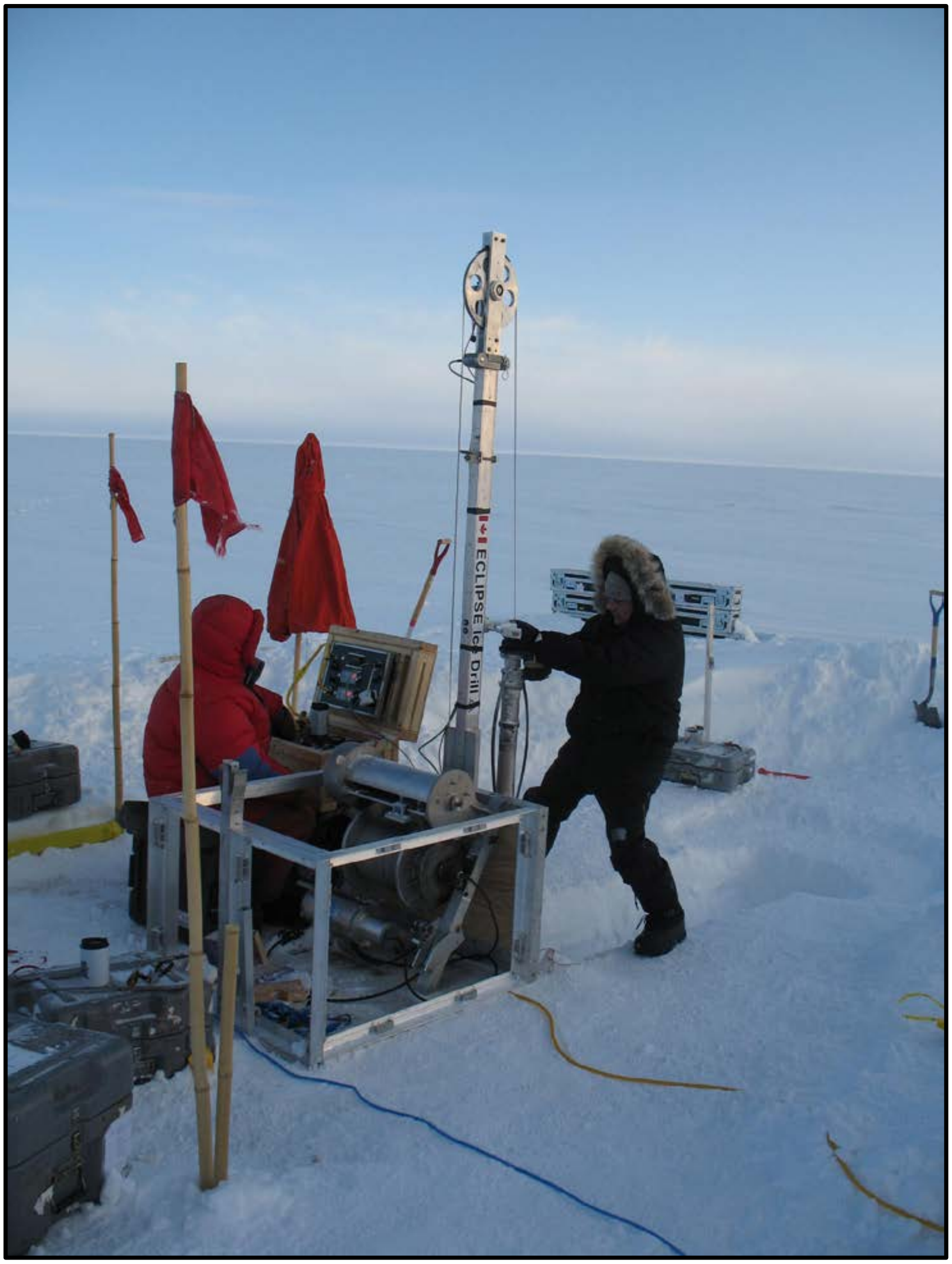

ECLIPSE DRILL
Operations and Maintenance Manual

July 23, 2019

U.S. Ice Drilling Program
University of Wisconsin-Madison Space Science & Engineering Center

Table of Contents

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1.0 PURPOSE

The objective of this document is to provide the operator a working knowledge of how the Eclipse Drill is assembled, tuned and operated. This document outlines the assembly instructions, operating instructions, troubleshooting, tips, tools and spares, extended mast drill configuration, wet drill modifications, and a level wind assembly.

2.0 SCOPE

This Operator's Manual applies to the Eclipse Drill maintained and operated by the Ice Drilling Program (IDP).

3.0 REFERENCES

- 8512-0007, Eclipse Failure Mode and Effects Analysis (FMEA) – Table
- 8512-0008, Eclipse FMEA - Summary
- 8512-0009, LCI90i Quick Setup Guide
- 8512-0010, LCI90i User Manual
- 8512-0011, Eclipse Control Box Wiring Diagram
- 8512-0012, Eclipse Drill Readout Wiring Diagram

4.0 DEFINITIONS

- IDP – U.S. Ice Drilling Program, formerly IDDO.
- QAS – Quality Assurance and Safety group.
- SSEC – University of Wisconsin-Madison, Space Science and Engineering Center.

5.0 RESPONSIBILITIES

- IDP Management is responsible for ensuring that operators run the Eclipse Drill in accordance with this Operator's Manual.
- SSEC QAS is responsible for ensuring that this document is created, reviewed, approved, maintained and updated per appropriate procedures.
- IDP Engineering is responsible for ensuring that the content of this document is correct and up-to-date.
- Eclipse Drill Field Management and Staff are responsible for ensuring this manual is followed.

6.0 RECORDS

None

7.0 CONTENTS

The following contains the Icefield Instruments, Inc. User Manual for the ECLIPSE Ice Coring Drill; Rev. 6 dated February 2016. This manual has been edited with information specific to the IDP version of the system.

8.0 ASSEMBLY INSTRUCTIONS

8.1 General Notes

- Unless otherwise noted, all the hardware/fasteners on this drill are of Imperial dimensions (fractional inches). Please refrain from using metric tools as damage to the unit may result.
- Many fasteners on this drill are secured using Loctite (a cyanoacrylate thread- locking compound). Red (permanent) Loctite is used, for example, on the screws holding the plastic flights onto the inner barrel. Blue (removable) Loctite is used on frame fasteners. If you suspect that a screw or bolt is not rotating because it has this material applied to it, you can heat the part with a torch to soften the locking compound. Take care not to damage plastic and/or rubber components.
- Frame fasteners are all stainless steel – where they attach to load-bearing aluminum parts, there is often a steel Helicoil® thread insert used to strengthen the joint and to avoid thread wear on the aluminum. If you see evidence of thread damage on a fastener (the inserts are harder than the fastener), please replace the fastener as soon as possible.
- Fasteners mating to Helicoil® inserts should be treated with anti-seize compound (thread lubricant).
- Assembling a large machine with many close-tolerance parts can be made much easier if fasteners are left a bit loose until all the fasteners are in place.

8.2 Winch Frame Assembly

Reference Frame Figure 1 below shows the general layout of the drill when assembled. The drill shown consists of the short boom configuration in the horizontal position.

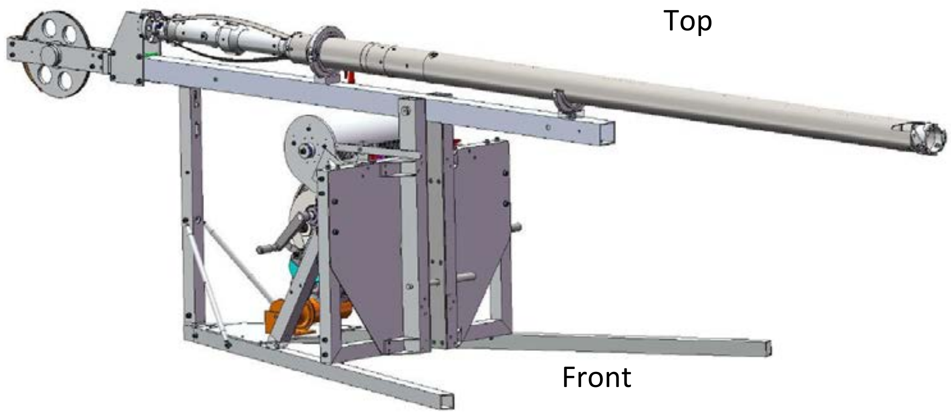


Figure 1. Reference Frame

To have a base onto which to assemble other components it is suggested that the Winch Frame be assembled first, Figure 2.

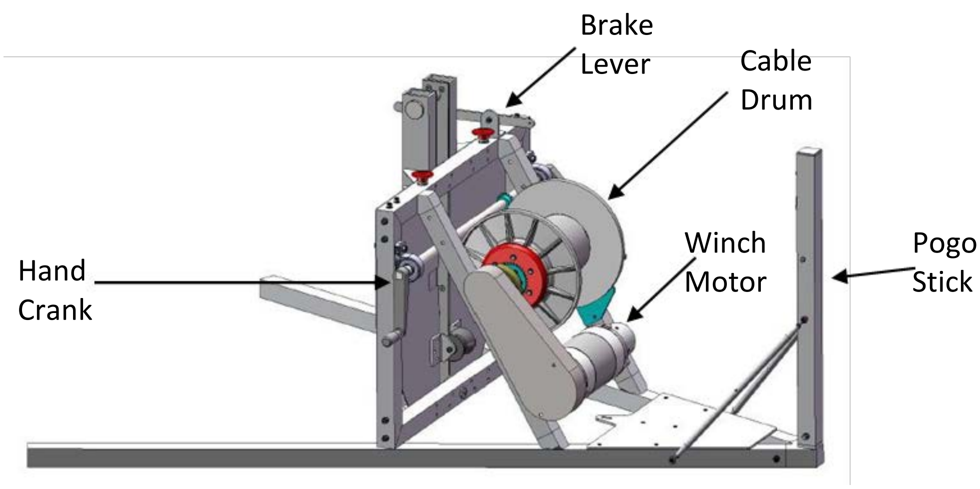


Figure 2. Winch Frame Assembly

8.2.1 Short boom configuration overall dimensions

Approximate weight for the drill system including spare parts and shipping cases is 1500 lbs., Figure 3.

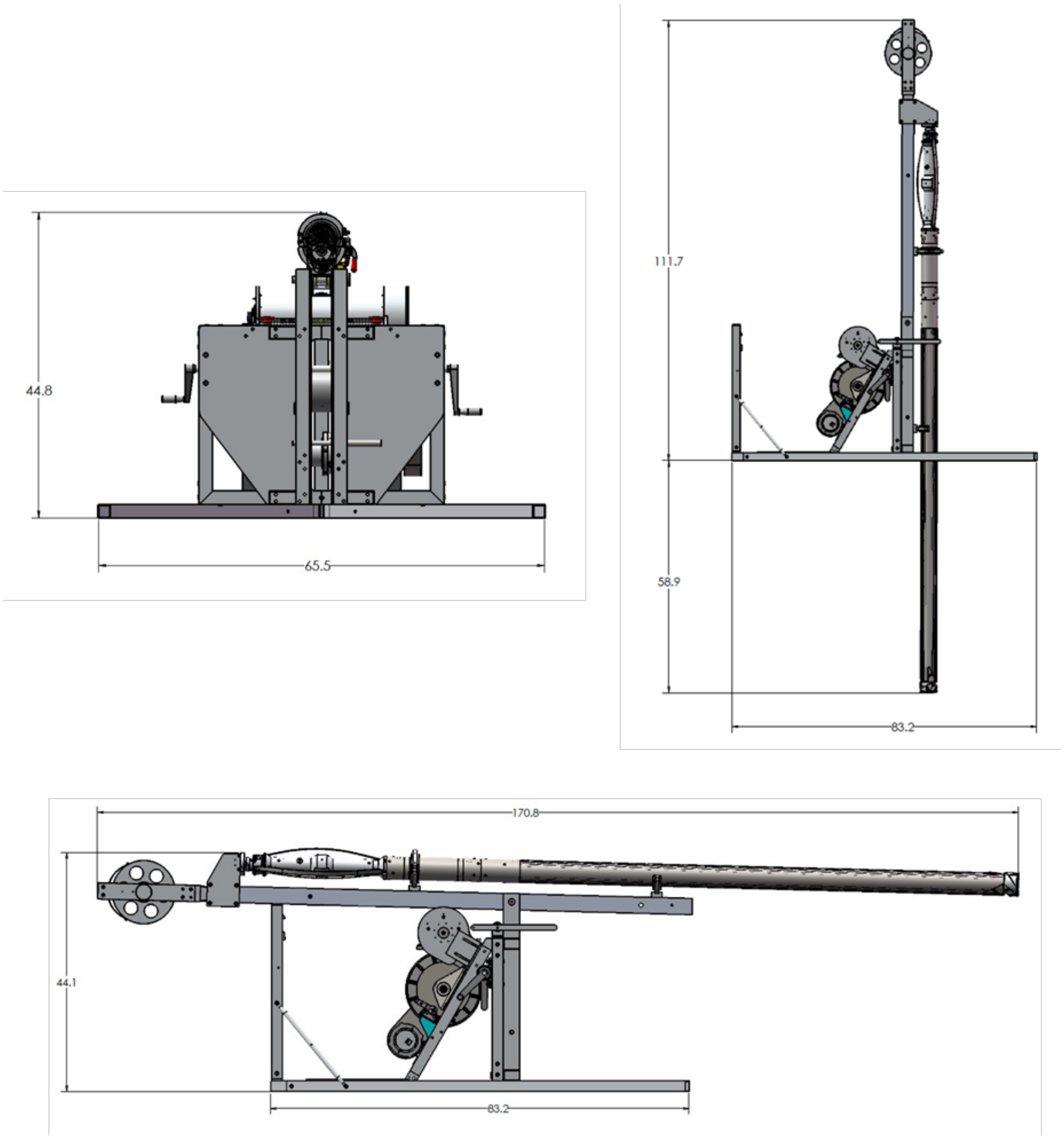


Figure 3. Short boom configuration.

8.2.2 Bare Frame Assembly

All frame components are stamped with letters to aid in assembly. Each component should have a corresponding letter on each of its mating components.

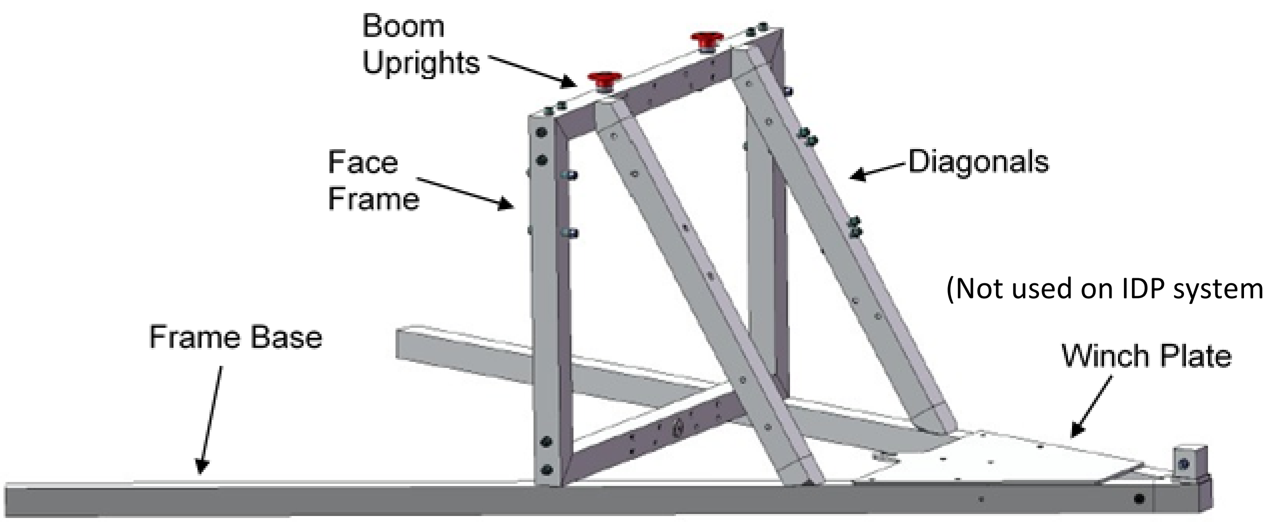


Figure 4. Bare Frame Assembly

First Assemble the Frame Base, Figure 4. This consists of two long base frame members and one A-frame block. The Face Frame can then be assembled and mounted to the frame base. Next, the diagonal frame members can be mounted. Lastly, the Winch Plate can be mounted to the back of the frame base (some models will not include a base plate).

8.2.3 Mounting the Cable Drum and Winch Motor

The winch motor and cable drum can now be mounted onto the frame. The input shaft of the cable drum should be on the right side of the winch, as shown. Figure 5 shows two chains installed. The right-hand chain (shown in foreground) is used to drive the level winder. If the drill has no level winder, then omit this chain. The second chain (the bottom is just visible in the photo) is for the hand crank. This second chain should always be installed.

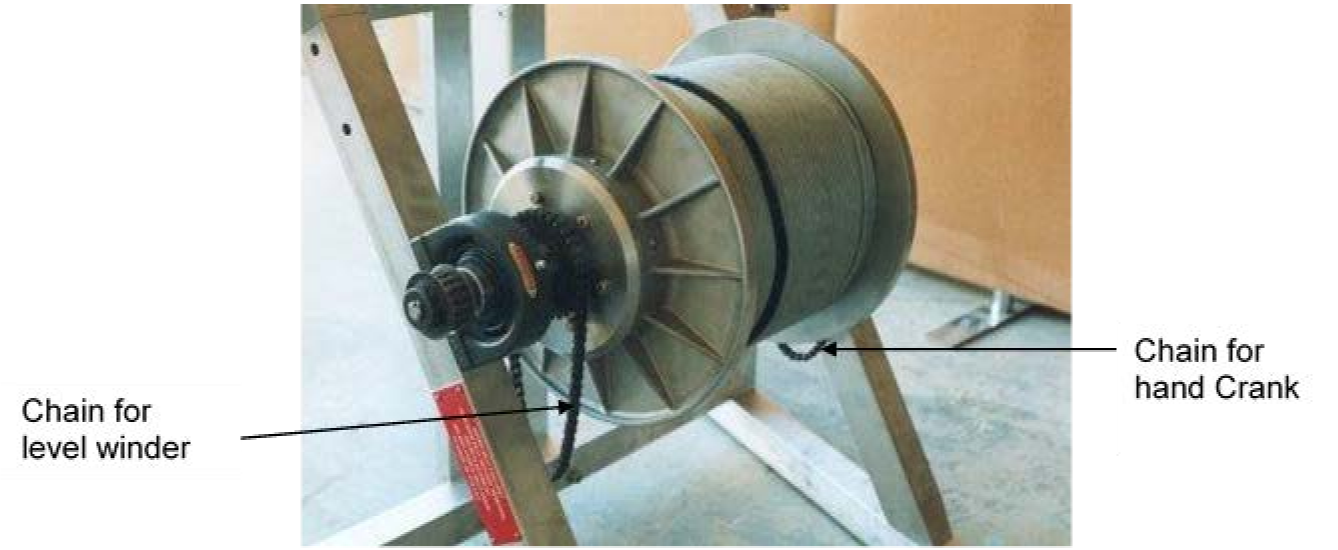


Figure 5. Winch Cable Drum

Mount the winch Motor to the right diagonal frame member. Before tightening the mounting fasteners for the winch motor, attach the drive belt to the motor and drum. Take care that the belt is not stretched and/or twisted when installed. The belt tension should be such that about 5mm deflection results from modest thumb pressure, Figure 6. Also ensure that the two pulleys are lined up so that the belt runs perpendicular to the shafts.

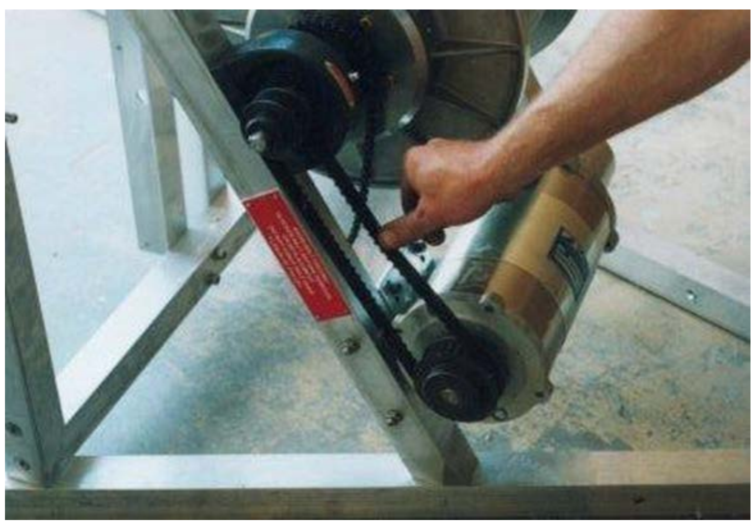


Figure 6. Installing the Drive Belt

Attach the belt cover plate on the two posts attached to the winch motor using the supplied thumb screws, Figure 7.

Figure 7. Installing the Cover Plate

8.2.4 Mounting the Pogo Stick

Mount the Pogo stick to the frame base, Figure 8. Also mount the Pogo Supports. The pogo supports can be lengthened or shortened by turning the support when its ends are held in place. In this way the pogo stick can be stiffened if required.

Figure 8. Pogo Stick Installation

8.2.5 Mounting the Boom Supports and Face Plates

Mount the Face Plates and Boom Supports to the front of the Face Frame, Figure 9. Also insert the Boom Locking Pin into the bottom of the boom supports. It is suggested that this pin be tied to the frame or another object using the supplied cord. This will avoid dropping the pin down the drill hole or losing the pin.

