

Patent Landscape Report on Ophthalmic Devices



I. INTRODUCTION

Ophthalmic devices are used in the detection and treatment of ocular defects or deficiencies. Ocular defects can range from minor vision correction to complete loss of vision. The devices can be non-invasive such as a fundoscope or invasive such as contact lenses or implant devices (e.g., glaucoma stents and intraocular lenses). Ophthalmic devices also include surgical systems such as lasers and phacoemulsifier.

The practice of ophthalmology goes back to ancient times. Many of the present ophthalmic devices trace their history back to several decades.

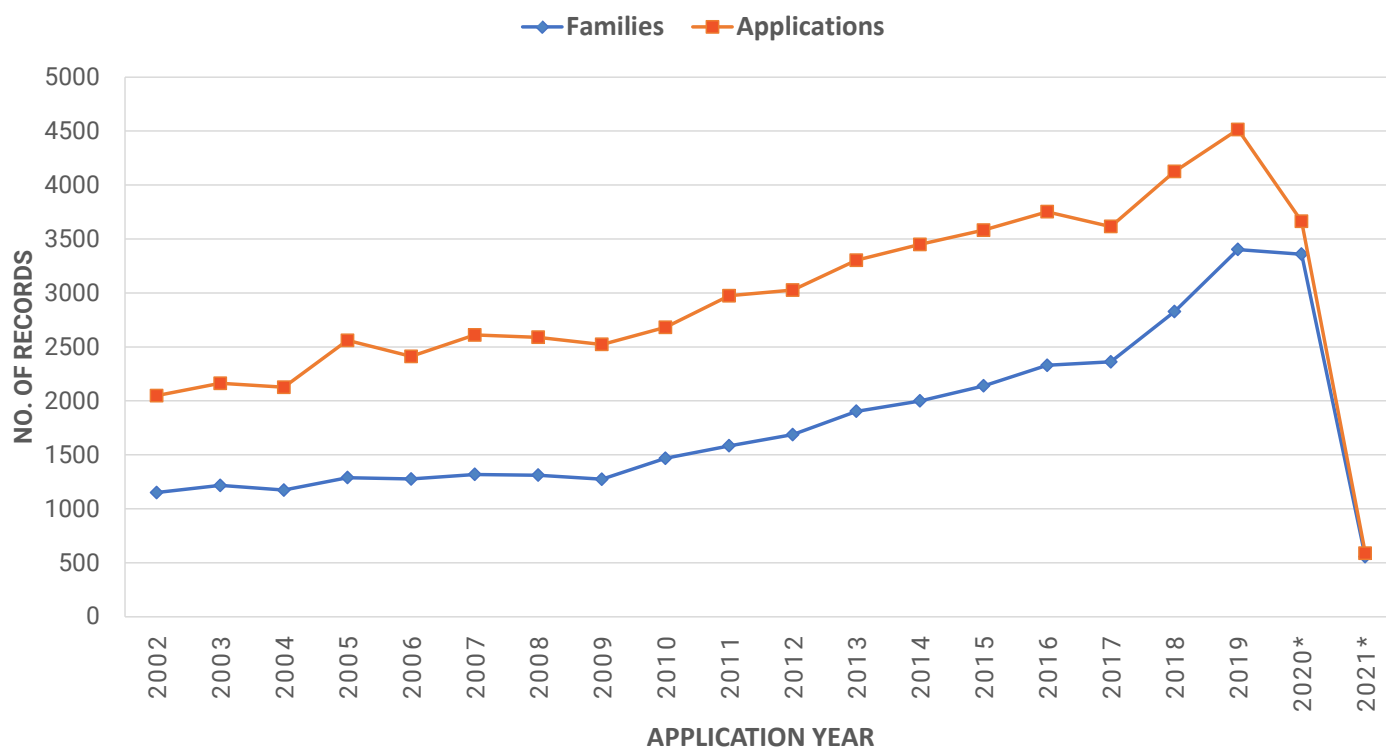
- The first ophthalmoscope is considered to have been [invented](#) in 1851 by the German physiologist Hermann von Helmholtz. It is also sometimes credited to English mathematician and inventor Charles Babbage, who developed an instrument in 1847 that resembled the ophthalmoscope. It was the precursor to modern endoscopes. The first slit lamp goes back to 1911 when Allvar Gullstrand came up with his large reflection-free ophthalmoscope.
- Sir Harold Ridley, a World War 2 eye surgeon who cared for crash pilots, had observed that small pieces of Polymethyl methacrylate (PMMA) that penetrated the eye during a crash did not cause an inflammatory reaction. He went on to develop the [first](#) intraocular lens (IOL) for cataract implantation in 1947. The use of modern IOLs is not just limited to cataract surgery. Presbyopia-correcting IOLs are used in patients who do not qualify for laser refractive surgery.
- In 1948, a Spanish ophthalmologist named Jose Barraquer Moner used a procedure called [keratomileusis](#). The procedure involved shaving tiny sections off of his patients' corneas to improve their vision using a scalpel and later a device known as a microkeratome.

- The Russian ophthalmologist Svyatoslov Fyodorov invented a technique called radial keratotomy around 1980. In 1989, Gholam Peyman patented a laser specifically for reshaping the cornea, also known as LASIK (laser-assisted in-situ keratomileusis). His patent and clinical trials were inspired by earlier research. Today, more than [10 million](#) people have had LASIK since its approval by the U.S. Food and Drug Administration (FDA) in 1999.
- Ultrasound was [first used](#) in ophthalmology in 1956 by the American ophthalmologists Mundt and Hughes. They used an A-Scan mode to evaluate an intraocular tumor. B-scan ultrasonography was first utilized by Baum and Greenwood in 1958. It is now a regular test for the clinical assessment of various ocular conditions.
- The American ophthalmologist [Charles Kelman](#) introduced phacoemulsification as an alternative approach to cataract extraction in 1967. It is now considered the safest and most preferred method of cataract surgery.
- Perimetry and optical coherence tomography (OCT) are standard procedures in early diagnosis of glaucoma and other conditions. The first perimeter system was designed by Goldmann in 1945. Humphrey Field Analyzer became popular in clinics as early as 1984.
- The early demonstration of OCT goes back to the 1980s and can be attributed to Adolf Fercher and colleagues in Austria. They measured axial eye length using low coherence interferometry. Prof. Fujimoto's group, who also coined the term OCT, performed the first [retinal imaging](#) in 1989. The early pioneers - Swanson, Puliafito, Schuman, Huang and Fujimoto founded Advanced Ophthalmic Diagnostics (AOD) and subsequently transferred the technology to Carl Zeiss Meditec, Inc. (Dublin, California).

Ophthalmology is one of the areas which features innovations to this day in spite of its early advancements. The need for eye treatment in children, rise in geriatric population, increasing prevalence of chronic disorders such as diabetes and hypertension will drive future growth. COVID -19 containment measures had temporarily deferred clinical trials, eye care procedures and exams in several markets. The pending backlog of eye care procedures and elective surgeries that were postponed due to COVID-19 are expected to drive future growth in ophthalmic devices and equipment.

II. PATENT FILING TRENDS

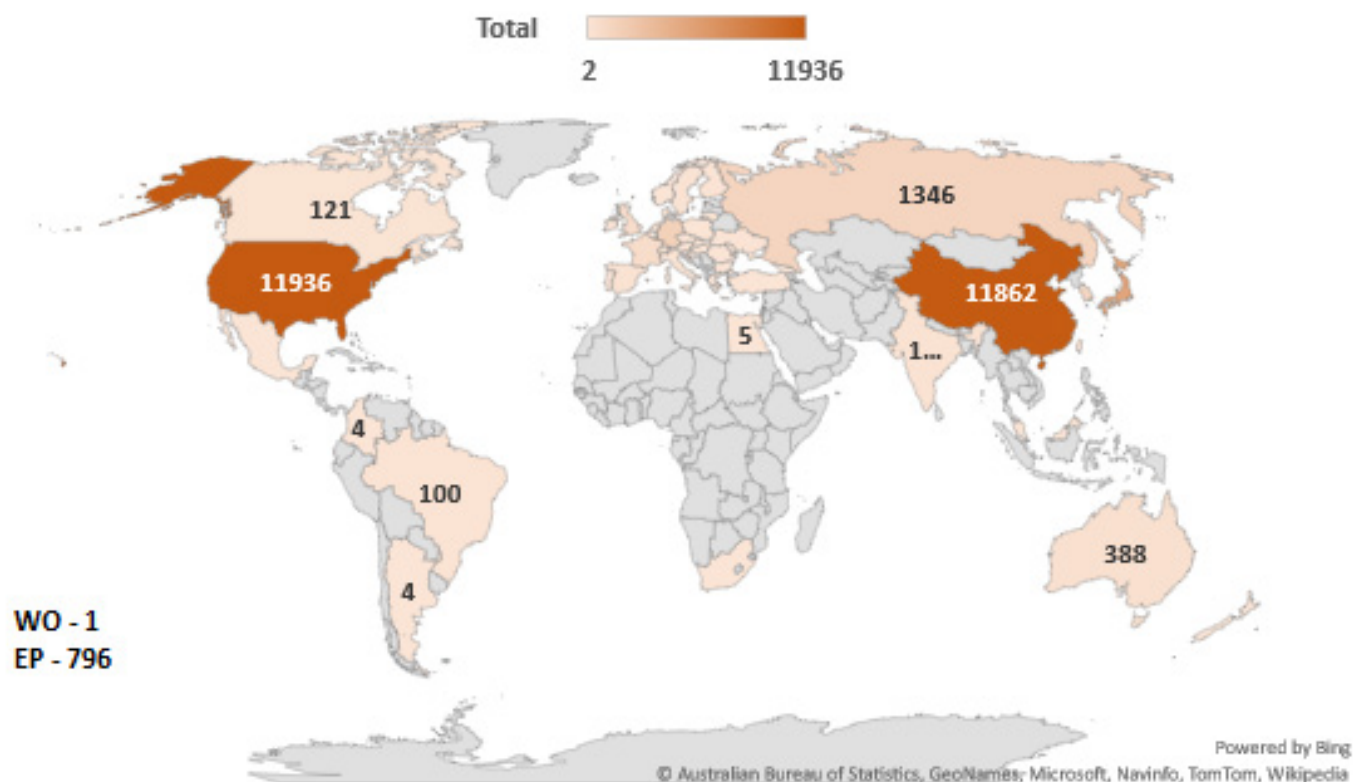
Now that you have a background on ophthalmic devices, let us take a look at the patent filing trends for 2002-2021. As per the graph below, patent families have grown at an annual rate of 9% during 2010-2019. The ratio of patent families to the number of applications has increased over time from about 1:2 to 1:1 during the same period.



* Incomplete data due to delay in publication

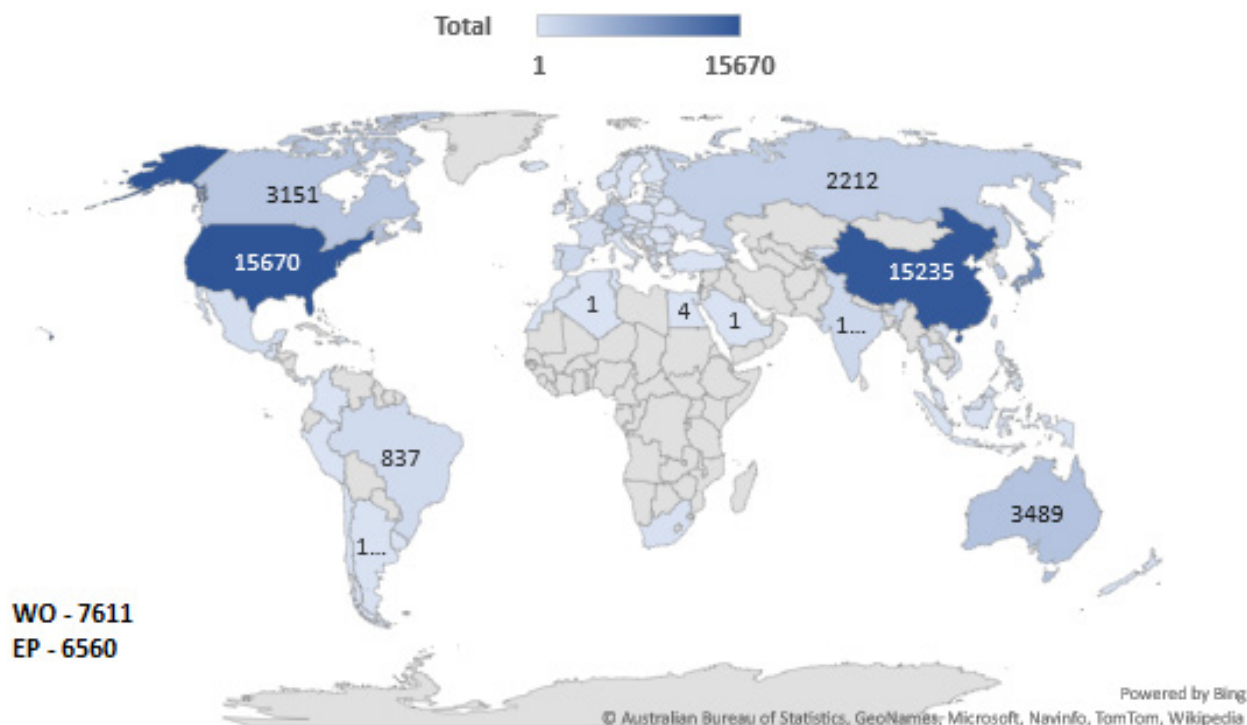
The top originating/priority country for inventions are the United States, China, Japan, Germany and Russia.

Priority Countries



The top destination countries/jurisdictions for patent filings are the United States, China, Japan, WIPO (PCT) and Europe.

Publication Countries



The top patent filers include medical device companies, pharmaceutical companies, optical equipment manufacturers and universities.

Patent Owner	COUNTRY/JURISDICTION				
	US	CN	JP	EP	WO
JOHNSON & JOHNSON SERVICES, INC.					
NOVARTIS INTERNATIONAL AG					
BAUSCH HEALTH COMPANIES INC.					
ALLERGAN PLC					
CARL ZEISS AG					
NIDEK CO., LTD.					
CANON INC.					
ALPHABET INC.					
TOPCON CORPORATION					
ESSILORLUXOTTICA SA					

TOP AND EMERGING PATENT FILERS AROUND THE WORLD

Alcon**NIDEK****verily***Johnson & Johnson*
VISION**HOYA****OLYMPUS** **Allergan****SONY**

GLAUKOS®

AcuFocus™
THE INTRA-CORNEAL COMPANY™ **Menicon****Panasonic** **mojo****Canon****BAUSCH+LOMB** **IVANTIS®****Santen****OMEGA**
OPHTHALMICS**LenSGen****Ambu** **RODENSTOCK****Geuder®**
Precision made in Germany **equinox** **RxSIGHT** **eyevensys** **KERANOVA** **oculentis®** **Brien Holden Vision Institute** **Eyebright 爱博诺德®** **ziemer**
OPHTHALMOLOGY **Halma****ESSILOR** **TOMEY** **kejako**
keep your eyes young **KOPTi**
Korea Photonics Technology Institute **Roche** **Fraunhofer** **SHIFAMED** **VSY**
BIOTECHNOLOGY**PHILIPS****VIVIOR**
Personalized Vision Performance **ONPOINT**
VISION INC. **Rayner** **edenlux** **Akkolens**
International bv**Huvitz**

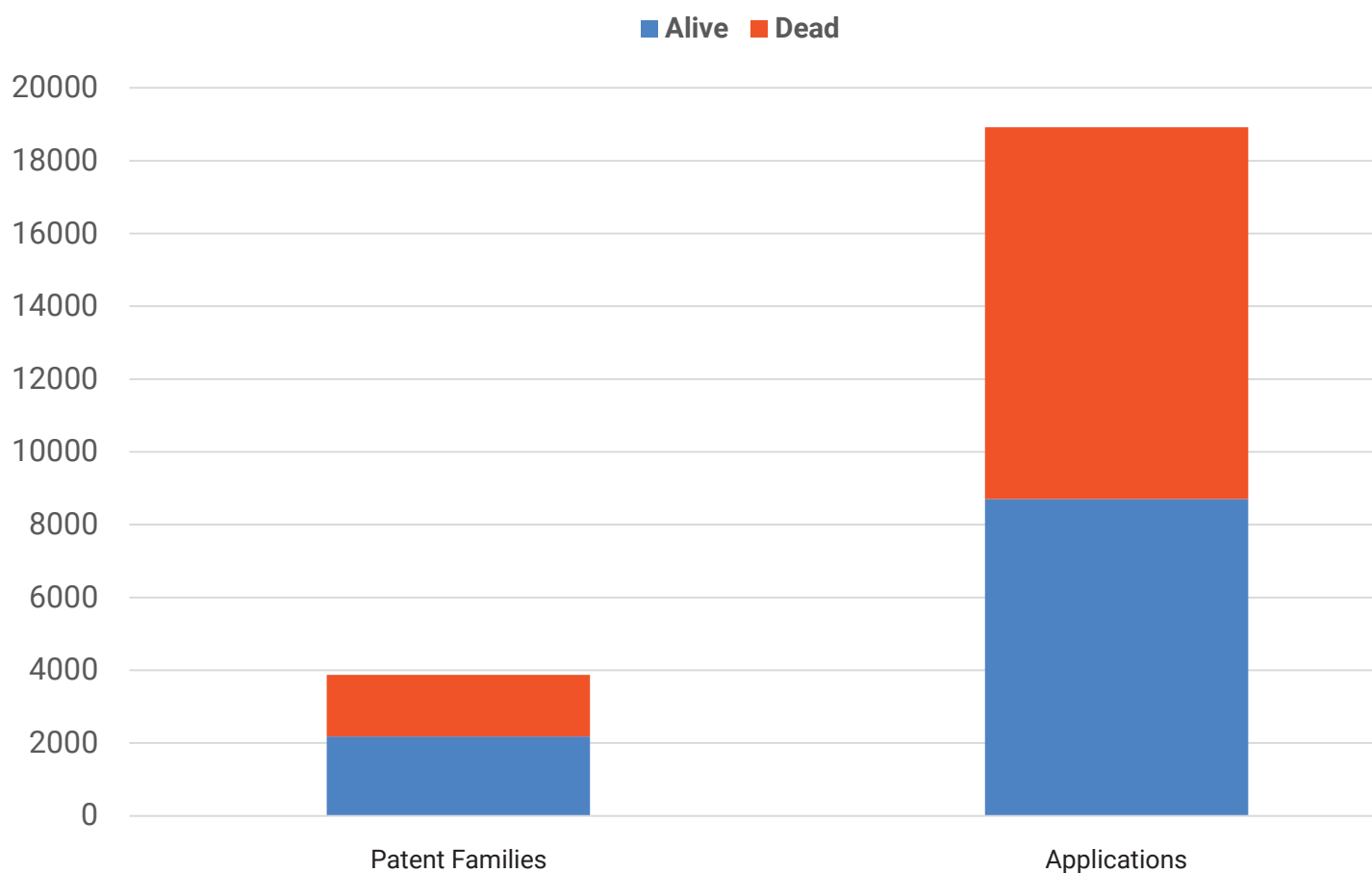
III. SELECTED COMPANY PROFILES

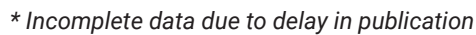


Alcon became an independent and publicly-traded company after splitting from Novartis in September 2019.

It is headquartered in Geneva, Switzerland.

The company generated [\\$6.7 billion](#) in combined revenue from its surgical and vision care segments.





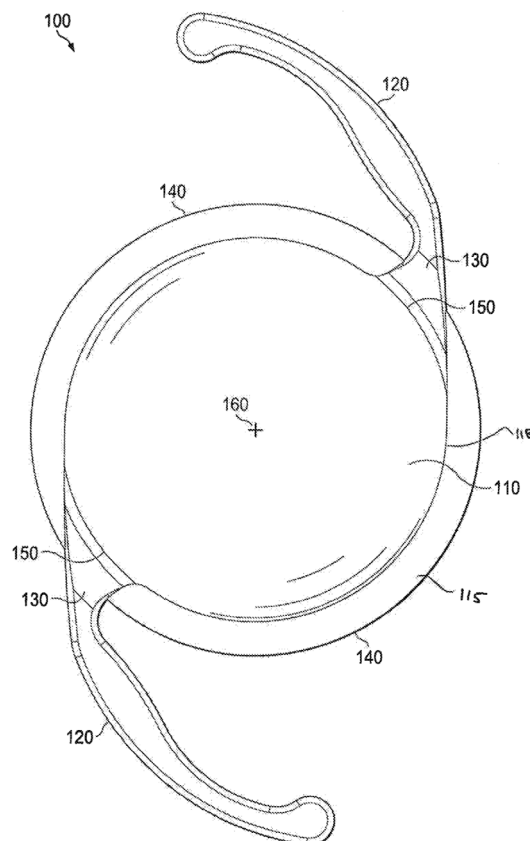
The diagram is a circular chart with five main segments, each representing a functional area of a LASIK laser system. Each segment is color-coded and contains a list of components. Red arrows indicate the flow between adjacent segments.

- LAZAR BEAM (Green):**
 - LAZAR LIGHT
 - LAZAR SOURCE
 - MULTI-SPOT LAZAR
 - LAZAR ENGINE
 - SEMI-PULSED
 - INTENSITY
 - HYDROGEL CONTACT LENSES
 - LENS MATERIAL
 - SILICONE HYDROGEL CONTACT
 - OPHTHALMIC LENSES
 - LENS PORTION
 - SOFT CONTACT
- FLUID FLOW (Yellow):**
 - AFFECT FLOW
 - FLUID FLOW MANAGEMENT
 - CONTROL DEVICE
 - RESPONSE TO PRESSURE
 - DEVICE IN RESPONSE
- OPTICAL ELEMENT (Blue):**
 - MULTI-SPOT LAZAR
 - REFRACTIVE CONTACT LENS
 - LENS MATERIAL
 - OPHTHALMIC
 - LENS PORTION
 - LAZAR LIGHT
- HAND PEE (Cyan):**
 - LAZAR LIGHT
 - LAZAR PORTION
 - OPHTHALMIC
 - LENS MATERIAL
 - REFRACTIVE CONTACT LENS
 - MULTI-SPOT LAZAR
- INTRAOCULAR LENS (Light Green):**
 - LAZAR LIGHT
 - LAZAR PORTION
 - OPHTHALMIC
 - LENS MATERIAL
 - REFRACTIVE CONTACT LENS
 - MULTI-SPOT LAZAR

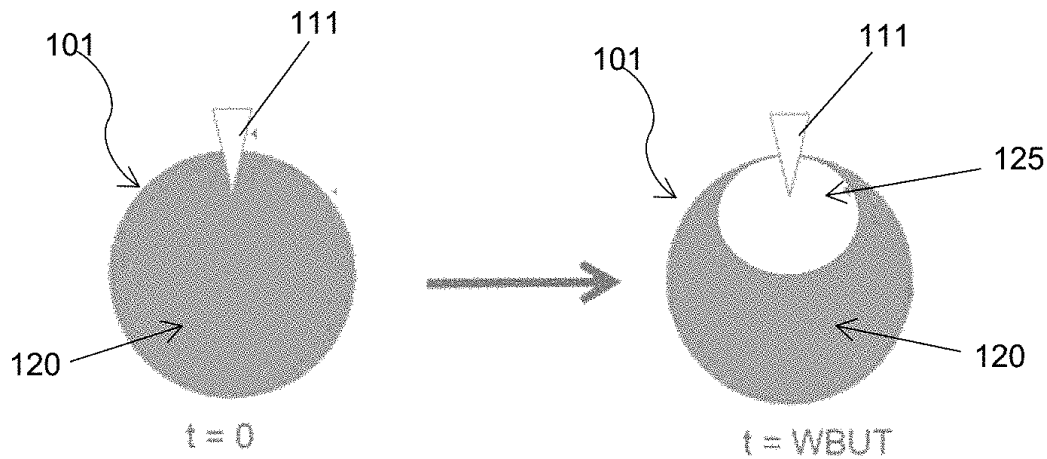
Alcon's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while the sub-topics are shown in the outer circle. Ophthalmic lenses (contact and intraocular) continue to dominate in recent years. The number of patents focusing on surgical handpieces have decreased in recent times while those related to laser/optics and fluidics are on the rise. Alcon has more than 2,000 active patent families of which 20% patent families were shortlisted for claiming ophthalmic devices.

Some of Alcon's notable patent applications are shown below.

