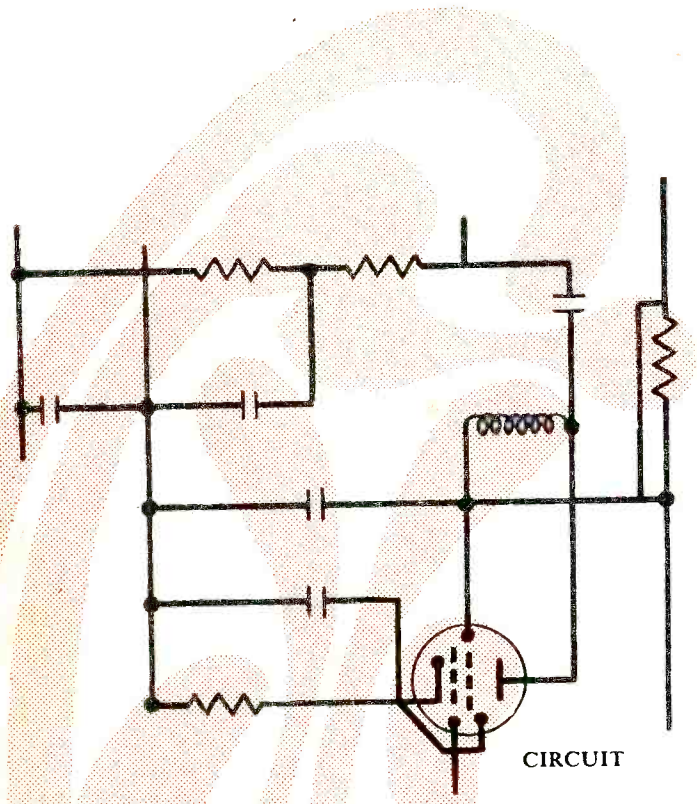
# SERVICE DEALER & ELECTRONIC SERVICING

NOVEMBER
1956
50¢



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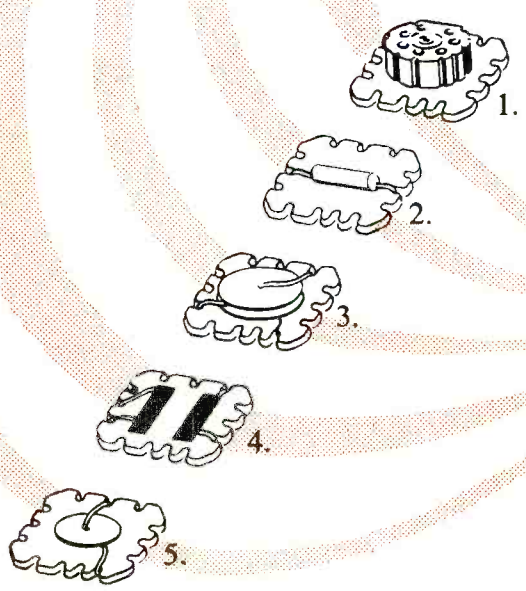


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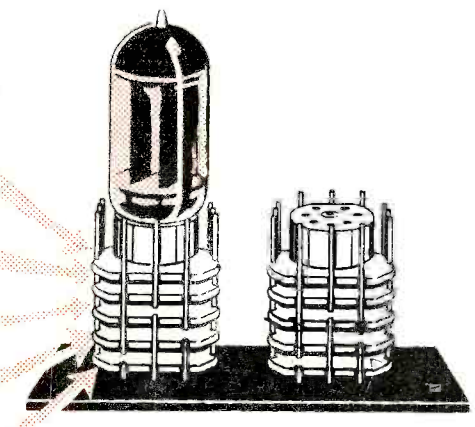

MODULES

- NCB Colortennas
- Understanding Tone Controls
- Automation for Electronics
- Flat Frequency Antennas
- Marine Electronics
- AGC in Color Receivers

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# SERVICE DEALER and ELECTRONIC SERVICING

VOL. 17, NO. 11 | Member BPA | NOVEMBER, 1956


## FEATURE ARTICLES



## CIRCUIT AND SERVICE FORUM



## DEPARTMENTS



### THIS MONTH'S FRONT COVER

Photo by U. S. Bureau of Standards. See page 10 for article on Automation, explaining significance of these new units.




COWAN PUBLISHING CORP., 67 West 44th Street, New York 36, N. Y.

S. R. COWAN

# Ad Libs

### More LARGER Schematics

When we changed format last May we believed the Complete TV Manufacturers Schematics section would be improved and the diagrams easier to read. Experience proves we were wrong. So, starting with our January 1957 issue we will revert to our old style, which with modifications, should vastly improve this department. More important is this additional fact: whereas we have in the past only carried 4 or 8 pages of TV schematics monthly, starting in January each issue will carry 16 pages.

### "Contact" starts this issue

A vitally important new department makes its bow in this issue. Called "Contact" this department will serve to bring together Service Firms which seek appointment as Factory Service Branches for manufacturers of all types of industrial electronics and commercial communications equipment, and for Manufacturers of that equipment who seek to appoint qualified service firms or independent servicemen as their Branch Service Depots. In addition "Contact" will open the way for industrial firms which use various types of automation and electronics devices to obtain the services of quali-

fied servicemen who operate near their locales.

To date hundreds of service firms have written us asking to be put in touch with electronics equipmnt manufacturers and users of such equipment who seek field service agencies, and this liaison work is being attended to, without cost or obligation, as the occasion arises. To those of you who intend to write us so your available services may be listed, may we suggest that full details be given.

## Facts & Figures worth having

RETMA's 1956 edition of The Electronics Industry Fact Book (50¢) has just been released. Unless we are mistaken RETMA figures are based upon a fiscal year period running from July 1st to June 30th and the new Fact Book gives radio-TV-electronic production, sales and service statistics from 1922 to June 30, 1956.

The Fact Book statistics together with statements recently made by such authorities as Dr. Allen B. DuMont, Mr. H. L. Atkinson (Mgr. Sales Services, RCA) and Dr. W. R. G. Baker (Pres. of RETMA and V.P. of G.E.) point to the stupendous (no other word suffices) earnings potential which lies ahead for all men engaged in all phases of civilian, industrial and military electronics equipment servicing. You owe it to yourself to digest carefully the following facts, some of which are quoted from the Fact Book, others from recent utterances by the afore-mentioned authorities:

1) — **Civilian Radio-TV:** Since 1922 over 244 million radios have been produced. Approximately 142 million are now in use. Last year auto radio production exceeded 6 million units for the 1st time and upwards of 40 million auto radios are now in cars but only 75% are in operating condition. Phonograph

sales in 1955 were 2.2 million units (over 4 times greater than any previous year) and approximately 20 million phonograph players are now in use. Television set sales in 1955 exceeded 7.4 million units (or over 7 million for the 3rd consecutive year) and now over 41 million TV sets are in use. (Almost 80% of homes in U.S.A. have 1 set or more). Nearly 200 thousand color TV sets are now in homes with every likelihood that 1 million will be in by Christmas of 1957. (Color telecasts run up to 30 hours per week in some cities and that fact has stimulated color set sales tremendously).

So much for Civilian radio-TV *sales* figures. Now for the Civilian radio-TV *service* figures: There are over 110 thousand divers types of retailers of radios and TV but less than 17 thousand of these retailers operate their own service departments. There are approximately 25 thousand service firms. Service Dealers and Service Firms combined employ 58 thousand full-time technicians. Stated another way approximately 100 thousand men earn their living from and are engaged in full-time servicing of civilian radios and TV sets. One can guess, but no one knows positively, just how many part-time independent or part-time employed servicemen there are.

Last year servicemen paid to Mfrs. over $850 million for the replacement tubes, components, etc. which they bought. Servicemen actually spent $1.3 billion buying the stuff from Jobbers with the difference going into Jobbers' cash-registers. The nation's service firms and service dealers received about $600 million from the set-owning public for services rendered.

2)—**Military Electronics**—quoting from Fact Book, "Vast quantities of radio equipment, from million watt transmitters to pocket size receivers, form the life line of military communications. Guided missiles are making piloted aircraft obsolete for many purposes. It is estimated that missiles and rockets will replace piloted aircraft in 50% of strategic and 30% of tactical missions." Every year since 1952 the Gov't has purchased about $2.5 billion worth of electronics gear per annum and expects to continue to buy that volume annually for the next several years.

Heretofore the great bulk of all military electronics equipment was serviced and maintained by members of the Armed forces. In ever-increasing degree civilians are taking over the service of military electronics equipment. The $ figures are not available.

3)—**Industrial Electronics** — This subject is covered so well by the Fact Book

that entire paragraphs are worth quoting, and every serviceman should analyze their import, keeping in mind how he fits into the picture. Says the Fact Book, ". . . electronic devices sort, control, measure and count . . . mold plastic and metal products, find flaws in textiles." Data process equipment, X-ray machines, heating apparatus, microwave relays, and radiation instruments make possible the abundance of modern production. "Two-way radios direct the taxicab, summon the police, provide protection against forest fires. Nearly 900 thousand mobile, base and portable transmitters are operated by 19,000 FCC licenses to provide two-communication for railroads, buses, emergency vehicles, etc.

"Automation is the technique of improving human production, in the processing of materials, energy and information by utilizing elements of control and of automatically executed programming. From simple photoelectric counters to huge data computers, automation is rapidly expanding industrial electronics.

"During 1955 industrial electronic apparatus sales were $700 million—a threefold increase over 1948. Industrial electronics will exceed $1.2 billion by 1960 and $2 billion by 1965." Our market research indicates that there are approximately 700 firms engaged in making the various types of automation, industrial electronic and commercial communications equipments that are being used by industry. Only a handful of these manufacturers hold the maintenance and servicing of it under their control while it is in use. In other words 99% of all industrial electronics and commercial communications installations equipment is today being serviced and maintained by the firms that own and use it or by service firms and independent service contractors whom they engage to do the work for them. To the best of our knowledge there are less than 4000 such independent industrial electronic equipment service specialty firms. But there is a great shortage of qualified servicing manpower and most all experienced radio-TV servicemen can service industrial electronic installations using their present knowledge and test equipment.

In all industrial electronic devices the components are of closer tolerance and better quality than those used in mass-produced radios. But the circuitry is basically the same. Most parts jobbers stock the needed replacement tubes and components. Whereas jobbers sold servicemen $1.3 million worth of replace-

nance of radios and TV sets last year, they also sold upward of $1 billion worth of replacement tubes and components to be used solely for the maintenance of industrial electronic and commercial communications installations. In coming years that figure will spiral upward. No wonder every radio and television serviceman is desirous of going into the vast new vista called industrial electronics servicing!

### Paradoxes

Here are some (of the many) things, published in newspapers recently, that puzzle me: A crack Pennsy train is derailed killing several people, injuring 72 others and the newspapers report the incident, in 2 brief paragraphs buried in the middle of the issue. In contrast, the same day a small privately-owned plane cracks up and although the event is of no import, except to the injured pair who were in it, yet the newspapers blast the event into front page and headline news.

Next item: Two of the radio industry's largest manufacturers, each having several thousand people on their payrolls, merge and the newspapers don't even report the transaction. That same day a "schlock" radio manufacturer is sued for divorce by his wife and the split-up is reported in newspapers from coast-to-coast as though it were a history-making event.

Finally, item three: Over 150 thousand radio-TV servicemen, in a routine day's work, repair upwards of a million receivers without a single word of publicity or praise being published by newspapers. Again, in contrast, newspapers blatantly report the story about a humble serviceman who is fined $5 by a magistrate because he (the serviceman) refused to give the repaired set to its owner when the latter insisted he would not pay the bill that was presented to him "until he had taken the set home to try it out and make sure a good job was done." Seems to me we live in a cock-eyed world wherein editors permit much really important news to be relegated to the background while "dud" material hits front pages. By the same token I believe the aforementioned magistrate is a "goof" who should be reprimanded for not using common sense. I hope the next serviceman he calls on "fixes" his set by "giving him the business."

### "Super" Size Format

Our decision to broaden the editorial policy of this magazine so that *all phases* of industrial electronic and commercial communications equipment servicing could be covered along with radio-TV servicing techniques was, as we've said before, resolved for us by you, our subscribers.

Since the program has been in effect, not one single solitary letter of complaint or objection about our new editorial policy has come in. As a matter of fact, between June 15th and September 5th, upwards of 1,700 unsolicited letters of praise and commendation have been received—and for that we are grateful. Dozens of subscribers also suggested that we make available binders in which copies can be retained for filing.

But life is not a "bowl of cherries." We must confess that to date 82 complaints, 71 of them on postcards, have arrived from subscribers who state frankly, and in some instances very vehemently, that they do not find the present "super size" format to their liking. The big gripe is that the 11¼" width of our magazine makes their copies extend over edges of shelves that are 9" deep. We've tried to be courteous and in busienss-like fashion have replied directly to every complaining reader, going to the extreme, offering to cancel the balance of their subscription and making a pro-rata cash refund. Not a single one has accepted that offer. Not one subscriber has asked for the offered refund.

However, from the mail received, we know that practically all of our subscribers retain their copies, using them for reference over a long period of time. That being the case, we are now looking for a binder supplier who can furnish durable but inexpensive binders which will hold and protect copies of our magazine. We will let you know what success we have. ■ ■

## We Are Moving!

**Effective Nov. 23, 1956, Cowan Publishing Corp. offices will be located at 300 W. 43 St., New York City, New York.**

# trade

*Replacement of transistors in portable radios and other electronic equipment may never be necessary if they are used within the limits set by the manufacturer, a General Electric engineer suggested. In addition he said transistors are rugged enough to withstand the jolt of being fired from a mortar and still operate at full ratings.*

• • •

Over 3,000 distributor and dealer service men have been trained by Admiral Corporation in the installation and servicing of the company's color TV receivers thus far this year. According to Joe Marty Jr., general manager of the electronics division, the men received their training in special schools held in 35 major cities. The training program will continue until all cities providing color programs have been covered, Marty said.

• • •

The first in a series of color TV lectures sponsored by Cowan Publishing Corp., and prepared by Samuel L. Marshall, Editor of Service Dealer and Electronic Servicing, was delivered before the Associated Radio Television Servicemen of New York on Wednesday, Oct. 17, 1956. This series consists of unit lessons prepared on color slides accompanied by a tape recorded presentation of the subject matter covered.

Shown from left to right are: Wm. Feingold, Sandy Cowan (rear), Marty Boxer—Corres. Sec., Oscar Fisch, Sam Marshall, Pete La Presti—Pres., Bob Dargan, and Jacob Allen—Rec. Sec.

Assisting Mr. Marshall in his presentation were Robert T. Dargan and Oscar Fisch, Assistant Editors, and William Feingold, Emerson color engineer. Mr. Feingold conducted a question and answer period following the presentation. More than 150 servicemen were present, all of whom expressed their approval and appreciation of the manner in which the program was initiated.

*An unusual alliance announced between organized TV servicemen and Philadephia's up-coming Channel 35 promises easy, reasonable arrangements for area viewers to convert local sets to the UHF band before WHYY-TV gets on the air in November. Albert M. Haas for the Television Service Advisory Council of Philadelphia and Richard Burdick for WHYY signed a joint proclamation calling for close teamwork adapting area sets so they can pick up the ultra high frequency signal of Channel 35.*

• • •

A new Rider service offers TV technicians the opportunity of buying TV servicing information on specific television receivers at the most economical price. Announcement has been received from John F. Rider, President of John F. Rider Publisher, 116 West 14 Street, New York 11, N. Y., that they have launched a new TV receiver diagram service called S-D-O (pronounced ess-dee-o) aimed to satisfy the "Single Diagram Only" needs of the servicing industry. The S-D-O service is sold through electronic parts distributors. This new service presently covers the products of the 8 largest producers of television receivers active during the past 5 years, inclusive of present production. They are: RCA, Philco, Admiral, General Electric, Emerson, Motorola, Crosley and Zenith. Other manufacturers will appear later. The service information is very detailed yet right to-the-point, including schematic, voltage data, tube layouts, alignment information, trimmer locations, adjustments, parts lists, etc.

• • •

*Completion of an integrated automatic test and inspection system for the evaluation of a wide variety of electronic components and other products has been announced by Electronic Control Systems, Inc., of Los Angeles, an affiliate of Stromberg-Carlson, and a subsidiary of General Dynamics Corporation. This new system automatically transports, tests, and physically sorts for quality components such as semiconductor diodes, and, in addition, keeps records on punched paper tape. It also automatically assembles over-all quality statistics. This new integrated system will be exhibited to the public for the first time at the Third Annual International Automation Exposition to be held in New York City, November 26-30, 1956, according to Bernard Elbinger, Manager of Special Products at E.C.S.*

# flashes

*Public confidence in the nation's television service technicians is one of the most important factors in the tremendous growth of the television industry, Frank M. Folsom, President of the Radio Corporation of America, declared in presenting the "President's Cup" to winners of RCA's national competition for achievement of TV customer satisfaction. The trophy, awarded annually by Mr. Folsom, was presented to one independent distributor of RCA consumer products and to four branches of the RCA Service Company. The winning distributor was Louis E. Randle, President, Associated Distributors, Inc., of Indianapolis, Ind.*

• • •

*Bill Mallingly has just written a two page open letter titled "Wake up Mr. Independent Serviceman." This interesting letter points out many practices which are working hardships upon the electronic servicing business. Bill says, "Electronics is in its infancy and the surface of electronic servicing has just been scratched." In dealing with various aspects of the electronic service business, he emphasizes the big need for independent servicemen to join the service association of their choice. The letter was written by an independent serviceman who feels that in this small way he can contribute some time and effort to help promote the cause of the independent serviceman. Bill Mallingly is the operator of Matt's Radio and Television Sales and Service Co., 21401 Fenkell Ave., Detroit 23, Michigan.*

• • •

With the appointment of Bill Ashby as Director of Service Engineering, Cornell-Dubilier Electric Corporation has injected another bright new spark into its constantly expanding program of jobber assistance. An "engineer's engineer" (as well as a raconteur second only to George Jessel), Bill has logged an astronomical record in his last five years of service engineering. He has traveled well over 250,000 miles and discussed service problems with a small army of servicemen—50,000 in 600 meetings!

• • •

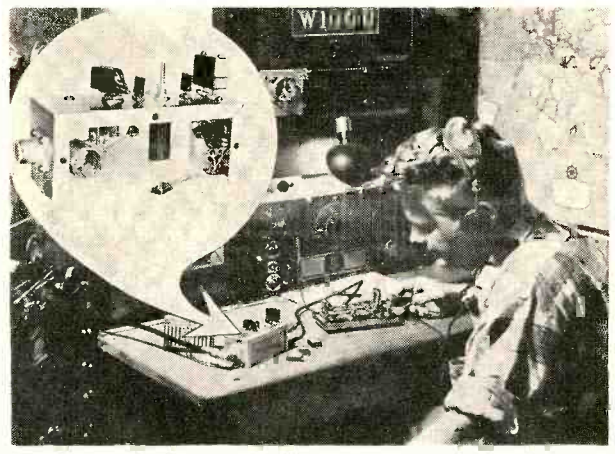
*Clarostat Mfg. Co. has received an award of merit conferred by the President of the United States through the President's Committee on Employment of the Physically Handicapped for the company's contribution toward providing equal opportunity for employment to the physically handicapped. The award is the second received by Clarostat since the company moved to Dover in 1949.*

• • •

E. P. Atcherley, merchandising manager for Sylvania Electric Products Inc., told the National Alliance of Television and Electronic Service Associations (NATESA) convention that television service technicians must re-examine and re-vitalize their approach to the public in this ever advancing field. Atcherley compared television service today to the automobile service station of yesteryears. Citing his own experience as a customer, he assured his audience that in their daily calls there is always more to sell than is asked for or meets the eye. The Sylvania executive cited numerous examples where good planning, courtesy and skilled performance spelled success for the independent serviceman. He called selling a full time project where the manner in which service is performed determines the probability of repeat business.

