Section I

Clinical Dispensing Optics

Chapter 1

Introduction

"Dispensing Optics" defined by the United States Department of Labor. Dispensing optics is the fitting of glasses in frames and contact lenses after a given prescription by an ophthalmologist/optometrist. It also defines as dispensing opticians who are involved in supplying spectacles lenses and frames with their fittings, selling glasses, contact lenses, and low vision devices after prescription received by an optometrist ophthalmologist (ophthalmic optician). Do not perform eye tests, but advise customers on the best type of frames, glasses according to their needs. This book put light on the detailed collection of the evidence-based history of spectacles frames, lenses, and contact lenses form the early medieval period to the 21st century, verification of lenses, frame types, what materials are used in it, its measurements, markings, adjustments, standard alignments, lens processing, frame adjustment tool and how to adjust a frame, along with the distance between pupil, how to change one prescription power to a new prescription power, problem-solving numerical, list of words with their meaning in vocabulary sections along with illustrations, etc. The text briefly discusses the practical information on corrective lenses, transposition, bifocals, trifocals, progressive lenses, and aphakic lenses. Optical materials and measurements are covered with details on types of lenses, frame materials, and parts, pupillary distance, prescription verification, lensometer, bifocal verification. The author then focuses on the art of dispensing, including frame selection, fit, pantoscopic tilt, retroscopic tilt, and the hot salt pan for the frame adjustment. A brief guide for frame, lenses, and their fitting, a step-by-step approach to solving vision difficulties/patient complaints, and a significant section on frame types, problems solving numerical round out this well-illustrated manual.

History

We are living in the 21st century, where on the whole, work is accomplished by digital approaches. Genuine working on it requires a massive effort physically, mentally and psychologically, and in every aspect eye performs a crucial role. Hedge A (1996) and Begley CG (2002) investigated that the recurrent reason for workplace disorders is tiredness and strained eyes followed by mental fatigue and headache.[1] Currently, these are best corrected using a variety of frames and lenses. But the question arises from where they are originated. In this chapter, we will depict the archives of lenses and spectacles. Let us initially interpret the history of lenses, spectacles frames, contact lenses, and their journey from the early medieval period to the 21st century.

- Chapter 2 illustrates the Journey of Lenses, covering all essential aspects, its origin, and its implementation to the 21st century.
- Chapter 3 deals with the History of Spectacle Frame.
- Chapter 4 explains the detailed history of the contact within the Contact Lens Era.

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Chapter 2

Journey of Lenses

LENS

The word lens comes from the lens (genus of the legume family mostly known for its edible seeds), Latin referred to as lentil because of its lenticular-shaped structure (double-convex lens). It is also known as Aquila, which in Latin means a small amount of water. It is a crystal clear material typically circular in shape with two refined surfaces, either or both of which are in spherical curvature and may be either convex or concave.[1] The lenses have two main varieties: (a) Solo and (b) compound. The solo lenses are used in eyeglasses, contact lenses, pocket magnifiers, signal lights, simple box cameras, etc. While compound lenses are made up of different materials used in instruments such as cameras, microscopes, telescopes, etc. The lens adjustments are known as accommodation **(Fig. 2.1a and b)**. These lenses previously were made up of glasses which nowadays turn into high-technology plastics that have an unbreakable property, are light-weighted, thinner, scratch-resistant, and come with filter shields to protect the eyes from the UV rays. The types of high-technology plastics are: (1) Polycarbonate, (2) trivex, (3) high index plastic, (4) aspheric, (5) photochromic lenses, etc.[2] The most commonly used lenses in the mid-40s of age are the multifocal and monofocal lenses. The multifocal like bifocals have the property of splitting into two sections, the upper section for distance vision and lower section for near vision, and trifocals have the third section that sits above the bifocal portion of the lens while the

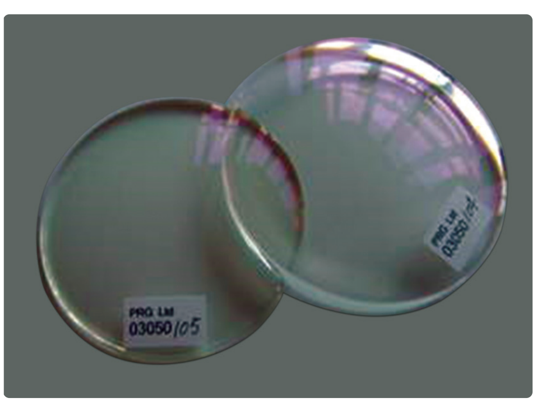


Fig. 2.1a: Spectacles lens

Fig. 2.1b: Spectacle frame

monofocal lenses are the most common type of intraocular lens for cataract patients.[3] The Cochrane researchers assessed that people with multifocal lenses may have better near vision and may be less likely to need spectacles than people with monofocal lenses (low-certainty evidence).[4]

Spectacle frame: It is an optical appliance consisting of frames and lenses with sides extending towards the ears. It aids in correcting serious eye defects like myopia, hypermetropia, or astigmatism conditions by mounting a lens in a structured frame.

Optical frame: The optical frame is a structure that holds the optical lenses in a proper manner. These are found in different styles, designs and materials, etc.

Parts of the frame

Frame front (Fig. 2.2a) is subdivided into:

- Lugs (hinges).
- Bridge (nose pads).
- End-piece (guard arm).
- Frame rim (full frame, semi-rimless, rimless).

Temple: If is attached to the front and clip over the ears to hold the spectacles in place. It is subdivided into **(Fig. 2.2b)**:

- Butt.
- Shaft or shank.
- Bend.
- Ear-piece.

The varieties of the temple used are explained in **Table 2.1**.

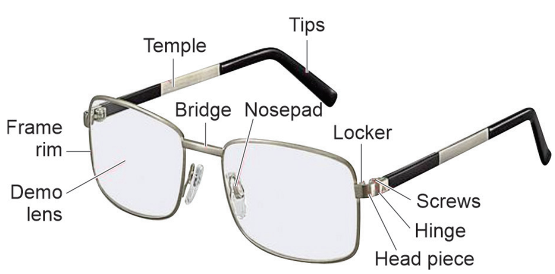


Fig. 2.2a: Parts of frame front

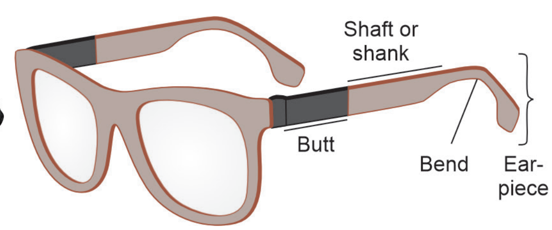


Fig. 2.2b: Parts of temple

Table 2.1: Pictorial presentation of standard varieties of temples

Skull	*Library*	*Convertible*	*Riding-bow*	**Comfort-cable*
				

*Comfort-cable is same as Riding-bow except these are made up of metal.

CHRONICLES OF LENSES AND THEIR JOURNEY THROUGH TIME

"Eyes so transparent that through them the soul is seen"

—Laurence Olivier

A little evidence was collected from the ancient pieces of literature about eye screening through the glasses. In 300 BC, Euclid in his optics noted that light travels in straight lines and described the laws of reflection. In the 7th century BC, during excavation by archaeologist Austen Henry Layard at the Assyrian palace of Nimrud (ancient Assyrian city in the Nineveh plains in upper Mesopotamia, nowadays Iraq). In the year 1850, found antique lens-shaped pieces of glass and rock crystal called Nimrud or Layard lenses.[5] The proposal was given by David Brewster as the lens can be used as a magnifier glass or as a burning glass to start fires by concentrating sunlight.

GT Willoughby Cashell (1971) documented that as long as 5000 BC, Egyptians manufactured glasses; man-made reading aid from the remnants of Nineveh cave made up of pebbles or semi-precious transparent stones used as a magnifier.[6] In 4 BC–65 AD, Roman introduced a magnifier that used a glass globe of water for reading all books of Rome.

According to **Pliny the Elder records** (wrote an encyclopedic Naturalis Historia (Natural History) which became an editorial model for encyclopedias.); Nero was the last Roman emperor of the Julio-Claudian dynasty who was fond of watching the gladiator fight using a piece of Emerald which he always wears in his thumb finger to view the fight.[7] There is no evidence-based from the primordial culture on using natural sources like stones, mirrors, and water for wearing eyeglasses. Around 140 AD **Claudius Ptolemy an *Almagest*** studied refraction and described its illumination trail through lenses.[8] In 525 AD, **Anicus Boethius** attempts to document the speed of light but is decapitated for his efforts after being accused of treasons and magics.

In 999 AD, **Abu Ali Hasan Ibn al-Haitham (Alhazen) was born in the Arab city Basra, which is now known as Iraq City**. He did tremendous work and evidenced his experiment rather than abstract reasoning. He was fond of studying the various shades of light, colors, rainbows, etc. which gave him an idea to work on the effect of light rays on the eyes. He performs his experiment in a dark room and places a hole in one side of the wall from which two lanterns hang on different heights. When both lanterns blew, each lantern followed a straight line with a wall hole and illuminated the room from other areas. His experiment proves that light comes from various sources like lanterns and travel from these objects through straight lines. He also investigated that magnification resulting from atmospheric refraction. His remarkable work in the field of optics is evidence from his seven-volume work on optics titled *Kitab al-Manazir as Opticae Thesaurus—Alhazen's Book of Optics* in the first millennium and used a camera obscura effect to study eclipses which is clearer with the pinhole size and notes that images appear clearer when the pinhole size is reduced.[9] Robert Grosseteste (1235–1253), a remarkable thinker of the 13th century study on the phenomena of refraction to understand the optical properties. Venice and Florence were the primary country to instigate the setup of the optical industry for grinding and polishing lenses for the spectacles; later, the centers were open in both Netherlands and Germany. Roger

Fig. 2.3: First wearable glasses manufactured in Italy between 1260 and 1290

Bacon (1268), student and follower of Grosseteste at Oxford University, wrote several books and extended his work on Grosseteste phenomena in optics and established that the speed of light is finite and propagated through the medium as an approach parallel to the transmission of sound. The 840 pages books written in Medieval Latin **Opus Majus** were the most significant work of Roger Bacon. He was the first to mention that a small object can be magnified with the help of the convex lens and is a very effective way of correcting the defective eyesight trouble.[10] The magnifying lenses inserted in frames were used for reading in Europe and China, and it is a matter of controversy whether the west learned from the east or vice versa.[11] In the year 1280, the lenses have come to use more in European countries, mostly Italy, as spectacles. The first wearable eyeglasses were invented in Italy around the year 1286. Bernard of Gordon (1303), a physician from France, declared that spectacles are the best way for treating farsightedness. In **1517 Leo X**, originally Giovanni de' Medici, one of the leading Renaissance popes painted by Raphael, manifests that a concave lens is used for myopia or nearsightedness.

In the eighth century BC, the writing system used by Egyptians was a hieroglyphic script that Herodotus and other Greeks alleged as something sacred presentation; due to this, they called this holy script writing. According to this script magnification, lenses were described as simple glass meniscus lenses.[12]

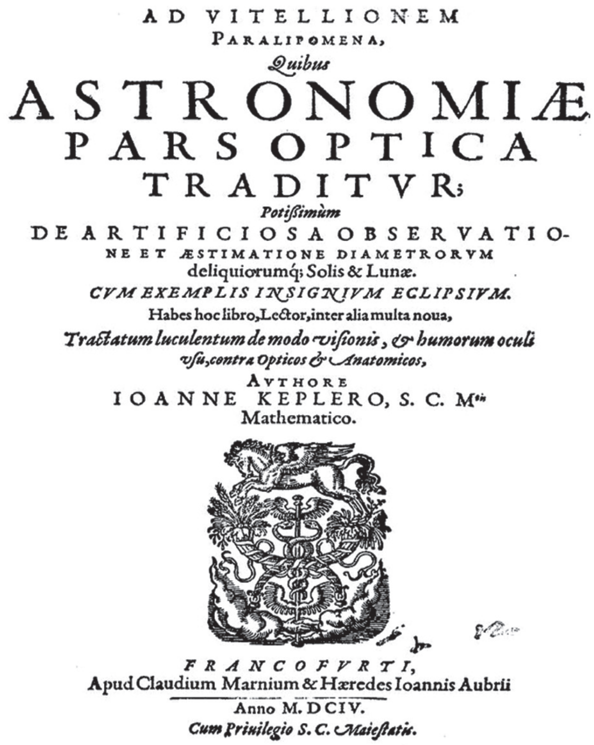
In the year 1595, for practical growth and experimentation purposes, the compound optical microscope came into the trend, and in 1608; the refracting telescope and compound optical microscope appeared in the spectacle-making centers in the Netherlands.[13, 14]

In the early 17th century, a higher magnification using two convex lenses was introduced as Keplerian Telescope by Johannes Kepler. He did a splendid job in geometric optics casing lenses and flat and curved mirror reflection, inverse square law phenomena governing the force of light, and standards of a pin-hole camera. The major contribution to his work was to assess the effects did by a variety of lenses on the retina, which was being experimented by various spectacle makers over the preceding 300 years[15] **(Fig. 2.4)**.

René Descartes was a French philosopher, mathematician, and scientist, widely regarded as one of the founders of modern philosophy. In his mid 17th century (1629–1633), he addressed the thesis **The world,** also known by the **Treatise on Light,** with a complete version of his philosophy, from the method to metaphysics physics, and biology. He wonderfully explained various optical phenomena, including reflection and refraction, by assuming that light was emitted by objects that produced it.[16] This differed substantively from the ancient Greek emission theory **(Fig. 2.5)**.

In the late 17th century (between the 1660s and early 1670s), The president of the royal society (PRS), Sir Isaac Newton; who was a mathematician, physicist, astronomer, theologian, and author, was recognized as one of the most influential scientists of all time, and a key figure in the scientific revolution. He made decisive contributions to optics. Between the 1660s and 1670s, his tremendous work was appreciated on the Descartes studies and concluded the corpuscles theory of light that the white light is a mixture of several colors which can be separated into various colors using a prism. In 1704 a second major book on physical science was published in English by him. In 1706, he appeared in Latin translation as **Opticks** or, **a treatise of the reflexions, refractions, inflexions, and colours of light (Fig. 2.6)**. The explanation was well accepted until the 19th century.[17] his name did not appear on the title page on the first edition of the book.

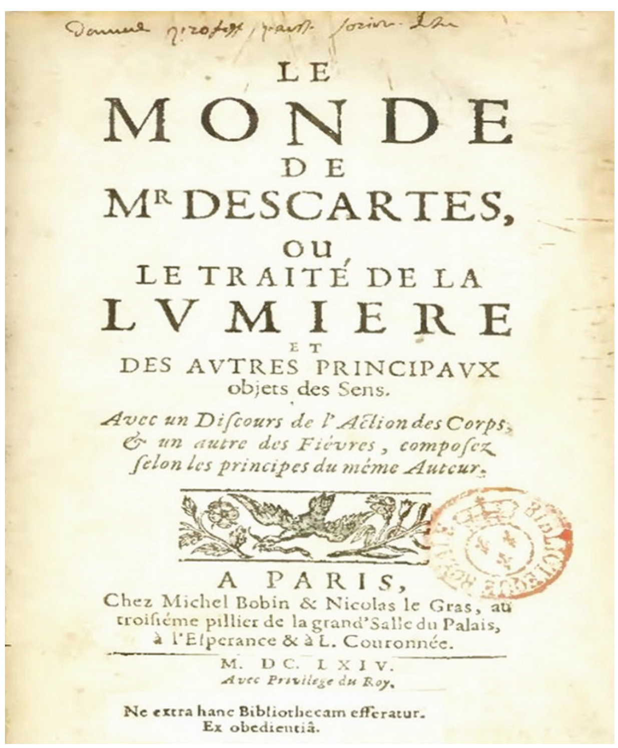
In the early 19th century, Thomas Young and Augustin-Jean Fresnel experiment brings a new turning point on the nature of light by interference and double-slit experiment



AD VITELLIONEM
PARALIPOMENA,
Quibus
ASTRONOMIÆ
PARS OPTICA
TRADITVR;
Potiſsimùm
DE ARTIFICIOSA OBSERVATIONE ET ÆSTIMATIONE DIAMETRORVM
deliquiorumq; Solis & Lunæ.
CVM EXEMPLIS INSIGNIVM ECLIPSIVM.
Habes hoc libro, Lector, inter alia multa noua,
Tractatum luculentum de modo viſionis, & humorum oculi
vſu, contra Opticos & Anatomicos,
AVTHORE
IOANNE KEPLERO, S. C. M[tis]
Mathematico.

FRANCOFVRTI,
Apud Claudium Marnium & Hæredes Ioannis Aubrii
Anno M. DCIV.
Cum Priuilegio S. C. Maieſtatis.

Fig. 2.4: The original and primary treatise (dissertation) about optics by Johannes Kepler (1604)



LE
MONDE
DE
M[R] DESCARTES,
OU
LE TRAITÉ DE LA
LVMIERE
ET
DES AVTRES PRINCIPAVX
objets des Sens.
Avec un Diſcours de l'Action des Corps,
& un autre des Fiévres, compoſez
ſelon les principes du méme Auteur.

A PARIS,
Chez Michel Bobin & Nicolas le Gras, au
troiſiéme pillier de la grand'Salle du Palais,
à l'Eſperance & à L. Couronnée.
M. DC. LXIV.
Avec Privilege du Roy.

Ne extra hanc Bibliothecam efferatur.
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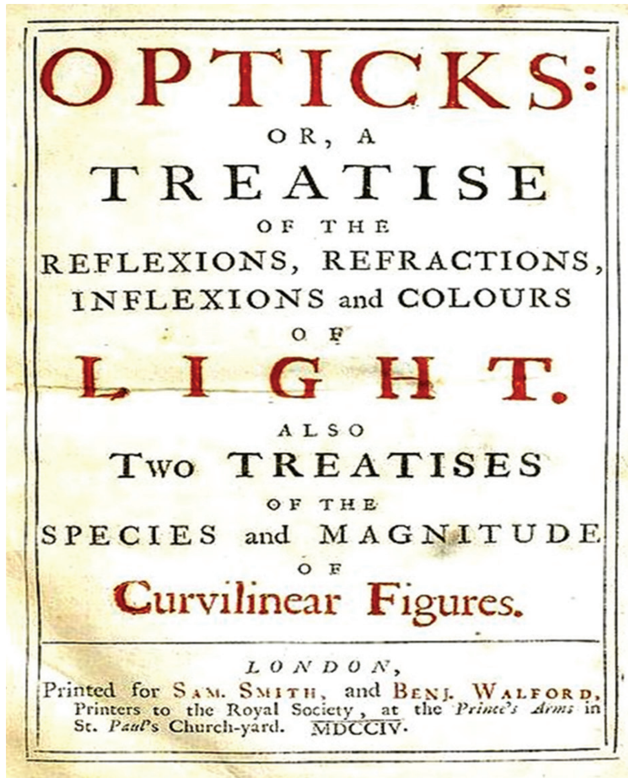
Fig. 2.5: Treatise by descartes on the world "Treatise on Light" (1664)



OPTICKS:
OR, A
TREATISE
OF THE
REFLEXIONS, REFRACTIONS,
INFLEXIONS and COLOURS
OF
LIGHT.
ALSO
Two TREATISES
OF THE
SPECIES and MAGNITUDE
OF
Curvilinear Figures.

LONDON,
Printed for SAM. SMITH, and BENJ. WALFORD,
Printers to the Royal Society, at the *Prince's Arms* in
St. *Paul's* Church-yard. MDCCIV.

Fig. 2.6 Opticks (1706), or a treatise of the reflections, refractions, inflections and colours of light

and focused on the light with the wave-like property. It brings kind attention to all the researchers to study deeply about physical optics which in the 1860s was theorized by James Clerk Maxwell in wave optics explaining electromagnetic theory.[18] Later the experiments continue by many researchers about light phenomena which **Albert Einstein (1905)** quotes the photoelectric effect that steadily recognized the quantization of light itself. [19]

These phenomenal experiments by the esteemed philosophers and researchers mark a line that light and matter are responsible for quantum optics and quantum mechanics as a result of the exchange of real and virtual photons.[20] This eventual conclusion facilitates inventions of the **Maser**. This device produces coherent electromagnetic waves through amplification by stimulated emission and was first constructed by **Charles H Townes, James P Gordon,** and **HJ Zeiger** at Columbia University in 1953. With this modality, a new idea was introduced in 1960 by **Theodore H Maiman** at **Hughes Research Laboratories**, based on theoretical work by Charles Hard Townes and Arthur Leonard Schawlow in the form of **Laser** (light amplification by stimulated emission of radiation).[21]

After the invention of the telescope, various experiments were performed on the shape, size, curvature, and quality of the lenses to correct chromatic errors. The **Chester Moor Hall** in **1973** (England), an English jurist and mathematician, invented the achromatic lens for building the first refracting telescope free from chromatic aberrations. In 1729, after experimenting with a variety of glasses, hall succeeded in combining two variations of glasses.

1. **Crown glass** is manufactured in Syrian, which in later years was used in the Normandy industry of Europe. It is a handmade glass of soda-lime composition for domestic

Fig. 2.7: Crown glasses

Fig. 2.8: Flint glasses

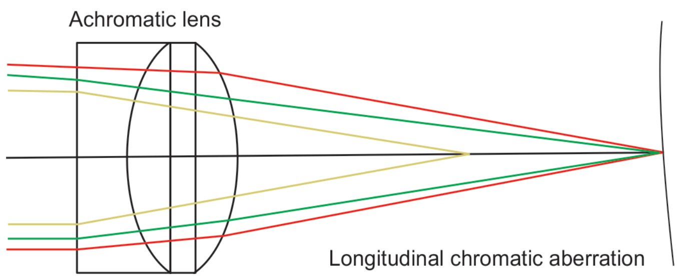


Fig. 2.9: Achromatic lenses

glazing and optical uses. In this process, a bubble of glass is blown into a pear shape structure was transferred to the glassmaker's pontil, which was reheated and rotated at speed until centrifugal force formed a large circular plate of up to 60 inches in diameter. The spinning results in a partially convex shape, with the center bull eye thickened from where the pontil was attached. These lenses have superior quality and clarity.[22] Crown glasses having Indices of refraction 1.5/1.6nd **(Fig. 2.7)**.

2. **Flint glass** is also known as Crystal or **Lead Crystal**. Their properties are its heaviness and durability, characterized by its brilliance, clarity, and highly refractive quality. George Ravenscroft first developed it in 1675. Due to its high refractive power, it is used by several industries to make lenses and prism. The glass assets were its high absorbing UV lights; it is also used for making telescope lenses.[23] The flint glasses containing lead give high indices of refraction 1.75/1.80nd **(Fig. 2.8)**.

John Dollond, the British maker of optical and astronomical instruments, developed an achromatic refracting telescope and practical heliometers, used a divided lens to measure the Sun's diameter and the angles between the angles celestial bodies. In 1758, Dolland's achromatic lenses came into vogue, which made its huge demand in the mid-1700s[24] **(Fig. 2.9)**.

VISBY LENSES

The Visby lenses are made up of quartz crystals (rock crystals) found in several Viking graves on the island of Gotland, Sweden, and dating from the 11th or 12th century. Some were in silver mounts with delicate jewelry of metalwork. Some of these lenses can be seen at the Fornsal historical museum in Visby, some are in the Swedish National Museum in Stockholm, and others have been lost. The lenses are bi-aspheric, with an oblate ellipse

Fig. 2.10: Silver-mount filigree Visby lens

surface with the nearest surface called a parabola. It measures 50 mm (2.0 in) in diameter and has a thickness of 30 mm (1.2 in) at its center, with an angular resolution of 25–30 µm. In 1999, in Sweden, during exhumation at Fröjel on Gotland, found proof of local manufacture beads and lenses from rock crystal, with unworked pieces of crystal coexisting with partially finished beads and Visby lenses which were capable of accumulating enough sunlight to fire ignition[25] **(Fig. 2.10)**.

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Chapter

3

History of Spectacle Frame

INTRODUCTION

The glasses are the timeless staples that earn more popularity day by day. Eyeglasses become a necessary part of human life according to the style, trends, protection, and corrections. Going through many articles from the ancient medieval time to date, glasses appears to be a keystone for any activities of daily livings. Previously when magnifying glasses/lenses/frames, etc. was discovered, it was only worn for magnifying things for the smooth conduction of specific performance. Still, if we compare today, it is a matter of concern for the improvement and enhancing cosmetic appearance. The all and sundry's of the 21st century have an opinion of wearing glasses that suit personality according to the occasions. Among all the hipster styles, thick black glasses are becoming the highlighted version among all generations due to their high quality rated designs attracts individuals. These spectacles stay in style year after year with its modifications as it was in the 19s. There will be many upcoming modifications in the frames and the lens styles and transitions within 21st, so it becomes a matter of curiosity to learn more about these spectacle frames with modifying lenses in the upcoming years with recent research done on it. Any discomfort in the eye can be corrected by visiting an optometrist or an eye doctor for a screening process with the glasses prescription. This is so easy and simple, but if we look back in history, it was not so easy at that time. In this chapter, we will discuss the history of spectacles and their journey through time.

MURANO GLASS

In the 13th century, the wooden glasses came into vogue with a wooden or shell edge on two carved crystals joined with rivets. These Prescription glasses (made with Murano glass and wood) were invented in Venice. Murano was a glassblower who knew how to make transparent glasses **(Fig. 3.1)**. In the mid-thirteenth century, the optical lenses were made by a pair of iron, fleece, lead, copper, and even wood hoops, joined by a rivet[1] **(Fig. 3.2)**.

In 1579, A Dominican monk from Pisa **(Fig. 3.3)** traditionally wrote about a letter dating from 1300 that the art of making the spectacles was discovered rarely than 20 years ago. There was precisely a superlative discovery made in the spectacle frames one of them was the bizarre-looking horned spectacled helmet also known as 'Armet' **(Fig. 3.4)** which was made by Austrian goldsmith Konrad Seusenhofer, a number one armor manufacturer

Fig. 3.1: Thirteen century in Murano glass

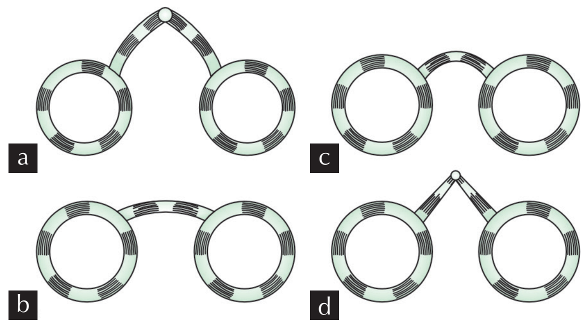


Fig. 3.2a to d: Rivet Murano glass

Fig. 3.3: A Dominican monk from Pisa (1579)

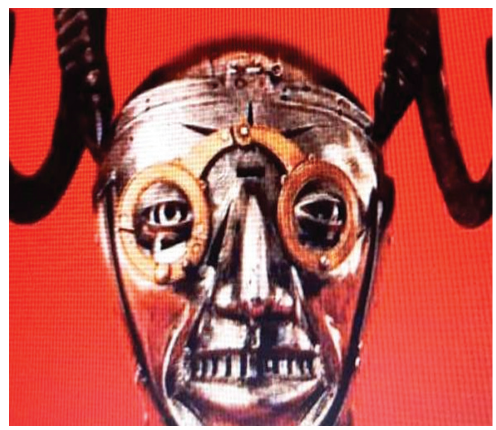


Fig. 3.4: Spectacled helmet or armet (1514)

of the 16th century; this horned frame was a part of a suit of armor and was presented by the Holy Roman Emperor Maximilian I to Henry VIII in 1514. In the year 1600, the catalogue of Ravensburg spectacles maker **(Fig. 3.5)** was much highlighted, then came the trend of the temple and Scissors spectacles **(Figs 3.6 and 3.7)**, in the year 1800. In 1830, the passengers being carried on the open-top carriages which directly impact the wind, funnel smoke and sparks directly into their eyes, so protective spectacles with D-shaped lenses arose sometimes with tinted lenses known as railway spectacles[2] **(Fig. 3.8)**.

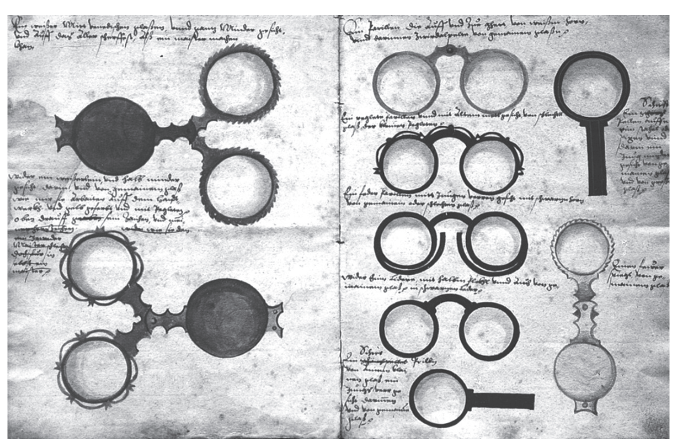


Fig. 3.5: Catalogue of Ravensburg spectacles makers (1600)

Fig. 3.6: Temple spectacles

Fig. 3.7: Scissors spectacles (1800)

Fig. 3.8: Railway spectacle (1830)

BIFOCAL LENS

In the 1780s, Benjamin Franklin developed the bifocal lens, the upper half for distance and the lowers half targeting two different areas of vision correction **(Fig. 3.9)**.

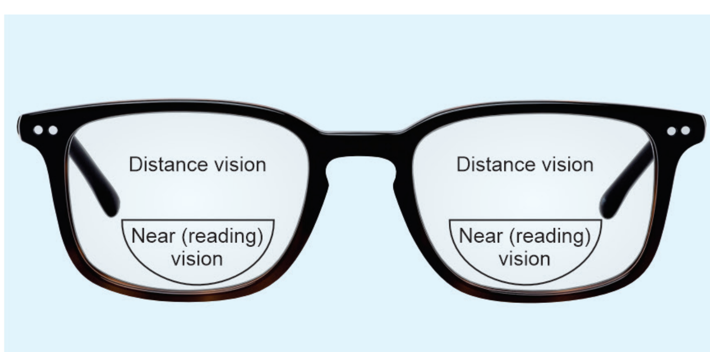


Fig. 3.9: Bifocals lens with upper and lower half serving for distant object as well as the near ones

LORGNETTES AND FOLDING EYEGLASSES

It is a spectacle front at the end of the short handle. It was supposed to be invented by George Adams in the 1770s (1709–1772). In his essay on vision (1789), he described it as a kind of spectacle substitute in which both eyes utilize its effect without any effort. Robert Bretell Bate (1825), the copyright for an "Improvement in eyeglasses frames" or handled spectacles with spring action. This spectacle has a unique property of folding and viewing as a single lens **(Fig. 3.10)**.

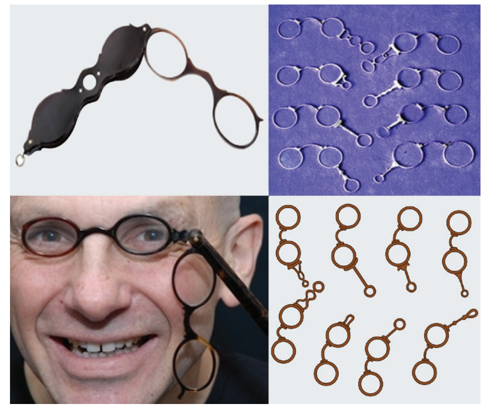


Fig. 3.10: Lorgnettes and folding eyeglasses

THE 19TH CENTURY EYEGLASSES

Monocle Lens

Eye-wear became a fashion tag. An iconic piece of eye-wear Monocle corrective lens (correction of one side of vision) is used with the impression that only the upper-class society wears it **(Figs 3.11 to 3.13)**.

Fig. 3.11: Monocle lens

Fig. 3.12: Gold-filled monocle

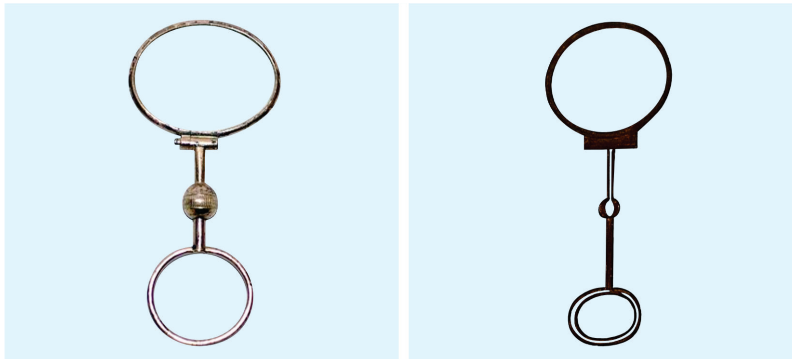


Fig. 3.13: Quizzing glass

PINCE-NEZ (THE EYEGLASSES WHICH GOT A GRIP)

Another achievement in the 19th century was the spectacle naming pince-nez which means "Pinching the nose," or an alternative definition which was unaccepted by historians "Absence of nose-piece (bridge)." In this, the glass had a spring clip to retain the item in place under its tension **(Fig. 3.14)**.

Another design patent was an obscure rimless finger-piece where fingers could control an opening process, pulling the nose pads apart. It was patent in France and abroad. Astigs lenses used for astigmatism correction were designed in the twentieth century in which the spring clip took a telescopic form allowing the two lenses to be pulled apart horizontally.[3] Much research was done on the variety of lens designs of pince-nez by OAICC (Ophthalmic Antiques International Collectors' Club). The research copies are available in the BOA (British Optical Association) Museum. In 2002, a revised book on spectacles, lorgnettes, and monocles was introduced by a publisher, Shire, an outstanding work performed in collaboration between OAICC and BOA. A variety of spectacles antiques is displayed in the museum[4] **(Figs 3.15 and 3.16a to c)**.

In 19th century, the Information Council of the Optical Industry (ICOI) began to encourage an interest and demand for eye-wear that was not just optically correct but in harmony with the face, dress, and environment. In 1950 Bausch and Lomb launched Cordelle Balgrip frame was manufactured as a new accessory to beauty. In the late

Fig. 3.14: Pince-nez

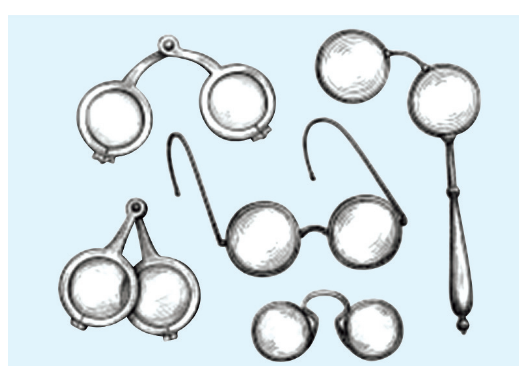


Fig. 3.15: A variety of spectacles antiques is displayed in the museum

Fig. 3.16a to c: (a) Finger-piece; (b) Description of nose grip liners (pads) for the type of finger-piece pince-nez becomes very popular in the year 1921; (c) Astigs lenses

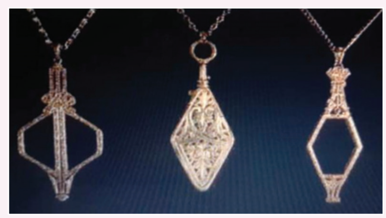
1980s, the stylish frame was replaced by the big frame to correct Presbyopia and can be used by young adults and children. In 1999, the largest British optical trade fair advised that the air titanium laminated plastic precious metal frames are trendy and more famous. This frame won the Golden Trophy in the Grand Prix of Technology held in Paris in 1994 with a pair weighing just 3 grams. Some of the 19s trendy spectacles are listed in **Table 3.1**.

