DESIGN AND ASSEMBLY OF CORNEAL TREPHINE HOLDER

Submitted in partial fulfilment of the requirements for the award of the degree of

B. TECH

by

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CERTIFICATE

This is to certify that the thesis entitled "DESIGN AND ASSEMBLY OF CORNEAL TREPHINE" submitted by **GUDURU VENKATA MARUTHI ABHIRAM, GOLLANGI HARSHITH,** to AKRITI OPHTHALMIC PVT. LTD. , M34, M35, M36, Medical Devices Park, Sultanpur, Patancheru Mandal, Hyderabad -502319, Telangana, India in partial fulfillment of the requirements for the award of the degree of **Bachelors of Technology** is a record of bonafide research work carried out by us under our supervision and guidance. This work has not been submitted elsewhere for the award of any degree.

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ABSTRACT

Blind spots in the eye or cornea area are a common symptom of several eye illnesses that are prevalent nowadays. Several factors, including ageing, negligent upkeep, pollution, accidents, etc., are to blame for this. In order to eliminate the blind spots, this results in corneal transplantation. The cornea is punctured by the endothelial punch after the eye is severed since the donors are deceased persons. The cornea is then separated. However, the receiver's eye is more difficult to remove since it is attached to the optic nerve, making it more difficult. The project's primary emphasis is on a challenging procedure termed cornea surgery on a human eye. In accordance with the requirements of the specific patient, the cornea is to be sliced. Because even a tiny difference in microns of length could result in eye sight damage, doctors are unable to be as precise when employing a trephine punch with their hands. Consequently, the machine possesses the most precise motor achievable, which also has a microns measure of perfection. The standards for being accepted of medical practises are closely adhered to, and the body weight and built quality are both maintained. The design and safety of the human eye are governed by numerous emergency security measures. The solenoid, trephine punch, and case that make up the trephine assembly mostly travel along its horizontal axis. The object can be moved horizontally with the help of the stepper motor and drivers. To adjust the features, such as speed, distance, and height, stepper motors and drivers are employed. The main axis of motion for the trephine assembly, which also includes a solenoid, a trephine punch, a lead screw, a ball screw, lead screw supports, and a case, is horizontal. The two core elements of linear motion systems are the motor, which converts electrical energy into rotating motion, and the lead screw mechanism, which transforms the rotational motion of the motor into linear motion.

CHAPTER 1
INTRODUCTION

To enhance patient outcomes and enhance surgical precision, new technologies are constantly being developed in the field of ophthalmology. The trephine punch machine for corneal surgery is one example of this technology. This device has completely changed how corneal procedures are carried out, enabling quicker recovery times and fewer complications. We will go into the specifics of this ground-breaking technology in this review and examine how it has changed the practise of ophthalmology.

The cornea is the clear window on the front of your eye. It's made of tough, transparent tissue. Together with the sclera (white of your eye), the cornea helps protect your eye. It keeps out dirt, germs and other particles. The cornea also filters out some of the sun's ultraviolet (UV) light.

A trephine is a surgical instrument used to make incisions in bones, remove a cylindrical bone core, or remove a spherical section of the cornea for use in eye surgery. It is 3D printable and constructed of stainless steel. The solenoid, the threphine punch, the lead screw, the ball screw, the lead screw supports, and the case make up the trephine assembly, which mostly operates along its horizontal axis. The two core elements of linear motion systems are the motor, which transforms electrical energy into rotating motion, and the lead screw mechanism, which transforms the rotational motion of the motor into linear motion. The main objective is to use the punch to automatically and without human assistance cut the human's cornea to deal with the damage.

CHAPTER – 2

PARTS

ENDOTHELIAL PUNCH:

The corneal button produced by this mechanical device is of good quality and is punched out from the endothelial side of the corneoscleral button. An extremely helpful tool for removing the donor cornea button from the endothelial side. Features unique to Universal: Trephines of any size, ranging from 6mm to 11mm, can be fitted. Prerendered: For all sized trephines, the trephine and Teflon block are automatically centred. System of spring recoil: When the cut is finished, the trephine retracts via an internal spring mechanism. Sterilization To sterilise the punch, any technique, including dry heat, autoclaving, and E.T.O gas, may be utilised.

This comes in a range of sizes. The endothelial punch should be positioned on a blade known as a trephine. As the depth grows, a nut inside the trephine can rotate. The endothelium punch's tip enlarges as internal pressure is applied in an outward manner, allowing it to firmly grasp the trephine. This only oscillates around one axis. Steel is used to make the punch.