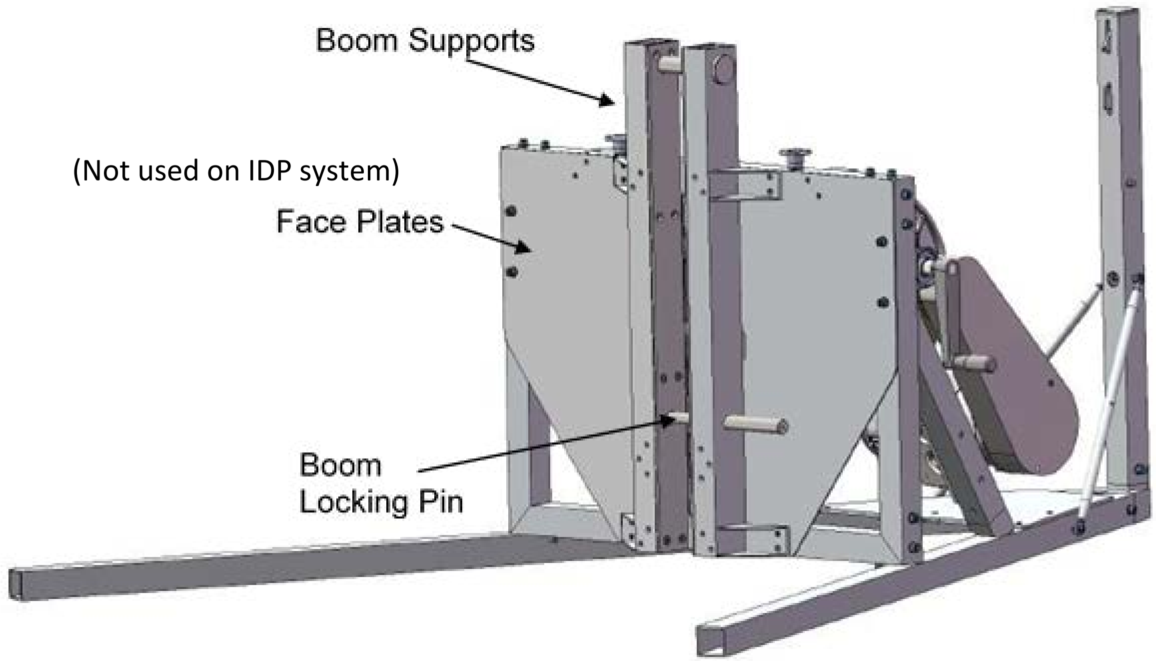


Figure 9. Installing the Boom Supports

8.2.6 Mounting the Hand Brake and Hand Crank

Attach the Brake Assembly (Brake caliper and Brake Handle attached with cable) to the frame as shown in Figure 10. Attach the bearing blocks for the hand crank on the upright members of the face frame. The Crank Shaft will have to be removed from one of the bearing blocks pass the chain from the cable drum. It is recommended that the crank handles only be installed if problems with raising the drill occur. The small gear on the axle should be positioned to line up with the large gear on drum axle (next to the brake disk).

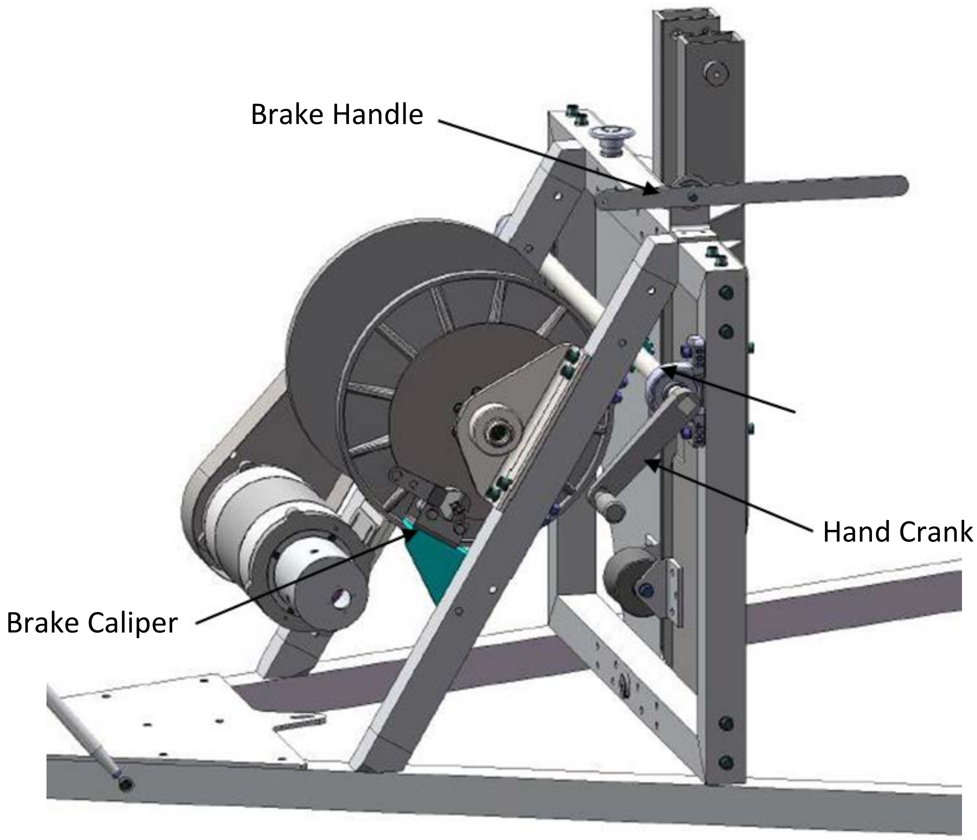


Figure 10. Brake and Crank Installation

8.3 Level Winder Assembly

The Level Winder Assembly is optional. If your drill does not come with a level winder, skip to the next section.

The Level Winder Accessory Module for the Eclipse II Ice Coring Drill System's winch provides is a virtually self-contained mechanical system for evenly wrapping electromechanical cable onto the drum of the Eclipse II winch. The Level Winder is shipped fully assembled, lubricated, and ready for installation, Figure 12.

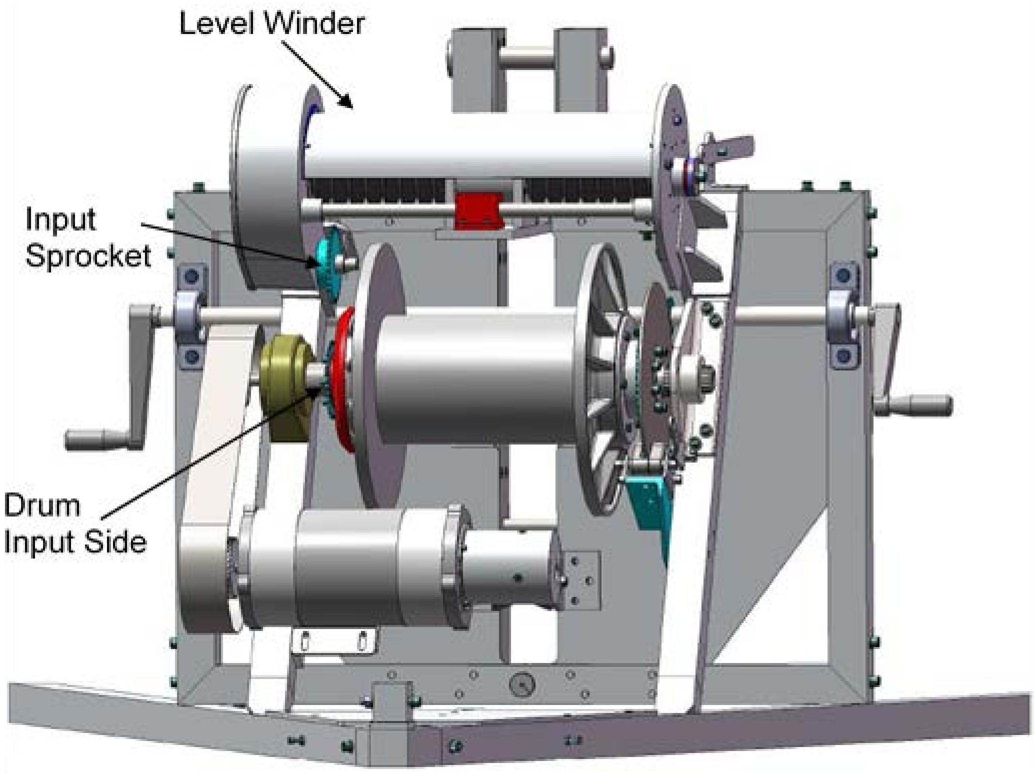


Figure 11. Installation of Level Winder

Ensure that the drive-chain for the Level Winder has been previously attached to the winch drum at the input side. If not in place already, some disassembly will be required to fit it now.

Mounting the Level Winder onto the frame is best done with two people. Lift the level winder into place, and tip the chain sprocket end downward to loop the drive chain over the input sprocket. Then mount the Level winder in place using the supplied 3/8” X 2” spring pins. Note mounting nuts and bolts may be provided with the drill. If so these can be used to secure the level winder, but it is suggested that spring pins are used to locate one side of the level winder to allow for movement between the level winder and frame.

8.4 Boom Assembly

This section outlines the assembly of the standard boom configuration.

If your drill has a long boom configuration, refer to section 11.1. The IDP system is not currently outfitted with the long boom configuration.

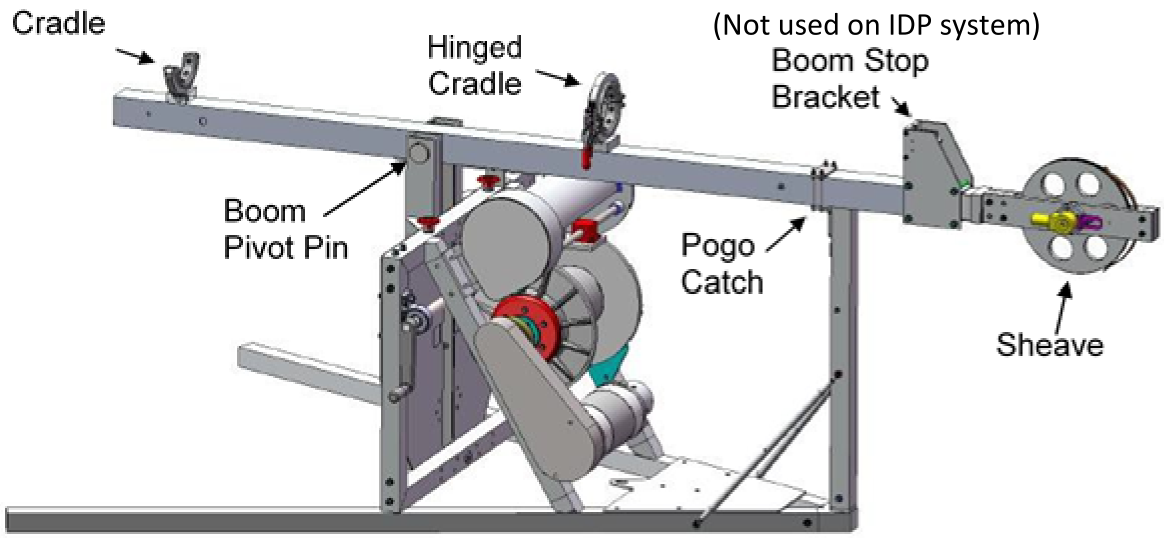


Figure 12. Short Boom Assembly

Mount the Boom onto the frame using the Boom Pivot Pin. The Boom Pivot Pin is secured with a supplied hairpin style cotter pin.

Note: The Boom Stop Bracket is not currently used on the IDP system; disregard this instruction. Mount the Boom Stop Bracket at the back end of the boom, as shown in Figure 12. Do not over tighten the mounting screws for the bracket. This will deform the boom and cause interference with the sheave.

Mount the cradles as shown in Figure 13. The hinged cradle is located closer to the sheave. Also mount the Pogo Catch as shown. Ensure that it is properly located to catch the pogo stick and prevent the boom from swinging into a vertical position.

8.5 Control System

Both of the IDP Eclipse drills are equipped with custom built control and read-out boxes. The IDP version control boxes feature simplified electronics which have proven more reliable in the field than the control boxes that originally came with the drill systems. The control box and read-out boxes ship in two separate water tight cases that nest together during use, Figure 14. Both cases are also water tight with the lids open.

- A 115V power feed is required to run the system. The drill has been run on a generator as small as a 2 kW, although it is recommended to use a 3 kW or larger to ensure full performance.

- Inspect all cables and connectors before hooking them up. Make sure the connector housings/strain reliefs are tight and the cables are free of nicks or damage.

Figure 13. IDP Version Control System

The winch and drill have separate speed, direction controls and amp meters. The outputs are not current limited, however the system is fused at 15 amps, so it is up to the operator to monitor the current draw by each motor and keep it within a safe range, Table 1.

Table 1. Winch and Drill Motor Current Limits

	Continuous Power	Peak power (short duration)
Winch motor	13 amps	15 amps
Drill motor	1.8 amps	5 amps

8.5.1 Control Box Setup

All cables are hardwired to the control box faceplate and are clearly labeled. To minimize the possibility of operator injury or damage to the equipment, confirm the power is turned off or disconnected before installing or removing cables. The black cable labeled “Winch” connects to the back end of the winch motor, labeled “Winch Motor Cable Connector” in Figure 15, and the other black cable labeled “Drill” connects to the end of the end of the winch drum shaft, labeled “Drill Cable Connector” in Figure 15. The cables each have different connectors, so it is not possible to plug them in to the wrong place. The yellow cord with the female cord end should ONLY be connected to the read-out box. It is fused at 1 amp (fuse is located on the faceplate), and therefore is not rated to run other equipment. If other 115v equipment needs to be plugged in, it should be put in line before the control box. Before powering on the control box, by either plugging it in or by resetting the E-stop, confirm both the drill and winch direction selector switches are in the center position and the speed knobs are at 0.

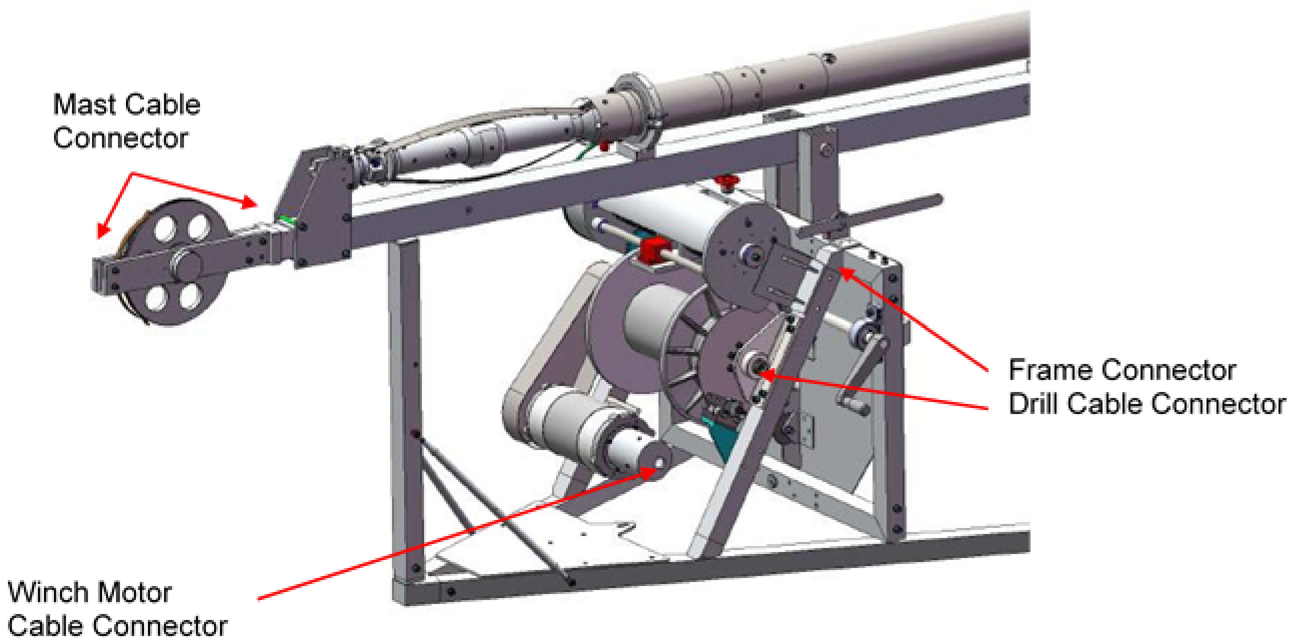


Figure 14. Drill Cable Connection Locations

8.5.2 Readout Box Setup

Unlatch the case lid, pull the two removable hinge pins, Figure 16, and remove the cover. The hinge pins are on lanyards so they don’t get lost, but it is recommended to reinsert them into the hinge for safe storage. The readout can then be placed in the control box case lid and held in place with the elastic cord, Figure 14.

Figure 15. Readout Box Removable Hinge

The yellow power cord can be plugged into any standard 115v outlet. However, a receptacle has been provided on the control box specifically for this. There are two receptacles on the faceplate, one for the cable pay out encoder and one for the load pin. Each readout box is calibrated for use with a specific load pin, so be sure to verify you are using the correct load pin. If the readout boxes are swapped out during operation, it is recommended to also change the load pin to maintain proper calibration. Plug the load pin cable into the receptacle labeled "LOAD PIN" and install the load pin as shown in Figure 16. Be sure to push the load pin keeper towards the load pin as you are tightening the two screws. It is important that there is as little rotational play as possible when the pin is installed to maximize accuracy of the system. Connect one end of the cable with plugs on both ends to the encoder and the other end to the "ENCODER" receptacle on the readout box. Secure the two cables to the tower using the included Velcro straps.

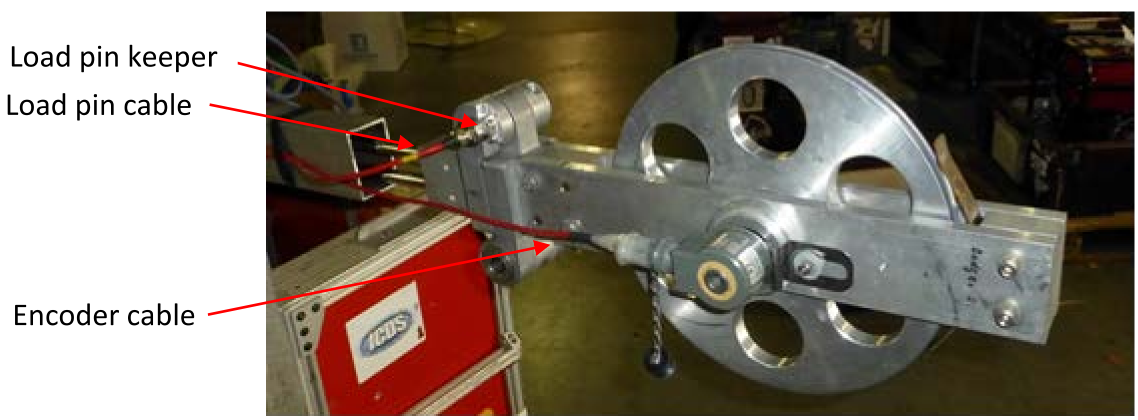


Figure 16. IDP version of the Eclipse Drill sheave

8.5.3 Winch Cable & Drill motor wiring

The connectors internal to the drill (between the drill motor assembly and the bottom of the anti- torque section), the connector on the end of the winch drum shaft, and the connector on the end of the drill cable coming from the control box are all wired the same. The pin out is as follows:

The cable plug is an Amphenol MS3116F8-4S (or MS3116E8-4S if there is no strain relief) connecting to an MS3112E8-4P receptacle.

Drill Power Cables	
Pin	**Function**
A	Drill Power -
B	Drill Power -
C	Drill Power +
D	Drill Power +

8.5.4 Winch Motor Cable

The black Winch motor Cable is hard wired to the control box on one end and has an 8 pin Amphenol connector, PT06E16-8S-SR, at the other end. The cable connects to the back of the winch motor, Figure 15.

Winch Motor Cable	
Pin	**Function**
A	Power +
B	Power +
C	N/C
D	N/C
E	Power -
F	Power -
G	N/C
H	N/C

8.5.5 Encoder Cable

The Encoder cable is red colored with 6 pin Amphenol connectors at either end. The cable connects between the encoder on the crown sheave, Figure 16 and the readout box. Velcro straps are provided to secure the cable to the mast. Ensure that all cables are secured so as to not get damaged during drill operation.

The plug on the readout box end of the cable is an MS3112E10-6P, mating with an MS3102F10-6S socket on the readout face plate. The plug on the encoder end of the cable is an MS3106A-14S-6S.

Encoder Cable		
Pin	**Readout Box Connector**	**Encoder Connector**
A	Sig. A	Com
B	N/C	+ 12v
C	+ 12v	N/C
D	Com	Sig. B
E	Sig. B	Sig. A
F	N/C	N/C

8.5.6 Load Pin Cable

Each load pin comes supplied with an attached red colored cable. Verify the number on the cable matches the load pin number on the readout box you are connecting it to. Connecting the wrong load pin to a read-out box will not damage the load pin or read-out box, but the calibration may be off. After installing the load pin, as shown in Figure 16, run the cable down the side of the tower with the encoder cable and secure it in place with the Velcro straps.

The plug on the readout box end of the cable is a PT06A10-6S, mating with a MS3112E10-6P socket on the readout face plate.

Load Pin Cable	
Pin	**Function**
A	S -
B	GND
C	V +
D	V -
E	S +
F	N/C

8.6 Winch Cable Set-Up

Before the winch cable is terminated at the drill (as described in section 8.7.1), it is recommended that the winch cable be routed through the drill. The IDP system includes the Level winder, and it is also suggested that the level winder be synchronized with the cable on the drum. To avoid bad cable layers wrap, it is a good idea to lay the cable out all the way on the ice and get some heavy people on a sled to take a "ride" (using their feet as brakes) back to the winch to ensure that tension is good and even; a shim can be added at the first wrap. The cable should be perfectly wrapped around the drum with no layers diving under the underneath one, Figure 18.

Figure 17. Installing the Winch Cable on Drum

8.6.1 Level Winder Synchronization

If a level winder is provided with the drill, it is important that it be synchronized with the cable on the Winch Drum.

With the cable wrapped onto the drum (if necessary, tidy this up manually) apply electrical power to the winch drive and slowly pay-out a small length of cable from the drum while noting in which direction the shuttle is moving.

Caution: Ensure that the cable is secure so that a large amount of cable does not spring from the drum.

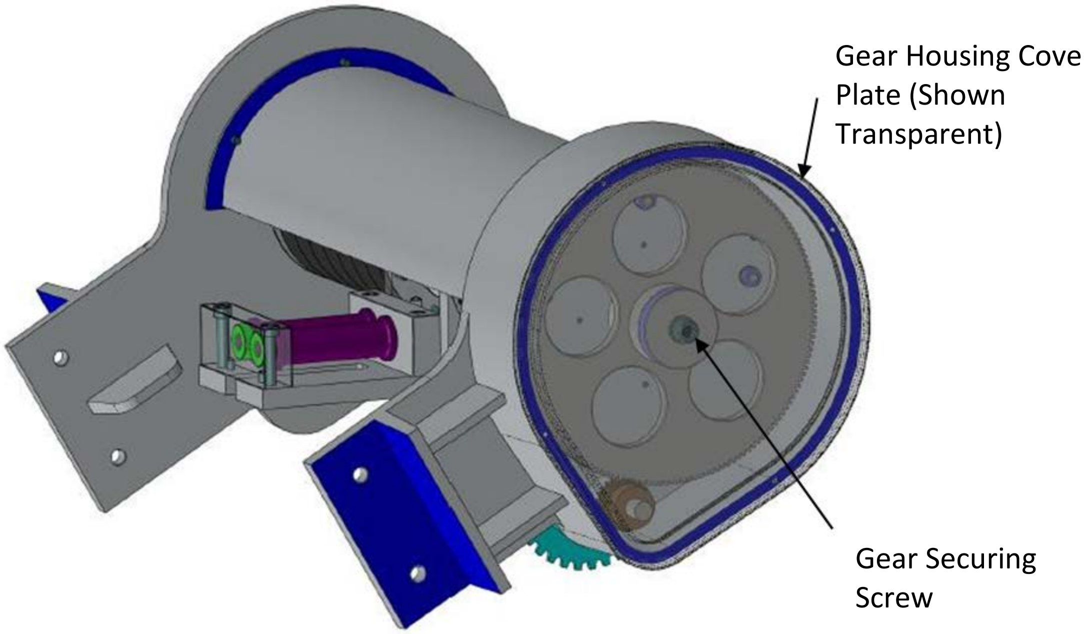


Figure 18. Level Winder Assembly, Gear Side

Remove the gear-housing cover plate. Loosen, but do not remove the socket head cap screw at the center of the large gear, Figure 19. This allows the reverser screw to rotate independently of the gear.

