



PNEUMATIC PIPE RAMMER

GRUNDORAM ***Operators & Parts Manual***



TT TECHNOLOGIES, Inc.

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Important Safety Instructions

1.

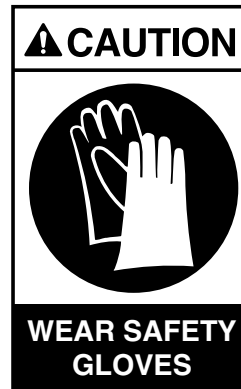
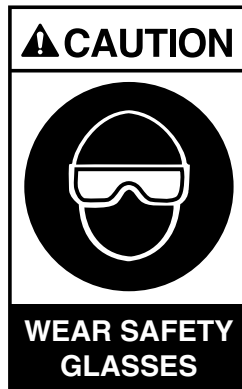
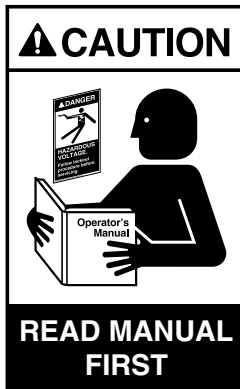
This symbol calls attention to important safety instructions which, if not followed, could result in serious personal injury or death.

Read, understand and observe all safety information and instructions in this manual, and on safety decals on the GRUNDORAM before using it. For safety reasons, read the operators manual carefully and exercise caution while using the GRUNDORAM. Please note specific safety requirements as explained by procedures called out in this manual. Failure to follow these instructions could result in serious personal injury or death.

All tools, materials and equipment manufactured and supplied by TT Technologies, Inc. are designed to be used by qualified and trained personnel only. TT Technologies, Inc. will not be held liable for any injury or damage to either people or property resulting from the misuse of TT Technologies equipment.



Please save this user's guide for future reference and have it available to all operating personnel. Personnel should thoroughly read this operating manual.



CAUTION:

When working with compressed air, follow necessary precautions to avoid injury.



WARNING:

Before you dig, contact the local utilities to determine the location of all area service lines.



DANGER:

Contact with electrical lines may result in death or injury. The user should be properly trained in correct procedures for work around electrical lines.

SAVE THESE INSTRUCTIONS

Follow all safety instructions concerning safety and possible danger.

Do not modify or remove the safety devices or warning labels of this machine. Keep all labels regarding safety and possible danger on the machine in good, readable condition. Special care is required before and during the safety check.

Every crewmember should fully understand the safety measures required for the operation and should be capable of following these regulations individually.

The GRUNDORAM is manufactured to the current technical safety-relevant regulations. Nevertheless, the use of the machine may represent a danger to the health and life of users or third parties. Always ensure that you pay particular attention to warnings, safety labels and instructions.

Read Operators Manual

Before starting the machine, fulfill all safety related requirements. All personnel should thoroughly read this operating manual.

Follow all safety instructions concerning safety and possible danger. Do not modify or remove the safety devices or warning labels of this machine. Keep all labels regarding safety and possible danger on the machine in good, readable condition. Special care is required before and during the safety check.

Every crew member should fully understand the safety measures required for the operation and should be capable of following these regulations individually.



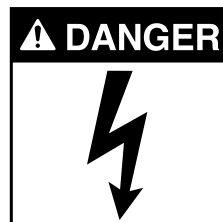
Call Before You Dig

Check the existence and exact position of buried pipe and cables by contacting the respective utilities or owners of networks. The exact and definite existence and position of buried cables and pipes should be defined by trial pits or using cable and pipe detection equipment or other means.



Cable Strike

Should you accidentally hit an electrical cable, immediately leave the site, ensure no one enters and contact the electrical company to turn off the supply. In case of a cable strike, the danger resulting from that damaged electric cable can only be evaluated following detailed information by the respective electrical company. Never rely on your own knowledge as to types of cables, safety measures and protective measures that may not be correct for the type of cable encountered. Always consider cables to be "live" and a potential danger to life. Do not re-enter the site until authorized by the electrical company.



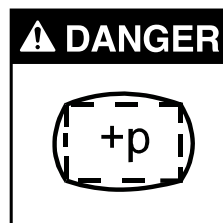
Disconnecting Air Hoses!

Only disconnect pressure free hoses. Always turn off the compressor and bleed all air before disconnecting hoses. Before starting any maintenance or inspection work, ensure that the GRUNDORAM is not connected to any air supply. During repair and maintenance operations always follow the respective safety recommendations. Repair and maintenance operations are restricted to trained and certified staff only.



Do Not Over-Pressurize!

Do not over pressurize, otherwise explosion or serious damage may occur. Do not exceed the operating pressure of 7 bar (100 psi). Make sure to only use original T.T. hoses with T.T. couplings that are suitable for this pressure.



SAVE THESE INSTRUCTIONS



No Loose Clothes

Do not wear loose clothes or long hair. Danger of body injury by loose clothes or hair being caught in the moving parts of the machine.

Safety Equipment

The operating crew should always wear the appropriate safety equipment, i.e., safety shoes/boots, hard hat, safety glasses, gloves, ear protection etc.



Operation by Qualified Personnel Only

Operation of the GRUNDORAM should be carried out by suitably trained, qualified, and certified personnel only. New operators or operators in training should be working under the constant supervision of a qualified person. Personnel operating the GRUNDORAM should have sufficiently studied the operating manual.



Skin Burning Warning

This item can be hot or cold. Do not touch as burns may result.

GRUNDORAM Maintenance

Use the machine only if it is in perfect working order and after studying the operating manual, particularly the safety-related sections. Always check the machine and its accessories for unwanted movements.

To guarantee long life, regular maintenance is essential. Inadequate or infrequent repair and maintenance operations may lead to accidents, downtime and costly repairs of the machine.

During repair and maintenance operations always follow the respective safety recommendations. Repair and maintenance operations are restricted to trained and certified staff only.

Transporting the GRUNDORAM

Danger of accidents. Do not overload the transportation vehicle.

Starting & Exit Pit Excavation

Make sure that start and exit pits are excavated and shored as necessary to comply with OSHA regulations and guard against collapse.

General Information

2.

A. General Description

For more than 35 years, TT Technologies has been a leader in trenchless replacement systems. Today, with more than 200 patents worldwide, TT Technologies' tools are used in trenchless applications ranging from pipe pulling, pipe bursting, slip-lining, directional drilling, and pipe ramming.

As with all construction operations, safe operational procedures must be observed. The safety alert symbol is used in this manual to advise you of the potential to bodily injury or death.

B. Basic Operation & Applications

The GRUNDORAM pneumatic ramming tool is used for the trenchless installation of steel pipe through a wide variety of soil types, without any rise or fall in the ground's surface. Models are available that will push pipe with anywhere from 80 to over 1,000 tons of thrust.

Although the GRUNDORAM is usually used for horizontal pipe ramming beneath roads and railroad lines (see Fig. 1), it can also be used for vertical pipe & pile driving (see Fig. 2). In addition, the GRUNDORAM can be used to drive steel pipe at an angle through rocky soils for directional drilling operations, a technique known as conductor barrel technology (see Fig. 3).

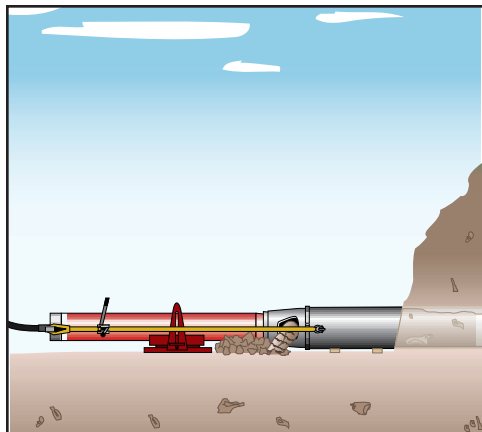


FIG. 1: HORIZONTAL PIPE RAM

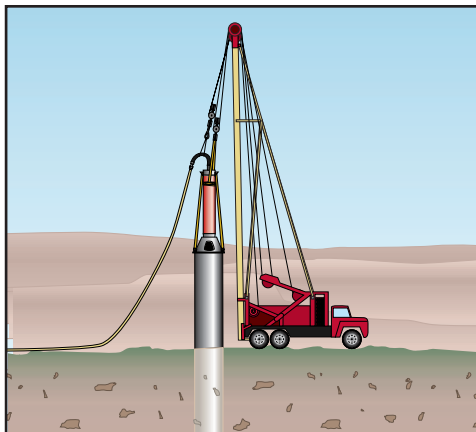


FIG. 2: VERTICAL PILE & PIPE RAM

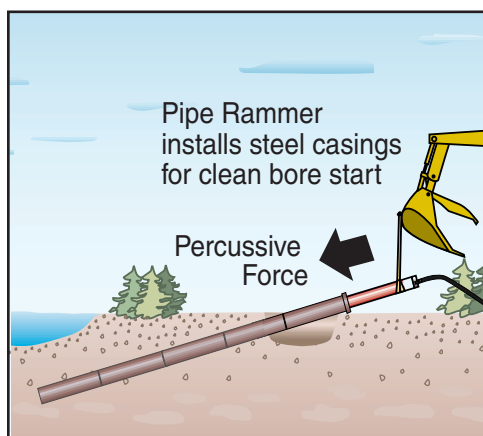


FIG. 3: CONDUCTOR BARREL

Without the use of any external support or fixed abutment, the GRUNDORAM literally drives the steel pipe into the ground, using a dynamic hammer action. Standard pipe ramming accessories can accommodate pipe diameters up to 80 inches (2032 mm) and installation distances up to 265 feet (80.8 m). Contact TT Technologies for specific information regarding pipe ramming equipment. It is important to choose the correct GRUNDORAM model for the job, based upon pipe diameter and the length of installation (see Fig. 4).

GRUNDORAM pipe rammers can also be used to free stuck HDD drill stems and product pipe including steel and HDPE (see Figs. 5 & 6). For more information on GRUNDORAM directional assist applications, contact TT Technologies customer service at 1-800-533-2078.

GRUNDORAM TOOL SPECIFICATIONS							
Tool Model	Tool Diameter in. (mm)	Length in. (mm)	Weight lbs. (kg)	Strokes/Minute	Air Cons. cfm (m3/min)	Recomm. Pipe Dia. in. (mm)	Bore Length ft. (m)
Mini-Atlas	5 (125)	37 (946)	132 (60)	580	60 (1.7)	2-8 (50-200)	50 (15)
Titan	5.7 (145)	61 (1545)	302 (137)	310	141 (4.0)	8-15 (200-400)	80 (25)
Mini-Olympus	7 (180)	43 (1080)	385 (175)	500	124 (3.5)	4-16 (100-400)	80 (25)
Olympus	7 (180)	66 (1690)	507 (230)	280	177 (4.5)	8-20 (200-500)	115 (35)
PCG 180	7 (180)	66 (1690)	490 (222)	280	159 (4.5)	8-20 (200-500)	115 (35)
Hercules	8.5 (216)	75 (1913)	811 (368)	340	282 (6.5)	12-20 (300-500)	130 (40)
HV 220	8.5 (216)	79 (2010)	945 (429)	300	282 (6.5)	12-20 (300-500)	130 (40)
Mini-Gigant	10.5 (270)	48 (1230)	1014 (460)	430	353 (10.0)	8-24 (200-600)	115 (35)
Gigant	10.5 (270)	79 (2010)	1356 (615)	310	424 (12.0)	15-32 (400-800)	165 (50)
PCG 270	10.5 (270)	84 (2134)	1540 (699)	310	424 (12.0)	15-32 (400-800)	165 (50)
Koloss	14 (350)	92 (2341)	2601 (1180)	220	706 (20.0)	20-48 (500-1200)	230 (70)
KV 350	14 (350)	102 (2591)	3375 (1531)	220	706 (20.0)	20-48 (500-1200)	230 (70)
Goliath	18 (460)	112 (2852)	5434 (2465)	180	1236 (35.0)	24-56 (600-1400)	265 (80)
Taurus	24 (600)	144 (3645)	10,580 (4800)	180	1766 (50.0)	56-78 (1400-2000)	265 (80)

Maximum bore lengths will vary depending on actual pipe diameter installed and GRUNDORAM tool used to install it.
Contact TT Technologies for detailed pipe vs bore length information.

FIG. 4: GRUNDORAM TOOL SIZE DEPENDS ON PIPE DIAMETER & LENGTH

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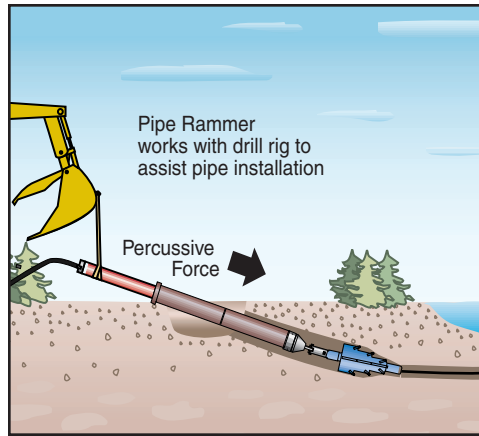


FIG. 5: OVERCOME HYDROLOCK

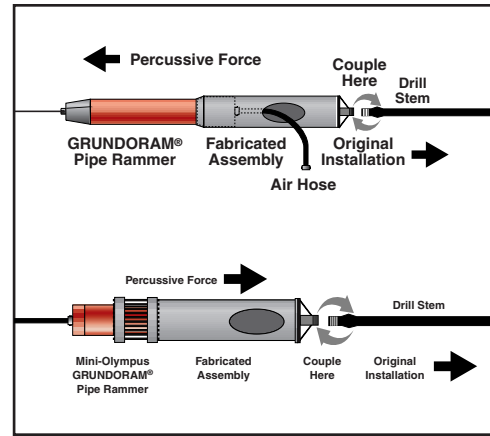


FIG. 6: DIRECTIONAL ASSIST

C. MINI-GRUNDORAM

MINI-GRUNDORAM models are available for job sites that do not allow for extensive entry pits. The tool fits almost entirely inside the pipe (see Fig. 7). This allows it to be first inserted into the pipe and then lowered down into the pit. This is especially useful in highly congested metropolitan areas. It is important to properly match the correct MINI-GRUNDORAM model to the pipe diameter and the length of the installation (see Fig. 4). If short entry pits are not necessary, then the MINI-GRUNDORAM can be fitted with ram cones and used in the conventional way.

The MINI-GRUNDORAM is equipped with a reverse control stud that enables the tool to be easily removed from the pipe by engaging its reverse motion with a few counter-clockwise turns of the air hose connector.

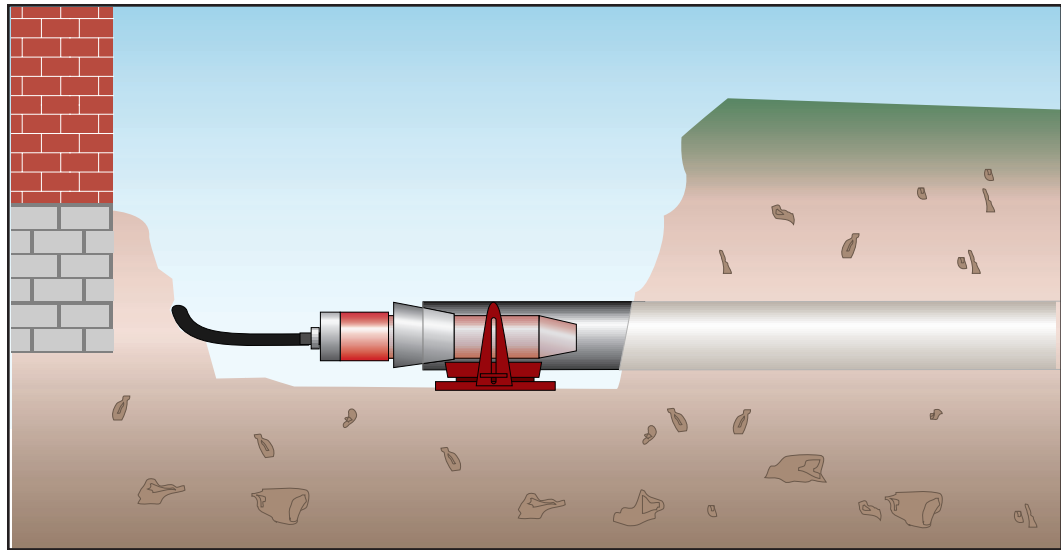


FIG. 7: MINI-GRUNDORAM TYPICAL SET UP

Technical Specifications

A. Compressor System Requirements

All tools require a compressor outlet pressure of 85-100 psi. TT Technologies supplies air hoses that are sized to operate each GRUNDORAM model at its highest efficiency. Do not use smaller diameter hoses.

If two compressors are used in parallel, place non-return valves between their outlets to ensure that air is not being pushed from one compressor back into the other. Install the non-return valves directly to the T-connector that joins the two lines together, and make sure that the non-return valves are facing in the proper direction (see Fig. 8).

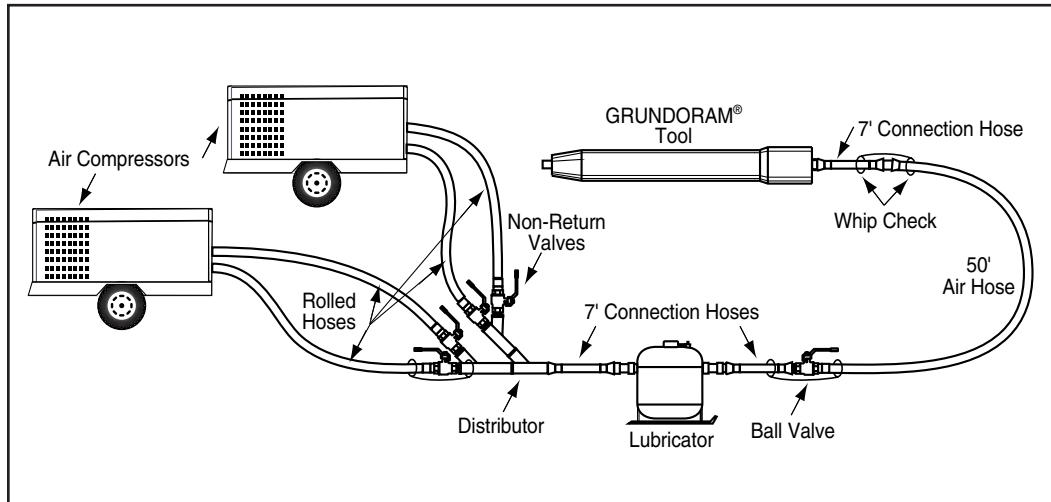


FIG. 8: GRUNDORAM SET UP WITH COMPRESSORS (MINI-ATLAS—KOLOSS)

WALL THICKNESS RECOMMENDATIONS		
Pipe Diameter	Minimum Wall Thickness	
	Bores up to 65 ft (20 m)	Bores over 65 ft (20 m)
in. (mm)	in. (mm)	in. (mm)
6 (150)	.25 (6.3)	.27 (7.1)
8 (200)	.25 (6.3)	.27 (7.1)
10 (250)	.25 (6.3)	.27 (7.1)
12 (300)	.25 (6.3)	.27 (7.1)
14 (350)	.27 (7.1)	.31 (8.0)
16 (400)	.27 (7.1)	.31 (8.0)
18 (450)	.31 (8.0)	.39 (10.0)
20 (500)	.31 (8.0)	.39 (10.0)
24 (600)	.39 (10.0)	.47 (12.0)
28 (700)	.39 (10.0)	.47 (12.0)
30 (750)	.47 (12.0)	.55 (14.0)
32 (800)	.47 (12.0)	.55 (14.0)
36 (900)	.47 (12.0)	.62 (16.0)
40 (1000)	.47 (12.0)	.62 (16.0)
42 (1050)	.59 (15.0)	.62 (16.0)
48 (1200)	.59 (15.0)	.70 (18.0)
51 (1300)	.62 (16.0)	.70 (18.0)
55 (1400)	.70 (18.0)	.78 (20.0)
60 (1500)	.75 (19.0)	.87 (22.0)
72 (1800)	.87 (22.0)	1.00 (25.0)
80 (2000)	.875 (22.2)	1.00 (25.0)

FIG. 9: MINIMUM WALL THICKNESS

WARNING: Incorrect hoses may fail. Only use air hoses that are rated for at least 145 psi. Install safety whip checks on all air hose connections. Failure to do so could result in serious personal injury or death.



B. Operational Capacities

Minimum Wall Thickness (see Fig 9), Tool Selection chart (see Fig. 4), Bore Length Recommendations chart (see Fig. 10) and an Entry Pit Calculation chart (see Fig. 11).

As a rule of thumb the recommended bore length with pipe diameters up to 32" (800 mm):

Pipe Diameter in mm divided by 10 gives the bore length in m.

Example:

Pipe Diameter of 200 mm divided by 10 = up to max 20 m long.

The ratio should be used to preserve target accuracy.

FIG. 10: BORE LENGTH EXAMPLE

Example:

Hercules GRUNDORAM tool dia. 8.5" (216 mm), steel pipe dia. 20" x .393" (508 mm x 10 mm) with soil removal cone REK 43 000 501.

Components:	Length in.(mm)
GRUNDORAM Tool (L3)	86" (2190 mm)
Tapered Locking Ram Cone (L2)	3.75" (95 mm)
Segmented Ram Cones if used / etc.	
Soil Removal Cone (REK 43 000 501) (L1)	24.6" (600 mm)
Pipe Length	238" (6000 mm)
Additional Working Space	60" (1524 mm)

Pit Length (Total Minimum) 413" (10,490 mm)

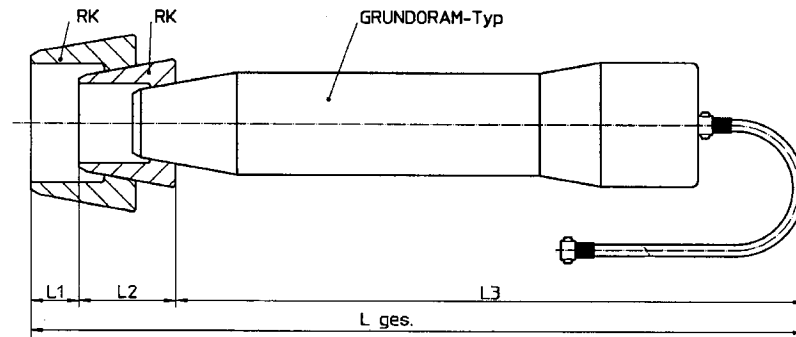


FIG. 11: ENTRY PIT CALCULATION

Generally, the bore pit needs to have a minimum length equal to the sum of the measurements of the ramming tool, the ram cone, soil removal cone, the length of the product pipe sections being used, plus 5 feet of working space behind the tool.