CONTACT LENS

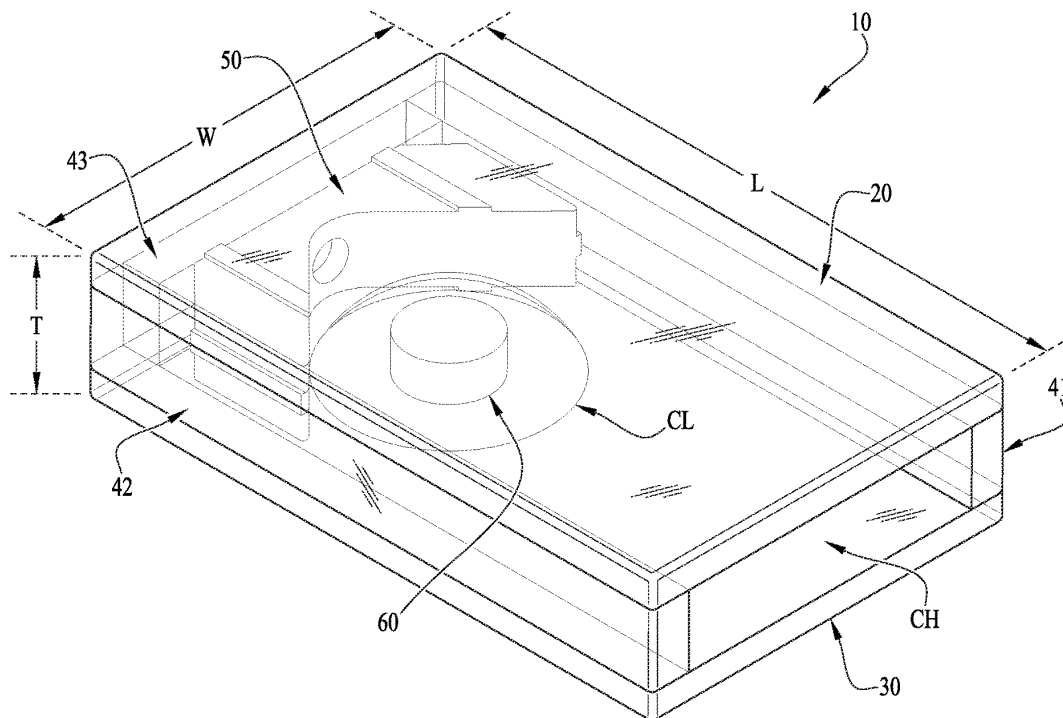


Application [US20210177575A1](#) titled "Intraocular Lens Having Increased Optic Diameter"



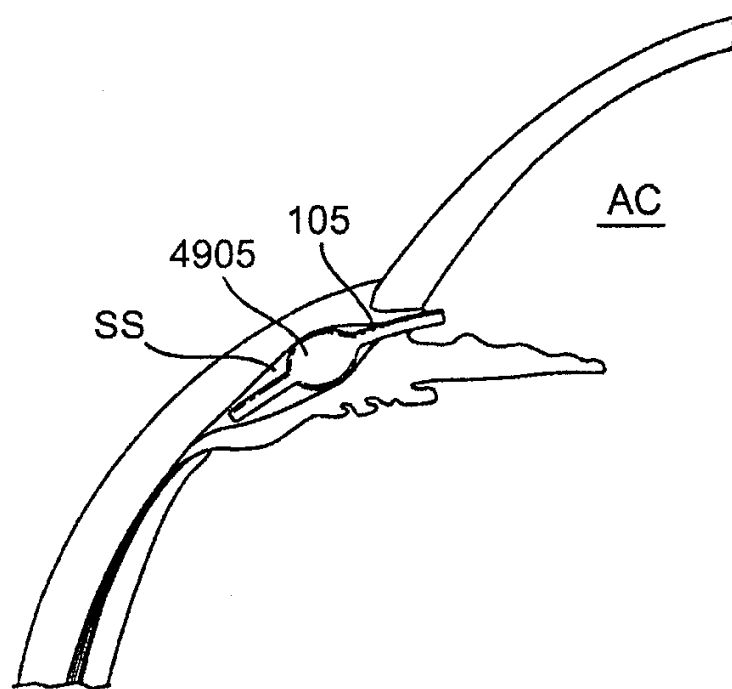
US Patent Application [US2021181379A1](#) titled “Wettable Silicone Hydrogel Contact Lenses”

LENS KITS, ILLUMINATION DEVICES AND OTHERS



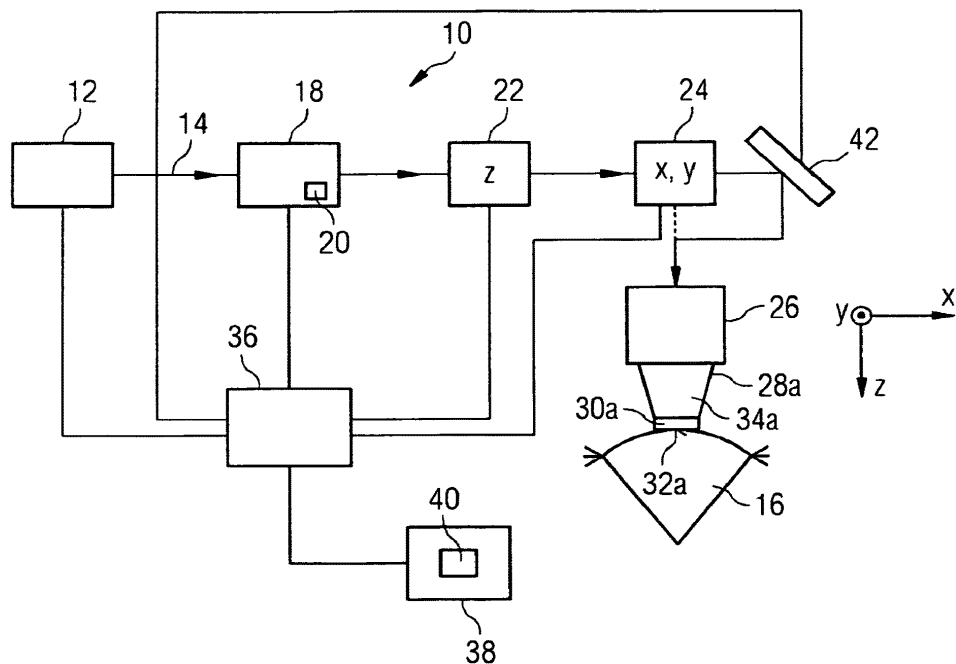
US Patent Application [US20210190630A1](#) titled “Cuvette for Optical Analyses”

IMPLANT DEVICES



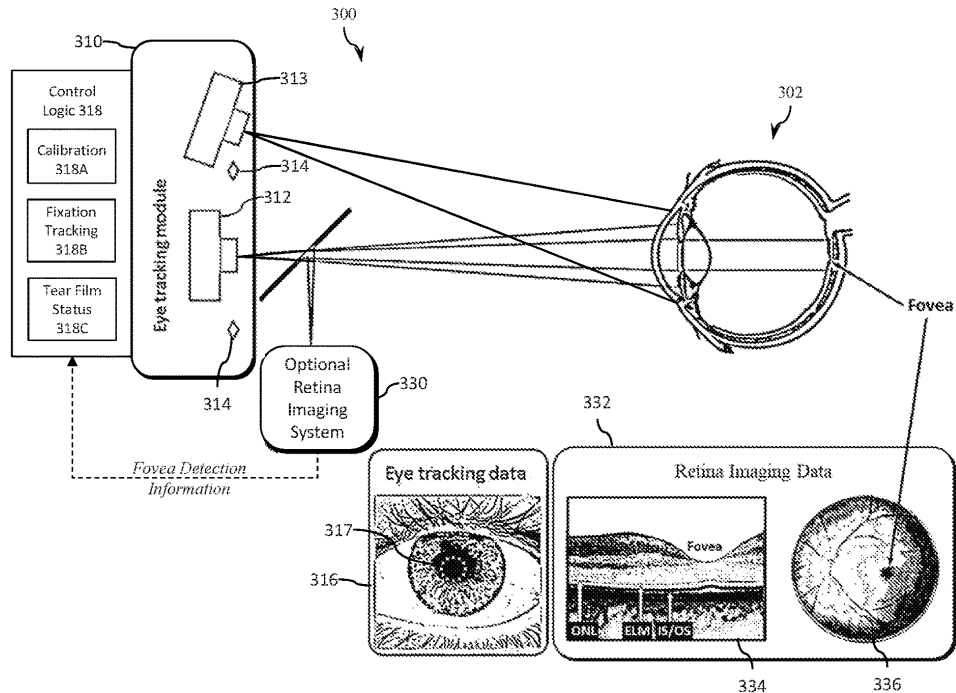
US Patent Application [US20210128357A1](#) titled "Glaucoma Treatment Device"

LASER SYSTEMS



US Patent Application [US20210106463A1](#) titled "System, Interface devices, Use of the Interface Devices and Method for Eye Surgery"

DIAGNOSTICS



US Patent Application [US20210190630A1](#) titled “Patient-induced Trigger of a Measurement for Ophthalmic Diagnostic Devices”

EMERGING AREA - AI AND MACHINE LEARNING

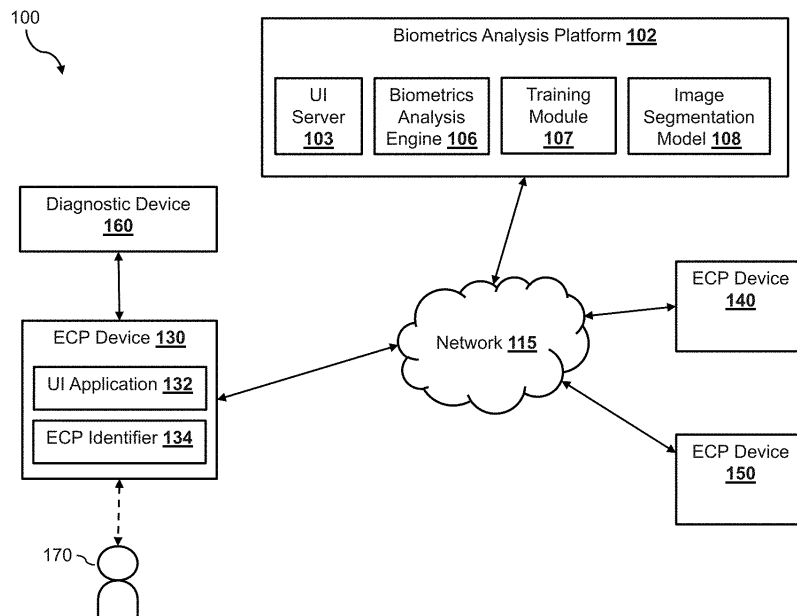
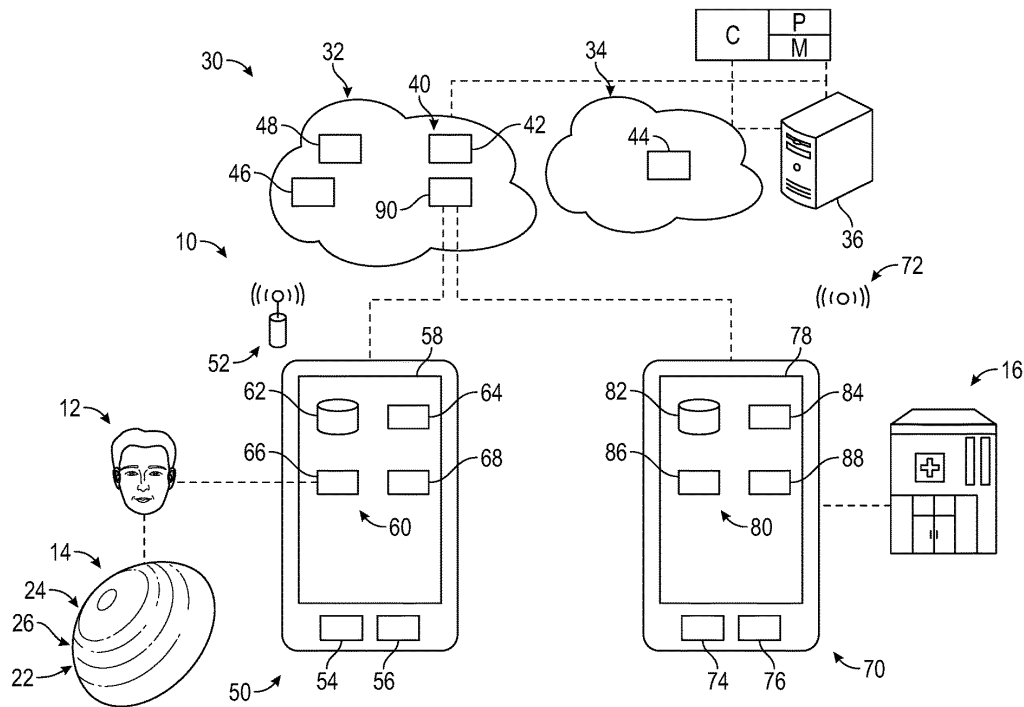


Figure 1

US Patent Application [US20210192732A1](#) titled “Deep Learning for Optical Coherence Tomography Segmentation”

EMERGING AREA - AI AND MACHINE LEARNING



US Patent Application [US20210193278A1](#) titled “Personalized Assistance System for User of Vision Correction Device”

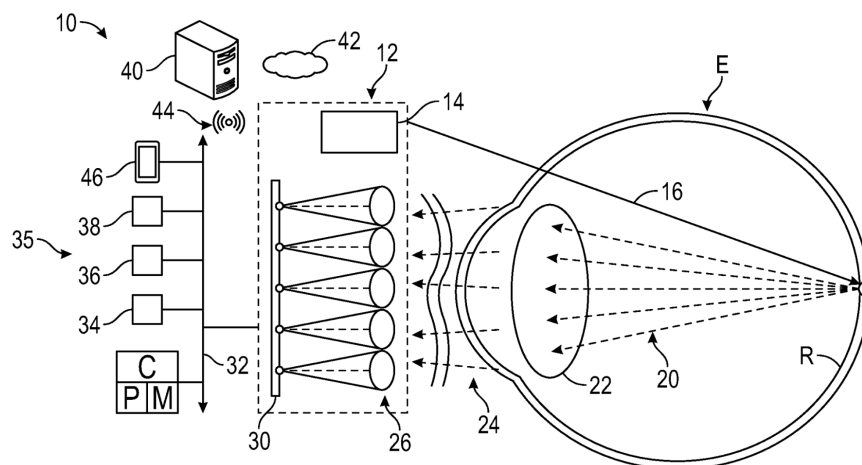


FIG. 1

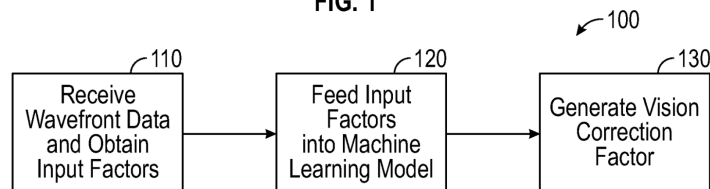


FIG. 2

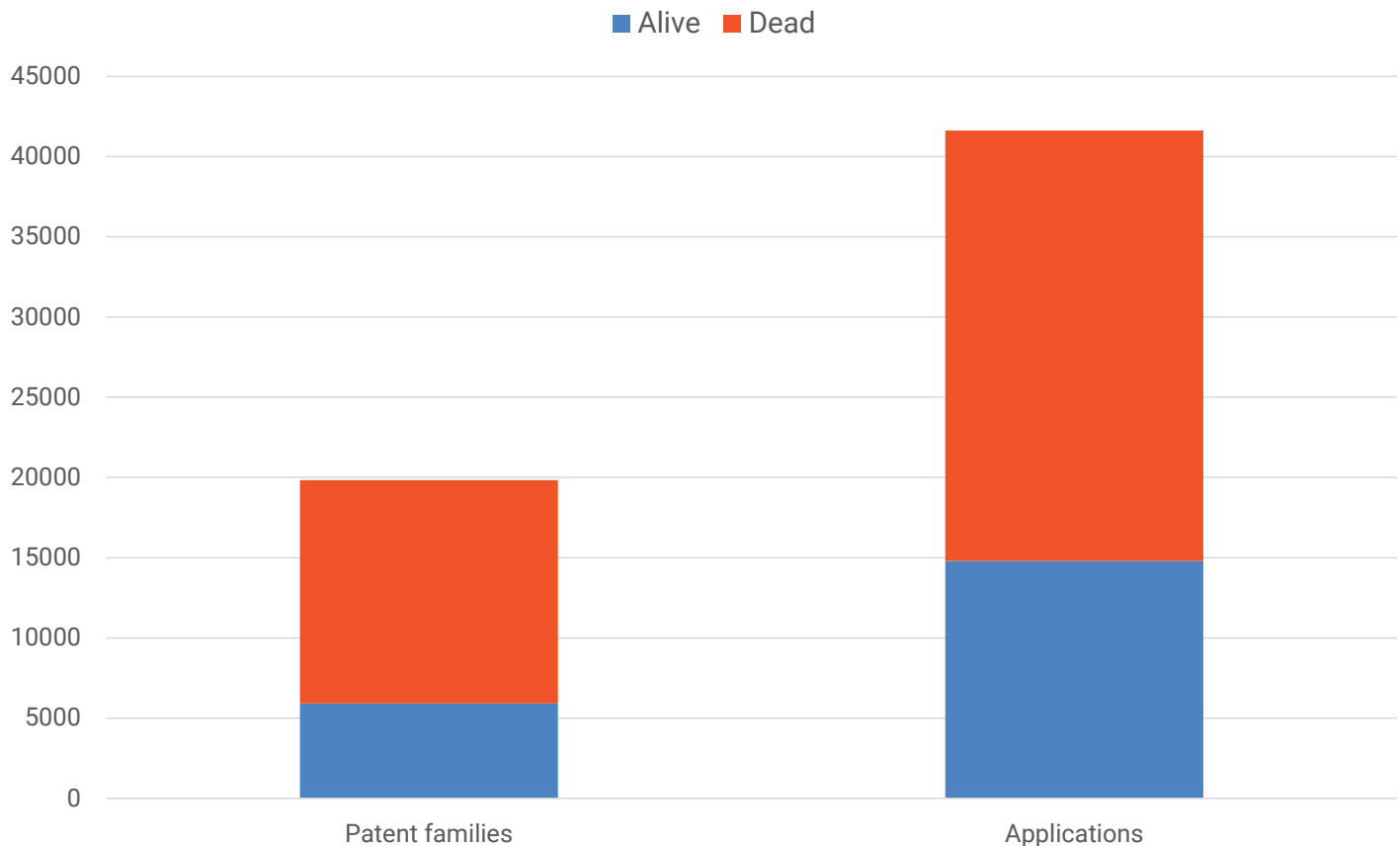
US Patent Application [US20210193278A1](#) titled “Vision Quality Assessment Based on Machine Learning Model and Wavefront Analysis”

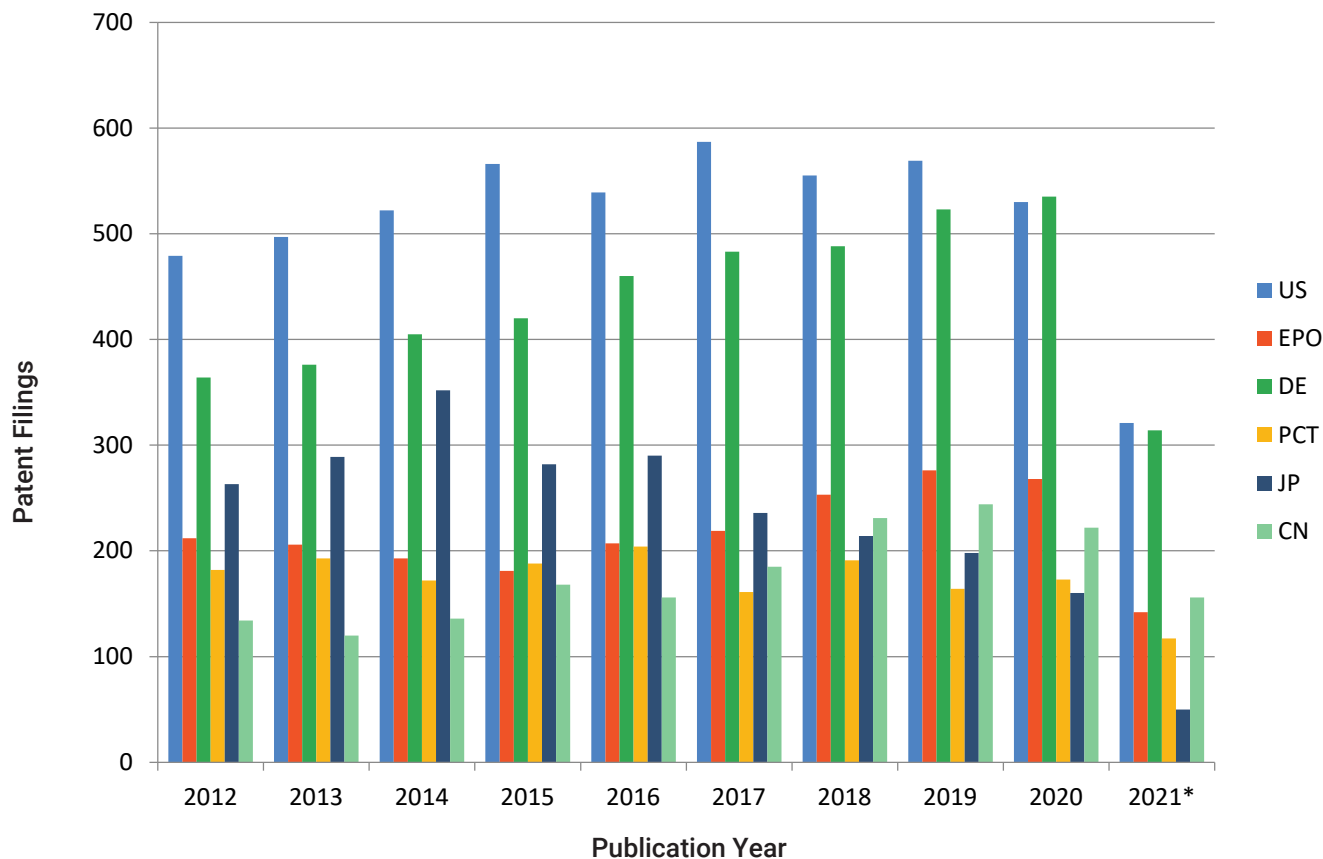


ZEISS is a pioneer in the fields of optics and optoelectronics. The company was founded in 1846 by the famous optician, Carl Zeiss.

It is headquartered in Oberkochen, Germany.

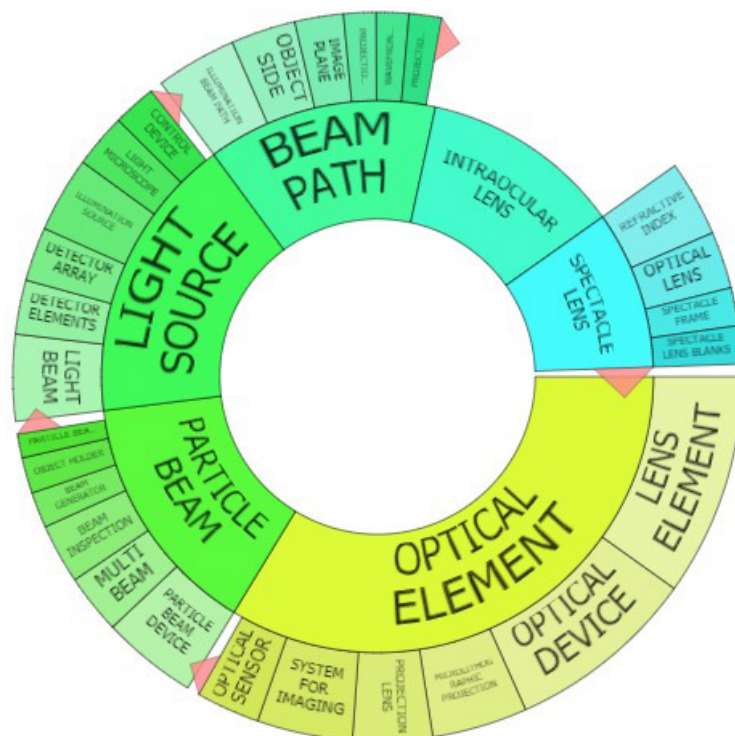
ZEISS Group reported annual revenue of €[6.3 billion](#) in 2019-20 across its four segments: Semiconductor Manufacturing Technology, Industrial Quality & Research, Medical Technology, and Consumer Markets. The medical technology segment includes diagnostics and treatment in ophthalmology and microsurgery.





* Incomplete data due to delay in publication

It is evident from the chart that Zeiss has ramped up its overall patent filings in Germany (DE) and Europe (EPO). Its recent filings in the United States (U.S.), PCT, and China (CN) have been steady while its filings in Japan have dropped during the



same period. Zeiss's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle, while sub-topics are shown in the outer circle. Patents related to optical elements (e.g., microscopy and imaging systems) continue to dominate in recent years. Patents focusing on laser, radiation, and imaging control systems are on the rise. Carl Zeiss has about 6,000 in force patent families of which only 5% of the patent families claim ophthalmic devices.

Some notable patent applications are shown below.

CONTACT LENS

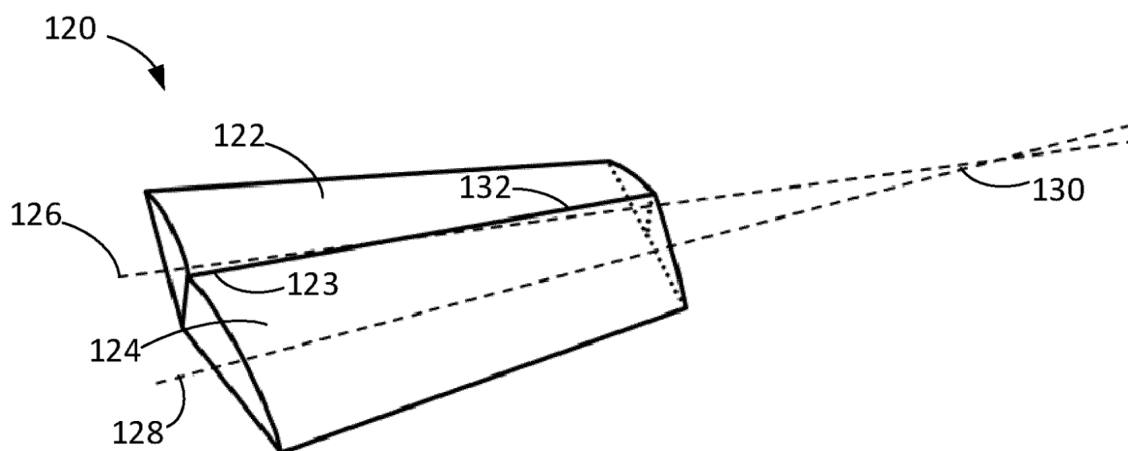
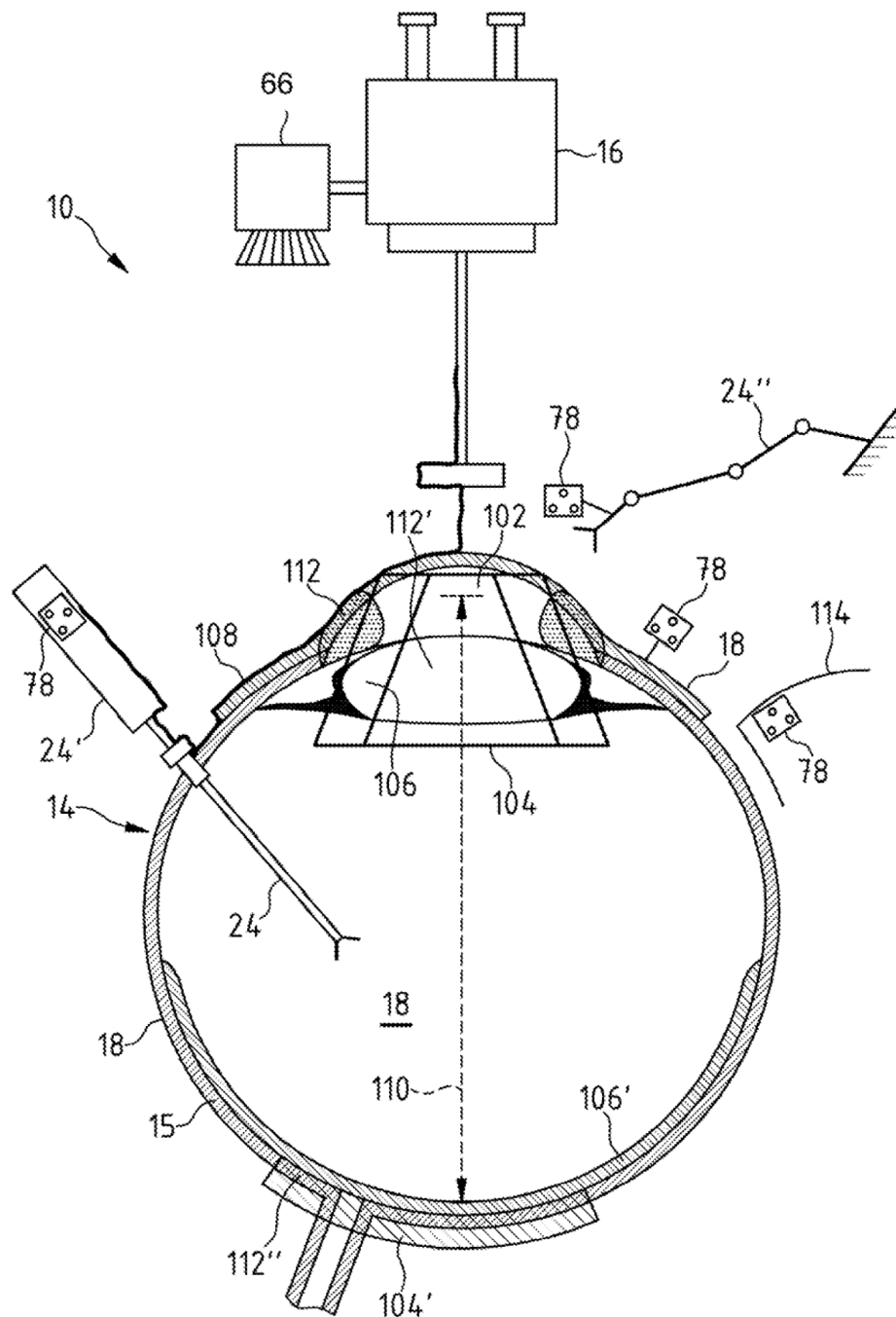


