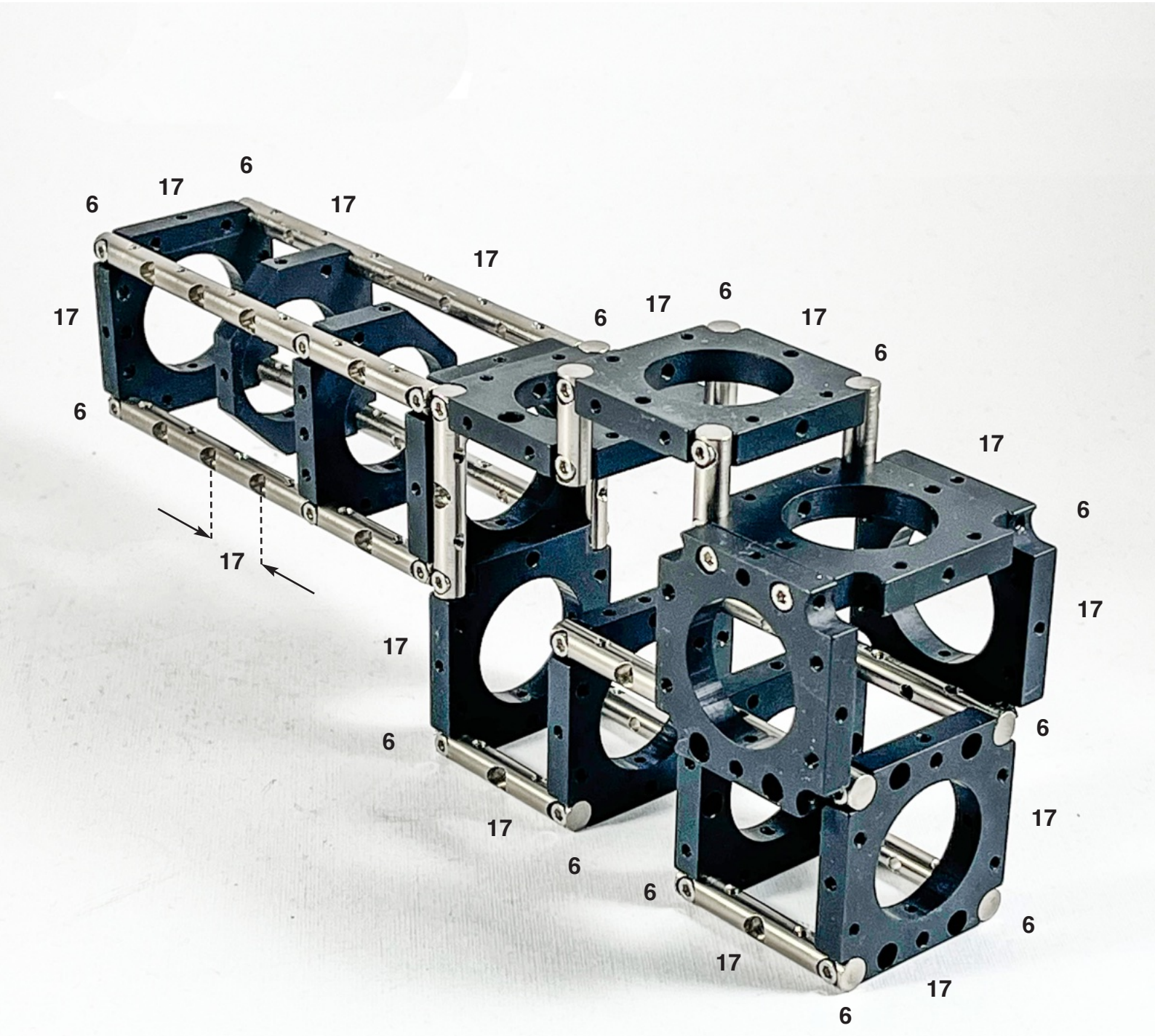
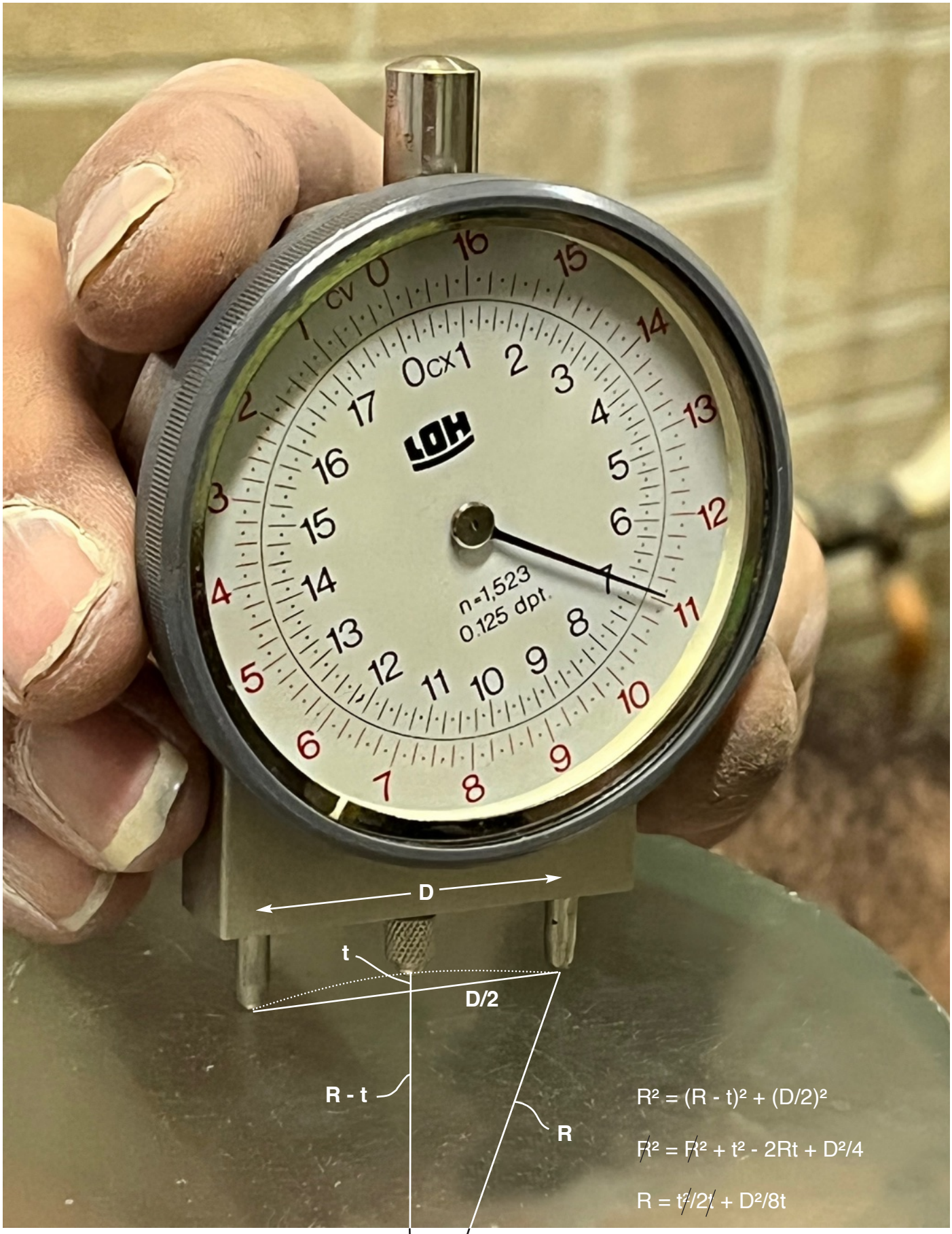
Optomechanix

New Optoform's Design Secret Revealed

Oct - Dec 2023



Technical journal of OMiD, Opto-Mechanical Institute of Design



The Spherometer

How a lens curvature R is measured with a dial indicator, See Page 11~13

$$R^2 = (R - t)^2 + (D/2)^2$$

$$R^2 = R^2 + t^2 - 2Rt + D^2/4$$

$$R = t^2/2t + D^2/8t$$

$$R = t/2 + D^2/8t$$

Very Small

$$\boxed{R = D^2/8t}$$

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This issue Dedicated to:

Abraham Maslow (1908 - 1970)

Abraham Maslow (1908-1970) was an American psychologist who developed a hierarchy of needs to explain human motivation. His theory suggested that people have a number of basic needs that must be met before people move up the hierarchy to pursue more social, emotional, and self-actualizing needs. Maslow earned all three of his degrees in psychology from the University of Wisconsin. He began teaching at Brooklyn College in 1937 and continued to work as a member of the school's faculty until 1951.

Maslow's hierarchy of needs is a motivational theory in psychology comprising a five-tier model of human needs, often depicted as hierarchical levels within a pyramid.

From the bottom of the hierarchy upwards, the needs are physiological (food and clothing), safety (job security), love and belonging needs (friendship), esteem, and self-actualization. Needs lower down in the hierarchy must be satisfied before individuals can attend to higher needs. Despite the ideas behind the hierarchy are Maslow's, the pyramid itself does not exist anywhere in Maslow's original work.

Maslow's theories were more focused on maximizing well-being and achieving one's full potential.

Web: www.optomechanix.org
Instagram: optomechanix
For digital subscription or suggestions email us at:
info@optomechanix.org
Chief Editor: Ali Afshari
Contributors: Kamal Kasiriha, Bob Shell
Web Designer: Mojtaba Moradli

Optomechanix is a quarterly journal of Opto-Mechanical Institute of Design (OMiD), with technical articles for practical, hands-on opto-mechanical engineers. This magazine is privately founded.

Cover page photo: Complex Optoform assembly with new design. See more views on pages 12, and 16.

Front back: An application of the dial indicator is the spherometer

In This Issue ...

In the last issue, we discussed a brief history of the optical erector set, and covered an entire user's manual for the Construments optical construction kit. Designing the building blocks for optomechanical instrumentation takes so much time and effort, and a lot of experience. Its instruction manual is also different from an ordinary product like a camera, or a microscope. Many possibilities of Optoform construction must be studied to compile an adequate user's manual.

I am confident that the philosophy of Optoform is well understood by now, and we will highlight its advantages in this issue so one could clearly understand our concept. It is so easy to say: "Oh, our optomechanical parts are built with precision, and high quality" by sales people, but most of them don't understand what they are talking about. I was fortunate to have a few years of watchmaking experience to know something about micromechanics.

Measurement devices are really fundamental in the study of optomechanics. In the May-June issue, we studied the micro-mechanics of Mitutoyo micrometers, and dial indicators, and in this issue, we will continue from where we left off. We will cover some of the unique designs of Mitutoyo, such as the test indicator, and the plunger-type dial indicators. In optomechanics, thermal expansion, and dimensional tolerances play a big role, and that's why studying the Mitutoyo design could help us be better designers.

Thermal Expansion, and Mechanical Tolerancing

A micron is only 10,000 atoms distance. A 100 mm long Aluminum rod, 25 mm in diameter measured at room temperature will expand up to 50 microns when heated up to 100 degrees C. Red blood cells measure 6-8 microns in size. holding an Aluminum rod in your hands could expand it more than 25 microns. A clearance gap to 2 - 5 microns is needed in engine parts for required oil film used in bearings. A 2–3-micron precision is usually needed in precision machinery, machine tools, tooling jigs, and opto-mechanical instrumentation. Utilizing gauge blocks to test Mitutoyo measurement devices

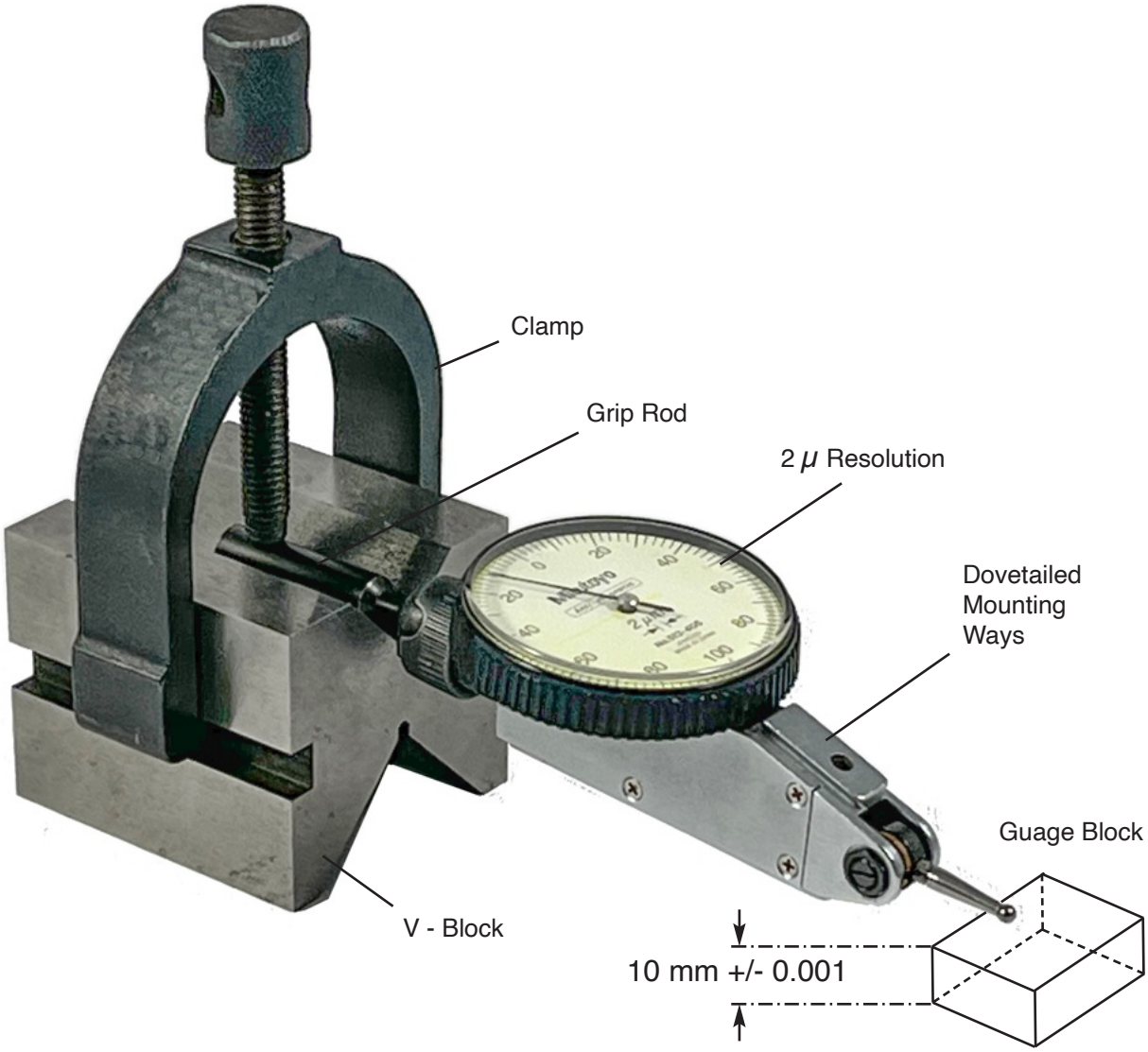
Mitutoyo dial indicator with 0.01 mm resolution (above), and 0.002 mm resolution (below).

could clearly help us evaluate, and understand the mechanical tolerancing of precision mechanics (below). We utilize many of Mitutoyo devices in Optoform as well, such as various dial indicators, and micrometers.

One of the main goals I have stood by in putting this magazine together is it should have useful content in hands-on, highly illustrated optical engineering. There are so many different aspects of micromechanics that will be discussed in this issue from dial indicator design to how a spherometer works in measuring the curvature of convex, and concave lenses, as well as camera design. This issue will cover the new Optoform's design in much greater detail, and basically, what's this new system is really about. That's why it took a lot more time to put this issue together.

During our patent process, we dealt with every patent examiner in our PCT designated countries saying: "Well, isn't this the same as prior art?", and we had to explain to every one of them how it's not. We did so much explaining that eventually this 14-page article: "23 reasons why Optoform is better" (P16~29) came about. To our surprise, the Chinese patent office clearly understood the novelty of our idea. As for sales, and marketing, Microbench system had a niche market back in the 70's, and 80's until Thorlabs copied them, and introduced it as their Cage system. Optoform 1 was also received by a small niche market since then, but compared to Thorlabs' marketing power house, we had a very small share. Optoform II mounts were invented to reduce the selling price to $10 a piece. It involves a huge effort in sales, and marketing for this low price to be considered. At the end of day, it is only by the decision of consumers that a good product is born.

Ali Afshari
Editor in Chief
Optomechanix

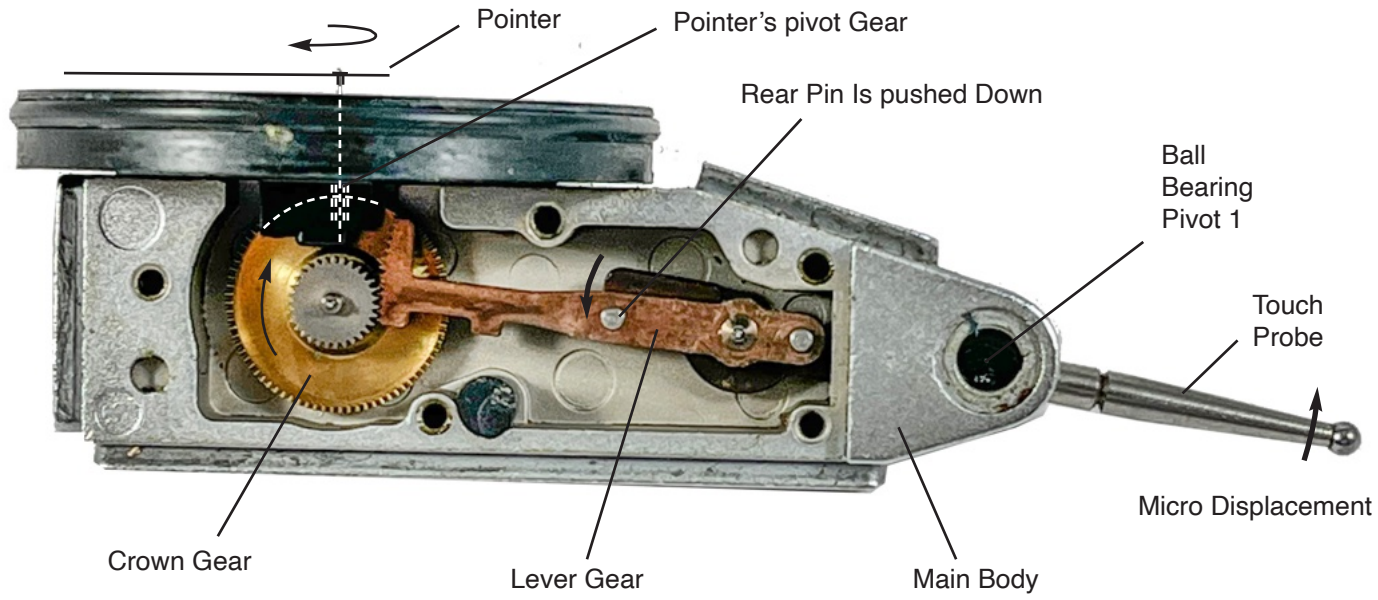


Test Indicators by Mitutoyo

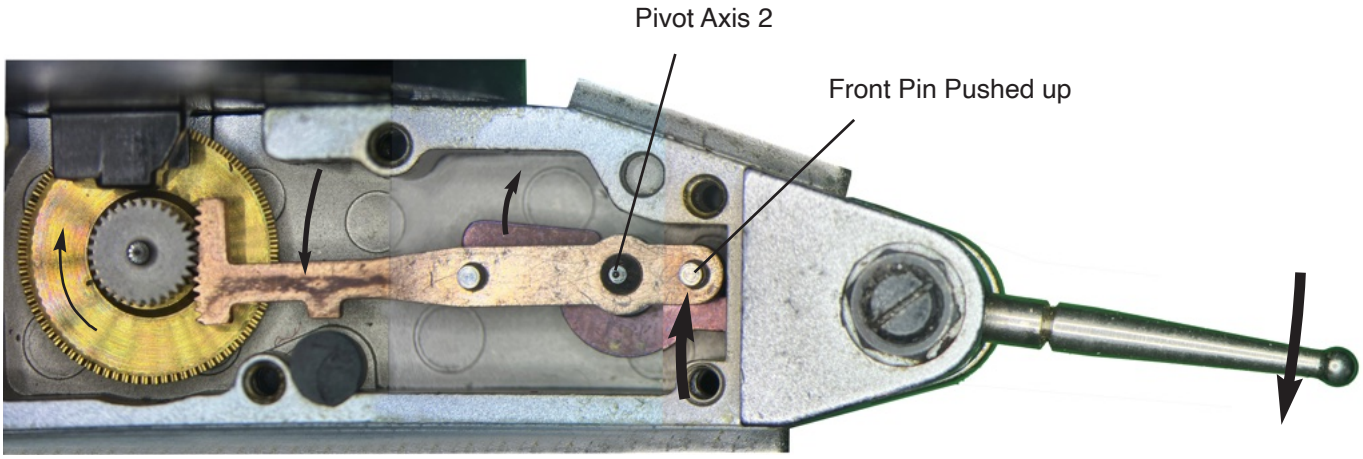
In dial indicators, there is obviously a mechanical transfer of probe's displacement through levers, and gears, causing a pointer to move around its circular measuring scale. Now that you are that sure you know how it works, let me ask you: The probe's tip is spring loaded on both directions; It rests at the center, and without any backlash, it could be pushed up or down to move its pointer. How could it so reliably work on both directions?

To show you how this works, let's take a closer look at the gears, and levers inside. To begin with, the probe drives the pointer through a lever gear by pushing it in two ways: There is a front pin, and a rear pin. When the probe is pushed up, it pushes down the rear pin (below), and when it's pushed down, it lifts up the front pin (Bottom).

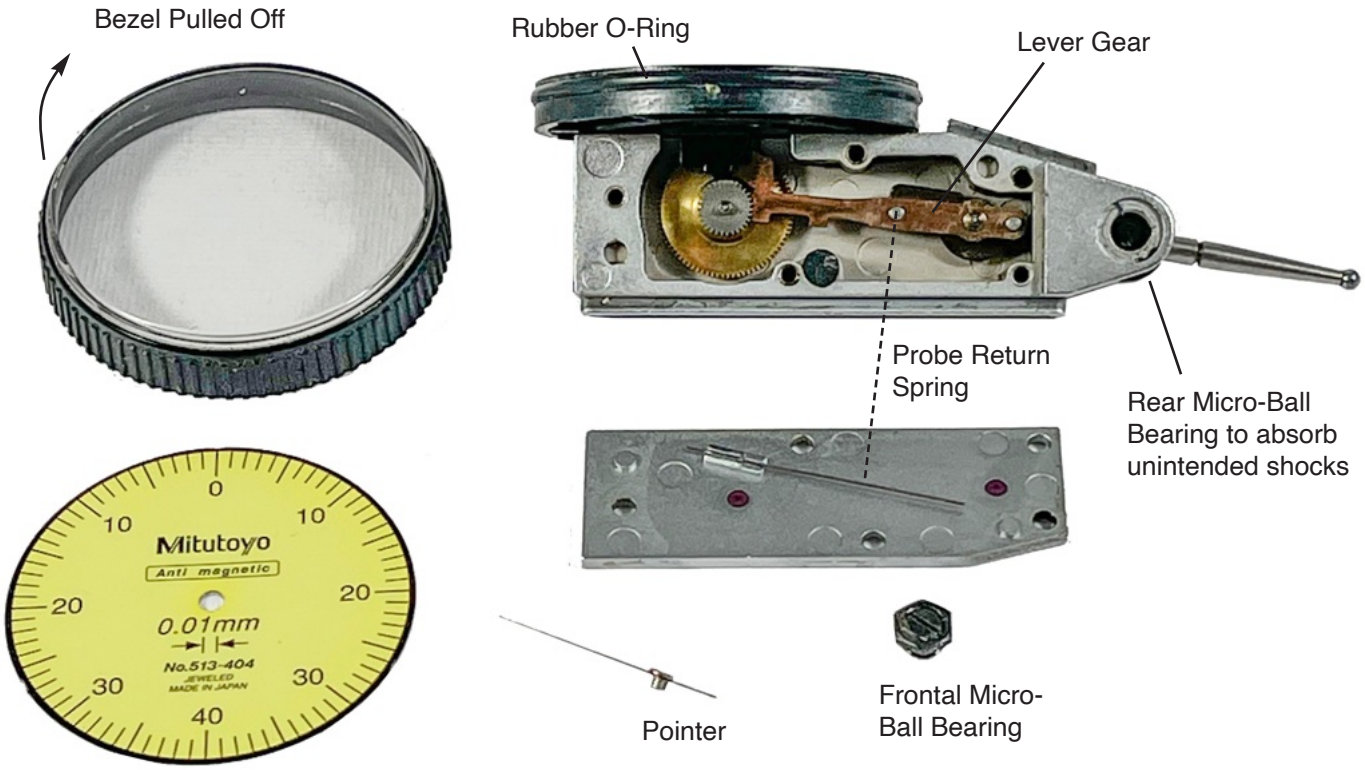
These test indicators are utilized in machine shops to measure concentricity, i.e., centering around machined part rotating on a lathe. The chuck is rotated by hand while the indicator probe leans against the part to show its deviation from chuck's center of rotation. The test indicator is also challenging to design because it has to be robust enough to take the unintended abuse of machine operators. Most of its pivots run on jewel bushings or ball bearings, and it is designed to withstand incidental shocks exerted on its test probe.



