Optomechanix

Design Study:

Mitutoyo Thickness Gauge

Mitutoyo Dial Indicators

Internal Measurement Micrometers

Internal Gauge

6 years of Optomechanix

The Art of Mitutoyo

Apr-June 2023

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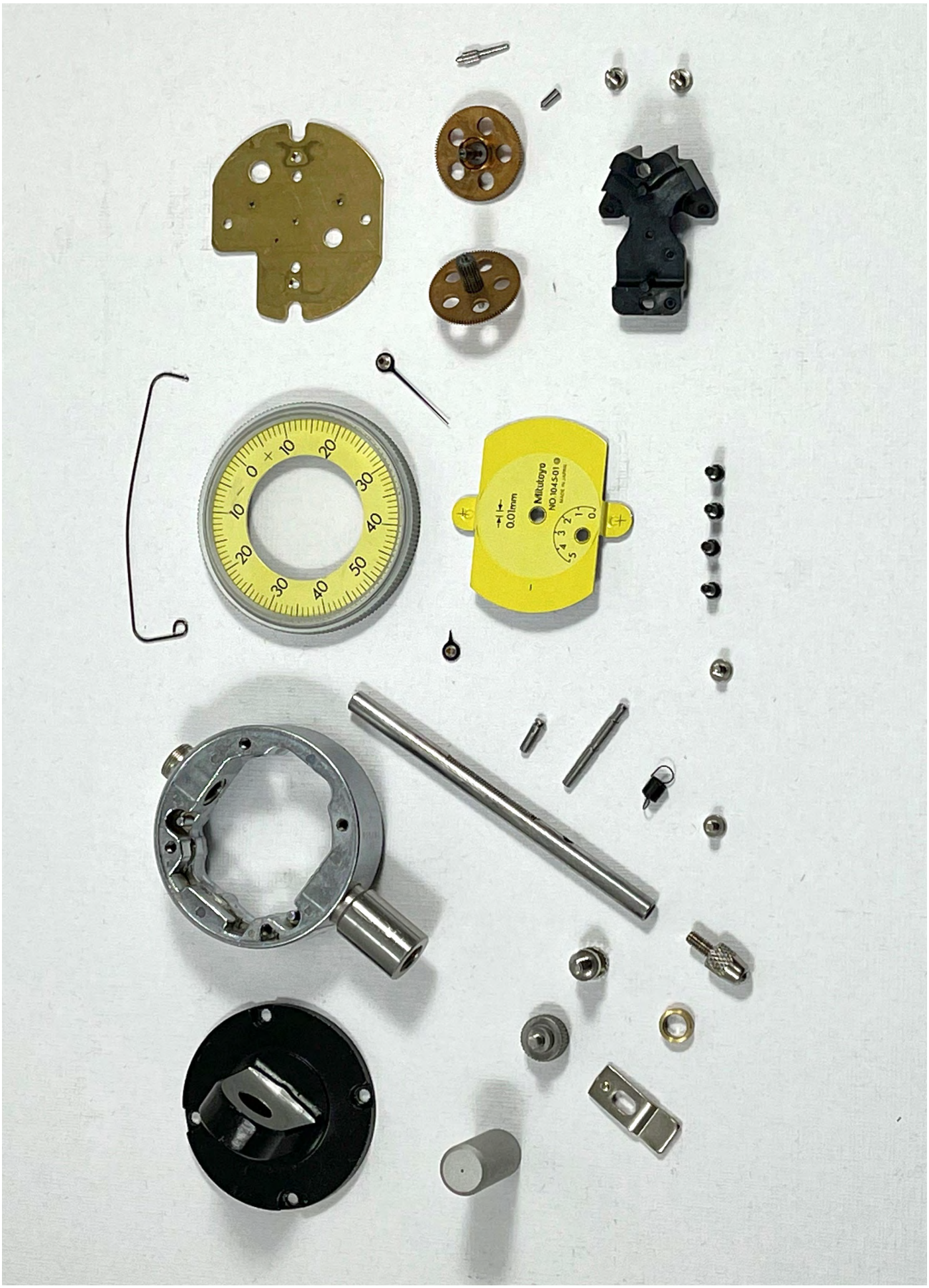

Back View Mitutoyo dial indicator disassembled to show its inner parts.

Contents

Mavlana Jalal-ad-Din Rumi

This issue Dedicated to:

Mavlana Jalal-ad-Din Rumi (1207-1273). Rumi was a Persian poet, philosopher, and master practitioner of Sufism. He was an Islamic scholar, and teacher before he met his life teacher Shams Tabriz, who liberated him from the impediments of orthodox religion, and turned him into one of the most influential poets in Iranian history. His life story was similar to "Missing piece meets the big O" by Shel Silverstein, or the inspiration to the movie: "Peaceful warrior". Shams means the sun, and literally means light that shines the path. It has been said Shams Tabriz was a manifestation of Messiah, who came to liberate Rumi.

Rumi's poetry book called "Masnavi" uses stories (exemplification) to simplify his teachings. It is also called the Farsi translation of Holly Quran. Similar to Buddhism, Sufis practice love, and peace. Rumi believes we are separated from our source, and long to return, and he uses the reed flute as a metaphor. He begins his Masnavi with these first lines:

"Hear the story as told by the reed, for being separated.
Ever since I was cut from the reed bed, I have made this crying sound.
Anyone separated from someone he loves, understands what I say.
Anyone pulled from a source longs to go back.

At any gathering I am there, mingling with the laughing, and grieving, a friend to each, but only a few could hear the secrets hidden within the notes,
no ears for that.

We are not given eyes to see the soul,
The reed flute is a friend to all who want the fabric torn, and drawn away."

I remember when a postage stamp was printed in US in his honor, the one poem they picked was: "To be one in heart is better than to be one in tongue".

Here's another good one that soothes grim moments in life: "When someone beats a rug, the blows are not against the rug, but against the dust in it".

Not everyone can be Rumi but Rumi could come from anywhere. Persian poet Bahar says: The world is filled with Shams yet where could one find a Rumi?

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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: Mitutoyo digital test setup to measure lens thickness.

Front back: Mitutoyo dial indicator disassembled to show its inner parts.

In This Issue:

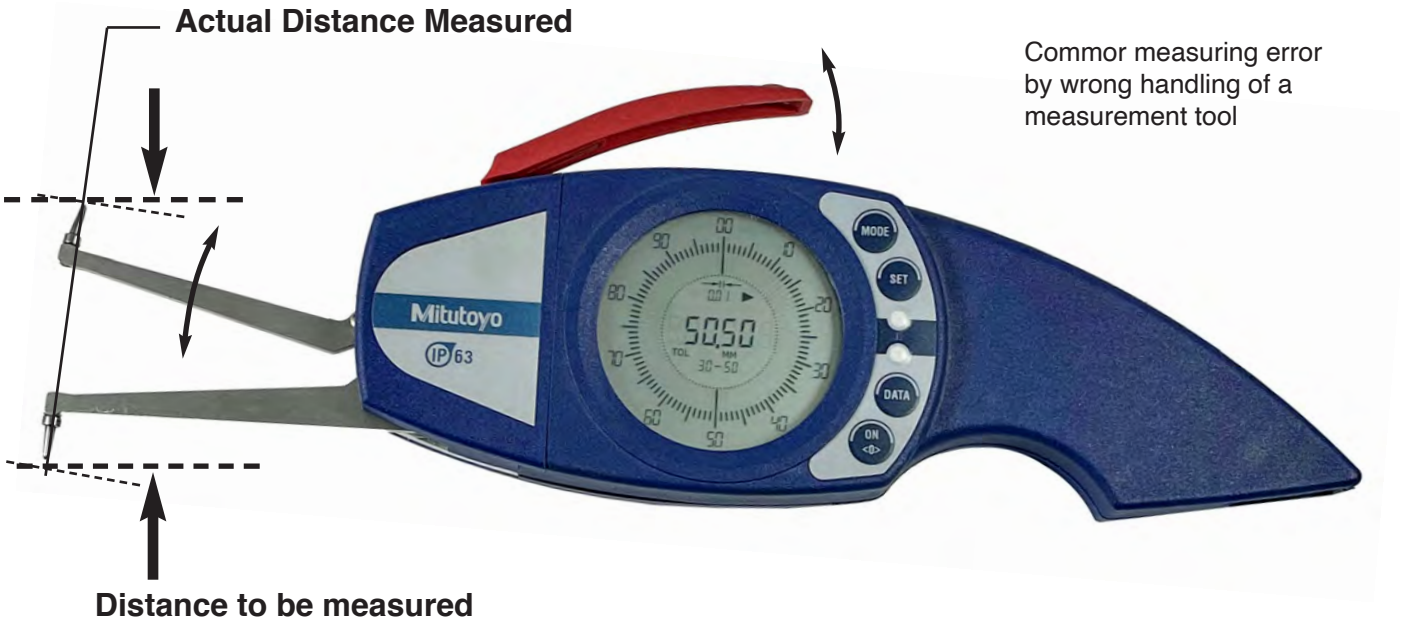
Measurement tools are the foundation in which micromechanics has been built upon. I have always been fascinated with the inner workings of measurement tools and the satin finish on their steel barrels with finely marked graduated vernier scales. Yet I found so little information available on the net about how these instruments work. There are a few famous brand names like Mitutoyo (Japan), Starret (US), Fowler, and Etalon (Swiss), Brown & Sharp, etc. I have more access to Mitutoyo mics so I will discuss some of the models, and explain their inner workings. Russian, and Chinese made measurement tools, although very practical, and affordable, they sometimes don't measure up to my standards.

I always thought of Mitutoyo as mechanical products that one could repair. Since 2016, they decided to redesign their test indicators to reduce their number of spare parts to a bare minimum. Some of these tools at OMiD museum happen to be the older version, so the purpose of these articles is not to teach repair but to understand micromechanics of measurement tool design. Although as a consequence, you'll also learn how to fix them beyond the limits of ordinary repairmen. Latest I heard, Mitutoyo has stopped supplying replacement parts for their older version test indicators.

For all practical purposes, the lighter the measurement tool, the easier it is to use. But lighter also means more delicate, and more delicate means much more care has to be made to protect it from falling down, or being scratched. In a student workshop, measurement tools are usually the worse-looking pieces around. So, precision tools must be separated from ordinary tools, and always be stored in separate boxes to protect, and preserve their accuracy. Companies also need calibration routines to keep the instruments in good shape during their lifetime.

My friends in the field often ask me why I continue Optomechanix? My answer is first of all, this is my passion. I think when I study these measurement tools, it also helps me improve the Optoform system I invented. Optoform is a system that enables users to create their ideas using a precision platform. In general, I think people lack sufficient knowledge of micromechanics. The most learned area for me in studying measurement tools is how to reduce friction at micron level, and what choice of materials would be best to accomplish it. It would be hard for me to imagine how anyone could understand the inner workings of these mechanisms without illustrations, I always find it necessary to make my own drawings. This is a gift I have been given to be able to explain the inner working of things. It's sad technical papers don't have illustrations anymore. That's how it used to be back in 1920's, and 30's. We now have computers with exceptional graphics capability, but very few are curious, and patient enough to enhance their imagination through hand drawn graphic design.

Ali Afshari
Editor in Chief,
Optomechanix



One of the marvels of measurement tools is their repeatability, and uniformity of measurement throughout their large measuring range. Above, this digital internal measurement device made by Mitutoyo measures the inner diameter of parts between its lower fixed arm, and upper swing arm that are brought close together by a hand lever (in red), and released inside, i.e. a tube. An internal encoder converts the rotary movement of the swing arm into a linear distance with 0.01 mm resolution. A mechanical version of this tool is also explained (refer to page 21) to show how it works.

Introduction to Dial Indicators, and Micrometers

By Ali Afshari

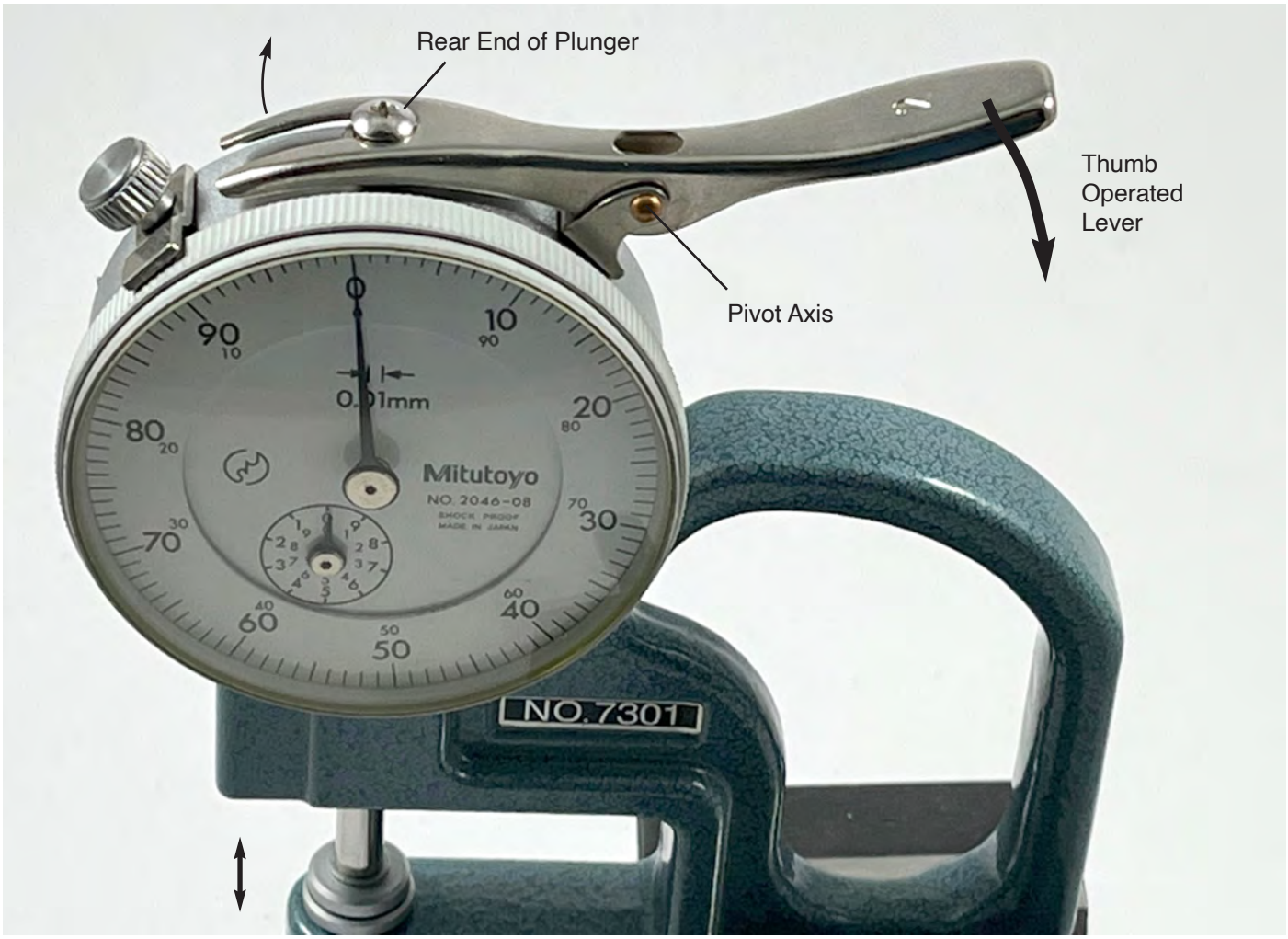
The best measurement instruments in the world are European, namely, the Swiss made Etalon. European made measuring instruments are more robust, made of diecast steel, and use less plastic parts. In contrast, Chinese measuring instruments use a lot of plastic parts. The main object of Chinese made instruments is to look the same but with plastics with an attractive price of 1/10 th. The Japanese version of measurement instruments is quite different from their cheap

Chinese counterpart. In Japanese measuring instruments, although still a copy of the European, there is a solid foundation both in design, and fabrication of parts. The best way to appreciate the quality is to disassemble these instruments, and to explain their inner workings. Mitutoyo is the best Japanese made measuring tools in the industry with thousands of devices, and accessories. At OMiD museum there are plenty of measurement tools that could be taken apart and explained to show their inner workings. By studying them, we could learn to do better optomechanical design. The precision, and tolerancing in measuring instruments dwells somewhere in between watchmaking, and cameras.

One question is why the inner parts need to have good finish? The simple answer is they don't need to be, but you can't really make precision parts without a good finish. We'll start by disassembling a few dial indicators to study their design and then move on to internal measuring micrometers made by Mitutoyo, Japan. Dial indicators are widely used in the industry but this particular one uses its mechanics to build a thickness measuring gauge.

Lever Operated Thickness Gauge

Lever operated thickness dial gauges are mostly used in printshops to measure thickness of paper by applying a constant light pressure on paper or film. The range usually 15 mm max. It employs the existing mechanics of a dial gauge, such as its plunger, and its rear end engaged with a thumb lever to conveniently open, and close its measuring contacts.

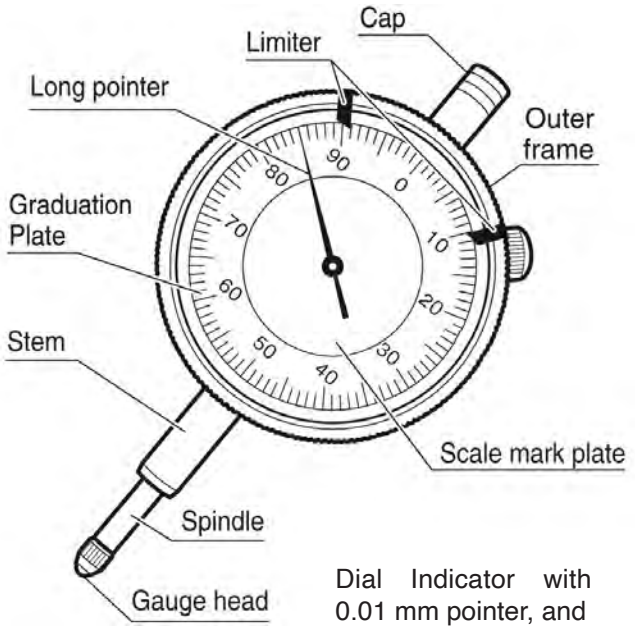


Dial Indicator, 30 mm Travel

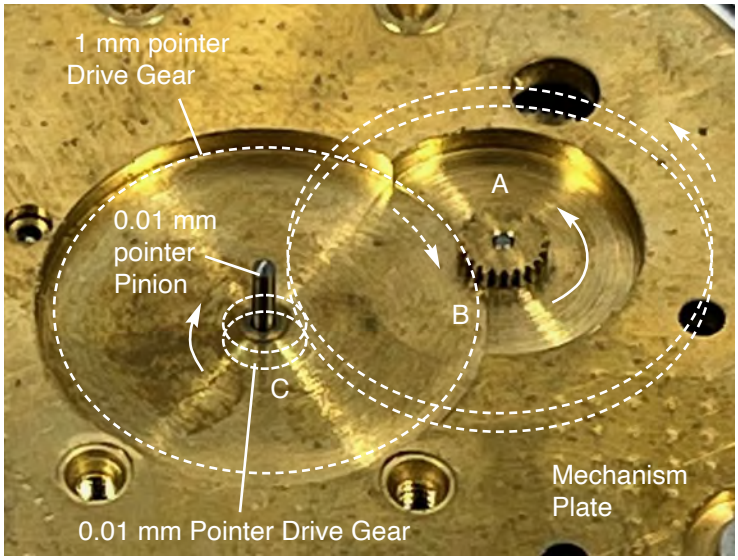
By Ali Afshari

At first glance, one would wonder how is it that the 0.01 mm measuring resolution dial indicator is using the obvious rack and pinon design but without slipping? These devices have been working reliably all over machine shops, and factories for so many years with no problems. So what is the secret of their design? well, contrary to what any mechanical engineer would think, the dial indicator design is more cleverly done that it meets the eye.

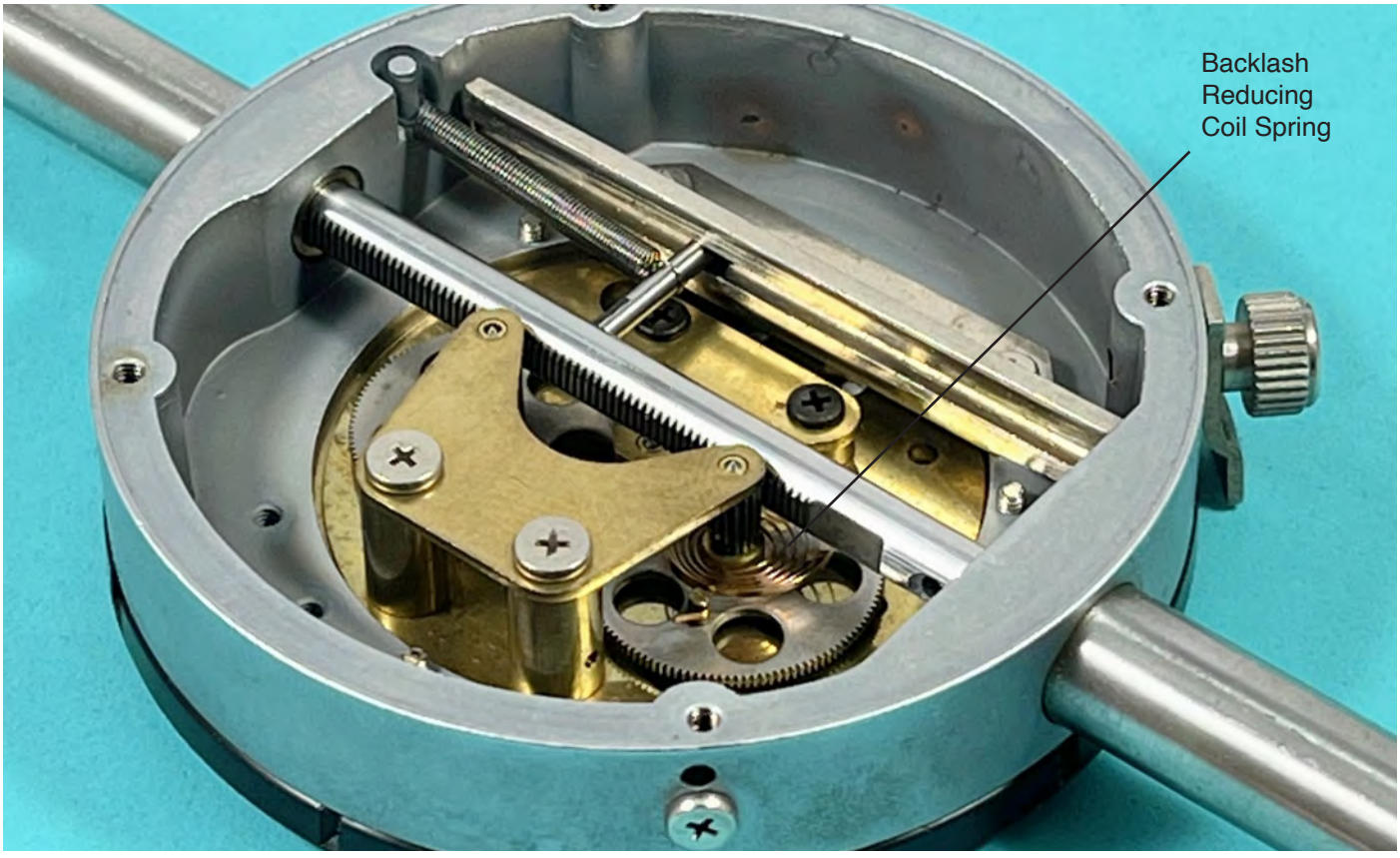
Yes this is a rack, and pinion design but the rack is not in direct contact with the pinion. There are two large gears that are in contact with the rack, and it is those gears that transfer the mechanical displacement of the rack to the pinion from both sides (below). To see these parts, the back cover could be removed. For further disassembly, the front crystal is re-



