

SUPER MAXBIT / SUPER MAXBIT G-MODEL **OPERATION MANUAL**



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MMC RYOTEC Corporation

A Group Company of  **MITSUBISHI MATERIALS**

SUPER MAXBIT and SUPER MAXBIT G-MODEL

devices stabilize boreholes in unconsolidated overburden formations.

This is an advanced technology compared to the other eccentric drilling methods. It consists of two to three wings connected to a Down the Hole Hammer. The bit heads are extendable/retractable when the drill string rotates in the forward/reverse direction.

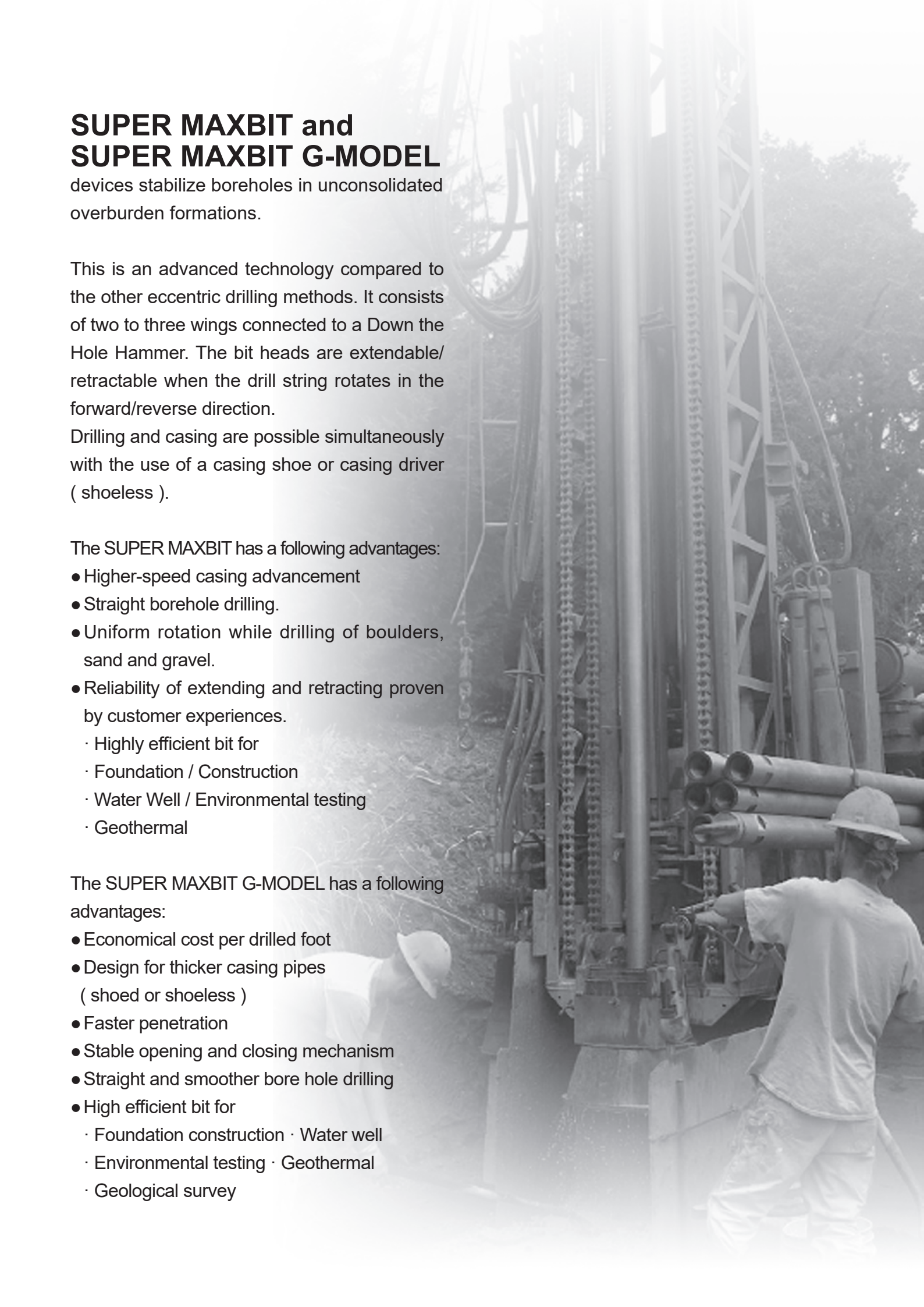
Drilling and casing are possible simultaneously with the use of a casing shoe or casing driver (shoeless).

The SUPER MAXBIT has a following advantages:

- Higher-speed casing advancement
- Straight borehole drilling.
- Uniform rotation while drilling of boulders, sand and gravel.
- Reliability of extending and retracting proven by customer experiences.
 - Highly efficient bit for
 - Foundation / Construction
 - Water Well / Environmental testing
 - Geothermal

The SUPER MAXBIT G-MODEL has a following advantages:

- Economical cost per drilled foot
- Design for thicker casing pipes (shoed or shoeless)
- Faster penetration
- Stable opening and closing mechanism
- Straight and smoother bore hole drilling
- High efficient bit for
 - Foundation construction · Water well
 - Environmental testing · Geothermal
 - Geological survey



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A. Drilling / Casing Advancement Procedures

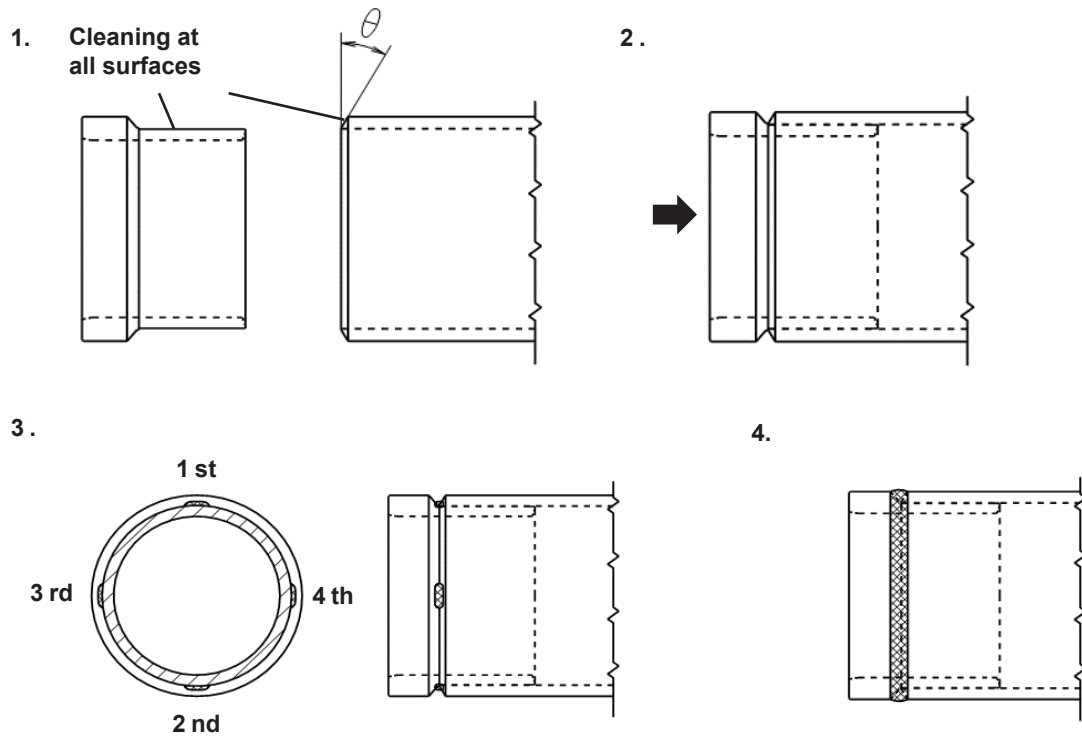
A-1. Before starting to drill

Knowing the formation you are drilling in helps, but isn't always known before you start drilling. Casing advancement is done with a top head rotary drive drill rig. You need to decide if you will advance the casing by the use of an internal drive shoe welded to the bottom of the casing (shoed application). This drive shoe welded to the bottom of the casing will pull the casing through the formation while being drilled. **NOTE:** smaller hole through the drive shoe.

The use of a casing hammer / casing driver, uses an exterior drive shoe like a cable tool style drive shoe welded to the bottom of the casing (shoeless application). Both of these applications will also work on a top hammer drills advancing casing in the ground. Casing size and wall thickness is very important to be known. This helps to decide the right device and drive shoe to match the casing being used. Also helps for the selection of bit heads to cut a large enough diameter borehole to advance the casing.

A-2. Casing shoe attachment (Welding procedure)

1. Bevel the end of the casing to an angle of about 60 degrees (θ in Figure1 should be 30 degrees). Be sure that all surfaces to be welded are clean and free from any dirt, contamination including moisture. Pre-heat the end of the casing shoe to 100 degrees (Celsius).
2. Insert the casing shoe inside the casing pipe. Be sure the casing shoe is in the center of the casing pipe.
3. Temporary tack-weld the casing to centralize. Tack welding should be done diagonally.
4. Welding on the circumference. Normally (3) passes is recommended. Take sufficient time to weld the casing using the correct welding rod.
5. After welding, use a grinder to smooth the weld. This will help while installing casing not to drag drill cuttings into the borehole on the outside of the casing causing drag during installation.
6. Recommendation: Plug welds or diamonds are cut in the casing and then welded to strengthen the casing to the drive shoe. Please refer Table1 for plug size and the number of plugs.



Tack welding should be done diagonally

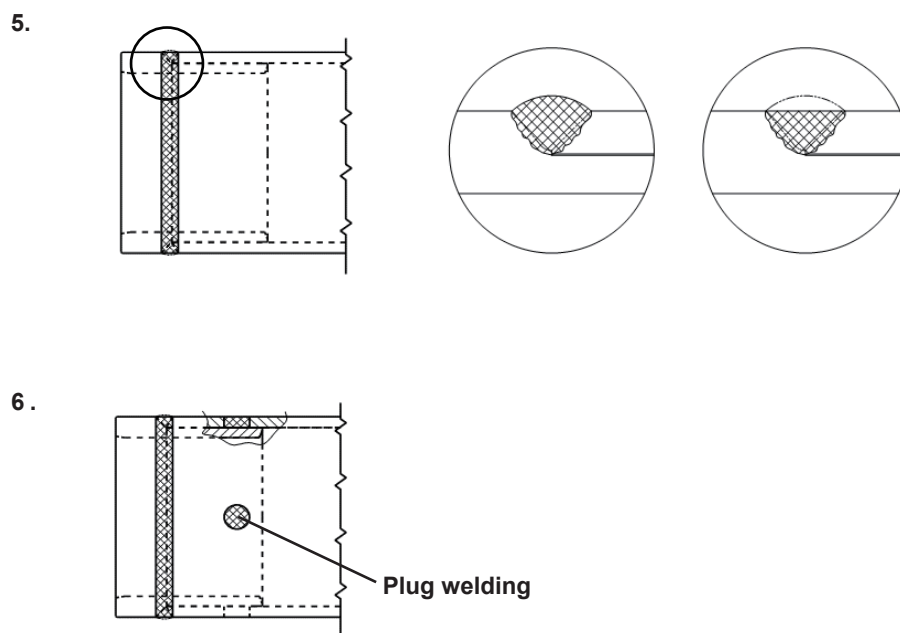


Figure1: Weldig procedure

Table1: Plug size and the number of plugs

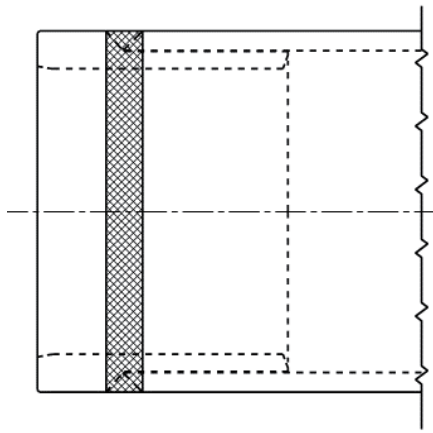
Casing size (inch)	Plug size	Number
4" – 6"	20 – 30 mm	3-4
8" – 12"	30 mm	6 and up
14" – 20"	30 – 35 mm	8 and up

OPERATION

NOTE:

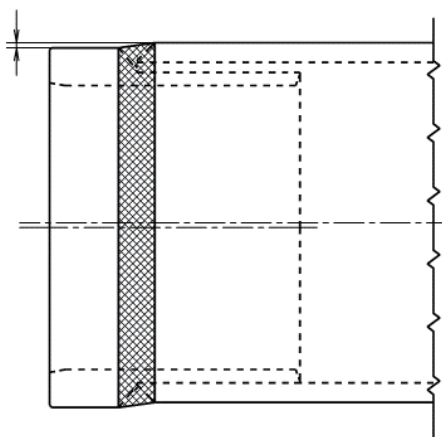
The casing shoe must be correctly welded to the casing in order to carry out a successful casing drilling operation. If the casing shoe is not welded correctly to the casing, possible premature failures could happen. The casing shoe could separate from the casing, possible borehole deviation or damage to the shoulder of device.

