

OPERATIONS & MAINTENANCE MANUAL

KENNETH WALKER OBSERVATORY AT DEMIGUEL
ELEMENTARY SCHOOL



NORTHERN ARIZONA UNIVERSITY

Department of Mechanical Engineering

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DOMES ROTATION

DOMES ROTATION OVERVIEW

Due to the nature of a wooden structure and the impossibility of a perfectly centric dome, the dome can become very difficult to rotate. Over time the bottom surface of the structure has become warped and some of the wheels may not make contact with the dome, eliminating their effectiveness. When this happens, some basic maintenance may need to be performed.

MAINTENANCE

The best gauge on whether or not the dome needs wheel alignment or wheel bearings need grease is the user's judgment. If the dome feels very difficult to rotate, do the following:

- a. Inspect the steel plates the centering and supporting wheels ride on. If they feel like they are dry and have no grease, add silicone grease to the surface and test the rotation again.
- b. Inspect the alignment of the wheels. This consists of checking both the support wheels and the centering wheels.

SUPPORT WHEELS

First, look at the support wheels the dome rides on. Look for any large gaps between the wheel and the bottom of the dome. If there are large gaps (1/8" or more) on more than four wheels, the wheel supports may need adjustment. To determine this, you need to check if the gaps are consistent throughout the rotation of the dome. If certain wheels have a gap at one position then after spinning the dome the gap goes away, this is fine. There is only an issue when the wheel never touches the dome surface throughout the full rotation of the dome. To fix a wheel that always has a gap:

To complete this task you will need the following tools and materials:

- 7/16" Wrench or Socket
 - Low Profile Jack
 - Shim Stock (washers, sheet metal scraps, ect)
1. Place the jack under the metal surface on the bottom of the dome next to the wheel. Raise the dome until there is about half an inch gap above the wheel.
 2. Use the wrench or socket to loosen the two nuts anchoring the support bracket down.
 3. Remove the bracket.
 4. Add a washer to each attachment point or place the shims under the bracket towards the rear of the support.
 5. Replace the support bracket and reinstall the nuts.
 6. Lower the dome back into normal position and check for a gap.
 7. If the wheel is still not touching repeat steps 4-6.

CENTERING WHEELS

When inspecting the centering wheels, having a gap between the wheel and dome is beneficial. The issue arises when one wheel does not have a gap and the wheel or set of wheels directly across the dome from it have no gap as well. In this case, the lack of a gap is causing the dome to bind up and be difficult to rotate. Before starting any adjustment, rotate the dome a full rotation and check if any of the other wheels might be binding up in the same fashion. If so, multiple wheels might need adjustment.

To complete this task you will need the following tools and materials:

- 7/16" Wrench or Socket
 - Low Profile Jack
1. Place the jack under the metal surface on the bottom of the dome next to the wheel. Raise the dome until there is no tension on the wheel from the steel strap (this shouldn't take too much lifting).
 2. Use the wrench or socket to loosen the two nuts anchoring the support bracket down.
 3. Slide the bracket towards you until there is a 1/16" to 1/8" gap between the wheel and dome.
 4. Tighten the two nuts holding the support bracket down.
 5. Lower the dome back into normal position and check for the proper gap.
 6. Rotate the dome and inspect for any binding. If there are still wheels in contact, more adjustment may be needed.

WHEEL BEARING MAINTENANCE

If the wheels do not need alignment, or alignment has been completed, regular maintenance of the wheel bearings may be required. To perform this task:

To complete this task you will need the following tools and materials:

- 9/16" Wrench or Socket
 - 1/4" Allen Wrench
 - Carburetor Cleaner
1. Place the jack under the metal surface on the bottom of the dome next to the wheel. Raise the dome until there is about half an inch gap above the wheel.
 2. Use the wrench or socket to loosen the two nuts anchoring the support bracket down.
 3. Remove the bracket.
 4. Take a 9/16" wrench or socket and remove the nut and lock washer.
 5. Take a 1/4" Allen wrench and remove the shaft
 6. Wipe down any dirt on the wheel and washers on both sides of the wheel that has now been removed.
 7. To access the bearing, pry off one of the metal retaining washers on the wheel.
 8. Once the bearing is removed, clean the dirt and old grease off with carb cleaner, as well as the inside metal surfaces of the wheel.
 9. After cleaning, grease the bearing with wheel bearing grease and reinstall into the wheel.
 10. Reapply the retaining washer onto the wheel.
 11. Reassemble the wheel, with one large washer on each side of the wheel and the lock washer and nut onto the shaft once threaded in.
 12. Replace the support bracket and reinstall the nuts.
 13. Lower the dome back into normal position and check for a gap.

