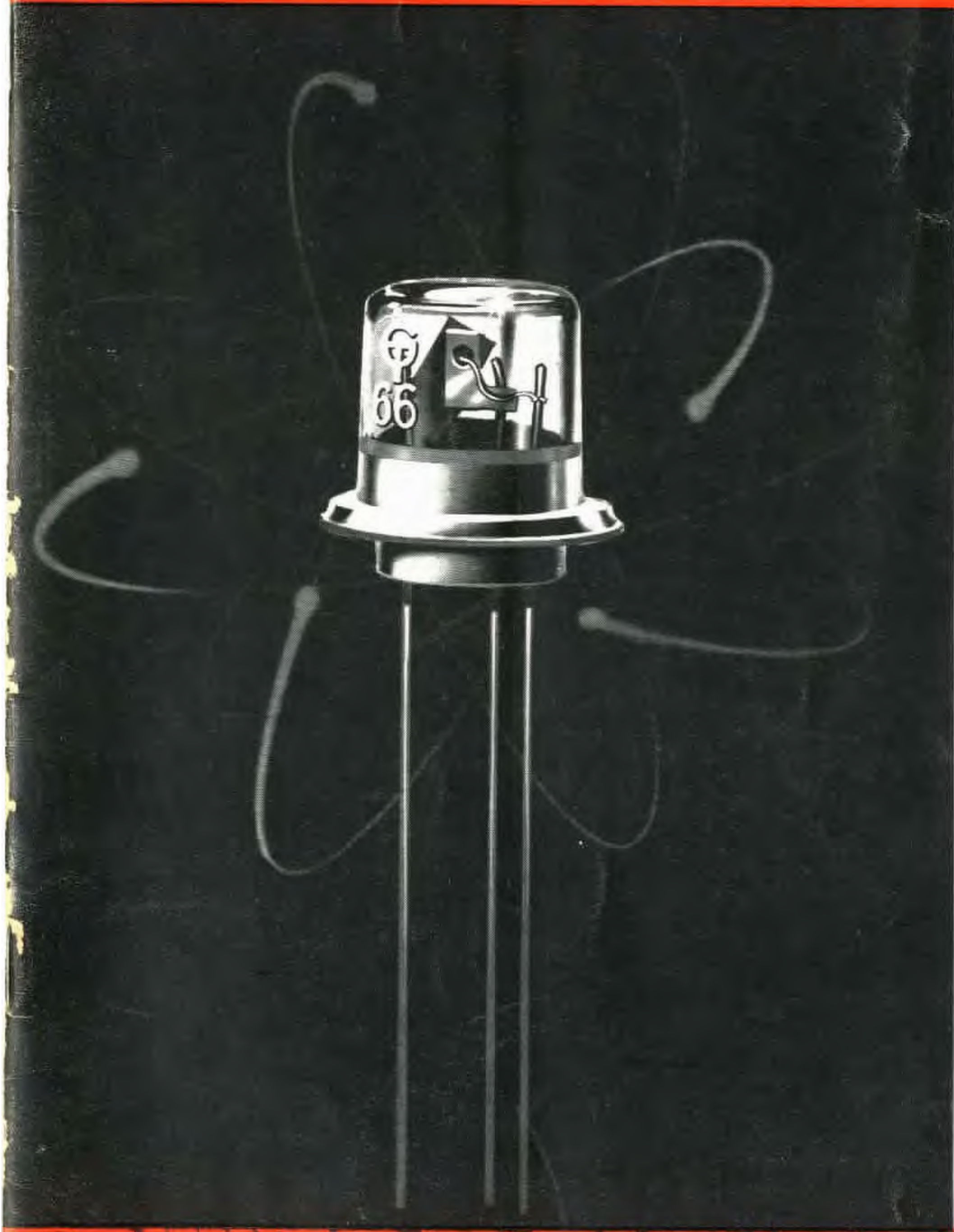
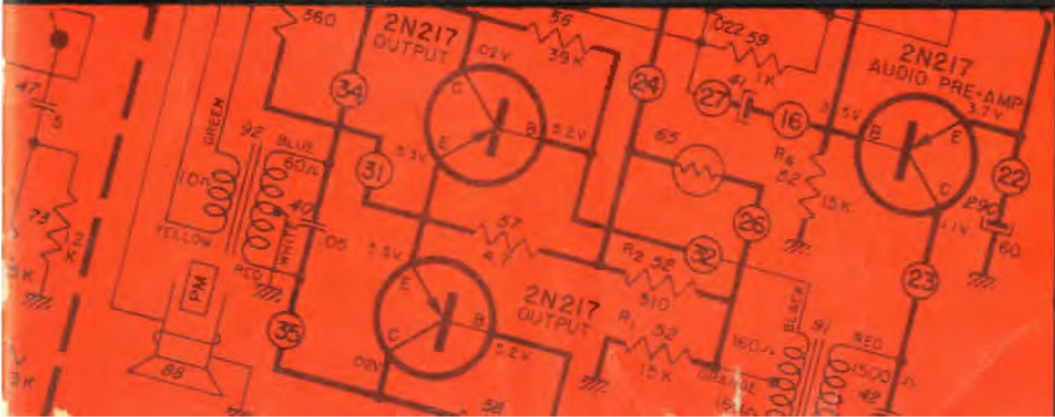
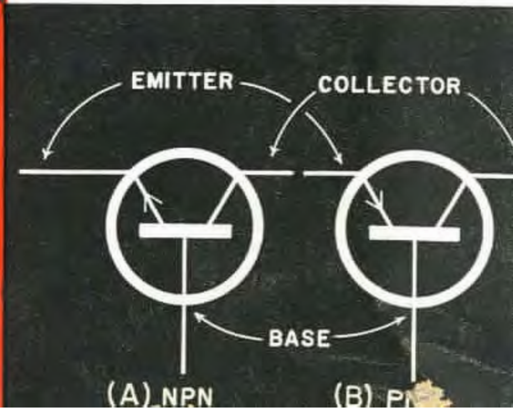
ELECTRONIC SERVICING

JANUARY 1958 • 50¢







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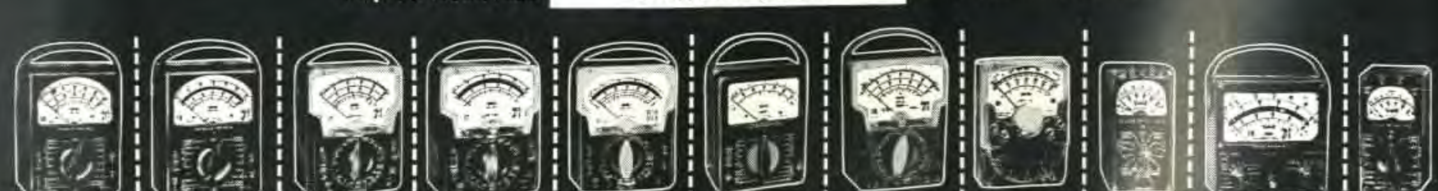

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ELECTRONIC SERVICING

VOL. 19, NO. 1   Member   JANUARY, 1958

COWAN PUBLISHING CORP., 300 West 43rd Street, New York 36, N. Y.

This recent advertisement in **LIFE** *was seen by 25,000,000 people...*

GOOD SPORTSMANSHIP is developed by Marcus E. Denham at Whitaker State Orphans' Home, Pryor, Oklahoma, where he assists in recreational activities. He is also prominent in many local community service groups. His work is typical of the many public service contributions of TV technicians everywhere.

BOY SCOUT WORK and assistance to Charlotte, Michigan, youth groups make Bart Rypstra, Jr., another "All-American". He is a member of the Charlotte city council, active in civil defense communications, and belongs to many community service clubs. When time permits, Bart devotes his technical talents to servicing sound equipment, movie projectors and record players at city schools.

GIRLS' DRILL TEAM at St. Joseph's Parish is supported by Remo De Nicola, Quincy, Mass., as one of his many community services. He also gives free television service to a school for retarded children and is always ready to lend sound equipment for charitable affairs.

CIVIL DEFENSE LEADER Richard G. Wells, Jr., Pikeville, Ky., installed television cables from a community antenna to Pikeville College, high school, fire department, Scout building and Methodist Hospital. He is working to give the high school a closed-circuit TV system.

FIVE PUBLIC SERVICE CITATIONS plus a civilian Navy award were given Frank J. Hatler, Roselle, N. J., for his communications work in community emergencies. As local civil defense head, Frank organized communications networks, helped many to get radio licenses.

JUDGES SELECTED 13 WINNERS to receive this trophy, $500 for use in community improvement, and luncheon with Under Secretary of Commerce Walter Williams at Washington, D.C.

"ALL-AMERICAN" TV TECHNICIANS WIN GENERAL ELECTRIC AWARDS FOR PUBLIC SERVICE

Americans everywhere responded to General Electric's invitation to nominate candidates for "All-American" Awards, honoring television technicians who have distinguished themselves in public service.

The winners, whose pictures appear on these pages, were selected by a panel of judges composed of *Wendell Barnes*, Administrator, Small Business Administration; *Wendell Ford*, 1956-57 President, United States Junior Chamber of Commerce; *Herman Hickman*, Sports Authority; and *Ed Sullivan*, Columnist and TV Personality.

General Electric has established these awards as another step in its program to recognize the public service contributions made by independent businessmen everywhere.

The accomplishments of these television technicians should serve as an inspiration to all Americans. *General Electric Company, Receiving Tube Department, Owensboro, Kentucky.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

11-21-104

BLIND CAN SKATE because Philip G. Rehkopf, Jr., Louisville, Kentucky, installed a record player and placed loud speakers around the walls of the gymnasium at the Kentucky Home for the Blind. He developed an electronic device to give scores to blind basketball fans, and tape records text books for blind students.

WHEEL CHAIR is no handicap for Mortimer Libowitz of Brooklyn, New York. Though disabled all of his life, Morty has devoted his time to helping others in his community. With a crew of student volunteers, he maintains the radio station at Thomas Jefferson High School, Brooklyn. He also services a Red Cross radio station and is active in civil defense communications. Morty has trained many youths in radio, developing some into amateur operators and skilled television technicians.

VOLUNTEER FIREMAN and Instructor John R. O'Brien, Evanston, Wyoming, teaches first aid at neighboring fire companies and schools. He is active in communications during civic emergencies, and lends and installs sound equipment for town functions. Many community service groups benefit from his time and skills.

MANY WERE SAVED by Scott Witcher, Jr., during Lampasas, Texas, disaster. Here he shows height of water in raging flood which swept his area. Scott saved lives and helped restore communications to the community. He is active in the National Guard, in civic and youth organizations.

TV FOR THE SICK is provided by Billy Joe Jenkins of Paducah, Texas. By installing antenna cable and servicing sets without charge, Billy Joe has made it possible for patients in Richards Memorial Hospital to enjoy TV. He helps community improvement drives, teaches electronics to Boy Scouts.

ELECTRONICS LABORATORY at Long Beach City College, California, was established with help from Harry E. Ward. Harry serves as chairman of the Business and Technology Advisory Committee and for fifteen years has devoted his time to finding work for students, graduates and others.

STUDENT BENEFACTOR Philip T. Di Pace, of Albany, N. Y., contributes used radio and television chassis and parts to Siena College students who are interested in electronics. Phil now heads a project to finance an athletic field and playground for 75 neighborhood children.

BASIC ELECTRONICS is taught to neighborhood boys by John H. Stefanski, Pontiac, Michigan. He has organized a scientific library for the boys and is now planning a new Pontiac Boy's Club. John has served as chairman of the Business Ethics Board of the Pontiac area Chamber of Commerce. Television sets in the Oakland County Sanatorium are serviced without charge through his efforts.

Introduction to Transistor Theory

Part 6
by George Browne

In this installment various transistors designed for improved high frequency operation are described

It was previously pointed out that transistor frequency response, in a large measure, depends on base width —the smaller the base width, the higher the frequency. The transit time, or the time it takes for a carrier to be transported across the base to the collector, is dependent on the base width. As base width is reduced transit time is likewise reduced. In junction transistors there is a limit to the reduction of base width, namely, that imposed by collector voltage. If this voltage is high enough, and the base width small enough, transistor punch through* occurs. Transistors differing in construction from conventional alloy junction types, and employing principles designed to enhance their operation at high frequencies, are discussed in this article.

Depletion Region

When, as in *Fig. 1*, a junction between an *n*- and *p*-type semiconductor is formed, a transient flow of carriers occurs whereby electrons flow from *n* to *p*, and holes from *p* to *n*.

*Punchthrough is a condition whereby the collector voltage appears across the emitter diode. This is a reversible effect meaning that the transistor will not be permanently damaged when the reverse collector voltage is removed.

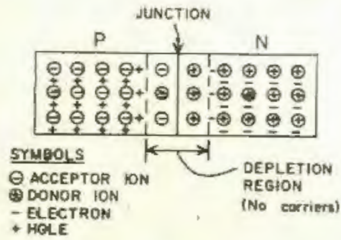

Fig. 1—Depletion region formed by a P-N junction.

This initial current is called a "diffusion flow" and depletes the immediate region around the *n* portion of the junction of electrons, leaving the atoms positively charged and the immediate region around the *p* portion of the junction of holes, leaving these atoms negatively charged. This region is called a "depletion region."

These charges give rise to a difference of potential across the junction which sets up an electric field in accordance with basic electrostatic principles. This field has a polarity which opposes further flow of electrons from *n* to *p*, or holes from *p* to *n*, or, what amounts to the same thing, favors an opposite flow of electrons from *p* to *n* and holes from *n* to *p*. This opposite flow is called a "drift flow," and it balances the original diffusion flow, thereby leaving the net flow zero.

Electric fields of the type just discussed are also called "built-in fields" and may be generated by various internal conditions such as lattice imperfections, or unequal impurity distributions within the semiconductor. The presence of built-in electric fields in the base regions of a transistor can be used to increase its high frequency response as we shall soon see. These built-in fields are produced by making the impurity distribution within the base vary along its width.

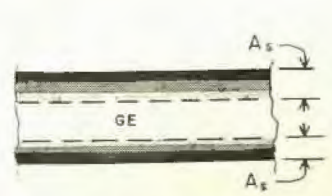

Fig. 2—Arsenic vapor diffusion through the germanium.

