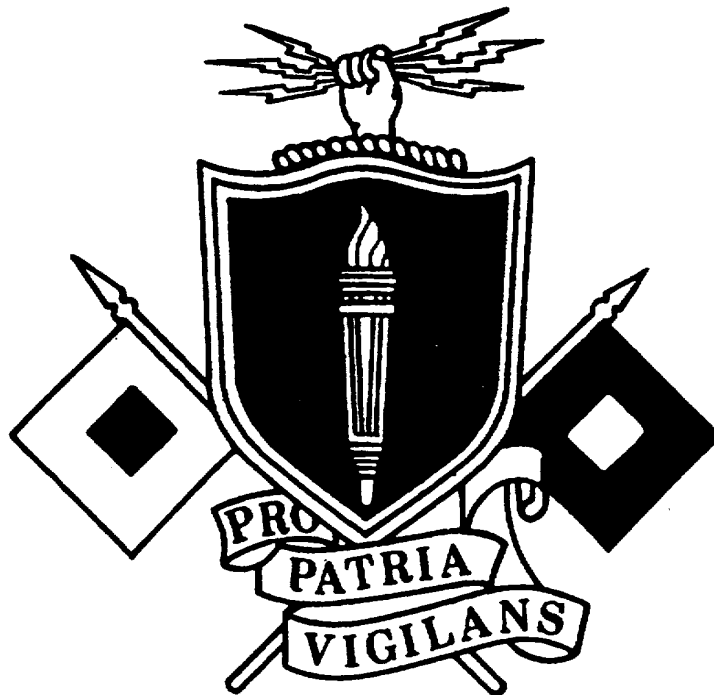


TELEVISION AND AUDIO SYSTEMS



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT
ARMY CORRESPONDENCE COURSE PROGRAM

A
I
P
D

READINESS /
PROFESSIONALISM



THRU
GROWTH

U.S. ARMY RADIO/TELEVISION SYSTEMS SPECIALIST
MOS 26T SKILL LEVEL 1

AUTHORSHIP RESPONSIBILITY:

SGT Renee Deramus
VI/Cal Division
U.S. Army Element
Lowry AFB, Colorado
AUTOVON: 926-2521
COMMERCIAL: (303) 370-2521

TELEVISION AUDIO SYSTEMS
(Developmental Date: 30 Sep 86)

SUBCOURSE NO. SS0603-6

U.S. ARMY SIGNAL SCHOOL
Fort Gordon, Georgia

Five Credit Hours

GENERAL

The Television Audio Systems subcourse is designed to teach the knowledge and skills for performing tasks related to operation and maintenance of the audio systems found in a typical television studio. Information is provided on several tasks which are performed at increasing levels of difficulty at Skill Levels 1, 2, and 3. Several of the tasks are shared with the MOS 84F, Audio/Television Specialist. However, the shared tasks do not appear on the Soldier's Manual, STP 11-26T13-SM-T6, dated September 1985, but they are published in the Soldier's Manual, STP 11-84F13-SM-TG dated September 1985. As a reminder, tasks with the prefix 113-575-XXXX are found in the MOS 26T manual and tasks with the prefix 113-577-XXXX are printed in the MOS 84F manual. The subcourse is presented in five lessons. Each lesson corresponding to a terminal objective as indicated below.

Lesson 1: DESCRIBE AND IDENTIFY THE AUDIO CONSOLE AND MAINTENANCE PROCEDURES REQUIRED TO TROUBLESHOOT AND REPAIR THE EQUIPMENT

TASK: Describe the functions of audio control consoles, and identify the equipment and maintenance procedures for troubleshooting and repair.

CONDITIONS: Given information and illustrations about terms relating to audio control consoles and troubleshooting and repair maintenance procedures.

STANDARDS: Demonstrate competency of the task skills and knowledges by correctly responding to 80 percent of the multiple-choice test items covering functions terminology and identification of audio control consoles and maintenance procedures for troubleshooting and repair.

(This objective supports Soldiers Manual Task 113-577-4001, Operate Turntable; 113-577-4006, Operate Studio Audio Console; 113-575-9002, Interpret Schematic Diagrams, Block Diagrams or Component Location Diagrams; and 113-577-9009, Perform Operator's Maintenance of a Turntable.)

Lesson 2: DESCRIBE AND IDENTIFY THE FOUR BASIC TYPES OF MICROPHONES AND THE MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATION

TASK: Describe and identify the four basic types of microphones and the maintenance procedures required for proper operation.

CONDITIONS: Given information and illustrations about terms relating to the four basic types of microphones and the maintenance procedures required for proper operation.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test items covering terms relating to the four basic types of microphones and maintenance procedures required for proper operation.

(This objective supports these Soldier's Manual Tasks 113-577-1039, Select a Microphone; 113-577-1043, Set Up Microphones for Multiple Music Instrument Presentation; 113-577-1053, Establish Audio Requirements for Audio or Television Productions; 113-577-9003, Perform Operator's Maintenance of Microphones, Microphone Cables and Connectors; and 113-575-9002, Interpret Schematic Diagrams, Block Diagrams or Component Location Diagrams.)

Lesson 3: DESCRIBE AND IDENTIFY THE THREE MAIN FUNCTIONS AND THE THREE MAIN SECTIONS OF AUDIO TAPE RECORDERS AND THE MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATION

TASK: Describe and identify the three main functions and the three main sections of audio tape recorders and the maintenance procedures required for proper operation.

CONDITION: Given information and illustrations about terms relating to the three main functions and three sections of an audio type recorder and maintenance procedures required for proper operation.

STANDARD: Demonstrate competency of the basic skills and knowledge by correctly responding to 80% of the multiple-choice test items relating to terms about the three main functions and three sections of an audio tape recorder and the maintenance procedures required for proper operation.

(This objective supports the Soldier's Manual Task 113-575-0042, Troubleshoot a Reel-to-Reel Audio Tape Recorder/Reproducer.)

Lesson 4: DESCRIBE AND IDENTIFY THE PRINCIPLES OF RADIO AND LINE TRANSMISSION, AM/FM CHARACTERISTICS, STEREO PHASE PROCEDURES AND THE ELECTRONIC REQUIREMENTS OF RADIO RECEIVERS

TASK: Describe and identify the principles of radio and line transmission, characteristics of AM/FM, stereo phase problems, and the electronic requirements of radio receivers.

CONDITIONS: Given information and illustrations relative to principles of radio line transmissions, AM/FM characteristics, stereo phase problems and electronic requirements of radio receivers.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test items covering principles of radio line transmission, AM/FM characteristics. Stereo phase problems and electronic requirements of radio receivers.

(This lesson supports these Soldier's Manual Tasks 113-575-4012, Replace RF Transmission Lines Between Antenna and RF Modulation, and 113-575-9002, Interpret Schematic Diagrams, Block Diagrams, or Component Location Diagrams.)

Lesson 5: DESCRIBE AND IDENTIFY COMPONENTS OF RECORDING SYSTEMS, AUDIO SPEAKERS, CABLE AND CORDS, AND USES OF BASIC MEASURING EQUIPMENT

TASK: Describe and identify components of recording systems, audio speakers, cable and cords, and uses of basic measuring equipment.

CONDITIONS: Given information and illustrations related to recording system components and audio speakers, cable and cords, and uses of basic measuring equipment.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test items covering identification of components of recording systems, audio speaker, cable and cords, and uses of basic measuring equipment.

(This objective supports Soldier's Manual Tasks 113-575-3033, Perform Measurement of the Visual and Audio Transmitter Carrier Frequency, and 113-577-9003, Perform Operator's Maintenance of Microphones, Microphone Cables and Connectors.)

TABLE OF CONTENTS

Section	Page
TITLE PAGE.....	i
TABLE OF CONTENTS.....	iv
INTRODUCTION TO TELEVISION AUDIO SYSTEMS.....	vii
Lesson 1: DESCRIBE AND IDENTIFY THE AUDIO CONSOLE AND MAINTENANCE PROCEDURES REQUIRED TO TROUBLESHOOT AND REPAIR THE EQUIPMENT.....	1
Learning Event 1: Describe and Identify the Functions of Audio Amplifiers, Switches, Mixers, Monitors, and Signal Paths.....	1
Learning Event 2: Describe and Identify the Performance Adjust- ments Required to Perform Operator's Maintenance of an Audio Console.....	4
Learning Event 3: Describe and Identify the Equipment Used in a Complex Audio Console.....	7
Practice Exercise.....	9
Lesson 2: DESCRIBE AND IDENTIFY THE FOUR BASIC TYPES OF MICROPHONES AND THE MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATIONS.....	10
Learning Event 1: Describe and Identify the Basic Construction of the Four Basic Types of Microphones.....	10
Learning Event 2: Describe and Identify the Adjustments and Maintenance Required for Proper Microphone Operation.....	17
Practice Exercise.....	19
Lesson 3: DESCRIBE AND IDENTIFY THE THREE MAIN FUNCTIONS AND THE THREE MAIN SECTIONS OF AUDIO TAPE RECORDERS AND THE MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATIONS...	20
Learning Event 1: Describe and Identify the Three Main Func- tions and Three Main Sections of an Audio Tape Recorder.....	20

Section	Page
Learning Event 2: Describe and Identify Maintenance Procedures for Proper Operation of an Audio Tape Recorder.....	30
Practice Exercise.....	34
Lesson 4: DESCRIBE AND IDENTIFY THE PRINCIPLES OF RADIO AND LINE TRANSMISSION, AM/FM CHARACTERISTICS, STEREO PHASE PROCEDURES, AND THE ELECTRONIC REQUIREMENTS OF RADIO RECEIVERS.....	35
Learning Event 1: Describe and Identify the Principles of Radio and Line Transmissions.....	35
Learning Event 2: Describe and Identify the Characteristics of AM Radio.....	38
Learning Event 3: Describe and Identify the Characteristics of FM Radio.....	40
Learning Event 4: Describe and Identify Phase Shifting and Distortion Problems in Stereo Systems.....	42
Learning Event 5: Describe and Identify the Electronic Requirements of Radio Receivers.....	42
Practice Exercise.....	44
Lesson 5: DESCRIBE AND IDENTIFY COMPONENTS OF RECORDING SYSTEMS, AUDIO SPEAKERS, CABLES AND CORDS, AND USES OF BASIC MEASURING EQUIPMENT.....	46
Learning Event 1: Describe and Identify the Components of Recording Systems.....	46
Learning Event 2: Describe and Identify the Components and Functions of a Typical Audio Speaker.....	49
Learning Event 3: Describe and Identify the Types of Cables and Cords Used in Radio/Television Studios and Uses of Basic Measuring Equipment.....	52
Practice Exercise.....	55
ANSWERS TO PRACTICE EXERCISES.....	56
FINAL EXAMINATION.....	57

Whenever pronouns or other references denoting gender appear in this document, they are written to refer to either male or female unless otherwise indicated.

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION TO TELEVISION AUDIO SYSTEMS

A radio/television systems specialist requires knowledge and skills in operation and maintenance of audio systems found in typical television studios which include production broadcast or Educational Television (ETV) facilities. It is important to understand the principles behind each piece of audio equipment and to be able to describe and identify the many items of audio equipment the 26T uses and maintains in a radio/TV operation.

LESSON 1

DESCRIBE AND IDENTIFY THE AUDIO CONSOLE AND MAINTENANCE PROCEDURES REQUIRED TO TROUBLESHOOT AND REPAIR THE EQUIPMENT

TASK

Describe the functions of audio control consoles, and identify the equipment and maintenance procedures for troubleshooting and repair.

CONDITIONS

Given information and illustrations about terms relating to audio control consoles and troubleshooting and repair maintenance procedures.

STANDARDS

Demonstrate competency of the task skills and knowledges by correctly responding to 80% of the multiple-choice test covering functions terminology and identification of audio control consoles and maintenance procedures for troubleshooting and repair.

REFERENCES

None

Learning Event 1:

DESCRIBE AND IDENTIFY THE FUNCTIONS OF AUDIO AMPLIFIERS, SWITCHES, MIXERS, MONITORS, AND SIGNAL PATHS

1. Audio console. The audio console is the nerve center for the audio portion of TV production, just as the sync generator is the heart of the video equipment. However, the basic functions of these two are vastly different. Whereas the sync generator provides a standard, the audio console does much more. In this section, we shall see just how much more it does as we study the functions, signal paths, mixing action, and monitoring facilities, which are all a part of the audio console. An audio console is designed to handle audio signals from microphones, tape recorders, special effects consoles, and other sources as necessary for sound production.

2. Functions. There are many functions which could be listed; however, for our purposes here, we will consider those functions performed by amplifiers, switches, mixers, and monitors. Of course, for the console to carry out its functions, there must be certain auxiliary equipment attached, as indicated by various input and output terminations in Figure 1-1. Most consoles contain their own power supply.

a. You know that audio frequencies range from about 15Hz to 20KHz. Television (TV) equipments that amplify signals for sound reproduction use amplifiers designed for this low-frequency range. It is the task of such amplifiers to strengthen the audio signal and reproduce it faithfully. The dominant requirements are, therefore, gain and fidelity. The three types of audio amplifiers used in the audio console are the preamplifier, driver, and power amplifier. The following is a list of their functions.

b. Audio preamplifiers are designed to increase the gain of low-level signals from transducers such as microphones and recorder-reproducer heads. They are operated Class A at power levels in the order of micro-microwatts or microwatts. Since the signals are so very small, special attention must be given to the noise factor, input impedance, and coupling.

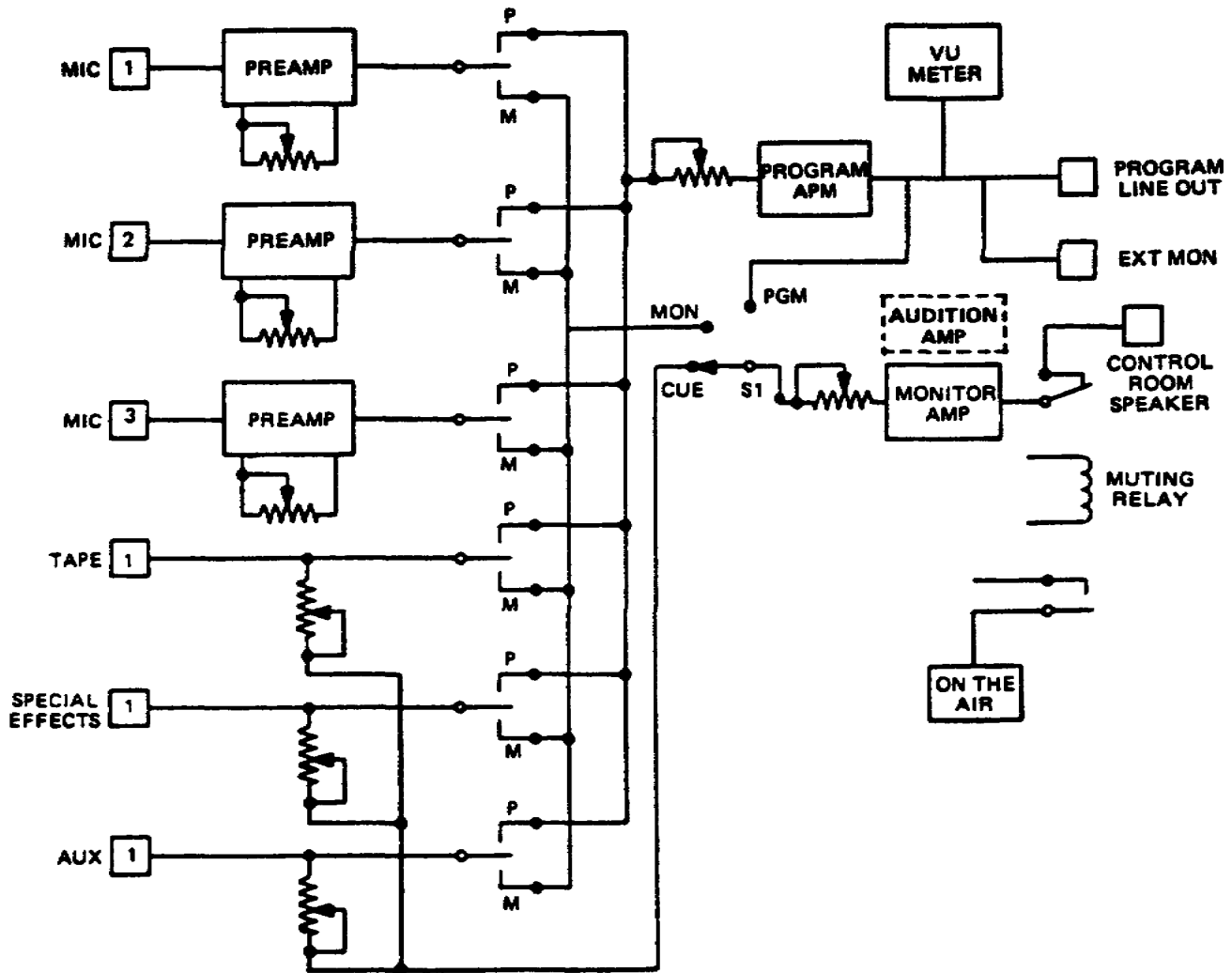


Figure 1-1. Block diagram of a basic audio console

c. Amplifier stages designed primarily to raise the power level of the signal-are known as drivers and power amplifiers. Driver stages usually develop power in the order of milliwatts. Power amplifiers develop watts or hundreds of milliwatts of power. This distinction based on power levels is approximate at best. The power levels of drivers and power amplifiers depend on the equipment in which they are used. A driver amplifier, as its name implies, is used to drive a succeeding stage. Thus, the driver states delivers power to another driver stage or to a power amplifier. The power amplifier builds the signal power to the necessary level to operate a device such as a speaker.

d. When microphones are discussed, you will find that the dynamic microphone is determined to have the best fidelity. However, this microphone requires a preamplifier (preamp) due to its low output voltage. Therefore, the audio console has built-in preamplifiers, which gives a sufficient signal level to drive the program and monitor amplifiers. The preamps used in this unit, as seen in Figure 1-1 have external gain controls, which are located on the front of the console along with the other input controls. These controls are actually labeled mixer. The program amplifier is also a multistage amplifier which falls in the class of a driver. This amplifier also has a gain control, which is the master control that enables the operator to adjust for the correct output level, as indicated on the VU meter. Microphones will be discussed in detail in Lesson 2.

e. The control consoles are equipped with a number of multiple contact double throw lever switches. These switches are used to perform a number of functions, some single and some multiple functions.

(1) The tape input is an example of a single function. When the switch is in either the program or monitor position, the only function is applying the tape signal to the respective amplifier. The microphone selector switches use an additional set of contacts to control the muting relay which removes the monitor speaker from the circuit. Also, the muting relay controls the on-the-air alert light.