FIG. 3

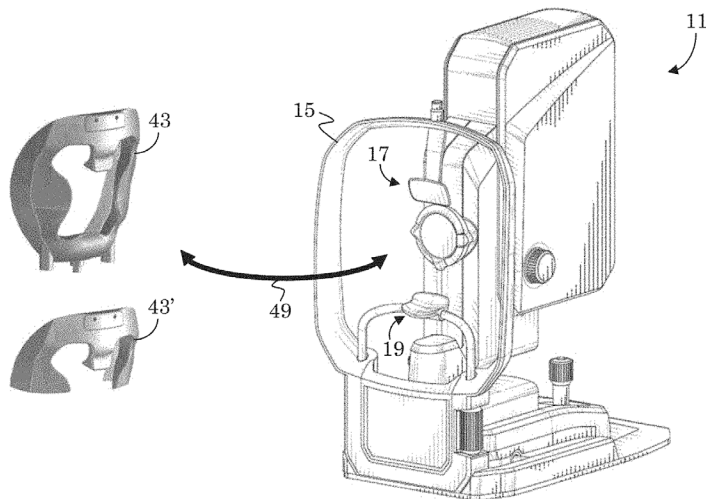
The PCT Application [WO2021144246](https://patents.google.com/patent/WO2021144246) titled "Astigmatism Correcting Lens and Method for its Elaboration"

SURGICAL DEVICES



US Patent Application US2021228284A1 titled "Eye Surgery Surgical System Having an OCT Device and Computer Program and Computer-implemented Method for Continuously Ascertaining a Relative Position of a Surgery Object"

DIAGNOSTICS



US Patent Application [US20210186319A1](#)
titled "Personalized Patient Interface for
Ophthalmic Devices"

LASER SYSTEMS

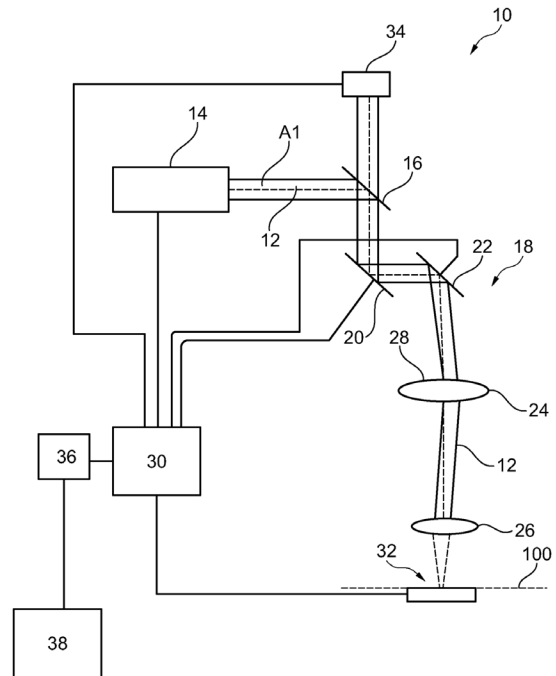
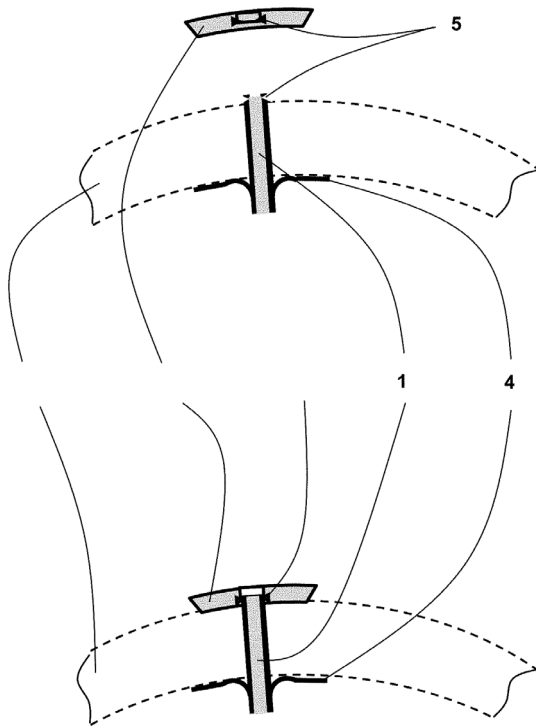


Fig. 1

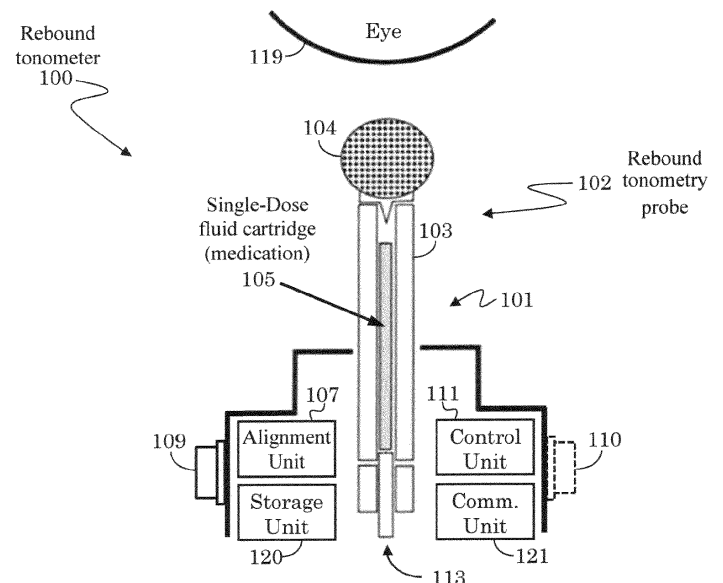
IMPLANT DEVICES



US Patent Application [US20210015665A1](#)
titled "Shunt Implant"

PCT Patent Application [WO2021121876A1](#)
titled "Planning Apparatus, Refractive
Laser System and Method for Automated
Planning of a Refractive Surgical
Treatment"

DRUG DELIVERY DEVICE



US Patent Application [US20210145278A1](#)
titled “Combination Device for
Tonometrical Measuring and Drug
Application on an Eye”

EMERGING AREA - AI AND MACHINE LEARNING

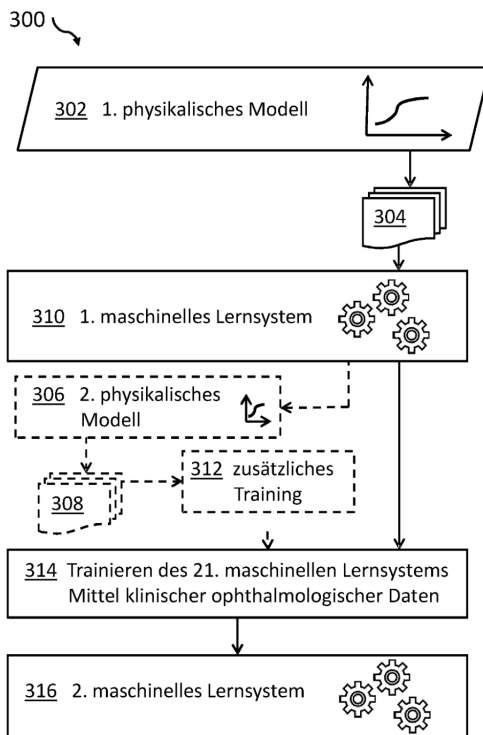


FIG. 3

- 302 1st physical model
- 310 1st machine learning system
- 306 2nd physical model
- 312 Additional training
- 314 Training the 1st machine learning system by means of clinical ophthalmological data
- 316 2nd machine learning system

PCT Patent Application [WO2021148517A1](#)
titled “Physically Motivated Machine
Learning System for an Optimized
Intraocular Lens Calculation”

WO 2021/148519

PCT/EP2021/051301

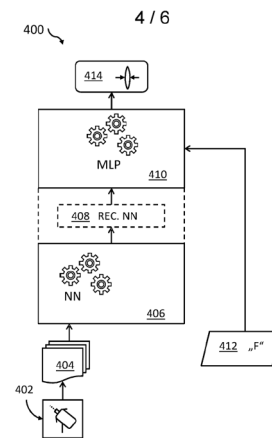


FIG. 4

PCT Patent Application [WO2021148519A1](#)
titled “Machine-learning-based
Determining of Refractive Power for
Measures for Correcting Eyesight from
OCT Images”

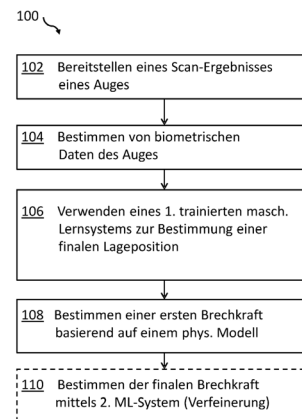


FIG. 1

- 102 Providing a scan result of an eye
- 104 Determining biometric data of the eye
- 106 Using a first trained machine learning system to determine a final position
- 108 Determining a first optical power based on a physical model
- 110 Determining the final optical power using a second machine learning system (refinement)

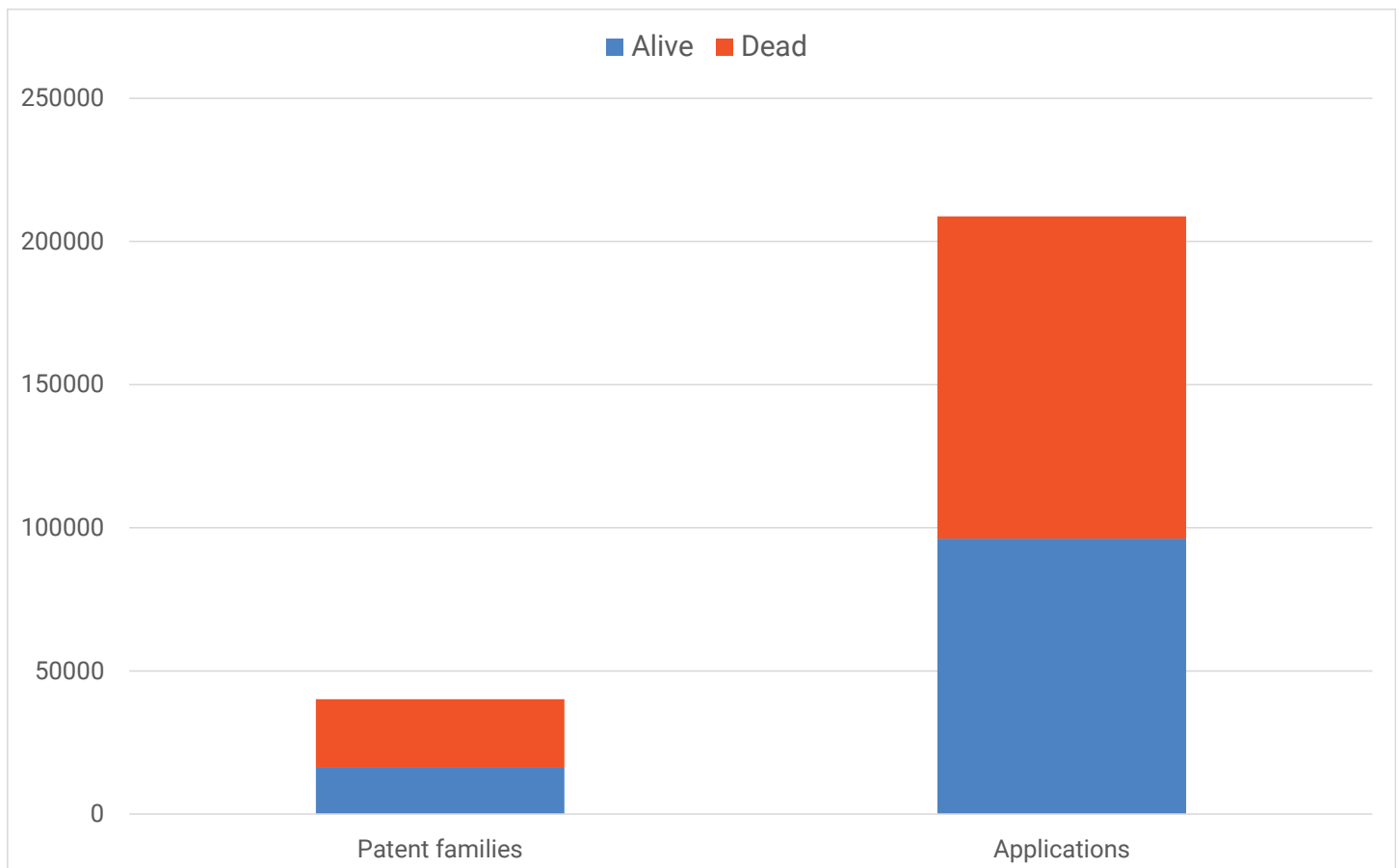
PCT Patent Application [WO2021148518A1](#)
titled “Machine Learning-supported
Pipeline for Dimensioning an Intraocular
Lens”

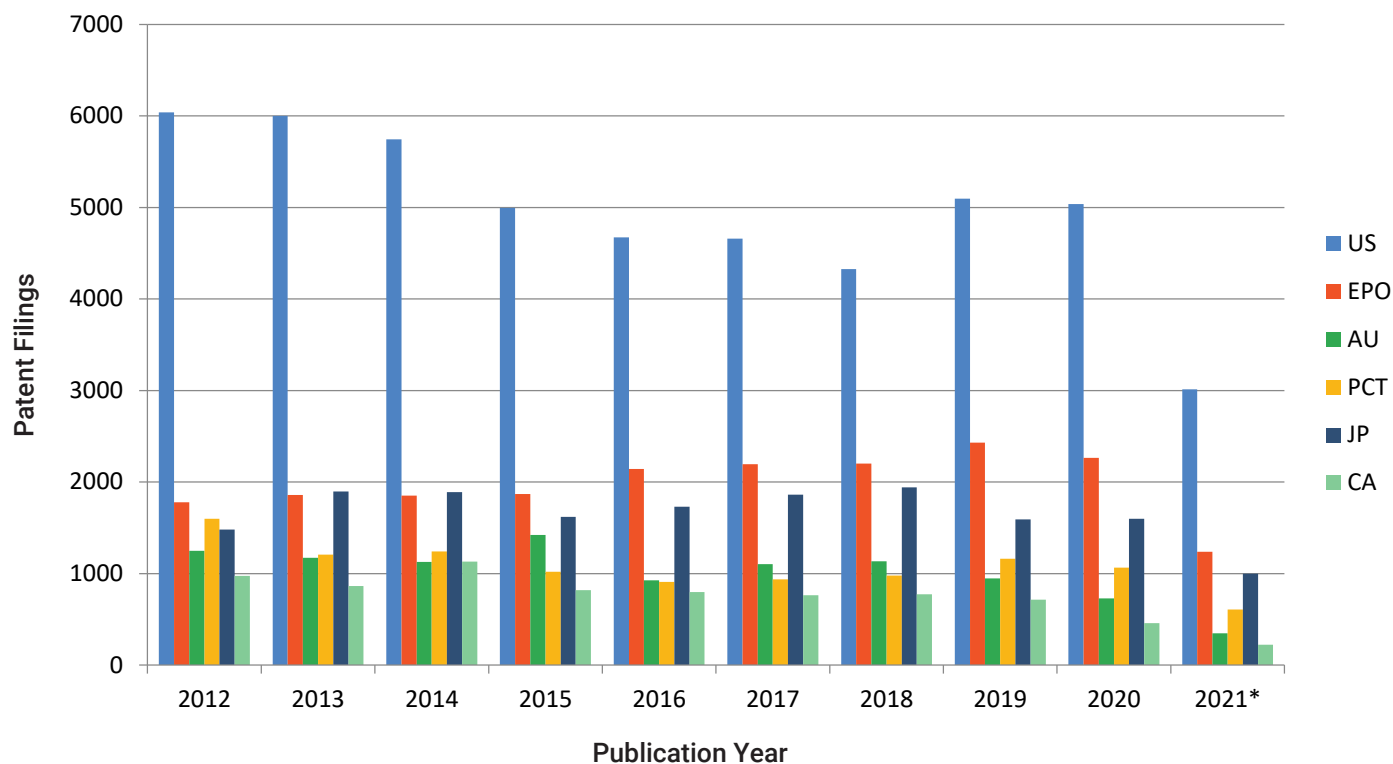


Johnson & Johnson Vision, the dedicated eye care unit of Johnson & Johnson (J&J), has been in existence since 1976 when it was known as American Medical Optics (AMO). It offers a wide variety of eye care and surgical products. The parent company, J&J, was founded in 1886 and is amongst one of the most valuable medical device companies in the world.

J&J Vision is dual-headquartered in Jacksonville, Florida and Santa Ana, California.

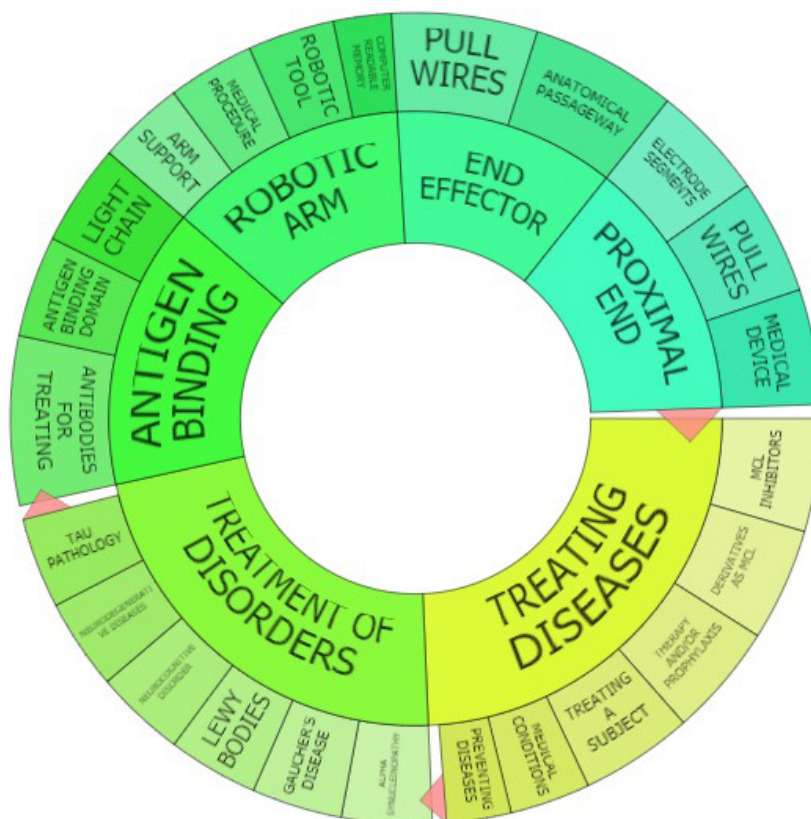
J&J Vision reported revenues of [\\$3.9 billion](#) in 2020, of which approximately \$3 billion was from the sales of contact lenses and \$900 million from surgical devices.





* Incomplete data due to delay in publication

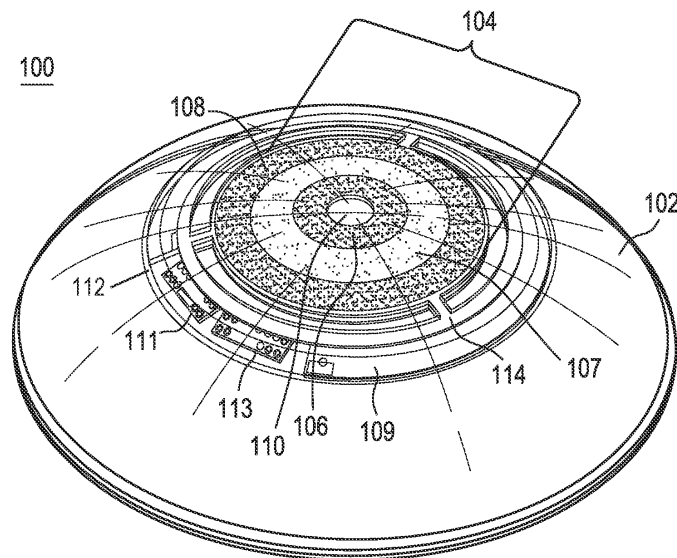
It is evident from the chart above that J&J, across all of its units, has increased its patent filings in Europe (EPO) in recent times.



J&J's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Patents related to ophthalmic devices including surgical devices, contact lenses and intraocular lenses continue to dominate J&J vision care's filings in recent years. The parent company has about 20,000 alive patent families, of which only 4% of the patent families claim ophthalmic devices.

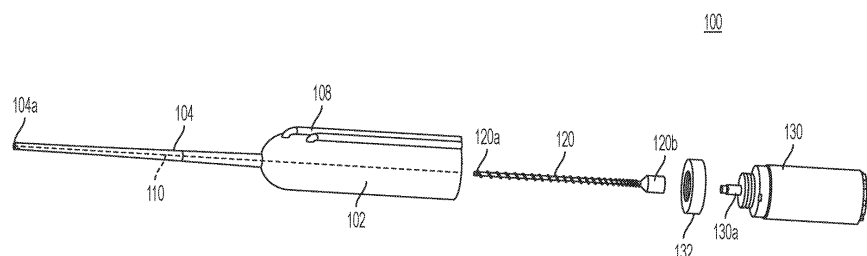
Some notable patent applications are shown below.

CONTACT LENS



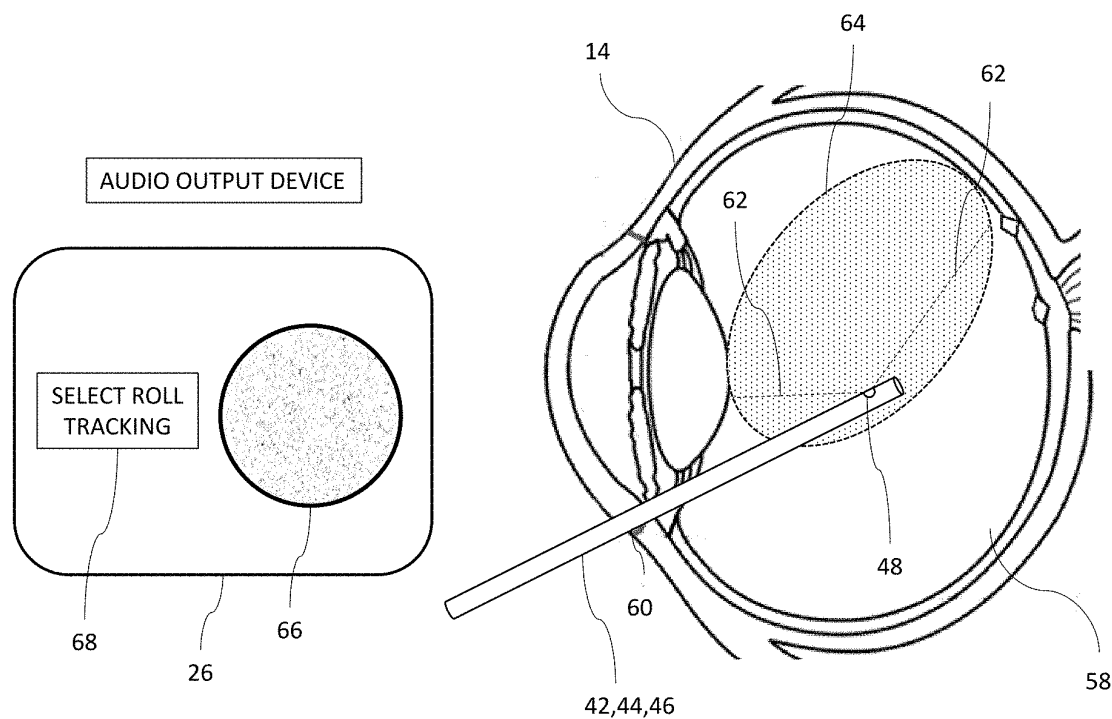
US Patent Application [US20210181531A1](#) titled “Dynamically Tunable Apodized Multiple-focus Ophthalmic Devices and Methods”

SURGICAL DEVICES



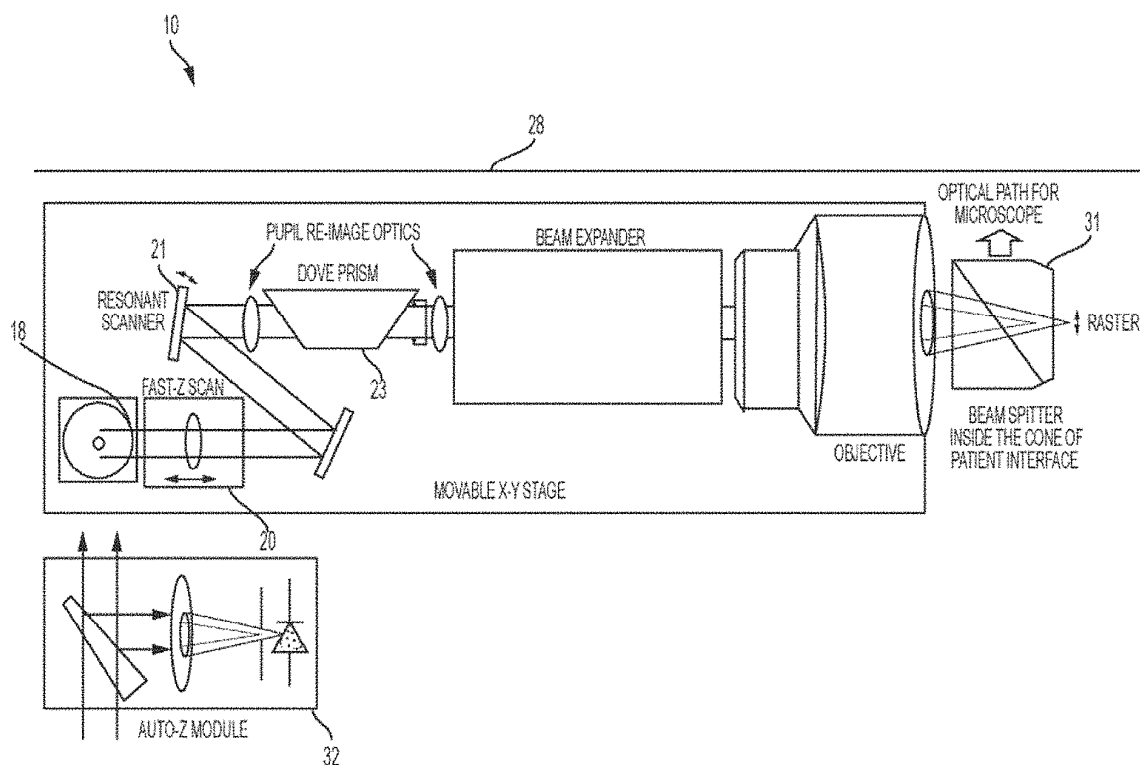
US Patent Application [US20210186756A1](#) titled “Surgical Instruments for Ocular Surgery”