• • •

*Three Raytheon "hams" using two Raytheon 2N113/CK761 Transistors wrote radio history recently when they made the first transatlantic contact ever achieved with a transistorized transmitter. Operating on the 20-meter amateur band, they exchanged messages with a fellow "ham" in Denmark, a distance of 3,800 miles. Scarcely larger than a*



*package of cigarettes, the transmitter uses two Raytheon 2N113/CK761 fusion-alloy transistors powered by one penlight cell and two six-volt batteries—the equivalent of nine ordinary flashlight cells.* ■■

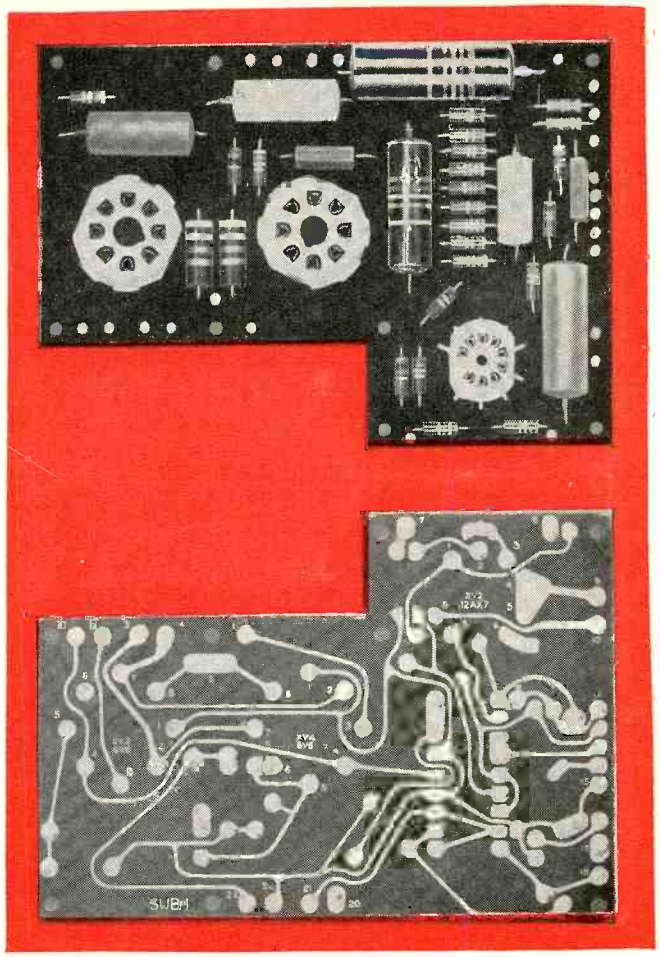


Fig. 1-Etched-wiring board of audio amplifiers, from Broadcast News, Aug. 1955, used with permission.

# Automation for Electronics

*Many different electronically controlled operations are automatically producing, with a minimum of human handling, a new electronic component, the Module.*


**by ALLAN LYTEL**

*Supervisor, Technical Information, Electronics Lab.*
*Electronics Park, General Electric Co.*


AUTOMATION refers to the increased use of machines, and the techniques of control of these machines in the process of production. It is now not only feasible for these machines to cut, drill, shape, and polish, but they also can shape to a given master, indicate when a drill requires replacement, and control some of their own machine operations by means of external electronic circuits using feedback. Finally, these machines can be inter-connected and related to other machines to make an integrated system of control and production, with a minimum amount of human intervention. This is, in essence, the meaning of the word Automation as it is now used.

## Where We Are Today—1956

Electronics, as an industry, has a special problem in Automation. The techniques of electronic controls are so firmly fixed in our technology that there is no other system for the control and operation of the tools of production, including all types of machine-tools. Electronics itself, however, was until quite recently, almost backward in its use of production machines for manufacturing. The normal chassis, say of a television receiver, or of a radar system, with the maze of wires and the great number of individual hand-operations, was behind other industries from the production viewpoint. As a rough comparison, the electronics industry of 1950 was quite like the automobile production of 1930. Machines were used for some isolated functions but, by far the greatest number of operations were done by hand.

There are now three separate areas which seem to point to the more advanced type of automatic production, which will come as a result of the present studies and engineering work in many organizations. These are, Mechanization, Modularization, and Digital Computer Control-Techniques. In each division there has been, and will continue to be, important developments. They could lead to complete machine production from start to finish without any more than nominal human intervention. The basic parts of Automation for electronics are here now.

## Mechanization

The design of electronic equipment for the greatest use of machines, that is, mechanization, is the first step. This includes the use of printed-circuit boards, (*Fig. 1*), which are now almost standard in advanced engineering groups. Upon phenolic base materials, a circuit design is made where copper-plated areas provide the connections between the components. Photography is being used, part in the production of these boards. This has the great advantage of repeatability. Once a master is made, the entire production run of boards is the same within very close tolerances.

Components are inserted in the boards, through holes located by a standard-grid system. Machines to drill the holes are now in production. By means of a program, the machine will locate and drill the proper holes. Components are inserted, with their leads through the holes, so that the components are connected in the circuit. The entire unit is then dip-soldered. Machine insertion of components has been developed by several independent groups. In the present techniques, components are fed into the machine, either by magazine or by means of a hopper. As the printed board passes under the head, a component is inserted in a predeter-

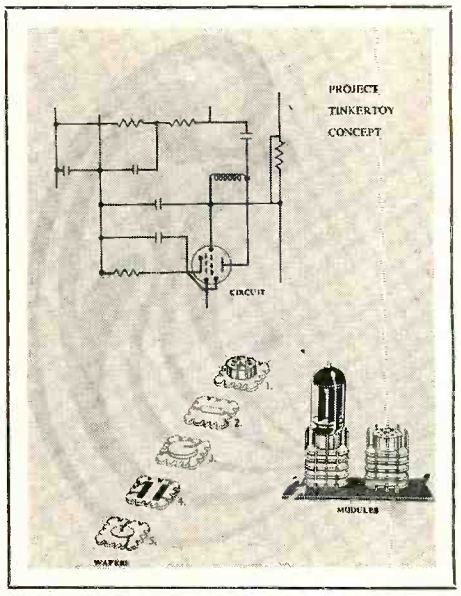



Fig. 2—Project Tinkertoy Concept, courtesy of the National Bureau of Standards, used with permission.

mined spot on the board. As the boards pass through a line of machines, their components grow in numbers, until all have been inserted. The completed boards are then removed and soldered.

This technique requires components which have certain standards with respect to lead size, component size, and lead mountings, because of the hole-pattern and because of the requirements of the insertion heads.

The boards themselves, their construction, materials, handling, and platings, require study and testing. Techniques for photo-reproduction of printed-wiring require investigation, and the translations of the engineering schematics to the final printed-wiring are still undergoing improvement.

Testing of the printed circuits is important and there are several methods used. Some of these are automatic and others are simpler.

All of these are methods and techniques which may be called mechanization; the use of machines to produce individual circuits from which equipment may be built. This far many engineering groups have gone; not all manufacturing activities use machine insertion of components. For a large number of printed-circuits, however, the component-insertion by mechanical

[*Continued on page 46*]

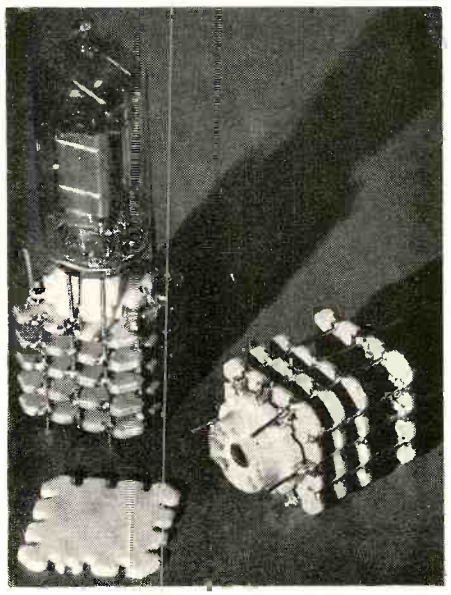


Fig. 3—Project Tinkertoy Module, courtesy of the National Bureau of Standards, used with permission.

*Part One discusses the importance of tone controls, their desirability in high fidelity sound reproduction due to such variables as the volume control settings, room acoustics, etc.*

# Understanding Tone Controls

Part One

by LAWRENCE FIELDING

PROBABLY the first difference between mediocre sound reproducing systems and higher quality systems that one notices, is the presence of a set of two tone control knobs on the so-called "better" high-fidelity equipment. Off-hand, this might seem like a direct contradiction to our earlier definition of high fidelity. You will recall that we stated an amplifier should have uniform, or "flat" response, at least throughout the audible range (20 to 20,000 cycles per second). Yet, in the very next specification listed in manufacturers' advertising literature we find statements such as the following:

"Separate bass and treble controls provide as much as 20 db of boost of attenuation at 50 and 10,000 cycles respectively." Why does the manufacturer take such pains to make a flat-response amplifier only to allow the "uneducated" customer to promptly upset this response by the use of such wide range tone controls? Actually, tone controls serve a great many useful functions. Before explaining their operation, the various types available, and the servicing problems they may create, let us investigate the need for tone controls in the first place.

## The Purpose of Tone Controls

It is well known that at low levels of hearing, the human ear does not respond with equal intensity to all the frequencies of audible sound. That is, at low volume, our ears respond *less* to the extremely low and high frequencies than to the middle frequencies. This fact would not necessarily be serious if all of us could listen to music exactly as it is played in a concert hall. However, since most of us play a recording of a symphony at considerably lower level than the original performance, the *relative* balance between lows, middles, and highs, is upset. This is due not so much to the equipment, but rather to our hearing mechanism itself. It would be desirable in such cases to emphasize, or "boost" those tones which our ears are attenuating at a disproportionate rate at low listening levels. This action is particularly needed for the very low frequencies, and gives rise to the so-called *bass boost* type of control shown in *Fig. 1.*

A secondary function of boosting the bass or lower tones arises from the fact that although the amplifier and other electronic parts of a high-fidelity system may be perfectly 'flat,' the loudspeaker usually is not. A small amount of bass boost, applied correctly in this case, can approximate correct relative response of the entire system. The action of this circuit is very desirable because the boost occurs only at low settings of the associated volume control. That is, at high listening levels the boost capabilities of the control are virtually negligible. As the user reduces the setting of the *volume* control to correspondingly lower listening levels, the range of the bass boost control becomes increasingly greater.

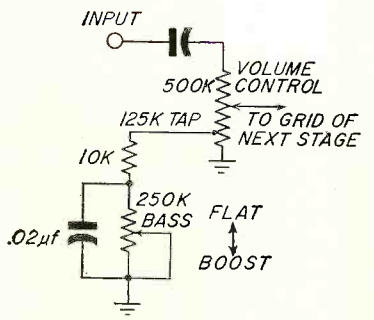



Fig. 1—The bass boost control can at low settings of volume control provide 17 db of boost adjustment.

Certain combinations of systems, when played at loud listening levels, may actually seem to have *too much*

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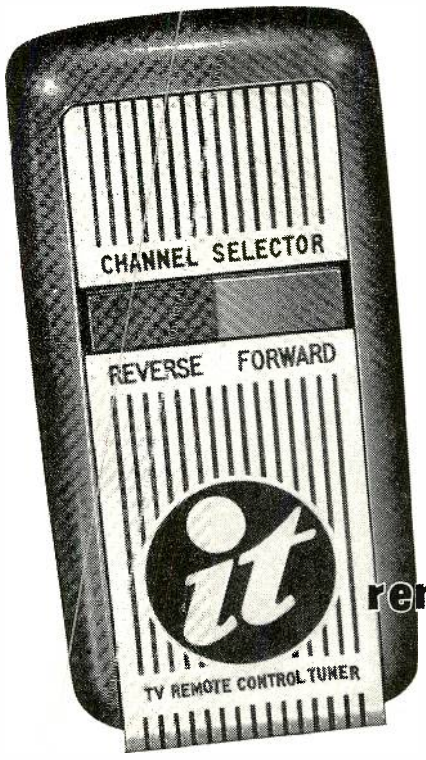
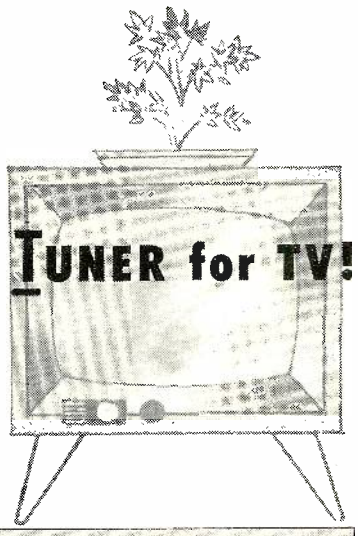



# New gift idea!

**. . . Terrific TV traffic-builder for Christmas!**



## remote CONTROL INSTANT TUNER for TV!

changes channels
from your
easy chair!

**DON WILSON—RADIO AND TV'S GREATEST SALESMAN WILL BRING CUSTOMERS IN DROVES!**

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**Goes On Practically Any Set!**

The **I-T** Remote Control Instant Tuner is engineered to go on practically *any* set—new or old. Your market is wide open!

**No Installation Problems!**

Customers can install **I-T** themselves in less than 3 minutes! It's easy—no tools needed—no electrical connections. And, there's no service problem!

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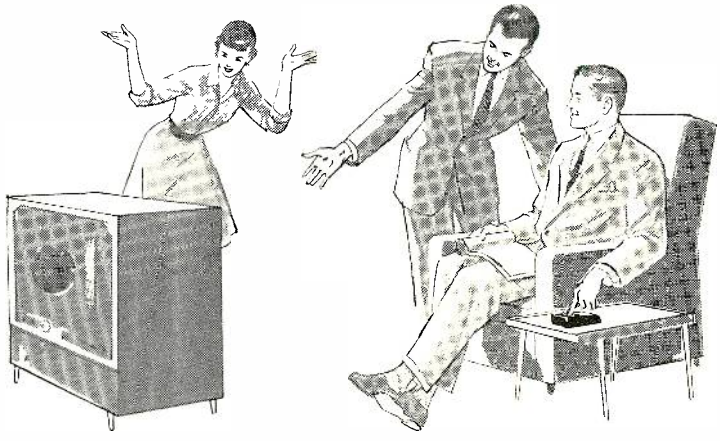

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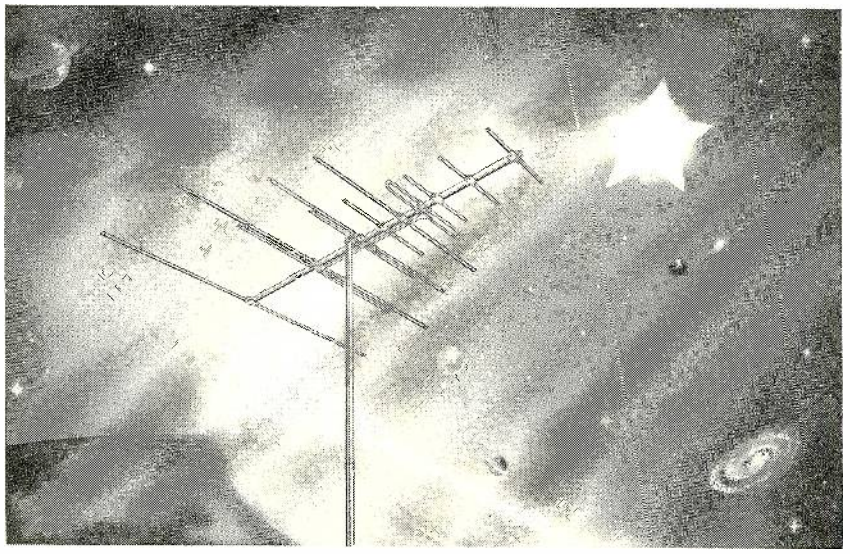

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**To induce you to try VEE-D-X, here is a startling INTRODUCTORY OFFER. One time only we will sell and ship direct to Service Dealers, at rock-bottom prices, one of any VEE-D-X antenna types. There are 7 types, each in single or double bay, so you can buy up to 14 antennas, at the prices shown. This offer expires February 1, 1957.**

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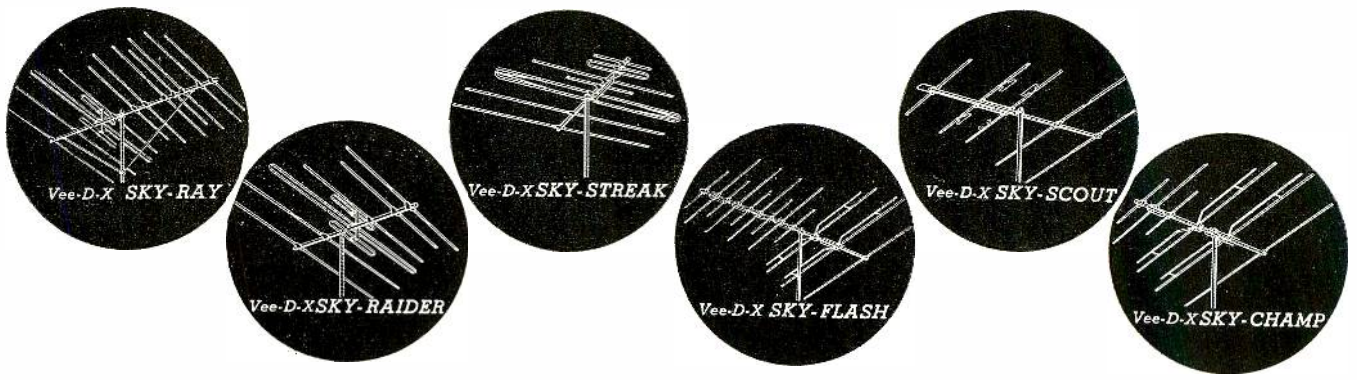


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**19 West 44th St., New York 36, N. Y.**

Ship 1 each of the VEE-D-X antenna types checked (maximum order 14). This offer expires Feb. 1, 1957. Check or M.O. must accompany order.

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CITY .....

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| TYPE | SINGLE BAY | DOUBLE BAY |
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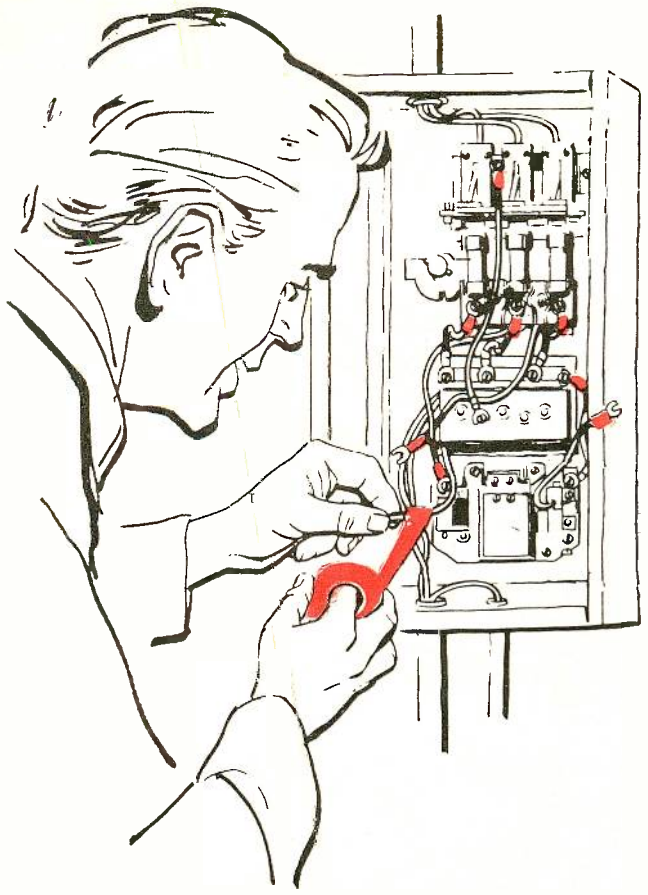
| VDX SKY STAR | ☐ $ 8.70 | ☐ $18.00 |
| VDX SKY FLASH | ☐ $13.25 | ☐ $26.50 |
| VDX SKY CHAMP | ☐ $ 9.60 | ☐ $19.25 |
| VDX SKY STREAK | ☐ $ 7.00 | ☐ $14.50 |
| VDX SKY SCOUT | ☐ $ 7.25 | ☐ $14.60 |
| VDX SKY RAY | ☐ $14.25 | ☐ $28.50 |
| VDX SKY RAIDER | ☐ $ 7.40 | ☐ $14.80 |



Quick identificaiton of switches, terminals, and controls is possible by using vinyl color tape on control panels.