Fig 1: Steel endothelial punch

Because the endothelial punch weighs a lot, it can be 3D printed using ABS or PLA materials to reduce its weight. A steel or aluminium endothelium punch's dimensions are set, but with 3D printing, the dimensions may be adjusted, allowing for the use of a single endothelial punch for all trephine sizes. The endothelial punch is now 3D printed and given different sizes with a threading

for a better accuracy. The trephine of various sizes can be mounted on the tip of the endothelial punch.

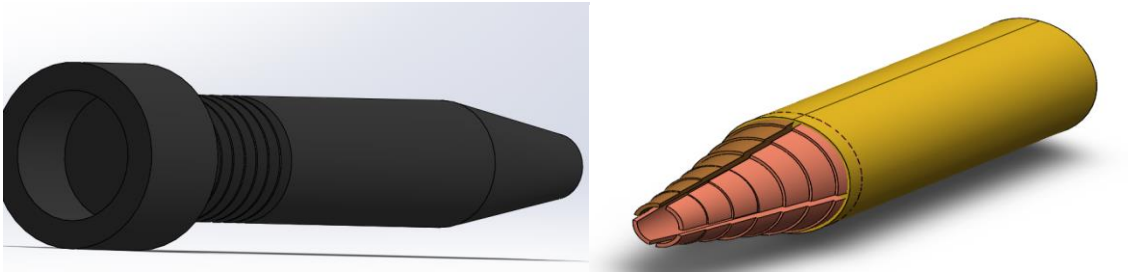

Fig 2: design of tip and nut of punch

TREPHINE PUNCH

A trephine, from the Greek trypan on, which means a drilling device. It has a cylindrical blade and is a surgical tool. Depending on what it will be used for, it can have a variety of sizes and designs. They could be made specifically for drilling holes in bones, collecting a cylindrical core of bone that can be used for tests and bone research, or extracting a round piece of the cornea for eye surgery. In a hospital's histology department, a cylindrical bone core taken with a bone marrow trephine is often inspected under a microscope. It is a helpful diagnostic tool that demonstrates the pattern and cellularity of the bone marrow as it lays in the bone in certain circumstances such as bone marrow cancer and leukemia. As the blade is used to cut human body components, these trephine punches cannot be 3D printed. Therefore, the best material to employ in the creation of these punches is stainless steel.

S. No	Diameter of the Step(mm)	Length of the step(mm)
1	4.58	2.5
2	5.48	2.5
3	6.38	2.5
4	7.38	2.5
5	8.38	2.5
6	9.38	2.5
7	10	2.5

CASING OF THE PUNCH

Our primary goal is to automatically and without human intervention cut the human's cornea using the punch. This may be accomplished by using a model that is akin to a 3D printer, which can move precisely and correctly cut human corneas down to the micron level. To handle the punch correctly without any vibrations or disruptions, we need a case. To retain the punch assembly and allow for unrestricted movement on the horizontal axis, a sturdy housing is needed.

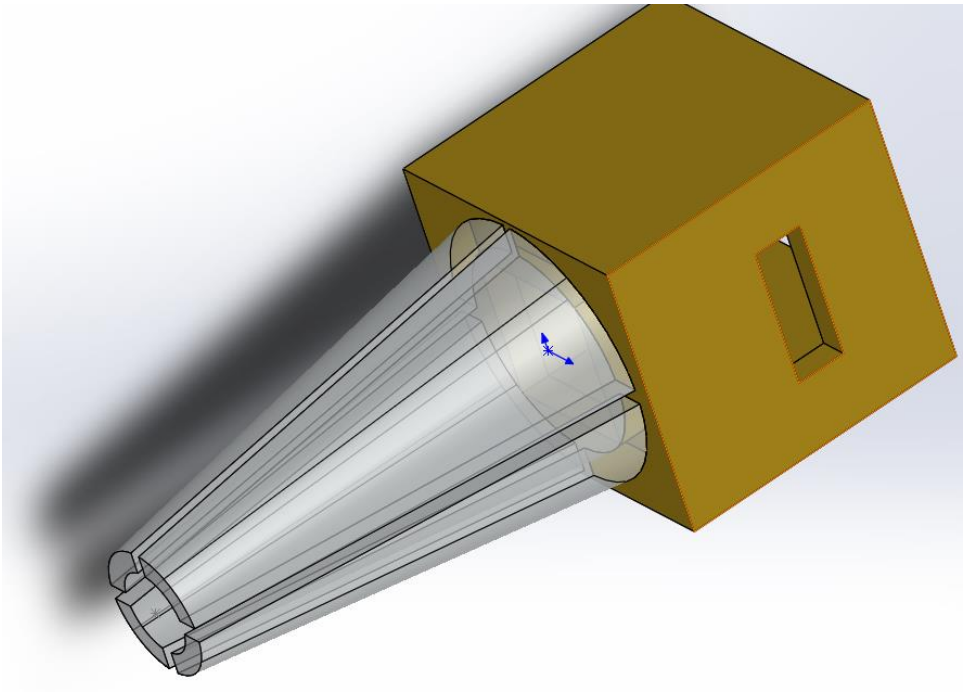

Fig 3: Casing

The gap is made for the doctor's better eyesight and clarity, and the tip is made tapered. The edge of the casing is made of glass because of its transparency, which makes it more comfortable for the doctor to see the section of the eye more clearly. A camera and lights can be placed in the gaps to increase effectiveness.