✓Good



✗Bad

Gap between casing and the casing shoe



Tilting connection

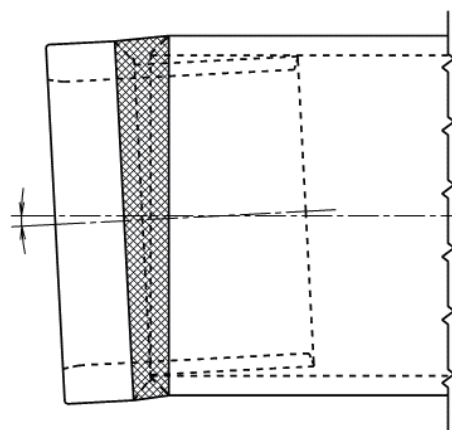


Figure2: Alignment for the casing pipes and casing shoe

A-3. Assembling and setting up the drill strings

After the casing shoe is attached to the casing pipe, the assembled **SUPER MAXBIT (SMB)** or **SUPER MAXBIT G-MODEL (SMB-G)** is attached to the down the hole hammer. The bit should be examined during assembly to be sure that all parts are in proper working order and complete. The hammer is threaded on to the drill string. An optional guide sleeve or stabilizer is recommended on the top of the hammer.

Before inserting the drill string into the casing inspect the tools, device and bit heads to be free to open and close with ease to a full open position before drilling. When inserting the drill string into the casing pipe, the SMB or SMB-G wings will be in the closed position.

Insert the SMB or SMB-G and drill string into the casing pipe until the bit wings have cleared the drive lip and casing shoe. The device now should be in contact with the drive shoulder and the drive shoe.

NOTE: Checking to see if bit heads are open

The SMB or SMB-G device now rotating or turning clockwise will open the bit heads to the drill position. To check the bit heads to see if they are open or in the drill position, stop rotation and slightly pick up on the drill string, with the bit heads open the tools will stop moving upward because the bit heads are hitting the bottom of the drive shoe. **DO NOT PULL EXCESSIVELY**, you could damage bit heads or break the retaining pins. (We recommend that pick up or lift the casing drill string separately, if the bit wings close or are in retract position, there is possibility that casing pipe will fall.)

OPERATION

A-4. Setting Up the Drill Rig to Drill

It is important for drilling to set up the drill rig so it is level and stable. This also helps in leveling the drill string to drill straight. Usually a leveling apparatus is used. In most cases, vertical to the ground, unless horizontally drilling.

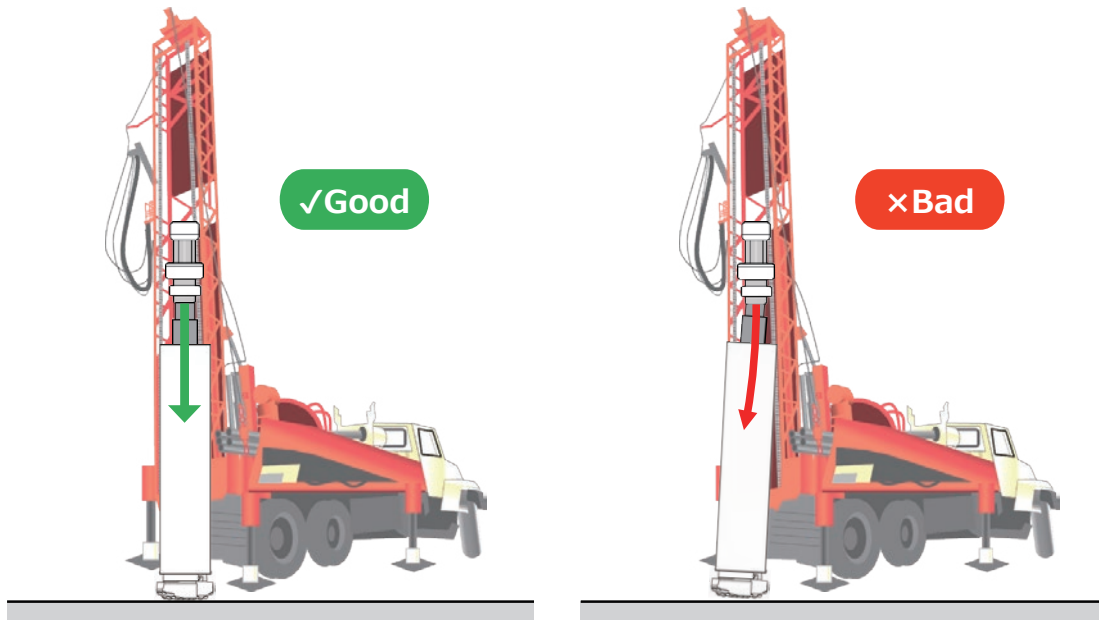


Figure3: Setting up the Drill Rig to Drill

A-5. Installing Casing

With the casing shoe or drive shoe welded on the 1st length of casing, the 2nd casing and each casing length after that should be aligned / leveled and welded keeping straight. The misalignment of the casing pipe / crooked pipe welds may cause drag / high friction on casing installation.

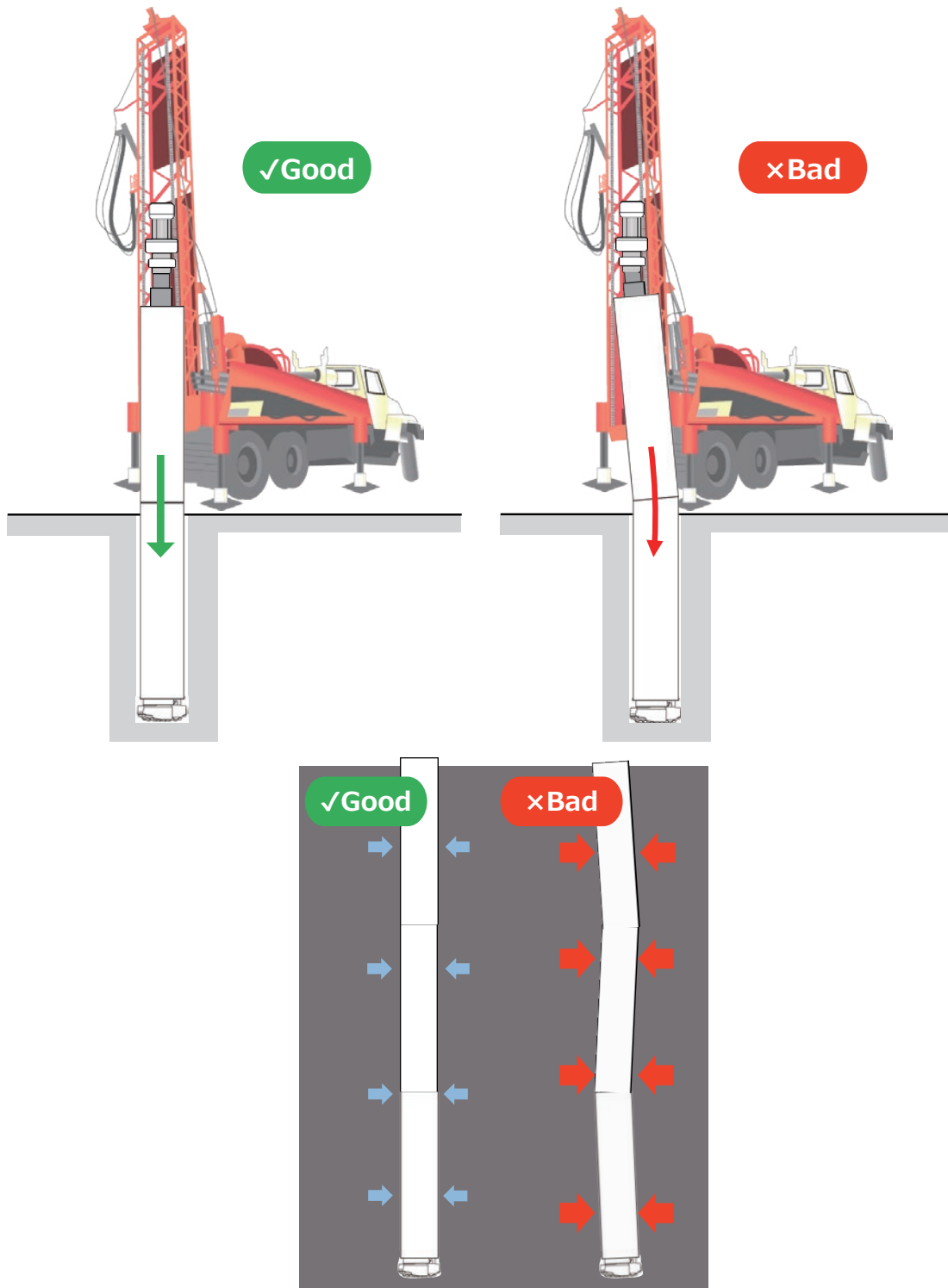


Figure4: Installing Casing

NOTE:

The misalignment of the casing pipes cause 1. Possibility of breaking of the welded joints. 2. Premature wear of the device shoulder. 3. The misalignment or welding slag occurring may cause friction on the drill string and or prevent the drill string from retracting after drilling. Also possible mushrooming.

×Bad

Misalignment drilling

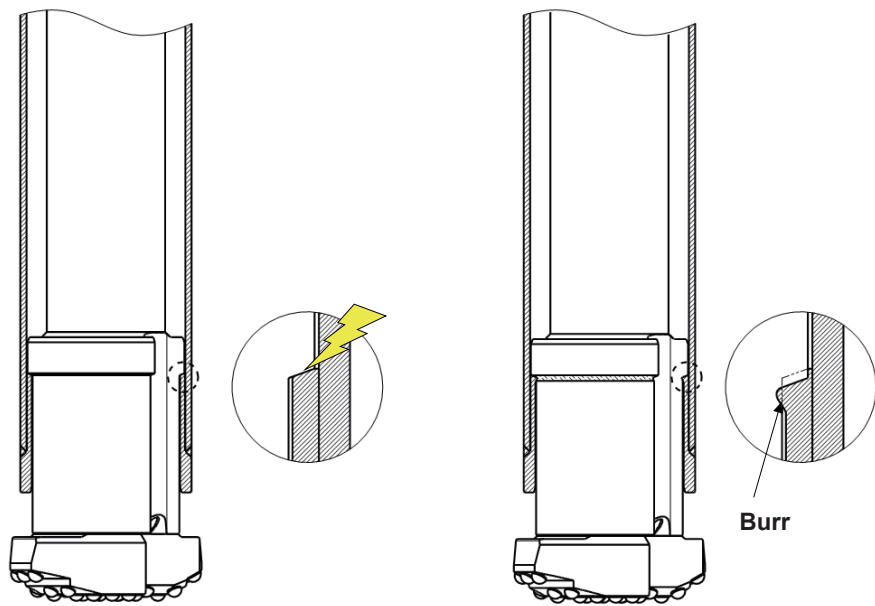


Figure5: The mushrooming caused by the misalignment of the casing pipes

A-6. Collaring/Drilling a pilot hole

Most water well drillers will drill a pilot hole to start drilling operation, this will help hold the casing pipe and stabilize the bit in place.

Before you start drilling, air pressure should be (depending on the device and hammer being used) set for operations between 125 to 185 PSI (8 to 12 bar).

Check that Bit wings are in the open position.

Before starting to drill, apply air, start rotation and (inject water / foam / or fluids) then lower / feed tools to start drilling.

It is good practice to run a stabilizer or centralizer over the UR and hammer.

NOTE:

Before you start drilling the air pressure should be set between 125 to 185 PSI (8 to 12 bar) (depending on the hammer size). Too much air pressure / volume at first will cause cuttings to come up around the outside of the casing instead of the inside of the casing pipe. In this case, cuttings inside of the casing cannot come up and may cause blockage. Also high PSI could cause premature wear and possible failure of the device.

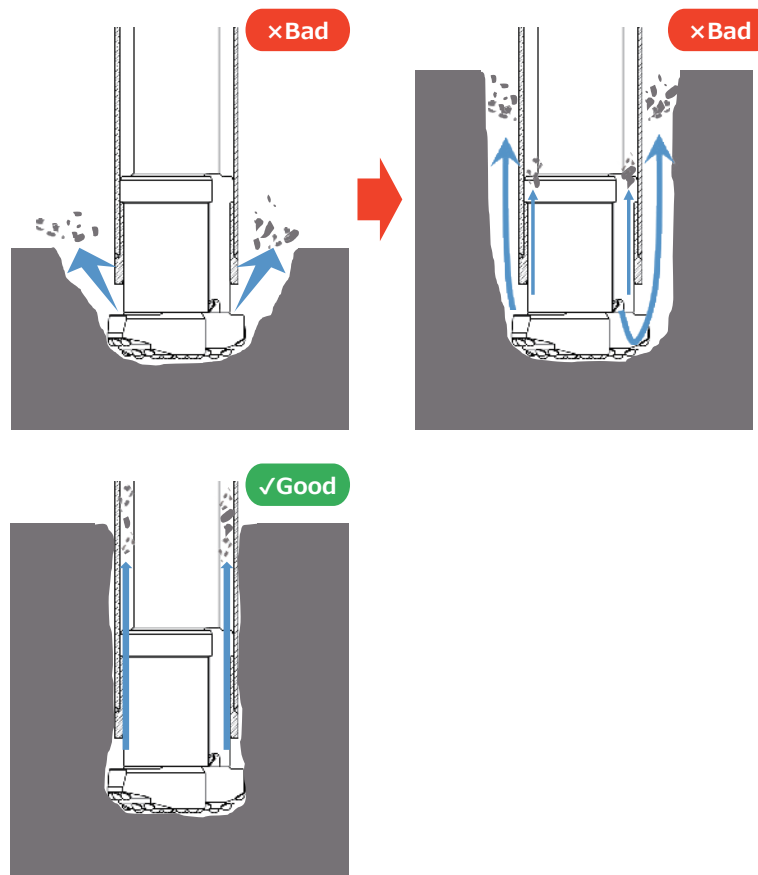


Figure6: Too much air pressure when start drilling / collaring

OPERATION

A-7. Checking the casing pipe alignment

When the casing pipe is driven, periodically check the angle of casing pipe. If the casing pipe is not parallel or straight with the mast, this will cause drag on the casing being installed and possibly require the extraction of the casing pipe and starting the hole again.



