Radio Mechanics
Fourth Year

Module 7
The Building Blocks
Stages of AM Radio Receiver

What this module is all about

Undoubtedly, the superheterodyne principle reigns supreme in current receiver design. Superheterodyne radio receiver or "superhets" were mass produced with great success every fifty years. The superheat design offers the prime advantages of high selectivity and high sensitivity which remain fairly constant throughout the tuning range of a receiver. It was natural that, from the very beginning, transistor radios used the superheterodyne principle.

At the end of this module you should have been able to:

1. Identify the basic stages of AM radio receivers.
2. Explain the function of each stage.

How to learn from this module

Following are some tips on how to use this module. These will guide you in working out the activities and summarizing what you have learned.

1. Read the objectives so you will know what you expect to learn from this module.
2. Be sure to work out each activity because each activity prepares you for the next.
3. Answer the pretest before you go through the module to determine what you already know about the topics. Use the key to correction to check your answers but do this only after completion of the module. Always do the self-check after each activity to determine whether you understood what you have read.
4. Read the lessons again if you were not able to answer the questions correctly.

Before going through this module, try to answer the pretest. This will enable you to find out what you already know and what you still need to know about AM-Radio Receivers. Good Luck!

PRETEST

Directions: Read each statement carefully and choose the letter of the best answer.

1. The modulated r-f signals, transmitted from radio stations in the area are picked up or intercepted by the
   a. speaker
   b. diode
   c. antenna
   d. IFT

2. This circuit is tuned by the listener who rotates the receiver tuning dial to the desired station's carrier frequency to accept and amplify the selected signal.
   a. IF amplifier
   b. detector
   c. RF amplifier
   d. mixer

3. _____ is also tuned to accept only R-F and oscillator signals.
   a. oscillator
   b. mixer
   c. signal
   d. AGC

4. _____ is a generator of an unmodulated r-f signal at a frequency of about 455 KHZ, above the desired incoming r-f signals frequency.
   a. mixer
   b. oscillator
   c. AFC
   d. AGC

5. _____is fixed-tuned to accept and amplify only the 455 KHZ difference signal (the intermediate frequency)
   a. IF amplifier
   b. Audio amplifier
   c. AGC
   d. detector

6. _____removes the audio component from the i-f signal and transfers it to the audio driver stage.
   a. AGC
   b. AFC
   c. oscillator
   d. detector stage

7. The gain of this stage may be controlled automatically by the _____circuit to compensate for variations in signal strength.
   a. automatic gain control
   b. automatic frequency control
   c. oscillator
   d. mixer

8. The normal frequency use for the IF stage
   a. 50 hz
   b. 120 hz
   c. 455 khz
   d. 60 hz

9. The IF stage of an AM receiver uses_____number of IFT (intermediate frequency transformer)
   a. 4
   b. 3
   c. 2
   d. 1

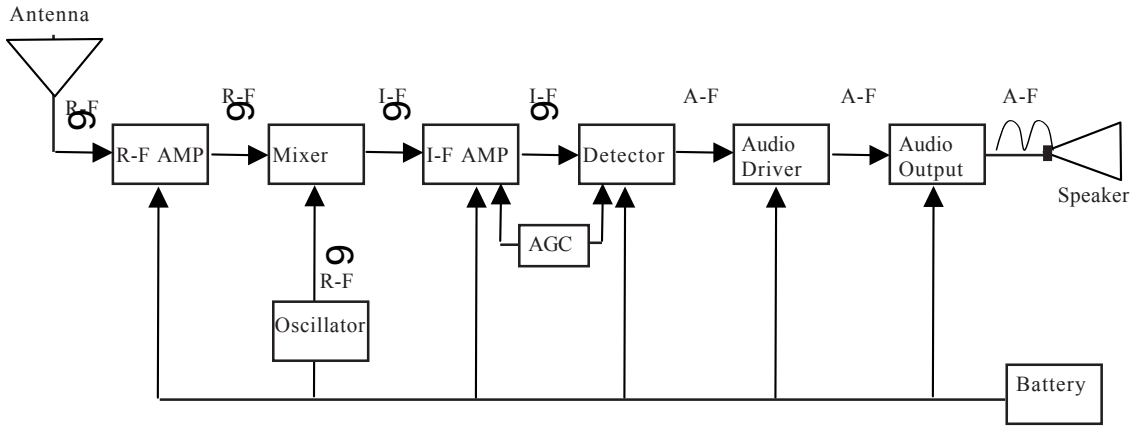
10. The AM tuner stage normally uses _____transistors specially in 7 transistor AM radios.
   a. 5
   b. 4
   c. 3
   d. 2

