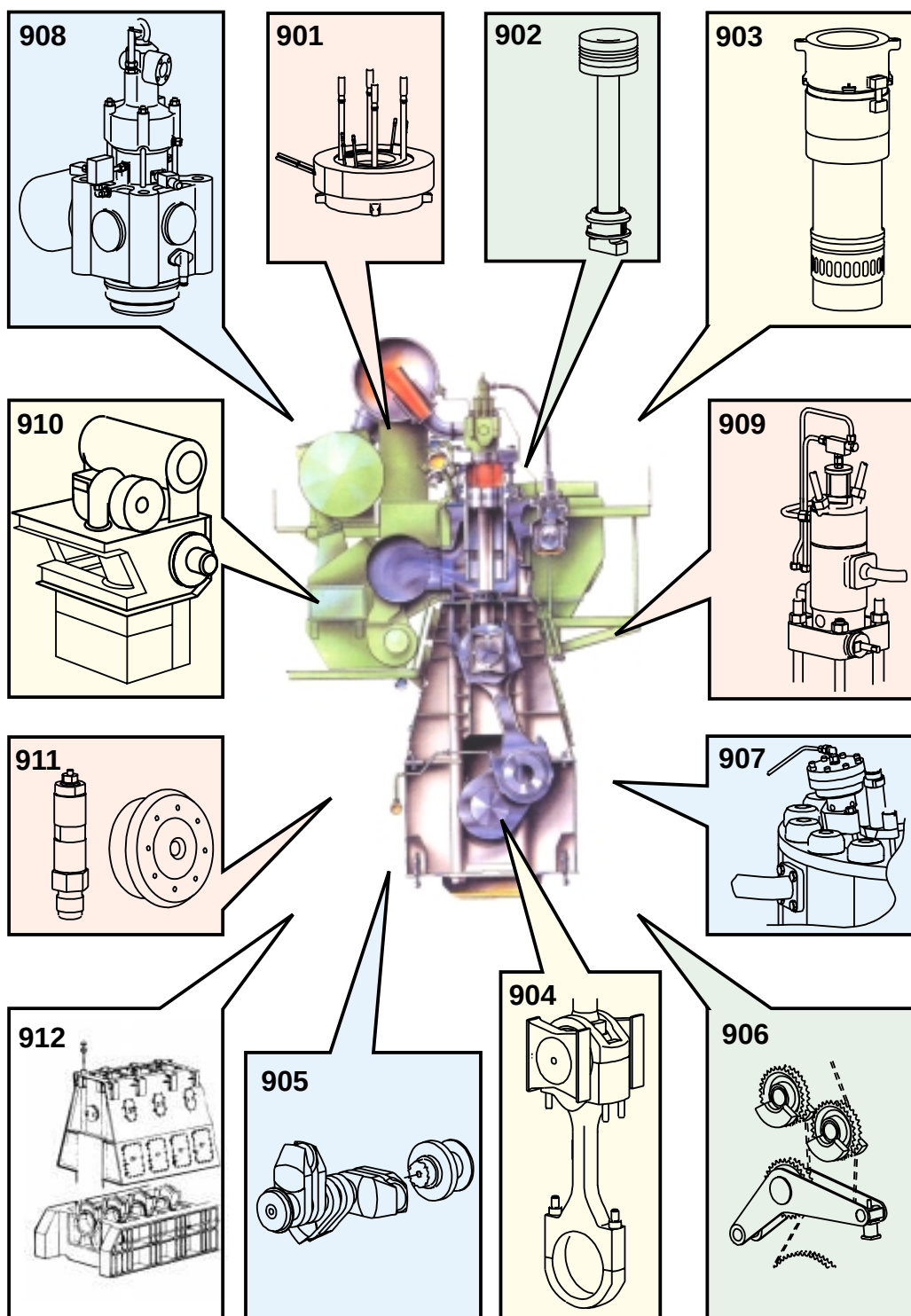


Index for Components Description

(Volume III)



Instructions for Main Engine

Type S70MC

This book forms part of a set of books consisting of three volumes entitled:

Vol. I OPERATION

Vol. II MAINTENANCE

Vol. III COMPONENTS, DESCRIPTIONS

The purpose of these books is to provide general guidance on operation and maintenance and to describe the constructional features of a standard version of an HSD ENGINE Co., Ltd. main diesel engine. Deviations may be found in a specific plant. In addition, the books can be used for reference purposes, for instance in correspondence and when ordering spare parts.

It is essential that the following data is stated in spare parts orders as it is used by us to ensure the supply of the correct parts for the individual engines:

1. Name of vessel
2. Engine No. built by
3. Plate No.
4. Part No.
5. Quantity required (and description)

Example: M/S Nybo – 7730 B&W – P90201-0036 – 059
 10 off (piston ring)

Furthermore, to ensure optimum efficiency, reliability and lifetime of the engine and its components, only original spare parts should be used.

The designation “D” used in texts and illustrations refers to the information given on the data sheets inserted in the respective books.

As reliable and economical operation of the diesel engines is conditional on the correct operation and maintenance, it is essential that the engine room personnel are fully acquainted with the contents of this book.

