BETE®
PERFORMANCE THROUGH ENGINEERING

HydroWhirl® Orbitor
Tank Washing Machine

Instruction and Maintenance Manual

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Introduction to the Orbitor Tank Washing Machine

This document is the Installation, Operation and Maintenance Manual, also known as the Product Manual, for the Orbitor Tank Washing Machine (TWM). These machines are supplied for use in the marine, industrial, and food processing industries.

Component Names

For part numbers and names see the Maintenance Manual section starting on page 18 and the Parts List starting on page 34. The figures shown throughout the manual are typical of a 4 nozzle machine. These examples may not directly resemble the machine supplied but are fundamentally the same in construction and part materials.

Operation Principles

The basic tank cleaning process is achieved by impinging high impact cleaning fluid jets on the inner walls of the vessel. The TWM action moves the jet nozzles in a spiral pattern that ensures correct and even coverage of the vessels surfaces through a washing cycle.

The flow of the cleaning fluid drives the machine causing the spherical body and nozzle head to rotate. There are no other power sources, control systems or electrical devices. The mechanism is self-lubricated and internally self-cleaned by the cleaning fluid. Three small fixed jets wash the machine exterior. The Orbitor TWM can be used with pressures as low as 45 psi (3 bar) due to a very low starting torque.

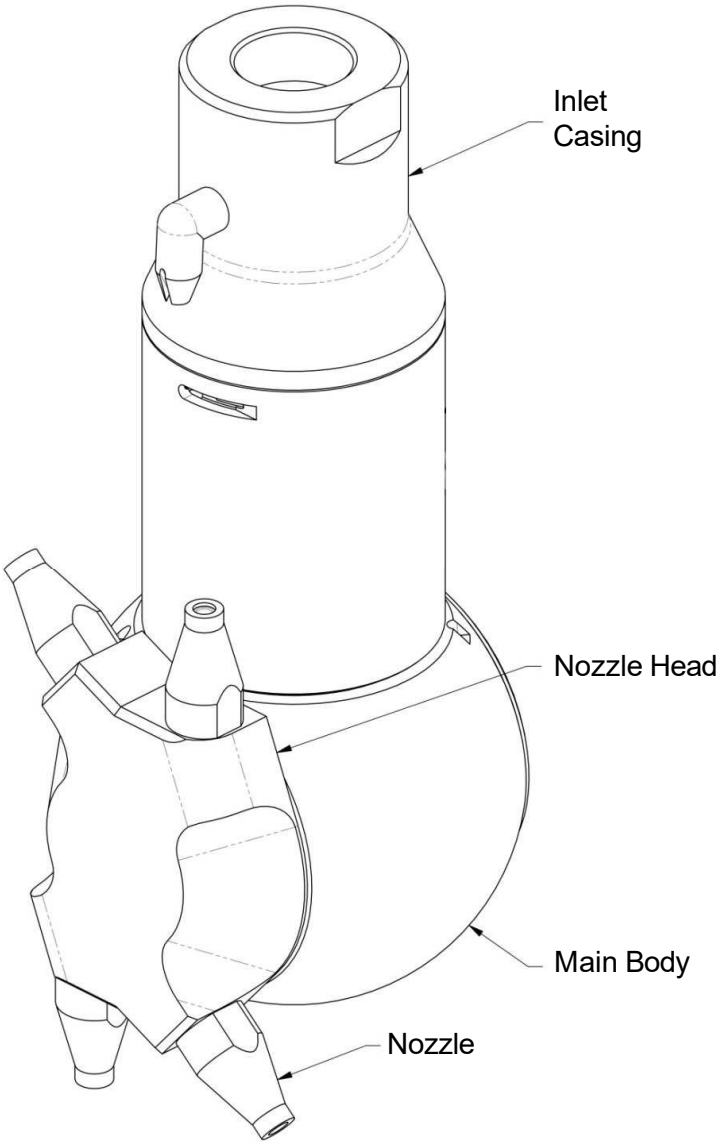

Figure 1: General arrangement.

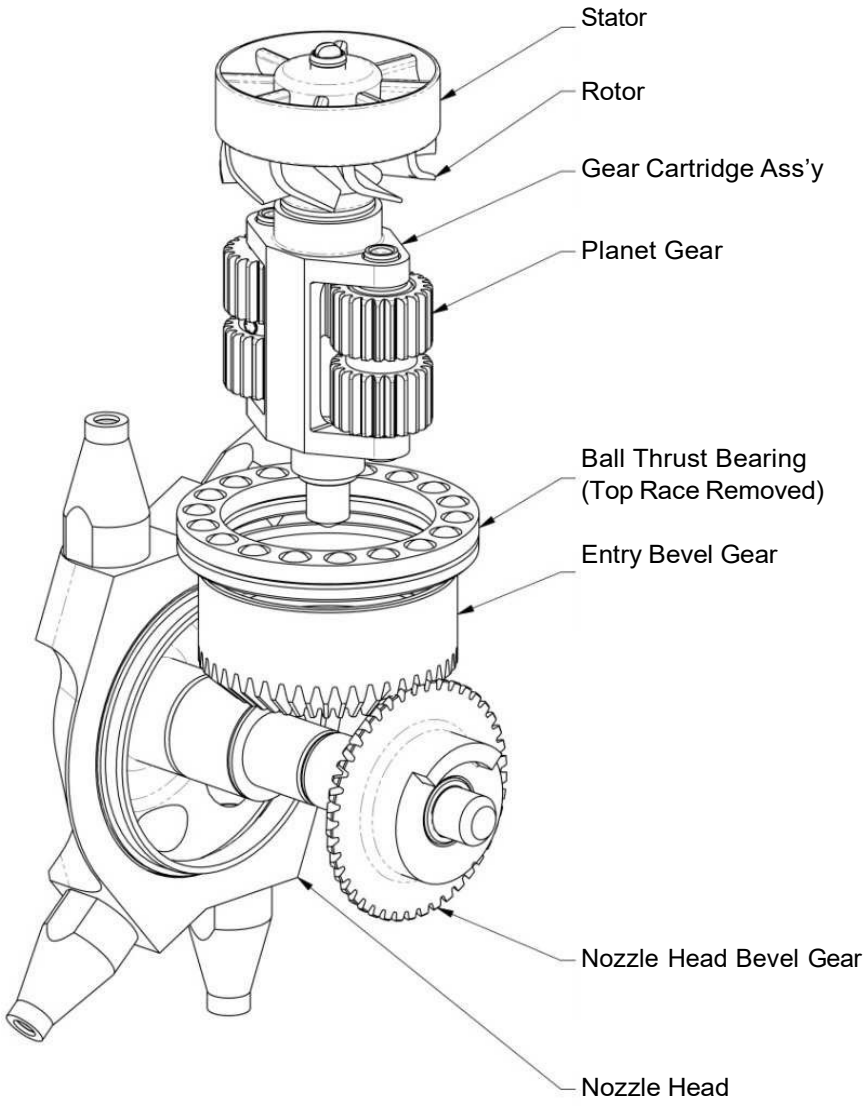

Figure 2: Orbitor tank washing machine with housings removed.