Figure7: Checking the casing pipe alignment

A-8. Rotation speed of Bit

Always drill considering ground formations encountered as they are drilled, hard formations – slower rotation speed, softer formations rotation speed is a little faster to achieve smooth drilling and not binding.

Refer to the following figure for normal rotation speeds.

Select the range of uniform rotation during drilling.

The normal rotation speed range from 10 to 80 rpm, all depending on the device size and formation being drilled.

Higher rotation speeds will wear the bit prematurely and possible bit breaking.

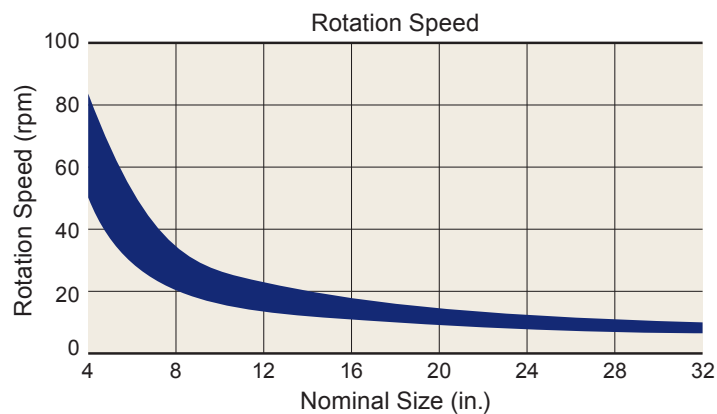


Figure8: Rotation speed of Bit

A-9. Continued drilling or Drilling Operation

While drilling the hole should be flushed out frequently to prevent blockage and help remove cuttings.

Under most drilling conditions, the most common operating pressure is 185 PSI (12.8 bar). You need to consider the operating pressure required to operate the DTH hammer, air pressure loss going through the hammer, water and oil injection.

NOTE: High PSI will cause premature wear and possible failure.

Do not reverse rotation while advancing/drilling for any reason.

The unscrewing of drill tools, retraction of the bit wings or heads. If the bit heads are not checked to be open or drill position, the bit heads will drill a smaller borehole, causing problems to advance the casing. (**see P.13**)

Drilling in difficult formation below or **see P.20**.

-Clay formation-

When drilling in clay formations, inject more fluids, helps clean the bore hole. Take time to drill and flush the borehole. Lower the bit a couple inches at a time allowing air to blow off and clean the bore hole until threw this clay formation.

-Sand formation-

When encountering sand, there is more flushing than actual drilling. This may cause the bit wings not to be able to contact the borehole bottom. Try to keep the casing from falling on or beating against the back of bit head wings which could cause a possible failure. While drilling through sand formations, the penetration rate and speed are relatively higher than other formations. Change the rotation speed higher or lower in accordance with drilling speed.

-Hard rock formation-

Drilling will be slower, adjust your air pressure and rotation speed, if binding occurs, adjust holdback, rotation and slowly lower drill string to achieve smooth drilling and proceed.

OPERATION

-Bit wings locking up / Encountering boulders-

When you feel the SMB or SMB-G bit heads / wings bind up, or lock up, you may be encountering cobbles or large boulders. Try to free by stopping the forward rotation, turn slightly backwards, then raising the bit off the bottom of the hole slightly, flushing out the hole, then start rotation again slowly. The lower feed/percussion will break or push the rock aside. If you continue to drill without freeing the bit and flushing the hole, damage to the bit may occur if binding.

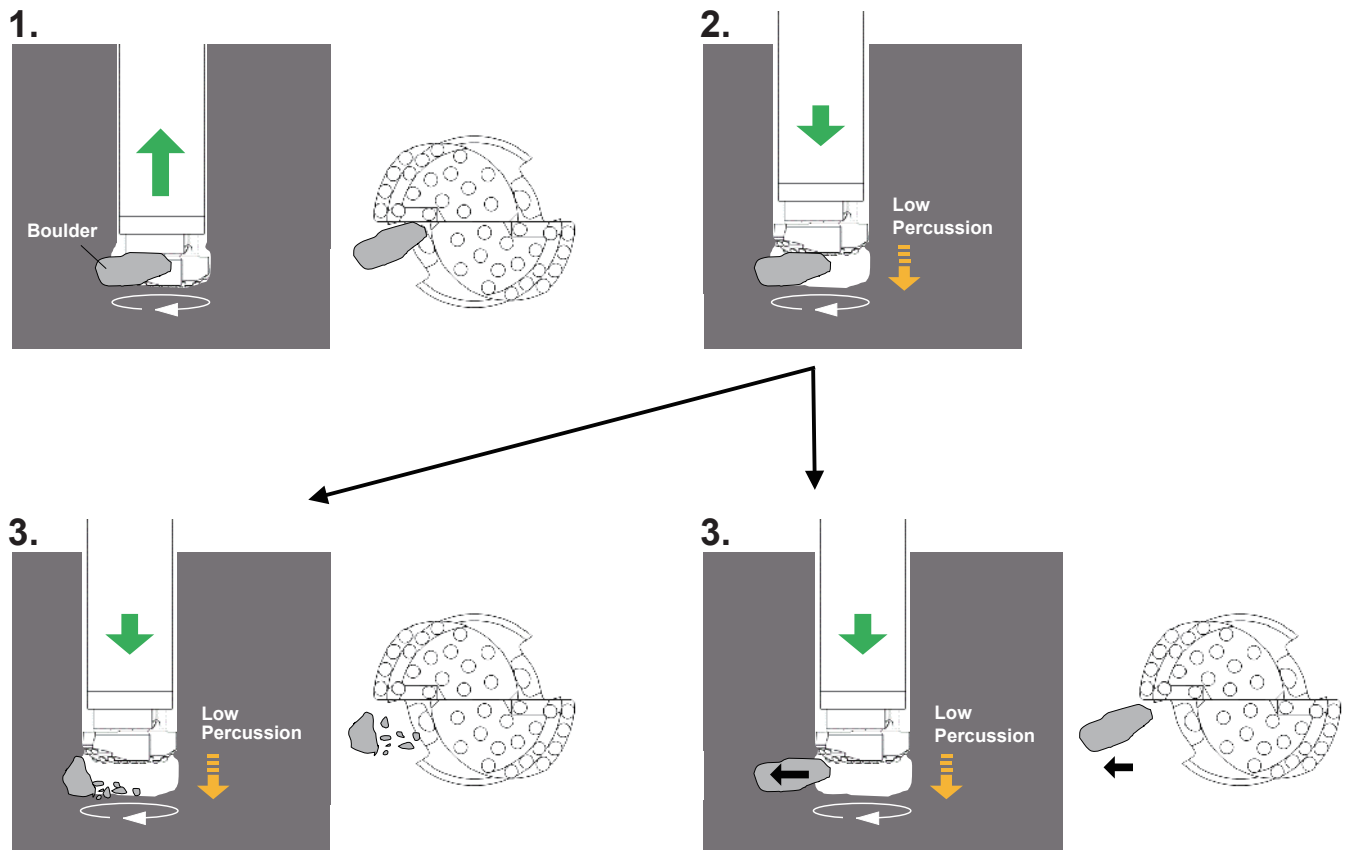


Figure9: Encountering Boulders

NOTE:

While drilling, if you notice any cases below, stop drilling and flush the hole clean.

1. Drill pipes are jumping (Drilling boulders) slow rotation and feed.
2. The hammering sound suddenly stops or is muffled. (The hole is filling with cuttings or bound). Rotation is stopped. Casing pipe is suddenly driven down more than 4 inch (10 cm) without down pressure. (Drilling in sand, clay or voids. After breaking through boulders.)

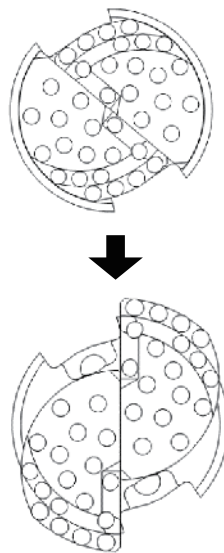
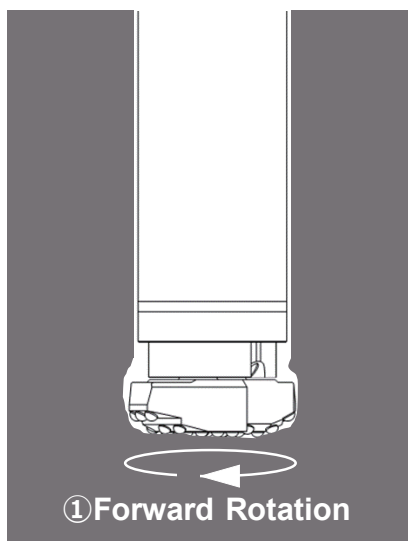
A-10. Reopening bit wings or restart drilling

Start rotation, Open the air valve and fluid injection

1. After flushing the hole clean lower the bit to the bottom of the borehole to proceed drilling.
(Do not reverse rotation)
2. Adjust Feed (Down pressure) and proceed drilling

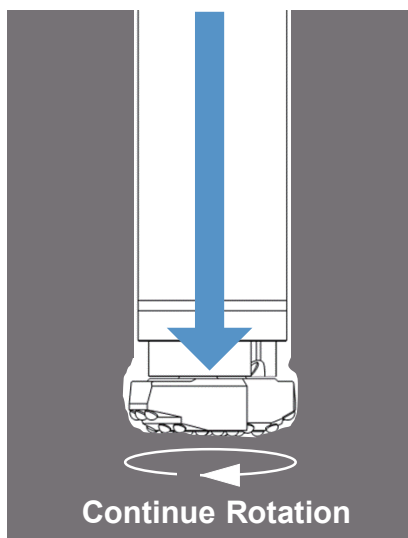
NOTE: rotation is necessary when reopening Bit wings.

1.



2.

② Open the air valve



3.

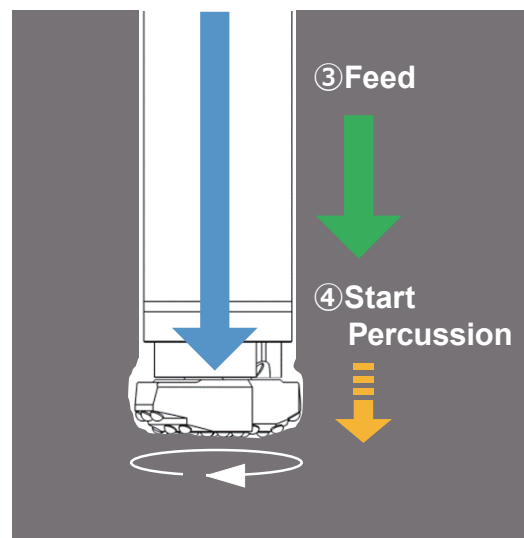


Figure10: Reopening bit wings or restart drilling

OPERATION

NOTE:

It is very important that the bit heads are “FULLY OPEN” before advancing the casing. If the bit heads / wings don't fully open, the bit heads will drill a smaller borehole. This may cause the casing pipe to become stuck in the smaller hole. This can also result in the breaking of bit heads/ failure of welds, premature device wear.

1. Raise the drill string and casing slightly till device turns freely.
2. Open the air valve, start forward rotation
3. Then adjust holdback and lower / feed tools to reopen bit wings and start drilling.

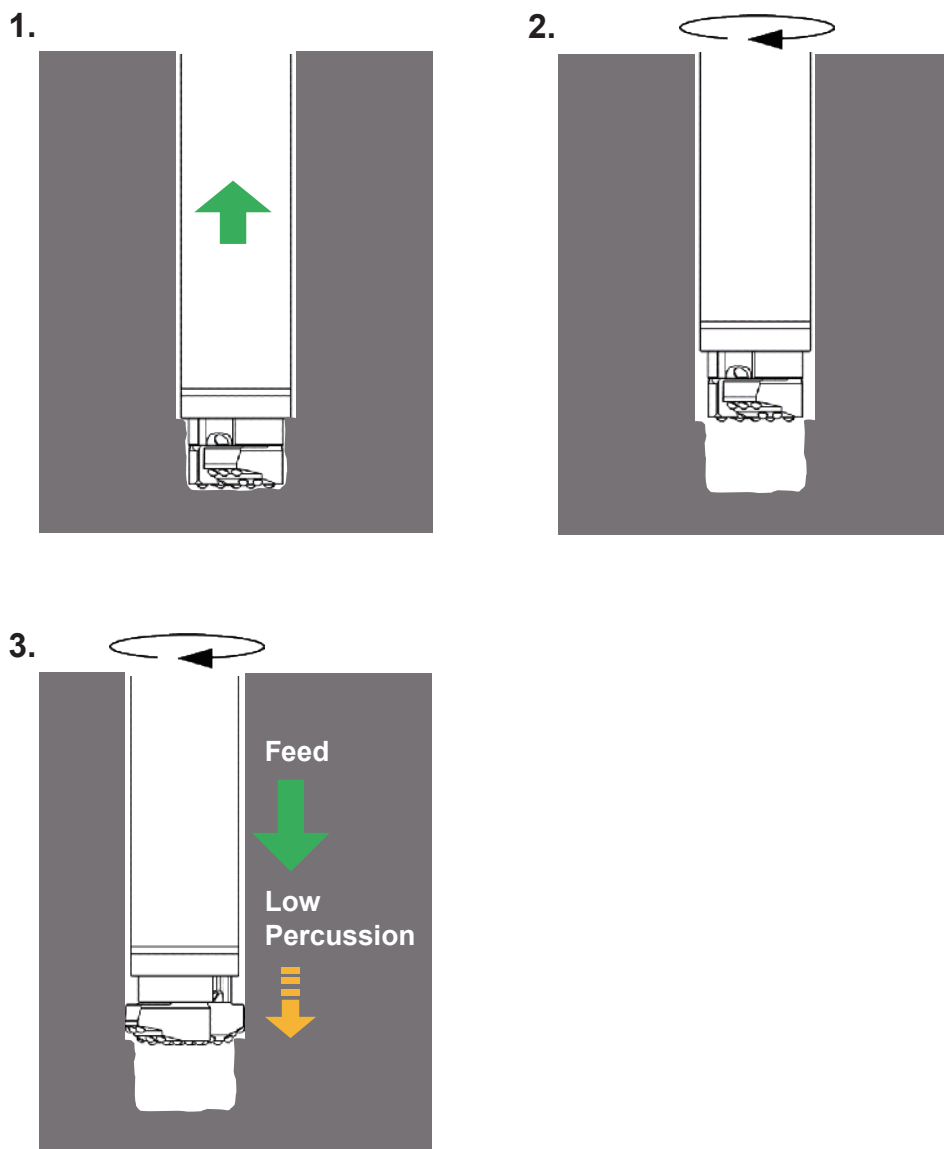


Figure11: Drilling with the Bit Wings open insufficiently

A-11. Jointing the drill strings and the casing pipes

Usually done before starting to drill, install drill rod into casing

Use a special lifting sling for the drill pipe and casing, normally called a casing elevator / clam shell or casing sling (picks up drill rod and casing at the same time).