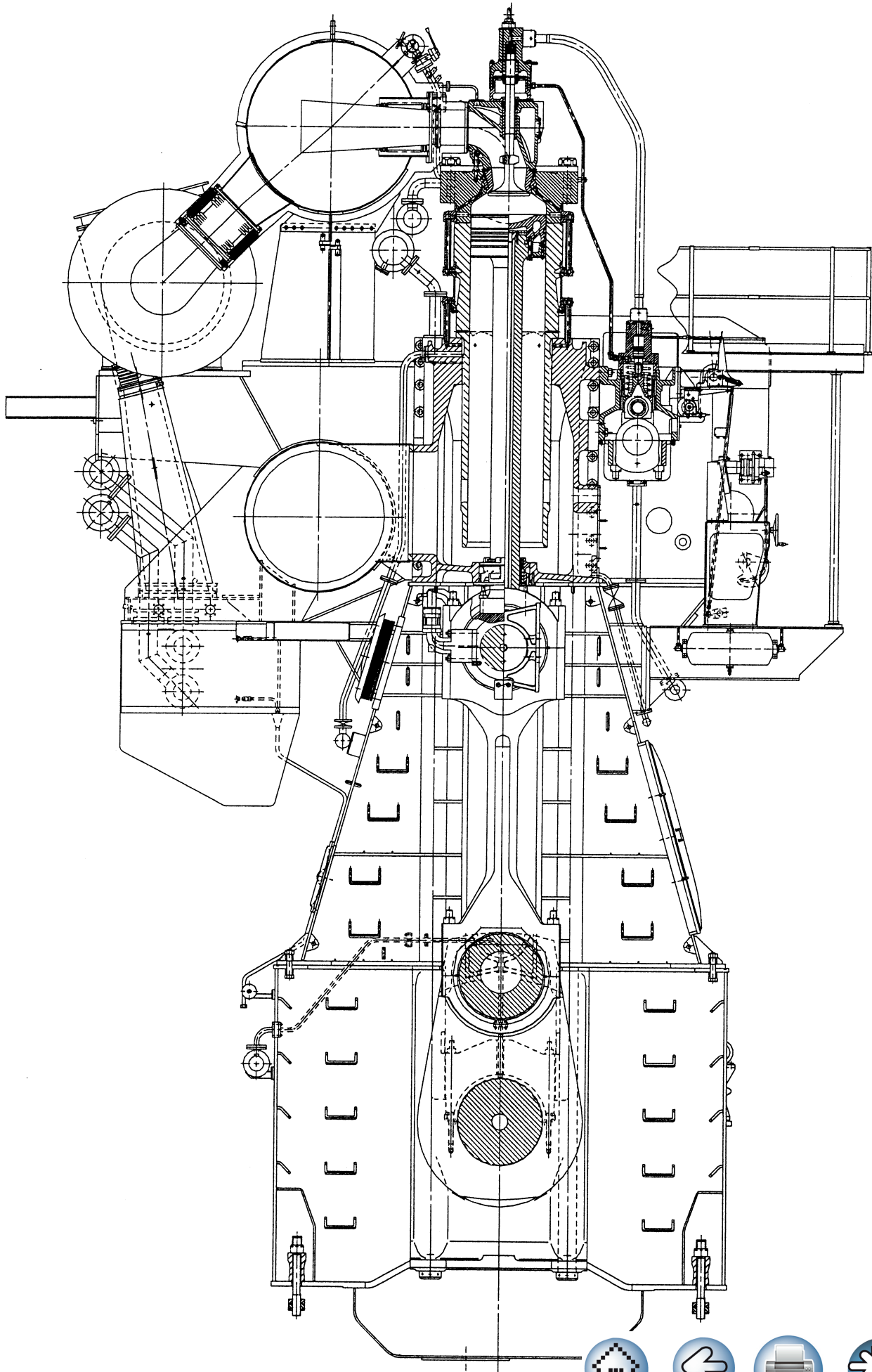
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General

The cylinder cover is made of steel and has a central bore for the exhaust valve, which is attached by means of four studs. The cover furthermore has bores for the fuel valves, which are resiliently mounted with disc spring housings with disc springs under the nuts of the studs. Other bores have been provided for starting valve, starting air inlet, safety valve and indicator cock.

A cooling jacket is mounted on the lower part of the cylinder cover, whereby a cooling water space is formed.

Another cooling water space is formed around the exhaust valve seat, when the exhaust valve is installed. These two spaces communicate through a large number of oblique/radial cooling bores in the cover.

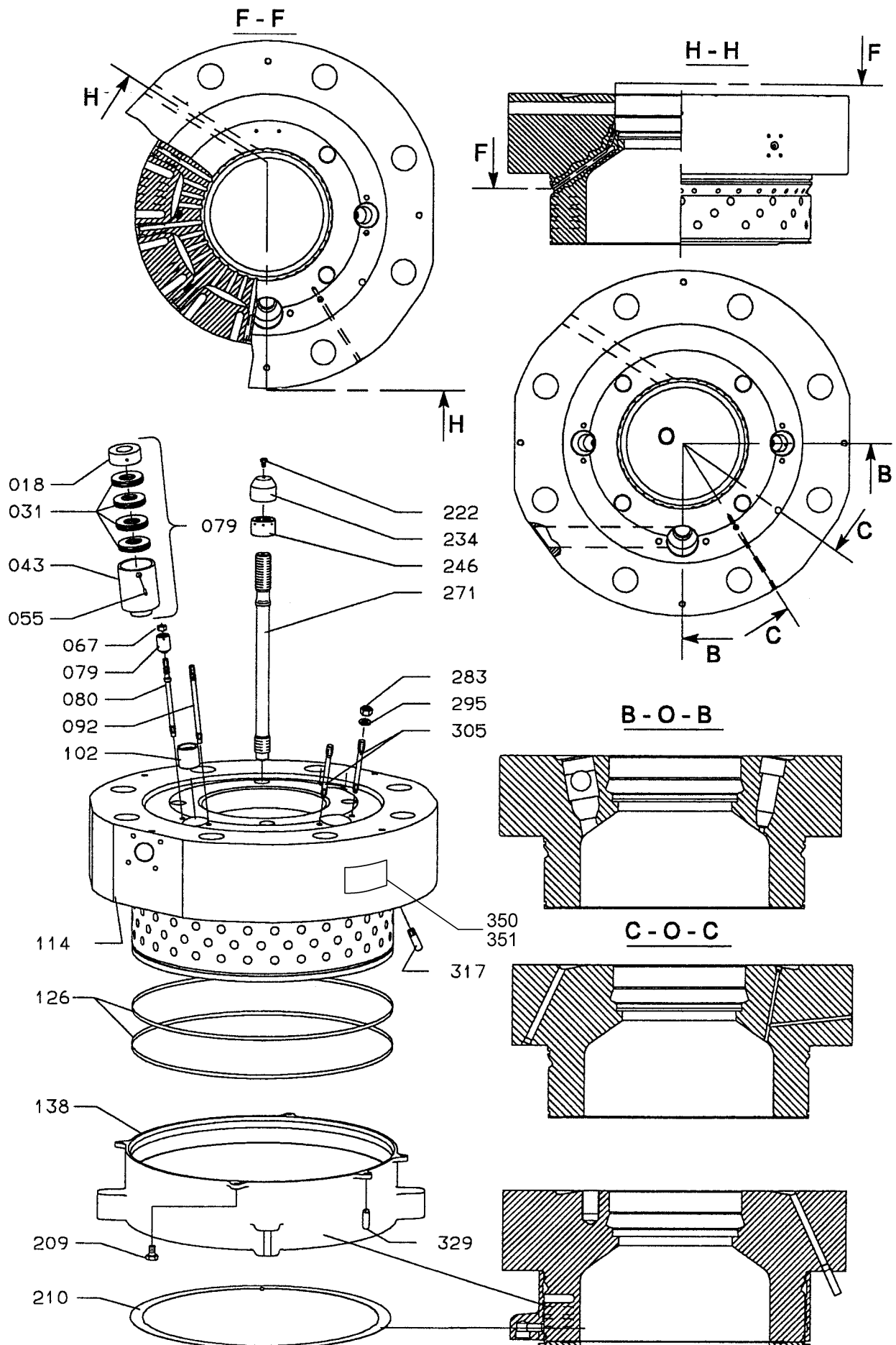
The water is supplied from the cooling jacket surrounding the cylinder liner and passes through water transitions to the cooling jacket surrounding the cylinder cover, and further on, through the cooling bores, to the space around the exhaust valve seat.