Table 3.1: Description of some 19s spectacles with pictorial presentation

S. No.	*Description*	*Figures*
1.	1950s Bausch and Lomb Vintage Cordelle Balgrip mounting	
2.	Titanium rimless eyeglasses frame super flex silver eye-wear frames	
3.	Optical rectangle titanium full glasses frame	
4.	Serious gentleman frame by Merx	

(Contd.)

Table 3.1: Description of some 19s spectacles with pictorial presentation *(Contd.)*

S. No.	*Description*	*Figures*
5.	Edna type ladies evening spectacle frame	
6.	John Lenon Replica Spectacles 1990s	
7.	A lorgnette pendant, 1920	
8.	Air titanium multicoloured frame, 1995	

HISTORY OF EYEGLASSES

A person who wants to appear unique, cool, and original without matching the common men with a higher interest in putting the most up-to-date trends like eyeglasses, clothes, shoes, etc. comes under the category of hipsters. It comes in fashion when many singers' actors (Ryan Gosling) in the year 1920 approx. During Jazz-age, gear up this style. The most common it was seen wearing by Bob Dylan, and his band does Buddy Holly. In the beginning, these glasses were only square-shaped "Wayfarer," but they continued with their modifications as the day advanced. These lenses became so trendy that people started wearing them without prescription lenses for an appealing look **(Fig. 3.17a)**.[5]

Fig. 3.17a: Eye glass model (appearance on face)

Fig. 3.17b: Geeky glasses for square shape

Fig. 3.17c: Cat-eye glasses

Fig. 3.17d: Brow-line glasses

Fig. 3.17e: Horn-rimmed glasses

The Hipster's styles are **(Fig. 3.17b to e)**

- Nerdy/geeky glasses
- Cat eye glasses and Brow-line glasses (1950s and 1960s style).
- Round, vintage, horn-rimmed/tortoiseshell (made from animal horns or tortoiseshell but later converted to plastic).

THE 20TH CENTURY GLASSES

In the past-mid century, to avoid undue pressure, pain, or scar, the nose pads (W-bridge) were therefore developed to increase the surface area of the pressure point. In the twentieth century, the first book, *Cult Eye-wear*, written by the museum's curator, referred to the styled spectacles frames and branded fashion eye-wear. This book accounts for the world's top eye-wear brands, from Ray-Ban to JF Rey, Persol to Polaroid, and from the 1780s to the present day spectacles. Some of the spectacles with or without prescription become a high-status symbol of the 20th century **(Table. 3.2)**.

Table 3.2: Several 20th-century trendy eye-wears

S. No.	*Description*	*Figures*
1.	Classic American Aviator style OPS glasses (original pilot sunglass)	
2.	Rodenstock Aviators style spectacles become very famous among actors and models for an aesthetic looks	
3.	Harry potter spectacles	
4.	Shuron Regis II rimless eyeglasses	
5.	Shuron Sidewinder eyeglasses	
6.	Cable temple eyeglasses “Ray-Ban Outdoorsman Aviator (RB 3030)”	

(*Contd.*)

Table 3.2: Several 20th-century trendy eye-wears (*Contd.*)

S. No.	*Description*	*Figures*
7.	Randolph Engineering P-3, Aka Submariner	
8.	Wooden-effect eye-wears	

THE 21ST CENTURY GLASSES AND LENSES

Thick Black Glasses

Fig. 3.18: Thick black eye-glasses

This 21st-century booms people's minds with trendy and fascinating eye-wears which balance the face. The multiple-choice glasses, according to the occasion, become a status symbol. This is the time when prescription glasses come in multiple varieties. The Thick black glasses presently become iconic wear for all ages. There are many eye-wear shapes available in the market like rectangle, round, oval, browline, square, wayfarer, horn, aviators, etc. **(Fig 3.18)**

NEW GENERATION LENSES

The 21st-century optic lab in New York, provides a quality service with modern technology and services in New York/New Jersey, eye care professional community approaching digital lens and Crizal processing centers with lens treatments. The modern features are introduced in the eye lenses are.[5]

1. **Varilux X Series Lenses:** It asllows seeing sharper vision within arm's reach allowing to control the multiple distances containing smart blue filters that protect the eyes from harmful blue lights allowing to not compromise with moving the head to find just the right spot.
2. **No-Glare Lenses:** Crizal lenses provide glare reduction, water repellence, smudge, and high-quality scratch resistance with the clearest vision protected by UV rays. It has an E-SPF®25 value, meaning an eye protected by the lens will receive 25 times less UV exposure than an unprotected eye.
3. **Digital Processing:** It has a high capacity for digital surfacing by the generators or orbits Satisloh VFT-Orbit. It gives priority to manufacturing control quality lenses with maximum qualities of around 110 lenses per hour. It has a surface accuracy to within 1/100th of diopters with superior vision satisfaction.

4. **Transition Signature Lenses:** The latest technology is launched by the Essilor of America on 10th July 2019, a new generation lens with a disruptive Nano Composite Matrix and an Ultra-Agile Dye Generation and include a standard plastic of 1.50 air wear polycarbonate and thin and lite 1.67 in colors gray, brown and green. The specifications of these new-generation lenses are clear with full clear indoor and no tints offering more protection, etc. The new transitions signature Gen 8 (premium progressive lenses) are available in 2 varieties (a) Transition signature lenses style colors and (b) transition XTRActive® style mirrors.
   a. **Transition signature lenses style colour** offers seven iconic and vibrant fashion colors for comfort and protection with indoor clarity **(Fig. 3.19 and Table 3.3)**.

Fig. 3.19: Transitions signature lenses in amethyst style colour

Table 3.3: Transition signature lens style colours

S. no.	*Lens name*	*Figures*	*S. no.*	*Lens name*	*Figures*
1.	Sapphire	**Sapphire** style color	5.	Gray.	**Gray** style color
2.	Amethyst	**Amethyst** style color	6.	Brown.	**Brown** style color
3.	Amber.	**Amber** style color	7.	Graphite	**Graphite green** style color
4.	Emerald.	**Emerald** style color			

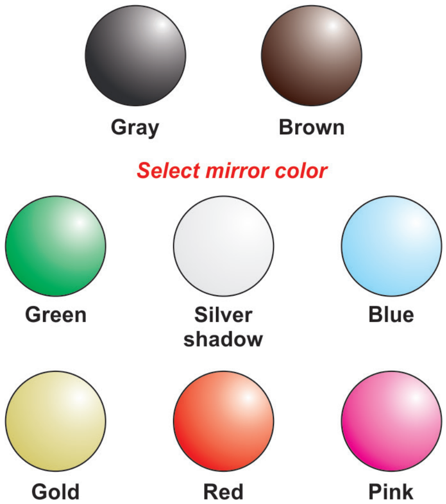


Fig. 3.20a: Transitions XTRActive® lenses in blue mirror finish

Fig. 3.20b: Transition XTRActive® style mirror colours

b. **Transition XTRActive® style mirrors**. These lenses are mirror finishes with extra protection from UV rays with advanced transition XTRActive® technology. The indoor mirror helps fade to a light reflection with a hint of color. These are manufactured in green, silver shadow, blue, gold, red or pink color **(Fig. 3.20a and b)**.

ANTIQUES EYE-GLASSES

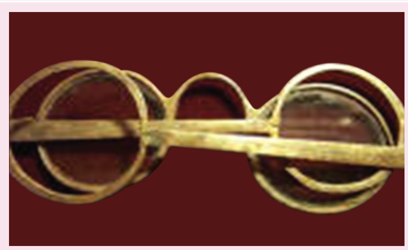
The collections of some of the antique eye-wears from the 16th century to 18th century are illustrated in **Table 3.4**.

Table 3.4: Some antique eye-wears

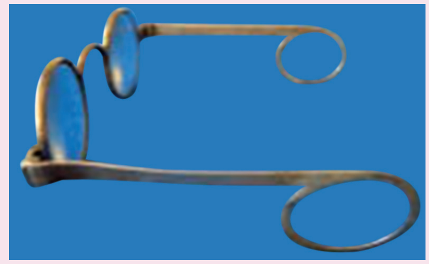
S. no.	*Description*	*Figures*
1.	A very rare piece of leather spectacle found in the foundation stone of old almshouses in Guisborough in the 16th century (around 130 years ago)[6]	
2.	A very rare and old piece of glass with a magnificent wooden spectacles carved	

(Contd.)

Table 3.4: Some antique eye-wears *(Contd.)*

S. no.	*Description*	*Figures*
3.	French silver temple specs 1612	
4.	Nuremberg-type one-piece nose glasses master-piece (1663)	
5.	Octagonal-shaped lenses on a wire-rim frame, a belief by the Archives and Museum of optometry believed to have been worn by Gen. Robert E Lee[7].	
6.	Large circular finials on temple specs 1740s	
7.	Nuremberg magnifier with elegant wooden case (1795)	

(Contd.)

S. no.	Description	Figures
	Table 3.4: Some antique eye-wears (*Contd.*)	
8.	18th-century large ring extended fourth-quarter frame.	
9.	18th century heart-shaped final fourth-quarter frame	
10.	19th-century frames of 3.2 cm from McCord Museum, Quebec	

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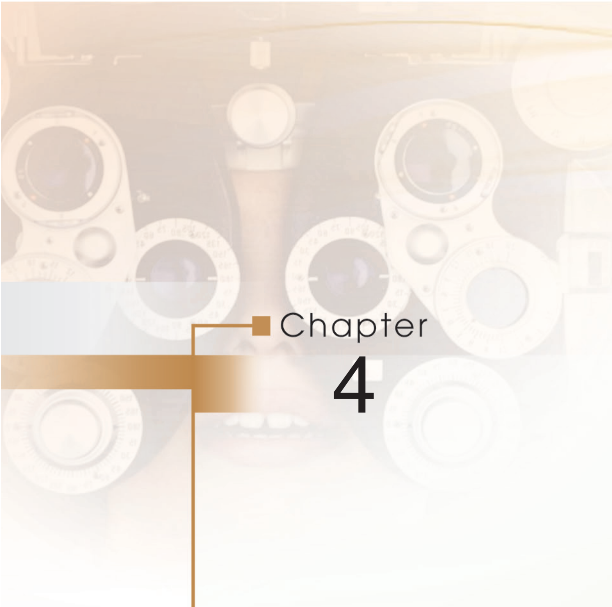

Chapter 4

The Contact Lens Era[1–3]

The contact lens was the man's finest invention whose roots are from the grounds of **Leonardo da Vinci** era 1508. He was a dynamic and multitasking personality with many areas of interest like new invention, drawing, painting, sculpture, architecture, science, music, mathematics, engineering, literature, anatomy, geology, astronomy, botany, paleontology, and cartography, etc. When the people hardly knew about the varieties of lenses used for magnification, his manuscript "Cordex of Eye" suggested that if the head is inundated in a bowl of water, it can correct certain ailments by placing cornea directly into the water. This invention was considered very impractical but provided a hint for upcoming researchers to anxiously work on it. After 150 years, around 1633 **René Descartes** describes a lens at the end of a water-filled tube placed on the cornea. He was the first to indicate that the lens can be placed directly onto the cornea, but his practical is still considered unreasonable.

Thomas Young, an English scientist in the year 1801, gives a path to the directions given by Leonardo da Vinci and Rene Descartes by placing the lens filled with water into his own eyes using wax and found that it assists in improving vision as compared to the descartes lenses that blur the vision. This conceptualizes the practical lens design by an English astronomer Sir John Herschel (1823), who invented an eye mold for corrections, also indicating while application of gel between cornea and lens for proper fitting.

The **first contact lens** was made in 1887 from a glass-piece and helps cover the entire eye; however, its production is a matter of controversy between the German glassblower F.A Muller, Swiss physician Adolf E. Fick and Paris optician Edouard Kalt. These lenses are manufactured in small and large sizes. The smaller, sized lens was very difficult to fit in the eye causing serious eye injuries, while the larger sized lens interfered with the lubrications and was quite uncomfortable. These lenses are very thick and heavy, covering the full sclera; these were referred to as Scleral lenses. These contact lenses need a high improvement to make them practicable.

William Feinbloom is a pioneer optometrist in low vision, visual rehabilitation, and advances in low vision gadgets. In 1936 his invention reached the heights by designing the latest **glass-plastic contact lenses**, which are much lighter and viable than the former glass blown lenses.[4,5] His invention was still a Scleral lens to be fitted over an entire eye, so difficult to wear for an extended period.

Kevin Touhy (1948) **accidentally** discovered corneal lens, while during the process of making the contact lens by chance the scleral part of the lens fell off, so the corneal part is only left to check its compatibility Touhy himself placed this lens into his eyes and found it comfortable in wearing with proper lubrication, easy blinking, and no irritation.

Chemists Wichterle and Lim (1960): The first finest and very comfortable hydrophilic contact lens was introduced in this era by purifying and casting hydrogels. This is found to be the greatest turning point for the application of contact lenses by any user throughout the day without unease. Many modern advances were available in the United Kingdom, with these specifications, like Bionite soft lenses, etc. These hydrogel lenses were more highlighted and popularized when the Canadian eye health product company Bausch and Lomb Inc. approved the US Food and Drug Administration for business purposes.

John de Carle and Galley (1970): Discovered **Permalens** and **Duragel lenses** **(Fig. 4.1a and b)**.

The gas permeable extended to wear hard contact lenses were the second-generation lenses with no water content and made up of firm plastic which releases oxygen and can be worn overnight. It comes with:

1. A red label for positive power, and
2. A blue label for negative power.

Titmus Eurocon (1974): The first cosmetic contact lens with the eye-painted iris and weicon soft toric contact lenses were introduced with the concept of dynamic stabilization. The toric lenses were made available in the market in the year 1978. The first aspheric soft bifocal lens—"Hydrocurve Bifocals," was introduced in the year 1977 **(Fig. 4.2)**.

Tinted daily-wear soft lenses were introduced in 1982, and bifocals daily wear in 1982. To make lifestyle more comfortable with unnoticed lenses, hygiene care, and excellent vision, Pierre Rocher (1984) developed Aoflex soft lenses. A more recent form of disposable soft contact lenses was introduced (1987), which is so popular to date that it allows users to dispose of it and post an application for a day. To appear fascinating cosmetic colored lenses were available in the year (1988). In early 1990 the 7 Polymacon B hydrophilic soft toric lenses with 43% water were introduced and were the advanced form from Hema lenses **(2-hydroxyethyl methacrylate)**, a transparent hydrophilic plastic lens material. Modern generation extended soft wear lenses were introduced in 1999, which can be worn overnight.

Fig. 4.1a: Permalens lens (1970)

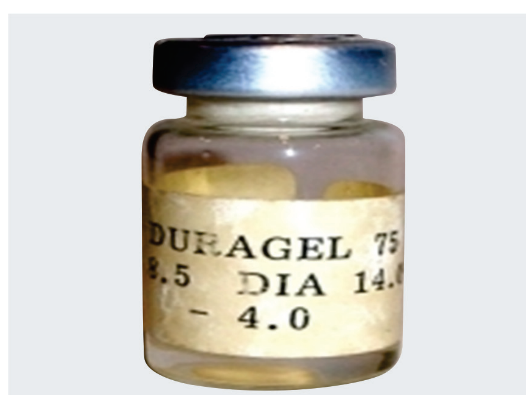

Fig. 4.1b: Duragel lens (1970)

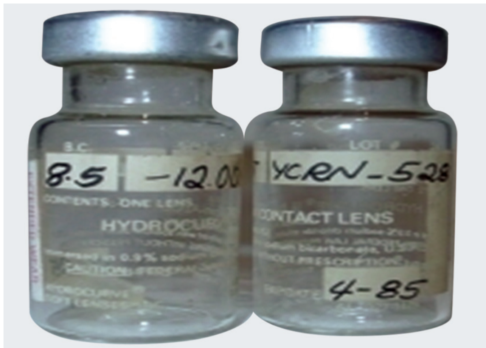

Fig. 4.2: Hydrocurve design bifocal and soft contact lenses

Fig. 4.3: SofLens 66

Fig. 4.4: Extreme H_2O lens

Fig. 4.5: Acuvue oasys with transitions contact lens (2018)

Bausch and Lomb in Waterford, Ireland, introduced spherical prescription lens **SofLens 66**, which is available in three sterile blister packs from circa 2000 and is available till **2008** with different packaged **(Fig. 4.3)**.

The **Extreme H_2O lenses** from Circa 2000 America promotes it as ***The contact lens that will not dry on the eye*** **(Fig. 4.4)**.

Effron N (2015) surveyed for 13 years to find the US trends regarding contact lens and found that females in comparison to males are wearing more CL than males. He also found that new rigid lens fits decreased from 13.0% in 2002 to 9.4% in 2014. Multifocal lenses are generally preferred to Monovision. From 2002 to 2014 the silicone hydrogels have replaced mid-water contact lens hydrogels as the soft lens material of choice, while 25–30% of toric lenses represented soft lens fits. Most lenses are prescribed on 1 to 2 weekly or monthly lens replacement regimens. Extended wear remains a minority lens wearing modality, and these are worn for seven days per week.[6]

The first light-adaptive (photochromatic) contact lenses are manufactured in collaboration with Johnson and Johnson Vision and transitions Optical, which helps block the sun's harmful UV rays and prevent potentially damaging blue light from entering the eye **(Fig. 4.5)**. A recent study conducted by Brian Pall (2019) on contact lenses with antihistaminic action. The researchers at Johnson & Johnson Vision care say that the lens/Ketotifen shows promising results in 2 phase 3 clinical trials and suggest that combining these two can provide a means of parallel vision correction and intervention for ocular allergies for contact lens wearers.[44] Anti-histamine contact lenses are the best option for allergy relief, and many investigators are preparing the regulatory submissions for approval to be helpful for every user.

21ST CENTURY LENSES USED FOR DRY EYE

1. **Bausch and Lomb ULTRA^{TM} at 1–800 contacts:** The moisture seal technology used in the lens helps to maintain 95% of their moisture for a full 16 hours **(Fig. 4.6)**.
2. **DAILIES AquaComfort Plus at EZ contacts:** It keeps eyes wet everyday **(Fig. 4.7)**.
3. **Air Optix Colors at EZ contacts:** It helps in keeping moisture in and debris out **(Fig. 4.8)**.

Fig. 4.6: Bausch and Lomb ULTRA^{TM} at 1–800 contacts

Fig. 4.7: DAILIES AquaComfort Plus at EZ contacts

Fig. 4.8: Air Optix Colors at EZ contacts

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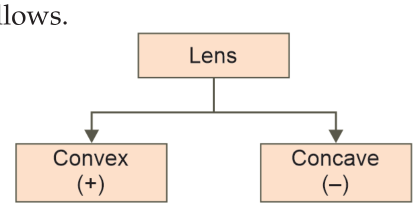
Chapter 5

Definition of Lens

The lens is a transparent optical media of light that focuses the light rays (beam) through the refraction process.

PARTS OF LENS

Two types of lens are as follows.



1. Convex Lens

When we move a convex lens in front of the eye and see the image through it, the image of that object will move in the opposite direction. It is made up of the base to base prism. It is a converging lens that converges the light rays at the focal point of the lens. The distance between the lens and focal point is known as the focal length. The convex lens is thicker from the center than the periphery **(Fig. 5.1)**.

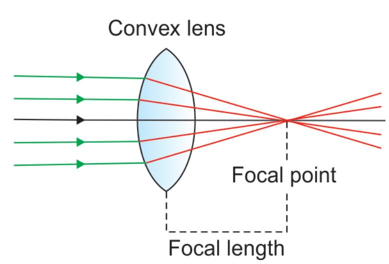


Fig. 5.1: Ray diagram showing light focus at a focal point through convex lens

Indications

1. Presbyopia
2. Hypermetropia
3. Aphakia
4. Used as magnifier

Disadvantage

1. High power produces scotomas (it is of different types)
2. Pin cushion effect
3. High power produces magnification 25% than the emmetropic eye (in aphakic eyes).

Magnifying Glass

Definition

A magnifying glass is a convex lens that produces a magnified (larger) image of an object. It produces a virtual image on the same side of the lens as the object. This image can be best observed when the distance between object and lens must be shorter than the lens's focal length **(Fig. 5.2)**.

Fig. 5.2: Hand held magnifier

Magnification

The magnification of a lens is often calculated using the subsequent formula;

$$\text{Magnification} = \frac{\text{Image height}}{\text{Object height}}$$

2. Concave Lens

When we move a concave lens in front of the eye and perceive the image through it, the image of those objects moves in the same direction. It is made up of apex to the apex of a prism. It is a diverging lens that diverges the light rays at the center point of the lens. The distance between the principal focus and the center of the lens is known as **focal length**. The concave lens is thinner from the center than the periphery. When the parallel light rays pass through a concave lens, the light rays diverge and appear to come from one point; this point is known as principle focus **(Fig. 5.3)**.

Uses

- Myopia
- Car side mirror

Disadvantage

- The barrel-shaped effect.

Ray diagram showing various types of convex and concave lenses are given in **Table 5.1** and **Fig. 5.4**.

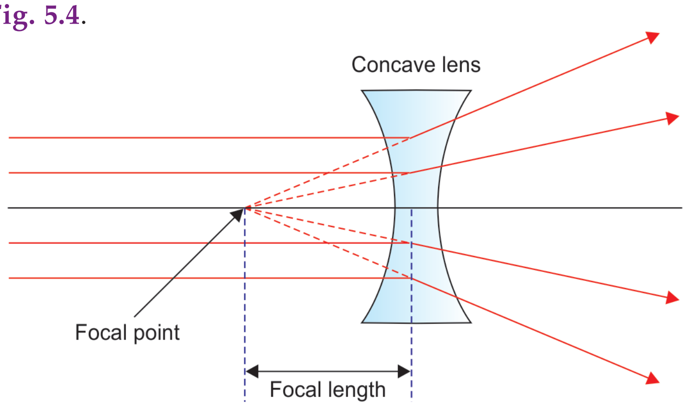
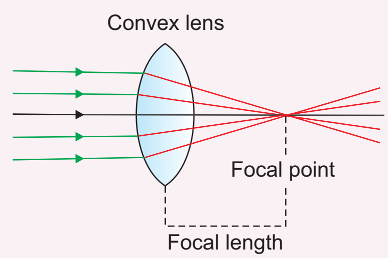
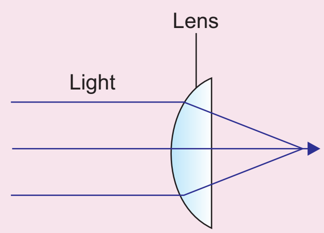
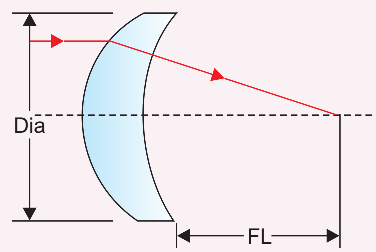
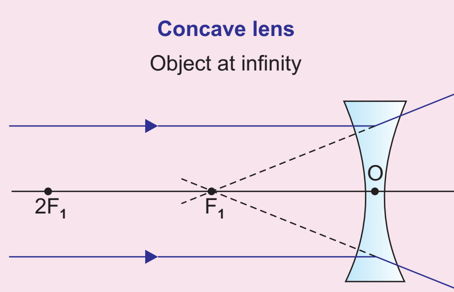
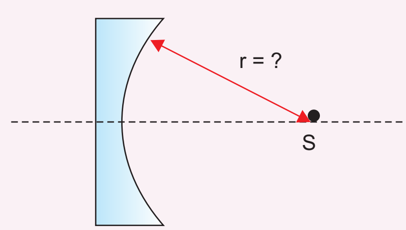


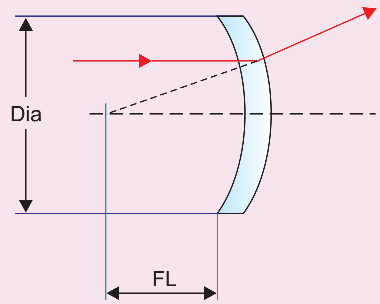
Fig. 5.3: Ray diagram showing ray diversion with the concave lens

Table 5.1: Various types of convex and concave lenses

S. No.	*Types of Lenses*	*Diagram*
1.	Biconvex	
2.	Plano-convex	
3.	Positive-meniscus	
4.	Biconcave	
5.	Plano-concave	

(*Contd.*)

Table 5.1: Various types of convex and concave lenses (*Contd.*)

S. No.	*Types of Lenses*	*Diagram*
6.	Negative-Meniscus	

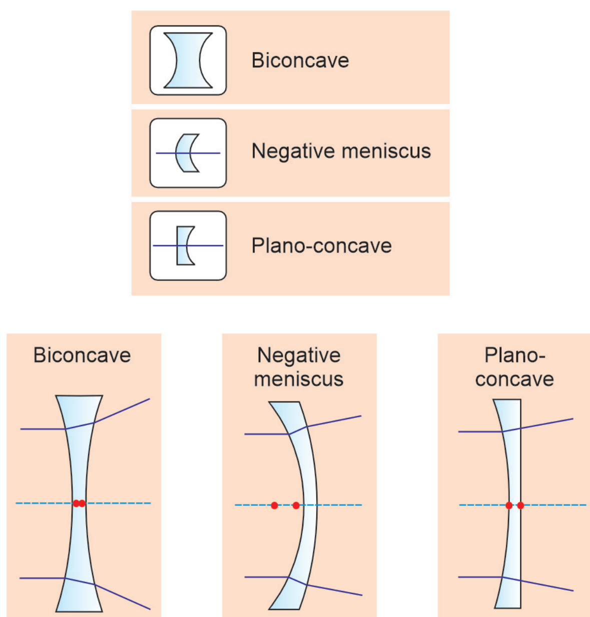
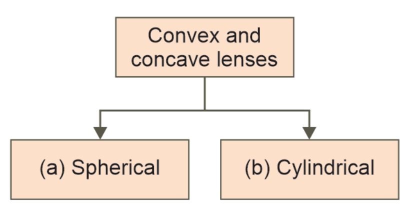


Fig. 5.4: Ray diagrams showing the various types of concave lens

Subdivision of convex and concave lenses is as follows.



A. **Spherical lens:** The eye (spherical) has the same curve on all axis and forms one image on the backside of the retina. It is a lens having the same power in all meridians of the lens; because of the same power in all meridians, the object's movement is also the same in all axis. In this lens, no image distortion appears. It is used to correct the spherical error, e.g. convex spherical, concave spherical. A convex and concave lens is for correcting nearsightedness or farsightedness. This number tells us the corrective power of a lens. The unit of measurement is diopter.

B. **Cylindrical lens:** It is a lens having one power and one axis meridian, axis meridian having no power, and because of this, axis meridians have no movement. The maximum power of the cylindrical lens is at power meridians which always act perpendicular to the axis meridian. It always acts as a plano lens. It is used to correct astigmatism. This lens produces image distortion. It is measured in diopters, e.g. convex and concave cylinder.

If a patient has astigmatism in the eye, the radius of curvature of that eye is different in both meridians, so two images form on the retina by the astigmatic **(Fig. 5.5)**. So the image appears fuzzy.

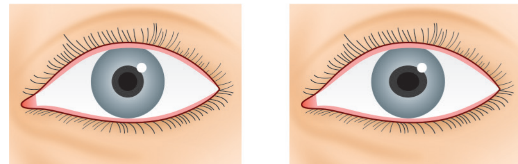


Fig. 5.5: Normal and astigmatic eyes

Axis

The cylindrical axis is measured in degrees. It can be in degrees from 0 to 180. The axis of cylindrical shows the orientation of astigmatism. Cylindrical power is always at the right angle, and we can calculate to reduce it from the cylindrical axis

For example, if cylindrical axis is at 90° then power should be at 180°

Chapter 6

Verification of Lens

The verification of the lens includes assessing the lens power (spherical and cylindrical) and axis of the cylinder (if any), near addition (if any), prism power with the base setting, centration, lens surface defect, and observation of lens fitting in the frame. Verification of the spectacle by the prescriber should be done after receiving it from the laboratory. Always use the original examination rather than received from the laboratory for verification.[1] Unless correct verification procedures are carefully followed, progressive lenses can be mistakenly identified as being in error when they are not.[2]

Verification of the lens can be done with the help of:

1. Lensometer method (manually or automated) **(Figs 6.1 and 6.2)**
2. Geneva lens measure (can check lens power as well as thickness at the time of lens processing method) **(Fig. 6.3)**
3. Trail box method (manually) **(Fig. 6.4)**

Fig. 6.1: An example of manual operated lensometer

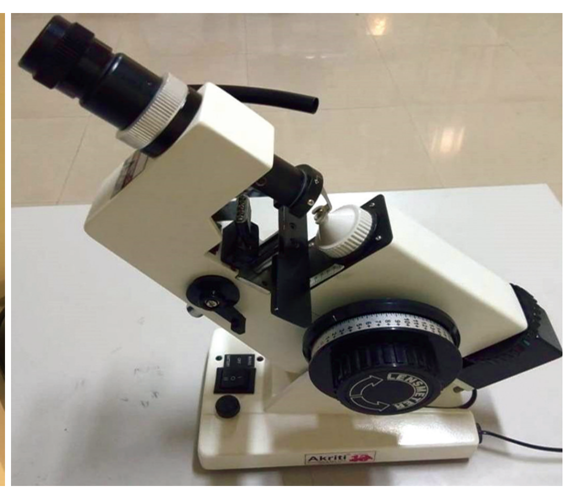


Fig. 6.2: An example of an automated lensometer

Fig. 6.3: An example of geneva lens measure (power and thickness of unknown lens)

Fig. 6.4: An example of trial box (neutralization of unknown lens)

VERIFICATION OF LENS POWER

The power of the lens can be verified by lensometer or by the process of neutralization **(Fig. 6.1)**.

Power verification by Lensometer

Before the lens verification, the following steps must be considered.

A. It must be calibrated with proper adjustment of an eyepiece for an accurate reading.
B. Move the lensometer eyepiece towards the operator's eye.
C. Now, move it slowly inward and stop as soon as the target is sharp and focused.
D. Place the posterior aspect of the spectacle on the lens meter's aperture.

Spherical Lens

The sphere has the same power over the whole surface as the spherical component of glasses, so there is a need to focus on only one position (both targets focused together and equally clear). The power is easily verified by reading the dioptric scale **(Fig. 6.5)**.

Sphero-cylinder Component

The glasses with the sphero-cylinder component cannot focus on the sphere and cylinder at a time. The sphere power should be cleared first. If the sphere lines are partially clear, then there is a need to adjust the wheel's power and axis until these lines are focused clearly, and once focused, its values from the power wheel are recorded as spherical power

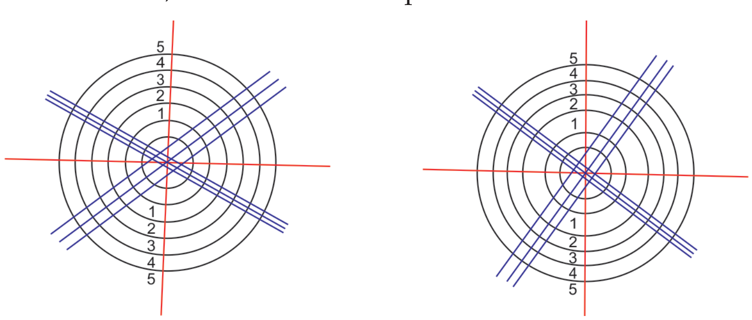


Fig. 6.5: Illuminated target is clear in both meridian means having sphere power only

of prescription. After finding the spherical power, we have to focus on Cylinder-power, which is done by turning the power in the opposite direction. As the sphere lines begin, it will become a blur, and cylinder lines will begin to focus. When the cylinder lines are entirely focused, then record the new power-wheel reading. The difference between the power of sphere reading and new reading, the wheel cylinder power can be verified **(Fig. 6.6)**.

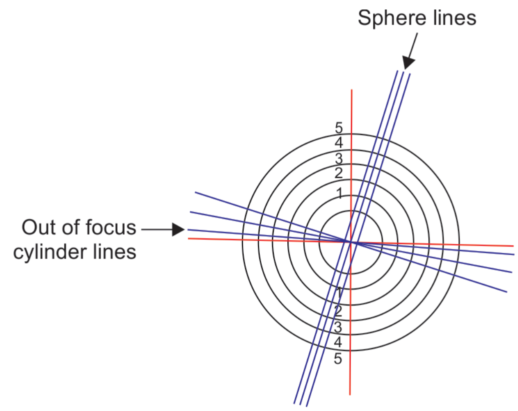


Fig. 6.6: Sphero-cylinder lens with focused sphere lines focus and out of focus cylinder lines

Spotting the Optical Center of the Lens

After obtaining the spherical and cylinder power traces, the optical center of the lens by centering the illumination target at the intersection of crosshair in the eyepiece reticle, the centration is found by gently moving the spectacle left or right on the instrument table or by adjusting and moving the instrument table up and down.

Unwanted Prism Evaluation

a. **Unwanted vertical prism:** There are two methods for examining unwanted vertical prisms **(Table 6.1)**.
b. **Unwanted horizontal prism (Fig. 6.9):** To check out the horizontal–vertical prism, properly measure the horizontal distance between where the OC is located or where OC should ideally be located on the two lenses. Compare this distance to the ordered PD. The prescription passes if the key difference between the ordered PD and measured PD is 2.2 mm or less. If the difference is greater than 2.5 mm, then the prescription might be failed.[1]

Verification of the Prescribed Prism

A lens that has the prescribed prism which is not centered in the lensometer as the glasses without prism, if the illuminated lensometer target is at the intersection of the crosshairs, the prismatic prescription is not centered correctly. The centration of prismatic glasses is correct when the illuminated target is located at the point that matches the prescribed prism **(Fig. 6.10)**.

For example, a right lens prescription reads +3.00-1.25*135, 2.00Δ base out.