Performance and Technical Data

Operating Conditions

Operating pressure range	3 bar to 10 bar	45 psi to 145 psi
Maximum pressure	12 bar	175 psi
Maximum operating temperature	95 °C	195 °F
Minimum ambient storage temperature	−40 °C	−40 °F
Maximum ambient storage temperature	140 °C	285 °F

Dimensions

Available inlet connections, female pipe thread	1 BSP (G)† 1 1/2 BSP (G)	1 NPT† 1 1/2 NPT
Length, not including nozzles	265 mm	10.5 in
Width, not including nozzles	120 mm	4.7 in
Height	125 mm	4.9 in
Overall nozzle length	Depends on nozzles	
Minimum opening diameter, nozzles in any orientation	Depends on nozzles	
Minimum opening diameter, nozzles vertically aligned	127 mm	5.0 in
Installed weight, approximate	8 kg	18 lb
Packed Dimensions		
Length	550 mm	21.5 in
Width	270 mm	10.6 in
Height	270 mm	10.6 in
Total gross weight	< 9 kg	< 20 lb

† *For models 4 x 4.2 and 4 x 5.0 only*

Cleaning Fluids

Orbitor TWMs are capable of resisting most cleaning fluids provided:

- They contain no
  - Solid abrasive particles
  - Chemicals liable to attack the TWM construction materials. See materials list below.
- Temperatures specified in Operating Conditions are not exceeded

Approved cleaning fluids:

- Water at a temperature below 200 °F (below 95 °C)
- < 5 % NaOH caustic soda solution
- Other cleaning fluids can be used with advice of BETE

Construction Materials

Component	Material
Nozzle head, nozzles and internal parts unless specified below	316L stainless steel
Body shell	Kolsterised 316L stainless steel
Gears	PEEK (PVDF or other materials available by special order)
Seals	PTFE, 10 % carbon filled
Seal seats	Ceramic coated
Bushings	PTFE, carbon filled
Ball bearings / race	Kolsterised 316 stainless steel Duplex 2205 steel (hardened)

Please note – Do not use any chemicals on the TWM while cleaning that might affect the integrity of the non-metallic component parts. If in doubt contact BETE for advice.

Performance Table

Tables 1 – 2 show total water flow, total jet length (effective cleaning may vary based on application), and typical cycle time for various nozzle configurations and sizes at different pressures.

Quick Wash or Rinse

The cycle times defined in the above table are for a full wash cycle.

Wash cycles can be repeated as many times as necessary. The TWM can also be stopped after one pattern generation for a quick rinse.

Installation, Mounting, and Washing Fluid Connection

Correct installation of an Orbitor TWM is the responsibility of the tank owners, constructors, or installers. Mounting and connecting is a straightforward task for a competent fitter or technician.

BETE is happy to offer technical support and recommendations upon request but does not normally carry out installation work and cannot be responsible for ensuring correct installation practice or application.

TWM machine installation - key points:

- Machines will be positioned in the tank to permit the best cleaning jet coverage of walls, floor and tank cover.
- The cleaning pattern required and selection of flow and jet length depends on:
  - Tank dimensions.
  - Properties of the stored product residue.
  - Available flow and pressure.
- The axis of rotation of the spherical main body is along the axis of the inlet.
- The axis of rotation of the nozzle head is perpendicular to inlet axis — see Fig. 3).
- Machines will normally be mounted to the tank top cover and project down.

Table 1
Orbitor Performance Information, US Units

Pressure	4 ×,04.2 Flow	4 ×,04.2 Jet Length	4 ×,04.2 Cycle Time	4 ×,05.0 Flow	4 ×,05.0 Jet Length	4 ×,05.0 Cycle Time	4 ×,06.0 Flow	4 ×,06.0 Jet Length	4 ×,06.0 Cycle Time	4 ×,07.0 Flow	4 ×,07.0 Jet Length	4 ×,07.0 Cycle Time	4 ×,08.0 Flow	4 ×,08.0 Jet Length	4 ×,08.0 Cycle Time
psi	gpm	ft	min	gpm	ft	min	gpm	ft	min	gpm	ft	min	gpm	ft	min
45	22.6	9.5	11.0	31.4	13.1	13.0	38.6	17.4	15.5	59.1	21.3	20.1	68.3	23.6	15.5
60	26.5	9.8	9.3	36.4	13.8	10.8	45.7	18.7	12.9	67.7	23.3	15.2	79.0	26.2	12.9
75	30.0	11.5	7.9	40.8	15.4	9.4	52.1	20.3	11.0	75.2	25.3	14.9	88.4	29.5	11.0
90	33.3	13.1	6.9	44.8	17.1	8.0	58.0	23.0	9.5	81.9	27.9	13.0	96.9	32.5	9.5
100	35.3	16.4	6.3	47.2	20.7	7.3	61.8	26.2	8.4	86.0	30.8	11.7	102	34.8	8.5
115	38.1	20.3	5.8	50.8	24.6	6.8	67.0	30.8	7.6	91.9	33.8	10.4	110	36.7	7.8
130	40.8	23.3	5.6	54.0	27.9	6.5	72.1	33.8	7.0	97.3	36.7	9.3	117	40.0	7.0
145	43.4	25.6	5.5	57.2	29.5	6.4	76.8	36.7	6.9	102	39.4	8.9	123	42.6	6.9

Pressure	2 ×,06.0 Flow	2 ×,06.0 Jet Length	2 ×,06.0 Cycle Time	2 ×,07.0 Flow	2 ×,07.0 Jet Length	2 ×,07.0 Cycle Time	2 ×,08.0 Flow	2 ×,08.0 Jet Length	2 ×,08.0 Cycle Time	2 ×,010 Flow	2 ×,010 Jet Length	2 ×,010 Cycle Time	2 ×,012.5 Flow	2 ×,012.5 Jet Length	2 ×,012.5 Cycle Time
psi	gpm	ft	min	gpm	ft	min	gpm	ft	min	gpm	ft	min	gpm	ft	min
45	21.5	18.0	33.0	26.1	21.3	37.5	33.5	23.6	25.7	59.1	32.1	41.0	89.4	33.1	26.8
60	25.4	19.7	27.2	31.3	23.6	31.6	39.3	26.2	22.9	68.7	34.4	34.2	103	36.7	24.0
75	28.8	20.7	24.7	36.0	25.9	28.2	44.4	29.5	20.5	77.2	37.7	30.5	115	39.7	21.7
90	31.9	23.0	22.6	40.4	27.9	25.8	49.1	32.5	18.9	84.9	41.7	28.0	126	44.0	19.8
100	33.9	26.2	21.0	43.2	29.2	24.0	52.0	34.8	17.5	89.8	45.6	26.0	133	48.5	18.4
115	36.7	29.5	19.5	47.2	30.2	22.3	56.2	36.7	16.4	96.6	49.9	24.5	143	53.8	17.2
130	39.4	33.5	18.4	51.1	37.0	21.0	60.1	40.0	15.6	103	55.8	23.2	152	60.0	16.3
145	41.9	37.7	17.4	54.7	40.4	20.0	63.8	42.6	14.9	109	61.7	22.0	160	65.9	15.5

Table 2
Orbitor Performance Information, SI Units

Pressure	4 ×,04.2			4 ×,05.0			4 ×,06.0			4 ×,07.0			4 ×,08.0		
	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time
bar	L/min	m	min	L/min	m	min	L/min	m	min	L/min	m	min	L/min	m	min
3	80.0	2.9	11	112	4.0	13.0	138	5.3	15.5	217	6.5	20.1	250	7.2	15.5
4	100	3.0	9.3	137	4.2	10.8	170	5.7	12.9	252	7.1	15.2	293	8.0	12.9
5	115	3.5	7.9	155	4.7	9.4	200	6.2	11.0	283	7.7	14.9	333	9.0	11.0
6	127	4.0	6.9	173	5.2	8.0	220	7.0	9.5	310	8.5	13.0	367	9.9	9.5
7	138	5.0	6.3	185	6.3	7.3	240	8.0	8.4	333	9.4	11.7	395	10.6	8.5
8	147	6.2	5.8	195	7.5	6.8	257	9.4	7.6	350	10.3	10.4	418	11.2	7.8
9	153	7.1	5.6	202	8.5	6.5	270	10.3	7.0	367	11.2	9.3	438	12.2	7.0
10	157	7.8	5.5	207	9.0	6.4	282	11.2	6.9	380	12.0	8.9	458	13.0	6.9