Unequal Impurity Distribution

Unequal impurity distribution may be produced in an intrinsic germanium pellet by subjecting it to hot arsenic vapor. Arsenic atoms produce *n*-type impurities in germanium. The diffusion of vaporized arsenic in germanium is greatest at the surface and least within the interior of the crystal. This unequal impurity distribution gives rise to a difference of potential and therefore a built-in electric field. The extent of diffusion of arsenic into the germanium pellet can be controlled so that only a thin skin of the impurity surrounds the pellet as shown in *Fig. 2*. During the manufacturing process one of the skins is removed by acid etching or mechanical means leaving only one impurity surface. Following this, *p*-type metallic junctions are alloyed onto both faces forming a *p-n-p* junction transistor with a base on which the impurity distribution varies from a maximum at the emitter junction to a minimum at the collector junction.

Drift Transistors

We are now ready to study the operation of the so-called "drift transistor." First, referring to *Fig. 3*, we observe again that the concentration of *n*-type impurities is high at the emitter junction side of the base and low at the collector junction side. As a result of this unequal distribution, an initial transient flow of electrons will diffuse through the base from left to right, setting up an electric field which promotes a drift flow of electrons in the opposite direction, that is, from right to left. Recalling that hole flow is opposite to electron flow, the field set up therefore favors hole flow from left to right.

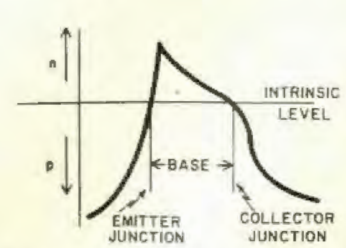

Fig. 3—Impurity distribution in a drift transistor.

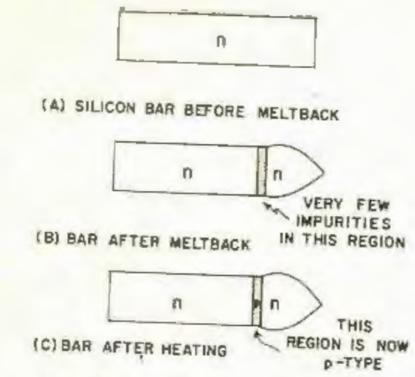

Fig. 4—Steps in manufacturing diffused meltback transistor.

With no external potential applied to the transistor, the system reaches a state of equilibrium at zero current flow. However, should forward and reverse potentials be connected, holes from the emitter will enter the base, in accordance with the principles just developed. These holes will be accelerated by the built-in field across the base to the collector junction. Here, as a result of the reverse bias on the collector the holes will be swept across the collector junction to the negative terminal of the base collector battery.

As a consequence of this carrier acceleration in the base region, what would normally, in a conventional transistor, be a slow diffusion of carriers, is now an acceleration of carriers across the base region. This acceleration reduces the transit time and as a result makes the drift transistor excellent for high frequency applications.

Diffused-Meltback Transistor

A unit incorporating unequal impurity base characteristics produced by a method of manufacture called "meltback" is the so-called "diffused-meltback" transistor now to be described. In this transistor the process of manufacture begins with the growth of single-crystal silicon, the latter being initially doped with a pre-determined amount of *n*-type impurity and a somewhat lesser amount of *p*-type impurity. Since *n*-type carriers are in the majority, the resultant crystal is *n*-type. The completed crystal is then sawed into bars approximately ⅛" long and .02" square, an example of which is shown in *Fig. 4a*. These bars are then subjected to a second series of operations. The first step consists of remelting one end following which it is recooled forming, as it does so, the tear-drop shaped pattern shown in *Fig. 4b*. Recalling that impurities are more soluble in liquids than in solids, the impurity content in the vicinity of the melted portion will be higher at the heated end of the bar than at the center. At the interface between the unheated section of the bar and the tear-drop section the impurity concentration will be relatively low, the impurities from this interface having entered the tear-drop. Thus, at this surface a junction is effected whereby the *n*-type concentration to the right of the interface is higher than to the left.

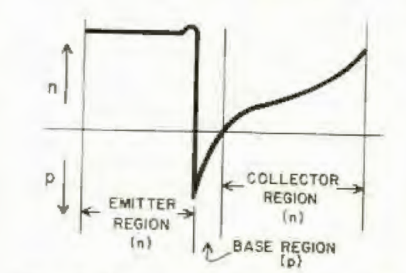

Fig. 5—Impurity distribution, diffused meltback transistor.

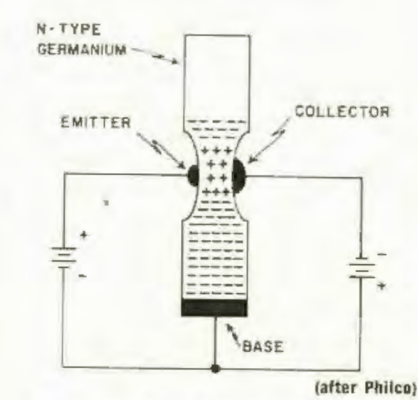

Fig. 6—Surface barrier transistor biasing.

The bar is now subjected to a long-time heating and equalizing cycle during which the high concentration impurities diffuse back into the low concentration region. During this operation the *p*-type impurities diffuse back with greater rapidity than do the *n*-type impurities, this being a peculiar characteristic of *p*-type impurities. As a result of this greater *p*-type impurity flow at a certain time during the cycle the interface between rod and tear-drop becomes *p*-type as shown in *Fig. 4c*. With accurate control of the forming process very thin *p*-type regions of the order of two microns may be formed between two *n*-type regions producing a diffused-meltback *n-p-n* transistor.

The solid-state diffusion of the *p*-type impurity is somewhat analogous to the diffusion of gaseous arsenic into germanium described in the previous section, so that a non-uniform impurity distribution in the *p*-type base section results. (See *Fig. 5*.) This gives rise to a built-in field effect. This effect, coupled with its very thin base region, makes the diffused-meltback transistor particularly suitable for high frequency work.

Surface-Barrier Transistor

The Surface-Barrier transistor shown in *Fig. 6* is an *n*-type transistor (not *n-p-n* or *p-n-p*) in which craters are formed at the center section of an *n*-type wafer of germanium. These craters are etched out electrolytically until the remaining section is approximately .0002" thick. Following this operation metallic anodes are electroplated on the cavities. Leads are then attached to the electroplated areas and the base as shown in the figure. These connections are ohmic and do not form *p*-type junctions as in conventional alloy junction transistors. Biasing is the same as in a *p-n-p* transistor, the emitter connected for forward bias and the collector for reverse bias.

The principle of operation of a surface-barrier transistor (see *Fig. 7*) is related to the manner in which electrons contained within the interior of the n-type crystal form a a relatively high negatively charged potential near the surface. These electrons repel other electrons near the surface of the crystal back into the interior. At the surface of the crystal itself another layer of so-called "surface electrons" exists at an even higher potential than that beneath the surface, and between these two layers is a thin insulated layer of

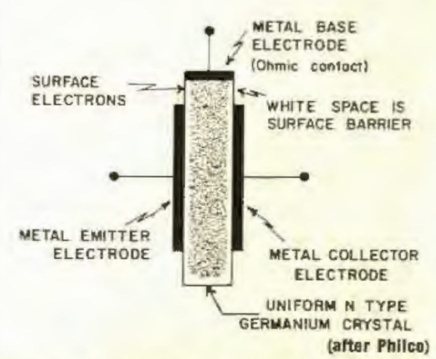

Fig. 7—Cross section of a surface barrier transistor.

germanium which is practically free of charge carriers. This layer is called a surface-barrier and, in effect, constitutes a leaky dielectric between the electron layer near the surface of the crystal and the electron layer at the surface itself. The significance of the difference in potential between these two electron layers is that an electric field is set up as a result.

In operation, the injection of electrons at the emitter increases the electric field mentioned above, making electron conduction more difficult. The injection of holes at the emitter reduces this field, resulting in more electrons being allowed to flow out from the interior of the crystal. This is equivalent to setting up a flow of holes in the opposite direction, that is, from the emitter to the collector.

Because of the thin base region about 95% of the emitter hole current reaches the collector. Voltage gain is obtained by a high collector to emitter resistance ratio (200 K/30 ohms). Because the base is thin and uniform, surface-barrier transistors exhibit excellent high frequency amplification characteristics.

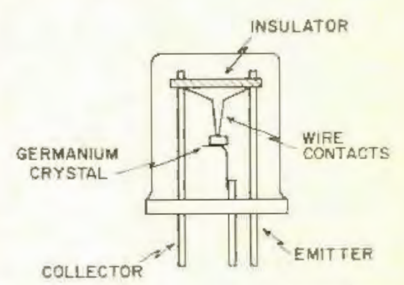

Fig. 8—Point contact transistor construction.

Point Contact Transistors

The earliest transistor made was of the point-contact type, the construction of which is shown in *Fig. 8*. Although the base may be *n*-type, or *p*-type, it is generally *n*-type. Two sharply pointed wires connected to the base contribute the emitter and collector contacts. The collector contact is phosphor bronze and the emitter contact some other springy metal such as beryllium copper. Mechanical firmness of the wires against the crystal surface is effected by bends as shown in the figure. At the outset it must be pointed out that the operation of point contact devices is not well understood. The explanation offered here is one that is commonly accepted.

Metal Semiconductor Contacts

The presence of a metal contact against a semiconductor can produce a *p-n* junction. This will be the case

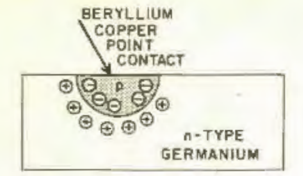

Fig. 9—P-N junction formed by metal-to-semiconductor contact.

if the semiconductor is *n*-type and if the metal used in the contact falls in the Table III classification (acceptors) of the chemical series. It will also be the case if the semiconductor used is p-type and the metal used in the contact falls in the Table V classification (donors) of the chemical series.

The manner in which a *p-n* junction is formed by a metal in contact with a semiconductor is explained by the fact that a difference of potential arises when conductors make contact with semiconductors. In the conductor the energy level is higher than in the semiconductor. Therefore, when the junction is made the difference of potential causes the electrons to be repelled into the interior of the semiconductor. As a result, the surface of the semiconductor is left depleted of its carriers.

As shown in *Fig. 9* the charge along the surface of an *n*-type semiconductor is positive. Electron carriers contained in the metal contact will be attracted at the point of contact to these positive charges. Since they cannot cross the junction into the semiconductor they accumulate at the tip and form the *p* side of an effective *p-n* junction.

Forming

On completion of a point contact transistor it is subjected to a process called "forming." During this process a momentary high temperature is applied between the collector contact and the base material. Such an action changes a localized hemispherical section of the base material from *p*-type to *n*-type as shown in *Fig. 10*. Inasmuch as the wire contact itself

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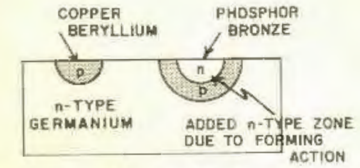
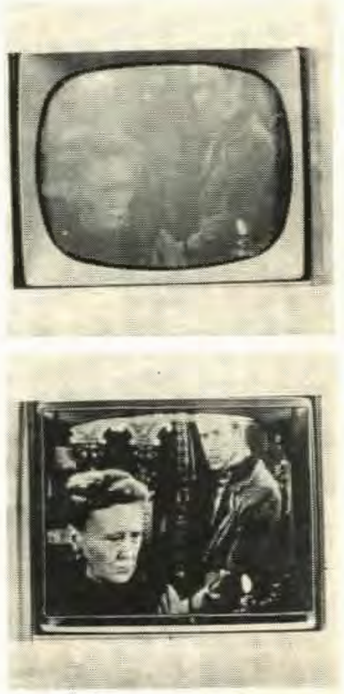


Fig. 10—Effect of forming voltage at collector point.

HONEYCOMB TV SCREENS

The extreme difficulties normally experienced in viewing television, oscilloscope or motion picture images under bright ambient light conditions have been surmounted by a new light-directional material now being manufactured by Hexcel Products of Oakland, California. The light-directional material, which is in effect an open, multi-cell honeycomb screen, sharply increases the contrast of the visual image by screening ambient light from the image.



Both of the TV pictures above are exposed to the same light. The lower tube is covered by a honeycomb screen.

When a thin panel of honeycomb material painted Hatte black is placed on the surface of either a cathode ray tube or motion picture screen, a large proportion of the ambient light is blocked from the viewed surface, greatly reducing the amount of light that reflects from the surface and distracts from the projected images.

The honeycomb panel is made of aluminum in the form of hundreds of small hexagonal cells with very thin walls. The action of the individual cells is somewhat analogous to cupping ones hands when looking into a store window on a bright day. As with the cupped hands, the cells prevent incident light reflections and allow objects on or behind the reflective surface to be seen.

Each cell of the honeycomb structure functions as a hood or light shield that limits the entrance angle of straight - line light. Therefore the frontal angle of vision is also limited at the same time, but this normally is of little importance since cathode ray tubes and motion picture screens are usually viewed through a relatively small frontal angle.

The arc of the viewing angle, as well as the degree of shielding, is determined by the cell size and depth. The deeper or smaller the cell, the more narrow the viewing angle. At the same time, as the viewing angle narrows, the reflected ambient light diminishes. With proper compromise between cell size and depth, optimum viewing angle and image intensity can be obtained. The optimum viewing angle has been determined to be 80 degrees or 40 degrees each side of center. With this construction, the normal 180 degrees exposure to ambient light is reduced to only 80 degrees. This reduction is usually sufficient to allow effective image contrast, even in direct daylight. The honeycomb layer actually casts a continuous shadow across the viewed snrface to make dark areas darker and light areas appear lighter and thereby increase contrast between the light and dark tones.

Discovery of this revolutionary new application of honeycomb core material is expected to be a boon to the electronics industry, where it will solve one of the major difficulties encountered in oscilloscope and TV viewing. Until this discovery was made, there were two potential alternatives to the solution of these difficulties. On was to increase the anode voltage for a brighter image, and the other was to develop better phosphor screens to produce a brighter image. Neither of these two improvements in cathode ray tubes is technically feasible at the present time, and the honeycomb light-directional screen is the only immediate solution. It is ideal for use in visual educational programs in well lighted school classrooms and auditoriums–obviating the necessity of darkening the room to view the image.

