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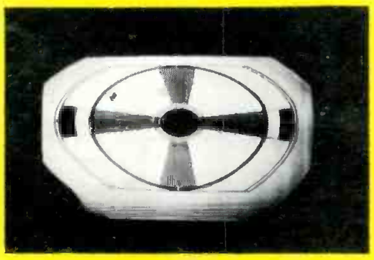
A HOWARD W. SAMS PUBLICATION

Electronic Servicing

Formerly PF Reporter

VECTOR SCOPES #18



Poor vertical linearity... GOOD

CAUSES AND CURES

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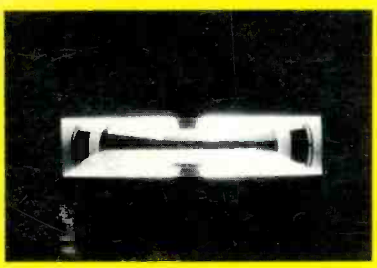

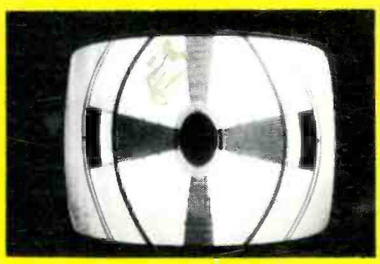

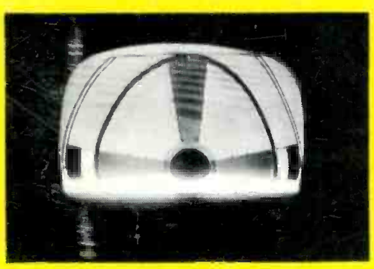

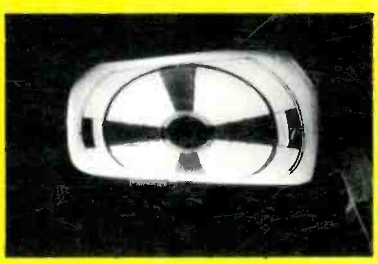

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Electronic Servicing

Formerly PF Reporter

in this issue...

DEPARTMENTS

Second class postage paid at Kansas City, Mo. and additional mailing offices. Published monthly by INTERTEC PUBLISHING CORP., 1014 Wyandotte St., Kansas City, Mo. 64105. Vol. 19, No. 7. Subscription rates $5 per year in U.S., its possessions and Canada; other countries $6 per year.

ELECTRONIC SERVICING (with which is combined PF Reporter) is published monthly by Intertec Publishing Corp., 1014 Wyandotte Street, Kansas City, Missouri 64105.

Subscription Prices: 1 year—$5.00, 2 years—$8.00, 3 years—$10.00, in the U. S. A., its possessions and Canada.

All other foreign countries: 1 year—$6.00, 2 years—$10.00, 3 years—$13.00. Single copy 75¢; back copies $1.

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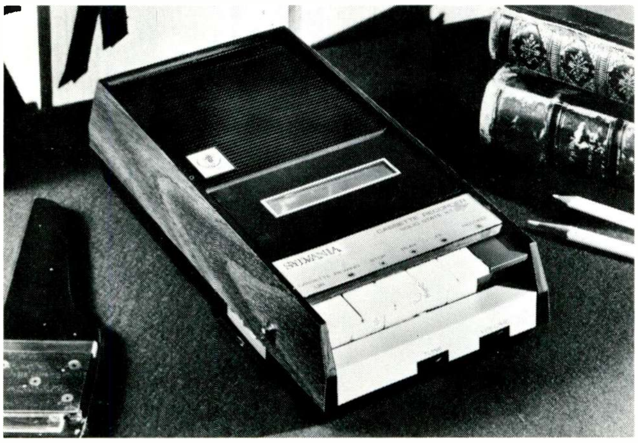
electronic scanner

news of the industry

Sylvania Begins Producing Tape Recorders

Sylvania Electric Products Inc. has announced its entry into the tape recorder business with the introduction of a portable, cassette unit.

Gordon C. MacDonald, Vice President-Marketing of Sylvania Entertainment Products, an operating group



of the company, said the new recorder-player is the first of a family of such products to be introduced within the next few months. "We believe the future of the tape recorder business is in the easy-to-operate, cassette-type units," he said.

Toward 3-D TV?

A system that uses laser beams to project what is reportedly true three-dimensional motion pictures has been demonstrated by North American Philips Corp., according to a recent report in **Electronic News.**

Philips researchers also are working on techniques to produce holographic motion pictures that do not require the use of lasers or special glasses for viewing. The special holographic film used in the Philips prototype projector moves continuously and does not require a shutter as do conventional projectors, which intermittently move the film from frame to frame. The holographic film is about 3 inches wide and is segmented horizontally by strips of "information" about one-half inch apart, which reconstitutes the image for laser projection.

Dr. Donald D. King, president of Philips Research Laboratories, said that current three-dimensional development appears to be most applicable to the entertainment field. He said the general goal of current research is to develop practical methods of recording and reconstructing 3-D images, particularly for commercial television applications.

NEA Appoints Executive Vice President

Richard L. Glass, C.E.T., has resigned as president of the National Electronic Associations (NEA) to accept the newly created full-time, salaried position ot Executive Vice President of NEA. The action took place during the quarterly meeting of the Board of Directors of NEA, held in conjunction with the Eastern Service Conference in Philadelphia May 9-11.

Emmett Metford of California was elected by the the NEA Board of Directors to succeed Glass as president of NEA.

Developments

A prototype laser color TV with a screen measuring 10 feet x 6 feet x 8 inches has been demonstrated by Hitachi, Ltd. of Japan. The color TV uses three laser beams, one for each primary color. The beams are modulated by a television signal received on a conventional NTSC-type color TV receiver.

A fail-safe high-voltage diode that reportedly will solve the problem of X-radiation from color TV receivers has been developed by Victoreen Leece Neville, Inc. The diode is designed to replace the shunt-type high-

voltage regulator currently in use. The Victoreen fail-safe design automatically reduces the high-voltage if the diode fails.

A miniature monochrome TV picture tube with a diagonal screen size of 1.2 inches has been developed by Nihon Denshi Kogyo, Ltd. of Japan. The new picture tube has a 40-degree deflection angle and measures 3.6

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WATCH FOR NEW CENTERS UNDER DEVELOPMENT

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inches in over-all length. The scanning capacity of the miniature tube is 350 lines; high voltage required is 3 to 5KV. Applications of the miniature picture tube are pocketable TV, VTR and ITV, according to a spokesman of the specialty manufacturer of TV picture tubes.

A visual-aid system for adjusting the tint of a color TV receiver has been developed by Hayakawa Electric Co., Japanese producer of color TV receivers. Pushing a knob produces on the TV screen two vertical stripes, the distance between which is directly proportional to the difference in phase between the broadcast burst signal and the receiver chroma subcarrier oscillator. Merging the two vertical stripes by rotating the control knob brings the output of the receiver chroma subcarrier oscillator into phase with the broadcast burst signal. A spokesman for the company said the new device, which uses an additional burst gate and phase detector, will be incorporated in color TV's to be exported by the company to the U.S. in the near future.

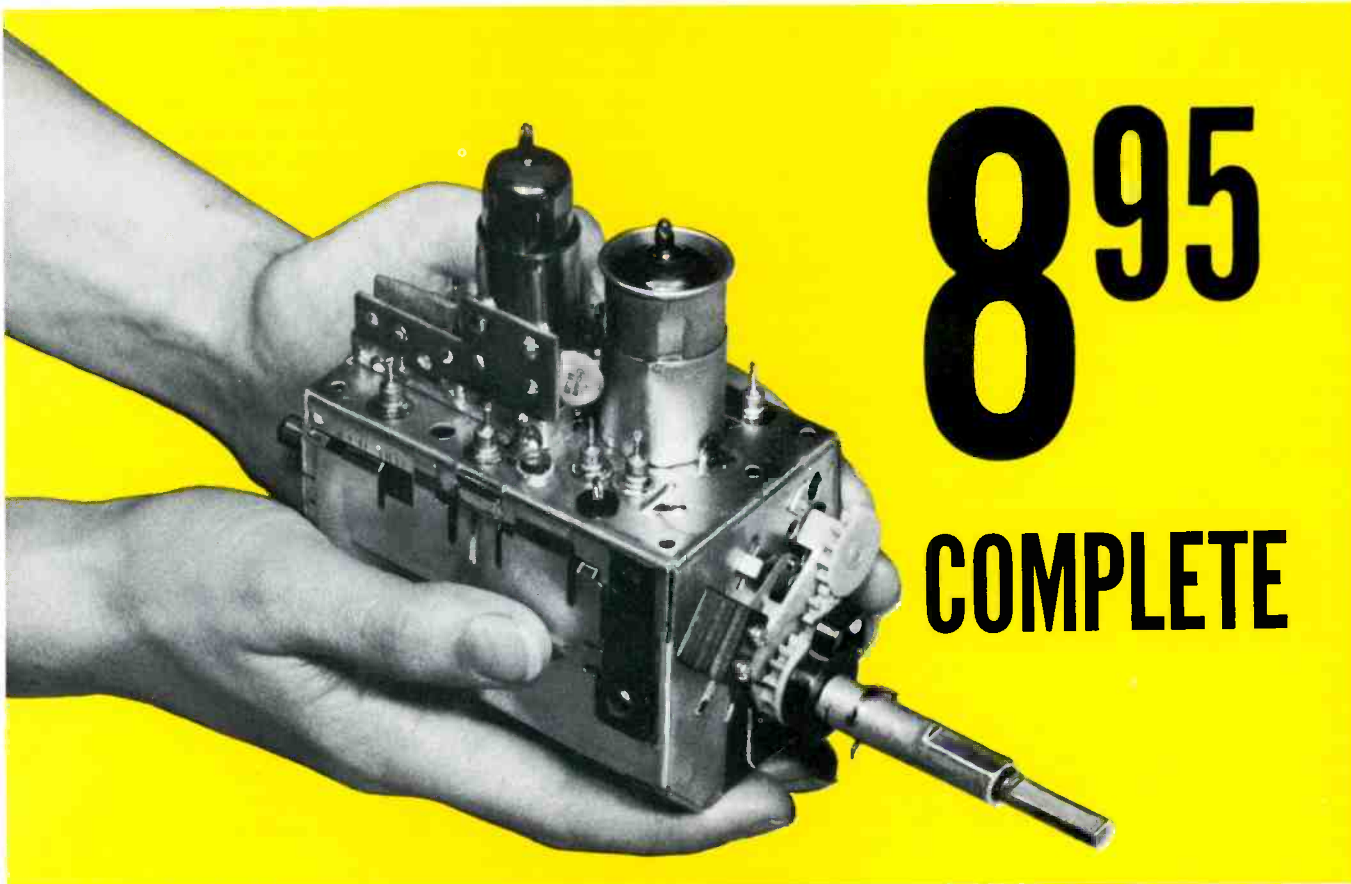
A new large-screen color TV picture tube that is reportedly twice as bright as current RCA color picture tubes has been announced by RCA Electronic Components. The increased brightness level is the result of RCA's newly developed precision matrix phosphor-dot screening process, which involves the placement of 1,267,650 red, green or blue phosphor-dots within an opaque, black matrix. According to RCA, the black matrix "selectively absorbs ambient light incident on the screen and, secondly, selectively releases the light emanating from the phosphors." Before the introduction of the black matrix, RCA explained, it was necessary to use dark-tinted filterglass face-panels in order to maintain good picture contrast at high ambient light levels. In the new HI-LITE MATRIX tube, RCA employs a light-tinted filterglass face-panel that traps less light than the darker tinted face-panels. Also used in the new picture tubes is a new electron gun that, according to RCA, provides sharper focus over the entire brightness range. The new picture tubes are electrically and mechanically interchangeable with the RCA 25XP22 color picture tubes.

NEA Convention Speakers

Six representatives of the electronics industry have accepted invitations to address the 1969 national convention of the National Electronic Associations (NEA) to be held July 23rd through July 27th in Waterbury, Connecticut.

Scheduled to address the NEA Convention are: Robert J. O'Neil, RCA Vice President of Consumer Electronic Sales; R. W. Woodbury, President of Sprague Products and chairman of the Service Division of the Electronic Industries Association (EIA); Aaron Neretin, Editor-In-Chief of **Merchandising Week;** George W. Bartlett, Vice President for Engineering for the National Association of Broadcasters (NAB); Robert Flanders, Director of Engineering of WFBM stations in Indianapolis; and Gail S. Carter, Executive Vice President of the National Electronic Distributors Association (NEDA).

—NESA News ▲



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CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

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letters to the editor

Technicians Need More "Customer Psychology"

Recently there have been many letters to the editor complaining about the business of servicing electronic products. This seems to be the age of complaint and dissatisfaction in all areas of human existence.

For a change, I would like to compliment the independent electronic service business. I know of no other business where a young man without a college degree can become involved in work of such a technical nature.

My own case is a good example. The school system did not make the classroom seem relevant to daily life to me, and, as a result, I was never interested in school and made only about average grades. I had no idea what I would like to do when I would have to make my own way in the world, but I was always interested in science and technology. My grades disqualified me from college. Any technical future was out of the question—except for electronic servicing. Due to the opportunities in electronic servicing, I have progressed to being the highest paid electronic technician in my area. Through my own study efforts, I now have a 1st class FCC license, and I am a Certified Electronic Technician [NEA certification]. I have been in this business 12 years.

There are oddities about this business, though. It is the only business I know in which the customer knows nothing at all about what the technician does and must know to complete his job. Yet, our customers take the attitude that they know all there is to know about electronics. We can all recite our experiences with customers who knew exactly what was wrong with their sets—all we have to do is "put in that little tube that takes the auto ignition interference out of the picture."

Somewhere along the line we have made our business look too easy to the customer, and we have failed to educate him in the intricacies of some of the problems we encounter. They expect TV technicians to be well paid—but "George" should be the one to pay.

Because of the difficult situations customer ignorance creates, I would like to see a few articles on psychology relating to customer satisfaction. In my opinion, a successful electronic service business is 10% know-how and 90% psychology (or that dirty word salesmanship). Not that technical competence is not important, but technical competence alone is not nearly enough.

MERVIN COLLIER C.E.T.

Campbellsburg, Indiana

Opinion About Licensing

I wish to express my opinion about requiring the licensing of electronic technicians. I think this is an unnecessary evil which will only make earning a living more difficult.

Most of the people in the electronics field are graduates of an electronics school and are well qualified in their work. If they were not proficient, they would not last. An electronics association executive has said that electronic servicing has made the manufacturer very happy and the sale of electronic goods a booming field. I agree to his statement and add that this was accomplished without licensing.

I believe the electronic technician has a natural talent for repair. That is what it takes—talent—not a license. A talented singer, dancer, actor, author or artist does not need a license to perform. Works of art do not have a fixed price; neither does the art of servicing.

If there were not so much greed, everyone would have a good chance to earn a living according to his ability. We have made it so hard for people to get a job that the welfare departments are overloaded with cases, and this is costing the people who do have good jobs millions of tax dollars.

The electronic organizations say they want to change the image of the technician. They do not like the name TV repairman. I do not see anything degrading in that name; it best describes the work. Whether an electronic technician has a license or an engineering degree, if he devotes his time to repairing televisions, he will be referred to as a TV repairman by his customers. Only by educating the public through literature and by calling him an electronic technician on TV and radio, will his title be changed to electronic technician.

In closing, I wish to inform you that I have been a happy subscriber to your fine magazine for many years.

LOUIS MONTOYA

Flat Rock, N. C.

Technicians Should Speak Out!

I want to express my satisfaction concerning Mr. Wolven's letter in your February '69 issue. I feel that Mr. Eldon E. Johnson's fear of the TV servicing industry "protesting too much" (April '69, Letters to the Editor) is ill-founded and smacks of a timidity which has become all too common. Unless we articulate our views, we cannot expect to see changes. This applies to the manufacturer as well as to the technician. Fear of angering the manufacturer hardly should silence criticism. It is obvious that the manufacturer, if he should choose to exclude TV repair shops, cannot service without competent TV technicians.

I believe that the present technician shortage will force a significant improvement in the deplorable wage earned by the rank-and-file technician, by economic necessity. If this does not ease the situation, I predict organized labor will be invited to champion the rights of technicians, a situation which has already occurred in certain cities.

TV technicians have remained silent too long. They must express their views. I commend ELECTRONIC SERVICING for providing an opportunity for dialogue. TV technicians must employ whatever means are at their disposal. Expressing their views is one step toward better wages and hours.

VINCENT L. IRVAN

Carmel, California

Electronic Servicing is About Servicing Electronics

This letter is in reference to Mr. Franzen's letter to the Editor in the April issue.

Mr. Franzen says: "However, I do not like to see articles on two-way radio because I think that is a separate field." Separate from what? On page 32 of the same issue, you state that ELECTRONIC SERVICING is "the country's only magazine devoted 100% to the Electronic Servicing industry . . ." With the rapid growth of the two-way radio field, we need many more service shops now, let alone five years from now.

It is true that, since electronics consists of only a few basic building block circuits, many of the troubleshooting techniques of one type of equipment can be applied to another. At the same time, however, each piece of equipment does have its own special problems. I believe that these "special problems" should be brought out in your magazine along with the general troubleshooting techniques which apply to several types and/or groups of gear.

Let's face it—the finest piece of equipment in the world is no good at all if you can't get it serviced.

If we don't train our technicians today to work with the components and equipment of tomorrow, what are they going to do when the gear is brought into the shop?

I would like to see articles on FET's, varicaps, CCTV, videotape, IC's, two-way radios and anything else new and/or different that is coming into the field.

Service shops of yesterday are now working on transistor equipment and color TV; we must now prepare to work on the components and equipment of tomorrow, or else stagnate.

Jon W. Wiswell

Bellingham, Washington

Info For ED VTVM

For information of G. L. LeBlanc, Electronics Design Model 100 VTVM was made by Eagle Electronics Inc., Irvington, New York, 1948.

I have schematics and kit instructions for this meter in case Mr. LeBlanc is unable to get what he needs from the Eagle Co. I have owned one of these meters for 15 years and am happy with it.

J. C. Varner

Fort Wayne, Ind.

Repair of Older Philco Test Equipment

In the May '69 issue of ELECTRONIC SERVICING, Mr. Selwyn Warner requested a schematic diagram or service manual for a Philco Model 7170 AM-FM signal generator.

I do not have a schematic for this instrument, but such older-model Philco test equipment can be repaired by Sunshine Instrument, 1810 Grant Street, Philadelphia, Pa., 19125. Equipment should be sent to the attention of "Test Equipment Repair Dept." An estimate of the cost of repair will be given.

John Simrell

Kansas City, Mo.

Consumer Electronic Service

Although licensing laws control a relatively small segment of the electronic servicing industry, licensing remains a much-discussed subject in the industry. Here, we give highlights of some laws, tell how various boards or bureaus function, and cite factors that cause some technicians to support licensing and reasons that others oppose it.

By Wendall J. Burns

Areas That Have Licensing Laws*: **States**—Louisiana, Massachusetts, Connecticutt, California, Indiana. **Cities**—Detroit, Kansas City, Mo.; Buffalo, N.Y.; Madison, Wisc.; St. Paul, Minn.; Tulsa, Okla.

*There are about 20 other states where licensing legislation has been defeated or delayed, and some cities where ordinances were proposed but failed to pass. One city, Akron, Ohio, passed a licensing law but later repealed it. A state law will replace a city law. For example, when Indiana adopted a licensing law, the South Bend ordinance was repealed.

What Are Objectives of Licensing?

To protect the consumer from the unethical and/or unskilled operator, and thereby also protect the bona fide technicians from the bad reputation that a shoddy operator gives to the whole industry.

Who Initiates Licensing Legislation?

In some places, the servicing industry, through associations; in other places, consumer protection organizations or those responsible for law enforcement.

Who Opposes Licensing?

Although not highly organized, nor open, there has been some opposition from nearly all sectors of the industry—technicians, manufacturers, distributors and other sources.

Why the Opposition?

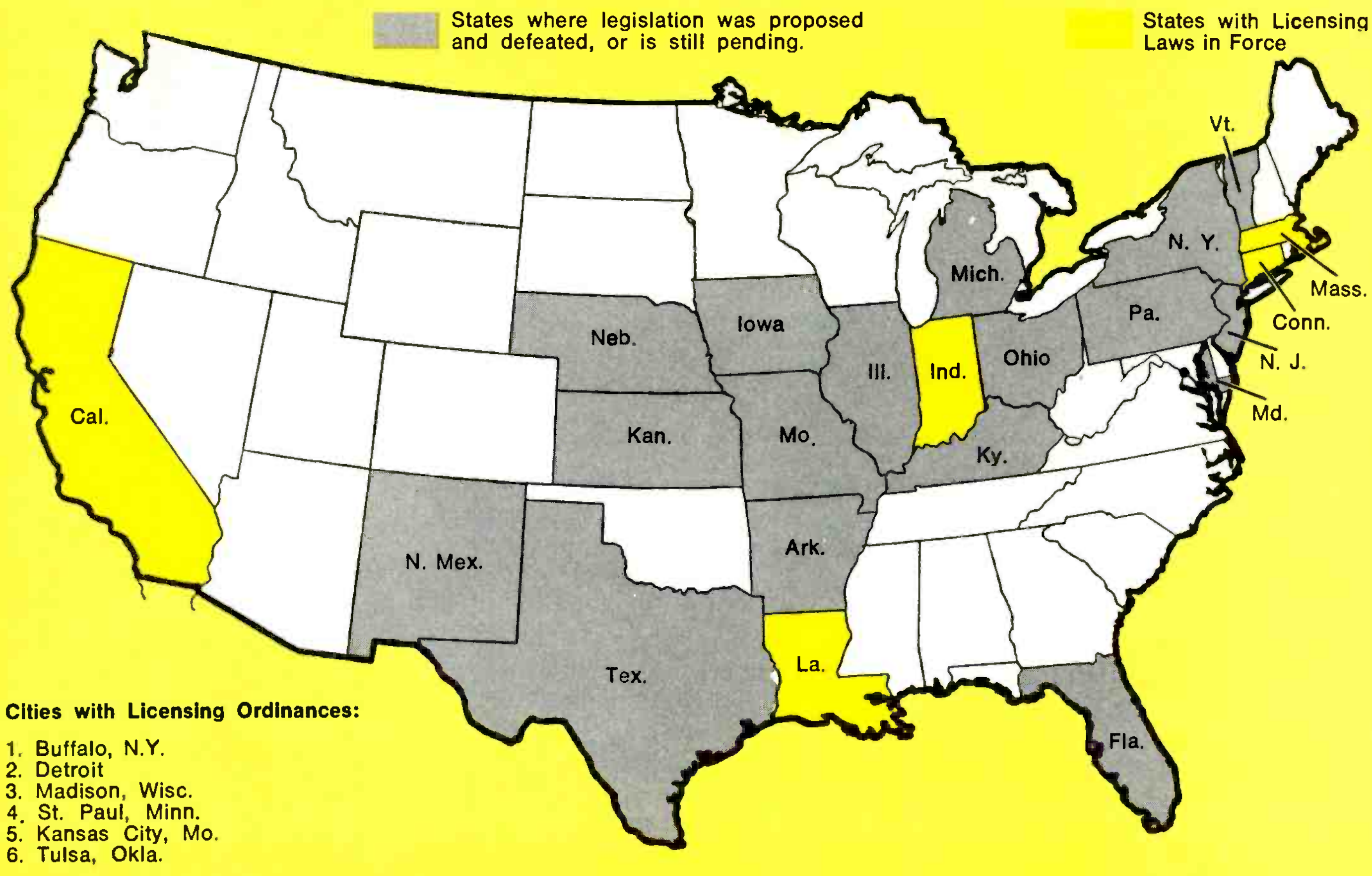
Here are some typical attitudes. "You lose a little bit of independence"; "I am opposed to any type of government regulation in any field"; "There are already enough laws to take care of the offenders"; "With all the red tape and time consumed in hearings and all, it could be very time-consuming, and it really isn't necessary."

Is the License Issued to the Firm or the Technician?

Some laws require that only the technician be licensed; others require licensing of the servicing firm. In California, where it is called a registration law, the firm is registered and must follow practices described in the law.

How It Comes About and How It Works Out—Some Case Histories

In California—After years of investigation and research, a law governing consumer electronic servicing was put into effect in this state in July, 1963. The law is adminis-



tered by the Bureau of Electronic Repair Dealer Registration, one of more than 30 bureaus, commissions and boards that come under California's Department of Professional and Vocational Standards.

Representatives of the television industry and organizations interested in consumer protection worked for its passage.

The California law makes no provision for testing the technical competence of the technician. (However, an amendment to include such testing was proposed this year in the California legislature.)

Primary objectives of the California code are to prohibit untrue or misleading advertising; to discourage false promises likely to induce a customer to authorize repair or any conduct which constitutes fraud or dishonest dealings; and to curb gross negligence. It also prohibits service dealers from making compensation to an employee depend on the value of parts placed in any customer's equipment.

This law also provides for the return of replaced parts to the customer, except those specifically exempted, and it requires that an estimate in writing be given when the customer requests it. The actual charge may not exceed this estimate without the previous consent of the customer.

In its first 5½ years of operation, the California Bureau received approximately 12,000 complaints from individuals and law enforcement agencies. There were 52 registration revocation proceedings initiated and 143 criminal actions concluded during that period.

During 1968, over 3,200 inspections of service dealers were conducted to enforce regulations regarding the full and fair disclosure of parts and labor charges on invoices.

The bureau has two electronic laboratories (one in Sacramento and one in Los Angeles) equipped with test equipment and operated by four experienced electronic technicians. Among other tasks, they work with the bureau's investigators by installing malfunctions in sets to trap firms suspected of dishonest practices. If petty theft or fraud is found, the evidence is presented to the district attorney.

The bureau reports that during one period, it sent 70 marked TV sets through suspect television service shops. According to the report, "In 80% of the cases, there was unequivocal fraud and petty theft which did not involve questions of judgment or electronic diagnosis."

The California law registers only the service dealer—not his employees.

In Indiana—The law was passed in 1967. (Four previous attempts to pass a law had failed.) The Indiana licensing board employed its first investigators in February, 1969.

"There is already evidence that the trade is being upgraded," says Leon Howland of Indianapolis, chairman of the board. The investigators are full-time employees of the board and are assigned specific territories. An injunctive action has been filed against one servicing retailer, and another is under investigation for fraud.

The primary purpose of the law, according to Howland, is two-fold:

Number one: "To give protection to the public—to give the customers recourse—someplace to go if they feel they have been treated badly.

Number two: "To upgrade the trade; to set minimum standards in this business that for so long has had no standards whatsoever." Overall objectives of the Indiana law are set forth in Section 1 of the Television and Radio Licensing Act.: 'It is hereby declared to be the public policy of the State of Indiana that the public should be protected from financial losses and other hazards resulting from irresponsible service methods, unethical practices, inferior installation, maintenance and repair of television and radio, including antenna receiving systems'."

BBB Report

Consumer dissatisfaction expressed to the Better Business Bureau is one barometer of business-consumer relationships. The BBB's current national summary sheet (covering 1967) lists 60 different categories of businesses, indicating for each category the volume of complaints. The summary had no special category for electronic servicing but included this industry in the classification, "TV-Radio, Sales and Service." The categories of business causing the largest number of complaints to the BBB:

Business Classifications	Complaints	Customer Relations Problems
Magazine (Subscriptions)	30,791	53,844
Automotive (Repairs & Service, Accessories, Tires)	23,368	53,277
Home Improvement & Remodeling	23,298	58,238
TV-Radio Sales & Service	22,795	51,775
Freezer Food Plans	21,729	53,507

The failure to pass a law in one of the first four attempts, Howland feels, was due to the lack of organized effort in favor of it, rather than organized opposition. But, there was opposition. "Many distributors think that it is not good to have unity among technicians, and licensing creates a common bond among them [the technicians]."

