Glassdance Manual #1

Glassdance: 1982–1983, San Diego, California

1. Components, 2. Assemblies, 3. Installations, 4. Machining, 5. Playing, 6. Maintenance, 7. Inventory, 8. Heidi Forster Playing Glassdance, 2007

Section 1

W.M. Berg Inc. Panel and Transmission Components

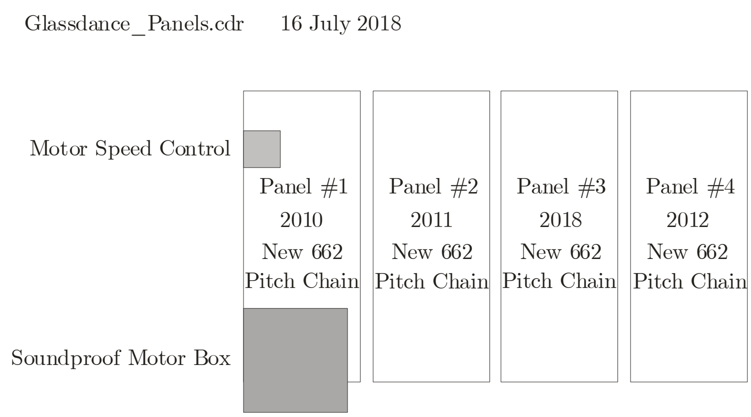
Panel Sprockets and Chains

52 Large 3 in. diameter, 24 pitch glass sprocket gears: W.M. Berg #24B8-72

4 Small 1½ in. diameter, idler sprocket gears: W.M. Berg #24B8-36

4 Red Panel Chains: W.M. Berg #24GCF-662-E; 662 pitches × 0.1309 pitch = 86.6558 in. long

All chains are *factory-spliced!*



Transmission Sprockets and Chain

4 Large Transmission Sprockets, ½ in. bore: W.M. Berg #25CP68A-40

1 Large Drive Shaft Sprocket: W.M. Berg #25CP68A-40; custom ⅝ in. bore; two custom ¼-20 set screws, 90° apart

4 Small Idler Sprockets, ½ in. bore: W.M. Berg #25CP68A-20

1 Yellow Transmission Chain: W.M. Berg #25CCF-369-E; 369 pitches × 0.250 pitch = 92.2500 in. long

Chain is *factory-spliced!*

Flexible Gearmotor-to-Driveshaft Coupling, ⅝ in. to ⅝ in. — ***W.M. Berg*** #CC3-9 (legacy part number)
2018: New Coupling — ***Manufacturer: Huco*** #047.40.4141 — ***Seller: MSC*** #88025903

After 35 years, the polyurethane of this flexible coupling disintegrated and simply fell apart.

Fafnir (Torrington) Ball Bearing Components

52 Panel Bearings: RCSM type, 1 in. diameter, Fafnir: RA100RR/FS-450

4 Panel Bearings for Sprocket Drive Shafts: RCSM, $\frac{5}{8}$ in. diameter, Fafnir: RA010RR/FS-450

12 Bearings for the Pillow Block Rail & 2 Bearings for the Gearmotor Drive Shaft:
RPB type, $\frac{5}{8}$ in. diameter, Fafnir: RA010RRB/FS-450

Right Angle Gearmotor. Bodine Electric Company, Old Model Number 587

Right Angle Gearmotor: Type-Frame NSH-54RL, 115 V. (D-C), 86 rpm, 54 lb.-in.

Right Angle Gearmotor: Old Model Number 587

Speed Control: Encased-Type ASH-500

Speed Control: Old Model Number 906. Bussmann Fuse: ABC-8 250V

For cooling the gearmotor, three Dayton Axial Fans: Old Model Number 4C548. See p. 28.

Use only Mobile SHC 630 Gear Oil. Do not overfill!

Fill only to the drain hole, which is located $1\frac{5}{16}$ in. from the bottom of the gearbox. The drain hole has a metal screw plug and neoprene washer. Allow excess gear oil to flow out before replacing plug and washer. Excessive hydraulic pressure from too much oil can destroy the motor.

See: Glassdance_RightAngleGearmotor-and-Fans_Manual-2.pdf

E-A-R: Energy Absorbing Resin

E-A-R ISODAMP C-1002 is a blue thermoplastic material designed to absorb vibration and dampen — reduce or eliminate — structure-borne sound and noise.

https://www.rathbun.com/e-a-r/damping-isolation#1

Inside the instrument case

Two blue rectangular pieces between two drive shaft pillow blocks and the drive shaft support assembly.

Eight blue rectangular pieces between eight idler pillow blocks and the mahogany pillow block rail.

Two blue rectangular sheets between — the drive shaft support assembly/pillow block rail — and the bottom of the instrument case.

Inside the gearmotor soundproof double-box

One blue rectangular sheet between the gearmotor and the birch plywood mounting plate.

One blue narrow strip between the edge of the gearmotor mounting plate and two stacked intake fans.

Aluminum Stem Parts *Outside* the Instrument Case

Aluminum Tubing Catalog.pdf

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Aluminum Ball Bearing Tube: 1 in. OD × ¾ in. ID × ⅛ in. Wall.
Alloy: WW-T-700/6 — Drawn 6061-T6
Seller: McMaster-Carr #89965K31
Seller: Tube Service Co.
Precision turned to a length of 1 5⁄16 in. for installing in the ball bearings.

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Aluminum Glass Stem Tube: 7⁄16 in. OD × 0.198 in. ID × 0.120 in. Wall
Alloy: WW-T-700/6 — Drawn 6061-T6
Seller: Tube Service Co. See: Aluminum Tubing Catalog.pdf
Precision turned to a length of 3 1⁄16 in.
Custom-machined with 7⁄16-14 threads.
See: Glassdance_MachiningTubes_Manual-3.pdf

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Aluminum Sleeve Tube: ½ in. OD × 0.402 in. ID × 0.049 in. Wall
Alloy: WW-T-700/6 — Drawn 6061-T6
Seller: McMaster-Carr #9056K65
Seller: Tube Service Co.
Precision turned to a length of 3 5⁄32 in.
See: Glassdance_MachiningTubes_Manual-3.pdf

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I machined the aluminum sleeve tube on a lathe: 0.491 in.–0.485 in. OD × 0.439 in. ID × 1.610 in. long.
Most have 0.490 in. OD's.

Small ≈ 0.485 in. OD's are for wobbling glasses. Insert a wood sliver between the aluminum glass stem tubes and the silicone liner tubes to create a second center of rotation. See pp. 24–25.

I bonded the stem tubes and sleeve tubes with Loctite #271. This increased the OD's of the stem tubes from 7⁄16 in. (0.438 in.) to 0.490 in. This enabled me to center the bonded stem tubes inside the silicone liner tubes and the inverted sprocket hubs.

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Silicone Liner Tube: ¾ in. OD × ½ in. ID × ⅛ in. Wall. Hardness: 50 Shore A
Manufacturer: NewAge Industries #2802471-100. ***Seller: MSC*** #48461073

The silicone liner tube fits inside the aluminum ball bearing tube.
See p. 15: Glassdance_SiliconeLinerTube_&_BabyPowder.jpg

In my book, *Musical Mathematics: On the Art and Science of Acoustic Instruments* (2010), Figure 12.7 shows the first version of the Glassdance stem and panel assemblies. In 2018, I changed this design, and in 2024, I changed it again. As shown below, I custom-machined the aluminum glass stem tubes (d) with 7⁄16-14 external threads, which facilitated the installation of aluminum hex nuts (o) and my newly invented aluminum locknuts (p). The new design also includes machined zinc plated steel coupling nuts (e), machined stainless steel threaded shaft collars (f), and bonded washers (m) and (n). The figure does *not* show an aluminum sleeve tube at the exterior end of the glass stem tube that increases the stem's diameter from 7⁄16 in. (0.438 in.) to 0.490 in. See pp. 7–9.

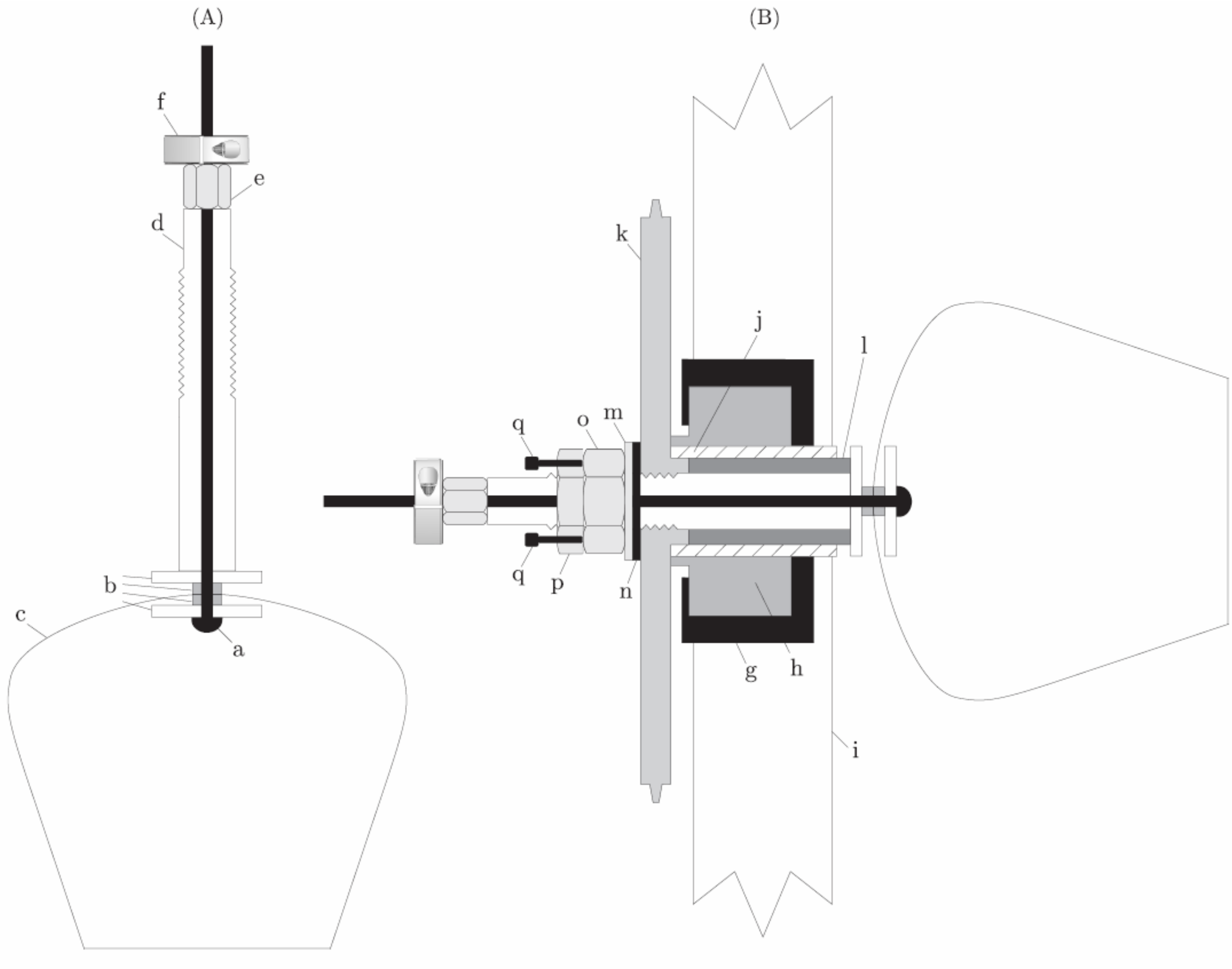


Figure 12.7 Two longitudinal cross-sections of the Glassdance stem and panel assemblies. (A) This cross-section illustrates that a stainless steel machine screw (a) passes through two standoff washers (b), a hole in the bottom of the crystal brandy snifter (c), two more standoff washers (b), and a custom-machined aluminum threaded glass stem tube (d). At the end of the machine screw, a machined zinc plated steel coupling nut (e) and a customized stainless steel threaded shaft collar (f) hold these parts of the stem assembly together. (B) This cross-section shows that I epoxied a rubber cylindrical cartridge (g), which holds a ball bearing (h), into a flat-bottom hole in the back of the Glassdance panel (i). I also epoxied an aluminum tube (j) into the inner race of the ball bearing. The hub of a chain sprocket (k) fastens into the aluminum tube from inside the instrument, and a silicone tube (l) slips into the aluminum tube from outside the instrument. The stem assembly passes through the silicone tube and the sprocket hub. A stainless steel washer (m) bonded to a neoprene washer (n) provides a protective surface for a standard aluminum hex nut (o). Finally, my newly invented aluminum locknut (p) and steel locknut screws (q) hold the stem assembly securely in the panel assembly. (Not to scale.)

