Introduction to Transistor Theory
Part 6

Impedance Matching in Hi Fi Circuits

The Neutrode Tuner

Eliminating Color TVI

Mobile Installations

Echo Sounders in Marine Radio
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HOW TO CHOOSE THE RIGHT MICROPHONE FOR YOUR APPLICATION

In selecting a microphone, you must be careful to analyze your needs very carefully. Microphones are highly specialized equipment, and for full satisfaction it is important that you consider, in advance, the use to which your microphone will be put. Otherwise, you may be paying for features you don’t need, and losing advantages your microphone should have.

Wherever feedback is a problem, the choice of a directional microphone is virtually automatic. Only the directional pickup pattern can effectively reduce or eliminate feedback. Furthermore this pickup pattern greatly reduces the pickup of distracting random noises. For floor stand usage, the directional microphone, with its ultra-cardioid pickup pattern, provides far greater freedom for positioning the microphone in the background, leaving the spotlight to the performer.

For applications where versatility is important, the omni-directional probe microphone is the recommended choice. A night club performer, for example, who roams around a large area while he performs, would find such a unit more convenient. The SLENDYNE, for example, can be used in the hand, on a floor or desk stand, or worn around the neck, and can easily be changed in seconds — from one application to another. Its unobtrusive design permits it to be held close, yet it remains in the background, leaving the spotlight to the performer. It offers a choice of frequency and antenna height.

For improved high frequency operation, high ambient light conditions, and plug-in cordless operation methods are dealing with interference from external sources.

Some Painters On Mobile Installation
Information on unit choice of operating frequency and antenna height.

Video Speed Servicing System
For stereo 2-channel service, with an indicator of high voltage and output power. Compact, inexpensive.

Echo Sounders in Marine Electronics, Part 2, by Elbert Robbinsen
Interference and operation methods for echo sounders.

Annual Index

Advocator’s Index

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JUDGES SELECTED 13 WINNERS to receive this trophy, $100 for one for community improvement; and Lockheed with Color Secretary of Commerce Walter Williams at Washington, D.C.

GIRLS' GYM TEAM at St. Joseph's Parish is supported by Numa de Veera, Quintin, Mass., as one of the many community services. She also gives free television service to a school for retarded children and always ready to lend out equipment for charitable affairs.

CIVIL DEFENSE LEADER Richard G. Wells, Jr., Pikeville, Ky., installed television sets for a community center in Pikeville College, high school, Junior College, Scout building and Methodist Hospital. He is working to give the high school a closed-circuit TV system.

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

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

Ameripfair everyday responds to General Electric's invitation to nominate fully 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 Harrill, Administrator, Small Business Administration; Wendell Ford, 1955 Presidential, United States Junior Chamber of Commerce: Herman Heckman, Sports Authority; and Ed Sulcic, Columnist and TV Personality.

General Electric has established three 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

GOOD SPORTSMANSHIP is developed by Maurice E. Borden at Whidbey Island Orphans' Home, Prineville, Oklahoma, where he teaches recreation 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 in Charlotte, Michigan, youth group make Bert Byrnes, Jr., another "All American." He is a member of the Charlotte Boy Scout troop, active in meetings, and helps in many community service clubs. When time permits, Bert donates his technical skills in service equipment, music producers and record players at city schools.

MANY WERE SAVED in Scott Walker, Ill., during a storm, Texas, disaster. Here he shows height of water in raging flood which swept his area. Scott saved lives and helped rescue communications to the community. His action in the National Guard in civil and youth organizations.

TV FOR THE SICK is provided by Billy Joe Jessop of Pasadena, Texas, by installing television and service sets without charge, Billy has made it possible for patients in Richardson Memorial Hospital to enjoy TV. He helps community programs, moves in the National Guard in civil and youth organizations.

ELECTRONICS LABORATORY at Long Beach City College, California, was established with help from Harry E. Ward, Harry served as chairman of Business and Technology Advisory Committee and for thirteen years he devoted his time in finding work for radio and television technicians.

STUDENT SENATOR Philip T. Di Pore, of Alliance, N. Y., enrolls in radio and television classes and parts to Siena College students who are interested in electronics. Phil now heads a project to finance athletic field and playground for 71 neighborhood children.

