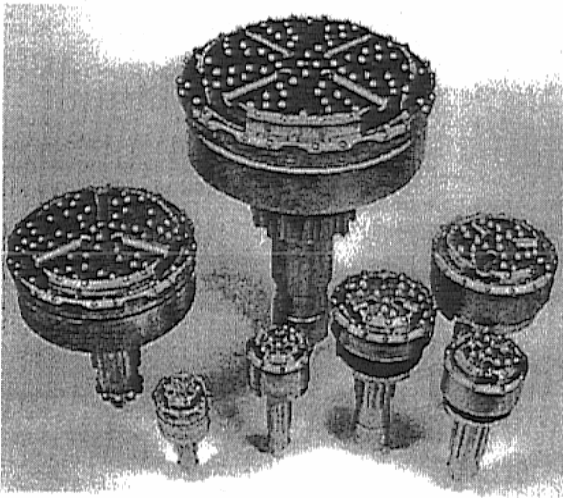


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# SYMMETRIX®



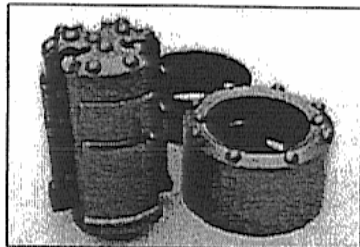
Driller's Manual

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## Symmetrix® Method

Symmetrix is a patented system for drilling through overburden with casing. Symmetrix system consists of three different parts:

- Pilot bit
- Ring bit
- Casing shoe



STD system's pilot bit, casing shoe and ring bit for top hammers.

The working principle is as follows:

1. The casing shoe is welded to the first casing tube.
2. The ring bit is locked to the casing shoe with retainer wire that allows the ring bit to rotate while the casing tube and casing shoe remain in place. This feature guarantees safe unlocking and relocking of the ring bit to the pilot bit. This feature is in all Symmetrix models except the economy model. In N-System the coupling is already done by the manufacturer.
3. The pilot bit is attached to the drill string with standard connection, with threads in top hammers and standard chuck for DTH-hammers.
4. The pilot bit is locked to the ring bit automatically when drilled.

5. The pilot bit is unlocked by rotating the drill string slightly to the reverse direction.

### Benefits of Symmetrix® method:

Due to symmetric structure the holes will be straight, which will less stress to the connections of casing tubes.

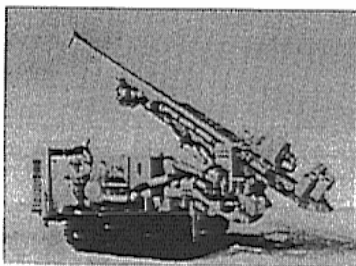
Effective flushing will improve drilling performance and reduce plugging risk of the hammer.

Locking between pilot bit and ring bit is simple and reliable.

The system has no eccentric elements, therefore pilot bit can not get stucked inside the casing tube.

If necessary, drilling with casing tubes can be continued afterwards.

Due to less torque required, lifetime of rotating unit and the whole drilling system will be prolonged.



Drill rig for DTH-drilling.

**ROTEX OY**

## Applications

Applications of Symmetrix® system include water well drilling, piling, anchor hole drilling, horizontal drilling including tube umbrellas, and any drilling application where casing needs to be advanced simultaneously through overburden and rock.

Due to ingenious simple design Symmetrix® system is fast and reliable and therefore Symmetrix® method will reduce interruptions in production and bending of the casings which gives less deviations for the structure. This feature gives also constructional benefits for example in piling.

The system is applicable for any drill rig. When there is overburden to be drilled with casings instead of normal rock drilling, there is no need for other investments than those three pieces of high quality steel parts pictured on page three. The following table will help you in selecting the most suitable version of Symmetrix® drills:

CASINGTYPE HOLELENGTH	PERMANENT		TEMPORARY	
	SHORT	DEEP	SHORT	DEEP
APPLICATION				
WaterWell Drilling	<u>ECON</u> STD	STD <u>N-Version</u>	<u>N-Version</u> ECON STD	<u>N-Version</u> STD
Piling	<u>ECON</u> STD	STD <u>N-Version</u>	<u>N-Version</u> ECON STD	<u>N-Version</u> STD
Anchoring	<u>ECON</u> STD	STD <u>N-Version</u>	<u>N-Version</u> ECON STD	<u>N-Version</u> STD
Thermal Wells	<u>ECON</u> STD	STD <u>N-Version</u>	<u>N-Version</u> ECON STD	<u>N-Version</u> STD
Chip Sampling	<u>T-Version</u> ECON	<u>T-Version</u> STD	<u>T-Version</u> ECON <u>N-Version</u>	<u>T-Version</u> <u>N-Version</u> STD
Telescopic Drilling		<u>N-Version</u>		<u>N-Version</u>
Tube Umbrella (Forepiling)	<u>T-Version</u> STD	<u>T-Version</u>		
Horizontal Drilling	<u>HORIZON</u> <u>N-Version</u> STD	<u>HORIZON</u> <u>N-Version</u>		

Underlined = recommended system

**ROTEX OY**

## Casing Tubes

Connection between tubes can be made either by weld or by threads.

Threads are faster to use and they ensure that the casing tubes are connected to each other in a parallel manner. Threads are recommended especially in tunnelling due to the difficulties in welding under circumstances faced in tunnelling environment. There are difficulties to make threads if thickness of the casing is less than 6,3 mm.

Most suitable Symmetrix product may be selected from tables shown on web site [www.rotex.fi](http://www.rotex.fi). Selection is based on casing tubes outer diameter, maximum wall thickness and purpose of drilling. Paper version of selection tables is also available on request. It must be required that deviations in casing tubes inner diameter is not allowed be so remarkable that pilot bit does not fit in to the casing tube.

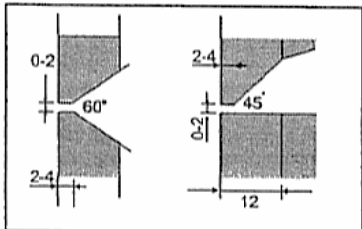
Deliverer of casings should be aware of requirement concerning dimensions. Possible deviations exceeding agreed tolerance should be under deliverers responsibility based upon agreement. It is recommended to order casing tubes precut to desired lengths. It is also recommended to order casing pipes beveled for example according to the figure beneath.



Welding under difficult circumstances.

It should be remembered that pipe welding is it's own special area among welders. It take a while even for experienced welder to adjust to the unfavorable working conditions of construction sites and to become familiar with specialties concerning pipe welding.

One weld run is adequate from wall thickness 3,2 mm up to 5 mm and 2,5 mm electrode is recommended. Beveling of these thin casings is not necessarily required. Current ought to be so high that small hole is burnt all the times, but the weld is not allowed to flow down wards. For 2.5 mm electrode this is approximately 80 Amperes with good weather conditions. For less experienced welders it is recommended to use beveling, thinner electrodes, less current and at least two weld runs.



Exemplary grooves for welding

The standards for covered electrodes are EN 440 and EN 757. No filler metals other than classified in accordance with these standards are permitted. Covered electrodes should meet standards EN 499 E 42 3 B 42h10 requirements for normal unalloyed carbon steel.

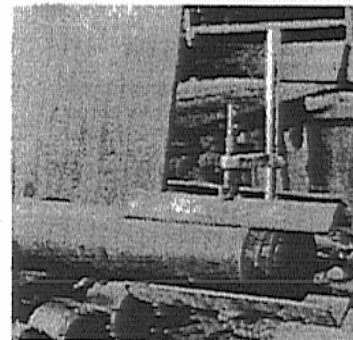
For example Esab OK 48.00 does meet these requirements. Company delivering electrodes should have information on standards.

For casings having wall thickness above 5 mm beveling is absolutely necessary if requirements for the weld are the same as for the casing it self. Root run is recommended to weld with 2.5 mm electrodes. Thicker electrodes are recommended for filling and cupping runs.

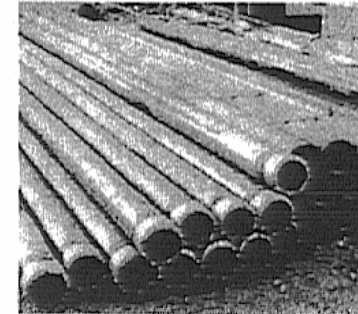
There are standards available according to which proper beveling should be selected. The beveling selection is made primarily on the basis of steel's thickness.