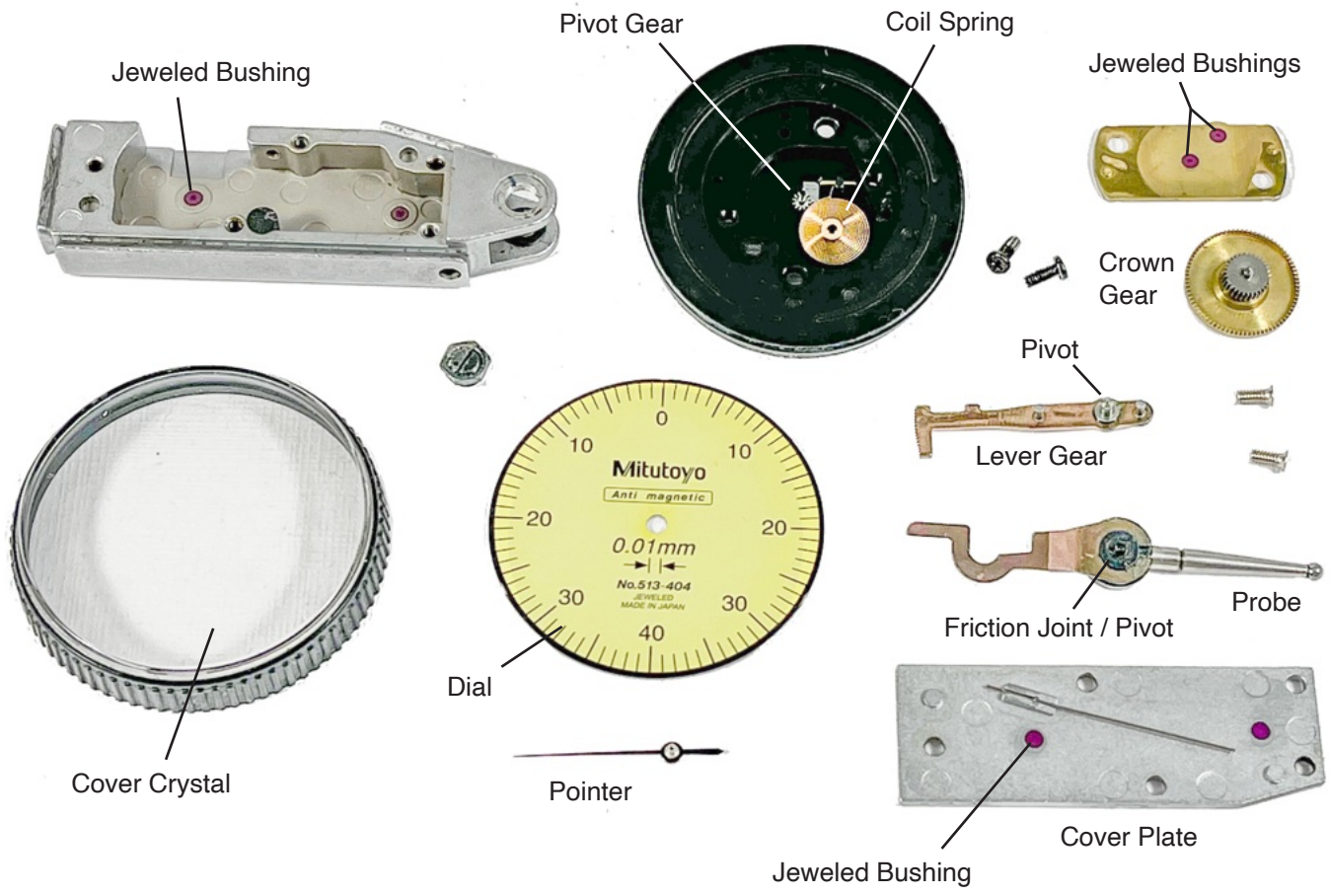
On the lever gear shown above, and below, there is a front pin, and a rear pin. When the touch probe is pushed up, it pushes down the rear pin (above), and when it's pushed down, it lifts up the front pin (Bottom) to move the pointer.

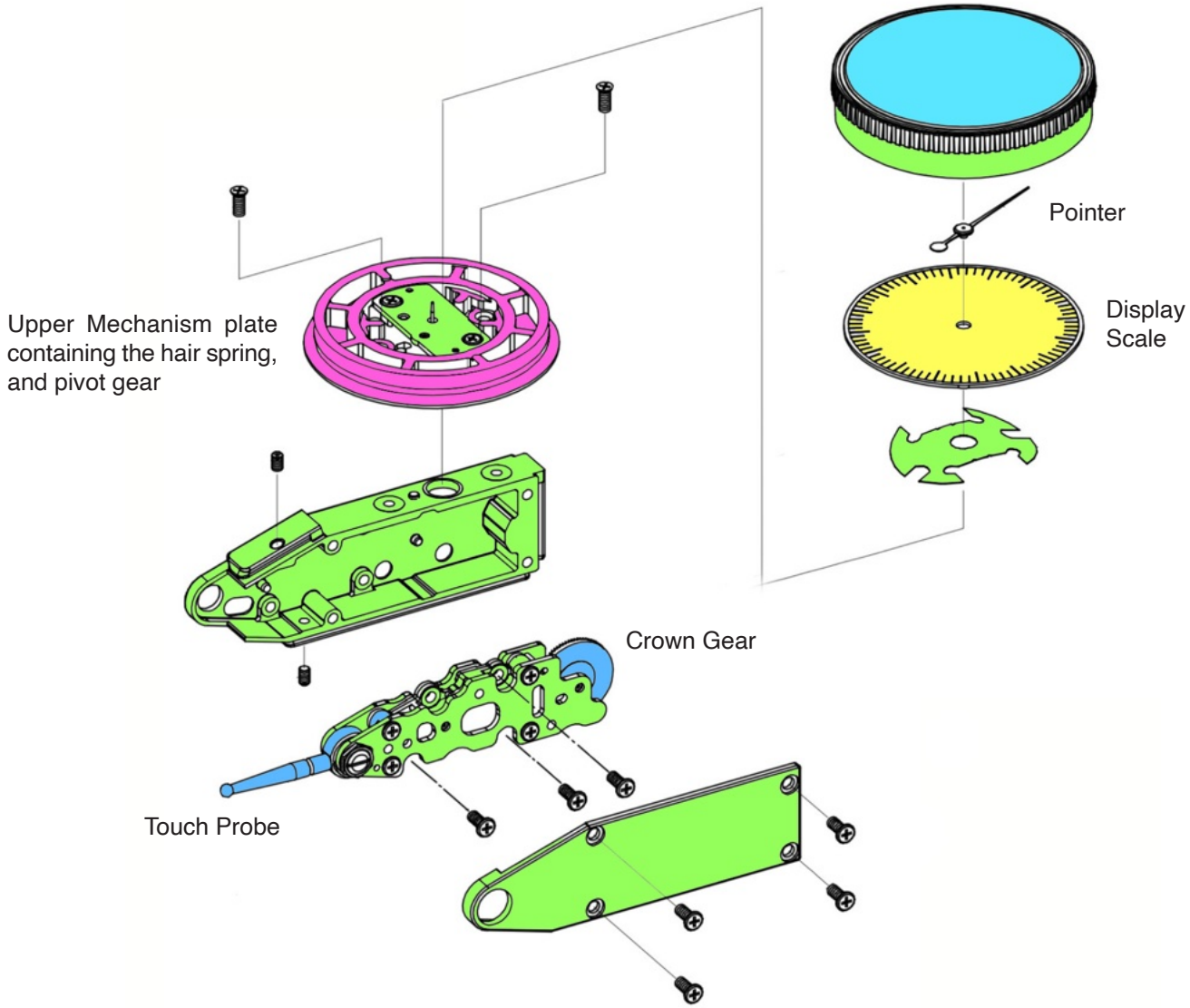


Close up view of the test indicator shows its mechanical amplification of its touch probe displacement to the pointer.

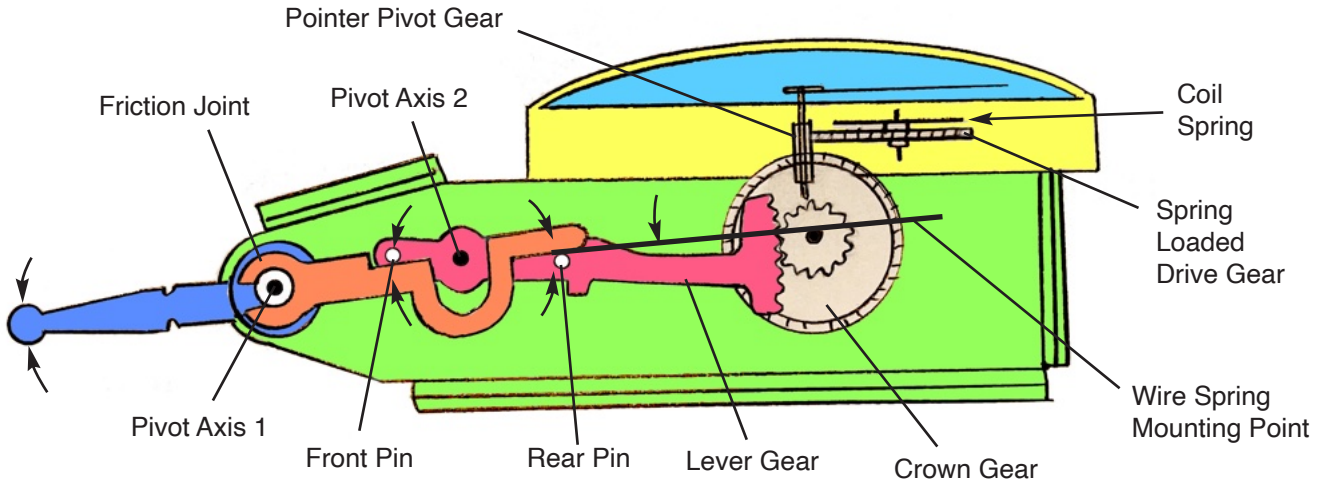


Disassembling the Mitutoyo test indicator reveals its intricate parts. This particular indicator was easy to take apart: Just pull off the bezel from a rubber O-ring that's holding it in place. To increase its accuracy, Mitutoyo uses jeweled bushings to insure long life - low friction operation. Several techniques are utilized to protect the indicator's gears from sudden shocks applied to the probe. All test indicators have two drive springs: A light coil spring that pushes back the pointer to zero, and a stronger spring to push the probe in the display direction. This technique is utilized to eliminate backlash.





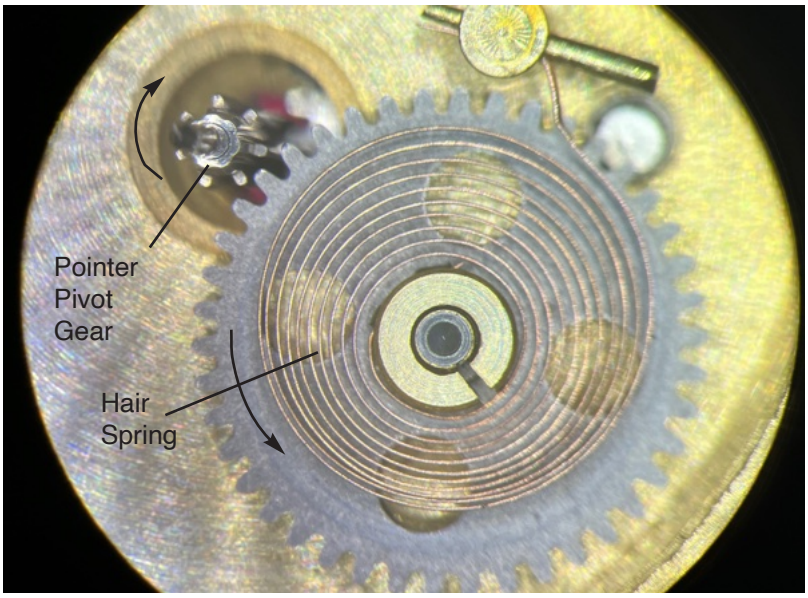
Above, an exploded view of Mitutoyo test indicator reveals its inner parts, and its disassembly. Below, as can be seen from the drawing, mechanical amplification is clearly visible. The resolution of this indicator is 0.01 mm, and no matter which direction the probe is pushed, the pointer moves in clockwise direction.



This cross section illustrates how the opposing spring forces center the touch probe to its mid resting point. Note the front pin, and rear pin are located on opposing sides of pivot axis 2. When the probe tip is pushed down, it lifts the front pin, and while it is lifted up, it pushes down the rear pin. The wire spring pushing down on the rear pin, rotates the lever gear (arrows) to bring it to its resting point. This is called smart engineering; A design that's both simple, and so useful.

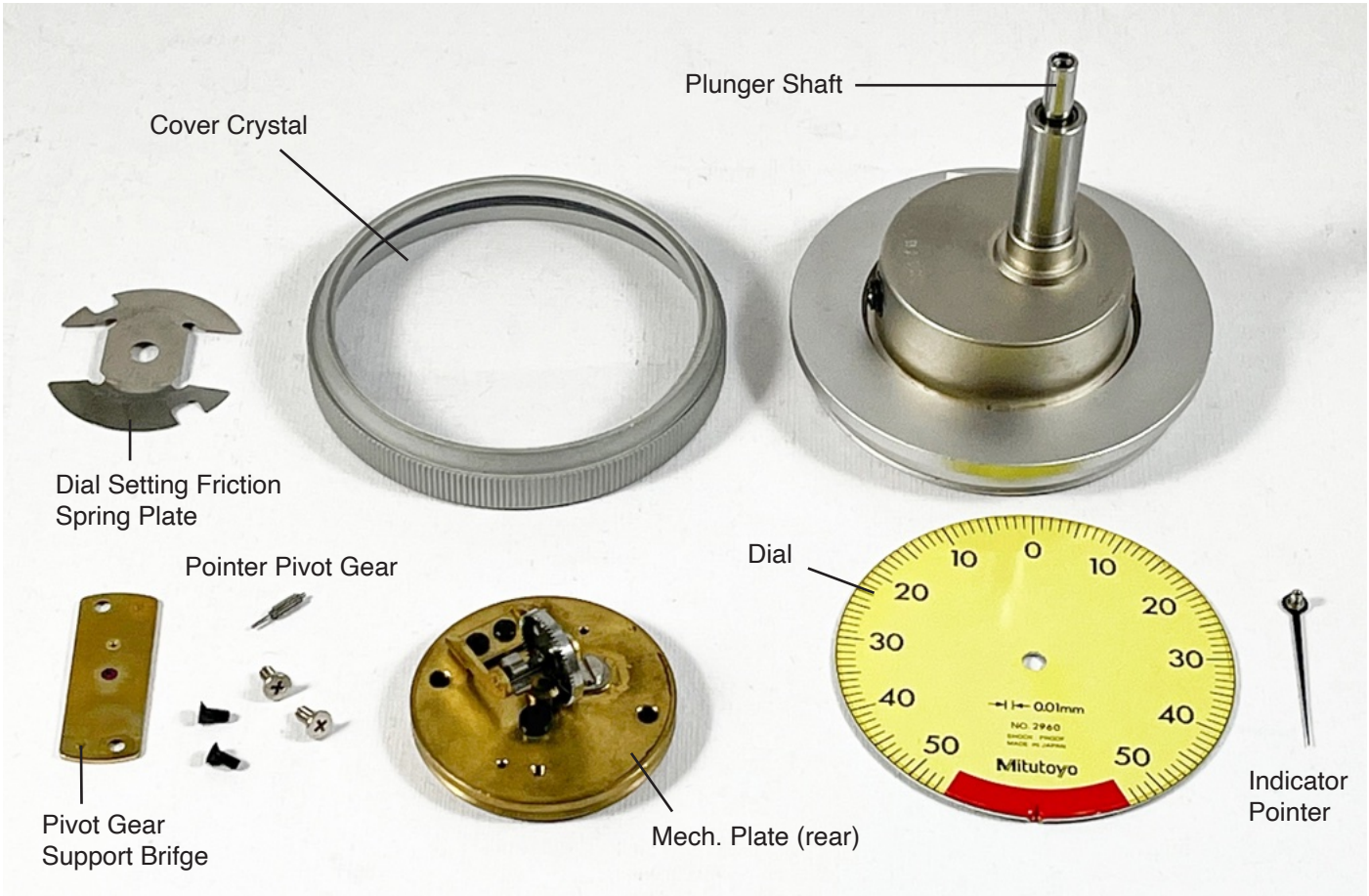
The Plunger Type Dial Indicators by Mitutoyo

Plunger type indicators are strange looking mechanisms. When the plunger probe is pushed in, it causes the pointer to rotate in a plane perpendicular to the plunger. One would think well how does it work? In this design, there is a sector cam that transfers the vertical movement of the plunger shaft to the pointer, and it's not a gear engagement but a very short transfer of motion driven by the end of plunger shaft.

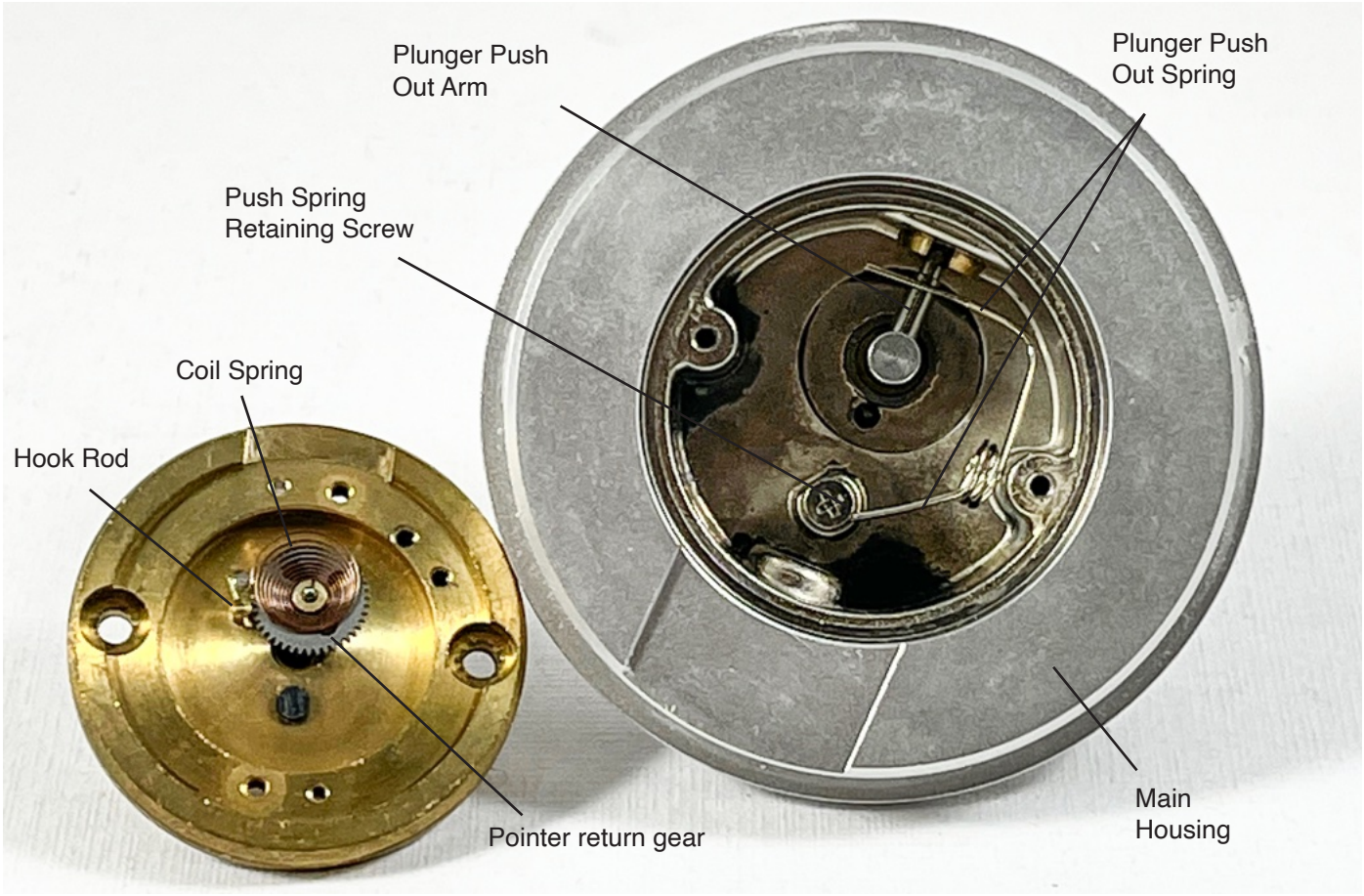


Close up of pivot gear being pushed in clockwise direction by a coil spring. This force is transferred to the crown gear.

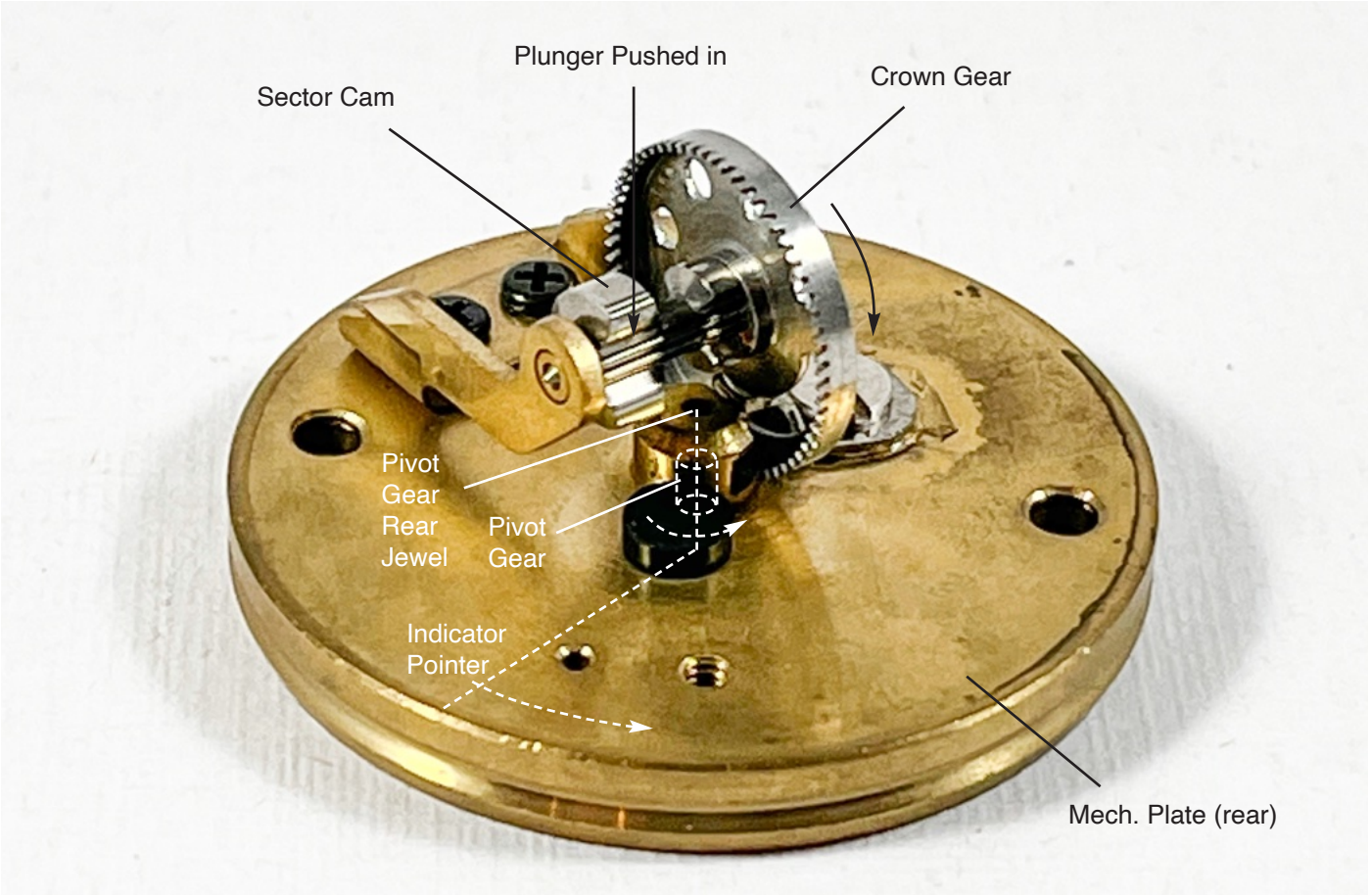
The side view of the design is shown on page 10 but before that, lets disassemble this very interesting design to see its inner workings. The pointer is connected to a pivot gear (right) that is driven by a crown gear (page 9). The pivot gear is lightly charged by a coil spring (right), and it is assembled with a positive force to bring the pointer to the red portion of the scale. The spring coil also causes the sector cam to want to lift the back of the plunger shaft. When the shaft is pushed in, the sector cam maintains its contact point with the shaft, causing the crown gear to rotate, and thus moves the pointer via the pivot gear. For a limited range (1 mm) the vertical translation of the shaft is transferred to the pointer in a linear fashion. Since the spring force behind the drive shaft is higher than the coil spring, the pointer would return when drive shaft moves back down.

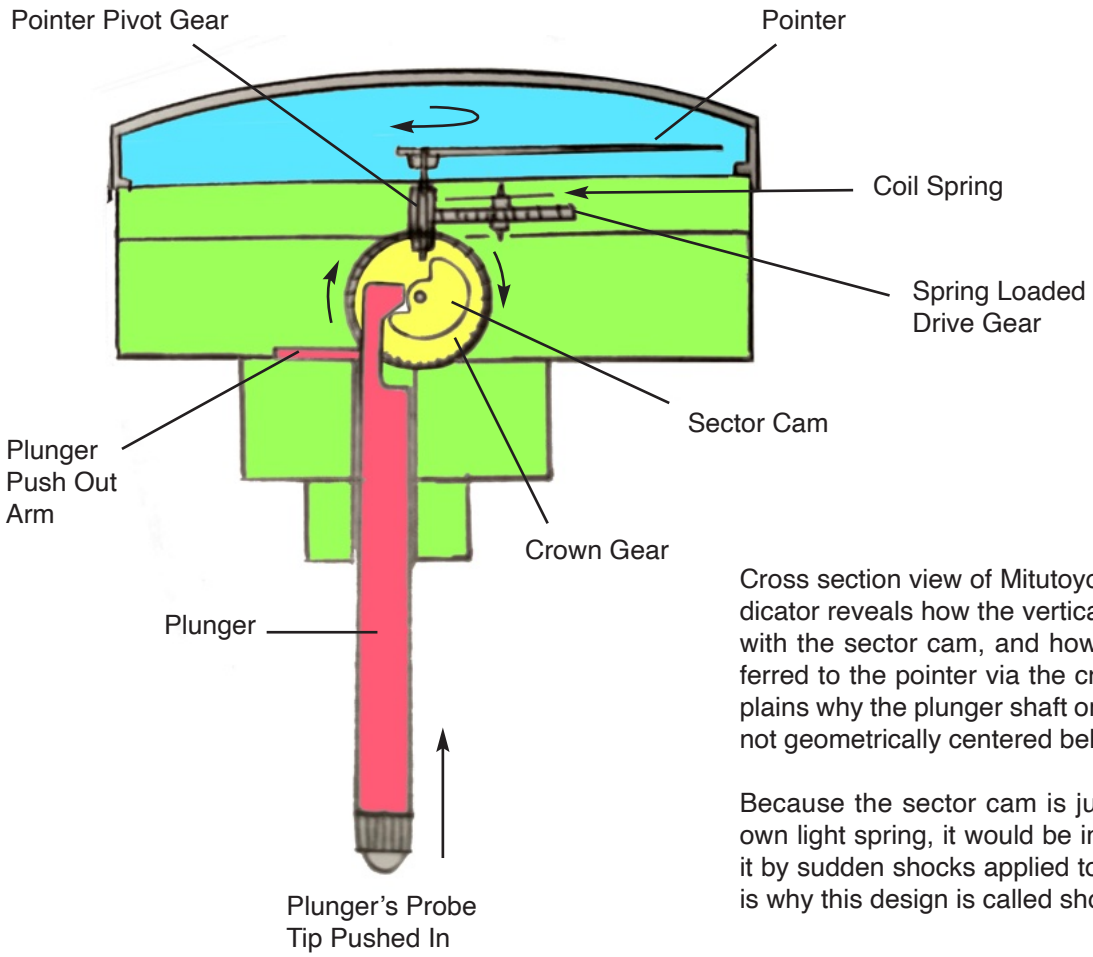


To disassemble the indicator, the bezel is gently lifted up with a lever, and the pointer is carefully extracted. The necessary tools are covered in the April - June issue of Optomex.