ASSEMBLY OF THE PUNCH

All the 3D printed components are currently being put together to test the punch's functionality. The nut is used to attach the tip and cylinder, and the casing of the punch is used to assemble the entire punch. All of this is given sufficient room to move flawlessly and smoothly. and holes must be drilled into the casing to make it simple to attach to the horizontal axis.

For the doctor or machine operator to remove and repair the trephine manually and to reinsert the cylinder back onto the nut, the tip's cylinder should have correct threading. It more closely resembles tightening a screw. Like that, if it is not snug, we take it out, adjust the size, and put it back in. When the diameter of the trephine must be changed, the cylinder is taken out, the punch is adjusted appropriately on the tip, and then the cylinder is put back together. This is how the punch is used.

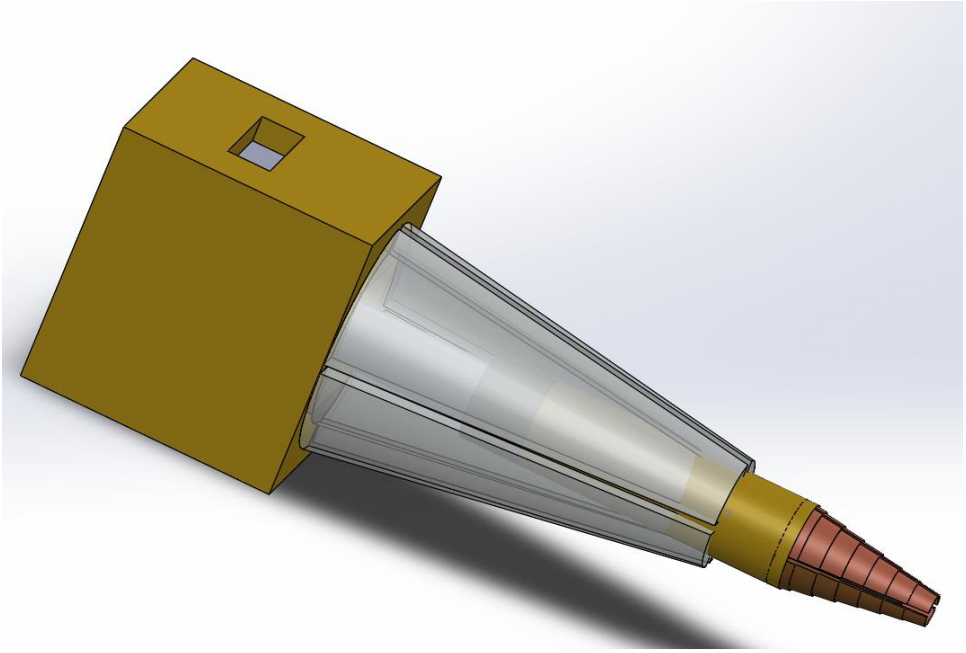

Fig 4: Punch assembly

It should be placed with a minimum distance of **8mm** from the eye and the total length is **110mm**.

HORIZONTAL MOVEMENT (X-AXIS):

The trephine assembly, which comprises of a solenoid, a threphine punch, and a casing, moves mostly along its horizontal axis. The stepper motor and drivers are

used to move the object horizontally. Drivers and stepper motors are used to change the characteristics, such as speed, distance, and height, as needed. The trephine assembly, which comprises of a solenoid, a threphine punch, a lead screw, a ball screw, lead screw supports, and a casing moves mostly along its horizontal axis.

The motor, which converts electrical energy into rotating motion, and the lead screw mechanism, which converts the rotational motion of the motor into linear motion, make up the two fundamental components of linear motion systems.

STEPPEER MOTOR – NEMA 17

A stepper motor is a particular kind of motor that enables a controller to specify the precise amount of rotation. In other words, the electronics are able to precisely regulate the stepper motor's orientation. The ability to precisely configure the orientation of the stepper motors translates into precisely setting the position of the extruder, a factor which is significant for horizontal axes.