With everything else stopped, rotate the reverser-screw by inserting a hex-wrench into the socket head cap screw on the idler side of the reverser screw, Figure 20.

Rotate the reverser screw to move the gap between the Level Winder Fairlead Rollers directly above the winch cable and so that the Level Winder Shuttle is moving in the same direction as the Winch Cable.

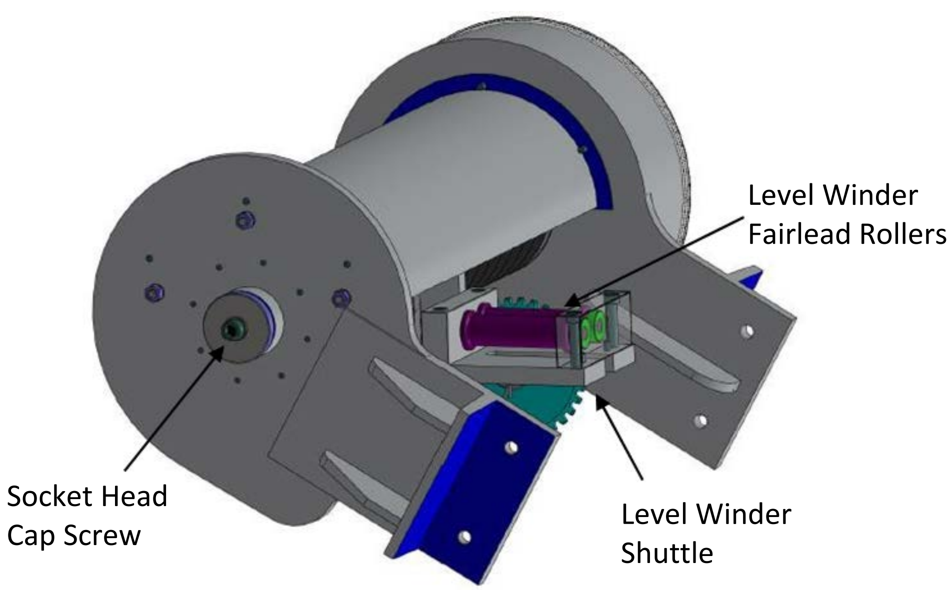


Figure 19. Level Winder Assembly, Idler Side

Once set, lock the synchronization by holding the reverser screw at the non-gear end with a hex-wrench, while tightening the hex-socket bolt at the gear end. Replace the gear-box cover plate.

After the initial (loosely wound and disturbed) cable has been spooled out, it may be necessary to re-synchronize the level wind, but this should only amount to a small positional adjustment.

8.6.2 Routing the Winch Cable

Using the control panel, slowly turn the winch cable drum (in the down position) to dole out a few meters of cable.

Caution: Ensure that the cable is secure so that a large amount of cable does not spring from the drum.

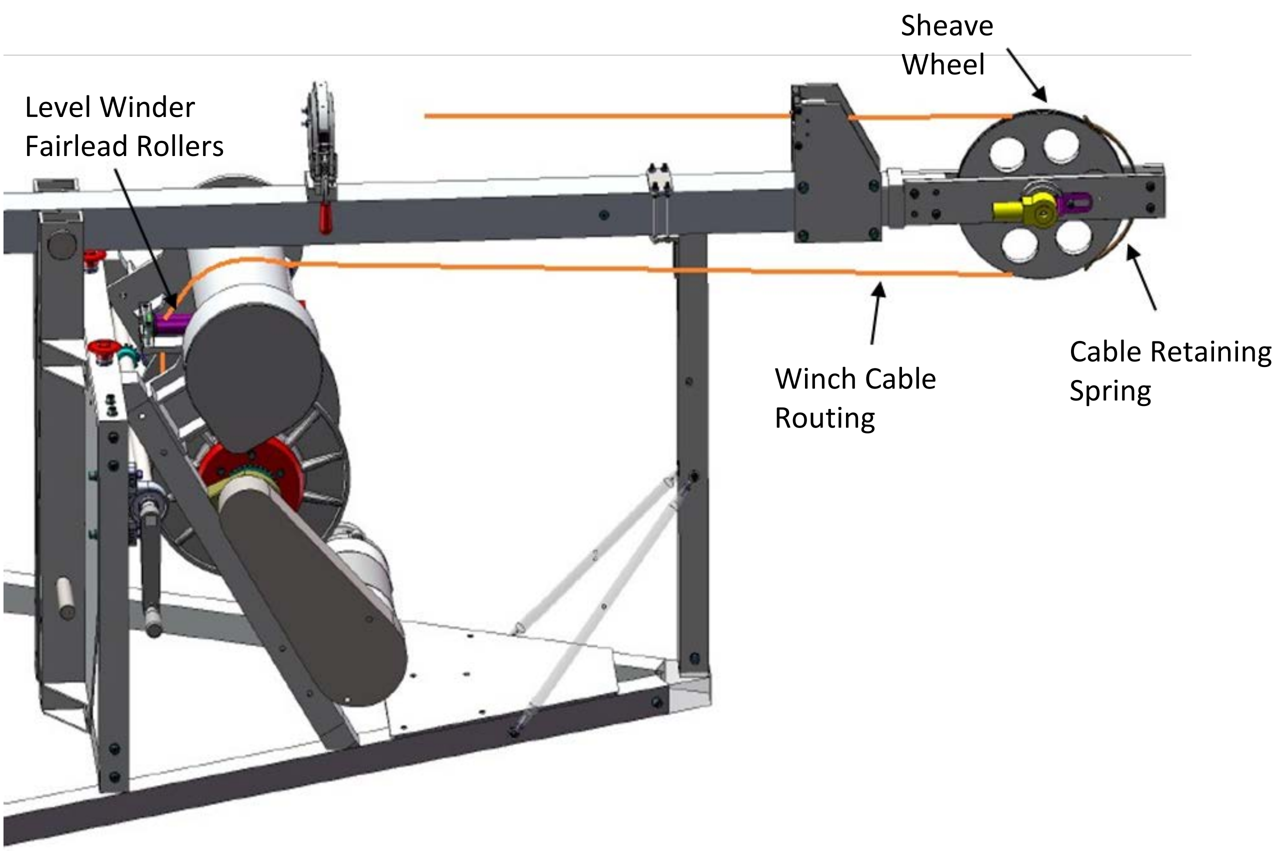


Figure 20. Winch Cable Routing

Route the winch cable as shown in Figure 21. The cable is routed through the Fairlead rollers on the level winder (if a level winder is included with the drill). The winch cable is also routed over the level winder cover and around the Sheave Wheel. Ensure that the cable is secure in the groove of the Sheave Wheel and held in place by the Cable Retaining Spring.

8.6.3 Routing the Winch Cable if Cable is Already Terminated

It is suggested that the winch cable be routed through the Level Winder and Sheave before terminating the cable at the drill (as described in section 8.6.2). If the cable has already been terminated it is still possible to route the winch cable.

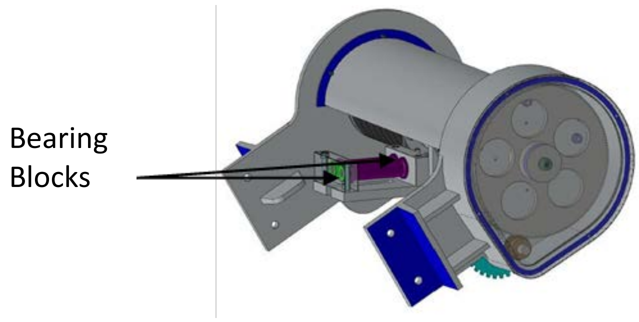


Figure 21. Fair Lead Bearing Blocks

The cable can be routed through the Fairlead Rollers in the Level Winder by loosening the two pairs of bolts which hold the two bearing blocks at the ends of the rollers, Figure 22. These bearing blocks are also held in place by a pair of short (hidden) dowel pins which accurately locate the blocks. It is possible to loosen the innermost blocks' bolts enough to lift the block off of the dowel pins, and tilt it enough to free the front block and one of its rollers. Disassembled this far, it is possible to thread the cable into the slot and reassemble the fairlead roller unit.

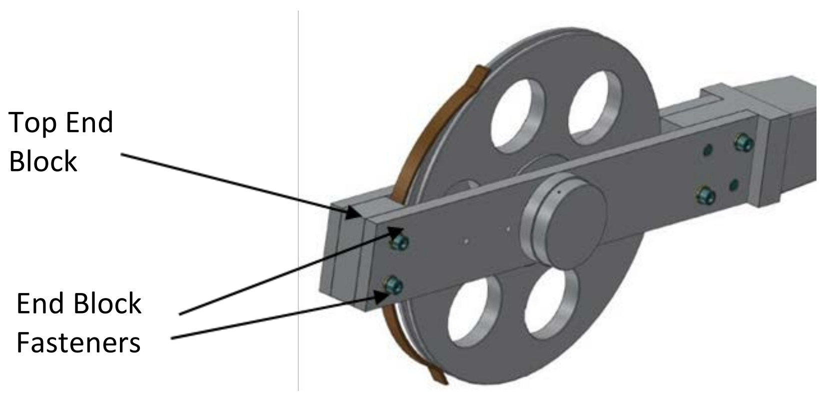


Figure 22. Sheave Top End Block

The winch cable can be routed onto the Sheave Wheel by removing the four Fasteners holding the Sheave Top End Block, Figure 23. This will allow the top end block with the Sheave Spring attached to be removed and the cable to be routed onto the wheel.

8.7 Drill Anti-torque Section

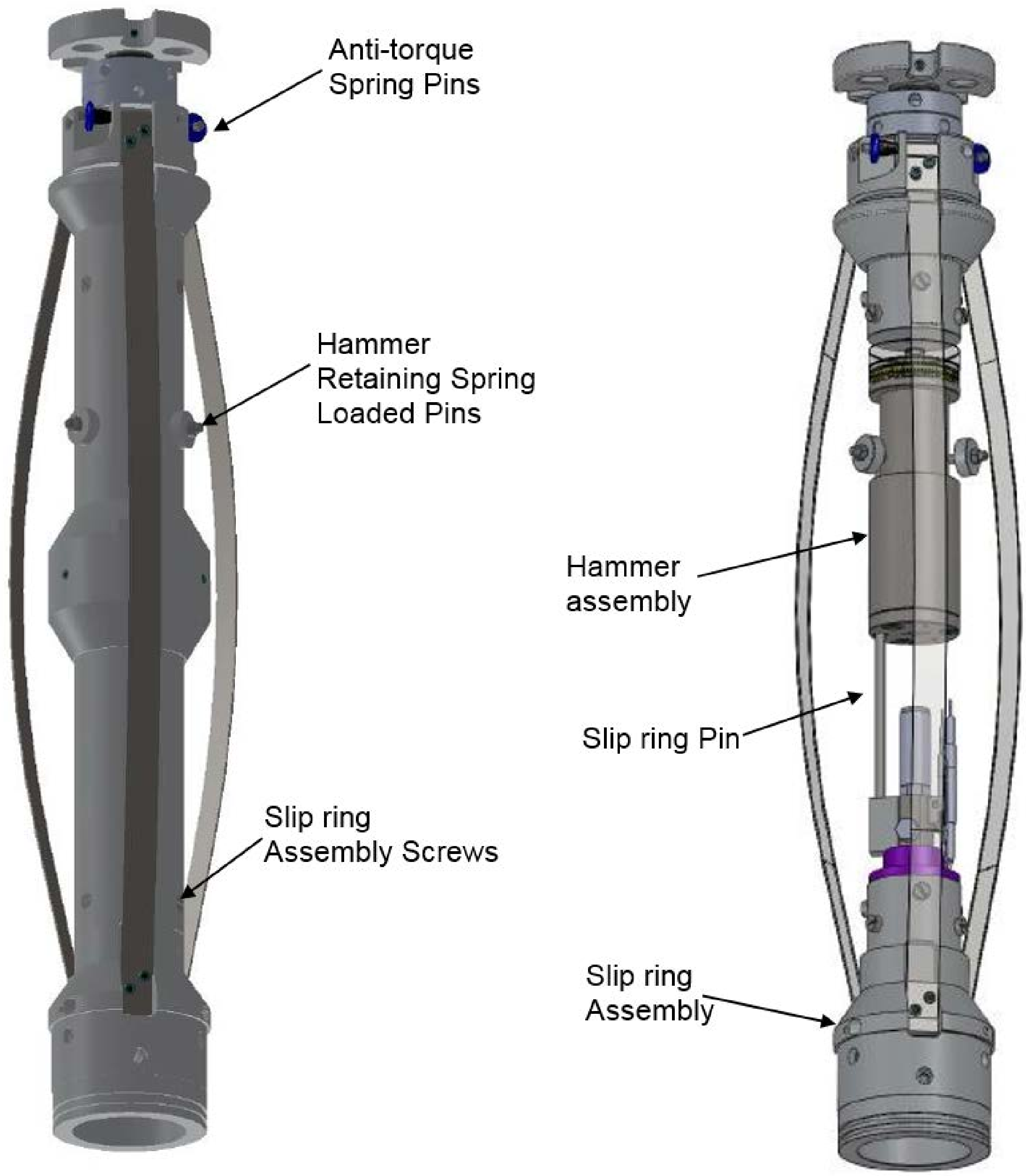


Figure 23. Anti-torque Assembly

8.7.1 Winch Cable Termination

Warning: Before the winch cable is terminated, ensure that the winch frame cable is unplugged!

Before terminating the winch cable, the winch cable should be passed through the level winder and sheave assemblies as described in section 8.6.2.

The winch cable termination mechanism is inside the anti-torque section of the drill. The termination is a pinch-type termination located inside the hammer

To attach the winch cable to the drill, the hammer assembly must first be removed from the anti-torque section. First remove the anti-torque spring pins near the top of the anti- torque assembly, and using a large flat head screw driver remove the six slip ring assembly screws, Figure 24. The slip ring assembly can now be removed.

The hammer can also be removed from inside the anti-torque tube. There are three spring-loaded pins that must be retracted in order to release the hammer. Hammer Pin Retraction tools are provided to make this easier, Figure 25. On the IDP version, the spring-loaded pins have been replaced with modified hex button head cap screws. To release the hammer back out each screw a few turns.

Figure 24. Hammer Pin Retraction Tool

Remove the hammer flange from the lower end of the hammer that contains the Evergrip termination, Figure 26. Thread the cable through the upper anti-torque assembly and the hammer and attach the cable to the Evergrip termination according to the manufacturers' instructions.

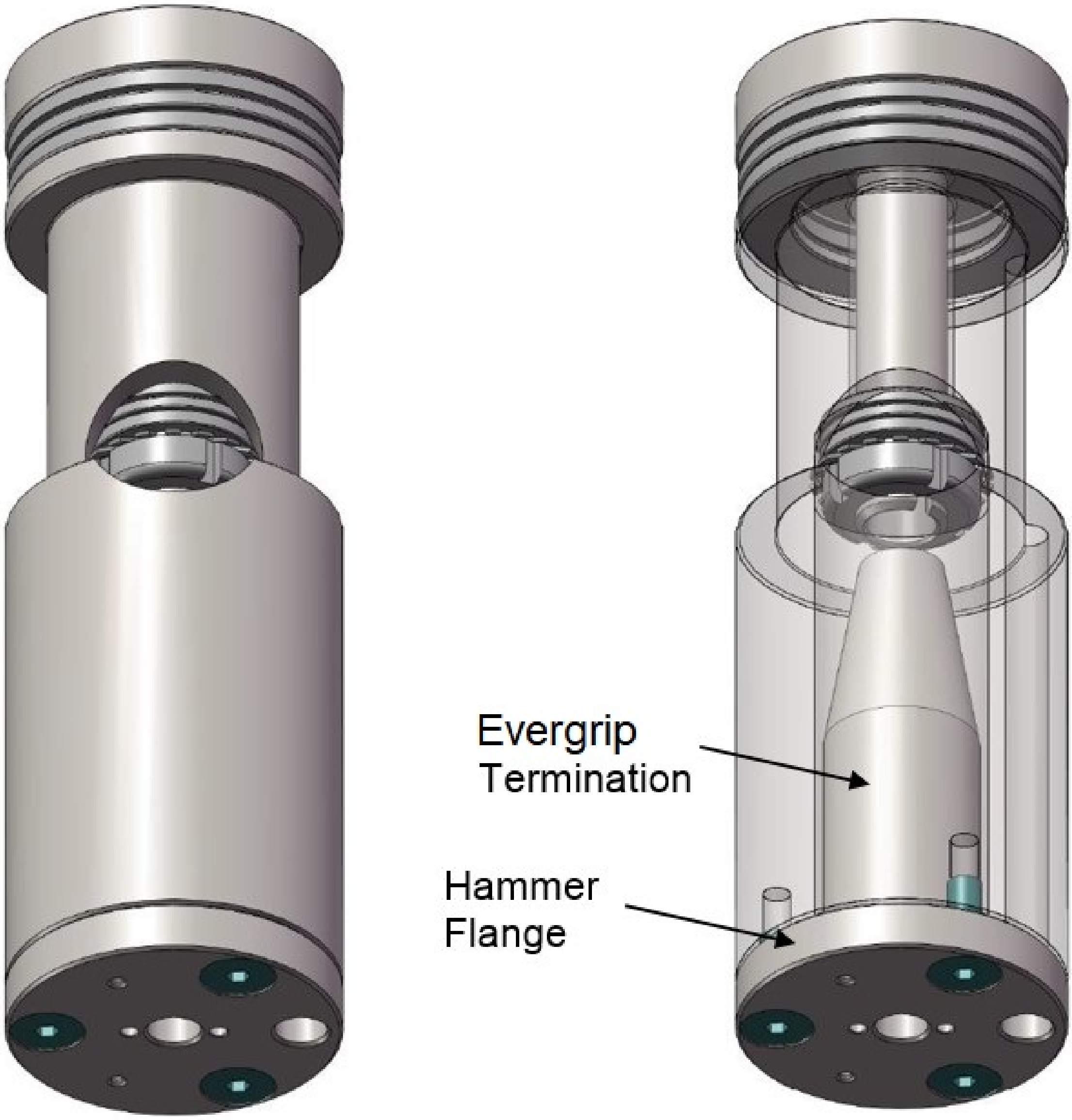


Figure 25. Hammer Assembly

The termination kit is the Evergrip part number P/N 9006120-1, and the re-termination kit (does not include the body) is 9006120-1R. Installation instructions are included with each re-termination kit, but more information is available on the PMI website:

www.pmiind.com/index.php?id=23 .

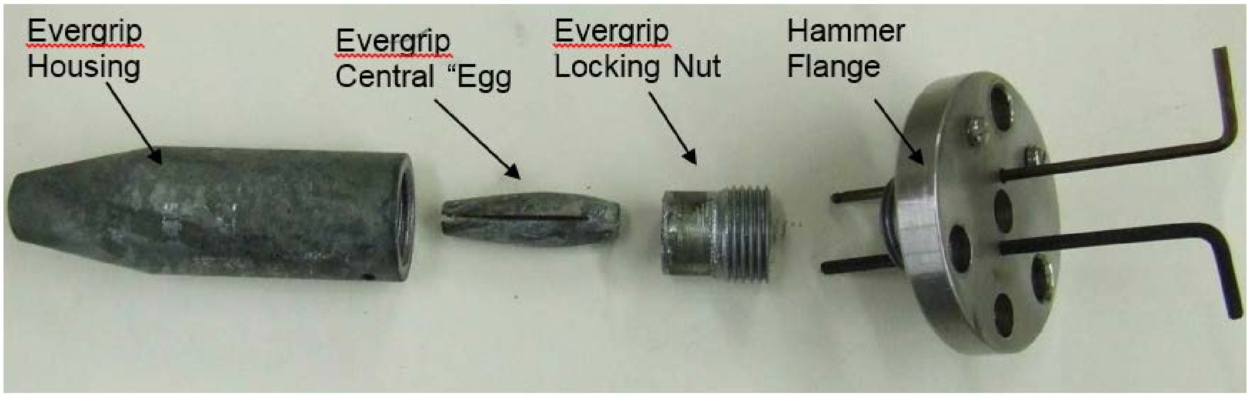


Figure 26. Cable Grip Assembly

The two small holes in the base of the hammer can be used (together with the two pins (Allen keys) supplied with the Evergrip termination kit) as a wrench to tighten the over- wraps onto the central "egg", Figure 27. Make sure that while you are tightening the "egg", the flange does not bottom out on the Evergrip housing, thereby giving you a false sense of having tightened up the egg.

Leave about 10cm of winch cable conductors below the hammer for electrical termination. The strands of the cable armor should be cut off immediately below the termination and covered with a length of heat shrink tubing to protect the conductors. The easiest way to cut the strands is using a Dremel tool with a cut-off wheel, as shown in Figure 28.

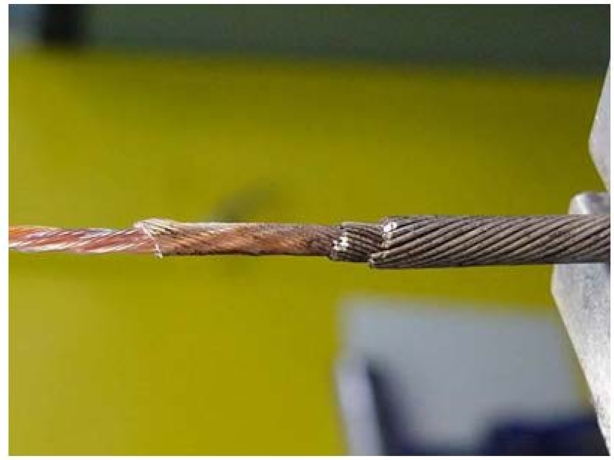


Figure 27. Winch Cable Preparation

When reassembling the hammer, make sure the 6mm (1/4”) clearance hole in the flange and the corresponding hole in the hammer body are lined up – this hole accepts the pin on the slip ring assembly that is attached to the bottom hinge block of the anti- torque section, Figure 29.