VOLUNTEER FIREMAN and Instructor John R. O'Brien, trimmer, engineer, teacher and aid at neighboring fire companies and schools. He is active in recreation department, and St. Barnabas with Color Secretary of Commerce Walter Williams at Washington, D.C.

WHEN WERE SAVED in Scott Walker, Ill., during a storm, Texas, disaster. Here he shows height of water in raging flood which swept his area. Scott saved lives and helped rescue communications to the community. His action in the National Guard in civil and youth organizations.

STUDENT SENATOR Philip T. Di Pore, of Alliance, N. Y., enrolls in radio and television classes and parts to Siena College students who are interested in electronics. Phil now heads a project to finance athletic field and playground for 71 neighborhood children.

BASIC ELECTRONICS is taught to neighborhood boys by John H. Soderlund, Pontiac, Michigan. He has organized a school for the boys and is planning to open a new Pontiac Boys Club. John has served as chairman of the Business Advisory Board of the Pontiac Area Chamber of Commerce. Television sets in the Oakland County Extension are used without charge through his efforts.  

This recent advertisement in LIFE was seen by 25,000,000 people...
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, 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. 2, a junction between an n- and p-type semiconductor is formed, a traveling flow of carriers occurs whereby electrons flow from n to p, and holes from p to n. This initial current is called a "diffusion flow" and depletes the immediate region around the p 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, so that amounts to the thing it favors an opposite flow of electrons from n to p and holes from p to n. 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 "field effects" and may be generated by various internal conditions such as lattice imperfections, or unequal impurity distributions within the semiconductor. The presence of such electric fields in the base region of a transistor can be used to increase its high frequency response as will be shown later. These built-in fields are produced by making the impurity distribution within the base vary along its width.

Unequal Impurity Distribution

Unequal impurity distribution may be produced in an intrinsic germanium pelt 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 across the junction, and therefore a built-in electric field. The extent of diffusion of arsenic into the germanium pelt can be controlled so that only a small section of the impurity surrounds the pellet as shown in Fig. 2. During the manufacturing process some of the germanium is removed by acid etching or mechanical means leaving only one impurity surface. Following this, p-type metallic junctions are allowed 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 n-type current flow of electrons will diffuse through the base from left to right, setting up an electric field which opposes the diffusion of electrons in the opposite direction, that is, from right to left. Recalling that hole flow is opposite to electron flow, the field is set up opposite forces hole flow from left to right.

With an external potential applied to the transistor, the system reaches a state where carriers are driven across the base region. The drift current flow is then controlled so that only a thin skin of the impurity surrounds the collector as shown in Fig. 2. During the manufacturing process some of the germanium is removed by acid etching or mechanical means leaving only one impurity surface. Following this, p-type metallic junctions are allowed 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.

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 predetermined amount of n-type impurity and a somewhat lesser amount of p-type impurity. Since n-type carbons are in the majority, the resultant crystal is n-type. The completed crystal is then sawed into bars approximately 5.5 cm long and 0.2 cm 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 removing one end following which it is recrystallized. As it is recrystallized, the impurity content in the vicinity of the recrystallized portion will be higher at the heated end of the bar than at the center. At the interface between the unlapped section of the bar and the heat-drop section the impurity concentration will be relatively low, the impurities from this interface having entered the crystal solid state at the process forming a "diffused-meltback" transistor particularly suitable for high frequency work.

Surface-Barrier Transistor

The Surface-Barrier transistor shown in Fig. 5 is a transistor (not p-n-p or p-n) in which crystals are formed at the center section, of an n-type wafer of germanium. These crystals are etched out electrically until the remaining section is approximately .0003 in thick. Following this operation metallic leads are electroplated on the cavities. Leads are then attached to the metallicized cavities and the surface of the crystal back into the collector battery. As a consequence of this carrier acceleration in the base region, the surface of the crystal becomes a relatively high negatively charged potential near the surface. These electrons repel the impurities near the surface of the crystal back into the collector battery. At the interface of the crystal the other layer of so-called "surface electrons" exists at an equal negative potential. As a result of this potential drop the surface and between these two layers is a thin insulating layer of
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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 30% of the emitter hole current reaches the collector. Voltage gain is obtained by a high collector to emitter resistance ratio (200 KOhm). Because the base is thin and uniform, surface-barrier transistors exhibit excellent high frequency amplification characteristics.