From here the water leaves the cover through two separate bores:

- through the one bore, the water is discharged to the main cooling water outlet pipe,
- through the other bore, the water is passed through the exhaust valve housing to the main cooling water outlet pipe.

Sealing between the cylinder cover and cylinder liner is obtained by means of a sealing ring, made of mild steel.





Item No.	Part Description	Item No.	Part Description
018	Disc		
031	Disc spring		
043	Spring housing		
055	Pin		
067	Nut		
079	Spring housing, complete		
080	Stud with guide face for fuel valve		
092	Stud for fuel valve		
102	Pipe for fuel valve		
114	Cylinder cover		
126	O-ring		
138	Cooling jacket		
209	Screw		
210	Gasket		
222	Screw		
234	Cover		
246	Nut		
271	Stud for exhaust valve		
283	Nut		
295	Washer		
305	Stud for starting valve		
317	Pipe branch		
329	Pin		
350	Caution plate		
351	Hex. screw		



Piston and piston rod

Plate 90201

The piston consists of two main parts:

- Piston Crown
- Piston Skirt

The piston crown is tightened to the upper end of the piston rod by means of screws. The screws are locked with locking wire.

The piston skirt is tightened to the piston crown by means of flanged screws. The screws are locked with locking wire.

The piston crown is further provided with chromium-plated grooves for four piston rings. The two uppermost may have increased height.

Piston ring No. 1 is controlled-leakage design (CPR)

CPR and piston rings Nos. 2, 3, 4 rings may have been coated on the external surface. Handle with care, as impact may cause the coating to crack and peel off. The other piston rings have oblique cuts:

- piston ring No. 3 has right-hand cut,

and

- piston rings Nos. 2 and 4 have left-hand cuts.

At the top, the piston crown has a three(3) slots groove for the fitting of lifting tools.

The piston rod has a through-going bore for the cooling oil pipe, which is secured to the piston rod top by means of flanged screws. The flange screws are locked with locking wire.

Cooling oil is supplied through a telescopic pipe connection on the crosshead and passed through a bore in the piston rod foot and, through the cooling oil pipe in the

piston rod, to the piston crown.

The oil is passed on through a number of bores in the thrust part of the piston crown and to the space around the cooling oil pipe in the piston rod.

From the bore in the piston rod foot, the oil is led through the crosshead to a discharge spout and to a slotted pipe inside the engine frame as well as through a control device for checking the flow and temperature.

The piston rod foot rests on a face cut-out in the crosshead pin and is guided by a pipe in the crosshead.

A shim is inserted between the piston rod and the crosshead. The thickness of the shim is calculated for each engine, in order to match the actual engine layout.

The rod is fastened to the crosshead pin by means of four studs and nuts. The nuts are tightened by means of hydraulic tools.

Piston rod stuffing box

The bore for the piston rod in the bottom of the scavenge air box is fitted with a piston rod stuffing box, which is designed to prevent the lubricating oil in the crankcase from being drawn up into the scavenge air space.

The stuffing box also prevents scavenge air (in the scavenge air space) from leaking into the crankcase.

The stuffing box is mounted on a flange which is bolted to the bottom of the scavenge air space.

The stuffing box is removed together with the piston rod during piston inspection, but can also be dismantled for inspection in the crankcase while the piston remains mounted in the engine.

The stuffing box housing consists of two parts, which are bolted together.



The housing is provided with seven machined ring grooves:

- The uppermost groove is provided with a four-part scraper ring with oblique edges, which serves to prevent sludge from the scavenge box from being drawing down to the other rings.

Furthermore, an eight-part sealing ring is located below the scraper ring to prevent scavenge air from passing downwards along the piston rod.

The scraper ring and the sealing ring are guided by two cylindrical pins.

- The two next ring grooves are each provided with a four-part sealing ring and an eight-part sealing ring below. The rings are guided by two cylindrical pins.

- The four lowermost ring grooves are fitted with three-part scraper rings which scrape the lubricating oil off the piston rod.

From the three lowermost grooves, the oil is returned to the crankcase, through bores in the stuffing box housing.

Each of the three parts consists of a base ring with two machined grooves, each containing a pressed-in lamella, with a scraping edge facing the piston rod.

Through bores in the housing and a pipe, the uppermost scraper ring groove communicates with a control funnel on the outside of the engine.

