Basic principles of clasp design:
1-The basic principle of clasp design referred to as the principle of encirclement means that more than 180 degrees in the greatest circumference of the tooth, passing from diverging axial surfaces to converging axial surfaces, must be engaged by the clasp assembly. The engagement can be in the form of continuous contact, such as in a circumferential clasp, or discontinuous contact, such as in the use of a bar clasp. Both provide tooth contact in at least three areas encircling the tooth: the occlusal rest area, the retentive clasp terminal area, and the reciprocal clasp terminal area (for circumferential clasp) or minor connector contacting guiding plane (for bar clasp).

2-The occlusal rest must be designed to prevent the movement of the clasp arms toward the cervical.
3-Each retentive terminal should be opposed by a reciprocal component capable of resisting any transient pressures exerted by the retentive arm during placement and removal.
4-Clasp retainers on abutment teeth adjacent to distal extension bases should be designed so that they will avoid direct transmission of tipping and rotational forces to the abutment.
5-Unless guiding planes will positively control the path of removal and stabilize abutments against rotational movements, retentive clasps should be bilaterally opposed, i.e., buccal retention on one side of the arch should be opposed by buccal retention on the other, or lingual on one side opposed by lingual on the other.
6-The path of escapement for each retentive clasp terminal must be other than parallel to the path of removal for the prosthesis.
7-The amount of retention should always be the minimum necessary to resist reasonable dislodging forces.

8-Reciprocal elements of the clasp assembly should be located at the junction of the gingival and middle thirds of the crowns of abutment teeth. The terminal end of the retentive arm is optimally placed in the gingival third of the crown. These locations permit better resistance to horizontal and torquing forces because of a reduction in the effort arm.

Types of clasp assemblies

They are of two types:-

1-Clasps designed to accommodate distal extension functional movement.

2-Clasps designed without movement accommodation.

1-Clasps designed to accommodate distal extension functional movement.

Two strategies are adapted to either:

A-Change the fulcrum location and subsequently the "resistance arm" engaging effect (mesial rest concept clasp assemblies).

B-Minimize the effect of the lever by use of a flexible arm (wrought-wire retentive arm).

A-Mesimal rest concept clasps assemblies (RPI, RPA, and Bar clasp):

These are proposed to accomplish movement accommodation by changing the fulcrum location to prevent harmful tipping or torquing of the abutment tooth and prevent more denture base movement. This concept include RPI and RPA clasps.

RPI clasps: Is referring to the:-

R = Rest, P = Proximal plate, and I = l-bar. These are component parts of the clasp assembly. Basically, this clasp assembly consists of:-

1-A mesioocclusal rest with the minor connector placed into the mesiolingual embrasure, but not contacting the adjacent tooth.
Occlusal view

2-A distal guiding plane, extending from the marginal ridge to the junction of the middle and gingival thirds of the abutment tooth, is prepared to receive a proximal plate. The buccolingual width of the guiding plane is determined by the proximal contour of the tooth.

3-The proximal plate, in conjunction with the minor connector supporting the rest, provides the stabilizing and reciprocal aspects of the clasp assembly.

4-The I-bar should be located in the gingival third of the buccal or labial surface of the abutment in a 0.01-inch (0.25mm) undercut. The whole arm of the I-bar should be tapered to its terminus, with no more than 2 mm of its tip contacting the abutment. The retentive tip contacts the tooth from the undercut to the height of contour. This area of contact along with the rest and proximal plate contact provides stabilization through encirclement.

The horizontal portion of the approach arm must be located at least 4 mm from the gingival margin and even farther if possible.
There are three basic approaches to the application of the RPI system:

1. The guiding plane and corresponding proximal plate minor connector extend the entire length of the proximal tooth surface, with physiological tissue relief to eliminate impingement of the free gingival margin.

   PP: proximal plate (minor connector), Gp: Guiding plane.

2. The guiding plane and corresponding proximal plate minor connector extend from the marginal ridge to the junction of the middle and gingival thirds of the proximal tooth surface.

Both approaches recommend that the retaining clasp arm be located in the gingival third of the buccal or labial surface of the abutment in a 0.01-inch undercut. Placement of the retaining clasp arm is generally in an undercut located at the greatest mesiodistal prominence of the tooth or adjacent to the extension base area.

A, on distobuccal surface (adjacent to the extension base area); B, at greatest mesiodistal prominence.

3. A proximal plate minor connector that contacts approximately 1 mm of the gingival portion of the guiding plane and a retentive clasp arm located in a 0.01-inch undercut in the gingival third of the tooth at the greatest prominence or to the mesial away from the edentulous area.
If the abutment teeth demonstrate contraindications for a bar-type clasp a modification should be considered for the RPI system (the RPA clasp; Aker clasp).