Pressure	2 ×,06.0			2 ×,07.0			2 ×,08.0			2 ×,010			2 ×,012.5		
	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time	Flow	Jet Length	Cycle Time
bar	L/min	m	min	L/min	m	min	L/min	m	min	L/min	m	min	L/min	m	min
3	80.0	5.5	33.0	93.3	6.5	37.5	117	7.2	25.7	217	9.8	41.0	330	10.1	26.8
4	91.7	6.0	27.2	117	7.2	31.6	150	8.0	22.9	255	10.5	34.2	383	11.2	24.0
5	108	6.3	24.7	137	7.9	28.2	172	8.7	20.5	290	11.5	30.5	433	12.1	21.7
6	122	7.0	22.6	153	8.5	25.8	190	9.4	18.9	320	12.7	28.0	473	13.4	19.8
7	130	8.0	21.0	168	9.2	24.0	203	10.3	17.5	347	13.9	26.0	512	14.8	18.4
8	140	9.0	19.5	182	10.4	22.3	213	11.3	16.4	368	15.2	24.5	547	16.4	17.2
9	148	10.2	18.4	192	11.3	21.0	223	12.4	15.6	390	17.0	23.2	572	18.3	16.3
10	157	11.5	17.4	200	12.3	20.0	232	13.5	14.9	405	18.8	22.0	600	20.1	15.5

- Machines may also be inverted and project through the tank floor.
  - Please assume the vertical down orientation in following text.
- BETE or its agents will be pleased to offer application and installation advice and can produce cleaning diagrams (also known as shadow diagrams) if required (refer to the Installation Checklist provided in this document).

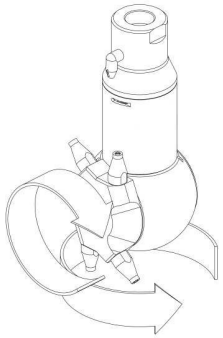

Figure 3: Rotation direction of nozzle head and body.

The inlet comprises a cylindrical housing with an internal (female) thread sized for alternative pipe thread systems. The standard internal threads are:

1 NPT and 1 BSP (G)	available in the 4x4.2 and 4x5 models
1 1/2 NPT and 1 1/2 BSP (G)	available in all models

This threaded interface provides both fluid connection and structural machine mounting functions. It is recommended to install a coarse filter of 0.06 in (1.5 mm) minimum mesh in the supply line.

Installation Checklist

TWM Serial Number	
Location of TWM Installation	
Date	

Stage	Task	✓	Details	Name of Technician
Pre-Installation	Has a system level Hazard Analysis been conducted?			
	Is the cleaning fluid supply filtered?			
	Test and record cleaning fluid supply pressure.			
	Record here the normal cleaning fluid specification and temperature.			
Post-Installation	Check pipe tightness.			
	Check nozzle tightness.			
	Test electrical resistance between nozzle tips and installation pipe and tank structure.			
	Test electrical resistance of portable hoses.			
	Rinse the system with clean water.			
	Test for smooth operation and regular running speed.			

Mounting - Loads and Weights

Tank owners, constructors, or installers are responsible for the structural integrity of the TWM mounting. The installation specification and design should consider the following.

- Maximum static weight is 17 lb (7.5 kg, 75 N) for a standard TWM and 20 lb (9 kg, 90 N) for a hi capacity TWM.
  - Weight of pipe work and fluids are additional.
- Single nozzle reaction forces can be up to 180 lb (800 N) depending on pressure and nozzle size.
  - Normally these forces are balanced by opposing nozzles.
- Structural strength and stiffness of the mounting must be sufficient.
  - The natural vibration frequency of the mounting must be many times the forcing frequency.
  - Masonry vessels are a particular concern and may require manufacture of large pipe flanges or structures to spread loads.
- Pipe work systems must be designed to prevent water hammer effects.
  - Forces produced by water hammer can far exceed normal reaction loads and can damage the TWM and supply pipework.
- Installations must be designed by a competent engineer or other qualified individual.

Fixed Installations

Fixed machines are used for applications where the stored media or process will not be affected by the presence of a permanent machine. This type of installation requires the least operator intervention and the lowest component costs. In practice, specification differences between fixed and portable machines are few.

The fluid coupling and machine mounting is specific to each tank installation. Normally, fixed machines are mounted on rigid pipes, often flange mounted to the tank roof or floor. BETE can supply suitable flanged and weld prepared pipe assemblies. Pipe length depends on tank size and

required jet pattern. Short flanged pipes form a compact unit ideal for top down washing.

Longer pipes, also known as Drop Pipes or Free Standing Units (FSU's), will require additional strengthening to prevent fatigue fracture due to vibration. Long pipe installations are designed in collaboration with the customer and often include steadying cable rigs or tie bars.

A machine fixed in a dirty environment might experience the nozzles becoming blocked by the contaminant which will affect the machines performance. If this condition is likely to occur, inspection and cleaning of the nozzles prior to use is advised.

Ensure all fixed installations are clear from any obstructions that might prevent the nozzle head from rotating.

Portable Installations

Portable machines are only needed while cleaning and are moved out the way during normal operation. The equipment is stowed when not in use. Portable machines are most often used with a large bore flexible hose with pipe threaded end couplings. Flexible hose mounting allows the cleaning machine to be guided into different positions in the tank with manually controlled cables. The TWM operator can thereby concentrate the cleaning action in particularly stubborn areas.

Operation Instructions

Conditions for Safe Working

- Only competent and qualified persons should carry out and check installation work.
- Follow the installation instructions in this manual.
- Complete the Installation Checklist printed in this manual.
  - Record installation details.
  - Store manuals with check lists appropriately in an accessible location.
- Use Orbitor TWMs within the technical parameters defined in the Operating Conditions.

- Ensure that personnel cannot touch hot TWM surfaces or be hit by high power cleaning fluid jets.
  - Beware of hazardous cleaning fluids.
- Maintain Orbitor TWMs in accordance with the instructions provided in this Product Manual.
  - Check nozzle tightness regularly.

General Operating Instructions

- Always
  - ✓ Rinse with clean water after operation.
  - ✓ Ensure that any tank openings are completely sealed off and can withstand the full force of the striking jet.
  - ✓ Allow the machine to gradually reach its operating pressure to avoid water hammer effects. A sudden spike could cause parts to wear prematurely or fail.
  - ✓ Store and dispose of cleaning fluids in accordance with current rules and directives.
- Never
  - ✘ Back drive the TWM by manually rotating nozzle heads.
  - ✘ Drive the TWM with steam or with a liquid at a temperature above 200 °F (95 °C).

Maintenance Manual

The Orbitor TWM is designed to allow for field maintenance. These machines may also be returned to BETE for maintenance if desired. To ensure correct operation of the machine, it is mandatory that all spare parts be supplied by BETE.

Once maintenance has been carried out by either party the installation test procedure must be conducted on reinstallation. A new Installation Checklist is required to be completed and maintained.

Schedule

In order to prevent machine failures, routine maintenance should be carried out at a maximum of

500 hours of operation

Maintenance should include cleaning all internal parts and assessing the wear of seals, gears, bearing and bushings.

- Any fine solid particles left inside the machine will increase wear considerably.
- Orbitor TWM requires no lubrication.
  - The Orbitor TWM is lubricated by the spray media during operation.

Attention

- Before maintenance can be carried out, it is important the machine is not contaminated with chemicals that could be hazardous.
- Always
  - ✓ Use the tools stated throughout this manual. Special tools for Orbitor maintenance can be purchased from BETE.
  - ✓ Read the technical data thoroughly before carrying out any work on this machine.
  - ✓ Record any wear found and check for smooth operation of the machine after maintenance.