Outdoor motion picture theatres are also expected to benefit greatly from the use of a honeycomb layer placed

[*Continued on page* 30]

Impedance Matching in Hi-Fi

by Lawrence Fielding

Methods of matching impedance from the amplifier to the speaker, switching multiple speakers and output transformer troubleshooting problems.

We have now traced the minute audio signal all the way from its inauspicious beginning (phono cartridge, tuner, tape head, microphone or any one of the many other sound sources), through many stages and varieties of amplification, equilization, modification and other electronic "treatment." One thing should be remembered at this point. We have been able to come up with an electronic wave-form which is, to all intents and purposes, an exact replica of that minute signal presented to the amplifying chain. Any errors or distortions introduced by the program source (such as a cartridge) are still present in the same proportion. All we have added is amplification, so that the signal is now ready for application to the final link in the system, the loudspeaker. Loudspeakers, essentially electro-mechanical devices, restore the signal to audibility. Construction and operation of loudspeakers must be relegated to a future discussion, for it is a subject every bit as large as the one we have covered in the preceding months.

For the moment, we shall content ourselves with an analysis of "what to do with the two wire that lead from the amplifier to the loudspeaker."

Loudspeaker Impedance

Loudspeaker specifications are notoriously brief. Perhaps it is because the manufacturers of these delicate yet massive instruments realize that the high-fidelity consumer, accustomed to reading specifications such as "absolutely flat from 10 cycles to 100,000 cycles" would be a bit shocked if the frequency response of a loudspeaker were published. A more valid reason for the omission is the fact that any loudspeaker's response will be considerably affected by the particular enclosure or baffle with which it is used and by the amplifier which "feeds" it. One specification which must always appear on a loudspeaker specification sheet is the "voice coil impedance." As we have seen previously, impedance matching is of relatively minor importance when we speak of voltage amplification. In transferring *power*, however, it is extremely important that the impedance of the device which is to absorb the power be equal to the impedance of the "generator," in this case, the power amplifier. A simple example will serve to illustrate this fact. Suppose the secondary of an output transformer of an amplifier is designed for a 16 ohm lead. In *Figure 7A* we have shown an 8 ohm speaker connected across a 16 ohm secondary. For simplification, we have shown the amplifier as a constant voltage generator, with its own source impedance in series with the lead. Suppose the "generator" produces a constant audio voltage of 40 volts. In *Fig. 6A* only 1/3 of that voltage will appear across the 8 ohm loudspeaker lead because of the voltage divider action. In other words, 13.3 volts across the speaker and 26.7 volts across the amplifier's own internal impedance. Now, power is equal to $E^2/4$ where E is voltage and R is the impedance of the load. Thus, in the case of *Fig. 6A*, the power absorbed by the speaker will be $(13.3)^2/8$ or 22.1 watts. Now let us consider *Fig. 6B*, in which a deliberate "mismatch" condition has been set up, this time with too high a load impedance. Now, ⅔ of the total voltage (or 26.7 volts) will appear across the impedance. But the load impedance (R) is four times the previous value. The use of the power formula tells us that approximately 22.3 watts will be developed across the load. In *Fig. 6C* we have shown a hookup with a perfect impedance match; that is, the load equals the amplifier impedance. Applying the formula once more, we see that 20 volts will appear across the load and $(20)^2/16$ is equal to 25.0 watts. In other words, maximum power transfer always takes place when the load impedance equals the source impedance. The mismatch illustrations are really on the optimistic side, because we have assumed a perfect "constant voltage" source. Actually, today's power amplifier falls somewhat short of a true constant voltage source and so, generally, the loss of power transfer will be even greater than that illustrated.

Speaker Connections

It follows, then, that a loudspeaker having an 8 ohm voice coil impedance should be connected to the 8 ohm terminals of the amplifier and one having a 16 ohm impedance should be connected to the terminals marked 16 and Ground (or Common). The problems generally arise when more than one speaker is to be connected for simultaneous use. We have pointed out that one of the flexible features of a high-fidelity installation is the ability to add loudspeakers in various parts of the house with an additional investment of merely the cost of each loudspeaker added. Improper connection of these additional speakers can lead to more grief than they're worth. Simple application of the series and parallel resistance formulas will avoid mismatches and attendant reduction of power. One word of caution, however. From an earlier article in this series you will recall that adding a second loudspeaker to a 10 watt amplifier does not mean that now each of two loudspeakers will handle 10 watts. At best, with a perfect match all around, the loudspeakers will receive a maximum of 5 watts each. This is still plenty of decibels of sound. If multiple speakers are carried to extremes (as for example, one installation we know of has eight loudspeakers throughout the house, all fed from one amplifier) it is a good idea to re-evaluate the overall power requirements in accordance with procedures outlined earlier.

Series, Parallel Arrangements

To make your job simpler, most commercially available amplifiers are now equipped with 4, 8 and 16 ohm terminals (in addition to the common or "ground" terminal). *Figures 8A, B, C, D* and *E* illustrate some of the more popular "multpile speaker" hook-ups which maintain correct impedance match to all speakers involved. A word about *Fig. 8C*. In this arrangement, a correct impedance match is maintained throughout, but you will note that each of the 8 ohm speakers will absorb only half as much power as the single 16 ohm speaker. Since each *parallel* branch of the circuit has equal current flow (the total impedance of each branch being equal: 16 ohms) the voltage developed across an impedance of 8 ohms will be only half that developed across 16 ohms. Very often, this arrangement can be used to advantage, as in cases where it is desired to have less audible sound from smaller, secondary speakers than from a single main speaker system. *Figure 8D* is employed very often and represents a slight departure from a true match of impedance. The mere fact that an amplifier possesses taps at 4, 8 and 16 ohms does not imply that a 4 ohm speaker can be connected to the four ohm tap, an 8 ohm speaker to the 8 ohm tap and a sixteen ohm speaker to the sixteen ohm tap *all at the same time*. Let us consider why this is so. The moment a 4 ohm speaker is connected across the 4 ohm winding of the output transformer, that section of winding now looks like 2 ohms (4 ohms in parallel with 4 ohm speaker) to the rest of the output transformer. Since the total secondary is but a single continuous winding with taps for the various impedance, this means that the 8 ohm winding is now something less than 8 ohms because part of its turns have been shunted by an external impedance. All of this notwithstanding, the arrangement shown in *Fig. 8D* (and similar arrangements which you will undoubtedly come across) can be used satisfactorily with only a negligible mismatch, if no other "perfect" arrangement suggests itself.

Speaker Switching

All of the arrangements for multiple speakers illustrated thus far depend on *all* speakers being permanently connected if a correct impedance match is to be maintained. The immediate disadvantage of such an arrangement is the fact that the customer may not desire to have all speakers blasting at once. Perhaps other members of the family in other rooms have had enough *hi fi* for one day and are intent on their favorite TV mystery. The simplest solution is to equip each loudspeaker with a "pad" or volume control. These are available commercially in either 4, 8 or 16 ohm values and when properly connected, per instructions supplied, they maintain a constant impedance (equal to the particular loudspeaker impedance) whether the speaker is "on full" or turned down to inaudibility. The only disadvantage in this method is that full power is always fed to each speaker (or pad, as the case may be) and, in certain instances where it might be desirable to feed full amplifier power to a single speaker, it is not possible to do so.

Switching Arrangements

There are several companies manufacturing a full line of rotary switches ranging from simple, three position types to eleven positions. The three position types will probably find greatest application in your installation work because they are ideal for two-speaker switching. The usual arrangement is to have the positions as follows: Speaker A, Speaker B and Speaker A plus B. The trick is to have these switching sequences always maintain a correct impedance match to the amplifier, whether there be one, two or more speakers connected at any given moment. In *Fig. 9A*, two 16 ohm (or two eight ohm or two four ohm, with corresponding transposition of notations in the diagram) loudspeakers are to be used singly or together. You will note, by tracing through the switching sequence, that when either single speaker is used, it is hooked between the sixteen ohm terminal and the common or ground terminal. In the third switch position, when both speakers are to be used, they are paralleled and connected across the 8 ohm tap and common. *Figure 10* illustrates the switching arrangement for a particular 3-speaker set-up employing two 8-ohm and one 16-ohm system. While considerably more complex, it can be traced step by step and will disclose that seven positions are available, as follows: Speaker A, Speaker B, Speaker C, Speaker A plus B, Speaker A plus C, Speaker B plus C and finally, Speakers A, B & C all together. Many other variations, for

[*continued on page* 31]

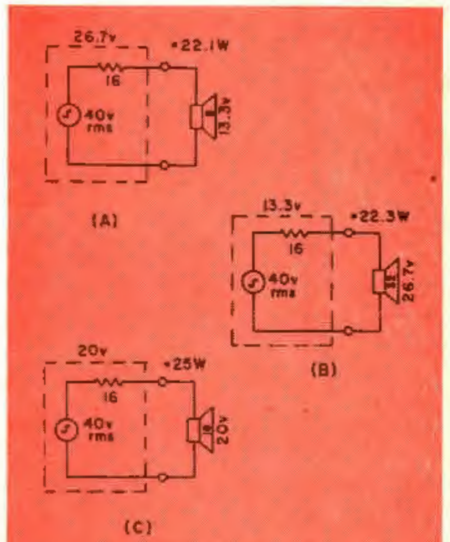


Fig. 7—Power loss due to improper impedance matching.

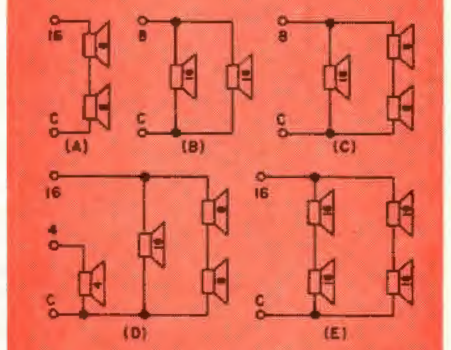


Fig. 8—Typical circuits for proper impedance matching.

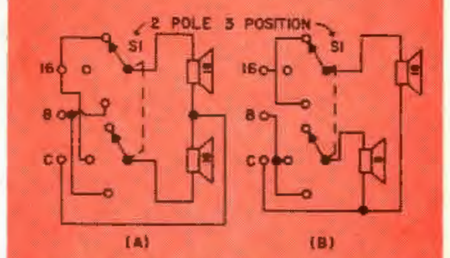


Fig. 9—Maintaining a match while switching speakers.

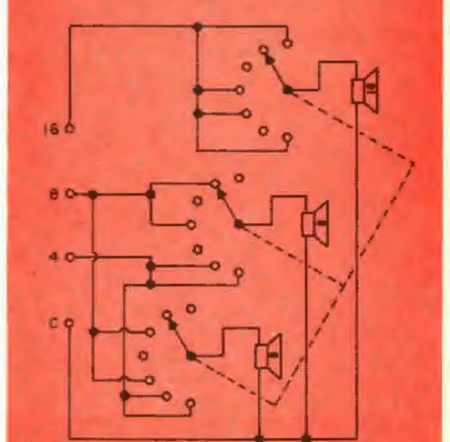


Fig. 10—Switching circuit for three separate speakers.

THE NEUTRODE TUNER

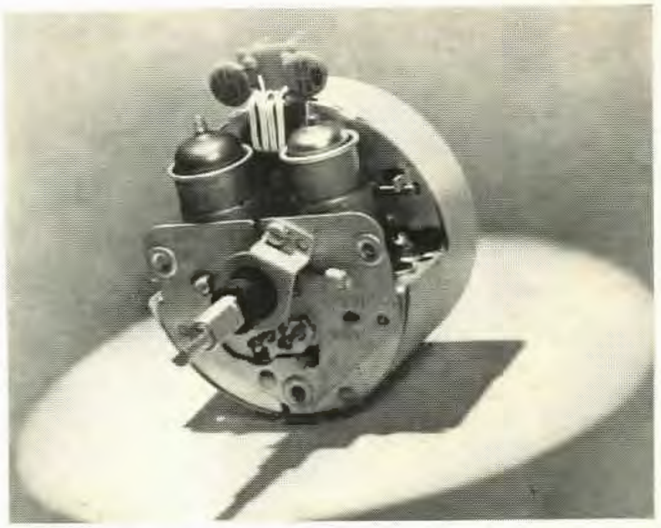


Fig. 1—The Standard Coil Neutrode Fireball Tuner.

by George Kravitz

How to troubleshoot, repair and align the new Standard Coil Fireball Tuner. The increased popularity of this tuner makes familiarity "essential".

NEUTRALIZATION is an old principle with a new application in *vhf* tuners. In the Standard Coil Neutrode tuner circuit, a neutralized triode is used as an *rf* amplifier. Special tubes were developed for use in this circuit, to provide a more efficient and durable *vhf* tuner.

The Neutrode circuit is used in two tuners: The Fireball, shown in *Fig. 1* and the conventional Turret tuner. Because of its newness and wide use, the Fireball is discussed in greater detail in this article. However, circuit details and alignment procedure are essentially the same for both tuners. The Fireball is shown in an exploded view in *Fig. 2*. When parts are referred to by number in this article, see *Fig. 2*.

The Neutrode circuit, because of its improved design and low cost, is becoming increasingly popular with receiver manufacturers. When more Neutrode tuners are put into service, the law of averages indicates that a greater number will require repair or adjustment. For this reason, the Neutrode is of interest to service technicians. The popularity of the Neutrode circuit is shown by the list below.

Receivers Using the Neutrode Tuner

A partial list of television receivers which may be equipped with the Neutrode tuner appears below.

MANUFACTURER	CHASSIS
Andrea	VQ21
Emerson	1400
Hoffman	327
Hoffman	332/333
Hoffman	422
Magnavox	24 series
Montgomery Ward (Airline)	4031
Montgomery Ward (Airline)	5041
Montgomery Ward (Airline)	5044
Packard-Bell	88S3
Packard-Bell	98D3
Westinghouse	V-2371
Westinghouse	V-2373
Westinghouse	V-2364
Westinghouse	V-2365
Westinghouse	V-2366
Zenith	17A20

Why the trend toward the Neutrode? The answer can be understood by considering the advantages offered.