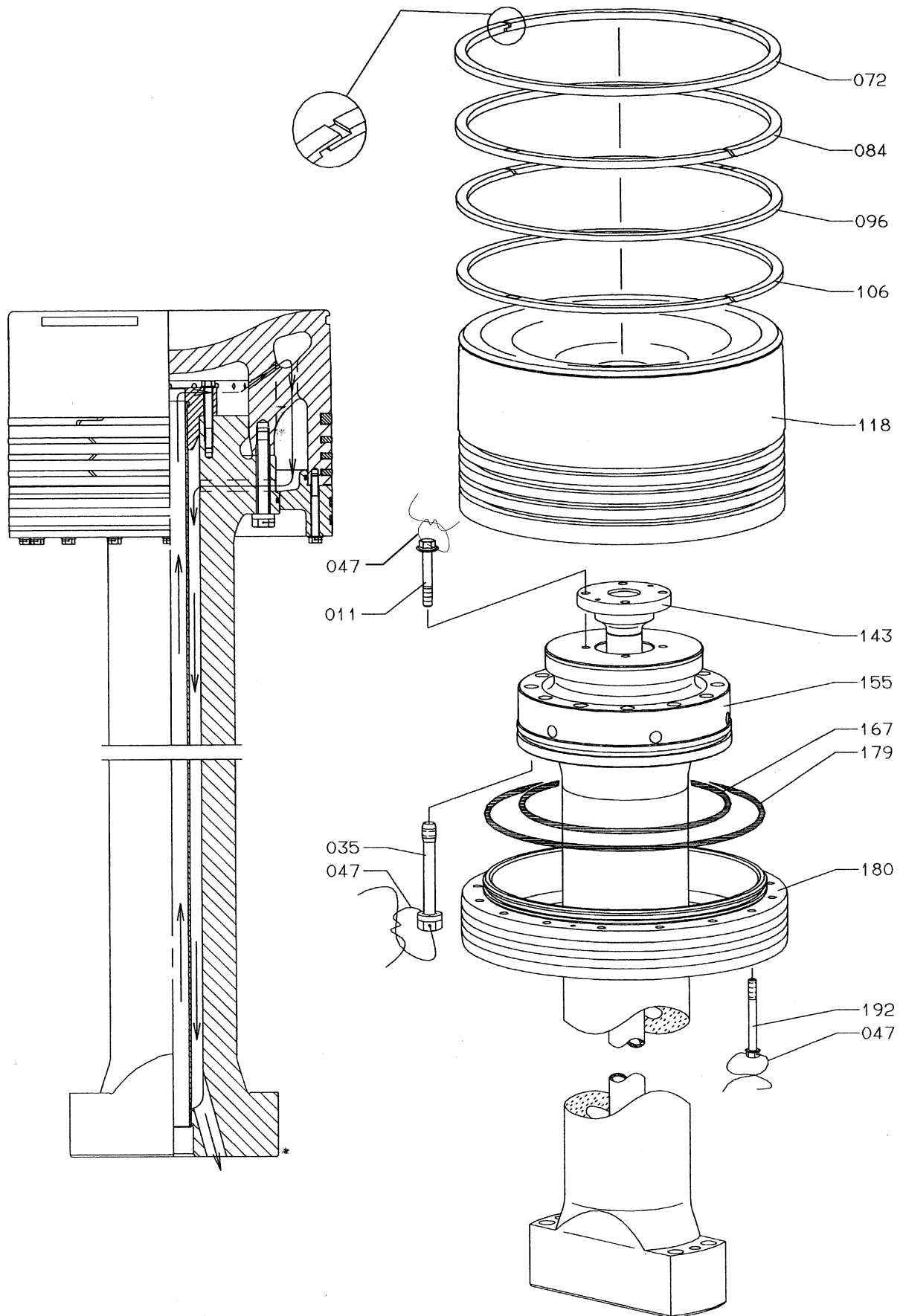
This funnel provides a means of checking that the sealing rings and scraper rings are functioning correctly:

- Blow-by of air indicates defective sealing rings, while excessive oil indicates defective scraper rings.

The parts are held in place round the piston rod by means of helical springs, which are located in machined grooves on the outside of the scraper rings and sealing rings.

Gaps at the end of the ring segments ensure that the rings will bear against the piston rod even in worn condition.

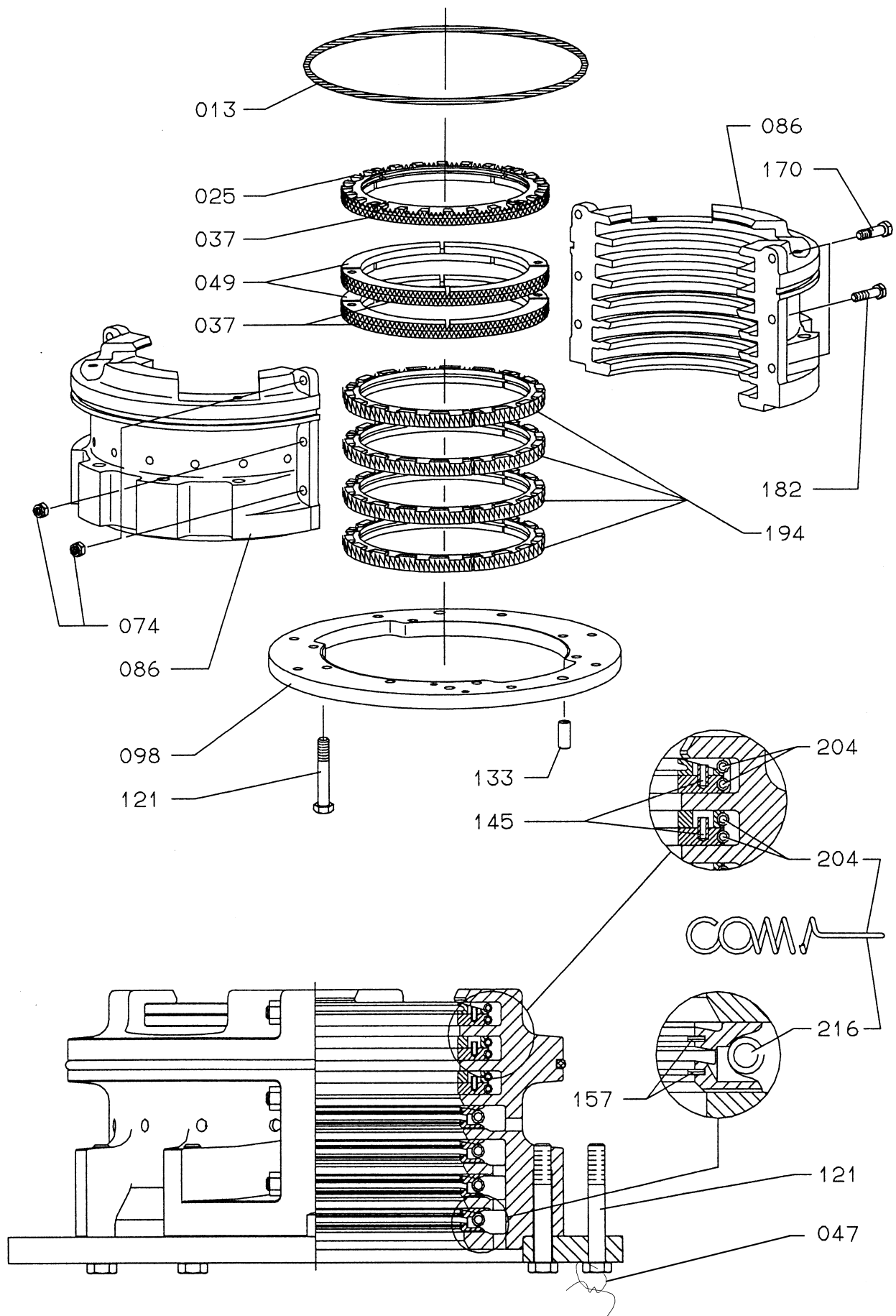




Item No.	Part Description
011	Screw
035	Screw
047	Locking wire
072	Piston ring No. 1
084	Piston ring No. 2
096	Piston ring No. 3
106	Piston ring No. 4
118	Piston crown
143	Cooling oil pipe
155	Piston rod
167	O-ring
179	O-ring
180	Piston skirt
192	Screw

Item No.	Part Description





Item No.	Part Description
013	O-ring
025	Top scraper ring
037	Pack sealing ring
047	Locking wire
049	Cover sealing ring
074	Nut
086	Stuffing box housing
098	Flange
121	Screw
133	Guide pin
145	Spring pin
157	Lamella for scraper ring
170	Screw
182	Fitted bolt
194	Scraper ring
204	Spring for item 025, 037 and 049
216	Spring for item 194

Item No.	Part Description



Cylinder Block

The cylinder section of the engine consists of a number of cylinder blocks, which are tightened together with the engine frame and the bedplate by means of through-going stay bolts. The cylinder blocks are tightened together in the vertical joints.