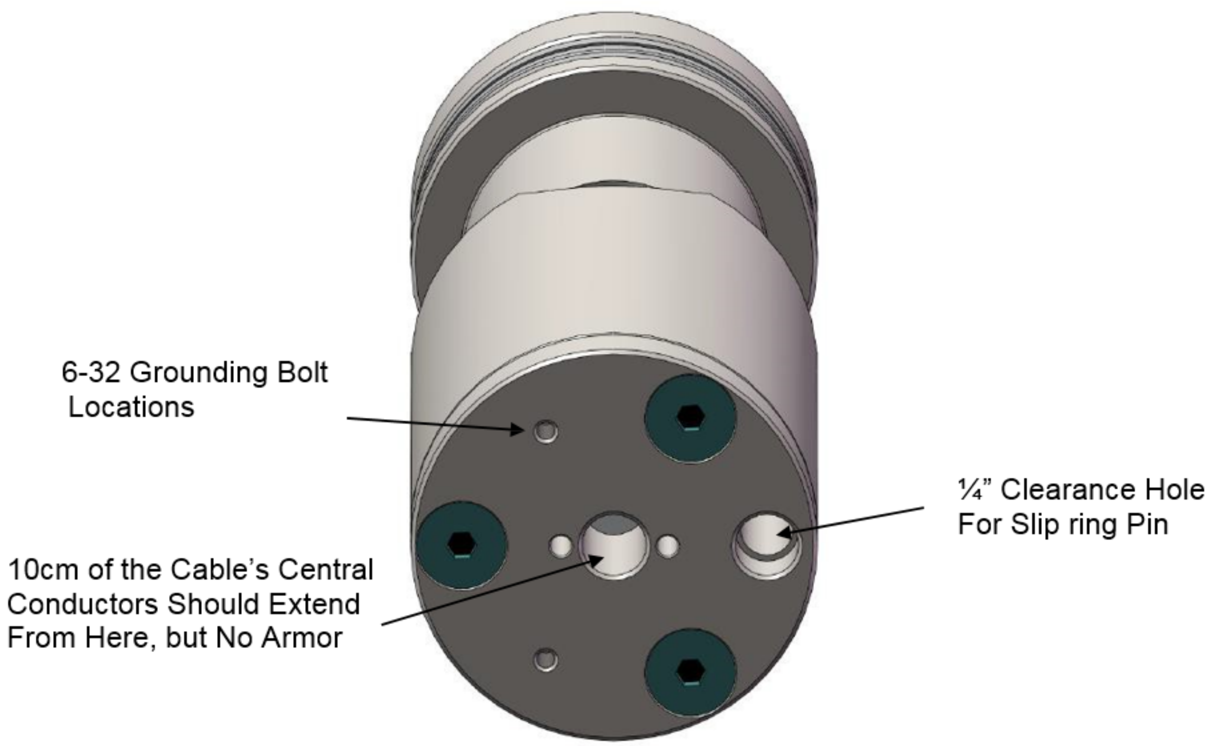


Figure 28. Hammer Flange

8.7.2 Slip Ring Wiring

Figure 29. Slip ring wiring

After the winch cable has been terminated using the Evergrip termination kit, the electrical connection of the winch cable can be completed. The winch cable is electrically connected to the top of the slipping assembly. The wires from the winch cable are terminated with a 4-pin Amphenol connector. Note, the connector is modified so the wires exit the side of the connector. This is because when the hammer is in its lowest position there is only about ½" of clearance between it and the back to the connector, Figure 30. When installing this connector, be sure pins are wired straight through (A to A, B to B, C to C, and D to D) to the connector on the other end of the cable. The cable wires may or may not be color coded, so the best way to determine the proper pinout is by checking continuity with a multi-meter. After completing the connector installation, again use a multi-meter to check each of the four wires for continuity, resistance (the resistance on each of the four conductors should be the same), and that they are not shorted to the cable armor. Section 8.5.3 identifies the wire pinouts and functions.

8.7.3 Re-Assembly

After the cable termination and wiring has been completed, the anti-torque assembly can be re-assembled. Make sure that the slip ring pin is lined up with the clearance hole in the hammer assembly.

The anti-torque section can then be reassembled to the drill motor section. Firstly, connect the Anti-torque to Drill motor Jumper, Figure 31.

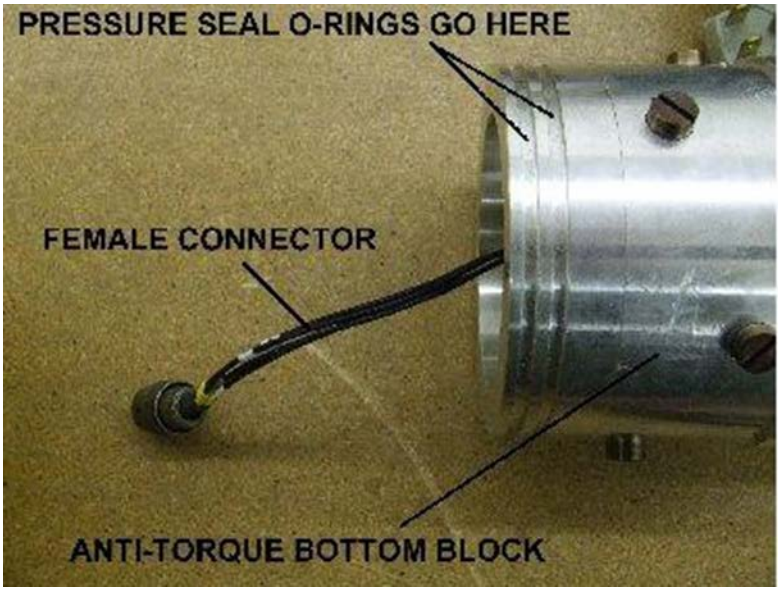


Figure 30. Anti-Torque to Drill Motor Jumper Cable

Insert the Anti-torque bottom block into the pressure housing of the drill motor assembly, Figure 32. Secure the assembly using the six drill assembly screws provided.

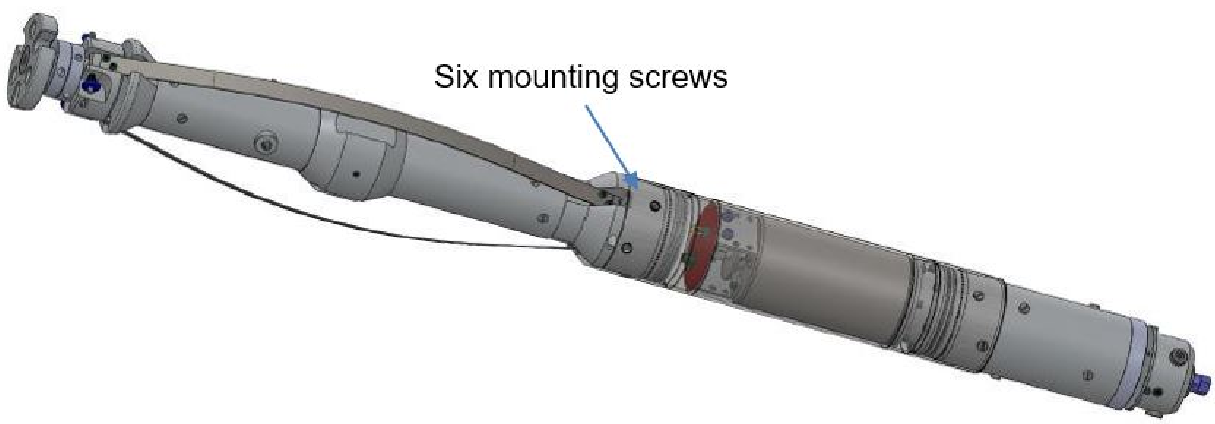


Figure 31. Anti-Torque and Drill Motor Assembly

8.7.4 Anti-Torque Spring Adjustment

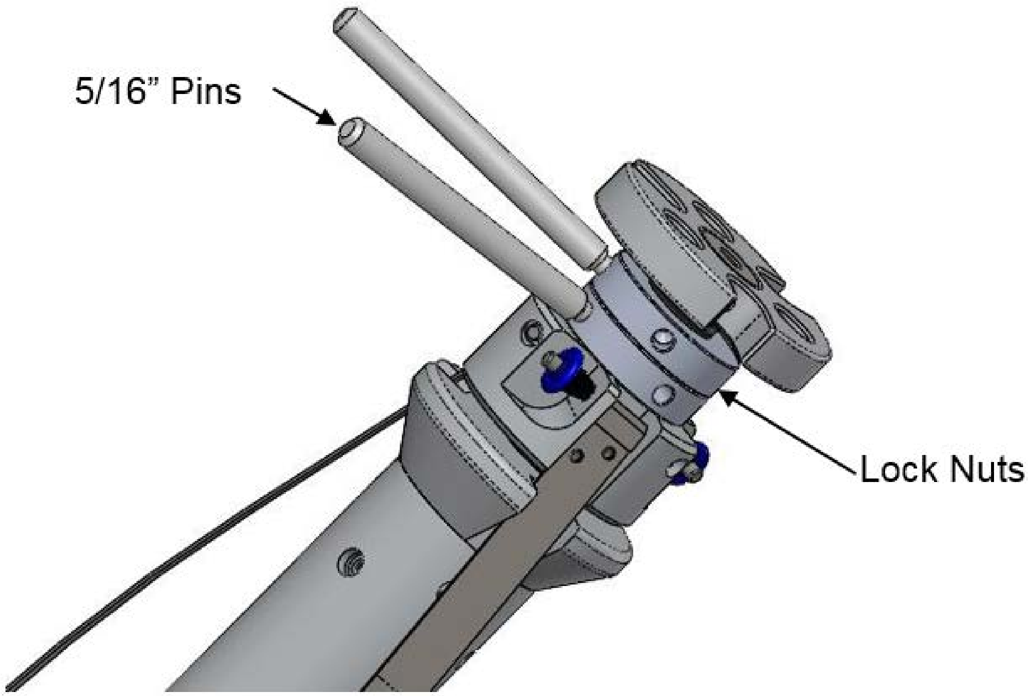


Figure 32. Anti-Torque Spring Adjustment

After the anti-torque section is reassembled, the anti-torque spring tension can be adjusted, and locked. The desired tension is dependent on the ice and drilling conditions; this is further discussed in section 10.6. Use the two provided 5/16" pins and the two lock nuts at the top of the drill to adjust and lock in place the spring tension, Figure 33.

8.8 Drill Assembly

The drill assembly is shown in Figure 34.

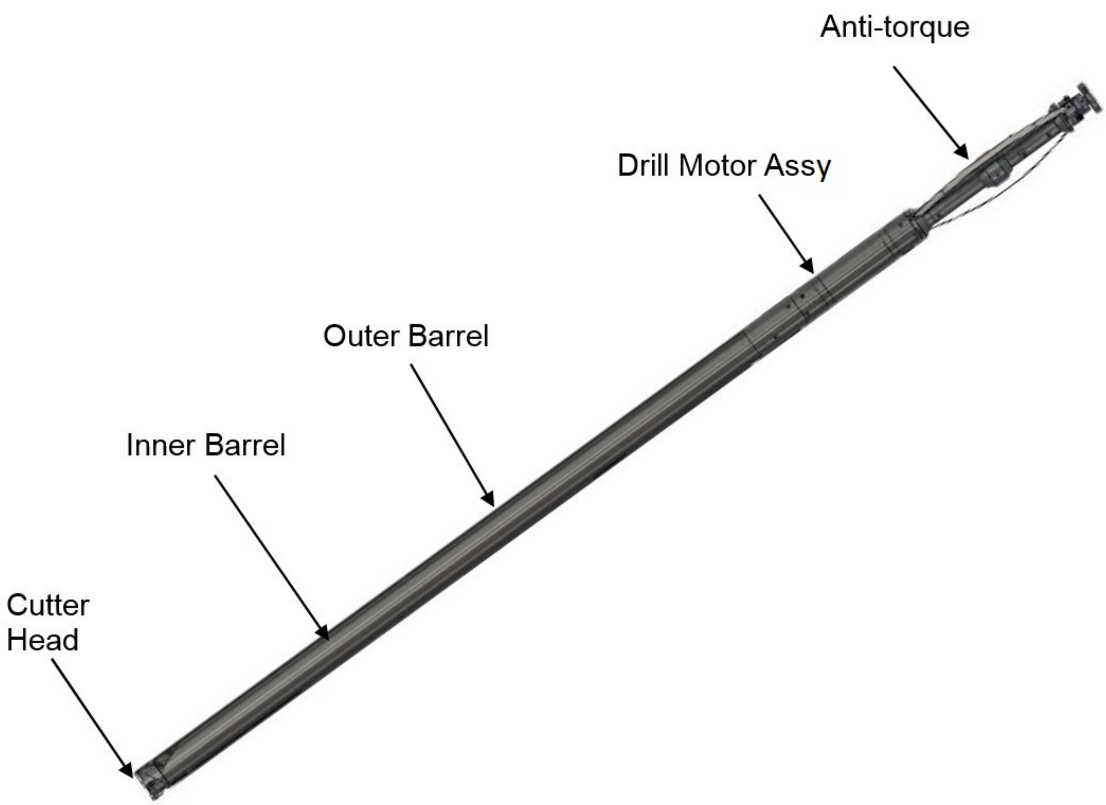


Figure 33. Drill Assembly

8.8.1 Outer Barrel

Assemble the drill motor section and anti-torque section as detailed in section 8.7.3. Place these two assemblies on top of the boom and secure them using the cradle. Slide the outer barrel over the drill motor section, Figure 35. This is best done by two people as this is a tight fit. The supplied strap wrenches can be used to facilitate turning the outer barrel into position. Once positioned, secure the outer barrel using six drill assembly screws.

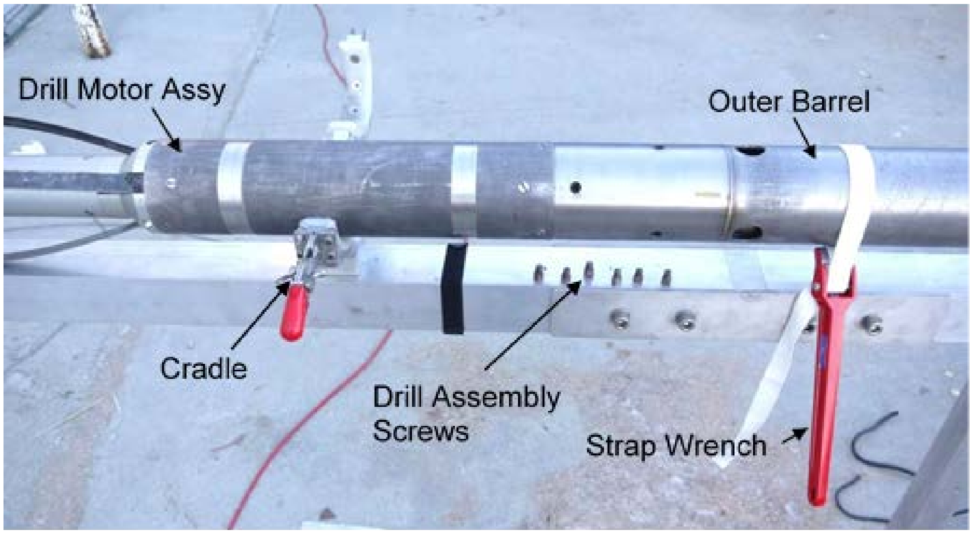


Figure 34. Positioning the Outer Barrel

8.8.2 Inner Barrel

Insert the Core plug (also referred to as "mango" or "little man") into the inner barrel. This core plug serves to separate the ice core from the chips that are dumped on top. The core plug must always be present when drilling. The core plug is suspended in the barrel by a length of para cord with a clip on one end that hooks in one of the chip windows at the top of the core barrel. The length of the cord should be adjusted so the bottom of the plug is about 1 meter above the cutters.

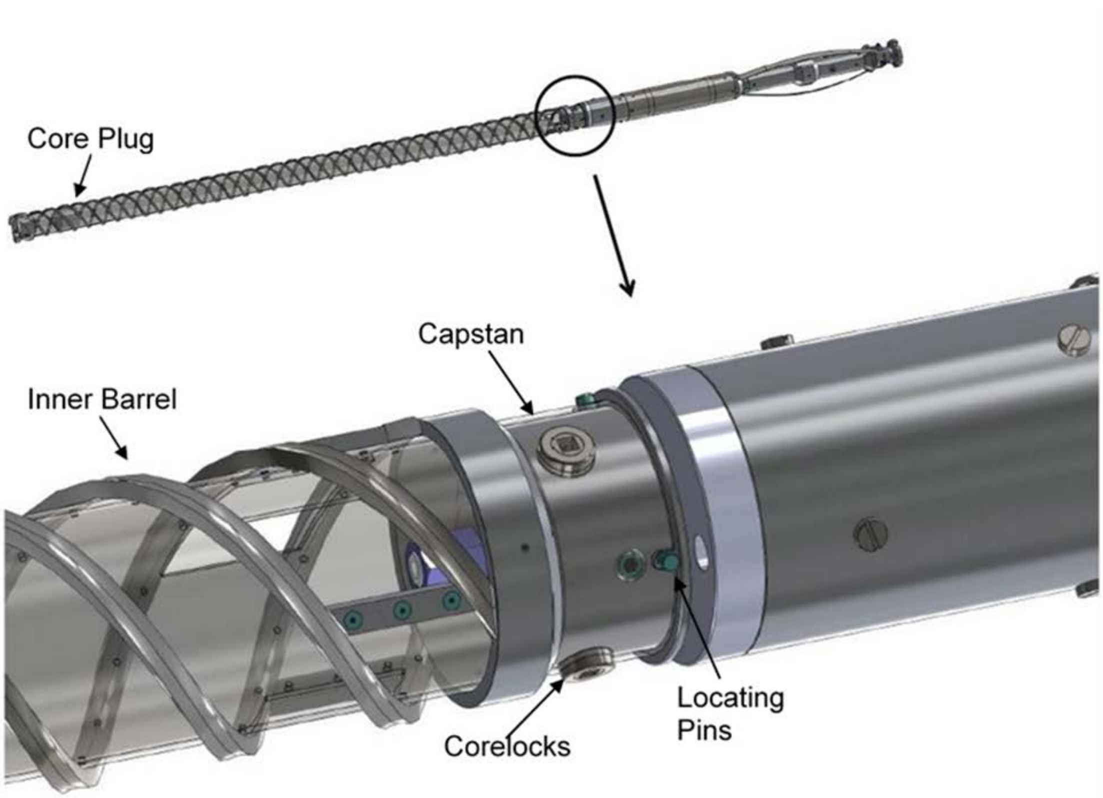


Figure 35. Inner Barrel Assembly

The inner barrel is attached to the capstan by three locating pins and three corelocks, Figure 36. Slide the inner barrel into the Outer barrel turn the inner barrel until the locating pins line up with the notches on the inner barrel.

Caution: The cutters are very sharp! Protect your hands from the cutters.

Figure 36. Engaging the Corelocks

Using the control panel to turn the drill slowly until the three sockets for the corelocks are accessible from the three access ports in the outer barrel. Use the provided ¼" driver to push and turn the three corelocks into their lock position, Figure 37.

8.8.3 Installing and removing the cutter head

The fit between the cutter head and the inner barrel is very tight. Generally, the head should be installed once at the start of the drilling project and removed only at the end when the drill is packed up. Before installing heels and cutters, you can use the dead- blow hammer to GENTLY tap the head onto the barrel. Make sure that the head does not get cocked sideways. The objective is to ensure that the three locking screws line up precisely with the three holes on the inner barrel, Figure 38. If the holes are not aligned properly, the nose of the locking screws will damage the holes in the barrel when they are tightened. If the holes aren't properly aligned, there is a special black handled tool in the tool kit that can be used to align the holes. The tapered nose on the tool will align the head with holes in the inner barrel as it is threaded into the locking screw holes. GENTLY tighten the three locking screws being careful to not over tighten the screws as they will deform the end of the barrel.

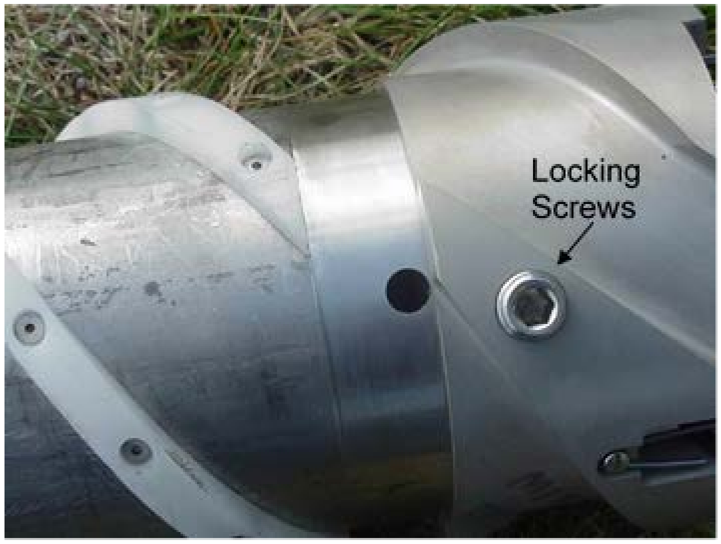


Figure 37. Installing the Cutter Head

To remove the head, disengage the three locking screws, and then gently tap the top side of the spiral flutes with a dead blow hammer and provided nylon rod. Knock each flute once, and then move to the next flute. Do not let the head become cocked on the inner barrel (this will stretch the head permanently) and **do not strike the plastic flights** on the inner barrel.

A dead-blow hammer is a plastic or hard rubber hammer filled with sand or lead shot. **Never use a metal hammer on the cutter head!**

8.8.4 Installing heels and cutter teeth

The three cutters and heels (also called shoes) are stacked on pairs of pins on the cutter head, Figure 39. The fit is tight, but this is intentional so that the cutters and heels stay in place.

The heels serve to limit the depth of cut. The heels are numbered and you should always drill with all three heels of the same number. The number represents the nominal cutting distance per revolution in mm. In other words, #4 heels permit up to 4mm of cutting per revolution, although in practice, the cut is shallower.

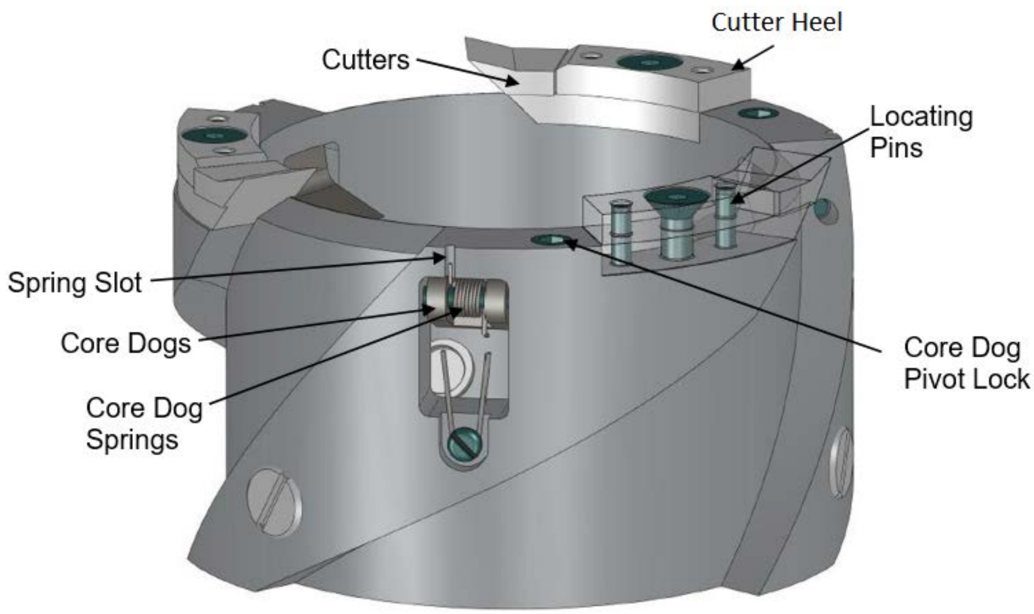


Figure 38. Cutter Head

The core dogs serve two purposes: they keep the core from falling out of the drill, and they break the core when the drill is raised. Long core dogs with weaker Core Dog Springs should be used when drilling in firn (to avoid the dogs “milling” the core). When drilling through the firn-ice transition, shorter core dogs with stronger spring need to be installed.

