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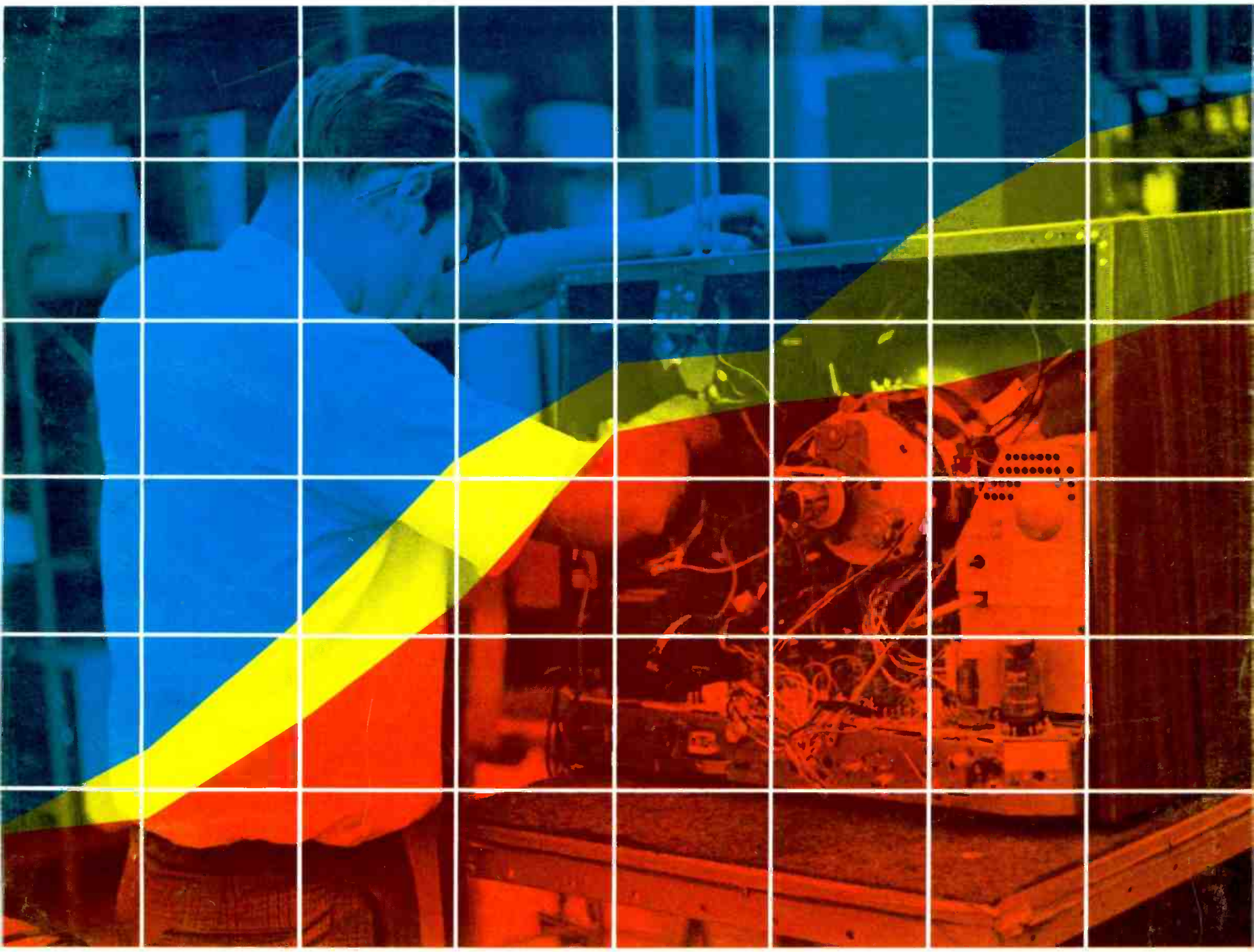
Electronic Servicing

Formerly PF Reporter



TECHNICIAN INCENTIVE PAY:

Increased productivity and profit, page 10

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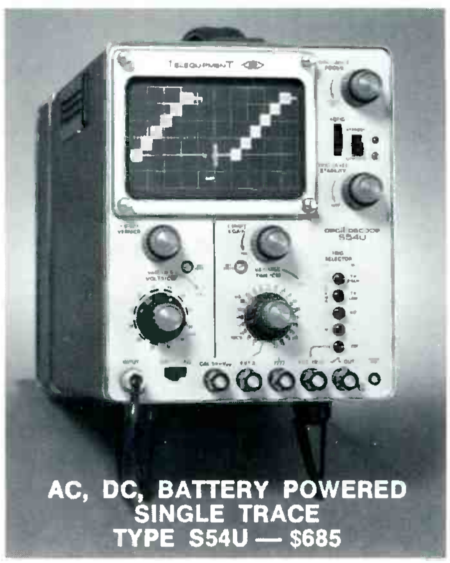

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April, 1970 • Volume 20, No. 4

Electronic Servicing

Formerly PF Reporter

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Robert E. Hertel, Publisher

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electronic scanner

news of the industry

TV Service Charges Lower Than Rates 5 Years Ago

Television-repair charges and telephone bills are the only services lower, on the average, than what they were five years ago, according to a compilation of the cost of 36 of the 80 services included in the U.S. Department of Labor's consumer price index, published in a recent issue of **U.S. News & World Report.**

Prices of all items included in the cost-of-living index have increased 21 percent over the five years, while services of all kinds are up nearly 28 percent.

Wages paid to service workers, according to the report, are the primary reason for the sharp increase in the cost of services.

Packard Bell Inboards Labor For 90 Days

Packard Bell has included 90-day inboarded labor in the warranty policies covering its product line for 1970.

Several months of conclusive experimentation with both inboard and outboard plans preceded the move to inboard labor warranty coverage, according to William J. Horn, vice-president and director of marketing for Packard Bell. Mr. Horn stated that consumers and dealers prefer the inboard plan.

New Illinois Technician Association Formed

A statewide association of electronic technicians was formed in Illinois in February. The new association reportedly is called ARTS/Illinois Electronics Inc.

President of the association is Bob Griffin of Bloomington.

The objectives of the new group include the promotion of a more favorable electronic technician image, promotion of certification, education, training and group insurance, and offering of legislative advisement to state and local government groups, according to Richard Glass, NEA executive vice president.

On-The-Job Injury Earns Technician $300,000

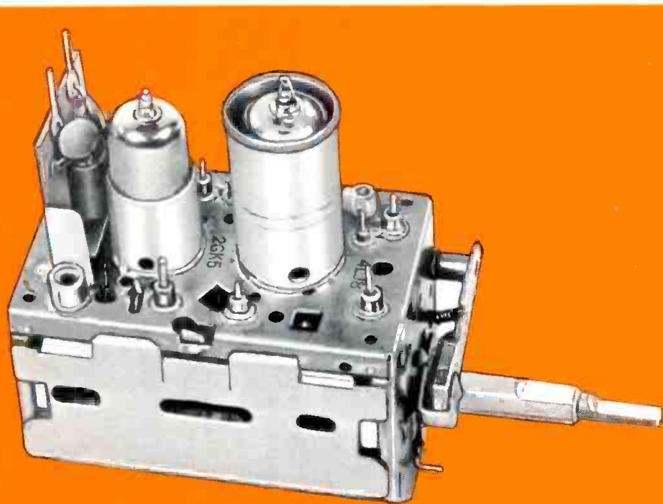
A part-time TV technician, who was blinded in one eye when struck by a part from a TV set he was servicing, was awarded $300,000 by a jury in a U.S. District Court in New York City.

The judgment, given to Thomas Caruloff, Lorain, Ohio, was against the Emerson Radio & Phonograph Co., according to a report in the **Michigan TSA News.**

The accident reportedly occurred in 1963 when Mr. Caruloff was attempting to repair a 1955 Emerson TV. He had changed several tubes, but was unable to obtain a satisfactory picture. Mr. Caruloff then consulted an Emerson service manual, which suggested that the tuner of the set be cleaned.

To gain access to the tuner, Mr. Caruloff had to remove a spring retaining wire that reportedly was a

(Continued on page 6)



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(Continued from page 4)

safety feature. While he was attempting to pry it loose with a screwdriver, the spring shot from the set and struck Mr. Caruloff in the left eye.

Admiral To Manufacture Emerson-Dumont TV Line

Admiral Corporation has signed a long-term contract with the National Union Electric (NUE), parent company of Emerson, to manufacture the Emerson and Dumont TV line.

Inability to raise prices to compensate for increased production costs reportedly was given as the reason for contracting out the manufacturing process. Sales and marketing will continue to be handled by Emerson TV Sales Corporation.

Admiral, who only recently purchased Cortron, former consumer electronics supplier of Montgomery Ward, with production of Emerson and Dumont lines could push ahead of Motorola and Warwick to become the 4th largest U.S. producer of color TV.

Ampex and Bell & Howell Cease Domestic Production of Consumer Tape Recorders & Players

Ampex, U.S. pioneer in magnetic sound recording, and Bell & Howell have revealed their intentions to curtail domestic production of consumer tape recorders and players. Both companies will continue to market imported consumer units manufactured by U.S. and/or foreign-owned overseas plants.

Only three major firms continue domestic production of tape recorders and players: 3M (Wollensak), Telex and V-M. Of these three, both 3M and V-M supplement their domestic-produced units with imported models.

New Service Manager Appointed by Admiral

Donald R. Baker has succeeded I. F. Johnston as electronics service manager of Admiral, according to a recent announcement by Willis L. Wood, general manager of the national service division of Admiral Corporation. Baker was promoted to assistant service manager in 1968.

I. F. Johnston has been appointed to the newly created position of manager of electronics service training for Admiral.

Japanese TV With Multiplex Sound

Multiplex TV, which enables the audience to hear musical programs in stereo and the sound of foreign programs in either Japanese or the original language, reportedly is now being broadcast in Japan, according to a report in **Home Furnishings Daily.**

Matsushita Electric reportedly has unveiled a 22-inch multisound, stereo color TV receiver and six multiplex TV adapters. The multisound receiver, which will be marketed in Japan for about $830, according to the report, is a solid-state unit employing one integrated circuit, 85 transistors and 74 other semiconductors.

The multiplex TV system reportedly operates similarly to the U.S. multiplex FM stereo system, in which a main and a subcarrier signal are broadcast simultaneously, containing left plus right and left minus right signals, respectively.

SENCORE Now in Sioux Falls on SENCORE Drive

The city of Sioux Falls, South Dakota, has officially renamed the street beside which is located SENCORE's new manufacturing facility. The new address is 3200 SENCORE Drive.

SENCORE, major manufacturer of electronic test instruments, began moving into the new 40,000 sq. ft. plant in mid-December. All production and shipping will be accomplished at the Sioux Falls location, according to Herb Bowden, SENCORE president.

Present at the ceremony officially informing SENCORE of the street's name change, and shown in the photo (left to right): Louis C. Warren, president of Warren Supply Co., SENCORE distributor in Sioux Falls and president of the Sioux Falls Chamber of Commerce; Al Schock, president of the Sioux Falls Industrial and Development Foundation; M. E. Schirmer, Mayor of Sioux Falls; Herb Bowden, president of SENCORE, who flew in from SENCORE headquarters at Addison, Illinois to attend the ceremony.

Licensing Bill Introduced to N.Y.

A TV technician licensing bill has been introduced to the New York State legislature by Assemblyman Leonard M. Simon, Kings County Democrat, according to a report in **Home Furnishings Daily.**

The bill reportedly would provide that, after Sept. 1, 1971, no one other than a licensed TV technician or a licensed TV trainee could, for compensation, repair or service a TV set in home use.

Included in the bill is a call for an appropriation of $25,000 for the creation of an advisory board of examiners of the Department of State of New York.

Hyde To Head NESA

Henry (Hank) G. Hyde, CET, of Omaha was elected to a one-year term as president of the Nebraska Electronic Service Association (NESA) at a meeting of the association at Grand Island in January. He succeeds Cap Enyeart, who has served as president of this active association during the past two years. Enyeart remains as a member of the Board of Directors of NESA.

Color TV in 40% of U.S. Homes

U.S. households having one or more color TV receivers total 23.4 million, or 39.3 percent of all TV households, according to quarterly estimates released by Allen R. Cooper, vice president, planning, National Broadcasting Co. (NBC).

The NBC estimates also stated that the number of households equipped with color TV increased during 1969 by 4.7 million, or 25 percent of the Jan. 1, 1969, total.

A recent study by the University of Wisconsin Survey Research Laboratory revealed that one out of every three Wisconsin homes has two or more TV sets and 6 percent of all households have at least three operating sets. Only 2 per cent of Wisconsin households do not own an operating TV.

The report also stated that one out of every five Wisconsin households have color TV, up from one out of 10 in 1966.

Regulation To Make Television Receiver Tuners Comparable For UHF and VHF To Go Into Effect Next Year

UHF and VHF tuning of TV receivers with screens larger than 9 inches measured diagonally must be comparable in sets manufactured after May 1, 1971, according to a recent amendment to Part 15 of the Federal Communications Commission (FCC) Rules.

The amendment also stipulates that comparable UHF and VHF tuning must be provided in sets smaller than 9 inches (diagonally) manufactured after May 1, 1973. The additional time is given for comparable tuning in smaller sets because of "the physical difficulties involved in mounting tuning systems of somewhat increased size in very small TV receivers."

The "all-channel receiver law," enacted by Congress in 1962, gave the FCC authority to require that television broadcast receivers be "capable to adequately receiving" both UHF and VHF TV channels.

The FCC noted that there have been a number of technical advances in TV tuners since 1962, but comparability has not been achieved except in the most expensive receivers.

The FCC said any tuning system selected by a manufacturer would be satisfactory provided that the same type of controls were used for tuning VHF and UHF channels.

Meanwhile, the Consumer Products Division of the Electronics Industries Association (EIA) has filed a petition with the Federal Communications Commission in an effort to delay the effective date of the new "comparable tuning" rule.

In a meeting in February with FCC Commissioner Robert Lee and UHF TV station officials, representatives of the Consumer Products Division stated that TV manufacturers, out of necessity, have a three-year cycle from the design of a new model until the model is marketed. They said that because of this cycle it would be impossible for them to meet the FCC deadline of May 31, 1971. ▲

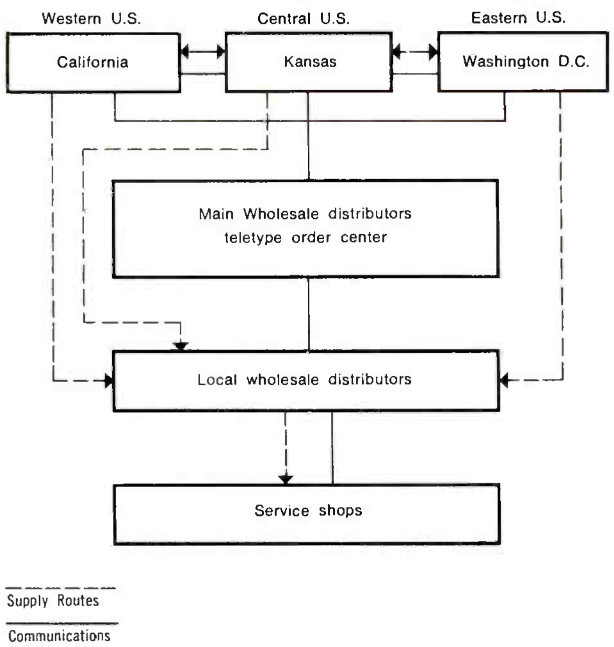
letters to the editor

System For Improved Parts Distribution

After reading the article titled "Parts Availability . . . A Special Report," which appeared in the February '70 issue of ELECTRONIC SERVICING, I would like to offer a system that perhaps will help speed up the distribution of parts.

I now have an imported set in my shop. This set will cost me money because I can't get the part I need. It is taking up space that could be used for storing and repairing other sets. If I haven't received the part in 30 days, I'll return the set unrepaired. If I still haven't received the part in 60 days, I will cancel the order for the part and notify the customer that it is unavailable.

I think the system I have diagramed would work wonders if all manufacturers would employ its principles. Each manufacturer would have a distribution warehouse at the three locations indicated, each of



which would have a teletype center and a computer. All of these would be linked together by a main teletype center. When a technician needs a part, he would go to his local parts distributor, who would then send the parts order via his teletype machine to the main center. The order then would be routed to the teletype center of the manufacturer's warehouse serving his area. At the warehouse, the order would be fed into the computer, which would indicate exactly where this part is stored, and a parts man would go there and get the part. He would then teletype back to the local distributor that the part had been located and that he is preparing it for shipment.

All companies making duplicate parts, such as capacitors and resistors, should standardize their parts numbers, using a suffix to indicate the manufacturer. For example, CR 33000.5WGE would be the part number for a ½-watt (.5W) carbon resistor (CR) made by General Electric (GE). The number 33000 would be the code designating it as a 2.7-ohm resistor. Or perhaps the rating itself could be used, resulting in the part number CR 2.7-.5WGE, using the example given previously.

Each part number would be unique, and, if ever discontinued, the part's number would be designated "discontinued" and would then be retired from use.

One more important facet could be added to this scheme to aid the technician: If a manufacturer discontinued a part, he would notify all local distributors immediately as to the day and year it was discontinued. This way, a technician wouldn't be left waiting for a part that is no longer available.

Billie W. Fowler
Memphis, Texas

Mr. Fowler, your proposed system deals with two prime elements of the parts problem: 1) effective communications between independent distributors and manufacturers and 2) a universal system of component designation. Both are needed to ease the parts availability problem.—The Editor.

Shop Owners and Technicians Under Consumers' Thumb

The tight situation of today's TV servicing is the most ridiculous farce around. When will shop owners see the false reasoning behind present servicing rationale? Most shop owners lack the guts to stop the silly sausage-factory system which decrees working at a full run. This is pure appeasement of the consumer, who has demanded service on his own terms. There can be absolutely no question but what this has inhibited shop owners at large to stay under the gun, servicing at rates which are clearly unrealistic.

Perhaps it is time we looked at the service technician and what this mad policy has done to him. He has been exploited to the hilt by timid employers and arrogant consumers. His hours are excessive and his pay too low. Yet he is called on to render service at a full run and to keep up on technical developments as they occur. Everything he does must be in high gear. It is little wonder that many color sets receive little more than superficial attention. In such a tight situation it is pure madness to admonish technicians to think and act as professionals. They are not paid as professionals; they are not treated as professionals; and they do not think they are professionals. It was Burke who said: "The degree of estimation in which any profession is held becomes the standard of the estimation in which the professors hold themselves."

I submit the following to prudent readers of ELECTRONIC SERVICING: The industry must stop its self-abuse and insist that the consumer come to terms with economics. If some shop owners fail to implement changes offering a better state for servicing, then it is up to good technicians to move on where their services are appreciated. The work load must be decreased so it can be done properly. Naturally the consumer will be required to pay more if the *volume is reduced, but present servicing trends are unreal; they benefit neither consumer nor service shop, so they must change. I propose a renaissance, gentlemen; it is time we turned on the lights.*

Vincent L. Irvan
De Queen, Ark.

Help Needed

Perhaps one of ELECTRONIC SERVICING'S readers could help me locate a firm that would fix the meter on a Superior Instruments Co. Model TV VOM. Thank you.

Freddie Schuckman
Brownell, Kans. 67521

I am in need of the schematic and parts list for a Kor-Sonic Model 1540X transistor radio. I would appreciate it if one of your readers could supply me with the name and address of either the importer or the manufacturer. Thank you.

Oscar Perkins
2603 West Front St.
Richlands, Va. 24641

I need help in finding a schematic and alignment instructions for a Model A460 television field-strength meter built by Approved Electronic Instrument Corporation of New York City. Can you help?

William Glomb
3836 West 134th Place
Hawthorne, California 90250

Where can I send my tube tester for up-dating? It is a Model NS802 manufactured by Radio City Products, Inc., who are no longer in business. Thank you very much.

Fred C. Mamay
465 E. Passaic Avenue
Bloomfield, New Jersey 07003

I am in need of a schematic diagram and, if possible, a manual for a Roland and Boyce Model 701 Television Picture Tube Tester. I will gladly pay a reasonable price for a copy of the schematic.

Rudolph Chlupsa
45-56 189th St.
Flushing, N.Y. 11358

I need a 12AE7 tube, and have been unable to locate one. I would appreciate it if one of your readers could assist me in finding one. Thank you.

Terry Kobel
R.R. #2, Box 344
Groveland, Fla. 32736

Approximately five years ago I purchased a Belcor Model B303 Tape Recorder, for which I need a pressure roller for fast forward speed.

This company is now out of business, and I cannot find any parts distributor who carries this part.

I would appreciate any information your readers could furnish on where I could obtain this part.

Melvin Sher
66 Virginia Ave.
Livingston, N.J. 07039 ▲

Flat-Rate Pricing and Incentive Pay:

Profit Boosters

by J. W. Phipps

Flat-Rate System of Pricing–

- *Because it encourages more profit from increased productivity of technicians, it is more adaptable to incentive pay plan than is direct hourly system.*
- *Insures more consistent pricing*

Percentage-of-Labor-Sales Incentive Plan–

- *Puts the technician in business with you, so he works more effectively.*
- *Automatically maintains profitable relationship between direct labor cost and labor income*

One of the primary advantages of the flat-rate system of pricing service labor is that it is adaptable to incentive pay plans, which can increase the net profit of your shop and enable your technicians to earn more.

The Hourly System of Pricing

A system of pricing service labor by the hour limits the maximum shop income from service labor to an amount equal to the total number of manhours available multiplied by the hourly rate charged the customer. For example, if you employ two benchmen and each works 40 hours per week, the maximum possible amount of manhours available for sale is 80. If your hourly service labor rate is $10, your maximum gross income from the sale of service labor is $800.

Thus far in our example of hourly pricing, we have assumed that you have been able to sell 100% of your total available manhours; in other words, you had 100% labor recovery. However, in actual practice a labor recovery rate of 100% is highly improbable. Because coffee breaks, sickness, time spent filling out paperwork and chasing parts and other nonproductive time reduce the total amount of manhours available for sale to customers, a labor recovery rate of 75 to 80% is more probable. Assuming your labor recovery rate is 80%, the maximum gross income you can expect using the hourly pricing system is $640 (80% of 80 hours = 64 X $10 per hour = $640).

Under the hourly system of pricing service labor, the only way to significantly increase your gross shop income from sale of service labor is to force your two benchmen to work more hours, or hire more benchmen. In either case, your cost of service labor also will increase; the increase will be disproportionately greater if you force your two benchmen to work more hours and you must pay them

Incentive Program Should Cover Labor Only

The Federal Trade Commission frowns on any type of incentive program that encourages technicians to sell more replacement parts. The reason for this is obvious: Some technicians might replace large numbers of parts that were not faulty. Consequently, it is advisable to limit incentive pay to a percentage of the shop income derived from labor.

overtime. If you hire more technicians, you probably will have to purchase additional tools and test equipment, and even purchase or lease a larger building; thus, your capital investment would increase along with your cost of doing business.

Flat-Rate Pricing

A system of pricing service labor by the *job* instead of directly by the hour is commonly called flat-rate. Essentially, it consists of predetermining the amount of time it typically takes to do various jobs, usually expressed in tenths of an hour, then multiplying your hourly rate by the amount of time indicated for the job involved. This is the amount the customer is to be charged.

The primary difference between direct hourly pricing and the flat-rate method is that in the latter the amount of time for which the customer is charged might not necessarily be the actual time it took *your* technician to do the job. If one of your technicians completes a job in less time than indicated in the schedule of flat-rates, your net shop income from service labor is increased by the difference. For example, suppose the flat-

PAYROLL WORK SHEET—Fred Ohm, April

Date	Job Ticket	Operation	Type, Make Chassis	—SERVICE LABOR SALES— Service Labor (Customer)	Service Labor (Internal)	Total
Apr. 1	#3031	Diagnose and replace defective horizontal output transformer	Color TV RCA CTC16	24.50		24.50
Apr. 1	#3032	Complete IF and Chroma alignment	Color TV Zenith 25LC30	38.50		38.50
Apr. 1	#3033	Clean tuner, check and replace defective tubes	B-W TV (trade-in) Admiral ID7		12.50	12.50
Apr. 1	#3034	Replace defective CRT, color setup	Color TV Magnavox T920	32.50		32.50
Apr. 2	#3035	Diagnose and replace defective capacitor in video amplifier	Color TV GE CB	22.50		22.50

	Service Labor (Customer)	Service Labor (Internal)	Total
Apr. Total to Shop LABOR SALES	$1643.00	$152.00	$1795.00
Apr. Total to COST OF SHOP LABOR SALES	$739.35	$68.40	$807.75*

Summary of Fred Ohm's Payroll and Earnings Record:

April	Guarantee	DEDUCTIONS Social Security	Fed. Income Tax	State Income Tax	Group Insurance	Total	Amount Paid
1st week	140.00	6.72	21.00	2.80	1.90	32.42	107.58
2nd week	140.00	6.72	21.00	2.80	1.90	32.42	107.58
3rd week	140.00	6.72	21.00	2.80	1.90	32.42	107.58
4th week	140.00	6.72	21.00	2.80	1.90	32.42	107.58
Total Guarantee	560.00	26.88	84.00	11.20	7.60	129.68	430.32
Earned share of service labor sales*	807.75						
Difference owed Ohm	247.75	11.89	37.16	4.95	....	54.00	193.75

NOTE: * $807.75 (45% of labor sales) has been earned during period. Against these earnings technician has drawn his guarantee. If earnings should be less than guarantee, technician retains guarantee drawing and does not owe shop anything.

rate manual indicates 2.5 hours for a specific job, and your hourly rate is $10. The price charged the customer for the job is $25 ($10 X 2.5 hours = $25). If your technician completes the job in 2 hours, you will have realized .5 hour or $5 more than you would have under the direct hourly system of labor pricing.

