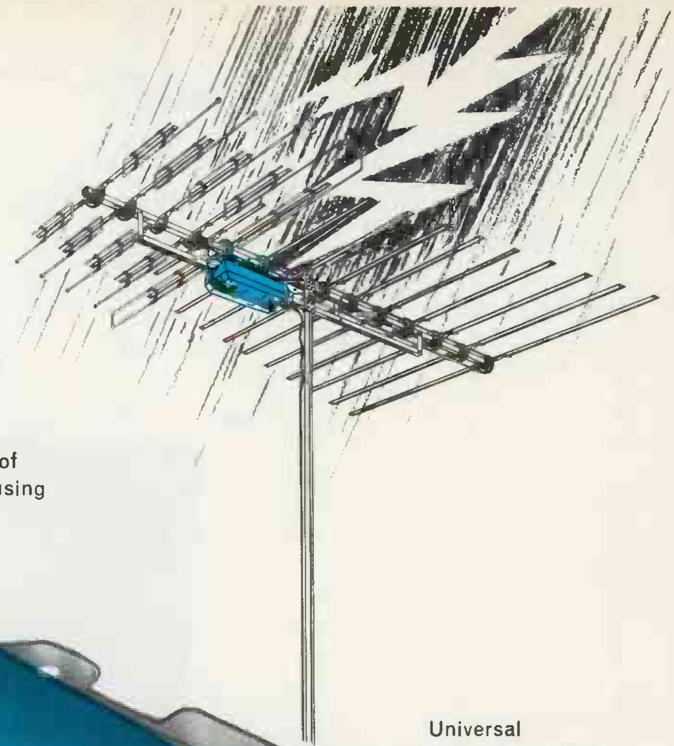

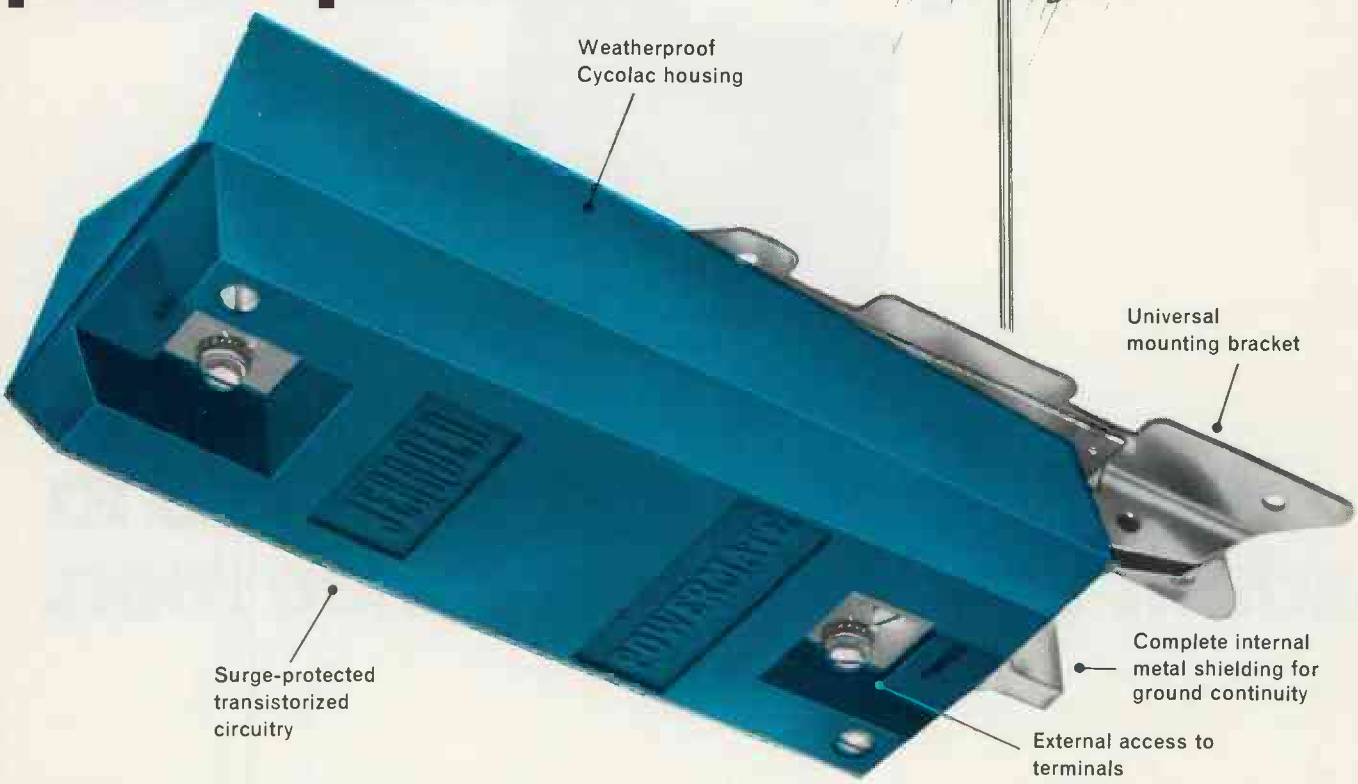

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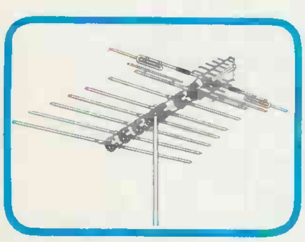

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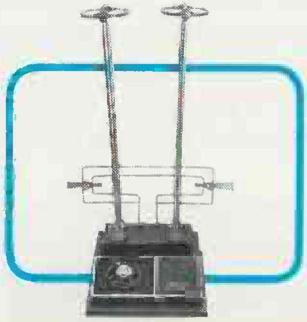

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Electrics' large-screen chassis has been changed; the previously used 3A3 high-voltage rectifier has been replaced by a 3CN3, and the shunt-type high-voltage regulator (formerly a 6EF4) now utilizes a 6LJ6.

Changes are also evident in the sweep circuitry of this chassis. Both horizontal and vertical centering are included in their respective circuits. Horizontal centering is provided by a potentiometer placed across the sweep supply windings of the horizontal output transformer (Fig. 19A.) The moveable arm of the pot is connected to the hot side of the horizontal yoke windings, thus controlling the potential supplied to them. The vertical centering provision consists of a jumper that can be placed at either end of a 3.3K-ohm resistor in the 400-volt line of the low-voltage supply (Fig. 19B).

The horizontal sweep system employed in RCA's new color chassis is changed somewhat from this manufacturer's previous designs. One change was made to increase the amplitude of the horizontal grid drive wave-form and assure that the horizontal output tube remains cut-off during retrace time, thus preventing unnecessary plate power dissipation. Instead of furnishing the horizontal oscillator plate with only B+, both boost and B+ voltages are supplied to the plate of this stage in the new color chassis, providing an additional 20- to 30-volt increase in plate voltage. This increase in voltage produces a similar increase in the drive waveform at the grid of the output stage which, in turn, results in an increase in the negative portion of the waveform.

Another sweep system change incorporated in all '68 RCA chassis involves a new horizontal efficiency coil with a core designed to reduce the possibility of saturation. Also, a new 6CL3 damper is used in chassis CTC35, CTC30, and CTC28. The increased efficiency of the 6CL3, as compared to the older 6DW4, has made it possible to reduce the screen dissipation of the **6JE6** horizontal output tube by increasing the screen resistor from 13 to 15K ohms.

Sound Circuits

The all solid-state sound system shown in Fig. 20 is employed in three of Catalina's 23" consoles and one 23" combination model. An integrated circuit is used in the sound IF and sound detector stages of this system. Motorola and Sylvania also use integrated circuits in their sound systems. Motorola's IC sound system is found in their TS-915 and TS-919 all-transistor chassis, while Sylvania has selected their D10 chassis series for the IC application. Another example of the increasing use of solid-state components in TV sound systems is found in Delmonico/Nivico's 18" portable chassis. Fig. 21 shows the transistorized sound section employed in this chassis.

• *Please turn to page 44*

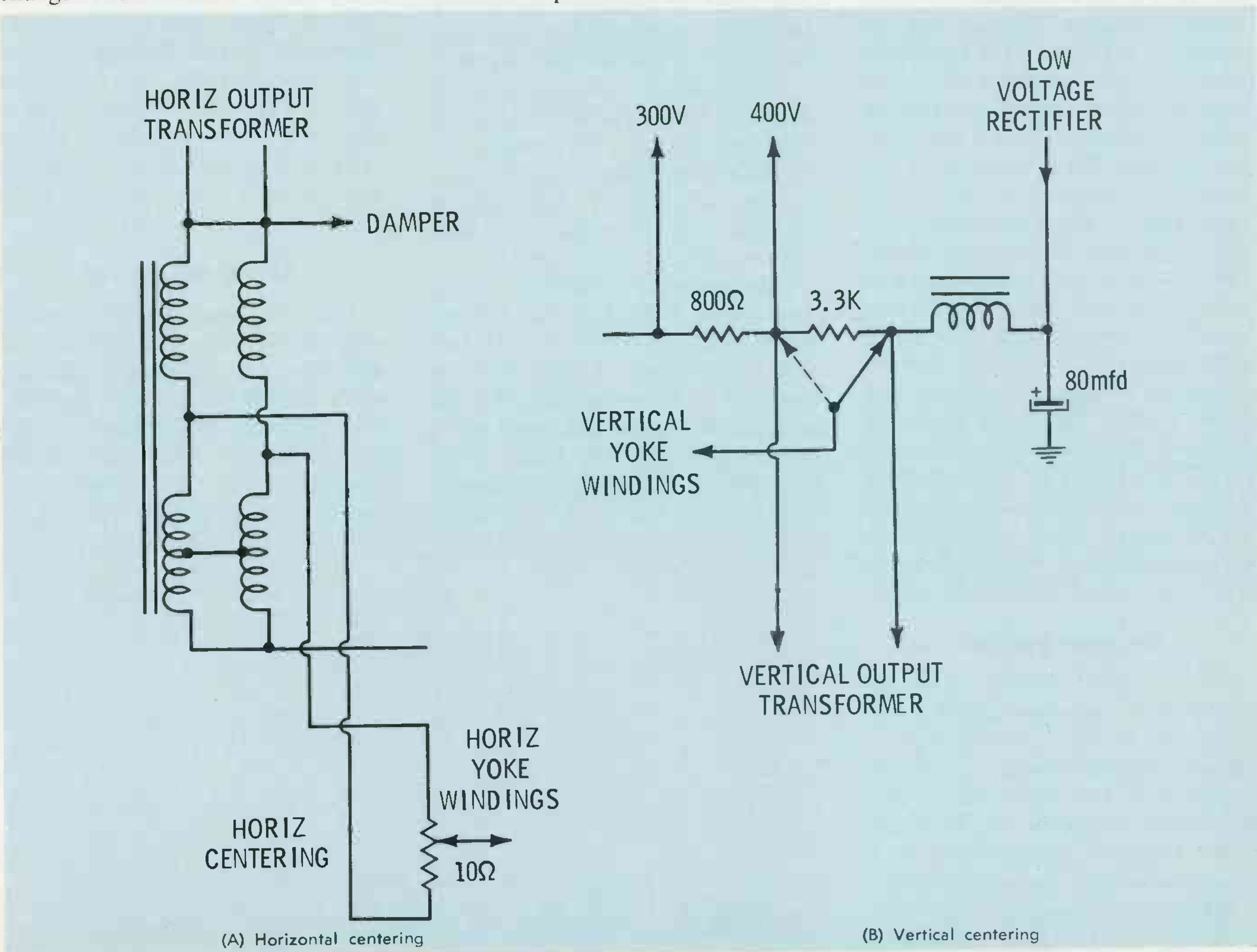
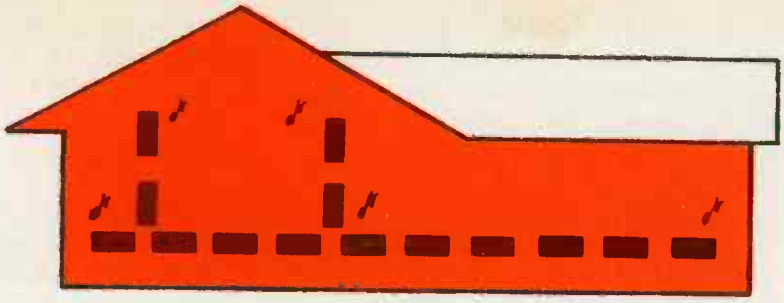


Fig. 19. Sweep centering provisions found in General Electric chassis.



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installing intercom and music distribution systems

by Louis M. Dezettel

There is no reason why the radio and TV servicemen cannot get a share of this increasingly prosperous business. Anyone capable of servicing radio and TV sets is capable of installing intercoms and music distribution systems in homes, businesses, and schools. The electrical knowledge required is fundamental, and no special tools or test equipment are needed.

The one requisite which you may not have is an understanding of the various intercom systems that are currently available. This knowledge is absolutely necessary if you are to properly advise your customer on what he needs to fill his particular requirements. Such information can usually be obtained at your local radio and TV parts distributor. The distributor may have a representative system of the line he handles hooked up and operating. If so, look it over carefully, paying particular attention to the cable connection strip, or separate junction box if one is used. Then, pick up all the pertinent literature you can, and spend an evening or two studying it to get a thorough idea of what the system(s) offers. Following is a general description of both intercom and music distribution systems.

Intercom Systems

An intercom system provides loudspeaker communication between two or more points without the use of microphones. A single amplifier is normally used. The loudspeaker is switched to the input of the amplifier and functions as a microphone when one station talks. A push-to-talk switch does the switching of speakers. While this eliminates duplex communication, such as that provided by a telephone, and does require switching each time one desires to talk, it is more economical from the standpoint of the equipment required.

The station in which the amplifier is located is called the "master," and the other station, consisting of only a speaker and switch, is called the "substation," or sometimes the "slave." Masters can be connected to a number of substations as in Fig. 1, or all stations may be masters (Fig. 2), or a system may combine several masters and slaves.

In nonprivate configurations, the master station's push-to-talk switch functions for both the master and the substation. Thus, only the master can originate a call and, in addition, can listen in on a substation, such as the nursery.

The nonprivate hook-up is also used for the front door station when one is installed. When the door bell rings, the master station can be switched to that substation, and the lady of the house can carry on a conversation with the visitor without opening the door. (Obviously, such a safety feature is an effective selling point.) There are other combinations of intercom systems, but the preceding ones are the most commonly found.

Music Distribution Systems

A home music distribution system is basically an intercom system with a radio tuner (Fig. 3) and/or record player (Fig. 4) added, in addition to a few other equipment refinements. The added refinements include better quality speakers for improved music fidelity and a switching function at each substation to permit selection of a particular music channel. Deluxe systems even include a dual-speaker installation in each room for stereo reception of music (not voice).

Sizing Up the Job

Once you have become familiar with the available music distribution and intercom equipment, you are ready to call on your first prospective customer. Determine his requirements and match these to the equipment you are prepared to install. After you have reached an

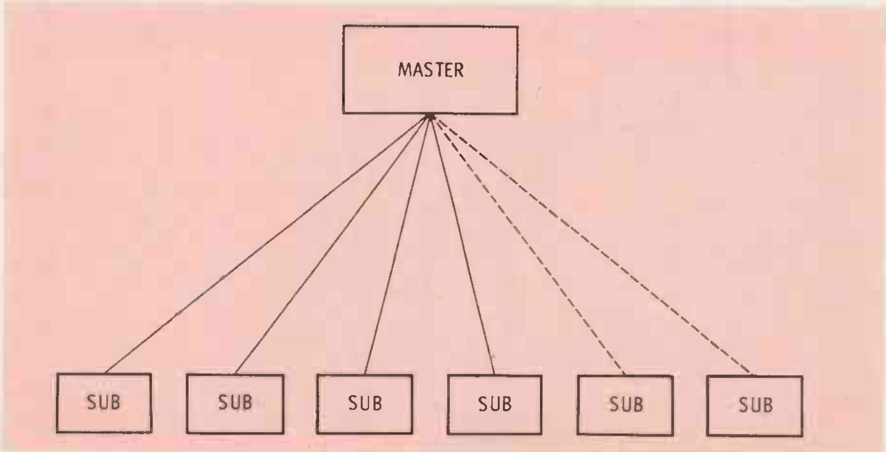

Fig. 1. System employing one master and any number of substations.