DIAGNOSTICS



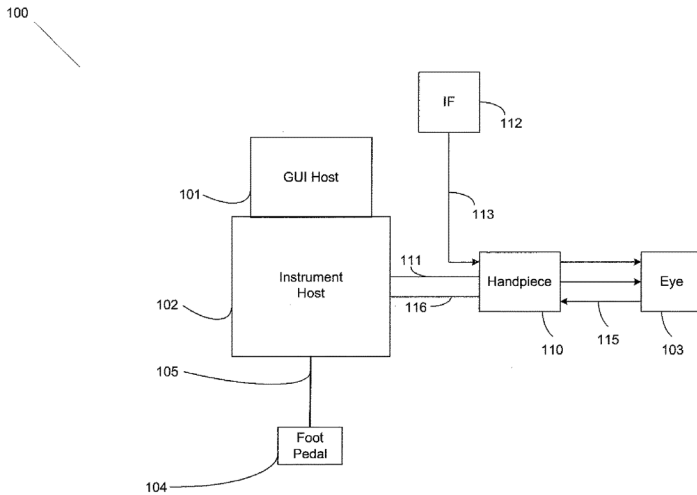
US Patent Application [US20210169695A1](#) titled “Eye Examination Apparatus”

LASER SYSTEMS



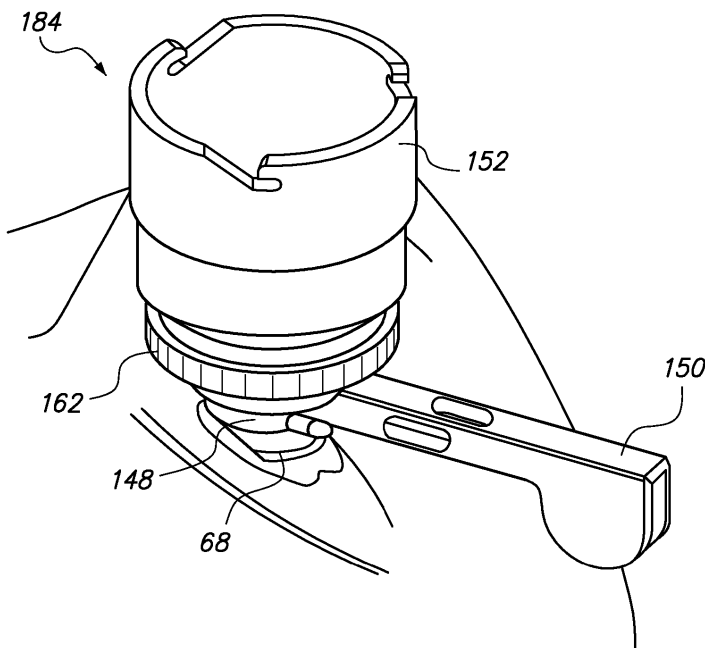
US Patent Application [US2021128358A1](#) titled “High Speed Corneal Lenticular Incision Using a Femtosecond Laser”

SUPPORT SYSTEMS



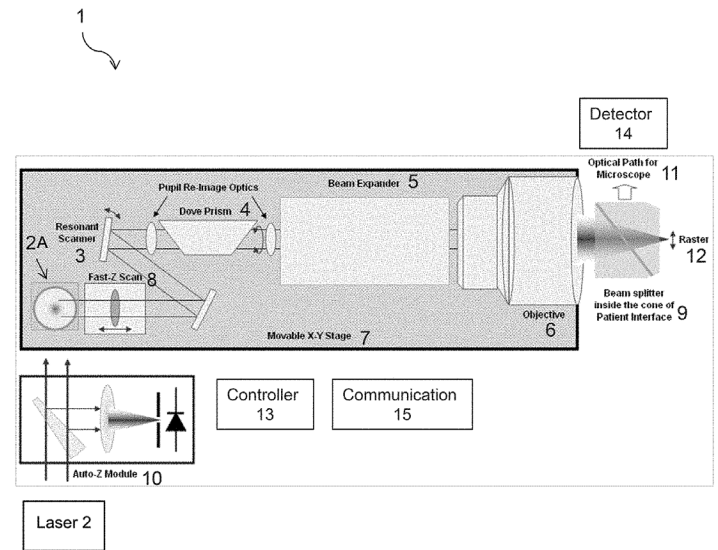
US Patent Application [US20210220168A1](#)
titled "Medical Device Data Filtering for
Real Time Display"

ACCESSORY AND OTHER DEVICES

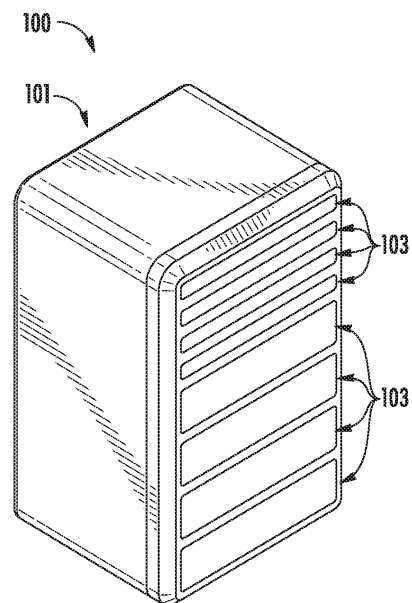


US Patent Application [US2021145637A1](#)
titled "Patient Interface for
Ophthalmologic Diagnostic and
Interventional Procedures"

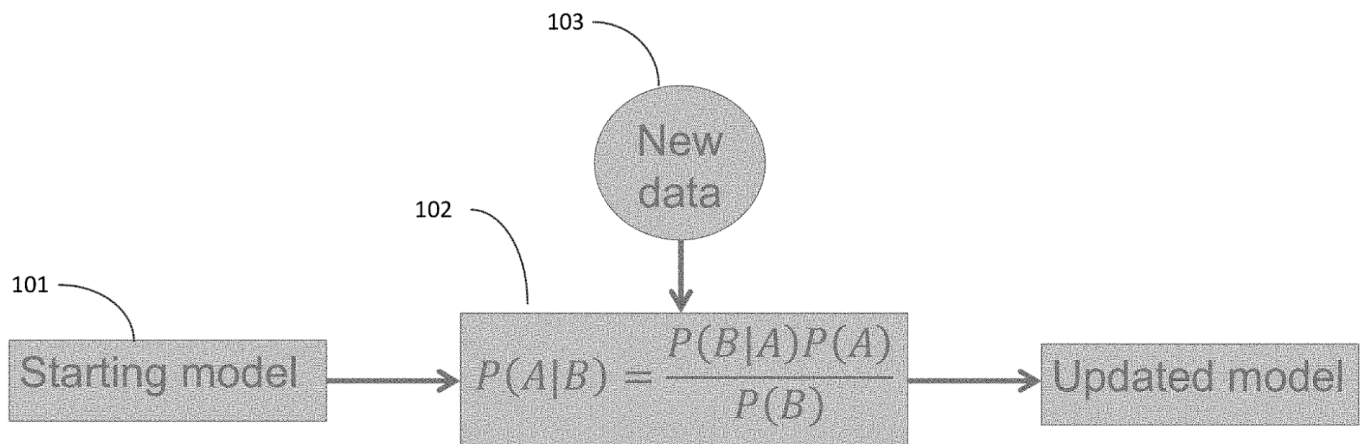
EMERGING AREA - AI AND MACHINE LEARNING



PCT Patent Application [WO2021137034A1](#)
titled "Multi-axis Motor Position
Compensation in Ophthalmic Surgical
Laser System Using Deep Learning"



US Patent Application [US20200364648A1](#)
titled "Automated Product Locker for
Inventory Control"



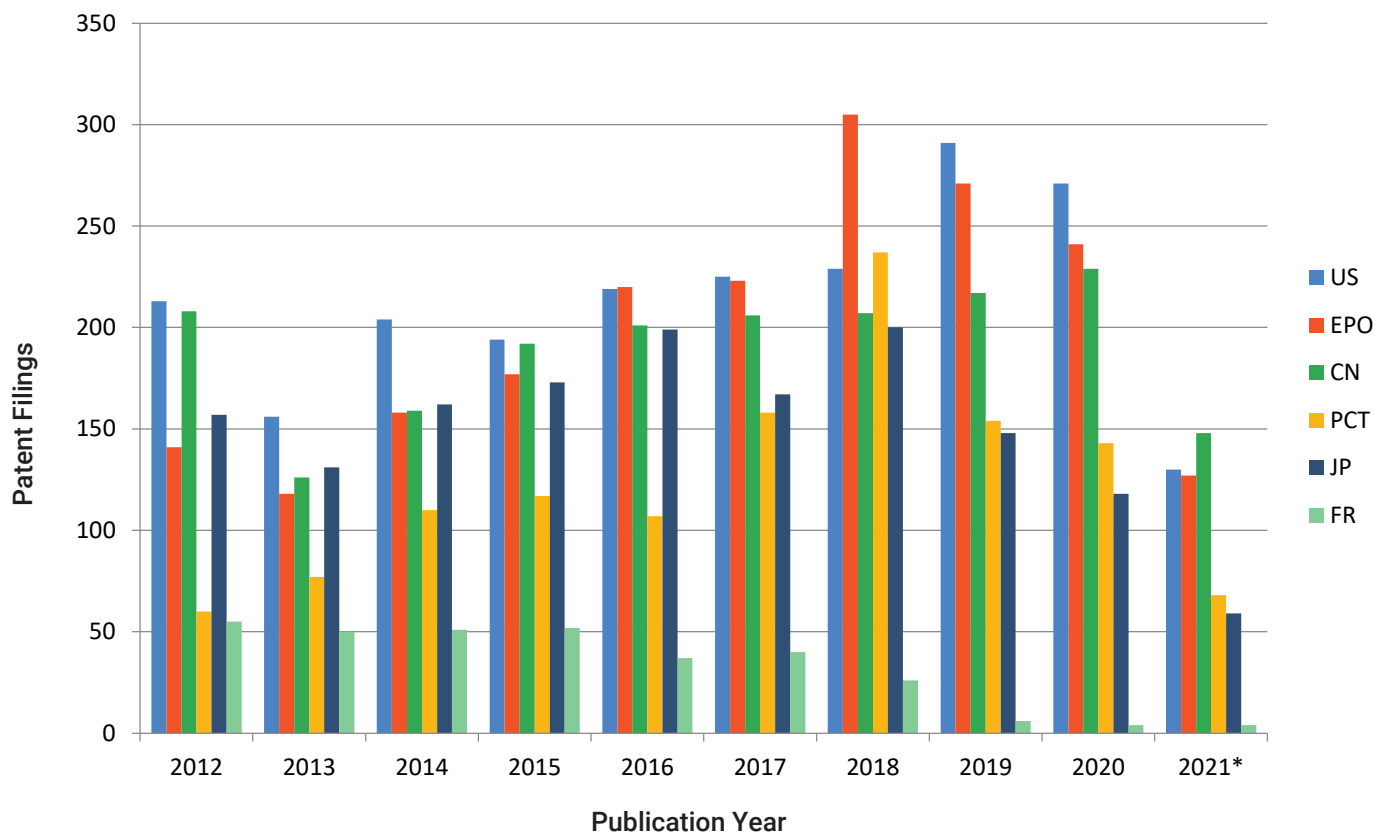
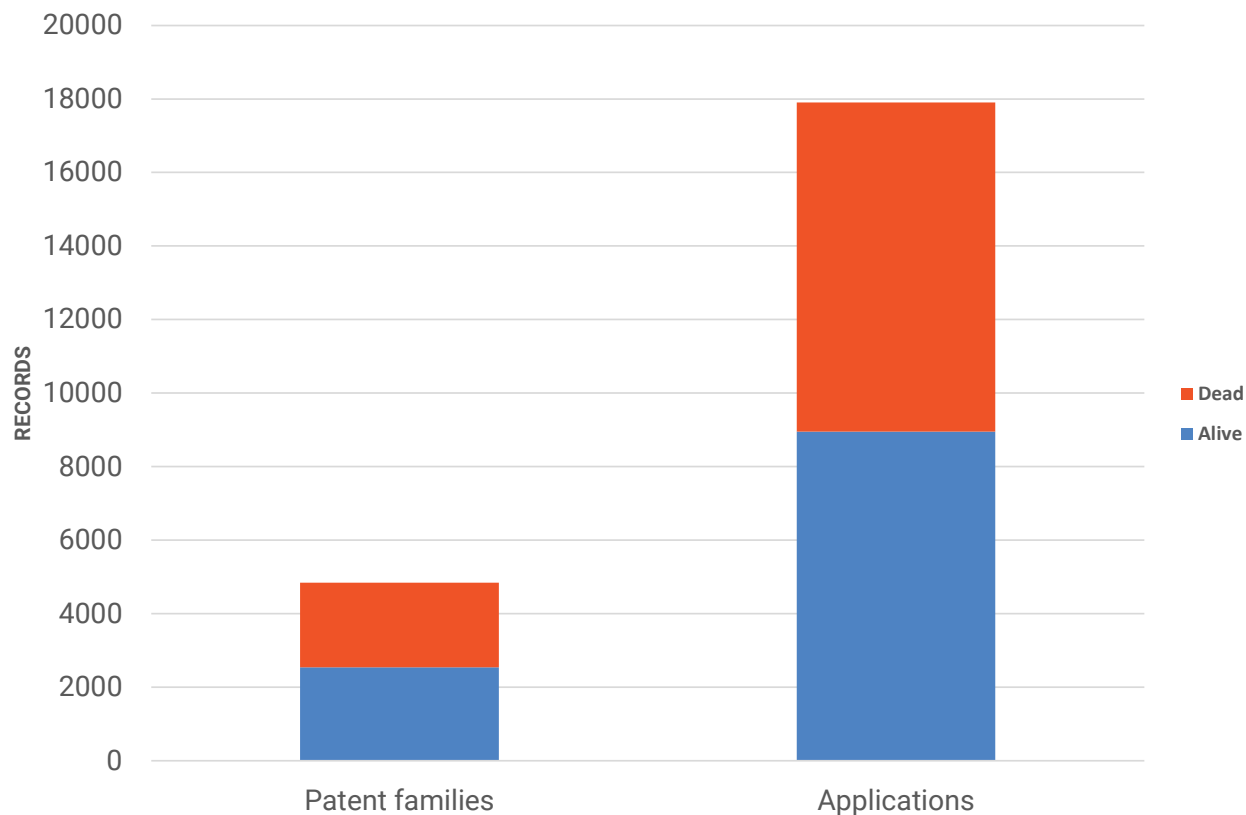
US Patent Application [US20190164647A1](#) titled “Intraocular Lenses that Improve Post-surgical Spectacle Independent and Methods of Manufacturing Thereof”



Essilor International is a renowned and R&D-intense ophthalmic optics company founded in 1849. It is now called EssilorLuxottica since its merger with the Italian eyewear behemoth Luxottica in 2017.

It is headquartered in Charenton-le-Pont near Paris in France.

EssilorLuxottica reported revenue of €[14.43 billion](#) in 2020, of which about €6 billion was from the lenses and optical instruments segment.



* Incomplete data due to delay in publication

It is evident from the chart above that Essilor's filings in EPO, PCT and JP have dropped since 2018 while their filings in the U.S. and China (CN) continue to remain high.



Essilor's broad technology areas (represented above) are based on automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Patents related to eyewear and lenses continue to dominate filings in recent years while areas such as image capture/analysis are recently gaining traction. Essilor has about 2,500 alive patent families, of which over 18% of the patent families claim ophthalmic devices. A few noteworthy patent applications from our shortlist are shown below.

OPHTHALMIC LENS

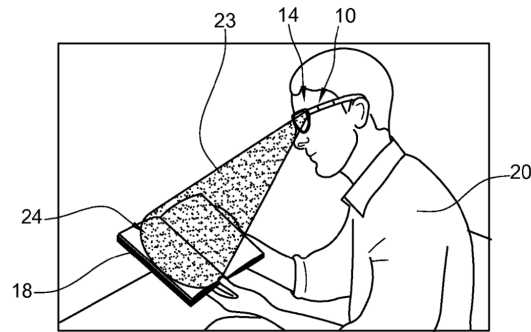


Fig. 1

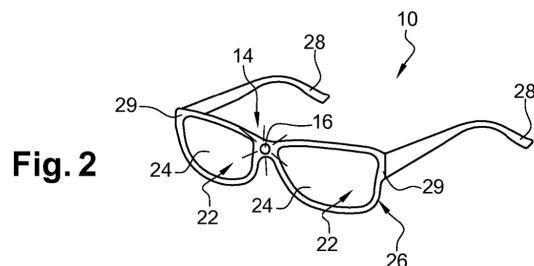


Fig. 2

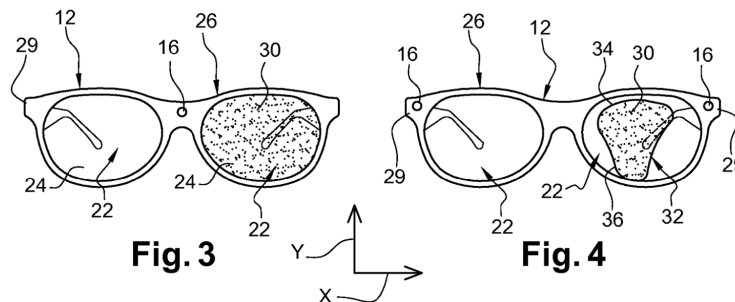
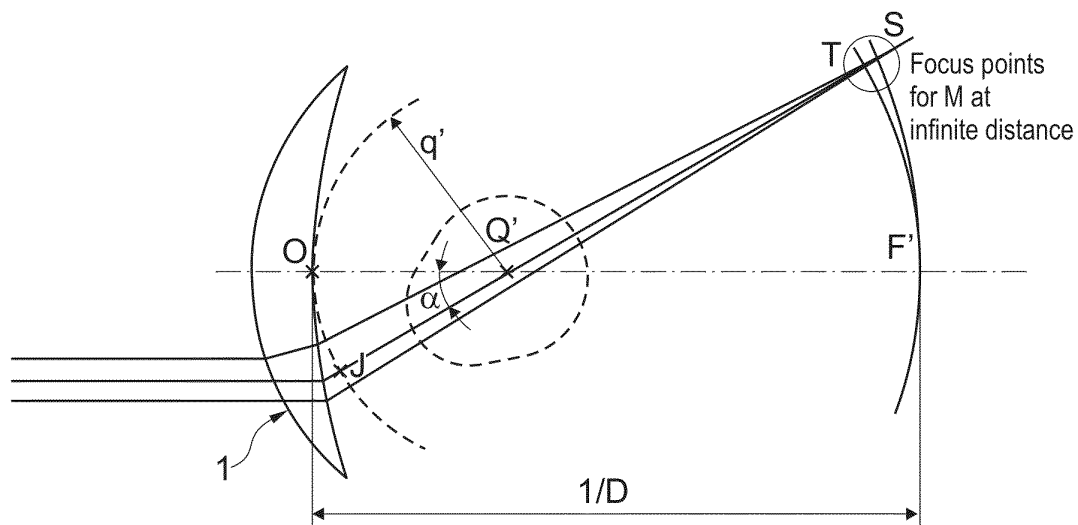


Fig. 3

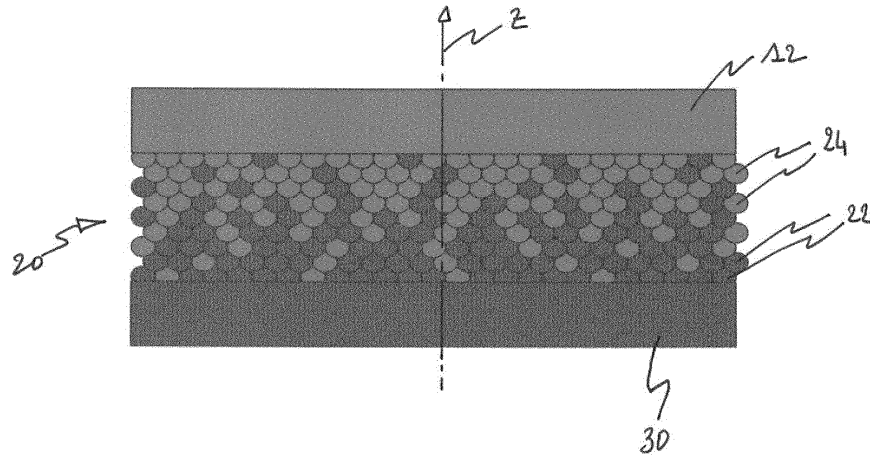
Fig. 4

US Patent Application [US20210181531A1](#) titled "Dynamically Tunable Apodized Multiple-focus Ophthalmic Devices and Methods"



US Patent Application [US20210018763A1](#) titled "A Method for Determining a Single Vision Ophthalmic Lens"

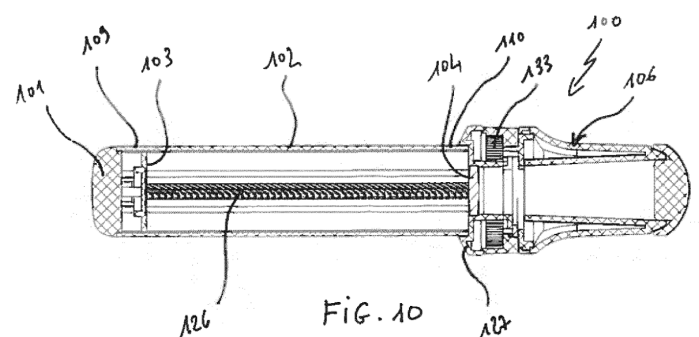
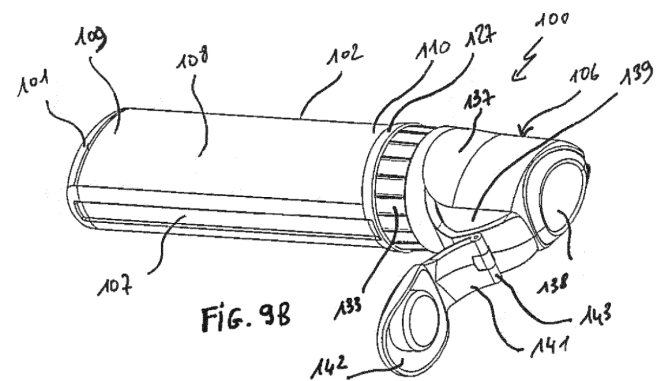
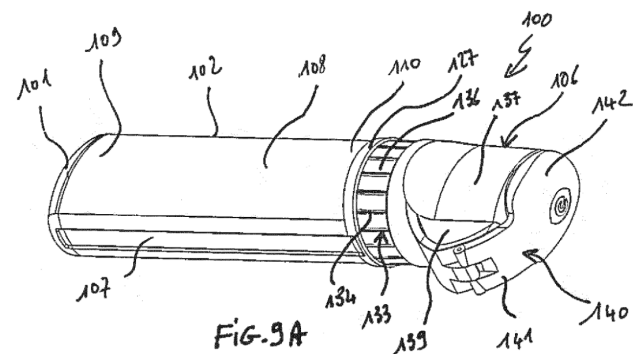
3D MANUFACTURING OF LENS

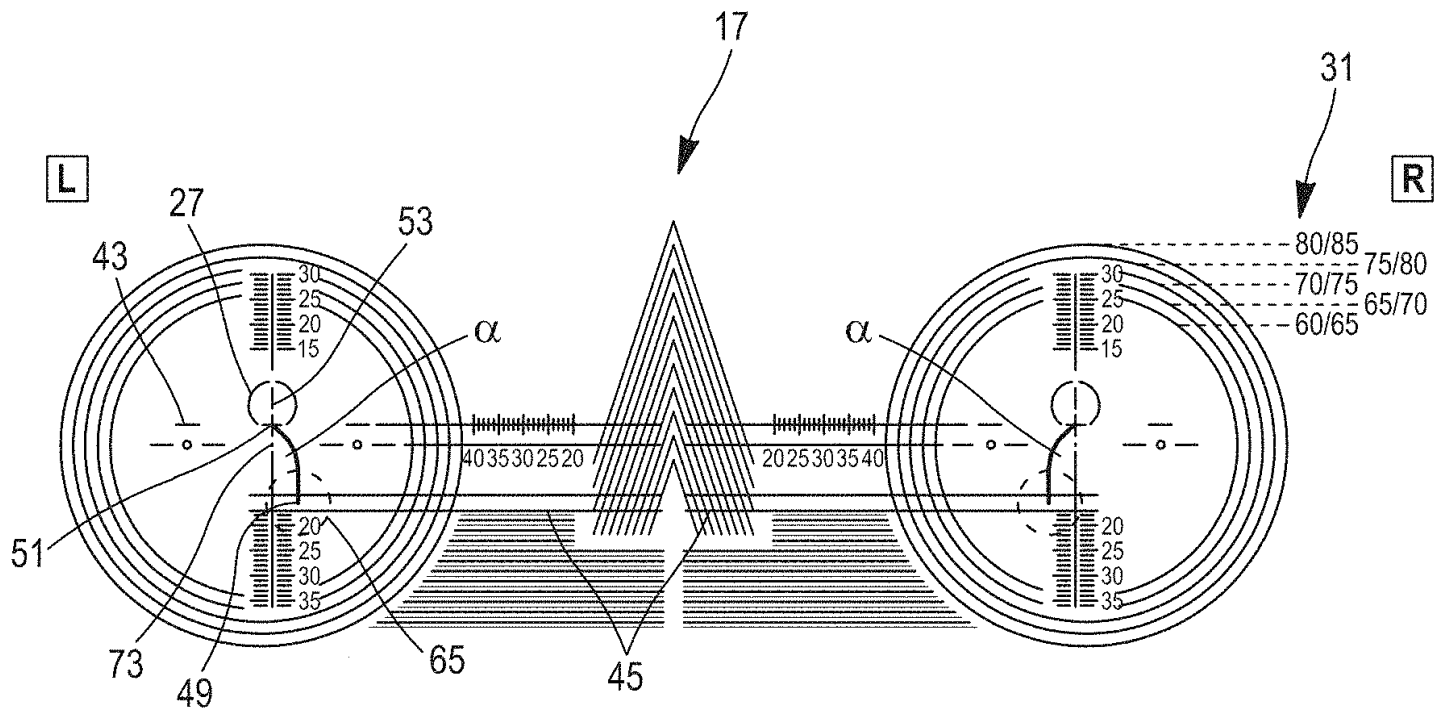


US Patent Application [US20200298512A1](#) titled “Method for Additively Manufacturing an Ophthalmic Lens and Ophthalmic Lens”