Even a very small deviation of casings from being parallel to each other may cause breakage of the welding. This is due to the soil pressure which is confronted from originally straight hole to the tube having deviation.

A simple way of installing tubes parallel to each other is to weld two v-sections to a



Clamp is an important tool in welding procedure.



Casing shoes and ring bits installed to casing tubes.

clamp and use this device to force tubes to the parallel direction as shown in the picture below.

After welding the straightness ought to be controlled with straight metal ruler. If deviation is observed it is highly recommended to brake the tubes apart from each other and weld them again. It is also important to make sure that casing shoe is welded with similar care as connections between casing pipes.

Electrode arc welding and shield gas welding (Mig) are both recommended. Faster shield gas welding is recommended indoors where wind or other environmental factors do not interfere welding process. It is also possible to use automatic welding with shield gas system.

Joint area ought to be washed prior to welding. It is recommended to use water and pressurized air for washing. The area to be welded may be pre-heated in order to improve the quality of the weld.

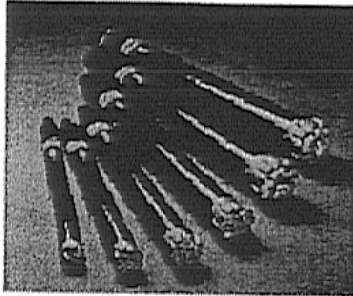
Preheating involves heating the base metal before welding is begun. Its main purpose is to lower the cooling rate of the weld, thereby reducing the thermal conductivity of the metal. Therefore there is less likelihood for hard zones to develop. Preheating also burns grease, oil and scale out of the joint. It also prevents cold cracks, reduces hardness in

## Hammer and Rotating Unit

*Tubes can be drilled with down the hole hammer (DTH) or with top hammer.*

DTH hammer is placed between the pilot bit and the first drill pipe. Hammer size is announced in inches and it varies between 3" and 30". It is most efficient to choose a hammer which fits in to the casing tube and allows free flow for the flushing aid. Recommended hammer sizes are presented in web site [www.rotex.fi/products](http://www.rotex.fi/products).

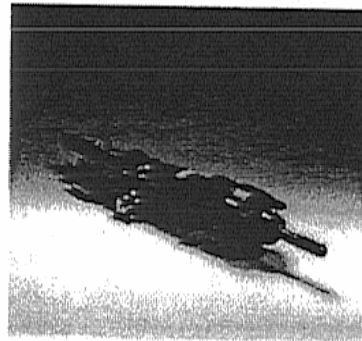
The advantage of DTH hammers is it's working principle where energy is directed straight to the pilot bit and not to the top of the very last drill pipe. Due to this energy loss it is most difficult to drill over 30 m deep holes with top hammer system.



Down the hole hammers

With some top hammers it is possible to hit upwards as well. This feature is most helpful when the casings are to be retrieved. In some countries retrieving of the drilled pipes are required by environmental regulations. Retrieving is also necessary when observation gauges or plastic pipes are installed to the drilled pipe.

Top hammers designed for quarry purposes have seldom rotating force which would be adequate to drill pipes having larger diameter than 140 mm. Maximum torque and other factors for hammers are available from producers of the equipment. The table below shows required minimum torque and recommended rotating speed for different pipe diameters.



Top hammer

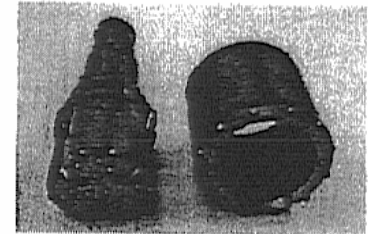
Outer diameter of the pipe	Recommended torque	Rotating speed
89 mm	500 Nm	50-70 r/min
114 mm	750 Nm	20-30 r/min
140 mm	1000 Nm	15-20 r/min
220 mm	2200 Nm	10-15 r/min
305 mm	6900 Nm	10-12 r/min
508 mm	11000 Nm	8-10 r/min