C. Physical Specs (see Fig. 12).

GRUNDORAM TOOL SPECIFICATIONS							
Tool Model	Tool Diameter in. (mm)	Length in. (mm)	Weight lbs. (kg)	Strokes/ Minute	Air Cons. cfm (m3/min)	Recomm. Pipe Dia. In. (mm)	Bore Length ft. (m)
Mini-Atlas	5 (125)	37 (946)	132 (60)	580	60 (1.7)	2-8 (50-200)	50 (15)
Titan	5.7 (145)	61 (1545)	302 (137)	310	141 (4.0)	8-15 (200-400)	80 (25)
Mini-Olympus	7 (180)	43 (1080)	385 (175)	500	124 (3.5)	4-16 (100-400)	80 (25)
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Maximum bore lengths will vary depending on actual pipe diameter installed and GRUNDORAM tool used to install it.
Contact TT Technologies for detailed pipe vs bore length information.

FIG. 12: GRUNDORAM TECHNICAL SPECIFICATIONS

Safe Operating Practices

A. Work Area Safety

1. Operator training is mandatory prior to use.
2. Always follow manufacturer's operating instructions.
3. All safety devices must be in place before and during operation.
4. Report any defects or safety device faults immediately.
5. Stop operation immediately if any safety device fails.
6. Maintenance work or inspections should be performed when the tool is off and not connected to the air compressor.
7. All safety devices must be replaced after maintenance or repair.
8. Follow all normal construction safety procedures.

4.

B. Pneumatic Equipment

1. Tighten all connections before applying pressure. Relieve pressure when servicing unit.
2. Visually inspect all hoses and connections regularly. Service if needed.
3. Do not exceed working pressure of pneumatic hoses.
4. Forced air creates flying debris. Always wear personal protective equipment. Severe personal injury could result.

C. Job Site Considerations

1. As with all construction operations, safe operational procedures must be observed. The safety alert symbol is used in this manual to advise you of the potential for bodily injury or death.
2. Prior to starting, check with the utility companies for the location and depth of existing cables and line.
3. Minimal ground cover is required with the GRUNDORAM resulting in shallower and less expensive entrance and exit pits.
4. There is no need for fixed abutments when using the GRUNDORAM.

Set Up

A. General Information & Basic Set Up

GRUNDORAM pipe rammer uses pneumatic power to insert casings through a variety of soils without a rise or slump to the ground surface. The soil is swallowed up inside the casing and is then removed by using the air compressor to clean out the spoils (see Fig. 13). The GRUNDORAM pipe rammer does not require the use of back abutments, thus set up times are decreased.

5.

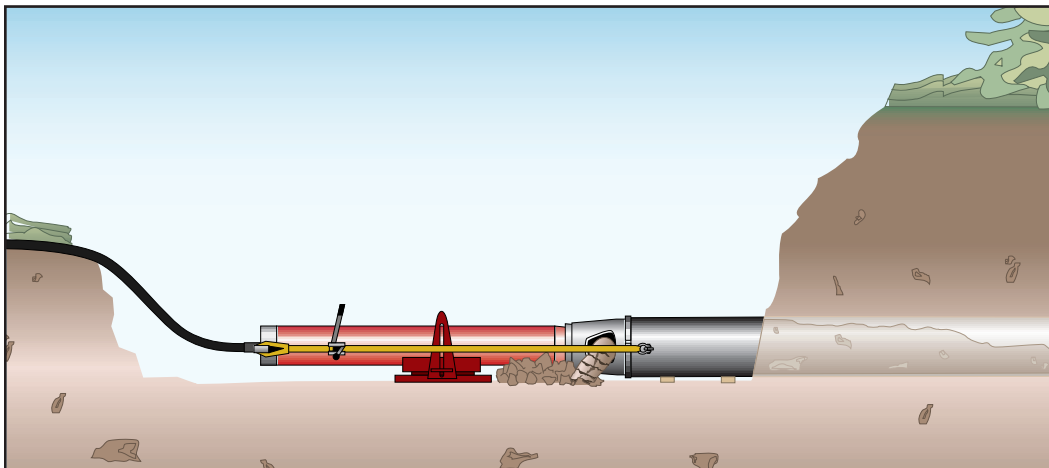


FIG. 13: TYPICAL GRUNDORAM SET UP

B. Compressor Connections

Make sure all hose connections are tight before starting the air compressor. When disconnecting the air hose make sure that all pressure is released first.

C. Lubricator

Proper lubrication is essential to the optimum performance of the GRUNDORAM. GRUNDO-OIL is fed into the GRUNDORAM through a lubricator (see Fig. 14). The lubricator is connected between the compressor and the GRUNDORAM tool. It atomizes the oil and feeds it into the GRUNDORAM through via compressed air. Oil flow can be regulated by adjusting the lubricator settings (see Fig. 15).

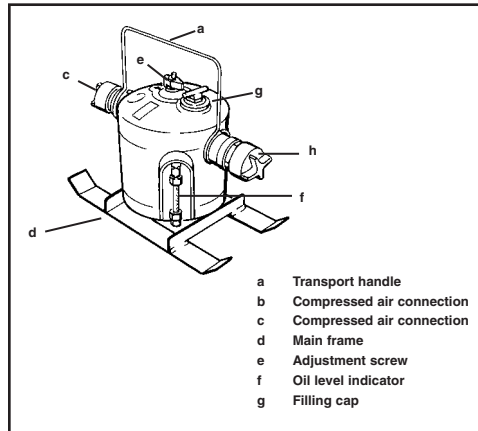


FIG. 14: LUBRICATOR

Tool Model	LUBRICATOR SETTINGS		Consumption gals/hr (l/h)
	Switch 1 gal (3.78 l)	Position 2 gal (7.5 l)	
Mini-Atlas	2	-	.15 (.5-.6)
Titan	2	-	.20 (.7-.8)
Mini-Olympus	1-2	5	.20 (.7-.8)
Olympus	1-2	5	.20 (.7-.8)
Hercules	-	4	.25 (1.0)
Mini-Gigant	-	2-3	.30 (1.2)
Gigant	-	2-3	.30 (1.2)
Koloss	-	2	.40 (1.5)
Goliath	-	2	.50 (2.0)
Taurus	-	2	.80 (3.0)

FIG. 15: LUBRICATOR SETTINGS



WARNING: System under pressure. Never unscrew the oil inlet under pressure.

GRUNDO-OIL is completely safe and biodegradable and has no harmful affects on rubber air hoses.

NOTE: In order to ensure adequate lubrication, tool lubricator must remain upright during while in use. Lubricator flow should be set at 0 when transporting.

NOTE: Increase lubricator's normal setting by 1 during cold weather conditions.

D. Pit Description/Construction

Pipe ramming bore pits do not typically require the use of reinforced back abutments and are not restricted in the length or diameter of the product pipe sections that can be used. Bore pit preparations will, in part, be dictated by job site conditions and will vary by project.

Generally, the bore pit needs to have a minimum length equal to the sum of the measurements of the ramming tool, the ram cone, soil removal cone, the length of the product pipe sections being used, plus 5 feet of working space behind the tool (see Fig. 11).



DANGER: Entrance & Exit Pits that are at least 3.93 feet (1.2 m) deep need to be shored as necessary to comply with OSHA regulations and guard against collapse. Failure to do so could result in serious personal injury or death.

E. Cradle/Adjustable Bearing Stand

The adjustable bearing stand is a heavy-duty mechanism that provides both support and alignment for the GRUNDORAM and the pipe. An inflatable air bladder allows for easy vertical adjustment (see Fig. 16). It can lift over three tons and can also be fitted with a special height adapter (see Fig. 17). With the use of ratcheting web straps, the bearing stand can be pulled along with the GRUNDORAM while it is pushing the pipe (see Fig. 18).

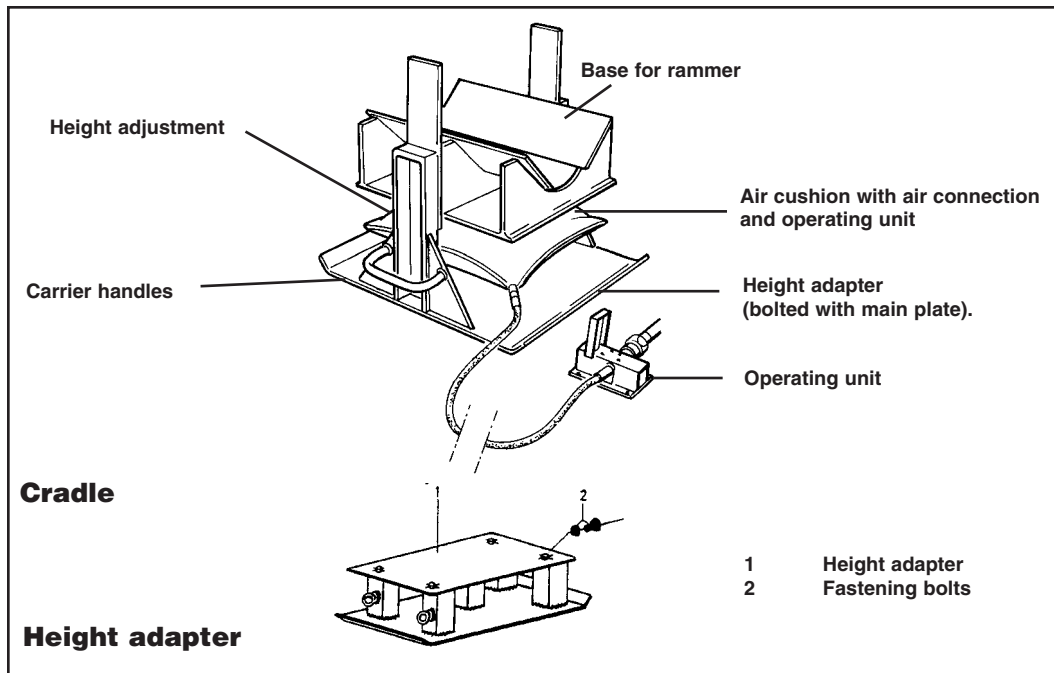


FIG. 16: ADJUSTABLE BEARING STAND

ADJUSTABLE BEARING STAND SPECIFICATIONS				
Part Number	Bearing Stand	Size (LxWxH) in. (mm)	Weight lbs (kg)	Lifting Power lbs. (kN)
G 450 0500	Type 1 up to Gigant	21x26x20 (530x660x505)	170 (77)	6741 (30 kN)
G 450 0400	Type 2 for Koloss-Goliath	30x33x17 (770x840x430)	267 (121)	6741 (30 kN)
TF 600 0400	Type 3 for Goliath-Taurus	30x36x17 (770x920x430)	298 (135)	6741 (30 kN)
G4500450	Height Adapter for Type 2	30x24x7 (770x610x170)	179 (81)	N/A
TF 600 0450	Height Adapter for Type 3	30x31x9 (770x790x225)	229 (104)	N/A

FIG. 17: ADJUSTABLE BEARING STAND SPECIFICATIONS

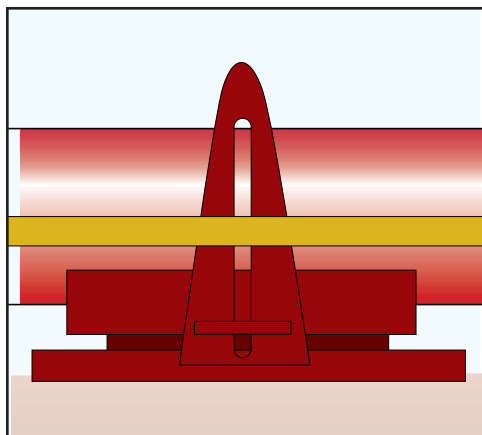


FIG. 18: ADJUSTABLE BEARING STAND SET UP

F. Support System Track/I-Beam

The accuracy of the installation is dependent upon the first pipes alignment. For this reason, it is imperative that the pipe has a stable support, in order to remain precisely aligned throughout the ramming process; this is especially important for long installations.

Support tracks can be built using an I-beam (girder) (see Fig. 19), a C-channel (see Fig. 20), or a sheet pile (see Fig. 21), for larger pipe sizes you can use (2) I-beams (see Fig. 22). About 3 feet (1 m) should be left between the support track and the face of the pit, in order to maintain an area for welding the pipe lengths together. Auger tracks can also be used as support tracks for pipe ramming operations. Ramming smaller diameter pipes can often be accomplished without any type of support track. Contact TT Technologies for specific information regarding pipe ramming support and track systems.

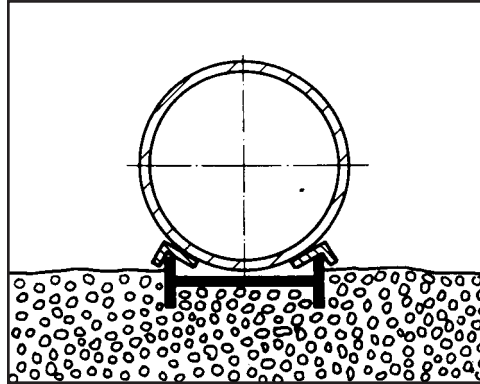


FIG. 19: ALIGNMENT ON I-BEAM

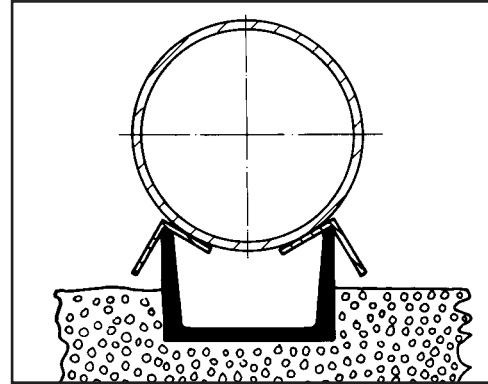


FIG. 20: ALIGNMENT ON C-CHANNEL

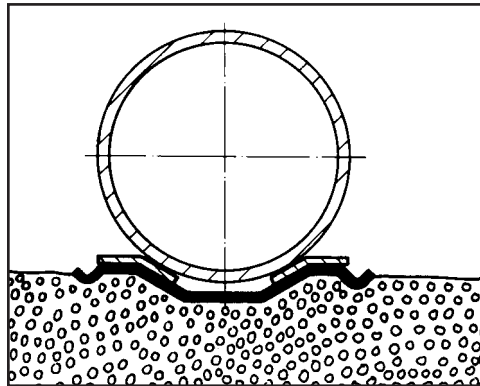


FIG. 21: ALIGNMENT ON SHEET PILE

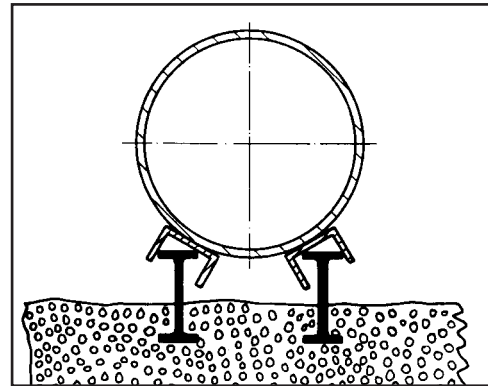


FIG. 22: ALIGNMENT ON TWO I-BEAMS

The support track should be secured in concrete, although in special cases, sand or gravel can be used. Recommended steel profiles (support tracks) in relation to various pipe sizes (see Fig. 23).

RECOMMENDATIONS OF STEEL PROFILES FOR ALIGNING STEEL PIPE			
Pipe Outer Diameter in. (mm)	I-Beam Profile	C-Channel Profile	Sheet Pile
4 (108)	1 x I 80	1 x C 80	
6 (159)	1 x I 80	1 x C 80	
8 (219)	1 x I 80	1 x C 80	
10 (273)	1 x I 80	1 x C 80	
12 (323)	1 x I 120	1 x C 120	KD III
16 (406)	1 x I 140	1 x C 140	KD III
20 (508)	1 x I 160	1 x C 160	KD III
24 (609)	1 x I 180	1 x C 180	
32 (813)	1 x IPE 200	1 x C 220	KD IV
40 (1016)	2 x IPE 140		HKD 700/6
48 (1220)	2 x IPE 180		
55 (1420)	2 x IPE 200		

FIG. 23: RECOMMENDATIONS FOR ALIGNING PIPES

G. Tapered Locking Ram Cones

The purpose of the ram cone is to provide a tight fit between the GRUNDORAM and the pipe (see Fig. 24). This ensures that all of the driving force is efficiently transferred. There are two types of ram cones: the tapered locking ram cones and the segmented ram cones.

The tapered locking ram cones enable one specific GRUNDORAM tool to be used for various pipe sizes. One or more can be used to provide a tight, solid fit, between the tool and the pipe. It should be noted that if these cones are fitted directly into the pipe, some flaring may occur. Ram cones come in specific sizes for each GRUNDORAM model (see Fig. 25).

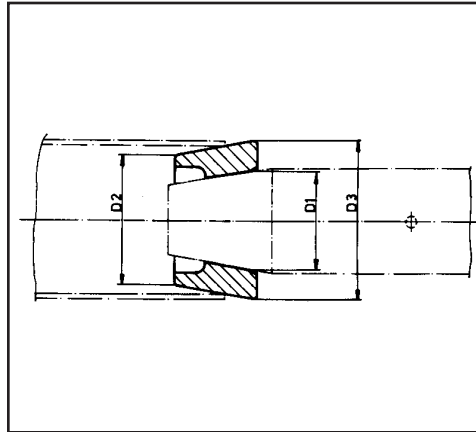


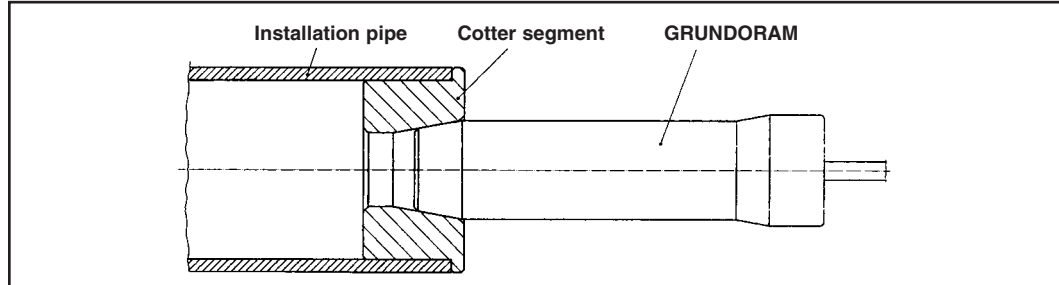
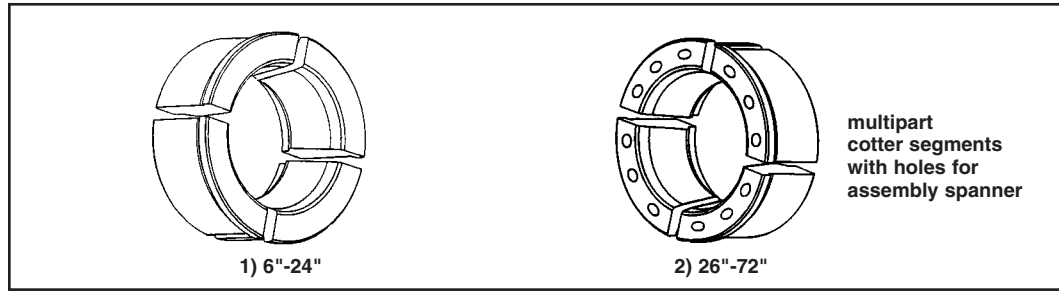
FIG. 24: TAPERED LOCKING RAM CONES SET UP

TAPERED LOCKING RAM CONES SPECIFICATIONS				
Part Numbers	D1 in (mm)	D2 in (mm)	D3 in (mm)	Weight lbs (kg)
2 in (50 mm) Step				
RK 09 09 13	3.94 (100)	3.58 (91)	5.12 (130)	7.5 (3.4)
RK 13 13 18	4.84 (123)	4.92 (125)	7.09 (180)	19.8 (9)
RK 18 19 24	6.50 (165)	7.28 (185)	9.45 (240)	33.1 (15)
RK 23 23 28	10.43 (265)	10.83 (275)	12.99 (330)	34.7 (15.76)
RK 33 33 38	12.40 (315)	12.00 (305)	14.61 (371)	59.5 (27)
RK 38 38 43	13.98 (355)	13.98 (355)	16.54 (420)	61.7 (28)
RK 43 43 48	16.34 (415)	16.57 (421)	18.90 (480)	70.5 (32)
RK 53 53 58	20.28 (515)	20.51 (521)	22.83 (580)	87.5 (39.7)
4 in (100 mm) Step				
RK 23 28 33	8.78 (223)	10.83 (275)	12.99 (330)	72.7 (33)
RK 33 38 43	12.40 (315)	14.76 (375)	16.93 (430)	105.8 (48)
RK 43 48 53	15.94 (405)	18.35 (466)	20.87 (530)	130.0 (59)
RK 53 58 63	19.88 (505)	22.05 (560)	24.25 (616)	163.1 (74)
RK 63 68 73	23.82 (605)	25.71 (653)	28.35 (720)	176.3 (80)
RK 82 88 93	31.70 (805)	34.53 (877)	36.61 (930)	264.5 (120)
8 in (200 mm) Step				
RK 23 38 43	8.78 (223)	14.76 (375)	16.93 (430)	101.4 (46)
RK 43 58 62	15.75 (400)	22.09 (561)	24.41 (620)	280.0 (127)
RK 63 78 83	23.62 (600)	29.53 (750)	31.93 (811)	385.8 (175)
Taurus Add on Ram Cones				
RK 63 71 81	24.41 (620)	27.80 (706)	31.89 (810)	1000.0 (453.6)
RK 83 115 122	31.97 (812)	44.41 (1128)	50.28 (1277)	3325.0 (1508.2)
RK 83 135 142	31.97 (812)	52.24 (1327)	57.56 (1462)	5700.0 (2585.5)
RK 83 145 152	31.97 (812)	56.18 (1427)	61.50 (1562)	6300.0 (2857.6)
RK 83 174 182	31.97 (812)	67.80 (1722)	73.11 (1857)	10000.0 (4535.9)
RK 83 194 202	31.97 (812)	75.59 (1920)	80.91 (2055)	11000.0 (4989.5)

FIG. 25: TAPERED LOCKING RAM CONE SPECIFICATIONS

H. Cotter Segments

The cotter segments ensure that maximum driving force is transferred to the pipe, with minimal flaring; this makes the welding job much easier (see Fig. 26). They are also useful when pushing thin-wall pipe for fifty feet or less.