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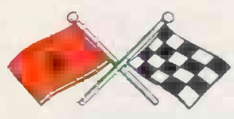

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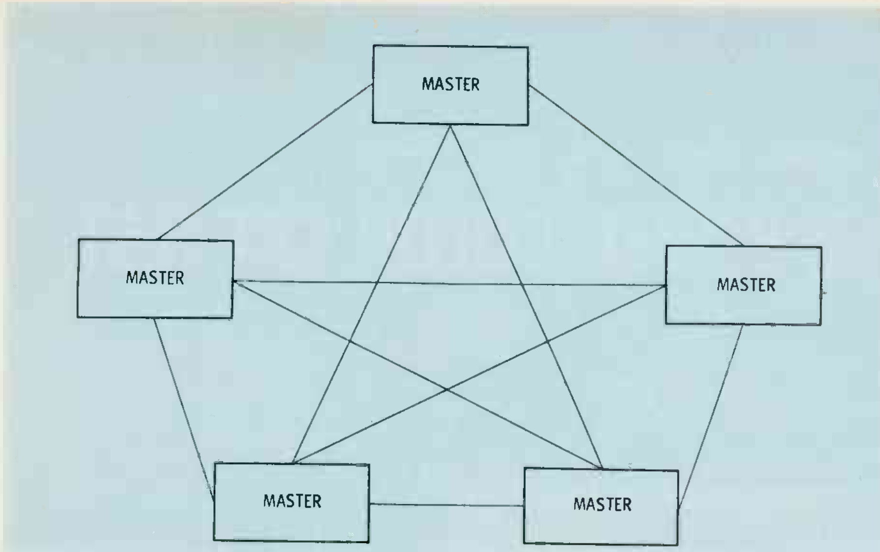

Fig. 2. Intercom system using master units at each station.

agreement on the type of system and number and location of stations, prepare a layout, such as the one in Fig. 5, to present to your customer for final approval before you make any definite statements concerning price.

There are a few pointers to keep in mind when you are selecting the location of the stations. The master station will need a source of AC, so locate it at or near an AC outlet (exception: some systems use a battery-operated transistor amplifier). Interconnecting cable should not be run near AC lines, even if the AC lines are in conduit. Reduce the risk of hum pickup by keeping the intercom cables and AC lines as far apart as practical.

There are a number of other factors to be considered in the layout of the system. Obviously, you must know something about the construction of the building or house in which the system is to be installed. A brick house has two courses of brick and only ¾" furring strips between the inner layer of brick and the plaster wall, offering very little room through which to draw cable. Only the inside walls, constructed of 2" × 4" studs, offer room for cables. A brick veneer house has one course of brick, with 2" × 4" studs in the outer as well as the inner walls. Frame houses have 2" × 4" studs in all walls.

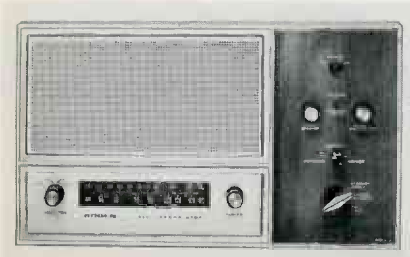

Fig. 3. Music distribution system.

Connecting the system from room to room requires running the cables up the space between studs to the attic, across the attic, and then down between studs in another wall. An alternate method is to run the cable down into the basement or crawl space, across and up into the wall between the studs again. The bottom of the studs are usually nailed to horizontal 2 × 4's (called the sole plate) which, in turn, are nailed to the flooring. Thus, you will have to drill through both the sole plate and the flooring to get into the space between studs. Similar construction is used at the top of the studs, so about the same amount of drilling will be required if you go up to the attic and over.

The toughest job is running the cable from floor to floor in a two-story house. This requires removal of the baseboard on the second floor and drilling down to the space between the studs in the floor below. Outlet holes to the stations should be drawn through the baseboard. (You will need an electrician's fish line to draw the cables through holes and spaces.)

Of course, installation is much easier in homes or buildings under construction. However, the job will probably be spread over a long period of time. In addition, the actual layout of the cable will probably have to be done by a union electrician. Indicate to the electrician where the cables are to run and, if junction boxes are used, have him leave about 3" of cable hanging out. If the cable is to run directly to the stations, have him leave about 8" of cable. Roll up the excess cable close to where it comes out of the baseboard, and enclose it in a plastic bag to keep it clean during plastering and painting, as shown in Fig. 6. After the interior is completely finished, you can return and hook up the stations.

Intercom Systems

During the planning phase of the operation, it must be determined if the complete installation is to be in-wall or on-wall, or if only the master station is to be built-in and the sub-stations on-wall. For built-in installations in new homes, you either will have to let the plasterer know where the wall outlets are to be located, or return to do the cutouts yourself after the plastering is completed and before the painting is started. Most in-wall stations hang from the plaster or wallboard, but some heavier units require wood framing for support. Also, some systems use metal boxes that can be put in by the plasterer.

If a front door station is to be part of the system installed in a brick house, it must be put in when the bricks are laid. The architect should include the box in his masonry specifications.

When a single in-wall master amplifier is centrally located and is not part of the master station, be sure the electrician provides an AC outlet where the amplifier is to be located. This should be a behind-

Fig. 4. Both radio and phonograph are included in this design.

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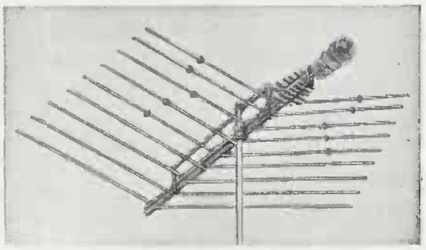

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the-wall outlet for a permanent connection. The same stipulation also applies to in-wall master stations with a built-in amplifier.

Since the output voltages from intercom amplifiers are low, it is not necessary to run the cables in conduit —unprotected cable meets electrical codes. The basic cable employed between a master and a substation is three-conductor; one wire is common, one is used for incoming, and one is used for outgoing. For convenience, most intercom systems employ multiconductor cable serving a number of stations. Some systems are designed with balanced lines and use twisted pairs. Others use shielded wire for the incoming lead; however, most do not. It is usually best to use the cable specified by the manufacturer of the equipment, even if it costs more. In most cases, the manufacturer's specified cable will assure proper operation.

You will not be faced with the problem of matching speaker impedances to the amplifier, as in public address systems. Most intercom systems utilize 45-ohm voice coil speakers. Although the amplifiers are designed to feed into a lower impedance, a near match for optimum power output is achieved when a number of speakers are connected in parallel. Since relatively little power is required for any one speaker, any mismatch associated with the system will not seriously affect the overall operation.

Music Distribution Systems

This type of system is nearly always an in-wall installation, which means additional plaster cutouts, not only for the control amplifier/tuner/record player, but also for the speakers in each room. (The plaster walls make excellent baffles for the speakers). Proper ventilation can be a problem with in-wall applications, so use transistorized amplifiers when possible—they run cooler. Also, don't forget the possibility of outdoor speakers. The cable can be run during the initial installation and the speakers added then, or if the patio has not been built or its location has not been determined, the speakers can be added later.

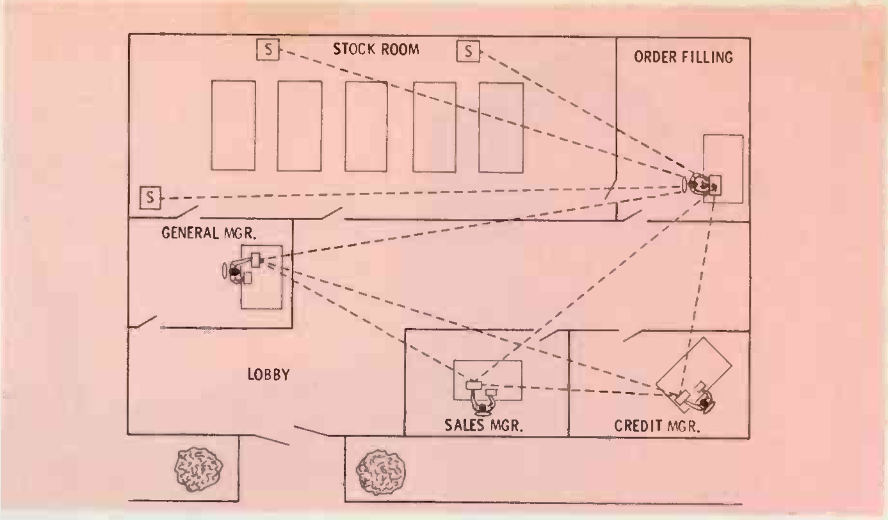

Fig. 5. Floor plan showing positions of stations and communication between each.

Industrial Installations

Installations in offices and plants are often easier than in homes. Frequently, the customer will permit you to tack the cables along the outsides of the walls. However, you will still have to go through the walls to get from one room or office to another. This will require a star drill and a lot of pounding or an easier method such as using an electric drill equipped with a carbide-tipped bit.

Schools

Most schools require that an "all-call" function be included in their intercom systems to permit the principal to make a general announcement to all classes at one time. Except for this added function and a few minor cable differences, installations in schools are no different electrically than a home or small office system. However, schools are frequently sensitive to even the most remote possibility of a fire hazard and may go beyond the requirements of local codes by demanding that the intercom cables be run in conduit.

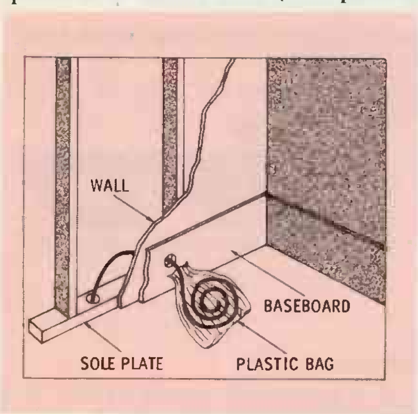

Fig. 6. Plastic bag protects cable.

Pricing

After you have sized up the job and determined what is going to be required in terms of equipment and labor, you are ready to sit down and figure out what you must charge to realize a reasonable profit.

Perhaps the most important point tó remember about pricing is to quote the customer a "package" price; don't price the equipment and labor separately. The primary reason behind this rule is that in today's marketing arrangements it is probable that the customer will be able to obtain the equipment at a price that is competitive to your "wholesale" or "dealer net." Thus, in many instances, if you are able to realize a profit on the equipment and yet retain the customer's good will, you must include your profit in the "package" price. Remember, you are not just selling the customer equipment and labor, but also your experience and knowledge. One vote of caution here concerning "package" pricing: some states regard package pricing as a form of contracting, and in order to do so you must have a contractors license.

Conclusion

Once you have familiarized yourself with the line(s) of equipment you plan to install, solicit the business and get the experience. You may quote too low a price for the first installation, but it's worth it to get the experience. After two or three installations you will be getting your share of this profitable field. ▲

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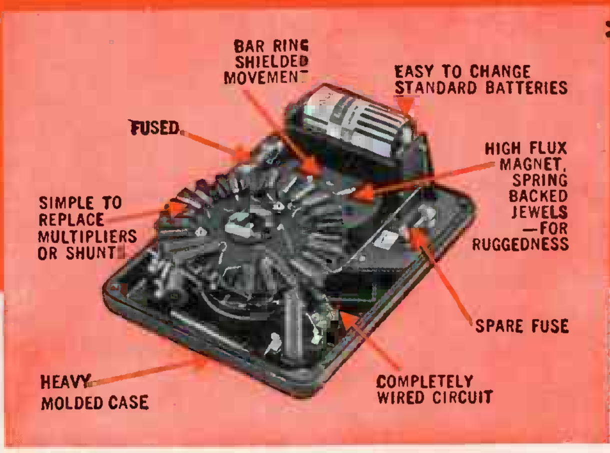

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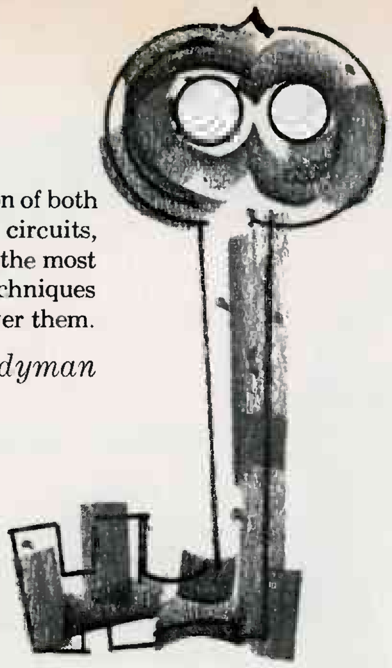

KEYED (GATED) AGC

A review of the operation of both tube and transistor AGC circuits, including an analysis of the most common troubles and the techniques used to uncover them.

by Ellsworth Ladyman

A major portion of letters requesting aid or information concerning "tough dog" situations involve either AGC or sync problems. A review of these basic circuits, along with troubleshooting procedures, should shed some light on the subject.

It is easy for a service technician to become complacent when most of the service problems he contends with are tube failure, input filter failure, defective low-voltage rectifiers, etc. Speaking from experience, a man has a tendency to quit thinking on such jobs, forgetting his knowledge of basic fundamentals and resorting to random replacement of parts when faced with a "hairy" service problem. Defects in horizontal AFC, AGC, and vertical sync circuits can indeed be "hairy" at times.

Many of the letters we receive contain information such as: "Tube element voltages all check OK"; "All components checked and rechecked, all check good"; I've changed all the parts from the yoke to sync separator, and it still rolls." This type of information is fine, as far as it goes. But the fact that a capacitor checks "good" only means that it is a capacitor and is functioning as one; it does not necessarily mean that the capacitor is functioning at a particular value of capacitance. The value of capacitors and resistors is extremely important in the design of wave-shaping circuits. The wave-shape, amplitude, and timing of voltage pulses present in vertical, horizontal, AFC, sync, and AGC circuits must be correct if the circuits are to perform properly.

An oscilloscope is a prerequisite for servicing TV receivers with trouble symptoms that indicate a defective component(s) in these circuits, or in any electronic circuit where voltage pulses trigger circuit action. A service technician who relies only on a VTVM limits his troubleshooting to measuring supply, bias, and filament voltages; checking resistors for changed values; and determining if capacitors are shorted or open.

Resistors with changed value upset time constants, capacitors with changed value distort waveforms, and in either case, operation of the circuit in question will be changed. The visual effects of this change usually will be evident on the screen of the picture tube. A look at some basic circuit configurations and a short explanation of their operation might help us understand why the shape and amplitude of waveforms are so important, and how voltage checks can be misleading when a defective component renders the stage inoperative.

Keyed AGC

Operation of the keyed AGC stage shown in Fig. 1 is as follows: Bias voltage is such that the keyer tube is cut off until signal voltages from the video output circuit and from the horizontal output transformer are applied simultaneously to the control grid and plate. When the two signal pulses (horizontal pulse to the plate and composite video to the grid) are applied

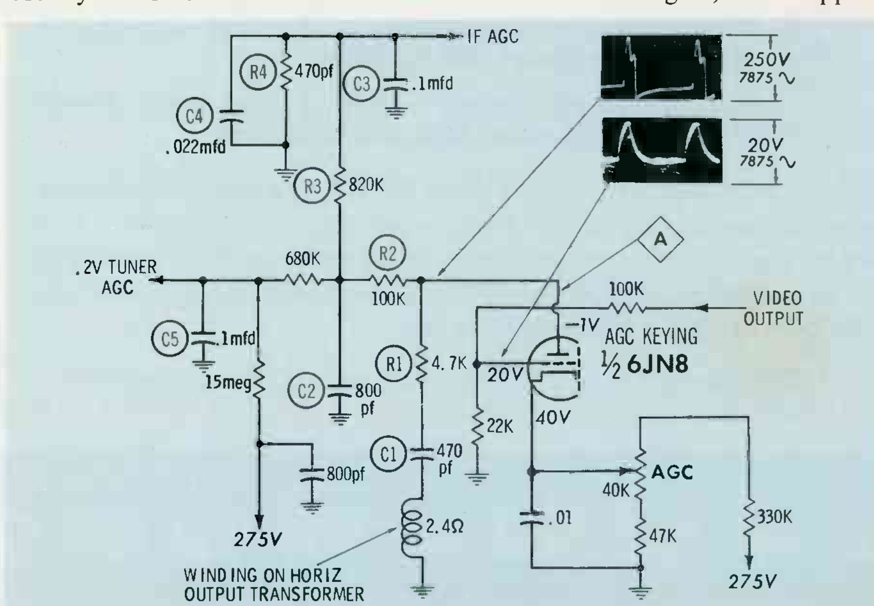

Fig. 1. Typical tube-keyed AGC system using triode.

Table I.

Reading at Point A (Fig. 1)	2nd Step in Service Procedure
1. AGC voltage is normal.	1. AGC can be considered as functioning normally.
2. Abnormally high AGC voltage	1. Usually caused by divider resistors in supply lines. Check all resistors in bleeder networks for value changes. 2. Bias voltages (grid and cathode) incorrect. Check bypass capacitors for opens; check cathode resistor for change in value.
3. Abnormally low AGC voltage.	1. Check shape and amplitude of pulse derived from horizontal output transformer. 2. Check shape and amplitude of waveform from video output circuit.

simultaneously, the plate voltage rises to a much higher potential, the grid voltage overcomes the fixed bias, and an instantaneous pulse of plate current flows. This rise in plate voltage and change in grid bias (caused by simultaneous arrival of signal pulses) must occur at the same time. Either pulse arriving by itself will not cause the tube to conduct.

When the AGC tube conducts and plate current flows, capacitor C1 charges very rapidly, but is prevented from discharging rapidly by the combined resistance of R1, R2, R3, and R4. Because of this rapid charge and slow discharge of C1, an average current flow is developed which, in turn, produces the AGC voltage. Additional filtering of the AGC voltage is accomplished by C2, C3, C4, and C5.

When a station signal with extremely stable strength is received, charge and discharge of C1 is almost nonexistent, and a constant negative AGC voltage is developed. This voltage is applied to the RF and IF stage(s) in the receiver.

