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INSTALLATION & SERVICING
HANDBOOK 1969

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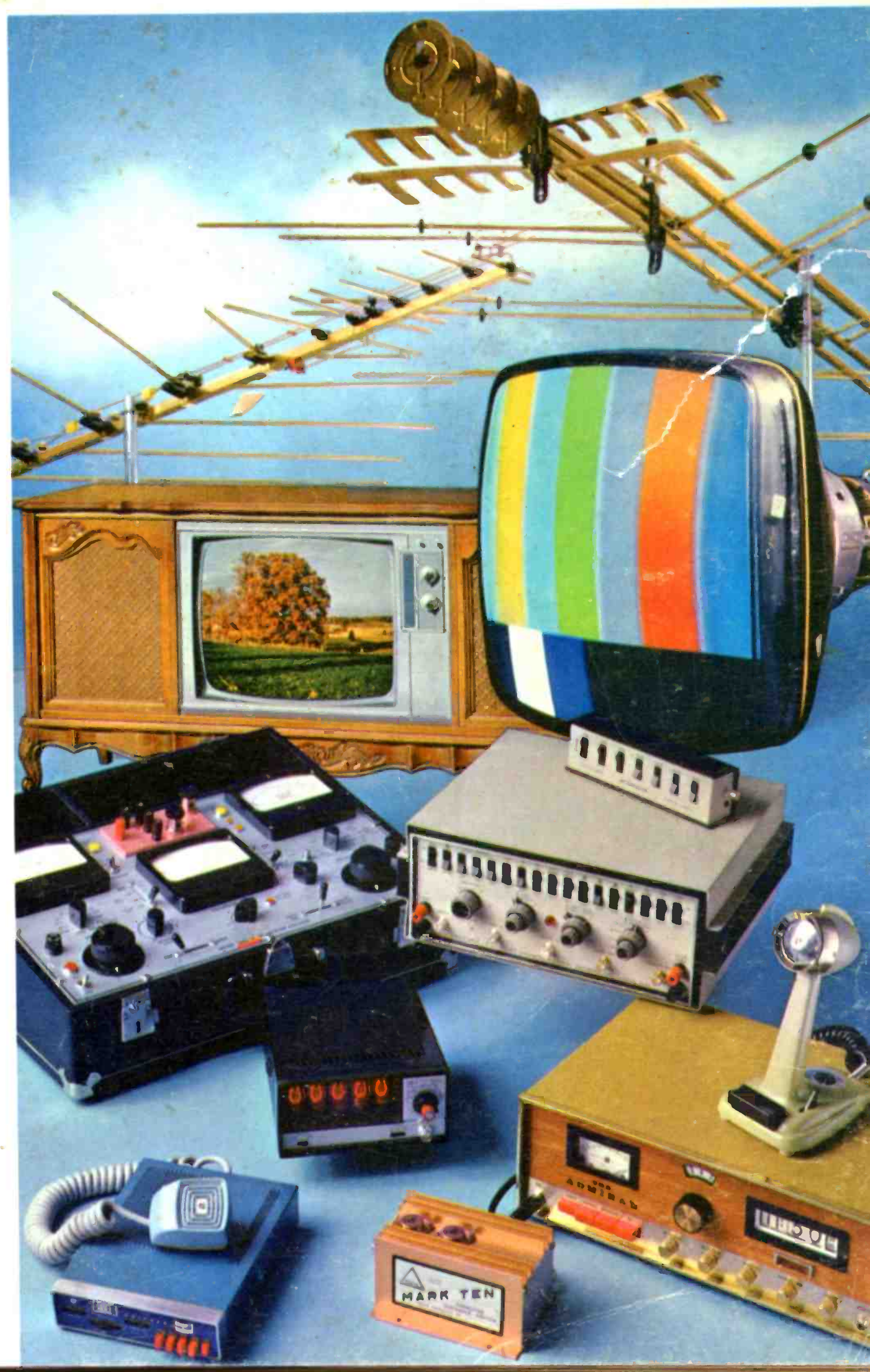

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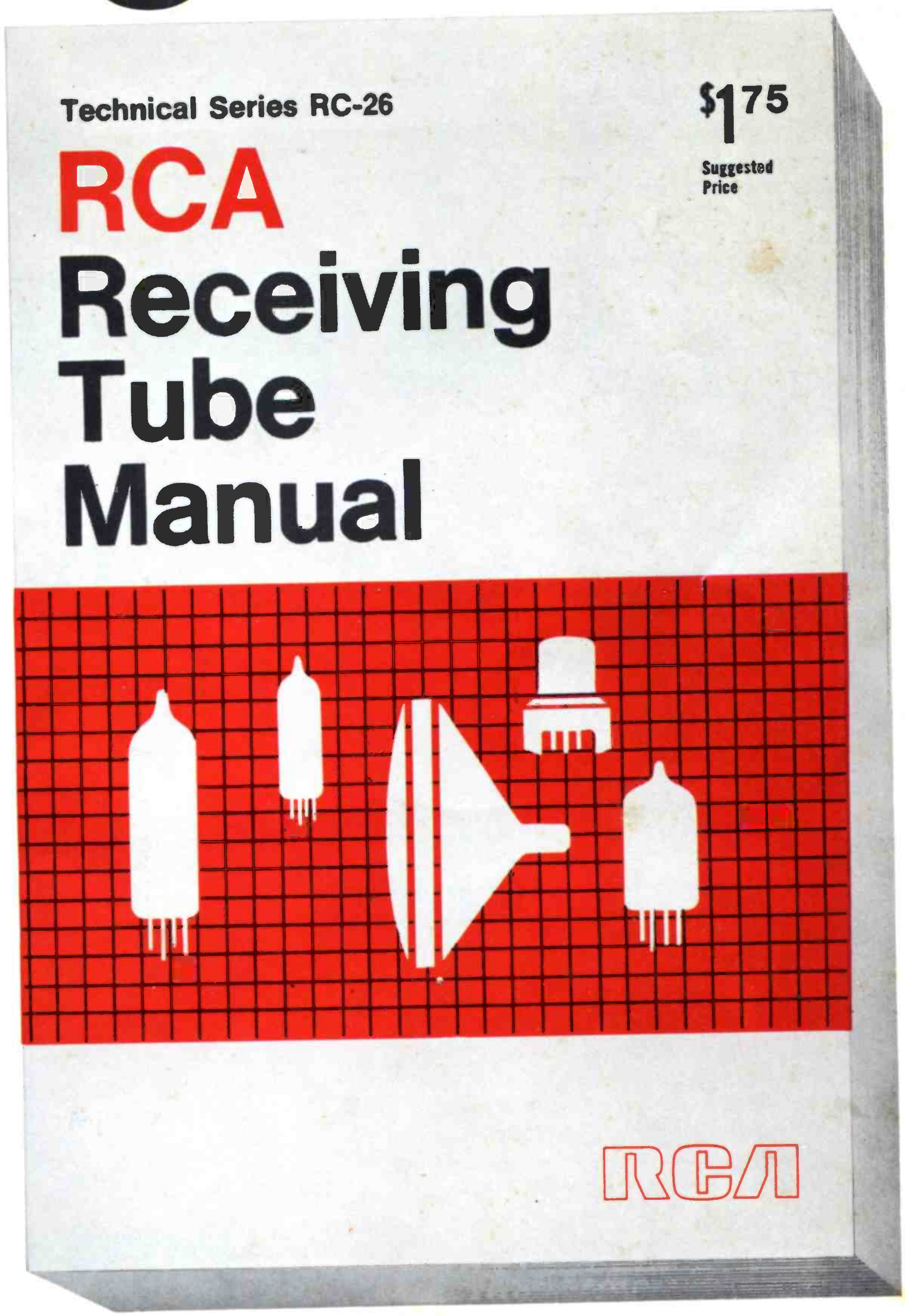

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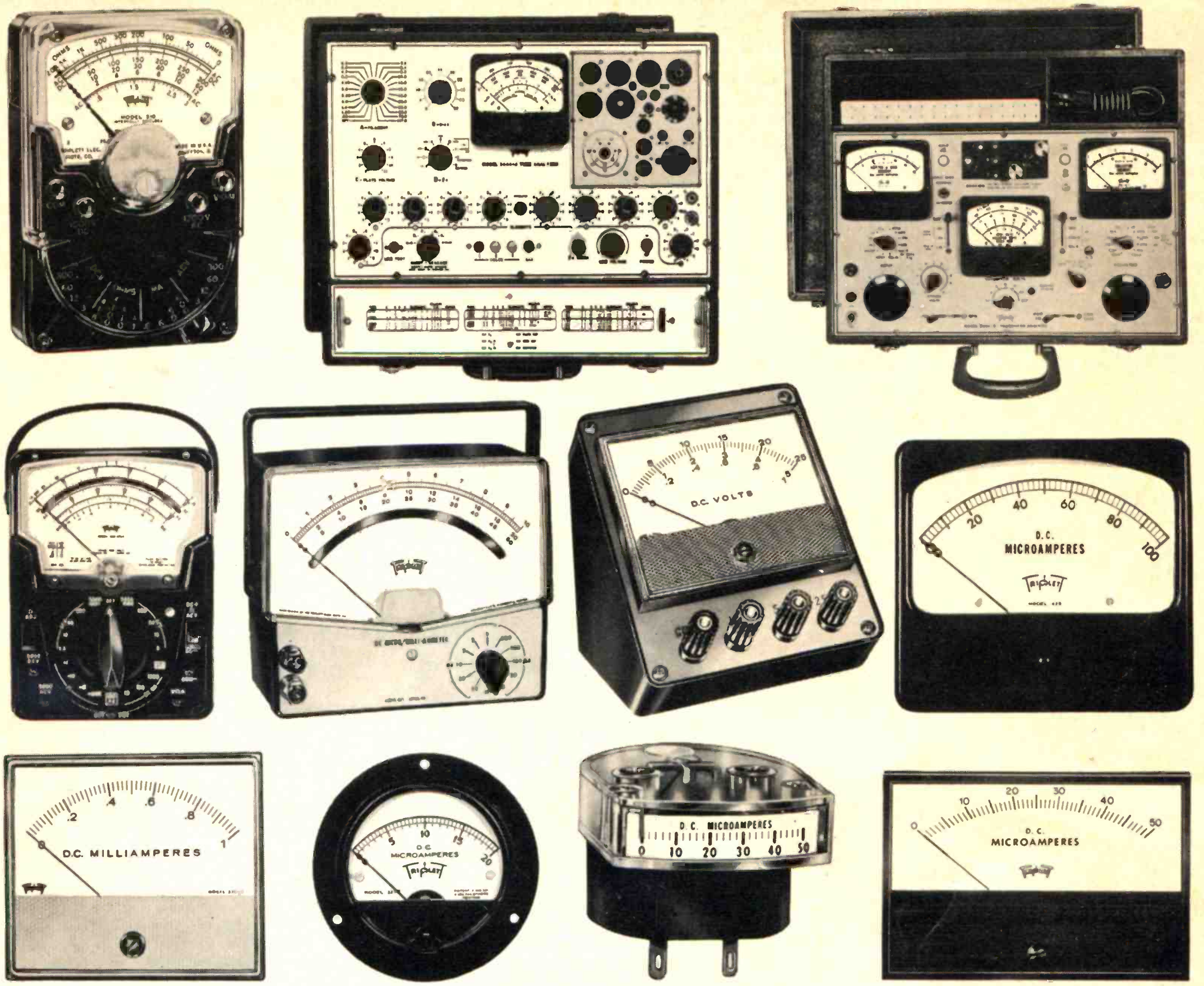

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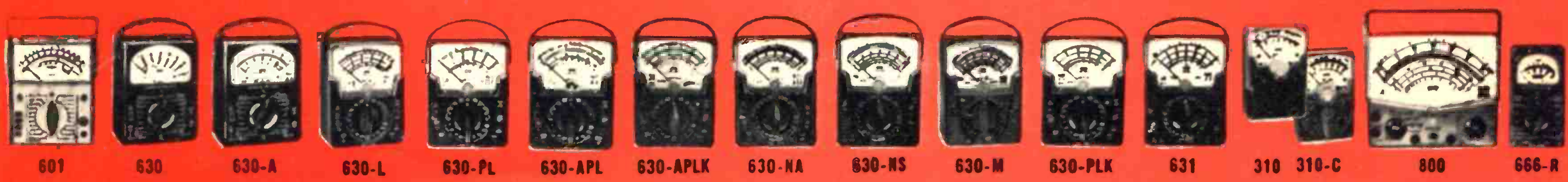

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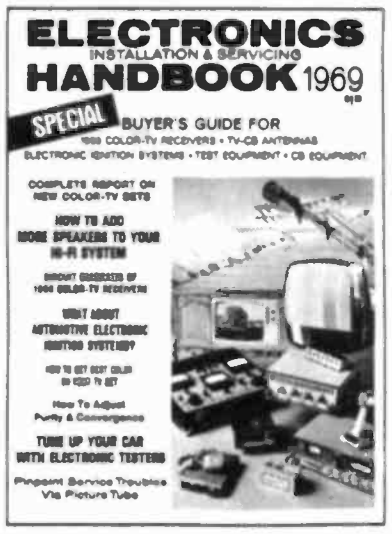

OUR COVER shows a number of new products that typify the coverage of this year's Handbook. At the top right is JFD's LPV-CL500, designed for v.h.f., u.h.f., and FM reception. To the left is the Finco CS-B1, also for v.h.f., u.h.f., and FM. The console color set is an RCA HL-854, which uses the new solid-state chassis. To the right is a Sylvania picture tube displaying a special color-bar pattern of the type used by some broadcasters. Directly below is the new Heath IG-57 TV sweep/marker generator along with its attenuator attachment. To the left is Triplett's 3490A transistor analyzer. Centered below these two pieces of test equipment is the Fairchild 8040 digital frequency meter. The two pieces of CB gear at the bottom of the photo are the Squires-Sanders "Skipper" (left) for mobile use and "Admiral" for base stations. At the bottom center is Delta Products Mark 10 capacitor-discharge ignition system.

Cover photograph by Dirone-Denner.

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Licensing of TV-SERVICE TECHNICIANS

By LARRY ALLEN

Will licensing be the answer to better consumer servicing or will it result in undesirable government interference? Here is a status report on which cities and states have licensing laws and how they are working in practice.

NOT many things over the past dozen years have divided the ranks of television service technicians as much as the subject of licensing. Some believe it will drive out fly-by-nighters and upgrade the industry; others contend it is unfair regulation, that the government should not try to run their businesses.

Within the past couple years, people outside the TV industry have grown concerned with regulating and controlling the men who work on TV sets. The public has become incensed by the shady practices of certain TV-shop operators, and government bureaus dedicated to consumer protection have picked up the cry. The result is that, like it or not, licensing is already a fact in several localities and is being considered seriously in many more. Loud criticism of the TV servicing industry—some of it unfair—is making it easier to push licensing bills through state legislatures and city lawmaking bodies.

To stir up so much controversy, licensing must have both good and bad points, at least in the eyes of those who have to make their living under license laws. Other skilled trades are licensed—electricians, plumbers, and so on. Most professionals and tradesmen who serve the public (doctors, lawyers, beauticians, barbers, taxi drivers, etc.) live with fairly strict regulation. From those who don't want TV-service licensing, you hear a whole string of objections and reasons why it won't work. From those who do want it, you hear strings of plaudits. Here are some of both.

Arguments Given For Licensing

- Upgrades the quality of servicing, by allowing only the competent and those legitimately in business to repair TV sets and other home-entertainment equipment.
- Hinders moonlighters, who are not likely to be competent. (Critics of this argument point out that many moonlighters are highly trained engineers and former technicians who have gone on to better jobs in industry, but like to pick up pin money at night or on weekends.)
- Cuts down on frauds, by making ethical operation a condition for keeping the license. Experience in California has lent validity to this contention.
- Improves customer relations and the public image of servicers by lending an aura of legitimacy to service technicians who have the license.
- Cuts repair costs in the long run, by eliminating some of the untrained operators, by maintaining the threat of license loss if charges are unethical, and by requiring itemized bills.
- Gives parts distributors a legitimate means of identifying who is entitled to wholesale prices and who is not. From the standpoint of the service-shop owner, this keeps him from having to argue with customers over the difference between a legitimate profit markup and the "price" the customer "can get it wholesale."
- Improves wage levels for underpaid technicians. With fewer licensed technicians who are better qualified, shop owners have to pay more. Thus better types of men are attracted to the field and ultimately are more productive, thus actually reducing over-all service costs.
- Gives the customer some recourse, if he is really convinced a technician has treated him unfairly. With an official complaint bureau, which knows the problems

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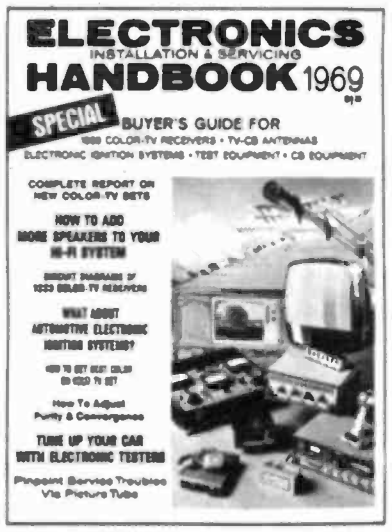

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inherent in servicing electronics gear, the technician has a better chance for a fair shake than in a cold, unknowledgeable court of law. Both customer and technician benefit.

Arguments Given Against Licensing

- Any government control is bad. Bureaucrats have no knowledge of the servicing business, and therefore can't possibly administer a regulation program fairly.
- The cost of licenses and registrations is too much. The fees cut into already-low earnings of television technicians and shop owners.
- It is impractical to enforce the anti-fraud provisions. "Bugged" sets (with artificial troubles put in by investigators) are not a fair way to catch crooks. There are too many variables in normal TV servicing, even for the highly skilled.
- It is a gimmick developed by those already in the business to hinder the efforts of others to get into the field by way of part-time servicing (as many have). Shops already in business want to keep down competition from low overhead "basement" operators. By keeping competition down, they can keep prices up.
- License and registration exams are unfair and don't really reflect the applicant's ability to fix a set or run a business. They can't keep out the unfair operator who is determined to cheat the public anyway.
- Don't like the people who will administer the law. Personalities often interfere with clear thinking, and the TV service business has run into a large share of this kind of opposition to licensing.
- Cuts down the number of technicians, thus forcing servicing costs too high. This is an argument given by a good many set manufacturers. Parts distributors, too, decry a possible decline in numbers of service businesses, since many of them cater to technician customers.

What's In The Laws

Most license laws are called "Radio and Television Licensing Acts." In fact, they cover only those who service radio and television receivers. Technicians who repair record changers, tape recorders, amplifiers, or speaker systems, are not regulated. Technicians are free to work without a license on any electronics equipment except receivers, tuners, radios, and TV sets, and sometimes TV antenna systems.

The laws cover only those who do electronics repair work "for compensation or hire." There are no restrictions on the do-it-yourselfer who works on his own set and on those of his neighbors, relatives, and friends . . . as long as he isn't paid for it.

A Board of Examiners, or some similar administrative body, is created by most of the laws passed or proposed. The Board is empowered to collect fees, to investigate complaints and infractions of the license law and take punitive action, and to design and administer qualifying examinations to applicants for licenses. Some of the laws have a "grandfather" clause that allows those who are already in the business, and have been for a specified number of years or months, to get their licenses without examination. The license is usually good for a year, ending each December 31. It can be renewed without examination, upon payment of the fee.

STATES AND CITIES WITH LICENSING LAWS

States	Cities
California	Buffalo, New York
Connecticut	Detroit, Michigan
Indiana	Kansas City, Missouri
Louisiana	Madison, Wisconsin
Massachusetts	St. Paul, Minnesota
	Tulsa, Oklahoma

Apprentices are permitted, under various conditions. The most general stipulation is that an apprentice can work only under the direct supervision of a licensed technician. The technician is then responsible for all the work done by the apprentice; in other words, if negligence or fraud is proved later, it affects the license of the technician as well as that of the apprentice.

Fraudulent advertising by license-holders is prohibited by some of the laws. Bait advertising has been one of the biggest complaints among technicians themselves, as well as from consumers. One law even prohibits the use of price as part of an advertisement for service. This takes some of the "teeth" out of the gyp operator who advertises low-cost or free service calls, then loads up the set with high-priced and unnecessary tubes and other parts.

Other means of forestalling fraud or unethical conduct include a rule that itemized bills must be made out for the customer. Also, at least one law requires that the customer be given all defective parts except tuners and picture tubes. Sometimes, a written estimate is required if the set is to be taken to the shop for repairs.

The state of Louisiana had the first statewide licensing law for electronic technicians. It actually started in 1959, and was limited to technicians and dealers in large metropolitan parishes (counties). It was successful. The state

STATES AND CITIES WORKING ON LICENSING LAWS
(may be passed or defeated by press time)

States	Cities
Illinois	Louisville, Ky.
Kansas	Washington, D.C.
Maryland	
Nebraska	
New Jersey	
New Mexico	
New York	
Pennsylvania	

STATE AND CITIES THAT HAVE TRIED TO INTRODUCE LICENSING LAWS BUT FAILED TO PASS
(may be trying again, though)

States	Cities
Arkansas	Akron, Ohio (passed, then repealed)
Florida	Columbus, Ohio
Iowa	Des Moines, Iowa
Kentucky	Waterloo, Iowa
Michigan	(probably others, but unknown)
Missouri	
Ohio	
Texas	

technicians' association promoted it and showed citizens and politicians it was a good thing for everyone who had a legitimate interest in making sure the public got a fair shake from electronic servicers. Not too long afterward, the bill was amended to cover the entire state.

Massachusetts passed a law in 1963 setting up a system for licensing radio and TV technicians. The licenses are not for businesses, but for individuals; but the law also prohibits hiring a technician who is not licensed. The administering board is called the Board of Registration, but it actually issues licenses. One interesting facet is the requirement that a "master technician" be over 21. The plain "technician" license can be held only by someone employed by a dealer or by a master technician; and the licensee must be at least 18. There is also a "learner" permit, renewable for only 3 years at most; the learner must be employed by and work under the supervision and responsibility of a master technician.

The California law, in effect since mid-1964, is actually only a registration law. Yet, it has the effect of a license. No dealer can legally work on a radio or TV set without being registered. A technician must be legitimately in business to qualify for registration, thus limiting activities of fly-by-nighters and moonlighters. A dealer must give estimates on sets removed from the home and must provide an itemized repair bill, showing his registration number. A state Bureau of Electronics Repair Dealer Registration administers the law, investigates all complaints, and occasionally spot-checks the ethics of registrants. Critics of the California law point out that no evidence of ability is required. The Better Business Bureau in the Los Angeles area, however, reports an 85% reduction in complaints since the registration law has been in force, and the BERDR itself tells of a one-third reduction in fraud claims.

Connecticut got its bill passed in 1965, but the law didn't get under way until 1967. It licenses individuals, requiring them to pass separate tests for black-and-white set servicing and for color-TV servicing. An applicant who passes the exams becomes a "certified electronic technician," a term coined by National Electronic Associations in its own program of testing and certifying technicians throughout the country. The law mentions only television specifically, but stipulates its provisions as applying to the servicing of "receiving equipment" in general; therefore it is safe to assume it also applies to radio receivers. Again, hi-fi gear—excepting tuners—is apparently not covered.

The Indiana law, passed in 1967, went into effect early in 1968. It has an unusual extra category: Auto Radio Repairman. The law covers TV and radio receiving equipment and their antenna systems. It licenses technicians, not businesses. The Board of Television-Radio Examiners issues licenses (and a lapel badge) to qualified applicants, investigates complaints, and otherwise regulates the activities of service technicians in Indiana. As in other states, the service technicians' association worked hard for passage of the bill, and some of its members serve on the Board.

There are also a good many city licensing acts now in effect, as you can see from the charts. Their details differ very little from those already described in the various states.

After A Law Is Passed

Some of the results of license laws now in effect are worth examining. Usually, technician association membership increases for a period of time. The common bond of being licensed seems to bring technicians together, some for the first time. Even those who fought licensing, and those who had a lackadaisical attitude toward association membership and work, find brotherhood in banding with their colleagues to solve problems created by licensing.

In Connecticut, the state association played an important part in the aftermath of the licensing law. It turned out that half the technicians in the state couldn't qualify for the license (there was no grandfather clause to fall back on). Association leaders jumped into the gap and quickly designed instruction courses to upgrade technicians who hadn't cracked a book on theory in many years (80% couldn't pass the color-TV test). With almost 4000 technicians, the classes were a big job, but the association got it done. Most of Connecticut's technicians got their licenses.

Technicians who can't pass licensing requirements are out of luck. They are usually the incompetents the laws hope to weed out, anyway. If they don't care enough to learn the business, they shouldn't be in it. The public has a right to competent technicians for their money.

Fraudulent practices fall off tremendously, as in California. Gyp dealers and technicians have their livelihood to lose if they are caught. Either through ignorance of proper servicing procedures or through intent to cheat, a few lose their licenses. The result for the industry and for the public: an improved level of competence and ethics begins to surface. Bait advertising falls off, even where it isn't specifically prohibited. Ads for "free" service and unrealistic charges are often fingers pointing to marginal operators—and where there's a license or registration at stake, what a marginal operator needs least is publicity.

Shop owners discover they need an apprenticeship program. They usually look to the local association. A solid apprenticeship program seems to be the least expensive way of training new and competent technicians. Schools, too, are looking heavily into this area; indeed, some have already introduced special courses designed to fit into apprenticeship programs outlined by the government and by state and local associations.

One thing licensing won't do is keep technicians qualified. As an example, consider the transistorized color-TV. Not many know how to service it. Those who learn how are the competent ones. Those who don't, however, are not penalized by a license law. They can be behind the times 2 years from now, yet still be licensed. In the meantime, they give a bad name to the industry in general—a reputation for incompetence.

Almost inevitably, the public also becomes aware of the servicing industry in their locality—more so than ever before. This opens the door for technicians to do a cleanup job on their image. They can play up the law, and point out the capability requirements. They can bring their association to the attention of the customer. Once the customers have something to connect the individual with, other than a hole-in-the-wall shop, they are likely to feel and show more respect and consideration.

The customer becomes more relaxed and less suspicious, because he knows there is somewhere to go if he is cheated. He is less likely to dream up unfounded complaints.

Yet, there is also the danger that the servicing industry will fall into apathy, expecting the license law to do all the image-building. It doesn't work that way. If shop owners and technicians develop a careless or arrogant attitude, the gains of licensing will slip right down the drain, leaving a restrictive law that only aggravatingly does its job. It is a mistake to think that licensing will *(a)* suddenly restore a better public image, or *(b)* suddenly drive shady operators out of business. It simply will not.

Even after licensing spreads through most of the states, and it seems likely it will, the industry still has a responsibility to keep itself clean. Ways to do this are:

(1) Voluntarily follow the rules of fair dealing, whether or not they are spelled out in some law.

(2) Charge prices and pay wages that attract intelligent, serious-minded young people to the field.

(3) Keep technicians trained to peak efficiency, not waiting until new devices are years old to institute training in how to service them.

(4) Use the principles of public relations that large corporations use to prove good will toward their public. Do a good job, and make sure the public knows it's a good job.

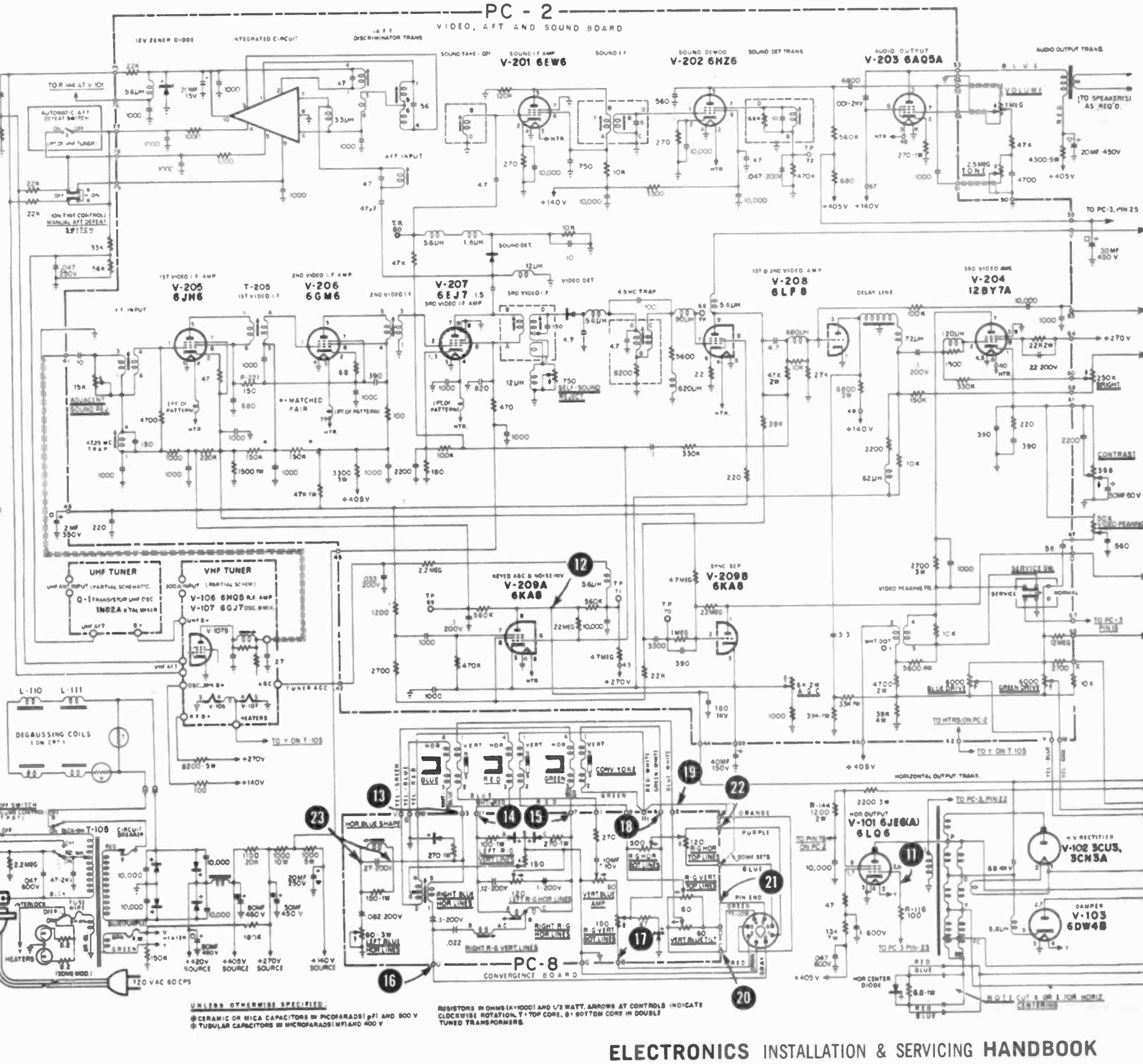
(5) Band together in associations that can effectively spot and discourage the shady operator, who brings down distrust on all.

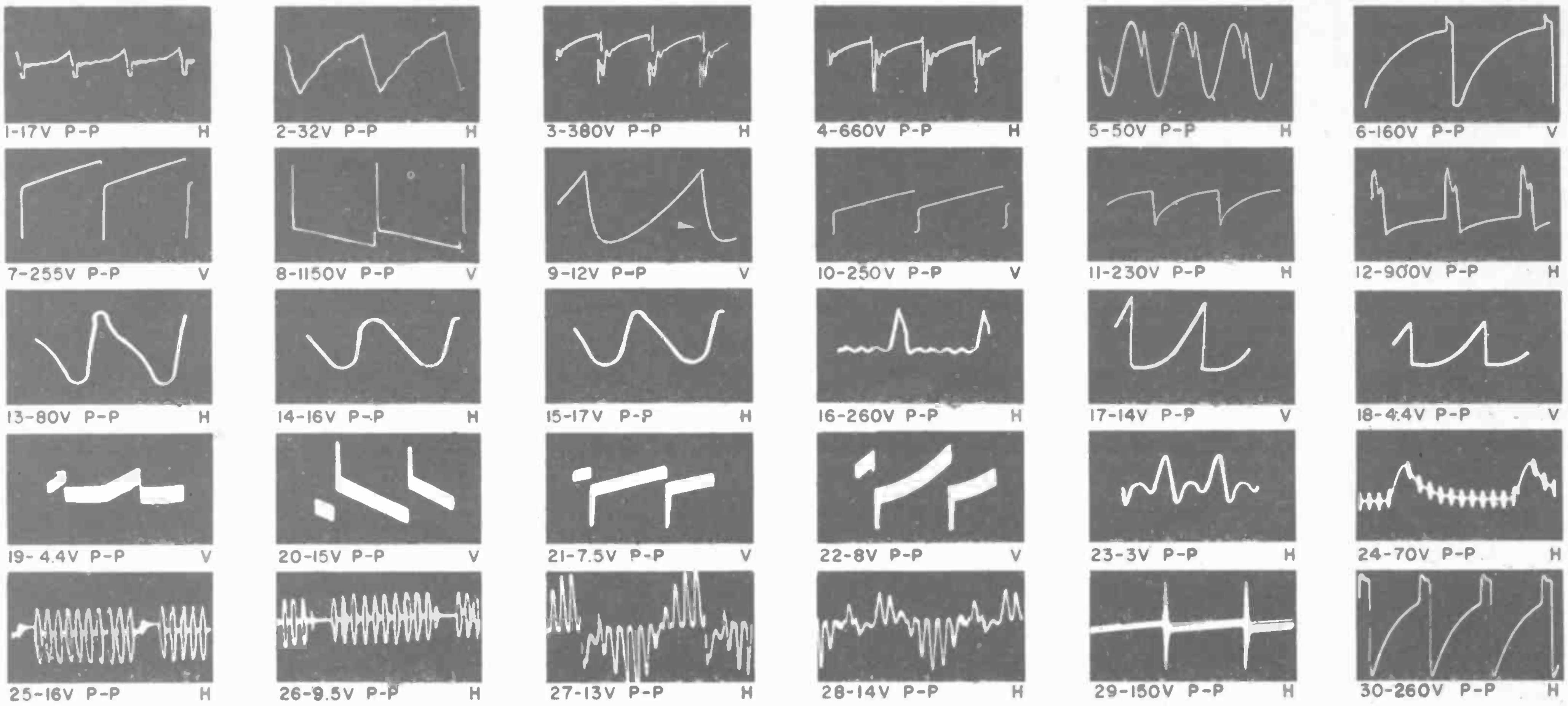
Had the servicing industry done all these things from the start, there would never have been a need or desire for licensing. ▲

EMERSON 120924

COLOR-TV CIRCUIT

This new chassis is used in Models 26C45, 26C47, and 26C48, all with 23-in picture tubes. New features that are found in these models include: quick-on provisions; improved automatic fine-tuning circuitry using IC's; improved automatic color-control circuit with 2 stages of chroma amplification; increased burst amplification; and, in addition, diode horizontal centering for cooler and more reliable operation of the horizontal-output transformer.





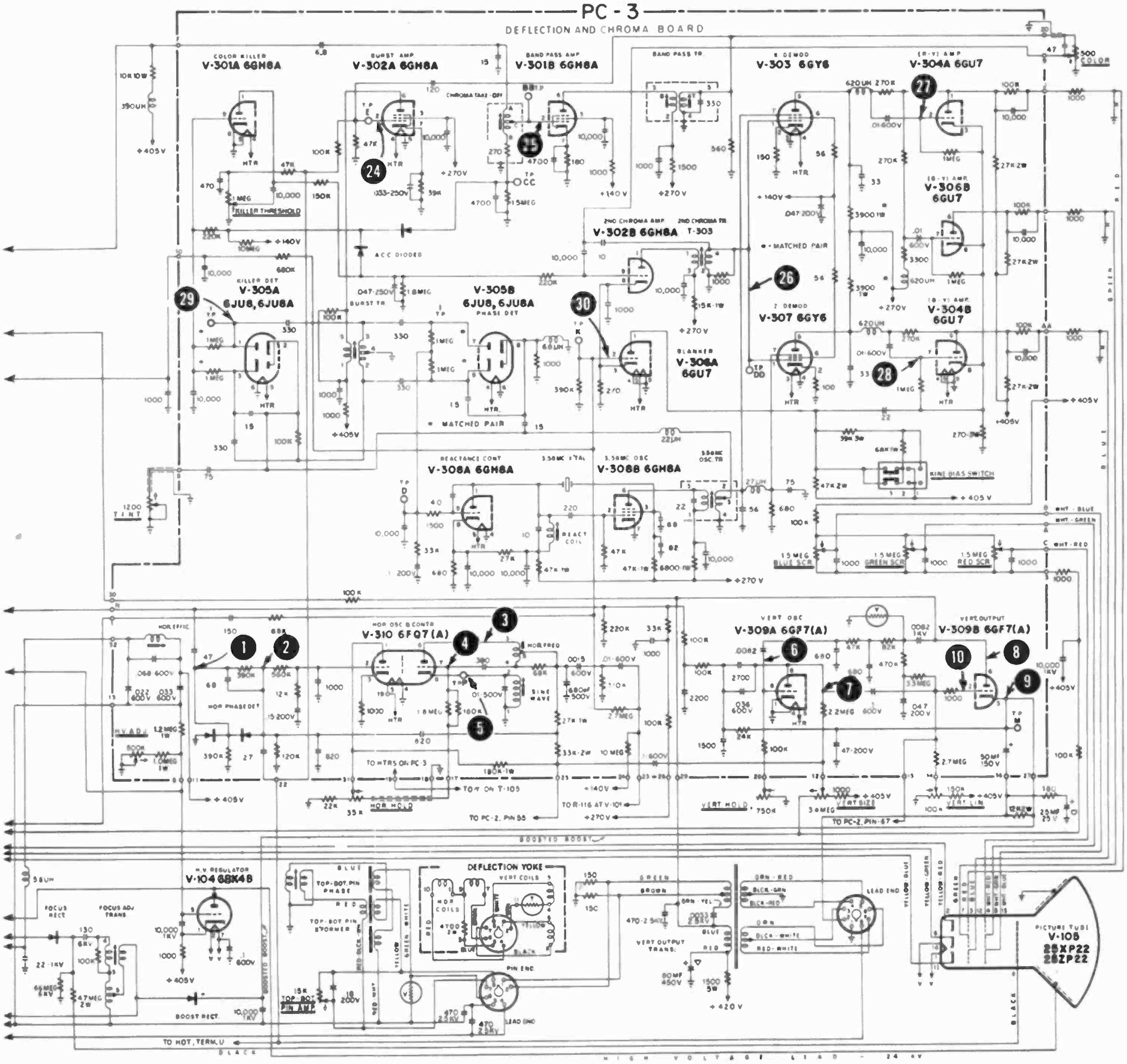
1-17V P-P H | 2-32V P-P H | 3-380V P-P H | 4-660V P-P H | 5-50V P-P H | 6-160V P-P V

7-255V P-P V | 8-1150V P-P V | 9-12V P-P V | 10-250V P-P V | 11-230V P-P H | 12-900V P-P H

13-80V P-P H | 14-16V P-P H | 15-17V P-P H | 16-260V P-P H | 17-14V P-P V | 18-4.4V P-P V

19-4.4V P-P V | 20-15V P-P V | 21-7.5V P-P V | 22-8V P-P V | 23-3V P-P H | 24-70V P-P H

25-16V P-P H | 26-9.5V P-P H | 27-13V P-P H | 28-14V P-P H | 29-150V P-P H | 30-260V P-P H



SERVICE ASSOCIATIONS—

how they help the technician and consumer

By RICHARD L. GLASS, CET / President, National Electronic Associations, Inc.

An overview of the various trade organizations for service technicians. How large are they, where are they located, and what are they doing for their members and the customers?

ACCORDING to figures compiled by NEA (National Electronic Associations, Inc.) in January of this year, there are about 4600 members of various trade associations for electronics dealers and technicians in this country. At the same time, NEA estimates that there are approximately 38,200 service dealers in the U.S. Thus, about 12% of the country's dealers belong to either a local association, one of the state organizations, or are individual members of NATESA (National Alliance of Television Electronics Service Associations) or NEA. In some states—Kentucky, Indiana, Iowa, Kansas, and Nebraska, for example, technicians joining a local association automatically become members of their state, as well as national, associations.

At one time, NATESA had more members than the combined total of local and state association memberships today. A turbulent period involving politics and a divergence of opinion among the leadership divided the organization and, as a result, NEA was formed as the second national association in 1963. Today, NATESA is dominant in such states as Wisconsin, Virginia, and Vermont, while NEA is strong in California, Connecticut, and Iowa. Neither group is extensively represented in Texas, Mississippi, or New York. Some states, notably Michigan and Pennsylvania, have locals in both national groups. See listing accompanying this article.

The great numbers of part-timers and meagerly trained TV repairmen who have dropped out of the service business because of the complexity of solid-state equipment and color receivers, plus the movement of technicians into higher paying jobs in industry have brought about an urgent need for more and better-trained service technicians. Results of licensing and certification tests have revealed an urgent need for further training. Bad publicity in various media has also pointed up the need for improved public relations. Licensing, certification of technicians, apprenticeship and training, and public relations are all areas demanding the attention of service associations.

State associations are most effective when it comes to getting state TV licensing laws through the legislature. In Massachusetts, Louisiana, Indiana, Connecticut, and California, local groups got behind licensing legislation and pushed it through.

Apprentice Training & Certification

Several years ago, both national associations adopted similar standards for an apprenticeship training program, which was approved and registered with the U.S. Department of Labor. These standards covered a four-year program for on-the-job training of electronics technicians, coupled with classroom instruction, to turn out hireable and competent journeyman technicians. The programs also included a step-by-step advancement in pay scale for the trainee during the four-year training program.

To stimulate the establishment of such programs in local areas, the Labor Department provided funds to operate short-time local classroom training programs for recruits. Funds were supplied under the Manpower Development and Training Act of 1962 (MDTA).

Trainees attended school full-time for sixteen weeks to learn the basics of electronics and practical electronic servicing methods. Then these embryo technicians went to work in local service shops. During the next sixteen weeks the local association's roving instructor visited the shops and helped the trainees become familiar with servicing methods and equipment. Following this period, the trainee received an additional 144 hours training each year for the remainder of his four-year apprenticeship. After that time (and, depending on performance, this period can be reduced to three years), the trainee is a full-fledged journeyman technician. Among cities where MDTA funds have been allocated for such programs are: Nashville, Tenn.; Akron and Columbus, Ohio; Houston, Texas; Denver, Colorado; Waterbury, Conn.; Detroit, Michigan; Waterloo and Des Moines, Iowa, as well as various individual shops in North Carolina.

The Certified Electronic Technician Program of NEA evolved to provide public recognition of the level of attainment of present journeyman technicians and to bestow a professional technician status (CET) at least as important as that of the graduate of the four-year apprentice training. Since its inception two years ago, nearly every state and some foreign countries have asked that their technicians be allowed to take the 120-question TV-Home Electronics Service Test to become nationally registered CET's. For more information on this program, interested technicians may write to NEA Certification, 5302 W. 10th Street, Indianapolis, Indiana 46224.

The state of Washington, through its electronics service association—The Washington State Electronics Council—has a similar program operating on a state level. Called the Certified Electronic Specialist Program, like the NEA CET program it qualifies the technician as an employable journeyman. In cases where WSEC requires a written test, in their extensive and detailed point system of qualification, the NEA CET exam is used. WSEC takes into account the past performance of the technician and his experience working with different brands and types of equipment.

Upgrading Training

Association-sponsored upgrading training courses have been started in many cities by local associations. These courses have been principally concerned with transistor fundamentals, color-TV, basic television circuitry and, in some cases, business management.

Commercial training schools, such as *Sams Technical Institute* and *R.E.T.S.*, as well as vocational and public schools have been involved in such training programs. Were it not for these local refresher courses, whose tuition is generally paid by the students themselves, there would be an even greater shortage of technicians than there is now.

The TELSA of Connecticut state association became deeply involved in such upgrading training in 1967 because of their new state licensing law. It was obvious almost from the start that a large percentage of the state's technicians had to be retrained if the licensing law wasn't to eliminate many of the state's practicing technicians. TELSA officers and local association members set up local schools in seventeen spots in Connecticut and alerted all shops to the locations and time schedules. They recruited instructors for the courses and amazed school officials in the state by the neatness and dispatch with which the program was put into effect.

In many other areas, associations have carried out similar programs. Louisville, Kentucky has made an outstanding record in its upgrading training as attested to by consistently high scores on the NEA certification test. In the areas of business management, one of the outstanding groups is undoubtedly the Texas Electronics Association (TEA) which for several years has conducted a Management Clinic that draws over 100 dealers per session, from Texas and other states.

Public Relations

Over the past two years, associations have published a number of consumer education pamphlets designed to acquaint customers with the electronics repair field. NATESA sponsors a sixteen-page pamphlet entitled "Joys of Electronic Living" with a series of typical questions and answers that a customer might be expected to ask a technician. It covers service charges and explains how they are figured, explains something about the equipment the technician uses, and discusses other items of interest to the customer.

NEA promotes several shorter messages, each dealing with a specific problem encountered by technicians on calls or in dealing with a customer in the shop. Titled "Your Warranty," "So Your TV is Going to the Shop," "At Your Service," and "Customer Return Postcards," these publications are intended to promote a better understanding between customer and technician.

The above pamphlets are available for a nominal fee from the sponsoring associations: "Joys of Electronic Living," from NATESA, 5908 S. Troy St., Chicago, Illinois 60629; the NEA pamphlets from association headquarters. Ninety thousand of one NEA pamphlet has been distributed to customers during the association-sponsored person-to-person public-relations campaign. California State Electronic Association has developed a public-relations pamphlet in cooperation with the Better Business Bureau that conveys a similar message. Technicians in California have distributed them to over 100,000 homes so far during 1968.

In many areas, associations have been able to obtain wide public exposure for their emblems on local radio and television stations in exchange for technical information reports and promotion of the stations. Many of the associations publish house organs and technical-information digests. Some associations are cooperating with colleges and high schools in improving their technical curricula.

Most local associations have created grievance committees where customer complaints can be handled, much like a Better Business Bureau does. Technical servicing information, business management ideas, awards, conventions, safety and publicity committees are just a few of the areas of association activity.

All dealers and technicians should realize that they are wanted by the associations and that all of them are needed to achieve a more effective association movement. If each and every shop joins the association crusade, it will mean higher profits or wages, a better vocation for the electronics technician, and better service for the customer—certainly all very worthwhile goals. ▲

RADIO-TV SERVICE ORGANIZATIONS

(Association officers or leaders of state or local groups who may be contacted for additional information on how to become affiliated with group in your area.)

NATIONAL ASSOCIATIONS

NATESA, National Alliance of Television and Electronic Service Associations Frank J. Moch, Exec. Director, 5908 S. Troy, Chicago, Ill. 60629

NEA, National Electronic Associations, Inc. 5302 W. 10th St., Indianapolis, Indiana 46224. PH (317) 241-5675

STATE, AREA, OR LOCAL ASSOCIATIONS

ARIZONA, Better Electronics and Service Technicians Assn., P.O. Box 1284, Phoenix
ARKANSAS, ETA of Arkansas, Chas. Erwin, 1110 N. 11th St., Ft. Smith (501) SU2-4457
TESA of Arkansas, P.O. Box 542, N. Little Rock
ALABAMA, A. S. Robertson, 201 4th Ave., Bessamer 35020
CALIFORNIA, Calif. State Electronics Assn., Ralph Johonnot, Exec. Sec. 13543 S. Hawthorne Blvd., Hawthorne 90250. (213) 755-5261
COLORADO, TESA of Denver, 1407 S. Holly, Denver 80220
CONNECTICUT, TELSA of Conn., Fred Haddad, Pres., CET, 191 Meriden Rd., Waterbury 06705. PL5-4920
DELAWARE, TSA of Delaware Valley, Anthony A. Marcozzi, Pres., 1900 W. 6th, Wilmington 19808
FLORIDA, Florida Electronic Ser. Assn., Sam Kessler, Sec. 120 SW 57 Ave. Miami 33144
GEORGIA, ETA of Georgia, Joseph Vannier, Pres., CET, 208 Webster Ave., Albany 31705. PH 436-3813
IDAHO, TESA, Guy Blakeslee, Pres., 107 Orchard, Boise. PH 342-8624
ILLINOIS, Associated Radio Television Servicemen's Assn., Howard Wolfson, Sec., 25 E. Congress Parkway, Chicago. PH (312) WE9-6495
TESA Chicagoland, Lyle Green, 802 S. Oak Park Ave., Oak Park
INDIANA, I.E.S.A., Edward Reich, Pres., 231 N. College Ave., Indpls 46202 PH (317) 634-4408
IOWA, TSA of Iowa, Clark Pohl, Pres., 302 Willis, Perry 50220. PH HO5-5351
KANSAS, K.E.A., Pres. Lloyd Milham, 709 Arkansas, Lawrence 66044. PH (913) VI3-8855
KENTUCKY, K.E.T.A., Pres. Fred Watjen, CET, 3628 Brownsboro Rd., Louisville 40216 PH (502) 893-3424
LOUISIANA TESA of the South, 706 Webster St., New Orleans, 70118
MAINE, Edwin A. Smith 96 State St., Presque Isle, 04769
MARYLAND, META, H.O. Johnson, 3538 Old York Rd., Baltimore
MASS., Electronic Technicians Guild, Art Diloreto, Pres., 151 Stroughton St. Dorchester 02124
MICHIGAN, TSA of Michigan, Pres. Robert Lewis, 15238 W. Warren, Dearborn 48126 PH (TSA Hall), (313) 846-0866
MINNESOTA, MINTSE, Pres., J. Hemak, CET, 4401 Quincy, NE., Minneapolis 55421
TESA of St. Paul, Don St. Clair, Pres., 450 Blair Ave., St. Paul PH HU6-2070
MISSISSIPPI, S. J. Thomasson, Jr., P.O. Box 944, Columbus 39701. PH 328-8426
MISSOURI, Electronic Specialist and Technicians Union, Hank Nieuwendaal, Pres., CET, 10323 Bon Oak Dr., St. Louis, 63136
TESA of Missouri, Bob Ferguson, Pres., 415 Locust St., Columbia
TESA of the Ozarks, Benton Linder, 854 S. Glenstone, Springfield
MONTANA, Ray Tuszynski, 151 Aluminum St., Butte
NEBRASKA, Nebraska Electronic Service Assn., Roger Brehm, CET, Ex. Sec., 1312 N. 66th Lincoln, 68505. PH (402) 466-0358
NEW JERSEY, Tri-State Council, Pres. Lewis Edwards, CET, 1451 Hamilton Ave., Trenton 08629. PH (219) 396-2452
NEW MEXICO, TESA of New Mexico, Pat Barr, 1001 San Mateo, S.E., Albuquerque 87108. PH AL5-2054
NEW YORK, Empire State Federation of Electronics Service Assns., Pres. Warren Baker, CET, 514 Second St. Albany 12206. PH (518) 462-2309
NORTH CAROLINA, ETA, M.D. Tedrow, CET, 1023 Goldfloss, Winston-Salem 27107. PH (919) 722-2970
NEW HAMPSHIRE, Radio and TV Assn., 334 Mitchel St., Manchester 03103
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WASHINGTON, W.S.E.C., James D. Willey, CES/CET P.O. Box 647, 726 Darst, Issaquah 98027. PH EX2-5979
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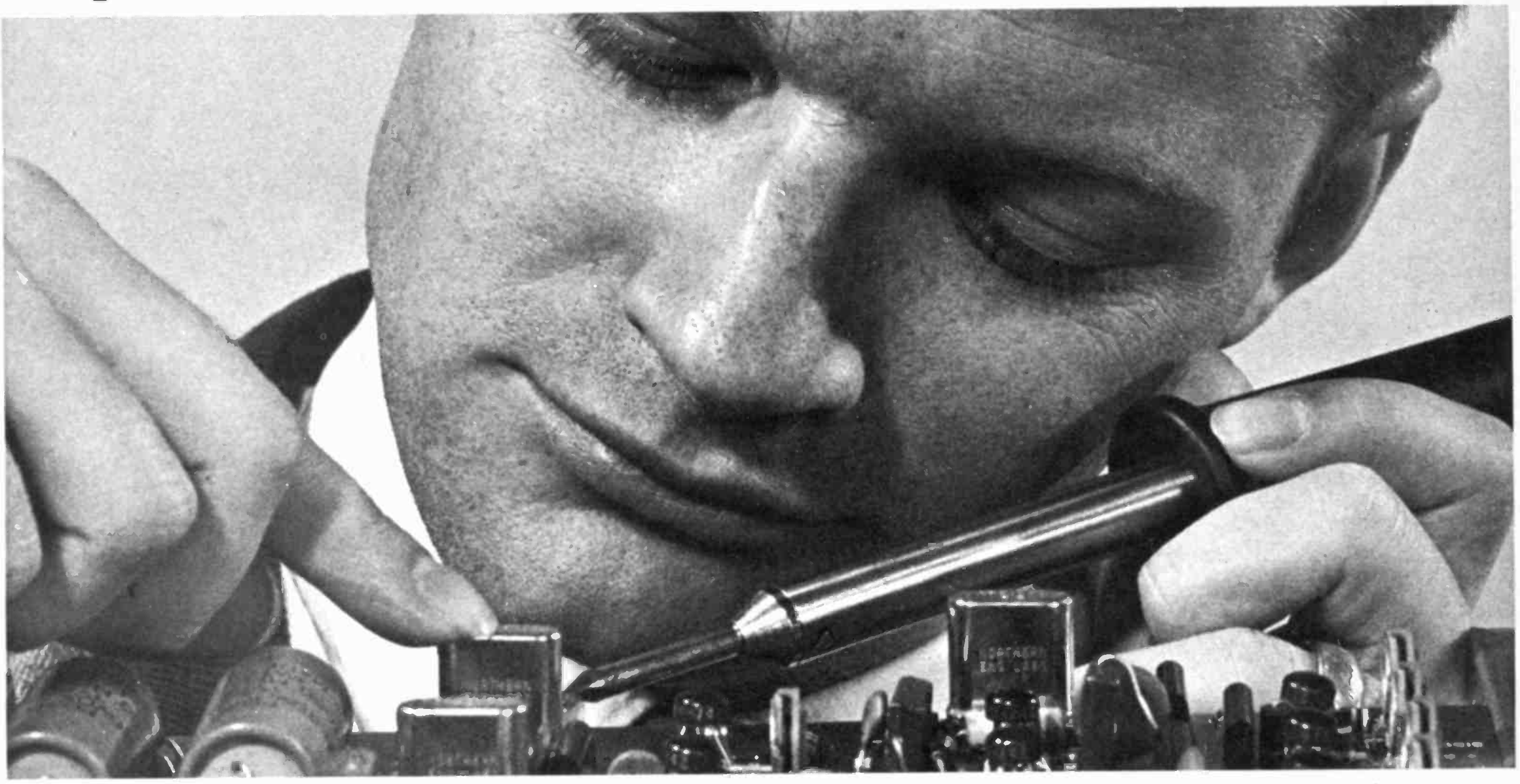

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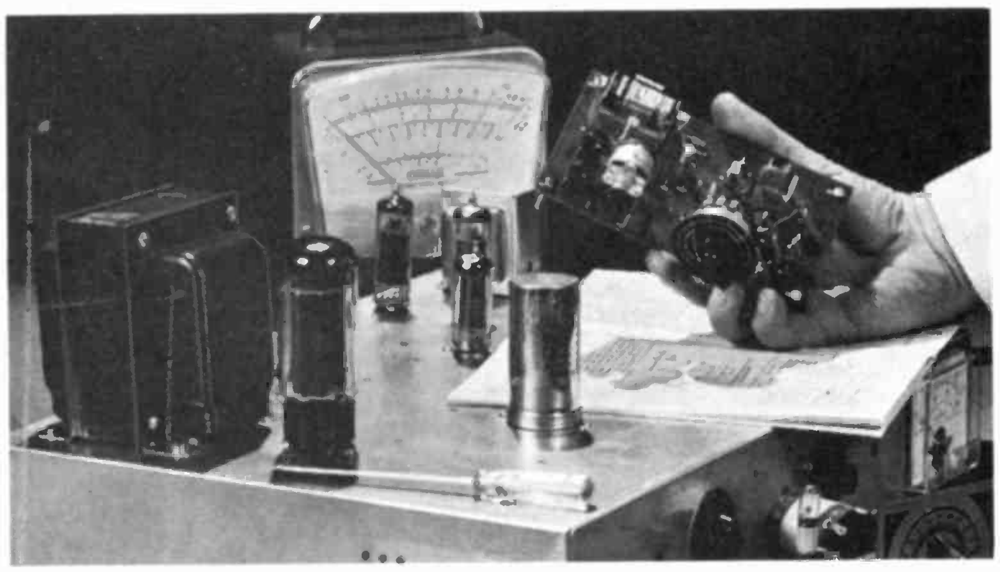

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Color-TV for 1969

By FOREST H. BELT

There will be more transistors and IC's in the new crop of models, and most makers are offering smaller picture-tube sizes. Users will also find more sets with automatic fine tuning and quick warmup features. Here's a complete roundup of the new sets and their circuit innovations.

WITH all the improvements that have been added to color-TV sets in the past couple of years, you'd think there would be few changes in the new sets for 1969. That's not the case, however. Quite a bit has changed, and—as always in this fast-paced branch of consumer electronics—design engineers have outdone themselves and each other in developing new attractions for the latest lines.

Some trends of last year continue: fine-tuning aids to make it easier to tune color stations; more transistors to take the place of tubes; and a few integrated circuits to take over new functions. None of the 1968 innovations has been abandoned.

But 1969 color models are starting a few trends of their own. One of the most noticeable, and probably the most important to future sales, is the trend toward smaller-screen portables. A dozen or so manufacturers now have portable color sets in 15-inch or smaller screen sizes. Prices, as would be expected, are lower than for consoles. Yet, prices haven't dropped enough to create any stampede by prospective buyers. The little *General Electric* 10-inch portable still holds the distinction of being the lowest-priced color set available, selling at less than $200. Other portable prices range between that and around $400, but their popularity is nevertheless rising.

Oddly enough, bargain-priced portable color receivers are not making the big splash that was expected in the "first-set" market. A significant number are going as a second set in families that already own a console color model. This is unusual, considering that first-set color-TV has barely scratched its market. (Fewer than 30% of U.S. homes have color-TV.)

At the more expensive end of the color-price spectrum, sales remain respectably high. Buyers want fancy features and nice furniture. The newest all-transistor and hybrid sets, which usually sell for more than comparable tube models, are in demand.

There was some worry during early 1968 that public uneasiness about x-rays from color sets might spoil some sales. It may have, slightly. But, by the time the 1969 models reached the retailers, there was little evidence of hesitancy in buying—at least not for that reason. Furthermore, in many 1969 models, manufacturers have taken steps to eliminate even the possibility of x-rays; nearly half the models we checked have no shunt-type high-voltage regulator tube—the usual source of possible x-rays. The tiny amounts that can be generated by faulty h.v. rectifiers and picture tubes have been proven insignificant.

Another trend, noticeable at least in color sets built in this country, is some form of quick-warmup circuit. Transistor black-and-white (and color) receivers show a picture almost instantly after being turned on; many set-buyers now like that feature in any set they buy. We counted ten manufacturers who offer fast-warmup on at least one of their models; some include it on all.

There are other "little things" to help pull 1969 color-TV sales up to the 8-million-plus expectation. *Sylvania*, for example, has put the transistors in its hybrid receivers into sockets instead of soldering them to circuit boards; the result is easier servicing. Another *Sylvania* sales feature is called Color Minder. It consists of installing the color, tint, brightness, and contrast knobs so they all point straight up when set properly; that way, they can be easily reset if someone misadjusts them.

Probably the greatest tool for 1969 color sales is an extended warranty, particularly on the costly picture tube. *Admiral* led the way (and still does at press time) with a 3-year picture-tube warranty. Practically all set-makers now offer a 2-year warranty on the color picture tube. A few have elaborate prorating schemes for easing the cost burden on a customer who is unfortunate enough to have a picture tube go bad. One prorating plan runs for 8 years. The customer pays for the plan at the outset, but it does make a new picture tube less expensive than the near-$200 one ordinarily costs.

One criticism of these extended warranties comes from service technicians. They complain that the set-owner is seldom told that, even though the replacement picture tube or other part comes free or at some reduced price, the set-owner must pay the usual service and repair installation charges. A good many manufacturers are taking steps to educate customers to this. Others include such charges in their warranties, and pay the service technician themselves.

The color-TV market is growing at a steady clip, whatever blandishments are responsible. Every reader needs to know more about these features that make modern color sets better, safer, more attractive, and more acceptable. In the next few pages, you can see what these features are and how they work.

The Right-Now Picture

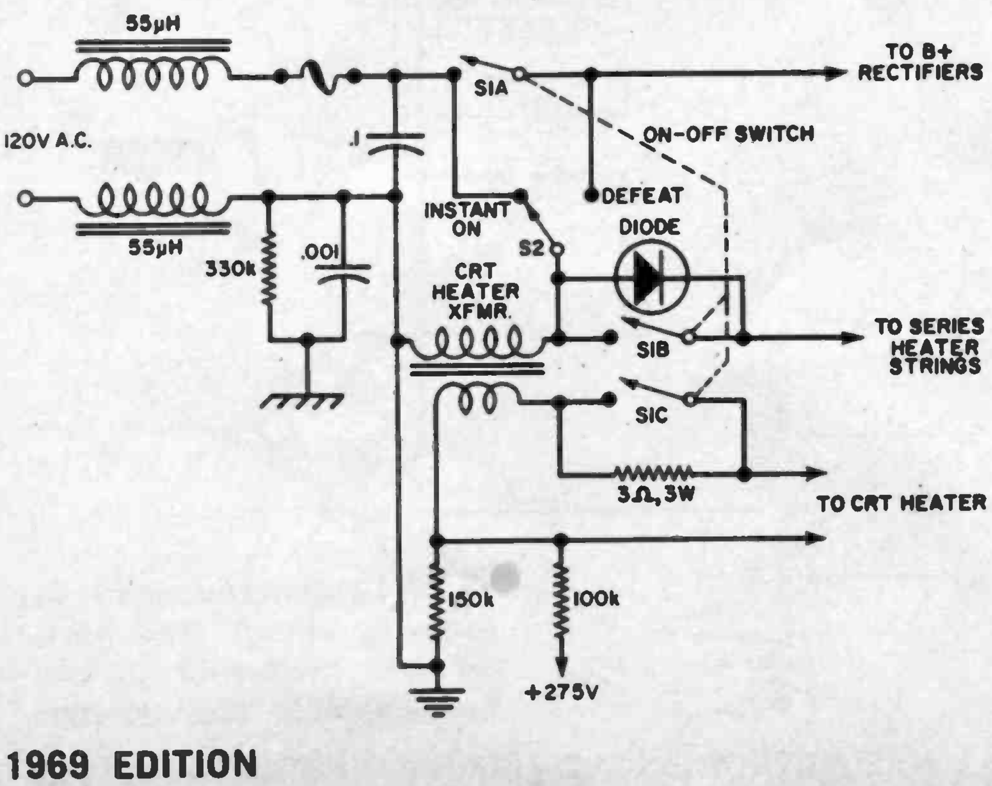
Turn on a transistor radio and sound comes on instantly; there's no warmup time. The same is true of most transistor TV sets. If you've seen one of the 1968-model *Motorola* transistor color receivers, you know that the sound comes on instantly, followed in 3 or 4 seconds by the picture. Since transistors require no warmup, most of the circuits operate instantly. However, the picture-tube heater must warm up before a raster can be seen; a quick-heating picture tube can handle that.

Even fast-warmup tubes haven't proved the answer for tube-type color receivers. Yet, customers want the instant viewing they're becoming accustomed to. So, designers worked out a way to keep tube filaments partly heated all the time, even when the set is "off." When the owner turns the set on, the tubes warm up completely and are ready to work in a couple of seconds.

The method is not new. In fact, neither is the idea. *Westinghouse* introduced its Instant-On feature a number of years ago. However, only this year, has the idea been applied widely to color receivers of both tube and hybrid (tube-and-transistor) design.

The basic method consists of applying reduced voltage to all tube heaters at all times, even though the set switch is "off." Turning on the switch causes full voltage to be applied to the tubes and also activates the "B+" supply. The entire set comes on almost instantly—within about 8 seconds in the slowest set. Sound is usually a little faster, sometimes preceding the picture by about 5 or 6 seconds.

Fig. 1. Rather common in 1969 models is some sort of instant warmup. Here's Westinghouse's version.



Exactly how the system works in a 1969 *Westinghouse* chassis is diagrammed in Fig. 1. A single-pole, double-throw switch on the rear of the chassis allows the set-owner to choose Instant-On or ordinary operation. That's S2 in the diagram, and it is shown in its Instant-On position. The silicon diode in series with the heater strings is a half-wave rectifier for the a.c. line voltage that is applied. Voltage is applied even when the "on-off" switch (S1) is open. Since there is no filter capacitor, the diode is very inefficient. The r.m.s. or effective voltage applied to the filament string is only about half the r.m.s. value of the line voltage. However, that is enough to keep the tube heaters fairly warm.

The picture-tube heater, meanwhile, is also getting partial voltage. Full line voltage is applied to the heater transformer, but the secondary voltage is reduced by the 3-ohm, 3-watt resistor. (The other two resistors are merely for CRT protection.)

As you can see, the "B+" rectifiers get no voltage until switch S1 is turned on. That's a three-section switch. Section *A* applies power to the "B+" rectifiers, and plate voltage is developed throughout the receiver. Section *B* simultaneously shorts across the diode, allowing full voltage to reach the heater strings. Section *C* shorts out the CRT-heater dropping resistor, and normal heater voltage is applied. Within 3 or 4 seconds, the whole set is operative.

Most instant-picture systems have a means for defeating their action. In this *Westinghouse* version, moving S2 to the Defeat position is what it takes. Section A of S1 is no longer bypassed, and the action of the other two sections becomes irrelevant; *nothing* operates at all when switch S1 is open and switch S2 is at the Defeat position.

There are a few other special considerations in quick warmup circuits in other sets. In *DuMont*, for example, a special quick-heating high-voltage rectifier is used. The 3CU3 or 3CN3A tube should never be replaced by one of a slower-heating type, such as a 3A3, even though they are otherwise alike.

The names of quick-warmup circuits are as similar as the principles of their operation. *Admiral* calls it Instant Play; *DuMont* has Quick-On; *Electrohome* uses Insta-Vu; *Magnavox* says Quick-Picture; *Olympic* calls it Rapid-On. *Motorola* and *RCA*, whose all-transistor color chassis have the feature inherently, don't bother to give it a name; it's just one more advantage of transistorization.

The method used in the latest *Electrohome* color chassis is different, but is easy to understand. Three-section switch S1 is shown in Fig. 2 in its "off" position. The line voltage is connected to the oversize primary winding of the power transformer, which reduces secondary

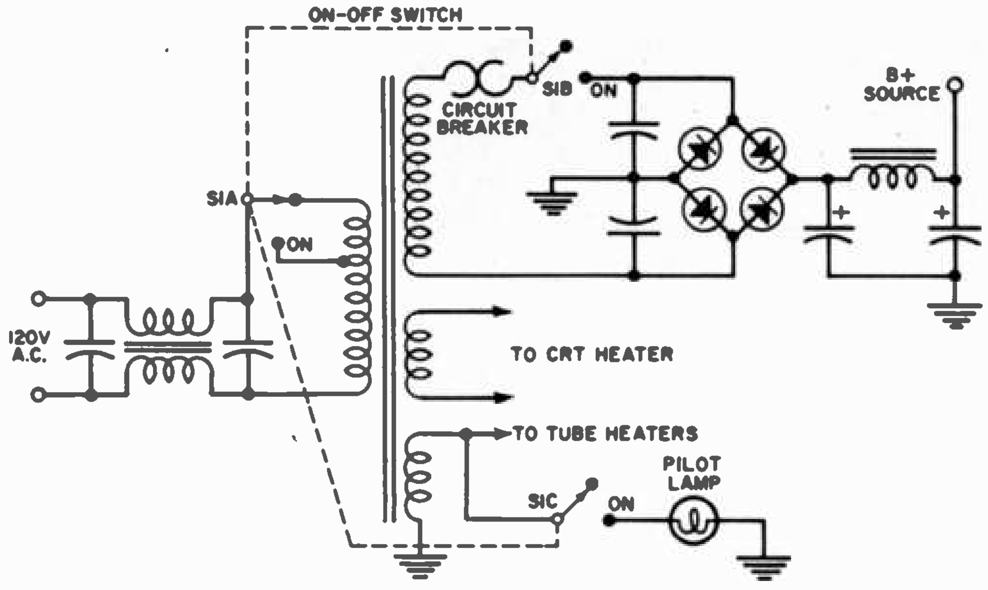


Fig. 2. This simpler version, from Electrohome, cannot be turned off completely except by pulling plug.

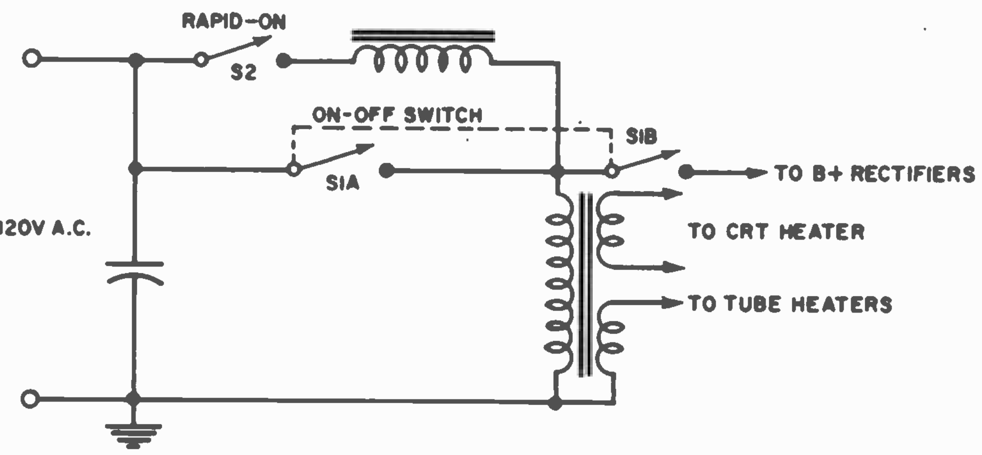


Fig. 3. Olympic quick warmup circuit is the simplest.

voltages to about 30% below normal. Section *B* of the switch keeps plate-supply voltage from reaching the rectifier pack, so no "B+" is developed. Tube and CRT heaters receive reduced voltages, so they're kept warm though not hot.

When the switch is turned on, section *A* connects the input voltage across the normal portion of the transformer primary, bringing all secondary voltages up to normal; the tube heaters rise to full temperature. Section *B* connects the plate-supply voltage to the rectifiers, and they develop "B+" for plates and screens throughout the set. Section *C* turns on the pilot light.

This *Electrohome* chassis has no provision for disabling the Insta-Vu circuit. The set remains partially on unless the line cord is unplugged. Some manufacturers claim an advantage to leaving the set thus warmed up at all times: it keeps moisture out, they say. It is true that constant warmth eliminates condensation that can occur in some humid climates when a set is alternately hot and cold.

Simplest of all in operation is probably the *Olympic* fast warmup version in Fig. 3. With S2 open, operation of the set is normal. The only unusual thing is that one section of "on-off" switch S1 is used to open the "B+" circuit. With Rapid-On switch S2 closed, an inductor is placed between the line voltage and the power transformer. The voltage is reduced because of the inductor in series, and the secondary voltages applied to the CRT and tube heaters are therefore low. The tubes are kept warmed up, but not to full temperature. Then when S1 is closed to turn the set on, the inductor is bypassed, applying full voltage to the transformer. The tubes heat to full temperature. The *B* section of the switch also closes the "B+" circuit, applying plate voltages through the set. Picture and sound both come on within a very few seconds.

(Editor's Note: All quick-warmup vacuum-tube circuits will add something to the user's electric power bill, although not much. Power consumption may be about ⅕ of the set's normal full-power drain on the a.c. power line. Some users may also worry that their tubes won't last as long if they are kept warm all the time. However, the repeated thermal shock of the usual "on-off" operation may result in a shorter tube lifetime than if the heater is kept partly on at all times. Hence, tube life should not be affected one way or the other.)

Preventing CRT Magnetization

One popular feature in 1969 color sets is a degaussing circuit. Its job, of course, is to keep the CRT shadow mask from becoming magnetized and spoiling purity. Most degaussing circuits are automatic; the set-owner never bothers with them. In a very few sets, the degaussing process is done at the customer's will, manually, even though it is as simple as manipulating a special switch. The color set without built-in degaussing is a rarity this year.

The common automatic version is shown in Fig. 4. Two special resistors, *R*1 and *R*2, are the heart of the automatic action. When the receiver is turned on, the resistance of voltage-variable resistor *R*2 is very low, and that of temperature-variable resistor *R*1 is high. Alternating current flows through the degaussing coil to the "B+" rectifiers. As the set warms up, voltage across *R*2 causes its resistance to rise, which forces some more current to flow through *R*1. As *R*1 begins to heat from current flow, its value drops. This chain reaction continues for several seconds—*R*2 increasing in value and *R*1 decreasing, with each aiding the action in the other. After several seconds, practically all current flows through the now-very-low resistance of *R*1, completely bypassing the degaussing coil and the now-quite-high resistance of *R*2.

The degaussing coil is wrapped around the periphery of the color picture tube. The alternating current in it creates a varying magnetic field that erases any residual magnetism in the shadow mask. The field is collapsed

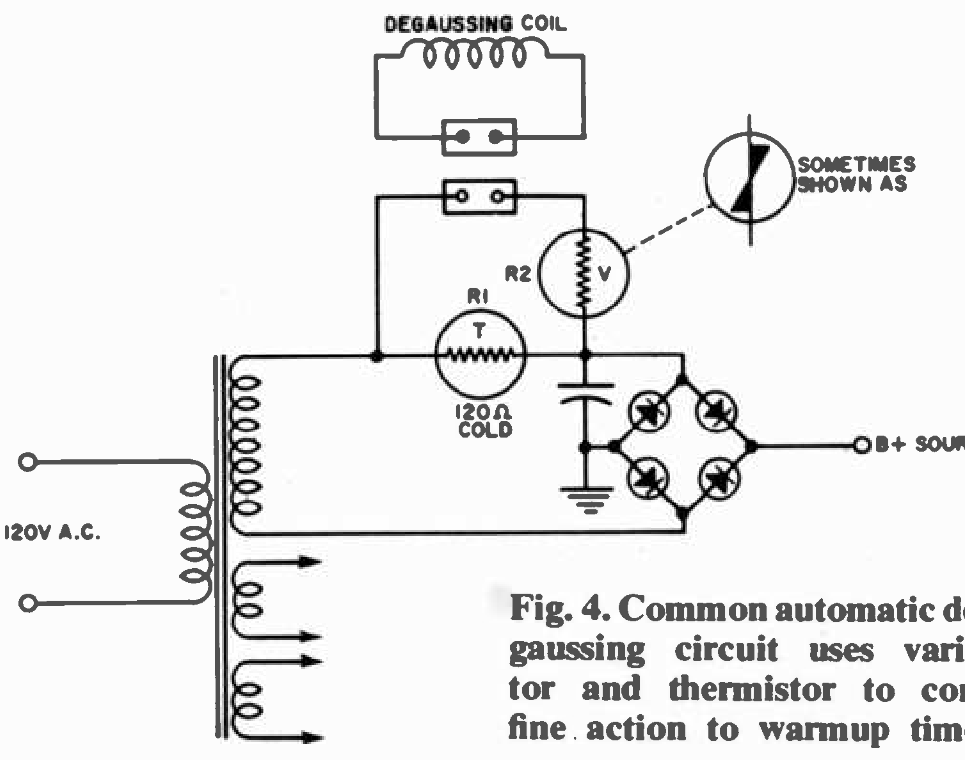


Fig. 4. Common automatic degaussing circuit uses varistor and thermistor to confine action to warmup time.

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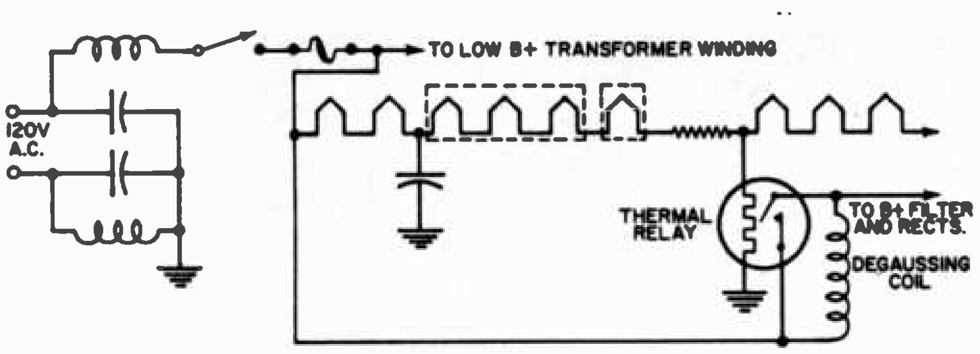


Fig. 5. Some sets use thermal relay to cut off degaussing action before receiver raster comes on. Action of large B + filter capacitor causes current to taper off gradually in degaussing coil before it is shorted.

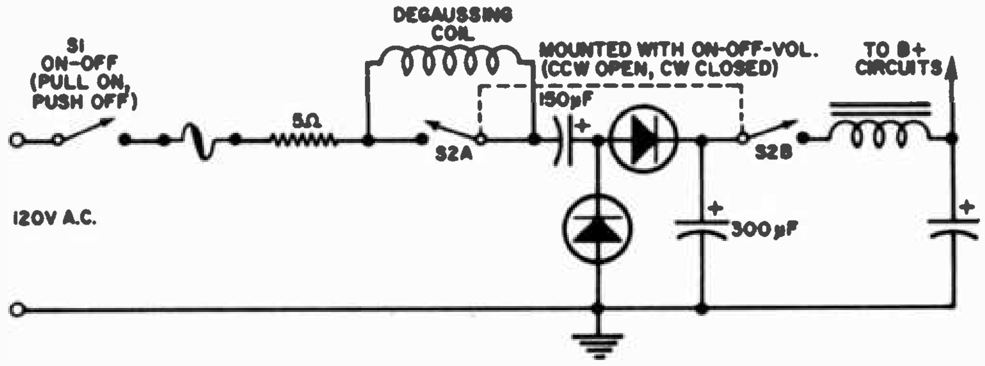


Fig. 6. Manual degaussing system used in a Philco.

rather gradually—over several seconds—by the thermistor/varistor action; by the time the raster shows up, there are no remaining fields from the degaussing coil. The set-owner is virtually unaware that anything has taken place.

This circuit is easy to check. Just short out *R*1 before you turn on the set, and the set comes on normally. Then remove the short. You'll be able to see the degaussing action by the multicolor lines it makes on the raster. They should fade away in a few seconds. Of course, multicolor lines on the screen at all times means *R*1 is open or is remaining at its highest ("cold") resistance.

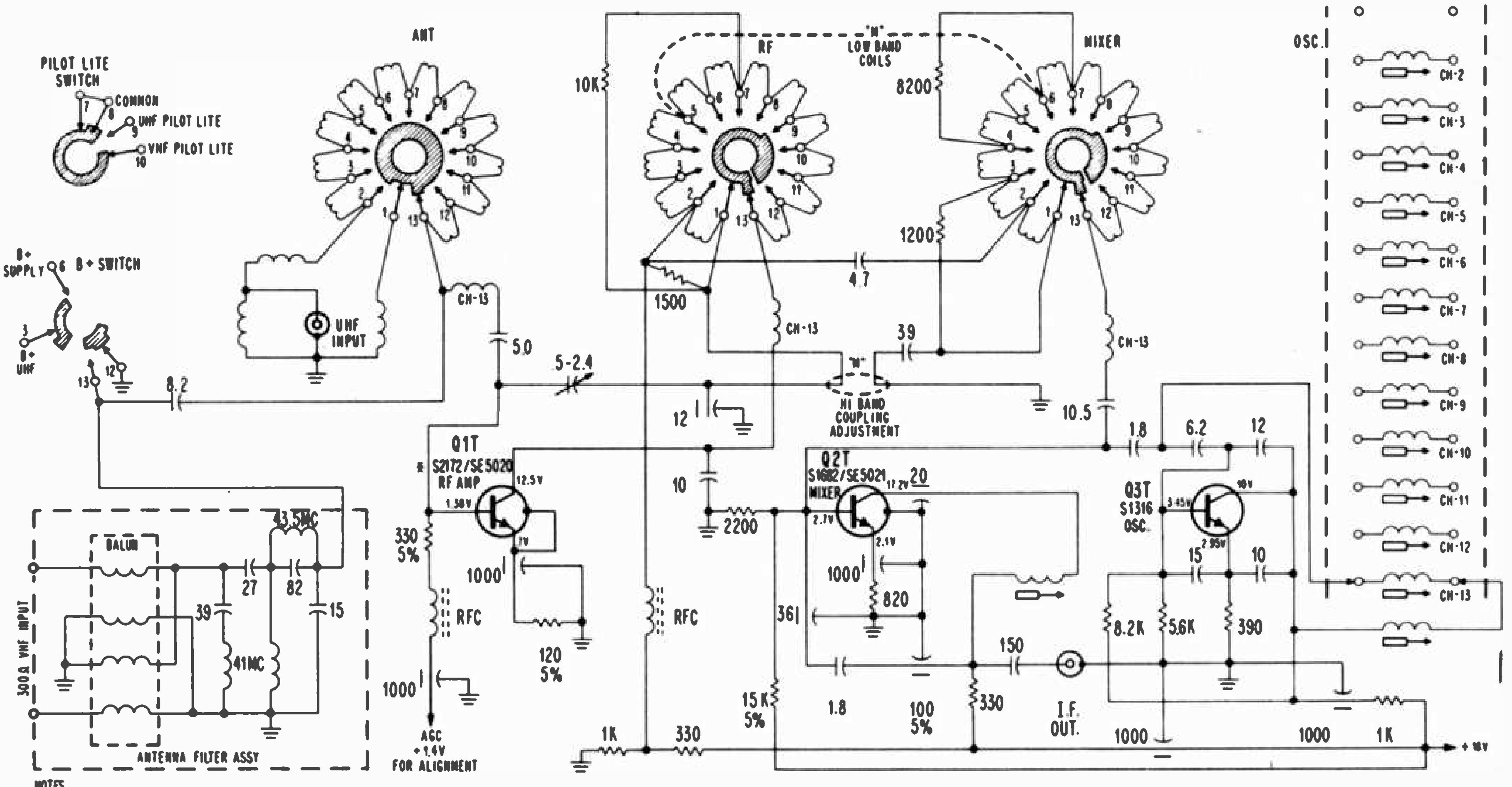
Some color receivers use a thermal relay for automatic degaussing action. Again, the demagnetizing occurs before the raster appears, and is unnoticeable. The circuit diagram of one model is shown in Fig. 5. Some imports that use this system may put the thermal element directly across the line voltage; in the one shown here (from a *Panasonic* CT-63), the voltage drop across part of the heater string makes it possible to use a lower voltage thermal relay.

Like the degaussing system in Fig. 4, the one in Fig. 5 uses the warmup sensor to bypass or short out the degaussing coil after the set has been on several seconds. The thermal-relay contacts are normally open when the receiver is off. With the receiver on, current heats the element and closes the contacts, shorting across the degaussing coil.

This circuit can't be checked out the same way as Fig. 4, however. For this one, you have to remove the connection from one relay contact, if you want to "see" the degaussing action after the raster comes on. Don't disconnect the thermal element, since it is part of the voltage-dividing circuit for the tube heaters.

Both degaussing coils shown here are in series with the "B+" rectifiers. The chief reason for this is to keep "B+" low or nonexistent until after degaussing action has ended. This reduces the likelihood that a raster might come on while the degaussing coil is still making magnetic fields around the CRT face. Hence, the set-owner isn't bothered by weird lines that would accompany degaussing action which might be the case if a raster were visible.