(2) There are other switches, such as S1 which are used to select the various circuits to be monitored. There is a switch, not shown in Figure 1-1 which enables the operator to select what is wished to be monitored on the phone jack. It should be mentioned that Figure 1-1 is a block diagram of a simple console; the more elaborate control consoles have many more switches.

f. The mixers consist primarily of the variable attenuators which are incorporated with the various amplifiers. In the amplifier circuits, the mixers are nothing more than gain controls. In the tape input, auxiliary input, and special effects, they serve as gain controls for the cue circuit. or those who have not actually worked on a control console, there might be some question as to why they are termed "mixers." This can best be explained by saying that as one input signal is used to replace another, one signal is increased as the other is decreased. In this instance, the operator increases the gain on one input mixer control while decreasing the gain for the other. If two inputs are to be used at the same time, the two mixer controls are set

to give the proper balance or desired mixing of the signals coming into the console. They are also set to give the correct overall amount of output signal.

g. The console incorporates a VU meter, which is used to monitor the signal level out to the line and the external monitor. When you are using the mixer controls, the VU meter is very important for adjusting and maintaining the correct level out (fig 1-1).

(1) The headset monitor (not shown on the block diagram fig 1-1) is also used for adjusting balance; however, since the operator's sense of volume is not good enough to set the level out, the VU meter is needed.

(2) The various speaker connections also serve as monitors in the control room at remote locations and other miscellaneous installations. Like a headset, the speaker serves to give you an idea of the output level, but is not exact enough when adjusting for the correct level while monitoring tapes or live programs. We should mention that some of the control consoles have selective scale adjustments for the meters, whereas others require modification for the pad circuit to change the meter scale.

h. Again looking at Figure 1-1, you see there are a number of possible signal paths. In this diagram (fig 1-1), there are a total of six inputs and three outputs. Remember, this is a simple setup. There are many more inputs and outputs in the more elaborate setups that have talkback circuits incorporated for classroom work.

(1) In the diagram illustrated (fig 1-1), start with microphone No. 1, trace a signal path through the preamplifier, level selector switch (program P position), program amplifier, VU meter, line out pad or extension monitor pad to the output. If switch S1 was in the PGM position, the output from the program amplifier would also be coupled to the monitor amplifier and the control room speaker terminal.

(2) As shown in the diagram (fig 1-1), all of the input signals can be connected to the program amplifier and monitor amplifier at one time. Let us suppose you have a studio program that requires the use of all the microphones and also requires specific sound effects which are recorded on tape. In this case, you must use the cue position; a signal is fed to the monitor amplifier. At the right moment, you use the selector switch to send the signal to the program line. Thus the tape input is mixed into and becomes part of the program.

Learning Event 2:

DESCRIBE AND IDENTIFY THE PERFORMANCE ADJUSTMENTS REQUIRED TO PERFORM OPERATOR'S MAINTENANCE OF AN AUDIO CONSOLE

1. Performance adjustments. Three types of adjustments of primary concern are (1) elimination of hum in the circuits, (2) prevention of erratic action from switch contacts, and (3) accurate control of output.

a. We need to mention at this point that hum is usually not a problem with a transistorized control console. However, the tube type consoles with AC filaments are subject to hum distortion. To eliminate this problem, you need to adjust the hum balance control, which is found in the power supply section.

(1) To make the hum adjustment, set all input selector switches to the center or off position. If there is an input that cannot be turned off, it should be terminated in a resistance, since it may pick up hum in a manner similar to an antenna.

(2) After all input circuits are either off or terminated, turn the master gain all the way clockwise. If the preamplifier is in the circuit following the selector switch, turn the preamplifier gain or mixer to minimum, fully counterclockwise. Now you are ready to adjust the hum control for minimum hum in the output of the program line.

b. The switch contacts can be a source of much trouble due to their position in the line relative to the amplifiers.

(1) When a switch spring becomes bent, it does not close properly; therefore, you must adjust it for good contact.

(2) If a contact becomes burned or otherwise pitted, erratic action may result. Switch contacts should be checked carefully and adjusted or aligned for smooth action. This is true for both rotary and lever action switches.

c. When setting up the output level, the important thing to remember is that your accuracy can be no better than the VU meter reading. In other words, you cannot properly set the output unless your VU meter is accurate. Depending upon the console, you may find various methods of calibrating the VU meter.

(1) If you find the meter is improperly calibrated, it must be recalibrated against a known standard. In some cases, it is necessary to change the resistors in the pad circuit to get the correct VU meter calibration.

(2) You should realize the importance of output level control since this signal goes to a recorder, a live broadcast, or a live CCTV network. Therefore, any distortion which results from the overdriven output causes a loss of intelligence.

d. The troubles diagnosed here are only a few that may cause the symptoms described. Some of the troubles may have many other symptoms which enable you to determine the most likely cause of malfunction.

(1) As we have already mentioned, some of the hum problems are found in both transistor and tube-type sets. However, we know that troubles with hum are less frequent with transistor units, because they do not use heater voltages. Most of the hum picked up in a transistor unit are from the

preamplifiers, amplifiers, long microphone leads, and other types of inputs. The tube-type control consoles are different because of the AC filaments. The hum balance adjustment procedure has already been discussed; however, this adjustment suffices only if all components are in good condition.

(a) For example, if you attempt to make the hum adjustment and find that the control does not have any effect, there is another reason for the hum. In some models of the control console, the hum adjustment is nothing more than a DC voltage that can be varied from one side of the filaments to the other.

(b) In essence, this applies a positive potential on the filaments with respect to the cathode, causing a current from the cathode to the filaments rather than from filaments to cathode. Thus, any hum which might ordinarily be coupled from the filaments is blocked.

(c) Now if you cannot make the hum adjustment with the balance control, there is a good possibility that the voltage is missing from the hum balance adjust. Depending upon the console model, you may have as much as 40 volts at the center tap of the balance control. This voltage is usually obtained from a bleeder circuit in the B+ supply. Therefore, when there is a hum control failure, you should check the power supply voltage and the balance voltage source.

(2) Recall that the muting relay is used to mute the speaker. If this fails, sound may be fed back from the speaker to the microphone. There are two possible places to look for the cause of this trouble one is the relay which does the muting, and the other is the switch which controls the relay. Of course, you can easily determine whether the switch is faulty by using another selector switch to see whether or not the relay is activated.

(a) If the relay is activated and the speaker is muted, you know that the trouble is in the switch.

(b) If the relay is not activated, then it should be checked.

(c) Another thing to remember about sound feedback is that the higher audio frequencies usually cause more difficulties than the lower frequencies. Also, do not overlook the possibility of sound feedback from extension monitors in adjacent rooms. These sources of sound can also be troublesome.

e. Since the microphone is the signal source in an audio system, it can also be the source of troubles. The microphone in most all instances requires a preamplifier as indicated on the block diagram (fig 1-1). There are many troubles that are attributable to the microphone itself, such as broken cords, loose connections, and corroded terminals--all of which could cause weak or erratic output. This is in addition to any other internal damage to the microphone; and, of course, any of these symptoms could be localized to the microphone by substitution of a known good microphone.

(1) If the trouble is in the preamplifier, then of course it would be a matter of checking tubes and other items or perhaps circuit tracing the preamplifier.

(2) However, a weak signal would usually be caused by a weak tube in the circuit. Other possibilities, although less probable, are low B+, low filaments, components value change, and other minor items.

f. The mixer control is one part of the control console which is used extensively and causes some trouble during operation.

(1) The mixer or variable attenuator is nothing more than a gain control; therefore, it has a sliding arm contact.

(2) The sliding contact may become dirty and cause noisy operation of the control. This is very apparent in the gain rather than a smooth change. The trouble can be eliminated by cleaning the wiper arm contacts with a good contact cleaner, or some other cleaner as recommended by the manufacturer.

Learning Event 3:

DESCRIBE AND IDENTIFY THE EQUIPMENT USED IN A COMPLEX AUDIO CONSOLE

1. Complex audio console. The basic configuration of the equipment consists of a main audio console, an auxiliary mixer console, and an auxiliary control console.

a. At the main audio console, mixers are provided for four microphones, one turntable, one tape station, one network audio circuit, and one remote audio circuit, providing a total of eight. By means of lever keys, each program source may be switched to a program bus or on audition bus. Keys for the microphone positions also provide studio speaker control, so that the speaker is locked out during a broadcast. Talkback facilities allow communication to the studio, except during on-the-air periods.

(1) Twelve microphone circuits may be connected permanently to the console, and through the use of lever-type switches, four of the microphones can be assigned to preamplifiers and mixers. Each mixer output is controlled by a key-type switch, so that the output may be connected to either the program or the audition bus.

(2) Either of two methods may be used to connect the auxiliary mixer and the main audio console. By paralleling the audition and program buses of each, a total of eight microphone mixers are available. In addition, a speaker interlock circuit is provided on the audition-program switches.

(3) By connecting the program output of the auxiliary mixer, one master mixer and four subcontrol mixers are provided. Such a configuration is desirable when an orchestral program is to be broadcast. Proper instrument balance can be obtained by settings of the individual mixers, and the master mixer can be used to provide cutoff or fading of the entire group.

2. The auxiliary console primarily provides intercom facilities. In addition a VU meter with selector and attenuator, a turntable volume control with studio playback switch, and a spare attenuator also are provided.

a. The VU meter may be used to monitor other functions when the master console unit is in use.

b. The turntable volume control and studio playback switch provide a means of introducing background material into the program material. For example, when an actor "on camera" appears to be thinking of something having a direct bearing on the plot or program, the thoughts (previously tape recorded) can be played through the studio speaker. Additionally, the actor is able to coordinate actions and facial expressions properly by listening to the played-back material.

c. The intercom facilities provided by the auxiliary console are controlled by the six telephone ring-down circuits, which may be connected to outside points. An additional intercom is necessary to provide talkback facilities to the projection room, studio, announce booth, and order wire. The intercom system should include a microphone, a preamplifier, and relay control key-type switches. The keys should be located near the director's operating position.

Lesson 1
PRACTICE EXERCISE

1. The drive stage usually develops power in which of the following forms?
 - a. Milliseconds
 - b. Milliwatts
 - c. Miniohms
 - d. Millicurrents
2. Which of the following are parts of the audio console?
 - a. Vector scope
 - b. Sync generator
 - c. Monitor facility
 - d. TV monitor
3. The hum balance control is used to make which of the following adjustments?
 - a. Hum leveler adjust
 - b. Hum device adjust
 - c. Hum effect adjust
 - d. Hum adjustment
4. Which of the following causes the sound from the speaker to be fed back to the microphone?
 - a. The muting relay does not mute
 - b. The oscillating amplifier does not oscillate
 - c. The mixer control does not mix
 - d. The hum device does not eliminate hum
5. A mixer is sometimes called a
 - a. Scrambler
 - b. Wiper arm
 - c. Gain control
 - d. Muting relay
6. Which of the following is a monitor for the master console unit?
 - a. A television screen
 - b. A VU meter
 - c. A studio speaker
 - d. An intercom

LESSON 2
DESCRIBE AND IDENTIFY THE FOUR BASIC TYPES OF MICROPHONES-AND THE
MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATIONS

TASK

Describe and identify the four basic types of microphones and the maintenance procedures required for proper operation.

CONDITIONS

Given information and illustrations about terms relating to the four basic types of microphones and the maintenance procedures required for proper operation.

STANDARD

Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test covering terms relating to the four basic types of microphones and maintenance procedures required for proper operation.

REFERENCES

None

Learning Event 1:

DESCRIBE AND IDENTIFY THE BASIC CONSTRUCTION OF THE FOUR BASIC TYPES OF MICROPHONES

1. Microphones. A microphone is a device which converts sound waves into an electrical signal, and applies this signal to an amplifying circuit. Following sufficient amplification, the electrical signal is used to drive a reproducer or to modulate a carrier frequency for transmission.
2. General Characteristics. The general characteristics of the most widely used types of microphones--dynamic, carbon, crystal, and capacitor--are discussed in this section. Each of these basic types of microphones uses a specific fundamental principle of operation.
3. Types of microphones. The basic operation of a microphone is dependent upon pressure of sound waves. The angles at which the sound waves strike the diaphragm of a microphone depend upon the positioning of the microphone in relation to the sound source. If the sound waves strike the diaphragm at different angles the pressure is different, this will cause the microphone to be directional in its frequency response. Most microphones are directional at

frequencies about 2000 Hz. Special construction of the microphone housing or case may produce additional directivity at frequencies below 2000 Hz. Examples of specially constructed microphones are the "shotgun" and "reflector" types. Nondirectional microphones also require special design considerations. For nondirectivity, it is necessary to so design the housing that signals from all directions exert uniform pressure on the diaphragm. The microphone which is designed for general purpose use is polydirectional; this type of microphone is usually mechanically adjustable to achieve the desired pattern of pickup.

4. Dynamic microphone. The dynamic or so-called moving-coil type is the most widely used. Because of its low (and adjustable) impedance, it can be installed with long cables without serious adverse effect to the overall audio system; it is not easily damaged by rough handling and is not particularly sensitive to blasts (instantaneous sound peaks).

a. A dynamic microphone contains a coil made of a large number of turns of extremely thin metal ribbon attached to the diaphragm. This coil is insulated from the diaphragm by a thin coat of insulating varnish. The coil extends from the diaphragm to a point between the poles of a powerful permanent magnet. When sound waves strike the diaphragm, the coil moves back and forth within the magnetic field between the poles of the permanent magnet and cuts the magnetic lines of force.

b. An illustration of a microphone designed to operate on this principle is shown in Figure 2-1a. This action induces a current in the coil in direct proportion to the sound pressure exerted on the diaphragm.

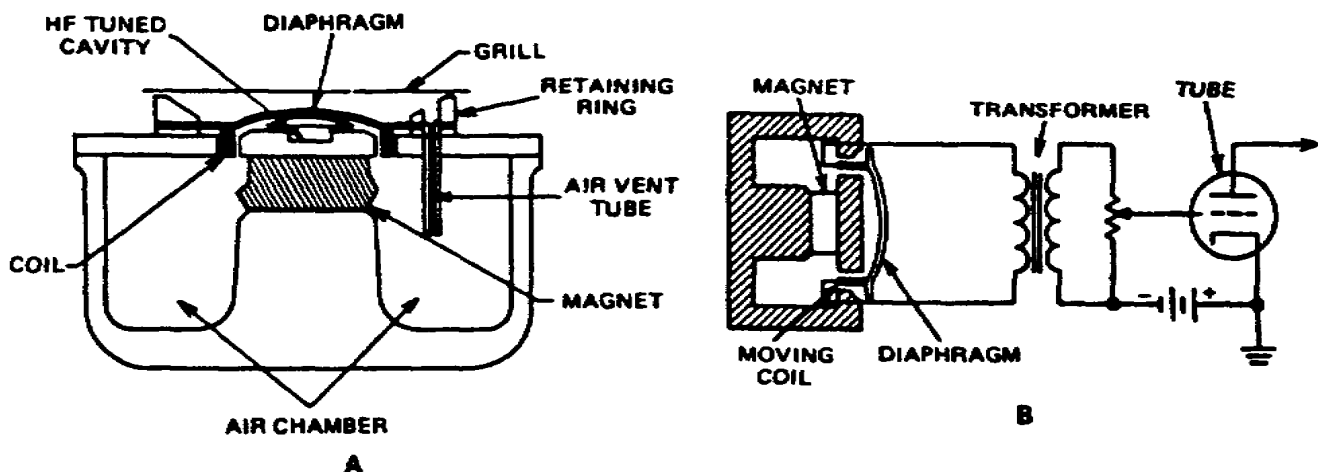


Figure 2-1. Dynamic microphone (A) mechanical details and (B) circuit diagram

c. The dynamic microphone elements are normally housed in a metal shell and covered with a metal grill and silk cloth to prevent damage from foreign particles and to minimize dust collection. The improvement in frequency response of this type of microphone over other types lies in the inclusion of an echo compensation circuit, which consists of an air chamber between the housing element and an air-vent tube; the length and diameter of the air-vent tube control the echo compensating action of the air chamber.

d. The impedance of the moving coil in the dynamic microphone is approximately 50 ohms; therefore, the coil may be connected to an amplifier by means of long cables. There are microphones available with built-in matching transformers to match low impedance of 30, 50, and 250 ohms or high impedance up to 50 kilohms. A switch is built in to select the various impedances. The frequency response of this type of microphone is reasonably flat over the range from 40 Hz to 10,000 Hz. Since the output voltage level is only about 0.00004 volt, a preamplifier must be used for adequate amplification. The circuit diagram of the dynamic (moving coil) microphone is illustrated in Figure 2-2B.

e. The ribbon microphone, a variation of the dynamic microphone using the moving coil principle, is widely used in studio operations. It has no real diaphragm, and its operation depends upon the velocity of air. Therefore, it is sometimes termed a "velocity" or "pressure gradient" microphone. The microphone, as shown by diagram in Figure 2-2A, consists of a powerful horseshoe-shaped electromagnet or permanent magnet, M, with special pole pieces between which a thin corrugated metal ribbon, R, is suspended. The ends of this ribbon are connected to the primary of a special step-up transformer.

f. The construction details of the ribbon microphone are illustrated in Figure 2-2B. The microphone should be so placed that the incoming sound strikes it at right angles, as those from the side have practically no effect. The sound striking the ribbon causes it to vibrate and thus cuts some of the magnetic lines of force between the pole piece. This action generates a voltage in the ribbon that is coupled to the grid of an amplifier via a special step-up transformer. Since the ribbon microphone is sensitive to velocity, it should be covered or otherwise shielded when used outdoors or in drafty areas, where air tends to produce undesirable ribbon vibrations.