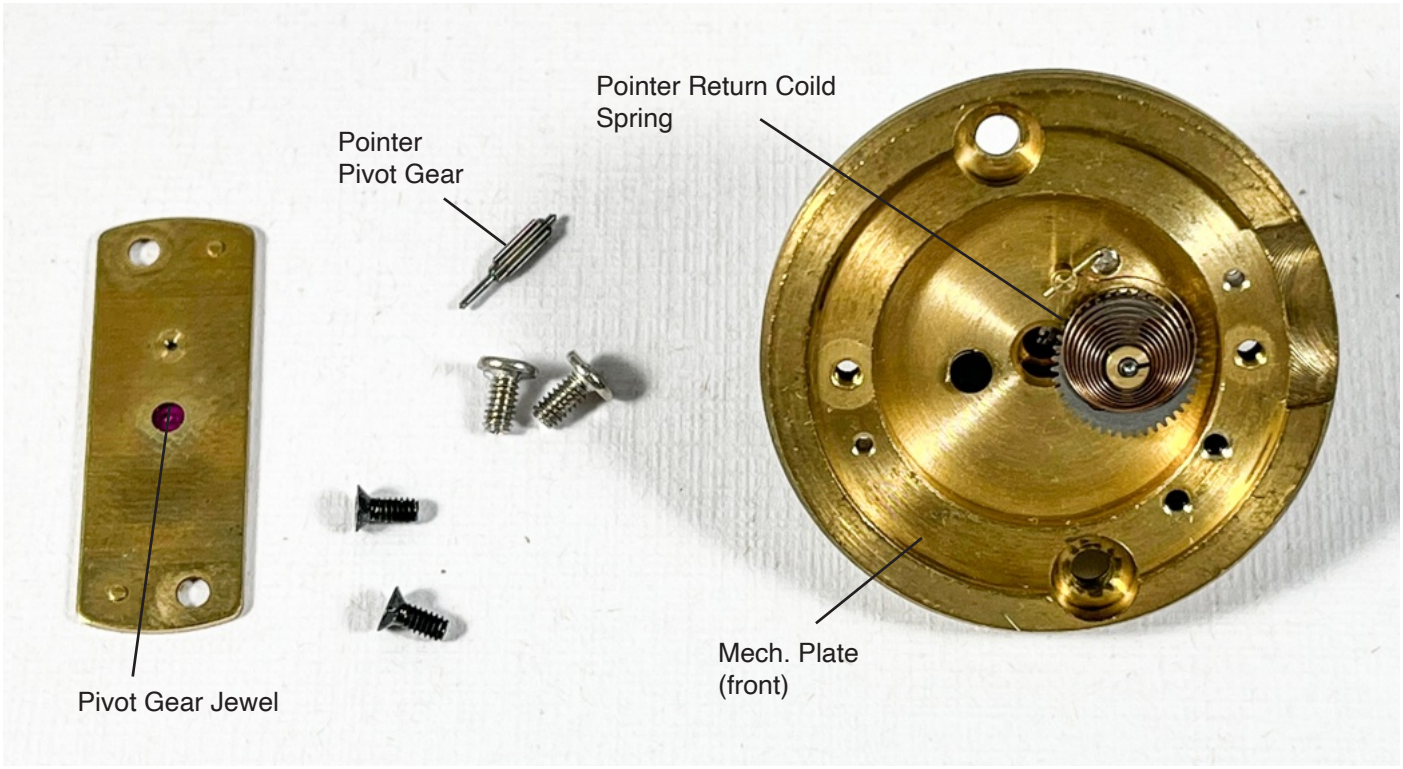
Above, the plunger is spring loaded by a wire spring. This is not something you could design on paper. It is done when building the device for the first time, and you'd realize there is plenty of space to utilize this type of spring. Below, top side of mechanism plate showing the sector cam and its engagement point with plunger shaft (see drawing on page 10).





Cross section view of Mitutoyo plunger type dial indicator reveals how the vertical plunger is engaged with the sector cam, and how its rotation is transferred to the pointer via the crown gear. It also explains why the plunger shaft on these indicators are not geometrically centered behind the indicator.

Because the sector cam is just a follower with its own light spring, it would be impossible to damage it by sudden shocks applied to the drive shaft. This is why this design is called shock proof.



Mitutoyo uses watchmaking jewels to reduce friction and therefore backlash in the mechanism plate assembly. This is necessary in this design to transfer the vertical motion of the probe to the indicator hand with high accuracy, and repeatability. Total measurement range in this particular indicator is 1 mm.

How the Spherometer works

By Kamal Kasiriha

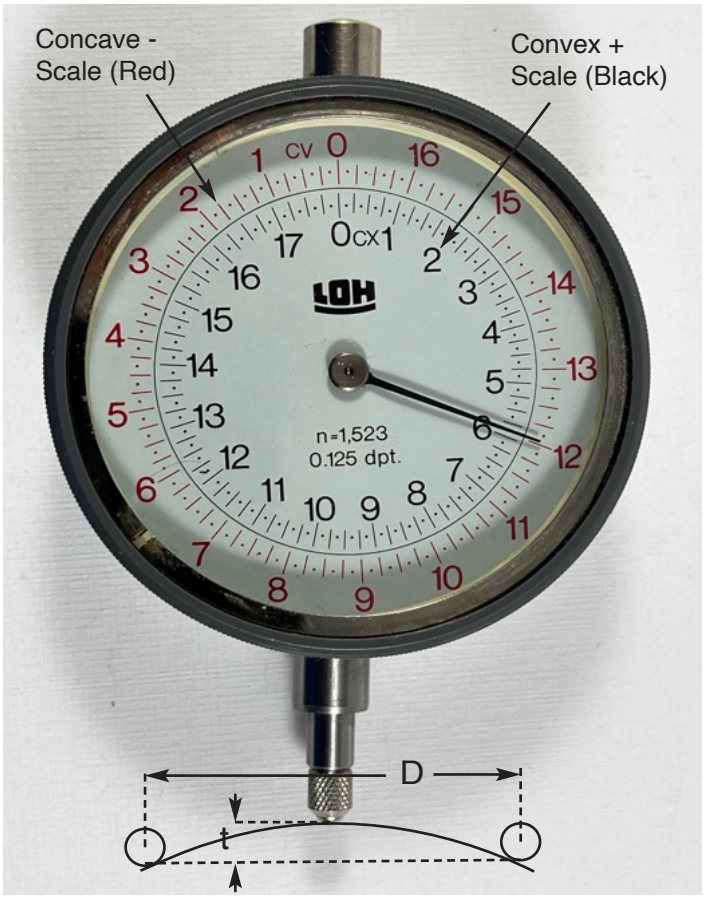
This article would be very interesting to those who want to see an application of dial indicators in optics. Many optical shops like ours use Satislow measuring tools like this spherometer. I'll be explaining how to measure the surface of an optical window we just made using the spherometer. The sperometer (below, right) consists of a dial indicator mounted between two anvils separated by a distance t. Calculation of radius R using the distance D, and dial indicator's reading t can be obtained by formula **$R = D^2/8t$**. To see how this formula is obtained, please refer to my geometrical drivation on the front back cover page.

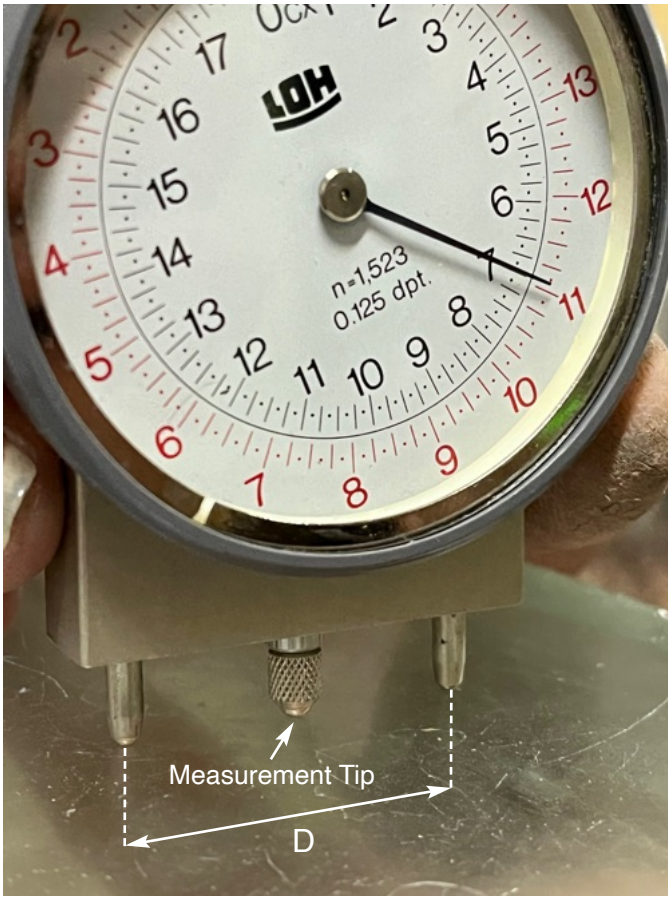
The diopter of the lens on the other hand is related to n, the refraction index of glass. Satislow indicator is graduated for n = 1.523. To calculate the power of the lens, we'll plug-in $R = D^2/8t$ in the equation:

$$P = (n-1)/R = (n-1)8t / D^2 = [\, 8(n-1)/D^2 \,] \times t$$

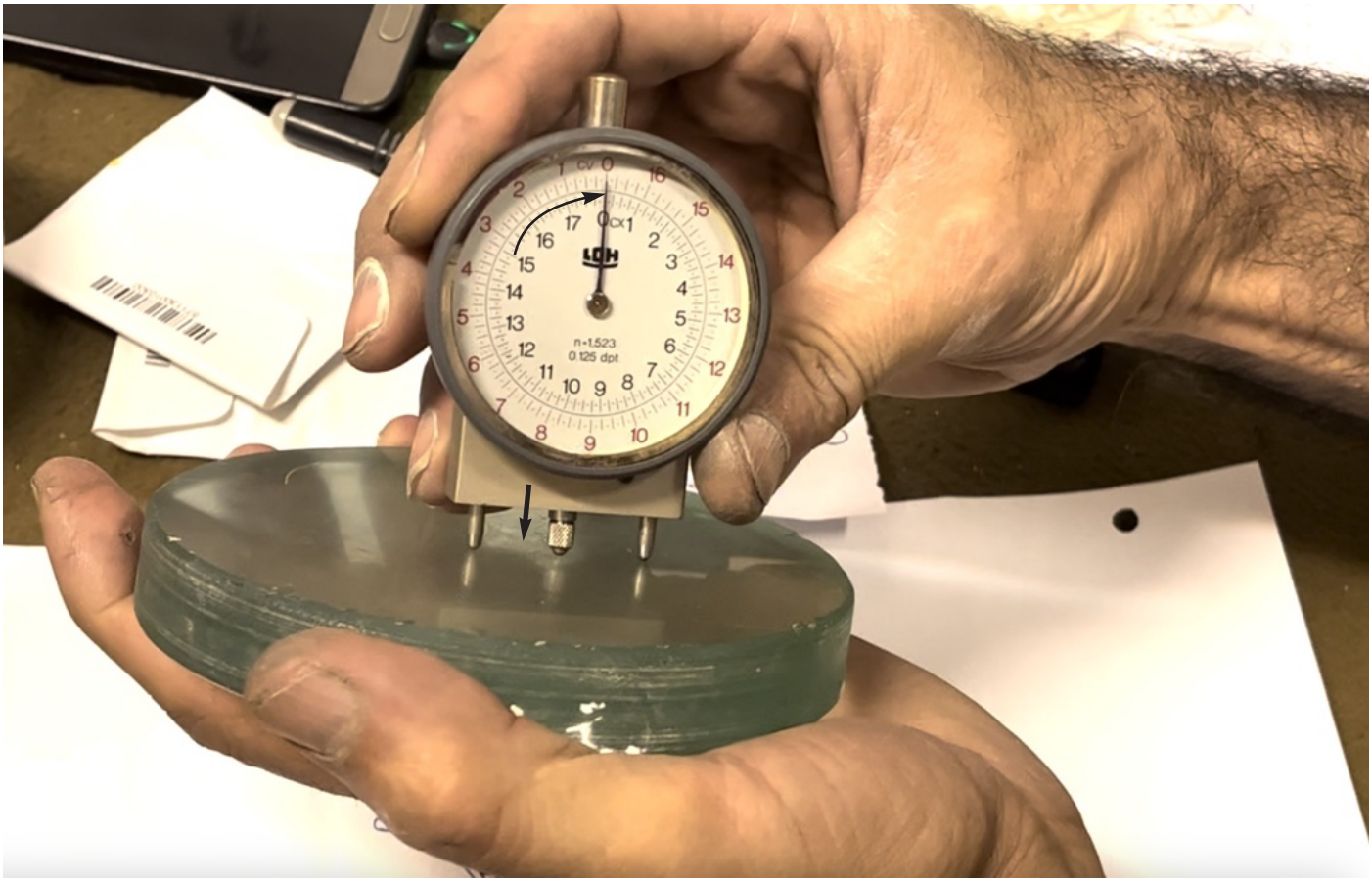
$P = \alpha\, t$

This is called the Spherometer Factor α (Alpa)

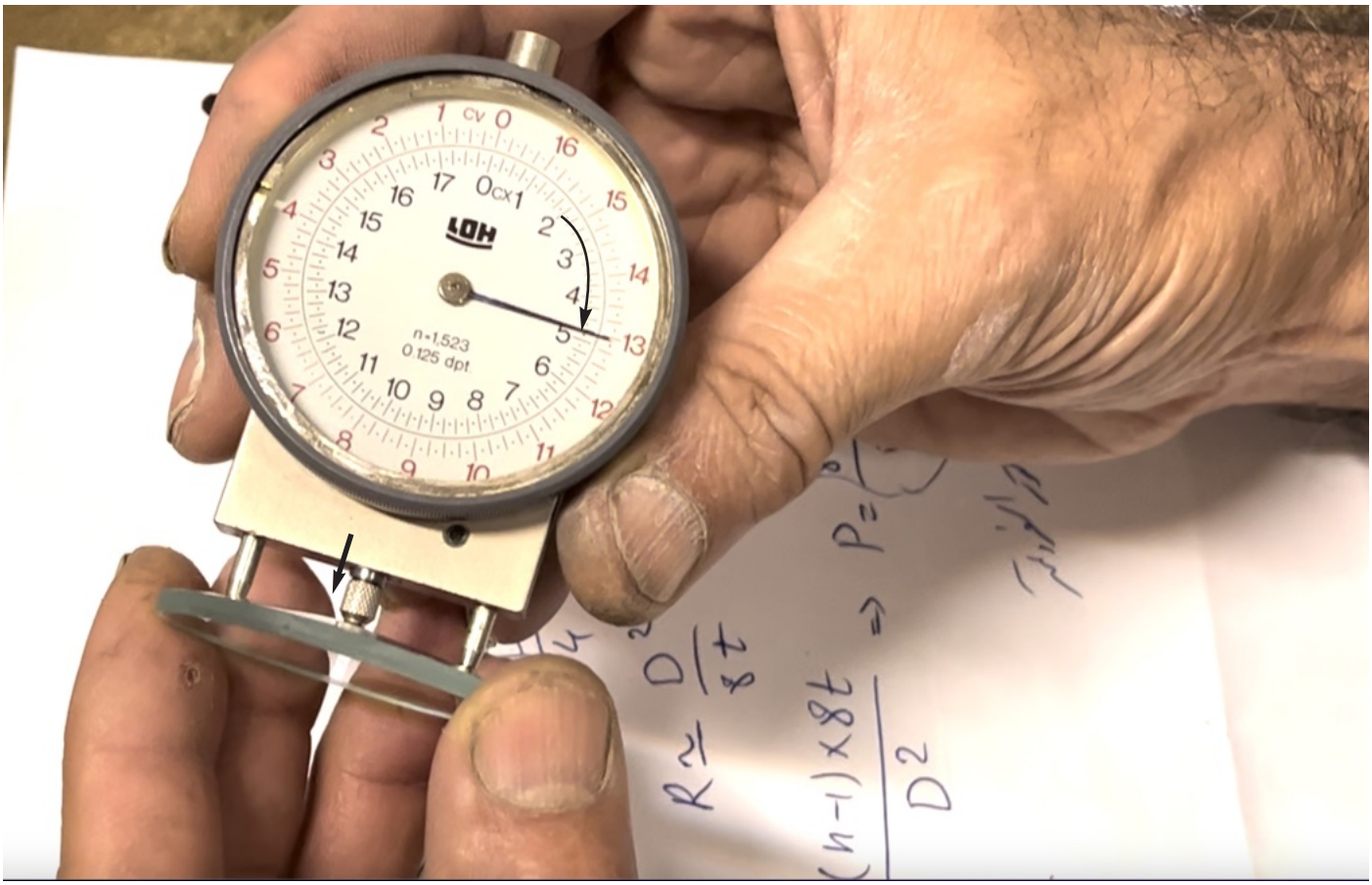




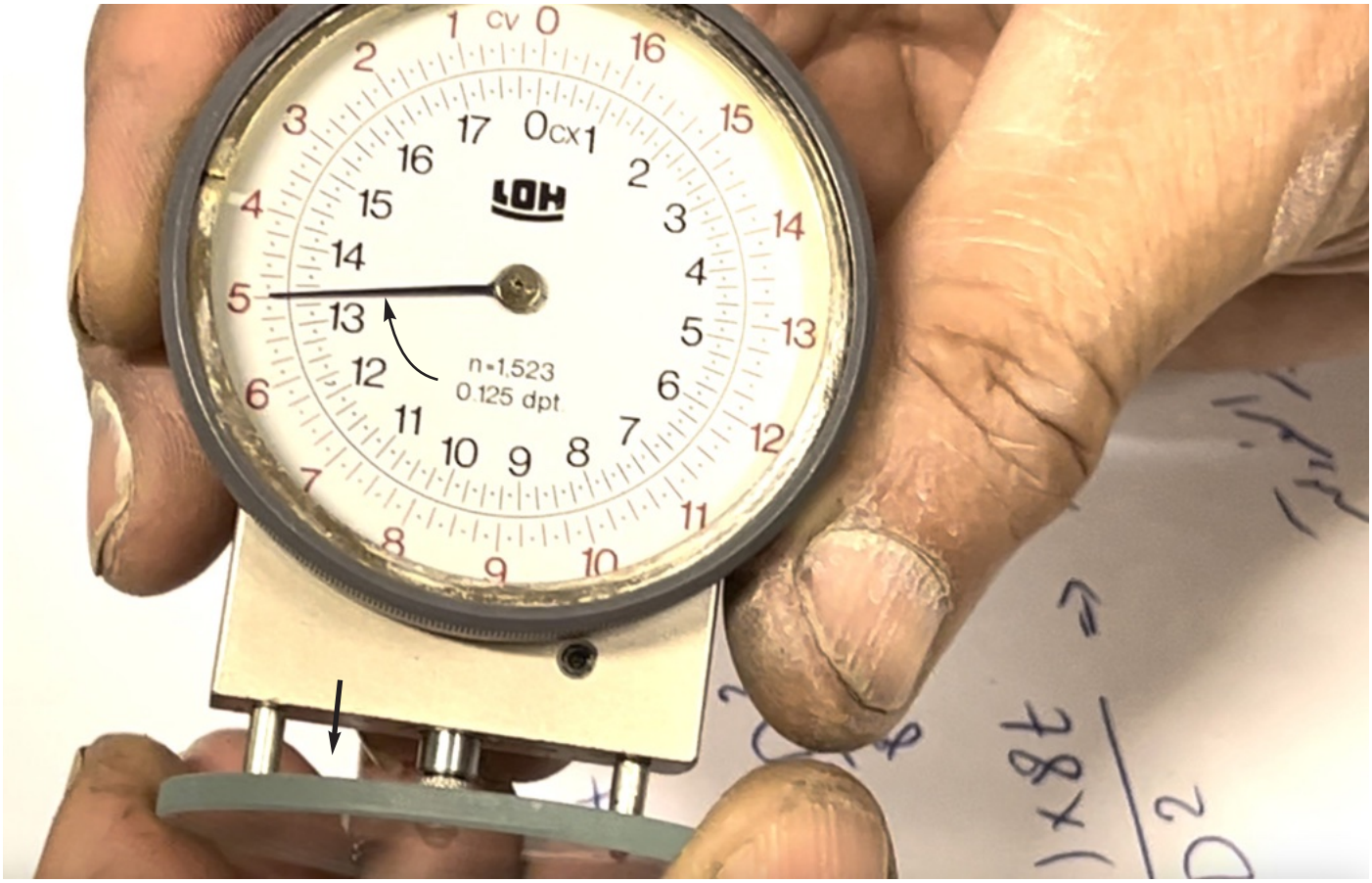
Satislow is the standard high quality spherometer in optical labs. They offer a wide range of lens grinding, and polishing tools, as well as measuremnet tools for quality control, and inspection.



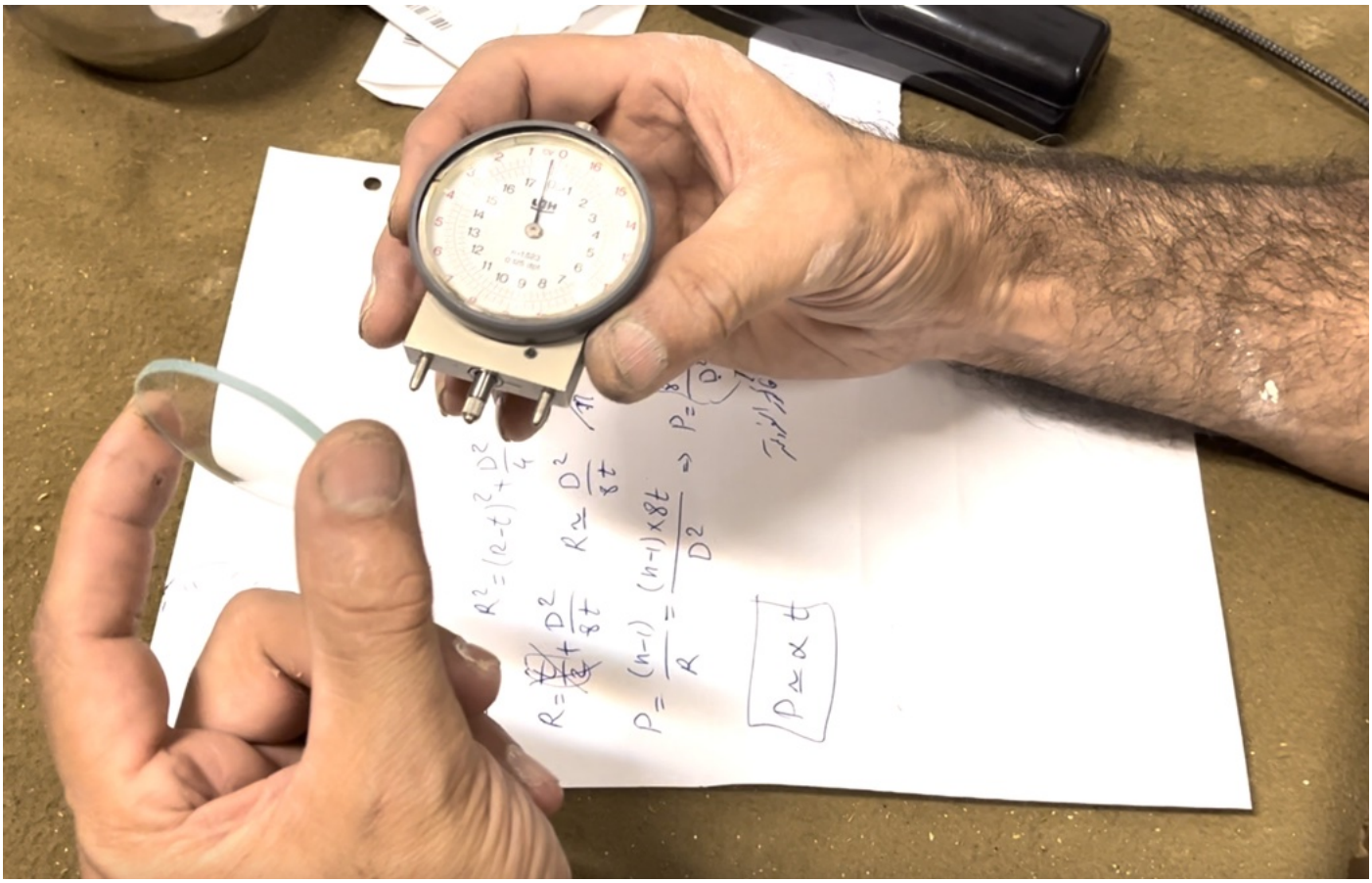
First the zero position of the indicator is checked against a flat.