"In Indiana, we felt that the manufacturers in general didn't want licensing," Howland said. Before the proponents of the law presented it to the 1967 legislature, they showed the bill to attorneys of a leading TV manufacturer and attorneys of a leading publisher of electronic service literature in order to work out a compromise on some provisions that might have been objectionable to these segments of the industry.

This law, as do most other laws on licensing and registration in this industry, provides that the customer must put the complaint in writing before it will be investigated. The board developed a complaint form for this purpose. When a complaint is received, the complaining party is sent a form. When it is completed, a copy is sent by the board secretary to the servicing dealer.

Previously, Howland said, the lack of a written complaint made it difficult to investigate alleged irregularities. "I feel that probably 99% of the complaints will be unjustified," he said.

The test in Indiana is in written form now, but it is believed feasible to introduce a practical aspect into the testing in the future.

In Kansas City (Mo.)—A licensing ordinance has been in effect since 1958. Immediately after the law went into effect, almost every service dealer in town policed himself, says the chairman of the city's TV License Examining Board, Earl Steffes.* But the few firms that were opposed to licensing, opposed it vigorously. They went to court to test its legality, going as far as the Missouri Supreme Court, which upheld the code.

One opponent to the law was advertising "service calls" and was charging customers for tubes that did not need replacing, says the present board chairman. His license was revoked. Some of the other five or six original opponents to licensing have changed their opinions and have become supporters of licensing, Steffes said.

*Steffes operates a service business, having established the firm in 1952. He had begun working in the industry as a technician in 1949.

The Better Business Bureau (BBB) in Kansas City says the licensing ordinance has been decidedly beneficial, but a BBB spokesman cited a problem that arises when only one city in an area is so controlled: A licensee was found guilty of abuses, and his license was revoked. He merely moved out of the city limits to a suburb to set up shop, but the Better Business Bureau continued to receive complaints against him. He later moved to another town 10 miles away, then two years later to another town 15 miles further. The BBB still receives calls complaining of his practices, but he is outside the reach of Kansas City's license law.

Complaints come to the board chairman from the BBB or from city hall. Most of the complaints can be handled by telephone, Steffes said, and the others are put in writing by the customer and presented to the board.

In Massachusetts—This state now has approximately 7,500 licensed technicians. The Board of Registration of Radio and Television technicians that regulates electronic servicing also issues learners permits and reports that it tests 600 to 800

Trade Associations' Attitudes

In interviews with the leaders of both national trade associations, NEA and NATESA, their viewpoints on licensing became evident: They favor licensing and have worked for licensing laws; they are promoting certification programs as well as licensing; they see no organized opposition among technicians to license laws.

The extent to which NEA leadership is involved in and supports licensing is demonstrated by the fact that Leon Howland, national secretary of the NEA, is serving as the first chairman of the Indiana Licensing Board.

Frank Moch, executive director of NATESA says, "NATESA and I have both been strong proponents of both a certification and a licensing program. We have sponsored legislation across the country. We were successful in getting the first licensing law passed in Louisiana; we were successful in getting the bill in Kansas City; we helped in the certification program in California; we were successful in getting the Massachusetts bill." He explained that he has also gone to six or eight sessions of the Illinois legislature to back licensing legislation, but, to date, these efforts have failed. He said he would not again work for passage of such legislation in Illinois "without pretty substantial agreement of the service people as a whole."

Moch said that just passing a law does not resolve the problem without continued organized support by the technicians. He said that lack of such organization and such support was one of the reasons that the ordinance on licensing that was adopted in Akron, Ohio, was later repealed. Moch explained why he went to bat in Illinois for a licensing program, even though he had been promoting NATESA'S certification program:

"We had no means of enforcement. The laws being what they are, it would be impractical for an organization to say that 'John Doe is unethical.' You can get yourself in some pretty bad lawsuits. We came to this conclusion [to support licensing] not because we love government control—because we don't. But, in order to get something, you have to give something. We had no funds for selling the certification program to the public, and we had no means of enforcement. We felt we needed the power of a governmental agency to put this across.

"Licensing will not put anyone out of business but the completely incompetent and the unethical. Our purpose never was, and certainly is not now, to put anybody out of business, although the parts distributors and those who cater most to the do-it-yourselfers apparently have been fearful.

"But there is no cause for this. This is an expanding industry. There is more than enough work for every operator in the business that wants to be in business."

applicants for licenses each year. The examinations are given in a number of locations across the state.

The law in Massachusetts was initiated and supported from the inception by the Electronic Technicians' Guild in that state. Michael Malone of South Hadley, chairman of the board of registration, said there was very little opposition to that state's licensing law.

"We paid a legislative lawyer to take our ideas and put them into legal language. His charge was very reasonable, too," Malone said. He said that the state representative who submitted the law before the legislature had done sufficient lobbying so that it was passed on the first reading. The manufacturers, according to Malone, "have been tremendously cooperative with us."

It has been the experience of the Massachusetts board, Malone said, that the great majority of the disagreements between the customer and servicer that are brought to the board are resolved without legal action. However, 35 to 40 cases have been taken to court since the board hired its first investigators 2½ years ago.

The law stipulates that any advertising, even the signs on service trucks, must show the license number of the servicing firm. The technician's pocket card also has his license number, and he must show it to the customer if requested. His card also shows his status as a master or journeyman technician.

Joseph Cassidy, full-time paid administrator of the board, described new equipment used to facilitate giving the "practical" part of the qualifying test. A portable overhead projector flashes onto the screen the diagrams of schematics and servicing problems. The applicant marks a worksheet corresponding to the projected diagram to show his knowledge.

In the board's initial stages, the examiners carried TV sets to the various examination sites throughout the state. Due to the large number of applicants, it was impractical to have sufficient personnel and sets available to check each man's performance on a set and to actually observe him troubleshoot a set.

Two separate practical examinations are given—one for the technician and one for the master technician.

"At first, when the board was transporting TV sets from one testing place to another, it got to be very, very inconvenient," said Malone. "Also, if we set everybody down with a scope and a VTM, we'd be there for a month."

Now, with the practical part of the test given by using a diagram, it is also easy to change the exam.

Cassidy was the board's original chairman.

"Our investigators make a complete check of newspaper ads and telephone directories, and we have had the cooperation of the big companies," he said. Among other things, the practice of "bait" advertising has been curbed by the licensing laws.

"We have prosecuted quite a few. We have to go through the state attorney general."

In Detroit—An electronic service technician and businessman told why a Michigan trade association, TSA (Television Service Association), first opposed licensing. "The feeling was that we didn't want any regulation. With licensing, you lose a little bit of independence," said this spokesman, Peter Fabbri. He is a service dealer and editor of his association's periodical, the **TSA News.**

He explained, however, that the TSA changed its viewpoint.

"In the end, we fought for licens-

Make Your Own Decision About Licensing

It can be uncomfortable when the consumer electronic servicer (or anyone in business) faces licensing or other laws that would restrict, impede or otherwise alter his way of doing business—and possibly add on some kind of a tax, examination, hearing or other by-product of our complicated society.

But he is probably already in an uncomfortable position. The fact that there are large numbers of consumers and government and consumer agencies dissatisfied with various types of servicing and demanding reforms is so well known that it needs no documentation here.

As the technician or service dealer faces this dilemma, some of these questions certainly occur to him: How would licensing affect my methods of doing business? Can I (or my employees) pass the test? What does licensing cost—in cash, in time lost, in business lost?

Finally, the man in this business might be asking himself: Isn't there some other way? Some alternative? Could not a strong national trade association establish standards and encourage self-policing by the industry?

Whatever the ultimate answers to these questions might be, it can be said that time studying the following three things would be time well spent: 1.) The provisions, advantages, disadvantages and over-all effects of licensing laws already in force; 2.) Provisions and possible effects of licensing proposed in your state or city; 3.) Alternatives to licensing, for example, self-regulation by a strong association of electronic technicians.

For it is possible for technicians—through lack of knowledge, through lack of organization, through inaction—to permit passage of unrealistic licensing laws or to let some alleged notoriously bad conditions in the industry to continue to grow worse. (Some service dealers have commented that support for licensing legislation is strongest in areas where abuses by some operators in this industry are the worst.) Laws can be tailor-made to meet the needs or desires of the sponsors and can eliminate many of the problems suggested in the questions above. Or, in attempting to cure some alleged industry ills through licensing of the technician or service dealer, it is possible to come up with a medicine that would cause a reaction more troublesome than the ailment.

On the other hand, the bitter pill of licensing may provide the servicing industry quicker relief from ills than the more palatable but probably slower acting effects of self-policing via a strong national trade association. Particularly since there presently exists no national trade association whose membership represents a majority of the electronic service shop owners and technicians in either the country as a whole or all major population centers in this country.

ing. Things were kind of bad here." He suggested that notoriously unethical practices tend to create strong support for licensing.

"Licensing in Detroit has helped to clean up the city, including the sharp boys who were using 'bait' advertising."

Fabbri sees the curb on advertising of service rates as one of the best features of the Detroit law. No service rates can be shown on store windows or in display advertising of any kind.

"We think we probably have the best licensing law in the country," Fabbri said. An attempt to adopt a **state** law in Michigan failed. Here, as in some other areas, there apparently was no organized opposition to licensing—only resistance from individual dealers.

A Detroit newspaper columnist recently commented on the effect of licensing in that city when he answered a reader's complaint about a TV service contract: "Plenty of shylock operators were in the TV fixing business till Detroit passed a licensing ordinance in 1957 (37 of the first 200 applicants flunked the first test). It's still a mess in the suburbs, since most don't have licensing laws. Detroiters can find out if an outfit is licensed by calling Electrical Inspection . . . If he's not one of the city's 371 licensed repairmen, the guy can be fined or jailed."

The reader's complaint stated that he had purchased a 5-year TV service contract but had called five times for service with no response.

The columnist assured the reader: "The company sent out a man right after we called. For $200, it's the least they could do. . . you could buy a new set for what you're paying on the service contract." ▲

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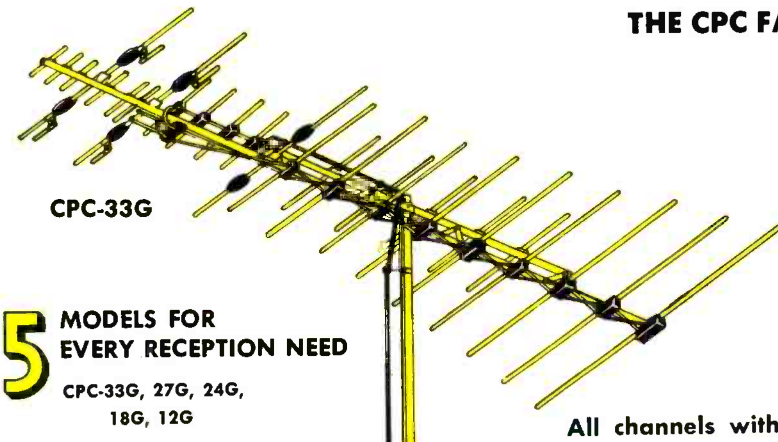

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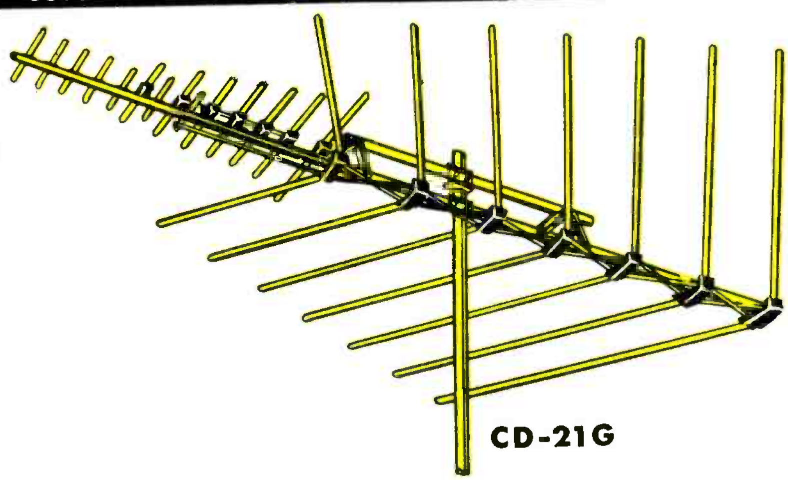

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Circle 11 on literature card

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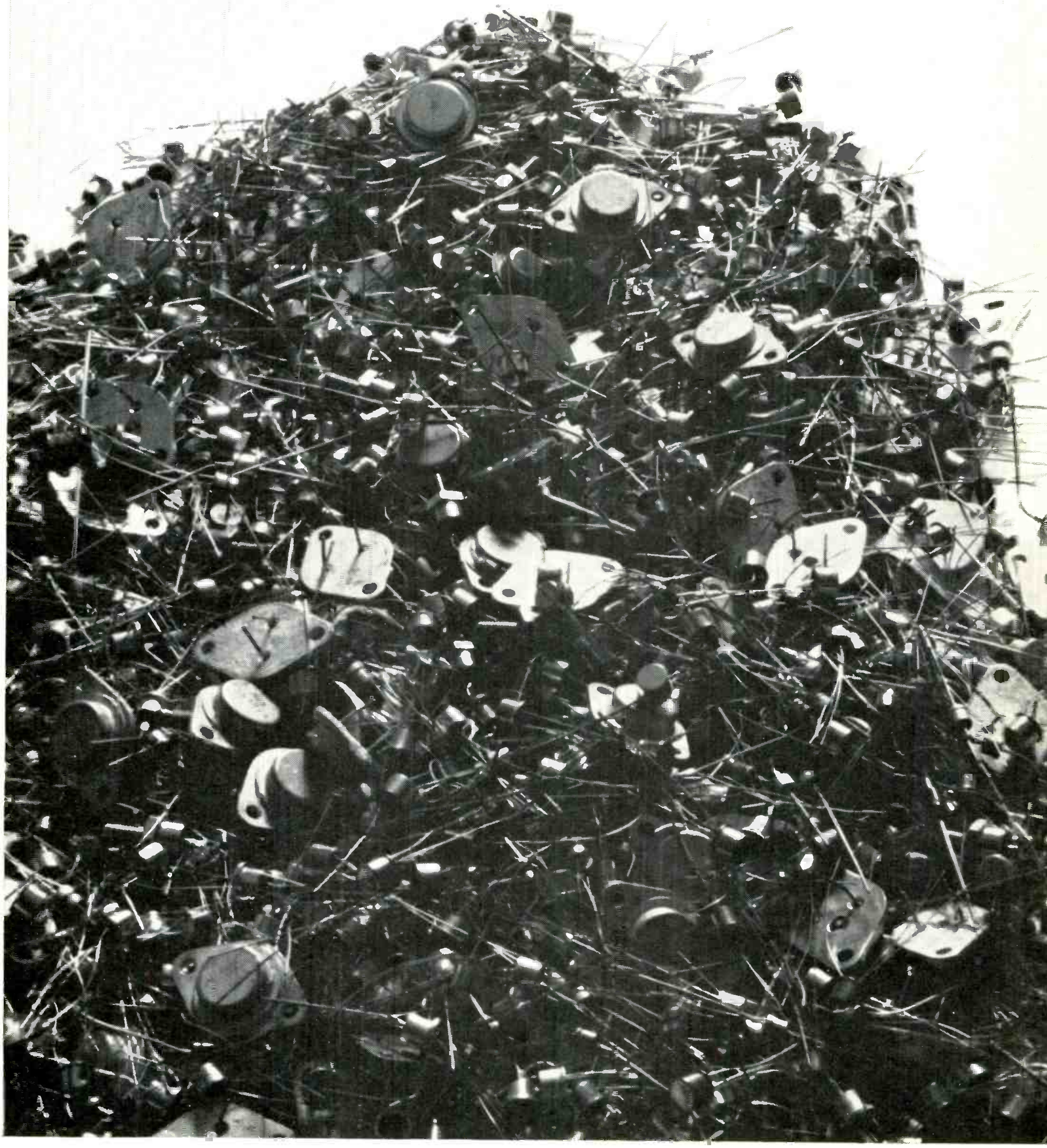
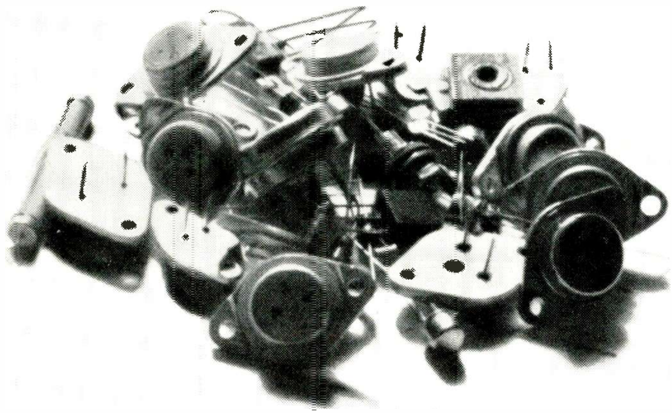


So is this.



It used to be if you wanted to satisfy everyone, you had to stock over 30,000 different solid state replacement parts.

Well, everyone realized that was ridiculous. So some enterprising people came up with a bunch of universal replacements.

Then you only had to stock about eleven or twelve hundred.

That was a lot better, but we still thought it was a little ridiculous.

So two years ago (when we went into this business), we figured out how to replace all 30,000 with only 60.

Now all you have to do is stock 60 of our diodes, transistors, integrated circuits, etc., and you can replace any of the 30,000 parts now in use. Including all JEDEC types, manufacturers' part numbers, and foreign designs.

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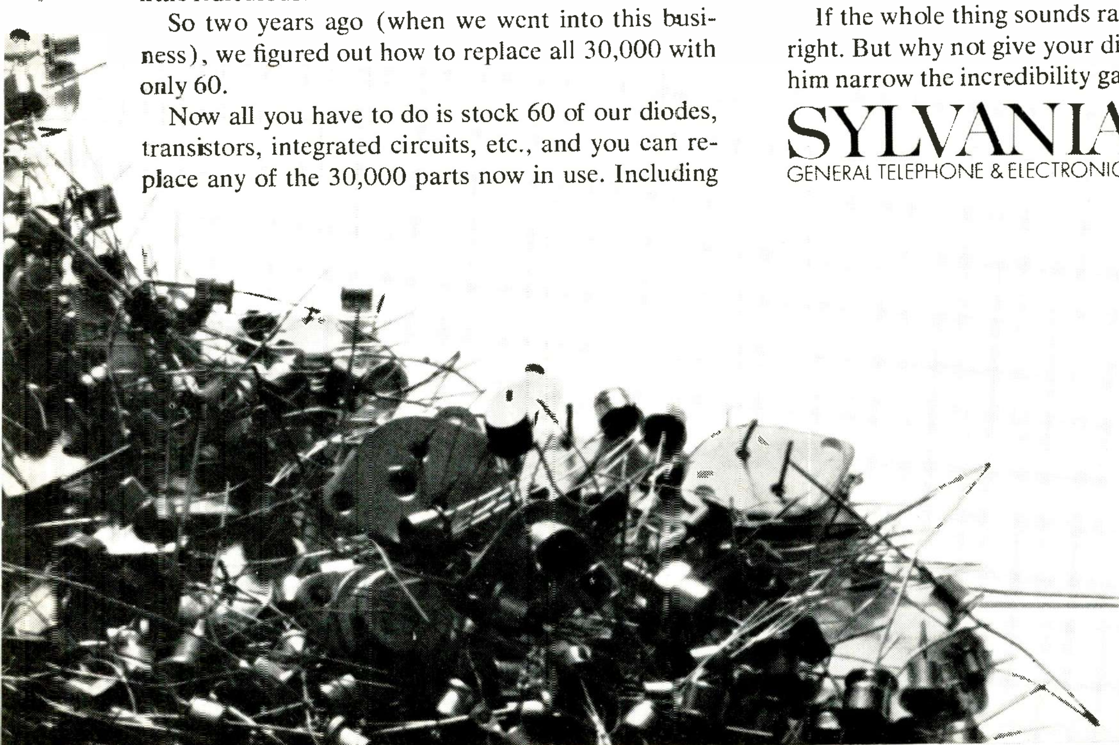

Circle 12 on literature card

Why Vectorscopes Are Popular

Application of vectorscopes and interpretation of the patterns they produce.

by Allan Dale

For a couple of years now, a new instrument for color-TV servicing has been gaining popularity. It's a special oscilloscope with a unique display which shows phase relationships among signal voltages in color demodulators. The thing is called a **vectorscope.**

Yet, technicians ask "Why buy such a limited instrument? It can only show you phase in the demodulators." The main answer covers several factors.

Stop and think about phase. You can't see it; you simply have to know what it is and watch for its effects.

For example, you adjust color demodulators to get the phase of their signals correct. Until the development of the vectorscope, you could watch the effects of adjustments in one of two ways: (1) On the picture-tube screen. With the blue and green guns disabled and a keyed-rainbow signal fed to the receiver, you adjust phase until the sixth color bar is of the same brightness as the spaces on either side of it. Then, with green and red disabled, you make sure the third bar is the same brightness as those beside it. (2) On a service scope connected to the red grid terminal of the CRT. You adjust phase until the sixth visible pip (Fig. 1) is at the zero line of the scope display and the third is at maximum amplitude. The ninth pip should also be at maximum, but in the opposite direction from the third bar.

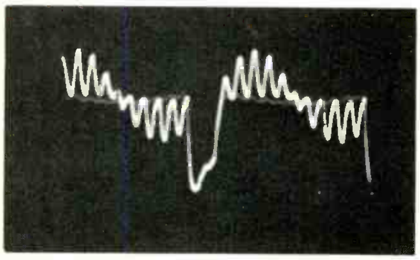

Fig. 1 Display on ordinary service scope connected to red grid of CRT. Phase is adjusted till sixth bar is right on base line.

Some technicians find it hard to really understand phase in color signals, no matter which adjustment method they use. They go through the motions of adjustment, but can't diagnose a fault if colors aren't just right or the pips don't appear where they should along the baseline of the scope.

For the technician who doesn't think in terms of phase, the vectorscope is great, because it presents phase information in a way he can actually **see** it. In other words, **phase** itself is visible and measurable on a vectorscope.

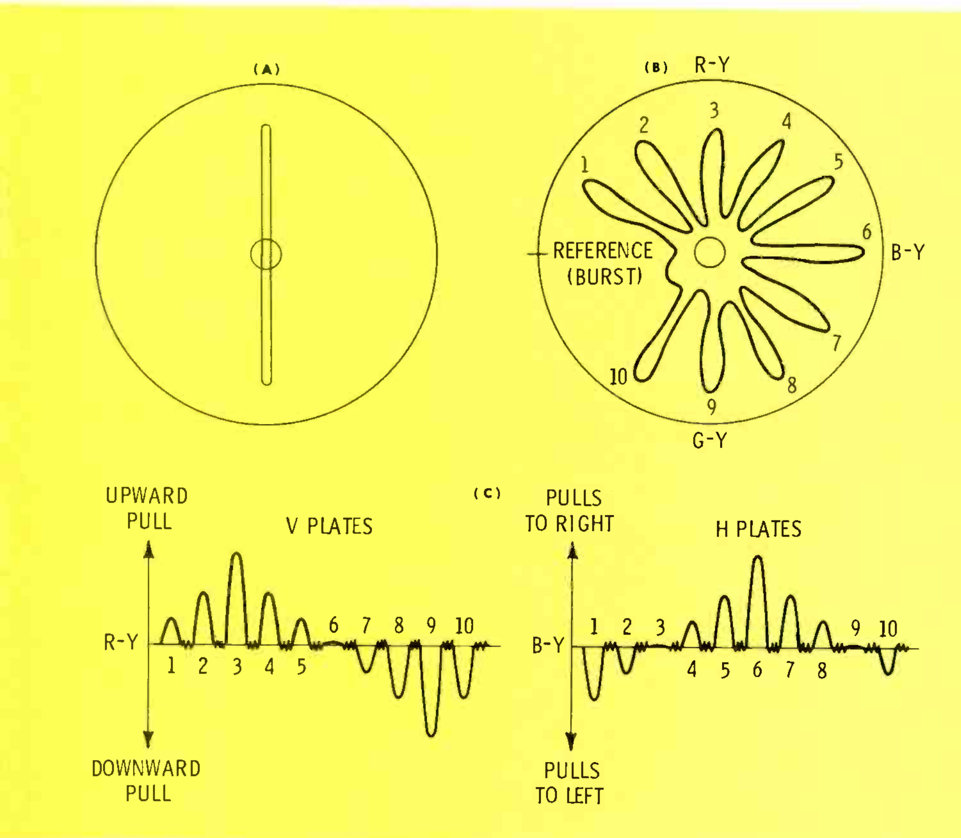

Fig. 2. How vectorgram is formed on vectorscope CRT. (A) R-Y connected to vertical deflection plates. (B) B-Y connected to horizontal deflection plates matrixes with R-Y to form "starburst" or "daisy" display. (C) The two signals as you'd see them on an ordinary wideband servicing scope; they combine in vectorscope to form the display.

The "Starburst"

To understand a vectorscope, you need to know how the display is formed. Briefly: the R-Y signal (the one that goes to the CRT red grid) is connected to the vertical deflection plates of the scope, and the B-Y (blue grid) signal is connected to the horizontal deflection plates. The diagrams in Fig. 2 show how these signals produce the "starburst" pattern. The display commonly is called a **vectorgram.**

With R-Y alone applied to the vertical plates, the display is merely a vertical line on the scope screen, as in Fig. 2A. But when the B-Y signal is applied to the horizontal plates, both signals deflect the beam in the scope CRT, Fig. 2B.

For the first bar, the B-Y signal is stronger than the R-Y, and it pulls the scope trace to the left. The

R-Y signal at the same time is pulling the trace slightly upward. That accounts for the 10-o'clock position of bar 1.

For bar 2, R-Y is stronger and B-Y is somewhat weaker. The position of the second bar is almost 11 o'clock.

The third bar, which you recall is red on the TV screen, has no B-Y in it at all (if the demodulator is working right). So, the trace is swept upward, and the loop for that bar is at 12 o'clock.

Notice in Fig. 2C that the relative strengths of the R-Y and B-Y signals are about the same for bars 2 and 4, but the **polarity** of the B-Y signal is opposite in bar 4. So the scope trace is pulled to the right instead of to the left. The R-Y force is still upward, so the loop takes a position between 1 and 2 o'clock.

You can figure out the vector forces for the remaining bars. At the ninth bar, the B-Y signal is back to zero, as it was at the third bar. Only the downward pull of the negative-going R-Y signal affects the vectorscope trace; the loop is at 6 o'clock.

Different Instruments

The two color signals must be fed to the deflection plates of the vectorscope in equal amplitude. In one late-model scope, you can connect them to the plates directly, through terminals on the back of the scope. Another model lets you connect R-Y and B-Y through the horizontal and vertical amplifiers of the scope; you adjust the horizontal and vertical gain controls so the amplifiers are equal in gain. One such scope is for vector use only, and the horizontal and vertical amplifiers have the same gain (and no control).

Technicians are resourceful. Some connect ordinary scopes as vectorscopes. It isn't all that complicated, really.

One technician made what he likes to call a "vectorprobe." The diagram is shown in Fig. 3. This probe is for the B-Y signal. It clips on the wire leading to the blue grid of the CRT, and its output goes to the scope's horizontal input. For the R-Y from the red-grid lead, you use the low-capacitance probe that comes with the scope. You have to adjust the vertical and horizontal gain controls to make the vectorgram round. You may have to juggle position controls to center the display.