✓ After any maintenance is carried out flush and sterilize (if appropriate) the machine before further use.

- Never

  ✘ Service the Orbitor TWM while hot.

- Any parts found to be unserviceable should be replaced before further use. If the tank being cleaned contains a combustible liquid or vapor with a risk of ignition or explosion, re-check that the Orbitor TWM is properly grounded after maintenance.

Recommended Tools List

- 6 mm Allen wrench
- 3 mm Allen wrench
- 12 mm open end wrench
- 18 mm open end wrench
- 19 mm open end wrench
- Strap wrench
- Screwdriver
- 3 mm pin punch
- Light hammer
- Vise
- Spider Tool (Part No. DM00748)
- Set of (2) Side Plate Tools (Part No. DM00749 for the set)
- Nozzle Head Tool (Part No. DM00750)
- Loctite® 638 or Vibra-TITE® 538 (if ceramic seals are removed)
- Torque wrench (suitable for applying 45 ft · lb_f [60 N · m])
- Fly-press or soft-jawed vise
- Loctite® 270 or Vibra-TITE® 141 (If dissembling main body or nozzle head threads)

Disassembly Operations

Nozzle Head and Rear Plate – Disassembly

Please refer to Figures 4 and 5.

1. Place the Orbitor in the vice, holding onto rear plate flats (DM02142). Ensure machine is securely held in place before proceeding to the next step.
2. Use tool (DM00750) to unscrew nozzle head (DM02141), in a counter-clockwise direction.

   Please note – The assembly has 180° of lost motion.
3. The nozzle head (DM02141) should now be free to lift off.
4. Lift machine off the nozzle head shaft (DM02143).

   Please note – Be careful not to lose any seals, spacers or bushings.
5. Check seal in nozzle head (DM00699) for wear or damage to the seal lip, if excessively worn or damaged, then remove by cutting free.
6. There should be a ceramic seal insert (DM00698) left in the main body. This should be replaced if the ceramic coating is chipped or worn.
7. The bushing (DM02032) will still be inside the main body (DM02139) and should be carefully assessed for signs of wear.
8. The nozzle head bevel gear (DM02147) should still be on the nozzle head shaft (DM02143) and should also be assessed for any signs of wear to the gear teeth.
9. Inspect the stream straighteners for any foreign bodies and remove if necessary.
10. Check rear plate seal (DM00699) for wear or damage to the seal lip.
11. Turn main body (DM02139) over and inspect second ceramic seal insert for wear or damage.
12. Now both bushings (DM02032) in main head can be removed but only if they are required to be replaced.

13. Lastly the nozzle head bevel gear (DM02147) can be lifted off the nozzle shaft.
14. For Hi-capacity version see Figure 16.

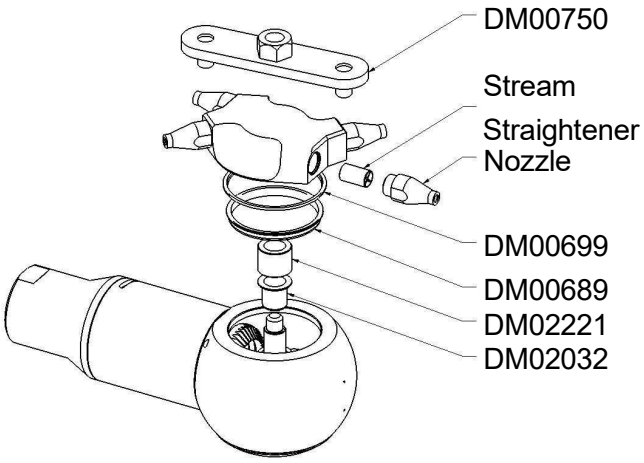

Figure 4: Nozzle head removal

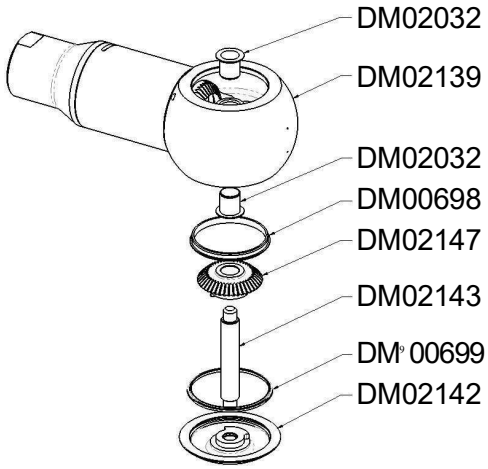

Figure 5: Back plate disassembly

Body Shell and Inlet Casing – Disassembly

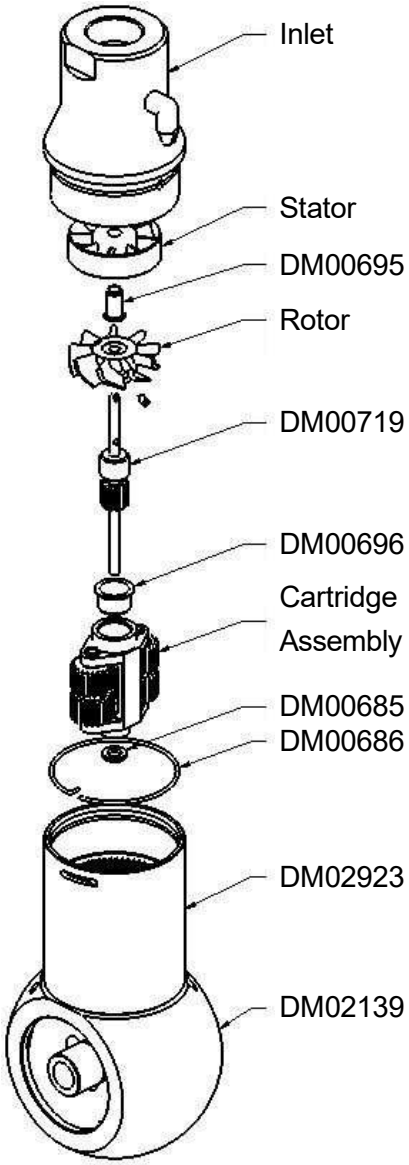

Figure 6: Body shell and inlet casing disassembly

1. Hold machine by inlet casing at the bottom and turn the body shell (DM02140) counterclockwise by hand, or alternatively with a strap wrench if tight.

   Please note – To find part number for a specific Inlet Casing please refer to the Interchangeable Parts list in the Appendix as they vary by model.

2. This should allow spring clip (DM00686) to extrude from slot. Unhook clip using a screwdriver.

3. Lift shell (DM02140) up from Inlet.

   Please note – You should be left with the cartridge and turbine subassemblies in inlet.

4. Pull out cartridge and turbine assemblies and inspect for wear.

5. Remove stator bushing (DM00695) if necessary.

Turbine Shaft Subassembly – Disassembly

Please Note – Turbine can be removed from shaft if necessary by unscrewing Hollow Set Screw (DM00702) (see Figure 7). For specific turbine (rotor) part numbers refer to Interchangeable Parts list in the Appendix as these vary depending on machine.