Neutrode Advantages

The Neutrode circuit offers the following advantages: 1—High gain, 2—Low noise level, 3—Low voltage operation (125 V), and 4—Tubes operate at low plate dissipation.

Items 3 and 4 indicate longer tube life and electrical durability. In fact, experience has shown that the Fireball Neutrode is remarkably free of electrical troubles. If a defect develops, it is likely to be mechanical in nature, although mechanical troubles occur less frequently in the Fireball than in other *vhf* tuners.

The rugged Fireball, small in size, is easy to service. The bottom cover assembly (10 in *Fig. 2*) can be lifted off without tools; coils and parts are accessible. To replace the bottom cover assembly, simply snap it back in place.

Neutrode Circuit Operation

Electrically, the Fireball is relatively uncomplicated and easy to understand. Since a theoretical (as well as practical) knowledge is important in servicing any electronic equipment a brief discussion of the circuit operation follows.

The Fireball Neutrode circuit is shown in *Fig. 3*. The vhf signal is fed to the 300 ohm antenna terminals, through *CR1* and *CR2*, to *T1*. Components *CR1* and *CR2* constitute isolation network. In many receivers, the tuner chassis ground is electrically hot with respect to earth ground. If the antenna and earth ground are touched at the same time, *CR1* and *CR2* prevent shock.

A ferrite core balun type matching transformer, *T1*, couples the balanced 300 ohm antenna lead-in to the 75 ohm tuner input. (*T1* is shown as part of the antenna board assembly, item 14, in *Fig. 2*).

A well-designed tuner should reject signals at the *if* frequency (41 *mc*) arriving at the antenna. Thus many interfering signals are not passed through the receiver due to rejection of 41 *mc* by the parallel trap, *L1* and *C1* and the series trap, *C3* and *L2*.

The antenna circuit is tuned to approximately the center frequency of the channel being received. The *rf* response curve is "rocked in" by spreading or compressing the turns of the antenna coil, *L3*.

A 30 mmf feed-thru capacitor, *C2*, situated between the parallel and series tuned traps, functions as follows:

1—It serves as low-side capacitive coupling to the *pi-type* resonant input circuit of the *rf* amplifier.

2—It combines with the antenna coil *L3* to form a low pass filter. This filter attenuates any local oscillator feedback through the *rf* amplifier circuit.

Condenser *C4* couples the *vhf* signal to the grid of the *rf* amplifier and also prevents the *dc* resistance of the antenna circuit from loading down the *agc* line. *C4* also performs an interference rejection function since it has a comparatively high reactance at lower frequencies thereby attenuating low frequency interference.

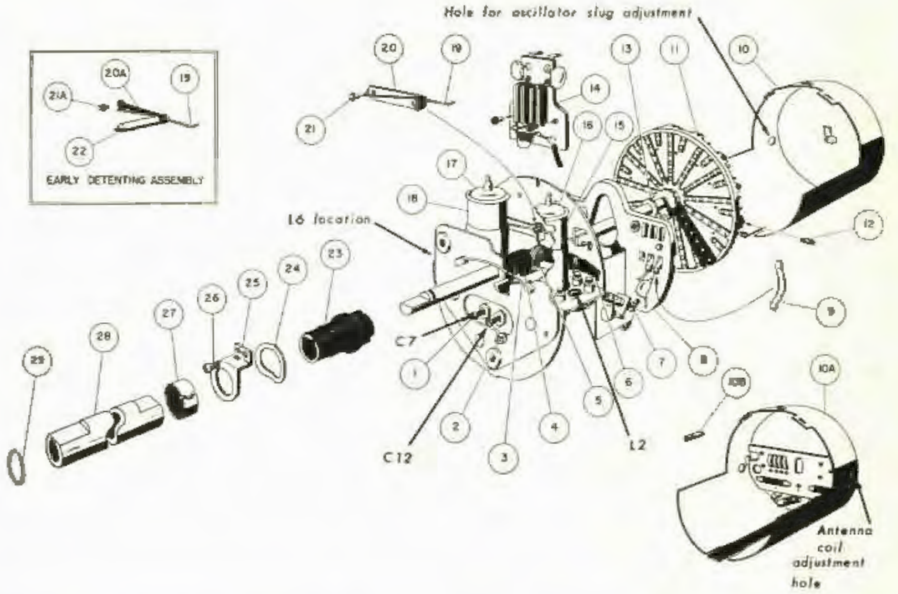
The *rf* input circuit (at the 2BN4 grid) consists of a resonant *pi* filter. The capacity of *C4* is relatively low; therefore, the inductance of antenna coil *L3* is made comparatively high. This design results in a higher than usual circuit Q and a resulting increase in interference rejection.

The input capacity of the 2BN4 is low compared to that of *C2* and *C4*. For this reason, most of the input signal voltage is developed between grid and cathode of the 2BN4, resulting in high gain.

An *agc* decoupling network, consisting of *R1* and *C5*, keeps the signal out of the *agc* line.

Triode Neutralization

The elements within a tube, and the space between the elements, act as a capacitor. At high frequencies, an in-phase signal would feed back through the inter-electrode capacity. To make it possible to operate a triode at high frequencies, the inter-electrode capacity is neutralized by feeding back a portion of the signal at the plate, 180° out-of-phase, to the grid of the same tube. This signal is fed through neutralizing capacitor, *C20*, which is adjusted to provide the correct amount of out-of-phase feedback. (Neutralization instructions are included under *RF* Alignment in this article).



Item	Description	Item	Description
1	Trimmer assembly, RF or mixer	15	Tube shield, RF
2	Test point	16	Tube, RF—type number stamped on cover
3	Retaining spring	17	Tube, oscillator-mixer—type number stamped on cover
4	Cam follower	18	Tube shield, oscillator-mixer
5	Return spring	19	Detent spring
6	Locking spring	20	Detent locator assembly
7	Neutralizing trimmer assembly	20A	Early detent locator
8	Stator board assembly	21	Rivet—mounts detent locator assembly
9	Spring contact	21A	Rivet—mounts early detent locator
10	Bottom cover assembly	22	Detent rod
10A	40 mc input cover assembly	23	Cam, fine tuning
10B	Extension contact—used with 40 mc input cover assembly	24	Washer
11	Shaft and rotor disc assembly	25	Fine tuning bracket
12	Oscillator slug	26	Screw—mounts fine tuning bracket
13	Detent spacer	27	Shaft retainer
14	Antenna board assembly — includes mounting eyelets	28	Shaft, fine tuning
		29	Retaining ring

Fig. 2—An exploded view of the Fireball Tuner with a parts key.

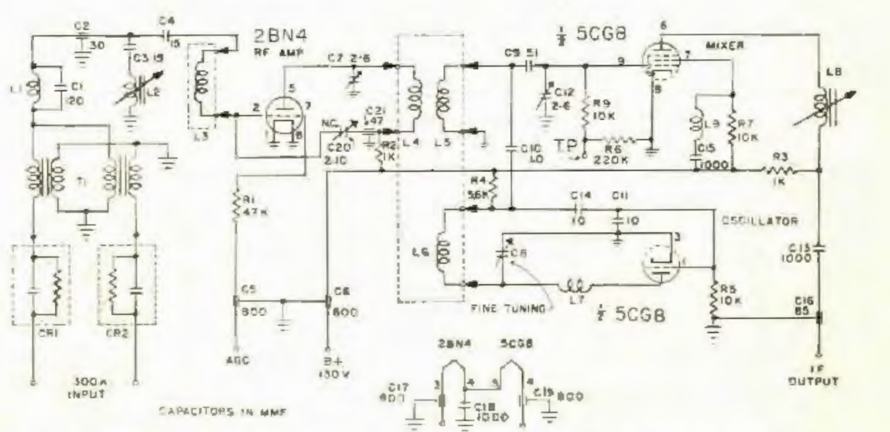


Fig. 3—Schematic diagram of the Neutrode Fireball and Turret Tuner.

The *rf* amplifier tubes used in the Neutrode tuner have been developed especially for this circuit. Note that two connections are provided for both grid and cathode of the 2BN4. This results in reduced lead inductance and makes a single neutralization adjustment suitable throughout the entire *vhf* band.

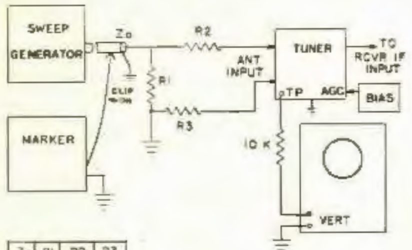
Feed-thru capacitor *C21* and resistor *R2* form the *rf* amplifier plate decoupling circuit.

Mixer Stage

Signal voltage, developed across *L4*, is inductively coupled to *L5*. The mixer grid circuit is tuned by trimmer capacitor *C12* which combines with the input capacity of the mixer tube. The

Channel	Frequency (MC)	Video Carrier Frequency (MC)	Sound Carrier Frequency (MC)	Receiver H-F Oscillator Frequency (MC)
2	54-60	55.25	59.75	101
3	60-66	61.25	65.75	107
4	66-72	67.25	71.75	113
5	76-82	77.25	81.75	123
6	82-88	83.25	87.75	129
7	174-180	175.25	179.75	221
8	180-186	181.25	185.75	227
9	186-192	187.25	191.75	233
10	192-198	193.25	197.75	239
11	198-204	199.25	203.75	245
12	204-210	205.25	209.75	251
13	210-216	211.25	215.75	257

Table 1—Sweep and Marker frequencies for RF alignment.



Z_0	R1	R2	R3
52	56	120	150
72	85	110	150

Fig. 4—Connections for visual alignment of the tuner.

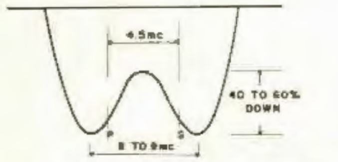


Fig. 5—Response curve with antenna swamped by a resistor.

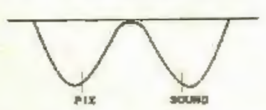


Fig. 6—Response curve during neutralization adjustment.

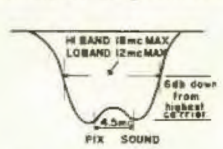


Fig. 7—Response curve when tuner is properly aligned.

adjustment of *C12*, similar to that of *rf* trimmer *C7*, involves adjusting the trimmer on one channel and adjusting all other channel coils to tune with this established capacity.

Resistors *R6* and *R9* constitute the mixer grid return. A test point is provided at the junction of the resistors.

The mixer stage is grid leak biased and most of the voltage is developed by the oscillator signal while a portion of the bias voltage is developed by the incoming *vhf* television signal. A grid leak circuit, in addition to developing bias, also acts as a detector. Therefore, with an *rf* sweep generator connected across the antenna terminals, an oscilloscope may be connected to the test point to observe the response curve of the *rf* circuit.

Inductance *L9* is to provide a small amount of in-phase feedback—not enough to cause oscillation, but enough to make the gain of the tuner more constant on all channels. Physically, *L9* consists of several turns in each of the leads of capacitor *C15* and need not be adjusted.

Oscillator

The triode section of the 5CG8 functions as an oscillator. A modified Colpitts circuit is used. The oscillator coil for each channel is slug tuned. To prevent the slug from being "lost", the inside diameter of each coil form is threaded throughout its length.

Oscillator coil *L6* is inductively coupled to *L5*, the mixer grid coil. Additional coupling is obtained through *C10* to minimize any possible decrease in oscillator injection at higher frequencies.

To stabilize oscillator frequency, *C10* and *C14* are temperature compensated. Their temperature coefficients are chosen to minimize oscillator frequency drift with changes in temperature.

The fine tuning capacitor is constructed so that it opens and closes like the cover of a book. For this reason, the tuner is often said to have "book" line tuning.

RF Alignment (Including Information on Neutralization)

Equipment required:

1. Sweep generator
2. Marker generator with the following frequency outputs:
   Sound: 59.75 *mc* to 215 *mc*
   Video: 55.25 *mc* to 211.25 *mc*
3. Oscilloscope
4. Bias supply
5. Matching pad, shown in *Fig. 4*.

RF alignment procedure:

Numbers in parenthesis refer to a part shown in *Fig. 2*.

1—Connect equipment as shown in *Fig. 4*. Turn on receiver and equipment and allow a five minute warm-up period.

2—Apply a negative 2.5 volts to tuner *agc* input (2).

3—Connect a 22 ohm resistor across the antenna terminals.

4—Switch to channel 10.

5—Remove bottom cover assembly (10).

6—Detune mixer plate coil, *L8*. The adjustment hole for this coil is located to the right of the oscillator-mixer tube, indicated in *Fig. 2*.

Note: This step is necessary to avoid kick-back (curve distortion due to inter-action). It will be necessary to retune *L8* according to the manufacturer's *if* alignment instructions after concluding the tuner *rf* alignment.

7—Adjust *C7* and *C12* (see *Fig. 2*) for response curve shown in *Fig. 5*.

Note: Ultimately, adjustments will be made to achieve the curve shown in *Fig. 7*. At this time, however, the response curve (*Fig. 5*) will be much wider and deeper because the antenna circuit is temporarily loaded with a 22 ohm resistor. The purpose of this resistor is to prevent curve distortion due to the effect of the input circuit. The 22 ohm resistor reduces the input circuit *Q* to a negligible value.

8—Remove the 22 ohm resistor connected across the antenna terminals.

9—Spread or compress the antenna coil for maximum gain between the *rf* markers for a balanced response. The two peaks should be symmetrical.

10—Remove the B+ lead from the tuner.

11—Increase the sweep generator output level.

12—Adjust the neutralizing trimmer, *C20* (7) located inside the tuner. Adjust *C20* for minimum gain between markers as shown in *Fig. 6*.

13—Re-connect the B+ lead to the tuner.

14—Switch sweep generator to channel 13.

15—Replace bottom cover assembly (10).

16—Adjust antenna coil by compressing or spreading the turns through a rectangular hole in the bottom cover assembly (10). The rectangular hole is shown in *Fig. 2*. Adjust the coil for maximum gain and a response curve similar to that shown in *Fig. 7*.

17—Repeat step 16 for each channel. Change sweep and marker frequencies to the frequencies required for the channel being aligned. A list of frequencies is shown in Table 1.

Note: If it is impossible to obtain a passband within the limits shown in *Fig. 7*, it will be necessary to adjust the inductance of plate coil L4, or mixer coil, L3. This can be done by applying a small amount of acetone to the coil winding and compressing or spreading the turns as required.