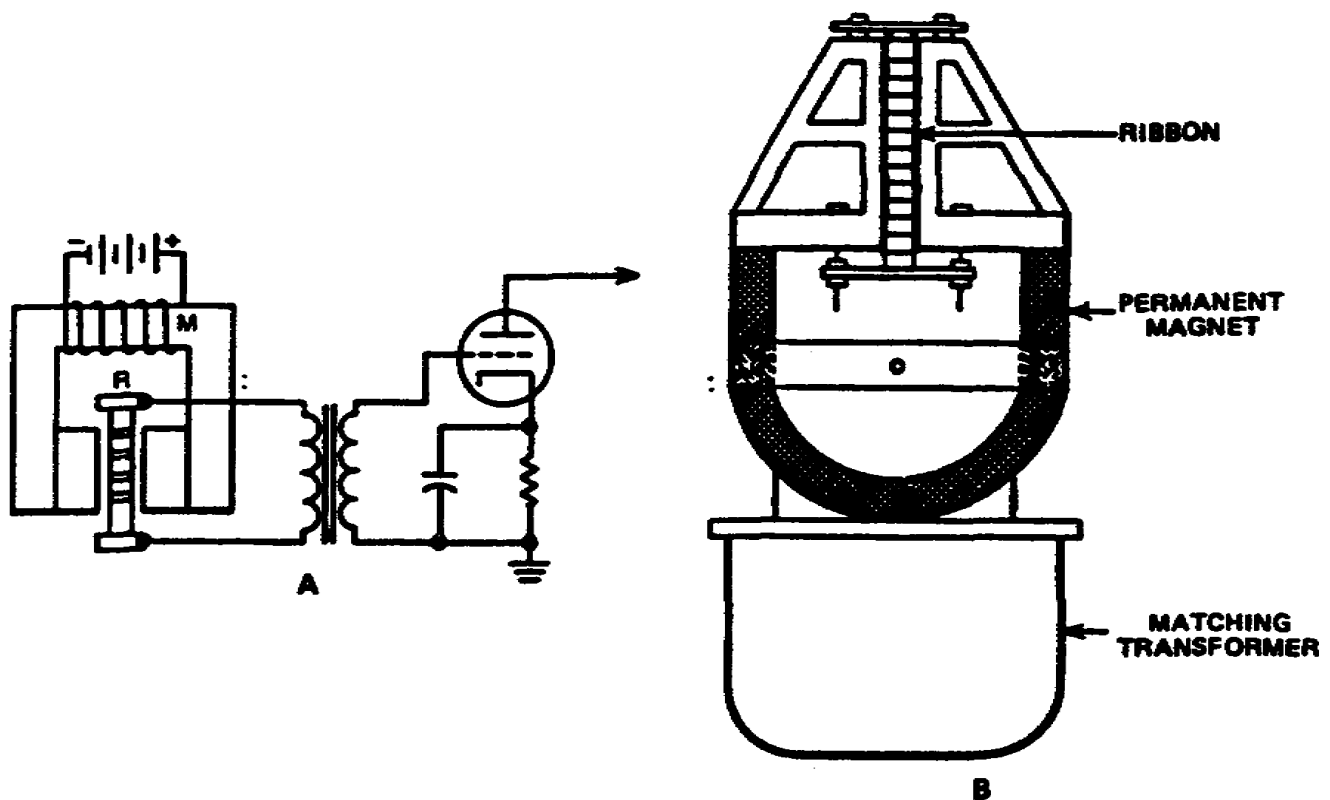


Figure 2-2. Velocity microphone (A) circuit diagram and (B) construction details

g. The voltage output of the velocity microphone across 250 ohms is 0.0002 volt. The corrugated ribbon has a resistance of only a fraction of an ohm; therefore, the matching transformer is usually built into the microphone to reduce losses. The frequency response is practically flat from 30 to 15,000 Hz. The low impedance of the velocity microphone permits a long cable connection to the amplifier, but the cable must be well shielded because of the possibility of AC hum pickup.

5. Carbon microphone. The carbon microphone is widely used in intercommunications and cueing systems. In the carbon microphone, a constant direct current is permitted to flow through a mass of carbon granules. As sound waves vibrate the diaphragm, its resultant motion alternately compresses and releases pressure on the mass of carbon particles. The changing pressure on the carbon causes the resistance value of the total mass to change, thus permitting either more or less direct current passage. A cross section of a typical carbon microphone is shown in Figure 2-3A; A and B are heavy steel rings. The ridge in one and the groove, D, in the other hold the diaphragm, C, very tightly. The diaphragm is made of a very tough steel alloy and is generally designed to be from 0.001 to 0.002 inch thick. The small ring, G, is screwed into the large steel ring, B, to adjust the diaphragm tension, so that its natural period of vibration is above the desired audio frequency range. The central portion of the diaphragm is gold-plated on each side to

ensure good contact. The back of the microphone is closed, except for a series of holes that permit the air and sound to reach the back of the diaphragm. The bridge, E, extends across the opening in the front of the microphone and supports the front carbon granule cup, or button, F. A similar one is supported by the back. These carbon cups, or buttons, do not touch the diaphragm and are partly filled with fine carbon grains. The size of these grains determines the sensitivity of the instrument, and soft felt washers prevent the carbon from getting out of the cup.

a. Figure 2-3B illustrates both the mechanical structure and the equivalent electrical circuit of the simple single-button carbon microphone. The single-button carbon microphone is characterized by high output level and ruggedness. It is practically unaffected by heat and humidity. When space and weight are limited in an installation, its high output is advantageous because fewer amplifier circuits are required. The output ranges from 0.1 to 0.3 volt across a normal transformer impedance of 50 to 100 ohms.

b. To secure a more uniform response from various frequencies, the double-button type of carbon microphone, illustrated in Figure 2-3C, is generally used in place of the single-button type. As you can see, the diaphragm is placed between the two cups which contain carbon grains. Vibration causes the grains of carbon on one side of the diaphragm to be compressed; at the same time, it causes the grains of carbon on the opposite side of the diaphragm to be loosened. This action permits more current through the first carbon button than through the second. The output voltage of the double-button carbon microphone ranges from 0.02 to 0.07 volts across a normal transformer impedance of 200 ohms.

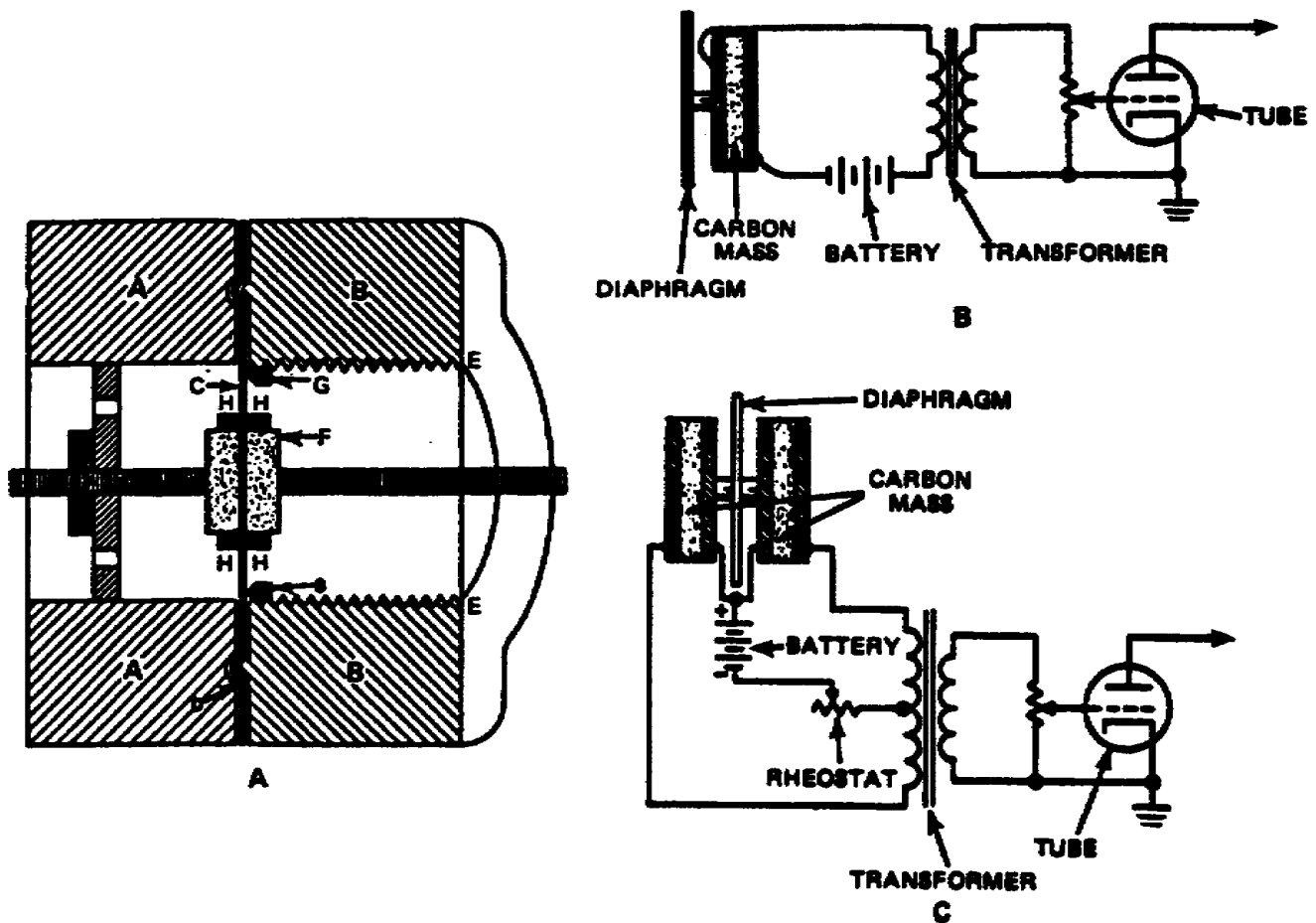


Figure 2-3. Carbon microphone (A) cross sectional view, (B) single-button circuit diagram, and (C) double-button circuit diagram

c. The frequency response is uniform from 60 to 1000 Hz. Above 1000 Hz, the response increases rapidly, becoming more than 15db higher at 2500 Hz than it was at 100 Hz. The response then remains uniform up to approximately 6000 Hz, where there is a marked falling off in response. Because of its poor response to the higher audio frequencies as well as its high noise level (hiss), the carbon microphone is not widely used for general television purposes.

6. Crystal microphone. The crystal microphone requires no energizing potential source such as the battery used with the carbon microphone. It requires no transformer or other coupling device. Its output, although not as high as the carbon microphone output, is adequate for direct application to the grid circuit of an amplifier. These features, plus its inherent simplicity and compact size, make this type of microphone unique among the devices designed to convert sound waves into electrical impulses.

a. Crystal microphones can be divided into two types--the diaphragm type and the sound cell type. The crystal element used in either type can be permanently damaged by high temperatures. This limits the number of useful applications. However, the crystal microphone is still widely used as a high-quality microphone for communications, both military and commercial. Figure 2-4A is a diagram showing the bimorph crystal unit; sound waves striking the diaphragm cause the diaphragm to vibrate. These vibrations are transferred to the surface of the crystal by means of the connecting pin. The fidelity of this type instrument is approximately equal to that of most double-button carbon microphones; however, the frequency response extends to a much higher range. In the crystal microphone, there is no background hiss or noise generated in the microphone itself. However, noise pickup on cables which are longer than 30 feet does limit the use of crystal microphones in television.

b. The sound cell is another type of crystal microphone, as shown in Figure 2-4B. The back-to-back crystal elements are enclosed within a rectangular bakelite frame sealed by two flexible membranes. No diaphragms are required in a sound cell microphone, because the membrane imparts the sound pressure directly to the crystals, which produce the resultant AC voltage.

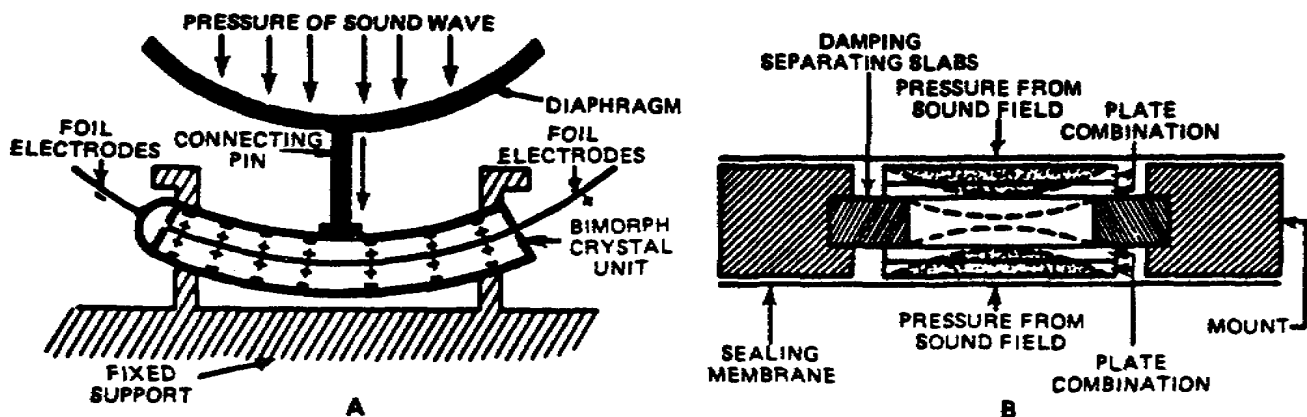


Figure 2-4. Crystal microphone (A) cross sectional view of diaphragm and crystal and (B) cross sectional view of single sound cell unit

7. Capacitor microphone. A capacitor microphone generally consists of two electrodes separated by a very thin dielectric, usually air. One electrode is the diaphragm, while the other is a rigid plate which has the same area as the diaphragm. The diaphragm motion changes the spacing between the two electrodes, varying the capacitance.

a. If a DC voltage is applied across the combination, the changes in spacing produce changes in the capacitor charge which can be obtained as an AC voltage.

b. This device has a very linear pressure response and a wide frequency response and is relatively insensitive to mechanical noise because of its stiffness of construction.

c. The capacitor microphone requires an external power source and is adversely affected by high or changing humidity.

d. The output voltage is small; therefore, amplification is required, and the leads must be kept very short to avoid picking up stray field noise. New developments with solidstate amplifier built into the microphone housing have changed this situation.

8. Microphone Characteristics. The characteristics of the various microphones are summarized in Figure 2-5 which lists the various major types of microphones, together with their output level in dB and their frequency range in hertz. From Figure 2-5, you can see that from the standpoint of output level the carbon type is best and from the standpoint of frequency range the velocity type is best.

MICROPHONE TYPE	FREQUENCY RANGE IN CYCLES	SIGNAL-TO-NOISE	EXAMPLES OF OUTPUT IMPEDANCE	AVERAGE DB OUTPUT	VOLTAGE OUTPUT
DYNAMIC					
MOVING COIL	30 TO 20,000	MEDIUM	10-Z 30, 60, & 260 H1-Z	-55 TO -60	0.00004V
RIBBON	30 TO 20,000	MEDIUM	50K 250 OHMS	-55 TO -60	0.0002V
CARBON					
SINGLE-BUTTON	70 TO 6000	LOW	50 TO 100 OHMS	-45	0.3V
DOUBLE-BUTTON	60 TO 6000	LOW	200 OHMS	-35 TO -45	0.07V
CRYSTAL	UP TO 14,000	HIGH	5 MEGOHMS	-50 TO -60	
CAPACITOR	20 TO 15,000	HIGH	30, 150 OR 600 OHMS	-63	

Figure 2-5. Comparison of microphones

Learning Event 2:

DESCRIBE AND IDENTIFY THE ADJUSTMENTS AND MAINTENANCE REQUIRED FOR PROPER MICROPHONE OPERATION

1. Microphone adjustments. It should be said that most of the difficulties with microphones are caused by misuse or careless handling. Nevertheless, let us mention a few adjustments that can be made on a microphone. The polydirectional microphone may be any of the basic types which have an adjustable aperture. When the aperture is fully open, the microphone has a bidirectional pattern; when the aperture is closed, the microphone is nondirectional. At shutter settings between the open and closed positions, the microphone is unidirectional. Some microphones are designed with blast filters which are adjustable and require settings commensurate with the operating conditions.

2. Microphone maintenance. The maintenance of microphones is-not so much in the microphone-itself but rather in the cords and connectors. If, for instance, you were told a carbon microphone did not have an adequate output, the first thing you should check is the carbon granules for a "packed" condition. This condition is caused by excessive current which causes the carbon granules to stick. Carbon granules that are packed can sometimes be loosened if you turn off the applied current and shake the microphone while holding it in various positions. If this does not correct the situation, you may have to replace the carbon granule mass. Do not shake a dynamic microphone, as this will not accomplish anything desirable and may damage the internal unit.

Lesson 2
PRACTICE EXERCISE

1. What are the four basic types of microphones?
 - a. Steel ring, attenuator, coil, magnet
 - b. Dynamic capacitor, crystal, carbon
 - c. Grill, pressure, directivity, shotgun
 - d. Diamond, resistor, tube, air-vented

2. What is the approximate impedance of the moving coil in the dynamic microphone?
 - a. 50 ohms
 - b. 75 ohms
 - c. 10 ohms
 - d. 100 ohms

3. Which of the following microphone has the highest output level?
 - a. Carbon
 - b. Crystal
 - c. Diamond
 - d. Velocity

4. Which of the following is a variation of the dynamic microphone?
 - a. Ribbon
 - b. Diamond
 - c. Carbon
 - d. Capacitor

LESSON 3
DESCRIBE AND IDENTIFY THE THREE MAIN FUNCTIONS AND
THE THREE MAIN SECTIONS OF AUDIO TAPE RECORDERS AND
THE MAINTENANCE PROCEDURES REQUIRED FOR PROPER OPERATIONS

TASK

Describe and identify the three main functions and the three main sections of audio tape recorders and the maintenance procedures required for proper operations.

CONDITIONS

Given information and illustrations about terms relating to the three main functions and three main sections of an audio tape recorder and maintenance procedures required for proper operations.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test relating to terms about the three main functions and the three main sections of an audio tape recorder and the maintenance procedures required for proper operation.

REFERENCES

None

Learning Event 1:

DESCRIBE AND IDENTIFY THE THREE MAIN FUNCTIONS AND THREE MAIN SECTIONS OF AN AUDIO TAPE RECORDER

1. Audio tape recorders. Perhaps you own a home tape recorder and have performed minor maintenance on it. In this section you are concerned with audio tape machines as they apply to TV production. You will notice that the terms "audio tape recorders" and "audio tape machines" are used interchangeably in this material. In the audio tape recording field, there is a difference in the tape player and tape recorder. A tape player can combine the three functions of erasing, recording, and playing back audio frequencies, the same as a home variety tape recorder. A tape recorder is usually limited to the erasing and recording of audio frequencies.
2. Audio Tape Machine. For our discussion, we have divided the audio tape machine into three main sections: transport mechanism, heads, and electronics. In the following discussion you will find variations in the functions of each

of these main sections. For example, the tape heads are identified according to their functions of erasing, recording, or playback.

a. All of the tape machines require some type of mechanism to move the tape past the record and playback heads. Such mechanisms have been given various names, but "tape transport" seems to be generally accepted as standard. "Tape handlers" is the term used to designate machines designed for fast start-stop operation. These fast start-stop machines are usually a type of computer or laboratory tape transport which require the tape to start or stop instantaneously. In contrast, the standard machine requires about 1 second to reach full speed and perhaps 5 to 10 seconds to fully stabilize.

(1) A good quality tape transport has the features of the mechanism illustrated in Figure 3-1. These features include the tape supply reel, which is provided with either a friction brake or an active back torque. The back torque is supplied by the drive system or a torque motor. Back tension (torque) is necessary to keep the tape from becoming tangled due to the inertia of the tape reel. The tension idler holds a certain amount of tape in its loop; this spare amount of tape is temporarily let out during quick starts. A slight delay in time is allowed for the supply reel, which has appreciable inertia, to start turning at operating speed. The tension idler and back torque work together to smooth out irregularities caused by the rubbing of the tape against the supply reel sides, sticking together of tape layers, or other causes.