A central bore at the top of the cylinder block encloses the cylinder liner. Cooling water is supplied at the top of the cylinder block, where a cooling water space is formed due to the shape of the cylinder liner.

A central bore in the bottom of the cylinder block encloses the piston rod stuffing box.

On the exhaust side of the cylinder block there is a circular opening which connects the scavenge air space around the cylinder liner with the longitudinal scavenge air receiver of the engine.

Furthermore, there are inlet pipes for cooling and lubricating oil and cooling water. The cylinder block is provided with cleaning and inspection covers giving access to the scavenge air spaces.

Studs for fastening of the cylinder cover are mounted in the cylinder block. The studs are equipped with sealing rings to prevent the formation of rust on the threads.

Cylinder Liner

Above the cylinder block, the cylinder liner is cooled by means of a cooling jacket and cooling bores.

Rubber rings located in machined grooves in the cylinder liner ensure cooling water sealing.

The cooling water is led through water transitions from the cylinder block to the lower part of the cooling jacket.

The water continues through a number of cooling pipes, located in bores in the cylinder liner, to the upper part of the cooling

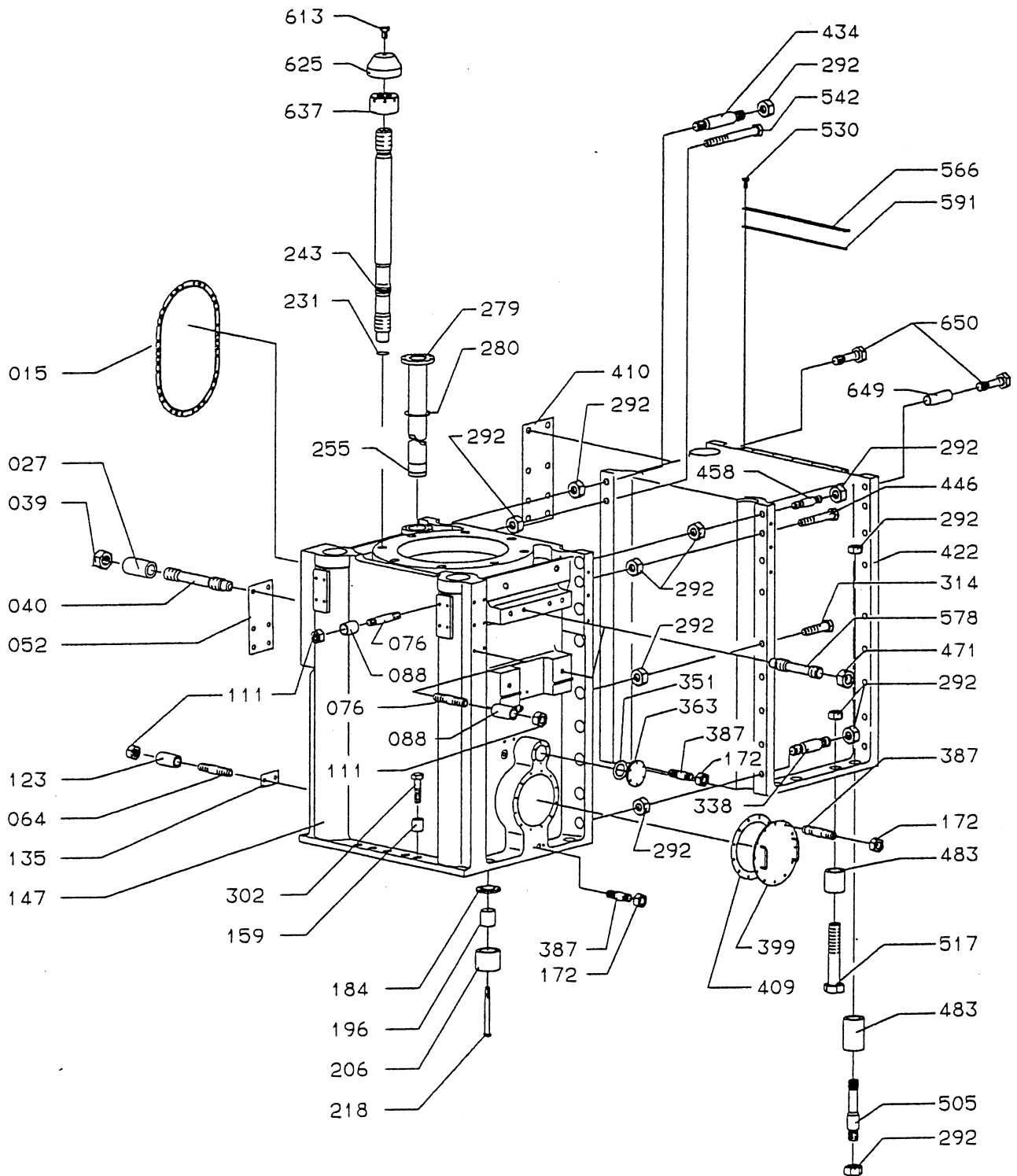
jacket, and from here through water transitions to the cooling jacket on the lower part of the cylinder cover.

The cylinder liner is tightened against the top of the cylinder block by the cylinder cover, so that it can expand freely downwards when heated during the running of the engine. Sealing against leakage of cooling water and scavenge air is obtained by means of two silicone rubber rings located in machined grooves in the guide of the cylinder liner, – one for cooling water and one for scavenge air. A bore is located between the sealing rings, enabling the effectiveness to be checked.

The part of the cylinder liner which is located in the scavenge air space of the cylinder block is provided with a number of scavenge air ports, which are uncovered by the piston when this is in its bottom position. The scavenge air ports are bored at an oblique angle to the axis of the cylinder liner so as to give the scavenge air a rotary movement in the cylinder.