When a weak signal is received, a comparatively weaker sync pulse is applied to the control grid of the AGC keyer and the control grid voltage becomes less positive. Consequently, the AGC keyer conducts less and the plate current decreases. The ratio of charge and discharge of C1 through the bleeder network changes, causing a decrease in the average current flow and, consequently, a decrease in the negative AGC voltage. The decrease in AGC voltage permits more amplification in the RF and IF stages.

Changing the channel selector to receive a station of comparatively strong signal strength results in the following actions: A much stronger sync pulse is applied to the control grid, driving it more positive. The AGC tube conducts more and the increased plate current charges the AGC capacitor. The charge-to-discharge ratio of C1 changes, and the negative AGC voltage is increased. When this increased AGC voltage is applied to the RF and IF stages, they conduct less and the amplification of the incoming signal is reduced.

Noise-Canceling Effects

In the foregoing discussion, it was noted that the AGC keyer tube will not conduct unless the proper signal pulses are applied simultaneously to its plate and grid. It was also noted that these pulses must be of the correct amplitude and polarity. The pulse applied to the plate is derived from a winding (separate or tap) on the horizontal output transformer. The pulse applied to the control grid is obtained from the video output circuit. Since both of these pulses occur during horizontal retrace and must arrive at the plate and grid at the same instant in order to cause conduction, any random, spurious pulses arriving at either the plate or grid cannot cause the tube to conduct. A spurious pulse arriving at the plate will not cause conduction because the grid bias keeps the tube cut off. A random noise pulse arriving at the grid of the AGC keyer will not produce conduction because of the extremely low value of voltage at the plate. Thus, any spurious noise pulses are prevented from reaching the RF and IF stages through the AGC line.

Servicing Procedures

The servicing of AGC circuits has always been a source of irritation to most service technicians, mainly because of difficulty in localizing the trouble to the AGC circuits. Visual indications on the picture tube screen often leave doubt as to whether the trouble is in the IF's, sync, or AGC circuits. The first step in localizing a trouble of this nature is to measure the AGC voltage. There can be three indications when you read this voltage: (1) AGC voltage is normal, (2)

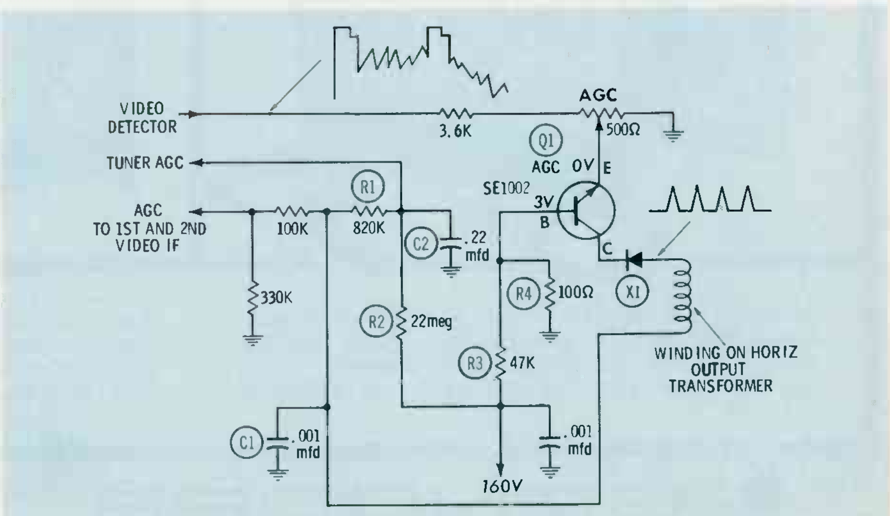

Fig. 2. Transistor-equipped AGC system employed in hybrid chassis.

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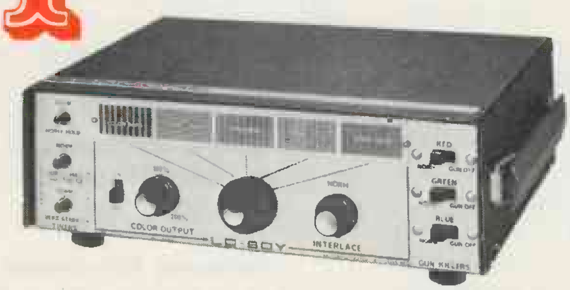

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AGC voltage is abnormally high, (3) AGC voltage is abnormally low. The next step in the servicing procedure is determined by which of these three indications you received. Table 1 lists the steps to be taken with each indication.

Hybrid Designs

Hybrid television receivers usually use a transistor in the AGC circuit. Transistors used in this function can be connected in a common-emitter configuration because the output is applied to the high impedance offered by the grids of the electron tubes in the RF and IF circuits.

The basic operation of the hybrid TV AGC circuit in Fig. 2 is as follows: Video signals from the video detector are applied to the emitter. The base is fixed biased, while the collector is pulsed or keyed from a winding on the horizontal output transformer. When the video signal is impressed on the emitter, the forward bias of the transistor increases and, consequently, the collector current increases. As the collector current flows through the external collector circuit, the voltage drop across R2 becomes more negative and an increased negative voltage is applied to the IF and RF stages via their respective AGC lines. Filtering and smoothing of the keyer output is accomplished by C1, C2, and R1.

This circuit, like all AGC circuits, has one basic function: To sample the video signal and produce a regulating voltage that is used to keep the gain of the RF and IF amplifier stages constant, thus providing a video output signal that is relatively independent of the strength of the received signal.

Waveform, DC voltage, and resistance measurements are all beneficial when servicing defects in this circuit. One inherent trouble symptom associated with this circuit is "negative picture." Some possible causes of "negative picture" are: shorted C1 or C2, open X1, defective AGC control, value changes of components, and faulty transistor (Q1). The main problem in troubleshooting this circuit, as with nearly all AGC problems, is in localizing the defect to the AGC circuit.

Transistor AGC Circuits

AGC circuit action in television receivers employing transistors differs from that of tube-type receivers. In tube-type receivers, the characteristics of the tubes (remote cutoff types) allows the tube to be biased to a level that requires simultaneous application of pulses from the video and horizontal output circuits before conduction will occur. The amount of conduction is dependent on the strength of the incoming pulses; therefore, the average plate current flow fluctuates in accordance with the strength of incoming signals.

This type of action is somewhat more difficult to accomplish in transistor circuitry. Characteristics of transistors are usually described as "sharp cutoff"; consequently, the design of a transistor circuit to regulate the stage gain of RF and IF amplifiers is a little more complicated.

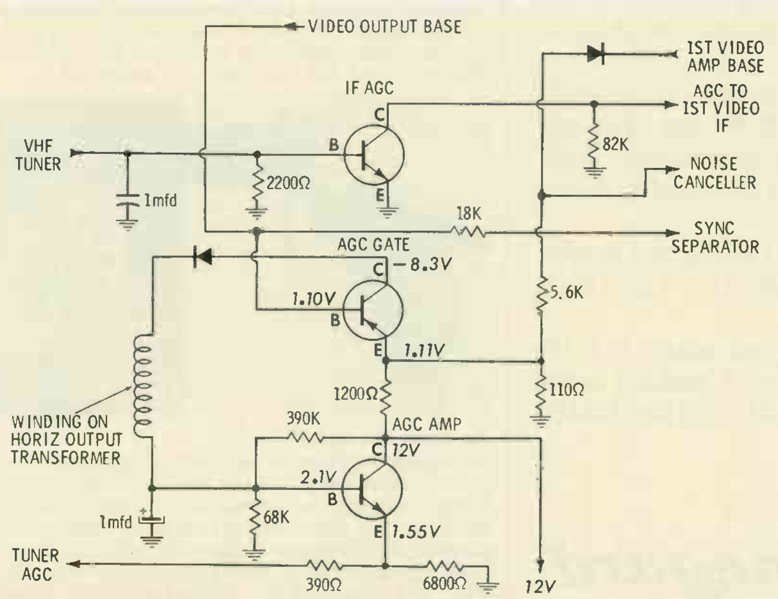

Fig. 3. Multistage AGC system required by transistor chassis.

As mentioned before, the purpose of any AGC system is to sustain constant voltage at the input of the final video amplifier stage, regardless of the signal strength at the antenna. Most transistor receivers accomplish this by controlling the gain of the RF amplifier and 1st video IF amplifier stages. This is done in the RCA KCS156 chassis (Fig. 3) in the following manner:

As the signal level increases at the antenna, the output of the video amplifier increases. Horizontal pulses from the horizontal output transformer arrive at the collector at the same time that pulses from the video amplifier arrive at the base, causing the AGC gate transistor to conduct. The long time constant of the AGC gate output circuit sustains the positive voltage during horizontal scan time. To prevent the collector-to-base junction of the AGC gate from becoming forward biased by the AGC voltage, a diode is connected in the AGC gate collector circuit. The AGC voltage is then applied to the RF AGC amplifier and, subsequently, to the RF amplifier stage.

The RF amplifier has two purposes: (1) to amplify the incoming RF signal and (2) to amplify and couple the AGC voltage variations to the IF AGC amplifier. The IF AGC amplifier then amplifies and couples the signal to the first video IF amplifier as reverse bias, reducing the gain of this stage in accordance with the strength of the AGC voltage. The stronger the AGC voltage, the more the gain of the first video IF is reduced. This circuit maintains a fairly constant signal level at the emitter of the 1st video amplifier transistor over a comparatively wide range of input signal levels.

The gain of a transistor amplifier circuit can be reduced by either forward or reverse bias. In the case of the RF amplifiers in Fig. 4, the gain is reduced by applying forward bias voltage; and in the video IF stage, the gain is reduced by applying reverse bias voltage. ▲

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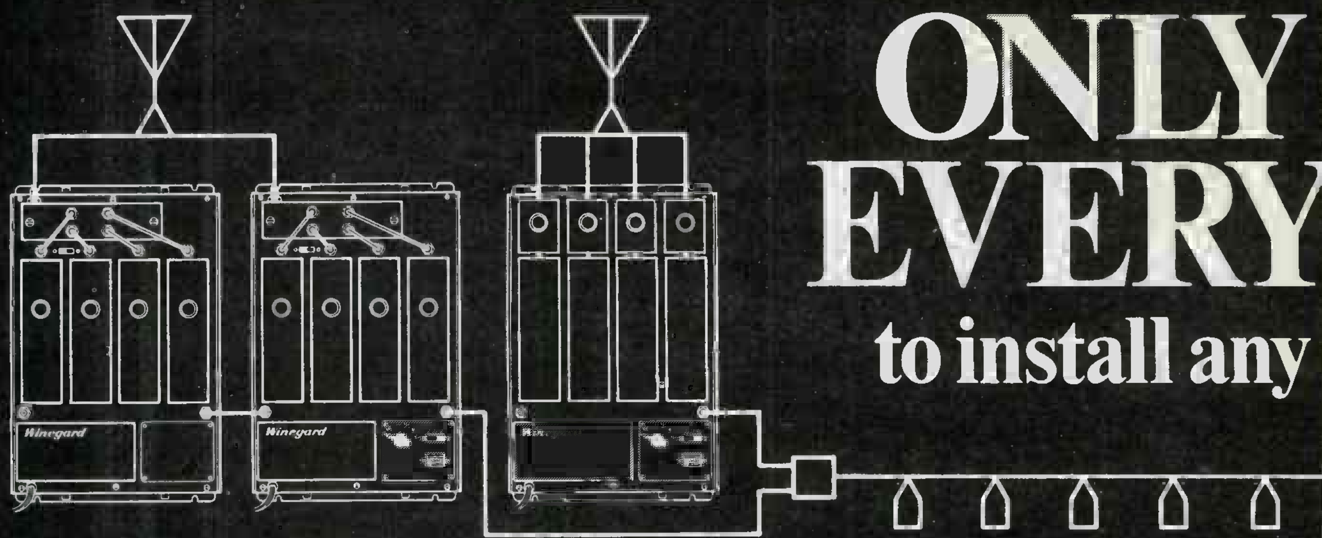

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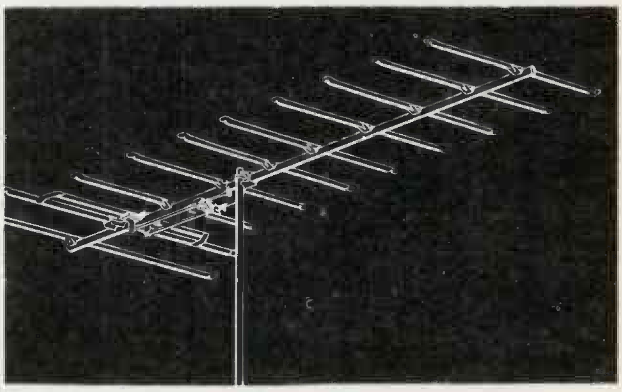

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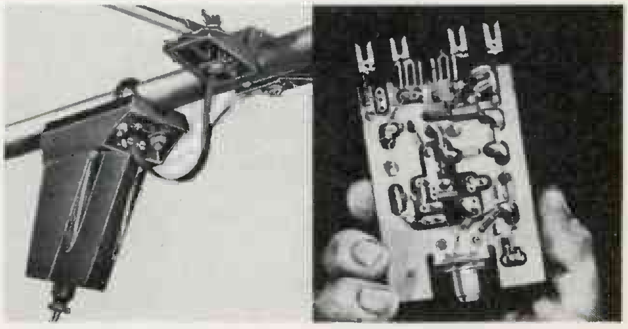

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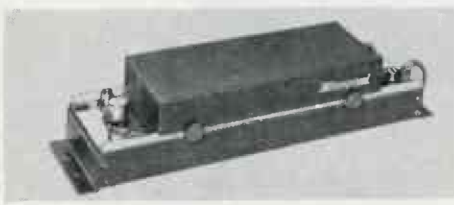

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Line splitters divide the tv signals on a trunk line into equal parts and, when properly used, greatly increase the number of taps in a tv distribution system. Winegard line splitters have very low insertion loss, low VSWR and high isolation between outputs to insure perfect transmission of color tv signals.

TV Signal Equalizers

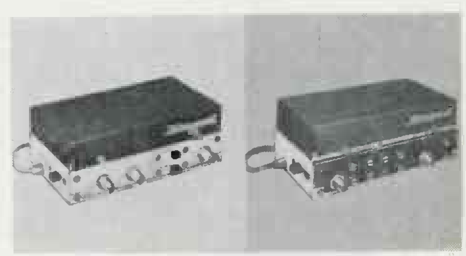
Broad band distribution amplifiers operate most efficiently when input signals are equal and total picture carrier signals are the specified level. Winegard makes equalizers that can couple and equalize up to four low band or FM single channel antennas—or couple and equalize up to four high band single channel antennas.

Variable Isolation 82-Channel Line Drop Taps

Drop taps allow the system designer to layout trunk lines in a straight line and operate outlet devices in remote locations with feeder lines. Variable isolation control from 10 to 25 db, with fast, easy adjustment, makes it unnecessary to specify and order several fixed values of tap to best utilize signals at the end of each trunk line.

Variable Isolation 82-Channel Line Tap Offs

All Winegard line taps have 82-channel capability, and can be used for VHF, UHF or FM or any combination of the three. The variable isolation feature enables the installer to independently vary the VHF and UHF isolation values from 10 to 25 db through simple adjustment of "wiper arms" located at front of tap. Use of 82-channel line taps insures that a system cannot become obsolete regardless of what channels are later added to the system. Flush and surface mounts.



Solid State Booster-Couplers

Winegard offers several transistorized booster-couplers which will handle up to 4 TV/FM outlets or sets from a single antenna —up to 16 sets using 75 ohm outlets. Seven different models: some for channels 2-13 plus FM, some for channels 2-83 plus FM. Built to finest commercial quality standards. Available in both 300 and 75 ohm models. Extremely high (500,000 microvolt) input eliminates overload problems.

82-Channel + 25 db Amplifier

New "color system" amplifier is ideal for home and smaller systems. Solid state, printed circuitry with excellent stability. Can't become obsolete when new channels come on the air. By adding Winegard's unique line amplifiers, you can lay out and install most systems without calculations of any kind. Separate VHF and UHF inputs and power for VHF and UHF preamplifiers. Easy to customize each installation to exact signal conditions.

Plus...UHF single channel converters, antenna and back-of-set matching transformers, band separators, interference rejection filters, etc.

Circle 17 on literature card

Book Review

FET Circuits: Rufus P. Turner; Howard W. Sams & Co., Inc., Indianapolis, 1967; 160 pages, 5½ x 8½", soft cover; $3.25.

An interesting book for the technician who likes to build or modify his test equipment. It is equally valuable to the Ham, CB'er, Hi-Fi addict, and other electronic hobbyists.

Mr. Turner devotes the first chapter to the fundamentals of the FET. This section is 10 pages of field-effect theory, geometry, history, and ratings.

With the necessary theory out of the way, we move to amplifier circuits. There's 22 pages here, and 18 circuits are shown. All circuits include complete parts data, so the reader can duplicate them as projects. Included in the chapter on amplifiers are: a simple small-signal AF preamplifier, AF source follower, two-stage RC-coupled AF amplifiers, transformer coupled amplifiers, phase inverters, audio mixers, audio bandpass and band-reject amplfiers, video amplifiers, IF amplifiers, etc.