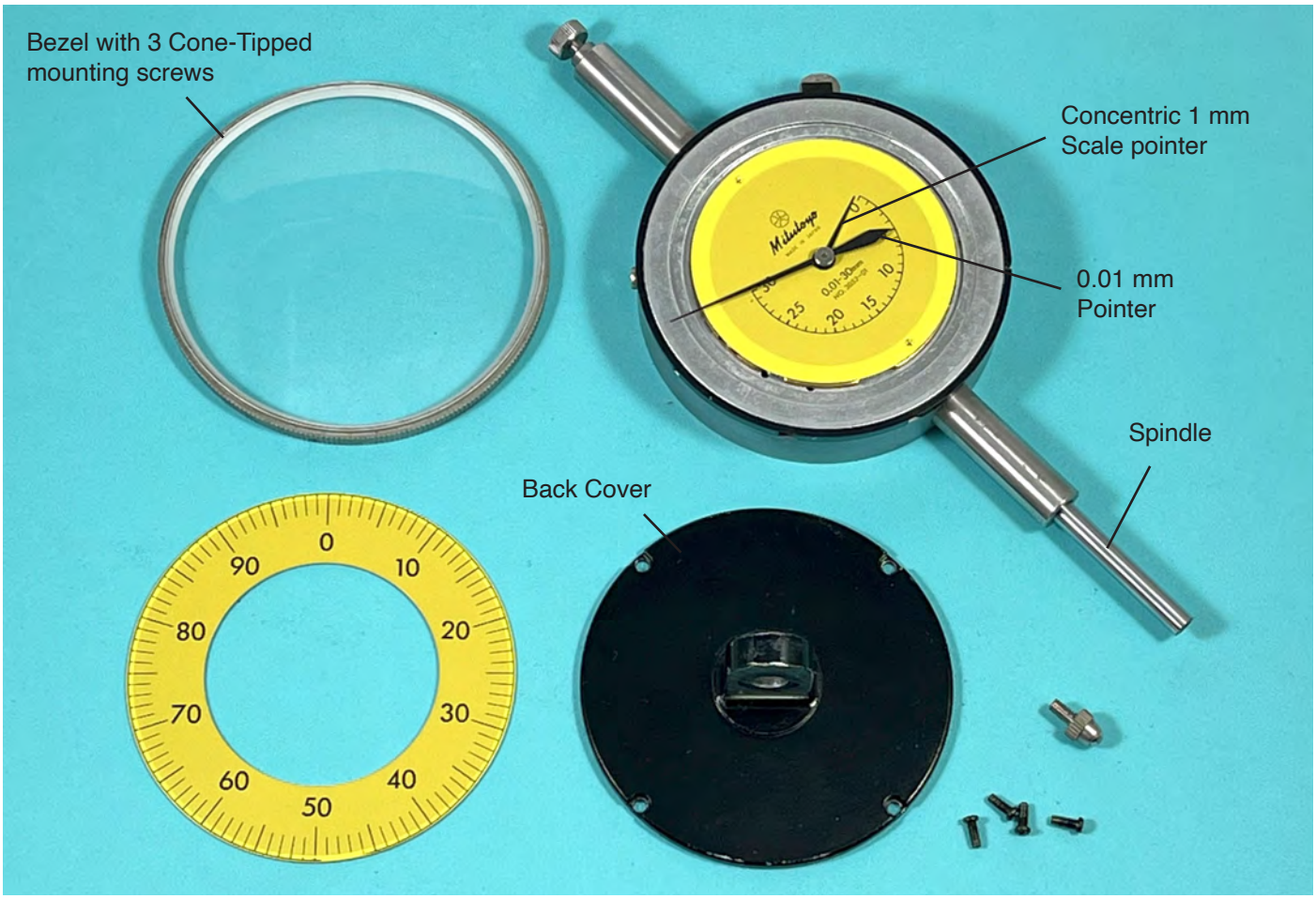
Dial Indicator with 0.01 mm pointer, and 1 mm travel

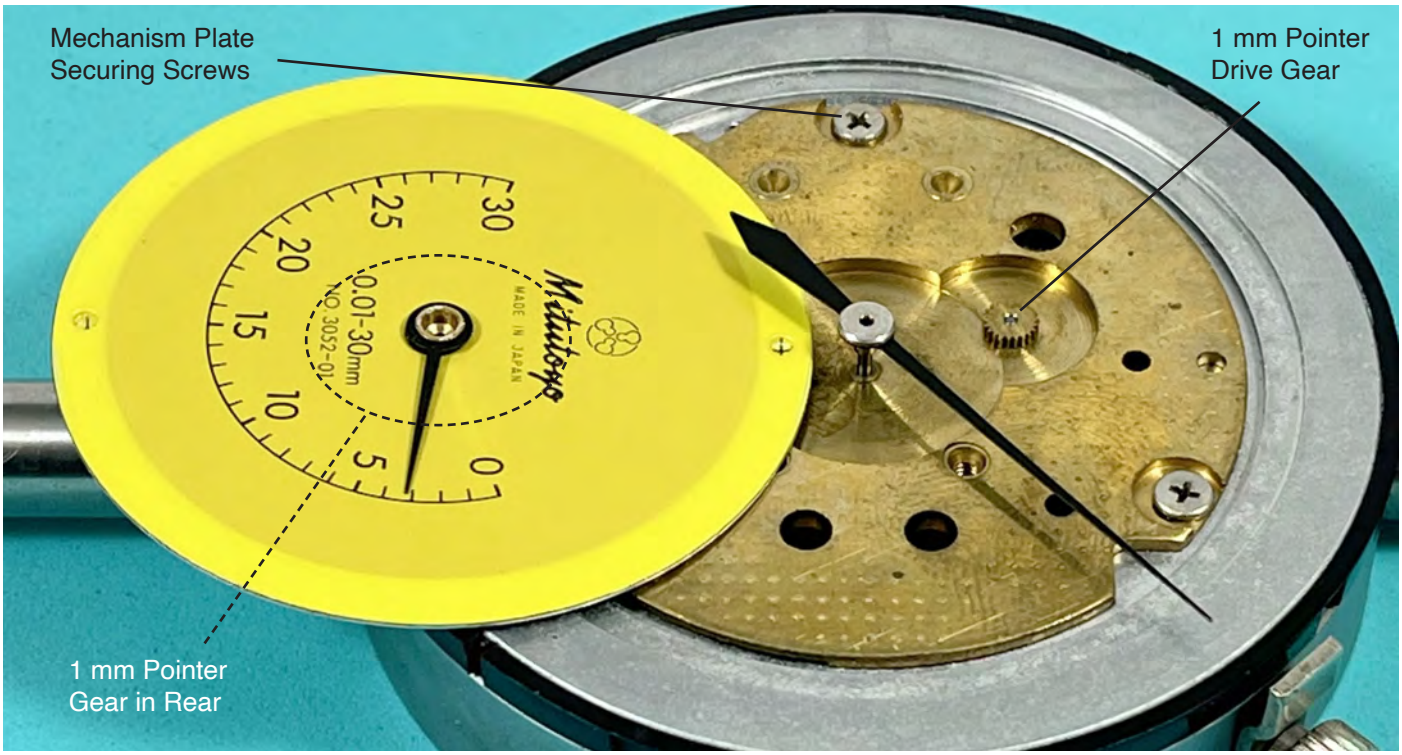


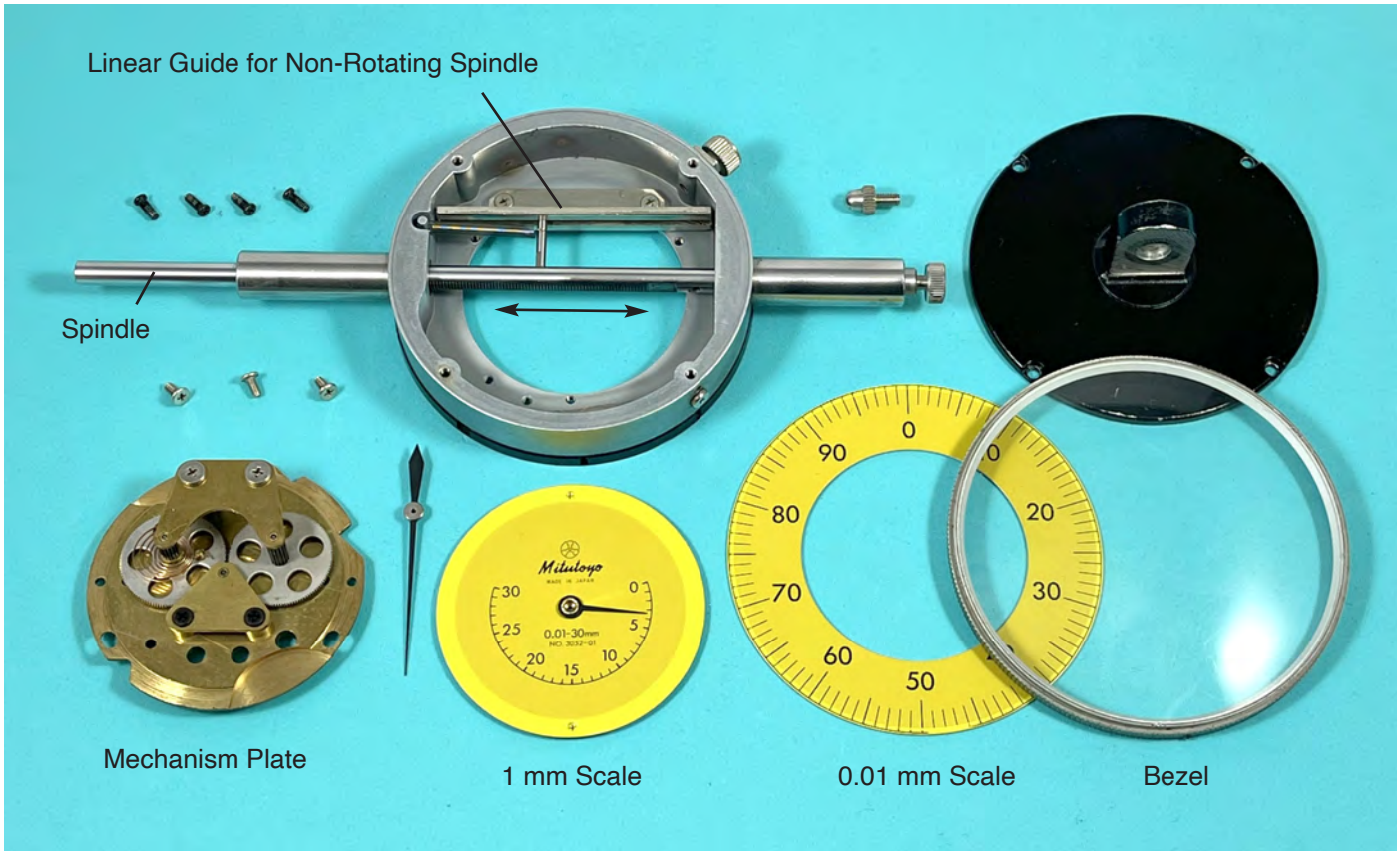
0.01 mm pointer shaft is driven by gear C, which is behind the mech plate. Concentric 1 mm pointer is driven by gear A as shown above the mech plate, and gear B (see Page 7).

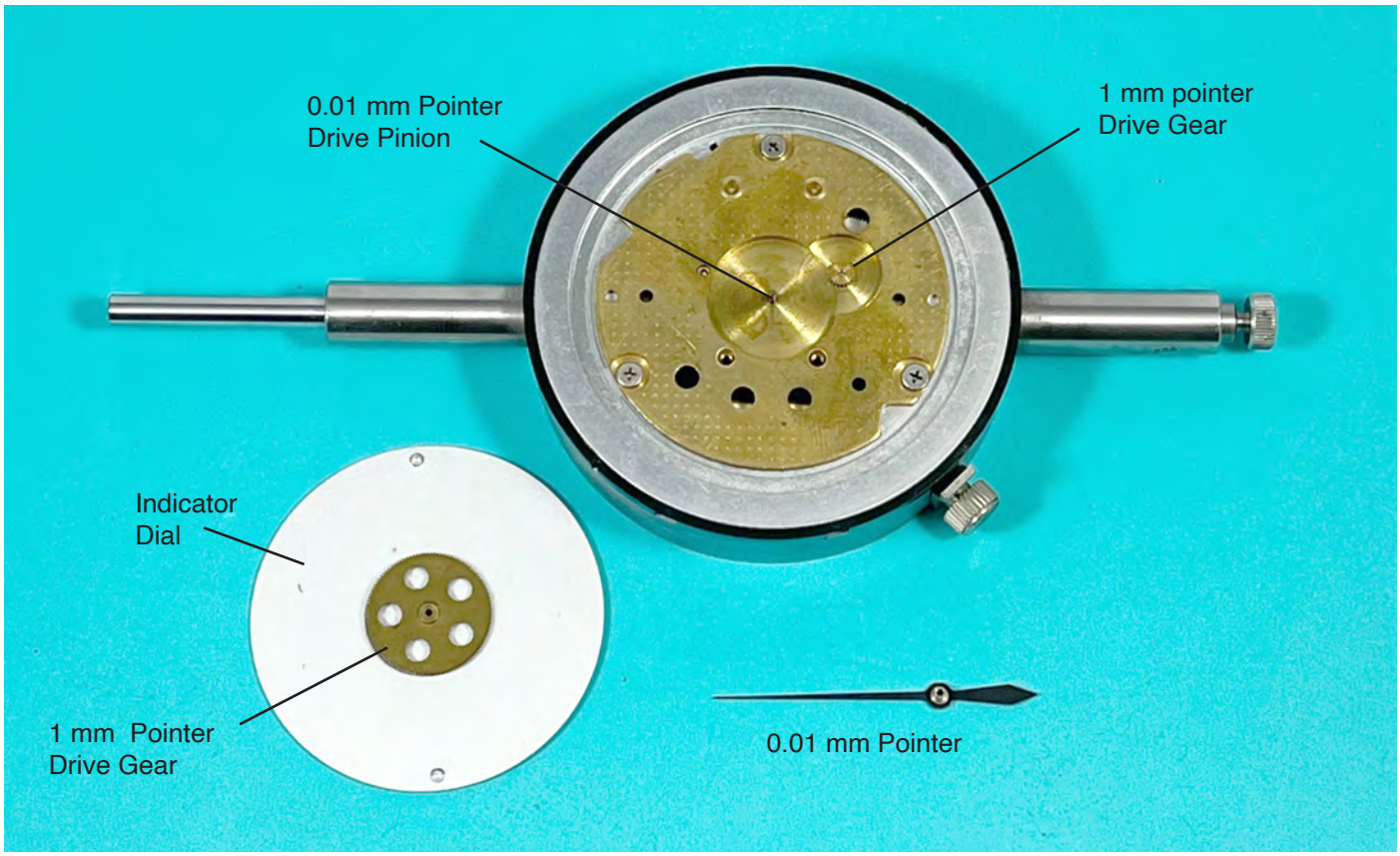


moved, and in this particular design, there are three cone-tipped screws on the bezel, that are 120 º apart, are disengaged. The dial face is now exposed. To further disassemble the indicator, a strong hand puller must be utilized to take off the hands. They are so tightly set that you would never find anything like it in watches, perhaps is large sized sports chronometers. In any case, by removing the main hand, the three mechanism securing screws are exposed (bottom), and the dial indicator could now be fully disassembled.





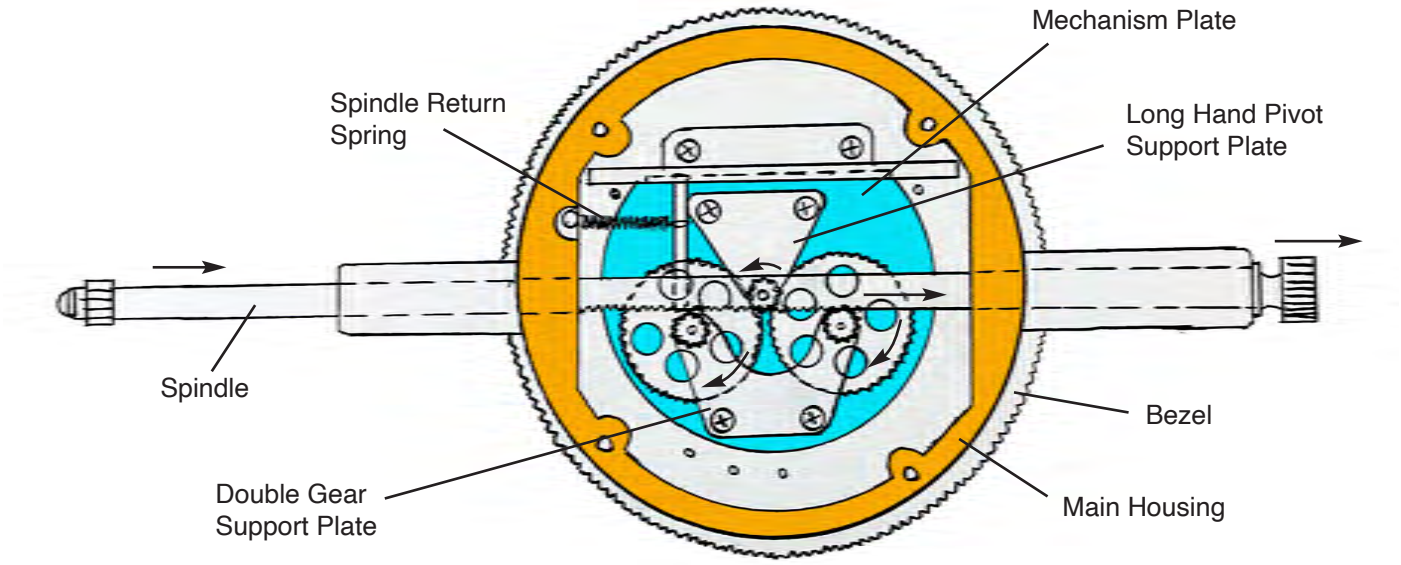

Linear Guide for Non-Rotating Spindle
Spindle
Mechanism Plate
1 mm Scale
0.01 mm Scale
Bezel


0.01 mm Pointer
Drive Pinion
1 mm pointer
Drive Gear
Indicator
Dial
1 mm Pointer
Drive Gear
0.01 mm Pointer

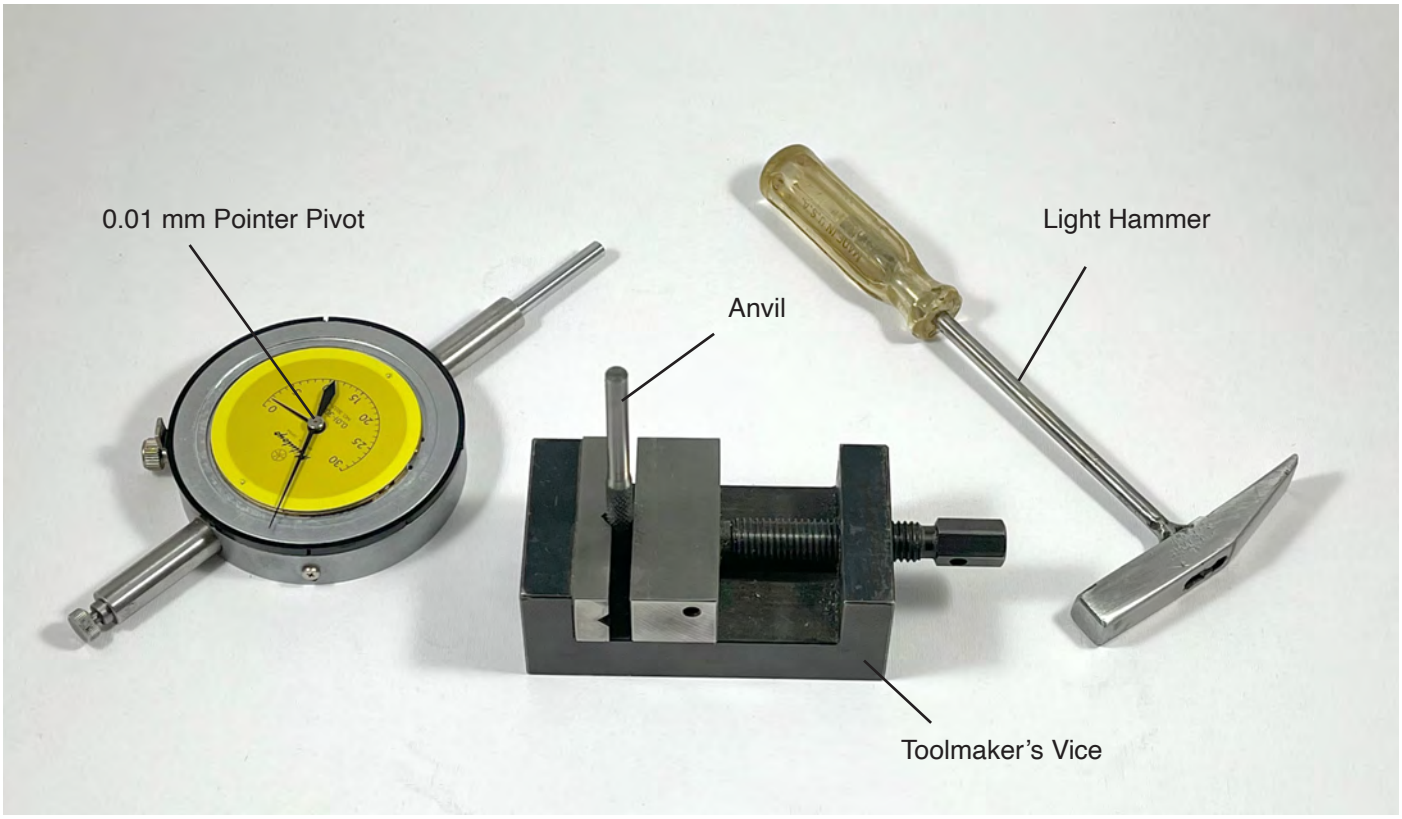
Reassembly

Reassembling the dial indicator is an art by itself. The three-mechanism plate (below) securing screws allow adjusting the gear engagements by slipping. Both gears have to be properly engaged to maximize their contact ratio while allowing smooth sliding of the spindle throughout its travel range. The return spring may be taken off to feel the smoothness of spindle's sliding action.

The long indicator hand (or the long arm) in dial indicators is as tight as hell. I was lucky I was able to take this off. I used a wire cutter that had just the right clearance to pull off the long hand against the short hand pivot. Don't do it unless you have to!



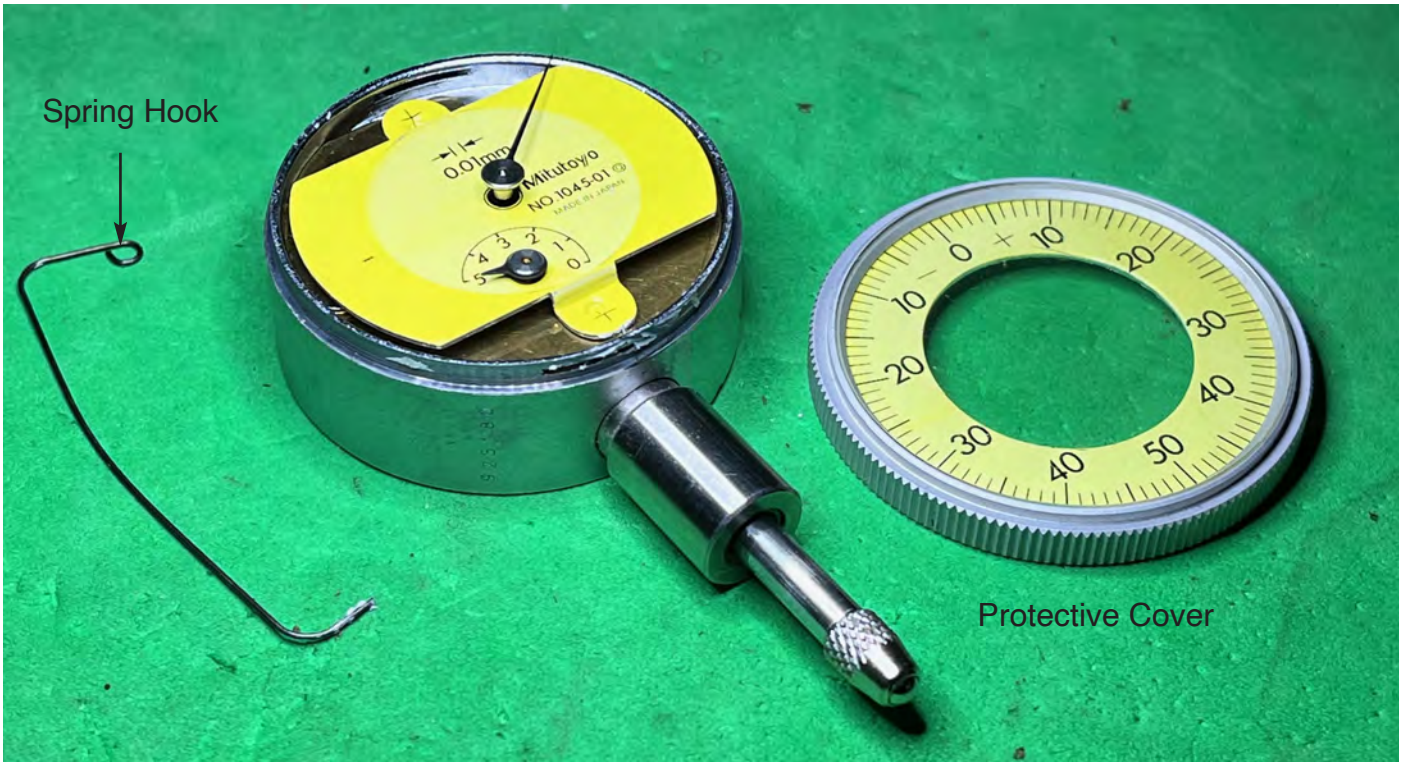
Installing the long hand requires striking it by a light hammer against its pivot. Make sure to support the pivot's support plate with an anvil (below) to avoid bending the mechanism plate.