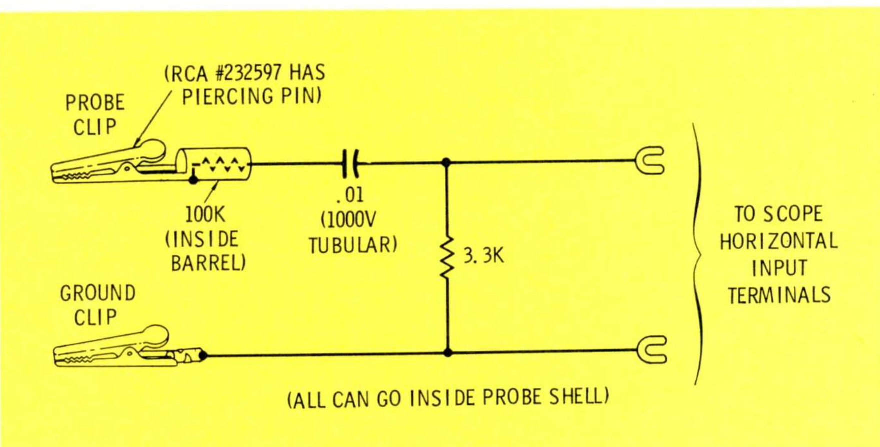

Fig. 3 Homemade probe for adapting any servicing scope to vectorscope servicing.

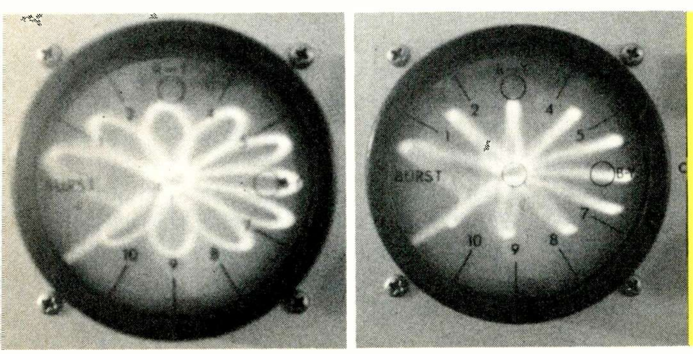

Fig. 4 Wide rounded loops (Left) mean the bandpass amplifier needs alignment. The vectorgram (Right) shows the correct shape.

What a Vectorgram Tells You

There's quite a bit of information in a vector display — more than some technicians use.

For one thing, you can tell if color gain is poor. Once you know what control settings on your scope make a normal display, you can judge from the size of the display whether the gain is enough in the color section. Just notice the length of the loops.

You can touch up bandpass alignment this way in a few chassis. Just set the bandpass transformer slugs for longest loops in the vectorgram. This doesn't work if bandpass alignment is staggered. Check the alignment instructions before you try this. If the bandpass stages are center-tuned, this trick can save you time. If adjusting the stages doesn't make the vectorgram large enough, check voltages; something is reducing gain.

A vectorgram is helpful in centering the Hue, or Tint, control range. The adjustment is the burst transformer slug in most color sets. You can watch the whole display rotate about its center as you turn the slug. With the Hue control at center, the correct setting puts the sixth bar opposite the burst or reference point. The burst is usually at 9 o'clock, so the B-Y bar should be at 3 o'clock.

You can also tell how well the color is locking in by watching a vectorgram. The loops hold still if the burst signal is synchronizing the receiver's 3.58-MHz oscillator solidly. Otherwise, they rotate slowly (or rapidly) or perhaps jump erratically around the center.

If the loops are wide and rounded, as in Fig. 4A, that's usually a sign that the bandpass amplifier needs alignment. Or, the loops may be wide but pointed. You can adjust the bandpass coil slugs until the pattern loops are straighter and narrower, as in Fig. 4B. First, be sure the receiver fine tuning is set right; if it's not, the loops will look fat and rounded.

Ease of adjustment, like this, is another reason vectorscopes have become so popular.

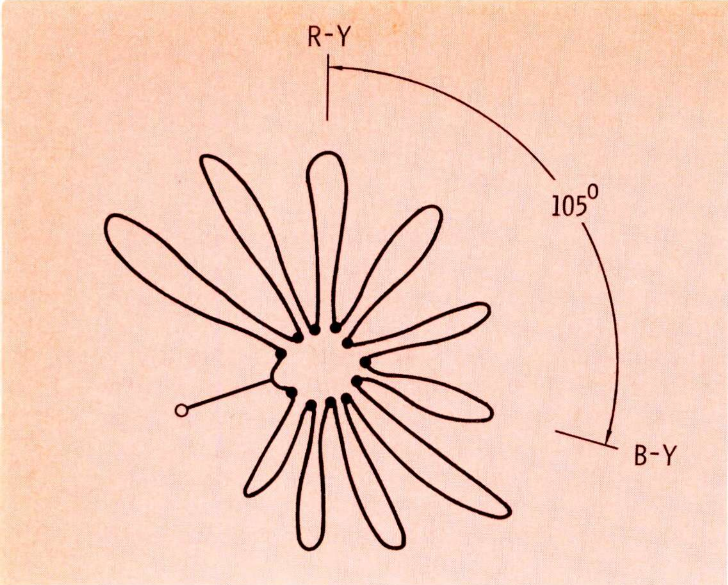

Fig. 5 This leaning, elliptical vectorgram is the pattern formed from 105-degree demodulator.

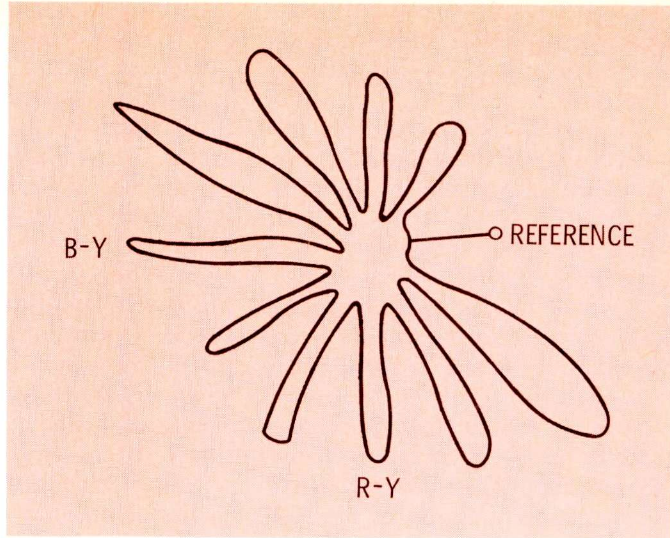

Fig. 6 When cathodes of CRT are driven, phase of the vectorgram is rotated 180 degrees.

Variations

The vectorgram patterns made by some chassis have an elliptical or oval shape. That is, the pattern is slightly wider than it is high (like those in Fig. 4), or vice versa. That's normal. The different color phosphors in color picture tubes do not always have the same efficiency. When you make gray-scale adjustments, you may turn up one drive control a little more to compensate for a weak gun or a weak phosphor. Then, when you connect the R-Y and B-Y signals to the vectorscope, one or the other is slightly higher in amplitude.

Not all demodulators show the pattern I've described. The variance is often so subtle that an inexperienced technician overlooks it or thinks the pattern is revealing a fault. For example, there's a difference between the patterns made by 90-degree and 105-degree chroma demodulators.

A chassis using 105-degree color demodulation produces an elliptical pattern that slants to one side (Fig. 5). With the R-Y loop at exactly 12 o'clock, the sixth (or B-Y) loop falls at 4 o'clock instead of at 3 o'clock. If it's **slightly** above that point, don't worry about it; the vectorscope lead may be shifting the B-Y phase slightly. But if the B-Y loop is at or near 3 o'clock, the demodulator is out of adjustment. The trouble could be poor alignment or a bad component among those that shift the phase of the color-reference (3.58-MHz CW signal for each section of the demodulator.

In chassis using 90-degree color demodulation, the B-Y (sixth) loop falls normally at 3 o'clock whenever the R-Y (third) loop is set at 12 o'clock. Remember, you position the R-Y loop by rotating the Hue, or Tint, control.

You should learn to distinguish the **tilted** ellipse of the 105-degree demodulator (Fig. 5) from the upright ellipse formed by a gain difference (Fig. 3).

There's one vectorgram pattern that can really throw you the first time you see it. You'll find it in sets where the color-difference signals drive the CRT cathodes. (In most sets, as you know, the R, G and B signals go to the grids.) An example is the Motorola **Quasar** (all-transistor) chassis. The whole vectorgram (Fig. 6) is rotated 180 degrees. The burst appears just below the 3-o'clock position. The third loop (which is actually a **negative** R-Y signal) occurs at 6 o'clock. The **Quasar** demodulator system is a 105-degree type, and the vectorgram is deeply elliptical. The sixth loop (formed by a negative B-Y signal) belongs at almost 10 o'clock.

In a chassis that uses 90-degree demodulation and yet drives the CRT cathodes, R-Y is at 6 o'clock and B-Y is at 9 o'clock. Either one of these patterns with the burst on the right-hand side can be considered as merely a normal vectorgram rotated exactly 180 degrees.

And so . . .

That gives you some idea why technicians like vectorscopes. The instrument isn't at all indispensable, yet it offers two powerful advantages: It's the only way you can **see** vector relationships of color bars developed by color-receiver demodulators; and it's an easy-to-use way to speed up testing and troubleshooting. Technicians who own vectorscopes and know how to use them generally swear by them.

An excellent little booklet on using vectorscopes is available from Lectrotech, Inc., 4529 North Kedzie Avenue, Chicago, Illinois 60625. The price is $1.25. Too, the manufacturers of most vectorscopes include in their instruction booklets some details on troubleshooting with the instrument. If you've had problems understanding color-section alignment and troubleshooting, a vectorscope might be the answer for you.

For next month, because of requests from technicians all over the country, I'm writing about TV alignment. It won't be the usual alignment instructions, because you can get those out of any Sams Photofact Folder or from manufacturers' service literature. I plan, instead, to **explain** the subject. If you're a technician who hesitates to do an alignment job just because it seems hard, or if alignment takes you so long that it's unprofitable, this department in the next issue is just for you. ▲

So what if you have to live with the old fear just a little longer? (It'll feel even better when you do get your 415!)

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Circle 13 on literature card

Poor vertical linearity

trouble symptoms • common defects • troubleshooting techniques

by Robert G. Middleton

■ Every TV technician has to contend with circuit defects that cause poor vertical linearity. Sometimes the job is simple, and tube replacement restores normal operation. However, when you must dig deeper, it is important to know the common causes and techniques for isolating defects in the vertical-sweep system. Not only time and tempers will be saved, but money will be saved also, because you can avoid building up a large inventory of "bench-warmer" replacement parts.

In this logical approach, we will start with an analysis of picture symptoms. Following are the most common basic symptoms:

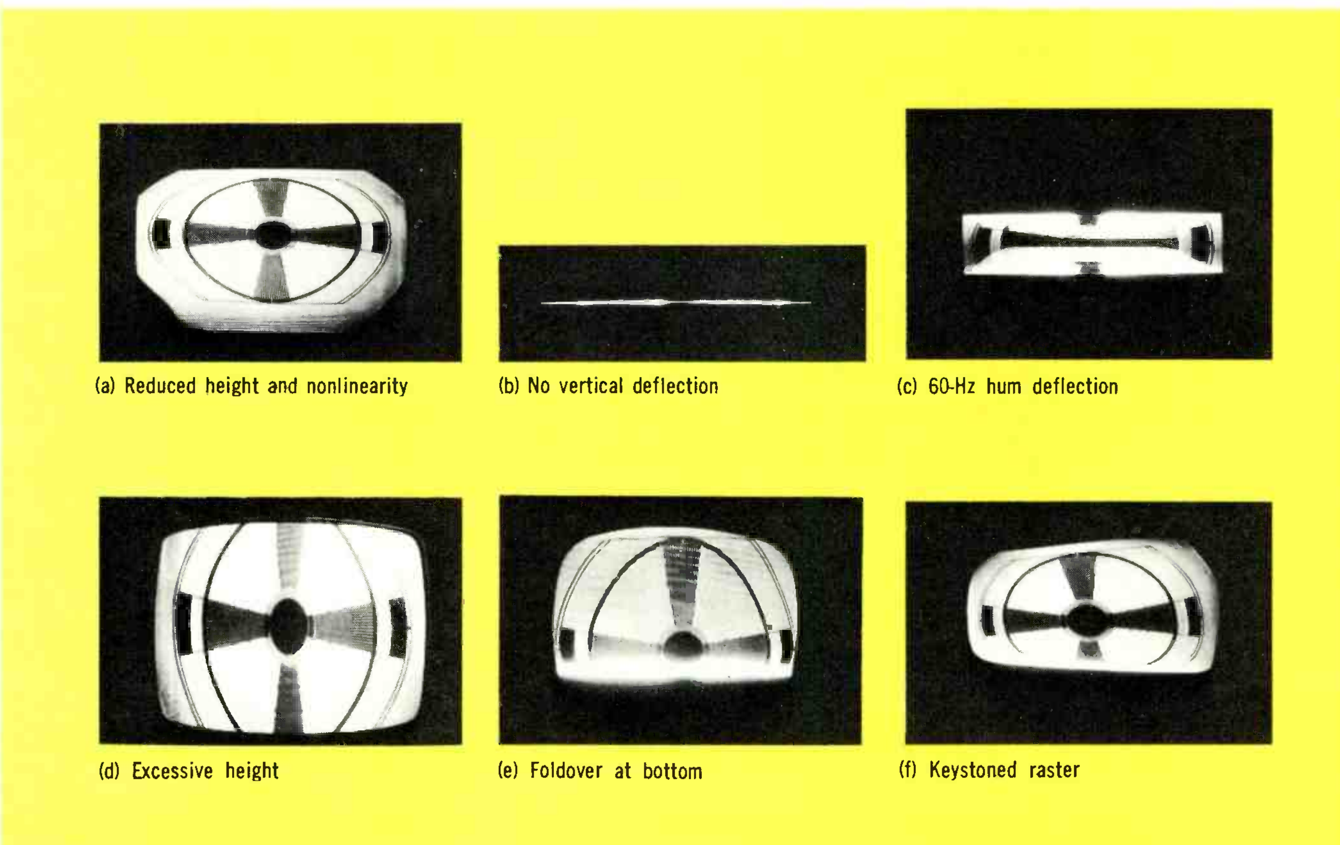
1. Top of picture stretched and bottom compressed.
2. Horizontal line only.
3. Both top and bottom of picture compressed.
4. Nonlinearity with insufficient height.
5. Nonlinearity accompanied by foldover.
6. Intermittent collapse or reduction in raster height.
7. Shrunken raster.
8. Reduced height with vertical oscillator far off frequency.
9. Vertical nonlinearity objectionable when vertical height is correct.
10. Picture "rolled up" along horizontal axis.

Some common symptoms of vertical-system trouble are illustrated in Fig. 1. With one exception, any vertical-sweep system can be divided into an oscillator section and an output section for quicker analysis. Therefore, we start by asking whether the picture symptom points to trouble in one of these vertical sections. For example, it is logical to suspect that the cause of the trouble symptom in Fig. 1C is an open grid circuit in the vertical-output tube, which is picking up stray hum voltage. Only sine-wave deflection can produce a "rolled-up" picture symptom.

It also will be helpful to consider the generation and control of vertical sawtooth deflection voltages.

Waveform Distortion and Correction

A vertical oscillator cannot generate an undistorted sawtooth waveform, because RC waveshaping circuitry is employed. For example, a



(a) Reduced height and nonlinearity

(b) No vertical deflection

(c) 60-Hz hum deflection

(d) Excessive height

(e) Foldover at bottom

(f) Keystoned raster

Fig. 1 Common symptoms caused by vertical-system trouble.

blocking oscillator may be used; although the circuit includes a tube and a transformer, these components operate simply in a discharge circuit. The semi-sawtooth vertical-deflection waveform is produced by an RC integrating circuit. With the arrival of the vertical sync pulse, the tube changes suddenly from an open-circuit to a short-circuit, thereby discharging the integrator capacitor. Feedback via the blocking-oscillator transformer quickly opens the tube circuit once more, and the integrator starts charging again.

We know that an RC integrator circuit always produces an exponential waveform, as shown in Fig. 2. The curvature in the rise of the waveform can be reduced by using a longer time constant. On the other hand, there is a practical limit to this method of linearization, because the output amplitude is reduced as the time constant is increased. Although the boost B+ voltage is used as a source of charging voltage, and although this does maximize the amplitude of the output, the practical limit has been reached. Therefore, the vertical oscillator generates a nonlinear sawtooth waveform that must be corrected by passage through a suitable waveshaping circuit.

To linearize this semi-sawtooth waveform, a vertical-output stage commonly is utilized to introduce an equal and opposite curvature into the waveform. A triode tube in the output stage is suitable for this purpose when it is operated at a certain value of grid-bias voltage. Fig. 3 shows the principle that is involved. If we compare curves A through D of Fig. 3 with the curves depicted in Fig. 2, we observe that the curvatures are opposite throughout. We also note that the amount of curvature in a dynamic transfer characteristic depends upon the value of the plate load. It also is important to recognize that the curves become more nearly linear as grid voltage (V) approaches zero volts.

Waveshaping Circuit Action

Now, let us see how these facts are put to practical use. First, we see that the curve labeled "RC=6" in Fig. 2 has approximately the same amount of curvature as curve A in Fig. 3. Therefore, we might suppose that if the exponential waveform (RC=6) were passed through an output tube that has the dynamic transfer characteristic of curve A, a linear sawtooth wave-

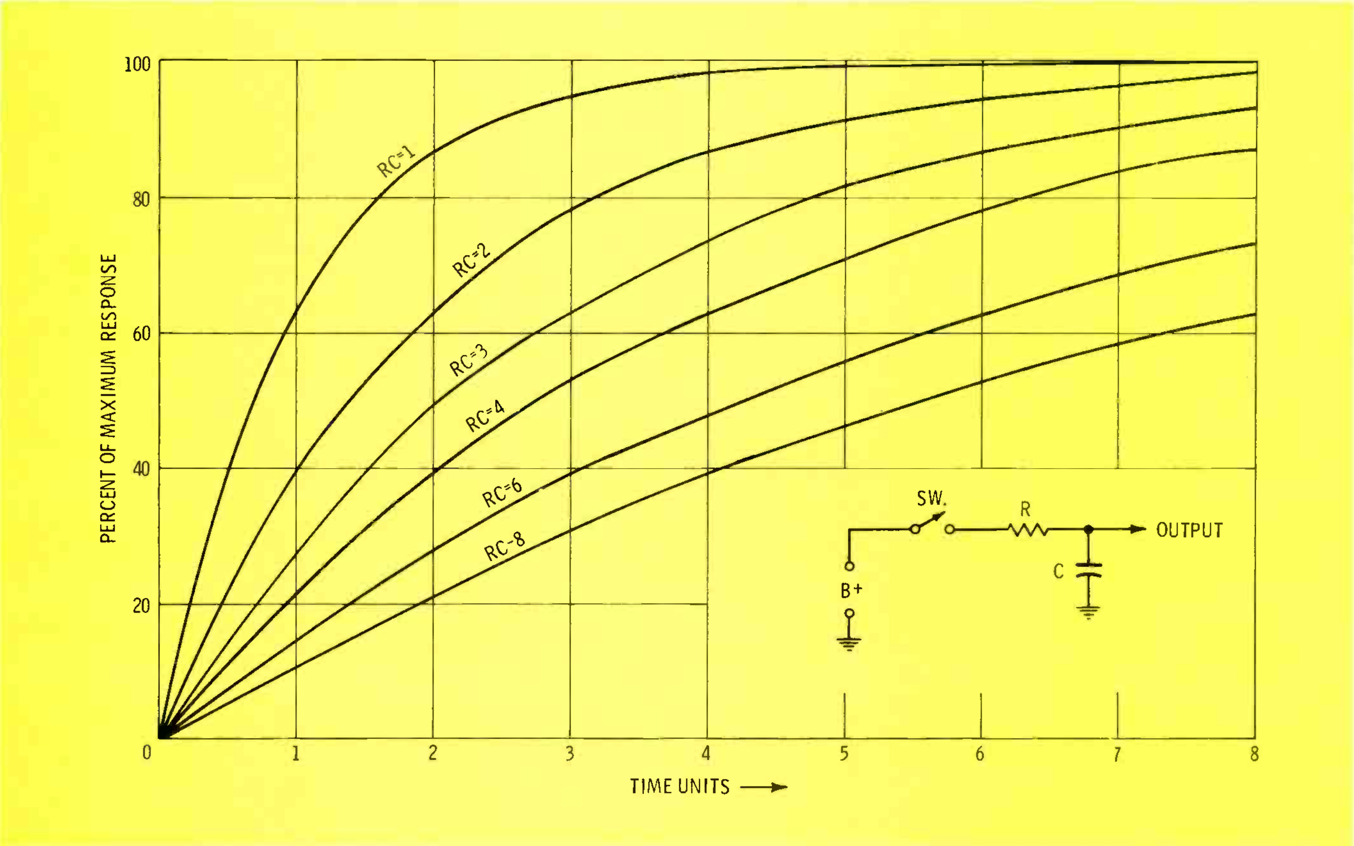


Fig. 2 Integrator waveforms for various time constants.

form would be produced. Fig. 4 shows that this supposition is not entirely true. In this example, the tube is operating at -20 volts grid bias. Linearization is evidently incomplete, as seen by comparing the "resultant" curve with the dashed line which represents ideal linearity.

What practical means can be employed to improve the waveshaping action depicted in Fig. 4? We know that a dynamic transfer characteristic becomes less curved when the tube is operated at lower grid bias. Therefore, we expect that the overcorrection in Fig. 4 could be eliminated by reducing the grid bias on the output tube. For example, if we use -12 volts bias, we obtain the waveshaping action depicted in Fig. 5. Note that we now have undercorrection in the resultant waveform. In other words, optimum linearization will be provided by a grid bias somewhere between -12 volts and -20 volts. Of course, optimum linearization is not ideal linearization, because no exponential waveform has exactly the same shape as a dynamic transfer characteristic; however, the nonlinearity will be reduced to minimum.

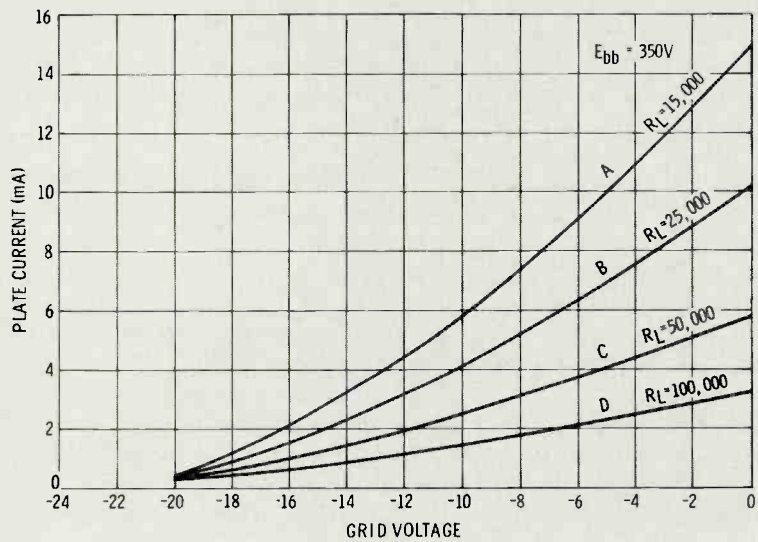


Fig. 3 Dynamic transfer characteristics for different loads.

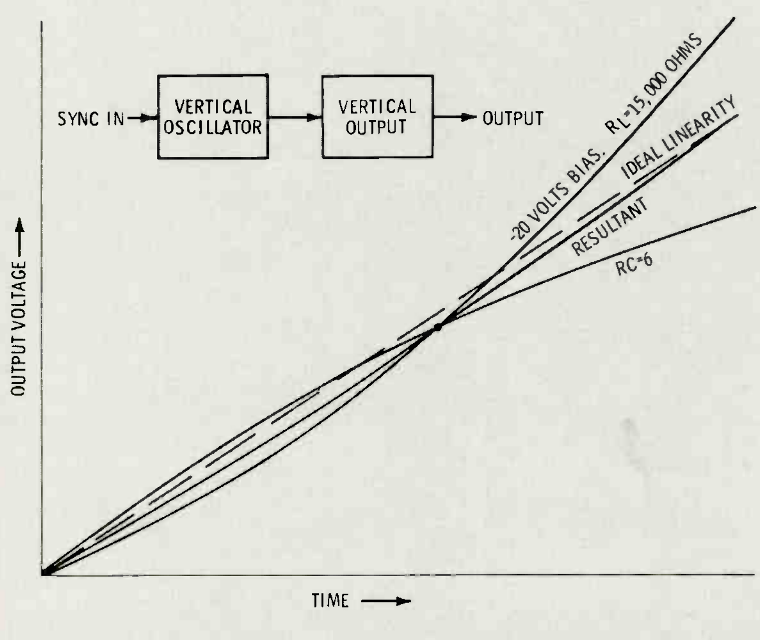


Fig. 4 Resultant of exponential waveform, linearized (approximately) by a dynamic transfer waveform.

Adjustment of grid bias on the vertical-output tube is provided by the vertical-linearity control. Although bias adjustment can compensate for component tolerances up to a certain point, various defects can defeat the purpose of the vertical-linearity control. Observe in Fig. 2 that the generated waveform becomes excessively curved when the time constant is short. From a practical standpoint, the time constant becomes shorter when the integrating capacitor becomes leaky. Again, observe in Fig. 3 that the extent of waveshaping action depends on the value of the vertical-output load. If a defect develops in the load, or if an incorrect replacement is made, the waveshaping action will become such that satisfactory adjustment of the vertical linearity control is impossible.

Distortion Due to Overloading

Vertical nonlinearity also results from overloading in the output stage. Normally, this stage does not overload. However, aside from tube aging, the boost B+ voltage can become subnormal, the heater voltage may be low, or the vertical-output plate-load impedance might be subnormal. Any of these defects can produce vertical nonlinearity. For example, as a tube ages, its cathode emission decreases. The practical result is the same as if the heater voltage were reduced, which in turn reduces the cathode temperature and affects the overload point of the tube. The characteristic curve becomes nonlinear at point X, and droops through points BC or DE, depending upon the temperatures chosen in this example.

If we consider the effect of employing an overloaded transfer characteristic in Fig. 4 or Fig. 5, we see that the resultant waveform will droop at the top. Since the top of the vertical-output waveform corresponds to the bottom of the picture, the effect is to compress the bottom of the picture, as illustrated in Fig. 7. A small amount of overload distortion can be partially corrected by adjustment of the vertical-linearity control. However, substantial overload distortion completely defeats the purpose of the linearity control. If the tube is not defective, and if the heater voltage and the plate-supply voltage are normal, we can still encounter overload distortion due to an incorrect value of vertical-output load.

Either a triode or a pentode may be used in the vertical-output stage. The effect of an incorrect value of plate-load impedance is basically the same in either case. Fig. 8 shows the overload characteristics for a pentode. We observe that overload occurs earlier as the value of the plate load increases. The symptomatic result is the same as if the heater voltage were reduced when the plate load is normal. Increase in value of the plate load can be caused either by a compound defect or by an incorrect replacement.

Interaction of Height and Linearity Controls

We know that the vertical-height control adjusts the plate voltage on the vertical-oscillator tube. In turn, this control varies the amplitude of the oscillator output waveform. If we increase the amplitude of this waveform, we drive the output tube harder, and we use a greater grid-voltage swing in Fig. 3. As noted previously, the transfer characteristic becomes more nearly linear as the grid bias approaches zero volts. In other words, by changing the amplitude of the drive waveform, we are also changing the amount of corrective curvature that is applied. Thus, it is inevitable that the height and linearity controls interact.