## Flushing

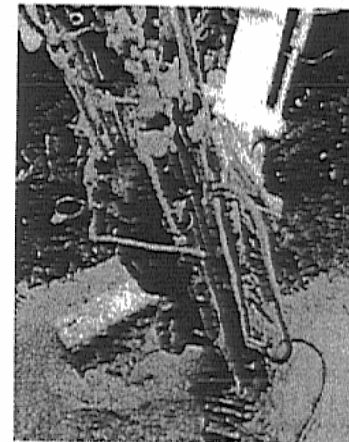
*Loose soil from head of pilot bit is flushed away. Flushing is done with flushing medium. As a flushing medium it is possible to use air, water, foam and cement grout.*

With top hammer systems air, grout and water are used as flushing medium. Water is most often used underground and air when drilled outdoors. When water is used pressure should be at least 20 bars and water consumption at least 20 liters/minute. With less pressure and consumption there is a risk of soil plugging the flushing holes in the pilot bit.

Flushing medium is forced to return via the casing annulus after exiting the pilot insuring high flushing velocity with low soil degradation. Efficient flushing will also reduce plugging of the holes in pilot bit. Recommended flushing velocity in the annulus is from 15 to 25 m/sec, depending on soil conditions.



Pilot bit and ring bit



Drilling with top hammer and grout flushing

Some DTH-hammers are able to use water pressure for operation. Working with water pressure requires 200 bars working pressure and some 400 l/minute water consumption for 4" hammer. Large amount of water is likely to interfere prevailing soil conditions, which is a limiting factor for use.

More information on water operating hammers is available at web site [www.wassara.com](http://www.wassara.com).

Dust problem with conventional DTH-hammers can be reduced by adding water into the flushing aid. Information on maximum amount of water to be added is available on brochures of DTH-hammers.

## Potential Problems

Drilling work is ready to begin when casing tube and drill bit parts are installed to the drilling rig. The work is performed as normal drilling to the rock. In this chapter we concentrate on potential problems we possibly face during drilling.

### a. Broken Connection of Casing Tubes

Tensile force and bending moment are affected to the pipe in drilling. Tensile dynamic forces are caused by the hammer. Bending moment is caused by heterogeneity soil masses. This kind of situation occurs for example when the drilling pipe confronts a boulder in a small angle. When that happens feeding force should be kept down and rotating speed ought to be increased to avoid harmful horizontal move of the tube.

If casing tube despite of all precautions brakes apart, whole casing tube ought to be withdrawn. If withdrawing is not successful the hole must be rejected.

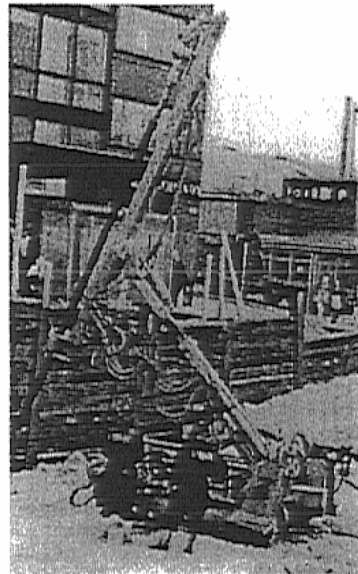
Welding issue is discussed in more detail in chapter 2.

### b. Breakage of Drill Tube

Drill tube is selected on the basis of maximum torque of rotating unit and casing tubes inner diameter. Manufacturer of drill tubes and rotating units will provide this information for contractor.

Drill tubes condition should be viewed after every use. There may be cuts that require welding. Bend drill tubes are recommended to reject.

In horizontal drilling gravity will bend drill tubes. This problem can be prevented by using more rigid drill tubes and by installing guide sleeves between drill tubes.



Starting with 6 m long casing tube

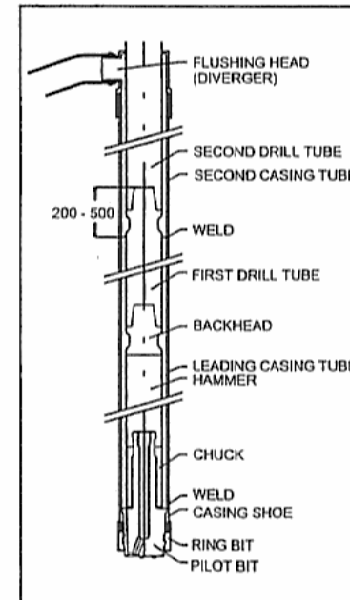
Guide sleeve has larger diameter than drilling tube and this will prevent drill tubes from bending too much.