From the foregoing example, it can be seen that under the flat-rate system of pricing the more productive your technicians become, the more net income your shop will realize from the sale of service labor. (Note that I have said *net* income. This is because such increases in labor sales are realized without additional direct labor costs; consequently, any increase is net profit.)

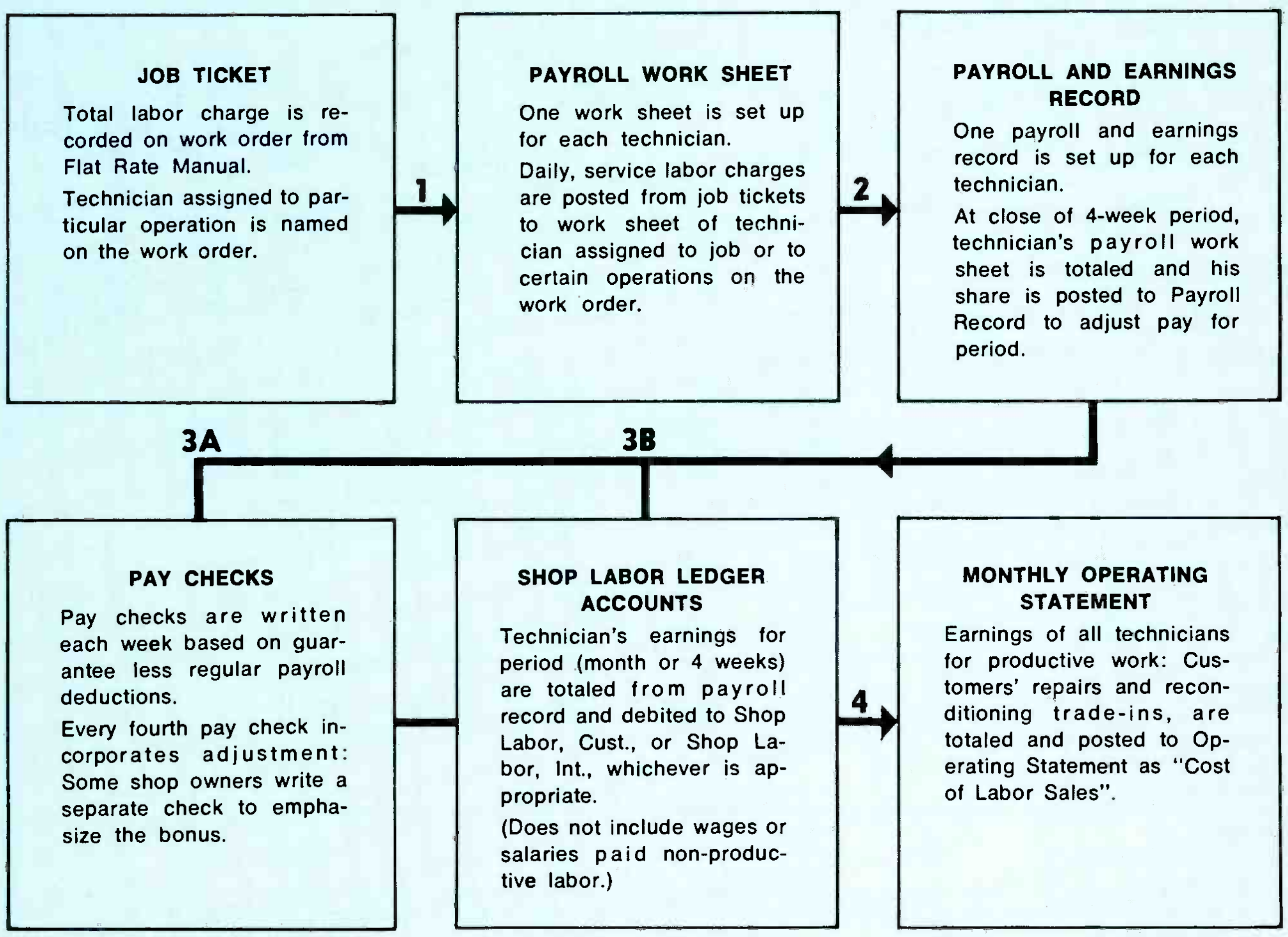
Under the flat-rate system of pricing, your maximum gross income from sale of service labor is not limited to the retail price of the exact number of man-hours available, as it is under the direct hourly system. Instead, it can be increased by greater productivity of your technicians —the purpose of an incentive pay plan, which we will discuss next.

An Incentive Pay Plan For Use with Flat-Rate Pricing

The simplest incentive pay plan to apply and administer is one in which each technician's compensation is based on a percentage of the shop gross service labor income he produces. The more a technician produces, the more he receives himself; this is the incentive.

The percentage of service labor sales that *you* should pay *your* technicians depends on *your* cost of doing business, profit margin and other related factors. However, as a general rule, direct labor costs (technicians' compensation) should not exceed 60 percent of total service labor sales. The ideal relationship exists when direct labor cost is half service labor sales. (Two highly successful service shops with whose incentive pro-

PAYING AND ACCOUNTING FOR SHOP LABOR



grams I am familiar pay their technicians between 45 and 50 percent.)

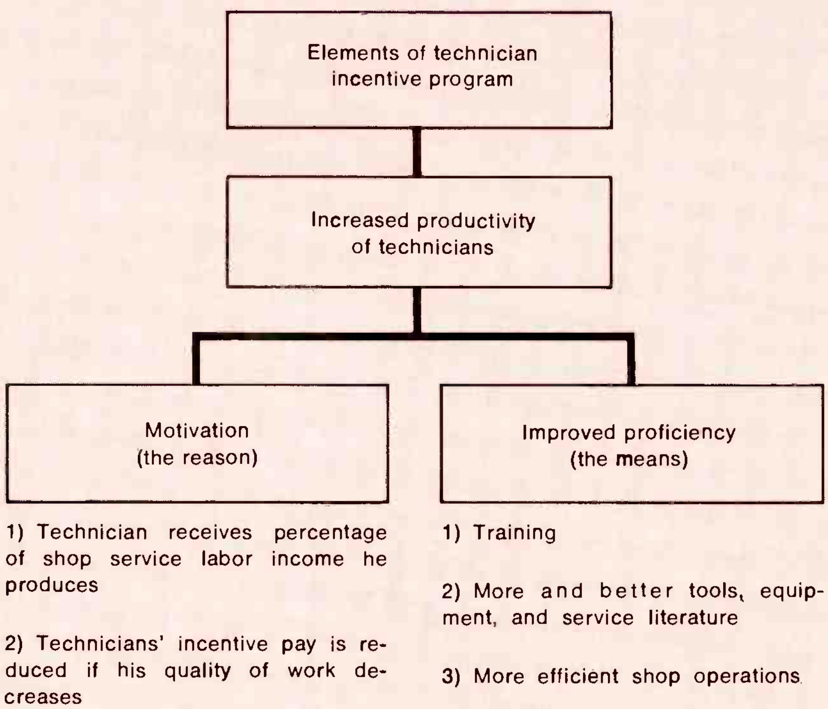
The necessary data for the incentive plan is compiled by setting up a payroll work sheet for each technician, as shown in the accompanying example. Post to it each day the total labor charged the customers for the service jobs which the technician has completed. You need not figure the technician's share of the labor charges until the end of the pay period, or if a system of guaranteed salary is established, whatever period is used to settle the difference between any guarantee drawn and actual earnings under the incentive program.

If your volume of business is seasonal or fluctuates considerably throughout the year, you might wish to guarantee your technicians a certain salary. Depending on particular conditions, the guarantee should be set somewhat below what would be considered normal earnings under the incentive plan. For example, if your technicians normally earn in the range of $200 per week under the incentive program, you could establish a guarantee of $140 per week. Then, periodically—every two or four weeks, quarterly or whatever period you choose — you settle the difference between the guarantee drawn and the technicians' actual earnings under the incentive program. (Before establishing a guarantee, check it against that required by the Fair Labor Standards Act as amended, if applicable to your situation.) If the technician fails to earn enough to cover his "draw" (guarantee) during any settlement period, he owes the shop nothing and starts the next period with a clean slate.

An accompanying illustration shows how to fill in the suggested work sheet. The purpose of the work sheet is to facilitate the computation and minimize the number of lines used on the payroll and earnings record form. Only totals need be posted to the regular payroll and earnings record. Thus, time and space are conserved.

The accompanying example shows that technician Fred Ohm drew a minimum guarantee of $140 each week for a total of $560 during April. Postings from job tickets identifying him as the responsible technician totaled $1795, of which his share is 45 percent, or $807.75. Since he has already drawn $560, the shop owes him the difference between his actual earnings ($807.75) and his drawings ($560), or a difference of $247.75.

If the following settlement period again contained four weekly pay periods, Fred's guarantee would again total $560. If the volume of business was slow during the settlement period and his actual earnings



A good technician incentive program is one that provides a proper balance of **motivation** and **improved proficiency.** With just motivation, the quality of service might decrease. With only improved proficiency, the technician has no practical reason for increasing his productivity. However, with the right amount of both elements—motivation and proficiency—he has the **reason** and the **means** to increase his productivity. Without some checks and balances, an incentive program can be prejudicial to both the shop and the technicians if attention is focused on speed at the expense of quality of service. This can be avoided if the following are made a part of your incentive program:

• Improve the proficiency of technicians so they can increase their productivity without increasing the number of callbacks. A continuing training program is one method of accomplishing this. Improved shop operations, specialization by brand, and more and better test equipment and service literature are other methods.

• Establish an inverse relationship between the additional income each technician earns through the incentive program and his rate of call-backs, or amount of work that must be redone—as a technician's rate of callbacks increases, his incentive pay decreases.

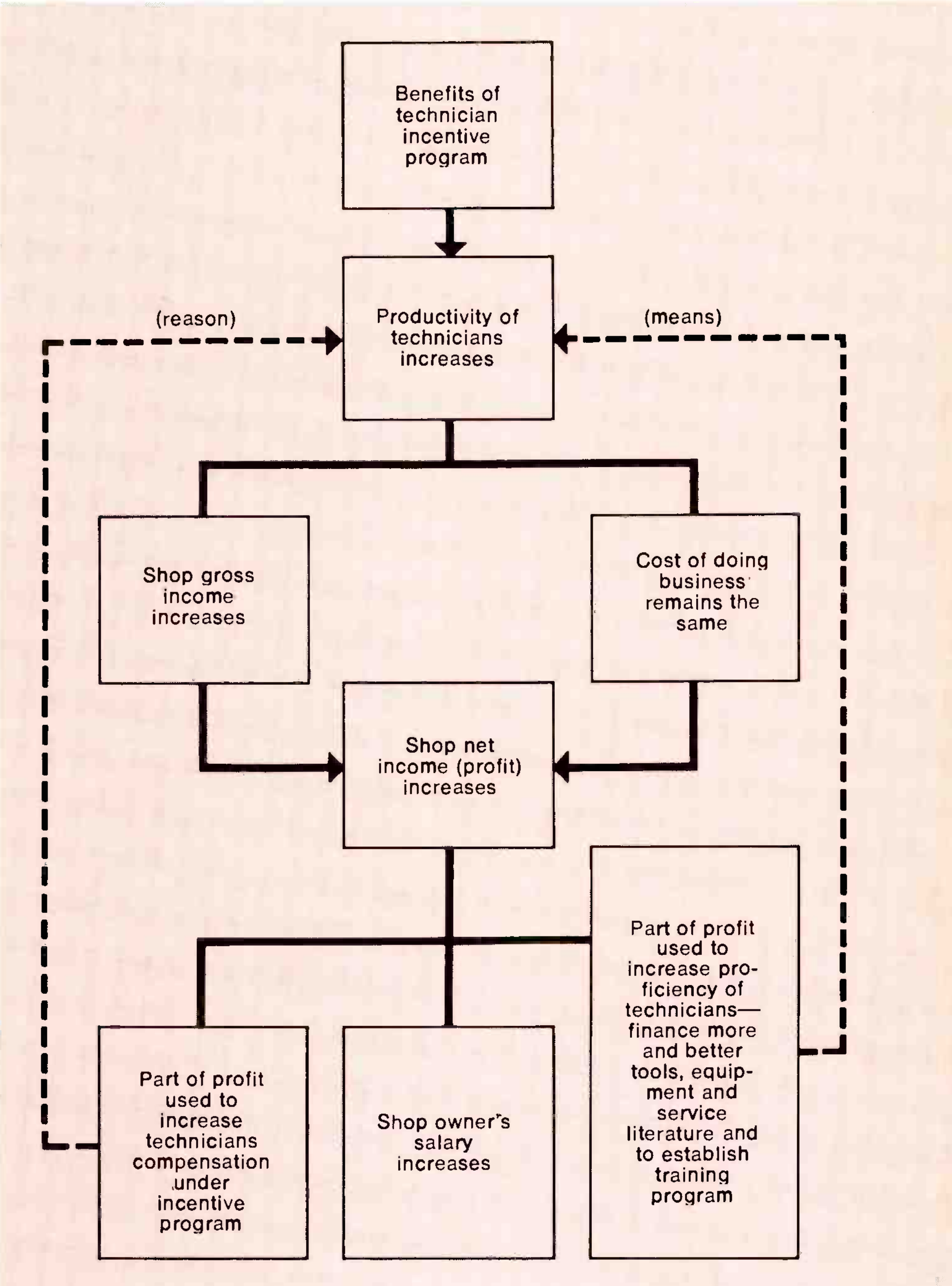
(45% of labor sales) from customer and internal labor totaled only $500, the account would be closed for the period and his guarantee would be his earnings for the period.

Note that the technician earns 45 percent of the full value of the labor he completes, whether it is servicing a customer's set or reconditioning a trade-in for sale. Allowing the technician 45 percent on all service jobs without regard to whose property he is servicing is the incentive for the technician to accomplish *all* servicing with dispatch. If you set up differentials based on one rate for reconditioning trade-ins and a higher rate for customer service, you will have a log jam at all times in all but direct customer servicing, not to mention the complications in record keeping and pay computation.

Conclusion

The combination of flat-rate pricing and an effective incentive program can increase your net profits by stimulating your technicians toward increased productivity.

The incentive pay plan just described—45 percent of total labor sales minus guarantee drawn during period equals total compensation—is the simplest, most effective and most practical system for the typical service shop. It eliminates all complicated methods based on quotas, excess over previous period and similar formulations. On the other hand, it is certainly more effective and more practical than bonuses based primarily on seniority without regard to output. And it is flexible and can be adapted to your own job price scale, your own seasonal work pattern and other conditions that might be peculiar to your service business. ▲



A portion of the increase in net shop income produced by an effective incentive program can be used to finance and supplement the incentive program. Part of it can be diverted to increase technicians' salaries and fringe benefits, and part can be used to offset the expense of training and new equipment needed to improve the proficiency of the technicians in your shop.

Increasing the productivity of your technicians is one sure method of effectively lowering your operating costs and at the same time increasing your margin of profit. This, in turn, will enable you to:

- Provide your technicians with better compensation and fringe benefits—which will help you attract and retain good technicians.
- Price your services more competitively—a wider margin of profit will allow you more flexibility in pricing.
- Establish a continuing training program for your technicians.
- Purchase more and better tools and equipment.
- Pay yourself a better salary.

Chroma Waveforms . . . where to find them and how they should look

by Forest H. Belt

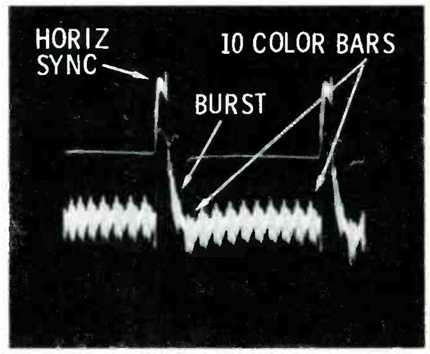


Fig. 2 When counting bars in a waveform, always omit the burst. The third color bar (red), therefore, is the fourth one to the right of sync.

Technicians who try to service color soon find there's no use tackling chroma troubles without an oscilloscope. Those who can't operate a scope just drop out.

Aside from knowing how to operate the scope, you also must be able to interpret the waveforms you obtain. To do this, you must be able to answer a number of important questions about the waveforms: Is something important missing? How critical is amplitude? What's the right shape? What should the burst output look like? The signal from the chroma reference oscillator? Demodulator waveforms? How to find the answers to these questions is the subject of the following paragraphs.

The Rainbow Waveform

You can trace chroma faults with a station color signal. But it's more dependable to use the signal from a color-bar generator. Nowadays, most color generators are keyed-rainbow types. Older NTSC types are seldom used.

The keyed-rainbow display on a color picture tube is sketched in Fig. 1. The keyed-rainbow waveform is directly below, so you can see the relationship.

A closeup version of a keyed-rainbow scope waveform is shown in Fig. 2. Study this photo carefully. Each label indicates a portion of the waveform that is important to troubleshooting and color-set adjustment.

A keyed-rainbow generator puts out a 3.563795-MHz signal (called a 3.56 signal for convenience). The 3.563795 frequency is just 15,750 Hz away from the 3.579545-MHz (3.58 MHz) frequency of the color oscillator in the receiver. Color phase thus rotates one full cycle for each raster line. The result is a rainbow-hued raster. It starts with yellowish-orange at the left, proceeds through red, then blue, to green.

With keying, the "rainbow" is interrupted every 30° by a black bar. To accomplish that, the 3.56 signal is shut off for about 5 μsec inter-

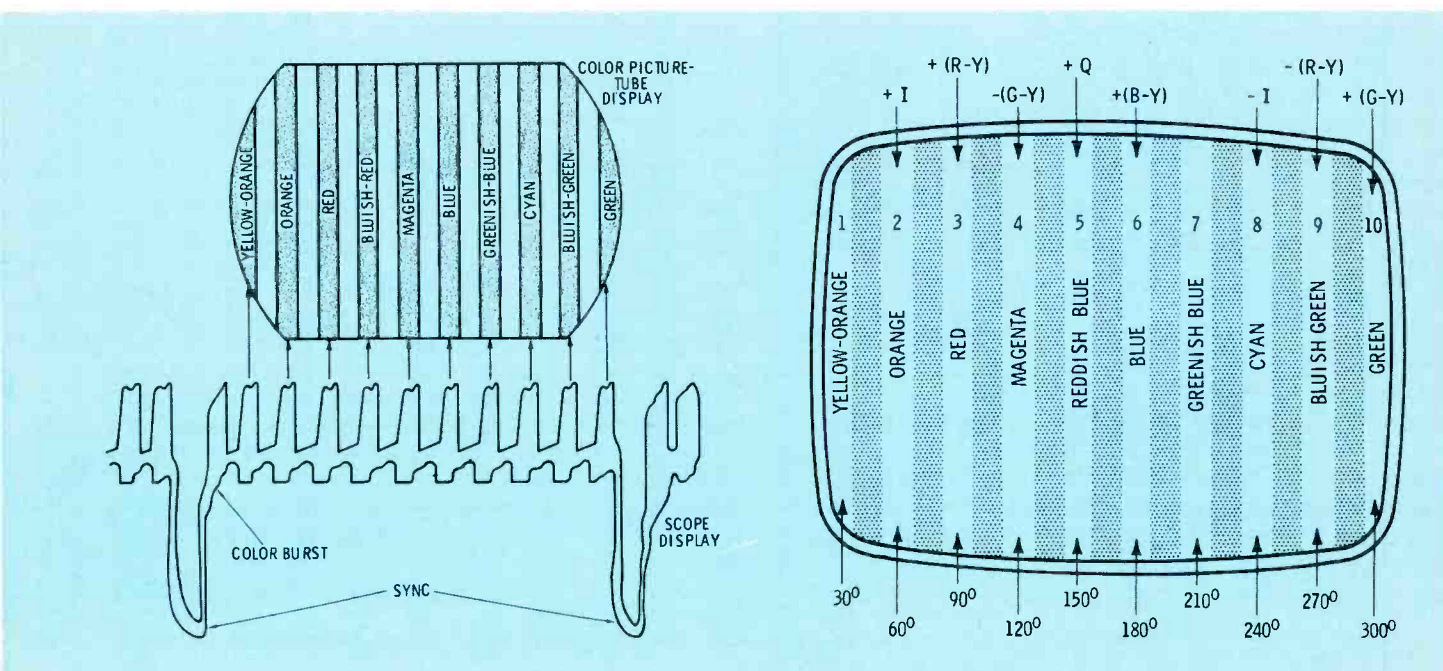


Fig. 1 Color-bar generator of keyed-rainbow type produces the series of bars shown here. The burst bar can't be seen on the screen because it is too far to the left side.

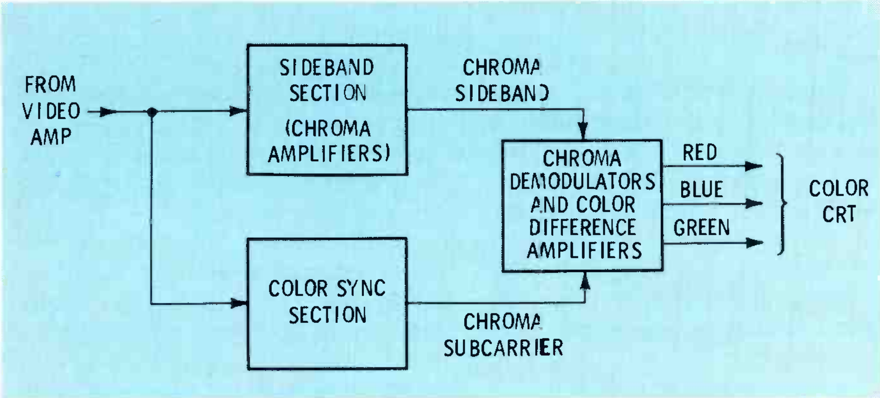


Fig. 3 Color circuitry of color receiver is comprised of three subsections, as shown here.

vals. The bars mark each definite color change in the rainbow pattern. There are ten color bars.

The color-synchronizing burst is one "bar" of 3.56 signal at the trailing edge of the horizontal sync pulse. It can't be seen on the picture tube because the CRT is blanked out during the time it is present.

Locking a chroma waveform on the scope screen is simple. Just set the horizontal sweep frequency at "H" or a little less than 8 KHz. Adjust the frequency vernier (fine frequency) for two steady groups of bars.

The sync control of the scope should be set for internal. Set it to positive (+) when the horizontal sync pulse in the waveform points upward, to negative (–) when the pulse points downward. If the horizontal pulse has been wiped out, either polarity is okay.

Chroma Subsections

The chroma section of a color receiver can be divided into three subsections, as shown in Fig. 3.

One is the sideband subsection. It processes the color sidebands from video detector to color demodulators. The stages in this subsection are called chroma amplifier, color IF, bandpass amplifier, chroma driver and similar names.

Another subsection carries color sync to the chroma reference oscillator. Stages in this subsection include: burst amplifier, color sync amplifier, chroma reference control, reactance stage and color oscillator; similar names of stages are used in various brands.

Signals from those two branches come together at the chroma demodulators. The stages that follow the demodulators carry reconstructed color information to the picture tube. The stages have titles like color difference amplifier, color video amplifier or driver, or similar names. Some are labeled with a color designation: B-Y (blue) driver, R-Y (red) amplifier, etc.

The Sideband Amplifiers

Stages in the sideband subsection must amplify equally all the color sidebands. No distortion can be allowed. Along the way, sometimes right at the input, the horizontal sync pulse and color-sync burst are eliminated.

Waveforms for this subsection are shown in Fig. 4. The first waveform (Fig. 4A) is the keyed-rainbow signal as it comes from a video amplifier. The horizontal sync pulse is prominent, and you can see the bars of the 3.56 color signal.

The horizontal pulse and the color-sync bar are eliminated from Fig. 4B. This waveform was obtained after the chroma takeoff coil.

The takeoff coil is wide band, picking off frequencies near 3.58 MHz. It easily passes the color sidebands (in this signal, the bars of color), but it can't pass video (luminance, or Y information), most of which lies in frequencies less than 2 MHz. And it can't pass the 15.75-KHz horizontal sync signal.

The amplitudes of the waveforms in both Figs. 4A and 4B depend on what video stages precede them. A few color sets feed chroma directly from the video detector, in which case the amplitude would be 2 or 3 volts p-p. When a video stage has boosted the signal before chroma takeoff, the amplitudes of the waveforms in Figs. 4A and 4B will be between 10 and 20 volts p-p.

Chroma sidebands get at least one stage of amplification, sometimes two or three. One transistor color set sends them through five stages. Somewhere in the subsection is a color control so a viewer can reduce the level of the color output and prevent too much color saturation at the picture tube. The chroma waveform fed to the color demodulators can be from 20 volts p-p to maybe 40 or so. It depends on the requirements of the demodulators. Its amplitude can be varied by the color control.