18—Retune the mixer plate coil, *L8*, according to the manufacturer's *if* alignment instructions. It will usually be necessary to connect the oscilloscope vertical input to the video detector output to make this adjustment.

Oscillator Adjustment

The simplest method for adjusting the oscillator is to do so with a TV signal received off-the-air. There is an individual adjustment for each channel. Use a non-metallic alignment tool for adjustments.

1. Turn on receiver. Allow a five minute warm-up period.
2. Set channel selector to an active channel.
3. Turn the fine tuning control to the approximate center of its range. Because the fine tuning is continuous, it is necessary to estimate the center of the fine tuning range by watching the picture.
4. Tune the oscillator slug for best picture. When the channel selector is switched to a channel, the oscillator slug for the channel is accessible through a hole (shown in *Fig. 2*) in the bottom cover assembly (10).

[*continued on page 30*]

TRADE FLASHES

Zenith Radio Corporation, in a sharp departure from industry practice, announced a new series of "carry about" TV sets with a precision built, high performance horizontal chassis to replace its vertical chassis portable TV receivers. Wired by hand—with no printed circuitry—the horizontal chassis offers the set owner greater operating dependability, longer TV life, and elimination of service headaches caused by printed boards. According to Zenith, the vertical chassis has been virtually "standard" throughout the industry in portable TV while the more costly, higher efficiency horizontal chassis with hand crafted wiring has been generally restricted to use in higher priced, big screen receivers. ■ ■

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Motorola has concluded what Floyd McCall, Vice President of railroad sales, termed an important "first" among manufacturers of 2-way radio equipment for railroad use. This innovation, McCall said, was the holding of a week-long service school designed strictly for railroad 2-way radio technicians at Motorola's service training center in Chicago. McCall emphasized that extensive use of radio equipment and new developments in the railroad industry have intensified the need for skilled technicians. Motorola's purpose in holding this school, he pointed out, was to help fill this need and also to bring latest servicing techniques and information to the technicians who maintain this gear. Motorola's newest developments in its 64-volt transistorized equipment, as well as its "Main-Line" communication system and standard 2-way radio gear, were features of the service school.

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According to a recent newspaper report, the Navy's quest for a simple instrument panel for planes might lead to three dimensional television for civilian use. The screen has been designed to replace the maze of dials and pointers a pilot must must watch and will be used to present flight information calculated by computers. This flat screen may lead to TV with perspective. The flat screen was developed by perfecting a transparent phosphor which can also be used for a simpler, more efficient color tube.

• • •

A new television station went on the air from Port Jervis, New York. Manufactured and designed by the Dodge Television Division of Thompson Products, the station lays claim to being the smallest television station in the world. It has one camera, is manned and directed by one person, and its programs boast of the top Trendex, for almost everyone in Port Jervis watches the local programs. The station is hidden from the rest of the nation by a range of mountains near the Pennsylvania state line. The TV station which is owned by the Port Jervis TV Company, Inc., is housed in a studio that formerly was a two-car garage and is unusual in that it's the only station in the world that is run and operated by one man. The total cost of the station is estimated at $5000, not including the cost of converting the garage into a television studio.

• • •

A new "live" color television camera, smaller in size, simpler in design and easier to operate than any now available, and which is expected to result in better home reception of color TV programs, was unveiled by the General Electric Company's Technical Products Department. It is the first such device to incorporate printed circuits and transistors. The new color TV camera weighs but 215 pounds; 75 pounds less than current models. Dimensions of 34 by 18 by 22 inches are 10 inches shorter; three inches narrower and about an inch lower. Special circuitry designed for the camera ensures truer registration of colors with no slur or runover into other colors.

• • •

Manufacturers' sales of receiving tubes in October increased over September while sales of television picture tubes declined somewhat from that level, the Electronic Industries Association (formerly RETMA) announced today. Sales of receiving tubes were reported to be over the October 1956 sales level while TV picture tubes were down. Cumulative sales of both types of tubes during the first 10 months of this year were reported to be under the cumulative level of sales of the first 10 months of 1956. Radio receiver retail sales in October continued to show increase over previous month while television sales lagged somewhat from the September level. Cumulative retail sales of TV sets during the first 10 months of this year remained about one-quarter million units under the like 1956 period while radio set sales climbed to nearly 800,000 more this year than were sold during the like months of 1956.

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In a move to step up its dispatching efficiency so that its cabs can hande more calls per day, Louisville Taxicab and Transfer Company has ordered 200 mobile radio units from the General Electric Communication Products Department. Louisville Taxicab, operator of Yellow Cabs in that city, has been using various kinds of two-way radio equipment since November of 1946. The firm operated on the 152 mc band, where crowded channel conditions existed, and thus was able to use only 125 of its more than 200 cabs for radio calls. The others were forced to communicate with the company's dispatchers through call-boxes and other methods. A year-long test of various types of communication equipment led the company to switch from the 152 mc band to 450 mc so that all of the cabs could be placed on the latter band. ■ ■

ELECTRONIC SERVICING • JANUARY, 1958

ELIMINATION OF COLOR TVI

This group of articles on Color TVI is from the fourth presentation in a series of "TVI Aids" posters and pamphlets prepared, published, and distributed nationally by the Washington Television Interference Committee in collaboration with cooperating individuals and agencies. The committee solicits opinions and helps from those in the electronics industry in order that its efforts along this line continue most effectively. The committee will be glad to include in future bulletins any pet remedies or informative TVI material you might wish to share with others. A limited number of the original bulletins are still available. You may write to: Harold R. Richman, Editor, WTVIC TVI Aids, 1110 Lake Boulevard, Annandale, Virginia.

by The Washington Television Interference Committee

SECTION III
EXTERNAL SOURCES OF INTERFERENCE

MANY external sources of interference in color television receivers can be eliminated by using the same techniques used on black-and-white receivers. The case of oscillator radiation serves as a good example. Radiation from the *rf* oscillator of some television receivers may cause interference on color television receivers. If the frequency is within .75 *mc* of the color subcarrier frequency it will appear as a red, green, and blue beat pattern. The most effective method of treating this type of interference is to align the offending receiver.

The following interference chart lists other external types of interference together with cause and suggested remedy. The method of installing the trap suggested in the chart is shown in *Fig. 2*.

If the interfering signal is on the image frequency of the receiver and all other means of eliminating the interference fail, re-aligning the *if's* to a frequency different from the interfering signal by a few hundred *kc* might help.

The transmission line trap illustrated in *Fig. 2* has a tuning range of 40 to 170 *mc*. A similar trap for the high frequency VHF channels can be made from a 4⅜" length of 300 ohm transmission line shorted at one end with a 2.5–13 mmf adjustable ceramic capacitor connected at the other end. Tuning this trap should be done with care because it is very sharp. More than one trap may be used if necessary.

Intermittents

Certain receiver and associated equipment failures may produce an effect very closely resembling the interference pattern of a nearby "CW" or radiotelephone transmitting station. The committee has found, in most such cases reported, one or more of the following troubles: (1) a loose, or weathered antenna connection or lead-in; (2) a loose antenna lead at the receiver antenna post; (3) other intermittent troubles including a faulty or aging tube or other receiver component.

Cross modulation external to receiver, including external rectification sources such as corroded antenna and transmission line connections may also occur in poor connections in house wiring, plumbing, stovepipes, etc.

Misadjustment of receiver tuning controls by the set owner may also produce interference patterns, or increase the susceptibility of the receiver to interference from outside sources.

SECTION IV
Antenna Systems for Minimizing Interference to Color Reception

Antennas which give clear and sharp black and white pictures free from ghost or noise interference will in most cases give good color pictures. Properly installed, most broad band antennas will generally give satisfactory results. Some designs may cause poor reception on one or more channels due to non-uniform response.

Narrow-band highly directive antennas such as a multi-element Yagi can be satisfactory for black and white reception, but may cause a complete loss of color due to sharp cutoff on the high frequency end of the pass band. With a well designed Yagi antenna color reception in the fringe areas can be excellent, if the pass band is broad enough so that the chroma sidebands have not been lost. It is essential that the antenna used have a flat response over the channel being received, and a reasonably close impedance match be maintained. Video carrier and color subcarrier both should fall within the flat portion of the passband, and major differences in level between the two carriers will result in a degraded color reproduction. Some existing community antenna systems may have to be re-engineered for flatter response before they will be satisfactory for high grade color reception.

Antenna orientation can be critical with ghost conditions caused by multi-path signals from the transmitter.

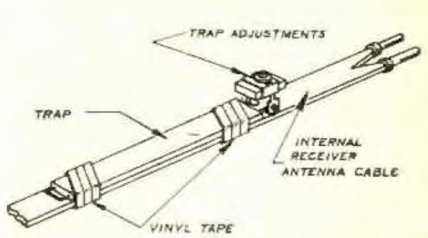


Fig. 2—Simple transmission line trap for 40 to 170 mc.

These ghosts can cause cancellation of the subcarrier or phase shifting of color sidebands. In some cases of compromise, orientation of the antenna for multistation reception will be completely unsatisfactory for color. The antenna should be oriented for the best reception from the station that carries color programs. Antenna rotors are desirable.

Boosters and Master Antenna Systems

Booster amplifiers in areas of very weak reception will operate properly with color signals only if the design characteristic of the booster has broad bandpass and high signal-to-noise ratio.

Antenna distribution systems must deliver to the antenna input of the receivers a high enough signal level to be free from noise and also have the proper bandpass characteristics. Interaction of one receiver on others due to radiation or loading effect of the transmission line can cause loss of, or unsatisfactory color reception. Not all types of distribution systems provide complete isolation from other outlets. This condition is particularly noticeable where resistors are used from a common transmission line, and various types of tuners are coupled to this line and tuned to a number of different channels. Each tuner reflects a different impedance to the line, causing interaction.

Care must be taken not to overload community receiving system line amplifiers, as overloading will show up more quickly on color than on black and white transmissions.

Care should also be taken when matching the antenna input to the antenna line of other than the conven-

[*continued on page* 33]

Interference Chart

Type of Interference	Character of Interference	Cause	Suggested Remedies
FM Interference	FM sound in TV sound.	FM signal over-loading *RF* unit creating harmonic in receiver falling on highband TV channel.	Very rare. FM trap cures.
		Second harmonic of FM transmitter falls on a high band TV channel.	Second harmonic radiation must be suppressed at transmitter. Orient TV antenna to reduce harmonic pickup.
Adjacent Channel Interference	Undesired Station causing blanking out of desired station or causing windshield wiper effect.	Inadequate receiver selectivity. Attempting to receive stations beyond service area.	Align the receiver with special attention to adjacent channel traps. Use antenna with good front to back or front to side ratio, if applicable, and orient antenna to minimize adjacent channel pickup.
Co-channel Interference	Horizontal bars moving up and down through pix. In some cases sound may be garbled.	Two stations operating on same channel. Customer located so as to receive signals from both stations.	Use antenna with good front to back or front to side ratio on that particular channel if stations are in different directions. Orient antenna for best results. "Venetian Blind" condition largely corrected by off-set carrier operation of stations.
Short wave and other *RF* transmitters.	Cross hatch, horizontal or diagonal bars in pix. In instances of extreme interference pix may be reversed (negative) or blocked out with no visible beat pattern.	Pickup of fundamental, harmonic or parasitic frequencies from transmitter.	1. Install a good standard high pass filter as close to the receiver input as possible (directly on head end unit) with short ground connection. 2. If filter *does not* remove interference report matter to Television Interference Committee or FCC Field office in area of complaint. Licensee of offending transmitter will be required to correct harmonic or parasitic radiation at transmitter.
		Overload of TV *RF* unit, from fundamental of transmitter.	Install transmission line trap tuned to interfering station, or good, properly installed high pass filter.
	Sound in TV sound.		Install a good AC line filter. If due to rectification occurring in audio section of receiver, See WTVIC TVI Aid No. 2 (REV.) 1-54.
Interchannel	Diagonal bars in picture or undesired pix superimposed on picture.	Double conversion or harmonic conversions (Cross-modulation)	Adjust FM trap. Install trap adjusted to interfering frequency—usually best to attenuate the stronger signal. Orient antenna to reduce interference.

Some Pointers on Mobile Installations

DETERMINING the exact power requirements, antenna height, and frequencies bands for optimum 2-way mobile radio communications for a specific type of service requires a rather complex procedure. However, there are some generalities, or rules of thumb that can be applied as a first step in planning or estimating the costs of a basic system. These are based on the broad and predictable phenomena experienced in the short wave and VHF bands of 25-50 *mc* and 150-160 *mc*. The generalities are these:

1. If the communication range required between the fixed and the mobile station is 10-12 miles, over flat or rolling terrain, FM-equipment operating in the 150-160 *mc* band is recommended. The fixed-station antenna should be at least 75 feet above the ground. A 15-watt fixed station, with 10-watt mobiles, is sufficient. Ignition suppression will not usually be required. If the range is 12-15 miles, the fixed-station antenna should be 100 feet above the ground; 30 watts for the fixed-station and 15 watts for the mobile should be satisfactory.
2. If the range is more than 20 miles, FM equipment in the 25-50 *mc* band is recommended. If a range of up to 25 miles is required, a 15-watt fixed-station with the antenna 75′ above ground should be adequate. Mobiles should be 10-watts. For communications over distances greater than 25 miles, the base-station antenna should be elevated to 100′. Power should be 30-watts for the mobiles and 30 to 60-watts for the base.
3. When mobile-to-mobile communication is required over distances greater than 2 or 3 miles, the 25-50 *mc* band is preferred. This is usually satisfactory over flat terrain up to 10 miles. Fifteen to twenty-five watts of power should be used.
4. In the 25-50 *mc* band, a frequency between 45 and 50 *mc* is desirable as there will be less "skip" interference. Frequencies in the 25-45 *mc* range are less desirable, but may be used where ranges of 35 to 45 miles are required and some "skywave" effects are tolerable.
5. In dense forest or tropical undergrowth a frequency between 25 and 30 *mc* is best for mobile-to-mobile work.
6. Man-made static is less in the VHF band than in the short-wave band. Therefore, for city communication (police, taxicabs, utilities, etc.) the 150-160 mc band is usually used.
7. Ignition and generator noise suppression (spark plug suppressors and band-rejecting generator filter) is generally required for the 25-50 *mc* band.
8. Static often affects the 25-50 *mc* band, causing the squelch to open. It usually has little or no effect in the VHF band.
9. For short ranges of from 5 to 10 miles, VHF equipment with only 3 or 4 watts output is satisfactory for mobiles. For fixed station operation, a 15-watt transmitter, with an antenna high enough to provide line of sight transmission, will be adequate.
10. VHF-AM equipment should be used only for very short range service requiring operation over 2 to 3 mile distances with flat terrain. Complete noise-suppression must be used on the vehicle when AM apparatus is used.