MEASUREMENT/TESTING

US Patent Application [US20210076929A1](#) titled “Vision Measurement Device and Method of Measuring Vision Using the Same”





US Patent Application [US2020234607A1](#) titled “System and Method for Demonstrating an Optical Disorder”

SMART GLASSES/AR/VR

US Patent Application [US20200241321A1](#)
titled "Method for Identifying a Device"

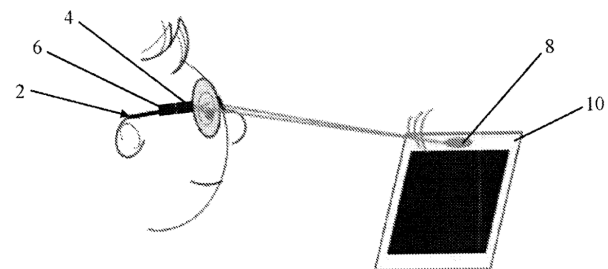


Figure 1

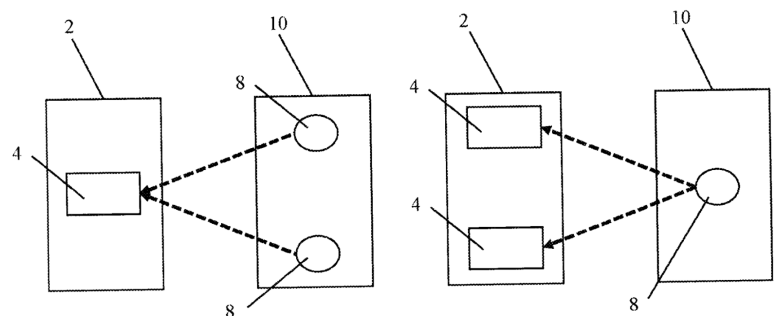


Figure 3A

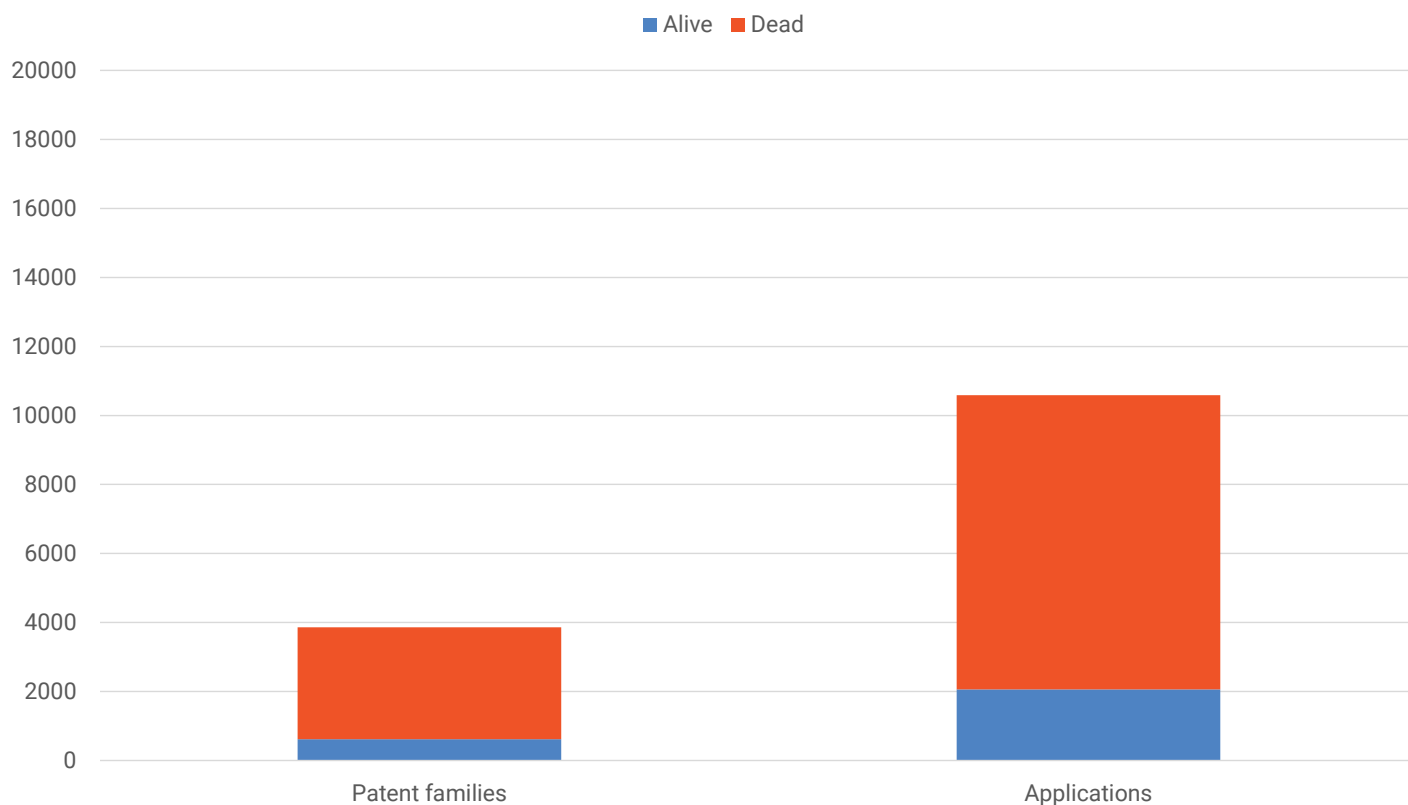
Figure 3B

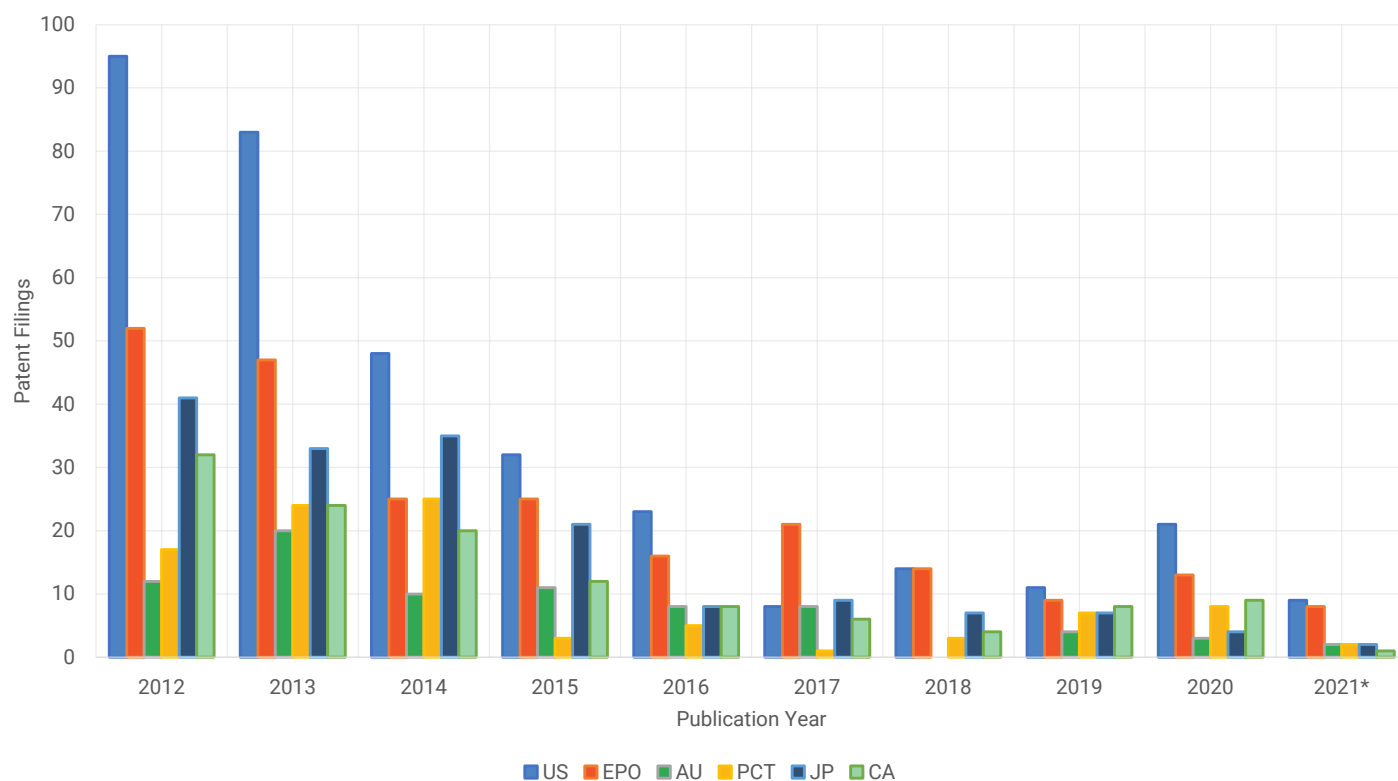
BAUSCH + LOMB

Bausch and Lomb was founded in 1853 by John Bausch and Henry Lomb, both German immigrants in Rochester, New York. It offers contact lenses and a broad line of eye care products for treating eye conditions.

It has been headquartered in Laval, Canada since its acquisition in 2013 by Bausch Health (formerly Valeant Pharmaceuticals).

Bausch & Lomb reported annual revenue of €[4.4 billion](#) for 2020.

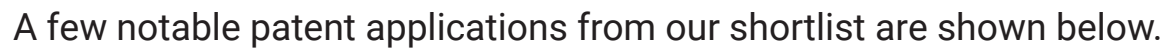




* Incomplete data due to delay in publication

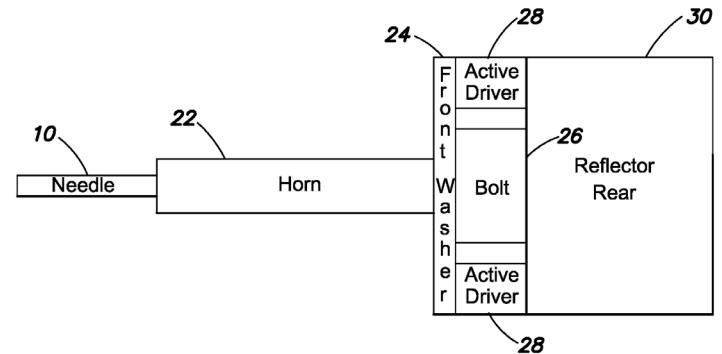
It is evident from the chart that Bausch & Lomb's patent filings across jurisdictions have fallen since 2012.

Bausch & Lomb's broad technology areas are represented above based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Patents related to contact and IOL lenses and kits continue to dominate filings. Bausch & Lomb has about 600 alive patent families of which 34% patent families claim ophthalmic devices.

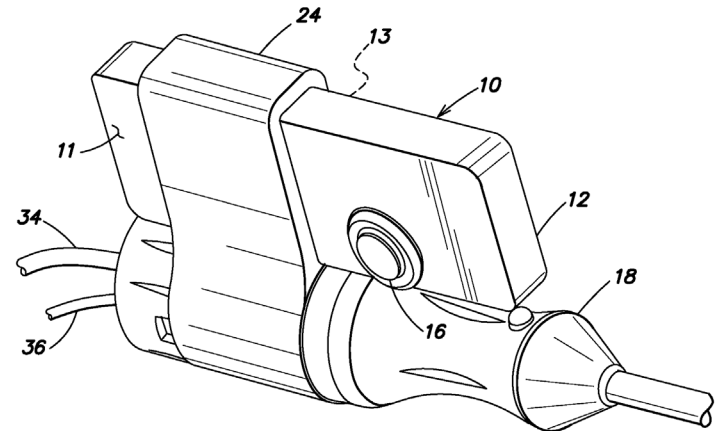


SURGICAL DEVICES

Intraocular Lens in Storage Vial and Operably Presenting Intraocular Lens in Injector Assembly”

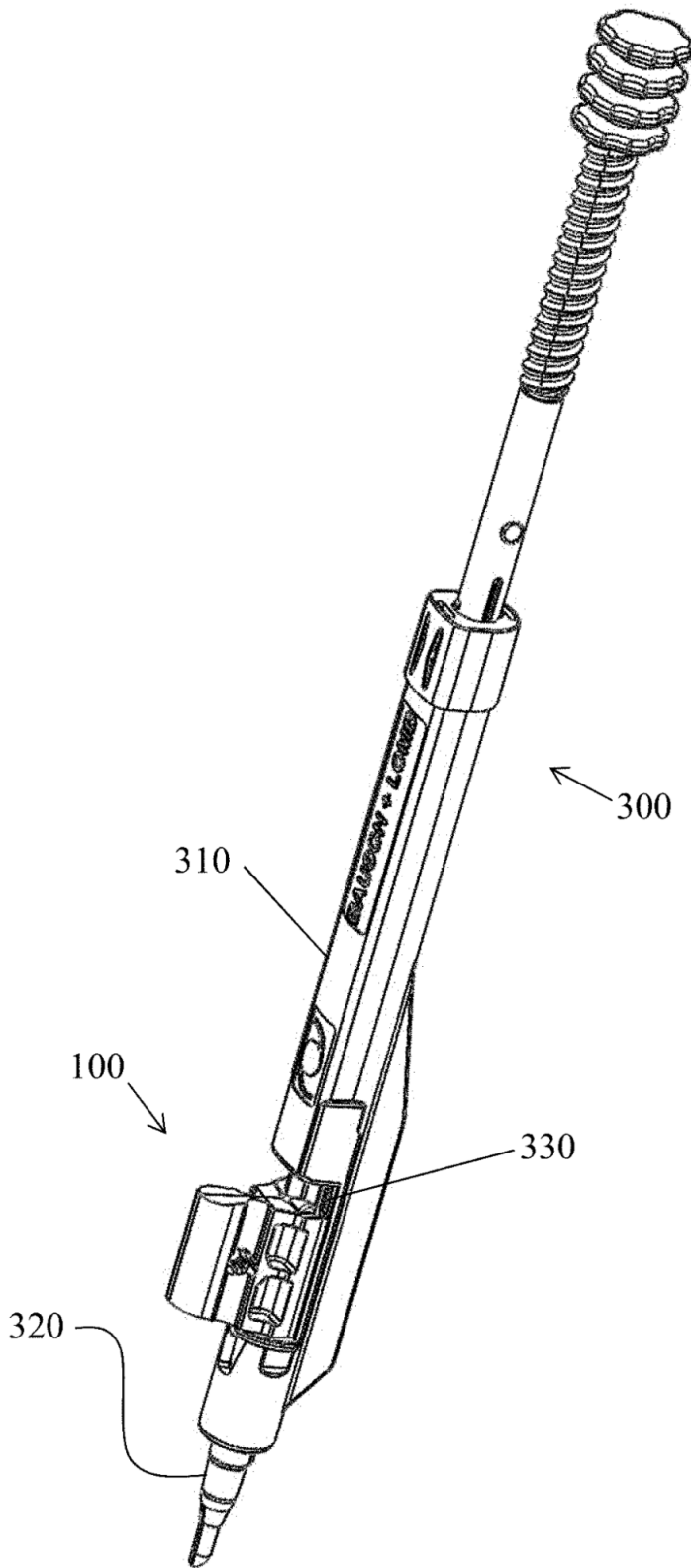


US Patent Application [US20210145639A1](#) titled “Ultrasonic Needles and Transducer Assemblies Formed of Non-Metal Materials or a Combination of Materials”

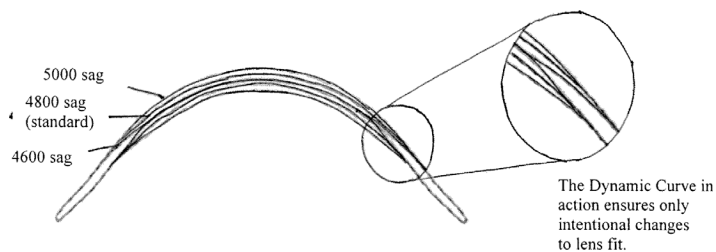


US Patent Application [US20200375681A1](#) titled “Detachable Finger-Activated Surgical Control Device”

US Patent Application [US20200323627A1](#) titled “Intraocular Lens Injector Assembly Having Shuttle Assembly Retaining



CONTACT LENS



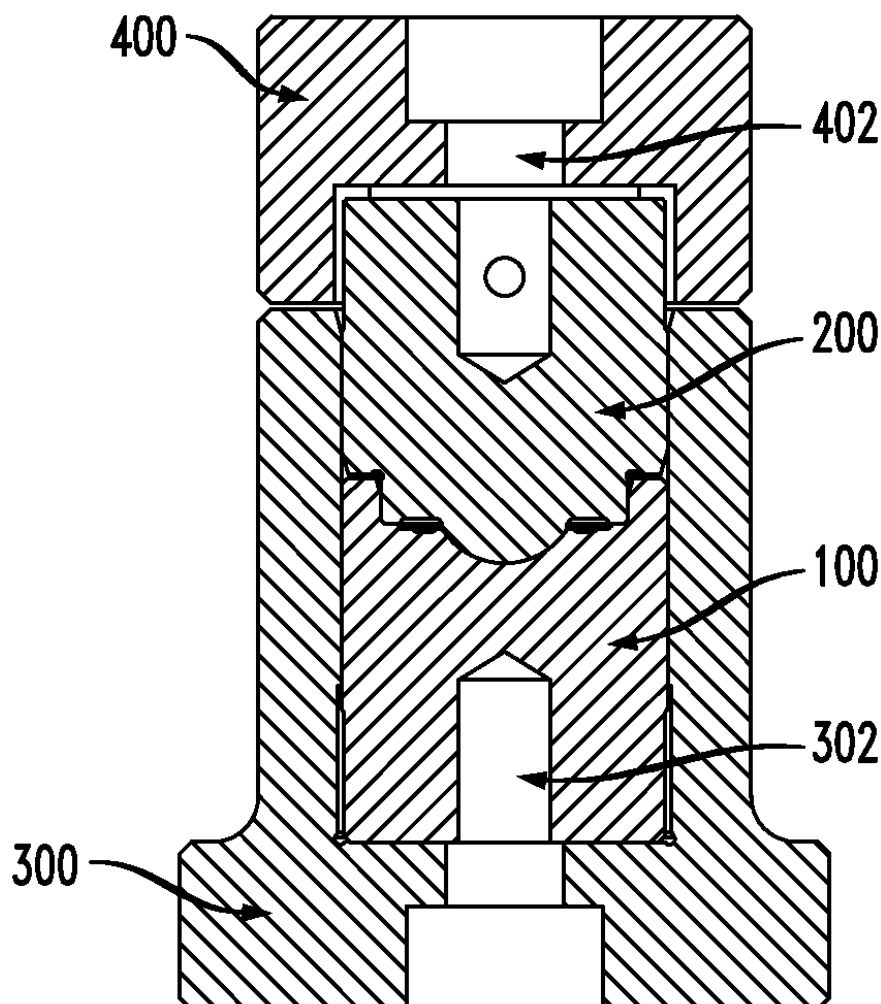
PACKAGING/CONTAINER

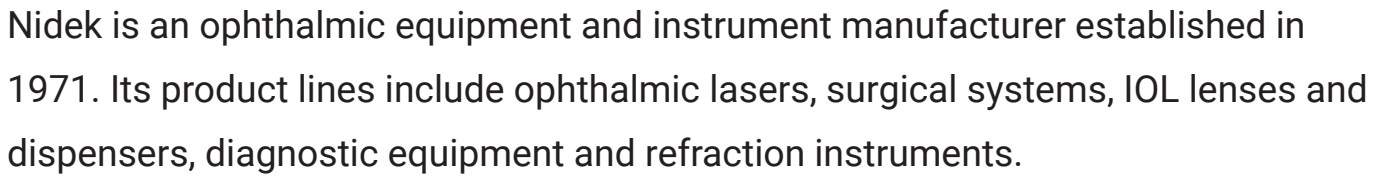
US Patent Application [US20200239217A1](#)
titled "Packaging Solutions"

US Patent Application [US20200292846A1](#)
titled "Method For Obtaining Contact Lenses With Dynamically Controlled Sagitta And Clearance"

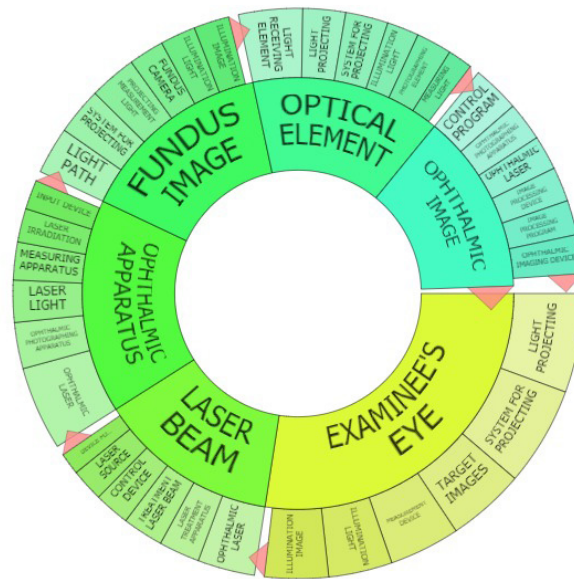
MANUFACTURING

US Patent Application US20210162692A1 titled "Direct Compression Molded Ophthalmic Devices"



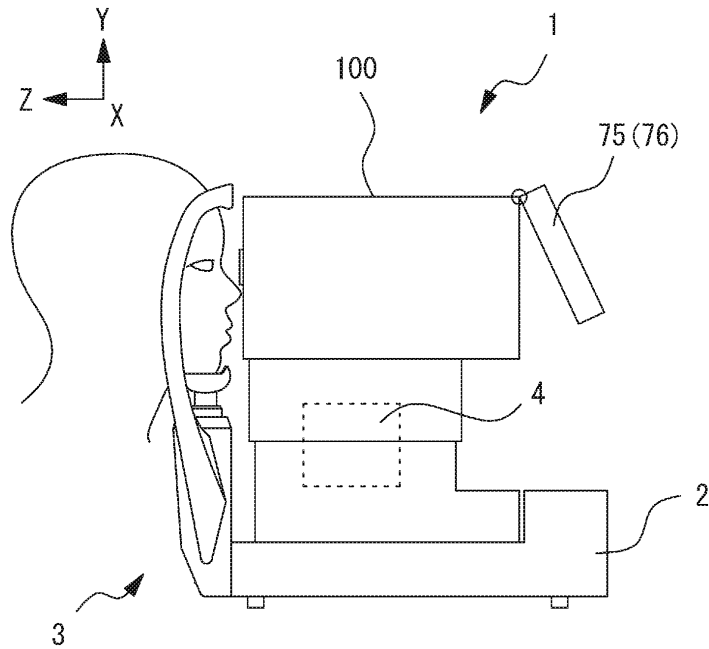


Nidek reported annual revenue of \$[410](#) million in 2020 across its three segments: Ophthalmology & Optometry, Lens Edging and Coating. The medical technology segment includes diagnostics and treatment in ophthalmology and microsurgery.

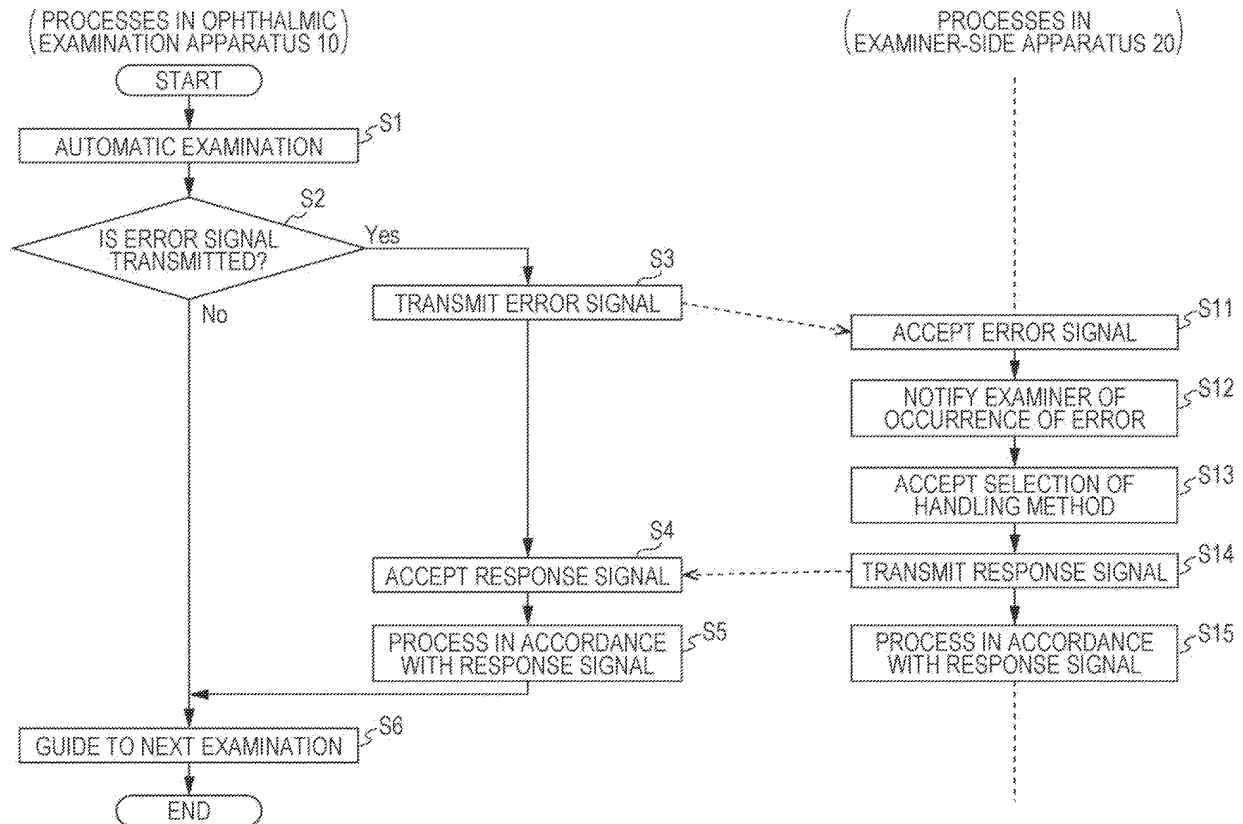


A few recent examples from our shortlist are shown below.