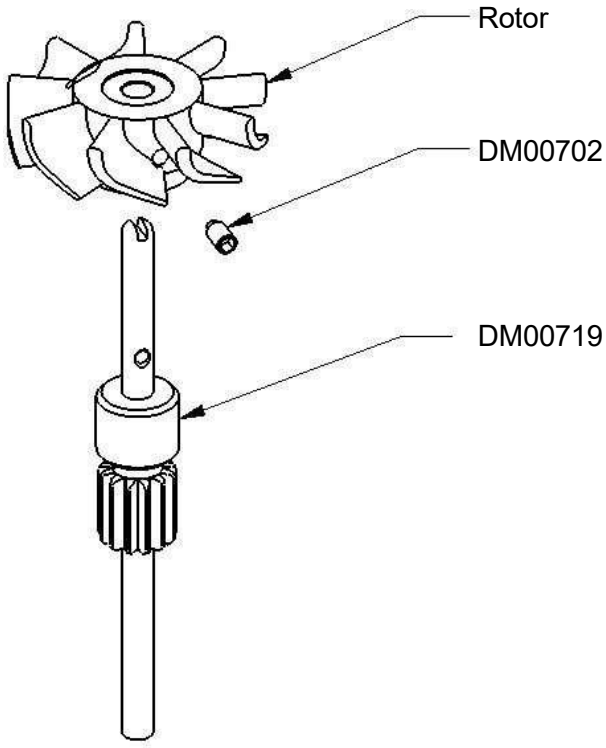

Figure 7: Rotor (turbine) subassembly

Gear Cartridge Subassembly – Disassembly

1. Check cartridge bushing (DM00696), shaft bushings (DM00697), and support washer (DM02226); inspect for wear.
2. Unscrew hollow set screws (DM00702) in both planet shafts, this should allow you to remove both shafts (DM00736).
3. Now remove the planet gears; both the Aligned (DM00721) and the 1/2 Displaced (DM00722); check for wear.

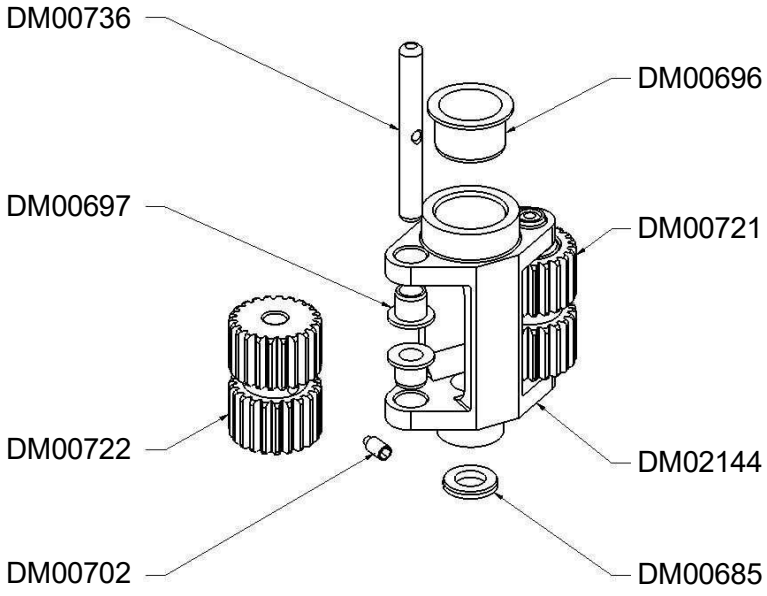

Figure 8: Gear cartridge subassembly

Main Body and Body Shell – Disassembly

Please note – Before attempting to unscrew shell from main body, ensure you knock pin out of main body using a 3 mm pin punch (Figure 9).

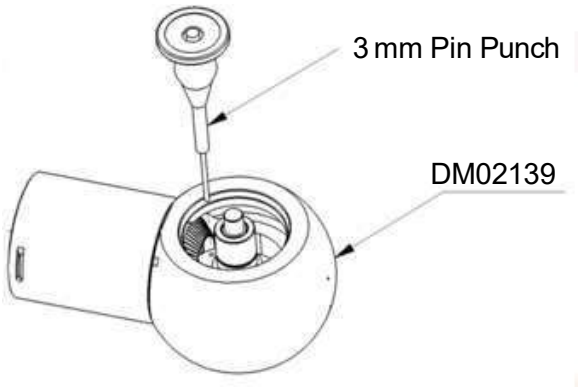

Figure 9: Pin removal

1. Fit the two side plate tools (DM00749) to the faces of the body and place in vice.
2. Using spider tool (DM00748), loosen spider (DM02145 Figures 10 and 11) from main body.
3. Lift shell and spider from ball and separate internal components to ensure all thrust bearing balls (DM00703) are retained. (Figure 11).
4. Inspect all seals, bearings, and bushings for signs of wear and replace if necessary.
5. Check spider and bevel gear teeth for wear.
6. Check ceramic seal insert (DM00698) on body shell.

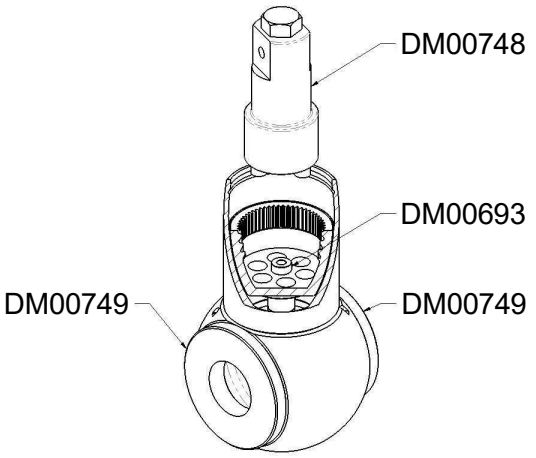

Figure 10: Assembly and disassembly tool

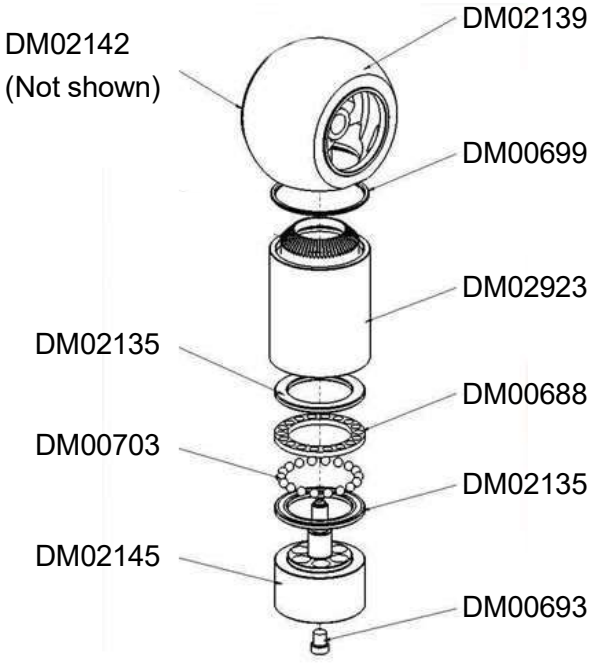

Figure 11: Main body and inlet shell

Reassembly Operations

Main Body and Body Shell – Reassembly

1. If removed, push ceramic seal inserts back into main body and body shell using Loctite® 638 or Vibra-TITE® 538
2. Re-assemble bearing assembly to spider and insert into body shell.
3. Pick up the main body and place the side plate tools on the sides of main body and hold in vice.

   Please note – This is to protect the ceramic seal inserts.
4. Insert seal (DM00698) to top of main body, if removed.
5. Locate spider using spider tool and screw assembly to main body through body shell. Using Loctite® 270 or Vibra-TITE® 141 on thread of spider shaft.
6. Using torque wrench, tighten spider to 45 ft · lb_f [60 N · m].
7. Remove whole assembly from vice and remove side plates.
8. Replace 3mm pin (DM00709) in hole inside main body.