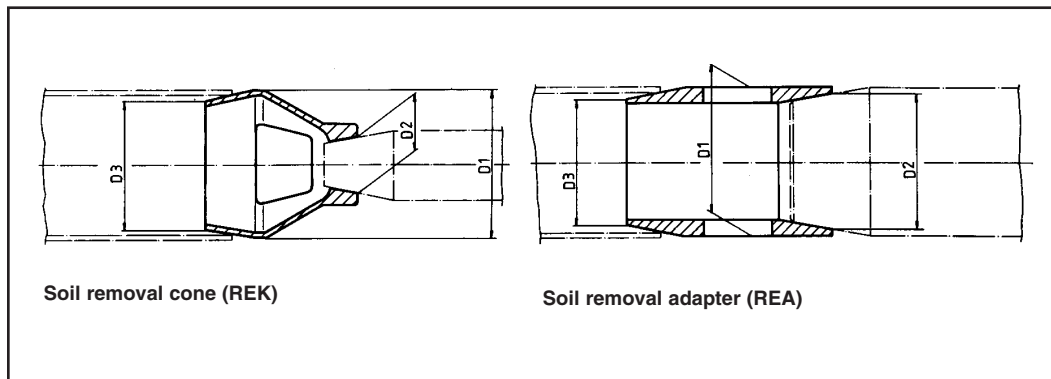
COTTER SEGMENT SPECIFICATIONS				
COTTER SEGMENTS	For Pipe in (mm)	Weight lbs (kg)	Suitable for Ram Cone/Soil Removal Adapter/Cone	
RSS 1680	6.6 x .25 (168.3 x 6.3)	16.0 (7.3)	RK 090913	N/A
RSS 2190	8.6 x .25 (219.1 x 6.3)	32.0 (14.5)	RK 131318	REA 14518013
RSS 2730	10.7 x .28 (273.0 x 7.1)	44.0 (20.0)	RK 181924	REA 20523019
RSS 3230	12.8 x .31 (323.9 x 8.0)	48.0 (21.8)	RK 232328	REA 26029023
RSS 3380	14.0 x .39 (355.6 x 10.0)	72.0 (32.7)	RK 232328	REA 26029023
RSS 4060	16.0 x .39 (406.4 x 10.0)	112.0 (50.8)	RK 282833 + 232833	REA 30533028
RSS 18	18.0 x .39 (457.2 x 10.0)	170.0 (77.1)	RK 282833 or 232833	REA 30533028
RSS 5080	20.0 x .39 (508.0 x 10.0)	152.0 (68.9)	RK 232843 + 383843	REK 33000401
RSS 6090	24.0 x .39 (609.6 x 10.0)	240.0 (108.9)	RK 434853	REK 43000501
RSS 6064	26.0 x .39 (660.4 x 10.0)	330.0 (149.7)		REK 43000501
RSS 7110	28.0 x .39 (711.0 x 10.0)	355.0 (161.0)	RK 434853	REK 43000501
RSS 7620	30.0 x .50 (762.0 x 12.5)	490.0 (222.3)		REK 43000601
RSS 8130	32.0 x .50 (813.0 x 12.5)	475.0 (215.5)	RK 435863 + 535358	REK 43000601
RSS 9140	36.0 x .47 (914.0 x 12.0)	1660.0 (753.0)	RK 535358	REK 43000601
RSS 1016	40.0 x .50 (1016.0 x 12.5)	1200.0 (544.3)	RK 637883	REK 43000801
RSS 1035	42.0 x .63 (1016.0 x 16.0)	1180.0 (535.2)		REK 43000801
RSS 1220	48.0 x .63 (1220.0 x 16.0)	1163.0 (527.5)	RK 8395102	REK 43001001
RSS 1420	56.0 x .69 (1420.0 x 17.6)	1799.0 (616.0)	RK 83115122	REK 43001201
RSS 60	60.0 x .79 (1520.0 x 20.0)	2650.0 (1202.0)		REK 43001201
RSS 9141	36.0 x .75 (914.0 x 19.1)	1547.0 (702.0)		Direct to Taurus
RSS 1067	42.0 x .88 (1067.0 x 22.4)	2422.0 (1098.6)		Direct to Taurus
RSS 48	48.0 x 1.00 (1220 x 25.4)	3550.0 (1610.3)		Direct to Taurus

FIG. 26: COTTER SEGMENTS SPECIFICATIONS

IMPORTANT: When using add-on cones and cotter segments, make sure the inner pipe wall has a smooth surface. The weld swelling on spiral-welded pipes must be ground in the segment mounting area to avoid pressure point loading. Straight welds may have sufficient space in the areas between cotter segments to avoid over loading.

I. Soil Port

The soil removal cone provides an exit for the compacted soil inside the pipe. The cone can be fitted directly to the pipe or directly behind a segmented ram cone. Also, tapered locking ram cones can be used behind the soil removal cone, in order to ensure a tight fit between the GRUNDORAM and the pipe (see Fig. 27).



SOIL REMOVAL CONE (REK) & SOIL REMOVAL ADAPTER (REA) SPECIFICATIONS				
Part Numbers	D1 in (mm)	D2 in (mm)	D3 in (mm)	Weight lbs (kg)
Soil Removal Cone:				
REK 33 000 401	16.9 (430)	12.4 (315)	14.8 (375)	275.5 (125)
REK 43 000 501	21.7 (550)	15.9 (405)	17.8 (452)	498.2 (226)
REK 43 000 601	25.6 (650)	16.5 (420)	22.0 (558)	628.3 (285)
REK 43 000 801	33.5 (850)	16.5 (420)	37.7 (958)	965.6 (438)
REK 43 001 001	41.3 (1050)	16.5 (420)	37.7 (958)	1422.0 (645)
REK 43 001 201	49.2 (1250)	16.5 (420)	45.6 (1158)	2449.3 (1111)
REK 43 002 401	57.1 (1450)	16.5 (420)	52.6 (1335)	4960.3 (2250)
Soil Removal Adapter:				
REA 145 180 13	7.0 (178)	5.8 (148)	5.5 (139)	50.7 (23)
REA 205 230 19	9.1 (230)	8.3 (210)	7.2 (183)	52.9 (24)
REA 260 290 23	11.5 (292)	10.2 (260)	9.3 (236)	116.8 (53)
REA 305 330 28	13.0 (330)	11.8 (300)	11.3 (288)	94.8 (43)
REA 345 390 33	15.1 (384)	13.9 (352)	12.6 (319)	138.9 (63)
REA 380 425 38	16.8 (426)	15.6 (395)	14.6 (370)	176.4 (80)
Soil Removal Adapter for Taurus:				
REA 530 650 54	25.6 (650)	20.9 (530)	21.1 (537)	2744.8 (1245)
REA 535 850 73	33.5 (850)	21.1 (535)	28.7 (730)	4762.0 (2160)

FIG. 27: SOIL REMOVAL CONE & SOIL REMOVAL ADAPTER SPECIFICATIONS

J. Pressure Plate

The pressure plate attaches to rear of the GRUNDORAM and acts as the anchor points for the ratcheting web straps. Steel eyes are welded on-site to the pipe and serve as the other attachment points for the ratcheting web straps (see Fig. 30).

K. Cutting Shoes

The cutting shoe is an integral part of the pipe-ramming process (see Fig. 28). Before the operation begins, it is tack-welded to the tip of the leading pipe. Its primary purposes are as follows:

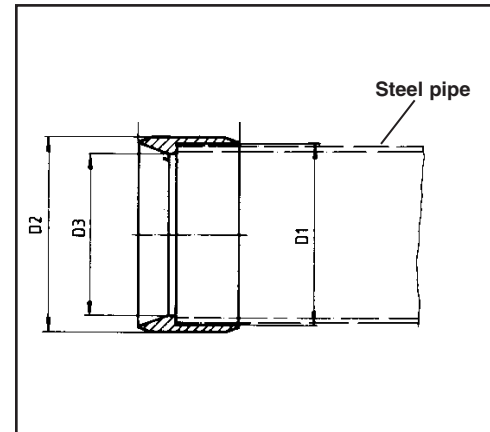
Strengthens the tip of the leading pipe for maximum penetration through difficult soil and rocks.

Reduces both external and internal pipe friction, due to its oversize cut.

Protects the pipes coating or insulation.

Cutting shoes also create a channel for the flow of a bentonite/polymer mixture.

Also, the cutting shoes conical internal surface reduces soil displacement and influences the bores accuracy.



CUTTING SHOE SPECIFICATIONS				
Part Numbers	D1 in (mm)	D2 in (mm)	D3 in (mm)	Weight lbs (kg)
7107604	4.3 (110)	4.8 (123)	3.9 (100)	7.0 (3.2)
	6.4 (162)	6.9 (176)	5.7 (145)	11.2 (5.1)
7107606	6.7 (171)	7.3 (185)	5.9 (150)	19.0 (8.6)
7107608	8.7 (222)	9.3 (236)	7.8 (198)	17.0 (7.7)
7107610	10.9 (276)	11.5 (293)	9.8 (250)	26.0 (11.8)
7107612	12.9 (327)	13.5 (343)	11.8 (300)	29.0 (13.2)
7107614	14.1 (358)	14.5 (368)	12.8 (325)	40.0 (18.1)
7107616	16.1 (409)	17.0 (432)	14.7 (373)	48.0 (21.8)
7107618	18.1 (460)	19.0 (483)	16.8 (427)	61.0 (27.7)
7107620	20.1 (511)	21.0 (533)	18.8 (478)	54.0 (24.5)
7107624	24.1 (613)	25.2 (640)	22.7 (577)	155.0 (70.3)

FIG. 28: CUTTING SHOE SPECIFICATIONS

Light and water-retentive soils require a special cutting shoe. The outer cutting ring encompasses only the top two-thirds of the pipes circumference (see Fig. 29). This eliminates the cutting action along the bottom of the pipe and reduces the pipes natural tendency to sink, due to gravity and the overcut of the outer cutting ring.

Cutting shoes are available through TT Technologies, and are reusable. Contact TT Technologies for specific information regarding cutting shoe requirements and specifications.

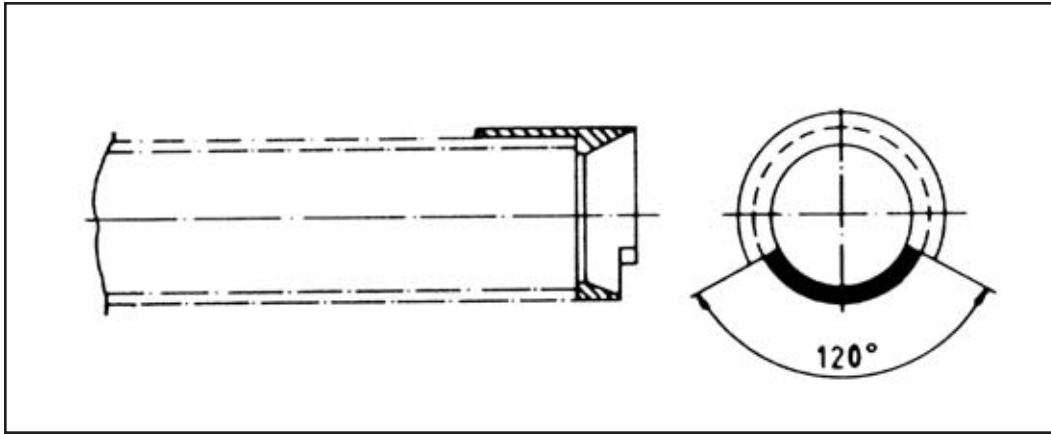


FIG. 29: GRADE BORE CUT-AWAY CUTTING SHOE

L. Tensioning Straps

The GRUNDORAM is held tightly to the pipe through the use of tensioning straps and ratchets. The straps are fastened on the pipe through two pre-welded eyelets. The pressure plate at the rear of the machine has a hook that can be used as a sling. The straps are tensioned with standard ratchets (see Fig. 30). Tensioning chains and turnbuckles are used with larger diameter tools and pipes. Contact TT Technologies for specific information regarding tensioning requirements.

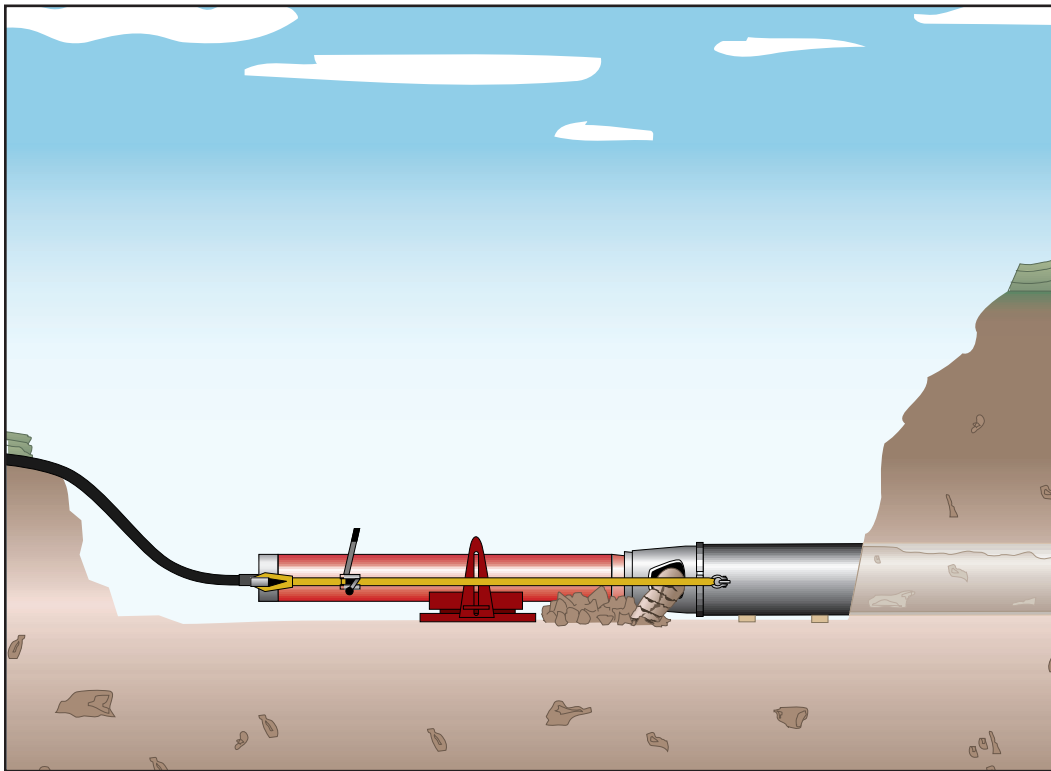


FIG. 30: GRUNDORAM TOOL SET UP

M. Bentonite/Lubrication

Bentonite or other polymer based lubricants are frequently utilized on long distance and/or large diameter pipe rams. Lubricant usage helps counter act soil friction inside and outside of the casing. The lubricant also aids in the removal of the soil column after the ram is complete. Consult TT Technologies for specific lubrication recommendations.

Operating Instructions

6.

A. General Information

Pneumatic pipe ramming can accommodate pipe diameters from 4 to 144 inches. Each job site should be evaluated on an individual basis. Contact TT Technologies for specific questions regarding tool and accessory selection, job site configuration and pit construction.

B. Set Up & Assembly

IMPORTANT: Proper pit, platform and support construction is essential to successful ramming operations. Construction considerations include safety, de-watering, equipment weight and support, line and grade, adequate space allotment. Contact TT Technologies for specific pit construction information.

After the pit, platform and support are in place, the lead section of pipe is positioned on the support platform. At this point the lead casing needs to be prepped for ramming operations. This includes the installation of the cutting shoe and bentonite line if needed.

Assemble tool and size specific accessories to meet the requirements of the specific project. Depending on the requirements these can include cotter segments, tapered ram cone, soil removal port, GRUNDORAM tool and tool cradle.

NOTE: Each project is unique and should be evaluated on an individual basis. Contact TT Technologies for specific questions regarding tool and accessory selection, job site configuration and pit construction.

Once the tool assembly is complete and secured with tensioning straps or chains, compressor connections are made. Compressor configuration will vary depending on the specific ramming tool used and the specifications of the project.



WARNING: System under pressure. Forced air creates flying debris. Always wear personal protective equipment. Severe personal injury could result.

IMPORTANT: Check all hose connections before operation. Safety whip checks must be used on all hose connections.

C. Testing the Rammer

Prior to ramming, start the rammer with minimal air flow in order to seat the steel components. Once completed, stop rammer and check all air connections, whip checks and tensioning straps. Check line and grade. Check Bentonite connection and flow.

NOTE: Actual Bentonite pumping should begin after the cutting shoe has been rammed into the pit wall at least 12 inches.

After all checks are complete, ramming is ready to begin.

D. Ram First Foot of Pipe

Slowly ram in the first one foot of pipe operating the compressor at approximately a 1/4 power, just enough to cycle the pipe rammer. Once the first foot is in place stop ramming. Using a transit or builders level check line and grade. Adjust pipe if necessary.

Visually inspect tool assembly and check tensioning straps or chains and adjust if necessary. Check bentonite flow if used.

E. Ram Second Foot of Pipe

Slowly ram in the second foot of pipe and repeat the steps listed in section D.

F. Continue Ramming

Continue ramming operations. Operate compressor at appropriate level for specific conditions. Closely monitor tool assembly, bentonite flow and ramming progress. Ram pipe section to within 1 foot of the platform's edge.

IMPORTANT: Stop ramming before the pipe section reaches the end of the platform. Pipe alignment can be seriously compromised if pipe is rammed past the platform. Stopping ramming operations before this occurs will also aid in the welding of the next pipe section.

G. Install Second Pipe Section

1. Stop GRUNDORAM tool and disconnect tensioning straps or chains.
2. Remove GRUNDORAM tool and accessories from the first pipe section.
3. Move tool and accessories back far enough to position second pipe section behind the first section on the tracks. Be sure to use the proper equipment for moving the GRUNDORAM tool and the pipe sections (backhoe, crane etc.).
4. Position second pipe section, and align with first pipe section.
5. Precisely weld the two pipe sections together with a 100% penetration weld utilizing E6010 root pass and E7018 cover passes to fill the bevel. **Factory midweld pipes should be avoided unless the welds are guaranteed 100% penetration welds (see Fig. 31).**

CAUTION: Welding should only be carried out by a qualified person, to produce a connection in accordance with the high demands of pipe ramming.

6. Position GRUNDORAM tool and accessories in place and attach to the second pipe section.
7. Check alignment and tension straps to verify everything is ready to begin pipe ramming again.
8. Start ramming in second pipe section, repeat these steps (1-8) until ramming is completed.

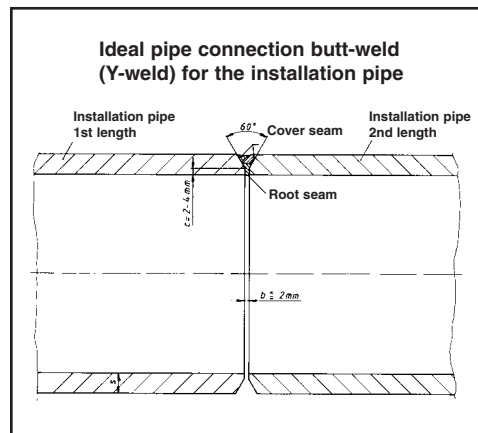


FIG. 31: PIPE CONNECTION



Breakdown/Tool Removal

After you have installed the last section of pipe, stop the GRUNDORAM tool. Shut down the air compressor and turn it off, release the pressure in the air hoses, then disconnect air hoses from the GRUNDORAM tool.

A. Remove Tension Straps or Chains

1. Disconnect Tension Straps or chains from the GRUNDORAM tool and the pipe section.

B. Remove GRUNDORAM tool and Accessories from Pipe Section

1. Move GRUNDORAM tool and accessories back away from the end of the pipe, again use proper lifting equipment to move the tool and accessories.



Spoil Removal

8.

The following methods can be used for removing the trapped soil inside the pipe: compressed air, compressed air/water, auger, high-pressure jet cutting, pressure jetting, vacuum excavation, or removal by hand. In large diameter pipes mini-excavators and skid steer loaders can be used. The compressed air method is the easiest and most economically feasible of all the options, but the proper technique must be used in order to ensure success.



WARNING: Incorrect hoses may fail. Ensure all hoses are rated for the expected pressures. Install safety whip checks on all air hose connections. Failure to do so could result in serious personal injury or death.

WARNING: The compressed air will force a sudden release of pressure creating flying debris. Keep all personnel out of the entry and exit pits. Failure to do so could result in severe personal injury or death.

A. Compressed Air Spoil Removal Procedures

1. Install the Seal-Off Plate into the end of the pipe (see Fig. 32).
2. Install two steel safety stakes behind the Seal-Off Plate (see Fig. 32).

