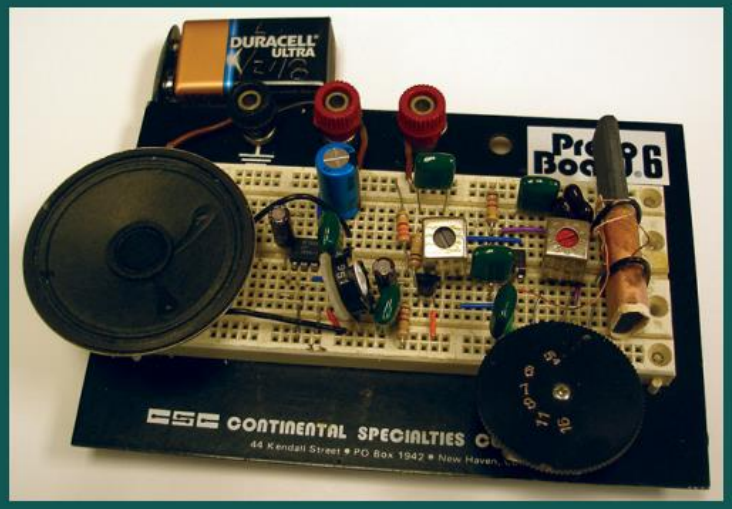
WHAT IS A SUPERHETERODYNE RECEIVER?

A superheterodyne receiver (or superhet) is a radio receiver that combines a locally generated frequency with the carrier frequency to produce a lower-frequency signal that is easier to demodulate than the original modulated carrier.



PRINCIPLE OF SUPERHETERODYNE RECEIVER

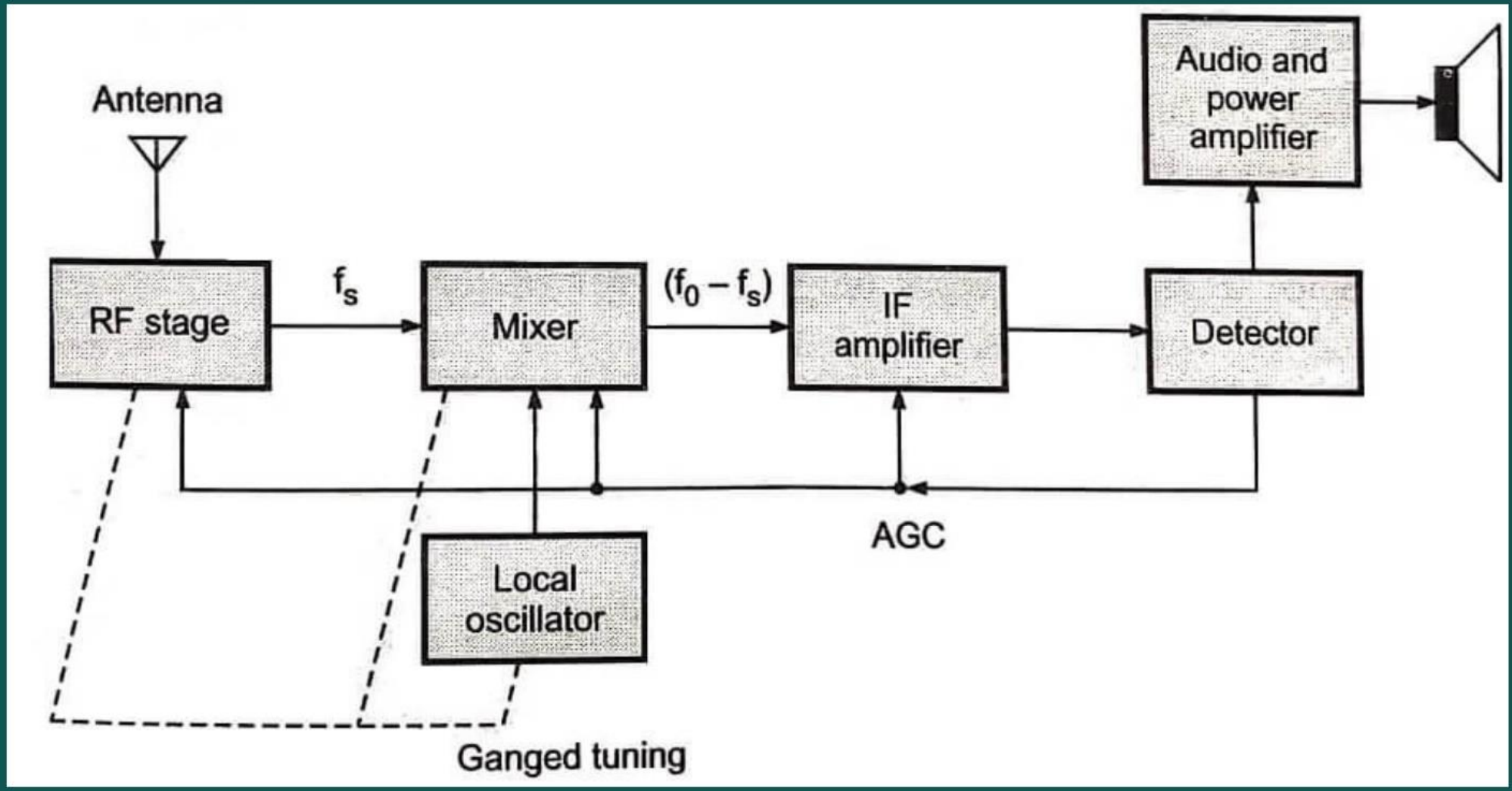
- In a superheterodyne reciever, by a process of mixing, the message bearing AM signal(irrespective if it's frequency) is converted into an AM signal.
- The converted AM signal carries the same message signal in a fixed frequency called Intermediate Frequency(IF)
- IF is lower than the lowest carrier frequency covered by the receiver.
- 70-75% of the gain of the receiver is obtained through amplification at IF by using a fixed-tuned high gain amplifier, called the IF amplifier.