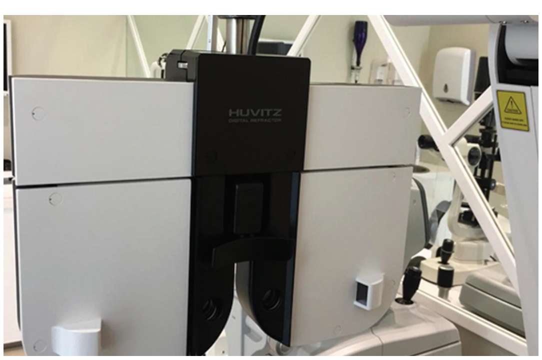


Fig. 6.7: An example of phoropter head (front view)

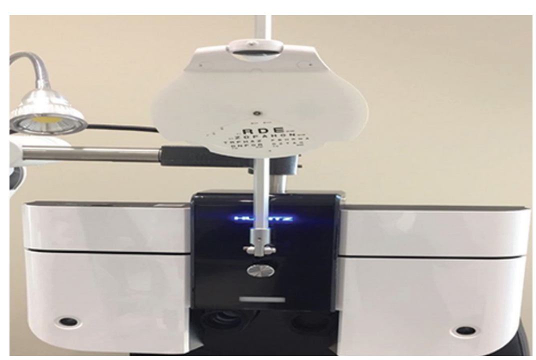
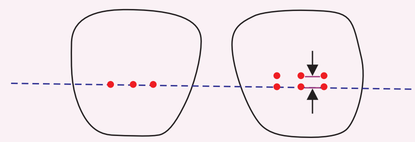


Fig. 6.8: An example of phoropter head (back view)

Table 6.1: Evaluation of unwanted prism

S. No.	*Methods*	*Description*	*Picture*
1.	Traditional method	Post-verifying the power and centration, if the second lens illuminated target is not visible on the center but seen above or below the intersection of the eyepiece crosshair, then the glasses are acquiring the unwanted vertical prism. With the illuminated target centered above or below the center of the crosshairs, measure the amount of unwanted prism present. If the prism amount is 0.33Δ or less, the prism is tolerable. If the prism is greater than the 0.33Δ and the vertical difference exceeds 1 mm, the lens pair will fail. **Note:** The lens with the highest power in 90° the meridian represents the first.	
2.	Cut-off power method	Same as traditional method excepts, if the lens amount of prism is greater than 0.33Δ and the power of the vertical meridian is 3.25 or less, then the prescription fails[1].	

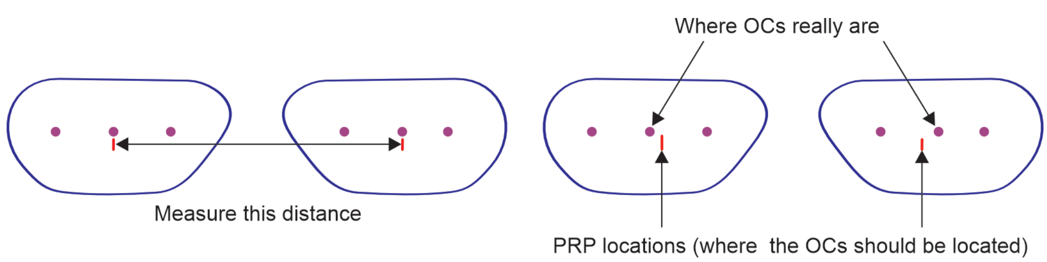


Fig. 6.9: Glance of horizontal unwanted prism

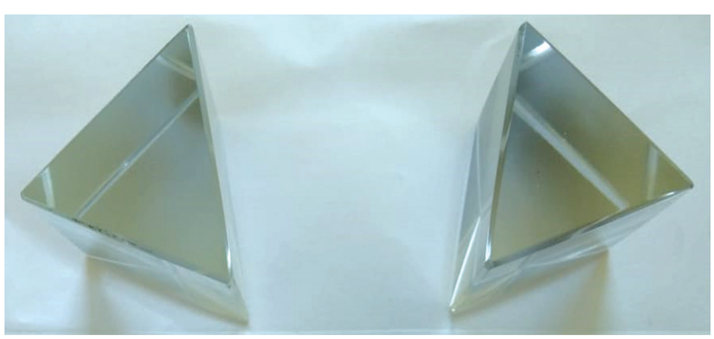


Fig. 6.10: An example of prism

To verify the above prescription, the lens should be placed in the lensometer and moved until the illuminated target is located at 2 units to the left of the crosshair origin **(Fig. 6.11)**.

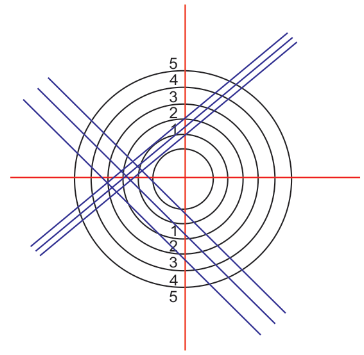


Fig. 6.11: Illuminated target indicating base-out prism

Verification of Lens Segments and Surface

a. **Verification of multifocal segment:** To verify the size and location of the multifocal segment, check the following.
   - Examine the segment height.
   - Check flat-top bifocals for tilt by a ruler.
   - Determine the segment width with the ruler at the segment broadest part.
   - Checking the lens exterior curves, size, and tint. Carefully verify the base curve and look for the visible presence of the war page with the help of the lens clock. War page is determined by both fronts and back surfaces power instead of just one surface power.
   - Note the lens size with order lenses only.
   - Checking for surface defects

   Check for media defects like striae and bubbles in the lens material. Striae typically cause a distortion in the lens. The surface is also inspected for waves (Waves cause' slight variation in lens power.), scratches, pits or areas of grayness.
   - Check for any distortion.

b. Verification of frames and quality of mountings
   - Initially check for the quality of the mounting.
   - The presence and absence of the air space between the lens and the frame revealed the security of the lenses.
   - Check for the style and colour, eye size and DBL, and length of the temple.
   - Inspect the frame damage (scratch or marred surfaces), or rolled eye wires.
   - Overall verification
   - Check the alignment of the frame.

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Chapter 7

Frame Types and Parts

FRAME

The frame is a portion of the spectacles which hold the lens in position and maintain in front of the eyes for visuals.[1] These are found in different styles, design and materials, etc. A-frame mainly consisting of two parts, one in front and another is the sides or temples, which attaches to the front and hook over the ears to help hold the spectacles in place. The frames are the globally widespread optical device that aid human vision.

Mihir Kothari et al. (2014) reported in his study about the poor quality of optical dispensing in children irrespective of their gender, age, type/material or duration of wear. The incorrect frame fitting may have an immediate effect on the compliance to spectacle wear and inappropriate lenses would have a further negative impact on the vision of the patient. He suggested educating parents to improve the quality of spectacle dispensing and also advised patients for a quality check, ideal fitting and quality criteria to ensure an optimum lens and frame dispensing.[2]

The human body is colonized by approximately 1013 microorganisms.[3] A few studies analyzed that spectacle users are environmentally exposed with close contact with their skin, nose, mouth, and frequent contact with hands making it more prone to microorganism contamination and fomites **(especially in surgeon eyeglasses)**.[4] Butt U et al (2012) reported in his study that the frames are highly contaminated with *Staphylococcus epidermis* with an increased risk to a patient during the operation proceedings. He recommended disinfecting spectacles on a regular basis.

PARTS OF FRAME

1. **Frame Front:** It is subdivided into:
   a. Lugs (joint or hinges)
   b. Bridge (nose-pads)
   c. End-piece (guard arm)
   d. Frame rim (eye-wire)
2. **Temple:** Temple is attached to the front and clip over the ears to hold the spectacles in place.

It is subdivided into:

a. Butt
b. Shaft or shank
c. Bend
d. Ear-piece

1. Frame Front

The frame front consists of lugs, bridge, end-piece, and frame rim with some other peculiarities **(Fig. 7.1)**.

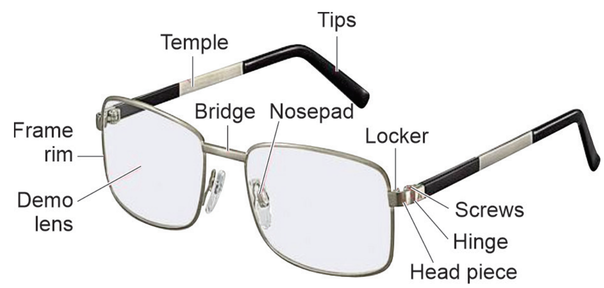

Fig. 7.1: Parts of frame front

a. **Lugs (joint or hinges):** These are moveable joints found on the inside of the frame which allows the temples to fold inward. The spring hinges in eyeglass frames allow the best flexibility with the advantage of hyperextension beyond 180 degrees.
b. **Bridge (nose-pads):** The bridge is the small pieces or a middle part secured under the frame bridge that rest on the nose.[1] It helps to keep the frame in place, provide comfort and a snug fit. On metal frames, nose pads are plastic, while most plastic frames have built-in nose pads.
c. **End-piece (guard-arm):** The end-piece is a small part of the front frame that extends outward from the lenses to connect the front frame to the hinges. The left and right side of the front frame where the temples attach are known as the end-piece. Some plastic frames may still have a metal shield on the front of the end-piece.[1]
d. **Frame rim (eye-wire):** The frame rim is also known as eye-wires. It is the front portion of a metal frame where lenses are inserted and held in place.

Other Peculiarities

- **Screws:** These are small metal or plastic pieces inserted into the hinge to connect the temple to the frame's end piece. It may also be found on the bridge to hold nose pads in place.
- **Lenses:** The lenses are clear or tinted material placed inside the selected frame. It is made up of clear plastic or polycarbonate. There is a variety of lenses available in the market like fully magnified, bifocals multifocal, reading sunglasses, and computer lens, etc.
- **Bifocal:** The bifocal reading glasses have unmagnified lenses that also contain inserts with an abundance of choices in magnification in the lower portion of the lenses.
- **Pad arms:** These are adjustable pieces attached to the frame on one end and the nose pad on the other. They allow room for adjustment, so the glasses fit the wearer's natural face shape.

  Note: The pad-arm is most commonly found on metal frames only.
- **Top bar:** The top-bars are most commonly seen in aviator or trendy frame styles glasses. It is a bar that sits above the bridge and connects the frame around each lens.

2. Temples

These are the long arms on the sides of the frame that extend from the hinge and over the ears to keep the glasses on the face. These are subdivided into 4 parts: Butt, shaft or shank, bend, ear-piece **(Fig. 7.2a and b)**.

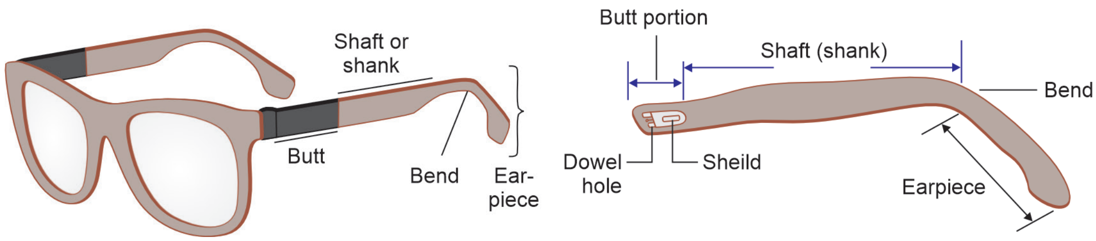

Fig. 7.2a: Parts of temple

Fig. 7.2b: An example of temple frame

a. **Butt (butt-end):** The portion of the temple which is attached to the frame front is known as butt portion or the butt-end.[1]
b. **Shaft (shank):** The shaft is also known as the shank is that part of the temple which lies between the butt end and the bend.
c. **Bend:** The bend is that portion of the temple; where it first bends down to go over the ears.
d. **Ear-piece (temple tip):** The part beyond the bend and behind the ear is referred to as ear-piece.[1] The temple tip is also known as ear-piece is a plastic piece that covers the temple-end where the temples rest behind the ears. It provides extra comfort to the wearer, especially on glasses with metal frames.

TYPES OF FRAMES

1. Plastic Frame

These are made up of plastic material and are occasionally referred to as **Shell Frames**. As in the previous years these frames were made up of tortoiseshell or **Zyl Zylonite (cellulose nitrate) was also termed for these plastic frames**. The plastic eye-wire holds the lens in position within a groove but the lens is generally inserted by heating or stretching the plastic. The plastic frame is thicker and generally heavier than the finer metal frames. These are more colorful and give a different variety of attraction[2] **(Fig. 7.3)**.

2. Metal Frame

The metal frames are those which are entirely made up of metal, except the nose pads and the posterior temple section which are made up of plastic. The eye-wire is completely

Fig. 7.3: An example of plastic frame

Fig. 7.4: An example of metal frame

found around the lens **(Fig. 7.3)**.[1] The benefits of the metal frames is that it is lightweight, limited interference with the field of view or durability[2] **(Fig. 7.4)**.

3. Nylon Cord Frame

The nylon frames are made up of a very tough material which can be used in protective spectacles and sunglasses.[2] The nylon cord frames are sometimes also called, **String mounted frames or Nylon Supra**, which hold the lens in place through the nylon cord. It fits around the edge of the lens and gives the appearance of rimless glasses[1] **(Fig. 7.5)**.

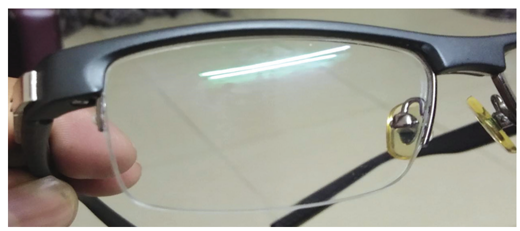

Fig. 7.5: An example of nylon cord frame

4. Combination Frame

The combination frames consist of both plastic and metal in differing amounts. They usually contain metal eye-wire with plastic trims and plastic sides[2] **(Fig. 7.6)**.

Fig. 7.6: An example of combination frame

5. Half Eye Frame

The half eye frame is suitable for those who need only near correction. These are manufactured like so that it sits lower onto the nose than the normal. These are made up of plastic, metal or nylon cord[1] **(Fig. 7.7)**.

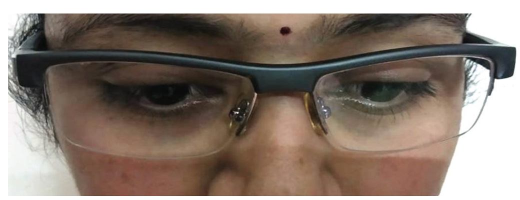

Fig. 7.7: An example of half eye frame

BRIDGE AREA

The bridge is the small area of a frame that can be either made up of plastic or metal.

A. Plastic Bridge

The bridge area of a plastic frame is performed and sits directly on the bridge of the nose. Bridge adjustments surely plastics like nylon, carbon fiber and polyamide are not possible.

Saddle Bridge

The saddle bridge shaped like a saddle in a smooth curve and follows the bridge of the nose.[1]

The weight is spread evenly over the sides and the crest of the nose **(Fig. 7.8)**.

Modified Saddle Bridge

In this the bridge area looks the same as the saddle bridge when viewed from the front. The only difference is the nose pads that carry some weight of the frame are a part of the back of the bridge **(Fig. 7.9)**.

Keyhole Bridge

The keyhole bridge is having a shape like an old-fashioned keyhole. The bridge rests on the sides of the nose and flares out slightly at the top **(Fig. 7.10)**.

B. Metal Bridge

The metal bridge is a pad bridge and is used mainly in the metal frames. In the pad bridge, nose pads are attached to the frame by metal pad arms. In this case the pads alone support the weight of the glasses **(Fig. 7.11)**.

End Piece Construction

Eyepiece construction is the same as the bridge area construction may be of either plastic or metal.

a. Plastic end-piece construction

The plastic end-piece is made up of cellulose acetate, propionate, optyl, polycarbonate, nylon and nylon-based materials like polyamide/co-polyamide, grilamid, rubber, carbon fiber or combination of plastic materials. These are available in three varieties.

Butt type: It is the most common type of end-piece construction in which the front is straight, temple, butt is straight and both meets at the angle of the 90-degree angle.

Fig. 7.8: An example of saddle bridge

Fig. 7.9: An example of modified saddle bridge

Fig. 7.10: An example of keyhole bridge

Fig. 7.11: An example of metal bridge

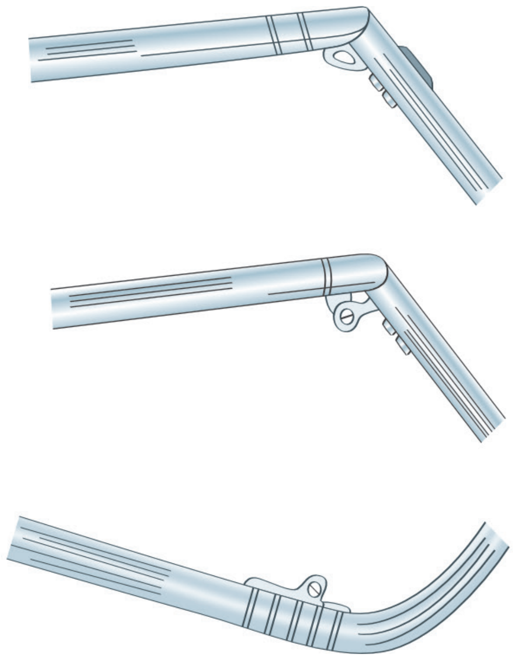

Fig. 7.12: Mitre and butt end-piece

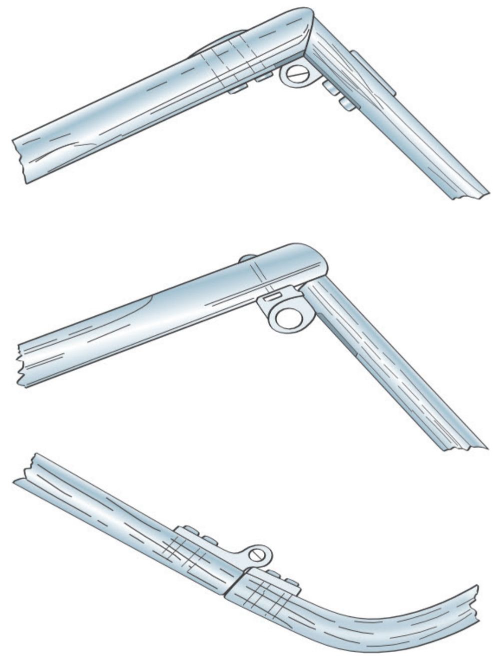

Fig. 7.13: Turn back end-piece

Mitre end-piece: In this type the frame front and temple butt meet at 45 degree angle **(Fig. 7.12)**.

Turn back end-piece: In this type the frame front bends around and meets the temple end to end **(Fig. 7.13)**.

b. Metal end-piece construction

Its construction is similar to that of turn back end-piece plastic frame construction except of an end-piece, some frame fronts and temples are made as the continuous piece.[1] The metal frames is made up of nickel-based materials (pure nickel, nickel silver, and monel metal), aluminum stainless steel, titanium, bronze, magnesium, and other material and alloys.

c. Wrap end-piece

These are typically not the end-piece at all as the end-piece and temple are one continuous piece of material as in this wrap end-piece design.

Temple Construction

The temple length varies and plays a factor in the fit of a frame. There are five major categories of temples **(Table 7.1)**, these are:

1. Skull temple
2. Library temple
3. Convertible temple
4. Riding bow temple
5. Comfort-cable temple

Table 7.1: Categories of temple

S. No.	*Type*	*Description*	*Figures*
1.	Skull	It follows the counter of the skull and bends down behind the ear. The bend-down portion is narrower at the top and widens towards the end.	
2.	Library	Anteriorly it has average width and the width increases posteriorly. They are practically straight and known as straight back temples.	
3.	Convertible	There are varieties of temples. It can be easily straightened out and than re-bent to the wearer.	
4.	Riding-bow	The riding bow are most commonly used in children for safety purpose.	
5.	Comfort-cable	These are same as riding bow with an advanced metal construction behind the ear portion.	

MOUNTINGS

A. Rimless Mounting

Rimless mounting hold the lenses in place with the help of screws, cement, clamps, and plastic post have been used other than the eye-wires or nylon cord. Most of the rimless has two points of attachment in a lens, one nasally and another temporally. The rimless mounting is also sometimes referred to as three piece-mounting.[1]

B. Semi-rimless Mounting

These are similar to the rimless which adhere to the posterior upper surface of the lens. It also joins the centerpiece of the frame to the end-piece. The center piece of the frame mounting has a bridge, pad arms or pads.

C. Numont Mounting

The nasal mounting holds the lenses in place at their nasal edge. It attaches the lens at its bridge area and temple at the metal arm, so that there is only one point on attachment per lens[1] **(Fig. 7.14)**.

Fig. 7.14: An example of numont mounting

D. Bal-grip Mounting

The bal-grip mountings keep the lens in place with clips adjoining to a bar of tensile steel fits into a nasal and temporal notch on each side of the lens. The notches are now mostly used in combination with drilled holes in rimless mounting to lend stability to the mountings[1] **(Fig. 7.15)**.

Fig. 7.15: An example of bal-grip mounting

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Chapter 8

Frame Measurements and Marking

It is enormously imperative to get familiar with the frame markings and measurements to prescribe the correct prescription glasses.[1]

AIM

The main aim of the frame measurements is to ensure that the frame which is selected fits the person or not.[2]

FRAME MEASUREMENT SYSTEM

There are two systems used in frame measurement.

1. Datum system.
2. Boxing system.

1. Datum System

Datum system is the older system was established as a reference point for frames and lenses for the consistent pattern of optical centers and bifocal segments.[1,2] The datum system is used for the lens measurement so that its optical center and focal segment height would be accurate[1] and is located around the datum line.[3] These lines were introduced in the year 1935[3] **(Fig. 8.1)**.

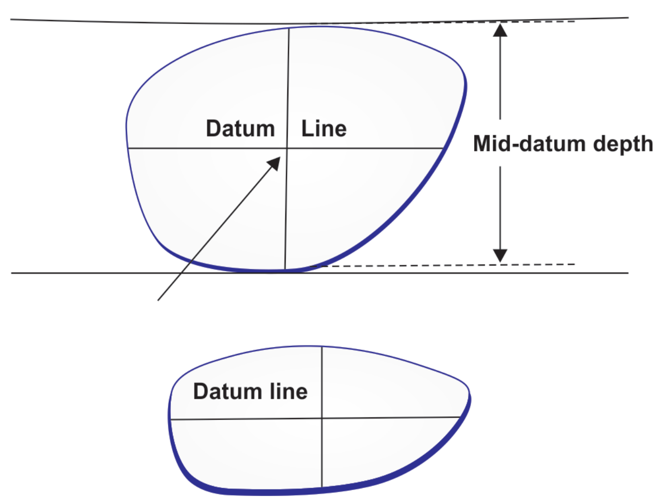


Fig. 8.1: Datum system

In the datum system, with the lens placed in the frame a line drawn halfway between the two horizontal lines one at the top and other at the bottom edge of the lens and parallel to them is known as a datum line.[1] The width of the lens by the side of the datum line is called the eye-size or datum length[1] **(Fig. 8.2)**.

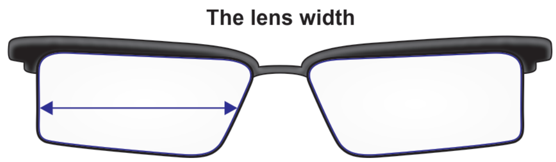


Fig. 8.2: Horizontal diameter of one lens also referred to as "eye-size"

The point at the middle of the edges of the lens by the side of the datum line is datum centre.[1] The vertical depth of the lens measured through the datum center is known as mid-datum depth[1] **(Fig. 8.1)**. As per the international standards, the boxing system has been officially used in the place of datum system.[1, 2]

2. Boxing System

The boxing system was introduced in the year 1962 by the Optical Manufacturers Association to provide a standard for the frame and lens measurement that greatly improved upon the accuracy of previous systems and to get consistent results **(Fig. 8.3)**.

- "A"measurement indicates the horizontal distance between the furthest temporal and nasal edges of the lens shape or the space between the vertical sides of the box."
- The "A" measurement is also generally known as the eye-size.
- "B"measurement refers to the vertical distance between the furthest top and bottom edges of the lens shape or the distance between the horizontal sides of the box.
- "C" indicates the width of the lens along the horizontal midline.

The boxing system is an advanced improvement over the datum system.[3]

1. It is based upon the idea of drawing an imaginary box around a lens shape with the box side's tangent to the outermost edges of the shape.[5]
2. It uses vertical tangents in addition to the horizontal lines by the side of the lens.[1] The system uses the sides of the boxes as reference points for the standard system of measurements.
3. It forms the box with horizontal and vertical tangents **(Fig. 8.2)**.[1,3]

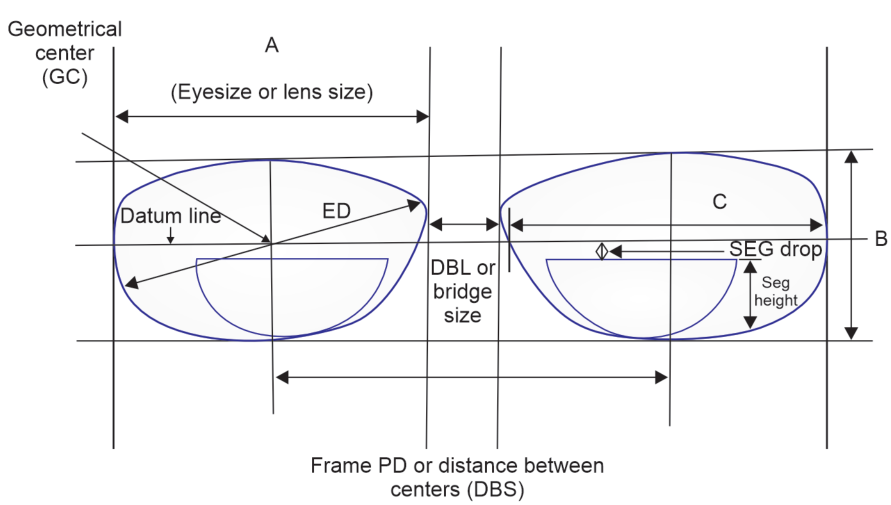


Fig. 8.3: Boxing system

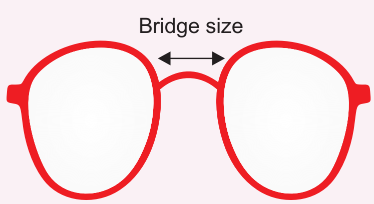
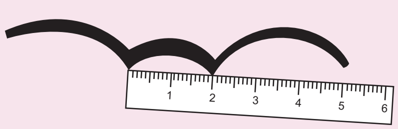
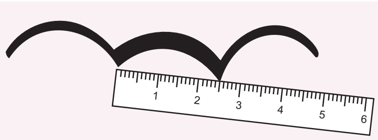
4. The ISO and other frame manufacturers follow the boxing system.[3]
5. The boxing system is also used by the automatic edging machines to determine lens center heights.[3]

Terminologies for Spectacle Frames

1. **Horizontal mid-line:** It is a horizontal line passing through the midway of top and bottom tangents and is also known as 180 degree line.[1]
2. **Vertical centerline:** It is the vertical line passing through the midway of the side tangents of the lens.
3. **Geometric center:** The central point in the lens at which both vertical centerline and horizontal centerline intersects is called the geometric center or boxing center.[1]

   Size: It is the distance in mm between the vertical and horizontal tangents. The Horizontal lines are named as the eye-size in reference to the frame and the lens-size in reference to lens[1]. The practitioners clinically investigates the eye size or lens size denoted by the letter "A", "B", and "C". The letter "A" indicates the horizontal measures of the lens, the letter "B" denotes the vertical measures of the box including the lens and the "C" is the width of the lens by the side of horizontal midline which is rarely used.[1]
4. **Effective diameter:** The effective diameter of a lens can be calculated by twice the distance from the geometrical center to the apex of the lens diagonal farthest from it.[1, 4]
5. It is used in combination with decentration distance to select the minimum lens blank size required to fit a given frame.[4]
6. **Distance between the lenses and bridge size (DBL):** It is the distance between the nasal edges of the lenses when both lenses are boxed off in the frame.[1, 4] DBL is also known as bridge size[1] and is measured in mm. This is not necessary that the two frames having the same DBL fit the same person in the same manner because of the alteration in lens shapes **(Table 8.1)**.

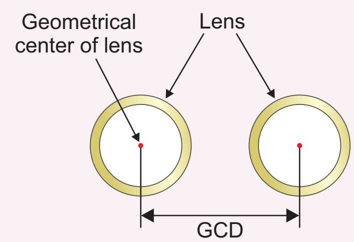
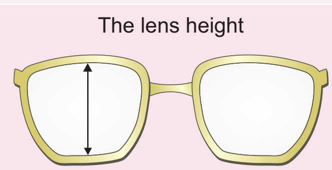
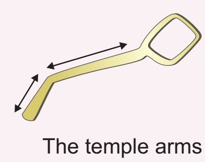
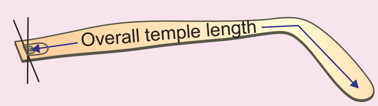
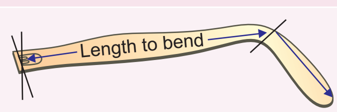
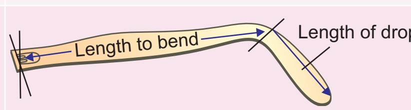
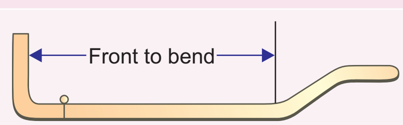
Table 8.1: Bridge lenses with their measurement on metal and plastic frame

	Bridge size
 Measuring DBL on a metal frame	Measuring DBL on a metal frame (frame edge to frame edge—20 mm)
 Measuring DBL on a plastic frame	Measuring DBL on the plastic frame (frame edge to frame edge—25 mm).

Frame Measurement

Table 8.2 gives measurement and description of frame.

Table 8.2: Measurement and description of frame

S. no.	*Measurement*	*Descriptions*	*Figures*
1.	Geometric center distance (GCD)	The geometrical center distance is the distance between the 2 geometrical centers of the lenses. It can be measured easily as the distance between the left side of one box to the left side of another box[1] or it can be easily calculated by adding the eye-size to the distance between the lenses. GCD is also known as. 1. Distance between centers (DBC) 2. Frame center distance (FCD) 3. Frame PD (FPD) The terminology frame PD is indicated in dispensing and does not correlate with the wearer's Interpupillary distance	
2.	Seg height/ seg drop	The vertical distance between the bottom edge of the box and the top of the bifocal or trifocal segment.[1,4] The distance between below the horizontal midline and top of the bifocal or trifocal segment.	
3.	Temple length	The temples are the long stems of the frames that connect the anterior eyewear to the back of the head just behind the ears. It is marked with the total or overall temple length and is measures in MMS. Most of the frames have temples that range in length from 120 to 150 mm.	
4.	Overall temple length	The distance from the middle of the central barrel screw to the end of the temple. During the measurement of overall temple length, it is necessary to measure by the side of the bend also, not in a straight line unless the temple is straight.	
5.	Length to bend	It is the distance between the center of the barrel and the middle of the bend.	
6.	Length of drop	The distance from the middle of the bend to the edge of the temple is known as length of the drop.	
7.	Front to bend	A distance from the plane of the front of the frame to the end of the temple.	

Frame Marking

It can be done.

- Frame size with the measurement of eye-size.
- Distance between lenses.
- Temple length.

The metal frames which are manufactured with rolled gold are also marked according to the amount of gold present in the frame.[1]

Frame Difference

The difference between horizontal and vertical measurement is known as the frame difference. It is also known as lens difference and is measured in MMS **(Fig. 8.4)**.

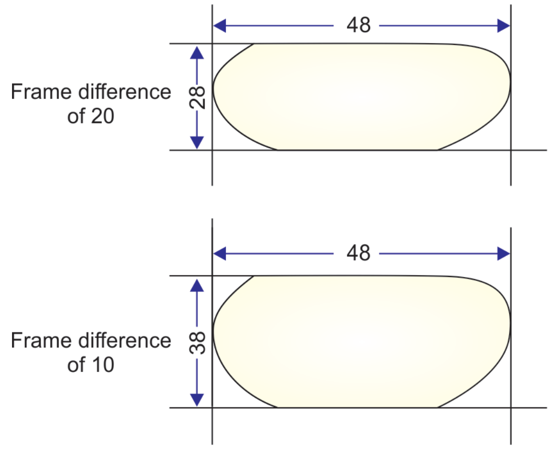


Fig. 8.4: Diagram illustrating the frame differences

The Eye size and Distance between Lenses (DBL)

If the prescribed marking is as 70 and 40, this means that 70 mm is eye size and 40 mm is DBL and the box in between means that this marking is done with the boxing system method.[1]

This marking is sometimes also written as 70–40 or 70/40. The sites of markings are discussed in **Tables 8.3 to 8.5** for frame and lens in details.

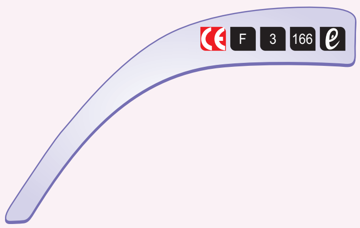
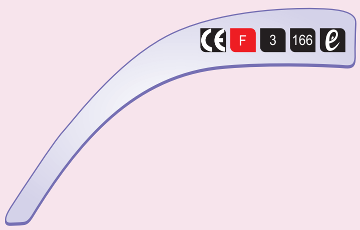
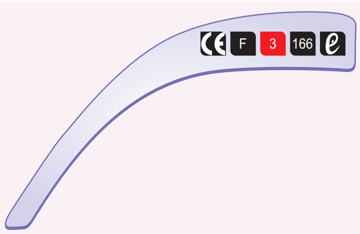
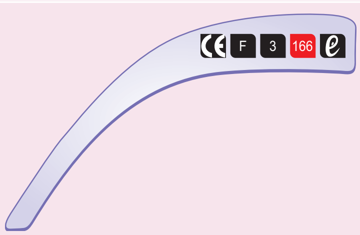
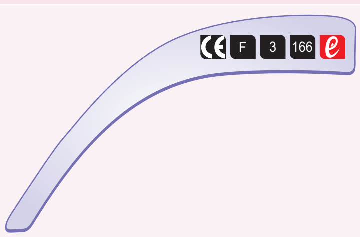
Table 8.3: Site of markings

On plastic frames	• The marking is accomplished in several places. • The visible marking can be carried out inside the nose pad or in the upper outer section of the eye-wire. • It can on top be noted on the posterior side of the eyepiece. • It is also observed that eye-size in some frames are carefully marked on one end-piece and the DBL on another. • Erratically all the 3 specific measurements are marked on the temple with the temple length on the inner side of it.
On metal frames	• The metal frame has markings inside the bridge.
*Country of origin, manufacturer and frame name must equally be marked on the frame. Many manufacturers capitalize on a number instead of a name.	