Insert the thread of drill pipe at the top of the mast first.

After tightening, install other end into drill pipe already installed in the ground and tighten. Lower hanging casing down to casing already installed, level and weld. After welding is complete, lower diverter / casing hammer onto the top of the casing. Start air compressor, (fluid injection,) rotation then check bit heads to see if they are in the open drill position (by slightly picking up drill strings and checking if the back of bit head wings hit the casing), lower casing / drill string and proceed to drill.

It is very important for a smoother drilling operations to set the drill rig stable and level. Also casing and drill rod are in alignment.

NOTE: The misalignment for the casing pipes cause wear on the device drive shoulder, drag on the casing from rubbing borehole wall and possible casing breaking at a welded joint.

A-12. Casing Welding procedure

1. Bevel both ends of the casing to be welded at an angle around 60 degrees (θ in **Figure12** should be 30 degrees). Ensure that all surfaces to be welded are perfectly clean and free from any contamination including moisture.
2. Use a casing alignment clamp / tool, to line up casing. Tack welding should be done diagonally. Remove the alignment clamp.
3. **Weld per A-2 Casing welding instructions (see P.1)** -Take sufficient time to weld not to cause a weld crack, due to sudden heating or cooling.

NOTE: The casing pipes must be correctly welded each other to carry out successful casing drilling. If the casing pipes is not welded accurately each other, misalignment will result. This may causes, 1. Hole deviation, 2. Damage to the casing, and 3. Damage to the shoulder of device.

4. After welding, if the weld and welding slag protrudes on the outside of the casing joint (exceeds 1.5 mm = 1/16 of an inch) grind down with an electric grinder. This will reduce the friction with the material in the holes wall.

OPERATION

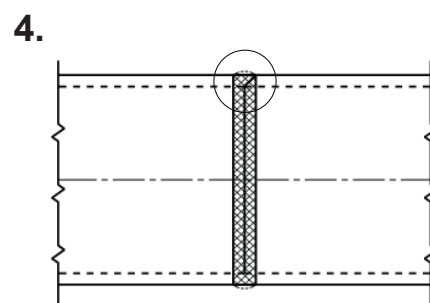
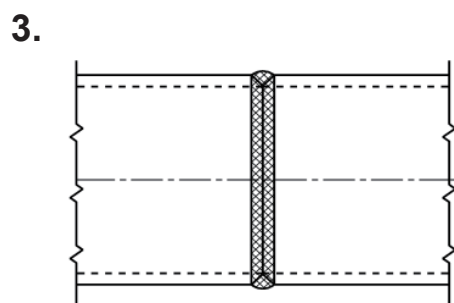
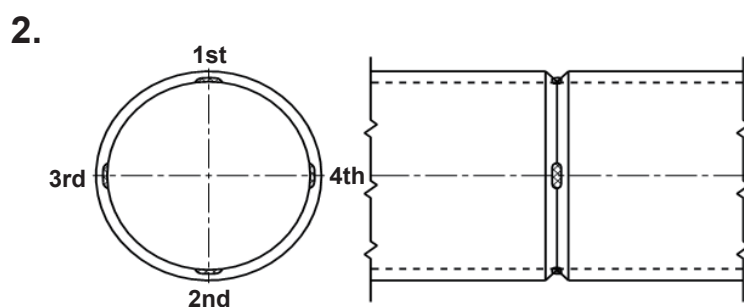
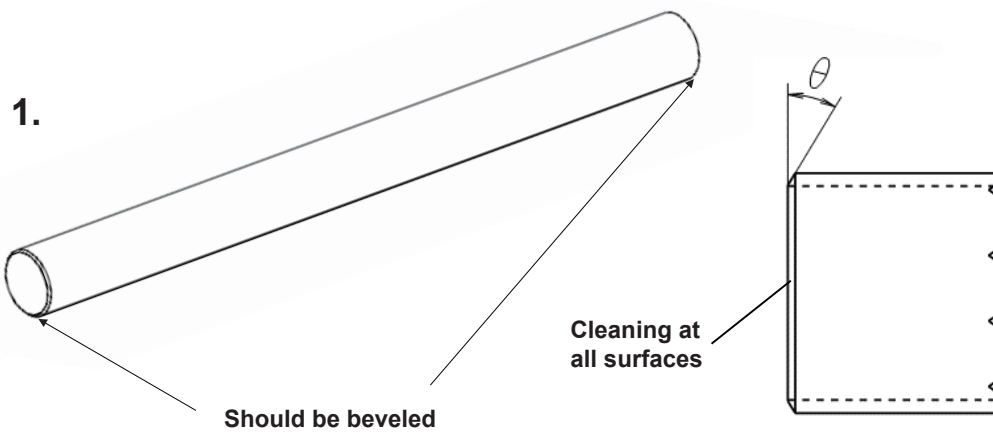


Figure12: Casings Welding procedure

When welding casing, the inside **h** should not exceed 0.5 mm (=1/64 inch) of material (weld) because the clearance between the bit and the casing pipe $(D-d)/2$ ranges from 0.85 to 1.15 mm (=1/32 to 3/64 inch). The weld thickness inside the casing may prevent the device from retracting after drilling.

h: Height of inside weld

d: The device diameter

D: The inside diameter of the casing pipe

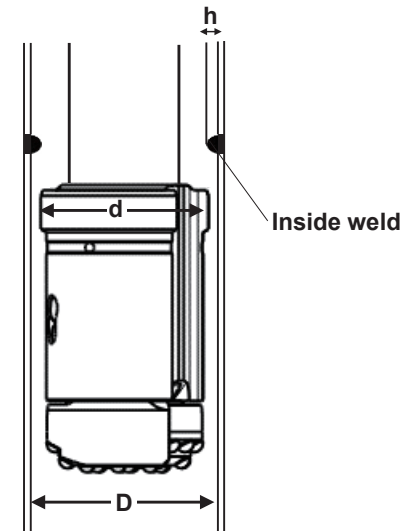


Figure13: Inside welding

NOTE: When the drill strings cannot be pulled out because of the weld inside, pull up the drill strings slowly with forward slow rotation carefully. Do not hurry to pull up, because the weld or burr inside of the casing can be ground off by the device shoulder. This isn't a fast process, may take time to achieve.

A-13. Termination/ End of drilling

After you have drilled to required depth, the SMB or SMB-G can be retracted back up inside the casing / drill pipe.

1. After drilling to a completion depth, flush out and clean the bottom of the hole. Normally with slow rotation and air. In water well drilling, stop rotation or slow rotation inside the casing pipe with air blowing (take sufficient time). The groundwater will be clear and developed.
2. Be sure to leave room under the casing or that last casing tube should not be buried totally. Need to reserve 20 to 30 cm (7 to 10 inch) of machine feed for percussion in order to retract the bit wings.

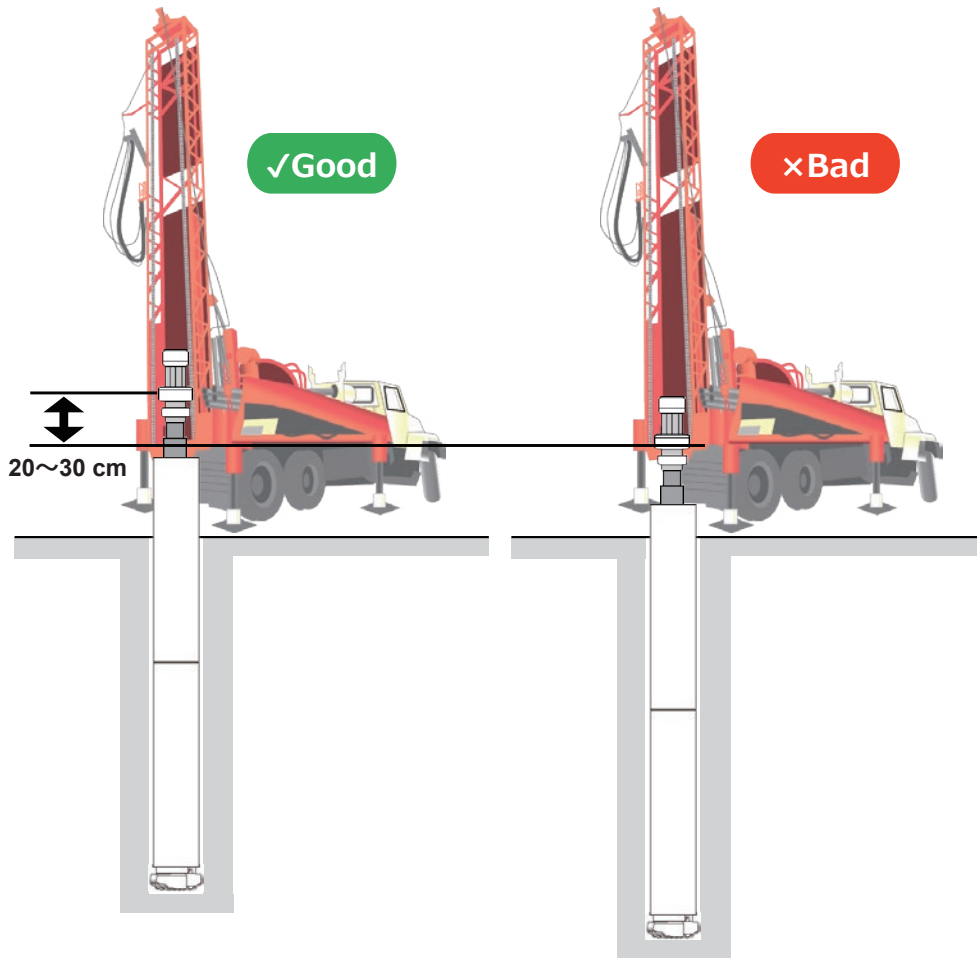


Figure14: Reserving machine feed for retraction the Bit wings

RECOMMENDATION: Normally turning counter clockwise (backwards) with the bit heads / wings on the bottom of the hole. Or pick up drill tools till the back side of the bit heads touch the bottom of the casing, turn backwards, 1-3 revolutions usually allows bit heads to close and then retract.

NOTE:

1. When the bit wings are closed or retracted, caution that too many turns backwards may loosen the hammer or drill strings. If the bit wings do not retract, the first time try again. Use forward rotation, stop then use suggestions 1-2 again.
2. In sand formations, be careful of excessive flushing after stopping feed. A washing and flushing occurs. This may cause the bit wings not to be able to contact the borehole bottom. Retraction is difficult when this happens.

NOTE: Important Device Information – Extended time in water or drill cuttings

The SMB or SMB-G device should not be left for a long period of time in muddy / drilling water after drilling completion. The clay and mud can solidify preventing the bit heads from opening / retracting properly. In this case, the drill strings and the SMB or SMB-G should be raised for one drill rod length.