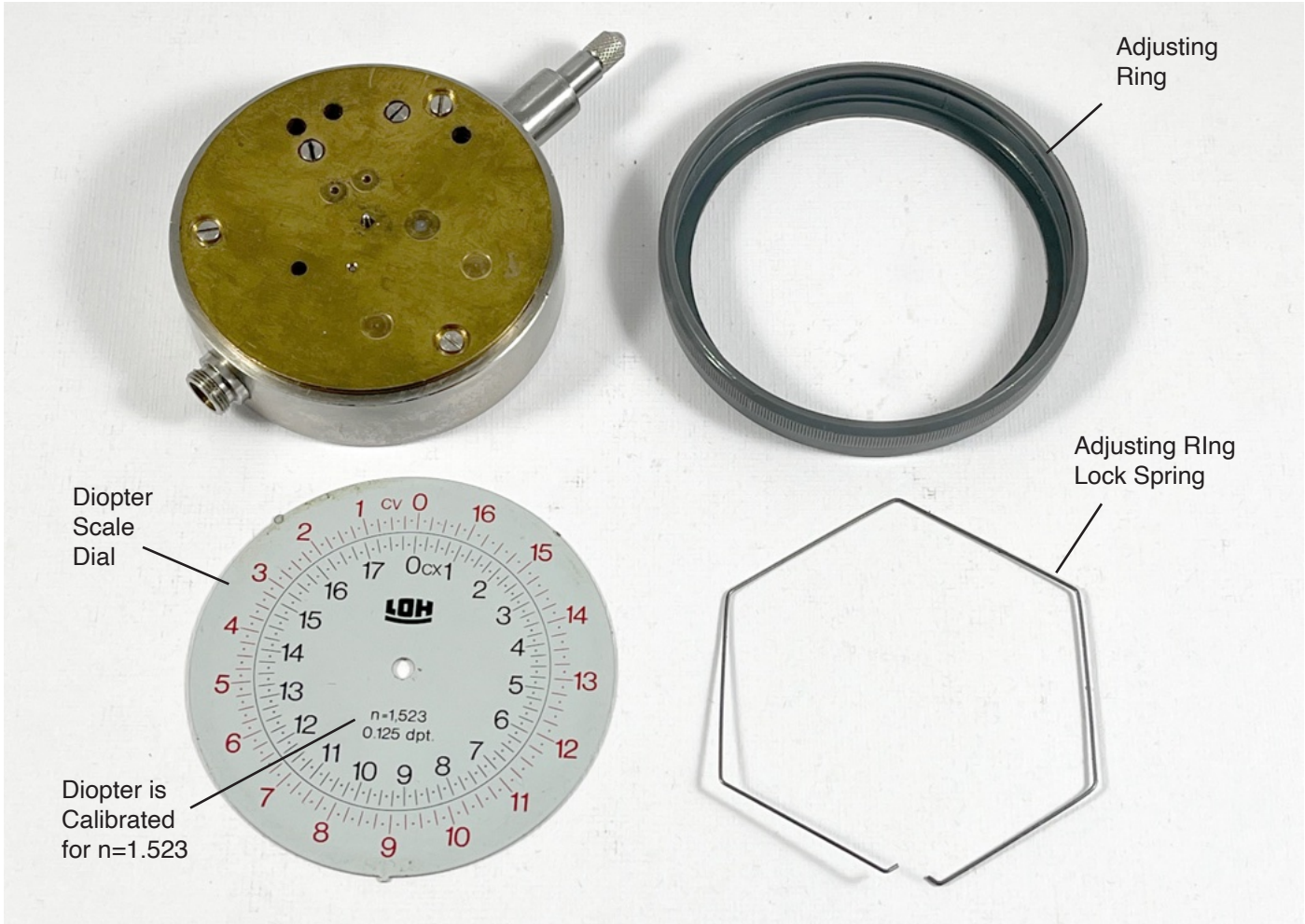
The power of the Convex side is measured to be 4.75 diopter

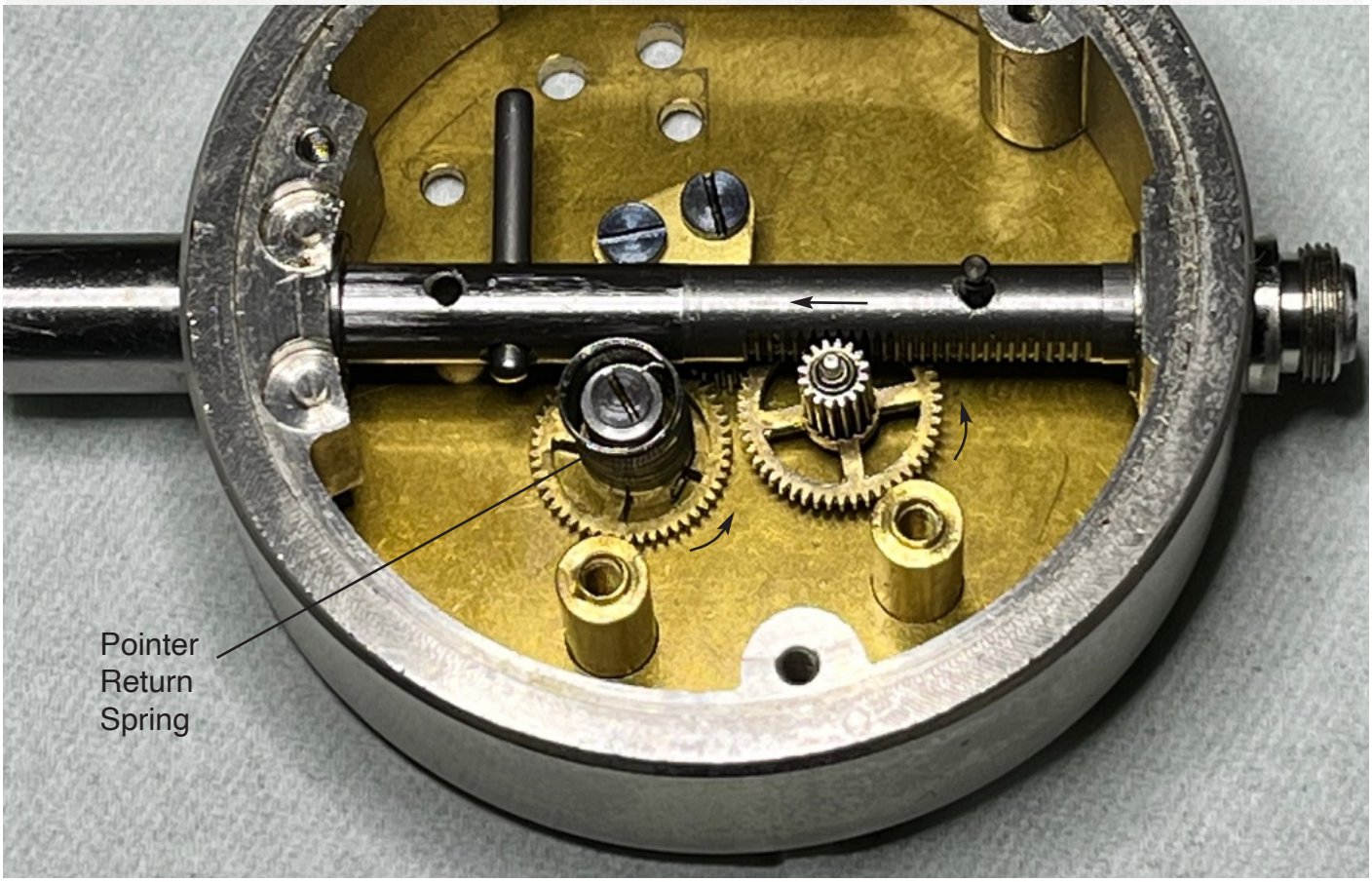


The power of the Concave side is measured to be 5.0 diopter

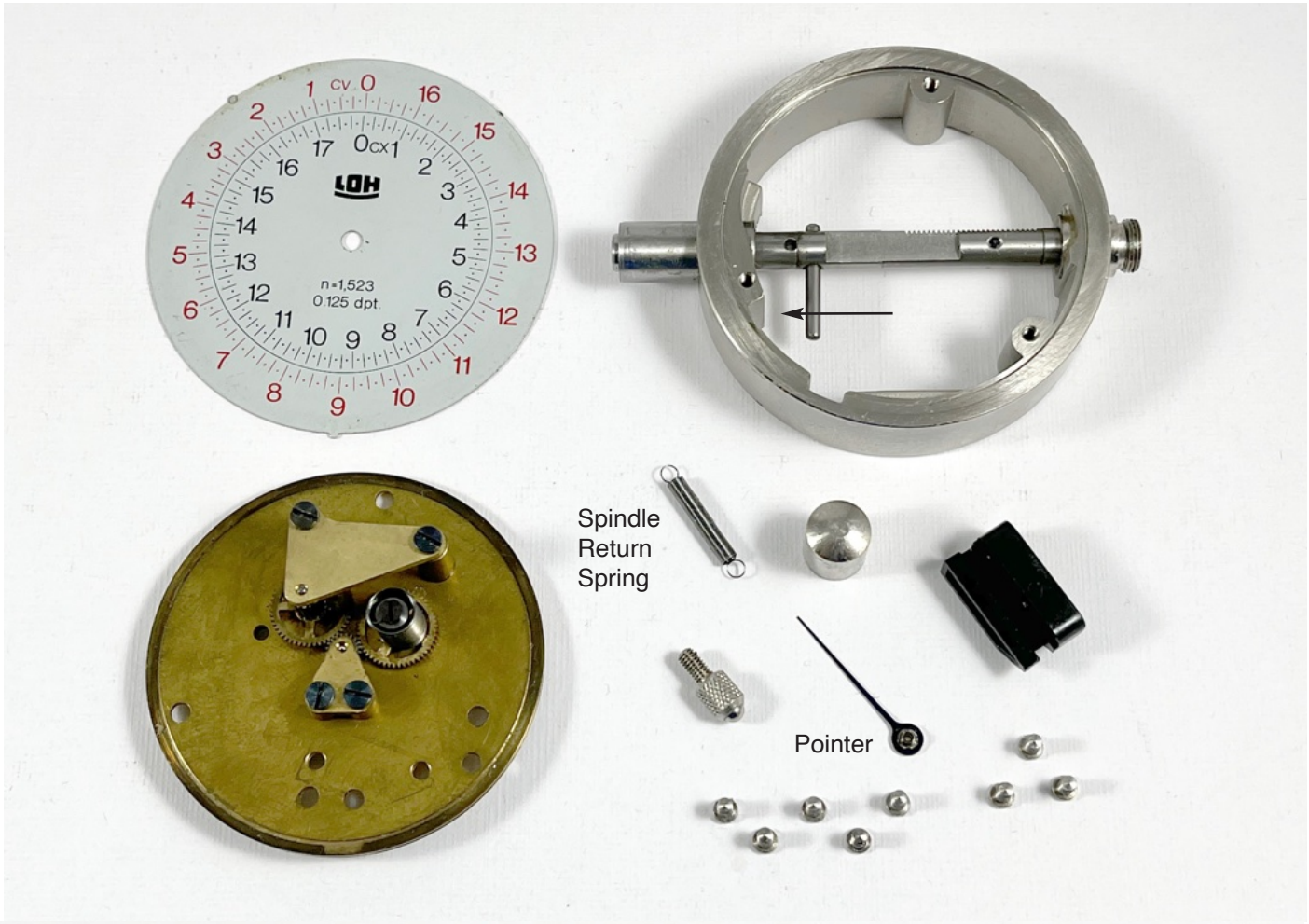


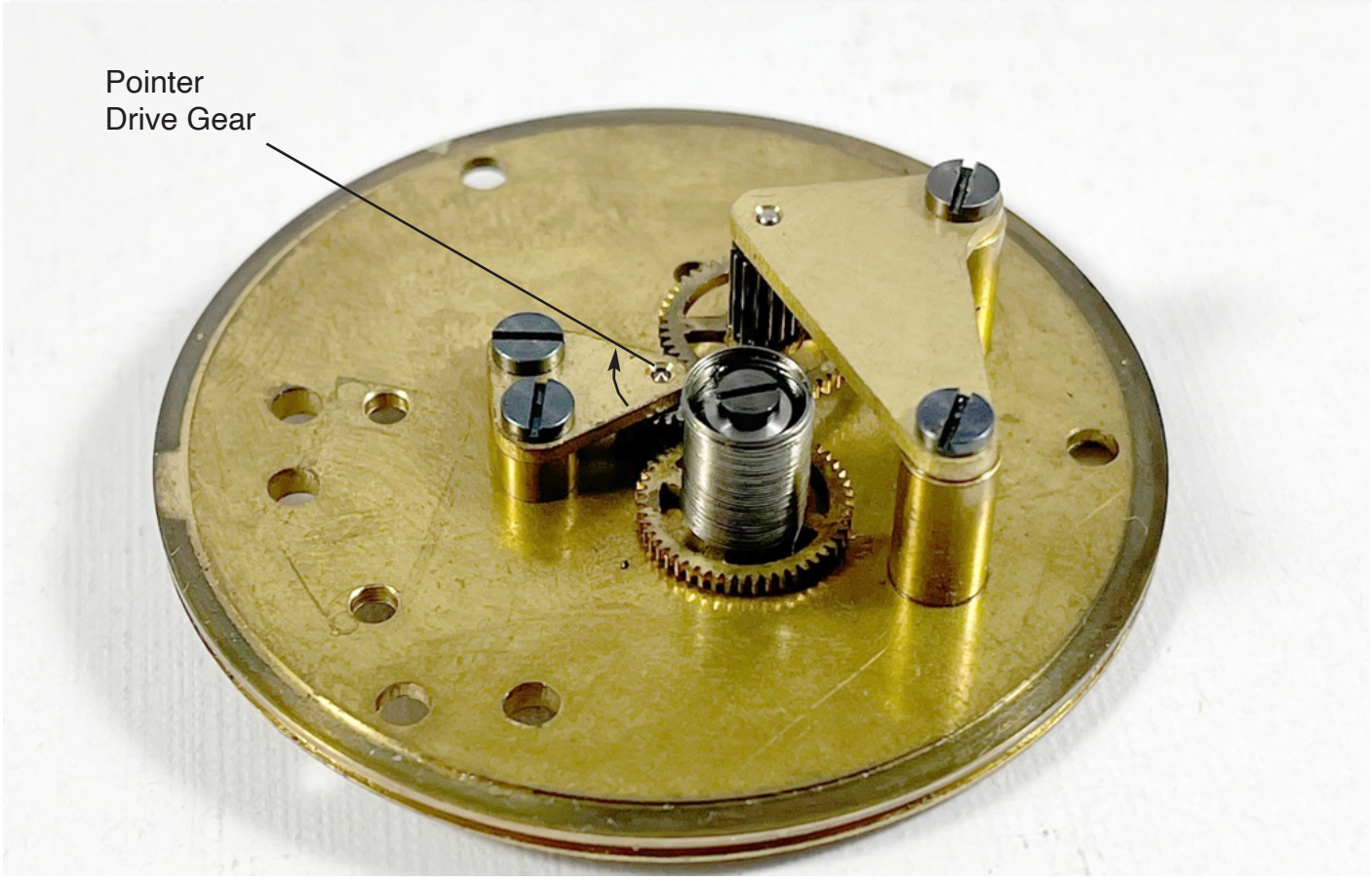
This slight power dfference is intended to compensate for the 3 mm thickness of this glass to make it neutral.





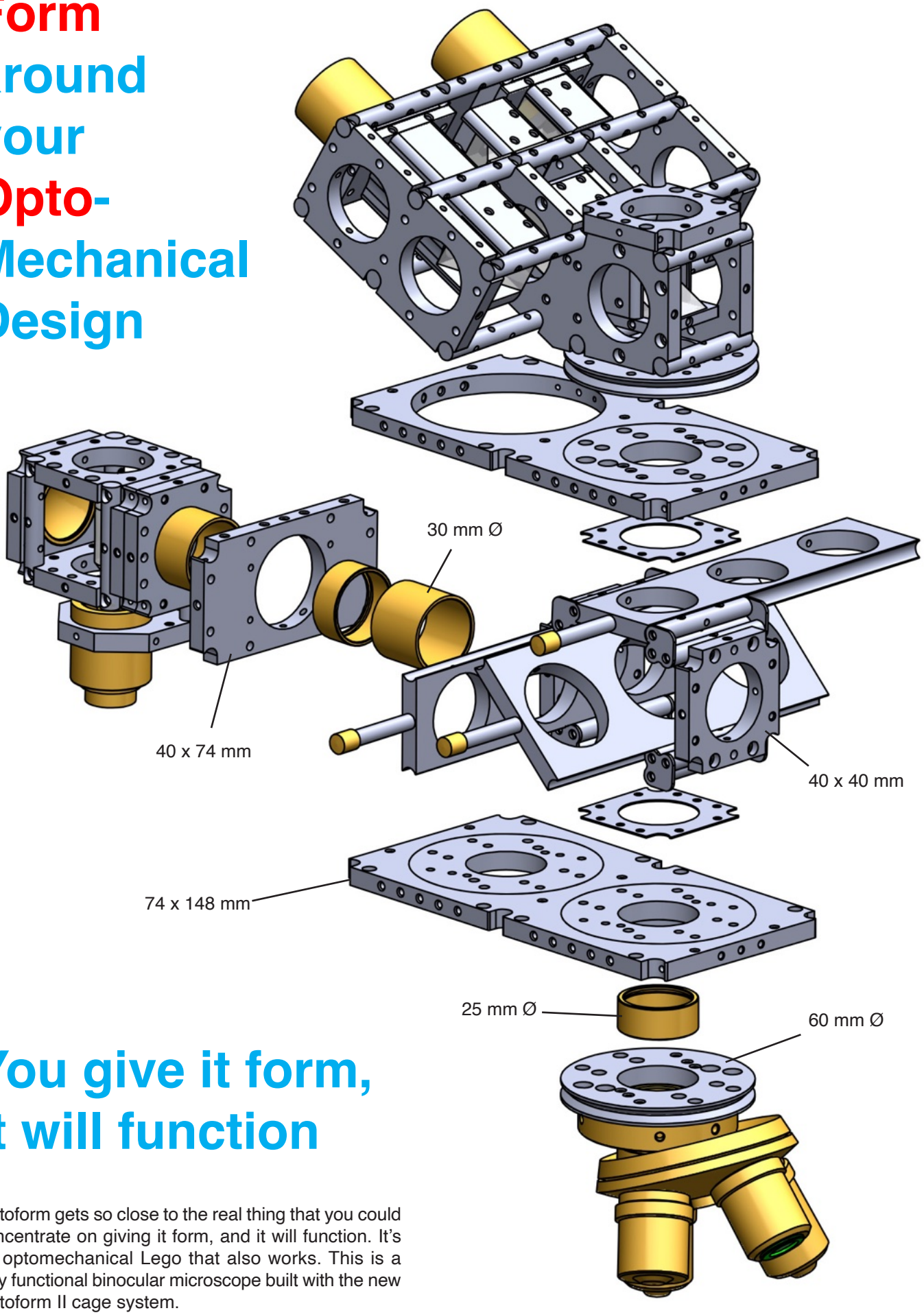
Disassembling this German made indicator reveals a similar design to the Mitutoyo indicagtors we discussed earlier. This fine mechanism could be exposed to ground glass particles in the optical shop, so a routine cleaning of its spindle would be good practice.





To reduce backlash, as in other dial indicators, there is a spindle return spring, and a pointer return spring. The pointer return spring is weaker, and it works against the spindle return spring. The gears, therefore, are always leaning towards on side of their teeth, thus, eliminating backlash.

Form around your Opto-Mechanical Design



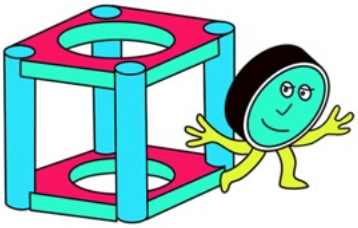
You give it form, it will function

Optoform gets so close to the real thing that you could concentrate on giving it form, and it will function. It's an optomechanical Lego that also works. This is a fully functional binocular microscope built with the new Optoform II cage system.

How Good is the New Optoform II Design?

Following up on “The brief history of optical erector set” article in the last issue of Optomex, here are 23 reasons why Optoform II is better.

Prior art

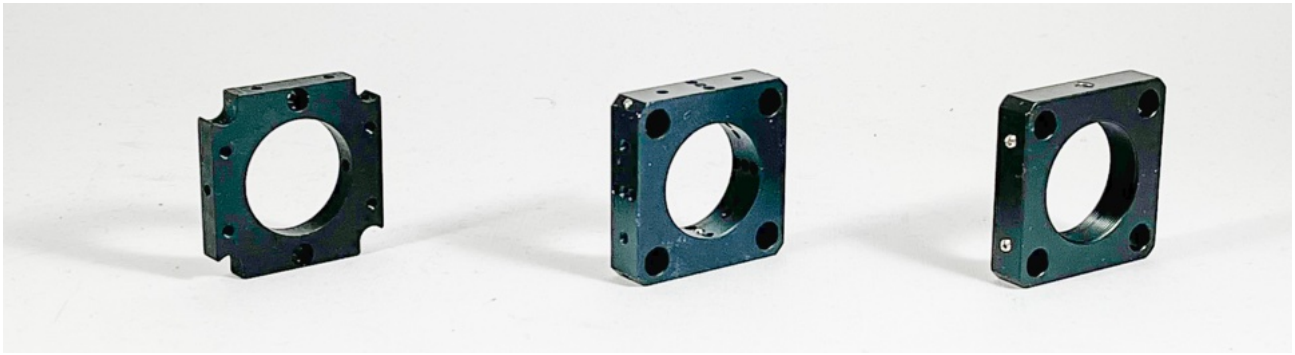


New Optoform II

1) Use Larger Optics

New Optoform 40 mounts are the same square size as Microbench, and Thorlab’s cage system (40x40 mm) but they accept up to 42 mm mounted optics inside its 4 rods.

	Optoform 40	Microbench	Thorlabs
Rods Clearance:	**42 mm Ø**	**36 mm Ø**	**36 mm Ø**



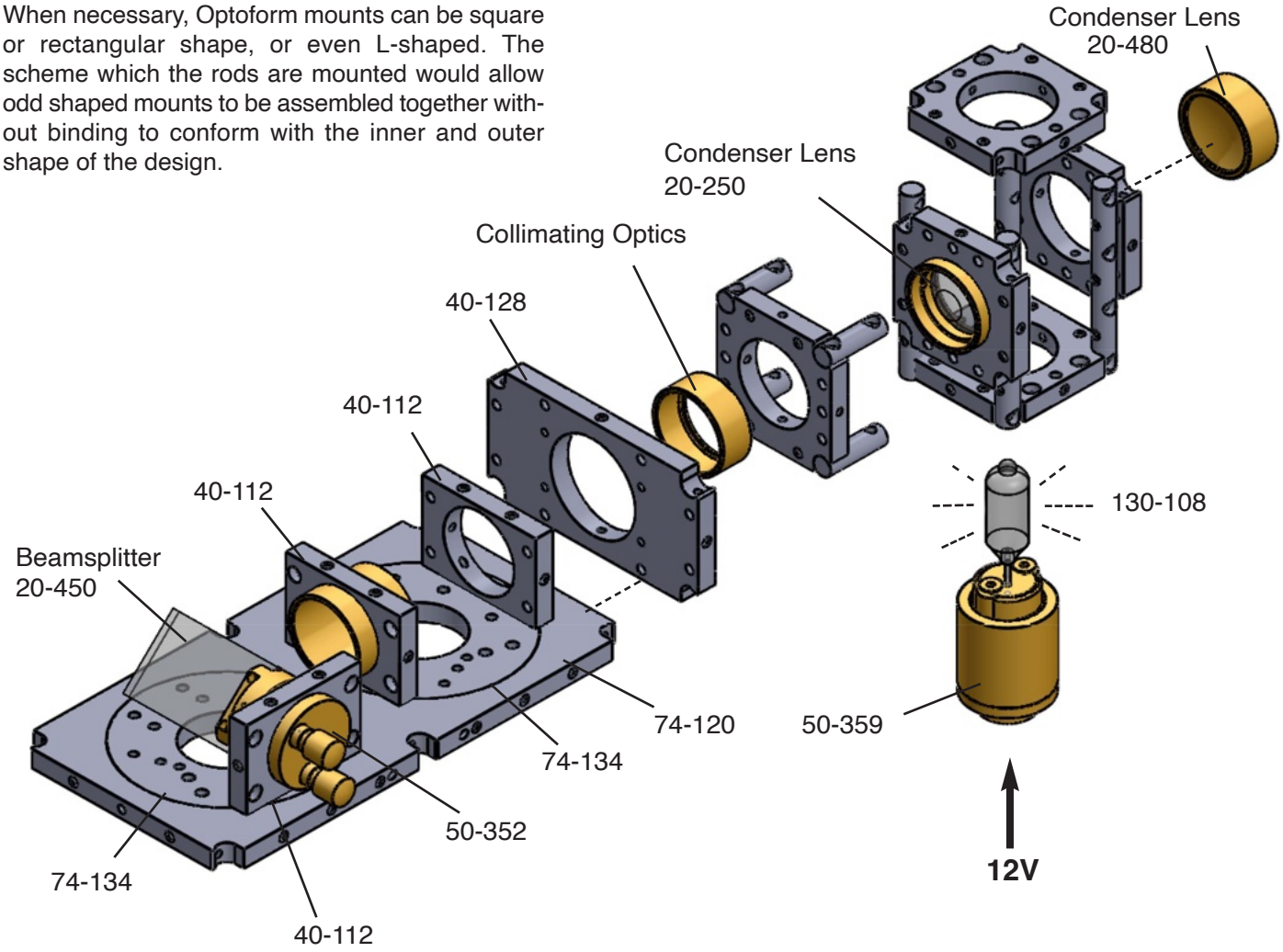
2) Lower Cost

Extruded Mounting plates instead of CNC machined mounts drastically reduce cost. Optoform mounts are produced by extruded Aluminum (right), an enormous cost saving in manufacturing. More affordable mounts mean less need to disassemble setups to reuse its parts. So your lab could have numerous custom-made instruments, such as autocollimators, interferometers, spectroscopes, alignment telescopes, and microscopes.

Optoform 74, Rods Clearance: 90 mm Ø

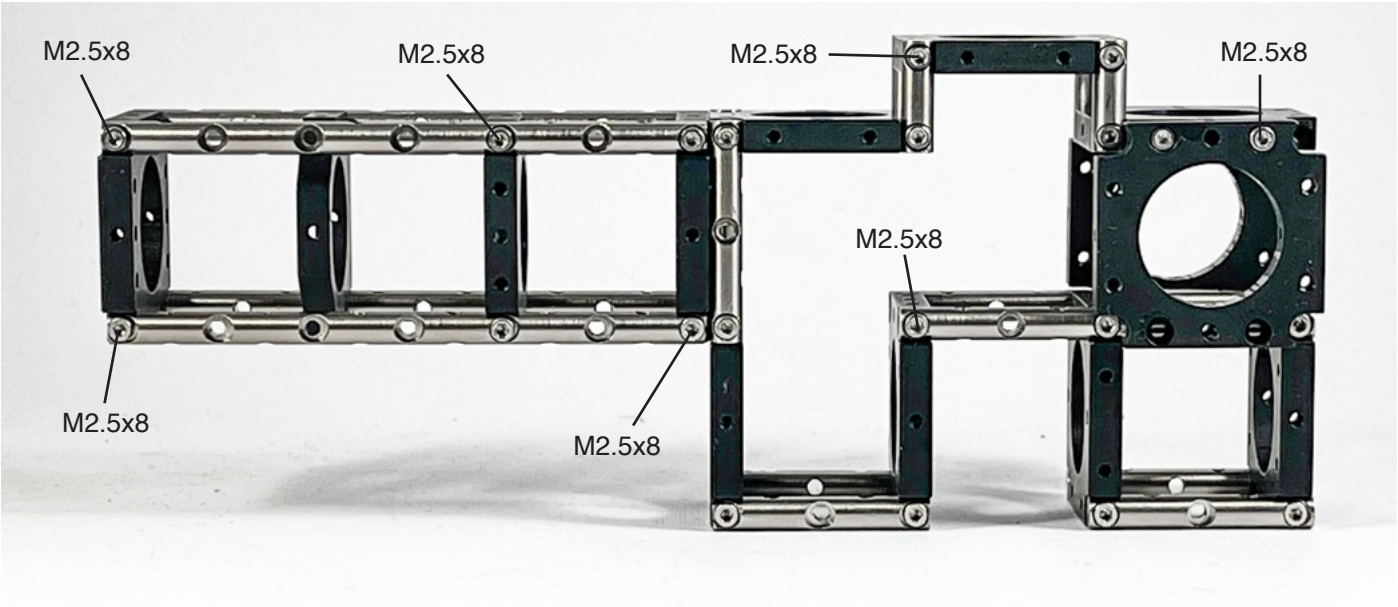
2) Odd Shaped Mounts

When necessary, Optoform mounts can be square or rectangular shape, or even L-shaped. The scheme which the rods are mounted would allow odd shaped mounts to be assembled together without binding to conform with the inner and outer shape of the design.