One manual degaussing circuit for 1969 models is typified by the *Philco* 19FT20 chassis. The circuit is extremely simple, (Fig. 6). In the normal position, the two degaussing-switch sections (S2A and B) are closed. When the receiver is turned on, warmup and operation are perfectly normal. Since section S2A is closed, the de-



NOTES
1. ALL SWITCHES SHOWN IN CH.13 POSITION
2. ALL ROTOR BLADES ARE SHORTING TYPE
3. ALL CAPACITORS IN PICOFARADS
4. ALL RESISTORS IN OHMS, K=1000
5. ALL SWITCH SECTIONS ARE VIEWED FROM FRONT OF TUNER
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Fig. 7. Transistor v.h.f. tuners, such as this one employed in Philco receivers, are becoming more popular.

gaussing coil is shorted out and there is no degaussing.

To initiate degaussing, the volume control is turned backward (counterclockwise), with the set off. A click indicates that the two degaussing-switch sections have opened. The set is then turned on by pulling outward on the volume-control shaft. No raster comes on, because section S2B of the degaussing switch is open; no "B+" is developed. The coil degausses the CRT only for as long as it takes the voltage-doubler capacitors to charge—a few seconds.

TRANSISTOR TRENDS IN COLOR-TV

A funny thing happened on the way to the all-transistor color-TV. What happened was the hybrid—a part-tube, part-transistor mixture that first appeared some years back. It looked for a time as if the meaning of the word transistorization might be taken literally—that tubes would be replaced by transistors only slowly, one by one.

And then, in mid-1967, it happened. Suddenly, there was an all-transistor color-TV set. The first skeptical cry was that it was probably a promotion gimmick. But it wasn't; it was a full-fledged, all solid-state instrument, already rolling off Motorola's production line. The only vacuum tube in the whole receiver was the high-voltage rectifier (and, of course, the picture tube). No matter what anyone said about its practicality, solid-state color had arrived!

Time has proven it is here to stay, too. It has even been improved. The 1969 version eliminated that last tube, replacing it with the industry's first solid-state high-voltage rectifier for color-TV (Fig. 1).

In the new Quasar series, there's nothing left to go solid-state but the color CRT. Coupled with an unusual solid-state remote control system (see page 25), Motorola's 1969 transistor color chassis was just about the last word in transistor color-TV.

Enter the Second One . . .

But not for long. Now RCA has one, too. Its CTC 40 chassis has unique features all its own.

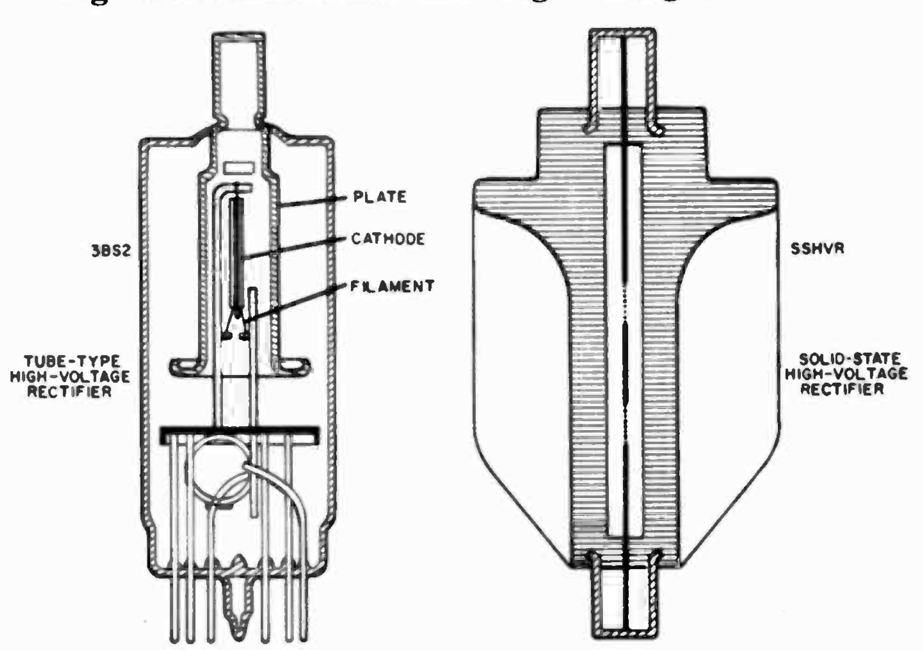
For example, take the horizontal-deflection circuit—long the chief holdback for any kind of transistor TV. It was only recently that anyone made a transistor that could handle both the fast switching and high power demanded by this section of a TV chassis. The RCA CTC 40 got around that nicely. Instead of using a special transistor, or even a bank of them, silicon controlled rectifiers are used for horizontal deflection. The SCR's act as high-current switches that are gated by pulses from a transistor blocking oscillator. The high energy developed by suddenly switching such high currents through the deflection yoke is turned to another useful purpose: generating picture-tube high voltage. (The high-voltage rectifier is the only vacuum tube in the CTC 40.)

An integrated circuit is used in the sound section, as in RCA tube sets, but it's a new IC that includes an extra audio amplifier. The tuner is something special; it's not only solid-state but is the first TV tuner we know of to use a MOSFET r.f. amplifier for v.h.f.

And The Almost . . .

A few chassis came so close this year to being all-transistor that they can hardly be overlooked in any discussion of solid-state color sets. The record for most transistors in a hybrid design seems to be held by Packard Bell; its CR-424 chassis has 33 transistors versus 11 tubes. Highest ratios of transistors to tubes are in Admiral's K10-2A and Setchell Carlson's U809. Here are some highlights of the color sets we surveyed that are more than half transistor.

Fig. 1. Tube and solid-state high-voltage rectifiers.



Admiral—new K10-2A chassis, with 7 tubes and 25 transistors. Screen size is 14-inch. Horizontal sweep and high-voltage section uses tubes. Has diode-type pulse-sampling high-voltage regulator. Video and color output amps are tubes. Something unique is special use of a junction field-effect transistor (JFET) as reactance control for the 3.58-MHz oscillator in the chroma section. (Only other FET we know of in color-TV is in tuner of RCA's all-transistor model.) Diagram of Admiral JFET reactance circuit is shown in Fig. 2.

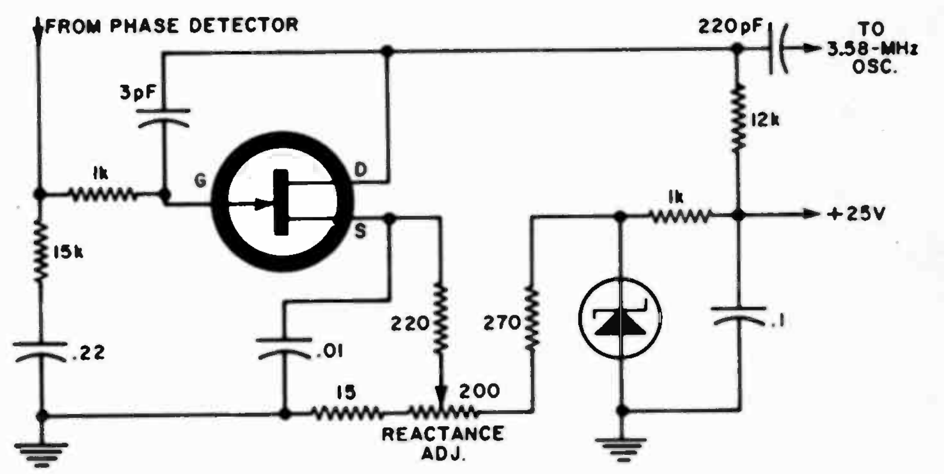


Fig. 2. Junction FET used in Admiral hybrid color-TV set is employed to control 3.58-MHz oscillator.

Delmonico—Another small-screen portable, 14-inch. Chassis 7208, imported. Uses 9 tubes versus 26 transistors. Tubes used in vertical and horizontal sweep circuits, video output, color-difference amps, and v.h.f. tuner. Diode-type pulse h.v. regulator.

Packard-Bell—Chassis CR-424, uses 14-inch picture tube, imported. Has 11 tubes, used in both sweep chains, in color-difference amplifiers, video output, pincushioning. Also has 6BK4 shunt regulator. Uses 33 transistors, three of them in v.h.f. tuner.

Panasonic—Two chassis, both imported. CT-21 has 12-inch screen. Uses 10 tubes, in same tube functions listed for other chassis plus audio amplifier and output. High voltage is regulated by a varistor in a pulse-sampling circuit. Transistors in this chassis number 25, including those in the v.h.f. tuner. Second chassis, the CT-63, has a 15-inch screen. Uses 10 tubes, in same functions as in CT-21 chassis. Has more transistors, 29 to be exact, owing to color-indicator circuit, extra color-killer amplifier. Both of these chassis have fine-tuning light.

Setchell-Carlson—Chassis U809, portable, 14-inch. Uses printed-circuit boards, new to Setchell-Carlson who formerly hand-wired everything. Uses 7 tubes, 25 transistors. Five of the transistors are in the u.h.f./v.h.f. tuner. Damper is solid-state instead of tube, and so is high-voltage regulator.

Sylvania—Chassis D12, only hybrid that drives a 23-inch picture tube. Has 12 tubes and 23 transistors. Tubes used for sweep chains, high voltage and regulation, 3.58-MHz oscillator and control, color-difference amplifiers, video output, tuner. Also has an integrated circuit to amplify sound i.f. and detect sound. One version, chassis D13, is used in Sylvania's Color Slide Theater—a unit with tri-color flying-spot scanner that shows 35-mm photographic color slides on TV screen.

You probably noticed that all the hybrid color-TV receivers except Sylvania's are small-screen. We keep hearing of other hybrids and transistor color chassis about to be introduced, but can get no further information at press time. A very-small-screen unit is promised by Sony, using a special picture tube called a Trinitron. It may be brought into this country in quantity sometime early in 1969, after this story goes to press. We have no details, except that it will be mostly (or all) solid-state. ▲

When the volume control is rotated clockwise, the degaussing sections of switch S2 close. The coil is no longer in the circuit, and the "B+" circuit is completed. The set operates normally.

The advantage of this circuit is that the set can be degaussed again if it needs it. The owner need only turn the set off and wait a few seconds while the capacitors discharge. With heat-operated degaussing circuits, the set must be off long enough for the thermal elements to cool before another degaussing action is possible. With a very tough case of impurity, a single occasional demagnetizing might not be adequate. That's why a few sets—notably this *Philco* model, most of *Setchel-Carlson's*, and one *Toshiba*—use manual degaussing instead of the more popular automatic version.

V.H.F. Tuners Go Solid-State

For several years, now, all u.h.f. tuners have been transistorized. Not so with v.h.f. tuners in color sets. Solid-state has been applied to v.h.f. tuners only in all-transistor receivers. For 1969, an impressive number of models include a transistor v.h.f. tuner. *Admiral, Packard-Bell, Panasonic, Setchell-Carlson,* and *Toshiba* each have it in at least one model. *Philco-Ford* has it for all 1969 models. The all-transistor sets from *RCA* and *Motorola* of course have transistor v.h.f., and one *RCA* model has a hybrid v.h.f. tuner that combines a transistor with a nuvistor.

Some set makers have dabbled with transistor v.h.f. before, but this is the first year a trend in this direction has developed. Most of the solid-state tuners are part of hybrid sets.

Transistor v.h.f. tuners aren't radically different from their tube counterparts. Fig. 7 is a diagram of one. This *Philco* version is a switch-type tuner, with a transistor for oscillator, one for mixer, and one for r.f. amplifier. You can see how nearly it resembles an ordinary v.h.f. tuner.

The diagram in Fig. 8 shows something a little different in transistor v.h.f. tuners. This one is from *Motorola's* all-transistor Quasar color set. What's different is that it contains circuits for automatic fine tuning (a.f.t.)—which *Motorola* calls FTL, for Fine Tuning Lock.

Connected across the channel-tuning coil in the oscillator stage is a voltage-variable tuning diode, *D*1. Whenever the tuner drifts off frequency, shifting the i.f. slightly, a correction voltage from the FTL section (elsewhere in the receiver) is applied to the tuning diode through *R*1. As the voltage changes on the anode of the tuning diode, capacitance across the channel-tuning coil varies and returns the oscillator to a frequency that produces the correct i.f. It is obvious, if you're familiar with tube-type a.f.t. tuners, that the transistor oscillator with a.f.t. works just the same.

Something really new is a field-effect transistor in a television tuner. *RCA* has one—a dual-gate MOSFET, no less—in the 5-transistor KRK 142 v.h.f. tuner used with the new CTC 40 all-transistor color set. This transistor can handle automatic fine tuning too; it uses one of the transistors as a tuning diode. The two gates of the MOS-

MANUFACTURER	CHASSIS	CRT SIZE[1]	DESIGN[2]	IC's
ADMIRAL	4H12	23	tube	–
	6H10,9H10	18,20	tube	–
	K10-2A	14	7/25[2]	–
ANDREA	VCX-325-1 to 6	23	hybrid[6]	sound sect. & remote control
	VCX-325-7	23	hybrid	sound sect. & remote control
CONAR (kit)	600	18	tube	–
DELMONICO	150	18	17/14[2]	–
	151	18	tube	–
	7208	14	9/26[2]	–
DUMONT	120926,28	23	tube	a. f. t.
ELECTROHOME	C5	23	tube	–
EMERSON	120921,23,24	18,21,23	tube	a. f. t.
GENERAL ELECTRIC	HC	10	tube	–
	KE	18,20,23	tube	–
HEATH (kit)	GR-180	18	tube	–
	GR-227	20	tube	–
	GR-681	23	tube	a. f. t.; remote rec'r.
HITACHI	CNA-24T	18	tube	–
	CNA-1900T	18	tube	–
MAGNAVOX	T924	18,20	tube	–
	T931,33	23	tube	–
	T932	15	tube	–
MOTOROLA	TS-915	23	trans.	sound sect.
	TS-921	20,23	tube	–
	TS-924	14	tube	–
OLYMPIC	CTC-30,31	22,23	tube	–
	CT911	18	tube	–
PACKARD-BELL	CQ-962	23	17/9[2]	sound i. f.
	CQ-964	23	tube	–
	CQ-966,8	23	17/10	sound i. f.
	CR-424	14	11/33[2]	–
	CR-634,36	18	tube	–
	CR-932	23	tube	–
PANASONIC	CT-21	12	10/25[2]	–
	CT-62,63	15	10/29	–
	CT-92	19	tube	–
PHILCO-FORD	19FT20	15	19/17[2]	–
	19KT40	18	hybrid[6]	color osc.
	19QT85	21,23	hybrid	–
RCA	CTC-22	14	tube	–
	CTC-28	23	tube	a. f. t.
	CTC-31	20,23	tube	–
	CTC-36	18	tube	–
	CTC-38	21,23	17/8[2]	a.f.t.
	CTC40	23	trans.	a.f.t.,sound
SETCHELL-CARLSON	U806,7	18,23	tube	–
	U809	14	7/25[2]	–
	U810	18	hybrid	–
	2700	23	tube	–
SHARP	CJ-45P	15	tube	–
	CN-32TA	18	tube	–
SYLVANIA	D08	23	tube	–
	D10/09	23	17/14[2]	sound i. f.
	D11-1-2	14	hybrid	–
	D12/13	23	12/23	sound i. f.
TOSHIBA	C2/C3	11	12/15[2]	–
	C4/C5	15	20/11	–
WESTINGHOUSE	V2655	18,23	tube	–
	V2656	23	24/11[2]	–
ZENITH	15Y6C15	14	hybrid	–
	16Z7C19	18	hybrid	–
	16Z7C50	20,23	hybrid	a. f. t.
	20Y1C50	20,23	tube	–

Notes: 1. Viewable diagonal inches; 2. Some hybrids show how many tubes/transistors; 3. All u.h.f. tuners are transistor; 4. auto. =automatic; 5. lo = lo level, hi = high level, D =

1969 COLOR–TV CHASSIS

FINE-TUNE AID	V.H.F. TUNER[3]	REMOTE CONTROL	QUICK WARM-UP	DEGAUSSING[4]	H.V. REG.	NO. VIDEO I.F.'s	NO. CHROMA B'PASS	DEMOD.[5]	COLOR-DIFF. AMPS.
a.f.t.	tube	7-function	Instant Play	auto.	shunt	3	2	X-Z hi	–
a.f.t.	tube	7-function	Instant Play	auto.	pulse	3	2	X-Z hi	–
–	trans.	–	–	auto.	pulse	3	2	R-Y, B-Y	yes
eye	tube	7-function	–	auto.	n.a.	3	2	X-Z lo	yes
eye	tube[7]	7-function	–	auto.	n.a.	3	2	X-Z lo	yes
–	tube	–	–	none	shunt	2	1	R-Y, B-Y	G only
–	tube	–	–	auto.	shunt	3	2	X-Z hi	–
–	tube	–	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
a.f.t.	tube	–	Quick-On	auto.	shunt	3	2	X-Z lo	yes
a.f.t.[8]	tube	–	Insta-Vu	auto.	pulse	3	2	R-Y, B-Y	yes
a.f.t.	tube	–	Quick-On	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	none	pulse	3	1	R-Y, B-Y D	yes
a.f.t.	tube	–	Insta-Color	auto.	shunt	3	1	X-Z D	yes
–	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	1	R-G-B	yes
a.f.t.	tube	4-function	Quick-Picture	auto.	pulse	3	1	R-Y, B-Y	G only
a.f.t.	tube	6-function	Quick-Picture	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	R-B-G D	yes
FTI/FTL[9]	trans.	7-function	yes	auto	pulse	3	2	R-B-G D	yes[10]
FTI/FTL	tube	4-function	–	auto.[12]	pulse	3	2	X-Z hi	–
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
eye	tube	–	Rapid-On	auto.	shunt (30) pulse (31)	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	2	X-Z hi	–
–	tube	–	–	manual	shunt	3	2	X-Z lo	yes
–	tube	–	–	manual	shunt	3	2	X-Z lo	yes
a.f.t.	tube	3-function	–	manual	shunt	3	2	X-Z lo	yes
–	trans.	–	–	auto	shunt	4	2	X-Z D	[11]
–	tube	3-function	–	auto.[12]	pulse	3	1	X-Z lo	yes
–	tube	–	–	manual	pulse	3	2	X-Z lo	yes
light	trans.	–	yes	auto.	pulse	3	2	X-Z D	[11]
light	trans.	–	–	auto.[12]	pulse	3	2	X-Z D	[11]
light	tube	–	–	auto.[12]	pulse	3	1	X-Z lo	yes
–	trans.	–	–	manual	shunt	3	2	R-B-G	yes
eye	trans.	–	–	na.	n.a.	n.a.	n.a.	n.a.	n.a.
[13]	trans.	8-function	–	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	2	1	X-Z lo	yes
a.f.t.	tube	8-function	–	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	2	2	X-Z lo	yes
–	tube	5-function	–	auto.	pulse	2	1	X-Z lo	yes
a.f.t.	hybrid	7-function	–	auto.	shunt	3	2	X-Z D	yes
a.f.t.	trans.	–	yes	n.a.	pulse	3	3	R-B-G	yes[10]
light & a.f.t.	tube	–	–	manual	shunt	3	1	X-Z lo	yes
–	trans.	–	–	manual	pulse	4	2	X-Z D	yes
light	tube	–	–	manual	shunt	4	2	X-Z D	yes
light	tube	–	–	manual	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
–	tube	–	–	auto.	shunt	3	1	X-Z D	yes
–	tube	–	–	auto.	shunt	3	2	X-Z lo	yes
a.f.t.	tube	yes	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z lo	yes
a.f.t.	tube	yes	–	auto.	shunt	3	3	X-Z lo	yes
–	trans.	–	–	auto.[12]	pulse	3	2	R-G-B D	yes
–	trans.	–	–	manual	shunt	3	2	R-G-B	yes
–	tube	–	–	auto.	pulse	3	2	X-Z lo	yes
on-screen bars	tube	–	Instant-On	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	3	X-Z lo	yes
–	tube	4-function	–	auto.	pulse	3	3	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	pulse	3	3	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	pulse	3	2	X-Z hi	–

diodes; 6. No tube/transistor count available; 7. Motor-driven, but push-button operated; 8. Called "Electrolock"; 9. Fine Tuning Indicator and Fine Tuning Lock; 10. Two stages for each color; 11. Has X and Z amps, plus R, G, and B amps; 12. Using thermal relay; 13. Has eye and a.f.t. (called "Autolock Channel Tuning"); n.a. = information not available.

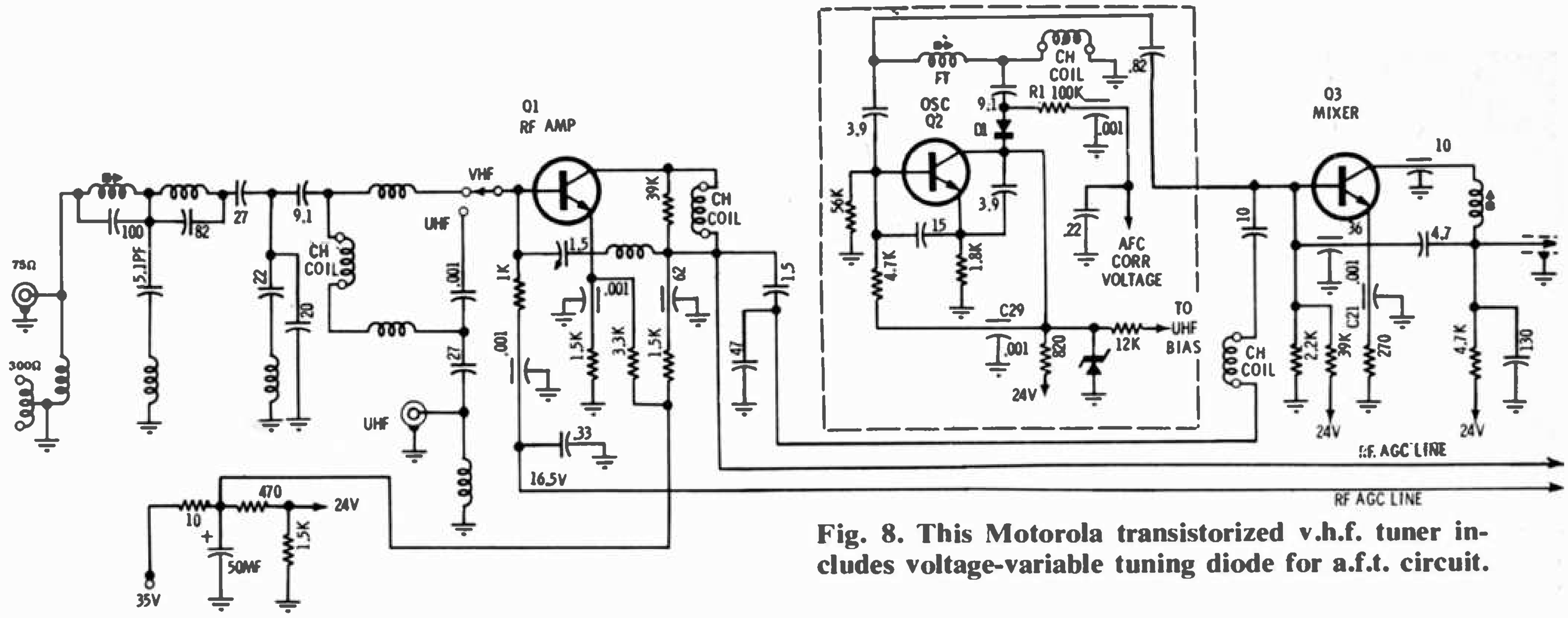


Fig. 8. This Motorola transistorized v.h.f. tuner includes voltage-variable tuning diode for a.f.t. circuit.

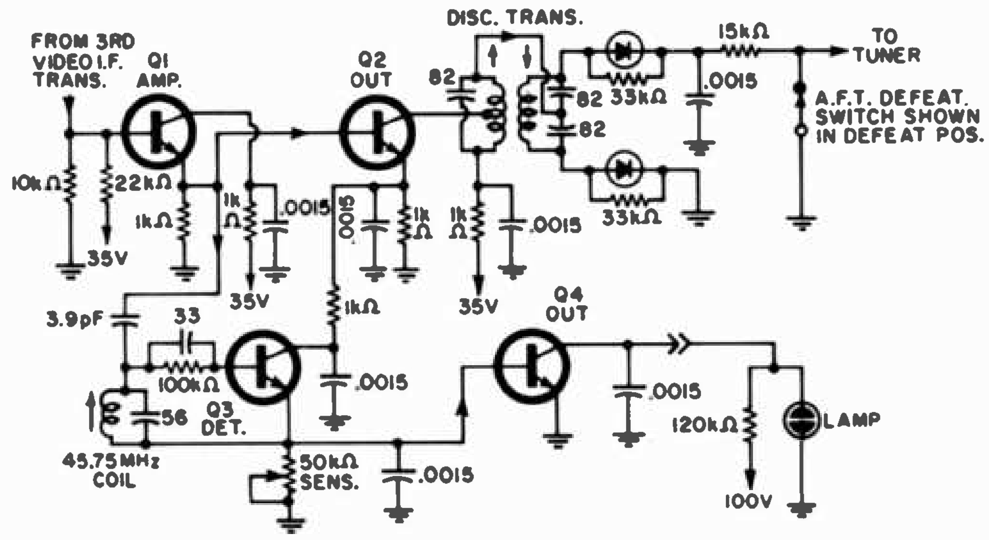


Fig. 9. Motorola's a.f.t. system, "Fine Tuning Lock."

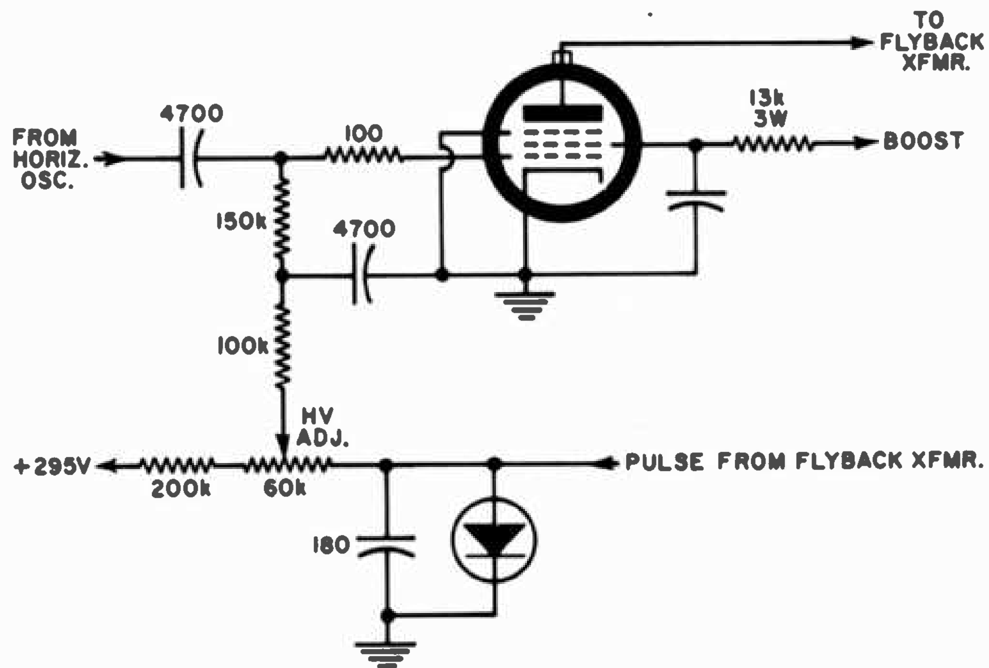
FET are connected together through an isolating resistor.

Toward "Just Right" Tuning

From the looks of 1969 models, 1968 was the year of the fine-tuning aid. This year's sets have just as many, but there's been no great rush to put them on models or brands that didn't already have them.

You've already seen a transistor tuner with an automatic fine-tuning circuit (Fig. 8). If you're interested in where the automatic fine-tuning control voltage comes from, take a look at Fig. 9. This circuit is typical, except that it also includes a tuning light.

Fig. 10. Pulse type high-voltage regulator can't produce x-radiation even if the circuit is badly misadjusted.



The automatic fine tuning stage takes its sampling signal from the third video i.f. amplifier in almost all sets. The 45.75-MHz signal is amplified and applied to a discriminator of some sort (diodes in Fig. 9). If the tuner frequency has drifted, and the picture i.f. carrier is no longer exactly 45.75-MHz, a correction voltage is developed by the discriminator and applied to the tuner.

In the *Motorola* a.f.t. stage shown, a couple of extra transistors light a neon lamp if the frequency drifts beyond "reach" of the a.f.t. section.

The 1969 *Philco* has a new a.f.t. system that goes by the name of Autolock Channel Tuning, or just ACT. Whereas a tuning diode is used in the tuner of Fig. 8, the *Philco* v.h.f. tuner uses a transistor (connected base and collector, with emitter open) as the voltage-tuned element. Otherwise, the system is similar to others: the 45.75-MHz signal is amplified and applied to a discriminator. A d.c. amplifier is used to boost the control voltage—a trick used in a few other brands.

Few color-set owners realize how important precise fine tuning is. It can make the difference between watching a color show in color and watching it in monochrome. Although the rush to fine-tuning aids seems to have passed, you can expect them to continue appearing until virtually all color sets have them.

High Voltage . . . The Regulator Story

Considerable publicity was given last year to the possibility of dangerous x-rays emanating from color-TV sets. Though small doses of x-rays were discovered coming from a few malfunctioning color receivers, they were *soft* x-rays that have not been proven harmful to man nor animal. However, it was enough to touch off considerable investigation, and the culprit was pinned down: some faulty shunt regulator tubes in the high-voltage section. Sets with defective regulator tubes were hunted down and fixed. A few other sets were found to be radiating slightly more than was considered healthy, and those were cured by slight adjustments.

Nevertheless, the spotlight on shunt regulators had a distinct effect on 1969 models; almost half of the new chassis use some other means of regulating high voltage.

By far the most popular is the pulse-sampling type.

Basically, this regulator takes advantage of the fact that high voltage in modern TV sets is developed from high-energy flyback pulses generated by the deflection yoke. The horizontal output (flyback) transformer has a large winding that builds up this pulse energy to many thousands of volts. The resulting high-voltage pulses are then rectified to make high-voltage d.c., which is applied to the color CRT. Anything that affects efficiency of the flyback transformer also affects the high voltage developed.

So, a sample of the flyback pulse is fed to a diode (Fig. 10) from which a stabilizing voltage is developed and applied to the grid of the horizontal-output tube. Suppose the high voltage decreases for some reason. There is a corresponding reduction in amplitude of the sampling pulse, which in turn produces less bias for the output tube. The tube amplifies more, building high voltage back up to normal.

If the high voltage gets too high, the pulse is larger than normal. So is the bias voltage at the grid of the

MOTOROLA'S NON-MECHANICAL REMOTE CONTROL

Probably the most unusual single feature introduced with the 1969 models is a thoroughly electronic remote control system—the TRR-7, built by Motorola for use with the all-transistor Quasar color chassis. The only mechanical devices are a tuner motor and relay, and an "on-off" relay. Without noisy motor-driven potentiometer controls, this unique seven-function remote-control system lets the viewer turn the set on and off, turn volume up or down, set color-picture hue, adjust color intensity (chroma), and change channels—all with a hand-held ultrasonic transistor oscillator transmitter. Operating frequencies are 35.5, 37, 38.5, 40, 41.5, 43, and 44.5 kHz.

The heart of the system is an insulated-gate field-effect transistor (IGFET), encapsulated with a neon switching tube, and a high-quality capacitor into a tiny device called a "memory module." Fig. 1 shows the circuit of the memory module. Primarily, the module can store, for many hundreds of hours, any particular level of voltage charge. It is that level of charge which controls the various functions.

As an example, consider how the memory module controls volume. The audio from the color receiver is fed through a special two-transistor amplifier in the remote-control chassis. The arrangement is diagrammed in block form in Fig. 2. The incoming control signal is amplified, as in any other remote arrangement. The signals detected by the audio-control discriminator circuit in the remote chassis are 38.5 kHz for volume up and 44.5 kHz for volume down. The volume-up signal produces a positive output voltage; and the volume-down signal, a negative output voltage.

The signal being sent from the remote transmitter is detected and applied to the memory module. The neon bulb lets the capacitor charge. The polarity and amount of that charge, with the amount determined mainly by how long the volume-up (or down) signal is received, sets conduction of the IGFET. That's what determines the d.c. control voltage that is applied to the special two-transistor audio amplifier. Essentially, the amplifier functions as a volume control. The control voltage sets the output level and effectively controls volume fed to the TV-set output amplifiers.

The "on-off" function for the set is handled by the same signals, and is also shown in Fig. 2. When the volume-up button of the transmitter is pushed, the positive d.c. voltage that raises volume in the two-stage amp is also applied to a one-shot multivibrator (flip-flop). The flip-flop fires, and its output pulls in a relay whose contacts turn on the receiver. Pushing the transmitter's volume-down button not only turns the volume down by reversing the voltage from the memory module, it also unlatches the relay-control circuit; turning the set off.

Other memory-module functions operate similarly. A two-stage hue amplifier simulates the up-and-down resistance variation of turning a hue potentiometer. Only one transistor stage is needed to handle the color-intensity function, with its variable emitter-collector resistance simulating the effect of a variable control.

Channels are changed by the seventh button on the remote transmitter—it generates a 43-kHz signal. No memory module is involved. In fact, this system is very similar to other remote channel-changing arrangements.

The color receiver that includes this remote system can't be used without it unless a special "simulator" is plugged in (for example, if the remote unit must be removed for servicing). The lack of moving potentiometers should remove one cause for early annoyance that recurs with the usual remote-control system. ▲

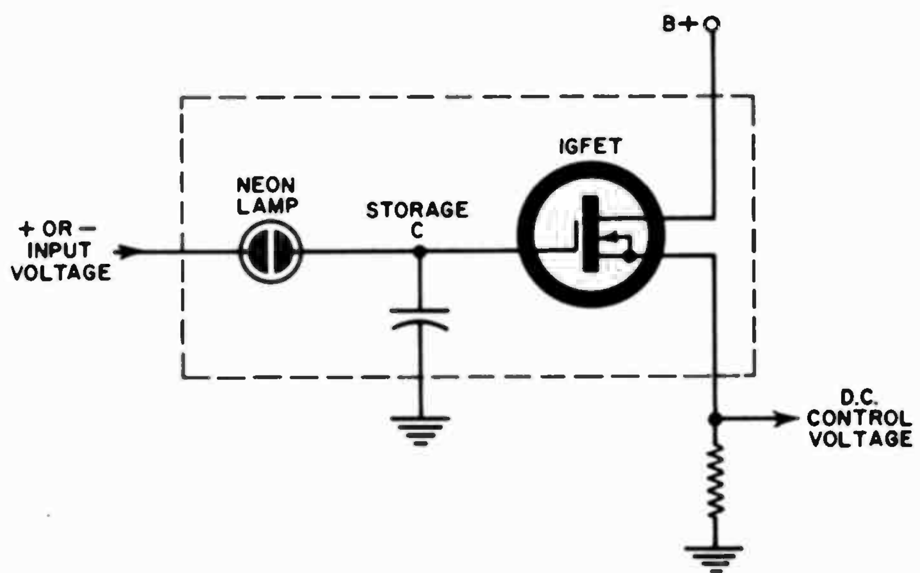
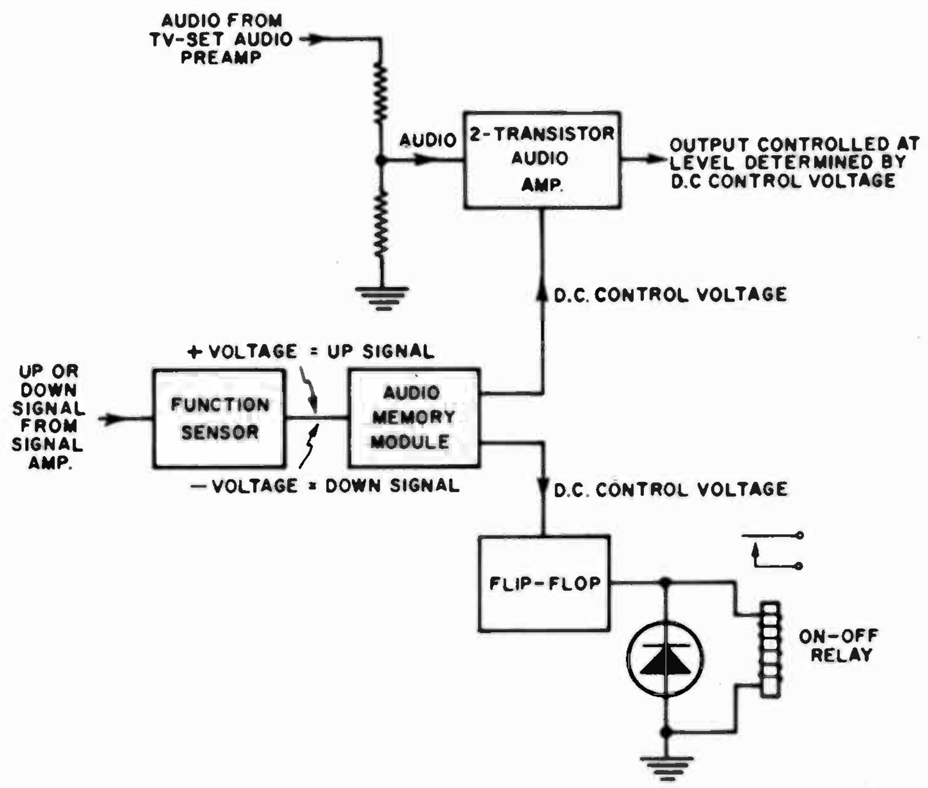


Fig. 1. Memory module for Motorola solid-state remote-control system. Neon bulb allows the capacitor to charge but prevents discharging. Capacitor is of very high quality, with virtually no leakage. The IGFET cannot discharge the capacitor either, because of its insulated gate which provides the device with extremely high input impedance. All three components are specially chosen and then sealed in a single module. The IGFET is a normally conducting device. How much it conducts is determined by polarity and value of the input voltage. The amount of conduction determines how much voltage is developed across the source-follower (output) resistor to provide control.

Fig. 2. Signal from remote transmitter is detected by discriminator (Function Sensor) and sent to appropriate memory module. In the audio module in this diagram, a voltage is developed that can turn the set on or off and also can control output volume by its effect on the gain of 2-transistor amplifier.



horizontal-output tube, and tube output is lowered to reduce the high voltage to normal.

A resistive adjustment in the pulse-sampling and voltage-feedback network allows for high-voltage adjustment. It is set, with a meter measuring actual high voltage at the CRT, for whatever value the manufacturer recommends for that particular picture tube. This ranges from 21.5 kV in certain sets with small 14-inch screens to as high as 26.5 kV in one *Olympic* model. For the usual 23-inch set (picture tubes beginning with the number 25), the value is 25 kV.

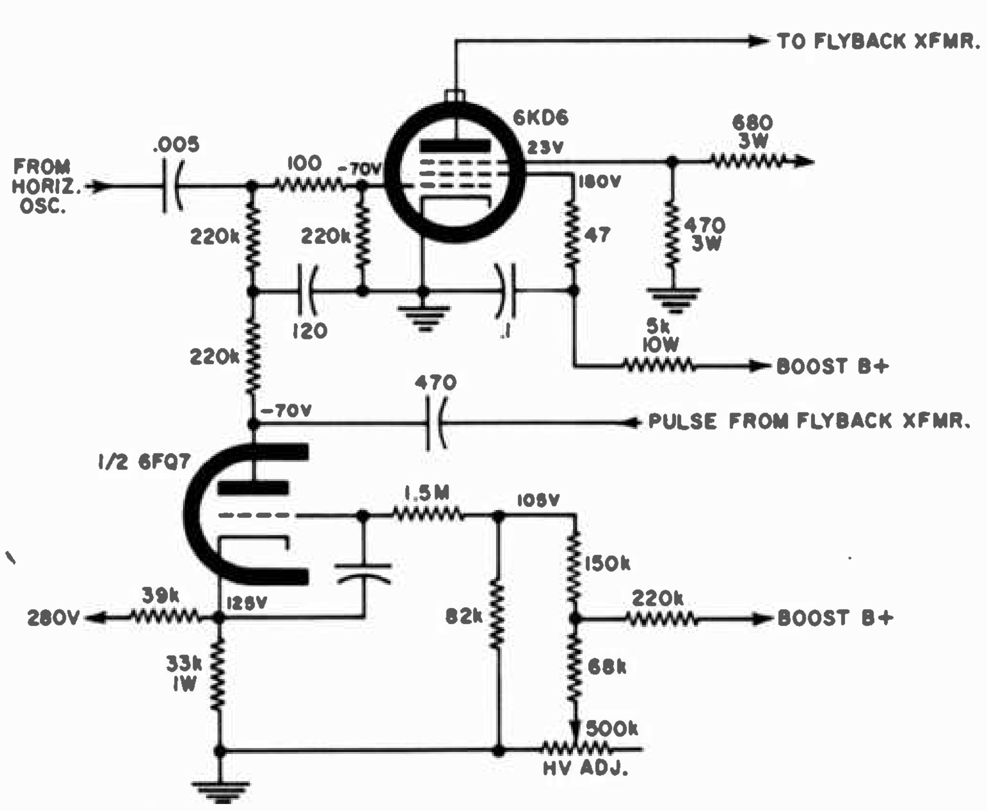
To avoid the possibility of even slight x-radiation from the high-voltage rectifier or from the picture-tube face, *keep the high voltage within the manufacturer's specified limits.* If you make any adjustments at all, use a dependable high-voltage meter to make sure the high-voltage level is kept where it belongs.

There are several versions of pulse regulators. Many use a varistor instead of sampling diode. Functionally, these versions work the same, controlling the horizontal-output stage. This, in turn, regulates high voltage developed by the flyback transformer.

One *Zenith* model and some *RCA's* use a tube-controlled regulator circuit that doesn't feed its output back to the output tube. Instead, the tube acts like a reactance connected across the flyback transformer windings. If high voltage gets too high, the tube senses it by changes in boost voltage. The tube's impedance lowers and loads down the flyback winding it is connected across. If high voltage gets too low, tube impedance rises; it becomes less of a load, and allows more high voltage to develop. As with simple pulse regulators, there is a potentiometer adjustment for setting the nominal operation point; it is adjusted while a high-voltage meter is connected to the CRT second-anode button.

In the *Olympic* CTC-31 chassis there is a gated pulse regulator using a triode tube—a 6FQ7—to set the bias level on the grid of the horizontal output tube. The circuit is shown in Fig. 11. A keying pulse from the flyback transformer is applied to the plate. The tube, with its operating point determined by bias from an adjustable voltage-divider network, acts like a rectifier of sorts. It produces a negative d.c. voltage with a level that is the combined result of the amplitude of the keying pulse and the bias setting. If high voltage rises, so does the pulse amplitude, and so does the negative output voltage. The output d.c. is then applied as bias to the horizontal output tube grid. If high voltage goes down, the pulse is lower; regulator-tube output is reduced, and therefore so is the bias. The action is much like that of keyed a.g.c.

Fig. 11. Olympic pulse h.v. regulator, using keyed tube.



What To Look For Next

A lot of last year's predictions for 1969 sets have come to pass. You see plenty of transistors working their way into top models; there are more integrated circuits scattered around; and another all-transistor color receiver, an *RCA*, has made its debut. What are some things you can expect to hear about toward the end of 1969, when the 1970 color receivers start coming out? Set manufacturers are naturally reticent. Yet, a few things can be figured out from what we already know and from the answers to a few carefully placed questions.

Watch, for example, for something exceptionally different in tuners. Of course, more tuners will be all-transistor for all channels. But something much more noticeable is in the offing. And it will make tuning a color set even more simple.

You can expect at least three more all-transistor models, probably from three different manufacturers. One will be an import.

Expect more small-screen portables, and at lower prices. The second-set market will be as important to tinycolor as the new-set market. A few low-to-middle-income families will buy tinycolor as their first set, but most sales will be in the middle-income bracket. Top-of-the-line models will go to middle- and upper-income families, much as they do now.

More innovations are forthcoming to make color sets easy to service. *Sylvania's* idea of putting transistors into sockets is one step; *Motorola's* modular concept is another. You'll see another, quite different, before the end of 1969.

No manufacturer has found a cure for the "green-face syndrome" that still plagues color viewing. *(This is the greenish cast that sometimes comes over the faces of TV performers when color cameras are switched.-Editor)* Receiver designers have toyed with a number of ideas, but none has been practical or economical; set-makers collectively contend that the trouble is one the telecasters should overcome. Yet, don't be surprised if at least one receiver manufacturer takes positive action on a circuit. One 1970 model will have a truly automatic hue control, if present lab sketches work out.

All-channel tuning—v.h.f and u.h.f.—is still a perplexing matter for manufacturers. Yet, a means of putting them both on one indicator dial and in a simplified control bank is possible. This, too, may get into production in time for 1970 models.

These are a few of the developments you can look forward to in future sets. You may hear rumors of other innovations. If so, they are probably true. ▲

PURITY and CONVERGENCE adjustments for color sets

By CONAN GORMAN

Training Coordinator, Field Service Department, Motorola Consumer Products Inc.

The most important adjustments the technician must make in setting up a color receiver are purity, static and dynamic convergence, and gray scale tracking. Here's the right method, with a step-by-step procedure.

THE heart of the modern color-TV receiver is the three-gun shadow-mask picture tube which displays the colored picture to the viewer. This tube is complex and must be very carefully manufactured in order to show the proper colors without contamination, and produce a realistic color picture.

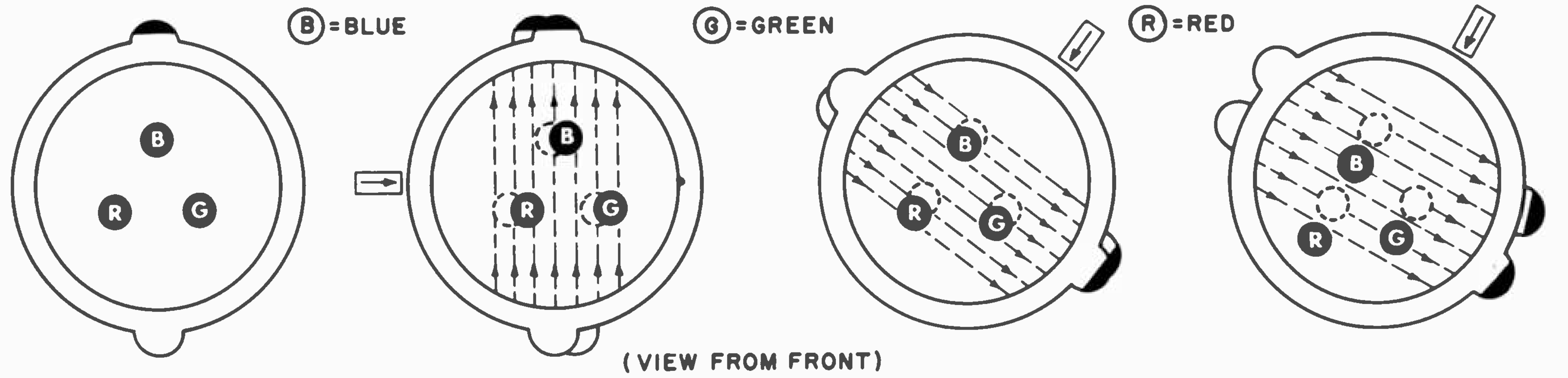
There are many external adjustments associated with this tube to assure that it does its job properly. These adjustments fall within three main categories: purity, static and dynamic convergence, and gray-scale tracking. The purity adjustments assure that red, green, and blue beams are oriented and centered properly, while the convergence adjustments cause the three beams to come together at the same spot on the screen as the beams trace out the displayed picture. Gray-scale tracking is done so that a black-and-white picture does not show color at various-brightness highlight and dark areas of the transmitted picture.

Purity Devices

The relation between the phosphor-dot screen and the shadow mask is highly critical. Anything that changes the electron-beams directions or mask orientation or shape will cause incorrect phosphors to light up. This condition is called "impurity." An improperly positioned yoke or a magnetized picture tube will also cause an impure raster.

A magnetic device similar in appearance to the centering rings on a black-and-white tube is used for purity adjustment. This device is mounted on the color-tube neck near the grid-3, grid-4 (G3, G4) location. The purity rings redirect the electron beams together and make them appear to originate from a slightly different location. The electron stream from any gun appears to come from a point in the deflection yoke area called the "apparent deflection center." This is the same point, incidentally, where the ultraviolet light source was placed during phosphor exposure when the tube was manufactured. The "red" electron stream, for example, must appear to come from the same point as the "red" light had during exposure of the red phosphor dots. If it does not, impurity results. Purity ring magnets rotate the three beams as a unit to make them appear to come from the correct apparent deflection center. The operation of the

Fig. 1. Effect of purity rings on three beams. As tabs are spread, magnetic field increases and beams move farther. Entire assembly can be rotated. Arrows in rectangles outside assembly indicate direction of movement.



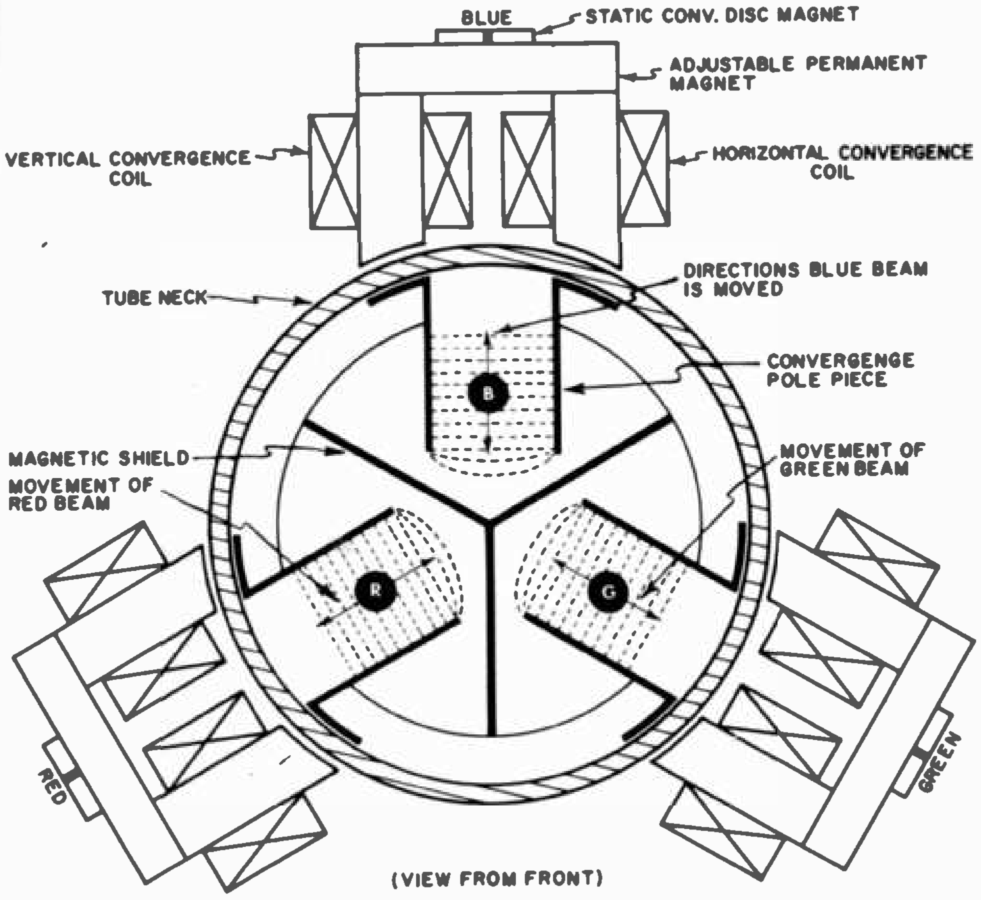


Fig. 2. Assembly for static and dynamic convergence.

purity ring is shown in Fig. 1. Note that the electron beams travel through the lines of magnetic force at right angles to them. When the tabs are spread apart, the magnetic flux increases and the beams move a greater distance. Rotation of the magnet assembly results in rotation of the beams in the deflection center.

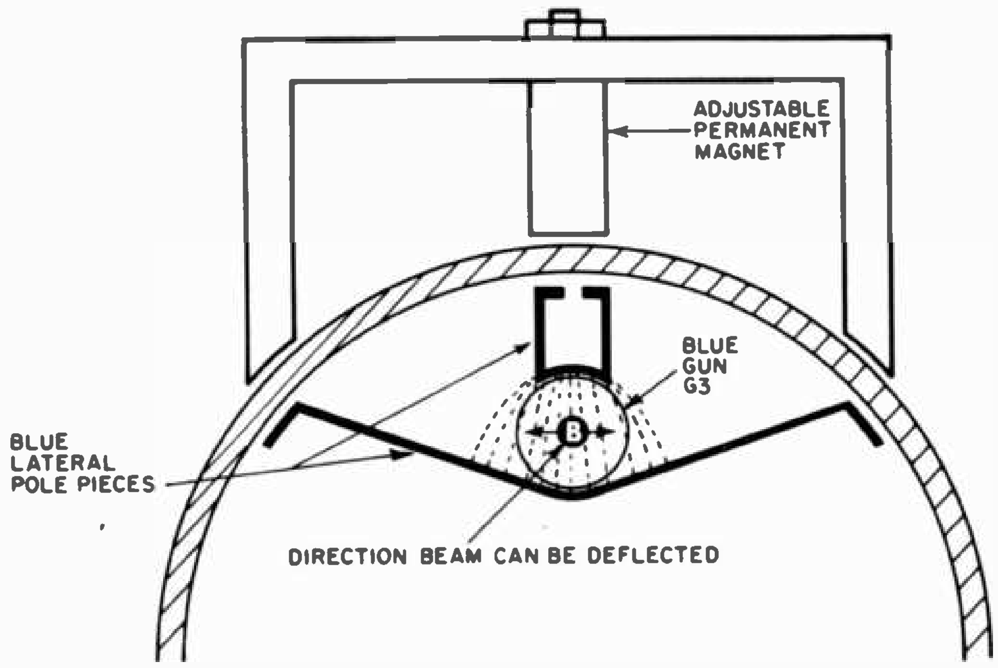
The purity device positions the three beams so that the shadow mask is approached from the correct direction in order to enable each beam to energize its related phosphor-dot screen.

Static Convergence

Even though tube purity is correct and each electron beam excites its own respective phosphor dots, this does not necessarily mean that the three beams come together or converge properly, because the guns may not be tilted at precisely the correct angle with respect to each other to accomplish this.

There's no way to move the guns mechanically, so a separate adjustable magnet for each gun moves each electron beam separately. The result is the same as if there were individual mechanical gun-aiming devices

Fig. 3. Blue lateral positioning magnet is not part of convergence assembly but is on tube neck over G3.



directing the beams to some common point in the center of the screen. Beam-positioning magnets for this purpose are called "static convergence magnets." Older television receivers used d. c. electromagnets; hence, the term "d. c. convergence" may still be used.

Rotatable disc-shaped static convergence magnets located atop the cores of the convergence electromagnets exert influence on any one beam in the area immediately forward of the focus electrode. Interaction between the effects of each magnet is minimized by shielding within the tube neck. The magnetic field is conducted from the cores to the beam for each gun by strips of magnetic material used as pole pieces. These are also within the neck of the tube (Fig. 2).

The static convergence magnets, in effect, aim each gun individually toward a single point at the center of the screen. Rotation of the static-convergence magnets changes the strength and direction of the magnetic field. Therefore, the beams can be shifted only along a line which is diagonal for red and green guns and vertical for the blue, as seen in Fig. 2.

The diagonal movement of the red and green beams makes it possible for these two beams to meet at a single point. The vertical movement of the blue beam however

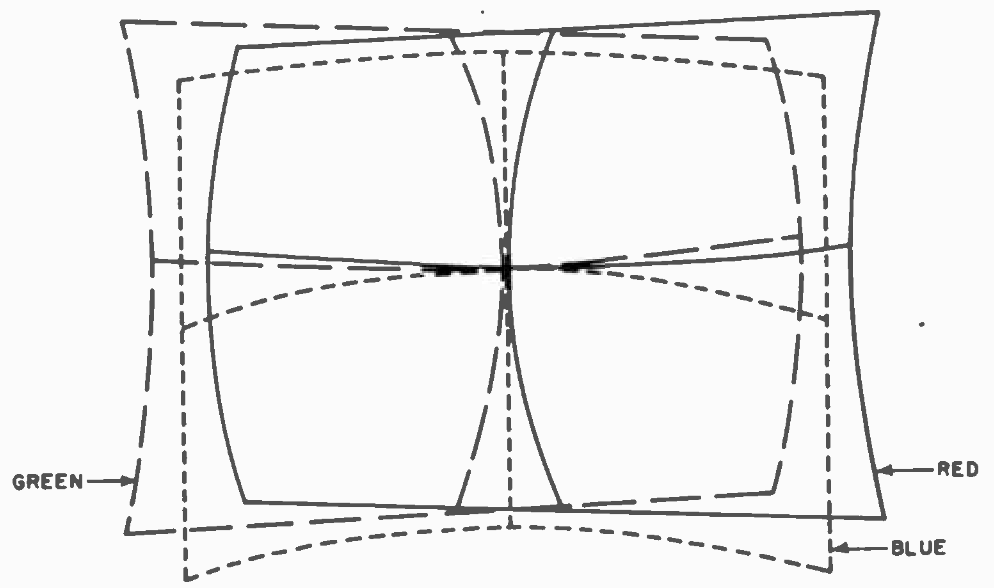


Fig. 4. Three rasters that would be produced without dynamic convergence. Note how convergence error increases out from center. After convergence has been done, there should be near-perfect overlap.

might miss this point; being either to the right or left of it. An additional beam-positioning magnet for the blue gun moves the blue beam sideways to make it fall upon the converged red and green beams. This Blue Lateral device exerts its influence on the blue gun in the vicinity of G3. The magnetic field has mainly vertical lines of force to enable the beam to be moved laterally through it (Fig. 3).

Dynamic Convergence

Three beams that converge at a single point at the center of the screen will not necessarily meet at a single point elsewhere. This is because of the curvature of the screen and the geometry of the electron guns. Each gun projects a slightly different raster which does not fall exactly on top of the others. The raster and picture shape are different for each of the three guns since they do not occupy precisely the same location or have the same angle. The idea behind dynamic convergence is to make the three beams meet at a single point no matter where deflected by the yoke. The objective is to modify the shape and tilt of each picture and raster to achieve a composite superimposed picture as though only one electron gun were used. Fig. 4 illustrates the raster distortion that must be corrected.

Superimposition of three pictures at one spot is accomplished by static convergence. Maintaining the superimposition at all points is a matter of dynamic convergence. Electromagnets with specially shaped deflection currents are used to accomplish dynamic convergence. These currents, parabolic in shape, come *via* dynamic

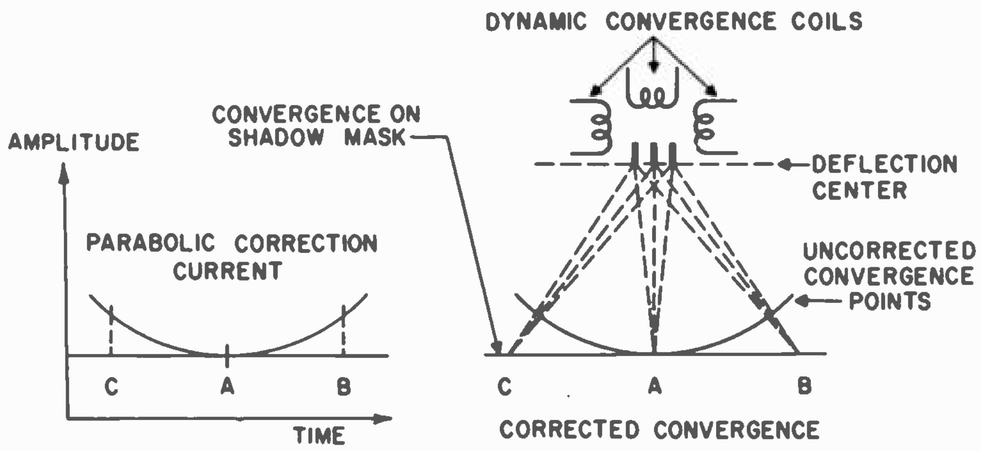


Fig. 5. Parabolic current is needed for convergence.

convergence circuits from the vertical and horizontal sweep circuits. The currents are applied to convergence coils mounted on the convergence assembly.

Along a vertical line at the center of the screen, horizontal deflection is zero; therefore, no horizontal dynamic convergence signal is required. The vertical line must be converged with a vertical-sweep-derived parabola.

Along a horizontal line at the center of the screen, vertical deflection is zero; therefore no vertical deflection signal is required. The horizontal line must be converged with a horizontal-sweep-derived parabola.

A horizontal and vertical convergence coil is required for each gun. The assembly is mounted on the neck of the of the CRT in the vicinity of convergence electrode, G4.

The red and green coils are connected in series. The same horizontal and vertical convergence signals are used for these two guns although balancing is needed, as will be described later. The blue gun has its own horizontal and vertical parabola signals.

At any other point on the tube face, other than dead center, three-beam convergence results from the sum of horizontal and vertical parabolas at that point. The technician generally observes the central vertical and horizontal lines generated by a crosshatch instrument in making initial dynamic convergence adjustments. Convergence at other points is the result of the technician's awareness of convergence principles that enable him to make compromises along the center line in order to achieve more favorable corner convergence.

Fig. 5 shows that the length of the three beams varies with scanning. The focal length is fixed at the center of the screen by a combination of purity and static convergence adjustments. To shift the focal length as a function of deflection, two correction signals are required. As mentioned previously, one is derived from the horizontal sweep circuit, and the other from the vertical sweep system. Synchronized convergence results from this technique.

As the three beams swing in an arc, maximum correction is required at the top, bottom, and sides of the screen. A parabolic correction signal matches this description nicely, having maximum amplitude at the start and finish, with zero amplitude at the center.

In general, each parabola is adjusted for amplitude and tilt to compensate for tube and circuit variations. Amplitude determines the amount of correction while tilt changes the parabola so that different amounts of correction can be made at one edge of the tube compared to the opposite edge.

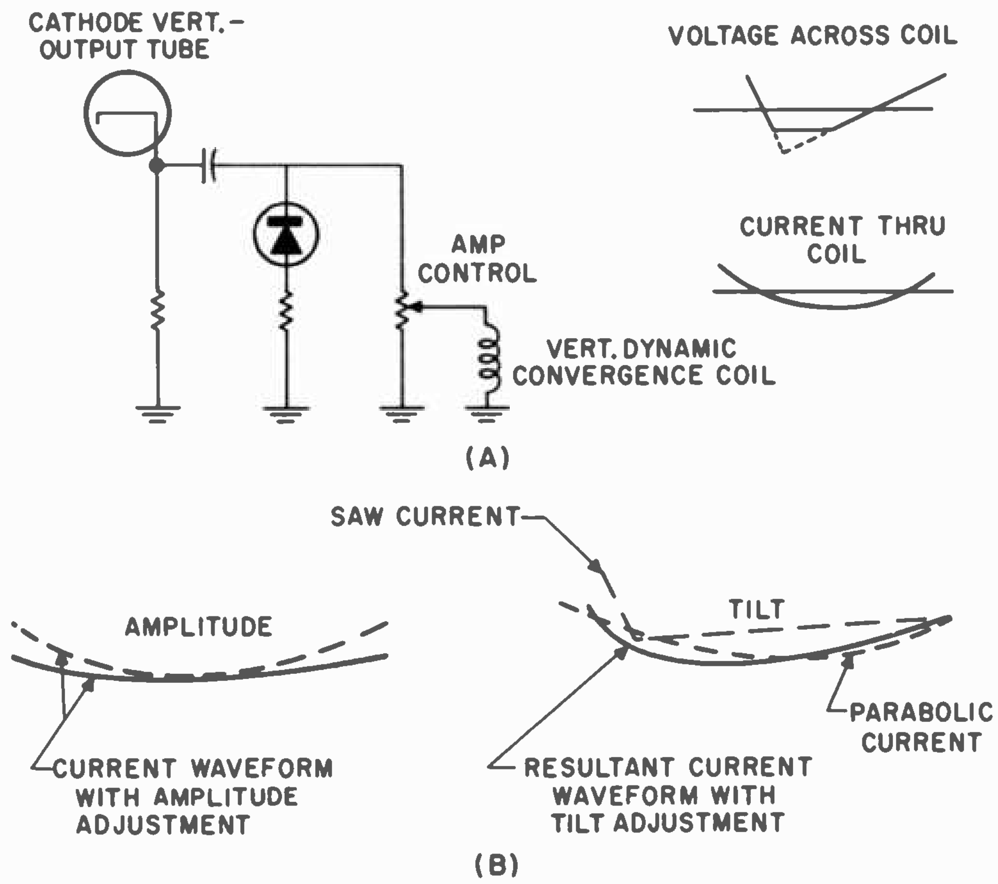
Vertical Dynamic Convergence

The vertical current parabola originates from a negative sawtooth voltage developed across the vertical-output tube's cathode resistor (or transistor emitter resistor). The convergence-coil inductance creates a parabola of current from the saw voltage (Fig. 6A). A diode flattens the most negative portion of the sawtooth. Otherwise, the parabola would be nonsymmetrical. An Amplitude potentiometer sets the amplitude of the parabola by adjusting the voltage across the convergence coils.

The red and green convergence coils are connected in series so that a single voltage source suffices for both. The red and green guns require similar correction due to identical convergence errors.

Current through the red and green coils returns to ground through the center tap on a secondary (tilt) winding on the vertical-output transformer by way of the wiper arm of a Tilt potentiometer connected across the winding (Fig. 7). Retrace voltage pulses across the tilt winding create a sawtooth current which combines with the parabolic current and tilts the resultant current waveform (Fig. 6B). The amount of tilt applied to the parabola is determined by the pot "R/G Vert Tilt" which has positive pulses at one end, negative at the other, and zero in the center. The object is to add or

Fig. 6. Vertical parabola generator and waveforms.



subtract correction at the top of the screen without affecting the bottom.

Hopefully, the amount of correction required by the red and green beams is equal. To assure that the red and green coils provide equal correction, current in each is adjustable by an "R/G Vert. Differential Amplitude" pot. This is the equivalent of a variable resistor across each coil. The control is connected so that an equal portion of its resistance is across each coil when the wiper arm is centered. Moving the wiper arm one way or the other places more of the resistance across one coil, less across the other. That's how the control gets its name "differential." This amplitude-balance control has its greatest effect at the bottom of the screen. An unbalanced condition is noted by observing horizontal red and green lines at the bottom center of the screen. The differential-amplitude control brings the lines together when coil currents are balanced.

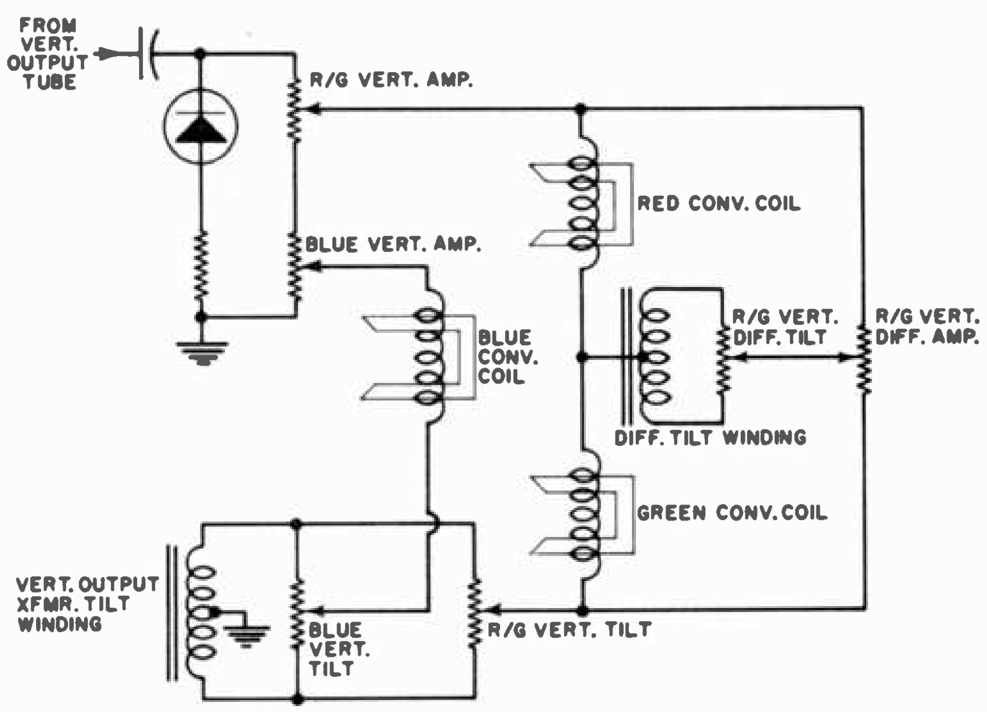
To assure balanced tilt waveforms in the red and green coils, an "R/G Differential Tilt" control is required. A separate center-tapped secondary winding on the vertical output transformer supplies varying amounts of positive and negative pulse voltage depending on the differential-tilt-control setting. The addition of a positive or negative pulse to the current through the coils results in more or less tilt correction at one coil with respect to the other. The tilt control described earlier applies identical waveforms to each coil. The differential-tilt control applies more or less tilt to one coil or the other. The pulses across the differential tilt secondary winding result from vertical retrace; therefore, the differential-tilt control has its greatest effect immediately after retrace, which is the top of the screen. Horizontal lines at the top center are the guides for this adjustment. The lines come together when the tilt waveforms are balanced.

The blue vertical dynamic convergence circuit has one coil; balancing or differential controls are not required. The amplitude and tilt controls permit correction for the blue gun. Horizontal blue lines at the top and bottom of the screen are noted in setting blue vertical convergence. Usually the blue vertical-tilt pot is centered as a start. The blue vertical amplitude is adjusted for convergence with the red/green lines from top to bottom down through the center of the screen. If correction is required at the top because everything from the center down is acceptable, the blue vertical tilt pot may be used to converge blue with red/green lines at top.

To summarize, R/G vertical amplitude affects the bottom center of the screen; R/G vertical tilt affects the top center; R/G differential amplitude balances red to green at the bottom of the screen; R/G differential tilt balances red to green at the top of the screen.

Blue vertical amplitude affects the blue horizontal lines at the top and bottom while blue vertical tilt permits additional correction for the blue lines at the top.

Fig. 7. Simplified vertical dynamic convergence circuit. Differential controls balance the currents and waveforms in the vertical red and green convergence coils.



Horizontal Dynamic Convergence

Correcting the three beams so that they meet at a single point as they trace from left to right along the center of the screen is accomplished with parabolic current generated by the horizontal sweep system. Resonant circuits are practical because of the higher frequency of the horizontal sweep system. This arrangement requires less power from the generating system. There is no sawtooth voltage readily available in the horizontal sweep system, so the parabola is derived from flyback voltage pulses in the horizontal output transformer. How this is done is illustrated by examining the horizontal dynamic convergence circuit for the blue beam (Fig. 8).

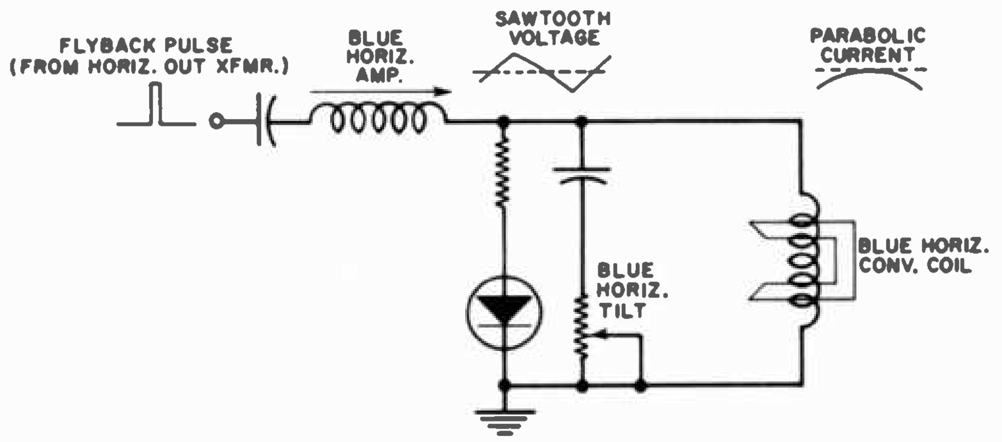


Fig. 8. Blue dynamic horizontal convergence circuit.

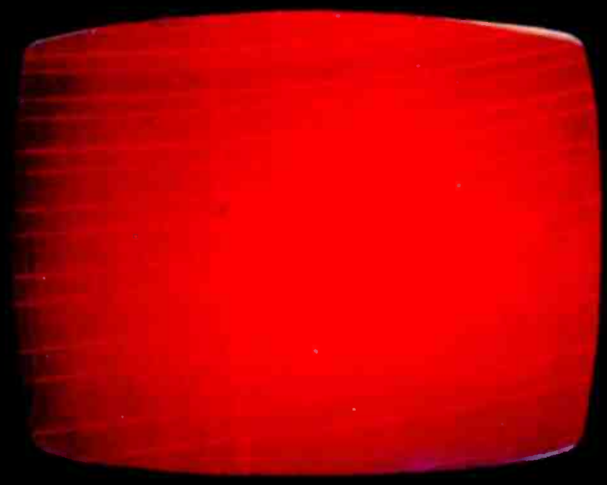
The input inductor and the inductance of the convergence coil produce a sawtooth voltage waveform for every flyback pulse applied. The sawtooth voltage across the convergence coil creates a parabola-shaped current through the coil. The inductor is tunable so that the amount of sawtooth voltage can be varied. As a consequence, parabolic current amplitude is varied.

The "Blue Horizontal Tilt" control is usually a potentiometer in series with a capacitor across the convergence coil. When the pot is shorted out by the wiper, the coil current is a true parabola because of the convergence-coil inductance. When resistance is added to the circuit, the current has a sawtooth component added, resulting in increased current at the beginning of the parabola (which corresponds to the beginning of scan).

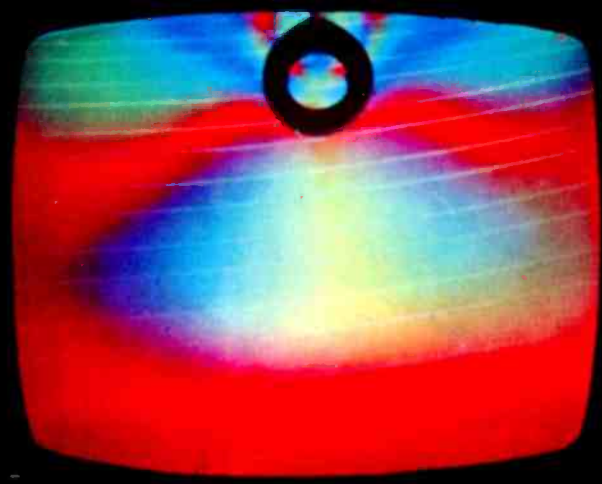
The picture-tube patterns shown on the facing page are discussed in full in the articles "Purity and Convergence Adjustments for Color Sets" (page 27) and "New Solid-State Color-Bar Generators" (page 118).

COLOR & TINT CONTROLS • PURITY

COLOR CONTROL Color intensity should be variable from no color, to washed out color (top, left), to normal (left), to excessive color (above). A little less color is often more pleasing to the viewer than saturated colors.

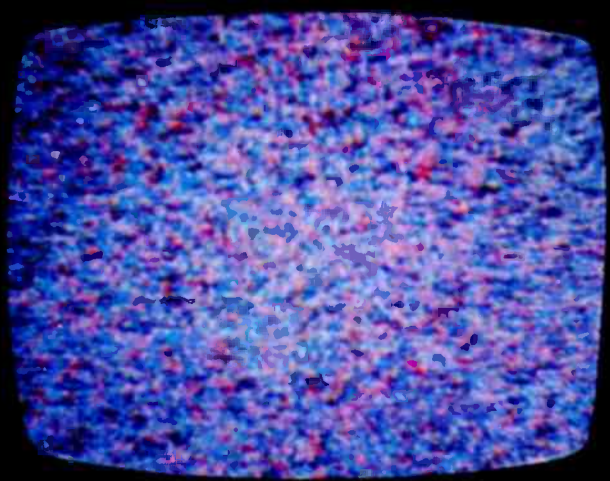


COLOR SPLASH Extreme corners of screen discolored due to secondary emission is of no great importance.

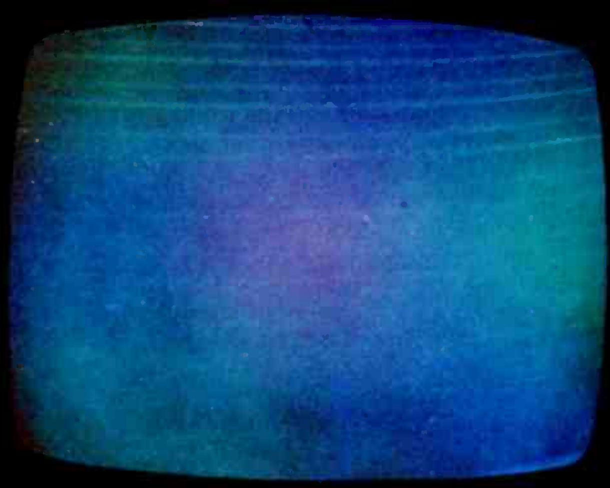


WEIRD COLORS Distortion caused by magnet held close to screen. Use degaussing coil to demagnetize tube and set before adjusting convergence.

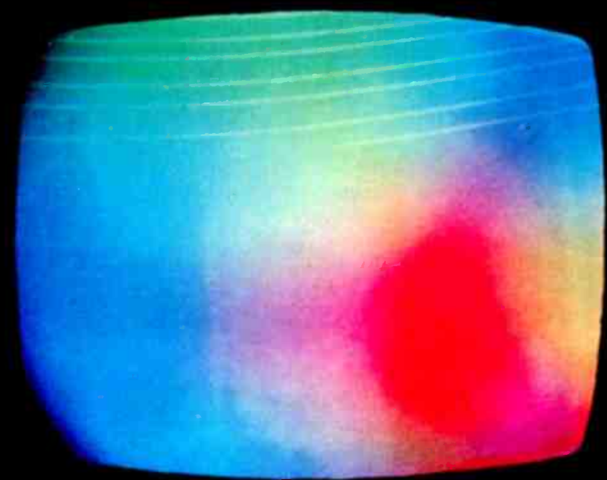
TINT CONTROL Always adjust for best skin color, or best red. Control range should extend from excessive green (top, left), through normal (left) to excessive purples or blues (above). Effects vary with content of program.

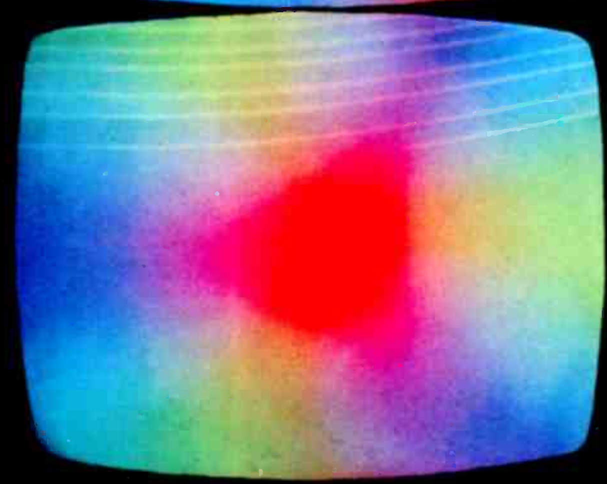


CONFETTI Snow turns to colored confetti in color TV set when control for the color killer circuit is misadjusted.



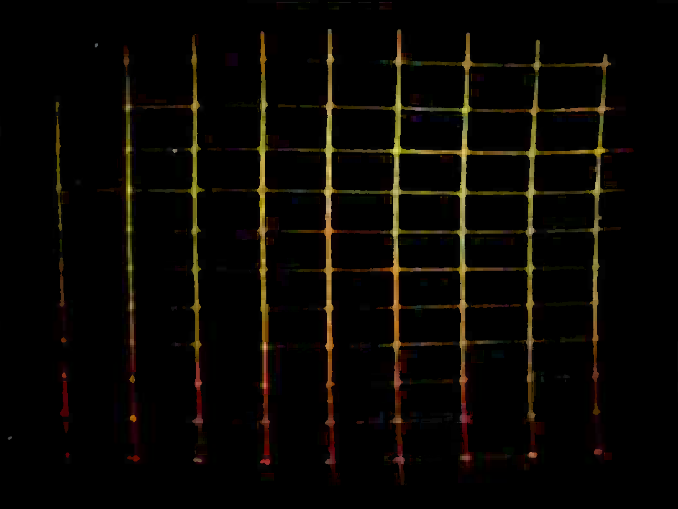
POOR FIELD UNIFORMITY With only the blue gun operating, discolorations due to poor purity adjustments show.



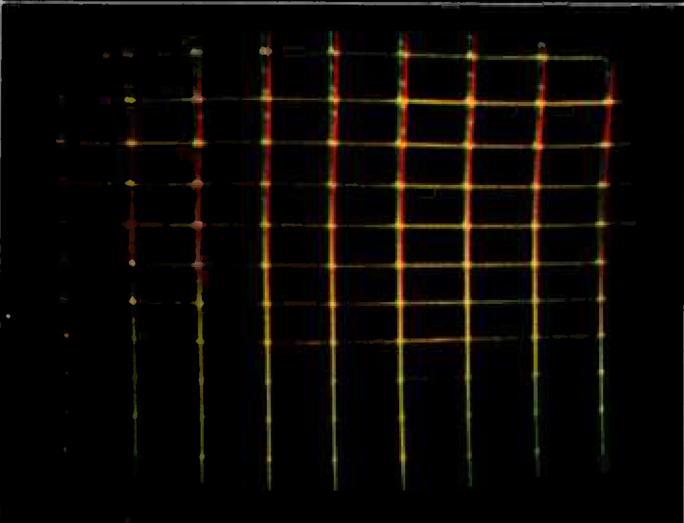


RED FIELD PURITY Set up screen for purity adjustments while operating red gun only with yoke pulled back. Off-centered red spot (top), is centered (above) by adjusting red purity magnet.

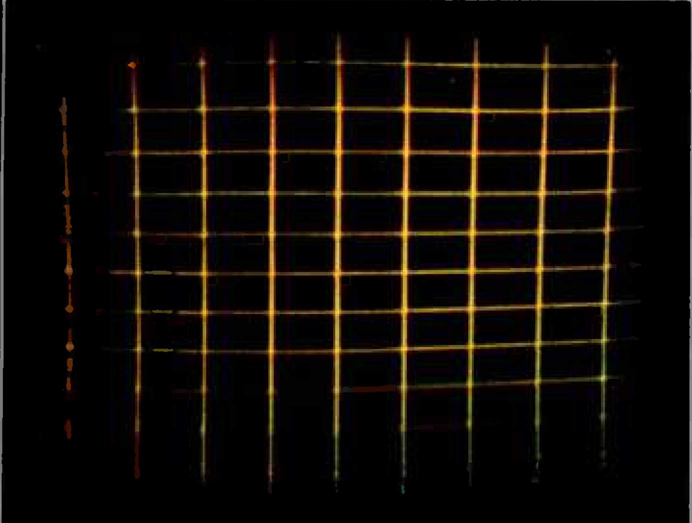
CONVERGENCE & COLOR-BAR PATTERNS



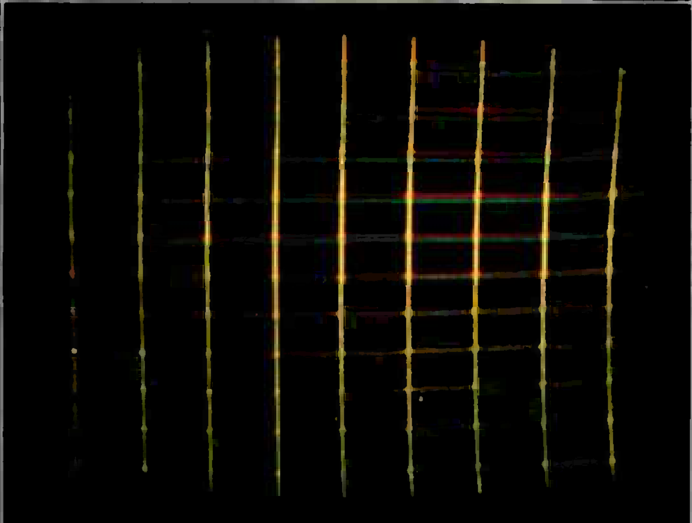
MASTER or R/G VERT. AMPLITUDE Converge bottom red and green vertical lines. Red and green become yellow.