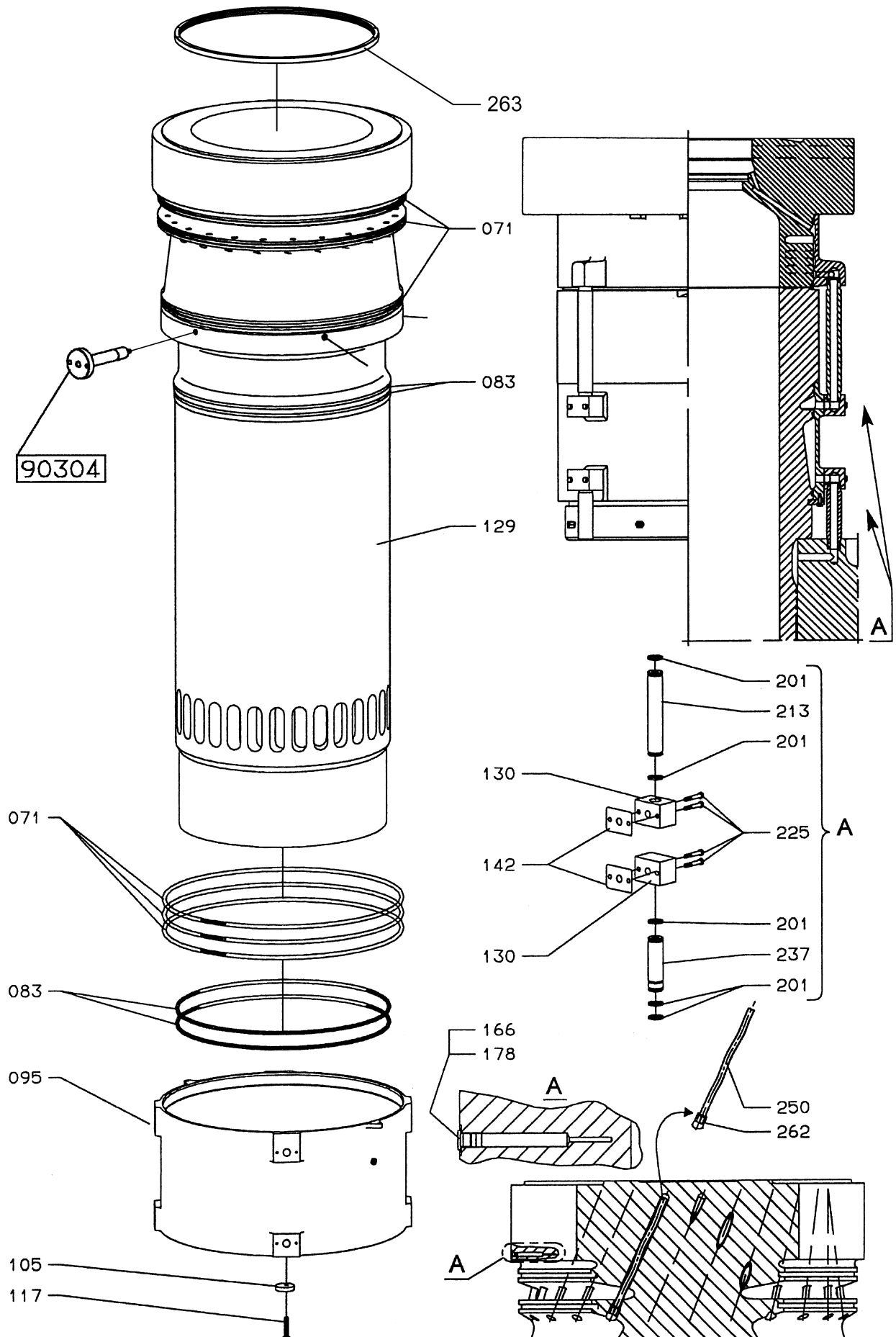
In the free part of the cylinder liner, between the cooling jacket and the cylinder block, there are a number of bores with non-return valves for supply of lubricating oil to the cylinder. On the working surface of the cylinder the bores are connected to zigzagging lubricating grooves to ensure an even distribution of the oil.





Item No.	Part Description	Item No.	Part Description
015	Gasket	637	Nut
027	Distance pipe, L=80	649	Distance pipe, L=40
039	Nut	650	Screw
040	Stud		
052	Shim		
064	Stud		
076	Stud		
088	Distance pipe		
111	Nut		
123	Distance pipe, L=60		
135	Shim		
147	Cylinder frame		
159	Distance pipe, L=40		
172	Nut		
184	Distance pipe		
196	Bush		
206	Stuffing box housing		
218	Screw		
231	Sealing ring		
243	Stud for cylinder cover		
255	O-ring		
279	Protective pipe		
280	Gasket		
292	Nut		
302	Screw		
314	Screw		
338	Fitted stud		
351	Gasket		
363	Flange		
387	Stud		
399	Cleaning cover		
409	Gasket		
410	Shim		
422	Cylinder frame		
434	Fitted stud		
446	Screw		
458	Fitted stud		
471	Nut		
483	Distance pipe, L=140		
505	Fitted stud		
517	Screw		
530	Screw		
542	Screw		
566	Rail for sealing		
578	Stud		
591	Packing, rubber		
613	Screw		
625	Cover		