To install springs, loosen the core dog pivot lock (a recessed set screw on the bottom of the cutter head as shown in Figure 39). Retract the pivot pin enough so that only one side of the core dog is on the pivot.

Flare the spring so that one arm engages the slot in the head and the other lays on the back of the core dog. Press the spring into the slot until the coil of the spring is lined up with the pivot – with your other hand, press the pivot through the spring and core dog. Secure the pivot lock set screw.

If you lose a spring, or need one with different strength, it is possible to make them in the field by wrapping spring wire around a mandrel such as a drill bit, Figure 40.

Figure 39. Fabricating Core Dog Springs

Note that the ends of the spring should drop into the spring slot on the cutter head – it is important that the spring does not protrude and get caught on the sidewalls of the hole.

9.0 Operating Instructions

9.1 General Comments

9.1.1 Winch setup

Make sure that the mast locking pin (3/4" diameter aluminum with handle) is tethered to the winch frame. YOU DO NOT WANT THIS PIN TO DROP INTO THE HOLE!!!

Solar radiation can warm the winch frame enough to cause it to sink into the ground. To prevent this, you may want to do the following:

- Clear off loose snow to expose a solid surface for the winch
- Place pieces of plywood under the frame to spread the load

9.1.2 Drill trench

A 1.5m deep trench is required into which the drill can swing. Because the main legs on the winch are splayed out, the trench does not have to be cut very carefully, but you should try to keep it about the same width as your shoulders. The trench should be fitted with steps as access to the trench is required during drilling.

If operating the drill without a tent, it is recommended you arrange a removable cover for the trench, both for safety and cleanliness, which can be put in place when the drill is not being run.

- Use extreme caution when working around the trench to prevent accidental slips or falls that could result in someone falling into the trench.
- It is recommended to install a warning line around the trench and about 3 feet above ground level.

- To reduce the chances of slips, roughen up the snow surface around the drill site if it becomes compacted or iced up.
- A neat and well organized work area can help prevent accidental slips and falls.

9.1.3 Trap door

It is strongly recommended that once a hole is started, a trap door be fitted over the hole so that the hole can be covered when the drill is at the surface (the trap door can be operated from the surface with a string).

If something magnetic is dropped into the hole, then the provided magnet can be used to attempt retrieval.

The trap door can be fashioned from a piece of plywood with hinges made of fabric or leather straps. Ice screws or nails can secure the straps onto the ice or snow.

9.1.4 Jammed Core Locks

If, during drilling, it becomes difficult to remove a core lock, it may be that snow/chips have packed into the hole. A small amount of anti-freeze or ethanol will un-stick the lock.

Cautions:

- ALWAYS start the drill or winch motors with the speed control set to zero. Starting the motor with higher speed settings may damage the electrical motor and/or the power system.
- Be aware of rotating components in and around the winch and drill.
- The cutters and core dogs are very sharp and will easily cut clothing and skin.

9.2 Drilling Core

When drilling there is a plastic core plug that floats freely inside the core barrel. This core plug serves to separate the ice core from the chips that are dumped on top. The core plug must always be present when drilling.

To drill core, follow this procedure:

9.2.1 Raise the mast with the drill attached.

9.2.2 Insert the mast locking pin.

9.2.3 Ensure cable is tight and the spring-loaded sheave is seated in the top of the mast.

9.2.4 Release the drill clamp and open the trap door.

9.2.5 Set the winch speed to zero (this should be done before each trip into the hole), set the winch motor direction in the “DOWN” position.

9.2.6 Lower the drill to the zero reference height.

9.2.7 Reset the zero depth counter if needed.

9.2.8 Reset the Weight On Bit (WOB) by pushing the “WOB rest” button on the readout box.

9.2.9 Lower the drill to within about 50cm above the hole bottom.

9.2.10 Set the drill direction to “FORward” position and run the speed up to 70-75 on the dial. This corresponds to a cutter speed of 60 – 87 rpm. Slowly lower the drill until cutting starts (you can see this happen when the drill motor draws more current). Push the “DIFF RESET” button on the readout box to start recording distance drilled. You should be able to drill 90-100cm in ice (more in firn) before the drill motor stalls and the current rises. The operator must respond quickly and stop the motor when stalling occurs. The drill motor should not receive more than 2A. Until the anti-torque section is below the surface, the anti-torque action will have to be provided by an operator standing in the drill trench. The reason it is important to start drilling before the drill touches bottom is that otherwise there is a risk that “fluff” gets caked onto the bottom of the heels, thereby preventing the cutters from advancing the drill (see notes in troubleshooting section).

9.2.11 Record the ending depth and core length in the log book.

9.2.12 Push the “DIFF RESET” button on the readout box before raising the drill. This gives you a depth count down to zero on the next run.

9.2.13 Stop the drill motor if you have not already done so, and raise the winch slowly. You should be able to hear/feel/see the core break (except in firn and fragile ice which breaks easily). If the winch motor cannot break the core on its own, you can use the hand crank to assist. For safety’s sake, make sure to remove the crank(s) before moving to high speed.

9.2.14 Raise the drill (max speed on winch motor is 100% (3000RPM)). Slow down as the surface is reached and the drill comes out of the hole.

9.2.15 Park the drill on the tower and close the cradle clamp.

9.2.16 Close the trapdoor (you have one, correct?)

Figure 40. Hanger Core

9.2.17 Remove the mast lock pin and lower the tower onto the locking pogo stick. WARNING! Before lowering the mast, check that you do not have a "hanger." A hanger is a section of ice core that is dangling out the front of the drill, Figure 41. This can happen if the core dogs slip a bit before they manage to grab onto the core. A hanger must be pushed up into the drill by someone who descends into the drill trench – otherwise, there is a risk that the core gets snapped off and falls into the hole.

9.2.18 Run the drill in reverse until chips stop coming out the barrel. This can make it easier to pull out the core barrel if the flights were packed with chips.

9.2.19 Remove the inner barrel core locks – this is done by slowly rotating the drill barrel to the three positions that expose the core locks through the access hole in the outer barrel. Push each core lock in and rotate it ¼ turn to lock it in the retracted position.

Figure 41. Extracting the Core Barrel

9.2.20 Extract the inner barrel by pulling on the cutter head, Figure 42. If the inner barrel does not come out easily, you can knock on the outer barrel with a dead-blow hammer to release it.

Figure 42. Removing the Chips

9.2.21 Shake out the chips located above the core plug. The chips are shaken out the top of the inner barrel. If the chips to not come out, you can CAREFULLY tap the inner barrel with a dead-blow hammer to release them. It can help if you place a screwdriver or dowel through the parallelogram-shaped holes – this will prevent the core plug (and the ice core itself!) from flying out of the barrel, Figure 43. The chips can be collected for analysis (e.g., pollen).

9.2.22 Remove the core plug

9.2.23 Slide the core out into a bag or tray

9.2.24 Reinsert the core plug

9.2.25 Reinsert the inner barrel and lock it in place

9.2.26 Repeat procedure!

9.3 Record keeping

With each run, you should record the following:

- The run number (increment each time, even if no core is recovered)
- The "up" direction and run number on the bag into which the core is placed
- Maximum depth reached
- Length of core recovered
- Whether the core had a "flange." A flange is a flaring at the bottom of the core that indicates that the core has broken off right to the bottom of the hole (i.e., it has broken just below where the cutter stopped cutting. This is VERY important because it means that the cumulative core length and depth counter must match at this depth.

10.0 TIPS

The following are general tips for drilling and drill operation.

10.1 Drilling a straight hole

Good drilling is a bit of an art. There are several tradeoffs:

- You want big chips to make chip transport efficient (i.e., aggressive cutting)
- You want good quality core with no cracks (i.e., gentle cutting)
- You want a straight, vertical hole, which means you have to use the sonde as a pendulum to find the vertical. If you let all the weight of the sonde rest on the cutters, you will lose the pendulum effect and the hole will eventually curve off to the side.
- You want the anti-torque springs to be tight enough to prevent rotation, yet not so tight that they do not allow the drill to descend easily.

Generally, the weight of the drill is just about right to provide the correct drilling pressure. Nevertheless, the “pressure on bit” will change depending on whether the winch transmission is warm (cable pays out more easily) and the depth of drilling. Changing ice conditions also mean that different amounts of drill pressure are necessary (for example, in brittle ice (found at 100-150m)), you need to reduce pressure to minimize cracking the core.

The best technique for the ECLIPSE drill seems to be to set the winch to pay out cable (but with the speed set to zero, or almost zero) and then to use the hand brake to control the drilling speed, as necessary.

Under some conditions, you can leave the winch in the “UP” position while drilling, thereby applying a bit of tension to the cable and allowing the drill to pull cable off the winch.

10.2 Keeping the drill cold

The ECLIPSE drill works best when it is cold (below freezing) and dry. Water can freeze on drill components, and will tend to gum up the free movement of cuttings.

The sun is your enemy! When the drill is on the surface, solar heating of the drill is rapid. The first place you will notice melting is over the motor section where there is heat liberated by the drill motor.

There are a number of techniques to keep the drill cold:

- Drill at night or, at least, avoid drilling during the heat of the day.
- Drill under cover, or at least arrange a tarpaulin to shield the sonde from the sun’s rays.

10.3 Cleaning the drill

We strongly suggest that at the beginning of each season, a short (10m or so) hole be drilled to test out the system and “scrub” the inside of the drill clean. Snow makes an excellent scrubbing powder! The core from this initial hole can be discarded.

10.4 Keeping the drill clean

While drilling, care should be taken to ensure that the flights are cleaned after every run. Any chips stuck on the flights of the inner barrel will impede the free movement of chips while drilling and will result in poor performance. Use the dead-blow hammer (carefully!) and a stiff bristle brush to keep the inner barrel spotless!

It is also important to keep the cutter head clean. After each run the core dogs should be inspected to ensure that they can swing freely (otherwise you may not be able to retrieve the core you cut!)

A clean, dry drill is a happy drill!

10.5 Over Night Storage

Frost tends to form in the drill overnight, impeding early-morning operation (the added drag seems to prevent normal chip-transport). To avoid this problem, the last core drilled in the day can be left in the drill and the drill stored at 15-20m depth (below the winter cold wave) overnight. In the morning, the drill is raised to the surface and the core removed – this will ensure that the barrel is clear of frost.

10.6 Setting the Anti-Torque Spring Tension

The anti-torque springs need to be adjusted so that they are tight enough to prevent the drill from rotating when the cutters engage the ice. Generally, the springs need to be tighter in firn than they do in ice. If the springs are too tight, they may prevent the drill from descending easily – you can judge this when you are lowering the drill. Springs that are too loose in firn will “windmill” and cause large cavities to form.

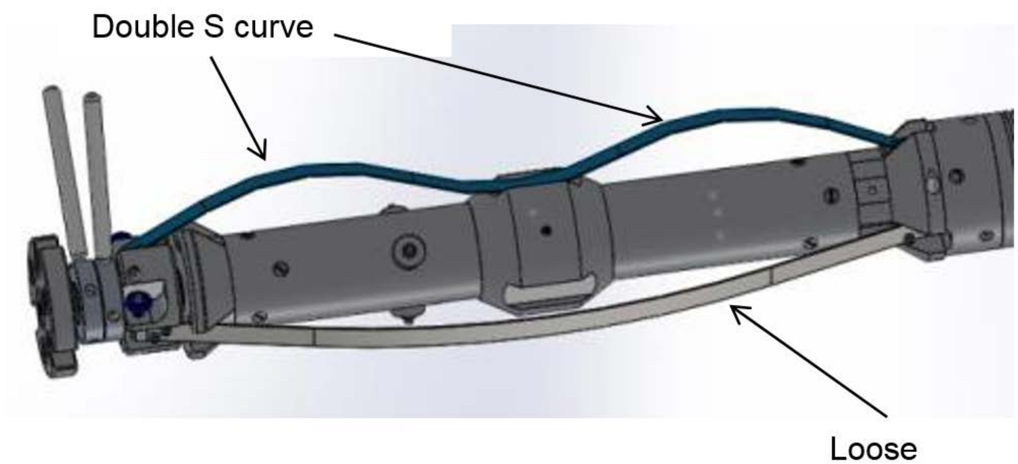


Figure 43. Anti-Torque Spring Curve

In operation, it is supposed to be tight enough to make the double S curve, Figure 44. The center block forces the spring into a double recurve with 4 separate points of contact; 2 on the leading edge and 2 on the trailing edge.

10.7 “Feeling” the drill

The driller can learn a lot about what is happening down in the hole by placing their hand on the cable. Even at depths of several hundred meters, you can feel exactly when the drill begins to cut core and when something happens (such as the anti-torque springs letting go). This is a good habit to develop.

10.8 Cutter heel choice

The objective when drilling is to produce as large of chips as possible (i.e., a high-numbered, thin heel) without causing aggressive drilling damage to the core (cracking or making wafers). Big chips transport better and are less prone to sintering in warm conditions.

#5 heels work fine in firn, #4 heels are better in ice. #3 heels cut slowly and in general produce very fine chips that do not transport well and tend to sinter in the flights.

10.9 Losing the lock pins

The inner barrel lock pins are magnetic (martensitic stainless steel) and can be recovered with a magnet if dropped into the hole (although they will tend to drive themselves in firmly after the long drop). Avoid this situation, if at all possible! We highly recommend the use of some sort of "trap door" arrangement which can be closed as soon as the drill is out of the hole.

10.10 Drilling without a Cable Level Winder

It is quite possible to drill without the level winder. The only consideration then is to keep the cable under tension as the mast is lowered, as the geometry of cable path is different without the level-winder mechanism in place. It appears that there is enough motion in the spring-loaded sheave assembly to keep the tension on, but take care to ensure that slack is not formed. If necessary, jury-rig a hooking device on which to manually place a loop of the cable---some experimentation will be required if this proves necessary, but is easy to do. Most drills without a level winder have a "dummy" level winder fitted that keeps proper tension on the cable when the mast is lowered; the IDP system does not have the dummy level winder.

11.0 ECLIPSE ICE DRILL OPTIONAL UPGRADES

The following describes optional upgrades and their operation.

Note: The IDP drills do not have these optional features.

11.1 Long Boom Assembly – Not included with IDP system

The Long Boom is an optional feature that allows drilling without a drill trench. If your drill is equipped with a standard boom configuration refer to section 8.4.

This configuration of the ECLIPSE ice coring drill is designed so that the requirement for a drilling trench is eliminated. In order to achieve this without shortening the drill sonde (and hence the ice core capacity per trip), the mast has been extended upwards.

Increasing the height of the mast changes the balance point of the winch frame. The standard ECLIPSE frame is balanced such that the mast can be raised and lowered manually (with or without core in the sonde). Increasing the length of the mast changes the balance point and necessitated the following design changes:

- To make transport easier, the mast is broken into two pieces and has reinforcing plates at the pivot point.
- To accommodate the longer mast, an auxiliary "pogo" is provided to give additional support to the mast when it is in the lowered position.

- An electrically-powered winch and pulley system has been fitted to make raising and lowering the winch easier

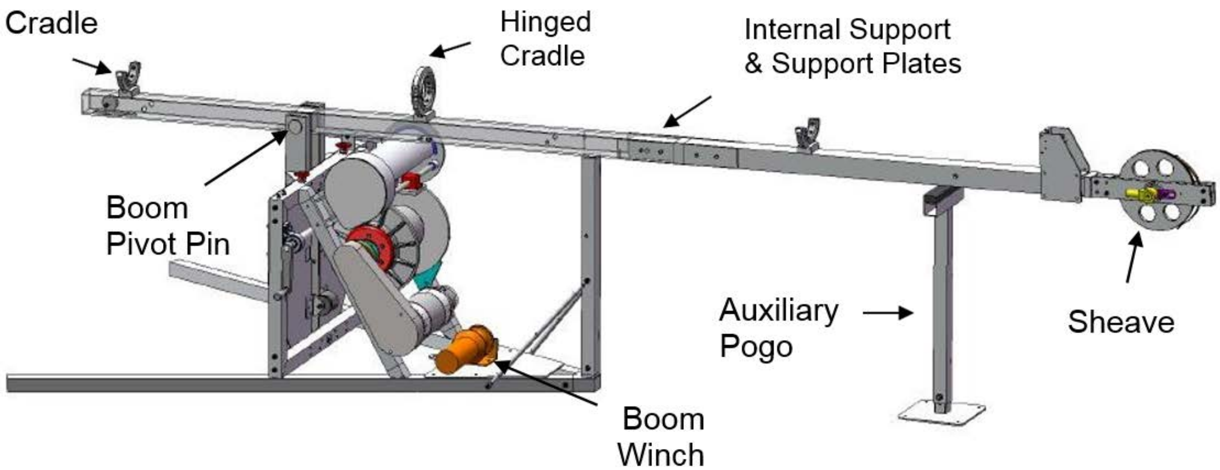


Figure 44. Long Boom Assembly

11.1.1 Assembly of Long Boom

Assemble the top and bottom section of the boom using the internal Support and Support Plates.

Mount the Boom onto the frame using the Boom Pivot Pin. The Boom Pivot Pin is secured with a supplied hair pin cotter pin. Use the Supplied Auxiliary Pogo to provide support for the boom. The Auxiliary Pogo can be mounted to piece of plywood or other material to increase its stability.

Mount the Boom Stop Bracket at the back end of the boom as shown. Do not over tighten the mounting screws for the bracket. This will deform the boom and cause interference with the sheave.

Mount the cradles as shown in Figure 45. The hinged cradle is located in the center position with the other two cradles nearer to either end.

11.1.2 Mounting the Winch

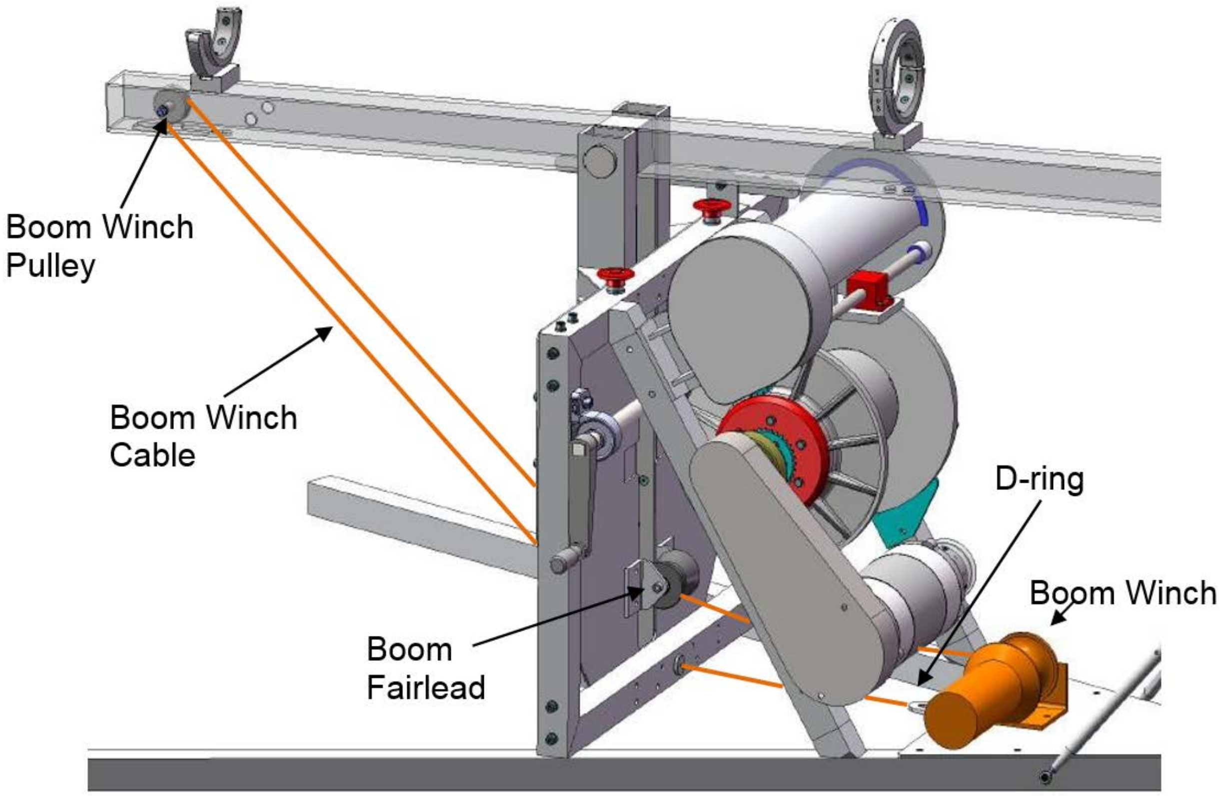


Figure 45. Boom Winch Mounting

Mount the boom Fairlead onto the face shear plates as shown in Figure 46.

Mount the boom winch onto the winch mounting plate. Note that the mounting of the winch will differ slightly depending on the winch used. The drill can be supplied with a 12VDC winch, or a 230VAC winch.

Spool out some of the boom winch cable and route it as shown in the Figure 46 above. The cable is attached to the boom support plate using a supplied D ring and can be terminated in a loop using the supplied crimps as shown below in Figure 47.

Figure 46. Boom Winch Cable Termination

11.2 Wet drill modifications – Not included with IDP system

A wet drilling option is available for the Eclipse Ice Drill. The wet drill modification consists of two additional components: (1) a Tanaka-style booster pump and (2) a bailing system. Additional modifications or items requiring attention are pressure sealing and cleaning.

11.2.1 Sealing the drill

Because the drill is operating in fluid, sealing the motor section of the drill is critical. The drill motor output shaft has a high-pressure shaft seal installed, and the top of the motor section has a high-pressure slip ring.

The O-rings between the motor transmission and the pressure housing for the electrical motor were installed in the factory, but the O-rings on the anti-torque bottom block must be installed in the field, Figure 48.