When the height control is adjusted to increase the picture height, the corrective curvature can be optimized by reducing the bias on the vertical-output tube. When the linearity control is adjusted, the resulting bias change effects the picture height. The reason for this is seen in Fig. 9: If the grid bias is changed, the plate current is also changed. In turn, the transconductance and the plate resistance of the tube take on different values. Since the gain of the stage is a function of transconductance and plate resistance, it follows that the linearity control

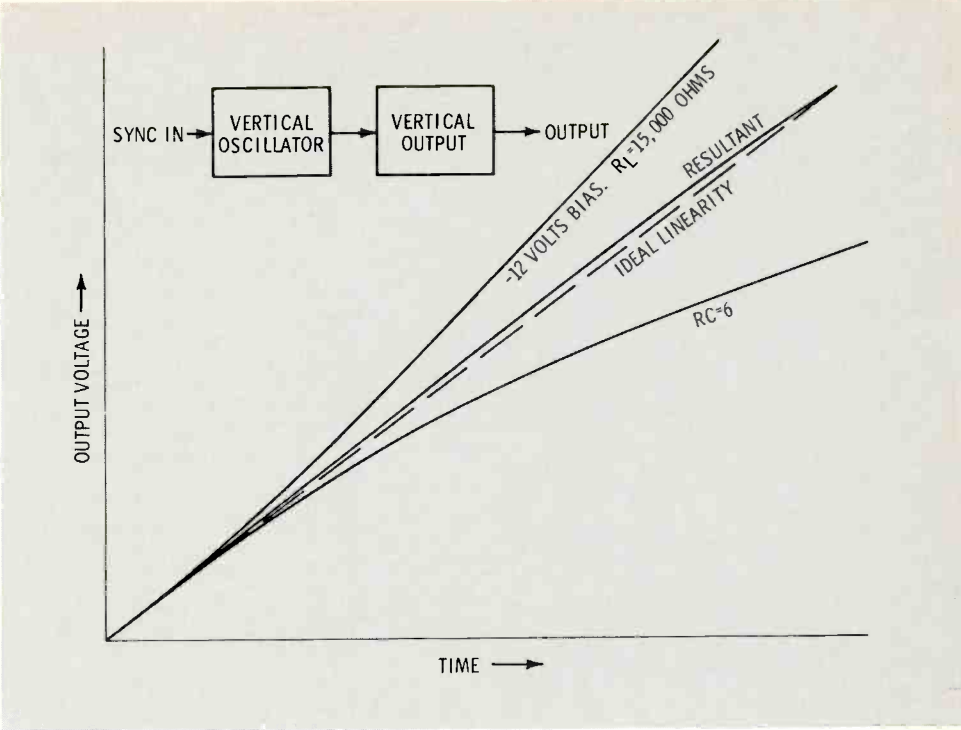


Fig. 5 Another example of approximate linearization.

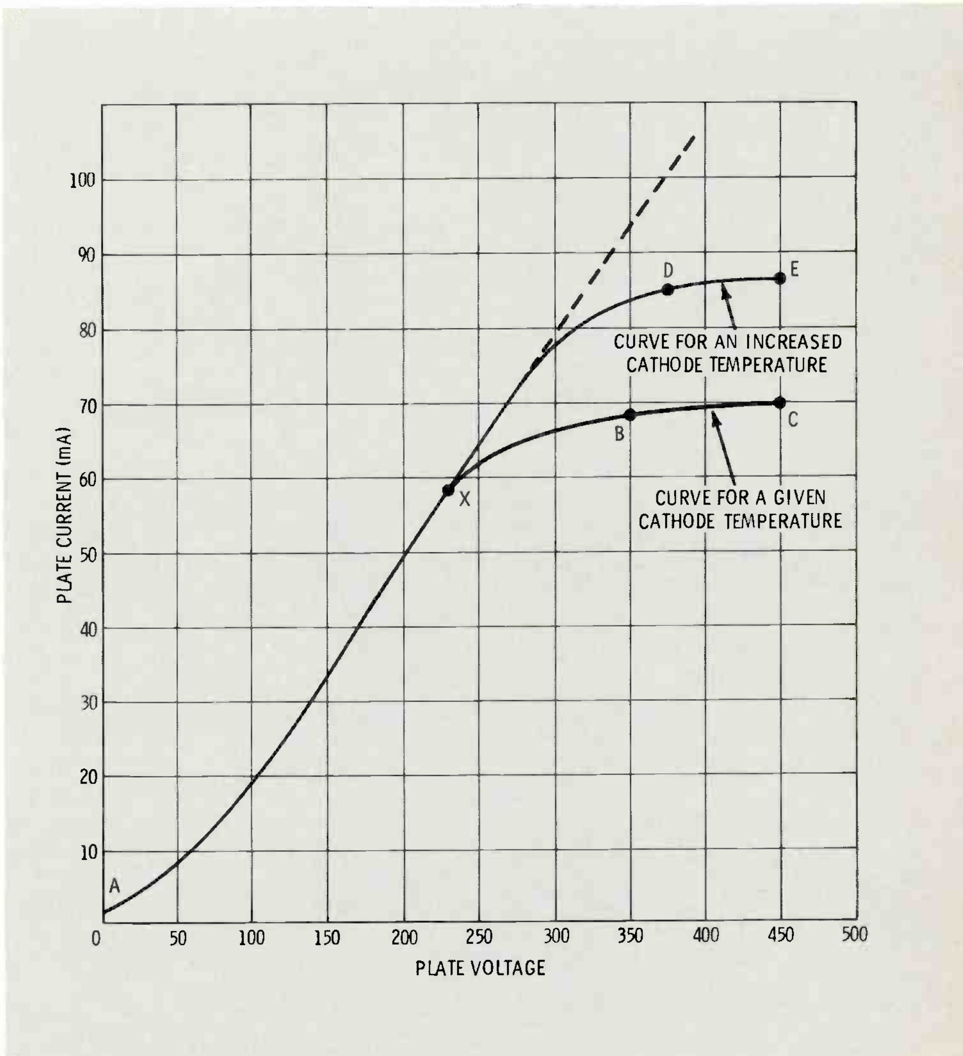


Fig. 6 Plate-current plate-voltage characteristic curves.

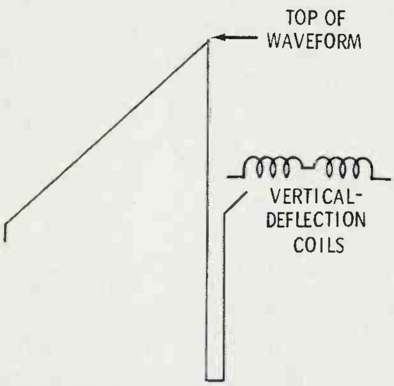
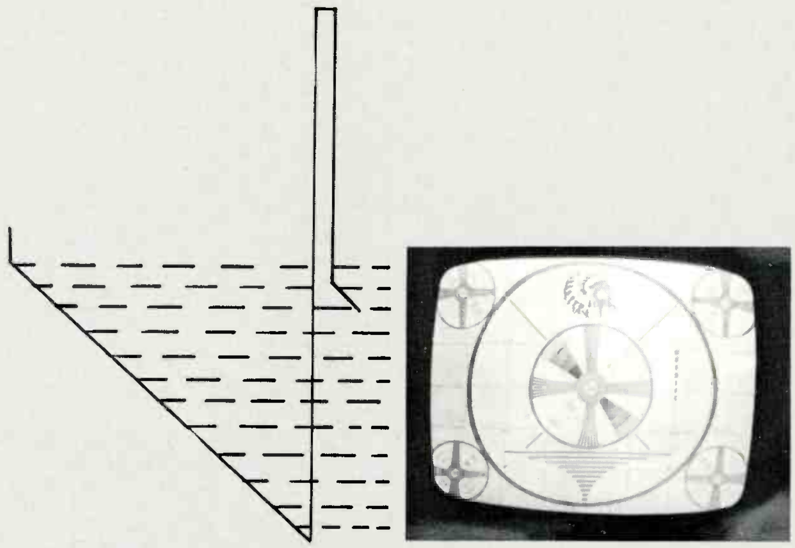


Fig. 7(a) Vertical-output waveform applied across yoke.



(b) Waveform and picture relation.

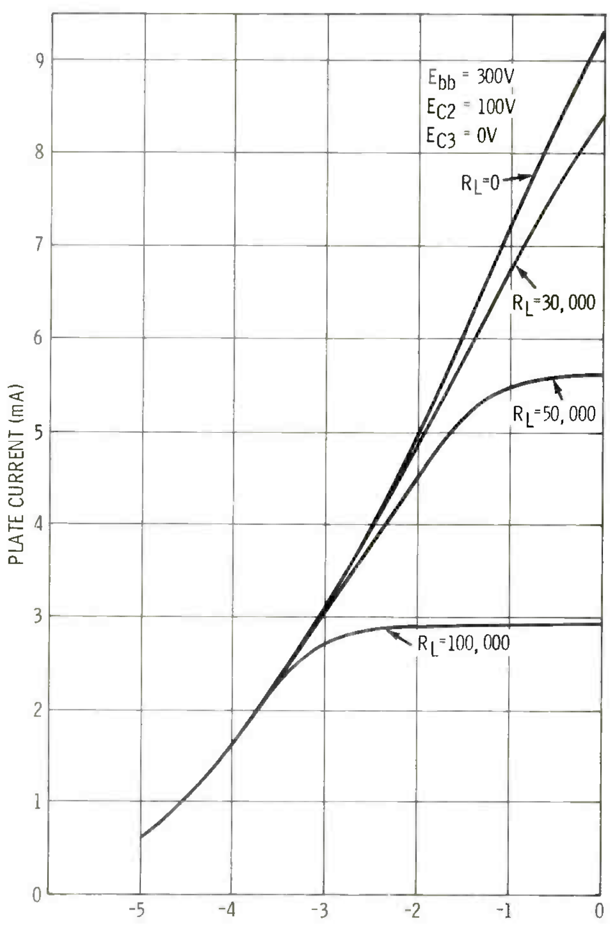


Fig. 8 Overload characteristics for a pentode.

will have some effect on picture height.

Peaking Pulse

The vertical-output stage develops a peaked-sawtooth waveform, as depicted in Fig. 7. This waveshape is required because the vertical deflection coils have both resistance and inductance. A sawtooth voltage drives a sawtooth current through resistance. On the other hand, a pulse waveform drives a sawtooth current through inductance. Therefore, a combination of these two waveforms, called a peaked-sawtooth, must be used to drive a sawtooth current through an RL load. Since vertical oscillators commonly use multivibrator or blocking-oscillator circuits, additional circuit means are required to produce peaking pulses. Circuit defects which affect the amplitude of the peaking pulse will also affect vertical linearity.

If the vertical oscillator has a multivibrator configuration, it is arranged as an unsymmetrical multivibrator, and generates a rectangular waveform. This rectangular waveform is then passed through an integrating circuit to shape it into a semi-sawtooth waveform. At this point, the semi-sawtooth lacks a peaking pulse. We will find that there are two ways in which a peaking pulse is added to the sawtooth. For example, the integrating capacitor may be returned to ground through a suitable value of resistance, as depicted in Fig. 10. If a blocking oscillator is employed, a similar peaking circuit is suitable. It is evident that an incorrect value of peaking resistance will impair vertical linearity.

The other method of adding a peaking pulse to the sawtooth waveform is to feed back the reactive kick from the vertical-deflection coils. That is, when the end of the sawtooth voltage wave is reached, the voltage across the deflection coils suddenly drops to zero. The effect is the same as if a switch had been opened in the coil circuit. In turn, the stored magnetic energy in the deflection coils discharges, and produces a voltage surge, or pulse, across the coils. This pulse is fed back through an attenuating branch and added to the original sawtooth to produce a peaked-sawtooth waveform. This completely cuts off the tube during retrace. Obviously, if a defect occurs in the feedback circuit, vertical linearity will be impaired greatly.

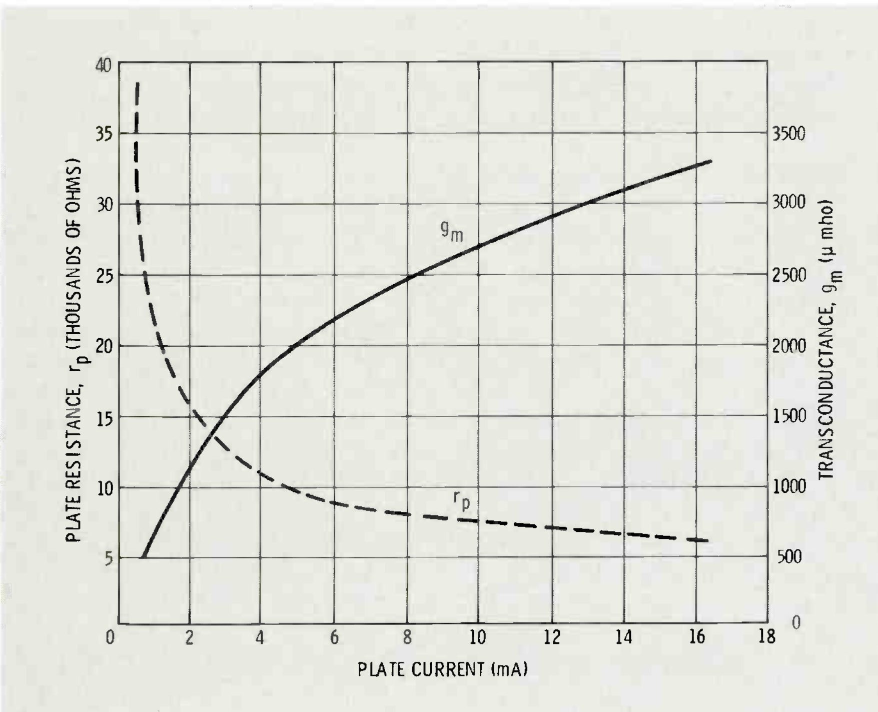


Fig. 9 Triode transconductance and plate resistance versus plate current.

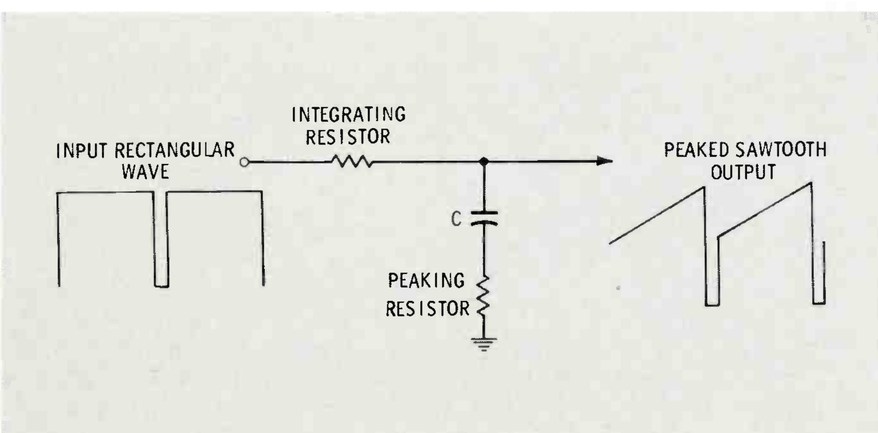


Fig. 10 Resistance-type peaking circuit.

Waveshaping by Transformer Characteristic

Virtually all vertical-deflection systems include a vertical-output transformer. This transformer serves two purposes: It provides impedance matching between the output tube and the deflection coils, and thereby develops maximum power transfer; the transformer also has a transfer characteristic as depicted in Fig. 11, which contributes to waveshaping and optimum vertical linearity. That is, the amount of curvature in the characteristic curve depends on the width of the air gap in the transformer core. This gap is chosen by the manufacturer to provide optimum vertical linearity. Obviously, vertical linearity will be impaired if an incorrect transformer replacement is made.

Since inductance and capacitance form a resonant circuit that rings due to shock excitation when the Q is greater than a certain critical value, damping resistors are used in Fig. 11B to lower the system Q below the ringing point. That is, if the vertical-output transformer develops a ringing waveform, it is practically impossible to obtain a linear deflection in the top portion of the raster. Note that if there are short-circuited turns in a vertical deflection coil, the Q is reduced, and the circuit produces a characteristic type of nonlinearity commonly called "keystoning."

Defective Bypass Capacitors

Poor vertical linearity is often caused by defective bypassing capacitors. For example, let us consider what happens if capacitor C1 in Fig. 12 opens up. The result is that the cathode is no longer at AC ground potential. Cathode degeneration now occurs because of the varying voltage drop across R8 and R3. There are two symptomatic results: The amplitude of the output waveform is reduced because of reduced stage gain, and vertical linearity is reduced because the waveshaping action of the tube is much less effective than in normal operation. This change in waveshaping action might puzzle the beginner; therefore, let us analyze the stage operation.

When negative feedback (degeneration) occurs in the circuit in Fig. 12, due to an open C1, this negative-feedback action reduces the distortion. Such reduction is undesirable in this situation, because the distortion characteristic is needed for waveshaping. To summarize: The abnormal negative feedback tends to linearize the tube transfer characteristic, which means that the

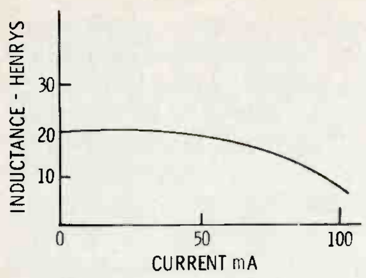
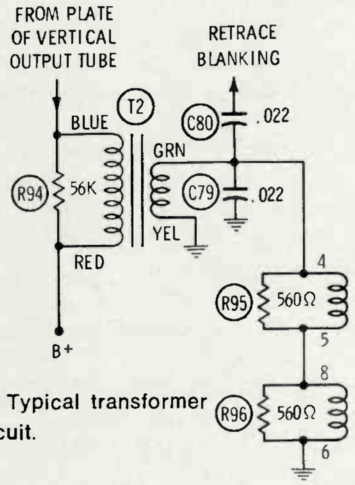


Fig. 11(a) Magnetizing inductance of vertical-output transformer versus current.



(b) Typical transformer circuit.

stage undercompensates the exponential curvature of the drive waveform. From previous discussion, it follows that the bottom of the picture will be compressed by this circuit defect.

Next, let us consider what happens when C1 (Fig. 12) becomes leaky. Although the cathode remains at AC ground potential, the DC bias on the cathode is reduced. If the leakage is sufficient to upset the normal range of the linearity control, the exponential curvature of the drive waveform is under-corrected, and the stage gain becomes abnormal. The symptomatic result is vertical overscan and nonlinearity, with the bottom of the picture compressed. To summarize briefly, the nonlinearity symptom is the same whether the bypass capacitor is open or leaky. However, the trouble symptoms relating to height are opposite, with reduced height indicating an open circuit, and increased height indicating leakage.

Defective Coupling Capacitors

Defective coupling capacitors also impair vertical linearity. For example, let us consider the effect of leakage in C2 in Fig. 12. This defect permits B+ voltage from the previous section to bleed into the grid circuit. In turn, the grid becomes less negative than normal, the cathode voltage increases, and the plate current increases. The trouble symptom is the same as if C1 becomes leaky: Vertical overscan and compression at the bottom of the picture. From a troubleshooting standpoint, the change in cathode voltage pinpoints the culprit. That is, subnormal cathode voltage points to leakage in C1, whereas abnormal cathode voltage points to leakage in C2.

Next, let us consider the trouble symptom that results when C2 in Fig. 12 opens. Although this does not produce an open-grid condition, it does make the grid "float." Because the grid impedance is now 1 megohm to ground, stray 60-Hz hum fields are very likely to be picked up, producing the "rolled-up" picture illustrated in Fig. 1C. However, if the floating-grid circuit is not near a source of 60-Hz hum, only a horizontal line is displayed on the picture-tube screen, as illustrated in Fig. 18.

Defective capacitors in the vertical-oscillator section also cause trouble symptoms, although these symptoms usually take on dominant aspects other than poor linearity. For example, if a charging capacitor opens up or becomes leaky, the vertical-hold control is thrown out of range. In turn, the picture rolls, and this is the dominant symptom. Again, if a coupling capacitor opens up or becomes leaky in the oscillator section, the picture will roll or the oscillator will stop completely. Accordingly, the general rule is to check the vertical-output stage when a nonlinearity symptom occurs.

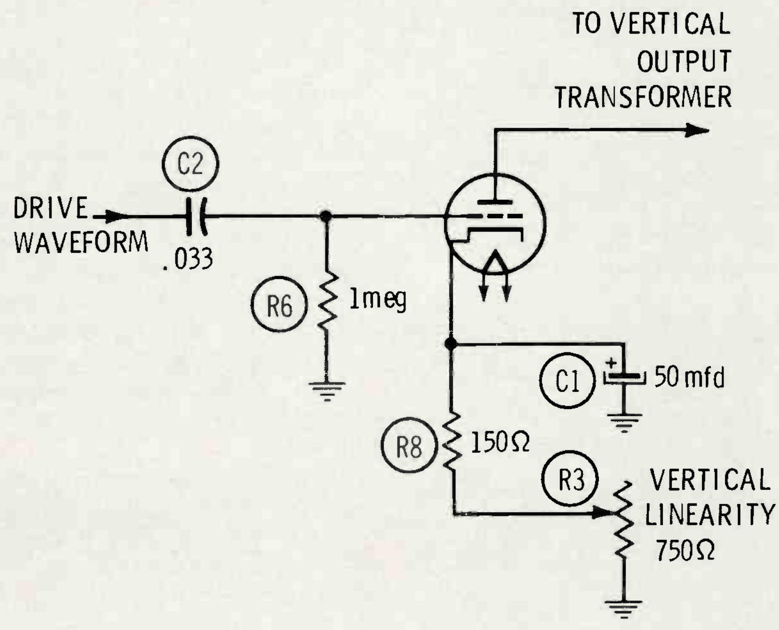


Fig. 12 Capacitors C1 and C2 affect vertical linearity.

Resistor Defects

Off-value resistors are occasionally responsible for vertical nonlinearity symptoms. If we include potentiometers among resistors, the prime suspect is the vertical-linearity control. When the resistance element becomes worn and erratic, its stability is also impaired in most cases. The result is that its resistance value tends to drift and cause poor vertical linearity. With reference to Fig. 12, if R6 opens up (sometimes due to mechanical damage), the signal-developed bias on the grid becomes higher then normal. In turn, overcorrection of the exponential curvature in the drive waveform occurs, producing compression at the top of the picture.

Again with reference to Fig. 12, let us consider the situation in which the resistance element in R3 has become defective, so that excessive resistance is in series with R8 and ground, regardless of the control setting. In such case, the cathode voltage is abnormal, and the picture symptom is the same as for an open grid resistance—the top of the picture is compressed. In practice, the potentiometer would be suspected, because the control is out of range and the cathode voltage is too high. On the other hand, if R6 is open the linearity control might be out of range, but the cathode voltage will be too low.

Summary

This article has reviewed the common causes of poor vertical linearity, and has explained some of the finer points so that picture symptoms can be evaluated more effectively.

It has been pointed out that the same nonlinearity symptom can be caused by more than one type of defect. Therefore, it is often necessary to narrow down the possibilities by DC voltage measurements and waveform analysis.

It is a waste of time to go looking for a defective component in the vertical system if the plate or heater supply voltages are subnormal. However, if the supply voltages are normal, and the predominant symptom is nonlinearity, the grid and/or cathode voltages in the output stage may be incorrect because of a defective component.

The final waveshaping function is provided by the vertical-output transformer, by virtue of its transfer characteristic. Thus, poor vertical linearity can be caused by an incorrect replacement transformer. Note that shorted turns or layers in a transformer cause nonlinearity and reduced height; however, keystoning is seldom a prominent symptom. On the other hand, shorted turns in a vertical-deflection coil cause symptoms of nonlinearity, reduced height, and prominent keystoning. An incorrect replacement yoke can cause poor vertical linearity by mismatching the impedance of the output tube. ▲

Facts about Servicing solid-state TV

Analysis of the similarities and differences between fundamental tube and semiconductor circuits along with troubleshooting techniques and transistor substitution.

by Bruce Anderson

Although television receivers employing only solid-state devices are still comparatively rare, several models are available from the various manufacturers. Included are two color receivers, the Motorola and the RCA. Much more plentiful are the hybrid receivers, both monochrome and color, which use some transistors and some vacuum tubes. Since the advantages of using a transistor in lieu of a tube for some circuits (vertical output, for instance) are hardly sufficient to warrant the additional cost, it is likely that the bulk of the receivers will continue to be hybrid for some time to come. Nevertheless, transistors are definitely here to stay in color as well as monochrome receivers. Because of this, it behooves all technicians to become familiar with the techniques involved in troubleshooting receivers using solid-state devices.

There Are Similarities

A vacuum tube may be used in three basic circuit arrangements: common cathode, grounded grid and cathode follower. Likewise, a transistor may be used in three analogous circuits: common emitter, common base and emitter follower (or common collector), respectively. These basic layouts are shown in Fig. 1.

The circuits in Fig. 1A show the most common configuration for both tubes and transistors, common cathode and common emitter. In this circuit, the input controls the current which flows from ground to B+, and the output is developed across the plate (or collector) load resistor.

In Fig. 1B, the output still is developed across the plate (collector) load resistor, but the point of signal injection is the cathode or emitter.

The third possible configuration is shown in Fig. 1C. Here the input is the same as in Fig. 1A, but the output is derived from the cathode or emitter.

But There Are Also Differences

Having examined the similarities between vacuum-tube and transistor circuits, it is appropriate to consider some of the basic differences. Consider the circuits in Fig. 1A. The means of biasing the two circuits and the effects of bias on the device constitute one major difference. A vacuum tube is normally biased so that the grid is a few volts negative with respect to the cathode. In some instances, the bias may be much greater than this (the horizontal-output tube, for example, operates with about 40 or 50 volts of negative grid bias), but in stages which neither cut off nor saturate, bias normally ranges from 1 to 10 volts. If the tube is operated with the grid slightly positive with respect to the cathode, there will be some grid current, which lowers the input impedance and may cause distortion, but the circuit may continue to work after a fashion.

This is not true with a transistor. In the case of an NPN transistor, no useful current can flow in the device until the base is made positive with respect to the emitter. (To avoid confusion, PNP transistors will be ignored since operation is similar except for reversed polarities.) The exact amount of positive base bias required varies slightly for various transistors but it is about .3 volt for a germanium transistor and .7 volt for silicon transistors. These values are known as the **barrier voltage,** and until this barrier voltage is overcome by the bias, the transistor remains cut off.

Furthermore, the bias voltage cannot be increased above the conduction point because attempts to increase it will simply increase the emitter-to-base current. This is more fully explained by the circuit and tabulation in Fig. 2. Actually, the base voltage will rise very slightly as the current is increased, because the transistor leads and the semiconductor material do have some resistance; however, this voltage rise is hardly measurable with service-shop equipment. The important point, from the standpoint of serving, is that if the voltage from emitter to base is very much different from .3 volt for a germanium device or .7 volt for a silicon transistor, the device is not functioning properly.

Unfortunately, some service data being published indicate the typical voltages of the emitter and base with respect to ground, but not with respect to each other. These can be misleading because the accumulated errors in measurement often exceed the tolerance of the base-to-emitter voltage drop. The example in Fig. 3 was not taken from any particular publication; however, it is representative of the type of discrepancy which can occur. According to the call-outs, the emitter and base voltages are 0.3 volt and 0.9 volt, respectively; but this indicates a base - to - emitter voltage of .6 volt, which is too great for a germanium device and not enough for a silicon transistor.