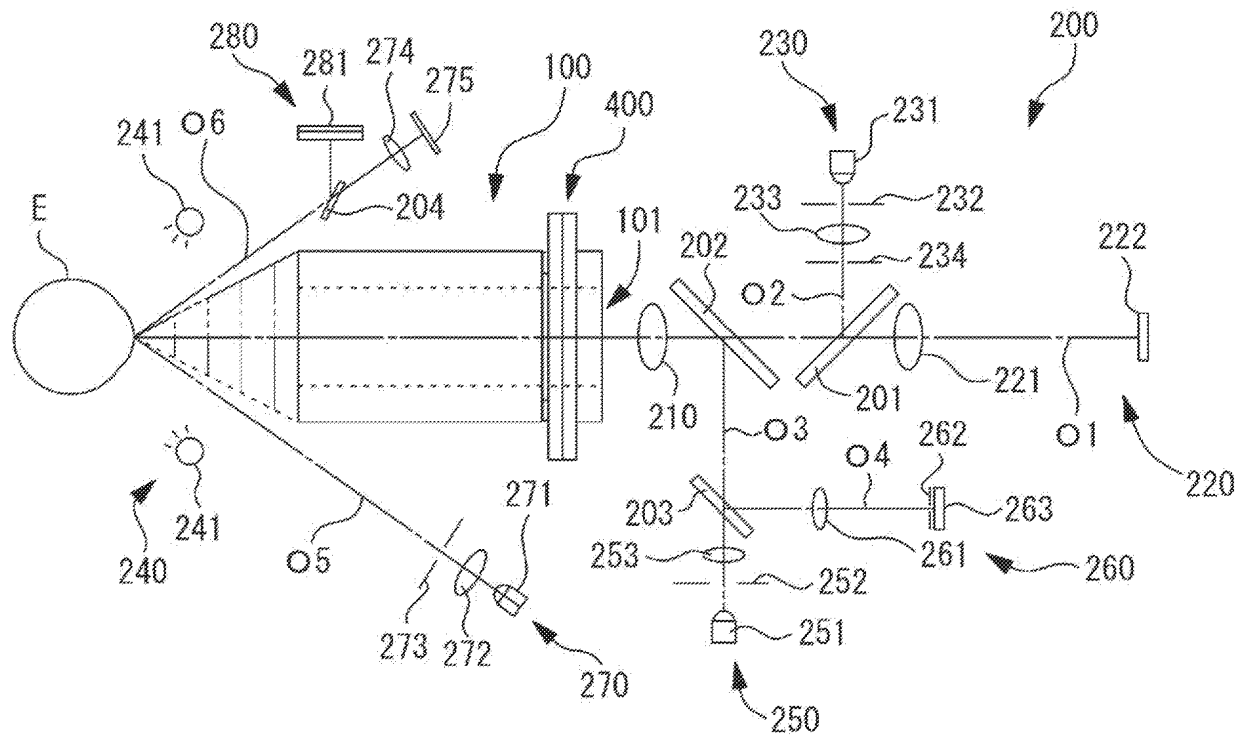
MEASUREMENT/TESTING



US Patent Application [US20210186322A1](#) titled “Ophthalmologic Measurement Apparatus, Ophthalmologic Measurement System, and Ophthalmologic Measurement Program”



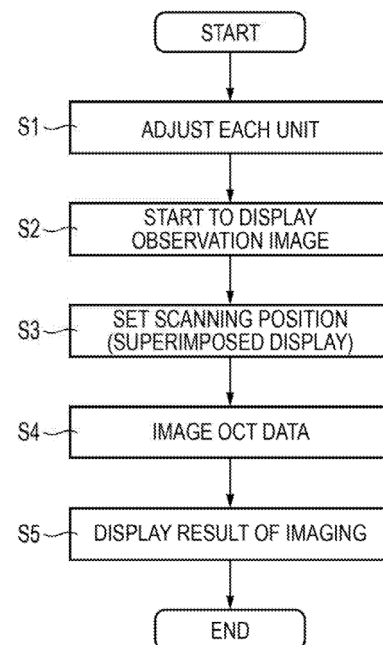
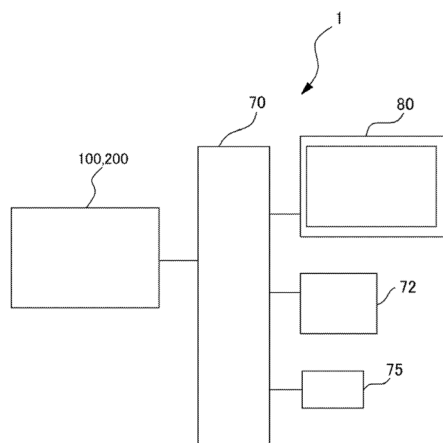
US Patent Application [US20210169323A1](#) titled “Method for Ophthalmic Examination and Remote Examination Program”



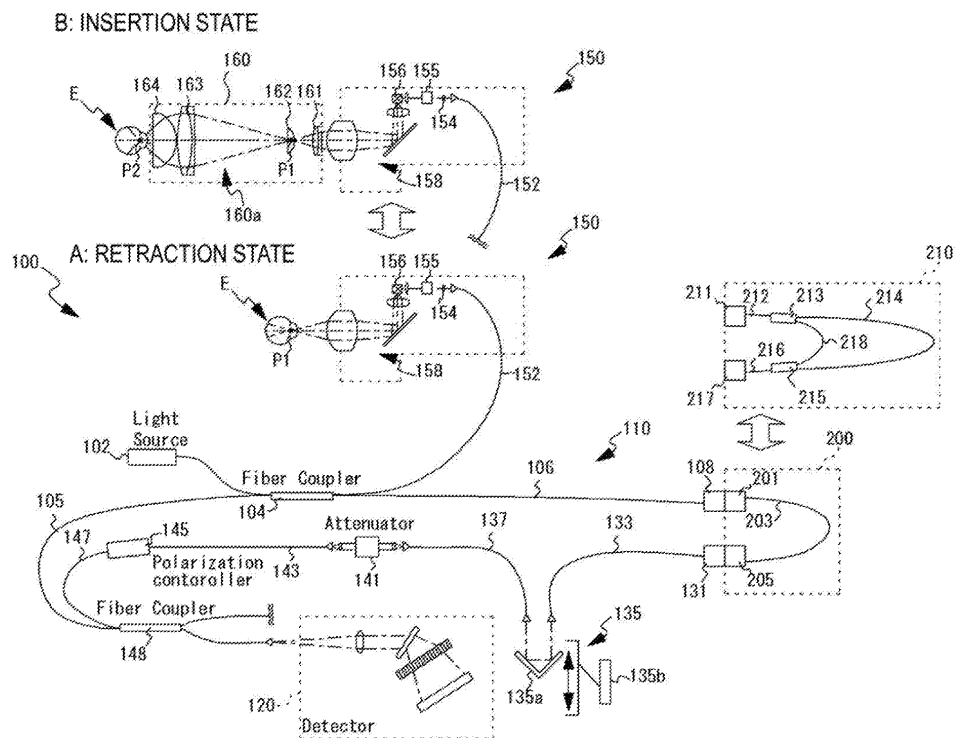
US Patent Application [US20210068656A1](#) titled “Non-contact Ultrasonic Ophthalmotonometer”

IMAGING

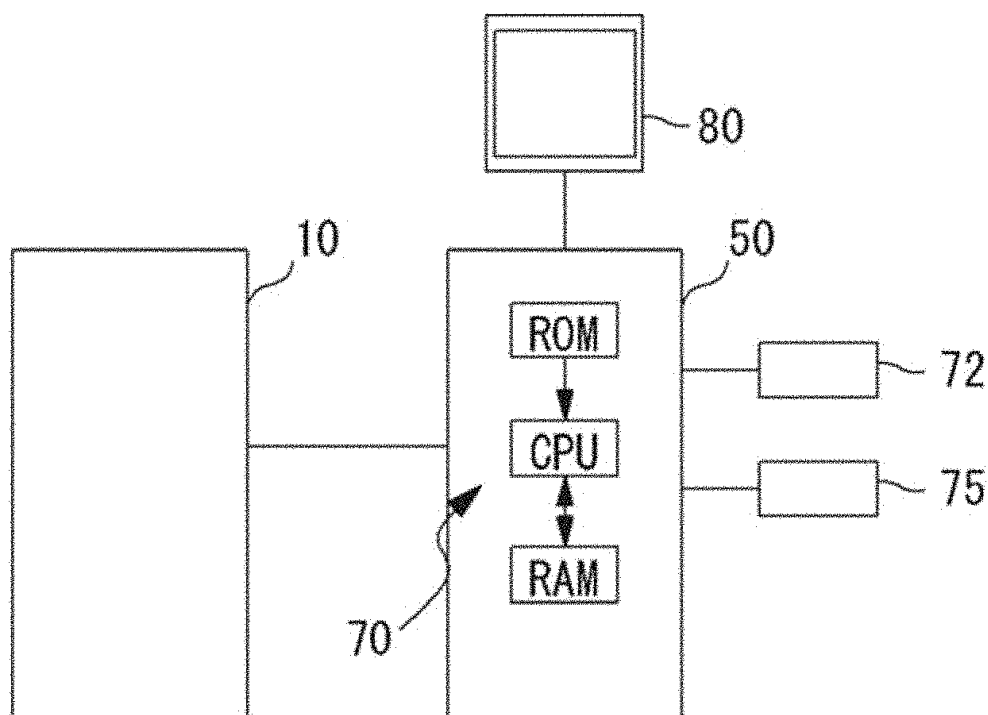
FIG. 1



US Patent Application [US20210093187A1](#) titled "Ophthalmologic Imaging Apparatus"



US Patent Application [US20200245863A1](#) titled “Oct System and Reference Attachment”



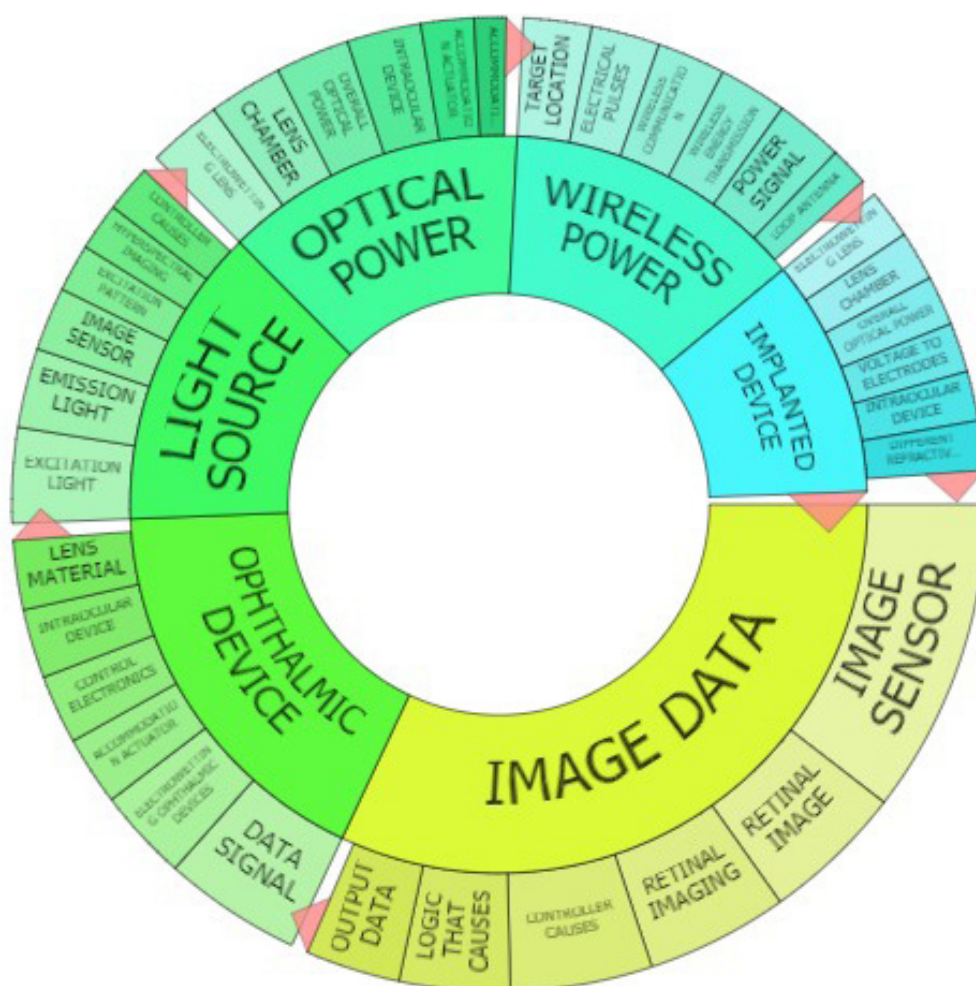
US Patent Application [US20210093186A1](#) titled “Ophthalmologic Image Processing Method and Oct Apparatus”



Verily Life Sciences is an Alphabet subsidiary focused on Life Sciences and Healthcare. It was founded in 2015. The Smart Lens program initiated in collaboration with Alcon for glucose-sensing was shelved in 2018. Verily's focus has since [evolved](#) into a versatile electronics platform that can support smart, accommodating contact lenses and smart intraocular lenses among other areas.

Verily is headquartered in San Francisco, California, United States.

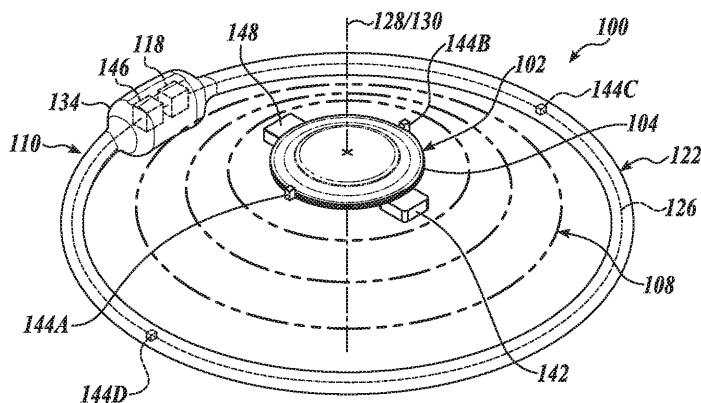
Alphabet's estimated revenue was \$[650](#) million in 2020 for other bets that include Verily. Verily also continues to receive outside funding through collaboration and investments.



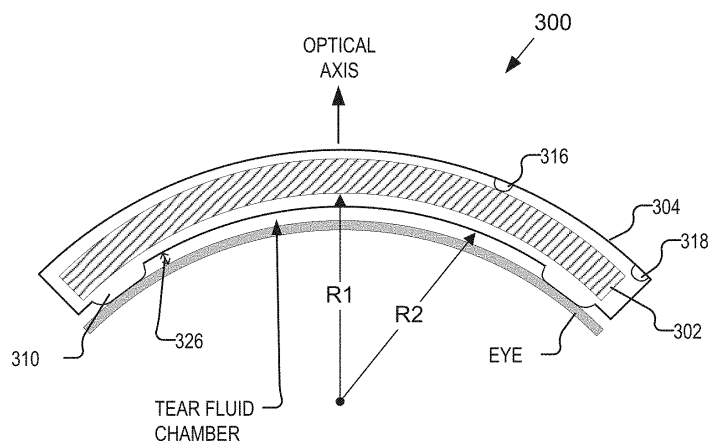
Verily's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Patents related to wearables, ophthalmic devices and image sensors are the dominant themes. Verily Life Sciences has about 1500 alive patent families, of which 17% of the patent families claim ophthalmic devices.

A few recent examples from our shortlist are shown below.

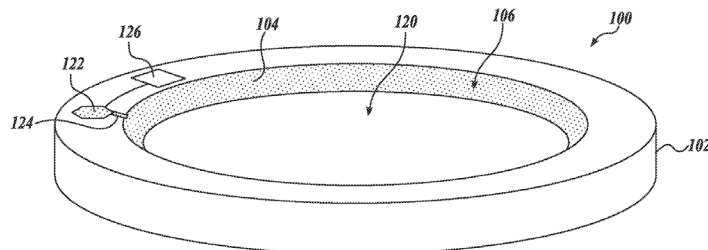
CONTACT LENS



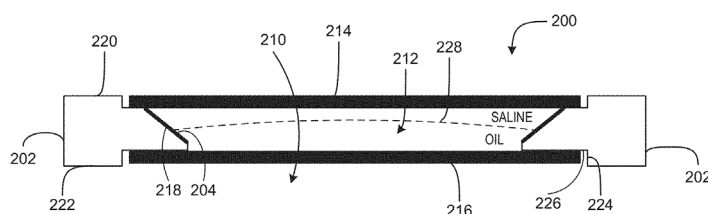
US Patent Application [US20200138565A1](#) titled "Ophthalmic System Including Accommodating Intraocular Lens and Remote Component and Related Methods of Use"



US Patent Application [US20210149219A1](#) titled "Multi-Component Contact Lens Having Posterior and Anterior Features"

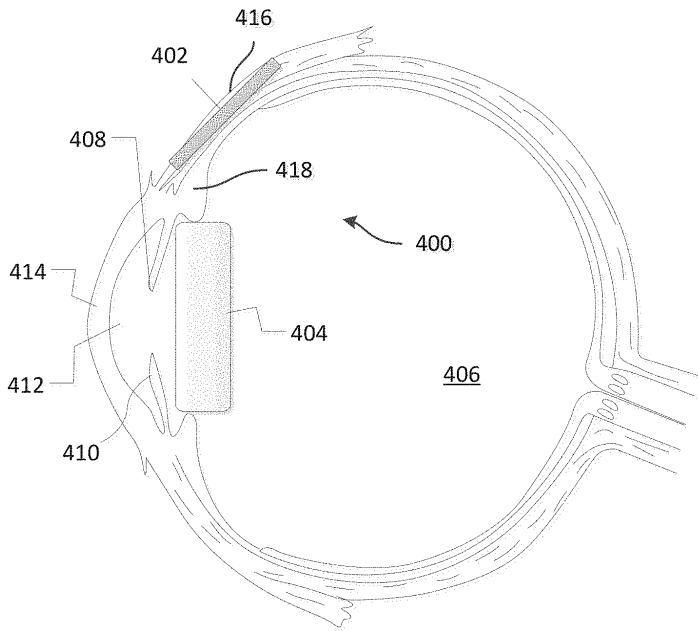


US Patent Application [US20210121287A1](#) titled "Intraocular Lens With Reinforcing Layer"

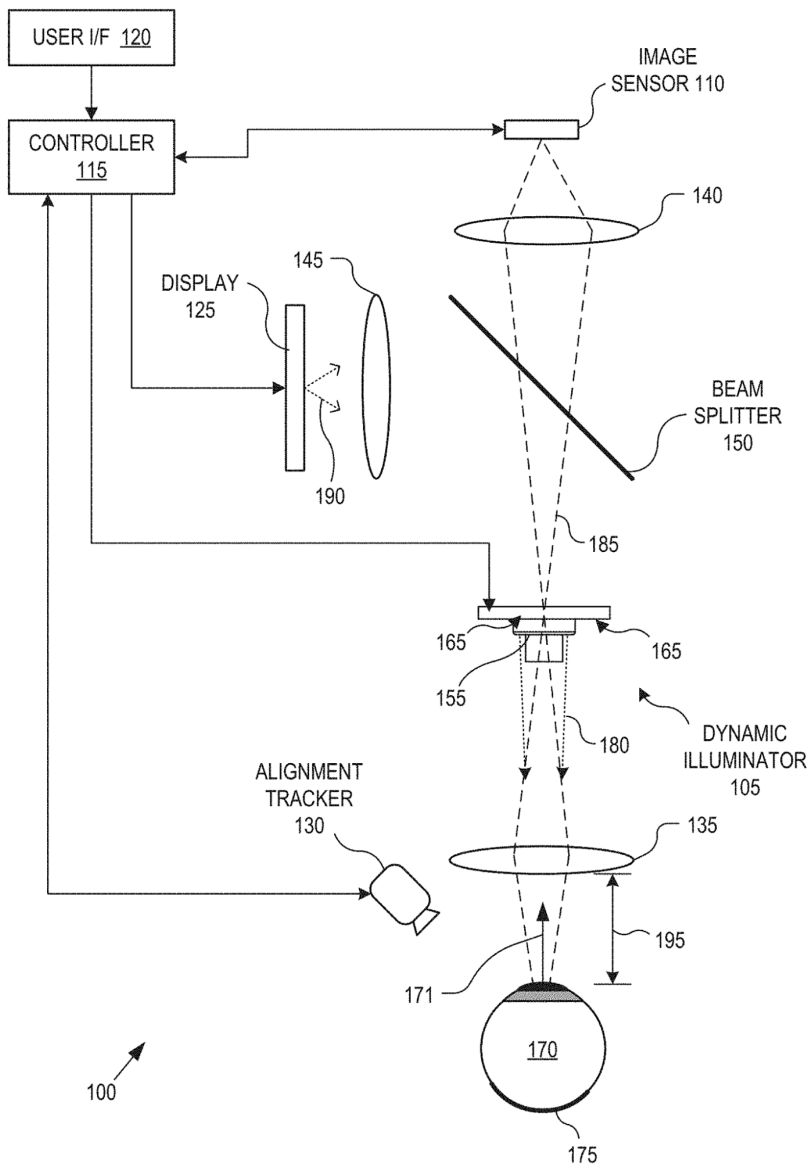


US Patent Application [US20210154003A1](#) titled "Electrowetting Ophthalmic Devices Including an Elastic Electrode"

US Patent Application
[US20210015603A1](#) titled
 “Intraocular Device With Wirelessly
 Coupled Auxiliary Electronics”



US Patent Application
[US20210076926A1](#) titled “Retinal
 Camera With Dynamic Illuminator
 for Expanding Eyebox”

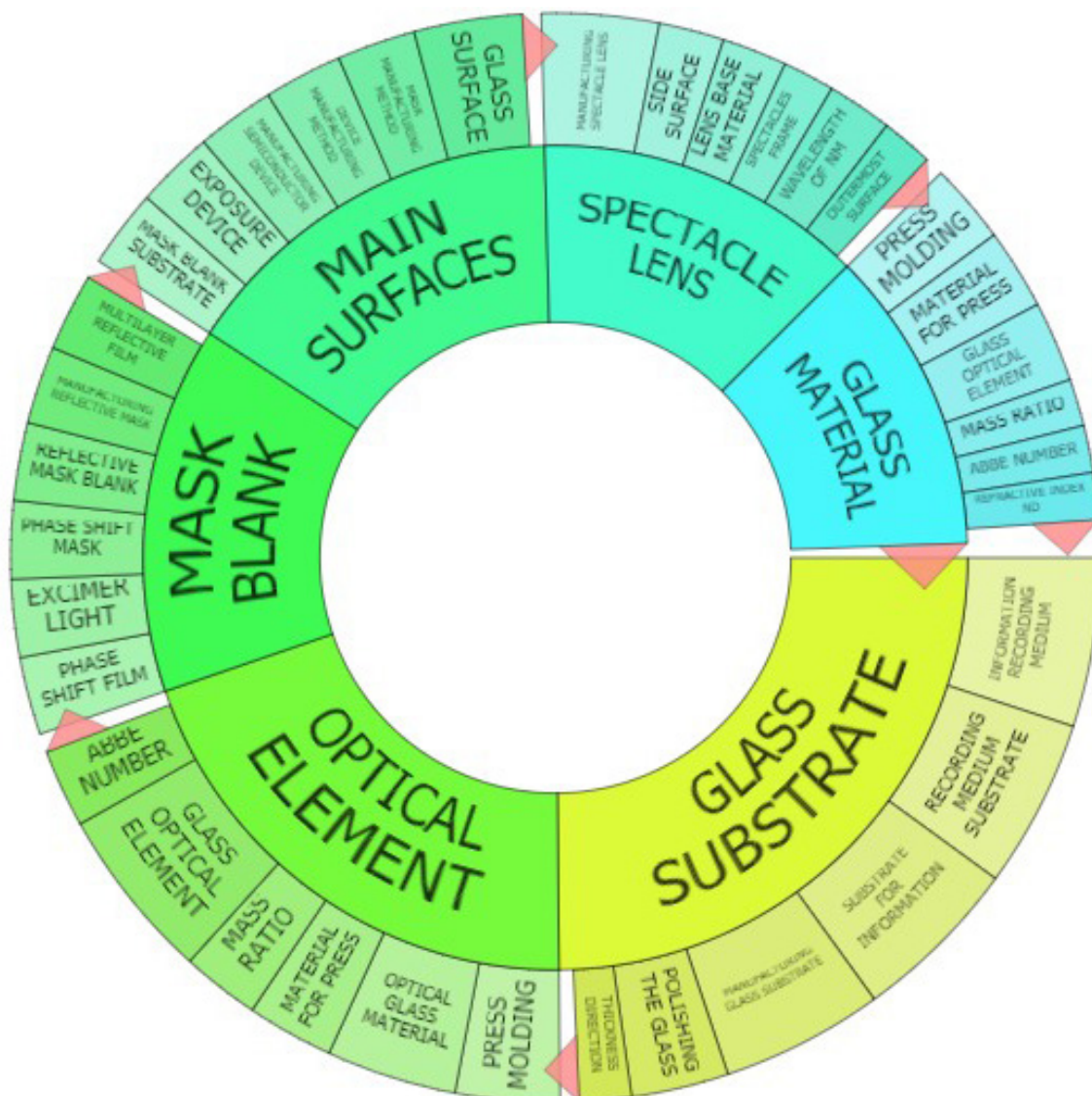




Hoya is a diversified global manufacturer of imaging products, electronics, and medical-related equipment. It was founded in 1941.

Hoya was founded in its namesake city - Hoya - and is currently headquartered in Tokyo, Japan.

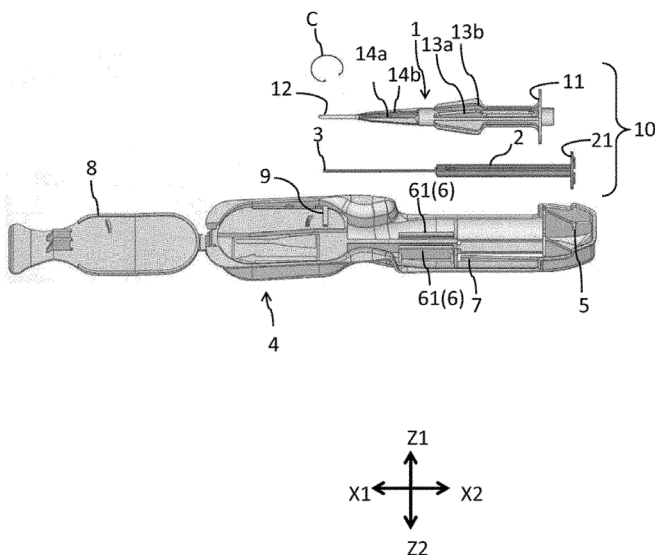
Hoya's consolidated revenue was \$[5.2 billion](#) in 2019, nearly half of which is from the Life Care segment that includes eyeglass and contact lenses, medical endoscopes, and intraocular lenses.



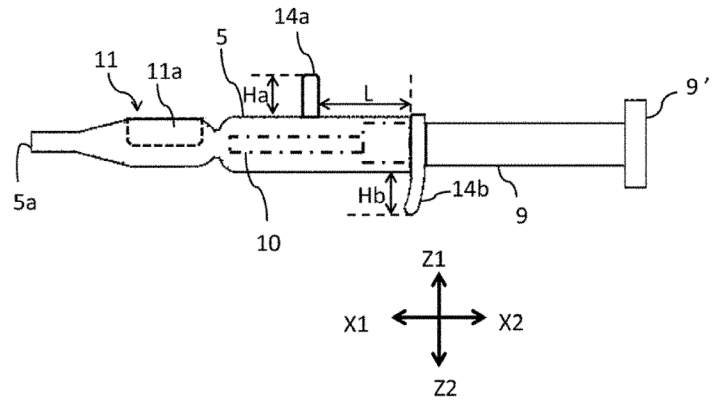
Hoya's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle, while sub-topics are shown in the outer circle. Patents are broadly related to optical, med-tech, materials, manufacturing, semiconductors, and audio-visual technologies. Hoya has over 6000 alive patent families, of which 2% of the patent families claim ophthalmic devices.