The sideband waveform at the demodulators should be clean, as is the one in Fig. 4C. The "blanking" space has been stripped of both sync and burst. The tops of the 3.56-MHz bars are even and level. The color sidebands are ready for demodulation.

In the Color-Sync Subsection

Exactly what the color-sync input waveform looks like depends on where it is taken from. In some color sets, it comes directly from the video amplifier, same as the sidebands. In others, it is picked off following a stage of chroma amplification.

An RF capacitor—around 100 pf—usually couples the signal to the first stage, the burst amplifier.

Another signal also is fed to the burst amplifier; it's a keying pulse from the flyback transformer. The burst amplifier is cut off most of the time, but this keying pulse turns it on for a short period. The timing is such that the stage turns on only while color sync is being applied. During the rest of each input waveform, when the color bars are being applied, the burst amplifier is cut off. As a result, only color sync gets through the burst amplifier.

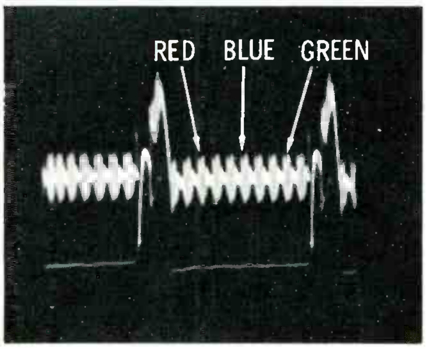
You've already seen the waveform from the video amplifier (Fig. 4A). Shown in Fig. 5A is the keying waveform from the flyback. It is large, generally 100 volts p-p or more, sometimes up to 200. A resistor and capacitor generally lower it to about 50 volts p-p at the burst amplifier.

The combined waveform is shown in Fig. 5B. You can see how the 10-volt color signal modulates the 50-volt keying waveform. You can count the burst bar and all ten color bars strung out along the pulse.

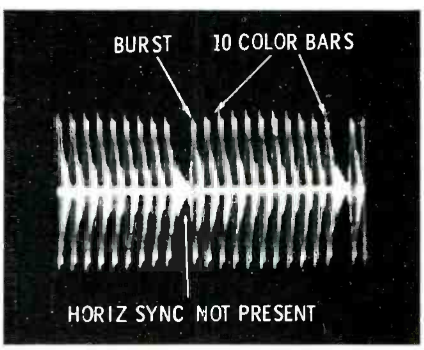
But the burst amplifier is biased deep into cutoff. Only the burst bar high up on the pulse gets amplified. That's why the burst output waveform in Fig. 5C is completely devoid of bars. All you see at the output of the burst amplifier is a periodic burst of color sync.

A balanced transformer feeds the

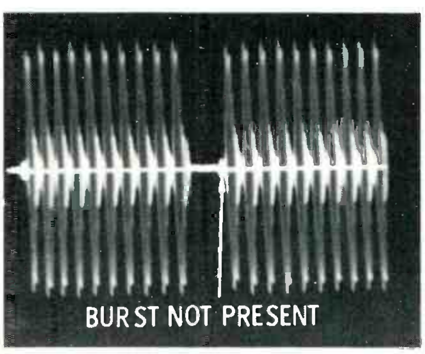
Fig. 4 These are the waveforms in the chroma, or bandpass, section of a color receiver. Any of them can be inverted at certain points if passed through a common-cathode or common-emitter amplifier.



(A) Chroma signal from video detector or amplifier.

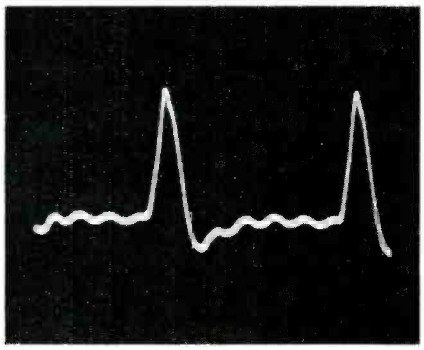


(B) Chroma takeoff coil eliminates sync pulse.

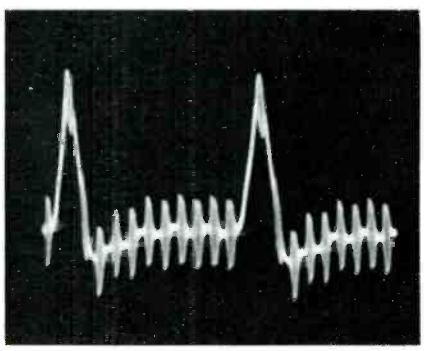


(C) Blanking in chroma or bandpass amplifier eliminates burst.

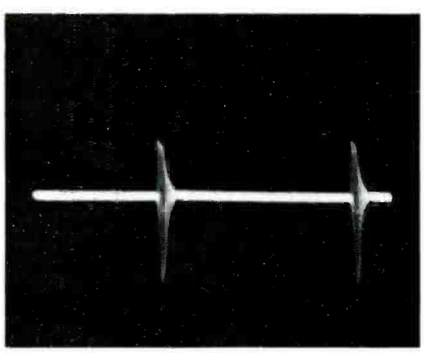
Fig. 5 Waveforms in color-sync section of color receiver. The keying pulse is shaped differently in some chassis, especially transistor models.



(A) Flyback pulse turns on the burst amplifier.

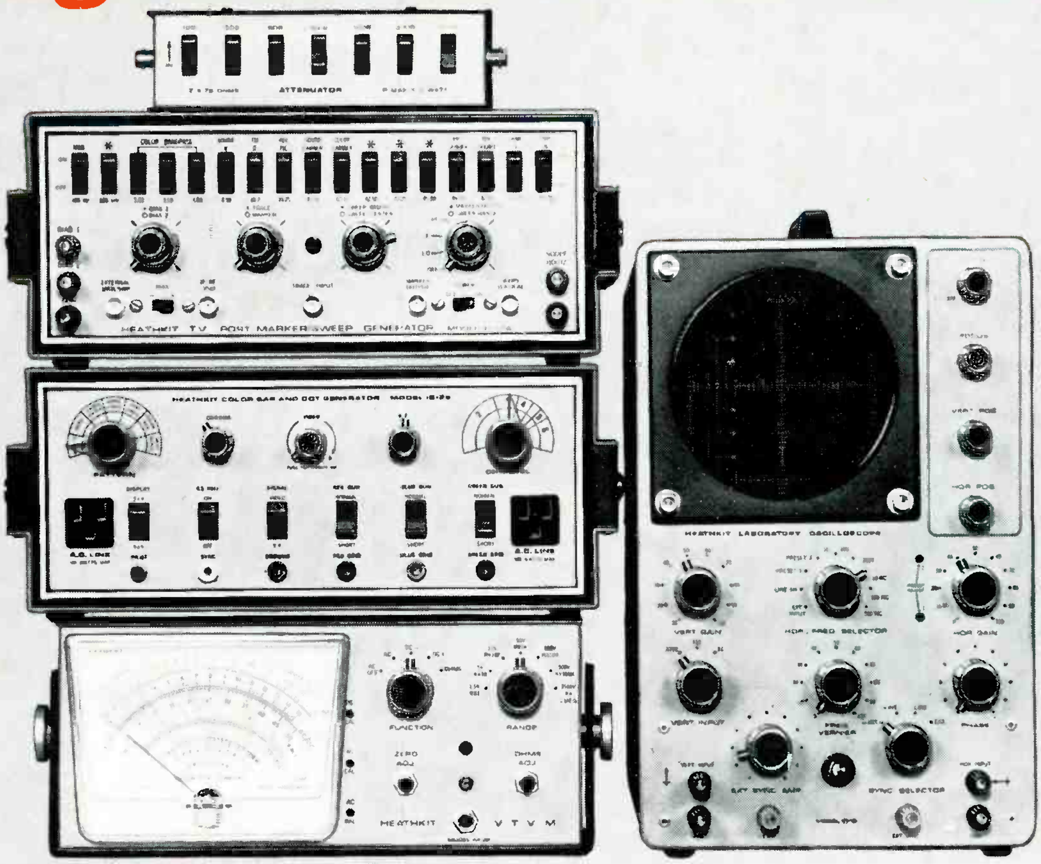


(B) Keying pulse and color-bar signal.



(C) Output of burst amplifier is color sync only.

stack these up against the others . . .



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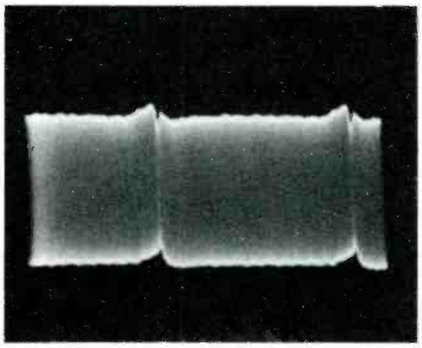


(A) Scope set for TV-horizontal sweep rate

(B) Scope sweep at nearly 2 MHz

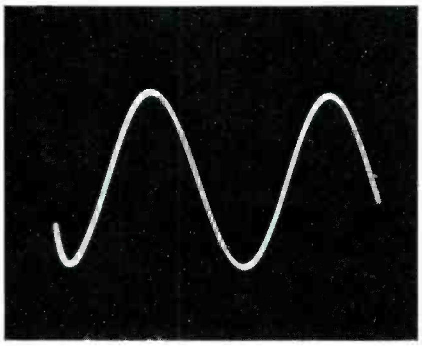


Fig. 6 Waveforms you see if you scope a normally functioning color oscillator.

color sync to several other stages. Amplitude of the burst is often 100 volts p-p or more. In most chassis, the burst output operates a DC detector that controls the oscillator, color killer and automatic chroma control stages. There are no waveforms in these DC-control stages. In some newer chassis, the burst directly triggers a crystal that synchronizes the color oscillator.

From the oscillator to the demodulators, a scope is little help. The only signal is chroma reference, near 3.58 MHz. You can scope it if you like. With the scope set the same as for the other waveforms, the trace will be like that shown in Fig. 6A. Amplitude is anywhere from 15 volts p-p to 40 or more. If this waveform is missing, the oscillator is dead. If your scope sweep frequency goes high enough, you can look at individual cycles of the signal (Fig. 6B). It's just a sine wave, and there's no real troubleshooting to be had from it.

Scoping Past the Demodulators

Following the color demodulators, the bars are no longer 3.58-MHz RF. They are the actual signals that turn on the guns of the picture tube.

There are three color waveforms coming from the demodulators. At first glance they may look alike, but there are important variances. Looking at them together in Fig. 7, you can probably spot the minute differences.

The thing to notice is which bar has the most positive amplitude. If it's the wrong bar, the demodulators or certain adjustments are at fault.

Fig. 7A is the red waveform, from the R-Y demodulator. This is the waveform that feeds the red gun, and the third color bar is supposed to be red. Consequently, the third bar in the waveform should have the greatest amplitude in the positive direction.

The blue waveform, from the B-Y demodulator, is shown in Fig. 7B. The sixth bar in a normal keyed-rainbow display is blue. So, if the demodulators are working right, the sixth bar in the B-Y waveform should be the tallest.

The green demodulator waveform is shown in Fig. 7C. The last (tenth) bar is the most positive, because the final bar in the screen display is pure green. (The green color bar might be almost hidden off the right side of the picture tube.)

Coming from tube-type demodulators, the p-p amplitudes of these waveforms might be 200 volts or more. Green usually has the lowest p-p voltage. Transistor or diode demodulators may produce less amplitude, but amplifiers that follow make up for that.

The color or color-difference amplifiers should amplify the waveforms without changing them. They should look like Fig. 7 right up to the picture tube. But don't forget about amplifier inversion; each stage can flip the waveform upside down.

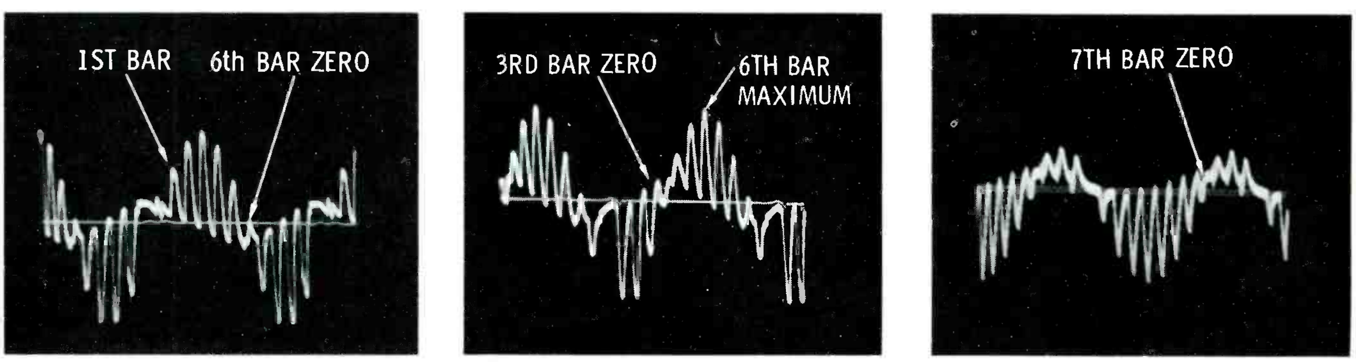
Trust What You Find

These waveforms are typical of those found in many color TV brands and models. The PHOTOFACT schematic for each model is your authority on exactly what to expect. Most manufacturers' recent schematics also include waveforms to guide you.

Most important, though, is that you get that wide-band scope out and put it to use. Try it in sets that are operating normally. Learn what the waveforms look like and exactly where they are found in each section. Make setting up the scope second nature.

And then trust your scope. If it says the waveform isn't right, track down the trouble. It's fast . . . and often the only way. ▲

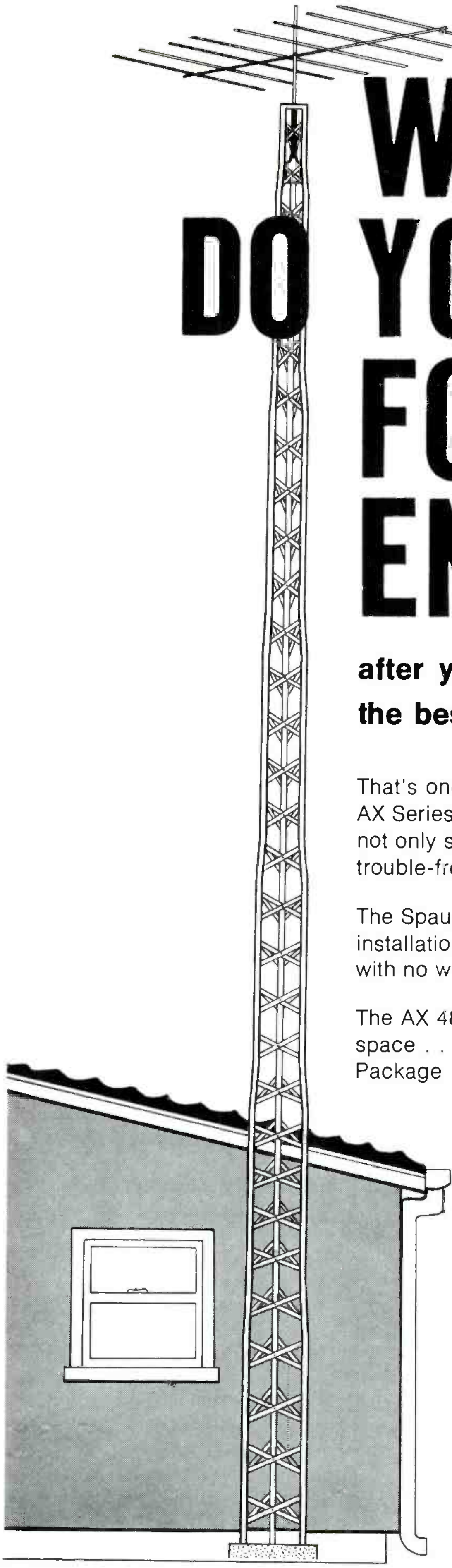
Fig. 7 Demodulated color signals still have rainbow pattern.



(A) At CRT red grid

(B) At CRT blue grid

(C) At CRT green grid



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audio systems report

MATV Background Music Unit

A unit that permits reception of FM broadcast programs through an unused TV channel is announced by the Systems Division of JFD Electronics Co.

Designed to provide a channel of FM background music to all TV receivers connected to a master antenna system (MATV), the self-contained solid-state unit converts the FM signal to the VHF frequency of any (6 and 13 excluded) unused TV channel.

The MusiMix, connected between the antenna and the MATV amplifier, passes all UHF and VHF TV

frequencies as well as all FM frequencies. The low-level output of the unit prevents overload, according to the manufacturer.

The unit also reportedly can be adapted as a maid-call, paging system, or for use with a phono by adding an FM microphone.

Price of the unit is $125.

Circle 50 on literature card

Solid-State Telephone Amplifier

A solid-state, battery-powered telephone amplifier, Model TA100, has been introduced by RCA Parts and Accessories.

The completely portable device reportedly allows "no-hands" telephone conversation between individuals or groups. It is made up of two units: the amplifier unit and the speaker unit.

Operation is accomplished by placing the telephone handset on the cradle of the RCA Telephone Amplifier, with the mouthpiece of the handset in the "well" at the front of the amplifier unit. The user talks toward the mouthpiece of the telephone, his voice is picked up and the listener can hear him as if he were speaking directly into the mouthpiece, according to the manufacturer. The voice of the other individual comes through the speaker unit, which is positioned by

the user for easy listening. The speaker volume can be raised or lowered by turning the volume control. After a call is completed, the RCA TA100 reportedly shuts off automatically when the handset of the phone is lifted off the device and returned to its cradle.

The telephone amplifier operates on four ordinary penlight batteries, and requires no wiring or installation.

The price is $17.95.

Circle 51 on literature card

Microphone for Cassette Recorders

A new microphone, equipped with universal fittings and designed as a replacement unit for portable cassette recorders, has been announced by the Mura Corp.

The unit features a 20- to 20,000-Hz response, an impedance of

200 ohms and a sensitivity rating of 78 dB. An on/off switch is also included.

The Piezo DX-133 microphone sells for $3.75.

Circle 52 on literature card

Cassette Adapter

The C/8 Coordinator, designed to adapt tape cassette machines to 8-track stereo cartridge units for better sound reproduction, has been introduced by the Weltron Company.

The unit reportedly enables owners of cassette machines to attach them to any audio equipment which

has an earphone jack, such as radios, television, phonographs, etc., allowing greater fidelity.

The Weltron C/8 Coordinator is list priced at $9.95.

Circle 53 on literature card

Music Loudspeaker

A new 18-in., 250-watt electronic musical instrument loudspeaker has been introduced by Jensen Manufacturing Division of The Muter Co.

The Model SMI 285 features a 12½-lb. magnetic structure, using

a 3¾-lb. DP-Alnico-5 magnet and a precision-wound 4-in. voice coil fabricated on a special highpower bobbin, according to Jensen. Solid, low bass notes reportedly are achieved with a laminated, reinforced, flexible edge suspension, and the rugged cast construction of the housing maintains precision line-up and protects against damage from rough handling.

The price is $262.00.

Circle 54 on literature card

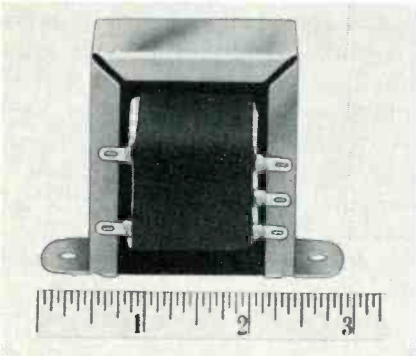
Audio Transformers

Four new audio transformers, designed for use in intercom speaker systems, have been introduced by Essex International, Inc., Controls

Division, Stancor Products.

Stancor transformer Models A-8076 through A-8079 are designed for 70.7-volt line-to-voice coil usage. Each transformer has 4/8/16 ohms of secondary impedance and four primary impedance ratings. The power rating ranges from 2.5 watts to 50 watts.

The four transformers reportedly feature low distortion, low noise



and excellent frequency response. Eight-in. leads are available, with quick-connect lugs.

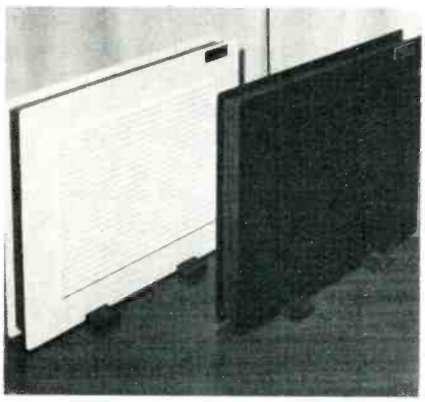
The prices range from $5.90 to $8.00 each in quantities of 1 to 9.

Circle 55 on literature card

Lightweight Speaker

A lightweight plastic loudspeaker, designated the Poly-Sonic, has been made available by Magitran, a division of ERA Acoustics.

According to ERA, the speaker can be connected easily to a hi-fi set or radio, and can be used in a standing position, mounted or hung.



The molded plastic baffle on the unit reportedly has punch-out screw holes to simplify edge-mounting or hanging. Mounting hardware, stand and 8 ft. of clear audio wire come with the speaker.

The Poly-Sonic measures 13¾ in. X 16¼ in. X 2 in., weighs less than 4 lbs., and has an input impedance of 8 ohms. The price is $19.95. ▲

Circle 56 on literature card

Dale's service bench

by Allan Dale

AM and FM Signal

Search tuners have been around a long time. But I guess not long enough. Letters I get suggest that, although the signal seeker is well known, it isn't always well understood.

Originally, search tuning was limited to AM car radios. Now it's available in Delco AM/FM auto receivers. There's also a German-built multiband car radio that's enjoying some popularity in the U.S. It's the Becker, and it includes a search tuner.

Though they are quite different in most ways, these two sets have signal-seeker circuits and mechanisms that are similar. After all, how many ways are there to get an auto radio to tune across its dial automatically, stopping when it happens upon a station strong enough to listen to?

The Action's in the Relay

You should understand what goes on inside the tuners of these radios. First, let's take a look at the mechanical operation.

The tuner scans by spring-power. The dial-and-tuning assembly is spring-loaded when it's at the left, or low-frequency, end of its travel. From that position, the dial moves across to the right. At the same time, the tuning cores are pulled out of their coils, moving the tuning upward in frequency. The speed at which the spring pulls the assembly depends on a gear wheel and a spinning centrifugal governor.

When it gets all the way to the right end, the mechanism hits a switch. That activates a heavy, powerful solenoid that pulls the mechanism back to the left end, stretching the drive spring. Then the assembly scans across again.

A **search relay** starts this scanning. It could then repeat indefinitely. But something happens to stop it. The coils tune in a strong station. Special transistor stages cause the relay to open. A latch bar on the relay catches the toothed gear wheel on the speed governor. It stops the tuner on-station.

To get another station, you touch a starting switch (such as the "wonder bar" of Delco). The relay closes and its latch is pulled away from the governor. The spring moves the tuner mechanism along until another station makes the relay drop out again, and the latch once more catches the gear wheel.

So, the search relay is the key component. When it's energized or pulled in, the tuner scans or searches. When it's de-energized, the tuner stops. Operating that relay is the job of the electronic stages in the search-tuning system.

An Electronic Signal-Stopper

Circuits and stages that sense a station and shut off the search are diagramed in Fig. 1. They're redrawn from the schematic of a Delco AM/FM Wonder Bar receiver.

The search sequence begins when you momentarily push switch S1 (a bar on the front of the receiver). The switch grounds one end of the coil of search relay K1; the other end is already connected to the 14-volt battery supply. The relay energizes and opens two sets of contacts and closes a third. These contacts start a lot of things happening:

1) They apply voltage to a regulated source—R21 and zener diode D13. This, in turn, supplies power to the transistors.

2) The 14 volts is connected to one end of solenoid K2.

3) Mute diode D11 becomes forward biased, and couples a high positive voltage to the audio predriver (not shown).

4) A disabling short is removed from a sensitivity network consisting of S3, C12, R17 and R18.

5) The time constant of the AGC line is made longer by removing a short across R20, putting that resistor into the AGC circuit.

Now examine these operations.

Energizing the 8.4-volt regulated source puts positive voltages on the base and collector of Q2, the relay amplifier. It's forward biased. Current goes high, making a large positive voltage at the emitter, across R14. This forward-biases Q3. Current through Q3 must flow in the coil of relay K1. This keeps the relay energized, even after the start bar is released.

The 8.4-volt source also powers the trigger amplifier, so it is "armed" and ready when a station is received.

A ratchet bar on the K1 armature disengages from the spring-driven gear wheel when K1 pulls in. This lets the search mechanism start scanning.

Meanwhile, the voltage going through mute diode D11 reverse-biases the first audio transistor. This blocks audio and keeps the radio silent while the tuner is seeking a signal.

The sensitivity circuit affects the gain of a stage up front. (It's an RF amplifier for AM and an IF amplifier for FM.) Switch S3 is shown in the least sensitive position. The network reduces the gain of the receiver so that only a strong local station can produce enough signal to stop the tuner.

If the switch were in the Distant position, the stage which the sensitivity circuit affects would operate normally. The tuner would then stop searching at practically every station whose signal is sufficiently strong to hear above the noise level.