Safety Frame

The safety glasses generally trait a solid and durable frame than the standard glasses. The frame having "Z87" or "Z87-2" with the name or logo of manufacturer stamp on the frame front and temples is specified by the American National Standards Institute, or ANSI also known as American National Standard Practice for occupational and educational eye and face protection, has developed standards to ensure that safety frames meet the terms incorporating the proper materials to indemnify its impact resistance property. The frame must be stamped and marked with the ANSI designations as according to recent updates of ANSI Z87.1-2010 standards followed by "plus-Sign" which means they are impact-rated. If the frames are not marked with these designations along with plus marking they can be considered as not impact rated no safety glasses[5] **(Table 8.6)**.

The system used to determine the amount of gold present is the karat system.[1]

<table>
<tr><th colspan="3">Table 8.4: Frame markings</th></tr>
<tr><td>1.</td><td></td><td>CE = Certification mark</td></tr>
<tr><td>2.</td><td></td><td>F = Mechanical strength
<table>
<tr><td>S</td><td>F</td><td>B</td><td>A</td></tr>
<tr><td>Increased strength</td><td>Low energy, impact, resist a 6 mm, 0.86 g ball at 45 m/s</td><td>Medium energy impact, resist a 6 mm, 0.86 g ball at 120 m/s</td><td>High-energy impact, resist a 6 mm, 0.86 g ball at 190 m/s</td></tr>
</table></td></tr>
<tr><td>3.</td><td></td><td>3 = Field of use (where applicable)
<table>
<tr><td>None</td><td>3</td><td>4</td><td>5</td><td>8</td><td>9</td></tr>
<tr><td>General use</td><td>Liquid droplet of splashes</td><td>Large dust Particles >5 μm</td><td>Gases & small dust particles <5 μm</td><td>Short circuit electric arc</td><td>Molten metals and hot solids</td></tr>
</table></td></tr>
<tr><td>4.</td><td></td><td>166 = No. of the EN standard</td></tr>
<tr><td>5.</td><td></td><td>e = Identity of the manufacturer</td></tr>
</table>

Fine gold: It only contains gold (100%).With the karat system, the pure gold is of 24 karat fine means all the 24 parts are of gold.

Solid gold: It is an alloy and consisting of metals besides with the gold (a mixture of gold and base metal). The symbol is used for a 12K solid gold bridge and ∅ is for a 10K solid gold bridge.

Gold filled: The gold-filled are made up of metal and having a coating of gold.

Gold plating: These are made of metals but its surface is plated with gold by an electrolytic process.

Gold flashing: It is the method in which gold applied in the same manner as gold plating is done. It is done by using a cyanide-based bath.

Table 8.5: Lens markings

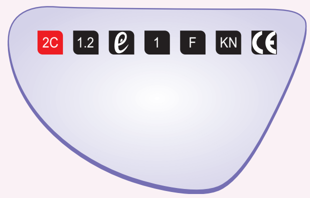
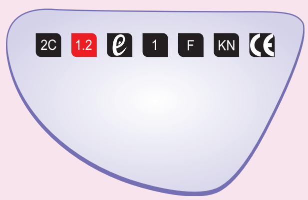
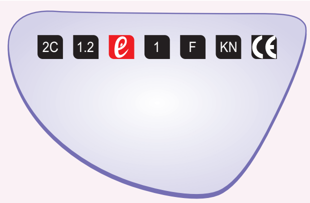
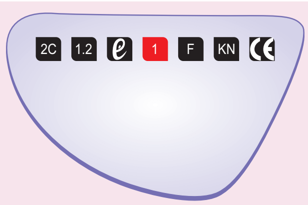
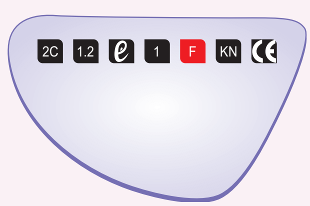
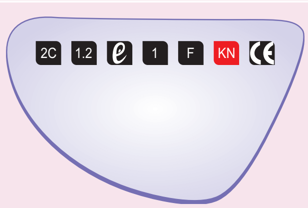
1.		**Lens filter type protection** 2,2C — UV (2C does not affect colour recognition) 4 — IR filter 5 or 6 — Solar filter 1.7 to 7 — Welding filter if no shade number
2.		**Scale number (shades)** 1.2 — Clear or amber 1.4 — Blue or waterproof 1.7 — Minimizes or I/O 2.5 — Grey or revo 3.1 — Dark grey or mirror
3.		**℮ = Identity of the manufacturer**
4.		**1 = Optical class (high optical quality)**
5.		**Mechanical strength** S — Increased strength. F — Low energy impact resists a 6 mm, 0.86 g ball at 45 m/s. B — Medium energy impact resists a 6 mm, 0.86 g ball at 120 m/s. A — High energy impact, resists a 6 mm, 0.86 g ball at 190 m/s.
6.		**Optional requirements** 8 — Short circuit arc 9 — Molten metal splash K — Resistance to scratches by fine particles N — Resistance to fogging
7.		**CE = Certification mark**

Table 8.6: Safety measures in frame	
Plastic frames	The plastic frames tested for its impact resistant with unbroken able properties and to approach a quality product, the lenses must be made up of polycarbonate.
Metal frames (Fig. 8.5)	The wire or metal frame typically gives under pressure and provide side-shield so its difficult for the object to pierce peripherally.
Tinted safety glasses	It also features some special designations as follows. • "L" + a number – the visible light filter rating. • "R" + a number – the infrared filter rating. • "V" – photochromic or transition lens designation. • "S" – Special-purpose lens designation. • "U" + a number – the ultraviolet light-scale rating • "W" + a number – a welding designation, including the lens shade number.

Fig. 8.5: An example of metal frames with gold content

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Chapter

9

Spectacle Frame Material

The spectacle frame is a very simple object in appearance shaped by various synthetic materials and metals. Many of them have combined materials.[1, 2] The options of frames are never-ending and are available in a huge selection of sizes, styles and materials. For fashion-conscious people, the multiple choices and variety of designs are available in the market. Many new and advanced varieties of safety frames are also introduced for childrens.[3] The companies are manufacturing various newer and improved materials and design frames that are lightweight and comfortable and user-friendly.[4] The basic function of the frame is to maintain the corrective lenses in the original position required until such time as they need to be changed.

Properties of Frame Material

An ideal frame should have the following properties[2]

1. The material needs to be firm and flexible.
2. It should be corrosion-resistant.
3. It should be cheap, durable, and non-allergic.
4. Easily adjustable to the wearer face.
5. Prior assembling into the frame, it should be carefully tested and operated.
6. It must also evolve with the wearer tastes and allows for shapes in the current fashion.

CLASSIFICATION

There are varieties of frame material available for spectacle frames, these are:

I. Plastic materials.
II. Metals and alloys.

I. Plastic Material

The name is used for any material of macromolecular structure which can be deformed by heating with or without some kind of mechanical action (thermohardening or thermosetting). The first plastics which were used for the manufacturing of spectacle frames were **Bakelite and Galalith**. Its disadvantage is the poor performance and brittle property in the damp cold climate because of their frangibility. The cellulose nitrate (zylonite) was the next most widely used material but the cons are it can burn too easily.[1] Most of the plastic spectacle frames is made up of ‘zylonite’ or “propionate.’ The other material used is polyamide, nylon, polycarbonate, carbon and opty[1]. These are considered as hypoallergenic.[3]

Types of Plastic

The plastic are divided into two groups:
1. Thermosetting (thermo-hardening) and
2. Thermoplastic (thermo-softening).

Description of Materials Used in Frame

1. Cellulose acetate

During the First World War in the year 1915, the cellulose acetate is used for aircraft wings. It is a clear thermoplastic polymer.[3] This is the best and probably the most common plastic frame available in the market.

A cellulose ester is obtained by the chemical reactions of the base element and cellulose which is exposed to the action of a mixture of anhydride and acetic acid using concentrated sulphuric acid as a catalyst. The cellulose acetate is manufacture by plasticizing cellulose ester with added dyes at 80°C for a period of 90 min in a spiral mixture. This mixture is then put into the cylinder machine, mixing it with the helix at about 200°C. The mixed material is drawn through a dye to make a strip and made-up into pellets which will be used as such by the manufacturers.

It softens around 50-degree temperature so intend to damage by the excess heat. Frames which are made from cellulose acetate are also called **Zyl frames**.[3] The improved quality frames of cellulose acetate are coated to seal the surface, when left uncoated; it may absorb materials that might produce allergies[1] **(Fig. 9.1)**.

Advantage

1. It is very strong.
2. It is light-weighted.
3. Mechanically stable at normal temperature.
4. It can easily work and relatively inert.
5. It is cosmetically attractive.
6. It is made up of transparent material.

Fig. 9.1: An example of cellulose acetate frame

Disadvantage

1. Skin allergies

2. Cellulose propionate

It is also referred to as propionate with properties similar to that of cellulose acetate. It worked easier for injection molding.[1] This is lightweight and cares must be taken when heating. Adjusting frames made with this material because it will shrink with overheating.[3] Cellulose propionate is a material of choice for manufacturers because it is much cheaper to produce propionate by injection molding and is colored after manufacturing **(Fig. 9.2)**.

Fig. 9.2: An example of cellulose acetate frame

3. Optyl

Epoxy resin now known as Optyl is a thermo-hardening material like ORMA CR39, but unlike other plastic it is very powerful. The frames made with Optyl are more difficult to adjust because the material can return to its original molded shape; this quality of Optyl makes Optyl a unique frame material. It also has considerably greater durability than any other material **(Fig. 9.3)**.

S. no.	*Role*	*Features*
1.	Advantage	a. Lighter b. Hypoallergenic c. Low flammability d. Very hard, durable surface
2.	Disadvantage	a. Gain its original shape if overheated b. It cannot be repaired

4. Nylon

Nylon is a highly flexible, light-weighted and almost made up of unbreakable material. This type of frame is often chosen for safety purposes (industrial safety spectacles) and also for sport activites.[1] The material used is typically gliamides, grilamid or trogamid which are highly resistant to hot and cold[3] **(Fig. 9.4)**

S. no.	*Role*	*Features*
1.	Advantage	a. Light-weighted b. Low flammability c. Strong and flexible d. Not affected by heat or cold
2.	Disadvantage	a. Very difficult to adjust b. Poor surface quality c. Manufactured only in darker colours d. Frame can become brittle over time

5. Carbon fiber

This material is used to make a thin, strong spectacle frame. It is made from nylon mixed with strands of carbon fiber **(Fig. 9.5)**.

S. no.	*Role*	*Features*
1.	Advantage	a. Strong b. Good shape retention c. Lightweight d. Low flammability
2.	Disadvantage	a. Difficult to adjust b. Not available in transparent colours c. Brittle when dropped

6. Rubber (Fig. 9.6)

- Rubber frames are made from the combination of nylon and rubber and used for sports eye-wear and sunglass frames.[1]

Fig. 9.3: An example of cellulose acetate frame

Fig. 9.4: An example of nylon frame

Fig. 9.5: An example of carbon fiber frame

Fig. 9.6: An example of rubber frame

- It is also known as 'soft flexible material'
- It is used for making bridges, side-tips, rim-liners of the spectacle frames.

7. Titanium (Fig. 9.7)

- Titanium is a very light-weighted material.
- It will not corrode.
- It is the most expensive frame material used in the spectacles.
- It is very thin allowed by its strength.[1]
- It also holds its adjustment well.
- This material is also known by its other brand in the market as **alpha-titanium** and **beta-titanium.**

S. no.	*Role*	*Features*
1.	Advantage	a. Hypoallergenic b. Easy to adjust and align c. Greater durability d. Holds its adjustment well
2.	Disadvantage	a. Most expensive metal frame material b. It cannot be easily repaired

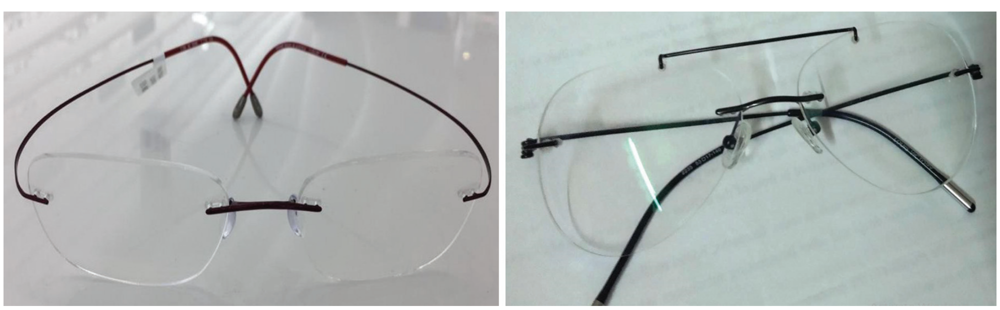

Fig. 9.7: Examples of titanium frames

Stainless Steel (Fig. 9.8)

Stainless steel was developed in the early twentieth century before it some frames were made from no stainless steel material. This material is resistant to corrosion and mainly made from iron and chrome.[1] It is mainly useful for those patients who are allergic to nickel.

S. no.	*Role*	*Features*
1.	Advantage	a. More durable b. Useful for people with a nickel allergy c. Easy to adjust and align
2.	Disadvantage	a. Cannot be repaired b. Relatively high

Fig. 9.8: An example of stainless steel frame

Kevlar (Fig. 9.9)

- Kevlar is strong, light-weighted ophthalmic material mixed with nylon.
- It was developed by DuPont for the use in the bullet-proof vests.
- It can withstand high impacts as experienced in the sports events.
- It remains stable at the high temperature range.[1]
- It is having Un-shrinkable property.
- It comes in a few colours.

Fig. 9.9: An example of Kevlar material frame

Polycarbonate (Fig. 9.10)

- It is also known as lens material, but it can be molded into frames.
- It is made from polycarbonate for safety and sports purpose.
- It is more impact resistance than the other frame materials.

Fig. 9.10: An example of polycarbonate type safety frame

II. Metal and Alloy

- The metals are used for making a spectacle frame.
- Some of which also contain gold. These frames only require heat to adjust the temple ends so as to avoid cracking the plastic end-pieces.

Nickel Silver

It is a type of common frame material which is mainly used in hinges, end-pieces and heavy bridges, and for the inner care of temples. It is mainly containing 25% nickel but mostly copper (more than 50%) **(Fig. 9.11)**.

Fig. 9.11: An example of nickel and alloys material frame

Aluminum

- Aluminum is very lightweight and stronger.[1] It is difficult to solder or weld, limiting its adaptability to different designs. It can accept a verity of colors, and chemical anodizing is sometimes used to create black, brown and gold colors.[2] It is soft material so side is made thick. It is a very good conductor of heat hence becomes very cold in winters and not in summers **(Fig. 9.12)**.

Fig. 9.12: An example of aluminum alloy half rim frame

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Chapter

10

Frame Selection

INTRODUCTION

The frame selection is the basis of being fashionable and looking good for all the spectacle wearers. The frames are available in wide varieties. Prior to the fitting of eye-glasses, it is recommended to select the frame which suits the face aura keeping in mind that frame may either fits or they do-not.[3]

Benefit of Frame Selection[2]

It is highly recommended to select the frame before fitting into the glasses because of the following reasons:

- It is more time-efficient.
- It provides greater satisfaction to the patient.
- It helps in gaining preferred dispenser status.
- It passively facilitates the spectacle advertisement.

Application of the Old Frame

It is not apt condition for the wearers to use the old frame for an extended period of time in place of choosing a new frame.

Consideration Prior Applying Wearer's Old Frame

There are particular safety measures that should be considered before using the frame for the new prescription and these are:

- While fitting the new lenses in the wearer's old frame could cause additional stress on the frame which can break it.
- Occasionally the frames may withstand the stresses due to new lens fitting but may break shortly after a moment in time.
- It cannot be predicted how long an old frame will last so the new lenses must be fitted in the new frame.
- If repairing is needed in the wearer old frame so their parts will be available in the market or not.
- Using the old frame eliminates emergency breakup.
- While using the older frame one should consider that frame are in style or out of style.

Cosmetic Deliberation

Cosmetic consideration is very important during the frame selection, and one should prescribe the framework of current eyewear trends.[1]

Facial Types and Frame

The followings are the dimensions while selection of frames on the basis of face shape[1]

- The frame form ought to distinction with face form.
- The frame size should be of face size.
- The eyewear represents the patient's best feature.

Oval Face (Fig. 10.1)

Features

- The oval face is considered to be one of the ideal the type.[1,3]
- It is epitomized by the Leonardo da Vinci's Mona Lisa.
- This shape represents the chin slightly the narrower than forehead with defined high cheekbones.[3]

Frame for Oval Face

- The major advantage of an oval face is that it can wear any type of frame.[1]
- The frame should be wider than the widest part of the face.
- It does not use a low dropped temple in oval shape.[3]

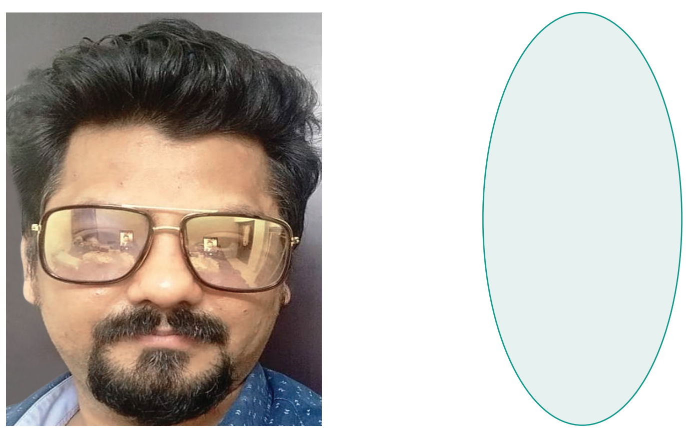

Fig. 10.1: Oval face

Round Shape (Fig. 10.2)

Features

- The round shape is more circular than the oval.[1]
- Its width and length is in same proportion.[3]

Frames for Round Shape

- The round shapes frame is slightly angular frames or narrow frame.[1,2]
- It should have high or mid-height temples.
- Frames for round shape are wider than they are deep.[2]
- It does not use excessively round or square styles.

Fig. 10.2: Round shape

Oblong Shape (Fig. 10.3)

Features

The oblong shapes are thinner and longer than it is wide with long, straight cheek line.[1,2]

Frames for Oblong Shape

- These are round, deep or low triangle shapes.
- The oblong shapes are decorated with contrasting temples.

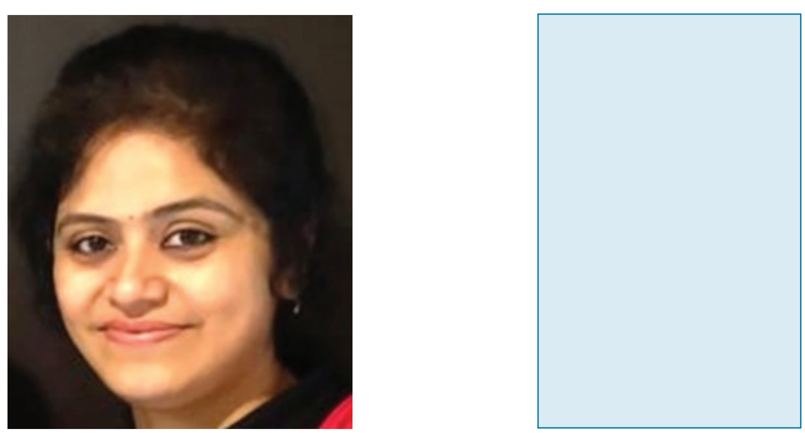

Fig. 10.3: Oblong shape

Square Shape (Fig. 10.4)

Features

The square shape person has a broad forehead, wide chin, cheekbones, and strong jawline.[1,2]

Frames for Square Shape

- These are gently curved with narrow style.
- These are wider than the widest part of the face.
- It is more horizontal than vertical.
- These are frames with weight on the top.[3]

Fig. 10.4: Square shape

Diamond Shape (Fig. 10.5)

Features

- In the diamond shape the central section of the face is wider.
- It is narrow at the eye line and jawline with a small, forehead and chin.
- This shape has a high, dramatic cheekbone.[1,3]

Frames for Diamond Face

- These are available in square frames, light or medium weight frames.
- These are obtainable in lighter color frames.
- The frame sides are straight or rounded.
- The demerit is that it does not use lowered temple frames.[3]

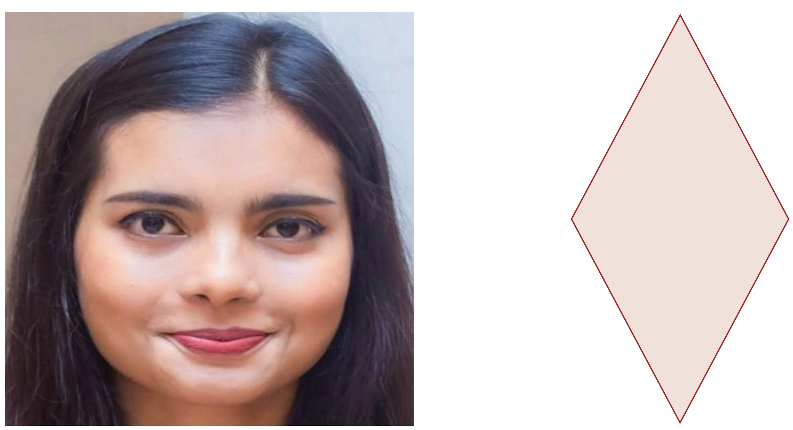

Fig. 10.5: Diamond shape

Triangle Shape (Fig. 10.6)

Features

- Triangulum face includes a slim forehead.
- The lower part of the face is wider.[1,2]

Frames for Triangle Shape

- The triangle shape frame fits into the size with the largest part of the lower facial area.
- These are darker in color.
- Its top is slightly heavy.
- The bottom angle inward.[3]
- Demerit

Do not choose low temple styles.


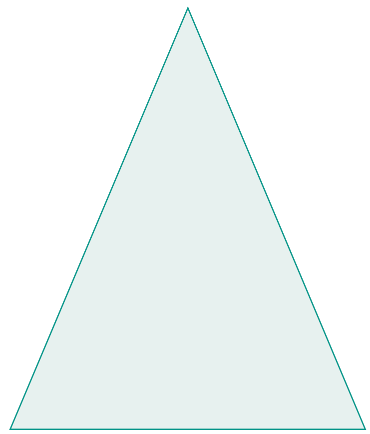

Fig. 10.6: Triangle shape

Heart Shape (Fig. 10.7)

Features

Wide/high foreheads, high cheekbones, narrow gradually to the chin.

Frame with Heart Shape

- The frames with heart shape are wider at the bottom.
- It has low temples, rounded tops and squared bottoms.[3]


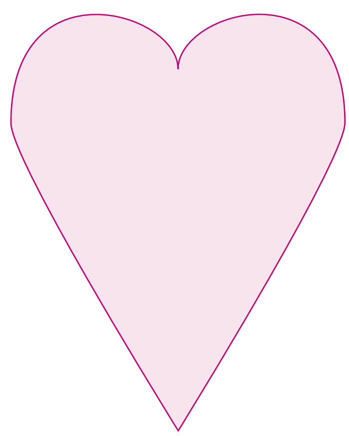

Fig. 10.7: Heart shape

Facial Features and Considerations for Frame Selection

1. **Frame lines**
   a. The upper part of the frame or upper rim should have the same shape as that of the eyebrows.[1]
   b. Mild deviation in it can result in a different look.
   c. Desirably the upper rim of the frame should follow the lower edge of the eyebrows. This is not always possible, some may prefer above the eyebrows.
   d. The most important thing to be kept in mind while dispensing the conventional eyewear is following the basic line of the eyebrow by the upper line of the frame in any case.
   e. The lower area is concerned with the lower rim which can add a lift to a face.
   f. Use an upsweep on either upper or lower rim of a frame.
   g. The use of lower rims is to help in hiding the bags under the eyes.
   h. These individuals should choose the dark color frames which can properly hide the bags.
2. **Frame colour**
   a. The frame colour should be noticed carefully.
   b. The skin color, eye colour, and hair color is of great worth in providing clues to the suitability of the eyewear colour.[1]
3. **Clothing and accessories:** It can be applied to choose the proper eyewear
4. **Hair**
   a. The people with thicker and darker hair should wear heavier, darker, and bolder frames.
   b. The person with gray hair should use frames of silver, pale or blue tint colour frames.
   c. Those with blond, light brown or red hair can wear a gold colour frame.
   d. The person with black or extremely dark hair can wear a gold or silver colour frame.
   e. The one with salt and pepper hair should use a silver frame.
5. **Facial features**
   a. The smaller and more delicate facial features can use lighter colour frames.
   b. The person with the heavier feature should use the darker colour frame.
6. **Narrow and wide-set eyes**
   a. The person whose eyes are narrow should use low-set, thick dark bridged frame.
7. **Lens tint**
   a. The look enhances by the tinted lenses, and it should be co-ordinate with the frame.
8. **Frame thickness**
   a. The person with larger and broader facial features should use thicker frames.
   b. The person with normal features (large and small features) should use medium thickness.
   c. The lighter frames are better for the small delicate features.[1, 2]
9. **Lengthening nose**
   a. To lengthen the nose, a type of frame is chosen that exposes the nose as much as possible.
   b. The frame in (a) is correct; (b) is incorrect **(Fig. 10.8a and b)**.

Bridge Designs

Table 10.1: Bridge design

S. no.	*Bridge design*	*Specification*
1.	Shorter nose	A lower bridge frame should be used. The bridge "a" is correct while the bridge "b" is incorrect **(Fig. 10.9a and b)**.
2.	Narrow nose	The high, thin bridge style frame should be used **(Fig. 10.10a)**.
3.	Wide nose	The low-set vertically wide bridge is ideal[1] **(Fig. 10.10b)**.
4.	Long nose	The low dark, straight bridges style is used.[2]
5.	High forehead	Ideally a frame that is even with the brow and slightly higher is used.[2]
6.	Wide jaw	It is recommended to use a narrower frame.
7.	Narrow face	Recommended decorative or contrasting temples.

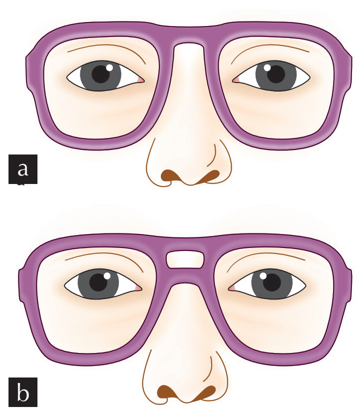

Fig. 10.8a and b: Lengthening nose

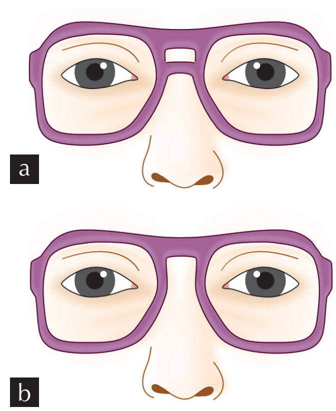

Fig. 10.9a and b: Shorter nose

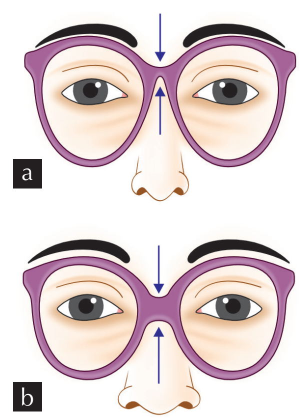

Fig. 10.10a and b: (a) narrow nose, (b) wide Nose

Fitting Consideration (Table 10.2)

The Bridge

In plastic frame, the bridge is determined by its weight on the nose.[1] The appropriate bridge is determined by (a) width and position of pads, (b) frontal angle, (c) flare angle, splay angle of the pads and (d) vertical angle of the pads.

Children's Bridge

- The children between the age-group of 3 and 18 years have a slight change in the crest angle of the nose.
- The main change is in the splay angle and depth of the bridge.
- The frames used in children should fulfill the following criteria:
  a. It should have more support at the bottom of the nose pad area.
  b. It should have a larger pad splay angle.

Temples

a. The comfort-cable or riding bow temple should be used inactive people.
b. These cables are recommended for off and on wear for the person with unusual head posture during work and in young children.

Table 10.2: Various angle specification

S. no.	Nasal angles for fitting	Specification
1.	Frontal angle	• The angle in which each side deviates from the vertical is called the frontal angle **(Fig. 10.11)**. • It will be noted from the two sides of the frontal angle. • Its apex is on the forehead, base is towards the nostrils and tip of the nose. • In this type of the frame is used who's inner bottoms rim or top of the bridge crest rest on the nose.
2.	Splay angle	• In this type of angle the nose becomes wider as it reaches the inner corner of the eyes. • The front of the pads or eye wire will cut into the side of the nose.
3.	Crest angle	• The crest angle of the nose is visible once the face is turned to the facet. • It is the angle from the base to the top along the vertical plan **(Fig. 10.12)**.

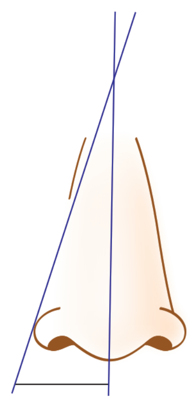

Fig. 10.11: Frontal angle

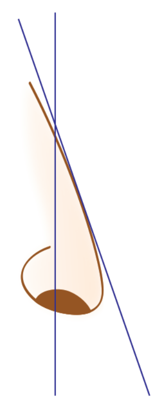

Fig. 10.12: Crest angle

c. These temples are useful in person with the straight back alignment.
d. The skull style temple is useful for normal everyday wear.

Precaution

- It should not be used in heavy lenses.
- In-person with parallel-sided noses
- In-person with flat noses.
- In the frames with weak fronts.

Selecting Frames for the Progressive Wearers

a. The progressive wearer should have a minimal vertex distance and an adequate pantoscopic tilt.
b. Progressive wearers require minimal vertex distance because of relatively small viewing areas.
c. The frame with an adequate pantoscopic tilt brings the reading portion of the lens closer to the eyes.
d. Good frames for progressive lenses are those which have sufficient vertical depth and limited nasal cut.

e. The designs are that which have excessive vertical depth in the inferior, nasal portion of the shape **(Fig. 10.13)**.
   i. This progressive lens frame is not good to use.
   ii. This frame is used for progressive if the frame is designed for a narrow vertical dimension.
   iii. The best frame style for progressive lenses.
   iv. Not always cosmetically appropriate.

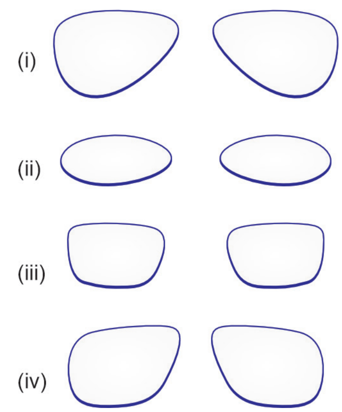

Fig. 10.13: Types of lens design

Frames for High Minus Wearers

Size of the Frame

a. A large size frame should be avoided.
b. The frames having rounded corners should be used.
c. The excessive decentration should be avoided.

Lens Material

The lens material should be:
a. Low index.
b. CR-39.
c. Made up of polycarbonate lenses.

Selecting Frames for High Plus Wearer

Size and Thickness

a. The large lenses should be avoided because with a large lens there is an increase in the central thickness.
b. The frame which has an effective diameter of more than 2 mm is larger than the eye size.

Frame Difference

a. It is an additional factor during the selection of the frame for high plus wearer.
b. The difference between the horizontal and vertical measures of the lens.
c. For the plus lens wearer, frame difference should not be greater than 9 mm.

Frame Characteristics

a. A-frame should properly align with the distance optical center of the lens to be positioned properly before the eyes.
b. The frame should be selected in such a way that it can hold the lens as close as possible.
c. The wearer's eyelashes should not touch the back surface of the lens.
d. Nose-pad should be adjustable.

Selecting Frames for Children

1. During the frame selection, safety measures should be of first concern.
2. The frames of the children should be sturdy.
3. The solid frame should be used (metal and plastics).
4. The lens groove of children must be deep.
5. The nylon cord frames, shallow groove frame, highly impact resistances frames should be avoided.

6. The high-quality spring temples are recommended for children.
7. The polycarbonate and Trivex lenses are used for children.

Selecting Frames for Older Wearers

a. The frame with light eyeglasses should be recommended for older wearers.
b. Its bridge should be fit correctly.
c. The larger pads frame must be used when available.

Selecting Frames for Safety Eyewear

a. These are available in a large variety of styles.
b. The safety frames should have the marking of "Z87" or "Z87-2" on both the temples and frame fronts.
c. In case, where electrical hazards are available, metal frame should be avoided.
d. Side shields are necessary when the eye can be injured from the sides.

Devices for Frame Selection Process

- Bring a friend.
- Use a trial lens.
- Use a visio choix.
- Use a video system.
- Computerized image—capturing system.

Closing the Frame Selection Process

The following are some of the suggestions.

a. Let each person make his or her own decision in selecting the cost of the frame.
b. Do not underestimate a person's financial situation by only showing less expensive frame.
c. Do not categorize the person's face as a certain shape is for them. Sometimes patients may not agree with you. Be diplomatic.
d. Do not force for certain frames if the wearer does not like it, even after it may be best for him/her and be optically better.
e. Do not advise unsafe and optically unsound frames.
f. Do not spread out a large number of frames at any one time. The patient may get confused.
g. Help the patient in choosing the best frame out of two selected frames.
h. Be sure during the frame selection only positive aspects should be pointed out.

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Chapter

11

Frame Adjustments

SECTION A

Frame Adjustment

The art of dispensing has evolved from monocles and rivet frames to today's metallic, plastic and rimless frames with adjustable nose pads and spring hinges.[11] A proper fitting of eye-glasses is needed for a good vision. The frame, if used for an extended period of time can pinch the nose, may hurt an individual's ears, or simply appeared crooked, so the adjustment of the frames is obligatory.[3] It is suggested to adjust it by a licensed optician as they are familiar with the techniques and can customize the frame according to the face type via adjusting its bridge, nose pads or temples into proper alignment using a combination of hands, pliers, and heating equipment, etc. It is very important for the user to have adjusted their frame glasses for smooth work-execution and comfort so that it can give a desirable fit all day and every day.[4]

Complaints Etiology

The fundamental factors to satisfaction are.

1. Physical features of individuals.
2. Fitting of glasses to individuals.
3. Adaptation of the individual.

The poorly fitted spectacle frame may be neglected by an individual even if the prescription is correct.[1]

Adjustment of the Frame

The spectacles fit according to the following parameters.

1. Frame width.
2. Arm length.
3. Bridge width.

The frame adjustments take place in three sections.