(2) Again looking at Figure 3-1, note that the tape is drawn from the tension idler, across the rolling tape guide erase head, tape guide, record head, tape guide, and reproduce head. The force, which draws the tape across the heads at a constant speed, is provided by the capstan and the capstan pressure roller. The combination of the capstan, the tension idler, and reverse torque of the supply reel keeps the tape under constant tension. There is friction between the tape and the stationary heads. This friction is a source of vibration. Attempts to eliminate this vibration are included in the design of the transport mechanism by using a rigid base on which to mount the transport components. Other causes of vibration are the amount of wrap around the head, smoothness of head faces, tape tensions, tape condition, tape composition, temperature, and humidity. The capstan may be either the shaft of the drive motor or a shaft driven through a speed-reducing mechanism. The capstan and any associated mechanism must be made with precision, or it causes problems during both record and playback. This requirement for precision components includes the drive motor, as it must drive the capstan mechanism at a constant speed.

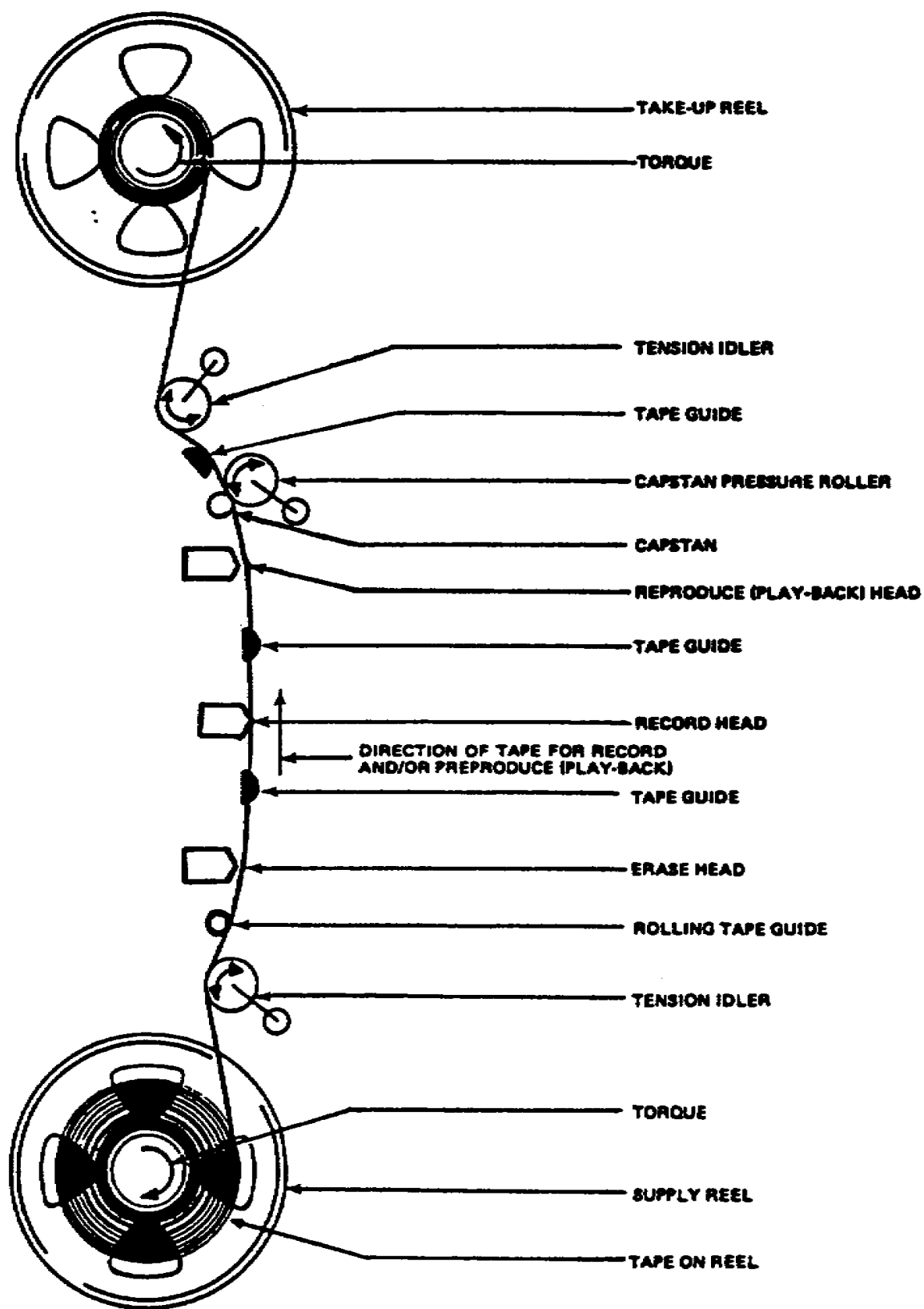


Figure 3-1a. Tape transport mechanism (record mode)

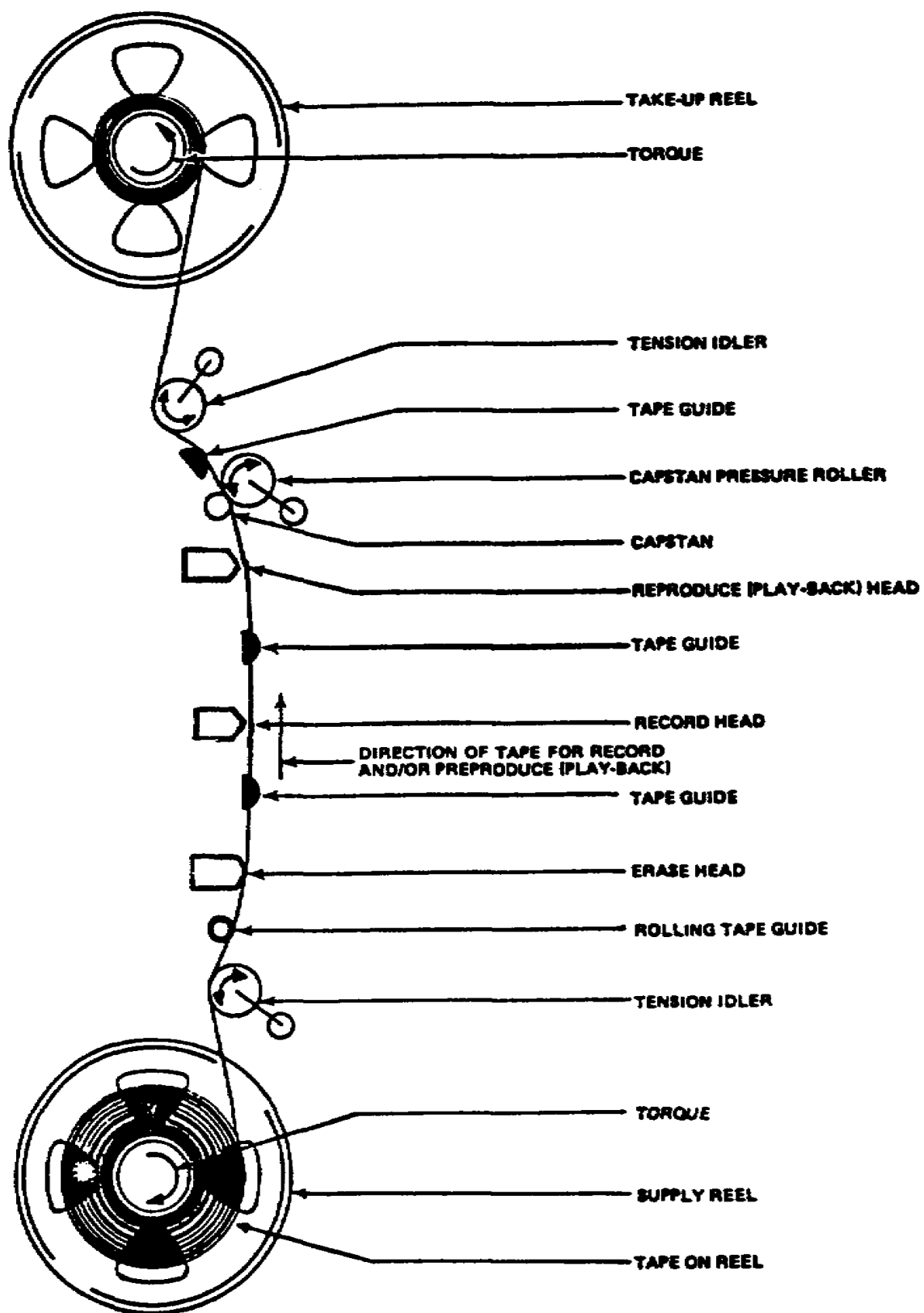


Figure 3-1b. Tape transport mechanism (erase mode)

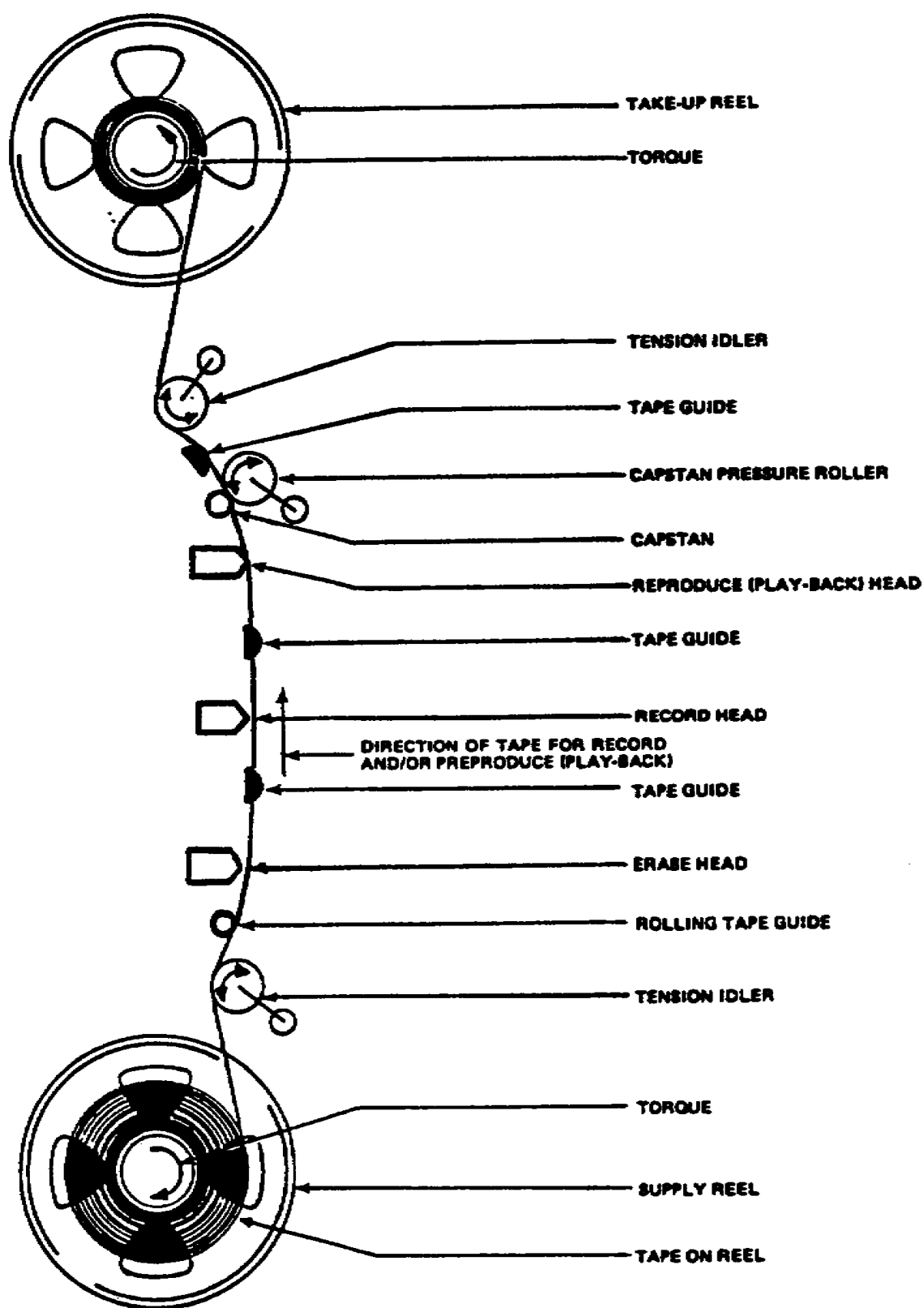


Figure 3-1c. Tape transport mechanism (reproduce mode)

(3) Immediately following the capstan and the capstan pressure roller is another tape guide. Each tape guide serves to keep the tape in alignment with the heads at all times. If the tape guides permit any vertical variation of the tape, a possibility exists of attenuation of the recorded signal during reproduction. In extreme cases the signal could be lost entirely, or the erase head would either fail to erase or improperly erase when a recording is made. The tension idler near the takeup reel serves the same purpose as the other tension idler. The torque on the takeup reel changes according to the amount of tape on the reel.

b. Three tape heads may be used on the more expensive tape machines. Some machines, such as those designed for home use, use the same head for recording and reproducing.

(1) The basic construction of tape heads is the same--that is, the head consists of a core of permeable material which is wound with a coil of wire (fig 3-2). This core of permeable material is formed into a contact. The core material is usually of a laminated construction (fig 3-3) rather than nonlaminated. The nonlaminated heads are cheaper to construct, but they usually produce poor results. The laminations, produce a better response to higher frequencies by reducing magnetic losses due to eddy currents.

(2) The core of the head is wound with a number of turns of wire, but the number of turns depends upon the purpose for which the head is designed. The manner in which the core is wound is dictated by the head use; also, two windings may be used. Most of the newer heads follow the two-winding design, one winding on each side of the gap. In most of the newer designs, the two windings are terminated externally, thus they may be connected in a parallel or series arrangement as desired. The core and winding are enclosed in a protective metal housing to prevent the winding from picking up hum emanating from motors, transformers, etc.

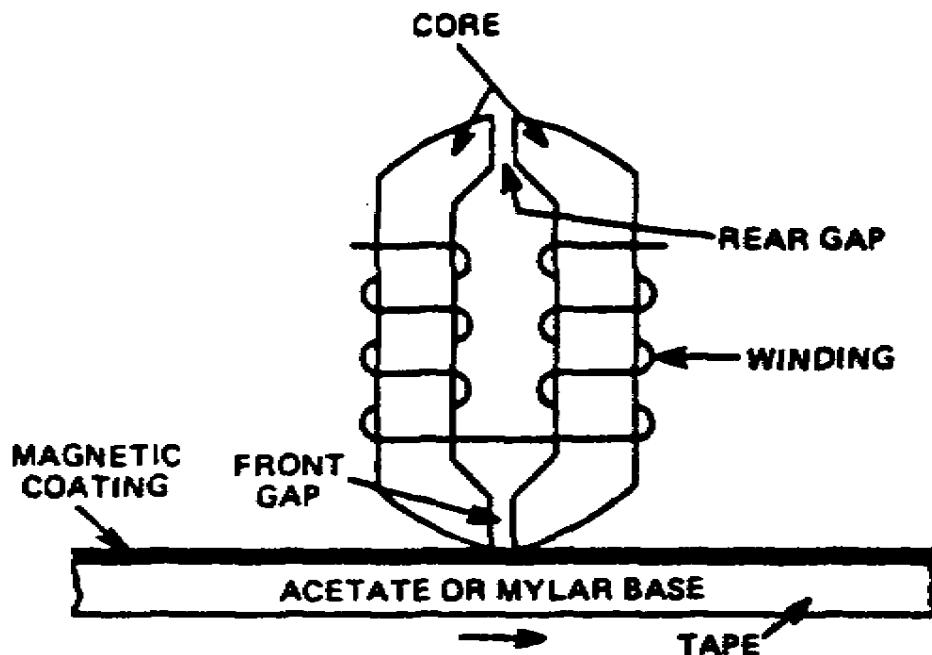


Figure 3-2. Construction of magnetic head

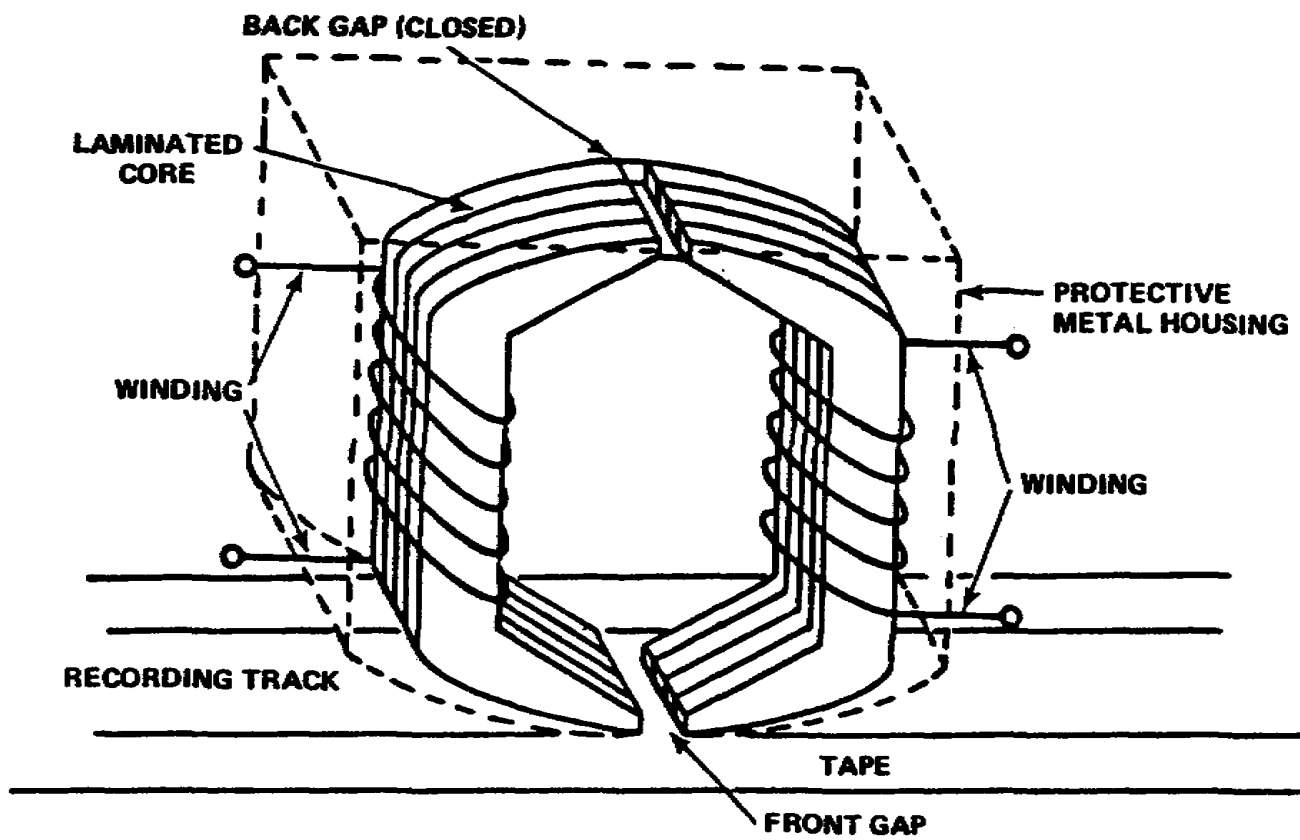


Figure 3-3. Laminated core tape head

c. So far, all of the heads under discussion have been of the electromagnetic type. To further expand on the erase head, some are constructed to use either a single permanent magnet or a series of permanent magnets to set up a magnetic field.