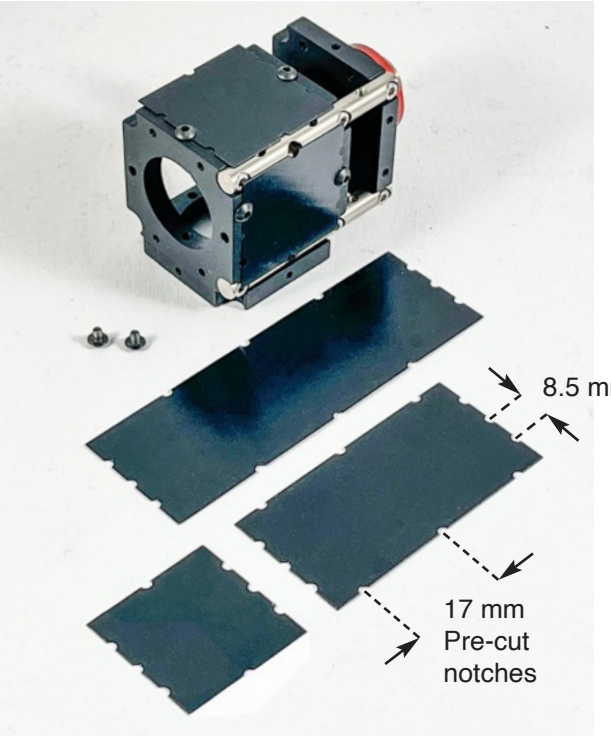
4) More Rigidity

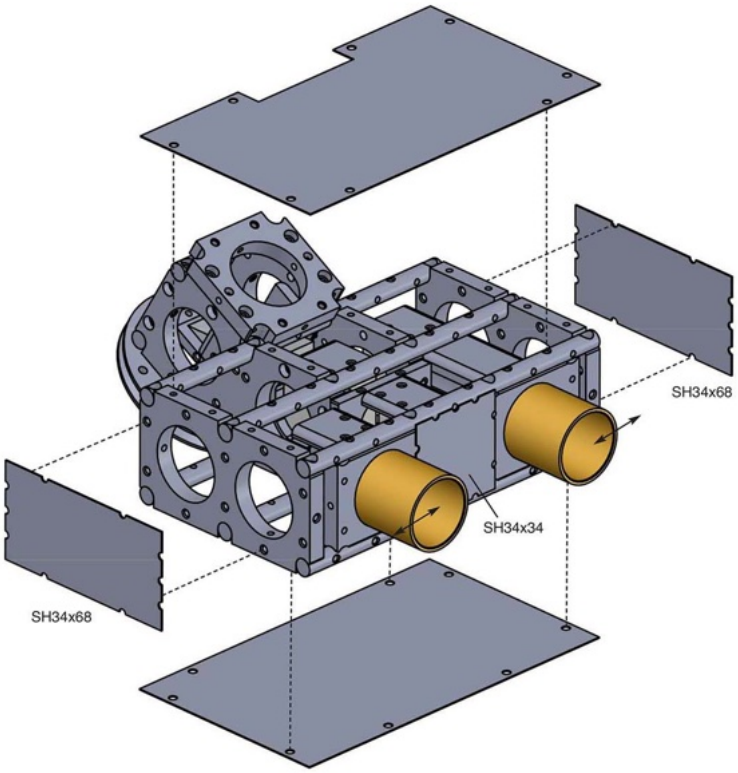
Full size standard Allen screws instead of tiny set screws increases rigidity



5) Light Seal Covers

Thin sheet metal covers will cover any contour in your assembly conveniently, and efficiently. These are low cost, laser cut, anodized Aluminum sheets that may be easily cut to any size, and shape.



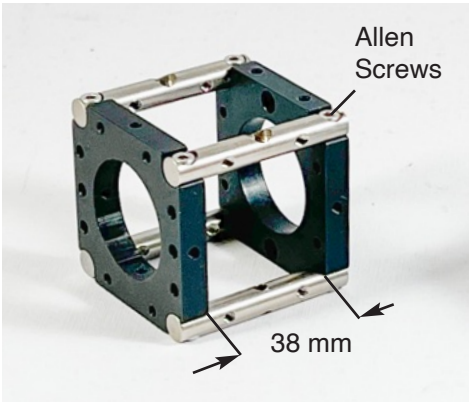


A binocular head built entirely with Optoform 40. The entire assembly is covered with sheet covering. For fully assembled design refer to page 21.

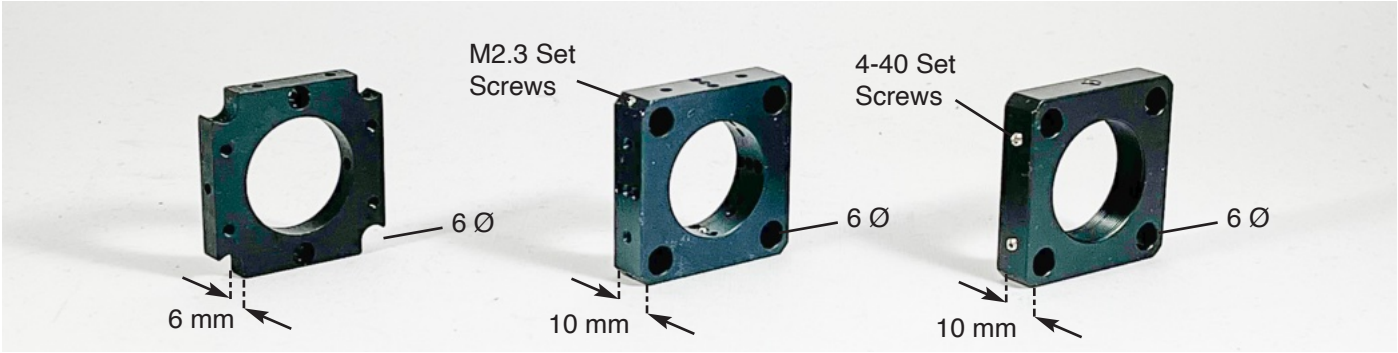
6) More Compact Design

With only 6 mm thick mounting plates, Optoform is the most compact cage system in the world. How this is possible is by utilizing Allen screws to secure the rods (right), whereas Microbench, and Thorlabs use set screws.

2.5 mm Allen screws are not only bigger in size, but the rods are secured in place by a 4.5 mm screw head, instead of a tiny M2.3 set screw. This allows the mounts to be thinner, and yet have more rigidity than the through-hole scheme. In an assembly, because the mounts are thinner, there is more room for optics. In comparison with Microbench, and Thorlabs, the clearance between two plates mounted on L = 50 mm rods would be 30 mm, while 38 mm with Optoform (right).



Clearance space for L = 50 mm rods

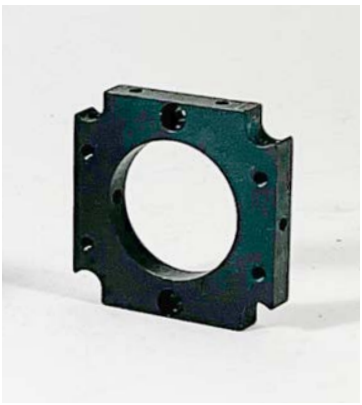


Optoform 40 Microbench Thorlabs

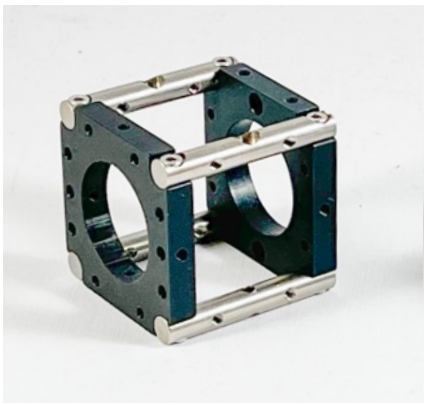
7) Lighter Weight

New Optoform 40 mounts are the same square size as Microbench, and Thorlab's cage system (40x40 mm) but they are much less weight:

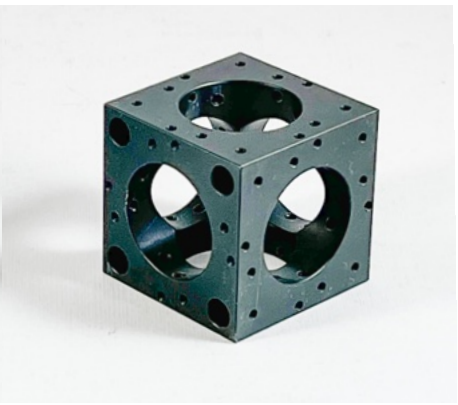
System:	Optoform 40	Microbench	Thorlabs
Optics Mount	**25 mm Ø**	**25 mm Ø**	**25.75 mmØ**
Weight Each	**14.5 g**	**25.3 g**	**23.2 g**
Cube 25	**25 mm Ø**	**25 mm Ø**	**25.75 mmØ**
Weight Each	**41.3 g**	**63.5 g**	



Optoform 40



Optoform Cube 40



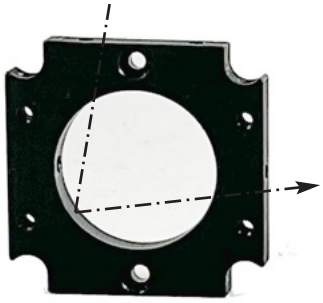
Microbench Cube 40

8) Less Internal Reflections

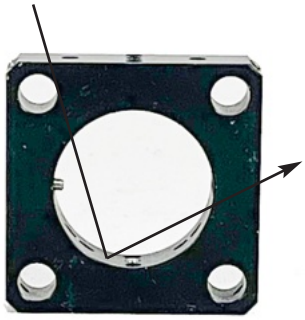
There are two causes of internal reflections in cage systems:

1) An obvious source of internal reflection in cage system are the stainless-steel rods. Steel rods are necessary because both Microbench, and Thorlabs use set screws to secure the rods, and they could be easily damaged if made out of Aluminum. New Optoformorm mounts use Allen screws, not set screws. This allows the rods to be made of black anodized Aluminum rods. So, the internal reflections are considerably reduced. We could also offer stainless steel rods if needed.

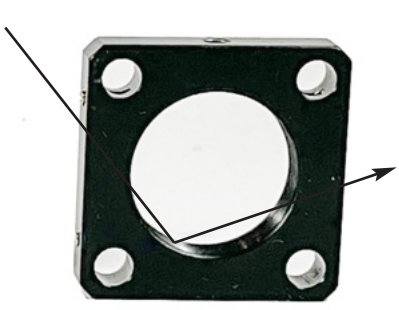
2) All optical mounts have internal reflections. This is because they are cylindrical in shape which are not customized for a particular optical layout. Internal reflections could be reduced by each lens cell that is inserted inside the mounts. It is obvious thinner mounts provide less area to produce internal leflections.



Optoform 40



Microbench



Thorlabs

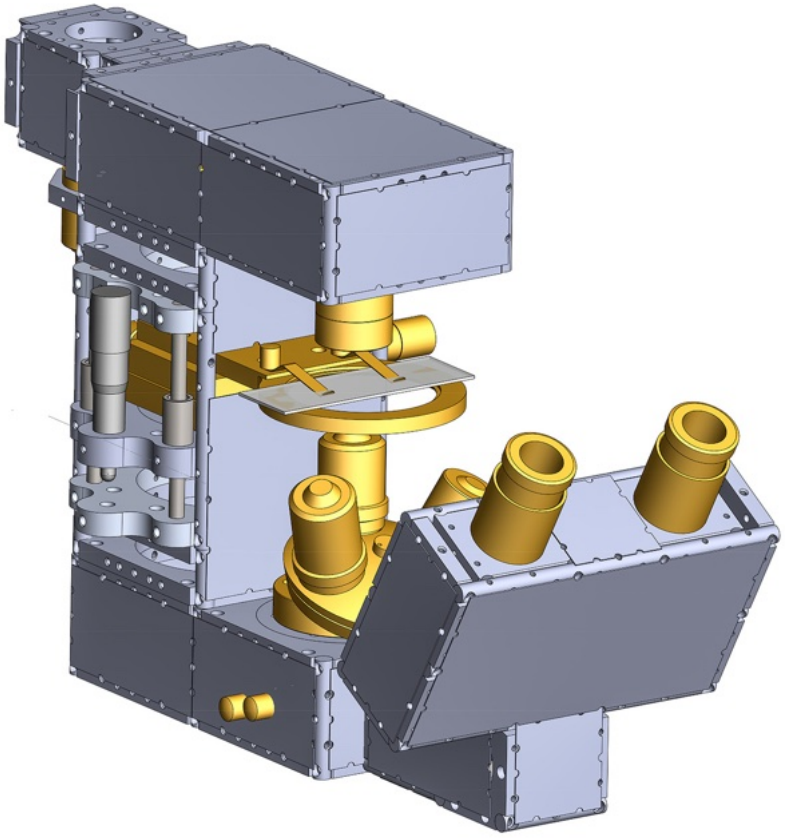
9) Form = Function

Microbench's original patent offered corner connectors but Thorlabs' inexpensive copy did not back then, and still does not offer corner connectors. I had played with Microbench before inventing Optoform, so I considered it an inseparable part of the optical erector set that we introduced.

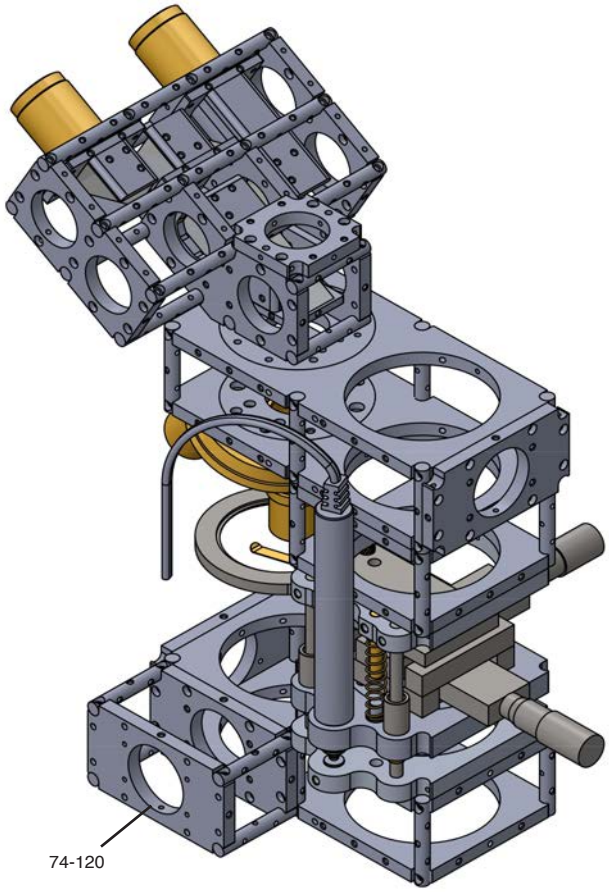
Without corner connectors, one could not build stages of their own, and must always buy one. For example, when we introduced linear bearings for Optoform 1, the end user was able to buy two linear bearings, their choice of micrometer, and the necessary mounts to construct it on their own design.

Well, when you have more control over details, your microscope would look like a kludge. In new Optoform II design, we transferred the bore pattern of corner connectors along the rods. This allows many new possibilities in constructing complex opto-mechanical assemblies.

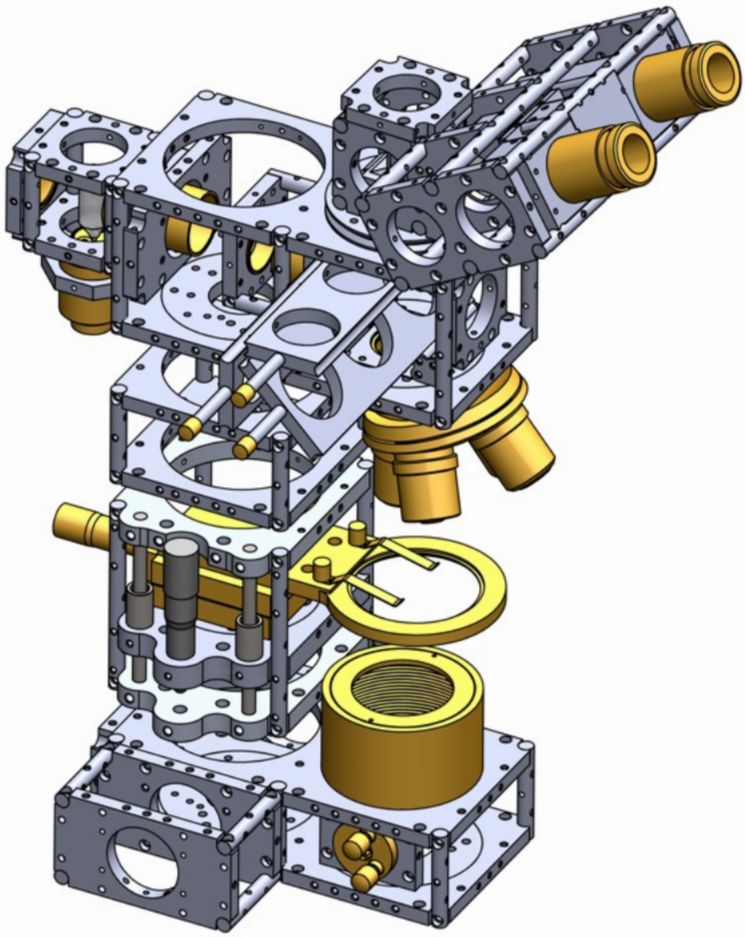
What's powerful about Optoform microscopes is they could be reconfigured from one form to another.



Inverted Microscope



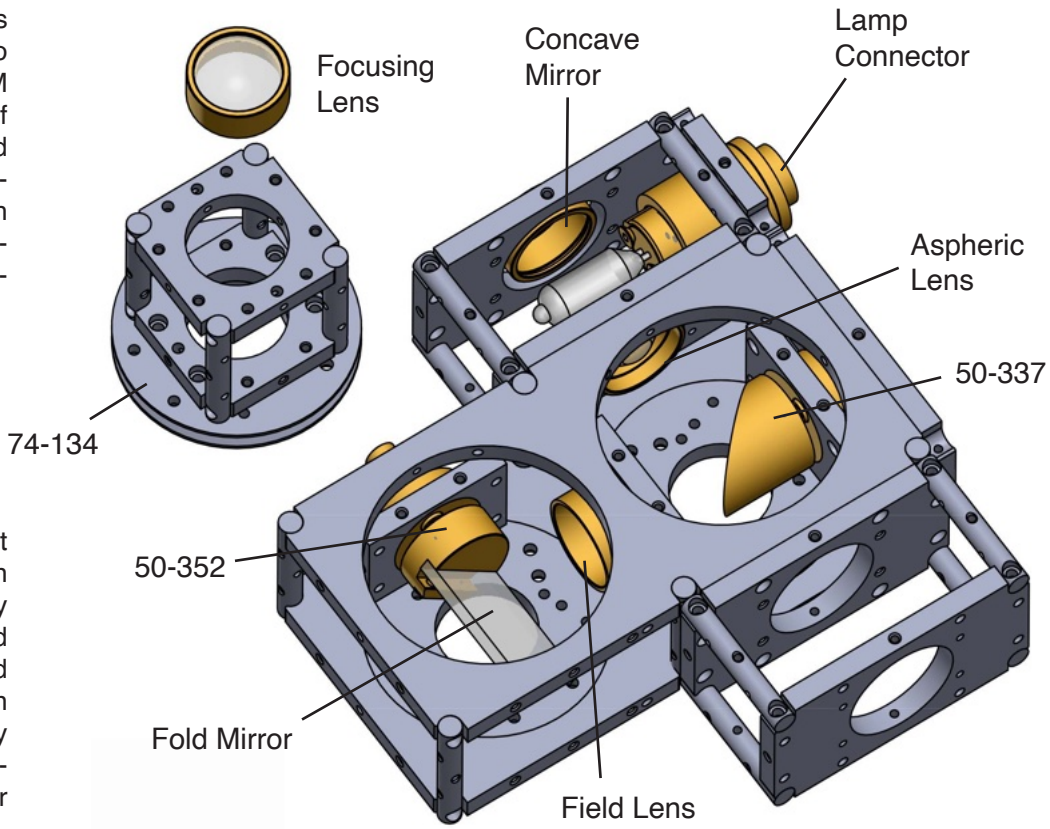
Biological Microsope
Forillumination source see P22



Fuorsescent Microscope
For exploaded view see P 16,
Illumination source P18, 22

10) Offer Off the Shelf Modules

A small number of parts could be put together to form an assembly as OEM modules. Lower cost of Optoform II mounts would make them suitable for creation of accessories such as a detector module or imaging device for microscopy.

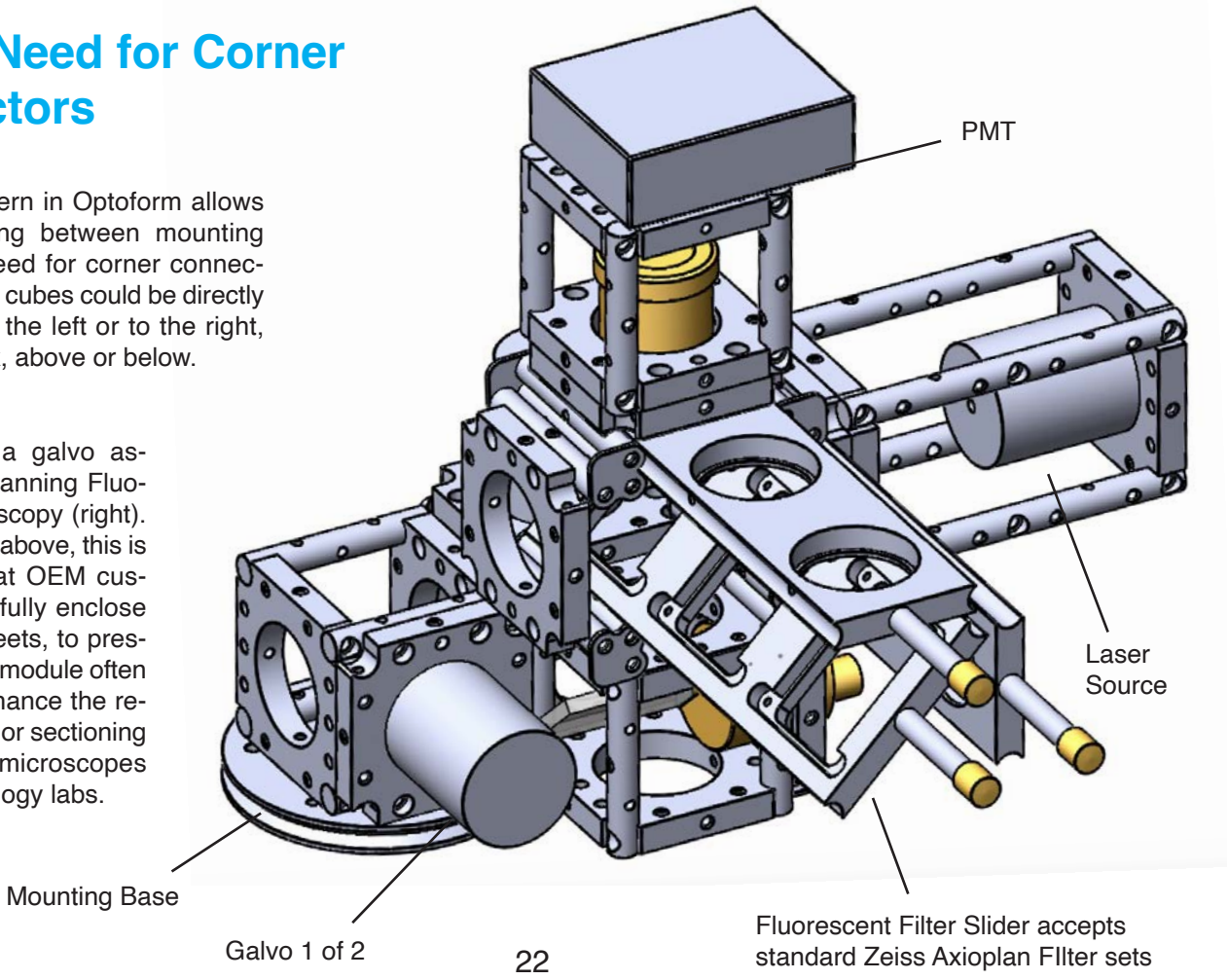


Right, this is a compact metallurgical illumination module that could be fully enclosed to be installed under an observation head for OEM applications. Thin sheet metal covering may be modified to provide adequate air ventilation for the lamp.

11) No Need for Corner Connectors

The bore pattern in Optoform allows direct mounting between mounting plates - No need for corner connectors. Basically, cubes could be directly stacked up to the left or to the right, front and back, above or below.

Constructing a galvo assembly for Scanning Fluorescent Microscopy (right). As mentioned above, this is something that OEM customers could fully enclose with cover sheets, to present as add-on module often needed to enhance the resolving power or sectioning capability of microscopes in existing biology labs.



12) Mount on the Rods

Optoform rods allow direct mounting of mounting plates or assemblies on the rods. On any pair of rods, one could install, a mounting plate to secure, i.e., a beamspitter mirror with tilt adjustment.

Basically, the bore pattern in Optoform rods are equal to the bore pattern that exists on the sides, and on the faces of mounting plates (below), as well as the bore pattern on cover plates. So, what is the secret of this bore pattern? It's all a multiple of magic number 17 plus 6:

Optoform's bore pattern follows a mathematical proportion:

17 x 2 + 6 = 40

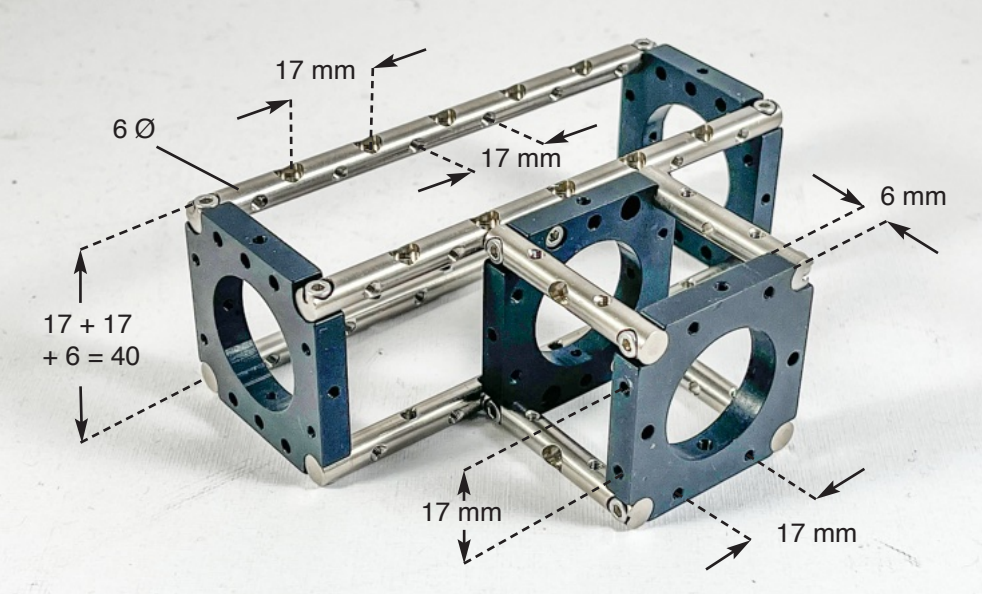
17 x 4 + 6 = 74

17 x 6 + 6 = 108

17 x 8 + 6 = 142

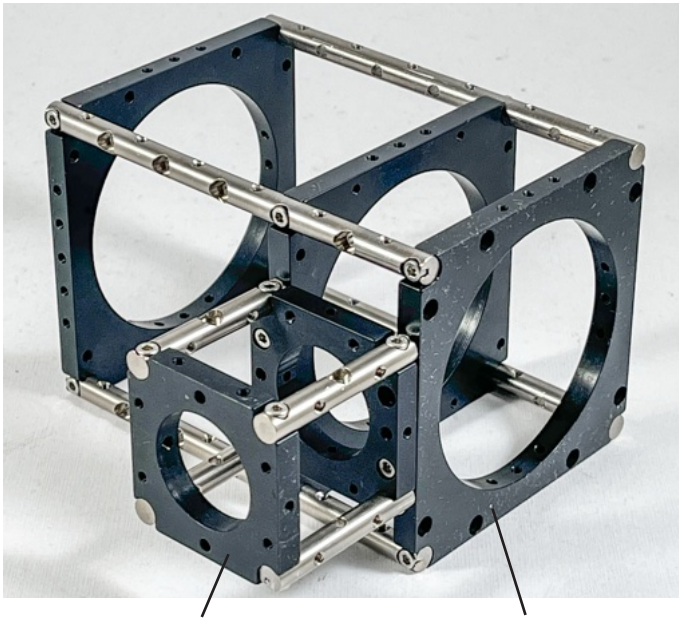
17 x 10 + 6 = 176

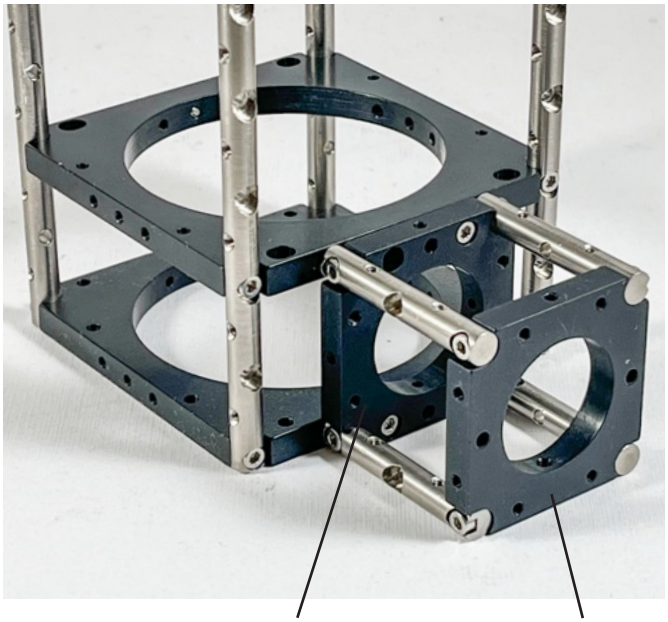
17 x 12 + 6 = 210



13) Upward/Downward Compatibility

Optoform is not limited to standard 40x40 mm mounts. There are also larger sizes: 74x74, 108x108, 142x142, and they are all directly compatible with each other.