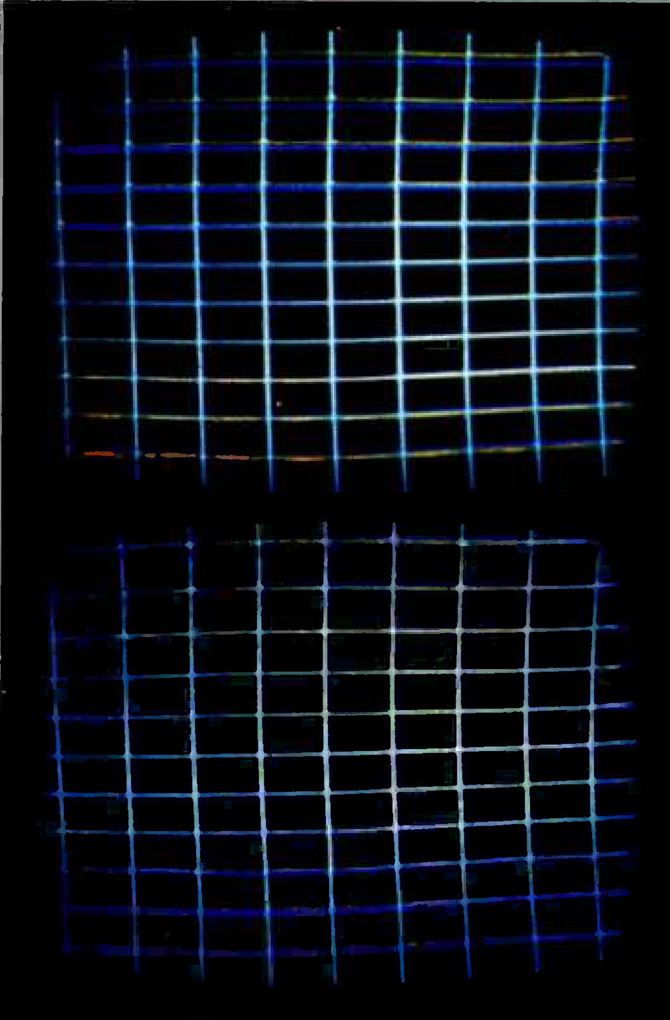
MASTER or R/G VERT. TILT Converge red and green vertical lines at top. Recheck the static convergence.



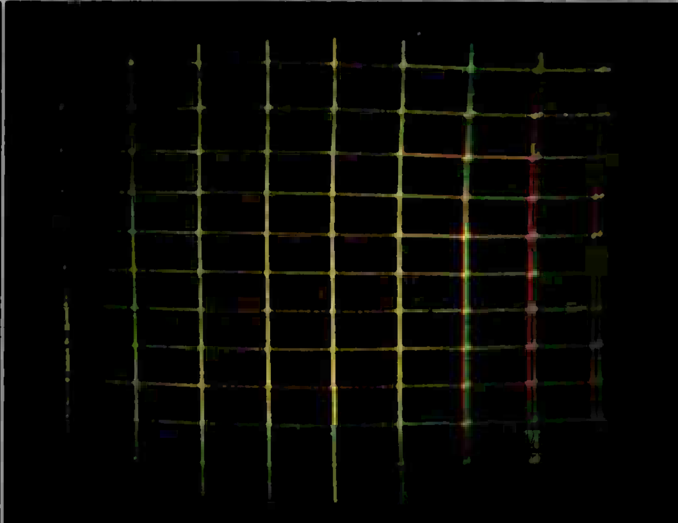
R/G VERTICAL DIFF. AMPLITUDE Converge horizontal red and green lines in the lower portion of the screen.



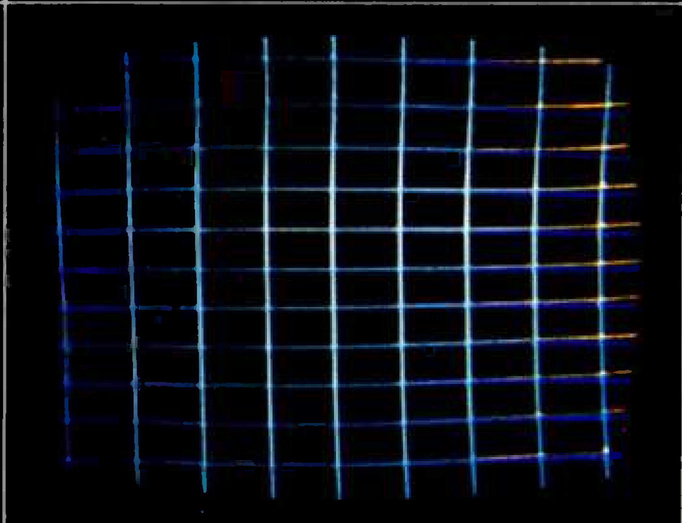
R/G VERTICAL DIFF. TILT CONTROL Converge horizontal red and green lines at the top. Optimize central area.



BLUE VERTICAL AMPLITUDE & TILT Shift the top and bottom blue horizontal lines up or down to converge with the yellow (red and green) lines to form white lines. Misconvergence is present in both photos. Lower photo shows top lines almost converged.

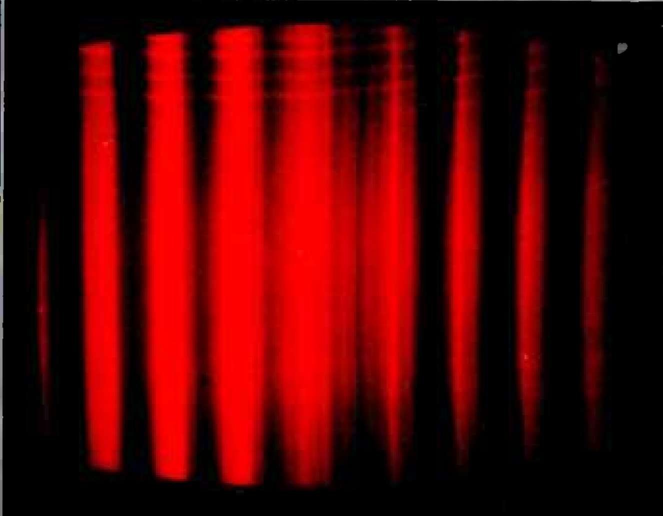


RED AND GREEN VERTICAL LINES Converge vertical red and green lines on right side. Optimize central area.



BLUE HORIZONTAL LINES Straighten the blue horizontal center lines to correct droop and misconvergence.

COLOR BAR PATTERN Normal display is indication of proper operation of phase, matrix, and other circuits.



HUE CONTROL Proper setting blends sixth bar into background. Kill green and blue guns to obtain this display.

DEMODULATORS INOPERATIVE Defective Z (or B-Y) demodulator shows up mostly as loss of blues (top); predominant loss of reds (above) can be traced to troublesome X (or R-Y) demodulator. Absence of the red or blue colors also causes a loss of the green.

The picture-tube patterns shown on the facing page are discussed fully in the articles "How to Tune for Best TV Color" (page 46) and "Purity and Convergence Adjustments for Color Sets" (page 27).

Its effect on convergence is viewed at the left side of the screen.

A diode and resistor in series serve as a d. c. clamp to prevent the parabola from affecting static convergence at the center of the screen. The positive peaks of the sawtooth voltage and the crest of the parabola are clamped at zero. Because of this, horizontal convergence current is zero at the center of the screen. Convergence coil current is maximum at the ends of the parabola, which correspond to the left and right sides of the screen where maximum correction is needed.

The red/green dynamic horizontal convergence circuit is the same as for the blue but these are combined so as to be supplied from a common generator (Fig. 9). The basic sawforming and amplitude adjustment component is the input inductor, *L*1. The tapped inductor *L*2, balances the voltage distribution between the red and green coils; therefore, this is the "R/G Horizontal Differential Amplitude" control. The effect of this adjustment is observed at the end of the horizontal scan—the right side of the screen.

The basic red/green horizontal tilt control is *R*1, which adds or subtracts resistance in series with the capacitors in the same manner as the tilt control in the blue circuit. Its effect is noted on convergence at the left side of the screen.

*R*2, the "R/G Horizontal Differential Tilt" control, operates the same way but adds or subtracts an amount of tilt current to one coil or the other. This control is a balancing component to equalize tilt between red and green. It has its greatest effect on the left side of the screen.

The diodes are d. c. clamps to reduce dynamic signals to zero at the middle of the parabola which is at the center of the screen. No dynamic correction is needed at screen center; static magnets take care of things there.

Other variations in convergence circuits appear from one manufacturer to another, but the objective is always the same: to produce a parabola of current which can be adjusted in amplitude and tilt. Red/green beams have additional balance or differential controls for amplitude and tilt so one coil can be balanced against the other.

General Purity & Convergence Procedure

No single step-by-step purity and convergence procedure will do for all sets. However, the information presented here will help a technician understand basic principles and make the manufacturer's specific procedures more significant.

The receiver must be in good working condition before setting up a color tube. If problems exist, attempting a setup will be an exercise in futility.

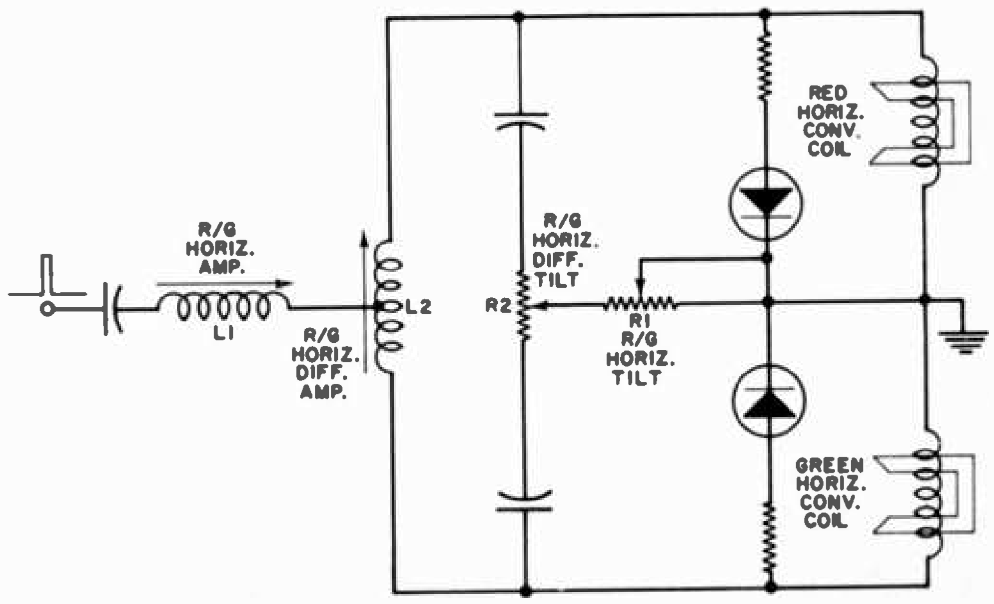
All regular receiver adjustments must be completed beforehand. A.g.c., height, width, linearity, centering, high voltage, focus, noise gate, vertical hold, horizontal hold, efficiency coil, etc. must all be done correctly. Improper adjustment here will affect purity and convergence adversely. Finally, the CRT must be demagnetized with a degaussing coil.

The dynamic convergence procedure is based on the accepted principle that vertical red and green be done first. Blue vertical is usually done next, but a strong case can be made against this because of the uncorrected blue horizontal errors that are misleading at this early stage of convergence. Therefore, this procedure suggests that blue vertical convergence be done as the last step. Horizontal red and green are done next, followed by horizontal blue. The very last is the blue vertical convergence.

The following summary outline of adjustments will prove helpful (Fig. 10): It is assumed, that a dot pattern is used for static convergence and a line pattern for dynamic convergence. These patterns are produced by the usual color-bar generator.

1. Converge all beams with static magnets. Observe: dead center.
2. Red/Green Vertical
   a. Red/Green Vertical Amplitude. Observe: vertical R/G lines at bottom.
   b. Red/Green Vertical Tilt. Observe: vertical R/G lines at top.
   c. Red/Green Differential Amplitude. Observe: horizontal R/G lines at bottom.
   d. Red/Green Differential Tilt. Observe: horizontal R/G lines at top.
3. Red/Green Horizontal
   a. Red/Green Horizontal Amplitude. Observe: vertical R/G lines at right side.
   b. Red/Green Horizontal Tilt. Observe: vertical R/G lines at left side.
   c. Red/Green Differential Amplitude. Observe: horizontal R/G lines at right side.
   d. Red/Green Differential Tilt. Observe: horizontal R/G lines at left side.
4. Blue Horizontal
   a. Blue Horizontal Amplitude. Observe: maximum blue bow across tube.
   b. Blue Horizontal Phase (if used). Observe: screen center; raise crest of bow.

Fig. 9. Red/green horizontal dynamic convergence is same as blue, except for differential balancing controls.



c. Blue Horizontal Tilt. Observe: left to right; straighten bow.

5. Blue Vertical

a. Blue Vertical Amplitude. Observe: horizontal blue lines top and bottom equally displaced from previously converged red and green.

b. Blue Vertical Tilt. Observe: top to bottom for equal displacement of blue horizontal lines.

6. Recheck static convergence and purity.

A More Detailed Procedure

A. Preconditions

1. Adjust the red and green static convergence disc magnets to superimpose the red and green beams at the center of the screen. Use a dot pattern for this purpose.

2. Adjust the blue static convergence disc magnets and the blue lateral magnet to superimpose the blue beam on the red and green at the center of the screen.

3. Extinguish the blue and green fields, leaving only red. G2 controls can be used for this purpose. Then remove the dots and obtain a blank raster.

4. Slide the deflection yoke back as far as possible without hitting the convergence-coil assembly.

5. Separate the tabs on the purity ring magnet. Slowly rotate the purity ring as a unit and adjust the tabs to center the red area on the screen. Note: Some receivers require that the deflection yoke be pushed *forward* for this purity adjustment. If the red "fireball" doesn't appear when the yoke is moved back, try it in the forward position.

6. Restore the blue and green field with the G2 controls; recheck static adjustments to maintain center-screen convergence.

7. Once central static convergence and purity are obtained, extinguish the blue and green fields again, leaving red. Slide the deflection yoke forward (or back) to obtain an over-all red field.

8. Advance the blue and green G2 controls to produce an approximately white raster.

9. Set up receiver to display a clear white-on-black crosshatch pattern.

10. Extinguish blue field with blue G2 pot.

B. Red/Green Vertical Convergence

11. Adjust Red/Green Vertical Amplitude to superimpose red/green vertical lines at the bottom of the screen.

12. Adjust Red/Green Vertical Tilt to superimpose red/green vertical lines at the top of the screen.

13. Readjust Red/Green Vertical Amplitude and Tilt for best convergence at bottom and top of screen.

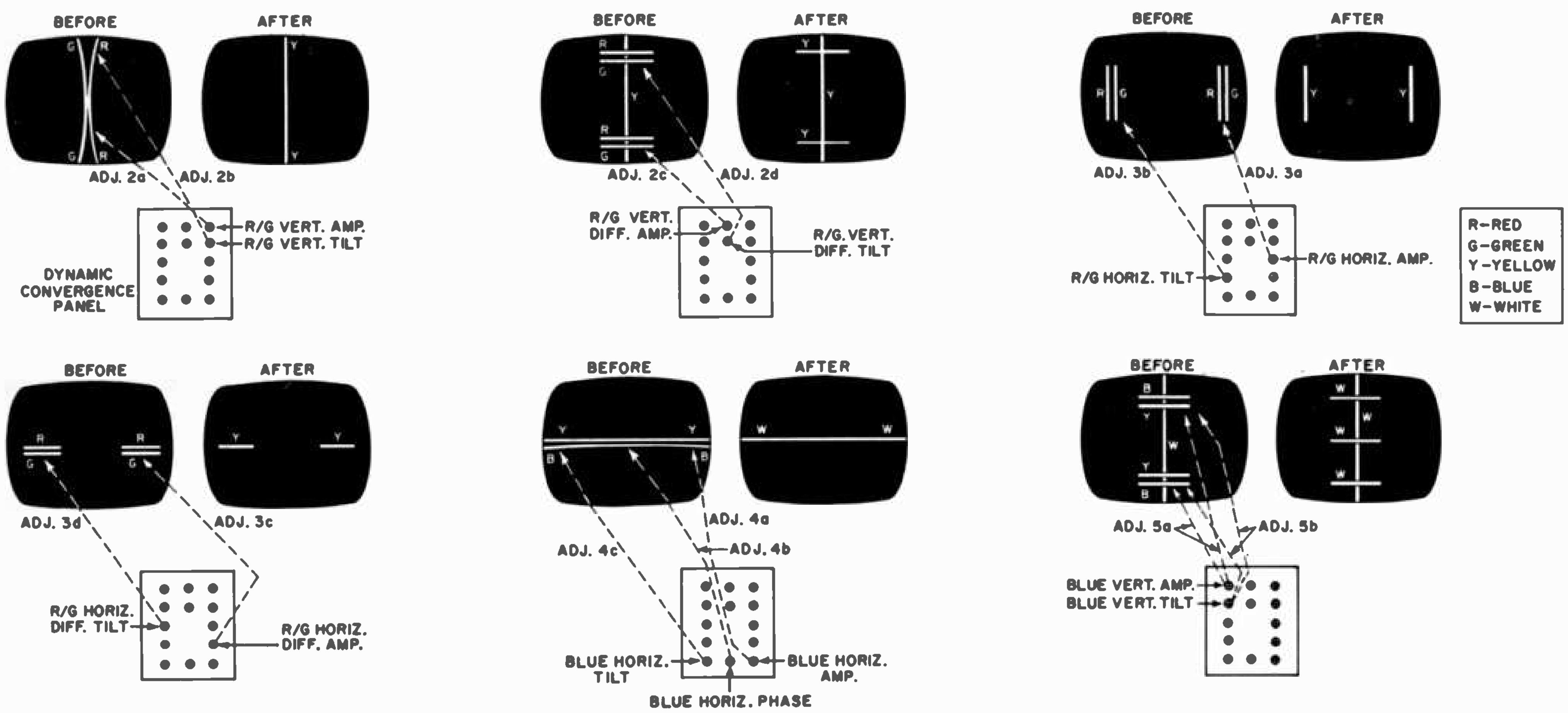
14. If misconvergence exists between the ends of the central vertical line, touch up Red/Green Vertical Amplitude and Tilt for best convergence over as much of the line as possible. Note: Some receivers have a red/green vertical range switch or tap on the convergence panel which is useful when the range of convergence is short. Selecting a larger range requires readjustment of the Red/Green Amplitude and Tilt controls.

15. Adjust Red/Green Differential Amplitude to superimpose red/green horizontal lines at bottom of the screen.

16. Adjust Red/Green Differential Tilt to superimpose red/green horizontal lines at the top of the screen.

17. If misconvergence of the red/green horizontal lines occurs between the center and the bottom, or between the center and the top of the screen, readjust Red/Green Differential Amplitude and Tilt for best convergence of the red/green horizontal lines from the center outward as far as possible. Alternate: Adjust Red/Green Vertical Amplitude and Tilt for equal displacement, in the same direction, of the red/green horizontal lines from top to bottom. Adjust red and green static convergence magnet to superimpose the red/green horizontal lines.

Fig. 10. Convergence procedure illustrated. Adjustment numbers refer to summary outline steps in text. Some manufacturers may use different terminology for controls and their controls may be located differently. The service data for particular receiver in question should be referred to for specific convergence procedure.



18. Retouch Red/Green Vertical Amplitude and Tilt to improve convergence of central vertical red/green line.

C. Red/Green Horizontal Convergence

19. Adjust Red/Green Horizontal Amplitude to superimpose red/green vertical lines at right side of the screen.

20. Adjust Red/Green Horizontal Tilt to superimpose red/green vertical lines at the left side of the screen.

21. Retouch Red/Green Horizontal Amplitude and Tilt for best convergence or equal displacement of red/green vertical lines from the center outward to both sides. Equal displacement can be corrected with red and green static-convergence magnets.

22. Adjust Red/Green Horizontal Differential Amplitude to superimpose red/green horizontal lines from left to right, or mainly at right, through center of the screen.

23. Adjust Red/Green Horizontal Differential Tilt to superimpose horizontal red/green lines at extreme left and right of the screen.

D. Blue Horizontal Convergence

24. Restore the blue field with the blue G2 control.

25. Adjust blue lateral static-convergence magnet to superimpose blue on the converged red/green vertical center line.

26. Adjust Blue Horizontal Amplitude for maximum effect, usually fully clockwise. The blue horizontal line forms an inverted bow from left to right.

27. Adjust Blue Horizontal Tilt to balance the blue bow for equal displacement at the left and right of the screen.

28. Adjust Blue Horizontal Phase (not available on all sets) to raise the middle portion of the bow at the center of screen.

29. Adjust Blue Horizontal Amplitude to straighten blue horizontal line. Note: Because of the interaction between these controls, some back-and-forth adjustments may be required.

E. Blue Vertical Convergence

30. Adjust Blue Vertical Amplitude to displace the horizontal blue lines equally at top and bottom of the screen.

31. Adjust Blue Vertical Tilt to produce equal displacement of the blue horizontal lines from the top to the bottom of the screen.

32. Adjust blue static-convergence disc magnet to superimpose the blue horizontal lines on the previously converged red/green lines. Note: Some receivers have a blue vertical range switch that provides more range if required. Repeat the Blue Vertical Amplitude and Tilt adjustments.

33. Touch up static convergence at screen center.

Fig. 11 shows the location of the purity and static convergence adjustments referred to above as well as the proper location of the CRT components.

Black-and-White Tracking

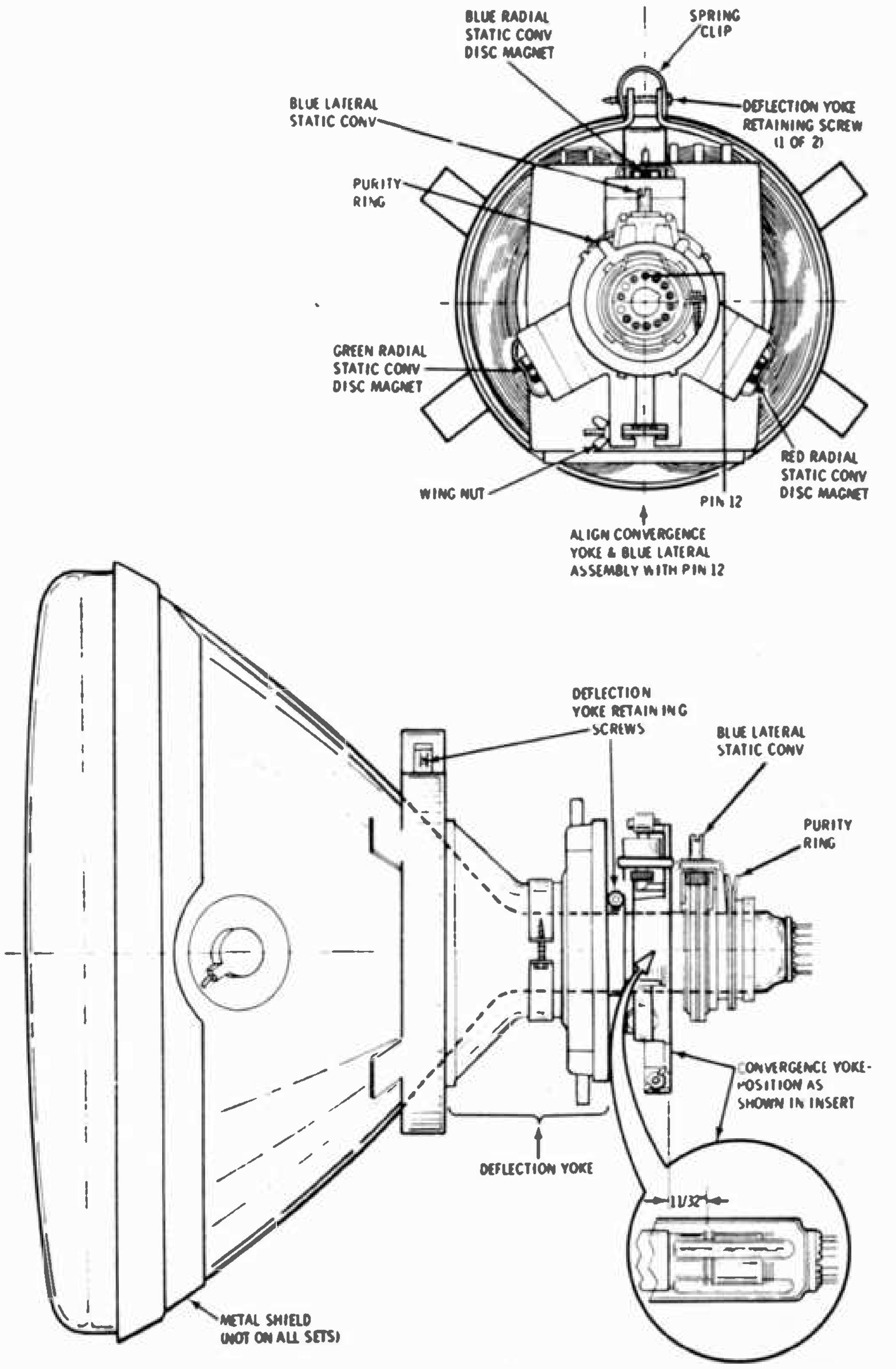
G2 (screen) controls set the cut-off point of each gun so that cut off for all guns occurs at the same low setting of the brightness control. Video drive controls correct gun tracking at high brightness. Adjustment of the latter controls may also affect the cut-off point.

There are various techniques for helping gray-scale tracking at low beam current. Some manufacturers use a service switch which collapses vertical sweep, forcing the technician to reduce brightness much lower than would otherwise be possible with a full raster. If no service switch is available, a very dimly lit raster is used as a guide for G2 tracking. Most manufacturers suggest setting the G2 of the weakest gun fully clockwise and tracking the other two guns to it at low brightness. White compression is usually an indicator that G2 of the weakest gun should be set at mid-range.

High-brightness tracking is adjusted with the video drive controls while the brightness control is set fairly high. The G2 pots may require readjustment after this. The idea is to maintain a good black-and-white picture with no color evident in either high-brightness or low-brightness areas.

The white raster should be "warm" on most tubes compared to typical black-and-white tubes which display a rather cold blue-white. Reference white on a color tube is ever-so-slightly sepia—but still close to white. This makes facial color more accurate over a wider range of brightness, hue, and saturation settings. ▲

Fig. 11. The correct positioning of CRT components.



A typical low-cost mobile type, solid-state CB transceiver.

This base-station transceiver is mounted atop housing that is used for a.c. power supply and speaker.

Installing & Servicing

CITIZENS-BAND EQUIPMENT

By ROBERT M. BROWN

Poor installation and lack of periodic maintenance plague many CB setups. Here is help in overcoming these deterrents to best system performance.

While a vast variety of CB equipment is available today (see accompanying directories), the most frequently encountered problems facing service technicians and users are not those of improper equipment or antenna selection. Rather, the difficulties arise from poor installation or the utter lack of periodic system maintenance.

For the most part, then, this article will concern itself with combating these ills—with a result, hopefully, of providing more reliable CB communications over greater distances to the end user.

Mobile Installations

Installing a tube-type or semiconductor Citizens Band transceiver requires little time and no special tools. Most transceivers are designed to operate from 12-volt auto batteries, with the negative pole of the battery grounded (see Fig. 1). Check to make sure that the battery terminal marked "Neg" or "—" has a braided metal strap connecting it to the auto body or engine block. As long as the car or truck is of at least 1960 American vintage or later, this will probably be the case. Foreign cars have varied electrical systems—for example, the pre-1966 *Volkswagen* has a 6-volt battery.

Assuming the car has a 12-volt negative-ground system, the next step is selecting a place under the dash for mounting the transceiver. The unit should not be positioned directly in the path of the heater air stream, because temperature extremes can affect frequency stability, and excessive heat often damages components. Crystal microphones are particularly susceptible to damage by high temperatures.

Another paramount factor to consider in equipment mounting is safety of operation. The unit should be mounted in such a way that it does not interfere with proper operation of the car. If it is situated beneath the dash but too near the steering column, it could interfere with brake-pedal travel or cause the driver trouble when applying the brakes. Also as dangerous is a location too far to the right, requiring the driver to lean over to reach the transceiver. For safety reasons it is advisable to employ a microphone with a push-to-talk button. The underside of the dash is sometimes not level, or it is cluttered with heater controls, cigarette lighters, ash trays, accessories, etc. In these cases, there are several alternatives for mounting: (1) choose a different location; (2) move the interfering object; or (3) use mounting brackets that extend below the interfering projection. Another location might be the hump in the center of the front floorboard. The microphone hanger can be fastened to the dash within easy reach of the operator. Self-tapping screws are generally used to fasten the unit to the floorboard.

Once it has been determined that the transceiver can be safely mounted and operated in this position, trace the mounting holes in the bracket onto the underneath of the dash. It will require some gymnastics to see these tracings and drill the holes. Although the position seems a bit ungainly, experienced installers usually lie down a little to the right of the driver's seat, so that the small of their back is where the seat of their pants usually rests. This position provides a clear view of what is happening and leaves both hands free for tools.

With a center punch or a large nail, make a clear indentation in the middle of each mounting hole mark under the dash. This gives the electric drill bit something to seat into, and practically eliminates the chance of slippage.

Now, don a pair of clear goggles—the type used for skin-diving will do if you don't have one of the clear types used for protecting the eyes when spray-painting. When drilling, tiny shavings of metal will spiral away from the bit and fall on your upturned face. Only goggles which seal the eyes from particles entering from the sides are safe.

Drill the punch-marked holes to the correct diameter with a ¼-inch chuck drill (or larger) equipped with the proper bit. Don't let the drill zip through the metal too fast—use just enough pressure to keep the bit against the dash, and no more. When the holes are drilled clean and the burrs removed with a file or tapered reamer, bolt the mounting bracket in place using lock washers under each bolt head and nut to prevent vibration from loosening them. Install the transceiver in the bracket, and make sure that it is correctly placed.

The next step is bringing power to the transceiver. With tube-type units, it is necessary to wire the power lead in series with the ignition switch, so that if the transceiver is accidentally left on, the tube filaments will not run down the car battery while the engine is turned off. Connecting the transceiver power lead to the ignition switch, however, is not desirable because the switch wiring usually has high resistance and resulting power losses cause transmitted signals which are weaker than if the transceiver were connected directly to the battery.

Transistorized units have such low battery drain that it makes little sense to worry about accidentally leaving the transceiver on when the engine isn't running. In fact, in a test run several months ago a transceiver was left on for a month without the engine running. At the end of the month, the auto's engine turned over on the first try.

Most transceivers come equipped with a female power plug for connecting the transceiver to the battery. One lead on the plug is usually black, and the other red. Ground the un-fused lead to the body by wrapping it tightly around one of the bracket mounting bolts, and screw the nut down firmly to keep it in place.

Trace the dash wiring to the firewall to find the hole through which you can run the power lead from the battery to the transceiver. Then, splice a # 18 or larger rubber-insulated wire to the fused lead from the power plug, long enough to reach the positive battery terminal. Don't just wrap the wires together—solder and tape the splice to prevent power losses or accidental short-circuits. At the battery end of the # 18 wire, form a ¼-

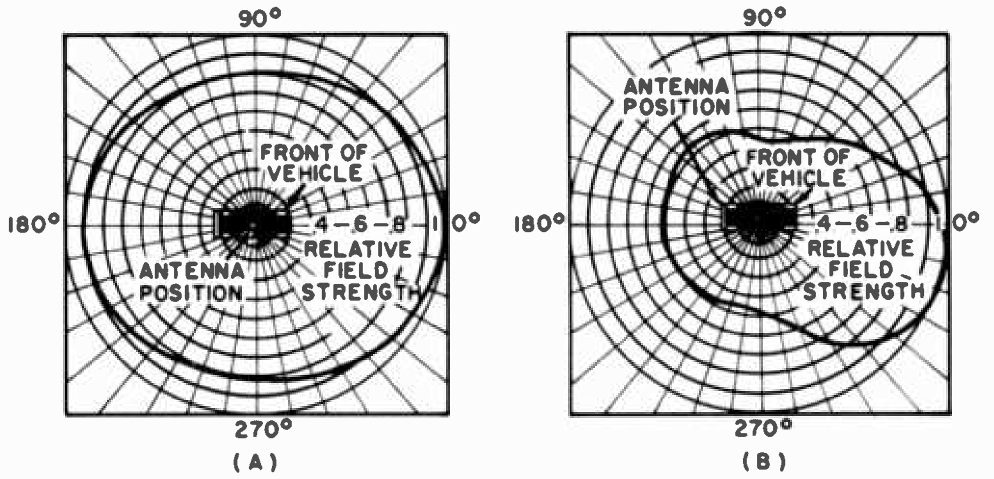


Fig. 2 (A) With the omnidirectional antenna mounted in the center of the rooftop, the pattern remains fairly omnidirectional with possibly a slight gain in the forward direction. (B) When the same antenna is remounted on the left rear bumper, pattern becomes directional, with gain in the direction of right front fender.

inch diameter loop and coat it with solder for rigidity. Then unscrew the bolt on the positive battery lead, remove the nut, slip the loop on the exposed bolt end, and replace the nut. Make certain that the bolt is tightened firmly, then coat the battery terminal, battery lead, and power lead with petroleum jelly. The transceiver is now electrically connected and needs only an antenna.

Mobile CB Antennas

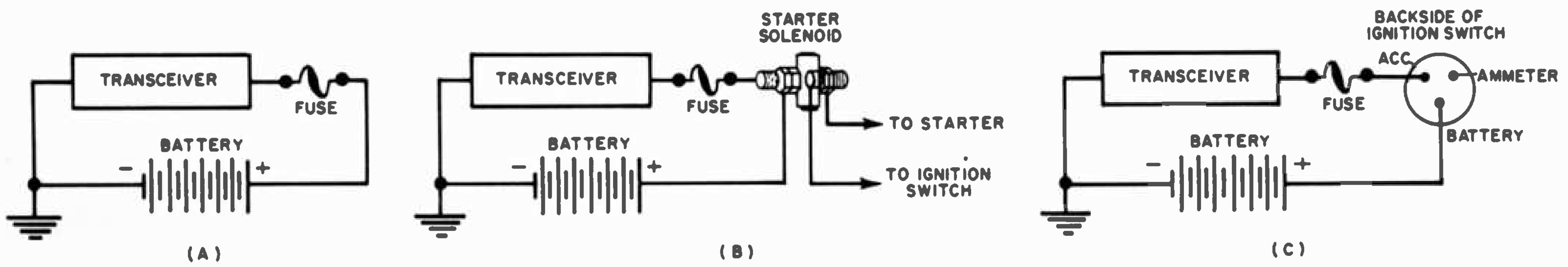
Mobile antennas for a CB radio system must be selected with care if maximum efficiency is to be attained.

Appearance is a major concern in some cases—for example, a limousine service wants the least conspicuous antenna for aesthetic reasons, in other cases the user may want inconspicuous antennas for company cars, etc. Other users, such as salesmen, may be limited by leasing company contracts which forbid cutting a hole in the auto body for mounting an antenna.

Because of the irregular shape of an automobile (or other vehicle), there is actually only one place where the antenna should be mounted—in the middle of the roof. Antenna length and aesthetics may rule out the location, but it is practically the only place where radiation patterns are unaffected by the car's steel body (Fig. 2A).

The mobile antenna against which all others are referenced is the quarter-wave whip. Note that at 27 MHz this antenna is about 104 inches (8⅔ feet) long. This limits it to either bumper or fender mounting. In Fig. 2B the radiation for a bumper-mounted quarter-wave whip is shown. Note how the antenna, which was omnidirectional before mounting, is now exhibiting directivity and a slight amount of gain over the opposite front fender. In addition, wind resistance to the long whip will

Fig. 1. CB unit may be connected (A) directly to the battery, (B) to starter solenoid, (C) to ignition switch.



cause signal "flutter", variations in signal strength of about ±1.0 dB at 60 mi/h.

Through the use of a loading stub in the coaxial feedline, the quarter-wave whip can be shortened to about 54 inches. Because it is shorter than a full-sized whip, it can be mounted on top of the rear fender to improve the radiation pattern over that of a bumper-mounted antenna. This rear-fender mounting is common with law-enforcement vehicles. The shortening stub is cut to the correct length, so that a wattmeter in series with the antenna and transmitter reads minimum reflected power. An excellent omnidirectional antenna for CB frequencies is the base-loaded rooftop whip. An inductor and a capacitor in a sealed cylinder at the antenna base combine to match the shortened antenna to the transmission line.

A variation of the base-loaded antenna is the helically wound fiber-glass whip. Essentially a large radiating coil, the helical antenna can be made in varying lengths for a single resonant frequency. It is shorter than a whip and its efficiency is about the same.

By increasing the length of a stub-loaded whip to ⅝ wavelength, omnidirectional gain of about 2.5 dB will be obtained. Like the unity-gain model, the ⅝ wavelength whip can be either cowl or fender mounted.

A ⅝-wavelength-gain antenna is available without the stub loading. This antenna combines the characteristics of base-loaded rooftop and stub-loaded models. A loading coil is formed into the base of the spring-tempered stainless steel whip, resulting in a gain of about 2.5 dB over a simple quarter-wave whip.

Adapted versions of many of the above are now available as car-radio-antenna replacements. While not ideal, they should be considered.

CLASS-D CITIZENS-BAND EQUIPMENT DIRECTORY

CB transceivers licensed under Class D of the FCC Rules & Regulations (Part 95) are designed to operate with five watts input to the final r.f. amplifier stage of the transmitter. This is the maxiumum allowed for 27-MHz licensed operation.

In the tabulation that follows, it can be assumed that all transceivers listed are five-watt units (with output to the antenna falling into the 2½ to 3½ watt category). With 23-channel operation, the maximum allowable, many transceivers here utilize the full-band capability. Others are limited to, for example, five of the 23 available channels. This means that any five of the 23 can be used, although the manufacturer usually includes transmit and receive crystals for channel 9 (or 11) and leaves it at that. The user then buys compatible crystals for the balance of the available channels, specifying which channels he desires. This is indicated under "CHAN." in the directory. Most transceivers with a "23" rating come either equipped with all necessary crystals or have a built-in frequency-synthesizing circuit to permit the same thing.

Furnishing power to Class-D units is a subject of increasing controversy in the CB industry. A few years back, nearly all units came equipped with "Univ." (for universal) power supplies. This meant the set could be used both at home and in a vehicle (with built-in 12 V d.c/6 V d.c./117 V a.c. capability). Today, however, there is a definite trend to 12-volt-only sets. Reason? There are nearly four mobiles to every base station purchased. With competitive pricing constantly in mind, manufacturers now provide base capability as an option, through purchase (at varying prices) of a 117-V a.c. supply. These power adapters are usually designed to be used only with specific CB units.

Although the trend to solid-state continues, a few manufacturers continue to produce tube-type units. These are indicated in the directory by a "—" under the "SEMI." category.

Guide to footnotes: [1] In kit form only. [2] All transmit and receive crystals included.

MFG.	MODEL	CHAN.	VOLT.	SEMI.	PRICE ($)
Amphenol	675	10	12	X	159.95
	725	8	12	X	99.95
	750	6	12	X	79.95
	777	23[2]	12	X	169.95
Apelco	AR-15	9	117	X	99.95
	AR-16	10	12	X	159.95
	565	5	12	X	129.95
Autronics	C	23	Univ.	X	385.00
	Mobile	12	12	X	265.00
B&K	CAM-88	23	Univ.	—	214.95
	Cobra V	5	12	X	99.95
	Cobra 23	23[2]	12	X	169.95
Browning	Eagle	23[2]	117	—	359.00
	Eaglette	23[2]	12	—	209.50
	Golden Eagle	23[2]	117	—	395.00
Burstein-Applebee	BA-8	8	Univ.	—	79.95
	BA-23X	23[2]	Univ.	—	119.95
Courier	Classic	23	12	X	199.00
	Royale	23	Univ.	—	279.00
	Traveller	23[2]	12	X	149.00
	TR-5	5	117	X	99.00
	TR-23S	23	117	X	169.00
	23	23[2]	Univ.	—	189.00
	23 Plus	23[2]	Univ.	—	199.00
	12	12	Univ.	—	110.00
Craig	4301	5	12	X	99.95
Demco	Chalet	6	12	X	129.95
	Ravelle	6	Univ.	—	134.50
	Ravelle 23	23	Univ.	—	224.50
	Super Satellite	23	Univ.	—	430.00
Eico	Nova-23	23	12	X	189.95
	Sentinel Pro	23[2]	Univ.	—	169.95
	Sentinel 12	12	12	—	99.95
General	MC-11	23	Univ.	X	229.50
	Super MC-11	23	Univ.	—	259.50
	Super MC-9	23	Univ.	—	189.50
	VS-6	5	Univ.	—	89.50
	MC-8	23	Univ.	—	199.50
Hallicrafters	CB-17	6	Univ.	X	99.95
	CB-19	23	Univ.	X	149.95
	CB-20	5	12	X	99.95
	CB-21	8	12	X	139.95
	CB-24	23[2]	12	X	199.95
Hammarlund	CB-205 (CB-Ham rig)	6	117	—	259.95
Harmon Electronics	HCB-100	6	12	X	95.50
Heath	GWW-14A	23	12	X	124.95
	GW-12A	23	117	—	39.95[1]
	GW-14	23	12	X	76.95[1]
	GW-22A	5	117	—	47.95[1]
	GW-22D	5	12	—	49.95[1]
International	MO-23	23	12	X,—	245.00
	660	23[2]	Univ.	X,—	205.00

Most service people who need standard-type coax cable for a CB installation will go to an electronic supplier, merely call out a catalogue number, an RG designation, and length requirement—and patiently wait at the counter for the merchandise. To others, more thought is given to selecting the line. Unfortunately, this consideration never gets much further than the length of feedline required *vs* attenuation per foot. And even then they may purchase inferior cabling for the CB installation to be made.

To all too many, standard coaxial cable is a foolproof commodity which can normally be bought "blind." Few realize that a feedline made by one manufacturer can exhibit completely different characteristics from one made by another—even though both cables carry the same RG designation.

Moreover, too free usage of the term "RG cable" has led to considerable procurement confusion. The term RG actually connotes cable meeting latest revision specs of MIL-C-17; older versions of JAN-Spec and MIL-C-17 cable do not. Unless the manufacturer clearly states this, it cannot be assumed that the latest spec is being met. Additionally, some manufacturers have blurred this distinction with meaningless terms such as "RG-type." It is essential that these possibilities be kept in mind—since highly inefficient operation and perhaps even a failure of the entire CB cabling system could result if the wrong coax is used. Slow cable degradation, a prime cause of gradually deteriorating signals, is extremely hard to detect.

How is a poor coax-cable dielectric spotted? If a thick-wall coaxial line with silver-plated copper conductor has a dielectric that appears amber or gray when placed upon a sheet of white paper, it is probably made of in-

MFG.	MODEL	CHAN.	VOLT.	SEMI.	PRICE ($)
Johnson	Messenger I	5	Univ.	—	114.95
	Messenger II	10	Univ.	—	159.95
	Messenger III	12	12	X	159.95
	Messenger 100	6	12	X	129.95
	Messenger 110	5	12	X	99.95
	Messenger 223	23	117	X	214.95
	Messenger 300	12	12	X	189.95
	Messenger 320	23	12	X	199.50
	Messenger 323	23	12	X	229.95
	Messenger 350 (SSB)	2	12	X	299.95
Kaar	Skyhawk Mark II	23[2]	12	X	229.95
	Skylark	11	12	X	179.95
Knight & Knight-Kit (Allied)	A-2530	10	Univ	X	109.95
	A-2567	23	Univ.	X	109.95
	A-2569	23	12	X	149.95
	Safari II	5	12	X	49.95[1]
	Safari III	23	12	X	79.95[1]
Lafayette	Comstat 9	9	Univ.	—	54.95[1]
	Comstat 19	9	117	—	59.95
	Comstat 23	23	117	—	114.95
	Comstat 25A	23	Univ.	—	139.95
	HB-23	23	12	X	99.95
	HB-525C	23[2]	12	X	149.95
	HB-555	12	12	X	89.95
	HB-600	23[2]	Univ.	X	219.95
	HB-625	23[2]	12	X	189.95
	HE-20T	12	Univ.	X	89.95
	Telstat-23	23[2]	Univ.	X	159.95
Mark	Invader 23	23	12	X	169.95
Messenger	Fieldmaster TR-18	23[2]	12	X	149.95
Midland	13-150	8	12	X	84.95
	13-860	12	12	X	99.95
	13-865	23	12	X	119.95
	13-870	23	12	X	149.95
	13-875	23	Univ.	X	169.95
Mobilefone	Mountaineer	10	12	X	195.00
Multi-Elmac	Citi-Fone SS	23	Univ.	X	169.95
	Citi-Fone II	2	12	X	49.95
	Citi-Fone 99	8	Univ.	X	99.95
Olson	CB-8	8	12	X	80.00
	CB-12	12	12	X	99.95
	CB-88	23	12	X	149.98
Pace	Auto-Mate	12	12	X	69.95
	Pace Plus-23	23[2]	12	X	199.95
	Pace 100	6	12	X	129.95
	Pace 200	12	12	X	159.00
	Pace 2300	23[2]	12	X	219.95
Pearce-Simpson	Companion II	5	Univ.	—	159.90
	Companion IV	10	12	X	139.90
	Director 23	23[2]	12	X	269.90
	Guardian 23B	23[2]	Univ.	X	269.90
	Sentry II	5	12	X	99.90
Penney	Pinto 23	23[2]	12	X	129.00
Polytronics	PC-23	23	Univ.	—	229.50
	PC-23C	23[2]	12	X	199.50
	Poly-Otter	7	12	X	199.50
	Poly-Pup	7	12	X	149.50
	Utility 5	7	12	X	243.95
Raytheon	TWR-7	5	12	X	129.95
	TWR-9	6	Univ.	X	99.95
	TWR-11	10	12	X	159.95
Realistic (Radio Shack)	TRC-14	8	12	X	79.95
	TRC-15	12	12	X	88.44
	TRC-18	12	12	X	99.95
	TRC-24	23[2]	12	X	139.95
Regency	Bronco	8	12	X	89.95
	Charger	12	12	X	110.00
	Imperial (SSB)	23/46	Univ.	—	299.00
	Pacer II	11	Univ.	—	110.00
	Range-Gain II (DSB)	23	Univ.	—	235.00
Robyn	Bronco 7 + 4	11	12	X	139.50
	24 Range Gainer	23	Univ.	—	189.50
Sears Roebuck	6556	5	12	X	99.95
	6558	12	12	X	134.95
	6562	23	12	X	199.95
Sonar	FS-23	23[2]	Univ.	—	299.95
	H	7	Univ.	—	159.95
	J-23	23[2]	12	X	230.95
Squires-Sanders	Admiral	23	117	X	329.95
	Commodore	23	12	X	199.95
	Skipper	23	12	X	159.95
SSBCO	ASB-11(AM, SSB)	5	12		277.50
	ASB-11A(AM, SSB)	5	12		322.50
	SSB-27 (SSB only)	5	12		249.95
	SSB-27A (SSB only)	5	12		299.50
Tram	Titan	23	117	—	434.00
	Titan II	23	117	—	482.00
	XL-100	23	Univ.	—	318.00
World Radio	Rustler II	11	Univ.	—	79.95

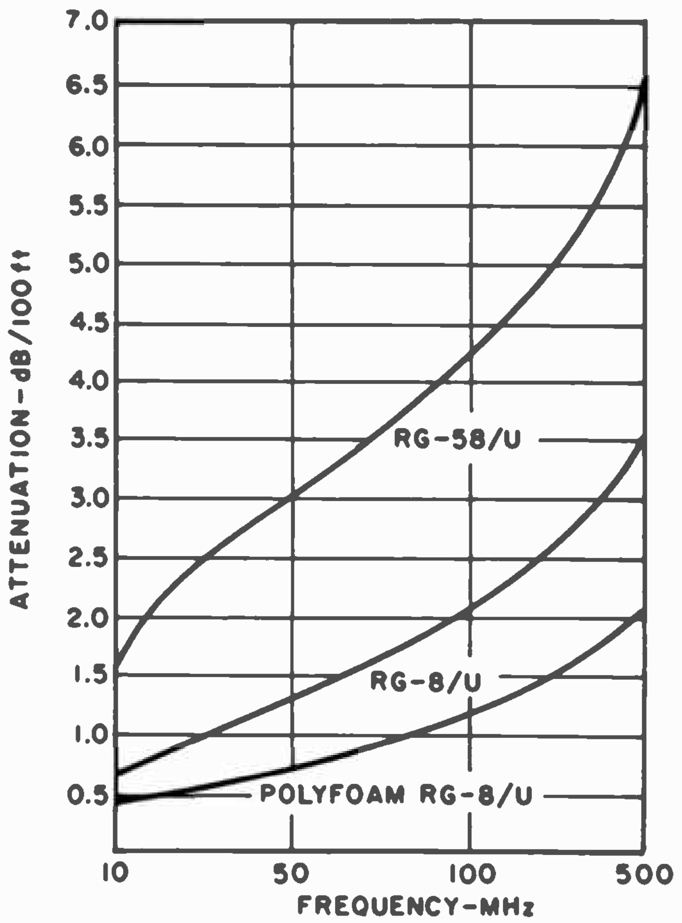


Fig. 3. Attenuation of common coaxial feedline cables.

ferior or scrap polyethylene. Inspect a sample of the cable being replaced (or currently in use). Bear in mind, however, that wall thickness—which can vary from one impedance to another (such as among 50-, 75- and 95-ohm types)—determines color hue. Also, conductor color can affect over-all hue. What about foam cables? These, too, can be checked visually. Bubble size should be tight on conductor and round in shape throughout.

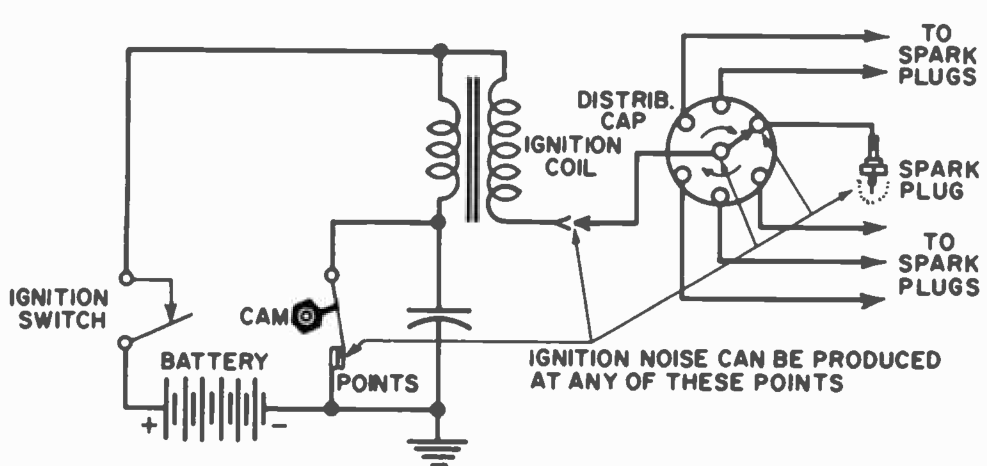
RG-8/U and RG-58/U cable, the most popular 50-ohm lines for CB use, should be examined in terms of attenuation. (See Fig. 3). Here, both solid-polyethylene and polyethylene-foam types are compared. The dB rating is for 100-foot lengths. These figures assume no cable degradation due to heat or general aging—and under ideal circumstances such as with new Type I or Type IIa jacketed lines.

If a sample of in-use cable can be obtained, much can be learned. With a micrometer, check whether the conductor is off center in the dielectric. (If there is more than 10 percent error—maximum allowed under MIL-C-17—serious problems can be expected.)

In most good-quality standard coax lines, braid should fit tightly. If it does not, this can indicate a strong possibility of change in electrical characteristics. Braid tightness, however, can vary; RG-8A/U, for example, has an extremely loose braid. Again, it is wise to check cable specifications.

Be sure to ask about flexibility requirements. Maximum flexibility is achieved with strand-type center conductors, although attenuation losses can be cut appreciably with solid conductor carriers.

Fig. 4. Standard ignition system and noise sources.



Transmission line for mobile installations should be kept as short as possible and at the same time should be routed away from the engine, gages, switches, and relays. If a rear-bumper antenna mount is used, the cable can be run either through the inside of the car or along the underside. On an inside route, lay the cable along the edge of the floor, beneath the removed carpet, and perhaps a small hole will have to be drilled, in order to feed the line into the trunk area. Another hole may have to be drilled so that the line can pass from the trunk area to the antenna. Check for existing openings before drilling a hole. If it becomes necessary, fit the hole with a rubber grommet to keep the cable from being damaged.

Mobile Noise Suppression

The following are some tips to reduce receiver noise in a mobile installation. (See Fig. 4.) None of these should cause the car to operate with any noticeable difference.

Spark Plugs. Install resistor plugs or purchase clip-on spark suppressors for each of the existing plugs.

Voltage Regulator. Install a coaxial capacitor (.22-μF) on the "B" (battery) terminal of the regulator. Do not bypass the "F" (field) terminal.

Generator. Install a .22-μF coaxial bypass capacitor between the generator's output (armature) terminal and a nearby grounding point on the engine block or firewall. Several tunable generator noise traps are listed in electronics mail-order catalogues.

Auto Gages. Place a .015-μF capacitor (disc) between each gage terminal and the nearest point on the frame of the car. Do this for the ignition switch as well.

Distributor. Install a distributor suppressor (check large auto suppliers for this) at the center terminal of the distributor.

Coil. Install a .002-μF disc ceramic capacitor with short leads from the battery terminal of the coil to the case. Next, get some bonding braid and run it from the firewall to the engine block, touching the coil case along the way. Make certain that there is a good connection at each point of contact and keep the braid as short as possible.

Tires. Insert anti-static powder by means of an air pressure hose at a service station. Place static collector springs inside the front-wheel grease-retainer cups.

Motors. Install .47-μF capacitors between the motor cable and ground at the heater motor, defroster, electric windshield wiper motor, and any other accessory motors.

Alternators. Despite all the above efforts, the most effective way to take the radio noise out of an alternator is by adding an alternator noise filter, available from electronics supply houses.

Base-Station Antenna Installation

Once the base-station antenna has been installed, there is little involved in getting a base CB rig on the air. The key to optimum performance, of course, is in selecting the best location for the antenna. Normally, of course, the highest possible spot is the best—but sometimes it is also the least practical. Questions that should be answered at this point: 1. Will the proposed structure support the antenna in high winds? 2. Is it surrounded by other high objects, such as trees, etc., which might sideswipe the antenna in a high wind? 3. Is it a safe location, from an installation and servicing aspect?

Most CB antennas should be guyed securely to withstand the rigors of wind and driving rain. All installation instructions included with the antenna selected should be followed exactly. Many have to be weatherproofed after coaxial connection has been made; in such cases, the manufacturer usually includes a rubber insulation material. Another factor of prime importance to achieving desired performance is related to cable length. The base antenna should be mounted at a point that will afford maximum elevation (chosen with the steps above in mind), yet still be a reasonable distance from the CB equipment itself.

CB antennas, unfortunately, are unwieldy when it comes to actual installation. Recruit some help; a two-man team is the minimum required. Some planning is also mandatory. Consider:

1. How much time will it take to assemble the antenna?
2. How much time will it take to locate a proper mounting point?
3. How much time may be wasted running back and forth to the workshop for additional tools and materials?
4. How much drilling must be done?
5. Are guy-wire points easily accessible, or will they have to be provided, thus eating away still more time?
6. How many men can be recruited for the job?
7. How much time will this take?
8. How much time must be spent fastening connectors and soldering on new ones? What about holding points for the cables?
9. If a rotator is used, how much more time will its installation require?

Estimates of this type are tricky, yet they are still a big help in planning antenna installations. Why the emphasis on time? Simply because it can prove the most critical factor; if pressed for time, results can be disastrous, both from performance and safety aspects. To a shop charging for the customer installation, time is the basis for its cost estimate and certainly governs whether a profit is made or not.

Nearly all installations demand a ground connection, which can be provided by driving a standard copper ground rod into the earth and running a wire (not less than 14 gauge) between it and the antenna support pole. Another lead should run to the chassis of the equipment itself. A secure connection to the cold-water piping system is also a good ground.

Antennas: The Tower Prohibition

The 20-foot height limitation imposed by the Federal Communications Commission on Citizens Band antennas is not as bothersome as it might appear. The FCC

CITIZENS-BAND ANTENNA DIRECTORY

Antennas for the 27-MHz CB band come in a wide variety of configurations and prices. The listing that follows is the result of a questionnaire mailed to known CB antenna manufacturers. In all cases, specifications are those contributed by the antenna producer and do not represent results of tests by this publication.

The first significant category in the directory is "TYPE." Here again, the listing is that supplied by the manufacturer. Many closely resemble conventional designs, such as coaxial, half-wave whip, yagi, etc. Generally, however, it can be assumed that "vertical" in the mobile category signifies a whip configuration; "LENGTH" listing provides insight into wavelength fraction or possible loading-coil construction.

For the most part the "GAIN," shown here in dB, is referenced to a typical half-wave 27-MHz dipole. This depends, however, how individual antenna manufacturers measure "gain." Most seem to use the dipole reference, however.

Most antennas listed accept standard 50-ohm coaxial cable; many, indeed, are supplied with an appropriate length of RG-58A/U already terminated to the antenna and equipped with Amphenol 83-1SP connector. Others come with a coaxial fitting for plugging the cable connector into. Still others—notably a few of the yagi/beam configurations—require that impedance-matching baluns be constructed by the installer.

Nearly all antennas not fitting into the mobile whip category come in kit form with all necessary component parts included. Allow adequate time for assembly. Assembly of complex, directional beams can take as much as five hours, depending upon design configuration and number of elements.

V.s.w.r. ratings, also supplied by manufacturers, are generally referenced to the entire 27-MHz CB operating band. As a result, they can be improved upon in many cases by trimming (adjusting T-matches, etc.) to the most-used operational frequency.

BASE-STATION ANTENNAS

MFG.	MODEL	TYPE	GAIN (dB)	V.S.W.R.	LENGTH	WGT. (lbs.)	PRICE ($)
Antenna Specialists	M-113	vert/hor 3-element	hor 8 vert 9.75	1.5:1	108" boom	26	50.50
	M-117	½-wave shunt-fed	3.75	1.5:1	216"	10	32.55
	M-119	sector-phased beam	7.75	1.5:1	17.5'	17	75.15
	M-134	vert/hor 5-element	hor 11 vert 12.5	1.5:1	22' boom	19	56.80
Apelco	BCL-1	vertical	–	–	234"	9	29.95
Avanti	Astro-plane	vertical	4	1.4:1	12'	3.5	29.95
	PLD	vertical	11	1.2:1	11.9'	13.5	79.95
Cush Craft	Ringo	vertical	3.75	1:1	214"	5	18.95
	CB-11	3-element beam	7.5	1:1	120"	15	29.50
	CB-114	4-element beam	9	1:1	192"	20	39.50
	CB-115	5-element beam	10	1:1	288"	25	59.50
	CB-11D	6-element dual beam	10.5	1.2:1	216"	30	99.50
	CB-1140	8-element dual beam	12	1.2:1	216"	45	119.50
	TS-1	universal	0	1.5:1	216"	2	6.45
	DGPA	gnd.-plane	0	1.2:1	216"	5	16.00
Francis	Octopus	vertical	–	–	17'3"	–	32.50
Gam	Projector	vertical	1.5	1.5:1	18'	–	29.50
Hy-Gain	SDB4	vertical	9.2	1.1:1	9' cross boom 3'1"beam boom	16	49.95
	SDB6	vertical	12.7	1.1:1	14'cross boom 12'2"beam boom	30	79.95
	SDB10	vertical	13.9	1.1:1	24' cross boom 20'beam boom	55	149.95
	CB3	vertical	8	1.4:1	12'boom	7	25.95
	CB5	vertical	9.5	1.1:1	18'boom	18	44.95
	CBGP	vertical	unity	1.1:1	9' ht	3	11.95
	CBV	vertical	3	1.1:1	17' ht	6	24.95
	CLR2	vertical	3.4	1.1:1	19'10" ht	8	32.95
	GCLR2	vertical	3.4	1.1:1	19'10" ht	14	44.50
International Crystal	CBA-1	attic	–	2.1:1	18"	3	8.50
	CBD-1	dipole	–	2.1:1	36"	6	12.95
	CBG-1	vertical	–	2.1:1	18"	3	13.95
	CBB-1	gnd.-plane	–	2.1:1	18"	3	14.95
	160-133	vertical	–	2.1:1	16"	10	26.00
Knight (Allied)	KN-2574	beam	12.3	1.5:1	18'8¾" each element	15	39.95
	KN-2505	vertical	unity	1.5:1	9'	4	9.95
	KN-2570	vertical	5	1.5:1	9'	4	13.95
	KN-2572	vertical	6	1.2:1	19'8"	7	24.95

MFG.	MODEL	TYPE	GAIN (dB)	V.S.W.R.	LENGTH	WGT. (lbs.)	PRICE ($)
Lafayette	Range Boost II	vertical	3.75	1.17:1	210"	10	19.95
	3-element beam	vertical	8	1.6:1	198" elements	11	17.95
	4-element GP	vertical	–	1.8:1	108" element 108" radials	4	9.95
	5-element beam	vertical	10	1.5:1	204" (boom)	15	39.95
Mark Products	MK-11	vertical	–	–	19'	12	36.95
	MJ-27	vertical	–	–	19'	11	28.95
	MJ-3	beam	–	–	19'	23	39.95
	CBB-1	vertical	–	–	17'	8	21.95
	MK-V	vertical	–	–	20'	23	47.50
Master Mobile Mounts	GPC	vertical	3.7	1.5:1	17'3"	–	31.17
Mosley Electronics	X-27-3	beam	8	1.5:1	224¾"	12.5	29.40
	X-27-4	beam	8.7	1.5:1	224¾"	15	36.98
	X-27-5	beam	9.5	1.5:1	224¾"	16.5	44.18
	AD-311	beam	8	1.5:1	216½"	14	48.31
	A-311-S	beam	8	1.5:1	224¾"	12.5	38.50
	A-411-S	beam	8.7	1.5:1	224¾"	15	49.50
	SA-511-S	beam	9.5	1.5:1	224¾"	20.5	60.50
	SKT-3	beam and stacking kit	11	1.5:1	224¾"	29	80.25
	SKT-4	beam and stacking kit	12	1.5:1	224¾"	38	93.45
	SKT-5	stacking kit	13	1.5:1	224¾"	47	109.95
	A-311-511-S	conversion kit	–	–	–	10	28.98
	A-311-SK	stacking kit	–	–	–	18	65.62
	H-CB-SK	stacking kit	–	–	–	8	23.87
	Devant 1	vertical	–	1.5:1	235 1/2"	7.5	25.04
	Devant Special	vertical	–	1.5:1	245"	7.6	32.59
New-Tronics	PRO-27	vertical	–	–	19'8"	15	34.95
	PRO-27-JR	vertical	–	–	19'10¾"	8.75	24.95
	PRO-27-SD	vertical	–	–	19'8"	16	39.95
	GP-1	vertical	–	–	–	6	10.95
	11M-3	beam	–	–	18'10" boom	8.5	29.95
	11M-4	beam	–	–	14'1" boom	10.75	39.95
	RTG-27-L	gutter clamp	–	–	25"	–	11.95
Polygon	CBQ-2	vertical	7.5	1.1:1	–	11	69.95
	CBQ-3	vertical	9	1.1:1	–	16	94.50
	CBQ-4	vertical	10.4	1.1:1	–	22	139.50
Shakespeare (C/P Corp.)	176	vertical	–	1.5:1	18'6"	7.5	32.95
Webster	BCL-1	vertical	3.4	1.1:1	234"	9	29.95
	BCX-1	vertical	unity	1.4:1	216"	7	24.95

MOBILE ANTENNAS

MFG.	MODEL	TYPE	GAIN (dB)	V.S.W.R.	LENGTH	WGT. (lbs.)	PRICE ($)
Antenna Specialists	M-1	whip, base-spring	–	1.5:1	108"	6	10.45
	MR-58	trunk-mt.	–	1.5:1	48"	1.5	10.85
	M-67	roof-mt.	–	1.5:1	44"	1.5	12.95
	M-73	trunk-mt.	–	1.5:1	48"	2	14.60
	M-74	fender-mt.	–	1.5:1	44"	1.5	14.60
	M-103	combination CB/AM	–	1.5:1	46"	1.5	17.55
	M-123	roof-mt.	–	1.5:1	44"	1.5	14.60
	M-124	roof-mt.	–	1.5:1	46"	1.5	16.70
	M-125	roof-mt.	–	1.5:1	46"	1.5	16.70
	M-130	roof-mt.	–	1.5:1	18"	1.25	12.10
	M-131	gutter-mt.	–	1.5:1	18"	1.25	16.30
	M-168	magnetic-mt.	–	1.5:1	–	1.25	16.25
	M-176	trunk-mt.	–	1.5:1	46"	1.5	23.75
	M-180	gutter-mt.	–	1.5:1	48"	1.5	18.30
Apelco	A-48	vertical	–	–	96"	1.5	20.25
	A-49	vertical	–	–	49"	1.5	14.50
	A-85	CB/AM	–	–	48"	2	16.25
	A-50	vertical	–	–	103"	1.5	8.35
Francis Industries	CB-14	vertical	–	–	96"	–	12.95
	CB-22	vertical	–	–	30"	–	8.95
	CB-24	vertical	–	–	48"	–	8.95
	CB-26	vertical	–	–	66"	–	10.95
	CB-28	vertical	–	–	96"	–	11.95
	CB-50	vertical	–	–	96"	–	10.95
	CB-229	vertical	–	–	30"	–	7.95
	CB-249	vertical	–	–	30"	–	8.95
Gam	8-Ball	vertical	1.5	1.5:1	86"	–	24.50
General Radiotelephone	M-27	vertical	–	1.2:1	–	–	14.95
Hy-Gain	CBW	vertical	–	1.1:1	26"	1	9.95
	TJCQ	vertical	unity	1.1:1	46"	2	16.95
	TMCQ	vertical	unity	1.1:1	50"	2	15.95
	TMPQ	vertical	unity	1.1:1	46"	2	16.95
	TQCW	vertical	unity	1.1:1	32"	1	7.95
	TQMA	vertical	unity	1.1:1	59"	3	24.95
	TQRDX	vertical	unity	1.1:1	50"	2	16.95
	TQRMB	vertical	unity	1.1:1	28"	2	16.95
	TQW	vertical	unity	1.1:1	46"	1	8.95
	TRQS	vertical	unity	1.1:1	19"	2	15.50
	TTMPQ	vertical	unity	1.1:1	46"	2	16.95
	W102	vertical	unity	1.1:1	102"	3	4.95
	Hellcat 1	vertical	unity	1.1:1	47"	3	17.50
	Hellcat 2	vertical	unity	1.1:1	23 7/8"	1.7	14.95
	Hellcat 3	vertical	unity	1.1:1	34 5/8"	3.2	16.95
	Hellcat 4	vertical	unity	1.1:1	47"	3.1	19.95
International Crystal	CBM-1	vertical	–	2.1:0	18"	3	6.95
	160-134	vertical	–	2.1:0	30"	3	18.50
Knight (Allied)	17-6705	vertical	–	–	102"	7	14.95
	17-6756	vertical	–	–	30"	1	9.95
	17-6757	AM – FM/CB	–	–	50"	1	11.95
Lafayette	base-loaded auto-top mt.	vertical	–	1.7:1	39"	2	7.99
	base-loaded trunk-mount	vertical	–	1.7:1	39"	5	9.99
	mobile CB-AM	vertical	–	1.8:1	46"	4	7.95
	CB bumper-mount	vertical	–	1.6:1	102"	3	8.95
	mobile CB-AM antenna converter	vertical	–	1.8:1	Reg. ant. plus 7¼"	2	6.95
	center-loaded CB gutter-clamp	vertical	–	1:1	20"	3	10.95
Mark Products	SM-27A	vertical	–	–	6'	1.5	15.50
	HW-11S-4	vertical	–	–	4'	.5	4.95
	HW-11S-6	vertical	–	–	6'	1	5.95
	HW-11-4	vertical	–	–	4'	1	9.95
	HW-11-6	vertical	–	–	6'	1.25	10.95
Master Mobile Mounts	CB-35A	vertical	unity	1.5:1	63"	–	15.20
	CB-52	vertical	unity	1.5:1	42"	–	12.95
	CB-55	vertical	unity	1.5:1	44½"	–	13.95
	CB-129A	vertical	unity	1.5:1	45"	–	8.95
Mosley Electronics	Devant 2	vertical	–	1.5:1	45"	2	15.95
	DP-27	vertical	–	1.5:1	43¾"	1	17.59
	DA-27	vertical	–	1.5:1	17"	1	13.19
	SUC-1	vertical	–	1.5:1	36"	1	22.92
	PER-1	vertical	–	1.5:1	36"	1	22.66
	CBL-23	vertical	–	1.5:1	100"	3	25.26
New-Tronics	CB-2	vertical	–	–	26½" 60½"	.75	7.75
	CB-27-L	vertical	–	–	26½" 60½"	1.5	10.95
	CB-102-A	vertical	–	–	108"	4.5	9.95
	CB-111	vertical	–	–	83"	2.75	15.25
	CB-211	vertical	–	–	83"	2.75	15.25
	BM-1-SPL	bumper-mt.	–	–	108"	5	18.95
	FG-27	vertical	–	–	–	.33	5.50
	FGB-27-L	vertical	–	–	–	1	6.95
	MO-1	mast	–	–	54"	2.25	8.95
	MO-2	mast	–	–	54"	2.5	8.95
	RM-11	mobile rec.	–	–	29"	.5	6.95
	RTB-27-L	base-loaded	–	–	45¾"	3	26.95
	RTG-27-L	gutter-clamp	–	–	25"	1	14.95
	RTS-27-L	roof-mt.	–	–	30"	1	12.95
	SW-102-R	vertical	–	–	102"	1.5	4.95
	SW-108-R	vertical	–	–	108"	1.5	5.25
	TC	vertical	–	–	–	.75	7.95
	TCS-2	vertical	–	–	–	.5	5.50
	TCS-27	vertical	–	–	–	.75	6.95
	TCS-27-L	vertical	–	–	–	1	10.75
	TCS-27-M	vertical	–	–	–	1.5	15.25
	TGA-27-L	trunk-groove	–	–	–	1.25	12.25
	TGF-27-L	trunk-groove	–	–	–	1.25	11.95
	TMA-27	trans. ant.	–	–	–	–	6.95
Shakespeare (C/P Corp.)	10-3	vertical	–	1.5:1	8'	1	8.65
	173	vertical	–	1.5:1	4'	.5	6.95
	181	vertical	–	1.5:1	9'	1	10.45
	345	vertical	–	1.5:1	36"	1	14.95
	345-1	vertical	–	1.5:1	36"	1	22.90
Stinger Antennas	MM-500A	magnetic-mt.	4.1	–	32"	–	19.95
	Terry I	vertical	5.2	–	32"	–	24.95
	Terry II	mtch. network	–	–	–	–	17.95
	Circamount	–	6.4	–	10"	–	24.95
Thunder Industries	7010	vertical	–	1.1:1	35"	.75	21.95
	7020	vertical	–	1.1:1	36"	1	24.95
	7030	vertical	–	1.1:1	35"	.75	18.95
Thunderstik Products	48	vertical	–	–	48"	–	19.95
	100	vertical	–	–	96"	–	19.95
	T60	vertical	–	–	–	–	7.95
Versa-Tronics	CB-11	vertical	–	–	38"	–	9.95
	CB-11-½	vertical	–	–	20"	–	9.95
	CB-11W	vertical	–	–	37"	–	6.95
	CB-11-½W	vertical	–	–	19"	–	6.95
	CB-11K	vertical	–	–	38"	–	9.95
	CB-11-½K	vertical	–	–	20"	–	9.95
Vistaco	Coiltenna	vertical	–	–	3"	4 oz.	4.95
	Electenna	vertical	–	–	18"	6 oz.	6.95
Waters	370-CB	vertical	4	1.1:1	108"	5	42.85
Webster	MA-100	vertical	unity	1.1:1	46"	1.5	14.50
	MA-110	vertical	unity	1.1:1	45"	1.75	16.50
	MA-120	vertical	unity	1.1:1	18"	1.5	11.95
	MA-130	vertical	unity	1.1:1	18"	1.5	15.95
	MA-300	vertical	unity	1.1:1	45"	1.5	17.90
	MA-310	vertical	unity	1.1:1	46"	1.5	11.60
	MA-500	vertical	unity	1.1:1	48"	2	17.30
	MA-510	vertical	unity	1.1:1	50"	2	11.60
	MA-530	vertical	unity	1.2:1	93"	4	29.95
	MA-540	vertical	unity	1.2:1	77"	4	29.95

MARINE ANTENNAS

MFG.	MODEL	TYPE	GAIN (dB)	V.S.W.R.	LENGTH	WGT. (lbs.)	PRICE ($)
Antenna Specialists	ASM-4	vertical	–	1.5:1	96"	4	21.60
	ASM-23	vertical	–	1.5:1	97"	3	29.50
Apelco	M-29	vertical	–	–	54"	2	26.50
Gam	Mariner	vertical	1.5	1.1:1	19'11"	–	49.95
Mark Products	HW-11-6M	vertical	–	–	6'	4	23.95
	SMP-27-AM	vertical	–	–	6'	4	27.95
Master Mobile Mounts	CBM-16	vertical	1.5	1.5:1	79"	2	19.95
Mosley Electronics	CC-27-A	vertical	–	1.5:1	96 3/8"	2	36.78
Shakespeare (C/P Corp.)	72-1	vertical	–	1.5:1	12'	7.5	61.95
	176-1	vertical	–	1.5:1	18'6"	9	54.15
Stinger Antennas	ST-27	vertical	4.1	–	30"	–	15.95
Webster	M-29	vertical	1.4	1.5:1	60"	2	26.50

Channel	Freq. in MHz	Channel	Freq. in MHz
1	26.965	12*	27.105
2	26.975	13*	27.115
3	26.985	14*	27.125
4	27.005	15	27.135
5	27.015	16	27.155
6	27.025	17	27.165
7	27.035	18	27.175
8	27.055	19	27.185
9*	27.065	20	27.205
10*	27.075	21	27.215
11*	27.085	22	27.225
		23*†	27.255

* For communications between units of different stations.
† Shared with other services.

Table 1. Listing of Class-D CB channel frequencies.

permits mounting an antenna on a high rooftop, water tower, chimney, or other structure—as long as the top of the antenna is not more than 20 feet higher than its supporting structure.

Experienced CB users are aware of the prohibition on use of towers which elevate Citizens Band antennas more than 20 feet higher than the supporting structure on which the antenna is mounted, or the ground. However, there is some confusion on the interpretation of the Part 95 rule which permits the use of higher towers "licensed under other services."

Contrary to certain interpretations, this rule does permit the use of towers supporting home-TV antennas. True, the tower does not come under the classification of a specially built structure for supporting a CB antenna, since its original intention is improved TV viewing. But it is not a licensed tower.

Licensed towers which may support a Citizens Band antenna are those which have been registered by the FCC for elevating a non-CB Business/Public Safety two-way radio antenna. This provision is especially important to commercial and municipal users of CB who already have some other type of two-way radio antenna. If, for example, a small community has a police FM system operating on 150 MHz, it can install a CB antenna on the same tower for increased range. It is this provision which makes CB equipment valuable not only as the sole method of communications for a business, but also as a supplementary radio system. By adding CB to its Business/Public Safety licensed system, a two-way radio user can effectively add 23 channels of communications to his already licensed v.h.f. system. And the additional height offered by the v.h.f. tower (often 100 feet or more) will result in solid coverage over a 20-25 mile range.

Making Frequency Measurements

In setting up the Citizens Band channels with frequencies ending in 5 rather than 10 (see Table 1), the FCC seemingly ruled out the possibility of using the inexpensive and commonly available 100-kHz crystal, 10-kHz multivibrator arrangement for frequency-checking this service. Nevertheless, such a standard can be used, but in a slightly different manner than that to which we have been accustomed.

First, the standard should now be set up as usual and checked for positive 10-kHz operation and the output coupled to a CB receiver set to the desired channel. Before turning on the transceiver to be checked, however, the output tube must be temporarily disabled, either by opening the screen connection or by disconnecting the cathode lead, in order to weaken the signal in the receiver.

If the crystal is slightly off-frequency (as it will normally be), two unequal beat notes will be heard in the checking receiver. For example: 4500 and 5500 Hz, if it happens to be 500 Hz off. This, of course, is a result of the frequency beating against the two adjacent 10-kHz markers of the frequency standard. The crystal frequency screw is then turned until the beat notes equal each other at exactly 5 kHz. This is a simple matter for the average ear, easily accomplished after a small amount of practice. *(Note: This and any other adjustments affecting output frequency and/or modulation of a CB rig must be made by or under the supervision of a holder of a commercial radio operator's license.—Editor.)*

The output of the normal 10-kHz standard has been used to drive a second multivibrator set to 5 kHz. This single-tube device can be found in any of the various radio handbooks. It was set to frequency by matching the audible beat note set up between adjacent markers as heard on the CB receiver with the 5-kHz tone from a calibrated audio oscillator. In this case, the signal from the CB transmitter was set to zero-beat with the 5-kHz marker.

Troubleshooting Tips

For repairs that cannot be field-serviced practically, the workbench should be used and the equipment removed from its housing. Next, determine which section is defective—the transmitter, receiver, or power supply. It's unlikely that all three will become defective at one time, although a common receiver-transmitter stage may develop trouble and impair the operation of both these sections.

Since the power supply is common to all stages, a defect in it can affect the operation of all three sections. When a fuse blows, it is usually an indication that excessive current is being drawn by the equipment.

Assuming that the trouble occurs during operation, check such components as the rectifier, vibrator (if one is used), and buffer capacitor(s). Other than tubes or semiconductors, a defective buffer capacitor is one of the most common power-supply troubles. If the buffers check out, remove the vibrator or semiconductor(s) and replace with one(s) known to be good.

The majority of equipment malfunctions in older units are due to tube defects. Open filaments can often be spotted by a quick visual inspection. Other tube defects can be readily located by direct substitution (the preferred method) and can usually be confirmed by a tube tester. Some CB equipment will not work efficiently if one or more tubes fall even slightly on the weak side.

A number of CB transceivers use printed-circuit boards. Special care must be exercised when servicing equipment of this type. Conductors break due to physical strain and warpage. This can be nothing more than a hairline break, although it can be sufficient to disable the entire transceiver. The break can usually be spotted by placing a light on the underside (opposite the wiring side) of the board.

When checking PC boards, use a test prod with a sharp point to pierce the epoxy resin coating over the printed wiring. Tests should be made at soldered junctions rather than by punching holes at just any point along the delicate conductors. When replacing components in a printed circuit, special soldering techniques must be used to prevent damaging the board.

Making Periodic Antenna Checks

The antenna and lead-in should be inspected at regular intervals for obvious damage; corrosion at the coaxial terminals and abrasions. More important, the antenna should maintain a minimum s.w.r. over the range of frequencies on which it will be operated. Periodic s.w.r. checks are in order. Some CB stations have an s.w.r. meter connected in the antenna lead-in at all times, providing a constant check of antenna operation.

It is possible to check a mobile antenna with an ohmmeter; at least, a simple continuity check can be made if it is suspected that the antenna or lead-in is shorted or defective. Connect one ohmmeter lead to the antenna tip and the other to the lead-in that plugs into the transceiver. Long leads for the ohmmeter may be used effectively, depending upon the installation. Set the ohmmeter to its lowest scale. Then shake the antenna and lead-in. Resistance should be about 3 to 5 ohms. If resistance is considerably higher, or if it varies when either the antenna or the lead-in from the antenna is moved, there is a poor connection between the antenna and lead-in. Disconnect the lead-in from the antenna and check both items individually to locate the fault although the lead-in connector is almost invariably the most likely culprit.

Next, connect one ohmmeter lead to the antenna tip and the other to a ground. Shake the antenna and lead-in. With the ohmmeter set to its highest range, it should indicate an open circuit. If there is a constant high-resistance reading, there is a high-resistance short between the antenna and ground or the auto body. If an intermittent short is indicated, a visual check will usually pinpoint the source. Finally, connect one ohmmeter lead to the outer conductor at the transceiver end, and the other lead to ground. Set the ohmmeter to its lowest scale and shake the lead-in. The resistance should be zero or near zero. If it is higher, the outer conductor is not making proper contact with the ground. ▲

HOW TO TUNE FOR BEST TV COLOR

Here's the right way to tune your color receiver, along with an explanation of what the various controls do.

COLOR-TV is about 15 years old and, like most teenagers, it isn't always understood by the adults who live with it. With both, there is a certain amount of adjustment to be made before they work their best. Fortunately, there are definite rules to guide the person faced with developing a working relationship with a color receiver.

Explaining these guidelines is one of the responsibilities of the service technician when he installs the color receiver. Some do the job well; others either neglect the job or are unable to make the instructions clear. When the job is done right, the owner will know the 1-2-3 procedure that produces a clear and properly hued picture—every time.

The color tuning procedure isn't really difficult to understand. There are five controls which determine how well the color set renders color. They are: Brightness and Contrast, which also affect the black-and-white picture; Fine Tuning, which affects black-and-white but must be set much more carefully for color; and Hue (or Tint) and Color controls, both used only for color. There is a definite order in which to operate these five controls. Out of sequence, tuning in a really good color picture becomes a haphazard process. Someone with experience can do it, but for the average color-set owner it may not be so easy.

To understand the color-tuning process thoroughly, you need to know what effect each control has on the picture, and on one another. Here's the correct way to tune in a color program, and some explanation of what the controls are doing to the set as you operate them.

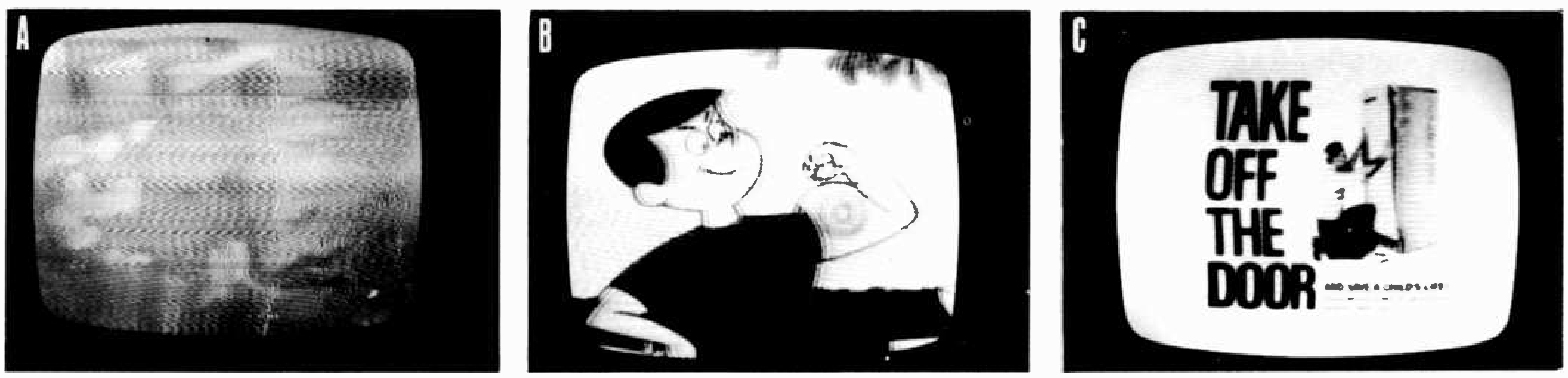
From Black-and-White to Color

If you're starting from scratch, the best thing is to turn the Color control to minimum (counterclockwise) and the Hue or Tint control to its center. The other three controls can be set best on a black-and-white picture, without color to confuse.

