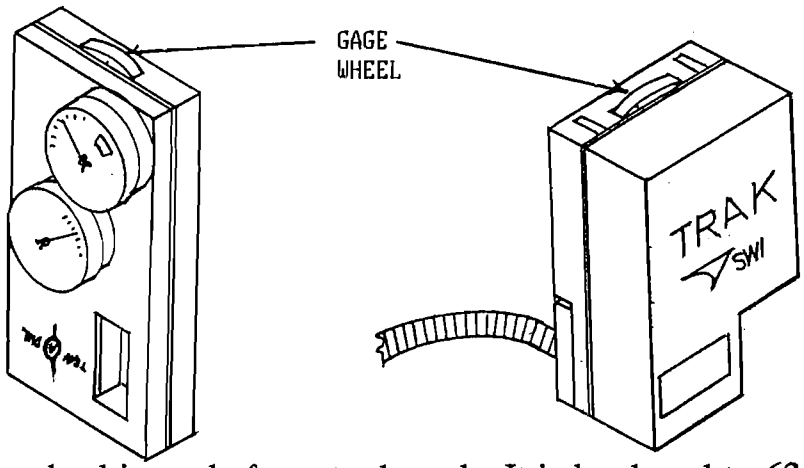
SECTION II

Technology of SWI Measurement Products

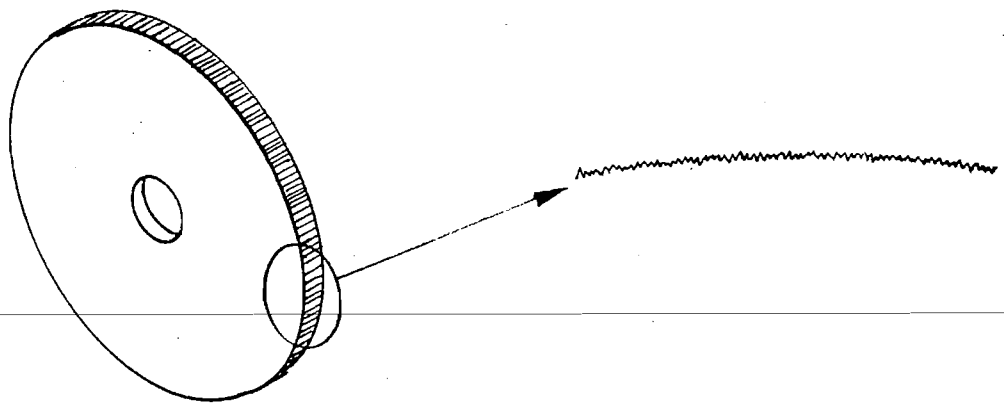
A - THE GAGE WHEEL PRINCIPAL

1. The Micro-Rack-and-Pinion System



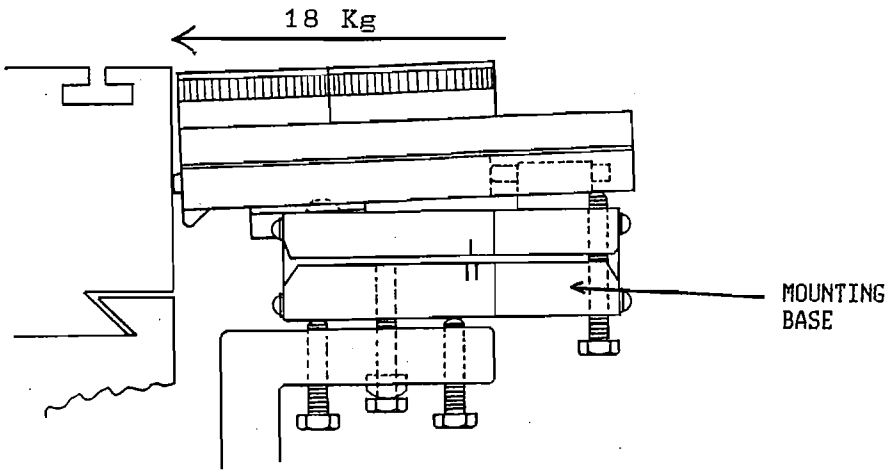
The gage wheel is made from tool steel. It is hardened to 63C on the Rockwell Hardness Scale.

On the wheel surface are thousands of tiny scratches formed by a special diamond grinder.

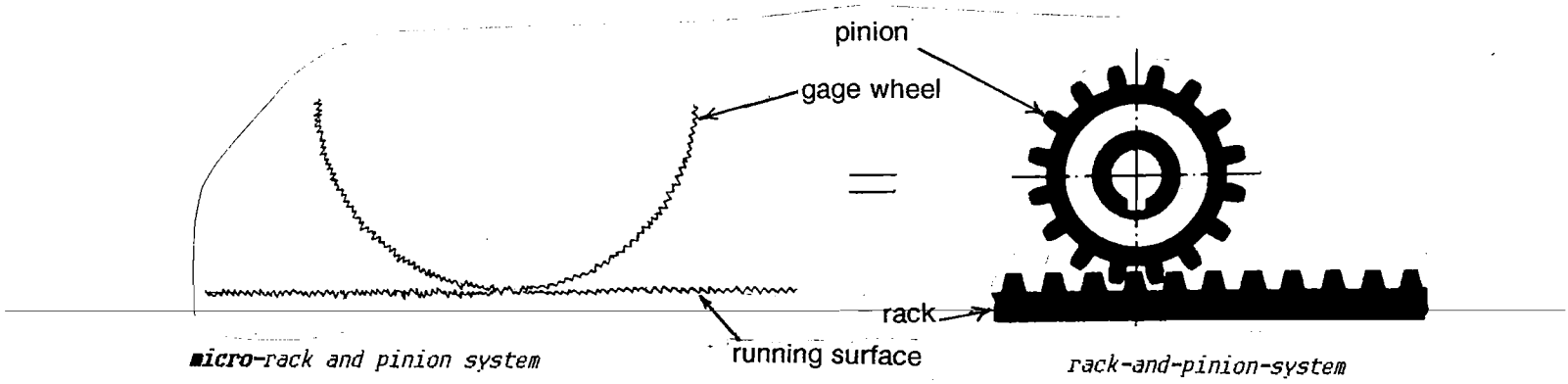


These scratches form a random pattern so that no part of the wheel is exactly like another part.

The Trav-A-Dial and TRAK Sensor are installed on a Mounting Base. This Mounting Base pushes the Gage Wheel against the running surface with 18 Kg of force.



After the Gage Wheel has rolled over its running surface a few times it forms a track or rack in its own image. This is because the hardness of the Gage Wheel and its pushing force actually deform the running surface. This "rack" is small, less than .04mm of depth.



When this pattern is formed, the Gage Wheel is operating in its own "micro-rack-and-pinion" system.

In order for the Gage Wheel to form the "Micro-Rack-and-Pinion" system, it must roll on a suitable running surface.

Very often, the running surface is part of the machine tool. For example, the way surface of a lathe or a milling machine table.

If part of the machine tool is not suitable, a running surface (Run Bar) must be installed.

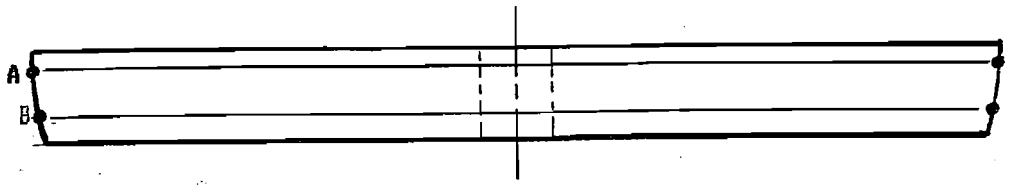
The wheel never slips because the "teeth" of the pinion always go back to the same "groove" in the rack that it formed originally.

If the wheel is removed and then replaced, it will form a new rack over the old.

When the wheel rolls over oil, the oil is pushed away from the teeth.

2. Mechanical (Tilt) Calibration (Trav-A-Dial only)

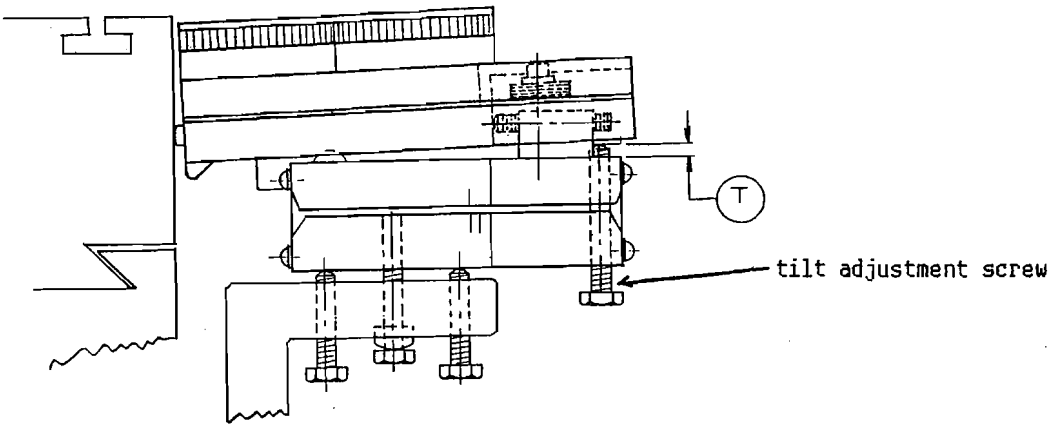
The Gage Wheel of a Trav-A-Dial has a radius on its rolling surface.



contact at point A = big wheel
contact at point B = small wheel

Changing the point on which the wheel makes contact, changes the circumference of the wheel. The wheel becomes "bigger" or "smaller" depending on its point of contact.

The contact point of the wheel is changed by adjustments to the tilt of the Trav-A-Dial.



The adjustments are made by the Tilt Adjustment screw on the Mounting Base.

B - ELECTRONIC CALIBRATION

Digital Readout and control products manufactured by SWI incorporate computerized machine tool error compensation.

During the calibration procedure, the microprocessor in the DRO calculates and stores a linear compensation factor.

This compensation factor is automatically applied to all measurements. It is stored on an EEPROM so that it will remain the same until it is changed by repeating the calibration procedure.

C - SWI GEARS

1. Gears in Gage Wheel Products

Trav-A-Dials and TRAK Sensors detect linear motion by the contact of the Gage Wheel on a running surface.

The rolling motion of the Gage Wheel is translated to analog or digital readout by a very special gear train.

The accuracy of the Trav-A-Dial and TRAK Sensor is obtained by the precision of the gears made by SWI.

2. Manufacture of Gears

SWI has specialized in the manufacture of precision instrument gears since the company was founded in 1952. Our gears are part of aircraft and missiles used in industry and the military.

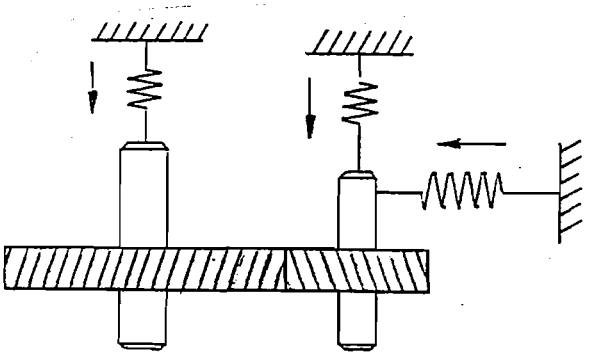
All the equipment for manufacturing gears has been designed and made by SWI. Our gear-making process is protected by patents.

Gears are formed or rolled from super-accurate master gears. A unique cold-forming process is used.

3. Gear Characteristics and Assembly

All gears are helical and of an involute, or curved gear shape. This yields uniform meshing of gear teeth and a smooth transfer of motion.

The gears are preloaded by springs in the axial and radial direction to eliminate backlash.



SWI gears are the most accurate, low cost instrument gears in the world. Average tooth-to-tooth gear accuracy is within .0005mm.

D - THE ELECTRO-OPTICAL SYSTEM OF THE TRAK SENSOR

All of the internal electronic components of the TRAK Sensor are solid state.

The TRAK Sensor is modular so that any part can be replaced easily and cheaply.

Gage Wheel motion is translated to a photo-optic disk which turns inside a Hewlett Packard encoder. This transforms the analog motion of the wheel into diital pulses. Motion of the disk is sensed by a sophisticated chip (IC) in the encoder which contains 20 photo-diodes. Phase errors are eliminated by algorithyms programmed into the chip. This means that physical alignment is not critical, and replacement is possible without specialized equipment.

A Line Driver in the sensor ensures that pulses reach the TRAK DRO display accurately. The Line Driver eliminates signal degredation and susceptibility to noise even when the pulses are sent over long wire.

E - THE TRAK 100 DISPLAY

The TRAK 100 DRO is microprocessor controlled.

It uses software to perform all of its functions.

Each TRAK 100 contains the software to enable it to perform any of its functions. Upon installation, or when he chooses, the user may select the features desired through a simple keystroke procedure contained in the Users Manual.

All selections are stored in EEPROM's. This allows the unit to retain the configurations until they are intentionally changed.

Application Specific Integrated Circuits (ASIC's) are utilized. These "custom chips" keep the size requirements of the PC Board low and reduces operating power requirements.