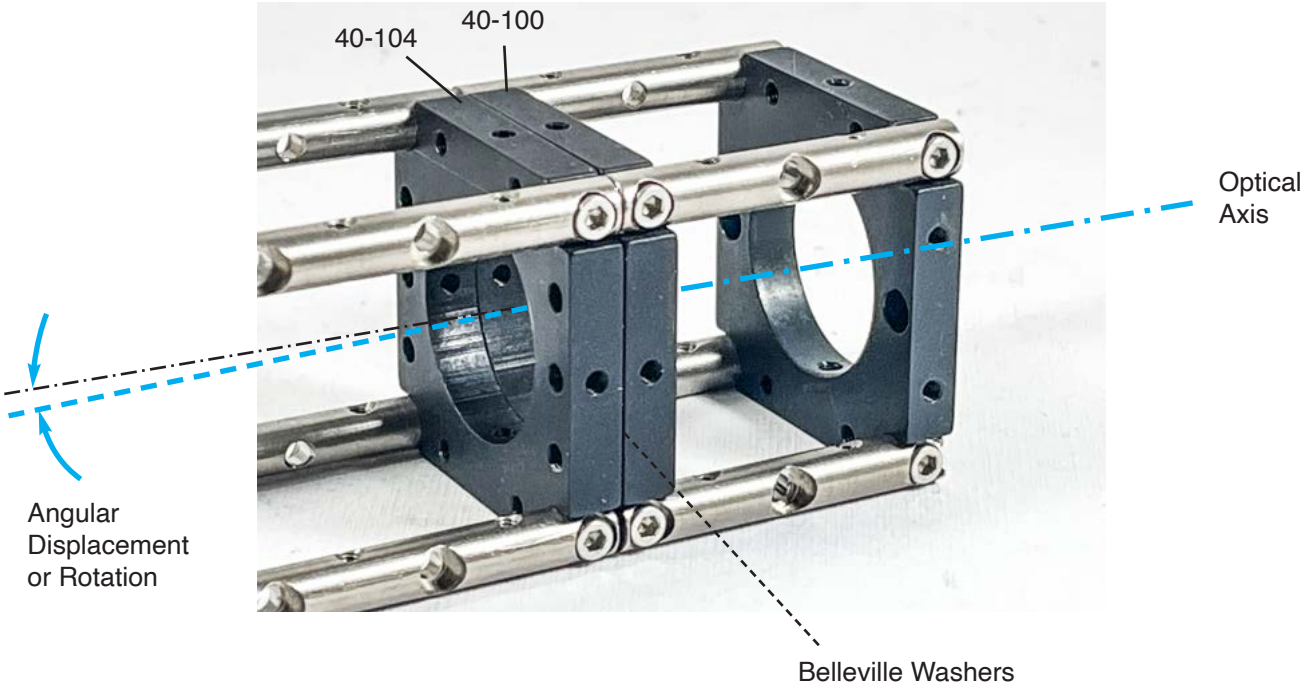




Mixing of various mounting plates are possible with Optoform. There is a uniform 17 mm bore pattern spacing on each plate, and along every rod. This bore spacing is used to design the mounts as well as rod lengths in similar lengths.

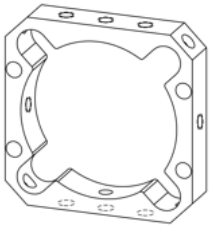
14) Shift/Tilt Between Subassemblies

The bore pattern on Optoform mounts allow face to face mounting between modules, and by adding belleville washers, shifts, or tilts are possible. This is a common sense technique, introduced in Optoform I, and now available in new Optoform II. Common applications would be when attaching diode lasers to an optical assembly or fiber optics, etc.

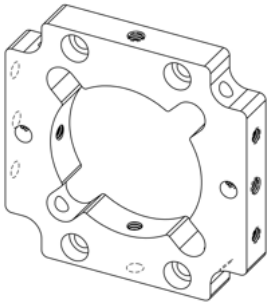


15) Assemble with Inner/Outer Rods

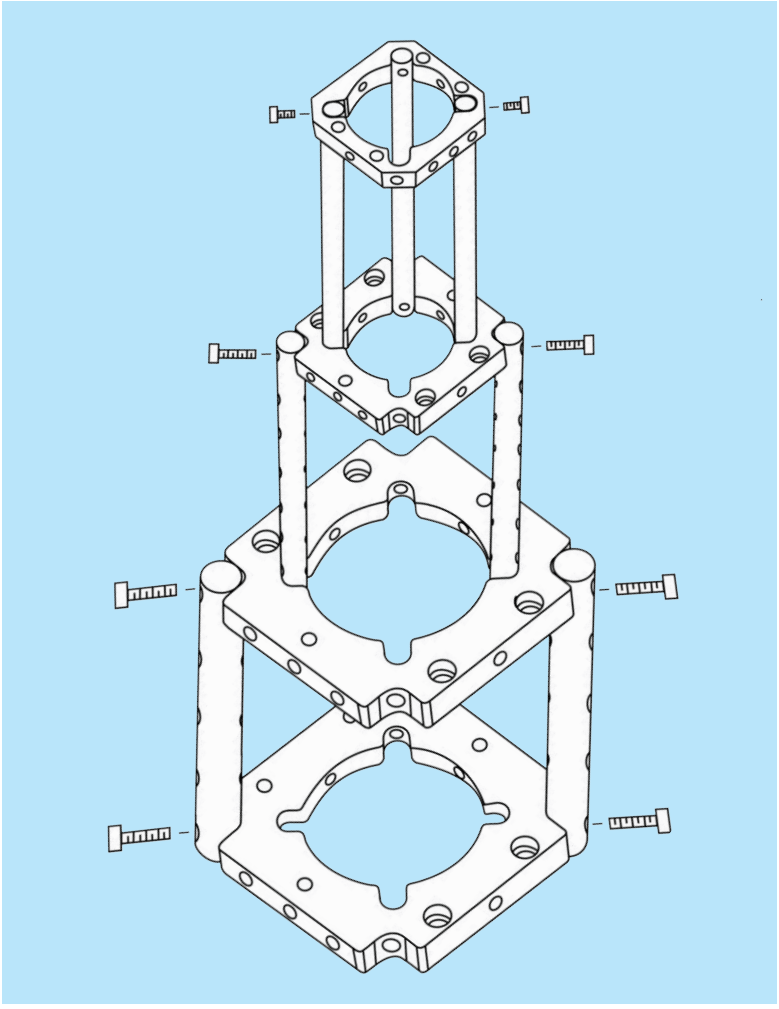
Optoform mounts allow inner or outer support rods to follow the contour of inner optical elements. This is for special cases where extreme compact setups are required in building an instrument.



Mount 30 for mounting inner rods



Mount 40 for mounting inner and outer rods

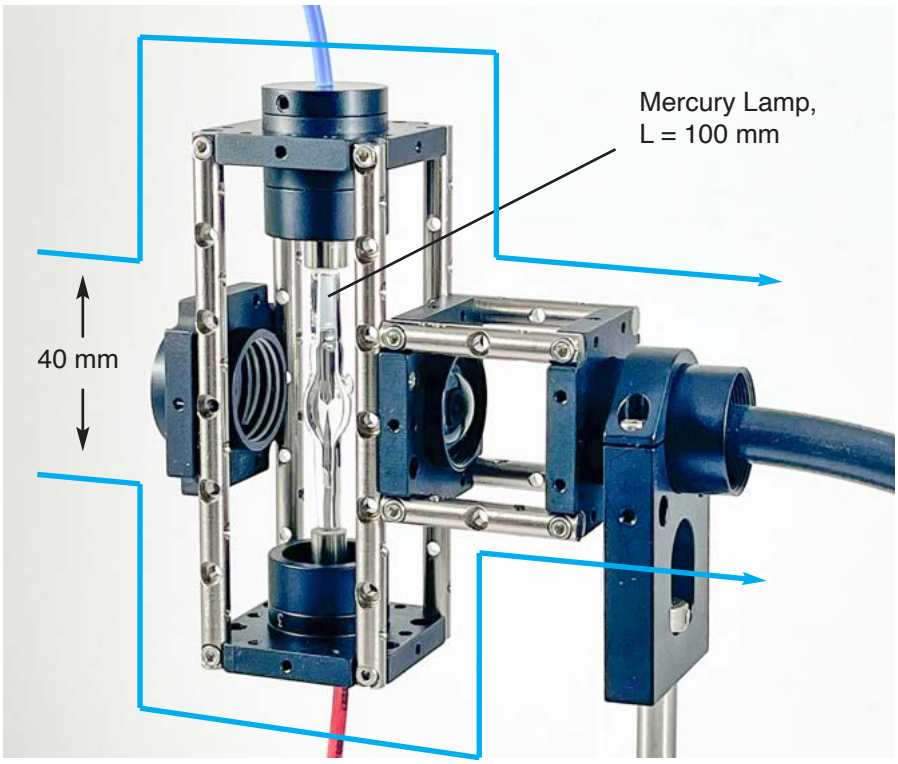


16) Build Around Large Devices

You could integrate large accessories, and devices within Optoform by utilizing extension rods. Basically, new Optoform's ability to mount against the rods allows you to go around large lamps (right), and to contain it in a small assembly.

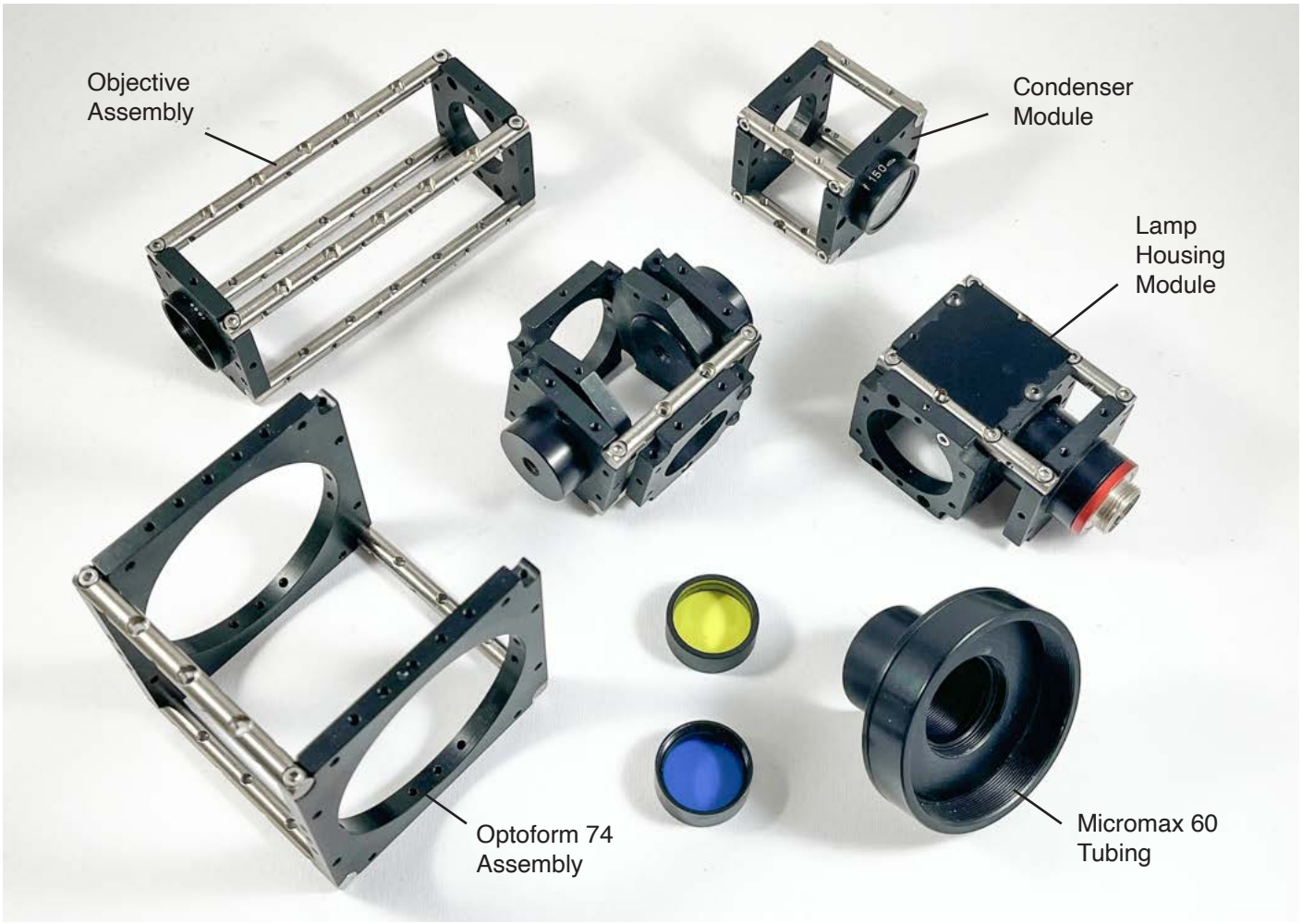
This arrangement could apply to any size accessories to be integrated within optoform setups such as AO modulators, large optics, large cylindrical lenses, large mirrors, etc.

Cover sheets are removed to show the inside of this assembly. Mercury, and Xenon lamps are widely used in fluorescent microscopy.



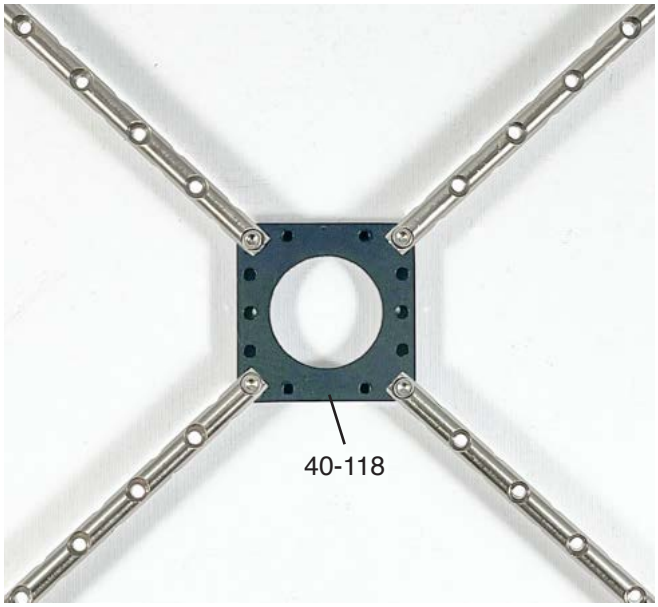
17) Modularity means Less Screws

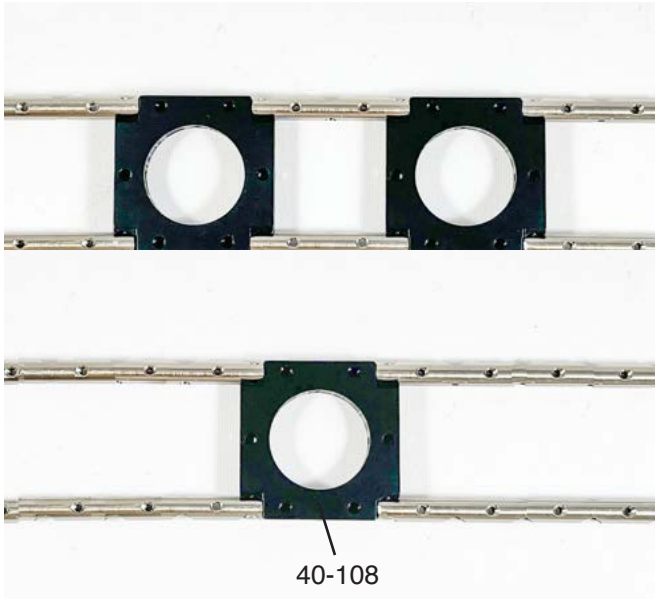
Cost reduction has a secondary benefit in optical labs: More affordable mounts mean less need to disassemble setups to reuse its parts. The result is utilizing pre assembled modules rather than individual mounting plates. Optoform's range of off the shelf modules allows system level design and integration instead of having to start from basic components, with so many mounting screws.



18) Side Mount or Diagonally Mount Rods

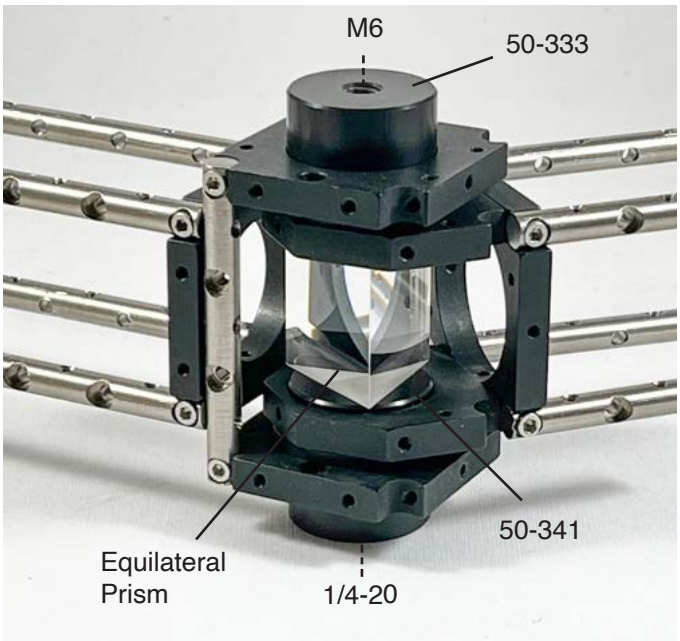
Optoform II design allows side mounting and diagonally mounting of rods on mounting plates. When rods don't pass through bores on the mounts, you could mount in any direction! To do it right, special mounts are offered that allow side mounting (below right) or diagonal mounting of rods (left). Applications include spiral assembly in telescopes, or building large space frame structures that are both light weight, and may be covered by thin cover sheets for structural rigidity.





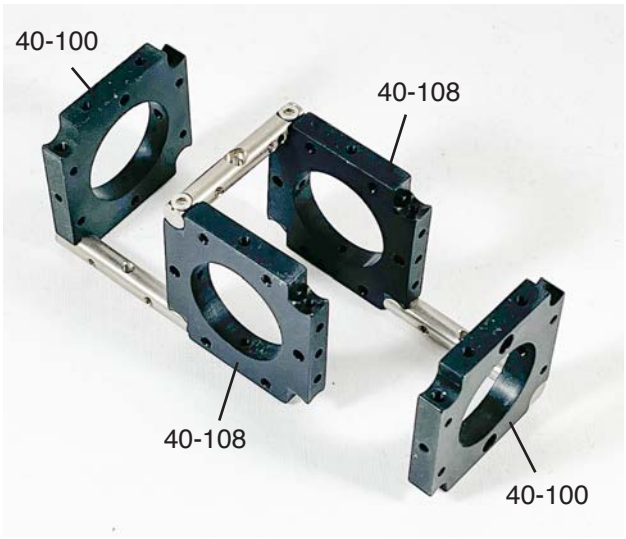
19) Set up Angles with Standard Mounts

Optoform's more advanced users could setup angles with standard mounts. The pivot point would be 50-333 for attaching to M6 mounting posts or 50-241 for 1/4 posts. Optoform is divisible to individual components that gives you the choice to configure setups as you find most useful for your experimentation. This is another example of the low cost of optoform II allowing these modules to be put aside for later use. This is a substantial time saver advantage of new Optoform II.



20) Mount Support Rods at Dual Angles

Optoform is the only mounting system that allows mounting rods at dual angles. This is because there are no through bores. The rods may be secured along the plates or perpendicular to the plates. Mount 40-108 is a special mount that has concavities in both directions, allowing support rods to change directions to create more complex assemblies.

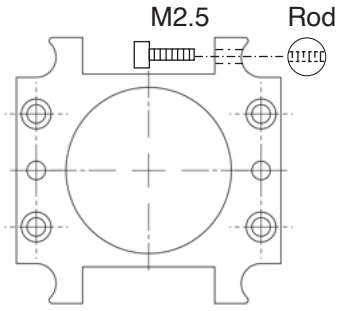


Standard 40-100

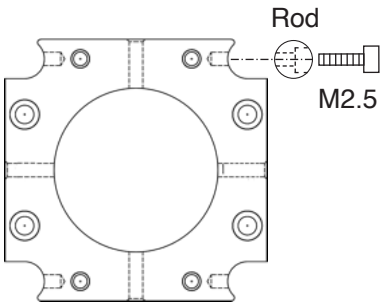
Special Mount 40-108

19) Mount Inside Out

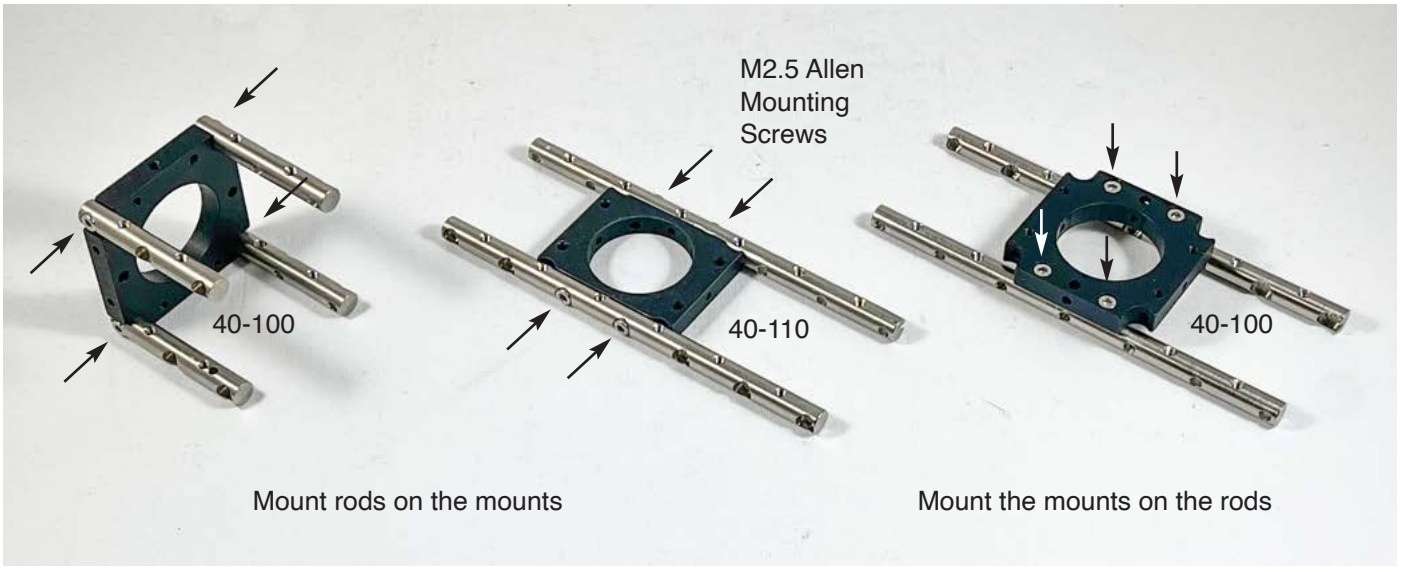
Optoform rods could either be bolted to the mounts (40-100), or the mounts could be bolted to the rods (40-134, right). This feature allows extremely compact assemblies because closely situated parallel assmblies could share rods in between. Because the rods are placed on the edges of the mounts, no optical obstruction will occur between parallel beams.



40-134



40-100

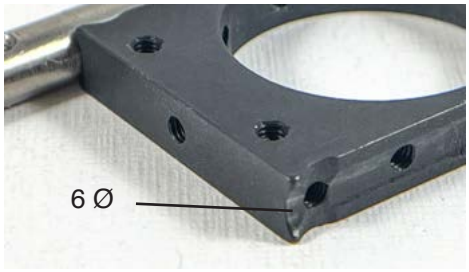


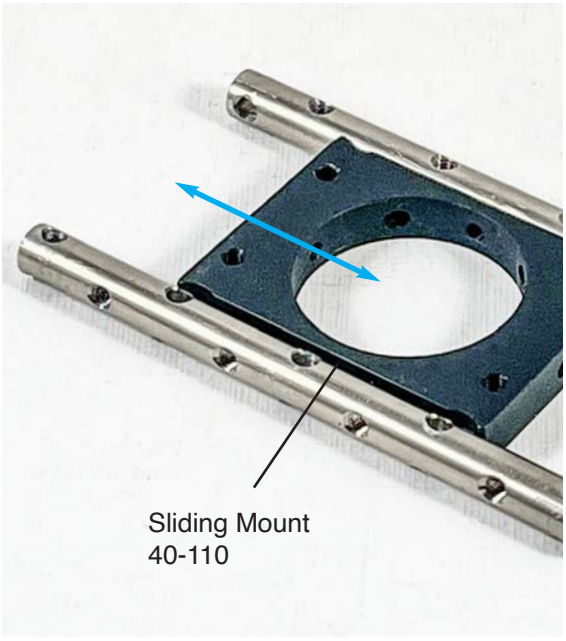
Mount rods on the mounts

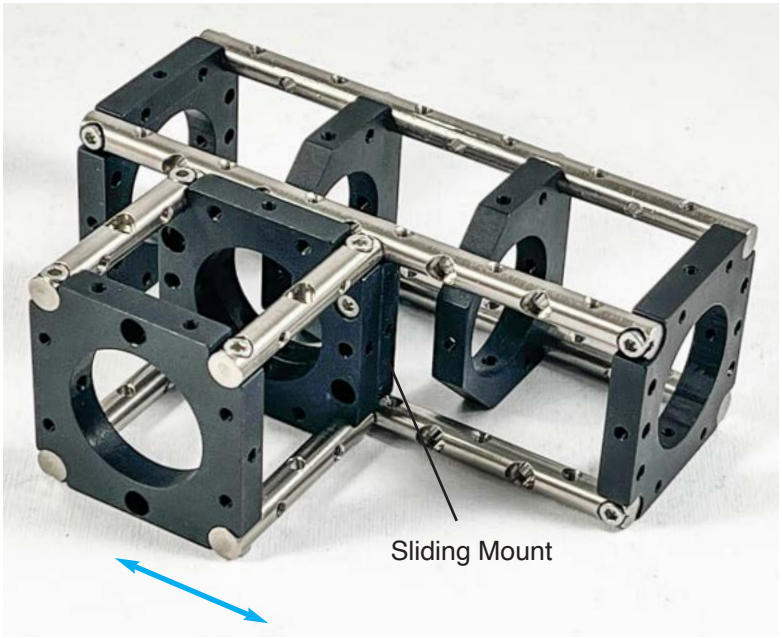
Mount the mounts on the rods

22) Slide Along the Rods

Optoform mounts may slide along rods. One application is to build binocular heads with interpupillary distance adjustment. A sliding plate allows several assemblies to be side mounted in parallel or orthogonal direction. One other example would be in constructing a beam height adjustment column to elevate a laser beam to any height across an optical table.