A few recent examples from our shortlist are shown below.

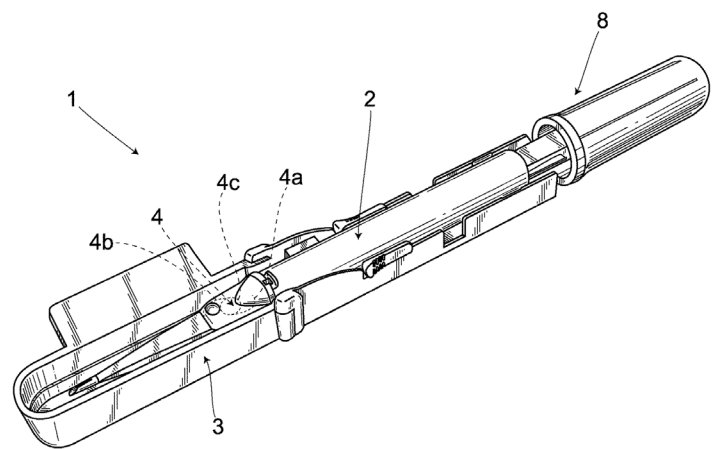
SURGICAL DEVICES



US Patent Application [US20210145570A1](#)
titled “Intraocular Lens Injector With
Container”

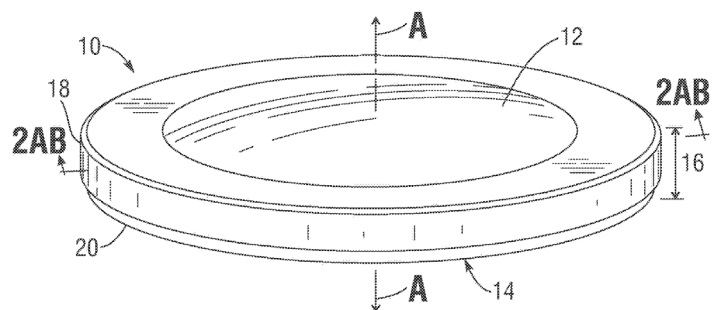


US Patent Application [US20210161653A1](#)
titled "Intraocular Lens Injector"

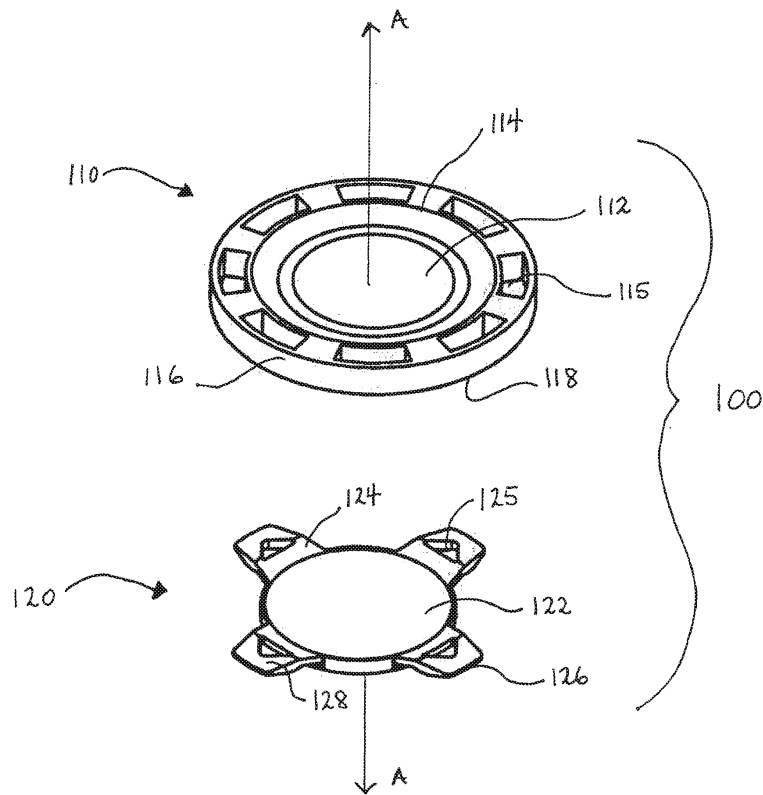


US Patent Application [US20200113674A1](#)
titled "Intraocular Lens Insertion Device"

CONTACT LENS



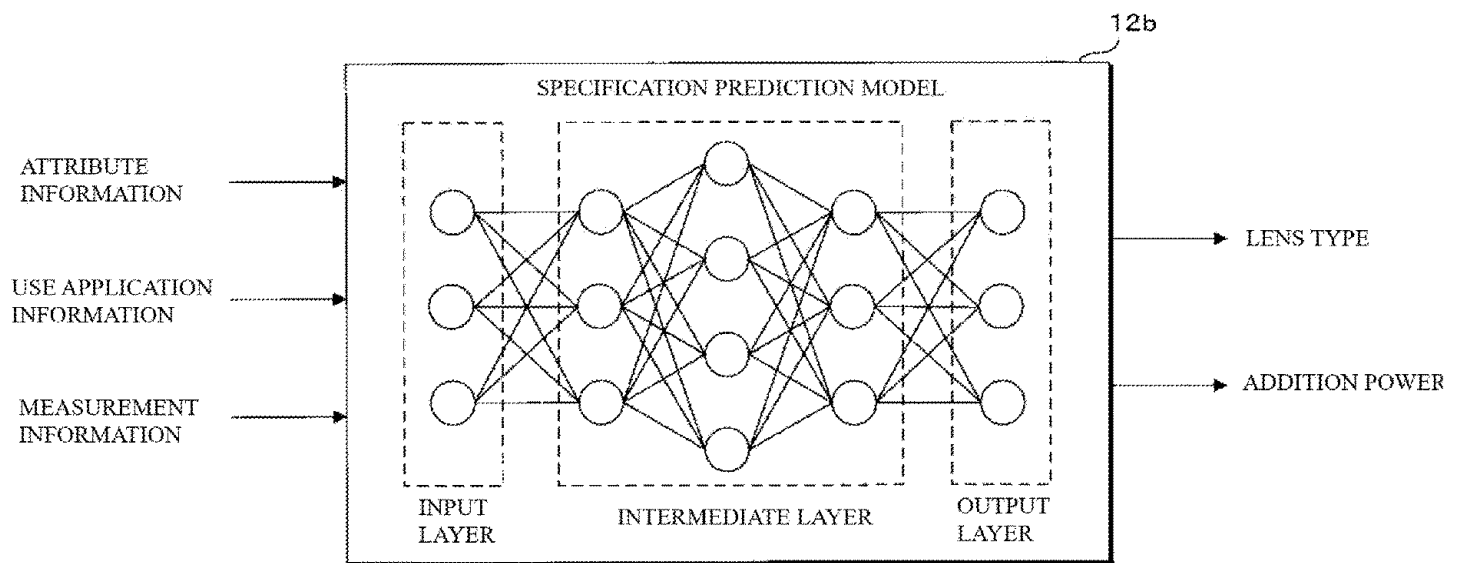
US Patent Application [US20200179104A1](#)
titled "Accommodating Intraocular Lens
Device"



US Patent Application

[US20200085568A1](#) titled "Two-Part Accommodating Intraocular Lens Device"

AI/ML



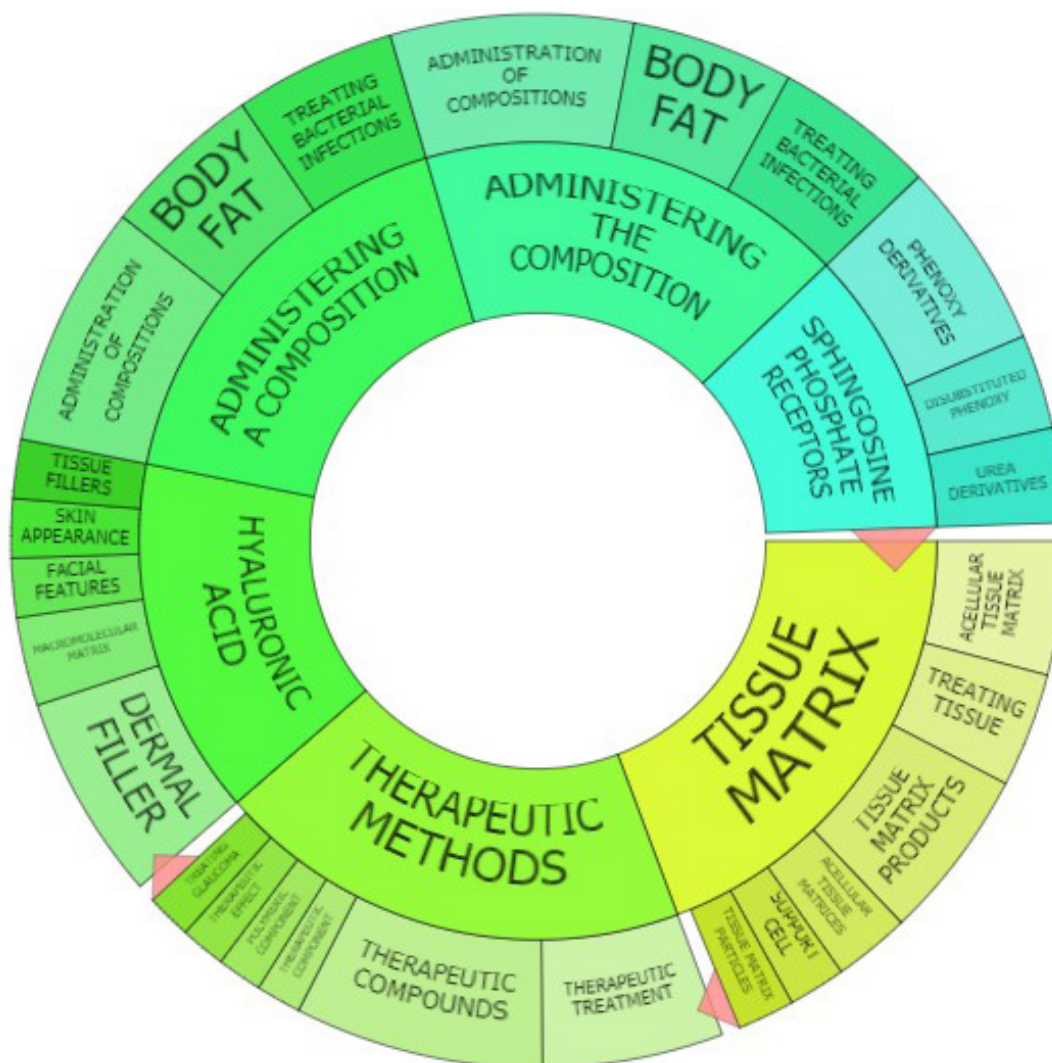
US Patent Application [US20210097412A1](#) titled "Learning Model Generation Method, Recording Medium, Eyeglass Lens Selection Support Method, and Eyeglass Lens Selection Support System"



Allergan, an [Abbvie](#) company, manufactures and markets drugs and medical devices in the areas of medical aesthetics, eye care, central nervous system, and gastroenterology. The drugmaker is best known for its product, Botox.

Allergan was founded in 1948 by pharmacist Gavin S. Herbert. It is currently headquartered in Dublin, Ireland.

Abbvie reported revenue was \$[2.184](#) billion in 2020 from its eye care division, nearly one-third of which is coming from Restasis, one-third from other eye care products and the remaining from Lumigan/Ganfort and Alphagan/Combigan.

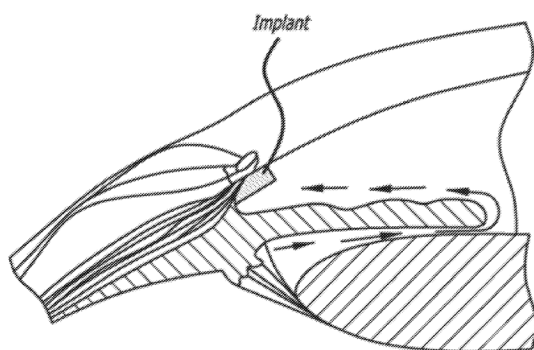


Allergan's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Allergan has over 2,000 alive patent families of which 7% patent families claim ophthalmic devices. Patents related to ophthalmic devices include those focused on contact lenses, ocular implants, and drug delivery devices.

A few recent examples from our shortlist are shown below.

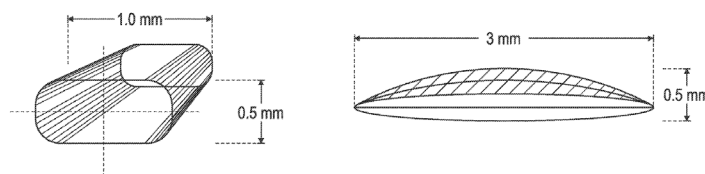
DRUG DELIVERY DEVICES

FIG. 1B



US Patent Application [US20210228408A1](#) titled "Glaucoma Treatment Via Intracameral Ocular Implants"

(a) Bar-shaped polymer implant and (b) Disc-shaped polymer implant



US Patent Application [US20210161809A1](#) titled "Biodegradable Alpha-2 Agonist Polymeric Implants and Therapeutic Uses Thereof"

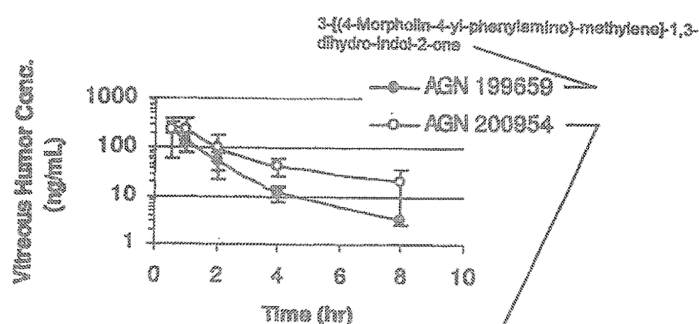


Fig. 1

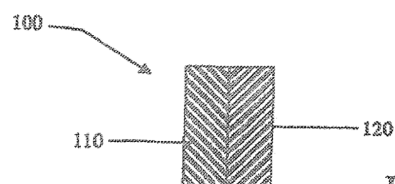
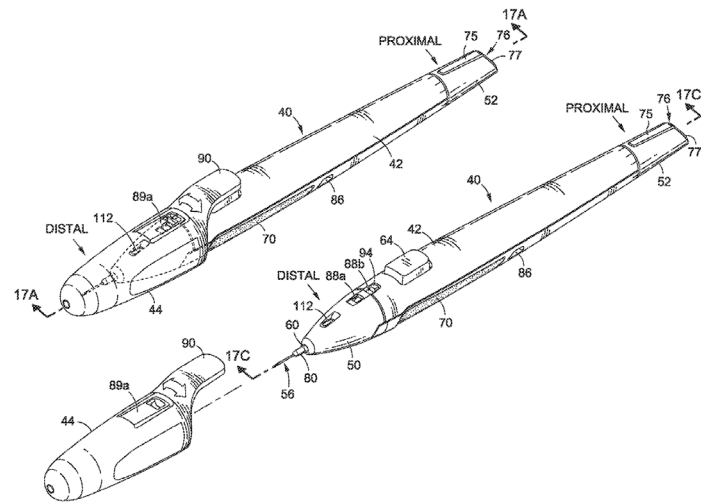


Fig. 14

US Patent Application [US20210121397A1](#) titled "Biodegradable Intravitreal Tyrosine Kinase Implants"



US Patent Application [US20200113674A1](#)
titled "Intraocular Implant Delivery
Apparatus and Methods of Use Thereof"

MEASUREMENT/TESTING

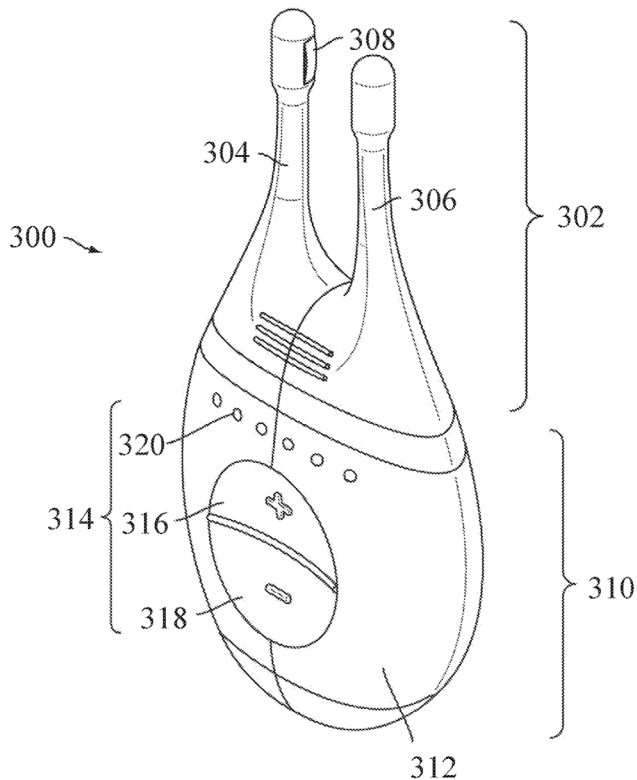


FIG. 3

US Patent Application [US20200179104A1](#)
titled "Apparatus and Method for Dry Eye
Forecast and Treatment Recommendation"

MANUFACTURING

Oil in Oil Manufacturing Process

Batch Size: 1g

Phase I (Discontinuous)

Acetonitrile	20 mL
Bimatoprost	100 mg
PLGA	900 mg

Phase II (Continuous)

Cottonseed Oil	800 mL
Span 85 (or 80)	12.8 mL

Emulsion

Mixing Speed	350 rpm
Time	90 min
Temp	20°C

Evaporation

Under Filtered Air Flow	
Time	45h
Mixing Speed	250rpm

Centrifugation/Collection

+250 mL Hexane and Stirring 1h	
Centrifugation 7000 rpm/10 min	

Centrifugation/Rinsing

+100 mL Hexane 7000 rpm/10 min	
(2 times)	
+15 mL Hexane	

Drying

On Filtered Air Flow - Overnight	
----------------------------------	--

FIG. 1

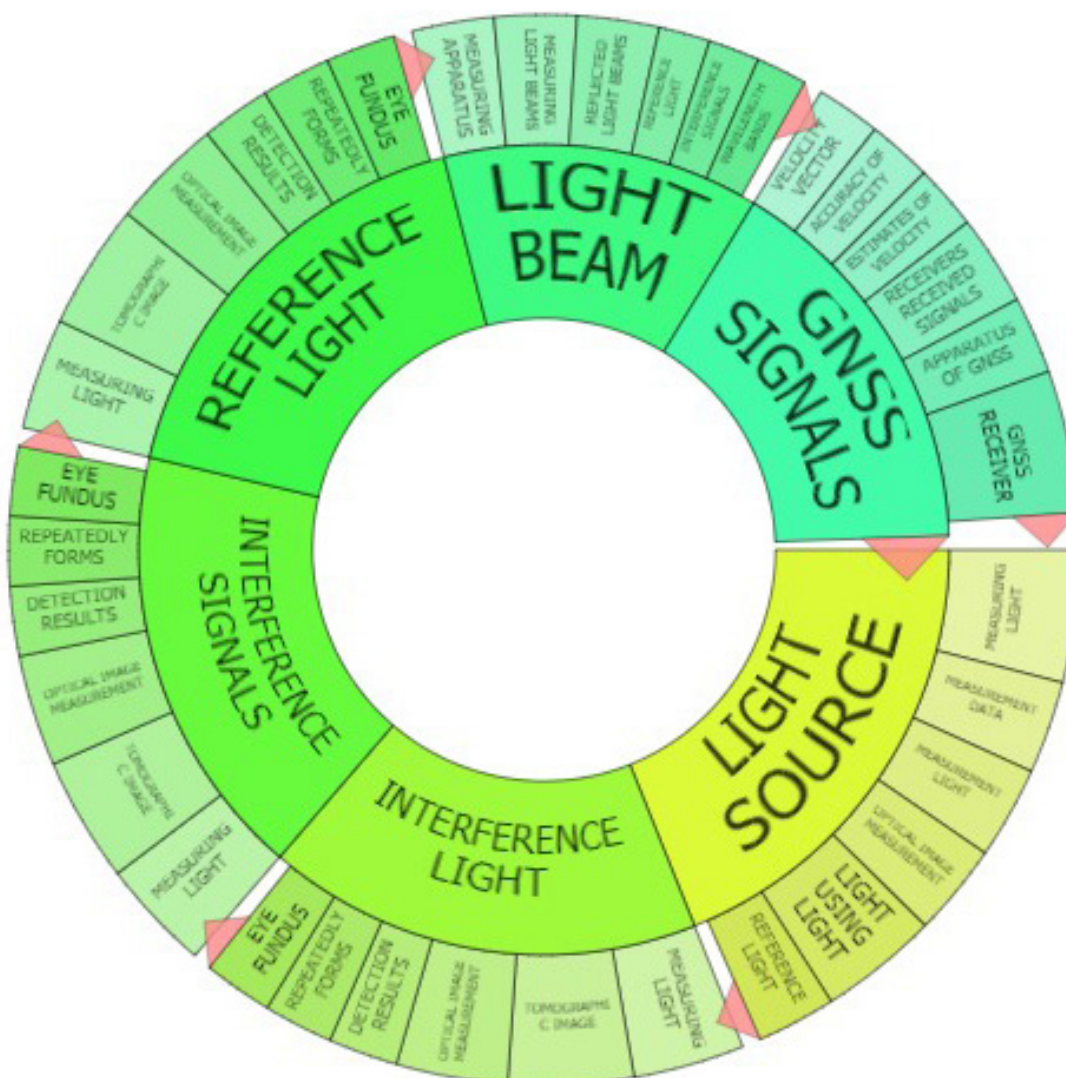
US Patent Application [US20200345750A1](#)
titled "Oil-in-Water Method for Making
Polymeric Implants Containing a
Hypotensive Lipid"



Topcon is an integrated eye care device manufacturer focusing on a wide variety of equipment for ophthalmology and surveying. They are pioneers in manufacturing advanced OCT systems for eye care.

Topcon was founded in 1932 as a surveying instruments division of K. Hattori & Co., Ltd. (currently SEIKO). It is currently headquartered in Tokyo, Japan.

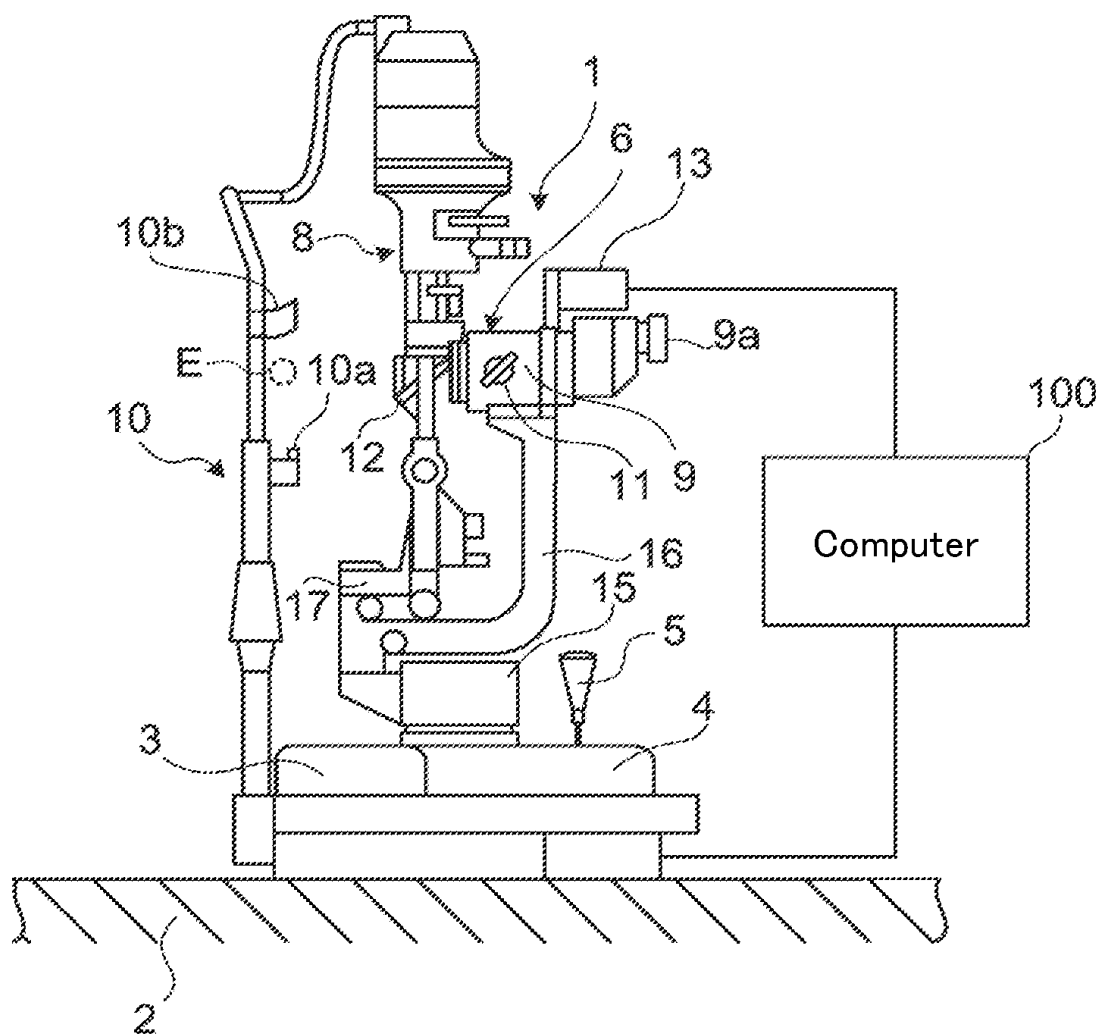
Topcon reported revenue of \$1.2 billion in 2019 of which \$ 434 million was from its eye care division which includes 3D OCT system and screening equipment.



Topcon's broad technology areas (represented above) are based on an automated clustering of keywords from active patents and pending applications. The main topics are represented in the inner circle while sub-topics are shown in the outer circle. Patents related to wearables, ophthalmic devices and image sensors are the dominant themes. Topcon has over 2,500 alive patent families, of which 10% of the patent families claim ophthalmic devices.