All radio transmitters must be licensed by the Federal Communications Commission, Washington, D.C., before being put into operation. The method and form of the license application depends on the proposed service in which the equipment is to be used. Application for station licenses for Public Safety, Industrial, and Land Transportation Radio Services is made on F.C.C. form #400. There is no charge by the government for a radio-station license. It is suggested that service dealers interested in the installation, service, maintenance, or operation of 2-way radio equipment in the above services become familiar with the F.C.C. Rules. The Rules are divided into "Parts" which can be obtained from the Superintendent of Documents, United States Government Printing Office, Washington, D. C. Each "Part" costs 15 cents.

A summary of the contents of some of the more pertinent "Parts" follows:

PART 9—AVIATION SERVICES. Details of the aviation services are described. F.C.C. form No. 401 is used for license applications.

PART 10 — PUBLIC SAFETY RADIO SERVICES. General information on technical standards, operating requirements, and details concerning police radio, fire radio, forestry-conservation radio, highway maintenance radio, and special emergency services such as ambulance, doctor, veterinarian, etc.

PART 11—INDUSTRIAL RADIO SERVICES. General information on technical standards, station operating requirements such as record keeping; details concerning the power radio, petroleum radio, forest products radio, motion picture radio, relay press radio, low-powered industrial radio, industrial radio-location and the special industrial radio services. The last service mentioned includes the following types of activities: agricultural, heavy construction, building construction, manufacturing, mining, special industrial service and trade, general industrial service and trade, engineering service, and miscellaneous public service activities.

PART 13 — RESTRICTED RADIO OPERATOR'S LICENSE. The base station of a communication system must be operated by a person holding at least a "Restricted" license. Rules covering the application for and the granting of this license or permit are given in this pamphlet. (10 cents per copy)

PART 16 — LAND TRANSPORTATION RADIO SERVICES. General information for taxicab radio, automobile emergency radio, railroad radio, and motor carrier radio services are described here.

PART 17—CONSTRUCTION, MARKING, and LIGHTING OF ANTENNA STRUCTURES. The rules and regulations governing such structures are outlined. These are of particular importance if a base station antenna tower is near an airport or presents a potential hazard to aircraft navigation. ■ ■

Mfr: Dumont **Chassis No.** RA-400/401

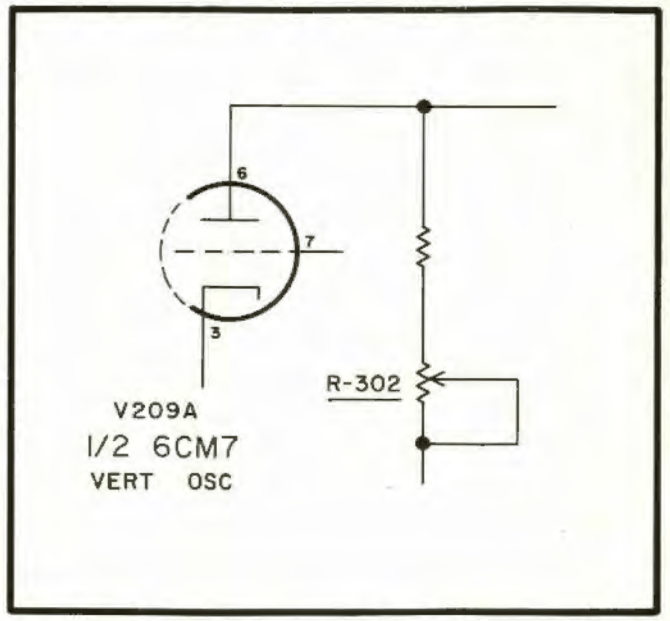
Card No: Du-400-1

Section Affected: Vertical

Symptoms: Intermittent vertical collapse.

Cause: *R302* opens intermittently.

What To Do: Replace *R302*, a 7.5 megohm potentiometer.



Mfr: Dumont **Chassis No.** RA-400/401

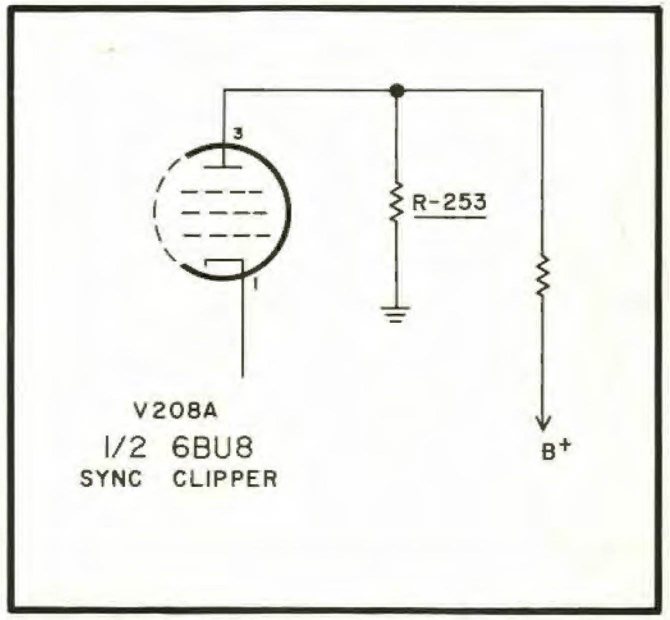
Card No: Du-400-2

Section Affected: Sync.

Symptoms: Intermittent vertical roll and horizontal tearing.

Cause: Open *R253*

What To Do: Replace *R253*, a 120K ½ w.



Mfr: Dumont **Chassis No.** RA-400/401

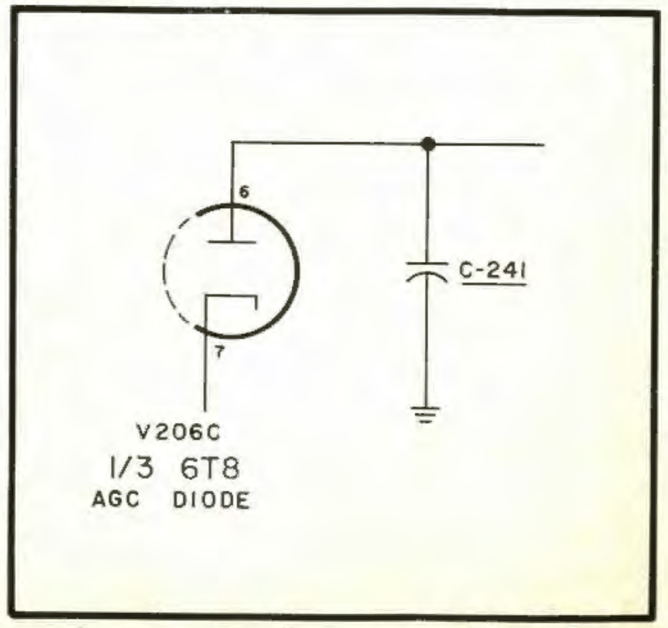
Card No: Du-400-3

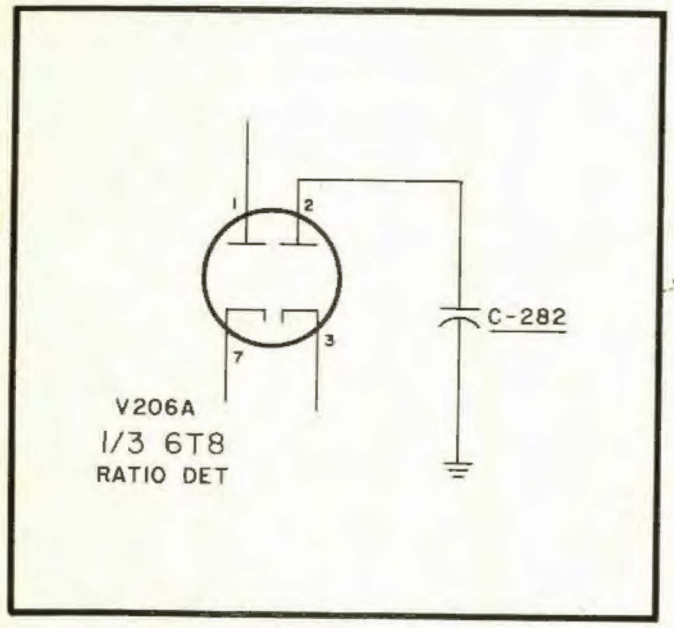
Section Affected: *agc*

Symptoms: Video overload.

Cause: Shorted *C241*.

What To Do: Replace *C241*, a *.15 mf.*





Mfr: Dumont **Chassis No.** RA-400/401

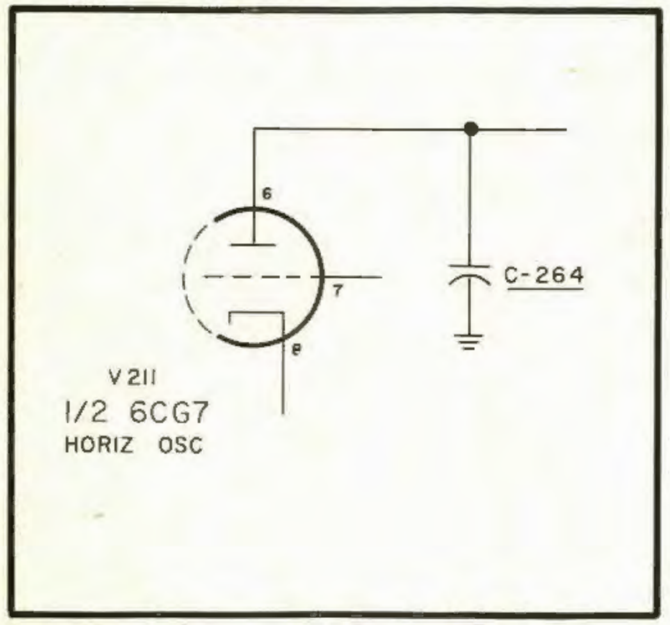
Card No: Du-400-4

Section Affected: Sound

Symptoms: Distorted sound after receiver warms up.

Cause: Defective *C282*

What To Do: Replace *C282, 5 mfd,* 100V.



Mfr: Dumont **Chassis No.** RA-400/401

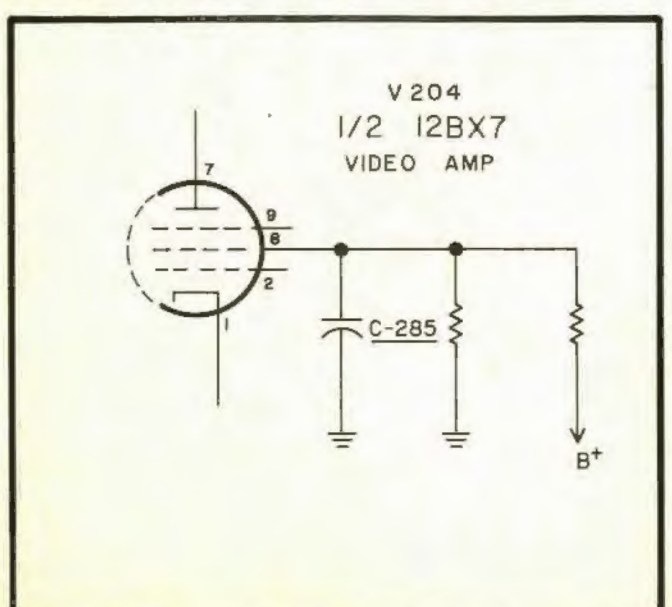
Card No: Du-400-5

Section Affected: Sync.

Symptoms: Horizontal oscillator drifts out of frequency.

Cause: Defective *C264.*

What To Do: Replace *C264, 22mmf* 10%.



Mfr: Dumont **Chassis No.** RA-400/401

Card No: Du-400-6

Section Affected: Video

Symptoms: No picture, no sound

Cause: Shorted *C285C.*

What to Do: Replace *C285C, 4mf* 400V.

Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

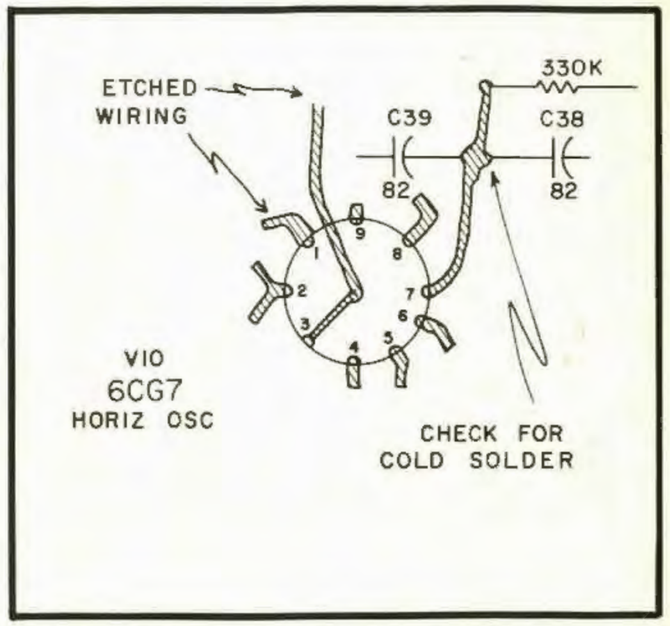
Card No: EM-120293-1

Section Affected: Horizontal *afc.*

Symptoms: Erratic horizontal hold.

Cause: Cold solder connection on etched board at junction *C38* or *C39, 82 mmf.*

What To Do: Re-heat and run fresh solder to pigtail and etched circuit wiring.



Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

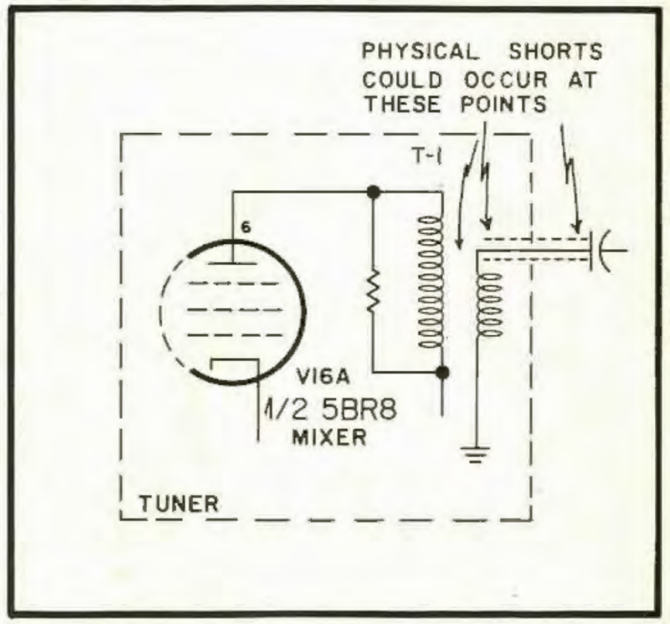
Card No: EM-120293-2

Section Affected: Video *if*

Symptoms: Weak picture (excessive snow) and sound.

Cause: Short in shielded output cable from tuner to 1st *if* tube.

What To Do: This short is usually a mechanical problem—due to solder blob on tuner *if* coil shorting inner conductor and outer shield of insulation at either end of the shielded cable. Locate the cause and repair.



Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

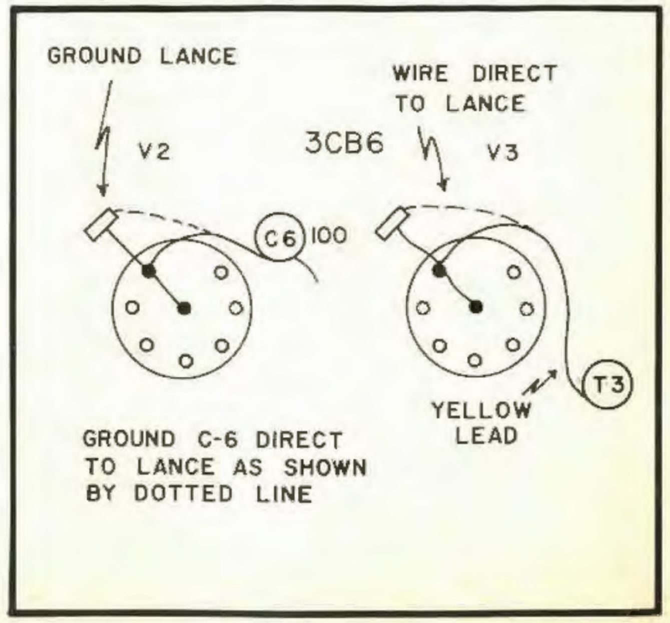
Card No: EM-120293-3

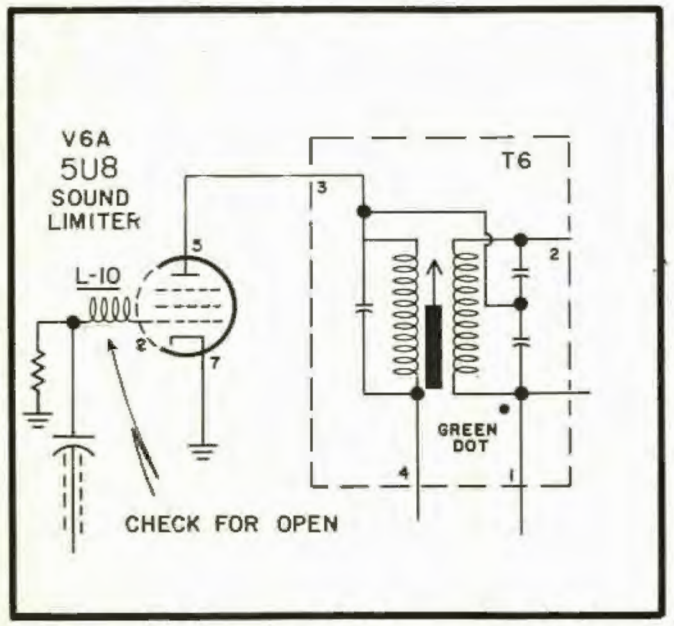
Section Affected: Video *if*

Symptoms: Abnormally high *agc* voltage causing anything from excessive snow to picture and sound cut off.

Cause: Spurious oscillations in video *if* due to ground loops.

What To Do: Check ground wires at 2nd and 3rd video *if* amplifiers (V-2, V-3, 3CB6's) and rewire ground points as shown in following diagrams, if not already done.





Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

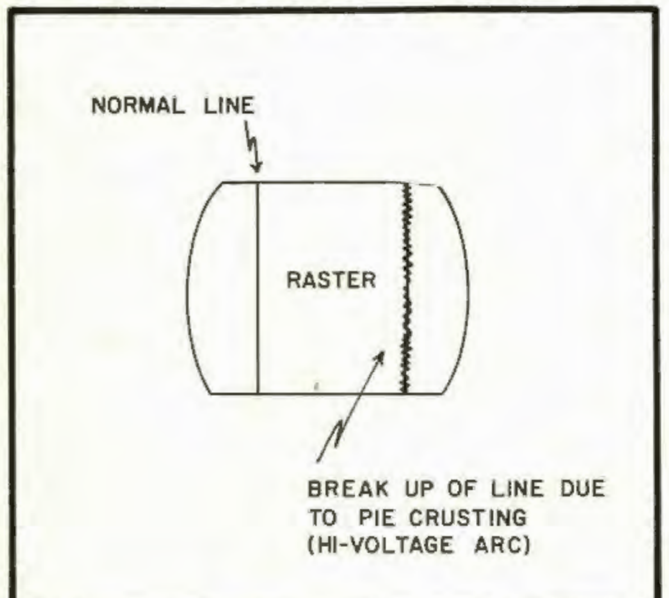
Card No: EM-120293-4

Section Affected: Sound *if*

Symptoms: Poor sound and audio buzz.

Cause: Defective discriminator transformer or open *rf* choke in grid of sound limiter tube 5U8 (V-6A).

What To Do: Check *L10* (*rf* choke) and replace with a *4.6uh* if open. If good check discriminator transformer for open winding or shorted base capacitor. Replace transformer if necessary.



Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

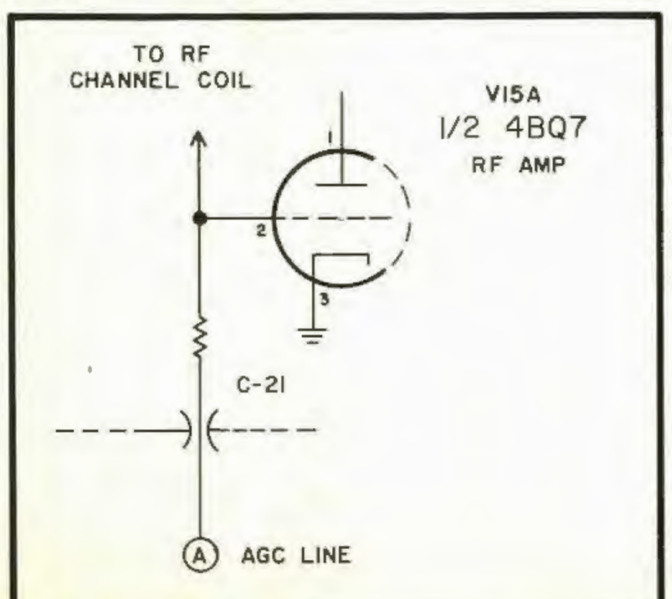
Card No: EM-120293-5

Section Affected: Raster

Symptoms: Hissing sound from deflection yoke and severe pie crust effect.

Cause: Arcing between deflection yoke and aluminum width shim.

What To Do: If horizontal width is not excessive remove the aluminum width shim completely. If width is excessive due to high line voltage increase the value of the screen resistor to the horizontal output tube (12DQ6 or 12CU6). If adjustable control of width is required then the deflection yoke will have to be changed.



Mfr: Emerson **Chassis No.** 120293T,X 120299V 120300X 120302V 120303V

Card No: EM-120293-6

Section Affected: Video

Symptoms: Picture bending depending on video information.

Cause: Shorted tuner *agc* feed thru condenser causing overloaded *if* due to tuner operating at maximum gain.

What To Do: Check *agc* voltage at the tuner input. If very low when receiving a relatively strong signal, disconnect lead from tuner *agc* lug. If the voltage is then normal, change the *agc* feed thru capacitor in the tuner (*800 mmf*).

TRANSISTORS

[*from page* 9]

contains phosphor (Table V) and *n*-type area is formed at the point. Thus, as shown in the figure, a *pn-pn* junction is actually formed. The explanation for this is that because of the phosphor contained in the collector wire and the forming action, an additional *n*-type zone is added to the *p-n-p* zone.

In *Fig 10* we show the wire contacts as being widely separated. Actually, they are very close to one another, the separation being about 1/1000″.

Operation

The biasing applied to the emitter is conventional as shown in *Fig. 11;* the forward bias reducing the space charge at (A) for forward carrier flow. At the collector, however, we are faced with conditions differing considerably from a conventional transistor. Here the collector junction actually to be taken into consideration for reverse biasing is at (B). In operation, holes from the emitter and base are swept across this junction and then on to the negative terminal of the battery through junction (C) by virtue of the high electric field set up across both junctions in series by the reverse bias.

In the process of sweeping across junctions B and C it is observed that more holes flow than were originally injected into the emitter. This is explained as follows. The collector bias, as connected in the figure, is, in effect, in a forward direction as applied to the n_1-p_2 junction and as a result additional electrons are injected into the collector from the battery. The number of these additional electrons is roughly equal and proportional to the original hole flow from the emitter, so that the net carrier flow is twice that of the normal hole flow. Thus, current gain, alpha, in a point contact transistor is about twice that of a junction transistor.

Point contact transistors operate well at high frequencies because of the small effective base width, the latter being made possible by close spacing of the point contacts; also because of the fact that point contacts themselves give rise to very small input and output capacitances. However, because they are not too well understood their reproducibility in production is rather limited. For these reasons very little manufacture goes on as far as point contact transistors are concerned. Also because the properties of these devices have changed inexplicably with time their reliability has been poor.

[*To be continued*]

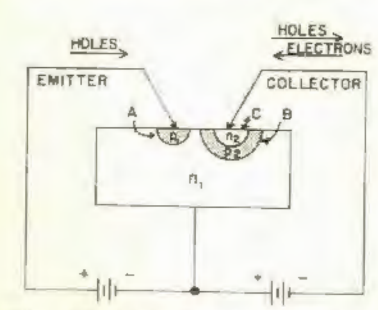


Fig. 11—Point contact biasing.

Ever since Sophia Loren was on—.

ECHO SOUNDERS IN MARINE ELECTRONICS

Installation methods for mounting indicator. units and inboard and outboard transducers. Also, some operational techniques and tests.

by Elbert Robberson

THE best market for most small-boat electronic equipment exists in the early spring and summer. That is when boats are first being commissioned and receive their pre-season testing and servicing. But a good time to sell and install echo sounders is also during the winter, when the boats are laid up. Thus, an alert marine-electronics service agency may fill part of the slack season by pushing the sale of sounding equipment.

The transducer of most echo sounders is mounted underwater, on the bottom or keel of the boat. By installing the equipment while the boat is laid up, the expense and trouble of a special haul-out is avoided, and one sales barrier removed. In fact, some agencies make a practice of installing (and charging for) just the transducer while the boat is on dry land, leaving the remainder of the installation until Spring, which spreads the total cost over a greater length of time, and at the same time gets the messy part of the job out of the way first.

On the other hand, it is possible to install a sounder at any time, and some units have even been engineered to be put into operation while the boat is actually in the water.

Indicator Location

Echo sounders consist of two or three packages—an indicator or recorder, the transducer and sometimes an external power supply. The main requirement for the indicating equipment is that it be placed where observation by the man at the helm will be easy. Earlier flashing-light indicators were often very difficult to read in a glare of light or bright sun, but recent designs with higher-intensity lights and built-on hoods do not suffer much from this trouble. Nevertheless, it will save the operator eye strain if flashing-light indicating units can be placed in a somewhat shaded location.

In the case of chart-type recorders, where the writing line is along the right side of the paper, placing the recorder in a port-side fore-and-aft position will permit the recording to have the proper relation to the boat's movement.

Be sure to leave some slack in the interconnecting cables, so that equipment can be moved for servicing without having to disconnect. Also, if it is not provided for in the interconecting cable furnished, the cabinets of the indicator and power supply should be bonded to the vessel's ground to minimize the possibility of interference to and from other equipment on board.

Transducer Mounting

The success or failure of an echo-sounder installation depends upon the placement of the transducer (s). In the first place, it is obvious that if the active face of the transducer is aimed off at an angle, echos will bounce off away from the boat and little or no "return" will be indicated, unless the sea bottom just happens to slant sharply, or the boat heels over to the right angle. Transducers must be aimed exactly downward for optimum operation.

Excessive vibration of the transducer, from the engines or propeller, may adversely affect operation, by giving rise to intermittent or false indications. The same difficulty may be produced by excessive turbulence, which might be experienced if the transducer face is immediately behind some underwater projection, such as a water intake or outlet. In order to transmit and receive the maximum signal, the transducer face must be in complete contact with the water. A void, film of air, or even bubbles caused by air being entrained under the boat, can block off operation completely. Therefore, on boats that "plane," or lift their bows out of the water while underway, the transducer should be placed far enough aft so it has water to work in at all times. Depending upon the boat, the best location is usually somewhere around one-third of the way back from the bow. Take care that the location chosen is not already occupied by a radio ground plate. This would needlessly complicate what might be a simple installation.

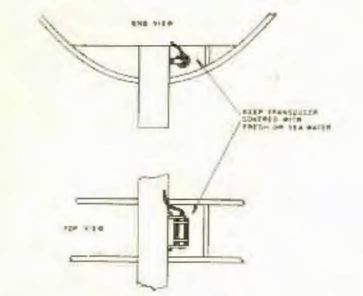


Fig. 1—Transducer mounted inboard in a water filled box.