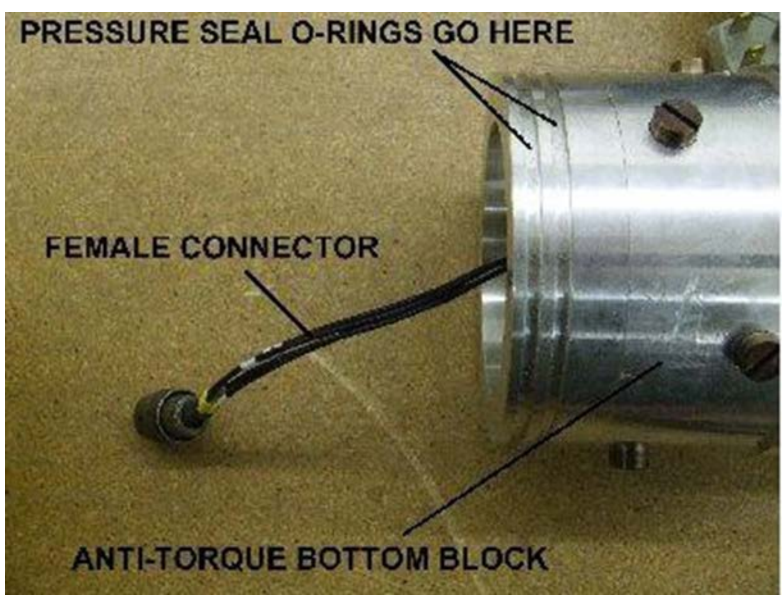


Figure 47. Sealing the Anti-Torque Bottom Block

It is **critical** that the inner surface of the motor section pressure housing and the O-ring grooves on the bottom block are clean. Spreading some grease on the inner surfaces of the drill motor pressure housing helps get the O-rings over the compression step in the housing (and also helps get the drill apart later). The O-ring size is AS568-154.

It can also help to wipe some grease on the O-rings themselves before assembly. Take care not to nick the O-rings as they pass the mounting holes, Figure 49 (if you see any bits of black, you have nicked an O-ring – take it apart, change the O-ring(s), and try again).

Figure 48. Installing Pressure Sealing O-rings

11.2.2 Tanaka-style booster pump

To drill in fluid, the normal inner barrel of the Eclipse drill is replaced with a shorter inner barrel above which a combination filter, chip chamber, and booster pump are installed. The booster pump assembly connects to the motor section and rotates while the drill is running. Figure 50 below shows the booster pump at the right (bottom) with the drive capstan for the short inner barrel partially-obscured. On the left is the filter pancake and the connection to the drill motor drive capstan.

Figure 49. Tanaka Style Booster Pump

The short inner barrel, Figure 51, is different from the longer "dry" inner barrel in that it does not have chips ports at the top – just the holes for the core lock pins. This inner barrel also has a small hole at the top to let fluid escape from the inside of the barrel. The same cutter head is used for both the short and long inner barrels.

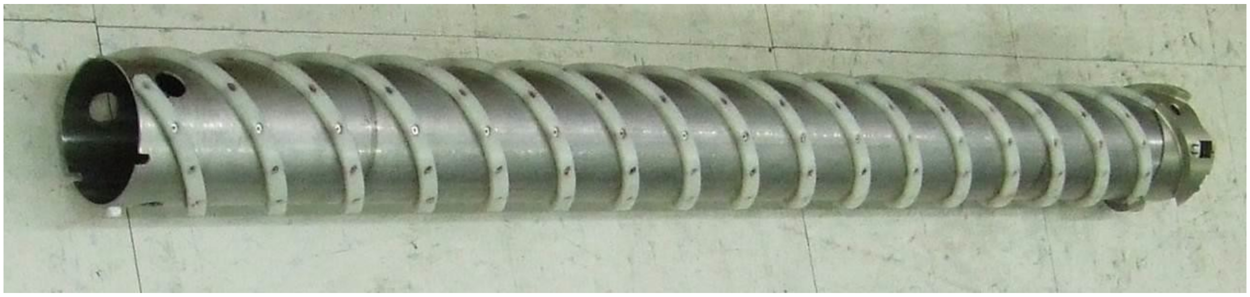


Figure 50. Short Inner Barrel

The theory of operation is that the chip/fluid material is carried up the flights of the inner barrel (just like in “dry” operation). Instead of dropping into the inner barrel (as they do in dry drilling with the long barrel), the chips carry on into the booster pump where they are packed into the space below the filter pancake. The filter, of course, lets the fluid through, keeping the chips behind.

The corelocks used to attach the short inner barrel to the booster pump are special – they have a lower profile and are curved so that they sit flush with the inner barrel. This minimizes the drag on the chips as they flow past.

11.2.3 Assembly and Drilling Procedures

Drilling proceeds in much the same manner as with a dry drill. To start drilling, lay the drill horizontal, and then follow these steps:

- Load the booster pump into the outer barrel. The filter pancake end goes first, Figure 52. Do not push it in all the way, but leave the capstan sticking out.

Figure 51. Inserting the Booster Pump into the Outer Barrel

- Attach the (short) inner barrel to the booster pump using the short, curved core locks, Figure 53.

Figure 52. Inserting the Short Barrel

- Push the combined booster pump and inner barrel up into the outer barrel and connect the core locks at the top, as per usual.
- Lower the drill down the hole. You may elect to run the drill at low speed while descending to help the drill “pull” or “suck” its way down the hole. This will also help clean stray chips out of the borehole fluid and may reduce the frequency that bailing is required.
- Drilling proceeds much as in dry drilling, although the “feel” may be different owing to the increased power required to drill in fluid vs air (overcoming fluid viscosity). Monitor the motor current (normally about 1A for dry drilling), but do not exceed 2A (this is the stall current of the motor). If you see a sharp rise in motor current and a drop in rpm, this means that the drill has stalled and drilling should stop. You may elect to run the drill in reverse **(briefly!)** to clear a jam, but the risk is that you dump a lot of chips into the bottom of the hole.
- After retrieving the drill, reverse the procedure. As with dry drilling, blows with a dead-blow hammer on the outside of the outer barrel can help loosen the chips so that the inner barrel and booster pump can be removed.
- As the inner barrel is disconnected, you can dump the core out the top directly into a tray or bag.
- As the booster pump is removed, the wet chips will drop off.
- Before reassembling the drill for the next trip, make sure that the flights on the inner barrel are completely clear of chips and that the bore is clean.

- Adjustments can be made to the filter pancake by removing or adding filter elements. A word of caution if you consider removing the fine filter… you may get a lot of fine chips in the borehole fluid and the risk of getting the drill stuck would therefore increase.

11.2.4 Tips

Some wet drilling tips in no particular order:

- Make sure you have propylene glycol on hand and some system to deliver this to the top of the drill should it get stuck.
- The square holes in the core locks on the inner barrel can get plugged with chips, so you may need to use a screwdriver to clean them out. A squirt of propylene glycol or ethanol may also help.
- If the fluid is corrosive (salty), you need to take special care to disassemble and rinse the drill as much as practicable during operations, and especially before shipping and storage! The aluminum surfaces of the drill (even those that have been anodized) will corrode and expand, causing joints to freeze. Pay particular attention to aluminum; aluminum and aluminum-steel joints. Examples include:
    - Top/middle/bottom blocks of the anti-torque section
    - The cutter head/inner barrel joint
    - The motor section-outer barrel joint
    - The core dogs, heels, and teeth on the cutter head, as well as all springs and fasteners should be removed for shipment/storage and occasionally when the drill is in use; Pivot pins for the core dogs should also be removed. The only things that can be left on the head are the three backstop wires that prevent the core dogs from rotating back too far.
    - The thrust bearings on the hammer are plain steel and susceptible to corrosion; They must be kept clean and dry (certainly not salty) as much as possible or you will be replacing them.

11.2.5 Bail

The filter pancake in the booster pump assembly is not perfect – chips will escape and get into the borehole fluid. If drilling in water (fresh or saline), these chips will tend to float to the surface; if drilling in a hydrostatically-balanced fluid, they will remain in suspension.

Either way, it is important that these chips be meticulously removed. If the chips accumulate on the top of the drill as it is being removed, there is a significant risk that the drill gets stuck **under** a pack of chips. The risk is greatest when drilling in water because the chips have a tendency to float to the surface and accumulate.

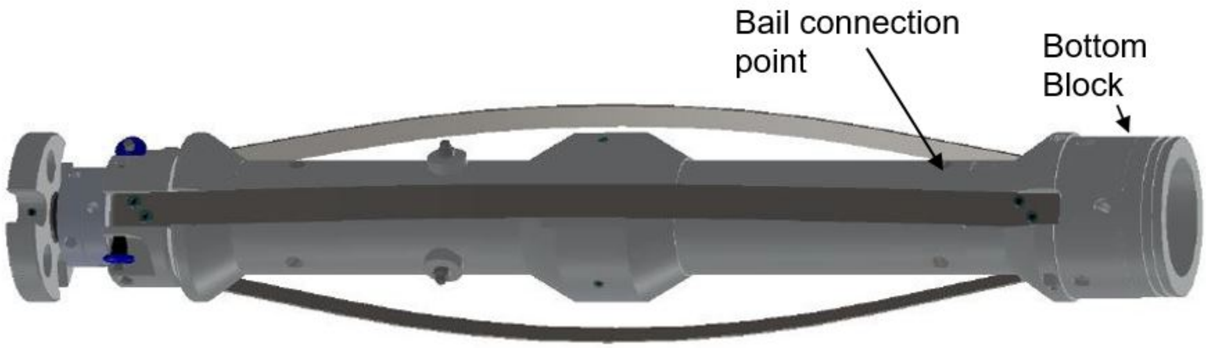


Figure 53. Anti-Torque Section

In order to clean the chips out of the borehole fluid, a bail is used. The bail is attached to top part of the anti-torque section, Figure 54.

- Remove the quick-release pins on the leaf springs (at the top of the anti-torque section).
- Remove the six screws holding the bottom block to the anti-torque tube.
- Carefully remove the bottom block and attached slip ring – you will need to release the hammer so that you can push it out the bottom of the anti-torque section.
- Remove the ground wire from the hammer, and disconnect the remaining three wires. The three female sockets (these are the ones wired to the winching cable conductors) should be plugged with the dummy pins supplied with the drill (as shown in Figure 55); this is to keep fluid out of the electrical contacts.

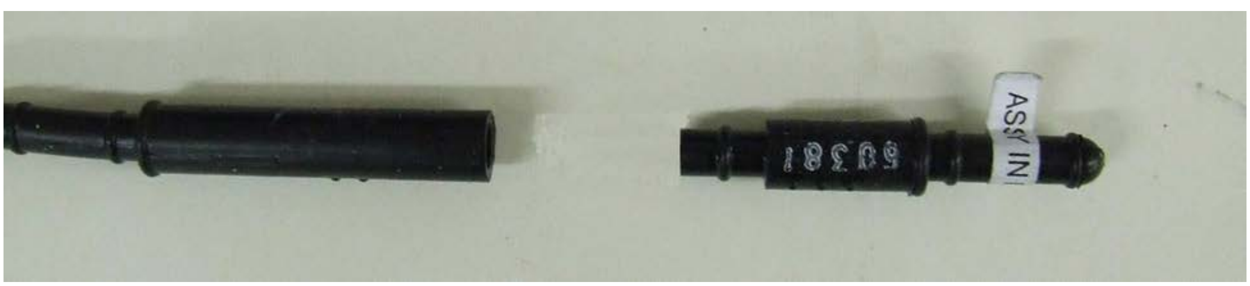


Figure 54. Seaconn Dummy Plugs

- Return the hammer to its proper locked position
- In place of the bottom block and slip ring, attach the bail assembly using the same six screws

Figure 55. Bail Connection

- You can now use the two quick-release pins to remove the bail filter tube easily so that you can make repeated bail runs until the hole is cleaned to your satisfaction.
- Not shown in Figure 56 is the aluminum sealing ring that improves the seal between the top of the filter tube and the hole wall. The sealing ring is attached using six small pan-head screws and washers.
- At the bottom of the filter tube is a flap-valve assembly that will let fluid flow up through the bail, but not back down. The idea is that the bail can be lowered freely through the fluid, but when it is pulled back up, the sealing ring forces the water flow through the inside of the filter tube and (because the flap valve is closed) out through the filter screen.
- To empty the filter tube, remove it from the anti-torque section using the quick- release pins, and back-flush the filter with fluid poured in through the flap valve.
- Unless there are serious performance issues, it is unwise to try to remove the filter screens from the filter tube. Installing the triple layer of screens (heavy screen in and out, fine screen between) is very difficult.

12.0 ROUTINE MAINTENANCE OF ECLIPSE ICE DRILL

Some routine maintenance is required to keep the ECLIPSE drill running properly and extend its running lifetime.

12.1 Honing the Cutters and Core Dogs

Efficient cutting of core requires razor-sharp cutters and core dogs. Honing these components in the field can be done easily with a fine diamond hone. The cutters and heels are made of hardened D2 tool steel, so sharpening with a file will not work.

12.2 Storing the Drill for the Season

The most important thing to remember when storing the drill away for the season is to make sure it is dry. The control panel, anti-torque section, and drill motor section (especially if sealed) should be dried carefully, inside and out. In other words, the motor section should be opened at the end of the season.

12.3 Saline environments

If the drill is used in a saline environment, corrosion of the aluminum can be a problem. When it corrodes, aluminum forms an oxide (whitish coating) that thickens the surface (i.e., a shaft-like part will expand). Where such a part is inside another (e.g., the anti- torque section in the motor section pressure barrel), the aluminum part may bind inside. For this reason, please rinse with fresh water before moving to a warm, above-zero environment. The drill should be salt-free and dry before shipping and storage.

A clean, dry drill is a happy drill!

12.4 Oil

The Winch motor and the drill motor Harmonic Drive transmissions should be lubricated with Synthetic Dextron II or equivalent automatic transmission fluid.

The oil level of the winch can be checked with the transmission axis horizontal and the plug hole on a horizontal line through the drum axis, Figure 57. The oil should just reach the plug. The normal contents of the transmission are 375 ml of Dextron II fluid.

The oil level of the drill sonde motor can only be checked by opening the transmission. Remove the motor section can from gearbox and motor assembly. With the motor section vertical (motor on top) remove the six screws between the motor adapter and the gearbox and remove the motor. The gearbox spline cup will now be visible. The oil level should be visible in the spline cup and be ¾” below the top edge of the spline cup.

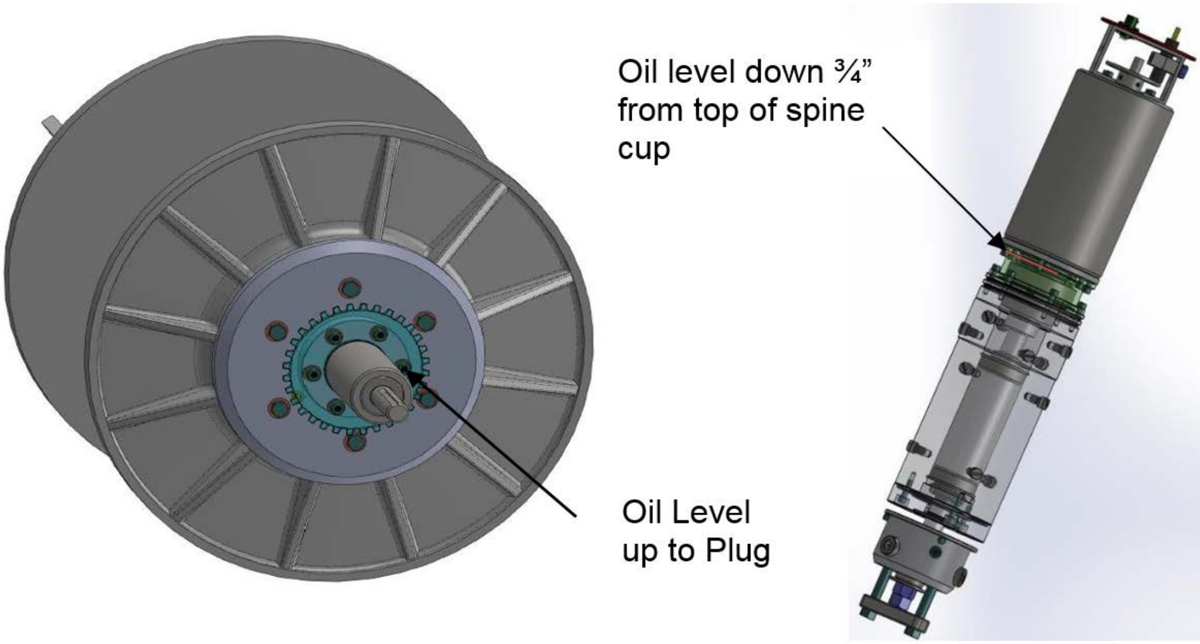


Figure 56. Winch Transmission Oil Level

12.5 Level Winder Maintenance

With the exception of the enclosed gears which are steel and cast iron, the important operating components and framework components of the Level Winder are made of aluminum alloys, stainless steels, and bronze and so are robust and not subject to corrosion. However, we suggest that you:

- Avoid allowing snow to melt and freeze onto the bellows.
- Periodically grease the linear bearing with a high quality corrosion-preventing grease of NLGI #1 consistency, such as "snowmobile grease".
- Use a corrosion-inhibiting spray grease (such as a white lithium-based spray grease) when disassembling and subsequently reassembling the gear train.
- At the end of every season, dry the level wind thoroughly, and re-grease the bushing bearings.

13.0 TROUBLESHOOTING

The tips below are intended to help an operator problem solve some issues that might be encountered. First check the obvious, such as power connections (recall that the drill motor requires a separate, isolated power feed), and blown fuses.

13.1 Drill motor will not start

- Is the direction switch set to "FORward" or "REVerse"? The motor will not work if the switch is in the middle position.
- Is the emergency stop switch on the control box depressed? Pull up the emergency stop switch to reset.
- Check if the 5 Amp fuse is blown.
- Check electrical connections between the control box and the drill motor.
- Swap in the spare control box.

- Replace the motor section.

13.2 Winch motor will not start

- Is the direction switch set to “UP” or “DOWN”? The motor will not work if the switch is in the middle position.
- Is the emergency stop switch on the control box depressed? Pull up the emergency stop switch to reset.
- Verify the winch motor power cable is connected.
- Check if the 15 Amp fuse is blown.
- Swap in the spare control box.
- Replace the winch motor.

13.3 Depth counter runs in reverse

Turn the sheave 180 degrees (to move the encoder to the opposite side of the mast).

13.4 Drill motor is trying to rotate the barrel, but not working

Either the drill is packed full of chips and core, or the barrel is frozen (i.e., water frozen to ice) to the outer barrel. In either case, gently banging the outer barrel with a dead-blow hammer will free the chips. Sometimes, running the drill motor in reverse will clear a “packed” drill.

13.5 Freeing a stuck drill

The worst has happened. The drill has gotten stuck. The response to this situation should be rapid, particularly if the drill has been trapped by borehole closure (a danger below about 300m, depending on ice temperature).

- Apply tension on the cable with the winch motor
- Preferably using a hose or balloon, deliver a “bomb” of anti-freeze (glycol or alcohol) to the drill in order to reverse the freezing or counter the closure

13.6 “Gum” in the sheave

Particularly with a new cable, you may notice a noxious mixture of cable lubricant and ice chips building up in the groove on the sheave. Clearly this must get cleaned out so that the depth counter can register accurately.

13.7 Winch motor failure

If the winch motor fails while the drill is in the hole, first check that the problem is not simply the fuse on the control panel. If the problem cannot be resolved (e.g., broken generator) it is prudent to get the sonde out of the hole (or at least up to shallow depth where it is accessible). There are two ways to raise the sonde manually.

- Using the hand cranks. This is slow and laborious as you are fighting against the winch transmission. You must also ensure that the winch brake (the electric brake) is disengaged. Since electrical power is required to release the brake, this will not be possible in the case of a power outage. In this case, the cover on the rear bell of the winch motor can be removed and the brake carefully unbolted from the motor.
- The sonde can be raised by pulling on the cable. The easiest way to do this is to grab the cable where it descends to the winch drum and walk away from the winch. Wear gloves!

13.8 Winch transmission failure

Since 1996, though ECLIPSE drills have drilled many kilometers of core, we have had only one report of the winch transmission failing. When this happens, it is likely that the drill will go into free-fall. If possible, apply the hand brake as quickly as possible to slow the descent of the drill. You may not be able to stop the descent, but the damage will be lessened.

The sonde will then have to be raised using the hand crank.

13.9 The drill does not advance

This problem can be caused by cakes of ice building up on the bottom of the heels. The best solution is to prevent this from happening in the first place:

- When starting a new drill run, always approach the bottom of the hole with the drill running; this will prevent the cutter head landing on the chips that are lying at the bottom.
- Some operators have had luck coating the heels with a thin layer of epoxy – this seems to discourage the formation of cakes.

If the drill is in the hole and you suspect that cakes have formed, you can try a few things:

- Reverse the drill motor to try to wipe the cakes off. There is a danger in doing this too much because it will also cause chips that are up in the flights to be driven back down to the cutter head, thereby possible clogging the cutter head.
- You can use the hammer on the drill to “tap” on the drill (while it is running) to try to get the drilling started; you do this by getting a bit of slack on the cable and tapping the hammer by hand.
- You can also raise the drill a few decimeters (by pulling sideways on the cable) and dropping the sonde onto the bottom; If the drill is running, this can knock off the cakes; of course, this is also hard on the drill sonde!

13.10 Calibrating the depth counter and load pin

If you find the depth encoder or load pin are not reading the correct values, it is possible to recalibrate them in the field. Reference the LCI-90i quick setup guide and manual in Appendix A for further instructions.

14.0 TOOLS AND SPARES

14.1 Supplied Tools List

The following tools are supplied with the ECLIPSE ice drill to aid in assembly, maintenance and basic repair:

- 1/4" square drive hand tool for removing core locks x2
- Trimmed 5/32" hex wrench for disassembly of drill motor section
- 5/16" steel pins for adjusting anti-torque section x3
- Hex wrench (Allen key) kit, imperial, 3/8" to 0.050" x 2
- 6" adjustable wrench
- 5" needle-nosed pliers
- Multi-driver screwdriver (flat, Phillips, etc.)
- Blue Loctite thread locker
- 8" diagonal cutters or linesman pliers
- Rubber or plastic-faced hammer
- Dead-blow hammer (plastic hammer with head filled with metal beads)
- Small ball peen hammer
- Claw hammer
- Teflon plumbing tape (for water/oil sealing tapered pipe threads)
- Flat screwdriver for cutter head screws and drill assembly screws
- Magnet for picking up dropped parts
- Diamond plates for core dogs and cutter teeth
- Nylon rods 10’’x1’’diam. and 10’’x1.5’’ diam.
- 2 Strap wrenches
- Locking needle-nose pliers
- 2 sets of diamond files
- Hack saw blades
- 10 plastic zip ties
- Capstan removal tool
- Low temperature grease
- Scotch bright pads
- Sharpies x 2
- Anti-seize compound
- Roll of emeries cloth, 150 grit
- Dremel tool with assortment of bits including cutoff wheels
- Wire brush
- Wire strippers
- Dental pick(s)
- Soldering iron and rosin-type electronics solder (this type of resin does not necessarily require cleaning). Do not use organic or acid flux solder!
- Color assortment of 22AWG PVC-coated stranded copper wire
- 3/16" heat shrink tubing

- Self-vulcanizing electrical splicing tape (or as a poor alternative, electrical tape - splicing tape works better in the cold and leaves no horrible residue). Normal vinyl electrical tape is messy and does not perform well in cold temperatures.
- Sufficient string or cord to lower the supplied magnet to the hole bottom. This may be required to retrieve dropped objects.
- Cordless drill with bits
- Drill bit set
- Socket set
- Wrench set
- Assortment of screw drivers

14.2 Suggested Tools List

The following are items that are not supplied with the drill, but it is suggested that they be available for emergency use.