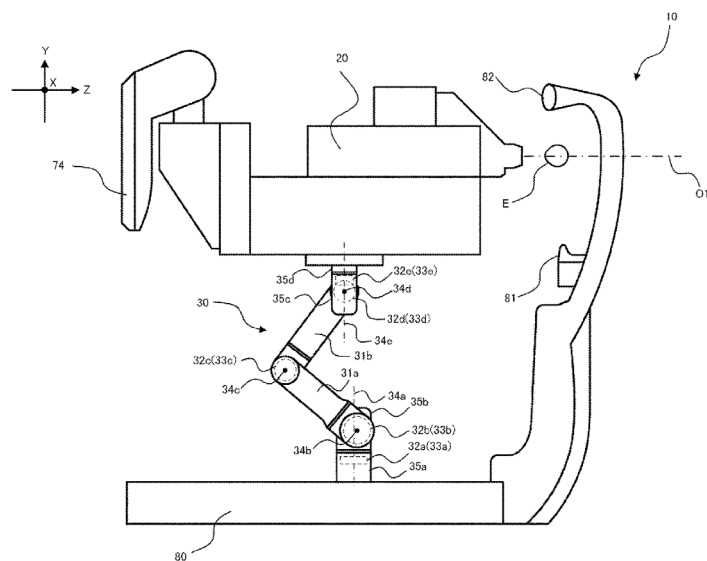
A few recent examples from our shortlist are shown below.

IMAGING/AI/ML



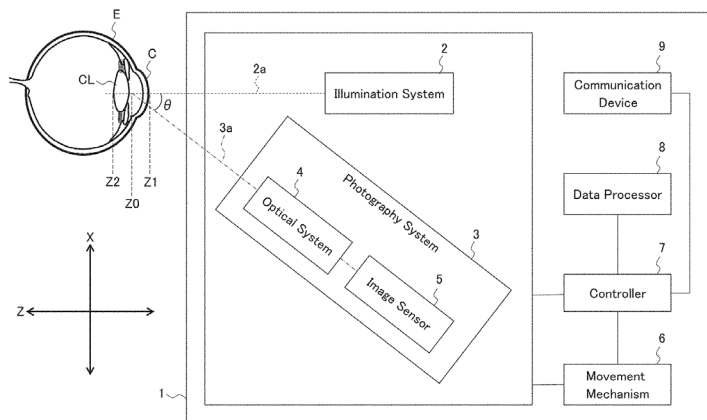
US Patent Application [US20210153735A1](#) titled "Ophthalmic System, Ophthalmic Information Processing Device, and Ophthalmic Diagnosing Method"

IMAGING



US Patent Application [US20210030272A1](#)
titled "Ophthalmologic Apparatus and
Ophthalmologic System"

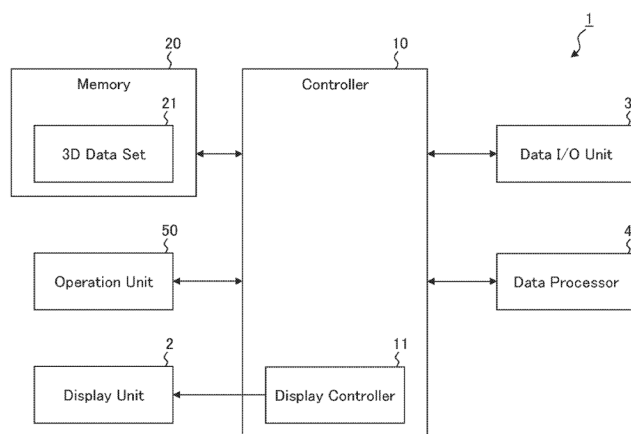
IMAGING/SLIT LAMP



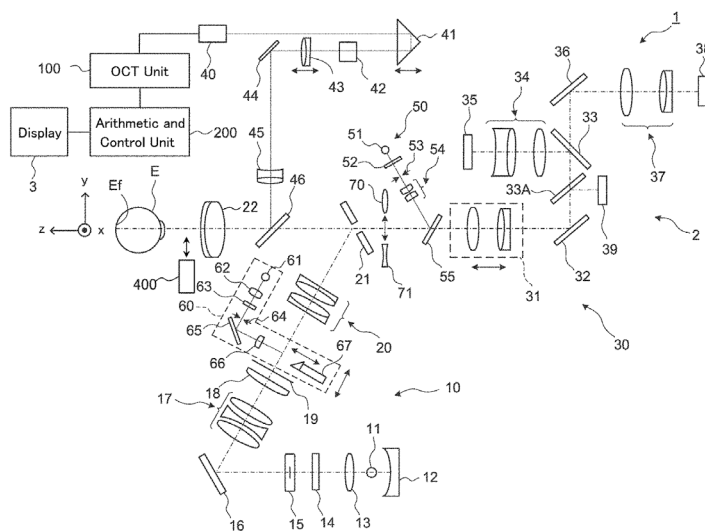
US Patent Application [US20210153740A1](#)
titled "Slit Lamp Microscope and
Ophthalmic System"

IMAGING/OCT

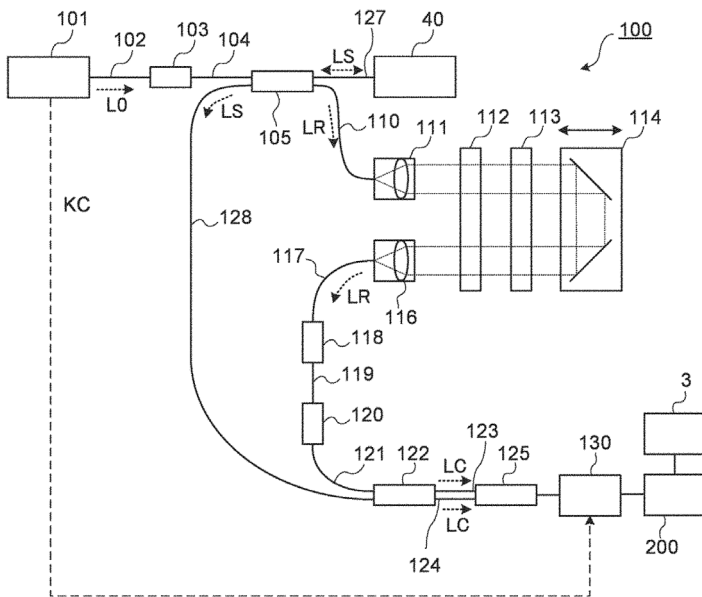
FIG. 1



US Patent Application [US20210093191A1](#)
titled "Ophthalmological Device"



US Patent Application [US20210161376A1](#)
titled "Ophthalmic Device, Control Method
Therefor, and Recording Medium"



Pathway: PMA

Approval Date: April 28, 2021

Clinical Trial: [NCT03949335](https://clinicaltrials.gov/ct2/show/study/NCT03949335)

Source: [FDA](https://www.fda.gov/)

Bausch Health's ClearVisc Ophthalmic Viscosurgical Device (OVD)

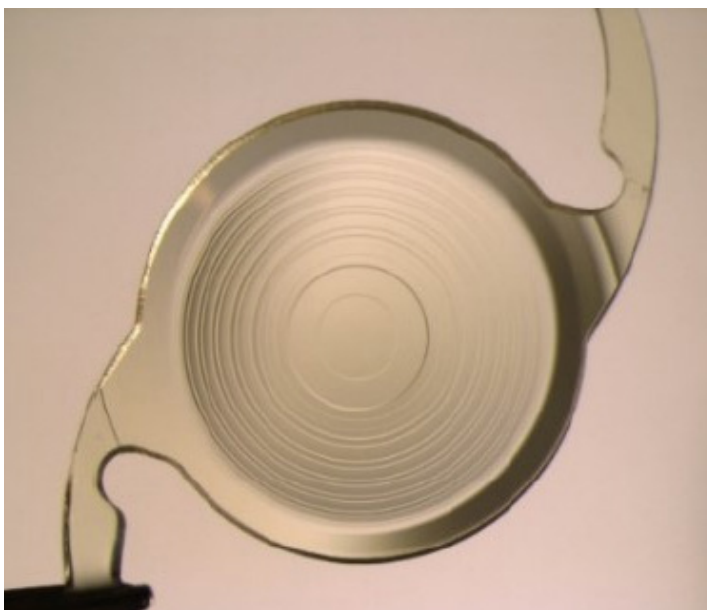


US Patent Application [US20200345750A1](https://patents.google.com/patent/US20200345750A1) titled "Oil-in-Water Method for Making Polymeric Implants Containing a Hypotensive Lipid"

IV. REGULATORY AND CLINICAL TRIALS

Selected Approvals

Johnson & Johnson Surgical Vision's TECNIS Synergy Intraocular Lens (IOL)



Pathway: PMA

Approval Date: March 23, 2021

Clinical Trial: [NCT03511638](#)

Source: [FDA](#)

Alcon's AcrySof and Clareon Intraocular Lens (IOL)



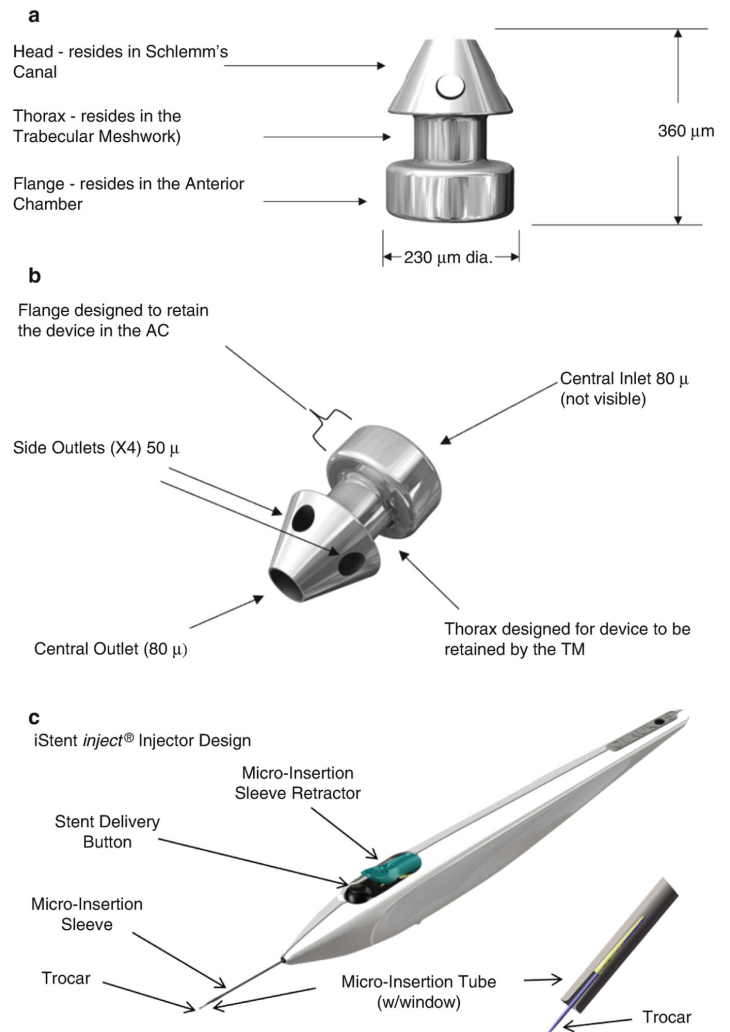
Pathway: PMA

Approval Dates: February 26, 2020 and January 7, 2020

Clinical Trials: [NCT04098367](#) and [NCT03170154](#)

Source: FDA 1 and 2

Glaukos's iStent Inject Trabecular Micro-Bypass System



Pathway: PMA

Approval Date: 06/21/2018

Clinical Trial: [NCT01461291](#)

Source: [FDA](#)

Allergan's TrueTear Intranasal Tear Neurostimulator



Pathway: De Novo

Approval Date: May 17, 2018

Source: [FDA](#)

Lumenis's Stellar M22



Pathway: De Novo

Approval Date: February 23, 2021

Source: [FDA](#)

AMO Manufacturing's CATALYS Precision Laser System



Pathway: 510K

Approval Date: April 7, 2021

Source: [FDA](#)

Nidek's Ophthalmic Yag Laser System YC-200



Pathway: 510K

Approval Date: October 19, 2020

Source: [FDA](#)

Carl Zeiss's XPORT S Lens Fragmentation System

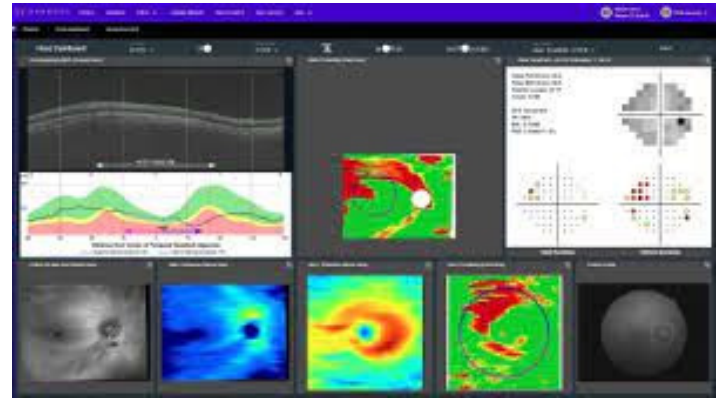


Pathway: 510K

Approval Date: October 15, 2020

Source: [FDA](#)

Topcon's Glaucoma Module



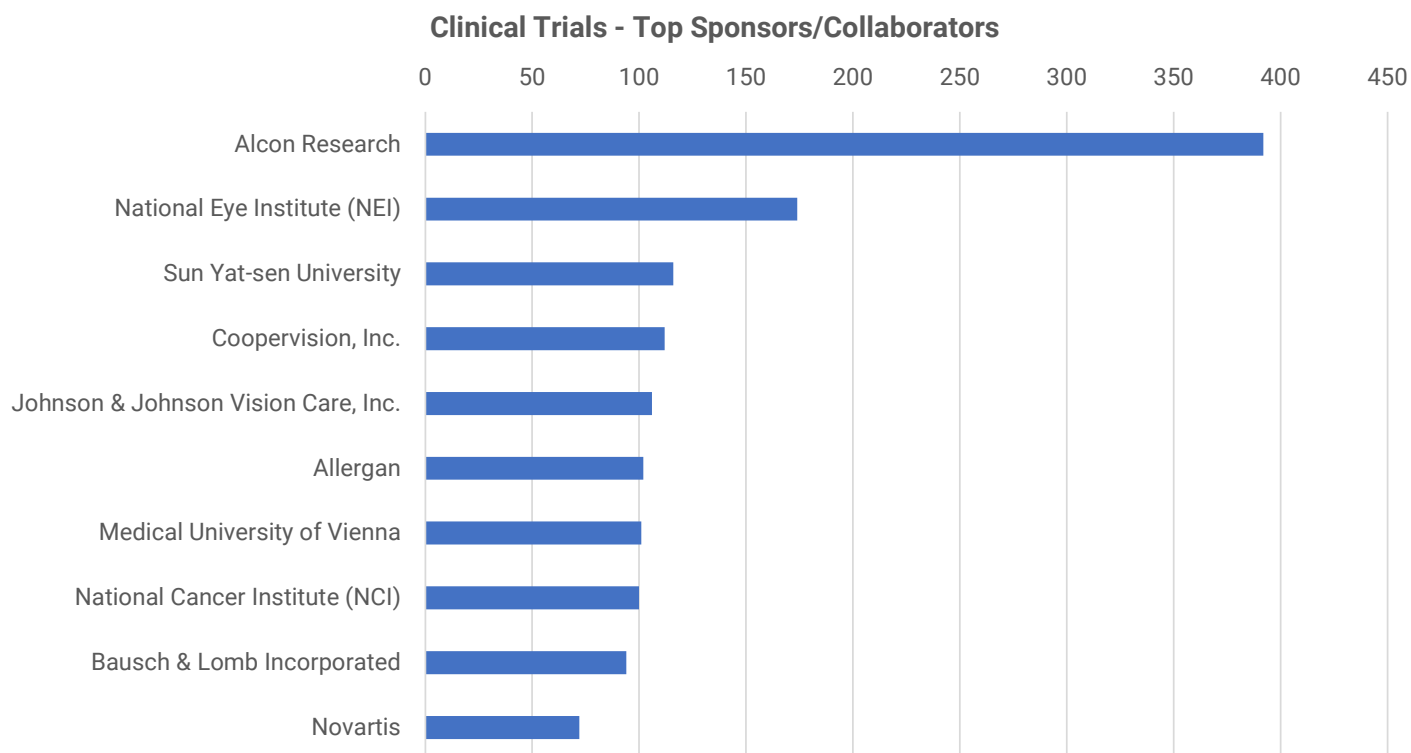
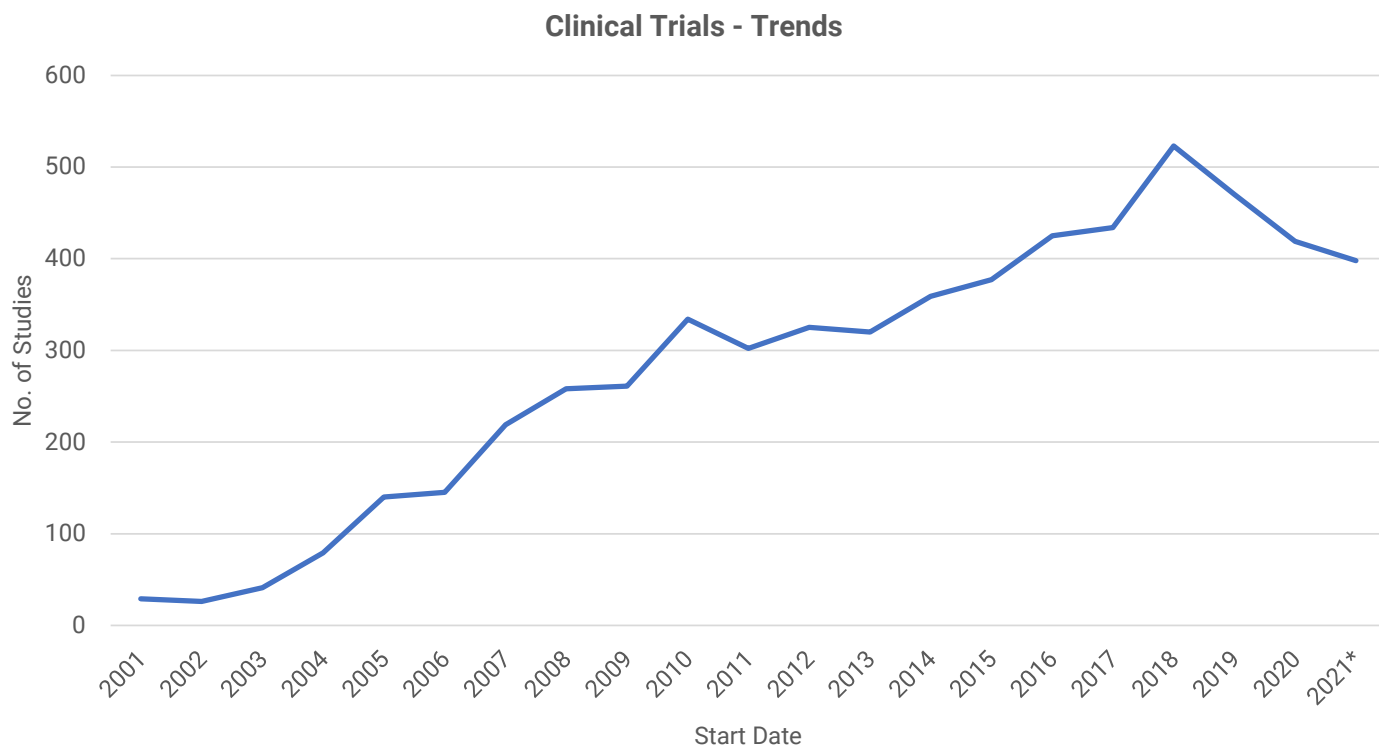
Pathway: PMA

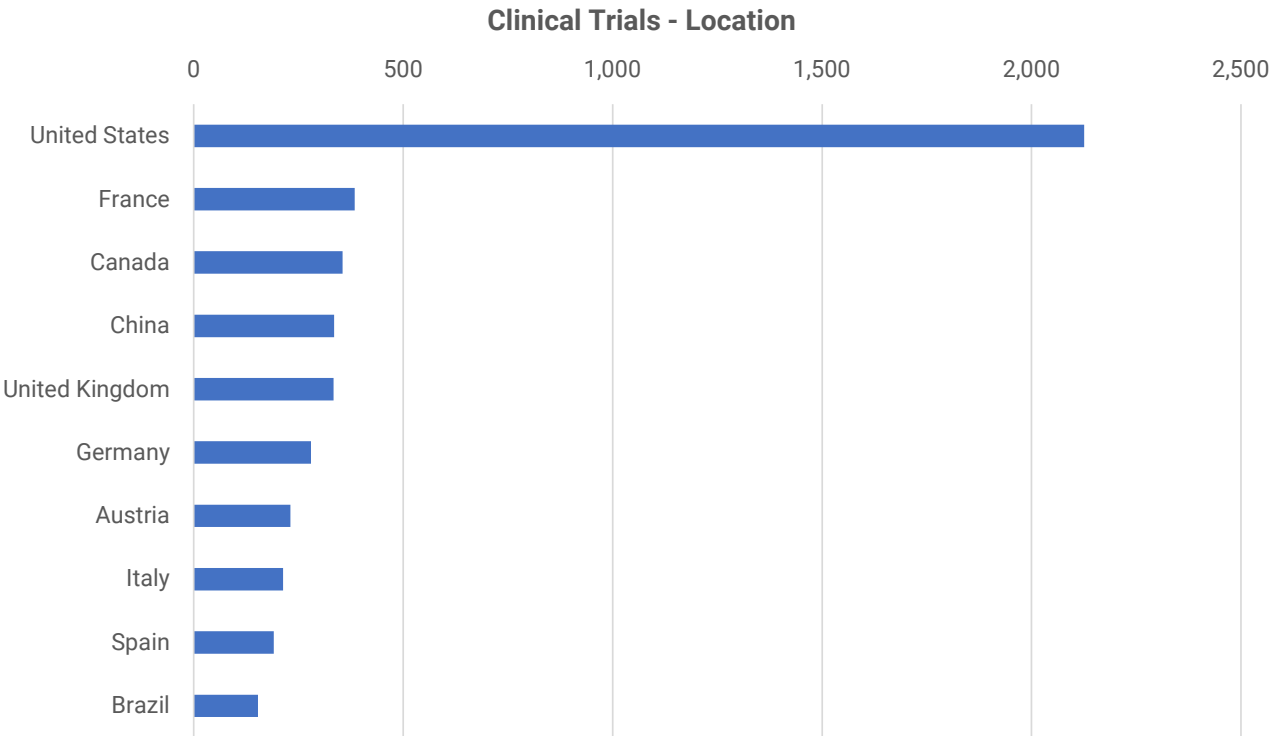
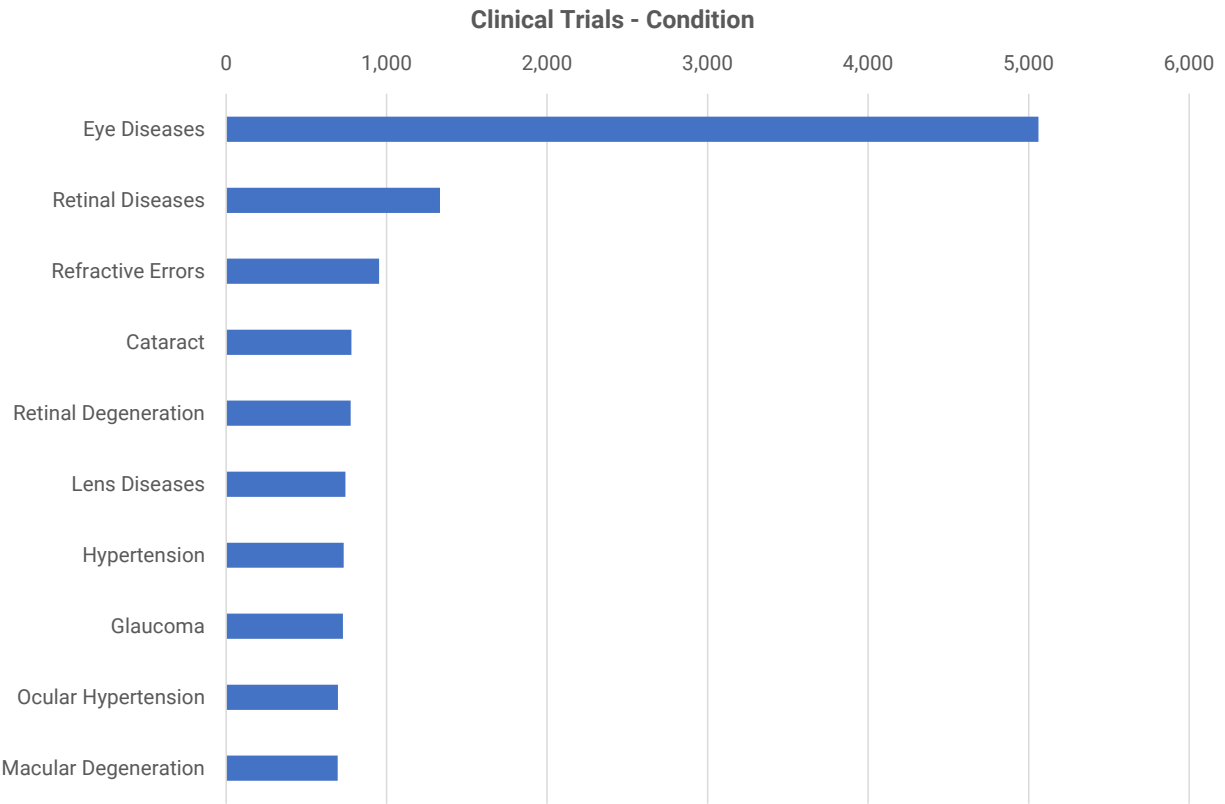
Pathway: 510K

Approval Date: April 9, 2020

Source: [FDA](#)

Clinical Trials





We shortlisted interventional clinical trials related to eye disorders and those involving a medical device or surgical procedure. To give a clear picture of these trials, we have provided the study filing trends (top left), top sponsors/collaborators (top right), top

conditions (bottom left), and top study locations (bottom right). If we look closely, there is a significant drop in the posted clinical trials starting from 2019 to 2021. COVID-19 could be a major reason behind this decline.

Furthermore, when it comes to the trial collaborators and sponsors, Cooper Vision (Cooper Companies), one of the world's largest manufacturers of soft contact lenses, is amongst the leading clinical trial sponsors. Although, it featured low among the list of the top patent filers.

V. FINAL THOUGHTS

Experts believe that the ophthalmic device industry will likely see a significant recovery in 2021-2022 after a COVID-19 mediated slowdown. R&D and patent departments have a key role to play as companies are increasingly looking to secure the next big opportunity. The long-term success and resiliency for many of these companies will depend on a clear IP strategy. This is because by strategically leveraging internal and external resources, companies can establish rewarding working relationships with key stakeholders to achieve common desired outcomes. The first step towards achieving this is setting global IP priorities in association with the business executives and General Counsel to facilitate budgets and goal-setting within patent departments. Teams should increasingly look towards fostering data-driven decision-making in portfolio management and monetization, and also leverage technology-enabled solutions in building and maintaining IP portfolios. End-to-end IP partners can be extremely helpful in optimizing your team's performance by supporting these initiatives.

IP strategists, R&D and business heads should also increasingly look into conducting technology-enabled and focused landscape studies to understand the competitive, risk and market landscape. Other initiatives such as portfolio analysis, opportunity scouting, pruning/renewals, and litigation/licensing support can help patent departments stay updated, efficient and focused on higher value work.



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