Chapter 3 deals with oscillator circuits. Twelve circuits are shown, ranging from AF oscillators to HF crystal oscillators. Analyzing these circuits, the reader immediately perceives that FET's can be substituted for tubes in nearly all triode applications.

Chapter 4 is titled "Receiver and Receiver - Accessory Circuits." The first circuit shown is a basic broadcast-band superhet receiver. There are several interesting innovations, including the use of ceramic filters instead of IF transformers. Other circuits in this chapter include crystal converters, BFO's, a Q-multiplier, and a squelch circuit.

Chapter 5 deals with transmitters and accessories. Several flea-powered transmitters are shown, as well as frequency multipliers, a balanced modulator, and two monitors.

Control circuits are explained in Chapter 6. Among the projects are every kind of controlled relay imaginable, from VOX to light-operated. Also shown is a modulated-light detector/amplifier.

The last chapter covers instruments. Circuits are shown for nineteen different test instruments, from voltmeters to light meters. Included is a circuit for a direct-reading audio-frequency meter. This instrument employs two FET's and eighteen resistors and capacitors, covering 0-100 kHz in four ranges.

Included in the appendixes are basing diagrams and source guides for all the FET's mentioned in the text. ▲

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FINCO MODEL #65-2
Distribution Amplifier $39.95 list 2-tube 4-output VHF-TV or FM Distribution Amplifier for 75 OHM CO-AX Operation, providing 6 dB gain at each 75 ohm output to feed deluxe home or commercial systems.

FINCO MODEL #65-6
Amplifiers $79.95 list. VHF-TV Antenna Mounted two-transistor preamplifier with 75 OHM two-tube Single Output Distribution Post-amplifier up to 30 dB gain for improved reception. Used in home or commercial installations to feed multiple sets.

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Circle 20 on literature card

NOTES ON TEST EQUIPMENT

analysis of test instruments ...operation...applications

by T. T. Jones

CRT Cadet

The new CRT tester/rejuvenator shown in Fig. 1 is SENCORE's Model CR13. It's an update of the older model CR133. Several improvements have been incorporated, including the use of a more rugged heater transformer. It is no longer necessary to have a separate switch position for color tubes. The new heater transformer has only seven windings; some of the voltages formerly furnished have been considered to be unnecessary. The voltages actually furnished are given in the table.

Table 1

Switch Position	Actual Voltage
2	2.3
4	4.2
5	4.7
6	6.3
8	8.4
12	12.6

Another new feature is the added sockets, one for the GE 11SP22, and one for 7-pin portables. This latter we think has been long overdue. These small-size 7-pin CRT's have been around for several years, and it's surprising that only in the last few months have the equipment manufacturers begun to incorporate sockets for them in CRT testers.

The CR13 performs all essential tests on both color and B-W CRT's. For an analysis of the circuit, see

SENCORE CR13 Specifications

CRT's tested:
All presently manufactured TV types, both color and B-W.

Tests performed:
Interelectrode shorts; emission; cutoff; life; color gun balance.

Corrective functions:
Rejuvenates cathode; removes cathode-to-grid shorts; welds open cathode.

Features:
Variable G1 and G2 voltages; line voltage compensation; replaceable plug-in socket cables; automatically controlled rejuvenation and weld.

Size (HWD):
10¼" × 10¾" × 4¼".

Weight:
8½ pounds.

Power Source:
105-125 VAC, 50-60 Hz, 23 watts.

Price:
$79.95.

Fig. 1. SENCORE's CRT Cadet.

"Notes on Test Equipment", Feb. and Sept., 1965.

The tester is housed in a black vinyl-covered steel case. It's quite rugged, yet weighs a pound-and-a-half less than its predecessor.

Transistorized Voltohmmeter

The model designation on Triplett's new FET meter leads us to believe there's more to come. Fig. 2 shows this meter, the Model 600 Type 1. Remembering the Model 630, with all its variations, we wonder just how far the Triplett engineers intend to go with this one. In any event, the Type 1 is a first-rate meter and may well be the start of a new family.

The instrument (Fig. 2) is a completely new concept in design, and resembles nothing that Triplett has produced heretofore. The styling is eye-catching, with a modern high-impact plastic case. The leads are streamlined and compact, through the use of an RCA-type phono jack for the signal lead. The signal probe has a switch to select either

Fig. 2. Model 600 Type 1 FET meter.

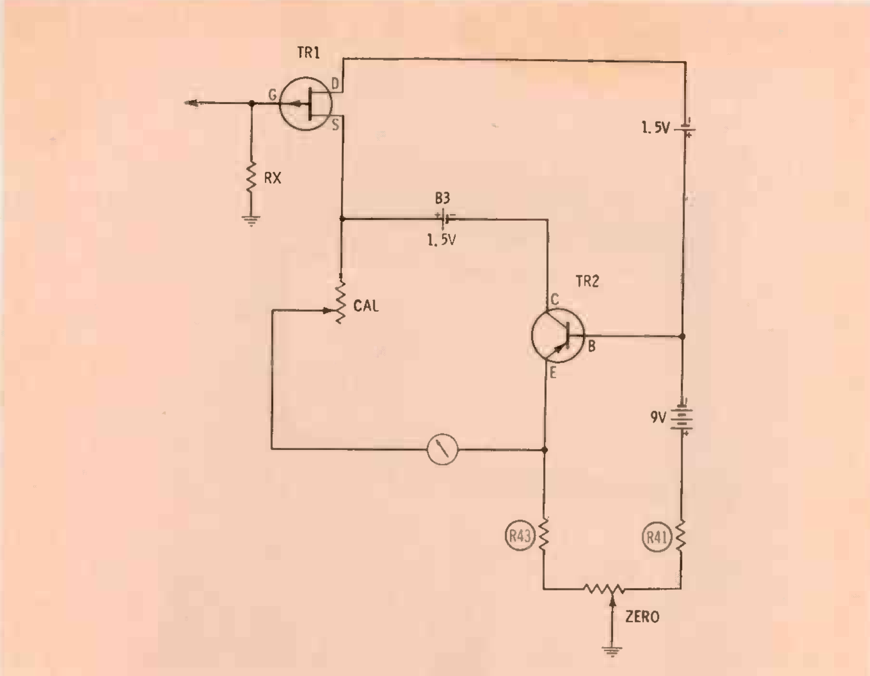

Fig. 3. Simplified schematic of the FET meter.

Triplett Model 600 Type 1 Specifications

DC Voltmeter

Ranges:
0-.4, .8, 1.6, 4, 8, 16, 40, 160, 400, 1600V.

Input Resistance:
2.75MΩ at .4V, 5.5MΩ at .8V, 11MΩ remainder of scales.

Accuracy: ±3%.

AC Voltmeter

Ranges:
0-4, 8, 16, 40, 160, 400, 800V.

Input Impedance:
.75MΩ minimum.

Accuracy:
±3%.

Ohmmeter

Ranges:
0-1K, 10K, 100K, 1M, 10M, 100MΩ with 10 center.

Voltage:
1.06V on 100MΩ, 1.47V on 10M, 1.5V remainder of scales.

Accuracy:
Unspecified.

Size (HWD):
6½" × 5½" × 3½"

Weight:
2½ pounds.

Power requirements:
One size D cell, two size AA cells, one 9-V volt #216 cell.

Price:
$78.

DC or AC-ohms measurements, yet it is only 7/16" diameter.

The basic circuit is shown in Fig. 3. Rx is a lump representation of the multiplier resistors, all of which are 1% tolerance units. The input is fed to the gate of TR1, the FET. The drain of the FET is connected to the base of TR2, which in turn has its output connected to the source of TR1. The result is a stabilized circuit, relatively insensitive to changes in supply voltage and ambient temperature. The circuit arrangement also tends to raise the input impedance of the FET, which is already quite high.

The meter is actually reading two voltage; that produced by the source current of TR1, and also the collector-emitter voltage on TR2. R43 and R41 are hand-picked resistors, chosen to match the FET parameters so that the TR2 emitter-collector voltage is 1.5 volts under zero input conditions. B3 is inserted to buck out this voltage, so the meter reads zero.

Putting the Model 600 Type 1 through its paces in the lab, we quickly found that the meter leaves little to be desired. Inserting the batteries was a snap, and this is often not true of modern battery-operated equipment. There's one large thumbscrew in the rear which, when removed, gives access to the battery compartments. The instrument uses one size D cell, 2 penlight cells, and one 9-volt #216 cell. These are all common-type cells, usually for sale at your front counter. We purposely left the meter on overnight with a mid-scale reading, to see how quickly the batteries ran down. After 18 hours, the needle had not perceptibly moved. Characteristics of the transistors indicate that the battery consumption under normal usage should be little more than shelf-life.

We ran some frequency response checks in the lab since the manual gave only a response range (15Hz to 2 MHz) rather than an accuracy figure. The meter proved acceptable for audio work. From 20 Hz to 20 kHz there was a gradual rise in readings, about ±1 dB with 1.5 kHz reference. Above 20 kHz the meter seemed to flatten out, and climbed only about 1/10 dB in the next 500 kHz. (We did not measure above 500 kHz.)

DC measurements were simple. All the ranges were useful, but we would trade the .8V range for an 800V range. Many TV sets have voltages between 400 and 600 volts, and these voltages appear a bit cramped on the top scale.

The ohmmeter is setup on the most popular linearity configuration, with a 10 center. On the lowest range it is possible to read .2 ohm; the highest reading is 100 Megohms. In an interesting though not new variation, zero ohms is on the left end of the scale, the same as zero volts. Whether this is easier to use depends on the operator's preference, but we like it.

Also included in the Model 600 is a zero-center scale which is actually readable. Many of the meters presently on the market omit this scale; others include it as an after thought so that it's not really convenient to use. The usefulness of a center-zero scale becomes apparent when you attempt to align a discriminator stage.

The internal construction of the Model 600 Type 1 shows careful engineering and assembly. The circuit board is epoxy-fiberglass, a very rugged material. All components are laid out in neat rows, and each is mounted so the value may be easily read. The instrument should be very easy to service, should it become necessary. ▲

 (Continued from page 23)

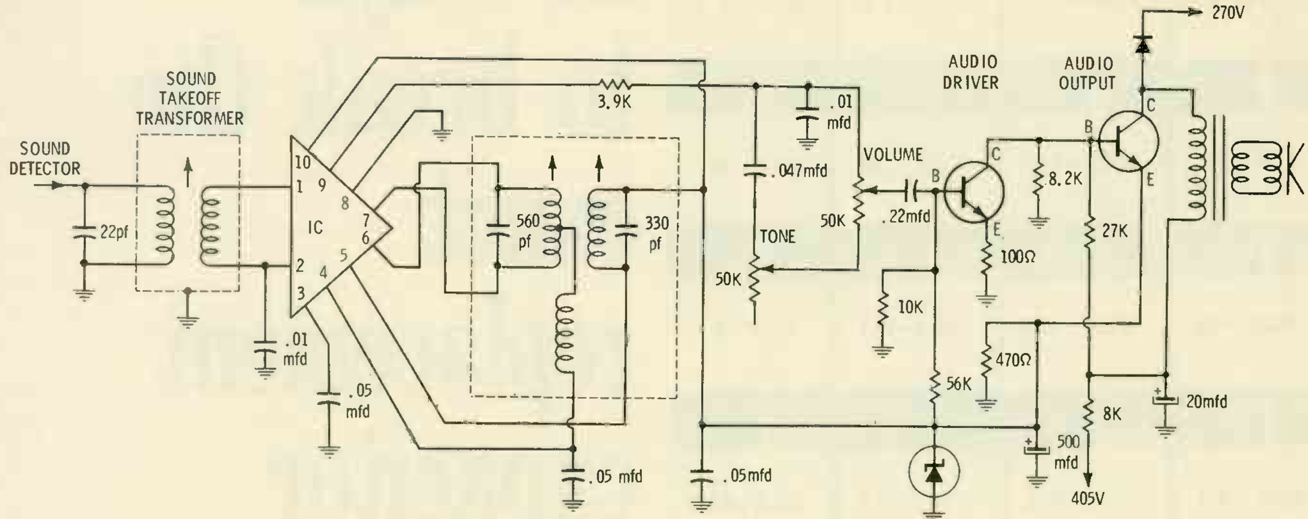

Fig. 20. Catalina's solid-state sound system utilizes IC in IF amplifier and detector stages.

Tuning and Indicator Circuits

Automatic frequency control of the VHF and UHF tuners employed in Admiral's 23" color models (Chassis 4H12) is accomplished by the new AFC circuit shown in Fig. 22. This system samples the video IF carrier (45.75 MHz) and develops a correction voltage that corresponds to any deviations from this frequency.

The video IF carrier is amplified by Q1, the AFC transistor, and is then coupled to the discriminator circuit via two paths. One route is through loosely coupled coils L1 and L2. The other path is from the top of L1 through C1 and C2 to diodes X1 and X2. With the receiver correctly tuned (video IF carrier exactly 45.75 MHz), both discriminator diodes will conduct equally and, since their load resistors are connected so that their outputs add algebraically, no AFC correction voltage will be developed.

When the fine tuning is not properly adjusted, or if the local oscillator in the tuner drifts, the phase of the signal across L2 will shift, causing diodes X1 and X2 to conduct unequally, developing a correction voltage across their outputs. If the video IF carrier shifts downward, diode X2 will conduct more and a negative correction voltage will be developed. An upward shift in the frequency of the video IF carrier causes diode X1 to conduct more, producing a positive correction voltage.

The correction voltage is applied to both tuners, as shown in Fig. 23. Although an NPN transistor is used in the AFC circuit of the VHF tuner, it is connected so that its base-to-collector junction functions as a diode. Changes in the AFC correction voltage produce corresponding changes in the capacitance of the base-to-collector junction. Since the

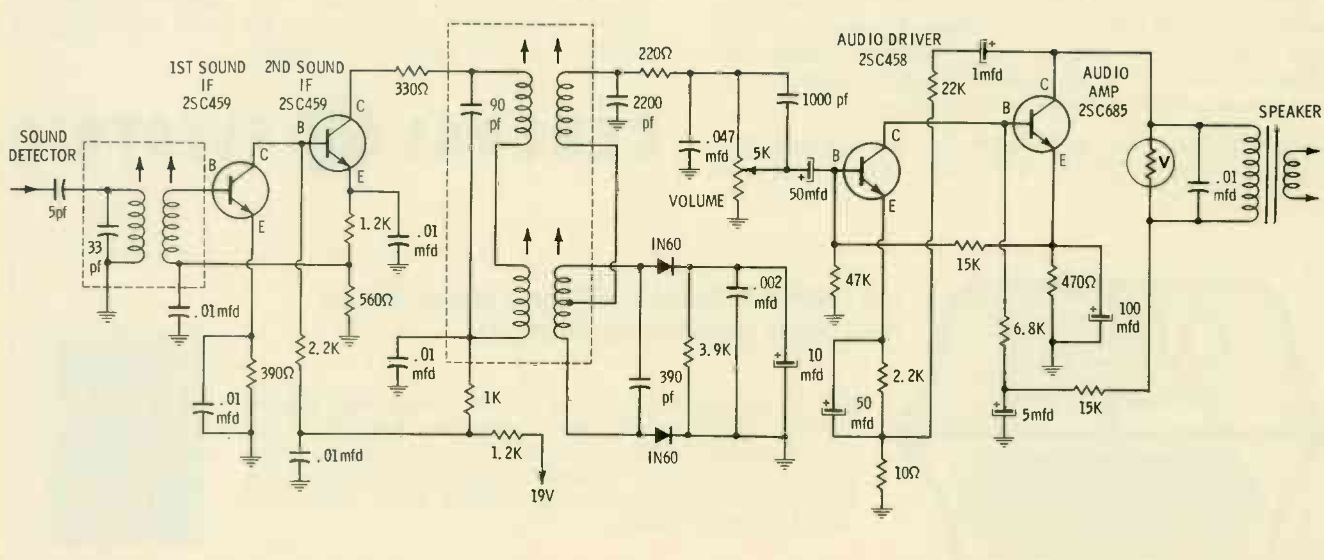

Fig. 21. Sound circuitry of Delmonico/Nivico's 18" chassis is also solid-state.

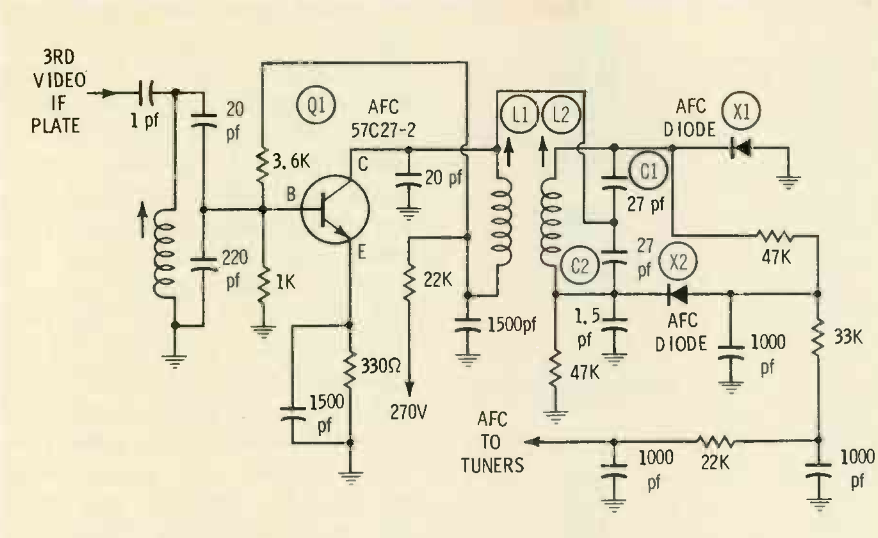

Fig. 22. Solid-state circuitry of Admiral's new tuner AFC system.

transistor is connected across the oscillator tank circuit, the varying capacitance of the junction produces changes in the oscillator frequency. Automatic frequency control of the UHF oscillator is accomplished in the same manner, although a diode is used instead of a "diode-connected" transistor. The AFC system can be disabled by a switch located on the front control panel. For correct tuning, it is recommended that the AFC on-off switch be placed in the off position while "roughing in" the fine tuning with the manual control, then switched to the on position for AFC action.