These errors may be the result of a number of things: meter inaccuracy, changing scales to read the two voltages, "rounding off" the values, etc. Rather than waste time on speculation, simply measure the voltages at the collector, emitter and base, and draw your own conclusions. If the emitter-to-base voltage is about .7 volt (.3 volt for a germanium device) and the collector voltage is within 20% of the specified value, it is safe to assume that the device is working. If the transistor is shorted, the current through the device probably will be many times greater than normal, reducing the collector voltage to near zero; if it is open, the collector voltage will be near B+.

A leaky transistor can be detected, in most cases, by cutting off the emitter-base junction and observing collector current. Any transistor should cut off if the base and emitter are shorted together; so, short these leads and measure the collector voltage. If the device is truly cut off, there will be no current through R3 (Fig. 3) and the collector voltage and B+ will be about the same. If there is collector leakage, it will cause a drop across R3, reducing the collector voltage. If, for example, the base and emitter of Q1 in Fig. 3 are shorted together with a jumper, Q1 should not conduct and the currents through R2 and R3 should be small and equal. Computed using Ohm's law, this current is about 0.5 ma and the voltage drop across R3 is about 5 volts, making the collector potential about 25 volts. If the collector voltage is much lower than this, there is probably collector leakage current.

Obviously, if the collector remains at about 25 volts when the jumper is removed, the transistor is not conducting. Either the device is open or the bias supplied by R1 and R2 is incorrect. For instance, if R2 of Fig. 3 increases in value to 200K ohms, the divider action of R1, R2 and R3 will produce slightly less than 0.5 volt at the base of Q1, which is not enough to bias Q1 into conduction. If the value of R1 should drop to 1,000 ohms, the result would be the same. In either case, the emitter voltage would be near zero and the base voltage would be abnormally low, but the collector voltage would be almost the same as the supply voltage.

On the other hand, if R2 should decrease in value, the base voltage would tend to increase, but the base-to-emitter voltage would remain nearly normal. The emitter current would increase, raising the emitter voltage; however, the base voltage still must be equal to emitter voltage, plus the barrier-voltage drop in the transistor.

Circuits With Feedback Loops

In many instances, two or more

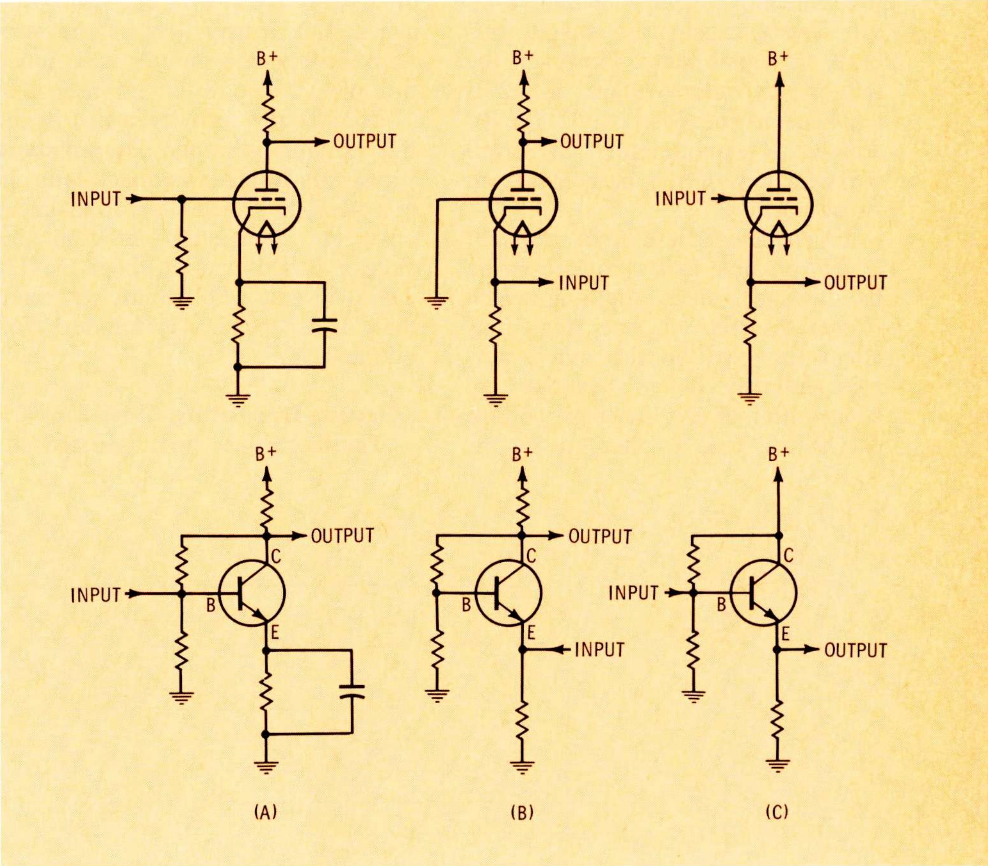


Fig. 1 Basic tube and transistor configurations. **A.)** Common cathode and common emitter. **B.)** Grounded grid and common base. **C.)** Cathode follower and emitter follower.

amplifier stages may be stabilized by a feedback loop as shown in Fig 4. Q1 is an emitter follower which matches a high-impedance source to the low input impedance of Q2. The bias stabilizing network, consisting of R2, C1 and R4, counteracts changes in transistor current which could be caused by such things as variations in beta, temperature-caused changes in transistor conduction, variations in resistance values at the time of manufacture and long-time drifts in resistance values. For example, a slight increase in the value of R1 would increase the base voltage of Q1. This would cause the emitter current to increase, increasing the base current of Q2. As a result, the emitter and collector currents of Q2 would increase several times (depending on the transistor beta).

If it were not for the bias feedback, this change in the collector current of Q2 could be so great that the collector voltage would drop excessively, causing the stage to saturate on signal peaks. However, the reduced collector voltage of Q2 is fed back to the base of Q1 via R4 and R2. This counteracts the original tendency of the base of Q1 to swing positive.

In checking these two stages, it is very possible that a transistor may be damaged, since anything which affects the bias on one stage may affect the bias on the other, perhaps radically. If you short the base and emitter of Q1, the base voltage of Q2 will tend to increase by the amount of the barrier voltage of Q1 (0.7 volt); however, the feedback loop immediately will reduce the voltage at the junction of R1 and R2 by a like amount. As a result, nothing in the circuit will change very much and no damage is likely.

On the other hand, suppose you short the base of Q2 to its emitter. Now Q2 is cut off and the collector voltage rises nearly to B+. This causes the voltage at the base of Q1 to rise sharply, and both the base and collector currents will rise. If R6 and R3 are sufficiently large, they will limit the currents in Q1 to safe values—but don't bet on it! Remember, R3 was designed to develop 3 volts with the currents of both transistors passing through it, and the normal current of Q2 probably is 10 times greater than the current of Q1. Now Q1 must pass 10 times its normal current just to develop 3 volts of emitter bias. But the base voltage of Q1 has been increased by the rise in collector voltage at Q2, causing even more current through the emitter-base junction of Q1. The result: no more Q1.

The lesson to be learned from this example is simple: **Do not short transistors inside a feedback loop.** If you want to check Q2 for leakage, open the connection between the emitter of Q1 and the base of Q2. This will cause Q2 to cut off, since there is no longer any forward bias on the base.

Circuits Operating Class B or C

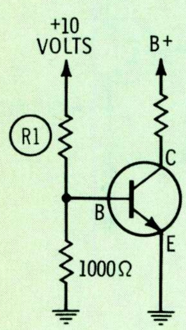
The techniques just discussed are helpful in many circuits, but especially in circuits which are normally conducting at all times(class "A" bias). However, in a television receiver several circuits may be cut off during a large part of their cycle of operation. The sync separator, AGC keyer and burst amplifier are three examples.

Fig. 5 shows one type of sync separator. The transistor in this example cannot conduct because there is no forward bias on the base. If a VTVM is connected to the base, it will read zero volts if no signal is applied. Obviously, some different testing techniques are required.

Collector leakage can be discovered by metering the collector voltage with no signal applied (ground the base to be sure). If there are no DC paths to ground in the load circuit, the collector voltage should equal B+. The two transistor junctions can be "diode checked" with an ohmmeter by observing the amount of resistance measured from base to emitter and from base to collector. With the positive meter lead connected to the base of the NPN device, the resistance should be low; with the leads reversed, it should be very high. The opposite is true of a PNP transistor. Of course, an in-circuit transistor tester also may be used.

Scope Tests

It has been proven many times that a scope is the most versatile instrument in the repair shop. Nevertheless, there are still many technicians who are reluctant to use their scopes to the full extent of its capabilities. How much simpler to merely check the input and output of a circuit to determine if it is working. Consider the circuit of Fig. 5, for example. Even if no waveforms are supplied in the service data, it should not be difficult to scope this circuit. Since the transistor is an NPN type, we know immediately that the base must be more positive than the emitter to make it conduct. Since there is no bias source for the base, other than the signal, the signal must be positive going.



R1	BASE CURRENT	BASE VOLTAGE
49K	0	0.2 (CUTOFF)
14K	0	0.67 (CUTOFF)
13K	15.4 µA	0.7
12K	58.3 µA	0.7
10K	.23 mA	0.7
5K	1.16 mA	0.7
1K	8.6 mA	0.7

Fig. 2 Base current as a function of bias.

From our basic knowledge of how a TV receiver works, we know that the normal input to a sync separator is composite video. Since the transistor is NPN, this video must be positive. The next step is to determine how much signal should be expected at the base of the transistor. A review of our electronics knowledge will help to estimate the signal level. There is no emitter resistor in Fig. 5, so the input impedance of the transistor will be very low **when it is conducting.** But, each time the device conducts, C1 charges. As a result, the DC level on Q1 will be a negative potential with an amplitude only slightly less than the peak-to-peak amplitude of the signal. For example, if the peak-to-peak amplitude of the composite video (white level to sync tip) is 4 volts at the point where it is taken from the video-amplifier circuit and routed to the sync separator, the bias must be large enough to keep the transistor cut off at all times except when the sync pulse is present. If the black-video, or blanking, level of our assumed signal is 3 volts (¾ of the total amplitude), we should expect a bias voltage of about -2.5 to -3 volts, since the signal must exceed the sum of the bias and the barrier voltage before conduction can begin. This point is reached when the signal amplitude

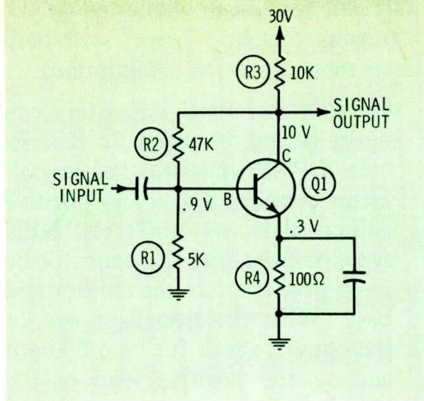


Fig. 3 Example of a transistorized amplifier.

reaches 3.2 to 3.7 volts, assuming a .7-volt barrier potential.

Because the input impedance of Q1 suddenly drops to nearly zero when it begins conduction, the voltage at the base can rise only to the value required to cause base current to flow. Beyond this point, base **current** will increase rapidly, but the base **voltage** is clamped to a positive value of .7 volt. Accordingly, the waveform at the base will indicate that the sync pulses are clipped, as indeed they are.

Another departure from what is normal in a tube-type amplifier is illustrated in Fig. 6. This particular circuit has been used to follow the video delay line because it allows an excellent impedance match. In this configuration, the input impedance of the transistor is practically zero at all times because it is never biased into cutoff. As a result, the resistance of R1 drops practically all the signal voltage present at the output of the delay-line, and only a few millivolts will be present at the transistor emitter. If a sizeable signal should be present at the emitter, it would indicate either that the transistor was open, that it was biased into cutoff, or that the bypass capacitor was open.

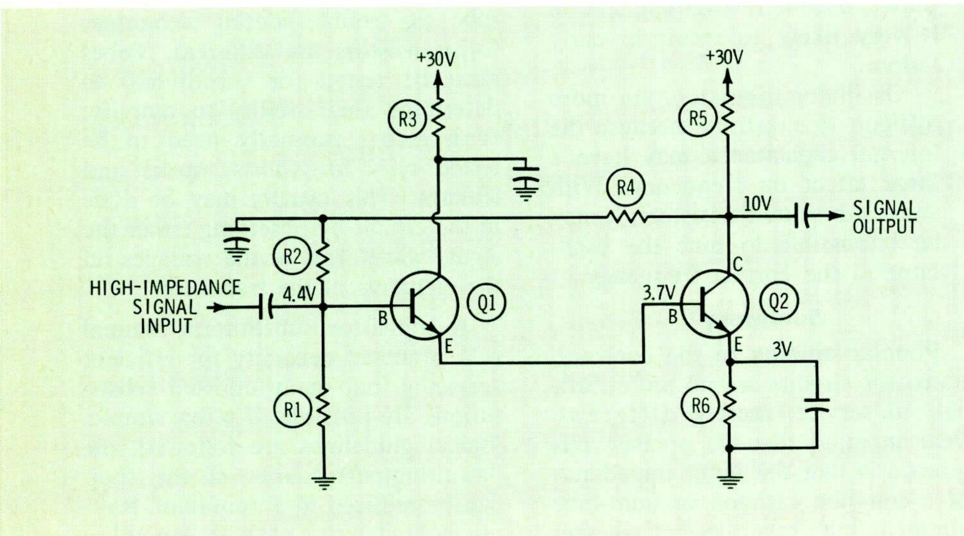


Fig. 4 Two-stage amplifier with feed-back bias stabilization.

Notes on Substitution

An attempt to compile any type of fool-proof transistor substitution manual is met with almost insurmountable difficulties. For one thing, new types of transistors, each designed for a specific application, are being introduced each day. Another reason is that tolerances in transistors are very broad in many instances and, also, the tolerances of different types may overlap. For example, one type may have a specified beta of from 25 to 50 and another may "spec" from 30 to 55. While these two transistors might be interchangeable in a certain circuit 90% of the time, in some instances performance would be degraded. Because of this, equipment manufacturers often are reluctant to suggest that one transistor type may be substituted for another, even though we often may observe that they are interchangeable. Coupled with all these problems is the fact that there simply are so many transistors and many of them bear only the manufacturer's number.

To be sure of optimum performance, it is best to replace defective transistors only with like types or approved substitutes.

Unfortunately, Mr. Smith, the typical customer, is not interested in all these problems. He wants to see the big game tomorrow—he does not want to hear about a lot of problems. Mr. Smith's set is a "Brand X" and the second video amplifier transistor (NPN type) is shorted. The parts house closes at 5:30 on Friday and it's 6:00 now. So, dig into the bench stock of transistors to see what can be found.

As might be expected, neither the correct type nor a recommended substitute is in stock, but there are some NPN transistors that work in an audio amplifier with the same B+ voltage as this TV. So far, so good. How about signal levels? The data for the audio amplifier shows that the transistor under consideration is used to drive the output circuit, so it should handle several volts of video signal. The collector-load resistors are about the same in both circuits—another good omen.

After this "boot-leg" transistor is installed and the set is turned on, the picture appears normal, but there is a slight loss of detail. However, turning the peaking control all the way up produces an acceptable picture. Probably, the transistor which was installed doesn't have quite the frequency response of the original, but Mr. Smith will be satisfied, nevertheless. As a final precaution, let the instrument run a few hours before delivery. This is a good idea in any case.

Undoubtedly, not all attempts to substitute transistors will be so successful. On the other hand, not a great amount of time will be lost if the experiment is a failure. And even if an occasional transistor is ruined, the monetary loss is probably not too great. Adhering to the following "ground rules" will help keep these losses to a minimum:

1. NPN and PNP transistors can never be interchanged. In the circuit, a PNP transistor has its collector connected to a less positive source than its emitter; NPN types require that the collector be more positive than the emitter and base. With the transistor out of the circuit, check for type by connecting the positive lead of the ohmmeter to the base and the negative lead to either of the other elements. If the device is NPN, the meter will indicate low resistance; if it is PNP, the reading will be high.
2. Many substitutions are "one way." A video-amplifier transistor may substitute in an audio-amplifier circuit, but the audio device may not work in the video amplifier.
3. A device which operates in a circuit which has a relatively high supply voltage probably will work in a circuit which has a lower supply voltage.
4. If the normal peak-to-peak signal levels in two different circuits are about the same, the transistors are more likely to be interchangeable.
5. The more nearly alike two circuits happen to be, the more probable it is that the transistors can be interchanged.
6. Transistors used in pulsed applications are usually more rugged than those used in audio or video amplifiers. For example, a horizontal-output transistor may operate very well as an audio amplifier; but the reverse application is very likely to result in early failure.
7. Oscillator transistors are more difficult to substitute because the internal capacitance may have a large effect on frequency. With some substitute transistors, it may be impossible to tune the oscillator to the correct frequency.

Summary

Popular opinion to the contrary, transistor circuits are no more difficult to service, merely different. Bear in mind that the greatest difference is that the input impedance of a common cathode vacuum-tube circuit is high regardless of whether the tube is conducting or cut off;

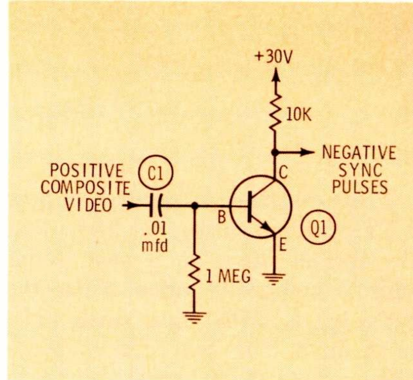


Fig. 5 A simplified sync separator.

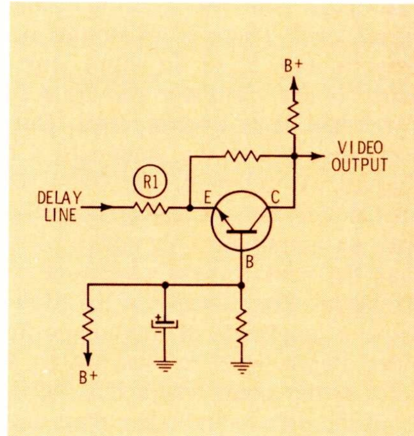


Fig. 6 A common-base video amplifier.

but a common emitter transistor circuit has high input impedance when it is cut off and low impedance when it is conducting. This causes the input waveforms to be radically modified in many cases.

A characteristic of transistors is that the beta remains substantially the same, regardless of age. Tubes "wear out" or lose the ability to amplify after a period of time; transistors do not. Since their mode of failure is different from that of a tube, the troubleshooting techniques for transistors are different. Tubes must be tested (or substituted) to determine their ability to amplify; transistors normally need to be tested only for shorts, opens and leakage. This usually may be done in the circuit by observing either the signal waveforms or the voltages on the elements of the transistor.

A transistor substitution manual is a practical necessity for efficient servicing, but many unlisted substitutions are possible. If a few simple, logical guidelines are followed, the "awaiting-parts" area of the shop can be reduced to a minimum, leaving behind extra cash in the till—and happy customers. ▲

testequipment

notes on analysis of test instruments, their operation and applications

X-Y Oscilloscope with 7" CRT

A new X-Y oscilloscope with matched amplifiers and a 7-inch display tube has been announced by Data Instruments Division.

The new scope, the Model 572,

is designed for educational, laboratory and servicing applications. It is capable of accurate phase comparison and measurement involving Lissajou functions and differential signals, and permits direct viewing of the low-level outputs of industrial and medical measurement devices. The 572 can be converted to a conventional single beam scope by means of a front-panel control.

The precision of the Model 572 is achieved by the use of matched amplifiers and balanced attenuators for each axis, and is enhanced by the large CRT—a 7-inch flat-faced tube with a 10 x 12 cm. display.

The unit has a sensitivity of better than 20 mv/cm. over a bandwidth of 600 KHz. A 5% calibrator is built into the instrument to standardize time and voltage. All amplifiers are solid-state and fully compensated for optimum response, and the four-step attenuator is provided with a variable trimmer for frequency compensation.

The unit measures 9½ inches wide by 13½ inches deep and is priced at $566.00.

Circle 29 on literature card

Resistance Substitution Unit

This hand-size Resistance Substitution Unit from Phipps & Bird, Inc., can be used as a decade resis-

tor, as a voltage divider or as a substitute resistor.

Model 236 provides seven decade ranges from 1 to 1,111,110 ohms in 1-ohm steps. All resistors employed in the unit are .5 watt and are rated at 1% tolerance. The unit is housed in a shielded aluminum case that measures 4" x 6" x 1½". Price is $48.00.

Circle 30 on literature card

Tube Tester

Seco introduces its Model 88A tube tester which tests both color and b-w picture tubes. It also evalu-

Circle 16 on literature card

ates all other popular tubes including novars, nuvistors, 10-pin types, compactrons, decals and magnovals.

Test voltages do not exceed 25V DC or 22V AC; current is comparably low.

The unit utilizes Seco's Patented Grid Circuit Test to make up to eleven simultaneous checks for leaks, shorts and grid emission or current reversal, as well as tube merit and filament continuity tests.

The unit weighs 6 lbs. and sells for $89.50 with the CRT adapters; $5.00 less without the adapters.

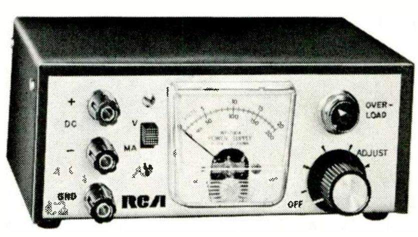
Circle 31 on literature card

Regulated Solid-State Power Supplies

Two bench-type, regulated DC power supplies have been announced by RCA Electronic Components.

Models WP-700A and WP-702A are identical except that Model WP-702A is a dual unit, with separate controls, output terminals and meters for each section. The two sections of the WP-702A are electrically isolated from each other.

The output voltage of both units is continuously adjustable from 0



to 20 volts, with a load capability up to 200 milliamps. Either output voltage or current can be read on the meter, depending on the setting of the slide-type meter function switch.

The circuitry of the units automatically limit the overload current to prevent damage to the power supply. According to the manufacturer, the power supplies will not be damaged even if connected to an external short circuit. An overload indicator lamp on the front panel begins to glow when the current level approaches 200 milliamps and glows brighter if the current exceeds 200 milliamps.

A negative-feedback regulator circuit maintains a constant output voltage with low ripple regardless of varying line voltage or load resistance, according to the manufacturer.

Three five-way output terminals are provided on the faceplate of each unit: +DC, –DC and GND. The circuit under test can be connected to the power-line ground through the "GND" terminal on the power supply.

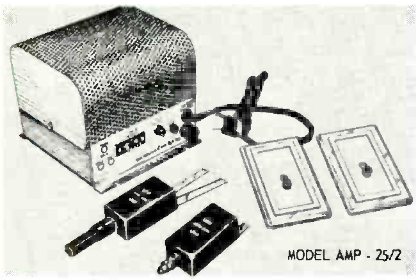
Model WP-700A measures 4″ x 6½″ x 3″, weighs 3 lbs., 10 ozs. and is priced at $87.00. ▲

Circle 32 on literature card

antenna systems report

MATV Distribution Amplifier Kits

The development of four MATV distribution amplifier kits has been announced by Mosley Electronics, Inc. Each kit contains in one package all the components necessary for a two-outlet, amplified TV distribution system, including a broadband 25-dB amplifier designed to handle up to six additional outlets if a larger system is desired.



The kits designed for use with coax include two wall taps and two matching transformers; the kits designed for twin-lead contain two wall plates and a coupler. Each kit also contains all the necessary mounting hardware and installation instructions that offer suggestions about system planning and provide simple block diagrams of systems with the coax loss figured.

Models and corresponding prices are:

Model AMP-25/2 for RG-59/V coax, $128.72.

Model AMP-25/62 for BC-6/V coax, $128.72.

Model AMP-25/T2 for flat 300-ohm twin-lead, $104.33.

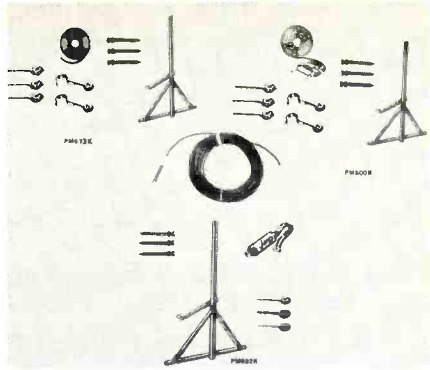
Model AMP-25/BL2 for encapsulated or shielded twin-lead, $108.05.

Circle 33 on literature card

Antenna Mounting Kits

A new line of TV antenna mounting kits has been introduced by **JFD Electronics Corp.**

All kits have a universal tri-mount and a 5-foot 1¼" O.D. mast. The tri-mount is adjustable and is made of light, rugged aluminum



which has been gold alodized to resist corrosion.

They offer the user a choice between VHF/FM only or UHF/VHF/FM, and a choice between twinlead or coaxial cable.

The model numbers are: PM-600K, PM613K, PM682K and they range in price from $9.50 to $23.75.

Circle 34 on literature card

"Multi-Set" Antenna Rotator

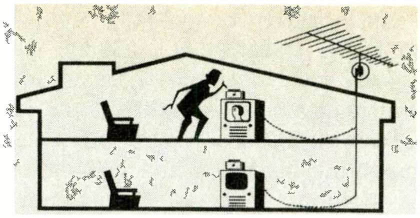
A "multi-set" antenna-rotor system has been announced by The Alliance Manufacturing Company, Inc.

Designated Model T-45 "Tenna-Rotor," it reportedly is the first an-

Circle 19 on literature card

tenna rotator which can be operated by two or up to five controls located in different areas of the home, while showing antenna direction on all controls simultaneously. Complete antenna control is possible from any control unit in the system.

Heart of the T-45 "Tenna-Rotor" is a five-wire circuit unaffected by motor current, cable length and line-voltage variations. The rigid offset rotator unit is weatherproof and will turn the largest color antennas in winds of 90 miles per hour or



more, according to the manufacturer.

The unit is housed in a ribbed die-cast zinc housing, and all exposed metal parts are of stainless steel or other corrosion-resistant materials.

The system's control units are styled in walnut-toned, phenolic plastic. A finger-pressure control bar directs rotation of the antenna through 360 degrees, at one r.p.m. Price is $39.95 for the rotor and one control. Extra controls are $21.25 each.

Circle 35 on literature card

MATV Line Extenders

The Systems Division of JFD Electronics Corp. has introduced a new series of cable-powered "Line Stretchers" for Master Antenna TV (MATV) Systems. Their function is to reamplify the TV signal at the end of a long trunkline, thus extending the trunkline to handle additional TV outlets.

The Line Stretcher is solid-state and requires no AC power source; it receives power from the head-end

amplifier over the same coaxial cable that carries the TV signal.

There are four models available in the Line Stretcher series: Model SL6300 provides 13.5dB of gain for all VHF and FM signals and 3 to 6.5dB of gain for VHF signals. Model SL6301 is similar except that it includes a 6-dB gain-control range. Model SL6310 is basically a VHF line extender, providing 12dB of gain across the VHF spectrum and passing VHF. Model SL-6311 is similar to Model SL6310 except that it includes a 6-dB gain control.

VHF and UHF models can be cascaded to provide 82-channel amplification. Size is 2 5/16" x 2 5/16" x 1½".

Line Stretchers without gain controls sell for $37.50, and those with gain controls list for $47.50.

Circle 36 on literature card

Circle 20 on literature card

Troubleshooting the Mechanics of Tape Recorders

Operation, Measurements, Troubleshooting, Lubrication

by Robert G. Middleton

Although few technicians are tape-recorder specialists, this field can be a substantial source of supplementary income to many TV and radio shops.