Aluminum Stem Parts *Outside* the Instrument Case *(Continued)*

10-24 stainless steel machine screw: Pan-head Phillips, 5.0 in. long

First stainless steel fender washer: #10 × 1 in.

#10 stainless steel washer

000-beveled plumber washer: 15⁄32 in. OD
Manufacturer: Danco #35089B

Lubricant between 000-beveled washer and glass
Manufacturer: Dow-Corning Molykote O-ring Grease #55

Unetched Sasaki "Isabelle" Crystal Brandy Snifter with 1⁄4 in. countersunk hole

#10 brass washer at the external base of the glass

#10 nylon washer: 3⁄8 in. OD × 13⁄64 in. ID × 1⁄16 in. thick
Manufacturer: Abbatron / HH Smith #2674

Second stainless steel fender washer: #10 × 1 in.

For several short glasses:
#10 stainless steel *standoff* washers between nylon washers and second fender washers. See p. 16.

Aluminum Stem Parts *Inside* the Instrument Case

Bonded stainless steel and neoprene washer.

Stainless steel washer: 7⁄16 in. (0.469) ID × 1 in. (0.922) ID × 0.051 in. thick
Seller: MSC #82294653

Neoprene washer: 1⁄2 in. ID × 1 1⁄16 in. OD × 0.108 in. thick
Seller: MSC #06043780

Aluminum Front Nut: 7⁄16-14, 11⁄16 in. width across flats, 3⁄8 in. thick
Manufacturer: Accurate Mfg Products Group. Seller: McMaster-Carr #90670A170
Other Seller: Aluminum Fasteners Supply Co. Inc. (less expensive; quality?)

10-24 stainless steel Threaded Shaft Collar: 3⁄8 in. OD × 0.281 in. thick
Manufacturer: Ruland Manufacturing Co., Inc. #TCL-3-24-SS
Machined with two flats to fit a 1⁄2 in. open end wrench.

New 'Locknut': Front Nut faced on a lathe to a thickness of 1⁄4 in., and tapped with threads for two parallel 4-40 × 1⁄2 in. alloy steel socket head cap screws, 180° apart. I invented this new kind of 'locknut' to replace 48 previously installed 7⁄16-14 jam nuts. The Locknut (1) has excellent holding strength, (2) does not distort the threads of the Front Nut and glass stem, and (3) it is easy to tighten and loosen the cap screws, called **_'Locknut Screws'_**. See pp. 12–14. (In 2025, I discovered that industrial versions of this nut are called 'Tensioner Nuts'.)

4-40 × 1⁄2 in. alloy steel cap screws — **_Manufacturer: Holo-Krome_** #72022 | **_Seller: Zoro_** #G800432305

Back Nuts: 10-24 zinc plated steel coupling nuts; sawn in half and faced on a lathe; 5⁄16 in. width across the flats.

❖ **The Back Nuts must have a 5⁄16 in. width across the flats. Otherwise, the Front Nuts and Locknuts with 7⁄16-14 threads cannot pass over the Back Nuts and, therefore, cannot be installed.**

❖ ***Also, never remove a Back Nut while an aluminum glass stem tube is installed in the case. The machine screw could slide out of the tube and the attached glass could fall and break. Even worse, if a glass is located in a row above other glasses, the fall could break several glasses.***

One Critical Structural Component

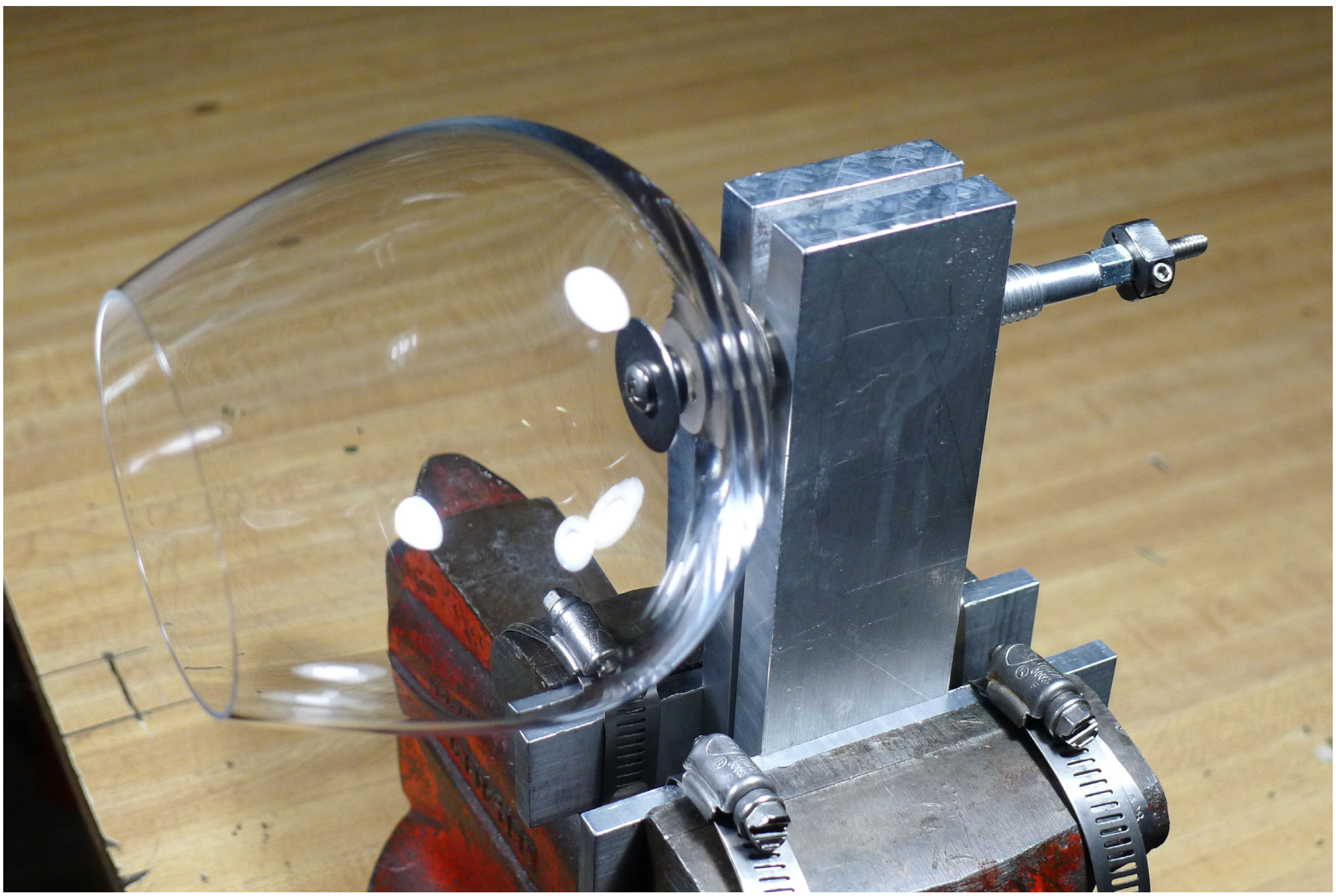
Due to the weight of the Glassdance, I installed four high-quality casters to minimize wear and tear on the instrument stand. ***Manufacturer: Darnell-Rose*** #52-5-XDN. The number -5- refers to an optional factory-installed top plate. I also used this caster on Chrysalis II. The catalog only lists #52-13-XDN, where the number -13- identifies the standard top plate. Darnell-Rose Catalog.pdf

Section 2

Aluminum Glass Stem Assemblies

To fasten a glass to an aluminum glass stem,* (1) attach the glass holder jig to the vice jaws with four hose clamps; (2) open the vice; (3) place a glass stem into two half-holes at the top of the jig; (4) close the vice to hold the glass stem securely in the jig; (5) attach the glass to the stem with various mechanical components. See: pp. 7–8.

Glassdance_GlassHolderJig.jpg



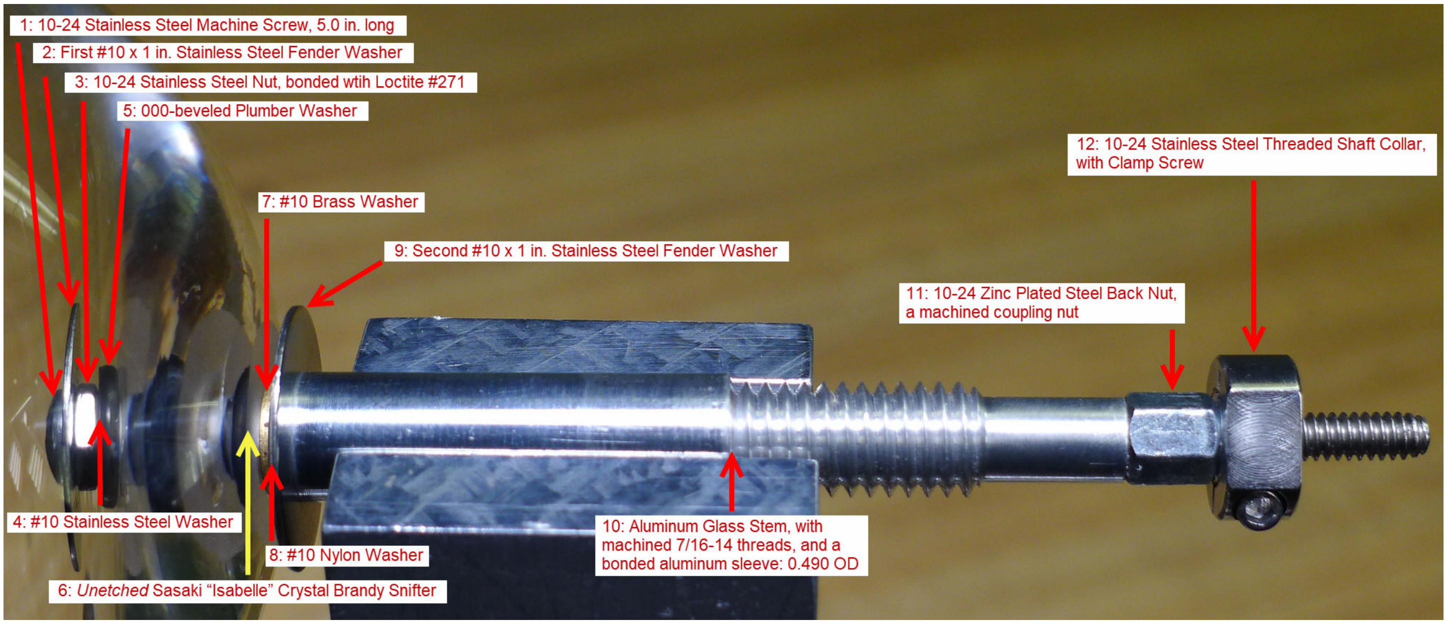
*Please note, I will now refer to all aluminum glass stem tubes as aluminum glass stems, or simply as glass stems, and to all aluminum sleeve tubes as aluminum sleeves.

Assemble the glass stem parts in the following order: **(1)** 10-24 stainless steel machine screw, 5.0 in. long; **(2)** first #10 × 1 in. stainless steel fender washer; **(3)** 10-24 stainless steel nut; **(4)** #10 stainless steel washer; **(5)** 000-beveled Danco plumber washer; *lubricate with Dow-Corning Molykote O-ring Grease #55 between the 000-beveled washer and the countersunk hole in the glass;* **(6)** *Unetched* Sasaki "Isabelle" Crystal Brandy Snifter with ¼ in. diameter countersunk hole; **(7)** #10 brass washer; **(8)** #10 nylon washer; **(9)** second #10 × 1 in. stainless steel fender washer; **(10)** aluminum glass stem with machined 7⁄16-14 threads and bonded aluminum sleeve: 0.490 in. OD; **(11)** 10-24 zinc plated steel Back Nut; and **(12)** 10-24 stainless steel Threaded Shaft Collar.