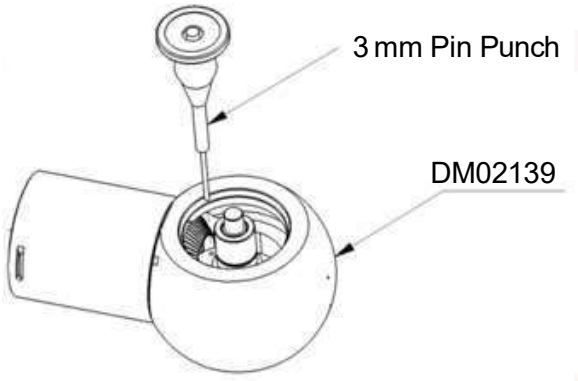

Figure 12: Pin insertion

Gear Cartridge Subassembly – Reassembly

1. Replace cartridge bushing (DM00696), shaft bushings (DM00697), and support washer (DM02226) if removed.
2. Slide both gears into place and insert shafts aligning holes in gears and shafts for hollow set screw.
3. Insert set screw (DM00702) and tighten.

Turbine Shaft Subassembly – Reassembly

Please note – Turbine can be replaced on shaft if necessary by sliding onto shaft and reinserting hollow set screw (DM00702). For turbine part number refer to the Interchangeable Parts list in the Appendix.

Body Shell and Inlet Casing – Reassembly

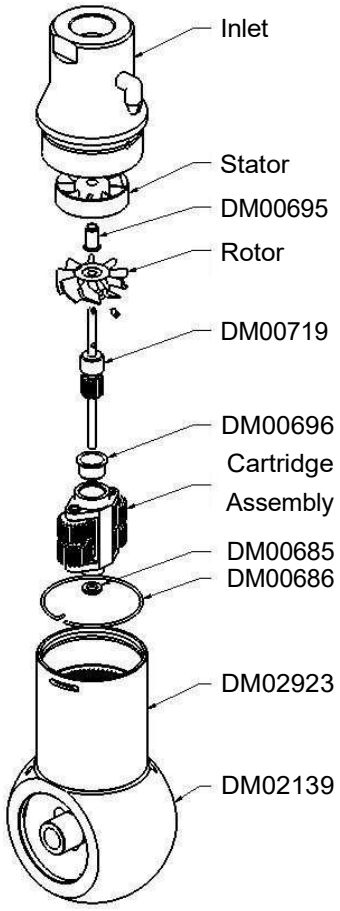

Figure 13: Body shell and inlet casing

1. Hold machine with main body (DM02139) under body shell (DM02923) and insert gear cartridge subassembly.
2. Insert turbine shaft subassembly guiding turbine into cartridge.

   Please note – Check for smooth operation by spinning the turbine shaft by hand.
3. Replace stator bushing (DM00695) in stator inside inlet casing, if removed.
4. Hold machine with main body under body shell and slide the inlet casing into body shell.

   Please note – Ensure hole in inlet casing is aligned with slot in main body shell.
5. Fit spring clip through slot in the shell into the hole in the inlet connection and turn slightly to locate in its position.
6. Rotate machine vertically and hold inlet connection in vice, located on flats.
7. Turn shell 360° clockwise to fit spring clip completely in inlet connection.

Please note – Use new spring clip (DM00686) if necessary.

Please note – Tighten with strap wrench if necessary.

Nozzle Head and Rear Plate – Reassembly

Please refer to Figures 14 and 15.

1. Hold rear plate in vice using flats and place new seal, if necessary.
2. Slide nozzle head bevel gear onto nozzle shaft.
3. Push bushings (DM02032) into main body if necessary and slide assembly back onto nozzle shaft.
4. Fit stainless steel spacer (DM02221) onto nozzle shaft.
5. If nozzles were removed now replace nozzles to nozzle head.

   Please note – Ensure nozzles are tightened sufficiently in order to avoid machine failure.
6. Locate seal into grove of nozzle head.
7. Finally screw nozzle head back onto main assembly using Loctite® 270 or Vibra-TITE® 141 and tighten with tool (DM00750) to 60 N·m (45 $ft{\cdot}lb_f$).
8. For Hi-capacity version, see Figure 16.