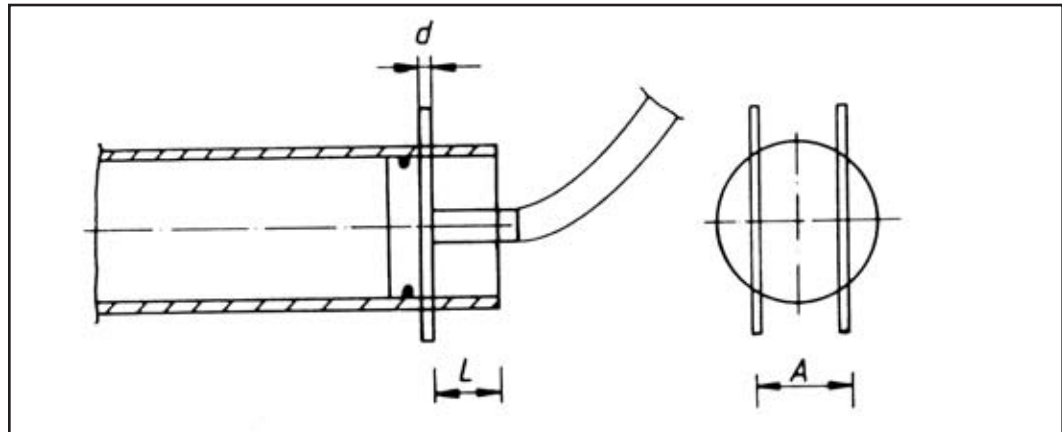


FIG. 32: INSTALL SEAL-OFF PLATE AND SAFETY STAKES



WARNING: Without Safety Stakes, the compressed air will blow the Seal-Off Plate out of the pipe. Always correctly install two steel Safety Stakes. Failure to do so could result in severe personal injury or death.

3. With the air compressor turned off, connect the airline to the Seal-Off Plate, and turn the air line's valve to the open position.
4. Start the air compressor and then gradually open the airline's valve from the compressor, until full air pressure is entering the pipe.
5. The soil will then be blown out of the pipe. If it does not blow out, then the compressed air was able to escape. In this case, a Polyurethane Pig should be used. Follow the same above steps, but insert the Polyurethane Pig into the pipe before the Seal-Off Plate is installed (see Fig. 33). This will force the air pressure to build up because it will not be able to escape past the pig.

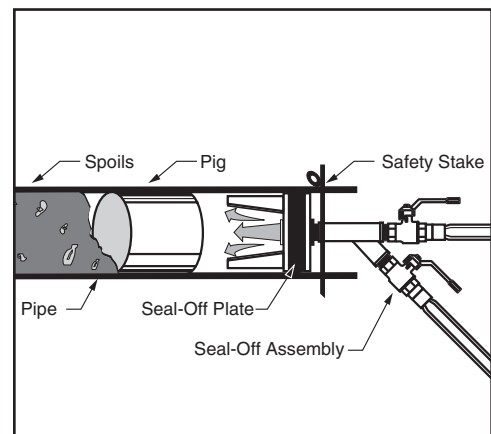


FIG. 33: POLYURETHANE PIG

If the previous steps do not successfully work, then internal friction caused by wedged rocks or other materials are overcoming the compressed air. In this case, water pressure should be considered as a viable option, but be careful not to exceed the pressures listed (see Fig. 34).

MINIMUM SPECIFICATIONS OF THE SECURITY STEEL BARS						
Material of Steel Bars	RDP Type	Steel Pipe Dimensions in (mm)	D in (mm)	L in (mm)	A in (mm)	Maximum Pressure psi (bar)
ST 70	100	4.25 x 0.1 (108 x 2.5)	0.50 (12.7)	4.00 (101.6)	2.75 (69.9)	214 (14.8)
ST 70	120	5.00 x 0.1 (127 x 2.5)	1.00 (25.4)	4.00 (101.6)	2.75 (69.9)	286 (19.7)
ST 50	150	6.25 x 0.2 (159 x 5.1)	1.50 (38.1)	4.00 (101.6)	2.75 (69.9)	571 (39.4)
ST 50	160	6.60 x 0.2 (168 x 5.1)	1.50 (38.1)	4.00 (101.6)	2.75 (69.9)	428 (29.5)
ST 50	210	8.62 x 0.25 (219 x 6.4)	2.00 (50.8)	4.00 (101.6)	2.75 (69.9)	428 (29.5)
ST 50	260	10.75 x 0.25 (273 x 6.4)	2.00 (50.8)	5.00 (127.0)	2.75 (69.9)	357 (24.6)
ST 50	310	13.00 x 0.25 (330 x 6.4)	2.50 (63.5)	5.00 (127.0)	3.20 (81.3)	357 (24.6)
ST 50	400	16.00 x 0.30 (406 x 7.6)	3.00 (76.2)	6.00 (152.4)	4.00 (101.6)	357 (24.6)
ST 50	500	20.00 x 0.30 (508 x 7.6)	3.50 (88.9)	7.00 (177.8)	4.75 (120.7)	286 (19.7)
ST 50	600	24.00 x 0.40 (610 x 10.2)	4.00 (101.6)	8.25 (209.6)	6.00 (152.4)	286 (19.7)
ST 50	700	28.00 x 0.50 (711 x 12.7)	5.00 (127.0)	10.00 (254.0)	6.25 (158.8)	286 (19.7)
ST 50	800	32.00 x 0.50 (813 x 12.7)	5.50 (139.7)	11.00 (279.4)	7.50 (190.5)	286 (19.7)

FIG. 34: MAXIMUM PRESSURE

B. Water & Compressed Air Spoil Removal Procedures

1. Install the Seal-Off Plate into the end of the pipe.
2. Connect the water/air Y-Adapter Assembly to the Seal-Off Plate.
3. Install two steel Safety Stakes behind the Seal-Off Plate (see Fig. 35).

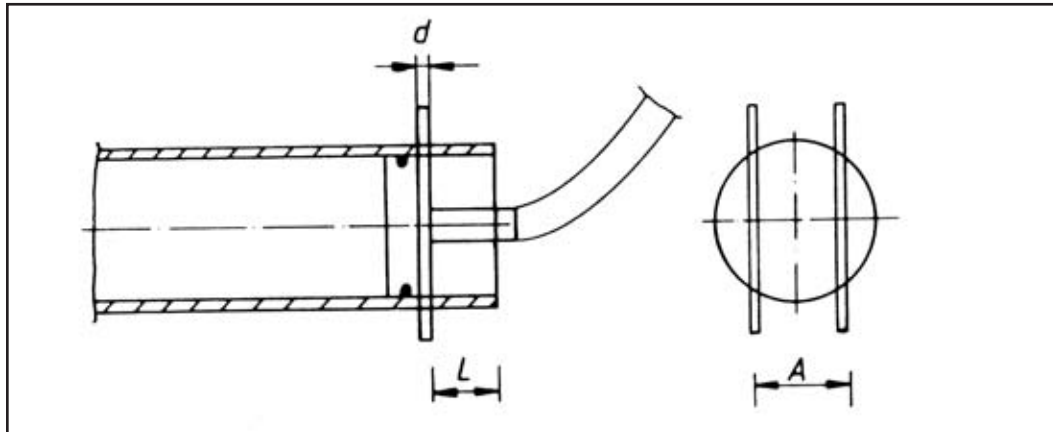


FIG. 35: INSTALL SEAL-OFF PLATE AND SAFETY STAKES

4. With the air compressor turned off, connect the air line to the Seal-Off Plate, and turn the air line's valve to the closed position.

CAUTION: Water will damage the air compressor. Use non-return valves in the air lines. Failure to do so could result in property damage.

5. With the TT Technologies' hydrostatic pump turned off, connect the hydrostatic pumps water line to the Seal-Off Plate's Y-Adapter Assembly, and turn the water line's valve to the closed position.
6. Start the hydrostatic pump, and then gradually open the water line valve, until full water pressure is entering the pipe. When soil starts moving close hydrostatic pump valve and open the air compressor valve.



7. The soil should then be blown out of the pipe.

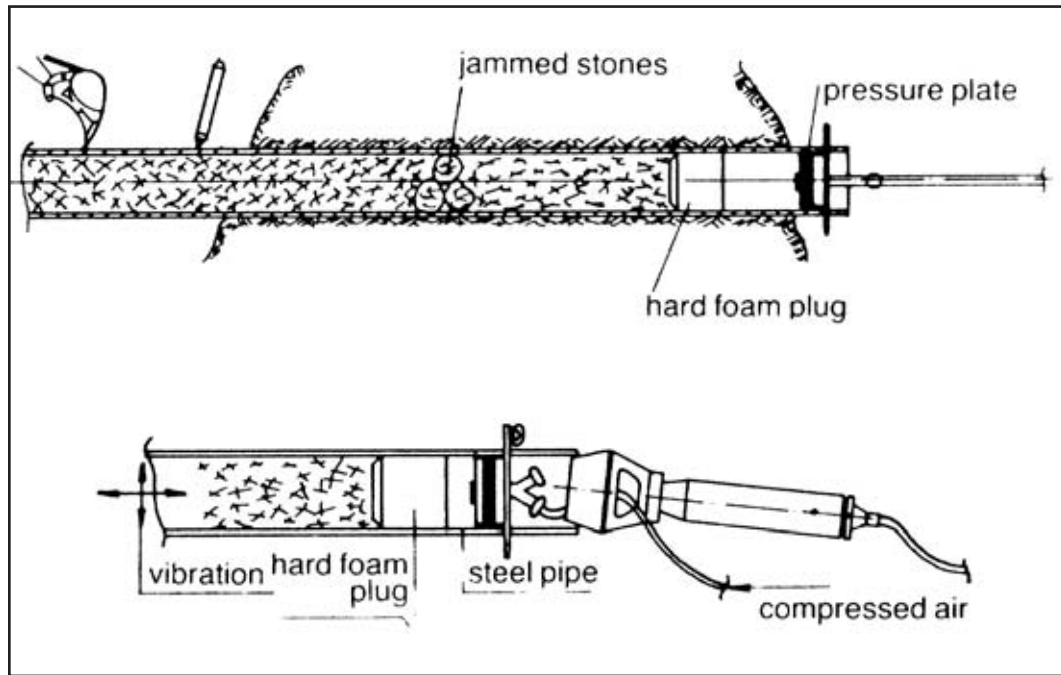


FIG. 36: VIBRATE OR LOOSEN JAMMED OBJECTS

NOTE: If this does not work, then the wedged rocks, etc., are only jamming tighter and tighter together. In this case, equipment should be used to try and vibrate the jammed objects loose. Some possible onsite solutions are the GRUNDOMAT, the GRUNDORAM, or an excavator bucket (see Figure 36). If none of these methods are successful, then the blow-out procedure can be tried in reverse, starting at the exit pit.

If all of the above methods are still unsuccessful, then using an auger or pressure jetting may be the final options. Sometimes, just partially using one of these methods may sufficiently dislodge the wedged objects, so that the above compressed air/water methods can be tried again.

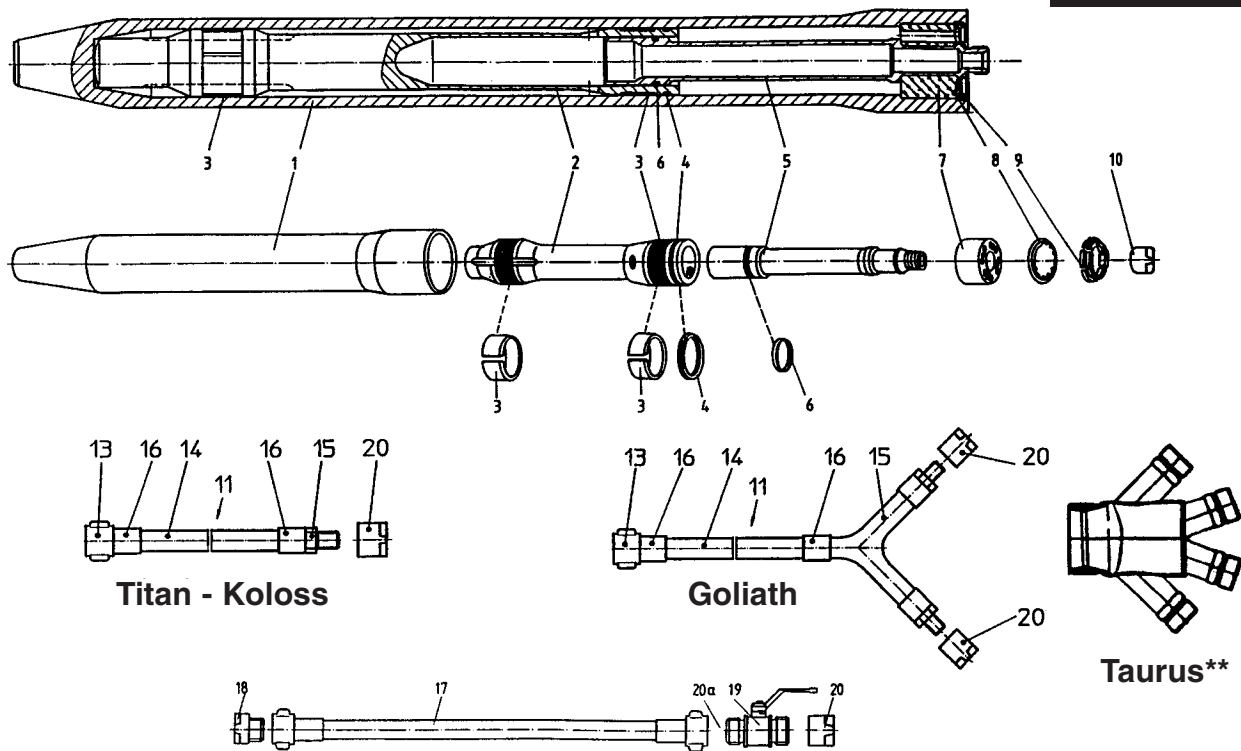


FIG. 37: PARTS BREAKDOWN FOR THE GRUNDORAM TOOL

1	Machine casing	10	Cap, Hose	17/19	Connection hose with ball valve
2	Piston	11	Whip hose	17	Connection hose 2 m*
3	Piston slide rings (set)	13	Hose coupling ND 105	18	Lock screw
4	Piston seal	14	Connection hose ND 105 w.o. coupling	19	Ball valve with both-sided round corded thread*
5-7	Control tube with elastic-block and seal	15	Fitting, complete	20	Cap, Hose
5	Control tube	16	Swaging sleeve for hose ND 105	20a	Seal nut
6	Piston seal	16	Hose clamps (set) alternatively		
7	Elastic block				
8	Support ring				
9	Segment ring				

*= with Type Goliath 2x

**= with Type Taurus 4x

A. Grundoram Disassembly

NOTE: The following items correspond to Fig. 37. The complete control stud (Items 5, 6, 7) is pushed into the machine casing (Item 1) and is safely held in position by means of a support ring (Item 8) and a segment ring (Item 9).

1. Removal of the control stud.
2. To remove the control stud, lay the GRUNDORAM on a support frame or on the ground.
3. Remove the connection air hose (see Fig. 38).
4. Push the carrier cone (Item A - Fig. 39) of the clamping device over the machine body (see Fig. 39).
5. Push the three draw rods (Item B - Fig. 39) through the holes of the Carrier Cone and attach the nuts at the Carrier Cone (Item A - Fig. 39).
6. Push the thrust piece (Item C - Fig. 39) over the connection threads of the control tube.



FIG. 38: REMOVE AIR HOSE

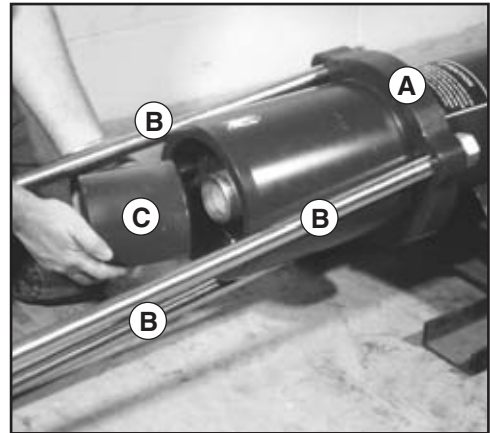


FIG. 39: CARRIER CONE & DRAW RODS OF CLAMPING DEVICE

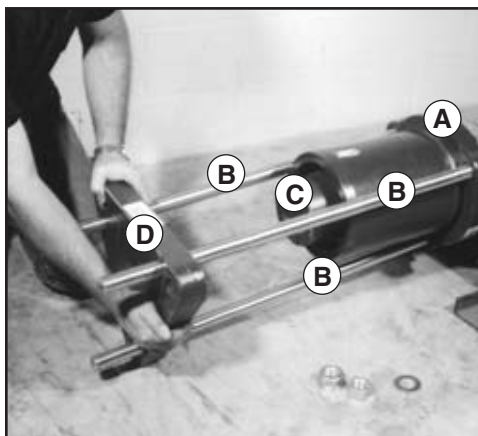


FIG. 40: SLIDE ON CLAMPING PLATE

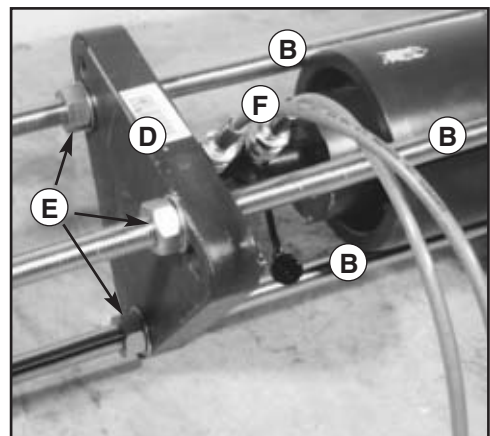


FIG. 41: HYDRAULIC CYLINDER IN PLACE AND CONNECTED

7. Slide the clamping plate (Item D - Fig. 40) onto the three draw rods (Item B - Fig. 40).
8. Screw the nuts (Item E - Fig. 41) evenly onto the draw rods (Item B - Fig. 41) to ensure that the clamping plate (Item D - Fig. 41) is parallel to the end of the machine body.

9. Insert the hydraulic cylinder (Item F - Fig. 41) and ensure that the bottom of the cylinder is on the clamping plate (Item D - Fig. 41).
10. Connect the hoses of the hydraulic pump (see Fig. 41).
11. Operate the hydraulic cylinder using the manually operated pump (see Fig. 42) until the complete segment ring (Item 9) can be removed.

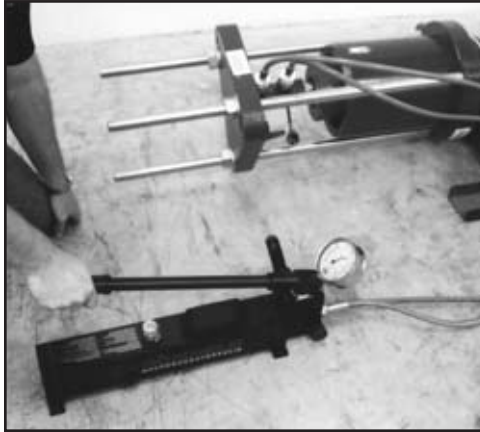


FIG. 42: OPERATE HAND PUMP



FIG. 43: REMOVE COMPONENTS OF SEGMENT RING

12. Remove components of the segment ring (see Fig. 43).

IMPORTANT: Do not touch segment grooves with hand. The hydraulic press may fail. Use tools to remove stuck segments.

13. Remove the clamping device.
14. Remove the support ring (Item 8 - Fig. 37, also see Fig. 44).
15. Removal of the complete control stud. Fit the connection air hose to the thread of the control tube and use to help remove the complete control stud (shown without air hose connected) (see Fig. 45).



FIG. 44: REMOVE SUPPORT RING



FIG. 45: REMOVE CONTROL STUD

B. Piston Removal

1. Remove the piston (Item 2 - Fig. 37) with a pulling hook (see Fig. 46).
2. Lift the piston using a textile strap, with a crane, fork lift or hoist. For safe working and lifting, use appropriate lifting equipment. On removal, the piston should be kept parallel to the machine body to ensure that no damage is caused to slide tapes or threads (see Fig. 47).



FIG. 46: REMOVE PISTON WITH PULLING HOOK



FIG. 47: LIFTING PISTON WITH TEXTILE STRAP

C. Grundoram Assembly

1. Replace piston slide rings and piston seal. After removal of the main piston from the machine body, remove the old, worn slide rings and the piston seal.
2. Clean all the grooves for replacement seals.
3. Thoroughly clean the main piston and the inner part of the machine body (see Fig. 48). Follow safety regulations when using degreaser.
4. Push the piston insertion sleeve into the hole of the machine body (see Fig. 49).

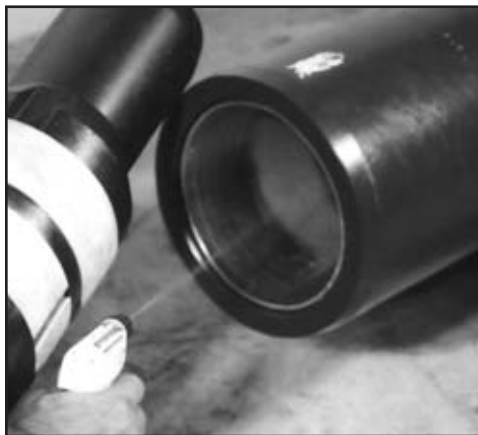


FIG. 48: THOROUGHLY CLEAN PISTON AND MACHINE



FIG. 49: PUSH PISTON INSERTION SLEEVE INTO MACHINE

5. Move the slide rings onto the groove for the rings on the piston (see Fig. 50 and Fig. 51).
6. There must be a gap at the end of the slide rings (see Fig. 51 and Fig.53).



FIG. 50: INSTALL FRONT SLIDE RING



FIG. 51: INSTALL REAR SLIDE RING

7. Finally, fit the piston seal (rubber ring and white piston seal - see Fig. 52). The white piston seal shall have the same gap (see Fig. 53).



FIG. 52: INSTALL PISTON SEAL

GRUNDORAM MODEL	Piston Slide Ring Gap (inch)
DAVID	0.15-0.20
MINI-ATLAS	0.15-0.20
ATLAS	0.15-0.20
TITAN	0.20-0.24
MINI-OLYMPUS	0.20-0.24
OLYMPUS	0.30-0.39
HERCULES	0.39-0.47
MINI-GIGANT	0.39-0.47
GIGANT	0.39-0.47
KOLOSS	0.55-0.63
GOLIATH	0.55-0.63
TAURUS	0.55-0.63

FIG. 53: PISTON SLIDE RING GAPS

8. Once the slide rings and the piston seal have been installed, slide the piston into the machine body.
9. Remove the piston insertion sleeve.