REPLACEMENT PARTS

For reference, the dome structure weighs approximately 2,000 pounds, is 18 feet in diameter and uses 15 supporting wheels. If wheel replacement is needed, each supporting requires a minimum of 300 pound load rating. There are also 15 side alignment wheels that give the dome stability as the dome rotates. Specifications, as well as replacement information is included in the next few pages. Table 1 below gives necessary part quantities.

Table 1. Dome Rotation Parts List

Part Description	Quantity
Side Alignment Wheels	15
Vertical Support Wheels	15
Silicone Grease	(as necessary)
1/4" Washers	2 per mounting bracket



3" Supporting Wheels

PRODUCT SUMMARY	
Description:	Phenolic Wheel with Straight Roller Bearings
Quantity:	15
Location:	Mounted directly below wooden dome structure.
Purpose:	Support wheels.
Load Capacity:	400 lbs
Axle Dia.:	1/2"
Wheel Dia.:	3"
Wheel Thickness:	1-1/4 "
Wheel Material:	Phenolic
Wheel Durometer:	95A

VENDOR SUMMARY	
Vendor:	McMaster-Carr
Contact:	www.mcmastercarr.com
	562-692-5911
Part No.:	2315T525
Unit Price:	\$5.31



3-1/4" Side Alignment Wheels

PRODUCT SUMMARY	
Description:	Phenolic Wheel with Straight Roller Bearings
Quantity:	15
Location:	Mounted directly adjacent to the wooden dome structure.
Purpose:	Alignment wheels.
Load Capacity:	600 lbs
Axle Dia.:	1/2"
Wheel Dia.:	3-1/4"
Wheel Thickness:	1-1/2 "
Wheel Material:	Phenolic
Wheel Durometer:	95A

VENDOR SUMMARY	
Vendor:	McMaster-Carr
Contact:	www.mcmastercarr.com 562-692-5911
Part No.:	2315T51
Unit Price:	\$6.93

SHUTTER SYSTEM

SHUTTER SYSTEM OVERVIEW

The aluminum shutter door is constructed of two curved side beams made of 3 x 1 x 1/8 6063-T5 aluminum rectangular tubing and 3 x 1.41 x .170 6061-T6 aluminum channel for its cross beams. In total, the door weighs approximately 100 pounds, is 54" in width, 169" long and has an inner radius of 115". There are four vertical support wheels and four side alignment wheels that help move and center the shutter door as it moves up and over the dome.

A pair of 3/16" wire cables are anchored to a worm gear winch, which is attached by 3 bolts to the lower left inside of the door frame (left is designated by facing the shutter opening from inside the observatory). One cable is used to pull the viewing shutter open while the other cable is used to pull the shutter closed. The opening cable is run from the winch along the right side of the shutter opening through a series of guide pulleys, then around a large pulley at the top and back down to the bottom cross-member of the shutter. The closing cable is run from the winch into two small pulleys to the other side of the shutter opening, and is run straight to the second lowest cross-member on the shutter. Both of these cables are fixed to their respective cross-members with bolt-on cable clamps.

Figure 1 in the Shutter System Drawings section gives a schematic on the pulley and wire layout. Manufacturer instructions on how to attach the wire cabling to the winch is found in Appendix 2.

OPERATION

The worm gear winch can be operated two ways: the user can either crank the handle or attach an electric drill with a 1/2" chuck to the shaft of the winch. Turning the crank counter clockwise will open the shutter while turning it clockwise will close it. When opening the shutter the opening cable is pulled in and spooled on the right hand side of the winch reel. While the opening cable is being pulled in, the closing cable is being released allowing it to travel with the shutter as it opens. When closing the shutter the opposite occurs; the closing cable it is pulled in and spooled up while the opening cable is released and follows the shutter as it closes.