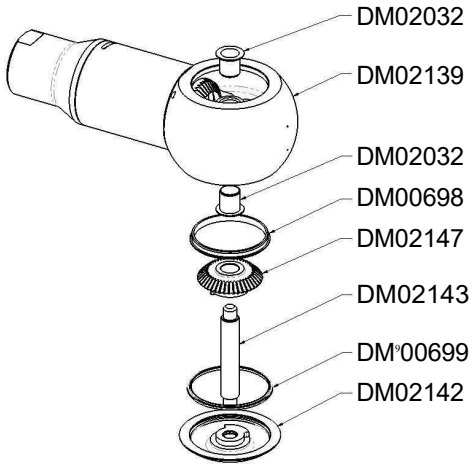

Figure 14: Back plate reassembly

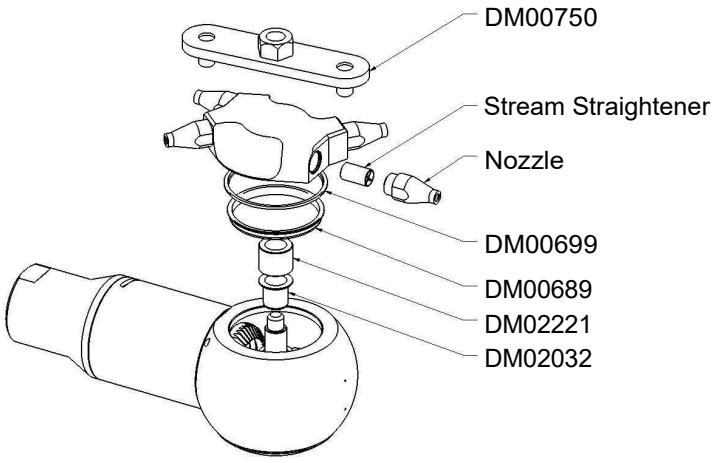

Figure 15: Nozzle head reassembly

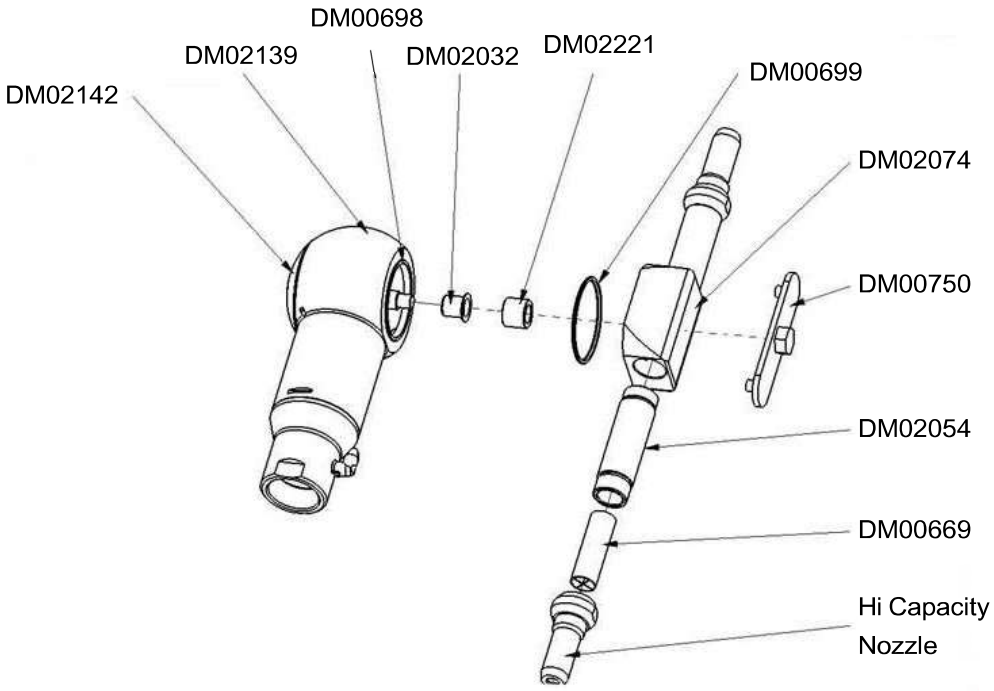

Figure 16: Hi-Capacity Orbitor

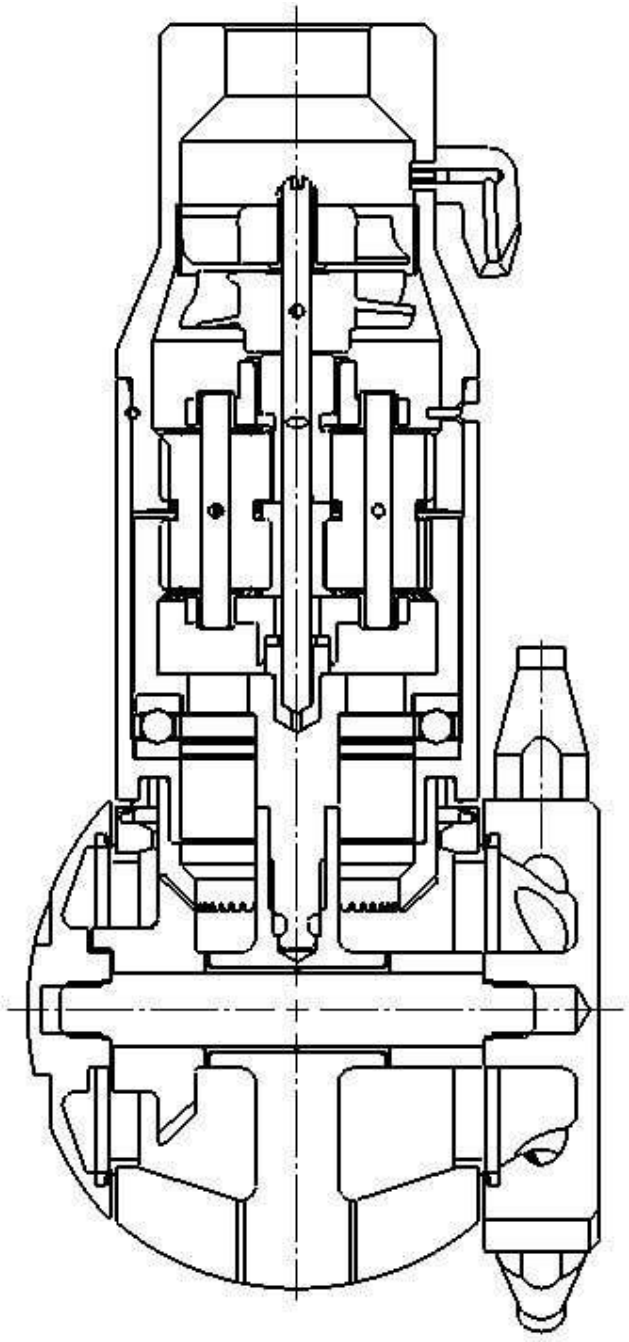

Figure 17: Section view of the Orbitor

Parts List (see Figure 18)

Part No.	Quantity	Description
DM00685	1	OB/3009 - Washer support (coated)
DM00686	1	OB/3010 - Clip spring
DM00688	1	OB/3012/2 - Thrust bearing cage
DM00693	1	OB/3020 - Spider bushing
DM00695	1	OB/3022 - Stator bushing
DM00696	1	OB/3023 - Cartridge bushing
DM00697	4	Bushing
DM00698	3	Ceramic seal insert
DM00699	3	Seal
DM00702	3	Hollow set screw, M4x8, dog point
DM00703	18	OB/3036 Ball, 7 mm dia., (Hardened)
DM00709	1	Pin, 3.0 mm dia x 18.0 mm long
DM00719	1	OB/ASSY2 - Sungear/Turbine shaft assembly
DM00721	1	OB/3001A - Planet gear
DM00722	1	OB/3001B - Planet gear 1/2
DM00736	2	OB/3008 - Planet shaft
DM02032	2	Nozzle head bushing
DM02135	2	Thrust bearing race (electro-polished)
DM02139	1	Orbitor (H) Main body (electro-polished)
DM02141	1	Nozzle head, 4-way, Orbitor (H)
DM02142	1	Rear plate Orbitor (H)
DM02143	1	Blind shaft, Orbitor (H)
DM02144	1	Cartridge, Orbitor (H)
DM02145	1	Spider, Orbitor (H)
DM02147	1	Nozzle head bevel gear, 45T
DM02221	1	Spacer for blind shaft
DM02923	1	Body shell, Orbitor (H) (includes entry pipe bevel gear, 45T E-P)

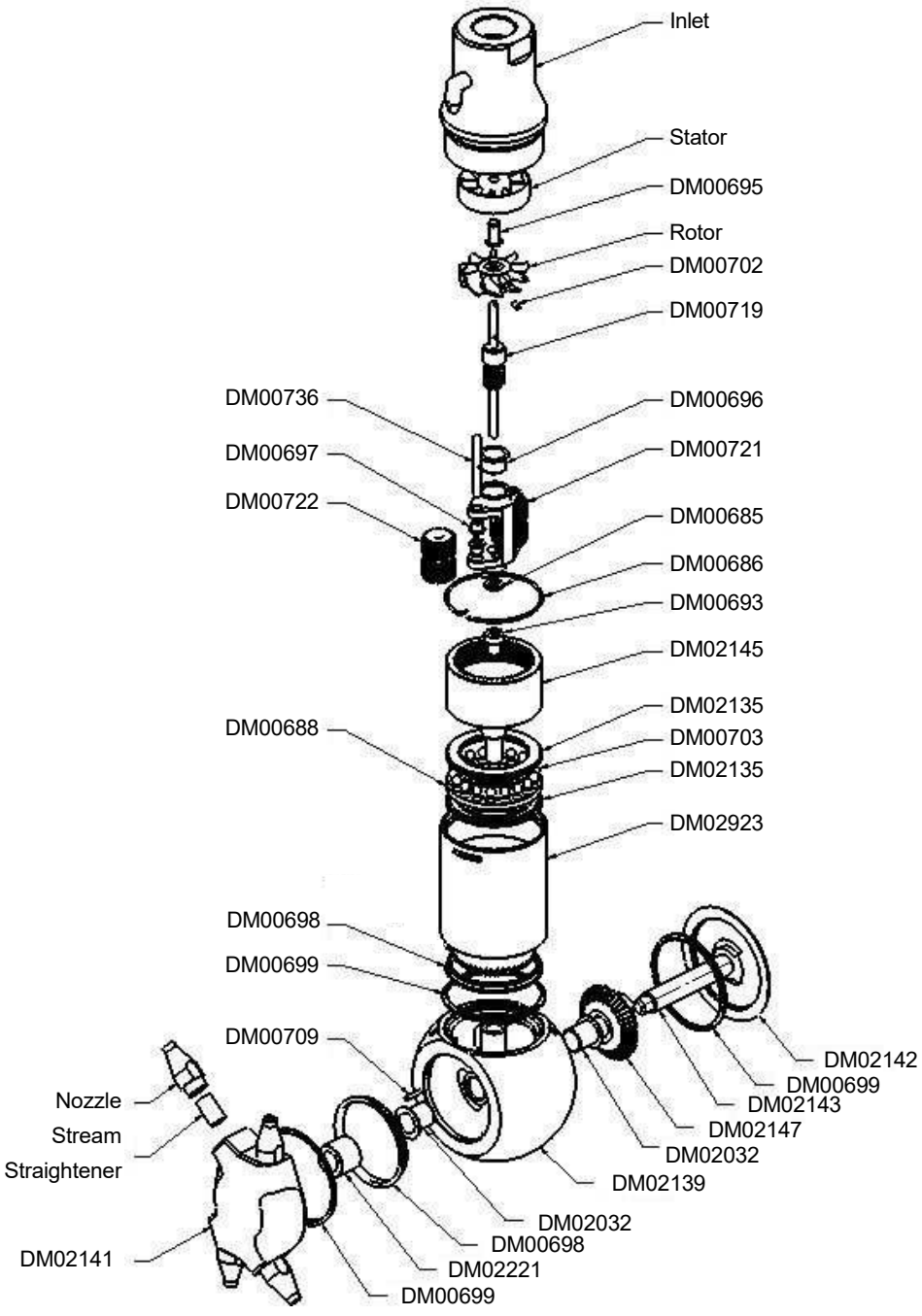

Figure 18: Exploded view of the Orbitor

Interchangeable Parts

Part No.	Description
Rotors	
DM02237	5° Positive
DM02137	20° Negative
DM02172	Full Rotor
DM02319	Flat Rotor
Stators	
DM02136	2 mm Cut Back
DM02173	4 Vane
DM02234	Full Stator
Nozzles x4	
DM02169	4.2 mm Diameter
DM02233	5.0 mm Diameter
DM02236	6.0 mm Diameter
DM01694	7.0 mm Diameter
DM02148	8.0 mm Diameter
Inlet Casing	
DM02227	1” NPT Female
DM02228	1” BSP Female
DM02160	1.5” NPT Female
DM02171	1.5” BSP Female
Hi Capacity Components – Refer to Figure 16	
DM02053	10.0 mm Diameter Nozzle
DM01692	12.5 mm Diameter Nozzle
DM00669	Stream Straightener
DM02054	Nozzle Extension Tube
DM02074	Nozzle head, 2-way

Service Tool Kit

Part No. 153203

Each kit includes:

Part No.	Qty	Descripction
DM00748	1	Spider removal tool
DM00749	1	Side plate tool, set of 2
DM00750	1	Nozzle head tool

Each part number in the tool kit can be purchased separately.

Rebuild Kits

Three rebuild kits are available depending on the level of service your Orbitor has experienced. A tabular list of the items supplied in each kit is shown on the following page. This list is also shown graphically on the subsequent page in Fig 19.

Kit A, Part No. 178121
The basic kit that provides replacement of the seals.

Kit B, Part No. 178122
The standard kit that provides replacement of the seals and the bushings.

Kit C, Part No. 153417
The complete kit that provides replacement of the seals, bushings, and ceramic seal inserts.

Orbitor Rebuild Kit Contents

Part No.	Qty	Description	Material	Kit A	Kit B	Kit C
DM00686	1	Spring Clip	17-7 PH Stainless Steel (Werkstoff 1.4568)	✓	✓	✓
DM00693	1	Spider bushing	PTFE + 10% Carbon Fill		✓	✓
DM00695	1	Stator bushing	PTFE + 10% Carbon Fill		✓	✓
DM00696	1	Cartridge bushing	PTFE + 10% Carbon Fill		✓	✓
DM00697	4	Bushing	PTFE + 10% Carbon Fill		✓	✓
DM00698	3	Seal insert	Stainless Steel Tech 28 Ceramic Coated			✓
DM00699	3	Seal	ACoflon 212CF (PTFE + 10% Carbon-Fiber)	✓	✓	✓
DM00709	1	Pin, 3.0 mm dia x 18.0 mm long	316L Stainless Steel	✓	✓	✓
DM02032	2	Nozzle head bushing	PTFE + 10% Carbon Fill		✓	✓
DM02922	1	Gear bushing	PTFE + 10% Carbon Fill		✓	✓

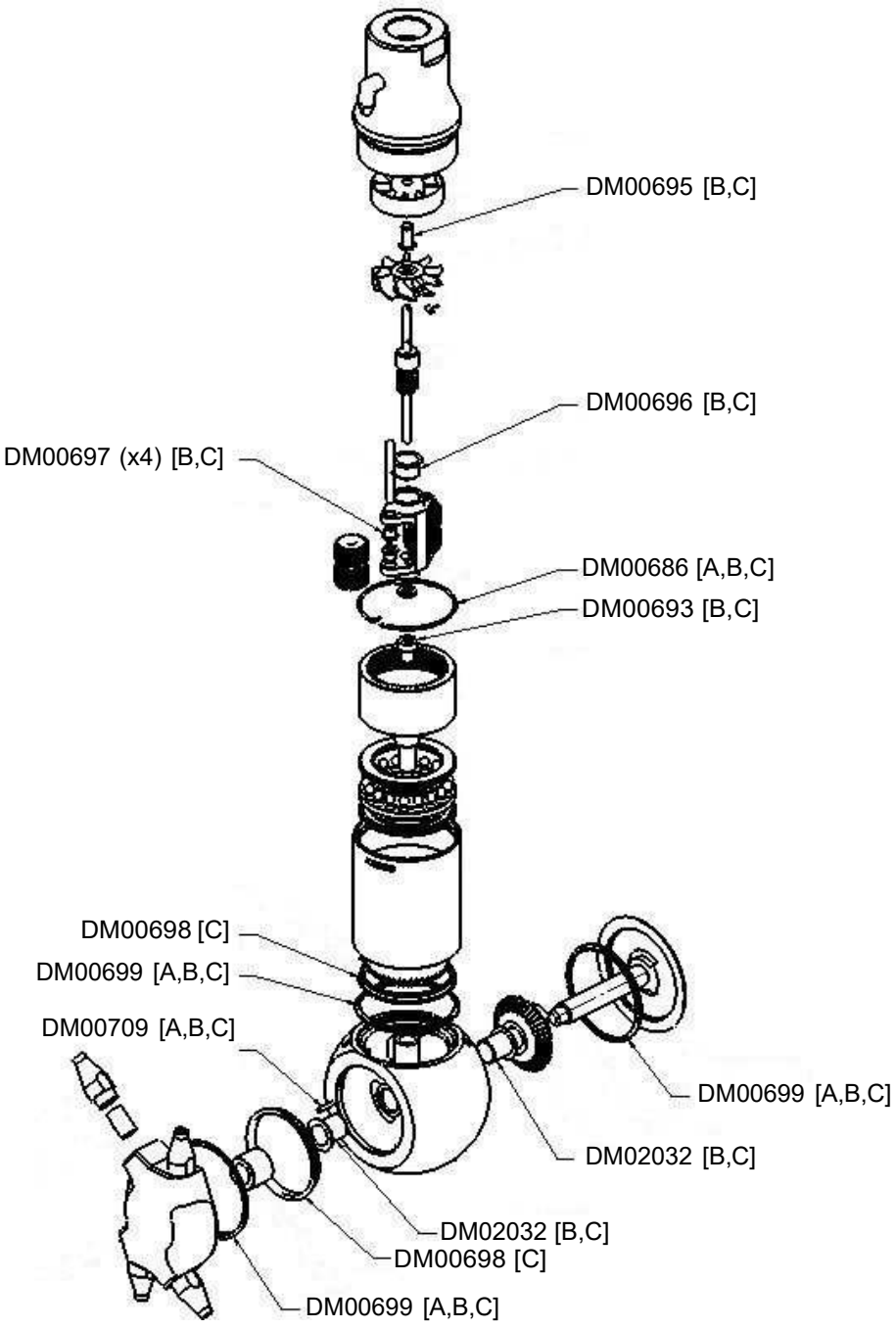

Figure 19: Rebuild kit components. Letters in brackets are the kits in which that component is included.