(1) If a single magnet is used, the tape is erased by the magnetic flux.

(2) However, with more than one magnet, the tape is erased by the changing cycles of the magnetic flux fields.

(3) The more popular erase heads are those which use a high-frequency current to create an AC magnetic flux. This current is supplied by the bias oscillator, which also provides the bias current to the record head, where the magnetic flux lines penetrate the magnetic coating of the tape (fig 3-4). The AC erase head has fewer turns of wire than the standard playback head, and it passes current easier and operates better at the higher frequencies.

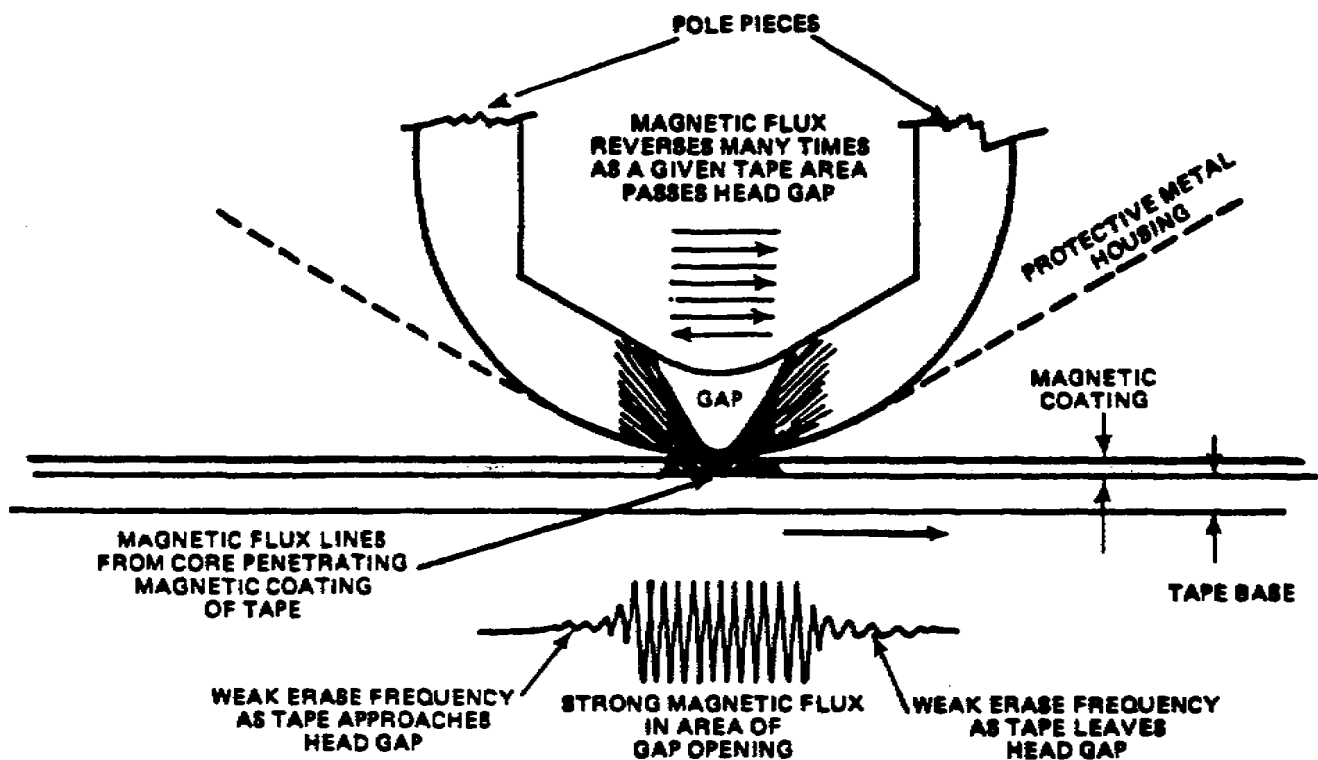


Figure 3-4. Action of high-frequency erase head

(4) Another feature of an AC erase head is a wider gap which permits the tape particles to change direction more times, thus giving a more complete erasure of the tape.

(5) Notice that as the tape approaches and then leaves the gap in the head, the erase action builds up from zero to maximum and back to zero. Thus, any magnetic pattern which was previously recorded is obliterated by the action of the high-frequency bias oscillator.

d. When an alternating current is sent through the winding of a record head, a magnetic field corresponding to the applied current is produced in the core (fig 3-5). The magnetic field has a great deal of difficulty passing through the nonmagnetic gap in the core. However, when the magnetic coating of the tape closes the gap, the field can easily complete its journey via the tape. The tape now becomes magnetized in accordance with the fluctuations of applied current.

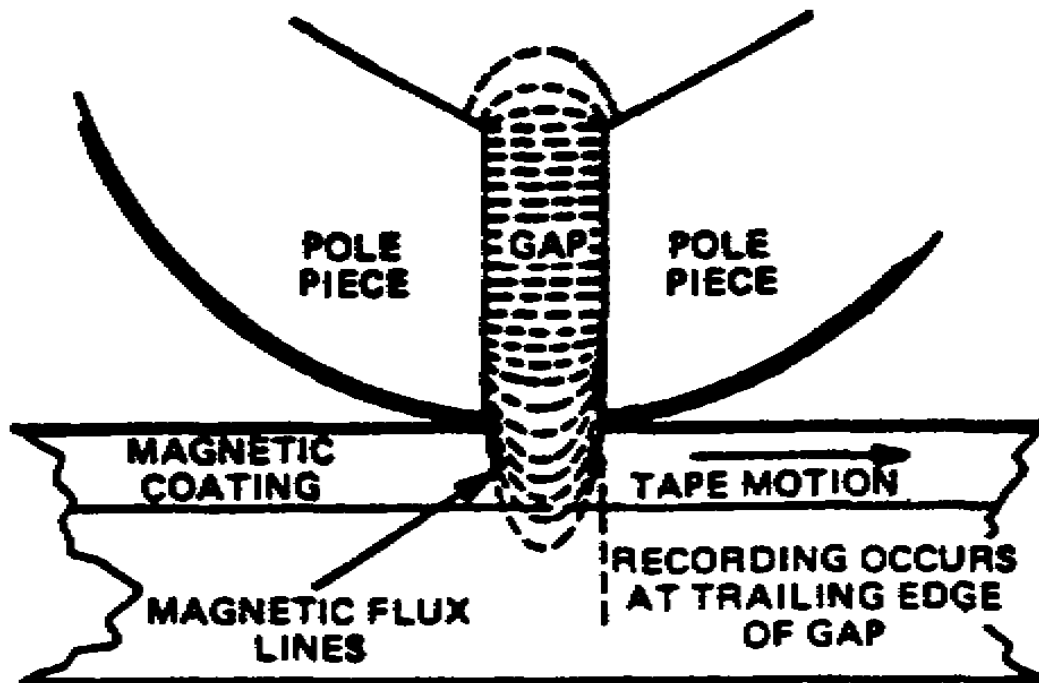


Figure 3-5. Flux lines in a recording gap

(1) The magnetic fluctuation of the tape continues until the instant the tape passes the trailing edge of the gap. The magnetic orientation at the instant of departure from the gap edge is the pattern that remains on the tape. For the best possible recording, the trailing edge of the gap should be as straight and sharp as possible. A principle difference between heads of poor quality and high quality is the definition of the gap edge. The amount of electrical signal required to produce a certain amount of magnetic flux on one head may create a stronger magnetic flux on another head because of differences in efficiency or elements of design. The signal level that causes distortion varies among heads of different manufacturers. You must take these factors into account if you substitute a different make or model of head for the one that originally came with the tape recorder.

(2) As the signal current is fed to the head; the high-frequency bias current is supplied simultaneously to the head (fig 3-6). The residual magnetization of the tape is accomplished by passing the signal current, plus a high-frequency bias current, through the recording head winding. This technique is referred to as direct recording.

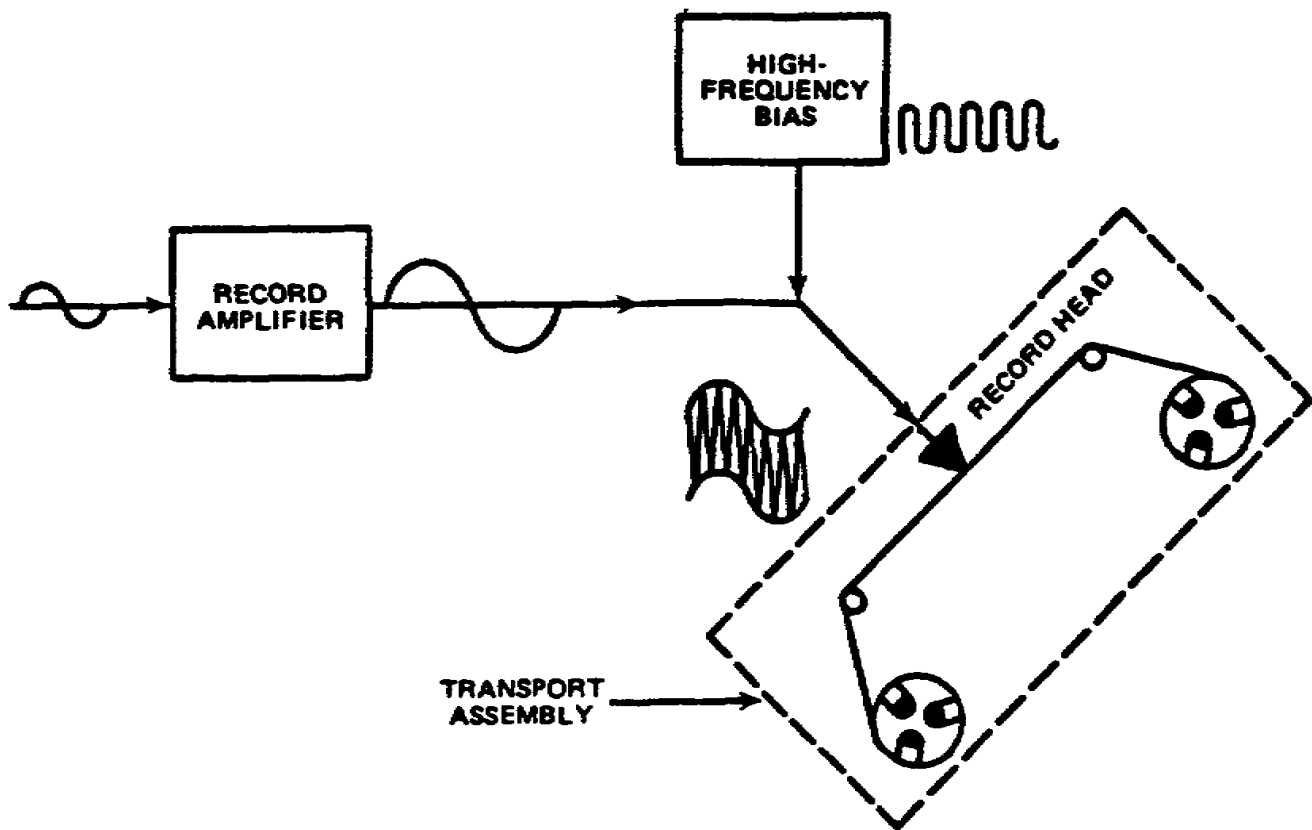


Figure 3-6. Recording with high-frequency bias

(3) The high frequency of the bias oscillator serves to activate the head over the linear portion of its magnetization curve. The linear operation puts the audio signal in a magnetization area for the most faithful recording. If, however, the bias signal is increased until the head is saturated, the linear operation is disturbed. The final magnetization produced in the tape is determined by the last flux encountered close to the trailing edge of the gap as the tape leaves the gap area. For this reason, the length of the recording gap is not as critical, within limits, for recording heads as it is for reproducing heads. The recording heads usually have a gap in the range of 0.0005 to as much as 0.001.

e. Certain features of the playback (reproduce) head are required to provide full response to the audio frequencies. One requirement is that the head gap be very narrow; that is, 0.0001 inch or smaller. A large number

of turns of wire is required in the winding since the head must be sensitive to the changes in flux recorded on the tape. The playback head functions in an opposite manner to the record head; that is, the tape induces a flux into the head core. The flux passing through the core induces a voltage into the winding, causing current in the associated circuit. This signal current is amplified by the playback amplifier for operation of speakers, headphones, or other devices. The playback head is of prime importance in the faithful reproduction of a recorded signal. For example, if we assume that a head is good mechanically, and it is playing back a signal which has all frequencies recorded with equal magnitude, we will find that the higher audio frequencies will produce a greater voltage output.

(1) An inherent characteristic of a playback head is that the rise in output is proportional to the rise in frequency response. However, remember that although a new head may have a narrow gap, as the head wears, the gap becomes wider, and as a result, the high-frequency response drops off.

(2) Also, along with gap width, the definition of the edge of the head must be smooth to produce high frequencies. If the edges of the gap are not straight and sharp, the gap behaves magnetically as though it were much wider than its physical dimensions.

f. Other factors which affect the frequency response of the head are tape speed, smoothness of the tape, pressure of the tape against the head, and quality of the tape. The tape speed is important because the more rapidly the changes in flux are drawn across the head gap, the stronger the voltage induced into the head gap, and the stronger the voltage induced into the head windings. This added strength, in turn, gives improved frequency response to the recorded signal. You can understand this condition if you consider that a slow moving tape causes the head to see an average change in the flux and not each small change, which is necessary to reproduce high frequencies. Smoothness of the tape and tape-to-head contact are directly related in their effect on frequency response as well as voltage output. If the tape is rough, the magnetic particles are not maintained constantly closed to the head, which is necessary to induce a smooth flow of flux variations. The rough spots or portions of the tape move the particles farther from the head and cause weakening of the flux changes; thus, the high frequencies are lost. Carrying this through further, you can understand that the same losses are prevalent if the pressure holding the tape against the head is weak.

Learning Event 2:

DESCRIBE AND IDENTIFY MAINTENANCE PROCEDURES FOR PROPER OPERATION OF AN AUDIO TAPE RECORDER

1. Electronics. Typical electronic circuits used in tape recording are indicated in Figure 3-7. There are certain refinements as dictated by performance requirements. Normally, the higher the frequency response required, the better the overall quality of the circuit components. Even though the record head requires very little drive power, the need for bias injection, impedance matching, and possible preemphasis makes it important to use the correctly

designed amplifiers in the recorder. In recorders, there is a requirement for voltage equalization of frequencies in the output. Earlier we said that the higher the frequency, the more the voltage output; for the lower frequencies, the opposite is true. Therefore, the very weak, low frequencies must be boosted. It is not enough to increase the gain of the amplifiers. The problem is to boost the low frequencies and limit the high frequencies. In most instances, it is sufficient to add RC networks to the input signal path of an amplifier. To attenuate the high frequencies, RC network values are selections that result in bypassing a major portion of voltage of the higher frequencies to ground. The reduction of the higher frequencies input voltage of an amplifier results in a relative boost of the lower frequency voltage. Frequency-selective feedback circuits between amplifier stages may also be used to equalize the output voltages of the high and low frequencies. Many variations of equalization circuits are used in both playback and record amplifiers.

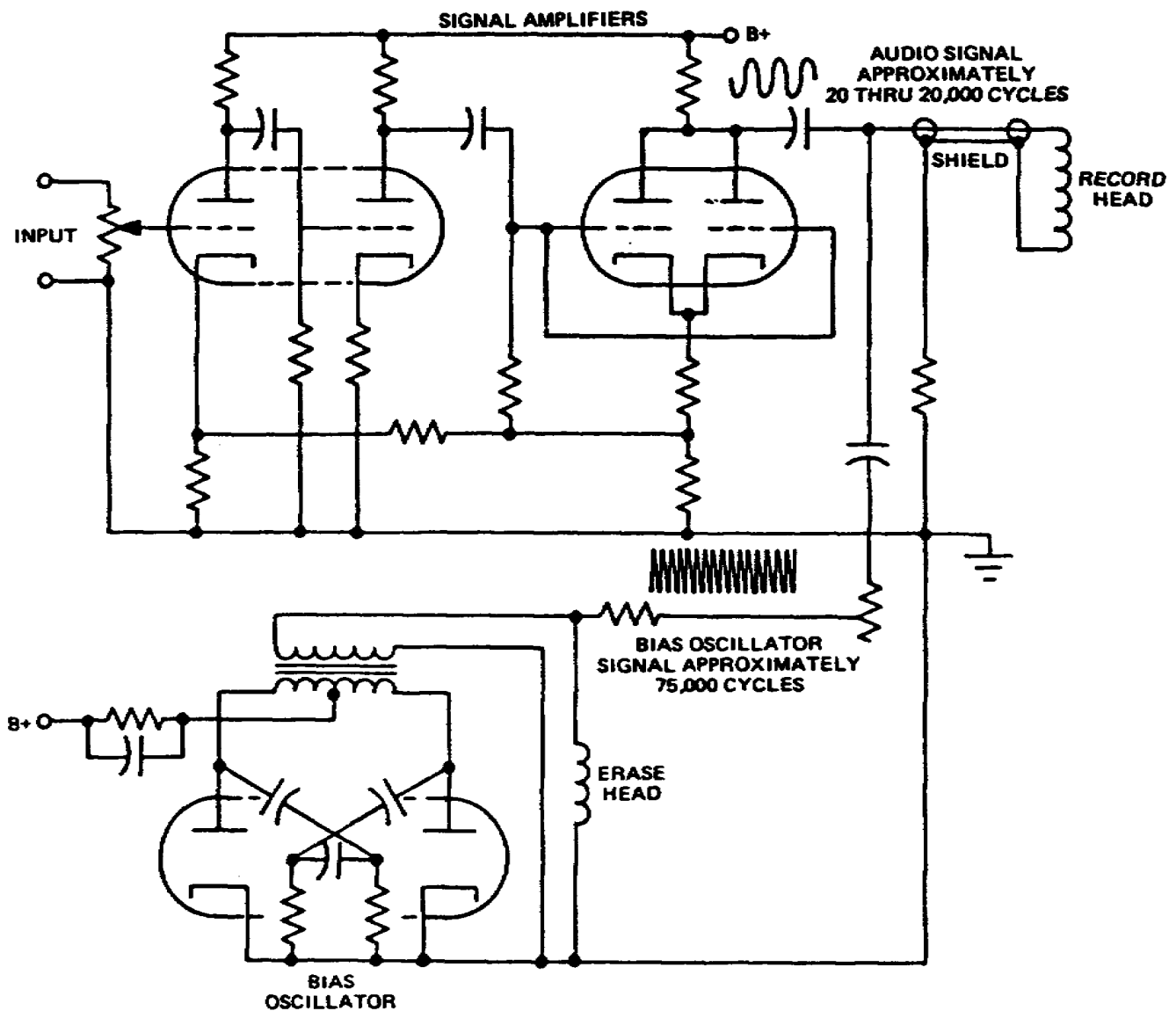


Figure 3-7. Typical record and bias oscillator circuits

2. Trouble diagnosis. To diagnose troubles in a tape machine, you need to remember that a combination of features can cause trouble. In a tape machine, you have a group of mechanical functions as well as the various electrical circuits. Indications obtained from the electrical circuits point to most of the troubles. These troubles may or may not be in the mechanical mechanism, but you must "read through" the troubles to make your diagnosis. Once you detect a malfunction, you should look immediately for the cause; however, a quick mental reference to the most common troubles and their causes should speed your diagnosis.