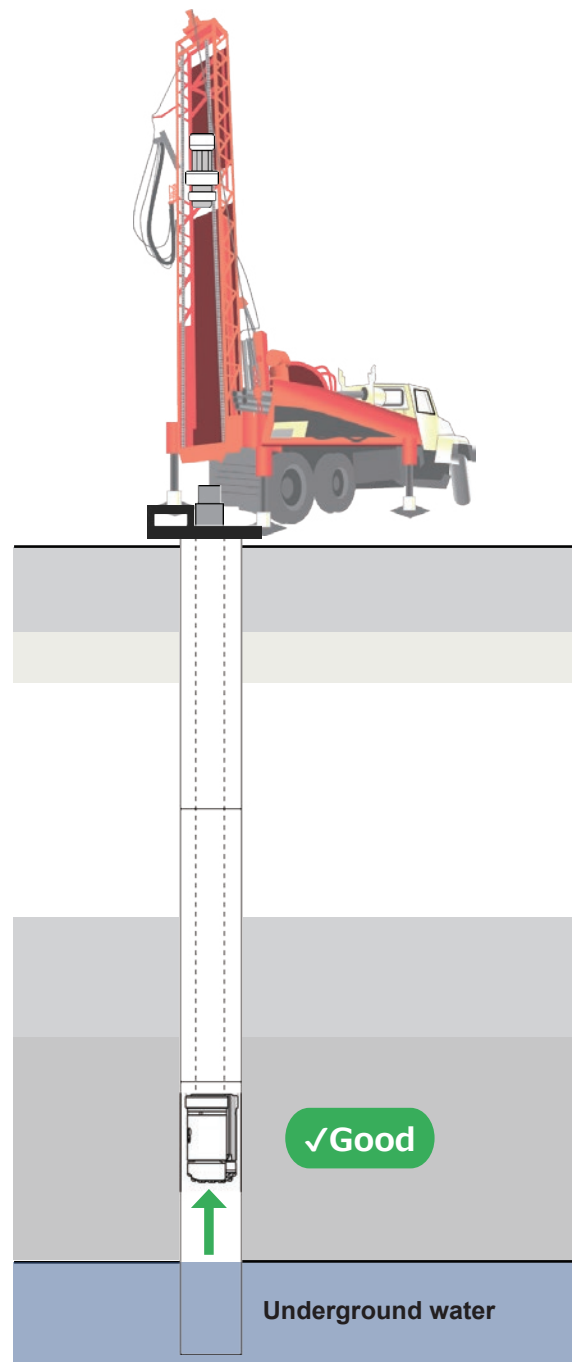


Figure15: Important point for when the Bits be left for a long period

OPERATION

A-14. Pulling casing pipes out

When pulling casing pipe, use elevators on the casing. Use of the device / bit heads is NOT recommended. Friction on the casing pipe can be too high to move casing pipes. There is a risk that the bit wings will break at the retaining pin or pin breakage due to pulling load is on the pin.

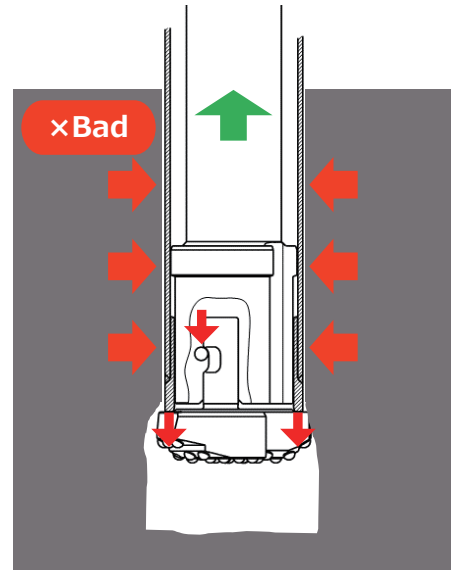


Figure16: Pulling casing pipes out

A-15. Water injection

Water injection will help flush out cuttings. Allows the hammer and the device or bit wings to run cooler. Improve the environment / dust around the work site.

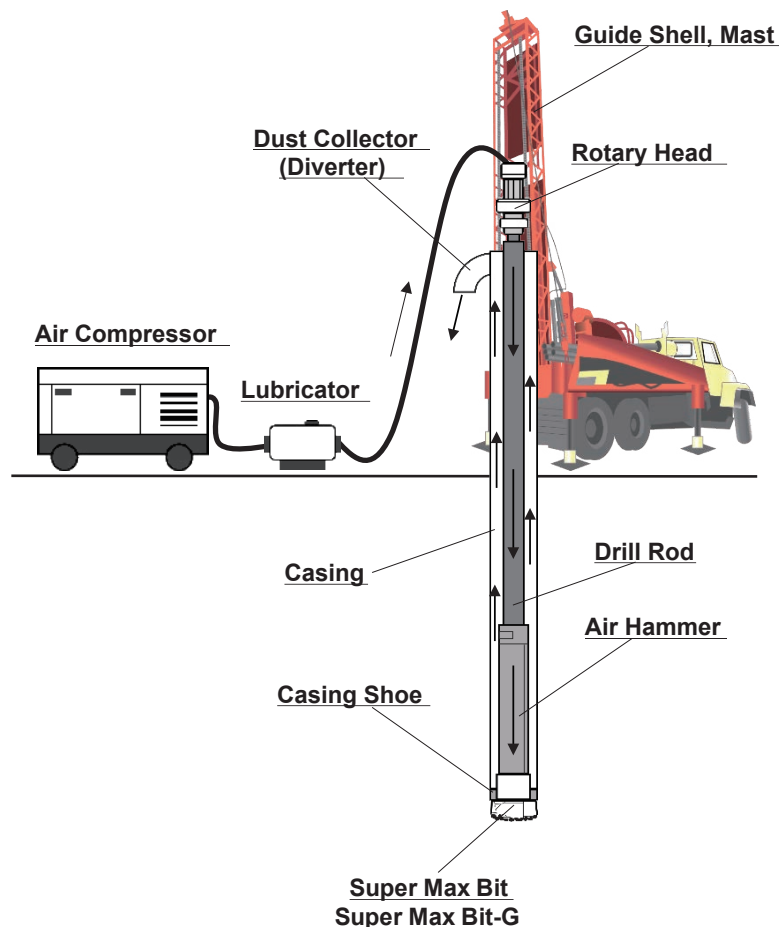


Figure17: Typical Rig Setup

B. Drilling in difficult formations

B-1. Clay formations

It is easy to notice drilling through clay formations because the hammering sound becomes difficult to hear.

1. Periodically, you should stop drilling and flush the hole clean. In clay formations, frequent hole cleaning is necessary.
2. Clay will drill faster, beware of drilling too fast. Air pressure will increase, use plenty of water when drilling. Water inside the casing pipes helps cutting flush the cuttings out.
3. If casing isn't moving downward, stop to inspect and figure out why, continual driving without movement will cause a failure or casing breaking.

B-2. Fractured zone – Broken rock formations

While drilling through a fractured zone, drill strings may rotate irregularly.

1. The bit should be operated with lower feed pressure. If the bit is operated at normal speeds and pressures, the rotation and down pressure will be too great and the bit wings cannot rotate and will possibly be damaged.
2. When irregular rotation is observed, the bit should be pulled up a little to make drilling smoother and be sure that the hole is cleaning adequately. Drill with less or lower feed pressure until drilling conditions change.
3. When the bit cannot rotate at all, pull up the casing pipe a little until rotation is possible.

B-3. Sand formations

When encountering sand formations, the penetration rate and speed are relatively higher than other formations.

Be careful when too many cuttings are flushed out relative to the drilled depth. Heaving sands and cleaning sand / material too far ahead of the casing must be cautioned. A washing and flushing occurs. This may cause the bit wings not to be able to contact the borehole bottom. There is a risk that the bit wings will break at the retaining pin or pin breakage, because all load of bit wings is on the pin.

Feed and air pressure must be carefully watched to keep the bit wings at hole bottom.

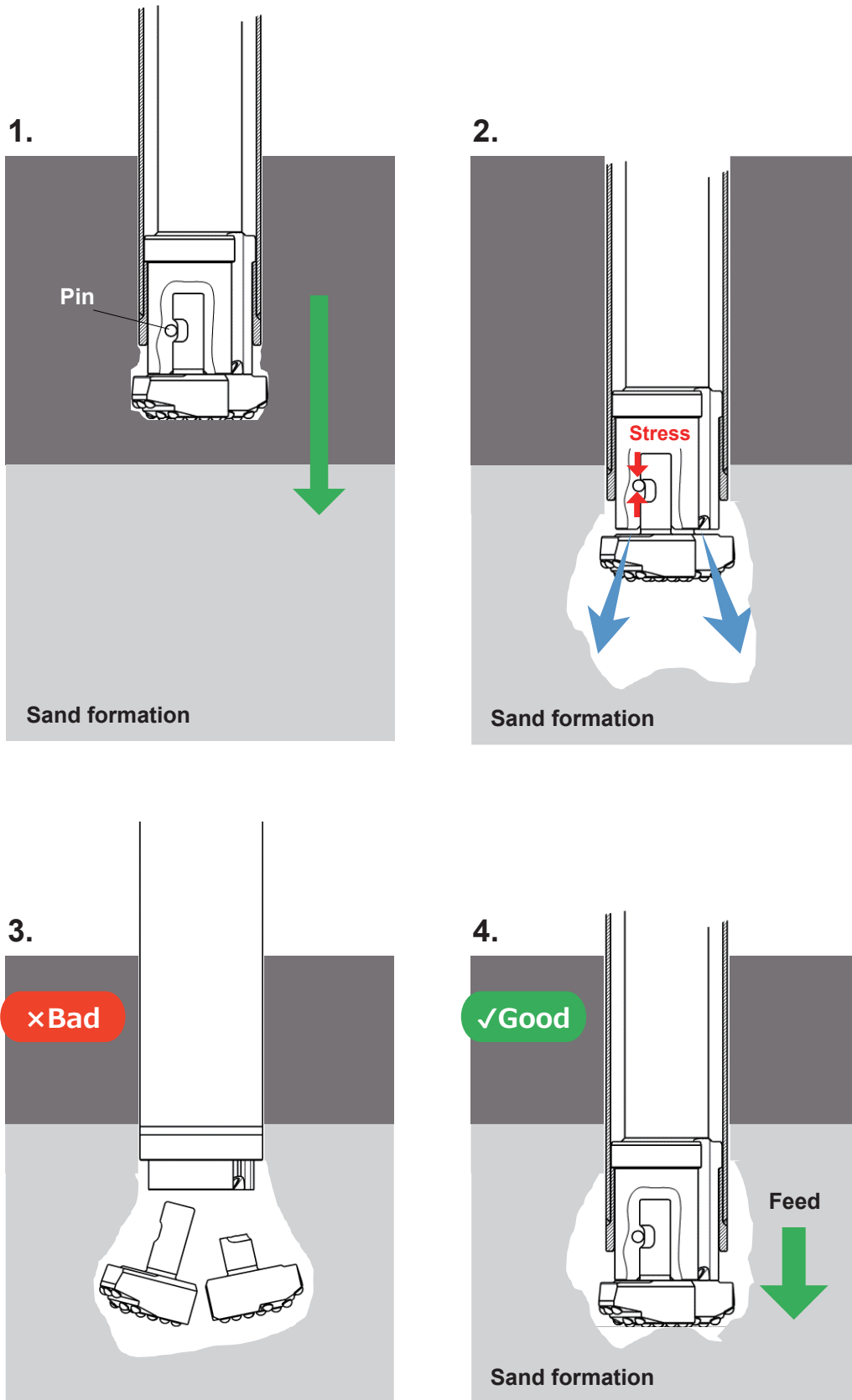


Figure18: Encountering Sand formation

B-4. Self-Sustaining Hole / Solid rock formation

In some drilling conditions, friction on the casing pipe is minimal to help keep the casing shoe off back side of the bit wings. The load of the casing pipes may be on the bit wings and the retaining pin. There is a risk that the bit wings will break at the retaining pin. Use casing hold back or casing blocks on the casing to keep the casing weight off the back of the bit heads.

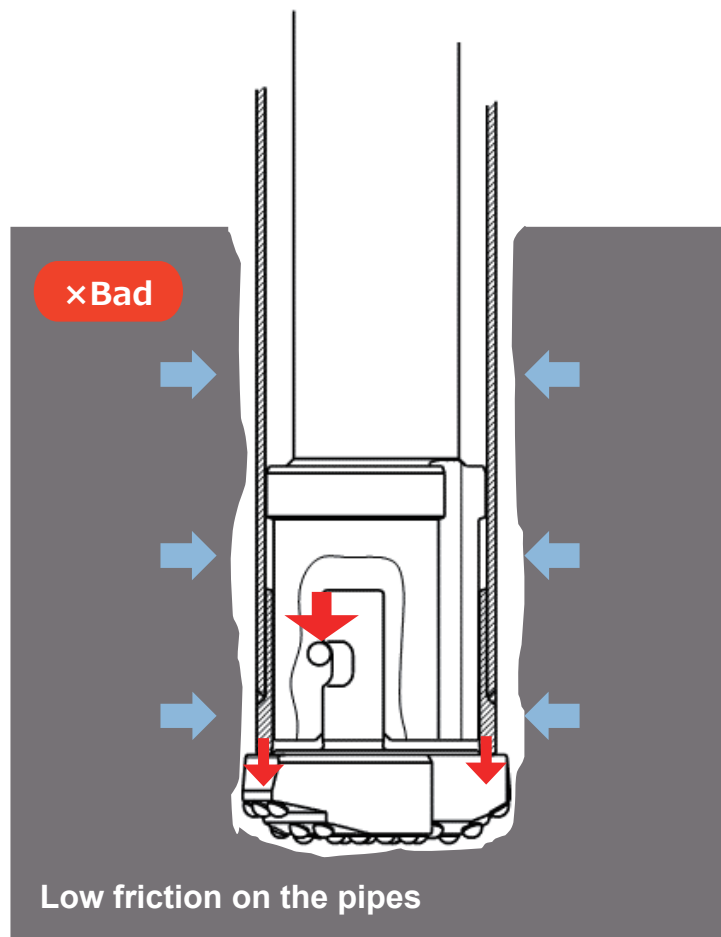


Figure19: Self-Sustaining Hole / Solid rock formation

C. Components

Bit wings

Device

Pin sets (Pin, Plastic seal, Retainer ring Casing shoe **see P.28**)

Casing shoe

SUPER MAXBIT (SMB)