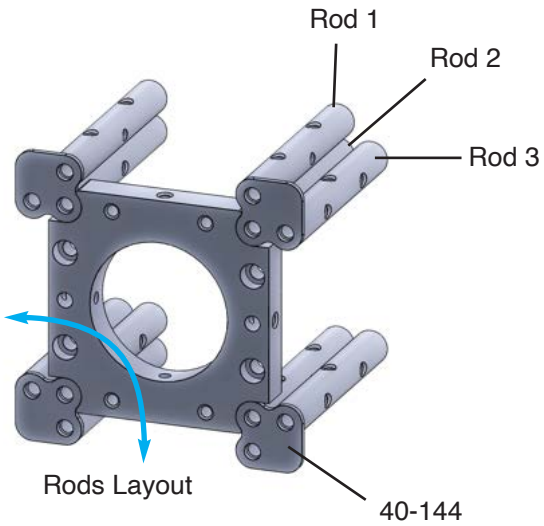


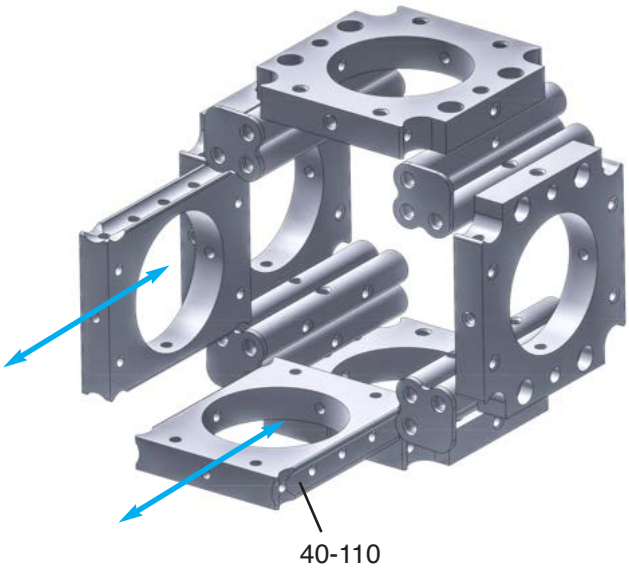




22) Build with Any Number of Rods, Cut to Any Length

Several rods may be arranged side by side to build complex sliding structures, i.e., building a beamsplitter cube with sliding filters in a single module (below) for fluorescent microscopy. We would only recommend this to more advanced users. Optoform users modify sheet covers, or add spacers between the mounts, modify mounting bores, and cut rods to length. Aluminum rods are much easier to cut with a professional finish than hardened stainless steel rods. When we reach our lowest price goal, Optoform II will be ready to be mixed with electronics components around the prototyping labs to be cut to pieces, and machined off to fit specific needs. It will be pitiful to find the edges of a $40 Microbench mount filed because it didn't fit another device but a $10 Optoform mount would be far more user friendly.



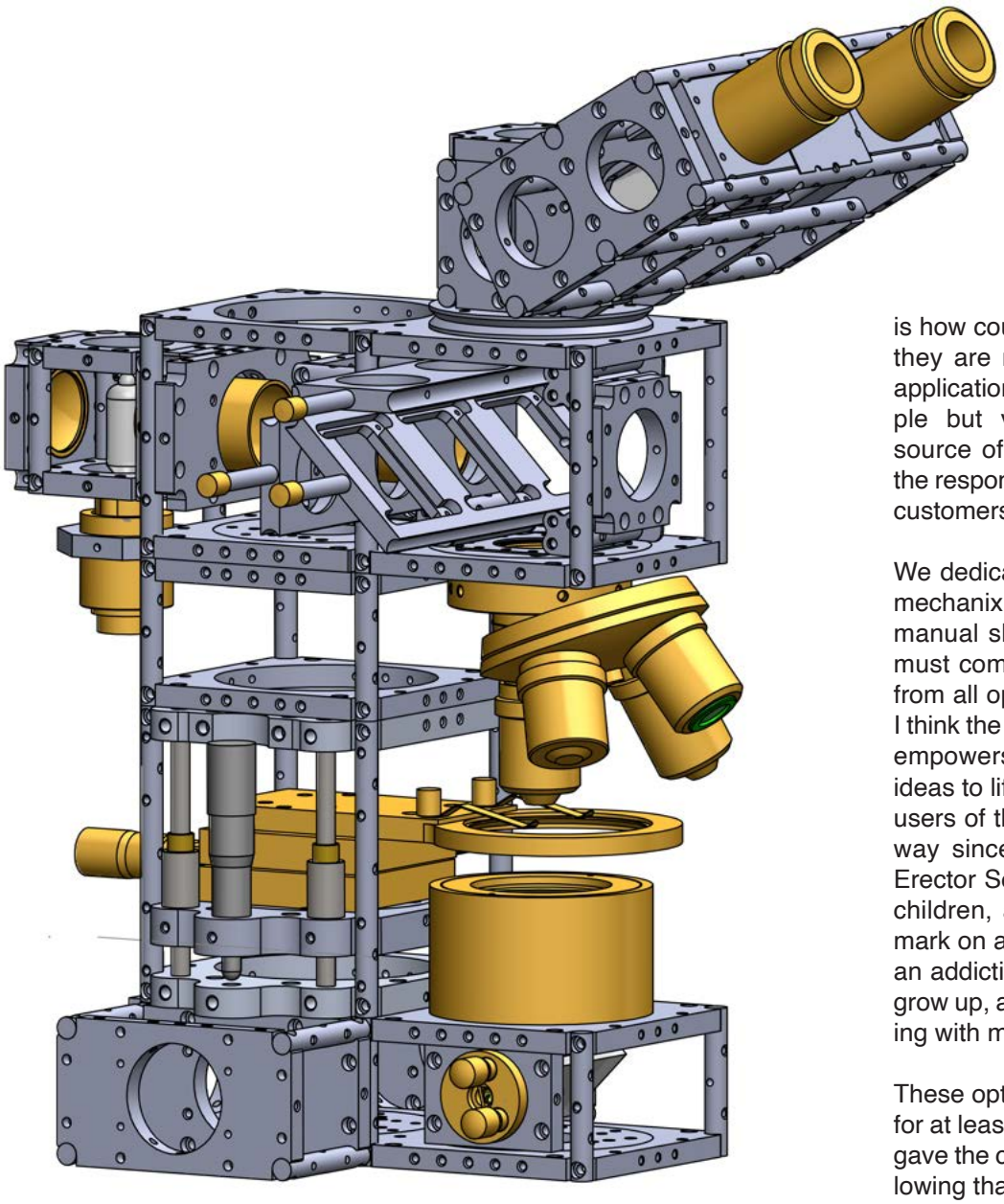


23) User's Manual

Optoform's user guide has been 5 years in the making. Those 5 years were spent in creating real applications. Optomechanix magazine is dedicated to educate lab technicians, and optical engineers the fine art of opto-mechanical engineering. It also covers new ideas for constructing a variety of opto- mechanical layouts with Optoform.

We covered the importance of user's manuals in great detail in the last issue because it has been ignored enormously in past 60 years. In spite of the wide use of Microbench in US, and Europe, whom were the original cage system, not so many real applications were published. Peter Andreas, the past US president of Spindler, and Hoyer sales office in MA, said one main reason was most of Microbench applications were proprietary, and their customers didn't wish to share them. So the question remains

New Optoform's user's manual has been compiled to follow the tradition of Erector sets for adults. Every layout is lavishly illustrated to show how each instrument is put together.

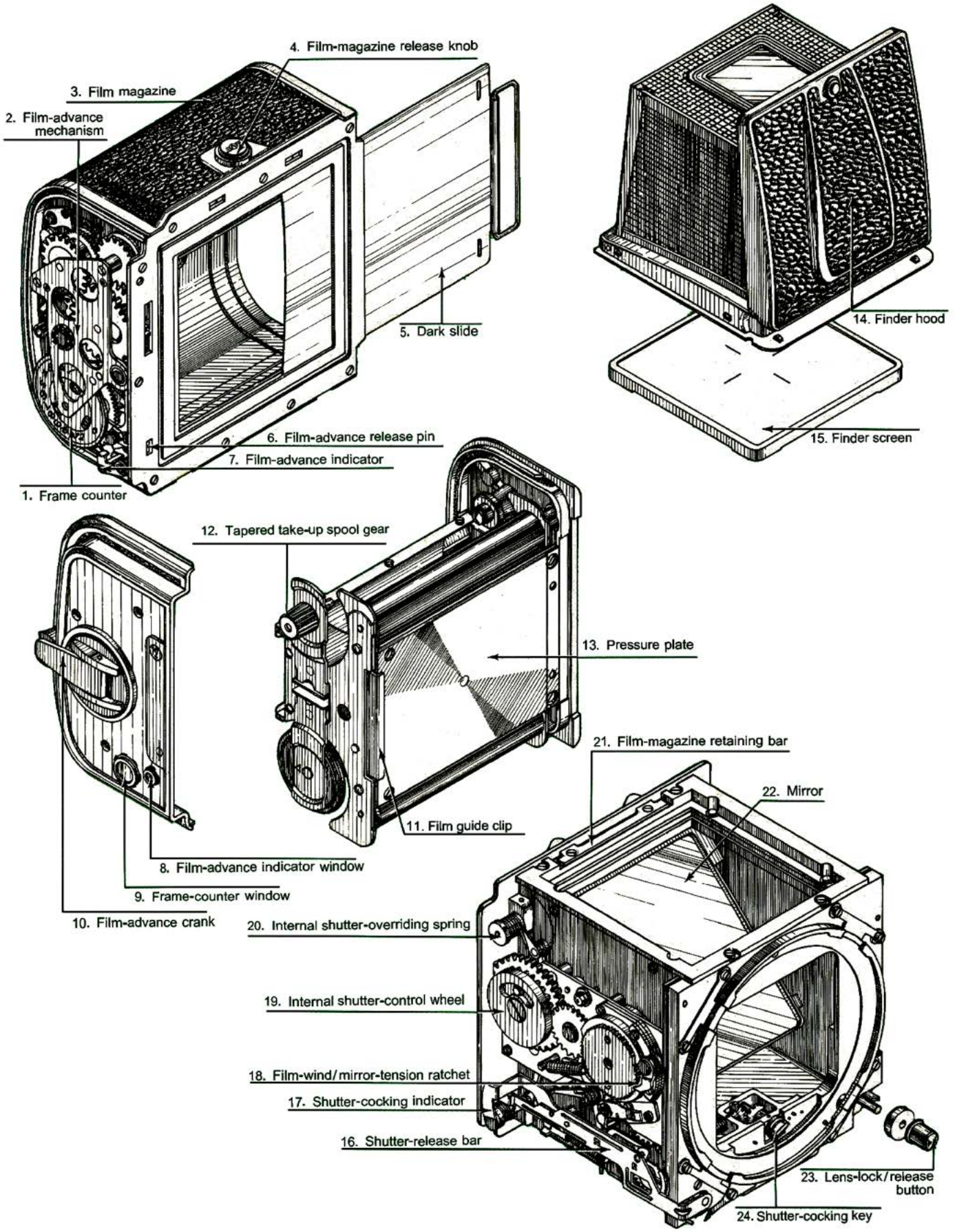


is how could users learn to use them if they are not presented with practical applications? The solution is really simple but very time consuming: The source of the applications material is the responsibility of the supplier, not the customers.

We dedicated an entire issue of Optomechanix to reveal how a good user's manual should look like, and how we must come to expect it as a standard from all optical cage system suppliers. I think the craving for such systems that empowers our creativity to bring our ideas to life stems from childhood. The users of these systems have lived this way since childhood. The role of an Erector Set is to stoke the creativity of children, and it leaves an everlasting mark on a child's mind. Something like an addiction to be creative, and as we grow up, and start to work, we like playing with more creative tools.

These optical kits have been produced for at least 100 years. In this article, we gave the contribution of Optoform in following that trend.

Hasselblad 500 C/M Design

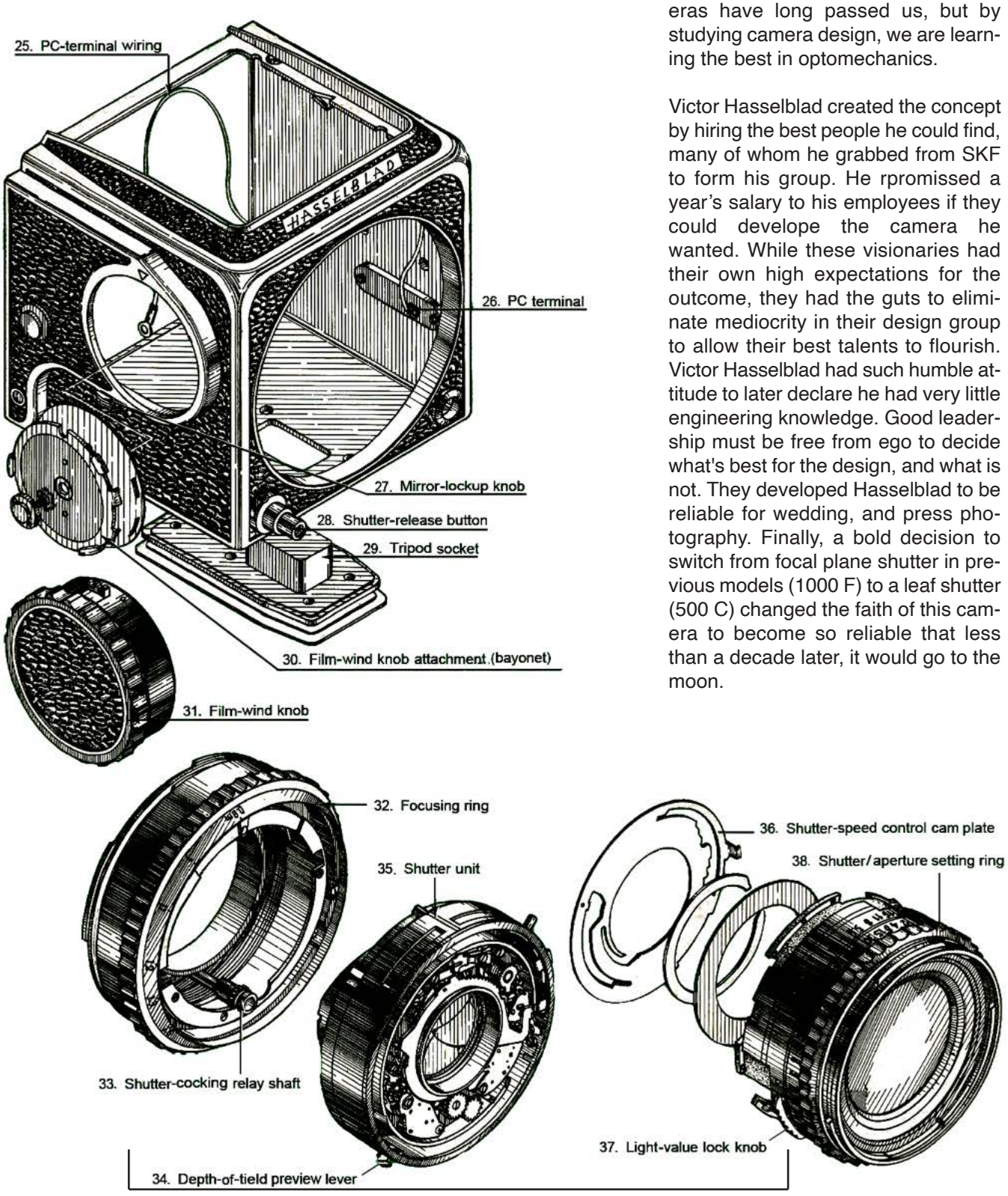


New comers like Japanese made Bronica got side tracked with other features to stand out in the crowd. Bronica played with mirrors inside the camera, and they came up with creative designs but they put reliability second. Openning up this camera, I expected a simple design but instead, I found a sophisticated mechanism but with a clear mind to reach their

Designed for Reliability

I am currently working on my Hasselblad book, and I am going to discuss its design, including the design of its exceptional Zeiss lenses. Analog cameras have long passed us, but by studying camera design, we are learning the best in optomechanics.

Victor Hasselblad created the concept by hiring the best people he could find, many of whom he grabbed from SKF to form his group. He rpromissed a year's salary to his employees if they could develope the camera he wanted. While these visionaries had their own high expectations for the outcome, they had the guts to eliminate mediocrity in their design group to allow their best talents to flourish. Victor Hasselblad had such humble attitude to later declare he had very little engineering knowledge. Good leadership must be free from ego to decide what's best for the design, and what is not. They developed Hasselblad to be reliable for wedding, and press photography. Finally, a bold decision to switch from focal plane shutter in previous models (1000 F) to a leaf shutter (500 C) changed the faith of this camera to become so reliable that less than a decade later, it would go to the moon.



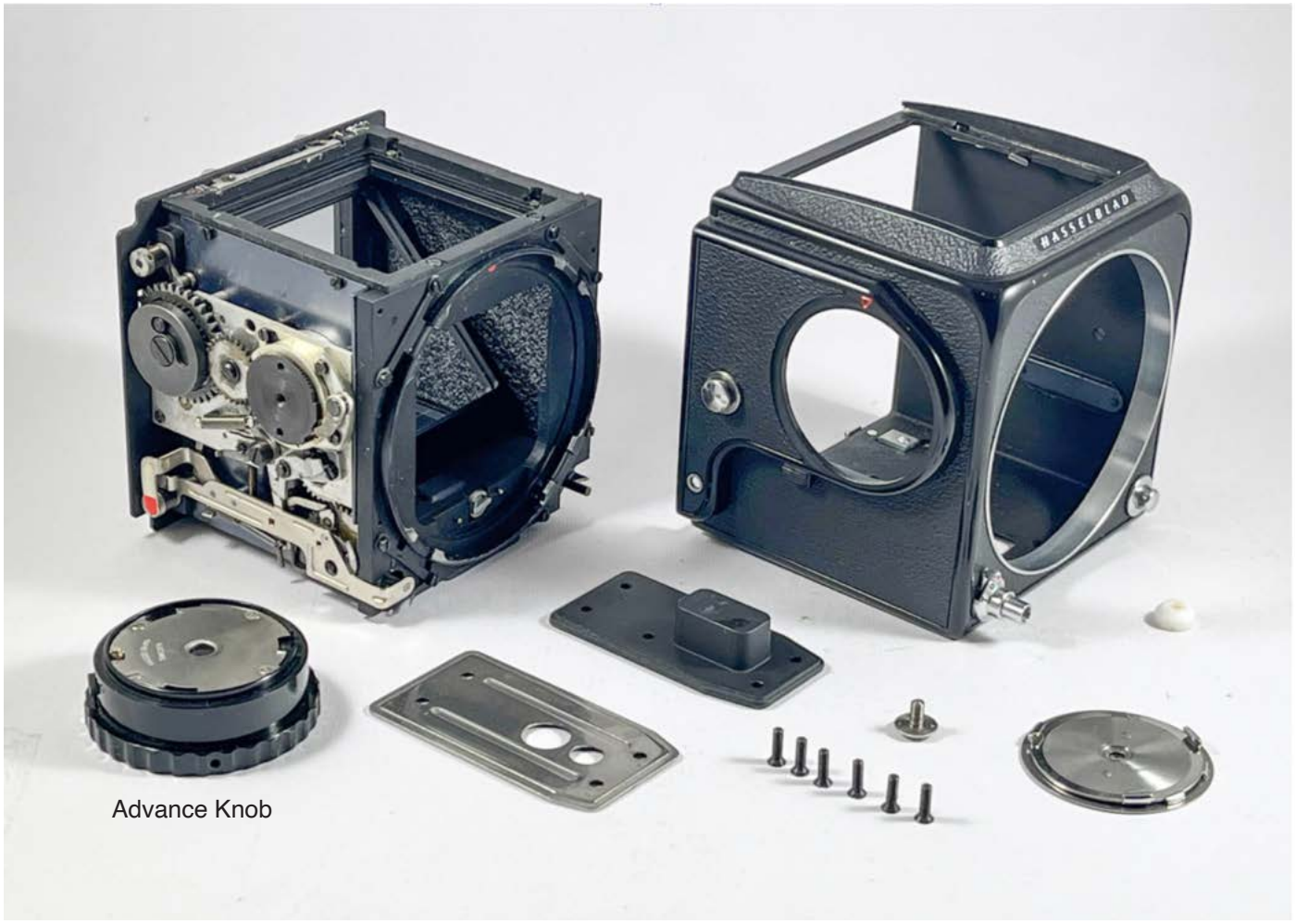
Zeiss Planar 80 mm f/2.8

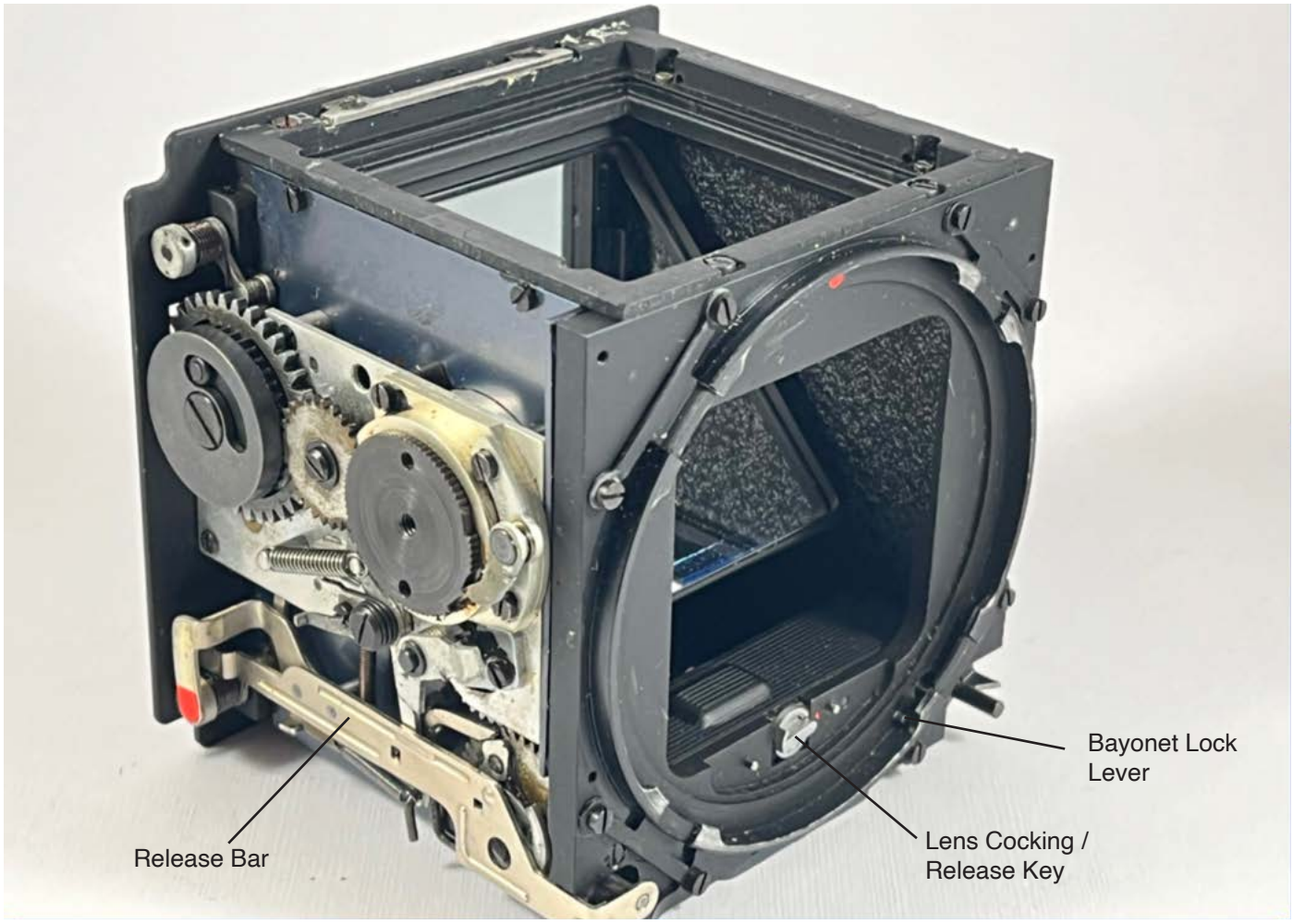
design goals. Lecia's design took the same path. Oscar Barnak made a similar decision when designing his focal plane shutter. He first made prototypes that are now selling for 2,5 million in European auctions, but the design he chose was a simplified version that was put into production in 1925. Leica was also the first 35 mm camera to go to space.