3. Variations of speed. Identifying "wow" and "flutter." The word "wow" is used to describe a slow variation of speed, whereas, "flutter" describes a fast variation of speed. If the speed is consistently wrong, the audio signal is off pitch. This condition is easily recognized with music but can be difficult to determine with spoken words.

a. A "wow" could be caused by certain faults, such as a slipping belt, a lack of proper pressure on the capstan motor winding damage, or an uneven tape surface.

b. A "flutter," which is much faster, would more likely be caused by something moving at a higher speed. The capstan could be out of round and give this fault with every revolution.

c. Sometimes a tape guide can cause a bouncing action to be repeated at a fast rate. A signal which is consistently off pitch or key may be caused by insufficient or excessive drag on the tape as it passes through the transport system. This could be incorrect action of the supply reel, the pressure pads, tape guides, or improper threading of the machine.

4. Weak outputs. If you have an indication that the output seems to be weak, or that it is not giving full response to the higher frequencies, you might look for electrical trouble. Pause for a moment and think what would happen if you have only a portion of a track passing over a head. We know that the strength of the output signal is relative to the magnetic influx recorded on the tape and the tape speed. You already know that head wear causes a drop in high-frequency response, but if the track or head is misaligned, you will not get full benefit from the recorded signal. You may need to check head wear, track, and head alignment. If these seem to be correct, then check the circuit components. Again, you can solve many of the tape machine problems by "reading" the symptoms and making a logical conclusion.

a. For still another example of a problem, let us assume that when you make an audio recording and play it back, you don't get a signal. There are two ways to start checking. Use a known good machine to check the tape or a known good tape to check the machine. If you determine that the trouble is in the record or playback portion, you should proceed to check out the items in those sections.

b. If the trouble is in the record circuits, you may check the input source or the bias oscillator; either one could cause a failure in the record mode.

c. If the bias oscillator is not working and the machine uses this same signal to erase the tape, a recorded tape would not be erased prior to a new recording. This is one quick check of the bias oscillator.

d. A substitute microphone can be used to make a quick check of the input source. Many recorders have a monitor jack which can be used to determine whether a signal is being fed into the recorder. Most recorders have a record indicator, either a light or a meter, which gives a visual indication of the input. By checking the circuit of the recorder in use, you can, through a process of elimination, narrow the area of trouble to a limited number of stages.

e. From this point, it is necessary to make the more routine checks of tubes and other components. To prevent head magnetization, do not check the continuity of heads with an ohmmeter.

f. The following check list is suggested for locating the cause of poor high-frequency response due to head problems.

(1) Check azimuth alignment with an alignment tape.

(2) Check for tape skewing which seems to occur simultaneously with amplitude fluctuations.

(3) Check to be sure the head meets the tape squarely.

(4) Check for stability of the tape path in its guides.

(5) Check for foreign deposits, nicks, or gauges on the head surface.

(6) Check for "breakthrough" in the head gap. A magnifying glass or microscope is helpful.

(7) Check for uneven wear.

(8) Replace the head if necessary.

4. Playback problems. A trouble in the playback circuits is most readily found by using a known good tape for playback. With some machines you have an intermediate output which can be checked to determine whether or not the signal is reaching a given point in the machine.

a. Some machines have a visual output indicator; if you have this type, you know that all circuits are good up to a stage prior to the power output; here, all but the last stage could be eliminated as the source of trouble.

b. In all cases, it is a matter of taking logical steps toward localizing the trouble to an area, to a circuit, and finally, to a component or components.

Lesson 3
PRACTICE EXERCISE

1. Erasing and recording are the two main functions of which of the following?
 - a. TV monitor
 - b. Camera chain
 - c. Tape recorder
 - d. Video selector
2. What are tape handlers?
 - a. People who have a degree in handling tapes
 - b. A term used to designate machines designed for fast start-stop operation
 - c. A machine designed to repair tape and play it back for proper operation
 - d. A term used to designate machines designed for automatic rewind
3. What is the purpose of the tape guide?
 - a. To guide the tape at a constant speed
 - b. To guide the tape to the tension idler
 - c. To permit vertical variation of the tape
 - d. To align the tape with the heads
4. How is a tape erased if the erase head is constructed of a single magnet?
 - a. By magnetic loss
 - b. By magnetic oscillation
 - c. By magnetic flux
 - d. By magnetic current
5. What do you do after a malfunction has been detected?
 - a. Report it to your supervisor
 - b. Look for the cause
 - c. Reduce the input voltage
 - d. Change the fuses
6. Which of the following statements describe the word "flutter?"
 - a. A broken audio signal
 - b. Moderate variation of speed
 - c. A fast variation of speed
 - d. A slow variation of speed

LESSON 4
DESCRIBE AND IDENTIFY THE PRINCIPLES OF RADIO AND
LINE TRANSMISSION, AM/FM CHARACTERISTICS, STEREO PHASE
PROBLEM, AND THE ELECTRONIC REQUIREMENTS OF RADIO RECEIVERS

TASK

Describe and identify the principles of radio and line transmission, characteristics of AM and FM stereo phase problems and the electronic requirements of radio receivers.

CONDITIONS

Given information and illustrations relating to principles of radio line transmissions, AM and FM characteristics, stereo phase problems and electronic requirements and radio receiver.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test covering principles of radio line transmission, AM and FM characteristics, stereo phase problems, and electronic requirements of radio receivers.

REFERENCES

None

Learning Event 1:

DESCRIBE AND IDENTIFY THE PRINCIPLES OF RADIO AND LINE TRANSMISSIONS

1. Transmission of sound. Radio communications include transmission of signals through space to a point of reception from a point of origin not connected by wires. This is accomplished by the use of microphones to convert sound waves into patterns of electrical energy. This energy is amplified and modulated by transmitting apparatus and broadcast on radio frequencies into the air. At the point of reception, the electrical patterns are converted by sound waves, which emerge from the loudspeaker.
2. Modulate. To modulate means to regulate or adjust within a communication system, modulation has three very important functions.
 - a. It converts electrical signals from information; it sends multiple channels of information over one communication line (multiplexing) and it makes radio transmission possible.

b. A good example of a single amplitude modulated system is the fuel-level indicator system used in most cars. The fuel-level (the information) regulates the amplitude of an electrical current which is then transmitted to an indicator on the dash-board panel. Thus the current is said to 'carry' the information and is therefore referred to as the carrier.

c. AM adds range to a signal in the radio frequency range. The audio information in this procedure is identified as a modulating signal; the radio frequency signal is called the carrier. The purpose of the carrier is to get the message delivered. In other words, the carrier, as its name indicates, carries the information to the receiver from the transmitter. The amplitude of the carrier signal varies as the information varies (fig 4-1).

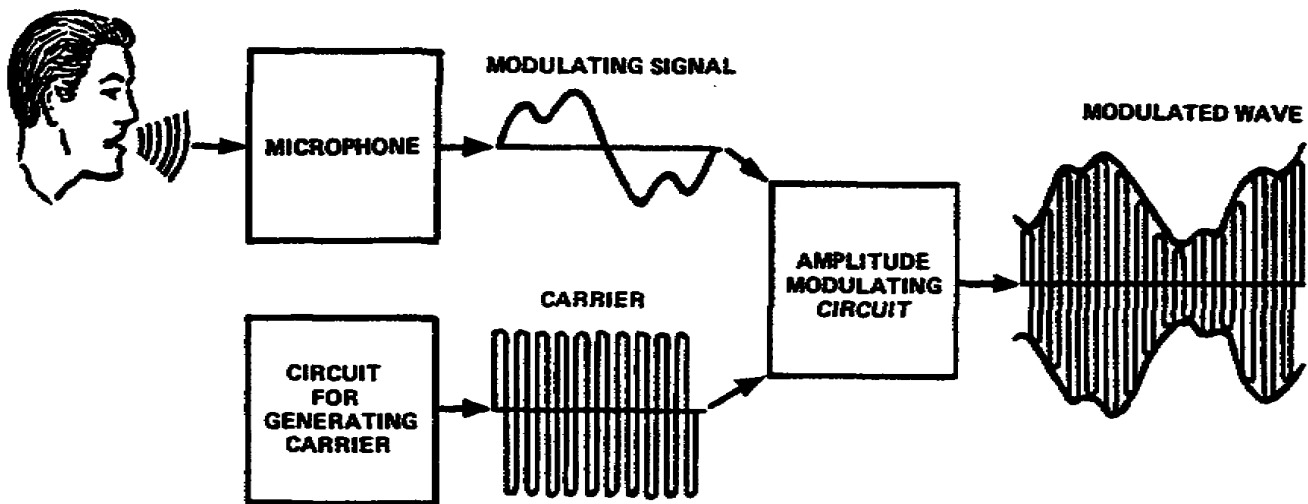


Figure 4-1. The amplitude modulating process. A modulating signal in the audio frequency range is imposed upon an RF carrier signal. The result is the modulated carrier signal

d. We've discussed two signals, one being the modulation signal, the other the carrier signal. These signals combined function at the carrier frequency. These signals are not alone when transmitting a modulated carrier, because when two electrical signals are combined they produce other signals. This process is called heterodyning, and as a result we get two other signals. One is developed when the carrier signal is mixed or added to information or intelligence frequency, and is called the upper sideband frequency. If one of these signals are deleted then what is remaining is called the lower sideband frequency.

e. If these three frequencies are combined (upper and lower sidebands and the original carrier) they form what is known as the modulated carrier signal. If a single frequency for the modulated signal changes, then there will be a pair of sidebands created for every new frequency. When more sidebands are added to the carrier, the modulated signal needs more space in which to operate in the broadcast band.

3. Heterodyne Process. Figure 4-2 is a block diagram of a superheterodyne radio-receiver. This receiver produces a carrier at a new frequency, keeping the information being transmitted unchanged.

a. To help you understand how the superheterodyne radio works, look at the section of the radio in which all of the tuning and station selection occurs (consists of the RF amplifier, the mixer, and the local oscillator). This section of the receiver receives the signal being broadcast, heterodyne this signal with the one that is produced in the local oscillator and a third signal is produced called the Intermediate Frequency (IF) signal. This IF signal is processed through the radio and soon the original broadcasted information is heard coming out of the speaker.

b. Figure 4-2 illustrates two carrier signals being mixed in the superheterodyne system (receiver). F_1 and F_2 will be heterodyned in the mixer block of the receiver, and the result is the production of four signals. They are: F_1 at 1.5 MHz, F_2 at 1 MHz, the sum of the two signals ($F_1 + F_2$) or 2.5 MHz, and the difference of the two signals ($F_1 - F_2$) or 0.5 MHz. If, however, the incoming signal at F_2 was modulated, then both the sum and the difference signal would contain modulation.

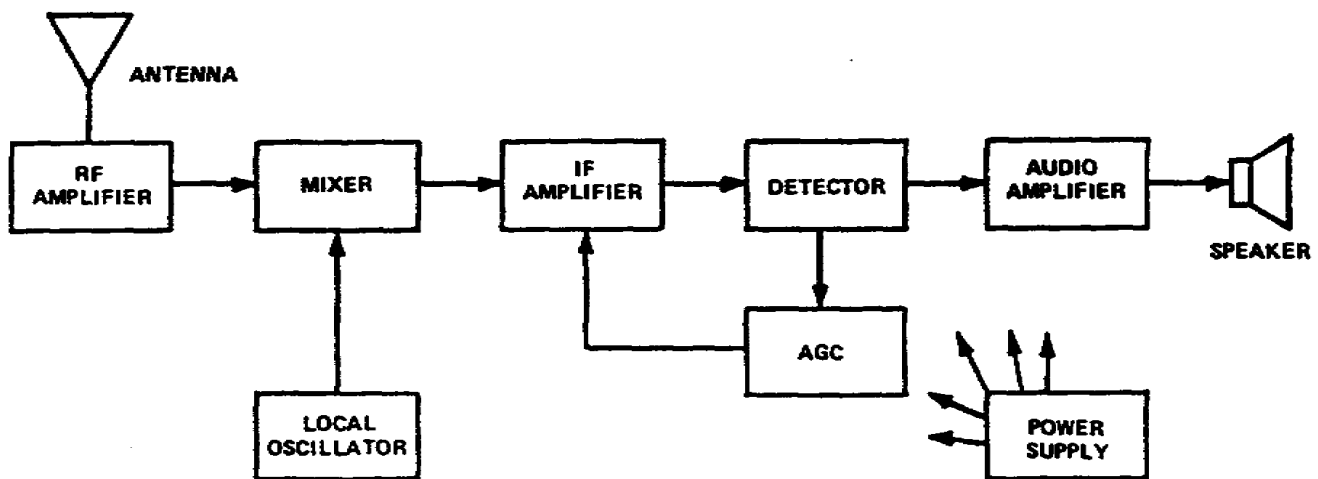


Figure 4-2. The heterodyning process produces four signals through the action of the mixer stage

4. AM's disadvantage. AM's biggest disadvantage, to be discussed further in the next learning event, is that electrical discharges in the air allows the carrier to be amplitude-modulated. As a result the listener hears interference and static and very often noise will override the modulation and interrupt the broadcast signal rather than the amplitude. The limiter block in the receiver cuts off any and all amplitude modulation intelligence upon receiving a frequency modulation signal.

Learning Event 2

DESCRIBE AND IDENTIFY THE CHARACTERISTICS OF AM RADIO

1. AM radio signal. The AM signal is one of the first kinds of transmission of radio signals. The information being broadcast by the station is varied in step with the amplifier of the transmitted signal. This type of system is what we know today as the superheterodyne radio.

a. The superheterodyne radio has several particular functions (fig 4-2). All of the functions are similar regardless of the components used in the radio. Therefore, whether the radio was a transistor solid-state or a vacuum-tube type, they both use the same functional diagram. We can go on to say that the electronic signal received from the transmitting source or station are processed the same whether the radio is transistorized or vacuum tube.

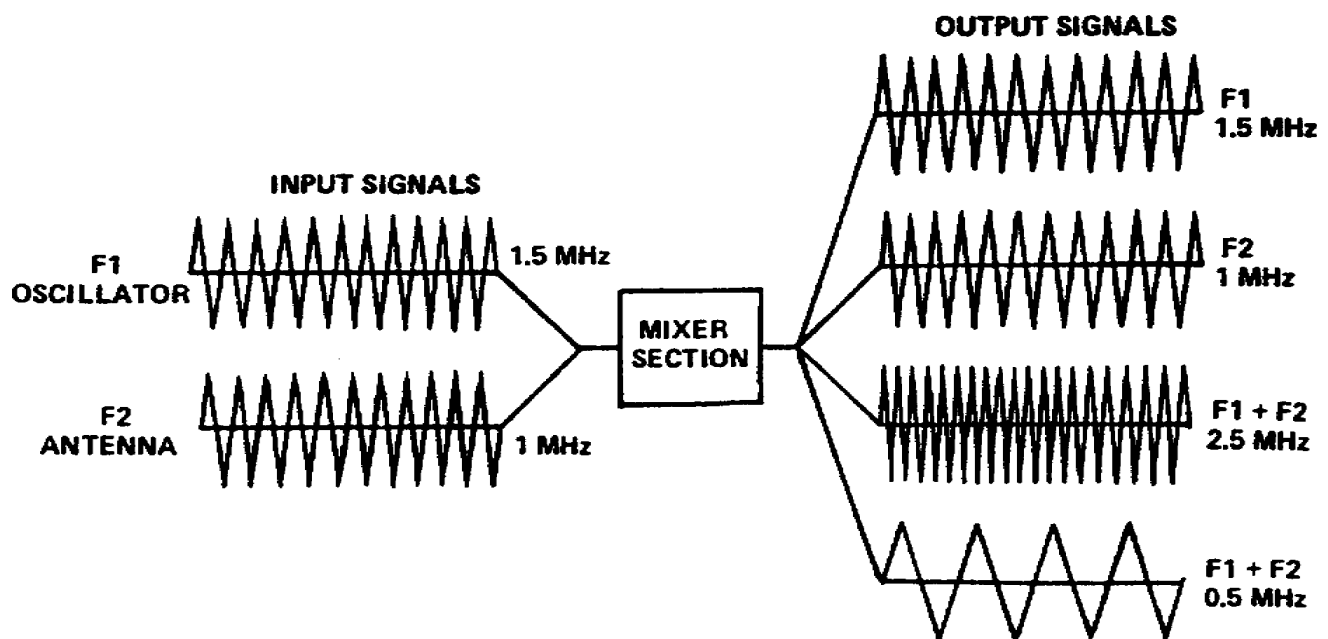


Figure 4-3. The AM radio block diagram

b. The AM superheterodyne radio works by a transmitted signal which is picked up by the antenna, processed through the set to the speaker as follows:

(1) The main purpose of the antenna is to pick up a broadcast signal and take that signal into the receiver for processing into sound waves.

(2) The "radio frequency amplifier" does what its name says. This amplifier is designed to operate in the radio frequency range. The amplifier provides for tuning or selecting a specific frequency and it amplifies the signal received in this frequency. The output goes to the mixer block.

(3) The "local oscillator" produces an electronic signal of its own. This signal is sent to the mixer block and is tunable. The main purpose of this block is to provide the electronic signal that is generated in the radio receiver. The electronic signal will mix with the signal selected by tuning elements in the RF amplifier. Newer models have a single knob that will allow for the tuning of the RF amplifier and the local oscillator at the same time.

(4) The mixer receives signals from the amplifier and the local oscillator. These signals are then mixed together electronically and as a result, there is a third signal produced. This third signal is known as the IF, or Intermediate Frequency signal. The IF signal operates on a frequency 455KHz for the AM radio. The IF amplifier block processes the signal that contains the same information as the receiver from the broadcast station, along with a signal known as the carrier.

(5) The "IF" or "Intermediated Frequency" is the output frequency from the mixer. This frequency is normally a fixed frequency where the superheterodyne receiver is concerned. Because the IF amplifier can be tuned for excellent performance, it is easy to acquire high gain and optimum selectivity.