MAINTENANCE

Greasing of the gear system within the winch should occur once a year. Conduct a visual inspection of the winch to ensure that no dirt or grime is collecting on the gear teeth and that the wire rope is maintaining its knot around the winch. This visual inspection should be conducted every time before use. The user can also reference Section 4.4 for the manufacturer's recommendations.

Once a year, inspect the wire cabling to ensure that there is no visible wear or stretching of the cabling. If wear or stretching is noticed, replace wire rope immediately.

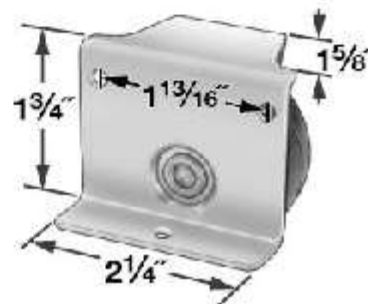
REPLACEMENT PARTS



2" Shutter Wheels

PRODUCT SUMMARY	
Description:	Concealed-Mounted Rigid Caster, 2" x 7/8", Polypropylene Wheel
Quantity:	4
Location:	Mounted within the shutter door frame on exterior channels.
Purpose:	Allows the shutter to move along exterior dome track.
Load Capacity:	100 lbs
Mounting Holes Dia.:	3/16"
Wheel Dia.:	2"
Wheel Thickness:	7/8"
Wheel Material:	Polypropylene
Wheel Durometer:	93A

PURCHASE SUMMARY	
Vendor:	McMaster-Carr
Contact:	www.mcmastercarr.com
	562-692-5911
Part No.:	9994T91
Unit Price:	\$4.38





3-1/4" Double Guide Pulleys

PRODUCT SUMMARY	
Description:	Mounted Pulley for Wire Rope, with Double Galvanized Iron Pulley, 3-1/4" OD
Quantity:	3
Location:	Pulley blocks mounted around the left hand arc of shutter door opening.
Purpose:	Provides bi-directional movement of the wire cable as the winch is being operated.
Load Capacity:	Not Rated
Mounting Holes Dia.:	3/4"
Rope Dia.:	1/4"

PURCHASE SUMMARY	
Vendor:	McMaster-Carr
Contact:	www.mcmastercarr.com
	562-692-5911
Part No.:	3074T35
Unit Price:	\$37.74



3/16" Wire Rope

PRODUCT SUMMARY	
Description:	Crown Bolt 3/16in. Wire Rope Plain
Length:	50 FT
Location:	Secured to the door, around the pulleys and ends at the winch.
Purpose:	Helps lift the shutter around the dome.
Load Capacity:	1,050 lbs
Rope Dia.:	3/16"
Coating:	Galvanized

PURCHASE SUMMARY	
Vendor:	The Home Depot
Contact:	www.homedepot.com 928-556-1529
Part No.:	MFG Model#: 11920
Unit Price:	\$0.48/FT



2" Guide Pulleys

PRODUCT SUMMARY	
Description:	Zinc-Plated Steel Pulley Block for Wire Rope, with Zinc-Plated Pulley, 2" OD
Quantity:	2
Location:	
Purpose:	
Load Capacity:	600 lbs
Mounting Holes Dia.:	3/16"
Rope Dia.:	3/16"

PURCHASE SUMMARY	
Vendor:	McMaster-Carr
Contact:	www.mcmastercarr.com 562-692-5911
Part No.:	3099T34
Unit Price:	\$6.39



Worm Gear Winch

PRODUCT SUMMARY	
Description:	Dutton-Lainson Worm Gear Winch, bronze, WG1500
Quantity:	1
Location:	Mounted against the lower right hand side of the shutter opening.
Purpose:	To lift the door up and over the dome in a controlled loop.
Load Capacity:	50lbs minimum – 800lbs maximum
Mounting Bolt Type:	3/8" (M10) with washers and lock washers
Drum Dia.:	1-1/2"
Gear Ratio:	30:1
Wire Rope Dia.:	3/16"

PURCHASE SUMMARY	
Vendor:	Dutton-Lainson Company
Contact:	www.dutton-lainson.com
Part No.:	WG1500
Unit Price:	\$84.99

MANUFACTURER SUMMARY	
Manufacturer:	Dutton-Lainson Company
Contact:	www.dutton-lainson.com 402-462-4141
Part No.:	WG1500
Offer:	Replacement parts, warranty, manufacturer's data

SHUTTER SYSTEM DRAWINGS

The manufacturing drawings for the shutter can be found in Appendix 1.