If drill tube despite of all precautions brakes apart, there are two possibilities to choose from. Primary action is to try to catch broken tube with a pike. If catching is not successful the whole casing tube ought to be withdrawn.

### c. Plugging of Flushing Holes In Hammer or Pilot Bit

When drilling proceeds through cohesive soil it is important to keep feed force and flushing aid's pressure positive all the times. This will prevent flushing holes from being plugged. With DTH-hammers it is important not to pull pilot bit upwards before next casing tube is added. DTH-hammers valve stays closed, if pilot bit is kept firmly against hammer during casing tubes installation brake.

If flushing canal despite of all precautions is plugged it may help if feeding and rotating force are varied constantly. Also pressure of flushing medium should be increased to maximum. It may help if liquid flushing aid is changed to pressurized air. If these procedures are not successful pilot bit must be withdrawn.



Flushing head placed on the top of the casing tube

### d. Penetration through Wood and Steel

With Symmetrix method it is possible to penetrate even through steel bars having diameter up to 25 mm. Penetrating trough steel is not recommended and it may be damaging the carbide inserts of pilot bit and ring bit. When drilling is started from concrete floor it is recommended to drill trough the sections having steel inside with diamond drill and then continue drilling with Symmetrix system.

Symmetrix method is able to penetrate trough wood. Penetration rate of Symmetrix in to sound wood is from 25 to 100 cm/h depending on direction the wood is drilled. In case there are lots of wooden constructions to be pierced there is a pilot bit available having sharp buttons in it.

### e. The Penetration Rate Slows Down

Ground resistance will increase with the depth of the hole. There are several variables affecting to the rate of drilling:

- Flushing medium pressure
- Feed pressure
- Effect of hammer
- Carbide inserts condition

Ground resistance of casings may be reduced with chemical liquids. For example some environmental friendly soaps has been used for these purposes.

### f. Safety of Work

Compounded pressurized air and soil running out of the hole will cause problems to work safety. This problem can be avoided by using flushing head on the top of the steel pipe to

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## Maintenance

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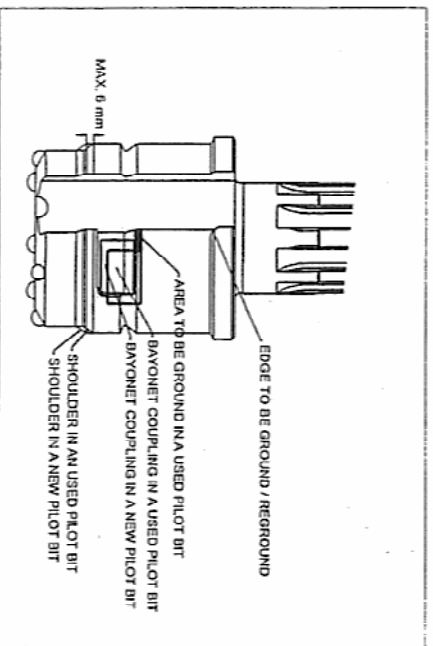
The impact, feed and torque stresses generated during drilling cause gradually wear to the shoulders of the ring bit and the pilot bit. This wear is usually the limiting factor of the life-time of the pilot bit and ring bits.

In order to extend lifetime of drill bits and to guarantee trouble free operation and unlocking of the bayonet coupling, the shoulder of the pilot bits recommended be ground according to the picture.

The pilot bit has to be rejected and replaced by a new one when the vertical wear of the shoulder against the ring bit exceeds 6 mm.

During drilling with the STD system and Econ system the casing shoe is sliding against the top shoulder of the pilot bit. If the shoulder edge in the pilot bit shown in the picture is sharp, it may mill the casing shoe during drilling. It should be checked after every hole that there is a proper radius in the edge. If needed this edge should be reground.

These actions are not a necessity, but they will prolong efficient lifetime of drill bits.



Areas to be ground to prolong lifetime of Symmetrix® system.