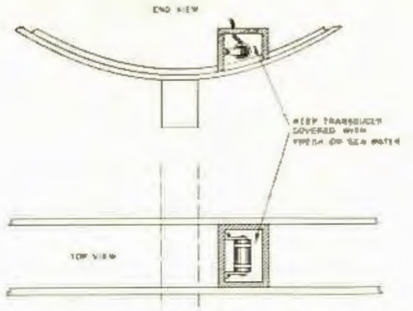


Fig. 2—Construction of watertight box for a transducer.

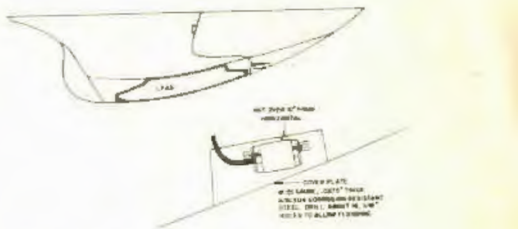


Fig. 3—Wet box transducer installation for a sailboat.

Inboard Mountings

Some of the earliest echo-sounding transducers were installed inside the hull of the vessel, in a flooded cofferdam arrangement. With modern transducers designed for inboard mounting, a somewhat similar arrangement may be used, eliminating the necessity for hauling and doing any work underneath the boat. The simplest manner of accomplishing this job is to wall off a section in the bottom next to the keel, between a pair of boat's frames (or as they are improperly called, ribs). This type of installation is illustrated in *Fig. 1*. In this instance, the well must be kept full of water supplied from inside the boat. In a vessel with a "wet bilge," the bilge-water naturally present may do the job, flowing into the well through limber holes (openings between frames and keel). In case the location of the well is such that the water runs out of the well when the boat changes trim, as it may in a high-speed boat underway in planing attitude, the well must be watertight, and water to cover the transducer poured in. This must also be done in a boat that keeps a "dry bilge".

Construction of a watertight box, which may be used to keep water in the well from slopping out is shown in *Fig. 2*. A watertight box may be filled from inside the boat, or a hole may be bored into the planking to allow the compartment to fill before the top plate is sealed in place. The transducer cable must, of course, be passed through a watertight stuffing tube to prevent leakage.

Figure 3 shows a "wet" box in the hull of a sailboat, placed forward of the metal keel. Such a box should be placed alongside the keel, and not over or recessed into the heavy timber. Inboard transducers are generally unable to operate through more than two-inches of wood, or up to one-quarter inch of steel without loss, especially of "close-up" readings.

Figures 1 to 3 courtesy of Raytheon Corp.

Outboard Mountings

Most transducers are designed to be mounted outside the boat. Those which require little or no "fairing" or fitting may sometimes be installed while the boat is in the water. While details will differ with various configurations of transducer, the principle of this operation is roughly the same as the old-time system originally devised for installing bolts to plug holes in ship's plating, caused by rivets dropping out. (Yes—this happens!)

Easiest to install are transducers having single-hole mounting. Procedure is outlined in *Fig. 4*. Tie a length of fishing line to one end of a slender piece of light wood, such as a dowel, about three-feet long. (This will be used after the next operation.) Then, at the location chosen for the transducer, bore a hole of the size required by the transducer "stem," vertically down through the bottom of the boat. Do not be alarmed by the geyser. Just go on about your work as not enough water will come in to harm anything. Push the dowel down through the hole, aiming it outboard, and as it passes through the hole, give it a little "send off" with your finger, and pay out the fish line. On a boat with a fairly clean bottom, the dowel will shortly float to the surface alongside the boat, and can be hauled aboard with a boathook. At this time the hole can be plugged temporarily with a rag.

If the dowel hangs up against the bottom of the boat, start the engine and "back down." The propeller wash will soon free the dowel and allow it to float to the surface.

Then take off the dowel and tie the end of the fishing line to the end of the transducer cable, remove the rag from the hole and haul back gently on the inside end of the line, allowing the cable to drop over the side; and then, as slack is removed and the cable brought up through the hole and into the boat, drop the transducer over the side. The transducer stem is pulled

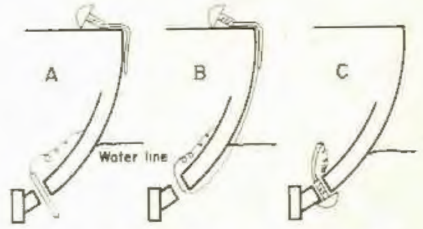


Fig. 4—Procedure for mounting a transducer while afloat.

up through the hole, washers and nuts put on and tightened up.

On rounded or V-bottoms, a fairing or leveling block is used. If necessary, this can be given the proper shape by matching it to the inside of the planking before starting the installation. The block should be given a coat of anti-fouling paint—but no paint should ever be put on the transducer face. Then, before going through the above steps, the block is put in place on the transducer through-bolt. When the bolt is brought up through the planking, turn it so the leveling block is seated at the desired angle and the transducer stem is vertical before fastening the unit in place.

Transducers having two mounting bolts can be installed in the same manner. All that is required is to use two holes in the bottom and to pass a fish line up through both of them. Then work the lines and the cable so both bolts come up to the holes at the same time, and they should readily find "home."

The transducers of some equipments are designed in such a manner that the boat must be out of the water for installation. Some boats can be "beached" at high tide for this purpose, and careened for maximum working space as the tide recedes. Keel sailboats or twin-screw powerboats, however, will probably have to be hauled in a shipyard.

Figures 5 to 7 inclusive, show several possible arrangements suitable for mounting transducers. The one to use depends upon the transducer design.

[*continued on page* 33]

HONEYCOMB SCREEN

[*from page* 11]

across their screens. Until now, these theatres have been unable to operate before sundown and have encountered some difficulty with bright illumination from the moon or nearby city lights. The use of a honeycomb layer will give outdoor theatres more flexibility and longer operating hours by making motion pictures visible under conditions of relatively bright ambient light.

In fact, anywhere that it is necessary to view objects or images on or behind a reflective surface, light-directional honeycomb screens may prove of benefit. Currently, light-directional screens for home television sets are being tested to determine consumer reaction; screens for oscilloscopes and other laboratory instruments are already being sold. ■ ■

NEUTRODE TUNER

[*from page* 17]

Note: If the oscillator-mixer tube is replaced, the inter-electrode capacity of the new tube may be different. Therefore, the oscillator may require re-adjustment.

Troubleshooting the Neutrode Fireball

Some old time service technicians (and a few new-timers) delight in poking and probing merrily around a circuit, moving parts here and there with gay abandon. This may provide innocent fun in an *ac-dc* radio but not in a high frequency tuner. Be careful not to move parts or change adjustments indiscriminately—especially if you don't have the required alignment equipment. If you turn anything, count the rotations and direction of turn. It will then be possible to restore the adjustment to its original setting.

If a feed-thru capacitor is replaced, be sure to use the correct replacement part. An ordinary capacitor, although the same value, cannot be substituted for the correct replacement feed-thru.

As mentioned earlier, the Fireball is durable, both electrically and mechanically. Nevertheless, any electronic device can develop trouble. A list of Fireball troubles, based on practical experience, appears below.

Electrical troubles:

1) Symptom: No picture. No sound.
   Cause: Defective tube.
2) Symptom: No picture. No sound.
   Cause: Shorted *C13*. *R3* burns.
   Remedy: Replace both *C13* and *R3*.
3) Symptom: No picture. No Sound. A tube filament unlit.
   Cause: Short between filament tube socket prong and bottom cover assembly (10).

Mechanical troubles:

1) Dirty contacts.
2) Bent wipers.
3) Contacts improperly seated.
4) Antenna board assembly (14) cracked or broken.
5) Shaft and rotor disc assembly (11) tilted. Makes contact on one side.
6) Fine tuning cam (23) cracked.
7) *L8* slug "freezes" in core. (Slug cannot be turned). Coil must be replaced if it requires adjustment.
   Note: Use an alignment tool which fits correctly. Do not attempt to adapt an improperly fitting alignment tool to adjust a slug.

Servicing Hints

If the symptom is no picture and no sound, here is a suggestion to isolate a defective stage within the tuner by using the signal substitution method.

Remove the antenna lead-in. Ground one end of the antenna lead-in to the tuner chassis ground. Use the other lead-in as a signal injection probe. Connect a capacitor in series with the "probe" lead in as a safety precaution. If a picture appears on the screen when the lead-in is placed at some point along the signal path, it indicates that the trouble exists before that point. For example, if placing the lead-in on the grid of the *rf* amplifier brings in a signal, trouble is indicated before the *rf* amplifier grid. In a similar manner, an air signal can be injected after the *rf* amplifier.

The oscillator can be checked by testing for a negative voltage at the oscillator grid. Absence of a negative voltage indicates a non-functioning oscillator. ■ ■

HI-FI

[*from page* 13]

speakers of equal or differing impedance are possible. A workable system must simply follow the principle of "correct impedance match at all times."

Output Transformer Troubles

Usually, an output transformer of a high quality power amplifier seldom causes trouble. The heat generated by this unit under normal program use is very small because, as we have seen earlier, average power delivered to the loudspeaker is usually ten to twenty decibels below peak power and these units are generally designed to handle *more* than continuous peak power. About the only rare cause of transformer failure in this part of the circuit is a "shorted turn" which can occur in the secondary winding either because of "dried up" insulation or a severe transient waveform causing premature breakdown. The symptoms of such a condition are generally severe reduction in maximum power output, heating of the transformer and, in rare cases, faster deterioration of the output tubes themselves. The condition is difficult to diagnose by the simple use of an ohmmeter, because the DC resistance of the secondary of an output transformer is very low, and varies considerably from model to model and from manufacturer to manufacturer. Thus, the indirect symptoms described will serve as your only clue. Since output transformers are probably the most expensive single item in an amplifier, make certain all other possible sources of trouble (such as defective output tubes, low B plus, improper bias or screen voltage, etc.) have been eliminated before "pulling" this component. One last word of caution: A glance at jobber catalogues would seem to indicate that an output transformer is specified by:

1. Case size
2. Power handling capacity
3. Primary Impedance
4. Secondary Impedance

Choosing a transformer replacement by the above criteria alone is almost sure to lead to failures such as poor power output after the job is completed, and unaccountable low and high frequency oscillations. Suffice it to say that a manufacturer's typical drawing of an output transformer lists at least fifteen *more* specifications than the few noted above. *DC* resistances of all windings, leakage inductance, primary inductance, unbalanced *dc* current and others all form a part of the design. Therefore, always use the manufacturer's own replacement part in this case, even if the cost seems higher than you might deem reasonable.

With this article, we conclude our discussion of the "audio electronics" of the science of High Fidelity. From this point on, we shall concern ourselves with the transducers (speakers and cartridges) and the "signal sources" (tuners, tape recorders, microphones, etc.). ■ ■

ECHO SOUNDERS

[*from page* 29]

The wooden blocks used to level, streamline and protect the transducer and cable, can be very easily made by any qualified ship's carpenter—or even the electronics serviceman if he has access to a bandsaw and sander. Sealing compound should be used at all joints, and Monel or Everdur screws used for fastening. Take care that the unit is mounted where it cannot be knocked off or damaged by keel blocks or chocks when the boat is hauled. To prevent marine growth, the same kind of anti-fouling paint as is used on the bottom of the boat should be put on all wooden parts—but not on the transducer face. Before launching the boat, clean off the transducer with detergent soap to remove grease and prevent the collection of bubbles on the face.

After connecting the equipment according to the manufacturer's instructions, it is a good idea to take the boat out on a test run. Echos obtained alongside a bulkhead, piling or other boats may be difficult to interpret. Furthermore, a test run enables the installer to show the buyer how to adjust the equipment and to interpret the indications obtained—often very important to prevent callbacks and reports that the equipment is not working properly. Be sure to take along a chart to check the depth of the water against the indicator readings.

Equipment instruction books generally tell what to expect in more or less detail. Here, however, are the main points. First, the sensitivity control should be set to the minimum value which will give an echo. Otherwise, noise pickup and multiple bounces may register as echos. A hard, level bottom will return a single well-defined echo, whereas a grassy or soft-mud bottom will be comparatively indefinite, and may even fail to "register" unless the sensitivity is increased. As the water gets deeper it may be necessary to raise the sensitivity. As the speed of the boat is increased, a point may be found where soundings are "missed," or where the equipment stops operating altogether. This is unavoidable, and the cure is to slow down. The sounder should always be used in conjunction with a chart, so the equipment indications can be properly identified.

Above all, stress to the owner that the equipment should be used at every opportunity, especially when it is not actually needed. This will keep the gear from deteriorating through non-use, and also build his operating experience and confidence so that when the time comes that it is urgently needed it will perform properly, and the owner will know how to interpret the readings. ■ ■

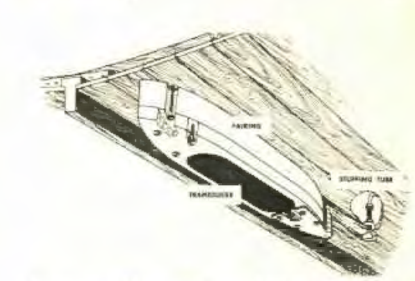


Fig. 5—Use of a fairing block to mount a Bendix transducer.

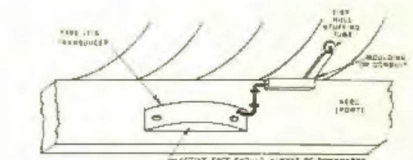


Fig. 6—Keel mounted Raytheon transducer with cable cover.

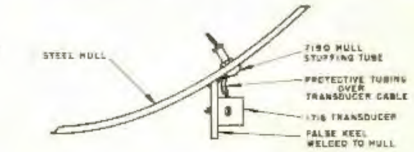


Fig. 7—Transducer of Fig. 6 mounted on a false keel plate.

COLOR TVI

[*from page* 21]

tional 300 ohm impedance. If a 75 ohm or 50 ohm coaxial cable is used, it will be necessary to use a matching pad or a matching transformer to match the line to the receiver. Careful installation of the antenna lead-in can aid materially in reducing interference effects from stray noise impulses.

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