The bar clasp arm arises from the denture framework or a metal base and approaches the retentive undercut from a gingival direction. The bar clasp arm has been classified by the shape of the retentive terminal. Thus it has been identified as a T, modified T, I, or Y. I shape bar is prefer than other shapes because this shape being biologically and mechanically sound.

Indications for bar clasp arm:
1-When a small degree of undercut (0.01 inch) exists in the cervical third of the abutment tooth, which may be approach from a gingival direction.
2-On abutment teeth for tooth-supported partial dentures or tooth-supported modification areas.
3-In distal extension base situations.
4-In situations in which esthetic considerations must be accommodated and a cast clasp is indicated.

Contra indications:
1-When a severe tooth and/or tissue undercut exist, a bar clasp arm usually is annoyance to the tongue and cheek and also traps food debris.
2-When a deep cervical undercut exists.
3-Shallow vestibule.
4-An excessive buccal or lingual tilt of the abutment tooth.
There are several other types of bar clasps; example: **Infrabulge clasp:**

It is designed so that the bar arm arises from the border of the denture base, either as an extension of a cast base or attached to the border of a resin base. It is made more flexible than the usual bar clasp arm.

(Clap arm arises from border of metal base.)

(Clap arm is attached to buccal flange of resin denture base with auto-polymerizing resin.)

**Advantages:**

1- Its interproximal location, which may be used to esthetic advantage.
2- Increased retention without tipping action on the abutment.
3- Less chance of accidental distortion resulting from its proximity to the denture border.

**B-Combination clasp:**

Another strategy to reduce the effect of the Class I lever in distal extension situations is to use a flexible component in the "resistance arm," which is the strategy employed in the combination clasp. The combination clasp consists of a wrought-wire retentive clasp arm (round, uniformly tapered 18-gauge wrought-wire) and a cast reciprocal clasp arm.

The retentive arm (wrought-wire) is almost always circumferential, but it also may be used in the manner of a bar, originating gingivally from the denture base. The cast reciprocal arm may be in the form of a bar clasp arm, it is usually a circumferential arm.
Advantages:
The advantages of the combination clasp lie in:-
1-The Flexibility.
2-The adjustability.
3-The esthetic appearance of the wrought-wire retentive arm over other retentive circumferential clasp arms (it may be used in smaller diameters than a cast clasp, with less danger of fracture).
4-Minimum of tooth surface covered because of its line contact with the tooth, rather than having the surface contact of a cast clasp arm.
5-A less likely occurrence of fatigue failures.

Disadvantages:
1- It involves extra steps in fabrication, particularly when high-fusing chromium alloys are used.
2-It may be distorted by careless handling on the part of the patient.
3-Because it is bent by hand, it may be less accurately adapted to the tooth and therefore provide less stabilization in the suprabulge portion.
4-It may distort with function and not engage the tooth.

Indications:
1-When maximum flexibility is desirable, such as on an abutment tooth adjacent to a distal extension base where only a mesial undercut exists on the abutment or on a weak abutment or where a large tissue undercut, contraindicates a bar-type direct retainer.
2-It may be used for its adjustability when precise retentive requirements are unpredictable and later adjustment to increase or decrease retention may be necessary.
3-When esthetic required over cast clasps, because wrought -wire is round, light is reflected in such a manner that the display of metal is less noticeable than with the broader surfaces of a cast clasp.

2-Clasps designed without movement accommodation.

Circumferential Clasp:
The Circumferential Clasp will be considered first as an all-cast clasp. The basic form of the circumferential clasp is a buccal and lingual arms originating from a common body (principle occlusal rest and minor connector). Circumferential Clasp has only one retentive clasp arm, opposed by a nonretentive reciprocal arm on the opposite side. It
approach the undercut area from an occlusal direction so it is called (occlusally approaching clasp), since it is coming to the undercut area from above the bulge area so called (suprabulge clasp) and since it is pulling the tooth during action also called pull clasp and also called Aker clasp.

Indications:
1- It is most logical clasp to use with all tooth-supported partial dentures because of its retentive and stabilizing ability.
2- On free end extension when minimal undercut is utilized.
Contra indication:
1- When the retentive undercut may be approached better with a bar clasp arm.
2- When esthetics will be enhanced by using bar clasp arm.
Disadvantages:
1- More tooth surface is covered than with a bar clasp arm because of its occlusal origin.
2- On some tooth surfaces, particularly the buccal surface of mandibular teeth and the lingual surfaces of maxillary teeth, its occlusal approach may increase the width of the occlusal surface of the tooth.
3- In the mandibular arch, more metal may be displayed than with the bar clasp arm.
4- Its half-round form prevents adjustment to increase or decrease retention. True adjustment is impossible with most cast clasps.