1. Overall frame adjustment.
2. Fitting adjustable nose-pad section.
3. Non-adjustable bridge adjustment.

1. Overall Frame Adjustment

a. **The fitting process:** When the frame is received by the fitter, it should be in the standard alignment. Fitting spectacle frame is one of the most important factors in an individual's adaptation[2]. The frame should have pantoscopic tilt and facial wrap and must sit comfortably on the face.[2]

b. **Putting the frames on the wearer's face:** This is recommended to start the fitting procedure by putting the frame on the wearer's face for the first time. If there is any need for adjustment, the fitter should recognize this and remove it immediately. While putting the frame on the wearer's face, it is necessary to hold it by the temples with both the hands gently and pull slightly outward to facilitate slopping of glasses and put the ends of the temples just over and down the ears.[1]

c. **Fitting triangle:** Characteristically, a frame rests on the nose, balances on the ears and anchors around the ears. The three points of contact are known as the fitting triangle. It plays a role in equilibrium and weight distribution.[9, 10]

The means to learn the fitting of eyeglasses is by understanding the fitting triangle and is best described by **Russell Stimson** in his book. He noted three points of contact for the glasses. These three points are the bridge and the sides of the head at the top of each ear. These points are also known as triangles of fitting **(Fig. 11.1)**. A well-fitted frame should put pressure at only these three points. The apex of the triangle is in contact with the nose and the endpoints of the base of the triangle contact with the roots of the ears. If pressure applied to the sides of the head and in front of the ears, the frame will be forced forward.[1, 2]

Spring hinges: Due to inexperienced and ill-trained opticians, the ease of use of frames with spring hinges becomes worse due to completely rely on the spring hinges for holding poorly fitted eyeglasses in place. In this case only springs works which increases the inward pressure of the temples against the head. When these temples square measure adjusted incorrectly, the springs can squeeze the glasses forward forcefully and unceasingly.

d. **Frontal angle:** This is the angle of the bridges of the frame when viewed from the front of the patient. Patients with wide and flat bridge need a greater frontal angle than normal[2] **(Fig. 11.2)**.

e. **Bridge fitting:** The bridge is that the half that goes over the nose, supports most of the load of the spectacles and may work firmly neither too tight nor too loose. The metal

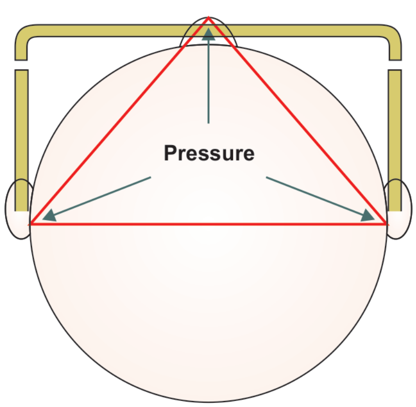

Fig. 11.1: Fitting triangle

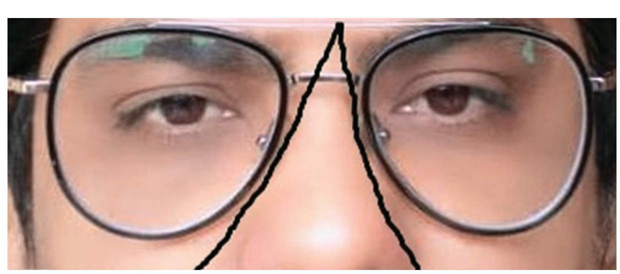

Fig. 11.2: Frontal angle

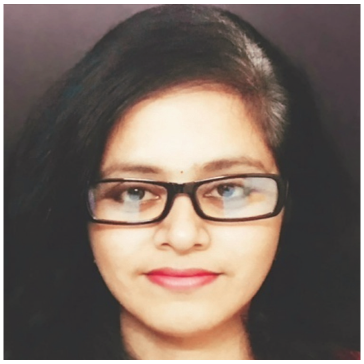

Fig. 11.3: Bridge fit

Fig. 11.4: Splay

glasses commonly have adjustable nose pads to aid in achieving a proper fit, but acetate frames lack adjustable nose pads. It is important that the frame even applies pressure on the nose by adjusting pads, the splay and the frontal angle.[1] If the frame bridge is too tight on the face, it will be uncomfortable and compromise in vision correction and if the bridge is to lose then it will fall down on the nose, requiring for frequent readjustment **(Fig. 11.3)**.

f. **Splay:** It is the angle formed by the bridge of the frame on viewing from the top.[2] The wide and flat bridge frame require greater than normal splay[2] **(Fig. 11.4)**.

The Temple Adjustment

a. **Achieving the proper temple spread:** The temple spread of the frame should be like that the shaft of the frame exerts no pressure on the face even after touching the face at the point just above the root of the ears.[1]

b. **Temples not spread enough**
   - If the temples are not spread enough then too much pressure is exerted on both sides of the head causing the frame to tilt forward until the temples are opposite of the narrower part of the head. This forward placement of the frame tends to relieve the pressure.
   - If the temples are not spread enough in the frames then it can cause the glasses to slide down and the bent down the portion of the temples pull against the back of the ears[4].
   - If temples are bent before the ears then it need to be loosened.[4]
   - There are many disadvantages on loose or tight glasses.
   - The purpose of the adjustment procedure is to achieve that angle of temple spread which allows the front of the frame to rest on the nose without being forced forward.[1] The place where pressure is permissible is above the ears.[1]
   - The condition in which the head is round or wider in front of the ears then the temples must be bending into an arc that follows the wider portion of the head.

c. **Temple spread too far:** If the temple angles are too wide for the individual's head then it can cause glasses to slide down the nose. The methods used to reduce the temple-spread angle are already discussed in the standard alignment chapter.

d. **Vertex distance's equality**
   - During adjusting the frame, it is recommended to check the equality of vertex distance of glasses. This is checked by asking the wearer to tilt his head forward

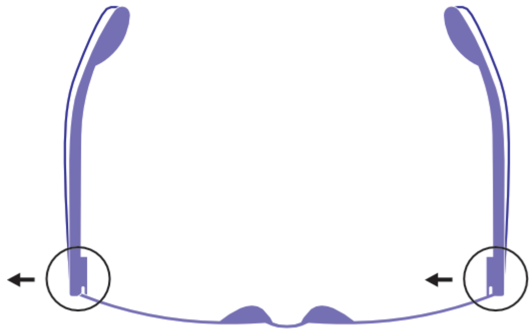

Fig. 11.5: If left lens is closer in

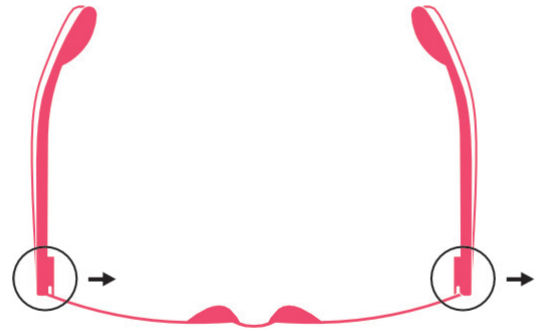

Fig. 11.6: If right lens is closer in

while the examiner views the glasses from above. If the distance of lenses from the wearer's eye is the same then the lenses are properly adjusted.[1]

- If one lens is closer to the eye than the other, it means it is not properly adjusted.[5]
- If the left lens is closer than the right, then the examiner should bend the left arm in or the right temple arm in[5] **(Fig. 11.5)**.
- If the right lens is closer than the left then bending of right temple arm in or left temple out at the hinge[5] **(Fig. 11.6)**.

The Frame Front Adjustment

After adjusting the temples, the frame front adjustment should take place. The methods of frame front adjustments are:

1. The pantoscopic angles
2. Straightening of the frame on the face

1. **Pantoscopic angles**
   - The adjustment of pantoscopic tilts or tilts of the frame front is necessary.
   - The normal tilt of frame front lies somewhat between a 4–1 degree from the vertical.
   - While evaluating the examiner must have to take care of the lenses or rim of frames.
   - The lenses or rim of the frame should not touch the brows or the cheeks.[1]
2. **Straightening of the frame on the face**
   - When viewed from the front, the straightness of the frame with the face is adjusted.[1]
   - If the temples are not parallel and fail to fulfill the flat surface touch test, then the frame cannot sit straight on the face.[1]
   - In this situation pantoscopic tilt requires to be changed on one or both sides.[1]
   - If the right side of the frame is very high, the right temple must be angled up.
   - If the left side is down, bend the left temple down.

Reference Points

- Eyebrows during the identification of the level of the frame.
- The facial asymmetry can cause one lens higher than the other.
- In bifocals, the reference point is the relationship between the bifocal line and the lower edge of the pupil.

The Arm Length (Temples)

- It should extend straight back to your ears and only touch the side of your head just in front of your ears **(Fig. 11.7)**.
- The arms must also not curve too early as it will push the glasses down on the nose.
- The improper temple fit is uncomfortable, unusual and applied extra pressure over the ears and front resulting in headaches and sinus problems.[2, 7]

Fig. 11.7: Temple width

- If the temple arms are too short, they are adjusted and pushed too close to the face.
- Any pressure against the individual's temple will cause forced forward of the frame, creating pressure against the side of the head and behind the ears.[2]
- The correct amount of pressure is that on which individual feels no pressure or no discomfort.
- The best way the glasses are held in their place, is with friction, not by pressure.[1]
- The library and skull adjustment temple are best if its inside is parallel to the head from the three areas.
  a. Along the temple shaft.
  b. Above the root of ears.
  c. Along the slope of the head behind the ear.[1]

Fitting Straight Back and Skull Temples

- The temple which has no vertical bend behind the ear is straight back or library temple.
- The skull temple is bent down behind the ears.
- The principles which are applied to a straight back or library temples are also applied to the skull temple.
- In the adjustment of straight back temples, the inward bending is necessary which lies just at top of the ears.
- The common errors in tighten frames, are:
  a. The bending of the very last portion of the temple too far inward.
  b. The inward bend can cause a pit into the side of the head where the tip presses against it **(Fig. 11.8)**
- Widely bowed temples and an excessive bent of the frame front cause a viscous circle **(Fig. 11.9)**. The dispenser may heat and press an indentation into a bend-down portion of a skull temple with both thumbs known as adding a thumbprint to the temple. In the place of the thumb, the eye wire forming pliers can be used.

Fig. 11.8: Shows how the temple presses both outward on the lobe of ear and inward against the side of the head

Fig. 11.9: Viscous circle due to excessive bending of the frame

The Temple Bend Positioning

- The proper position of the temple bend is just behind the top of the ear.
- The downward slant of the earpiece should be parallel to the slope of the back of the root of the ear **(Fig. 11.10)**.
- The temple must not press into the crease [the most sensitive part] between the ears and head that help in correcting the ear to head **(Fig. 11.11)**.
- The temple bend should be against the side of the head, usually needs inward angling.

Fig. 11.10: Properly positioned temple the bend

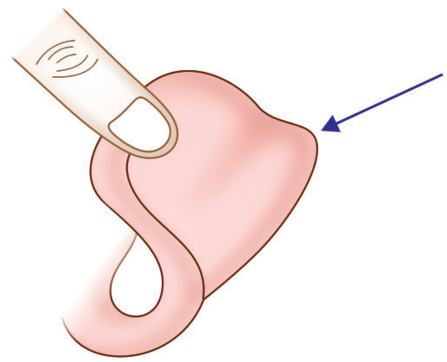

Fig. 11.11: Arrow indicates the most sensitive part of ear

Temple too Long or too Short

- The temple bend position can be modified for the temples which are too long or too short **(Fig. 11.12)**.
- A change in temple bend performed easily in plastic temple than in temples which are entirely made from metal.
- If the temple shaft is too long, then the bend should be beyond the required position which is just hardly past the top of the ear causing the spectacle to move forward rests against cartilage in the back of the ear.
- If the shaft is too short, the bend occurs forward of the top of the ear, causing bent down the portion to rest on the posterior slope of the cartilage.

Fig. 11.12: If temple shaft is too long the bend will occur past the desired position

The following methods are applied for changing the position of the bend.

1. Note the bend position **(Fig. 11.13)**.
2. Estimate the new bend position **(Fig. 11.14)**.
3. Straighten and bend or bend and straighten.

Optyl Temple

The temples made of Optyl are adjusted the same as of other materials. There are two types of Optyl temples.

Fig. 11.13: Inspection of proper fit temple

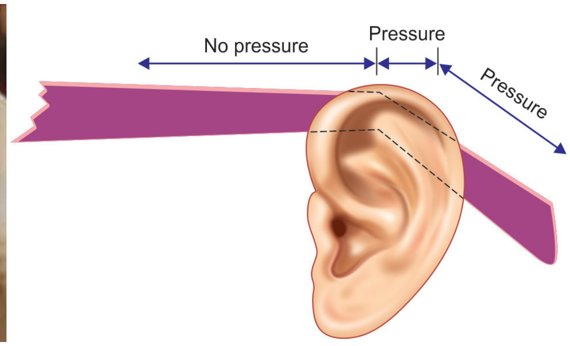

Fig. 11.14: Proper location for the temple bend is immediately behind the top of the root of the ear

1. Temples of original material.
2. Light coated material (LCM).

Temple Adjustment of Original Material

It requires sufficient heat for bending. Adjusting of Optyl frame without heat can break the temple. The heat should be preferred for that portion of the frame which requires bending. Hold the temple is that position for cooling until it retains new shape after bending the temple with heat.

A second bend in a new area of temple should be done after the first area must be shielded from heat.[1] The length of an Optyl the temple having no metal reinforcement can be extended by heating the temple.[1]

LCM Temple Adjustment

It consists of plastic of different composition covering a metal core. These temples are easily to influence able a very great degree and can be adjusted with only minimum heat. These temples cannot restore post heating.[1]

Types of Hinges in Eyeglasses

The hinges are the most important part of the eyeglasses. The different types of hinges used in spectacle glasses are.

1. **Standard hinge (barrel hinge):** It is the most common type of hinges also known as barrel hinges. These hinges are of the oldest types and work correspondingly as the door hinges. These barrel-shaped hinges allow moving in and out by fitting their ends into each other like a zipper and slides into the middle with a small screw to keep a barrel in place. The hinge if are more barrels it will be more durable, an average pair of glasses may have 3 barrels however but some other manufacturers five and six-barrel hinges. For example, Ray Ban's new Wayfarer's frames[8] **(Fig. 11.15)**.

Fig. 11.15: Wayfarer eyeglass with hinge

Advantage
1. Standard hinges are easy to repair.
2. Easily available.
3. Durable

The parts for standard hinges are easily available to buy at your local pharmacy or to.

Disadvantage
1. Lack of flexibility.
2. Require more adjustments.
3. It can fall off during intense physical activity or bending.

2. **Spring hinge temple (flex hinge):** The spring hinge is also known as flex hinges. Spring hinge temples are fit exactly in the same manner as other temples. It is fitted with a small spring that allows a greater range of movement and does not the limit to the traditional 90-degree angle. These hinges are very comfortable for the wearer and can be used in the activity of daily livings. Most of the spring hinges are constructed with 3 barrels. For example, Ray Ban RX5268 **(Fig. 11.16)**.

Fig. 11.16: Spring hinge temple

Advantage
1. It requires less adjustment[1].
2. Less repair[1]
3. These temples feel like glass-hug.
4. These are snug fit.

Disadvantage: These hinge areas unit considerably harder to repair

3. **Hingeless frame:** These frames are without hinges and have no screws, no barrels. Most of these frames are sculpted to fit the shape of the wearer's head. The rounded temples resemble the shape of the skull. The body or frame is made up of titanium. These frames are often used for sport activities. For example, Silhouette Brand eyeglasses **(Fig. 11.17)**.

Fig. 11.17: Hingeless frame

Advantage
1. These are sharp, innovative and with sleek design.
2. These are flexible and can be bent to fit the face.
3. They are also made of durable materials like titanium so they can stand up to normal wear and tear and lots of physical activity.

Disadvantage: These frames are hard to repair.

Riding Bow and Cable Temple

Riding bow and cable temples are used for children and also for working people.[1] These are made from plastic and cable temples from coiled metal. It is adjusted along the root of the ears the end of the cable must be bent back and slightly away from the head with the double padded pliers.

Instruction to Wearer on Frame Handling

1. While removing glasses, make use of both hands for smooth take off the spectacles.
2. If removing from the right hand, grasp the right end piece, lift the right temple off the ear, and move the glasses to the left side of the face so that the left temple comes off the ear easily.
3. Do the opposite for the left hand also.
4. The frames having cable and comfort cable temples, grasp the right end-piece with the right and the tip end of the left cable temple with the left hand. Put the left temple off the ear and swing the glasses to the right so that the right cable temple comes of the ear easily.
5. Do not leave the glasses on the dashboard of a car or at the place which is exposed to heat.
6. Glasses should keep in a case, when they are not in use.

SECTION B

Fitting Adjustable Nose Pads

1. If the frame has nose pads then adjustment is necessary so that the splay angle, frontal angle and vertical angle are all corrected for the individual. Slim pad adjusting pliers work well for this[6] **(Fig. 11.18)**.
2. The frame may be changed in height by narrowing or widening the distance between the pads in place where adjustable pads, pad arms are present.[1]
3. The loop of the pad arm should be kept small to keep the vertex distance to a minimum.[6]
4. If glasses are sitting too high on the nose, gently end the nose pads outward a little.
5. If the glasses are too low, bend the nose pads inward.
6. Nose pads should ideally sit evenly on nose bridge with as much of the pad in contact with a nose as visible to prevent red marks.[4]
7. To keep the symmetry of glasses, the nose should be bending together or apart at equal distance.[7]

Fig. 11.18: Hand friendly slim nose pad arm adjusting plier

Steps to Loosen Nose Pads

1. Grasp glasses by the bridge between the thumb and forefinger. Do not hold by the frame or lenses.
2. Gently pull apart the nose pads. Try to not do that too typically otherwise you can alter the metal.

Steps to Tighten Nose Pads

1. Grasp glasses by the bridge between the thumb and forefinger. Do not hold it by the frame or the lenses.
2. Gently push the nose pads together. Try to not do that too typically otherwise you can alter the metal.

Achieving the Proper Angle for Adjustable Bridge

The pad adjustment can be easily done with the help of a pad adjusting pliers.[1] It has one jaw that holds the base pad securely without damaging the pad attachment and another jaw that cradles the face of the pad **(Fig. 11.19)**. For this they should fulfill the following criteria:

- The pads should rest halfway between the crest of the inner corner of the eye and the nose.
- The large diameter of the pads must be at the right angle to the floor when the head is erect.
- The full surface of pads must rest uniformly on the nose.

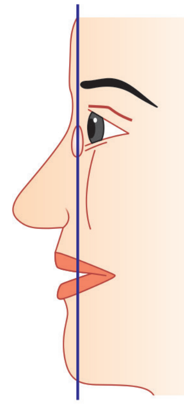

Fig. 11.19: Pads between the nose and corner of the eye

To correct these problems, the pad face must be adjusted as follows:

- If lower edge cuts in change the frontal angle by moving the bottom of the pads apart **(Fig. 11.20a)**.
- If the upper edge cuts in change the frontal angle by moving the lower part of pads together.
- If the front's edge cuts in decrease the splay of the pads **(Fig. 11.20b)**.
- Increase the splay of the pads, if the back edge cuts in **(Fig. 11.20c)**.
- Alter the vertical angle, if the cutting edges seen obliquely.

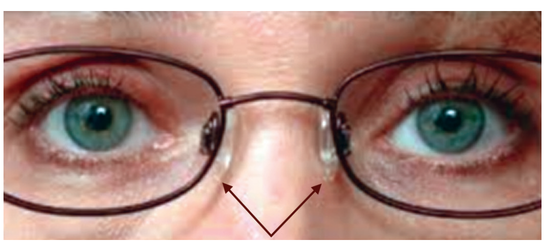

Fig. 11.20a: Lower edge of the pads cut into the nose surface

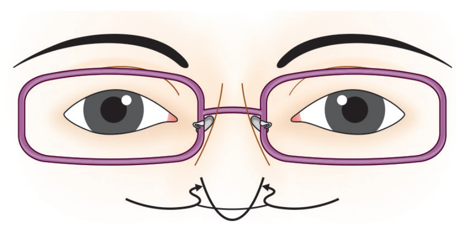

Fig. 11.20b: Splay when viewed from the top of the frame

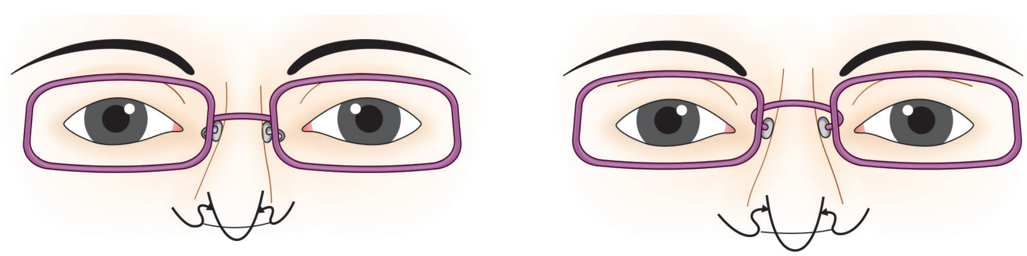

Fig. 11.20c: Cross-section view

If Pad Angle are Correct but Still Hurt

It occurs due to the straightening up or straightening down of the frontal angle. When this situation occurs, then follow the following steps.

1. Replace the nose pads, with the pads made from silicone material.
2. Replace the existing pads with larger pads. These pads are helpful in skin irritation.
3. Replace both pads with a strap material.

Adjusting Pad Angle for Rimless or Semi-rimless Mounting

- For adjusting pad angles in rimless or semi-rimless mountings, rimless adjusting pliers should be used to hold the lens at its nasal point of attachment while adjusting the pad angle with the pad adjusting pliers.
- When rimless adjusting pliers are not available and then try to hold the bridge of the frame during pad adjustment with the help of the thumb and forefinger.

Adjusting Nose Pad with Inverted U-shaped Pad Arms

- Change the distance between pads for inverted U-shaped pad arms.
- Most of the pad adjustments are done in two movements:
  - In the first move—make changes.
  - In the second move—complete the change and restores the proper pad angle.

Widening the Distance between the Pads

- Widen the distance between the pads when the distance between pads is too small.
- To widen the distance between the pads, grasp the pad with the pad adjusting pliers.

Procedure

1. First tilt the top of the pliers outward. The pivot point is the point of attachment of the pad arms. This bends the pad arm at its base and changes the frontal angle.
2. Now without moving the pliers tilt the bottom of the pliers outward.
3. This causes the U to bend at the top with the center of the pad moving temporally. The first bend cause change in frontal angle and the second bend restore it.

Narrowing the Distance between Pads

The procedure will be the same as in widening the distance between pads except that the bends are in nasal or inward directions.

1. For the first bend the upper parts of the pliers are tilted inwards.
2. Then tilt the bottom of the pliers inward, complete the bend, and restore the angle.

Moving Frame Left or Right

A frame can place too left or to right on the face of an individual. The problems caused by the following reason.

1. Nose pads are asymmetrical.
2. Wearer's nose is asymmetrical.

Adjusting the Nose-pad with Question Mark Style

When viewed from the top, the nose-pads are supported by pad arms look like a question mark.[1]

- Change the distance between the pads for question mark-style pad arms.
  Widening the distance between the pads may cause the frame to be lower and sit closer to the face.
- Narrowing the distance may cause a frame to be raised and sit farther from the face.

Widening the Distance between Pads

Working with question mark style pads, some may use a pad adjusting pliers on the face of the pad, and some may use thin nosed pliers and grasp the pad arm directly. Widening the distance between the pads is as follows.

By Adjusting Pliers

- Grasp the pad with the pad adjusting pliers and move the pad arm temporally.
- The bend should be at the point of attachment at pad arms and rotate around the point.
- Correct the splay angle by rotating the pliers with the point of rotation at the pad arm curl.

Widening by Square Round Pliers

- Grasp the pad arm near the base with square round pliers held vertically.
- Bend the pad arm outward.
- Remember to place the round jaw on side of the direction; the pads are to be moved pivot the pliers around the round jaw.
- Hold the pliers vertically, grasp the pad arms directly in the back of the pad and restore the splay angle.[1]

Narrowing the Distance between the Pads

This is the same as widening the distance between pads. The method is:

1. Bend the pad inward.
2. Correct the splay angle of the pads.

Moving the Pad with Question Mark Style Pad Arms

When the frame sits too far the left or right on the face, this may be due to the following reasons:

1. Nose pads are asymmetrical.
2. Wearers' nose is asymmetrical.

SECTION C

Non-adjustable Bridge Adjustment

1. **Plastic Bridge:** The plastic frame which does not have adjustable pads requires an essential check for its correct bridge fit.
2. **Modified Fixed Pad Bridge**
   - A little plastic frame has a bridge with small built-in pads made from the same material of which the frame is made up of.[1]
   - If the splay is incorrect and the plastic pad flares are attached such that its inner edge project into the backward sloping of the nose and indent it. This can cause visibly as well as potential painful signs.
   - This problem can be corrected by heating the pads and modify their angle of splay by using some hot salt from the salt bath and hold it against the pads or by giving the concentrated stream of hot air against the pads. It can be corrected by giving pressure from a smooth flat surface.[1]
3. **Modifying Sculptured Bridge**
   - This type of frame has no pads. The bridge of the frame sits directly on the nose.[1]
   - When a sculptured bridge needs alteration, it is usually a result of poor frame selection.[1]

Frame Bridge Height and Vertex Distance Change

- The frame is already at the correct weight if the fixed bridge frame is properly selected.
- If there is any need to change their height, there are few ways
  a. In plastic frames and other non-adjustable fixed bridge frame sit can be changed by altering the distance between the lenses.
  b. If the bridge is intended, it will cause the frame to sit lower.
  c. If the bridge is narrowed, it can raise the frame.[1]

Plastic Frame

To change the distance between lenses in plastic frame, the following methods are used.

1. By using pliers to change the bridge size.
2. By using a dowel rod to change the bridge size **(Fig. 11.21)**.
3. By using a staking tool to change the bridge size **(Fig. 11.22)**.
4. By using the hands alone to change the bridge size.

Rechecking the Fit

- Are the glasses vertically at the correct height?
- Are both the lenses the same or one is higher than the lens?
- Is the frame having correct pantoscopic tilt?
- Are the lenses at equidistance from both eyes?
- Is there any overpressure on the side of the skull due to the temple?
- Is the bend position of the temple correct or not?
- Is the distance between the pads are correct?
- Are the pads sitting the correct part of the nose?
- Do the frontal angles of the pads are correct?
- Do the splay angle of the frame is correct?

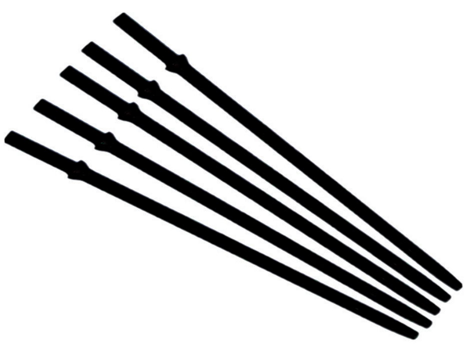

Fig. 11.21: Dowel rods

Fig. 11.22: Staking tool

Changing bridge size by Customizing the Frame

The customizing methods used are:

1. Adding adjustable pad arms or unfit bridge.
2. Using build-up pads.

Innovative Researches for Vision Aid

- Helen Eng OD (2002) investigated a 15-year-old girl with multiple abnormalities [Microtia (hypo-plastic pinna) complete right hearing loss, spinal bone malformation, speech impairment, Ptosis of both the eyelids, complete hearing loss] and surgeries making it difficult to wear spectacles. He discovered a kicker's 27761 children's straight sports band frame with 12 mm plastic headband screwed at the temples for attaching

Pressure alleviation area: Ear
options with similar concepts: Designer Frames—OverTheTop (www.oakley.com), RC 17S, Theo GB 10 (www.theo.be)
Example: OverTheTop–(*Courtesy:* Oakley)

Pressure alleviation area: Ear
options with similar concepts: Spectacle head-band (can be made with materials from a local craft store)
Example: PolyU designed spectacle headband

Pressure alleviations area: Ear and nose
options with similar concepts: Temple rest frames, weightless, bridgeless, multiframe, Astro II
Example: Weightless (www.franeloptical.com)

Pressure alleviation area: Nose
options with similar concepts: Headband eyeglasses suspender—noseguard or adhesive tape such as Micropore, Dermiclear, Blenderm
Example: Noseguard (www.franeloptical.com)

Pressure alleviations area: Nose
options with similar concepts: Cheeklifts, Clip-on pedestals—Frame-ups (www.cosmeticpioneer.com/frameups.htm)
Example: Cheeklifts

Fig. 11.23

the frame over the head with further fewer more modifications using 0.6 mm copper wire interwoven to create a customized headband to maintain frame integrity, balance, and to avoid the frame slipping forward[12] **(Fig. 11.23)**.

- Kaplan (1995), a dermatologist uses a binder clip to suspend the bridge of the frame from a patient's sport cap through a three-millimeter hole.[13]
- Other solutions for reducing the pressure on the nose
  a. To select frames with large bridge sizes.[14]
  b. Extra padding to redistribute the pressure over a larger area.[15]
  c. Special nose-pads, footpads, surgical dressing.[15]

d. Customized silicone nose-pad.[16]
e. Those with auricle deformities many commercial frames are available in the market.

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Chapter 12

Frame Adjustment Tools

INTRODUCTION

It is seen worldwide that approximately 60% of individuals require a visual aid, such as spectacles or contact lenses, for proper visual acuity.[1, 2] The WHO report reveals that if these visual acuities are not corrected, it can become the principal cause of visual impairment[3] and about 50% of the visual impairment is caused in high rate by the application of inappropriate glasses, lenses even in the countries with readily accessible healthcare services or by some economic inference.[2–4] The eye-related problem can be best corrected by the admittance of consistent and reasonably priced tools for measuring eye defects. The role of fitting the correct spectacles which suit the face is also very important. These frames and the lenses if damage results in difficulty for the wearer to apply it and will cause disturbances in their day-to-day life.

The proficiency of an optician in fitting, adjusting and repairing frames can smoothen the wearer's activities of daily livings. The frame, if damage needs alignment and repairing. Most of the lens and frame repairing is done by the variety of tools, and some repairing requires manual pressure for corrections.

DISPENSING OPTICIAN

These are the practitioner, who designs, fits and dispenses corrective lenses for the correction of a person's vision. These opticians use a variety of equipment to fit, adjust and dispense eyewear, contact lenses and low vision aids. Many licensed optician's design and fit special appliances to correct cosmetic, traumatic or anatomical defects which are called shells or artificial eyes. Some are registered to manufacture lenses, frames to their own specifications and design.[5, 6]

In many countries like Canada, New Zealand, this profession is often regulated by specific agencies like New Zealand Optometrist and Dispensing Opticians Board or the United Kingdom General Optical Council where the optician works in the optical laboratory, independently or dependently with an optometrist and ophthalmologist. Their role is to convert a prescription for the correction into an ophthalmic lens or some other device, such as reading aids or telescopic lenses.[7–9]

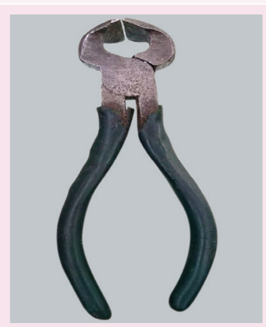
The following is a list of common **tools/pliers** and **eyeglasses parts** that an optician needs to perform their daily responsibilities **(Table 12.1)**.

Table 12.1: Varieties of tools and pliers for repairing and corrections in eyeglasses and lenses

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
1.	Double nylon jaw plier **(Fig. 12.1)**	a. The double nylon jaw plier is 5.3 inches long. b. The tip width opened up to 1 inch. c. Its replacement jaws are available. d. It is used for adjusting bridges, end pieces, and temples.	 **Fig. 12.1:** Double nylon jaw plier
2.	Angling plier **(Fig. 12.2)**	a. It is hand-friendly wide jaw angling plier. b. It is used for making pantoscopic and retroscopic angle adjustments. c. Its wide jaws can be used on even the thickest temples. d. It has parallel jaws which feature mirroring holes that fit over the temple hinge screws. e. It is also used to modify end pieces and heavy bridges as well.	 **Fig. 12.2:** Angling plier
3.	Adjusting eyeglass arms frame plier multi-purpose **(Fig. 12.3)**	It is an optical multipurpose tool used for corrections.	 **Fig. 12.3:** Adjusting eyeglass arms frame plier multi-purpose
4.	Snipe nose plier **(Fig. 12.4)**	a. The snipe nose plier is used for fine eye wire adjustments. b. It is safe and comfortable dual-compound. c. The product is made up of thermoplastic grips with double leaf springs. d. Its surface is polished With high gloss steel.	 **Fig. 12.4:** Snipe nose plier

(Contd.)

Table 12.1: Varieties of tools and pliers for repairing and corrections in eyeglasses and lenses *(Contd.)*

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
5.	Cutter plier **(Fig. 12.5)**	a. It is 9LPC, 9-1/2" high leverage pliers with fish tape puller and crimps for side cutting. b. Its hardened property helps in cutting the edges. c. It cuts the toughest materials including ACSR, nails, screws, etc. d. It is coated for superior rust-resistance and longer tool life. e. Its special feature is a 3-zone comfort grip for more control and more cuts comfortably.	 **Fig. 12.5:** Cutter plier
6.	Nose pad plier **(Fig. 12.6)**	a. It can be used to adjust bridges, pad arms, and temples when extra length is required. b. The jaws of the extended point chain nose pliers are flat and smooth on the inside and taper to a fine point. c. The pliers' vinyl grips are comfortable during long work hours. d. The extended point chain nose pliers is designed for delicate and comfortable work. e. It used for nose pad assembly adjustments.	 **Fig. 12.6:** Nose pad plier
7.	Axis plier **(Fig. 12.7)**	a. It is used for lens axis alignment. b. It endows with less effort and more torque in a compact design. c. These pliers are designed for lens axis correction on small eye wire or half eyes. d. The narrow pads allow the operator to work effortlessly. f. The ergonomic handle gives the operator a more comfortable and sturdy grip.	 **Fig. 12.7:** Axis plier
8.	Compression plier **(Fig. 12.8)**	a. It is easy to access. b. It is designed with ribbed ends for gripping and compression. c. The plier is made from good quality steel with draper blue plastic dipped handles. d. It is used for corrections in the rimless eyeglass frames.	 **Fig. 12.8:** Compression plier

(Contd.)