D. Control Stud Assembly

1. Changing the seal for the control stud. When the seal of the control stud is worn it must be replaced.

IMPORTANT: The seal for the control stud consists of one rubber ring and one white cylindrical ring. (The DAVID, MINI-ATLAS, ATLAS, TITAN, MINI-OLYMPUS, and OLYMPUS have no rubber ring). Do not cut the seals apart like the piston seal.

2. Cut off and remove the worn control stud seal.

3. Fit the new control stud seal into the groove:
 - a) First fit the rubber ring (Not applicable to the DAVID, MINI-ATLAS, ATLAS, TITAN, MINI-OLYMPUS and OLYMPUS).
 - b) Carefully stretch the white control stud seal and fit into the groove.
4. After fitting the complete seal into the groove, compress the seal to its original size using a hose clamp (see Fig. 54).



FIG. 54: COMPRESS WITH HOSE CLAMP



FIG. 55: INSTALL CONTROL STUD INTO PISTON

5. Position the ring and the draw rods on the machine body and insert the complete control stud into the piston (see Fig. 55).

NOTE: Check whether or not the elastic block (Item 7 - Fig 37) is worn. Replace if necessary.

6. Position the support ring (Item 8 - Fig 37). The lugs of the support ring must fit into the holes in the elastic block (see Fig. 56 and Fig. 57).



FIG. 56: POSITION SUPPORT RING



FIG. 57: SUPPORT RING IN PLACE

7. Fit the clamping device (see Figs. 39-41) and connect the manually operated hydraulic pump.
8. Compress the elastic block (Item 7 - Fig 37) using the manually operated hydraulic pump until the single components of the segment ring (Item 9 - Fig 37) can be put into the groove (see Fig. 58).

NOTE: Ensure that the segments are put into the groove in the correct direction. If the segments are worn, assemble only new segments. Only exchange the whole set of segments. Never exchange single components.



FIG. 58: INSTALL SEGMENT RING

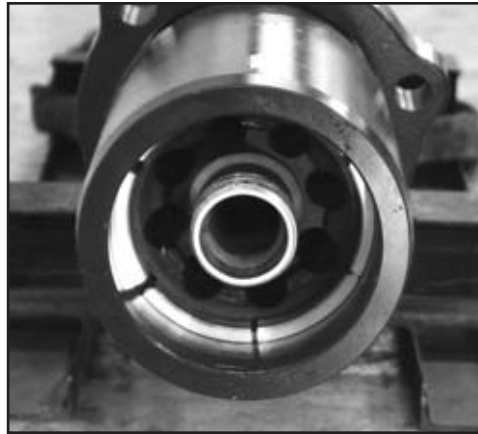


FIG. 59: SEGMENT RING IN PLACE

9. Apply grease onto the three last components of the segment ring to ease the fitting.
10. Release the pressure of the hydraulic pump.
11. Check the correct position of the single components of the segment ring.
12. Remove the complete clamping device.
13. The segment ring must be radially positioned behind the edge of the support ring (see Fig. 59).

NOTE: All components of the segment ring must be checked for the correct position prior to each operation. If single components do not fit correctly, contact the manufacturer or your GRUNDORAM distributor.

14. Screw on the connection air hose and secure with hammer.
15. Briefly run the machine to check the operation
16. After this test, check the position of the single components of the segment ring again.
17. The GRUNDORAM is now ready for operation.

E. Connection Air Hose Replacement

1. The connection air hose is connected via a thread to the control tube. Only unscrew the swivel coupling (see Fig. 60).



FIG. 60: REMOVE OLD AIR HOSE AND REPLACE WITH NEW ONE

F. Removal and Disassembly of the Control Stud of the Mini-Atlas GRUNDORAM

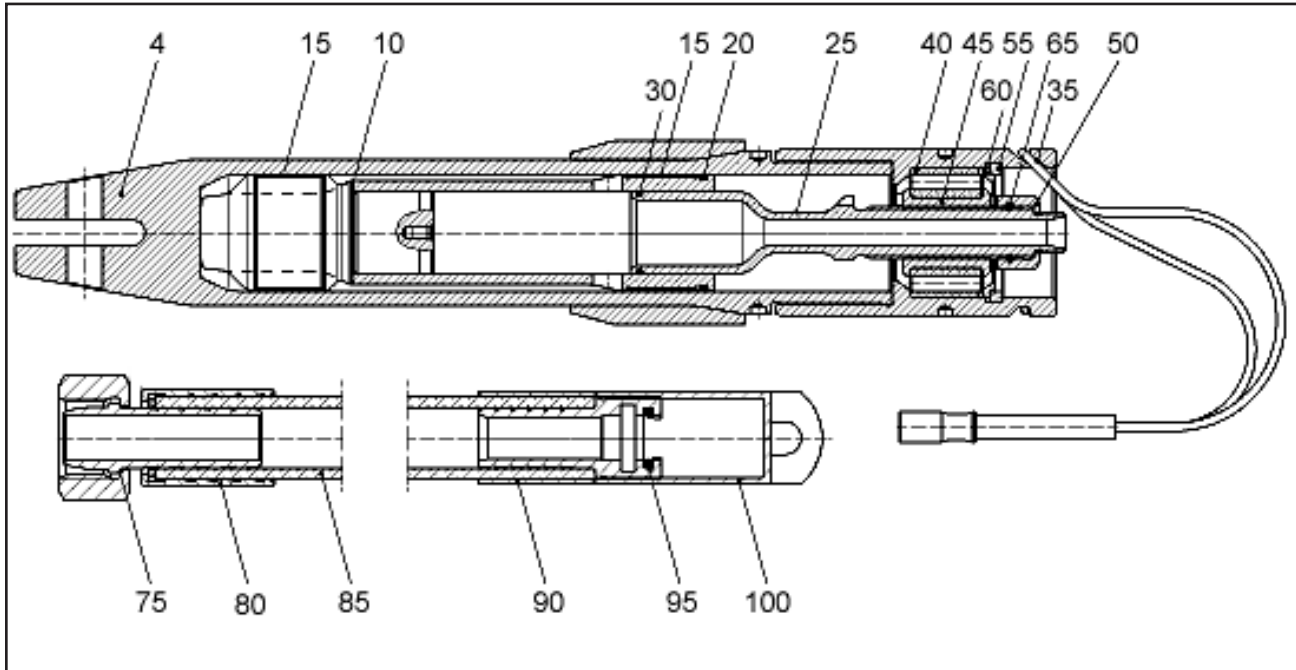
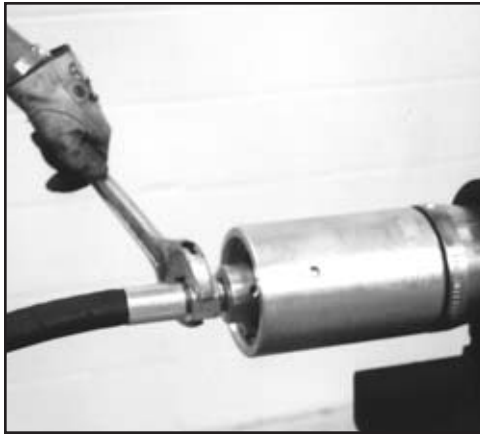


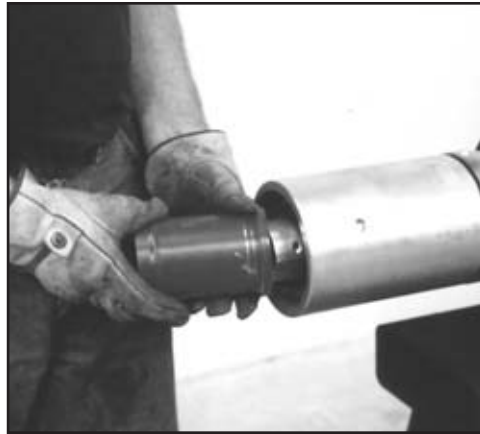
FIG. 61: PARTS BREAKDOWN FOR THE MINI-ATLAS GRUNDORAM TOOL

4	Machine body with knife head and RK reception	40	Elastic block	75-100	Connection air hose, complete, 0.3 m long
10	Piston	45	Adjusting nut for reverse run control	75	Nozzle DN 25 with ring and spigot nut
15	Piston slide tapes (set)	50	Stop nut for reverse run control	100	Sealing cap for quick-coupling DN 25
20	Piston seal	55	Segment ring for reverse run control	15/20/30	Seals (complete set)
25	Control tube for reverse run control	60	Support ring for reverse run control	4-100	Mini-Atlas 130 with slotted head, 10 degrees reception and 1' whip hose
30	Control stud seal	65	Pin set (set=2 pieces)		
35	Casing end with cable connection, without cable				

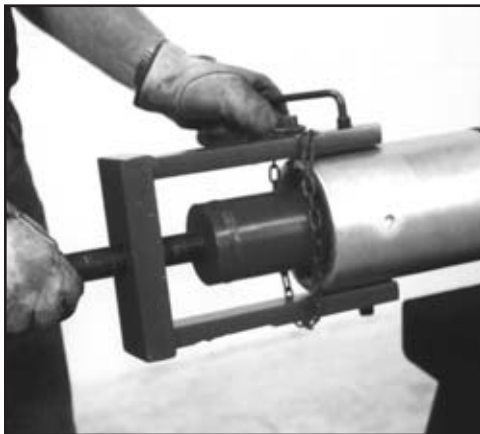
1. The complete control stud (Items 25, 30, 40, 45, 50, 60, 65 - Fig 61) is positioned in the casing end (Item 35 - Fig 61) and is secured with a segment ring (Item 55 - Fig 61) . The casing end (Item 35 - Fig 61) itself is screwed onto the machine casing (Item 4 - Fig 61) and is secured by metal adhesive.
2. Remove the connection air hose (see Fig. 62).
3. Move the sleeve of the assembly tool over the thread of control tube (see Fig. 63).
4. Screw the bolts of the assembly tool frame into the holes for the C-spanner at the casing end (see Fig. 64).
5. Position the tensioning bolt of the assembly tool onto the sleeve and press the elastic block (Item 40) until the segments of the segment ring (Item 55) can be removed easily from the groove of the casing end (Item 35 - see also Fig. 65).
6. Reduce the tension of the assembly tool and move it aside.



**FIG. 62: REMOVE CONNECTION
AIR HOSE**



**FIG. 63: INSTALL ASSEMBLY TOOL
OVER THREAD OF CONTROL TUBE**



**FIG. 64: ATTACH FRAME
ASSEMBLY TOOL**



FIG. 65: REMOVE SEGMENT RING



FIG. 66: REMOVE SUPPORT RING



FIG. 67: REMOVE CONTROL STUD

7. Remove support ring (Item 60 - see Fig. 66).
8. Pull the control stud out of the casing end (Item 35 - see Fig. 67).
9. For further control stud assembly and disassembly please contact TT Technologies technical support personnel.

G. Mini-Atlas Piston Removal

1. Place a C-spanner on the machine body (Item 4 - Fig 61), or clamp it into the TT Technologies, Inc. repair stand.
2. Quickly heat up the thread of the casing end to 390° F to destroy the adhesive on the threads.
3. Position C-spanner or O-spanner at the casing end (Item 35 - Fig 61). Loosen it with a hammer and unscrew it completely (see Fig. 68 and Fig. 69).

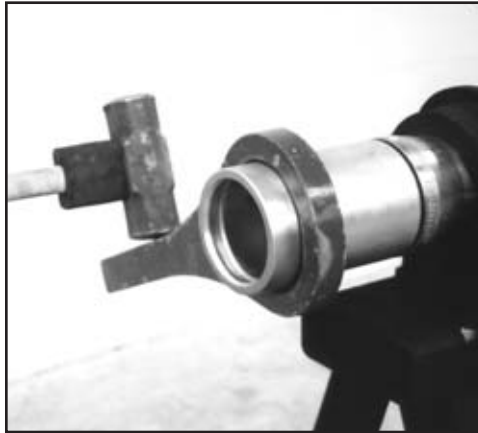


FIG. 68: LOOSEN CASING END

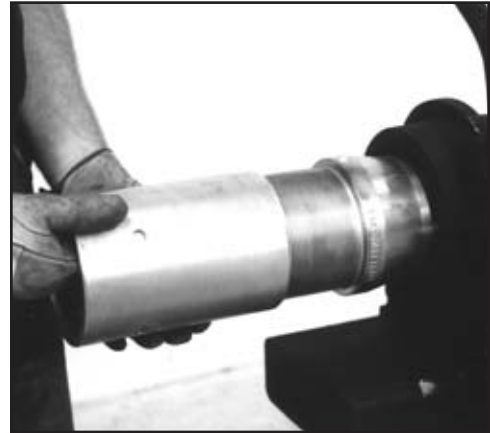


FIG. 69: REMOVE CASING END

4. Clean all the threads while they are still warm using a wire brush.
5. Remove the piston with a pulling hook (see Fig. 70).



FIG. 70: REMOVE PISTON

H. Mini-Atlas Assembly

1. Replace the piston slide rings and the piston seals. To renew the piston slide rings and the piston seal, proceed as described in Section 9C.
2. Push the piston into the casing once piston slide rings and seals have been replaced (see Fig. 71).
3. Apply loctite to the threads on the casing end and tighten with a hammer (see Fig. 72, Fig. 73 and Fig. 74).



FIG. 71: INSTALL PISTON



FIG. 72: APPLY LOCTITE



FIG. 73: ATTACH CASING END

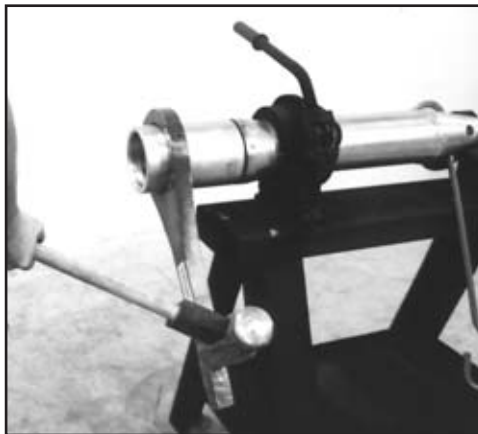


FIG. 74: TIGHTEN CASING END

4. Allow 24 hours at 70° F for loctite to cure to full strength. If time does not allow, loctite can be force cured by heating to 250° F using a gas burner. After the initial heating, secure the casing end (Item 35) again with a hammer onto a C-spanner. Keep a maximum temperature of 250° F for approximately 30 minutes.

NOTE: Only threaded parts firmly screwed together can transmit the full power of the GRUNDORAM. The adhesive prevents the thread from subsequent loosening. Do not cool with water.

5. Ensure the machine has cooled down prior to being used. Do not use water to cool.

I. Mini-Atlas Control Stud Assembly

1. Changing the seal for the control stud. When the seal of the control stud is worn it must be replaced.
2. Cut off and remove the worn control stud seal.
3. Fit the new control stud seal into the groove. Carefully stretch the white control stud seal and fit into the groove.
4. After fitting the complete seal into the groove, compress the seal to its original size using a hose clamp (see Fig. 75).

NOTE: Check whether or not the elastic block (Item 40) is worn. Replace if necessary (see Fig. 76).



FIG. 75: HOSE CLAMP



FIG. 76: REPLACE ELASTIC BLOCK

5. After the casing end (Item 35) has cooled, push in the complete control stud (see Fig. 77).
6. Move the support ring (Item 60) behind the control stud into the casing end with the shouldered edge to the outside (Item 60 - see Fig. 78).
7. Screw the bolts of the assembly tool frame into the holes for the C-spanner at the casing end (see Fig. 78).



FIG. 77: INSTALL CONTROL STUD



FIG. 78: INSTALL SUPPORT RING

8. Position the tensioning bolt of the assembly tool onto the sleeve and press the elastic block (Item 40) until the segments of the segment ring (Item 55) can be positioned easily in the groove of the casing end (see Fig. 79). To assist the fitting of the segments assembly grease can be applied onto the single segments.

9. Slowly reduce the tension of the assembly tool until the elastic block safely sits against the segment ring.

10. Remove the assembly tool.

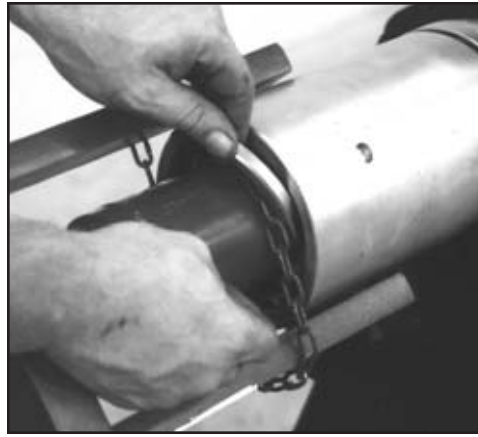


FIG. 79: INSTALL SEGMENT RING

11. For further control stud assembly and disassembly procedures please contact TT Technologies technical support personnel.

12. The Mini-Atlas GRUNDORAM can be used immediately.

J. Connection Air Hose Replacement

1. The connection air hose is connected via a thread to the control tube. Only unscrew the swivel coupling (see Fig. 80).

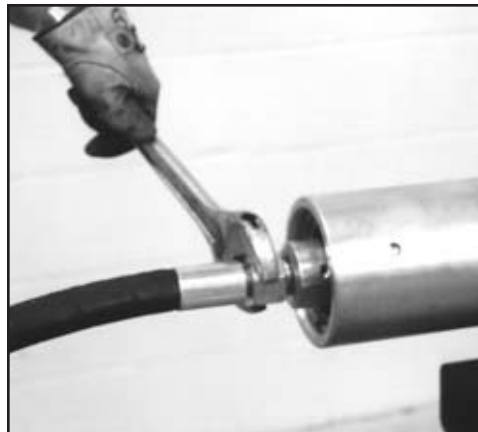


FIG. 80: REMOVE OLD AIR HOSE AND REPLACE WITH NEW ONE

K. Mini-Olympus and Mini-Gigant Disassembly

For assembly and disassembly procedures please contact TT Technologies technical support personnel.

1. Replacement of the connection air hose, refer to Section 9J.

L. Disassembly of PCG GRUNDORAM

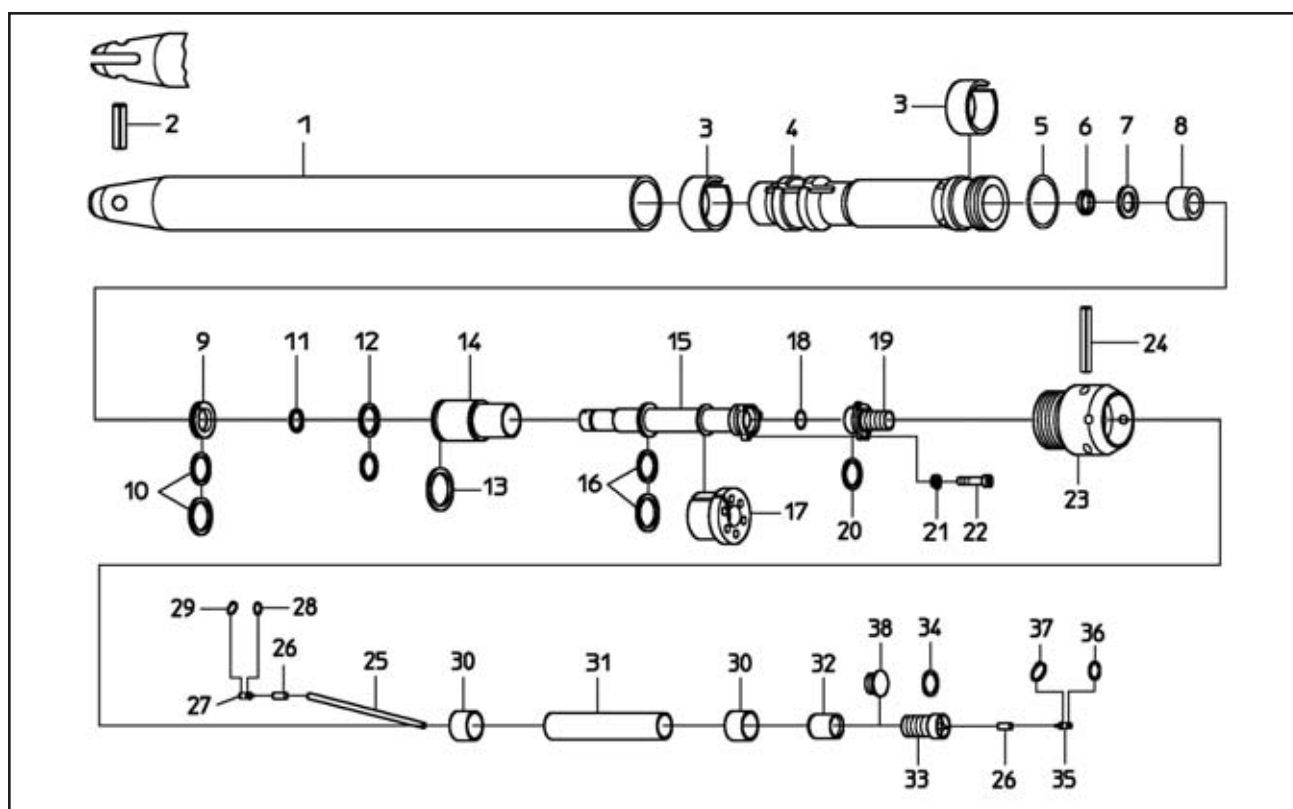


FIG. 81: PARTS BREAKDOWN FOR THE PCG GRUNDORAM TOOL

1 Machine casing	15 Control tube	28 O-ring 6,5x2 mm
2 Lock Pin (set)	16 Control sleeve seal 2(set)	29 External securing ring 9x1 mm DIN 471
3 Piston slide tapes (set)	17 Elastic block for air-operated control stud	30 Swaging socket 62x2,5x60
4 Piston	- Connection air hose, complete	31 Connection air hose without couplings
5 Piston seal	- Connection air hose, (interior)	32 Sleeve nut ND 40
- Control stud with connection air hose (items 6-22, 22-38)	18 O-ring 40x3 mm	33 Hose nipple
- Control stud without connection air hose (items 6-17)	19 Hose connection for connection air hose	34 O-ring 48x3 mm
6 Segment ring	20 O-ring 60x3 mm	36 O-ring 6,5x2 mm
7 Support ring for elastic block	21 Lock washer M 10 DIN 127	37 External securing ring 12x1 DIN 471
8 Elastic block for control sleeve	22 Cheese head screw M 10x30 DIN 912	38 Locking nipple for spigot net
9 Stop ring	23 Casing end with additional bore hole D 14	- Seals (complete set)
10 Control sleeve seal 1(set)	24 Pin set for casing end	1-38 Grundocrack PCG 180 with air-operated control stud, casing end pinned, with additional bore hole
11 O-ring 51x4 mm	- w.o. pic. Pin punch with safety impact head 15x18x180x300 mm	
12 Seal for control tube (set)	- Control hose (interior)	
13 Seal for control sleeve (exterior)		
14 Control sleeve		