Set Brightness and Contrast arbitrarily at first, so you can see a picture of some sort. Then concentrate on the first and perhaps most important of the five adjustments —Fine Tuning. This operating adjustment is critical; it is the only one of the five that so far has deserved special aids in some of the newer models, and even automatic adjustment in more expensive ones.

First, though, without aids: Turn the Fine-Tuning adjustment knob toward the end of its rotation which pro-

Fig. 1. (A) Severe beat interference. (B) Slight beat interference. (C) Properly tuned-in black-and-white picture.



duces clear sound but a blanked-out picture or severe sound-grain interference such as that shown in Fig. 1A. Then turn it back, almost clearing up the interference grain (Fig. 1B). It is at this point that the chroma signal and the color-sync burst are tuned in most strongly. But you can't view the picture comfortably with this interference in it, and besides, the video signals are not yet properly located on the receiver band-pass curve. So you turn the control just a little more to rid the picture of the grain—but no further. This is a critical adjustment; make it carefully. When it is done properly, the black-and-white picture should look smooth, as in Fig. 1C. There will be no interference and picture details will be clear.

Next, adjust the Brightness and Contrast. This must always be a compromise between too dark and too light. The usual tendency is to turn the Brightness too high, then make up for it by turning the Contrast well up. Fig. 2A shows the result—a rather garish, harsh picture. Such a picture would never look well when color is added. Rather, keep both the brightness and the contrast as low as possible without washing out the picture. Fig. 2B shows both at too-low settings. Start with them low and work up to a good range of blacks, grays, and whites. Too much brightness will wash out colors and too little contrast will even affect hues. The picture should appear soft, but with good "body". Fig. 2C shows a picture that will portray color well, when color is finally added.

Now comes the color. Turn up the Color control slowly. On most sets, it is labeled Color. On *General Electric* sets it is called Chroma Gain, and *Packard-Bell* labels it Color Gain; both more aptly describe its action. On *Motorola* sets, the label Color Intensity is used. On the screen, the result appears as intensifying whatever color is visible; that is, the control increases *color saturation*. This control should not affect the hue of any color; that is, it shouldn't make green turn blue, or anything like that. Turn it up only until you see color. You'll readjust it again after you have made the next tuning-in adjustment.

It is the job of the Hue control to make the colors what they should be. The Hue control is called Tint on about half of the most recent models. It could be labeled Color Phase. Its action is most noticable in the faces of actors, since the flesh color makes a good reference. With the Color control already set for not too strong colors, the Hue control is adjusted for as accurate a flesh tone as you can get. Too far one way makes faces green, and too far the other makes them purple. (One caution: Certain *Motorola* models have a control called Tint which is *not* a color-phase control; on *Motorola* color sets, the color phase is adjusted with the Hue control. This unorthodox Tint control will be explained later.)

Next, readjust the Color control for a *soft* flesh tone, and so that other colors are not garish. Turning the Color control too high may also result in slight interference patterns in the color picture, a pattern that somewhat resembles the grain effect from incorrect fine tuning. A "dead" and faded picture is a sign that the Color control is too low.

The Color and Hue controls should show very little interaction, although the Hue control cannot be adjusted at all unless the Color control is turned up enough to put color on the screen. But, once the Hue control is set, the Color control on most models will not alter the flesh tone —just make it lighter or deeper. If the Color Gain control does affect phase, there is trouble in the set which should be cleared up.

Auxiliary Controls

On some sets there are two other operating controls which affect the color picture as well as the black-and-white. They are not basically for color reception, but like the Brightness and Contrast they must nevertheless be set properly before a decent color picture can be viewed. Both are most easily adjusted with the receiver tuned to a black-and-white picture. If a color show is on, turn the Color control all the way down to view a monochrome picture.

The first of these auxiliary controls is called a Peaking control, although it has several designations. *Clairtone* and *Magnavox* label it Sharpness, *Packard-Bell* calls it Pix Fidelity, and *Setchell Carlson* labels it Detail. One older set calls it Crispness. Most others call it Peaking, if they have it. In some, notably *Motorola,* it is a servicing adjustment rather than an operating control.

It may be a switch and it may be a control, but its purpose is to give the picture whites sharper edges. With a monochrome picture, set the peaking control for a crisp picture, but don't overpeak it. Overpeaking may cause some color "bleed", particularly in the red; if so, turn it down some for a softer picture. One important point about setting this control: It is for the viewer's taste, so don't set it for a crisp picture unless the viewer wants the picture that way; some prefer softness.

The other control is a sort of "trick" control—sometimes a switch—that lets the viewer make a black-and-white

Fig. 2. (A) Excessive brightness and contrast. (B) Insufficient brightness and contrast. (C) The proper settings.

ELECTRONIC AUTOMOTIVE TESTING INSTRUMENTS

By ALAN JAMES

By using a few inexpensive testing devices, such as a dwell tach, auto analyzer, and ignition scope, the car owner can do a lot to keep his car in shape and avoid expensive repair bills.

"A MISS is as good as a mile," goes an old saw. But *not* when the miss is in the engine of your car or service truck. Some kinds of engine troubles are best handled by a professional auto mechanic, who has special instruments to help him diagnose the precise trouble. Several, however, are less complicated and can be tracked down by any owner who knows electrical principles and who has a few inexpensive testing devices.

Automotive Testing Units

The electronics-trained car owner recognizes an old friend in voltage and current testers: the volt-ohm-milliammeter, or v.o.m. The volts- and amps-reading functions are useful for checking battery, voltage regulator, generator or alternator—in short, the entire auto electrical system. The ohmmeter helps check alternator diodes, continuity of wiring, and so on. For automotive testing, the voltmeter or ammeter may be individual units; more often they are combined in a multipurpose instrument that also checks continuity, dwell angle, engine speed (tachometer), and certain parts.

The dwell-angle meter, more commonly called a *dwell tach* if it also indicates engine speed, measures how long the breaker points in the distributor stay closed. Operation of the car is seriously affected by this adjustment, and so is the life of the points themselves. The dwell-meter face is calibrated in degrees, because what is really being measured is how far the distributor cam or rotor turns while the breaker points are closed. Dwell meters are sold separately, or as part of a multipurpose instrument.

Several engine adjustments, particularly those involving the carburetor, are related to engine speed. An electronic tachometer—again, either separate or in an analysis instrument—measures revolutions per minute without resorting to mechanical connections.

Most sophisticated of the common instruments for checking auto ignition systems is the ignition oscilloscope. Its chief advantage is that it presents a visual display of the firing characteristics of the entire ignition system: points, capacitor, coil, plugs, distributor rotor and cap, and all associated wiring. Anyone familiar with the scope's patterns can diagnose accurately the cause of any trouble that shows up in the ignition system. A really sharp diagnostician can even spot certain carburetor and other engine troubles by analyzing the waveforms. Refer to Fig. 1. *(A conventional service scope cannot be used for this purpose since it has non-triggered sweeps that will not produce the proper display. Also pickup of spark pulses and hash makes synchronization of just about any pattern almost impossible.—Editor)*

Also among the instruments available to the nonprofessional auto mechanic are exhaust analyzers. Their chief function is to check carburetor efficiency. With an electronic tachometer and an exhaust analyzer, ordinary carburetor adjustments are not too difficult. The important thing is that you can "see" the result of your adjustments. (Many mechanics also use a vacuum gage in connection with carburetor adjustments, but that isn't electronic.)

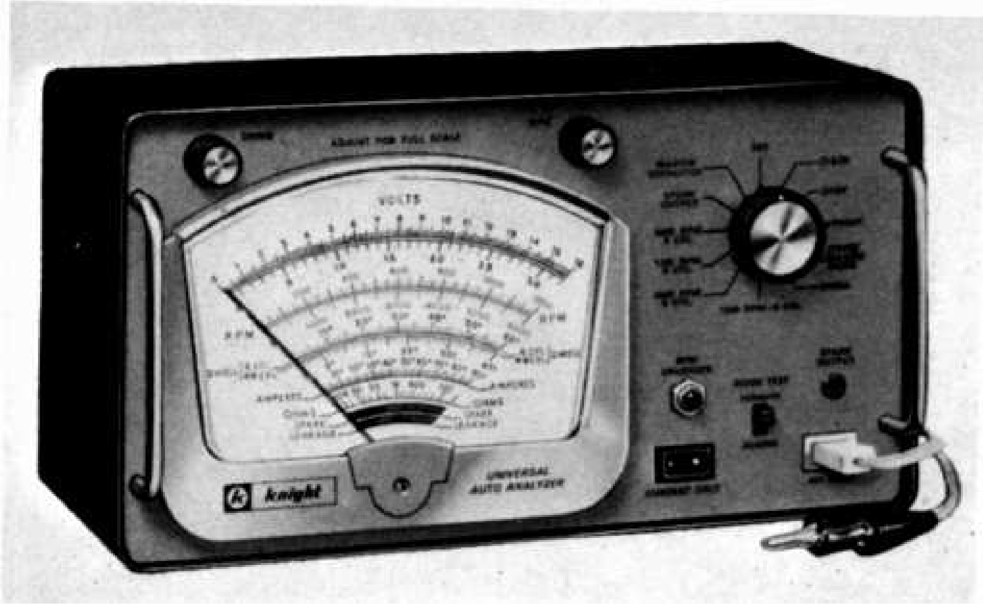
With such an array of electronic instruments available, at reasonable prices, there is little excuse for the serious auto owner to drive around with minor engine troubles uncorrected. Many of the instruments can be bought in kit form at even lower prices. Table 1 shows a few of these auto-testing instruments and their manufacturers. Some brands of instruments are available at auto-supply stores, some at electronic parts dealers, and others must be ordered from the manufacturer.

The Battery and Charging System

The electrical system of an automobile comprises the battery, the wiring to lights and accessories, the generator or alternator that keeps the battery charged, and

Table 1. Manufacturers of electronic automotive testers.

Delta Products	"Computach" Tachometer Model D-1000 Dwell Meter Model T-1000 Tachometer
Eico Electrical Instrument Co.	Model 888 Engine Analyzer
Heath Company	Model IO-20 Ignition Analyzer Scope Model ID-11 Timing Light
Knight Electronics Corp.	KG-271 Timing Light KG-375A Universal Auto Analyzer
Lafayette Radio Electronics	Dwell-Tach (Cat. 11-0101). Dwell-Tach (Cat. 11-0105) Timing Lights
Tune-Up Equipment Co.	EGA-100 Exhaust Gas Analyzer



Knight-Kit KG-375A is a combination instrument including functions of v.o.m., dwell meter, and tachometer.

To analyze the exhaust gas from your car's muffler, a gas analyzer, such as Tune-Up's EGA-100, may be used.

the voltage regulator that determines how much of the generator (or alternator) voltage and current is applied to the battery. Tests of the electrical system are usually confined to voltage, current, and resistance measurements. The electronic technician can use his v.o.m. for the voltage and resistance measurements. Currents in the car's electrical system may be too high for the average v.o.m.; these may run up to 30 to 60 amperes. Ammeters for measuring such currents are available.

Best of all is the combination auto analyzer unit mentioned earlier, which contains voltmeter, ammeter, and resistance ranges suited to auto testing, along with other special testing facilities. You should, whether hunting a fault or performing preventive maintenance, give the electrical system a fairly thorough going over. The following steps constitute a logical analysis procedure: if you are only tracking trouble, you may want to skip past certain of the steps.

1. *Check battery*. Clean off all corrosion with a solution of bicarbonate of soda. Be careful you don't get the solution in the battery through the vents in the caps. Set the instrument to read at least 16 volts. Icepicks make good contact as probes, with the test leads clipped to their metal shafts. Touch the black (negative) test lead to the battery post marked (−), and the red (positive) one to the post marked (+); be sure the probes contact the posts, not the cable clamps. Turn on the headlights—on bright—to give the battery a load. The voltmeter should indicate close to 12.6 volts. Reset the voltmeter to measure at least 3 volts. Touch the black test lead to the (−) battery post, and the red lead to the other end of the first cell; the reading should be 2.1 volts. Move the black lead to where the red lead is, and move the red lead to the opposite end of the next cell; again, 2.1 volts. Continue "walking" the leads up on the battery, checking each cell. None should vary more than 0.1 volt from the others. The tops of the cells are frequently coated with an insulating "tar", you'll need the icepicks to get through it to the bare metal of the tie straps. *(In other cases, rubber or plastic covers are used so that the cells cannot be measured individually. In this case, a hydrometer reading of each cell can be made to indicate the state of charge. A fully charged cell should have a specific-gravity reading of 1.260 to 1.280.—Editor)*

2. *Check battery cables*. Leave headlights on, and the instrument set for 3 volts. Touch the black lead to the battery-cable post on top of the starter or on the starting solenoid, and the red lead to the (+) post on the battery (not to the cable ends). Remove the coil wire from the center of the distributor cap and ground its end, so the engine won't start. Crank the engine and note the meter reading. Move the black lead to the (−) post of the battery and the red lead to the ground strap somewhere on the engine. Again crank the engine and note the meter reading. The voltage in both cases should be no more than 0.2 volt; if it exceeds that, the cables are bad or the connections need cleaning and re-tightening.

3. *Check starter ground*. Turn headlights off. Move the black lead to the (−) post of the battery, and the red lead to the metal frame of the starter motor. Crank the engine and note the meter reading. If it exceeds 0.2 volt, the starter motor isn't grounded well.

4. *Check generator*. Put the coil wire back into the center of the distributor cap, and set the instrument to read 16 volts. Connect the red lead to the Armature (A) terminal of the generator, and the black lead to the generator frame. At the generator, remove the lead from the Field (Fld) terminal and connect a jumper wire between that terminal and the generator frame. Start the engine, and watch the meter reading. As you speed up the engine, the meter reading should rise to about 16 volts. *(Don't operate the generator very long this way as excessive voltage may be produced which may burn it out.—Editor)* Note: If the generator field is grounded internally, as in most *Ford* and *American Motors* vehicles, connect the Field terminal to the Armature terminal instead of the ground.

5. *Check alternator*. Set the instrument to read 16 volts. Connect the red lead to the output terminal of the alternator, and the black lead to its frame. Start the engine, and speed it up slightly; the output reading should exceed the battery voltage (usually goes to about 14 or 15 volts). Different alternators have different specifications, but if its output can't exceed the battery voltage, it can't charge the battery. (Note: Most automotive test instruments include an ohmmeter for checking alternator diodes; this requires opening up the alternator to gain access to the diode terminals.)

6. *Check voltage regulator*. Set the instrument to measure 16 volts. Disconnect the wiring cable from the battery (Bat) terminal of the regulator. If your instrument has a shunt to use when measuring high current, connect one end to the regulator Bat terminal and connect the wiring cable to the other end of the shunt. Be sure the connections are tight and well made. Connect the red test lead of the analyzer, set to measure voltage, to the Bat terminal and the black test lead to the ground strap on the engine. If the generator has an externally grounded field, *momentarily* jumper the Bat and Gen (sometimes marked Arm) terminals together at the voltage regulator. If the generator field is internally grounded, remove the Fld wire at the regulator and touch it *momentarily* to the Bat terminal; reconnect the wire to its Fld terminal. Start the engine, and speed it up to about 1500 r/min. The meter should read about 14 or 15 volts, depending on the adjustment or setting of the voltage regulator. Switch the instrument to measure current, connecting the instrument across the shunt as recommended by the manufacturer. Current should be fairly high (30 amps or more) if the battery is low or if you are just starting the engine. After the engine runs awhile and the battery is good, current should fall back to only a few amperes.

7. *Check wiring and fuses*. You can trace faults in

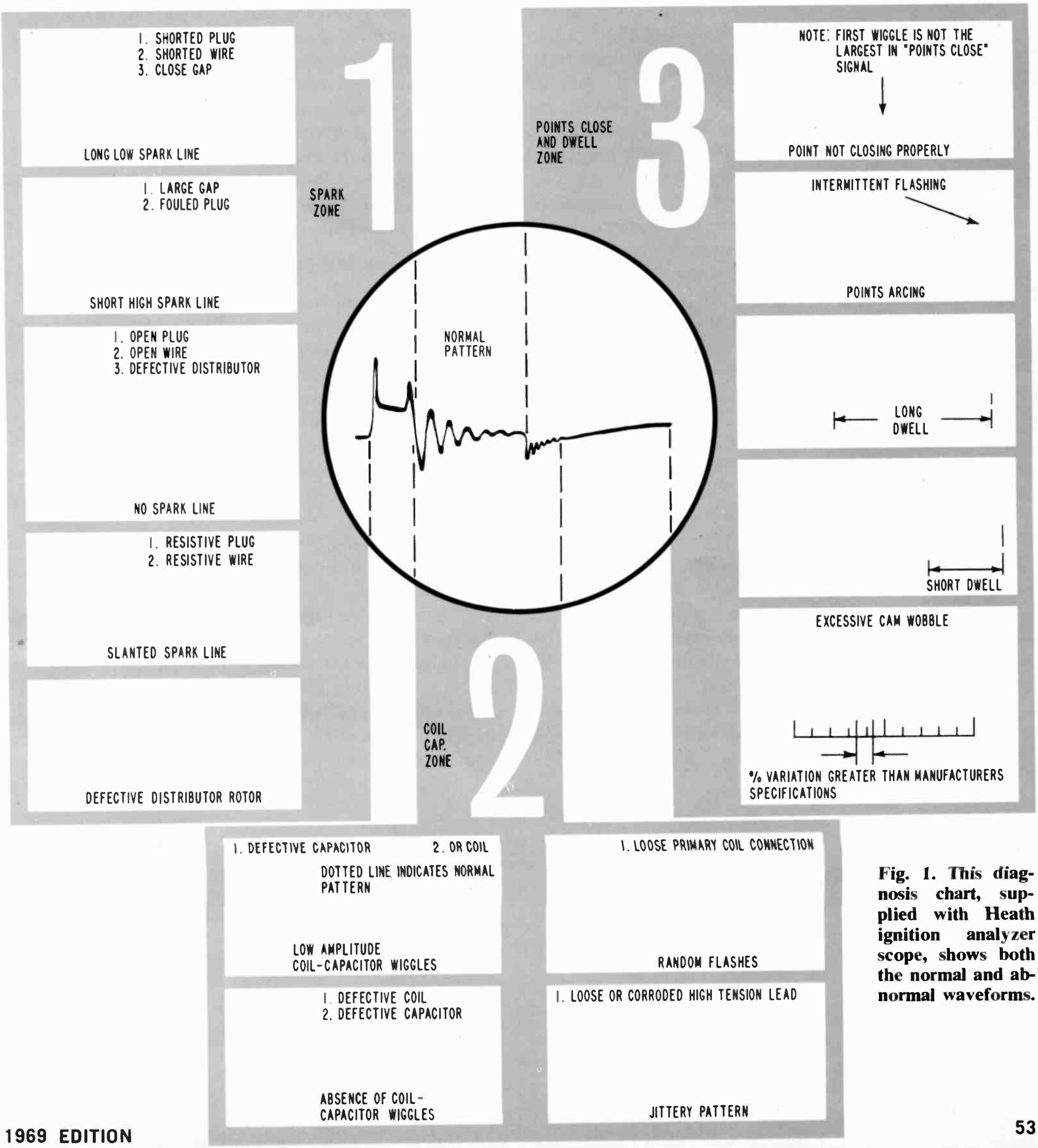


Fig. 1. This diagnosis chart, supplied with Heath ignition analyzer scope, shows both the normal and abnormal waveforms.

headlight or accessory wiring by connecting the black test lead to any convenient ground point and checking for 12.6 volts at points along the wiring to whatever accessory isn't working. The icepick test probe is handy for piercing insulation without damaging it. If you suspect a fuse, a quick way to check is to turn on the accessory in doubt and connect the black test lead to one end of the fuseholder and the red lead at the other; a full-voltage reading indicates a bad fuse.

Conventional Ignition Systems

Not many cars have transistor ignition systems as yet, so we'll cover the conventional type. *(See also "Electronic Ignition for Automobiles" on p. 64. Editor)*

The ignition system is divided basically into two sections: (1) the primary portion, including the ignition switch, the lead (sometimes containing a ballast resistance) to the coil primary, the coil itself, and the breaker points and capacitor inside the distributor; and (2) the secondary portion, which includes the coil's secondary, the distributor cap and rotor, and the spark plugs and their wires.

Most troubleshooting and preventive maintenance with the multipurpose instruments already mentioned are done in the primary circuit. A few such instruments contain a circuit for checking the strength of spark output, but the indication is only relative. For thorough study of the ignition spark, both from the coil and as applied to each spark plug, the ignition analysis oscilloscope is the more dependable instrument. It displays each electrical action and reaction in the ignition system. The display is easy to analyze.

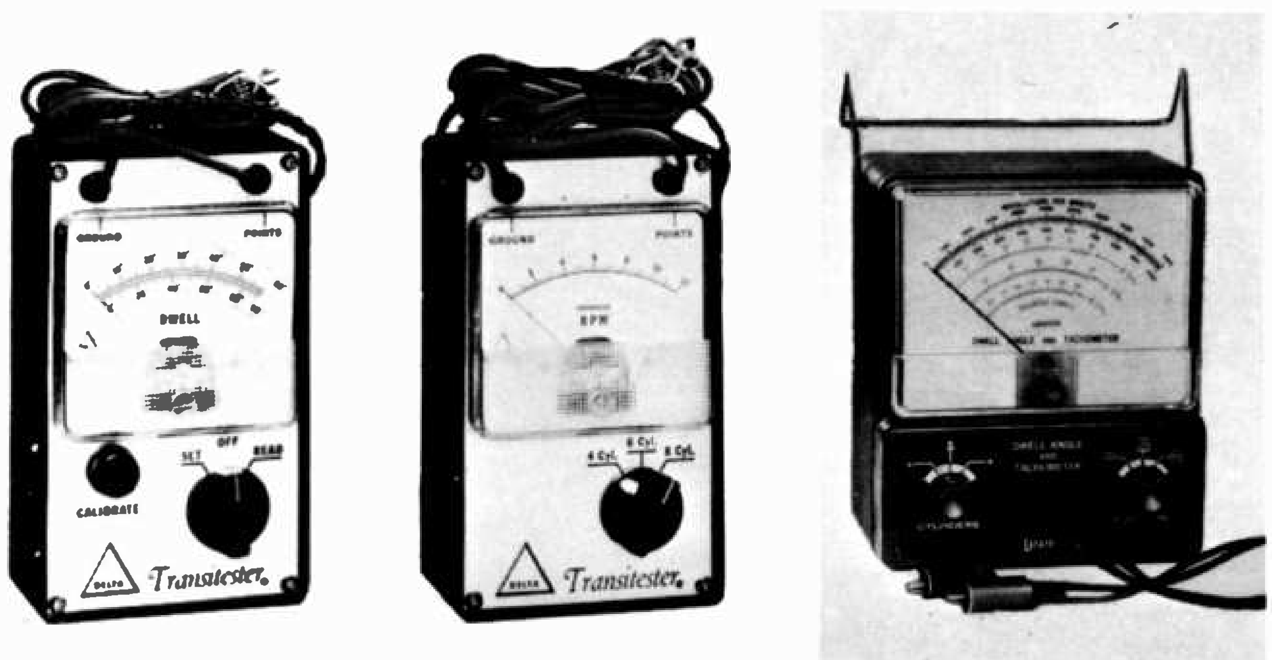
Maintenance usually consists of replacing spark plugs and distributor parts every 10,000 or 15,000 miles; some owners wait 20,000 miles or until some trouble begins to show up. Replacing the plugs is a purely mechanical job; set the gaps and screw them into the holes. So is installing a new set of breaker points, a new capacitor, and a new rotor. If there is any sign of pitting on the contacts inside the distributor cap, it should be replaced too. Afterward, performance depends on adjusting the points properly. This is where the dwell meter or dwell-tach comes in. The procedure is easy:

1. Install the points, capacitor, and rotor in the distributor and replace the cap. Make sure the cap is seated properly, and that all the wires are pushed firmly into their proper sockets. Make sure the coil wire is firm in the center post of the coil.
2. Clip the black test lead of the dwell meter to a good ground point on the engine. The housing of the alternator or generator is a handy point for this one. On the coil there is a small wire that goes to the distributor. Clip the red lead to that terminal (not to the wire that goes to the wiring harness).
3. Start the engine and let it run at fast idle. Calibrate the instrument according to its instructions. Switch to the "Read" position. If the instrument has switch positions for 6- or 8-cylinder, be sure you have selected the right one.
4. In some cars, you adjust the points with an Allen wrench through an access door in the side of the distributor. Be sure the wrench doesn't bind the distributor on something; the vacuum advance has to be free.
5. If you don't know what dwell angle is correct for your engine, use these as a guide: 8-cylinder, 30 degrees; 6-cylinder, 40 degrees; 4-cylinder, 60 degrees.
6. Speed up the engine a time or two and see that the dwell angle stays about the same, with the Allen wrench removed. (Dwell angle is not affected by the vacuum advance, except momentarily.)

Troubleshooting a Stopped Engine

If you are troubleshooting a stopped engine, here is a sequence that will reveal the source of trouble quickly:

1. Use the voltmeter, set for 16 volts. Clip the red lead to the wiring-harness side of the ignition coil, and the black lead to a good metal ground on the engine. Turn on the ignition switch. You should get a healthy reading on the meter, the exact amount depending on the ballast in the ignition primary wire. If you get more than 5 or 6 volts, the ignition switch and ballast are probably okay.
2. Try cranking the engine. The voltage reading will waver, but should not disappear. If it does, the ignition switch is faulty.
3. Move the red test lead to the other terminal of the ignition coil. You may or may not get a reading, depending on whether the points are opened or closed. Crank the engine a little bit at a time. You should alternately get a reading and not get one, if the points are opening and closing properly. If you get no reading at all, they are stuck, the coil primary is open, or the capacitor is



Examples of typical dwell meter (far left) and tachometer (center) are these Delta D-1000 and T-1000. Such units show how long breaker points stay closed, and speed of engine. A combination automotive dwell meter and tachometer (right) is this Lafayette No. 11-0101 unit.

shorted. If you get a continuous one, the points are not closing at all.

4. Disconnect the voltmeter. Pull the heavy center high-voltage wire from the distributor cap and make sure its other end is firmly pushed down in the coil center. Push the free end near metal (keep fingers away) and crank the engine. A healthy spark should jump to the metal very rapidly as you crank the engine. If so, the coil is okay. The spark should be hard blue, should *snap* across the gap, and should be at least ¼-inch long. If it is yellow and weak, the coil is probably bad.

5. Replace the coil wire in the center of the distributor cap. Take the wire off one of the spark plugs. Turn its rubber covering backward to expose the metal shell that slides down over the spark plug. Hold the exposed metal end near the engine block. Crank the engine. The spark that jumps to the block should be hard and blue, and ¼-inch long, although it doesn't occur as frequently as the one from the coil wire. If the spark is weak or missing, the trouble is in the distributor cap, rotor, or the plug wire. If it is healthy and regular, check the plug. Go through this step for every plug.

Electronic ignition analyzer, such as Heath's IO-20, displays waveforms (Fig. 1) that will show operating condition of an automobile's ignition system.

A Missing Engine

For an engine that is missing, the ignition scope is best. It is easy to hook up. There are two types of spark-pickup devices: one that is inserted between the spark-plug wire and the plug, and the one that merely clamps around the plug wire. The scope's operating instructions give the control setups for viewing the different types of displays. The parade display shows each cylinder in firing order; and the superimposed display shows all four, six, or eight patterns as one, so that any discrepancy in one will be easy to see. Once you know which part of one waveform is wrong, you can parade them all to see which cylinder is the one affected.

The normal pattern in the center of the diagnosis chart (Fig. 1) shows which segment or "zone" of the waveform represents which part of the ignition system. Since the scope synchronizes on the strongest pulse, it is the spark zone that appears first along the time base. Next is the ringing pattern of the counter-e. m. f. in the coil, affected by the capacitor (the coil and capacitor resonate to make the distinctive ringing pattern—a decaying wavetrain). Last on the scope trace is the closed-points-and-dwell zone. With the scope graticule calibrated in degrees across the horizontal axis, you can see the dwell angle—in fact, you can adjust the points by the reading.

The diagnosis chart tells you a lot about how the scope can be used to hunt troubles that hamper engine performance. Keep in mind the two sections of an ignition system: primary and secondary. In the secondary portion, the ignition scope is your best electronic aid.

There is other inexpensive electronics equipment that can aid in making other tests and adjustments. For example, there's the timing light. This is usually merely a discharge circuit, triggered by the spark from the number-1 spark plug and causing a special strobe-type gas-discharge tube to fire. The light illuminates timing marks either on the flywheel, flywheel housing, or the crankshaft vibration damper. You disconnect the vacuum line from the distributor and plug it in, start the engine, and aim the light at the timing marks, and adjust the distributor until timing is set according to the specs for your car. Don't forget to re-install the vacuum line.

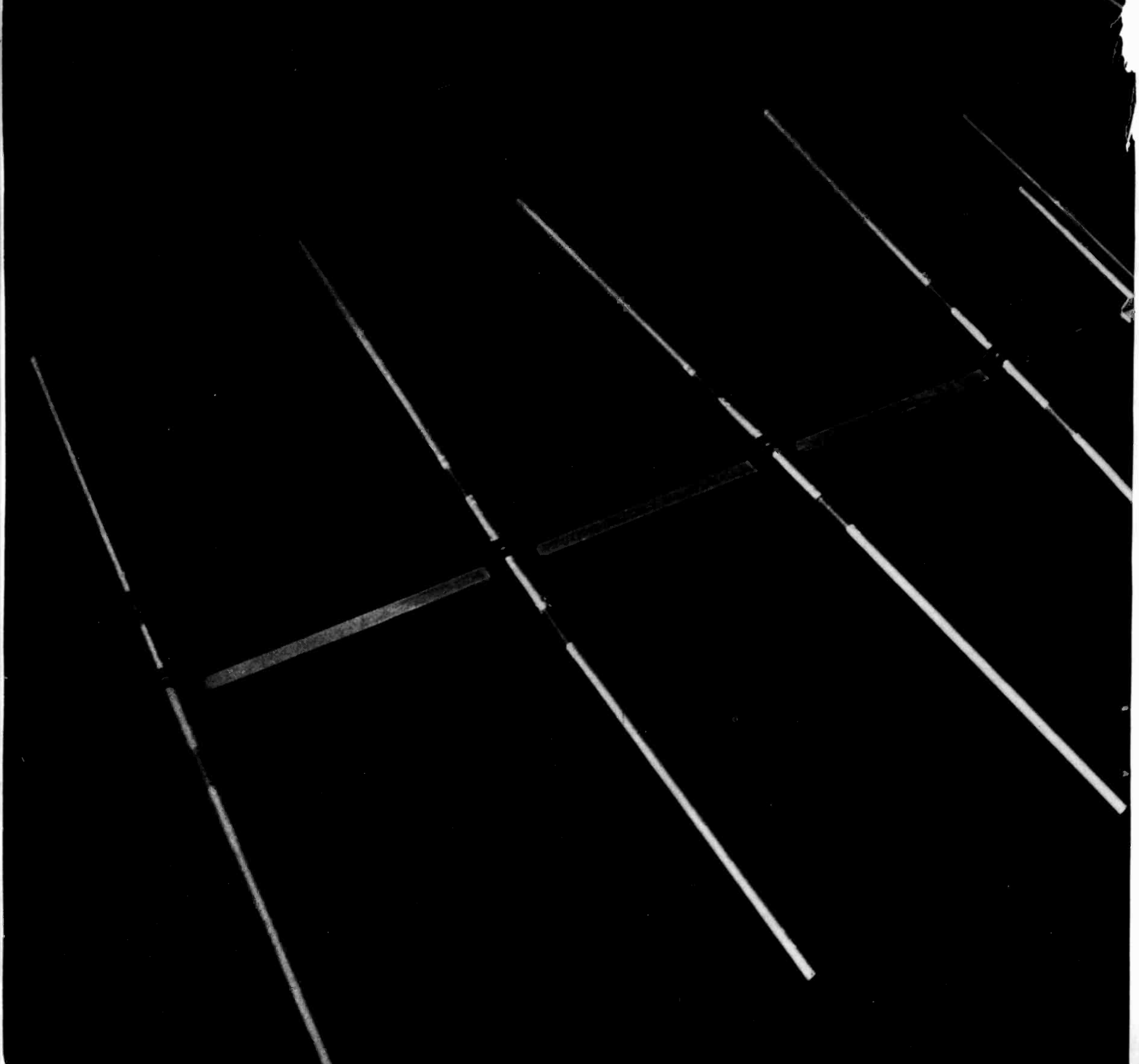
Also incorporated in some multipurpose analysis units is a speed tachometer. It's handy for adjusting the carburetor jets very roughly—for maximum r/min. More important, it can be used to set idling speed properly for cars with automatic transmissions. ▲

This Eico 888 auto analyzer combines functions of dwell meter, tachometer, and v.o.m. in a single instrument.

For additional information on the various test instruments mentioned in Table 1, please circle the following numbers on Reader Service Card.

For products made by:	Circle No.
Delta Products	81
Eico Electrical Instrument Co.	82
Heath Company	83
Knight-Kit	84
Lafayette Radio Electronics	85
Tune-Up Equipment Co.	86

Sylvania goes into the ghost-fighting business.



Use TV Pictures For Clues To Circuit Troubles

By VIC BELL

A careful study of the picture-tube patterns often leads directly to troubled stage in your black-and-white or color-TV receiver. Included is a detailed logic chart used for TV trouble analysis.

THE picture on a TV receiver is the easiest-to-use service tool obtainable. Armed with a working knowledge of picture details, an astute observer is often quickly led to the stage causing the trouble. Too often, however, even experienced TV technicians ignore signs that could lead from the possible directly to the probable. Generally speaking, conditions of no sync, weak sync, or snowy picture are only part of the story. A complete analysis of the symptom requires more than just a glance at the picture.

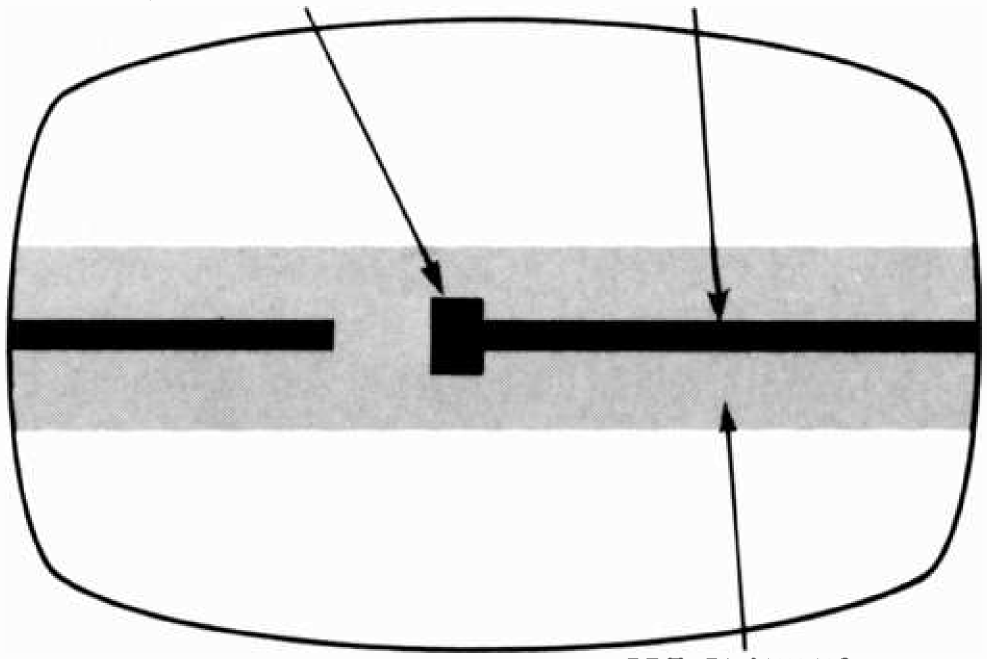
Most service technicians know that a no-raster with normal sound fault is usually caused by a malfunction in the horizontal section. But it ends there. When a sync problem or poor video condition presents itself, the scope and meter come off the shelf. What frequently results is a haphazard search through any section that could conceivably cause an associated malfunction.

Let's examine some TV picture details, see where they are formed, and what would result if a malfunction occurred there.

Vertical-Sync Display

One of the most useful trouble indicators is the vertical blanking and sync bar or cross-pulse display. This can be seen when a normal picture is offset by turning the vertical hold control for a stable vertical blanking bar about midway across the screen. Another type of cross-pulse display is created with the horizontal bar similarly misadjusted. Misadjusting the horizontal in this manner is not usually practical, however, and modern TV circuits make it impossible to view this with the hold control alone. In fact, some receiver circuits make it difficult to adjust even the vertical hold control for a stable bar. With patience, however, you can get a good look at this vertical-sync display.

Fig. 1. Cross-pulse display of vertical blanking and sync as would be displayed with vertical hold misadjusted.



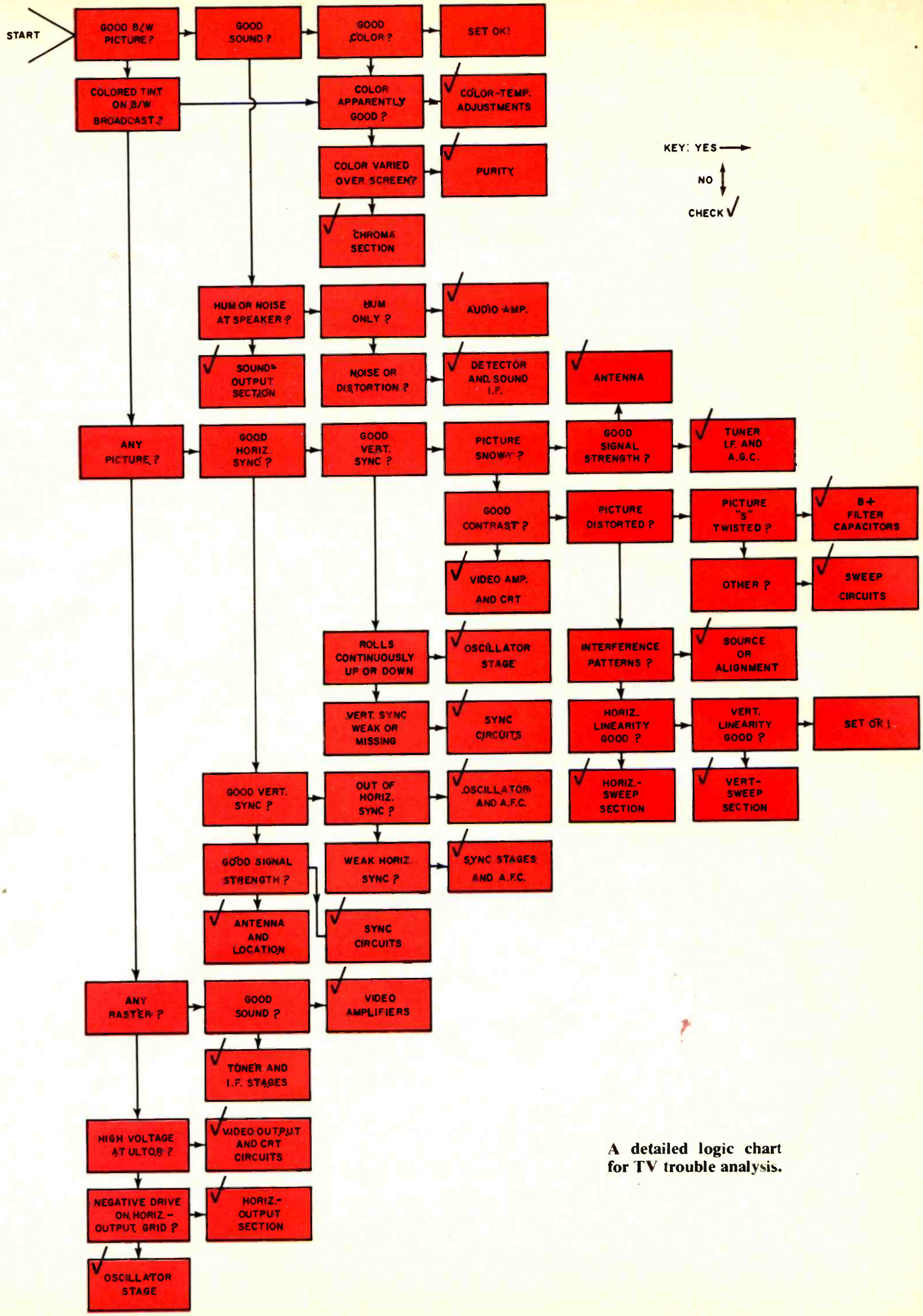
When the vertical-sync bar is set up as described, the cross pulse (sometimes called the "hammer head") should appear as shown in Fig. 1. If a broad, solid black bar is present, you should be able to adjust the contrast and brightness controls so the thin center bar is black and the wider bar is gray.

The broadest portion of the cross pulse is vertical picture blanking. The dark, narrow bar is vertical sync. If the sync pulses were weak, it would be very nearly the same shade of gray as the blanking bar. Without picture sync, the thin black bar would not be present in the display at all.

If the vertical hold cannot be adjusted to stop picture roll—even momentarily—we can point to oscillator-stage trouble and look no further. This is true since the hold control is an oscillator frequency adjustment and it should have sufficient range and stability to make the picture roll up, down, or stop briefly even without sync.

However, when poor or no sync is the complaint, it is desirable to view the cross pulse to determine where the fault might be. Fig. 2 is a block diagram of the area in which we are concerned. Note that the sync in this set is removed after the first video amplifier. Consequently, if a good hammer head is found on the screen and sync is poor, the problem must be in the area of the sync amplifier or sync separator. If the sync is weak or missing in the cross-pulse display, the fault must be between the tuner and the take-off point. See Fig. 3. (We assume the fault is not *beyond* the take-off point, since the sync *is* affected.)

The most common cause for a poor or no sync condition of the latter type is sync compression or stripping caused by a gassy tube or a stage running near cut-off



A detailed logic chart for TV trouble analysis.

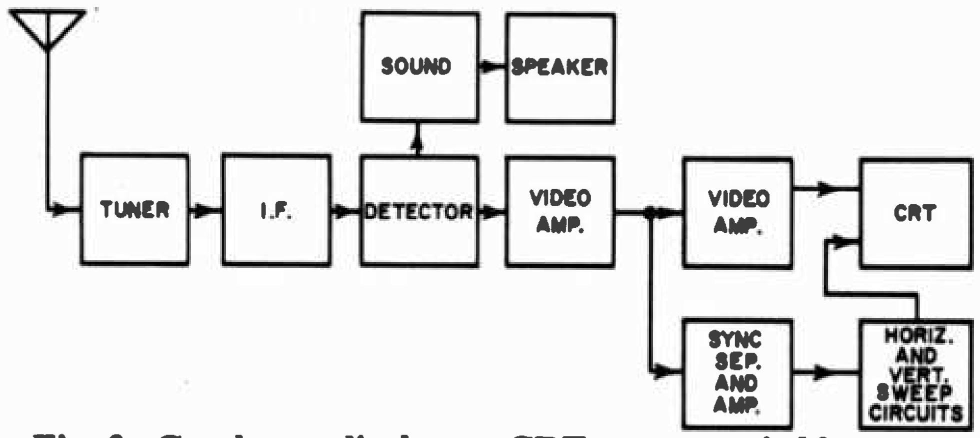


Fig. 2. Good sync display on CRT accompanied by poor or no sync indicates trouble in sync circuits. With poor sync display, trouble is between tuner and video amp.

or saturation. Adjusting the a.g.c. control may help narrow the possible area of trouble still further. If an a.g.c.-controlled tube's operating point is causing loss of sync, changing the a.g.c. control setting may cause sufficient change in the cross-pulse display to merit looking for the trouble only at a.g.c.-controlled stages. If nothing happens when the a.g.c. is varied, the search should begin in stages not connected to the a.g.c. line. If you have not pinned down the exact stage at this point (after checking all associated tubes), a good scope is required to locate the exact stage of trouble. Remember to use the demodulator probe when checking from the tuner to the detector.

Poor alignment can also cause poor sync and a rough alignment check can also be made with the cross-pulse display.

If the blanking bar cannot be made darker than the darkest picture element, poor low-frequency response may be responsible. If sync is completely unaffected, the video amplifier is probably at fault. The problem may be caused by misalignment of tuner or i.f. stages, however. Generally, this is caused by the video being too far down on the response curve. Of course, re-alignment should only be attempted with a sweep generator and scope setup.

The vertical blanking interval also contains field identification and test information on most network broadcasts as well as some local broadcasts. A total of four horizontal lines is reserved during each frame for this purpose. These lines usually contain, among other items, a frequency response test used by the TV stations.

The Horizontal Section

Let's start with a blank screen. All indications are that the horizontal section is faulty. But are you sure there's no picture information? Have you done everything you can to get a semblance of a picture? By turning the contrast first to minimum and then to maximum and advancing the brightness slowly in both conditions, you may get a glimmer of a picture.

Turn the set on and off; change channels. Does the screen "flash?" Change the setting of the horizontal hold control from one extreme to the other.

By such control manipulations, you may see enough of the screen to track down the fault more quickly. For example, if you can faintly see multiple images, or a smear indicating the wrong horizontal oscillator frequency, you have narrowed the trouble from a large section of the set to the horizontal oscillator and its control circuitry.

If you can see a flicker of the picture while changing channels, or when turning the set off and then on, the trouble very likely lies in the video-amplifier section. Such a symptom usually comes from trouble in the video output or some stage directly coupled to it. The voltage indication at the CRT drive electrode would be one causing CRT cut-off (negative for grid drive, or positive for cathode drive).

When the picture comes on, blooms, or just fades away, the trouble is most likely caused by a weak high-voltage section. This is actually the same symptom seen when the picture can be made to come in by critical adjustment of the brightness and contrast controls.

If the high-voltage section checks out okay, look again for trouble in the video-amplifier stage. Unlike the fault outlined for the video amplifier trouble above, the weak, soft, or blooming picture caused by video amplifier failure will be caused by CRT saturation. Look for opposite voltage indications.

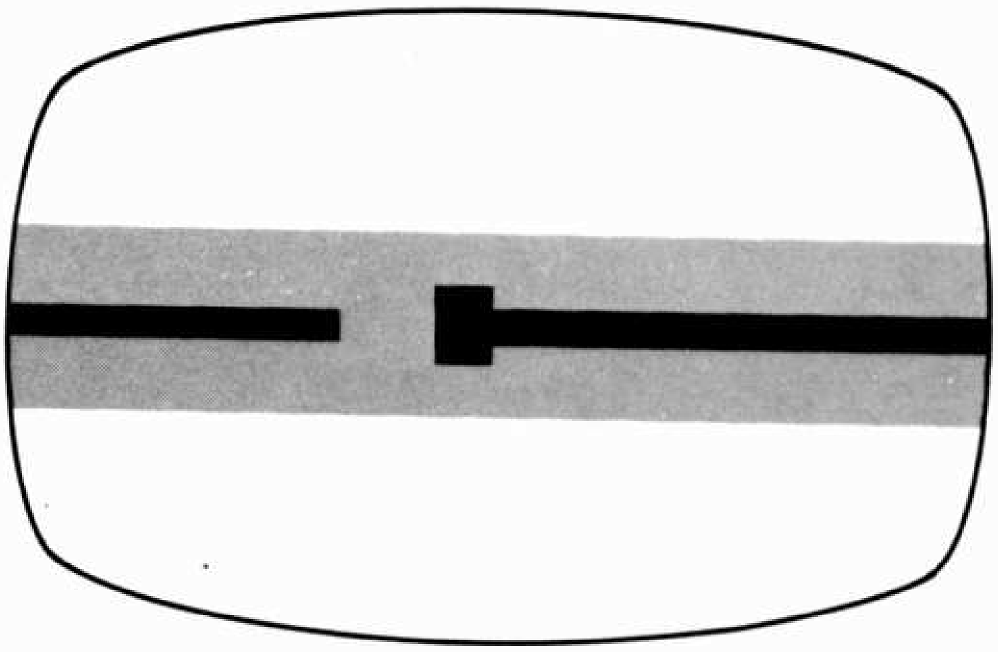
Many TV shops have invested in a 0-2 milliamp high-voltage meter to help them diagnose high-voltage problems more easily. For example, if there is no picture because of CRT cut-off, the current meter will read zero, even though high voltage is present. Similarly, if the CRT is operating in saturation, the meter will read very high. A black-and-white set normally draws around 0.25 mA depending on the CRT size. A color set rarely draws more than 1 mA when properly adjusted. Color sets usually will draw close to 2 mA before the picture disappears and black-and-white CRT's can rarely supply more than 0.75 mA.

Color—More Clues

In many ways, color can make picture trouble diagnosis easier than can black-and-white sets. For although the color set is more complex, the added circuitry makes it easier to pin the trouble to a given stage.

If the malfunction causes a color symptom, you should take note of whether it occurs on color-only programs or black-and-white and color programs. If it occurs on color-only programs, the color killer is probably cutting out the defective stage when black-and-white programs

Fig. 3. Weak sync caused by malfunction between tuner and sync take-off point shows up as weak or no sync pulse.



are broadcast. This, of course, narrows the trouble to the bandpass amplifier or other chroma stage ahead of the killer-controlled circuitry.

The color on a black-and-white picture is also a good indication of where the actual problem lies. Unfortunately, it is sometimes easy to compensate for a tinted screen by misadjusting the screen and drive controls. If this is done, the symptom would appear to be a color-only malfunction and you'd head down the wrong path of chroma take-off and bandpass amplifier trouble.

Assuming the set displays an abnormal tint on black-and-white broadcasts and incorrect colors during color broadcasts, and that it has not been tampered with—the trouble can be pinned down by looking at the picture.

A color-bar generator can be a valuable tool in diagnosing color problems but it can also cause some confusion. Keep in mind that the standard or keyed rainbow generator has no Y or luminance channel. Consequently, the picture faults produced by the generator would not be the same as with a standard color-TV picture. For example, weak red in a standard color-TV picture would show up as no red if a color generator were employed.

Trouble in the R-Y amplifier would cause weak red and red's complementary color (cyan). Trouble in the B-Y amplifier causes weak blue or its complement (yellow). G-Y trouble causes green and magenta color problems. Demodulator trouble follows a similar pattern.

Do not confuse a bluish cast in the picture background of color broadcasts with any of the chroma problems just described. This symptom is generally caused by loss of the horizontal blanking signal.

If all colors are wrong, the probable cause is in the hue-control circuitry or in the set's chroma alignment.

No color can be caused by a fault anywhere from the antenna to the demodulators; but most likely fault will be found in the chroma section.

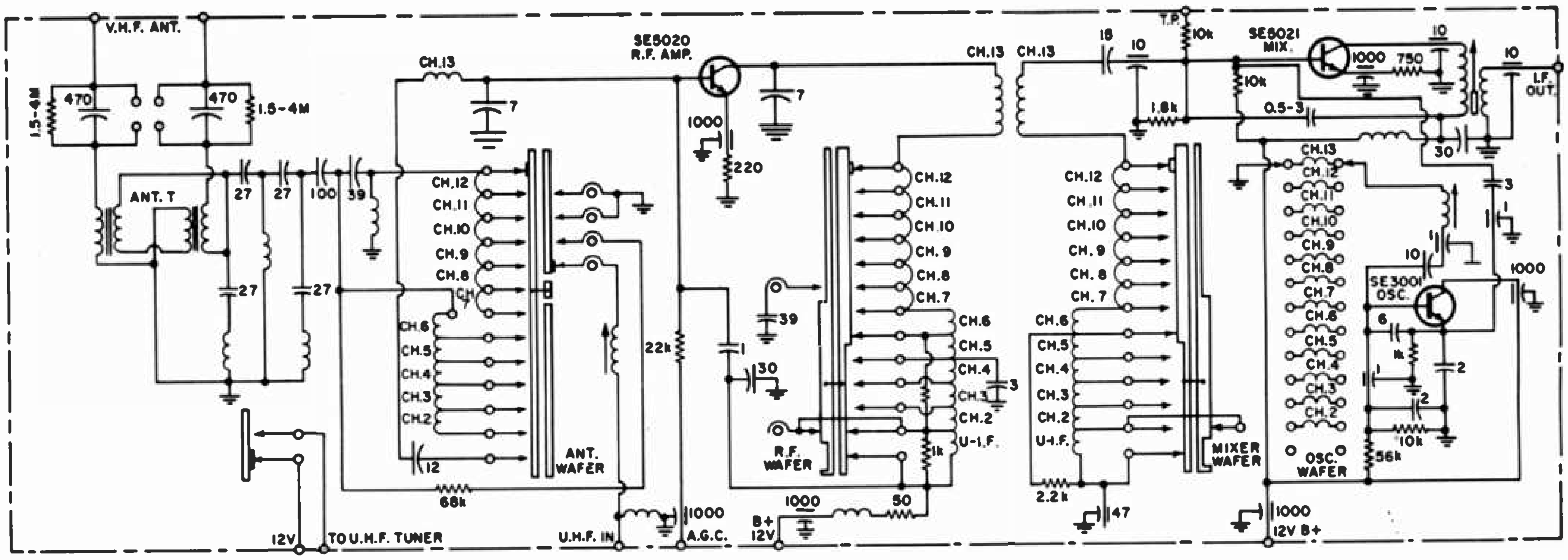
Of course, the killer-control adjustment should be checked first. Slight signal-strength changes and circuit drift can cause a temporary or permanent loss of color. To check the killer-circuit operation, ground the grid resistor on the killer-controlled stage. This will remove the killer bias but will allow the chroma signal to go through. Watch the screen carefully. If you get no change in the screen presentation, rock the bandpass amplifier tube in and out of its socket. If you get colored flashes, you can be reasonably sure that the trouble is in the bandpass amplifier or an earlier stage.

Frequently, the 3.58-MHz oscillator is sufficiently far out of adjustment so that the killer will be turned on. When the killer is disabled, the familiar "barber-pole" effect will be seen. If the 3.58 is really far off, the barber pole may run through the picture so rapidly that the change in picture information may be only barely noticeable or not noticeable at all.

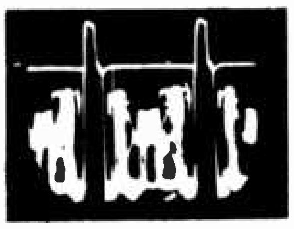
The logic trouble chart accompanying this article can be used by novice or expert. It helps the novice keep from overlooking possible trouble areas. For the expert, it's a good memory jogger. ▲

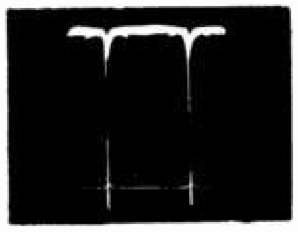
PHILCO 19FT20 COLOR-TV CIRCUIT

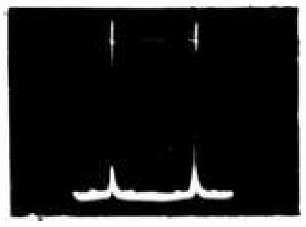
The 19FT20 is an all-new hybrid chassis used in Model S5102WA, a compact portable color set incorporating a 15-in picture tube. Circuits are quite similar to other Philco hybrid chassis in the field with four main differences: A 6BK4A shunt regulator tube is used in place of the varistor regulating circuit; the focus rectifier is a vacuum tube instead of a solid-state rectifier; the chassis contains three rather than four printed-circuit panels; and it utilizes a series filament string.

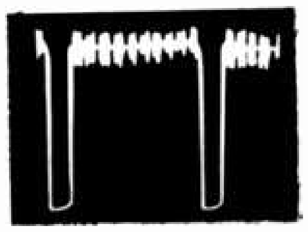


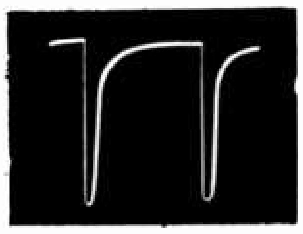
Circuit diagram of the solid-state v.h.f. tuner used in Philco's 19FT20 chassis.

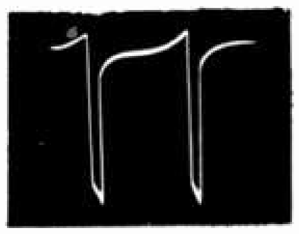

1 H

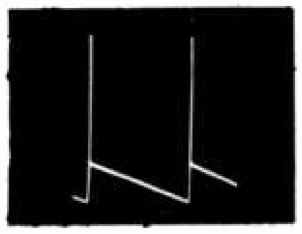

2,20 V

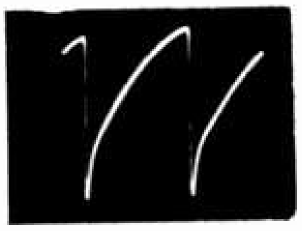

3 V

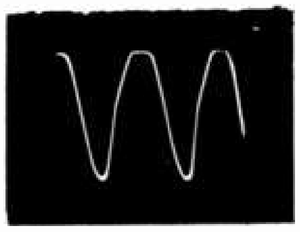

4 H

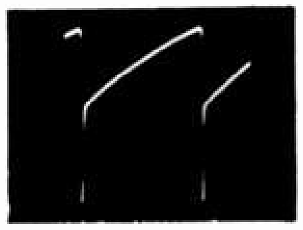

5,10 H

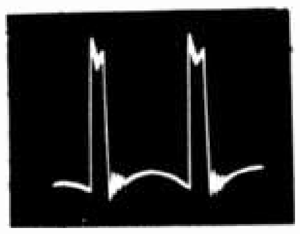

6,7 H

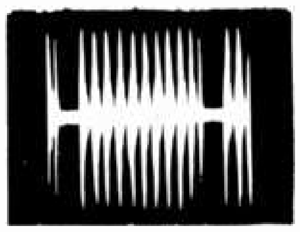

8 V

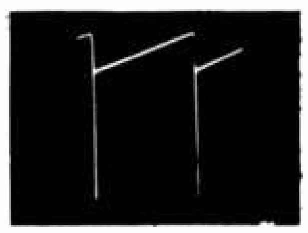

9 H

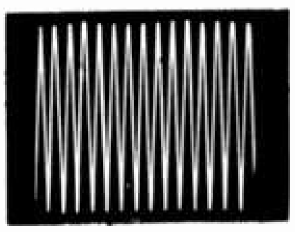

11 H


12 V

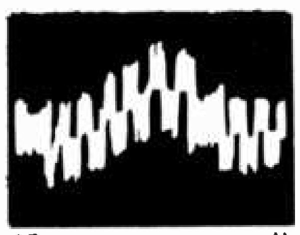

13,16,17 H

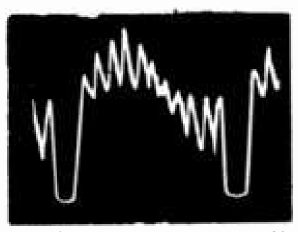

14,15,21 H

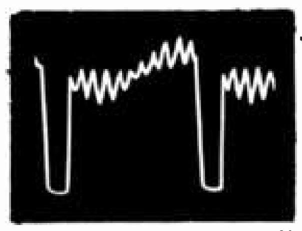

18 V

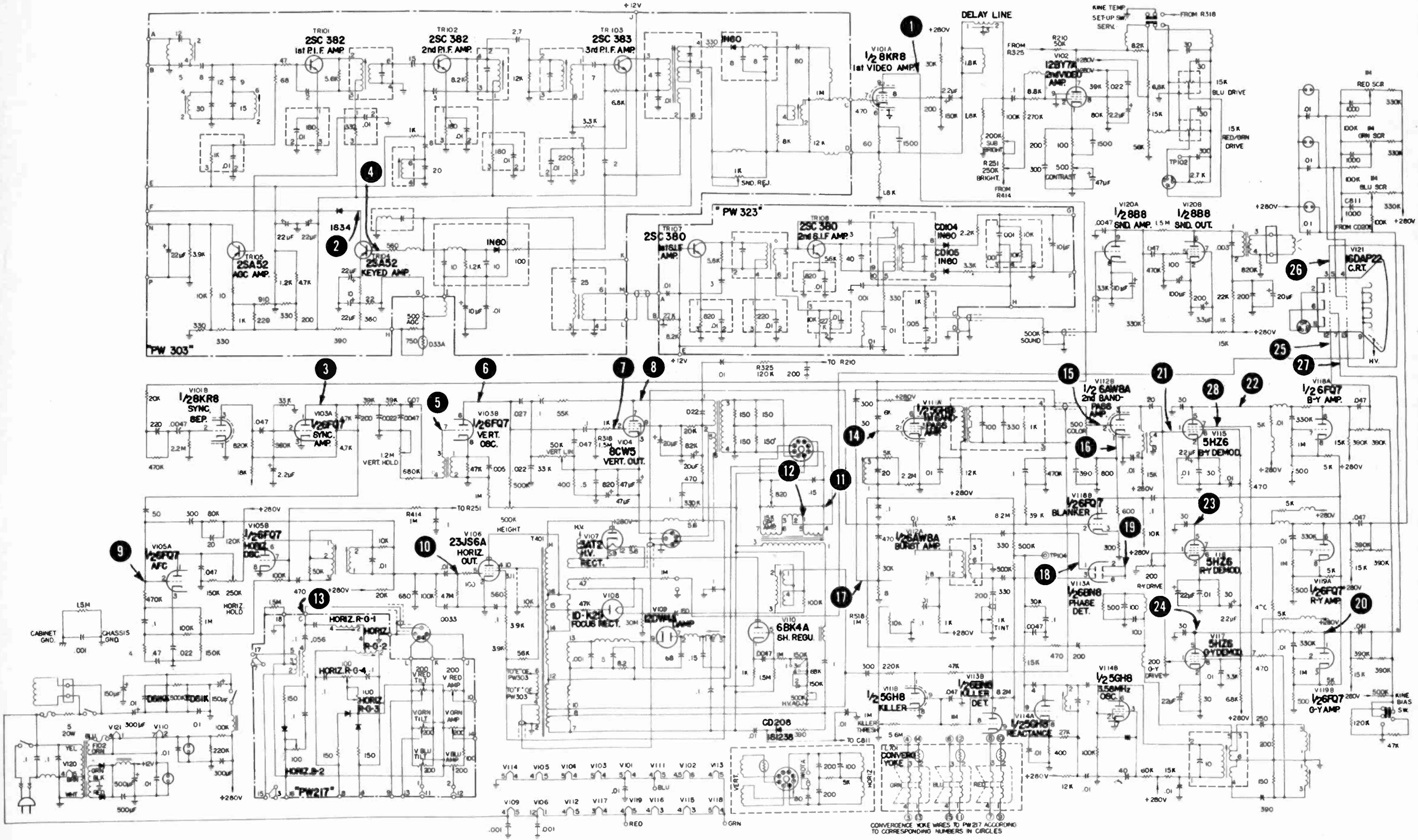

19,28 3.58MHZ


22,24 H


23 H


25,26 H


27 H



2SC 382 1st P.I.F. AMP.
2SC 382 2nd P.I.F. AMP.
2SC 383 3rd P.I.F. AMP.
1/2 8KR8 1st VIDEO AMP.
DELAY LINE
12BY7A 2nd VIDEO AMP.
2SA52 AGC AMP.
2SA52 KEYED AMP.
"PW 303"
"PW 323"
2SC 380 1st S.I.F. AMP.
2SC 380 2nd S.I.F. AMP.
1/2 888 SND. AMP.
1/2 888 SND. OUT.
16DAP22 C.R.T.
1/2 28KR8 SYNC. SEP.
1/2 6FQ7 SYNC. AMP.
1/2 6FQ7 VERT. OSC.
8CW5 VERT. OUT.
1/2 6AW8A 2nd BAND-PASS AMP.
5HZ6 B-Y DEMOD.
1/2 6FQ7 B-Y AMP.
1/2 6FQ7 AFC
1/2 6FQ7 HORIZ. OSC.
23JS6A HORIZ. OUT.
3AT2 H.V. RECT.
1D-K27 FOCUS RECT.
12DW4A DAMP
6BK4A SH. REGU.
1/2 6FQ7 BLANKER
1/2 6AW8A BURST AMP.
1/2 6BN8 PHASE DET.
5HZ6 R-Y DEMOD.
5HZ6 G-Y DEMOD.
1/2 6FQ7 R-Y AMP.
1/2 6FQ7 G-Y AMP.
1/2 5GH8 KILLER
1/2 6BN8 KILLER DET.
1/2 5GH8 REACTANCE
1/2 5GH8 3.58MHz OSC.
CONVERG. YOKE
CONVERGENCE YOKE WIRES TO PW217 ACCORDING TO CORRESPONDING NUMBERS IN CIRCLES
"PW217"
CD208
CABINET GND.
CHASSIS GND.

ELECTRONIC IGNITION FOR AUTOMOBILES

By ART HUFTON Project Manager, Ignition Systems, Motorola Inc.

A comparison among conventional, transistor, and capacitor-discharge ignition systems along with some helpful troubleshooting suggestions.

OVER the past few decades, the conventional ignition system has been the one used on almost all automobiles in all countries. It is simple and inexpensive and, when properly maintained, it provides satisfactory ignition for most types of cars.

A schematic of the conventional ignition system is shown in Fig. 1. When the ignition switch is closed and the points also close, current flows through the ballast resistor, through the primary of the ignition coil, and through the breaker points. This current flow through the primary of the ignition coil establishes a magnetic field in the coil. When the breaker points open and interrupt this current flow, the magnetic field collapses and causes a high voltage to appear across the primary of the ignition coil (about 250 volts). Since the ignition coil has a turns ratio of 100:1 between the primary and secondary, approximately 25,000 volts is available from the coil secondary for the spark plugs.

The capacitor across the points plays a vital role in the operation of the ignition system. As soon as the points begin opening, the magnetic field around the ignition coil tries to keep the current flowing across the points. Thus, severe arcing would occur and the stored magnetic energy would be dissipated in the arc instead of causing a high voltage in the primary. However, the capacitor prevents this from happening by momentarily providing an alternate path for the current. Then, by the time the capacitor becomes fully charged and non-conducting, the points have opened far enough to prevent the current from arcing. Since the current cannot flow, the magnetic field suddenly collapses and induces a high voltage into the primary of the ignition coil which, in turn, is stepped up to the 25,000 volts on the secondary needed for ignition.

Troubleshooting Conventional Ignition

To explain the complete troubleshooting and tune-up procedures for the conventional ignition system would require a whole manual in itself. However, basic troubleshooting procedures and a few common problems can be mentioned. Refer to Fig. 2 for a diagram of the complete conventional system.

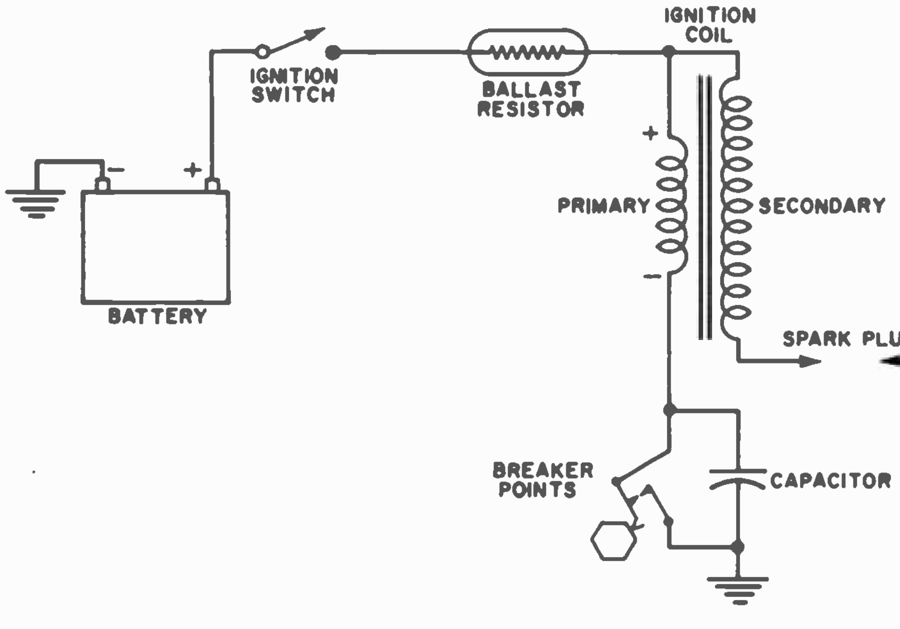
First, the problem should be isolated between the cranking system and the ignition system. If the starter motor does not turn when the key is in the cranking position, the problem is in the cranking system consisting of the battery, ignition switch, starter solenoid, and the starter motor. One simple check that can be made immediately is a visual inspection of the wiring for open or shorted leads, and corroded or loose connections. Any questionable wires should be replaced and bad connections should be cleaned and tightened.

If the wiring appears to be in good condition, the faulty part can easily be found by a few simple checks with a voltmeter. With the ignition switch in the cranking position, the voltage at the terminals of the battery, ignition switch, starter solenoid, and starter motor should be approximately the same as the battery voltage (12 or 6 volts, depending on the type of car). Low voltage at any point will indicate the faulty part. If all the voltages are correct, the starter motor probably is faulty.

If the engine cranks but does not start, the problem may lie in the ignition system. One simple test that can be performed is to see if a spark is available from the ignition coil. Remove the high-tension lead from the center terminal of the distributor cap and hold it about a quarter of an inch from the engine block while the engine is cranking. If there is no spark, the portion of the ignition system consisting of the ballast resistor, ignition coil, breaker points, and capacitor, needs attention—again, a voltmeter can be of use in checking to see if voltage is available at the "+" terminal of the ignition coil. With the engine cranking, the voltage should be about one-third of the battery voltage. If the voltage is correct and there still is no spark, the source of trouble is probably a faulty ignition coil or capacitor.

If there is no voltage on the "+" terminal of the ignition coil while the engine is cranking, this indicates either an open wiring connection between the ignition switch and the ignition coil, or a short somewhere between the ignition coil and ground. This could be caused by improperly set points, a shorted capacitor, or a short in the wiring. Full battery voltage indicates

Fig. 1. Circuit diagram of conventional ignition system.



an open circuit between the "+" terminal of the ignition coil and ground. This could be caused by a bad ignition coil, improperly set or dirty points, or an open wiring connection. The source of trouble can usually be isolated by checking continuity with an ohmmeter, or by trial and error substitution of components.

If there is a spark, but the engine still does not start, the problem may lie in the distributor cap, faulty spark plugs, or poor high tension wires. The distributor cap should be inspected for cracks and dirty contact terminals, the spark plugs should be clean and properly gapped, and the high-tension wires should be dry and show no signs of arcing.

If the car starts but does not run properly, the breaker points should be checked to see that they are clean and properly set. They can be adjusted with a feeler gage or with one of the many dwell meters on the market. The engine timing should also be checked with a timing light to see that the distributor is set properly.

Starting problems can be caused by a number of factors other than ignition; such as a dirty or improperly adjusted carburetor, flooding, vapor lock, or gasline freeze, to mention only a few of the more common problems.

Transistor Ignition

Transistor ignition is a rather recent development, and it has not as yet found widespread usage. However, since it is employed on some cars and fleet vehicles, any complete discussion of ignition systems should include the transistor system.

Transistor ignition is basically the same as conventional ignition with one basic difference. Instead of the ignition coil primary current passing through the breaker points, one or more transistors are used to switch the current. The points only serve to switch the power transistors on and off. Thus, the points are now called upon to handle only a small voltage and current so they do not degrade nearly as rapidly as with the conventional system. Since no arcing is produced, the capacitor across the points can also be eliminated.

Refer to Fig. 3 for a simplified schematic of a one-transistor ignition system. Some systems use two transistors in series, other systems place the transistor unit between the coil and ballast resistor, and nearly all systems have additional components to protect the power transistor. But for clarity, the transistorized system will be explained with just one power transistor in use.

When the ignition switch and the points close, the power transistor switches on and conducts current through the ballast resistor and primary of the ignition coil. As in the conventional system, this current forms a magnetic field around the ignition coil. When the points open, the transistor switches off rapidly and the magnetic field collapses, inducing a high voltage on the primary which is transformed to about 27,000

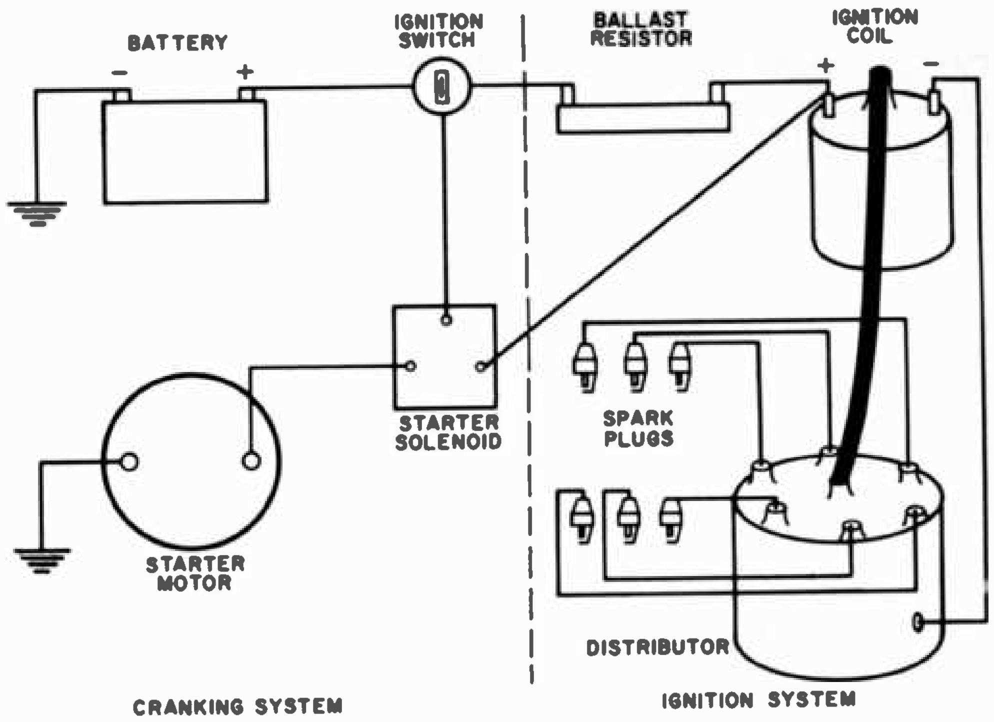


Fig. 2. Arrangement of conventional ignition system.

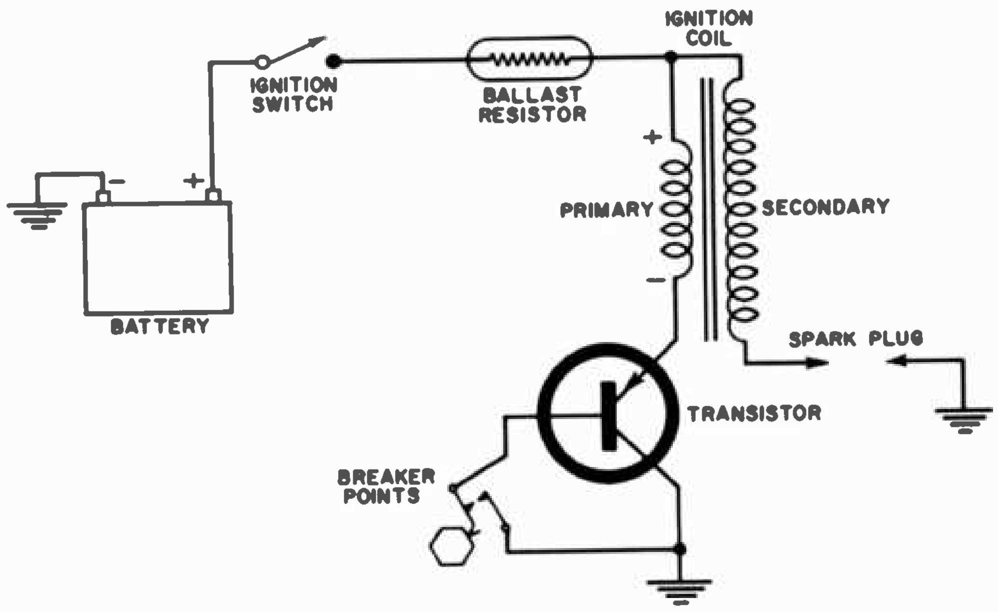
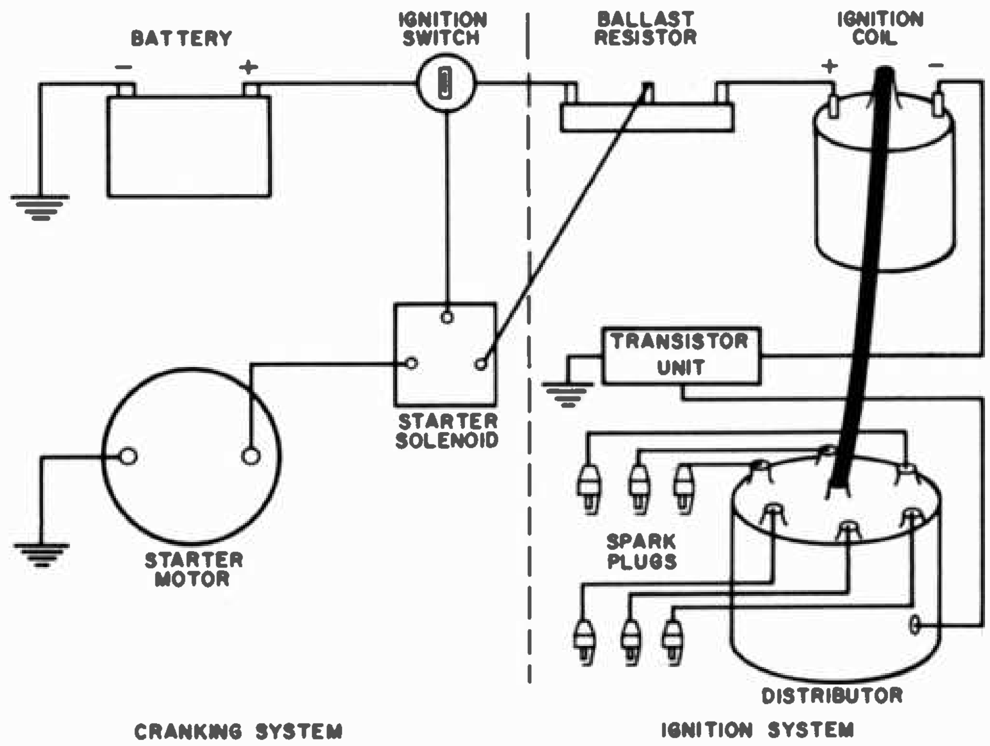


Fig. 3. Simplified schematic of 1-transistor ignition.

volts on the secondary winding of the ignition coil.

The main difference from the conventional ignition is in the rapid switch-off of the power transistor. In the conventional system, a capacitor was necessary across the points to prevent arcing. However, this capacitor tends to prevent the magnetic field from collapsing rapidly. In transistor ignition, a power transistor takes care of the current switching and thus eliminates the need for a capacitor. Thus the magnetic field around the ignition coil can collapse immediately and make more efficient use of the stored

Fig. 4. Parts arrangement in transistor ignition system.



DIRECTORY OF ELECTRONIC IGNITION SYSTEMS					
MFG.	MODEL	TYPE*	VOLTAGE (V)	GND. (+,−)	PRICE ($) (k = kit)
ANDERSON	AD8A	T	6,12	−	19.00 15.00 (k)
	AD8AP	T	6,12	+	21.00 17.00 (k)
DELTA	Mark Ten	C-D	6 12	− −,+	44.95 29.95 (k)
EXCEL	X-L Trigger	T	6,12	−	14.95
JUDSON	Electronic Magneto	T	6,12	−,+	49.50
KNIGHT-KIT	KG-372	C-D	12	−,+	28.95 (k)
SYDMUR	Fyreball	C-D	6,12	−,+	84.75
	Maraner	C-D	6,12	−,+	79.95 54.50 (k)
	Flyaway	C-D	6,12	−,+	60.00 44.50 (k)
	Compac	C-D	6,12	−	34.75 24.95 (k)

* T = transistor;C-D=capacitor-discharge

magnetic energy of the ignition coil. This efficient use of the stored magnetic energy enables the transistor system to outperform conventional ignition with respect to available high voltage, especially at very low and very high engine speeds. Also, since the points last longer, the time between major tune-ups is increased with a transistor system.

In most cases a special ballast resistor and ignition coil are used for the transistor ignition system because of the low voltage requirement of the power transistor as compared to breaker points. The primary of the ignition coil must have fewer turns than the conventional coil to keep the primary voltage, and also the voltage across the transistor, low. Now if the transistor ignition coil is to store approximately the same energy as the conventional coil, the current through the primary will have to be increased. Thus the total resistance of the ballast resistor and ignition coil primary in this system is much less than in the conventional system. The average transistor ignition system draws over twice as much current as the conventional system. This is one of the disadvantages of a transistor system. Later types of transistor ignition systems use improved high-voltage power transistors which allow a coil similar to the conventional ignition coil to be used.

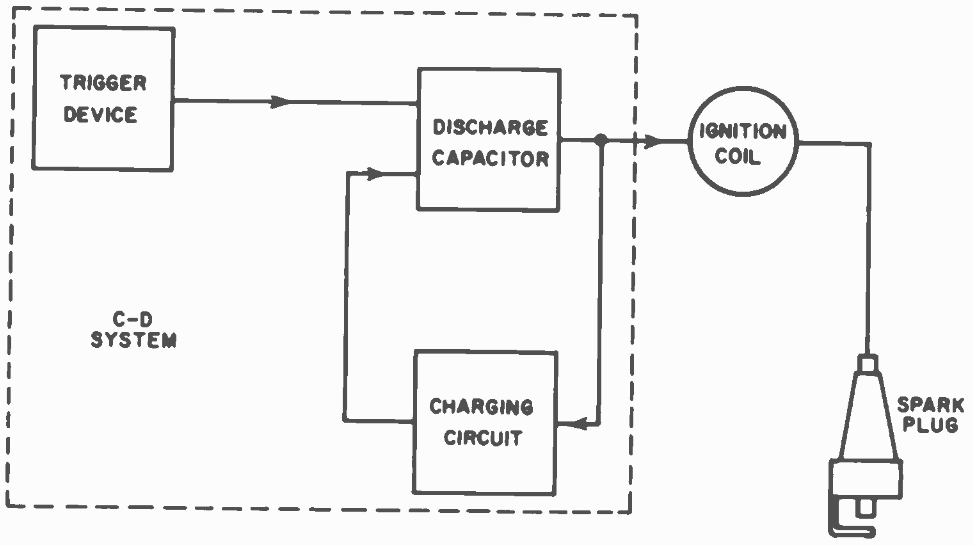
Troubleshooting Transistor System

Refer to Fig. 4 for a diagram of the transistor ignition system. The troubleshooting and tune-up procedure for the transistor system are much the same as for conventional ignition. The general problem area should first be determined.

If the engine cranks but there is no spark, the problem may lie in the transistor ignition system. A voltmeter can be used to isolate the faulty component. The voltage should be checked on the "+" terminal of the ignition coil while the engine is being cranked. The voltage should be somewhat less than the battery voltage. If the voltage is correct and there is still no spark, the source of trouble is probably a faulty ignition coil. If there is no voltage on the "+" terminal of the ignition coil while the engine is cranking, this indicates either an open ballast resistor or a short somewhere between the ignition coil and ground. This could be caused by a shorted transistor unit, improperly set points, or a short in the wiring. Full battery voltage indicates an open circuit between the "+" terminal of the ignition coil and ground. This could be caused by an open ignition coil, bad transistor unit, improperly set points, or an open wiring connection. The source of trouble can usually be isolated by checking continuity with an ohmmeter, or by trial and error substitution of components.