LEAD SCREW AND BALL SCREW

A mechanical linear actuator termed a ball screw (also referred to as a ball screw) effortlessly transforms rotational motion to linear motion. A threaded shaft generates a helical raceway for ball bearings that act as precision screws. It is possible to apply or withstand high thrust loads with negligible internal friction. They can be employed in applications seeking a high level of precision as a result of their near-tolerance construction. The ball assembly functions as the nut and the threaded shaft as the screw. Since they need a mechanism to recirculate the balls, ball screws tend to be larger and heavier than predictable leadscrews.

SOLENOID

A solenoid is a device that uses an electromagnet made of a wire coil to convert electrical energy into mechanical energy. Electric current is converted into a magnetic field by the device, and linear motion is produced by the magnetic field. A solenoid is an actuator assembly used in electromagnetic technology that has a movable ferromagnetic plunger inside the coil. When power is applied, the plunger is drawn into the coil for most of its length. Solenoids are not to be confused with electromagnets with fixed cores. A solenoid, to put it simply, transforms electrical energy into mechanical work. To increase efficiency, it typically contains a multiturn coil of magnet wire enclosed in a frame that also serves as a magnetic flux carrier.

LEAD SCREW SUPPORTS

Lead screw supports are used to maintain lead screw stability and to lessen the lead screw's undesired vibrations.

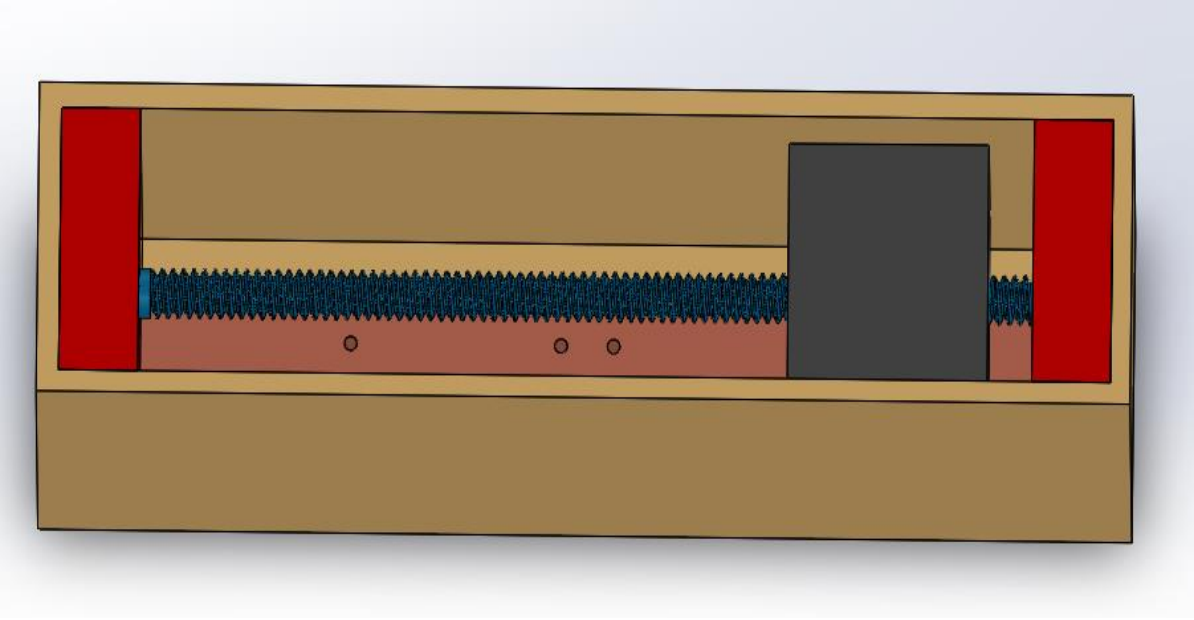

FIG 5: FINAL ASSEMBLY OF HORIZONTAL AXIS

CONCLUSION

This is a machine part that was 3D printed and joined to the entire assembly to cut the cornea, a sensitive area of the eye. The machine's case is made of a variety of materials for reduced weight and greater visibility for the physicians. To make the doctor's job simpler, lights and cameras are placed in the space between the punch holder’s tip. The speed of the motors determines how the trephine moves. A solenoid with push and pull force and precision down to the micron level produces the up and down movement and cutting. The AI is utilized to identify the patient's face, and it then uses automated face and eye coordinate detection. This precisely places the trephine punch on the cornea's surface. The solenoid is activated as soon as the location is precisely attained. This forces the trephine to travel the distance that the doctor has determined. The robust enclosure is constructed from a variety of materials to minimize vibration. Due of its transparency, glass was used to create the punch case's tip, which allows for greater eyesight. The general frame is created and constructed in this manner.