# ARE YOU USING THE RIGHT TAPE?

*The important characteristics and specific applications of four different types of insulating tape are presented in this article.*

Varying requirements in the trade call for different kinds of insulating tape. Some are needed for holding and protecting, others for their fusing and insulating properties, and others for color coding. Still other tapes offer resistance to weather, oils, grease, acids, and alkalies.

The Johns-Manville Co. manufactures four different types of tape to meet these particular needs. The following description of these tapes will help the serviceman select the tape which best meets his requirements.

### Plastic Tapes

Plastic tapes offer maximum versatility and performance. They stretch and conform readily to irregular surfaces. They resist galvanic corrosives, mildew, and are not affected by oil, rot, conditions, acids, severe weather water, grease, alkalies. These tapes are available in different thicknesses for application in general use, heavy duty, or extra heavy duty applications, such as those where abrasion and wear are encountered.

### Friction Tape

Friction tape provides positive insulation protection under severe climatic conditions. It provides economical insulation whether used alone or in conjunction with rubber tape. A single layer of this tape resists voltages from 1000 volts to as high as 2000 volts, depending on the particular variety used.

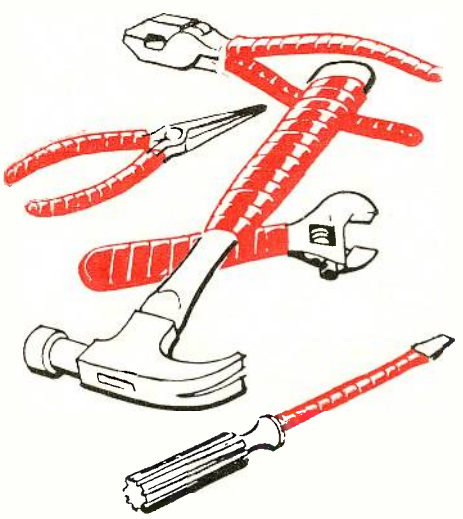
### Rubber Tape

Rubber tape fuses to itself instantly without the application of heat. It forms an all-around sealed, protective rubber insulation with more than 18,000 volts dielectric strength per thickness of tape. It stretches to conform to irregular shapes, cushions corners and projections, and fills voids and low spots. Rubber tape is non-corrosive to electrical conductors, elastic, and easy to work with at all climatic temperatures and weather conditions. It offers a safe completely sealed and fused protective covering for dependable insulation.

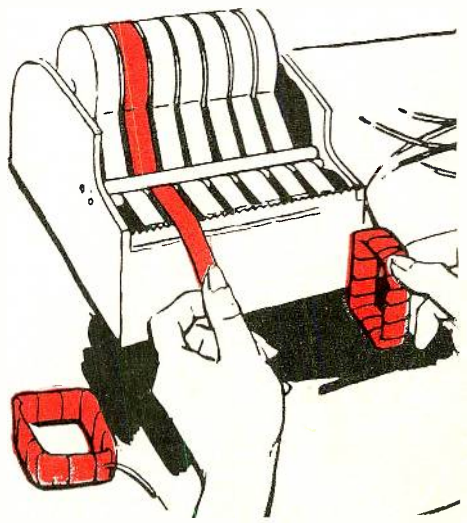
### Vinyl Tape Color Tapes

The vinyl color tapes are true electrical insulating tapes in colors which can be used for color coding terminal strips and splices while providing 6000 volts of dielectric resistance. This corresponds to more than 1,000 volts per mil of thickness. This tape is moisture proof, fungus and mildew proof. It also resists both fresh and salt water, oil, grease, acids, and corrosive chemicals. In addition, it is a flexible tape, and as such, conforms readily to irregular surfaces.

Vinyl tape is available in a choice of colors. These include red, green, yellow, blue, black, brown, white, gold, and silver. The color is all through the vinyl film backing and so will not fade or wear off. A pressure sensitive adhesive with quick grab and holding power is peramently bonded to the film backing. It will not pull off and leave bare spots.



The non-slip surface and insulation insurance makes vinyl color tape ideal as a tool handle wrap.



Color coding tapes on the assembly line may be used to identify parts and circuits with ease.

# THE WORK BENCH

*Unusual Service Problems And Their Solutions*

by **PAUL GOLDBERG**
Service Manager

**This Month's Problem: AGC Circuits**

THIS month's installment is devoted to an *agc* problem. A thorough knowledge of the receiver circuitry is necessary in order to solve problems in these circuits.

## RCA Chassis KCS82

The receiver was turned on and it was observed that the picture was hooking at the top. The horizontal hold was adjusted but it had little effect on the hooking. The synchroguide transformer *T114* was also adjusted but the hooking remained. The *agc* control *R154* was next adjusted. It was noted that when the picture was set at a low contrast point, the picture did not hook, but as soon as the *agc* control was set properly, the hooking appeared. It was also seen that the picture had a tendency to overload when the channels were changed.

Knowing these facts, V111, 12AU7, V112 6SN7, and all the video and tuner tubes were replaced individually but without effect. The *agc* control *R154* was adjusted from minimum to maximum. This varied the video gain in such a way as to cause us to believe that this was a horizontal sync problem rather than an *agc* problem.

The scope was then set up and the wave shape was measured at the grid pin #7 of V111B, ½ 12AU7, the horizontal sync separater. The wave shape was correct at this point.

A similar measurement was next taken at Pin #6 plate of V111B. Here the wave shape was too small. Thus the trouble was in this tube's circuitry.

Voltage checks were next made at the plate, grid and cathode of V111B and all were approximately correct. We thought at this point that a slight condenser leakage might not show up in the voltage checks. Condensers *C146,*

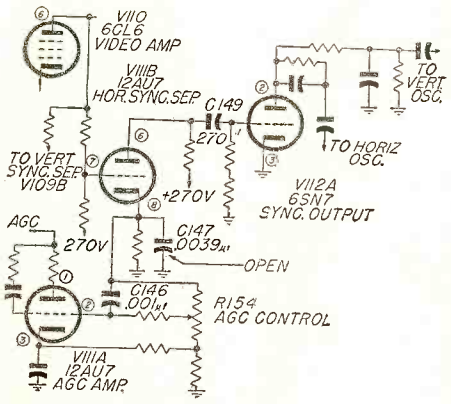



Fig. 1—Partial Schematic of the RCA KCS 82 showing agc circuit.

*C149* and *C147* were therefore all checked, but showed no leakage.

At a loss for an idea for the moment, the diagram was studied. In this receiver, the composite video signal is fed directly from the plate of the video amplifier, 6CL6, V110 to the grid of V111B. V111B, ½ 12AU7, is so biased as to permit only the horizontal sync pulses to cause this tube to conduct. Thus, only the horizontal sync pulse appears at the plate of V111B. With these facts in mind the horizontal sync separater circuitry was again examined. As we had not checked for condensers being open, *C147* was clipped out of the circuit and a new .0039 uf condenser was installed. When this was done the receiver instantly functio properly. The *agc* control w to the proper point and was sent back to the

When *C147* ope cathode voltage to with the grid volt making the horiz circuit degenerati ered the normal a ing the horizonta

the reset ed it customer. receiver vary in accordance age of V111B, thus

# ASSOCIATION NEWS

by SAMUEL L. MARSHALL

### Associated Radio Television Servicemen of New York (ARTSNY)

On Sunday, October 14, 1956, a committee of ARTSNY travelled up to Bridgeport, Conn. to meet with other Associations of the New England States. The major portion of the discussion centered around manufacturers going into the service business and other phases of the service industry.

### Radio and Television Guild of Long Island

One of the numerous "man sized" jobs associated with the forthcoming Electronics Fair to be sponsored by the Guild in December is the formulation of a lecture program. Many people have already pledged their participation and a partial list of speakers and topics is as follows:

Mr. Samuel L. Marshall, editor of Service Dealer magazine, will speak on "The Outlook for Servicemen Handling Color TV and Industrial Electronics Servicing."

### NATESA

The National Alliance of TV & Electronic Service Associations has declared war on Captive Service.

So that there can be no mistake in what NATESA considers captive service, the following definition was adopted by unanimous vote of the membership: Services offered to consumers on a fee or no charge basis by a TV and/or radio receiver manufacturer, their subsidiaries, agents or segment of a receiver distribution other than the retail merchandiser.

### TESA, St. Louis

At a recent meeting reports on progress in cooperation made with distributors in fighting "Captive Service," were made. Also a report by Howard Freiner on the NATESA convention was presented.

[*Continued on page* 44]

# PYRAMID technical bulletin

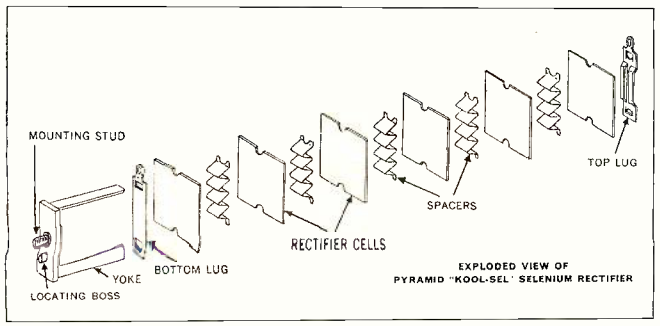
## NO.66

### SELENIUM RECTIFIERS

**General:**

The trend toward component miniaturization with attendent increase in equipment compactness has resulted in a steadily rising ambient operating temperature. Selenium rectifiers are particularly critical in this respect because much depends on their ability to maintain a high output voltage over extended periods of time. A major limiting factor in this respect has been the "Center-support" type of construction of conventional rectifiers and the tendency of this construction to concentrate the generated heat within a relatively small area. The Pyramid patented-type construction, known as the "Kool-sel," is a significant break-through of this heat barrier.

An exploded view of a Pyramid rectifier is shown below. Note that the center support has been eliminated completely; instead, the individual selenium rectifier coils are supported at their outer edges. A molded phenolic yoke forms the main supporting member, with a mounting stud and locating boss molded into the yoke. In this way, they become integral parts of that yoke. The lugs of the rectifier are slotted to accommodate the two arms of the yoke and the rectifier cells and spacers are notched to fit snugly on the yoke arms. Clinching lips are provided on the top lug so that when it is pressed on the yoke, all components are locked together to form a rigid assembly. During assembly, the spacers are flexed slightly to insure that the unit remains tight under all normal environmental conditions.



EXPLODED VIEW OF PYRAMID "KOOL-SEL" SELENIUM RECTIFIER

### ADVANTAGES OF "Kool-sel" CONSTRUCTION:

**Mechanical:**

1. Cells and lugs are locked in place and cannot rotate.
2. Locking together of the components is accomplished without the current pickup contacts exerting excessive pressures on the cell counter electrode. Too much pressure may produce three detrimental effects: First, it may decrease the reverse resistance and thereby lower rectifier efficiency. Second, there is a cold flow of the counter electrode from under the pickup contacts. Third, fracture or damage to the counter electrode adjacent to the pickup contacts may occur.
3. The locating boss, being an integral part of the yoke, is always in the correct position.
4. Pulling on the positive lug cannot crack or break the alley (counter electrode) of the adjacent rectifier cell.
5. This particular mechanical construction results in fewer component parts.

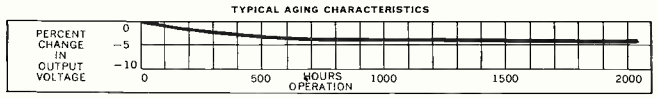
**Electrical:**

1. There is a high dielectric strength between the "live" components (i.e., cells, spacers, and lugs) and the mounting stud. The normal insulation thickness over the mounting stud is 1/16".
2. There is high resistance to burnouts on current surges.
3. The current pickup points are distributed over the full width of the rectifier cell. This means that heat is dissipated rapidly and the temperature rise of the rectifier cells during the flow of current surges is relatively low.

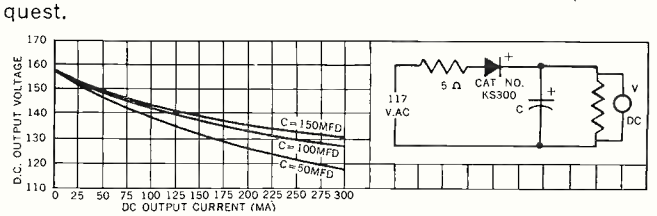
### CHARACTERISTICS:

Illustrated below is a typical aging Characteristics Chart, showing percentage change in output voltage vs hours of operation.

| CATALOG NUMBER | KS-65 | KS-75 | KS-100 | KS-150 | KS 200 | KS-250 | KS-300 | KS-350 | KS-400 | KS-500 |
|---|---|---|---|---|---|---|---|---|---|---|
| Maximum RMS Input Voltage | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 | 130 |
| Maximum Inverse Peak Voltage | 380 | 380 | 380 | 380 | 380 | 380 | 380 | 380 | 380 | 380 |
| Maximum Peak Current (MA) | 650 | 750 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 | 4000 | 5000 |
| Maximum RMS Current (MA) | 162 | 187 | 250 | 375 | 500 | 625 | 750 | 875 | 1000 | 1250 |
| Maximum DC Current (MA) | 65 | 75 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 |
| Approximate Rectifier Voltage Drop | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Minimum Series Resistance | 22 | 22 | 22 | 15 | 5 | 5 | 5 | 5 | 5 | 5 |
| Maximum Operating Plate Temperature | 85°C | 85°C | 85°C | 85°C | 85°C | 85°C | 85°C | 85°C | 85°C | 85°C |




**Voltage Regulation:** The voltage regulation curves for a 300 ma selenium rectifier in a half-wave circuit with 117-volt rms input shown below. Suitable voltage regulation curves for all Pyramid "Kool-sel" selenium rectifiers are available upon request.




### APPLICATIONS:

**Radios and Radio-Phonographs:** Low-cost, efficient rectifiers for radios and radio-phonograph combinations are "Kool-sel" KS-65, KS-75, and KS-150. The needs of most 5-tube chassis are met by the KS-65, while the KS-75 and KS-150 are used in sets with larger current requirements.

**Television Receivers:** High-voltage power supplies in television receivers—including color sets—use "Kool-sel" numbers KS-200, KS-250, KS-300, KS-350, KS-400, and KS-500. These rectifiers, used in voltage doubler or voltage tripler circuits provide the proper B-plus voltage, eliminating the size, cost, weight and hum problems of power transformers. "U" shaped brackets are available which permit the rectifiers to be mounted either in vertical or horizontal positions.

**Radio Accessories:** TV boosters, UHF converters, phonograph oscillators, inter-coms and the like can usually be powered suitably by a "Kool-sel" KS-65 rectifier.

**Laboratory Instruments, Power Supplies, Amplifiers:** Rectified high voltage through the use of voltage doubler and tripler circuits, for equipment where current requirements run as high as 500 ma, may be provided with "Kool-sel" rectifiers. Types KS-200 through KS-500 will be found useful for laboratory power supplies, DC filament supplies, motion picture projectors, amplifiers, test equipment and other specialized uses.

**FOR COMPLETE DATA SEND FOR ENGINEERING BULLETIN—FORM KS-1**

**PYRAMID** ELECTRIC CO. North Bergen, New Jersey

# THE ANSWERMAN

**BY SERVICE DEALER & ELECTRONIC SERVICING TECHNICAL STAFF**

*Dear Mr. Answerman:*

I have a Philco 7E10 TV chassis that has poor horizontal and vertical sync operation. The circuits have been gone over in the chassis quite thoroughly and the cause of this condition has not been determined. Actually, it takes a period of time for the trouble to appear, which makes locating the trouble even more difficult.

*T. C.*
*Newark, N. J.*

As can be noted in *Fig. 1* a dual selenium diode is employed to perform horizontal phase comparing action. On occasion these combination selenium diodes have been known to fail causing a variety of troubles. When a dual diode becomes faulty the horizontal oscillator frequency goes out of sync. In most instances when one side or the other is open the condition is permanent and can be determined easily with an ohmmeter. This is the more easily determined type of trouble encountered with dual selenium diodes.

If the diode section that connects to ground should short internally the horizontal and vertical pulses to their respective circuits will be reduced, caus-

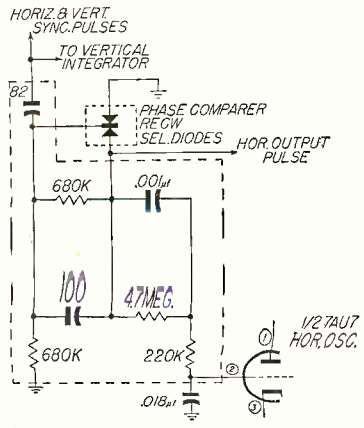



Fig. 1—Partial schematic of Philco 7E10

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

ing loss of, or poor, horizontal and vertical sync.

Many of these troubles appearing in the new receivers occur during the receiver warm-up process. In one particular known case the receiver drifted out of the horizontal hold control lock-in range in about 20 minutes.

Dual selenium diodes such as shown in the Philco circuit of *Fig. 1* are also being employed by many other manufacturers in their receivers. These dual diodes have been a source of some trouble causing weird effects such as poor vertical sync and others. On some occasions replacement diodes have not been available. In these instances a pair of 1N60 or similar crystals have been temporarily substituted to allow the receiver to be operated so as to troubleshoot other difficulies. This type of substitution is not generally desirable as the correct replacement part should be used for best results. A match between the diode sections is desirable.

Care should be used when installing the dual diode type of component just as with other type of crystal units. Employ as small an amount of heat as possible and permit no tension to exist on the pigtails.

*Mr. Answerman:*

I am having a problem of obtaining a sufficiently bright picture on a TV receiver I am servicing. The picture tube voltages have been checked and seem to measure about normal. A new picture tube was substituted with no improvement. Have you any suggestions. The chassis is a Crosley 472.

*W. T.*
*Los Angeles, Cal.*

[*Continued on page* 29]

# AGC CIRCUITRY IN COLOR TV RECEIVERS

by BOB DARGAN and SAM MARSHALL

From a forthcoming book entitled "Fundamentals of Color Television"

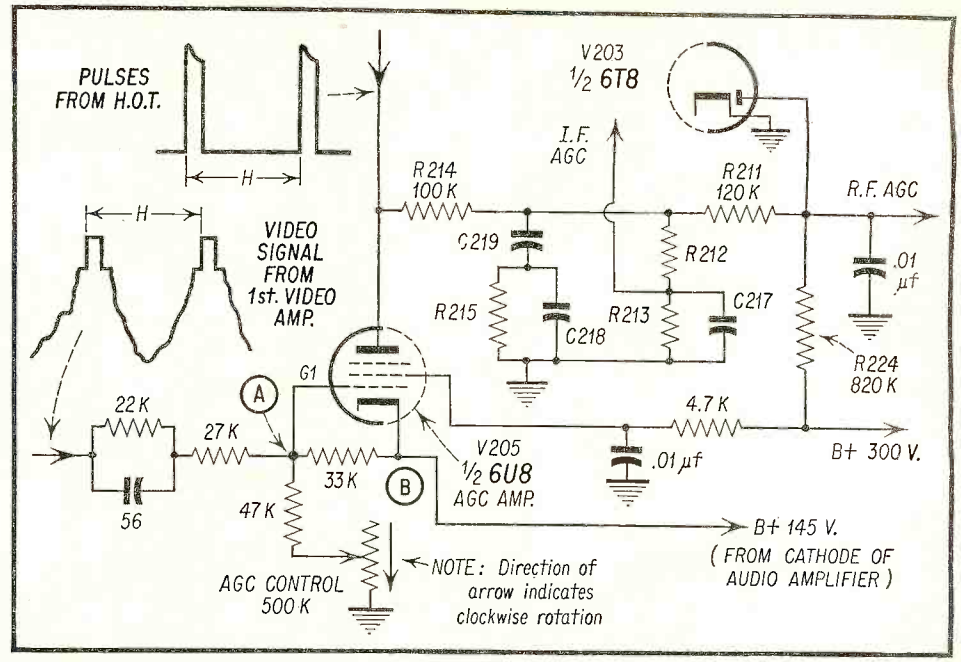



Fig. 2—Simplified schematic of AGC circuit used in RCA color receiver.