Ending the Search

The start button has been pushed and the tuner mechanism is scanning. If it reaches the right end before a station stops it, the mechanism pushes limit switch S2, in series with the solenoid coil. There is already 14 volts at the other end of K2. When the switch closes, the solenoid operates, pulling the whole mechanism back over to the left end. Another part of the mechanism

Seekers Part 1

then opens S2. The tuner is free to scan from left to right again.

So how can a station stop the seeking? Take an AM signal for the first example.

The front end of the receiver acts the same as it would if you tuned across the dial by hand. Muting keeps you from hearing anything. At some point, the tuner encounters a station signal that is strong enough (remember the sensitivity network) to reach the last FM IF amplifier. A connection from that stage feeds the signal to capacitors C1 and C3. Through C1 it is applied across coil T1, which is tuned by a capacitor and by varicap diode D8. T1 peaks the input circuit at 10.7 MHz. Then the signal is coupled by C2 to the base of trigger amplifier Q1.

Q1 ordinarily has a slight forward bias developed by resistors R8, R9 and R10. The sudden rise in signal strength as the tuner encounters a station drives the base of Q1

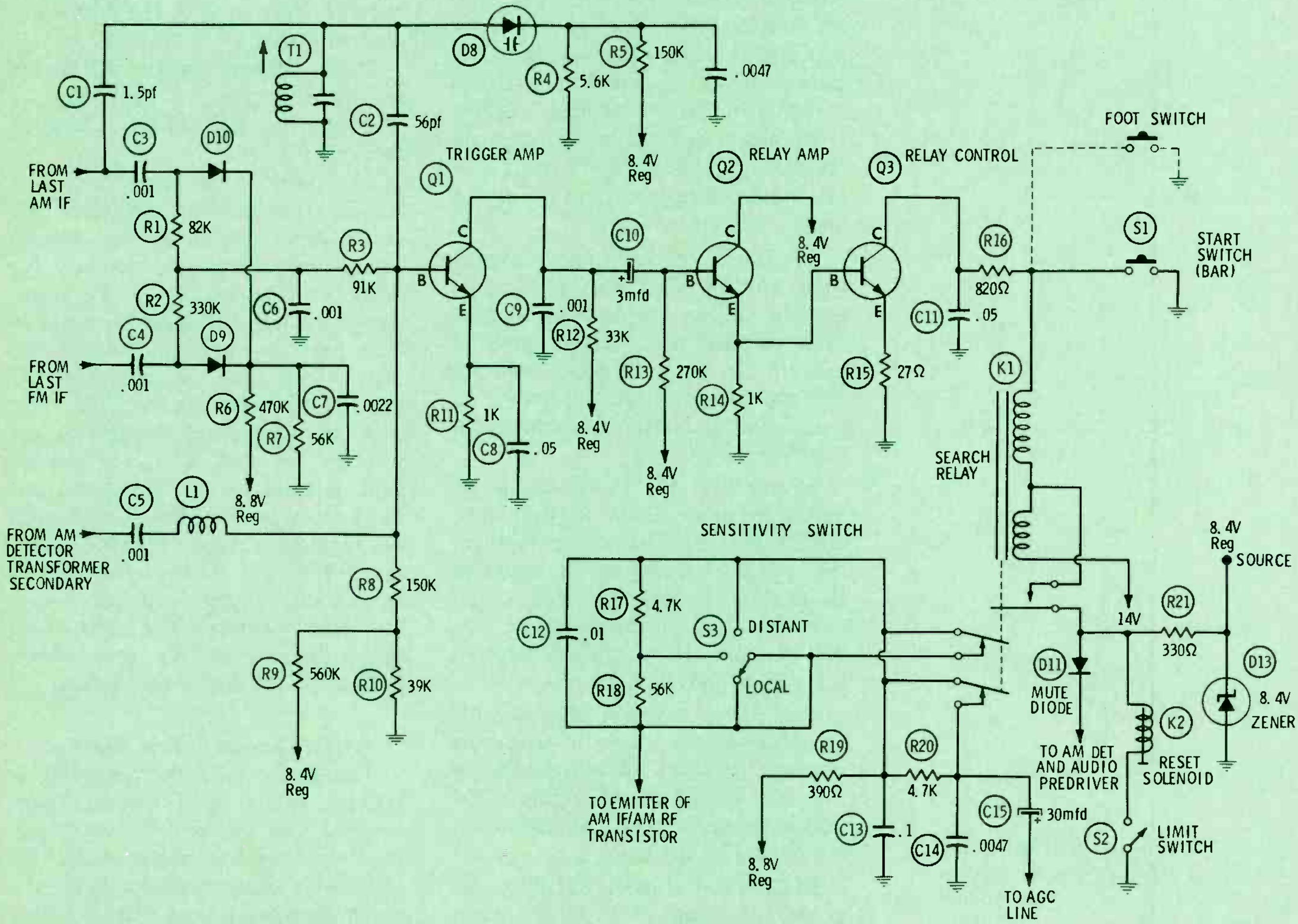


Fig. 1 Simplified diagram of signal-seeker portion of a Delco AM/FM Wonder Bar auto radio. The relay control stage holds the search relay energized until a station turns on the trigger amplifier and stops the other stages from conducting.

positive. The transistor suddenly conducts heavily, causing a sharp drop in collector voltage.

This wide negative-going pulse developed at the collector of Q1 is coupled by C10 to the base of the relay amplifier, Q2. It cuts off transistor Q2. The resulting absence of voltage across R14 cuts off Q3, and the search relay opens.

The ratchet bar on the relay armature catches the toothed governor gear, and stops the tuner. Muting voltage is removed when the relay opens, and the sensitivity circuit is disabled so that you can hear the station normally.

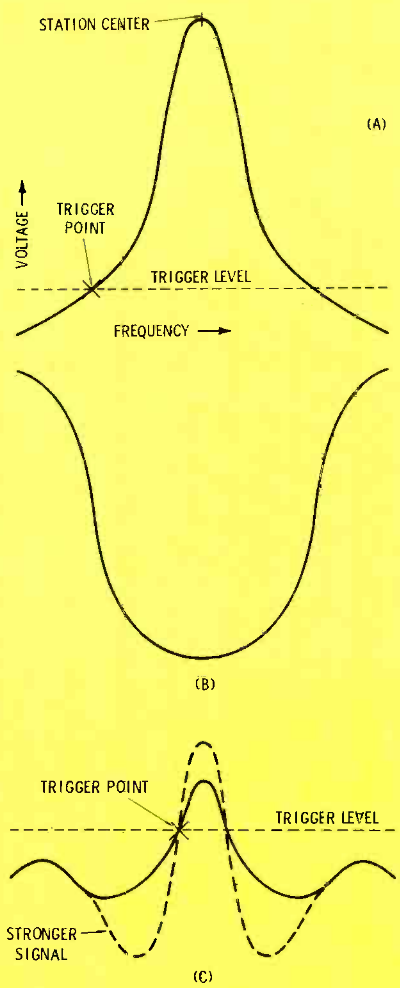


Fig. 2 Graph of rise and fall of DC voltage at base of trigger transistor as tuner scans through station signal. (A) Main signal. (B) Signal for gain control. (C) Resultant trigger voltage.

Smoothing Out Accuracy

Getting the tuner to stop accurately can be a problem in some cases. AM stations have sidebands that can falsely trigger the relay and control amplifiers into stopping the search. FM stations create sideband pairs that can have considerable energy. In either case, if the sideband triggers the stop, the tuner ends up mistuned.

A gain-control system in the trigger stage overcomes this problem. It reverses the normal reaction of the trigger amplifier to the outer edges of the station signal.

Fig. 2A is a graph of the DC voltage developed in the base circuit of trigger amplifier Q1 as the tuner scans.

The tuner approaches the station signal from below the frequency. Think of it in slow motion. As the tuner gets close, some of the sideband energy starts developing a positive voltage across the base-emitter junction of Q1 (Fig. 1). At first it's only a little. But, as the tuner gets closer to the exact center of the station signal, more and more signal strength builds the voltage higher. If nothing stops the tuner, it scans on through the station signal, and DC voltage drops away as the signal does.

Of course, this isn't happening in slow motion. The rise in voltage actually occurs during a small part of a second, because the tuner is moving. To the transistor, the voltage appears as a positive pulse. In the collector circuit, it becomes a negative pulse.

Meanwhile, C3 feeds the same signal to diode D10, in the input circuit of Q1. The diode rectifies the signal, developing a negative DC voltage across R1. This negative voltage is proportionate to signal strength. It is applied through R3 to the base of Q1.

Fig. 2B is a graph of this voltage. As you can see, it is almost opposite to the voltage shown in Fig. 2A. The chief difference is the curve's broadness (T1 sharpens the curve in Fig. 2A).

Both voltages affect Q1. Fig. 2C is the resultant curve. If you compare C with A, it's easy to see why this gain-control system lets Q1 trigger only near station center. A stronger or weaker station signal has little effect on how far from center frequency triggering takes place. The resultant curve (in Fig. 2C) merely steepens when the signal gets stronger (the dashed lines) and becomes shallower with weaker signals. The **width** of the center pulse stays about the same.

The trigger point on the curve is slightly before the station peak. That allows the fraction of a second it takes for the relay to drop out and the ratchet bar to catch the gear wheel. Any backlash in the mechanism is accounted for, and the station tunes in right on the nose.

Seeking an AM Station

The main AM signal comes from the secondary of the AM detector transformer, but before detection. It reaches the base of Q1 through C5 and L1 (Fig. 1).

The signal that develops the opposition DC voltage for gain control comes from the collector of the last AM IF stage. Its peak is broader, just as with the FM gain-control signal.

Diode D9 and resistor R2 do the gain-control job for AM signals. The opposing DC voltage is applied through R3.

The result is the same as in Fig. 2. The transistor is triggered into conduction only near the station center frequency (the carrier for AM). The output of Q1 is a negative-going pulse shaped the same as that part of curve 2C above the trigger-level line. It cuts off Q2 and Q3 the same as for FM.

A station strong enough to get through the AM RF stage (whose gain depends on the sensitivity setting) turns on Q1. The broad pulse of negative voltage on the collector of Q1 cuts off the relay amplifier which, in turn, cuts off the relay-control transistor. The relay drops out, blocks the gear wheel, and stops the tuner on station.

Other Brands Are Similar

The Delco isn't the only signal-seeking radio, as I already mentioned. The Becker, for example, has circuits that work much the same. But German schematics, even when translated, aren't always easy for U.S. technicians to follow.

The signal seeker of a Becker model "Mexico RT" has been redrawn in Fig. 3. The original part numbers are used, so you also can

work from a Becker schematic.

The start switch, S5, grounds the cold end of search relay Rel-1. Four sets of contacts pull in (up) toward the relay.

The 8.5-volt regulated line is connected to the collector supply networks of transistors T401 and T402. They, in turn, switch on transistor T403, which holds relay Rel-1 energized.

The second set of relay contacts apply a ground to certain audio stages, for muting.

The third set does two things. When the middle leaf moves away from its normally closed contact, it breaks a connection that forms the ground return for an IF stage. The leaf then closes with the top contact, applying the ground through two limit-switch contacts to one end of a sensitivity network comprised of R6, R214, R215 and R216.

Exactly which sensitivity resistors are between the IF stage and ground depends on the setting of Local-Distant switch S4, and on the setting of the radio's bandswitch. Whichever resistors aren't jumpered out lower the IF gain during search. Thus, weak stations can't stop the tuner.

The search mechanism is spring driven, like the Delco. When it reaches the right end, the mechanism nudges the limit switch. The search relay already has a ground connection applied to the center pole of the switch. The switch now grounds the "cold" end of the reset solenoid coil.

The solenoid pulls the mechanism back over to the left, reloading the spring that drives it. This also flips back the limit switch. It re-establishes the ground on the sensitivity resistor network. The tuner begins its hunt for stations again.

Sooner or later, a station is strong

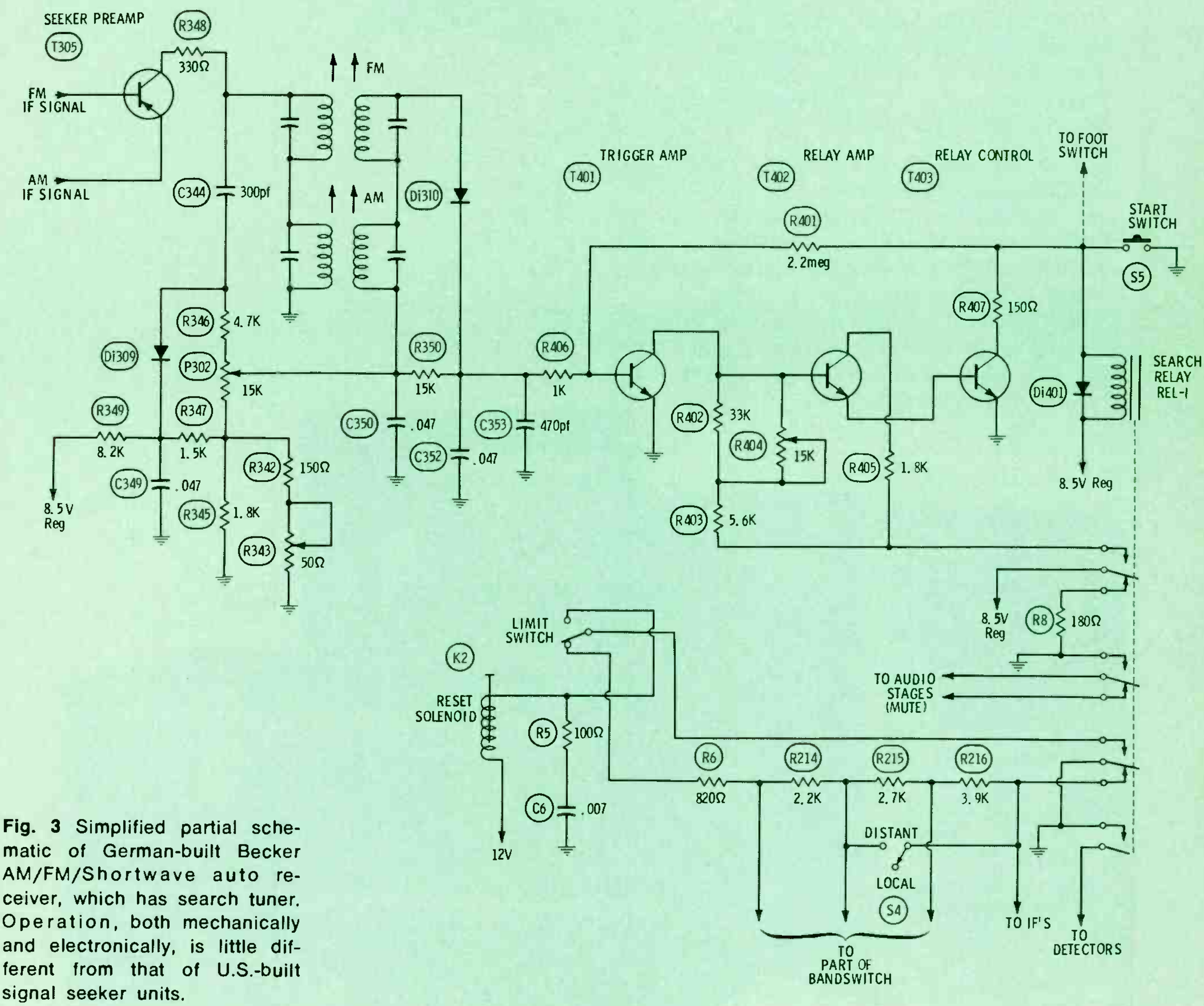


Fig. 3 Simplified partial schematic of German-built Becker AM/FM/Shortwave auto receiver, which has search tuner. Operation, both mechanically and electronically, is little different from that of U.S.-built signal seeker units.

enough to get through the desensitized IF stage. Whether AM, shortwave or FM, it is applied to a seeker preamplifier, transistor T305. One of the collector transformers couples the signal to diode Di310. The signal is rectified, developing a DC voltage across R350. The positive "end" of that voltage is applied through R406 to trigger amplifier T401.

The voltage developed by Di310 isn't really simple DC. As the tuner scans, this DC has the same rise-and-fall characteristic you saw in Fig. 2A. It appears across R350 as a fairly sharp positive pulse. Since T401 is an NPN transistor, this pulse at its base turns it on.

Conduction of T401 makes a similar pulse—only negative-going—at the collector. This is applied to the base of T402, cutting off this transistor. And this, in turn, cuts off T403.

The search relay drops out. It stops the mechanism, through a ratchet bar that engages the speed-governor gear. The relay contacts also unmute the audio, restore the IF stages to full sensitivity, and remove power from T401 and T402. The station is tuned in and audible, until you push the start switch again.

Diode Di309 is the gain-control diode. Capacitor C344 feeds it a sample of the incoming signal. Di309 rectifies the signal, but the DC voltage is applied to R350 in opposite polarity from the DC voltage of Di310. The graph in Fig. 2C shows the result.

The amplitude of the opposing voltage is controlled by a bias network, R342, R343, R345, R347 and R349. This is a divider between ground and 8.5 volts regulated. An adjustment, P302, determines how much of the opposing DC voltage is applied to R350.

Hunting Trouble

In the next issue I'll tell you how to troubleshoot signal seekers. Now that you have a good idea how they work, troubleshooting and repairs won't be difficult.

Signal seekers are partly mechanical, partly electronic. I'll explain how you can separate the two functions to make troubleshooting easier. And I'll include some hints that can take you directly to the fault in the least amount of time. ▲

Circle 20 on literature card

SIMPLE VOM TESTS

In Solid-State and Tube Circuits

by Robert G. Middleton

Basic solid-state and signal-tracing tests using the VOM are discussed in this article. The individual topics include out-of-circuit and in-circuit tests for junction transistors, test of unijunction transistors and tests of zener and tunnel diodes. Nine fundamental signal-tracing procedures in b-w and color TV also are described.

Out-of-Circuit Tests of Junction Transistors

Junction transistors used in consumer electronic equipment have three leads, and are categorized into PNP and NPN types. If there is doubt about which is the base, emitter or collector lead, use the ohmmeter section of the VOM to check the front-to-back resistance ratios, taking two leads at a time. The RX1000 range of the VOM is suitable for this test. If the transistor is not defective, one pair of the transistor leads will have a high resistance in both directions (high resistance using either polarity of the ohmmeter test leads). This pair is the collector and emitter. The remaining terminal is the **base lead.**

Next, compare the resistances from the base to each of the other terminals to identify exactly which are the emitter a d collector leads. If the transistor is not defective, the emitter-to-base resistance will be higher than the collector-to-base resistance (comparing either forward resistances or back resistances). During this same test, you can determine whether the transistor is a PNP or NPN type. If low forward resistance is observed when the positive lead of the ohmmeter is connected to the emitter terminal, the transistor is a PNP type; otherwise, it is an NPN type. These relations are depicted in Fig. 1. Shorted or open junctions are recognized immediately during this test; however, since ohmmeter battery voltages vary considerably, evaluation of suspiciously low front-to-back ratios are made best by comparison with a known good transistor of the same type.

A useful merit test of a transistor can be made as shown in Fig. 2. The ohmmeter leads are connected between collector and emitter, so that the collector junction is reverse-biased (negative lead to collector of PNP transistor). Normally, a high back resistance is indicated. Next, short-circuit the base lead to the emitter lead; the back resistance reading will now increase a number of times proportionate to the approximate beta value of the transistor. A small or no increase in back resistance denotes a defective transistor. The same general ohmmeter tests that apply to low-power transistors also apply to power transistors, except that a substantial front-to-back resistance ratio between collector and emitter will be indicated for the power type, as shown in Fig. 3. Again, because of variation in ohmmeter design, evaluation of front-to-back ratios for power transistors should be made by comparison with a known good transistor of the same type.

In-Circuit Tests of Junction Transistors

Since transistors usually are soldered into their circuits, it is a considerable time-saver to know how to make in-circuit tests. A turn-on test can always be made; however, a control-action (turn-off) test cannot be made in some types of circuits. A turn-on test is less conclusive than a turn-off test.

Fig. 4 shows how to make a turn-on test. A small amount of the collector voltage is bled into the base circuit. A voltmeter is connected between the collector and emitter terminals. If the voltmeter reading decreases when the 10K resistor is bridged between the collector and base terminals, the transistor is responding to the turn-on test. If there is no response, the transistor is defective.

When making DC tests, regard coils as short-circuits and capacitors as open circuits. Only the transistors, resistors and voltage sources are taken into account. Thus, the circuit in Fig. 5 has been stripped to its DC essentials.

A control-action (turn-off) test is illustrated in Fig. 5. When the base is short-circuited to the emitter, the voltmeter should read virtually zero because the collector current normally is cut off when the base and emitter are at the same potential.

Only a limited control-action (turn-on) test can be made on the circuit in Fig. 6 because of R_B. A voltmeter is connected across R_L, and R_B is bridged with another 75K resistor. If the voltmeter reading doubles approximately, the transistor passes this limited control-action test.

When testing power-type transistors, a turn-off test is always safe. On the other hand, a turn-on test should be made with care, to avoid applying excessive forward bias to the base and burning out the transistor. The voltmeter normally will not indicate zero collector current during the turn-off test of a power transistor, although the current will be rather small. That is, the leakage current of a power transistor normally is several times greater than that of a small transistor.

VOM Test of a Unijunction Transistor

The test circuit in Fig. 7 is used to test a unijunction transistor (UJT) with a VOM. The VOM is set to a low-current range, such as 0-50 μa, and the potentiometer setting is slowly increased until the UJT is triggered on. Normally, because of circuit oscillation, the pointer will jump part way up the scale and vibrate; if not, the UJT is defective.

VOM Test of a Zener Diode

A zener diode can be tested using the circuit shown in Fig. 8. A pair of VOM's is convenient for simultaneously measuring the voltage and current values. The power supply must provide sufficient voltage to check the zener point, plus the resistive losses. For example, use a 12-volt power supply with an 8-volt zener diode. The current reading must not be allowed to exceed the maximum-current rating of the zener. Set the 5K potentiometer to minimum, turn the power on, and slowly advance the potentiometer setting. When the milliammeter reading suddenly starts to increase, the voltmeter reading should remain practically constant. Failure to re-

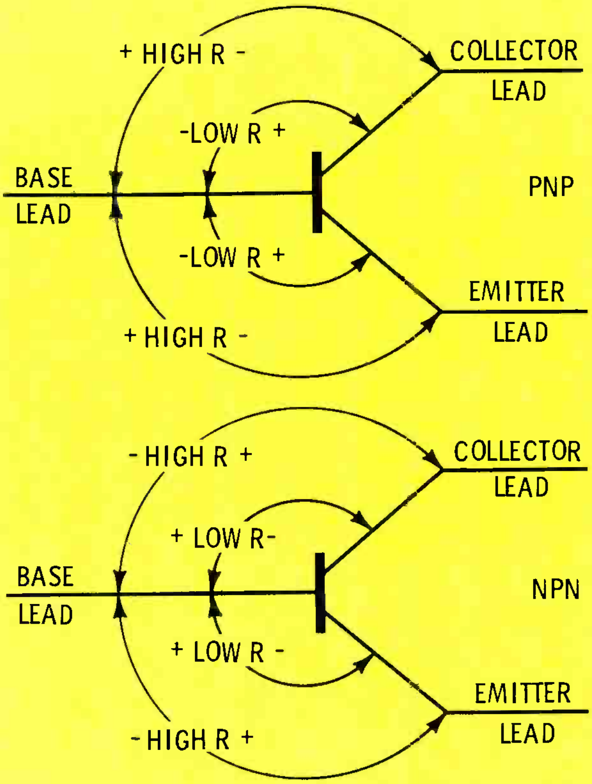


Fig. 1 Comparative ohmmeter readings for low-power PNP and NPN transistors.

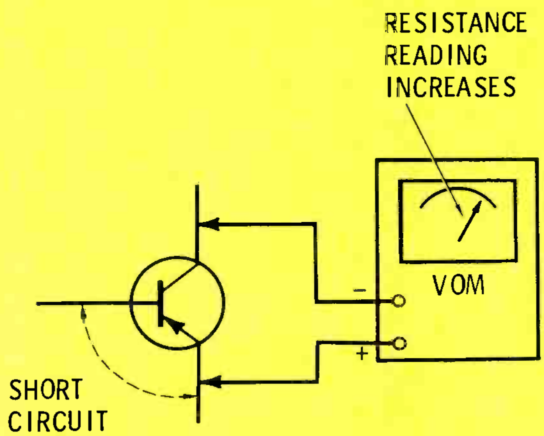


Fig. 2 Ohmmeter merit test of a transistor. Reading should increase when base is shorted to emitter.

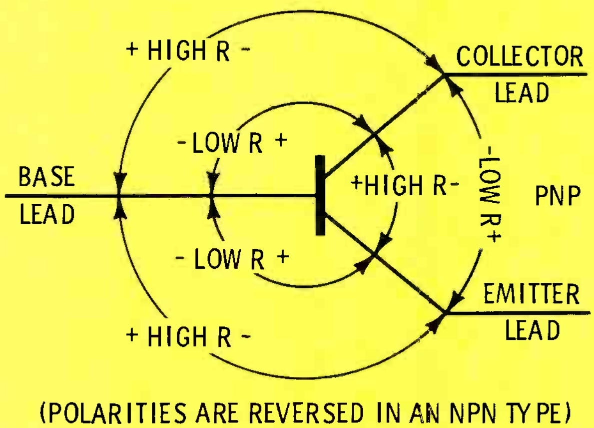


Fig. 3 Comparative ohmmeter readings for high-power PNP and NPN transistors.

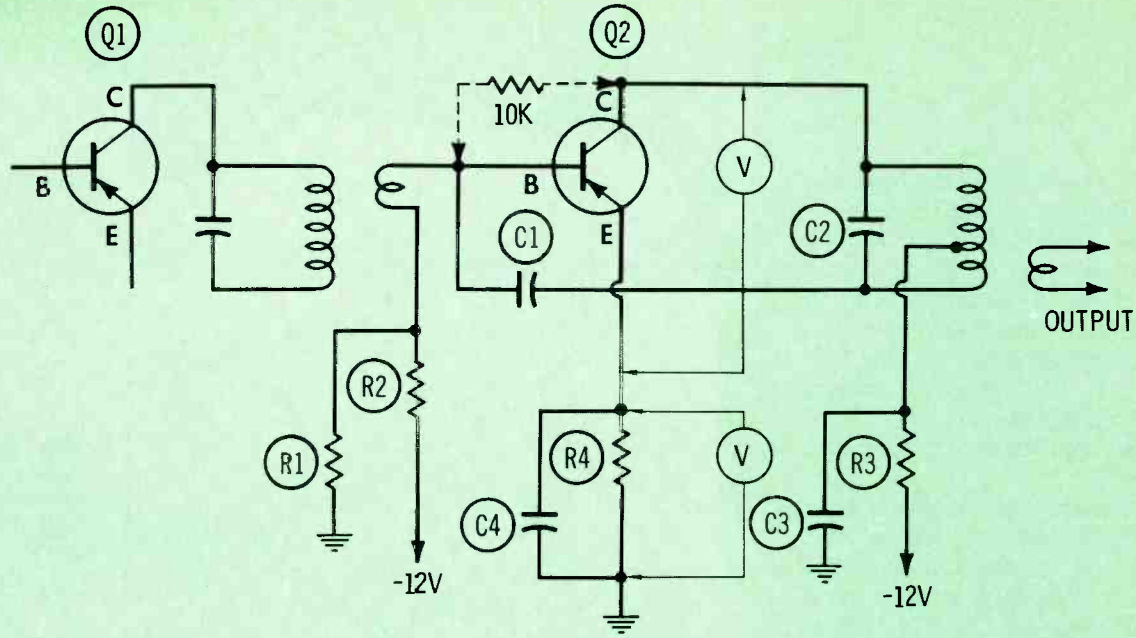


Fig. 4 In-circuit test with a 10K bias resistor. Voltmeter reading should decrease when transistor is turned on.

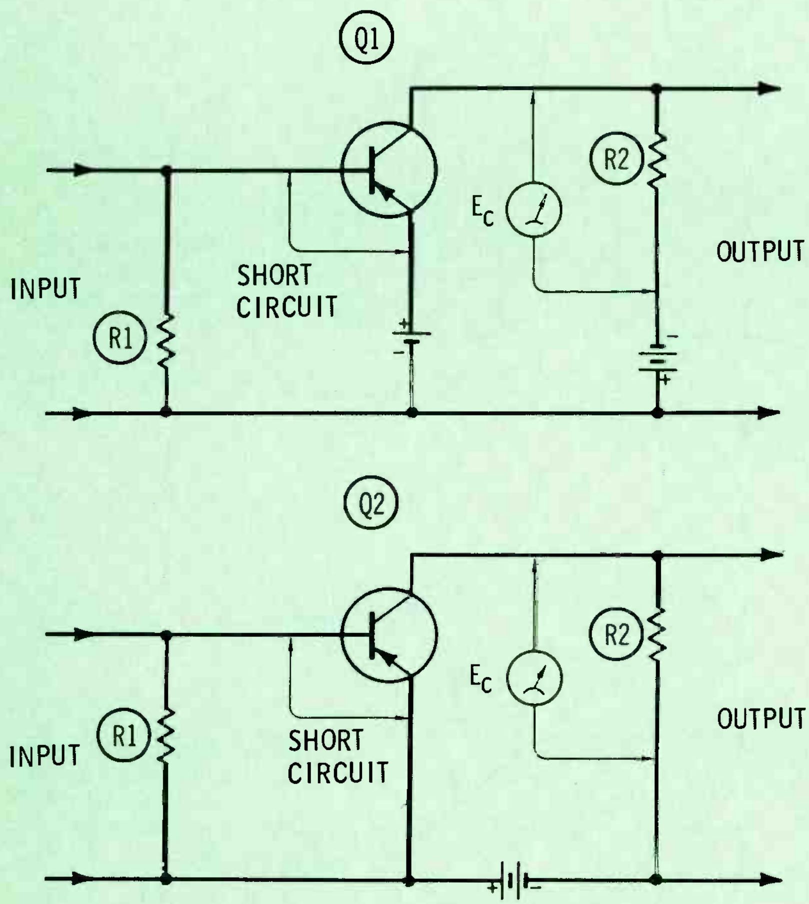


Fig. 5 Basic control-action, or turn-off, test. Voltmeter reading should decrease when base is shorted to emitter.

spond in this manner indicates that the zener diode is defective.

VOM Test of a Tunnel Diode

A tunnel diode can be tested with a VOM using the circuit shown in Fig. 9. Operate the VOM on its lowest DC voltage range, and slowly advance the output from the power supply. At first, the voltmeter should read a very small value. However, when a critical power supply output voltage is reached, the tunnel diode should suddenly switch, and the voltmeter, in turn, should jump to a typical reading of 0.5 volt. (The output of the power supply might be 200 volts at the diode switch-over point.) As the applied voltage is reduced, the voltmeter reading should drop slightly until a critical value of applied voltage is reached, at which time the voltmeter reading should drop suddenly to a very low value. The tunnel diode will appear to be defective if the power-supply voltage is applied with the incorrect polarity.

Signal-Tracing Tests in TV Receivers

Pinpointing Open Screen or Cathode Capacitors

Comparatively high-frequency AC voltages can be checked with a VOM using the signal-tracing probe shown in Fig. 10. The probe out-

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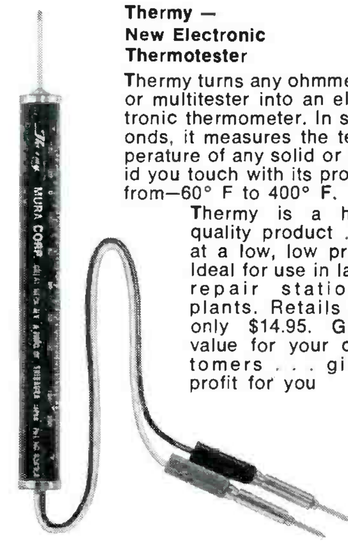

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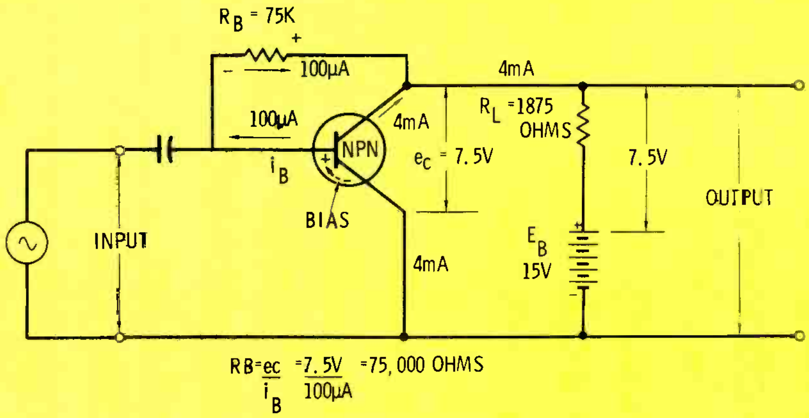


Fig. 6 Limited control-action test can be made. Voltmeter reading should double when RB is bridged with another 75K resistor.

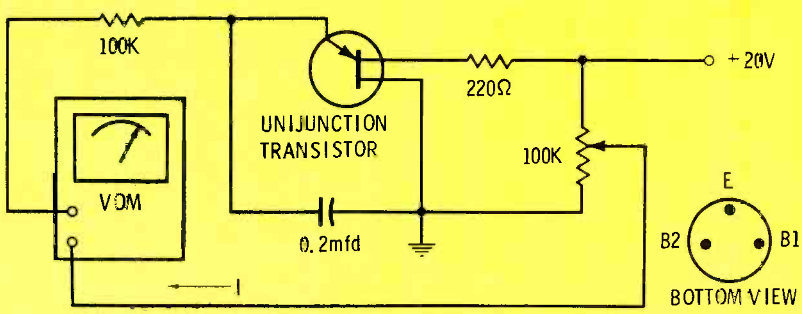


Fig. 7 Unijunction transistor test circuit.

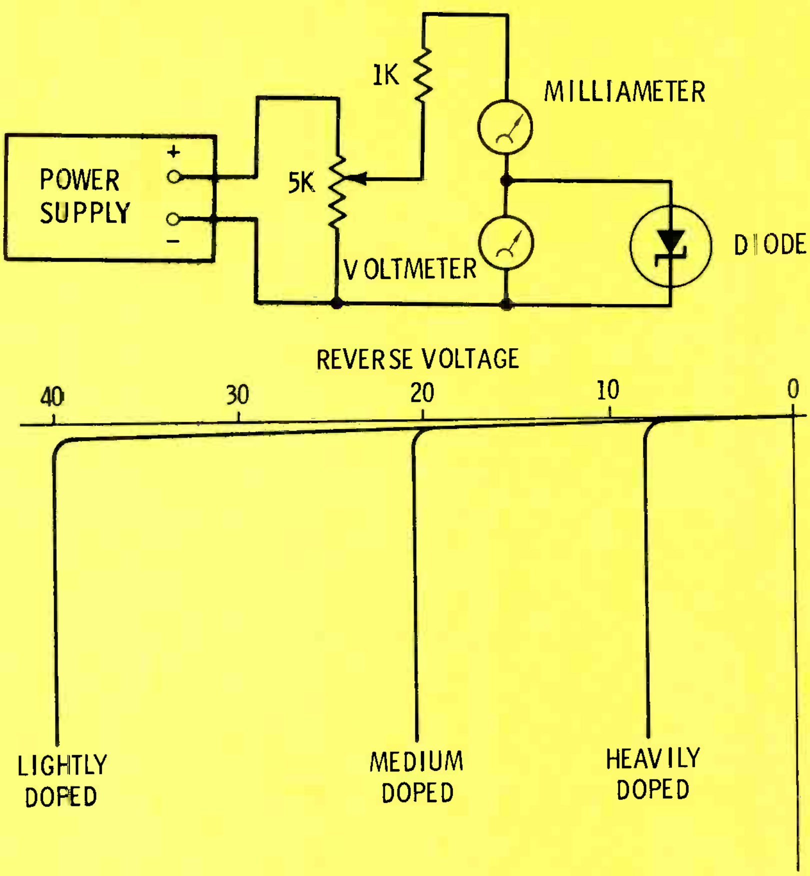


Fig. 8 Checking a zener diode. Voltage should level off and current increase when 5K potentiometer is increased after zener action has been attained. A) Test setup. B) Zener voltage depends on concentration of doping.

put is indicated by the DC voltage function of the VOM. When a screen or cathode capacitor opens, the AC voltage across the capacitor rises considerably. For example, when the screen capacitor in a typical flyback circuit opens, the meter reading increases about 10 times.

The same general reaction applies to cathode bypass capacitors in typical receivers.

Checking the Local Oscillator

To check for a dead local oscillator in a tuner, lift the tube shield as illustrated in Fig. 11 and apply the signal-tracing probe between the tube shield and chassis ground. An active oscillator will provide a meter reading of approximately 0.5 volt. Remember, a 100,000 ohms-per-volt VOM will give a higher voltage reading than a 20,000 ohms-per-volt instrument.

Tracing the IF Signal

Because the level of an IF signal is comparatively low, use a probe amplifier, such as that shown in Fig. 12, and operate the VOM on a low-current range, such as 0-50 µa. It sometimes is helpful to select a transistor that produces minimum no-signal zero offset (minimum leakage current). The probe amplifier increases the sensitivity of response more than 10 times, making it practical to trace IF signals and to check for open bypass capacitors in the IF section. An IF signal must be present.

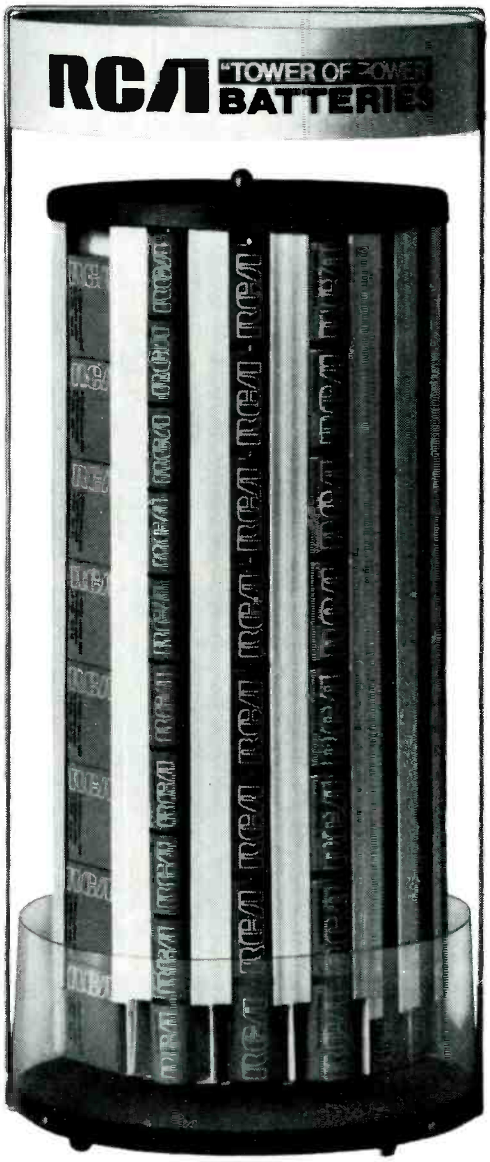
Tracing the Video Signal

The signal-tracing probe is used without a probe amplifier to signal-trace the video-amplifier section. The normal readings are about 0.5 volt at the picture-detector output, and about 25 volts at the video-amplifier output. Of course, a TV station signal or generator signal must be applied to the receiver.

Tracing the Intercarrier Sound Signal

The intercarrier sound signal can be traced with the signal-tracing probe in the same manner as the video signal. A TV station signal is required, or an intercarrier sound signal from a generator. Tests in this

How to spend less time selling more batteries



RCA's new "Tower of Power" merchandiser does almost everything for you but make change. It holds over 10 dozen batteries—in just 10 inches of counter space!

Its gravity-feed means automatic stock rotation. It rotates at the touch of a finger (great for impulse sales). It tells your salesmen what they need to know—battery data and prices. And it has individual channels for each of the popular sizes, 9-Volt, "D", "C", and "AA" cells.

Another great feature. If you're concerned about pilferage, the "Tower of Power" can be set up so only your sales clerks can remove the batteries!

Designed to display any or all of the top 10 types that cover 9-out-of-10 customer needs...Zinc Carbon, Alkaline, or Mercury.

Think round, think today. Get the "Tower of Power" and you'll sell more batteries without even trying. Contact your RCA Battery Distributor for complete details or write RCA Electronic Components, Commercial Engineering, Section C93N, Harrison, N. J. 07029.

RCA

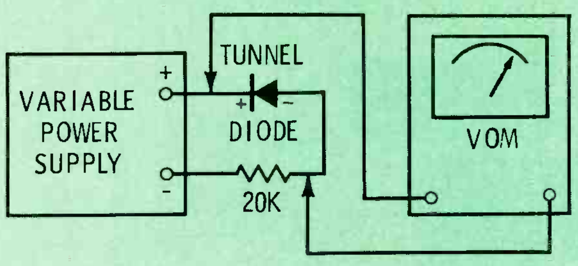


Fig. 9 Testing tunnel diode for switching action.

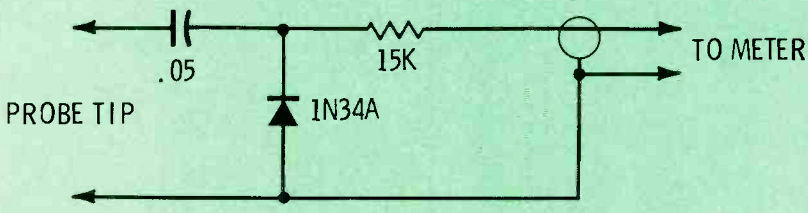


Fig. 10 Half-wave signal-tracing probe for VOM. Use a low voltage range on the meter.

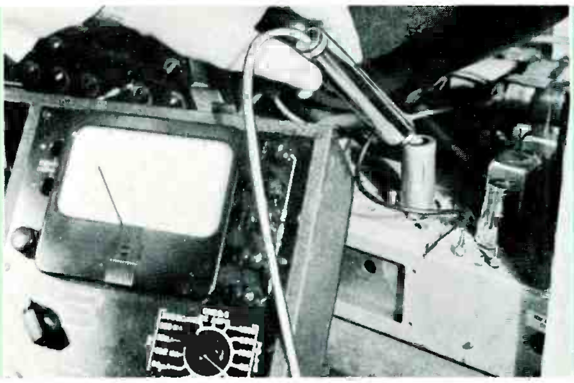


Fig. 11 Checking local-oscillator operation.

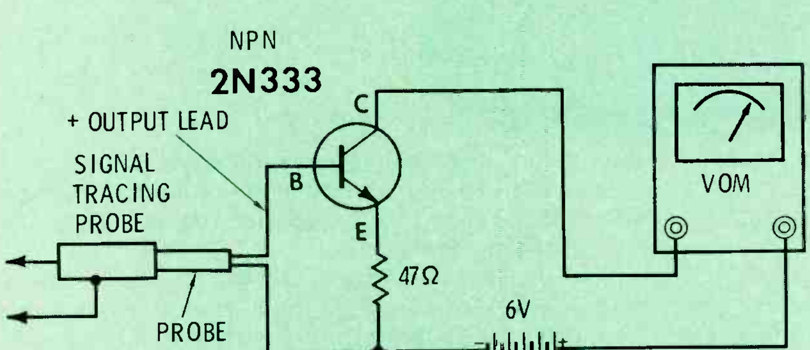


Fig. 12 Transistor probe amplifier. Use a low DC current scale on the meter.

section usually are used to show only the presence or absence of signal.

Tracing the Sync Signals

Signals in the horizontal- and vertical-sync sections can be traced using the signal-tracing probe. It is necessary to tune in a TV station, or to apply a pattern-generator signal to the receiver. Tests in the sync sections also are used to determine only the presence or absence of specific signals.

Checking the Vertical-Output Drive Voltage

To check the vertical-output drive voltage, apply the signal-tracing probe between the grid of the vertical-output tube and chassis ground. In a typical receiver, the meter should indicate 4 volts during normal operation of the receiver.

Checking the Horizontal-Output Drive Voltage

To check the horizontal-output drive voltage, pull the horizontal-output tube (transformer-type receivers only). Apply the signal-tracing probe between the grid terminal of the socket and chassis ground. In a typical receiver, the meter should indicate 20 volts.

Tracing the Audio Sound Signal

The "output" function of a VOM is most useful for tracing the audio sound signal. A signal-tracing probe is not used in this application. Of course, an audio tone must be present, provided either by a suitable generator or by a TV station signal.

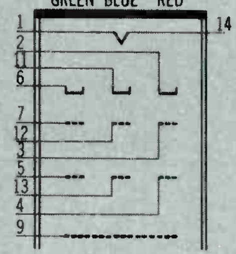
Summary

It has been pointed out in this article that a VOM has many more uses than merely direct measurements of voltage and resistance values. This basic instrument is a diagnostic aid, both in analysis of solid-state control devices, and in localizing defective circuits.

Practical work is facilitated by use of VOM's that have diode-protected meter movements, because the technician does not have to be continuously on guard against possible meter damage. ▲

Protection—Banded
Deflection—90°
Filament—6.3V @ 1.35A
Grid 2—400V

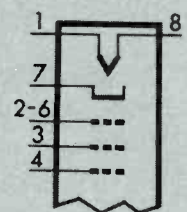
19HXP22



14BE

Protection—Banded
Deflection—114°
Filament—6.3V @ .450A
Grid 2—35V

20ADP4

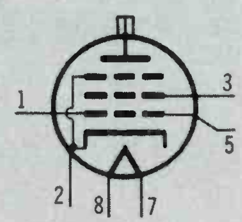


8HR

Horiz Output
Fil.—26V @ .04A

E_P	=	175
E_{SG}	=	110
E_G	=	−21
I_P	=	125mA
I_{SG}	=	3.3mA
G_m	=	14,000

26HU5

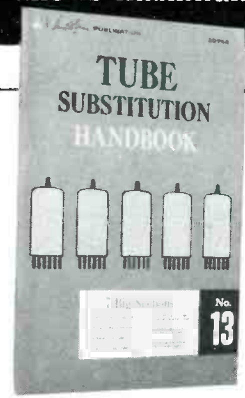


8NB

d

Electronic Servicing Tube Substitution Supplement

This Supplement has been designed to provide you with the latest up-to-date information on new tubes. The format allows maximum use during a house call or at the bench.



REMOVE THIS SUPPLEMENT FROM **Electronic Servicing** and put it in the back of your **TUBE SUBSTITUTION HANDBOOK**

direct substitutes

Included are the older tubes that will substitute directly for the new tubes. This information supplements the sections in the Tube Substitution Handbook for American Receiving Tubes and Picture Tubes.

basing diagrams

The basing diagram for each new tube will help you in the servicing of new receivers when service literature is not available.

typical characteristics

The typical, or average, characteristics of each new tube can be of great help when troubleshooting new circuits.

easy reference

The direct substitution list will be cumulative each month. Thus, only the latest edition need be carried in the Tube Substitution Handbook.

Direct Substitutions

To Replace	Use	To Replace	Use
2AS2A	*	16LU8A	16LU8
3BN2A	*	17ESP4	*
4LU6	*	17EVP22	*
5MQ8	*	17FCP4	*
6AG9	6AL9	18AJ10	*
6AK10	*	19DE3	*
6AL9	6AG9	19HXP22	*
6BW3	*	20ADP4	*
6KV6A	*	20AHP4	*
6MQ8	*	22AHP22	*
8AL9	*	25CK3	*
8KR8	*	25GP22A	*
8LS6	*	26HU5	*
9AK10	*	31AL10	
10ASP4	*	32HQ7	*
10LY8	*	33HE7	*
11CF11	*	12DEP4	*
11MS8	*	12DHP4	*
12DGP4	*	19GEP4	*
12DKP4	*	19HNP22	*
15ACP22	*	22TP4	*
16BX11	*	22ZP4	*
16DCP4	*	25ALP22	*
16LU8	16LU8A		

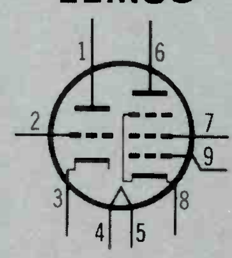
*No substitution at present time.
Thirteenth edition of Tube Substitution Handbook now available at your distributor.