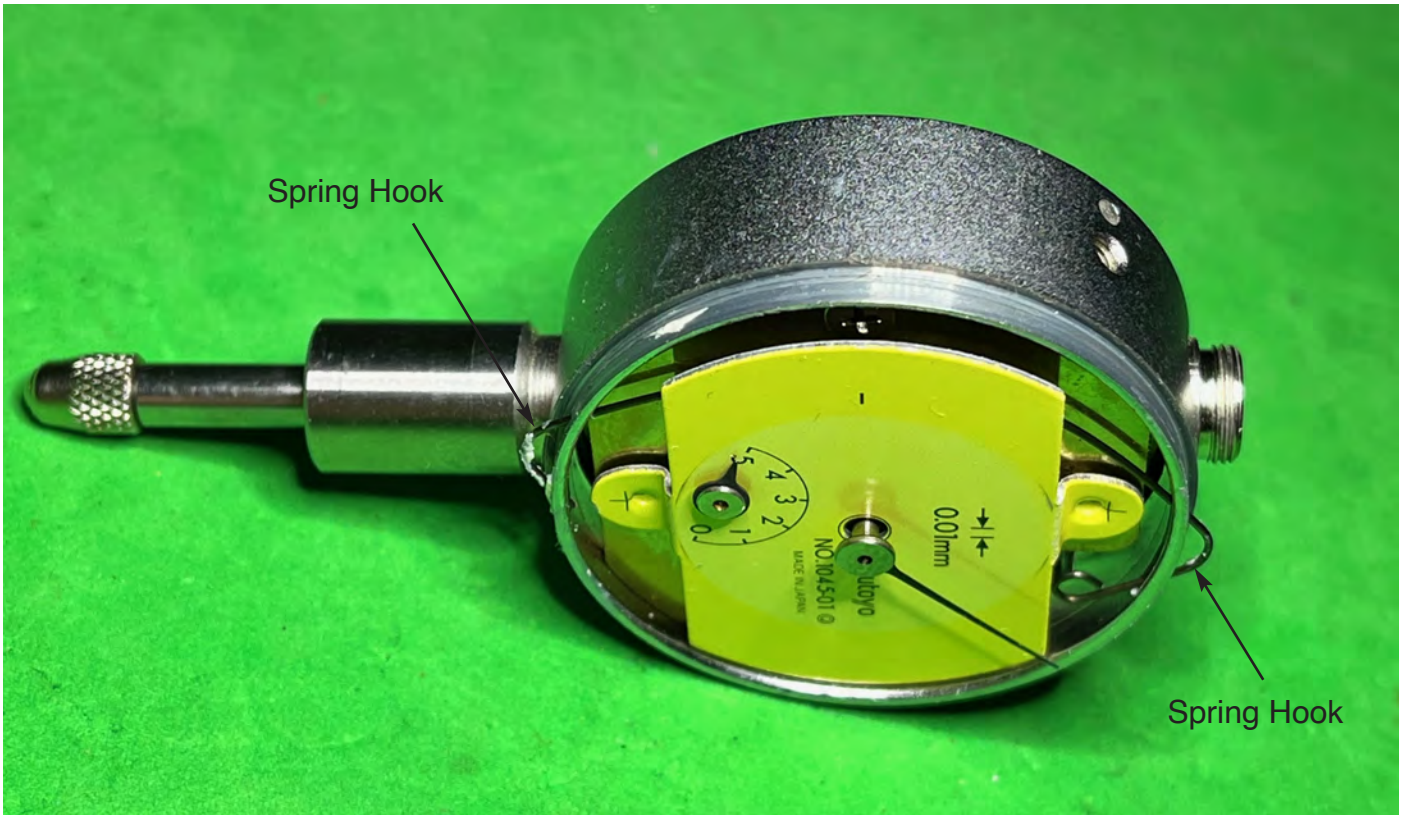


Specially made anvil rod to support the pivot plate from the back while installing the long arm pivot.

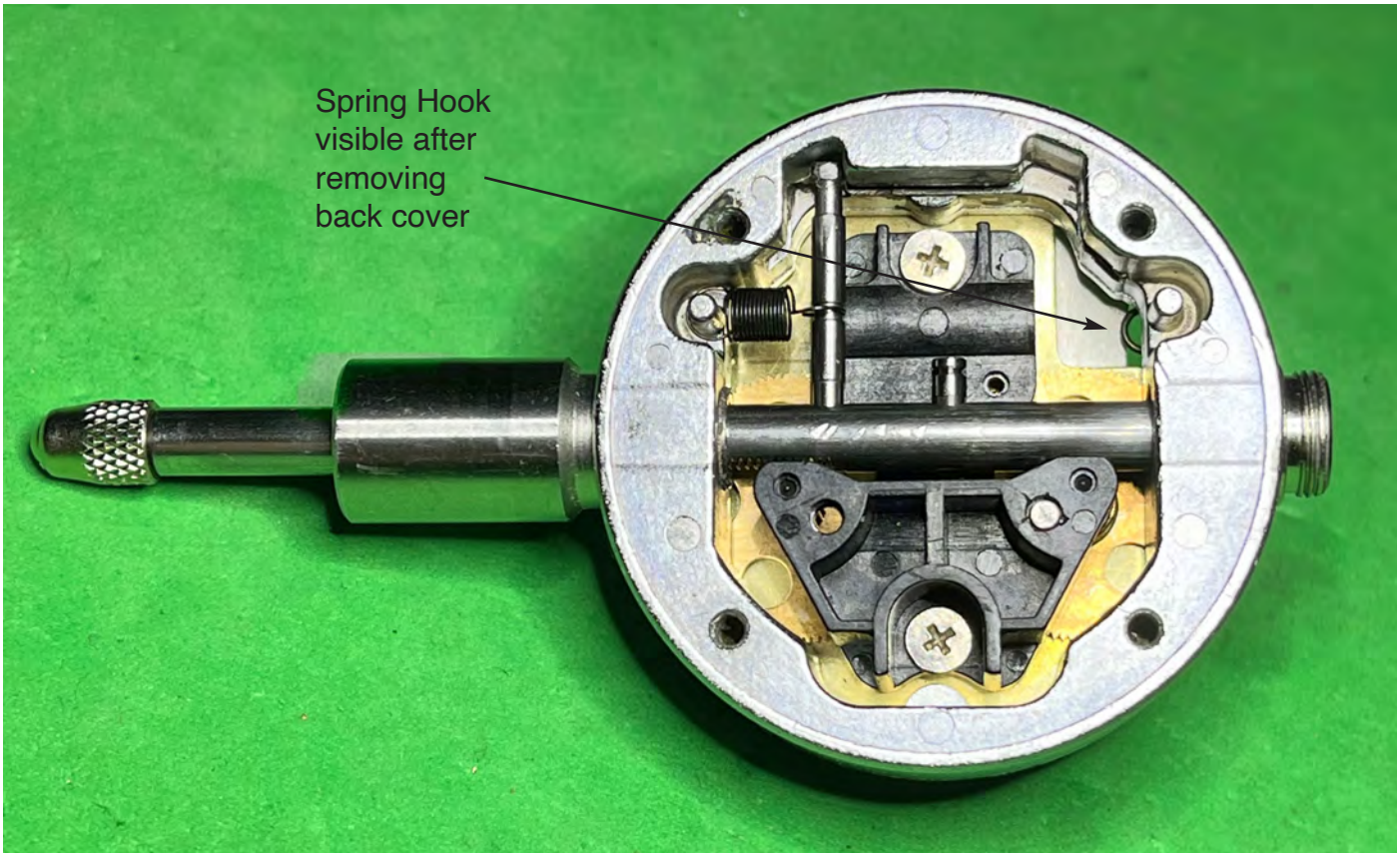
Dial Caliper, 5 mm Travel

We'll disassemble this miniature dial indicator to study its design, and even learn how to fix it. This design is the most common among Mitutoyo indicators, and there is a secret entry way to disassemble it. The first thing to be removed is the dial itself which is held by a wire spring accessible by removing the back cover. Once the spring hook is pulled in, the protective dial would come off, and the spring could be pulled out from one side (below).

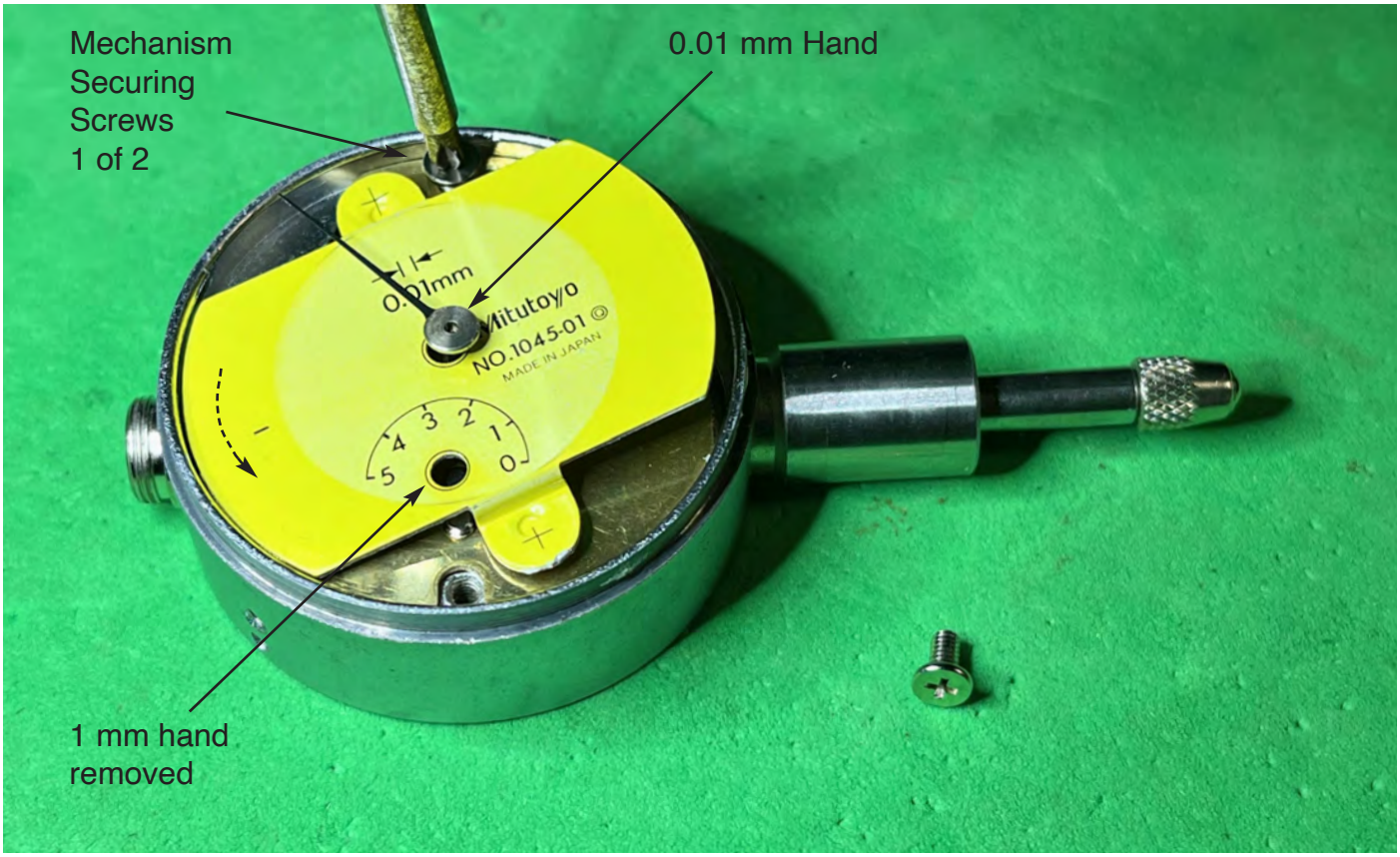




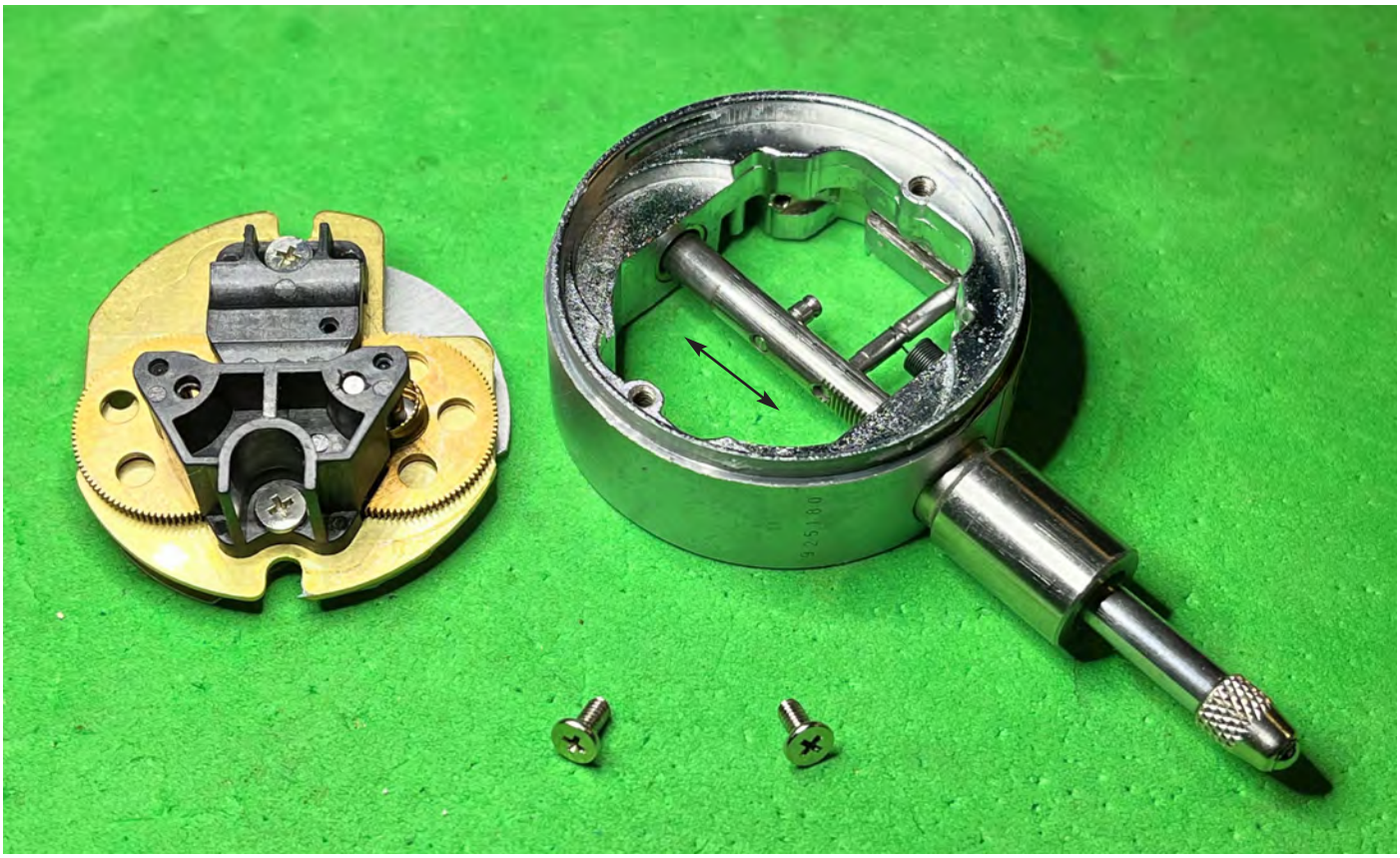
It's easy to remove the front bezel off of a dial indicator but further disassembly needs special tools, see page 16.



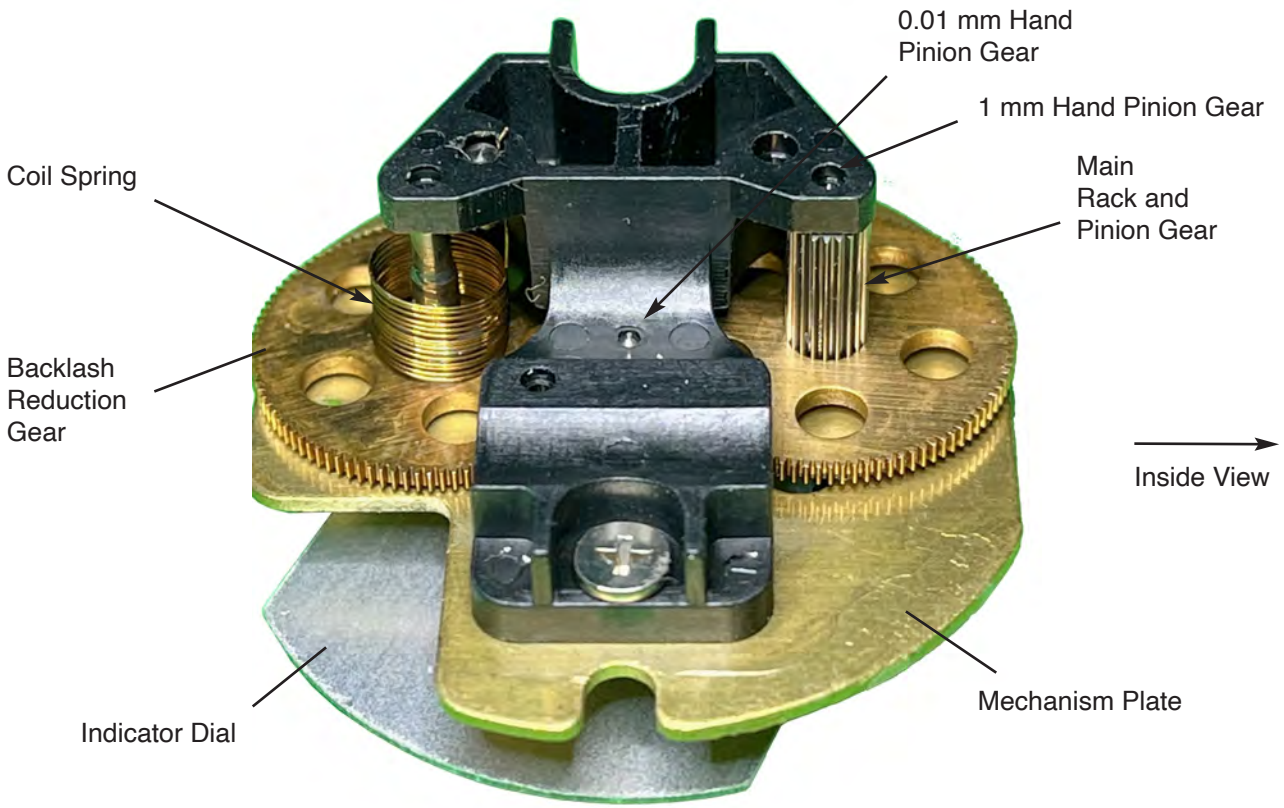
Two levers are shown pulling the hand out placed on top of the dial face. They could actually be placed below the dial face to avoid scratching it. This is a watchmaking procedure that one must learn to continue disassembly. Watch hands are never installed this tight.

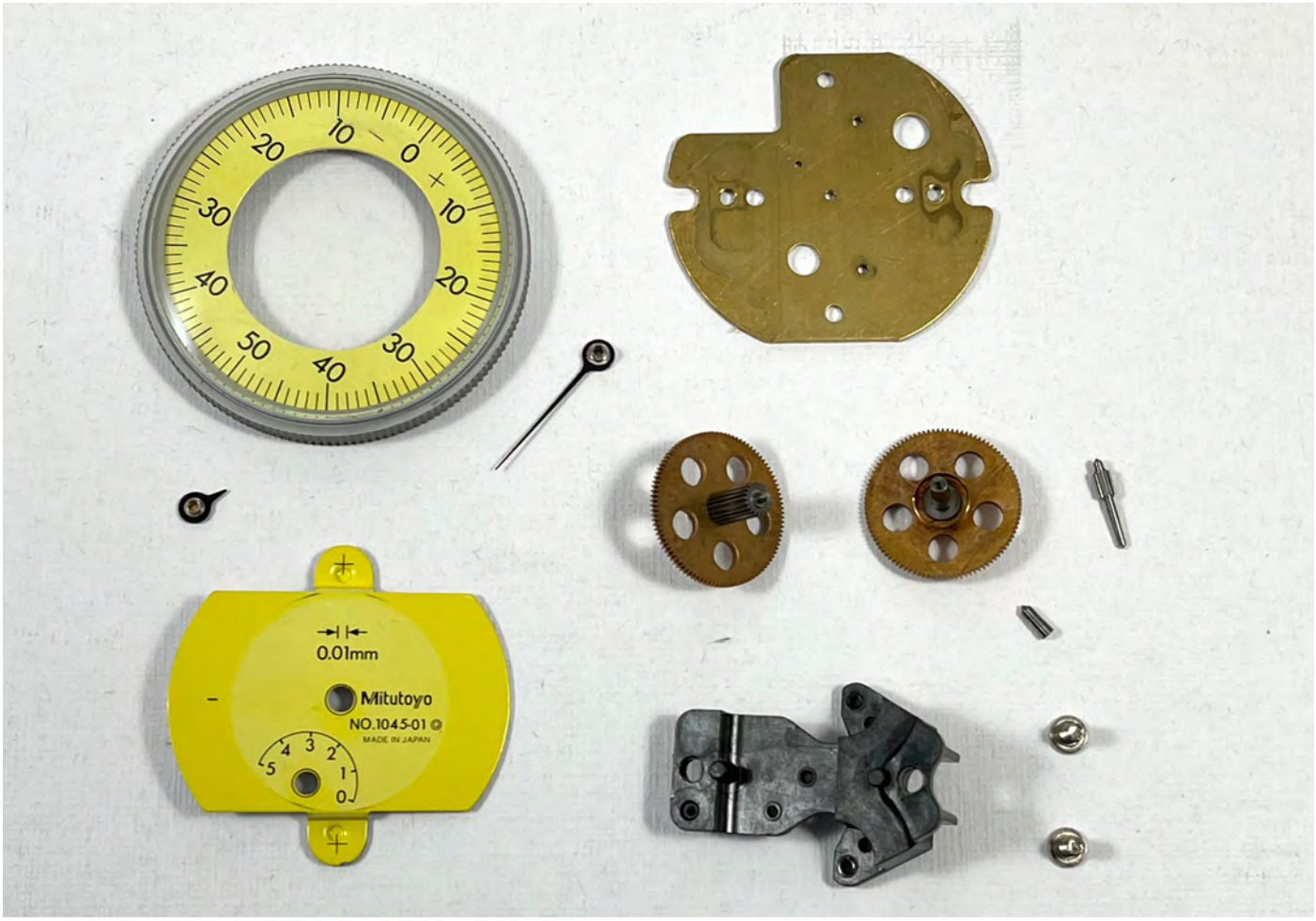


Disassembling the dial indicator takes a series of steps that are common in taking apart these precision instruments. The first step is to remove the front bezel, then the indicator hands, and then the mechanism plate behind it.



Taking off the mechanism plate takes a bit of courage because you'd be afraid if you would mess up the timing. This is not really the case. Dial indicators are quite easy to disassemble, and to put them back together.