PRINCIPLE OF SUPERHETERODYNE RECEIVER

- This signal is then detected and the extracted message signal is then amplified and fed to the loudspeaker.

Why superheterodyne reciever over TRF(Tuned Radio Frequency reciever)?

The problems of TRF receiver are overcome in this receiver. The superheterodyne receiver converts all incomming RF frequencies to a fixed lower frequency, called Intermediate Frequency (IF). This IF is then amplified and detected to get the original signal.


Antenna
RF stage
f_s
Mixer
$(f_0 - f_s)$
IF amplifier
Detector
Audio and power amplifier
AGC
Local oscillator
Ganged tuning

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

i) RF Amplifier:

- It is a tuned voltage amplifier.
- Selects and amplifies the signal induced in the antenna.
- Its bandwidth is 10 kHz.
- not designed to give a high gain

FUNCTIONS:

- **Ensures that the receiver has a good overall signal-to-noise ratio.**
- **To give good image frequency rejcction and IF rejection capability to the receiver**
- **To give some amount of adjacent channel selectivity.**

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

ii) Local Oscillator:

- This is an LC oscillator which produces a sinusoidal signal of frequency f0 which is such that f_0 - f_c = IF.
- f_c is the frequency to which the RF amplifier is tuned.
- receiver may be tuned to any frequency from 550 kHz to l605 kHz.
- local oscillator frequency tracks frequency in such a way that it maintains the local oscillator frequency above the signal frequency by 45 kHz, the usual IF used in AM broadcast receivers.
- This is achieved by using ganged variable capacitors for tuning the tank circuits of the RF amplifier and the local oscillator and also by using appropriate tracking techniques.
- f_0 is always kept higher than the signal frequency.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER ----→

iii) MIXER:

- The received AM signal with a carrier frequency , amplified by the RF amplifier, is fed as one of the inputs to the mixer
- the other input signal being the output of the local oscillator, a sinusoidal signal of frequency f_0 =f_c + f_if
- Mixing is a non-linear process
- The output circuit of the mixing tank circuit tuned to the IF, rejects all other frequency components. Thus, the output of the mixer is an AM signal whose carrier frequency is IF (455 kHz) and it's modulated by the original message signal.
- Thus, the mixer and local oscillator convert the received AM signal with a carrier frequency fc into another AM signal with fr as the carrier frequency.
- The mixer output circuit is designed to have a 3 db bandwidth of 10 kHz to accommodate all the side-frequencies of the AM signal.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

iv) IF Amplifier:

- One or two stages of IF amplifiers are generally used.
- These are fixed-tuned voltage amplifiers of high gain.
- These IF amplifiers provide a 3 dB bandwidth of 10 kHz centered on the intermediate frequency.
- They provide good sensitivity and selectivity to the receiver.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

v) Detector:

- Extracts the modulating signal from the AM signal.
- In commercial AM broadcast receivers, envelope detectors are used and they require a minimum of at least 1 volt amplitude for proper operation.
- They are designed to provide linear operation and avoid distortions- particularly the distortion due to diagonal clipping and negative peak clipping.
- Envelope detector can be used to provide a dc voltage of appropriate polarity for automatic gain control (AGC).
- This voltage is used for biasing the preceding stages so as to control their gains and thus provide AGC.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

vi) Automatic Gain Control(AGC):

An arrangement for automatic gain control, or AGC, is necessary for radio receivers for the following reasons.