General Specifications

11MS8

Filament—11.6V @ 0.45A

		Pent	Triode
E_P	=	120	100
E_{SG}	=	110	---
E_G	=	10	0
I_P	=	50mA	10
I_{SG}	=	3.0mA	---
G_m	=	8500	7000

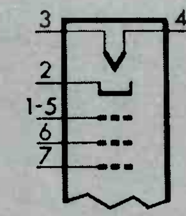


9LY

b

12DGP4

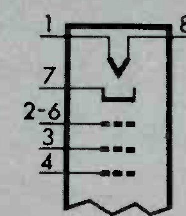
Protection—Banded
Deflection—110°
Filament—6.3V @ .45A—11 sec warmup
Grid 2—50V



7GR

17ESP4

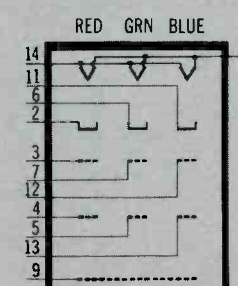
Protection—Banded
Deflection—114°
Filament—6.3V @ .45A
Grid 2—300V



8HR

17EVP22

Protection—Filled rim.
Deflection—90°
Filament—6.3V @ .9A
Grid 2—200V



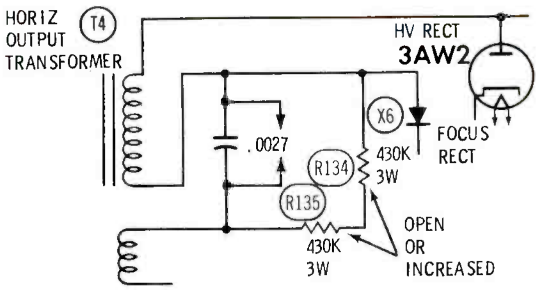
14BH

c

sym cure

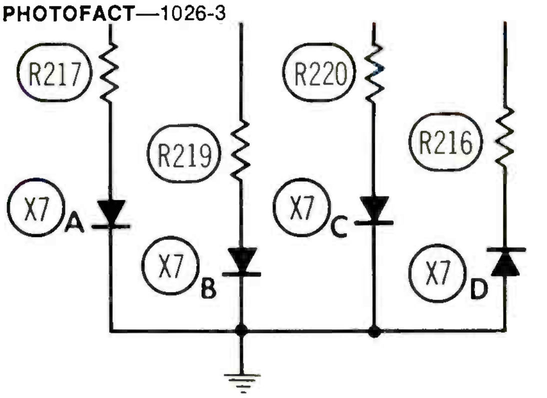
Symptoms and cures compiled from field reports of recurring troubles

Chassis—Philco 19QT87
PHOTOFACT—1026-3



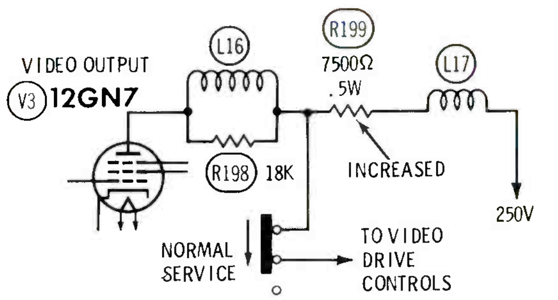
Symptom—poor focus
Cure—check R134 and R135; replace if they are out of tolerance

Chassis—Philco 19QT87
PHOTOFACT—1026-3



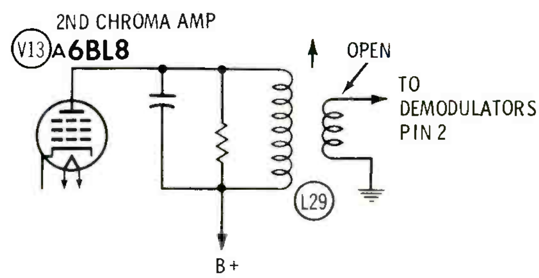
Symptom—intermittent convergence, or components on convergence board heat excessively
Cure—replace X7, the 4-section diode

Chassis—Philco 19QT87
PHOTOFACT—1026-3



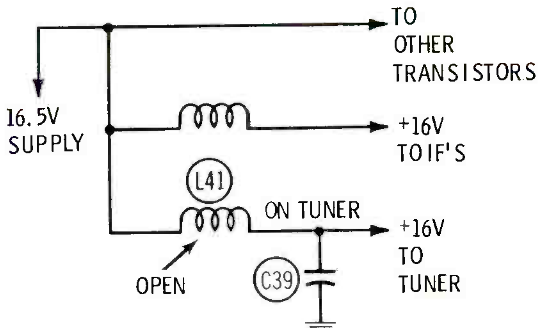
Symptom—excessive blooming when brightness increased
Cure—check R199; replace if value increased

Chassis—Philco 19QT87
PHOTOFACT—1026-3



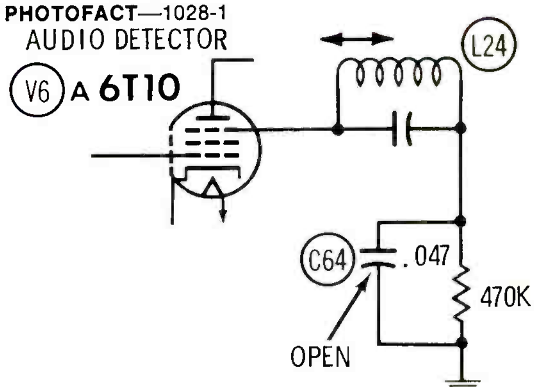
Symptom—green vertical bars, but no other color
Cure—check the secondary winding of L29 for an open circuit; repair bad connection or replace the coil

Chassis—Philco 19QT87
PHOTOFACT—1026-3



Symptom—no sound; no picture; normal raster
Cure—check and, if defective, replace L41 (on VHF tuner)

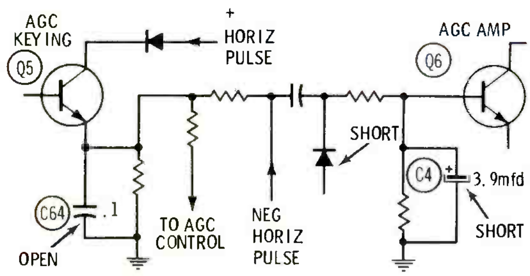
Chassis—General Electric KE
PHOTOFACT—1028-1



Symptom—intermittent loud buzz and weak audio
Cure—replace C64

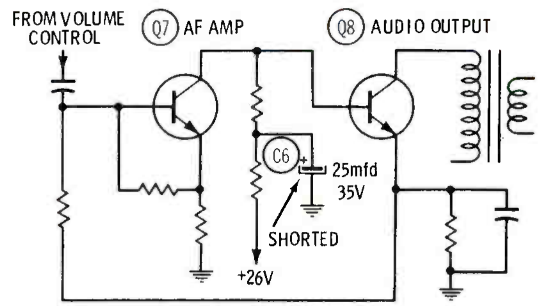
symcure

Chassis—Philco 19QT87
PHOTOFACT—1026-3



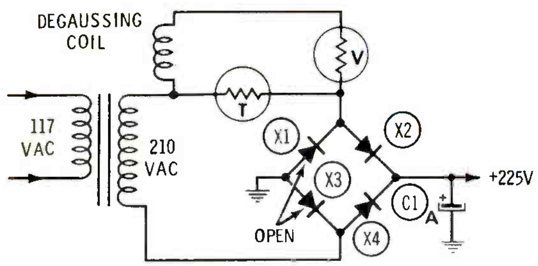
Symptom—normal snow off channel; picture blacks out on station
Cure—check for open C64, shorted X8 or C4

Chassis—Admiral K10
PHOTOFACT—1022-1



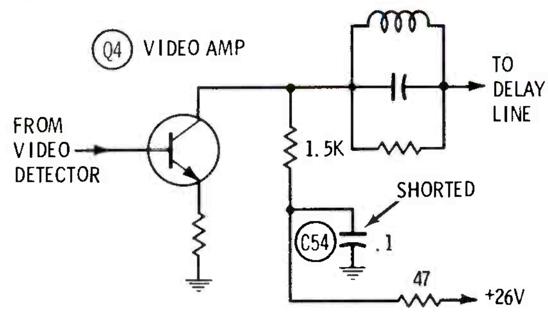
Symptom—no audio; no voltage on collector of Q7
Cure—replace shorted C6—25 mfd, 35 volt

Chassis—Philco 19QT87
PHOTOFACT—1026-3



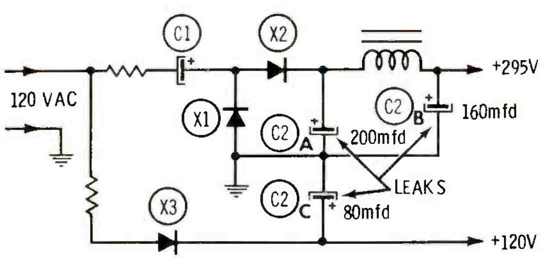
Symptom—poor purity that can be cured by external degaussing
Cure—check and replace X1 or X3, if open

Chassis—Admiral K10
PHOTOFACT—1022-1



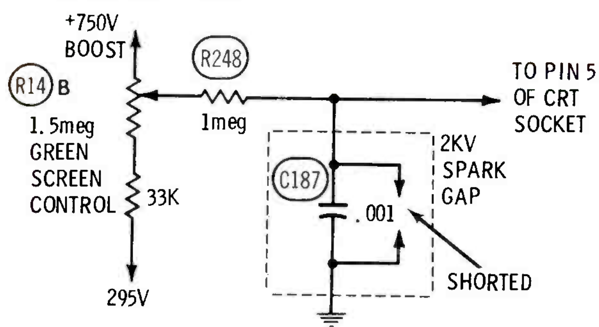
Symptom—no sound or picture; no voltage on collector of Q4
Cure—replace shorted C54

Chassis—Admiral K10
PHOTOFACT—1022-1



Symptom—horizontal AC weave in picture
Cure—check C2; replace if it has leakage between sections

Chassis—Admiral K10
PHOTOFACT—1022-1



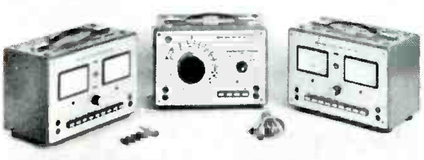
Symptom—no green in raster
Cure—check for shorted spark gap; replace C187 and spark gap assembly ▲

Flutter Meters and Wave Analyzer

Two solid-state flutter meters (Models ME-102b and ME-104) and a solid-state precision wave analyzer (Model ME-301) capable of determining the frequency of flutter are announced by Gotham Audio Corp.

Both flutter meters feature separate instruments that indicate the percentage of drift (deviation from correct speed) and flutter content. Both instruments also have self-contained 3150-Hz oscillators which permit recording of the test signal as well as calibration of the metering section. Both weighted and unweighted measurements can be made, and both meters feature a unique input circuit which allows use of any input level above 30 mv without level adjustment. A relay in the ME-102b unit prevents erroneous readings from insufficient input signal level.

The ME-102b also provides switching between 3000 Hz and 3150 Hz to accommodate both international and U.S. frequency standards. Flutter between 1 Hz and 315 Hz is metered.



The companion ME-301 Wave Analyzer reportedly provides precision continuous tuning between 1 Hz and 330 Hz, making possible exact diagnosis of the source of flutter. Filter steepness of more than 40 dB/octave, self-contained amplifier for loss-free operation, and means for self-calibration are included in the features of this unit.

Prices are: ME-104, $365.00; ME-102b, $460.00; ME-301, $780.00.

Circle 60 on literature card

Transistor and FET Tester

In-circuit and out-of-circuit tests are possible without removing transistors or without change in basic

procedure with a new transistor/FET tester added to the B & K line.

The new B & K Model 162 also tests diodes, unijunctions, SCR's and triacs. Other features include: a special balancing circuit that permits balancing out as low as 6 ohms circuit impedance for in-circuit Beta test; current capabilities up to 1 ampere; Beta readings from 1 to 5000; five selective current ranges; and front panel sockets for con-

Circle 22 on literature card

ventional FET and transistors. This is useful for FET tests, as it minimizes the possibility of damage due to static changes, according to the manufacturer. Tests reportedly are made under circuit conditions to give more valid readings.

The unit offers three leakage tests: Icbo, Iceo and Ices. All three leakage tests are necessary, according to the manufacturer, since there is a common class of failures, namely "avalanche mode breakdown", which can be missed if all three tests are not performed.

The Tester comes complete with programmed instruction guide which provides instruction on Go-no-Go conditions for Beta and leakage testing of transistors.

Measuring 9 in. wide by 7¼ in. high by 4 in. deep, the unit weighs 6 lbs. It is battery operated for complete portability. Price is $99.95.

Circle 61 on literature card

Sensitive AC Meter

A new amplified-type millivoltmeter, Model LMV-86A, has just been announced by the Leader Instruments Corporation. This meter is designed to measure in 12 ranges AC voltages from 100 microvolts to 300 volts rms, and decibels from –80 to +52.

Input impedance is 10 megohms on all ranges; full-scale accuracy is listed as ±3%, and bandwidth as ±1 dB from 10Hz to 1MHz. The meter is powered from line voltage,

and features a regulated power supply and solid-state components.

High-sensitivity AC meters are useful in hum, noise and frequency-response measurements, and will show the output voltage of many phono cartridges and microphones. In addition, this meter can be used as a wide-band preamplifier for oscilloscopes.

Price of the LMV-86A meter is $129.00.

Circle 62 on literature card ▲

Erratum

Three of the waveform photos on page 49 and the two waveform photos on page 51 of the February '70 issue of ELECTRONIC SERVICING are improperly positioned. On page 49, the waveform in Fig. 9 should be repositioned with the caption for Fig. 8; the waveform in Fig. 8 should be repositioned with the caption for Fig. 10; and the waveform in Fig. 10 should be repositioned with the caption for Fig. 9. The two waveform photos on page 51 should be interchanged. ▲

book review

101 Questions & Answers About Hi-Fi & Stereo: Leo G. Sands and Fred Shunaman, Howard W. Sams & Co., Inc., Indianapolis, Ind. 46206, 1969; 128 pages, 5½ in. X 8½ in., paperbound, $3.50.

This book was written for anyone interested in hi-fi or stereo, from amateurs to the experienced service technician. Written in question-and-answer form, it explains high-fidelity systems in simple, clear language.

The book is divided into six parts and each separate "chapter" answers a question frequently asked about the circuit operation, characteristics and troubleshooting of hi-fi systems.

Part 1 deals with hi-fi systems in general, explaining many of the terms used regarding such systems. Amplifiers are covered in Part 2, and Part 3 examines tuners and related parts and components.

Part 4 covers record and tape players, and Part 5 deals with speakers. The final section illustrates and explains troubleshooting and maintenance of hi-fi systems.

Workshop in Solid State: Harold E. Ennes, Howard W. Sams & Co., Inc., Indianapolis, Ind. 46206, 1970; 382 pages, 5½ in. X 8½ in., hardbound, $9.95.

The stated purpose of this book is to provide a transition from vacuum-tube circuitry to solid-state circuitry. It is assumed that the technician has received basic electronics training. Although originally developed for use in training broadcast technicians and employing broadcast circuits and techniques, this book also is useful to commercial electronics technicians.

The book progresses from "Orientation in Solid State" through all the facets of solid state to the final chapter on troubleshooting. Two appendices, one containing "Useful Information" and the other containing answers to the exercises presented at the end of chapters, are also included. ▲

Characteristics of transistors

A to-the-point review of transistor characteristics that are important to the technician.   *by Carl Babcoke*

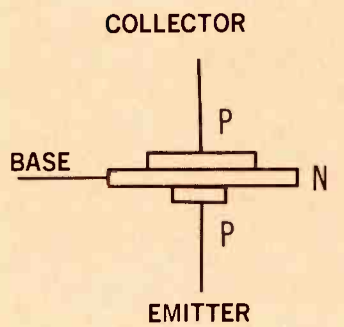


Fig. 1A PNP transistors have a thin section of "N" material between the "P" sections. NPN types are reversed.

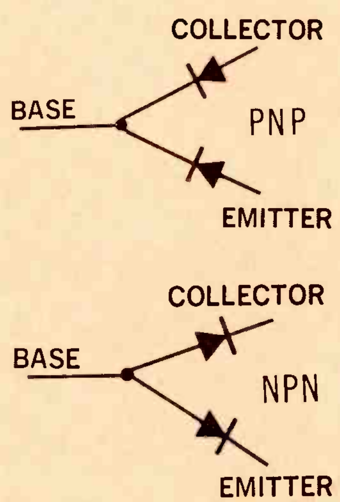


Fig. 1B Each junction of "P" and "N" material has diode properties. For resistance tests they can be diagramed as diodes.

Knowledge of the internal construction and chemistry of a transistor is not necessary for efficient troubleshooting. But it is very helpful to take the basic physical construction of a typical transistor (Fig. 1A) and visualize it as two diodes wired back-to-back as shown in Fig. 1B. Of course, two separate diodes cannot possibly have collector-emitter current and thus cannot amplify.

In an actual transistor, the two diode junctions are seldom symmetrical and the base material is so thin that current can flow through it between collector and emitter when stimulated by collector voltage and a forward base bias. Varying the base bias by a signal causes collector current variation; this is amplification.

According to the way a transistor measures on an ohmmeter, its "black box" circuit consists of three diodes and two resistors, as shown in Fig. 2A. The chart in Fig. 2B is a good guide to the approximate readings expected with germanium transistors when checked on a VTVM has a 1.5 volt ohmmeter battery. Don't be surprised if many normal transistors show more base-emitter than base-collector leakage. This only means the collector and emitter are not symmetrical. If you use other scales, or a meter with another battery voltage, the resistance readings will be radically different, since all solid-state diodes change resistance according to the voltage applied to them.

The same low base-emitter, base-collector or collector-emitter ohmmeter reading when the test lead polarity is reversed, indicates a defective transistor with a shorted junction. An open reading for both polarities indicates an open junction. One common defect is a short from collector to emitter. Often there is no corresponding short from the base to either the collector or emitter. This is difficult to understand since the base is located between them. Evidently the excessive current caused by the collector-emitter short burns away the base material around the shorted area.

Silicon power transistors also can be checked as shown in the chart of Fig. 2B, although all the resistances will be much higher than those listed. Tests of small silicon transistors will be limited since the leakage resistance will be above the highest ohmmeter scale. During checks on both germanium and silicon transistors, don't use a lower scale than the ones specified in the chart for forward bias readings because the ohmmeter current (which reaches 150 mills on the X1 scale) might damage small transistors.

You may question why we should bother to check transistors with an ohmmeter when there are many excellent transistor testers on the market. First, there are many more ohmmeters than transistor testers around a typical workbench. But more important, the ohmmeter tests give more of an insight into circuit voltage and resistance measurements and how they are affected by transistor defects. It is excellent belt-and-suspenders technique to use ohmmeter readings to verify the verdicts of the transistor tester.

Tubes vs. Transistors

After the obvious lack of a heater in a transistor and the necessity for a high vacuum surrounding the elements of a tube, the next radical difference between tubes and transistors is in the polarity of the bias and the elements (Fig. 3.)

A tube without bias (grid shorted to cathode) will draw excessive plate current. A transistor without bias (base shorted to emitter) will have a minimum collector current, and making the base positive increases the collector current. The tube plate voltage is positive, the polarity to cause maximum conduction, while the grid is negative to prevent any grid current.

By contrast, the positive voltage applied to the transistor collector will cause less collector current than would a negative supply (but this current would not be under the control of the base-emitter). The base is positive which is the polarity to cause maximum base current. A negative base voltage would be reverse-biased and would result in no base or collector current (except leakage).

To say these facts another way, a grid is reverse-biased, a plate is forward-biased, a base is forward biased and a collector is reverse-biased. A transistor always draws base current (low impedance input) and a tube has no grid current (high impedance input) when both are operated in class "A".

Effects of Heat

Current and gain in vacuum tubes are affected very little by ambient temperature since each tube has its own private built-in furnace that is many times hotter than the surroundings. Not so with transistors. Heat is not necessary for normal operation; any generated heat is strictly a byproduct, and often a detrimental one.

Those of you who have experience only with well-designed solid state circuits may be surprised how thermally unstable some of the simpler circuits can be. In the low-level audio circuit of Fig. 1A, assume that the base resistor is the correct value to produce maximum gain. Use an audio oscillator for an input signal, monitor the output with an AC meter and the collector with a DC meter. Just cup your thumb and forefinger around the transistor case for a few seconds and watch both the output AC and collector DC voltages drop enough for a definite difference in reading. If you go one more step and also monitor the base-emitter voltage, you will discover that the base voltage decreased from this slight increase in heat. The transistor conducted **more** collector current with **less** base voltage. Or turn that statement around

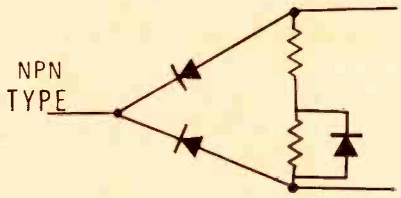


Fig. 2A This is the equivalent of a transistor when it is measured by an ohmmeter.

Test	Connect negative lead to:	Connect positive lead to:	Ohmmeter scale	Desired reading in ohms
		Small RF and audio transistors		
Forward	base	collector	X10	50 or less
Forward	base	emitter	X10	50 or less
Leakage	collector	base	X10K	20K or more
Leakage	emitter	base	X10K	20K or more
Forward E-C	collector	emitter	X1K	2K or less
Leakage E-C	emitter	collector	X1K	25K or more
		Power transistors		
Forward	base	collector	X1	5 or less
Forward	base	emitter	X1	5 or less
Leakage	collector	base	X1K	10K or more
Leakage	emitter	base	X1K	10K or more
Forward E-C	collector	emitter	X10	2K or less
Leakage E-C	emitter	collector	X100	4K or more

Fig. 2B Chart for measuring the junction resistances of PNP germanium transistors. All polarities should be reversed to test NPN types. These readings are for VTVM's using a 1.5 volt ohmmeter battery. Meters with other battery voltages will show different resistances.

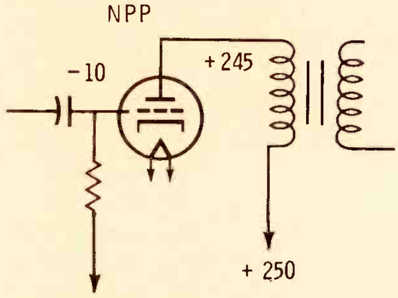


Fig. 3A Any tube could be called an NPP type since both grid and plate will pass current if they are positive in relation to the cathode. In practice, a tube is operated with a reverse-biased grid and forward-biased plate.

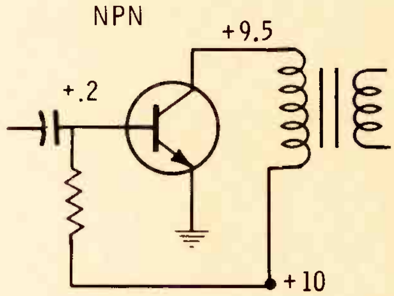


Fig. 3B Transistors are operated with the base (grid) forward-biased, and the collector (plate) reverse-biased. Forward-biased elements are low impendance and reverse-biased elements present a high impedance.

so it reads: for the same collector current, less forward bias is required at higher temperatures.

It is undoubtedly true that **more** base current caused more collector current (transistors are "current amplifiers"), but base current is very difficult to measure, while base voltage measurement is simple if you have a meter with a full-scale reading of .5 or 1.0 volt. Later we will show that collector or emitter current can be measured easily by reading a resistance, the voltage drop across it and calculating the current by Ohms Law.

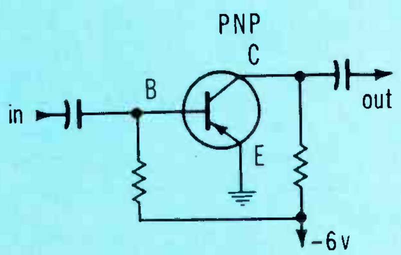


Fig. 4A Simple audio amplifier without thermal stabilization.

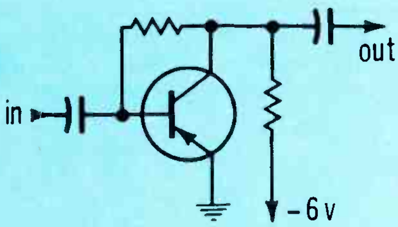


Fig. 4B Effective stabilization for resistance-coupled circuits.

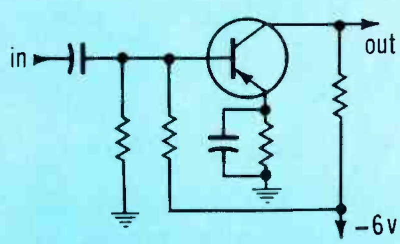


Fig. 4C Base voltage stabilization by a voltage divider. The emitter resistor helps thermal stabilization the most of the two methods.

Stabilization

Four basic types of temperature stabilization are commonly used. Fig. 4B shows the base voltage supply taken from the collector rather than the supply voltage. This is an effective method, if the resistance in the collector circuit is fairly high. Any increase in collector current will lower the collector voltage which in turn reduces the base supply voltage. And this lower base voltage will decrease the collector current. The opposite action takes place if the collector current goes down.

There are two limitations. Transformer output coupling is not practical since the collector DC voltage would not change enough for effective control, and the resistor between collector and base can introduce negative feedback which lowers the gain.

The two most common thermal stabilizing methods are both shown in Fig. 4C. Forward bias for the base is developed by a voltage divider to minimize voltage variations, and more important, an emitter resistor is added. For example, increased emitter current raises the emitter-to-ground voltage and any emitter voltage is subtracted from the base-to-ground voltage to give the true forward bias. The more emitter voltage, the less forward bias and this causes less gain and collector current.

Let's consider some hypothetical voltages. Assume a base-to-ground voltage of –2.15 and an emitter-to-ground voltage of –2.0; the forward bias is –.15 volt. Suppose that a higher transistor temperature increases the collector-emitter current so the readings become: base –2.15 and emitter –2.05 for a forward bias of –.10. This reduced forward bias decreases the collector-emitter current and restores the change in gain. Of course, reverse action takes place if the emitter current goes down, but we are not so concerned because this is just the opposite of "thermal runaway".

Omission of the emitter bypass capacitor would allow AC current feedback which reduces gain just as an open cathode capacitor will do in tube circuits. In practice, however, we find the gain reduction in transistor circuits to be much larger than that caused in tube circuits by an open capacitor, where the resistor is the same in both cases. In a tube circuit, the gain might be reduced 10 dB, while the transistor circuit gain could be decreased by 20 to 30 dB.

The fourth type of heat stabilization uses a diode (of the same material as the transistor) as a voltage regulator.

How Critical is Forward Bias?