Since the electronic section in a tape recorder presents little difficulty to the experienced technician, this article will cover the common mechanical problems that occur in both mono and stereo tape recorders. Trouble symptoms, their evaluation and localization, and pertinent repair procedures will be discussed. In addition, this article will point out the parts and areas of tape recorders that require cleaning and lubrication, as well as those that must not be lubricated.

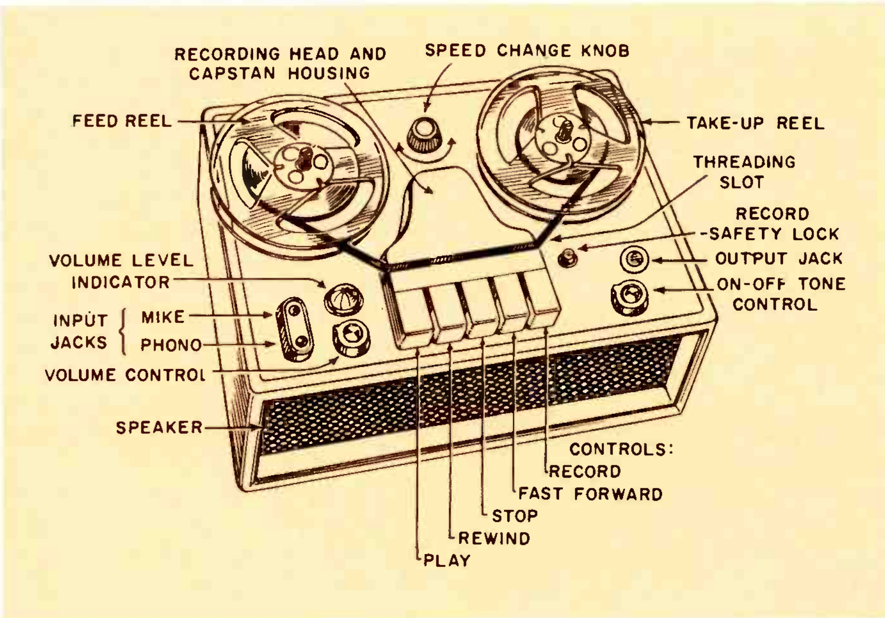


Fig. 1 Typical two-speed recorder with principal features indicated.

General Considerations

A comparatively simple type of recorder is shown in Fig. 1. The tape is coated on one side and must be threaded with the glossy side facing the controls. The feed and reel spindles both must rotate freely during certain operations and provide back tension during others, while permitting high-speed rotation during rewind. All rotating shafts are suitably controlled by a system of clutches and brakes to enable rapid changes in tape direction and speed, while providing proper tension to avoid tape slack. In normal operation, the tape is transported at a precise speed through the recording-head and capstan housing.

Fig. 2 shows the top view of a typical motorboard. The motorboard comprises the primary mechanical mechanism of a recorder. This mechanism transports the tape past the magnetic heads and winds it on

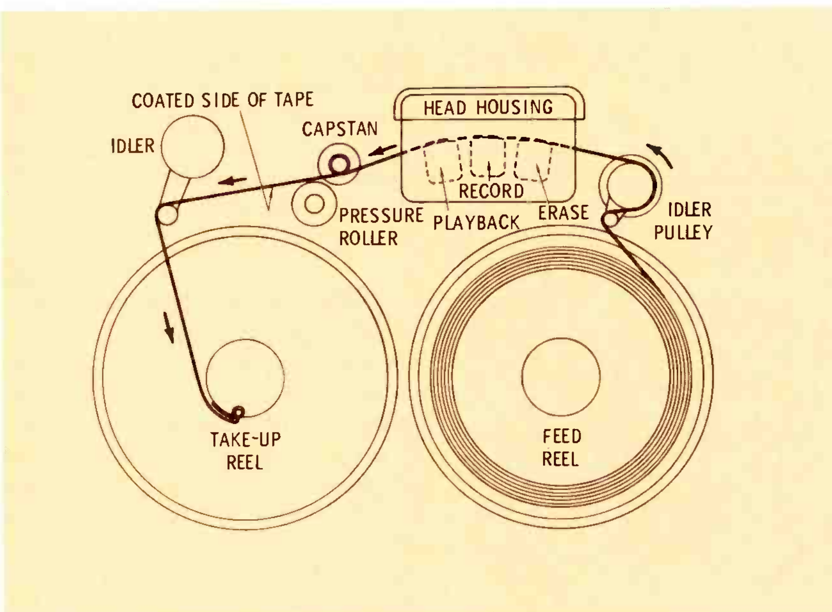


Fig. 2 Top view of a motorboard showing major components.

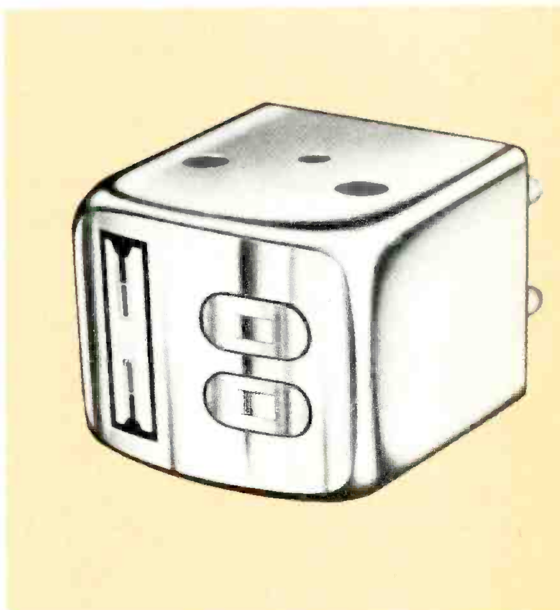


Fig. 3 Modern stereo recording head.

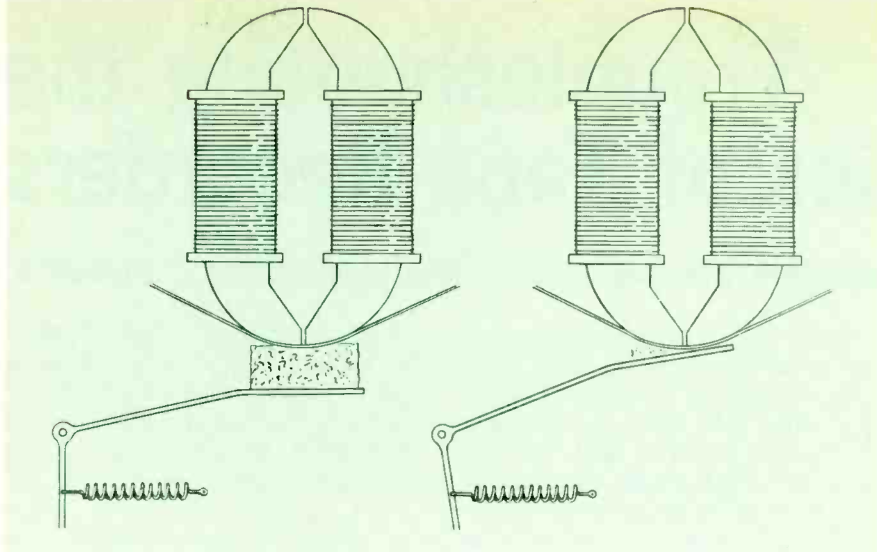


Fig. 4 New pressure pad compared to worn pad.

a take-up reel. If the pressure roller does not exert sufficient force on the tape and capstan, the tape may not move at all or may move erratically. The motorboard mechanism also provides rewind and fast-forward functions. Abnormal clutch and/or brake action can impair these functions and may cause tape spillage or breakage. Note that the fast-forward and rewind functions permit rapid location of any desired portion of a recording on the corresponding interval of the tape.

The idlers in Fig. 2 provide a rapid-action tension compensation so that a constant tape tension is maintained at the capstan and pressure roller. That is, an idler "smooths out" any fluctuations in the tensions exerted by the feed and take-up reels. If an idler becomes defective, a "wow" or "flutter" trouble symptom can result. Although three heads are depicted in the example of Fig. 2, many recorders employ only two heads, one for both recording and playback and the other for erasure. The tape must be transported with adequate pressure against the heads; otherwise, the sound will be weak or distorted. A typical recording head is illustrated in Fig. 3.

"Wow" can also be caused by foreign matter or traces of oil on the capstan. Recorder service data often recommends alcohol as a suitable cleaning solvent. In the case of weak or distorted sound, first check to see if the tape is moving in close contact with the heads. Some recorders use pressure pads to insure adequate tape pressure against the heads. The use of a pressure pad is shown in Fig. 4. Worn or matted pads should be replaced; also check to see if the pad spring is weak or broken. The service data may specify a normal operating pressure, such as 1¾ ± ¼ oz., measured with a spring scale (illustrated in Fig. 5). An adjustment screw may be provided for increasing the pull of a weak spring.

Fig. 5 A spring scale, which measures forces up to 8 ounces, for making torque and pressure measurements.

The rubber-tired pressure roller, which holds the tape by spring tension against the capstan, normally exerts considerable pressure. For example, the service data may specify a pressure in the range from 1 to 5 lbs. To measure the spring force, a calibrated spring scale with a suitable range is hooked over the roller, and the force required to draw the roller back is observed. A weak spring must be replaced. Or, if a new spring exerts too much force, it can be stretched as required. Tension adjustment screws are the exception rather than the rule.

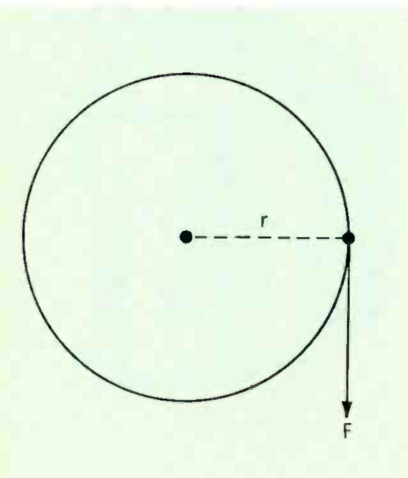


Fig. 6 Illustration of twisting force called torque.

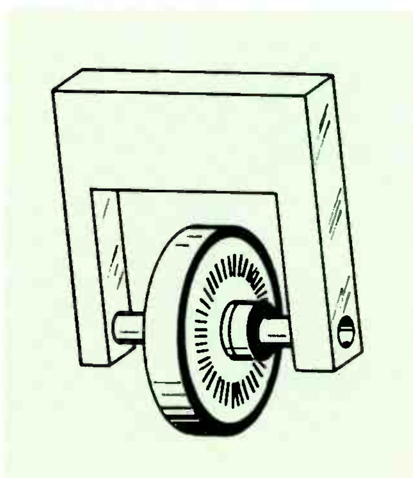


Fig. 7 A typical tape strobe for measuring speed.

Torque Measurements

As noted previously, correct tape tension is necessary for normal transport, and tension is evaluated in terms of torque, as depicted in Fig. 6. In a typical example, the take-up torque specified for the record and play functions is from 2½ to 3½ oz. measured 3 inches from the center of the take-up reel. The fast-forward torque is specified at 4½ oz., minimum, measured 3 inches from the center of the take-up reel.

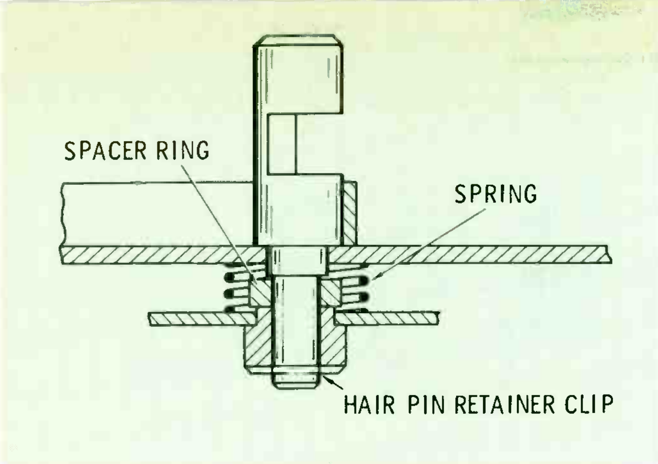


Fig. 8 A tape guide with a stop control pin assembly.

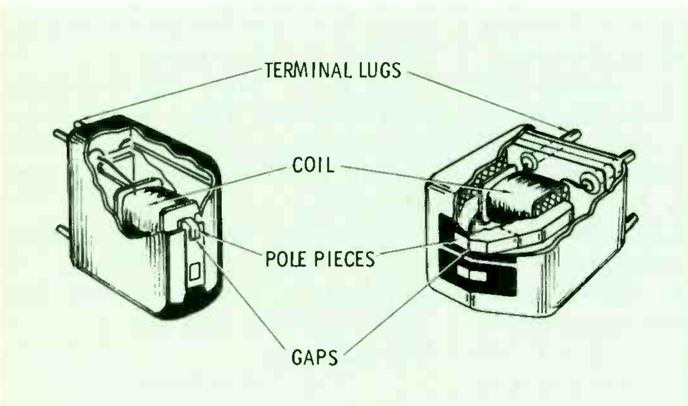


Fig. 10 Detail of typical erase (A) and record (B) heads.

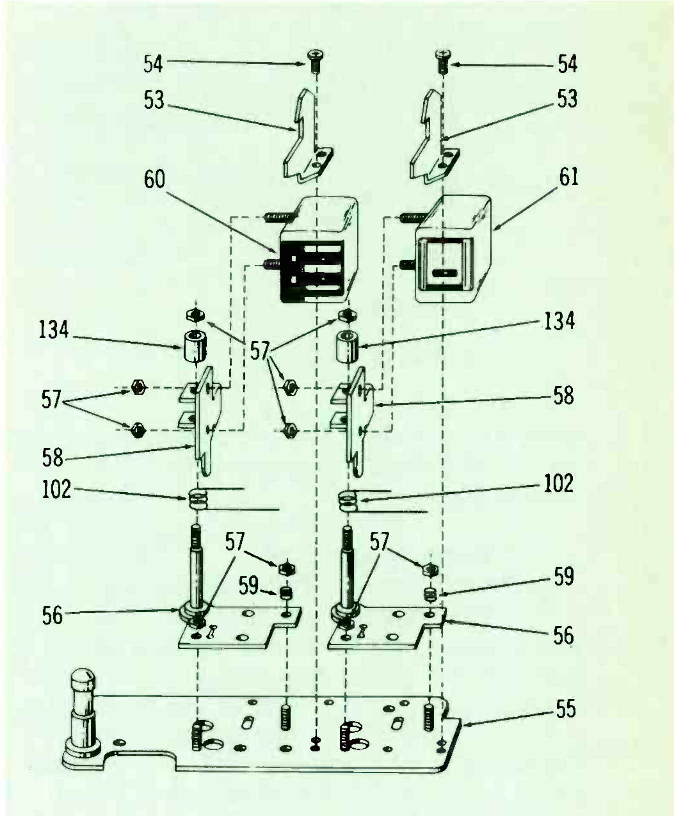


Fig. 9 Exploded view of a typical head assembly.

Also, in this example, the rewind torque is specified at 5 oz., minimum, when measured 3 inches from the center of the rewind reel. Other manufacturers specify different torque values.

Note that the spring scale pointer should remain steady in each of the foregoing tests. If the torque fluctuates appreciably, a transport-mechanism trouble symptom is indicated. The most common cause of trouble is contamination of belts, pulleys, friction surfaces or bearings. In a typical situation, the torque exerted by a belt-type clutch would be measured with a 0-8 oz. spring scale. Proceed as follows:

1. Either a standard plastic reel or a measuring hub may be employed. If the hub diameter is exactly 2 inches, the spring scale will read directly in ounces per inch. Reels with smaller hubs can be brought up to 2 inches by winding sufficient tape on the hub. On the other hand, if the hub is greater than 2 inches in diameter, multiply the spring-scale reading by the hub radius to find the ounces of torque per inch.

2. A piece of string 30 inches long is required, with a loop tied in one end.

3. The take-up torque is measured on the driven reel; hold-back torque is measured on the supply reel.

4. Wind a few turns of string around the driven hub; hook the spring scale into the loop at the end of the string.

5. Start the recorder and observe the scale reading.

6. To measure the hold-back torque, place the measuring hub on the supply spindle. Wind the hub with the full length of string and attach the spring scale. Do not start the recorder; instead, pull the scale back from the hub slowly and read the scale while the string is being unwound.

The recorder service data should be your guide to specific torque values and torque-measuring procedures. Only experienced technicians who are absolutely familiar with various types of recorders can safely dispense with such pertinent service data.

Speed Measurements

Measurement of tape speed is accurately made with a tape strobe, illustrated in Fig. 7. A deluxe recorder may have a built-in strobe disk and 60-Hz lamp. A tape strobe is held against the moving tape, and the segmented circles are observed under a 60-Hz neon or fluorescent lamp. If more than one operating speed is provided, check each of the speeds. The segments in the associated circle will appear to stand still if the tape speed is correct. On the other hand, if the segments appear to rotate clockwise, the tape is moving too fast. Conversely, apparent counter-clockwise rotation indicates that the tape is moving too slowly (linear motion of tape from left to right).

A few recorders provide a maintenance control for adjustment of tape speed. However, no adjustment is provided in most units. Therefore, if the tape speed is appreciably too fast or slow, look for a defect in the tape-transport mechanism. Note that in the case of slow speed, it is good practice to check the line voltage. Most AC-operated recorders employ induction motors, which have a certain amount of "slip". If the line voltage is low, the amount of "slip" increases. Defects in the

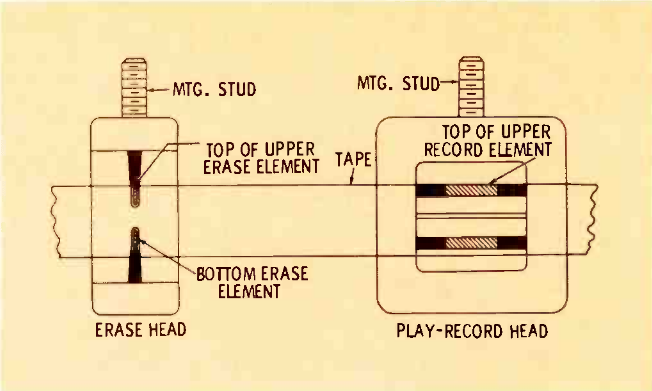


Fig. 11 Proper head height location.

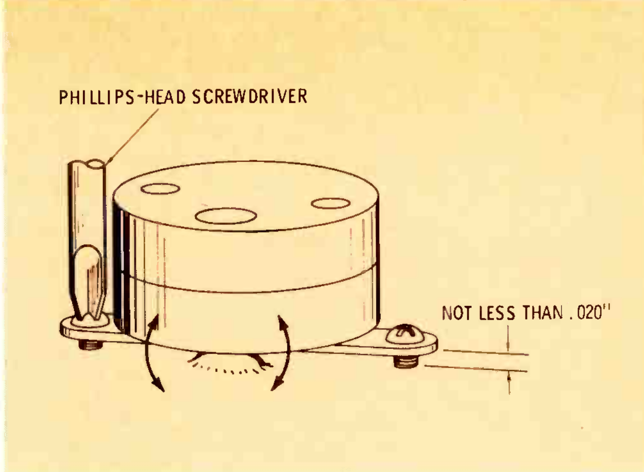


Fig. 12 Typical azimuth-adjusting screws.

transport mechanism that can cause tape-speed trouble symptoms will be discussed later.

Head Defects and Associated Trouble Symptoms

Weakening and distortion of the sound signal can be caused by a contaminated head. For example, some of the oxide may wear off the tape and build up on the heads, capstan and tape guides (Fig. 8 shows one form of tape guide). A guide constrains the tape to travel in line with the gaps in the magnetic heads. When oxide or other contaminants build up on the head, the tape does not make snug contact with the pole pieces, and the first trouble symptom is loss of high audio frequencies, followed by progressive weakening of the sound output and increase of the noise level.

Heads must be cleaned periodically with a soft cloth or cotton swab moistened with an appropriate solvent; the service data might specify alcohol or some specially formulated solvent. At the same time, the head should be inspected for excessive wear. Fig. 9 shows an exploded view of a typical head assembly. The tape guides (53) are secured by mounting screws (54); check the guides during inspection, and tighten the screws if they have worked loose. In this example, two heads are employed: a combination record-play erase head (60) and a play head (61). The lower parts are associated with head azimuth and height adjustments, which will be explained later.

A slight grooving of the head face, with a slight but uniform widening of the gap over its entire length, indicates normal wear and correct head position. Fig. 10 shows the appearance of typical top and bottom gaps. In case of doubt, it is helpful to compare a worn head with a new head, using a magnifying glass. If the gap has worn more at the top than at the bottom, or vice versa, the head may be out of adjustment. Uneven wear can also be caused by pressure pads exerting unequal forces. (Heads with hyperbolic face contours do not employ pressure pads). Unless a head is worn to the point that weakening and distortion of the sound is noticeable, it is not replaced, but merely cleaned and its adjustment checked.

Depending upon the type of recorder, several adjustments may be required to bring the heads into correct relation with the tape; they are as follows:

1. Height adjustment.
2. Parallel positioning.
3. Azimuth adjustment.
4. Contact angle.

The chief adjustments are called vertical alignment (or height) and azimuth. As depicted in Fig. 11, height refers to the position of the tape with respect to the top and bottom of the head. Azimuth refers to the angle (tilt) of the sides of the head (or gap) with respect to the direction of tape travel. The service data will call out the height adjustment screws or nuts (if provided). The azimuth angle is standardized at 90°. Precise positioning adjustments

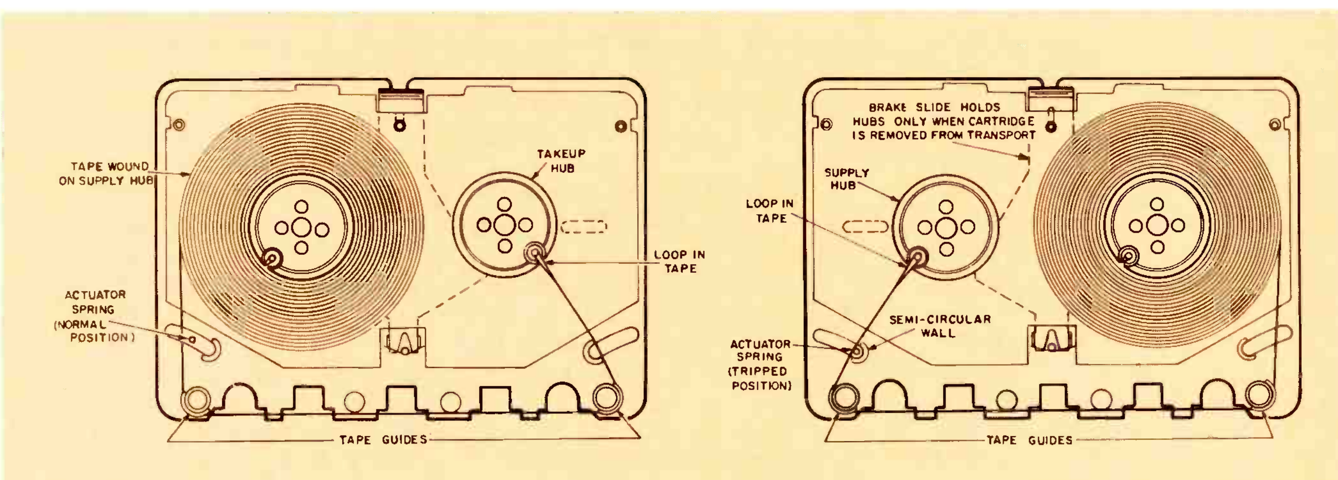


Fig. 13 Design of conventional tape cartridge.

are made with an AC VTVM and a standard alignment tape (a tape that provides a constant-level tone). Observe the tape movement to see if it tracks in the center of the head face. In case of a tracking error, the height is adjusted as specified in the service data.

Next, it is advisable to check for parallel positioning. Look at the head from one side and sight along its face to the capstan. If the surfaces are not parallel, adjust the mounting screws as specified in the service data. In simplified recorders, it often is necessary to bend the mounting bracket slightly, as required. The erase head should also be checked for parallelism. To proceed with the azimuth adjustment, connect the AC VTVM to the output jack or terminals and turn up the volume control. The standard alignment tape is put in motion and the meter reading noted. The azimuth adjustment is then made for maximum reading on the meter. Fig. 12 shows a typical arrangement for the adjusting screws.

In the example of Fig. 12, the adjustment screws provide control of both azimuth and height. Several minor peaks may be found on either side of the maximum peak; therefore, make certain that the true maximum peak has been obtained. If a recorder has separate record and playback heads, and the playback head has been aligned previously, you can align the record head by using the output from the playback head. If the recorder has separate record and playback amplifiers, the job is further simplified. Connect the AC VTVM to the output of the playback amplifier, with a 0.01-mfd capacitor across the VTVM terminals to bypass any bias signal picked up by the playback head. In the majority of cases, the same amplifier is used for both record and playback; if so, feed the output from the playback head to an external amplifier that has a low-level, high-gain input section. Connect the VTVM leads to the output of the amplifier.

Next, thread a blank tape on the recorder and feed in a 10-KHz signal from an audio oscillator. The signal level should be adjusted for about 0.1-volt reading on the VTVM. Then, adjust the azimuth of the record head for maximum meter reading. Although difficulty

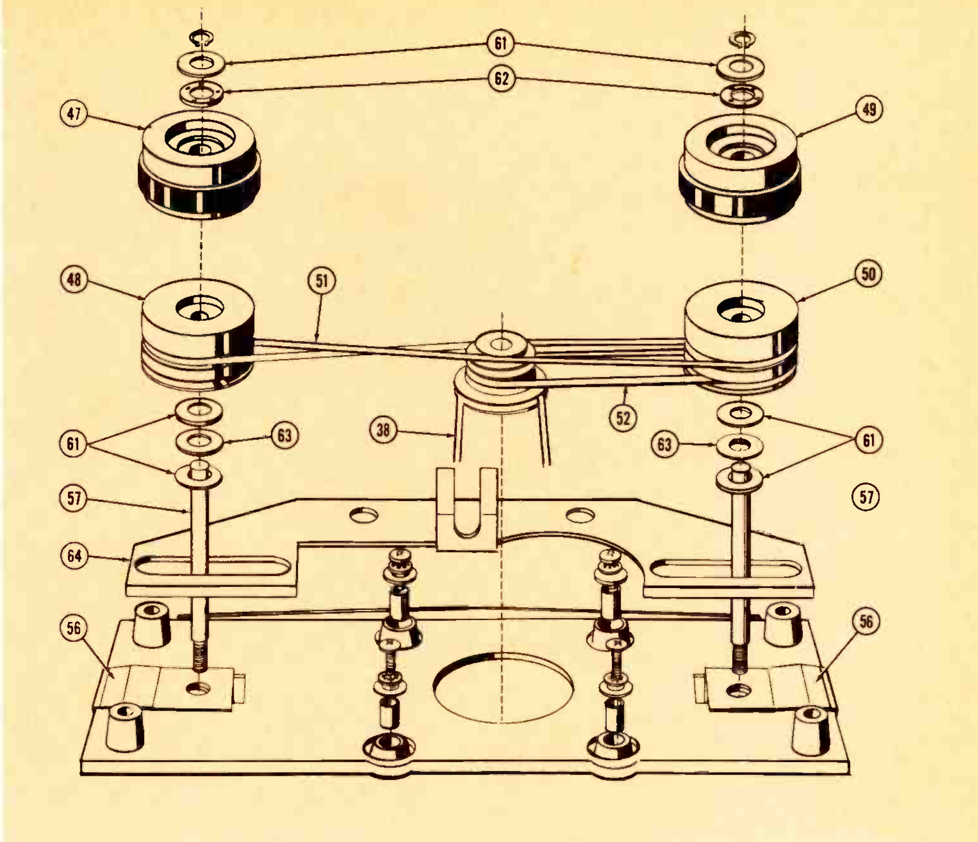


Fig. 14 Typical belt-drive clutch assembly.

is seldom encountered, it is possible that the head assembly has been forcibly bent by accident so that the contact angle is incorrect. Contact angle refers to the axial rotational angle of the head with respect to the tape. If this angle is not zero degrees, the tape might be contacted by only one edge of the gap (disengage the pressure pads to check the contact angle). If no adjustment is provided to correct a faulty contact angle, the assembly must be replaced.