Table 12.1: Varieties of tools and pliers for repairing and corrections in eyeglasses and lenses *(Contd.)*

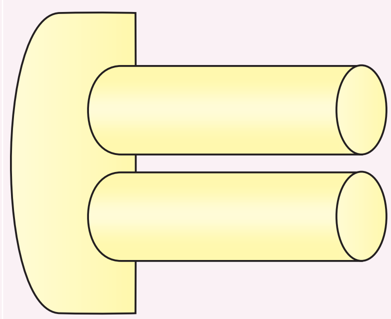
S. no.	*Pliers name*	*Specifications*	*Supporting picture*
9.	Compression sleeve trimming plier **(Fig. 12.9)**	a. Its compression-sleeved property is too quickly and cleanly trim without damaging the lens. b. Its razor-sharp edges provide a clean cut. c. The Highly polished the surface protects lenses from scratching. d. This designed plier trims off extra plastic bushing material before mounting. e. It is also useful for cutting extra plastic bushing to remove lenses. f. It is highly recommended to apply it over the plastic only and not on metals.	 **Fig. 12.9:** Compression sleeve trimming plier
10.	3-Piece frame adjusting plier **(Fig. 12.10)**	a. It is ergonomically built for comfort and easy to use. b. The plier is constructed with high quality polished stainless steel and features a non-slip cushion grip handle. c. It eliminates sticking. d. It helps in the modification of rimless frames. e. The Fragile drill-mounts are protected with this plier. f. It easy to access and fits easily into tight places and prevents damage to expensive lenses.	 **Fig. 12.10:** Piece frame adjusting plier
11.	Screwdriver set **(Fig. 12.11)**	Screwdriver is used for removing and replacing screws.	 **Fig. 12.11:** Screwdriver set
12.	Nut driver set **(Fig. 12.12)**	The driver is used for removing and replacing nuts.	 **Fig. 12.12:** Nut driver set

(Contd.)

Table 12.1: Varieties of tools and pliers for repairing and corrections in eyeglasses and lenses *(Contd.)*

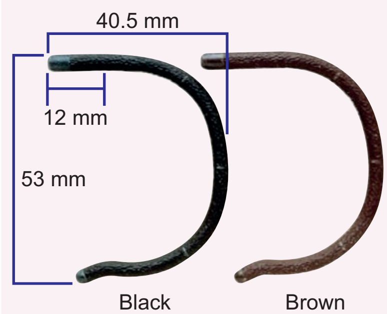
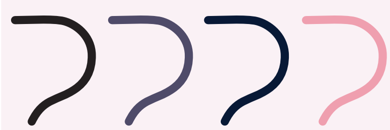
S. no.	*Pliers name*	*Specifications*	*Supporting picture*
13.	Hot air frame warmer **(Fig. 12.13a and b)**	a. It is used for warming plastic frames. b. It is used for heating and adjusting the eyeglass frame when processing glasses. c. It is extensively used in the eyeglasses shop and eyeglasses processing industry. d. The maximum temperature is 266°F with the temperature adjustable knob with ideal temp—158~266°F (70~130°C). e. The even heating process is done with inbuilt ceramic material. f. For faster heating close the air hood flaps of the heater (Fig. 12.13b) g. It is highly protected by the wool felt material of cloth pad and protects the glasses legs and frames. h. Close the air outlet if not working on it in order to prevent it from the invasion of the dust particles.	 **Fig. 12.13a:** Hot air frame warmer  **Fig. 12.13b:** Hot air frame warmer

Table 12.2: Eyeglasses parts

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
1.	Plastic bushing **(Fig. 12.14)**	a. Plastic bushing made up of firm and rigid plastic. b. **Dimensions** • **Plastic tubes:** –0.8 mm inside × 1.4 mm outside × 7 mm long beneath the base. • **Base:** –5.3 mm long × 1.5 mm wide × 0.7 mm. There is a 1.6 mm gap between the two plastic tubes. c. It can be safely cut to the exact length with the help of compression sleeve trimming pliers.	 **Fig. 12.14:** Plastic bushing
2.	Cable temple cover **(Fig. 12.15)**	a. The cable temple is made with soft and flexible covers adding colour and comfort to straight or wrap-around wire cable eyeglass temples. b. Easy to install. Slides right on. c. It measures the diameter of the eyeglass. d. The cable temples with a micrometer or calliper determine the correct temple tip size. e. These temple covers will not shrink like heat shrink tubing.	 **Fig. 12.15:** Cable temple cover

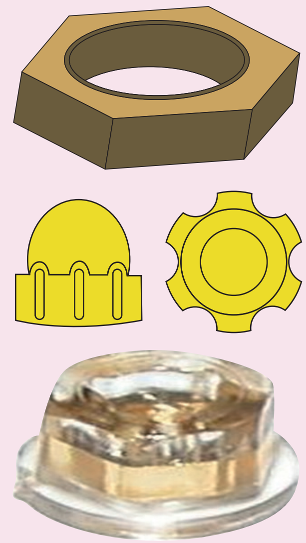
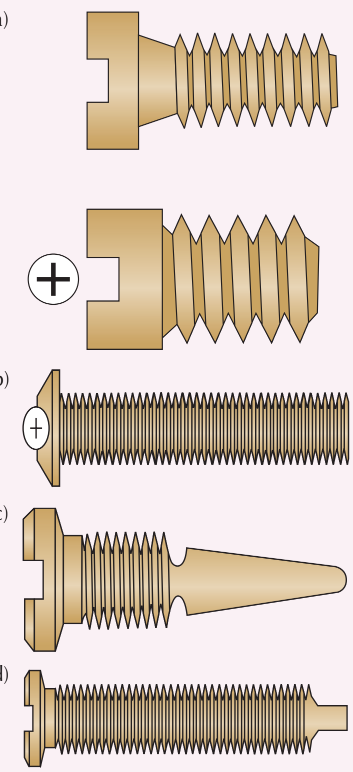
(Contd.)

Table 12.2: Eyeglasses parts (*Contd.*)

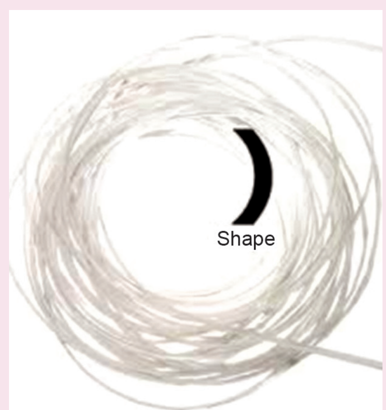
S. no.	*Pliers name*	*Specifications*	*Supporting picture*
3.	Cable temple end converter **(Fig. 12.16a and b)**	a. It converts the straight wire cable temples to wrap-around temples with these high quality silicone cable temple conversion assemblies. b. Its core diameter is 1.4 mm (.055") and fits in a broad range of frames. **Procedure** a. The first step is to line up the accessible temple bends with a bend in cable end and make a mark on this temple where the cable converter starts. b. Now cut the existing temple 8 mm back from the mentioned mark. c. Next strip-off the old temple cover. d. A few slash marks or a few drops of glue is highly recommended for securing a correct fit especially in the case of active children. e. The last step is to the warm-up the exposed metal for the correct fit with the help of hot air warmer. f. Push the conversion end and let it cool for a minute.	 **Fig. 12.16a:** Adult cable converter  **Fig. 12.16b:** Child cable converter
4.	End caps **(Fig. 12.17)**	a. These are cone shaped nylon end caps used for drilling rimless eyeglasses. b. Its diameter is 1.4 mm with 2.5 mm outer diameter × 3.5 mm high. c. These caps have holes.	 **Fig. 12.17:** End caps
5.	Eyeglass hinges **(Fig. 12.18)**	The eyeglasses hinge comes with a plastic box with nickel silver hinges, nickel silver spring hinges, marked with sizes, part numbers and pictures.	 **Fig. 12.18:** Hinges

(*Contd.*)

Table 12.2: Eyeglasses parts *(Contd.)*

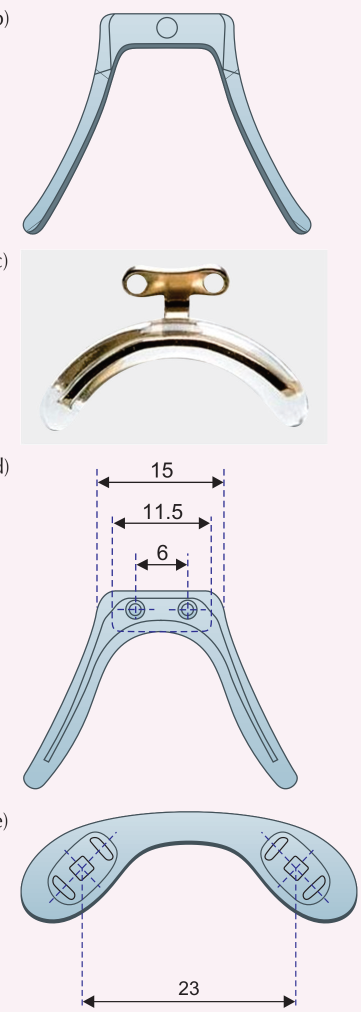
S. no.	*Pliers name*	*Specifications*	*Supporting picture*
6.	Eyeglass nuts **(Fig. 12.19)**	1. These miniature nuts are to repair and join parts of the eyeglasses and are available in varieties in the market, like:- a. Caps nuts. b. Gold nuts. c. Plastic pol nuts. d. Hex nuts. e. Star nuts. f. Ray ban nuts. 2. These nuts are of different diameters and thicknesses. 3. The plastic nuts and washers help to get rid of the loose screws and nuts of the rimless eyeglasses.	(a) (b) (c)  **Fig. 12.19:** (a) Hex gold nuts; (b) Gold cap nuts; (c) Plastic nuts and washer
7.	Eye-glasses screws **(Fig. 12.20)**	1. The eyeglasses screws come in kit or plastic box. 2. There are varieties of screws available in the market allocating assorted purposes of repairing and reconstructions. 3. These screws are of different diameters and thicknesses. 4. Few varieties of screws are listed below: a. Eyeglass screw starter. b. Hinge screws. c. Nose pad screws. d. Trim screws. e. Self-tapping screws. f. Self-aligning screws. g. Philip screws, etc.	(a) (b) (c) (d)  **Fig. 12.20:** (a) Gold philip hinge screws; (b) Self aligning screws; (c) Stainless trim screws; (d) Self-tapping screws

(Contd.)

Table 12.2: Eyeglasses parts (*Contd.*)			
S. no.	*Pliers name*	*Specifications*	*Supporting picture*
8.	Guard arm for nose pad **(Fig. 12.21)**	1. The loop nose pad arms are with push-on-nose pads. 2. These pads are soldered, painted or plated.	 **Fig. 12.21:** Nose pad
9.	Black heat shrink tubing **(Fig. 12.22)**	1. The heat shrink tubing covers a bare metal cable temple. 2. It eliminates irritation and discoloration. 3. It is also used as a clip shrink to prevent the lens and frames from scratching. 4. It is 2.36 mm (.092″) ID × 100 mm (4") long with 1.17 mm (.046″) ID of shrink capacity.	 **Fig.12.22:** Black heat shrink tubing
10.	Lens liner **(Fig. 12.23)**	1. The lens liner material is used to engage the periphery of an eyeglass lens with the groove in the eyeglass frame. 2. 1.8 mm wide × 0.25 mm thick × 4 meters.	 **Fig. 12.23:** Lens liner
11.	Nose pads for glasses	1. These are available in a variety of materials, shapes, and sizes. 2. The commonly used materials are: a. **Silicone nose pads (Fig. 12.24a)** i. Nose pad size is 11 mm (7/16″) length × 6 mm (15/64″) wide × 2 mm (5/64″) thick. ii. These are allergy-free (nose pad burns). iii. Comfortable for the wearer.	 **Fig. 12.24:** (a) Silicone nose pads

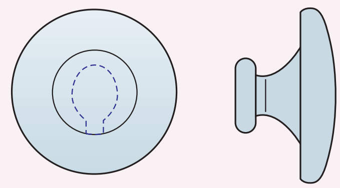
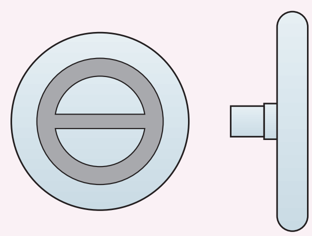
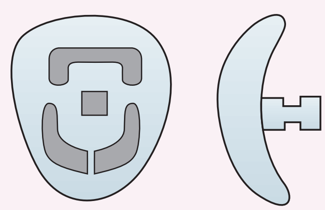
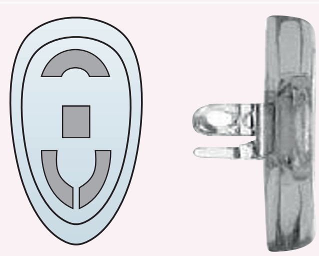
(*Contd.*)

Table 12.2: Eyeglasses parts *(Contd.)*

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
		b. **Bridge nose pad (Fig. 12.24b)** i. This nose pad is 17 mm wide and 27 mm lengths from the top corner down to the bottom of the tip. ii. It is attached to the metal built eyeglasses. iii. It is also available in some varieties: • Harmony bridge nose pad **(Fig. 12.24c)**. • Soft silicone wings bridge nose pad **(Fig. 12.24d)**. • Saddle wings nose pads **(Fig. 12.24e)**.	(b) (c) (d) (e)  **Fig. 12.24:** (b) Bridge nose pad; (c) Harmony bridge nose pad; (d) Soft silicone bridge nose pad; (e) Saddle wings nose pad
		c. **Clip-on nose pad (Fig. 12.24f)** i. The measurement of a clip-on nose pad is 15 mm. ii. It is soft and clear silicone nose pad with the older style U-shaped horseshoe mounting iii. It provides the frame a good appearance and is very comfortable for the wearer. iv. Its structure is symmetrical with a teardrop shape that fits the right or left side.	 **Fig. 12.24f:** Clip on nose pad

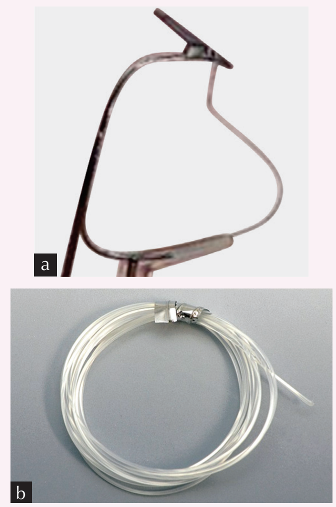
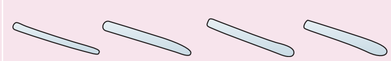
(Contd.)

Table 12.2: Eyeglasses parts *(Contd.)*

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
		d. **Glass nose pads (Fig. 12.24g)** i. The hypo-allergic property of glass nose pads made it comfortable for the wearer. ii. These are with push on mounting.	 **Fig. 12.24g:** Glass nose pads
		e. **Hard polycarbonate thin nose pads (Fig. 12.24h)** i. These pads are thin clear polycarbonate nose pads with a mushroom-shaped slide-on-base. ii. The measurement of these pads is 12 mm long × 7 mm wide x 1mm thick. iii. These are preferable for those wearers who prefer hard nose pads.	 **Fig. 12.24h:** Hard polycarbonate thin nose pad
		f. **Hard acetate nose pad.** The hard nose-pads come in 2 varieties: 1. Hard nose pad with the screw-on base. 2. Hard nose pad with the push-on base. • Hard nose pad with screws-on base **(Fig. 12.24i)** 1. It is 9 mm round hard polycar-bonate nose pad with a screw-on base. 2. It measures 9 mm in diameter × 1.5 mm in thickness. 3. These pads are a good choice for those who prefer hard nose pads. • Hard nose pad with push-on base **(Fig. 12.24j)** 1. It is 20 mm D-shaped hard plastic nose pad with a clear push-on base. 2. These eyeglass pads measure 20 mm long × 9.5 mm wide × 2 mm thick	 **Fig. 12.24i:** Hard acetate nose pad with screw-on base  **Fig. 12.24j:** Hard acetate nose pad with push-on base
		g. **Combination nose pad (Fig. 12.24k)** i. It comes in combination with the push-on/screw-on silicone nose-pads. ii. Snip off the piece which is not needed during mounting.	 **Fig. 12.24k:** Combination nose pad

(Contd.)

Table 12.2: Eyeglasses parts (*Contd.*)

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
12.	Lens liner tool **(Fig. 12.25)**	1. The lens liner is a hook-style lens mounting the tool. 2. In semi-rimless nylon cord frames, it comes with easy lens insertion and removal. 3. It eliminates the shredded ribbon between the lens and the strap.	 **Fig. 12.25:** Lens liner tool
13.	Nylon cord for semi-rimless frames **(Fig. 12.26a and b)**	1. The nylon cord for semi-rimless frame measures to 0.5 mm diameter × 50 feet. 2. The nylon cord for rimless or semi-rimless frame measures up to 0.62 mm thick × 1.26 mm wide.	 **Fig. 12.26:** (a) Nylon cord for semi-rimless frames; (b) Nylon cord for rimless or semi-rimless frame
14.	Temple cushions **(Fig. 12.27)**	1. The temple cushions come in various shapes and sizes (small, medium, and large). 2. Cushions provide more comfort to the wearer. 3. These cushions are made up of soft material and provide a clear slip on the temple by sliding right over the existing temple ends of the eyeglasses frames. 4. The wearer with sensitive ears can wear these cushions with no discomfort. 5. These can be smoothly and quickly slide over the temple tip, if eaten by the animals, etc. 6. The various sizes available are: a. Extra-small—1/8" round inside diameter × 2–1/2" long b. Small—1/8"× 9/64" rectangular inside dimension × 2×1/2" long c. Medium—1/8"×11/64" rectangular inside dimension × 2–1/2" long d. Large—1/8" × 3/16" rectangular inside dimension × 2–1/2" long.	 **Fig. 13.27:** Temple cushions of various sizes

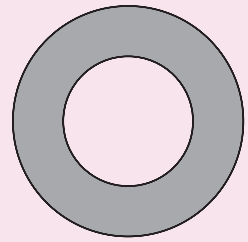
(*Contd.*)

Table 12.2: Eyeglasses parts *(Contd.)*

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
15.	Temple Tip	1. There are various types of temple tips: a. Cable temple end converter. b. Silicone temple tip. c. Hard acetate temple ends. d. Black cable temple cover	
a.	Cable temple end converter **(Fig. 12.28a)**	It converts the straight wire of the cable temple to wrap-around the temples with the high-quality silicone cable temple conversion assemblies into curved shapes with a core diameter of 1.4 mm.	**Fig. 12.28a:** Cable temple converter
b.	Silicone temple tip **(Fig. 12.28b)**	1. It comes in various diameters like. a. 1.4 mm core diameter × 65 mm length. b. 1 mm × 65 mm. c. 1 mm × 100 mm. 2. The temple tip styles like a spatula. 3. The property of these tips is that it helps reduces slippage and are hypoallergenic. 4. Due to firm polyamide inserts, the tip remains stiff and is helpful during the installation procedure. 5. To insert it within the frame, first apply heat with the help of warmer and then hold it in place.	 **Fig. 12.28b:** Silicone temple tip
c.	Hard acetate temple ends **(Fig. 12.28c)**	1. The hard acetate temple ends come in various sizes and colours: a. 1 mm round ID × 65 mm length. b. 1.1 mm round ID × 70 mm length. c. 1.3 mm round ID × 65 mm length. d. 1.6 mm round ID × 65 mm length. e. 1.9 mm round ID × 63 mm length. 2. These tips are hard with non-stretchable property. 3. These tips will not shrink like a heat shrinking tube. 4. To set up a correct temple tip on the frame, it is obligatory to measure the frame diameter carefully.	 **Fig. 12.28c:** Hard acetate temple end
d.	Temple cover **(Fig. 12.28d)**	1. The temple covers come in various colours and sizes. 2. Colours like black, brown and tan. 3. Sizes like: a. 1.6 mm ID × 100 mm length. b. 2.70 mm ID × 100 mm length. c. 1.98 mm ID × 100 mm length. d. 2.38 mm ID × 100 mm length, etc. 4. These covers are soft, flexible and very comfortable for the wearer with easy installation.	 **Fig. 12.28d:** Black temple cover

(Contd.)

Table 12.2: Eyeglasses parts *(Contd.)*

S. no.	*Pliers name*	*Specifications*	*Supporting picture*
16.	Washers **(Fig. 12.29)**	1. The nylon washers come in various sizes like: a. 1.17 mm ID × 2.5 mm OD × 0.5 mm thick. b. 1.2 mm ID × 2.5 mm OD × 0.5 mm thick. c. 1.3 mm ID × 2.5 mm OD × 0.3 mm thick. d. 1.40 mm ID × 2.5 mm OD × 0.5 mm thick. e. 1.9 mm ID × 3.2 mm OD × 0.45 mm thick.	 **Fig. 12.29:** Nylon washers
17.	Rhinestones **(Fig. 12.30)**	The crystal rhinestones come in various sizes and are the perfect choice of replacement stones for rhinestones eyeglasses or custom designs.	 **Fig. 12.30:** Crystal rhinestones

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Chapter 13

Standard Alignment

INTRODUCTION

> The real challenge for nay eye care professional is to manually craft a proportionate 4-point squared device to fit a disproportionately shaped surface.

A comfortable fitting spectacle frame defines the ultimate wearer's satisfaction. The method starts with selecting a frame with adequate dimensions which will allow manipulation and adjustments once the lenses have been fitted. The process by which the glasses are readjusted or manipulated to bring them to proper alignment is known as **Standard alignment**. It should not be done before fitting the frame to the patient and is carried out first by the manufacturer's and then in the lens laboratory. The standard alignment process is also known as **truing**. The process to reshape the cutting surface of a worn grinding wheel so that it cuts at the angles and in the manner originally intended.

The truing is the starting point for adjusting the spectacles especially, those spectacles that have been born for a long time without any recent adjustments. After putting the lens in frames, the dispenser's duty is not over because the glasses may not be aligned properly. It must be carried out in the correct sequence because certain adjustments may affect the previous step is carried out later.[1–4]

Sequential Alignment of Frames

1. First, begin with the bridge.
2. After bridge adjustment end pieces should be adjusted.
3. Lastly, go with the temple adjustment.

Different Types of Frame Alignment/Adjustment

1. Horizontal alignment.
2. Vertical alignment
3. Open temple alignment.
4. Temple parallelization.
5. Alignment of drap of the bend.
6. Temple fold angle.

> Plastic frames are always heated to be aligned.
>
> The metal frames do not need heating except for those parts which are covered with plastic.

Standard Alignment of Plastic Frame

Heating the Frame

In general, the standard plastic frame must be heated for most or any alignments. The frames are heated by 2 methods.

a. Through the use of a ***salt bath*** (*salt pan or glass beads*).
b. By ***forced hot air***.

The salt pan contains heated table salt or a pan having small heated glass beads. The hot air is the best method or the method of choice for adjustment with heat. Salt is appropriate if there is no danger of damaging the frame or lens being used.[1, 2]

Hot Salt or Beads Method

It is not recommended to use.[1] The hot salts or beads may affect some frame materials and can damage the coating of the lens, even if the coatings are noticed undamaged during the use of salt pan, it may not last longer.[1] The new dispenser should not use this because of difficulty in identifying the frames or lens materials that can be affected by the hot salt pan.

Procedure

1. Always stir the salt to equalize the heat before inserting the frame.[1, 2]
2. A wooden spoon is an excellent tool for stirring the salt because it cannot heat too much and can also be used to push the salt into mounds for heating the specific parts.
3. Insert the frame into the salt and the area which is being heated is kept parallel to the surface of the salt.
4. Keep the frames moving to prevent the portion which is too close to the heating element from being distorted.
5. The highly polished Jet black frame can cause dullness due to the possibility of indentation by too much heat in frame.[1]
6. Talcum powder should be added to the salt to prevent.
   a. Sticking of salt to the frame, and
   b. Formation of the frame lumping.[1, 2]

Forced Hot Air Method

The forced hot air is the method of choice or highly recommended method as it allows heating only the portion of the frame to be worked on.[1]

Procedure

1. It is used to heat a frame.
2. Move or rotate the frame to prevent the overheating of one area.
3. Ensure heating of different surfaces especially when the heat is supplied from one direction by hot air warmer.
4. Overheating on one side only may cause a bubble in the surface of the plastic frame[1, 2] **(Fig.13.1)**.

Fig. 13.1: Bubbling of the plastic upper rim due to overheating

The Bridge

There may be many errors in relation to the bridge. The bridge alignment is judged mainly by the effect. It has on the plane of the lenses. The bridge of the nose may be relatively high or low in relation to the eyes.

> If bridge is misaligned
> a. A proper plane is carried out by heating the bridge area
> b. Grasp the frame by the lens areas.
> c. Adjust according to the correction required.

Heating the Bridge by Salt Pan Method (Fig.13.2)

1. The salt should be stirred so that it forms a centrally located peak across the pan.
2. Place the frame in the pan.
3. Temple up and draw the bridge through the central peak of mold.
4. Repeat the process until the bridge is flexible enough to bend.[1, 2]

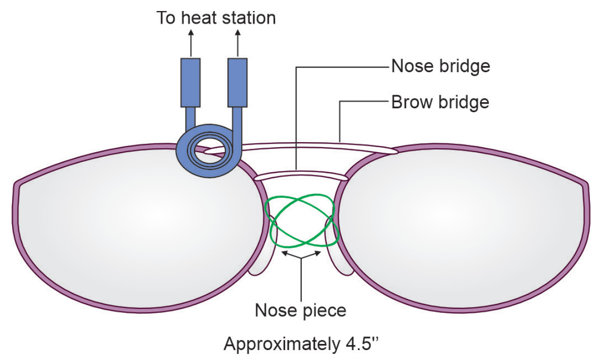


Fig. 13.2: Heating the bridge area of the spectacle frame

Heating the Frame by Hot Air Method

1. The airstream should be concentrated on the bridge.
2. The bridge should be moved across the hot air stream until it becomes flexible.
3. Once the bridge becomes flexible, it can be adjusted as required.

Bridge Misalignment

1. If one lens is pushed up or one lens is pushed back in relation to the other.
2. If one lens is higher than the other.
3. The lenses deviate from the horizontal plane is said to be out of horizontal alignment.
4. If they deviate from the vertical plane means one lens appears to be farther forward or backward than another, they are said to be out of vertical alignment.

Horizontal Alignment

The horizontal alignments of plastic frames are very difficult to adjust because the reference points are not clear enough.

Procedure for checking horizontal alignment

- Place a ruler or a straight edge across the back of the frame at the top of the pads.
- In spectacles with no pads, then there is a point where the sculptured shaping of the bridge area ends.
- Both ends must be equidistant from the straight edge when it is aligned horizontally **(Fig. 13.3)**.

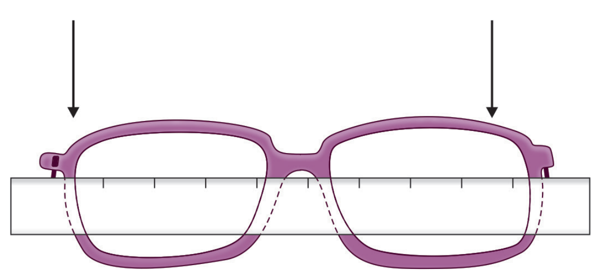


Fig. 13.3: Horizontal aligned frame with the distance between ruler and end-piece reference points are equal on both sides

Causes of Horizontal Misalignments

The most common causes of the frame out of alignments are:
1. A rotated lens
2. A skewed bridge

1. Rotated Lens

It causes the top of eye wire either to hump up at the nasal area or one end piece to appear up-swept in shape. This problem can be nest corrected using lens turning plier **(Fig. 13.4a and b)**.

This plier is equipped with rubber pads of 20 mm diameter with a 4 base curve set. These pads cradle the lens rather than flattening it.

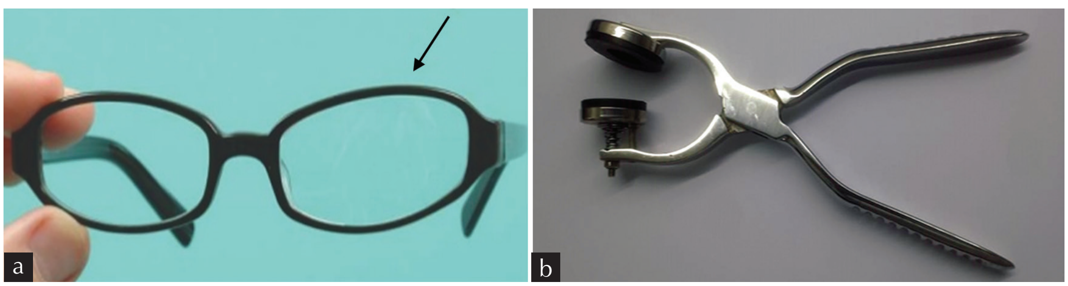


Fig. 13.4a and b: (a) Rotated lens; (b) Lens turning plier

2. Skewed Bridge

The skewed bridge lens when viewed from anterior (front) appears higher than the other lens **(Fig. 13.5a).** This malfunction is due to incorrect placement, mishandling during the dispensing process, or due to poor manufacturing.[2] This can be corrected by heating the bridge and then grasping its front using eye wire in each hand which is pulled in opposite directions until its top becomes parallel **(Fig. 13.5b)**.

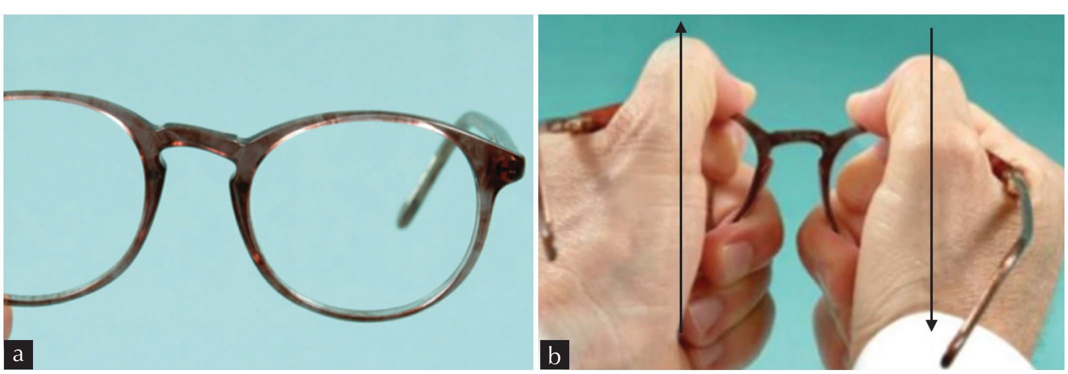


Fig. 13.5a and b: (a) Skewed bridge; (b) Skewed bridge correction by heating and pulling one side up and the another down to bring the ends parallel

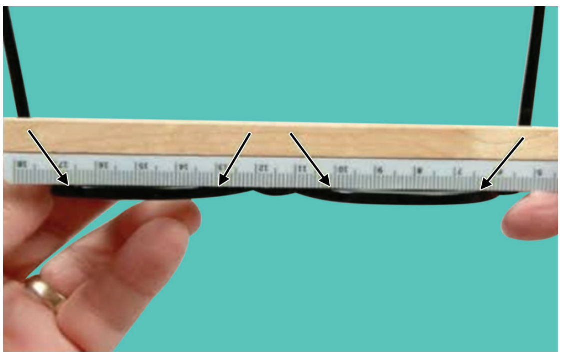
Vertical

Alignment (4 Point-Touch)

The vertical alignment is also known as four-point touch.

Examination of 4-Point Touch

1. A ruler is needed.
2. Place the ruler or straight edge so that its edge goes across the inside of the entire front of spectacles below the nose-pad area **(Fig. 13.6)**.
3. The frame eye wire should touch at the four points on the ruler (it only occurs if the size of the frame is smaller than the users head size.)
4. Correct alignment ≥ Frame PD = Wearer's IPD.



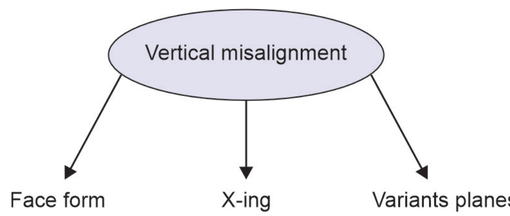
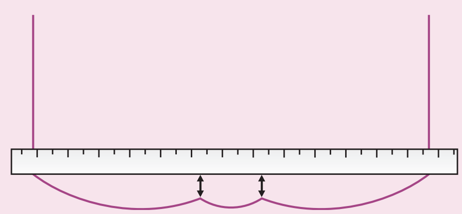


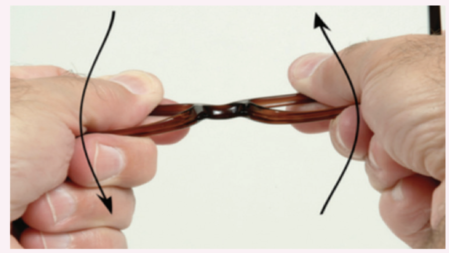
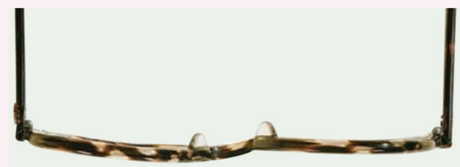
Fig. 13.6: Examination of four-point touch of frame

Face Form X-Ing Variants Planes

Table 13.1: Face form (wraparound)

S. no.	*Vertical misalignment*	*Description*	*Picture*
1.	Face form	1. The face form (wraparound) is when the frame front is slightly rounded to the form of the face. Most of the frames are constructed with at least a degree of face form. 2. This is true for large and thick metal frames. 3. The face with face form should not confirm to the four-point touch test. The temporal side should not be touch and nasal sides should be at the equidistance from the ruler. 4. If two nasal eye wires are at a great distance from the ruler, too much face form would be evident in this case.	 The nasal side of the eye-wires should be equidistant from the ruler for the frames which are not confirmed to a perfect four-point touch.

(Contd.)

Table 13.1: Face form (wraparound) (*Contd.*)			
S. no.	*Vertical misalignment*	*Description*	*Picture*
2.	X-ing	The twisted frame front is called X-ing. It can cause the temples to be out of line with each other.	 Correction of X-ing error
3.	Variant Planes	1. It is a form of vertical misalignment. 2. When the lens planes are variant or out of coplanar alignment. 3. This happens when the lens planes are parallel but one lens is more forward than the other.	 Variant planes

THE TEMPLE

After the horizontal and vertical adjustment of a bridge and eye wire, the next area considered for adjustment is the temple area. To check and verify the temples, the **open temple spread** is first checked because the adjustments may affect the end-pieces, next evaluation done is of **temple parallelism**, finally the **fold angle** is looked after.[1, 2]

To dispense aligned spectacle. The proper assessment is obligatory for those wearers who have facial cranial anomalies.

I. Open Temple Spread/Let Back

1. The open temple spread is the angle formed by each open temple into the front of the frame.
2. The correct way of administration of temples is it should touch at all points behind the ears with no pressure felt by the wearer.
   "No Touch No Hold"
3. A temple shaft must be straightened from the end-piece for a good picture of the temple spread.
4. In case of any curve in the temple shaft then it must be straightened manually or by heating with the help of hands.
5. Usually, 94–95° open is the normal condition of the temple (farther than 90° angle)[1, 2].

Basic Frame Alignment

S. no.	*Problem*	*Solution*
1.	When temples too tight	Spread temples
2.	When temples too loose	Bring temples in
3.	When facing just right	Temples touch head with no pressure

Variations in Temple Spread

a. Temple spread too far (Fig. 13.7a)

Temples flaring more than 90° means too much spread for standard alignment. The methods used for end piece adjustment for reducing the temple spread are:

a. By using a thumb.
b. By using a flat surface.