1. To remove the control stud, lay the GRUNDORAM on a support frame, or on the ground.

2. Remove the connection air hose (see Fig. 82).

3. Loosen the three set screws (see Fig. 83).



**FIG. 82: REMOVE CONNECTION
AIR HOSE**



**FIG. 83: LOOSEN THREE
SET SCREWS**



**FIG. 84: REMOVE THREE
SET SCREWS**



**FIG. 85: REMOVE CABLE
FROM TOOL**



**FIG. 86: USE TWO SET SCREWS
AS JACK SCREWS**



**FIG. 87: REMOVE HOSE
CONNECTION**

4. Remove the three set screws (see Fig. 84).
5. Remove cable from tool (see Fig. 85).
6. Use 2 set screws as jack screws to remove hose connection (see Fig. 86).
7. Remove the hose connection (see Fig. 87)



FIG. 88: PLACE CARRIER CONE ON TOOL



FIG. 89: INSTALL TWO RINGS IN GROOVE OF TOOL BODY

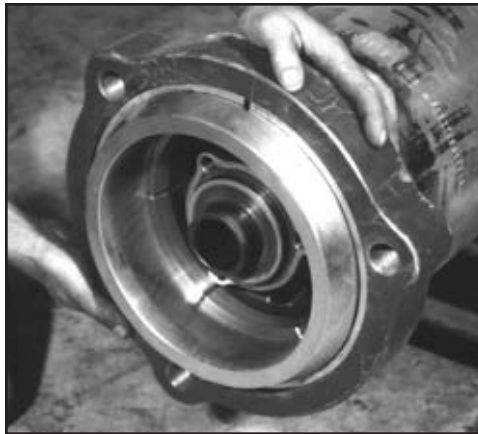


FIG. 90: POSITION CARRIER CONE

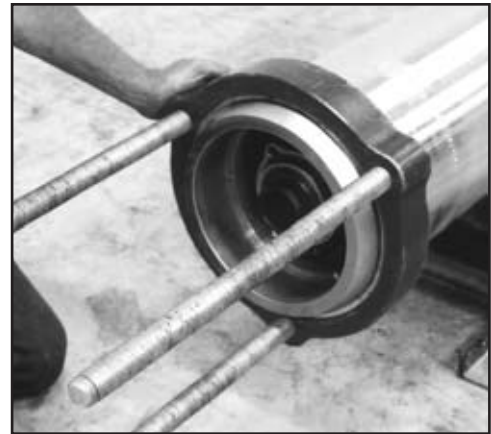


FIG. 91: ATTACH DRAW RODS



FIG. 92: INSTALL THRUST PIECE

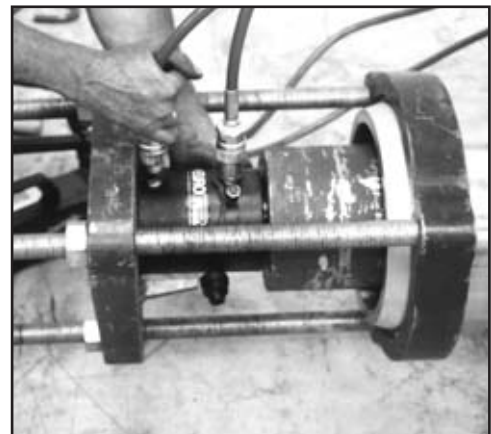


FIG. 93: INSTALL HYDRAULIC CYLINDER

8. Place carrier cone of the clamping device on the PCG GRUNDORAM tool (see Fig. 88).
9. Install the two rings into the groove of the tool body (see Fig. 89).
10. Position the carrier cone on top the the two rings (see Fig. 90).
11. Attach the three draw rods by screwing them into the carrier cone (see Fig. 91).
12. Slide the clamping plate onto the three draw rods, screw the nuts evenly onto the draw rods to ensure the clamping plate is parallel to the end of the machine body. Install the thrust piece (see Fig. 92).

13. Insert the hydraulic cylinder and ensure that the bottom of the cylinder is on the clamping plate, then connect the hoses of the hydraulic pump (see Fig. 93).
 14. Operate the hydraulic cylinder using the manually operated pump (see Fig. 94) until the complete segment ring can be removed.
 15. Removal of the components of the segment ring (see Fig. 95)
- NOTE:** Do not touch segment grooves with hand. The hydraulic press may fail. Use tools to remove stuck segments.
16. Remove the hydraulic cylinder, the clamping plate and the three draw rods (see Fig. 96).
 17. Remove the complete control stud (see Fig. 97).

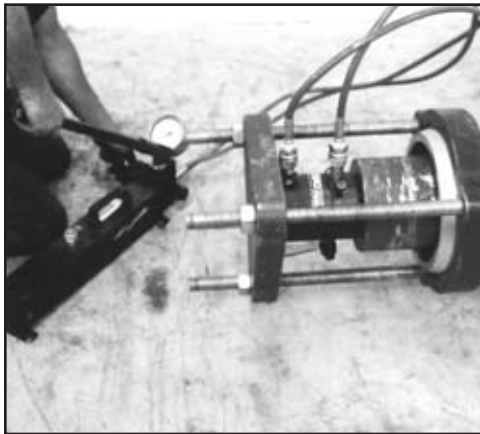


FIG. 94: OPERATE HAND PUMP



FIG. 95: REMOVE SEGMENT RING

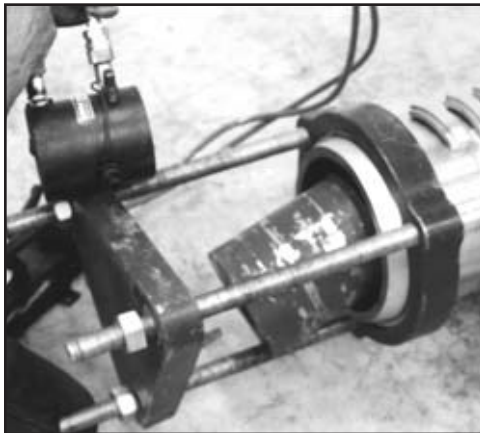


FIG. 96: REMOVE HYDRAULIC CYLINDER

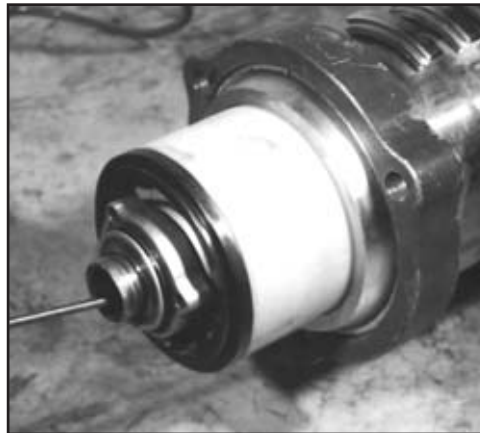


FIG. 97: REMOVE CONTROL STUD

18. Use the jacking rod to remove the support ring (see Fig. 98 & Fig. 99).



FIG. 98: USE JACKING ROD TO REMOVE SUPPORT RING

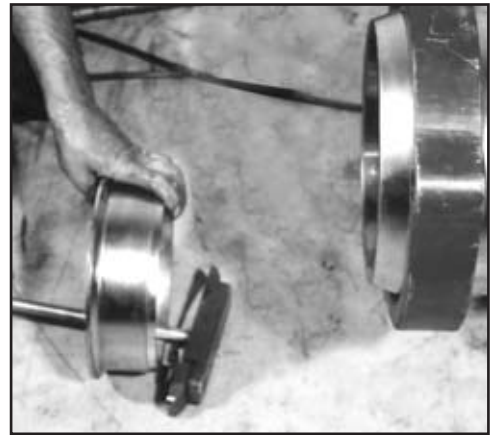


FIG. 99: REMOVE SUPPORT RING

19. Remove the small section first, you will need to twist and turn the part to remove it from the tool (see Fig. 100). Then remove the large section (see Fig. 101). Both pieces are shown together (see Fig. 102).

20. Remove the piston with a piston hook (see Fig. 103).



FIG. 100: REMOVE SMALL SECTION



FIG. 101: REMOVE LARGE SECTION

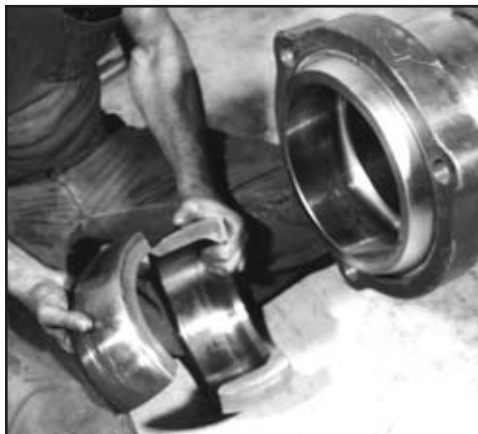


FIG. 102: SHOWING TWO SECTIONS

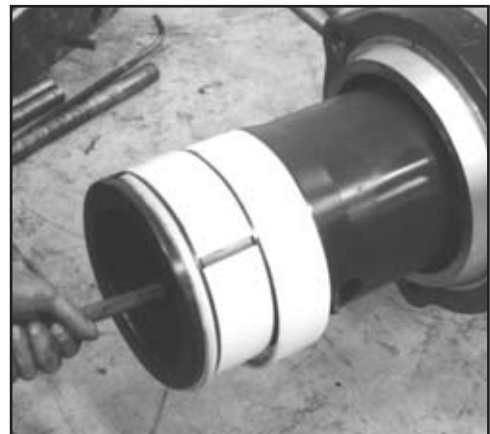


FIG. 103: REMOVE PISTON WITH PISTON HOOK

M. Piston Assembly

1. Once the piston is removed you need to insert the insertion sleeve into the tool in order to get the piston to slide back into the tool (see Fig. 104 and Fig. 105).
2. Now you can replace the piston seals (see Fig. 106 & 107).
3. When the piston is inserted back into the tool, then remove the insertion sleeve (see Fig. 108).



FIG. 104: INSERT INSERTION SLEEVE



FIG. 105: PUSH INSERTION SLEEVE IN



FIG. 106: REPLACE PISTON SEALS



FIG. 107: REPLACE PISTON SEALS



FIG. 108: REMOVE INSERTION SLEEVE

N. Control Stud Disassembly

1. Place the control stud into the TT Technologies repair stand to hold it in place. Install the disassembly tool onto the control stud (see Fig. 109).
2. Insert pin into the disassembly tool (see Fig. 110). Install the cover on the disassembly tool (see Fig. 111). Tighten the nut of the disassembly tool so the segment rings can be removed (see Fig. 112). Remove the segment ring (see Fig. 113).
3. Loosen the nut so you can remove the disassembly tool cover (see Fig. 114), remove the pin and disassembly tool.



FIG. 109: INSTALL DISASSEMBLY TOOL



FIG. 110: INSERT PIN INTO DISASSEMBLY TOOL



FIG. 111: INSTALL COVER ON DISASSEMBLY TOOL



FIG. 112: TIGHTEN DISASSEMBLY TOOL



FIG. 113: REMOVE SEGMENT RING



FIG. 114: REMOVE DISASSEMBLY TOOL COVER

4. Then remove the seal ring and the elastic block (see Fig. 115).
5. Remove the outer control tube section (see Fig. 116). Remove the stop ring (see Fig. 117).
6. Replace the inner control tube seal (see Fig. 118). Use a compression clamp to reform the seals (see Fig. 119 & Fig. 120).

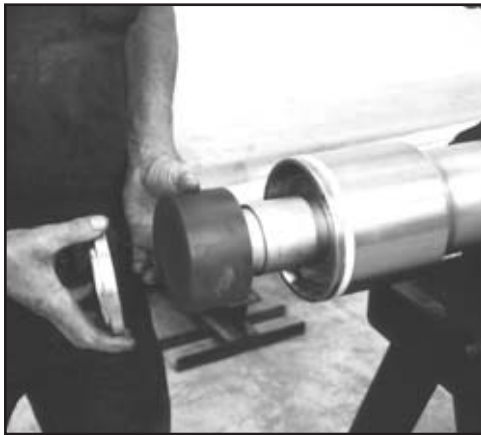


FIG. 115: REMOVE SEAL RING AND ELASTIC BLOCK

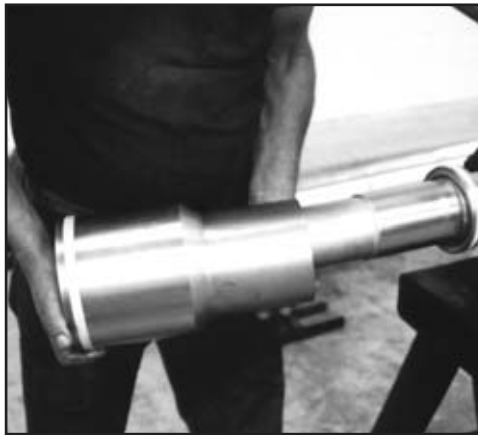


FIG. 116: REMOVE OUTER CONTROL TUBE



FIG. 117: REMOVE STOP RING



FIG. 118: REPLACE INNER CONTROL TUBE SEAL



FIG. 119: USE COMPRESSION CLAMP TO REFORM SEAL



FIG. 120: USE COMPRESSION CLAMP TO REFORM SEAL

7. Replace the black o-ring (see Fig. 121).



FIG. 121: REPLACE O-RING

O. Control Stud Assembly

1. Install the outer control tube (see Fig. 122). Then you can install the sealing ring (see Fig. 123).

2. Install the elastic block (see Fig. 124), and the seal ring (see Fig. 125).

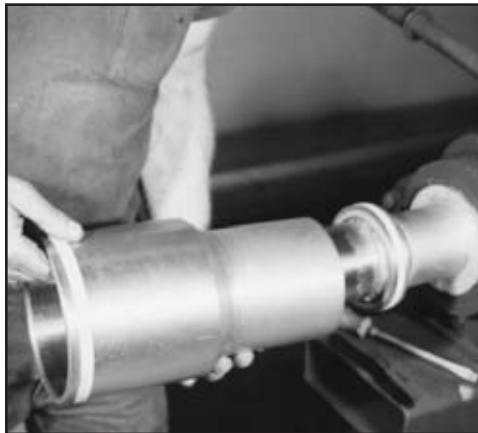


FIG. 122: INSTALL OUTER CONTROL TUBE



FIG. 123: INSTALL SEALING RING



FIG. 124: INSTALL ELASTIC BLOCK



FIG. 125: INSTALL SEAL RING

3. Install the disassembly tool on the end of the control tube (see Fig. 126), install the pin into the disassembly tool (see Fig. 127).
4. Install the disassembly tool cover and tighten the nut so the segment ring can be installed (see Fig. 128).
5. Install the segment ring (see Fig. 129).

IMPORTANT: Do not touch segment grooves with hand. The hydraulic press may fail. Use tools to remove stuck segments.



FIG. 126: INSTALL DISASSEMBLY TOOL



FIG. 127: INSTALL PIN INTO DISASSEMBLY TOOL



FIG. 128: TIGHTEN DISASSEMBLY TOOL



FIG. 129: INSTALL SEGMENT RING

6. Once the segment ring is installed, loosen the nut to remove the disassembly tool, remove the cover, the pin and the disassembly tool. Remove the control stud from the TT Technologies repair stand and install the control stud into the machine (see Fig. 130).

7. Attach the three draw rods by screwing them into the carrier cone. Slide the clamping plate onto the three draw rods, screw the nuts evenly onto the draw rods to ensure the clamping plate is parallel to the end of the machine body. Install the thrust piece. Insert the hydraulic cylinder and ensure that the bottom of the cylinder is on the clamping plate, then connect the hoses of the hydraulic pump. Operate the hydraulic cylinder using the manually operated pump until the segment ring can be installed (see Fig. 131).



FIG. 130: INSTALL CONTROL STUD



FIG. 131: INSTALL SEGMENT RING

8. Release the pressure on the hydraulic pump so you can remove the hydraulic pump, thrust piece, clamping plate, three draw rods carrier cone and two rings in groove of tool body.

9. Attach hose connection to tool with three set screws (see Fig. 132). Tighten set screws, replace cable into the groove of the tool, then attach connection air hose.



FIG. 132: INSTALL SET SCREWS

10. Specifications of the air hoses. If spare parts are required, use original spare parts for the TT companies or approved agents. The same applies to air hoses. According to the regulations, only use compressed air hoses with a minimum safe working pressure of 145 psi.

11. Function test. After assembly, check the GRUNDORAM (i.e. lay GRUNDORAM on the ground and connect it to the compressor). Open the air valve slowly and check if the piston reciprocates freely. Allow GRUNDORAM, operating at reduced pressure, to run in all new seals, etc., for a few minutes.
12. Remarks about the oil to be used. GRUNDO-OIL is a synthetic lubricate with very good lubrication properties. It is odorless, non-toxic and virtually inflammable. GRUNDO-OIL is not harmful to synthetic materials and is completely biodegradable. GRUNDO-OIL is water-soluble and has anti-freeze properties. Should you wish to use another type of oil, we recommend only pneumatic lubricants with similar properties.

Troubleshooting Guide

10.

Observation	Reason	Solution
1. The GRUNDORAM is lacking power. Usually the problem is that the lubricator and moisture from the air compressor gum up the inside of the barrel and the seals. Remove whip hose and pour in diesel fuel, reattach hose and run tool. It is good practice to clean the tool this way during heavy use or when storing the tool during down time. Diesel fuel cuts through the moisture and helps prevent the pitting that can occur when water sits inside the tool.	a) The compressor is not developing its rated psi. b) Internal piston resistance due to dirt or sludge buildup. c) Air requirements of rammer too high due to worn or missing seals. d) Insufficient or incorrect type of air tool oil. e) Compressor discharge temperature too high.	a) Check air pressure at the compressor gauge (95 to 105 psi). b) Flush rammer with diesel fuel or cleaning solvent. c) Disassemble rammer and inspect or replace seals. d) Check function/setting of lubricator. Use GRUNDO-OIL or approved alternative. e) Check seals. High temps cause seals to wear faster.
2. GRUNDORAM is difficult to start, after starting runs at about 50% and the air is exhausting through the back in an excessive amount. Check air discharge from compressor, also check air discharge temp. This will tell you how hot the tool was running.	a) OSHA safety valve on compressor not allowing surge of air to start tool. b) Seals on control stud and piston are worn or missing, due to high air temp or lack of lubricant. High discharge pressure can cause the seals to fail also.	a) Contact compressor service tech for adjustment. b) Replace worn or missing seals. Check function/setting of lubricator. Use GRUNDO-OIL or approved alternative.
3. GRUNDORAM is filled with water and silt. Do I need to take it apart to clean it?	a) Pit was flooded before the tool was removed.	a) Tool normally can be cleaned without disassembly. Power wash inside of tool through control stud opening or through the holes in the exhaust block. Lift the tool and tilt to wash and drain. Then flush with diesel fuel or cleaning solvent.
4. Straight Barrel Reversible Tools Only—Reversing GRUNDORAM, if the tool is dirty or gummed up inside it can cause the tool to run in reverse or neutral.	a) Internal piston resistance due to dirt or sludge buildup. b) Reversing air line plugged or not installed.	a) Flush rammer with diesel fuel or cleaning solvent. b) Make sure reversing air line is installed and open during forward operation.

Warranty Information

DISCLAIMER FOR RAMMING MANUAL:

NO WARRANTY AS TO MANUAL

TT Technologies makes no warranty that the information provided in this manual is complete, accurate in all respects, or up to date. This manual should be used as a reference work to provide a starting point for addressing pipe ramming situations. Each particular situation is different. The user is responsible for providing the expertise and skill necessary to properly execute a given pipe-ramming job. TT Technologies specifically disclaims all express or implied warranties concerning this manual, including the implied warranties of merchantability and fitness. In no event shall TT Technologies be liable for consequential, special or incidental damages or contingent liabilities (including, without limitation, lost profits or goodwill, whether such claim arises in tort, contract, negligence, strict liability or any other basis) arising in any way out of the use of this manual.

LIMITED WARRANTY AS TO PRODUCTS

TT provides a limited warranty to the original purchaser of its new products that new products will be free from defects in materials and workmanship for 90 days or 500 hours of actual use, whichever occurs first, provided they are properly maintained serviced and used for the intended purpose of the product. (A one year warranty applies to the barrel and piston, otherwise the period is as previously stated.) During the 90 day or 500 hours period, buyer's remedies are limited to repair or replacement, at TT Technologies' discretion.

TT Technologies makes no other warranty, express or implied, and makes no warranty of merchantability or fitness for any particular purpose. No person, representative or agent of TT Technologies has the authority to change this warranty in any manner whatsoever. Any oral or written statements inconsistent with this limited warranty shall not apply.

In no event shall TT Technologies be liable for consequential, special or incidental damages or contingent liabilities (including, without limitation, lost profits or goodwill, whether such claim arises in tort, contract, negligence, strict liability or any other basis) arising in any way out of the use of any product or any parts thereof.

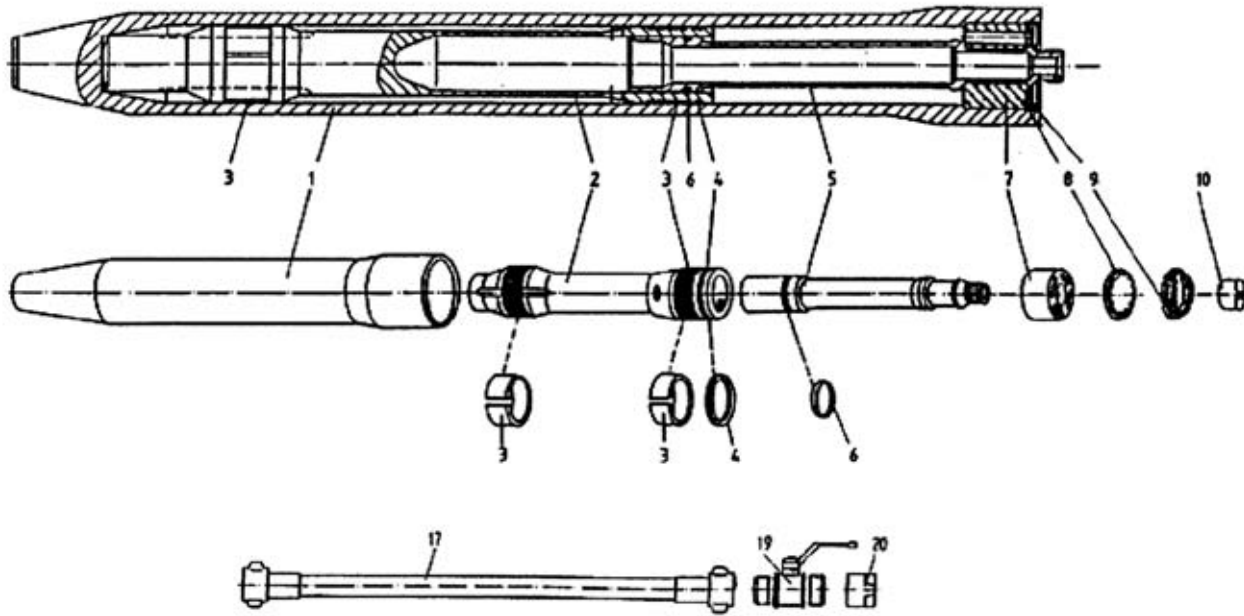


Appendix

A. Parts List for 095 David

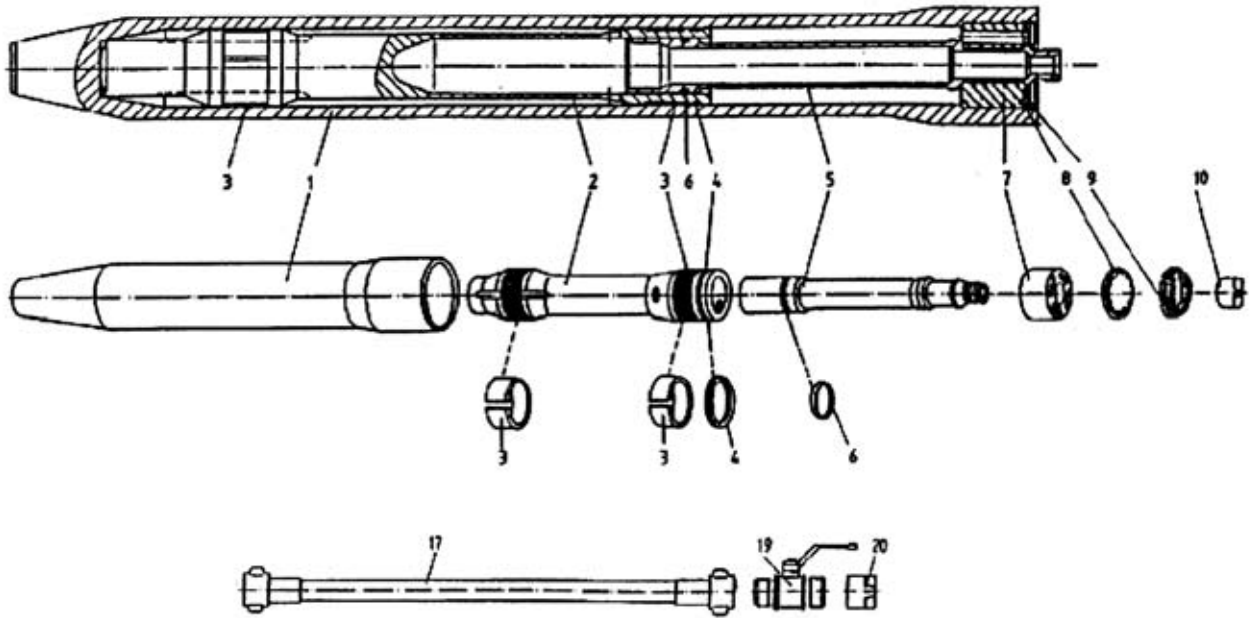
12.

APPENDIX



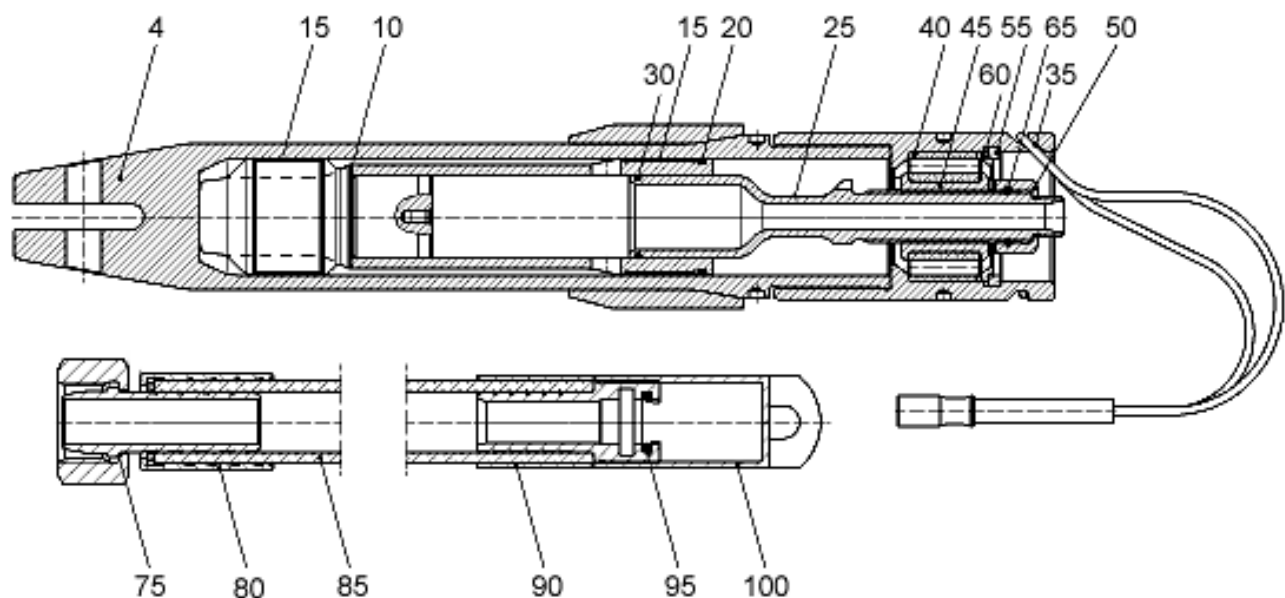
Item No	Description	Qty	Part Number
1	Machine body	1	DF 0950150
2	Piston	1	GRU 0955141
3	Piston slide tapes (set)	1	GRU 0955130
4	Piston seal	1	GRU 0955160
5-7	Control tube with elastic block and seal ring	1	DF 0950159
5	Control tube	1	DF 0950160
6	Control stud seal (2 pcs.)	1	GRU 0956530
7	Elastic block	1	DF 0950165
8	Support ring	1	DF 0950166
9	Segment ring	1	DF 0950167
10	Lock nut	1	DF 0950121
17/19	Connection air hose with stop valve	1	AF 1300170
20	Locking coupling for Mody couplings	1	GRU 2002060
—	Grundoram David 95 F complete	1	DF 0950000
—	Seals, (complete set)	1	DF 0950104

B. Parts List for 130 Atlas



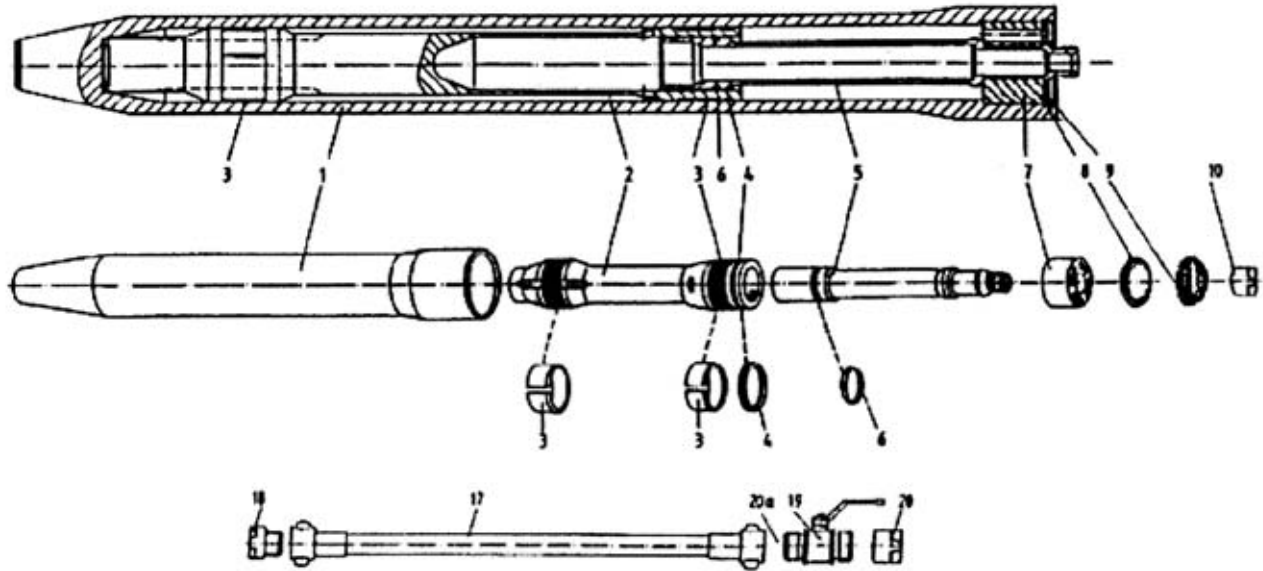
Item No	Description	Qty	Part Number
1	Machine body	1	AF 1300150
2	Piston	1	G-Z 1305141
3	Piston slide tapes (set)	1	GRS 1305130
4	Piston seal	1	GRU 1305160
5-7	Control tube with elastic block and seal ring	1	AF 1300159
5	Control tube	1	AF 1300160
6	Control stud seal	1	A 1300107
7	Elastic block	1	AF 1300165
8	Support ring	1	AF 1300166
9	Segment ring	1	AF 1300167
w.o pic	Robber buffer	1	AF 1300180
10	Lock nut	1	DF 0950121
17/19	Connection air hose with stop valve	1	AF 1300170
20	Locking coupling for Mody couplings	1	GRU 2002060
—	Grundoram Atlas 130 F complete	1	AF 1300000
—	Seals, (complete set)	1	AF 1300104

C. Parts List for 130 Mini-Atlas



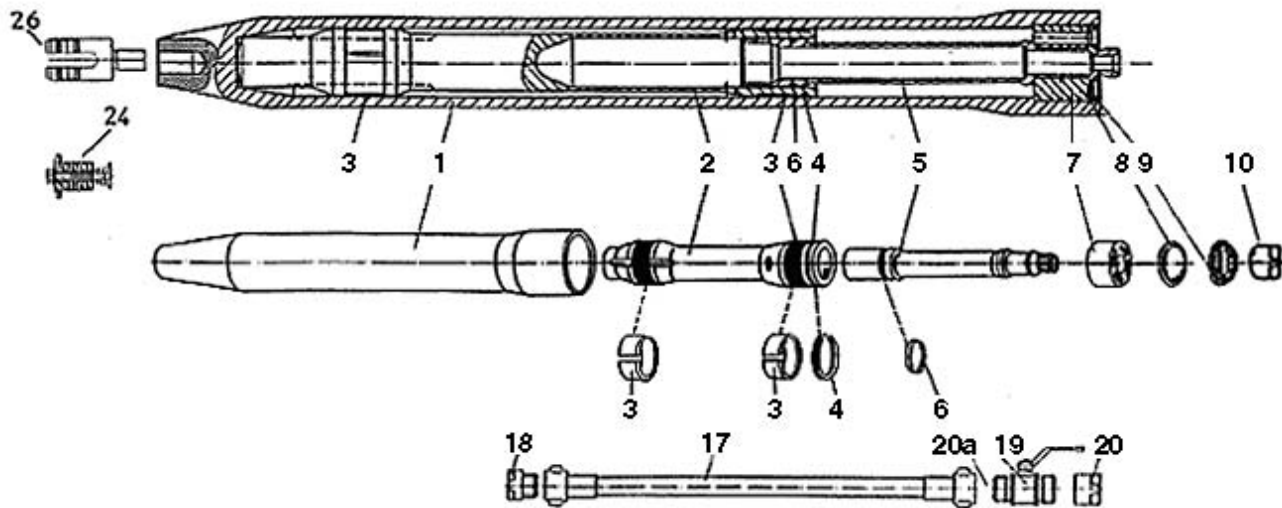
Item No	Description	Qty	Part Number
4	Machine body with knife head and RK reception	1	AM 1300153
10	Piston	1	AM 1300103
15	Piston slide tapes (set)	1	GRS 1305130
20	Piston seal	1	GRU 1305160
25	Control tube for reverse run control	1	AM 1300156
30	Control stud seal	1	A 1300107
35	Casing end with cable connection, without cable	1	AM 1300118
40	Elastic block	1	AM 1300122
45	Adjusting nut for reverse run control	1	AM 1300121
50	Stop nut for reverse run control	1	AM 1300120
55	Segment ring for reverse run control	1	AM 1300125
60	Support ring for reverse run control	1	AM 1300128
65	Pin set (set=2 pieces)	1	AM 1300123
75-100	Connection air hose, complete, 0.3 m long	1	AM 1300160
75	Nozzle DN 25 with ring and spigot nut	1	AM 1300161
100	Sealing cap for quick-coupling DN 25	1	G-E 0902390
15, 20, 30	Seals, (complete set)	1	AM 1300115
4-100	Mini-Atlas 130 with slotted head, 10 degrees reception and 1' whip hose	1	AM 1300004

D. Parts List for 145 Titan



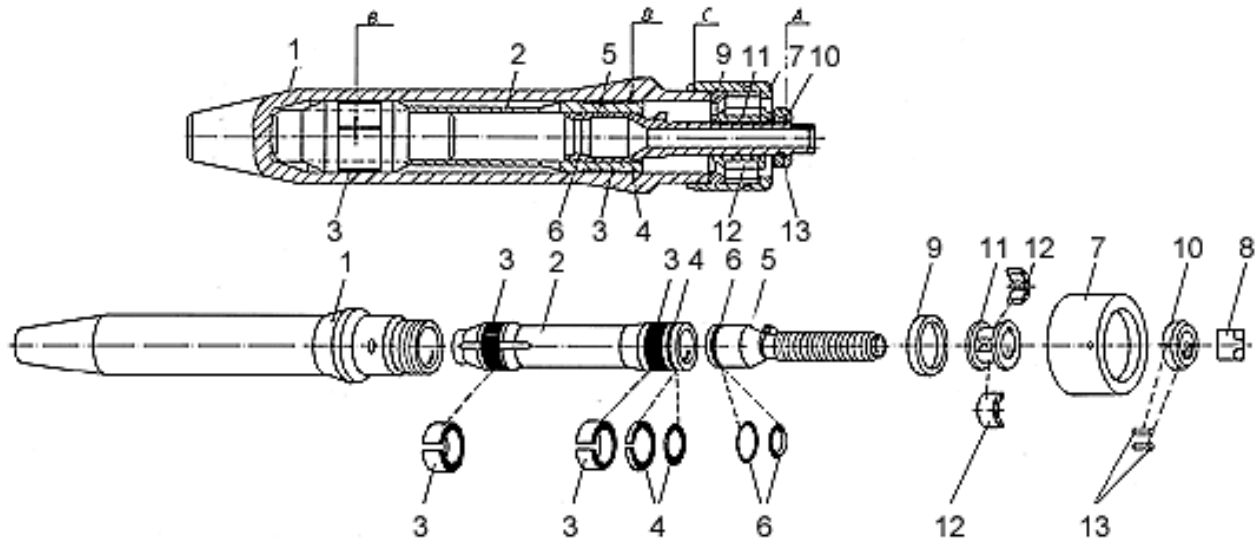
Item No	Description	Qty	Part Number
1	Machine body	1	TF 1450150
2	Piston	1	G-E 1455141
3	Piston slide tapes (set)	1	G-E 1455130
4	Piston seal	1	G-E 1455160
5-7	Control tube with elastic block and seal ring	1	TF 1450159
5	Control tube	1	TF 1450160
6	Control stud seal	1	T 1450107
7	Elastic block	1	TF 1450165
8	Support ring	1	TF 1450166
9	Segment ring	1	TF 1450167
10	Dust cap with 55x1/6" knurled thread	1	G 2600221
17	7' air hose, complete	1	G 2600223
18	Dust plug with 55x1/6" knurled thread	1	G 2600245
19	Ball valve 55x1/6" knurled thread on both sides with locking nuts	1	H 2200242
20	Dust cap with 55x1/6" knurled thread	1	G 2600221
20a	Dust cap with 55x1/6" knurled thread	1	G 2600221
—	Grundoram Titan 145 F complete	1	TF 1450000
—	Seals, (complete set)	1	T 1450104

E. Parts List for 180 Olympus



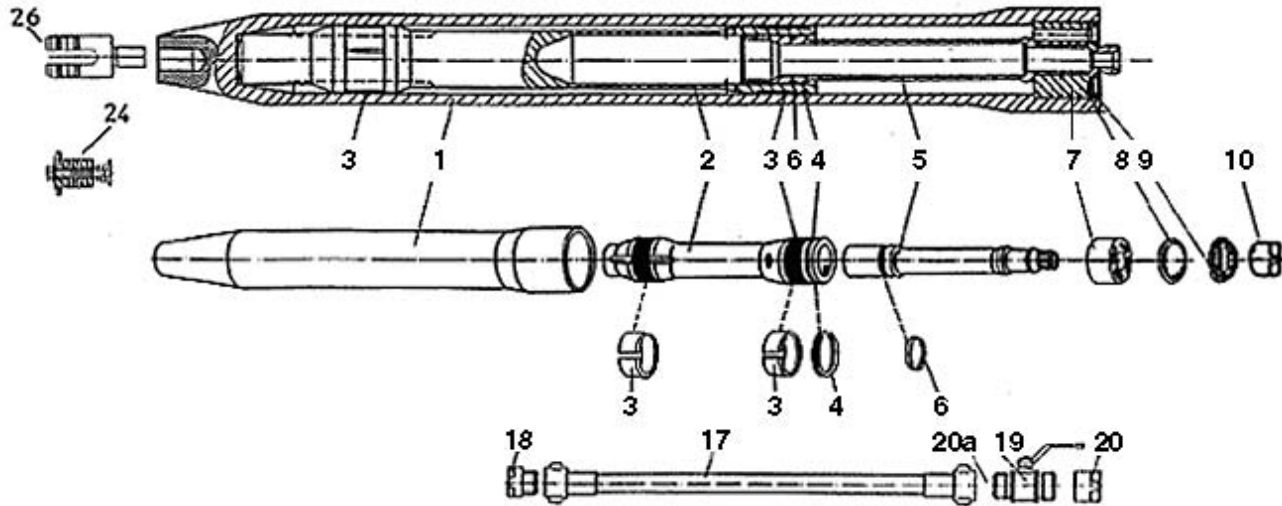
Item No	Description	Qty	Part Number
1	Machine body (front thread M 60, plug)	1	OF 1800152
24	Seal plug, complete, for thread M 60 (from 01.96)	1	H 2200335
26	Pulling eye (bore-D 30) M 60, complete (from 01.96)	1	H 2200319
2	Piston	1	O 1800103
3	Piston slide tapes (set)	1	O 1800104
4	Piston seal	1	G-E 1805160
5-7	Control tube with elastic block and seal ring	1	OF 1800159
5	Control tube	1	OF 1800160
6	Control stud seal	1	O 1800107
7	Elastic block	1	OF 1800165
8	Support ring	1	OF 1800166
9	Segment ring	1	OF 1800167
10	Dust cap with 75x1/6" knurled thread	1	G 4500113
17	7' air hose 2", on both sides knurled thread connection 75x1/6"	1	G 4500381
18	Dust plug with 75x1/6" knurled thread	1	G 4500245
19	Ball valve 1 1/2", on one side 55x1/6", on the other side 75x1/6" knurled thread connection	1	HF 2200241
20	Dust cap with 55x1/6" knurled thread	1	G 2600221
20a	Dust cap with 75x1/6" knurled thread	1	G 4500113
—	Grundoram Olympus 180 F complete (front thread M 60, plug)	1	OF 1800005
—	Seals, (complete set)	1	O 1800109