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 or wires connected to the base contribute the emitter and collector contacts. The collector contact is phosphorus 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 bending as shown in the figure. At the output end 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 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 in potential arises when conductors make contact with semiconductors. In the conductor the current 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 end 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 causes a layer of the base material from p-type to n-type as shown in Fig. 10. Instantly such the wire contact itself.

"Continued on page 27"
The extra values are “on the house”

Want more capacitor for your dollar? Here’s how: Cornell-Dubilier has originated a “preferred-type” program on twist-prong electrolytics. Now, a relatively few types fill over 90% of all replacement requirements. You need less – to do more. Fewer types, fewer prong electrolytics. Now, a relatively few types fill over 90% of all replacement requirements. You need less – to do more. Fewer types, fewer prong electrolytics.

How is it done? Instead of producing hundreds of types with odd and critical capacitance and voltage ratings, each “preferred-type” carries the highest value and rating called for in each category. In most cases you get more capacitor at lower cost—plus added safety factor, improved performance and “call-back” protection. It’s on the house!

To get more capacitor for your dollar, ask your C-D Distributor about your preferred-type Cornell-Dubilier Capacitors, South Plainfield, New Jersey.

HONEYCOMB

The extreme difficulties normally experienced in viewing television, oscilloscope or motion picture images under bright ambient light conditions have been augmented by a new light-directional material now being manufactured by Hercules 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 slate-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 distorts 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 one’s hands when looking into a store window on a bright day. As with the cupped hands, the cells prevent incident light reflections and allow ob-

TV SCREENS

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 shading, 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 surface 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 oscilloscopes and TV viewing. Until this discovery was made, there were two potential alternatives to the solution of these difficulties. One 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-lit school classrooms and auditoriums—absolutely eliminating 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 on or behind the reflective surface to be seen.

RADIANT VIBRATORS

Next time an auto-radio vibrator replacement is called for, try Radiant. There’s a complete line for 12-volt and 15-volt applications. And no waiting for the type you want, because your local Radiant Distributor maintains a full stock for your convenience. Ask him for your free copy of the Radiant Vibrator Replacement Guide. Or write to Dept. S-1, The Radiant Corporation, Indianapolis 5, Indiana.

CONSISTENTLY DEPENDABLE

CONSISTENCY DEPENDABLE
**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 the microphone (or phono cartridge, tape head, microphone or any one of the many other sound sources). And we have noted the many and varied steps of equalization, amplification, and power transformer treatment. One thing should be remembered at this point. We have been able to come up with an electronic wave-form which, to all intents and purposes, can duplicate the response 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 magnitude of these delicate signals may now be increased sufficiently to reach the final link in the system, the loudspeaker. When this amplifier, containing the electronic-electrical devices, restores the signal to audibility. Construction is important, but it must be remembered that it is not to 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 concern 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 manufacturer of these delicate yet massive devices realizes 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 he were to learn that the frequency response of a loudspeaker seems to have been lost. 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. In other words, which must always appear on a loudspeaker specification sheet is the "correct" or "nominal" impedance. 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 loudspeaker. In Figure 7A we have shown an 8 ohm speaker connected across a 16 ohm load. For amplifiers, we have shown the amplifier as a constant voltage generator, with its own source impedance of 8 ohms in series with the load. The "generator" produces a constant-sound voltage of 40 volts. In Fig. 7A only of 8 ohm loudspeaker will appear across the 8 ohm loudspeaker lead because of the voltage divider action. In other words, 13.8 volts across the speaker and 26.7 volts across the amplifier's own internal impedance. Noise, power is equal to E/V4 where E is voltage and R is the impedance of the load. Thus, in this example, the power absorbed by the speaker would be (13.8/26.7) or 25.1 watts. Now let us consider 60 ohms, in which a deliberate "mismatch" condition has been set up, this time with a too high a load impedance. Now, if the total voltage (or 26.7 volts) will appear across the impedance. In other words, the amplifier impedance (16) is far less than the previous voltage. The use of the power formula again, we see that 20 volts will appear across the load and 21.6 watts will be developed across the load. In Fig. 6C we have shown a hook-up of 4 parallel loudspeakers, each with the proper impedance, matched correctly (equal to the loudspeaker impedance); whether the speaker is "on full" or turned down, no difference. The only disadvantage in this method is that full power is always led to each speaker (or pair, as the case may be) and, in certain instances where it might be desirable to feed full amplifier power to a stereo speaker, it is not possible to do so.