Six of the new models in Coronado's '68 color line employ the lamp-type fine tuning indicator circuit shown in Fig. 24. This circuit is an "AND" configuration requiring the presence of both the video

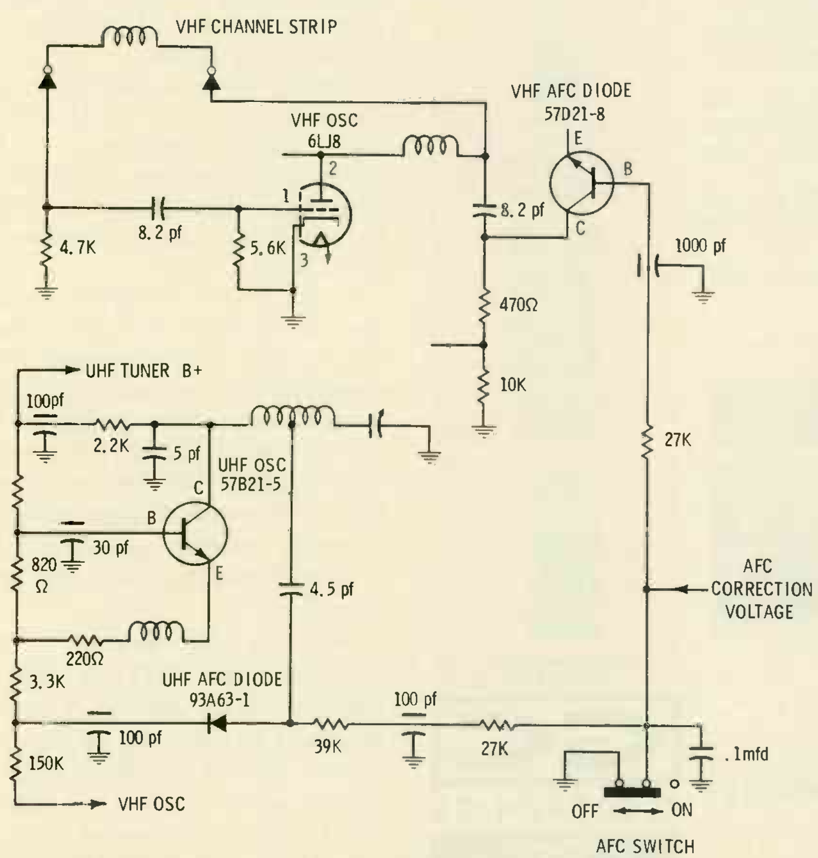

Fig. 23. AFC application in Admiral's VHF and UHF tuners.

IF carrier signal and a pulse from the horizontal output system before the indicator light is illuminated. X1 rectifies the video IF carrier signal and forward biases Q1 into conduction. Q1, in turn, forward biases Q2, which conducts only when a horizontal sync pulse is applied to its collector circuit. The necessity of this "keying" action results from the fact that the video IF carrier level fluctuates with the modulated signal impressed on it and is at a constant level only during the horizontal sync pulse time. Thus, the use of a keyed circuit prevents the indicator light intensity from fluctuating because of modulation-produced video IF carrier level changes. R1, the indicator sensitivity control, is properly adjusted when maximum carrier level does not saturate Q2 and, therefore, the intensity of the indicator light.

Some Emerson models are equipped with an automatic fine tuning (AFT) circuit. This particular AFT system is designed around the now familiar discriminator circuit. Operation of the system is nearly identical to the previously described AFC system. Other manufacturers using the basic discrimination-type tuner AFC systems are Sylvania and Zenith.

Twelve General Electric models continue to use the "Meter-Guide" tuning system introduced in last year's color models. This system detects the video IF carrier, amplifies it with a transistor amplifier and feeds it to a meter.

Seven models in Hoffman's new line are equipped with the transistorized color indicator circuit (Colorcaster) that has been used in this manufacturer's color models for the past two years. During color reception, the gated DC transistor amplifier of this system is triggered by the bandpass amplifier and fires three neon bulbs that illuminate the color controls.

Motorola also employs a fine tuning indicator (FTI) in their all-transistor color chassis. A voltage doubler (X1 and X2 in Fig. 25) detects the 45.75-MHz video IF carrier, converting it to a positive DC voltage that forward biases a two-stage DC amplifier. A feedback path via R1 saturates both DC am-

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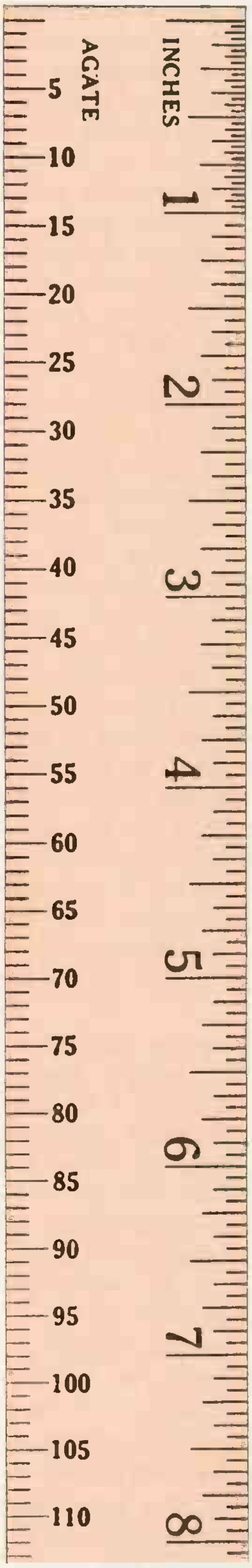

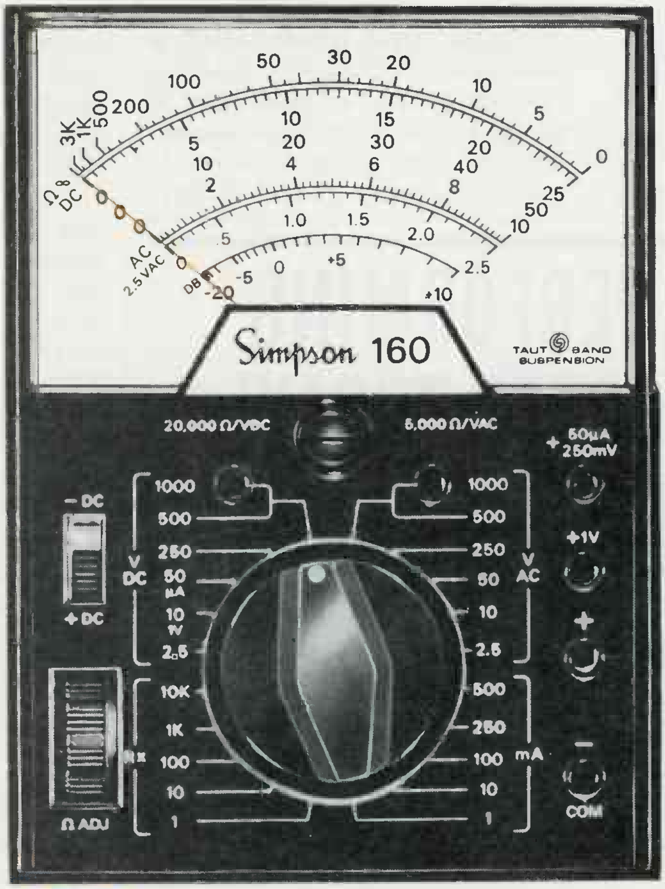

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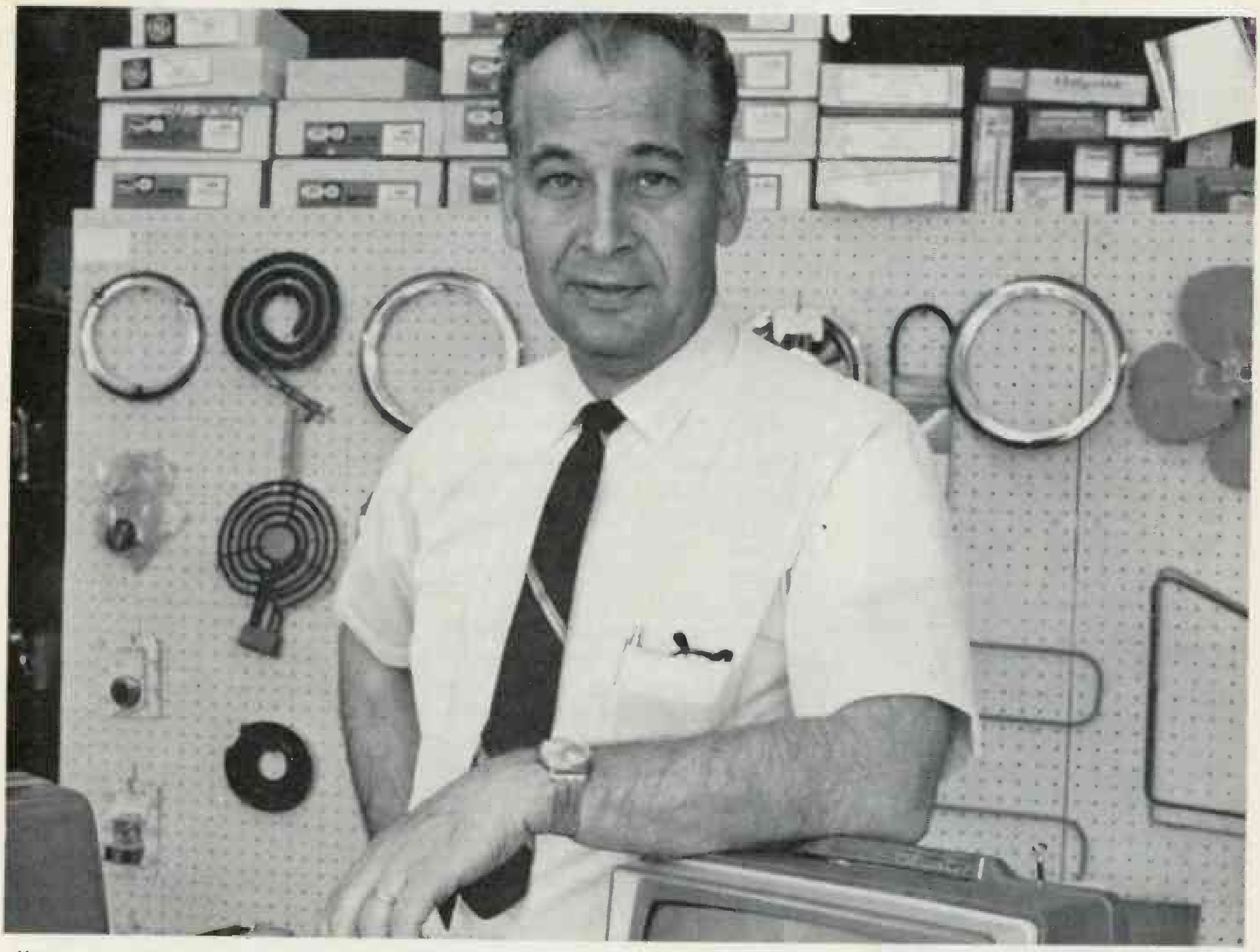
plifiers which, in turn, triggers the output amplifier. Conduction of the output transistor completes the ground path for a panel light operated from a 55-volt DC source. When the receiver is properly tuned, all three DC amplifiers are saturated and the panel light remains on.

RCA has introduced a new integrated circuit (IC) automatic fine tuning (AFT) system in their top-of-the-line CTC30 color chassis. The new circuit, shown in Fig. 26, employs a single IC that performs the functions of IF amplification, detection, and differential DC amplification. Operation of the circuit is similar to the transistor AFT system introduced in the CTC21 chassis in June '66. A portion of the video IF carrier is amplified and fed to a discriminator circuit. The discriminator output is delivered to a differential amplifier that produces two voltages, the difference of which is the correction voltage. When the video IF carrier is exactly on frequency (45.75 MHz), there will be no difference in the two voltages and no correction voltage is developed. However, when the video carrier deviates from 45.75 MHz, one output will increase or decrease in relation to the other, depending on the direction of carrier deviation. A maximum differential voltage of ±9 volts is possible with this system, providing nearly twice the pull-in range of the transistor system. A customer AFT defeat switch is located on the receiver front control panel, in addition to the normal defeat provided during channel switching and manual fine tuning (depressing the spring-loaded VHF fine tuning switch defeats the AFT). Some RCA models continue to use the transistor AFC system introduced in the '67 color model line.

The most unique tuning indicator introduced for the coming year is Westinghouse's "on-screen tuning bar" that uses the CRT itself as the visual indicator. Depressing a button labeled "tuning bar", located on the front control panel, produces two black vertical lines on the screen. One is a stationary reference line down the center of the screen and the other is displaced from it to indicate that the receiver is mis-tuned. Rotating the fine tuning control causes the two lines to converge when the set is properly tuned. A functional block diagram of the transistorized circuitry employed in this system is shown in Fig. 27.

The reference bar on the CRT is generated by the marker multivibrator which produces a 25-volt negative pulse of short duration each time it is keyed by the comparing multivibrator. The purpose of the comparing multivibrator is to delay the horizontal sync pulse exactly one-half of the horizontal scan interval to produce the reference bar and a variable amount to produce the indicating bar. It consists of two transistors in a free-running multivibrator circuit which is synchronized by the horizontal sync pulses. When it is generating the delay for the reference pulse, its output is symetrical, that is, the two half-cycles are of equal duration. The end of the first half-cycle is used to key the marker multi-

Customers wear out the Yellow Pages getting to New Haven Appliance



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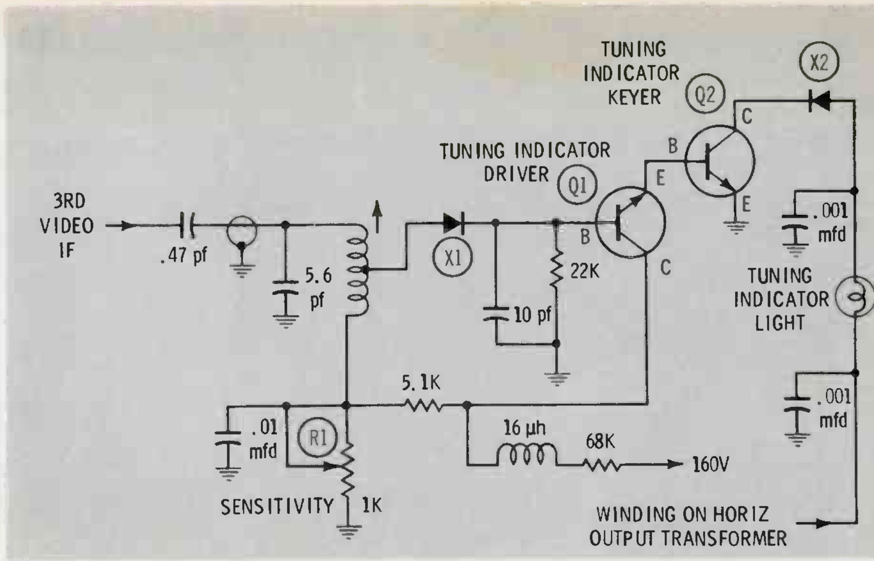

Fig. 24. Coronado's lamp-type fine tuning indicator circuit.

vibrator, and so the video pulse appears on the CRT at the center of the horizontal scan. A bias adjustment, labeled "pulse position adjustment", is used to center the reference bar.

Two other signals are applied alternately to the comparing multivibrator. During one vertical scan of the CRT, bias voltage from the "reference voltage adjust" potentiometer is fed through the gate circuit and operates in conjunction with the "pulse position" adjustment to control the delay of the comparing multivibrator, and the position of the reference bar. During the next vertical scan, the output of the peak detector (error signal) is applied to the comparing multivibrator through the gate circuit in lieu of the voltage from the "reference voltage adjust" potentiometer. If the receiver is correctly tuned, the voltage to the comparing multivibrator remains the same and the reference bar and the indicator bar are superimposed on each other.

The vertical gating multivibrator is a 2:1 counter synchronized by the vertical sync pulses. Thus, the gate circuit applies the reference signal and error signal to the comparing multivibrator on alternate vertical scans.