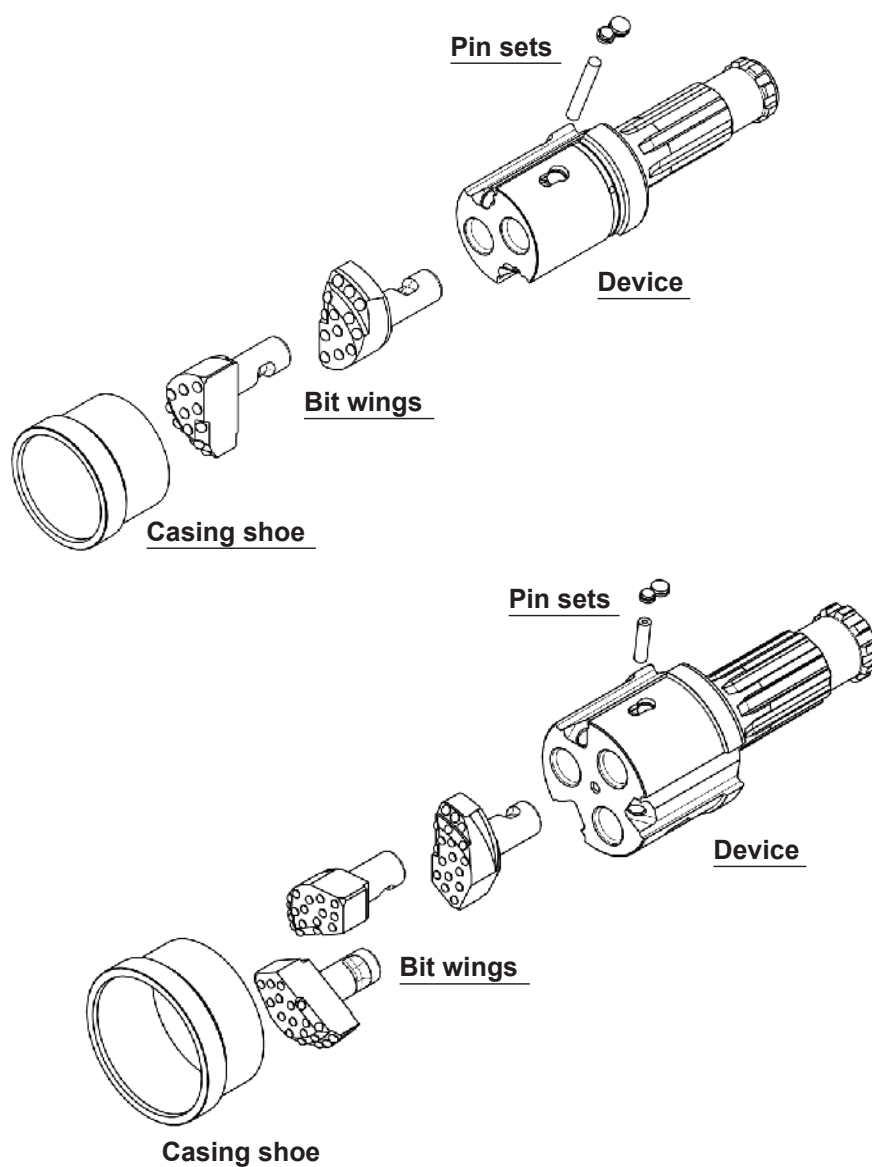


Figure20: SMB Components

SUPER MAXBIT G-MODEL (SMB-G)

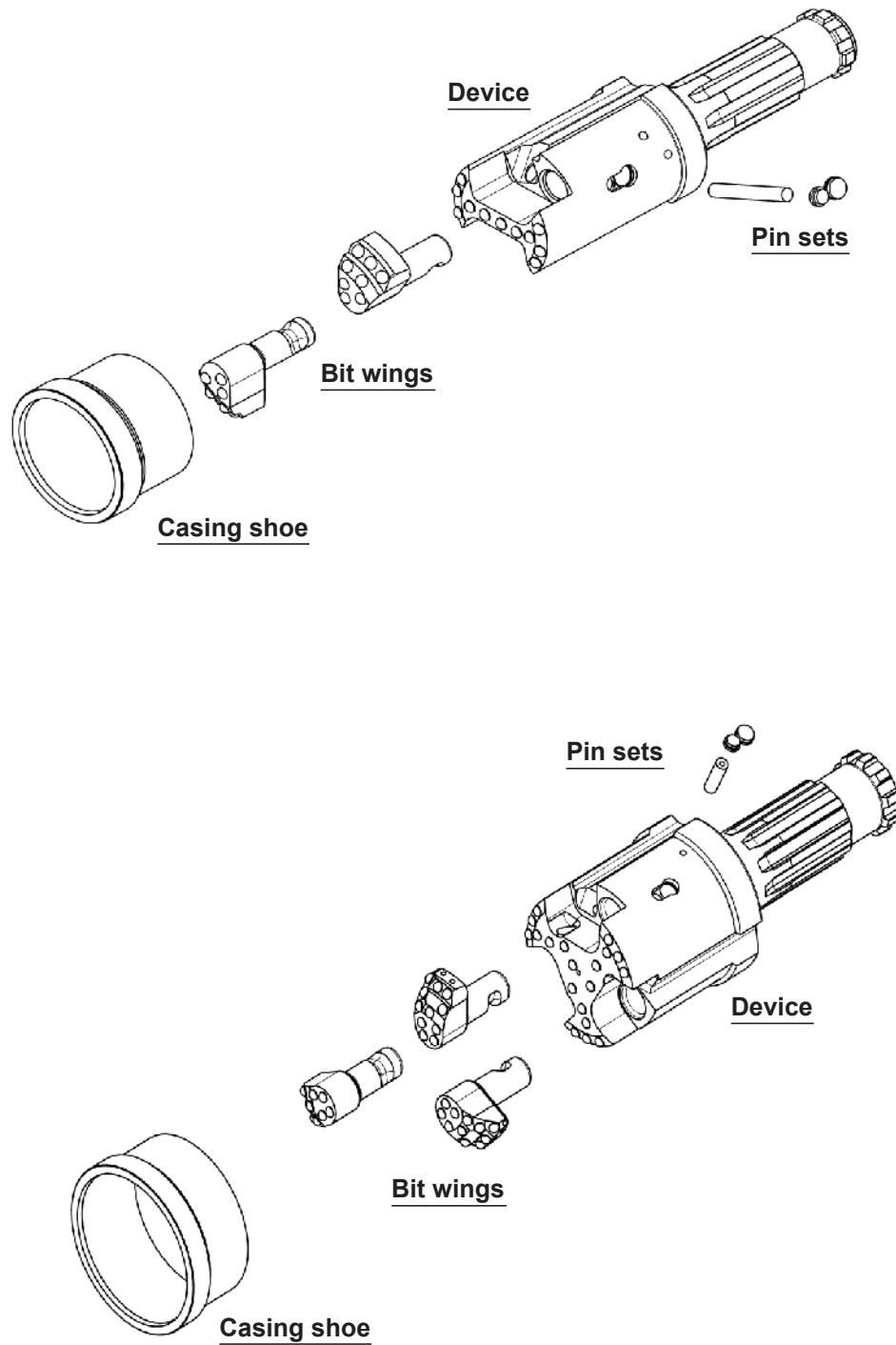


Figure21: SMB-G Components

D. Exchange of components

D-1. Bit wings

1. When the wear detection mark on a wing disappears. SMB-G doesn't have the wear detection mark. Please check excessive wear on gauge carbides or broken carbides or wear on the upper side of bit head next to the casing.

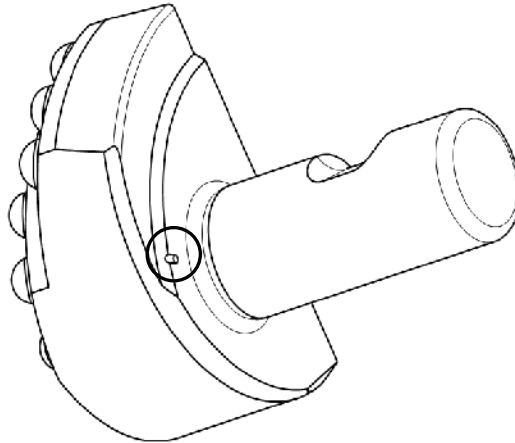


Figure22: The wear detection mark on a wing

2. When the carbide wear is excessive. (Check $1/3 < W/D < 1/2$)

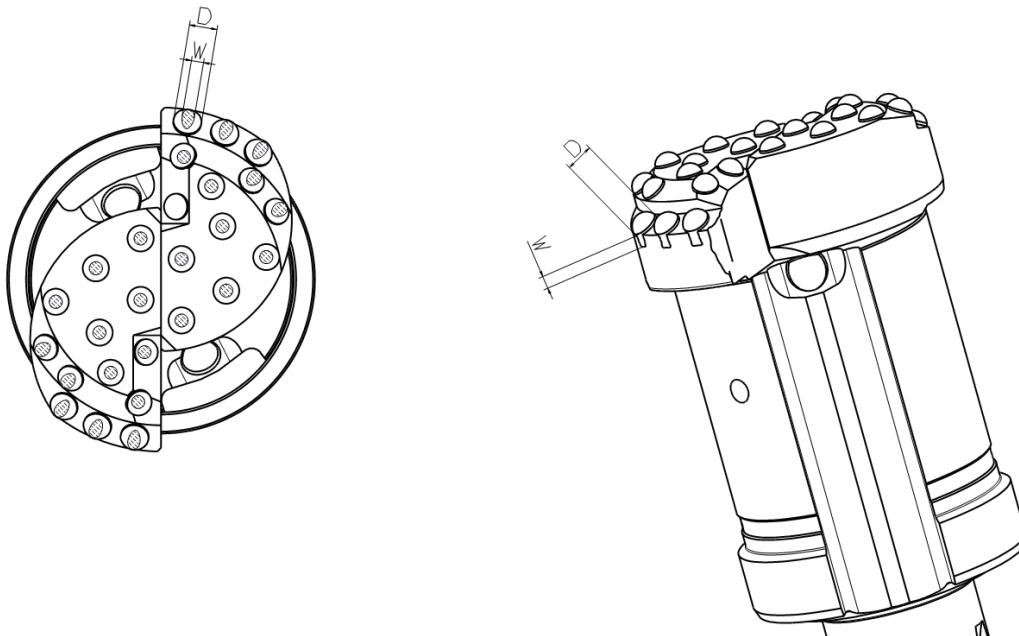


Figure23: The carbide wear

3. When wing body wears and carbides pop out.

D-2. Device

When the wear detection marks on the device end disappear.

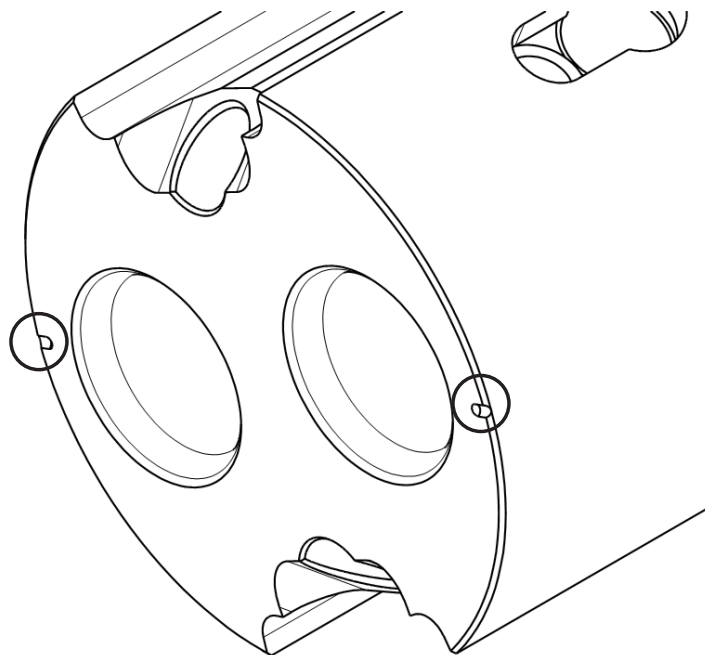


Figure24: The wear detection mark on the device end

D-3. Pin

When the wear attains the following value.

Please exchange the pin if you observe excessive wear.

Recommendation to inspect the retaining pins and retaining clips every 500 foot (150 m).

Table2: The pin wear

	Two Wing Type	Three Wing Type
Amount of Wear (mm)	0.5-1.0	0.5-1.0
Geometry	<p>Amount of Wear (mm)</p>	<p>Amount of Wear (mm)</p>

E. Reassembling bit wings on the device

E-1. Disassemble - Take off the pin sets

1. CCR (C-Clip Retainer) pin sets

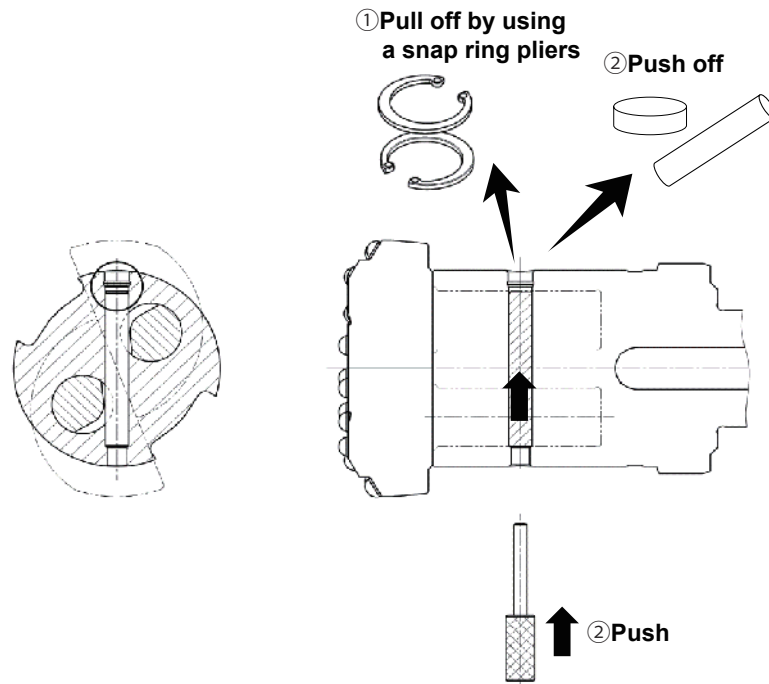


Figure25: Take off the CCR pin sets

NOTE:

We have a special tools for pulling off pins for 3 wings type.