AUTOMATIC gain control (*agc*) is designed to maintain a constant video signal level at the CRT grid for a given setting of the contrast control, despite variations of input signal at the antenna terminals.

## Block Diagram Analysis

There are many types of *agc* circuits, however, the one most often used in color TV receivers is *keyed agc,* shown in block diagram form in *Fig. 1.* This type of *agc* provides the most effective control for possible signal variations and noise interference because its action depends on the sync pulse amplitude of the signal which is constant, rather than the average value of the video signal which varies continuously.

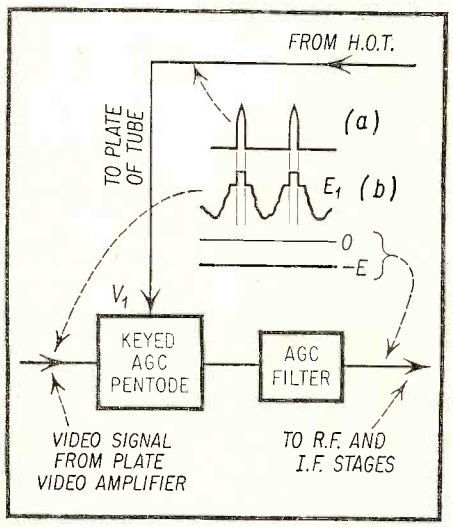



Fig. 1—Block diagram of keyed AGC systems.

This characteristic provides a fixed value of signal level against which signal deviations may be compared and corrected. Another advantage of keyed *agc* is its quick action in following rapid signal variations such as those caused by airplane reflections. This quick action is effected by means of fast acting RC filters in the circuit.

As shown in *Fig. 1,* the operation of the keyed *agc* circuit is centered around a pentode tube the input of which is fed positive sync video signal information from the plate of the video amplifier, and the plate of which (top) is fed a high amplitude positive pulse from the horizontal output transformer. When this pulse is present at the plate and the grid bias is of the right value, tube conduction takes place. Thus, tube conduction can only occur during sync pulse intervals. Under these conditions noise present during the actual video signal interval will not affect the *agc.*

When no signal (E1 = 0) is present at the grid of the *agc* tube (antenna is disconnected) the control grid is highly negative with respect to cathode. Even the presence of a large positive pulse at the plate from the horizontal output transformer is not adequate under these conditions to produce a flow of plate current. With no plate current flowing, there is no *agc* voltage developed, and the tuner and *if* stages are in a maximum gain condition, that is, zero bias.

Now consider the condition where a very small video signal is applied to the antenna terminals. Under these conditions a small signal, E1, is applied to the input of the *agc* tube. This signal, we will assume, is too small to produce conduction, that is, plate current in V1. As the signal increases in amplitude, a critical value will be reached which will cause V1 to go into conduction. This conduction will produce plate current which gives rise to an *agc* voltage applied to the *rf* and *if* stages.

Now as the antenna signal increases still further, the increased *agc* bias will reduce the tuner and *if* stage gains in direct proportion to the increased antenna signal. Under these conditions E1 remains constant, as does the signal level at the video detector output, thus producing the desired *agc* action.

Notice that conventional B plus voltage is not applied to the keyed *agc* tube. Instead, a positive pulse from the horizontal output transformer is fed to the plate. This pulse triggers or "gates" the tube into conduction during the time interval in which the sync pulse is active as shown at (a) and (b). Thus, the signals appearing at the plate are amplified negative versions of the positive sync tips at the grid. These plate pulses are smoothed out by the fast acting filter network connected in the plate circuit, thereby providing a negative *dc* voltage which is applied to the grid returns of the *rf* and *if* stages. In this manner variations in *rf* signal strength are transformed into variations of negative *dc* voltage, the *dc* voltage variations being applied to the grids of the *rf* and *if* tubes.

If, for some reason or another, the incoming *rf* signal should suddenly increase, the grid bias on the *rf* and *if* tubes would also increase, thereby reducing the gain of these tubes by an amount that would bring the video signal at the CRT input back to its original value. Similarly, if the antenna signal should suddenly decrease, the *agc* bias would also decrease, thereby increasing the *rf* and *if* tube gains; again bringing the video signal back to its original value.

## Circuit Analysis

A typical *agc* circuit used in color TV receivers is shown in *Fig. 2.* The video signal from the first amplifier is fed into G1 of V205 via the parallel combination comprising the 22K resistor and 56 $\mu\mu f$ condenser, both in series

with the 27K resistor. Fixed operating bias for this tube is provided by the network comprising the 33K and 47K resistors, and the *agc* control.

The latter adjusts the conducting level of the *agc* tube for the most powerful station being received. In practice, when making this adjustment, the most powerful station available is tuned in, and the control is rotated until the picture contrast and sync appears normal.

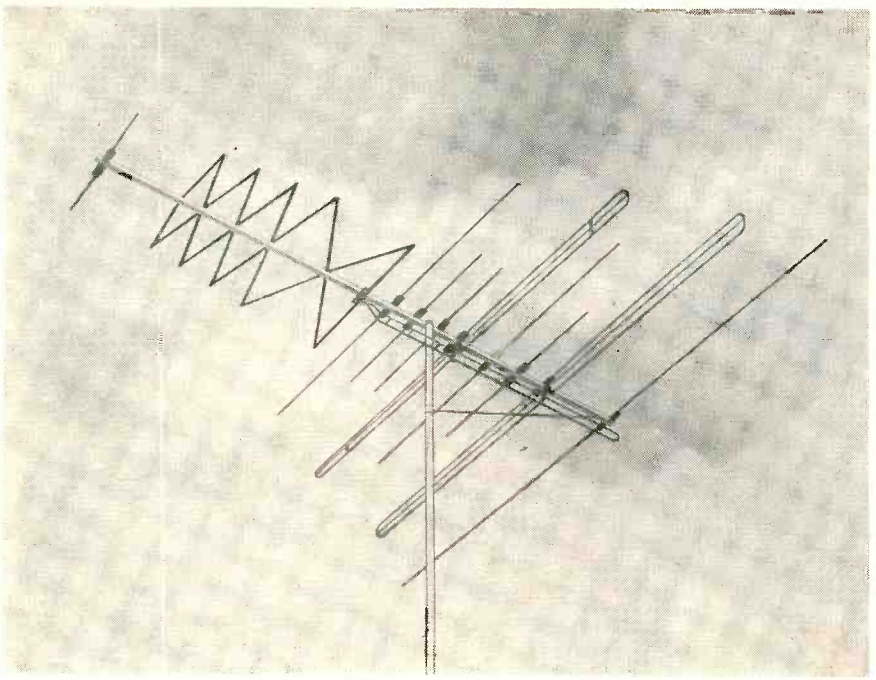
The action taking place during these adjustments is as follows: Starting with the control arm in its maximum clockwise position (grounded) the *dc* voltage drop across the 33K resistor between grid and cathode is a maximum. In this position of the control the bias on the tube is very high, and even during the application of the plate sync pulse the tube is cut off. When the control arm is in its maximum counterclockwise position the voltage drop across the 33K resistor is a minimum, and the tube becomes conductive (that is, during sync pulse intervals).

Relative output *agc* voltages produced by a given signal amplitude for different settings of the *agc* control are shown in *Fig. 3*. The net *dc* operating points shown at (A) and (B) are the resultant grid to cathode voltages developed by the combined setting of the *agc* control, the plate voltage of the video amplifier, and the reference supply voltage (in *Fig. 2* it is 145 volts).

Observe that the same amplitude of input signal (signal 1 and signal 2) can produce different *agc* control voltage values, depending on the setting of the *agc* control. Thus, signal 1 produces plate current pulse 3; and signal 2 produces plate current pulse 4. These plate current pulses in turn produce different *agc* voltages.

In weak signal areas, the best setting of the *agc* control corresponds to (A) of *Fig. 3*. Under these conditions little plate current swing and corresponding *agc* bias is developed. In strong signal areas, the best setting of the *agc* control is in the vicinity of point (B). Under these conditions the *agc* sensitivity is much higher than at (A), and the same value of incoming signal will produce higher *agc* voltages than at (A). Thus, a strong signal will produce a very high

[*Continued on page* 44]



The Wonder-Helix, Model WX811, particularly suitable for deep fringe areas. It features high gain on both bands and a high average front to back ratio.

*The antenna is a vital link in the satisfactory reception of color TV signals. This article describes the JFD NCB (non color blind) series of antennas, for color and monochrome reception.*

By Simon Holzman
*Chief Engineer,*
*JFD Antenna Development Division*

# The JFD NCB Colortenna Series

With the advent of compatible color television, it became obvious that an important decision had to be made. The importance of the choice of an antenna could not be overestimated. The best of color sets cannot give satisfactory results unless the signal at the tuner input is of good quality. Many antennas which gave good performance on black and white transmission would be unusable for color due to frequency hiatus, gain and beamwidth characteristics, and high VSWR.

Rather than attempt to recheck all models and publish a listing, showing which of our present antennas are suitable for color reception, it was decided to design a complete, distinctive series of antennas which would be ideal for both color and monochrome and would cover the problems encountered in most locations from metropolitan to deep-fringe areas. This

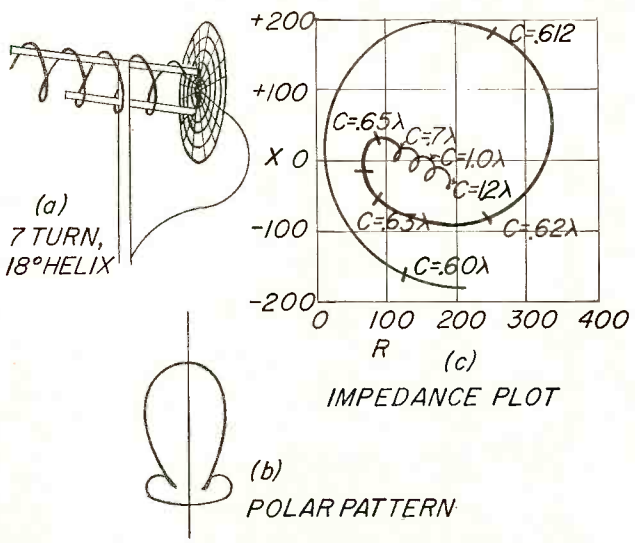



Fig. 1—The circular helix antenna showing construction, and both polar and impedance plots.

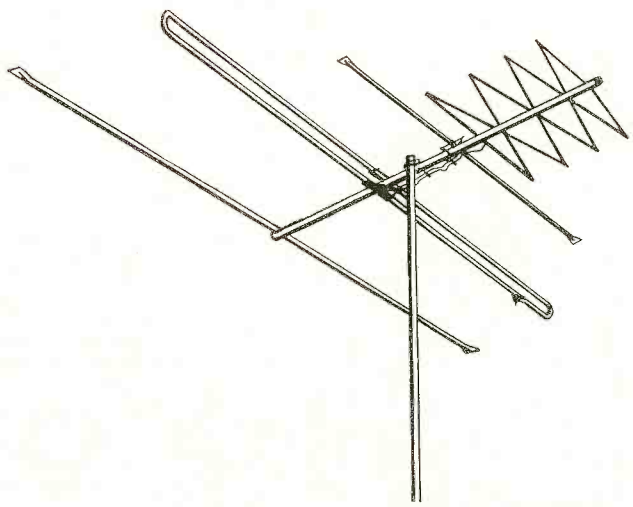


Fig. 2—The Junior-Helix, Model JX311, designed for average strong signal metropolitan areas.

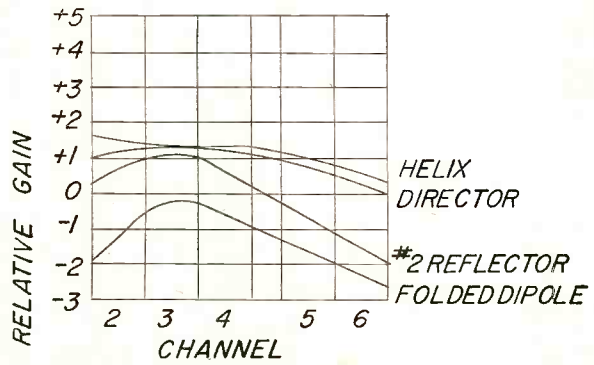



Fig. 3—The reflector in the Junior Helix serves to bring up the gain on Channel 2.

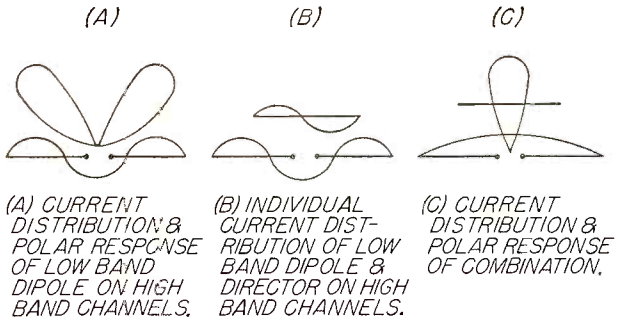



Fig. 4—Current distribution and polar response of individual and combined elements.

group was given the designation of the NCB (non color-blind) Colortenna* series.

The flat-plane helix was chosen as the distinctive high-band receiving element for the entire series. The operation of this element may best be understood by the consideration of the circular helical antenna (*Fig. 1*). The true, or circular helix, has a diameter of $1/\pi$ wavelengths, at least 3 turns, and a spacing of approximately 1/4 wavelength. The polar pattern and impedance characteristic is as shown in *Fig. 1*. It will be noted that this antenna has an almost constant impedance of 150 ohms resistive for circumferences between 3/4 and 4/3 wavelengths. The bandwidth is such that the gain is down only 1 db. at 150% of center frequency. The gain at center frequency is about 8 db.

The major disadvantage of this array from the point of view of television reception is the fact that it is circularly polarized. It will, then, not only receive horizontally polarized television signals, but a good deal of random noise arriving at polarization angles other than horizontal.

By flattening the original cylinder so that the high current points are adjacent to each other, and tapering the dimensions, an element was obtained having high inherent gain, narrow polar pattern, and an extremely flat bandpass characteristic making it ideal for the reception of color as well as monochrome television. The entire NCB series utilize this element, making them instantly recognizable to the service-dealer and the public. Thus, there need be no confusion as to the suitability of an antenna for color reception.

The first antenna in the NCB series is the Junior-Helix, model JX311 (*Fig. 2*). This was designed for use in average strong-signal metropolitan areas. The Junior-Helix uses a 4-turn helix for the high band. The low band element is a 300 ohm dipole cut for the video carrier of Channel 3. The reflector brings the gain up at Channel 2 (*Fig. 3*). The looped element in front of the folded dipole has a dual function. On the low band, it acts as a Channel 5-6 director, flattening the gain curve. On the high band, it acts as a

* Trade name registered.

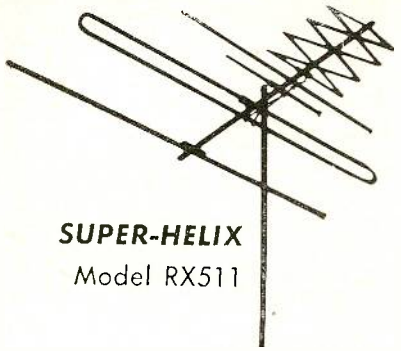



Fig. 5—The Super-Helix, Model RX511, for suburbans.

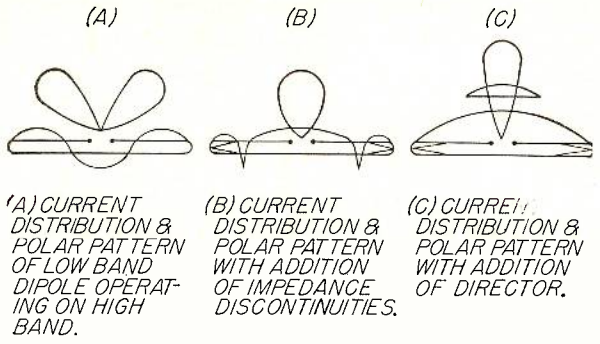



Fig. 7—Third harmonic response is changed to half wave response on low band dipole.

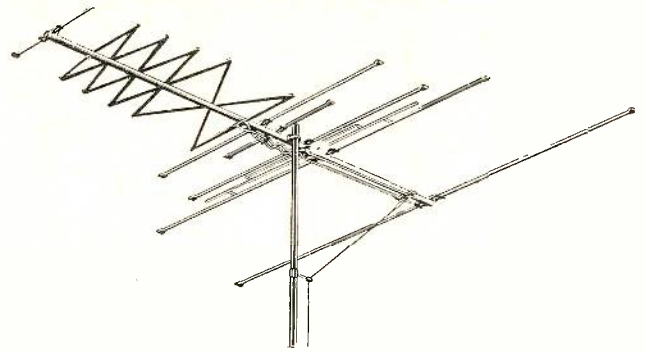


Fig. 8—The Power-Helix, Model PX911, a high gain antenna for fringe to deep-fringe areas.

full-wave element blocking the folded dipole and preventing lobe response on the highs (*Fig. 4*). The helix is connected to the takeoff points of the folded dipole thru a length of open wire transmission line in such a manner that the loop formed by the harness and the last section of the helix acts as a stub cancelling a good portion of the reactance of the folded dipole on channel 5 and 6, thereby giving a relatively flat response curve on both high and low bands.

The second antenna in the series, the Super-Helix model RX511, was designed for use in near suburban areas and ghosty metropolitan areas (*Fig. 5*). The 4-turn helix in this case is combined with a half-wave reflector. This has the dual function of increasing high-band gain and sharpening the polar pattern. The low-band folded dipole has both a Channel 2-3 reflector and a full sized Channel 5-6 director, resulting in a similarly sharpened pattern and somewhat higher gain. The harness length was changed to compensate for the variation in impedance caused by the different loading characteristics of the parasitic elements. The narrower polar pattern is of use in minimizing ghost pickup in reflective areas.

The popular Star-Helix, Model SX711, *Fig. 6,* is a semi-fringe to fringe area antenna. It may be used for master installations in the city and, with appropriate attenuators, in extremely ghosty neighborhoods. The Star-Helix has a full 5-turn helix augmented by a half-wave reflector. In this antenna, full use is made of the high-band pickup of the low-band dipole. As shown in *Fig. 7,* the third harmonic response of the low band dipole is changed to half-wave response by the insertion of sharp impedance discontinuities at the half-wave points. This response is further increased by the use of a high-band director. The high band then, is effectively a helix and reflector in series with a folded dipole and two directors. On the low band, this antenna is equivalent to a four element stubbed yagi having two reflectors, a driven element, and a director, the whole being boosted by the stub formed by the harness and the last section of helix.

The Power-Helix, Model PX911, is next to the last antenna (*Fig. 8*). This antenna is an extremely high gain fringe to deep-fringe model. It consists of a 5-turn helix with both a director and reflector. The low-band portion is a four element yagi utilizing the JFD poly-phase dipole, a stepped, T-matched broad-band element. This antenna has somewhat more gain and flatter response on the low band, and increased gain and directivity on the highs.

Here's the most recent addition to the Colortenna series, the Wonder-Helix model WX811 (*Fig. 9*). To date, most high-gain fringe area antennas were designed for maximum gain on the high band and only moderate to good low band response. The reasoning that justifies this approach is correct in that the higher frequencies are attenuated more rapidly with distance and are more easily absorbed by intervening man-made and natural obstructions. The design considerations are also somewhat simplified in this type of array since the low band loading is kept down and the harmonic response of the long elements may, as a rule, be added to the signal received by the high band elements. In some models, there is no separate 7-13 driven element. The total high band response is derived from the low frequency drivers by means of phase reversal elements and added parasitics.