Procedure

1. Bend eye wire and end-piece.
2. Bend the butt portion of the temple.
3. Sink the hidden hinge deeper into the frame front.

b. Temple not spread enough (Fig. 13.7b and c)

The temples which are not spread enough after the lenses have been inserted occur in step front curves frames.[2]

Procedure

1. The lens may not be completely in the frame at the end-piece.
2. The end-piece needs to bend outward.
3. File the butt end of the temple.
4. Bend the temple outward.

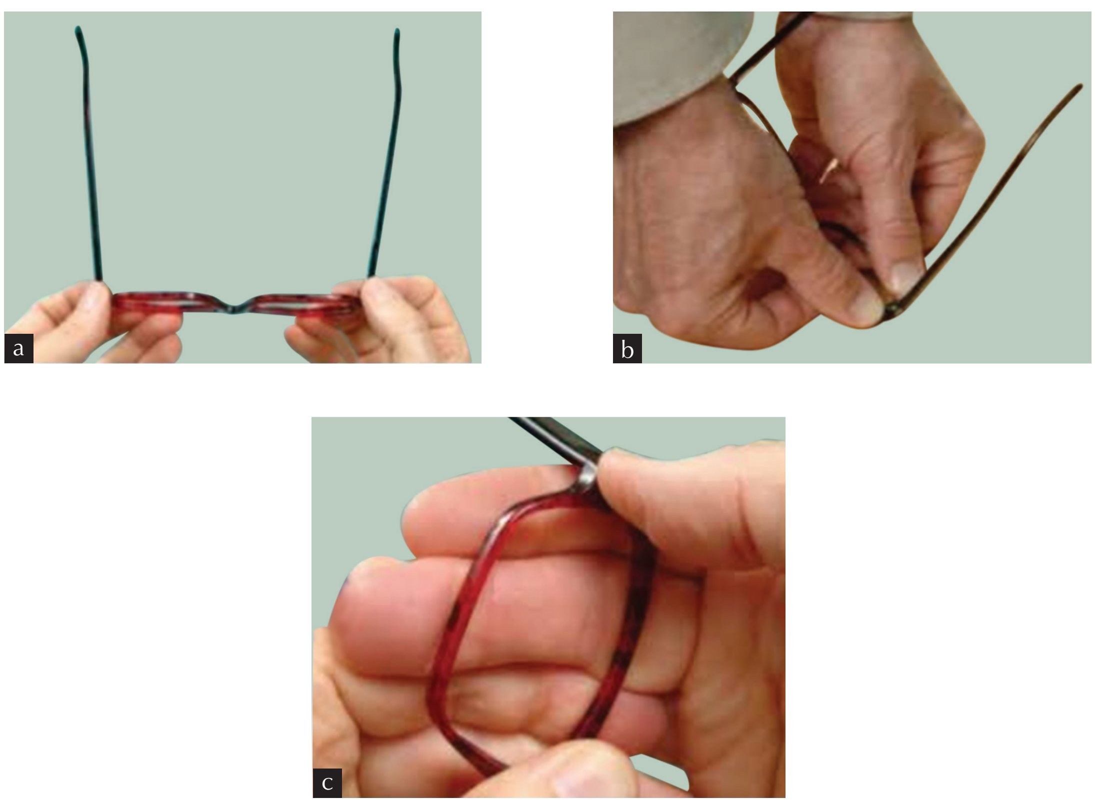


Fig. 13.7a and c: (a) Temple spread too far; (b) Reduce temple spread; (c) Brace the eye-wires with fore-finger and thumb

II. Temple Parallelism (Fig.13.8)

The temples parallel to one another, when viewed from the side are said to be in standard alignment. A good alignment is said to be when both the ends of both temples are bent down equally. They should bend upward slightly. If the pantoscopic angle of the left and right temple is unequal, the temple will not be parallel.

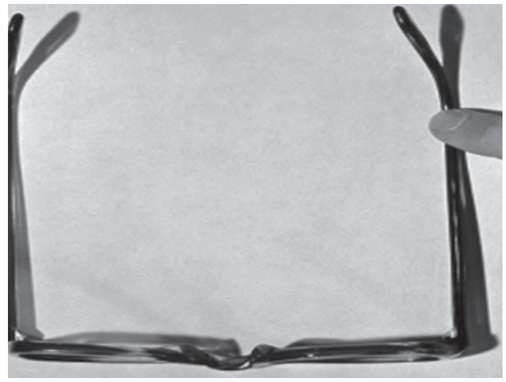


Fig. 13.8: Flat feet surface test for assessing parallelism

Errors in Temple Parallelism

1. End-piece not straight.
2. Bend in the temple shaft.
3. Twisted bridge.
4. Loosened and broken hinge rivets.
5. Faulty hinges.

Temple-fold Angle (Fig.13.9)

1. The final step is to fold the temple to the closed position and look after the angle formed as the temple cross.
2. The temple fold should be parallel to one another and must cross one another in the center of the frame.

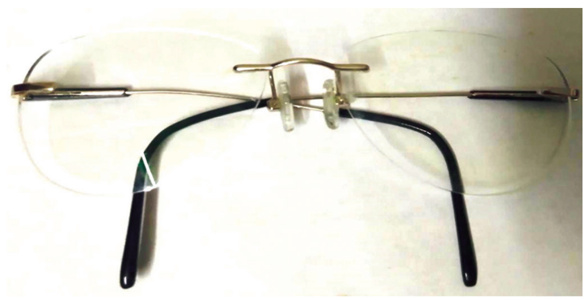


Fig. 13.9: Temple fold angle

Standard Alignment of Metal Frame

1. The metal frame alignment is the same as of plastic frames.
2. The parts of metal frames covered by plastic need to be heated and the rest of the entire bend are done cold.
3. The pliers are used for the majority of adjustments.
4. The frame must be assessed for horizontal alignment, a rotating lens, face form, X-ing.
   a. **Horizontal alignment:** Place a ruler on the frame front at a point where pad arms are attached. The end-piece should be equidistance from the ruler.
   b. **Rotated lens:** This condition occurs when the top of one lens is not parallel due to nasal or temporal upsweep. For aligning the rotating lens in a metal frame.
      i. Eye wire screw must be loosened.
      ii. Turn the position of the lens until it aligns correctly with the collateral lens.
      iii. Retighten the screw.[1]
   c. **Face form:** If the size of an eye is bigger than a metal frame is designed according to the face form. The plier and hands may be used to change the degree of face form in a metal frame.[1, 2] While checking the vertical alignment, the two things should be kept in mind.
      i. Does the frame have a face form curve or four-point touches?
      ii. Does the frame have a face curve?

iii. Are the two nasal eye wires equidistant from the ruler, or one is farther from another?

d. **X-ing:** The misalignment known as X-ing is the same as of plastic frame and can find out by the same methods which are used in plastic frames.

Correction: It can be corrected by grasping the lens between the thumb and fingers or by the use of two pairs of pliers.

The temple: The examination of the temple used in a metal frame is the same as that plastic frame, initializing with: 'Open temple spread', 'Temple parallelism', 'Temple fold angle', 'Temple ends.'

Temple parallelism: Temple parallelism refers to the relative pantoscopic angle when viewed from the side. Checking proper temple is the same as of plastic frame.

S. no.	*Temple spread*	*Description*
1.	Open temple spread	The temple should be at the same angle as was for the plastic frames.
2.	Temple spread too far	**Methods for correction.** Close the temple and grip the hinge from below with the thin half padded plier. The end-piece can be bent with the help of a smooth flat surface.
3.	Temple not spread enough	**Methods for correction.** Close the temple, grasp the hinge and bend the end-piece outwards with the help of padded plier.

Aligning the temple ends: The end-piece or bent down is portion of the metal frame temples aligned the same as in the plastic frames.

S. no.	*Procedure for an alteration of the pantoscopic angle of a metal frame*
1.	With hands by grasping the lens and eye wire
2.	With two-padded pliers.
3.	With one hand and one double-padded pliers
4.	With one hand on the frame front and angling pliers.
5.	By gripping the eye wire screw.

Temple fold angle

Methods for changing the fold angles are:

1. With hand and double-padded pliers.
2. With hand and half-padded pliers.

Standard alignment of rimless eyewear: The adjustment of rimless eyewear is difficult than plastic and metal frames.

Bridge alignment: In rimless frames, the mounting line serves as a line of reference. It is a line passing through the points of eye wire at which the pad arms are attached.[1]

Horizontal alignment: The distortion in the horizontal alignment can be noted by placing a straight edge at the mounting line.

If the temples are attached to the mounting line, all four points must line up on the straight edge.

If the temples are not on the mounting line, the nasal points are on the straight edge, and the point at which temples are attached should be equidistance from the straight edge.[1] The lens is said to be out of horizontal alignment if one lens is drilled improperly and if the bridge is bent.[1]

Methods of Correction

1. With the use of rimless pliers and double-padded plier.
2. With the use of two pairs of the double-padded plier.

Vertical Alignment

Vertical alignment is done in the same manner as for plastic or metal frames.

1. Place a straight edge on the inner side of the lens below the pads.
2. The nasal and temporal side of the lens must touch the straight edge.
3. The procedure is again repeated but now the straight edge is placed above the pads.
4. Again the nasal and temporal sides must touch the straight edge.

X-ing: X-ing is said to occur when the nasal and temporal side of the lenses in upper and lower positions does not touch the straight edge.[1]

Face form: To increase or decrease face form, grasp the nasal point with rimless bracing pliers and bend the bridge forward or backward by using double padded pliers[1]. Sometimes partially the bend of the bridge is useful for maintaining symmetry.[1]

The Temples

Open temple spread: If the spread of temples is at a too large or too small angle, this error can be corrected by bending the end-piece. It can also be done by using triangling pliers. If bending of the end-piece is not possible, then bend the temple.[1]

Temple Parallelism: Parallelism is checked in the same way as in metal and plastic frames.

Methods for Correction

1. Remove the unwanted bend with the help of hands.
2. By using rimless bracing and double padded pliers.
3. By using rimless bracing and end-piece angling pliers.
4. Bending the temple by hand.

Aligning the temple ends: The method used for aligning the skull temple ends is the same as for metal frames. Cable temples are best aligned by the hands.[1]

Temple fold angle: It is the same as used for plastic and metal frames, except that the point of attachment to the lens must be held with rimless bracing pliers to prevent the stress on the lens.[1]

> Using the correct tool for adjustment is necessary in order to avoid lens damage and trauma to the adjuster.

Stepwise Illustration of Standard Frames Adjustments

1. It is mandatory to use the correct tool for adjustments.
2. Inspect the plastic fibers of plier before using it for easy and smooth corrections.
3. For adjusting plastic frames "frame heaters" are required.
4. For adjusting metal frames pliers are used and occasional application of 'Frame heaters."
5. Special care must be taken while adjusting the rimless frame.
6. Sequence of standard alignment

The Order is Very Important in Aligning the Frame

1. The process of alignment starts with 'frame front' and ends till the back of the "Temple ends."
2. Assess whether the horizontal alignment and bow of the frame front are at the same level.
3. Check for the two possible errors **(Fig. 13.10a)**
   a. Is the bridge twisted: The twisted bridge is known as axing (when viewed from the side, it forms X's) if twisted then it must be straightened **(Fig. 13.10b)**.
   b. Look down onto the frame from the above. It should be aligned in the same plane and if not then apply frame heater and readjust it by twisting and stretching with the help of both hands (thumb on the top and rest of the fingers grasping the bottom of the frame) until it comes in a straight line **(Fig. 13.10c)**.
   c. Check for the angles that the fully open temples make with the frame front. It should make an angle of 95° each or perpendicular to the frame front when opened. If not aligned then realign it **(Fig. 13.10d)**.
4. *Check for temple parallelism:* By side viewing and assessing the angles between the temple with the frame front and pantoscopic tilt. These angles must be the same, if not then fix it by aligning in the same plane **(Fig. 13.10e)**.
5. *Next, we check for temple ends and angles:* These must be in the same length and angles to one another, if not aligned properly then fix the misaligned temple bends by heating the ends by frame heater and then adjust it with the help of hands in order to bring them in same length and angles.
6. Check the whether the temples are parallel with correct angles done. It is checked by resting the spectacle evenly on the flat surfaces. If it is aligned properly then, it will follow a four-point touch **(Fig. 13.10f)**.
7. When folding the temples, it should be equal and should be crossing the center of the frame or behind the center of the bridge **(Fig. 13.10g)**.
8. Next open and close the temple to assess for smooth conduction (loose or tight); if it is tight or loose then tighten or loosen it with the help of a screwdriver.
9. Inspect again for an evenly balanced frame from every aspect. Now clean the frame with the cleanser and put it into the frame box to deliver.

Alignment of Drill Mounted Frame

1. The drill mounted frames are also known as 'Rimless frame 'or '3-piece frames.' The frame comes in three pieces which are connected to the lens itself. These pieces are:
   a. The two temples with a hinge.
   b. The bridge with the nose pads.
2. These frames have an attachment where the temple piece and bridge are attached by the 2 little holes done in the lens with the help of either twist drill machine or hand drill by a sharp object.
3. These little holes are eventually having attachments with the two plastic bushing pieces also known as compression plugs to attach the temple piece to the lens.

> Always compress the lens from the top otherwise it could damage or brittle the lens if working from the bottom.

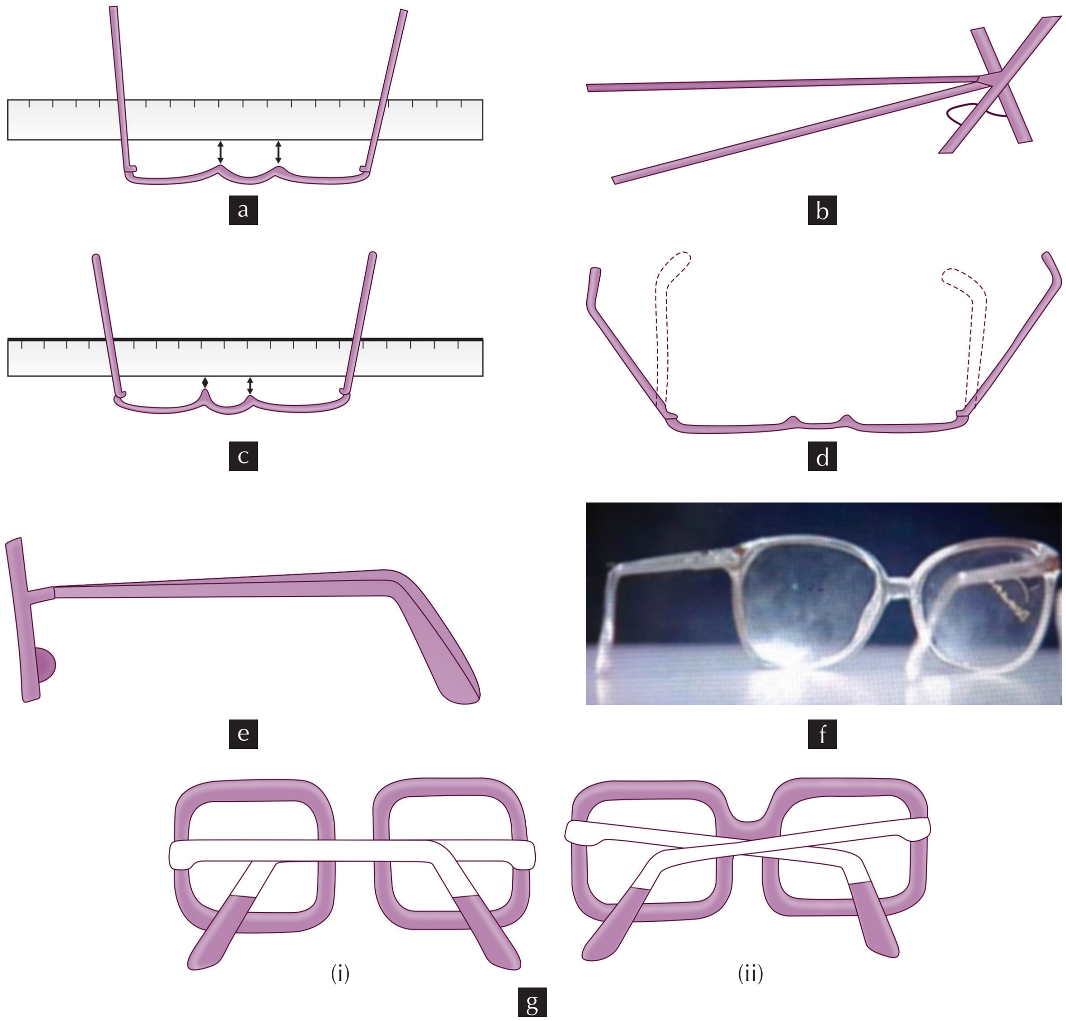


Fig. 13.10a to g: (a) Gentle and consistent bow of the frame front; (b) Axing; (c) Frame not aligned in the same plane; (d) Temple ends making an angle of > 95°; (e) Incorrect angle between the temples with frame front; (f) Four-point touch; (g) The (i) correct and (ii) incorrect temple foldings

Procedure

a. Insert the bushing piece into the backside of the lens keeping in mind that the tubes lie anterior of the lens while the connector lies posteriorly into the two little holes of the lens **(Fig. 13.11a)**.
b. After inserting bushings into the lens, trim the excess piece of the tube lies anteriorly using compression sleeve trimming plier the remnant should be in MMA **(Fig. 13.11b)**.
c. Now with the help of the 'pushpins tool' (plastic bushing opener opens plastic bushing after cut-off.), open the holes of the tube **(Fig. 13.11c)**.
d. Next attach the temple piece tongs to the 2 little bushing pieces.
e. With the help of "plastic bushing closer vertical groove plier', or by 3-piece frame adjusting plier compress the temple piece from the top of the lens **(Fig. 13.11d)**.
f. Now give a gentle squeeze to the attached portion in order to set and attach the bushings to the temple piece.

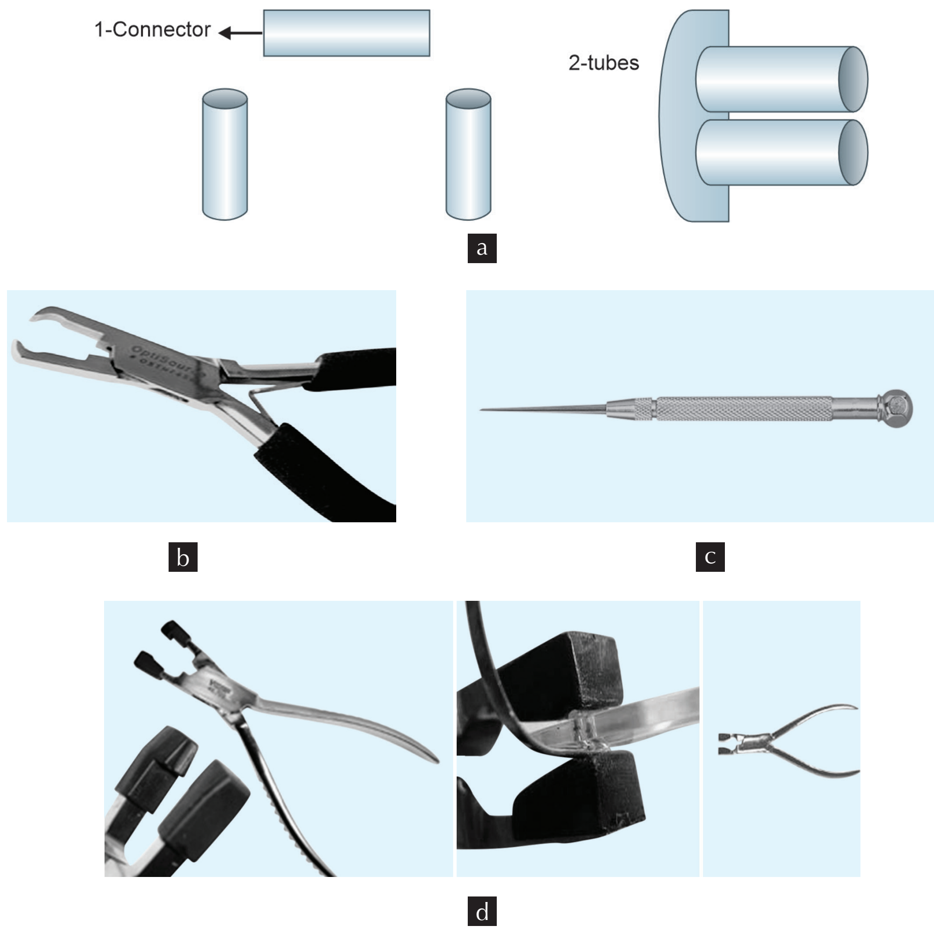


Fig. 13.11a to d: (a) Plastic bushing with tubes and connector; (b) Compression sleeve trimming pliers; (c) Push-pin opener; (d) Plastic bushing closer vertical groove plier

g. Clean the lens and the temple using the cleanser and dispense it in the spectacle box.
h. The drill mounted frames are ready to dispense with the customer.

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Chapter 14

Interpupillary Distance

INTRODUCTION

The interpupillary distance (IPD) is typically defined as the distance between the center of one pupil and the center of another pupil **(Fig. 14.1)**. It is measured in mm[1, 2] and is abbreviated as IPD.[2]

IPD establishes the stereo separation of two images, superimposed in the brain to produce stereo perception.[3] Its measurement is necessary for an interorbital parameter by which the distance between the eyeballs can be precisely measured[2] and is different for distance and near viewing. Its clinical importance is to make possible correct positioning of lenses before the eye to reduce the prismatic effect induced by the lenses and to progressively eliminate unwanted eyestrain.[2] Many published studies divinely reveal that IPD is affected by age, ethnicity and gender variations.[4, 5] The average adult's PD is between 54 and 74 mm and in kids between 43 and 58 mm.[6] Maximally IPD increases in the first year of life and continues to increase in the early adulthood.[7] One of the reports reveals that there was, moreover, a tendency for greater near esophoria in subjects with near IPD, which was smaller than 62.5 mm, and greater near exophoria in subjects with larger near IPD.[8] According to the researchers the eyeglasses and optic devices can typically decrease the eye-related complaints, such as tiredness, a headache, and nausea, which are referred to as asthenopia.[9, 10] The knowledge of the normal IPD values could be helpful for the proper diagnosis of syndromes such as ocular, hypertelorism Waardenburg syndrome, and Down syndrome, etc.[11, 12]

The IPD values are extremely significant in optometry profession as published most of the time its profound ignorance during the eyeglasses placement can result in decreased

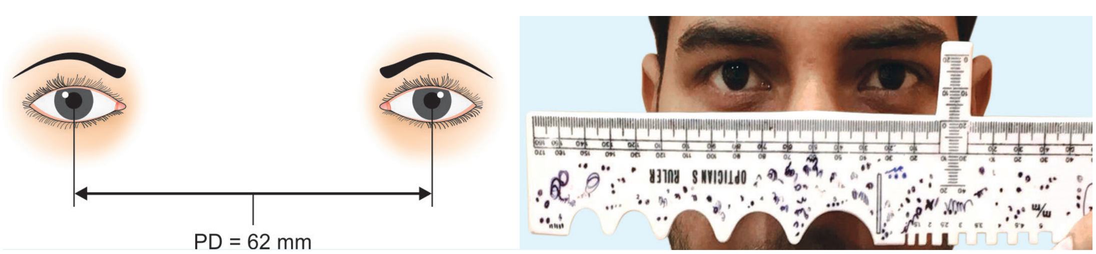

Fig. 14.1: Pupillary distance

image quality which is caused by spherical aberration, chromatic aberration, distortion coma, etc. The convergence and near focus become harder because of the increased IPD and there is a gradual loss of accommodation ability with time.[13]

Measuring Tool

1. PD ruler **(Fig. 14.2)**
2. Rodenstock interpupillary gauge **(Fig. 14.3)**
3. Pupillometer (Essilor pupillometer) **(Fig. 14.4)**
4. Topcon digital PD meter, model PD-5 **(Fig. 14.5a and b)**
5. Cal Coast PD ruler **(Fig. 14.6)**

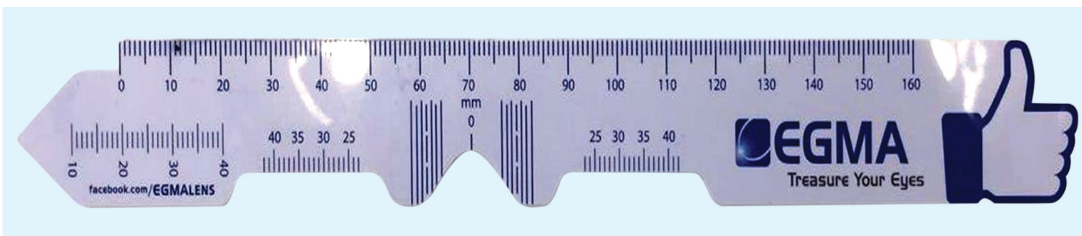

Fig 14.2: An example of PD ruler

Fig. 14.3: An example of interpupillary gauge

Fig. 14.4: Instruments for measuring PD

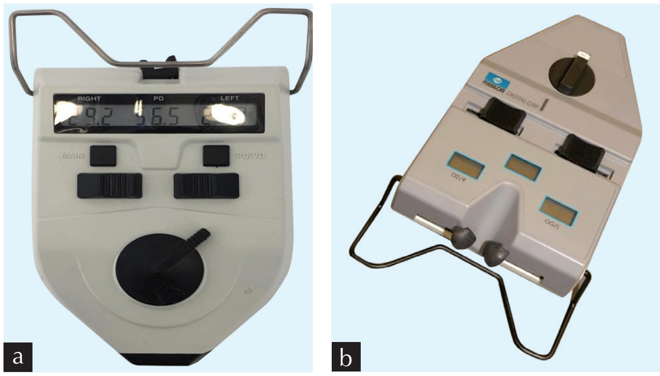

Fig. 14.5a and b: (a) An example of digital PD meter; (b) Topcon PD-5 PD meter/digital pupillometer

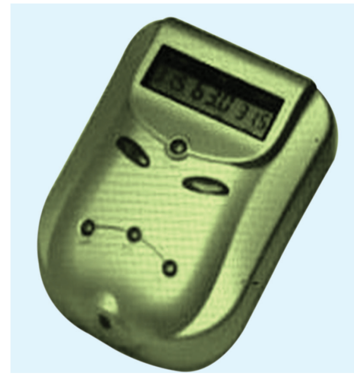

Fig. 14.6: Cal Coast PD ruler

Necessary tools to measure individually
1. Millimeter ruler.
2. Mirror.

Distance of IPD

Binocular distance of IPD (Fig. 14.7)

This is measured with the simple millimeter ruler known as PD ruler **(Fig. 14.8)**.[1]

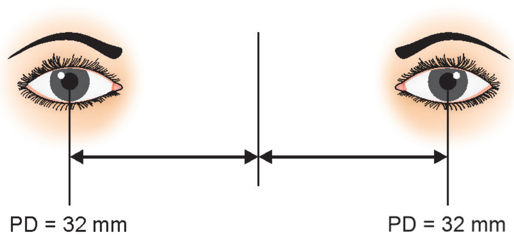

Fig. 14.7: Binocular IPD

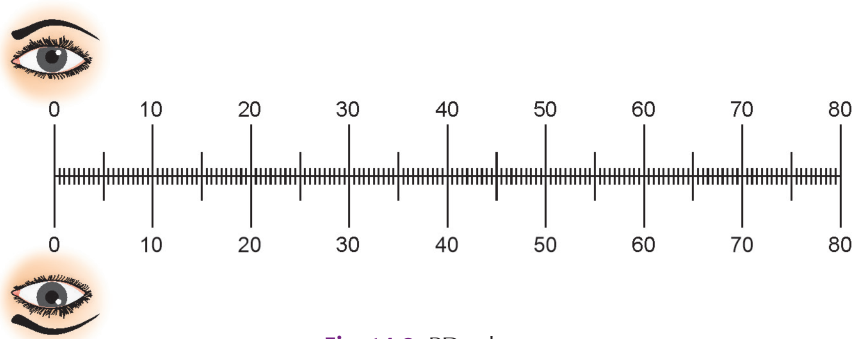

Fig. 14.8: PD ruler

Techniques

Steps in measuring binocular distance PD using a ruler

To measure the distance of the center of the pupil, the following steps are as follows:
- During the PD measurement, the examiner should be seated comfortably at a distance of 40 cm or 16 inches in front of the subject.[1, 2]

- The eyes of the subject and the examiner should be at the same level.[1, 2]
- The PD rule is gently placed over the subject's nose.
- The dispenser holds the rule with the forefinger and thumb and remaining 3 fingers placed against the subject's head to stabilize the hand.[1]
- The examiner closes his right eye and sees from the left eye, and the subject is instructed to fixate on the examiner's open eye.
- The examiner aligns the zero point of scale on the right eye, left pupillary border or left limbus of the subject.[1]
- The examiner closes his/her left eye, open the right eye and instruct the subject to look at the open eye.
- The examiner reads off-scale directly by aligning with left pupil center, left pupillary border, or left eye.[1, 2]
- The procedure was repeated three times on every subject and the average reading is recorded as the distance PD of subject.[2]

Major issues noted during PD measurements and their possible solutions are given in **Table 14.1**.

Table 14.1: Major issues and their possible solutions

S. no.	*Major issues*	*Possible solutions*
1.	The dispenser cannot close one eye	The eye can be occluded with the free hand
2.	The subject is strabismus	Expose the tested eye and cover the eye not to be observed
3.	Uncooperative subject (child)	Take a canthus–canthus measurement

Elements of Errors

Possible errors during the use of PD rule are:

1. When the subject does not fixate binocularly or have strabismus.
2. Due to the subject's head movement.
3. When the examiner does not close his/her one eye during measurement.
4. When the subject does not look directly into the examiner's pupil during the procedure.
5. When the examiner is too close to the subject.
6. When the examiner and subject eyes are not at the same level.

2. Monocular Distance IPD

Monocular PDs are important during the use the aspheric, high index and polycarbonate lenses[1] and is the best measure with the help of a tool known as pupillometer.

Techniques

Steps in measuring monocular distance PD using a ruler

There are three steps for measuring the monocular PDs implementing a ruler.

Step 1: Measure the binocular PD as described previously.

Step 2: Note the accurate reading from the right monocular PD by keeping the scale at the center of the nose prior to moving the PD ruler.

Step 3: Now subtract the reading obtained from the right monocular PD with binocular PD to obtain the value of the left monocular PD.

The procedure is the same as binocular PD measurement, except that the two readings are independent of one another.[1]

Procedure

Steps in measuring the PD using the frames:

1. The selected frame should be carefully placed in the same manner as it will be when worn.
2. The examiner sits comfortably at a considerable distance of 40 cm from the subject and the examiner and subject should be at the same level.
3. The examiner opens the left eye, closes the right eye, and instructs the wearer to focus on the examiner's open eye.
4. The examiner carefully marks the center of the pupil on the lens.
5. The examiner exposes his/her right eye, closes the left eye, and properly instructs the patients to focus on the examiner's open eye.
6. The examiner marks the subject's left pupil center on the lens.
7. The examiner repeats the procedure at least three times and after that examiner measures the monocular PD from the frame center.

3. Near Distance IPD

Near PD is typically needed for single-vision reading glasses or for the multifocal lenses. It can be either measured or calculated.

For the single-vision reading glasses: When eyes are converged for reading, the lenses must be properly set as that of the optical centers of the lens.

For the distance reading: The portions are corresponding to the distance PD while bifocal or trifocal is decentered inward so that it can be properly situated for near vision.[1]

Techniques

Steps in measuring near distance PD using a ruler

1. For measuring the near PD, the examiner should sit comfortably at the subject's working distance.
2. The subject's working distance is the distance for which the near power is prescribed at (40 cm).
3. The examiner closes his/her non-dominating eye.
4. The examiner aligns his/her dominant eye directly in front of the subject's nose and instructs them to focus on their open eyes.
5. The examiner set and points the PD rule with the center of the subject's right pupil.
6. The examiner then notes the scale marking at the center of the subject's left pupil.
7. The examiner is not advised to change eyes during the procedure and while the subject is instructed not to shift his/her gaze.

Taking Near PD using a Pupillometer

This is done by using a movable internal lens which helps change the image distance and converges for the subject. The near PD accurately measured the same as that of the distance PD.

Near Distance PD for Bifocal Inset

1. It requires a proper positioning of the presbyopic lenses for the purpose of reading.
2. A proper fixation must be done for the horizontal placement of the near segment by near distance PD.
3. The segment inset must be identified individually for both the eyes as because of the probability of unequal monocular PDs.
4. The formula for the segment inset is

$$\text{Segment inset} = (\text{distance PD} - \text{near PD})/2$$

Calculations of near distance PD

It follows the three-quarter rule. It states that for every diopter of dioptric demand, the optical center of each reading lenses, or the geometrical center of each bifocal addition, should be insert 0.75 mm.

Dioptric demand = Inverse of reading distance in meters and is independent of the actual addition power.

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Chapter 15

Progressive Addition Lens

The progressive addition lenses (PALs), sometimes referred to as no-line bifocals or multifocal lenses have a gradual progression of auxiliary magnifying power for intermediate and near vision.[1] These are line-free multifocal.[2] These lenses are prepared with the help of specially designed front surface curves. These curves cause the lens to gradually increase in their plus power from the initial distance portion and terminal near portion **(Fig. 15.1)**.

Leung, JT (1999) reported shows a significant progression of myopia by 0.50 D approx after 2 years in one study of 80 Chinese children which is not found in other studies of Chinese children.[3, 4] These lenses assist the presbyopic patients to see clearly at all distances without disturbing the bifocal lines that result in jumping image.[2] The first modern progressive lens to correct presbyopia was invented by Bernard Maitenaz which was released in the year 1959. These lenses are also known as Varilux lens manufactured from the French company Essel.