- 20L of antifreeze to use in case the drill gets stuck in the hole (propylene glycol is preferred as it is aircraft safe and relatively nontoxic – propanol, ethanol, or ethylene glycol may also be used)
- Hose or balloons that can be used to deliver anti-freeze to the drill sonde in case of it getting stuck

14.3 Spare Parts Inventory

These lists contain the minimum quantity of spares provided with an Eclipse drill.

14.3.1 For Winch:

- Mechanical Components
  - 3 ea P.D. drive belt (Eagle)
  - 1 ea Harmonic Drive transmission (HDC-040-050-2A)
  - 1 ea Spare motor (MET 5A-F014336G)
  - 1 ea Misc. spare bolts/nuts/washers
- Electrical components
  - 1 ea Spare control box
  - 1 ea Spare readout box
  - 1 ea Spare depth encoder (Dynapar HS20051263105)
  - 1 ea Spare load pin with cable (Magtrol LB 212)

14.3.2 For Drill:

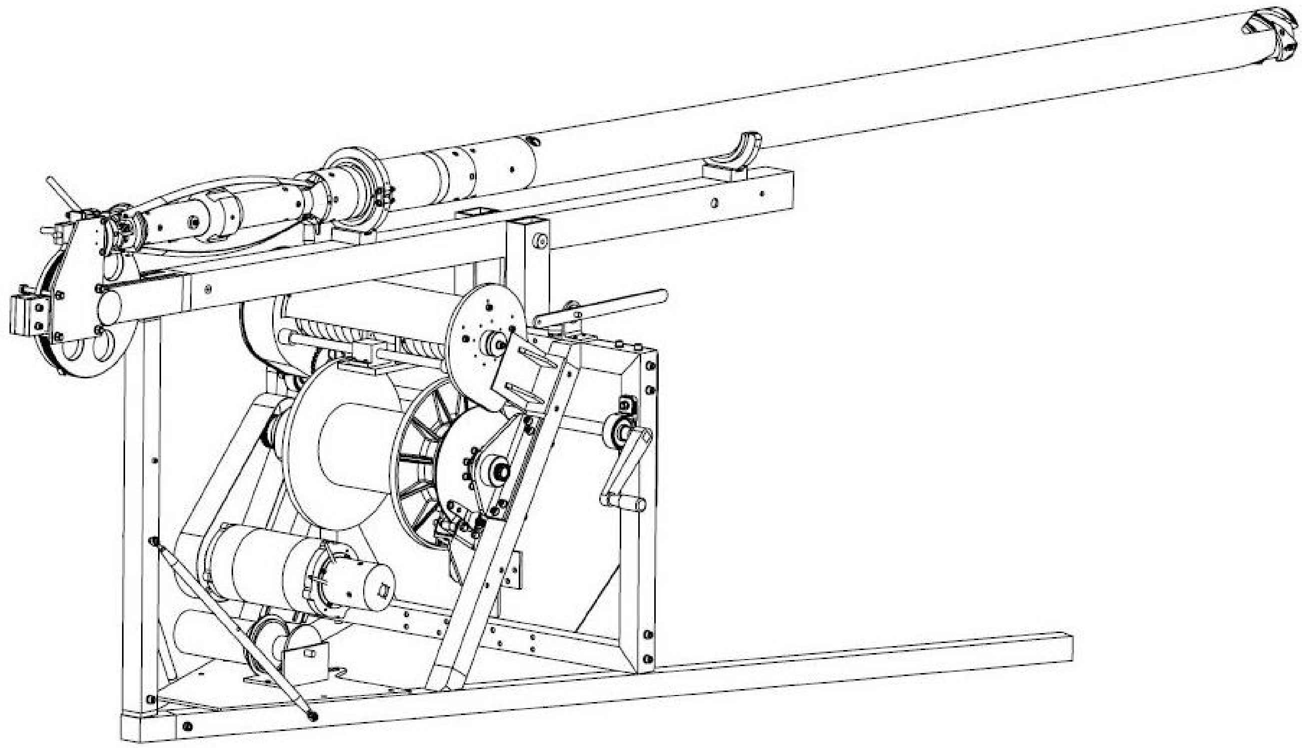
- Mechanical components
  - 2 L Automatic transmission fluid for harmonic drive
  - 1 ea Spare motor section
  - 1 ea Spare core barrel assembly
  - 1 ea Spare cutter head – core dog type
  - 1 ea Collet for collet cutter head
  - 9 ea Cutters (3 operational and 6 spare)

- 6 ea Short core dogs (3 operational and 3 spare)
- 6 ea Long core dogs (3 operational and 3 spare)
- 6 ea Penetration shoes - size 2 (3 operational and 3 spare)
- 6 ea Penetration shoes - size 3 (3 operational and 3 spare)
- 6 ea Penetration shoes - size 4 (3 operational and 3 spare)
- 6 ea Penetration shoes - size 5 (3 operational and 3 spare)
- 9 ea Penetration shoe shim – 0.002” Thick
- 9 ea Penetration shoe shim – 0.003” Thick
- 9 ea Penetration shoe shim – 0.005” Thick
- 6 ea Flat-head screws for retaining cutters
- 9 ea Cutter dowel pins
- 6 ea Set screws to secure core dog pivot pins
- 9 ea Core dog spring – 6 turn, 0.027” wire
- 9 ea Core dog spring – 4 turn, 0.019” wire
- 9 ea Core dog spring – 7 turn, 0.019” wire
- 6 ea spare ½-13 cutter head retaining screw
- 1 ea Spare egg/housing for cable termination
- 3 ea Evergrip cable overwrap (1 operational and 2 spare)
- 3 ea Leaf springs for anti-torque section
- 3 ea Spare anti-torque slide hammer retaining screws
- 8 ea Spare drill assembly screws
- 1 ea Core barrel lock pin assembly
- 1 ea Misc. Heat Shrink tubing

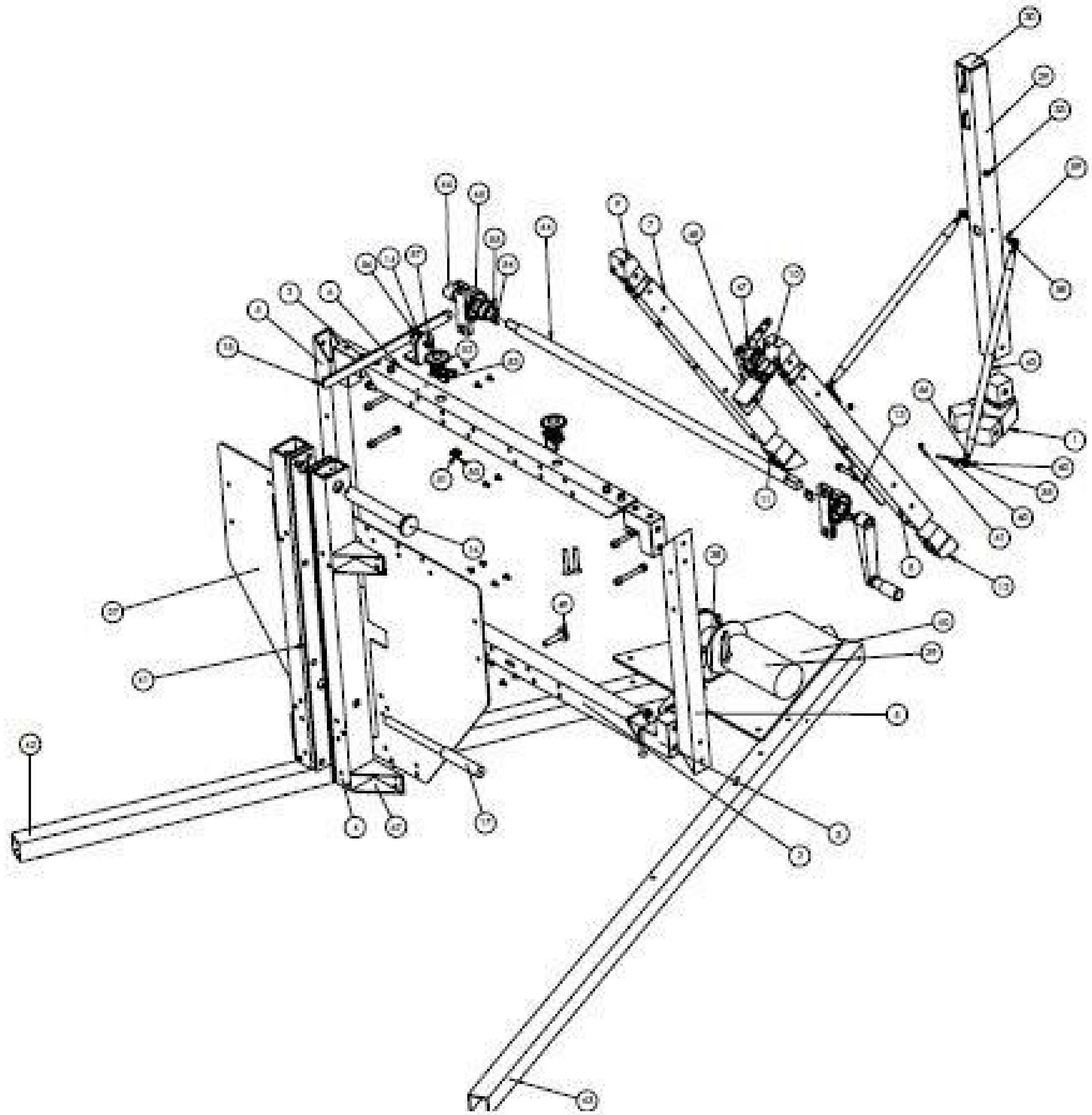
15.0 DRAWINGS

These drawings are for information purposes only. Please contact us for more information.

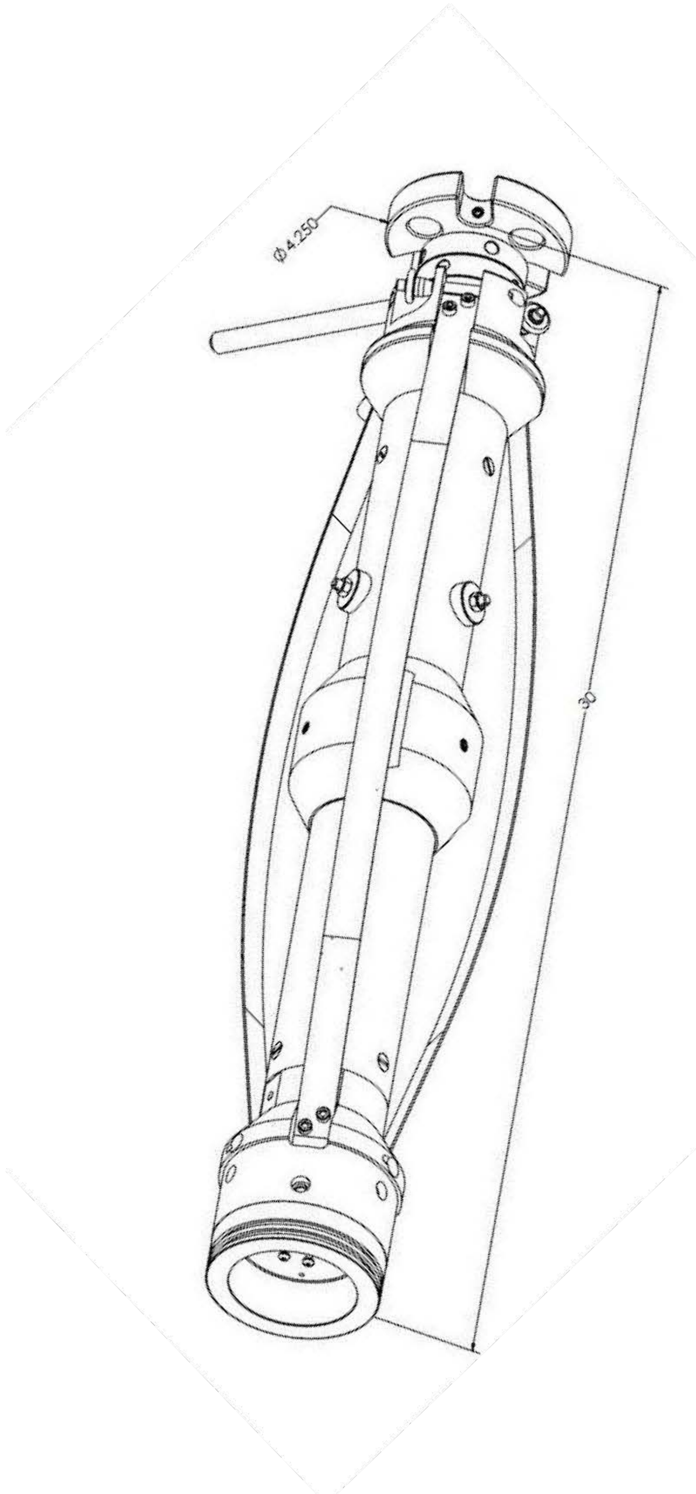
15.1 Complete drill short boom:

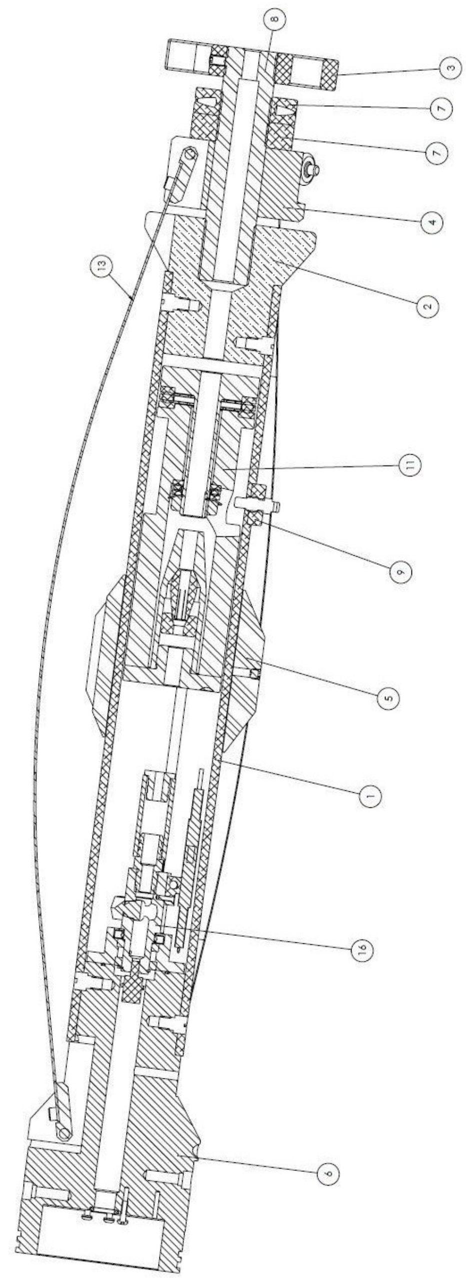


15.2 Frame exploded view:

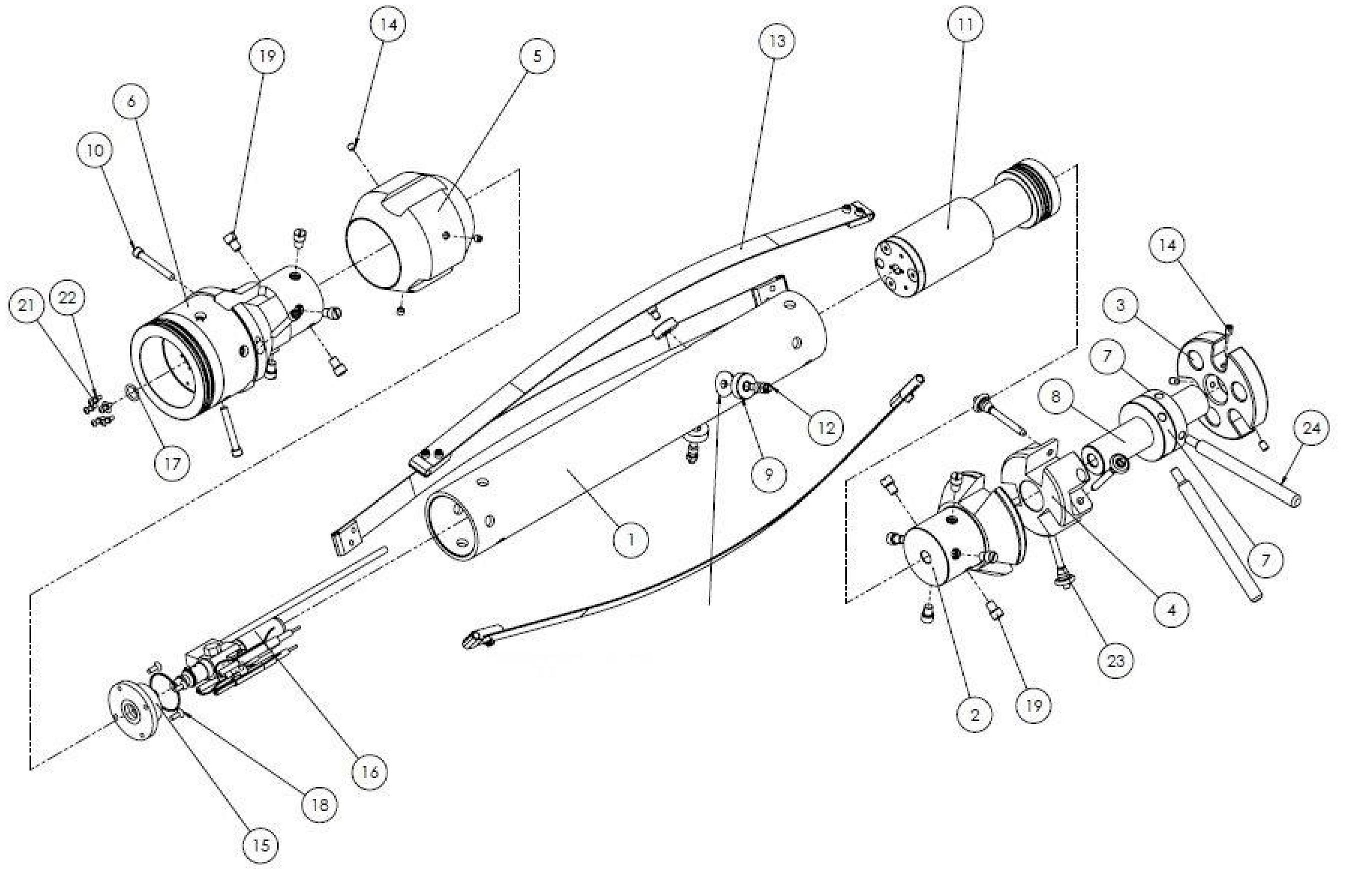


15.3 Anti-torque:

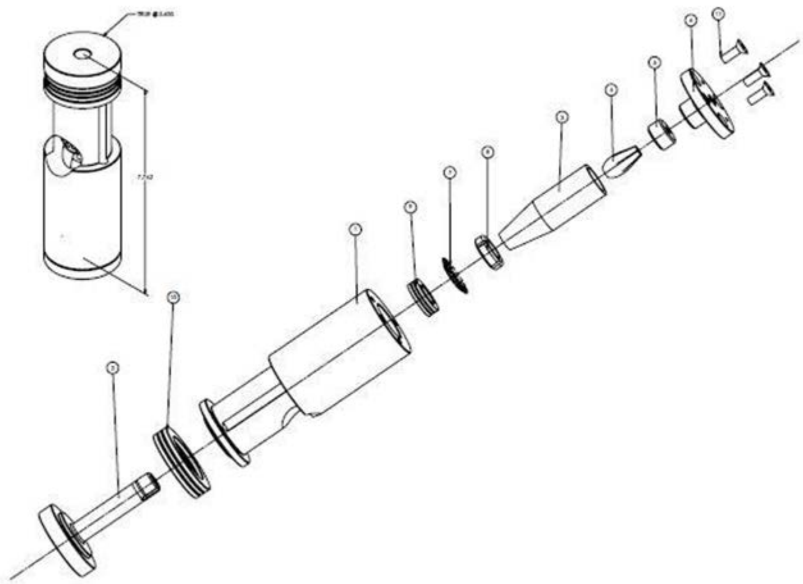




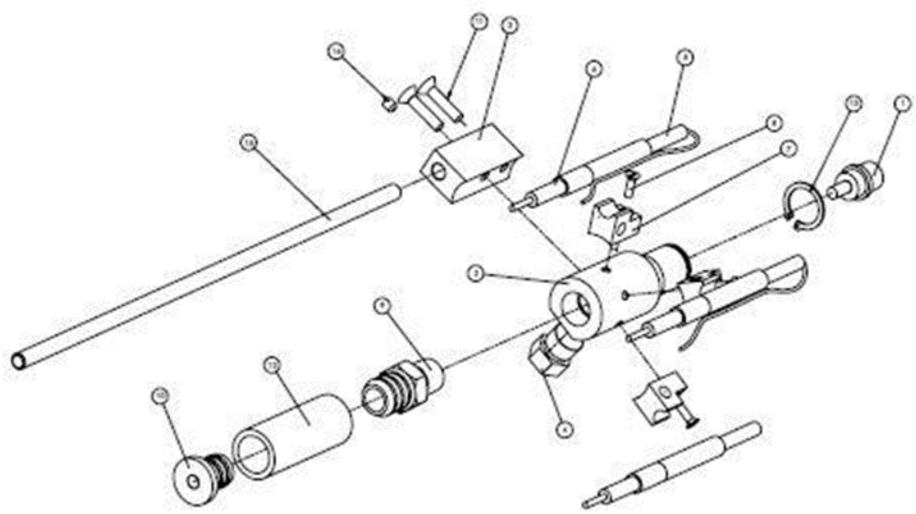
15.4 Anti-torque exploded view:



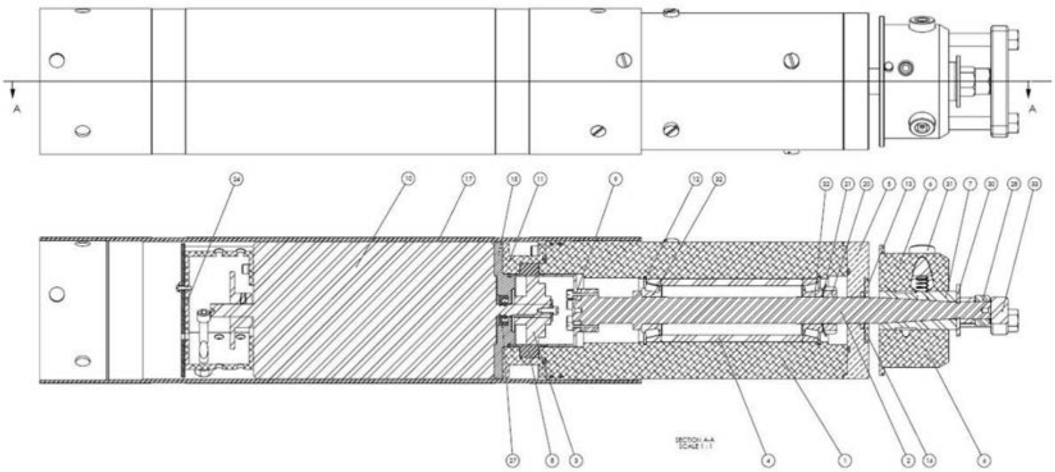
15.5 Hammer assembly in the Anti-torque:



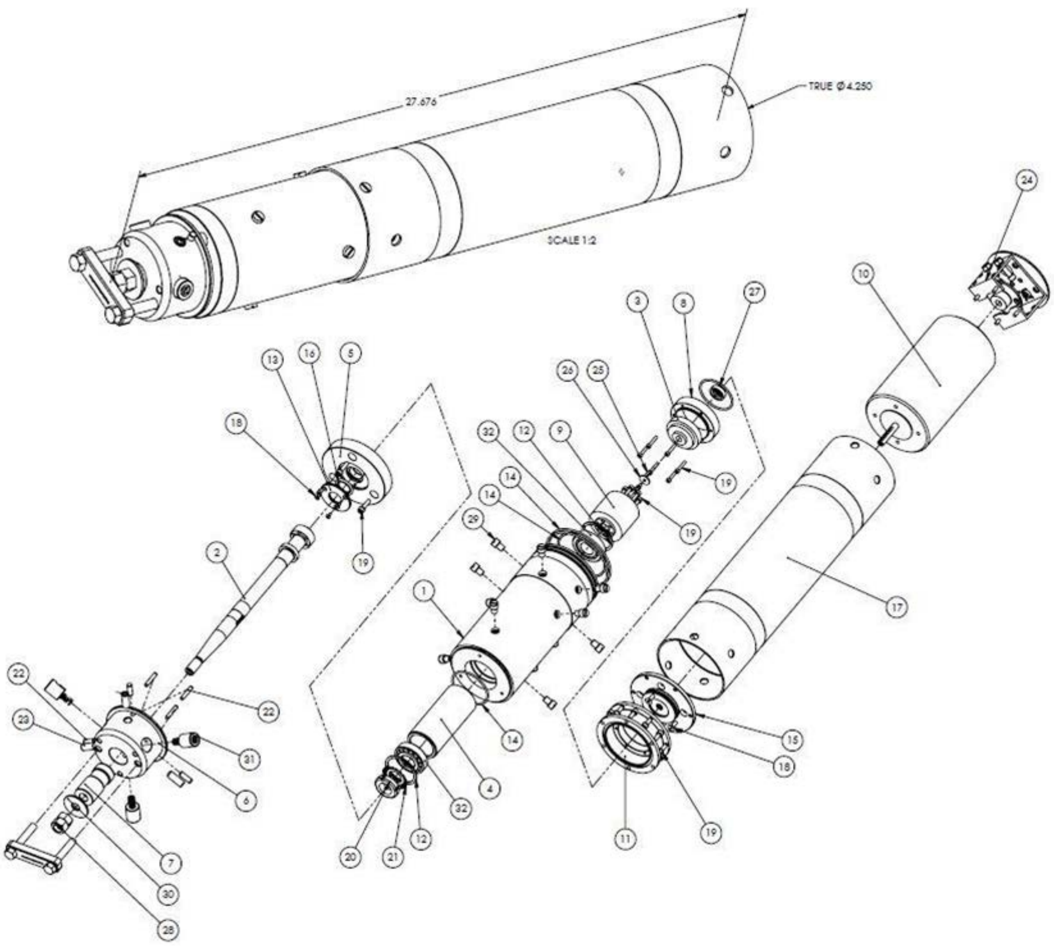
15.6 Slip ring assembly in the Anti-torque:



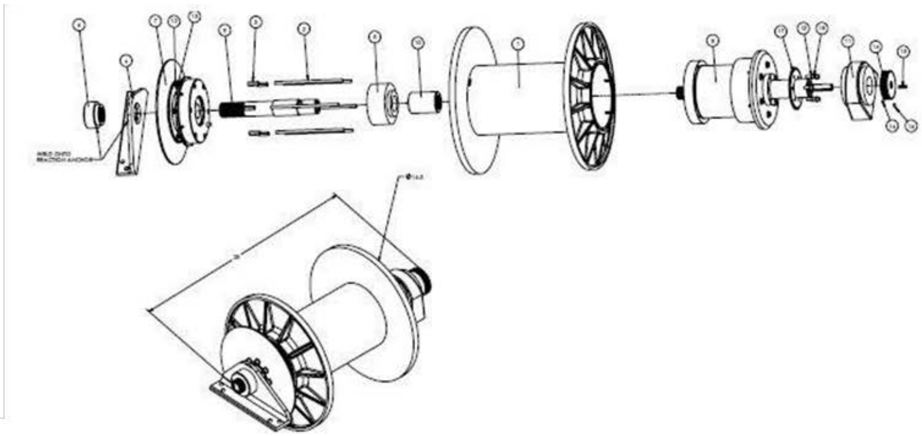
15.7 Drill motor:

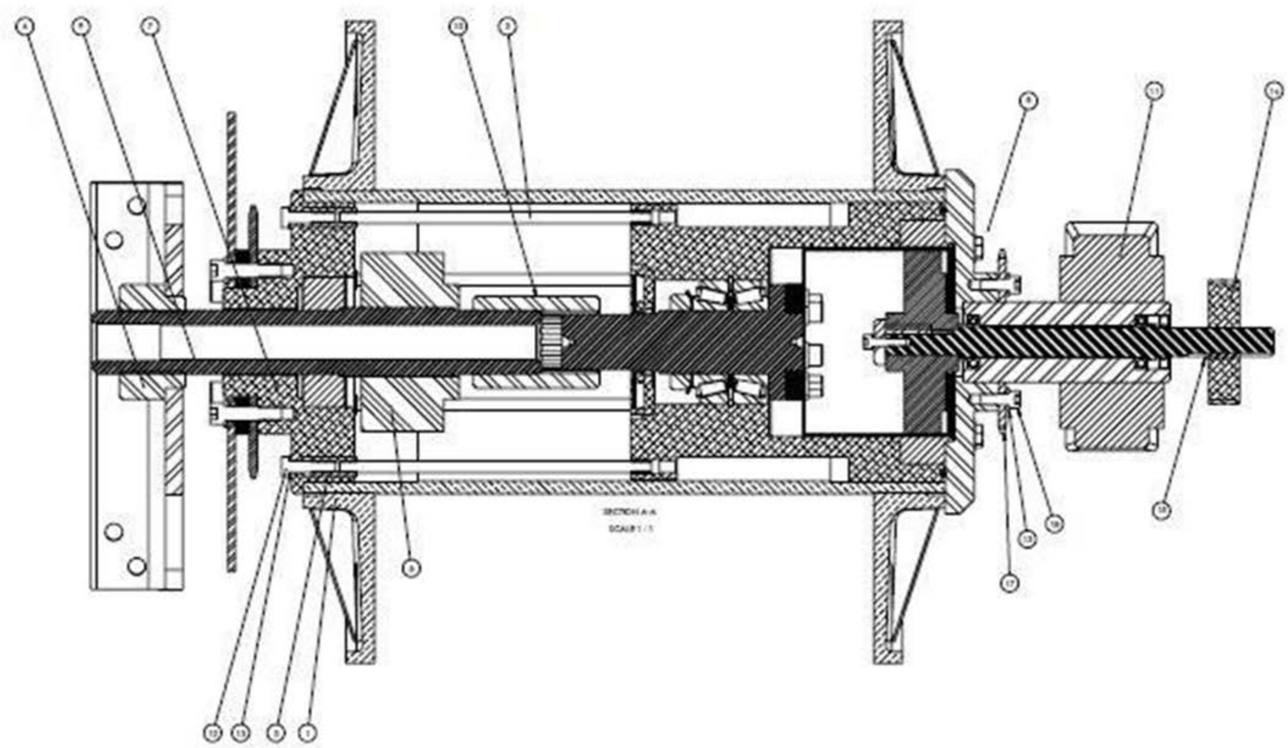


15.8 Drill motor, exploded view:

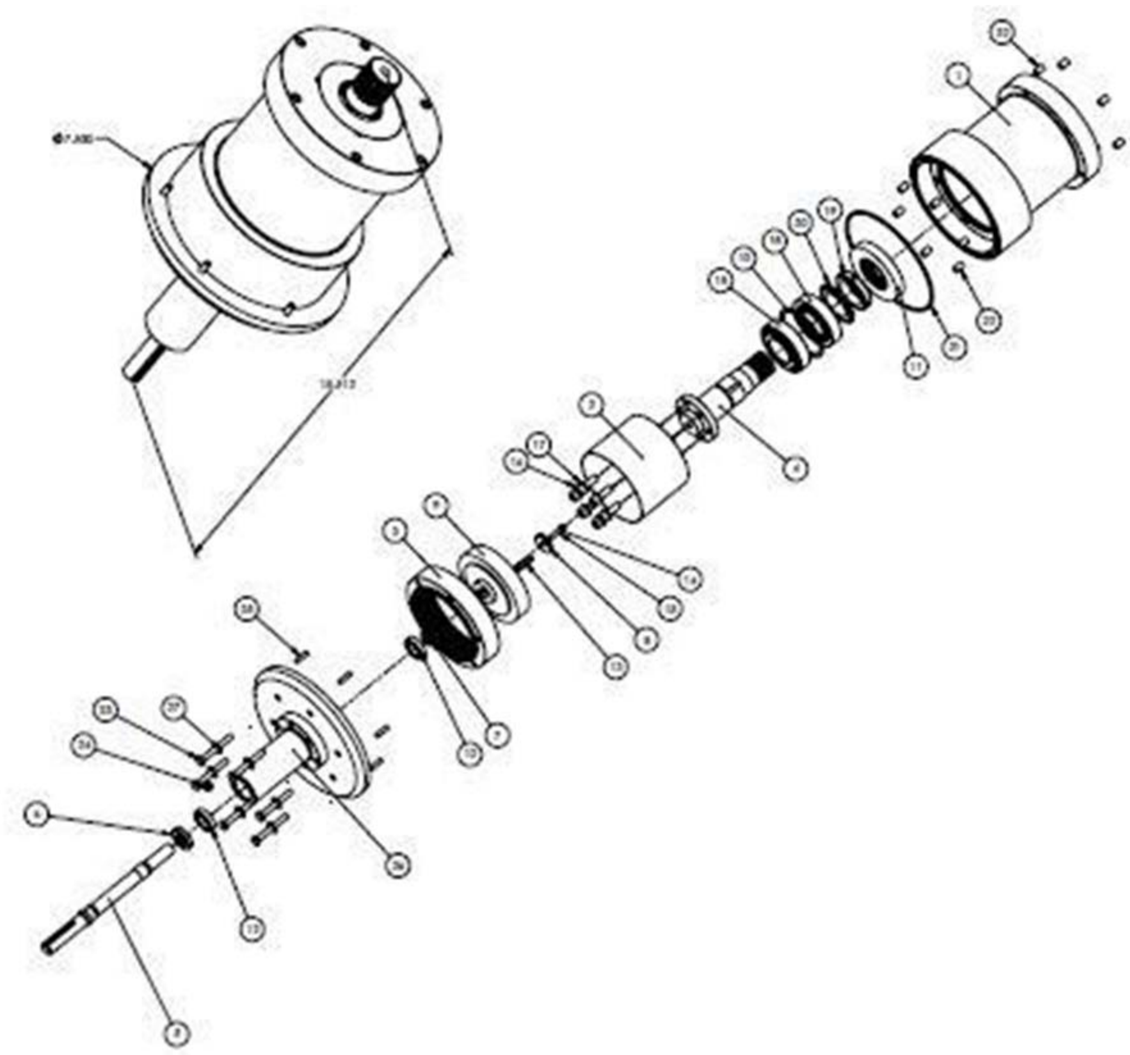


15.9 Winch assembly:

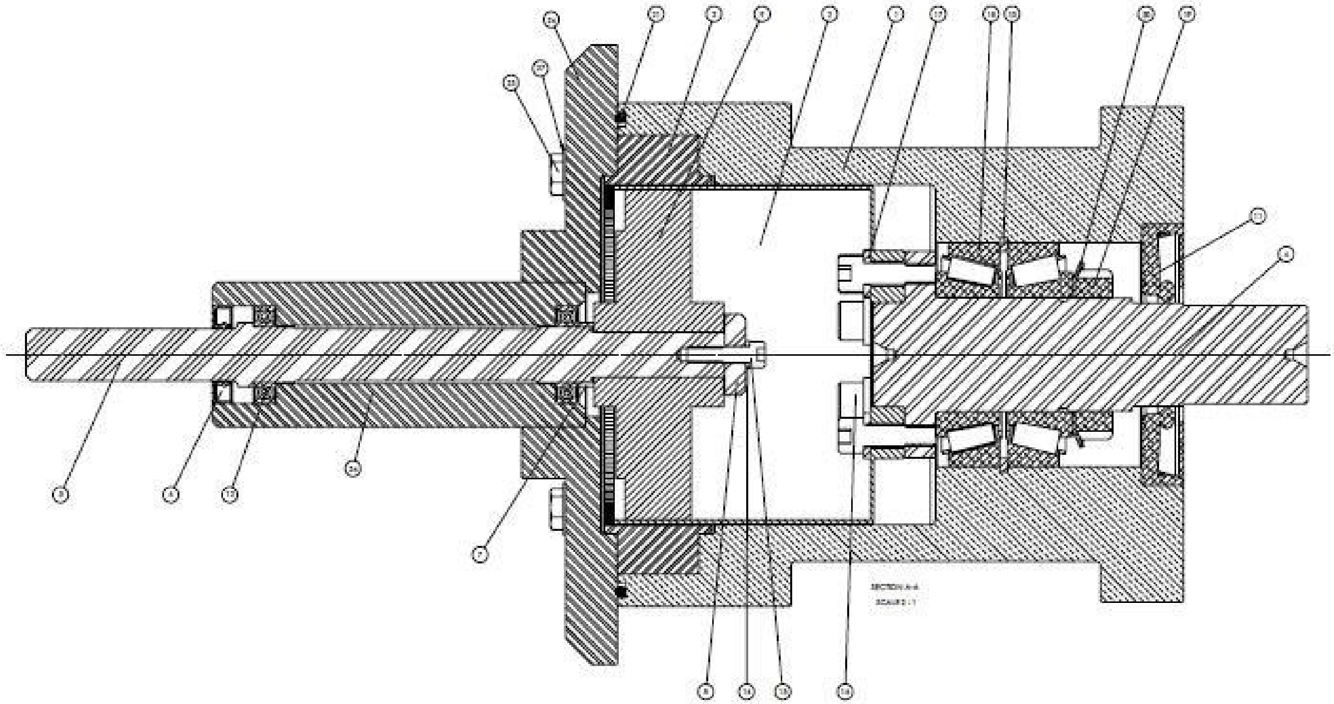




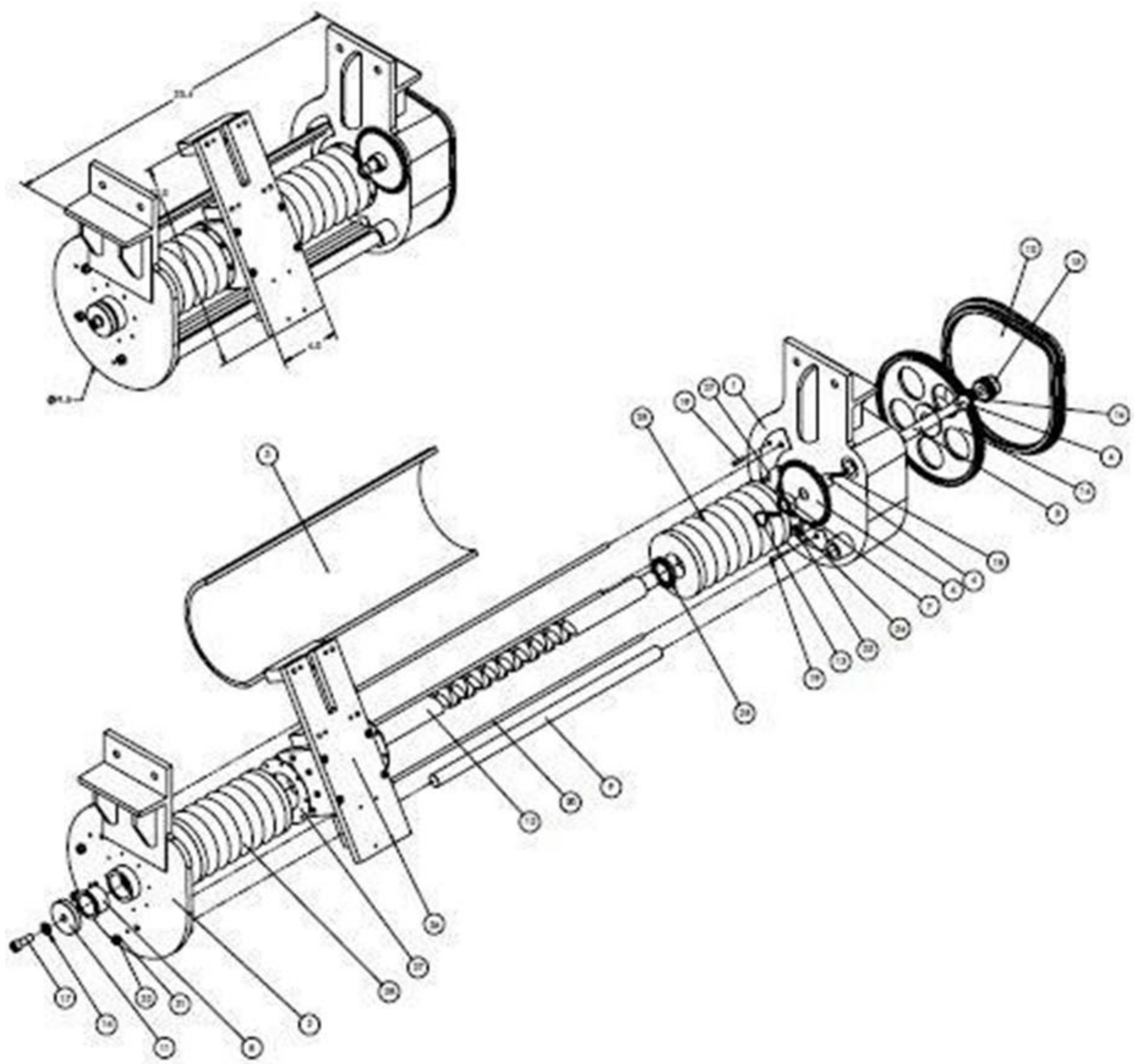
15.10 Winch transmission assembly exploded view:



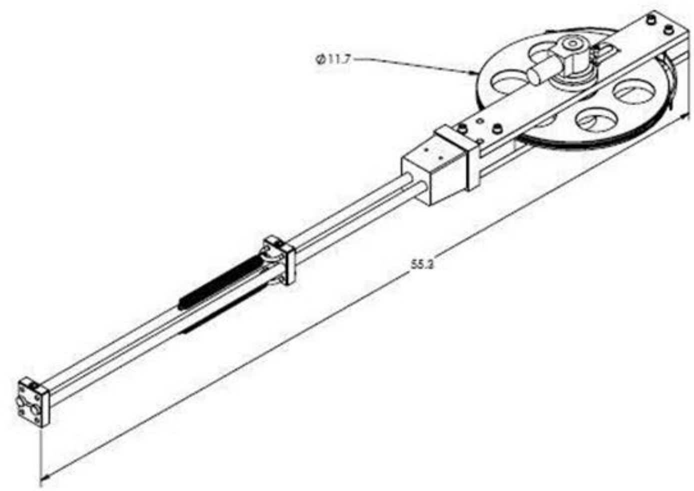
15.11 Winch transmission assembly:

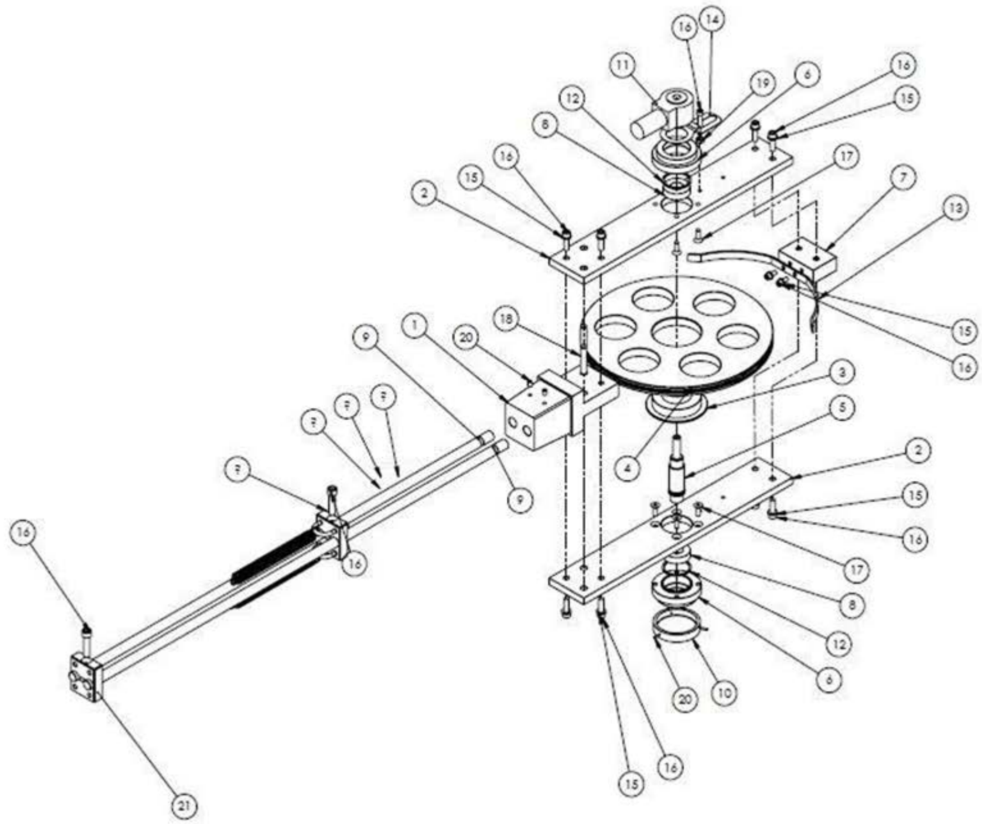


15.12 Level Winder assembly:



15.13 Sheave assembly:





15.14 Head assembly: