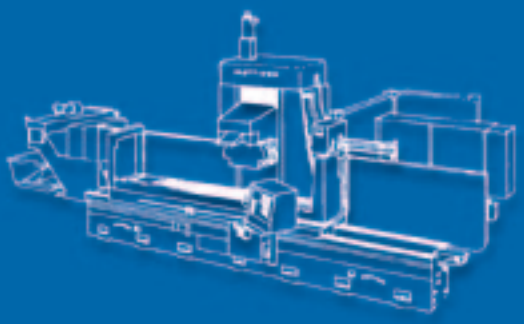
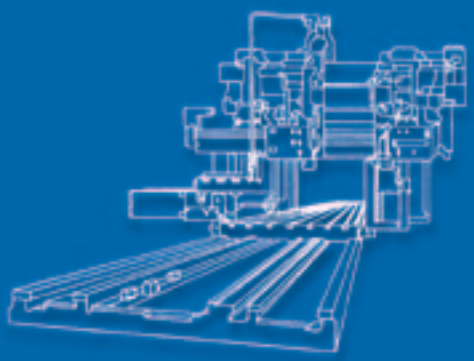


# MACHINE TOOL WAY REBUILDING

## THE MOGLICE™ MOLDING METHOD

## DEVITT MACHINERY COMPANY

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# History & Concepts

***History***

**Diamant** Metallplastic GmbH of West Germany was founded in 1886 as a family business. Diamant continues today as a closely held family company. They were involved in the earliest days of reactive resins, creating innovative formulations to meet industry needs. Since the mid 60's they have produced products for machine tool assembly and machine tool bearing surfaces. Their formulation experience and quality standards allows them to offer technically superior products in the critical areas of wear resistance, coefficient-of-friction and dimensional stability.

**Devitt Machinery Co.** of Aston,Pennsylvania, has been the North American distributor of Diamant's Moglice and DWH materials to machine tool builders, rebuilders and large maintenance departments for over two decades. Calling Devitt Machinery for application assistance means speaking with someone that has experience in scraping and precision machine alignments. Devitt Machinery offers the widest variety of the product viscosities: fluid,semi and putty; and convenient sizes: 100gr., 250gr., and 500gr. kits.

***Concepts***

**Replication:** When you have one accurate part, it is possible to replicate a mating surface. This eliminates the need for costly match machining or scraping of parts.

**Standardization:** When replacing bearing material, the thickness of the bearing material required is seldom a nominal size so the next larger nominal size is applied and then precision machined or scraped to the correct thickness. In contrast, Moglice can be molded to fit any required thickness. It is not uncommon for a taper to be required. In this case the Moglice easily allows for varying thicknesses across the length or width of a way. In new construction head stock centerline can be set at a standard height not a .001" high or low depending on how the machining and scraping went.

**Ability to join diverse materials:** Moglice can be used to create low-friction bearing liners in nuts or bushings made of cast iron, steel, aluminum, phenolic or carbon fiber. It is frequently used to create or rebuild low-friction surfaces on steel fabrications or epoxy granite bases.

**Low-friction bearing - dynamic:** A low-friction Moglice bearing is used to replace a metal-to-metal bearing to reduce the coefficient-of-friction and reduce costly labor and machining hours in the precision fitting process.

**Structural alignment material - static:** DWH is used to match two components without the need for precision machining. The material is injected or poured between the aligned machine components providing 100% bearing contact. DWH is used in static applications only.

# Choosing the Correct Material


SECTION

A

***Moglice Types "Product Descriptions" & Technical Data***

**Moglice FL/P** Formulation Release Date 1988 - is a fluid with a consistency similar to gear oil. It can be injected or poured to produce way systems, quill bores, nuts or tapers. It is also used in the pour and set application technique.

**Moglice P-500** Formulation Release Date 1986 - is a slightly thicker fluid with a consistency similar to honey. It is still injectable and is often used in ball nut applications, air bearings and in the production of sub-micron accurate bores.

**Moglice 628** Formulation Release Date 1985- is a semi fluid having the consistency of a thin putty and tends to run on a vertical surface with minimal damming required, but will not run off a flat way. It is most commonly used on machines with large flat ways because it is easier to mix, apply and get the component down and aligned.

**Moglice Putty Hard** Formulation Release Date 1983 - is a non-slump putty and is the most common material used on standard way systems. It can be applied to vertical or overhead surfaces without running or dripping.

**Moglice 1000 Fluid** Formulation Release Date 1997 - is a fluid about the same viscosity as the Moglice P-500 above. Moglice 1000 Fluid differs in that it contains Teflon and results in a 25% to 30% further reduction in friction. It also provides added protection against moisture absorption.

| PRODUCTS | HARDNESS SHORED | COMPR.STR. daN/cm2 (psi) | BEND.STR. daN/cm2 (psi) | E-MODULUS daN/cm2 (psi) | ADHES.STR. daN/cm2 (psi) | TENS.STR. daN/cm2 (psi) | SP.WGT. g/cm3 | COEFF.OFEXP. cm/cm/°C |
|---|---|---|---|---|---|---|---|---|
| Moglice FL/P | 84/85 | 1400 (19900) | 660 (9400) | 64000 (900000) | 160 (2250) | 125 (1775) | 1.6 | $45 \times 10^{-6}$ |
| Moglice P-500 | 86/87 | 1600 (22750) | 665 (9455) | 63000 (895860) | 145 (2060) | 130 (1848) | 1.6 | $40 \times 10^{-6}$ |
| Moglice 628 | 86/88 | 1620 (23030) | 675 (9585) | 64000 (908800) | 138 (1950) | 125 (1775) | 1.7 | $39 \times 10^{-6}$ |
| Moglice Putty Hard | 88/89 | 1650 (23460) | 695 (9880) | 66000 (938520) | 135 (1920) | 120 (1705) | 1.8 | $39 \times 10^{-6}$ |
| Moglice 1000 Fluid | 88/89 | 1500 (21750) | 680 (98620) | 98000 (1421000) | 170 (2465) | 210 (3045) | 1.4 | $43 \times 10^{-6}$ |

**To Find the Grams of Moglice Required:**

**Example:** 5" wide x 48" long x .062" thick = 14.88 cubic inches x 33 (FL/P) = 491 grams of Moglice FL/P needed.

Cubic Inches to be Filled x

**33 Moglice FL/P**
**36 Moglice P-500**
**37 Moglice 628**
**41 Moglice Putty Hard**
**37 Moglice 1000 Fluid**

## *Examples of Viscosities Used for Different Applications*

**Male Double Vee Way**

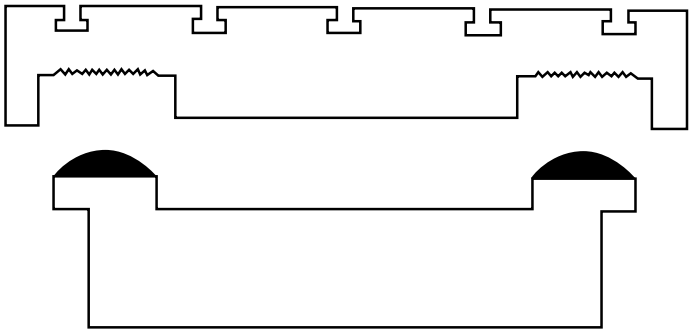
*American Lathe Saddle*

Putty applied to bed way will adhere to saddle.

**Wide Flat Ways**

*G&L HBM Table*

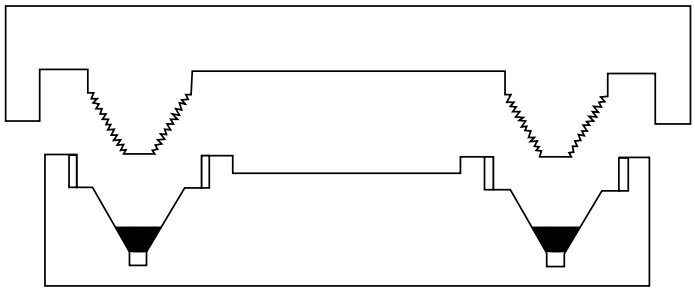
Semi spread out on ways adheres to table.



**Female Double Vee Way**

*Rockford Planer*

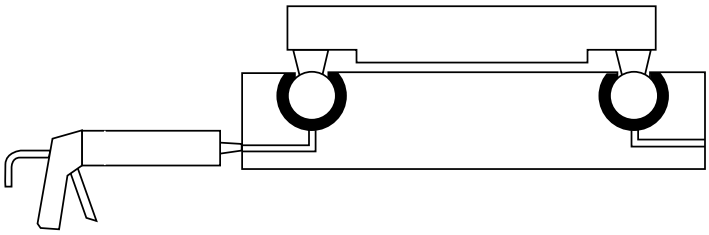
Fluid poured in dammed bed way will adhere to table.



**Round Ways**

*Bryant I.D. Grinder*

Fluid is injected. Hydrostatic pockets molded in.



DWH grades are designed for static fits in machine assembly so they do not include low-friction fillers. DWH resins are produced in various viscosities and have more than 80% metallic fillers. DWH is used to mold static machine components in-place and to eliminate expensive machining and scraping. It can also be used as a repair material in maintenance. Common uses for the different grades are listed below. Its ability to mold to any shape makes it possible to shim with 100% contact.

***DWH Types "Product Descriptions" & Technical Data***

**DWH 310 FL** - has steel fillers and is often used to produce bearing seats, align ball screws, align columns to beds, locate hardened seats in identical pallets, etc.

**DWH 311 FL** - has aluminum fillers with a lower specific weight therefore, is less expensive for a given volume. It is frequently used for filling key ways and bolt holes.

**DWH 311 Putty** - is a thin putty used in applications where the sealing and injection method is less practical; for instance, a segmented surface. A thickener powder is available for vertical or overhead applications.

- Thickener Powder is available for all DWH grades.

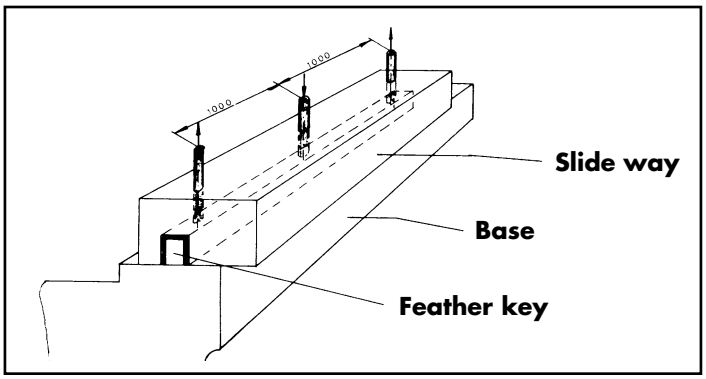
| PRODUCTS | HARDNESS SHORED | COMPR.STR. daN/cm2 (psi) | BEND.STR. daN/cm2 (psi) | E-MODULUS daN/cm2 (psi) | ADHES.STR. daN/cm2 (psi) | TENS.STR. daN/cm2 (psi) | SP.WGT. g/cm3 | COEFF.OFEXP. cm/cm/°C |
|---|---|---|---|---|---|---|---|---|
| DWH 310 FL | 87/88 | 1685 (23960) | 1250 (17775) | 53000 (753660) | 140 (1990) | 130 (1848) | 2.2 | $50 \times 10^{-5}$ |
| DWH 311 FL | 79/80 | 1500 (21330) | 1000 (14220) | 48000 (682560) | 140 (1990) | 135 (1920) | 1.4 | $55 \times 10^{-5}$ |
| DWH 311 Putty | 80/81 | 1550 (22040) | 950 (13510) | 50000 (711000) | 130 (1848) | 120 (1705) | 1.5 | $50 \times 10^{-5}$ |

**To Find the Grams of DWH Required:**

**Example:** 5" wide x 48" long x .062" thick = 14.88 cubic inches x 45 (DWH 310 FL) = 670 grams of DWH needed.

Cubic Inches to be Filled x

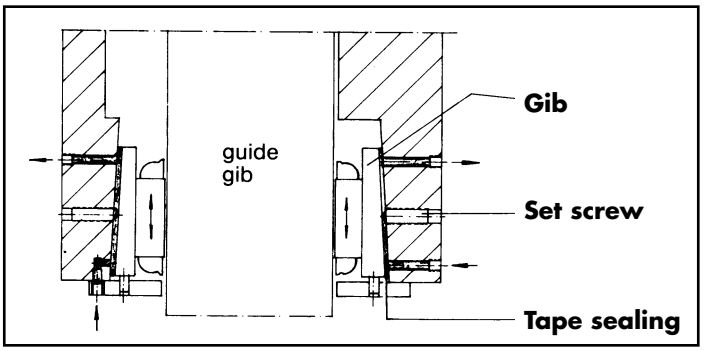
**45 = DWH 310 FL**
**31 = DWH 311 FL**
**32 = DWH 311 Putty**




*Improving the stiffness of metal slide ways:* The structural connection of the key way and the base are accomplished by the molding technique with DWH 310 FL.

The special properties of DWH 310 FL allows a structural connection between the base, key and slide way in an uncomplicated application method.

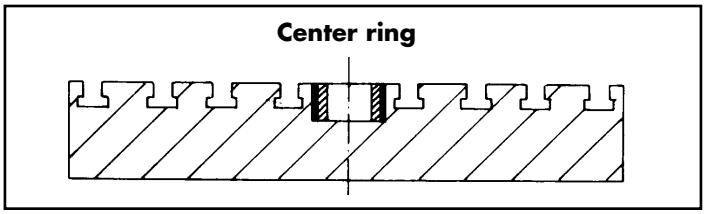
Tests of the static flexural strength showed higher strength than metal-to-metal due to evenly distributed load.



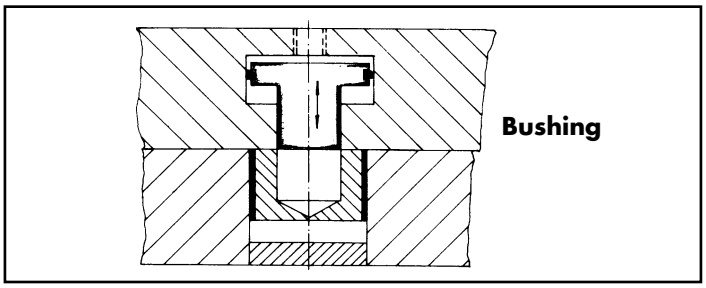

*Price worthy, highly precise assembly of bearing elements:* After alignment (by set screw and gib), the gib screwed to the roller bearing is fixed in position by DWH 310 FL.

The gib is treated with separator to ease disassembly for repair and maintenance.

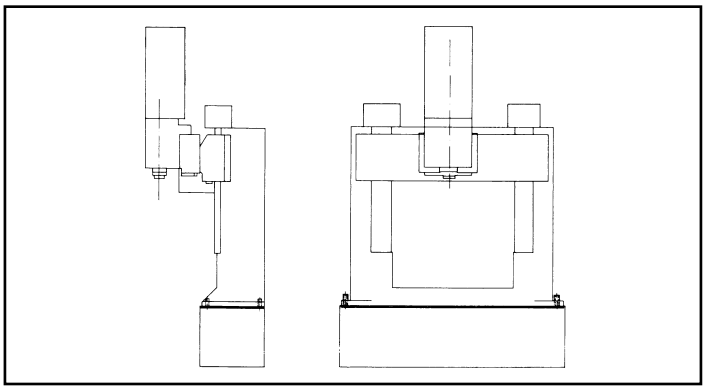
In principle, all similar assemblies are possible due to the excellent, proven properties of DWH 310 FL.




*Center rings:* Center rings are molded in position after alignment using DWH 310 FL with a reproducible exactness of 2µ.




*Bushings:* The bushing of an indexing cylinder is molded after alignment with DWH 310 FL (high precision without machining).



*Machine parts:* The top part and base of the machine are aligned by set screws, the top part being sprayed with separater for eventual disassembly and the edges sealed. The gap (between 1/10" thickness and several mm theoretically) is filled with DWH 310 FL by pouring or injecting. (No machining, excellent damping and cost saving)


Devitt Machinery is proud to announce **Set Right**, a two component 100% solids filled epoxy resin system. Developed primarily from the need to make precision alignments of rigidly attached components to metallic or composite bases during assembly or retrofit. One typical application is the installation of a ballscrew nut and bearings. This normally requires a precision shim mounted to a machined flat surface on a component. **Set Right** was formulated to our highest standards to achieve precision alignment and durability without the need for match machining. **Set Right** is very cost competitive for all alignments as well as the setting of machinery mounts, leveling wedges and sole plates. Its thin viscosity makes it easy to use in thin cross sections typically .200" to 1" thick.

### *Physical Properties*

- Color ..... Medium Grey
- Max Service Temperature ..... 150°F
- Mixed Viscosity ..... 6,000 cps
- Specific Weight ..... 1.7
- Hardness (Shore D) ..... 90
- Pot Life @77°F ..... 10-15 minutes
- Tensile Modulus (millions) ..... 1.01 psi
- Tensile Strength (ASTM D-638) ..... 4,800 psi
- Adhesion Slant Shear Test ..... 4,200 psi
- Flexural Strength (ASTM D-790) ..... 6,800 psi
- Compressive Strength (ASTM D-695) ..... 16,800 psi
- Linear Shrinkage (ASTM D-2566) ..... 0.00025 in./in. @77°F
- Coefficient of Thermal Expansion (ASTM D-696) ..... 2.0 x $10^{-5}$ in./in. @ °F

***Liquid Separator W-11*** - is an easy flow, ready-to-use release agent that can be applied by a brush, cloth or spray gun, and will leave a thin even coating. It takes approximately 15 minutes to cure and can also be polished with a soft cloth.

***Spray Separator W-11*** - is an easy to use spray release agent that comes in an aerosol can and can be polished in approximately 15 minutes after spraying with a soft cloth.

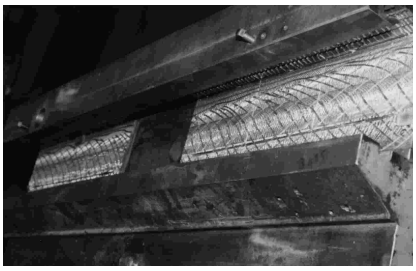
***Paintable Wax*** - is a thick general purpose release agent that is applied by brush to non-critical surfaces to aid in separation. This release agent does not leave an even film but is commonly used on vertical non-critical surfaces to provide .002" - .004" clearance.

***Spray Separator TF (Teflon)*** - is an easy flow, ready-to-use release agent that can be applied by a brush, cloth or spray gun and leaves a thin even coating. Typically used on quills and bushings, it makes detachment easier than with the wax release. It is used when the surfaces must be sheared at seperation.

***Separator Paste*** - is a light, paste-like consistency with an excellent releasing quality which is applied with a soft cloth. This release takes approximately 30 minutes to cure and can be polished to a very accurate coating thickness. It can be left rather thick in an attempt to build up clearance. This is the most environmentally friendly release agent in that it only contains Petroleum Distillates.

***Diamant Cleaner/Degreaser*** - has been specifically formulated to deep clean metallic surfaces of oil and grease. With its high delivery rate under pressure, it is used to clean surfaces without the need for wiping or blow drying. Our cleaner leaves no residue making it an excellent cleaner for adhesion surfaces.

# Preparation of Adhesion Surface

SECTION

B

# Preparation of Adhesion Surface

***Mechanical Preparation of Adhesion Surface***

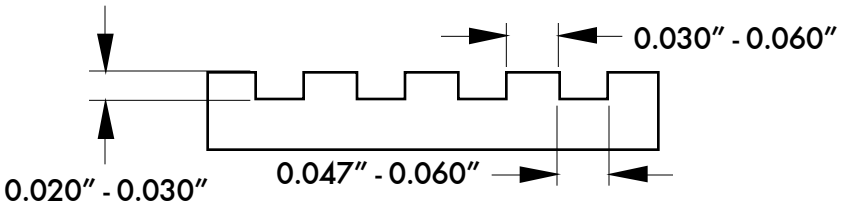
A rough surface finish is best for Moglice adhesion, as it increases surface area as well as providing a mechanical lock for the material. Matte finishes (like a sandblasted surface) have higher adhesion strength than a shiny surface. When cutting cast iron it is better to rip it off than to use a cutter that smears the porosity over. When removing old way liners all glue residue must be removed. Fresh cast iron can be presented for adhesion by sanding or grinding with hand tools. If Moglicing perpendicular surfaces on a box way using putty, make sure there is enough clearance on opposing surfaces for positioning. When upgrading from metal-to-metal to a low friction Moglice bearing, it may be necessary to machine clearances for the Moglice. Refer to charts below for surface finishes and coating thickness recommendations.

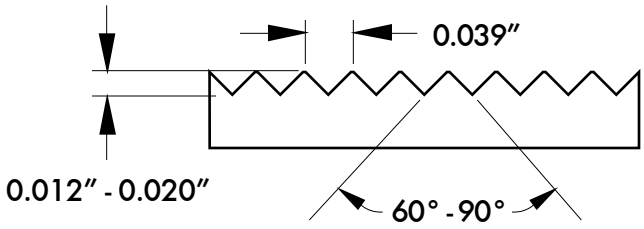
**Recommended Clearances for Moglice & DWH***

| | Injection | Pour & Set | Semi | Putty |
|---|---|---|---|---|
| Recommended thickness | .060 to .125 | .060 to .125 | .060 to .125 | .060 to .125 |
| Practical limits on thickness | .015 to .250 | .015 to .250 | .015 to .250 | .015 to .250 |

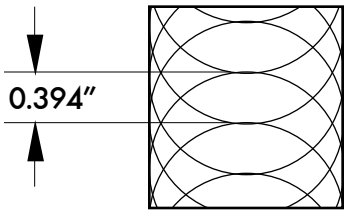
Hydraulic resistance to the flow of Moglice through a gap is a factor in coating thickness selection. Please see the application sections for more details. For gibs, plates or nuts sandblasting is recommended.

* DWH can be used as a near zero clearance filler under plates or between flush mounted components to fill potential gaps, providing 100% contact. In some areas (around screw holes) there will be physical contact between the surfaces, the DWH fills all other gaps. This technique is not recommended if there will be frequent disassembly of the components.




Roughen long surfaces using 60° triangular inserts.




Roughness depth 0.012" - 0.020"

# Preparation of Adhesion Surface

***Mechanical Lock***

Sandblasting has been proven to generate the best adhesion surface, although it is not practical for larger components.

Using a die grinder with a thin cutoff wheel, cut angular notches on the surface. This will vent and not capture air and enhance adhesion. Never drill holes for adhesion; they do not fill and will cause voids in the Moglice bearing. Also, cut notches at lubrication points. Any lube holes must be recorded and plugged below these adhesion notches before application and then redrilled after molding of bearing.

***Deoiling***

Devitt Machinery also has a deoiling powder used in rebuilding, primarily to act like oil dry; it draws excess oil out of old oil soaked cast iron. The deoiling powder will change color when it absorbs oil and should be reapplied several times until it stops changing color. Gentle heat can also be used to sweat oil out of a casting.

***Cleaning***

After deoiling it is recommended that Diamant spray cleaner, or its equivalent, be used to clean the surface for adhesion. Diamant spray cleaner has a high delivery rate under high pressure which when used in a sweeping motion on adhesion surfaces gives excellent cleaning without the need for wiping or blow drying. After cleaning do not touch the surface with hands, rags or blow with oily compressed air as it will contaminate the adhesion surface. Be sure cleaning does not excessively cool the surface causing water in the air to condense on the surface. Allow a few minutes between cleaner applications for the metal to normalize in temperature; this prevents condensation and dimensional changes due to temperature.

***Nuts & Bores***

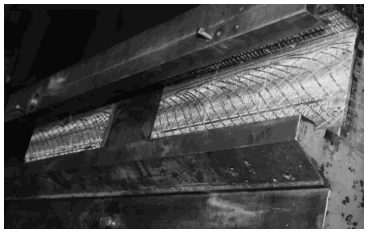
(See Screw & Nut Injection Methods, Section G)

***Coating or Wear Plates***

If a machine table has phenolic bearing plates or wear plates already on it, it is cost effective to replace them with plates and then mold a Moglice low-friction bearing surface over them. These plates or wear strips are often .250" thick and to fill a gap of that thickness with Moglice would not be cost effective. When replacing these plates care must be given to ensure they are securely fastened and have 100% contact on adhesion side. In some instances these plates have been found to be worn yet they are still securely fastened. In this instance cleaning and roughening of their surface for adhesion of Moglice is all that is needed. Breaking the glaze with a disc sander and notching for mechanical lock is all that is required besides cleaning.

Screwing plates to the table ways

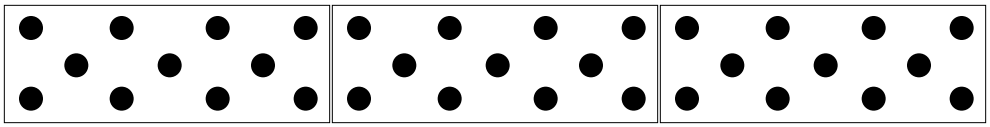
Notching phenolic plates for mechanical lock



Bronze plates roughened for adhesion

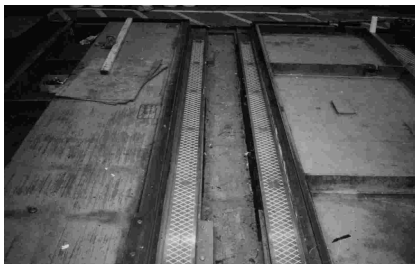
***Procedures for Installing Plates:***

1. Clean glue residue from cast iron.
2. With a grinding wheel cut surfaces to remove glaze.
3. Position plates, then drill, counter cut and thread holes for screws. Use the following pattern for screws:



4. Move plates off, apply DWH 311, and reinstall plates. Try not to get material in the threaded holes as it will make it harder to get screws to go in.
5. Run screws in tight and remove excess DWH with a putty knife.
6. Allow 18 hours for cure.
7. Plates can be sounded for full contact by tapping with a box wrench.

# Preparation of Molding Surface

SECTION

C

# Preparation of Molding Surface

***Checking Geometry***

The first thing to do is verify the accuracy of the guide or molding surface. Remember replicating to an inaccurate surface will mean a duplication of the error. Check

molding surfaces for flatness, straightness and with no twist. If molding to a diameter check for taper and roundness. When molding to a screw mold to the largest threads. Checking straightness is commonly overlooked, however it is very important. If overlooked it can cause premature bearing failure. With the use of a long straight edge and an indicator, check straightness on smaller machines. When doing larger and longer ways like those on a planer or grinder, either the Ingersoll wire micrometer or the use of a laser is recommended. Flatness can be checked with straight edges and a level or with the laser. Again the bearing is a mirror image of the molding surface. Take the time to check before molding. Remember if there is a low spot in the bed way of .002" and it is molded, the Moglice will have a high spot of .002" in that area or what translates to an error of .002" when the slide is moved on the bed way. When molding to a twist, that error is multiplied depending on the thickness of the table or the distance between the bearing and cutter of the machine. Please contact Devitt Machinery or a local rebuilder to make the checks if this is something that needs to be verified and cannot be done in-house.

***Surface Finish***

The surface finish is important. A ground surface is best, but a finely scraped or milled surface is also appropriate. The finer the surface finish the longer the life of the bearing. A surface finish in excess of 100 R.M.S. should be scraped or stoned to improve the finish.

## Release Agents

**Spray Separator W-11**: is an easy to use spray release agent that comes in an aerosol can and can be polished in approximately 15 minutes after spraying with a soft cloth.

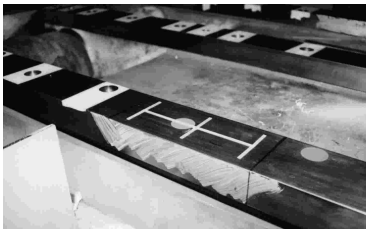
**Liquid Separator W-11**: is an easy flow, ready-to-use release agent that can be applied by a brush, cloth or spray gun, and will leave a thin even coating. It takes approximately 15 minutes to cure and can also be polished with a soft cloth.

**Paintable Wax**: is a thick general purpose release agent that is applied by brush to non-critical surfaces to aid in separation. This release agent does not leave an even film but is commonly used on vertical non-critical surfaces to provide .002" - .004" clearance.


Release agents

***Diamant Separator (Standard wax)***

***Paintable Wax (Release-All)***



Shown here, paintable wax applied to the clearance side of a rail

| Coating Thickness | Separator Liquid Unpolished | Separator Liquid Polished | Separator Spray Unpolished | Separator Spray Polished |
|---|---|---|---|---|
| One Coat | .00016" | .0001" | .00012" | .00008" |
| Two coats | .00032" | .0002" | .00032" | .0002" |

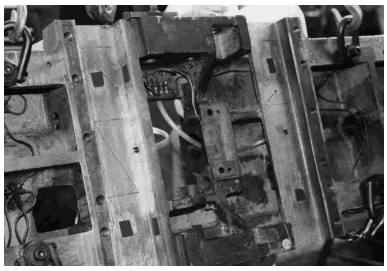
**Separator TF (Teflon)**: is an easy flow, ready-to-use release agent that can be applied by a brush, cloth or spray gun and leaves a thin even coating. Typically used on quills and bushings, it makes detachment easier than with the wax release. It is used when the surfaces must be sheared at separation.

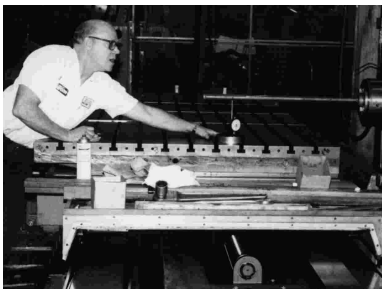
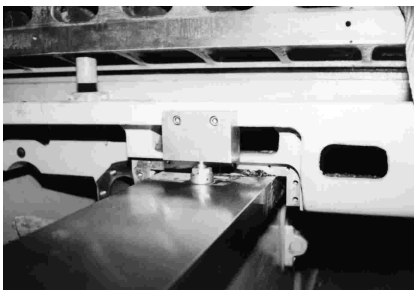
| Coating Thickness | Separator TF Unpolished | Separator TF Polished |
|---|---|---|
| One Coat | .00012" | .00008" |
| Two coats | .00028" | .0002" |

**Separator Paste**: is a light, paste-like consistency with an excellent releasing quality which is applied with a soft cloth. This release takes approximately 30 minutes to cure and can be polished to a very accurate coating thickness. It can be left rather thick in an attempt to build up clearance. This is the most environmentally friendly release agent in that it only contains petroleum distillates.

| Coating Thickness | Separator Paste Unpolished | Separator Paste Polished |
|---|---|---|
| One Coat | .0002" | .00008" |
| Two coats | .00036" | .0002" |

# Alignment Methods



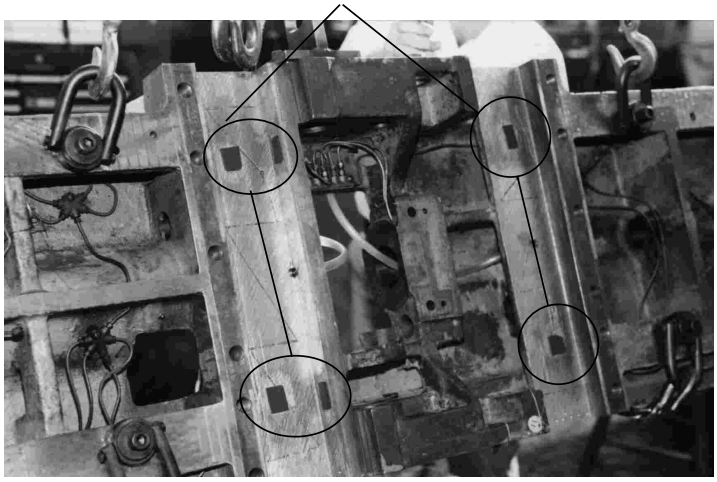
SECTION

D

***Alignment Methods***

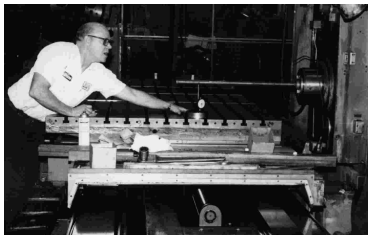
The Moglice molding method presumes that the component is held in its correctly aligned position while the Moglice cures. There are several ways to align components.

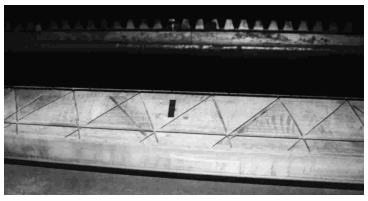
## Moglice Shims



Moglice shim is commonly used in rebuilding applications. Small pieces of Moglice shim in the correct thickness are Super Glued to the adhesion surface. The shim can be as small as 1/4" x 1/4" or for very large machines as much as 1"x 1". Devitt Machinery stocks Moglice shim in different thicknesses for your convenience (see chart). On long way surfaces a series of shims every 2' to 3' down the length of the way minimizes component sag. For best results, the shim should be positioned in line with structural webbing in the casting. This minimizes deflection in casting and results in a better print or rub when checked with marking compound. The component is then set down on the shims and alignment is checked. Should adjustment be necessary the high shims can be scraped or plastic shim stock can be added to the low shims. After final alignment it is a good idea to set it down twice to be sure the alignment repeats. This method can be readily used to achieve alignments on the order of .0005". If more precision is required, alignment jacks or wedges can be used to raise up a low corner or section the last few ten thousandths of an inch. It is not recommended to raise the component more than a few thousandths, if the Moglice has already been applied, because air will be drawn into the bearing surface.

| Moglice Shim Sizes | | | | | | |
|---|---|---|---|---|---|---|
| .029" | .040" | .055" | .072" | .092" | .120" | .143" |
| .032" | .045" | .063" | .081" | .108" | .127" | .185" |

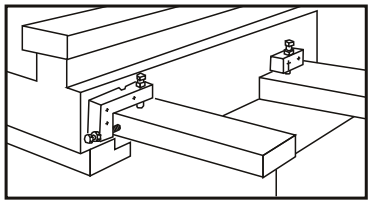




**Centering Rings -** Bushing and nuts are typically held concentric with centering rings that pick up the O.D. of the quill or screw and a reference surface on the nut or bore housing. (Refer to Section G on Screw & Nut Injection.)

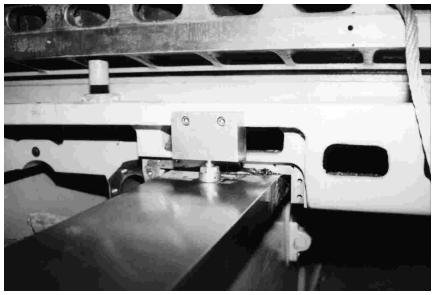
Centering rings.

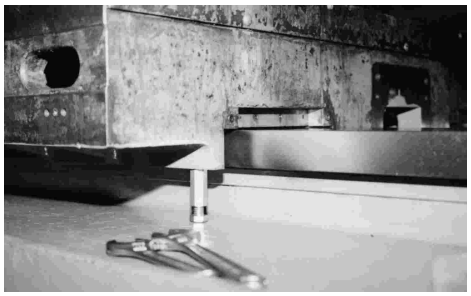
**Jack Screws -** The use of jack screws is more common on smaller components like a lathe saddle or cross slide; however, it is not necessary to drill and tap through the components. When the jack screws are threaded through a block of steel or other metal and then that block is secured to a lathe saddle using existing threaded way wiper holes, it is possible to achieve proper alignment quickly. Remember, cast iron will bow so do not span more the 36" between jack screws. Jack screws do not have to contact way surfaces. They can contact adjoining clearance surfaces and still provide excellent alignment. The use of small jack screws along the sides of a longer table have been successfully used. If jack screws are used touching ways, be sure to use screws with brass tips to prevent damaging way surface. This method allows exact alignment with the ability of fine adjustment at final set. It is very important to achieve correct alignment with the ability to repeat that alignment before mixing and applying Moglice. Jack screws can be used without shims. They are usually left slightly, (.002" or .003") high and final alignment reached by lowering to the correct elevation at final set in Moglice. Set screws can be installed in tapped holes in the actual casting or they can be in blocks attached to the end of a way.



Jack screws.

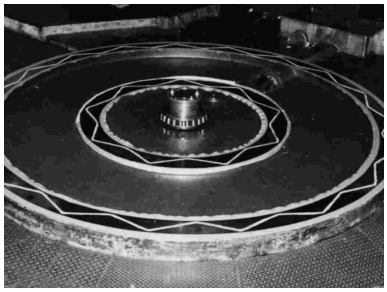
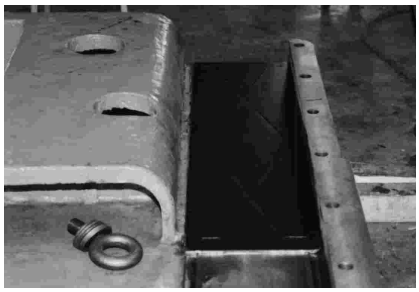
**Unlike conventional rebuilding, with Moglice alignments are done prior to applying bearing material. If alignments are correct while the Moglice is curing there will be no need to scrape for alignment. If the component is supported evenly across its length there will be no need to scrape for bearing contact.**





# Molding of Oil Grooves



SECTION

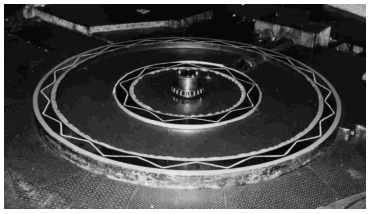
E

# Molding of Oil Grooves

***Molding in an Oil Groove Pattern***

When rebuilding large machine tools with very heavy and large components it can be very time consuming to move the piece to a machine large enough to machine in oil groove patterns. Another thing to take into consideration is a table 20' long may have oil grooves 90" x .5" x .06" deep which will require 1500 grams of Moglice to fill. Taking all this into consideration, it is definitely more cost effective to mold the oil grooving when molding the bearing. Once the component has been rough aligned, mark its location on the bed. Lines across the bed at the ends of the ways to be molded make a good reference for laying out an oil groove pattern to be molded. When using shims for alignment, blueing should be used on the shims to verify contact, this also transfers the position of shims to the ways when the component is indexed in the molding area as mentioned above. These marks are to be avoided when laying out the oil groove pattern. Devitt Machinery stocks and sells two thicknesses of wax sheeting with an adhesive backing. The thicknesses are .031" and .063". Simply slice the wax with a razor knife to the desired width and length, remove the paper backing and adhere to the bed way. The bed way should be clean and free of release agent and oil when doing this. If shims interfere with the oil groove pattern, simply cut wax strips back away from the shim points and connect them after molding, with a die grinder. This method is commonly used in rebuilding. For the OEM it is recommended a master form be produced to mold the pliable oil groove resin to the desired pattern, remove from mold and then glue to the bed ways. This saves a lot of time in production. Once the mold is made, a complex oil groove pattern can be produced time after time, thus eliminating a secondary machining operation. Devitt Machinery would be glad to help in selections and applications.

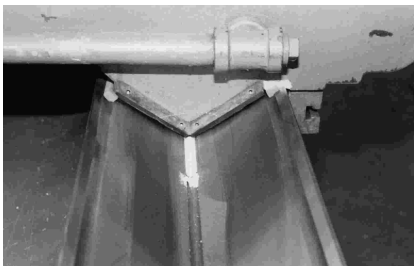
Laying down strips of adhesive backed wax cut to size



Molding surface complete

Wax strip ready to be peeled out of finished Moglice surface.

# Injection Methods

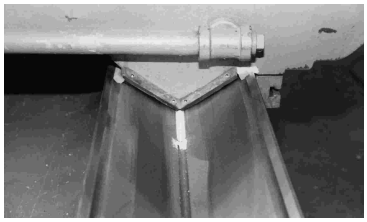
SECTION

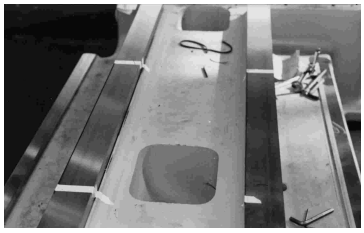
F

### *Injection Methods*

The injection method was the most common way to apply Moglice. Over the last 10 to 15 years putty and semi viscosities have become more popular in large way applications. Injection methods are still necessary for molding around 360° as in nut threads or quill bores. Injection is also appropriate for components that are difficult or time consuming to align and check.

### *Sealing*





The injection methods requires sealing to contain the Moglice in the void to be filled. It is often necessary to apply the sealing before final alignment because when the components are aligned the edges are not accessible. It is for these applications, and there are far too many to cover completely, that will be addressed in an effort to pass on some tried and proven methods. Remember these blind areas to be sealed must withstand injection pressure without leaking. The larger the gap and shorter the run, the less pressure will be needed. The smaller the gap and longer the run, the more pressure will be needed. Keep pressure down as high pressure will not only move components out of alignment through hydraulic force but can cause a leak in a location with no access for resealing. It is not that difficult to create a good dam as long as pressure or force that will be put against it is taken into consideration. Some of the most common damming materials are “o” rings, foam tape, rubber tubing like screen cord, or even Moglice putty. The most important characteristic of these materials is that they will compress if needed and allow movement of the component into alignment and still provide a good seal. In the case of Moglice putty as a seal, wait 4 hours before injecting. A look at the following pictures can be used as a guide to set your dams for injection. For specific application advice, please fax a sketch of the way system to Devitt Machinery; we would be happy to advise the best way to seal the bearing area.

### *Mixing*

First scrape around walls and bottom of resin container as some sedimentation may have occurred. After pre-mixing the resin to an even consistency empty the hardener into the resin container until it just about stops dripping.

Mix the material for 5 minutes. The mixing time is based upon temperature of both hardener liquid and resin being at ambient temperature of 68° to 72° F. It may be necessary to mix an additional 3-5 minutes when materials are cold and a slightly shorter period of time when warmer. If using a jiffy mixer, do not exceed 100 r.p.m. to avoid generating heat during mixing. When mixing, be sure to scrape sides and

bottom to ensure an even mix as unmixed Moglice will not cure and causes soft spots in finished bearing surfaces. Mixing well is critical so care must be taken. Immediately remove from the container, whether injecting or pouring, as letting the mixture sit in a container in mass shortens the pot life considerably. The 50 minute pot life starts when the mixing is started. Moglice uses an exothermic curing system so the cooler it is the longer it takes to cure and the warmer it is the quicker it cures, so pot life would be shorter. It is recommended that materials be kept at 68° to 72° F until ready to mix. When pouring into an injector, available from Devitt Machinery, pour out in a long thin stream into a tilted cartridge as this will remove air entrapped during mixing and also fill the cartridge without entrapping air. Insert piston slightly into the cartridge and turn over. Cut nozzle tip and allow entrapped air to rise to the tip and vent. Work piston up slowly to vent the rest of the entrapped air just like a doctor vents a needle.

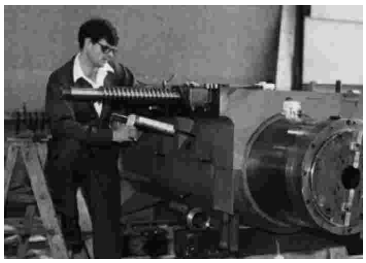
After venting the injection cartridge it can be placed in a standard caulking gun. When the tip of the injector is pushed into the injection hole, the catheter tip will make an air tight seal. Be careful not to let the point of the catheter bottom out in the hole; trim if necessary to make seal. Injection holes of 3/8" to 1/2" are common. Inject slowly to avoid air inclusions and keep pressures low. When Moglice arrives at vent holes keep injecting until either riser tube or reservoir is full, then remove injector and seal off injection hole with plug or some other means to keep Moglice from leaking back out. When injecting a series of holes; when the Moglice comes out of the next hole remove the caulking gun, plug that hole and move to the hole that had the Moglice overflow and continue injection, being careful not to push an air bubble into the injection site. Continue this process until the last riser or vent is full.

Mixing

Pouring

Venting

One man mixes while the other injects.



Large bores can be injected horizontally or vertically.

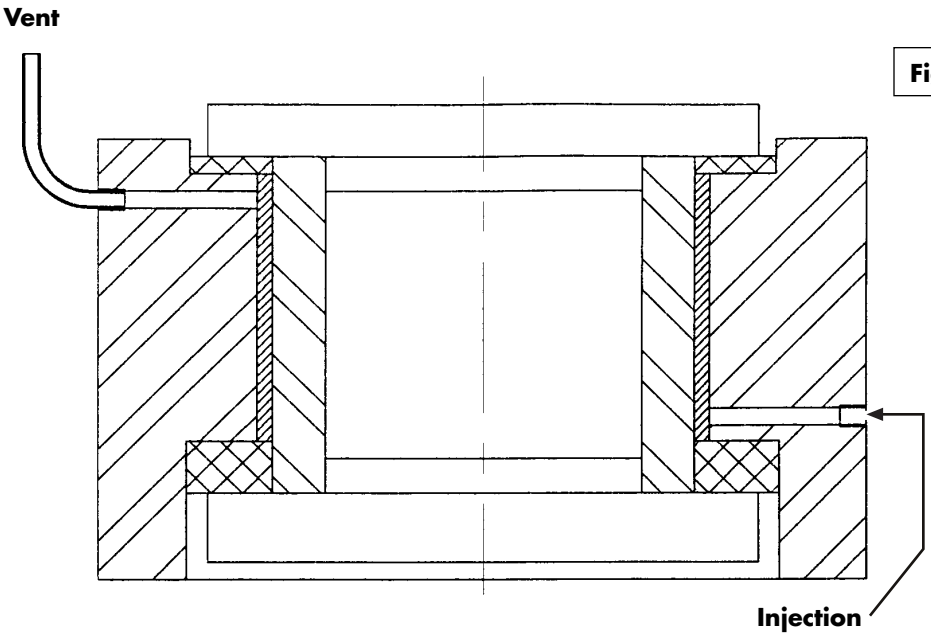



Figure 1

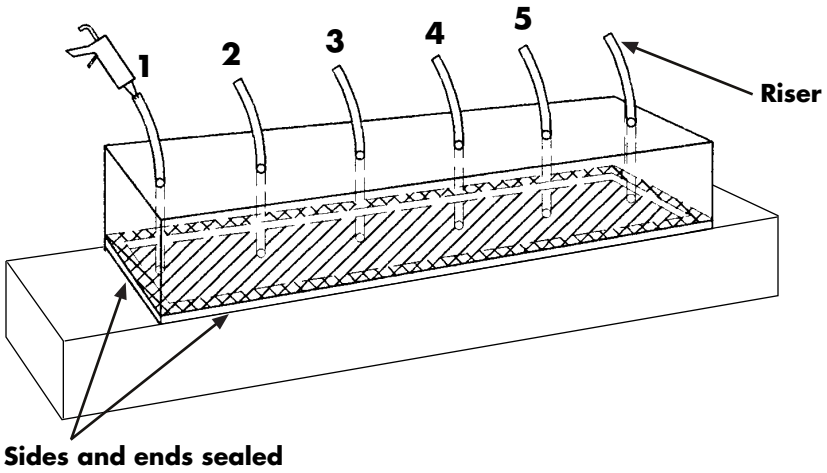



Figure 2

***Figure 2***

Leave 18" to 24" between injection ports; for thin gaps leave less distance between injection ports to minimize pressure.

***Figure 3***

When injecting from the center to both ends, you can push the material a little further because it will flow in both directions. Clay reservoirs at end of the ways can be used instead of riser tubes.

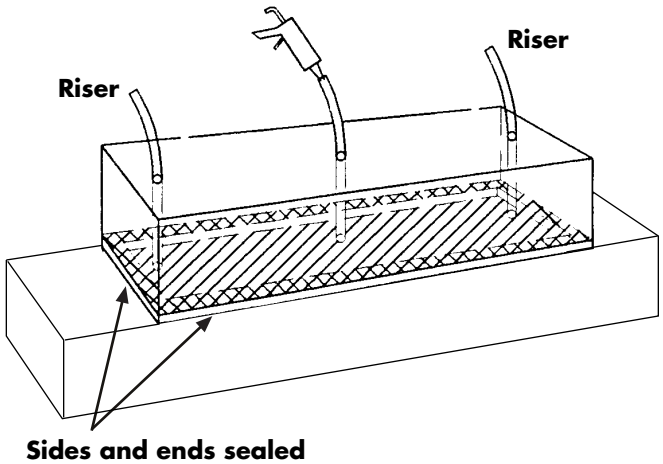
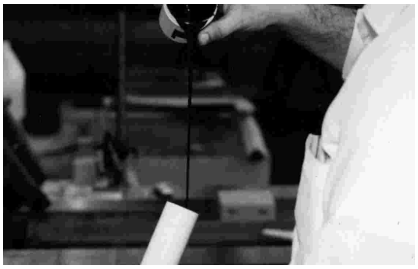
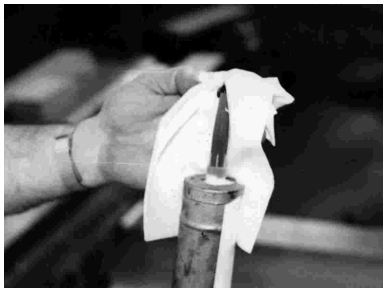



Figure 3

# Screw & Nut Injection


SECTION

G

***Determine your requirements***

First decide to what accuracy the screw and nut must be made. Some screws hold critical positioning requirements while others are used for rapid traverse or other less critical tasks. Keep in mind that typically 90% of the backlash in a screw and nut is found in the nut. Often, by Moglicing the nut it can operate within tolerance. This is not always the case, and it may be necessary to regrind or rechase the screw to achieve the accuracies needed. If it is decided to reproduce a nut using the old screw, it will be necessary to measure the threads carefully to locate the area having the least amount of wear. When replicating a nut with Moglice, it is necessary to mold to the largest dimensions of the screw. If molded to a smaller area of the screw, the nut will not pass over the larger end.

The screw sprayed with release agent and the nut housing is bored out by Howard Hackelton.

***Choosing the correct separator*** is important to the fit of the nut. If the screw is accurate end-to-end, then use standard spray release which leaves a coating thickness of .0002". This can be polished to less than .00005". Liquid separator sprayed from a hand pump can build up .0003" to .0004". For nuts that require more clearance, paste separator can build up .001" to .003" thickness, depending on application technique. If more clearance is necessary please call for advice. Remember, Moglice replicates exactly, so checking measurements and choosing release agents is critical to end results.
Refer to release agents in Section C.

Howard Hackelton, master machinist, Philadelphia Gear. Ask for video interview.

***When preparing the nut for Moglice***, start by boring out the old threads, typically cutting the bore .120" over the major O.D. of the screw. The bore of the nut should be rough cut to improve adhesion. Shallow threads .030" to .060" wide and deep, cut in both directions (left and right hand), will provide mechanical lock. Sandblasting the nut bore is another way of enhancing adhesion surface. On larger nuts, it is possible to leave some of the old thread to back up the Moglice, but remember the nut will have to be threaded on the screw without damaging the coating of release agent, which can be difficult.

***Refer to illustrations figure A and B***

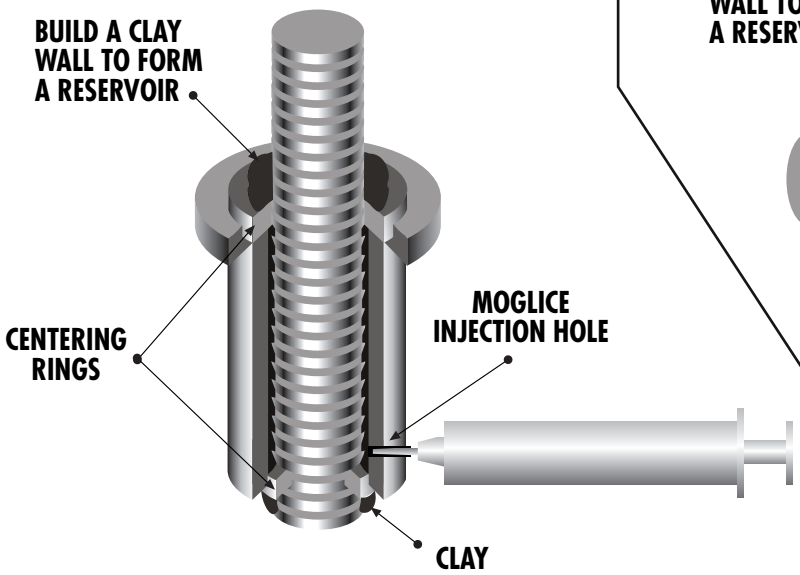
***Figure A and B*** Illustrate where to drill injection holes and how to vent a nut, whether doing the job horizontally or vertically. Also, take note of the use of modeling clay to dam openings in centering rings due to thread on screw. In the vertical

application, this thread opening can be used as a vent. Clay is used to form a reservoir for Moglice. In the horizontal application, a tube or injection cartridge can be used as a vent and riser for the Moglice reservoir. Venting and the use of a riser or reservoir is important because when you stop injecting and pressure is released, small amounts of Moglice may seep out. The reservoir allows Moglice, rather than air, to be pulled back into the nut.

***Holding the nut body centered*** on the screw is easily done by using centering rings at both ends of the nut. The centering rings can be made to pick up an accurate O.D. of the nut or concentric counter bores can be machined into the nut ends while the old threads are being bored out. The I.D. of the centering rings should just slip over the major O.D. of the screw. The easiest way to position the nut on the screw is to first put one centering ring on the screw past where it is going to mold. Then place the nut body over the screw and on the centering ring. Next, treat the screw with release agent where it is going to be molded and position the second centering ring. With the first centering ring in the end of the nut body, carefully slide the nut body over the release agent, using the ring to help center on

## VERTICAL

*FIGURE A*




## HORIZONTAL

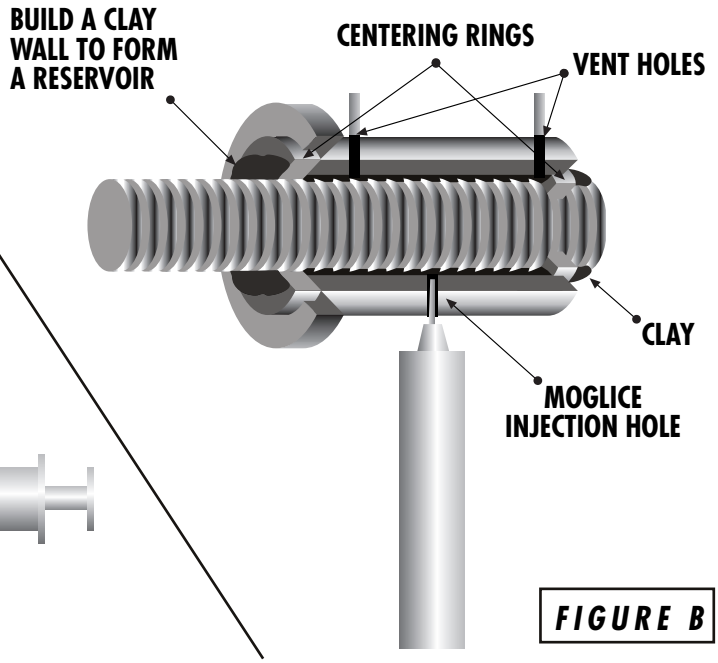



*FIGURE B*

Mixing

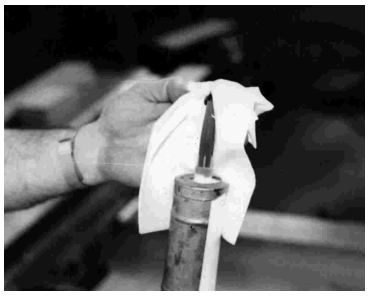
the screw and not touch or rub off the release agent. Bring the nut body onto the second centering ring and it will be centered. Dam and install vents as indicated on the previous page and it is ready to inject.

***Material Mixing***: The quantities supplied in the kits are in the exact ratio required. It is *essential* to keep to this ratio. Order kit sizes for particular applications. The material is available in 100 gram, 250 gram and 500 gram kits. Matching injectors are available separately.

***Pre-mix***: Scrape resin off the walls and bottom of container and pre-mix, as some sedimentation may occur. Empty hardener into resin container making sure to empty container until it starts dripping.

Pouring

***Mix 3-5 minutes, scraping sides and bottom***: The mixing period of 3 to 5 minutes is based upon the temperature of the two substances mixed and the ambient temperature being between 68°F and 72° F. It may be necessary to mix an additional 3 to 5 minutes when the material is cold and a shorter time when the material is warmer. If using a mechanical mixer do not exceed 100 r.p.m. to avoid heat generation during mixing. Immediately remove from container (letting it set in the container in mass shortens pot life considerably). The 45-minute pot life starts when mixing starts. Moglice uses an exothermic curing system. The cooler it is, the longer it takes to cure and the warmer it is, the quicker it cures and pot life is shorter. Although it is not necessary it is recommended to keep resin and hardener between 68°F and 72°F until ready to mix.

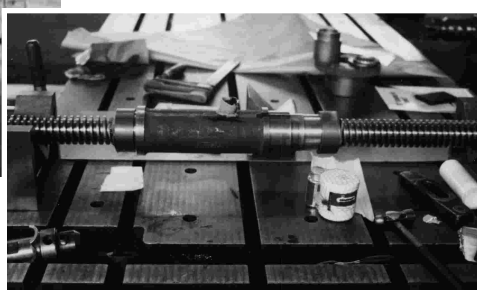


Venting

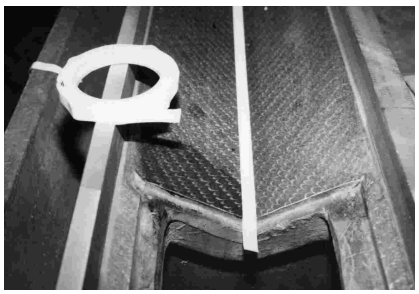
***Pouring into injector***: After trimming injector tip to provide an air tight fit at the injection point, the Moglice can be mixed and then poured into the injector in a long thin stream with the cartridge tilted. The technique removes entrapped air in the mix. Placing your finger over the injector tip will stop Moglice from running out of the cartridge while filling it. Then insert the piston slightly into the cartridge and rotate so the tip is up. Allow air to purge to the nozzle end; then work piston up slowly to vent, much like the way a doctor would vent a syringe.

***Injection***: After venting injection cartridge, it can be placed in a standard caulking gun. When pushing the tip of the injector into the injection hole, the catheter tip will make an airtight seal. Be careful not to let the point of the catheter bottom out on the screw; trim if necessary to make seal. Although the tip does not have threads it can be screwed into a tapped hole. Inject slowly to avoid air inclusions. When Moglice reaches vent holes, keep injecting until either riser tube or reservoir is full; then remove injector and seal injection hole with a plug or some other means to keep Moglice from leaking out. The use of a riser or reservoir is important for the same reasons they are used in the casting industry. By having a riser or reservoir, the extra material is then drawn in when needed.

***Finishing***: Allow at least 18 hours at ambient temperature for Moglice to cure, then turn nut body off screw. Gently warming the nut (not to exceed 100°F) will make turning it off easier. Remove centering rings, and trim as required. Open up lube hole being careful not to overheat Moglice. Drill bits tend to get extremely hot cutting Moglice, so use a coolant when drilling. If the nut is too tight on the threads, a non-charging lapping compound can be used with an oil mixture to lap the nut. Contact Devitt Machinery for advice and materials used to lap Moglice bearing surfaces.



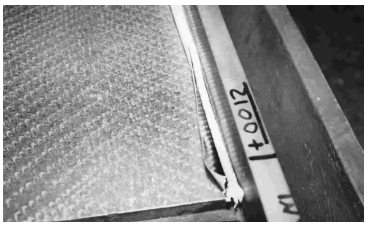
# Pour & Set Method

SECTION

H

# Pour & Set Method



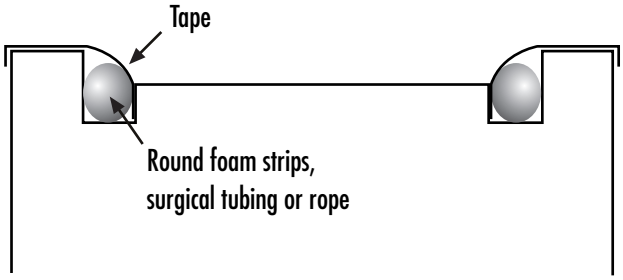
Oil return being filled using rope and tape

This method is typically used in rebuilding grinders and planers that have a female vee way in bed but can be employed on some flat ways. When doing a long table that is relatively thick the drilling of required injection holes is very time consuming so the pour and set method was devised to save time. The technique has been tested and improved over the last several years and proves to be the most practical approach for these large machines.

By talking about a typical application and trying to explain why each step is done should give a good idea of how to do it.

Examples of prepared bed ways with an oil groove pattern installed

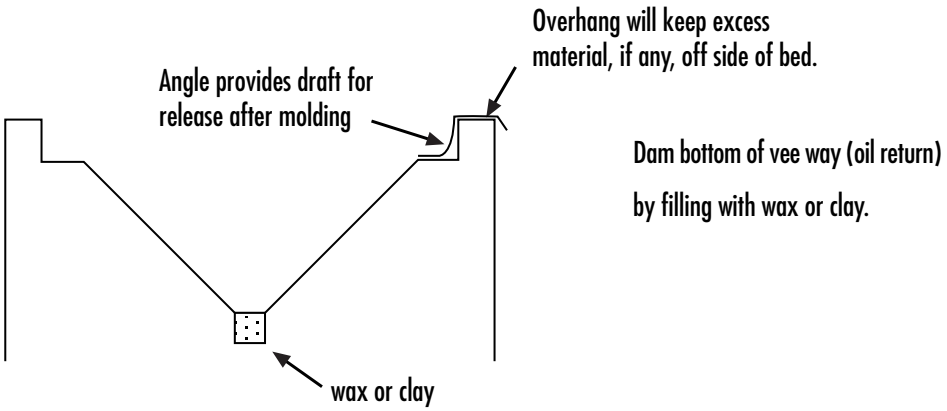
The first step is to clean and stone the molding area being used. The adjacent surfaces must also be cleaned using a solvent so that the masking materials have good adhesion. This cleaning is very important because you don't want to clean again later with solvents after taping off adjacent areas with tape and foam. When setting table for alignment check, put blueing on shim pads so their location is noted on bed way. With table in position mark the ends of both vee and flat with a magic marker on the bed. When table is removed shim locations and molding point is then well-defined and now masking can start. The oil return grooves on both sides of the flat can be filled with wax (paraffin), clay or foam insulation (the type to seal windows and doors). When the oil groove is filled it eliminates vertical edges next to bearing as well as creating a dam down the sides of the flat way to contain Moglice fluid. This area can also be dammed using round foam or tubing and masking tape as shown in the diagram.



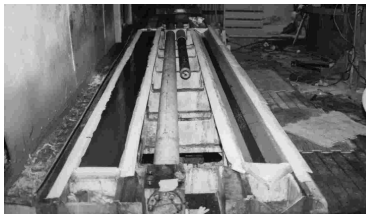

Install dams at bottom ends of molding area at 1/2" past where the table will be set. Then spray all surfaces of bed ways with separator spray.

Take notice in the diagram to the angle of the dam away from bearing, this allows air and excess Moglice to escape. On the ends of the flat way molding area place dams using clay or foam covered with tape approximately one inch beyond the

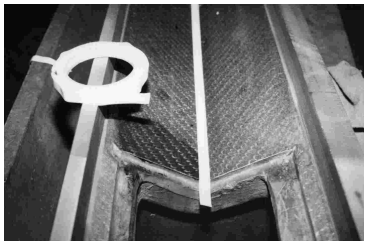
magic marker lines you drew on bed ways during last alignment check. This will create a completely closed in area on the flat to pour Moglice fluid into. After dams are complete, cover all remaining surfaces adjacent to flat way with masking tape leaving only the bed way bearing area exposed. At this point, lay out the wax oil groove pattern on way being careful not to obstruct any Moglice shims on the table. These shim locations are marked with blueing on bed way. When finished with taping, building dams and layout of oil grooving wax, any oil feed lines in bed way have to be plugged and filled. Foam earplugs and clay over the top works best. With a safety razor blade you can trim excess clay from surface. The last step is to coat all surfaces including tape with release agent.



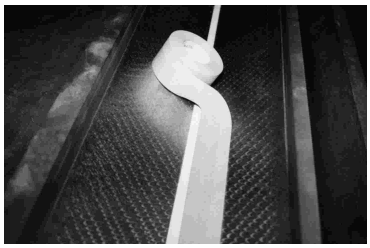

Prepared double vee ways with liquid Moglice evenly distributed



Prepared bed ways showing vee & flat with Moglice evenly distributed

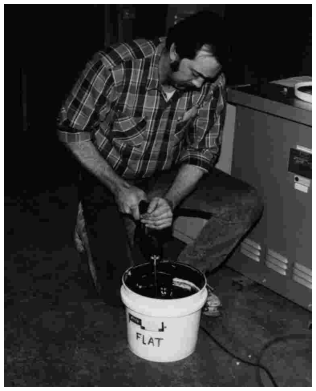


Put a run of fiber tape down the oil return groove before pouring wax. It will ease wax removal.



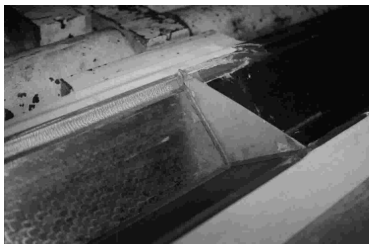
Painter's tape used to keep excess paraffin wax off molding surfaces. The warm wax can be dressed with a box end wrench.

The vee way is done as follows. Again clean and stone the molding area as well as adjoining surfaces and oil returns. Remember tape wax and foam won't stick to an oily surface. Mask off all vertical and horizontal surfaces not associated with vee way. Fill in the oil return in center of the vee way with wax or clay making sure to cover the vertical edges of the oil return. The return should be filled flush with the bottom edges of vee way bearing surfaces. Cut and place wax strips for molding oil grooves, again being careful not to place them in a shim location as marked with bluing. Cut triangular shaped pieces of cardboard to be used as dams and affix at both ends of vee way one inch beyond magic marker lines locating end of molding site. Duct tape works best for this. Make sure it is sealed well as it must contain Moglice fluid. Then coat all surfaces including tape, dams and




Liquid Moglice being mixed in bulk container

Pouring evenly from bulk mixing bucket

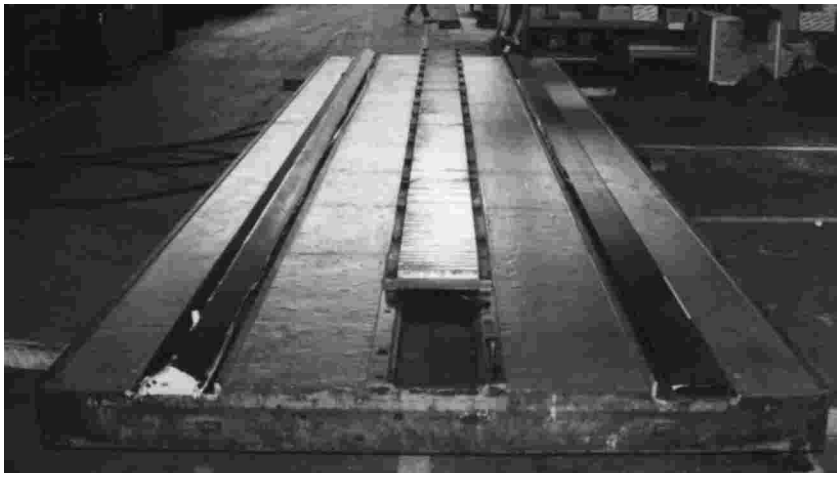


Cardboard dam in a Vee way

25' long Moglice bearing surfaces molded with the pour and set method

bearing surfaces with release agent.

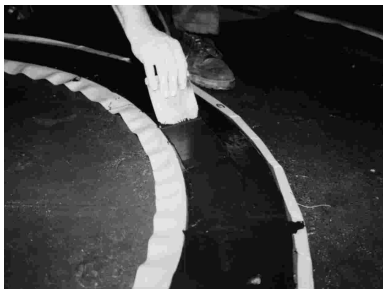
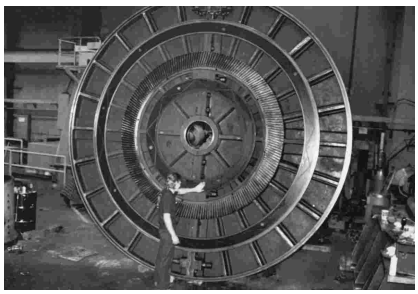
Calculate the required amount of Moglice for the flat way and add an additional 20%.* This total can be poured into a larger bucket and mixed at one time then poured evenly in the dammed in area on the flat bed way. Again the Moglice needed for the vee way plus 20% can be mixed at one time and poured into dammed area of vee way. The Moglice can be mixed with a drill motor and jiffy mixer, not to exceed 100 r.p.m.'s to keep heat generation to a minimum. This cuts mixing time to a minimum and speeds application. Lower table slowly and as level as possible into the Moglice. Even with extreme care if the table does not touch down into the Moglice evenly, it will tend to float or move in one direction. It is a good idea to clamp blocks to the bed at both ends of the table to ensure proper location in the molding area. Watch alignment side to side when coming down to ensure Moglice in vee way is divided evenly. Once down, immediately check the alignment to be sure you are on the alignment devices. Adjustment can still be made to improve the alignment if necessary. After 18 hours at 70°F remove table after breaking it loose using jack screws or hydraulic jacks. Then remove with crane and roll table, being careful not to break edges of bearing.



* Use charts found on A-1 and A-2 to calculate required amounts of Moglice.

# Application of Semi

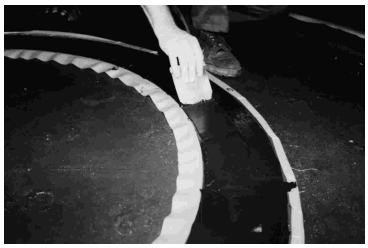


SECTION

Semi being poured on large flat bearing

Semi being spread and crowned



Picture shows crowning of Moglice before setting table

Spreading and crowning of Semi

This viscosity of Moglice is most commonly used on large flat way applications and it is recommended that kits be ordered per way rather than trying to divide the kits between two surfaces, as it can be difficult. The consistency of the material is that of a thin putty and stays crowned on a flat level surface. This makes it possible to mold these flat surfaces with little to no damming required. When mixing, first scrape resin from sides and bottom of container as this will help ensure a thorough mix. Then empty the hardener container into resin container. Mix for 3-5 minutes with a jiffy mixer at 100 r.p.m. Be sure the mixer scrapes the sides and bottom of the mixing tin to ensure an even mix. When mixing is complete, pour Moglice on the molding surface and spread out evenly, using a putty knife crowning material to the center. This will help in preventing air inclusions by venting air to both sides of the way surface.

**Example**: Box ways. When preparing a box way and its vertical guiding edge there are a few differences. The biggest difference being the three vertical surfaces adjacent to the flat way bearings. (Only one of the four vertical edges is likely a positive side to be molded at the same time as the flat surfaces.) When molding flat bearings, the Moglice used is usually in a putty or semi form and the excess will be squeezed out and onto these surfaces. If molded it will be very difficult separating the components due to "0" clearance on four vertical surfaces. To avoid this problem, make sure there is enough clearance and apply at least one layer of masking tape to the vertical clearance surfaces. This tape will generate a few thousandths clearance for disassembly. Paintable wax can also be used for this purpose (See C2). The shim locations and layout of the molding surface is also done in a similar way as the pour and set procedure. The Moglice will be applied to the way surface on large applications and probably to the component on smaller applications, but, shim location must be noted on bed way so as not to get hung up on oil groove wax. Remember, all alignments are made prior to molding and once the component is set into the Moglice it should not be lifted out except for small adjustments of .001" or .002" done slowly with screws or wedges. Make sure all surfaces of bed ways are sprayed well with release agent.

**Generally, keep in mind that Moglice will replicate line-to-line any surface it touches. Only replicate accurate surfaces of way bearing and do not allow line-to-line molding of adjacent inaccurately machined clearance surfaces. When applying multiple kits divide the molding area into sections to be covered by one kit. This helps to distribute the material evenly.**

# Application of Putty




SECTION

J

# Application of Putty

***Putty***

Putty is a non-slump viscosity and is commonly used on vertical applications or male vees on a bed way. No sealing or injection holes are required simplifying irregular or segmented bearing applications.

***Pre-mix and Mixing***

Putty can be mixed in its own container with a small jiffy mixer, or it can be removed to a clean flat sheet of metal or plastic for mixing with a putty knife. The material should be mixed for at least 3 to 5 minutes. When using the mechanical mixer keep speeds under 100 r.p.m.'s to avoid heat generation. On first applications it is recommended that after mixing with a drill motor the material should still be pulled out on a flat sheet to verify there are no unmixed bits of resin. Unmixed resin parts will not cure and will appear as soft spots in the finished bearing. The spreading operation also allows the heat generated by reaction to be dissipated and extends the pot life. If material is allowed to stay in the tin or in a mound, the heat remains trapped and causes premature cure. The working pot life of Moglice is 50 minutes when kept spread out at 72°F ambient temperature.

Putty being crowned to the center on a strap.

Putty being mixed and kept spread to extend pot life and remove air entrapped

Putty being pre-mixed with power mixer at less than 100 r.p.m.

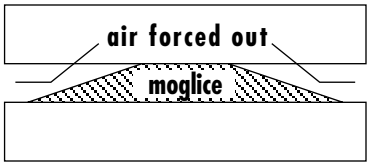
***Applying the Material***

The Moglice is applied by hand using a spatula or putty knife. Apply the first thin coat carefully and with firm pressure to ensure good adhesion. Apply the rest of the material avoiding trapped air and crowning to the center, the full length of bearing.

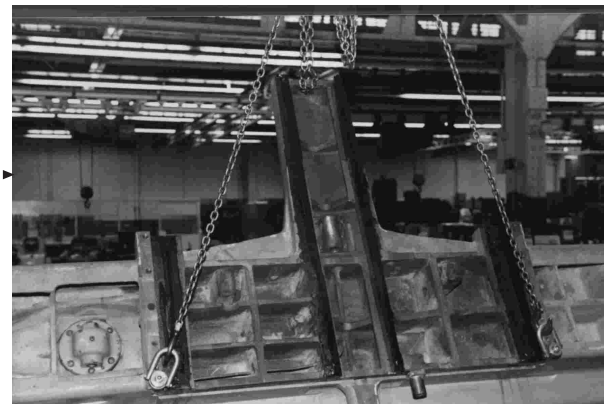
***Setting components down in Moglice***

Lower components carefully staying level, side-to-side and end-to-end once into the Moglice. If the element is lifted again, air bubbles will form. With light elements, additional pressure may be necessary to squeeze out excess Moglice. If clamps or

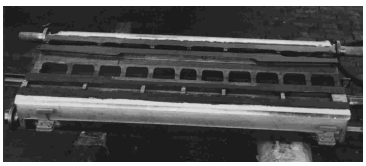
weight is applied do so over shims to avoid distortion. When datum position is reached, release pressure and re-check alignment. At room temperature (68° to 72° F) the cure time will be between 18-24 hours. After this time, elements can be separated. Use jack screws or hydraulic jacks to separate elements before trying to lift with a crane. After coated element has been removed, being careful not to bump excess beads of squeezed out material, carefully turn over. Trim excess material using die grinder with a thin cut off wheel. Bearing surface should be stoned and flaked. Oil grooves, if not molded in, can now be cut in using carbide tooling. If alignment was achieved with the use of Moglice shim, check these spots for being high. This is due to the shim deflecting the cast iron. Having such a high point loading and then when the load is removed, the cast will return to its original relaxed state making the shim print high to a master flat. Be sure to have shims near the end (if using shims) of the way to ensure good bearing contact on the ends after cure.



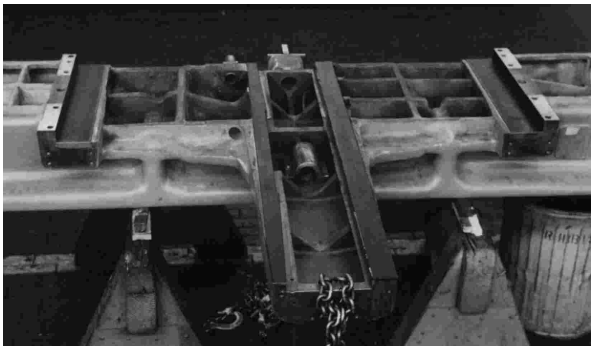

Irregular way easily coated with putty.



Pratt & Whitney jig bore saddle with Moglice Putty applied and crowned to the center.



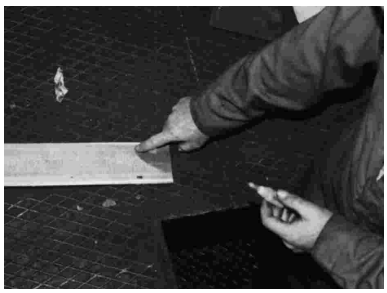
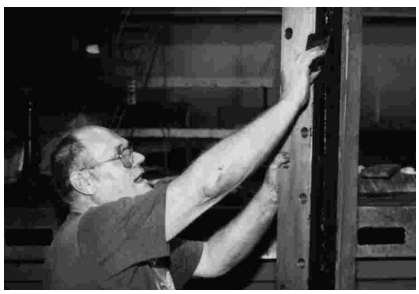
Note the irregular way perimeter on the Pratt & Whitney jig bore table is easily coated with Moglice Putty.



The next day; cured and trimmed bearing surfaces.

# Resurfacing of Gibs, Straps, or Keepers



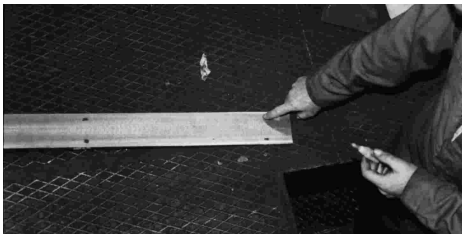
SECTION

K

# Resurfacing of Gibs, Straps, or Keepers

***Gibs***

The Moglice replication process makes gib refurbishing quick and economical. So often ordering a new gib or manufacturing a new one in-house can take days or even weeks. The Moglice process can take as little as 18 hours. There are several methods of molding new gib surfaces that have been field proven. One method, and probably the easiest, is molding a surface to shims that have been fit to the machine. The first step in this process is to machine approximately .060" off the gibs and prepare it for adhesion. Machining this surface can cause the gib to bow. Sandblasting the machined surface may help to straighten it. This sandblasting also enhances the adhesion of Moglice to the roughened surface. The gib can also be straightened by peening or using a press, but use extreme care not to break the gib. Determine the approximate thickness of material required to achieve full adjustment with feeler gauges. Next, Super Glue two small pieces of Moglice shim to each corner of the toe. Install gib and remove, checking both contact and depth. Adjust by scraping or sanding these pieces of shim until the right depth and good contact is achieved at full adjustment. Super Glue two slightly thicker shims to the heel surface of the gib and refit by scraping these shims until the gib goes into the same full adjustment position. Longer gibs may require a set of shims in the middle also.



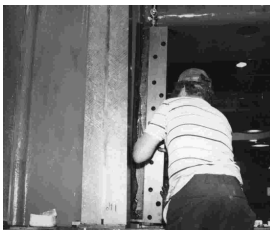
The gib can be molded on a prepared section of way or cast iron surface plate that has been sprayed with release agent. Typically a clean way surface is available and the most common choice. If using Moglice Putty, calculate the amount of material needed and mix properly; then apply to the gib surface. The gib is then turned face down on the way and weighted to bring it down on shims. It is important to apply the weight evenly over the entire length of the gib and even beyond the ends to ensure the back of the gib is straight. When a large parallel is placed on the gib back and overhangs the ends, it will bring the gib down at both ends and maintain flatness on the back side of the gib. After curing, the gib is trimmed and oil grooving cut into the Moglice without cutting through the Moglice and the oil feed hole is drilled open. Typically the gib is fit to the machine and requires very little scraping if any. If fluid or semi is chosen to do this method, dam up a molding surface to contain the liquid and follow the directions given above. This method

of using shims to fit has been proven to be the best, as well as the safest method of coating gibs and is recommended. When the gibs are held in place with a removable keeper or strap, the procedure is modified. After the machine component is positioned on the way system, make sure the bearing surfaces are all making full contact and lock the component in this position with clamps or jack screws in a manner that will not hinder installation of the keeper and gib. Make sure to apply release agent to the rail system that receives the gib. Surface preparation is then done on the gib to provide for at least a .060" coating thickness of Moglice. If these keepers are to be installed in the vertical position or you are not sure how to hold the two components in correct relationship, the gibs can be screwed to the keepers through the keeper and into the back of the gib to hold the gib at full adjustment, then molded as if it were just one piece. The grade most commonly used is Moglice Putty Hard. When calculating the amount of Moglice needed, use only the amount required (to minimize excess or the amount squeezed out during installation and tightening). Another procedure would be to put a coat of Moglice on the face of the gib and after cure, machine and scrape to fit; however, this is time consuming and not the best way to use Moglice.

When installing Moglice low-friction surfaces on straps or keepers it is best to first replace or re-scrape all other bearing surfaces. For example, if resurfacing a saddle, the flat bearings and guiding edges are done first and the straps are then fit. Check the machine specs for any running clearance if required. Some straps on tables require .001" running clearance. Head slides are generally fit line-to-line. When doing a line-to-line fit with no clearance, first position the slide so the flat ways are in full contact and then prepare the keepers or straps generating a clearance with a rough adhesion surface. Clean the adhesion surface and apply only the required amount of Moglice, crowning slightly off center, away from the bolting surface and then install on component. Make sure the way surface has been treated with release agent. After the Moglice has cured, remove and trim. If there are any lube holes they will have to be drilled open and an oil groove pattern cut in the Moglice surface making sure not to cut through the Moglice coating. This procedure is generally done with Moglice Putty Hard. However, if care in damming is taken, it can also be done by injecting Moglice Fluid. If a running clearance is required, simply install shims having the same thickness as the required running clearance on the component's flat ways and then follow the above process or take a scrape cut on the Moglice after cure.

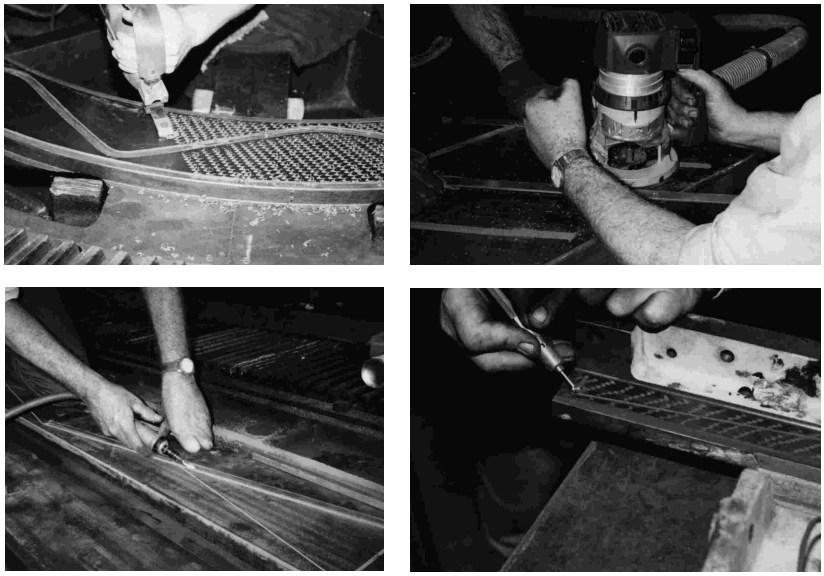
### *Straps or Keepers*

The Ingersoll gib has been screwed to its retaining strap in its full adjustment position. Moglice Putty has been applied and crowned toward the middle.



The assembly is then bolted in place as if it was one piece. After cure, the gib is unscrewed from strap and trimmed. At assembly the strap is bolted in place and the gib is inserted for perfect fit and full adjustment.

# Finishing Procedures



SECTION

L

Table being broken loose with jack

When separating a component that has been molded, keep in mind there is a line-to-line fit with the absence of all air. The components are going to be stuck together the same way joe-blocks are when they are wrung together but on a much larger scale. These molded parts must be jacked apart, one against the other, before trying to lift them with a crane. The use of jack screws or hydraulic jacks is the best way of doing this. Once air is allowed between the way and the Moglice bearing, a crane can be used.

When lifting with a crane, lift clear of all clearance surfaces to avoid the possibility of the two surfaces bumping due to the swing of the components, as this could fracture the bearing surface. There is always excess material around the edges of the bearing. This must be cut off using a die grinder. Never try and snap off excess material as this can cause a fracture into the accurate bearing surface, not to mention the excess cures to a razor sharp edge and can cut like one. Always wear some kind of gloves when trimming to avoid being cut. Keep an eye out for onlookers as it is common for them to touch and try to snap off excess material to look at it.

***Trimming***

Excess Moglice being cut from sides of bearing surface

Make sure there is clearance on chamfered corners.

The preferred trimming tool is the die grinder set up with a resin fiber cutoff wheel .030" thick. The thin blade removes the least amount of material which means less dust. Use it to make a surgical cut down to the base material between the Moglice bearing area and the excess Moglice. The excess can then be chipped off. Usually a shop vac is used to collect the dust while cutting. The dust is listed as a nuisance dust but a good mask should be worn while trimming. The dust can cause a rash in small percentages of people so long sleeve shirts are also recommended.

The use of a cone shaped bit and straight edge to cut in oil grooves

After trimming is complete, the surface will have to be stoned using a very light oil

or mineral spirits. Using mineral spirits will keep the stone clean and works well to lubricate. The stoning removes high spots on the bearing surface due to the porosity of cast iron. After this operation flaking or spotting the surface can be done. Spot marks should begin 3/4" of an inch from the ends and 1/2" from the sides of the ways. When spotting only the inside area, the perimeter of the bearing acts as a seal to keep dirt out. Make these spot marks .001" - .002" deep. The next step is to lay out and cut an oil groove pattern if not already molded in. The use of a die grinder and a carbide cone shaped bit works well, however, if there is room, a router equipped with a carbide bit also does an excellent job. After cutting oil grooves, take a scraper and bevel cut all edges to allow easier disbursement of oil. Restone bearing surfaces and clean thoroughly. DO NOT oil bearing before rolling table. An oiled surface collects dust and dirt. Oil should be applied just prior to assembly. Care should be taken when assembling not to bump or strike the bearing on a sharp edge as this could damage the Moglice.

***Cutting Oil Grooves***

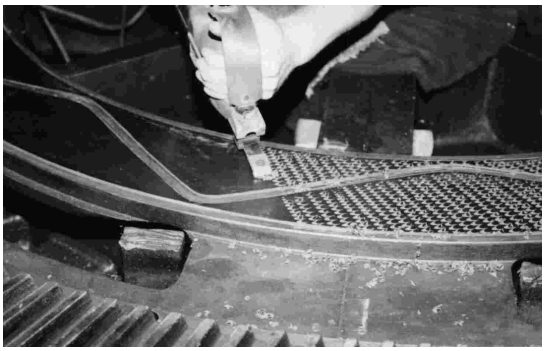
**Right**


Oil grooves cut in Moglice not through Moglice

**Wrong**


Oil grooves cut through Moglice into adhesion surface

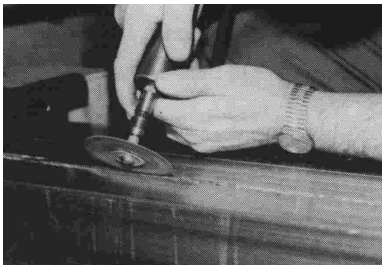

Moglice may de-bond

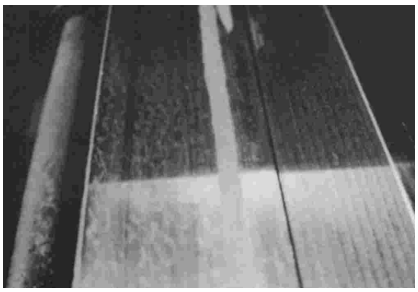


Spot marks being put in, after first pass do the same at 45° angle intersecting your first pass to break bearing surface area for oil retention

A Dremmel tool with a carbide bit being used to cut oil grooves

# Score Repair



SECTION

M

***Mechanical Prep***

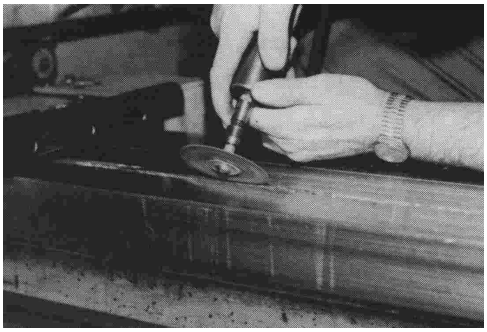
Two .030" thick 3" diameter cutoff wheels are included in the kit for the mechanical preparation of the score. These wheels can be fit to an arbor and used in a die grinder (Note: right angle die grinder is easier to use).

Find the deepest part of the score and make the whole score the same depth. If the score is not at least .030" deep for cast iron or .010" deep for a hardened way, then cut it to these suggested depths.

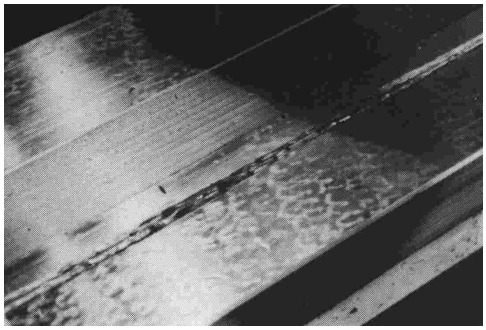
Figure 1

Suggested dovetail cut of score for good adhesion.

Cross section view of typical score.



RIGHT
Undercuts lock material in.



WRONG
Holes drilled in way trap air and take damage deeper.

The suggested depths are a good compromise between giving the score repair material enough thickness and further damaging the way. Not drilling holes into the end of the score or making deep cuts allows for the possibility of machining all the scores out at a future date, during a rebuild for instance.*

The .030" thousandths deep groove in cast iron is deep enough that the side can be undercut. See Figure 1 for ideal score profile. Even if this undercut is only a few spots along the edge of the score, it provides extra insurance.

*Ask Devitt Machinery about Moglice low-friction slide way material and in-place machining techniques for quality rebuilding of way surfaces.

***Oil Removal***

Cast iron is quite porous and absorbs oil almost like a sponge. This is a major reason for bond failure of repair materials. Oil near the surface can be removed with Deoiling Powder or mild heat from a heat gun. The Deoiling Powder included, draws oil from the casting when left in the score for one hour or more. If the powder becomes

dark with oil, replace with fresh powder until it remains light blue.

Using heat from a propane torch can be faster and more effective, but requires more care and skill to prevent overheating.

### *Cleaning*

Wipe the score with a lint free rag dampened with the Cleaner spray. Then spray Cleaner starting at one end allowing the pressure to push oil and dirt down past the opposite end. Because the Cleaner is expanding as it escapes from the can and because it evaporates quickly, it can cool the metal enough that humidity in the air may condense into water on the score surface. Be sure the score is completely dry (allow the way to stabilize in temperature-approximately 5 minutes) before applying Dichtol or STF.

### *Sealing*

**For cast iron only**; not required for hardened steel ways.

The Deoiling Powder and heat drew the oil to the surface and the Cleaner removed it, however, oil will still be deep in the casting which must be kept away from the bond line. Dichtol is a thin liquid sealing agent with a very good capillary sealing factor. It penetrates and seals the micropores in the cast iron. To apply Dichtol, brush on generously. Reapply quickly 4 or 5 times trying to keep the surface wet. Allow approximately 2 hours for penetration; then, with a dust free cloth dampened with spray Cleaner, wipe the score thoroughly until you can see no residue left on the surface. Then using a soft brush or rag, paint the Release Agent around the score. This will prevent any excess STF from sticking to undamaged way surfaces, being careful to avoid getting Release material in the score.

### *Mixing*

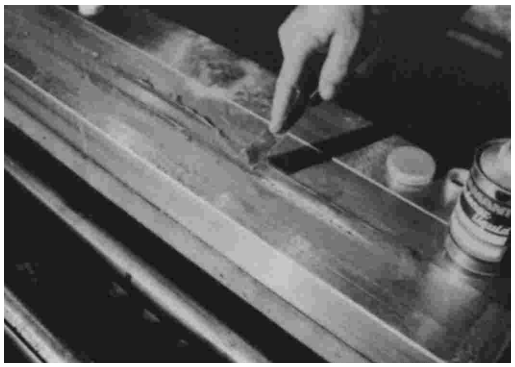
Structural Resin (STF) consists of two compounds: STF Powder and STF Hardener liquid. Mix 1-1/2 to 2 parts STF Powder to one part STF Hardener liquid by volume. The consistency of this mix is pourable but can be varied to a putty by adding additional STF Powder or Alloy Powder to the mix.

The Alloy Powder is used only to lighten the color of the STF, if required, to

obtain a closer match to the parent metal. It is suggested that you experiment with smaller quantities of STF to get a feel for mix ratios and pot life before you try to match the color of cast iron on a repair.

It is important to remember that higher percentages of Powder, higher room temperature or a large mass reduces pot life. It is for this reason that both a mixing bowl and mixing sheet have been supplied in the kit. When repairing a small area, use the bowl; and, when repairiang large areas use the mixing sheet. Never try to mix and apply more STF than can be applied and finished within a 10-15 minute period. It is better to repair a large score through repeated mixing and applications than to have the material start to set as you are working it into the score.

***Applications*** Using a putty knife, work the STF into the score by starting at one end and working toward the other. This avoids trapping air inside the score. You should be working quickly during this part of the process. Allow the STF material to be slightly higher than the way surface. A straight edge or any reasonably flat surface coated with Release Agent can be set over the score. This results in a flat layer of STF several thousandths higher than the way surface.

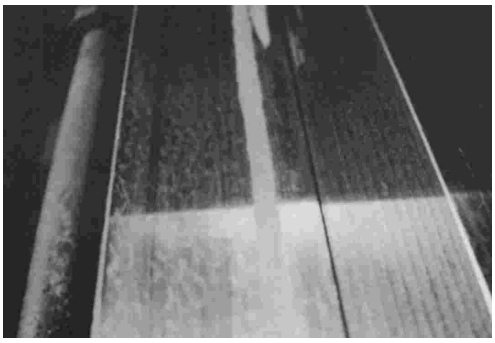


***Finishing***

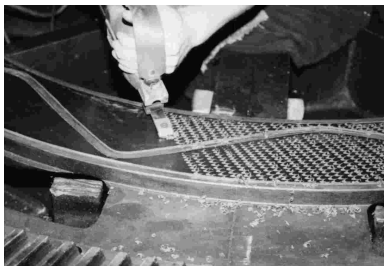
After curing approximately 1 - 2 hours, remove the straight edge. A putty knife or razor knife can be used to remove excess STF that squeezed out over the good way surface. Then, use a hand scraper or stone with oil to work the STF flush with the way surface.

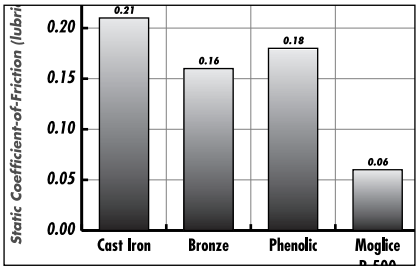
Check to be sure the STF is not left higher than the surrounding way. This can be checked with a straight edge and printing compound or the pivot test can be done using a setup parallel.

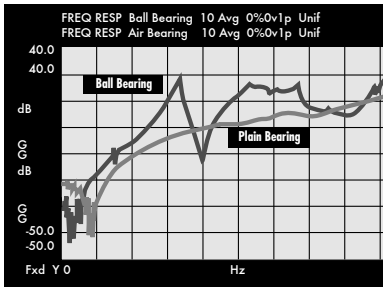
After oiling the way you are ready to reassemble and put the machine back in service.



# Straight Talk on Ways






SECTION

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Three basic types of ways exist: plain sliding, rolling element and hydrostatic ways. The plain sliding way, the oldest type, remains in common use. In this design, the moving surfaces slide against each other assisted by a layer of lubrication which, when operating correctly, actually produces a hydro-dynamic bearing. That is a bearing which guides on a controlled layer of lubrication created by motion.

***The Way Ways Were***

The first machine tools for cutting iron used wooden ways, but by the mid 19th century, cast iron became the material of choice for machine elements. It had the advantage of easy formability. Builders could produce it into shapes, cut it with the single point tooling of the time and hand fit it with a scraping operation. Few other options existed. When two scraped cast iron surfaces meet with a layer of oil in between, they slide rather well. For 100 years cast iron to cast iron plain slide ways were the state-of-the-art in way design.

There is a good deal of art in the production of cast iron way surfaces. Historically, plain ways represented an important part of the value added by a machine tool builder. A highly skilled trade called "hand scraping" was, and still is, necessary to properly fit cast iron way surfaces and make a machine both geometrically correct and long lasting. But for years machine tool builders have tried to eliminate this labor-intensive manual scraping process.

Match milling or grinding has only been marginally successful. In most cases, builders can machine the longer guiding surfaces, but the fitting of the mating component still requires scraping. In fact, the cost, time and skill involved in scraping plain ways have been major factors in the current move to rolling element linear way systems.

Today, many machine manufacturers purchase some type of rolling element linear guide. This reduces cost of entry for new builders because the linear guide "erector set" assembly eliminates the need to scrape.

***Why scrape?***

Plain bearings do offer important advantages over rolling elements and so scraping lives on. The scraping procedure attempts to spread the points of bearing contact

evenly across the whole bearing face, while achieving the correct geometric alignments. In fitting a way, workers identify points of contact by applying thin coats of marking compounds to both surfaces. After sliding the surfaces against each other for about an inch, the technician removes the slide and examines the bearing points left in the marking compound.

A common standard is ten to fifteen points in any one square inch of bearing area. It is possible, and to a certain extent desirable, to achieve forty or more points with repeated fine scrapings. Whether the count reaches ten points per inch or forty, the percentage of area in contact should be 50 to 60 percent. The spaces between high and low points provide oil reservoirs important to accuracy and long life. When bearing contact exceeds 80 percent there is an effect similar to the ringing together of joe-blocks resulting in "stick-slip" effects.

Thousandths of high and low spots in a scraped surface provide evenly distributed oil reservoirs, and drains. As motion starts, oil is dragged between high spots across the whole surface. Perfectly flat surfaces ( 100 % ) at rest would with time squeeze out all oil and ring together. As this “sticktion” is overcome, the slide must move the distance between oil grooves to become lubricated. At that point, the slide rides up on a hydroplane of oil without the draining effects of the low spots in the scraped surface (like the thread of a tire), the slide rises up several thousandths causing inaccuracies.

Breaking up a bearing surface with a power spotter, which leaves a series of half moon shaped marks on the ways, provides a quick fix for this problem. These spot or flaking marks are not to be confused with scraping. Developed as a cosmetic treatment, the marks give the surface a uniform appearance. Today, spotting provides relief in bearing surfaces that have lapped themselves flat by wearing through their relief. Spotting will not improve the straightness or flatness of a way surface, but it will help with stick-slip problems.

Scraping is the only way to sculpt flat straight surfaces in cast iron that make contact evenly across the whole length and width of their mating surfaces. For instance,

if a vee and flat way were not at the exact height and angle with respect to each other, one edge of the flat would hit the bed ways causing the load to be focused on that area. Then the oil layer would breakdown and spalling, scoring or uneven wear would occur. In other words, unless the technician does the hand scraping correctly, the slides are not likely to have a long life.

To overcome the problem of spalling and scoring, builders introduce other bearing surfaces. First there was bronze, a definite improvement in the coefficient-of-friction for bearing surfaces, especially in nuts and spindles. The dissimilar materials also reduced spalling and scoring.

***Non-Metallic Materials***

The first composite material used in machine tool construction was phenolic; a resin and fiber combination often referred to as "Micarta". Glued and screwed to the underside of the slide, usually 1/8" to 1/2" ( 3mm to 13mm ) thick, this material further minimized galling and scoring of the cast iron guide ways, but did little to reduce friction in the slides.

Now dominant in plain slide manufacturing, true low-friction slide ways finally came to market in the late '60's and early '70's. Teflon impregnated sheet-type materials, such as Turcite and Rulon, first caught on here in the U.S., while replication materials containing molybdenum disulfide ( MOS2 ) and graphite, such as Moglice and SKC, became popular in Europe. The Teflon low-friction materials exhibit the unique phenomenon of a coefficient-of-friction that falls as load is added. An examination of a Turcite brochure shows a coefficient-of-friction that falls as load is increased until about 100 psi is reached. The friction coefficient then levels off at .04". Unfortunately, most plain bearings have less than 35 psi loading even when fully loaded. But Teflon impregnated sheet-type materials have greatly reduced friction problems in plain slide ways by reducing the difference between static and dynamic coefficient- of-friction.

Another interesting attribute of Teflon sheet-type materials is the relatively low compression strength and hardness. This is generally an advantage; as in the presence of contamination, the softer wear material will wear sacrificially rather

than taking an equal toll on the more expensive to repair guide surface. In certain conditions though, contamination can embed into the softer material creating a sandpaper like bearing surface that will destroy the guide ways.

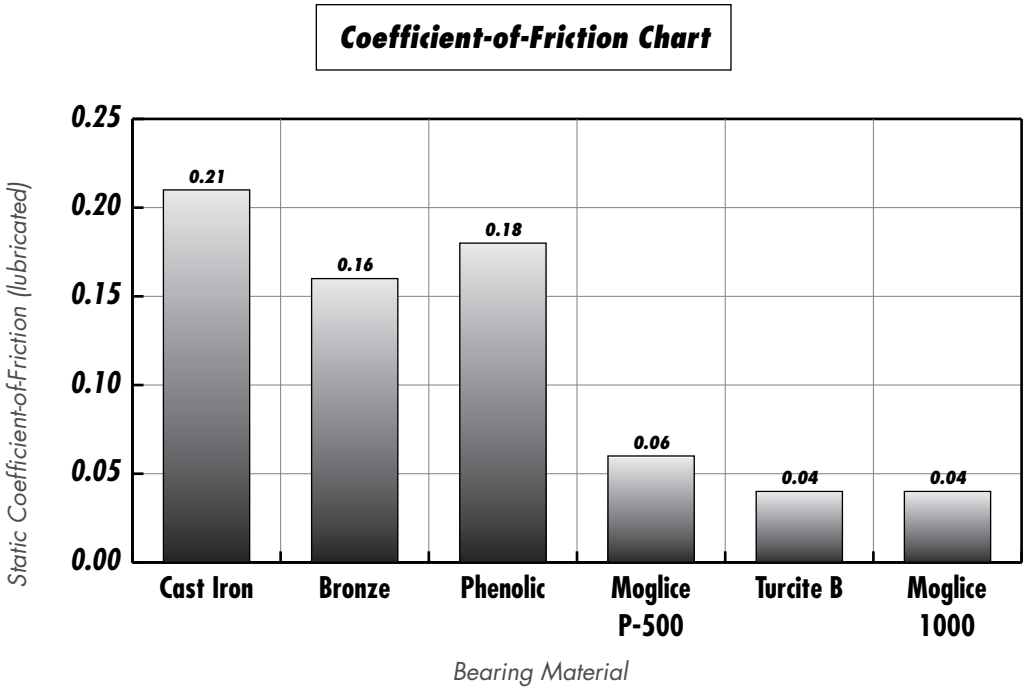
Low hardness also means sheet-type materials are faster to scrape and provide some added damping effect. The low compression strength (2,400 psi) is not a factor in accuracies (except under extreme clamping or over hung loads) because of the low psi loadings (35 psi) on typical plain bearings, as mentioned earlier.

Sheet-type materials are available in standard thicknesses; they are commonly applied at .031" , .062" , or .093" thick. The thin thickness makes securing the material to the slide with screws impractical so a gluing procedure is used. Most manufacturers provide an etched side to be glued which eliminates the problems of adhering to Teflon. Still, the gluing operation requires care.

If the adhesion surface was machined with care, it is possible to apply sheet-type material and have a relatively small amount of scraping. Usually though, as in a rebuilding application on a vee and flat, the use of the same thickness material will result in the vee and flat with different elevations. This situation still requires a careful machining and scraping process.

German machine builders developed replication materials such as Moglice and SKC as another assault on the need for scraping. Epoxy based, these materials could be poured and molded like a babbit material. Ambient temperature processing, and the low shrinkage rates of modern epoxies allow for very accurate molding. The concept is to produce an accurate guide surface, then to position the mating slide in its correct position using alignment screws. A gap of 1mm to 3mm remains left between the guide and the adhesion surface on the slide. The guide is pre-sprayed with release agent and the adhesion surface cleaned. Injected into the gap, the Moglice cures as a perfect copy of the guide while the slide is in perfect alignment.

With the correct procedures, this process eliminates the need for the scraping process and allows for the standardization of machine dimensions. However, it is still necessary to breakup the replicated surface because as molded, it exhibits near 100 % bearing contact. This is another occasion to employ a power spotter. Alternatively, builders can mold reliefs into the bearing surface rather than scraping. To do so, the builder makes a tightly crisscrossed oil groove pattern that relieves some 40% of the bearing surface and provides for the even distribution of oil reservoirs across the whole way. These advanced replication techniques are now being used with the newest Moglice 1000 , which utilizes Teflon low-friction elements. The result is high dynamic stiffness in machine elements that are necessary to achieve fine surface finishes on hard parts.

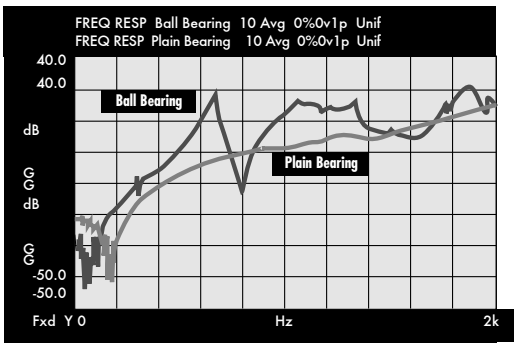


***What is Dynamic Stiffness?***

Quite a bit of controversy exists as to which bearing system, plain slides or rolling elements is best for metal cutting. Many consider plain guides superior because of their high dynamic stiffness. In simple terms, dynamic stiffness equals static stiffness times damping. Plain slides, due to their large surface areas and oil film lubrication, develop much higher damping than rolling element bearings which have very little surface area. Rolling element bearings do possess a high static stiffness, but taking a high static stiffness times a relatively low damping factor results in low dynamic stiffness. Plain slides on the other hand, have a high static stiffness and a higher damping, resulting in a much higher dynamic stiffness.

Plain slide ways experience speed limitations due to their hydrodynamic nature. The oil in the small gaps between the bearing surfaces acts like the oil in a shock absorber and the small gap between the surface acts like the small hole that restricts the oil flow in the shock absorber. This viscous shear resistance is very significant when you consider the surface area of the bearing and the small gap. Another disadvantage of plain slides is that at rest, contact occurs between the bearing surfaces. This contact results in a static friction which is higher than the dynamic friction once the bearing surfaces generate an oil film during motion. The difference between static and dynamic coefficient-of-friction results in the phenomenon referred to as "stick-slip" and can make it difficult to position plain slides accurately when the application requires very small motions.

Rolling element bearings have seen wide acceptance mostly because they enable higher speeds than plain bearing surfaces and because smaller axial steps can be made without "stick-slip" but these advantages come at the expense of dynamic stiffness.



# Test Data

SECTION

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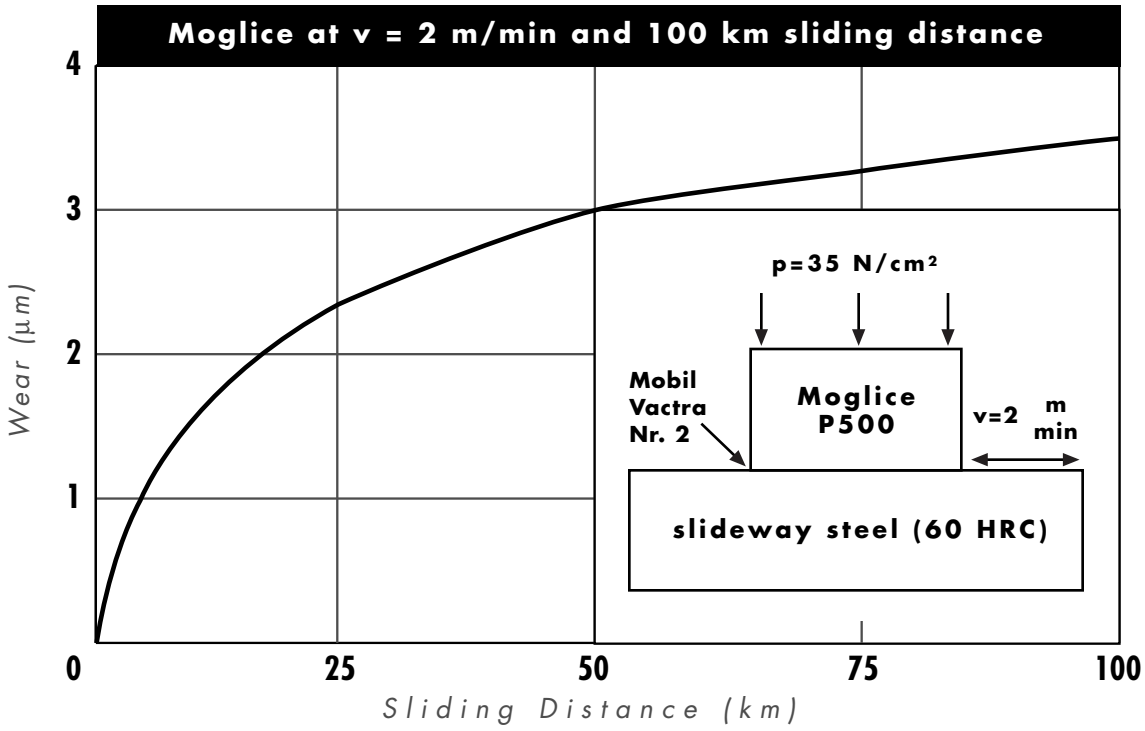
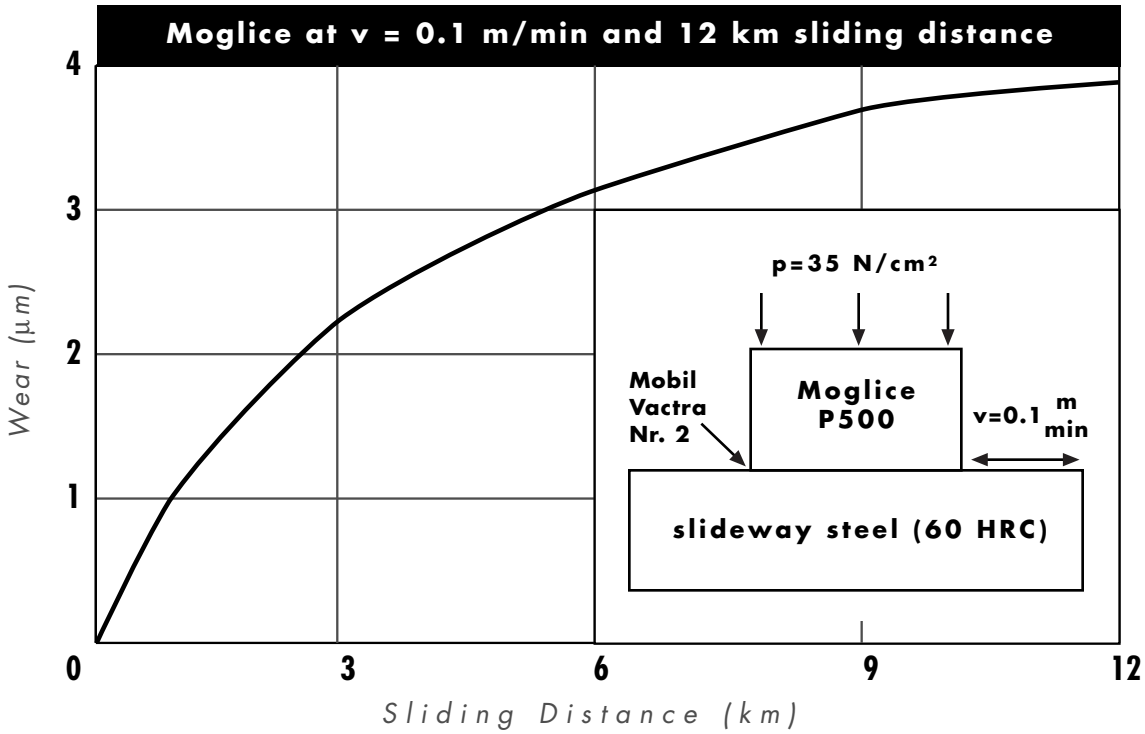
## Wear with Reference to Sliding Distance

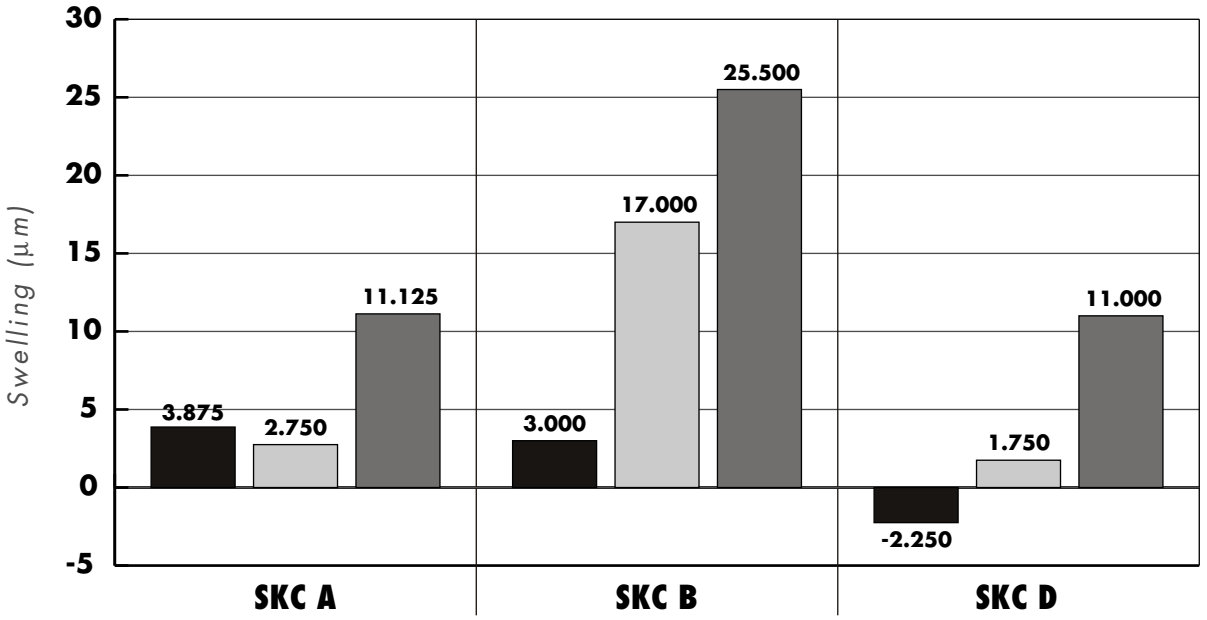



Details established by an Institute of a German University

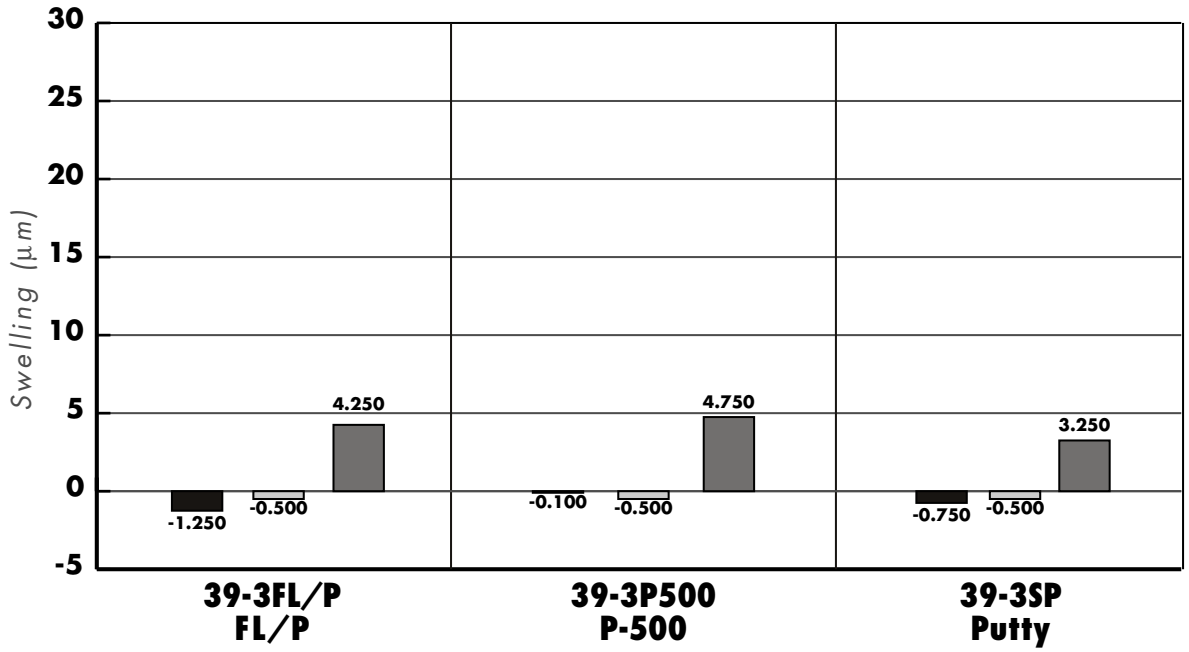
## Swelling of different SKC materials after 15 weeks of storage in different fluids

SKC




## Swelling of different Diamant materials after 21 weeks of storage in different fluids

DIAMANT® MOGLICE



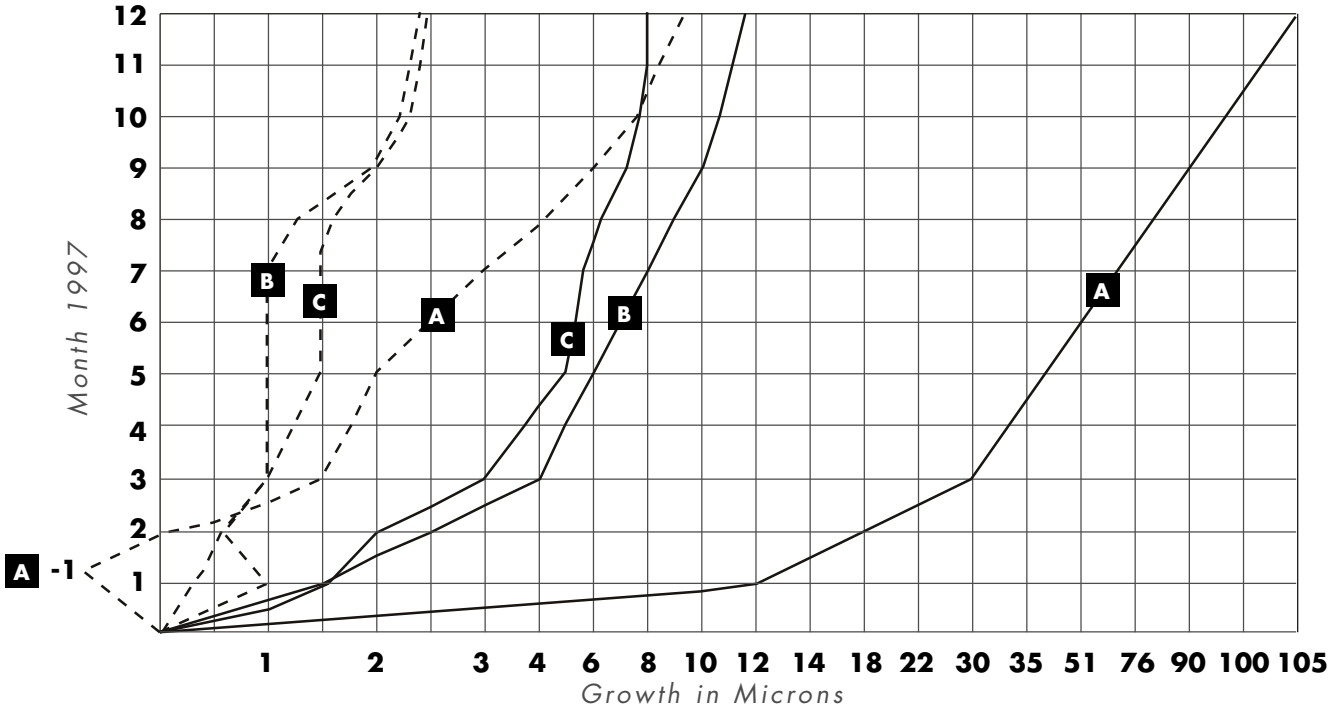

Research from the Fachhochachule Darmstadt, Germany

# Test Data

**Philadelphia Resins**

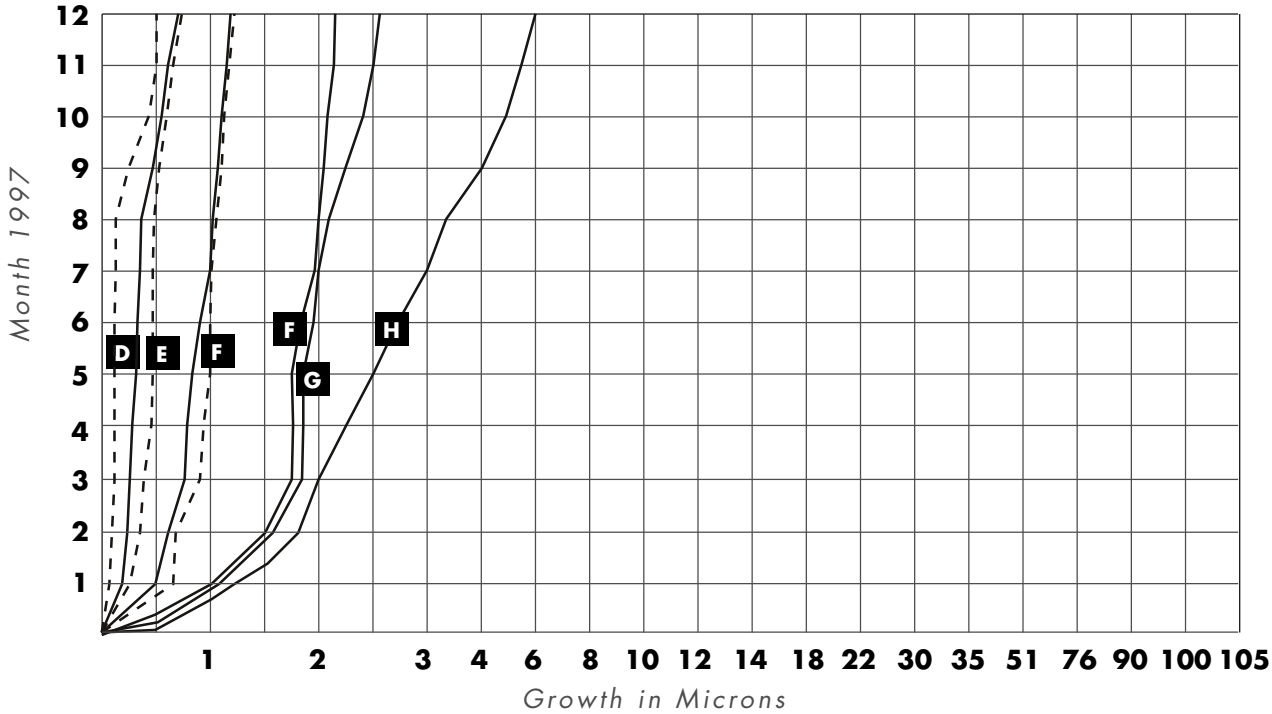
**A** Black 2000 **B** Black 1500 **C** Silver 500

Way lube - - - - - Coolant ———




DIAMANT® MOGLICE

**D** Moglice 1000 **E** Moglice P500 **F** DWH 311FL **G** Quick Silver FL **H** Quick Cure




Research from the Fachhochachule Darmstadt, Germany