If there is a spark but the engine still does not start, or if the engine starts but does not run properly, the same procedures as outlined in the section on conventional ignition can be followed. However, there may be a problem using a standard conventional ignition dwell meter with a transistor system. In this case, the points will have to either be set mechanically with a feeler gage, or a special dwell meter for transistor systems will have to be used.

Fig. 5. Basic capacitor-discharge ignition system.



Capacitor-Discharge Ignitions

The second electronic ignition system for automotive use today is the capacitor-discharge (C-D) type. This system consists of three basic components. These are: 1. a discharge capacitor, 2. a charging device, and 3. some type of triggering mechanism. Fig. 5 shows a typical method of connecting these three parts to form a complete ignition system.

To begin, consider the discharge capacitor and its associated circuitry (Fig. 6). Assume that capacitor C is charged initially to some voltage V_0. When switch

S is closed, the voltage V_0 is immediately impressed across the primary winding of the ignition coil. Since the ignition coil in the example shown is an auto-transformer with a secondary to primary turns ratio of N to 1, the initial voltage applied to the spark plug will be NV_0. Assuming that the spark plug will fire when the secondary voltage NV_0 is applied, the spark plug will continue to fire until the secondary voltage drops below the minimum voltage required to sustain the arc. It is this discharge of the capacitor into the primary of an ignition coil to generate a spark which characterizes all capacitor-discharge ignition systems.

The next question that arises is how the capacitor gets charged in the first place. This is the function of the charging circuit. Most charging circuits consist of an oscillator-rectifier configuration (using transistors and diodes) in which the discharge capacitor acts as the rectifier load until the desired charge voltage is obtained.

There are a number of oscillator circuits which may be used to generate the charge voltage. However, these circuits generally may be classified as either "continuous running" or "pulsed." The continuous-running type ordinarily will oscillate at a frequency well in excess of the maximum spark rate required of the system. This type of oscillator may either be allowed to run 100% of the time, or it may be gated by the triggering circuit. The pulsed type of oscillator, on the other hand, usually is designed to charge the discharge capacitor in a single cycle of oscillation.

The final component to be considered is the triggering mechanism. This is the device which controls the rate at which the capacitor-discharge system generates spark pulses. To control the repetition rate, the triggering mechanism must perform two functions: 1. discharge the capacitor, and 2. initiate the cycle which charges the capacitor.

To gain some insight into the operation of simple triggering circuits, consider the diagram of Fig. 7. This is the discharge circuit of Fig. 6 with switch S replaced by a set of breaker points, an SCR, and resistor R. The operation of the circuit is as follows: When the points are closed, no signal is applied to the gate of the SCR, and this device remains in its non-conducting state. When the points open, battery voltage is applied to the gate through resistor R causing the SCR to switch to its high conducting state. With the SCR conducting, capacitor C discharges through the primary of the ignition coil and the SCR. Since the SCR can conduct only one way, this device will switch to its non-conducting state when the discharge current tries to reverse its direction. With the SCR shut off, capacitor C is now ready to be recharged.

The initiation is usually accomplished by connecting a tap from the discharge circuit to the charging oscillator. The tap is adjusted so that the charging circuit will start near the end of the capacitor discharge.

Today, virtually all triggering circuits use an SCR

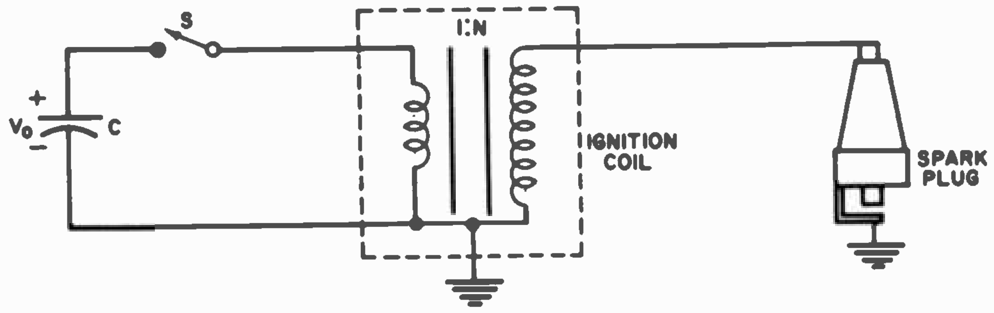


Fig. 6. A simple capacitor discharge circuit and coil.

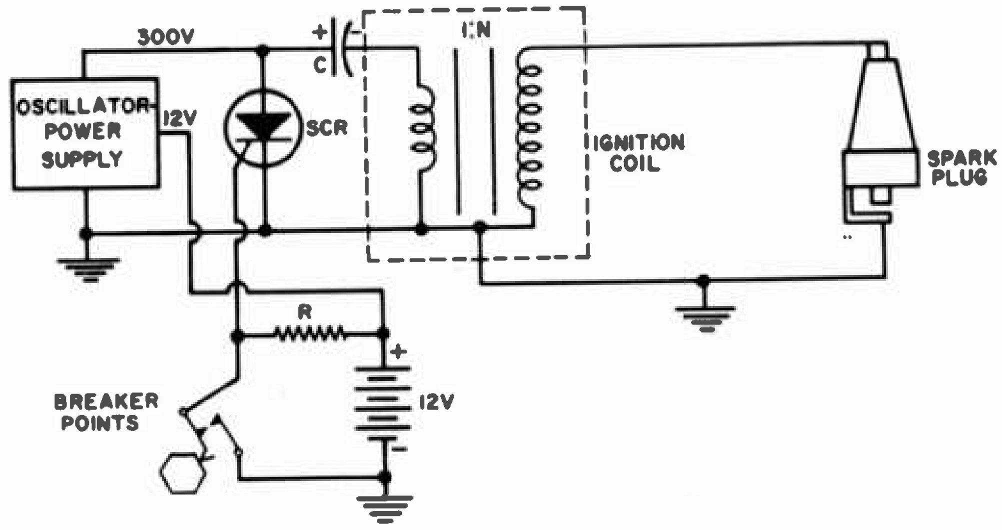


Fig. 7. Simplified schematic of C-D system using SCR.

to complete the discharge path. There are numerous methods employed to gate the SCR. Among these are mechanical breaker points, magnetic sensors and any necessary associated circuitry, photoelectric devices, and piezoelectric devices.

To summarize, a capacitor-discharge ignition system is one in which the spark producing energy is produced by discharging a capacitor into an ignition coil. Some of the areas where capacitor-discharge systems have been used with success are outboard motors, motorcycle engines, in addition to the automobile.

Capacitor-discharge ignition systems have definite advantages which make them attractive. Some of these advantages are an inherently fast risetime, longer spark-plug life, longer breaker-point life, higher speed capability, low battery current drain, and foul plug firing capability. This all means a longer period between tune-ups. It is these advantages which are causing automobile manufacturers to supply this ignition as an option on some models.

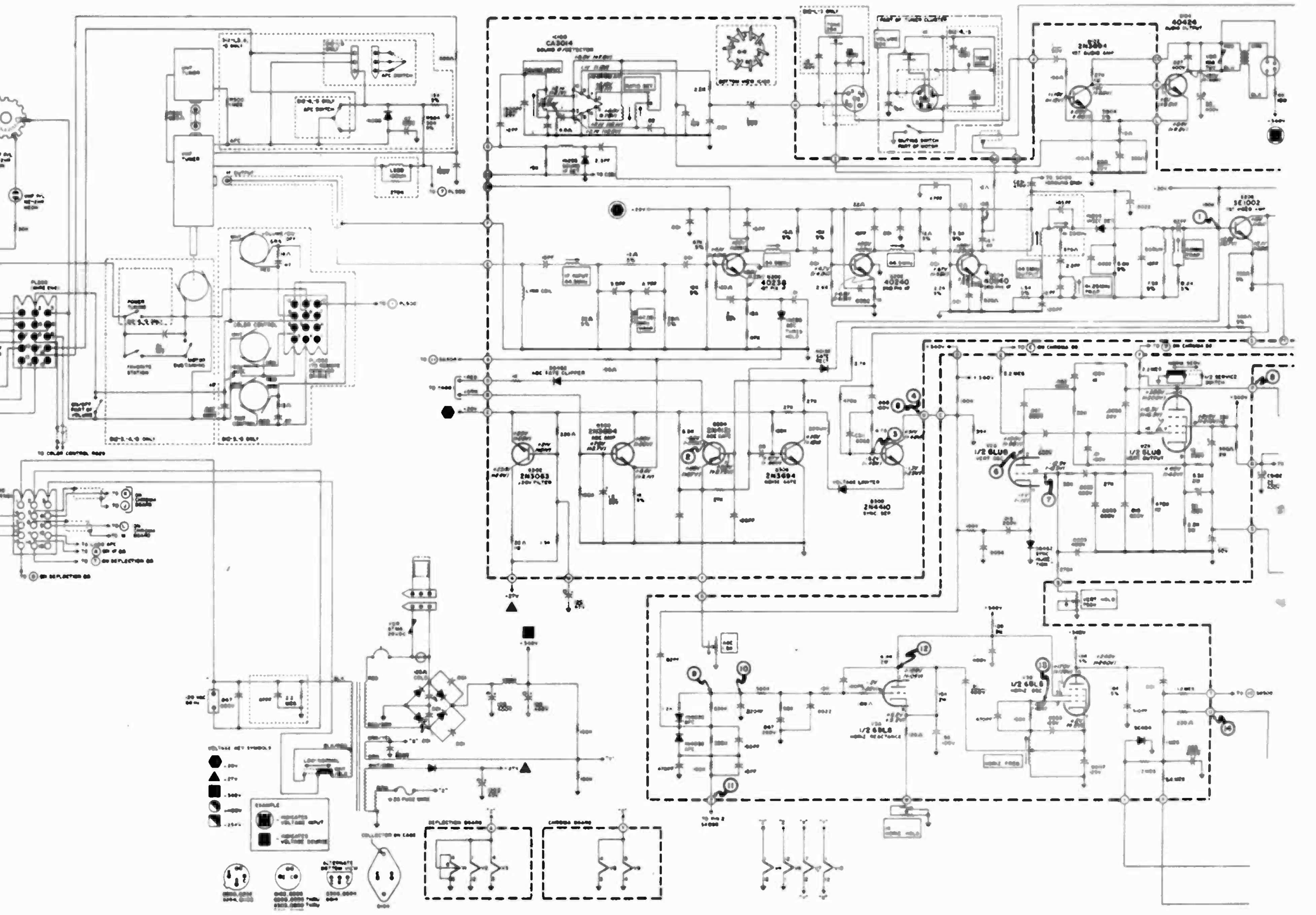
Capacitor-discharge ignition systems also have their disadvantages. Two of these are, lower reliability due to the large number of components needed, and high cost. However, with rigid specification of components and good quality control, the reliability of a capacitor-discharge ignition system can approach that of conventional ignition. With increased reliability and more widespread usage, high volume production can be expected to greatly lower the cost of capacitor-discharge ignition. ▲

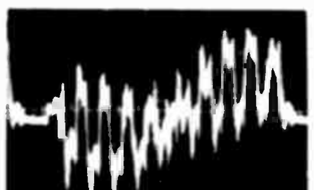
For additional information on electronic ignition systems from manufacturers listed, simply circle corresponding number on Reader Service Card.

Anderson Engineering	**60**
Delta Products, Inc.	**61**
Excel Electrical Products	**62**
Judson Research & Mfg. Co.	**63**
Knight-Kit Allied Radio Corp.	**84**
Sydmur Electronic Specialties	**64**

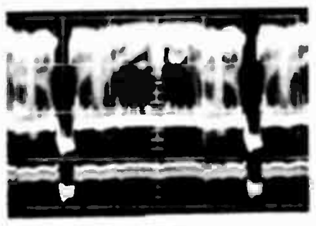
SYLVANIA *D12 1-3-4-5* COLOR-TV CIRCUIT

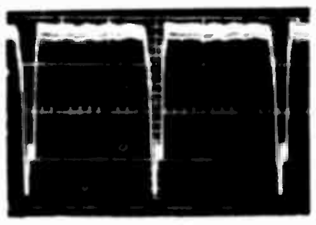
The circuit shown is basically a "universal" diagram in that it can be used for quite a few different Sylvania chassis. The difference is that D12-1 is with a.f.c.; D12-3 is with a.f.c. and remote; D12-4 is with a.f.c. and power tuning; D12-5 is with a.f.c. and remote and power tuning. This same circuit could also be used for several other models. The D12-2 has a.f.c. but is wired for home music systems. D12-7 is the same as -6 except that the tuner section carries last year's parts numbers. D12-8 is the basic chassis without a.f.c. There is also similarity between these chassis and Sylvania's D13-2. This newest design is wired for use with their Color-TV Slide Theater. All these sets are designed around a 23" color picture tube and the various chassis appear in quite a few different consoles and table models.





31-✱ 12.5V P-P HORIZ.


1-2V P-P VERT.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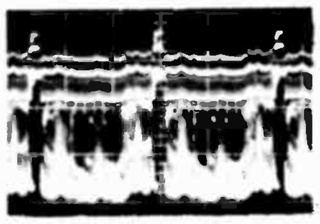
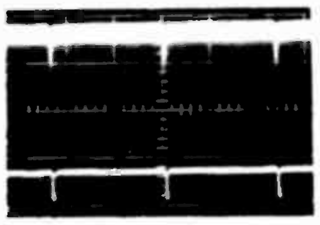
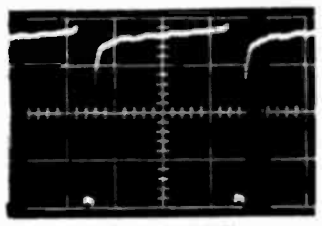
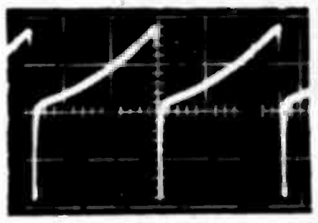
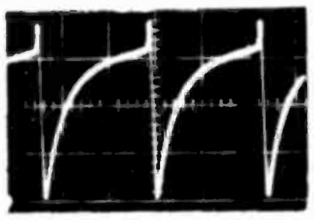
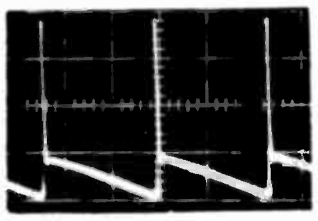

3-8V P-P VERT.

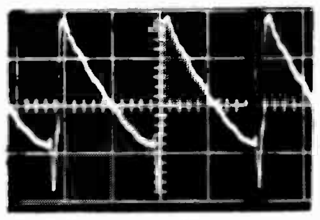

4-50V P-P VERT.

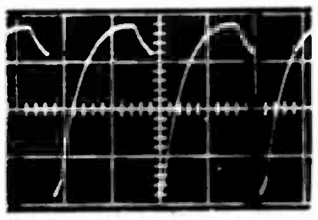

5-50V P-P HORIZ.

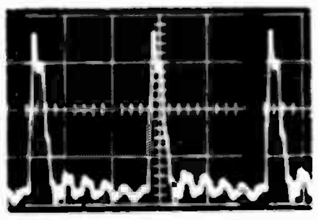

6-100V P-P VERT.

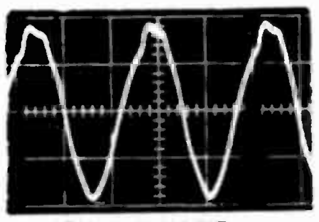

7-40V P-P VERT.

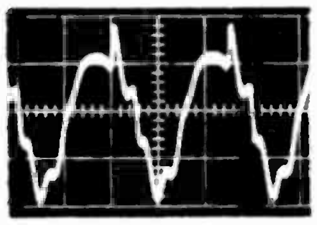

8-1300V P-P VERT.

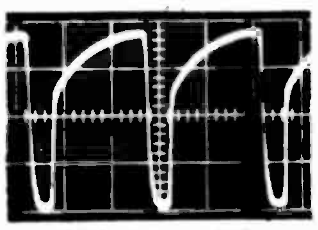

9-30V P-P HORIZ.

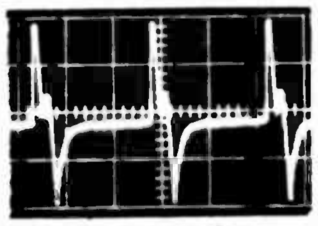

10-78V P-P HORIZ.

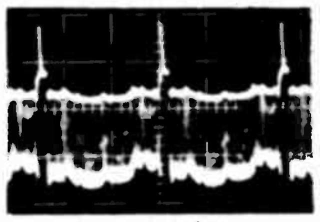

11-220V P-P HORIZ.

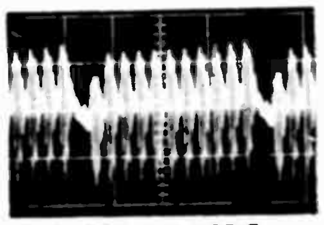

12-45V P-P HORIZ.

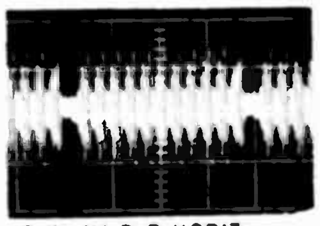

13-60V P-P HORIZ.

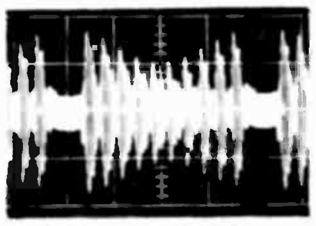

14-192V P-P HORIZ.


15-192V P-P HORIZ.


16-75V P-P VERT.


17-* .62V P-P HORIZ.


18-* 4V P-P HORIZ.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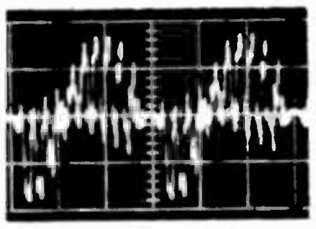
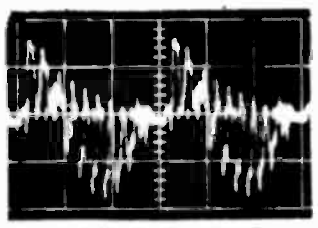
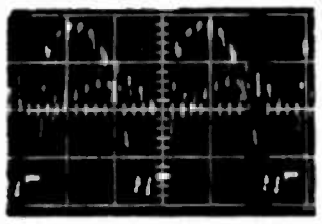
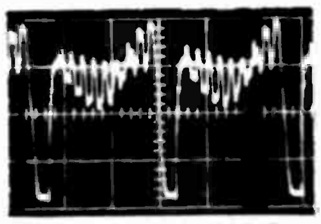
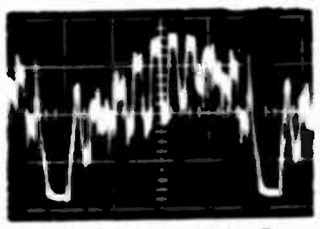
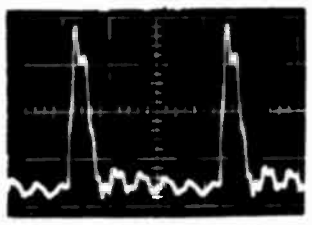

20-* 14V P-P HORIZ.

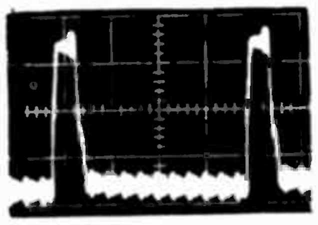

21-* 14V P-P HORIZ.

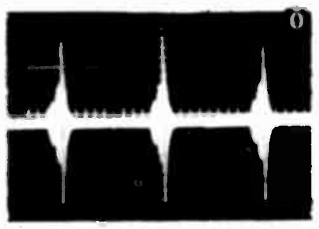

22-* 138V P-P HORIZ.

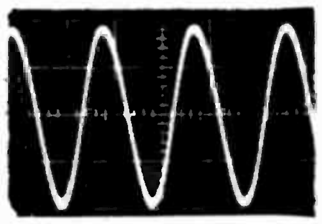

23-* 93V P-P HORIZ.


24-* 120V P-P HORIZ.


25-* 20V P-P HORIZ.


26-* 3.5V P-P HORIZ.

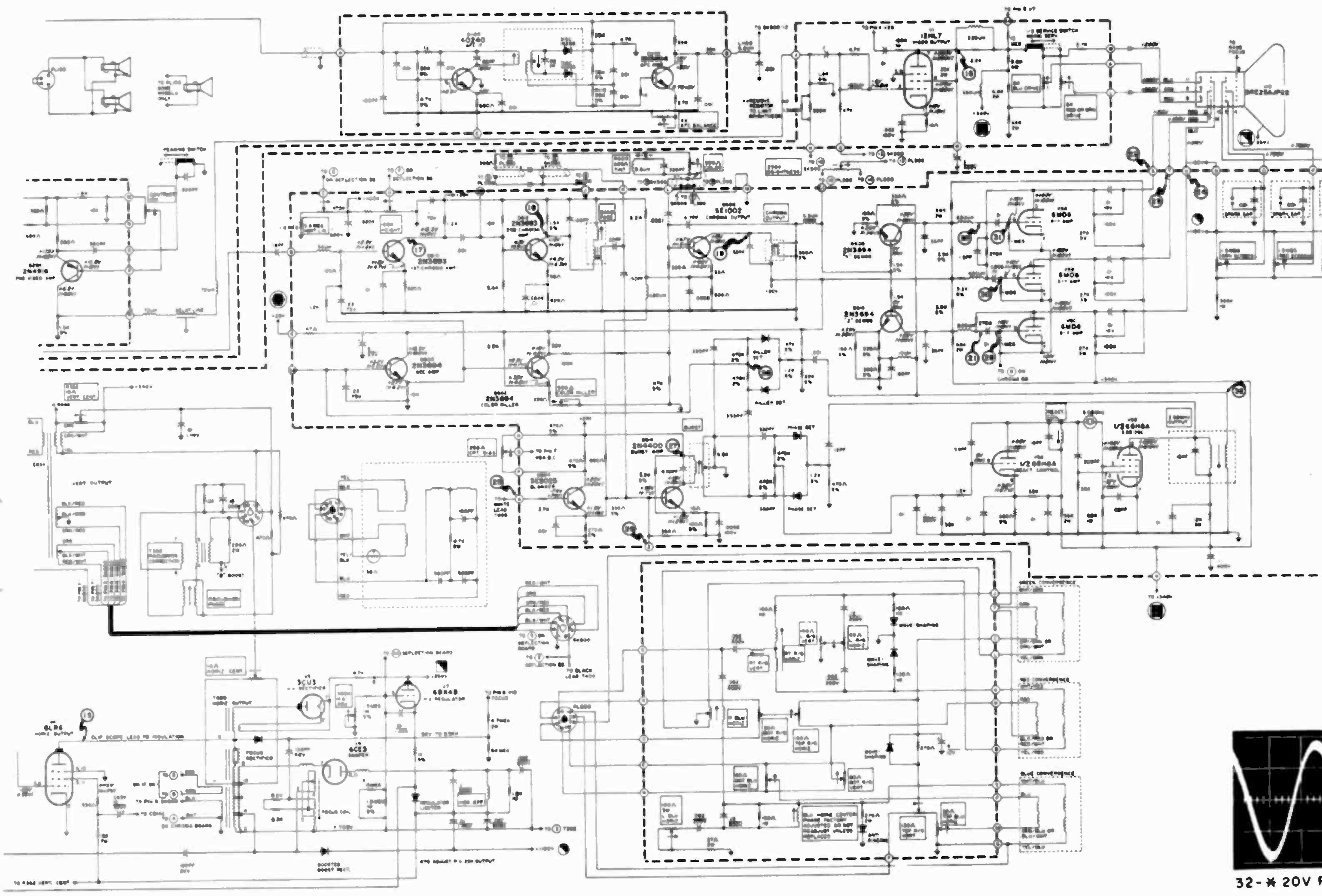

27-* 19V P-P HORIZ.

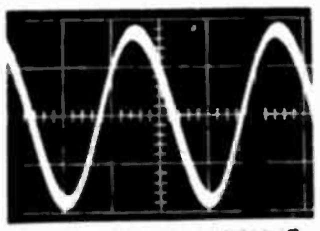

28-* 13V P-P HORIZ.


29-* 11V P-P HORIZ.


30-* 4V P-P HORIZ.

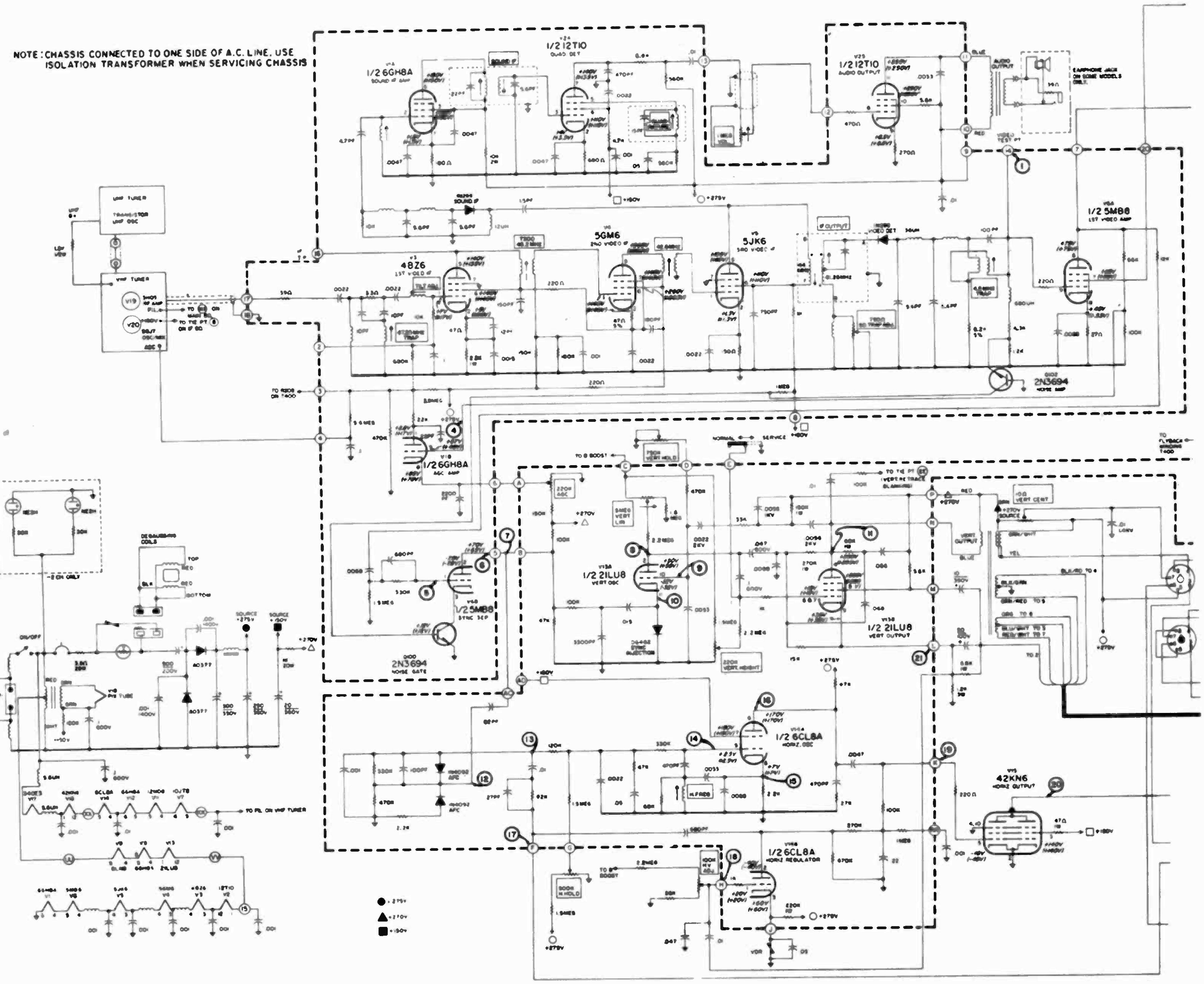
WAVEFORMS MARKED WITH AN (*) WERE TAKEN USING A COLOR BAR GENERATOR AS SIGNAL SOURCE

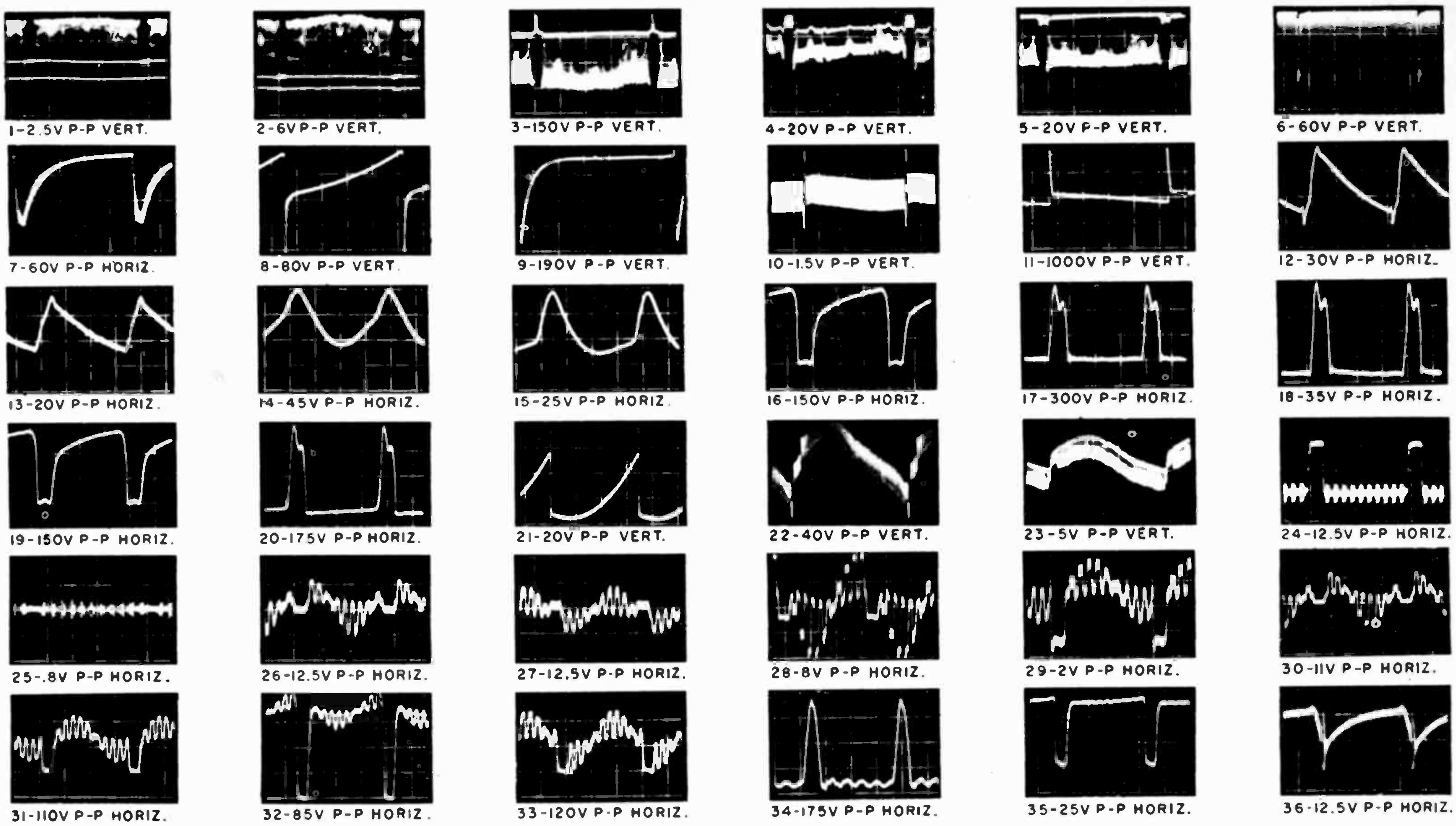



32-* 20V P-P 3.58MHZ

SYLVANIA *D11 1-2* COLOR-TV CIRCUIT

The circuit shown is a hybrid design, combining transistors and tubes, used in Sylvania Chassis D11 1-2. These two chassis are basically identical—the only difference being that the 11-2 includes dial lights and an earphone jack. These sets use a 14" color-TV tube and the chassis appears in a number of portable sets in company's 1969 line.





1-2.5V P-P VERT. | 2-6V P-P VERT. | 3-150V P-P VERT. | 4-20V P-P VERT. | 5-20V P-P VERT. | 6-60V P-P VERT.

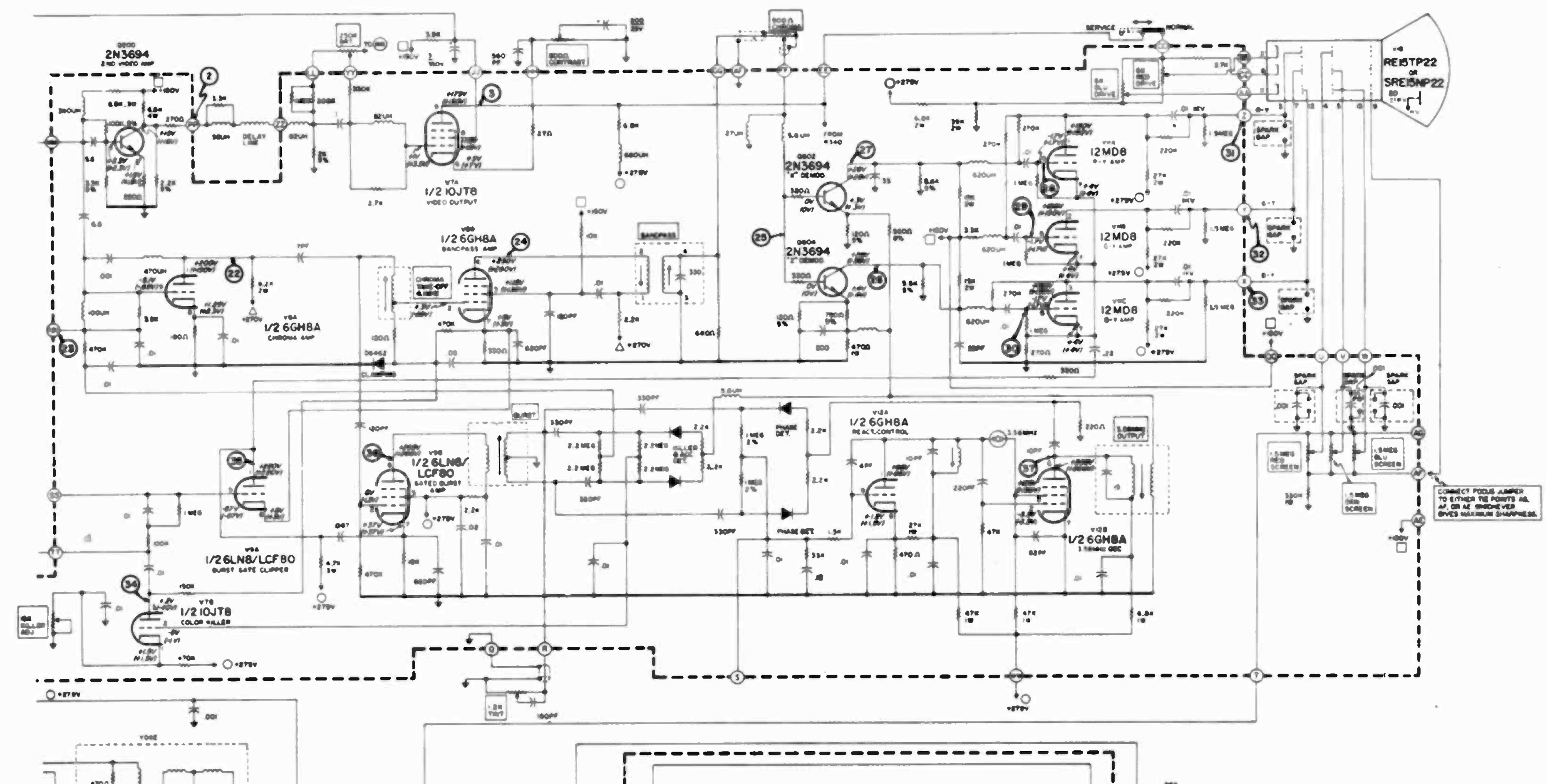
7-60V P-P HORIZ. | 8-80V P-P VERT. | 9-190V P-P VERT. | 10-1.5V P-P VERT. | 11-1000V P-P VERT. | 12-30V P-P HORIZ.

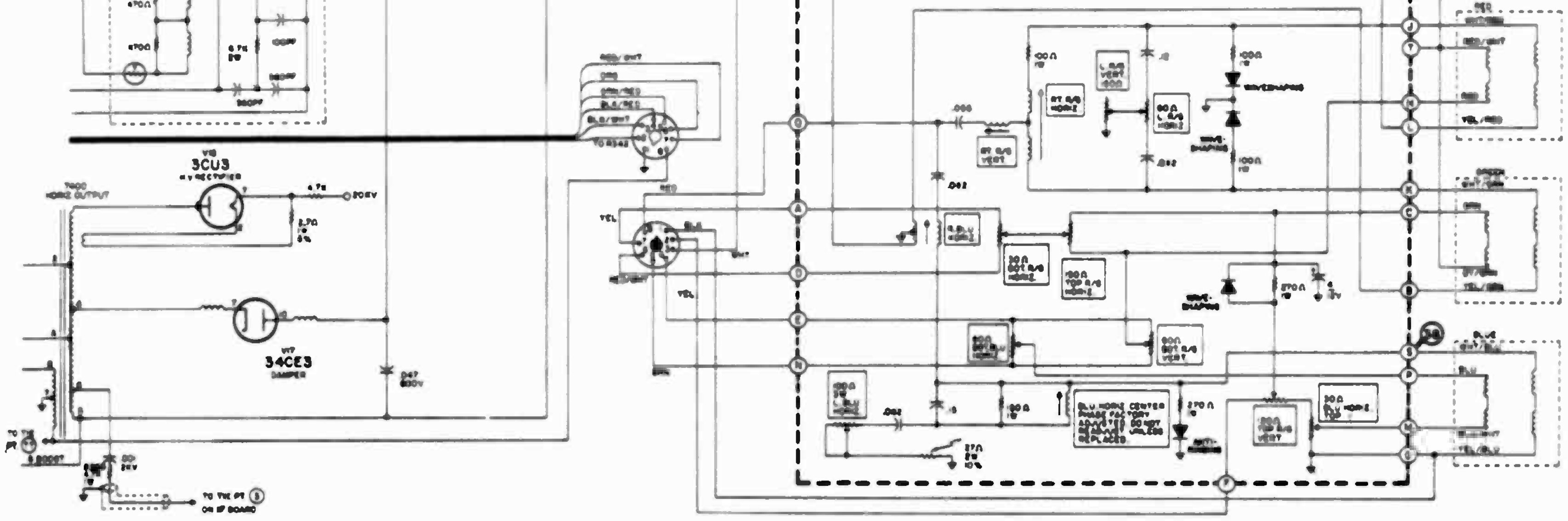
13-20V P-P HORIZ. | 14-45V P-P HORIZ. | 15-25V P-P HORIZ. | 16-150V P-P HORIZ. | 17-300V P-P HORIZ. | 18-35V P-P HORIZ.

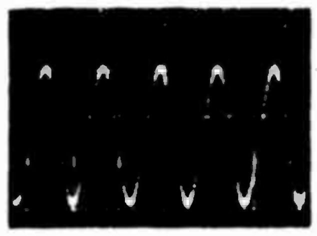
19-150V P-P HORIZ. | 20-175V P-P HORIZ. | 21-20V P-P VERT. | 22-40V P-P VERT. | 23-5V P-P VERT. | 24-12.5V P-P HORIZ.

25-.8V P-P HORIZ. | 26-12.5V P-P HORIZ. | 27-12.5V P-P HORIZ. | 28-8V P-P HORIZ. | 29-2V P-P HORIZ. | 30-11V P-P HORIZ.

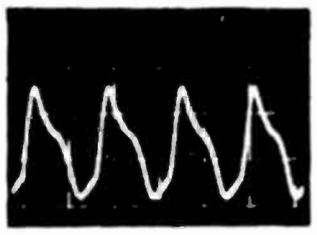
31-110V P-P HORIZ. | 32-85V P-P HORIZ. | 33-120V P-P HORIZ. | 34-175V P-P HORIZ. | 35-25V P-P HORIZ. | 36-12.5V P-P HORIZ.







37-150V P-P 3.58MHZ



38-15V P-P HORIZ.

TEST EQUIPMENT FOR SERVICING

By RHYS SAMUEL RCA Electronic Components

Servicing is getting more sophisticated and so is service test equipment. New instruments are solid state, more portable, with better performance. Here's the test equipment that is needed, along with its specifications for servicing audio, radio, and black-and-white and color-TV receivers.

THE fast-changing technology of today's electronics can make servicing a fascinating business. But it can also whiz past the fellow who stops learning. All the new components, circuits, and electromechanical gadgets in today's radios and TV receivers are tough enough to keep up with; it's just as hard to evaluate the procession of new test instruments appearing on the market.

For years, the servicing trade has asked for solid-state test instruments. Until recently, however, solid-state versions couldn't match their tube counterparts in performance, cost, and reliability. But they are here at last, and some are very good indeed. We'll see even more in the future.

Their most welcome advantage is portability. Solid-state electronic v.o.m.'s and color-bar generators can be battery-operated. Other instruments can be made smaller, lighter in weight, and—in some cases—more stable with transistors and integrated circuits.

Along with the trend toward solid state has come the need for new types of instruments and better-performing veterans. Voltmeters need both lower and higher ranges; oscilloscopes need greater sensitivity and frequency response; and signal generators need lower leakage, greater accuracy, and lower distortion. In brief, servicing is getting more sophisticated.

Knight-Kit KG-600B tube tester.

Triplett 344-A tube analyzer.

Hickok 123R "Cardmatic" tube tester.

Audio Servicing

Although nearly all of the mono and stereo systems pouring off today's production lines are solid state, many tube systems are still in use. For professional audio work, you'll need the following equipment:

V.o.m., V.t.v.m., or T.v.m. (Transistorized Voltmeter). Emphasis here is on the lowest d.c.-voltage range; it should be on the order of 0.5 volt. For minimum circuit loading, however, an electronic voltmeter is desirable. (A 20,000-ohms-per-volt meter will present only 10,000 ohms to the circuit being tested on the 0.5-volt range.) You'll also need to measure direct current from 1 milliampere to 1 ampere in transistor circuits.

A. c. Electronic Voltmeter. An electronic audio voltmeter is excellent for measuring low-level a.c. signals. Most commercial units are also calibrated in decibels. These meters should measure down to at least 1 millivolt, and should have an input impedance of 1 megohm or more and a response from 10 Hz to 1 MHz or higher. Unless they have a shielded case, probe, and input cable, however, they may not be usable in very-low-level circuits.

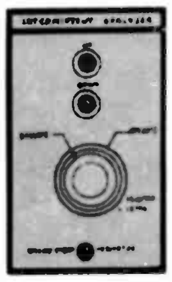
Sine-Wave Generator. A sine-wave signal is needed for locating defective stages, making checks on amplifiers and tone-control circuits, and checking speaker systems. A 10-Hz to 100-kHz signal is needed for high-quality amplifiers; a signal to 20 kHz will be necessary for speaker systems.

Most generators don't have enough output for driving multiple speaker systems, which are generally inefficient, and you may have to check for speaker-system rattles and resonances by feeding the signal through the power amplifier. A generator with a maximum harmonic distortion of 0.25% is adequate for service work.

Square-Wave Generator. A square wave is indispensable for instantly checking a system for frequency-response characteristics and ringing. A generator that has a square wave output from 30 Hz to 20 kHz and a rise time of 0.25 microsecond or better is good for general audio work. Combination sine-square generators are

Another benchwarmer?

Not this one. Our new B&K Diagnostic Oscilloscope is more than re-engineering of an old model to keep pace with TV technology. It is instead a basic departure from all other oscilloscopes. A departure that has simplified a complex instrument to make it easier for you to use. But there's something else.



What this oscilloscope has is exclusive. An Intermittent Analyzer with electronic memory—and optional remote Audio/Visual Alarm.

With it, the elusive intermittent conditions that make so many TV sets tough dogs can now be detected and identified in your absence. Preset one control. When the faulty stage is detected, you'll know about it as soon as you come back from service calls. Then run the scope overnight to check another set for an intermittent condition.

All this adds up to greater shop efficiency, more time for profit-making service calls and a lot more mileage out of a very fine diagnostic oscilloscope.

An oscilloscope that shows vector patterns exactly as specified by color TV manufacturers. (All vectorscope inputs and controls are conveniently located on the front panel.) Also allows you to read peak-to-peak voltages in all ranges on a double-scale calibrated screen—just by turning a switch. (As the range is selected, the appropriate scale lights automatically.)

Circle No. 4 on Reader Service Card.

Automatic synchronization locks in all patterns at any signal level or frequency. There are also fewer controls and these are positioned for easier operation.

Give our Diagnostic Oscilloscope some thought. It's worth it not to be sidelined with a benchwarmer. See your B&K Distributor or drop us a note for detailed literature on Model 1450 and our full-line test equipment catalog, AP-24.

DIAGNOSTIC OSCILLOSCOPE
Model 1450, Net: $\$279^{95}$

B & K Division of DYNASCAN CORPORATION
1801 W. Belle Plaine · Chicago, Illinois 60613
Where electronic innovation is a way of life.

TYPE OF INSTRUMENT	TYPE OF SERVICING AUDIO	AM RADIO	FM RADIO	B&W TV	COLOR TV
V.o.m.	X	X	O	O	X
V.t.v.m./T.v.m.	O	X	X	X	X
A.f. V.t.v.m.	X	O	O		
Oscilloscope	X		O	X	X
Transistor Tester	X	X	X	X	X
Receiving-Tube Tester	X	X	X	X	X
Picture-Tube Tester				X	X
Power Supply		X	X		
R.f. Signal Generator		X	X		
A.f. Sine Generator	X		O		
Square-Wave Generator	O				
Stereo Signal Gen.	X		X		
Battery Tester		X	X		
Capacitor Tester	O	O	O	O	O
Flyback Tester				O	O
Sweep Generator			X	X	X
Marker Generator			O	X	X
Marker Adder				O	O
TV Bias Supply				X	X
Color-Bar/Conv. Gen.				O	X
R.f. Modulator				O	X
Video Marker				O	X

X = Basic Instrument; O = Optional Instrument

Table 1. Check list of service test instruments that are required for various types of servicing.

available at moderate cost. You'll need a scope for observing square-wave patterns.

Oscilloscope. A d.c. or a.c. scope with a bandwidth of 2 MHz will handle audio frequencies, including square waves with rise times of 0.25 microsecond. But the scope must be hum-free. To check it, set controls for maximum gain, short the input leads, and examine the horizontal trace. It should be a flat, straight line of even intensity. Sensitivity of at least 25 r.m.s. millivolts per inch is needed.

Transistor and Tube Testers. Audio is one of the few areas where tube or transistor matching may be necessary. For transistors, you'll match *beta;* either a d.c. or a.c. *beta* tester will do the job. Remember, however, that *beta* will vary with the level of collector current. A transistor tester having an adjustable a.c. signal or level of collector current will be better able to accommodate the wide range of transistors used in audio equipment.

Tubes may be matched for either transconductance (g_m) or plate current, depending on system requirements. Make sure your g_m tester has a power supply husky enough to test power tubes properly. Because few testers measure current, you may have to check tubes by metering them in the audio amplifier.

In addition to the above items, a *stereo signal generator* is useful in working on FM-stereo tuners and receivers.

AM and FM Receiver Servicing

V.o.m., V.t.v.m., or T.v.m. Either an electronic multimeter or v.o.m. will serve for voltage and resistance measurements in radio receivers. You will find, however, that a high-impedance v.t.v.m. or t.v.m. having an isolating resistor in the d.c. probe will work better in receiver oscillator stages. Accuracies of ± 3 to ± 5 percent on any function are adequate for troubleshooting. Current-measurement facilities are helpful for checking solid-state circuits.

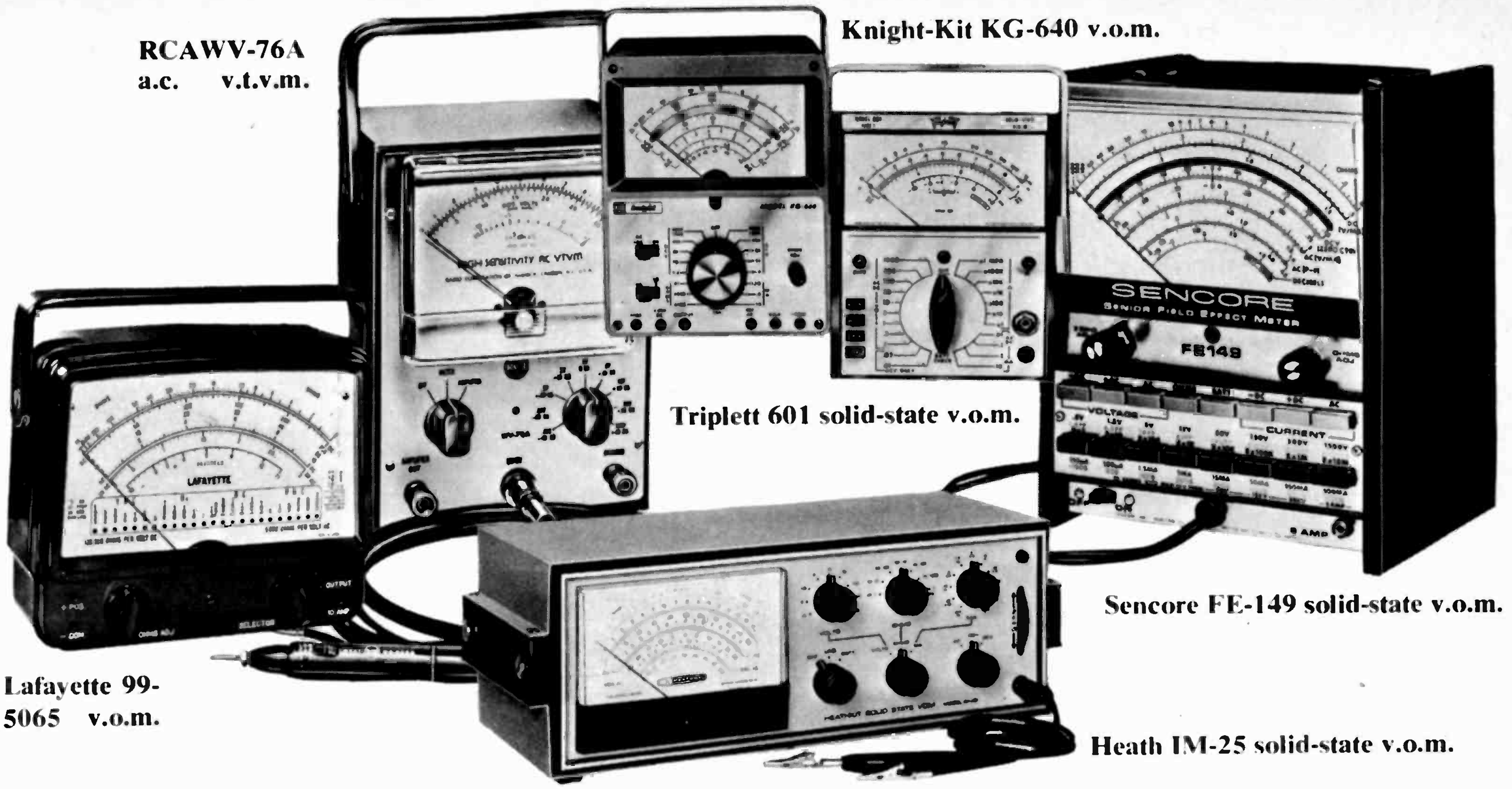
Signal Generators. A signal source is needed for locating a defective stage by signal injection and for alignment of front ends and i.f. amplifiers. For AM and short-wave radios, you'll need an AM generator having output from approximately 200 kHz to 40 MHz or higher. Look for a dial accuracy of ± 2% or better, an attenuator which can reduce r.f. output all the way to zero, a shielded output cable, a d.c. blocking capacitor in series with the cable, and adjustable internal modulation. If the internal audio signal is available separately on the panel, you can also use the generator for troubleshooting receiver

RCA WR-52A FM-stereo signal generator

RCA WA-504A sine and square-wave generator

Knight-Kit KG-688 sine/square-wave generator

Eico 342 FM-stereo signal generator.



RCAWV-76A a.c. v.t.v.m.

Knight-Kit KG-640 v.o.m.

Triplett 601 solid-state v.o.m.

Sencore FE-149 solid-state v.o.m.

Lafayette 99-5065 v.o.m.

Heath IM-25 solid-state v.o.m.

audio-frequency circuits. (*Note:* Requirements for aligning communications receivers are usually stringent and demand very precise, low-leakage generators having metered outputs.)

FM broadcast receivers require a stable AM signal from 88 to 120 MHz for front-end work, and FM sweep signal at 10.7 MHz for intermediate-frequency and detector alignment. These requirements place the generator in the category of TV alignment, which is discussed later.

Power Supply. A low-voltage d.c. power supply is needed for servicing battery-operated receivers. The supply can be tapped or be continuously adjustable, but it should have a range from 1.5 to 20 volts at 150 milliamperes or more. It should also be short-circuit protected, have metering of both voltage and current, and, preferably, be current limiting. It should have low impedance output to prevent motorboating of receivers. Power supplies of higher current rating (1 ampere or more) can be used to power battery-operated record and tape players.

Transistor and Tube Testers. An in-circuit transistor tester is handy because transistors can be tested without unsoldering them from their boards. *Beta*-measurement accuracy is generally not critical in receivers and, because transistor failures are usually catastrophic, you'll

TRANSISTORIZED V.M.'s/V.O.M.'s

MFGR.	MODEL	RANGES* D.C.,A.C. (r.m.s.) VOLTS	OHMS/ MID-SCALE	D.C.+A.C. CURRENT	D.C. INPUT RES. (MΩ)	A.C. INPUT Z (MΩ–pF)	ACCURACY % (FULL-SCALE) D.C.	A.C.	A.C. FREQUENCY RESPONSE	PRICE $(K-kit)	REMARKS
AMPHENOL	870	0.1–1000 d.c. 0.01–300 a.c.	10–10M	–	11	10–20	±2	±3	8Hz–300kHz	99.95	Uses FET's
HEATH	IM–16	0.5–1500	10–10M	–	11	1–	±3	±5	20Hz–1MHz	64.95 44.95(K)	Line or battery operated
	IM–17	1–100	10–10M	–	11	1–	±3	±5	10Hz–1MHz	21.95(K)	Portable
	IM–25	0.15–1500	10–10M	.015mA– 1500mA†	11	10–150	±3	±5	10Hz–100kHz	115.00 80.00(K)	Line or battery operated
RCA	WV–500A	0.5–1500 d.c. 1.5–1500 a.c.	10–10M	–	11	0.8–70	±3	±3	30Hz–3MHz	75.00	Battery operated
SENCORE	FE–14	1–1000	10–10M	1mA– 1A	15	10–29	±3	±5	10Hz–10MHz	69.95	Uses FET's
	FE–16	1–1000	10–10M	1mA– 1A	15	10–29	±1.5	±3	10Hz–10MHz	84.50	Uses FET's
	FE–149	0.5–1500	6–60M	150μA– 5A	15	15–	±1.5	±3	10Hz–10MHz	149.50	Uses FET's Push-buttons
SIMPSON	313	0.3–1000	10–10M	100μA– 1A	11	10–	±3	±3	20Hz–100kHz	100.00	Uses FET's
TRIPLETT	600	0.4–1600 d.c. 4–800 a.c.	10–10M	–	11	0.75–	±3	±3	–	78.00	Uses FET's
	601	0.1–1000 d.c. 0.01–1000 a.c.	10–10M	10μA– 10mA†	11	11–	±2	±3	50Hz–50kHz	125.00	Uses FET's Low-pwr. ohms

*Full-scale readings for lowest and highest ranges. †A.c. and d.c. current ranges.

ed input cable for both direct and low-capacitance work, a phase control for sweep alignment, and preset sync positions for vertical and horizontal TV waveforms.

Tube Testers. Your receiving-tube tester should measure g_m (not just emission) and interelectrode leakage. It should also have an instant heater-continuity check. Before you buy, make sure you can get test data on future tubes. Whether you buy a punched-card, roll-chart, or multi-socket type of tester requiring little setup is a personal choice. The larger multi-socket testers are suited to the "do-it-yourself" customer, who may or may not be an additional sales source, depending on your attitude toward do-it-yourselfers.

Be careful in selecting a picture-tube tester. It's no fun to replace a large color tube that checks "bad", and then find that your tube tester was fibbing.

What can you expect from a color-picture-tube tester? Let's understand first what *not* to expect. Included here are detection of intermittents, misaligned guns or shadow masks, and defects in the phosphor-dot patterns. Some types of internal shorts and faulty high-voltage connectors also cannot be detected.

Conversely, a tester should indicate shorts and interelectrode leakage down to two megohms within the same gun, and measure emission quality within ±5%. In color tubes, the quality of measurement should be based on a beam-current cut-off adjustment, which is also an excellent way of testing black-and-white tubes.

But no other tester parameter is so important as correct heater voltage at the picture tube under test. The dozens of color-tube types now in use encompass a wide variety of heater voltages, and several types employing the same heater voltage have different current ratings. Unless tube-tester design allows for these variations, tubes may be tested at out-of-tolerance heater voltages. Check this important parameter by measuring the heater voltage of the tube under test *at the tube pins.*

The tester should also have an adjustment for high and low line voltages; regulated grid-No. 1 and grid-No. 2 voltages are likewise desirable. Testers may also incorporate gun "rejuvenators" and a shorts-remover or "zapper." These features are usually of doubtful value, at best, and should *never* be used on in-warranty picture tubes.

OSCILLOSCOPES

		VERTICAL CHANNEL			HORIZONTAL CHANNEL						
MFGR.	MODEL	FREQ. RESP.	SENSITIVITY	DIRECT INPUT Z (MΩ–pF)	FREQ. RESP.	SENSITIVITY	INPUT Z (MΩ–pF)	SWEEP RANGE	CRT SIZE (in)	PRICE $(K=kit)	REMARKS
B & K	1450	5Hz–5.5MHz	25mV$_{rms}$/in	3–47	2Hz–750kHz	0.5V$_{rms}$/in	5–30	5Hz–500kHz	5	279.95	Vectorscope Intermit. analyzer
CONAR	250	10Hz–4.5MHz	23mV$_{rms}$/in	1–30	20Hz–250kHz	1.0V$_{rms}$/in	3–20	10Hz–500kHz	5	139.50 89.50(K)	Probe extra
EICO	427	d.c–500kHz	3.5mV$_{rms}$/cm	1–30	2Hz–450kHz	0.15V$_{rms}$/cm	10–40	10Hz–100kHz	5	139.95 99.95(K)	Auto sync.
	435	d.c.–4.5MHz	18mV$_{rms}$/cm	1–35	1Hz–500kHz	0.7V$_{rms}$/cm	4–40	10Hz–100kHz	3	159.95 109.95(K)	TV V&H sweeps
	460	d.c.–4.5MHz	5mV$_{rms}$/cm	3–35	1Hz–400kHz	0.24V$_{rms}$/cm	5–35	10Hz–100kHz	5	149.95 99.95(K)	TV V&H sweeps
	465	d.c.–10MHz	12mV$_{rms}$/cm	1–35	d.c.–1MHz	17mV$_{rms}$/cm	1–35	10Hz–100kHz	5	249.95 179.95(K)	TV V&H sweeps
HEATH	IO–12	3Hz–5MHz	25mV$_{rms}$/in	3.3–	1Hz–400kHz	0.3V$_{rms}$/in	4.9–	10Hz–500kHz	5	139.95 84.95(K)	Preset sweep freqs.
	IO–14	d.c.–8MHz	50mV$_{p\text{-}p}$/cm	1–15	d.c.–200kHz	1V$_{p\text{-}p}$/cm	0.1–	0.5sec/cm to 1μs/cm	5	399.00 259.00(K)	Triggered sweeps
	IO–17	5Hz–5MHz	30mV$_{p\text{-}p}$/cm	1–25	2Hz–300kHz	0.3V$_{p\text{-}p}$/cm	10–15	20Hz–200kHz	3	79.95(K)	
HICKOK	677	5Hz–4.5MHz	40mV$_{rms}$/in	3–10	5Hz–350kHz	0.25V$_{rms}$/in	5–30	10Hz–500kHz	5	249.50	
	770A	d.c.–4MHz	10mV$_{rms}$/cm	1–45	d.c.–500kHz	1V$_{rms}$/cm	2.2–25	0.5 sec/cm to 1μs/cm	5	675.00	Triggered sweeps
KNIGHT-KIT	KG–635	d.c.–5.2MHz	17mV$_{rms}$/in	3–35	1Hz–400kHz	0.6V$_{rms}$/in	7–25	10Hz–400kHz	5	119.95(K)	Probes extra
	KG-2100	d.c.–5MHz	50mV$_{p\text{-}p}$/cm	1–40	d.c.–800kHz	0.04V$_{p\text{-}p}$/cm	1–	0.05sec/cm to 200ns/cm	5	245.00(K)	Probes extra, built-in fan, trig. sweeps
PRECISION	ES–550B	10Hz–5MHz	10mV$_{rms}$/in	2–20	10Hz–2MHz	0.1V$_{rms}$/in	2–22	10Hz–100kHz	5	289.95	Auto sync.
	S–55A	d.c.–5MHz	25mV$_{rms}$/in	1.5–33	1Hz–400kHz	0.6V$_{rms}$/in	5–23	10Hz–500kHz	5	199.95	Auto sync.
RCA	WO–33A	5.5Hz–5MHz	3mV$_{rms}$/in	1–50	3.5Hz–350kHz	0.9V$_{rms}$/in	10–	15Hz–75kHz	3	139.00 108.00(K)	Wide or narrow band; lo or hi gain
	WO–91C	10Hz–4.5MHz	18mV$_{rms}$/in	1–40	10Hz–500kHz	0.18V$_{rms}$/in	2.2–30	10Hz–100kHz	5	269.00	Wide or narrow band; lo or hi gain
SENCORE	PS–127	10Hz–5.2MHz	17mV$_{rms}$/in	2.7–20	5Hz–400kHz	0.6V$_{rms}$/in	3.2–18	5Hz–500kHz	5	199.50	
	PS–148	10Hz–5.2MHz	17mV$_{rms}$/in	2.7–20	5Hz–400kHz	0.6V$_{rms}$/in	3.2–18	5Hz–500kHz	5	219.50	Vectorscope connections
SIMPSON	458	10Hz–5MHz	15mV$_{rms}$/in	3.3–20	10Hz–300kHz	115mV$_{rms}$/in	–	14Hz–250kHz	7	390.00	Wide or narrow band; lo or hi gain
	466	15Hz–100kHz	30mV$_{rms}$/in	0.5–35	15Hz–100kHz	0.7V$_{rms}$/in	0.25–40	15Hz–80kHz	5	180.00	

R. F. SIGNAL GENERATORS

MFGR.	MODEL	FREQ. RANGE (FUNDAMENTALS) (MHz)	NO. OF BANDS	CAL. HARMONICS FREQ. (MHz)	CAL. HARMONICS NO. OF BANDS	OUTPUT VOLTAGE (V)	OUTPUT Z (Ω)	MODULATION FREQ. (Hz)	PROVISION FOR EXT. MOD.	CALIB. ACCURACY (%)	AUDIO OUTPUT VOLTS	PRICE $(K=kit)	REMARKS
CONAR	280	.170–61	6	–	–	0.5	50	400	no	±1	2	35.95 24.95(K)	
EICO	324	.150–145	6	110–435	1	1.0	high	400	yes	±1.5	10	44.95 32.95(K)	
HEATH	IG–42	.100–30	5	–	–	0.1	50	400	yes	±3	–	59.00(K)	
	IG–102	.100–100	5	100–220	1	0.1	50	400	yes	±2	10	29.95(K)	
KNIGHT-KIT	KG–650	.160–112	5	to 224	–	0.4	–	400	yes	±3	10	29.95(K)	
	KG–686	.100–54	5	–	–	0.12	50	400	yes	±1.5	–	140.00 95.00(K)	Solid-state Built-in xtal calibrator
LAFAYETTE	TE–20	.120–130	6	130–260	1	0.1	–	400	yes	±2	3	29.95	
PRECISION	E–200C	.088–110	10	110–440	3	1.0	50	400	yes	±1	80	149.95	Built-in a.v.c. supply
RCA	WR–50B	.085–40	6	–	–	0.05	high	400	yes	±2	8	65.00 45.00(K)	10.7MHz, 455kHz sweep output
TRIPLETT	3432A	.160-110	7	68–220	1	–	–	400	–	–	–	137.00	

Transistor and Integrated-Circuit Testers. Integrated-circuit testers for service use are not available; a scope or voltmeter is the best instrument for checking these devices.

An in-circuit transistor tester is invaluable for measuring *beta* of the dozens of transistor types used in TV boards. For TV work, the tester should have an adjustable collector-current control. Some in-circuit *beta* readings may be lower than out-of-circuit readings, but should correspond. In some low-impedance circuits, such as those found in the horizontal-output section, it may be necessary to disconnect the transistor and measure its *beta* out of circuit.

In addition to the above, there are also some special instruments, such as flyback testers and capacitor testers, that may be useful.

Alignment Equipment

"Alignment" generators are misnamed in a sense because they find such great use in general troubleshooting applications. The professional who doesn't own this equipment is laboring under a handicap he cannot evaluate until the day he can run a quick sweep signal through a suspect tuner or amplifier and determine instantly where he should start troubleshooting.

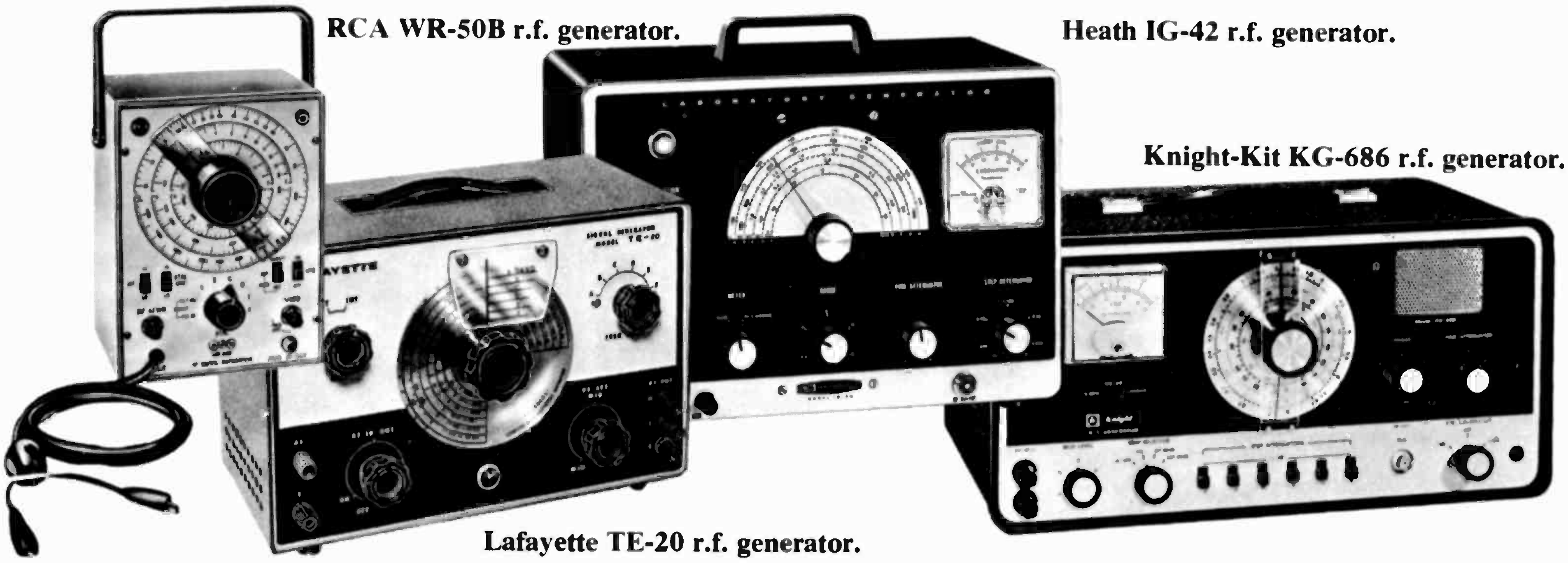
The necessity for alignment gear grows almost daily, and it is increasingly difficult to service color receivers without it. Alignment may be needed in the tuner, automatic-fine-tuning circuits, i.f. amplifier, sound-i.f. amplifier, sound detector, video amplifier, and chroma section. When any portion of these circuits is misaligned, there is no substitute means by which they can be set right.

Basic alignment generators for color work will be equally useful for black-and-white. These instruments should also encompass the needs of FM broadcast receivers.

Sweep Generator. The sweep generator must meet several requirements to qualify for black-and-white, color, and FM work, as follows:

1. Flat Output. The voltage output should be flat within ±0.1 dB per MHz of sweep through the rated sweep width. A sweep signal that is 10 MHz wide, for example, should have a maximum deviation of ±1 dB (approximately 10%) from true flatness. Otherwise, the displayed sweep curve from the receiver may be misleading.

2. Frequency Linearity. The sweep trace should be essentially linear from its low to high ends to prevent horizontal cramping of the waveform. A linear sweep makes it possible to scale the trace into accurate frequen-



RCA WR-50B r.f. generator.

Heath IG-42 r.f. generator.

Knight-Kit KG-686 r.f. generator.

Lafayette TE-20 r.f. generator.

cy intervals, and serves as the standard for checking circuit-response deviations.

3. R.f. Output Frequency and Sweep Width. A v.h.f. generator should sweep at least 12 MHz wide on v.h.f. channels to permit display of complete tuner curves. A u.h.f. generator should sweep three or more channels simultaneously. Output should preferably be on fundamental frequencies to minimize generation of beat and "birdie" signals, which can interfere with the trace.

4. Output Voltage. At least 0.1 volt is needed for ramming signals through defective tuners and other misaligned circuits.

5. I.f./Video Output. Sweep output should extend from 50 kHz to 5 MHz so that both chroma and sound circuits can be checked. Coverage to 50 MHz is also needed for i.f. amplifiers. Because signals in the i.f./video region must be generated by a beat system, generator output must be filtered to reduce beats and harmonics.

6. FM-Band Output. R.f. outputs from 88 to 108 MHz and at 10.7 MHz are needed if the generator is to be used for FM-receiver work. An audio modulation signal from 400 to 1000 Hz will help in FM-detector alignment.

7. Good Output Attenuator. This is the weak spot of many sweep generators. The output attenuator should work from zero to full output without distorting the flatness of the output signal.

In addition to these important features, the generator should have 300-ohm balanced r.f. output, a retrace blanking circuit, adjustable sweep width, and a system permitting its use with a marker-adder.

Swept output can be obtained through use of electromechanical vibrators, variable tuned-circuit inductances, and semiconductor diodes that have voltage-sensitive capacitance. All of these systems are used successfully in both service and laboratory-type sweep generators.

Marker Generator. A marker generator is needed to provide frequency check points on the sweep trace, and to facilitate accurate setting of gain, tilt, and trap adjustments in the tuner, i.f. amplifier, and other sections.

A v.h.f. generator should provide output in the i.f.-amplifier range (20-50 MHz) and on the v.h.f. channels (54 to 88 and 174 to 216 MHz), and have additional coverage to 260 MHz for the channel-13 oscillator frequency. Output in the 88- to 120-MHz region will facilitate alignment of FM-receiver front ends. Maximum output should be on the order of 0.1 volt and, preferably, be on fundamental frequencies.

U.h.f. markers may be needed at various spot frequencies from 470 to 1000 MHz. Present u.h.f. tuners are passive types having beat output on a v.h.f. channel or in the 40-MHz i.f. region.

Because the marker generator serves as a frequency standard, it must be very accurate. Accuracy can be obtained through individual dial-scale calibration, crystal-controlled output signals, or a built-in crystal calibrator. All three of these methods are used successfully in service-type generators.

Marker generators need other features to make them efficient. If they have a built-in r.f. detector, you can feed in an external r.f. signal, beat it with the marker oscillator, and measure its frequency directly by means of the heterodyne-oscillator technique. This is an excellent means for checking tuner-oscillator settings. Calibrators should also provide simultaneous dual markers spaced 4.5 MHz apart. With these markers, you can quickly check tuner and i.f.-amplifier bandpass curves. Other internal modulation, such as 900 Hz, can make the generator useful as a signal-injection troubleshooter; the modulation produces bars on the picture tube.

Marker generators should have tight r.f. shielding to

Sencore TF-151 transistor tester.

Triplett 3490-A transistor analyzer.

Heath IM-36 transistor analyzer.

RCA WT-501A transistor tester.

Hickok 870 transistor analyzer.

Seco 260 transistor tester.

TRANSISTOR TESTERS

MFGR.	MODEL	SHORTS (yes, no)	GAIN TYPE & RANGES	LEAKAGE TYPE & RANGES	FWD & REV. I (yes, no)	TEST VOLTAGE-CURRENT RANGES	PRICE $(K=kit)	REMARKS
AMPHENOL	830	yes	d.c. beta 1–1000	I_{CBO}, I_{CEO} 5000μA	yes	8V, 1.3V* 500μA–10mA	79.95	Can be used as d.c. voltmeter
B & K	161	yes	a.c. beta 2-500	I_{CBO}–5000μA	yes	0–2V 210mA	89.95	In-circuit calibrate level
EICO	680	yes	d.c. beta 2-300	I_{CBO}, I_{CEO} 0-500mA	yes	0–50V 0–500mA	39.95 29.95(K)	Can be used as v.o.m.
EMC	212	yes	beta 0–200	I_{CBO}	no	12V	19.50 13.50(K)	
HEATH	IM–36	yes	d.c. beta 0–400	I_{CBO}, I_{CEO} 15μA	yes	1.5–150V 15μA–15A	90.00 60.00(K)	
	IT–18	yes	d.c. beta 2-1000	I_{CBO}, I_{CEO} 5000μA	yes	1.5V 4mA	24.95(K)	
	IT–27	yes	d.c. beta	I_{CEO}	yes	3.0V 3mA	6.95(K)	
HICKOK	870	yes	beta 0–300	I_{CBO}–10mA	yes	0–5V 5mA, 200mA, 2A	395.00	Built-in roll chart
	890A	yes	beta 0–200	I_{CBO}–50μA	yes	1.5V, 3V, 4.5V 0–10mA	215.00	In-circuit
LECTROTECH	TT–250	yes	d.c. beta 0–500	I_{CBO}–5mA	yes	6Vd.c. 2Va.c.	89.50	
RCA	WT–501A	yes	d.c. beta 1–1000	I_{CBO}–2μA I_{CEO}–1A	yes	1.5V @ 1mA, 10mA, 100mA, 1A	66.75	Adjustable current
SECO	260	yes	beta 0–1000	I_{CBO}–200μA I_{CEO}–100mA	yes	6.8V 1A	69.50	Dynamic test for in-circuit
SENCORE	TF–151	yes	a.c. beta, G_m 1–500, 0–50,000	I_{CBO}, I_{GSS} 0–5000μA	yes	200μA, 2mA, 20mA	129.50	Also checks FET's
	TR–15A	yes	a.c. beta 2–500	I_{CBO}–5000μA	yes	2mA	64.50	In- or out-of-circuit
	TR–115	yes	d.c. beta	I_{CEO}–50mA	yes	3V	24.95	Out-of-circuit only
	TR–139	yes	a.c. beta 2–500	I_{CBO}–5000μA	yes	2mA	89.50	In- or out-of-circuit
TRIPLETT	2590	yes	d.c. beta 5–100	I_{CBO}, I_{CEO} 1mA	yes		68.00	
	3490A–2	yes	a.c., d.c. beta 0–600 h parameters	I_{CBO}, I_{CO}, I_{CEO} 6mA	yes	0–120V 0–3A	441.00	Also checks FET's, tetrodes

minimize leakage, an efficient r.f. attenuator, and a terminated, isolated output system to prevent oscillator "pulling" and excessive receiver circuit loading.

Marker-Adder. The marker-adder is little understood by those who haven't used it, and enthusiastically appreciated by those who have. If you use one for a couple of alignment jobs, you won't part with it. Here's why.

If you have a sweep and marker signal into the same test point in a receiver, the marker signal will too often distort the sweep curve. And, if you're injecting a marker at a trap frequency, it will get sucked out and you won't know where it is.

With a marker-adder, however, you inject the sweep into the receiver *but feed your marker signal into the adder unit*. With this sytem, you'll always have a marker, trap or not, and you can't distort the sweep curve. Some marker-adders also provide for positive- or negative-going markers and wide- and narrow-band markers. Once you have connected all of your sweep gear, the scope, and receiver together, you use the marker-adder as the "control center".

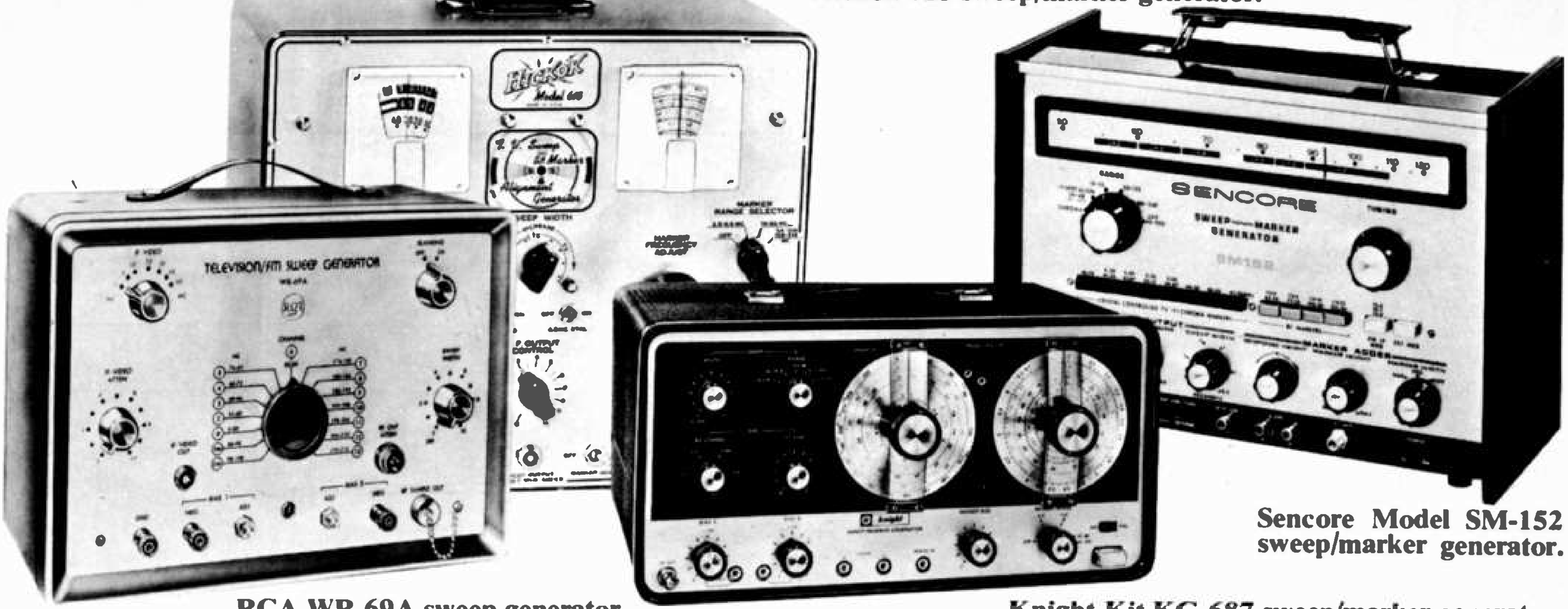
TV-Bias Supply. You'll need two external bias voltages for black-and-white alignment, and two or three for color, depending on the receiver, to prevent your alignment signals from pulling a.g.c. voltages around and distorting your sweep curves. Bias connections and voltage values are spelled out in the receiver alignment instructions. At least one service-type sweep generator contains a dual bias supply.

Video Marker. Video-frequency markers are needed in color alignment for marking key check points in the 0- to 5-MHz range. Without them, it would be impossible to adjust the chroma bandpass transformer and take-off coils properly.

A typical video marker is a passive, absorption type which "sucks out" seven preset frequencies from 0.5 to 4.5 MHz. The unit is connected in series with the output cable from the video sweep generator.

R.f. Modulator. With an r.f. modulator, you can modulate an r.f. output signal from the marker generator with the sweep signal from the video generator. This system (called VSM, for video sweep modulator) provides a complete check of frequency characteristics through the tuner, picture i.f. amplifier, video amplifier, bandpass amplifier, and color demodulators. Performance is checked on an oscilloscope.

Hickok 615 sweep/marker generator.



Sencore Model SM-152 sweep/marker generator.

RCA WR-69A sweep generator.

Knight-Kit KG-687 sweep/marker generator.

Accessories

Picture-Tube Test Jigs. If you have color-tube test jigs in the shop, it won't be necessary to pull the entire console from the customer's home—you simply haul in the chassis. The test jig includes a color tube, yoke, and convergence assembly. It may or may not include the dynamic convergence board.

With this setup, you will also need harnesses to connect the jig leads to the customer's chassis. Test jigs are available for both round and rectangular 90- and 70-degree picture tubes. The resulting picture or pattern may be smeared, and the raster might be incorrect, but the patterns are generally adequate for chassis troubleshooting.

High-Voltage Probe. An accurate means of measuring and setting the high voltage in a color receiver is mandatory to insure routine picture performance and to minimize x-ray generation. A high-voltage probe can be used with a v.t.v.m. or v.o.m. for voltages up to 30,000 volts or more. High voltage should be checked whenever blooming occurs, and each time the voltage regulator or horizontal-output tubes are replaced.

Power-Line Meter. Chronic TV troubles are often traced to abnormal line voltage. Color troubles, especially, can be caused by the excessively high line voltages encountered in many sections of the country.

An iron-vane power-line voltmeter will follow fast line-voltage changes. It can be installed temporarily in the customer's home if line trouble is suspected. It's also valuable in the shop as a permanent monitor.

Adjustable Isolation Transformer. An adjustable power-line transformer permits you to isolate transformerless audio equipment, radios, and TV sets from the power line, thereby greatly reducing shock and burn-out hazards. You can also correct for high or low line voltage during alignment. Make sure, however, that the transformer has an isolated secondary winding.

Degaussing Coil. Although today's color-TV sets have built-in degaussing coils for the picture tube, you still need a portable coil to degauss metal cabinets and hardware, and to service older sets which have no built-in degaussing.

Component Substitutor. Available types contain a range of capacitors and resistors in standard values for design and troubleshooting. A few units also include diodes. These instruments are especially handy if you're trying to locate an open capacitor or select a resistor value for a sync circuit. You merely clip the test leads from the substitutor into the set and dial the desired type and value of component.

Special Probes. Your scope must have a low-capacitance probe for TV work to reduce scope loading effects in sensitive receiver circuits. These probes have an input impedance on the order of 10 megohms, but they also reduce the input signal to the scope by a factor of 10.

An r.f. demodulator probe for your scope will enable you to demodulate TV sweep signals at various r.f. points in a receiver; you can also check r.f. output from sweep generators. These probes cannot be used indiscriminately, however, because they are relatively insensitive to low r.f. voltages, and may cause excessive circuit loading.