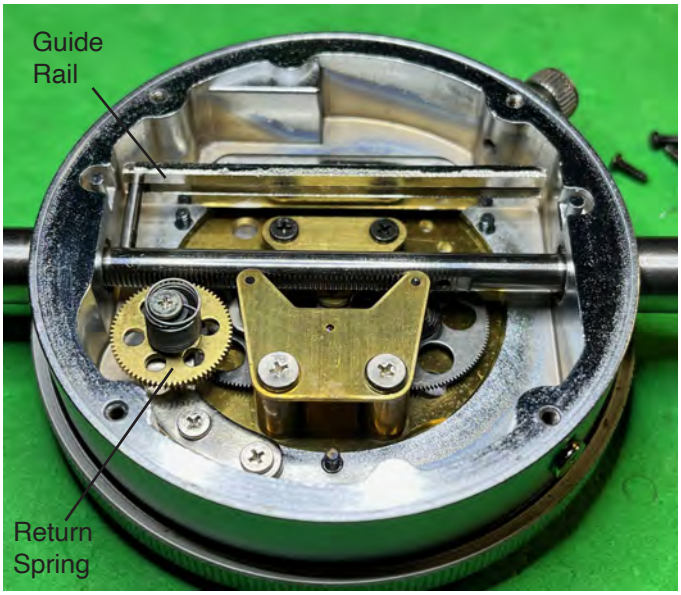

0.01 mm Hand
Pinion Gear
1 mm Hand Pinion Gear
Coil Spring
Main
Rack and
Pinion Gear
Backlash
Reduction
Gear
Inside View
Indicator Dial
Mechanism Plate

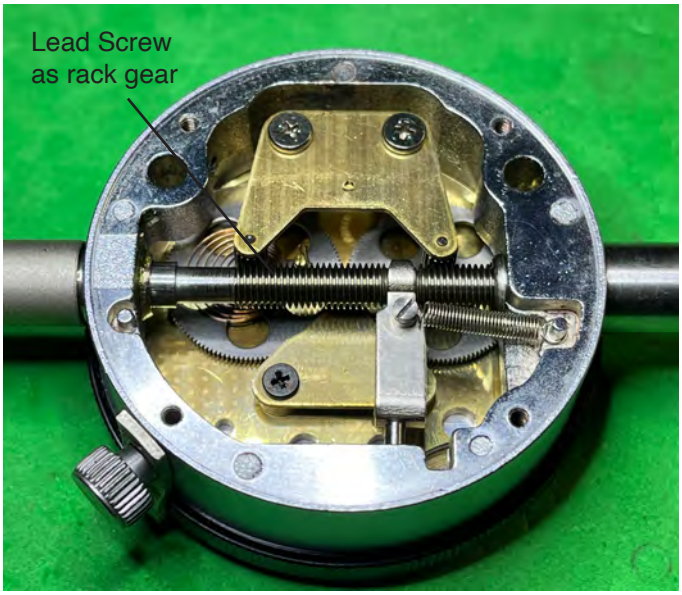

0.01mm
Mitutoyo
NO.1045-01
MADE IN JAPAN

Repair of the dial indicator

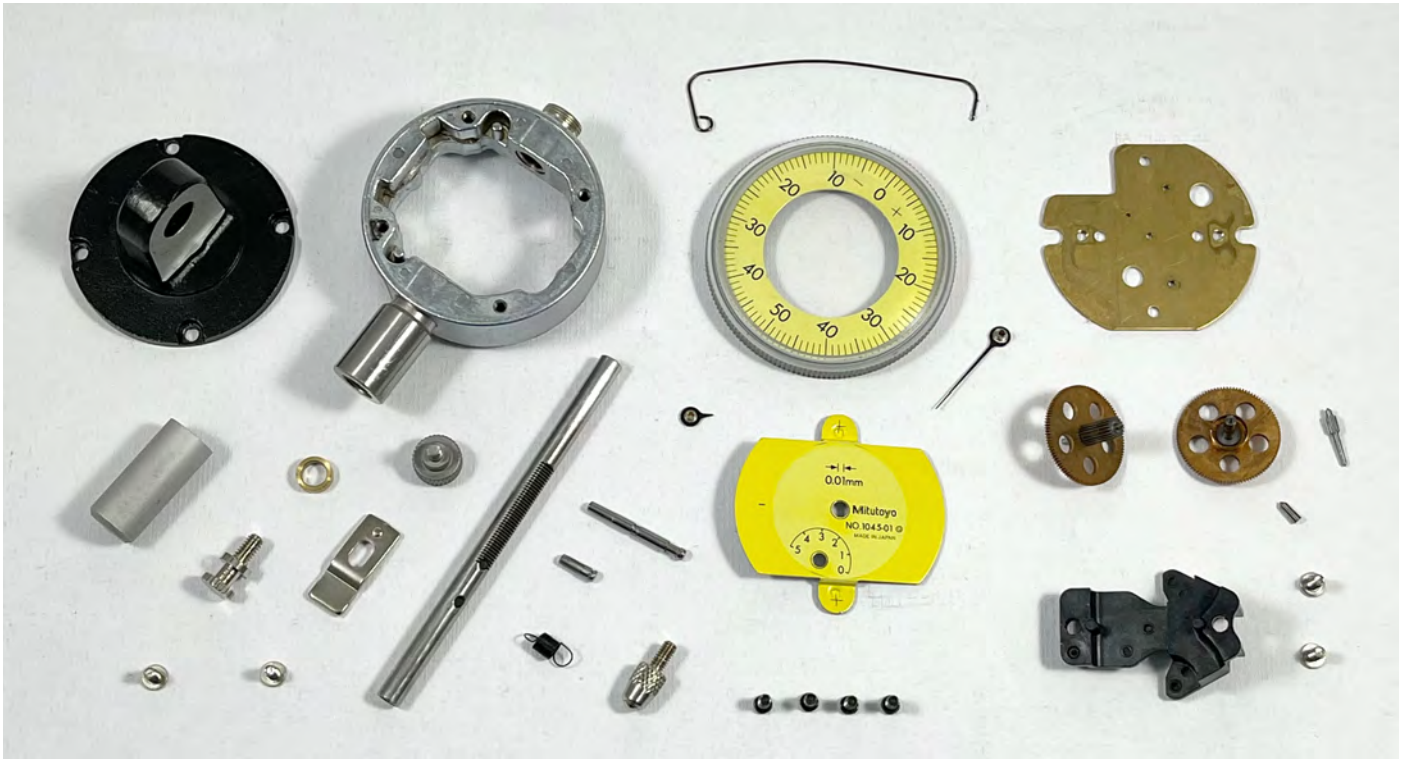
This is not a repair manual but I think it would encourage many to disassemble their faulty dial indicator, and as a result, learn how it works. The main dial housing has two concentric bores to secure both ends of the measuring shaft. The concentricity of these bores could be checks in a small lathe. If you have a precision watchmaker's lathe such as Levin, you are lucky because Levin has exact collets to secure the mounting rod of the dial indicator as well as its central measuring rod. The setup is show on the next page.

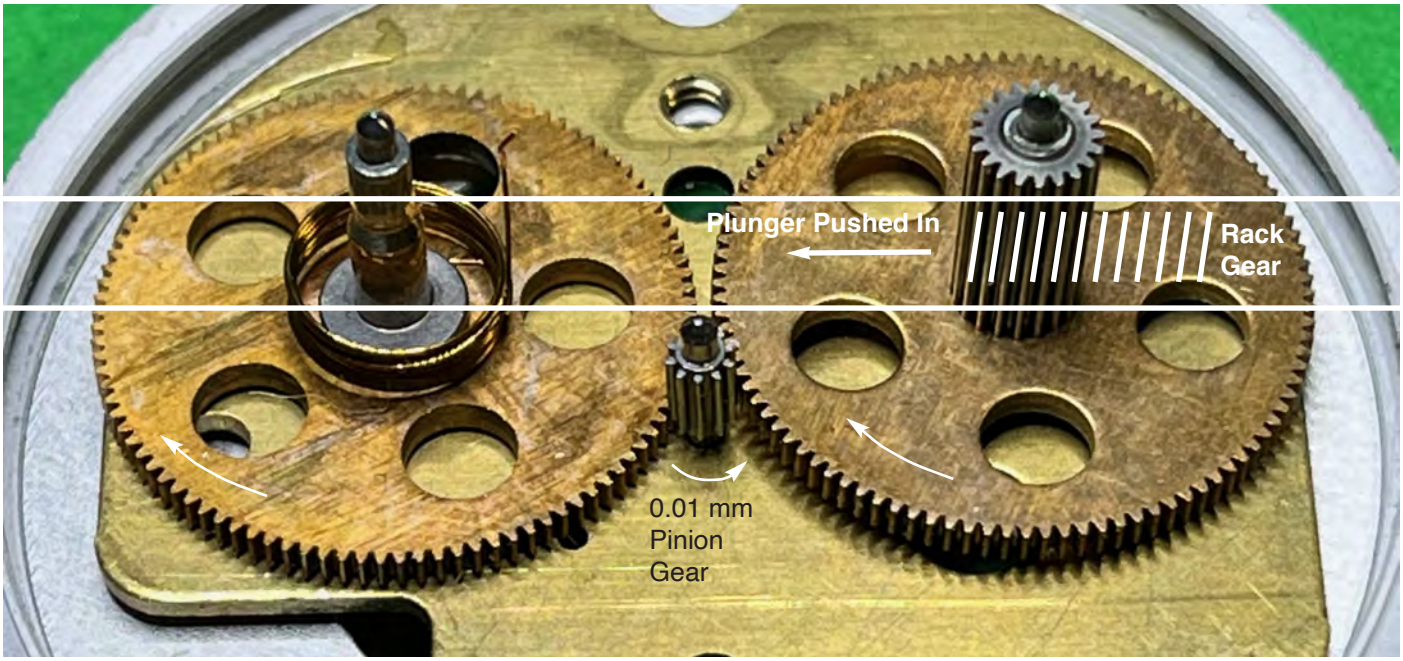
Design wise, you could now see how the dial indicator is cleverly constructed with minimum number of parts. Long travel dial indicators have a gear wound spring instead of a simple coil spring shown in this small travel indicator (below).



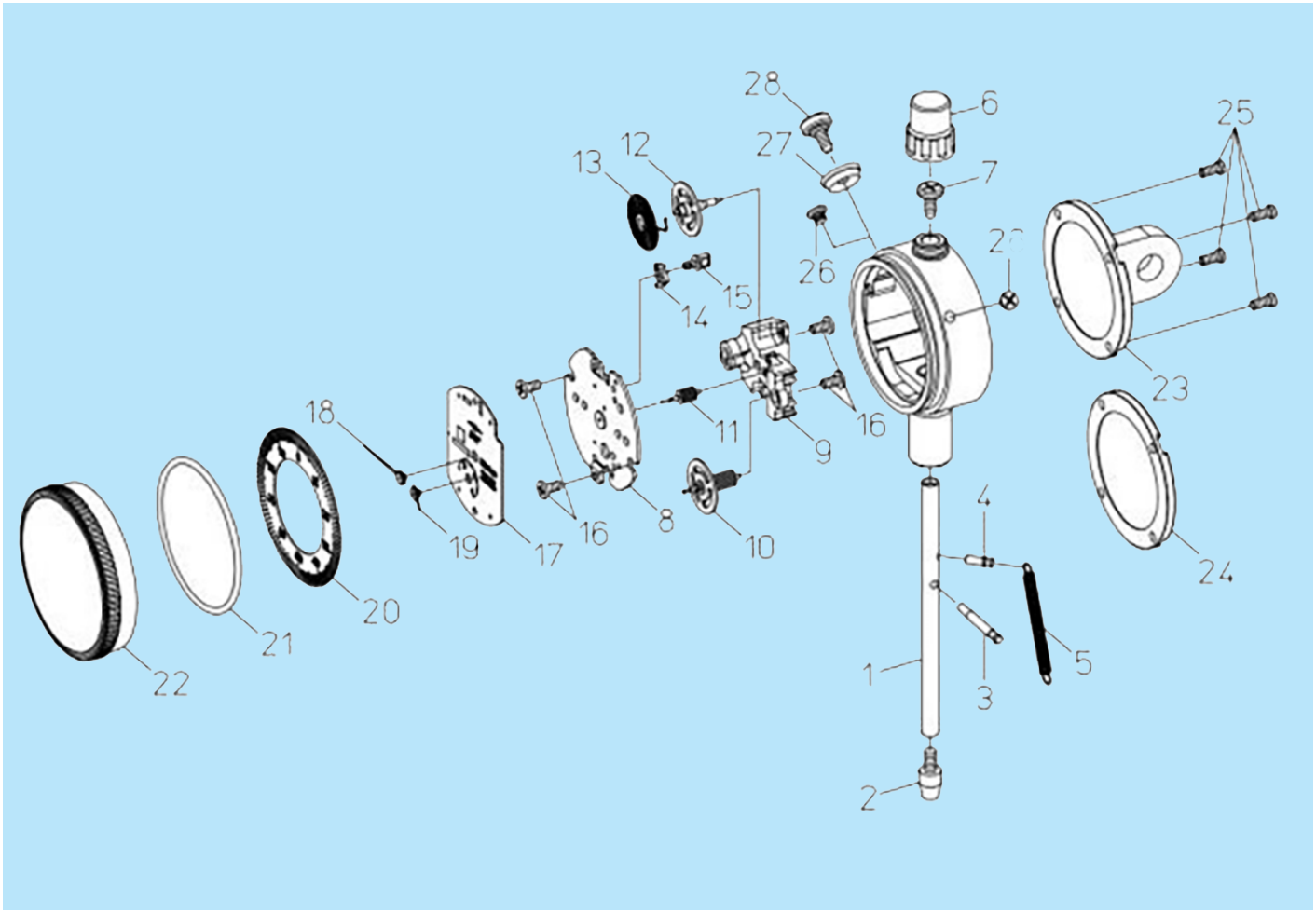


Above, left, 0-50 mm dial indicator. Right, 0-25 mm dial indicator with rotating measuring shaft uses a lead screw as a rack gear. This allows the user to rotate the shaft to zero the reading instead of rotating its bezel.

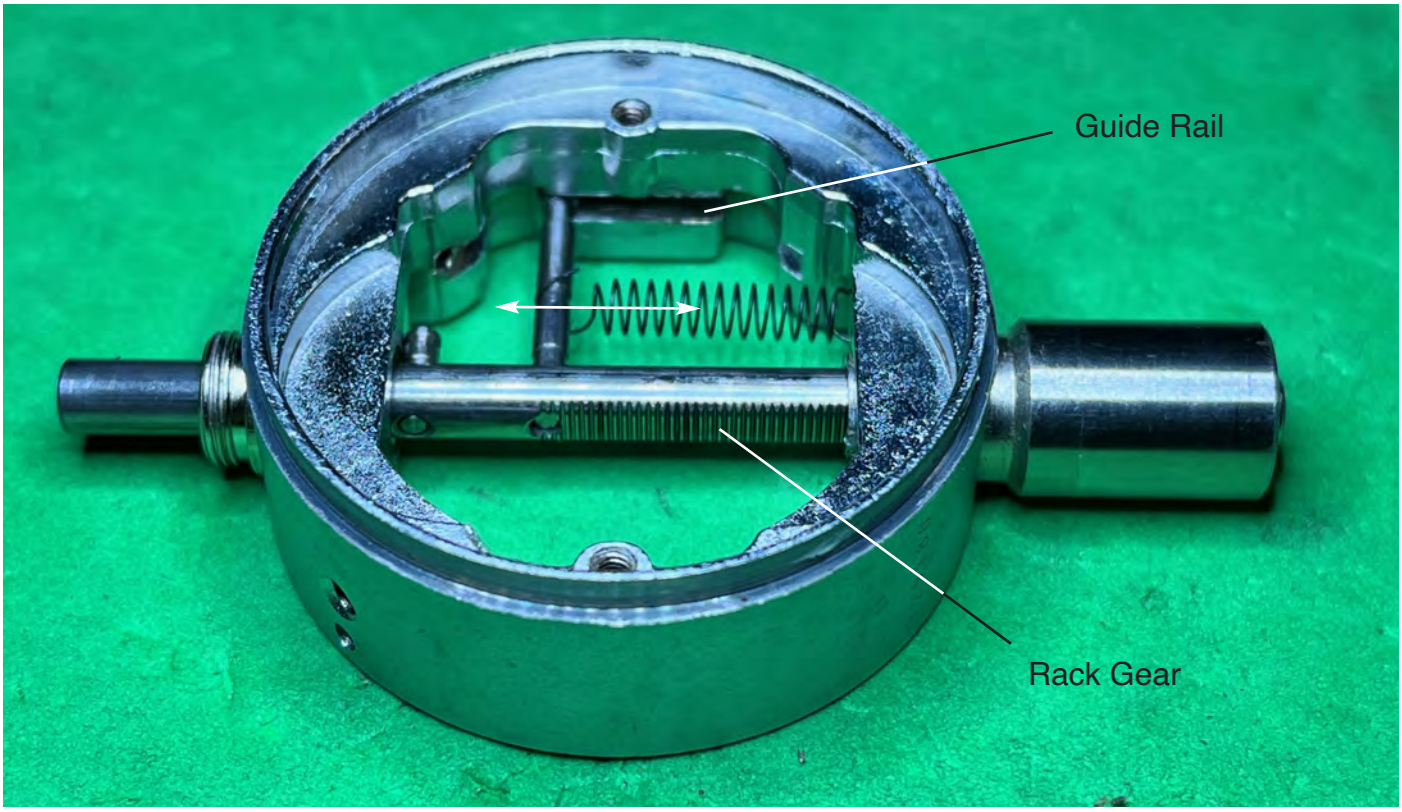




In this design, Mitutoyo engages only one gear to the spindle rack gear (above). For larger travel, larger dial indicators, there is much more inertia exerted by the long arm, and it would be necessary to implement a more robust design. But in this case, Mitutoyo designers decided not to deliver a more delicate approach. In this design, the backlash is minimized by utilizing a spring-loaded 2nd gear (left), While the shorter arm is driven by the first gear (right). The result is a more sensitive mechanism that would offer more accuracy than longer travel indicators. Although so visually user friendly, dial indicators don't have much better accuracy than 0.05 mm, but they are quite repeatable.



Exploaded view of the dial indicator shows internal parts as dictated by Mitutoyo design group.

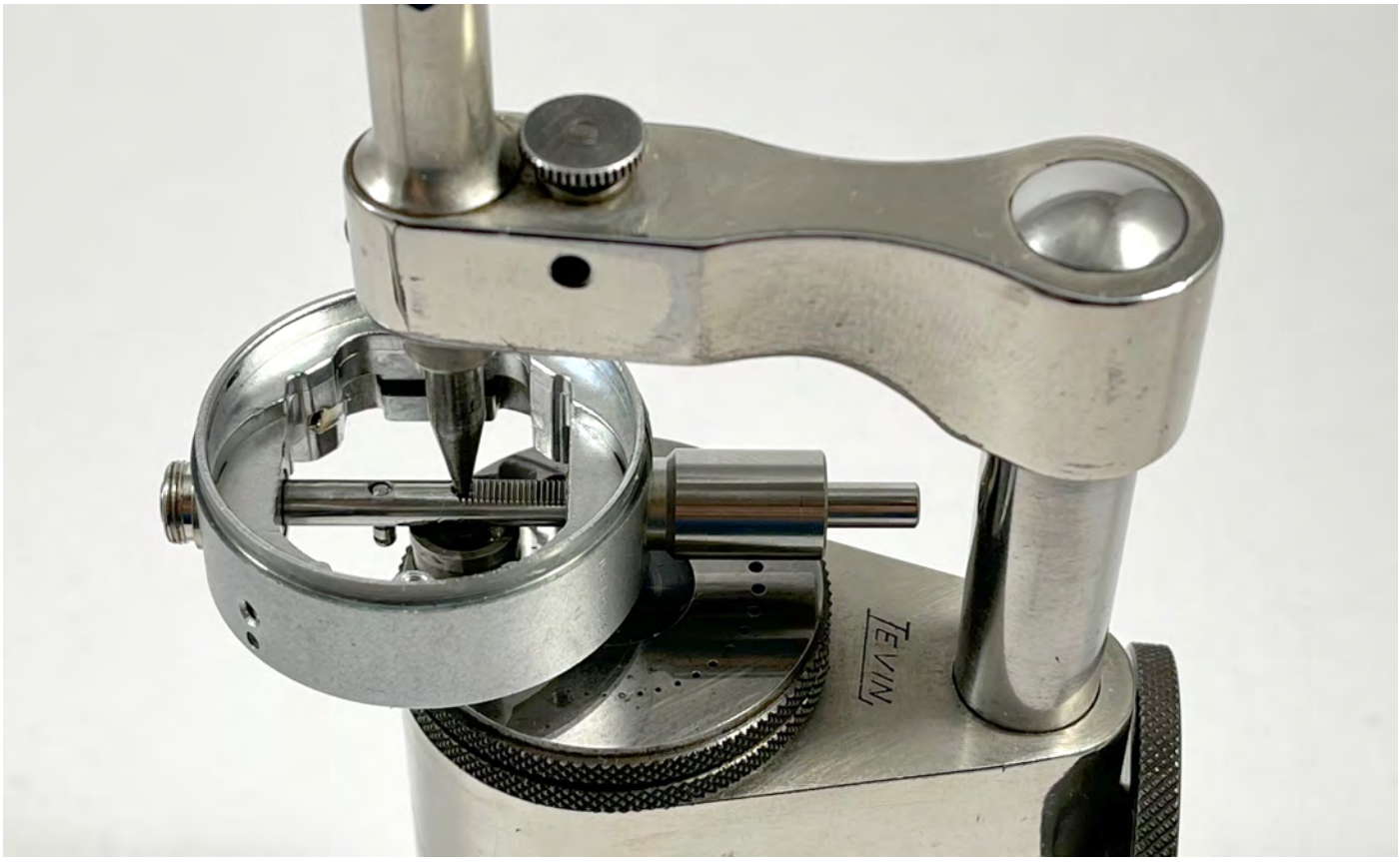

Guide Rail
Rack Gear

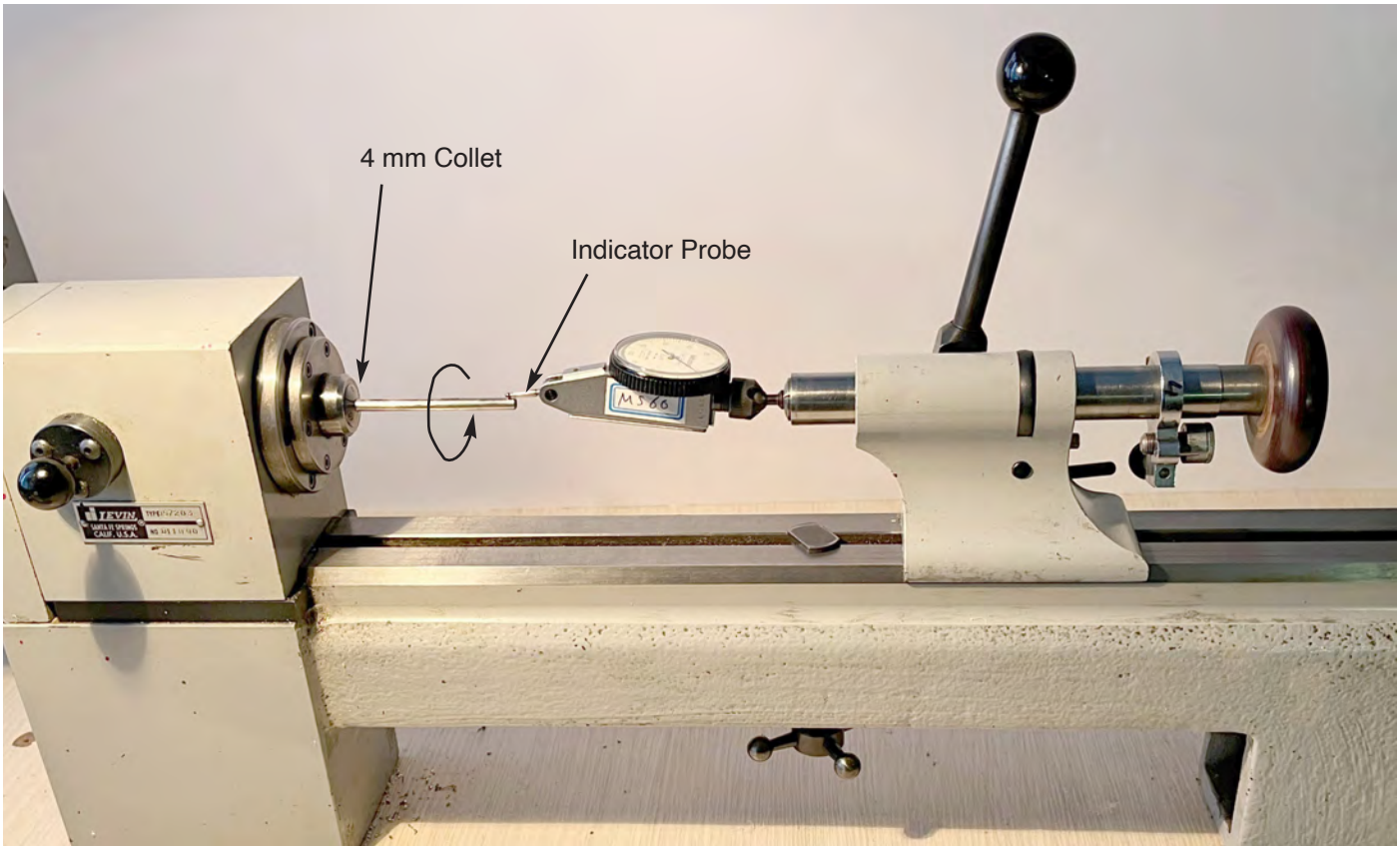

Watchmaker's
Staking Tool
Hand Pullers
Cross Point Screw Driver

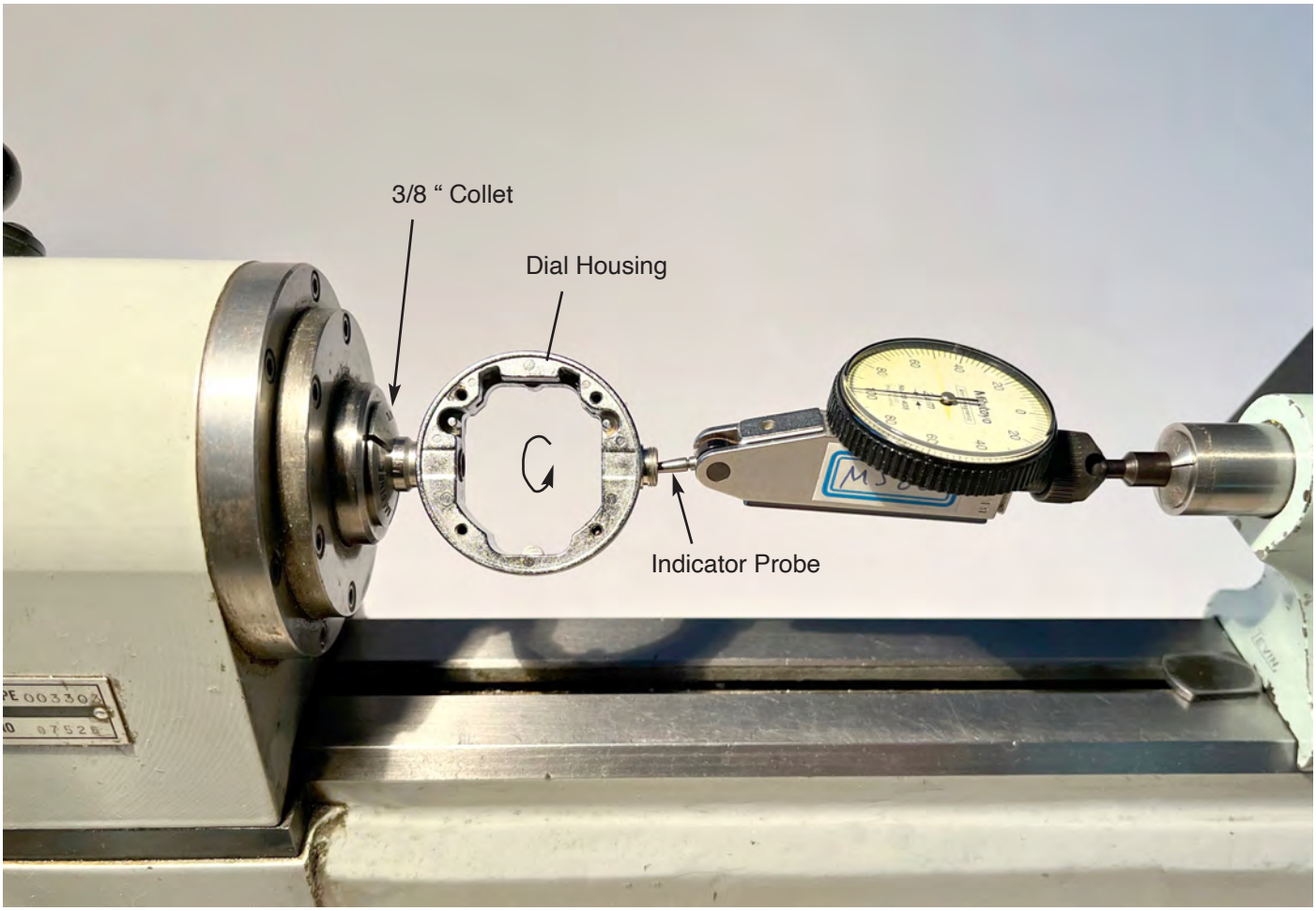
One of the tools for disassembly of dial indicators is watchmaker's staking tool. This is a precision punching tool (made by Levin) with over 40 various tip punches that you could utilize to pinpoint your punch force.

There are two pins that need to be extracted from the central shaft of the dial indicator. Without removing the shaft, it could not be checked or repaired. These pins are cone tipped so their reinsertion has to be carefully done. Because the pins are cone tipped, too much force on them could bend the shaft, and cause binding.

Checking, and straightening the shafts can be done on a lathe as explained next.

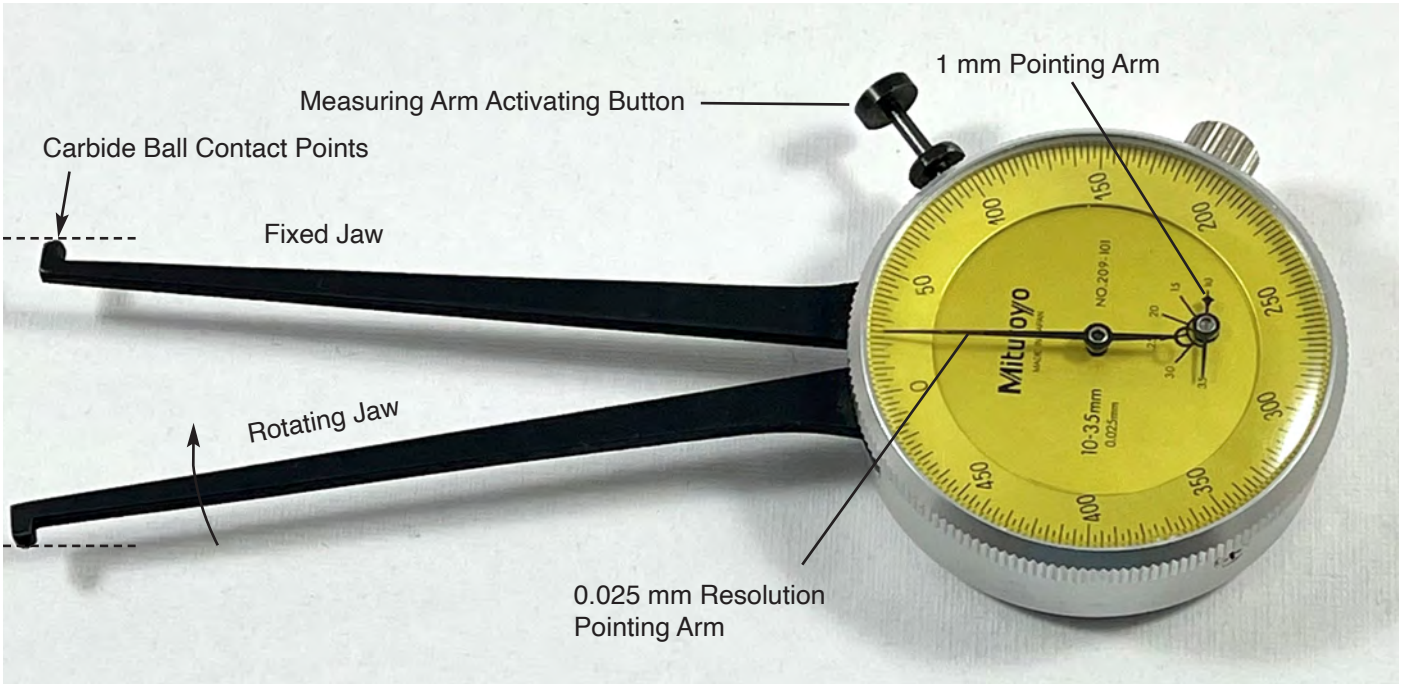


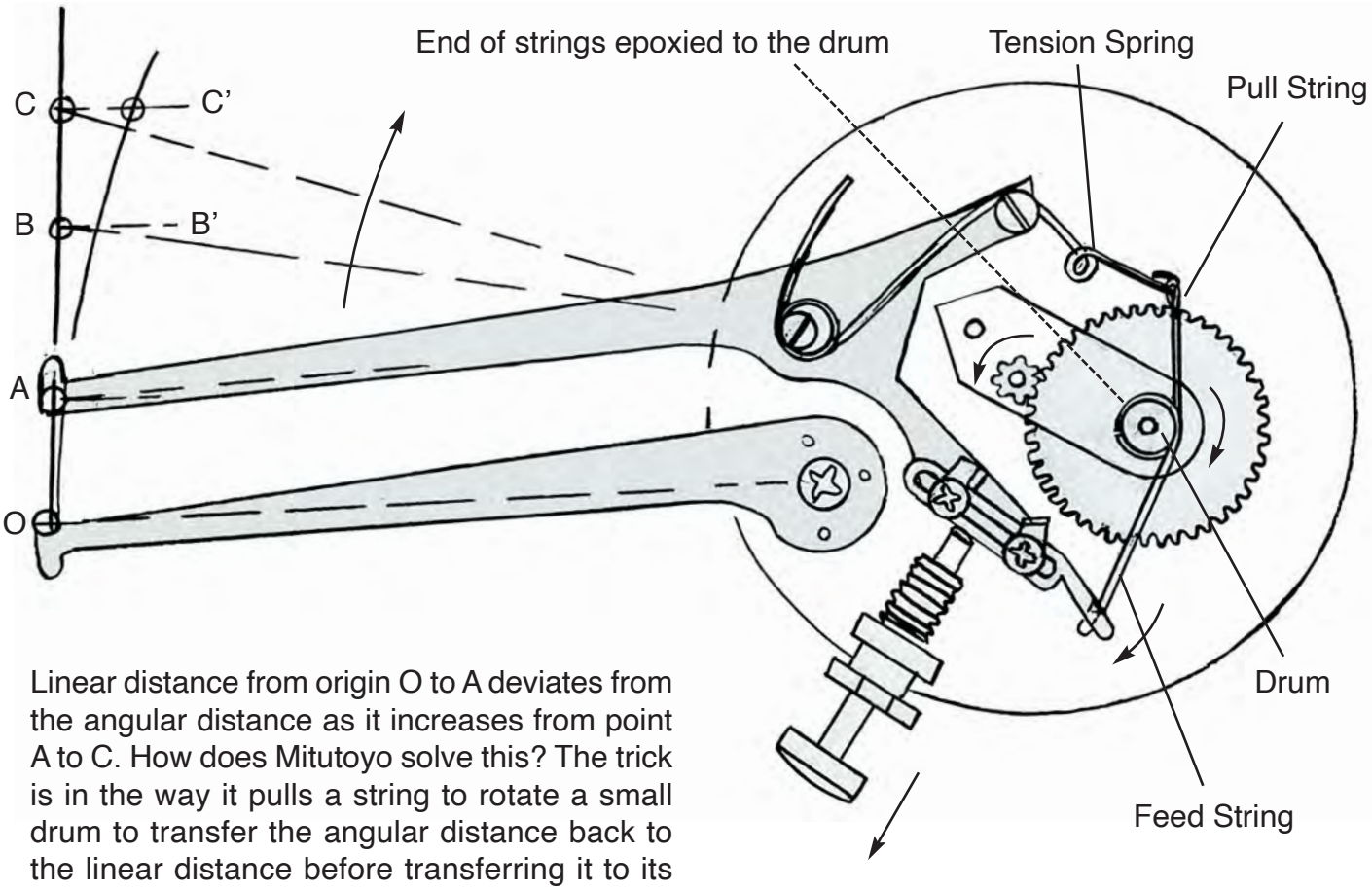

4 mm Collet
Indicator Probe


3/8 “ Collet
Dial Housing
Indicator Probe

Internal Dial Gauge

Internal dial gauge works unbelievably well. The reason I say it is because I always think of these things as trying to measure a diameter by a rotating jaw wouldn't be accurate because you'd need to always convert angle to distance. Well, after opening one, I figured out how Mitutoyo does it; They use a string instead of gears. The distance the tip of its moving arm travels, is proportionally transferred to the indicator dial by a string. So, it is actually the linear distance trans-

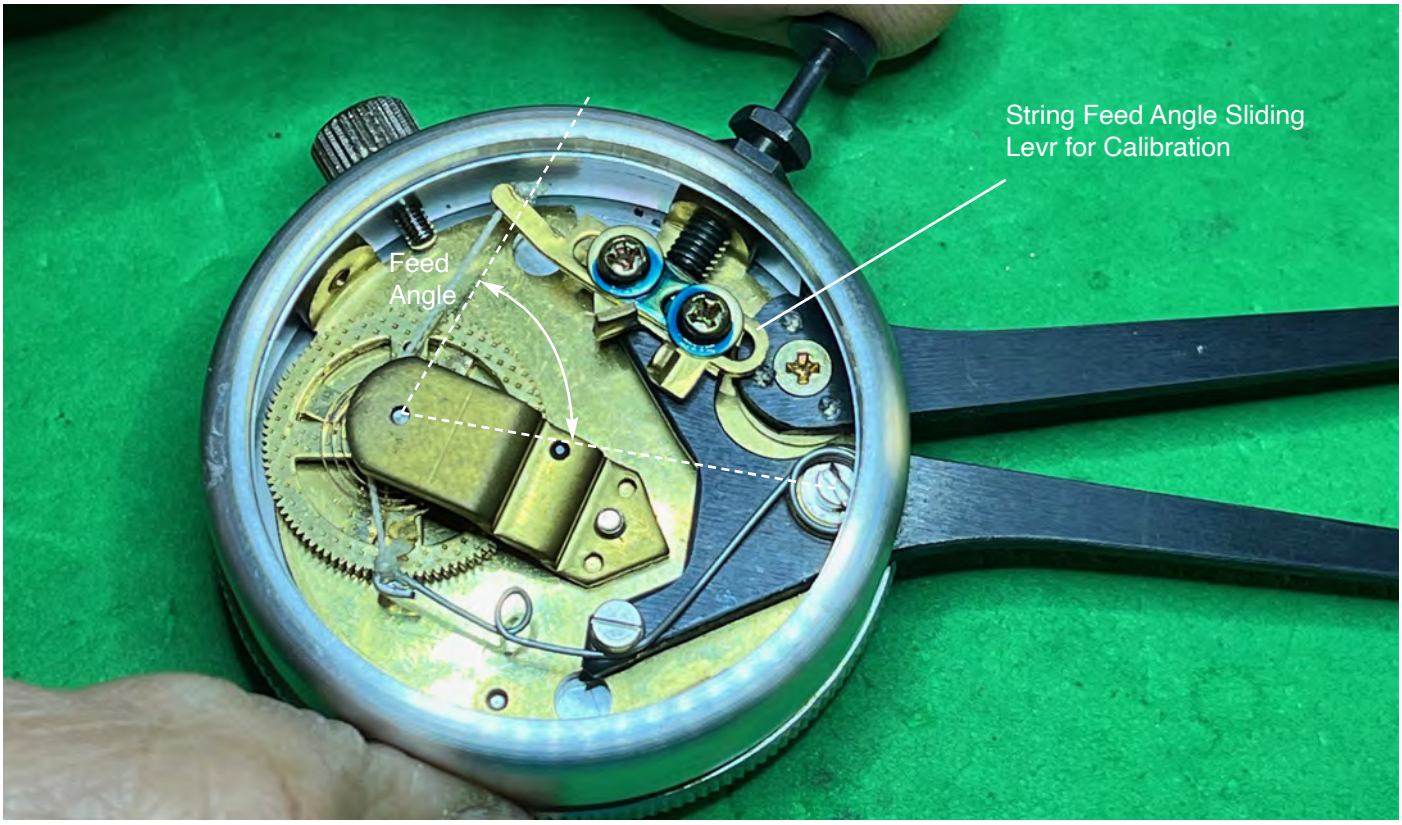


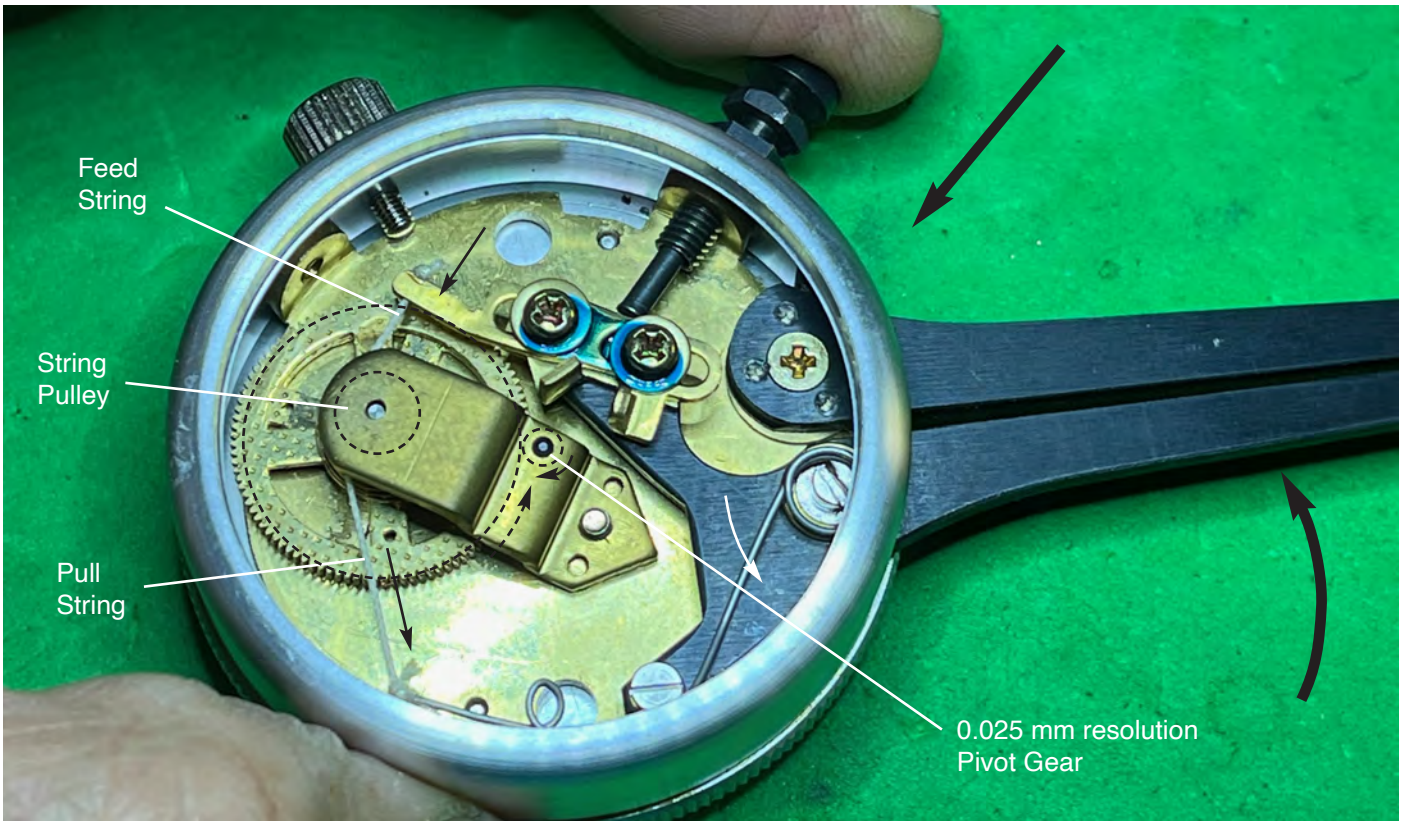


Linear distance from origin O to A deviates from the angular distance as it increases from point A to C. How does Mitutoyo solve this? The trick is in the way it pulls a string to rotate a small drum to transfer the angular distance back to the linear distance before transferring it to its gears.

ferred to the dial hand, not an angular distance. However, I do have two practical issues, with this design: One is, it is difficult to read. Second, it is like trying to fit a stick between two boats, while making sure it remains perpendicular to the side of each boat!

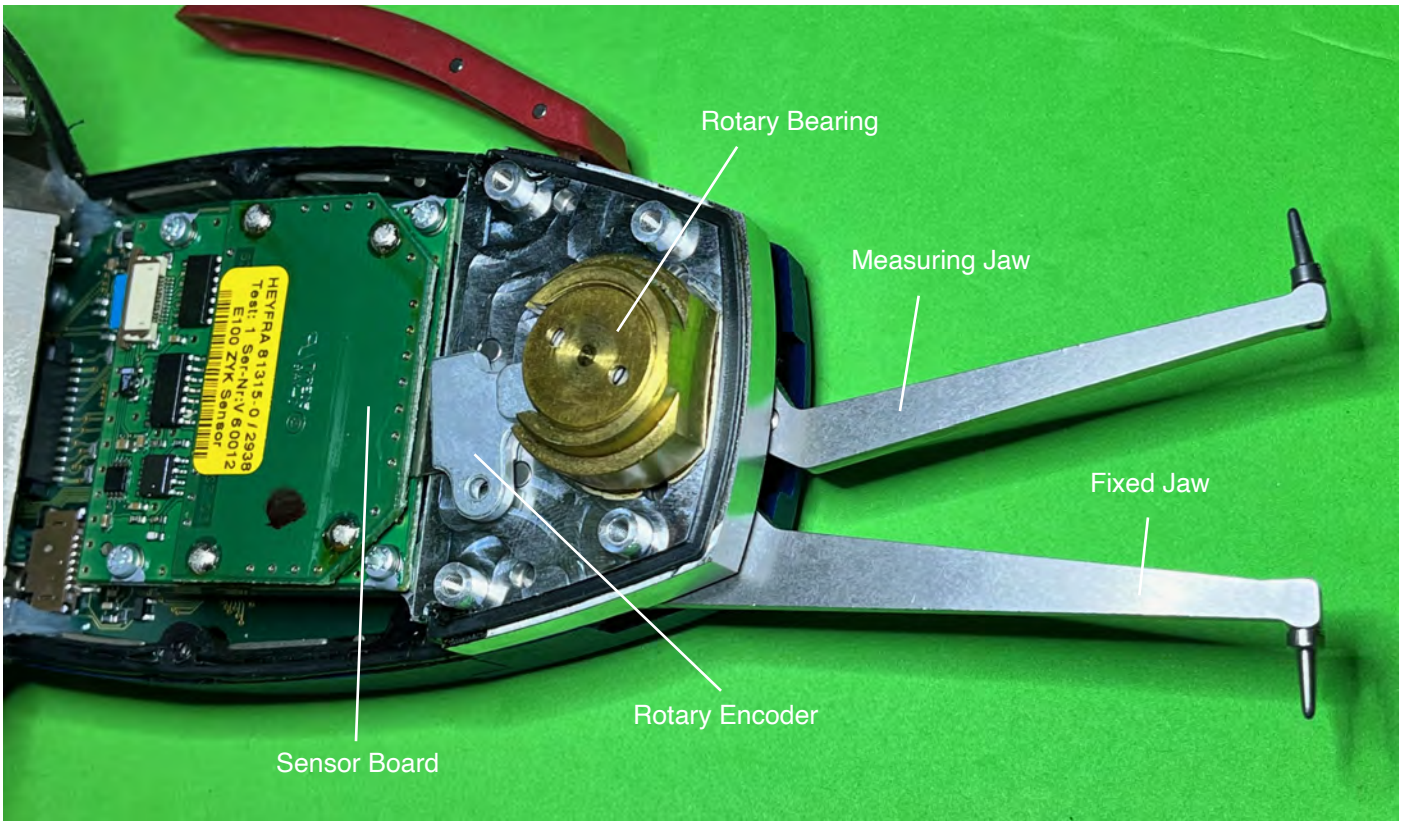
Otherwise, this is an extremely attractive device to use, and it could be so conveniently operated single handedly. I absolutely love its design. As far as packaging, this is one of the most cleverly packaged devices I have come across.





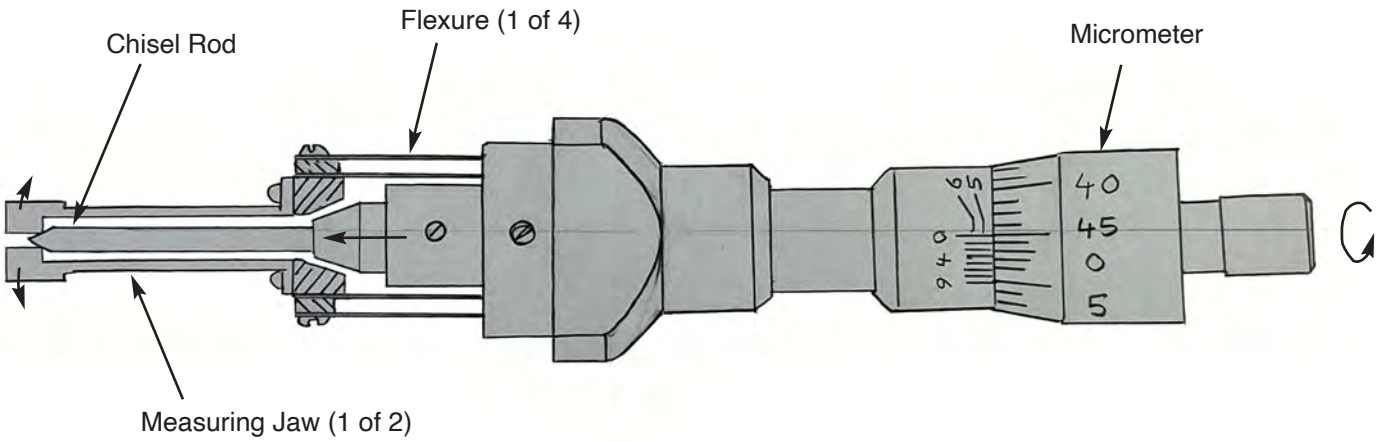
Digital Internal Gauge

In the digital version, it's easy to compensate for errors: The angular position of the moving arm is transferred to an electronics circuit via a high-resolution encoder. The linearity of measurement could then be calculated by built-in software, and displayed on its LCD display. If I would want to utilize one of these on my inspection line, I would pick the electronic version because it's much easier to read than the mechanical version.