The error signal is generated in the top four blocks of Fig. 27. The slope detector is essentially a discriminator which develops a DC voltage proportional to the difference between the actual IF frequency and the correct IF frequency of (45.75 MHz). This voltage is added to the horizontal sync pulses (of constant amplitude), passed through the buffer, amplified by

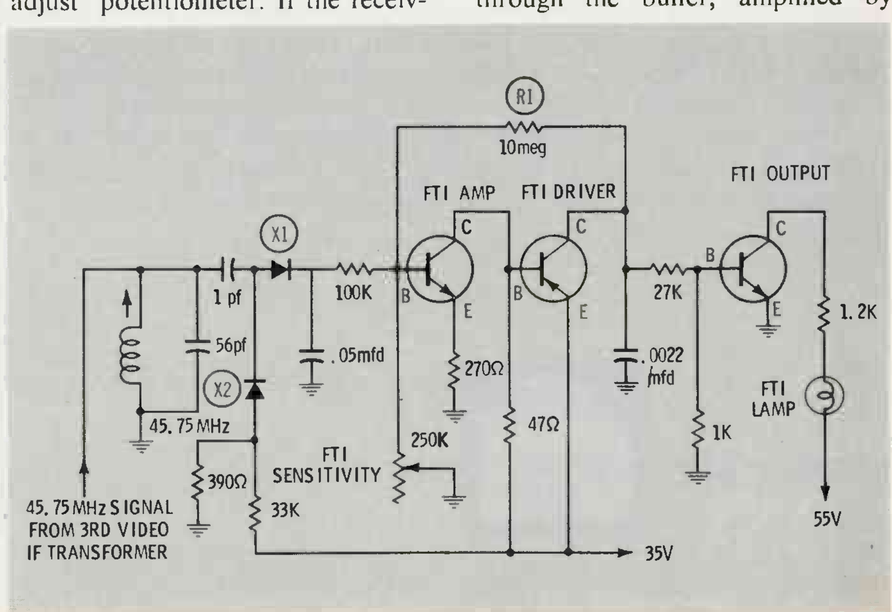

Fig. 25. Fine tuning indicator circuit employed in Motorola chassis.

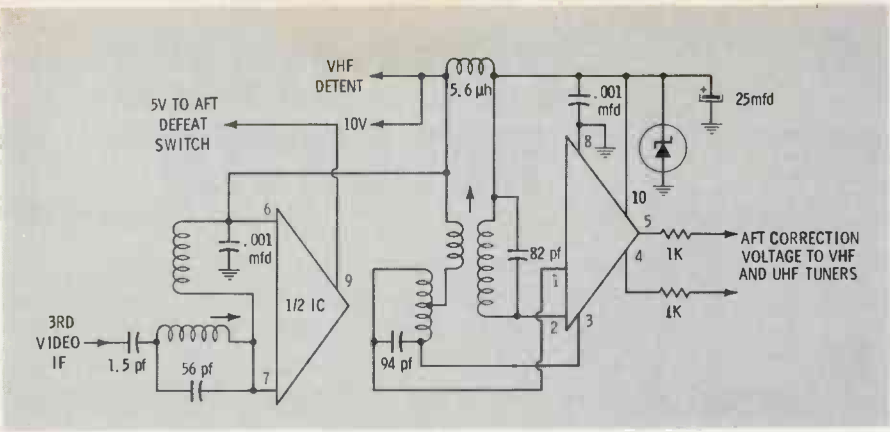

Fig. 26. Integrated circuit is used in RCA's new automatic fine tuning (AFT) system.

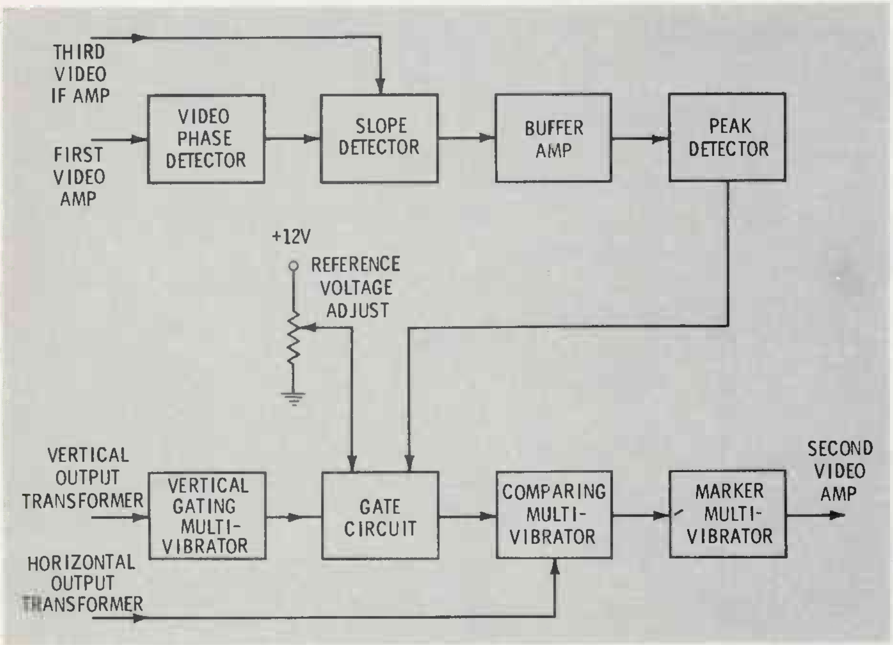

Fig. 27. Block diagram of Westinghouse's "on-screen tuning bar" system.

the peak detector and, finally, integrated to a DC level in the output of the peak detector.

Philco and Setchell Carlson are also on the list of manufacturer's who employ fine tuning indicator systems in their '68 color chassis. Philco is using the eye-type system they introduced in their '67 models, while Setchell Carlson employs a lamp-type indicator. Olympic has included the familiar "Colorglide" color indicator circuit in their new chassis. ▲

"He's my best customer. When he says the picture is lousy, it's lousy"

PHOTOFACT™ BULLETIN

PHOTOFACT BULLETIN lists new PHOTOFACT coverage issued during the last month for new TV chassis. This is another way PF REPORTER bring you the very latest facts you need to keep fully informed between regular issues of PHOTOFACT Index Supplements issued in March, June, and September.

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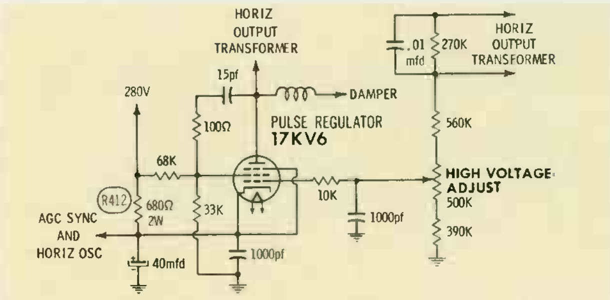
COLOR COUNTERMEASURES

SYMPTOMS AND TIPS FROM ACTUAL SHOP EXPERIENCE

Chassis: RCA CTC22

Symptoms: Intermittent horizontal and vertical sync; similar to AGC trouble. Brightness control acts like AGC control.

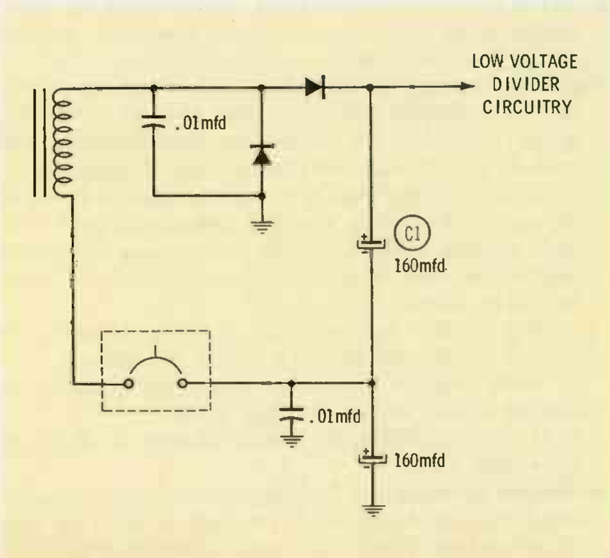
Tip: Trouble of this nature in several CTC22 chassis was caused by an open R412 (680 ohms, 2W) in the cathode of the pulse regulator stage. R412, in addition to serving as the cathode resistor, doubles as a B+ dropping resistor. Several other circuits—including sync and AGC—receive their operating voltage via R412.

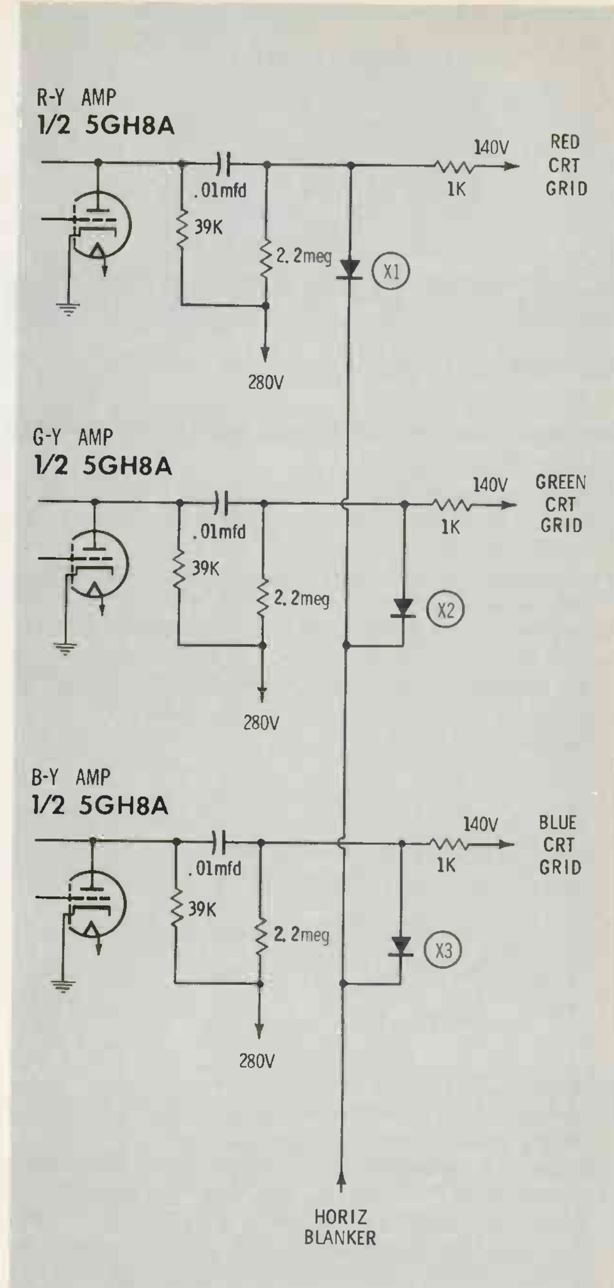


Chassis: RCA CTC15

Symptoms: Insufficient width; picture tends to defocus during station breaks or camera changes.

Tip: Loss of width will be marginal—raster fills screen to within ¼" to ½" on left side. Replacement of horizontal oscillator, horizontal output, and damper does not help condition. Possible trouble is defective C1 in the B+ voltage doubler circuit. Aging of C1 decreases efficiency, although B+ voltage *may* read within tolerance.





Chassis: RCA CTC22

Symptoms: Screen temperature slowly shifts to some predominate hue after warmup; hue *may* or *may not* be fully saturated.

Tip: This chassis uses DC clamp diode circuits at picture tube control grids. X1, X2, and X3 reset red, green, and blue CRT grids to approximately 140 volts at end of each horizontal scan. Voltage on all three grids should read the same. A change in diode characteristics during warmup unbalances grid voltages, causing either red, green, or blue gun to increase conduction. Defective diode is easily isolated using following method:

1. Select diode corresponding to predominate color on screen—X1 for red; X2, green; X3, blue.
2. With receiver operating, apply freeze-spray to selected diode while watching screen.
3. If diode is defective, instant change in shade of color will occur.

Additional Information: If fully saturated color appears, check corresponding diode for open or shorted condition—either defect will cause increased conduction of picture tube gun. ▲

THE TROUBLE-SHOOTER

Video and Audio Disappear

Please help with this tough dog. It's a Philco chassis 14N50 (Photofact folder 705-3).

When the contrast is turned down, both the video and audio disappear. The video output screen drops to 50 volts, and at the same time the plate of the AGC keying tube goes to 90 volts negative.

The plate and screen of the first IF tube are both 170 volts without signal; the screen drops to 150 volts with signal.

Bridging a 180-pf capacitor from plate to ground on V4 helps some, and shorting R74, the VDR, allows full range of contrast, but with slightly narrow and dim picture.

Please give me some helpful suggestions.

RICHARD K. SMITH
Richmond, Michigan

Mr. Smith's letter is the kind we can sink our teeth into. He's done most of the work for us. In addition to the many symptoms and voltage readings, he also furnished a list of components he has tested. Let's analyze his tests in order:

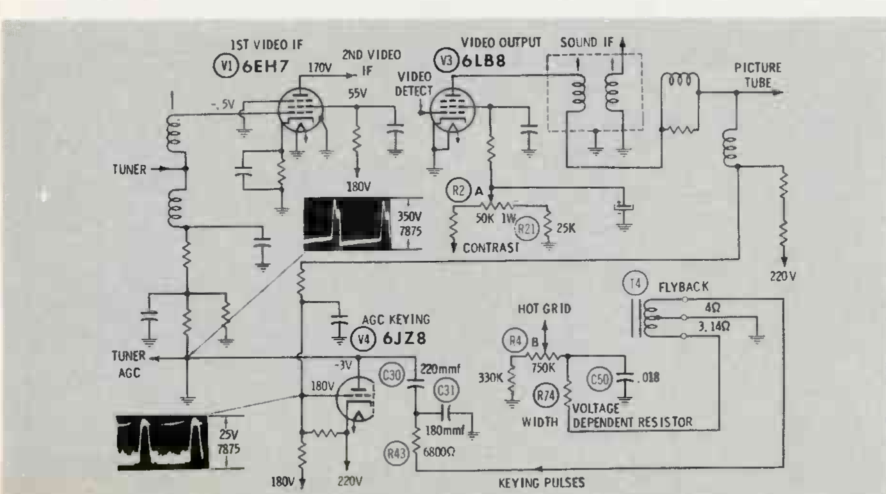
First, the video tube. The contrast control affects conduction by varying the screen voltage. The screen voltage reading is not greatly significant since it varies both with contrast setting and signal contact. The AGC grid signal is extracted from the video amp plate, so the contrast control is, in effect, an AGC control.

The reading of − 90 volts on the AGC plate is an important clue. This indicates that the keying tube is not conducting properly. At this point, scoping the plate signal would reveal the error.

The high screen voltage on the first IF tube indicates the tube is operating near cutoff. Type 6EH7 is a semi-remote cutoff tube, and requires about − 19 volts bias to cutoff. This is also significant, since it again indicates the AGC voltage must be greatly in error. (We are surprised that Mr. Smith did not include a grid reading here. He did indicate that both cathode and screen resistors are OK.)

Partial restoration of operation by bridging a 180-pf cap from plate to ground on V4 again indicates that the keying pulse is too strong; the bridge bypasses some of the excess signal. The final test, shorting the VDR again effectively is bypassing keying pulses, since it is loading the flyback through C50.

Our conclusion then, is that the AGC keying pulses are much too strong. The likely suspect is an open C31, which is ½ of a capacitance voltage divider. If C30 increases in value, it would produce similar symptoms.



DC Voltage

(Continued from page 6)

voltage drop across the emitter resistor and increases the emitter voltage.

To make a control-action test of the transistor in Fig. 8, connect a voltmeter across the 10-k collector load resistor, and short-circuit the base to the emitter. With the base and emitter at the same potential, the collector current normally cuts off. Therefore the voltmeter reading drops practically to zero. A sensitive voltmeter will show a very slight deflection from zero because of the small saturation current. If the collector junction is leaky, the leakage current flows through the collector load resistor and appreciable voltage drop is indicated across the 10-k resistor.

Common-Collector Circuits

The common-collector circuit (also called the emitter-follower circuit) is also found to some extent in electronic circuitry. Fig. 9 is typical. Note that the normal DC voltage values are the same as in the common-base circuits, because the DC circuit is the same in both instances. The distinction is that in the common-base circuit, the emitter is driven and the output is taken from the collector; in the common-collector circuit, the base is driven and the output is taken from the emitter. Note the collector-bypass capacitor in Fig. 9. This is not a part of the DC circuitry; its only effect is to keep the collector at AC ground potential when a signal is applied.

Since the DC circuitry is the same in both common-base and common-emitter circuits, the same DC distribution is found both in normal and abnormal operation. If there is collector-junction leakage in the transistor in Fig. 9, the base, emitter, and collector voltages increase. If we make a control-action test of the transistor by short-circuiting the base to the emitter, the voltage drop across the 10-k collector resistor normally goes to practically zero. On the other hand, if the collector junction is leaky, we will measure an appreciable voltage across the collector resistor when the base and emitter are connected together.