- When the receiver is tuned from one station to another, difference in signal strengths of the two stations causes an unpleasantly loud output, if from a weak station, we are moving to a strong one, unless we initially keep the volume control very low before changing the tuning from one station to another. Changing the volume control every time before attempting to re-tune the receiver, is however, cumbersome.
- Even if we are not retuning to another station, signal strength from the station to which the receiver is tuned can go on fluctuating due to signal fading, causing corresponding fluctuations in the audio output from the receiver.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

- The points noted above underscore the need for keeping the audio output power from the receiver constant when the input r.f. signal level changes.
- This calls for an arrangement by which the overall gain of the receiver can be made to automatically vary the signal strength changes to keep the audio output constant. Such an arrangement is called automatic gain control or AGC.
- In receivers, automatic gain AGC is achieved by producing an AGC voltage from the detector circuit.
- This AGC voltage will be high for stronger r.f. input signals and low for weaker signals.
- So we apply this as a bias voltage to the r.f. amplifiers, mixer and the IF amplifier stages that it reduces their gain of these stages by reducing their transconductance
- This type of arrangement is called 'simple AGC".

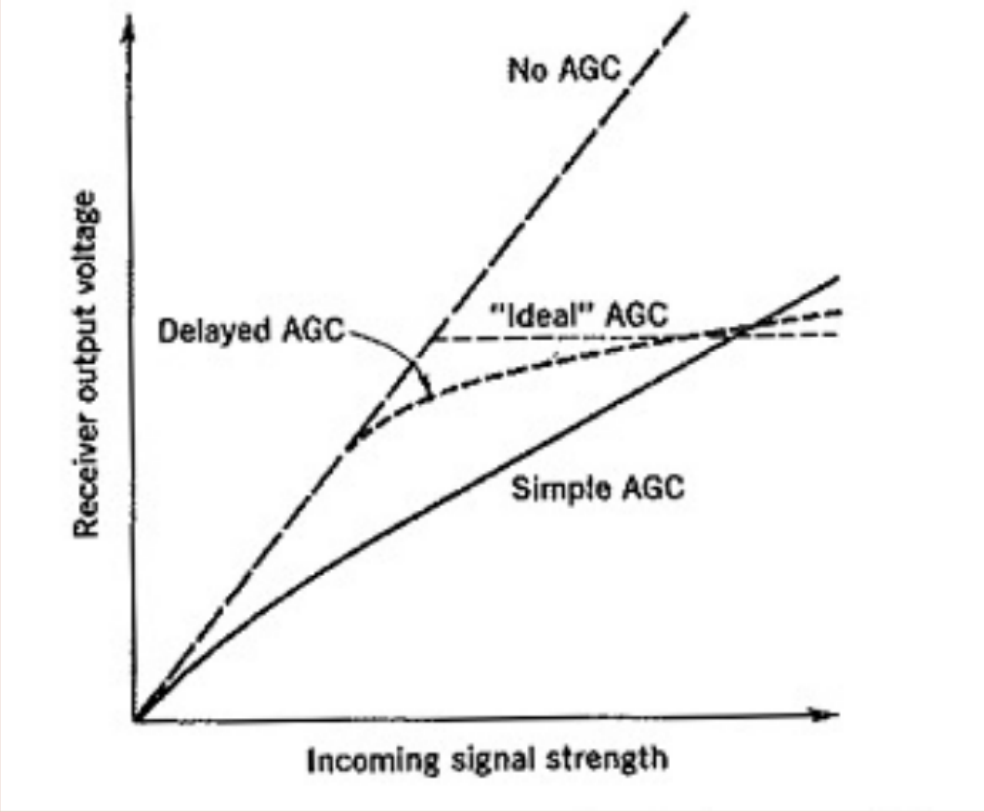
FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

What's the difficulty with 'simple AGC'?

- Even weak r.f. input signals also produce some AGC voltage, though it may be small. So while reducng the receiver gain for stronger RF signals, it reduces the receiver gain to some extent even for weak RF signals. This is undesirable.
- **Delayed AGC:** To overcome this disadvantage of a simple AGC the 'delayed AGC', is used. It allows the AGC action to commence only after the input RF signal level reaches a pre-determined level.

FEATURES AND FUNCTIONS OF PARTS OF THE SUPERHETERODYNE RECIEVER

AGC charecteristics:



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vii) Audio Voltage and Power Amplifiers:

- The demodulator output is the message signal. But it is very weak and cannot be used directly to actuate a loudspeaker.
- So the audio signal coming out from the detector stage is first amplified using a voltage amplifier stage
- It raises it to a level at which it can drive a class-A audio power amplifier which is the next stage.
- This power amplifier is designed to have minimum distortion and a 3 dB bandwidth of at least 5 kHz. It is transformer-coupled to a loudspeaker.
- It's output transformer is also called the matching transformer since it provides good matching between 3 output impedance of the power amplifier and the low impedance of the loudspeaker.