**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. A speaker having a 16 ohm impedance should be connected to the terminals marked 10 and Ground (or Analog). The problem generally arises when more than one speaker is to be used. In this event, power transfer will be even greater than that illustrated.

**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 "on" or "ground" terminal). Figures 8A, B, C and D illustrate some of the more popular "multiple" speaker hook-ups which maintain correct impedance matching to all speakers involved. We will first look at the correct impedance match to maintain the most efficient transfer of power to each speaker. It is apparent 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 each impedance of 9 volts will be only half that developed across 16 volts. Very often, this arrangement can be used to advantage, at least where it is desired to have two amplifiers of equal impedance, secondary speakers than from a single amplifier system. Figures 9A and 9B employ two amplifiers each in the proper ratio and maintain different power transfer from one primary to the other, as desired. Figures 10, 11 and 12 illustrate various parallel hook-ups where it is desired to maintain equal power transfer from a single amplifier to as many as three speakers. However, to maintain a correct impedance match to the speakers, there must be three 8 ohm speakers; otherwise, the impedance of the secondary speakers will not be derived from the main circuit, and will not be equal to the impedance of a 2 ohm subwoofer. The simple method illustrated in Figure 13A is to maintain a correct impedance match to all speakers involved. The only disadvantage in this method is that full power is always led to each speaker (or pair, as the case may be) and, in certain instances where it might be desirable to feed full amplifier power to a stereo 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 sophisticated, type of switch. There is no one type of switch which will probably find greatest application in your installation work, because they are ideal for speaker switching. The usual arrangement is to have the positions as follows: Speaker A plus B. The trick is to have these switch settings automatically maintain a correct impedance match to the amplifier, whether there be one, two or more speakers connected. For instance, Figure 5A shows a 16 ohm loudspeaker in series with a 4 ohm load. Three parallel branches of the circuit have equal current flow (the total impedance of each branch being equal; 16 ohms), the voltage developed across each impedance of 9 volts will be only half that developed across 16 volts. Very often, this arrangement can be used to advantage, at least where it is desired to have two amplifiers of equal impedance, secondary speakers than from a single amplifier system. Figures 9A and 9B employ two amplifiers each in the proper ratio and maintain different power transfer from one primary to the other, as desired. Figures 10, 11 and 12 illustrate various parallel hook-ups where it is desired to maintain equal power transfer from a single amplifier to as many as three speakers. However, to maintain a correct impedance match to all speakers involved. The only disadvantage in this method is that full power is always led to each speaker (or pair, as the case may be) and, in certain instances where it might be desirable to feed full amplifier power to a stereo speaker, it is not possible to do so.
The Neutrode Tuner
by George Kravitz

How to troubleshoot, repair and align the new Standard Coil Fireball Tuner.

The increased popularity of this tuner makes familiarizing "essential".

Neutrode circuit is an old principle with a new application in RF 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 RF triode.

The Neutrode circuit is used in two tuners: The Fireball, shown in Fig. 1 and the conventional Turret tuner. Because of its economy and alignment simplicity, the Fireball is discussed in greater detail in this article. However, circuit details and alignment procedures 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
Andrew 3925
Eaton 1400
Heffnoff 327
Hoffman 3932/33
Hoffman 422
Magavox 24 series
Montgomery Ward (Airline) 4031
Montgomery Ward (Airline) 5941
Montgomery Ward (Airline) 5044
Packard-Bell 8853
Packard Bell 9853
Westinghouse V-2377
Westinghouse V-2377
Westinghouse V-2364
Westinghouse V-2365
Westinghouse V-2356
Zenith 17AD2

Neutrode Circuit Operation

Electrodially, 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 RF signal is fed to the 100 ohm antenna terminals, through C1 and C2, to T1. Components C1 and C2 constitute isolation networks. 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, C1 and C2 prevent ground loop formation. A ferrite core balun type matching transformer, T1 couples the balanced 100 ohm antenna signal to the 75 ohm tuner input. (T1 is shown as part of the antenna board assembly, item 14, in Fig. 3.)