The forward bias of a transistor is the **most** critical factor that determines the performance of transistorized circuits. Without some forward bias, there can be no collector current (except undesired leakage), and since a small transistor typically operates with about .2 volts of forward bias for a germanium type and about .7 volts for a silicon, small voltage changes are significant merely because the bias is small. Logic and reason tell us that a 10% change in forward bias should have the same effect on gain and output current as a 10% change in tube bias. This is not so! In some transistor circuits a bias change of far less than 10% can increase or decrease the gain 30 dB, for example. This is far more critical than the bias on a high-gain sharp-cutoff tube.

It is poor design and practice to apply a fixed bias even from a well-regulated supply, for the optimum bias will be different for each individual transistor and will vary widely according to the junction temperature. For stages such as power output that are difficult to stabilize, a bias-regulating diode may be used if it is made from the same type of material as the transistor so it will have a similar temperature coefficient. Even applying a constant base current is not enough stabilization. If it were, a large source of voltage through a large base resistor would be sufficient. Two methods of stabilizing a single stage were given previously. One is to use a large emitter resistor, and the other is to take the bias from a source (such as the collector) that varies in voltage according to collector current. Later we will explore how multiple direct-coupled stages are stabilized.

Gain Control by Bias Variation

Every transistor has an optimum forward bias that gives maximum gain. Either more or less bias decreases the gain. There is no precedent in tube circuitry for this characteristic. The graph in Fig. 5 is not intended to be accurate, but only to illustrate general transistor functions. The forward bias is increased at a linear voltage rate. The collector current increases and the input impedance decreases at a logarithmic rate, while the gain peaks at one definite bias voltage. Starting at the bias for maximum gain, a decrease in bias uses the "cut-off" mode, and in increase takes advantage of the "saturation" characteristic for gain reduction. Either method can be made to give about the same degree of gain reduction. Current consumption would dictate use of the cut-off type of AVC for battery-operated equipment such as portable radios. AGC in television receivers usually employs the saturation method, for the lower input impedance obtained on stronger signals widens the bandwidth of the tuned circuits.

Silicon transistors used for IF and RF amplifiers in color TV receivers appear to have an extremely sharp cut-off when saturation biasing is used for AGC. Actual measurements made on several brands of receivers indicate that a bias increase of only .04 to .05 volts over the no-signal bias of about .7 volts will accomplish adequate gain reduction for a very strong TV signal. Translated, this means a bias increase of 7% will reduce the gain to virtually zero.

Pulsed Signal Operation

The preceding statements apply to AF, RF and IF amplifiers operated in class "A". Class "C" amplifiers (including oscillators, sync separators and power output stages) usually show reversed bias measured on a meter. This does not contradict facts on forward bias already given. Diode action of the base-emitter junction rectifies the incoming signal to produce reversed bias that is overpowered by the highest amplitude tip of the incoming waveform to become forward bias. Thus the base has reversed bias most of the time, and forward bias for a very short time during each cycle. A meter will average these voltages to read as reversed bias.

Load Impedance vs Gain

Load impedance in the collector circuit has a large effect on transistor gain. At the usual transistor impedances (under 50,000 ohms) the gain is in direct proportion to the load. If the collector load impedance is doubled, so is the gain (+6 dB). If the impedance is decreased 20%, the gain is reduced 20%. Remember this when analyzing some of the beginner circuits where the collector resistor is about 1.5K.

Other Factors Affecting Gain

Collector voltage is not a critical factor in determining gain except when the collector-emitter voltage drops to a few tenths of a volt, then the gain drops to nearly zero.

Negative feedback or degeneration in the emitter circuit from unbypassed resistors reduce gain with transistors the same as it does in tube equipment.

Next

In following installments in this series, we will discuss the characteristics of some simple amplifier circuits and the reasons why they are high or low gain, desirable or undesirable. This information can be the basis for effective trouble-shooting techniques. ▲

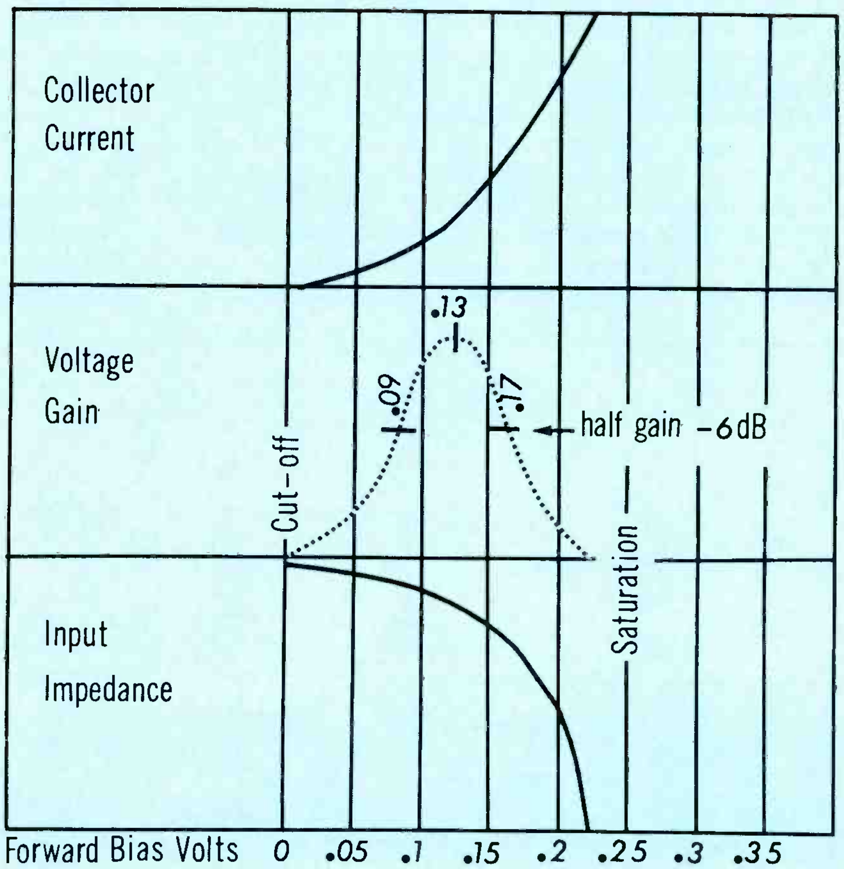


Fig. 5 Characteristics of transistor.

troubleshooter

Black Spot Increases With Brightness

A small black irregular spot appears in the center of a Philco 17N35 b-w TV chassis when the brightness control is turned up. The irregular spot becomes larger as the brightness is increased, and the raster eventually blooms out and becomes completely dark. The voltage at the anode of the CRT remains at 17 KV, even when the raster is completely dark.

E. A. Brack
Augusta, Ga.

I have witnessed the symptoms you have described. They were caused by a cathode-to-heater short in the picture tube, which removed the video and made the picture too bright. The dark area in the center of the screen would increase as the brightness increased. Such symptoms seem to be limited to rectangular black-and-white picture tubes that have low voltage focus characteristics.

I suggest that you test the picture tube by substituting it with another.

Video Lost

I have two problems on a Zenith 16E23 chassis (PHOTOFACT folder 525-2). Problem #1: The screen voltage of V3 IF tube 6DK6 is a normal +150, but as I touch the plate pin I get only +60 and lose the picture. Is this normal?

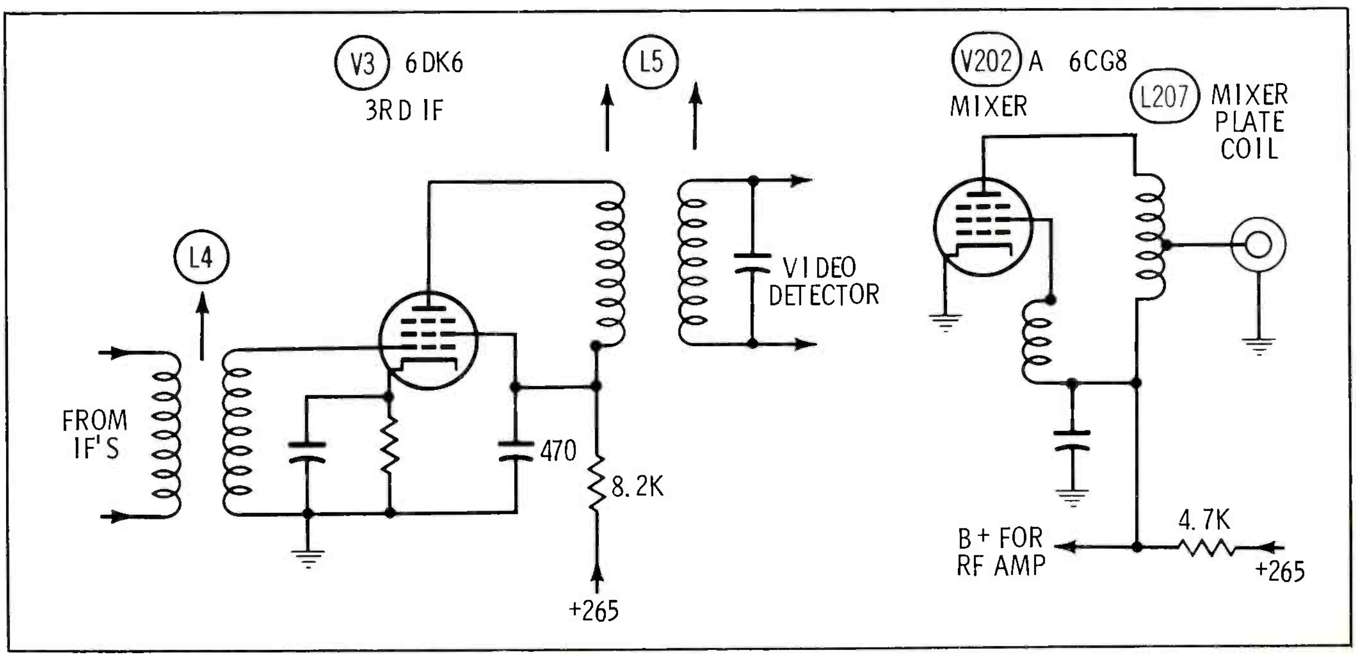
Problem #2: On the mixer tube 6CG8 plate I measure +150 volts, and the screen voltage is +125. How is this possible when B+ is 125 volts? Why is the plate voltage higher?

Walter Misiolek
Calumet City, Illinois

Both of these odd readings are likely to be caused by test equipment capacitance loading. Any VOM is almost certain to have effects like these, and even a VTVM may do so if it is not well isolated. The 1-megohm resistors built into the end of most VTVM and FET meter DC probes often have more capacitance than is desirable for use in critical circuits, such as IF's and color oscillators. I suggest that you add a ½- or 1-watt, 1-megohm carbon resistor to the outside of your VTVM probe. Keep the end away from the probe quite short and do not use a clip, but make contact with the resistor lead itself. If your meter probe has a switch for selecting AC/ohms or DC volts, change it to the AC/ohms position and this will restore the original calibration. Then try the DC measurements on the IF plates, and I am certain there will be no instability or false readings.

Specifically, the 3rd IF stage probably oscillated because the added meter probe capacitance tuned the plate transformer nearer the frequency of the grid transformer, and the increased current through the 8.2K-ohm decoupling resistor dropped both the plate and screen voltage. You could verify this diagnosis by measuring the screen voltage with a second meter to see if it is reduced at the same time the plate voltage is low.

In the second problem, the added meter capacitance lowered the resonant point of the mixer plate transformer, and this gave a stronger signal and caused more negative AGC to the RF stage, which raised the common B+ supply to the mixer and RF amplifier. We expect meter loading to reduce the voltage readings, but this is not always true in tuned circuits.



Quick Burn-Out of Linearity Control

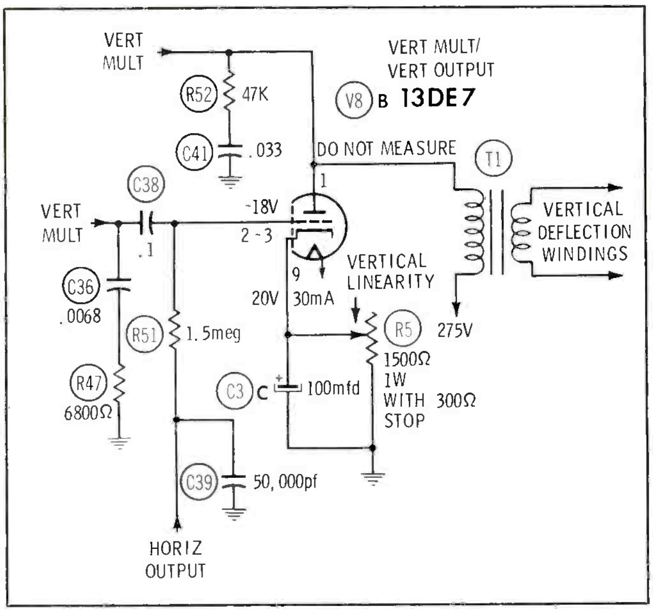
The linearity control of a Philco Model G3052BL b-w TV burns out almost immediately after the set is turned on.

I have changed capacitors C36, C38 and C40, and have checked electrolytic capacitor C3C, which is okay. V8B, the vertical multiplier/vertical output tube, checks normal on a tube tester.

The only other suspect I have checked is the vertical output transformer, T1, which I have checked with an ohmmeter.

What other components might be causing this trouble symptom?

R. F. Putnam
Melrose, Mass.



If the linearity control becomes hot only after 30 seconds or more of operation, excessive current through V8B is indicated, and the voltage on the grid of this tube should be checked (normally −18 volts).

If the linearity control becomes hot within about 3 to 5 seconds of operation, it is virtually impossible for excessive tube current to be responsible.

Although you said you checked capacitor C3C, it is still possible that it is shorted to one of the other capacitors in the same can. C3A should have about +265 volts on it, C3B should have +140 volts, and C3C should have +15 to +30 volts, depending on the setting of the linearity control.

Disconnect the cathode of V8B and C3C from the linearity control and check each of these three for voltage. C3C and the linearity control should not have any voltage on them, while the cathode of V8B should have no voltage on it when cold and about +50 volts when hot. There always is the possibility that a solder splatter or other type of short circuit is supplying voltage to a point in the circuit where none should be, and where a component failure could not be responsible. The preceding voltage test with the three elements of the circuit disconnected should point up quickly such a spurious source of voltage. ▲

Common causes of drift in stereo FM receivers

An examination of frequency shift and drift, plus actual case histories.

by Joseph J. Carr

Shift or Drift?

Since radio first was developed, frequency drift in receivers has been a problem. When FM broadcasting came along, such troubles became even more acute because of the nature of the tuned circuits needed to cover the FM band. Although many earlier causes of drift, such as heat, have been licked by the change to solid-state circuitry, new and different sources of drift have developed.

We will be talking about two closely related trouble symptoms during this discussion: frequency drift and frequency shift. The symptoms of drift (and shift) are either a loss of perfect center tune (which gives noisy and distorted reception) or a loss of the station altogether. The major difference between them is the amount and/or speed of the change in operating frequency. Drift is a slow, gradual change. We will also throw in the qualification that the change isn't many megahertz. Shift is a larger and faster change in frequency. In many cases, especially when dealing with large sudden changes, the customer's complaint is likely to be that "the set goes on and off."

The FM local oscillator transistor can be the cause of both drift and shift. All transistors have junction capacitance. At FM frequencies this capacitance easily can be a fairly large percentage of the total capacitance "seen" by the oscillator tank circuit. An example of how critical such capacitance can be was given recently in a manufacturer's service bulletin, which noted a change in suppliers for the FM oscillator transistor in their product. According to the bulletin, the new transistors were considerably different in characteristics from the older units. If one of the newer transistors is used as a replacement for an older type transistor, they recommend changing a certain capacitor so that proper oscillator tracking would be restored. It seems that the local oscillator would be 5 to 6 MHz off if this change wasn't accomplished. This is something to consider when choosing universal replacement transistors.

Intermittent coils and capacitors can cause as much trouble in FM solid-state sets as they can in tube-type models. Since most FM solid-state receivers used printed-circuit boards, there is an additional, although related, consideration. Board defects at the terminals where the tuning coils and oscillator capacitors are mounted can produce the same effect as an intermittent component. This problem usually will result in a large shift in operating frequency. In many cases, the change will be

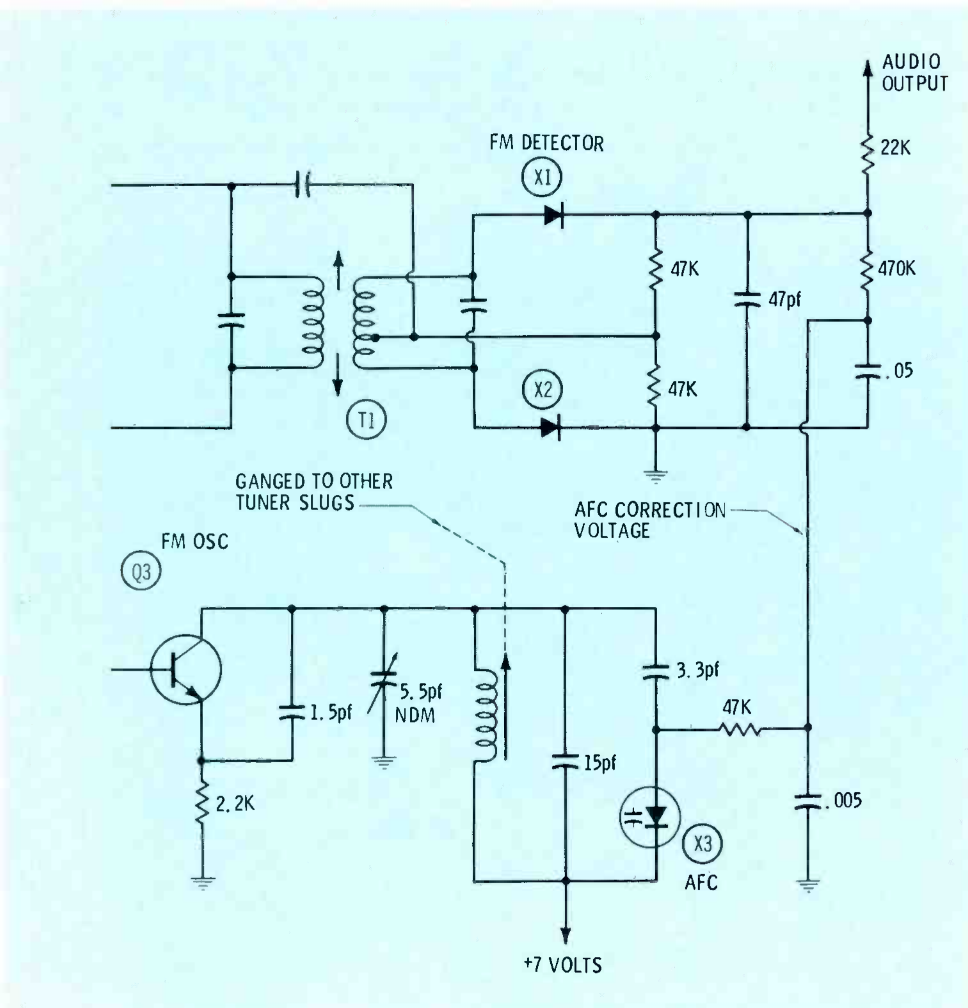


Fig. 1 A DC correction voltage from the FM detector changes the capacitance of X3, the AFC varactor, to compensate for drift or shift of receiver tuning. Circuitry shown here is employed in the Bendix Model 9FBM FM stereo auto receiver.

large enough to cause the oscillator to operate completely outside its normal range.

Heat

Internal thermal problems have been pretty well eliminated in solid-state FM receivers. If the set is operated within the ambient temperature specified by the designer, there will be few problems. The few thermal problems that do occur are likely to be installation problems. The author remembers a case that involved a popular FM car radio designed for underdash mounting. The installer placed the set right at the opening of the car's heating duct. The owner complained that the set would drift after he had driven the car a few miles. It was discovered later that the set was drifting because of the excessive amount of external heat. Moving the set to a cooler location was all that was required to cure the drift problem.

AFC-Related Causes

Another common complaint involves the oscillator end of the automatic frequency control (AFC) circuit. The specific point of trouble is the variable-capacitance (varactor) diode across the oscillator tank circuit. Diodes, like transistors, exhibit a certain amount of junction capacitance. Manufacturers of diodes try to reduce this capacitance to a minimum in most types of diodes. In a varactor, however, they try to increase the capacitance to a specific, predictable and controllable range. By varying the reverse voltage across these diodes, the junction capacitance is varied. For a more detailed treatment of varactors and the associated circuitry see **ABC's of Varactors** by Rufus Turner (Howard W. Sams book, catalog No. 20508).

The circuit in Fig. 1 is found in many FM solid-state radios of both home and automotive designs. An error signal (DC voltage) from the FM detector "tells" the varactor whether to increase or decrease its capacitance, or to remain steady. The DC error voltage appearing at the audio take-off point in the FM detector will be zero when the set is tuned perfectly to a station. If the tuning drifts above or below the station center frequency, the voltage at this point will go positive or negative accordingly. The AFC varactor diode in the FM oscillator circuit responds to these positive and negative excursions by altering the oscillator's operating frequency enough to null out the change in tuning. This restores the set to perfect center tuning.

There are three problems in which the AFC diode figures prominently. One of these is drift. In the presence of excessive heat this diode can change its characteristics. A drifting oscillator is the result. It also is possible, if certain internal defects exist, for the diode to drift under normal heat conditions.

The second common AFC trouble is the intermittent diode. In these cases the diode simply opens. This eliminates its capacitance from the circuit. The effect of this problem depends upon the specific diode in use and the circuit. In some sets the frequency shift will be so great that the oscillator will be operating completely out of the range covered by the set. The radio will appear to be dead; however, since all stages are still amplifying, there may be some background hiss present when this occurs. In other sets, the effect will be to effectively move all of the stations toward one end of the band.

The background hiss that is often still present when oscillator troubles occur can be misleading. It is not at all uncommon to find a technician trying to troubleshoot the FM RF stage when his attention should be directed toward the FM local oscillator. This is why the author likes to keep a grid-dip oscillator handy. It can be used either to substitute for the FM oscillator or as a regenerating detector (with earphones plugged into the meter jack) to determine the operating frequency of of the FM oscillator.

The third common AFC trouble is the "capture effect". This occurs when an extremely large signal is present at the input along with the desired signal. The larger signal will often cause the AFC to lock onto it rather than the signal to which the radio is tuned. Capture effect generally occurs when the radio is operated close to an FM transmitter. It can occur whenever an FM radio is near an FM broadcasting, police, fire, or aviation transmitter. It occassionally happens that an FM car radio will be "captured" by a mobile FM communications transmitter; instead of Rachmaninoff the

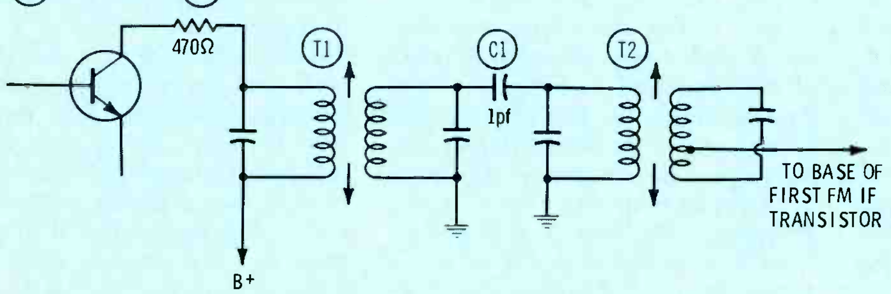


Fig. 2 Open C1 in the quadruple-tuned, two-transformer IF circuit shown here will cause a wide shift in the tuning of the receiver. Circuit shown here is used in Bendix Model 9FBM.

customer gets the fuzz!

Loose Connections

One trouble that seems to be "built into" some models is a loosely mounted FM tuner assembly. The symptoms that accompany a loose tuner vary according to the design of the various sets. In many receivers it will "kill" the set. In others it will cause momentary shifts in frequency. The author makes it a habit to check the FM tuner mounting screws on every FM set that comes into the shop.

Loose connections are still with us in these modern times. If the loose connection involves either the FM oscillator or the AFC circuit, the result can be a drifting, shifting radio. There was one type of set that came through for several months with the lead that carries the DC error voltage from the detector to the AFC circuit completely unsoldered. Not soldered improperly, NOT soldered.

Another common cause of shift involves sets that use "back-to-back" FM IF transformer arrangements (Fig. 2). These circuits are quadruple tuned. The values of inductance and capacitance of the individual components are not the same as they are in the conventional double-tuned, single transformer arrangement. An extremely wide shift in frequency will occur if the small capacitor (C1) that couples the two transformers should open up. This usually will not be indicated on the calibrated dial of the receiver unless the FM mixer output is affected. A case involving this problem is included in the following casebook of common shift and/or drift troubles.

Casebook of Common Troubles

The first case involves a 1969 Mercury FM stereo car radio manufactured by Bendix (Model 9FBM). The customer complained that he could only receive a few stations on the low end of the dial. When the set was checked out on the bench, this complaint proved to be **almost** correct. It seems that these "low end" stations were the ones that should have been coming in on the top end. For example, a station that normally is found at 105.1 MHz was received with the dial at 94 MHz. Although this is quite a large shift to be attributed to the AFC diode, it was checked, just to be on the safe side. An FM tuner usually will shift either just a little or it will shift completely off the dial. The 10-MHz shift experienced in this case seemed unbelievable until it was correlated with the 10.7-MHz IF frequency.