In many areas of the country, it was found that the high channel gain was more than adequate, but there was a definite need for better low channel operation. With these facts in mind, the Wonder-Helix was designed.

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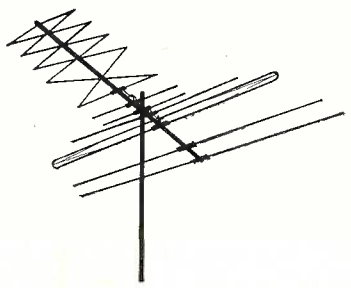


Fig. 6—The Star Helix, Model SX711, designed for fringe and semi-fringe applications.

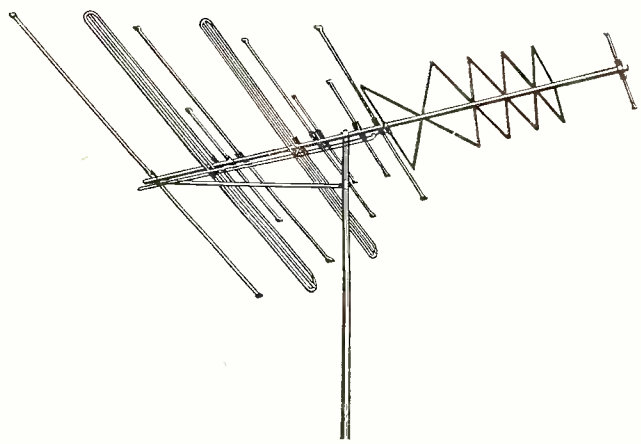


Fig. 9—The Wonder-Helix, Model WX811, designed primarily for deep-fringe areas.

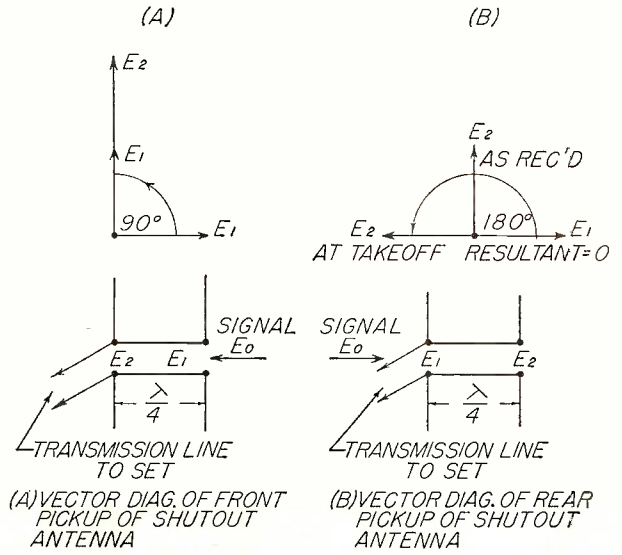



Fig. 10—Vector diagrams illustrating the operation of the Shut-Out Helix type of antenna.

## ANSWERMAN

[*from page* 19]

It has been found that where the brightness on a picture tube seems to be insufficient, a bad ion trap can be responsible for the condition. Substitution of another known good ion trap magnet is perhaps the best method for checking this possibility. Another point with respect to this is that the reversing of the ion trap magnet position on the tube neck can make a notable difference sometimes. The reversed magnetic field may allow an increase in brightness as well as a better focus of the picture. Generally, the red dot on the magnet should be towards the rear of the picture tube.

Circuitwise there are definite possibilities that can also be looked into. In examining Fig. 2 it will be observed that a coupling condenser, *C136,* is employed from the center of the contrast control to the cathode of the picture tube. Should the condenser become leaky, it will apply a positive voltage, higher than normal, to the cathode of the picture tube. This will bias the picture tube current so that at the full brightness position of the control the picture brightness will not be satisfactory. Should the .1 *uf* condenser (*C136*) be shorted an unusual symptom that can be easily recognized will become evident. In this case, with the receiver in operation on an unused channel, rotate the brightness control to maximum. Adjust the contrast control from maximum to minimum and observe the picture tube. Should the brightness on the picture tube decrease it will be a rather conclusive indication that condenser *C136* is defective. ■■

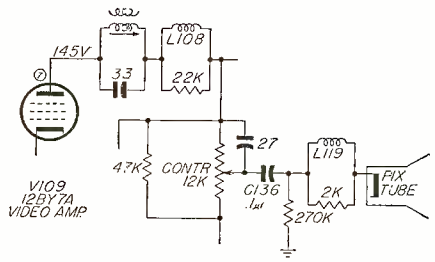
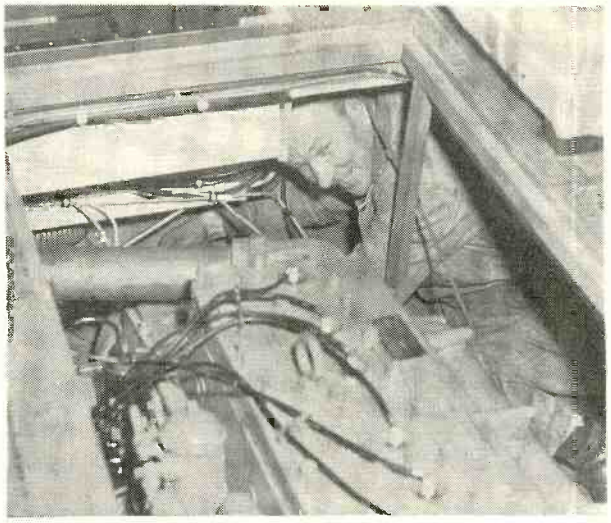



Fig. 2—Partial schematic of video output circuit.

Placing equipment as shown allows concealed wiring within cabinet. It should also be convenient to batteries, antenna, and ground.

Place equipment so that it is accessible for servicing. Heavy paper or a towel should be used to protect varnish finishes.



The wiring on many boats is a scramble. Try to install yours so that it is safe and accessible. Use adequate clamps and supports.

# MARINE ELECTRONICS

Part Five

by **ELBERT ROBBERSON**

*Factors involved in the placement of marine radiotelephone equipment are discussed. Both technical considerations and the desires of the owner of the vessel are fully dealt with.*

THE first, and often the most important step in installing any kind of marine electronic equipment is a preliminary survey, preferably conducted with the owner of the boat. After you have amassed a store of information and experience, this may not be essential in the case of every familiar stock boat, but, at first, the practice of conducting this initial survey should be strictly followed on every job.

The advantages are multiple. By agreeing exactly where and how the equipment and wiring is to be installed, chances of later disagreement and expensive rework is eliminated. Also, by looking the job over carefully in advance, the installer will not find himself planning to put a unit in a certain space, and then finding that under the panelling a pipe or some other object already occupies the space, or that, in order to get power wiring into the equipment, umpteen inaccessible hardwood panels must be pierced.

There are two sides to selecting the proper placement for marine electronic equipment: first the desires of the owner, which are concerned mainly with appearance and operational convenience, and, second, the technical aspects, which you are expected to know better than he. These may be at cross purposes, so that many installations represent a hard-won compromise.

For example, the radiotelephone location that is most convenient to batteries, ground connection, and antenna may be objectionable to the owner for some reason connected with the decor of his vessel, or it may not be convenient to operate while he is at the helm of the boat. In such cases, I have always tried to locate equipment so that technical requirements are best met, and then, if control of the gear at some other point is desired, to install a remote-control unit at this other point. Since this plan acually gives the purchaser better utilization of the investment he has made, I have found it good practice to "stick to your guns" as much as possible in holding out for locations which are technically the best.

In making the survey it is a good idea to have the actual equipment with you in order that it may be held in place, and the practicality of arrangements judged on the spot. If the equipment is heavy or bulky, using the empty cabinet alone for this purpose aids visualization far more than measurements with a ruler. An alternative to this method is to use a cardboard "mock-up" of the cabinet, which can be collapsible and easily carried.

From the technical standpoint, the item of next importance to proximity of batteries, ground, and antenna is the ease with which the gear can be serviced, once it is in place. Like any other electronic equipment, marine radiotelephones require periodic maintenance, and after the equipment has been installed, if it is almost impossible for a service man to have convenient access to all sides and parts of the set, keeping it operating will be a headache. For example, when I first started installing marine equipment, I screwed down a marine radiotelephone on a high shelf. By cocking an eye over the top of the panel I was just able to see the insides of the set to make adjustments. Several years later, the same boat came back to me for service, and I found, much to my chagrin, that my eyesight had changed, and with my face in the same spot at the top of the panel, my eyes would no longer focus on the tuning controls

inside. Be guided accordingly: give yourself working room!

It is often asked whether the installation of radiotelephone equipment will affect the steering compass. Technically, this is possible, and the only method of determining for sure, is to place the set in the proposed location, and at the same time, to note if he compass deflection is affected in any way. In case there is a question, this test should be made with the boat headed first north or south, and then with the boat headed east or west. From a practical standpoint I have found that conventional marine radiotelephone equipment does not materially affect the compass if a separation of at least a couple of feet is maintained from the compass.

The speaker magnet and steel cabinet are not the only possible sources of compass interference. The magnetic field around current-carrying wires can also affect compass accuracy if they are closer than this critical spacing. The least effect is attained when direct-current wires are twisted or else run very closely parallel. Since field area is relative to the spacing of the two conductors carrying the current, power feed lines should never be separated more than the thickness of the necessary insulation, especially in the vicinity of the compass.

## Power Wiring

Voltage drop in power wiring depends upon conductor length, resistance and current flow. Thus, with a given current, a 115-volt load may be such as to cause a drop at an appliance of say, 2 volts—less than two percent—certainly nothing to be concerned about. However, at the common battery level of 6 volts, the same current load will cause an identical drop of 2 volts—or 33 1/3%— which is enough to lower transmitter output quite seriously. Therefore, marine-radiotelephone power leads must always be quite heavy. The maximum voltage drop, under full load, should never be more than 10%, and half this figure is much to be preferred. The gage of the conductors may be computed by the formula:

$$cm = \frac{10.75 \times I \times L}{E}$$

Where: cm = circular-mil area of conductor
I = load current in amperes
E = tolerance voltage drop at load in volts
L = total length of wire. In a single wire system this length is equal to the distance between the equipment and the voltage source. In a two wire system this length would be *twice* the distance between the equipment and the voltage source.

The gage of wire for the required mil-area can be found in *Table 1*. In making the cable-length measurement, be sure you make allowance for all of the turns and zig-zags the wire must follow. As a general

rule, the figures given in *Table 2* can be used as a guide for choosing cable of the proper gage to prevent excessive voltage drop.

Two-conductor cable of the heavy gages usually required for marine radiotelephone power wiring is generally not available, so it is necessary to use two single wires to make up the power feed. In many instances, it is possible to route this cable so it will automatically be protected from sharp corners, contact with other metal, or abrasion from movable objects such as boat controls, drawers, etc. In such cable installations it is ordinarily sufficient to strap the cable in place, preferably with plastic or rubber-protected metal straps. Fastenings should be spaced closely enough to bear the mechanical weight of the cable and to prevent its looping down and getting out of place. However, in some spaces, it may be necessary to construct a wooden raceway or duct to make sure the cable is not exposed to any outside hazard.

Heavy-wall metallic conduit is not ordinarily used because it encourages condensation of water, which will collect in low spots and damage cable insulation. However, the newest types of thin-wall conduit are less susceptible to this trouble and in special cases, may be used to advantage. Easier to use, however, and about as effective for cable protection, is flexible non-metallic conduit or "loom." In spots where it is difficult to snake the power cabling past a number of projections, a piece of large flexible non-metallic conduit may first be routed through the cable path, after which the individual conductors may fairly easily be pushed through the conduit. This operation may be performed most easily by first pushing a heavy and strong lead wire or "snake" through the conduit, and then using this lead to pull the pre-cut pair of actual power wires on through. Then the non-metallic conduit may be formed into its final position and strapped securely in place.

The terminal connections of such heavy cable are quite often a problem. Connection must usually be made to screw or bolt-type terminals, and the size of the wire, of course, prevents simply wrapping the

Table 1—Wire Gage for Mil-Area:

| Wire Gage | Mil-Area |
|---|---|
| 4/0 | 212,000 |
| 3/0 | 168,000 |
| 2/0 | 133,000 |
| 1/0 | 106,000 |
| 1 | 83,700 |
| 2 | 66,400 |
| 3 | 52,600 |
| 4 | 41,700 |
| 5 | 33,100 |
| 6 | 26,300 |
| 7 | 20,800 |
| 8 | 16,500 |
| 9 | 13,100 |
| 10 | 10,400 |

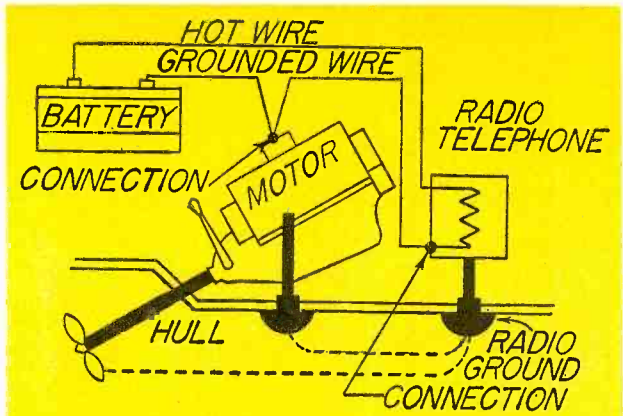



Fig. 1—The ground circuit should never be fused. A blown fuse places battery voltage between equipment ground and underwater parts, resulting in electrolytic deterioration.

cable around the terminal, and then tightening. It is therefore necessary to use lugs for connection. Soldering heavy connectors on a boat is a nuisance, although it can be done. A small alcohol torch will do the job, (suitably protected from breezes) and, naturally with great precautions as to the fire hazard. There are also chemically operated soldering irons which might be pressed into service. In emergencies, I have used a resistance-soldering arrangement using 6-volt battery current applied to the work through heavy cables, and a pointed carbon from a standard flashlight cell held in a pair of vise-grip pliers for the heat element. Connect one side of the battery to the heavy lug and the other to the vise-grip pliers holding the carbon electrode. Touch the electrode to the side of the lug and terrific heat will ensue, permitting solder to be run into the lug. Because this places quite a drain on the battery, this system should not be employed except in case of emergency, and be careful of your eyes—wear glasses, preferably dark tinted.

Much better is the use of terminal lugs of either the crimp-type or the screw-squeeze types. These require no heat and can be tightened with the crimp tool, or a pair of pliers or screwdriver. Several manufacturers produce suitable lugs and crimp tools.

Power cables should have no splices or other discontinuities. However, in the event that a splice is absolutely necessary, the safest place for it is on a terminal block, protected by a conduit-type splice box. Another fairly satisfactory splice can be made by using lugs on the ends of the wires, then bolting them together and protecting them with a heavy layer of plastic insulating tape. As a last resort, the wires may be twisted in the old Western-Union splice, then soldered by one of the above methods, and heavily taped.

Sometimes the equipment terminals are not heavy enough to accommodate cable of the size which must be used. In this case, the main cables can be terminated at a suitable connection block close by. The block should be of a protected type so terminals will not be exposed to accidental grounding. Short lengths of lighter gage cable can then be used to connect across to the terminals on the equipment, or power source. This kink is often very useful for attaching heavy power leads to radiotelephone equipment which must be pulled out from its cabinet for servicing. It is much easier to manipulate the equipment when it is attached by comparatively light pigtails, than if the heavy cables are directly connected. As long as these pigtail cables are no longer than absolutely required for movement of the set (no more than a couple of feet), the voltage drop will not be significant.

## Circuits

Power input to marine radiotelephones must be of the proper polarity, and it is easiest to make sure that no mistake will ever be made if the two feed wires are colored differently, or if one of them has some distinguishing feature, such as a tracer. Another means of marking cables for polarity is to affix tape bands on their ends. To make identification automatic, similar tape spots can be affixed to the corresponding equipment terminals.

Where to connect to the battery source is often a problem. As a general rule, cables should not be attached to the battery terminals themselves because there they will be exposed to acid and fumes, and may possibly be connected improperly if the battery is removed for charging or other servicing. A better spot to connect are the points on the engine to which the main battery cables are connected. One cable from the battery will be grounded to a point on the engine block. The other usually goes to the solenoid of the starter motor. If it is at all possible, connect your ground lead under the same engine stud that is used for the main battery lead. If this is not feasible, connect to a similar stud as close to the other as possible, in order not to have too much iron, corrosion, rust, and paint in the circuit. Now, suppose the solenoid terminal, or "hot" feed point, is already so overcrowded

[*Continued on page 37*]

Table 2—Conductor Sizes for Amperes—Lengths:

| Total Current in Circuit In Amps. | Length of Conductor in Feet from Source of Current to Most Distant Fixture | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| | 6 Volts Two-Wire—10% Drop | | | | | | | | | | |
| 5 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 |
| 10 | 14 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 15 | 12 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 |
| 20 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 3 |
| 25 | 10 | 8 | 6 | 6 | 4 | 4 | 4 | 4 | 3 | 3 | 2 |
| | 12 Volts Two-Wire—10% Drop | | | | | | | | | | |
| 5 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 |
| 10 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 |
| 15 | 14 | 14 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 |
| 20 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 25 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 4 |