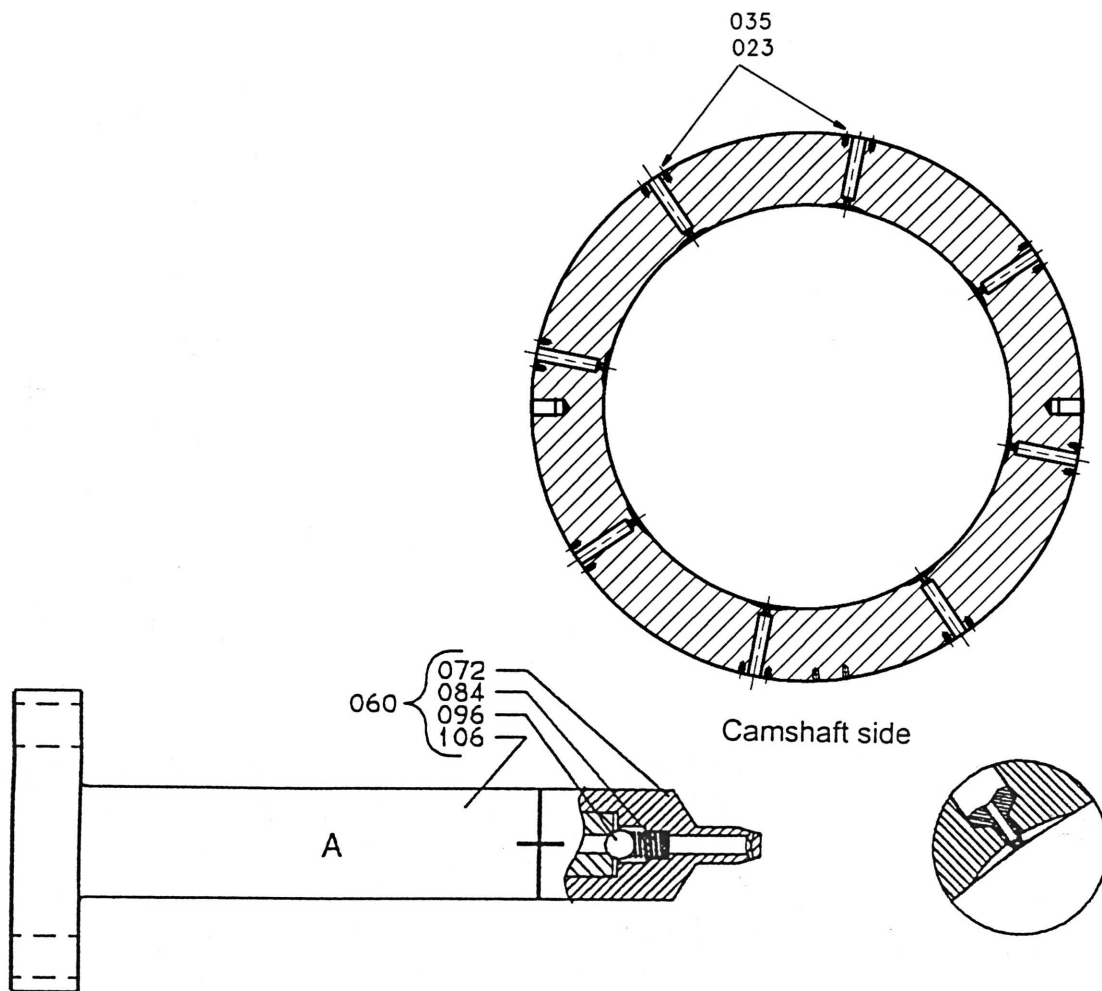




Item No.	Part Description
071	O-ring
083	O-ring
095	Cooling jacket
105	Clamp
117	Screw
129	Cylinder liner
130	Cooling water connection
142	Packing
166	Plug screw for thermo sensor hole
178	Gasket
201	O-ring
213	Pipe
225	Screw
237	Pipe
250	Pipe
262	Spring pin
263	Piston cleaning ring

Item No.	Part Description

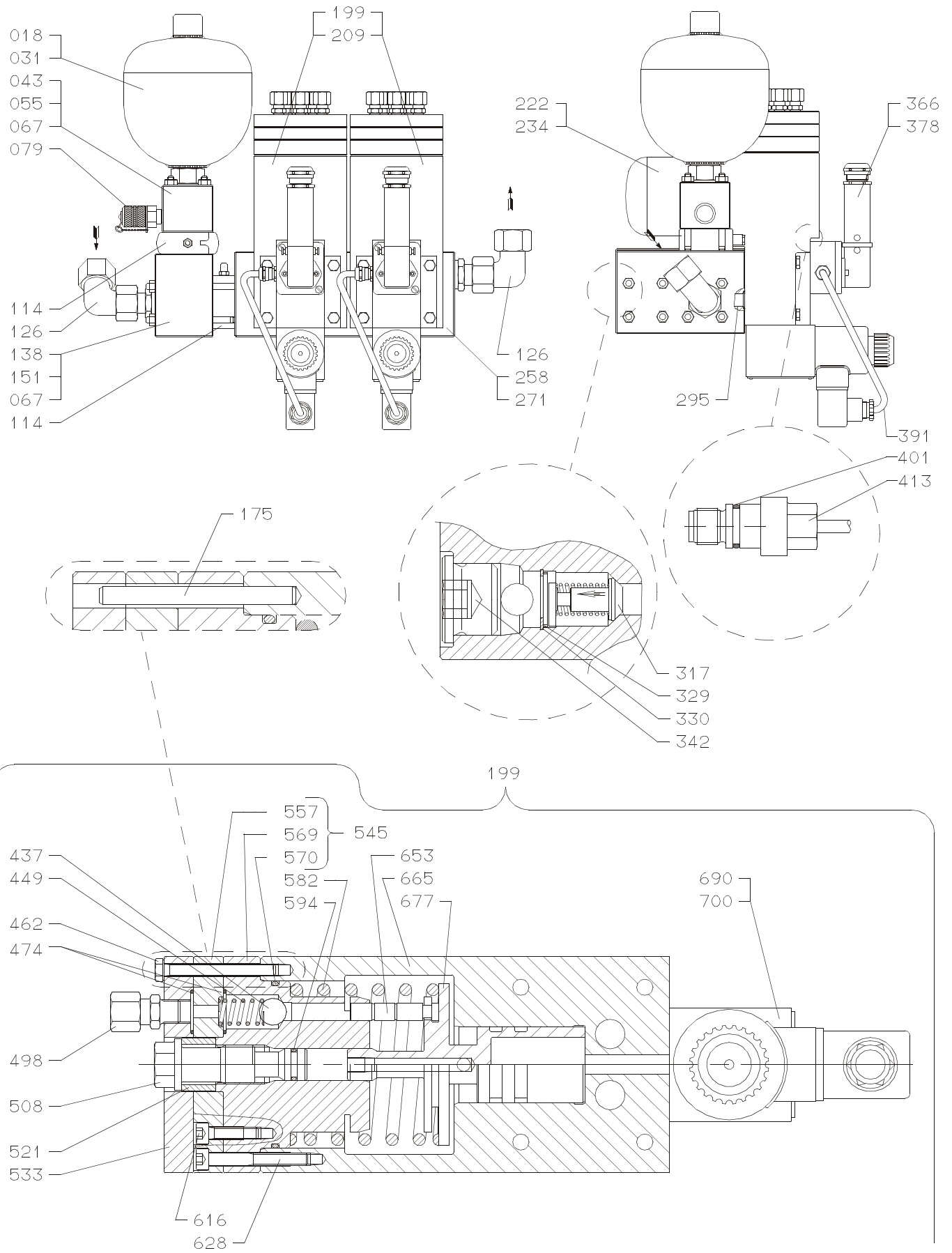




Item No.	Item Description
023	Stud
035	Nut
060	Non-return valve "A"
072	Valve housing
084	Spring
096	Steel ball
106	Thrust piece