A v.t.v.m. r.f. probe rectifies the incoming signal and feeds a low-level d.c. voltage to the v.t.v.m. input. These probes are useful for measuring relative r.f. levels, but they are generally limited to about 20 r.f. volts. ▲

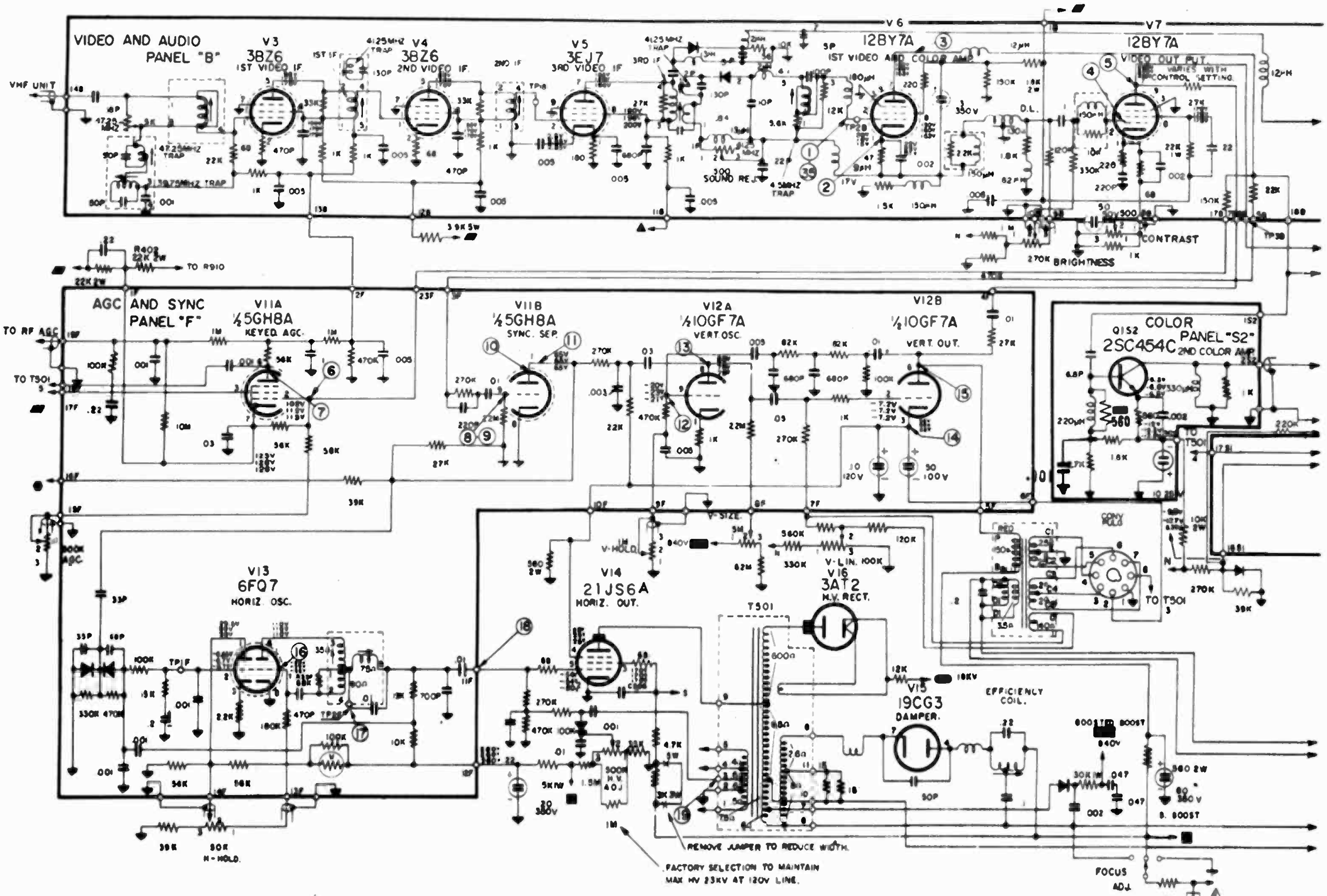
For additional information on test equipment, from the manufacturers listed, simply circle corresponding number on Reader Service Card.

Amphenol Corp. 65
B&K Div./Dynascan Corp. 66
Conar Instruments Div./National Radio Institute 67
Eico Electronic Instrument Co. 82
EMC, Electronic Measurements Corp. 68
Heath Co. 83
Hickok Electrical Instrument Co. 69
Knight-Kit, Allied Radio Corp. 84
Lafayette Radio Electronics Corp. 85
Lectrotech, Inc. 70
Precision Apparatus Div./Dynascan Corp. 71
RCA Electronic Components 72
Seco Electronics Corp. 73
Sencore, Inc. 74
Simpson Electric Co. 75
Triplett Electrical Instrument Co. 76

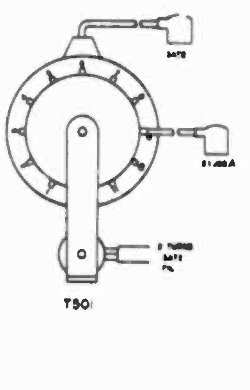
MOTOROLA *TS-924*

COLOR-TV CIRCUIT

The new TS-924 chassis is used in two 14-inch portable color receivers: Models CP468 and CP469. Both come in metal cabinets with suggested list prices of about $300 and $330, depending on finish. The picture tube is mounted with its blue gun down rather than up for improved pincushion correction. Weighing only about 50 lbs and measuring 20" x 14" x 16", they are easy to carry about.

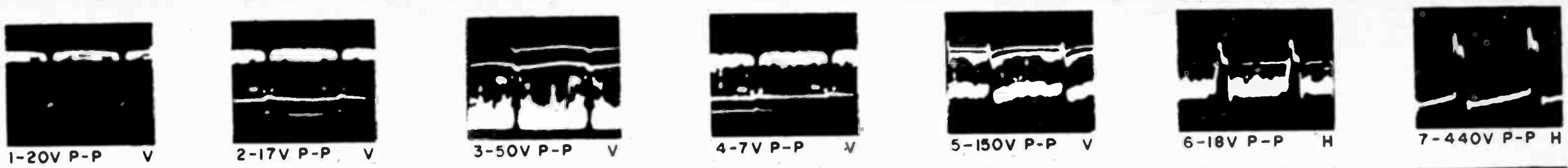


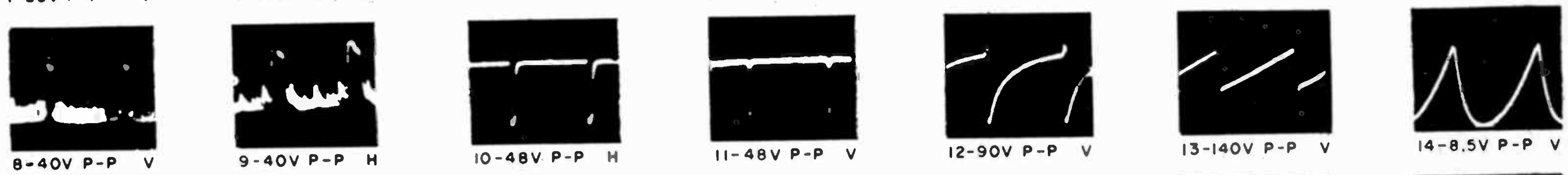
TYPE OF SIGNAL AND ORDER OF LISTING. — VOLTAGE
VOLTAGE ZERO SIGNAL (TUNER SET BETWEEN CHANNELS). — 190V
NORMAL SIGNAL (AIR COLOR PROGRAM). — 195V
STANDARD COLOR BAR GENERATOR. — 205V
NOTE:
CONDITIONS OF NORMAL AIR SIGNAL. -5 VOLTS PEAK TO PEAK MEASURED FROM GRID TO CATHODE OF FIRST VIDEO AMP AND APPROX. -0.5 VOLTS RF AGC BIAS.
CONDITIONS OF COLOR BAR GENERATOR -1 VOLT PEAK TO PEAK MEASURED FROM GRID TO CATHODE OF FIRST VIDEO AMP AND APPROX. -0.2 VOLTS RF AGC BIAS.



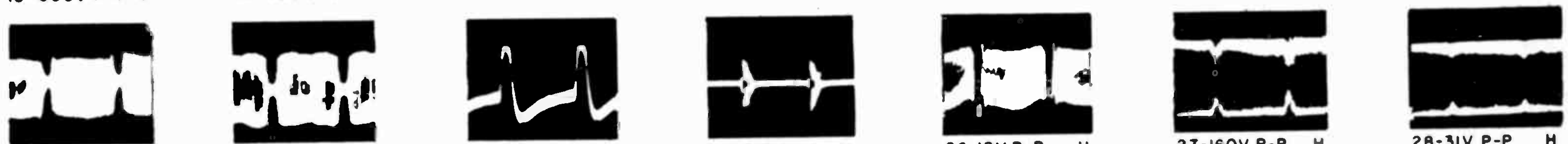
VOLTAGE SYMBOL LEGEND

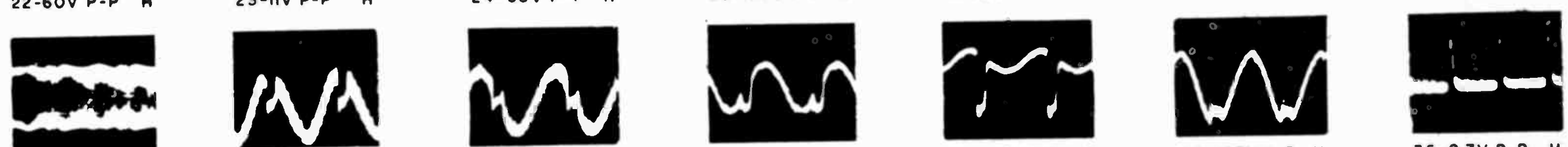
B1	B2	B3	B4	B5	B6
290V	265V	220V	190V	135V	100V
290V	270V	220V	195V	135V	205V
295V	265V	220V	205V	135V	225V

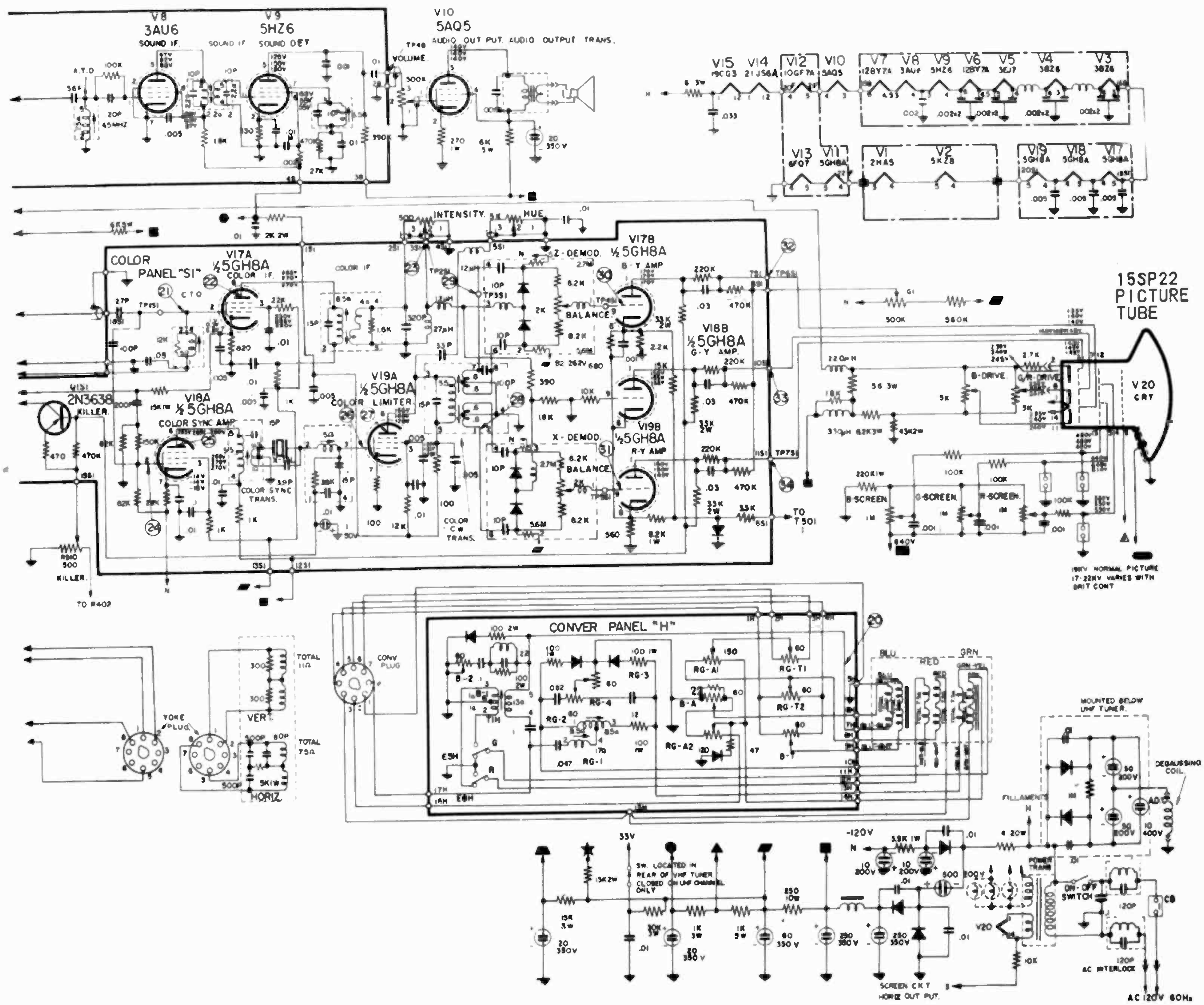

1-20V P-P V 2-17V P-P V 3-50V P-P V 4-7V P-P V 5-150V P-P V 6-18V P-P H 7-440V P-P H


8-40V P-P V 9-40V P-P H 10-48V P-P H 11-48V P-P V 12-90V P-P V 13-140V P-P V 14-8.5V P-P V


15-600V P-P V 16-48V P-P H 17-170V P-P H 18-160V P-P H 19-180V P-P H 20-35V P-P H 21-24V P-P H

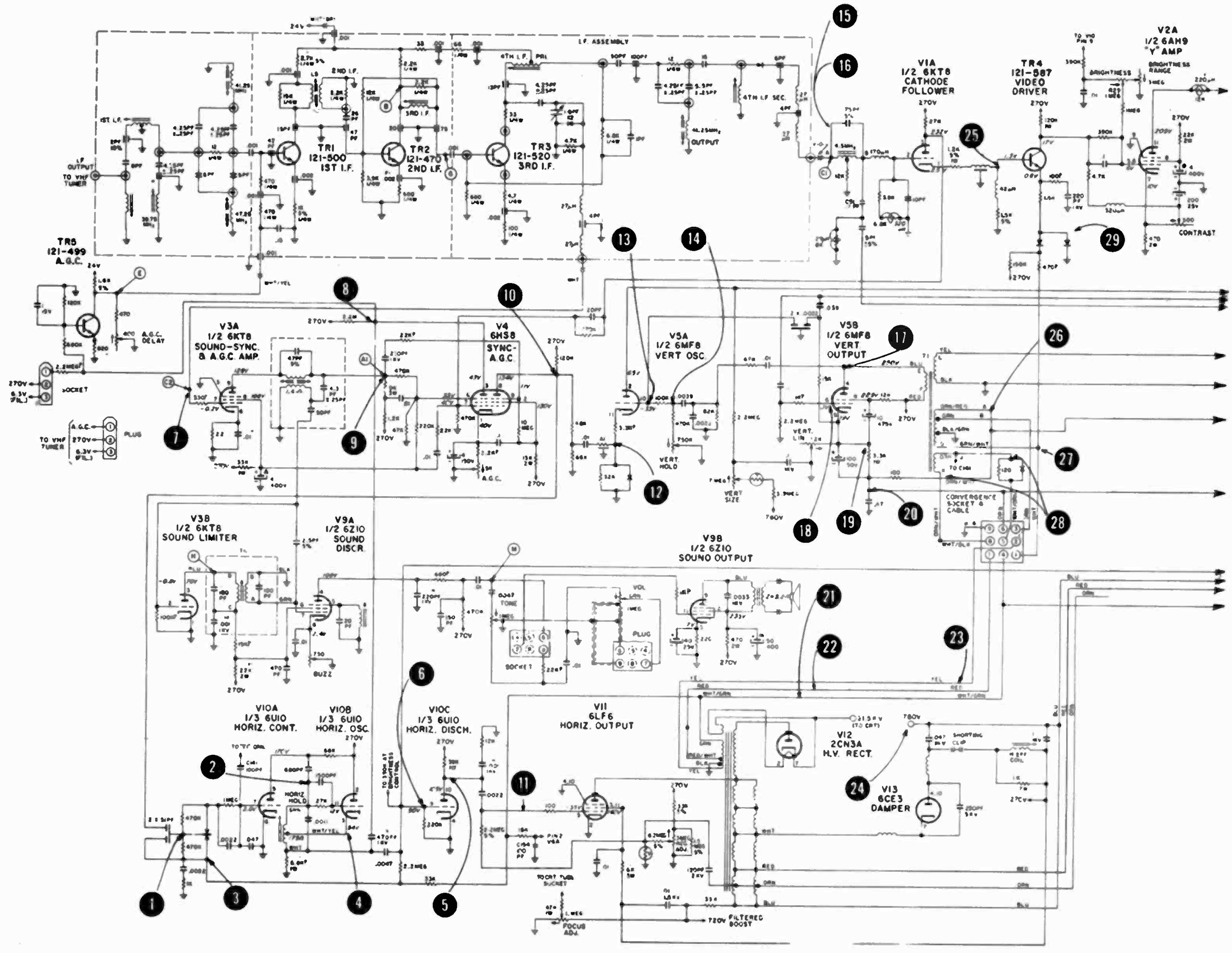

22-60V P-P H 23-11V P-P H 24-68V P-P H 25-210V P-P H 26-18V P-P H 27-160V P-P H 28-31V P-P H

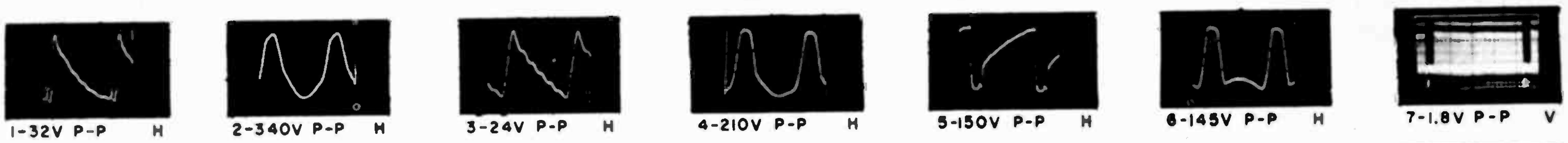

29-38V P-P H 30-13V P-P H 31-10V P-P H 32-120V P-P V 33-25V P-P H 34-105V P-P H 35-0.7V P-P H

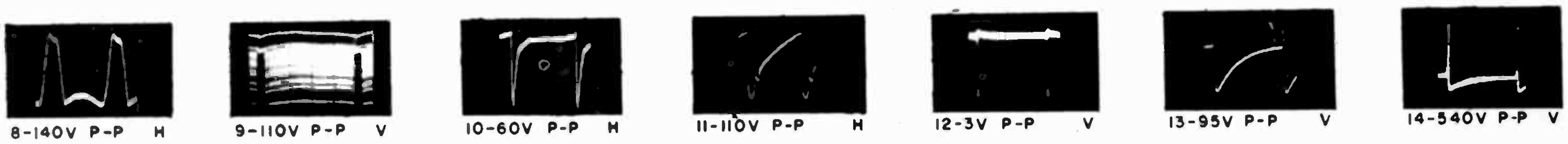


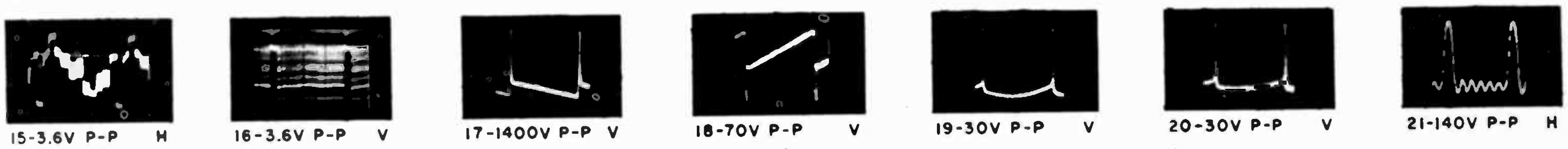
ZENITH 15Y6C15 COLOR-TV CIRCUIT

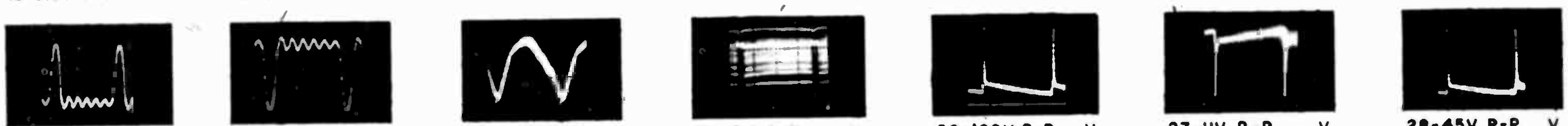
The new 15Y6C15 chassis employs either a 15LP22 or 15NP22 14-inch picture tube in a compact, portable color receiver. The manufacturer's models using this chassis are: T2920W1, W6; Z3504C, C1, L, L1; Z3508W, W1. Hybrid circuitry and low-level demodulation are used.



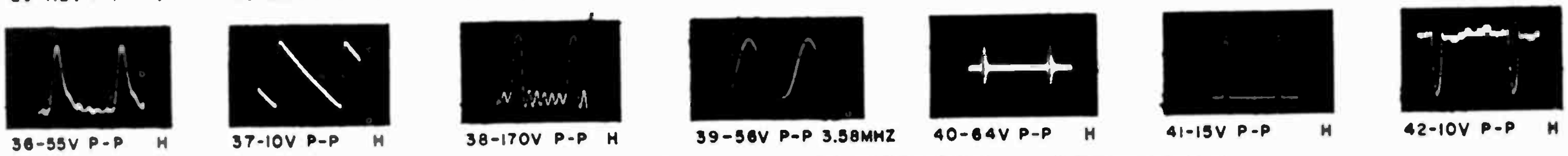

1-32V P-P H
2-340V P-P H
3-24V P-P H
4-210V P-P H
5-150V P-P H
6-145V P-P H
7-1.8V P-P V


8-140V P-P H
9-110V P-P V
10-60V P-P H
11-110V P-P H
12-3V P-P V
13-95V P-P V
14-540V P-P V

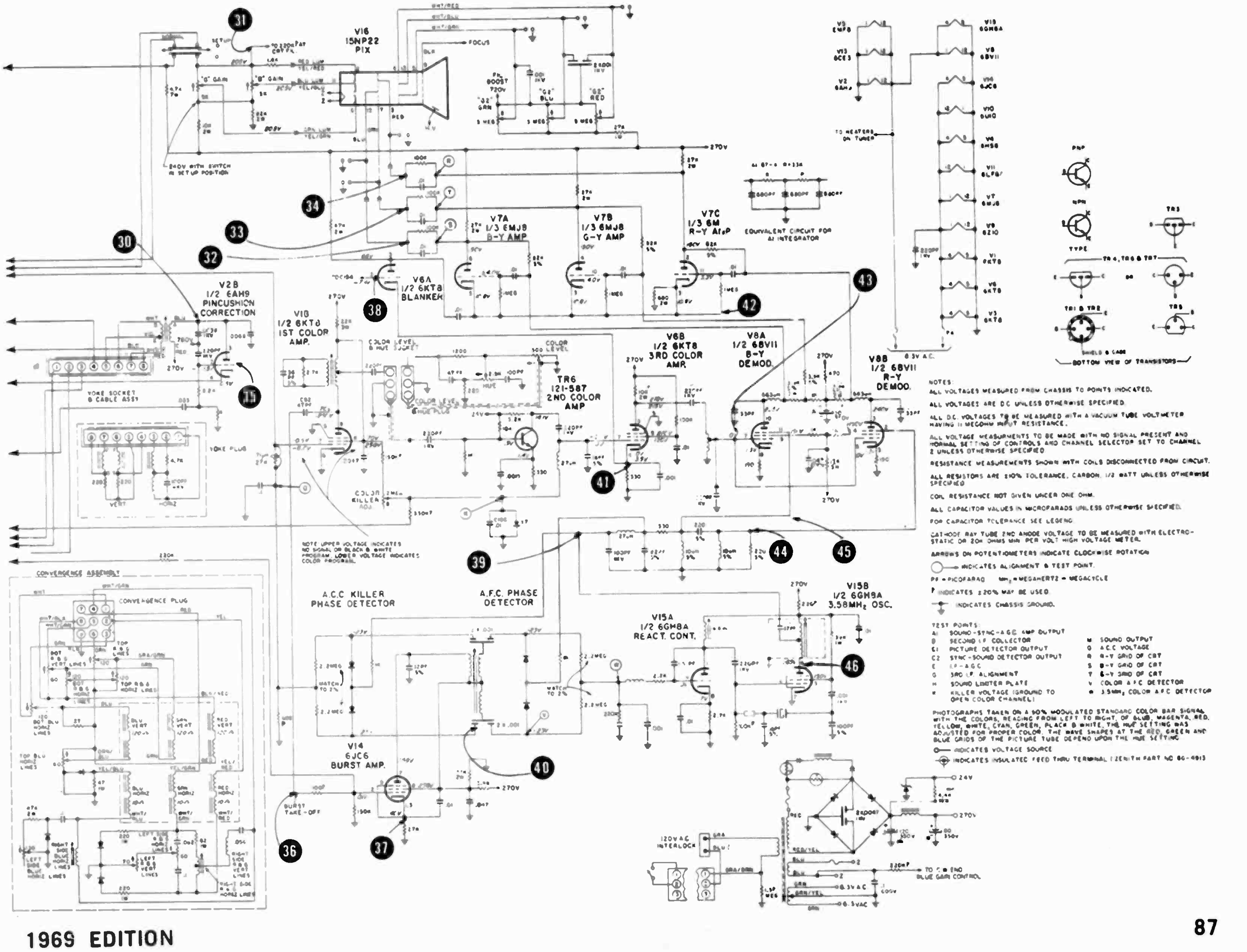

15-3.6V P-P H
16-3.6V P-P V
17-1400V P-P V
18-70V P-P V
19-30V P-P V
20-30V P-P V
21-140V P-P H


22-6V P-P H
23-17V P-P H
24-60V P-P V
25-2V P-P V
26-100V P-P V
27-11V P-P V
28-45V P-P V

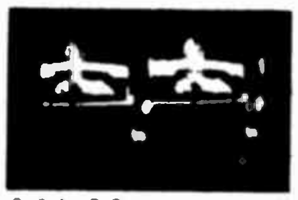

29-7.2V P-P V
30-150V P-P V
31-70V P-P V
32-70V P-P H
33-15V P-P H
34-80V P-P H
35-40V P-P V

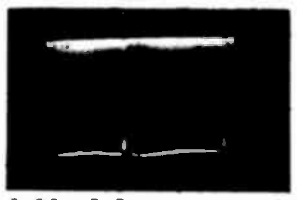

36-55V P-P H
37-10V P-P H
38-170V P-P H
39-56V P-P 3.58MHZ
40-64V P-P H
41-15V P-P H
42-10V P-P H


43-5V P-P H
44-19V P-P 3.58MHZ
45-19V P-P 3.58MHZ
46-270V P-P 3.58MHZ

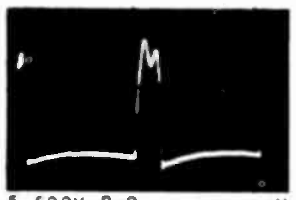



1-3.4V P-P V


2-3.4V P-P H


3-80V P-P V


4-80V P-P H

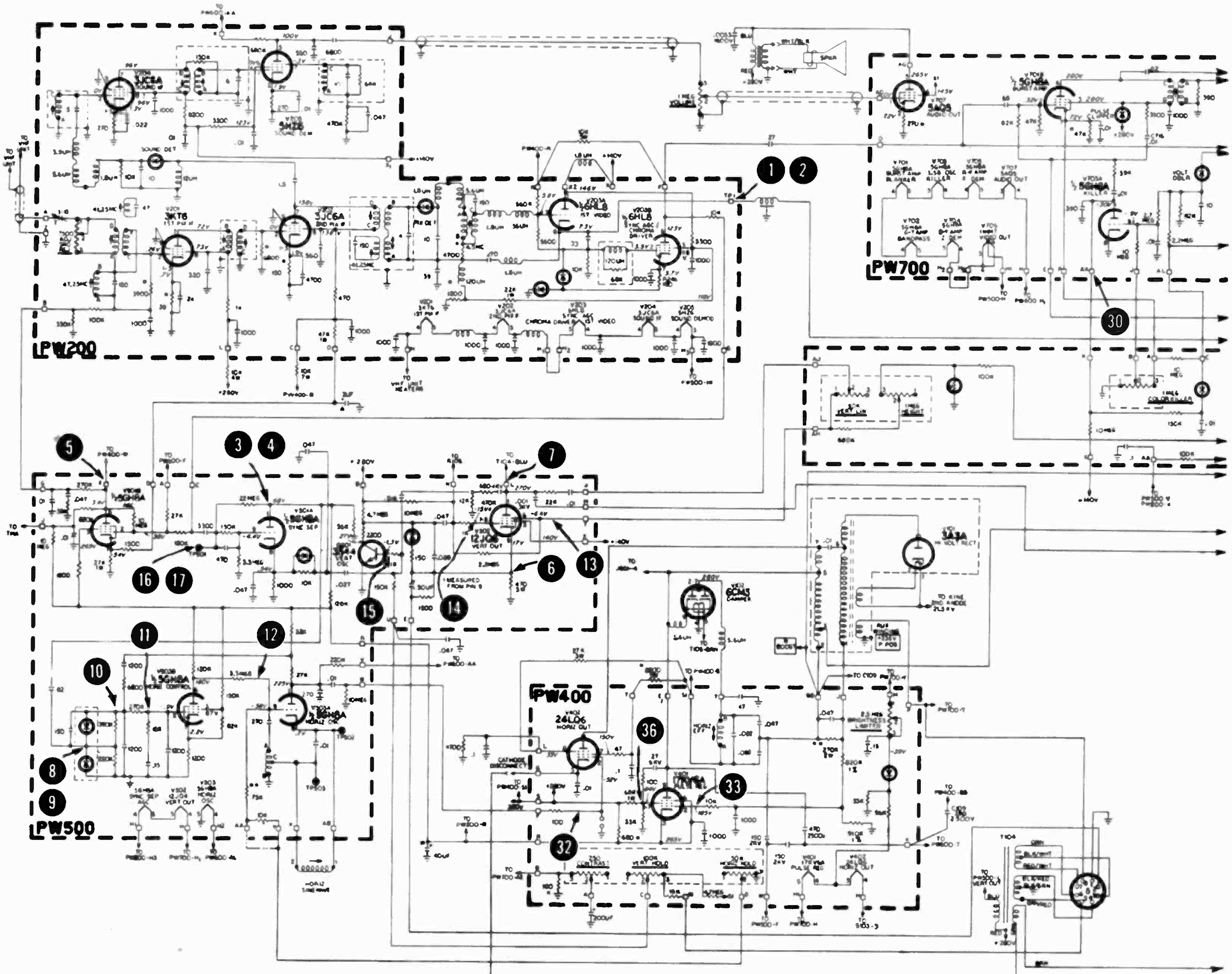

5-500V P-P H

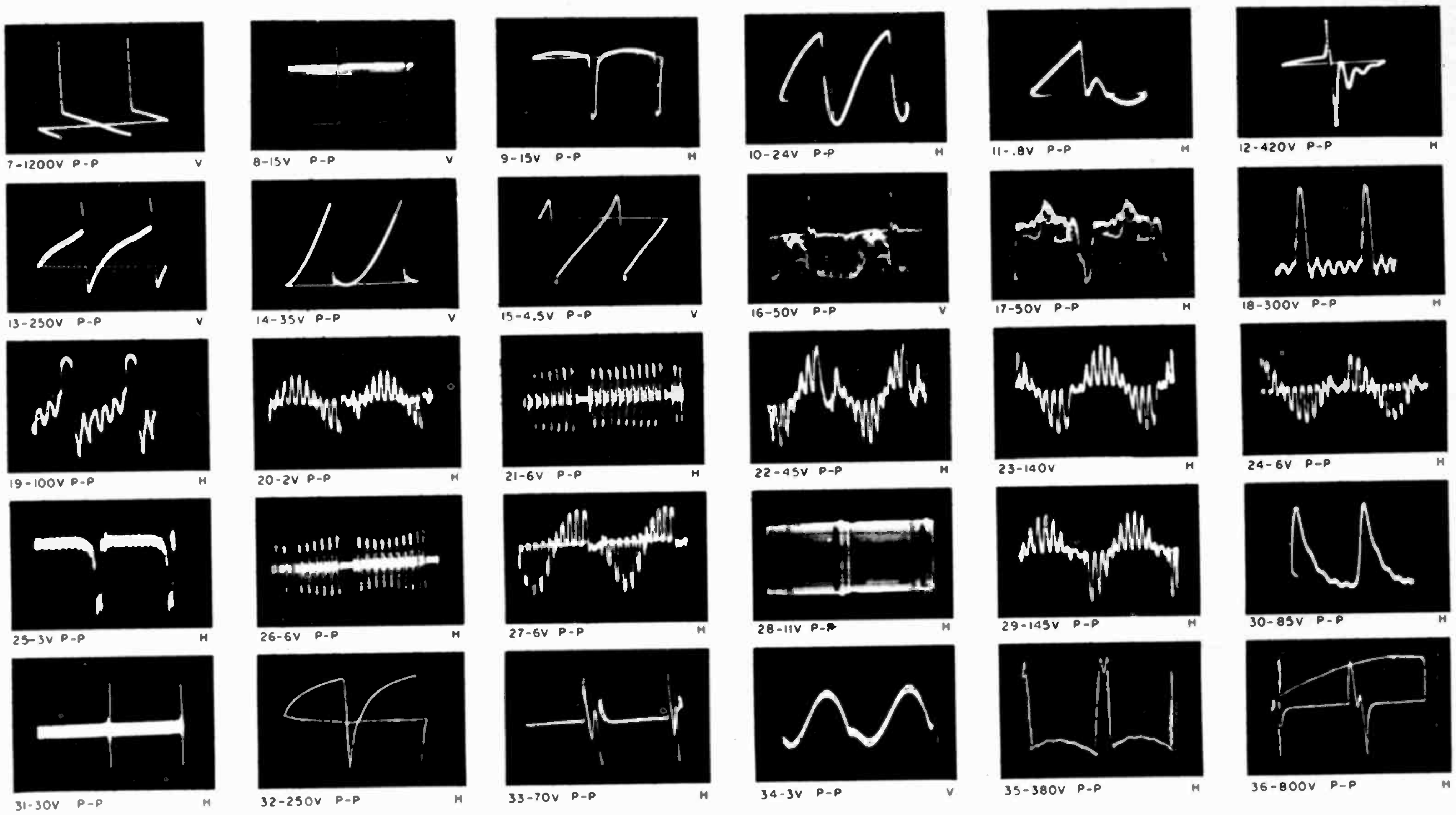

6-15V P-P V

RCA CTC 36

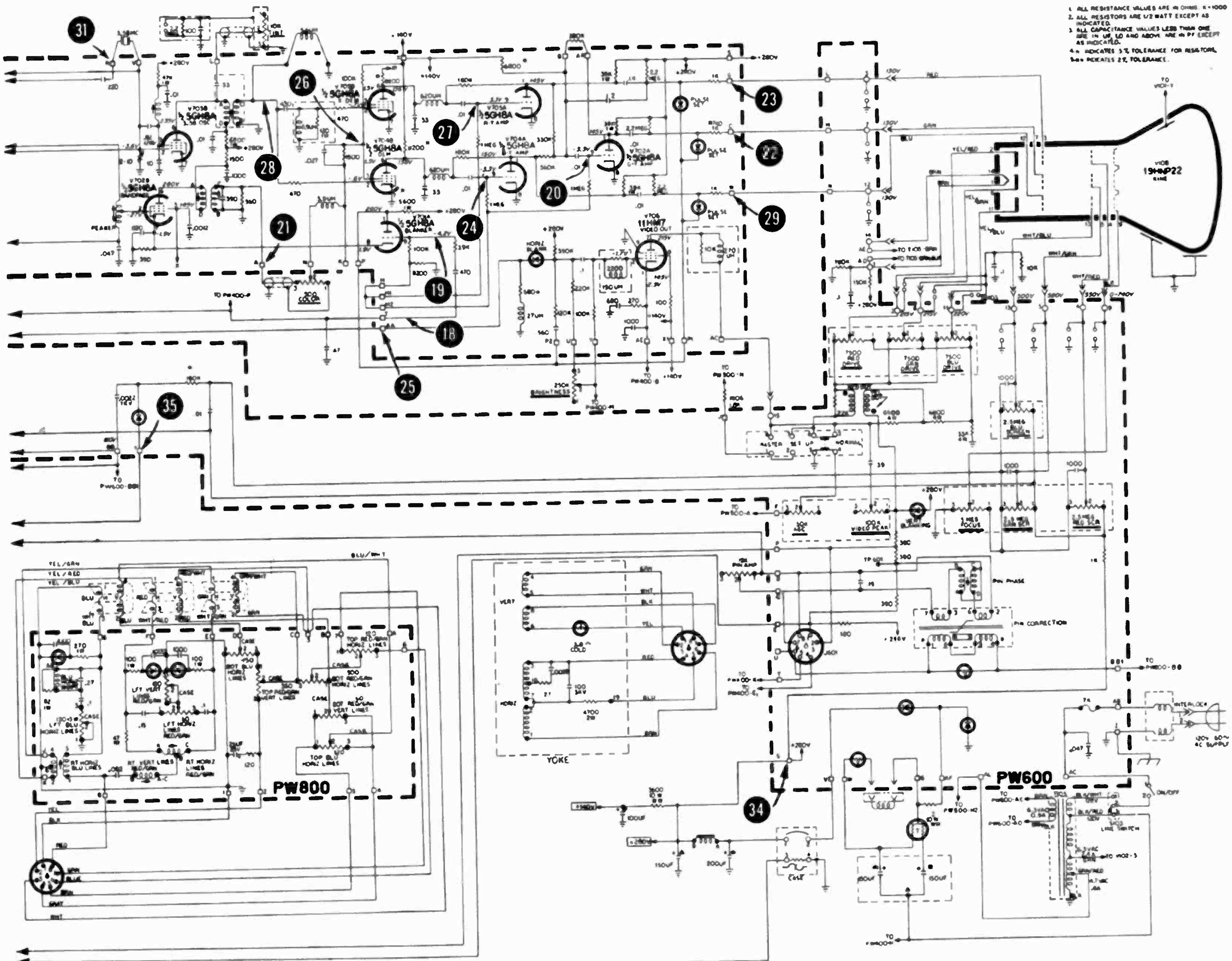
COLOR-TV CIRCUIT

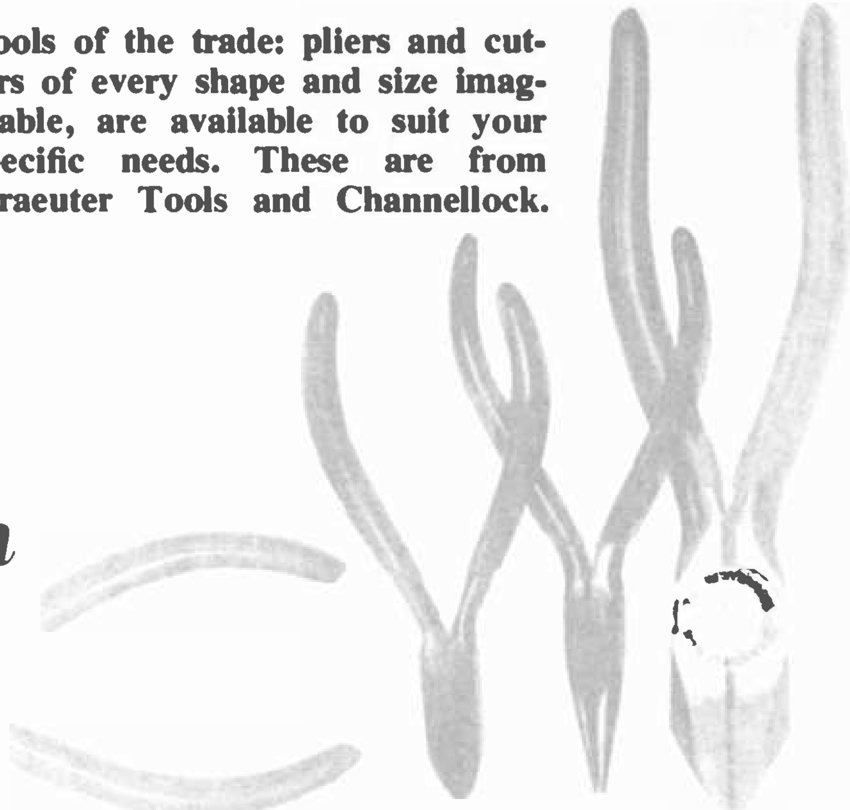
The new CTC 36 chassis is used in portable color receivers equipped with an 18-in rim-band picture tube. Remote control models are available, using a three-function remote system. All models include a four-circuit nuvistor v.h.f. tuner and a transistorized u.h.f. tuner. Models incorporating this chassis include: Model EL-442E, Y, EL-448G, W, Y, and EL-454WK. The various letters used designate different cabinet finishes.





7-1200V P-P V
8-15V P-P V
9-15V P-P H
10-24V P-P H
11-.8V P-P H
12-420V P-P H
13-250V P-P V
14-35V P-P V
15-4.5V P-P V
16-50V P-P V
17-50V P-P H
18-300V P-P H
19-100V P-P H
20-2V P-P H
21-6V P-P H
22-45V P-P H
23-140V H
24-6V P-P H
25-3V P-P H
26-6V P-P H
27-6V P-P H
28-11V P-P H
29-145V P-P H
30-85V P-P H
31-30V P-P H
32-250V P-P H
33-70V P-P H
34-3V P-P V
35-380V P-P H
36-800V P-P H





Tools of the trade: pliers and cutters of every shape and size imaginable, are available to suit your specific needs. These are from Kraeuter Tools and Channellock.

TOOLS

for servicing & installation

By RHYS SAMUEL
RCA Electronic Components

You need the right tools to do a good job. Here are the tools needed for TV repair, working on transistor equipment, and for custom installations and cabinet work. Included are complete listings of tools that can be used as guides for initial purchase or to "fill-in" an existing tool collection.

NO service technician or installer ever has too many tools. And today, he has never had so many types from which to choose. Many of today's tools are old friends redesigned for easier, wider use. Others are ingeniously new, intended to meet the special needs of modern components, hardware, and assembly methods.

The tools included in the accompanying tables have distinct functions, and all of them will be needed at some time or other in servicing and installation. They are also the tools most popular with professionals.

In recent years, tool inventories have followed the trend toward service specialization. Transistor radios and solid-state circuit repairs, for example, require miniature tools for efficient servicing. The custom-installation technician needs an additional array of wood-working tools.

With care and repair, few tools should ever break or wear out. Consider each tool purchase a life-time investment—it can be if you follow these rules:

1. Buy the best tools you can afford.
2. Use the correct tool for the job. Don't, for example, use long-nose pliers for tightening large nuts, or use a miniature cutting pliers for heavy wire.
3. Prevent rust by purchasing plated tools wherever possible.
4. Sharpen or repair tools immediately.
5. Store precision and cutting tools so they won't clip each other.

Table 1 lists the tools needed for TV servicing. All items shown are for in-shop use, while those in bold type are also recommended for use on house calls.

TV Repair Tools

Pliers. Insulated handles are recommended for all pliers, especially long-nose and diagonal cutters because they are so often used for "live" circuit work. Remember, diagonal cutters are designed for wire cutting—not sheet metal work. For general wire snipping, get a pair of 6-inch cutters. Use miniature (4-inch) diagonals for transistor circuits—they'll work into crowded spaces. They should also cut flush with the circuit-board surface. Check the cutting edges; they should meet at all points and cut right up to the tip. Good cutters and long-nose pliers should be a little stiff in action, and have no wobble or side play.

Screwdrivers. Manufacturers must love screwdrivers because they make so many of them. The one you should use for a particular job will have a tip that is slightly narrower and thinner than the screw slot. Straight-tip and Phillips drivers should have cabinet blades, which are the same diameter as the tip. Handles should be insulated and large enough to fit easily in your hand. An insulated blade is often useful on smaller drivers.

For work away from your bench, you can get a compact screwdriver kit with a single plastic handle and slip-in blades. These kits have interchangeable straight blades, Phillips blades, and nut drivers, and will fit in your pocket.

Wrenches. Hex (Allen)-head screws are common in knobs and shaft couplings. There is no substitute tool for a hex wrench when you encounter a hex-head screw. A set of "L"-shaped hex wrenches is inexpensive, and you'll need various sizes. Don't get the set in which the wrenches are attached, star-like, to a center hub. In corners or against panels, you won't be able to turn the wrench.

A set of five double, open-end wrenches will cover 10 nut sizes from 5/16 to 7/8 inch. They're handy for chassis-anchoring screws and repetitive turning tasks. Get short wrenches—6 to 8 inches long; they're better suited to confined cabinet spaces and "blind" work.

The indispensable hex-head nut driver is available in different lengths, all of which you may need at some time or other. But start with the 6-inch set; it will cover 95 percent of your work. Later, you can add ¼-inch drivers in the 3-inch and 10-inch lengths, and a ⅜-inch driver in the 10-inch length. Make sure the drivers have hollow shafts so they will fit over long screws. For house calls, carry the ¼- and ⅜-inch drivers.

Soldering Tools. For all-around shop work, you'll need three types of irons. The 100- to 150-watt gun is ideal for shop and house work. It has a built-in spot light, it doesn't overheat, and it's stingy with electricity. But it takes time to come to full heat. (If heating time is excessive, tighten the tip nuts with a wrench.)

Small printed boards require a miniature or "pencil-" type iron. Excessive heat can damage transistors and small components and lift the printed foil off the board. Small irons are mandatory for transistor radios and compact solid-state TV boards.

The heavier-duty conventional iron is still needed for both old and new TV sets. Chassis solder connections need a lot of heat for good joints. Use a 150- to 200-watt iron with a ⅜-inch tip here.

Take your choice of soldering aids. They come in different configurations, including sharp or blunt points, and slotted ends. These tools, made of aluminum or hard steel, are handy holding tools or picks for undoing wire terminals. A clip-on tool is also available for dissipating heat on component leads.

Drills. An electric drill will handle most of your drilling jobs, but you'll need a hand drill for close-quarter and low-speed work. A fractional-horsepower, ¼-inch drill will handle most shop and outside work; a ⅜-inch or ½-inch drill is better for antenna jobs.

For electrical safety, a good bet is a double-insulated drill. These drills have extra internal insulation, plastic handles, and external housings. Consequently, they don't need 3-wire power cords. Various models having *Underwriters' Laboratories* approval are available.

Your drill should also have a 10-foot power cord. You can spend a few dollars more and get variable-speed (SCR) control. Remember that the maximum no-load speed of a drill decreases as the drill size increases, and that larger drill bits should be driven at lower speeds.

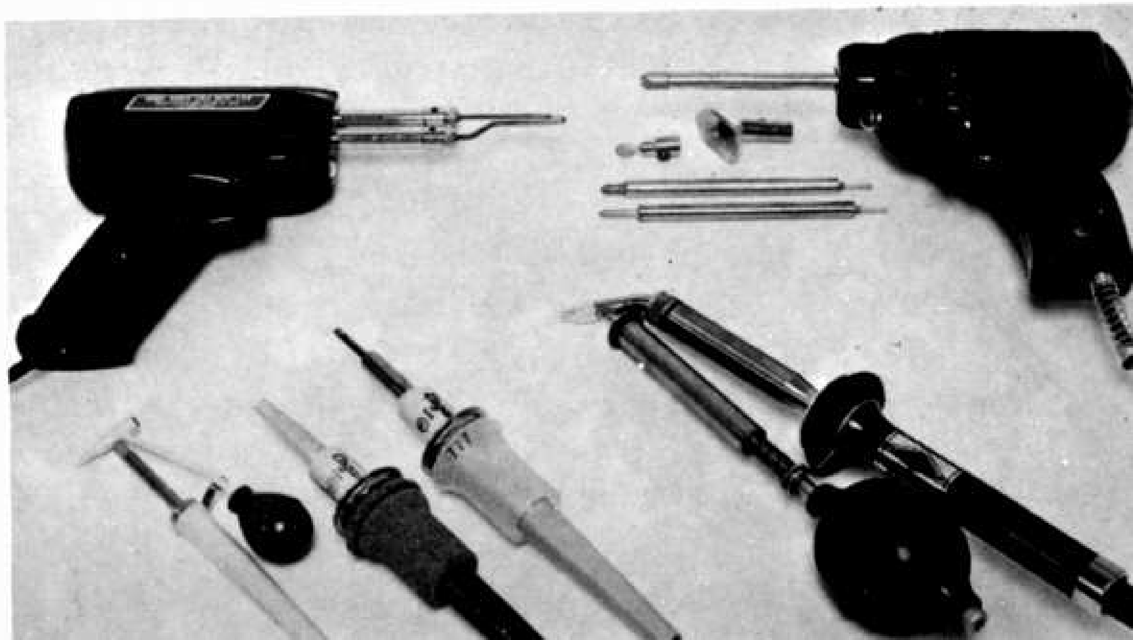
You will need drills ranging from 1/16-inch to ½-inch diameter. If you have a ¼-inch electric or hand drill, you will need turned-down or stepped shanks for all drills larger than ¼-inch. Remember, you can use the tapered reamer to enlarge ¼-inch holes by hand.

Here are some facts to keep in mind about drills:

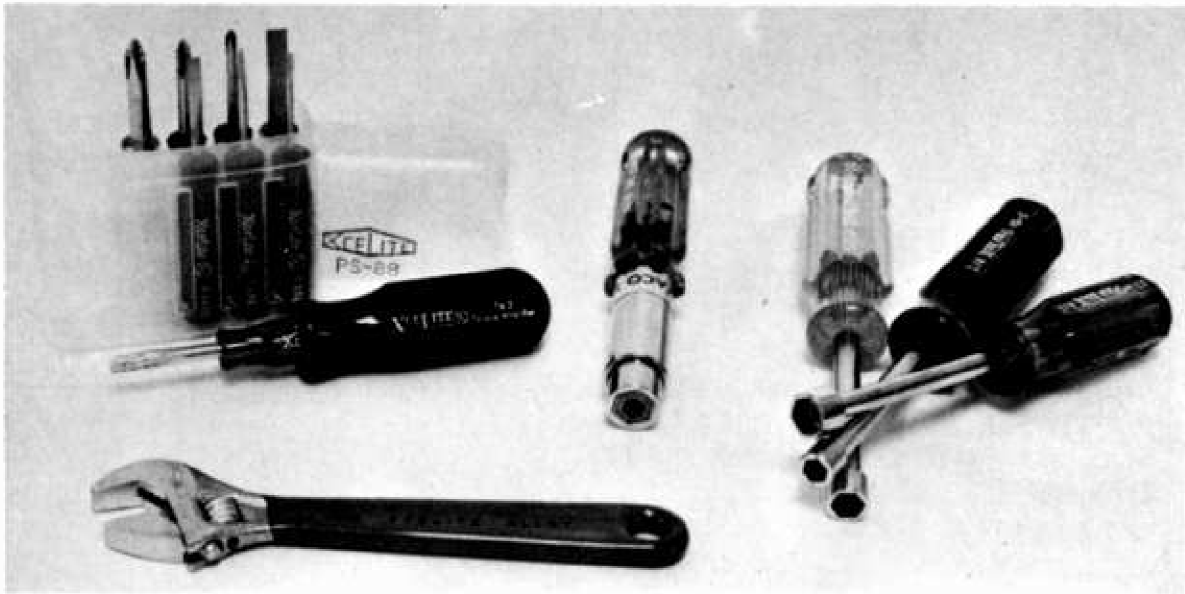
TABLE 1. TOOLS FOR TV SERVICING

PLIERS	**Slip-joint (gas): 6½" to 8" long, 9/16" jaw width** Locking plier wrench ● **Long-nose: 6" long, 1¾" jaws** Arc-joint: 9" long, open to 1⅛" **Diagonal cutting: 6" long, ¾" cutting edges**
SCREWDRIVERS: STRAIGHT TIP	Heavy-duty: blade 7" to 12" long, tip 5/16" to ⅜" **Heavy duty: blade 4" to 5" long, tip ¼"** **Stub: blade 1¼" to 1½" long, tip ¼" to 5/16"** **Extra long: 6" to 8" long, tip ⅛"** **Gen.-purpose: 4" to 6" long, tip ⅛"; 2½" to 3" blade, tip 3/32" to ⅛"**
SCREWDRIVERS: PHILLIPS HEAD	**No. 0: 2½" blade** ● **No. 1: 3" blade** ● No. 2: 4" blade
SCREWDRIVERS: OFFSET	(right angle): combination tips
WRENCHES	**Hex head (set of 7): 1/16" to ¼" in 1/32" steps** Adj. end: ½" max opening, 4" long **Adj. end: ¾" to ⅞" max. opening; 6" to 8" long** **Open End (set of 5): 5/16" to ⅞"** **Nut drivers, hexagonal (set of 7): 3/16" to ½"**
SOLDERING TOOLS	**Soldering gun: dual-heat 100/140 watts** ● Soldering aids Soldering iron: light duty, 23-50 watts; 150/200 watts, ⅜" to ⅝" tip
DRILLS	**Hand drill: for ¼" drills** ● **Drill set: 1/16" to ¼" in 1/64" steps** Drill: 5/16"; ⅜"; 25/64"; ½" ● Electric Drill
ALIGNMENT TOOLS (set)	
THREADING TOOLS	Machine-screw taps: 4-40, 6-32, 8-32, 10-32 ● Tap wrench Machine-screw dies: 4-40, 6-32, 8-32, 10-32, 1" dia. Die holder: 1" o.d. dies
FILES	Pattern: round, med. (No. 2) cut, 5" to 6" long; flat, med. (No. 2) cut, 5" to 6" long **Mill bastard: flat, tapered, 10" to 12" long** **Round bastard: 8" to 10" long** Half-round bastard: 8" to 10"
MISCELLANEOUS	**Wire strippers** ● **Utility knife** ● **Tweezers** ● Awl Center punch ● Hacksaw: 10" to 12" ● **Keyhole hacksaw: 7½" blade** **Tapered reamer: ½"** ● Cold chisel: ½" ● **Hammer: ball-pean** File card ● **Dust brush** ● Magnet ● **Flashlight** ● Scissors **Insulated clip leads (2): 24" to 36" long** ● **Tube puller** ● **Drop cloth** Mirror: 1' x 1' ● **Picture-tube tote bag** ● **Extension cord with cube tap** **Safety goggles** ● **Cheater cord** ● Line cord with insulated clips Bench vise

Note: Tools shown in bold type are used both in the shop and for house calls. All others are strictly for in-shop use.



The soldering gun or iron, whichever is suitable, is the most used tool for radio and TV servicing. The Wen Products gun on the right is available with many different adapters. Shown are a flat iron and plastic heat sealer, or cutter. The gun on the left is made by Weller Electric. Soldering irons by Ungar Electric Tools are available with many different tips and power ratings. Unsoldering suction instruments for fine printed-circuit work (also made by Ungar) are at left, and the larger one—for heavier work—is made by Enterprise Development Corp. Six different tips are available.



Every workshop should have a set of No. 8, No. 10, and No. 12 spintites or at least a universal nut tightener like the one shown in the center. Also of importance is a set of wrenches; two or three different sizes should be sufficient. Instead of carrying a large array of tools on house calls, many different and novel tool kits are available. The one shown combines a set of regular and Phillips-head screwdrivers. The universal handle provides a better grip. Although the type of tools shown are available from many different manufacturers, the automatic nut tightener in the center is made by Vaco Products. All other tools are from Xcelite.

1. "Bargain" drills are invariably inferior. They are often poorly ground, producing eccentric holes, they wear quickly, and they're usually too short for many jobs.

2. The best drills are the high-speed industrial types; they are also the most expensive. But they don't need frequent resharpening, which takes skill.

3. A carbon-steel metal-cutting drill made by a reputable manufacturer will usually suffice for general-purpose work. These drills are less costly than industrial grade high-speed drills.

4. Drills get shorter as their diameters decrease. But don't buy stubby drills.

Files. There are almost as many types of files as screwdrivers. The five files listed here, however, will enable you to enlarge round and square holes, remove burrs and rivet heads, and perform similar diverse tasks. Files are designed primarily for use on metal and plastic; with exceptions, they are poor tools for woodworking.

Files are classified by the character of their teeth (single-cut, double-cut, rasp, and curved teeth), and by coarseness (coarse, bastard, second, and smooth cuts). A *mill* file is designed primarily for sharpening saws, lathe work, and smooth finishing in general. They are single-cut. The double-cut *machinist's* file is used where metal must be removed quickly. Both are useful in electronics work. Buy files of known quality. To keep them clean, use a file card or brush.

Alignment Tools. Most tuning slugs and screws have straight or hexagonal slots in different sizes. You'll need an assortment of corresponding alignment tools for everyday needs. These are not expensive, and most are double-ended. In general, the metal-blade tool is sturdier than the plastic. If coil slugs are frozen, heat them with a soldering iron and free the slug with a metal screwdriver. Then, use an insulated tool for tuning.

Expendable Materials

For miniature-circuit repairs with 25- to 50-watt irons, use 16- or 18-gauge (.064-.048" diam.) solder; 1/16" diameter solder is best for larger irons and guns. The two-part *epoxy adhesives* are excellent for mending cracked circuit boards. If breaks are severe, jump the broken foil with a soldered wire—it's more reliable than a solder bridge. Use household cement for cementing r.f. coils, and speaker voice coils and cones.

Pressure-can *cleaners* are good for dirty tuners, switch contacts, and noisy pots. But get the type that doesn't react with plastics. *Isopropyl alcohol* is good for tape-recorder heads and general cleaning. It's especially good for removing rosins. It's inexpensive and sold at any drug store.

Chemical wire stripper is best for removing enamel insulation from very fine wire. Simply dip the wire into the stripper, the coating will dissolve. Temperature-sensitive components, including transistors, are exasperating to locate when they're intermittent. Next time, try a *coolant spray;* it drops the component temperature in seconds.

You'll need a spool of No. 18 *solid copper wire* for house calls. Also handy is *dial cord* for AM and FM radios. In a pinch, use braided (not monofilament) nylon fishing line of 20- to 30-pound test.

If you're too busy to remove and clean soldering gun and iron tips, coat the threads with *antiseize* compound. The tips will be easier to remove.

You can insulate your tools by dipping them in special *insulating solution.* It takes 24 hours to dry. You can reduce humidity effects on circuits and components by spraying them with a *moisture inhibitor and protector.*

Transistor-Circuit Repair Tools

Transistor-circuit repair requires special tools because of the high packing densities, small wires and components, and soldering-heat limitations. Whether you choose to repair transistor radios may be an emotional decision. If you do, however, you'll eventually acquire most of the additional miniature tools listed in Table 2.

The *portable bench vise* is fine for holding small circuit boards and miniature components, and is extremely flexible in its tilting angles.

A good assortment of small *clip leads* equipped with insulated, miniature clips is needed for connecting radio speakers and batteries to boards removed from the case. You'll find a *high-intensity lamp* and some type of *magnifier* helpful in locating cracks in printed wiring and examining hair-fine wires. A jeweler's loupe or a pair of binocular magnifiers of 5 to 10 power will enable you to work close to a trouble spot.

You'll also need a new assortment of small *screwdrivers, hex wrenches,* and *nut drivers.* These tools are readily available and are not expensive.

For poking and probing, get a *steel pick,* such as the dentist uses, and a small scraper. Use a 25-watt soldering iron on small boards so you don't lift the foil off the board. Solder of .048" to .068" diameter is best for these irons. In addition to narrow *tweezers*, you'll find a press-to-open *gripping tool* a temper-saver. It's good for inserting small parts into tight spaces. These grippers, which are also available with flexible shafts, have wire fingers that grip the smallest screw.

A small piece of *beeswax* on the end of a miniature screwdriver also makes a dandy gripping gimmick for small screws. Get it at the drug store. A couple of fine *pattern files* will let you work in tight spaces and smooth tiny burrs.

You will also find an assortment of small metric-sized screws, nuts, and washers for imported radios invaluable. Buy these convenient packages from your electronics distributor.

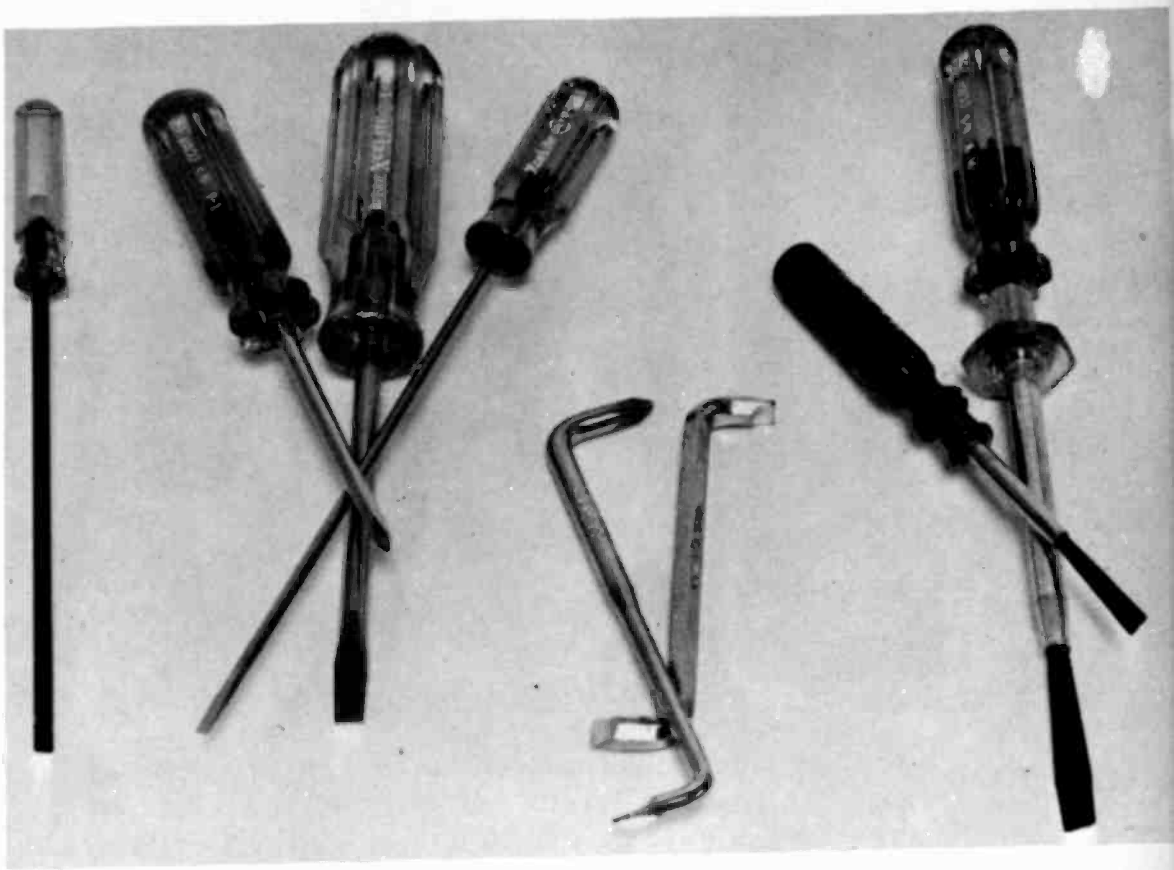
In this relatively young servicing area, you will undoubtedly adapt, discover, or invent new tools as you go along. The field is still wide open.

Custom Installations and Cabinet Work

The simplest custom installation involves fitting electronics gear to cabinetry the customer has already selected or purchased. The job may require cutting speaker openings and ports, installing grille cloth, mitering and installing moldings, cutting veneered panels for dials and controls, and fitting cabinetry into allotted spaces.

A complete custom job can require both design and construction of cabinetry, either as a built-in or as a separate piece of fine furniture. Such a task requires professional cabinet experience, and a substantial investment in portable and stationary power tools of several types. The most businesslike approach for a technician to these jobs is to team up with a local cabinet maker, as many electronic technicians have done.

A modest investment in basic hand tools, however, will enable you to install equipment in existing cabinetry. You should learn to use expertly all of the tools included in Table 3. Remember that customers are very critical; they will demand perfection in the way you fit pieces together, and in your finishing and touch-up work. Do-it-yourself quality and carpentry stand-

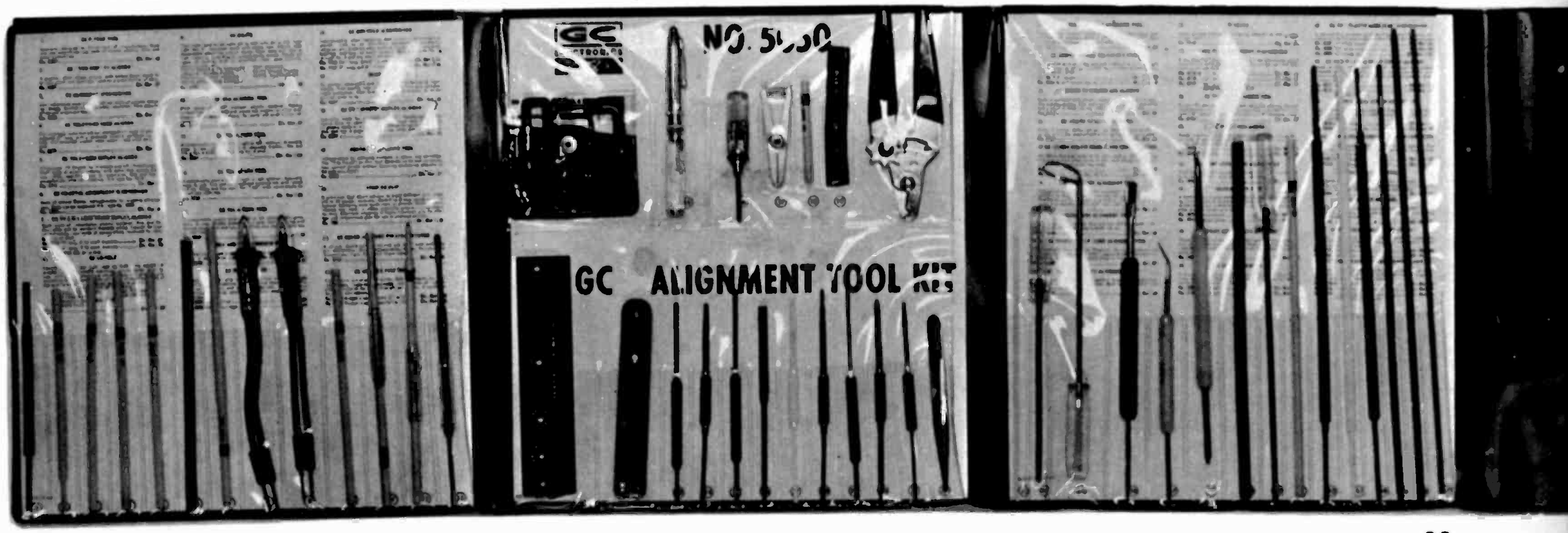


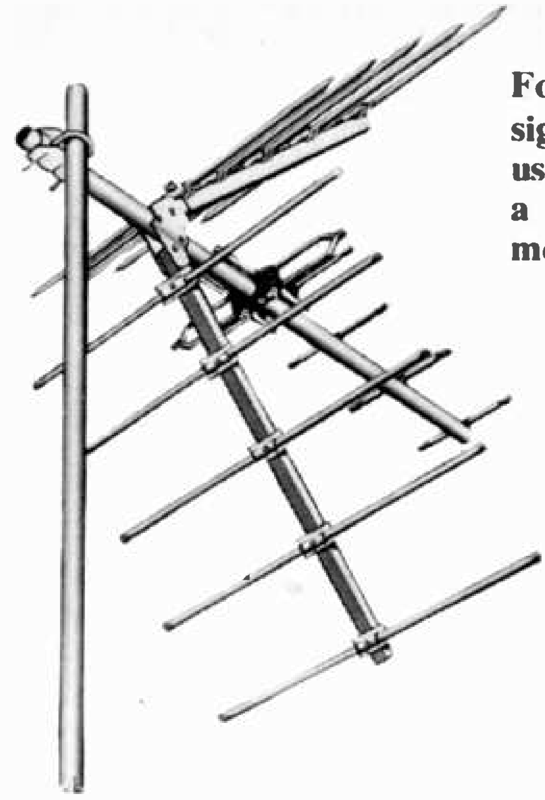
A complete set of good quality screwdrivers is a must for any service shop. Even 90° and insulated shank types must be included. The art of using the correct tool usually separates the pro from the novice. The two screwdrivers at the right are screw launchers. They can hold, start, and drive screws—using one hand—and are ideal for hard-to-get-at places. Each has dual blades sliding across each other, the thickness varying, and when properly set they bind against the slot in the screw head. Tools shown in this photo are from Vaco Products Co. and Xcelite, Inc.

TABLE 2. SPECIAL TOOLS FOR TRANSISTOR-CIRCUIT WORK

High-intensity lamp	Portable bench vise	Clip leads, insulated
Hexagonal (Allen) wrenches (8): 0.028"– 0.125"		Magnifier
Screwdrivers (3): 0.070", 0.080", 0.100" tip		Steel scraper
Socket (hex) wrenches (5): 5/64", 3/32", 7/64", 1/8", 5/32"		Steel pick
Small soldering tool	Heat-sink tool	Miniature wire brush
Gripping tool	Tweezers	Beeswax
Midget diagonal cutters: 4" long, flush cutting		
Pattern files: round, medium-cut, 5"- 6" long; flat, medium-cut, 5"- 6"		

One of the most complete alignment tool kits we've seen is by GC Electronics. The reflections are from the plastic cover. Each tool has its own plastic compartment for easy access. The kit goes beyond alignment tools to include tube-pin straighteners, fuse pullers, and low-and high-voltage test lights—to name a few.





For long-distance reception of u.h.f.-only signals, an antenna of this type may be used. The RCA 10B715 shown, combines a yagi antenna with folded-dipole driver mounted with corner-reflector assembly.

Antenna rotators are important where antenna must be turned for best signal strength and to eliminate ghosts. The two examples shown here are Jerrold's Dyna-Rotor mast assembly and control unit, along with Cornell-Dubilier's push-button type Autorotator control unit.

how to get TOP-QUALITY TV RECEPTION

By LON CANTOR

With so many good TV antennas available, making a decision on which to use is difficult. This article should help to narrow down the choice to one that will do the best job for your particular reception needs. A complete listing of recommended antennas for various signal areas is also included.

VIEWERS are becoming more and more critical of the quality of the TV pictures they watch. Early TV viewers were satisfied to get any kind of a recognizable picture. Ghosts, smears, snow, and interference were cheerfully ignored. However, just as radio listeners moved from tinny, staticy sound to high fidelity, so TV viewers are now demanding cleaner, truer pictures.

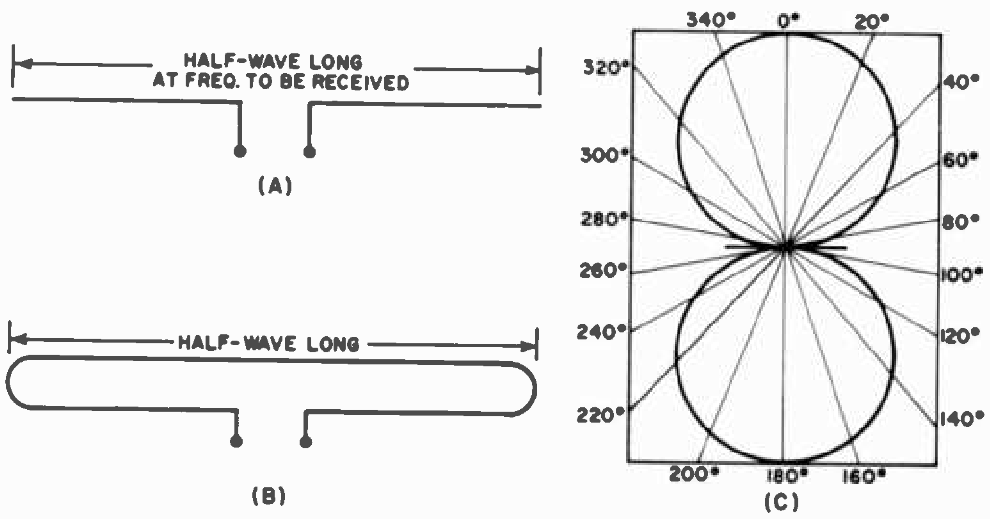
There are three factors behind the demand for top-quality TV reception:

1. *Color-TV*. Color-TV has already surpassed black-and-white TV in annual sales volume. And defects that were barely noticeable in monochrome really pop out in color.

2. *Cable TV*. As CATV moves into more and more areas and more buildings use quality MATV systems, many viewers are seing how good TV reception can really be—often for the first time. Many dealers, for example, are investing in excellent MATV systems for their showroom sales floors. Once people see top-quality TV pictures, they are unwilling to settle for less in their homes.

3. *Better home antennas*. Manufacturers have been making bigger and better home TV antennas each year, and sales continue to rise. Thus, viewers can see good pictures in more and more of their neighbors' homes.

Fig. 1. (A) Basic center-fed 75-ohm half-wave dipole. (B) Folded half-wave dipole has 300-ohm impedance. (C) Top-view polar chart of half-wave antenna.



Start With a Good Antenna

The first step on the road to top-quality TV reception is to select the right antenna. Unfortunately, this is not as easy as it sounds. There are quite a few well-known manufacturers and each makes a bewildering variety of antennas. No one type of antenna is "best" for all reception conditions. There are, however, a number of guidelines that can help you to choose the right antenna for each specific reception area:

Some antennas are made for v.h.f. only (channels

2 through 13), others for u.h.f. only (channels 14 through 83), and still others receive all 82 channels. Many installers prefer to use 82-channel antennas even in v.h.f.-only areas in order to accommodate any new u.h.f. stations that might go on the air.

TV signals get weaker as they travel away from the transmitter. Table 1 indicates the approximate distances at which TV signals can be received. Remember, however, that these distances are based on nearly perfect, problem-free areas. Put a hill, a tall building, or, in some cases, even a few high trees, between the transmitting antenna and the receiving antenna and these distances may have to be revised downward.

Also, the distance from which a TV signal can be received is affected by the channel frequency. The higher the frequency, the greater the signal loss. Thus, while you may be able to receive channel 14 at 90 miles, you probably can't receive channel 83 at that distance.

TV signals travel through space in at least three ways: 1. line-of-sight, 2. surface waves, and 3. waves reflected from ionized layers in the upper atmosphere.

Surface waves follow the curvature of the earth. They are very reliable at AM radio frequencies, which is why AM antennas are so small and simple. Surface waves at TV and FM frequencies, however, are very quickly absorbed.

Reflected waves are unreliable and unpredictable. The ionized layers in the upper atmosphere shift from day to day and hour to hour. Reflected waves are primarily responsible for the amazing distances at which both radio and TV signals are occasionally received. Reflected waves are friends of the patient DX-er, but we just can't count on them for consistent TV reception.

This leaves us with straight line-of-sight waves. At low v.h.f. frequencies, some bending does occur due to refraction of the atmosphere, but to a great extent, you can't get good TV reception over the horizon.

Gain and Polar Patterns

Some antennas pick up more signal than others. To make uniform, valid comparisons of relative antenna efficiency, engineers have chosen the simple half-wave dipole (see Figs. 1A and 1B) as a standard.

The amount of signal picked up by a standard half-wave dipole at any given location or distance from the transmitter is known as unity gain or 0 decibels (dB). An antenna that picks up twice as much signal voltage as a standard dipole at a given location is said to provide 6-dB gain. Of course, the antenna is a passive device. It doesn't actually amplify the signal; it simply captures more of the signal available in that area, in a given direction, at the expense of signal in other directions.

Table 2 shows how to convert dB to signal voltage. Remember that 0 dB is *not* equal to zero signal or zero times. It is equal to 1 time. From Table 2 you can see that an antenna specified at 10-dB gain picks up about three times as much signal voltage as a standard dipole.

All TV antennas, including the simple dipole, are directional. In other words, they must be aimed, or oriented in the right direction in order to pick up maximum signal.

	V. H. F.	U. H. F.
Local Signal	0 to 15 miles	0 to 15 miles
Medium Signal	15 to 40 miles	15 to 30 miles
Fringe Signal	40 to 80 miles	30 to 60 miles
Deep Fringe Signal	80 to 120 miles	60 to 90 miles

Table 1. Approximate distances for TV reception.

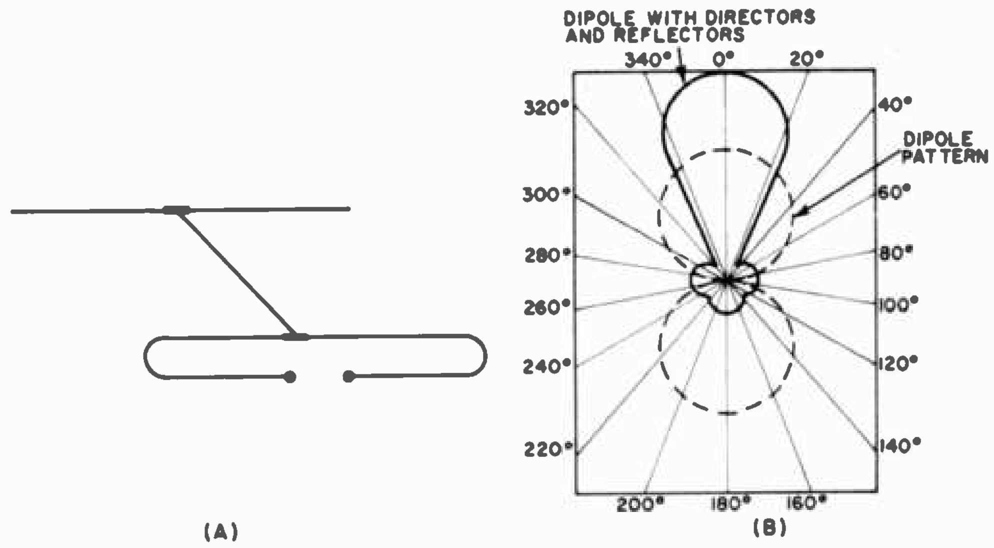
dB	Voltage Times(X)	dB	Voltage Times(X)	dB	Voltage Times(X)
1	1.12	16	6.3	31	35
2	1.25	17	7	32	40
3	1.4	18	8	33	45
4	1.6	19	9	34	50
5	1.8	20	10	35	56
6	2	21	11	36	63
7	2.25	22	12.5	37	71
8	2.5	23	14	38	80
9	2.75	24	16	39	90
10	3.16	25	18	40	100
11	3.55	26	20	43	140
12	4	27	22.5	46	200
13	4.5	28	25	50	300
14	5	29	28	56	600
15	5.6	30	32	60	1000

Table 2. Decibel (dB) to voltage gain conversions.

The directivity of an antenna is generally indicated by a polar plot. A polar plot is derived by rotating an antenna and measuring signal pickup for each direction in which it is aimed. Fig. 1C shows the polar plot of a standard dipole. Notice that the dipole receives signals equally well from front (0°) and back (180°). However, it doesn't receive signals from the sides (90 and 270 degrees). The curves on the polar plot are called "lobes." Notice that the front and back lobes on a half-wave dipole are equal in size.

In almost all cases, the back lobe is worse than useless. However, we can eliminate the back lobe and increase the forward pickup of the antenna by adding elements to the antenna. Fig. 2A shows a dipole with a reflector element behind it. There is no electrical con-

Fig. 2. (A) Folded dipole with reflector. (B) Polar pattern of dipole with reflector, director elements.



	Ch.	Bandwidth Freq. (MHz)	Video Carrier Freq. (MHz)	Sound Carrier Freq.(MHz)	Full Wavelength In Air (in)
V. H. F.	2	54-60	55.25	59.75	205
	3	60-66	61.25	65.75	186
	4	66-72	67.25	71.75	170
	5	76-82	77.25	81.75	148
	6	82-88	83.25	87.75	138
	7	174-180	175.25	179.75	66½
	8	180-186	181.25	185.75	64½
	9	186-192	187.25	191.75	62¼
	10	192-198	193.25	197.25	60½
	11	198-204	199.25	203.75	58½
	12	204-210	205.25	209.75	57
	13	210-216	211.25	215.75	55¼
U. H. F.	14	470-476	471.25	475.75	25
	24	530-536	531.25	535.74	22¼
	34	590-596	591.25	595.75	19¾
	44	650-656	651.25	655.75	18
	54	710-716	711.25	715.75	16½
	64	770-776	771.25	775.75	15¼
	74	830-836	831.25	835.75	14¼
	83	884-890	885.25	889.75	13¼

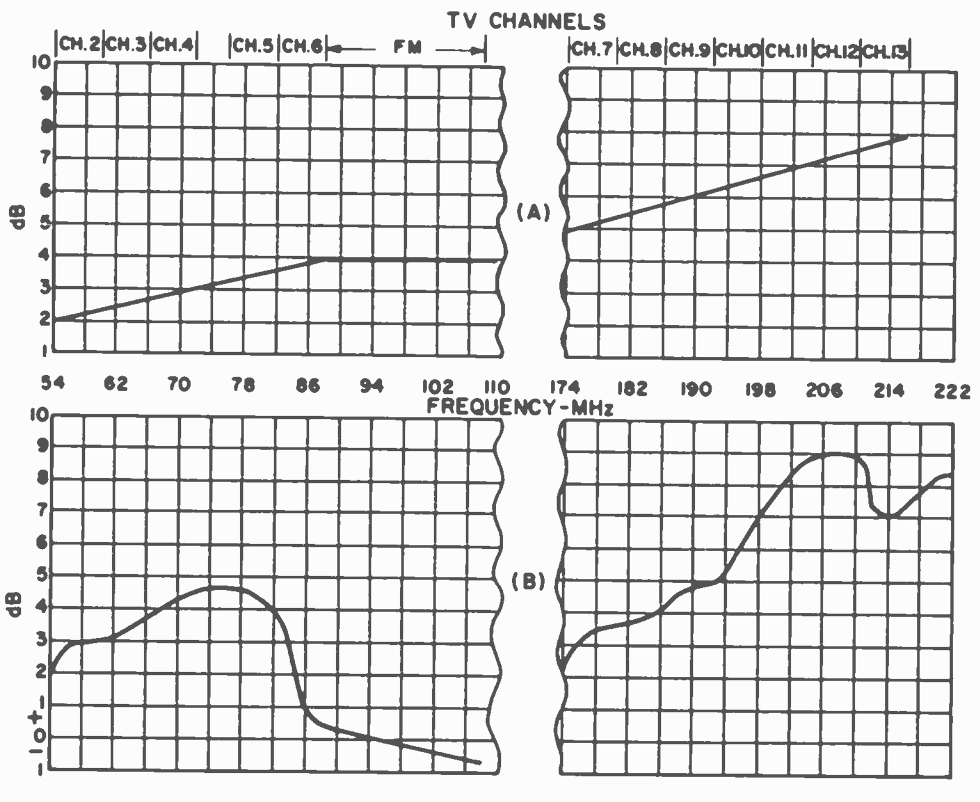
(Color Subcarrier = Video Carrier + 3.58 MHz)

Table 3. Frequencies of the various TV channels along with the lengths of a full wave measured in air. To find the length of a half-wave antenna for the various channels, simply halve the length shown and take about 95% of your answer. Because of "end effect," antenna element operates as though it were about 5% longer.

nection between the dipole and the reflector. Its function is similar to that of a flashlight reflector. Some of the TV signal from the transmitter hits the reflector, which bounces it back into the dipole. Director elements can also be used in front of the dipole, to focus more signal energy into the dipole. The effect of adding directors and reflectors to the dipole is shown in Fig. 2B.

It is impossible to eliminate the back lobe entirely.

Fig. 3 (A) Idealized gain curves for v.h.f.–FM antenna. (B) Actual curve of an older antenna once widely sold.



But one criterion of a good antenna is that it have a high front-to-back ratio. In other words, the front lobe should be much greater than the back lobe, to prevent pick-up of unwanted signals.