A well-designed tuner should reject signals at the IF frequency (41 mc) arriving at the antenna. 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 IF resonant curve is peaked to be spreading or compressing the turn of the antenna coil, L3.

A 50 ohm feed-through capacitor, C5, situated between the series and parallel tuned traps, functions as follows:

1. It serves as a 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 RF signal to the grid of the RF amplifier and also prevents the dc resistance of the antenna circuit from loading down the IF line. C4 performs an interference rejection function since it has a comparatively high resistance at lower frequencies, thereby attenuating low frequency interference.

The IF input circuit (at the 2BN4 grid) is a combination of an RF filter. The capacity of C4 is relatively low, therefore, the induced capacity 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 C3 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 age decoupling network consisting of R1 and C5, keeps the signal out of the age line.

Triode Neutralization

The elements within a tube and the space between the elements, act as a capacitor. At high frequencies, an image plate 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 degrees out-of-phase, to the grid of the same tube. This signal is fed through out-of-phase capacity, C20, which is adjusted to provide the correct amount of out-of-phase feedback. Neutralization instructions are included under RF Alignment in this article.

Fig. 1 - The Standard Coil Neutrode Fireball Tuner.

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

Fig. 3 - Schematic diagram of the Neutrode Fireball and Turret Tuner.
RF Alignment
(Including Information on Neutralization)

Equipment required:
1. Sweep generator
2. Marker generator with the following frequency outputs:
   - Channel 1: 250 kHz to 3 MHz
   - Channel 2: 3 MHz to 12 MHz
   - Channel 3: 12 MHz to 30 MHz
   - Channel 4: 30 MHz to 100 MHz
3. Oscilloscope
4. Bias supply
5. Matching pot, shown in Fig. 4.

RF alignment procedure:
Numbers in parentheses refer to a part shown in Fig. 5.
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 alignment input (18).
3. Connect a 22-ohm resistor across the antenna terminals.
4. Switch to channel 10.
5. Remove bottom cover assembly (9).
6. Deluxe 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 alignment instructions. The purpose of this resistor is to prevent curve distortion due to the effect of the input circuit.
   - Adjust C7 for a negligible value.
7. Adjust C7 and C12 (see Fig. 4) 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 flatter 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.
   - Remove the 22-ohm resistor connected across the antenna terminals.
8. Switch to channel 10 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 a cover of a book. For this reason, the tuner is often said to have "book" fine tuning.

Electronic Servicing • January, 1958
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, larger 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.

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 entirely 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 such a 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 school service.

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 watch and will be used to present flight information calculated by computers. 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 Jersey, New York. Manufactured and designed by the Dodge Television Division of Thompson Products, the station is claimed to be the smallest television station in the world. It has one camera, is manned and directed by one person, and its programs boost of the top Traders, for almost everyone in Port Jersey 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 Jersey TV Company, Inc., is housed in a studio that formerly was a two-room garage and is unusual.

In a move to step up its dispatching efficiency so that its cabs can handle more calls per day, Louisville Taxi and Transfer Company has ordered 200 mobile radio units from the General Electric Communication Products Department. Louisville Taxi's, 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 channels conditions existed, and thus was able to use only 125 of its more than 200 other 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 kinds of communication equipment led the company to switch from the 152 mc band to 455 mc so that all of the calls could be placed at the latter band.

Electronic Servicing • January, 1956
This group of articles on Color TV is from the ninth presentation in a series of "TVI Aids" posters and pamphlets prepared, published, distributed nationally by the Washington Television Interference Committee in collaboration with various individuals and agencies. The committee solicits opinions and helps from those in the electronics industry in order that its members will be continuously effective. The committee will be glad to include in future bulletins any remedial or noise interference 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 TV Aids, 1118 Lake Boulevard, Annandale, Virginia.