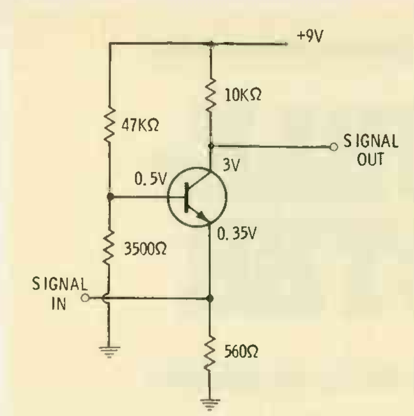


Fig. 8. Common-base circuit.

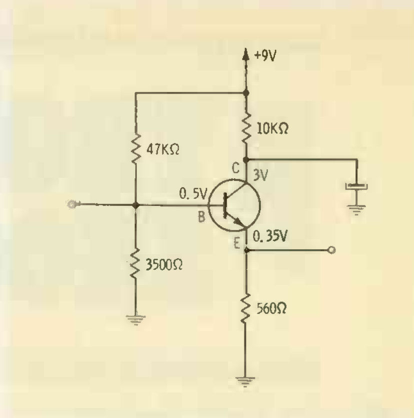


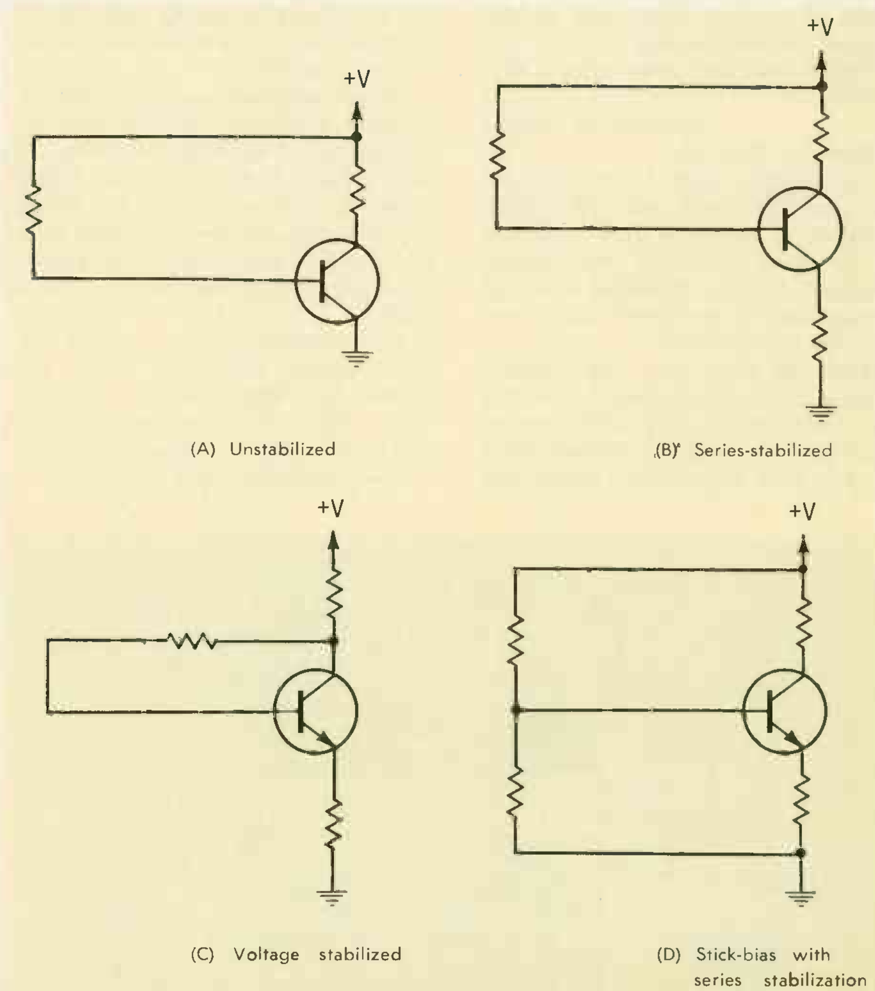
Fig. 9. Common-collector circuit.

Bias Circuits

The most common DC bias circuits are shown in Fig. 10. These circuits are all comparable since transistor defects cause changes in the normal electrode voltages. A control-action test of the transistor can be made in the unstabilized bias circuit by short-circuiting the base to the emitter and observing the voltage drop across the collector load resistor. Normally, the voltage falls to practically zero in the test.

The series-stabilized bias circuit can be checked for transistor control action in the same manner. However, a short-circuit test cannot be made in the voltage-stabilized bias circuit, because the base and emitter resistors continue to draw current through the collector resistor when the base is short-circuited to the emitter. The stick bias circuit can be tested for transistor control action, however.

Please turn to page 61



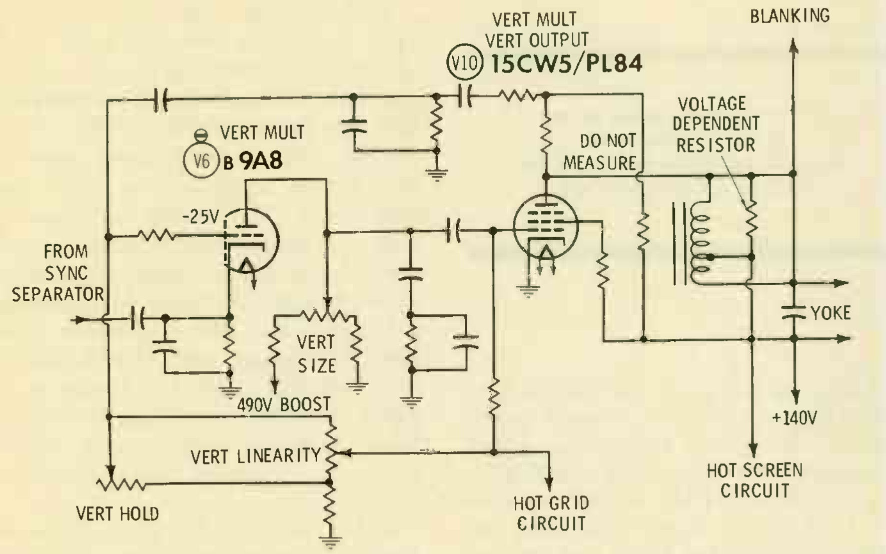
(A) Unstabilized

(B) Series-stabilized

(C) Voltage stabilized

(D) Stick-bias with series stabilization

Fig. 10. Bias circuits.



Insufficient Height

I am having trouble with a Motorola TS-586/Y (PHOTO-FACT 688-3). When the set is first turned on it has insufficient height. By adjusting the linearity and height controls it has slight nonlinearity and bottom foldover. I have replaced or checked the tubes, VDR, output transformer, yoke, resistors, capacitors, voltage and waveforms. Grid voltage on V6B is slightly high, and the V6B cathode waveform is slightly low.

IRVING RENZ

Missoula, Montana

The problem can often be narrowed down by observation during warmup. If the height slowly comes up, the problem is often in the power supply. If the height never comes up, then the problem is usually in the vertical stages.

Measure the B+ at the 140-volt source at cold start, and again after the raster is full. If there is little or no change, the power supply is probably OK. The same measurement should be made at the boost source since this supplies the vertical multivibrator through the height control.

Also measure the heater voltage on V10 to make sure is not a "slow warm-up;" this trouble can often be traced to the heater series dropping resistor.

Other causes of slow warm-up in height could be specific capacitors and resistors in either of the vertical stages, but your letter indicates these have been checked.

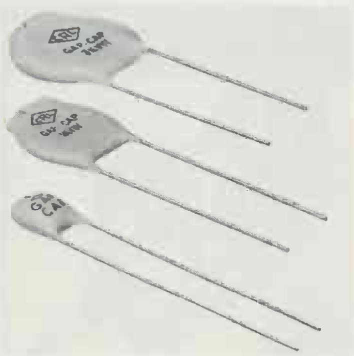
Share Your Troubles

Have you recently cured an unusual trouble symptom? If so, how about sharing your experience with the other readers of PF REPORTER? Include the make, model and/or chassis number of the set; a detailed description of the symptom(s); your troubleshooting procedure; and the exact nature of the defect that caused the trouble. Material for submission can be either typed or handwritten. Mail to:

The Troubleshooter
PF REPORTER
4300 W. 62nd St.
Indianapolis, Indiana 46206

PRODUCT REPORT

for further information on any of the following items, circle the associated number on the Catalog & Literature Card.



New Capacitors

(60)

The **Centralab** line of Gap-Cap spark gap capacitors is now available through all Centralab distributors. The Gap-Cap is a low-cost, reliable safety device with many applications where transient overvoltage is a possibility.

Voltage appearing at the terminals of the Gap-Cap is prevented from exceeding a specified value, and any excess energy which could endanger sensitive components is harmessly dissipated across the spark gap.

Units can be furnished with working voltages of 1 KV and 3 KV and arc start voltages of 1-2 KV, 2-3 KV and 4-6 KV. Available capacitances are .75 pf and .01 mf in the 1 KV unit and .004 mf in the 3 KV unit. Initial leakage resistance is 10,000 megohms minimum and dissipation factor is 2% maximum at 1 KC. Unit prices range from $0.21 to $0.66 net each.

Multitester

(61)

A fully illuminated dial, a probe light built into the test lead, and molded-in magnets on the rear cover are featured in **Components Specialties'** new Speco Model P-100-L Multitester. The magnetic cover permits the service technician to stick the unit on a TV chassis, refrigerator door, or other convenient iron-based metal surface, thus enabling the technician to use both hands for handling the test leads. The multitester provides DC ranges with 10,000 ohms/volt sensitivity and AC ranges with 5000 ohms/volt sensitivity. All functions, including current and resistance, are selected with a single switch.

Other features of the multitester include banana-type jacks, carrying strap, 1% precision resistors, printed-circuit board construction, and meter fuse protection. Price is $21.95, including batteries, test leads, probe-light test lead, and instruction manual.

Barrier Strip Terminal

(62)

A new barrier strip terminal for use in music, sound, and low-voltage control systems has been announced by the **3M Company.** Called "Scotch-

Circle 35 on literature card

flex" brand No. 515 Barrier Strip, the new connector comes with a foam adhesive backing. The vinyl foam backing is designed to provide greater gripping quality for installations on porous or sand-finished surfaces.

The new barrier strip works in conjunction with this manufacturer's "Scotchflex" brand cable system No. 500, and also can be used independently as a terminal box for standard solid and straned hookup wire. Four openings in the barrier strip's cover provide the necessary flexibility to handle various wiring arrangements. Connections are easily made to the four-post terminal either by using No. 571 Terminal Spades or by affixing connecting wires on the binding posts and tightening the screw. Terminal spades automatically grip the cable wire when screwed down to the terminal and no stripping of insulation is required. The barrier strips are individually priced at 93¢, or 74¢ each in lots of 10.

Solid-State Multimeter

(63)

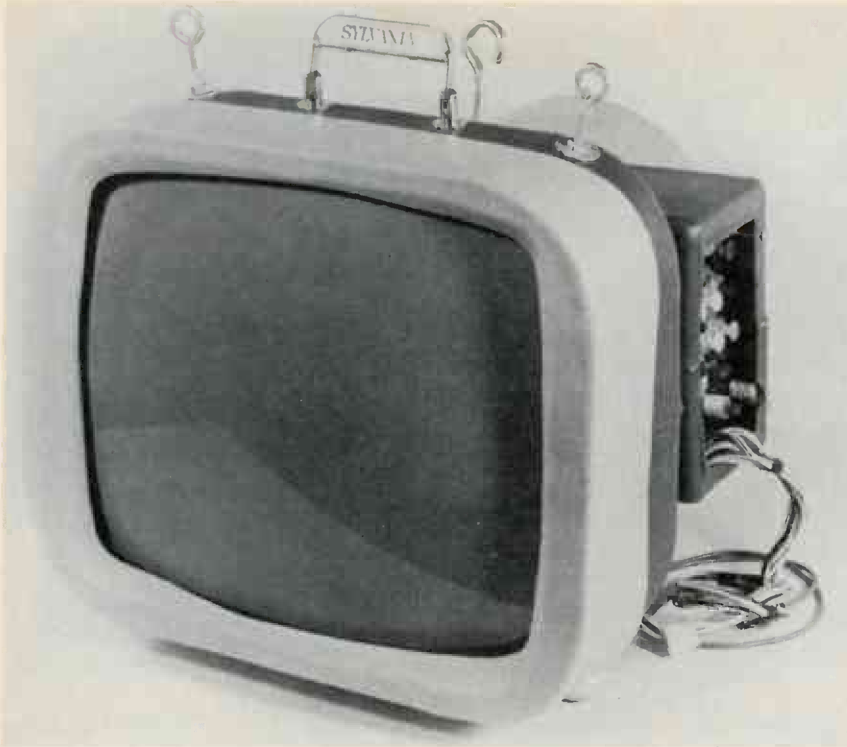
Full-scale sensitivities of the transistorized multimeter shown here are 500 mv to 5000 volts DC, 10 volts to 5000 volts AC, and 10 microamps to 1 amp DC. Resistance ranges cover R × 1 through R × 10K. The design of the unit provides protection against damage to the transistorized circuits.

AUL Instrument's battery-operated Model TVOM 3 employs a taut band meter and measures 3 1/16" wide by 2 9/16" deep by 5 7/8" long. Price is $44.00. An optional carrying case is available for $4.50.

Color Test Unit

(64)

Equipped with a 19" rectangular 90° bonded-shield color picture tube, deflection yoke, convergence assembly, and blue lateral magnet assembly, the **Sylvania** Chek-a-Color unit allows service technicians to quickly check all 19", 21", 22", or 25" color TV receiver chassis without disturbing the neck components or picture tube.



In addition to saving time and effort on service calls, Chek-a-Color provides conclusive support of the serviceman's recommendations for repair. For example, if the test unit delivers a good picture when connected to the chassis of a malfunctioning set, it shows that the trouble lies within the picture tube or neck components. On the other hand, if the same problems appear on the Chek-a-Color screen, it shows that the problem is in the chassis/tuner group.

In the repair shop, the unit can be used as a bench tool for trouble shooting and testing color chassis. The unit is contained in a high-impact plastic case and weighs less than 50 lb. Attachable feet and brackets permit use of Chek-a-Color as a standing or suspending bench unit. Price is $225.00.

New Microphone
(65)

The new **Electro-Voice** "hand-and-stand" entertainer's microphone, model 631, evolved from design concepts developed for the E-V professional 635A omnidirectional, dynamic microphone. Sharing the same background, and designed and field-tested under actual use conditions by stage and recording artists, the 631 has features that performers demand; ruggedness, reliability, good looks, and ease of handling, plus additional features for live performance use.

One such feature is the E-V "Uniseal" switch, a magnetically operated reed relay switch, sealed from dirt and corrosion. A magnet in the removeable actuator closes or opens the switch contacts when it is moved forward or back on the case; and, when the actuator is removed, the contacts remain in a fail-safe "on" position.

Inside the new microphone is a four-stage filter that traps dirt and magnetic particles before they can get to the element. This filter also provides blast and "pop" protection when performers work ultra-close. Frequency response is 100 to 13,000 Hz shaped for presence and control of feedback and rumble. The microphone's output is -55 dB. Available in satin chrome or matte satin nickel finish for $60.00. ▲

DC Voltage

(Continued from page 56)

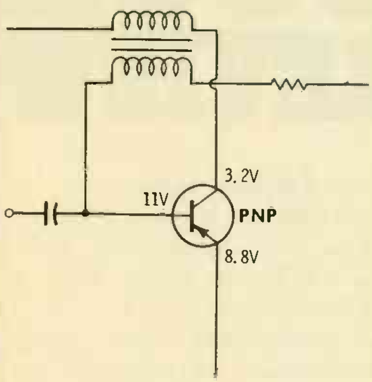


Fig. 11. Typical vertical oscillator.

Measurement Conditions

The circuits previously discussed are basically Class-A amplifiers. In theory, a Class-A amplifier is entirely linear, and the DC operating voltages do not change when a normal input signal is applied. However, transistors are not perfectly linear devices, and the DC operating voltages do tend to change somewhat when a signal is applied. Therefore, normal DC voltages are commonly specified with no-signal input. Exceptions are local-oscillator, vertical-oscillator, and horizontal-oscillator circuits, which generate their own AC signal. Self-generated signals do not affect the accuracy of DC voltage measurements because the signal amplitude is constant.

Even though no signal is applied to a TV receiver, there still is an AC signal present, in the video-output stage, for example. Noise voltages are appreciable at this stage when the receiver is tuned to a vacant channel. However, this noise signal has a reasonably constant level in normal operation, and does not affect the practical accuracy of DC voltage measurements. If the video-driver stage is dead, the DC voltages in the video-output stage will be changed to some extent. In this abnormal operating condition, however, the DC voltage changes in the driver stage will be greatly off-value, and attention is thereby directed to the actual location of the trouble.

We find that transistors in oscillator circuits are often reverse-biased in normal operation. Fig. 11 for example, depicts a PNP transistor with the DC electrode voltages found in a normally-operating vertical-oscillator circuit. Note that the base is more positive than the emitter, or, the transistor is reverse-biased. The reason for this is that the self-generated signal drives the base into heavy peak-current flow; the resulting surges of base-emitter current leave an average positive charge on the right-hand side of the base capacitor. Therefore, although DC voltage measurements make it appear that the transistor is cut off, it actually conducts heavily in short pulses.