The Back Nut is a coupling nut that I sawed in half and faced on a lathe. As described on p. 5, the coupling nut has a 5⁄16 in. width across the flats.

I machined two flats on the Threaded Shaft Collar to fit a ½ in. open end wrench.

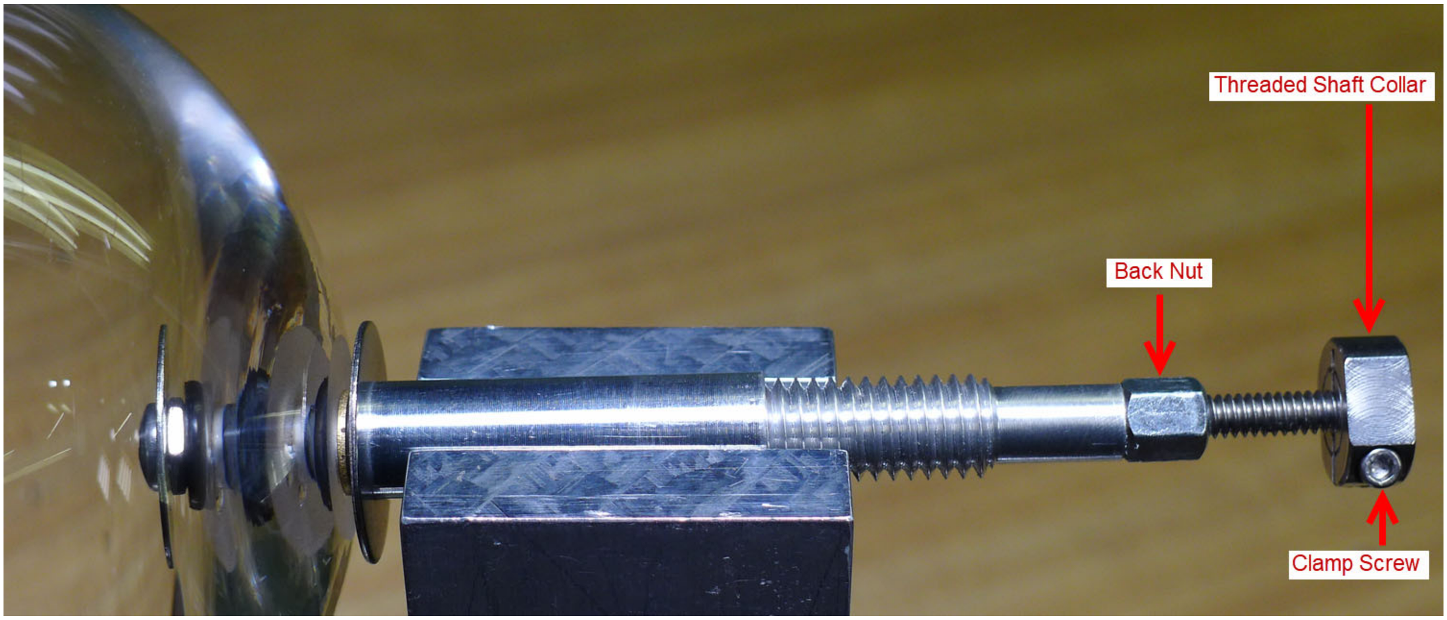
Glassdance_AluminumGlassStemAssembly.jpg



As shown in the graphic below, to tighten the Back Nut against the aluminum glass stem, first move the Threaded Shaft Collar close to the end of the machine screw and secure it by tightening the Clamp Screw. To prevent the machine screw from rotating, place a ½ in. wrench on the collar. Then, with a 5⁄16 in. wrench, tighten the Back Nut against the stem. Finally, as shown in the graphic on p. 7, loosen the Clamp Screw and spin the collar until it is only *finger tight* against the Back Nut. Now, retighten the Clamp Screw. Note that in this capacity, the Threaded Shaft Collar acts as a locknut. To prevent distortion of the machine screw threads, do not jam the collar against the nut.

This method of immobilizing the machine screw prevents inserting a Phillips screwdriver into the glass, and thereby eliminates the risk of breaking a glass with the screwdriver. It also enables a player to tighten a Back Nut from a location inside the instrument case.

Glassdance_BackNut_Adjustment.jpg



Adjusting the tightness of the Back Nut requires two important considerations.

(1) Because the 000-beveled plumber washer is pliable, moderately tighten the Back Nut against the stem and then wait a while to allow the washer to compress inside the glass. With a steady 5⁄16 in. wrench on the Back Nut, turn the glass several times in the clockwise direction. These rotations equalize the pressure on the washer and help to seat it against the glass. Then, tighten the Back Nut by half-turn or 180° increments until the machine screw starts to turn. Now, clamp a Threaded Shaft Collar near the end of the machine screw and continue to tighten the Back Nut. However:

If the Back Nut is too tight, the force will crack the glass.

But if the Back Nut is not tight enough, when a player touches the revolving rim, the glass will stop rotating. Therefore, the Back Nut must be tight enough so that when a player touches the revolving rim, the glass continues to rotate.

(2) Also, do not overtighten the Back Nut because too much pressure will dampen the resonance or the ring-time of the glass.

So, under these two conditions, tightening the Back Nut requires both mechanical and musical skill.

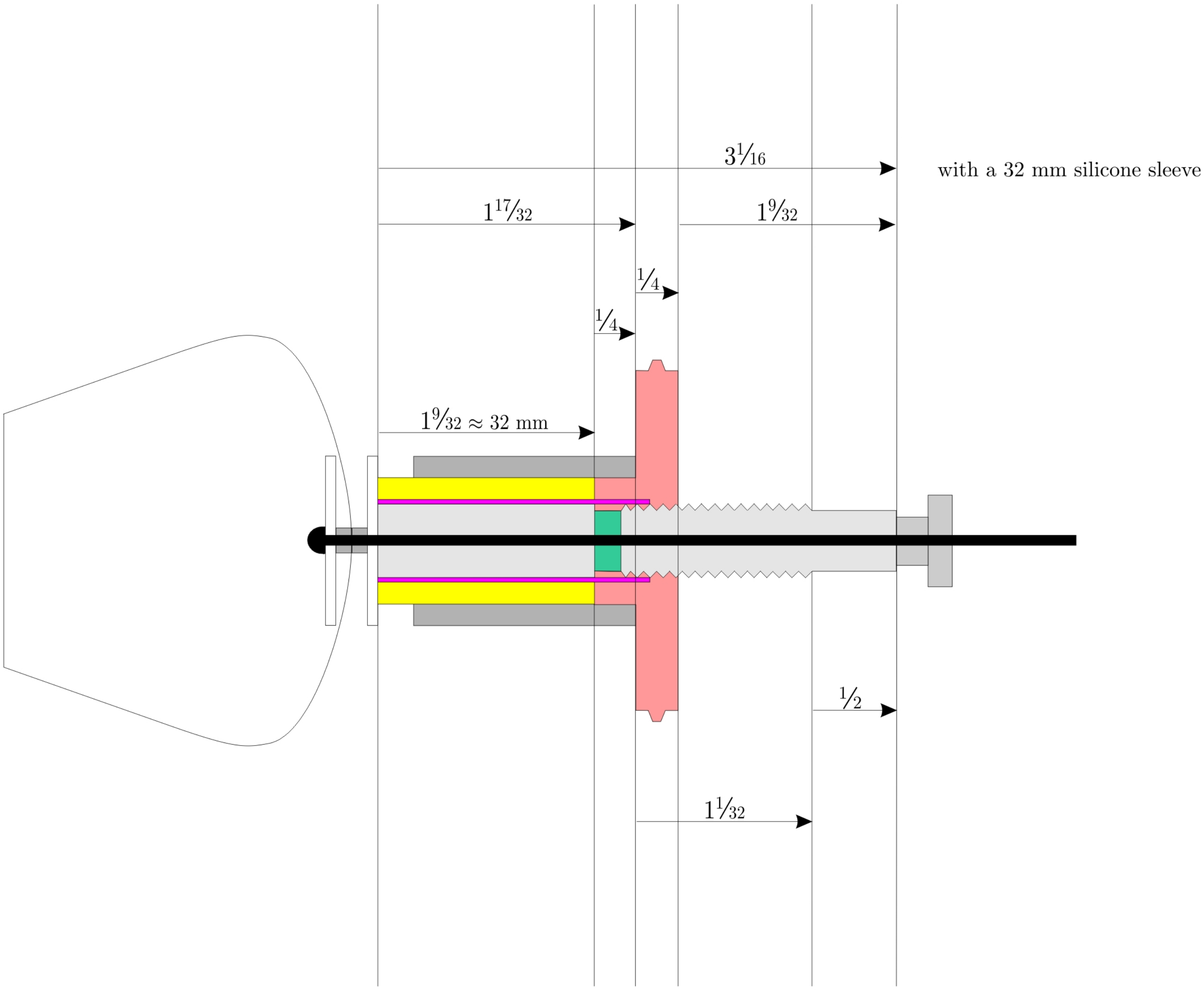
❖ ***Again: Never remove a Back Nut while an aluminum glass stem tube is installed in the case. The machine screw could slide out of the tube and the attached glass could fall and break. Even worse, if a glass is located in a row above other glasses, the fall could break several glasses.***

Aluminum Glass Stem Assembly Dimensions

In the graphic below, (1) the thread clearance groove with a width of $\frac{5}{32}$ in. is in green; and (2) the aluminum sleeve with a length of 1.610 in. is in magenta.

See: Glassdance_MachiningTubes_Manual-3.pdf

Glassdance_AluminumGlassStemAssemblyDimensions.jpg



Making 5.0 in. Long Machine Screws

The following instructions on p. 7:

"Assemble the stem parts in the following order: (1) 10-24 stainless steel machine screw, 5.0 in. long; (2) first #10 × 1 in. stainless steel fender washer; (3) 10-24 stainless steel nut."

require *fully threaded* 10-24 machine screws 5.0 in. long. I was unable to find such screws in stainless steel except at a specialty fastener company in San Francisco called Harrison and Bonini. Although difficult to locate, it is also possible to find fully threaded 10-24 machine screws 5.0 in. long in zinc plated steel. However, I prefer stainless steel for its corrosion-resistant properties. Since the ***safe method*** described above does *not* require a screwdriver inside the glass, it is possible to make fully threaded 10-24 screws 5.0 in. long (and longer) from stainless steel threaded rods, readily available in lengths from 1.0 ft. to 6.0 ft.

(1) From a 10-24 threaded rod, saw a screw with a length of $5\frac{1}{4}$ in.

(2) Thoroughly clean the threads of the screw and the threads of a matching 10-24 nut.

(3) Apply the following anaerobic adhesive — Loctite, Red, High Strength, Series 271 — to the threads of the screw and the nut. Turn the nut on the screw so that the nut is flush with the end of the screw.

If this adhesive is not available, it would be possible to make a screw head by jamming two 10-24 nuts together. An even stronger bond between these two nuts could be obtained by first applying a high quality epoxy — that requires a 24-hour cure time — to the threads.

(4) Wait a few hours to let the #271 harden. 24 hours full cure time. The nut is now attached to the screw.

(5) To discourage inserting a hex socket or a nut driver into the glass, it is possible to round over the hex corners of this screw — with a file or preferably on a lathe — so that no conventional tool can be used to turn it.