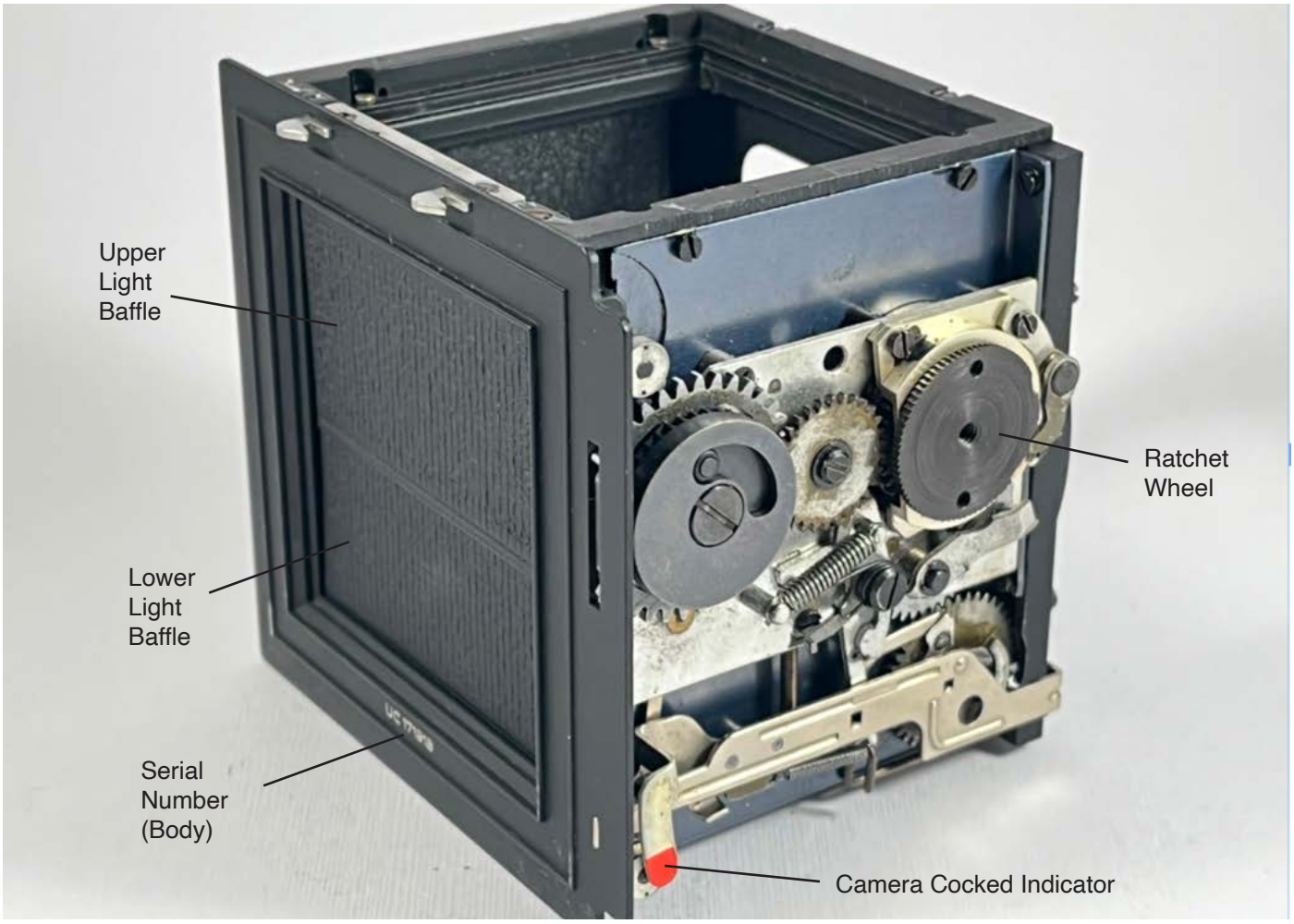
Hasselblad 500 C/M with 120 mm f/4

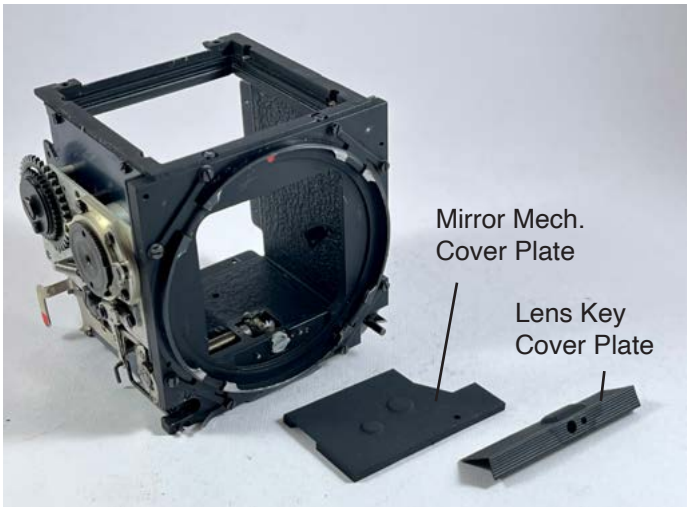
Hasselblad's modular design allowed interchangeable backs, viewfinders, winding knobs, lenses, and focusing screens. The Hasselblad system was the most versatile camera concept of its time, followed by Bronica, Mamiya, and Rollei. All medium format cameras were actually miniaturized versions of Graflex 6x9 cm, and many other 6x6 cm medium format camera introduced in early 1900s through 1930's.

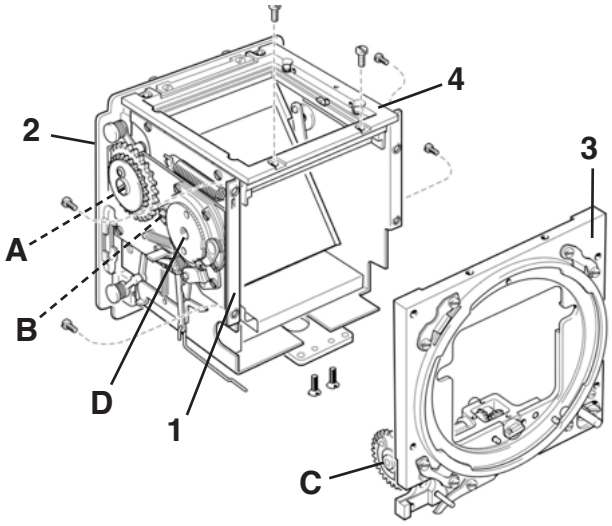
Referring to the exploded view in page 30, 31, to disassemble this camera, the film winding attachment (30), and tripod socket (29) are first removed, so its diecast body shell could be pulled off from the front. Hasselblad's difficulties with its large focal plane shutter led its designers to switch to leaf shutter design. According to Victor Hasselblad, when they requested Compur (their shutter manufacturer) to offer them a leaf shutter for their SLR, they said it couldn't be done. Hasselblad's team made a prototype of the shutter to convince Compur it could be done. They began producing it for Hasselblad with the condition that they could also offer it to other camera manufacturers. As it turned out, Synchro-Compur shutter became the favorite choice for many other cameras. The way this is accomplished is by a coupling key (33) between the lens, and the camera body (24).



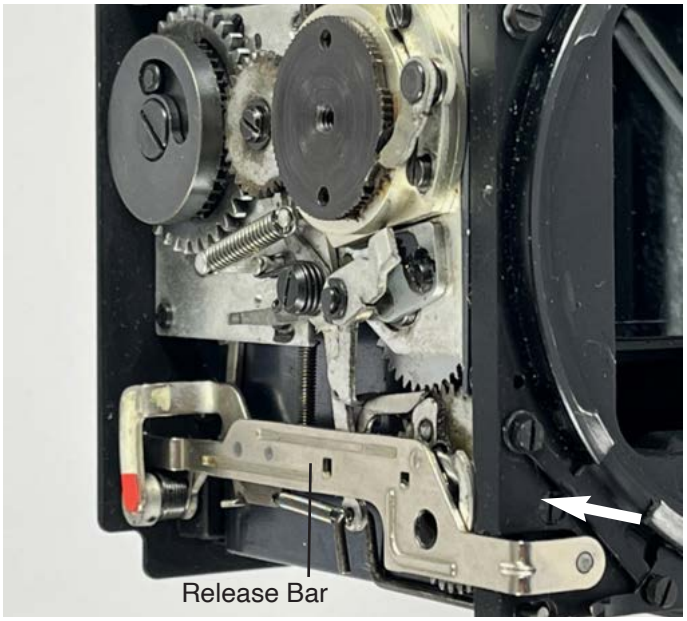

Bayonet Lock Lever
Lens Cocking / Release Key
Release Bar

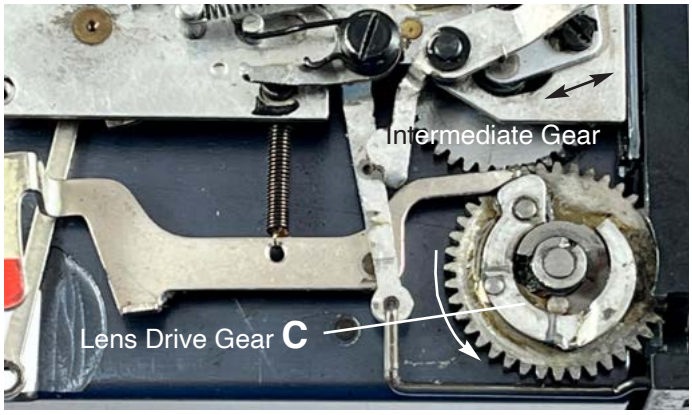

Upper Light Baffle
Ratchet Wheel
Lower Light Baffle
Serial Number (Body)
Camera Cocked Indicator



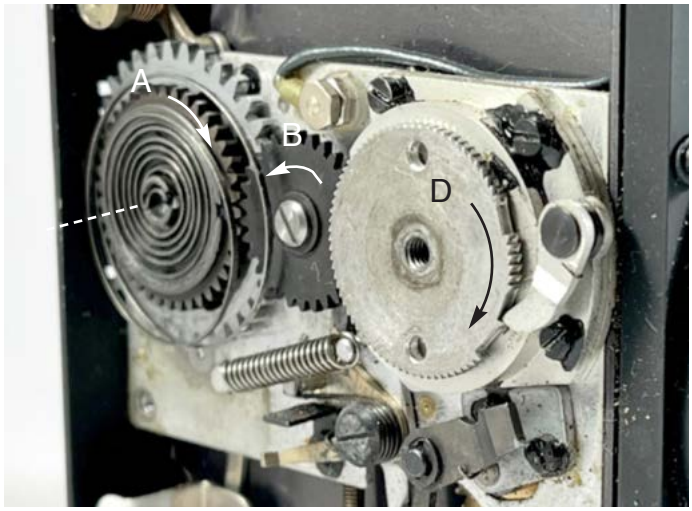


The mirror housing, and front lens assembly can be dissected into four major sub-assemblies: 1: A main U-shaped sheet metal shell; 2: The rear assembly carrying the mirror, and internal shutter; 3: The front lens board; 4: The focusing screen frame sitting on top. There are three operations inside this camera that are linked together by gears to happen in exact sequence: A: The internal shutter release; B: The mirror release; C: The body/lens coupling to release the leaf shutter. All these operations are cocked via a central gear D. The timing between these events can be independently adjusted.

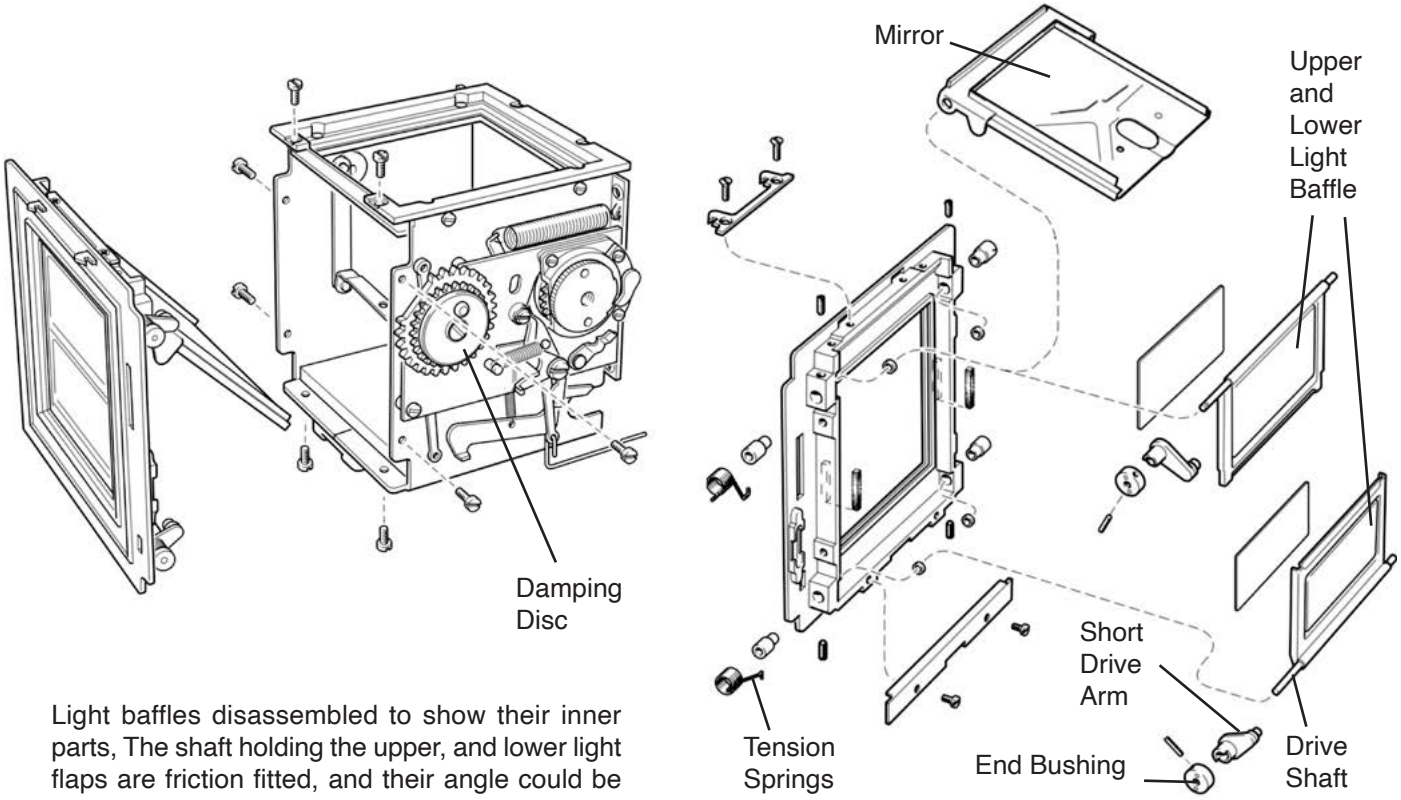




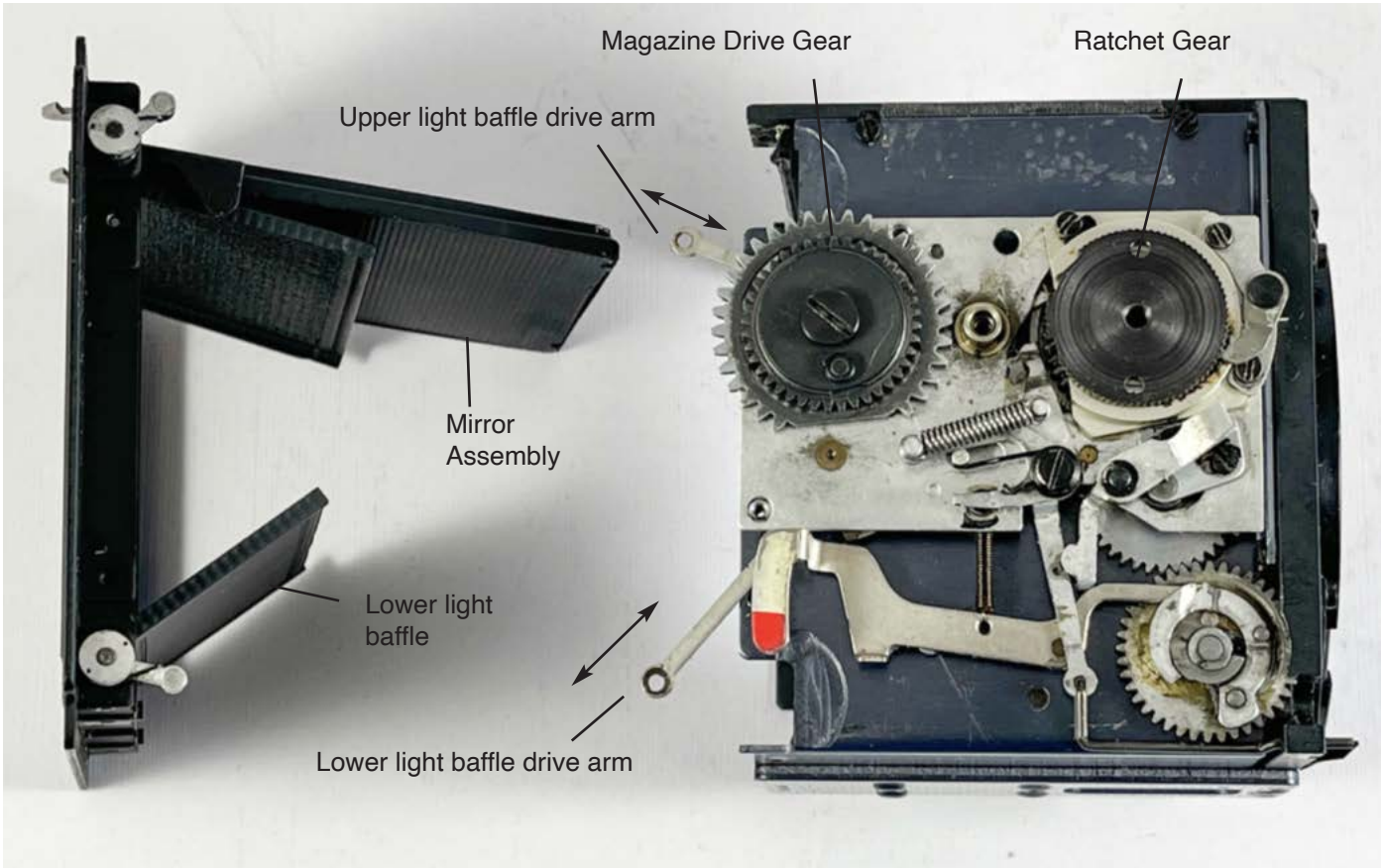
Removing the release bar (left) reveals the lens drive gear C (above). The timing between the inside the lens shutter, and camera's internal shutter, and mirror are linked by gears. The lens drive gear C (above), is adjusted by an intermediate gear that can be shifted (arrow) to adjust its exact timing with other sequences inside the camera.



Two views of the spring drive in Hasselblad 500 C, which has identical design to 500 C/M. Above right, in every winding cycle applied on ratchet gear D, intermediate gear B transfers this rotation to gear A to charge the light baffle or internal shutter blind's drive spring. During shutter release, the drive spring rotates its inner shaft (dotted line) a full turn to open, and close the internal shutter blinds.



Light baffles disassembled to show their inner parts, The shaft holding the upper, and lower light flaps are friction fitted, and their angle could be individually adjusted,



Taking off the back wall of the camera reveals its mirror, and upper, and lower light baffles. Most of the mechanism in 500C/M occupies the right side of the camera. The other side of the camera is empty. This empty space was intended for future options for the camera such as a flash meter or light meter, As it turned out, Hasselblad did offer a flash meter that would utilize that space.

To be continued

Burning of Quran

By Ali Afshari

I thought I should write something about Quran burning that has been happening in Europe this year. A good engineer could not afford to be one dimensional in his mind. I come from the eastern part of the world, and I feel I should say something about this because it means a great deal to me.

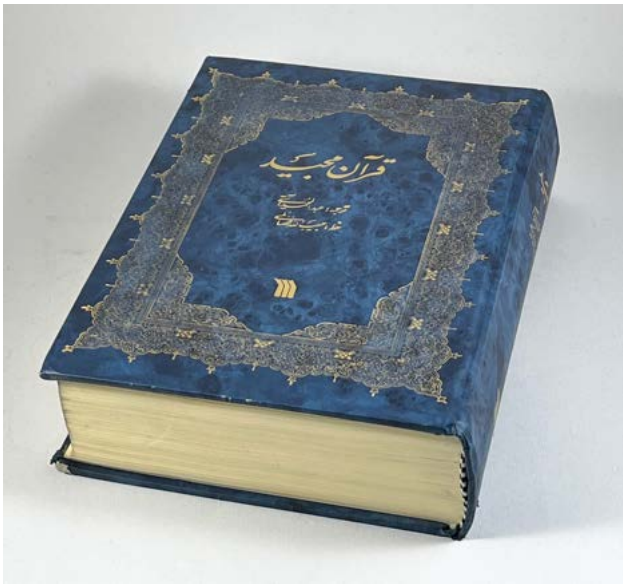
I used to be a Quran teacher for children so I know somewhat how to connect with this book. I remember when I was teaching, many parents would come to me, asking me to have their children memorize the verses. I never did. I placed pictures of Mickey Mouse, and Donald Duck on top of my handouts, and what I tried to teach were the concepts of Holy Quran, instead of memorizing it. My reason was there were thousands around the world who had memorized the entire Quran but were still unable to put its concepts to everyday use. It's really more important to learn how to think.

What I am about to say is not just about Islam but about many faiths. Religions were sent to man for guidance, but its followers turned it into a mission to try to convert others. In one way or another, religious people feel they are at the center of the world. Every sermon I attended I found a preacher who said to their followers: "You'll go to heaven but it's so unfortunate that others will not!". That kind of rhetoric evokes one to enter their own congregation with mindful of feelings, while attending other gatherings with logical mind. So, we have so many people against each other because nobody has been teaching them how to think. There are a few points I'd like to make to clear some false assumptions:

To make my first point, I'll pick the miracles of Quran, as an example: "Did you know one of the miracles of Quran is its verses, and chapters, are all divisible by number 19? Another miracle is every year, precisely 500 verses were revealed to prophet Mohammed." To some people, this could be the foundation for faith, but in my way of thinking, I'd say so what? I would look at the message in a book, not its miracles. Miracles are to convince brainless people. So, what could be wrong with relying on such miracles? Well, for one thing, if someone would become a believer because of 19, if someday, someone finds a single verse that is divisible by 18, they would lose their faith. So, don't ever add any assumptions to a faith to draw people to it. Having said this, I do believe in lifechanging power of both miracles, and the power of prayer but only at individual level.

Another false assumption is a certain religion would make you a good person, and if you are not a follower, then you are not. Religion is not supposed to make you a good person. Religion will only enhance a good person, but might make bad people worse. A bad person might find in a religion the rationale to commit crimes against humanity. A good example of this are religious extremists like Taliban, or Al Qaida, or the witch burning in Middle Ages. What you'd find life changing about any religion is because of the power of faith, and belief, and that too is an individual experience, and piety, not a general formula.

Holy scriptures are far more liberal than practiced. There is a verse in Koran (31:27) saying if all oceans turned into ink, and all trees turned into pen, and seven more oceans came to their



This is my own copy of Quran which I am not going to burn! Incidentally, the number of chapters in Holy Quran, and the total number of verses (6346) is divisible by number 19. I don't really pay much attention to these types of what's generally known as miracles.

Maslow's pyramid for a well lived life

Overwhelmed with material pursuit of happiness. As depicted in the movie "Soul", the Hedge Fund manager was obsessed with stocks going up or down.

aid, they would come short in writing God's words. This simply means not all words of God are written in Quran or in any other book. God's words are written everywhere. The west is looking for his signs through bigger, or more powerful microscopes. The problem with that is like an ant trying to comprehend the size of the earth, and it can't because an insignificant entity could not comprehend the whole. As Allen Watts puts it, the larger telescopes we make, the world gets bigger, and the more powerful microscopes become, the world gets smaller. In eastern thought, the search is through exploring the consciousness. It's only through consciousness that man could comprehend the whole universe because he encompasses it. It's only through that self-actualization that we could examine the world, entire.

Overwhelmed with spiritual persuit of happiness. People who'd jump to the end, will end up at the begining.

The third false assumption is we are obligated to become an end user of a religion once we submitted to it. That's again for brainless people. Hear it from someone who practiced them for over 40-50 years: Fully study, and sculpture a religion to your own needs. Only follow something if it feels right. Absorb what's useful as you go along, and put aside the rest. Eventually, you'd learn what agreed with your honest inner judgement is the true message of that faith, and the rest were only man made. God has given you that much freedom to find your own way, and will guide you through all your doubts.

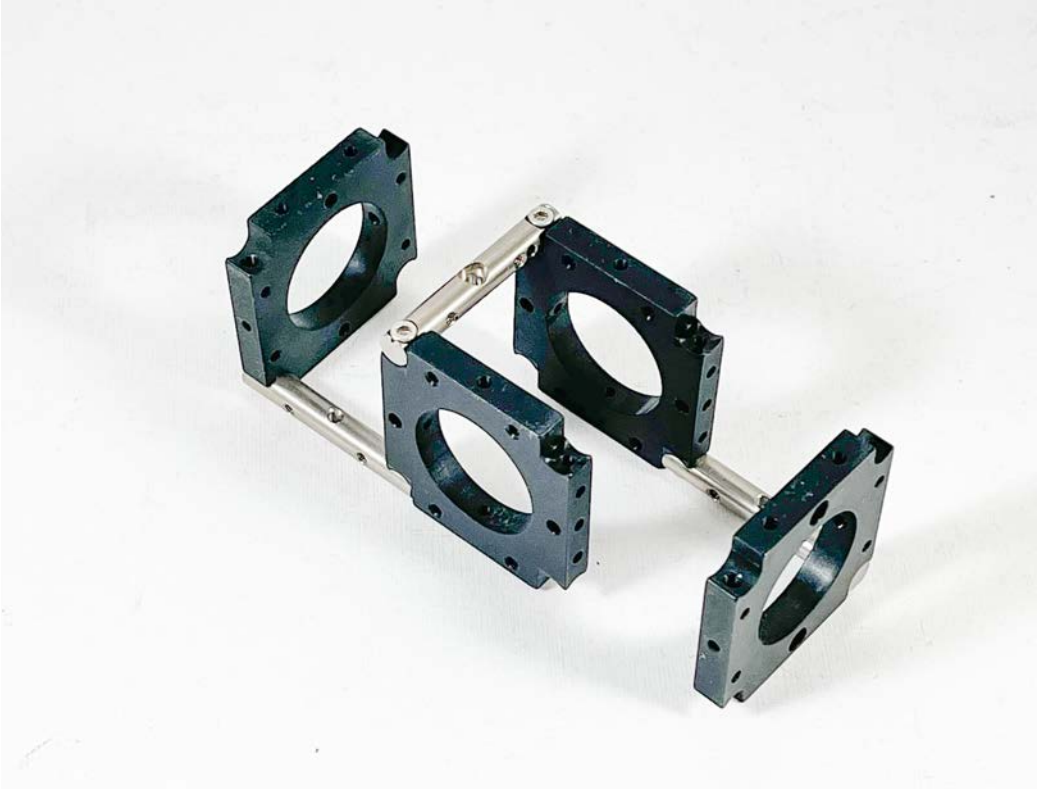
Carl Jung (1875 - 1961), founded analytic psychology

Prophet Mohamed said: "To the number of people in the world, there are unique paths to God". Light is a metaphor for guidance in holly books. In Holy Bible, there is parable of 10 wise, and foolish virgins who await the arrival of a bridegroom in Matthew 25:1-13. They carry lamps lit with oil, and five of them run out. Jesus says: "Be prepared for the day of judgement; You could only fill your lamps with oil from this world". Quran describes a similar scene in after life: A group of people are following a path lit by their faces. There are also those having dark faces who follow behind them at a distance. They ask for a portion of light from those ahead, so they could also see their path. They are told: "This is not what we could give you. You'd need to go back to earth, and have it sent forward to this place in hereafter. Suddenly, a door closes in between them". Holy books stories use metaphors because it could only be explained this way.

If I were ever to write the book: "Quran for Dummies", I would explain it this way: It begins with a chapter called: "The Key". It contains a man/God agreement, and it goes like this: "I will only worship you, and seek help from you, in return, guide me to straight path". Chapter 2 is named: "The Cow". It starts with 6 conditions Quran sets for its guidance: "This book will guide those whom: 1) Believe in the unseen, 2) Establish a connection with their source, 3) Share what is given to them with others, 4) Believe in this book, 5) Believe in books that came before it, 6) Believe in a day that our intentions will be judged. That's it. It also says this book has misguided so many because they didn't follow these rules.

Maslow's pyramid illustrates our life's journey and as we grow older, we feel more and more the presence of our soul. While climbing that pyramid, religious scriptures are like "The Giving Tree". If we need an apple, we could pick from it. If we need a house, we could use its branches to build it, and if we decide to leave, we could use its trunk to make a boat, and at the end, if we need a place of contemplation, we could use it as a chair. We'll overcome life's challenges by following its guidance. God concept is the only thing that's absolute. Every other doctrine seems to diminish and fade away.

We need to pick from a tree that has fresh fruits. Life always refreshes itself, and as we age, we consume its fruits of wisdom to find our path to the truth. As Carl Jong puts it: "We need more understanding of human nature because the real danger that exists is man himself. We are pitifully unaware of it. We know nothing of man. Far too little. His psyche should be studied because we are the origin of all coming evil. Man cannot stand a meaningless life." No one could tell where we are headed, but life isn't pointless as Nihilism suggests. Mankind is constantly in search of meaning, and we are given an innocent judge inside every one of us, to show our path through the unknown. Religious scriptures never tell us to harm one another.... Their universal message, as Bertrand Russel put it: "Love is wise, and hatred is foolish."



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