**Mfr:** Raytheon **Chassis No.** 21T42

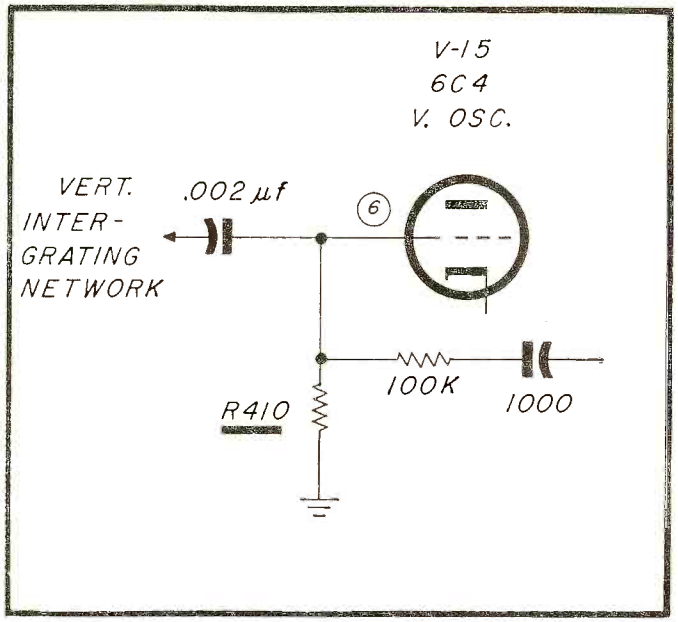
**Card No.** RA 21T42-1

**Section Affected:** Sync

**Symptom:** Poor vertical oscillator stability.

**Reason for change:** To improve vertical oscillator stability.

**What to do:**
Change: *R410* (47K) to 100K ohm.




**Mfr:** Raytheon **Chassis No.** 21T42

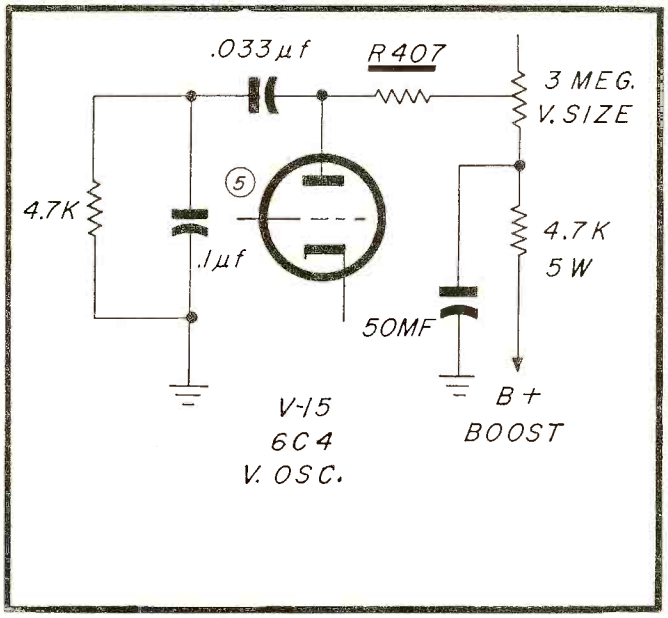
**Card No.** RA 21T42-2

**Section Affected:** Raster

**Symptom:** Insufficient vertical size.

**Reason for change:** To increase vertical size.

**What to do:**
Change: *R407* (3.9 megohm) to 3.3 megohm




**Mfr:** Raytheon **Chassis No.** 21T42

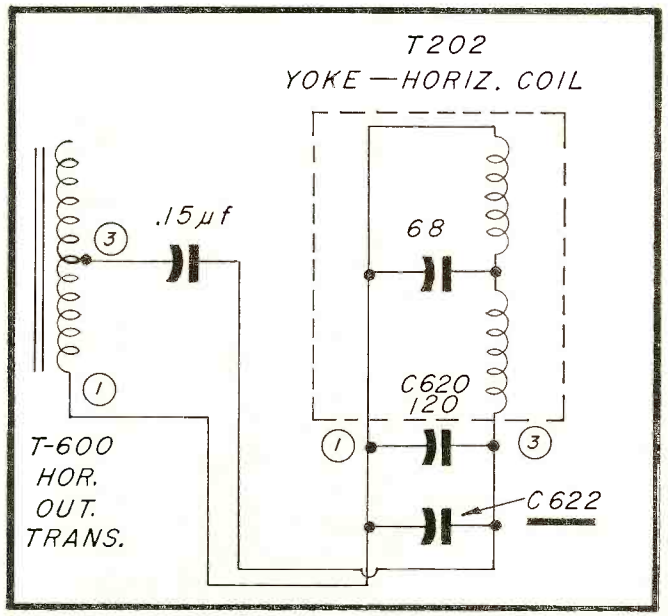
**Card No.** RA 21T42-3

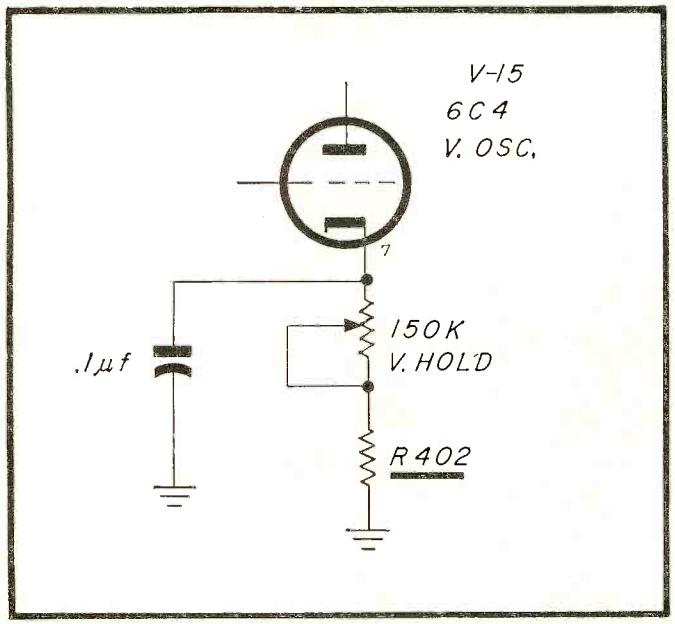
**Section Affected:** Raster

**Symptom:** Insufficient horizontal size.

**Reason for change:** To increase horizontal size.

**What to do:**
Add: *C622* (22 µf, 5000 volt) in parallel with *C620* across yoke winding.






**Mfr:** Raytheon **Chassis No.** 21T42

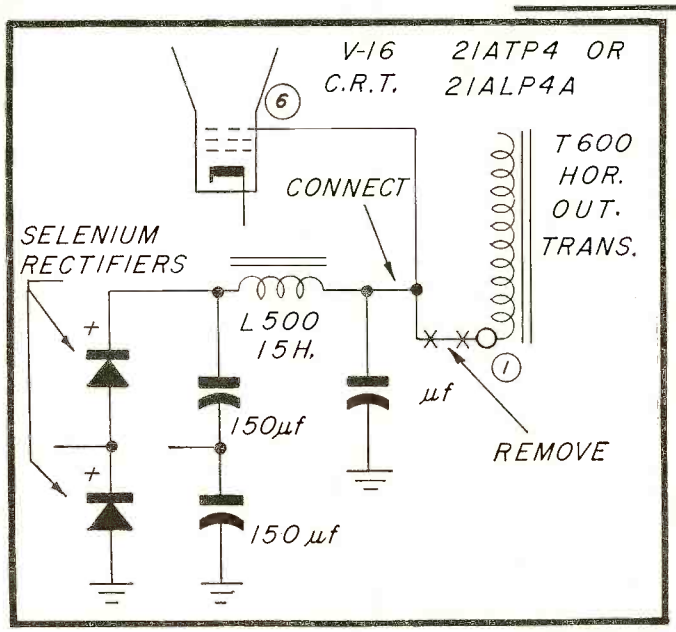
**Card No.** RA 21T42-4

**Section Affected:** Sync

**Symptom:** Poor vertical sync.

**Reason for change:** To improve vertical sync.

**What to do:**
Change: *R402* (68K) to 75K ohm.




**Mfr:** Raytheon **Chassis No.** 21T42

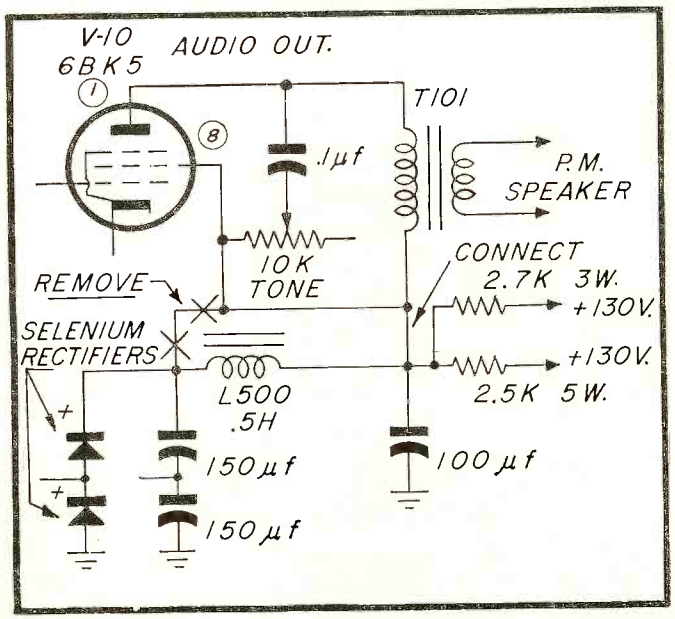
**Card No.** RA 21T42-5

**Section Affected:** Pix and/or raster

**Symptom:** Poor picture focus.

**Reason for change:** To improve picture focus. (Chassis so modified are coded 725.)

**What to do:**
Rewire: CRT pin 6 from boost B plus to 245 volt B plus.




**Mfr:** Raytheon **Chassis No.** 21T42

**Card No.** RA 21T42-6

**Section Affected:** Sound

**Symptom:** Audio hum.

**Reason for change:** To reduce audio hum. (Chassis so modified are coded 935.)

**What to do:**
Rewire: Primary of audio output transformer T101 from 255 volt B plus source to 240 volt B plus source.

**Mfr:** Sylvania **Chassis No.** 1-521 series

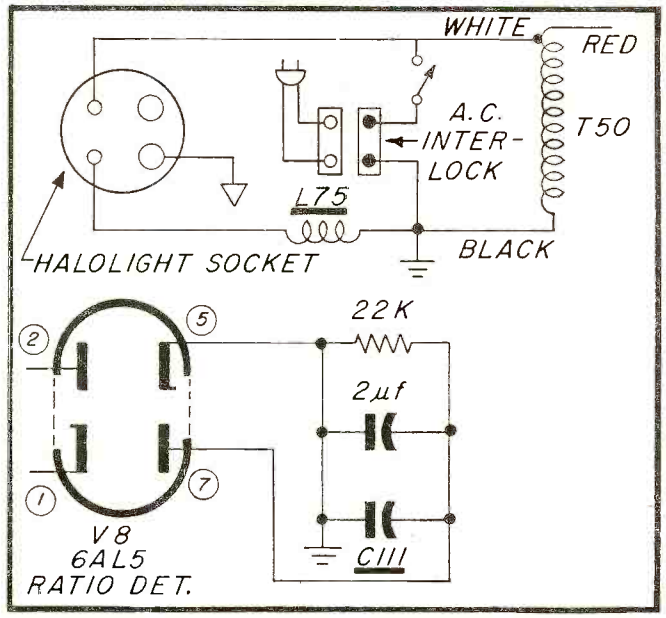
**Card No.** Syl 521-7

**Section Affected:** Pix and sound

**Symptoms:** Oscillation on Channel 2 through 6, or Mush on Channel 4 when operating with built-in antenna.

**Reason for change:** Production change to improve circuitry and eliminate above described condition.

**What to do:**
Replace: C111 (150 $\mu\mu f$) with a .001 $\mu f$.
Add: *L75* choke in heater lead to Halolight socket. (Sylvania part number 147-0014)

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**Mfr:** Sylvania **Chassis** No. 1-521 series

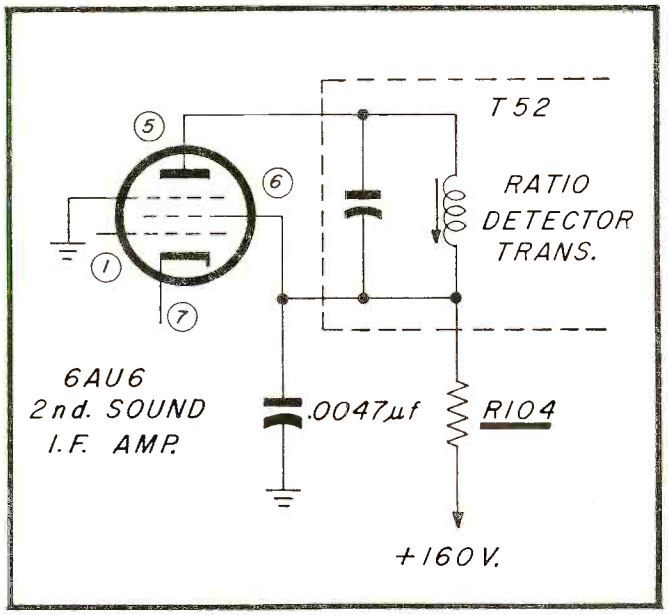
**Card No.** Syl 521-8

**Section Affected:** Audio

**Symptoms:** Sound output is low, picture information is normal.

**Cause:** The B plus feed resistor has increased in value decreasing the voltage to the 2nd sound *if* amplifier.

**What to do:**
Replace: *R104* (2.2K ohms).

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**Mfr:** Sylvania **Chassis No.** 1-521 series

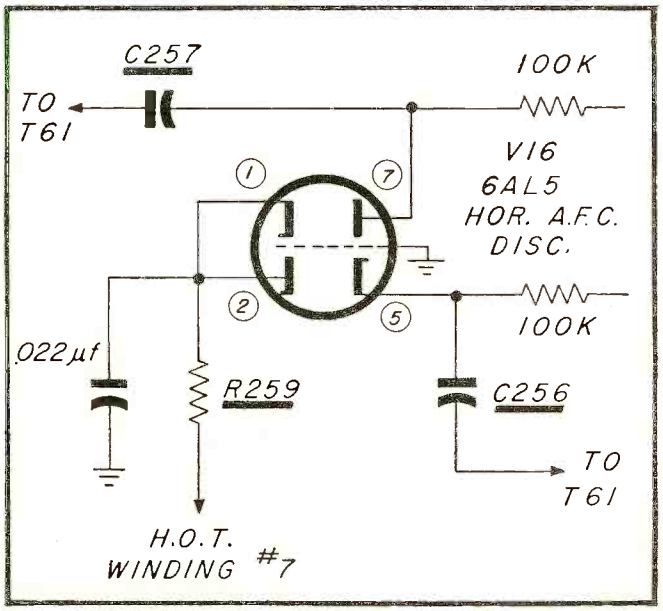
**Card No.** Syl 521-9

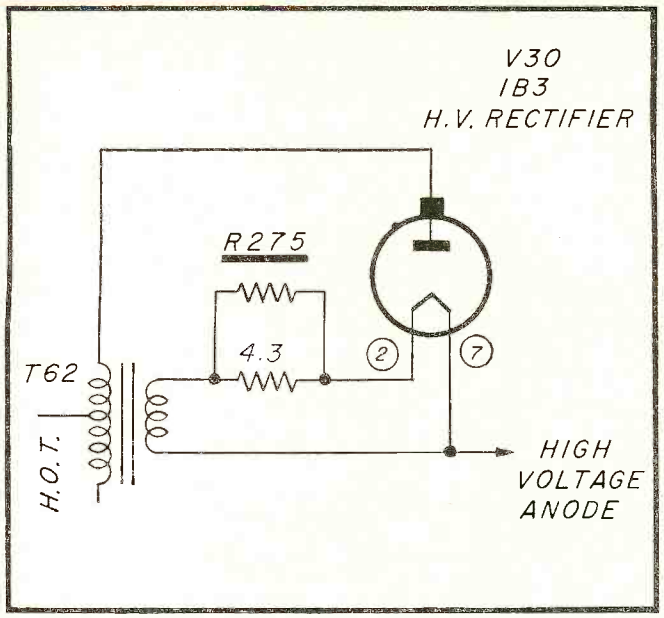
**Section Affected:** Pix and raster

**Symptoms:** Ragged edge on raster and line tear.

**Reason for Change:** The horizontal sync lock-in action is improved.

**What to do:**
Change: *C256* (.001 $\mu f$) to .01 $\mu f$.
*C257* (.001 $\mu f$) to .01 $\mu f$.
*R259* (1.8K ohms) to 3.3K ohms.






**Mfr:** Sylvania **Chassis No.** 1-521 series

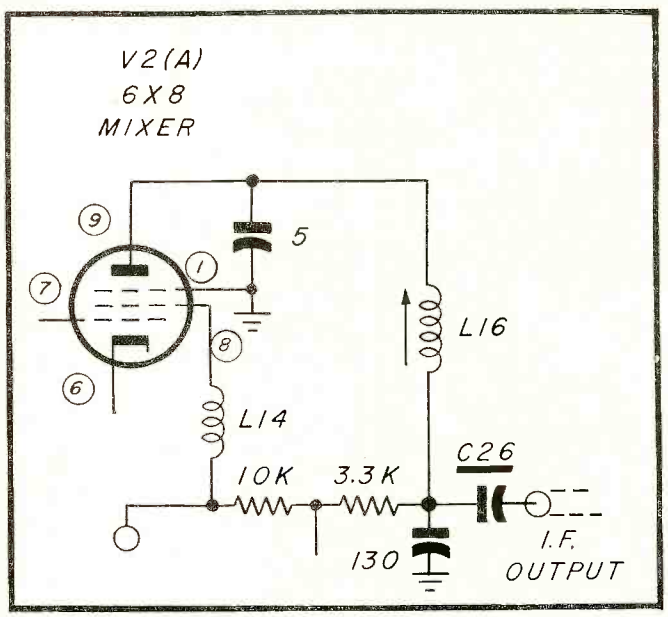
**Card No.** Syl 521-10

**Section Affected:** Raster

**Symptoms:** Picture blooming.

**Reason for change:** To increase the filament voltage to the high voltage rectifier tube.

**What to do:**
Add: *R275* (15 ohms) across 4.3 ohm filament dropping resistor.




**Mfr:** Sylvania **Chassis No.** 1-521 series

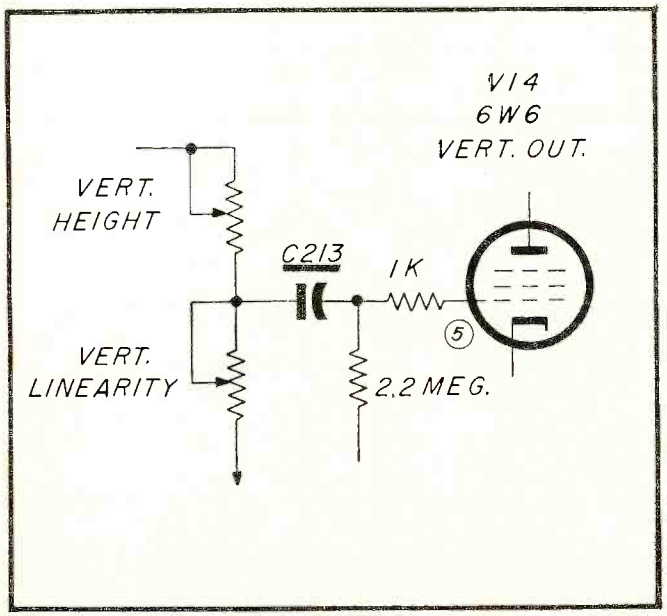
**Card No.** Syl 521-11

**Section Affected:** Pix and sound

**Symptoms:** Over-driven picture and slight buzz in sound.

**Cause:** Coupling condenser in tuner has developed leakage reducing the negative *agc* bias.

**What to do:**
Replace: *C26* (1000 $\mu\mu f$).




**Mfr:** Sylvania **Chassis No.** 1-521 series

**Card No.** Syl 521-12

**Section Affected:** Pix.

**Symptoms:** Vertical linearity cannot be made satisfactory.

**Reason for Change:** Coupling condenser to the vertical output stage has become leaky decreasing the grid bias.

**What to do:**
Replace: *C213* (.47 $\mu f$) with a .22 $\mu f$.
Note: The use of the smaller capacitance will also improve vertical linearity.

## MARINE ELECTRONICS

[*from page* 32]

that your connection cannot be safely made to it. In this case, a simple rearrangement will give room, not only for the radiotelephone, but also for other equipment which may be installed later. A piece of heavy brass strip should be drilled to accommodate a number of terminal screws. Then, remove all of the cluster of wires on the "hot" terminal, and in their place install your terminal strip, or "bus." The myriad of wires can then be connected to individual screws on the new "hot bus."

Because of the size of high-current fuses and their voltage drop, fuses are not ordinarily used in radiotelephone wiring. However, it does make sense to use either a suitably heavy fuse block or circuit breaker in the "hot" lead of the radiotelephone power circuit. The fuse block should be at the battery end of the circuit and enclosed in a protective box, and the fuse itself should, of course, be large enough to pass full load current without overheating or bringing the voltage drop above the tolerable amount. *Never fuse the ground circuit.* The diagram (see *Fig. 1*) shows the reason why. In a radiotelephone circuit any discontinuity in the ground circuit, whether it be from a corroded connection, broken wire, or a blown fuse, will place the full battery voltage between the radiotelephone ground and the engine's underwater appurtenances. Rapid electrolytic deterioration of underwater metal will result, and this is a danger which could lead to actual sinking of the boat. If you are ever called upon to service equipment in which the ground circuit has been fused, it is your duty to point out this danger to the boat's owner, and to strap the fuse out of the circuit.

In connecting the equipment, first attach the battery-ground power lead at both ends. Then attach the "hot" wire at the equipment end (with the equipment turned "off"). At the power-source end of the "hot" wire, first touch the cable end to the power terminal and see if there is any indication of current. If not, connect an ammeter between the power (battery) connection and the radiotelephone cable, and make sure there is no current flow, stepping the meter down into the 10-milliamp range. Indication of any current flow at this point means trouble, either cable leakage or a fault in the set, and should be traced out and the current flow reduced to zero. After it is certain there is no leakage current, permanent connection may be made.