The circumferential type of clasp may be used in several forms:
A- Ring-type clasp

Ring clasp, which encircles nearly all of a tooth from its point of origin. The clasp should never be used as an unsupported ring, because
if it is free to open and close as a ring, it cannot provide either reciprocation or stabilization. Instead the ring-type clasp should always be used with a supporting strut on the nonretentive side, with or without an auxiliary occlusal rest on the opposite marginal ridge. The advantage of an auxiliary rest is that further movement of a mesially inclined tooth is prevented by the presence of a distal rest. In any event the supporting strut should be regarded as being a minor connector from which the flexible retentive arm originates. Reciprocation then comes from the rigid portion of the clasp lying between the supporting strut and the principal occlusal rest. The ring-type clasp should be used on protected abutments whenever possible, because it covers such a large area of tooth surface.

![Diagram of clasp mechanism]

Indications:
1-It is used when a proximal undercut cannot be approached by other means. For example, when a mesiolingual undercut on a lower molar abutment (isolated lower molar such as in Class II modification one) cannot be approached directly because of its proximity to the occlusal rest area and cannot be approached with a bar clasp arm because of lingual inclination of the tooth.
2-It may be used in reverse on an abutment located anterior to a tooth-bounded edentulous space when a distobuccal or distolingual undercut cannot be approached directly from the occlusal rest area and/or tissue undercuts prevent its approach from a gingival direction with a bar clasp arm.
**B- Embrasure clasp**

The embrasure clasp always should be used with double occlusal rests, even when definite proximal shoulders can be established. This is done to avoid interproximal wedging by the prosthesis, which could cause separation of the abutment teeth and result in food impaction and clasp displacement. In addition to providing support, occlusal rests also serve to shunt food away from contact areas. Embrasure clasps should have two retentive clasp arms and two reciprocal clasp arms, either bilaterally or diagonally opposed.

Indications:

*In an unmodified Class II or Class III partial denture, where there are no edentulous spaces on the opposite side of the arch to aid in clasping. Other less commonly used modifications of the cast circumferential clasp are:

**A- Back action clasp**

Is a modification of the ring clasp, can be used on abutment anterior to edentulous space.

**B- Multiple clasp**

The multiple clasp is simply two opposing circumferential clasps joined at the terminal end of the two reciprocal arms.
Indications:
1-It is used when additional retention and stabilization are needed, usually on tooth-supported partial dentures.
2-It may be used for multiple clasping in instances in which the partial denture replaces an entire half of the dental arch.
3-It may be used rather than an embrasure clasp when the only available retentive areas are adjacent to each other.
Disadvantage:
* Its disadvantage is that two embrasure approaches are necessary rather than a single common embrasure for both clasps.

C- Half-and-half clasp
The half-and-half clasp consists of a circumferential retentive arm arising from one direction and a reciprocal arm arising from another. The second arm must arise from a second minor connector, and this arm is used with or without an auxiliary occlusal rest.

D- Reverse-action clasp (Hairpin)
Clasp arm is designed to permit engaging a proximal undercut from an occlusal approach. Ring clasp or bar clasp can be used with the same result getting from reverse-action clasp. The upper part of the arm of this clasp should be considered a minor connector, giving rise to the tapered lower part of the arm. Therefore only the lower part of the arm should be flexible. With the retentive portion beginning beyond the turn, only the lower part of the arm should flex over the height of contour to engage a retentive undercut. The bend that connects the upper and lower parts of the arm should be rounded to prevent stress accumulation and fracture of the arm at the bend.
Disadvantages:
1-Esthetically objectionable when use on anterior abutment.
2-The clasp covers considerable tooth surface and may trap debris.

Indications:
1-When a proximal undercut must be used on a posterior abutment and when tissue undercuts, tilted teeth, or high tissue attachments prevent the use of a bar clasp arm.
2-When lingual undercuts may prevent the placement of a supporting strut (of ring clasp) without tongue interference.

These are the various types of cast circumferential clasps may be used in combination with bar clasp arms. Circumferential and bar clasp arms may be made either flexible (retentive) or rigid (reciprocal) in any combination as long as each retentive clasp arm is opposed by a rigid reciprocal component.

Other types of retainers:
Lingual retention in conjunction with internal rests

The internal rest is not used as a retainer, but that its near-vertical walls provide for reciprocation against a lingually placed retentive clasp arm. Retentive arm is usually a circumferential arm arising from the body of the denture framework at the rest area, lying in natural or prepared Infra bulge area of the abutment tooth. It is either cast or of wrought wire, wrought wire is prefers because of adjustability and flexibility.

Indication:
*On Tooth supported partial denture, only on the anterior abutment when esthetic is consider.