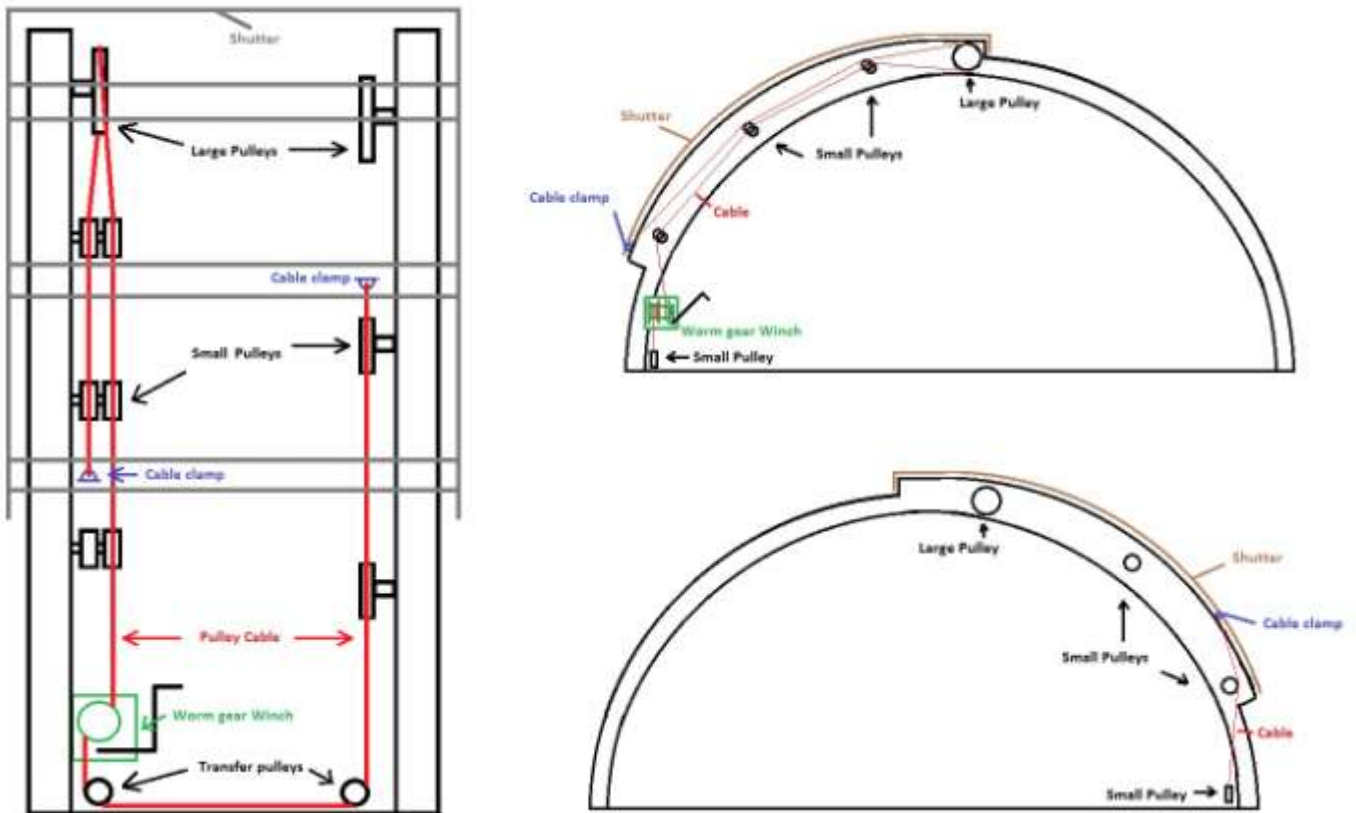


FIGURE 1 –BASIC LAYOUT OF SHUTTER PULLEY SYSTEM AND CABLE ROUTING

CLAMPING SYSTEM

CLAMPING SYSTEM OVERVIEW

There are two clamp systems on the telescope, the clutch clamp and the upper clamp. The lower clutch clamp connects the telescope to the drive system. Figure 2 below shows the locations of both the upper and clutch clamp.