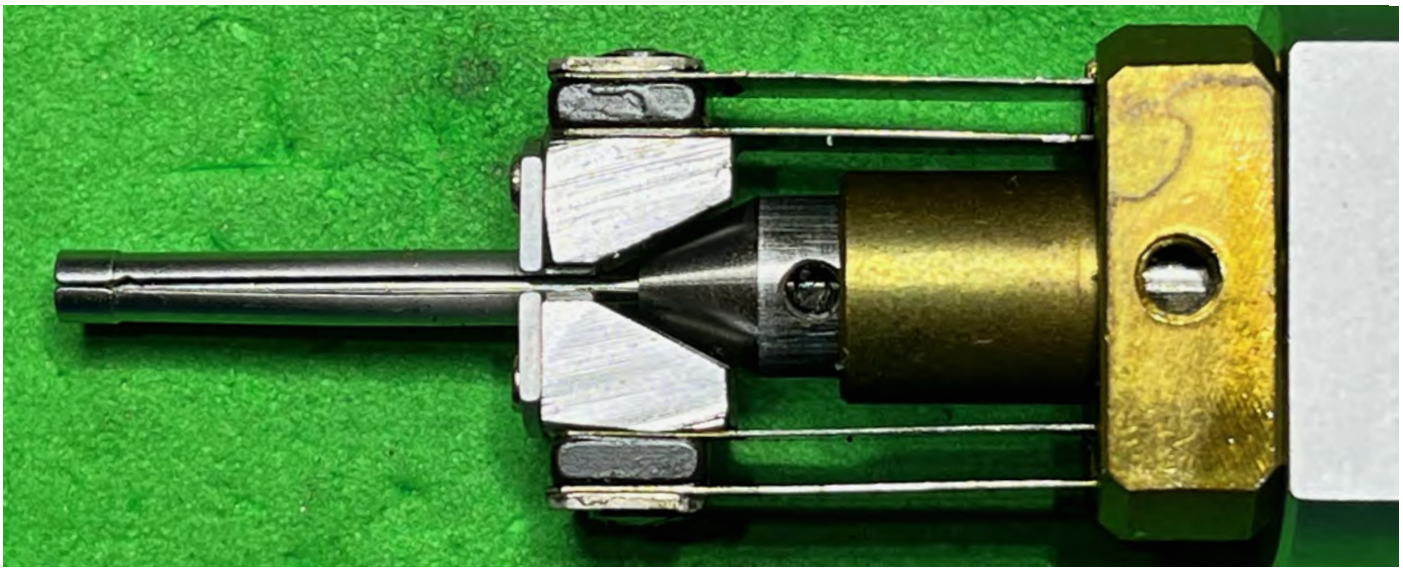
2-Point Internal Measuring Gauges

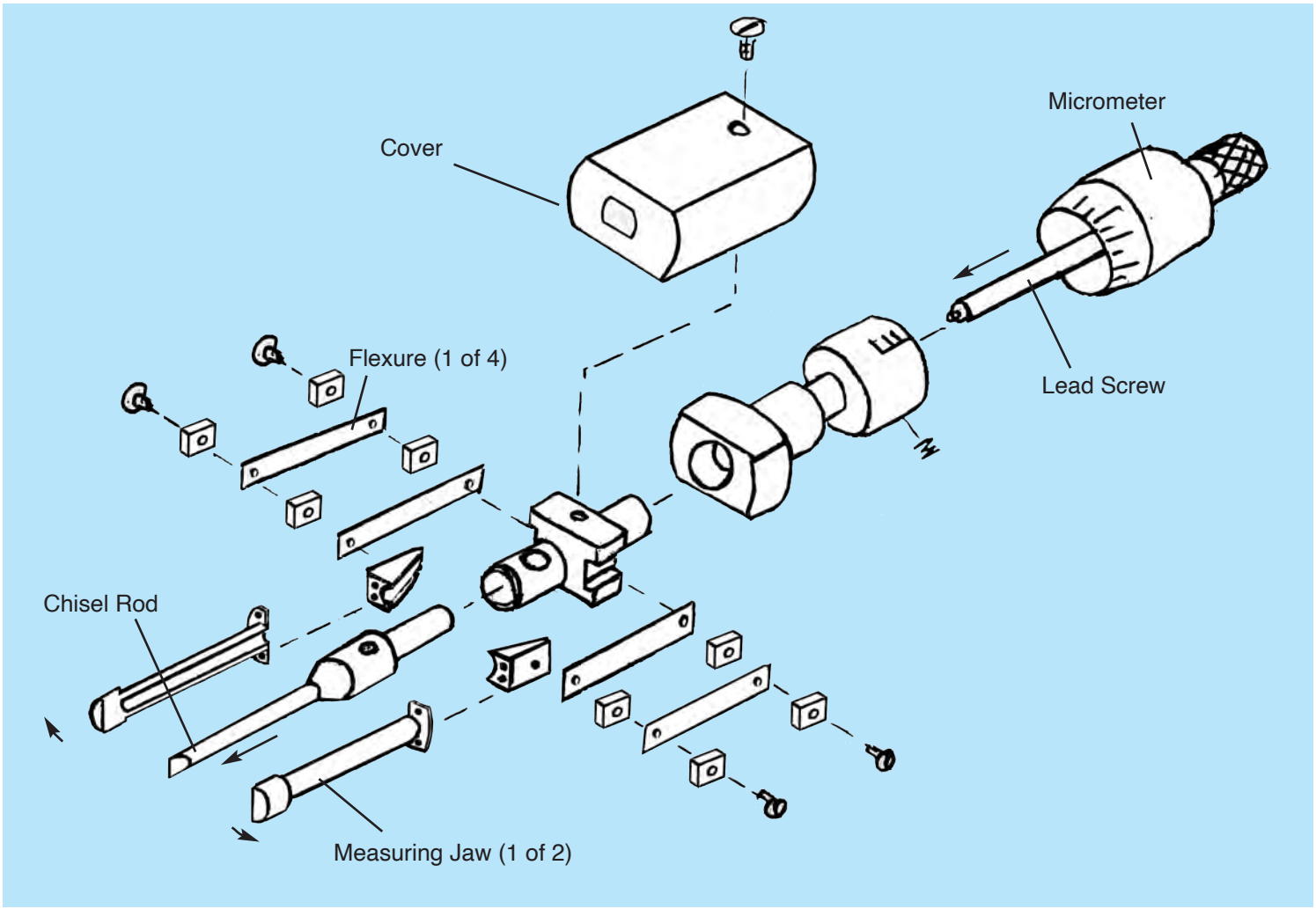
Micro Internal measuring gauges utilize a chisel type tip that is pushed in between two jaws to cause their separation, and therefore, internally push against micro bores to measure their inner diameter. Calibration standards are provided to set each micrometer (below).

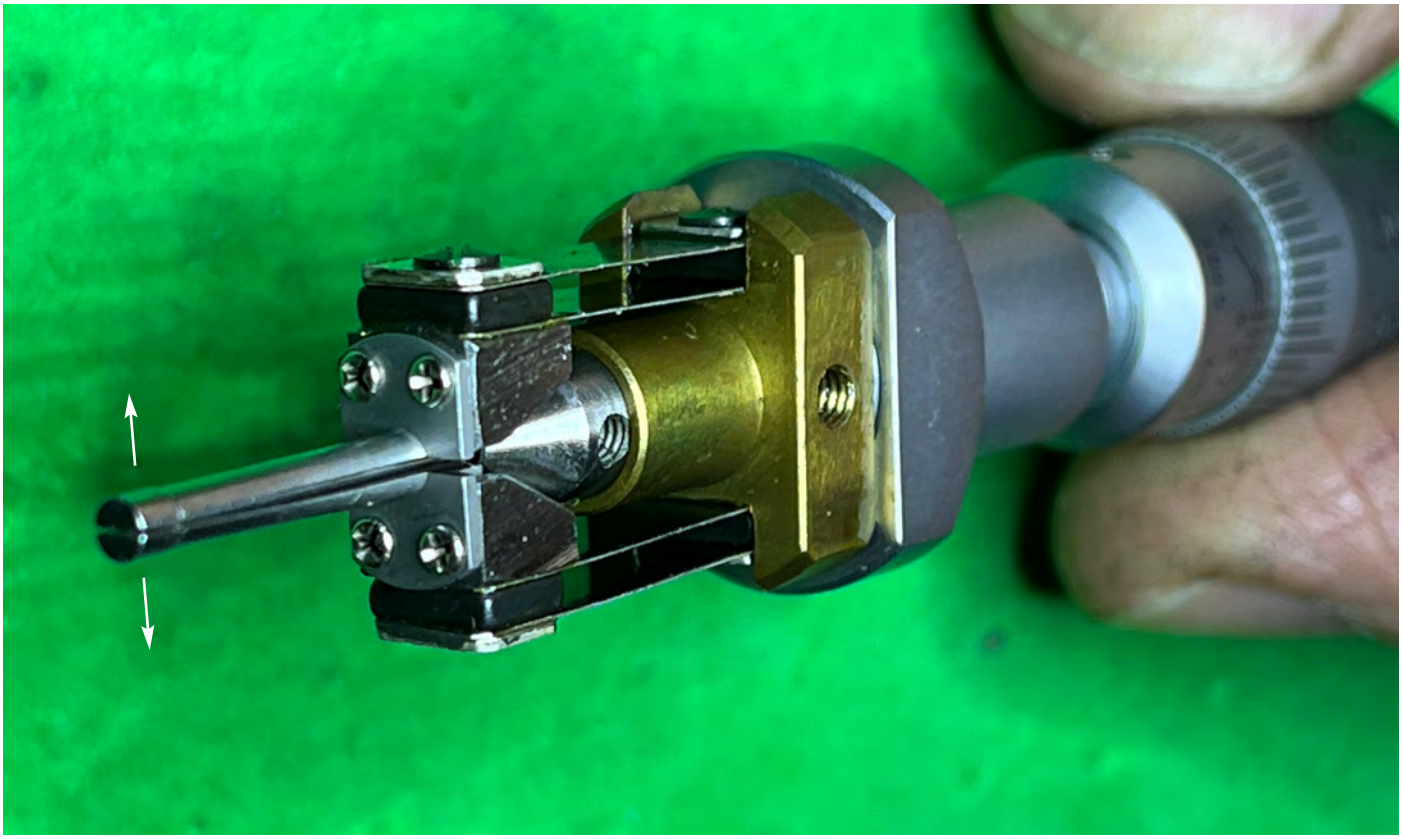


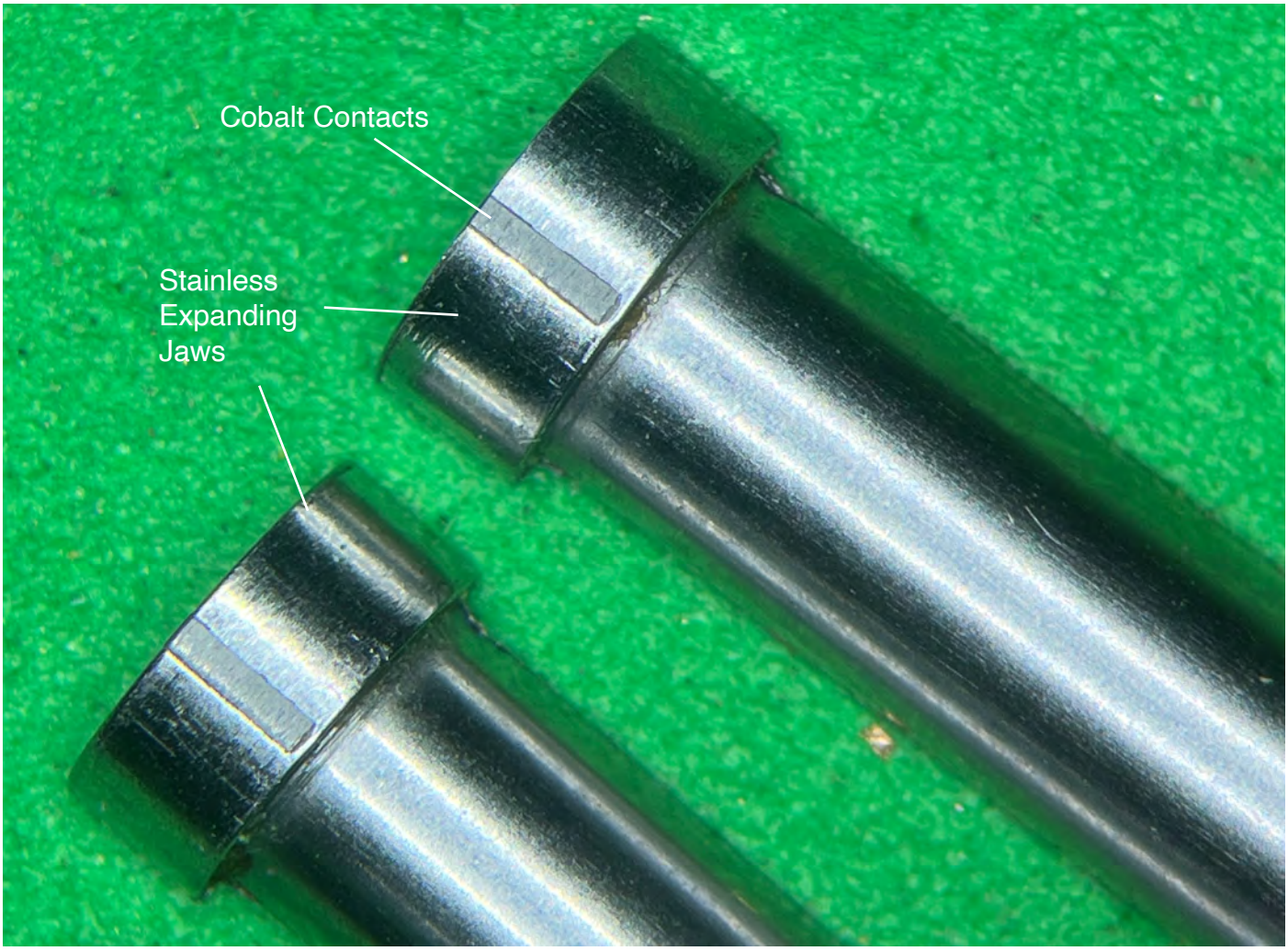
Side view of bore gauge micrometer reveals how the measuring jaws are expanded by a chisel rod pushed in between them via the tip of its micrometer. Flexures are utilized to maintain parallel expansion of the jaws.

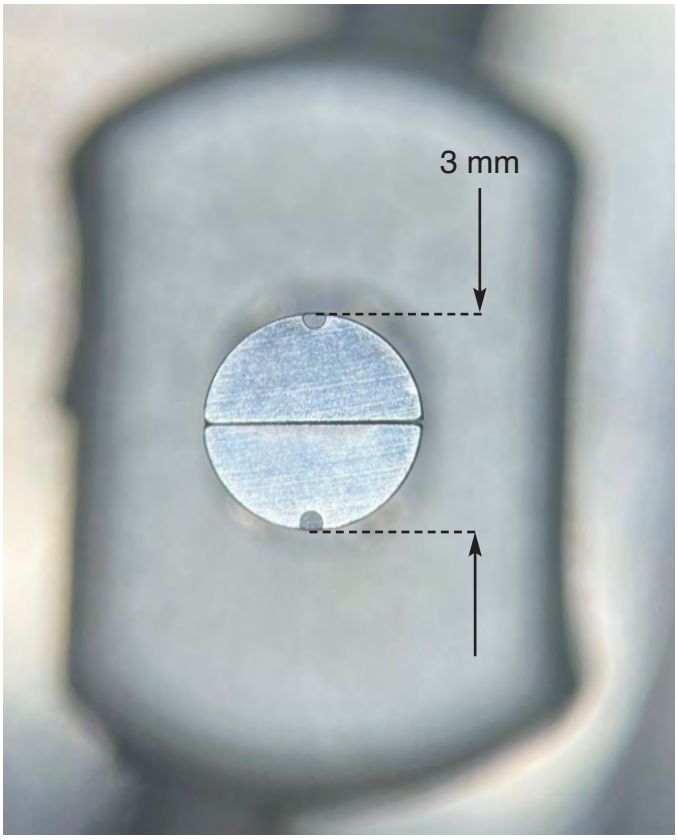

2,5–3mm
No,368–002
MADE IN JAPAN
25
30
35



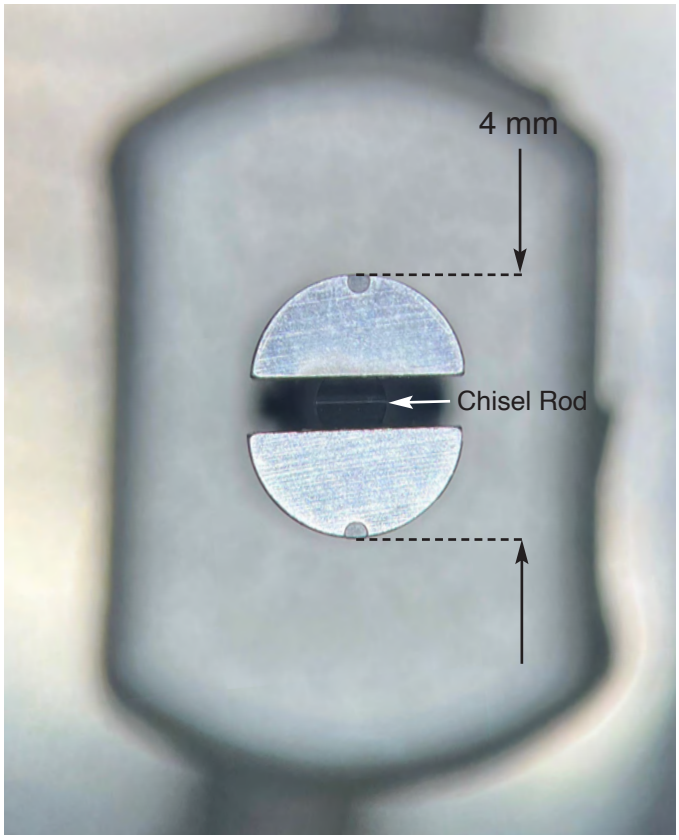

Micrometer
Cover
Flexure (1 of 4)
Lead Screw
Chisel Rod
Measuring Jaw (1 of 2)