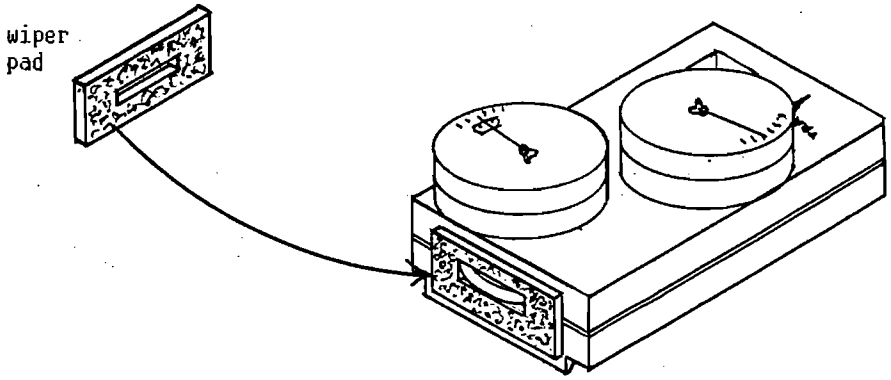
The TRAK 100 software is written in "assembly language." This enables the features to be packed into a small amount of memory.

F - PROTECTION SYSTEMS FOR GAGE WHEEL PRODUCTS

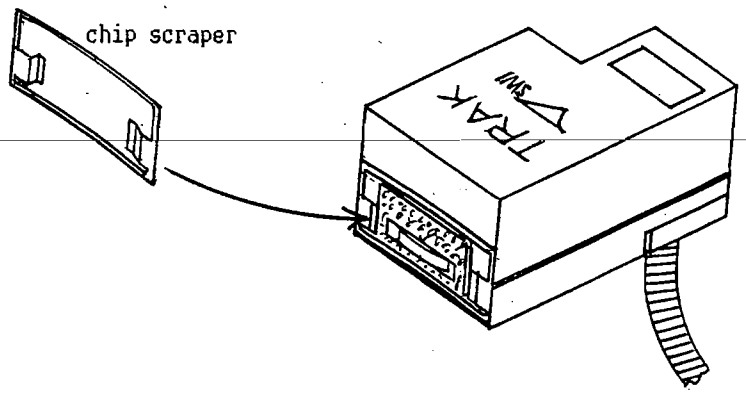
Trav-A-Dials and TRAK Sensors have been designed for use in the most difficult shop environments.

1. Protection of Gage Wheel

The Gage Wheel is protected from premature wear by a foam wiper pad which surrounds it.



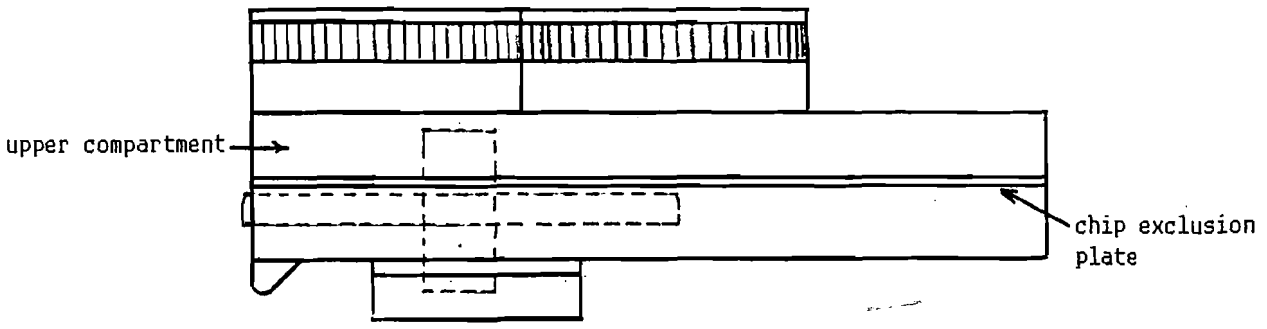
After installation this wiper pad is filled with oil. It forms a lubrication system which wipes the running surface clean as it passes.



The TRAK Sensor also employs a metallic Chip Scraper which pushes metal chips away and breaks long, stringy chips.

2. Protection of Internal Mechanisms

The gear train of the Trav-A-Dial and the electronic components of the TRAK Sensor are housed in an upper compartment. This upper compartment is protected from the outside environment by a Chip Exclusion Plate.



The Chip Exclusion plate is sealed by a rubber gasket which fits along the case.

Motion is transferred from the Gage Wheel through a pinion. Only the Gage Wheel is below the Chip Exclusion Plate. The pinion is sealed by a special teflon bearing.

The result is that the Trav-A-Dial and TRAK Sensor are completely protected from chips and contaminants entering the upper compartment.

3. Protection of TRAK Sensor Cable

The TRAK Sensor cable is protected by special armoured casing to prevent damage. The cable itself is shielded to prevent false readings due to electronic interference.

4. Protection of The DRO Display

The TRAK 100 Display is small and compact.

The outer case is made up of two pieces of die-cast aluminum. This makes it sturdy and helps to seal in and protect the internal electronic components.

The display face is one piece. All keys and LED's are sealed by a mylar membrane. Mylar is a very durable material which withstands adverse shop conditions.