2. AM carrier transmission. So far the radio we've been discussing has processed a signal containing two parts. One part consists of the intelligent information such as voice or music and the other part is the carrier. As stated previously, the carrier carries the information from the transmitter to the receiver at a certain frequency (each broadcast station operates at its own carrier frequency).

a. After the carrier transmits the information to the receiver, the carrier itself is processed along with the information through the mixer. This operation produces another carrier at the IF frequency.

b. This new carrier has included in it the information that is sent out on the broadcast station's carrier. Also, the intelligence contained in the IF carrier is sent through the IF amplifier to the "detector."

c. The carrier, after this process, is not needed for any reason; therefore, the radio acts as though this signal no longer exists. The detector's job at this point is to separate the carrier from the information, thus sending the information portion to the audio amplifier.

d. The input of the "audio amplifier" is designed to accept a tiny electrical signal. The electrical design of this block is able to amplify the electronic signal and apply enough power to operate the loudspeaker.

e. The "power supply" of all electronic devices are designed to provide certain operating voltages and currents from external sources, i.e., line voltage, battery, etc.

f. The "Automatic Gain Control" or "AGC" will compensate for the different signal strength levels sent to the radio receiver from the transmitter, and at the same time the AGC system monitors the amplification of the detector's signal. At this point the AGC returns a portion of the detected signal to the IF, and if RF amplifiers are either too high or too low, the AGC will act to either decrease or increase the amplification at these stages.

Learning Event 3:

DESCRIBE AND IDENTIFY THE CHARACTERISTICS OF FM RADIO

1. FM radio. The antenna serves the same purpose as it does in the AM radio; however, the "radio frequency" amplifier performs a dual function in the FM radio.

a. The first is to choose the incoming signal and then amplify this signal to a height that will allow the rest of the radio receiver to process it. This amplifier acts the same in an FM receiver as in an AM receiver, although some of the basic circuitry is different because of the different frequencies being received. In other words, the RF amplifier's function is the same in the AM radio and the FM radio, with the only difference being the frequency to be processed.

b. The purpose of the mixer is the same as in the AM radio. It mixes, as its name states, the signal received which contains the carrier signal with the signal from the local oscillator. These signals mixed together produce a third signal called the IF or Intermediate Frequency. This signal contains the IF carrier and operates on a frequency of 10.7 megahertz, and the intelligence found on the broadcast stations carrier.

c. The local oscillator generates a tunable electronic signal. This signal and the incoming signal in the RF amplifier are tuned at the same rate. The main purpose of the local oscillator is to generate and inject a carrier signal into the mixer block to develop the two signals which are required to produce the third signal known as the IF signal. The signal of 10.7 megahertz is produced in the mixer stage, and contains in it the carrier and the intelligence received from the broadcast station. This amplifier amplifies the signal from the very low level at the output of the mixer through several stages in order to get a large signal for the detector.

d. The limiter's functions is to expose the detector to a signal of constant amplitude. This process eliminates unwanted information in the signal, such as static, before it goes to the detector.

e. The purpose of the detector is to remove the broadcast information from the IF signal carrier. The carrier is no longer needed since it has taken the broadcast information through the receiver, in an amplified form and has presented this information to the detector. After the detector has extracted the carrier from the information, the information is sent to the audio amplifier, automatic frequency control, and the automatic gain control.

f. The basic purpose of any receiver is to reproduce broadcast information in the audio range (15Hz to 20KHz) as received from the transmitting station. The audio amplifier amplifies or magnifies this information, after which the information may go through several stages of amplification to produce a large enough signal to be processed by a power amplifier. After the information has been through the power amplifier, it is then sent to the loudspeaker. The loudspeaker transforms the electrical signal information back to sound waves where it is easily heard and understood.

g. The Automatic Gain Control operates the same in FM receivers as it does in AM receivers.

h. The Automatic Frequency Control can determine or sense deviation from a set frequency; its job is to keep the receiver at the desired operations frequency.

2. AM and FM receiver similarities and differences. There are both similarities and differences between AM and FM receivers.

a. Comparing the input of both the AM and FM receivers shows they both have antennas, RF amplifiers, mixers and a local oscillator. These blocks may be called "tuned," and will select one broadcast station's composite-signal.

(1) The composite-signal consists of the carrier and the information. Amplify and mix the composite-signal with the local oscillator signal and it will introduce an IF signal to the IF amplifier. Here again, the composite-signal is amplified and sent to the detector.

(2) In the AM and the FM detector, the information is removed from the carrier, and sent to the amplifier and converted to sound by the loud-speaker.

b. AM and FM differences.

(1) One difference between the two radio functions are the frequencies received and the detection systems.

(2) Another difference is that the FM radio requires an AFC to stabilize the local oscillator, thereby keeping the desired broadcast station tuned in.

NOTE: Study and memorize the basic block diagrams of radios and of televisions. Look for blocks that are common to all systems. Understand the purpose and/or functions of the blocks. You will find by doing this study and memorization, troubleshooting and servicing this unit will be a lot easier.

Learning Event 4:

DESCRIBE AND IDENTIFY PHASE SHIFTING AND DISTORTION PROBLEMS IN STEREO SYSTEMS

1. Importance of alignment. Accurate and precise head alignment is very important in terms of a stereo tape deck.

a. Azimuth misalignment between the record and playback heads, or from a different skewing of the tape during the record and playback modes, will result in phase shifting between channels. Because of this shifting, compatibility and interchangeability are much harder to obtain for stereo tapes than for mono tapes.

b. Therefore, this type of distortion is more evident when reproduced on a monophonic receiver. Keep in mind that monophonic receivers basically reproduce the sum of the two channels. Any phase shifting between these two channels differs with frequency, resulting in partial cancellation and reinforcement over the gamut of frequencies being reproduced. The end result can have a disastrous effect on the quality of the reproduced sound. This also means the stereo transmission is no longer compatible with monophonic reproduction when such errors exist.

2. Precise adjustment. Precise azimuth adjusting is required for reel-to-reel and stereo tape recorders. Earlier cartridge stereo systems did not provide for a tape-guide height adjustment, and the arrangement of the tape path allowed considerable "creeping" up the guide posts. More recent tape cartridges provide adjustable guide height as well as head adjustment. Some even have an additional guide post installed prior to the original input guide for the tape entering its final path across the head for a more rigid and flutter free state with just standard tension.

3. Aligning stereo head. Using a fulltrack monophonic alignment tape is a good way to align a stereo head. This allows excellent alignment of the two-head stereo assembly which receives equal amplitude and identical phase from the two tracks at the reference frequency on tape.

Learning Event 5:

DESCRIBE AND IDENTIFY THE ELECTRONIC REQUIREMENTS OF RADIO RECEIVERS

1. Radio receivers. The Federal Communications Commission (FCC) has assigned all radio broadcast stations their operating frequencies. The amplitude modulated band (AM) is assigned 540KH to 1.6MH, and the frequency modulated band (FM) is assigned 88MH to 108MH.

2. Electronic requirements. Radio receivers must meet particular electronic requirements. Among these requirement are sensitivity, selectivity, and fidelity.

a. Sensitivity means how well the receiver picks up or receives the broadcast signal. The higher the sensitivity of the receiver, the better it will pick up (weak) broadcast signals.

b. Selectivity is the ability of the receiver to select or tune into one station and refuse all the rest. In low quality receivers, the selectivity is poor, resulting with the listener hearing more than one station at a time.

c. Lastly, fidelity is how well the receiver reproduces the signal being transmitted with little or no loss of the broadcast signal.

LESSON 4
PRACTICE EXERCISE

1. Which of the following statements best describes modulation?
 - a. Information
 - b. Combination
 - c. Multiplication
 - d. Regulation
2. Which of the following statements best describes the process of heterodyning?
 - a. The combining of two electrical signals
 - b. The separating of two electrical frequencies
 - c. The combining of three frequency patterns
 - d. The separating of three frequency combinations
3. What does the local oscillator produce?
 - a. A mechanical signal
 - b. A sound wave
 - c. An electronic signal
 - d. A sine wave
4. What type of an input signal is the audio amplifier designed to accept?
 - a. An electrical signal
 - b. An electromagnetic signal
 - c. An outgoing signal
 - d. Multiplication signal
5. Which of the following generates a turnable electronic signal?
 - a. Mixer
 - b. IF carrier
 - c. Power supply
 - d. Local oscillator
6. Which of the following keeps the receiver at a desired operating frequency?
 - a. Automatic gain control
 - b. Automatic frequency control
 - c. Local oscillator
 - d. Power supply

7. What causes phase shifting between channels in tape decks?
- a. Distorted information
 - b. Azimuth misalignment
 - c. Poor selectivity
 - d. Guide height
8. Which of the following is a good way to align a stereo head?
- a. Use the one-hand tape
 - b. Use the high DC voltage tape
 - c. Use a full track monophonic alignment tape
 - d. Use the low DC current tape
9. The FM band is assigned which of the following frequencies by the Federal Communication Commission?
- | | |
|-----------------|-----------------|
| a. 88KH - 108KH | c. 108KH - 88MH |
| b. 88M - 108MH | d. 88UH - 808UH |
10. Which of the following statements best describes selectivity?
- a. How well the receiver selects its input voltage
 - b. How well the receiver selects its listeners
 - c. How well the receiver selects a frequency over all others
 - d. How well the receiver selects its measuring devices

LESSON 5
DESCRIBE AND IDENTIFY COMPONENTS OF RECORDING SYSTEMS, AUDIO SPEAKERS,
CABLES AND CORDS, AND USES OF BASIC MEASURING EQUIPMENT

TASK

Describe and identify components of recording system, audio speakers, cable and cords, and uses of basic measuring equipment.

CONDITIONS

Given information and illustrations related to recording system components and audio speakers, cable and cords, and uses of basic measuring equipment.

STANDARD

Demonstrate competency of the task skills and knowledge by correctly responding to 80% of the multiple-choice test covering identification of components of recording system, audio speakers, cable and cords, and uses of basic measuring equipment.

REFERENCES

None

Learning Event 1:

DESCRIBE AND IDENTIFY THE COMPONENTS OF RECORDING SYSTEMS

1. Recording system components. Components of recording systems are divided into two basic parts, equalizers, and attenuators.

a. All reproducing and sound recording equipment have something in common, that is, the loss of high frequency response. An equalizer, or compensator, is a device consisting of reactive elements that may be connected into an electrical circuit for the purpose of altering the frequency characteristics of that circuit. More simply, equalizers compensate for frequency distortion in cables, lines or loads, in broadcast audio systems. The basic equalizer is the integrated or the differentiated circuit which you'll find at the receiving end of the cable to acquire low frequency or high frequency attenuation.

(1) Most cables impose a progressive attenuation of the higher audio frequencies; this is shown in Figure 5-1. Therefore, an equalizer is used which imposes a progressive attenuation of the lower audio frequencies.

(2) Although it is impossible to make the frequency response of this system uniform, a good deal of improvement could be acquired by selecting a suitable equalizer circuit with correct component values.

(3) A limitation of the equalizer is the inability to make up or compensate for load changes. Such changes may occur during switching procedures. Therefore, equalizers can be switched in or out of the Load circuit. Also, equalizers have a definite insertion loss, and this loss may be compensated by increasing amplitude. Figure 5-2 shows a typical equalizer configuration.

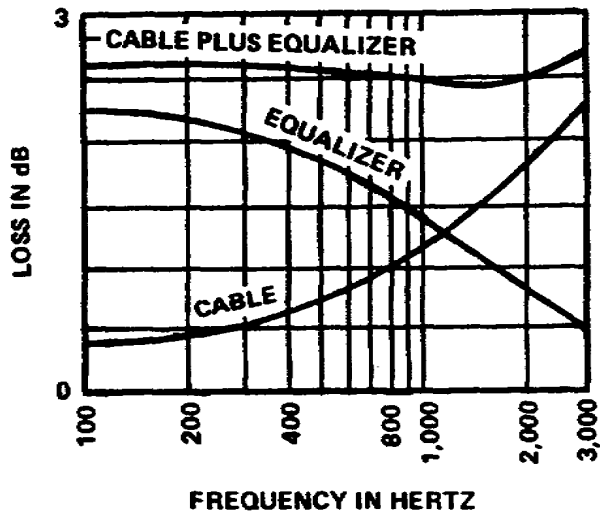


Figure 5-1. Cable, equalizer, and system frequency responses

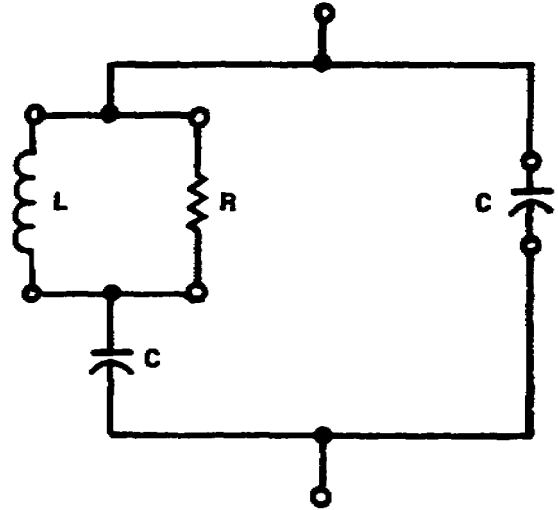


Figure 5-2. Typical equalizer configuration

b. Attenuator. An attenuator is a network designed to reduce the amplitude of a signal. For this reason the circuit is usually passive rather than active. These circuits are beneficial for calibrating or other sensitive measurements.

(1) If the attenuator is well designed, then the amount of attenuation is continuous over the entire range of frequency in the system to be checked. Attenuators pose no reactance; therefore, no phase shift. These circuits are built to handle various input and output impedances; therefore, these impedances must be matched properly or the attenuator will function improperly. Figure 5-3 shows two different passive attenuators made of non-inductive resistors.

(2) Circuit A is called a pre-network attenuator.

(3) Circuit B is called a T-network attenuator. Both circuits function from the audio-frequency range to the VHF spectrum.

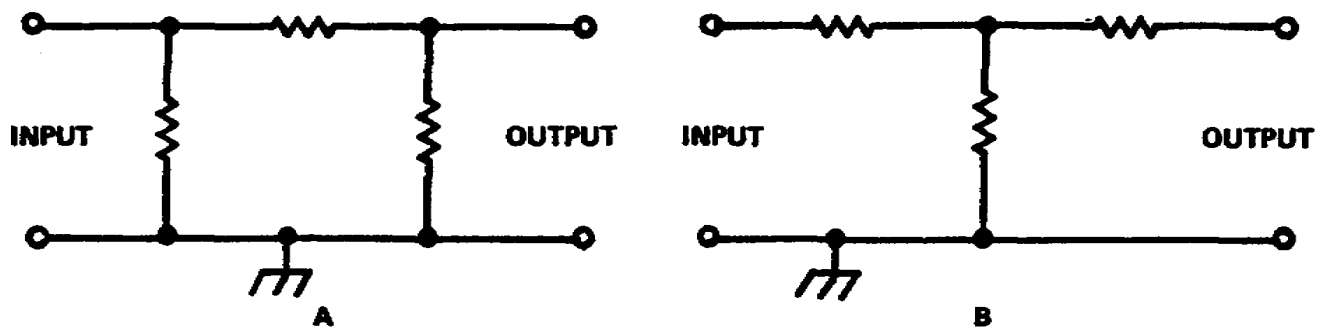


Figure 5-3. Attenuator. Attenuators often constructed from noninductive resistors. Here, two such devices are shown at A the pre-network and at B the T network. These attenuators are for use in unbalanced circuits

(4) However, from UHF and above the resistors begin showing inductive reactance. This happens because the wavelength is so short that the leads are quite long electrically; therefore, the attenuators no longer perform the function intended for them. Attenuators must be especially designed to suit the short wavelengths of the VHF's. These circuits must be physically small.

2. Attenuation. Attenuation is the decrease in amplitude of a signal between any two points in a circuit, usually expressed in decibels. Attenuation is the exact opposite of amplification and can be defined for power, current, or voltage. Occasionally attenuation in a particular circuit is sometimes expressed as a ratio.

a. As an example, the loss of signal in amplitude from say plus or minus 5 volts peak to plus or minus 1 volt peak is an attenuation factor of 5. This loss in decibels may be calculated using one of the following equations:

$$\begin{aligned} \text{ATTENUATION (db loss)} &= 10\log_{10} \times \frac{p_{in}}{p_{out}} && \text{"or"} \\ &20\log_{10} \times \frac{v_{in}}{v_{out}} && \text{"or"} \\ &10\log_{10} \times \frac{I_{in}}{I_{out}} \end{aligned}$$

b. Keep in mind that attenuation is the opposite of amplification. If the amplification factor is X db, then the attenuation factor is -X db.

3. Attenuation versus frequency characteristic. The attenuation versus frequency characteristic of a circuit is the amount of loss through the circuit as a function of frequency. The function is usually shown with the amplitude in decibels relative to a certain reference level on the vertical scale, and the frequency on the horizontal scale. Figure 5-4 illustrates the attenuation versus frequency characteristics curve for an audio low pass filter. This low pass filter was designed for use on an intelligibility enhancer for a voice-communications circuit.

a. Various devices are used for precise adjustments of the characteristics of attenuation versus frequency.

b. For instance, in high-fidelity recording equipment the equalizer is often used instead of the bass and treble controls to help obtain the desired audio response.

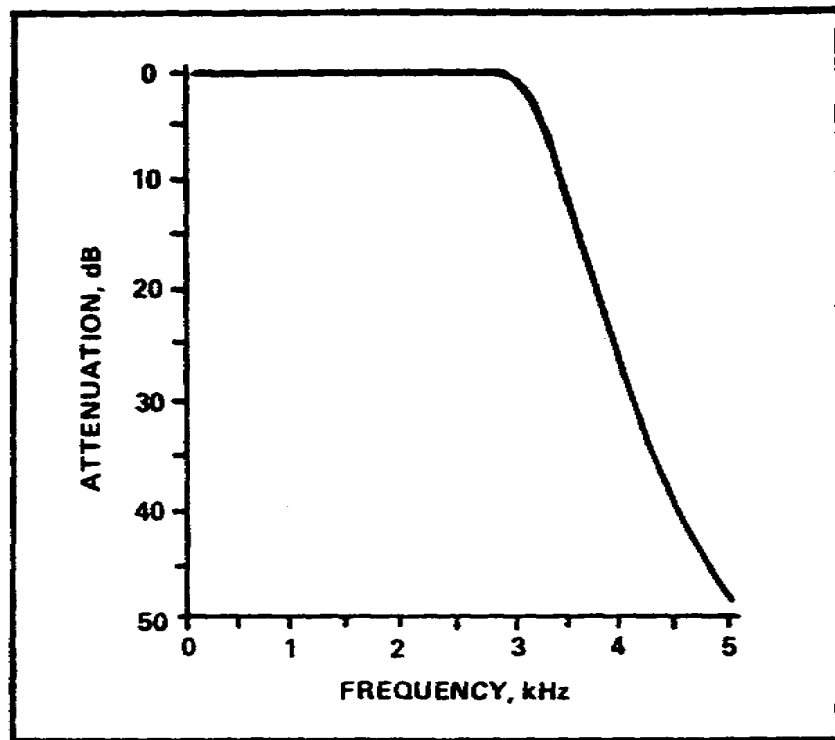


Figure 5-4. Attenuation. Attenuation versus frequency characteristics of a lowpass filter that might be used for communication purposes

Learning Event 2:

DESCRIBE AND IDENTIFY THE COMPONENTS AND FUNCTIONS OF A TYPICAL AUDIO SPEAKER

1. Speakers. Speakers transform energy from one form to another; i.e., electrical to mechanical energy. The speaker will convert the audio signal sent to it from the amplifier and change it into a instantaneous pumping motion. This motion (fig 5-5) is strong enough to transport air in vibrating patterns of waves that the ear hears as sound.

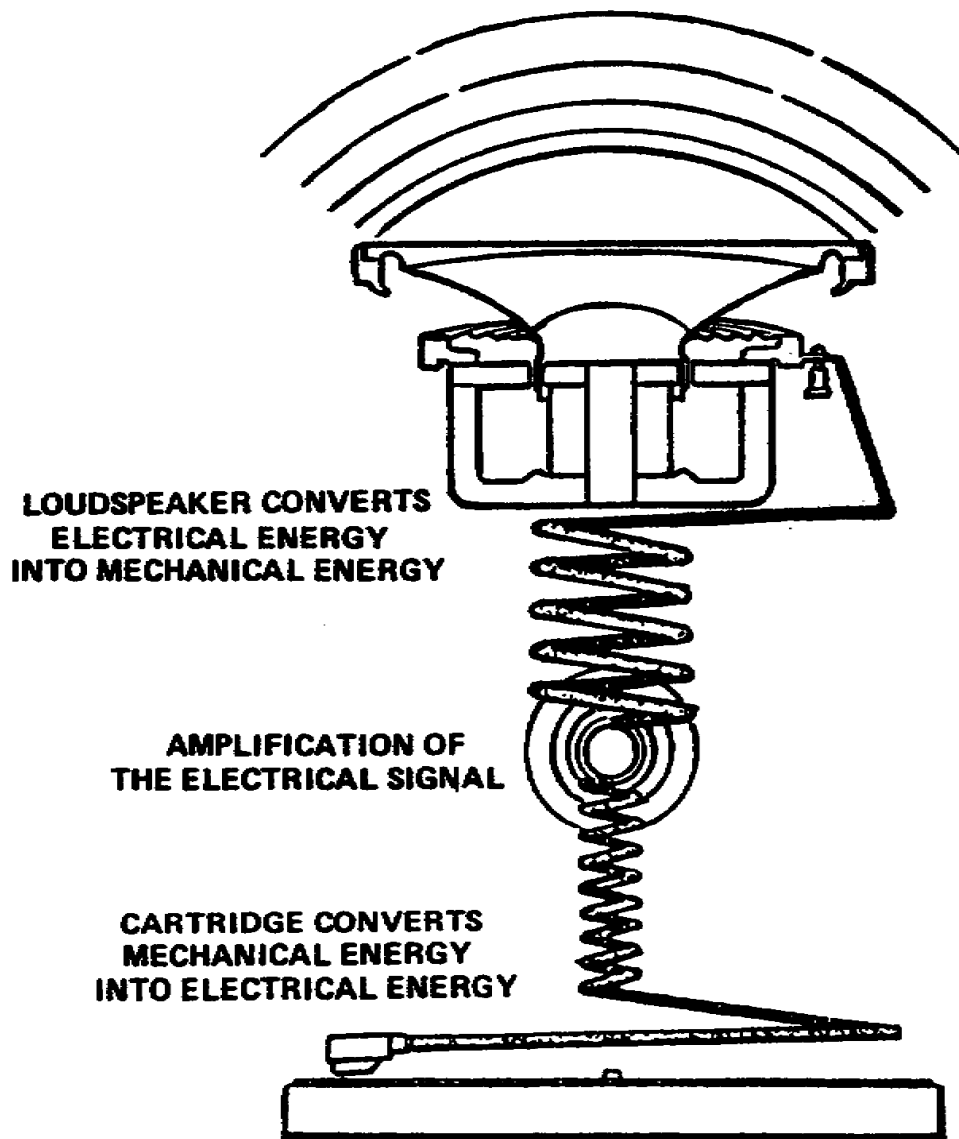


Figure 5-5. Speaker pumping action creates air vibrations we hear as sound

a. Drivers are the part of the speaker that actually move air. Drivers can be designed to get superior performance in the lower octaves (bass) or higher octaves (treble), usually not both. Most all speakers are basically AC electric motors functioning linearly instead of by rotation. Speakers have wire coils or another form of an electrical conductor hanging freely in the field of a permanent magnet.

(1) Electricity flows through the conductor and creates a magnetic field around the conductor with a strength equal to the amount of electricity moving through it.

(2) If the current changes directions, the north-south poles of the magnetic field reverses themselves with each current reversal. A permanent magnet's polarities remain constant.

(3) The law of magnetism states that opposite magnetic polarities attract, and like polarities repel each other. As a result, when alternating current in the form or configuration of an audio signal passes through the coil conductor, it interacts with the lines of force emanating from the permanent magnet. The conductor is alternately attracted and repelled, so forward and backward movement is created in accordance with the audio signal.

b. In most speakers the conductor is a wire coil and is attached to a cone that moves with it, pushing and pulling at the adjacent air surrounding it. Basically, you have just learned the classic operating principle of most speaker designs (fig 5-6).

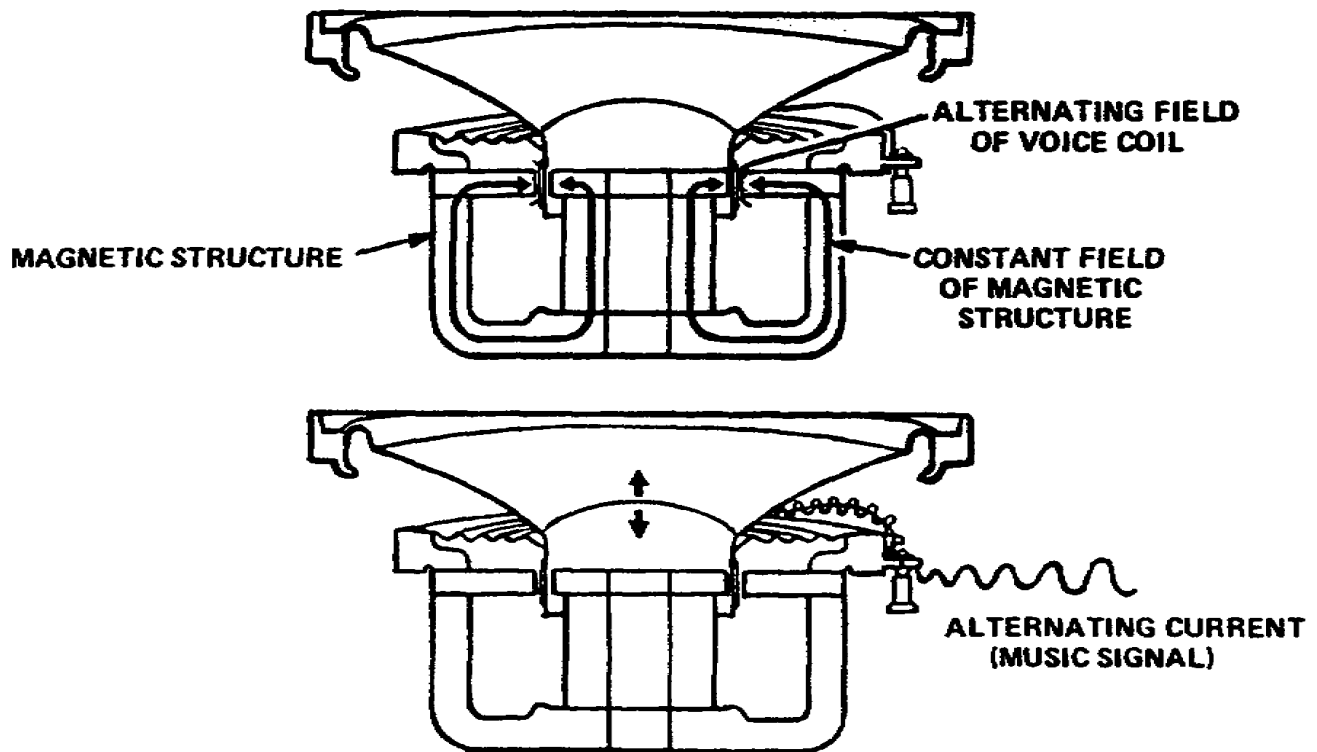


Figure 5-6. Changing field of voice coil causes oscillating movement relative to constant field of magnetic structure creating sound

2. Impedance. Impedance is the resistance to the passage of alternating electrical current. In the past, high-fidelity components were not as standardized as they are today, thus, making the input impedance of a speaker and the output impedance of an amplifier fairly critical to ensure they match. Today, most equipment is rated uniformly at an average of 8 ohms. Eight ohms is said to be average because impedance varies with the frequency of audio signal.

a. Even though impedance matching is basically a minor problem nowadays, there are some speaker systems with other ratings, like 4 ohms. Low impedance-rated speakers may afford you some trouble when you hook them up with the average 8 ohm speakers.

b. Normally, two sets of speakers are connected in parallel. The pair of 8 ohm speakers connected in parallel presents a 4-ohm load to the amplifier. An 8-ohm speaker and a 4-ohm speaker present the amplifier with 3 ohm average impedance.

CAUTION: The output stage of a transistorized amplifier can burn out if presented with a too low of an impedance load.

3. Damping factor. Damping factor is the ratio of its own internal impedance to the impedance present to the amplifier by an external load. The damping factor will increase as the load impedance increases compared with the internal impedance. Transistorized amplifiers possess fairly high damping factors. This is useful because it helps to damp excessive speaker oscillation which gives you a much better response to transient signals and a cleaner sound.

Learning Event 3:

DESCRIBE AND IDENTIFY THE TYPES OF CABLES AND CORDS USED IN RADIO/TELEVISION STUDIOS AND USES OF BASIC MEASURING EQUIPMENT

1. Cables and Cords. A cable is any group of electrical conductors bound together. A cable may consist of only two conductors, such as the coaxial cable familiar to RF design; or it may be made up of several individual conductors protected with its own layer of insulation (fig 5-7). Cables are widely used in electronic and communications systems. As an example, many telephone networks are completed with the use of cables, and in faraway areas, cable is the only means of television reception with the exception of satellite transmission.

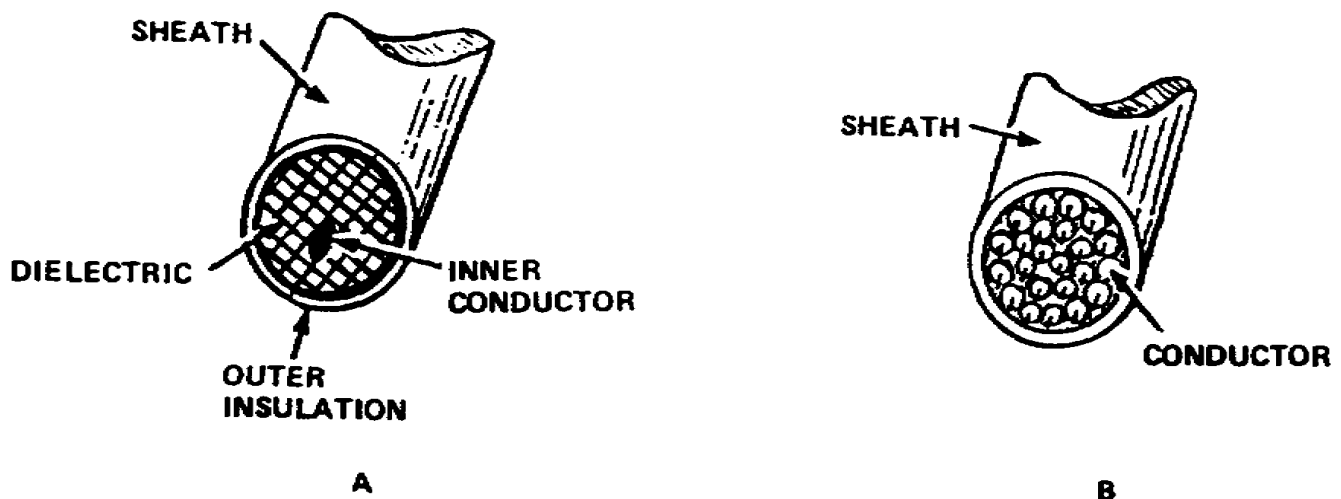


Figure 5-7. Two kinds of cable. At A, a coaxial cable with two concentric conductors. At B, a multi-conductor, unshielded cable

a. Coaxial cable is a two-conductor cable consisting of a single center wire surrounded by a tubular metal shield. Most metal shields are braided and insulated from the center conductor by polyethylene. Some coaxial cables have air dielectrics with the center conductor being insulated from the shield by polyethylene beads or spiral winding.

b. Coaxial cable is made in several diameters and characteristic-impedance values. A "hard line" cable is a low-loss, well-shielded coaxial cable, with an outer conductor of solid metal tubing.

c. Coaxial cable is easy to install; may be run next to metal objects, and installed underground without affecting the loss of performance. Many coaxial cables have greater loss per unit length than two conductor lines.

2. Radio-Television Cords. A cord is simple, durable cable, with two or three conductors, used to transfer electrical current to an appliance or device. The more familiar types of cords are the two and three conductors, 117 volts utility cords (fig 5-8).

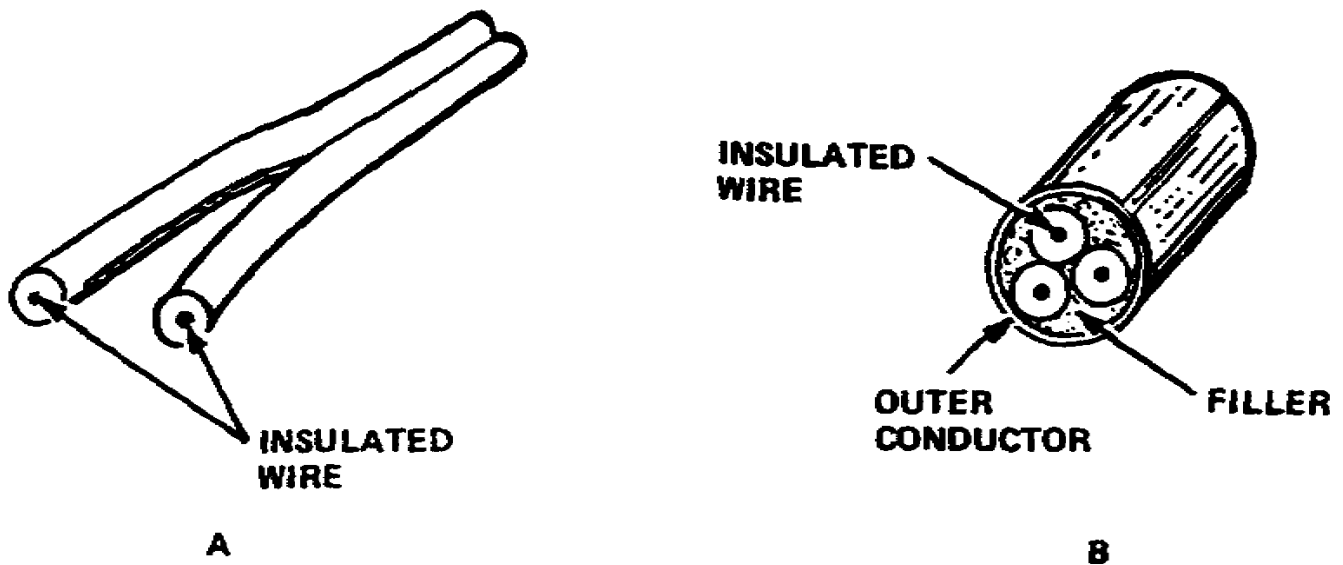


Figure 5-8. At A a two-conductor cord. At B a common three-wire utility cord

a. Basically, cords are not appropriate for transferring alternating current above the audio frequency range. This is because of dielectric and conductor losses.

b. Only cables designed especially for radio frequencies should be used for such application.

3. Basic measuring equipment. A technician uses basic measuring devices, such as oscilloscopes or multimeters, to measure actual working values or signals in a radio or television set, as well as for analyzing problems.

a. Turn on device. The first thing you would do to start the repair process is turn the device on and watch, listen, and smell trouble or malfunctions. After the initial diagnosis of which block or blocks of the radio are malfunctioning, refer to the manufacturer's manual, Technical Manual or Field Manual for schematics of the equipment you are troubleshooting.

b. Read schematics. To assist you on the schematic diagram, both the operating voltage values and typical waveforms should be printed. Also included on the schematic diagrams are the test points to measure signals and exactly how the equipment is wired.

c. Use test equipment. As a technician you use test equipment to measure voltage, current, resistance, or signal waveforms, then compare these values to the values indicated on the schematic diagram. If some values do not agree with the manufacturer's manual, Field Manual or Technical Manual (schematics), then you have probably located the trouble in your equipment. This is the point of troubleshooting where your knowledge of the circuitry coupled with the information obtained by using the test equipment plays a specific part in locating the malfunctions.

LESSON 5
PRACTICE EXERCISE

1. Which of the following statements best describes a speaker?
 - a. Transforms equalization into attenuation
 - b. Transforms backward sound into forward sound
 - c. Transforms DC current into AC current
 - d. Transforms electrical energy to mechanical energy
2. Which of the following is a characteristic of a speaker driver?
 - a. Operates a vehicle
 - b. Moves air
 - c. Creates equality
 - d. Reverses current
3. What will happen with a transistorized amplifier if the output stage is presented with a very low impedance load?
 - a. Flash its help light
 - b. Burn out
 - c. Respond better to signals
 - d. Disconnect itself
4. Which statement best describes a hard line cable?
 - a. High loss
 - b. Low loss
 - c. Medium loss
 - d. Wide loss
5. What must you, as a technician, do to start the repair process?
 - a. Ask advice from a friend
 - b. Wait for supervisor to talk to the commander
 - c. Turn equipment on and watch, listen, and smell
 - d. Leave equipment where it is, someone else will repair it
6. What is the purpose of an attenuator?
 - a. To reduce the switches of two circuits
 - b. To reduce the driver of the circuit
 - c. To reduce the amplitude of a signal
 - d. To reduce the entire range of DC current

ANSWERS TO PRACTICE EXERCISES

Lesson 1

1. c
2. c
3. d
4. a
5. c
6. b

Lesson 2

1. b
2. a
3. a
4. a

Lesson 3

1. a
2. b
3. d
4. c
5. b
6. c

Lesson 4

1. d
2. a
3. c
4. a
5. d
6. b
7. b
8. c
9. b
10. c
11. c

Lesson 5

1. d
2. b
3. b
4. b
5. c