Making_5-in_MachineScrews.jpg

Section 3

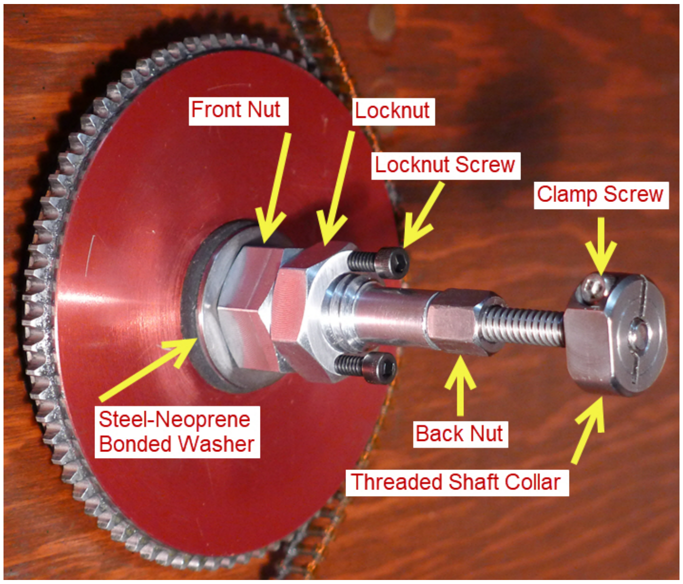
Glassdance Case Installations

As of February 2025: 18 extra red panel chains: ***W.M. Berg*** #24GCF-662-E.
6 extra yellow transmission chains: ***W.M. Berg*** #25CCF-369-E.

Inside the Glassdance case, the graphic below shows (1) backup chains, (2) glass stem installation and removal instructions, (3) Back Nut adjustment instructions, and (4) a container with extra Locknuts, Back Nuts, and Threaded Shaft Collars.

Glassdance_ExtraChains_&_GlassStemInstructions.jpg

Text from: Glassdance_Instructions-FrontNut-ThreadedShaftCollar.doc



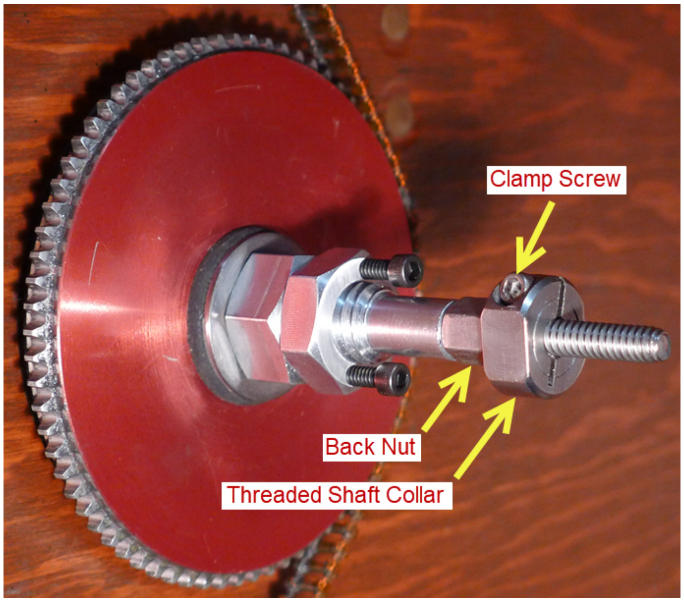
1. To install a glass in the instrument, push the aluminum glass stem through the center of the red sprocket. Place a Bonded Washer on the stem and push it against the sprocket. Spin on the Front Nut only *finger tight* against the washer. With an 11⁄16 in. wrench, give the nut only a 45° to 90° turn *or less*, or only an 1⁄8 to 1⁄4 turn *or less*. Then, spin the Locknut only *finger tight* against the Front Nut. Tighten the two Locknut Screws against the Front Nut with a 3⁄32 in. hex key.

2. To remove a glass from the instrument, with a 3⁄32 in. hex key, loosen the Clamp Screw of the Threaded Shaft Collar, and remove the collar from the machine screw. Next, with the same hex key, loosen the Locknut Screws and remove the Locknut, the Front Nut, and the Bonded Washer. Now, from the front of the instrument, pull the glass and the aluminum glass stem out of the case.

❖ ***Never remove a Back Nut while an aluminum glass stem tube is installed in the case. The machine screw could slide out of the tube and the attached glass could fall and break. Even worse, if a glass is located in a row above other glasses, the fall could break several glasses.***

3. However, follow these steps in the very unlikely event that the Front Nut and Locknut are difficult to move. (i) Remove the Threaded Shaft Collar. Then, with an assistant standing in front of the instrument, (ii) remove the Back Nut as the assistant pulls the glass and machine screw out of the case. Now, (iii) pull the aluminum glass stem out from inside the case.

Text from: Glassdance_Instructions-BackNut-ThreadedShaftCollar.doc



1. To safely tighten a glass against an aluminum glass stem — *without* the risk of inserting a Phillips screwdriver into a glass and breaking the glass — turn the Back Nut only *finger tight* against the aluminum glass stem.

2. To prevent the machine screw from rotating, (i) position the Threaded Shaft Collar near the end of the screw, (ii) tighten the Clamp Screw of the TSC with a 3⁄32 in. hex key, and (iii) apply a ½ in. wrench to the collar. Now, with a 5⁄16 in. wrench, tighten the Back Nut against the aluminum glass stem. Test the tightness of the Back Nut. If it is not tight enough, the glass will stop rotating when a player touches the revolving rim. However:

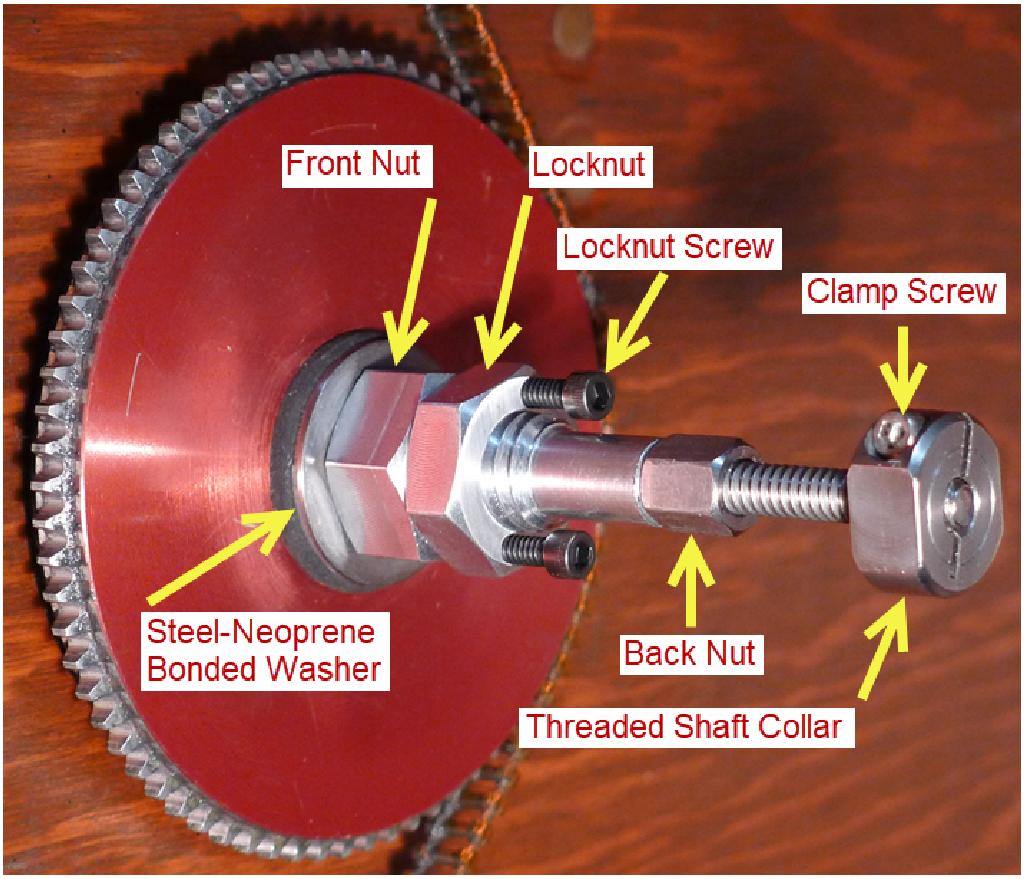
   If the Back Nut is too tight,
   the force will crack the glass.

   Also, test the tightness of the Back Nut to make sure that too much pressure is not reducing the resonance or the ring-time of the glass. So, under these two conditions, tightening the Back Nut requires both mechanical and musical skill.

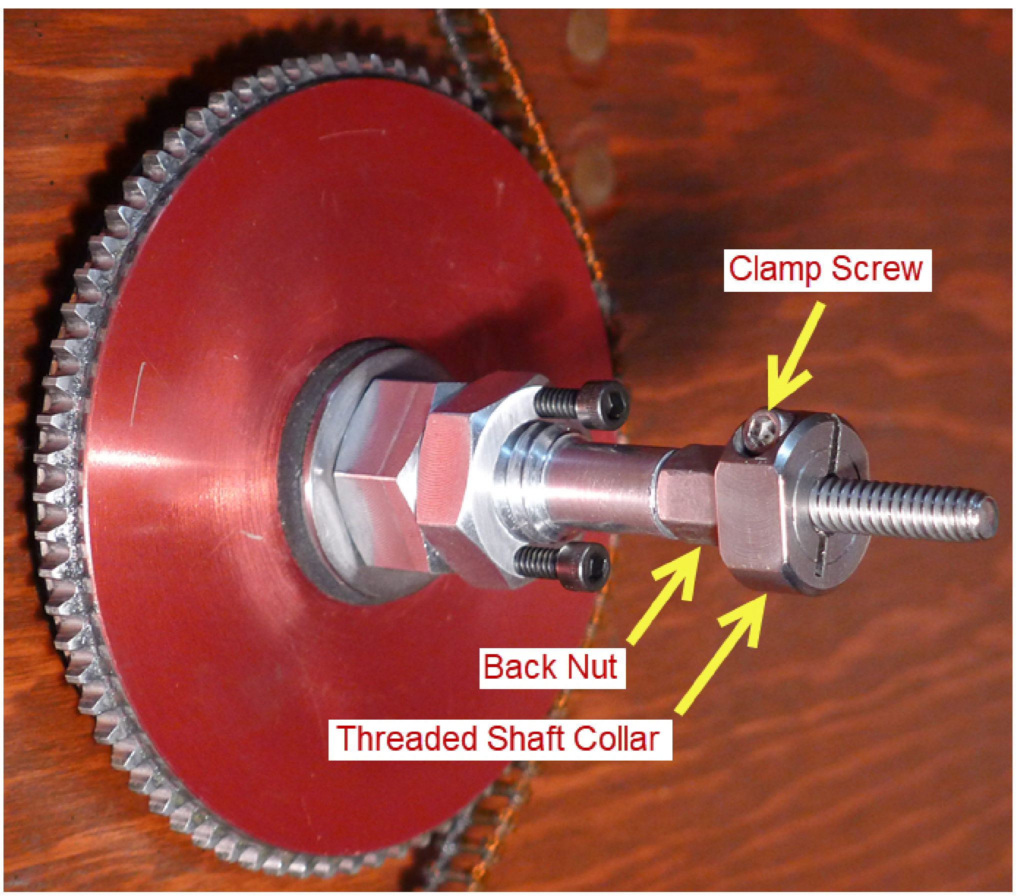
3. Finally, loosen the Clamp Screw of the Threaded Shaft Collar and spin the collar until it makes only *finger tight* contact with the Back Nut. Now, tighten the Clamp Screw. Note that in this capacity, the collar acts as a locknut. To prevent distortion of the machine screw threads, do *not* jam the collar against the nut.

4. In the very unlikely event that the Back Nut is difficult to move, remove the glass from the case, and at the thin end of the glass stem, cut through the stem and the machine screw with a hack saw or a small bolt cutter.

Glassdance_FrontNut.jpg



Glassdance_BackNut.jpg



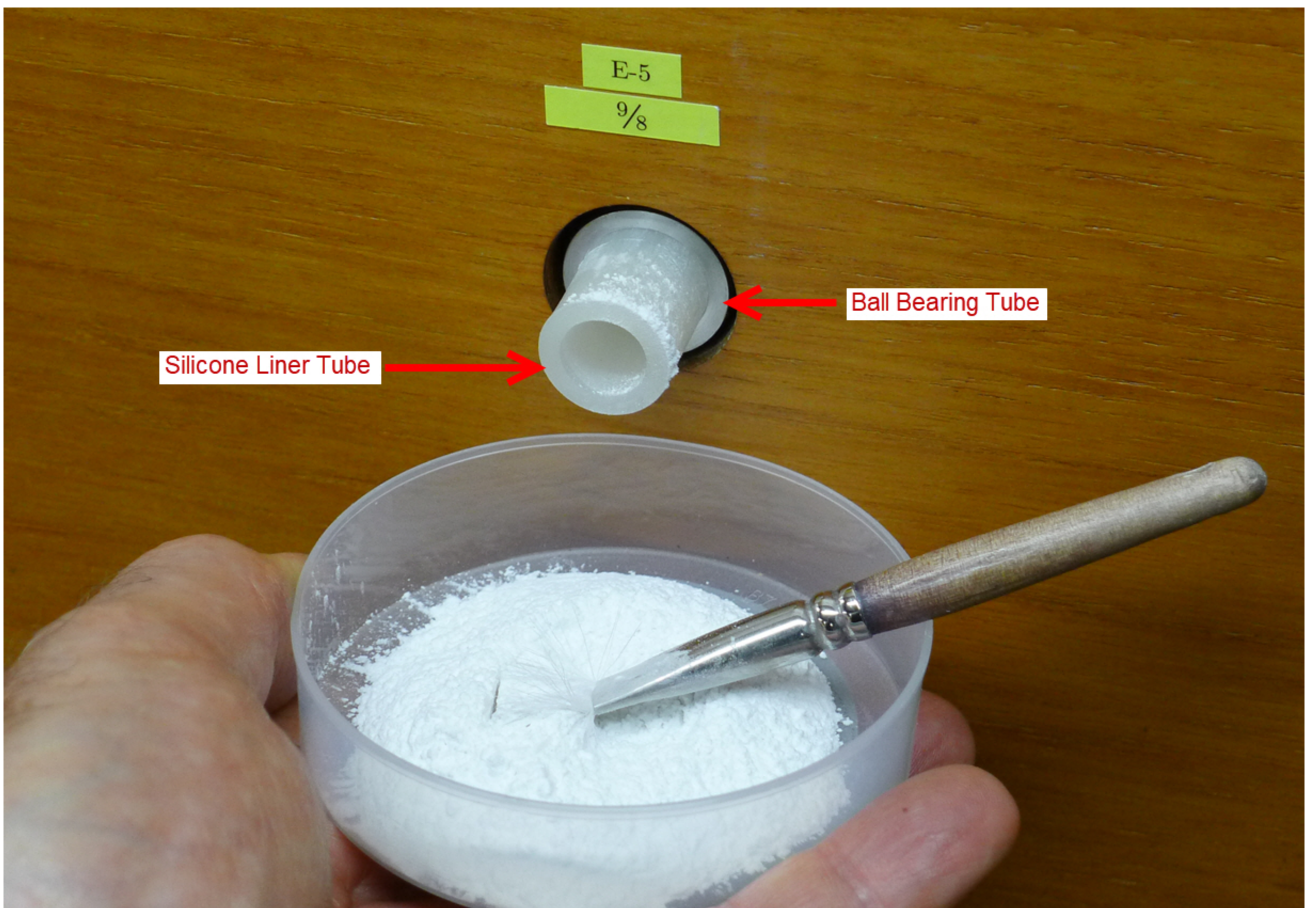
Installing Silicone Liner Tube

Silicone tubing, with a hardness of 50 Shore A, is a very pliable, resilient, and durable material. However, it also has a very high coefficient of friction. In other words, it is sticky and therefore does not slide very well. This stickiness can cause problems when sliding the silicone *liner tubes* into the aluminum *ball bearing tubes* that hold the aluminum glass stem tubes. And this stickiness can also cause potentially dangerous problems when sliding the aluminum *glass stem tubes* into the *silicone liner tubes*.

To resolve these problems, coat both the inside and outside surfaces of the silicone liner tubes with Johnson's Baby Powder. Baby powder is an excellent dry lubricant that can be used on metal, wood, plastic, etc. If the inside surfaces of the silicone liner tubes are not treated with baby powder, the silicone tubing will grab the aluminum glass stem tubes and make the insertion of the stems very difficult. This may result in breaking a glass. In a situation where baby powder may not be available, (1) coat the aluminum glass stem tubes with WD-40 or saliva, (2) insert the stems until the 7⁄16-14 threads are visible on the inside of the instrument case, and (3) use the Front Primary Nuts *to pull the stems* into the case.

In other words, ***do not push the stems*** *— with excessive and potentially dangerous force — into the silicone liner tubes from outside the instrument case!*

Glassdance_SiliconeLinerTube_&_BabyPowder.jpg



Installing Glass Stem Standoff Washers

#10 stainless steel standoff washers are designed to bring forward the rims of short glasses so that they are now approximately the same distance from the instrument case as the long glasses.

As of July 2018, seventeen glasses have standoff washers. #4-$^{12}/_{11}$ (8 washers), #16-$^{14}/_{9}$ (8), #19-$^{5}/_{3}$ (6), #20-$^{7}/_{4}$ (2), #21-$^{16}/_{9}$ (6), #22-$^{20}/_{11}$ (10), #23-$^{24}/_{13}$ (10), #26-$^{81}/_{80}$ (5), #27-$^{21}/_{20}$ (4), #31-$^{189}/_{160}$ (2), #32-$^{16}/_{13}$ (4), #34-$^{21}/_{16}$ (5), #36-$^{7}/_{5}$ (5), #39-$^{32}/_{21}$ (2), #44-$^{5}/_{3}$ (4), #47-$^{15}/_{8}$ (4), #48-$^{4}/_{1}$ (4).

Glassdance_StandoffWashers.jpg

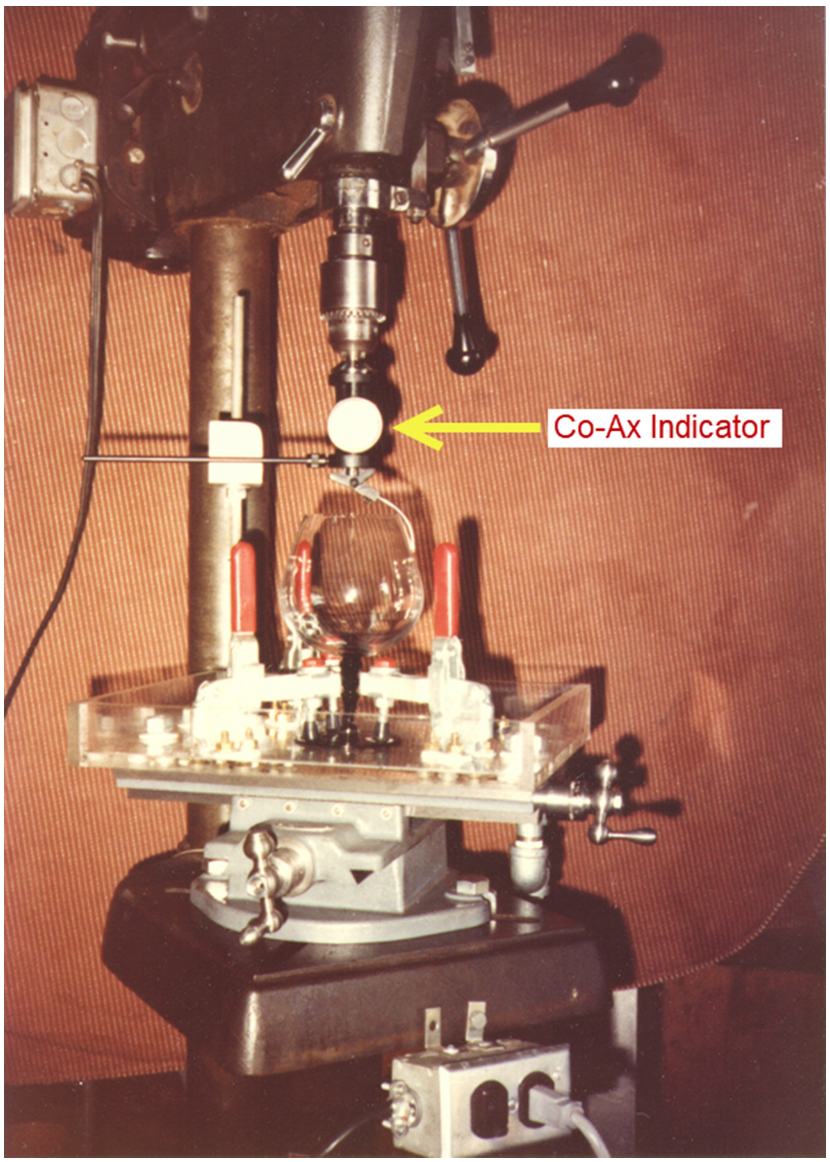
Section 4

Glass Drilling, Grinding, Annealing, Sawing, Tuning, and Runout Procedures

1. Clamp glass to a plastic tray mounted on a compound slide table.

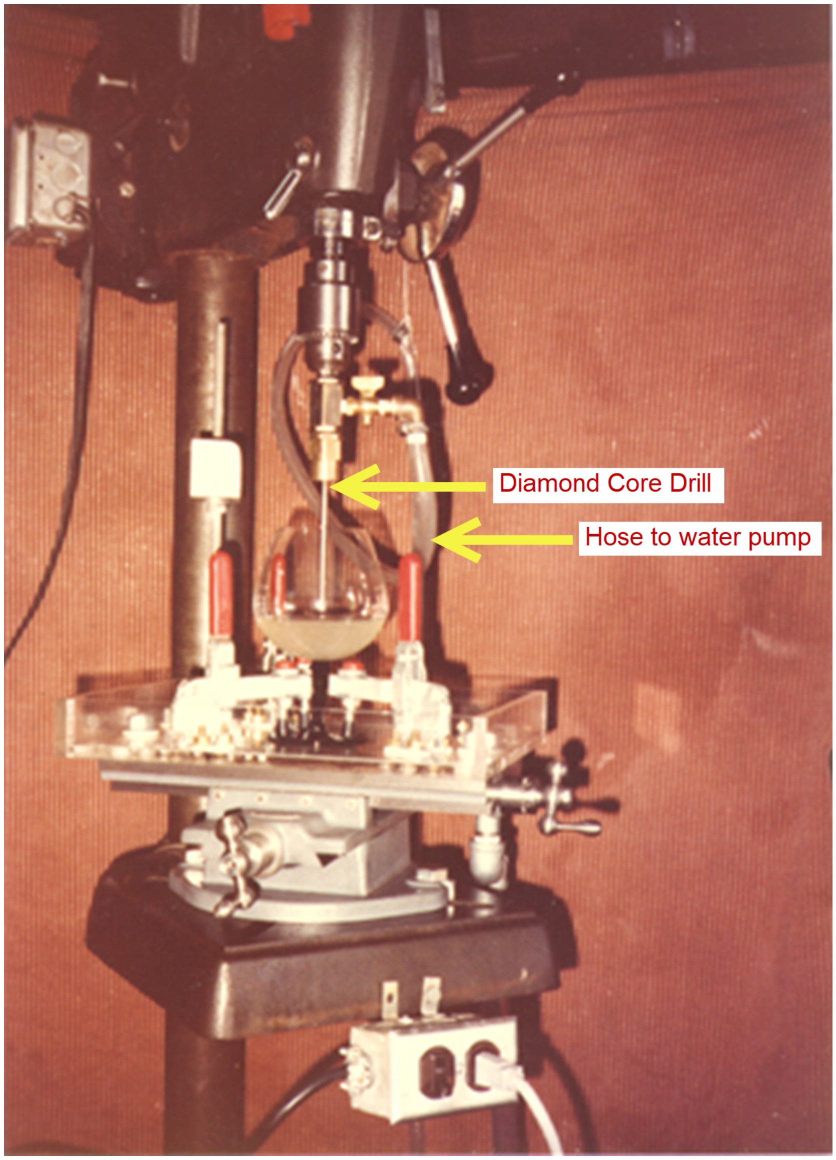
2. Set up a Blake co-ax indicator and center the glass.

Glassdance_Co-Ax_Indicator.jpg (1983)



3. With a ¼ in. diamond core drill attached to a water pump, drill a hole through the bottom of the glass.

Glassdance_DiamondCoreDrill.jpg (1983)



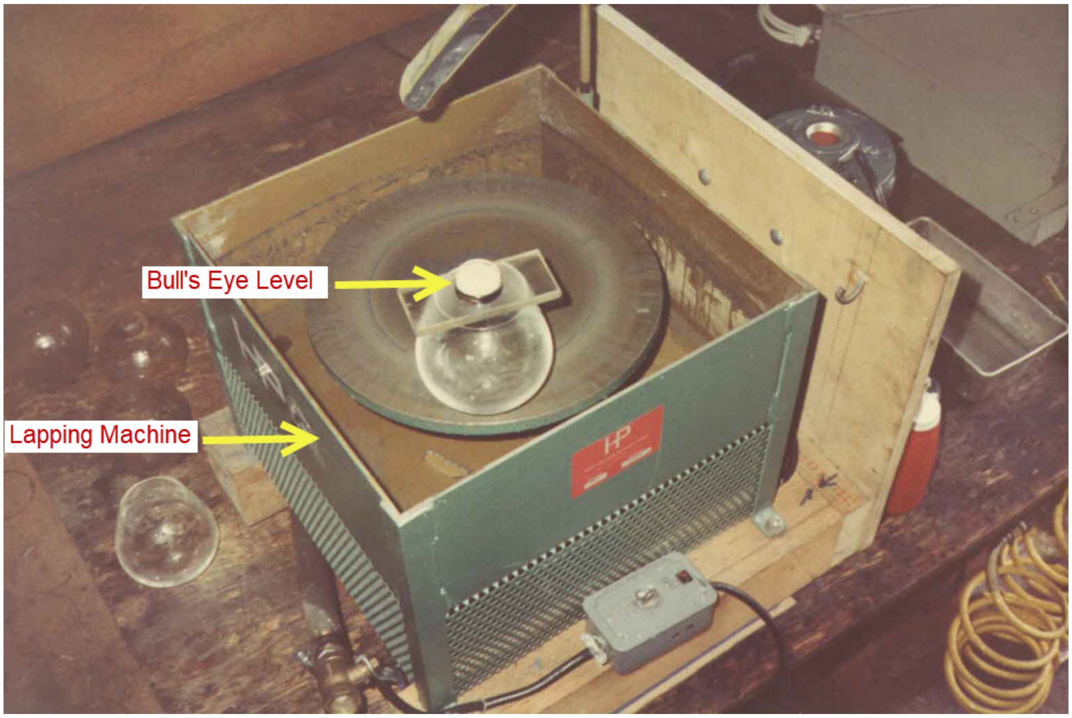
4. To accommodate a 000-beveled Danco plumber washer, countersink the hole with a diamond tool.

5. Unclamp glass and cut off the stem with a diamond wire saw.

6. On the lapping machine with a bull's eye level, grind the bottom of the glass parallel to the rim of the glass. Grinding is achieved with a revolving cast iron plate covered in silicone carbide powder and water.

(See p. 22: Glassdance_LappingMachine-TuningGlass.jpg.)

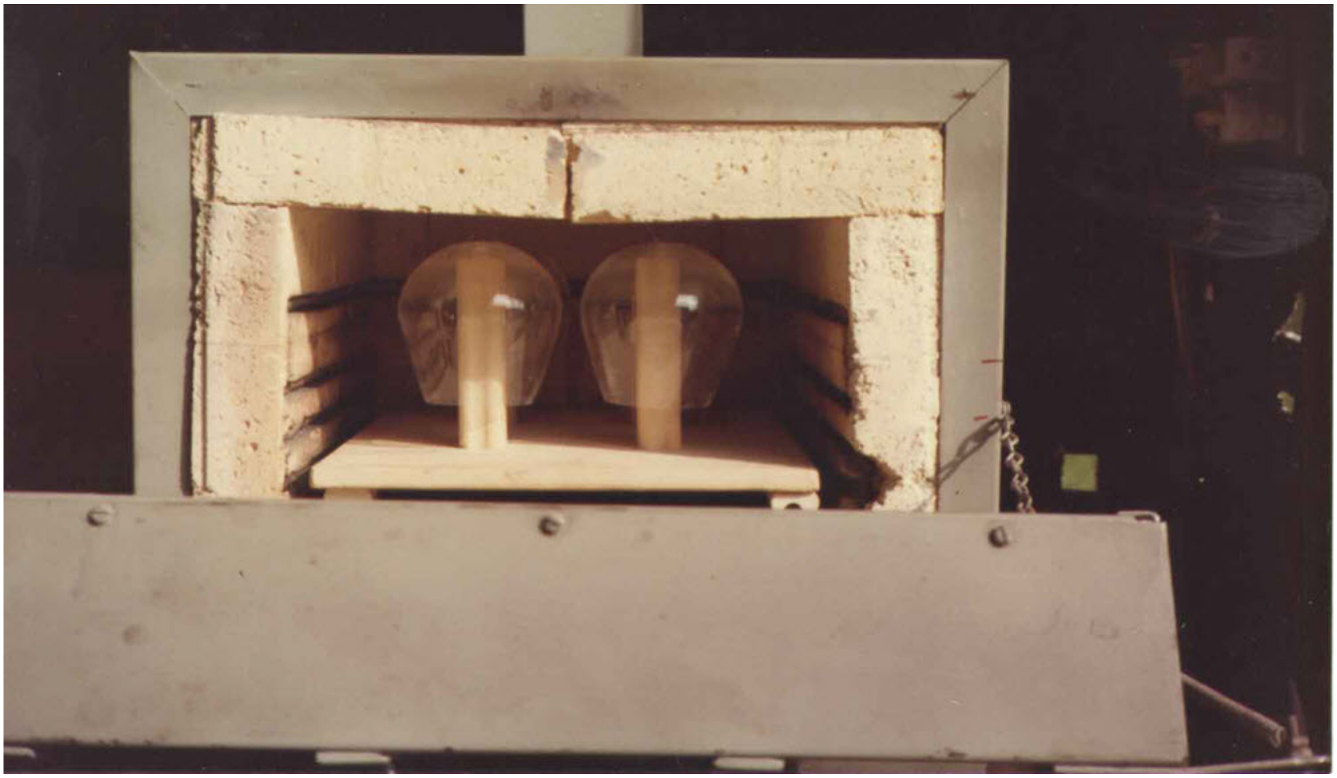
Glassdance_LappingMachine-GrindingGlassBottom.jpg (1983)



7. Anneal the glasses to remove any areas of strain in the glass.

(A) Position 1 in. × 1 in. ceramic posts on the bottom of the kiln. Turn the glasses upside down and hang them over the tops of the posts. The posts must be long enough so that the rims of the glasses do *not* touch the kiln.

Glassdance_Kiln.jpg (1983)



(B) Pre-heat the kiln for ½ hour with the door open. I set the pulse timer to 30 on an old kiln that I borrowed in 1983. This setting brings the kiln to about 400° C. (New Cress kiln never used.)

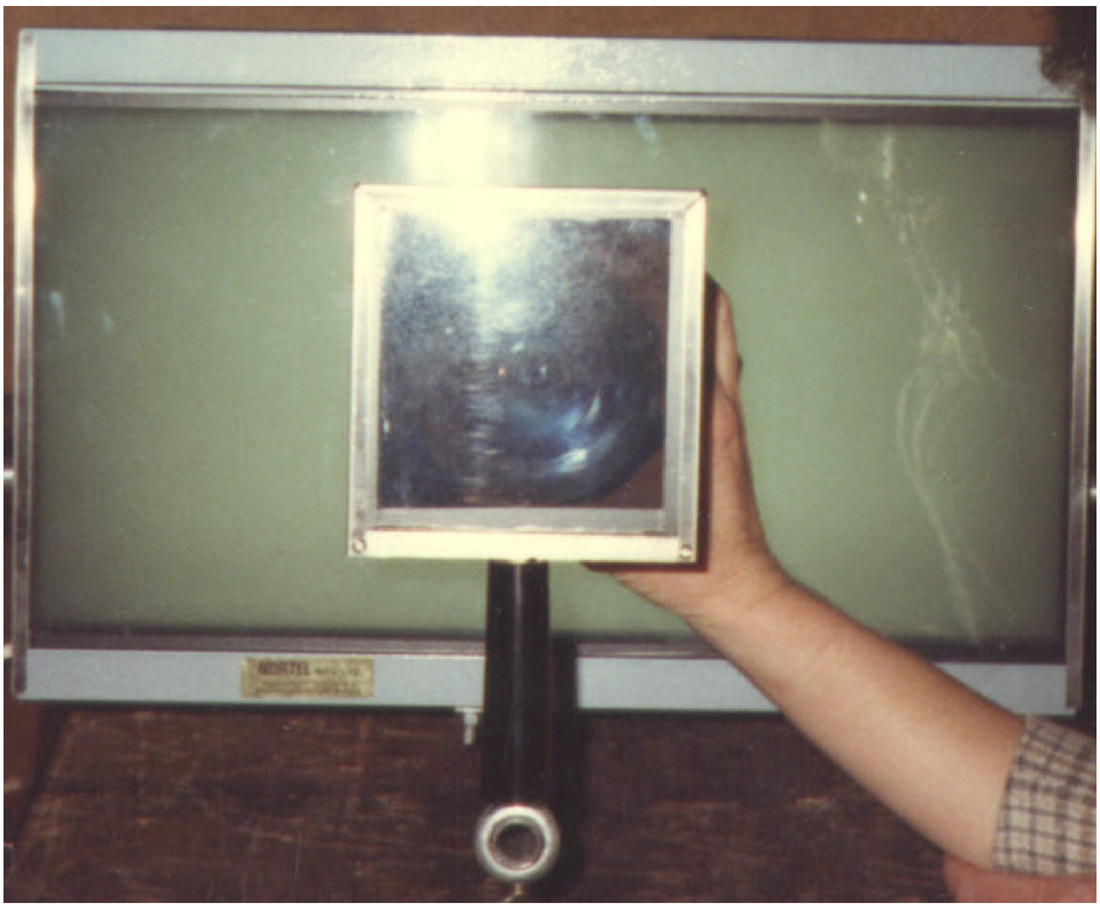
(C) Close the door with a ¼ in. aluminum spacer, which keeps the door slightly open. Set the timer to 60 for ¾ hour.

(D) Set the timer back to 30 for two hours (at about 400° C.) Leave the spacer.

(E) Remove the spacer, turn off the kiln, and let cool overnight.

8. Check for signs of strain with a polariscope. The entire glass should have a faint blue haze indicating that all areas of strain have been removed. Consequently, previous areas with strain are now no longer more likely to break than areas without strain.

Glassdance_Polariscope.jpg (1983)



Basic Tuning Procedures

1. Assemble glasses and aluminum glass stem tubes.

2. List the frequencies of the glasses.

3. Based on various physical and acoustical characteristics, start selecting glasses.

4. With a Gryphon diamond blade bandsaw, begin tuning a glass by cutting slices or rings off the rim of the glass.

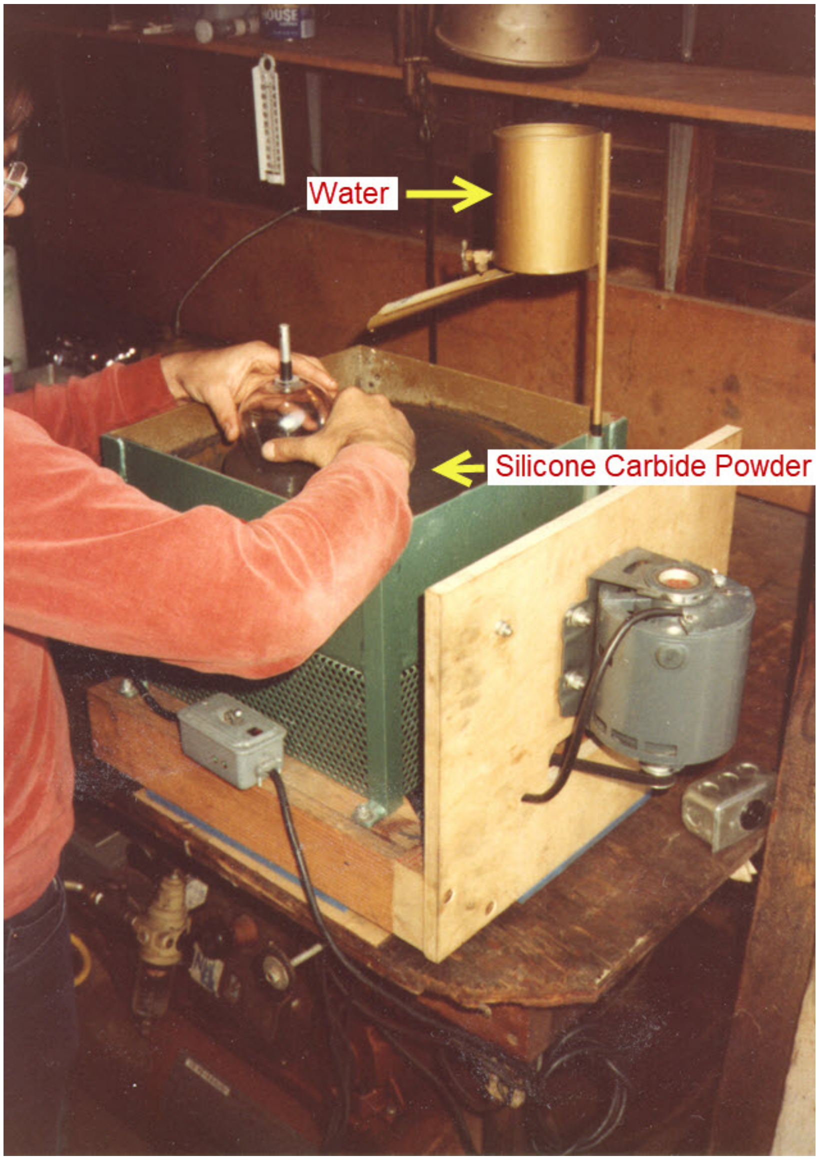
See: http://www.gryphoncorp.com/page/

Glassdance_GryphonDiamondBladeBandSaw.jpg (1983)

5. Begin fine-tuning by grinding the rim on a lapping machine with silicone carbide powder and water.

6. Periodically, check the rotation of the glass for run-out. It is possible to minimize or eliminate high spots at the rim while grinding on the lapping machine. See pp. 23–24.

Glassdance_LappingMachine-TuningGlass.jpg (1983)



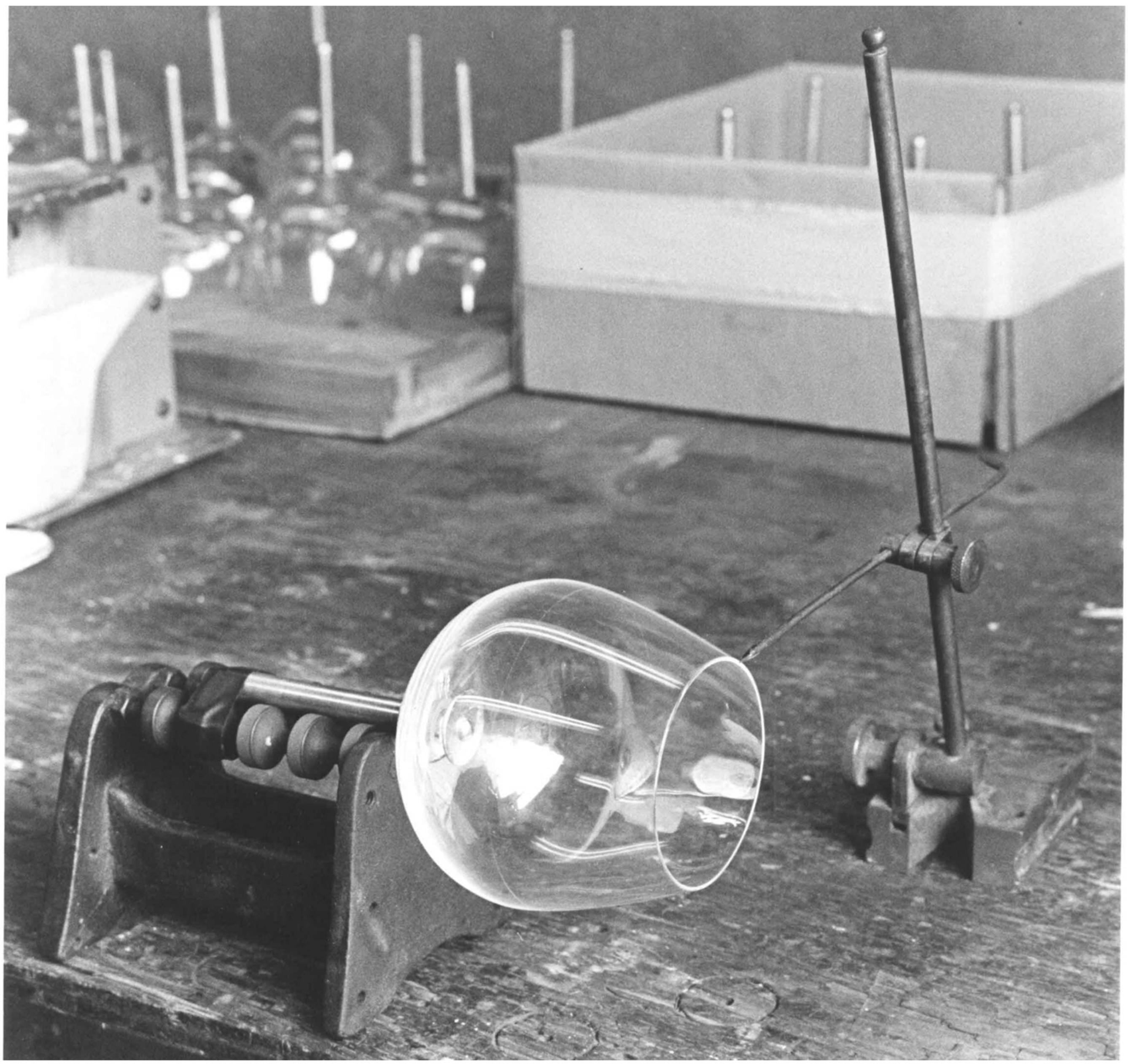
7. Bring the glasses into tune by sanding and polishing the rims with 220-, 320-, 400-, 600-, and 1000-grit wet/dry paper.

Radial Runout (at the body of the glass) and Axial Runout (at the rim of the glass)

Runout is a measurement of how far a revolving mechanism deviates from its true circular motion around an axis of rotation. Primarily, there are two kinds of runout: radial runout and axial runout. Radial runout measures the surface parallel to the axis of rotation; in this case, the circularity of the body of the glass from rim to stem. Axial runout measures the surface perpendicular to the axis of rotation; in this case, the circularity of the exterior surface of the rim of the glass. The first can be described as a measure of the roundness of the glass. Here, deviations may be clearly visible as the body of the glass *wobbles* around its axis of rotation. The second can be described as a measure of the flatness of the rim of the glass. Here, deviations may not be clearly visible as the rim of the glass *protrudes* — indicating high spots or bumps — around its axis of rotation.

Two tools are very important here: the Glass Roller and the Surface Gauge. In the photo below, the glass rests on the glass roller, and the pointer of the surface gauge is at the exterior surface of the rim of the glass.

Glassdance_GlassRoller_&_SurfaceGauge.jpg (1983)

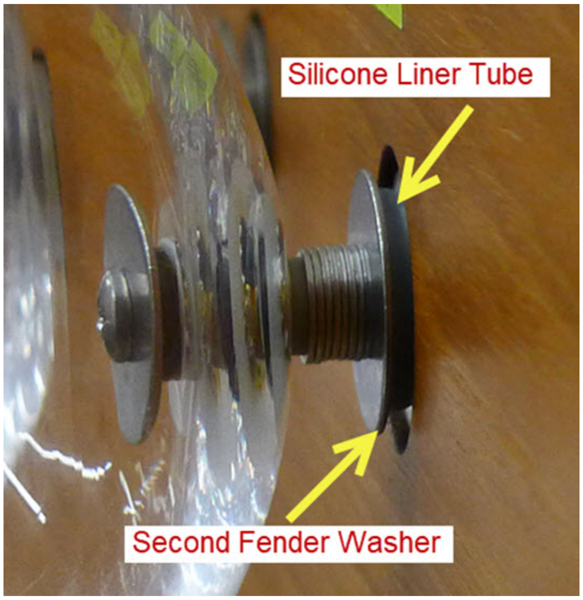


1. To check the radial runout, roll the glass on the glass roller in both clockwise and counterclockwise directions to see how true the center — or the widest part — of the glass is turning. If the *body rotation* indicates a significant wobble, regrind the bottom of the glass with the bull's eye level on the lapping machine. Also, while checking the body rotation, hold the glass with one hand and place a 5⁄16 in. wrench on the Back Nut with the other hand. Now, to *slightly* tighten the glass against the glass stem, rotate the glass to establish a different axis of rotation. This may decrease the wobble. Once the center rotation is OK, roll the glass on the glass roller in both clockwise and counterclockwise directions to see how true the rim of the glass is turning. If the *rim rotation* indicates significant protrusions — high spots or bumps — mark the areas with a waterproof pen and eliminate or minimize them while grinding the glass on the lapping machine

2. After each cut on the Gryphon diamond blade band saw, recheck the rim rotation. Also, during long lapping machine sessions, recheck the rim periodically. The glass stem should be fairly tight against the bottom of the glass so that the body rotation remains unchanged.

3. It is important to note that the wobble — *or body rotation* — can change after mounting a glass in the instrument case. The close-up graphic below, taken from the photo on p. 16, shows that the second fender washer makes full contact with the silicone liner tube. The function of the second fender washer is to act as a stopper to prevent the glass stem from being pulled into the instrument case while tightening the Front Nut inside the case.

Glassdance_SecondFenderWasher_SiliconeLinerTube.jpg



If a glass noticeably wobbles after installing it in the case, three adjustments can be made to minimize this problem. However, remember that these are hand-blown glasses and therefore not perfectly round.

1. While the instrument is turned on, grab the glass with both hands and then quickly let go. This changes its center of rotation on the glass stem. Repeat this several times to find the location where the glass wobbles the least.

2. If the wobble is still too great, *slightly* tighten the Front Nut. This pulls the second fender washer tighter against the silicone liner tube and may also decrease the wobble. The more flush the second fender washer is pulled against the silicone liner tube, the truer the glass will rotate at its center.

3. A slight wobble in the center of the glass can also be taken out by inserting a wood sliver (a thin piece of wood like the tip of a flat toothpick) between the silicone liner tube and the glass stem. This small piece of wood pushes against the silicone liner tube and causes the true ball bearing center to be slightly off-set. If one holds and quickly releases the glass while the glass is turning, one can find a *second* center of rotation. Under these conditions, both the center rotation and the rim rotation will be at a minimum. Again, these are hand-blown glasses and therefore some glasses will turn truer than others.

Insert a sliver in the following manner:

1. From inside the case, loosen the Clamp Screw of the Threaded Shaft Collar and remove it from the machine screw. Now, loosen the Locknut Screws and remove the Locknut, the Front Nut, and the Bonded Washer from the machine screw.
2. From the front of the instrument, pull the glass and the aluminum glass stem out of the silicone liner.
3. Pull the silicone liner out of the ball bearing tube.
4. Hold a sliver perpendicular against the second unpainted fender washer of the glass stem.
5. Push the liner over the sliver. Make sure that the sliver stays perpendicular and does not turn sideways.
6. When the liner is flush against the fender washer, apply plenty of baby powder on the liner.
7. Push the liner/stem assembly only *partially* into the ball bearing tube.
   Do not apply excessive or potentially dangerous force.
8. To pull the liner/stem assembly fully into the ball bearing tube, from inside the case replace the Bonded Washer, the Front Nut, and the Locknut. Now, pull the assembly inward by tightening the Front Nut. Finally, tighten the Locknut Screws against the Front Nut.

Section 5

Playing

Lead crystal glass is an extremely hard material. One cannot use conventional tungsten carbide tools to cut crystal glass; only diamond tools work. Due to this hardness, crystal glass has a very smooth surface that is difficult to play. To increase the friction, I have experimented with many materials and liquids. For me, the best combination is handmade chamois leather finger gloves dipped in denatured alcohol. After making the gloves, repeatedly soak the material in alcohol and then air-dry it. This removes most of the tanning oils in the leather. As shown on p. 30, play the glasses by regularly dipping the gloves in a container filled with denatured alcohol. For more information on the chamois leather suitable for playing this instrument, see: Glassdance_ToolsParts.pdf, p. 12. For instructions on how to make chamois finger gloves, see: Glassdance_MakingChamoisFingerGloves_Manual-4.pdf.

Glassdance_FingerGloves.jpg

Section 6

Maintenance

2003

1. Adjusted wobbling glasses in preparation for move to the studio. Lower $2/1$ range: $8/7$, $16/13$, $3/2$, $13/8$. Upper $4/1$ range: $3/2$. Replaced *all* washers and adjusted on the glass roller.

2. Installed a machine screw stopper on the Bodine gearmotor speed control so that the dial cannot be turned past the 40 mark. In other words, the maximum gearmotor speed is now set at 40.

3. Made a new Lexan cover for the pink warning sign inside the case.

4. Installed two new birch plywood blocks that support the drive shaft bearings.

5. Bonded a 1 in. thick foam liner — with perforated vinyl outer layer — to the inside surface of the case cover. Removed foam and replaced with acoustic polyester fiber panels in 2024.

6. Ordered 4 *factory-spliced* red panel chains with 662 links.
Manufacturer: W.M. Berg #24GCF-662-E

7. Taped together three electrical cords inside the case. Removed tape and replaced with machined cord restraints in 2024.

8. Widened the slot in the case cover required by the drive shaft and the three electrical chords.

9. Applied green paint to all the bare metal washers and machine screw heads inside the glasses.

10. In 2011, replaced rubber bands with three Scünci cords — Part No. 16775-Q — that secure the fans' electrical plug in the socket located near the intake fans' duct of the gearmotor soundproof double-box. Removed Scünci cords, plug, and socket; replaced with an Eilumduo 3-pin connector in 2024. See p. 27.

11. Bodine variable speed DC gearmotor: Removed the drain hole screw plug and black rubber washer and filled with Mobile SHC 630 Gear Oil to the bottom of the drain hole. Allowed excess gear oil to flow out before replacing plug and washer. Excessive hydraulic pressure from too much oil can destroy the motor.

2010

Installed two carabiners that hold extra red panel and yellow transmission chains in the upper right hand corner of the case. In 2010, 2011, and 2012, I installed 662 pitch chains in Panels #1, #2, and #4. July 2018, installed 662 pitch chain in Panel #3.

2013

On May 10, the upper right bent side of the acrylic shield broke off and shattered the $15/8$ glass, or the last glass in the third row from the bottom of the instrument. The only explanation is that for the last thirty years this bent area of the shield underwent continuous crystallization because the shield — after thermal bending of the sides — was never annealed. While putting the shield back on the instrument, the presence of strain in the acrylic caused the corner to simply snap off. I replaced the $15/8$ glass, which due to its large size (I could not find/make a small replacement glass) caused me to remount the $24/13$ glass to the left of the $15/8$ glass, and the

$^{14}/_{9}$ glass directly below the $^{15}/_{8}$ glass. Both of these glasses, due to their short lengths, were now located too far behind the large $^{15}/_{8}$ glass. I brought these short glasses forward with standoff washers.

For the $^{15}/_{8}$ glass, the best “small” uncut and annealed replacement glass I could find produced 500 ¢, so roughly C_5, or a $^{4}/_{3}$ above $^{1}/_{1}$, or a “fourth” above G_4. After cutting off a $^{7}/_{8}$-inch ring, the glass produced 650 ¢. I then cut off a $^{1}/_{4}$-inch ring and it increased by 200 ¢ to 850 ¢. I then cut off an $^{1}/_{8}$-inch ring, which increased it by 100 ¢ to 950 ¢. With 180 and 320 silicon carbide powder on the lapping machine, I then raised the glass by 100 ¢ to 1050 ¢. Finally, I raised it by 38 ¢ with 220-, 320-, 400-, 600-, and 1000-grit wet/dry paper to 1088 ¢.

I built a new shield made of Lexan (polycarbonate plastic) with two aluminum angles that hold the side sheets to the front sheet. This eliminated the need for thermally bent plastic.

<u>2018</u>

I installed new silicone liner tubes to replace the original rubber liner tubes, which had crystallized, corroded, and bonded to the inside surfaces of the aluminum ball bearing tubes. I carefully extracted these deteriorated liners with small needle nose pliers, and then cleaned out the residue with Jasco Paint and Epoxy Remover. For the final cleaning, I used sharp hardwood dowel scrapers and steel wool.

Remachined aluminum glass stem tubes with $^{7}/_{16}$-14 external threads, installed stainless steel 10-24 machine screws 5.0 in. long, and all new glass stem components.

Laminated and fastened two instructional texts with graphics inside the right corner of the instrument case:

Glassdance_Instructions-FrontNut-ThreadedShaftCollar.doc — See p. 12.
Glassdance_Instructions-BackNut-ThreadedShaftCollar.doc — See p. 13.

Also, installed a new flexible $^{5}/_{8}$ in. gearmotor-to-driveshaft coupling, with source information, and one spare coupling inside the gearmotor soundproof double-box.

Painted the fender washers inside the glasses with the following Rustoleum products:

Clean Metal Primer Spray: 7780830
Protective Enamel **Sunburst Yellow** Spray: 7747830
Protective Enamel **Sail Blue** Spray: 7724830
Protective Enamel **Sunrise Red** Spray: 7762830
Painter’s Touch **Meadow Green** Spray: 249100

<u>2024</u>

1. The original Bodine gearmotor electrical cord came with a (1) red plastic 4-pin connector and a (2) separate green ground wire connector. The wires of the ground connector broke off. Replaced both connectors with a single zinc alloy Eilumduo 5-pin aviation connector that includes a ground wire pin. After soldering, conducted continuity checks on all pins and sockets. Color-coded the male and female connector plugs with black shrink tubing.

2. For the three Dayton axial fans, replaced the electrical wiring inside the instrument case and inside the soundproof double-box. Inside the box, installed a new 4-circuit terminal block. Also replaced the original fans connector with an Eilumduo 3-pin aviation connector. Color-coded the male and female connector plugs with red shrink tubing.

3. For the 4-circuit terminal, machined a clear Lexan protective cover to prevent accidental contact with the electrical wiring.

4. Inside the box, made a new wiring diagram for the three axial fans.

5. For three electrical cords, machined and installed two cord restraints (3 pcs each) inside the instrument case, and one restraint (3 pcs) outside the case. I made the former from Honduras rosewood and aluminum, and the latter, from Delrin and aluminum.

6. Lined the internal side of the case cover with two layers of high density acoustic panels (18 pcs). The panels are made of 100% polyester fiber and have the following listed dimensions: 12 in. $\times$ 12 in. $\times$ 0.4 in., and listed density: 9.4 lb/ft^3. (Sold by Foocen.)

7. Inside the gearmotor soundproof double-box, for three Dayton axial fans — Old Part No. 4C548 — I installed new and improved Dayton electrical cordsets — Part No. 4YD79. For quiet operation, these fans have sleeve bearings, rotate at 1800 rpm, and produce an airflow of 55 cfm.

8. Installed new ground wires for these fans.

9. For the exhaust fan, replaced four finger guard machine screws with stainless steel screws.

10. Removed 48 previously installed 10-24 'back jam nuts' (machined coupling nuts) from the glass stems and replaced them with 10-24 stainless steel Threaded Shaft Collars, which in this capacity act as locknuts. Total replacements: 48 instrument glasses collars, 39 backup glasses collars, and 16 spare collars. Also, for all these stainless steel collars, machined two flats to fit a ½ in. open end wrench. The Clamp Screws of these collars require a 3⁄32 in. hex key.

11. ***New 'Locknut':*** Aluminum Front Nut faced on a lathe to a thickness of ¼ in., and tapped with threads for two parallel 4-40 $\times$ ½ in. alloy steel socket head cap screws, 180° apart. I invented this new kind of 'locknut' to replace 48 previously installed 7⁄16-14 jam nuts. Page 5 gives a detailed description of this fastener. For these Locknuts, the Locknut Screws also require a 3⁄32 in. hex key. (In 2025, I discovered that industrial versions of this nut are called 'Tensioner Nuts'.)

12. The new chamois finger gloves leather has the following description on eBay:
(1) Natural Chamois Leather Car Cleaning Cloth Washing Absorbent Drying Shammy Towel.
(2) Sold by an eBay company called Gets_AutoParts.
(3) Part #387488790490.

13. For the denatured alcohol, modified four acrylic trays with these original dimensions:
$H \times L \times W = 2$ in. $\times$ 6 in. $\times$ 3 in. Machined or reduced the height to approximately 1 in. Trays sold by Amazing Abby as a QuickSort Set. Also, machined three cast acrylic tray lids designed to minimize evaporation and contamination.

14. Replaced the yellow transmission chain that was originally installed in 1990.

<u>2025</u>

To eliminate light abrasive contact, reduced the diameter of the ⅝ in. stainless steel driveshaft where it passes through a slot in the case cover. The driveshaft connects the gearmotor to the drive sprocket inside the case.

* * *

Two Important Items Regarding the Axial Fans Inside the Gearmotor Soundproof Double-Box

Inside this box, I installed three Dayton axial fans to prevent the Bodine gearmotor from overheating. These include two vertical intake fans and one horizontal exhaust fan.

See: Glassdance_RightAngleGearmotor-and-Fans_Manual-2.pdf

I purchased these sleeve bearing fans — Old Part No. 4C548 — in 1982. The instructions mention two important items. (1) The installation must include a ground wire attached "...to the fan housing with a #10 self threading screw..." (2) "Dayton axial fans are designed to operate in any position."

Since the 4C548 unit is obsolete, I spoke with a Dayton agent who told me that the replacement fan — Part No. 4WT49 — is almost identical to the old unit. It has sleeve bearings, rotates at 1750 rpm, and produces an airflow of 55 cfm. All these specifications ensure quiet operation. Unfortunately, this fan is now made in China. Concerning Item No. 1, the description of the Chinese fan contains the identical text as the USA fan regarding the #10 or 3⁄16 in. grounding screw. This information is incorrect. The grounding screw threads have the following metric dimensions: M4 × 0.7. Not even close.

Concerning Item No. 2, two descriptions of the Chinese fan specify the following restriction: "Sleeve bearing units are horizontal shaft mount only." And, "Dayton sleeve bearing axial fans are designed to operate optimally in horizontal airflow position." I attribute this contrived, misleading, and bogus "sleeve bearing" limitation to a cheapened design, shoddy materials, and poor craftsmanship.

The three original USA fans are working fine. The current state of intentionally dumbed-down products inspired me to find three unused 4C548 backup fans online.

See: Glassdance_ToolsParts.pdf, p. 11.

Section 7

Sasaki "Isabelle" Crystal Brandy Snifters Inventory

As of October 2023, there are two boxes with 39 annealed snifters left over from the Glassdance build in San Diego, 1983. One box contains 23 glasses, and the other, 16 glasses. All glasses have been drilled and fitted with threaded glass stems. All are in various stages of having been cut and ground.

There are also two boxes with 48 brand new and unetched snifters contributed by Mr. Sasaki to the Chrysalis Foundation in 1985.

See: Glassdance_ToolsParts.pdf, pp. 8–9.

Section 8

Heidi Forster Playing Glassdance, 2007

From, *Musical Mathematics: On the Art and Science of Acoustic Instruments* (2010), p. 858, Plate 14.