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 kc of the subcarrier frequency it will appear as a red, green, or blue spot pattern. The most effective method of treating this type of interference is to align the offending receiver.

The following interference chart lists 4 other external types of interference. Proper installation and adjustment 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, realigning 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 by using a 6" length of No. 20 wire transmission line shorted at one end with a 2.5- to 13- ohm adjustable ceramic capacitor connected at the other end. This tuning trap should be done with care because it is a sharp motion.

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; (2) a loose antenna lead at the receiver antenna post; (3) other intermitter troubles including a faulty spigot 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 connection in house wiring, plumbing, switchgears, etc.

Misadjustment of receiver tuning controls by the owner may also produce interference patterns to 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, the antenna will generally give satisfactory results. Some designs may cause poor reception on one or more color channels due to non-uniform response.

Narrow-band highly directive antennas such as the 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 subbands have not been lost. It is essential that the antennas 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 better response before they will be satisfactory for high grade color reception.

Antenna orientation can be critical with ghost conditions caused by multipath signals from the transmitter.

These ghosts can cause cancellation of the subcarrier or ghost coloring of color sidebands. In some cases of compromise, orientation of the antennas for multilocation reception will be completely unsatisfactory for color. The antennas 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 ratios.

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 another 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 in a composite trap of color line, and various types of users are connected to the line and tuned to a number of different channels. Each tuner reflects a different impedance to the line, causing interaction.

Care must be taken out to overload community receiving system line amplifiers, as overload 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 concern.

[Continued on page 55]

Interference Chart

<table>
<thead>
<tr>
<th>Type of Interference</th>
<th>Character of Interference</th>
<th>Cause</th>
<th>Suggested Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM Interference</td>
<td>FM sound in TV sound</td>
<td></td>
<td>Very rare: FM trap curves.</td>
</tr>
<tr>
<td>Adjacent Channel Interference</td>
<td>Unaligned Station causing blanking of desired station or causing windshield wiper effect.</td>
<td>Inadequate receiver sensitivity. Attempting to receive stations beyond service area.</td>
<td></td>
</tr>
<tr>
<td>Adjacent Channel Interference</td>
<td>Interference caused by two stations operating on same channel. Station causing interference in poor connection in house wiring, plumbing, switchgears, etc.</td>
<td>Pickup of fundamental, harmonic, or parasitic frequencies from transmitter.</td>
<td></td>
</tr>
<tr>
<td>Short wave and other RF Transmitters</td>
<td>Cross hatch, horizontal or diagonal bars in picture.</td>
<td>Two stations operating on same channel.</td>
<td></td>
</tr>
<tr>
<td>Interference</td>
<td>Similar trap for high frequency VHF.</td>
<td>pickup of adjacent channel pickup.</td>
<td></td>
</tr>
</tbody>
</table>

Walker Avenue, Beverly Hills, Cal., has a tuning range of 40 to 170 mc.

Simple transmission line trap for 40 to 170 mc.

Sound in TV sound.

Overload of TV RF unit, from fundamental of transmitter. 11 M. A. 111.

Sound in TV sound.

Interchannel Diagonal bars in picture or modulated bars superimposed on picture. Double conversion or harmonic conversion (Cross-modulation)
Some Pointers on Mobile Installations

Determining the exact power requirements, antennas 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. Higher power will not be required.

2. In the range of 13-15 miles, the fixed-station antenna should be at least 100 feet above the ground. 30 watts for the fixed-station and 15 watts for the mobile should be satisfactory.

3. If the range is 16-18 miles, FM-equipment in the 25-50 mc band is recommended. A 5-watt fixed station, with 10-watt mobiles, is sufficient. Higher power will not be required.

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 25 to 45 miles are required and some "skewwave" effects are tolerable.

5. In severe forest or tropical undergrowth, a frequency between 25 and 50 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, taxis, utilities, etc.) the 150-160 mc band is usually used.

7. Ignition and generator noise suppression (spark plug suppressors and hard-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.