Cobalt Contacts
Stainless
Expanding
Jaws


3 mm

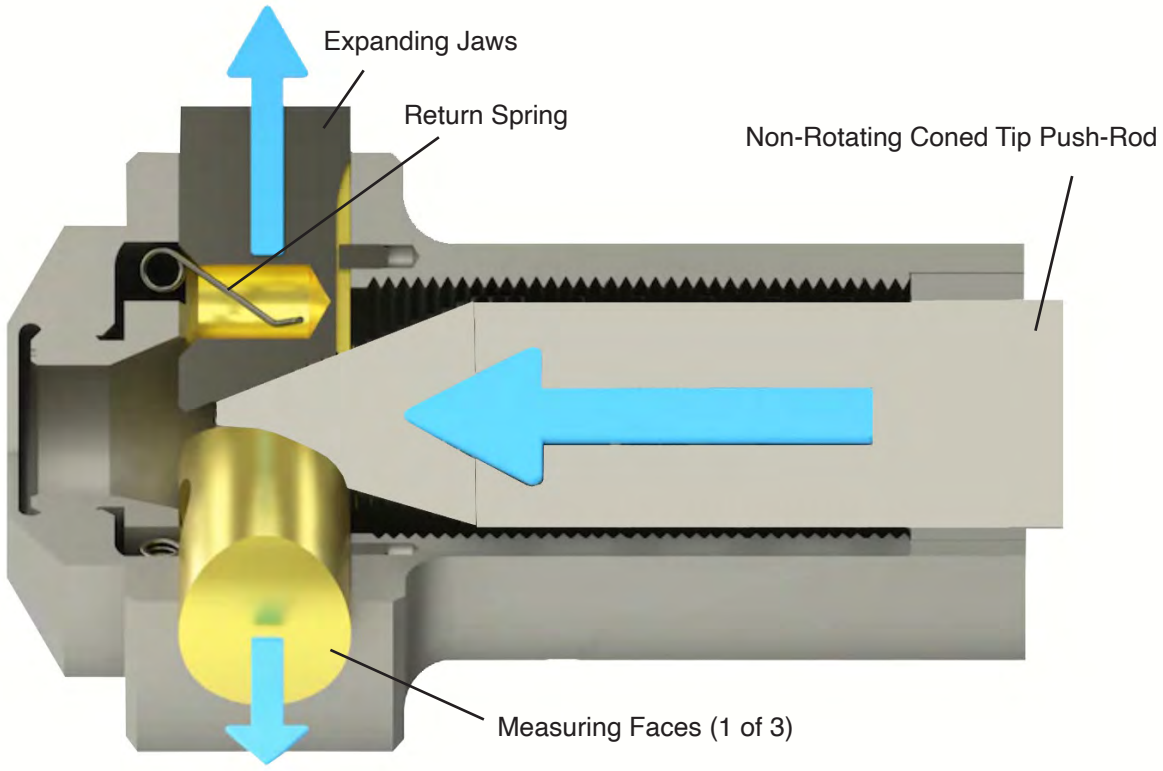
Min


4 mm
Chisel Rod

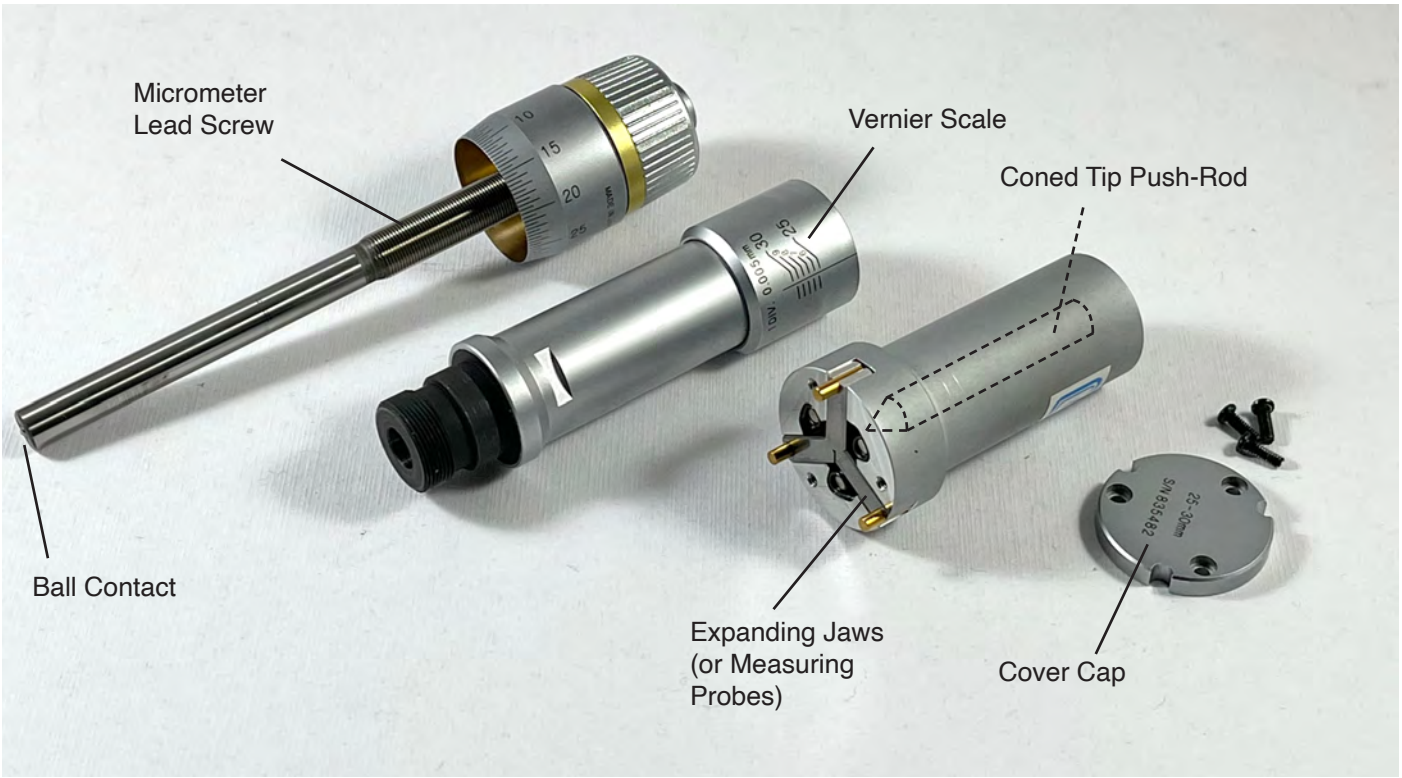
Max

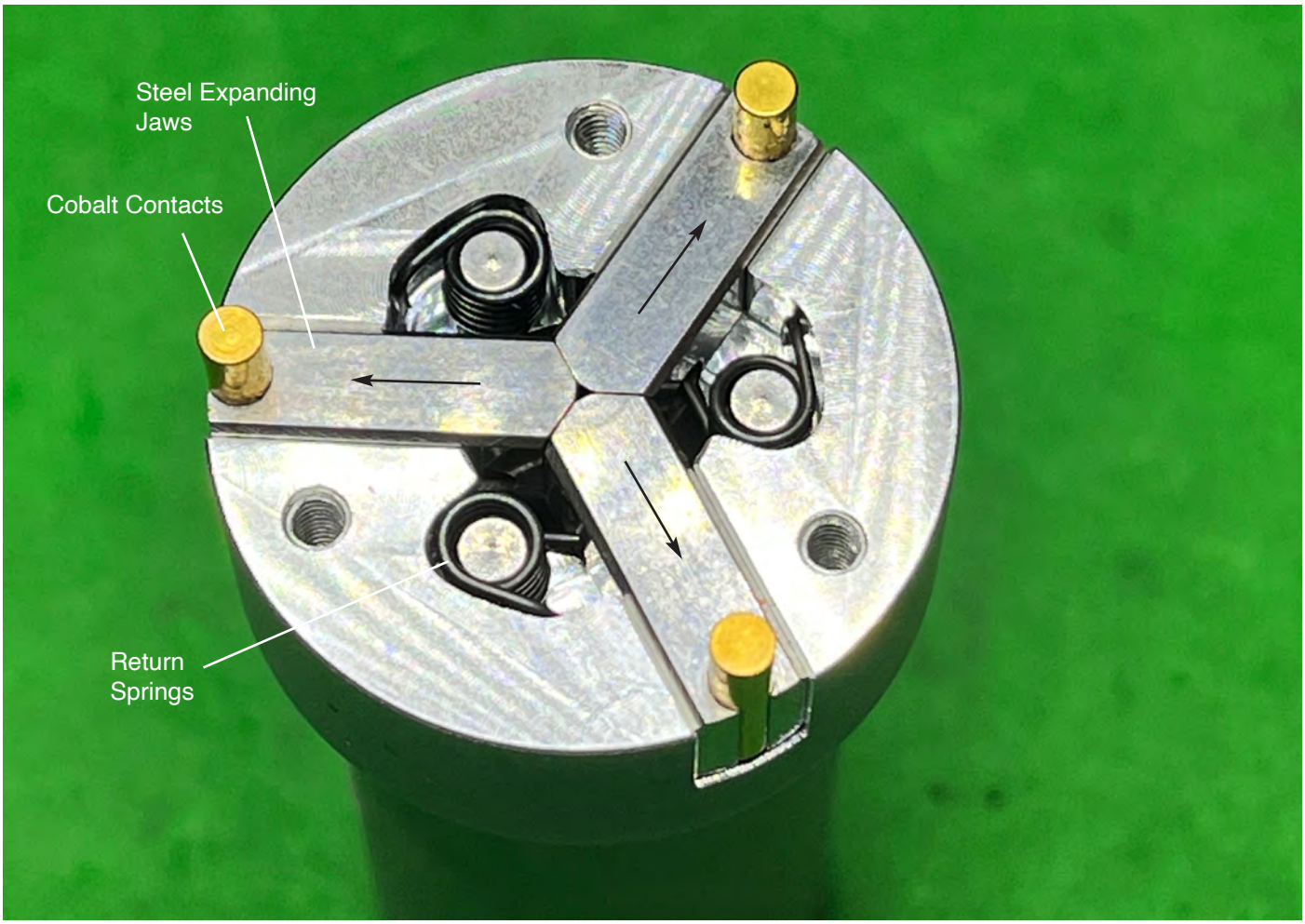
3-Point Bore-Gauge Micrometers

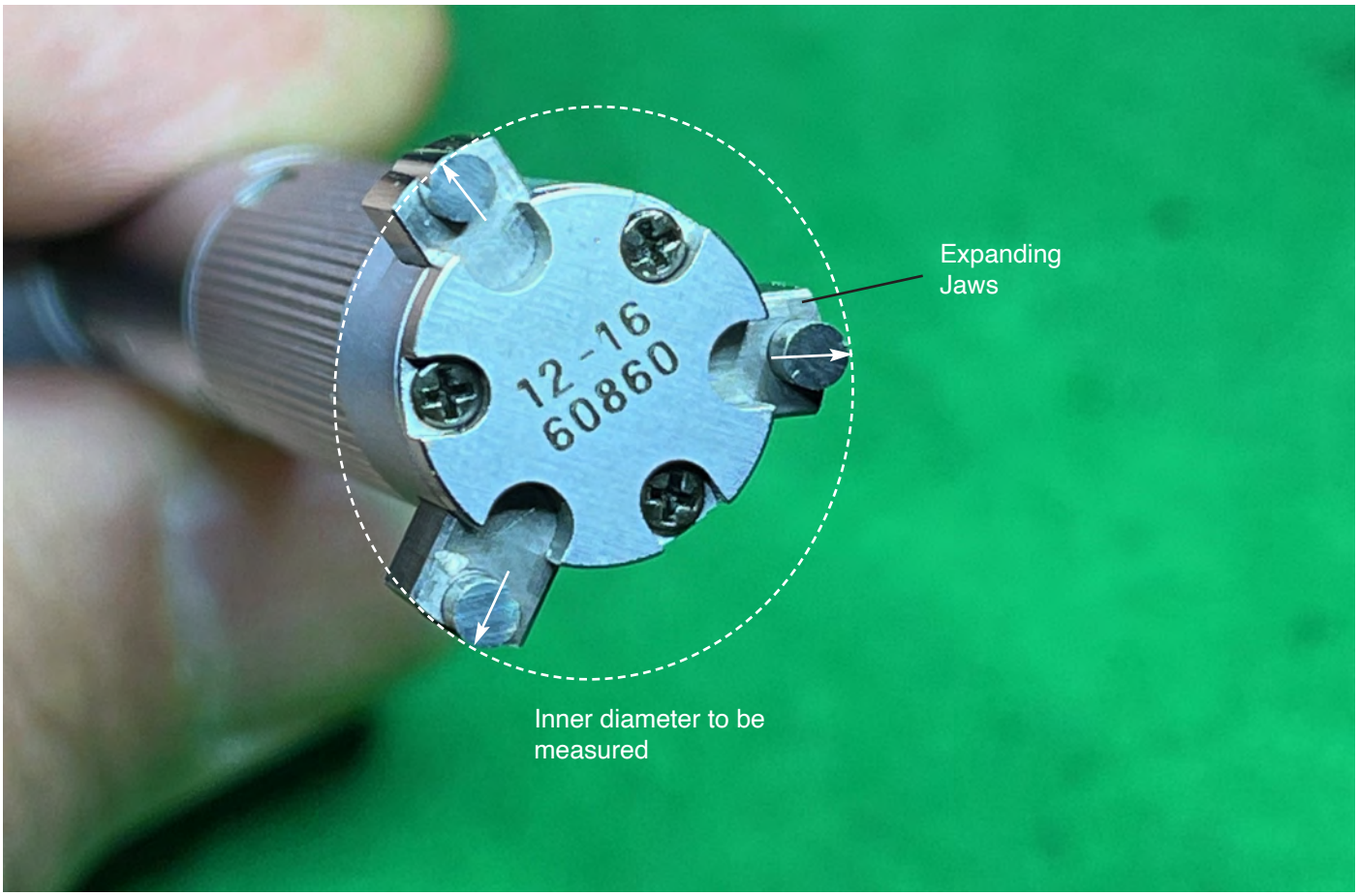
3-point internal bore gauge micrometers utilize a coned-tip push rod that leans against three expanding jaws (below). Expanding jaws have a sloped back that are in sliding contact with the drive cone, and are pulled back by separate springs to return to their in position when the cone is pulled back (below).

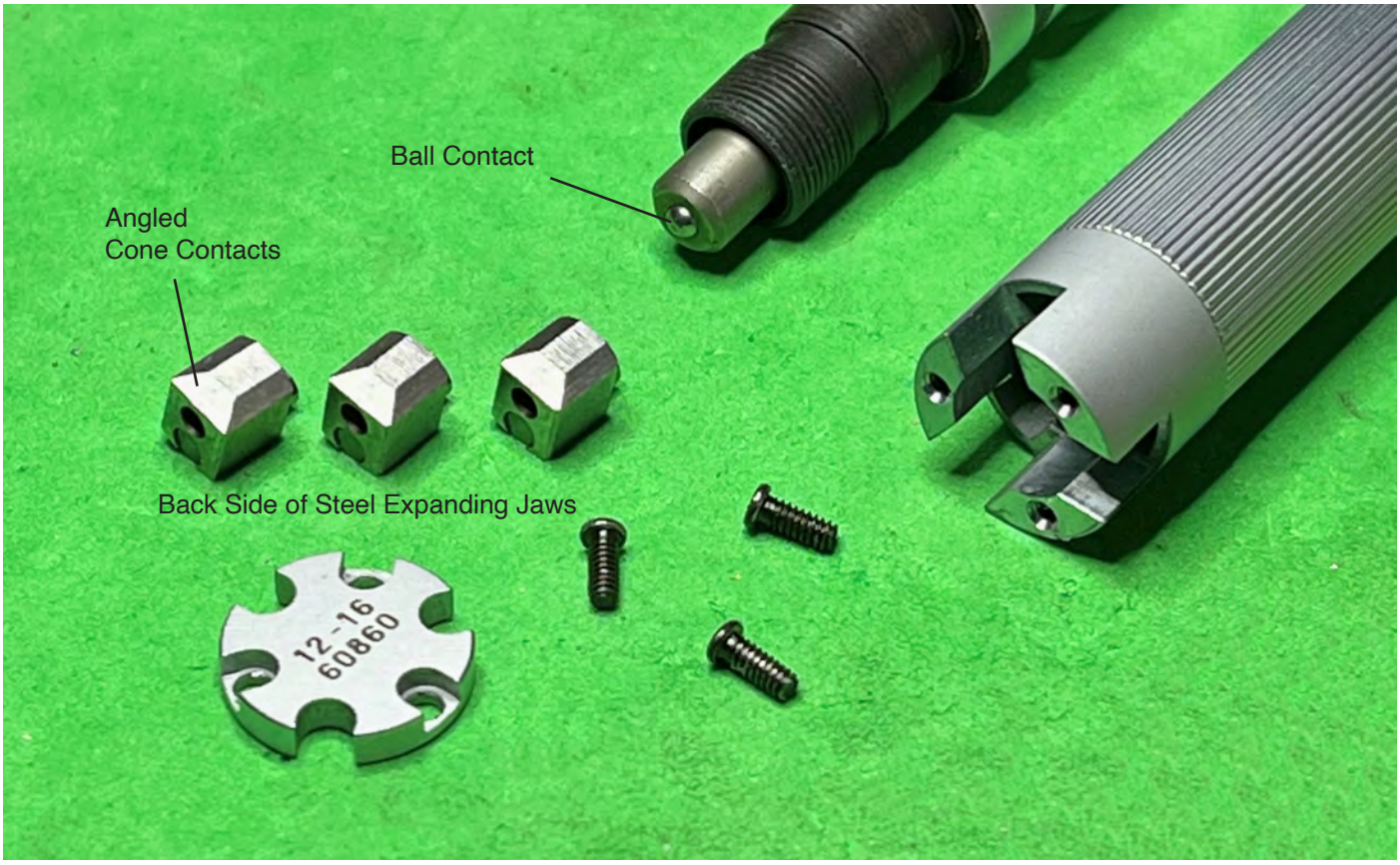


Section drawing shows how the measuring cone pushes out the expanding jaws outward.

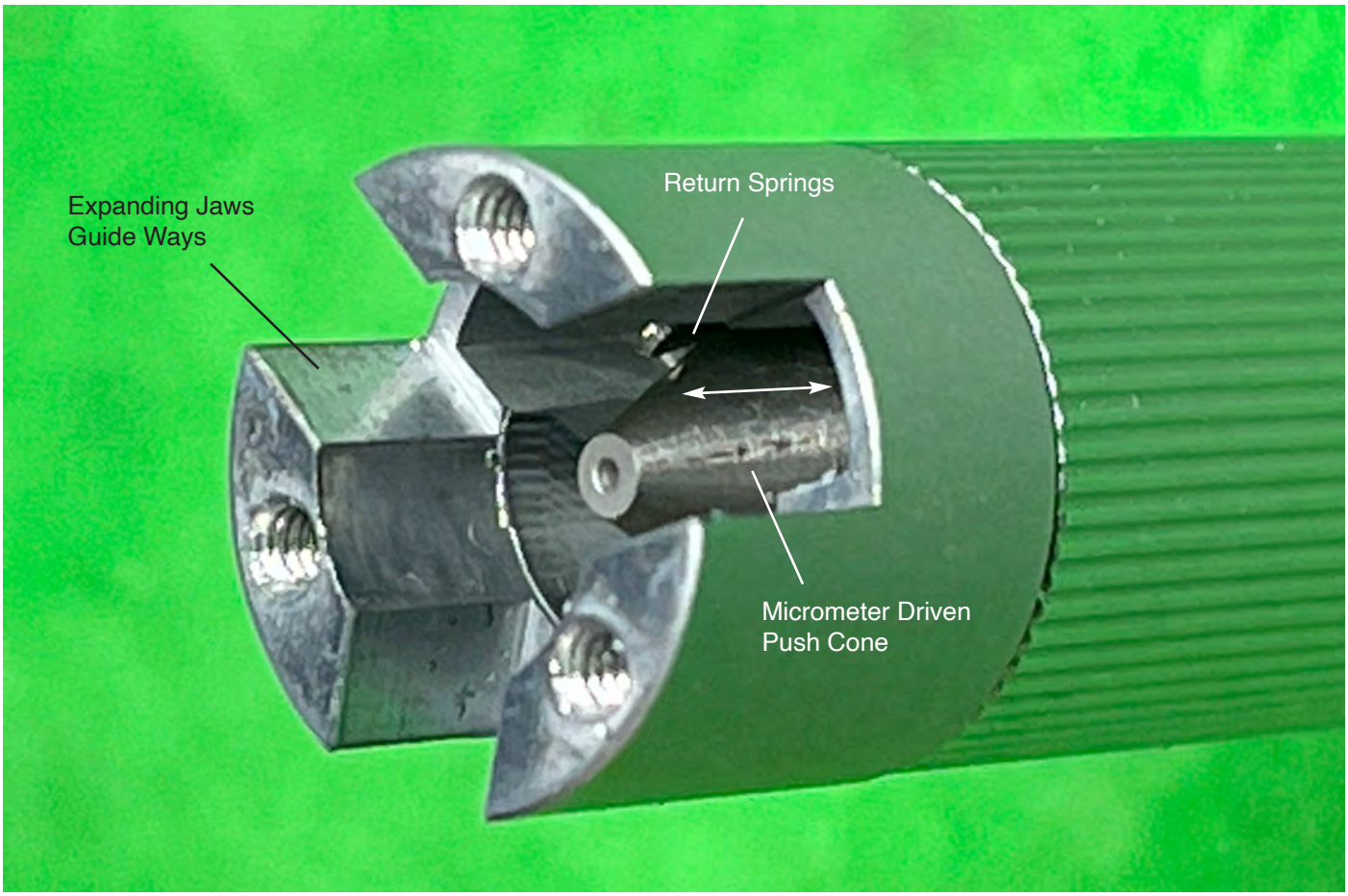



Steel Expanding Jaws
Cobalt Contacts
Return Springs


12-16
60860
Expanding Jaws
Inner diameter to be measured



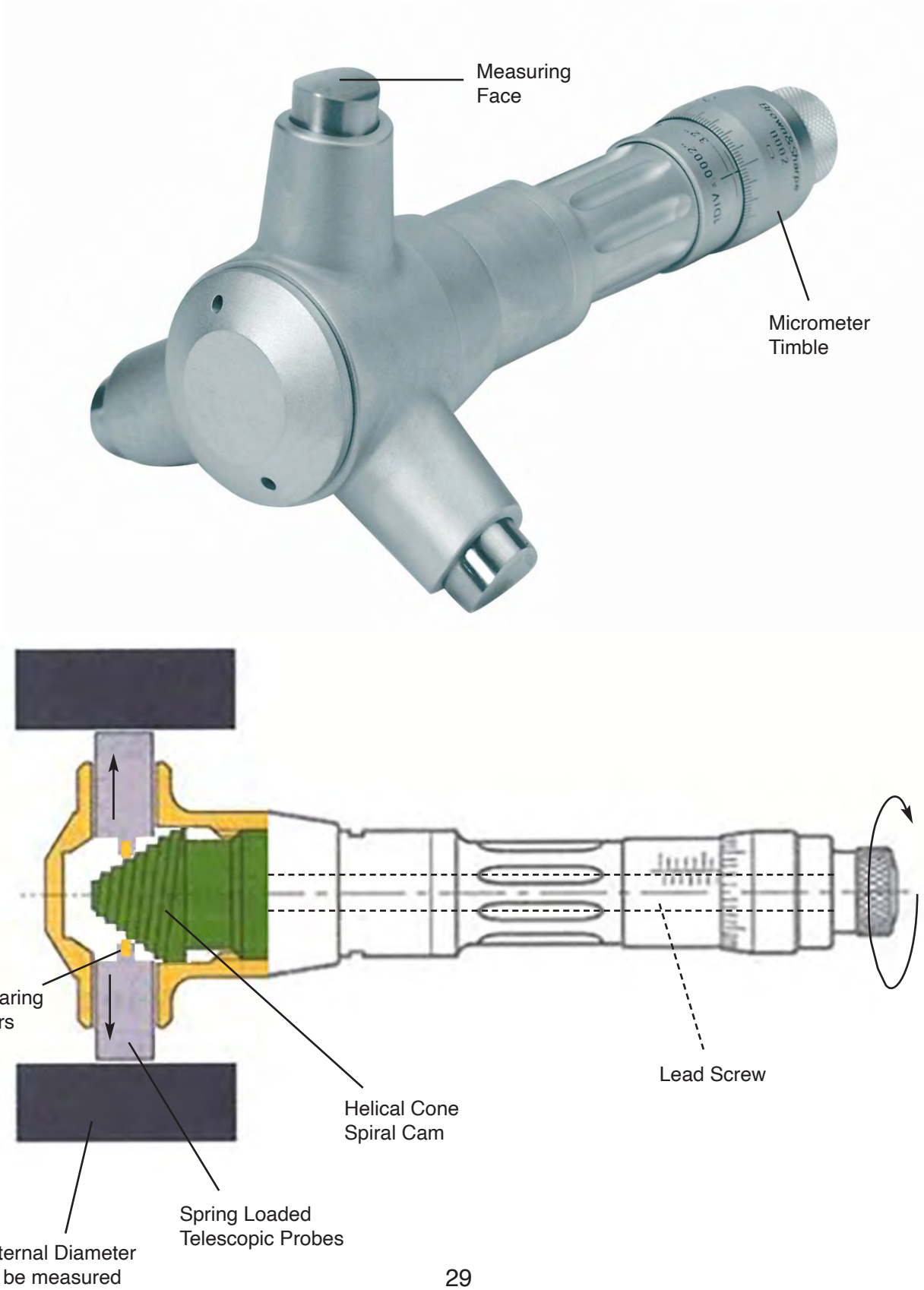
Inside bore gauge micrometer disassembled to show its inner parts.



A close-up of the push cone with the steel Jaws removed. The return springs are pulled back to allow re-assembly.

Brown & Sharp Internal Micrometer

The construction of this micrometer looks like something right out of a Sci-Fi movie! When I saw it for the first time, I wondered how they could possibly manufacture its components with its required degree of precision. The expanding mechanism of this micrometer consists of a cone spiral path made of polished steel that pushes out three rollers to expand its three spring loaded jaws. This design is utilized in large diameter 3-point internal micrometers in the order of 75 mm, and higher. Instead of a fine pitch lead screw, these micrometers utilize a large screw pitch that is in sync with the steps of its coned spiral cam. The cone therefore rotates while translating forward or backward so the ball bearings would remain in precise alignment with spiral path.

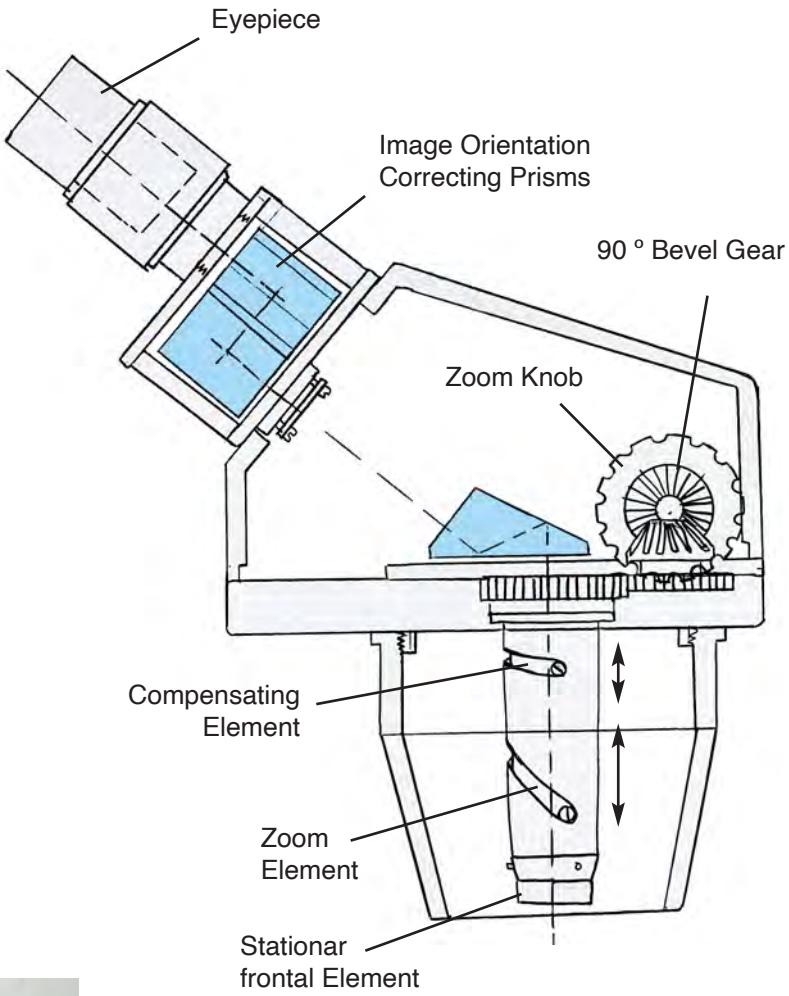


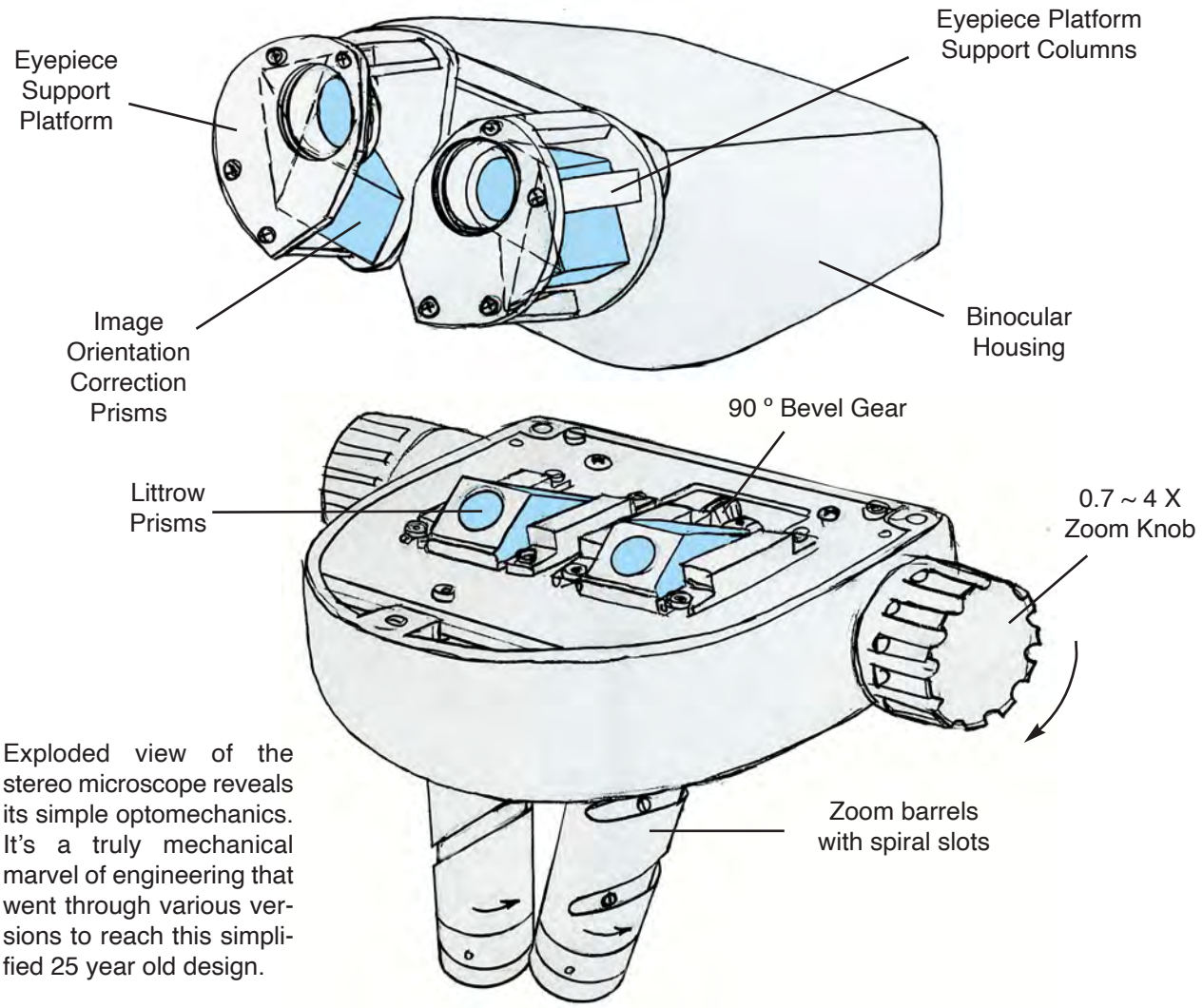
Zoom Stereo Microscope Design

For our discussion of stereo microscopes that began in the last two issues, I would like to discuss a classic zoom design. I first saw this mechanism while visiting American Optical company in Chicago, back in 1979. They had just come up with their series of stereo microscopes, and their salesman was enthusiastically showing off their complex dual cam design that translated the zooming and image focus compensating element. AO sold those microscopes by the thousands.