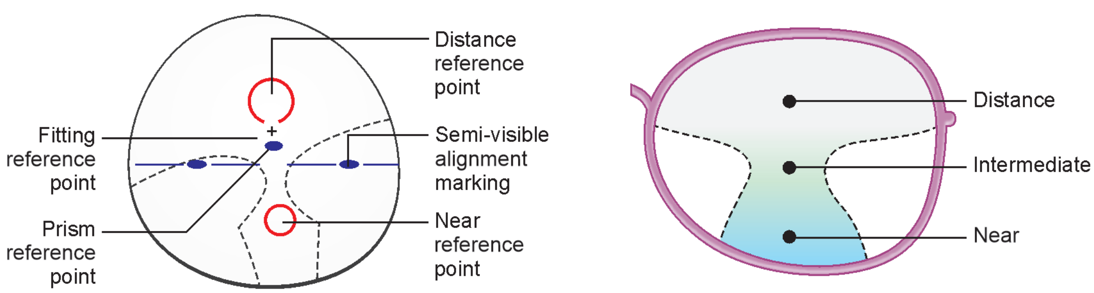

Fig. 15.1: Progressive addition lens

HISTORY

The progressive lens is characterized by correcting near, intermediate and far vision on the same lenses. The Essel merge Silor in the year 1972 with an innovation Varilux-2 with an advanced feature and comfort of adaption in the brand name as Essilor.[5] The Varilux comfort first introduced in the market with an advanced visual ergonomic criterion for comfort credibility and become the world's top-selling progressive lens.[6] In the year 2000, Varilux Panamic introduces a technology that manages central, peripheral and binocular vision parameters.[7] The Varilux Physio (2006) portrays as a patent advancement in lenses known as Twin RX technology that combines a method for calculating lens optics, wave-front management system with advanced digital surfacing.[8] The year 2008 is the turning point for the company for designing the Varilux Ipseo new edition, the first lens with a virtual stimulator using a vision print system that produces a diagnosis of eye and head movements.[9]

Characteristics of Progressive Addition Lens

1. The PALs are the demandable lenses.
2. The power is adjusted in such a way that it gradually changes from point to point on the lens surface and provides the power to observe clearly at any distances.[2]
3. These lenses are prescribed for those above, 40 years of age manifested currently by near glasses for reading with post-distant symptoms.[10]
4. These lenses are also prescribed for those who regularly work on the computer, desktop, laptop, etc.[10]
5. These acquire 3-viewing areas.
   a. Near area
   b. Intermediate area
   c. Far (distance) area
6. These areas are helpful for various activities like driving, walking, reading and computer use, etc.
7. The lobes are present on the right side and left side of the lens.
8. These are much more useful for older people and for children's present with symptoms nearsightedness or farsightedness.[6]

Types of Progressive Addition Lens (PALs)[13]

These lenses are varying in prices depending upon the size, brand, and functions.

- Standard progressive lens.
- Short corridor progressive lens.
- Computer progressive lens.
- Premium progressive lens

1. **Standard Progressive Lens (Fig. 15.2)**

   Features
   a. These types of lenses are easy to fit.
   b. Quite an affordable.
   c. It provides an expanded reading area.
   d. It executes an effective transition from down to reading.

Fig. 15.2: Standard progressive lens

2. **Short Corridor Progressive Lens**
   a. These lenses are slightly costly.
   b. They can be adapted comfortably into a small frame.
   c. Proper experience and meticulous care is required during the fitting process.
   d. Due to a narrow area/corridor for reading, it creates distortion while looking outside the corridor.
   e. A smaller frame can be used than previously possible.
3. **Computer Progressive Lens**
   a. These are moreover recognized as office lenses or near variable focus lenses.
   b. These lenses are exclusively designed for office use and provide clear vision at around 6 inches to 6 feet.
   c. These lenses are extremely useful for the person with intermediate and near distances, e.g. painters, artists, dentists, etc.
   d. These lenses are highly recommended for desk job worker working for more than 4 hours in order to reduce visual fatigue and computer vision syndrome.
4. **Premium Progressive Lens**
   a. These lenses are also known as free-form design or wave front technology.
   b. It provides a broad view and distortion-free reading areas.
   c. These lenses are totally customized, digitally grounded and surfaced.
   d. These lenses are easily adaptable.
   e. During the nodding movements of head, it produces a less dizzy effect.
   f. These lenses are most costly.
5. **Ground View Progressive Lens**
   a. The ground views progressive lenses are useful for those persons who have a keen interest in outdoor activities such as golf.
   b. These are more costly than standard progressive lenses.
   c. These are rarely available.
   d. These lenses reduce lens distortion.
6. **Transition Progressive Lens**
   a. Transition lenses are simply brand of a photo-chromatic lens.
   b. These provide one pair of glasses for indoor and outdoor activities.
   c. There are no distracting bifocal lines and only one pair of eyeglasses is used for everything.
   d. It takes time to adjust and is overpriced.

Construction of the Progressive Lens

The progressive additional lenses include some discrete areas which are not visible like the upper portion is basically a distance portion and down and inward portion of the lens is near portion. The lens power is progressively changes in progressive corridors areas, present between the distance and near portion of the lens **(Fig. 15.3)**.

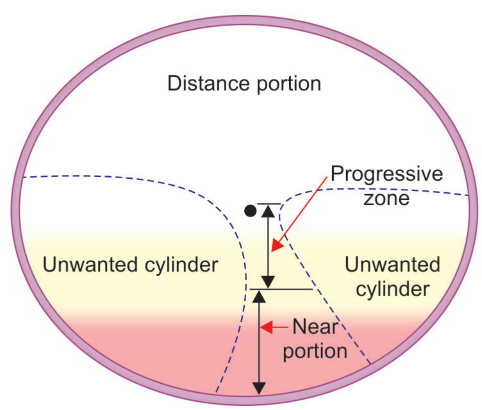

Fig. 15.3: Basic construction of the progressive lens

Frame Selection

It is very important to select a frame prior to dispensing it. The few important points must be kept in mind while selecting a frame for fitting progressives.

a. The vertical depth of the frame must be sufficient.
b. Each lens should have a minimum fitting height as per the manufacturer's recommendation.
c. The lower nasal portion of the frame must have sufficient area where the near progressive optics is found.
d. The vertex distance of the frame must be short.
e. When we keep frame closer to the eyes, it provides a wider field view for both distance and near.
f. The frame must be able to adjust for the pantoscopic angle when facial structures allow (10–12° angles are highly recommended).
g. The face form equally affects the frame selection process.

Measurement and Dispensing of Progressive Lens

The PDs measurement is recommended for each eye with vertical height individually. To make sure about the linking of the progressive corridor, a fitting cross of 4 mm is managed and is placed in front of the wearer's pupil center. The applicable measurement techniques for all manufacturers are given in **Fig. 15.4**.

Steps

- Measure the monocular papillary distance with the help of a pupillometer.
- Adjust the patient frame by pantoscopic tilt, frame height, vertex distance, face form, and nose pad alignment.
- The frame must be straight on the face.
- Hold the frame and adjust the temples.
- Place the transparent frame around the rim of the empty frame in case if the frame does not have clear plastic lenses.
- The position of the dispenser must be at the wearer's eye level.
- The dispenser draws a horizontal line on the lens by asking the wearer to look at the bridge of the fitter's nose that goes through the center of the pupil.
- The process is carried out in both the eyes.
- Place the frame on the manufacturer's chart and relocate it right or left until the bridge is centered on the diagonally central alignment pattern.

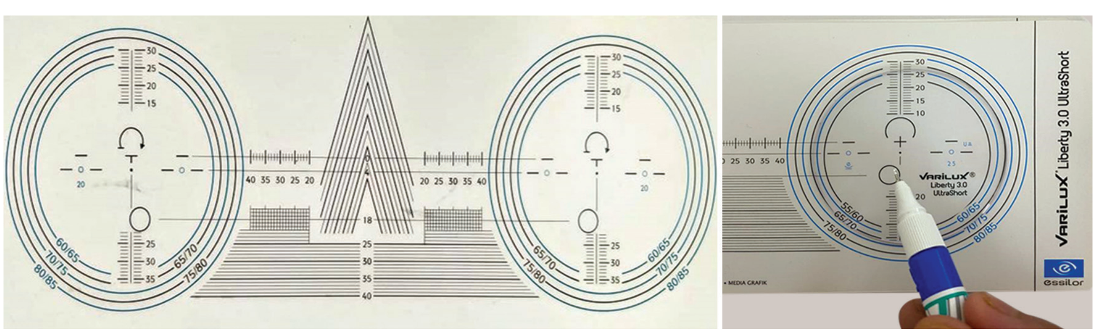

Fig. 15.4: Measuring chart for PALs

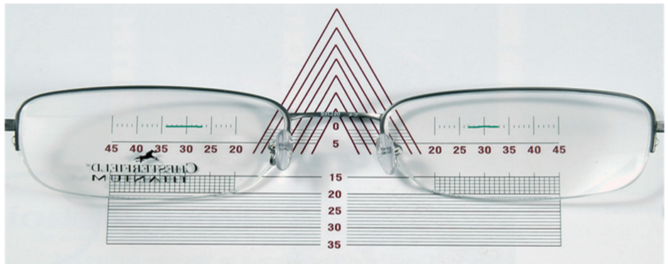

Fig. 15.5: Marking of the fitting-cross heights

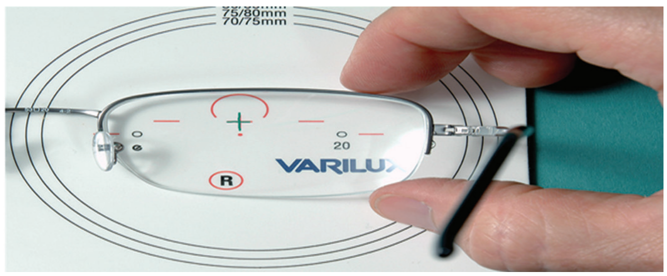

Fig. 15.6: Assesses the shape and size of the lens on the centration chart

Fig. 15.7: Monocular PD

- Now move the frame up and down until the marked horizontal pupil center lines are on the chart's horizontal axis.
- Mark the previously measured pupillary distance for each eye as a vertical line that intersects the horizontal line.
- Read the fitting cross height of both lenses from the chart **(Fig. 15.5)**.
- Record these fitting cross height and monocular PDs on the order form and in the wearer's record **(Fig. 15.7)**.
- Check the size and shape of the frame on the lens picture portion of the centration chart **(Fig. 15.6)**.
- Send the frame to the laboratory with the marks.

Verification of PALs (Fig.15.7)

a. After manufacturing, removable markings are present on the lens such as distance power arc, the fitting cross, horizontal dashes, and a prism reference point dot.
b. It may, in addition, contain a near-point power circle.
c. The distance reference is at the center of the arc.

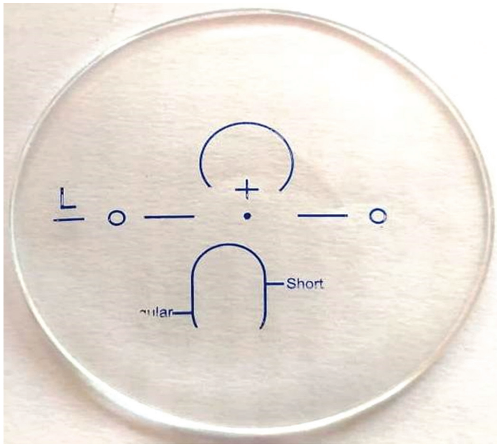

Fig. 15.8: Progressive addition lens with visible marking

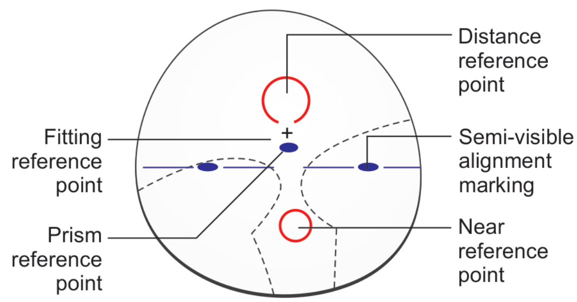

Fig. 15.9: Verification process

d. The fitting must be normally centered on the pupil.
e. Two horizontal dashes to the left or right sides of the lens help to tell if the lens is tilted or not.
f. The centrally located PRP (prism reference point) dot is used to verify prism power.
g. The circle located at the lower part of the lens, the near reference point is used to verify near power.
h. During the verifying process, the manufacturer determines where it should be verified the distance reference point, and marks its location with the semicircle **(Figs 15.8 and 15.9)**.

Dispensing Progressive

If the prescription has proved to be correct, it is adjusted to accommodate on the wearer's eye.

Rules for Frame Fitting

1. The frame should be adjusted for:
   a. Vertex distance.
   b. Adequate face form.
   c. A maximum pantoscopic tilt.
2. The fitting-cross should be checked (it must be in front of each pupil center).
3. The horizontal dashes on the lenses should not be tilted.

Remove Visible Markings

1. The visible marking must be removed or washed using an alcohol or alcohol swab.
2. At intervals, these marks can be obstinate and cannot be off easily so the lenses are heated in the hot air frame warmer. The alcohol may work better on the heated marks.

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Chapter 16

Lens Processing

INTRODUCTION

Once a frame is chosen, the selected lenses have to be fitted into the frame. Some lenses are stocked as ready-made lenses also known as **ready lenses** and others are processed only when an order is placed also known as **prescription lenses,** This segment discusses how to fit the lenses into the frame and also how to process prescription lenses.

Frame and Lens Checking

Before the process of spectacles making, it is recommended that the frame and lenses are verified against the order form. The following criteria should be checked before proceeding.

1. Check the condition of the frame.
2. Examine the center and power of the lens by neutralization with a trial set or a Lensometer.
3. Check the lens for defects like scratches and waves.
4. **In-case of bifocals:** Check if the frame can accommodate the sufficient reading area and if both lenses have matching segment sizes.
5. **In the case of progressive lenses:** Check if the frame can accommodate fitting height if both the lenses are of the same design and brand.

Manual Lens Fitting

In the manual method, approximately all the processes are done by hands like lens marking, cutting and edging, etc.

The steps involved are:

a. **Lens Marking**
   1. The first step is to mark the center of the lens with the help of the axis marker chart **(Fig. 16.1a)**.
   2. Then trace the shape of the frame onto the lens by adjusting its position for PD, centering and segment height.
   3. The lens is held against the rim of the frame in such a way that the above criteria are satisfied.

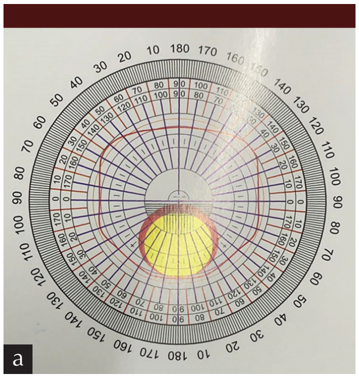


Fig. 16.1a: Axis marking chart

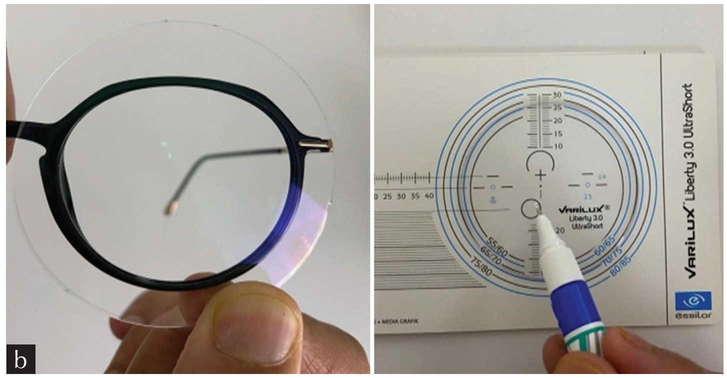


Fig. 16.1b: Lens tracing and marking

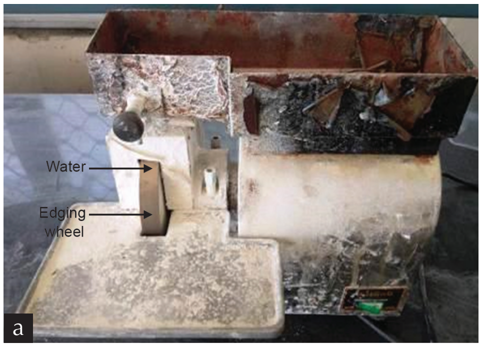
Fig. 16.2: Automated axis marking machine

Fig. 16.3: Lens cutting and snapping

4. Next, the frame shape is traced with the help of a marking pencil (Fig. 16.1b).
   Note: A slightly larger area is marked to allow for adjustments during edging.

b. **Lens Cutting and Chipping**
   1. After the lens is traced and marked, the next step is to cut the excess lens material around the usable areas.
   2. The excess lenses are grossly cut with the help of a diamond tip and chip-off the rest of the lens closed to the marked area using a chipper (Fig. 16.3).

c. **Lens Edging**
   1. The final step involves the finer edging of the lens to the shape of the frame rim and crafting in such a way that it seated in the frame groove.
   2. Advancement in the process makes these steps accurate and easy to install.
   3. Various modalities make the work productive and less consuming like manual edger electrically operated abrasive rotating diamond wheel (Fig. 16.4a) in which the lens is to be hold against the wheel for edging according to the desired shapes (Fig. 16.4b). The edger has multiple wheels for gross edging, finishing and for bevel creation. Water is also used as a coolant and to drain the excess material during the process.
   4. The lens is ready to be fitted into the frame.



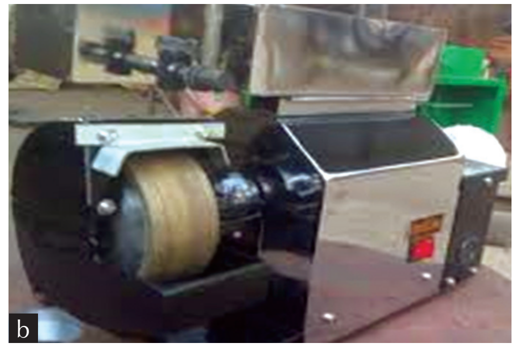


Fig. 16.4a and b: (a) Manual edger's; (b) Manual edger's electrically operated abrasive rotating diamond wheel

AUTOMATED LENS FITTING

The auto-edger machine is an exemplary intervention that makes the work easy and consumes less time to complete the task with the least human interference. This modality is too expensive, so difficult to set up in the clinics so a combination of manual and automated processes can be used.

A process in which a thousand of "Lens blank produced from the factory comes to the lab for finishing involves 6 steps and are collectively known as **Lens surfacing**

The essential steps involved in the process are: (a) Marking, (b) Blocking, (c) Grinding, (d) Smoothing, (e) Polishing and (f) De-blocking and cleaning

1. **Lens Marking and Frame Scanning**
   a. Check the power of a lens using lensometer.
   b. Trace the frame with the help of frame tracer. A pin helps in tracing and converts it into digital data that can be viewed on the screen.
2. **Blocking (Fig. 16.5)**
   a. An axis marker is a screen displaying the actual frame shape with a different axis in which the lens is placed, and the appropriate position is marked and the block is attached.
   b. The block holds the lens in position during the entire process by using alloy or wax for holding onto its surface.
   Merits of alloy: (1) Easily melted and can be reused and (2) Establish a bond between the lens and the tape.
   c. The frame shape can be viewed on a screen.
   d. The lens is prepared for the edging process **(Fig. 16.6)**.

Fig. 16.5: Lens blocking

3. **Lens Grinding (Fig. 16.7a and b)**
   a. For the lens to appear smooth in shape, the first step is to remove the unwanted material from the lens surface after marking by the process of **roughing** followed by truing and smoothing.
   b. The roughing (generating) is completed with the help of a surface generator in which the **Lap** (diamond wheel) is used as a grinding agent to accomplish the process.

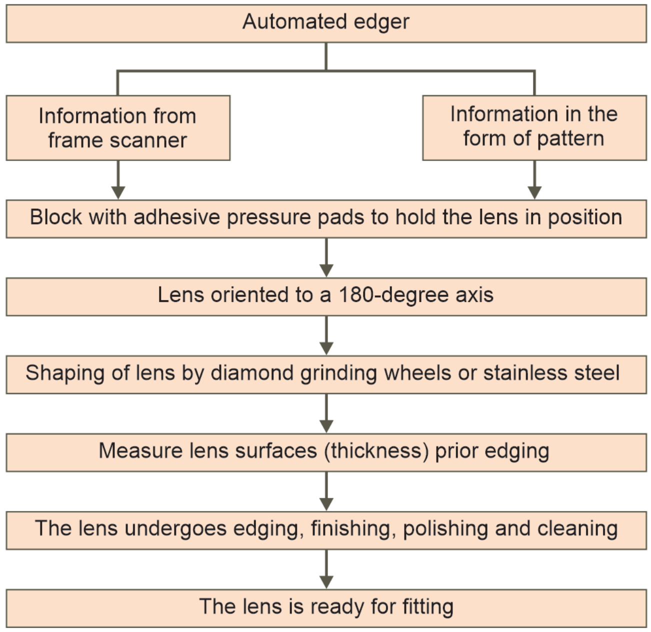


Fig. 16.6: Illustration of the lens edging till the fitting process

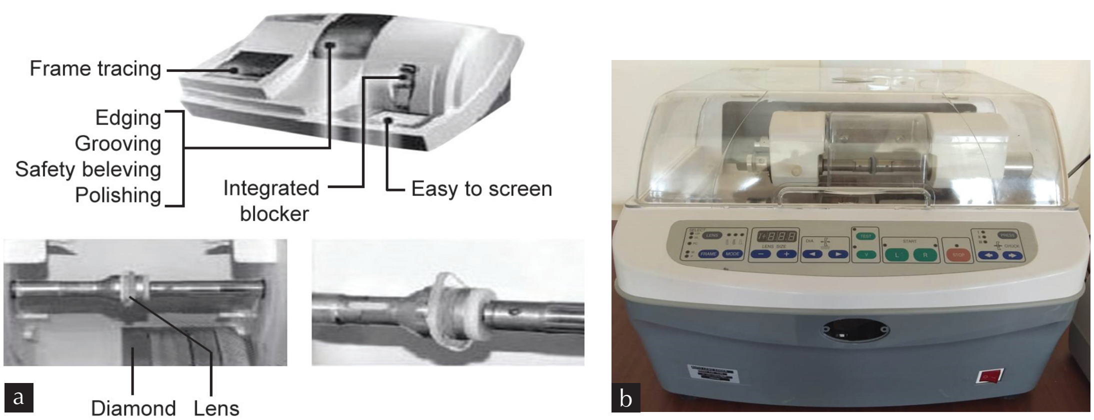


Fig. 16.7a and b: (a) Automated grinding machine; (b) Automated machine

4. **Lens Smoothing:** After grinding the lens, the next step is smoothening by the edging process which involves edging by using the pattern or pattern less edger.
   a. **Pattern edger:** An automatic process in which the information from the frame tracer is used to cut out a plastic pattern in the shape of the lens then runs along with a sensor that allows the edger to edge the lens **(Fig. 16.6)**.
   b. **Pattern less edger:** The information from the frame scanner is transferred directly to the edging machine which edges the lens accordingly.
5. **Lens Polishing:** The next step is polishing the edged lens with the help of a polishing tool lined with pads cut from the polyurethane sheets or rotatory cotton spindles. The

lens after edging needs to be cleaned for finishing, if it remain thick from the edges then the frame appears dull in shape to avoid it, the lens is polished against a rotatory cotton spindle or polyurethane sheet **(Fig. 16.8)**.

Fig. 16.8: Lens polis

6. **Lens De-blocking and Cleaning:** After the lenses have been edged, they are almost ready for tinting, coating, drilling or hardening. The lens is separated from the blocking holder, and this process is known as **De-blocking**. Now they are further cleaned to avoid any visible flaws **(Fig. 16.1)**.
7. **Lens Fitting:** The finished lens is then inserted into the frame.
   a. **Plastic frame:** The frame needs to expand allowing the lens to snap-in for this it is slightly warm in frame warmer.
   b. **Metal frame:** The lens can be inserted in metal frame eye wires by a screw.

The lens once fitted will be examined for the pantoscopic tilt, temples level, and nose pad adjustments, etc. with the help of various adjustment pliers each one with a specific function which we have already discussed in frame adjustment tool **(*see* Chapter 12)**.

Table 16.1: Cleaning of lens

Cleaning of Lens			
S. no.	*Glass Lens*	*Plastic Lens*	*Polycarbonate Lens*
1.	During marking if non-water soluble paint is used, then the lens surface must be cleaned with acetone or alcohol	The plastic CR39 lenses is safer and durable cleaning with acetone is highly recommended	The polycarbonate lenses are sensitive to solvents
2.	Dipped in an open container and wipe with a tissue or soft cloth (lint-free)	Detergent or ultrasonic bath effectively clean the plastic lenses	Only a liquid detergent is recommended
3.	The solution of detergent is effective where no spray is used	For removing the indentation at the location of the block, the lens must be kept at 200°F in the oven for a period of 20 minutes	Acetone is strictly contraindicated
4.	These lenses are cheaper, easy to process and are less expensive[8]	The sophisticated equipment is required for its edging and fitting process[8]	These lenses are highly recommended for children for safety and are very expensive[8]
5.	These lenses are heavier and can be broken very easily[8]	These lenses cannot be stocked for a longer period of time[8]	These lenses are more expensive so is useful for the one-eyed person or the one who need spectacle protection[8]

Fig. 16.9: Rimless fitting

Fitting Process for Rim-less Frame

The holes are drilled into the lens and the frame is attached by screws or clips and these frames require fragile handling **(Fig. 16.9)**.

CHAMFERING

The chamfering is also known as touching off in which the sharp outer rims must be slightly beveled approximately at an angle of 40 degrees to the flat edge of the lens and around 0.5 mm in width, to prevent flaking or breaking during its attachment in the frame. The holes created by drilling must also be chamfered by beveling rims with a chamfering point by the small plumb-shaped Carborundum drill bit **(Figs 16.10 and 16.11)**.

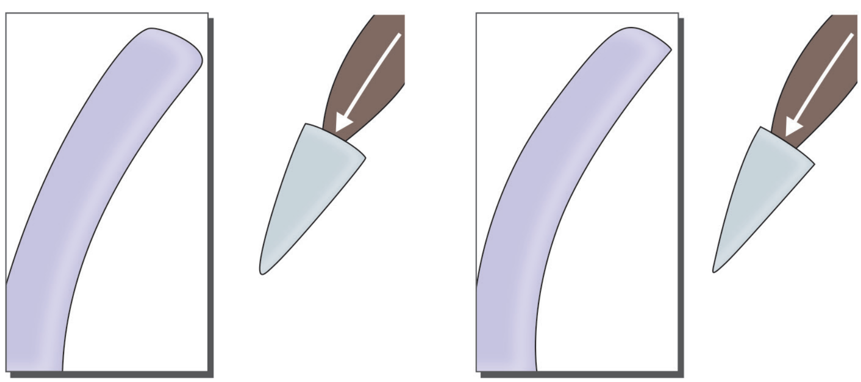


Fig. 16.10: A small plumb-shaped Carborundum drill bit

Fig. 16.11: Automated lens edge chamfering machine

Drilling Holes (Fig. 16.12)

1. **For plastic lenses:** Twist drills are used.
2. **In case of hand drill:** Start drilling from the sharp-pointed objects otherwise it will scratch the lens.

Fig. 16.12: Drilling machine

Key Points While Drilling

1. The lens is held in a proper position.
2. The cylindrical axis must be marked.
3. A distance of 3 mm from the hole to the edge must be maintained while drilling.
4. The holes must be drilled perpendicular to the lens surface.
5. Larger holes create a lens to wobble, not to drill hole oversized.
6. The lens must be drilled halfway and then turned over for completing the drilling.
7. The concave side must be up while drilling.
8. After halfway flip the concave side of the lens to meet the other half convex side for the drilling process.

Screw Fitting (Fig. 16.13)

Points to Remember

1. After the lens is drilled from both the concave and convex sides, the next step is to attach the screws into the holes and nuts to fasten it.
2. A plastic bushing is sometimes used. The screw and nut varieties are already discussed in Chapter 12: Frame Adjustment Tools.
3. Keep in mind not to cut the screw flush with the nut. Cut the screw 0.5 mm from the nut.
4. Do not file down the ridge of the screws as it will loosen it.

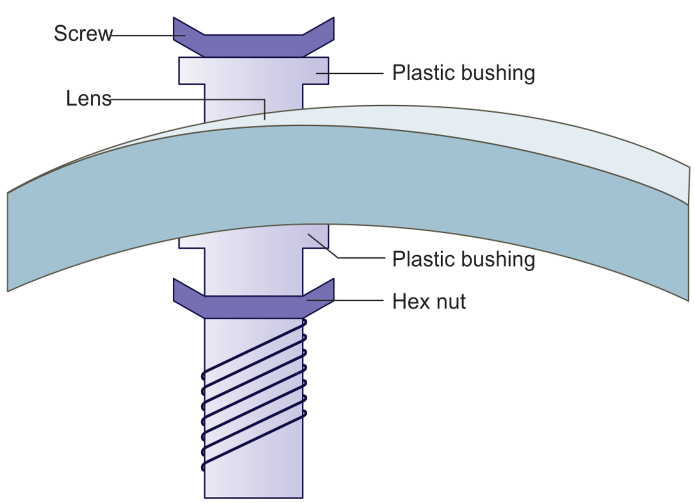


Fig. 16.13: Screw fitting

Table 16.2: Drilling key points
1. The lens is held in a proper position.
2. The cylindrical axis must be marked.
3. A distance of 3 mm from the hole to the edge must be maintained while drilling.
4. The holes must be drilled perpendicular to the lens surface.
5. Larger holes create a lens to wobble, not to drill hole oversized.
6. The lens must be drilled halfway and then turned over for completing the drilling.
7. The concave side must be up while drilling.
8. After halfway flip the concave side of the lens to meet the other half convex side for the drilling process.

5. To produce a reverse rivet effect, punch the tiny depression in the center of the screw ends with a pointed tool.
6. Apply some adhesive on it.

Fitting of Semi-rimless Frame (Fig. 16.14)

1. The frame
2. Ruler
3. Cutter
4. Nylon thread
5. Piece of ribbon or plastic

Fig. 16.14: Fitting of semi-rimless frame

Steps

1. After the edging process, a thick groove is cut from the lens edge with the help of a grooving machine.
2. Place the nylon thread into the lateral edges holes of the lens and weave its ends from both sides.
3. Leave a little nylon thread at its ends and cut off the excess nylon thread using the cutter.
4. Carefully measure the distance between the frame and the nylon thread on that side using a ruler.
5. Tighten or loosen the nylon thread accordingly, if needed.
6. Now place the processed lens into the weaved nylon thread arrangements.
7. To fit the lens between the nylon thread and lens groove, a piece of ribbon is inserted in between.

Tinting Process

The tinting as the word indicates colouring of the lens surface with a multitude of shades. It was first developed in the late 1980s with **FL-41 lenses** and first reported in 1991 by Wilkins and Wilkinson. It was designed to allow only 10% light filtration thereby reducing eye-strain, headaches to increase the productivity at the workplace stations.[1]

The tinted lenses traditionally serve its purpose only in migraines, traumatic brain injuries, benign essential blepharospasm (BEB), retinal dystrophies, etc.[2–5] But therapeutically seen in any patient with phobias inducing conditions related to intrinsically photosensitive retinal ganglion cells (IPRGCs) mediated neural pathways like ocular, neurologic, medication-related origins.[6, 7]

Process of Lens Tinting

The tinting lenses especially light brown or grey are most effective and provide relief from glare. These lenses are also known as cosmetic lenses.

1. The first step is to dip the lens into the heated dye.
2. The tint slowly absorbs in the plastic.
3. Dip the lens in the dye for a longer period to get a darker tint.
4. Immerse the absorptive lenses into the heated solution of UV filtering chemicals to provide protection against UV radiation.

Absorptive Lens

Absorptive lenses are those lenses that serve the purpose of reducing the amount of transmitted light or radiant energy or absorb a certain proportion of incident radiations. These lenses act as a filter and the absorption may be either selective or uniform.

Table 16.3: Classification of tint

S. no.	*Types*	*Subtypes*
1.	Fixed tint	a. Integral tint b. Surface tint c. Dye tint
2.	Variable tint	a. Glass tint b. Organic tint

Table 16.4: Process of lens tinting

S. no.	*Types*	*Description*
		Process of lens tinting
1.	Solid tint	The solid tint/Integral tint is applied throughout the entire surface of the lens. The colour tint may vary from very light about 3% very dark about 85%. Its major advantage is it does not affect the performance even if the lenses acquire scratches. These lenses are best used by welders. Disadvantage 1. There is a variation in the transmission from one eye to another in-patient with Anisometropia. 2. The tint remains permanent. 3. No equi tint.
		Surface tinting
1.	Glass lens	The tint is applied by depositing an AR coating of thin metallic oxide only on the back surface of the lens by the process of evaporation in the vacuum chamber and then re-condensed on the cooler lens surface. *Advantage* 1. Equi tinting. *Disadvantage* 1. ARC did only in glass lens. 2. Scratches effect transmission as coating done only on a single surface.

(Contd.)

Table 16.4: Process of lens tinting *(Contd.)*		
S. no.	*Types*	*Description*
		Surface tinting
2.	Plastic lens	The lens is immersed evenly in an organic dye solution for uniform tinting. *Advantage* It is a very easy process and any colour can be tinted. *Disadvantage* It fades faster.
		Dye tint
1.	Resin lens	The resin lenses are tinted in the dye solution in the form of powder or liquid dye mixed in the boiling water. The more dye will be absorbed if it remains for a longer period in the dye solution at the temperature of 92–96°C.
		Tint colours
1.	Yellow tint	1. The yellow tint is also known as Askalichrome. 2. These are sometimes marketed as "Blue blockers." 3. These were traditionally used as shooting glass 4. The sulphur or uranium oxide is used to prepare yellow tint. 5. It absorbs blue, violet and UV light. 6. These are used by the pilots. 7. These tint glasses are useful in foggy conditions.
2.	Red tint	1. The red tint is formed from selenium. 2. These can help in huge discrimination, e.g. in skiing, hunting, etc.
3.	Pink tint	1. The pink tint is formed by cerium. 2. It helps in soothing the eyes. 3. It is useful for computer workers sitting for an extended period in the offices.
4.	Green tint	1. The green tint is also known as a colour bar. 2. The ferrous oxide is used for preparation. 3. It helps in absorbing UV radiations as well as IRR rays. 4. It offers the highest contrast and greatest visual acuity of any tint.
5.	Brown or amber tint	1. The amber tint works well in variable light conditions. 2. It provides a good contrast. 3. The brown lenses are good general-purpose lenses and also used for sports.
6.	Purple tint	1. The purple tint allows 70% of visible light transmittance inside and 20% outside the lens. 2. It is a balanced colour that provides natural colour perception while shading the eye.
7.	Grey tint	1. The grey tint provides good protection from glare with minimal distortion of colors and referred to as a "True-colour tint." 2. It is a good choice for general use and for driving purposes.
8.	Blue tint	1. The blue tint is also known as "Alpha" and is used to reduce glare problems in aphakia. 2. It is a good fashion tint in lighter shades. 3. It is unadvisable for outdoor works.
9.	G-15	1. The G-15 is a combination of both grey and green that blocks 85% of light. 2. It reduces glare. 3. It also helps in reducing eye-strain in bright light. 4. These are good options for sunglasses.

Types of Absorptive Lens

1. Tinted lens.
2. Polaroid lens.
3. Photo-chromatic lens

Tinting Patterns

Equitinting: The equitinting refers to apply a uniform tint and tint depth throughout the lens.

Gradient pattern: A tint that is dark at the top and light at the bottom. This is due to the process of immersing the lens upside-down means the top of the lens is immersed first and withdrawn in the last makes it darker from the upside.

Double gradient pattern: This pattern has a darker tint at the top and bottom of the lens and a medium tint in the center of the lens. These tint glasses are useful for skiers.

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