Then, at the equipment, measure the power-feed voltage, and make sure polarity is proper. Some equipment has floating input so that no other check is necessary. However, other sets, particularly small ones using vibrator power supplies, may have the input circuit grounded internally. In this event, make sure that the internal ground polarity conforms to the grounded polarity of the battery-power source. If it happens to be opposite, as might be the case one-half of the time, the equipment ground polarity can be reversed, either by reversing the power-supply vibrator in its socket or taking other steps which will be specified in the equipment instruction book.

Lastly, the telephone should be turned on with the voltmeter still attached to the input terminals. If the voltage is up to the specified level, you have done the job properly.

The next stages in installing a marine radiotelephone will be covered in subsequent parts of this series. ■■

## THE JFD NCB COLORTENNA SERIES

[*from page* 24]

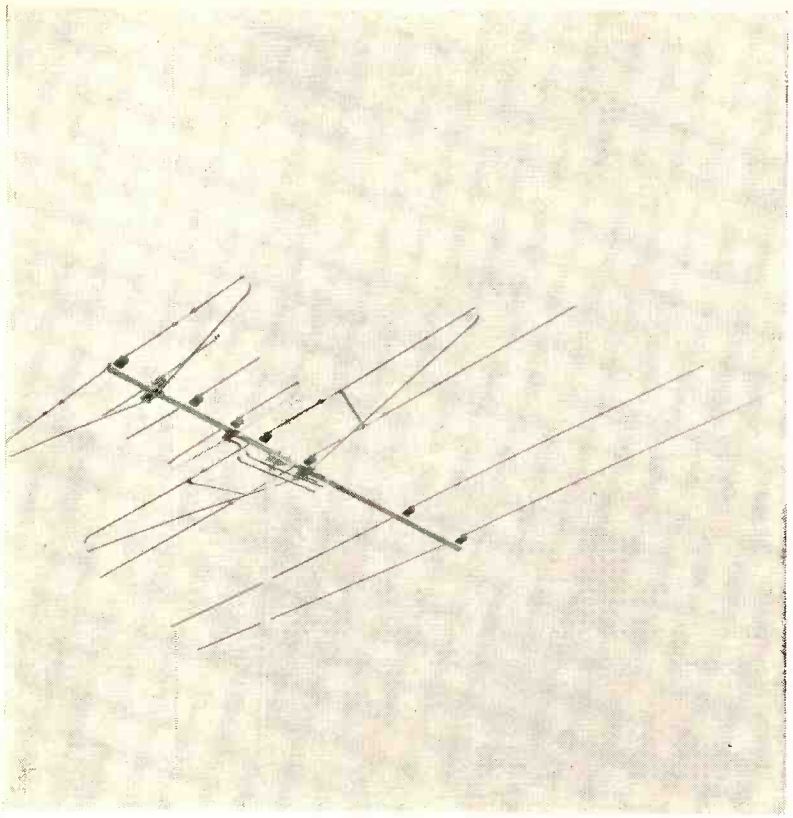
This antenna is fairly complex in view of the many interactions that take place between its elements. On the low band, it is inherently a double driven five element broad-band yagi. The driven elements, 600 ohm dipoles, are cut for Channel 2 video and Channel 5 sound. The use of 600 ohm dipoles makes possible a close 300 ohm impedance match despite the loading effects of the parasitic elements. A Channel 2 reflector and a Channel 5-6 director bring up the ends of the range. A diflector (director-reflector) between the two dipoles gives us the increased gain in the center of the band.

The addition of a 5-turn helix was the major critical design factor. To prevent side-lobe pickup and maintain sharp high-band directivity, it was necessary to add phasing elements to each of the dipoles as in *Fig. 7*. The length of the helix phasing harness was chosen in such a manner as to compensate for the reactance present at the terminals of the forward dipole. A shorted stub was added to the rear dipole for much the same reason. Effectively, then, the helix is in combination with a director and two reflectors.

At this point, it became evident that the helix portion looked back into a reactance formed by its harness and the forward 600 ohm dipole. This reactance did not match the characteristics of the helix. For this reason, the effective high frequency stub length of the front dipole was varied by means of a shorting bar placed across the dipole at both ends and positioned for the best match.

Because of the locations of the parasitic elements, this antenna has a comparatively high average front-to-back ratio. Its application is in far-fringe areas.

[*Continued on page* 42]



Shown above is the New Zephyr-Mite model ZM-1 antenna incorporating the "Wing" dipole and "Wing" director.

*A single closed stub with a "Wing" director provides high gain and a flat response without bulk in the Zephyr-Mite.*

# Flat Frequency Response in Single Dipole Antenna

by **JOHN F. GUERNSEY**
*Trio Manufacturing Co.*

THE old problem of securing broad band operation in a single dipole antenna has long plagued television engineers. This problem has been satisfactorily solved in the Trio Zephyr-Mite through the combining of a well-established antenna principle with a new engineering development. The Zephyr-Mite obtains its flat frequency response through the use of the well-known principle of stub matching in combination with a "Wing" director—a composite director specifically designed to function efficiently with the "Wing" dipole.

In the design of all-channel antennas great effort has been made to obtain a flat frequency response over the *vhf* spectrum with a minimum of compromise on any one channel within this spectrum. The advent of color has made the necessity of flat response more important than ever.

Previously, the problem of broad-banding has been accomplished by multiple dipoles with great success. This procedure is normally used in the higher gain or larger type of arrays. This problem cannot be so readily met in the smaller or lesser gain antenna where both size and price dictate the use of single driven elements. In the past, antenna of this class, with regards to the low band channels, find good gain on one channel but then have a tendency to fall off on the adjacent channels by as much as 2 to 3 db. The problem of broad-banding, when using a single resonant dipole, arises because of the decreasing resistance and increasing reactance as one deviates to one side or another of the self-resonant point of the dipole.

In the design of Trio's new Zephyr-Mite, which is in the class of single dipole antenna, a solution of this problem is obtained by the use of closed, single stub matching. It must be kept in mind that some compromising is necessary in the same manner that is anticipated in the lowering of the Q in a tuned circuit for greater band pass. Through experimentation it was found that a closed stub 48" in length with the feed line take off point being 26" from the closed end, as shown in *Fig. 1*, gave excellent results with regards to Channels 2 and 3, which normally is the weakest end of most single dipole antenna. This procedure gave a minimum of compromise on Channels 4, 5, and 6.

When classifying antennas as all-channel, it is normally assumed that they function satisfactorily on all *vhf* Channels 2 to 13, exhibiting good gain, impedance, and pattern. This is usually accomplished by means of various designs of composite dipoles which have been designed to function effectively on both bands, Channels 2 thru 6 and Channels 7 thru 13. Trio obtains this dual operation with their composite dipole referred to as the "Wing" dipole. Through past use of the dipole in Trio's Zephyr and Zephyr Royal, it has been found most effective as a composite dipole on Channels 2 thru 13. Since gain is an important factor in the design of antenna, the engineer must take every opportunity to improve the gain without increasing the bulk or size of the antenna. In mentioning how improved impedance match of the "Wing" dipole was obtained when used singly in an antenna, it will be recalled that the distance between leadin take off, and the closed or shorted end of the stub was 26". This 26" is also the proper length for a dipole tuned to Channel 13. To increase the gain of the antenna on Channels 7 to 13 it seemed feasible that, since the stub was the same length, it could easily be converted into a Channel 13 dipole, and with the proper selection of spacing between the "Wing" dipole

[*Continued on page* 46]

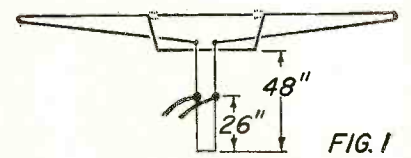



FIG. 1

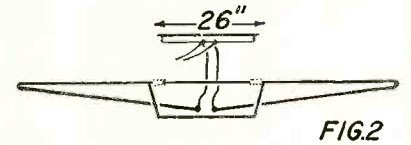



FIG.2

FIG.3

FIG. 4

Figs. 1 to 4 show the use of stub matching and a "Wing" director to achieve the wide band response and high gain of the Zephyr-Mite.

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*Reg. trade mark for volt-ohm milliameter.

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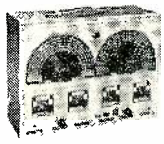
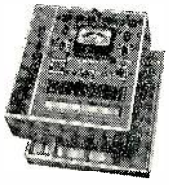


### MUTUAL CONDUCTANCE TUBE TESTER — EMC Model 206 P



One of the finest pieces of tube testing equipment at a price comparing favorably with emission-type testers. This completely flexible model using lever-type switches offers extremely accurate results with ease of operation.

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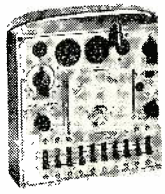

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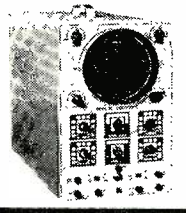

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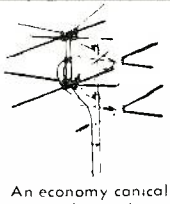

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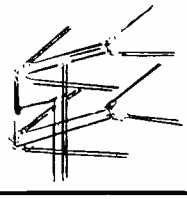

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# RIDER SPEAKS

by JOHN F. RIDER

*"Dean of America's Radio Servicemen"*

HAVING described the conditions which surround factory service in the previous installment, let's look at what the servicing industry can do to maintain its position, if not increase its stature.

Let's take a case in point, the city of San Antonio, Texas. Factory service hits the town. After a great deal of thinking and discussion, the owners of five independent TV service shops decide that it makes sense to discontinue individual operations and get together to function as a single large unit. Resources are pooled; a new corporation is formed, and a new building leased to house the effort. It is equipped with the testing devices originally in the possession of the five separate concerns. Operations are not limited to TV servicing. All kinds of electronic equipment are serviced—home radios, auto radios, portable radios, hi-fi systems, tape recorders, record players, intercommunication devices and everything else which falls in the realm of electronic servicing—even industrial electronics wherever possible.

Service is rendered on a basis of two shifts—from 9 in the morning until 11 o'clock at night and it is available six days a week. To serve a widespread area the service trucks are radio dispatched, using the 450-470 *mc* citizens radio band.

The officers of this firm expressed no fear whatsoever of factory service. They found that they could sell all-around competent service on all kinds of equipment. Service at hours during which the usual factory branch could not or would not operate was important to the public. Results achieved in a relatively short time of operation are gratifying, and the operation is gathering business which otherwise would have gone to factory service organizations.

Lest you get the wrong impression, this activity is not a cooperative. It is an enlarged operation which functions more effectively than five individuals competing with each other. Their sources of supply for components and everything else used in servicing are still the distributors in San Antonio.

Let's consider another town, Phoenix, Arizona. Factory service exists in that town, too, but the independent servicing dealers in that rapidly growing community are selling themselves to the public. All kinds of electronic devices are being serviced. Service business is plentiful—the problem is to get enough competent technicians. Although the factory service exists, it has in no way limited the capabilities of the servicing operators in expanding their activities. It is interesting to note that in one city in the United States a factory service branch ceased operation because its major competition were part-time technicians who worked in the local electronic equipment factory. The established service shops did enough business to make the factory service branch a loss operation, and it closed. In other words, factory service operation is not something which is so strongly entrenched that only the curtailment of independent activity can be the outcome.

In our travels throughout the country we have spoken to many operators of service facilities who now do all kinds of electronic equipment servicing. Naturally, they don't like factory service, but they have not allowed it to frighten them. Some of them said that it took a little while for the public to be cognizant of their expansion in terms of the kinds of equipment they service, but little by little their roster of customers grew, and the presence of factory service was taken in stride.

We don't kid ourselves about a service call taken by a factory not being a service call lost to a service shop. However, factory service can't get all the business. Moreover, competition with factory service is not an impossible task. A factory service operation must be profitable, therefore the charges made for service by these organizations is not cut-throat. Independent shops can do similar work, if not better work, and make a profit while charging less than the factory service operation. But the independent must work with equally effective tools—test equipment and service information. The phrase "factory service" carries a lot of weight. What is it that the independent can offer the public which would be of equal interest?

Technical competency is not an exclusive property of factory service facilities. It is possessed by a great many independent servicing shops and servicing

[*Continued on page* 43]

## JFD NCB COLORTENNA

[*from page 37*]

Included in the Colortenna series, is the Shut-Out Helix group. One of the major sources of interference in television reception is the co-channel beat. This is caused by the simultaneous reception of two channels of the same number whose carriers are offset by a small differential, usually between ten and twenty kilocycles. The two carriers will beat in the mixer stage of the tuner, causing the audio note to appear on the screen of the receiver.

In an attempt to eliminate this type of interference, the Shut-Out Helix series came into being. The design of these antennas is based on the fact that co-channel interference is, as a rule, caused by channels in opposite directions. One signal, the desired one, is picked up by the front of the antenna, while the interfering signal is received by the rear. This phenomenon is most usually encountered on the low band.

In theory, the antenna operates as follows: Two dipoles are mouted ¼ wavelength apart at the interfering channel. They are combined by the use of a quarter wave harness and the rear terminals become the takeoff. When a signal approaches from the front, it is first received by the forward dipole. From the terminals of this element, it is transmitted along the quarter wave harness to the takeoff terminals at the rear. In traveling this length, the vector is rotated 90 degrees (*Fig. 10a*). During this period, the space-wave continues to travel thru the air until it is received by the rear dipole. Since the spacing is one quarter wave, this vector also rotates thru 90 degrees, arriving at the takeoff terminals in phase with the front signal and thereby adding to it.

When the signal approaches from the rear, it is first received by the rear dipole and appears at the terminals with zero phase shift. The space wave rotates 90 degrees in its path to the forward dipole, and another 90 degrees thru the harness to the terminals (*Fig. 10b*). This is a total of 180 degrees out of phase with the rear dipole signal. If the amplitudes are adjusted to the same levels, there will be complete cancellation and thereby no rear pickup.

In practice, complete cancellation cannot take place due to a multitude of small phase shifts caused by interaction between elements and ground reflections. If, however, the spacing is made more than a quarter wave, at some point along the transmission line, there will appear a null. This null can give front-to-back voltage ratios of better than 300:1.

This NCB Colortenna series was designed to help simplify the job of the service-dealer in selecting and selling an antenna suitable for both color and monochrome. The distinctive physical appearance of these antennas will also be a major factor in their acceptance by the public.

## RIDER SPEAKS

[*from page* 41]

dealers and it must be demonstrated on a repair job. It is of the utmost importance to make the customer aware that a good job has been done. It must be a complete job. Close attention to so-called "small" details is vital. Politeness on the telephone, prompt service, keeping a promise, courtesy, respect, the absence of arrogance, the display of patience and understanding and treating the customer's equipment with care.

Solicitation of business on a personal basis while in the home is something which the independent can do and the factory service branch personnel cannot. Inasmuch as each factory handles only its own products, it cannot very well solicit additional business and then turn it down because it is some other manufacturer's product. The independent knows no such restriction.

The type of service desired by the public has long been a subject for discussion. Now that factory service is becoming more prevalent, the discussion stage has come to an end. Now the fulfillment becomes the important thing. The vast majority of set dealers are interested in having their customers served, and if they don't conduct their own servicing business, they are interested in getting the best service for their customers.

It is reasonable for service technicians to solicit the aid and guidance of the parts distributor in the effort to protect the interest of the servicing field. It is to the interest of the parts distributor that the servicing industry grow in size and financial stability. There has been talk about this in the past, but today action is necessary. It is not beyond the realm of possibility for the servicing dealers in a community to pool their efforts in direct mail solicitation; cooperative advertising, newspaper promotion and association effort.

Summarizing the entire issue, it is our considered opinion that factory service will not jeopardize the future of the servicing industry if the servicing industry makes up its mind to go out and get all the kinds of electronic equipment servicing business available. ■ ■



*Reprinted from* SERVICE DEALER and ELECTRONIC SERVICING, *November 1956*

## ASSOCIATION NEWS

[*from page* 17]

### Radio Television Technicians Association, Pasadena

At the regular dinner meeting of the Radio-Television Technicians Association of Pasadena (R.T.A.-Pasadena) preliminary arrangements were made to provide for an R.T.A. booth at the Pasadena Home Show, Nov. 16, 17, 18, 1956. Tentative plans call for an operating television chassis, surrounded by scopes and meters connected to major test points. R.T.A. code of ethics and folders listing R.T.A. members will be handed out.

### Associated Radio & Television Servicemen, Illinois

The Associated Radio & Television Servicemen, Illinois, held their semi-annual business meeting and election of Officers.

The following have been elected to office for the fiscal year of 1956-1957: Chairman, Howard Wolfson; Vice Chairman, Joe Ehlinger; Secretary-Treasurer, Delmar Kotrba; and Sergeant at Arms, George Neize.

### Radio & Television Servicemen's Association of Pittsburgh

Beginning with next month's issue, the Video Scope will take a militant stand on vital issues concerning the electronic service profession.



## AGC IN COLOR TV

[*from page* 21]

*agc* voltage, thereby protecting the *rf* and *if* circuits against overload.

In order to prevent the *agc* voltage developed on weak signals in strong signal areas from reducing the signal gain too much, the setting of the control on a strong station should be made judiciously. Thus, the control should be adjusted so that the setting is as much below point (B) as possible without overloading the receiver. Doing this, the developed *agc* bias will be high enough for the most powerful station, yet will not develop too much bias, that is enough to cause the gain of the *rf* and *if* stages to be reduced to a point where weak station reception is impaired. Care, therefore, should be exercised when adjusting the *agc* control to make sure that the control is not advanced beyond the required setting.

Referring again to *Fig. 2,* notice that the cathode of the *agc* amplifier is connected to B plus 145 volts, the source of which is the cathode of the audio output tube. For this reason, failure in the audio circuit will affect the *agc* action. This is an important point to keep in mind when servicing receivers using this circuit.

Another point to watch for in this circuit is the values of *R214, R212, R211, R213* and *R224*. Unless these values are maintained as rated, the relative applied *rf* and *if agc* voltages will be incorrect, thereby resulting in symptoms associated with defective *agc* action, that is snow, tearing, etc.

In order to minimize noise in a weak picture it is desirable to delay the *agc*

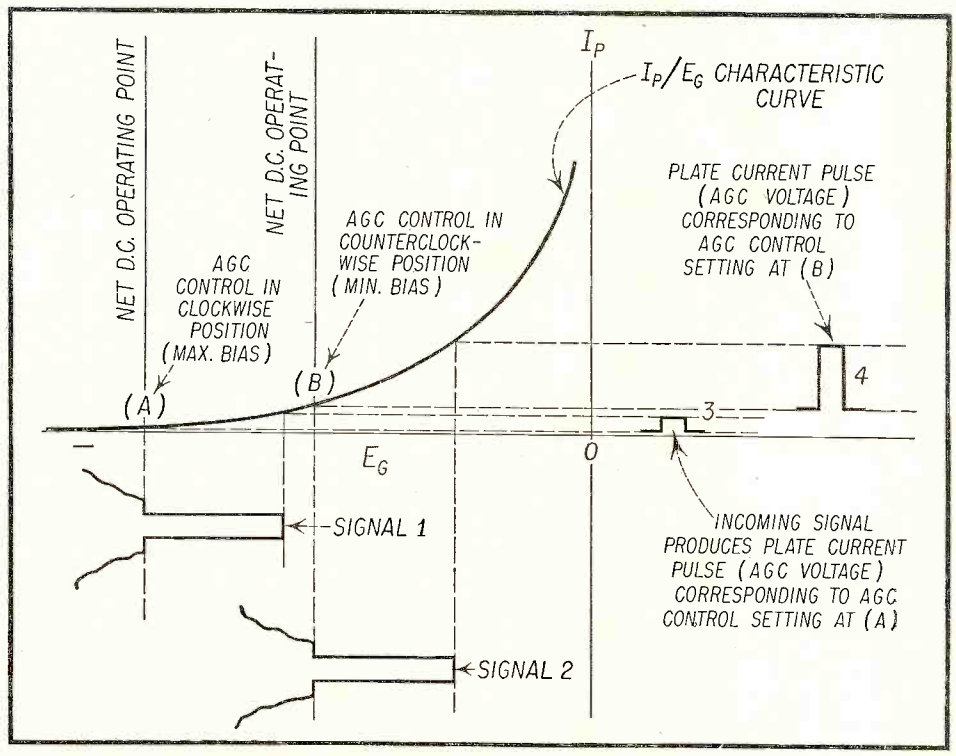


Fig. 3—Curve showing how different adjustments of AGC threshold control provides varying plate current output (AGC voltage) for same signal.