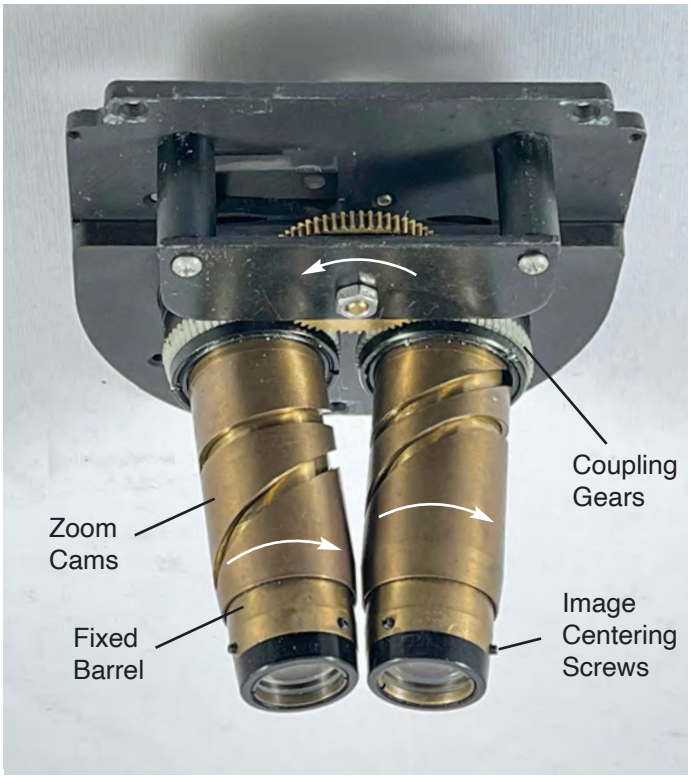
This version is a far more simplified version, and perhaps the simplest version that I know of with a relatively wide zoom range. This is not an infinity design so the two objective barrels are tilted towards each other so their optical path would coincide at the sample plane. The zoom mechanism consists of a zoom knob that is linked to two gears at the base of each zoom objective. The cams rotate in the same direction so their spiral slots are identical. Each cam translates a zooming element back and forth, while it also translates back and forth a compensating element to keep the image in focus.

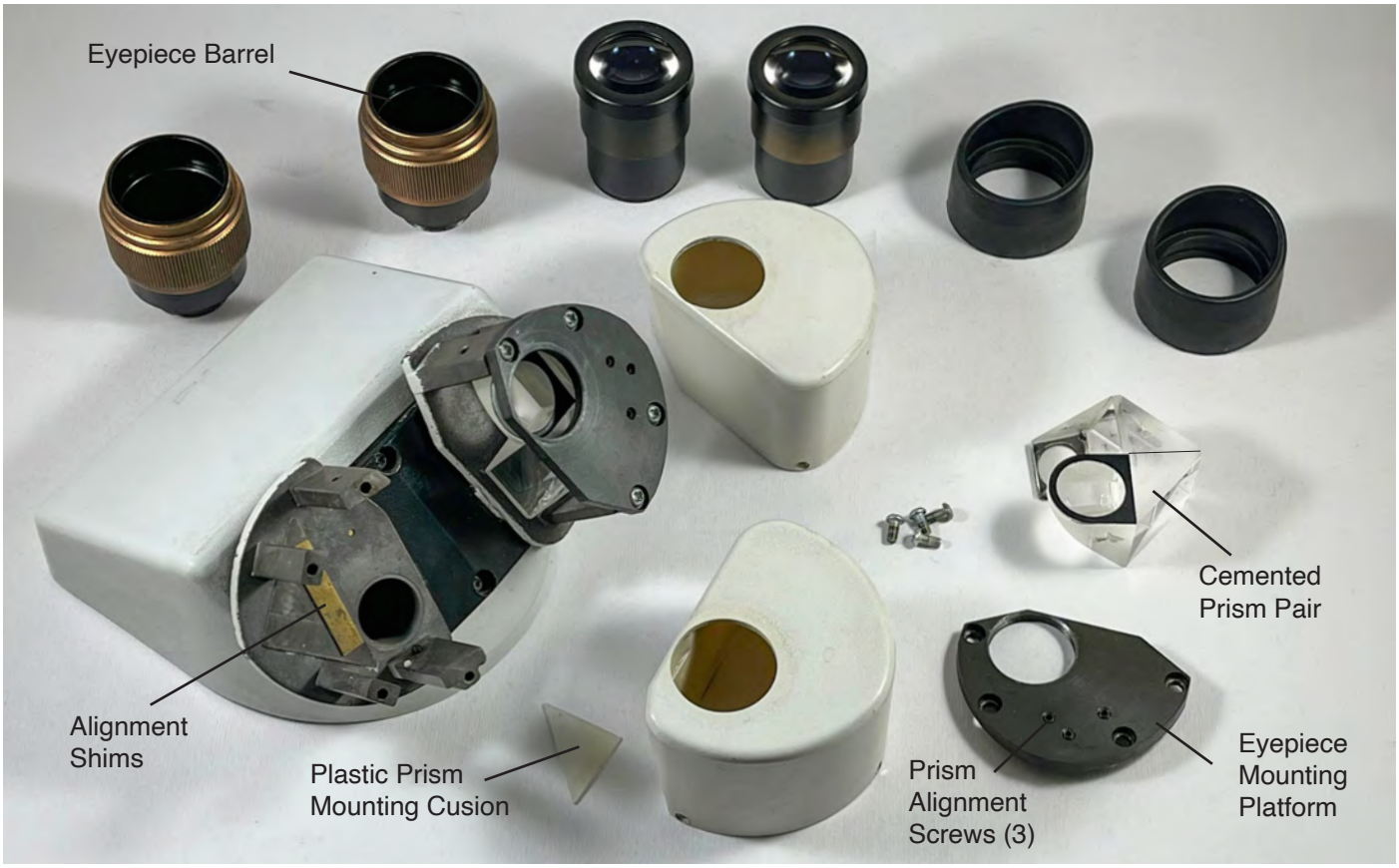
If you use Zemax software, it has various zoom designs on its library that you could play with.





Exploded view of the stereo microscope reveals its simple optomechanics. It's a truly mechanical marvel of engineering that went through various versions to reach this simplified 25 year old design.





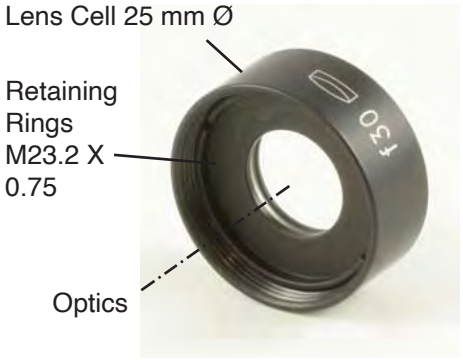
The viewfinder assembly shows the cemented image correction prism pair taken off for the left eye.

Image Alignment in a Stereo Microscope

Above, good old linkage to couple left, and right eye to set interpupillary distance is the simplest design to link two adjacent rotating rings together. Stereo viewfinder prisms are simple to align. This is not a porro-prism design as utilized in binoculars (with two separate prisms for each eye). It consists of two cemented prisms that is clamped down below eyepiece mounting platform (above). You could completely disassemble the microscope to study its optical design, and when you are ready to put it all back together, just make sure you can see a clear image through every prism you install. The next rough alignment is done by slight tilting the prisms (via prism alignment set screws, above), and finally, you could mount the microscope assembly on its stand, and focus it to a sample. The fine adjustment of the left, and right eye could be accomplished via three set screws securing the objective lenses (previous page). The rough alignments must be done first to avoid parallelism mismatch between the two zoom barrels. This is necessary to keep the image centered for each eyepiece throughout the zoom range.

How to Integrate Micromax in Optoform 40

Use of Micromax components goes back to the classical Optoform catalog, where its Micromax section lists every part, and shows its many uses. Today we're going to revisit Micromax system, and examine how it integrates with new Optoform 40 mounts. What you are going to see are the basics: Optoform 40 can handle optics mounted on Micromax 25, 30, and 35 lens cells. Let's see how it's done in practice:

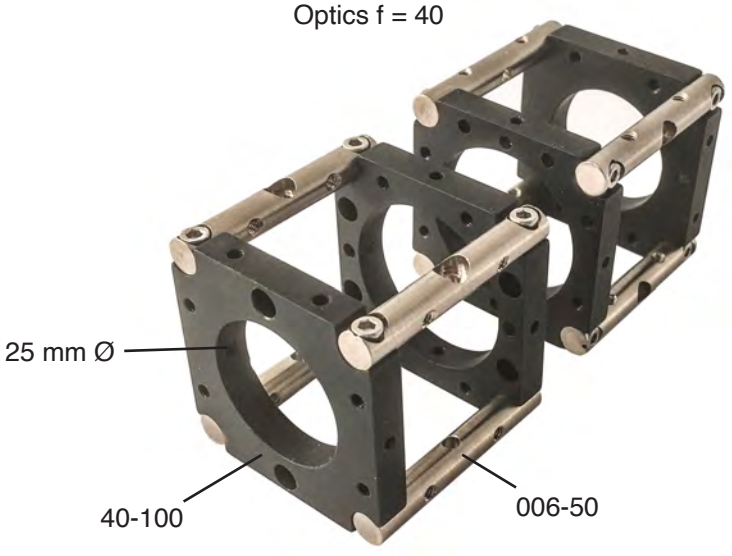


Mounting Optics in Micromax 25

There is a matching set of retaining rings with standard thread M23.2 X 0.75 to allow mounting any length of cylindrical optical elements between 6 to 22.4 mm in diameter inside Micromax tubing. Normally, the clearance aperture is the diameter of the lens minus 1 mm.

Standard M23.2 X 0.75 Retaining Rings

Retaining rings with standard thread M23.2 X 0.75 allow mounting any length of cylindrical optical elements between 6 to 50.8 mm in diameter inside Micromax tubing. Normally, the clearance aperture is the diameter of the lens minus 1 mm. Various cross connectors are shown below for Micromax 25, and standard microscope objective W0.8 x 1/36 thread. All Micromax tubing and accessories are cross compatible via various threaded interconnects to secure optics within Optoform 40 assemblies (below, right).

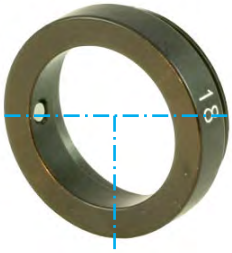


25-314

Connecting Ring
Tube 25 F to Tube 25 F

25-332

Microscope Turret Adapter
Tube 25 F to W0.8x1/36 F



25-202 ~ 224

Laser Diode Holder
3-20 mm Ø to Tube 25 F

25-402

C-Mos Adapter
1.085X32 Tpi to Tube 25 M

25-331

For Microscope Objectives
Tube 25 F to W0.8x1/36 M

25-306

Connecting Ring
Tube 25 F to Tube 25 F

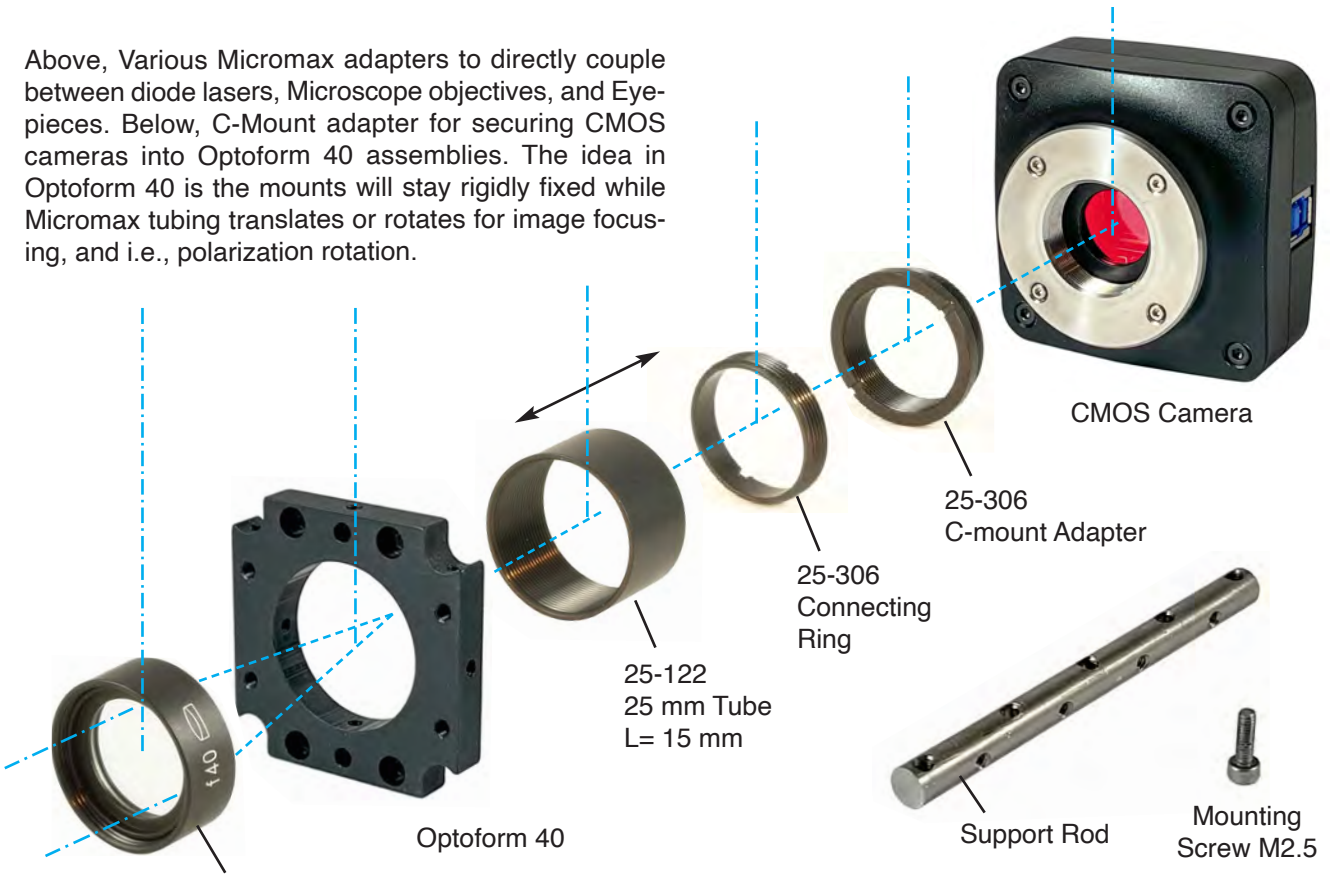
25-308

Accessory Adapter
Tube 25 F to Tube 25 F

25-308

Handling Ring
Fits Tube 25 F, Lens Cells

Above, Various Micromax adapters to directly couple between diode lasers, Microscope objectives, and Eye-pieces. Below, C-Mount adapter for securing CMOS cameras into Optoform 40 assemblies. The idea in Optoform 40 is the mounts will stay rigidly fixed while Micromax tubing translates or rotates for image focus-ing, and i.e., polarization rotation.



20-326
25 mm Mounted
Optics f = 40

Web: www.optoform.com, Email: afsales@sbcglobal.net

Psychology of Achievement:

Pleasure vs Happiness

By Ali Afshari

In a 2017 book called: “The hacking of American mind” by Dr. Robert Lusting describes the difference between pleasure, and happiness. Dr. Lusting believes most of us confuse the two to be the same thing but they are so different. Lusting believes our pursuit of pleasure is at the expense of our happiness. Drugs, mobile phones, social media, fast food, coffee, gambling and even shopping can have a similar, short-term but highly compulsive effect on human behavior. He presents seven differences between pleasure, and happiness:

1) Pleasure is temporary, and short-lived but happiness is long lived, eternal, and cannot be attained from substance or behavior.

2) Pleasure is material but happiness is visceral, and in a sense, deeply connected to our inner consciousness.

3) Pleasure is taking but happiness is by giving.

4) Pleasure can be bought but happiness cannot be bought.

5) Pleasure is gained alone but happiness is usually gained in social groups.

6) Extremes of pleasure whether they be substance or behavior, lead to addiction but there is no such a thing as excessive happiness.

7) Pleasure is based on dopamine, an excitatory neurotransmitter which causes excitement of neurons in the brain. Happiness is caused by Serotonin, which doesn’t excite neurons. It is instead, an inhibitor.

“Dopamine is what is called an “excitatory” neurotransmitter. “It turns out neurons like to be tickled, but they don’t like to be hammered. Chronic over-stimulation of a neuron causes neuronal cells to die.” As a consequence, the neuron next to a dead one will trigger a self-defense mechanism to down-regulate the receptors for dopamine, so that it too won’t die. What does that mean for humans? “You get a rush, the receptors go down and next time, because there are fewer receptors, you need a bigger hit to get the same rush.”

This goes on until even a huge hit has no effect. “That’s called tolerance. And when the neurons start to die, that’s called addiction.” Serotonin does not behave this way because it is an “inhibitor”. “It doesn’t cause the next nerve to fire,” says Lustig, “it causes the next neuron to stay silent. You can’t overdose on happiness.” However, there is one thing that can down-regulate serotonin – dopamine. “So, the more pleasure you seek, the more unhappy you get.”

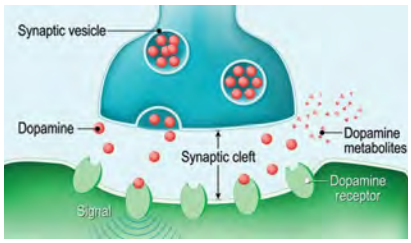
That’s why addiction and depression are different sides of the same coin. “Addiction is from too much dopamine driving down the receptor and then the neurons die. Whereas depression is serotonin deficiency – too little serotonin, which has been driven by the dopamine.” The process works the same way for things other than drugs that give us pleasure.

Lustig says he has a simple, evidence-based, four-step process to combat this problem. To tamp down the dopamine and up the serotonin, focus on the Four Cs – Connect, Contribute, Cope and Cook.

•Connect with eye-to-eye human contact, not social media. “It’s now been shown that Facebook drives unhappiness and depression. After two weeks of Facebook, you end up less happy than you were before,” he says.

•Contribute by forms of giving from which you gain no material reward.

Happiness is visceral, connecting the self with the whole universe



Dopamine is an excitatory neurotransmitter. Too much of it down-regulates receptors.

Serotonin is an inhibitor. You can’t overdose happiness.

Happiness is through creating bonds with family, and friends

Stop the noise, you will hear His voice in silence (Rumi).

If every tip of every hair on me could speak, I still couldn't speak my full gratitude (Rumi).

Wherever you stand, be the soul of that place (Rumi).

What if we'll just confront mirrors in the hereafter?

•Cope by getting enough sleep and exercise, and by being mindful.

•Cook to get the nutrients you need in the right amounts. "You need high tryptophan, high omega 3 fatty acids and low sugar. That's called a real diet."

What is life experience really all about?

If you have lost a loved one, you have already had the experience of asking yourself what was the purpose of it all? Life experience could be divided into three episodes: First, there is childhood where we have fun, and play. Second, we reach our adulthood, starting our own family. Third is our elderly years. In childhood we learn about love from our parents, and siblings, and in adulthood, we'd pursue our dreams, like launching a career, etc. If we learn to stay away from harming others, and live an honest life, our future problems will likely be resolved. The old age brings up a final battle in the minds, where our internal voices begin to put us on a trail. Most people would start seeing regretful visions of their past, and remember their mistakes, and the things they didn't do in life.

I'd better offer a genuine solution for this, since it's Ramadan - month of fasting, and contemplation for Muslims. I missed half of it by catching a mild Covid, but I hope I'll be able to finish the rest. In Ramadan, life slows down, and for me it has always been the month of my greatest inspirations. I started Optomechanix in month of Ramadan. I'll say something from what I saw in a dream recently, and it's an answer to our most common worries: "What will come of all our life experience?" I don't know for sure, but it reminds me of how I passed some of my difficult courses at school. I usually failed on my first test, and then a barely passing grade on the second. So, I went to the teacher, and explained I am not a fast learner, but neither a cheater. What if I make my best effort to do better on the final, will you ignore my previous test results? To my luck, most teachers agreed, and I managed to pass with a B score or better.

What if I tell you in God's eyes, you'd be scoring the same way? What if there were no sins or mistakes - just low grades? What if God would display all our life actions on our hall of fame, and would invite us to visit them. As we would ebter to see them, what if all we would encounter would be mirrors? So, we'll just see a reflection of our current state of being. At that point, it wouldn't really matter what we have done but what we have become.

I think this concept would at least wipe off all the past regrets from our minds, and bring us to present. It wouldn't do us any good to collect things along the way. We are here to gain something from life while using what we could use from its possessions. It's like a wealthy couple sending their only child to school, and at the end, when they ask: "What did you accomplish dear?" The answer better not be: "Well, mom, dad, I collected 5 notebooks, 10 color pencils, two erasers, and a pencil sharpener!"

Rumi has a story about a man who worked for 30 years to buy a piece of land. He then spent 30 more years to build his castile. As he was ready to move in, the city said no! The city's reason was: "We are sorry to inform you that you built your castle on your neighbor's land, not your own". Rumi points out that there is a body, and the is the soul. Make sure you share your castle with your soul because whatever you build here, you'd be leaving it behind. Human being is far richer to show interest in collecting paper, and pencils. Consider sharing the house you already live in with God, and when the right time comes, you'll see what a great castle you had, but just didn't know it. It's a house just like the priest had in Les Misérables.

Ref. Youtube interview with Dr. Robert Lustig: The pursuit of pleasure at the expense of happiness

6 years of Optomechanix

By Ali Afshari

I have been offering Optomechanix for free through these years, but because of its name, you'll still have a hard time finding it in search engines using the keyword: "Optomechanics". To continue these issues, you'd need to be passionate about learning, and enjoy sharing it with others. I think in addition to learning design, and entrepreneurship, we all deserve having a profound purpose in life. That's why I have a section at the end of every issue called: "Psychology of achievement". I have managed small companies before, and I know what it takes to succeed in small business. As Joe Cossman often said in his lectures: Don't be too much in hurry to get rich, because when you get there, you'd get a much better taste of enemies. I find myself to be rich by having the right tools to do my research. If you come and visit my house, you'd see a movie studio, a watchmaking shop with precision machine tools, and several musical instruments to play classical music with. You'd also see bits and pieces of many optical instruments, microscopes, cameras, and telescopes. That's how I'd like to live. I think when the death angle arrives, I'll say out loud a quote from the ending of "Pretty Woman"; When Julia Roberts asked her roommate to go away with her, she said: "Not in a million, and leave all this?!"

In Middle East, scientific progress has been systematically put to rest for many years. This is so sad for nations that their science led the world at one time. So many who get educated in the west dream of returning home to push progress in science, and technology. According to Tunisian director, Naser Khemir, in spite of many efforts to connect this isolated land to the rest of the world, the footprints seem to be erased by wind and sand. "Sometimes educators enabled the breakdown of our civilization, and allowed a rupture between generations. We are no longer societies with 1500 - 2500 years old past, with depth and history, but societies which are in fact 50 years old".

I believe in school, and education for all. So much of science advancement we have today is politically motivated to feed the race between nations to dominate one another. We live in a world that could benefit enormously from inspirations channeled through humanity as a whole.

Ali Afshari

Optomex 1
Apr-June 2017

Covers 85 years historical development of Optical Erector Set

Optomex 2
Jul-Sep 2017

Covers Laser Munich 2017,
Cinema Lens testing

Optomex 3
Oct-Dec 2017

Covers Optoelectronics 2017
in Shenzhen, China

Optomex 4
Jan-Mar 2018

Covers Photonics West 2018
San Francisco, CA

Optomex 5
Apr-Jun 2018

Covers Analytica Show 2019
in Munich, Germany

Optomex 6
Jul-Sep 2018

Covers brief history of photographic camera design

Optomex 7
Oct-Dec 2018

Covers the Wide Field / Planetary
Camera of Hubble Space Teslcope

Optomex 8
Jan-Mar 2019

Covers Photonics West 2019
Anouncing Optoform II

Optomex 9
Apr-Jun 2019

Covers Lasers and Photonics 2019
In Munich, Germany

Optomex 10
Jul-Sep 2019

Covers Hasselblad moon camera,
part 1, Russian Space Museums

37

Optomex 11
Oct-Dec 2019

Covers Hasselblad moon camera, part 2
Coung Dang's Watchmaking Shop

Optomex 12
Jan-Mar 2020

Covers Photonics West 2020
San Francisco, CA

Optomex 13
Apr-Jun 2020

Covers Electron microscopy
Review of Classical Optoform System

Optomex 14
Jul-Sep 2020

Covers OMiD Museum

Optomex 15
Oct-Dec 2020

Covers Optoform Projects, and explains Enneagram

Optomex 16
Jan-Mar 2021

Covers binocular optics design
Omur Khayyam's Jalali Calendar

Optomex 17
Apr-Jun 2020

Covers microscopy design:
Leica, Zeiss, Olympus, and Nikon

Optomex 18
Jul-Sep 2021

Covers Zeiss LSM-510
Scanning Confocal Microscope

Optomex 19
Oct-Dec 2021

Covers watchmaking

Optomex 20
Jan-Mar 2022

Compilation of all Optoform II articles published in Optomechanix

Optomex 21
Feb 2022

Covers Photonics West 2022,
San Francisco, CA

Optomex 22
Apr-Jun 2022

Covers camera manufacturing industry part 1

Optomex 23
Jul-Sep 2022

Covers camera manufacturing industry part 2

Optomex 24
Oct-Dec 2022

Covers optomechanical design of Olympus CX-21 microscope

Optomex 25
Jan-Mar 2022

Covers how to build a scanning inverted microscope
Zeiss Stemi Microscope

Optomex 26
Apr-Jun 2023

Covers micromechanics of Mitutoyo measurement tools part 1
Anatomy of Stereo Zoom Microscope