Antenna Flatness

Up to this point, we have assumed that the antenna worked equally well on all TV channels. However, this is not the case. As indicated in Table 3, a half-wave dipole for channel 2 is about 100 inches long while a half-wave dipole for channel 13 is only about 25 inches long. Therefore, a dipole cut for channel 13 won't be very efficient for picking up channel 2.

Rather than use antennas cut for a single channel, most antenna manufacturers use elements cut to compromise lengths in order to produce broad-band antennas covering all channels. However, no broad-band antenna is perfectly flat, picking up all channels equally. Most antennas, in fact, are deliberately designed to provide more gain at the higher frequencies where it is usually needed.

Fig. 3A shows an idealized curve for a v.h.f.-FM antenna. Notice that gain gradually increases from channels 2 through 6 and then from 7 through 13. Fig. 3B, on the other hand, is an actual curve of an older type of antenna once sold widely. Notice that gain fluctuates rather wildly. This causes little difficulty with black-and-white reception, especially if the low-gain channels are not used in the area. But uneven response can ruin a color picture, especially if there is a severe drop-off in gain at the color-carrier frequency. The color carrier is detected in phase, so that any significant tilt in frequency response shifts the phase of the color signals, changing colors on the TV screen. If there is not enough gain at the color-carrier frequency, then color will be lost altogether.

Antenna engineers generally agree that response within any single TV channel should be flat within 1 dB for really good color pictures.

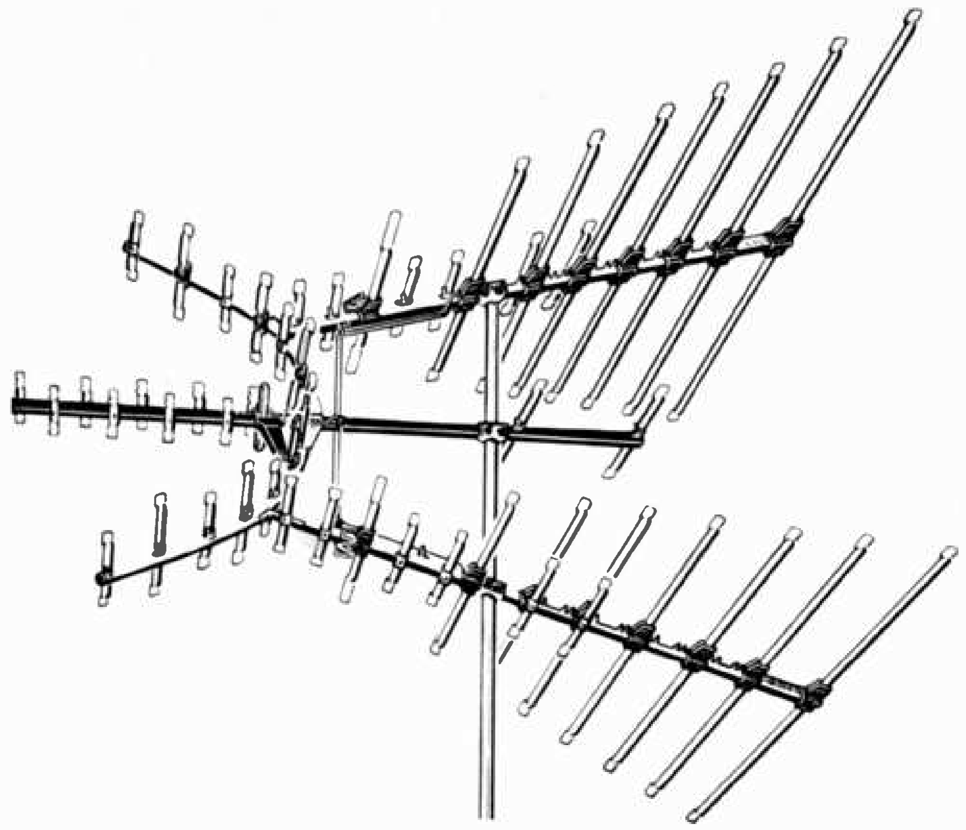
Table (right) shows antennas recommended by various antenna manufacturers for different signal areas. All antennas are outdoor types. We have limited each manufacturer to a single choice; in many cases, there are other antennas in the company's line with somewhat different gains and directional characteristics but at least we have given our readers a good starting point. Most of the antennas are general-purpose types where no special installation or interference problems exist. The suggested retail prices are given below each model. Although it is difficult to give exact mileage figures for local, medium, and fringe areas; in general, local signals are received in metropolitan areas within about 15 miles of the TV transmitters, medium signals are for suburban areas from about 15 to 40 miles, and fringe signals are for distances from about 40 to 80 miles and beyond. It is frequently possible to combine a v.h.f. antenna with a u.h.f. antenna provided a splitter and/or stacking bars are used. We have not listed such arrangements in our combination antennas, however, Our listings are only for those combination antennas that are sold in a single package or as a single antenna kit. Most of these antennas, although designed mainly for color-television, can be used for FM reception as well.

RECOMMENDED ANTENNAS FOR VARIOUS SIGNAL AREAS

MANUFACTURER	V.H.F. ONLY Local Signal	V.H.F. ONLY Medium Signal	V.H.F. ONLY Fringe Signal	U.H.F. ONLY Local Signal	U.H.F. ONLY Medium Signal	U.H.F. ONLY Fringe Signal
Antennacraft Co.	CS-600 $21.95	CS-800 $39.95	CS-1000 $69.95	Y-7G $ 6.95	G-1483 $ 9.95	Super G-1483 $19.95
Blonder-Tongue Labs. Inc.	CR-3 $10.95	CR-5 $17.95	CR-10 $33.95	Dart $ 7.95	Dart $ 7.95	Stacked Dart $17.50
Channel Master	3615 $16.95	3612 $44.95	3617 $84.95	4315 $11.80	4313 $18.48	4314 $25.56
Finney Co.	CS-V5 $18.50	CS-V10 $37.95	CS-V18 $59.50	CS-U1 $10.50	CS-U2 $15.95	CS-U3 $22.95
Gavin Instruments	1011 $23.95	1019 $41.95	1026 $62.50	CR-5 $ 6.75	CR-5 $ 6.75	CR-10 $11.50
Jerrold Electronics Corp.	VIP-301 $16.95	VIP-303 $32.95	VIP-306 $59.95	PUX-450 $10.95	PUX-700 $16.95	PUX-900 $28.95
JFD Electronics Co.	LPV-6L $23.50	LPV11L $44.50	LPV-17L $65.50	LPV-UCL 13 $15.50	LPV-UCL 22 $28.50	LPV-UCL 26 $33.50
Kay-Townes Ant. Co.	CP-7G $14.36	CP-15G $28.77	CP-28G $59.35	AAU-5G $11.10	UHF-4BT $ 8.03	AAU-21G $27.85
Lance Industries	LC-880 $20.30	LC-881 $29.90	LC-884 $59.80	KW4S $ 7.95	LU-820 $13.65	LU-840 $34.35
RCA Parts & Accessories	10B807 $15.95	10B814 $33.95	10B825 $62.95	10B705 $ 8.95	7B140 $ 8.25	7B141 $10.95
RMS Electronics, Inc.	STP-7 $14.45	STP-11 $20.95	STP-28 $56.95	BT-4 $ 7.95	U-9 $ 9.95	U-15 $19.95
S&A Electronics Inc.	ST-6 $13.50	ST-11 $22.95	ST-20 $49.50	UPW-12 $ 8.95	UPW-26 $19.95	UPW-36 $29.95
Sylvania Electric Products Inc.	007 SG $16.95	1010 SG $34.95	2525 SG $54.95	2U $11.95	2U $11.95	4U $14.95
Winegard Co.	SC-51 $24.95	SC-52 $34.95	SC-53 $49.95	U-965 $14.95	U-975 $22.95	U-995 $32.95
Zenith Sales Corp.	973-83 $19.95	973-85 $39.95	973-87 $59.95	973-101 $ 8.95	973-8 $14.95	973-10 $31.95

V.H.F.–U.H.F. COMBINATIONS

MANUFACTURER	V.H.F. LOCAL SIGNAL U.H.F. Local Signal	V.H.F. LOCAL SIGNAL U.H.F. Medium Signal	V.H.F. LOCAL SIGNAL U.H.F. Fringe Signal	V.H.F. MEDIUM SIGNAL U.H.F. Local Signal	V.H.F. MEDIUM SIGNAL U.H.F. Medium Signal	V.H.F. MEDIUM SIGNAL U.H.F. Fringe Signal	V.H.F. FRINGE SIGNAL U.H.F. Local Signal	V.H.F. FRINGE SIGNAL U.H.F. Medium Signal	V.H.F. FRINGE SIGNAL U.H.F. Fringe Signal
Antennacraft Co.	Big Shot 8 $ 9.95	CDX-650 $24.95	CDX-750 $34.95	CDX-750 $34.95	CDX-850 $44.95	CDX-1050 $69.95	CS-1000 $69.95	CS-1000 $69.95	CS-1000 $69.95
Blonder-Tongue Labs. Inc.	CR-3 with UR-6 $15.55	CR-3 with UR-6 $15.55	CR-3 with UR-11 $18.90	CR-5 with UR-6 $22.55	CR-5 with UR-6 $22.55	CR-5 with UR-11 $25.90	CR-15 with UR-6 $54.55	CR-15 with UR-6 $54.55	CR-15 with UR-11 $57.90
Channel Master	3668 $19.95	3667 $22.95	3666 $24.95	3665 $31.95	3664 $42.50	3663 $54.95	3662 $67.95	3661 $79.95	3661 $79.95
Finney Co.	CS-A1 $19.95	CS-A2 $23.95	CS-A3 $32.50	CS-B1 $31.50	CS-B2 $41.95	CS-B3 $52.50	CS-C1 $45.95	CS-C2 $54.50	CS-D3 $73.50
Gavin Instruments	1106 $16.95	1113 $29.95	1122 $47.50	1110 $21.50	1118 $37.50	1122 $47.50	1118 $37.50	1122 $47.50	1134 $67.95
Jerrold Electronics Corp.	VU-831 $21.95	VU-831 $21.95	PXB-48 $27.95	VU-832 $30.95	VU-833 $41.95	PXB-65 $47.95	VU-834 $51.95	VU-834 $51.95	VU-836 $79.95
JFD Electronics Co.	LPV-CL55 $19.95	LPV-CL100 $23.95	LPV-CL200 $27.95	LPV-CL300 $33.95	LPV-CL400 $45.95	LPV-CL500 $57.95	LPV-CL500 $57.95	LPV-CL600 $69.95	LPV-CL700 $79.95
Kay-Townes Ant. Co.	CPC-12G $19.27	CD-11G $18.58	CP-7G with AAU-21G kit $42.21	CP-15G with AAU-5G kit $39.87	CPC-27G $45.08	CT-34G $57.00	CD-19 with AAU-5G kit $41.45	CPC-33G $57.51	CT-40
Lance Industries	LC-80 $19.05	LC-81 $27.65	LC-81 $27.65	LC-81 $27.65	LC-82 $32.00	LC-83 $58.25	LC-32 $39.90	LC-117 $50.75	LC-119 $62.40
RCA Parts & Accessories	10B907 $14.95	10B910 $19.95	10B917 $29.95	10B910 $19.95	10B917 $29.95	10B920 $39.95	10B920 $39.95	10B925 $49.95	10B930 $64.95
RMS Electronics, Inc.	DYN-33US $19.95	DYN-54US $29.95	DYN-118US $44.95	DYN-54US $29.95	DYN-66US $34.95	DYN-118US $44.95	DYN-88US $44.95	DYN-118US $44.95	DYN-158US $49.95
S&A Electronics Inc.	FSM-20 $18.25	FSM-30 $29.95	FSM-35 $41.50	FSM-30 $29.95	FSM-30 $29.95	FSM-35 $41.50	FSM-35 $41.50	FSM-35 $41.50	FSM-40 $54.95
Sylvania Electric Products Inc.	10VUSG $44.95	10VUSG $44.95	10VUSG $44.95	22VUSG $54.95	22VUSG $54.95	25VUSG $64.95	25VUSG $64.95	32VUSG $74.95	32VUSG $74.95
Winegard Co.	SC-79 $21.50	SC-80 $29.95	SC-81 $39.95	SC-81 $39.95	SC-82 $54.95	SC-83 $69.65	SC-82 $54.95	SC-83 $69.95	SC-1000 $100.00
Zenith Sales Corp.	973-89 $21.95	973-90 $29.95	973-91 $36.95	973-92 $49.95	973-92 $49.95	973-92 $49.95	973-93 $59.95	973-93 $59.95	973-94 $79.95



Many elaborate antennas use a combination of driven and parasitic elements of various sizes to cover all desired channels. For example, this Winegard SC-1000 is designed for deep-fringe-area reception of all v.h.f., u.h.f., and FM stations in a given direction.

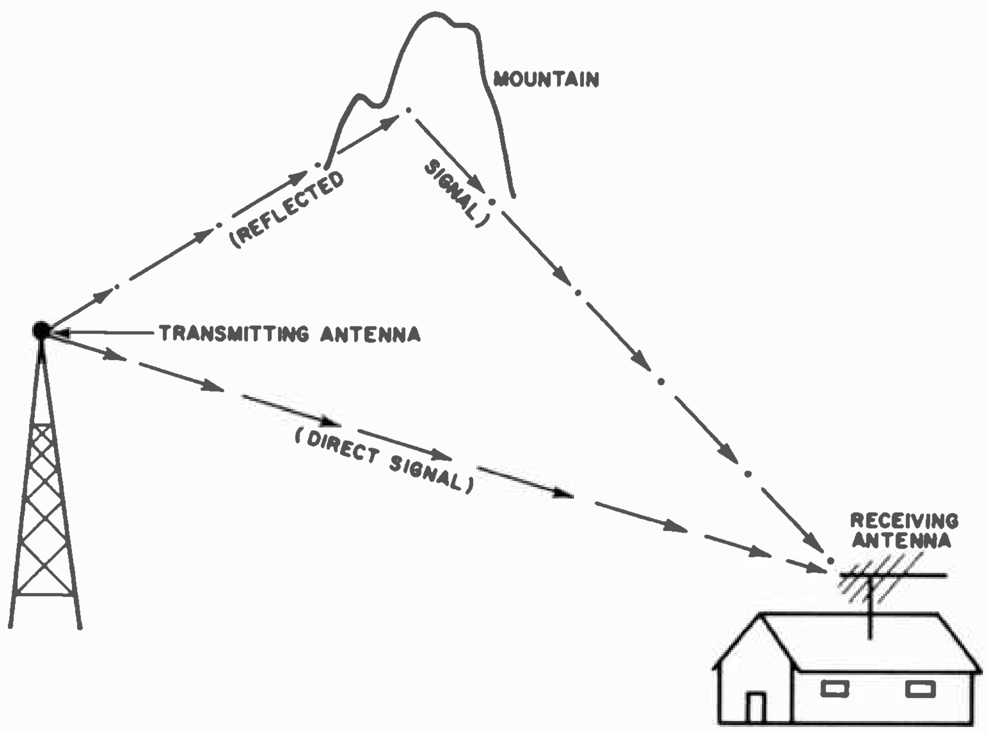
Height and Position

In general, the higher you get the antenna, the more signal it will pick up. Extra height means fewer obstructions in the way of the signal. However, it is not at all unusual to find "hot" and "dead" spots at various heights, especially at u.h.f.

The only accurate way to determine how high the antenna should be mounted is to make a signal survey, using a test antenna connected to a field-strength meter. Unfortunately, this is a difficult, time-consuming process. To do a really good job, you have to survey the signals at various heights and in various locations, over a period of 24 hours or more, for each channel to be received. MATV and CATV system installers can go to this trouble and expense, but it is generally not practical for a home installation.

For mechanical simplicity, you're better off to keep the antenna as low as possible. A 5- to 10-foot mast is a lot easier to install than a 20-foot mast. In fringe and deep-fringe areas, you'll need quite a bit of height, but

Fig. 4. Ghosts result from direct and reflected signals.



it's not a bad idea to start off low and add 5-foot sections only if they are needed. Of course, once you have made a few installations in a given area, you'll know how high you need to go.

Incidentally, in metropolitan and suburban areas, it's a good idea to consider attic installations. Keeping the antenna indoors simplifies the installation and makes it last longer.

Type & Construction

One type of antenna used for today's color installations, the yagi, is noted for high gain and excellent directivity. However, many early yagi designs were not flat enough for good color reception.

It was primarily for this reason that the log-periodic antenna was developed. Like the yagi, the log periodic uses groups of elements tuned to specific channels. The distinguishing feature of the log periodic is that the elements are spaced logarithmically and tapered from front to back. Log-periodic antennas are noted for flatness.

In both types of antennas, a single element may resonate in two or more modes to pick up two or more channels. For example, an 80-inch element is about a half wavelength long at channel 4 and about 3/2 wavelengths long at channel 12. Using double-duty elements makes today's antennas more efficient, but it does cause some problems. Elements resonating in the 3/2 wavelength mode pick up signals quite well, but they have side lobes, which can easily pick up unwanted signals.

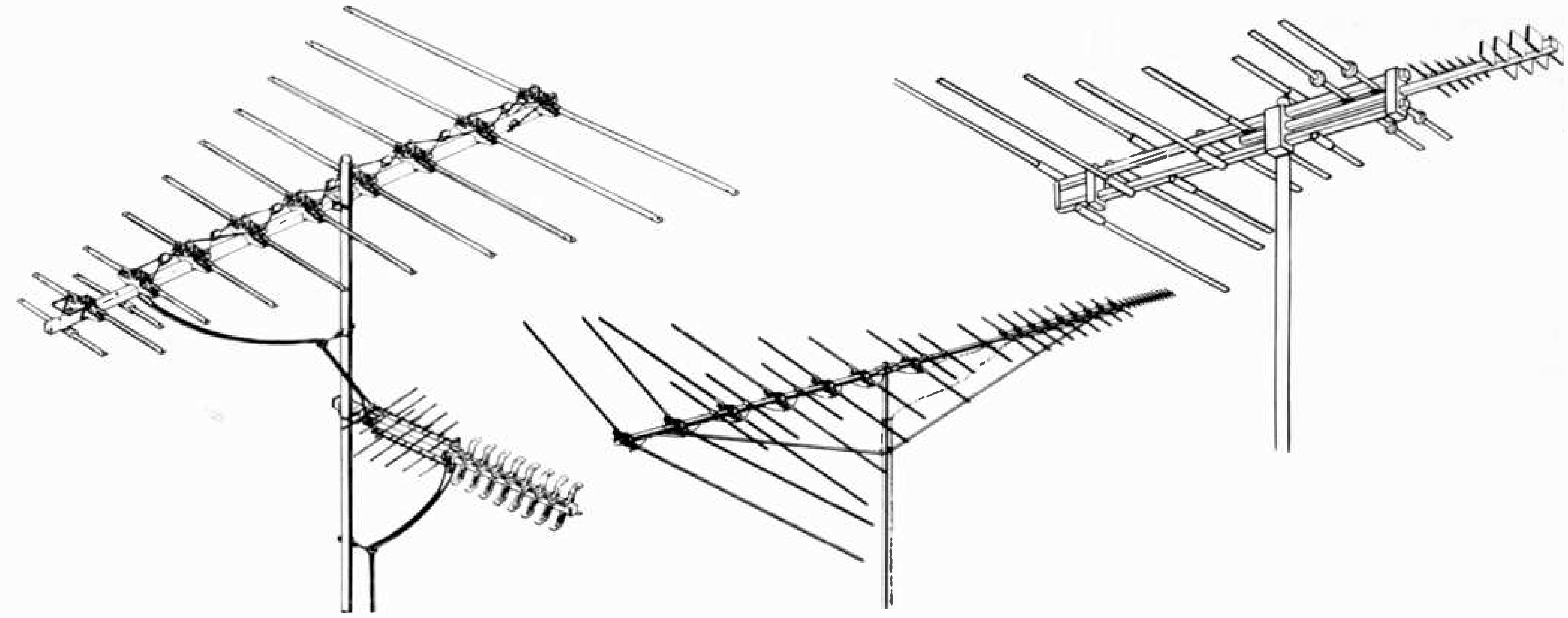
To eliminate side lobes, manufacturers uses a number of devices, such as angling elements forward or using special resonating devices. In any case, there is little to choose between modern, well-designed yagis and log periodics. Most of today's yagis are quite flat and most of today's log periodics are designed to pick up just as much signal as equivalent yagis. In addition, there are other elaborate types produced by some manufacturers that are neither yagis nor log periodics but use an array of interconnected and driven elements to produce the desired gain and directivity.

Another type of antenna is designed specifically for metropolitan areas. In metropolitan areas, gain is no problem. Signals are, if anything, too strong. Metropolitan type antennas are designed to overcome the problem of ghosts. Therefore, they are made not to pick up weak signals, but they use reflectors, phasing harnesses, traps, and other devices to minimize pick-up of reflected signals.

When you put up an antenna, you want it to last—to deliver top-quality pictures for many years. Therefore, mechanical construction is vitally important. Booms and antenna elements should be as heavy and strong as possible. Elements should be braced internally. Contacts should be secure—the type that tightens rather than loosens in the wind. And the entire antenna, including mounting hardware, should be protected by a corrosion-resistant coating.

Eliminating Ghosts

More TV pictures are ruined by "ghosts" or multiple



(Left) When u.h.f. stations are located in a different direction from v.h.f. stations and a rotator is not a part of the antenna installation, then separate u.h.f. and v.h.f. antennas may be used. In the example shown here, a Lancer Model LC882 antenna is connected to a Model LU820, from which a single downlead is run to the television receiver. Another alternative is to use a combination antenna with separately orientable sections.

(Center) For the deep-fringe reception of v.h.f., u.h.f., and FM signals, an antenna which combines a broadband yagi with the log-periodic design may be used effectively. The unit shown is the Gavin Model 1134 antenna.

(Right) This log-periodic antenna design uses capacitively loaded diploes along with staggered flat-plate u.h.f. directors at the very front of the antenna to achieve good wide-band, all-channel performance. The model that is shown here, designed for operation in near-fringe reception areas, is the Zenith 973-92 type antenna.

images, than by any other cause. Ghosts are caused by reflections, as shown in Fig. 4. The same transmitted signal reaches the receiving antennas *via* two paths—one direct, and one reflected from a building, hill, water tower, or some other obstruction.

The trouble is caused by the fact that the reflected signal travels farther, therefore it reaches the antenna a split second later. Since TV signals travel through the air so rapidly (about 1000 feet per microsecond), you might think that the delay would not be important. But the horizontal oscillator in a TV receiver sweeps the electron beam across the picture tube very rapidly too, at about 53 microseconds across the screen. If the picture is 20 inches wide and if the reflected signal travels only an extra 1000 feet, the "ghost" is displaced by about 1/53 of 20 inches or almost 4/10th of an inch to the right of the direct image.

Closely spaced ghosts appear on the screen as fuzzy smears that can be ignored on a monochrome receiver. But on a color screen, not only is the ghost displaced to the right, but it introduces extraneous new colors to the picture. That's why it's so important to eliminate ghosts for good color reception.

The best way to eliminate ghosts is to get an antenna that is highly directive, with good front-to-back ratio and a single, narrow front lobe. Then, orient the antenna for minimum ghost pickup, rather than maximum direct signal pickup.

In really difficult signal areas, you can try horizontal stacking of two identical directional antennas. If you space and orient the two antennas properly, they pick up reflected signals that are equal in amplitude, but 180° out-of-phase. Thus, reflected signals cancel each other out; the direct signals are received in-phase.

Rotators

Unfortunately, not all TV transmitters are located in the same direction. For black- and-white pictures, you could often use an antenna with a wide forward lobe, aim it between two or more stations, and get reasonably good reception. For color, however, you need a sharply directional antenna aimed precisely at the transmitter.

Therefore, in many locations, an antenna rotator is a must. A rotator consists of a top-of-the-set control unit connected to a mast-mounted motor-driven unit by a four or five-wire conductor. There is a wide variety of rotors available, but the two main types are automatic (the antenna can be aimed quickly to pre-set directions) and manual (the antenna can be rotated for best picture).

Rotators are excellent for eliminating ghosts; however, they are expensive and add weight to the installation. Guy wires are recommended for every rotator installation, and a thrust bearing should be used to take the weight off the turning motor.

In some cases, you can eliminate the need for a rotator by using multiple antennas, aimed in different directions. Two or more antennas can be combined into a single downlead using antenna couplers or mixers. However, the danger of multiple antennas is that they may interfere with each other or cause ghosts.

Lead-in Wire

Much has been said about twin-lead *vs* coax lead-ins for TV antennas. Generally speaking, twin-lead is less expensive and causes less signal loss, while coax minimizes standing waves and interference.

No transmission line is clearly superior to all others for every installation. Whichever you choose, however,

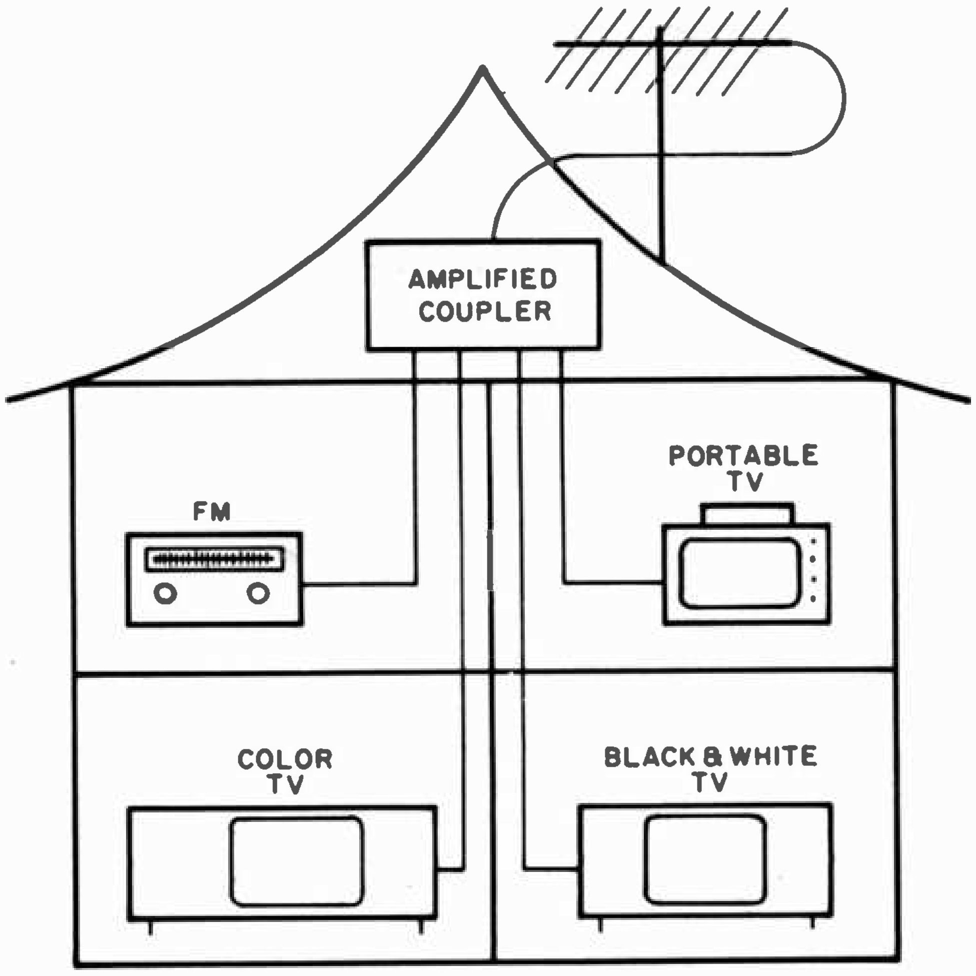


Fig. 5. An amplified coupler feeding four receivers.

don't skimp on quality. In most installations, it is the transmission line that goes first.

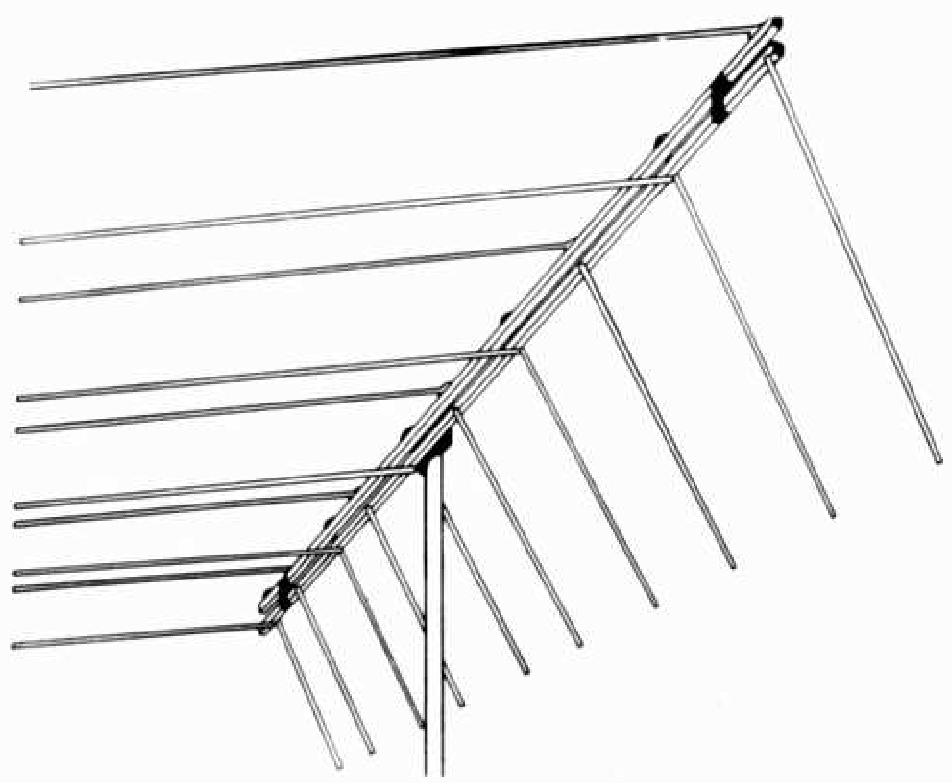
Also, if you do decide to use twin-lead, be sure to run it carefully. Twin-lead run close to metal, or held in place by metal stand-offs or staples, can result in standing waves. And standing waves show up on the TV screen as closely spaced ghosts. Therefore, use top-quality twin-lead and keep it away from metal.

If you use coax, the only precautions you must take are: 1. don't bend it too sharply, and 2. don't crush it. Of course, coax must be matched to 300-ohm antennas and TV sets with matching transformers.

Preamplifiers

Aside from ghosts, the most prevalent TV problem is snow. Snow is caused by r. f. noise.

For reception of v.h.f.-only TV stations, a log-periodic antenna of this type may be used. This antenna, a Blonder-Tongue CR-10, can be employed along with add-on u.h.f. antenna if it is desired to receive all the TV channels.



The way to eliminate noise from a TV picture is to pick up so much signal that the noise is drowned out. For a good color picture, the ratio of signal-to-noise should be at least 28 dB. In fringe or deep fringe areas, it is not always possible to get this much signal, even with the best of antennas.

This is where the preamplifier comes in. A good preamplifier can increase the signal strength by 15 or 20 dB. Unfortunately, it also increases the noise by the same amount. Thus, the output of a preamplifier has no better (in fact slightly worse) signal-to-noise ratio than the input.

However, the signal-to-noise ratio is at its best right at the antenna output. It is seriously deteriorated by the downlead, which attenuates the signal a lot, but the noise very little.

Therefore, preamplifiers are generally mounted right up on the mast, as close to the antenna as possible. Hence, they amplify the TV signals before they are made worse by the downlead. The result, generally, is a big improvement in system signal-to-noise ratio, and a sharp reduction of snow on the TV screen.

Mast-mounted preamplifiers are invariably teamed with an indoor supply unit which sends power for the preamp up on the same transmission line that brings the signal down.

Multiple TV Systems

Today, many people own two or more TV sets. It would be desirable to operate these TV sets from a single outdoor antenna. Also, a number of people connect their FM-stereo receivers to their outdoor TV antennas as well (assuming the antenna is suitable for FM). The simplest way to connect several sets to a single antenna is with a passive coupler. The single downlead from the antenna is connected to the input of the coupler while the outputs go to the various receivers that are in use. A four-set coupler causes about 7-dB loss, which has the same effect as increasing the distance from the transmitter to the receiving antenna.

To overcome this loss in weak-signal areas, you can use an amplified coupler, as shown in Fig. 5. Each output of an amplifier coupler generally provides more signal voltage than was present at the input. Another advantage of an amplified coupler is that you can then re-split each output with a passive coupler, to provide a TV outlet for every room in the house. This is especially handy if you have a portable TV which is moved from room to room.

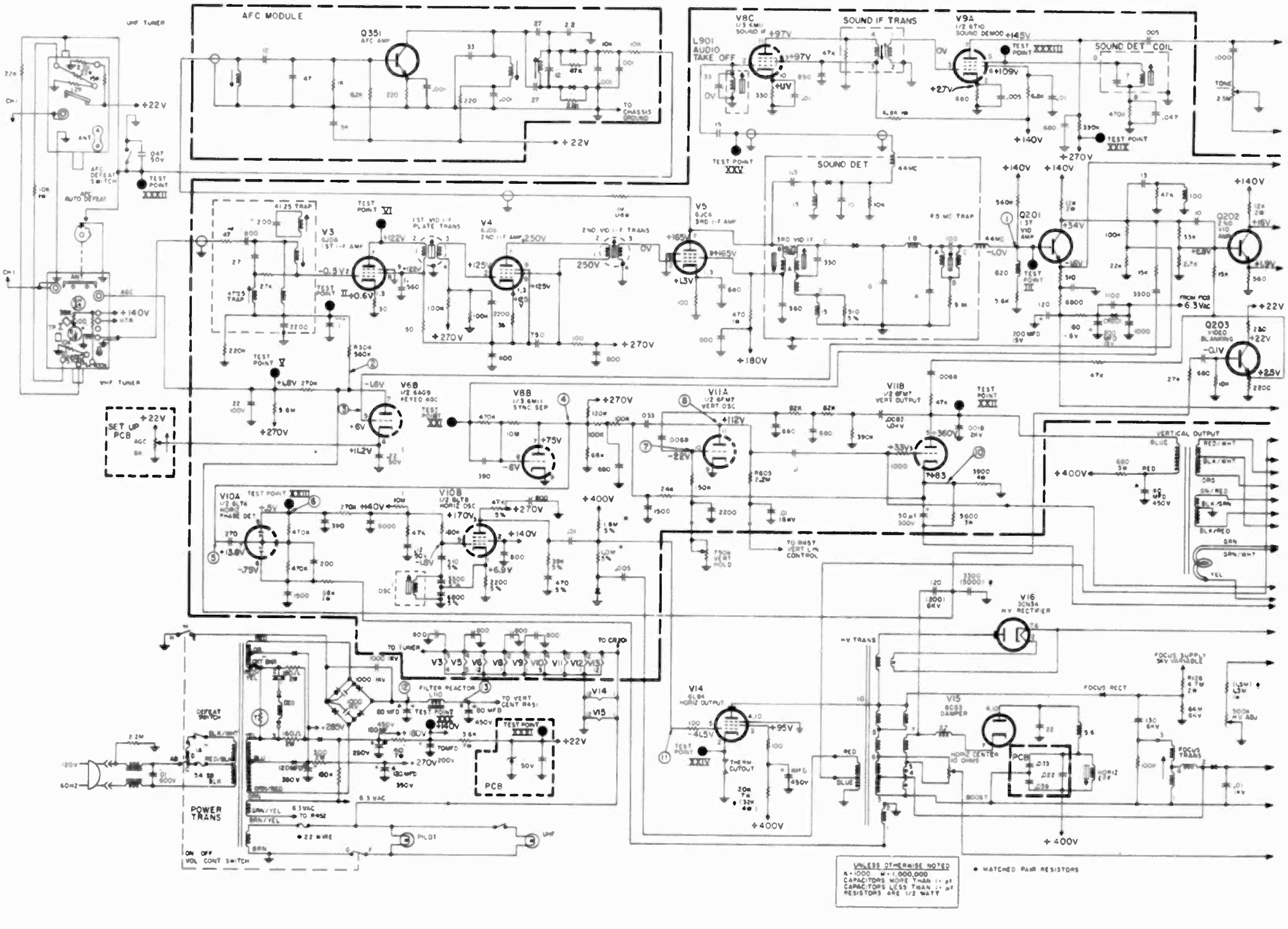
For top-quality TV pictures throughout the house, choose good quality antennas and accessories and install them carefully. A good antenna system can provide many, many years of worthwhile TV reception at remarkably low cost. ▲

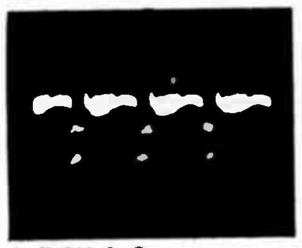
For additional information on products mentioned in article, circle the appropriate numbers on Reader Service Card.
For TV antennas, circle................ No.77
For TV antenna rotators, circle.......... No.78

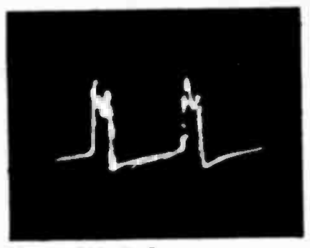
GENERAL ELECTRIC KE

COLOR-TV CIRCUIT

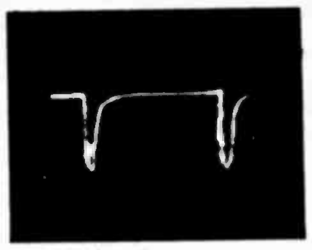
The new G-E KE chassis is used in a large number of table and console models, all of which include Insta-Color for almost instantaneous picture and sound as soon as the set is turned on. All models, except M906EWD, also have new solid-state a.f.c. in separate module. 23-inch picture tubes are employed in all models except M364EWD, which uses a 20-inch tube, and M275EMP, M276EWD, with 18-inch tubes. The following table models use this chassis: M275EMP, M276EWD, M364EWD, M906EWD, and M907EWD; consoles are M925EWD, M926EMP, M927EPN, M930EWD, M931EMP, M932EPN, M941EMP, M942ECL, and M950EWD.

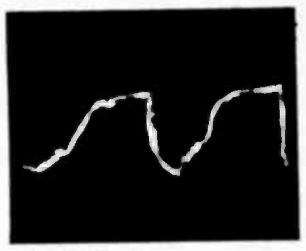


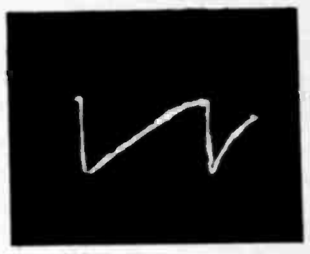

1-3.5V P-P

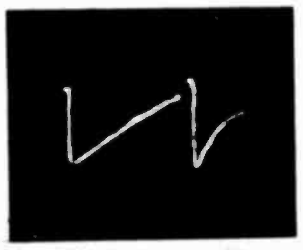

2-200V P-P

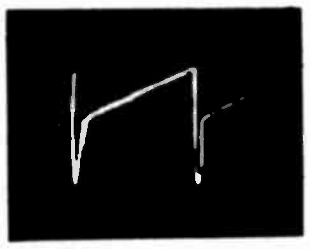

3-10V P-P


4-120V P-P

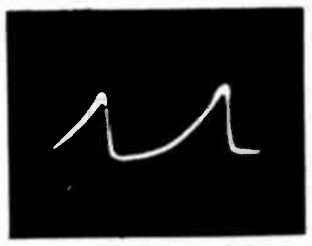

5-50V P-P

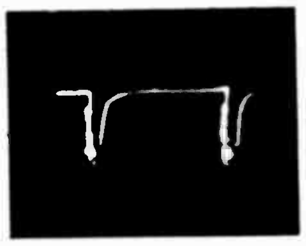

6-14V P-P

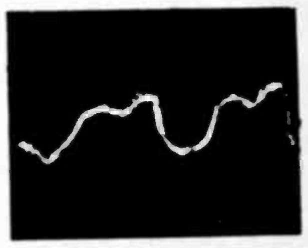

7-110V P-P

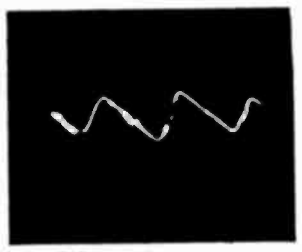

8-225V P-P

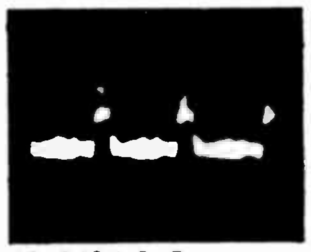

9-110V P-P


10-18V P-P

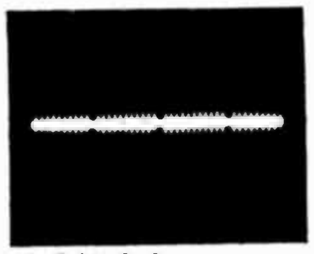

11-380V P-P


12-2.5V P-P

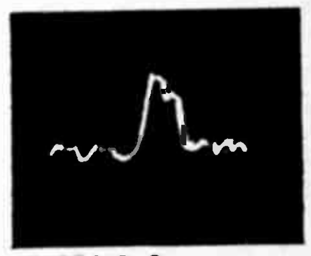

13-26V P-P

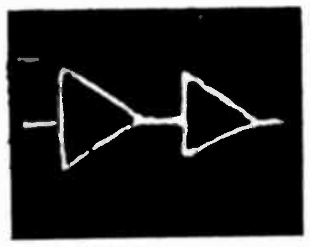

14-240V P-P


15-125V P-P

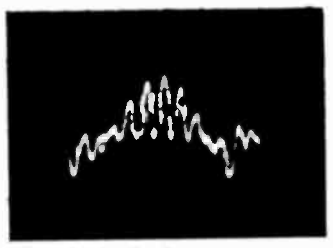

16-3.0V P-P

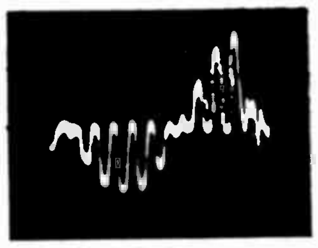

17-36V P-P

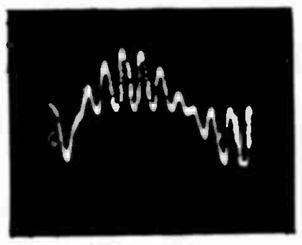

18-250 P-P


19-350V P-P

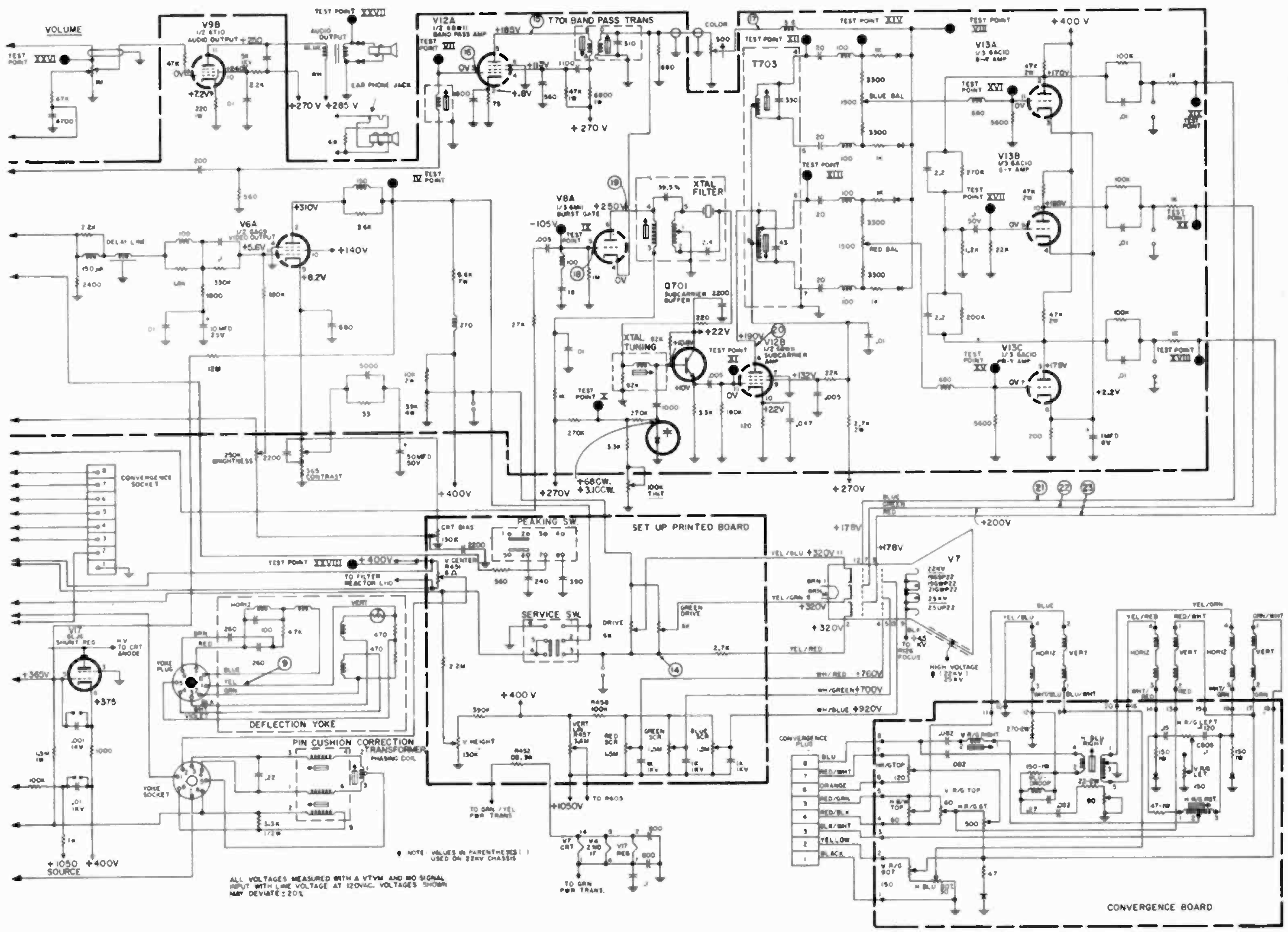

20-225V P-P


•21-160V P-P

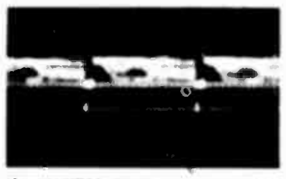

22-140V P-P


23-220V P-P

The troubleshooting waveforms shown above have been keyed, by means of numbers, to test points shown circled on schematic. For chroma waveforms, use color-bar generator, wide-band scope with low-capacitance probe.

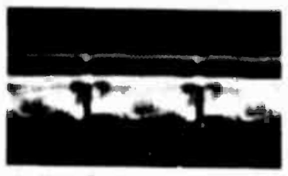


1-2V P-P V

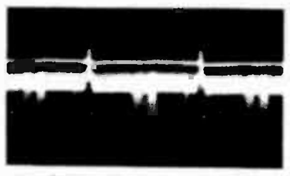


2-0.25V P-P V

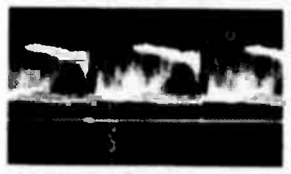
3-8V P-P V



4-2V P-P V



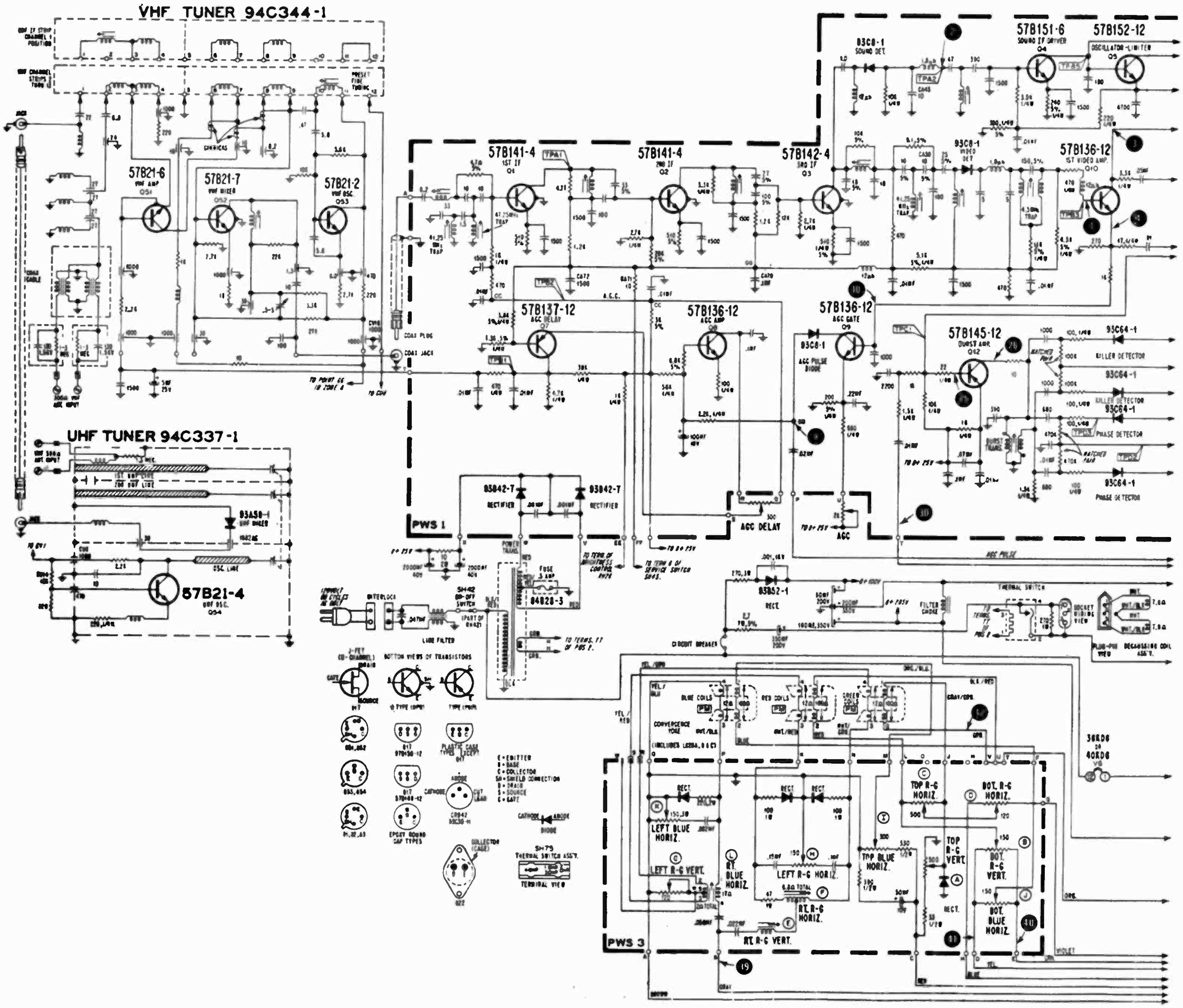
5-150V P-P V

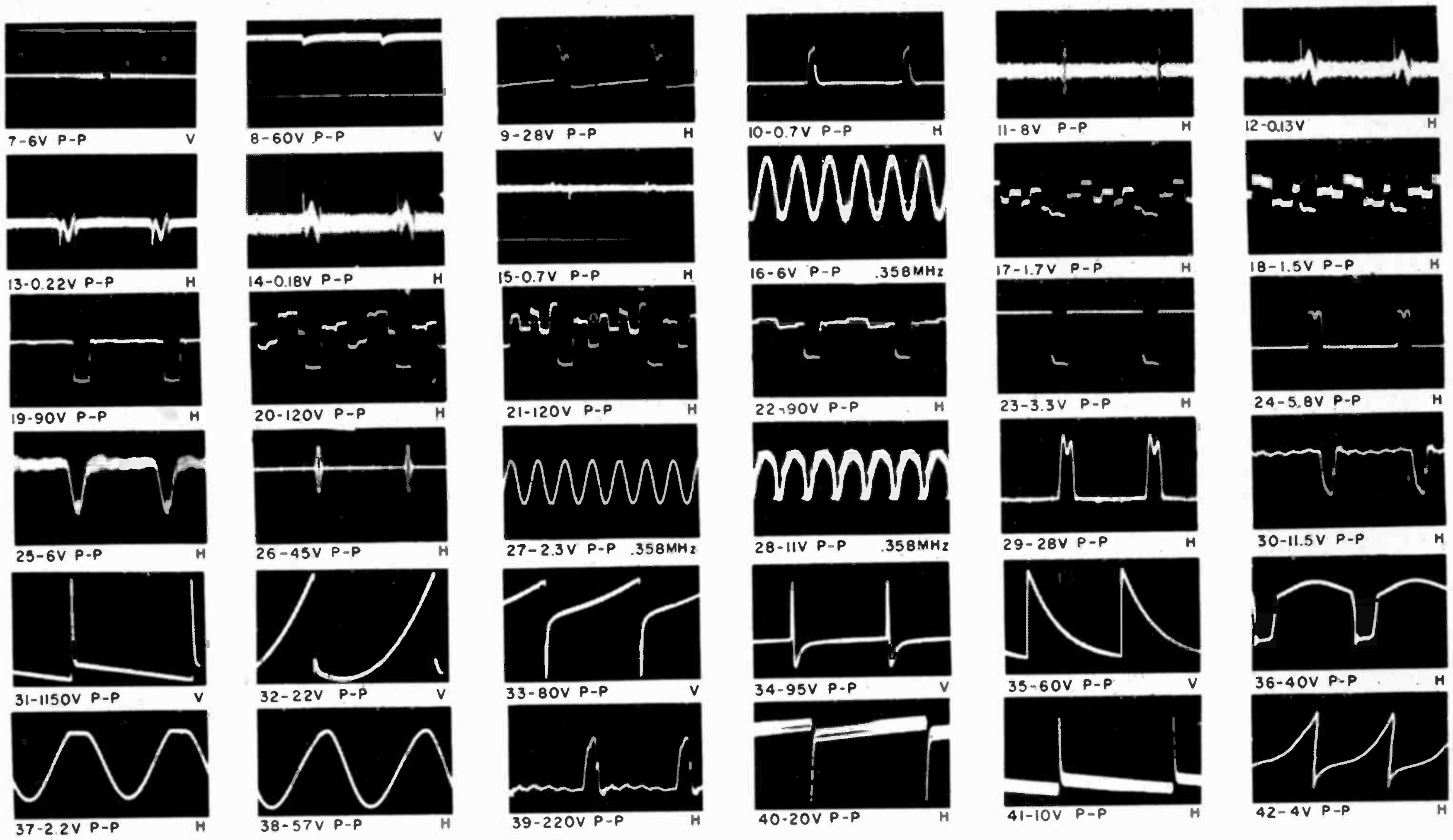


6-7V P-P V

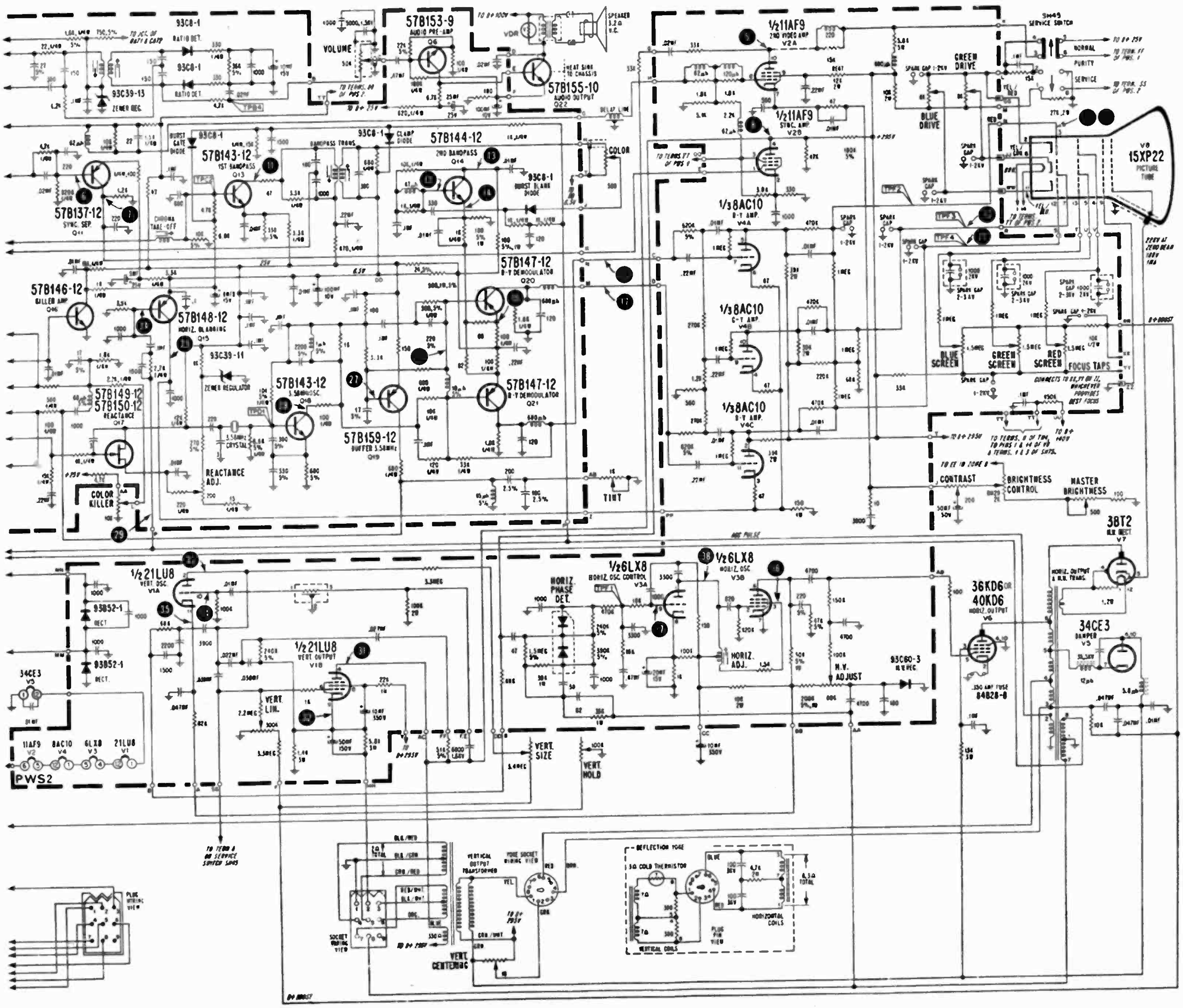
ADMIRAL K10-2A
COLOR-TV CIRCUIT

Chassis K10-2A is employed in Admiral's new 14-inch color-television receivers. There are four of these models that are currently available. These are designated as Models 4009P, 4010P, 4017P, and 4019P.





7-6V P-P V
8-60V P-P V
9-28V P-P H
10-0.7V P-P H
11-8V P-P H
12-0.13V H
13-0.22V P-P H
14-0.18V P-P H
15-0.7V P-P H
16-6V P-P .358MHz
17-1.7V P-P H
18-1.5V P-P H
19-90V P-P H
20-120V P-P H
21-120V P-P H
22-90V P-P H
23-3.3V P-P H
24-5.8V P-P H
25-6V P-P H
26-45V P-P H
27-2.3V P-P .358MHz
28-11V P-P .358MHz
29-28V P-P H
30-11.5V P-P H
31-1150V P-P V
32-22V P-P V
33-80V P-P V
34-95V P-P V
35-60V P-P V
36-40V P-P H
37-2.2V P-P H
38-57V P-P H
39-220V P-P H
40-20V P-P H
41-10V P-P H
42-4V P-P H



57B153-9
57B155-10
1/2 11AF9
1/2 11AF9
57B144-12
57B143-12
57B137-12
57B146-12
57B148-12
57B147-12
57B149-12
57B150-12
57B143-12
57B159-12
57B147-12
1/3 8AC10
1/3 8AC10
1/3 8AC10
15XP22
COLOR
TINT
COLOR KILLER
REACTANCE ADJ.
GREEN DRIVE
BLUE DRIVE
BLUE SCREEN
GREEN SCREEN
RED SCREEN
FOCUS TAPS
CONTRAST
BRIGHTNESS CONTROL
MASTER BRIGHTNESS
3BT2
1/2 21LU8
1/2 21LU8
1/2 6LX8
1/2 6LX8
36KD6 OR 40KD6
34CE3
34CE3
HORIZ PHASE DET.
HORIZ. ADJ.
H.V. ADJUST
VERT. LIN.
VERT. SIZE
VERT. HOLD
VERT. CENTERING
PWS2

Circuits to SIMPLIFY TUNING

Color-TV manufacturers are incorporating a number of special automatic circuits that make tuning simple and more accurate.

TV viewers should be instructed in the art of adjusting all the controls on their color sets. It's not quite as simple as tuning monochrome, but it isn't difficult, either. (See "How to Tune for Best TV Color" on page 46.) However, color-set manufacturers are doing more about it than just passing out better instruments. They are including circuits that aid the viewer in getting a better picture.

Fine Tuning Made Easy

Since the most misunderstood control—as far as color programs are concerned—is the fine tuning knob, the most useful aid in the modern color-TV receiver is the fine-tuning aid. Some versions only guide the viewer in setting fine tuning correctly. Typical of these are the fine-tuning indicators used by *General Electric* in the KD chassis, by *Philco* and *Andrea*, by *Motorola* in its transistor color-TV sets, and by *Westinghouse* and *Matsushita*. There are others, but these are examples of the different kinds.

All fine-tuning aids use one basic principle: tuning the receiver oscillator so that a precise 45.75-MHz video i.f. signal is produced. The diagram of the *G-E* tuning meter system in Fig. 1 shows how this principle is applied.

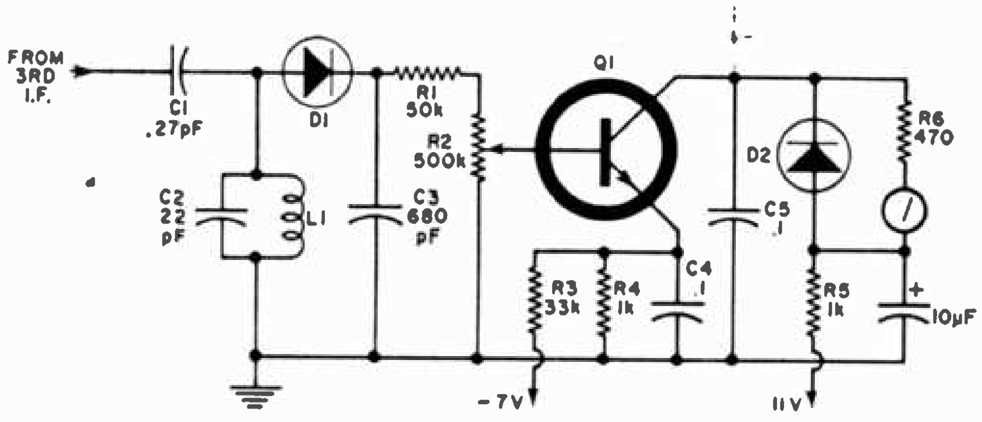
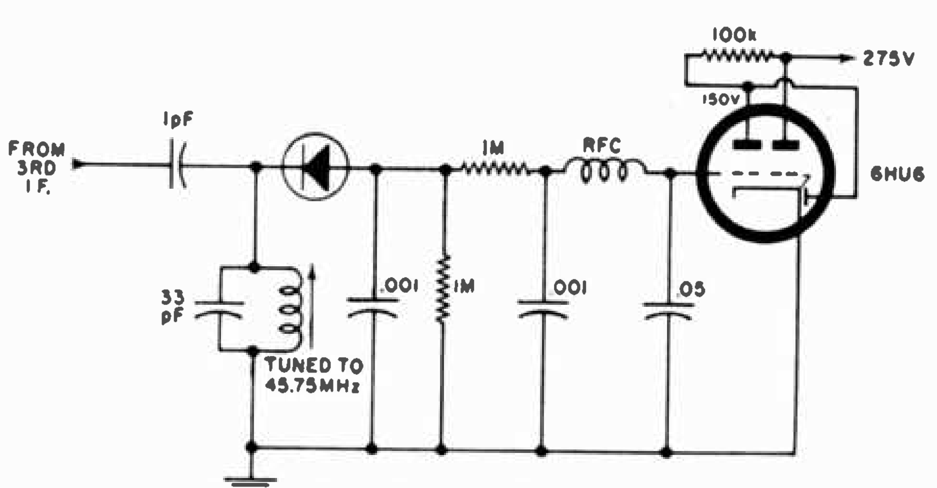


Fig. 1. Tuning meter circuit from a General Electric set.

Fig. 2. Target-ray tube used for tuning a Philco model.



A very small capacitor, *C*1, couples a sample signal from the third i.f. stage to a 45.75-MHz tuned circuit, *C*2-*L*1. Diode *D*1 rectifies the sample signal, and *R*2 feeds a certain amount of the resulting d.c. to the base of *Q*1, a d.c. amplifier. Conduction of *Q*1 determines how much current flows in the meter, which is in the collector circuit. As the fine-tuning control moves through the "best" 45.75-MHz point, the signal developed across tuned circuit *C*2-*L*1 goes through a peak. The resulting maximum of d.c. developed by *D*1 is passed on to *Q*1 and the meter registers a collector current peak. *C*3, *C*4, and *C*5 help keep the video signal from reaching the meter and making it "wiggle" with changes in scene brightness. Diode *D*2 damps the meter, making it easy for the viewer to see a true peak.

A meter isn't always necessary to show when the receiver oscillator is producing an accurate 45.75-MHz i.f. In some *Philco* and *Andrea* chassis, a tuning "bar" indicator is used—somewhat reminiscent of the tuning "eye" found in older radios. The main difference is the indicator tube, which instead of an "eye" target uses a shadow-bar target. The *Philco* circuit is shown in Fig. 2.

Again, a tuned circuit senses when the most 45.75-MHz signal is being produced by the tuner. The signal is rectified and filtered and the resulting d.c. applied to an indicator—in this case, a 6HU6 shadow-bar tube. The face of the indicator is aglow, except for a wide "bar" in the center. The bar closes up—becomes narrower—when the fine-tuning control is rotated through the position that peaks the video i.f. signal. It is at this point that most d.c. voltage is applied to the tube's input or control grid. Since maximum d.c. is developed when the oscillator fine tuning is creating the most 45.75-MHz signal, the narrowest bar occurs at the point where the best color signal can be received.

Another approach is used in some *Motorolas*. A light on the front panel of the set shows when fine tuning has drifted away from its best setting. If the lamp is out, the set is tuned in okay. If it glows, that tells the viewer the fine-tuning control needs resetting.

The manner of triggering the lamp is similar to the way the tuning meters operate. A 45.75-MHz tuned circuit and a transistor work exactly as with the *G-E* system already described. The d.c. "peak" is coupled, instead of to a meter, to a switching transistor that extinguishes the lamp when the set is fine-tuned for maximum 45.75-MHz i.f. signal.

The picture tube is used as the indicator in *Westinghouse* and *Matsushita* tuning aids. Both show similar indications, but the manner of generating them is different, and the patterns produced are not exactly alike. The *Matsushita* tuning-aid pattern is a wide vertical bar on the picture-tube screen; it narrows when the fine tuning is set correctly. The *Westinghouse* pattern consists of two vertical bars on the CRT screen, one of which moves back and forth as the fine-tuning control is rotated; when the two bars blend into one, the tuner is set for best color reception.

Producing the *Westinghouse* indicator pattern is more complicated than any of the others. Fig. 3 will help you understand how it is done. One of the vertical lines, the stationary one, is produced by "marking" the midpoint of each line during one vertical field; thus, 262 of the raster lines carry the video pip that produces the stationary vertical line which serves as the tuning reference. Its position on the screen is determined by a fixed d.c. reference voltage.

The movable tuning line is the result of video pips on the other 262 lines, during the alternate vertical field. Its position is determined by a voltage from the detector circuits, which sense the frequency of the i.f.—45.75-MHz when the oscillator is tuned correctly.

The detector circuits aren't as simple as those in other fine-tuning aids, either. Instead of sensing the peak, the system senses when the 45.75-MHz signal is at a particular point on the *slope* of the detector curve. The first peak detector uses the strength of the video signal to counteract effects of weak signals which might otherwise produce false indications from the slope detector.

The output of the slope detector is a steady video signal whose strength depends on correct tuning. The second peak detector rectifies that signal and produces a d.c. voltage that sets the position of the movable video pips on each alternate horizontal line of the raster.

Easiest of all, of course, from the viewer's standpoint, is the completely automatic fine-tuning circuit, the a.f.t. There are several of them in the new lines of color receivers.

Their operation is based on two things: a 45.75-MHz sensing circuit very much like those used for manual fine-tuning indication; and a tuner whose tuning can be affected by a d.c. control voltage developed in the sensing circuit. Basically, an automatic fine-tuning circuit senses when the local oscillator drifts off frequency enough to reduce the 45.75-MHz signal, then produces a d.c. correction voltage which is applied to the tuner to pull the oscillator back on frequency.

Fig. 4 shows the system in simplified block form. Tubes have been used in some models, although most recent versions use transistors. You'll even find integrated circuits in the a.f.t. stages of a few models—notably *Clairtone*, *RCA*, and *Zenith*. Most models apply a.f.t. to both u.h.f. and v.h.f. tuners. A backward-biased capacitance diode completes the tuning circuit in the oscillator. The d.c. correction voltage from the a.f.t. discriminator shifts

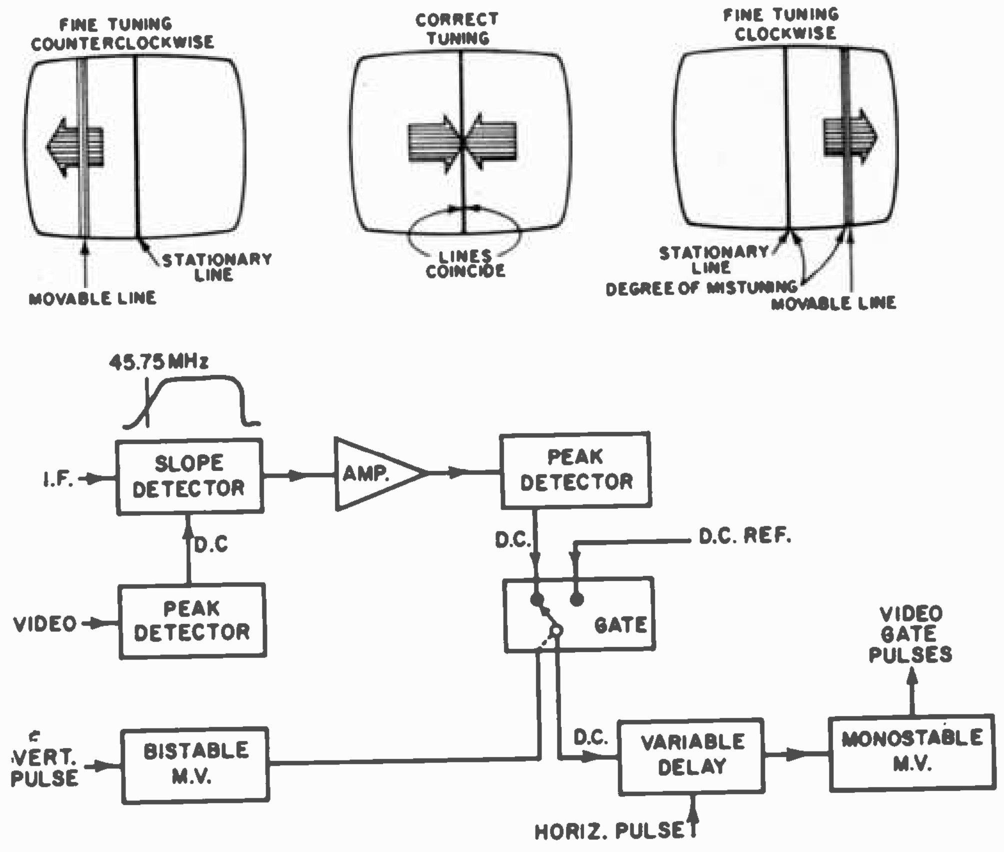


Fig. 3. Westinghouse fine-tuning indicator is probably the most complicated; uses vertical lines on tube screen.

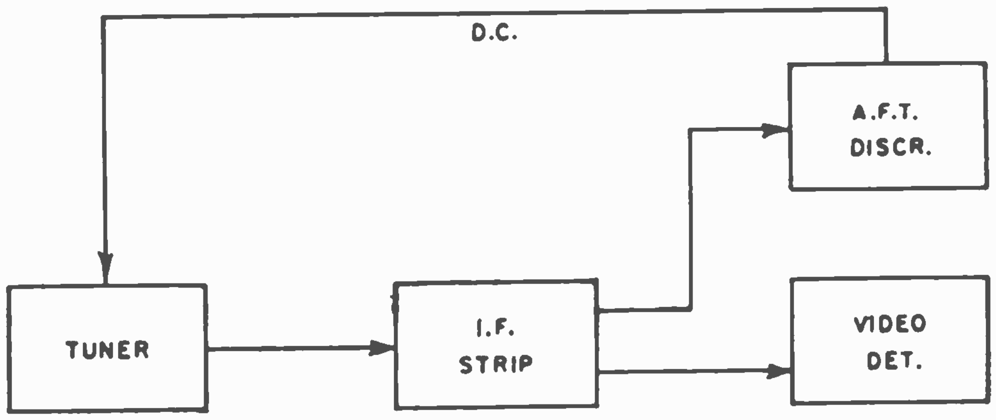


Fig. 4. Closed loop forms automatic fine-tuning system.

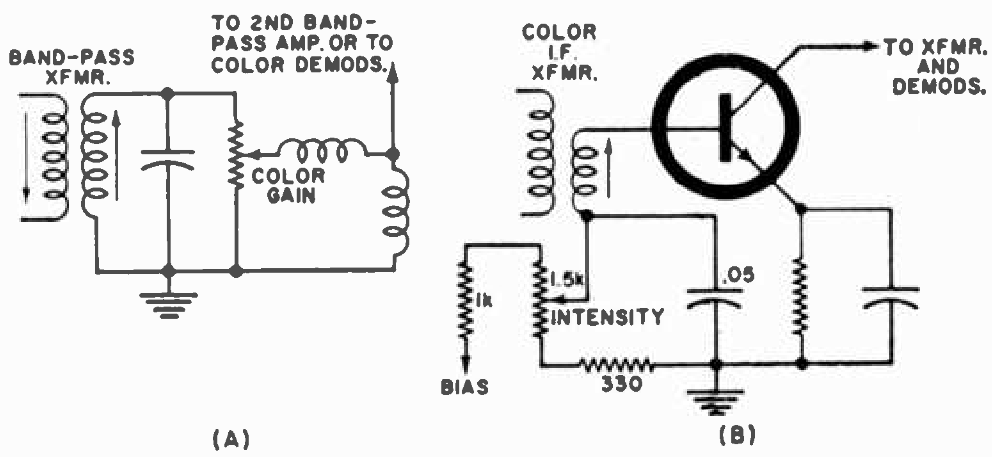
the capacitance in whatever direction is needed to bring the oscillator back to correct frequency so a precise 45.75-MHz video i.f. is produced.

Color and Hue Controls

Color reception depends on more than just accurate fine tuning. There are other controls that must be set correctly. More and more, manufacturers are developing circuits to make it easier for viewers to regulate these other color controls.

For example, consider chroma controls—usually labeled Color on the front panel of color-TV receivers. Their place and function in the circuit have been much the same for some time. If you've seen many color-TV sets, you're already familiar with the

Fig. 5. Typical color controls. (A) Most popular one acts like a color "volume control". (B) One that controls bias.



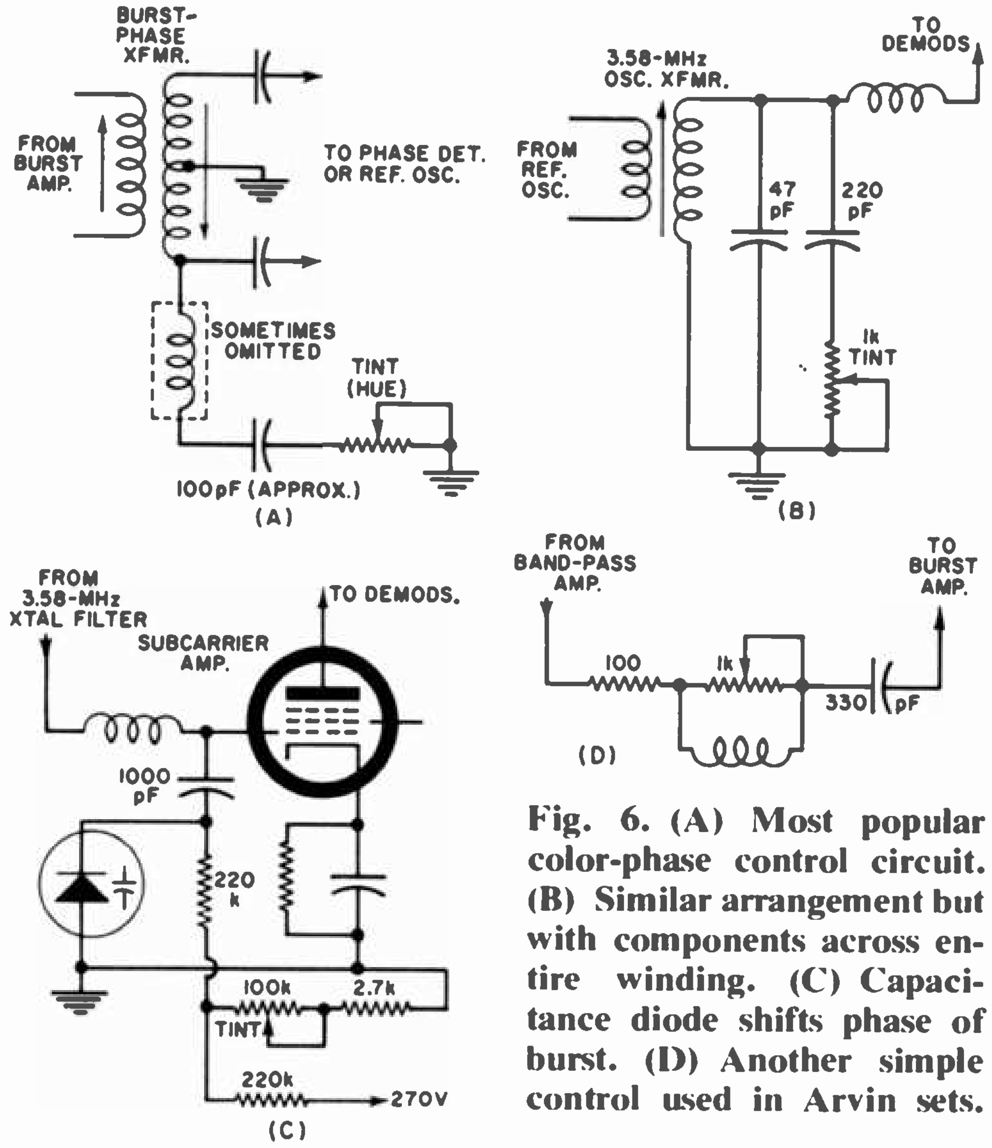


Fig. 6. (A) Most popular color-phase control circuit. (B) Similar arrangement but with components across entire winding. (C) Capacitance diode shifts phase of burst. (D) Another simple control used in Arvin sets.

popular arrangement in Fig. 5A. The control is merely a "volume control" following one band-pass amplifier (color i.f.; *Motorola* calls it). In some models, another band-pass amplifier follows the control; in others, the demodulators.

Motorola, which calls this control the Intensity control, places it in the cathode circuit of one color i.f. (band-pass) amplifier, a cathode-follower that drives the following stage. In the new *Motorola* transistor color receiver, the Intensity control is a potentiometer that sets the d.c. bias of one color i.f. amplifier (Fig. 5B). *Zenith*, in a tube model, also uses a bias-control pot for controlling chroma gain; it is placed in the cathode circuit of one band-pass amplifier (which the *Zenith* schematic calls a *color amplifier*).

Phase controls, too, aren't much different from those in use several years ago, although there is a wider variety of circuit schemes. The basic purpose of the Hue or Tint control is, ultimately, to affect the phase of the subcarrier re-insertion signal (3.58-MHz) fed to the demodulators, which affects the angle of demodulation and thus the hue of the signals applied to the CRT guns. This can be done by altering the phase of the color-sync (burst) signal before it reaches the reference oscillator, or by altering the phase of the reference signal after it is generated but before it reaches the demodulators. Both methods are used, but the first is the more popular.

The basic phase-control arrangement in Fig. 6A is common to *Clairtone, Hoffman, Magnavox, Motorola, Packard Bell, Philco, Setchell Carlson*, and *Zenith*. In some of them, only the capacitor is used, without the extra inductance; in *Zenith*, only a potentiometer is used. Varying the potentiometer setting increases or decreases the effect of the capacitor (or coil-capacitor) across one winding of the burst transformer, shifting the phase of the burst signal that is passed on to the phase detector. This, in turn, controls the reference oscillator phase. In the *Zenith*, the pot alone merely unbalances the winding and thus alters phase.

A similar arrangement, except that it is in the reference-oscillator output transformer circuit, is used in *Admiral* and many *RCA* models (Fig. 6B). The pot and capacitor are across the winding, but also interact with the inductance that follows.

One recent *G-E* model uses something entirely different, although its purpose and result are the same. Fig. 6C shows the arrangement. A biasing potentiometer varies bias on a Varicap diode in the special subcarrier amplifier circuit that *G-E* uses instead of the more common controlled oscillator. The stage amplifies the incoming 3.58-MHz burst, which arrives through a 3.58-MHz quartz-crystal filter, then feeds its phase-locked output to the demodulators. The variable-capacitance diode controls the phase of that output, depending on the bias set for it by the potentiometer.

Recent *Arvin* sets are different, too. Phase is controlled in them by the very simple device shown in Fig. 6D—a coil-capacitor combination, in series, preceding the burst amplifier. A potentiometer across the coil is the means for varying the phase shift introduced by the network. Simple, but effective.

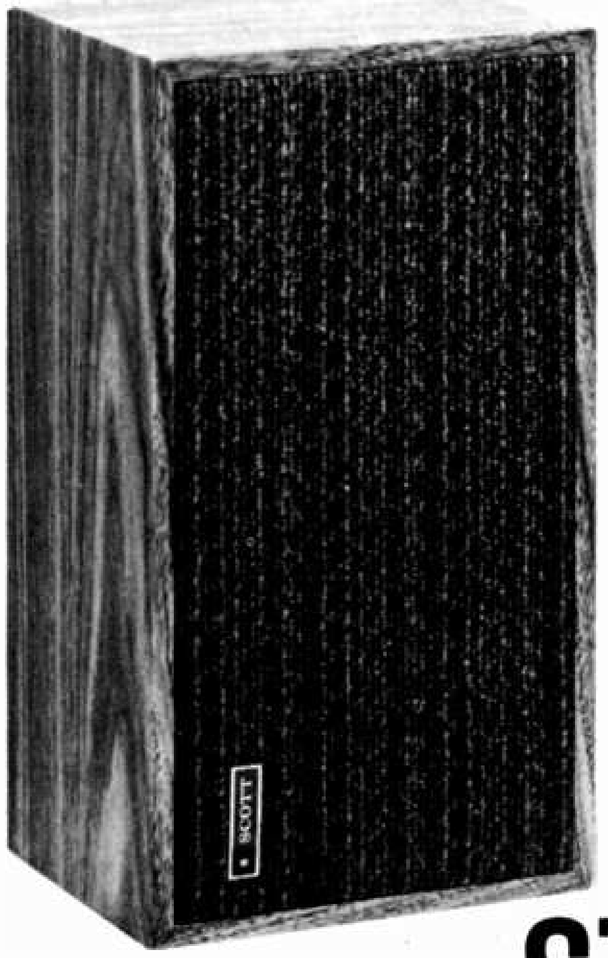
There are minor variations of these Color and Hue controls from model to model, but most resemble one of those already discussed.

Improvements to Expect

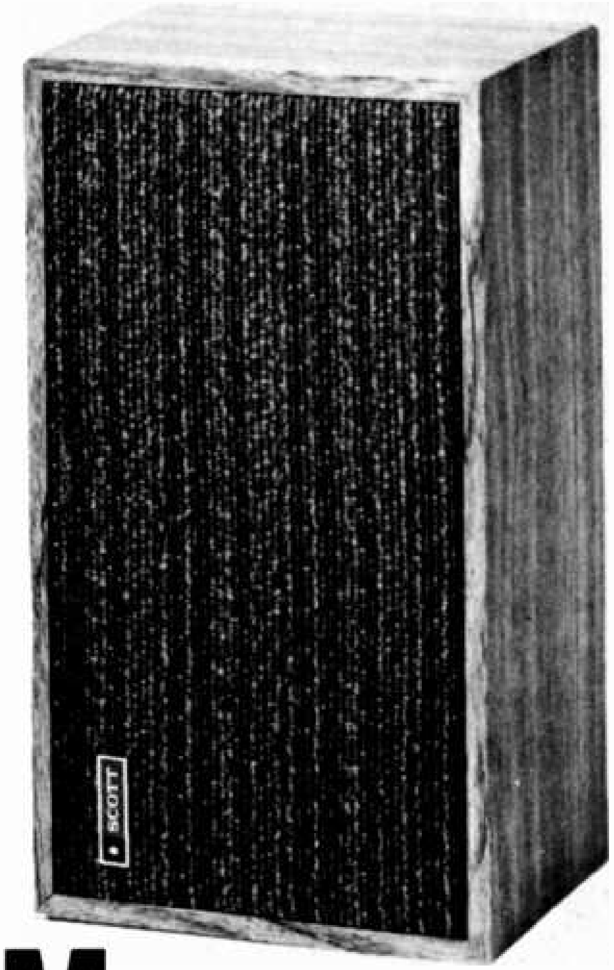
Just as they have developed automatic fine-tuning circuits, color-set manufacturers are trying for similar improvements in the chroma and phase circuits. There is already an *automatic color control* (a.c.c.), a sort of "a.g.c." for the band-pass amplifiers. If the color signal weakens, the gain is raised slightly; if it becomes too strong, making colors on the screen too harsh, the gain is reduced by the a.c.c. circuit. This levels out any fluctuations in color that might occur because of changes in signal level elsewhere in the receiver.

The color-sync section of the color receiver is often labeled the *automatic frequency and phase control* (a.f.p.c.), or simply *automatic phase control* (a.p.c.). However, these circuits are not fully automatic, either. That is, they cannot make up for the incorrect hues that appear on the screen when a color-program scene shifts to a commercial, or the hue change that occurs when the viewer changes stations. That adjustment must still be made manually.

Manufacturers are working on such improvements, though. It is merely a matter of time before even these difficult design problems will be overcome. Then, the entire task of tuning in a good color picture will be taken over by the circuits inside the receiver, leaving the set-owner free to do nothing but sit back and enjoy the shows. ▲



ADDING REMOTE SPEAKERS TO YOUR STEREO SYSTEM



By VICTOR BROCINER / Assistant to the President, H. H. Scott, Inc.

If a few simple precautions are observed, additional speakers can readily be added to either tube or transistor stereo amps.

ELECT. HANDBOOK-1969-OP12-113-128

WE HAVE become so used to the conveniences of our constant-voltage power line, into which one may plug household appliances almost at will, that it is sometimes difficult to remember that the output of a high-fidelity amplifier must be treated somewhat differently. Even in the case of the power line, one has to be careful not to plug in too many appliances, or the fuse will blow. A similar precaution must be exercised when connecting multiple loudspeakers to amplifiers, with the difference that in the case of solid-state amplifiers it can be the power transistors that blow instead of the fuse. However, if a few simple precautions are observed, no problems need arise.

Why is total available power not the only thing that needs to be taken into consideration when adding speakers to a hi-fi installation? One reason is that while the power line operates at a nearly constant voltage, the output of an amplifier fluctuates over a tremendous range from moment to moment as the audio signal varies, and the limits between which the output fluctuates are also variable depending upon the setting of the volume control. This is why it is not feasible to rate the loads (the speakers) in terms of power consumed or current drawn and why the concept of impedance comes into the picture.

The impedance of a circuit is equal to the voltage across the circuit divided by the current through the circuit: $Z = E/I$. When this is rearranged as follows: $I = E/Z$, it becomes a little clearer that impedance is the current-determining element for a given applied voltage, and in the case of amplifiers it is the current drawn by the loudspeaker load that we are concerned about. The internal heating in the power devices of an amplifier increases rapidly as the current drawn from them goes up. Of course, there is a point beyond which this heat damages the device. In the case of tubes, reasonably short periods of overload may cause the plates and screens of the tubes to glow red hot, but the tubes can recover from this. With solid-state devices the allowable time for an extreme overload may be on the order of microseconds.

There is an additional difference between the behavior of tube and solid-state amplifiers that is inherent in their design. With any output device, the power output varies as the load impedance is varied. At zero impedance the power output is obviously zero, as it is at infinite impedance. As the impedance is increased from zero value, the power output increases to a maximum and then decreases. Maximum power output is delivered when the load impedance is equal to the internal impedance of the amplifier. For impedance values near this optimum, the variation in power output is relatively small.

Tube amplifiers are designed to produce maximum power into a load whose value is somewhere near the optimum impedance, and the matching is done

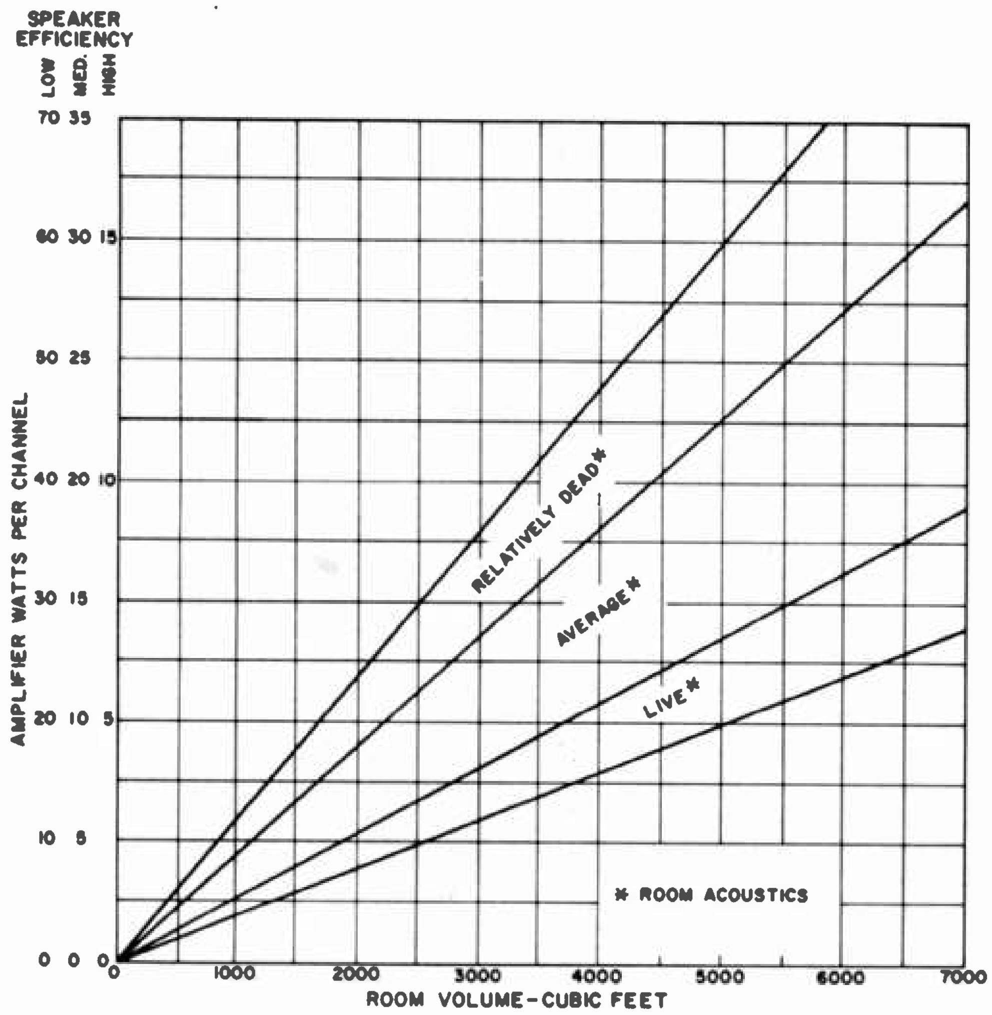
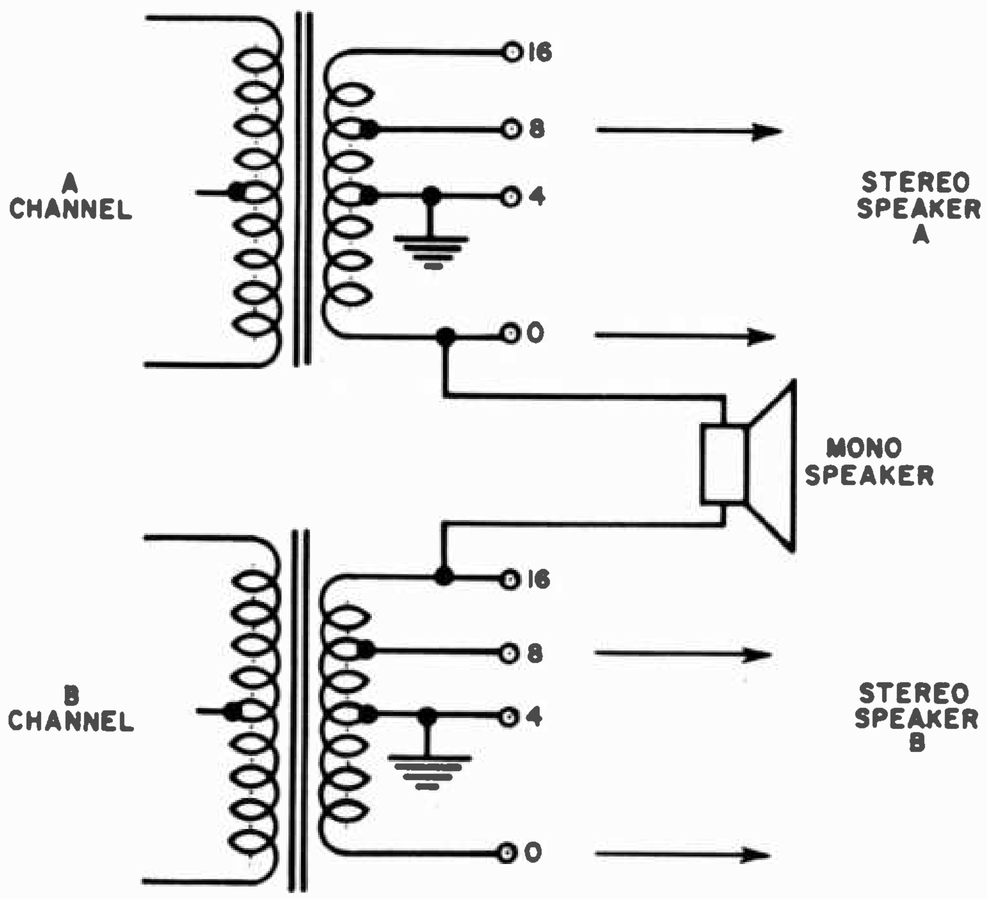


Fig. 1. Continuous power requirements for various room sizes and acoustics, for speaker systems of different efficiencies. In general, completely closed acoustic-suspension systems are fairly low in efficiency while closed and ported enclosures using efficient speakers are fairly high in efficiency. If most listening is at very high levels, somewhat more power is needed, at low levels, less power is needed.

by means of taps on an output transformer. With transistor amplifiers the internal impedance of the amplifier is so low that if a matching impedance were used to obtain maximum power, the current drawn from the transistors would be far in excess of their maximum capability. Consequently transistor amplifiers are designed to operate into impedances considerably higher than the optimum impedance;

Fig. 2. Method of connecting remote mono speaker to amplifier using center-tap-grounded output transformers. Stereo speakers are connected to impedance taps having half nominal impedances of the speakers used.



furthermore, since they are almost invariably output-transformerless, the power delivered is determined by the value of the load impedance and there is nothing one can do about it.

Suppose that a solid-state amplifier is designed to deliver its rated power into a 4-ohm load. If it is well-designed, the current drawn by this load will be such as to keep the internal heat dissipation in the output devices appreciably below their maximum. However, the safety margin is not made so great that a 2-ohm load, for example, which would draw double the current of the rated load, would be safe. Fuses do not act quickly enough to protect against the effects of extremely brief overloads. Electronic protective circuits may do so, but they add considerably to the cost of the amplifier if they are designed to provide adequate protection. Even when the danger of damage to the power transistors is small—and today's solid-state amplifiers are remarkably rugged—there is another factor that must be taken into account: distortion. Operating a solid-state amplifier into a load impedance lower than the rated value results in increased distortion,—and not only at very high power; the performance is deteriorated even at ordinary listening levels. Hence, with transistor amplifiers especially, it is important to keep the load impedance equal to or greater than the rated value.

Assume now that we want to connect one or more sets of loudspeakers to a hi-fi system, with the thought of operating more than one at one time. How shall we proceed?

Amount of Power Required

When a number of speakers are operated from the same amplifier, the power output of the amplifier is shared among them. This limits the number of speakers that can be operated from a given amplifier, depending on the levels at which they are to be operated. If an amplifier is just adequate to provide the desired levels in the main listening room, it will not be able to provide full room volume in an additional room as well. On the other hand, if the remote installation is intended to provide soft background music only, the arrangement will be quite acceptable.

In making judgments of the adequacy of the power available, it should be kept in mind that doubling the power output, or increasing it by 3 dB, does not double the loudness. A 7-10 dB power increase, the exact amount depending on the nature of the program material, is required to double loudness. Looking at it the other way, halving the power results in a noticeable but not pronounced change in loudness. Halving the *loudness* involves a decrease in power of $^1/_5$ to $^1/_{10}$. Of course this information has to be applied with a certain amount of judgment; otherwise it might well lead to the connection of 50 additional speakers, based on the argument that each speaker that is added results in an only slightly noticeable decrease in loudness!

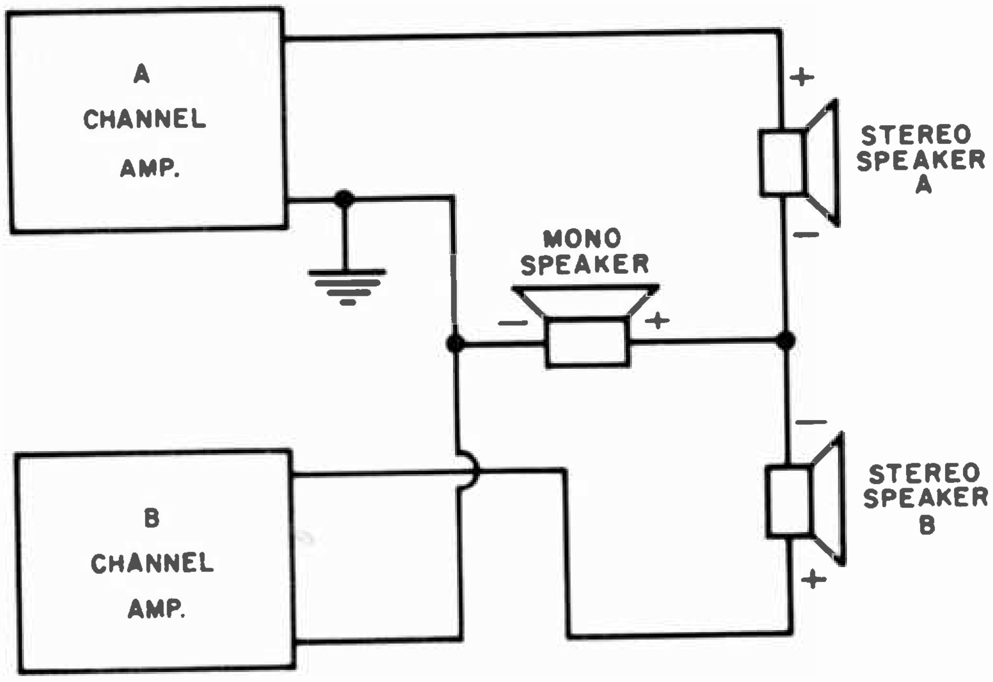


Fig. 3. Novel method of obtaining center mono channel. Special network ahead of amps maintains separation.

The amount of amplifier power required in an average living room depends, among other things, on the efficiency of the loudspeakers used. A guide to power requirements is given in Fig. 1. From this chart it is easy to determine the power requirements for each speaker station, and from this to find the total power required. If all of the loudspeakers are not going to be used simultaneously at any time, the power should be determined for the combination requiring the greatest total power.

Remote Speakers: Stereo or Mono

If stereo reproduction is desired wherever additional speakers are installed, each installation requires a pair of speakers for the two stereo channels. If monophonic reproduction is desired, things are a little less simple. Connecting a speaker to only one of the channels is obviously not a good solution. It is necessary to obtain the sum of the left and right channels in some manner to recover the monophonic program content. Many amplifiers have a low-level center-channel output connection which provides such a signal. While originally intended primarily to provide a center channel for wide-spread stereo using three speakers, it is eminently suited to the purpose we have in mind. This connection provides sufficient voltage to drive a separate power amplifier for the remote speakers.

Where sufficient power is obtainable from the main amplifier, it is of course far more convenient to use an arrangement which does not require an additional power amplifier. Bridging speakers across the respective outputs of the left- and right-channel amplifiers is not a satisfactory solution because, among other things, this provides a *difference* rather than a *sum* signal. Nor is it possible to remedy this by reversing the output of one of the channels because they have a common internal ground connection.

Some tube amplifiers had their transformers' secondaries grounded at a center-tap instead of at the end of the winding. With this arrangement it is possible to connect a speaker to obtain the full monophonic signal, as illustrated in Fig. 2.

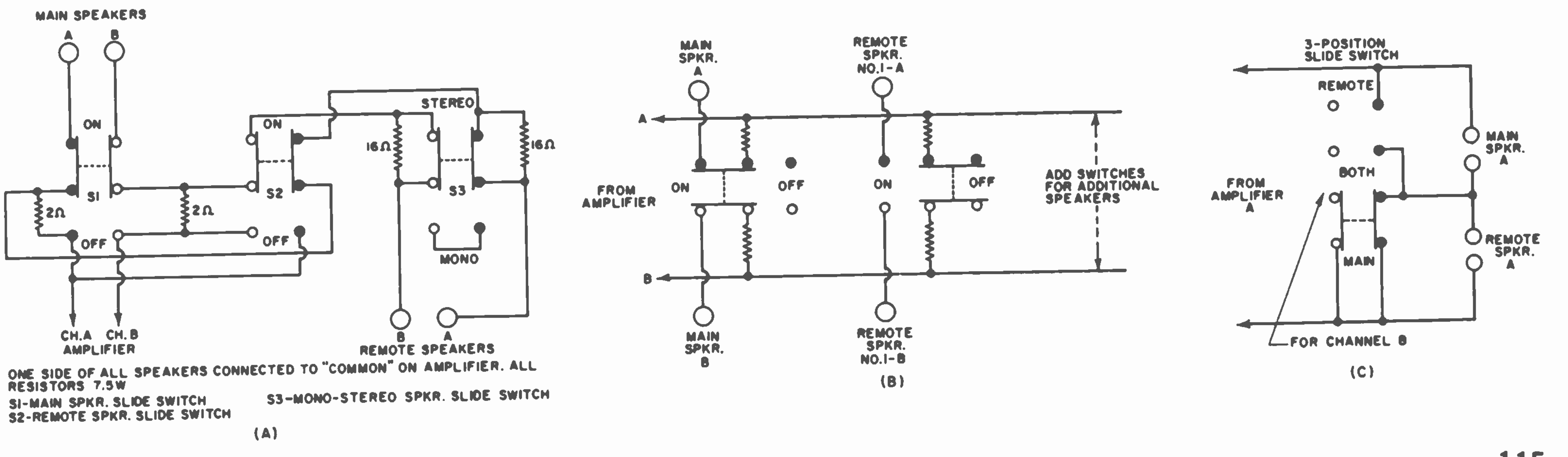
A novel system for obtaining a center channel is shown in Fig. 3. The part of the circuit illustrated, if used alone, has a detrimental effect on the separation of the stereo channels. In practice, a special input network is used ahead of the two channels of the amplifier to compensate for this.

A very simple and convenient provision for obtaining a powered monophonic channel is embodied in *H. H. Scott* amplifiers and receivers (Fig. 4A). The remote speakers are connected directly to the amplifier terminals marked "Remote" and switch S3 set to "Mono." For amplifiers not equipped with such conveniences, it is possible to use a high quality 1:1 transformer to reverse phase, as shown in Fig. 5A. For those who do not wish to go to the expense and trouble of using a transformer and are willing to tolerate a 6-dB loss in level when using a single remote 8-ohm loudspeaker, the circuit of Fig. 5B offers a simple solution.

Impedance Matching

Although the term "matching" has been used in this section heading in accordance with common practice, it should be pointed out that it is not really matching at all that we are concerned with, but rather the connection of the correct value of total load impedance to the amplifier. Tube amplifiers generally offer a choice of transformer taps for 4-, 8-, and 16-ohm loads. As already mentioned, this flexibility is not provided on modern solid-state

Fig. 4. Various switching circuits which may be used to operate remote loudspeaker systems.



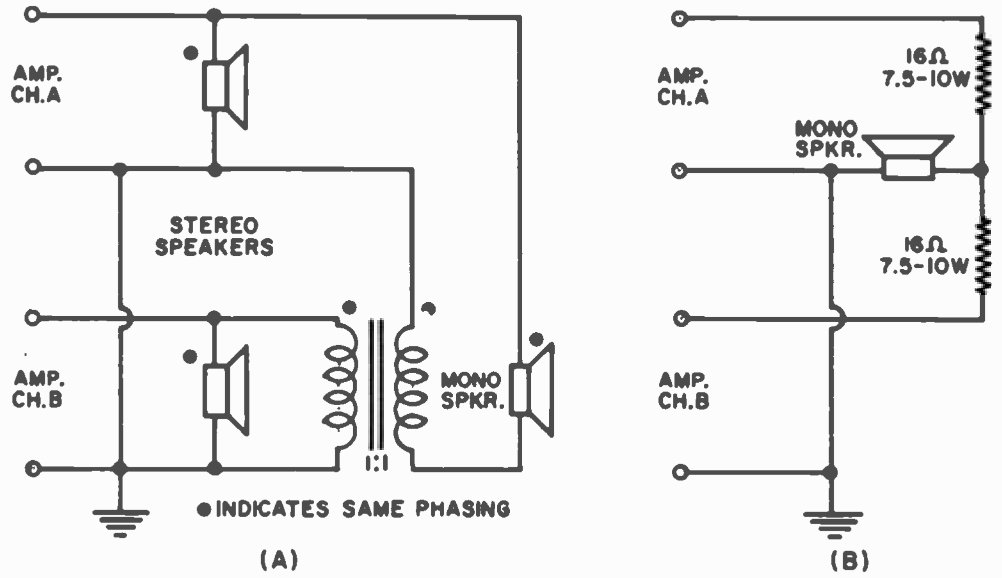
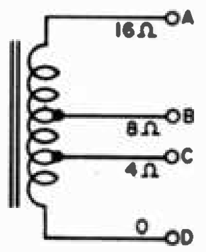


Fig. 5. (A) Using 1:1 transformer to power remote mono speaker. (B) Simple circuit but with 6-dB power loss.



AMPLIFIER		SPEAKER(S)	
CONNECT TO	FOR LOAD VALUE	IMPEDANCE	CONNECT TO
B–D	8Ω	16Ω	A–D
B–D	"	4Ω	C–D
A–D	"	2Ω	C–D
B–D	"	1.44Ω	A–B
B–D	"	.64Ω	B–C
A–D	"	.32Ω	B–C
B–D	4Ω	8Ω	A–D
B–D	"	2Ω	C–D
A–D	"	1Ω	C–D
B–D	"	.72Ω	A–B
B–D	"	.32Ω	B–C
A–D	"	.16Ω	B–C

Fig. 6. Using transformer secondary taps for matching.

amplifiers; consequently additional speakers must be connected in such a way as not to present a total load impedance of less than the minimum value specified for the amplifier being used. Since hi-fi loudspeakers are made with impedances of 4, 8, and 16 ohms, depending on the model and manufacturer, and since most solid-state amplifiers have a minimum specification of 4 ohms for load impedance: (1) up to four 16-ohm speakers may be used in parallel, (2) two 8-ohm speakers may be used in parallel, but (3) multiple 4-ohm speakers represent a problem.

If speakers of different impedances are paralleled, the resulting impedance can be found from the formula: $Z_{TOT} = Z_1 Z_2 / (Z_1 + Z_2)$.

When using a combination of speakers which present an unacceptably low value of impedance when paralleled, one is tempted to consider putting the speakers in series so that their impedances add. This is permissible provided the speakers are identical—and this means identical not only in impedance, but in all respects. With dissimilar speakers, interaction takes place between the two speakers, resulting in deteriorated performance for both. The same consideration also holds true, of course, for series-parallel arrangements.

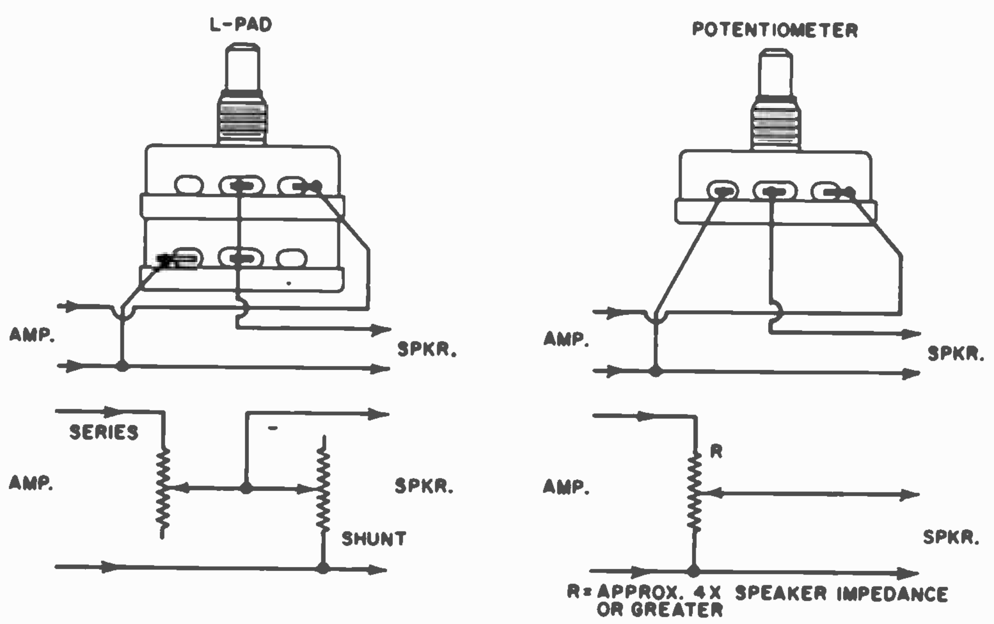
To avoid the problem presented by speaker combinations that would result in too low an impedance, as in case (3) above, one can resort to a transformer. Fig. 6 shows the large number of impedance transformations that can be obtained with a 0-4-8-16-ohm transformer. A high-quality output transformer designed for tube amplifiers can be used for this purpose, provided care is taken to cut off and insulate the high-impedance primary winding connections.

Switching of Speakers

Most of today's receivers and amplifiers are provided with terminals for extra speakers and some form of front-panel switching. The more elaborate units provide switching to permit changing from the main to the remote speakers and also to operate both at the same time. A series resistor is usually switched into the circuit when both sets of speakers are in operation to permit using 4-ohm speakers for both main and remote positions. This protects the amplifier against possible overload; it also results in a loss of total power available, usually on the order of 6 dB, plus a reduction of damping factor to around 1. These effects are proportionally less with speakers of higher impedance. The decreased damping factor results in a slight exaggeration of the very deep bass with low-efficiency speakers. The loss in power is unfortunate, especially since it takes place when extra power is needed for the operation of the extra speaker system, but this is the penalty one pays for using low-impedance speakers without provisions for matching.

If switching is not provided in the amplifier or if the switching that is present does not include operation of both sets of speakers simultaneously, the circuit of Fig. 4A can be incorporated into a separate switch box and connected between the standard amplifier output terminals and the speakers. The third switch, and associated resistors, for stereo-mono operation, may be omitted if desired. Slide switches rated at 2 amperes or more are satisfactory. If the total load presented by all the speakers that are going to be operating at the same time is no lower than the minimum value specified for the amplifier, the protective resistors may be omitted.

Fig. 7. Connections of L-pad and potentiometer in order to control the volume of sound of remote speaker.



If more than one set of additional speakers are to be used, all of them can be wired in parallel to the "remote" terminals, unless they are to be independently controlled by switches. In this case, a series of double-pole switches, wired as shown in Fig. 4B, is the simplest arrangement. If the load presented by all the speakers in parallel is too low, individual resistors should be used in series with all the speakers. If the main speaker impedance is appreciably greater than the recommended minimum, it need not have a series resistor. Circuits to switch these resistors in and out as needed would be excessively complicated.

When two speakers are operated in series, the switch can be connected most simply to short out the unwanted speaker (Fig. 4C).

Operating Levels and Controls

Since modern amplifiers are essentially constant-voltage devices, the same voltage is applied to all speakers operated in parallel. The power fed to a given speaker is inversely proportional to its impedance, while its output is directly proportional to its efficiency. For example, if an 8-ohm and a 16-ohm speaker of equal efficiency are paralleled, the 8-ohm speaker receives twice as much power as the 16-ohm speaker. When series resistors are incorporated into the amplifier, the effect is to reduce the discrepancy. In the circuit previously described for monophonic operation of remote speakers (Fig. 5B), there is a loss of about 9 dB for a 4-ohm speaker, 6 dB for an 8-ohm speaker, and 2 dB for a 16-ohm speaker. The 6-dB loss, incidentally, is desirable when the additional speaker is operated as a center-channel speaker for stereo reproduction.

Fig. 7 illustrates two methods of individual volume control for remote speakers. The L-pad is the more elaborate and expensive of the two, but it offers the advantages of little or no loss of power when set to maximum, proper impedance load seen by the amplifier, and preservation of a high damping factor. The potentiometer uses up some of the available power even when set to a maximum (about ⅓) and reduces the damping factor to a value of 1 at 50% of full rotation. A really elegant but expensive method is to use a small (0.5-ampere) variable transformer as a level control. Individual controls for all speakers provide means for balancing each stereo pair.

When using local controls, care should be exercised to avoid operating them at an unnecessarily low setting, with the amplifier volume control turned up high. This wastes power and increases distortion.

Power ratings on controls need not be as high as one might think. Heating in the controls is determined by the relatively long-term power dissipated. The average power, even of highly compressed program material, is well below 10% of the amplifier rating. Consequently, a control rating of 10% of the power fed to the speaker is satisfactory. This means 2-5 watts in most applications. ▲

New Solid-State COLOR-BAR GENERATORS

Improved stability, more reliability, longer life, cooler operation, light weight, and portability are the direct result of using transistors and IC's in a new generation of color-bar generators. Here is a complete directory of what's available, along with how the various units operate and compare.

TRANSISTORS are supplanting tubes in most home-electronics test equipment. Improved manufacturing control has eliminated much of the nonuniformity among transistors of identical types, making it possible to build predictable circuit designs; formerly a working prototype didn't necessarily mean that the production model would perform consistently. New types of transistors, too—notably MOSFET and unijunction types—have opened other avenues of approach to some of the design problems inherent in solid-state test equipment.

Perhaps the one instrument which has benefited the most from this trend to transistorization is the color-bar generator. A unit that the service technician can carry into the home for convergence adjustments is the one that pays for itself the soonest. The size and weight advantages of solid-state design are part of the answer.

Early transistor color-bar generators suffered from instability. It was difficult to keep the patterns steady on the screen of a color receiver. There are models still around that have this problem. The counting (divider) circuits keep jumping off-frequency—down-counting by some unwanted factor instead of by the intended one. Some designers include controls to allow the operator to reset the counter's dividing frequencies—occasionally on the front panel with a knob, but usually at the rear or side as a screwdriver adjustment.

Changes in the temperature around the transistors is the chief factor contributing to this instability, and therefore some designers have tried to control that environment. Other solutions for unsteady patterns include temperature-compensation in the circuits themselves. And there is the idea of designing a circuit so stable that parameter changes in the transistors can't cause a frequency shift in the divider.

All these approaches are used in recent solid-state color-bar generators. As a result, most modern color-bar generators can put a stable pattern on the screen within a reasonable (15-minute) warmup, even from a below-freezing start. That's important to the home-call service technician.

Knowing how an instrument works often helps in understanding where and how to use it. The major applications are, of course, obvious, but the finer techniques that distinguish the expert from the mechanic are often the result of familiarity with the instrument. So, first, take a brief look inside a typical color-bar generator.

What's In Them

The principal use of a color-bar generator in the home has little to do with color reception, oddly enough. Its video patterns are used for convergence. They are: thin vertical lines, thin horizontal lines, crosshatch containing both, and dots (formed at the intersections of the crosshatch and displayed without the lines). Some generators add special video displays.

The color bars themselves are seldom used outside the service shop. There, they make a good tool for analy-

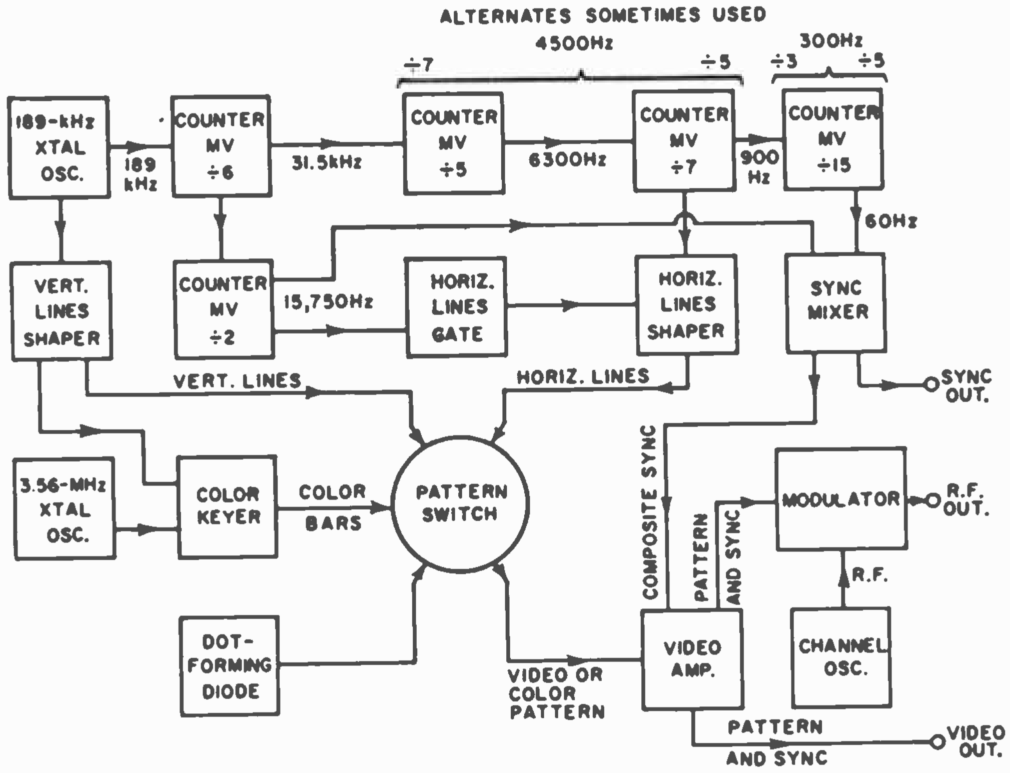


Fig. 1. The basic operating blocks of most color-bar signal generators.

zing operation and adjustment of the chroma section in color receivers. Teamed up with an oscilloscope, the color generator is the focal instrument for troubleshooting color stages in a set.

Fig. 1 illustrates how the various patterns are typically produced. The video patterns and the sync pulses are initiated by a 189-kHz crystal oscillator. The pulses are integrated in a shaper to form the vertical lines. At the 15,750-Hz horizontal sweep rate of a TV set, the 189-kHz signal produces 12 video "pips" on each raster line. In the full raster the pips form 12 thin white lines that run from top to bottom (vertical).

The 189-kHz signal also triggers a multivibrator that operates as a frequency divider, firing only on every sixth pulse. The output is 31.5 kHz which, in turn, triggers two other counting multivibrators—a 5-divider and a 2-divider. The 2-divider output is at 15,750 Hz and this is shaped into horizontal sync pulses.

The 5-divider output is fed to a 7-divider, which downcounts the 6300-Hz signal to 900 Hz. Properly shaped, the 900-Hz pulses can make a pulse of video 15 times during each raster scan from top to bottom (each field). If the pulses are wide enough—about 64μs—each one occupies one full line of each raster field. The gate circuit forces each video line to begin exactly at the left of the raster. The result is 15 horizontal bright lines that appear on a darker field.

The pattern switch mixes the vertical and horizontal video lines to display a crosshatch. For dots, a diode clipper chops out the lines in a crosshatch, leaving only the intersections showing.

In the divider chain, a 15-counter divides the 900-Hz signal to 60 Hz, which is made into vertical sync. Sometimes two dividers are used, to reduce the span of the down-count. A combination shaper-mixer stage puts the composite sync signal together.

The rainbow pattern most color-bar generators produce is originated by the offset-subcarrier method. A 3.563795-MHz crystal (called 3.56 for short) generates the signal. When it is mixed with the 3.579545-MHz (3.58) signal generated in a color receiver, the result is a continuous 360-degree phase shift that extends exactly across each horizontal line because the two signals are just 15,750 Hz apart. The effect on the color demodulators in the receiver is to produce a color-hue change from one end of each line to the other. Looking at the raster as a whole, a viewer sees the full "rainbow" that goes from a reddish-yellow at the left to green at the right, ranging through gradual shades of red and blue on the way.

All rainbow displays nowdays are keyed, or gated, so the technician can see accurately at what point along the raster lines each color is situated. The black bars are formed by interrupting the colored rainbow display every few microseconds along each raster line, and driving the raster dark for the same number of microseconds. The result: alternating bars of color and black, with each successive bar from left to right bearing the

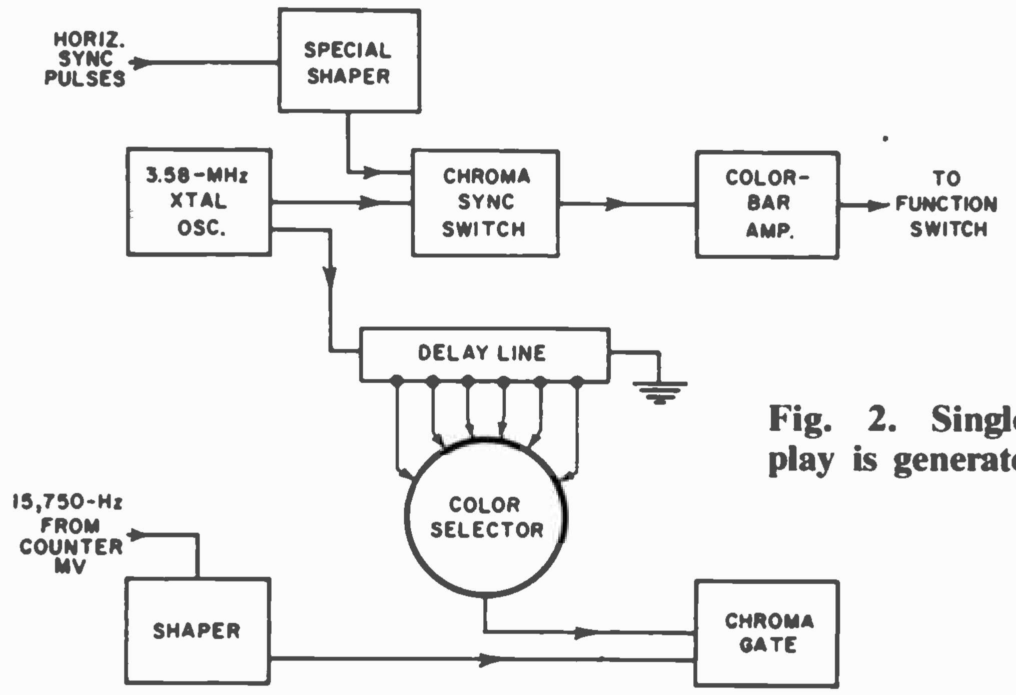


Fig. 2. Single-bar NTSC display is generated by this method.

rainbow color that would be in that space on the screen even if the color signal weren't keyed.

In Fig. 1, the keying is accomplished in a simple way. The color keyer uses sharpened signals from the vertical-lines shaper to block the offset subcarrier (3.56 MHz) signal. Time constants in the keyer stage are such that the signal is allowed through again after about 2.5 μs. Just 2.5 more microseconds later, the next pulse comes along and cuts the color off again for another 2.5. The alternating bars of black and color are the result, each bar being about 2.5 μs wide along the lines of the raster.

All the patterns, or the elements to form them, are fed to the pattern switch. It selects the signal(s) to form the desired pattern. Whatever is selected goes to a video amplifier, where it is mixed with the sync signal. A few generators make the composite video or color-bar signal available directly from this point. The composite signal is also fed to a modulator where it is mixed with an r.f. signal at some TV-channel picture-carrier frequency. A few generators also have the sync signal brought out to a separate jack where it is available independently for testing in color sets with separate video and sync detectors.

The other type of solid-state chroma generator (another name for the color-bar generator) is called an NTSC type. Its video-pattern functions are the same as in the keyed-rainbow just described, but the manner of generating the color-bar signal is different. In fact, the display itself is different.

Fig. 2 is a block diagram of just the color-bar section of a single-bar NTSC generator. The signal produced is more like a station signal than the keyed-rainbow signal is, in that it contains a color-sync burst on the horizontal-sync pedestal and the color is generated by phase-shifting a 3.579545-MHz signal. It also contains the proper amount of brightness-component signal. A crystal oscillator furnishes the signal which is fed to a delay line. Taps on the delay line permit the selection of desired phase of signal; it determines the color produced

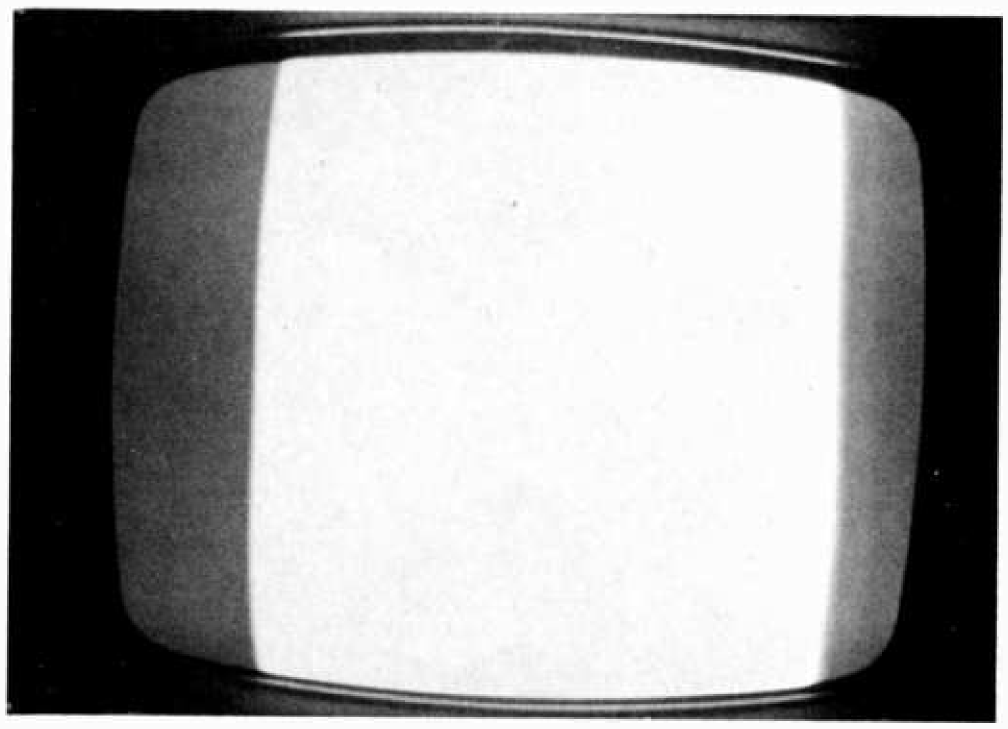


Fig. 3. The wide center bar is in a color which is selected by generator switch.

MAKE & MODEL	POWER		R.F. CHANNELS	SOUND CARRIER	OUTPUT		COLOR PATTERNS			H LINES	V LINES	VIDEO PATTERNS					GUN KILLERS	DIMENSIONS (in)			WT. (lb)	PRICE	
	BATT	A.C.			R.F. (µV)	VIDEO V_{p-p}	KEYED RAINBOW	NTSC BAR	OTHER			CROSS-HATCH	DOTS	SINGLE DOT	CROSS-HAIR	OTHER		H	W	D		WIRED ($)	KIT ($)
										SOLID-STATE MODELS													
AMPHENOL 865	12 AA CELLS	✓	3 or 4		50k		✓		1-bar variable 3-bar	15	20	15 X 20	300	Movable	Movable		✓	6⅜	9¼	5	4	189.95	—
B&K 1242		✓	3 or 4		5k		✓			13	9	13 X 9	117				✓	2¼	7	9⅜	3	99.95	—
CONAR 680	4 D-CELLS	✓	2 only or 3 only	✓	50k		✓			15	20	15 X 20	300	✓	✓	single H line single V line	✓	3	10	9	5	114.50	83.50
EICO 380		✓	3	✓	50k	10		✓		13	10	13 X 10	130					8½	5¾	6⅜	4	169.00	—
EICO 385	6 C-CELLS	✓	3		50k		✓			7	8	7 X 8	56				✓	3	8½	8½	3	109.95	79.95
HICKOK GC660		✓	3, 4 or 5	✓	50k	2	✓			18	18	18 X 18	324				✓	10⅜	10¾	5	6¼	179.50	—
JACKSON X 100		✓	2 thru 6		50k	4		✓		15	20	15 X 20	300				✓	6¼	10	4½	9	149.95	—
KNIGHT-KIT KG-685		✓	3, 4 or 5	✓	10k	2	✓			13	9	13 X 9	117			stair-step	✓	4⅝	12	9⅜	12	—	89.95
LEADER LCG-387		✓	5 or 6		10k		✓					11 X 14	154		✓			2¾	6¾	4¾	3¼	134.50	—
LECTROTECH V6-B		✓	3, 4 or 5		100k		✓			13	9	13 X 9	117				✓	3½	7⅝	9	5½	99.50	—
MERCURY 1900 (1901)	8 C-CELLS	✓	3, 4 or 5		100k		✓			13	9	13 X 9	117				✓	6¼	10	4½	5	99.95 84.95	—
RCA WR-502A	4.2V MERC.		3	✓	10k		✓			13	10	13 X 10	130				✓	6½	7½	4	4	169.00	—
SENCORE CG10	8 C-CELLS		3, 4 5 or 6		2k		✓			13	9	13 X 9	117				✓	3	10¼	8½	5½	89.50	—
SENCORE CG141		✓	2 thru 6	✓	2k		✓			13	9	13 X 9	117	Movable	Movable		✓	10¼	9½-	4	9	149.95	—
LECTROTECH V7[1]		✓	3, 4 or 5		100k		✓			13	9	13 X 9	117				✓	7½	8¼	12⅞	13	189.50	—
[1]Hybrid (includes tubes). Also includes vectorscope.																							
										TUBE MODELS													
HEATH IG-62		✓	2 thru 6	✓	100k	10	✓			15	12	15 X 12	180			shading bars		8½	13	7	11	—	67.50
HICKOK 661		✓	3 and 4		50k	2		✓		15	20	15 X 20	300					11	15	8⅛	18½	349.50	—
RCA WR-64B		✓	3 or 4	✓	50k		✓					14 X 9	126				✓	10	13½	8	13¼	189.50	—

Table 1. Listing of solid-state and tube-type color-bar generators along with their characteristics.

when the signal is demodulated in a color receiver.

To put the color signal into the form of a bar, a gating stage is used. Specially shaped pulses from the 15,750-Hz source are fed to the chroma gate stage, which blocks the color signal for the first few microseconds of each line, leaving the left side of the screen black. Then the gate stage allows the color signal through to the color-bar amplifier for about 40 µs; on the color-TV screen, color is visible. The gate then blocks color again, and the right side of the screen is dark. The screen pattern can be seen in Fig. 3 The bar in the center is in color.

Meanwhile, the color-sync burst signal is developed in a switching stage. The 3.58-MHz signal is turned on for just a few cycles at a time to coincide with the back porch (pedestal) of each horizontal sync pulse. (That is where the burst rides in a TV-station color signal, too.) Beyond the color-bar amplifier, mixing and distributing the color signal is carried out as in a keyed-rainbow unit.

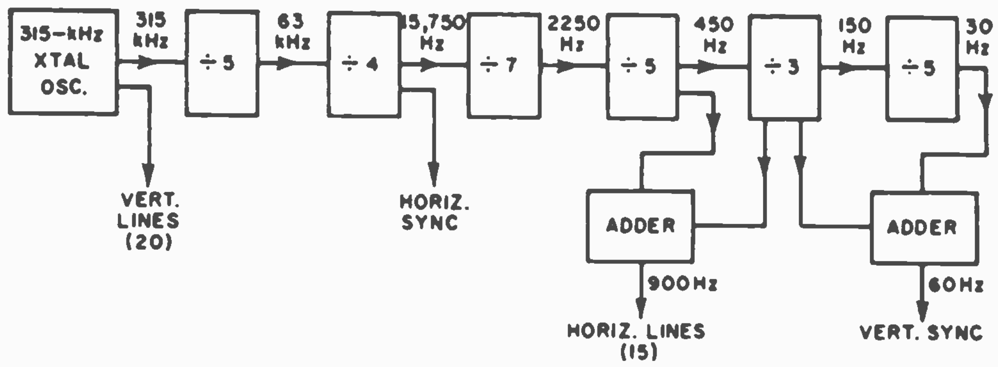
Several things are new, and most of them are designed to optimize stability. A few specifics illustrate the continuing concern with this particular bugaboo.

For one thing, as was mentioned earlier, transistors are improved. The earliest solid-state designs used cross-coupled and emitter-coupled two-transistor multivibrators for counting. With any small temperature change, one transistor would shift characteristics in a manner different from the other. Some of these instruments were slow to warm up to stability and then a slight breeze from an open window might throw them off again.

More recently, the newly developed unijunction transistor was incorporated by some designers. Their very nature made these semiconductor devices ideally suited to downcounting, because slight changes in bias controlled the triggering closely. But that very sensitivity was found to be a detriment—the trigger point shifted around with temperature. A number of models used them and still do, but only carefully engineered circuits offer enough stability to be satisfactory.

Most of the instruments introduced in the past year

Fig. 4. Low counting rates help stability. If dividers do not generate exact frequencies that are needed, adder / synthesis can be employed.



have gone back to the twin-transistor multivibrator. A production engineer can now buy a batch of transistors, demanding certain specifications of the supplier, and get units that have reasonably uniform characteristics. Hand-picked matching of multivibrator pairs is no longer necessary for acceptable stability.

And yet, in some parts of the country, the instruments are still subjected to extremes of heat and cold. In a Midwestern and Northern winter, for example, a generator hauled around in a service truck gets pretty cold. That makes warm-up time lengthy—if not impossible, for home service calls. To overcome that kind of trouble, the temperature inside the case of one model is thermostatically controlled; a heating element assures a constant ambient temperature for the counters, a quick warm-up time from any likely degree of cold, and steady patterns after warm-up.

Temperature-compensating components are sometimes included in the counter circuits themselves. Another way is to design each divider stage so it isn't very temperature-sensitive in the first place—not always an easy thing to do.

In certain battery-operated color-bar generators, a zener diode on the d.c. supply line to the counters keeps battery freshness from becoming a factor in pattern stability. In a.c.-operated models, regulation is equally important if the counter circuits are at all sensitive to voltage. In one new color generator, a mercury battery is used for power. Its constant-voltage discharge characteristic is considered adequate regulation for the counter circuits, which are themselves carefully stabilized.

Battery operation is not new, and several of the new generators include it. This freedom from the power cord is one of the more popular features for the home-call color-TV technician. Some recent instruments have both an a.c. power supply and battery provision.

Recent Solid-State Color Generators

The accompanying chart (Table 1) lists most of the available models of color-bar generators, and presents their most important features in condensed form. It includes a few tube-type models for reference, but the trend is to solid state. The following elaborations on features, therefore, relate only to transistorized instruments. They represent manufacturers who have given us data on their most recent models as of press time.

Amphenol

Newest version from this manufacturer is the Model 865 "Color Commander." A keyed-rainbow type, it has two special color-bar displays, not available—to our knowledge—on any other instrument. One is a three-bar color display for adjusting demodulators; it has R − Y (90°), B − Y (180°), and inverse R − Y (270°) bars, in that order. The other display is a single color bar, but its hue can be adjusted by a front-panel knob to any color phase from 30° to 300°. This model also generates two spe-

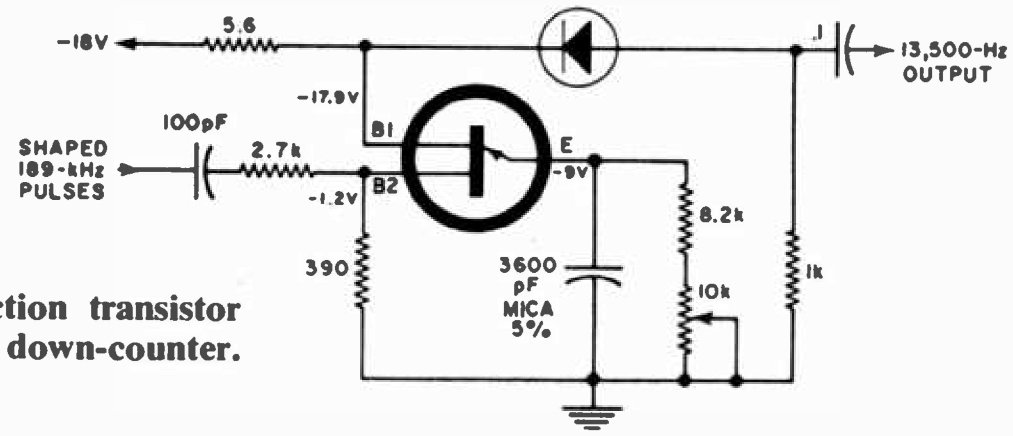


Fig. 5. The unijunction transistor as a color-generator down-counter.

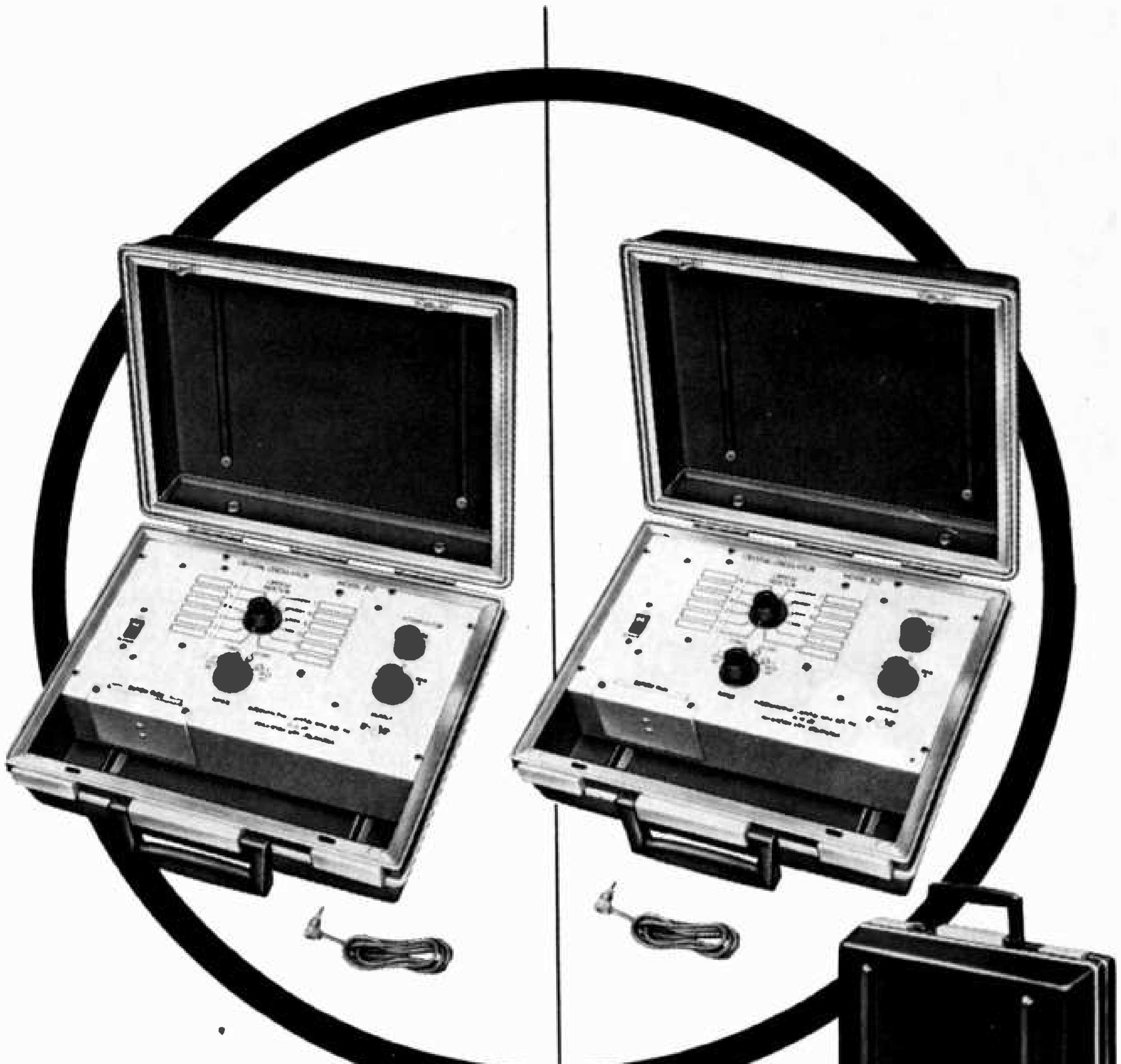
cial video-pattern displays: One is a single dot that is movable to any spot on the color-TV screen—the center for static convergence or any other location for checking dynamic convergence. The other is a two-line crosshair pattern, both lines of which are movable and can be made to cross at any point on the screen; the object is also to improve convergence checking. The Model 865 is one of the units that operates from both a.c. and batteries.

Internally, the Model 865 isn't as simple as the "typical" unit of Fig. 1. For example, the crosshatch pattern is generated by special mixing stages, and dots are produced by altering certain connections inside those stages to accentuate intersections while blanking the rest of the crosshatch lines. Extra circuitry is required, too, for special color-bar patterns and for movable dots and lines.

The counters are different from those in most, too. Fig. 4 shows the difference. A 315-kHz crystal oscillator is used instead of 189-kHz. The counting sequence is therefore different. The most practical reason for so many stages of counting is greater stability—there is less tendency for a divider to skip a count when it is dividing by some low factor (3 to 7) instead of a higher one (15, for example, as in Fig. 1). Also starting from 315 kHz, one of the intermediate rates is 15,750, which makes it unnecessary to have a separate counter for horizontal-sync and timing pulses. To develop horizontal lines, however, an extra stage is needed for adder-type mixing to create the required 900-Hz pulses. Another adder creates vertical sync.

B&K

The Model 1242 is another keyed-rainbow unit. This one uses unijunction transistors—four of them. Unijunction transistors are stable in the right configuration, and certainly contribute to instrument simplicity. A unijunction and a few resistors do the job that, in multivibrator stages, takes two transistors and over a dozen resistors and capacitors. Fig. 5 shows the circuit of a unijunction counter. Actually, as used in the 1242, this one is a controlled oscillator, trig-



gered by every 14th pulse of its input. The natural frequency of the stage is determined mainly by the time constant of the variable resistor in the emitter lead, working with the 3600-pF mica capacitor. The diode is part of a circuit that aids stability with high down-count factors; the one shown in Fig. 5 is shaping the output pulses for the stage that follows.

Two of these locked unijunction oscillators are controlled directly from the 189-kHz crystal circuit. One works at 15,750 Hz, and the other at 13,500 Hz. From the latter, a 900-Hz unijunction oscillator is triggered on every 15th pulse. That signal, besides making the horizontal video lines, locks a 60-Hz unijunction stage for vertical sync.

The a.c.-only power supply is transistor-regulated, with a zener diode for reference. The unijunction circuits are voltage-sensitive, and regulation is necessary. The use of a precision mica capacitor in the emitter time-constant circuit (Fig.5) is deliberate, an attempt to avoid any significant temperature-inflicted time-constant changes that would affect pattern stability. Other features and patterns of the 1242 are standard.

Conar

The Model 680 is the first color generator we know of that uses integrated circuits. Sixteen Type 914 digital IC's are used in the counting circuits. Besides the usual displays, single-dot and single-cross-hair patterns are provided, but they are stationary. A single vertical line and a single horizontal line are included. The color display is keyed-rainbow. The station-channel oscillator is crystal-controlled and comes with either channel 2 or channel 3—but not both. Most other generators have a coil that can be tuned between either of two or more channels, but their frequency is not so closely controlled as with a crystal. For power, the instrument can operate from either a.c. or four size-D (regular) flashlight batteries. The a.c. power supply is regulated by a series transistor, referenced to a zener diode.

Eico

The Model 380, an all-transistor unit introduced about 2 years ago, is a solid-state generator capable of producing an NTSC-type display. It generates a single wide bar of color on the color-set screen and a switch on the instrument lets the technician choose any one of ten phases of chroma signal for that bar. Some of the ten are NTSC "colors," but others are signal phase references, like R—Y, B—Y, I, Q, and so forth. An eleventh position of the switch produces a bar of white (Y or luminance signal only), which is fine for rough checks of the gray scale or purity.

The Model 385, just now being introduced by *Eico*, is a very compact, lightweight color-bar generator that produces the standard keyed-rainbow, offset-carrier type of color-bar display. The unit is only 3-in high, 8½-in wide, and 8½-in deep, and it weighs only about 3 lbs. The generator is completely portable, operating as it does from a built-in battery power supply consisting of 6 "C" cells. A plug-in adapter permits it to operate from the 117-volt, 60-Hz a.c. power line. Thirteen transistors, 6 diodes, and 3 crystals are used in the circuit.

Hickok

The Model GC660 is a keyed-rainbow generator, introduced some months ago; it has unijunction transistors in the counting circuits. One trick used to improve stability is more counting stages, with none of them dividing by a very large factor. The initial timer is a crystal-controlled 378-kHz oscillator. The first stage is a cross-coupled multivibrator—a down-counter by a factor of 2; the output is 189 kHz. That is followed by a series of unijunction dividers: by a 6 factor, to 31.5 kHz; by a 5 factor, to 6300 Hz; by a 5 factor to 1260 Hz; by a 3 factor to 420 Hz; and by a 7 factor to 60 Hz. From the 31.5-kHz counter, a 2-factor divider creates the 15,750-Hz horizontal sync and timing pulses. Vertical lines are formed from the 378-kHz pulses, shaped of course; that high frequency is why there are 18 lines, so many more than usual. Instead of the 900-Hz horizontal-line signal of most generators, a 1260-Hz signal is used in the Model GC660; the result: 18 horizontal lines instead of the usual 13 or 15. The Model GC660 is a.c. powered only, and regulation is employed.

Knight-Kit

Another keyed-rainbow generator, the Model KG-685 color-bar generator uses unijunction transistors for counting. A unique feature of this instrument is the stairstep signal that produces various shades of gray for gray-scale tracking tests. Fig. 6A shows a set with this pattern on its screen. A stairstep signal is generated just following the 189-kHz oscillator, using a transistor and a pair of diodes. Its video waveform is shown in Fig. 6B, so you can see how the rising steps of voltage drive the color CRT to successively lighter bars, then start again at black and go through another set of steps. The other video patterns are approximately standard.

Leader

A relative newcomer to the field, the imported LCG-387 incorporates a number of unorthodox approaches to accomplishing the functions of a color-bar generator. Although familiar cross-coupled multivibrators are used predominantly for timing and down-counting, diode logic circuits are the heart of the LCG-387's system of combining (synthesizing) the several signals into the patterns selected by the front-panel switch. Modular construction is used in the counter and logic circuits; many of the modules are alike.

The a.c. power supply is regulated by two transistors, referenced to a zener diode. Considering that the entire unit contains 50 transistors and 78 diodes, the LCG-387 is a study in miniaturization. Its bulk is less than any other color-bar instrument—less

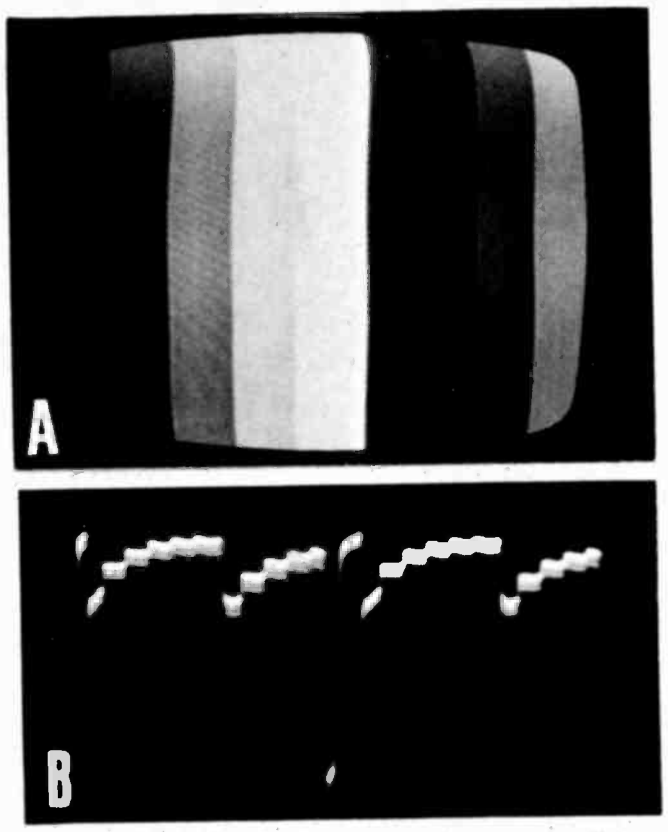


Fig. 6. (A) Stairstep pattern is for checking gray-scale tracking. (B) Waveform shows two "stairs" between each of horizontal pulses.

than 90 cubic inches and barely over three pounds.

No separate vertical or horizontal lines are developed, only crosshatch and crosshair patterns. There is a multiple dot pattern. The color-bar display is the standard keyed rainbow.

Lectrotech

Introduced about two years ago, the V6-B is an a.c.-powered keyed-rainbow generator, using unijunction transistors for all the divider circuits except the first—the one that steps the frequency down from 189 kHz to 31.5 kHz. For it, a cross-coupled multivibrator is used. The patterns generated by the V6-B, both video and color, are standard. A distinctive feature is a panel control for adjusting the thickness of the horizontal lines displayed, making them as little as one or as much as four raster-lines thick. There is also a special control, recessed at the rear of the instrument, to control the relative brightness of the horizontal and vertical lines; it is adjusted with a screwdriver to bring them to approximately equal intensity in any display.

RCA

After many years with the pioneering WR-64 series of keyed-rainbow generators, *RCA* has brought out a new one; the Model WR-502A "Chro-Bar." This one is solid-state, keyed-rainbow, and operates without power line, from a single 4.2-volt mercury battery.

Multivibrators are used for all counting. Of the 20 transistors used throughout the unit, 17 are of the same type—*RCA*40232 (SK 3020). The other three are 40238's.

The method of generating video signals is similar to that shown in Fig. 1, but there are important differences. The main timing oscillator is crystal-controlled at 189.645 kHz. The first down-count factor is 4, and the multivibrator output is 47.411 kHz. The next is 3, and yields the horizontal sync frequency, which in this unit is 15,802.7 Hz. (Scanning with the WR-502A is by a 264-line system instead of the common 525-line interlaced system.) A 5-count multivibrator generates a 3951-Hz signal, which is further divided by 6 to reach 659 Hz—which signal is used to generate eleven horizontal video lines. Of course, the vertical video lines are formed from the main 189.645-kHz timing signal. The 659-kHz signal is down-counted to 59.9 Hz for vertical sync.

The odd horizontal sweep rate necessitates a slightly different-than-usual frequency for the offset subcarrier. The subcarrier must differ from the 3.579545-MHz receiver reference by the horizontal-line frequency, which in this case is 15,802.7 Hz. The subcarrier crystal in the WR-502A is therefore cut to 3.563742 instead of the usual 3.563795 MHz.

The advantages of the unusual sweeping system in the WR-502A, as explained by its designer, are greater stability and cleaner video pattern displays. A built-in meter to check battery voltage, and a switch to cut in a fresh battery (a dual battery holder is used to carry a spare mercury battery), contribute to reliability in the field. The constant-voltage characteristics of mercury cells and the low (22 mA) drain make possible stable operation over a battery life of 100 hours or more.

Sencore

This manufacturer has two solid-state models, the CG10 and the CG-141, both keyed rainbow types. As you can see from the chart, the CG141 is the more elaborate (and expensive) of the two.

The CG10 is battery-operated. Its counting circuits are something not seen before in color-bar generators: transistor blocking oscillators. They seem to be as steady in this application as the old-standby blocking oscillator has been in many another piece of tube equipment in years past. A 189-kHz crystal oscillator starts the timing chain. A 12-divider is controlled by a special bistable multivibrator as well as by the 15,750-Hz signal from the first counter; the divider down-counts alternately by factors of 17 and 18, producing an average 450-Hz output from the bistable multivibrator. The 900-Hz signal for horizontal lines is developed by mixing 450-Hz pulses from a second source with the 450-Hz pulses already mentioned. It is this odd way of developing the 900-Hz pulses for horizontal video lines that allows another innovation—variable interlacing. The third counter also has a dividing factor of 15, forming the 60-Hz pulses needed for sync.

The unique feature called interlace is an adjustable delay in the timing of interlocking between the 450-Hz pulses from the second source mentioned—a circuit called a half-line multivibrator—and the 450-Hz (average) pulses from the bistable multivibrator. The adjustment is on the front panel and is turned to make the horizontal video lines start wherever the operator desires. It can blend distinctly separate video lines together to form a single thicker one. Because of the way dots are formed, it can also be adjusted for nice, round dots to make center convergence easy.

The Model CG141 is similar in basic circuitry to the CG10. The same kind of counting is used, but there are some additions in the pattern-combining circuits. The CG141, introduced last year, was the first color generator to offer the movable single-dot and movable crosshair patterns. It is accomplished with special delay multivibrators that determine—according to how the operator sets the controls—where on the screen the single vertical and horizontal lines are positioned, therefore where they intersect. It is, of course, that intersection which forms the movable dot.

The Model CG141 operates from the a.c. line only. It is the only color-bar generator we know of with a thermostatically controlled heating element inside. This is done in the interest of stability and quick warm-up. And it is effective. With stable blocking-oscillator counters, a zener-regulated power supply and almost absolute temperature control ambient to the counting transistors, there is little reason to expect anything but stability.

How Are They Used?

Not much mystery remains to using the video patterns of a color generator for convergence. The dot-line pattern generator antedated color TV. Besides, no home-service or installation technician who values his professional reputation can function without knowing at least the rudiments of convergence. The operation and application of color-bar generators for this purpose is, therefore, familiar to most of our readers.

Fewer technicians know as much about the color-bar pattern as they would like to. The keyed-rainbow display makes an easily indentifiable waveform for tracing through a chroma section with an oscilloscope; the distinctive normal shape is easily compared against shapes discovered at various circuit points, offering significant clues to the nature of any defect. The position of the rainbow patterns' colors, viewed on a color-set screen, is an indicator of correct (or incorrect) phase adjustment in the color-sync section of a receiver. Closer examination of the relative positions of individual bars of color on the screen gives a clue to proper adjustment of the color demodulators. When any of these adjustments is wrong, the color bar pattern is the standard against which it should be corrected.

The keyed rainbow colors are illustrated in four-color insert, page 32. Fig. 7A is an oscilloscope photograph of the keyed-rainbow waveform as it appears coming from the video output of a typical generator. Fig. 7B is of the waveform at the video detector of a color receiver, the rainbow signal being fed into the receiver through the tuner on an r.f. carrier. In both waveforms, the first "bar" after the sync pulse is the color-synchronizing burst and the remaining ones coincide with the bars of color shown on the "color bar pattern," page 32. Compare them and become familiar with the color sequence. Memorize it; you'll need to remember it if you troubleshoot many color receivers.

Chroma-section troubles yield readily to signal tracing, with the keyed-rainbow generator as the signal source and a scope as the tracer. Starting at the video detector, the technician moves progressively through the band-pass amplifier as he goes. Fig. 8 is a block diagram of the chroma section of one popular color set. It is useful as a guide to the steps of signal-tracing the keyed-rainbow signal.

A few of the most significant keyed-rainbow waveforms are shown in Fig. 8. The waveform at the band-pass amplifier grid contains all the bars, but the horizontal pulse has been chopped out from between each bar sequence. The small-value coupling capacitor that feeds video to the band-pass amplifier will pass the keyed-rainbow information at 3.56 MHz; the 15,750-Hz pulse can't get through.

In the burst amplifier, a keying pulse is dominant in the waveform. That is because the color-synchronizing pulse is the only information that is important; it is visible at the top of the large pulse. As you can see from the waveform, the color bars

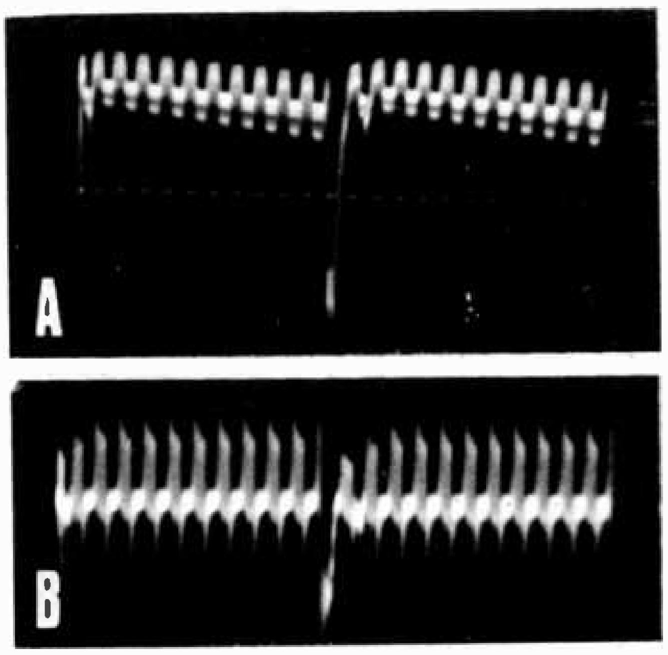


Fig. 7. Keyed-rainbow waveform pattern: (A) as it comes from the generator, and (B) as it appears at television set's video detector.

are subjugated; in some receivers, they may be completely swamped out at this point. The signals fed to the killer detector and phase detector from the burst amplifier need carry nothing but color-sync information.

Both the killer detector and the phase detector that controls the 3.58-MHz oscillator also receive a signal from the 3.58-MHz oscillator. Its waveform isn't shown, but it appears on the scope as a blur of r.f. signal. Moving the Tint control while observing the 3.58-MHz signal entering the phase detector tells nothing, because it is impossible to see any phase shift there with the scope. That phenomenon is best observed on the screen of the picture tube, or in the waveforms at the demodulators.

You can trace the color-bar signal through the band-pass amplifier (sometimes there are several stages) with the scope. Beyond the Color

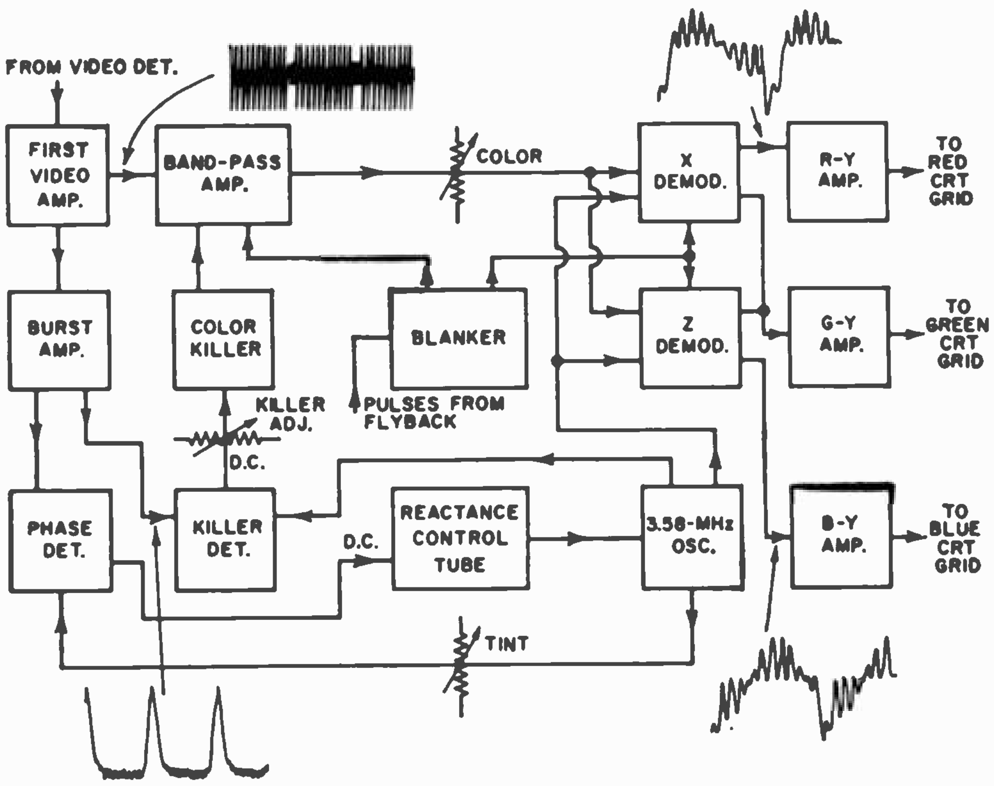


Fig. 8. Waveforms in chroma section of color-TV receiver with color-bar pattern applied are strong trouble shooting aid in servicing.

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control, you can check its action. As you turn it up and down, the amplitude of the color-bar waveform reaching the demodulators should increase and diminish noticeably. You can also check the action of the killer adjustment. Turn it to maximum and the waveform should disappear from the output of the band-pass amplifier; be sure to reset it to the proper operating point after you've checked its action.

The waveforms you see at the output of the demodulators are free from 3.58-MHz signals. They are simply lines representing the rising and falling signal levels at the various CRT grids for each color bar seen on the CRT face. As an example of how to interpret these waveforms, consider the one at the R − Y amplifier. Notice that maximum amplitude is the upward excursion third from left. In a normal color-bar display on the color-set's picture tube, the third bar is the deepest red. In the waveform, the sixth bar is at the zero line and the remaining ones go in the negative direction. On the CRT screen, the sixth bar is blue with virtually no red in it; the remaining ones are some combination of blue and green, with the red gun of the picture tube cut off completely.

Now you can twist the Tint knob back and forth and view the result of its action. If something is wrong with it, the highest amplitude of red will fall somewhere other than at the third bar. When the tint control is at its center of rotation, the third bar should be maximum red, and the sixth bar should fall at the zero line. If you decide to use the demodulated B − Y signal as a reference instead of the R − Y, normal action would place the amplitudes differently; the waveform at the B − Y amplifier shows normal positioning.

It takes practice to become familiar with the appearance of all the waveforms in the chroma section of a color receiver. Those few shown in Fig. 8 are the basic ones. Learn to trace them, and to recognize abnormalities, and you'll cut minutes—even hours—off your troubleshooting time in color sets. The best tool you can have is the steady standard signal from a good color-bar generator. ▲

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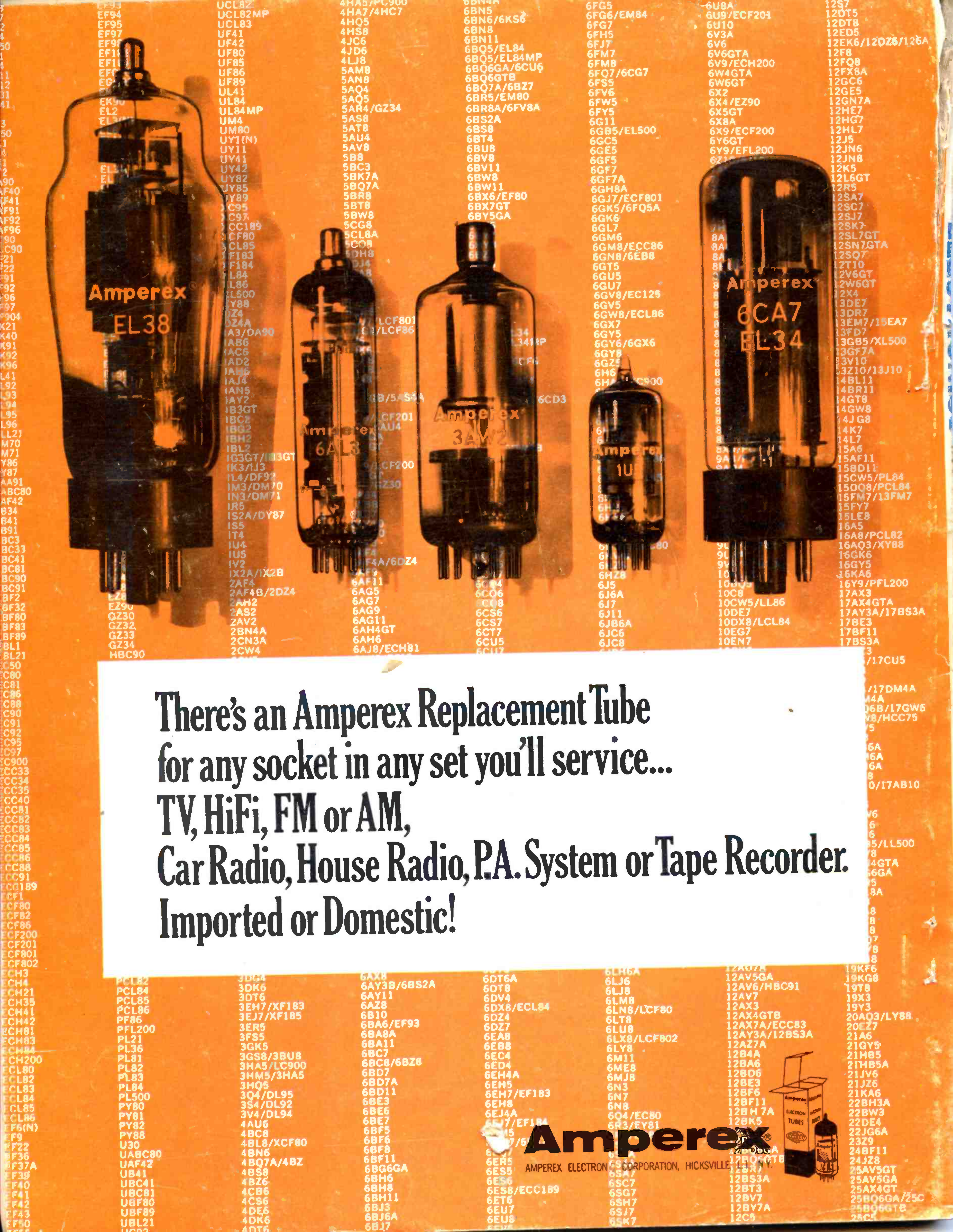

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