A sync-separator transistor operates with an average reverse bias when signal is present, because the incoming sync pulses drive the base into heavy current flow on pulse peaks; the coupling capacitor is charged to an average value that represents reverse bias in DC voltage measurements. On the other hand, if the stage preceding the sync separator is dead, the transistor in the sync-separator stage will measure a small forward bias (typically 0.6 volt). This can be a confusing symptom if it is not understood; the transistor seems to violate Ohm's law when the AC signal is ignored.

The normal DC voltages in a sync-separator stage are specified for no-signal input. This does not mean that there is actually no signal present, because noise voltages are normally applied to the transistor. Therefore, if the stage preceding the sync separator is dead, we measure seemingly abnormal DC voltages in the sync-separator stage. In summary, it is sometimes necessary to be on the alert for reflected trouble symptoms. A good understanding of transistor circuit action is the best insurance against wasted time looking for trouble in the wrong places.

Conclusion

DC voltage measurements are the basic approach to trouble localization in transistor circuitry. The first step is to compare the measured values with those specified in the receiver service data. Specified test conditions, such as "no signal applied" must be observed to avoid confusion. The next step, particularly in case of doubt, is to check suspected transistors for normal control action, provided the DC bias system permits this check. Remember that a leaky coupling capacitor can produce the same symptoms as a transistor with collector-junction leakage. If we are checking the later stages in a receiver, we would keep in mind the fact that noise voltages are normally present, and may affect the DC voltage measurements. In other words, we must be on guard for reflected trouble.

Most transistor failures are associated with leaky collector junctions. However, if circuit trouble causes a transistor to "punch through", the collector junction will be either open-circuited or practically short-circuited. An ohmmeter test out-of-circuit will give either an infinite reading, or a resistance value less than 100 ohms. Emitter junctions become damaged less often than collector junctions. However, if the collector is short-circuited to the base for any reason, it is possible for the maximum emitter-base current to be exceeded. The emitter junction then becomes either open-circuited or short-circuited.

Technicians often test a suspected transistor for control action by bleeding some collector voltage into the base circuit. However, this test is not as conclusive as a control-action test, to check whether the transistor can be cut off. In case a cut-off test is impractical (as in Fig. 10C), the bleed test must be used. Therefore, to speed up service jobs we must learn how transistor circuits operate, recognize the basic configurations, know the most useful tests, and keep the tricks of the trade in mind. ▲

BOOK REVIEW

Audio Amplifier Design:
Farl J. Waters; Howard W. Sams & Co., Inc., Indianapolis, Indiana, 1967; 160 pages, 5½" x 8½", soft cover, $4.25.

A combination book which can be used for study or reference, this book also includes a number of projects up to and including a 50-watt, solid-state, hi-fi amplifier.

Though this book is perfectly understandable to the educated hobbyist, is certainld should not be limited to just those readers. The author has managed to present an astonishing amount of information in what seems like a limited-size book. Design parameters are treated in depth, with considerable math, but all in simple algebraic form. For those readers who do not like algebra, nomographs are included for nearly every formula. For instance, nomographs are available for determining part values such as power supply filters, feedback capacitors, base biasing resistors, screen resistors, etc, etc.

Chapter titles include: Amplifier Theory, R-C Coupling of Transistors, Drivers, Controls, and others. Each stage of a typical amplifier is treated separately in its own chapter, and the final chapter illustrates how to join the stages to design a complete instrument.

"Audio Amplifier Design" answers such questions as "How much amplification is needed? How many stages will this require? What values of coupling and bypass capacitors are needed for a specified frequency response?" Building an audio amplifier should become a simple project with the help of the information in this book. ▲

INDEX TO ADVERTISERS

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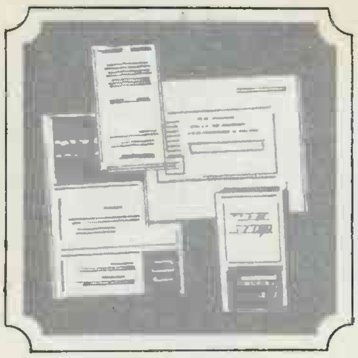

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65. *ALLIANCE* — Colorful 4-page brochure describing in detail all the features of Tenna-Rotors.
66. *ANTENNACRAFT* — New 6-page full color brochure describing vinyl-finished all channel antennas.
67. *BLONDER-TONGUE* — Colorful new flyer describes a complete line of UHF, VHF, & FM antennas. Describes various types to use depending on local reception problems.
68. *CORNELL-DUBILIER* — New 4-page brochure with instructions for installation of the AR10B skyline Series rotor.
69. *DELHI* — Twelve-page catalog introducing a complete new line of home TV towers, ham towers, citizen's band towers, masts and telescoping masts.
70. *FINNEY* — 4-color brochure with description and technical details on new Finco color spectrum frequency dependent antennas for UHF-VHF-FM, VHF-FM, and UHF. Form 20-413.*
71. *JERROLD* — New 4-page full-color catalog describes the new Paralog Plus antennas.*
72. *JFD* — Color Laser and LPV antenna brochures. New 1967 dealer catalog covering complete line of log-periodic outdoor antennas, rotators, and accessories.*
73. *MOSLEY* — Catalogs on CB, Amateur radio, and TV/FM antennas.
74. *WINEGARD* — New 40-page MATV catalog features Ultra-Plex amplifier system and installation instructions.*

AUDIO

75. *ALTEC-LANSING* — Brochure AL-1315-3 describes speaker systems for theaters, night clubs, auditoriums, arenas, etc.
76. *ATLAS SOUND* — Specification sheets on new models AP-15, AP-15T, and APT-34T paging speakers.
77. *ELECTRO-VOICE* — Catalog 167 on microphones and PA equipment.
78. *OXFORD TRANSDUCER* — Bulletin A-109 features speaker installation in automobiles, hospitals, and recreation rooms.
79. *SWITCHCRAFT* — Bulletin 170 describes seven new audio accessories.

COMMUNICATIONS

80. *AMPHENOL* — 2-color spec sheets on new Model 650 CB transceivers and Model C-75 hand-held transceiver.
81. *MOTOROLA* — New brochure tells how to reach people on-the-move through use of personal two-way radio.
82. *SQUIRES—SANDERS* — Brochure entitled "Skip is Legal".

COMPONENTS

83. *BELDEN* — Catalog 867, a 56-page catalog of the complete Belden Line.*
84. *BUSSMANN* — 12-page booklet listing the complete line of BUSS and FUSETRON small dimension fuses by size and type, also indicates proper fuseholder — also shows list prices. Ask for *BUSS Bulletin SFUS*.*
85. *CENTRALAB* — 24-page replacement parts catalog No. 33GL.
86. *LITTELFUSE* — Pocket-sized TV circuit breaker cross-reference gives the following information at a glance. Manufacturer's part number, corresponding *Littelfuse* part number, price, color or b/w designation. A second glance gives trip ratings and acquaints you with a line of caddies. Ask for CBCRP.*
87. *MALLORY* — Bulletin 4-82 describes radial and axial lead tantalum capacitors.*
88. *MILLER* — Catalog 167, a 156-page general catalog with complete cross-reference guide to the J.W. Miller Line.*
89. *NATIONAL TEL-TRONICS* — Flyer about a new flexible terminal block.
90. *QUAM-NICHOLS* — New catalog No. 67 has complete, detailed information on the entire Quam line.
91. *RELCOA*—Tech-Spec Series SR-1 about sensitive miniature relays.
92. *SPRAGUE* — C617, a complete catalog of the Sprague Line.*
93. *TEXAS CRYSTALS* — 12-page catalog of crystals including engineering data, specifications and prices.

SERVICE AIDS

94. *CASTLE TUNER* — How to get fast overhaul service on all makes and models of television tuners is described in leaflet. Shipping instructions, labels, and tags are also included.*
95. *GC*—FR-67, the full-line catalog.*
96. *INJECTORAL*—24-hour service on any make tuner is described in colorful brochure.
97. *MID-STATE TUNER* — Colorful brochure describes 24-hour service on any make tuner.
98. *PERMA-POWER* — New 4-page catalog of TV accessories.
99. *PRECISION TUNER* — Free mailing kit and replacement tuner list for same-day tuner service.
100. *T.V. TUNER SERVICE* — Brochure lists cost and mailing instructions for 24-hour service on any make tuner. Repair tags and shipping labels included.
101. *VECTOR* — Flyer sheet on current test tube socket adaptors.

SPECIAL EQUIPMENT

102. *ANDREA* — Folders on the new line of color and B/W TV receivers.
103. *ATR* — Literature about DC-AC inverters up to 600 watts load.
104. *KEARNEY* — Folder describes new "Shock-Shield safety circuit breaker. Instantly senses danger of ground leakage,
105. *LUXO* — 4-page catalog A-421 about bench and desk lamps.
106. *WINDSOR ELECTRONICS* — Booklet entitled "The Open Door to TV Profits".

TECHNICAL PUBLICATIONS

107. *CLEVELAND INSTITUTE OF ELECTRONICS* — Free illustrated brochure describing electronics slide rule and four lesson instruction course and grading service.*
109. *RCA INSTITUTES* — New 1967 career book describes home study programs and course in television (monochrome and color), communications, transistors, industrial, and automation electronics.*
110. *SAMS, HOWARD W.* — Literature describing popular and informative publications on radio and TV servicing, communication, audio, hi-fi, and industrial electronics, including special new 1967 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

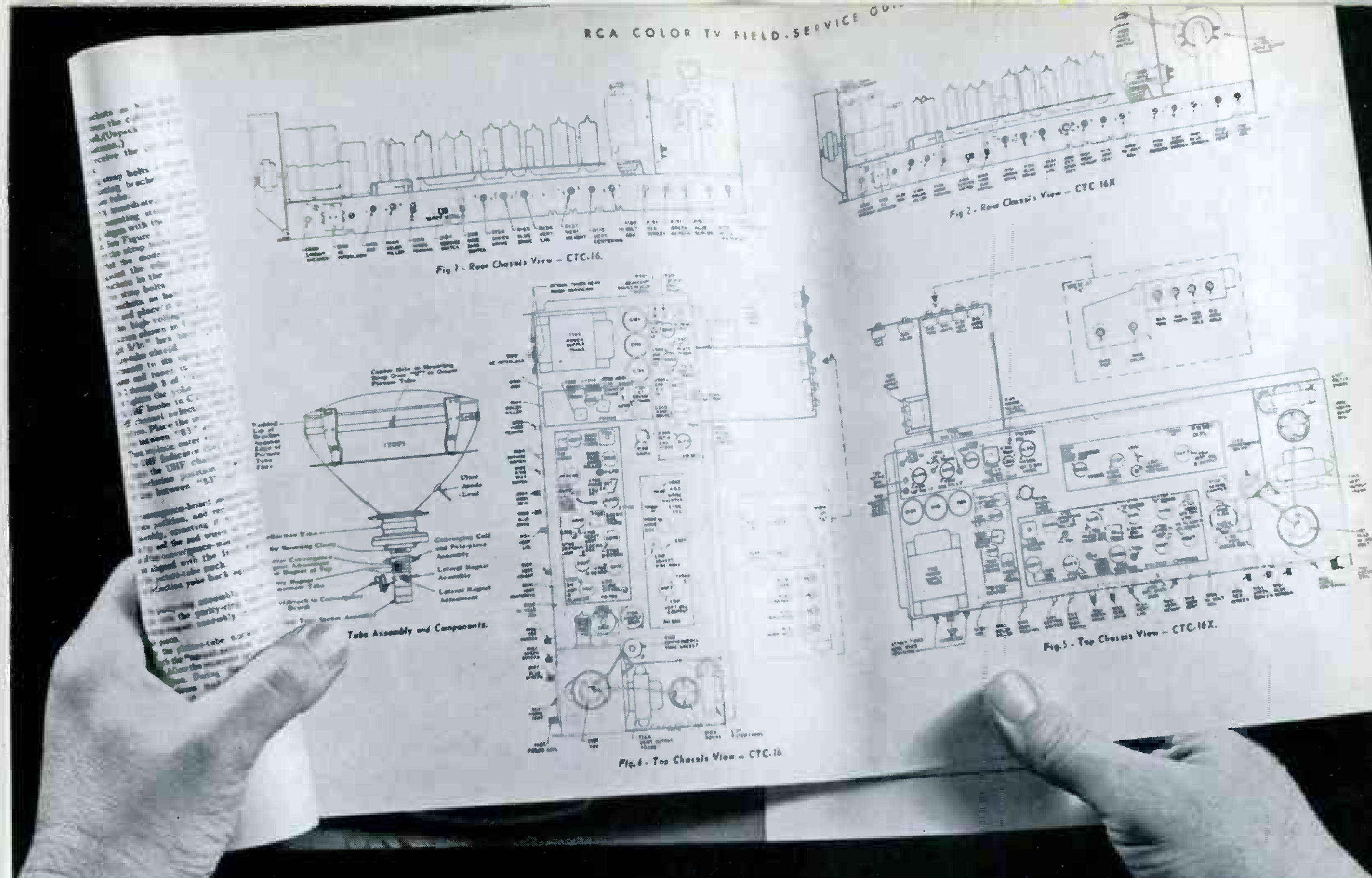
111. *B & K* — New 1967 catalog featuring test equipment for color TV, auto radio, and transistor radio servicing, including tube testers designed for testing latest receiving tube types.*
112. *EICO* — New spec sheet describes model 100A4 multimeter with DC sensitivity of 100K ohms per volt.*
113. *HICKOK* — Quick reference catalog No. 67D gives brief descriptions and prices for complete test equipment line. Also specification data on Models CR-35 CRT tester, GC-660 color generator, and 860 Injecto-Tracer.
114. *JACKSON* — New full-line brochure includes the all-new in-circuit transistor checker with 8" meter.
115. *LECTROTECH* — Two-color catalog sheet on new Model V6-B color bar generator, the latest improved model of the V-6. Gives all specs and is fully illustrated.*
116. *MERCURY* — All-new 16-page test instrument catalog.
117. *PRECISION APPARATUS* — 12-page illustrated catalog describes the application and features of a complete line of test equipment — scopes, sine-square wave generators, RF generators, sweep generators with marker adder, Low- and Hi-voltage power supplies, VOMS and VTVMS.
118. *SECO* — Operating manual for the HC8 in-circuit current checker for horizontal output tubes.*
119. *SENCORE* — New 12-page catalog on all SENCORE products.*
120. *SIMPSON* — Reprint: "A Guide to the Selection of Multitesters." Explains how to evaluate multitesters before you buy.*
121. *TRIPLETT* — Catalog No. 51-T features the complete line of VOM's, VTVM's, tube and transistor analyzers and accessories.*

TOOLS

122. *ARROW* — Catalog sheet showing 3 staple gun tackers designed for fastening wires and cables up to ½" diameter.
123. *BERNS* — Brochure about three models of pin-crimpers.
124. *DIAMOND TOOL AND HORSESHOE* — 16-page booklet W-68 describing several lines of wrenches, pliers, snips, and electronic pliers.
125. *ENTERPRISE DEVELOPMENT* — Time-saving techniques in brochure from Endeco demonstrate improved desoldering and resoldering methods for speeding and simplifying operations on PC boards.*
126. *UNGAR* — Catalog of 2 lines of soldering equipment.
127. *VACO* — Catalog SD-126 describing complete line of Pow'-Rivets for blind riveting.
128. *XCELITE* — Bulletin N867 describes hollow-shaft nutdrivers which speed lock-nut/screw adjustments.

TUBES AND TRANSISTORS

129. *MOTOROLA* — New semiconductor catalog HMA-27 lists device ratings and characteristics of the HEP line.
130. *RCA* — PIX 300, a 12-page product guide on RCA picture tubes covering both color and black-and-white. Includes characteristics chart, terminal diagrams, industry replacement, and interchangeability.*



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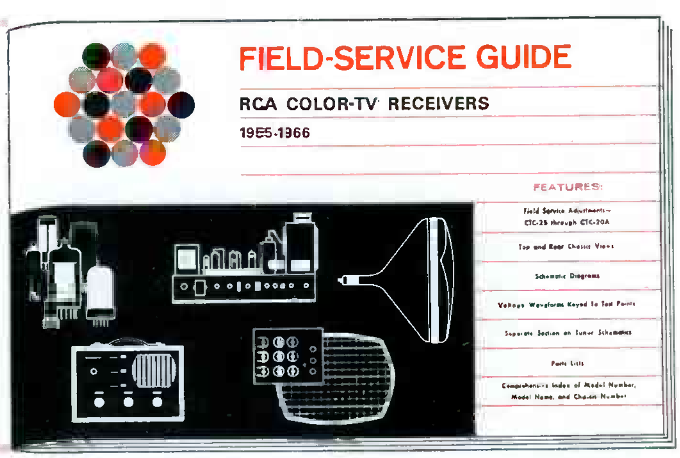
- Field service adjustments (AGC, linearity, centering, etc.)
- Convergence, purity and black and white setup adjustments
- Parts lists
- Wave forms keyed to test points for majority of chassis
- Top and rear chassis views
- Photos of typical receivers
- Index of models from CTC2 through CTC20
- Separate section on tuner schematics
- Separate section on remote tuner schematics



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