F. Parts List for 180 Mini-Olympus



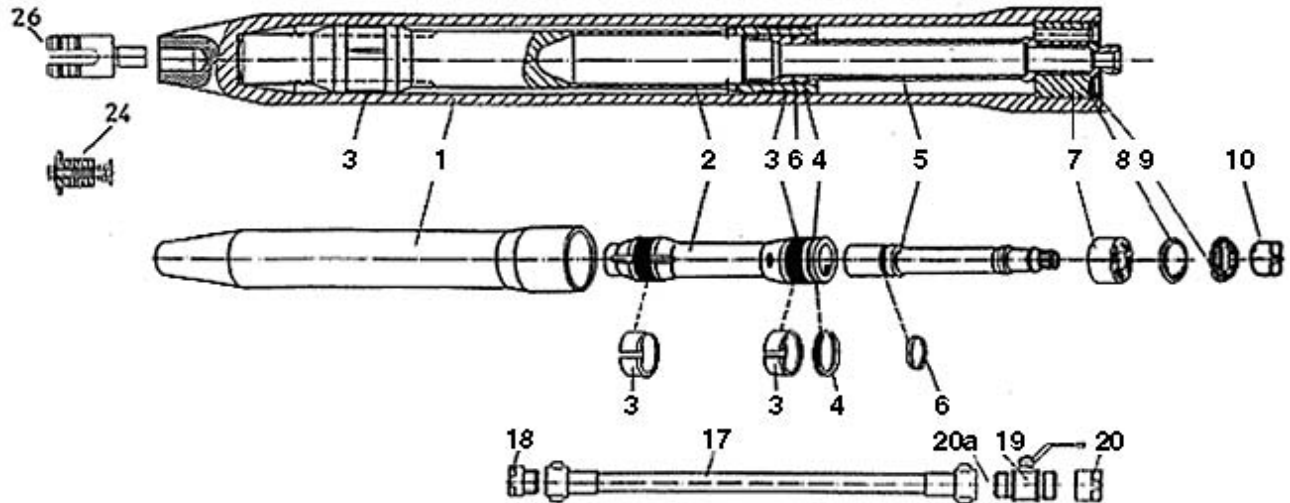
Item No	Description	Qty	Part Number
1	Machine body with thread M 60x3 and vent plug	1	OM 1800157
w.o. pic.	Seal plug, complete, for thread M 60	1	H 2200335
w.o. pic.	Pulling eye (bore-D 30) M 60, complete	1	H 2200319
2	Piston	1	OM 1800103
3	Piston slide tapes (set)	1	OM 1800104
4	Piston seal	1	G-E 1805160
5	Control tube for reverse run control	1	OM 1800156
6	Control stud seal	1	O 1800107
7	Casing end	1	OM 1800125
8	Dust cap with 55x1/6" knurled thread	1	G 2600221
9	Stop ring for reverse run control	1	OM 1800119
10	Stop nut for reverse run control	1	OM 1800120
11	Adjusting nut for reverse run control	1	OM 1800121
12	Aeration block semi-shells (set=2 halves)	1	OM 1800122
13	Pin set (set=2 pieces)	1	OM 1800123
w.o. pic.	Connection whip hose 7', complete without ball valve	1	G 2600223
w.o. pic.	Dust plug with 55x1/6" knurled thread	2	G 2600245
w.o. pic.	Ball valve 55x1/6" knurled thread on both sides with dust caps	1	H 2200242
w.o. pic.	Dust cap with 55x1/6" knurled thread	2	G 2600221
no pos.	Seals, (complete set)	1	OM 1800115
w.o. pic.	Mini-Olympus 180 with 10 degrees reception, thread M 60x3	1	OM 1800005

G. Parts List for 220 Hercules



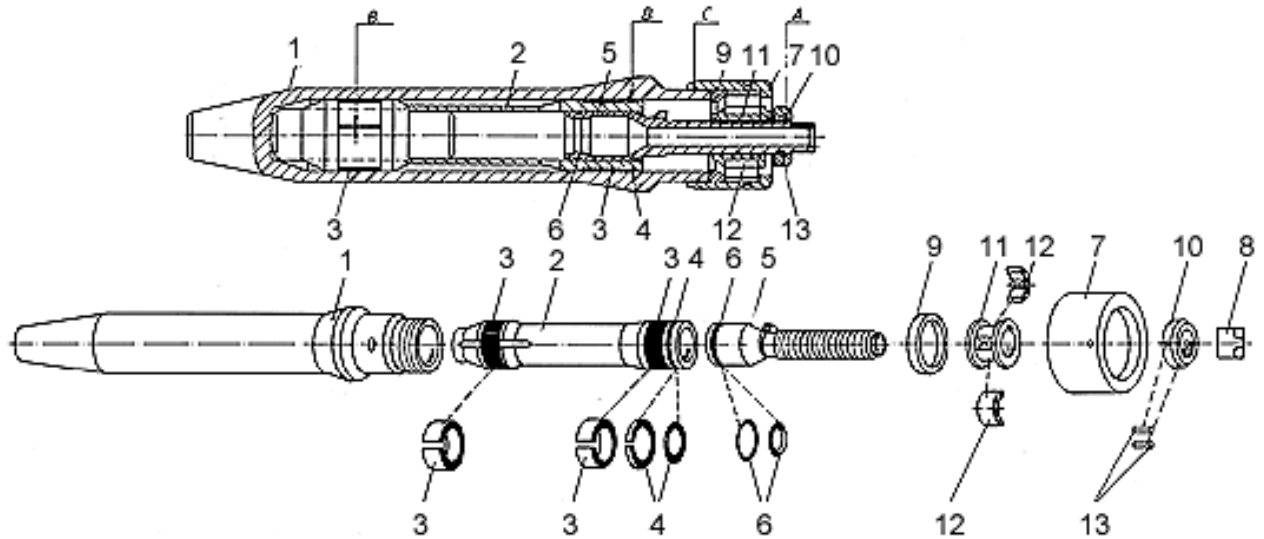
Item No	Description	Qty	Part Number
1	Machine body (front thread M 60, plug)	1	HF 2200152
24	Seal plug, complete, for thread M 60 (from 01.96)	1	H 2200335
26	Pulling eye (bore-D 30) M 60, complete (from 01.96)	1	H 2200319
2	Piston	1	H 2200103
3	Piston slide tapes (set)	1	H 2200104
4	Piston seal	1	H 2200105
5-7	Control tube with elastic block and seal ring	1	HF 2200159
5	Control tube	1	HF 2200160
6	Control stud seal	1	H 2200107
7	Elastic block	1	HF 2200165
8	Support ring	1	HF 2200166
9	Segment ring	1	HF 2200167
10	Dust cap with 75x1/6" knurled thread	1	G 4500113
17	7' air hose 2", on both sides knurled thread connection 75x1/6"	1	G 4500381
18	Dust plug with 75x1/6" knurled thread	1	G 4500245
19	Ball valve 1 1/2", on one side 55x1/6", on the other side 75x1/6" knurled thread connection	1	HF 2200241
20	Dust cap with 55x1/6" knurled thread	1	G 2600221
20a	Dust cap with 75x1/6" knurled thread	1	G 4500113
—	Grundoram Hercules 220 F complete (front thread M 60, plug)	1	HF 2200005
—	Seals, (complete set)	1	H 2200111

H. Parts List for 260 Gigant



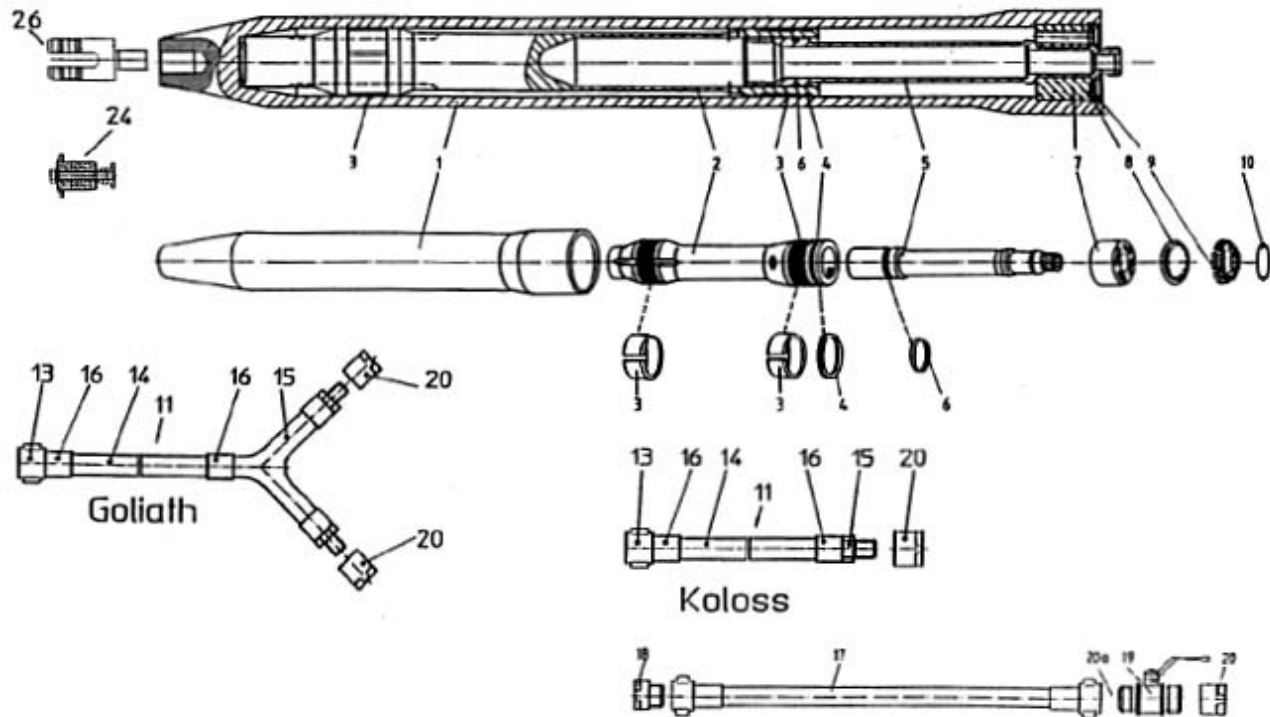
Item No	Description	Qty	Part Number
1	Machine body (front thread M 90, plug)	1	GF 2600152
24	Seal plug, complete, for thread M 90	1	703249
26	Pulling eye (bore-D 30) M 90, complete	1	G 266032
2	Piston	1	G 2600103
3	Piston slide tapes (set)	1	G 2600104
4	Piston seal	1	G 2600105
5-7	Control tube with elastic block and seal ring	1	GF 2600159
5	Control tube	1	GF 2600160
6	Control stud seal	1	G 2600107
7	Elastic block	1	GF 2600165
8	Support ring	1	GF 2600166
9	Segment ring	1	GF 2600167
10	Dust cap with 75x1/6" knurled thread	1	G 4500113
17	7' connection air hose 2", on both sides knurled thread connection 75x1/6"	1	G 4500381
18	Dust plug with 75x1/6" knurled thread	1	G 4500245
19	Ball valve 75x1/6" knurled thread on both sides with locking nuts	1	G 4500217
20	Locking nut with 75x1/6" knurled thread	1	G 4500113
20a	Locking nut with 75x1/6" knurled thread	1	G 4500113
—	Grundoram Gigant 260 F complete (front thread M 90, plug)	1	GF 2600005
—	Seals, (complete set)	1	G 2600115

I. Parts List for 260 Mini-Gigant



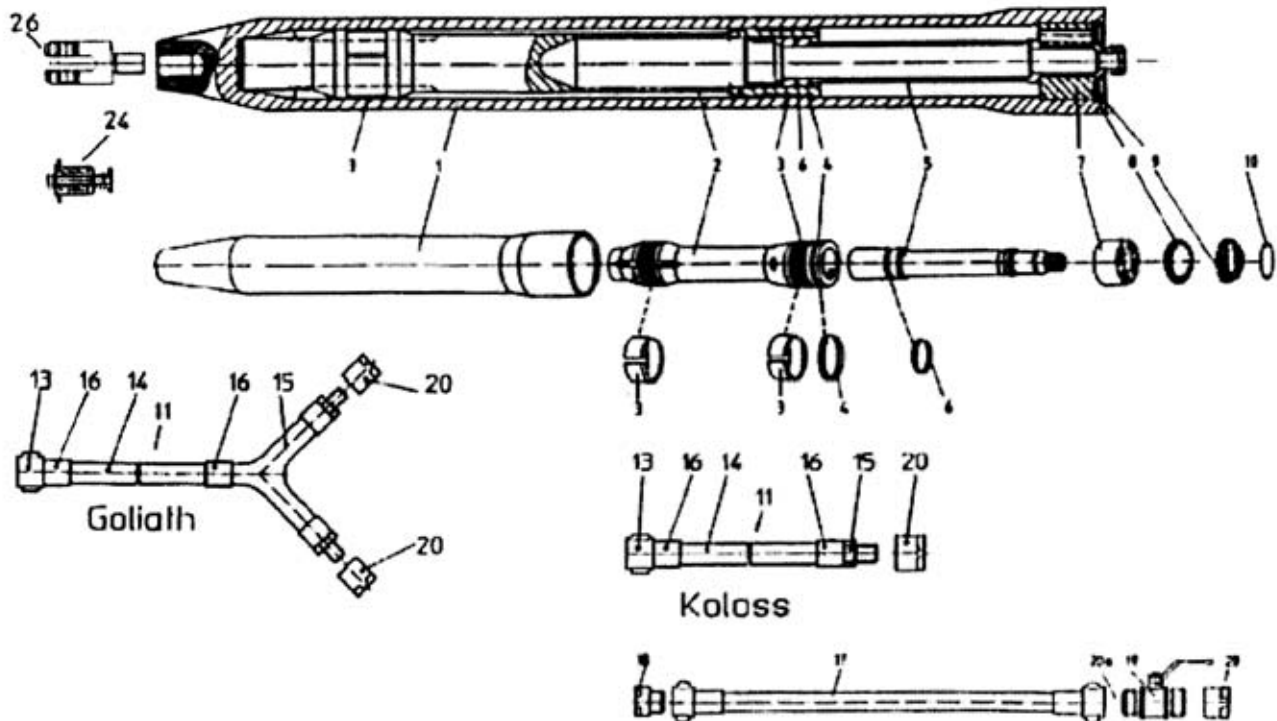
Item No	Description	Qty	Part Number
1	Machine body with bore hole, plug and RK reception	1	on request (4)
w.o. pic.	Seal plug, complete, for thread M 80	1	G 2600331
w.o. pic.	Pulling eye (bore-D 30) M 80, complete	1	G 2600319
w.o. pic.	Lock pin (set)	1	PAA 1300110
2	Piston	1	GM 2600103
3	Piston slide tapes (set)	1	GM 2600104
4	Piston seal	1	G 2600105
5	Control tube for reverse run control	1	GM 2600156
6	Control stud seal	1	G 2600107
7	Casing end	1	GM 2600118
8	Locking nut with 75x1/6" knurled thread	1	G 4500113
9	Stop ring for reverse run control	1	GM 2600119
10	Stop nut for reverse run control	1	GM 2600120
11	Adjusting nut for reverse run control	1	GM 2600121
12	Aeration block semi-shells (set=2 halves)	1	GM 2600122
13	Pin set (set=2 pieces)	1	GM 2600123
w.o. pic	Dust plug with 75x1/6" knurled thread	2	G 4500245
w.o. pic	Ball valve 75x1/6" knurled thread on both sides with locking nuts	1	G 4500217
w.o. pic	Dust cap with 75x1/6" knurled thread	2	G 4500113
no pos.	Seals, (complete set)	1	GM 2600115
—	Mini-Gigant 260 with 10 degrees reception	1	GM 2600005

J. Parts List for 350 Koloss



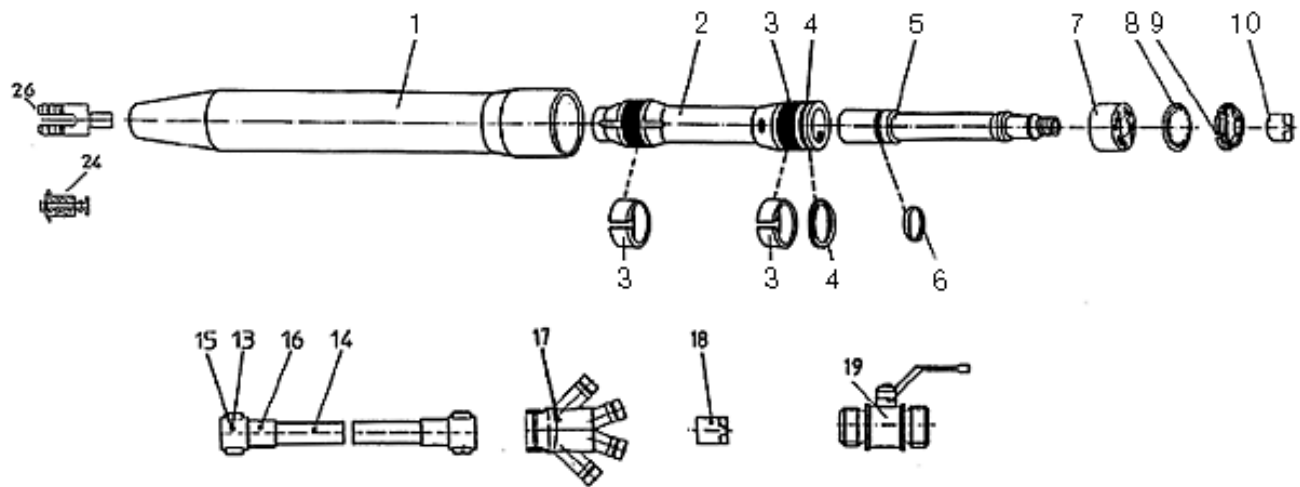
Item No	Description	Qty	Part Number
1	Machine body (front thread M 100, plug)	1	KF 3500152
24	Seal plug, complete, for thread M 100 (from 05/97)	1	GF 4500331
26	Pulling eye M 100 with screw (set) (from 05/97)	1	GF 4500319
w.o. pic.	Screw with nut (set) for towing eye (from 05/97)	1	GF 4500323
w.o. pic.	Lock pin (set) (until 04/97) alternative	1	PAA 1300110
w.o. pic.	Lock pin (set) for towing eye (from 05/97 alternative)	1	GF 4500322
2	Piston	1	K 3500103
3	Piston slide tapes (set)	1	K 3500104
4	Piston seal	1	K 3500105
5-7	Control tube with elastic block and seal ring	1	KF 3500159
5	Control tube	1	KF 3500160
6	Control stud seal	1	K 3500107
7	Elastic block	1	KF 3500165
8	Support ring closed	1	KF 3500166A
9	Segment ring	1	KF 3500167
10	Dust cap, steel	1	GF 4500168
11	Connection whip hose, complete	1	KF 3500100
13	Hose coupling ND 105	1	KF 3500101
14	Connection air hose DN 105, blank	1	G 4500111
16	Swaging socket for hose ND 105	1	KF 3500103
16	Hose clips (set) alternative	1	G 4500110
17	2 meter connection air hose 2", on both sides knurled thread connection 75x1/6"	1	G 4500381
18	Dust plug with 75x1/6" knurled thread	1	G 4500245
19	Ball valve 75x1/6" knurled thread on both sides with locking nuts	1	G 4500217
20	Dust cap with 75x1/6" knurled thread	1	G 4500113
20a	Dust cap with 75x1/6" knurled thread	1	G 4500113
—	Grundoram Koloss 350 F complete (front thread M 100, plug)	1	KF 3500005
—	Seals, (complete set)	1	K 3500109

K. Parts List for 450 Goliath



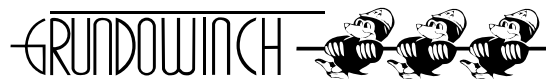
Item No	Description	Qty	Part Number
1	Machine body (front thread M 100, plug)	1	GF 4500152
24	Seal plug, complete, for thread M 100 (from 01/96)	1	GF 4500331
26	Pulling eye M 100 with screw (set) (from 01/96)	1	GF 4500319
w.o. pic.	Screw with nut (set) for towing eye	1	GF 4500323
w.o. pic.	Lock pin (set) for towing eye (alternative)	1	GF 4500322
2	Piston	1	G 4500103
3	Piston slide tapes (set)	1	G 4500104
4	Piston seal	1	G 4500105
5-7	Control tube with elastic block and seal ring	1	GF 4500159
5	Control tube	1	GF 4500160
6	Control stud seal	1	G 4500107
7	Elastic block	1	GF 4500165
8	Support ring closed	1	GF 4500166A
9	Segment ring	1	GF 4500167
10	Dust cap, steel	1	GF 4500168
11	Connection whip hose	1	GF 4500100
13	Hose coupling ND 105	1	KF 3500101
14	Connection air hose DN 105, without couplings, blank hose	1	G 4500111
16	Swaging socket for hose ND 105	1	KF 3500103
16	Hose clips (set) alternative	1	G 4500110
17	2 meter connection air hose 2", on both sides knurled thread connection 75x1/6"	2	G 4500381
18	Dust plug with 75x1/6" knurled thread	1	G 4500245
19	Ball valve 75x1/6" knurled thread on both sides with locking nuts	2	G 4500217
20	Dust cap with 75x1/6" knurled thread	2	G 4500113
20a	Dust cap with 75x1/6" knurled thread	1	G 4500113
—	Grundoram Goliath 450 F complete (front thread M 100, plug)	1	GF 4500005
—	Seals, (complete set)	1	G 4500109

L. Parts List for 600 Taurus



Item No	Description	Qty	Part Number
1	Machine body (front thread M 100, plug)	1	TF 6000152
24	Seal plug, complete, for thread M 100	1	GF 4500331
26	Pulling eye M 100 with screw (set)	1	GF 4500319
w.o. pic.	Screw with nut (set) for towing eye	1	GF 4500323
w.o. pic.	Lock pin (set) for towing eye (alternative)	1	GF 4500322
2	Piston	1	TF 6000103
3	Piston slide tapes (set)	1	TF 6000104
4	Piston seal	1	TF 6000105
5-7	Control tube with elastic block and seal ring	1	TF 6000159
5	Control tube	1	TF 6000160
6	Control stud seal	1	TF 6000107
7	Elastic block	1	TF 6000165
8	Support ring closed	1	TF 6000166A
9	Segment ring	1	TF 6000167
10	Dust cap, steel	1	TF 6000168
13-16	Connection whip hose, complete	1	TF 6000101
13	Hose socket for hose coupling	2	TF 6000171
14	Connection air hose, blank	1	TF 6000111
15	Spigot nut for hose coupling	2	TF 6000170
16	Hose clips (pair)	2	TF 6000110
17	Connection T-piece, complete (incl. 1x Item 10 and 4x Item 18)	1	TF 6000102
18	Dust cap with 75x1/6" knurled thread	4	G 4500113
19	Ball valve 75x1/6" knurled thread on both sides with locking nuts	4	G 4500217
—	Grundoram Taurus 600 F complete (front thread M 100, plug)	1	TF 6000005
—	Seals, (complete set) (item 3, 4, 6)	1	TF 6000109

Get to Know the Mole



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