How did you fare? If not, don't worry. Anyway you will take the same test after you have studied all the lessons in this module. By that time you shall have been able to answer all the questions correctly.

If you need any assistance in carrying out the different activities, don't hesitate to ask the help of your teacher.

Lesson 1

Basic Stages of the AM-Radio Receiver



Block Diagram of a Typical AM Superheterodyne Receiver Signals at Various Points in the Receiver.

This is a block diagram of a typical amplitude-modulated (AM) superheterodyne broadcast band receiver. Each block represents a stage. In some receivers, some of the stages shown are omitted or additional stages added, according to the requirements of the particular receiver design.

Activities in the operation of the receiver are as follows:

The modulated r-f signals, transmitted from radio stations in the areas are picked up or intercepted by the *antenna* and fed to the first stage - the *r-f amplifier*. This circuit is tuned by the listener who rotates the receiver's tuning dial to the desired station's carrier frequency to accept and amplify the selected signal. In the standard broadcast band, there will be a frequency between 530 khz to 1600 khz. After the modulated r-f signal is selected and amplified, it is fed to the mixer stage. The r-f amplifier has thus provided a certain extent of selectivity and sensitivity that is required. This stage is omitted.

The *mixer* and *oscillator stages* perform the actual superheterodyne function. The *oscillator stage* is a generator of unmodulated r-f signals at a frequency of about 455 khz above the desired incoming r-f signals frequency. The oscillator stage is tuned simultaneously (ganged) with the r-f amplifier stage in order that the r-f amplifier is tuned from one frequency to another, the oscillator is tuned to a frequency precisely 455 khz above the radio frequency. Both the r-f and oscillator signals are fed to the mixer.

The *mixer* is also tuned to accept only the r-f and oscillator signals. In this stage, the two signals are

heterodyne (beat together) to produce new signals. The output of the mixer stage consists of the incoming r-f signal, the oscillator signal, and two new signals - the sum and difference of the two input signals. As the receiver is tuned throughout the band, one of these frequency signals remains constant. This is the difference signal, which is always 455 khz and contains the same audio modulation as the original r-f signal at the antenna. This signal is fed to the i-f amplifier stage.

The *i-f amplifier* is fixed to accept and amplify only the 455 khz difference signal (called the intermediate frequency). The gain provided by this stage remains constant over the entire broadcast band and provides high gain since amplification of a lower frequency signal is being performed. The gain of this stage may be controlled automatically by an AGC (automatic gain control) circuit to compensate for variations in signal strength. The i-f signal is then fed to the detector stage.

The *detector stage* removes the audio component from the i-f signal and transfers this to the audio driver stage. The signal is recovered by rectifying and filtering the modulated i-f signal. The detector is also the source of AGC voltage.

The *audio driver stage* amplifies the audio signal and feeds it to the *audio output stage*. The *audio output stage* further amplifies the audio signal thus developing sufficient power to drive the speaker. The sound waves produced by the *speaker* are the same sound waves which are used to modulate the r-f carrier at the radio station's transmitter.

Power for the transistors to accomplish its diverse functions is most often supplied by a battery. Battery power is supplied to all stages except the detector when a diode rectifier is used.

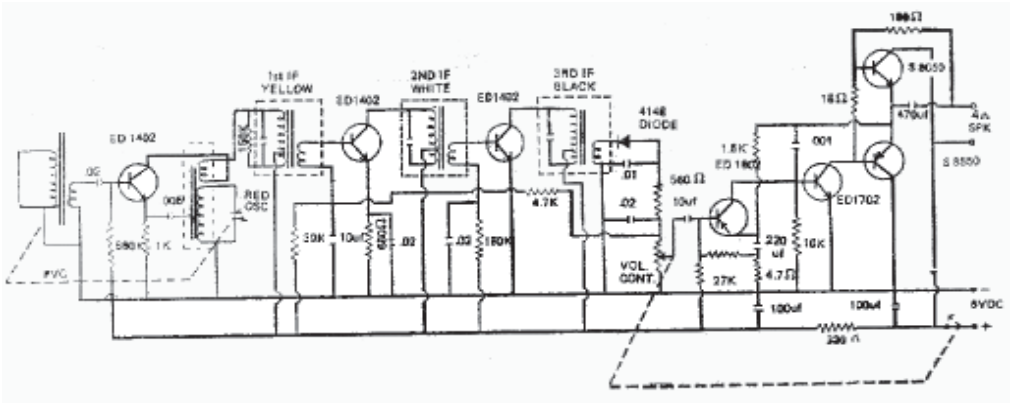


Figure 2 Schematic Diagram of an AM Receiver

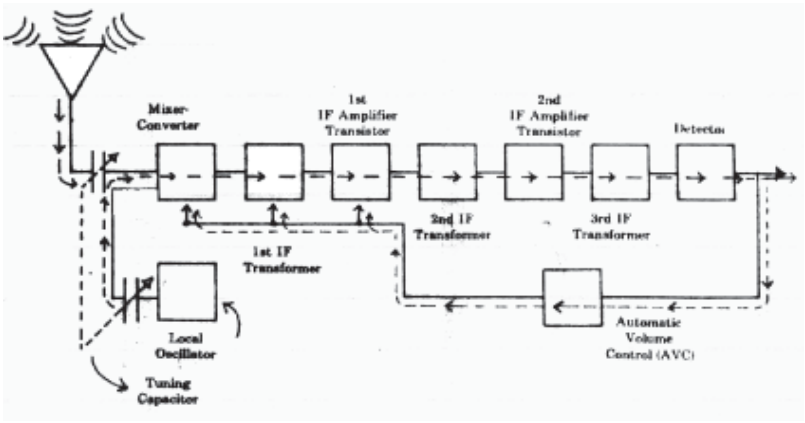


Figure 3 Block Diagram of an AM Radio Tuner

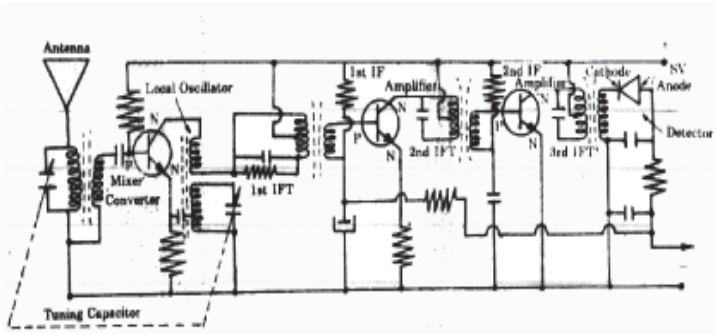


Figure 4 Schematic Diagram of the Radio Tuner

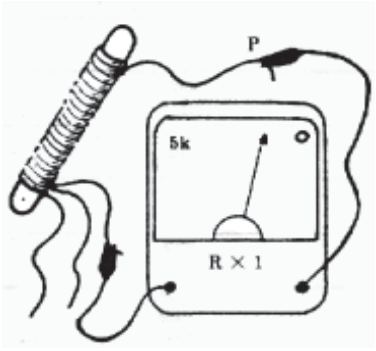


Figure 5 Test results show that resistance of the coil is higher.

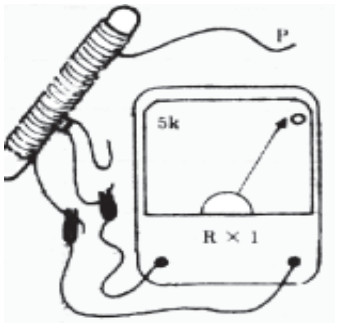


Figure 6 Test results show that resistance of the coil is lower.

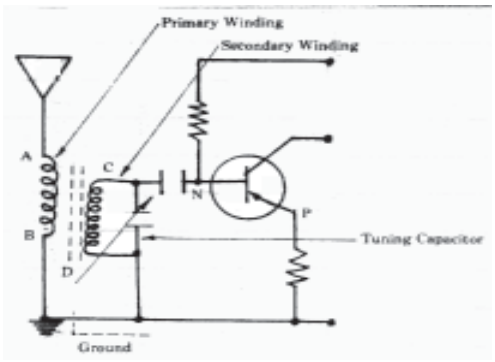


Figure 7 Schematic circuit showing the connection of the antenna.

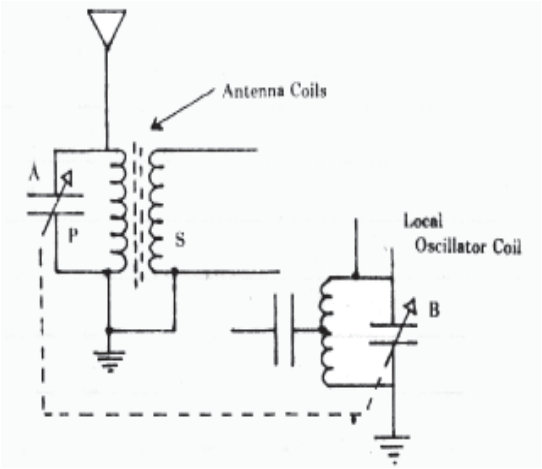


Figure 8 Schematic circuit showing the connection of the tuning capacitor to the antenna and local oscillator.

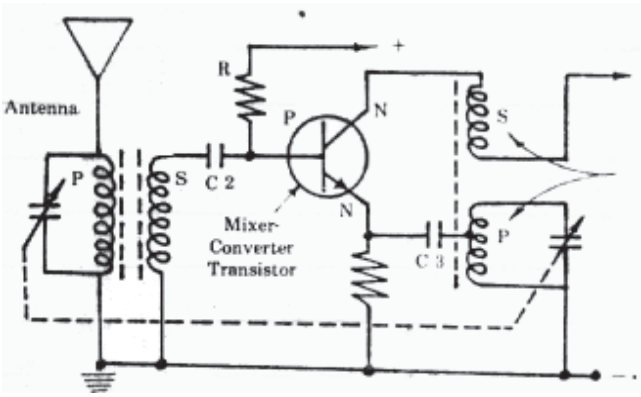


Figure 9 Schematic circuit showing the connection of the mixer-converter transistor.

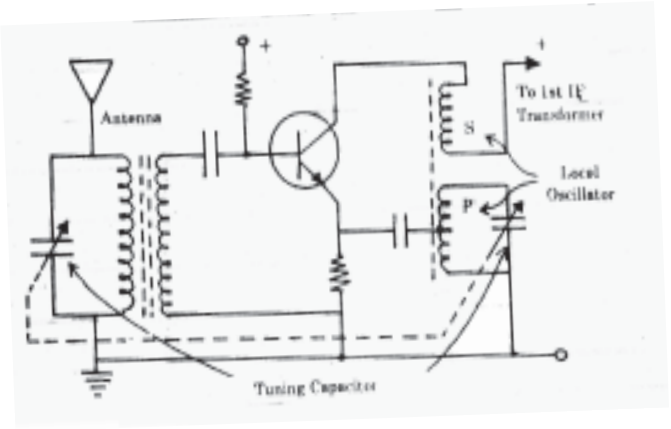


Figure10 Schematic circuit showing the connection of the tuning capacitor at the antenna and the local oscillator.

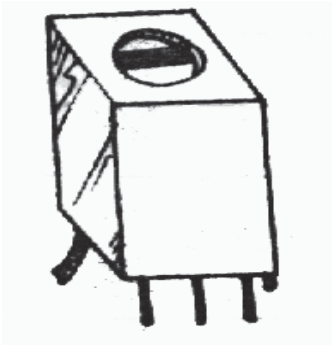


Figure 11 Actual appearance of the first IFT with its metal shield.

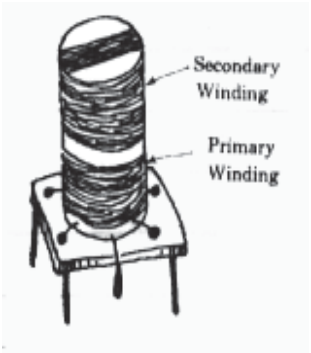


Figure 12 Actual appearance of the first IFT showing the primary and secondary windings, without the metal shield.

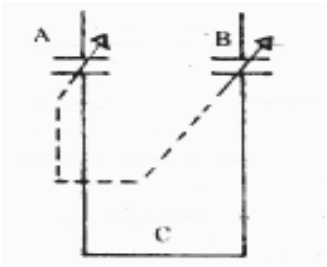


Figure13 Schematic symbol of the tuning capacitor.

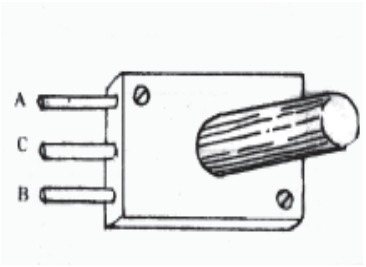


Figure 14 Pictorial appearance of the tuning capacitor.

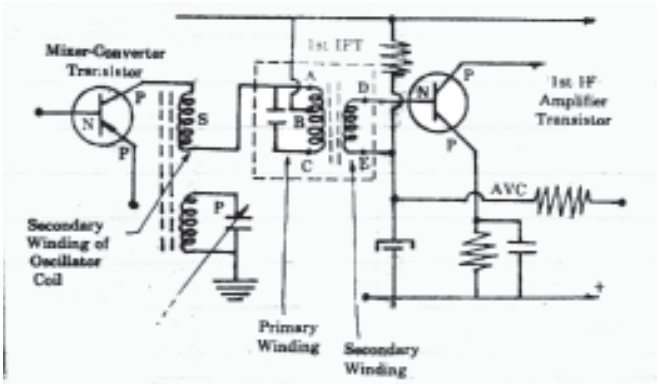


Figure 15 Schematic circuit showing the connection of the 1st IFT.

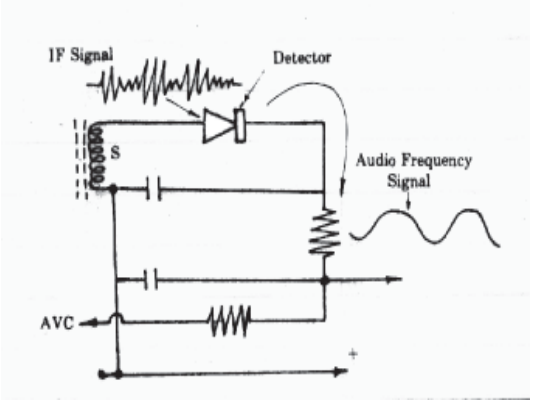


Figure16 IF signal is converted by the detector to audio signal.

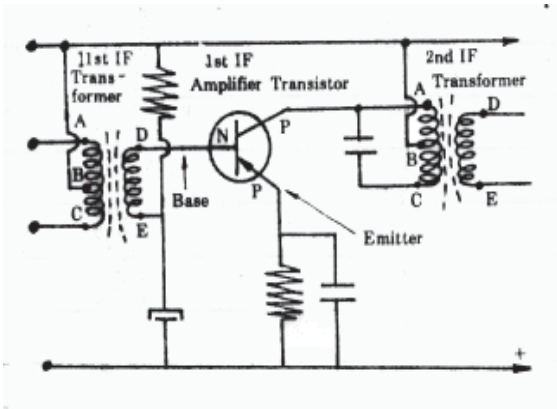


Figure17 Schematic diagram showing the connection of the first intermediate frequency amplifier transistor.

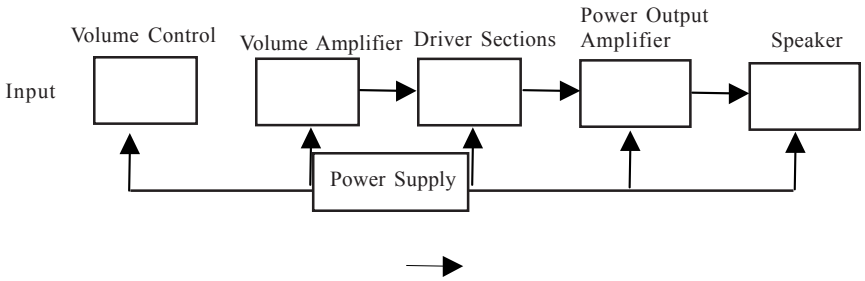


Figure 18 Block diagram of the amplifier.

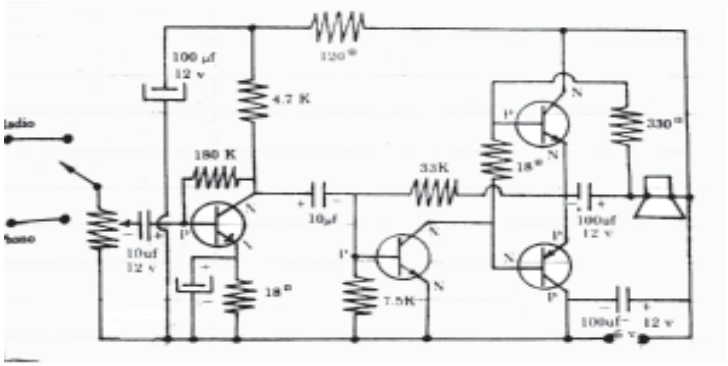


Figure 19 Schematic diagram of the amplifier.

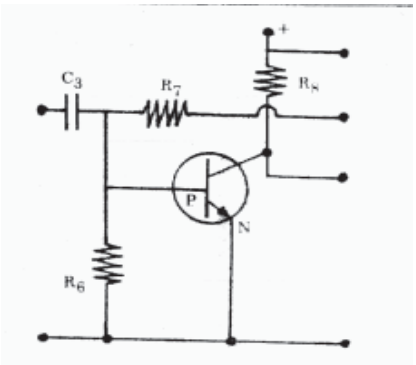


Figure 20 Circuit connection and parts of the driver transistor.

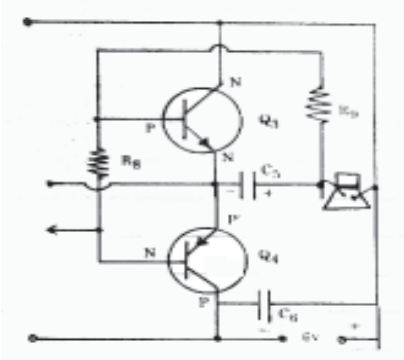


Figure 21 Schematic circuit of the power output amplifier section.

Activity 1

Assembling the AM Radio Receiver

You will assemble an AM radio receiver based on the kit model available at the market.

Materials Needed

Buy : 1 - CMC kit - 7 transistor radio

Borrow from your teacher the following tools and instruments:

1 - soldering iron - 30 watts - 220VAC
1 - long nose plier
1 - diagonal cutter
1 - screwdriver (standard) small
1 - Phillip's screwdriver
1 - V.O.M.

Procedure:

1. Count the number of components you bought from the electronics store. List of components are listed down on the schematic diagram given to you. Check the pictorial diagram, too.
2. Test all components, using V.O.M. to determine if it is good or bad. Use the testing procedure you learned in Module 4.
3. Check and give the color code of all the resistors to be used in assembling your AM radio receiver.
4. Check also the value of capacitors, diodes, and transistors given to you.
5. If everything is ready, start mounting all the resistors, followed by ceramic capacitors, electrolytic capacitors, transistors, diode, IFT, volume control, antenna coil, antenna holder, connecting wires, black for negative and red for positive.
6. Follow the correct procedure of mounting components as illustrated in Figure 1.

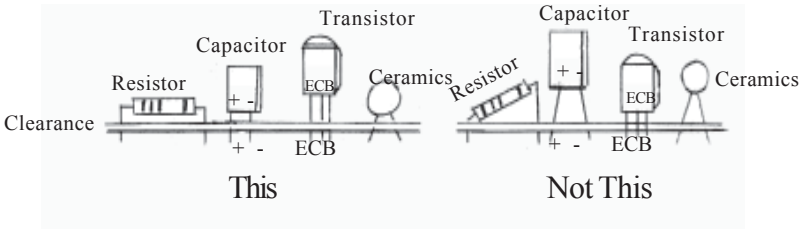


Figure 22 Positioning of Components

7. Observe correct polarity of electrolytic capacitors, correct basing of transistor leads, the emitter must be mounted to letter E, collector to letter C, base to letter B. Ceramic capacitors have no polarity or negative (-) or positive (+) signs, so you can invert the lead of ceramic capacitors.
8. If everything is mounted properly then you can now start soldering the components. Follow the correct soldering procedure as illustrated in Module 2 - Soldering Techniques.
9. Cut all the excess wires or leads after soldering the components. Use the diagonal cutter in cutting excess leads.
10. Observe the correct positioning of the antenna coil specially the connection of primary and secondary windings. Refer to the pictorial and schematic diagram given to you.
11. After soldering all the components, connect the speaker (4 inches, 8 Ω, 2 watts) and the 6-volt battery. Observe the correct polarity of batteries- negative to the black wire and positive to the red wire.
12. Turn on the switch of the volume control and start testing your radio receiver. If any problem arises, refer to Module 8 for troubleshooting techniques.

Self-check:

1. What is the meaning of AM?
2. Give the main function of the antenna.
3. What component is usually used as detector?
4. What stage of the AM receiver provides radio station from 530 khz to 1600 khz?
5. Name the stage that provides audio or sound in a radio receiver.

Activity 2

AM Tuner Alignment

Materials Needed

1 - AM radio receiver -- Assembled with 3 or more stations
1 - screwdriver (standard) small -- if possible with a plastic end

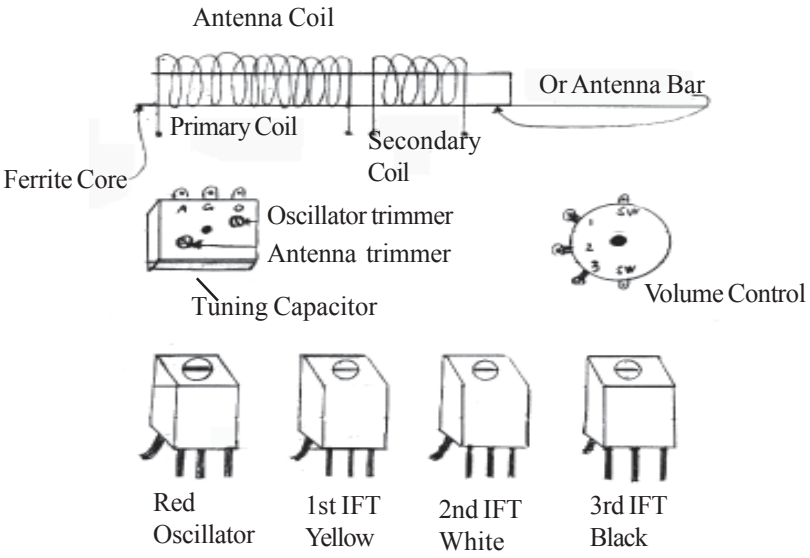
Procedure

A. IFT Adjustment Procedure

1. Turn the radio to ON with 50% sound.
2. Turn the tuner slowly from right to left and stop at a weak station.
3. Tune the tuning capacitor to 1600 khz, or to the highest station in your area.
4. At this point, adjust IFT black slowly back and forth until the maximum signal is achieved.
5. Follow the same procedure with IFT white and IFT yellow for maximum volume.

B. Tracking Alignment

1. Set the pointer of the dial to the station with the lowest frequency (M. Mla. Area - 558 khz - RMN). Adjust the antenna coil back and forth for maximum signal.
2. Turn the pointer of the dial to the station with the highest frequency (M. Mla. Area - 1570 khz DZHH). Adjust the oscillator trimmer (o) to obtain the station, then adjust the antenna trimmer (a) to achieve maximum signals. Use a small standard screwdriver in adjusting, the IFT, Red Oscillator, antenna trimmer, and oscillator trimmer.
3. Return to the station with the lowest frequency, following the same procedure as B-1, then back to the station with the highest frequency using the same procedure in No. B-2. Repeat procedures B-1 and B-2 at least twice. The alignment is now complete.



Pictorial view of the most important components in the alignment of the AM tuner-radio receiver.

Self-check:

1. What is the frequency of the RMN station?
2. The color of oscillator coil is _____.
3. The frequency of the DZHH station is _____.
4. To achieve 1570 khz DZHH, adjust _____ for maximum signal.
5. To achieve 558 khz RMN, adjust _____ for maximum signal.

LET'S SUMMARIZE

This module is all about the operation of radio receivers and the function of each block. It also takes up the principle of modulation in radio broadcasting and reception. In this module, students experience basic RF communications, using the AM radio receiver as medium. The module also includes discussion on adjustments and signal orientation. Assembling of an AM receiver is also one of the activities. Standard radio broadcast stations use amplitude modulation (AM) to transmit audio signals or information (voice and music) in the radio frequency (RF) carrier wave. Amplitude modulation also involved mixing AF and RF signals, although this time and the amplitude of the carrier is altered. The mixing of these signals is similar to the heterodyning process.

POSTTEST

Directions: Choose only the letter of the correct answer.

1. The AM tuner stages normally use _____ number of transistors specially in the 7 transistor AM Radio.
   a. 5
   b. 4
   c. 3
   d. 2

2. The IF stage of AM receiver uses _____ number of IFT (intermediate frequency transformer).
   a. 4
   b. 3
   c. 2
   d. 1

3. The normal frequency of the IF stage is
   a. 50 hz
   b. 120 hz
   c. 455 khz
   d. 60 hz

4. The gain of this stage may be controlled automatically by _____ circuit to compensate for variations in signal strength.
   a. automatic gain control
   b. automatic frequency control
   c. oscillator
   d. mixer

5. _____ removes the audio component from the IF signal and transfers this to audio driver stage.
   a. AGC
   b. AFC
   c. oscillator
   d. detector stage

6. _____ is fixed-tuned to accept and amplify only 455 khz difference signal (called intermediate frequency).
   a. IF amplifier
   b. audio amplifier
   c. AFC
   d. AGC

7. _____ is a generator of an unmodulated r-f signals at a frequency of about 455 khz, above the desired incoming r-f signals frequency.
   a. mixer
   b. oscillator
   c. AFC
   d. AGC

8. What is also tuned to accept only R-F and oscillator signals?
   a. oscillator
   b. mixer
   c. signal
   d. AGC

9. A circuit tuned by the listener who rotates the receiver's tuning dial to the desired station's carrier frequency to accept and amplify the selected signal.
   a.. IF amplifier
   b. detector
   c. R-F amplifier
   d. mixer

10. The modulated r-f signals transmitted from radio stations in the areas are picked up or intercepted by the
   a. speaker
   b. diode
   c. antenna
   d. IFT

11. A device used to amplify signals
   a. diode
   b. transistor
   c. antenna
   d. coil

12. Something used to convert electrical energy to sound energy.
   a. speaker
   b. IFT
   c. oscillator
   d. microphone

13. A device used to increase and decrease the sounds of the radio receiver.
    a. microphone
    b. volume
    c. headphone
    d. speaker

14. A device used to convert the IF signal to the AF signal.
    a. detector diode
    b. IFT
    c. oscillator
    d. trimmer

15. What supplies power to all stages to accomplish their functions?
    a. transistor
    b. batteries
    c. diode
    d. transformer

KEY TO CORRECTION

Pretest	Posttest
1. c	1. c
2. c	2. b
3. b	3. c
4. b	4. a
5. b	5. d
6. d	6. b
7. a	7. b
8. c	8. b
9. b	9. c
10. c	10. c
	11. b
	12. a
	13. b
	14. a
	15. b