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 li-
**Dumont Chassis No. RA-400-401**

*Card No.: Du-400-5*

**Section Affected:** Horizontal oscillator drifts out of frequency.

**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 or coil shorting inner conductor and outer shield or insulation at either end of the shielded cable. Locate the cause and repair.

---

**Emerson Chassis No. 120293T.X**

*Card No.: EM-120293-3*

**Section Affected:** Video IF

**Symptoms:** Abnormally high scope 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 (V2, V3, S286’s) and redraw ground points as shown in following diagrams, if not already done.

---

**Emerson Chassis No. 120293T.X**

*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 or coil shorting inner conductor and outer shield or insulation at either end of the shielded cable. Locate the cause and repair.

---

**Emerson Chassis No. 120293T.X**

*Card No.: EM-120293-1*

**Section Affected:** Horizontal oscillator drifts out of frequency.

**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 plug and etched circuit wiring.

---

**Emerson Chassis No. 120293T.X**

*Card No.: EM-120293-1*

**Section Affected:** Sound

**Symptoms:** Distorted sound after receiver warms up.

**Cause:** Defective C282.

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

---

**Section Affected:** Raster

**Symptoms:** Picture bending depending on video information.

**Cause:** Shorted tuner amp feed thru condenser causing overload due to tuner operating at maximum gain.

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

---

**Section Affected:** Video

**Symptoms:** Poor sound and audio buzz.

**Cause:** Defective discriminator transformer or aluminum width shim.

**What To Do:** If adjustable control of width is required then remove the aluminum width shim completely.

---

**Section Affected:** Sound

**Symptoms:** Poor sound and audio buzz.

**Cause:** Defective discriminator transformer or aluminum width shim.

**What To Do:** If adjustable control of width is required then remove the aluminum width shim completely.

---

**Section Affected:** Sound

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**Section Affected:** Sound

**Symptoms:** Poor sound and audio buzz.

**Cause:** Defective discriminator transformer or aluminum width shim.

**What To Do:** If adjustable control of width is required then remove the aluminum width shim completely.
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 received 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, alert marine electronics service agencies may fill part of the slack season by pushing the sale of sounding equipment.

The transducer of most echo sounders is mounted under-water, on the bottom or bow of the boat. In a lorry the equipment while the boat is laid up, the expense and trouble of a complete service 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 dock. Leaving the remainder of the installation until spring, which spreads the expense and trouble over a longer length of time, and at the same time gets the necessary part of the job out of the way.

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

**Indicator Location**

Each sounder consists of two or three packages—an indicator or recorder, the transducer and sometimes an external power supply. Just the requirement for the indicating equipment that it is placed where it will be observed by the man at the helm will be easy. Faster flash-light-guides are often very difficult to read in a glare of light or bright sun, but recent designs with higher-intensity lights and built-in housings do not suffer much from this trouble. Nevertheless, it will save the operator eye strain if the flash-light-guiding units can be placed in a somewhat shaded location. In the case of chart-recorder sounding, where the writing line is along the right side of the paper, placing the recorder in a port-side forward position will permit the recording to have the proper relation to the boat's movement.

The success or failure of an echo-sounder installation depends upon the placement of the transducer (1). In the first place, it is obvious that if the center line of the transducer is aimed off at an angle, echoes will bounce off from the boat and not be returned. Leaving the remainder of the installation until spring, which spreads the cost over a greater length of time, and at the same time gets the necessary part of the job out of the way.

**Transducer Mounting**

The success or failure of an echo-sounder installation depends upon the placement of the transducer (2). In the first place, it is obvious that if the center line of the transducer is aimed off at an angle, echoes will bounce off from the boat and not be returned. Leaving the remainder of the installation until spring, which spreads the cost over a greater length of time, and at the same time gets the necessary part of the job out of the way.