At this point, the grid-dip meter was used to locate the operating frequency of the FM oscillator. (Most of these instruments will function nicely as an oscillating detector if a pair of earphones is substituted for or connected in series with the meter movement.) The receiver was tuned to a station at 105.1 MHz. The oscillator was found to be running on the proper frequency.

This model receiver uses the quadruple-tuned, two-transformer circuit illustrated in Fig. 2. In this type of circuit, the two tuned transformers have a mutual effect on each other. For this reason, they are individually resonant at some higher frequency. The trouble finally was traced to coupling capacitor C1, which was not soldered properly at one end. The 105.1-MHz station was strong enough to get through the IF strip even though only one stage was tuned to the higher frequency. Resoldering the capacitor restored the set to normal drift-free operation.

The second case involved a 1968 Delco Model 7303153, out of an Oldsmobile. A "kind neighbor" had attempted to repair the set and had failed. The original complaint had been that the set would not receive FM but operated normally on AM. The neighbor correctly had diagnosed the cause of the trouble—a defective FM oscillator transistor—but had installed an off-brand replacement (at a so-called bargain price). The set played, but the calibration was way down-scale from where it should have been. The trouble was still in the FM oscillator circuit.

The oddball replacement apparently had considerably different junction capacitance than the original. How this change affected the oscillator's operating frequency can be seen by examining the circuit in Fig. 3. The capacitance of the transistor is very much a part of the total capacitance seen by the oscillator tank circuit. At these frequencies it doesn't take a great change

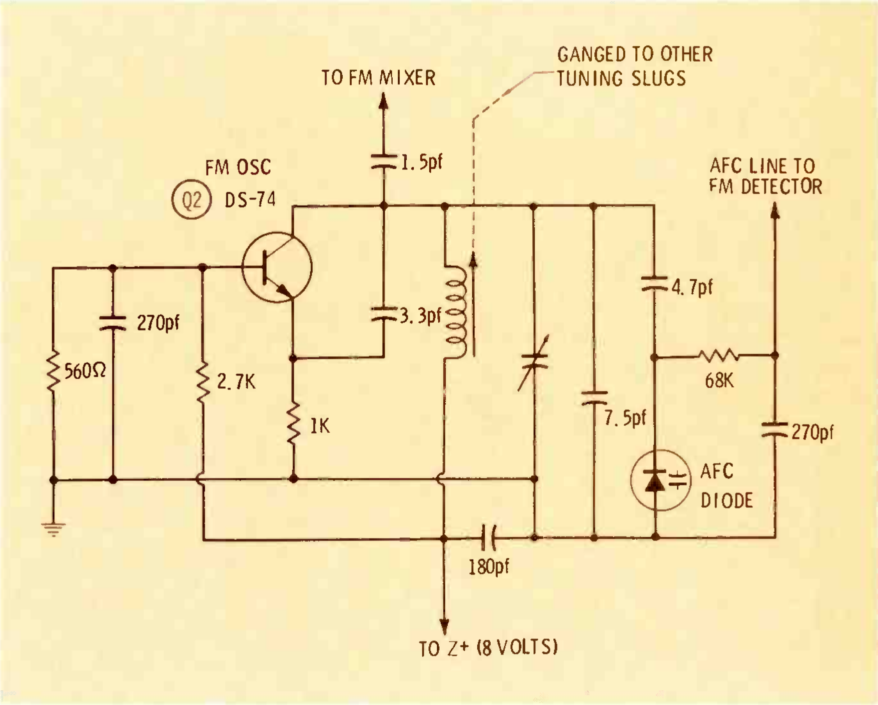


Fig. 3 Capacitance of FM oscillator transistor is part of the total capacitance of the oscillator tank circuit. Substituting it with the incorrect type will shift the natural frequency of the oscillator enough to prevent reception. Circuit here is employed in Delco Model 7303153 AM/FM auto radio.

in absolute values to create a large change in the relationships of the reactances that determine the circuit's operating frequency.

This example is a powerful argument in favor of those who insist on using exact replacements in critical applications. A new Delco DS-74 transistor in the oscillator circuit cured the off-frequency operation of the set.

A table model FM radio made by Motorola (Model TT22C, Chassis HS-67206) was involved in the third case. This set is an all-solid-state AM/FM/FM Stereo receiver for home use. The customer complained that it would not hold an FM station very long.

Letting the set play for a while on the bench revealed that the set was drifting just enough to "slide" the station out of the receiver's passband.

As can be seen in Fig. 4, this chassis uses the standard variable capacitance diode (varicap) AFC circuit. This diode is controlled by the DC potential that develops at point "X" whenever the set starts to drift. This DC voltage causes the varactor to change capacitance to null the detector DC voltage back to zero.

A VTVM showed that the correction voltage for the varactor was developing normally either side of perfect center tune. Suspicion fell on the diode. In this case, because of the nature of VHF circuits, it was decided to check the AFC diode, D3, by replacement. A new Motorola 48-6344A01 varicap was installed, and the set did not drift in the two hours that we let it operate on the bench.

The fourth case is about a large AM/FM/FM Stereo-Phono Magnavox console that would drift, produce static, go completely off and then would come back on. This cycle would repeat during the first half hour or so of operation. Because the set was new, I recommended that the customer call the dealer from whom he had purchased the set, because he has a very good service department. Before they called him, however, I made an off-the-cuff guess that the difficulty was the AFC diode. When the technician returned the set he said that it was, in fact, the AFC diode.

This case was included to show how frequently drift in solid-state FM receivers can be the fault of a defective AFC diode. Both the author and the dealer's technician were able to spot the trouble from past experience.

Depending on past experience alone, however, can lead to problems. A case in point involved a 1969 Thunderbird FM stereo radio, Bendix Model 9FBS. The complaint on the service record ticket looked so much like the almost-classic AFC diode problem that I quickly changed the diode without properly checking the set first. The trouble turned out to be intermittent. It returned, and I had one of those embarrassing situations we know as a callback.

The real trouble turned out to be an intermittently open diode in the FM detector circuit—not the AFC diode. This diode, when open, would throw the detector out of null and, thereby, would produce a bias on the AFC line. Looking over the ticket for the previous (unsuccessful) visit, I noticed that the customer had listed distortion as a minor complaint. This should have set my mental wheels clicking—and avoided a callback.

The last case involves another 1968 Oldsmobile radio, Delco Model 7303153. The complaint was that the set would shift frequency whenever the car was accelerated or slowed down. This sounded like a case of poor voltage regulation. This angle was checked out by monitoring the regulated zener (Z+) voltage while varying the "A" lead (input) voltage from 10 to 15 volts. There was no significant change in either the zener voltage or the set's stability. While adjusting the set's position on the bench, however, we noticed that it would slide through quite a few stations without the tuning knob being moved. In this particular case the trouble was caused by a loose corebar in the tuner. A keeper that is supposed to prevent the bar from moving of its own accord was missing. ▲

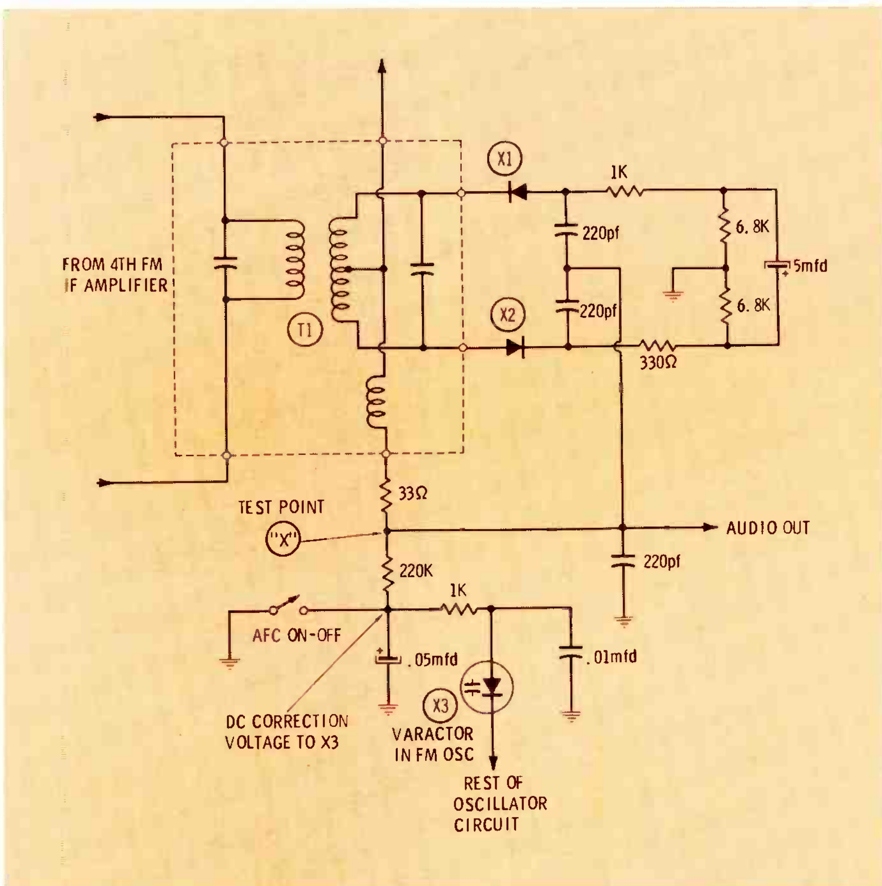


Fig. 4 Defective varactor, X3, caused slight drift of tuning in Motorola table model AM/FM/FM stereo home radio.

Testing Windshield Antennas

All 1970 General Motors cars with factory-installed radios are equipped with nonrepairable windshield antennas. The fine antenna wires are laminated between the glass, and any breakage or shorting requires windshield replacement. To test whether the antenna is operational, GM has available a pencil-type tester, Tool J-2352, to determine antenna operability and eliminate unnecessary windshield replacement. —**CHEK-CHART**

NESA Pricing and Time Survey

Following are average service prices and times obtained recently in a survey of 50 service dealers attending a meeting of the Nebraska Electronic Service Association in Grand Island.

	Average Service Chg.	Average Time
Color Home Call	$ 9.52	34 min.
B-W Home Call	$ 7.50	29 min.
Stereo Home Call	$ 7.80	29 min.
Color Shop Service	$32.20	2 hrs.
B-W Shop Service	$20.00	1.2 hrs.
Stereo Shop Service	$21.80	1.5 hrs.
Color Carry-In (minimum)	$ 9.50	38 min.
B-W Carry-In (minimum)	$ 6.00	30 min.
Stereo Carry-In (minimum)	$ 6.70	40 min.

Service Call Warranty—varies from 3 days to 90 days—**NESA News**

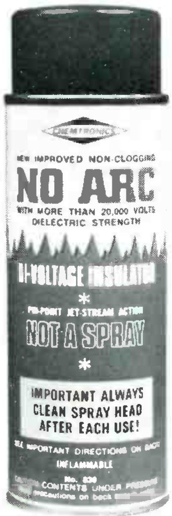
product report

for further information on any of the following items, circle the associated number on the reader service card.

Insulating Spray

An improved version of NO-ARC high-voltage insulating spray has been announced by Chemtronics Inc.

The new spray is said to leave a tough, thick, smooth protective red insulating coating capable of withstanding up to 30,000 volts. It



is recommended by the manufacturer for stopping arcing and corona shorts and "potting" components, as well as water-proofing and insulating printed-circuit boards and exposed wiring.

The price of an 8-oz. spray can is $2.79.

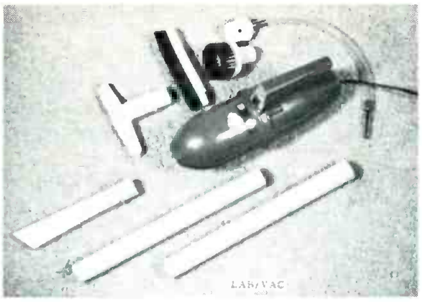
Circle 65 on literature card

Miniature Vacuum Cleaner

Lab/Vac, a new and improved version of the miniature vacuum cleaner, is introduced by the Electronic Tools Division of C. H. Mitchell Co.

The vacuum cleaner has an internal filter that collects and holds the dust and dirt sucked up by the vacuum, so that no dust can blow into the work area being cleaned, nor into the vacuum's motor.

The unit's high-speed motor reportedly provides vacuum pulling power previously not available in a cleaner of this type. Extension wands and a choice of five cleaning tools make it easy to clean the tops of cabinets and racks, out-of-the-way places, inside chassis, racks,



instruments, assemblies, components, circuit boards, connections, chart drives, test equipment, etc.

Lab/Vac comes complete with two extension wands, an all-purpose nozzle, a bristle brush, a round brush, a crevice tool, and a needle nozzle for extremely tight places that require pinpoint cleaning.

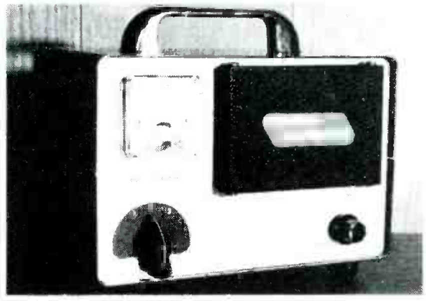
Designed for use on 115-volt, 60-Hz AC current, the unit is priced at $29.95.

Circle 66 on literature card

Solid-State Receiver

A portable, solid-state receiver, which brings in the exact time and radio or audio frequency standards, has been announced by Wisconsin Electronics Corp.

The new battery-powered Model GSP-3 receiver reportedly lets the user monitor National Bureau of



Standards stations WWV and WWVH. Three channels allow clear reception at any time of day, according to the manufacturer. The stated uses include calibration of radio or audio frequency measuring devices.

The unit has 1 μv sensitivity, a radio frequency input impedance of 50 ohms, and 1-watt audio output. It weighs 6 lbs. and measures 5 in. X 7 in. X 6 in.

Price is $185.00.

Circle 67 on literature card

Gas Welding Kit

A gas welding kit has been introduced by Microflame, Inc. The completely self-contained miniature torch produces 5000°F pinpoint accurate flame. No wires or connections are needed, according to the manufacturer.

The kit contains: a Microflame torch unit, 6 oxygen cylinders, 3 LP gas cylinders, a spark igniter, 3 different welding tips (small, medium and large), four 6-in. gold-silver

alloy brazing rods, a two-way bench bracket for mounting on bench or pegboard, and a booklet titled "How to Solder and Weld".

The kits sell for $29.95 each.

Circle 68 on literature card

Solder Remover

A product designed to remove solder has been announced by Easy Electronics Co.

By laying the solder remover wick on the material and applying for a second a 35-watt or larger solder iron, the connection is made solder-free and ready for circuit salvage or re-soldering, according to the manufacturer. Easy Electronics states that the "Solder Blotter,"

which works on all types of connections, such as post, pot and lug, leaves no adverse residuals or flux contamination.

Bonus-Wik, which is designed for larger connections and comes in 10-ft. spools, sells for $1.80 per spool. Micro-Wik, which is designed for more delicate connections and comes in 20-ft. spools, is priced at $3.50 per spool.

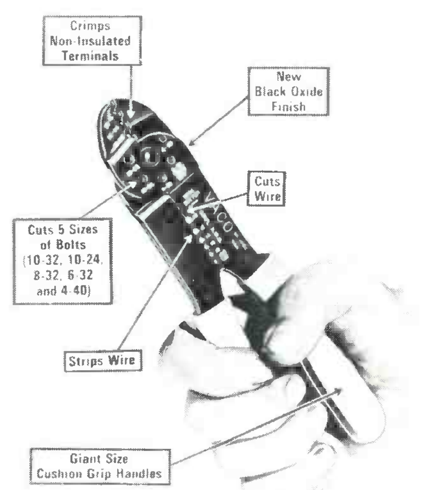
Circle 69 on literature card

Crimping Tool/Wire Stripper/ Bolt Cutter

Vaco Products Co. has redesigned its No. 1900 Crimping Tool to include a bolt cutter.

No. 1902 cuts five sizes of bolts (10-32, 10-24, 8-32, 6-32 and 4-40). It also cuts and strips wire sizes 10-22 A.W.G. and crimps non-insulated, solderless terminals.

Operation is accomplished by screwing the bolt into the correct



opening and squeezing the handle. Vaco states that the bolt is automatically deburred when it is unscrewed from the tool.

The price is $4.50.

Circle 70 on literature card

Control Cleaner and Lubricant

RCA Deluxe Control Cleaner and Lubricant (stock number SC101) is intended for use on all low-power

carbon composition and wire-wound potentiometers and rheostats, including all types of radio and TV controls, according to the manufacturer. It reportedly is safe for plastics. Price is $1.90 per spray can.

Circle 71 on literature card

Insulation Shrinker

The "Heat Tunnel", which is designed for shrinking shrinkable tubing, has been introduced by Russell Industries, Inc.

The Heat Tunnel is portable, weighs less than 1 lb., and reportedly shrinks tubing and insulation to 50 % of its original diameter in 5 to 7 seconds.

The unit, designated part No. HUG-TH, sells for $17.95.

Circle 72 on literature card

Repair Bags

Clear polyethlene bags for replaced parts are available from Vision-Wrap Industries, Inc.

The bags are available with or without customer imprinting of

name, address and sales message on large and small quantity runs. The size is 7 in. X 11 in.

Imprinted bags, No. PB 711P, are priced from $70 per thousand for quantities of 1000 or less to $35 per thousand for quantities of 25,000 or more. Bags without an imprint, designated No. PB 711, sell for $45 per thousand for quantities of 1000 or less to $20 per thousand for quantities of 25,000 or more.

Circle 73 on literature card

Voltage Regulator

A new voltage regulator for color television, and other appliances rated at 400 watts or under, is now

available from Perma-Power, Division of Chamberlain Manufacturing Corp.

The new Model D-111 voltage regulator reportedly lowers the line voltage 10 volts when the selector switch is set to the "Down 10" position, and increases it by 10 volts when set up to the "Up 10" position. When line voltage is normal, requiring neither an increase or decrease, the voltage regulator selector switch is set to the "Direct Line" position.

The unit is list priced at $12.40.

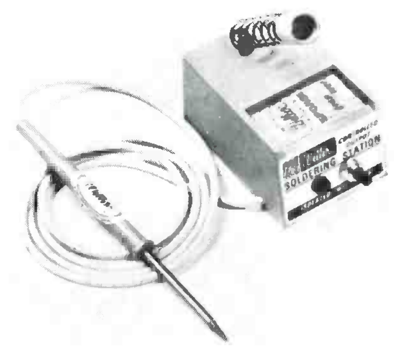
Circle 74 on literature card

Miniature Soldering Stations

A new series of miniature, low-voltage, controlled-output soldering stations has been made available by the Weller Electric Corp.

The W-MCP series tools have a solid-state, closed-loop control system coupled with Weller's curie point temperature sensing system, which reportedly controls output and temperatures automatically. The units are available with fixed control point temperatures of either 500°F, 650°F or 750°F.

The working end of the station is made up of a 6½-in. long pencil



iron weighing 1.35 oz. and featuring a flexible, burnproof silicone rubber cord. The iron is normally supplied with a ⅛-in. chisel tip; however, interchangeable 1/32-in., 3/64-in. and 5/64-in. tips also are available from the manufacturer.

The power unit is isolated and electrostatically shielded. Incorporated in the case are a non-sinking iron holder, an on/off switch, an indicator light and a tip-cleaning sponge.

The prices range from $29.70 for quantities of 1 to 3 to $21.60 for 24 or more.

Circle 75 on literature card

Multi-Purpose Epoxy

A new multi-purpose epoxy, which reportedly has a complete curing time of less than sixty seconds, has been announced by the Instrument Division of Tescom Corp.

Called Minit-Cure, the epoxy is designed for jobs requiring fast curing time at room temperature

(75°F). It can be used to bond metals, woods, plastics, rubber and glass.

Applied with a brush, Minit-Cure has a tensile strength of 2900 psi and sells for $24.95.

Circle 76 on literature card

Tape-Head Demagnetizer

A new demagnetizer, which has been introduced by Robins Industries Corp., reportedly removes excessive magnetic buildup from cassette equipment heads. It is built

into a compact-cassette case. A flat, mylar-copper laminate lead wire permits closing the cover of the player. Other features include a pilot light and operation on standard house current.

The price of Model TD-10 is $8.30. ▲

Circle 77 on literature card

Circle 30 on literature card

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100. *Gavin Instruments, Inc.* — has issued a catalog covering their new line of electronic hardware and related accessories.

AUDIO

101. *Nortronics Company, Inc.* —has released a 6-page leaflet, form No. 7260, which shows how to determine whether or not the tape head of a tape recorder is worn to the point where replacement is required.

BUSINESS

102. *Datastrip Corp.* — announced the publication of a 12-page illustrated catalog covering their line of cross reference visible indexing systems and general list-keeping books and equipment.

COMMUNICATIONS

103. *Antenna Specialists Co.* — has made available an easy-to-use slide rule wheel calculator, which is designed to tell how far a given system can be expected to communicate, as well as taking into account the effects of antenna gain, increased tower height, transmitter power, receiver sensitivity, etc.

104. *Apelco* — has published a 12-page catalog covering their line of 1970 marine communications and navigation equipment.

COMPONENTS

105. *Essex International, Inc., Controls Division*—has issued their 1970 "STANCOR Color and Monochrome Television Parts Replacement Guide," containing a list of over 500 STANCOR transformer and deflection components, a cross reference guide and a section covering the STANCOR line of flybacks, deflection yokes, vertical outputs, power and output transformers and filter chokes, plus several pages of schematics.

106. *General Electric* — a 12-page, 4-color, illustrated "Picture Tube Guidebook" brochure No. ETRO-5372 provides a reference source for information about GE color picture tube replacements and tube interchangeability.

INSTRUCTIONAL MATERIAL

107. *Graymark Enterprises, Inc.* —has released a catalog of electronics transparencies, plus other electronics components and instructional projects.

SPECIAL EQUIPMENT

108. *Ideal Industries, Inc.* — 2-page, 2-color Bulletin No. 6A has been issued, which illustrates and describes their new electric heat gun.

109. *Power Electronics, Inc.* — has published a brochure illustrating and explaining the uses of their Model PEP IV portable electric power unit.

TECHNICAL PUBLICATIONS

110. *Howard W. Sams & Co., Inc.* —Literature describes popular and informative publications on radio and TV servicing, communications, audio, hi-fi and industrial electronics, including 1970 catalog of technical books on every phase of electronics.*

TEST EQUIPMENT

111. *Sencore, Inc.* — announces the availability of its 12-page 1970 catalog, Form No. 517, describing the company's complete line of electronic test equipment, featuring 5 new instruments.*

112. *Tucker Electronics Co.* — has issued a 44-page catalog, No. 18, which describes over 2000 different test instruments or microwave components for sale or rent.

*Check "Index to Advertisers" for additional information.

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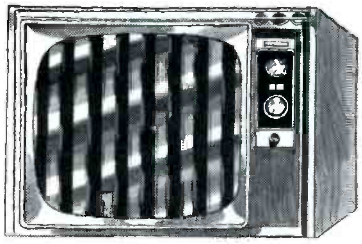

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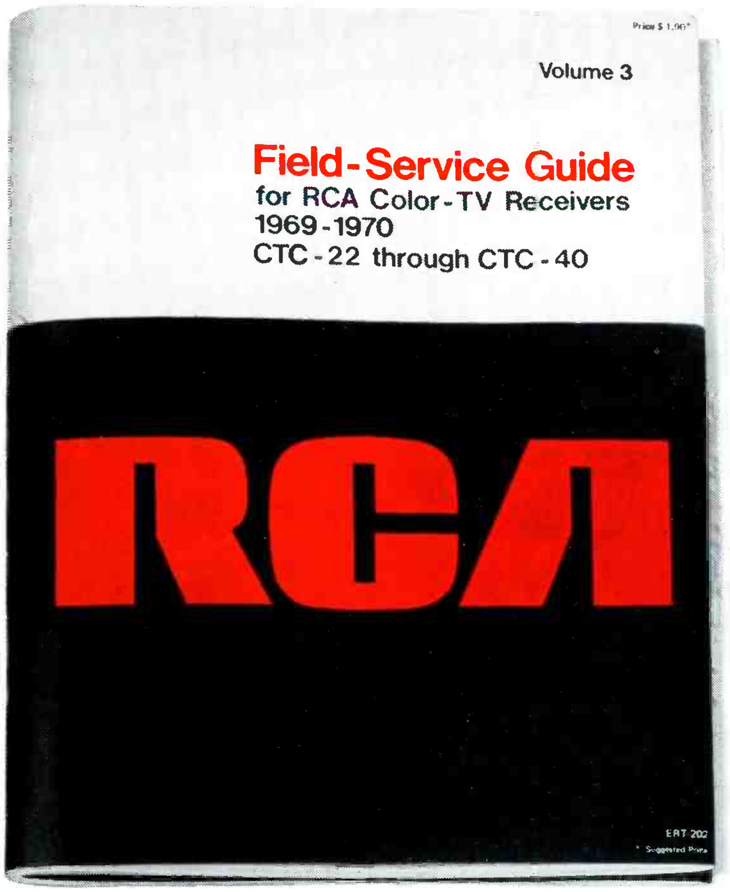

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