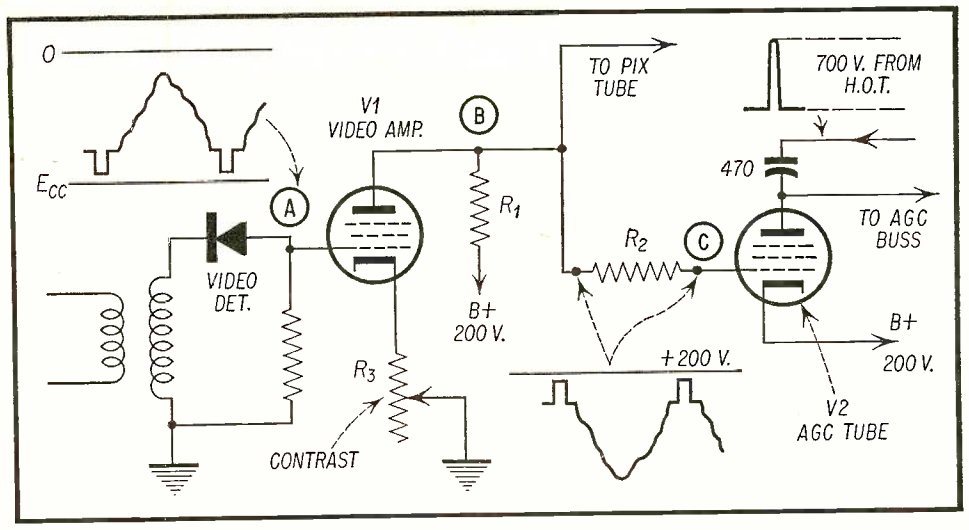


Fig. 4—Simplified schematic of AGC circuit used in Emerson color set.

action in a tuner until the signal reaches a reasonable signal-to-noise ratio (500 $\mu v$). This is accomplished by bleeding a small positive voltage through *R224* into the tuner *agc* buss. This positive voltage in the presence of extremely small *agc* action is sufficient to cause the diode of V203 to conduct, and effectively holds the tuner *agc buss at* ground potential. When the signal is large enough to override this small positive potential the diode becomes non-conducting and normal *agc* action continues from this point on.

Another type of keyed *agc* circuit used by some manufacturers is shown in *Fig. 4*. Notice that again the output of the video amplifier is *dc* coupled to the keyed *agc* tube.

The *agc* action in this circuit may be described as follows. Visualize the conditions that exist in the absence of an antenna signal. The voltage at point A is zero (in contrast to a normally present negative signal). Tube V1 therefore conducts heavily causing the potential at point B to fall, say to 100 volts. Since the cathode of V2 is fixed at 200 Volts, V2 is now in a cut-off condition. As long as V2 is cut-off, the *agc* buss potential is zero, and the tuner *rf* stage and the *if* strip are at full gain, that is, wide open.

Let us now imagine a small but increasing-in-amplitude signal at the antenna terminals. The signal voltage at A is now going to increase in the negative direction as indicated until an amplitude is reached such that the sync tips approach the cut-off potential of V1 (say minus 5 volts).

Note what happens in the plate circuit as this cutoff point is reached. As the sync tips at the grid go more and more negative the plate current during these sync intervals becomes less and less and the drop across RL becomes smaller and smaller. Point B approaches +200 volts during these sync intervals. When point B reaches a potential within the conductive grid base of V2 (say 195 Volts) V2 *begins* to conduct. The conduction of V2 produces a negative *agc* potential and a subsequent reduction in the *rf* and *if* gain. This sudden conduction of V2 when the sync tips of the signal at A produces cutoff of V1 tends to clamp the amplitude of the signal at A to a constant value dictated by the cutoff potential of the tube.

It is worth noting at this point that the dependence of the signal amplitude at A on the cutoff of the tube *produces an inherent sync protection against impulse noise*. Inasmuch as impulse noise is blacker than black information it will be almost entirely restricted to the cutoff region of V1. None of this noise data will appear at the plate of V1 where the sync is taken off.

It might appear at first glance that the degenerative action of the contrast conrol *R3* in the cathode might disturb the *agc* action. However it should be noted that although the amplitude of the voltage at B will be reduced as *R3* is increased, the sync tips will still be setting at or near the same point that will cause V2 to conduct. The *agc* action is independent of the amplitude at B, only being dependent upon the sync tip potential. ■■

## DIPOLE ANTENNAS

[*from page* 38]

and Channel 13 dipole as shown in *Fig.* 2, an increase in gain could be accomplished on the high band channels. Upon experimentation it was found that proper spacing gave an increased gain of from 1.5 db on Channel 7 to 3 db gain on Channel 13.

Keeping in mind the desire to attain as flat a response as possible it was necessary to include or add to the antenna, components that would favor the low end of the high band and overcome the variation in gain between Channels 7 thru 13 caused by the addition of the Channel 13 dipole and the directors normally added for high band operation. The equalization of the response curve was accomplished by the addition of two reflectors which operate on the outer half wave sections of the "Wing" dipole, shown in *Fig.* 3, which gave a 3 to 4 db gain on the low channels of the high band. These reflectors become an integral part of the dipole and are so called integrated reflectors in the same manner as the integrated director which acts upon the center half-wave section of the "Wing" dipole on the high bands. By converting the stub into a Channel 13 dipole in connection with the "Wing" dipole and integrated reflector, the Zephyr-Mite showed a gain of 10 db on Channels 7 thru 13 with only a variation of .5 db from Channel 7 to 13.

For the same reason that a low channel dipole is ineffective on the high band channels, a director tuned for low channel operation is also ineffective. Therefore, to obtain maximum results from a composite dipole such as the "Wing" dipole, it is necessary to design a composite director—that is, one which will function on the high channels as a high channel director as well as operate on the low channels as a low channel director. Trio's solution to this problem was the designing of the "Wing" director shown in *Fig. 4.* The basic idea was to make use of the bent antenna effect often used by amateurs to eliminate the extreme lengths encountered in amateur work. This was carried still further by folding the ends so that a cancelling effect was encountered on the outermost sections which left the center section of the "Wing" director to act effectively as a director for the high band channels, yet when properly tuned and spaced to operate as efficiently on the low band channels as a low channel director. Due to the contour of the "Wing" director it was necessary, for mechanical reasons, to support it at more than one point on the boom. This was done effectively by the use of an element tuned to act as a director on the high channels and insulated from the folded ends, allowing the "Wing" director to take on the same form as the "Wing" dipole. This construction and design enabled Trio engineers to obtain excellent gain and pattern characteristics in the Zephyr-Mite, which shows a gain of 5½ db on Channel 2 to 6.5 db on Channel 6 with only 1 db variation on the low bands. On the highs, with the construction explained in the article, the antenna shows a gain of 10 db on Channels 7 thru 13 and only .5 db variation. ■ ■





## AUTOMATION

[*from page* 10]

means is a cost savings, since the initial cost can be written off over a large group of finished products.

### Modularization

The very use of printed circuits implies a further step. Since a circuit such as audio amplifier, or a cathode follower, or a pulse-generator can be built on a single board the question arises as to the final use of these circuits. In any given line of electronic equipment, a circuit can be found more than once. Some, as the examples above, will occur many times. If the proper evaluation is made, a standard circuit will be found which will answer the needs for many equipments. Thus, the basic module is born; a standard circuit which may be used in many equipments. Modular construction has a two-fold advantage. First, the production techniques may take advantage of it by producing the standard modules, as end-items, and then storing them until the final assembly operations. Secondly, standard circuits allow engineering effort to be directed toward the best possible circuits, rather than a number of circuits which differ only in details.

Packaging of these standard modules is also a fertile field because many interconnected modules make up the electronic equipment. The packaging techniques and the modular construction complement each other. One cannot very well be changed without considering the other.

The modules, as above, can be considered as the starting point from which smaller units may be developed. For

example, several resistors and capacitors can make up a package which is used very often in modular circuits—indeed in almost all circuits. If a package is made up of these several components, it can be applied to different circuits in different ways. This is the concept of the "super-component"—the group of individual components mounted as a unit and treated as a unit in purchasing, manufacturing, and servicing the completed equipment. The printed circuit module could contain several super-components.

Modularization is not confined to the approach outlined above. Another approach is the *Tinkertoy* project. Here the basic module is a stack of notched ceramic wafers, each ⅞ of an inch square and 1/16th of an inch thick. These may be clearly seen in *Figs. 2* and *3*. Components are not mounted but are actually constructed on each wafer. For example, by producing a metal film on each face of a wafer, a capacitor is made; or by placing a layer of resistive material on one face of the wafer, a resistor is produced. By connecting the wafers with vertical wires, a complete modular circuit is produced.

This approach to Automation was developed by the National Bureau of Standards and sponsored by the Navy Bureau of Aeronautics. Starting from the raw materials, machines produce modular wafers, which when used in groups, make up the modules of an electronic circuit. The basic wafer is ⅞ inches square, and it can contain almost all of the components of the circuit—resistors, capacitors, coils, or tube sockets. When these wafers are stacked vertically, and inter-connected, the result is a complete circuit.

A complete circuit has the component wafers and a final wafer with a tube inserted in the tube-socket. In *Figs. 2* and *3*, counting down from the top, the individual wafers each have different parts. One is the tube socket; two is a coil; three represents the three capacitors—as indicated on the schematic—with a common connection; four has the resistors of the circuit—there are four resistors; and five is the capacitor without any common connection to the other capacitors. Connecting wires, which fit into the notches in the wafers,

[*Continued on page* 49]

# CONTACT

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

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form the circuit from the individual components.

From the raw materials, all of the individual items, with the exception of the tube, are manufactured by machine. Tubes are purchased rather than made on the production line. Automatic inspection is used to examine every module for the proper electrical and mechanical characteristics. The final result is a rugged, standard package which is interchangeable with all others of the same type.

Project Tinkertoy has two parts. MDE, or Modular Design of Electronics and MPE, Mechanized Production of Electronics. MDE establishes a series of standards, both electrical and mechanical, to provide a group of electrical circuits which will cover a wide range of characteristics. There are many single-circuit functions which have a high degree of repeatability. Amplifiers, i-f, a-f, and r-f, to name only a few, are in very wide use. Other circuits quite often used, are cathode-followers, clippers, and phase-inverters. Each of these can be designed as a module, and from the appropriate selection of modules, many complete electronic devices may be made through proper interconnections.

There are four to six wafers to each module; just as an equipment can be made up of a group of modules so a module can be made from a group of individual wafers. For the MPE line these individual parts are made automatically and inspected automatically. Quite clearly, this technique is suited for large-scale production; this is it's intended purpose.

### Digital Computer Control Techniques

The third leg of the three-sided program for Automation is the use of digital-computers for control. In many areas, large-scale computers are now being used for machine control. Drilling machines, lathes, and drill-presses have all successfully been regulated by this means. Numerical data is fed into the system, whose output controls the action of the machine. There are other systems where punched-cards are used

to generate control signals which operate many types of machines for production.

For inventory records, as would be required in an automatic factory, these computers are becoming increasingly important. As they are used now, operators punch information into the machine, which then records the data, and also provides a printed-output of the actual inventory at any time. In other inventory applications, these computers can consider past usage, fluctuations in the business cycle, and the cost of ordering parts—as well as the quantity discount—before ordering parts to replenish the inventory.

Even from this short sketch, the application of digital computers to the control of automatic-production of electronics, through the control of not only individual machines but the flow of material between these machines, appears quite feasible. The computer could control the production rates, production machines, the inventory level in the stockroom, or even the progress reports for management. These are all possible and they all apply to the Automation system for tomorrow.

### The Automation System of Tomorrow

The basic parts of the present trend toward Automation, as discussed in the preceding section can form the background for the Automation system of tomorrow. Mechanization, Modularization and computer control are used today as separate parts in the overall technology. As each expands, it can be brought into a unified system. This requires further refinement of present methods, the development of new methods, and the system thinking and planning needed to tie all of the elements into an integrated whole.

## UNDERSTANDING TONE CONTROLS

[*from page* 12]

bass response, because of room acoustics, a loudspeaker which is perhaps a bit more efficient at certain low frequencies, or other peculiarities of individual components of the total system. As a result, it would seem desirable to incorporate a means for attenuating the bass response. Such combination tone control circuits will be discussed below.

There are also several valid reasons for the incorporation of treble or high-frequency tone controls in high fidelity systems. For one thing, AM broadcasting still constitutes the most important means of communication in this country, and this form of transmission is notorious for its static content. This is esepecially true in remote areas during electrical storms. Most of the static we hear is of a high frequency or "hissing" nature. Furthermore, AM broadcasting is generally limited to a maximum tonal spectrum of only 5000 cycles or so. It is therefore pointless to run a high-fidelity system "wide-open" only to allow this annoying static to get through and with no particular improvement in the program sound itself. A moderate amount of treble attenuation would seem desirable in this case, for this cut serves to reduce the static amplitude without biting into the program content materially. Room acoustics are also a big factor in determining whether or not to deviate from flat response by means of treble controls. A heavily carpeted room containing draperies on one or more walls absorbs an appreciable portion of the high frequencies and gives the listener the impression that the electronic system is deficient in "highs." On the other hand, hard, bare walls and floor have the reverse effect and tend to render the overall sound too shrill and harsh. Proper use of tone controls in these instances is simpler than complete refurnishing of the home.

### How to Check the Action of Tone Controls

The typical tone control set-up in high fidelity components consists of two individually and continuously variable knobs marked "TREBLE" and "BASS." These controls may be located on the amplifier itself, on a separate audio control chassis, or on the tuner, if it is the type of tuner which is serving as the center of operations for the entire system. In rare cases, you may find a customer who has had the misfortune of assembling a system in

which *two* of the components have duplicate sets of tone controls. In such instances, it should be emphasized to the customer that only *one* set should ever be used. Better still, if it is possible to by-pass one set of controls completely (as in the case of a tuner, which may have a separate output at the detector ahead of any tone controls) this should be done to avoid confusion and duplication of functions.

Determine the required specification with regard to the tone controls of the particular system directly from the manufacturer's specifications or instruction sheet. If this information is not available, it may be stated generally that most universal tone controls have a maximum range of about 15 decibels of boost or attenuation at the two check points of 50 cycles and 10,000 cycles. Set both the treble control and the bass control for flat response. (This point is usually indicated by means of a dot on the knob lining up with a corresponding dot or symbol on the control panel.)

Apply a 1000 cycle signal to any one of the high level inputs of the system (*not* to the phonograph or other low level, equalized inputs). Replace the speaker with a "dummy load" of 4, 8 or 16 ohms, depending upon the output impedance of the power amplifier. Connect an *ac* VTVM across the dummy load and increase the input signal until a reading of one volt or so is obtained. Check the frequency response at 50 cycles with the tone controls still in the flat or uniform response position. The reading should still be one volt, within the tolerance permitted by the manufacturer (usually plus or minus 1 decibel or so).

Very often, the real trouble will show up at this point. That is, the customer may be complaining that his treble control does not afford enough boost, when actually his system has lost its uniform response even at flat response settings. Obviously, if a point other than the tone control circuit causes a drop of 10 db at 10,000 cycles, then the best the treble control can do is a boost maximum of only 5 db, even though the control circuit itself is contributing a total boost of fully 15 db (and is conforming to its specifications), the two effects are additive and might cause the customer to falsely suspect that his treble conrol is not operating properly. In such cases, point by point signal tracing is required, in accordance with methods outlined in an earlier article of this series.

If the system checks out at 50 and 10,000 cycles in the flat response position, set the audio generator to 50 cycles and rotate the bass control clockwise, noting the increase in reading on any VTVM. If your VTVM is not equipped with a decibel scale, you may use the table in *Fig. 2,* which indicates

Table 2. Decibel relationship to voltage, using a reference of 1 volt equal to 0 db

| VOLTS | DB | VOLTS | DB |
|---|---|---|---|
| .10 | 20 | 1.00 | 0 |
| .12 | 19 | 1.12 | 1 |
| .13 | 18 | 1.26 | 2 |
| .14 | 17 | 1.41 | 3 |
| .16 | 16 | 1.58 | 4 |
| .18 | 15 | 1.78 | 5 |
| .20 | 14 | 2.00 | 6 |
| .22 | 13 | 2.24 | 7 |
| .25 | 12 | 2.51 | 8 |
| .28 | 11 | 2.82 | 9 |
| .32 | 10 | 3.16 | 10 |
| .36 | 9 | 3.55 | 11 |
| .40 | 8 | 3.98 | 12 |
| .45 | 7 | 4.47 | 13 |
| .50 | 6 | 5.01 | 14 |
| .56 | 5 | 5.62 | 15 |
| .63 | 4 | 6.31 | 16 |
| .71 | 3 | 7.08 | 17 |
| .79 | 2 | 7.94 | 18 |
| .90 | 1 | 8.91 | 19 |
| | | 10.00 | 20 |

the relationship between voltage and decibels, starting with a reference of 0 db equal to 1 volt. Note whether the total increase is equal (within reasonable tolerance) to the value specified by the manufacturer and repeat this procedure by rotating the control fully counterclockwise, noting the decrease in reading below the fixed reference of 1 volt. Next, switch the audio oscillator frequency to 10,000 cycles and repeat the boost and attenuation readings varying the treble control fully counterclockwise and clockwise. If all checks out as expected, illustrate this fact to the customer graphically (by showing meter readings) and aurally (by replacing the dummy load with the loudspeaker and feeding appropriate frequencies through the system while varying both the bass and treble controls.)

[*Continued on next page*]

If the results of these tests indicate that insufficient boost is available, the cause, once again, may not be the tone controls themselves. To check this point, set the tone control in question back to the flat response position and increase the signal input (at the audio generator) to raise the output level by the total number of decibels expected if the tone control were to be rotated fully clockwise. If the rise in output falls short of the expected amount (that is, further increase in signal input results in no further increase in output) then it is the signal handling capability of the amplifier itself which should be questioned, rather than the tone control system. In such cases, either the output tube or tubes or the associated circuitry is usually at fault. In order to evaluate other forms of trouble with tone controls, it is now necessary to consider in detail how these typical circuits actually work.

### A Simple Bass-Boost Circuit

The action of the circuit of *Fig. 1* has been explained briefly above. It has been pointed out that the most boost action is obtained at lower settings of the volume control. Suppose the arm of the volume control is at the tap point and suppose that the *250K* bass control is shorted out by its arm being in the uppermost position. Under these conditions, the impedance from the arm of the volume control to ground will be very nearly *10K* (actually *10K* in parallel with *125K*) or 1/50th of the total resistance of the volume control (*500K*). Thus, 1/50th of the signal applied to the volume control will be fed to the next grid by voltage divider action. This will be true at *all* frequencies and no boost action occurs.

Now, suppose the arm of the bass control is moved downward toward the ground connection. At frequencies above 1000 cycles or so, the impedance of the .02 $\mu f$ capacitor becomes smaller and smaller and finally approaches a negligible value with respect to the *10K* resistor in series with this capacitor. As a result, the effective impedance from the arm of the volume control to ground is about *10K*, or 1/50th of the total impedance. At lower frequencies, the capacitor begins to look like a higher impedance until finally, at about 50 cycles, for example, it looks like an open circuit. Under these conditions, the impedance from the arm of the volume control to ground is about *80K* or about 1/6th of the total *500K*. Thus, at 50 cycles, 1/6th of the total signal will be sent along to the next grid, or about 8 times as much as at 1000 cycles and above. This corresponds to a boost of about 17 db at 50 cycles (maximum). It can be seen from the foregoing that intermediate settings of the bass boost control will provide intermediate amounts of bass boost.

*[To be continued]*

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