**Inboard Mountings**

Some of the earliest echo-sounding transducers were installed inside the hull of the vessel. In a flooded collision, watertight mountings for transducers designed for inboard mounting, a somewhat similar arrangement may be used, eliminating the necessity for hauling and doing any work under-water. The transducer construction for an inboard installation for a sailboat is shown in Fig. 1. In this instance, the transducer must be placed inside a watertight housing. If the housing is filled with 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 hull. Do not force the hole by thegeometry. Just go on about your work as not enough water will come in to harm anything. Fit the dowel down through the hole, aiming it outboard, and as it passes through the hole, give it a little "seat off" with your finger, and pay out the fish line. On a boat with a fairly clean bottom, the dowel will simply float to the surface and be covered with a headtank. At this time the hole can be plugged temporarily with a cork.

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 fish line to the end of the transducer cable, remove the sag from the hole and let back gently on the inside end of the line, allowing the cable to drop over the side, then, as slack is removed and the cable brought up through the hole and into the boat, slip the transducer over the side. The transducer stem is pulled up through the hole, washers and nuts put on and tightened up.

**Outboard Mountings**

Most transducers are designed to be mounted outside the boat. Those which require little or no "faking," or fitting into some extra hole are sometimes installed while the boat is in the water. While details will differ with various configurations of transducer, the principles of this operation is roughly the same as the old-time system originally devised for installing bulbs to place hooks in ship's plating caused by rivets dropping out. (Yes—this happened!)

Ease of installing transducers having single-hole mountings. Procedure is outlined in Fig. 2. 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 force the hole by thegeometry. Just go on about your work as not enough water will come in to harm anything. Fit the dowel down through the hole, aiming it outboard, and as it passes through the hole, give it a little "seat off" with your finger, and pay out the fish line. On a boat with a fairly clean bottom, the dowel will simply float to the surface and be covered with a headtank. At this time the hole can be plugged temporarily with a cork.

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On round or V-bottoms, a faising or leveling block is used. If necessary, this can be the proper shape by matching it to the inside of the planking before starting the installation. The block should be given a coat of anti­corrosion 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-hold. When the bolt is brought up through the plumbing, turn it so that the leveling block is seated at the desired angle and the transducer stem is vertical before fastening the nut in place.

Transducers having two mounting holes 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 put the block and the cable so both bolts come up to the holes at the same time, and they should readily find their proper place.

The transducers of several equipment are designed in such a manner that the boat must be out of the water for installation. Some boats can be "beached" for this purpose, and carried for maximum working space at the tiller. Most sailboats or twin-stern powerboats, however, will probably have to be laid up to install.

Figure 3 shows several possible arrangements suitable for mounting transducers. The one to use depends upon the transducer design.

---

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

**Fig. 2—Construction of water-tight box for a transducer.**

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

**Fig. 4—Procedure for mounting a transducer while afloat.**
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HONEYCOMB SCREEN
[from page 11]
across their screens. Until now, these screens had been able to operate before sun-down 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 pokng and probing merely around a circuit, moving parts here and there with gay abandon. This may provide incosistent faults 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-down capacitor is replaced, be sure to use the correct replacement part. A ordinary capacitor, although the same value, cannot be substituted for the correct replacement feed-down.

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:

Mechanical troubles:
1) Dirty contacts.
2) Bent washers.
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 cap (83) cracked.
7) LS 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 rf 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-functional oscillator.

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Note: Use an alignment tool which fits correctly. Do not at­ttempt to adapt an improperly fitting alignment tool to adjust a slug.

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ECHO SOUNDERS
[from page 26]

The wooden blocks used to level, streamline and protect the transmitter and cable can be very unsafe made have an echo. Other than a qualified ship's carpenter or even the electronics serviceman if he has access to a handi and reader. Seclining compound should be used at all places. Polished or Evapor, screws should be used for fastening. Take care that the unit is mounted where it cannot be knocked off or damaged by keel blocks or checks when the boat is hauled. To prevent marine growth, the same kind of antifouling paint as is used on the bottom of the boat should be put on all wooden parts but not on the trans­

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. Echoes obtained alongside a bulkhead, piling or other boats may be difficult to interpret. Furthermore, a test run enables the installer to arrive at the most practical way 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.

COLOR TVI
[page 31]

1. Case line
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 unmountable 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 stated above. DC resistance of all windings, leakage inductance, primary and secondary impedance, unbalanced detected level are all 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 (tapers, tape recorders, microphones, etc.).

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.

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