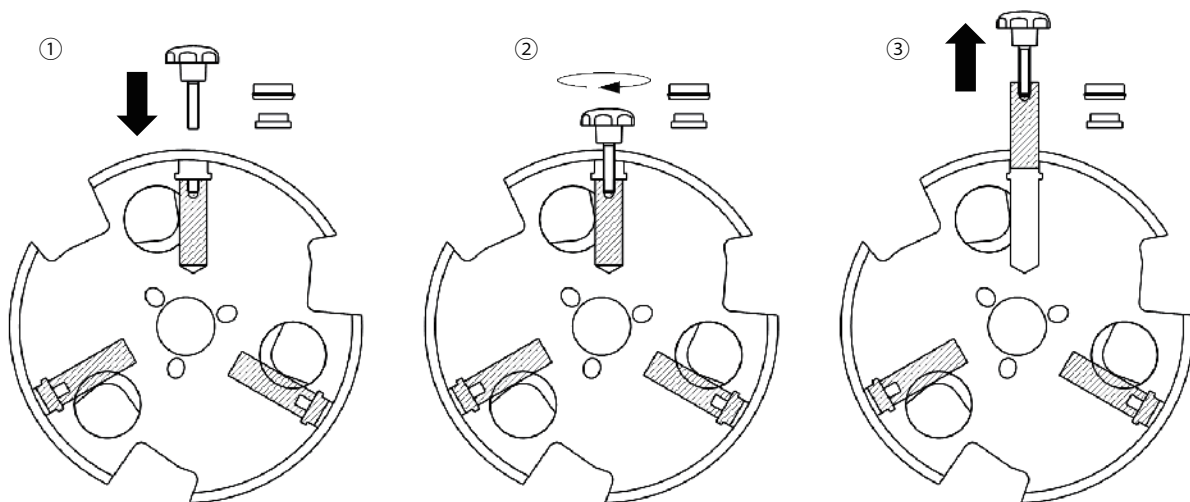


Figure26: Retracting pins with special tools

2. SCR (Seeger-Clip Retainer) pin sets

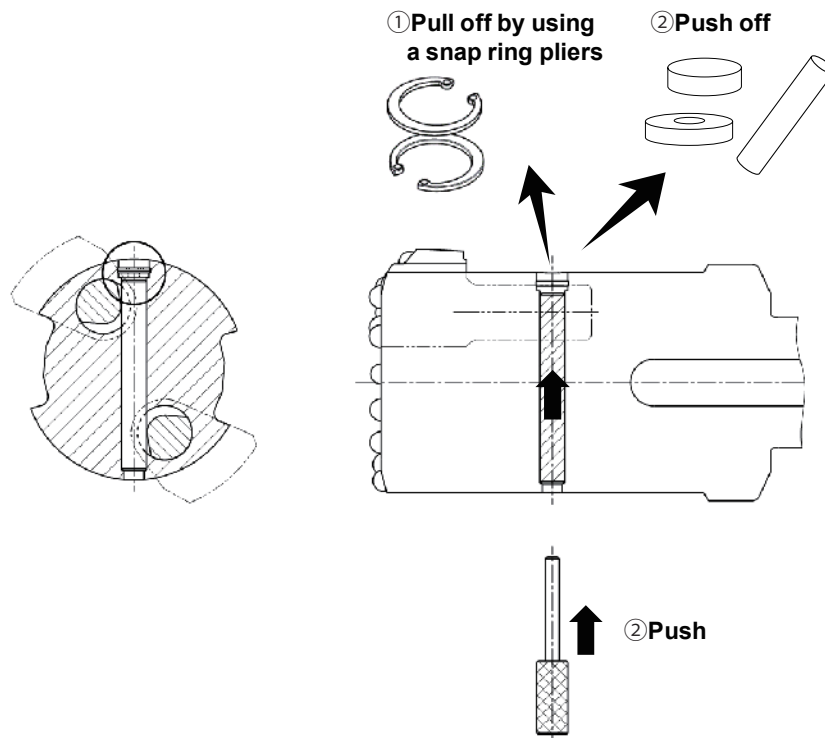


Figure27: Take off the SCR pin sets

3. NPR (New Pin Retainer) pin sets

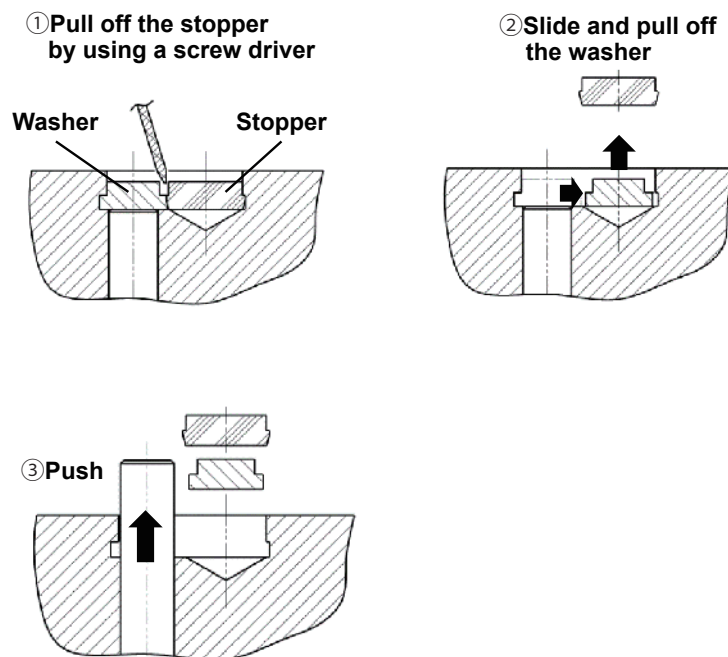


Figure28: Take off the NPR pin sets

4. SPR (Spring Pin Retainer) pin sets

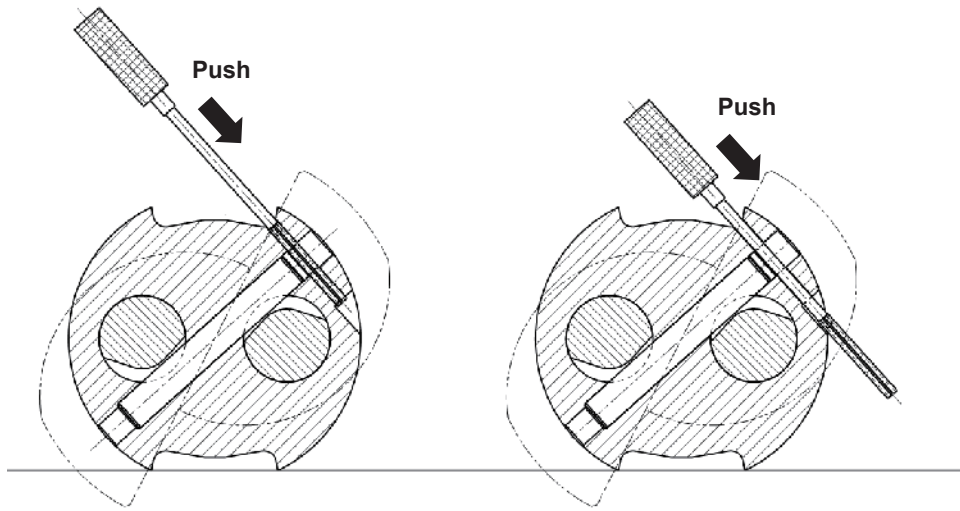


Figure29: Take off the SPR pin sets

5. CSR (Coil Spring Retainer) pin sets

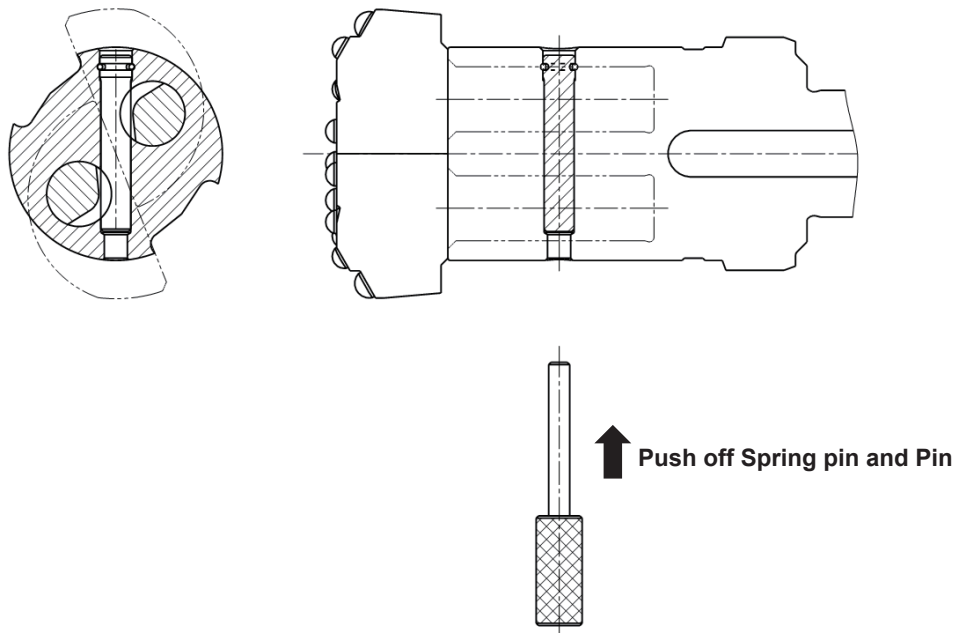


Figure30: Take off the CSR pin sets

E-2. Pull out the bit wings

Clean the holes of the device. Mud or sand should be removed.

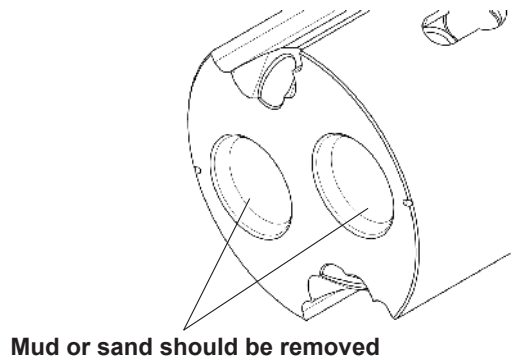


Figure31: Clean the holes of the device

When the wear attains the following value.

Please exchange the pin if you observe excessive wear.

Recommendation to inspect the retaining pins and retaining clips every 500 foot (150 m).

E-3. Re-assembling procedure

SPR (Spring Pin Retainer) pin sets

NOTE:

If after pushing the SPR pin out, one end of the Spring pin driven may deform or spread. If you take the pin completely out, change ends and reinstall.

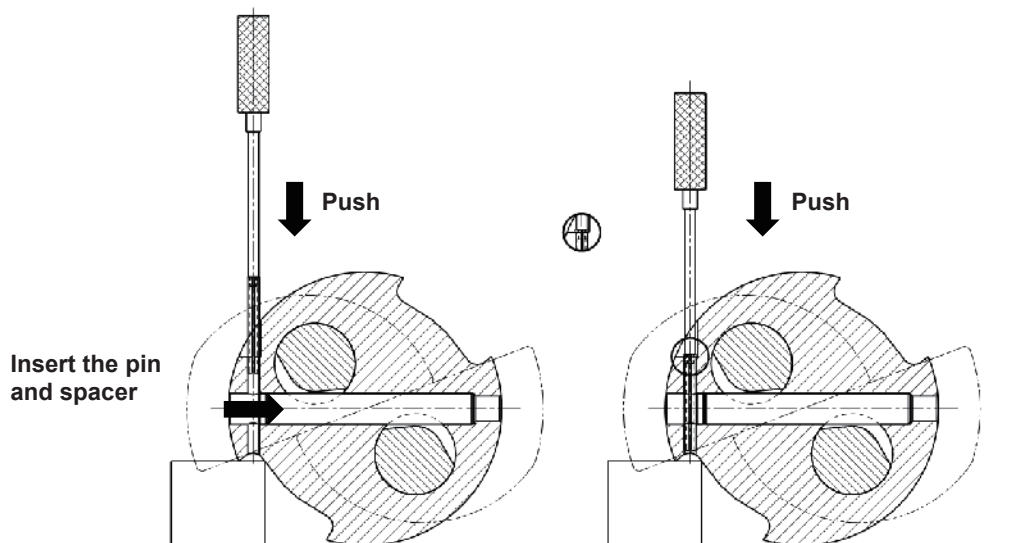


Figure32: Re-assembling for the SPR pin sets

MAINTENANCE

CSR (Coil Spring Retainer) pin sets

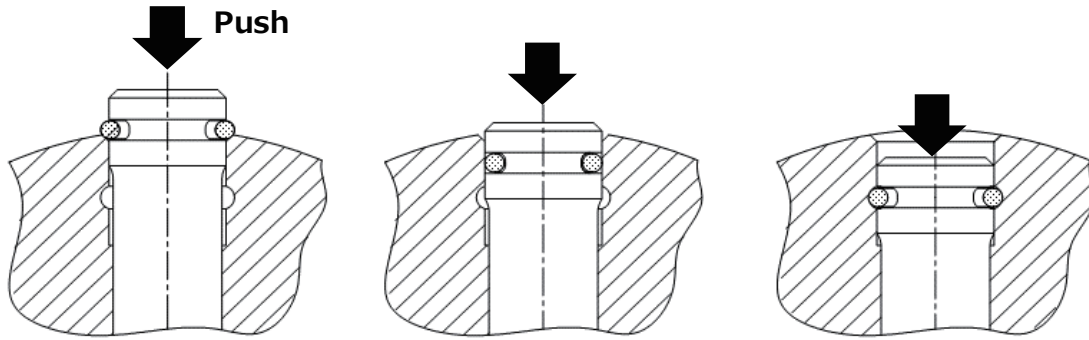


Figure33: Re-assembling for the CSR pin sets

NOTE:

When installing the CSR pin in, the Spring pin must be set in the center of the Pin.

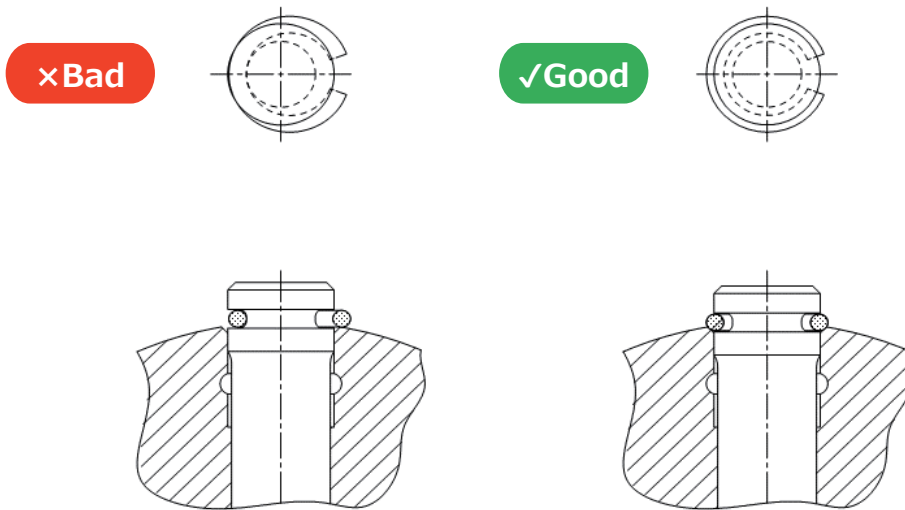


Figure34: Important point for Re-assembling for the CSR pin sets

F. Build-up welding repair of the device shoulder

In the case of wearing of the device shoulder, build-up welding repair is needed. Carefully follow the procedure to perform the build-up welding repair or take to a welding shop that can do this for you. Otherwise heat treatment issues will cause welding cracks.

NOTE: Product repaired with the build-up welding cannot be guaranteed.

1. Pre-heat the base material to 200 to 300 degree Celsius.
2. Weld the material layer on the surface of the base material.
3. Gradually cool the device. Never rapidly cool it.
4. Apply a finishing process. The angle of the device shoulder should be 30 degree.

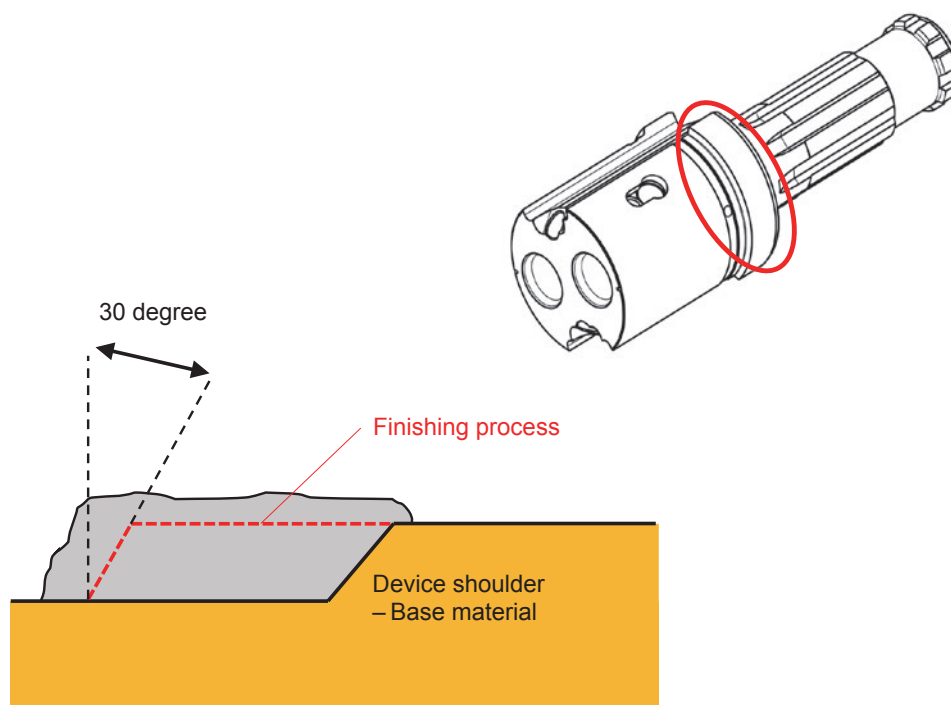


Figure35: Build-up welding repair of the device shoulder (cross-section)

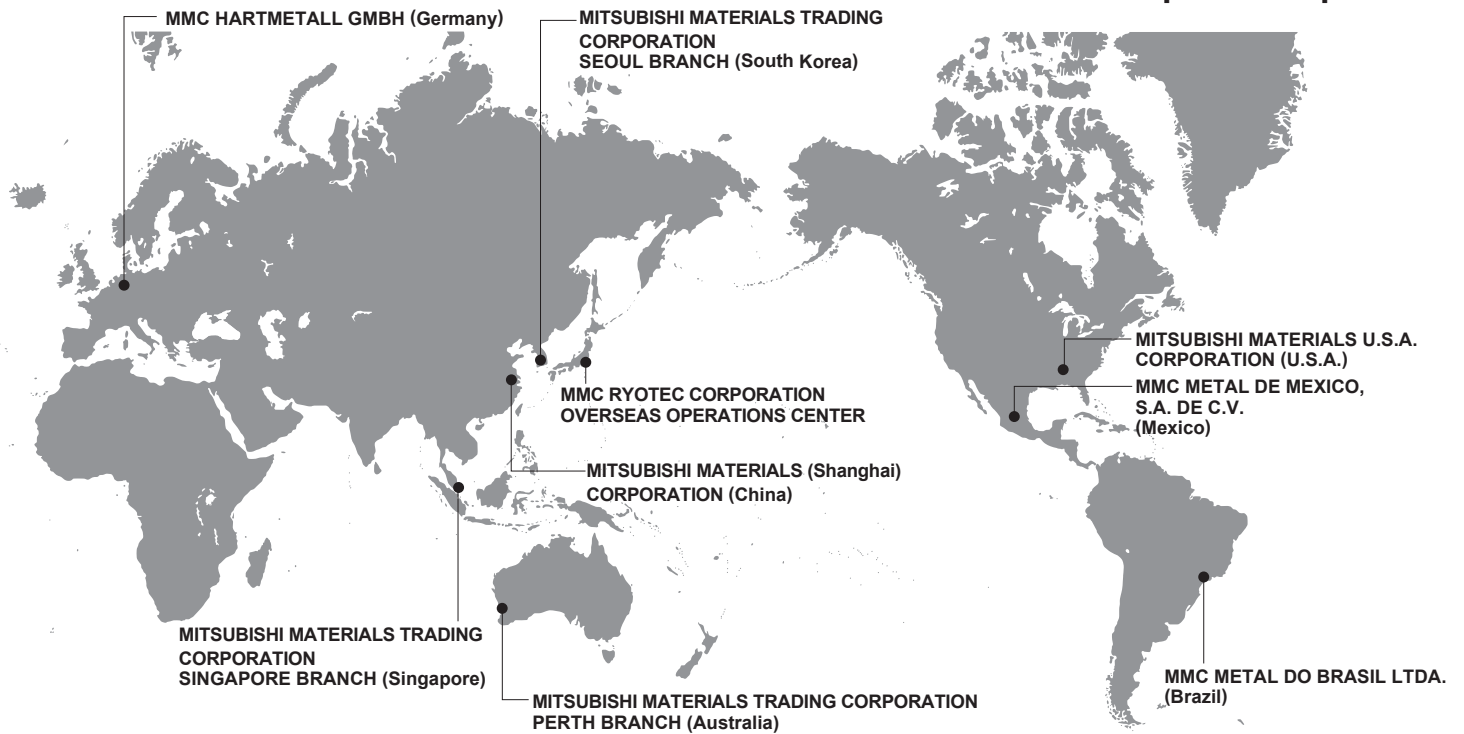
TROUBLE SHOOTING

Reason	Solution
Less hammering.	
Air pressure is too low to work. (The hole is too deep that causes shortage of air pressure)	Compressor should be replaced with a larger one or install additional air compressor and air receiver tank.
Just drilling through clay formation.	The frequent hole cleaning is necessary. (see P.20)
Drive sub is loosened	Be sure to tighten all drill tools and joints when installing. Rotate in forward direction, pull drill string and retighten.
Cuttings, Sand or clay infiltrating into the hammer.	Check for broken or weak check valve spring in hammer back head.
Cutting are remaining between driver and bit	Use plenty of water to help flush the cuttings
Cutting are sticking in bit blow hole.	Flush frequently.
The bit does not rotate at all. Rotation fluctuation or jamming.	
Drilling through fractured zone.	The bit should be operated with lower feed pressure. (see P.20)
Hit a scrap iron or steel in the bore hole.	Be cautious, drilling scrap iron or steel will damage any bit. Try to remove steel with magnet.
The bottom of the hole is filled with cuttings.	Use water injection, also adding drilling foam can help flush out.
Sticking through cave zone.	Be cautious, drill slowly with light feed until drilling smooth out.
Hit a boulder.	Drill slowly to try to cut a straight hole through the boulder. Otherwise raise the drill string up slightly to get boulder in front of the bit to break it up or straight hole is achieved to continue drilling.
Too many cuttings are flushed out relative to the drilled depth.	
Drilling through soft sand zone.	Be careful not to pull too many cuttings out in front of the bit. Try stopping drilling earlier than normal.

Reason	Solution
Cuttings are not flushed out of the hole well.	
Air compressor air volume.	Compressor should be replaced with a bigger one or install additional compressors and air receiver tank.
Just drillings through Clay formation.	The frequent hole cleaning is necessary. (see P.20)
Cuttings are staying inside the casing pipe.	Be sure bit isn't plugged. Use plenty of water for flushing while drilling
Drilling through crack formation, Formation air loss	Use water and drilling foam until circulation resumes.
Casing pipes are not driven down.	
Breakage of the weld joint.	Use three passes while welding each joint. Check the casing pipe is vertical and straight Check that each weld is smooth so that weld size doesn't cause friction between the casing pipe and bore hole wall is minimum.
Threaded casing Joints.	Never use threaded joint casing pipe in with cause drag and failure
Breakage of the pin.	
Hammering while the bit is not on the bottom of the hole.	Keep the bit wings on the bottom of the hole.
Hammering in sand formation.	Feed and air pressure must be carefully watched to keep the face at the bit wing. (see P.20)
The bit wings does not open.	
The bit wings are not on the bottom of the hole.	Keep the bit wings on the bottom of the borehole
Clay or mud has intruded into the hole of the device.	Clean the holes of the device. Flush with water / drilling fluids
Sticky Clays	If sticky clay is encountered, take time to drill, flush, drill, flush with lots of water to keep the bit heads open. Leave bits heads under casing in drill mode when adding a new rod / casing.

TROUBLE SHOOTING

Reason	Solution
Sudden drop of drilling speed.	
Reaching the hard rock formations.	Slow down and operate the SMB / SMB-G device like a DTH bit. Change to the single DTH drilling.
The bit wings don't open fully.	Pull up both the drill strings and the casing pipes to a position where the bit wings can open fully. A slight amount of percussion and rotation will make the bit wings open fully.
Premature wear of the device shoulder.	
Insufficient hardness of the casing shoe.	The use of other manufactures / untreated drive shoes not to Mitsubishi specifications will cause premature mushroom effect of drive shoes, wear on the drive lip on the SMB device and void warranties.
Rotation speed is too high.	See rotation chart (see P.9)
Premature breakage of the bit wings shaft.	
Premature wear or breaking bit heads.	Rotation speeds, Check the wear detection marks on the device, too much down pressure.
The bit wings does not close.	
The bit wings is not on the bottom of the hole.	See Termination of drilling (see P.16)
Cuttings are sticking around the bit wings so much.	Flushing out cuttings with AIR and Water
The drill strings cannot be pulled out.	
The thickness of the weld inside of the casing pipes exceeds limitation.	Pull up the drill strings slowly with forward slow rotation, carefully. Do not hurry to pull up, because the weld or burr inside of the casing can be ground off by the device shoulder. This isn't a fast process, may take time to achieve. (see P.16)
There is a dent on the outside or inside of the casing pipe which happened during drilling.	Check casing before installing. In water well drilling, sometimes rocks / large gravel can roll into the casing wall during drilling and driving causes a dent, so careful casing inspection before drilling installations and operations are necessary.



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