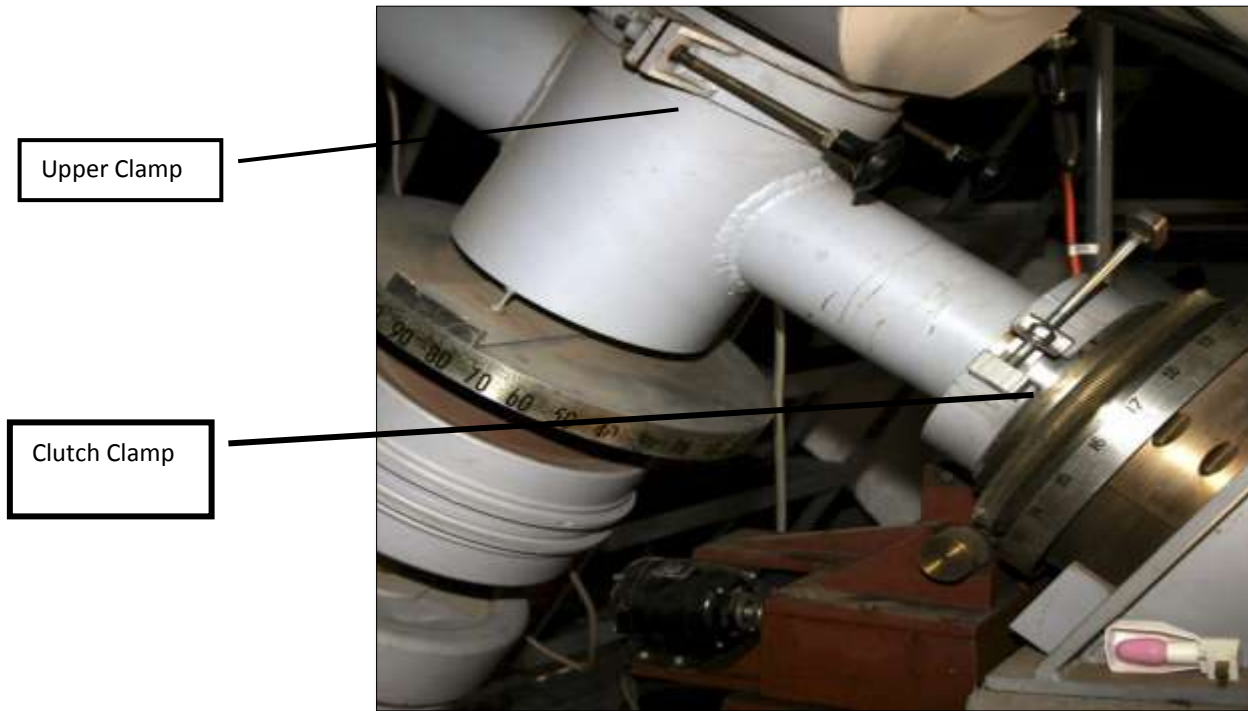


FIGURE 2 – CLAMP LOCATIONS

The clutch clamp is composed of an open ended steel ring with a fibrous backing that makes direct contact with the telescope mount. On the ends of the ring there are two tabs with two steel stabilizing blocks that lock and tighten via a steel rod. The steel rod has a welded bolt that pulls the steel ring together locking the telescope in place. The steel rod is 10" in length and 3/8" in diameter. 1-1/2" of the rod is composed of course threads (16 threads per inch).

The upper clamp has two locations that can tighten to engage the clamp. One of the locking spots has been bolted down with a 3/8" diameter 1-3/4" long bolt. This bolt is fine threaded (24 threads per inch). There are also washers for spacing which allows the clamp to distribute the forces evenly across the telescope. The second locking spot allows for a 10" long 3/8" diameter steel rod with a handle to tighten the clamp. This rod also contains the same fine thread pattern.