After careful alignment, the recording and playback action is usually normal. Beginning technicians should not be misled by badly worn or otherwise defective cartridges. Fig. 13 shows the design of a typical cartridge.

Belt-Drive Troubleshooting

Various forms of belt-drive systems are in wide use. A typical arrangement is shown in Fig. 14. The belts (51) and (52) may be of the rubber or composition types. Excessive belt wear results in low or erratic torque, as explained previously, or the tape may not move at all; defective belts must be replaced. However, a new belt may not operate properly if it is contaminated by oil, lint, grime or dust deposits on pulleys (48) or (50). Therefore, it is good practice to clean the surfaces as specified in the service data. Be alert also for dry, scored or excessively worn bearings. If defective, the associated parts must be replaced.

As noted previously, the motorboard is the primary operating mechanism of a recorder. One type of motorboard is illustrated in Fig. 15. Although the take-up drum is driven at constant speed by a belt attached to the motor shaft, the drum is separated (by a felt clutch) from the turntable that holds the take-up reel. This clutch provides friction by slipping so that the tape is reeled up as fast as needed at the time—not at full motor speed. Thus, incorrect torque may be due to defective clutch parts instead of belt defects. In some recorders, a clutch adjustment is provided; otherwise, the clutch assembly must be replaced. Careless lubrication can result in oil-soaked clutch felts, causing loss of torque.

Flywheel Drive

A flywheel is often mounted on the capstan shaft to stabilize rotation. In turn, the motor drives the

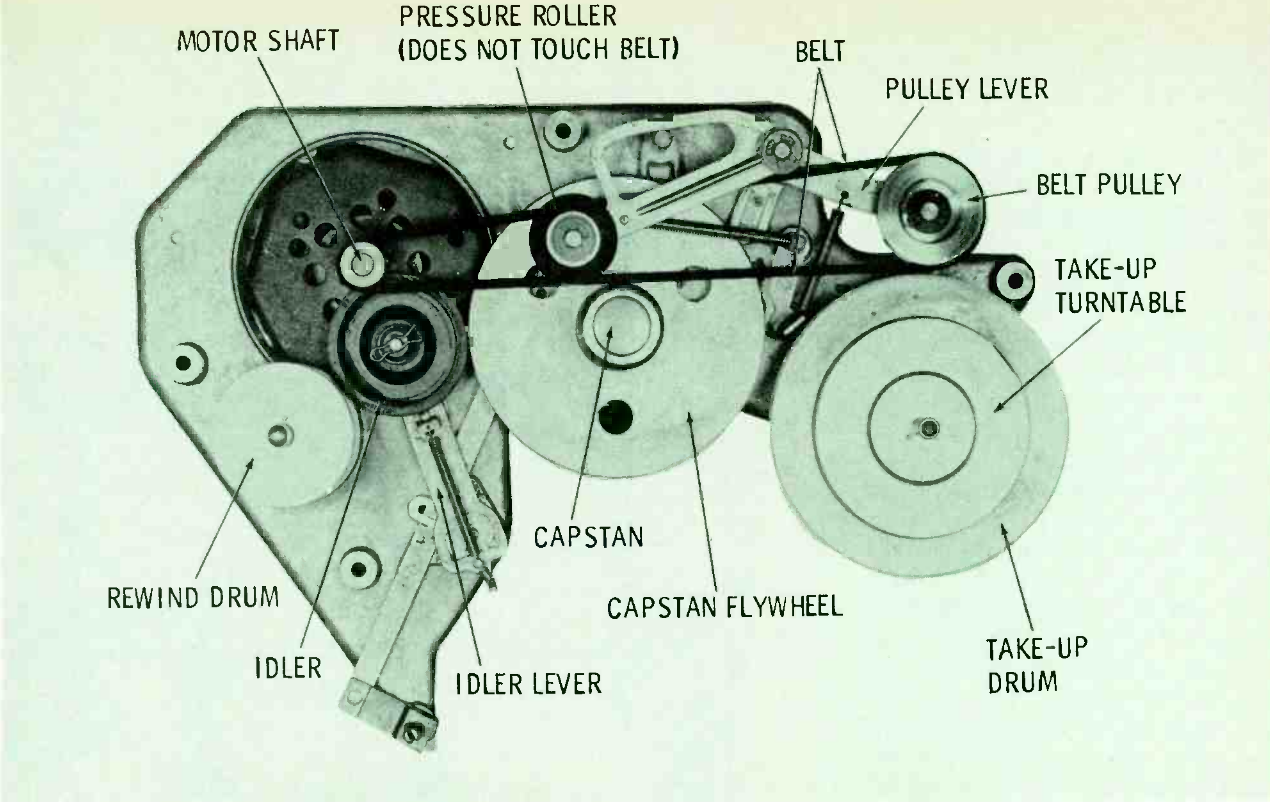


Fig. 15 Transport mechanism of a conventional tape recorder.

flywheel by a puck-, belt-, or direct-drive arrangement. The drive system provides speed reduction.

In the puck-drive design, a friction disk is mounted at the flywheel rim. For example, the flywheel may be provided with a rubber tire and driven by the motor shaft, as shown in Fig. 16A.

Another method employs an intermediate puck to drive the flywheel, as shown in Fig. 16B. This arrangement utilizes the typical idler-wheel design shown in Fig. 17. The center bearing of an idler wheel is mounted on a plate. Regardless of manufacturing variations, its primary functions are as follows:

1. To maintain a correct "wedge" angle of the idler wheel between the flywheel rim and the motor pulley; the correct "wedge" angle will exert adequate traction without causing stalling.

2. To maintain horizontal movement of the idler wheel so that spring tension can be applied to the bearing mounting in the direction of the wedge angle, thereby providing a constant pressure between the idler wheel and both the flywheel and the drive pulley.

3. To maintain proper vertical alignment between the idler wheel and both the motor pulley and the flywheel rim.

An exploded view of a bearing mounting system is shown in Fig. 18.

Trouble in rim-drive systems is often traced to the idler drive wheel. All parts should be inspected for foreign matter and cleaned, if necessary. The rubber (or equivalent) tire is cemented in place. It normally has an accurately ground crown. In trouble situations, the crown may become excessively

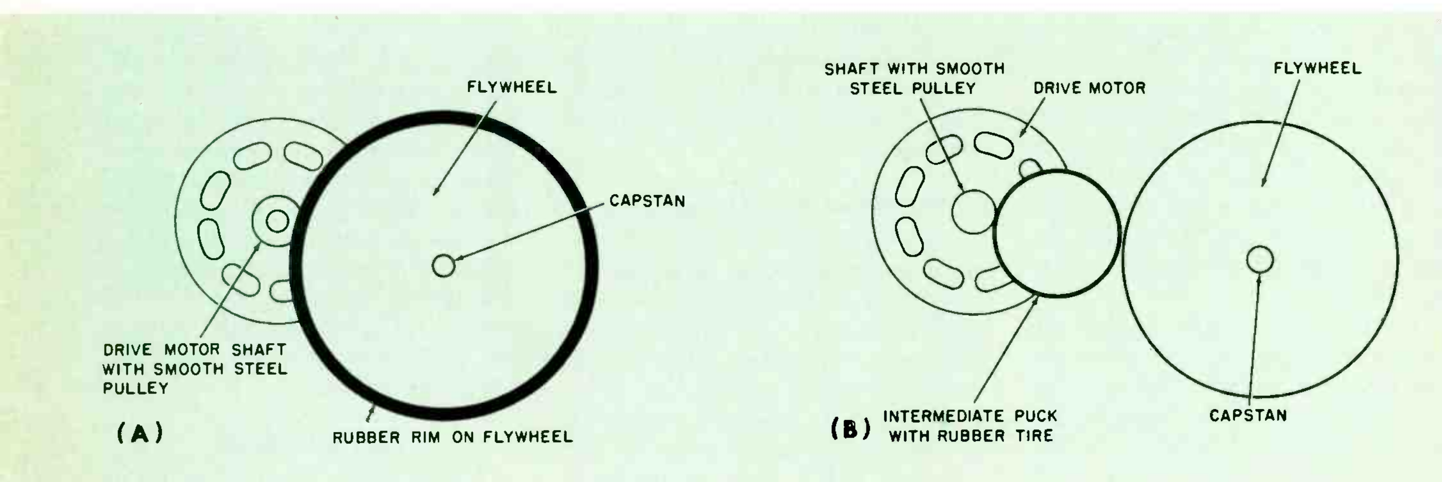


Fig. 16 Two methods of capstan drive. (A) Rim drive to flywheel. (B) Intermediate-puck drive.

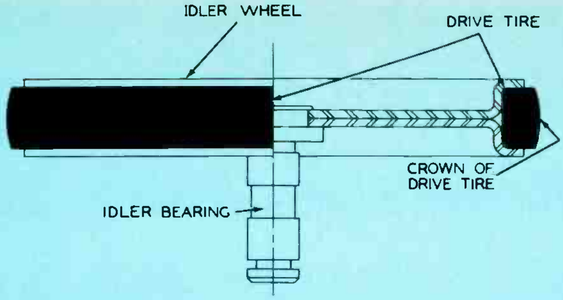


Fig. 17 Details of an intermediate-puck wheel.

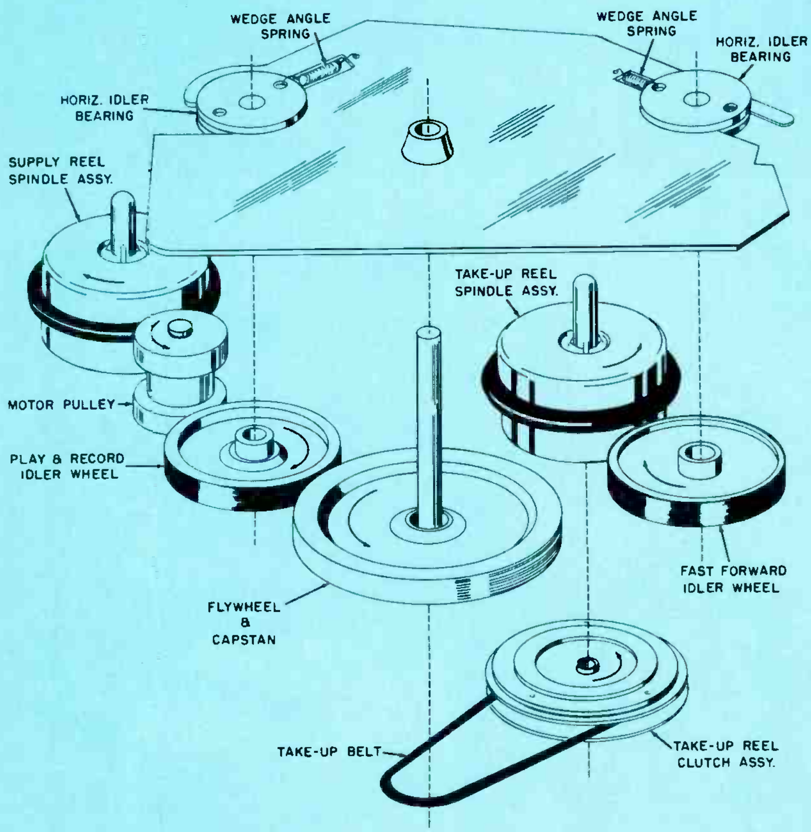


Fig. 18 Exploded view of a typical bearing mounting.

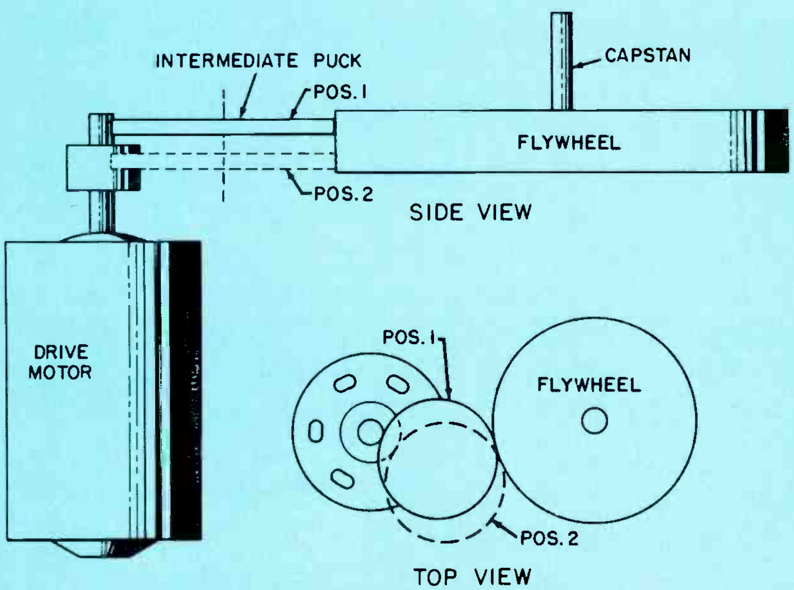


Fig. 19 Changing speed by changing puck position.

worn, glazed or dented. Defective tires must be replaced. Drive trouble can also be caused by a film of oil on the idler tire. It may be possible to restore normal operation by thorough cleaning with carbon tet or an equivalent. Since carbon tet has poisonous fumes, equivalent solvents are preferable.

If the speed selector does not operate normally, look for broken or unhooked springs in the speed-selector mechanism. The basic plan of speed change by shifting the puck position is shown in Fig. 19. If all speeds are incorrect, and a felt clutch is used, check the clutch assembly (Fig. 20) for incorrect adjustment, worn parts or contaminated friction surfaces. If the recorder has been stored in a very cold location, the lubricants could be congealed, and the mechanism may not attain normal speed until the lubricants reach ambient room temperature.

Brake Troubleshooting

When a recorder is set to its stop function, the reels are braked as rapidly as possible without damaging the tape. Faulty brakes can cause tape spillage, stretching, distortion or breakage. In the example of Fig. 21, the brakes are pads or shoes which rub against drums mounted on the reel shafts. When braking trouble symptoms occur, the drums should be inspected and cleaned. Oil, grime or other foreign matter can impair the braking action. Inspect the pads also; if they are worn considerably or contaminated, they should be replaced. If the pads wear away completely, the drums may be scored and require replacement.

The brake pads exert their force against the drums by spring pressure; weak or broken springs must be replaced. If tension adjustments are not provided, flat springs may be bent slightly, as required. Spiral springs can be stretched to relieve excessive tension.

Trouble symptoms can also be caused by worn or defective parts in the brake retraction assembly. Tape breakage is often caused by grabbing brakes; look for gummy deposits on the drums. Clean thoroughly (per service data) and replace the pads if they show signs of damage.

In other designs a brake may be

a metal wheel that engages a rubber rim on the spindle shaft; the end result is the same in any case.

Lubrication

The general rule for lubricating is to clean the surfaces before applying the lubricant; rubbing alcohol or a solvent specified by the manufacturer should be used for cleaning. In most cases, a few drops of No. 20 machine oil may be applied to bearings and rotating bushings. A thin film of light, non-hardening grease ordinarily may be applied to sliding surfaces and detent rollers. Excessive oil or grease should be wiped off. In each case, the recorder service data is the authority for lubrication procedures, and any special requirements will be listed.

Binding or other abnormal operation can often be corrected by applying the proper lubricant at the trouble spot. Some lubrication points require a drop or two of No. 10 sewing machine oil, while points that are under greater load or stress require a high-temperature grease of medium consistency.

Some recorder motors require periodic lubrication, others do not. To determine whether the motor bearings are dry, pull the motor away from the rubber wheels and turn the motor on. If the bearings are dry, a chattering noise probably will be audible. A drop of light machine oil will stop the chattering, unless wear is excessive. ▲

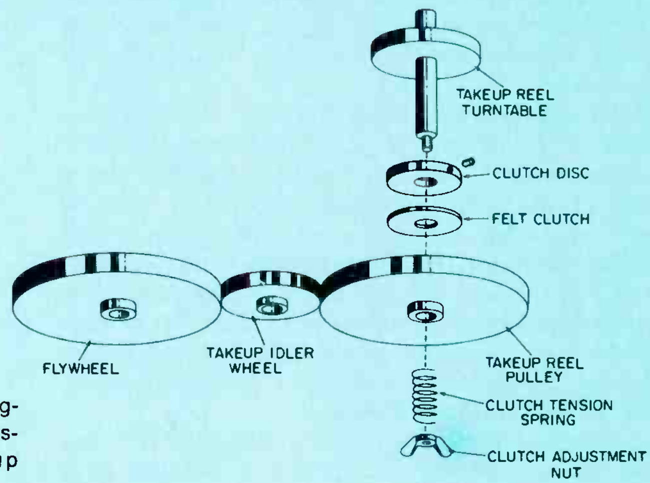


Fig. 20 Slipping-clutch drive system for take-up reel.

1. RECORD BUTTON
2. LOCK LEVER
3. PRESSURE ROLLER
4. CAPSTAN SHAFT
5. PADS
6. RECORDING HEAD
7. BRAKE
8. BRAKE
9. MOTOR BUSHING
10. CAPSTAN RIM
11. ERASE MAGNET
12. PRESSURE PAD
13. REWIND LEVER
14. SWITCH LEVER

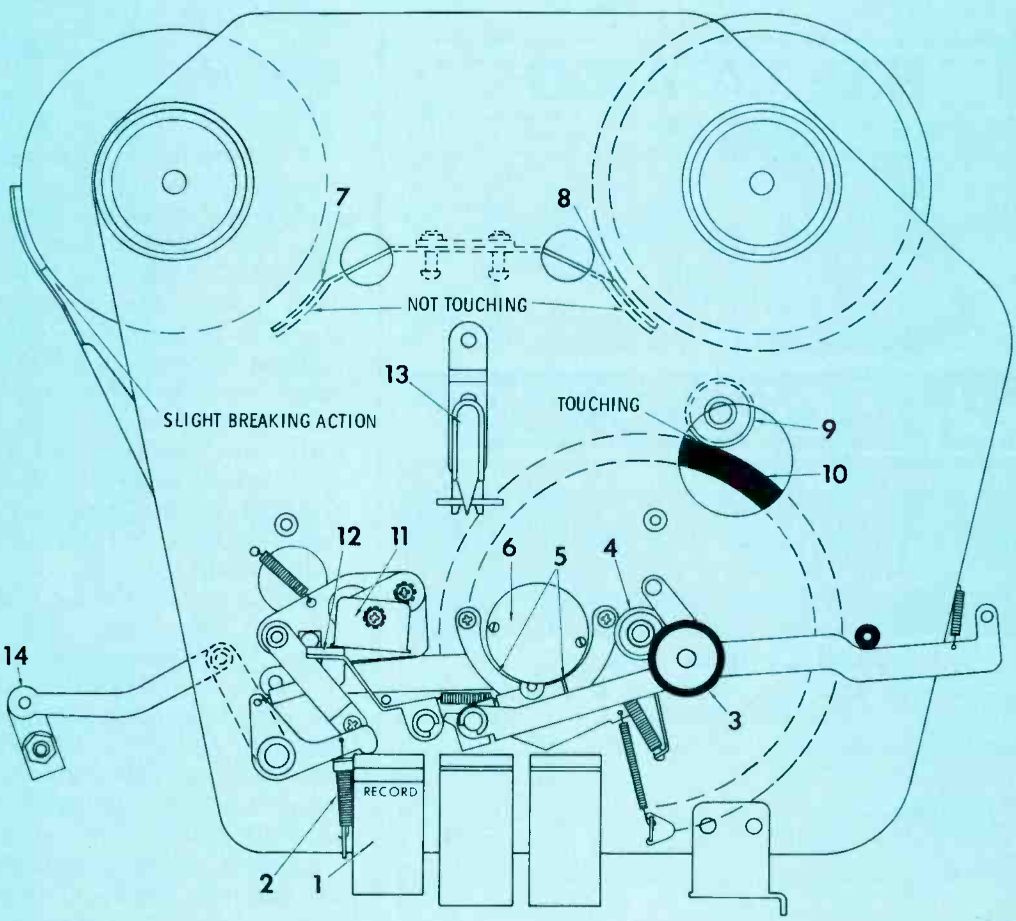
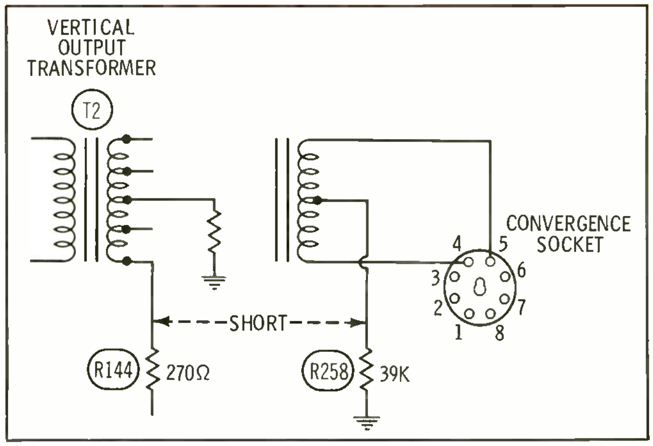


Fig. 21 Top view of tape transport mechanism in "Record" position (3¾ in./sec.).

troubleshooter



Defective Transformer and A "Blob" of Solder

Mr. Edwin Crawford described in the Troubleshooter column in the April '69 issue a "picture missing" trouble symptom caused by an open video-output plate transformer (L13) in the RCA CTC 31A color chassis.

I have recently encountered two other trouble symptoms caused by a defective L13 in the same chassis: One symptom was what appeared to be a blue arc in the base of the picture tube and was accompanied by a black screen but normal sound. The screen would light dimly at times. The combination of these symptoms at first caused me to suspect the picture tube, but further troubleshooting revealed that the voltage on the plate of the video output tube was low. Bridging across L13 restored the raster and picture; replacing L13 cured the problem.

The other symptom caused by a defective L13 was a weak, washed out picture. Again, reduced voltage at the plate of the video output tube led me to the defective L13.

The cause of the above trouble symptoms was isolated by voltage measurements. However, there are troubles and combinations of troubles that involve a physical defect which, in many instances, can be isolated much more quickly by close visual inspection. For example, I recently made a home call on an RCA CTC 38 color chassis that displayed a multitude of trouble symptoms: poor convergence, poor purity and reduced vertical sweep and other symptoms that appeared to be caused by an AGC filter defect. I removed the chassis and, after a close visual examination, discovered the fact that a "blob" of solder was shorting together R144 and R258. Removing this short restored the set to normal operation.

This trouble eventually would have been isolated using test equipment; however, in this case a visual inspection was much faster—and time saved adds up to more profit.

CHARLES E. JACKSON

Buckner, Ill.

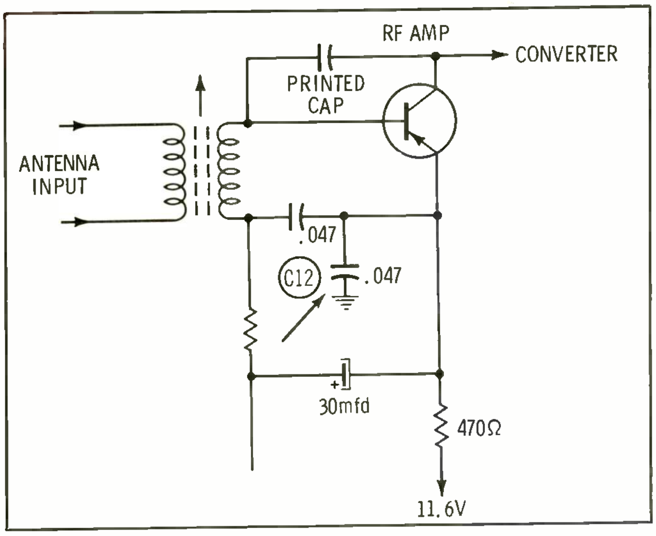
Auto Radio With Sensitive Capacitor

A Model 986545 Chevy auto radio operated normally when it was first turned on in the morning, but after the customer had driven for a few miles, a "static-like" noise would drown out both strong and weak stations. After a few minutes of such noise, the operation of the radio would return to normal.

When the radio was brought into the shop, it functioned normally and no static was evident. I placed the radio in the freezer section of a refrigerator for several hours, then removed it and turned it on. After about fifteen minutes of operation, a "static-like" noise drowned out the station signal, just as the customer had described, but the noise disappeared before I could isolate the cause.

Next, I chilled the set with Freon 12 and turned it on. This time I was ready. When the noise started again, I shorted out the emitter-base junction of the IF transistor and the noise stopped. When I removed the short, the noise returned. I shorted the emitter-base junction of the RF amplifier transistor and the noise was reduced but could still be heard in the background. At this point, the radio began to play normally again.

I chilled all components directly associated with the RF amplifier stage. After the radio operated for a couple of minutes, the noise returned. I measured the RF amplifier collector voltage; it was varying from 2 to 0 volts. Since I had not chilled the transistor, I knew



a defect in it was not directly responsible for the varying collector voltage. I then measured the emitter voltage; it was varying from 11 volts to less than 7 volts. I checked the voltage across the emitter resistor; it was varying from approximately .4 volt to over 5 volts. Again, the noise disappeared and the radio returned to normal operation.

I checked the emitter resistor of the RF amplifier; it measured 500 ohms—within tolerance of its rated value. I chilled it and waited, but the noise did not return. This left only the .047-mfd capacitor, located between the emitter and ground. I chilled this capacitor and the noise returned.

I removed the capacitor and checked it with a leakage tester; it measured infinity. I sprayed it with Freon 12 and the meter flickered but quickly returned to a reading of infinity. As I sat and watched the meter, it suddenly indicated a dead short. After a short period, the meter returned to an indication of infinity.

I removed the capacitor from the leakage tester and connected an ohmmeter across it. On the 1K range, the ohmmeter applied 3 volts across the capacitor. I once again chilled the capacitor and the ohmmeter indicated a dead short for a short period.

From the results of the foregoing tests I concluded that the capacitor was sensitive to a very limited range of ambient temperature. I replaced the capacitor, monitored the radio for a period of time and then returned it to the customer. Several weeks later the customer informed me that the noise had not returned since I replaced the capacitor.

David T. Drage

Bethania, N. C.