Pictures of the upper clamp can be found in the Maintenance section. Figure 4 in the System Assembly Drawings Section shows the lower clamp.

OPERATION

The clutch clamp is simply operated by turning the tee handle clockwise to tighten and counterclockwise to loosen.

The upper clamp is operated by turning the knob counter-clockwise to loosen and clockwise to tighten.

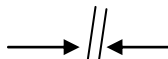
MAINTENANCE

If the upper clamp or clutch clamp feels difficult to turn, apply some grease to the threads.

For the upper clamp, the tightening bolt will need to be adjusted as the system expands and contracts to the season's temperature fluctuations. Use a 9/16" wrench to either loosen or tighten the bolt accordingly. It is important that the position of the bolt leaves equal spacing between both locking supports. See the picture below for a basic representation of proper spacing.



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REPLACEMENT PARTS

Part Description	Quantity
3/8" Washers	3
3/8" Dia. By 1-1/2" Fine Thread Bolt	1
Grease	(as necessary)
9/16" Wrench	1

SYSTEM ASSEMBLY DRAWINGS

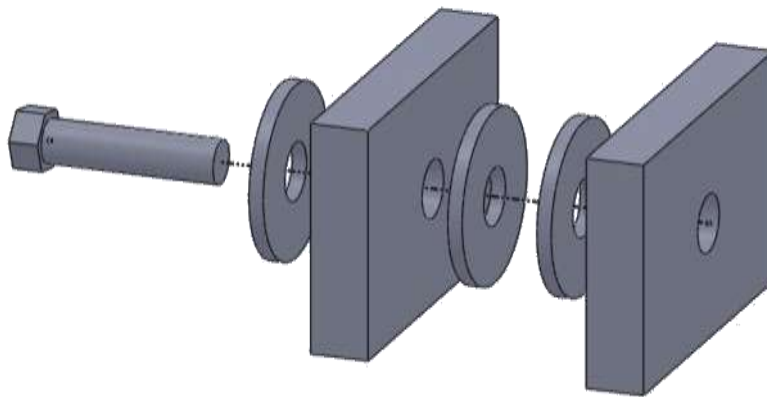


FIGURE 3 – BASIC REPRESENTATION OF THE WASHERS USED IN THE UPPER CLAMP

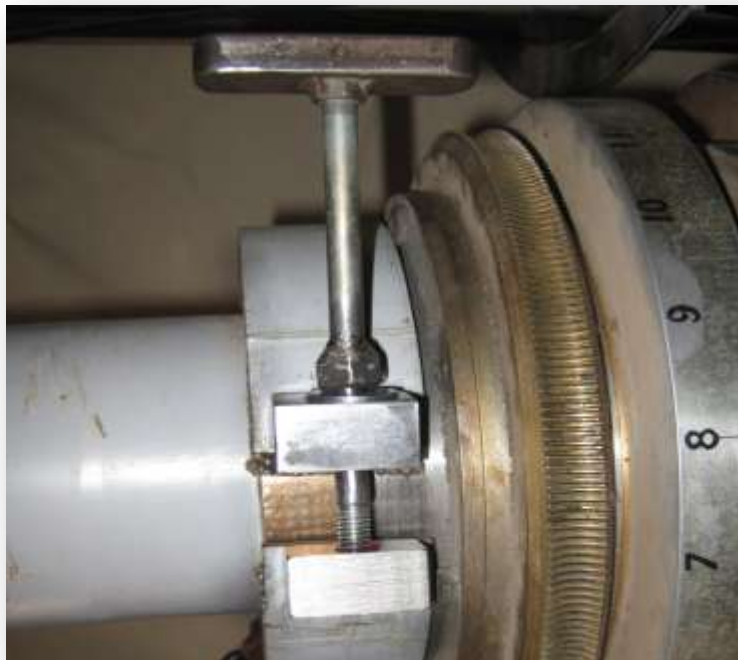


FIGURE 4 – ILLUSTRATION OF STEEL BLOCKS USED ON LOWER CLAMP

APPENDIX 1

Manufacturing drawings for aluminum shutter.

APPENDIX 2

Worm gear winch manufacturer instructions.