Very interesting! Your perseverance and troubleshooting technique are to be recommended. Situations such as you have described help confirm the fact that nothing is impossible—at least in electronics. ▲

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Tips and shortcuts for more accurate color TV alignment

First of a series that provides both general alignment and troubleshooting information and step-by-step procedures for specific chassis. by Carl Babcock

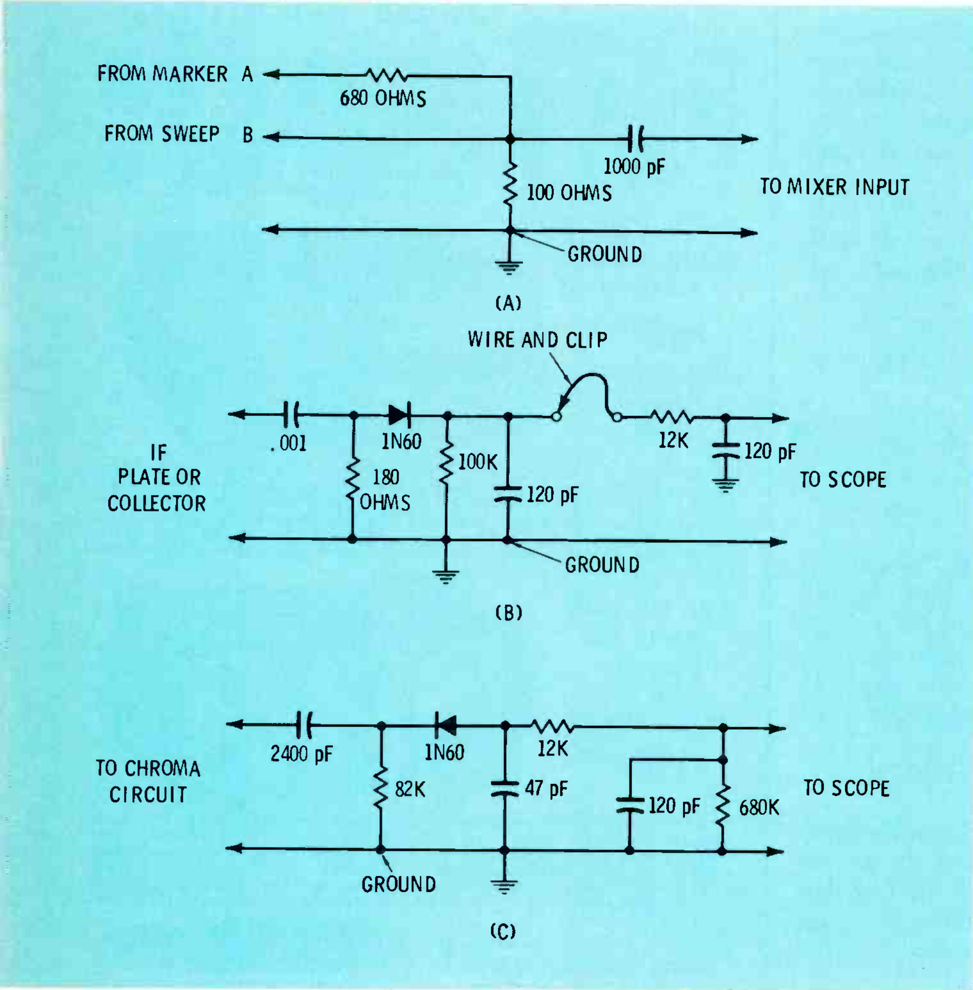


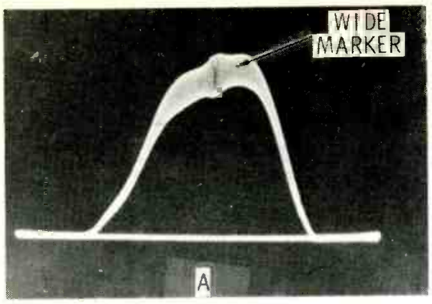
Fig. 1 Three typical pads and rectifier probes for IF and chroma alignment. **A.)** Matching pad for use between sweep generator and the mixer input of the tuner. **B.)** "Loading" type of detector probe for link alignment. (Reverse diode polarity to produce negative-going curve.) For sweep alignment, connect as shown. To align traps, remove the probe from the plate or collector of 1st IF, remove clip from the detector probe and connect it to the video detector test point on the receiver (provides more gain for accurate trap adjustments). **C.)** Video detector probe for chroma alignment.

Do you now align color receivers but wish you could become faster and the results more consistent? Do you believe you can help the b-w or color picture by touching up the alignment while you watch the picture? Or have you bought expensive equipment and then neglected it after a few half-hearted or unsuccessful attempts at alignment? If you answer "yes" to any of these questions, this article was written especially for you.

Symptoms Caused By Misalignment

1. Either weak or strong and blurred color.
2. Critical fine tuning to obtain color.
3. Critical color killer action.
4. Beat pattern (jagged or cloth-like lines) in the picture.
5. Smeared, unsharp b-w or color pictures.
6. Color tint which cannot be adjusted for good skin color, even after resetting the color-locking and tint adjustments.
7. Weak vertical locking or AGC overload when the color is correctly fine tuned.
8. Two points at which the fine tuning control will produce color. Don't blame the tuner for this one!

Other defects also can cause these same symptoms, but poor alignment should be suspected if two or more of these symptoms are observed in the same receiver.



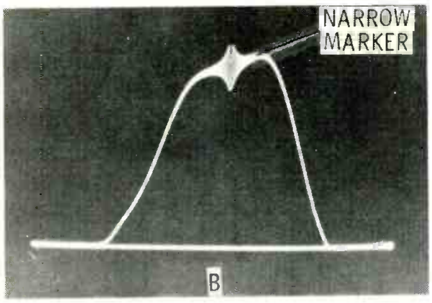


Fig. 2 Photos illustrating the advantage of using a low-pass filter between the probe and the input of the scope. (Probes shown in Fig. 1 have a built-in low-pass filter.) **A.)** Curve produced using a probe without a low-pass filter—the marker covers the whole curve. **B.)** Curve produced using a low-pass filter in the probe—marker is much sharper.

Reasons For Misalignment

Most alignment adjustments are done by turning a powdered-iron core inside a coil; this method can have excellent stability. Why then should any color set even require realignment after it leaves the factory? This is a fair question, for many individual receivers never again need adjustment. Here are some of the reasons other sets may need alignment:

1. Tubes (or transistors) age or may be replaced with others which change the curve.
2. Loading resistors or ceramic tuning capacitors may change in value, or coil forms may deteriorate and allow the turns of wire to move.
3. Coil or tube shields may become improperly grounded, and board grounds or tube sockets may become corroded or develop a high-resistance connection.
4. A loose coil core may have been turned by vibration during shipping. Apply wax, similar to that on the coil forms, to the core threads to prevent future shifting.
5. Another technician may have turned a core by mistake or deliberately in a futile attempt to improve the picture.
6. The iron core may be cracked. If so, it must be replaced; a cracked core will not tune properly, and most will freeze so they can't be turned. TIP: a worn hex tool will often crack a core. I remember one chassis that had 5 cracked cores in it.

Sweep Curves Help Diagnosis

The alignment scope pattern can be an excellent help in many kinds of troubleshooting. Suppose you are working on a color TV that has low contrast and very little snow off channel. Obviously, one or more stages are weak. But which one? It might be the mixer or any of the IF amplifiers. Signal injection analysis works fine in cases where a stage is completely dead, but it can be confusing if the problem is low gain. Just measure the gain of a stage by inserting an IF sweep signal into the base or grid circuit through the mixer input pad and rectifying the resultant output at the collector or plate with a video detector probe which is attached to a calibrated scope. Do each stage in turn until the bad one is found. After a little practice to acquaint you with what gain and voltages to expect, you can analyze with precision the gain and bandwidth of each stage (or the entire IF).

How would you pinpoint the faulty stage in a transistorized IF circuit that was on the verge of overload not caused by wrong AGC action? My solution is to hook up the sweep equipment exactly the same as for IF alignment and then look at the output of each stage as the generator sweep output level is varied from low to high. In one case, every stage reacted normally, except that the output from the third IF transistor would flatten, then turn **upside down** as the generator signal was increased. (This inversion causes the picture on the

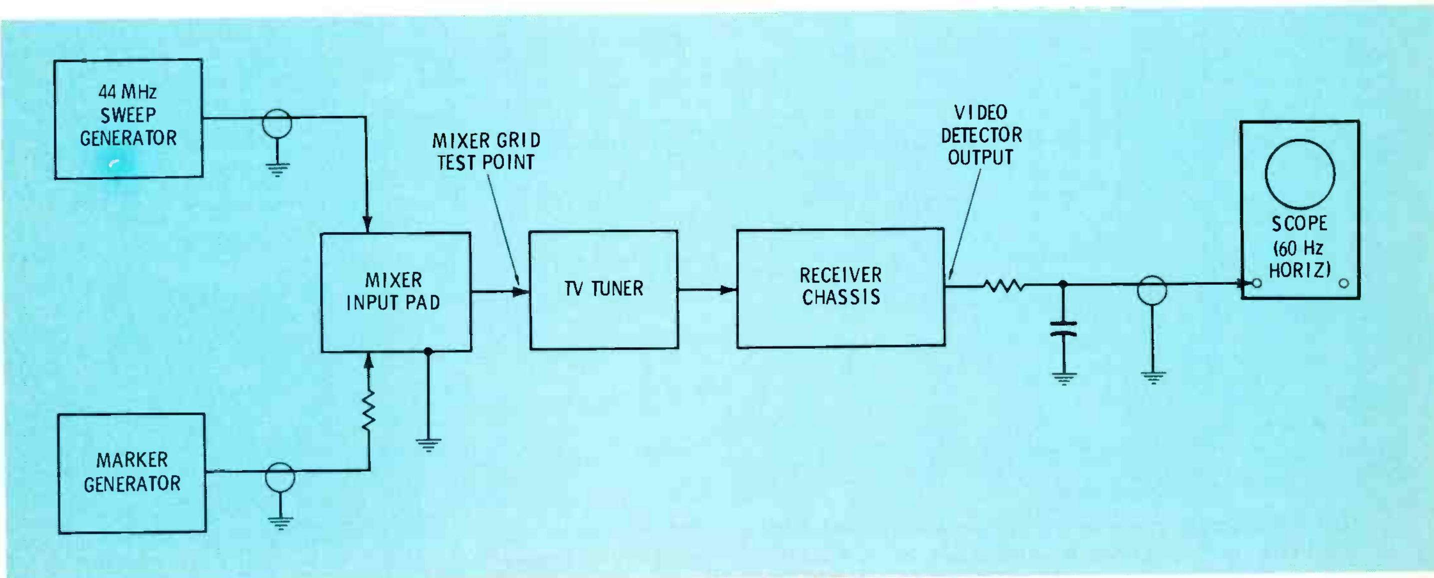


Fig. 3 Equipment connections for IF-sweep curve alignment.

screen to resemble a photographic "negative".) Voltage analysis of the third IF stage revealed nothing suspicious, so the transistor was replaced, and the set operated fine. Alignment was not necessary in this case, but could have been done quickly if the new transistor had distorted the curve.

When you do this type of analysis regularly, you will be amazed at the difference in alignment even a tube replacement can make. The fact that a weak, shorted or gassy tube will distort the IF curve is well known and accepted. However, it is not too unusual to find individual tubes, even new ones, that will change the alignment curve radically or, in some cases, will not permit satisfactory realignment at all. Such tubes may test perfect in a good tube tester, yet not work right in these critical stages.

Sweep analysis also can be an excellent test of IF tubes and gives the additional benefits of better set performance with less bench time. If you replace a tube and watch the picture tube for signs of change or improvement, any increased gain is likely to be masked by the AGC action. But with the fixed AGC voltage, which is necessary for alignment, any change in gain or bandwidth can be noticed immediately. A 20-percent increase in gain will cause 20-percent more height on the scope trace.

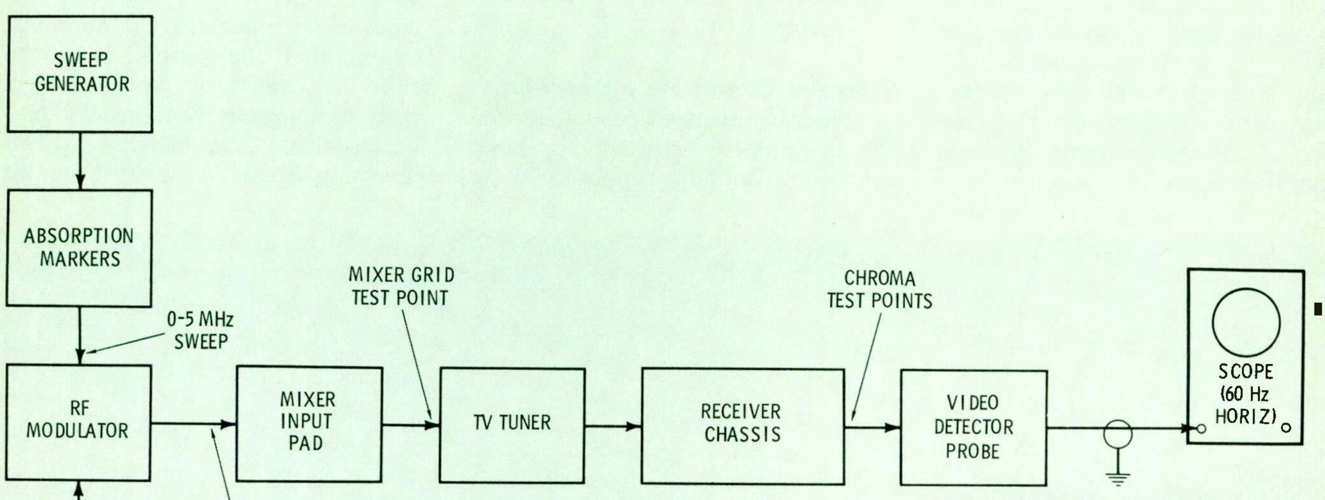
Intermittents, whether they are flashes across the screen or changes in gain or contrast, often can be spotted faster on an alignment curve. Watch the scope pattern while you poke, prod and tap the components in the suspected area. Apply tuner cleaner to tube socket pins or the carbon element of trap-balancing controls and notice if the curve changes. Replace tubes or other parts, solder PC board grounds and move IF coils by touching the cores with an alignment tool.

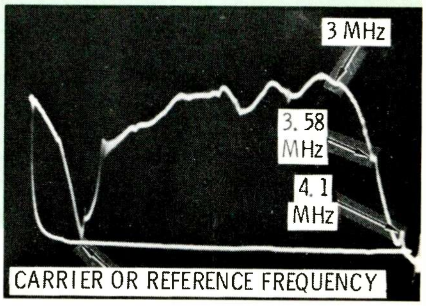
When the intermittent is located and cured, look at the overall IF curve. If it is normal, you are through with this particular job, but the equipment is ready if a touch-up is needed.

Sweep Alignment Equipment Specifications

Three major pieces of equipment are necessary for complete color alignment: sweep and marker generators and a scope. Whether they are built together or are available as separate units is not important, but the specifications and performances are vital. Here are some important equipment characteristics:

1. The output from the sweep generator must be absolutely flat over the range of frequencies used. These include: 0 to 5 MHz to cover video and chroma IF frequencies, up to 5 MHz deviation centered around 44 MHz for IF alignment, and 6 MHz or more deviation at the center of each VHF channel frequency. The flatness can be checked by connecting the sweep output to the scope through a video detector probe. Two parallel horizontal lines indicate that the response is flat; a tilted or curved line shows amplitude variations. The level of





(B)

Fig. 4 Equipment connections for video sweep modulation (VSM) method of alignment and resulting curve. **A.**) Test setup. **B.**) A typical VSM curve of the receiver's response from tuner to video detector output. (Do **not** align the IF's using this curve.)

RF output voltage should be adjustable, and the maximum voltage should be high enough to use when only one stage is being swept. This last requirement usually rules out the use of harmonics to reach the 40 MHz IF band.

2. A good marker generator must furnish beat-frequency or absorption markers of high accuracy and stability at all the frequencies needed. Beat-frequency markers must be either crystal-controlled or easily calibrated against an internal standard crystal oscillator. It is very desirable to have more than one marker on at a time. High output voltage and a circuit to allow modulation of the carrier by a low-frequency audio tone are essential in adjusting the phasing type of high-attenuation traps. A 4.5-MHz carrier, with and without audio modulation, is helpful in setting post-detector sound traps (4.5 MHz) and the sound IF alignment.

3. A marker-adder is favored by many good technicians since the marker signal does not go through the receiver at all and, thus, cannot distort the curve under any conditions. In addition, the beat-frequency marker amplitude changes with its height on the curve, if a marker-adder is not used. However, the marker-adder must be disconnected and the modulated marker routed through the receiver IF's during trap and trap-balancing control adjustments, and this takes extra time. I usually take shortcuts here and dispense with the marker-adder.

4. Almost any high-gain scope can be used, since the high-frequency response needs to be flat only to about 10 KHz. But low-frequency response below 60 Hz is important because roll-off will tilt the curve. When used with most sweep generators, the scope must furnish its own 60-Hz sine-wave horizontal deflection, the phase of which should be adjustable. A method of measuring the input waveform voltage and a switch to invert the polarity of the curve from top to bottom are very helpful.

5. Adjustable bias supplies of the recommended voltage and polarity and a full set of matching pads, loading pads and rectifier probes are essential.

6. With some brands of sweep equipment, additional 0- to 5-MHz markers and a device to permit the video sweep to modulate the marker picture carrier (45.75 MHz) are necessary for the VSM (overall chroma) type of alignment.

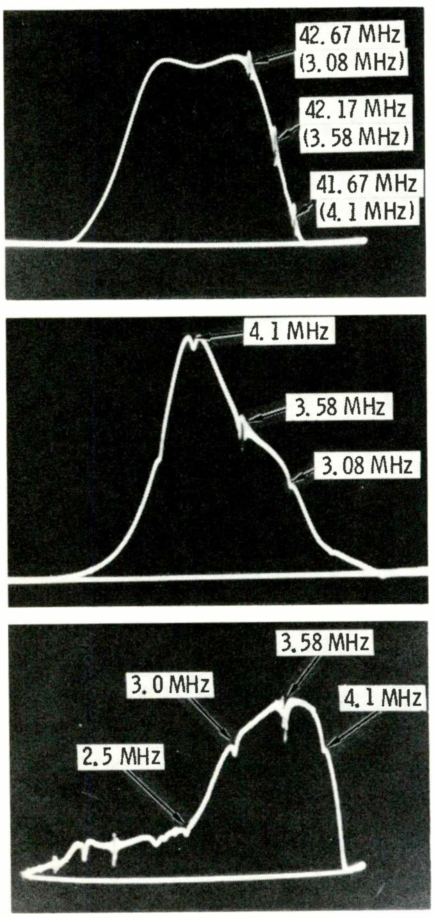


Fig. 5 Adding the color-carrier side of the IF curve (A) to the overall chroma IF curve (B) produces the VSM curve (C) at the chroma demodulators.

General Adjustment Tips

Here are a few valuable tips on alignment in general, listed in approximate order of importance:

1. Use the right AGC bias during IF sweep and use the correct ACC voltage during chroma alignment. A bias which gives too little gain reduction will distort the curve, while too much gain reduction may result in so little scope curve that the alignment is not accurate visually. Use the bias specified in Sams PHOTOFACT or the manufacturers data. Or measure the AGC bias on a strong station before you start the alignment procedure and use this voltage.

   NOTE: In sets with transistorized IF's, it is advisable to obtain this AGC voltage from an internal power-supply voltage through a variable control.

2. All sweep output cables should have a carbon resistor equal to the output impedance at the end of the cable. This flattens the frequency response and minimizes any shifting of the curve when the cables are moved or handled. Keep the wire lengths between the cable-termination resistor and the receiver very short. Receivers with two high-gain IF stages may show a completely false curve if these leads are too long. I have found it best to solder the cable shield directly to the tuner near the test point. Check for stability or standing waves by running your hands along the cables while you watch the curve; there should be no change. If there is a change, check the grounding between the various generators and the resistor-cable terminations.

3. Leave all important chassis shields in place during alignment, especially tube shields. If you want to remove a shield to make it easier to attach the

cables, watch the alignment curve while you hold the shield in position and then remove it. If the curve shifts, the shield should be returned to its original position.

4. The amplitude of sweep and marker signals should be kept near optimum. Design engineers state that a low-to-moderate sweep signal will give a more truthful curve; however, the scope gain may be insufficient if it is too low. If you don't know the recommended amount of sweep signal, raise the amplitude until the curve distorts or flattens, then reduce the sweep output to about ¼ the curve size. Without a marker-adder, the IF markers should be strong enough to be easily seen, yet not large enough to distort the curve or cause it to pull up from the bottom.
5. Fig. 1 shows some typical pads and rectifier probes which will work satisfactorily on most tube receivers. Or use the ones specified in the service data. Just remember that a wrong pad or probe may show an ideal curve, but the picture quality may be poor when the receiver is tuned to a color broadcast.

   NOTE: All the scope probes shown have a low-pass filter as part of the circuit. Fig. 2 shows the same curve with and without this simple filter. If you use the scope's normal low - capacitance direct probe at the video detector test point, you should add a resistor of approximately 27K to 39K between the test point and the probe (which is switched to direct).
6. Before you actually turn any of the alignment adjustments, check the curve at the video detector test point and repair all sources of intermittent operation or erratic curves. Such repairs may eliminate any need for realignment.
7. Traps and tuning adjustments, which are all part of one circuit, often interact, especially in any stages that have a bandwidth adjustment. It is best to "rough in" such stages several times before making the final adjustment.

Equipment Connections For IF And VSM Sweep

Fig. 3 shows a method of connecting the equipment to a typical receiver for overall IF sweep adjustments. The sweep generator is electronically changing the carrier frequency from about 41MHz to 47MHz every 1/60 second. The scope screen shows an instantaneous graph of the amplitude of the sweep signal and how it is affected by the IF tuning transformers and traps. When this sweep signal passes a marker, it heterodynes with the marker signal. Such a heterodyne signal is the difference between the two frequencies, and its bandwidth of several Megahertz must be restricted by a low-pass filter so that only the very low frequencies near zero-beat are visible in the form of a narrow marker.

VSM (video-sweep modulation) operation of the equipment is shown in Fig. 4. A 45.75-MHz carrier from the marker generator is amplitude-modulated by a sweep signal which is varied from 0 to 5 MHz 60 times per second. The scope pattern in Fig. 4 shows the precise response of the IF stages when the receiver is tuned to a TV station; it includes the "hills and valleys" caused by phase addition and cancellation of the sidebands. It is the most truthful curve of all, but should **NOT** be used to actually align the IF's. Instead, it is used to view and align the chrome IF's.

Markers consisting of fixed carriers in the 0- to 5-MHz range can be used instead of the absorption markers shown, but the equipment would be more complex. The absorption markers are series - tuned circuits connected in parallel with the video sweep signal to make a notch (or "suckout") at the marker frequency. Since only a part of the total video band is used for chroma alignment, it is essential that each marker be easily identifiable. These markers disappear when the rivet head for each frequency is touched with a finger.

The sloping (color carrier) side of the IF curves of either Fig. 4 (VSM) or Fig. 5 (sweep) must be combined with a rising chroma IF response to give the required relatively flat response between 3 and 4 MHz measured at the color demodulators (Fig. 5C). Obviously, the tilt and curvature of the IF and chroma response curves must be exact or else the overall curve will be wrong. Of the two, the IF curve is created by a more complex circuit and is much more difficult to make right than is the simpler chroma response.

Next month: Actual alignment procedures using the RCA CTC38 hybrid chassis (with transistorized IF's) as an example. ▲

photofact bulletin

Photofact Bulletin lists new Photofact coverage issued during the last month for new TV chassis. This is another way Electronic Servicing brings you the very latest facts you need to keep fully informed between regular issues of Photofact Index Supplements issued in March, June, and September. Photofact folders are available through your local parts distributor.

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Service Training Schedule

Consumer electronic service training sessions conducted by TV manufacturers, distributors and service associations which are open to all interested consumer electronic service technicians will be announced in this column. Send the dates, location and a brief description of the subjects to be covered to: Service Training, ELECTRONIC SERVICING, 1014 Wyandotte St., Kansas City, Mo. 64105. All information should be submitted two months prior to the date of the training session.

General Electric (C-1 chassis and general service information) Time of each meeting: 5:00-9:30 p.m. (Local time)

DATE	LOCATION
August 5	Stacey Restaurant 12th & Broadway (Meal) Paducah Power 1400 Broadway (Meeting) Paducah, Kentucky
August 6	Weinbach Pharmacy One Weinbach Street Evansville, Indiana
August 7	Jim Taylor Restaurant Cabell & By-Pass (Meal) RECC Building 31 W. By-Pass (Meeting) Bowling Green, Kentucky
August 12	General Electric Company 4421 Bishop Lane Louisville, Kentucky
August 13	Llewellyn Hotel Harlan, Kentucky
August 14	General Electric Company 1133 Commercial Drive Lexington, Kentucky
August 17	General Electric Company 3304 Mynatt St., N.W. Knoxville, Tennessee
August 20	General Electric Company 613 N. 11th St. Chattanooga, Tennessee
August 21	Greers Cafeteria Murfreesboro Road Nashville, Tennessee
August 27	Broadway Motor Court Bristol Highway Johnson City, Tennessee ▲

product report

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

Screw Extractor

For removal of broken screws, bolts and studs, Vaco Products Co. introduces a 5-piece set of screw extractors with complete directions on the pouch. The operation involves drilling a hole in the broken

or buried stud, pounding in the correct size extractor which has special ground flutes for gripping, then unscrewing with a plier or wrench. The set, Vaco Kit No. 70007, handles all screw sizes from ¼ inch to ⅝ inch and costs $6.50.

Circle 38 on literature card

Connector Potting and Junction-Molding Compound

TC-447, an EPD Laboratories product, is a flexible transparent resin used in electronic and aerospace industries and military projects. Resistant to fungus, age-hardening, oils, J. P. fuel and most common solvents, TC-447 reportedly has good electrical properties and

adheres to rubber, neoprene, PCV and nylon when the surface of the materials is properly prepared (cleaned and roughened). Prices range from $4.60 for a 1-lb. kit (1 pt.) to $34.00 for an 8-lb. kit (1 gal.). The prices of larger kits are available on request.

Circle 39 on literature card

productreport

(continued)

Converter

The Pro Tunaverter is manufactured and guaranteed by Herbert Salch & Co. for drift-free UHF reception on standard broadcast radio or any frequencies between 26 and 175MHz. Complete with squelch, coax cable, swinging mount, mounting screws and instructions, the converter can be ordered

with 1 or 2 crystals accessible from the front and interchangeable within the 3% frequency range. It is 4½ inches x 2 inches x 3 inches and light gray. The unit can be installed in vehicles having either a 6- or 12-volt system. With one crystal, price is $39.95 and with two, $44.95.

Circle 40 on literature card

Color TV Voltage Adjustor

Saturn Model 50-172 is produced by Terado Corp. for improved color TV picture performance in areas of low and changing

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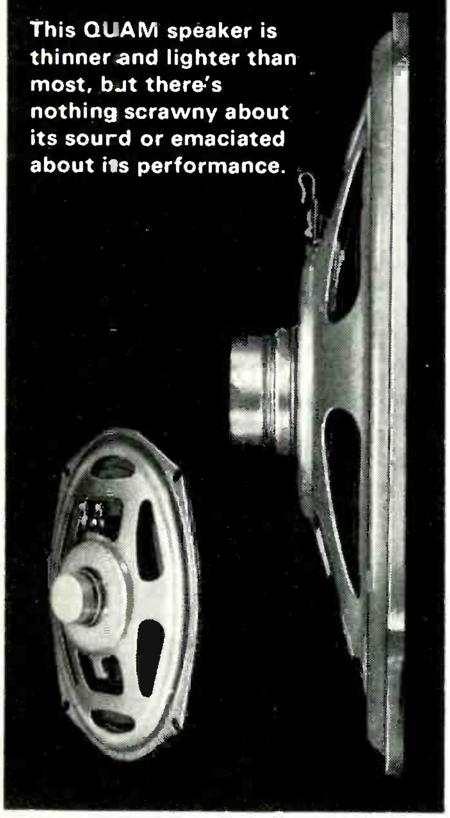

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102. *Rohn*—Illustrated wire catalog No. W-2 covers the complete Rohn wire line, which includes UHF and VHF television transmission lines, coaxial and rotor cables, ground and guy wires, with specifications.*

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103. *RCA*—A microphone selection chart that lists RCA types and cable and termination specifications.*

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