Item No.	Item Description

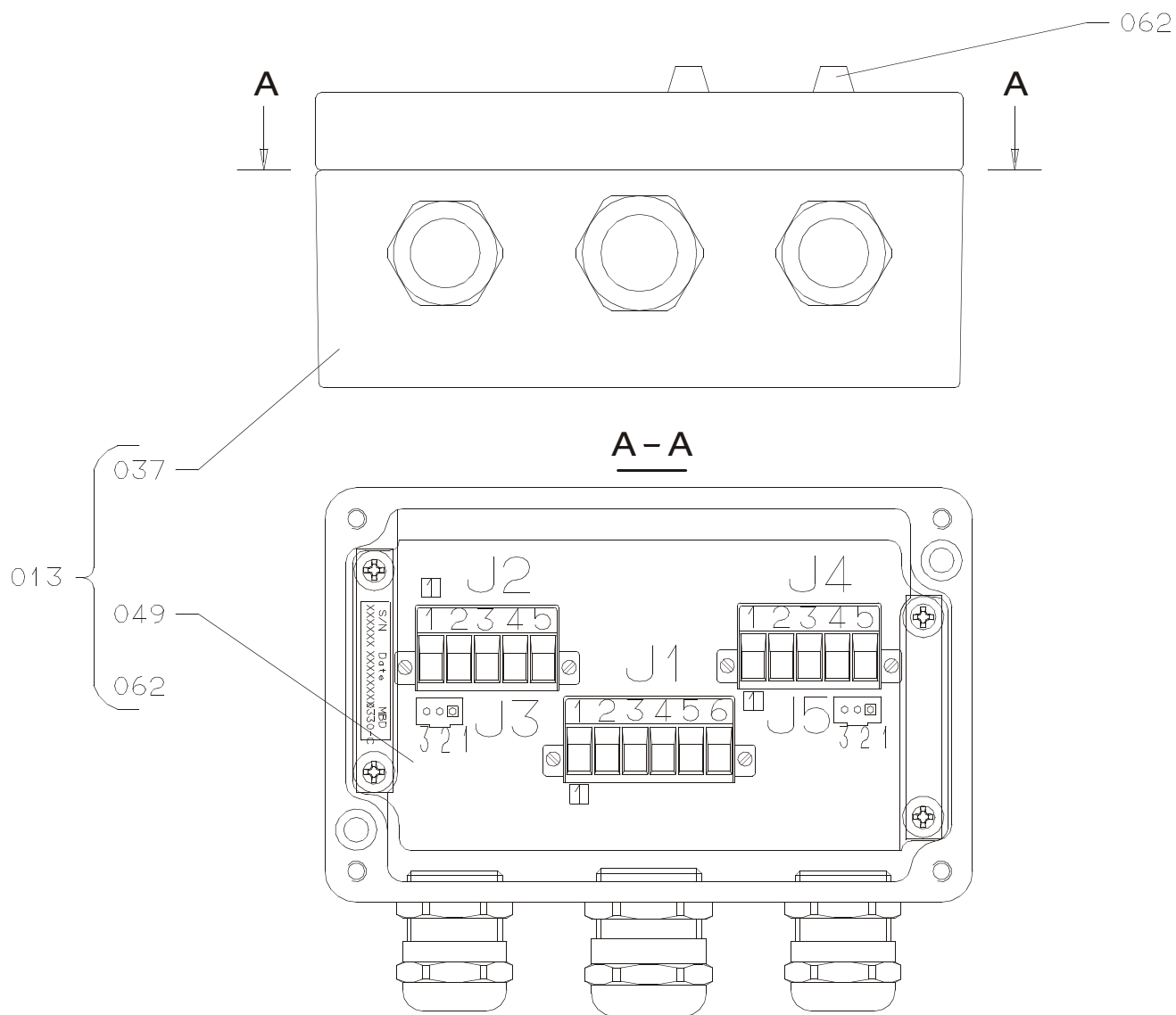




Item No.	Item Description
018	Accumulator membrane
031	Shim
043	Distributor block
055	Studs
067	Nut
079	Coupling, minimess
114	Ball valve
126	Coupling
138	Distributor block
151	Stud
175	Spring pin
199	Lubricator
209	Screw
222	Accumulator membrane
234	Shim
258	Distributor block
271	Plug screw
295	O-ring
317	Non-return valve
329	Disc
330	Circlip
342	Plug screw
366	Terminal box, complete
378	Screw
391	Cable
401	O-ring
413	Inductive sensor, complete
437	Steel ball
449	Spring
462	Screw
474	O-ring
498	Coupling
508	Adjustment screw
521	Spacer
533	Cover
545	Cylinder block
557	Cover
569	Cylinder block
570	O-ring
582	Spring
594	O-ring
616	Screw
628	Screw
653	Plunger
665	Cylinder housing
677	Actuator piston
690	Solenoid valve, complete

Item No.	Item Description
700	Screw





Item No.	Item Description
013	Intermediate box, complete
037	Electric enclosure with cables
049	Printed circuitboard
062	Light emitting diode

Item No.	Item Description



The crosshead is designed as a centre part with a bearing journal fitted at each end, on which the guide shoes are fitted floating.

The centre part of the crosshead is designed as a bearing journal which is housed in the crosshead bearing.

The crosshead bearing cap is provided with a cut-out for assembling the piston rod with the crosshead.

The crosshead bearing is equipped with bearing shells, which are lined with white metal. Furthermore, the lower shell has an overlayer coating.

See also Vol. I, OPERATION, Chapter 708.

The piston rod foot rests on the crosshead, and is guided by a guide ring in the crosshead.

A shim is inserted between the piston rod and the crosshead.

The thickness of the shim is calculated for each engine, in order to match the actual engine layout.

The piston rod is fastened to the crosshead by means of four studs and nuts. The nuts are tightened by means of hydraulic tools.

A bracket on the crosshead, fitted between the guide shoe and the crosshead bearing, supports the telescopic pipe which supplies lubricating and cooling oil to the crosshead, crankpin and piston.

The outlet pipe for piston cooling oil is fitted to the opposite end of the crosshead. The outlet pipe slides within a slotted pipe inside the engine frame, and from there the oil is led through a control device for each cylinder for the purpose of checking the temperature and flow before the oil is passed on to the lube oil tank.

The crosshead block is provided with bores for distributing the oil supplied through the telescopic pipe, partly as cooling oil for the piston, partly as lubricating oil for the crosshead bearing and guide shoes and –

through a bore in the connecting rod – for lubricating the crankpin bearing.

The two sliding faces of the guide shoes are lined with cast-on white metal.

A stop screw is fitted at the bottom of the central bores of the guide shoes.

The crosshead is guided by crosshead guides in the engine framebox and properly secured against displacement by guide strips fastened to the guide shoes.

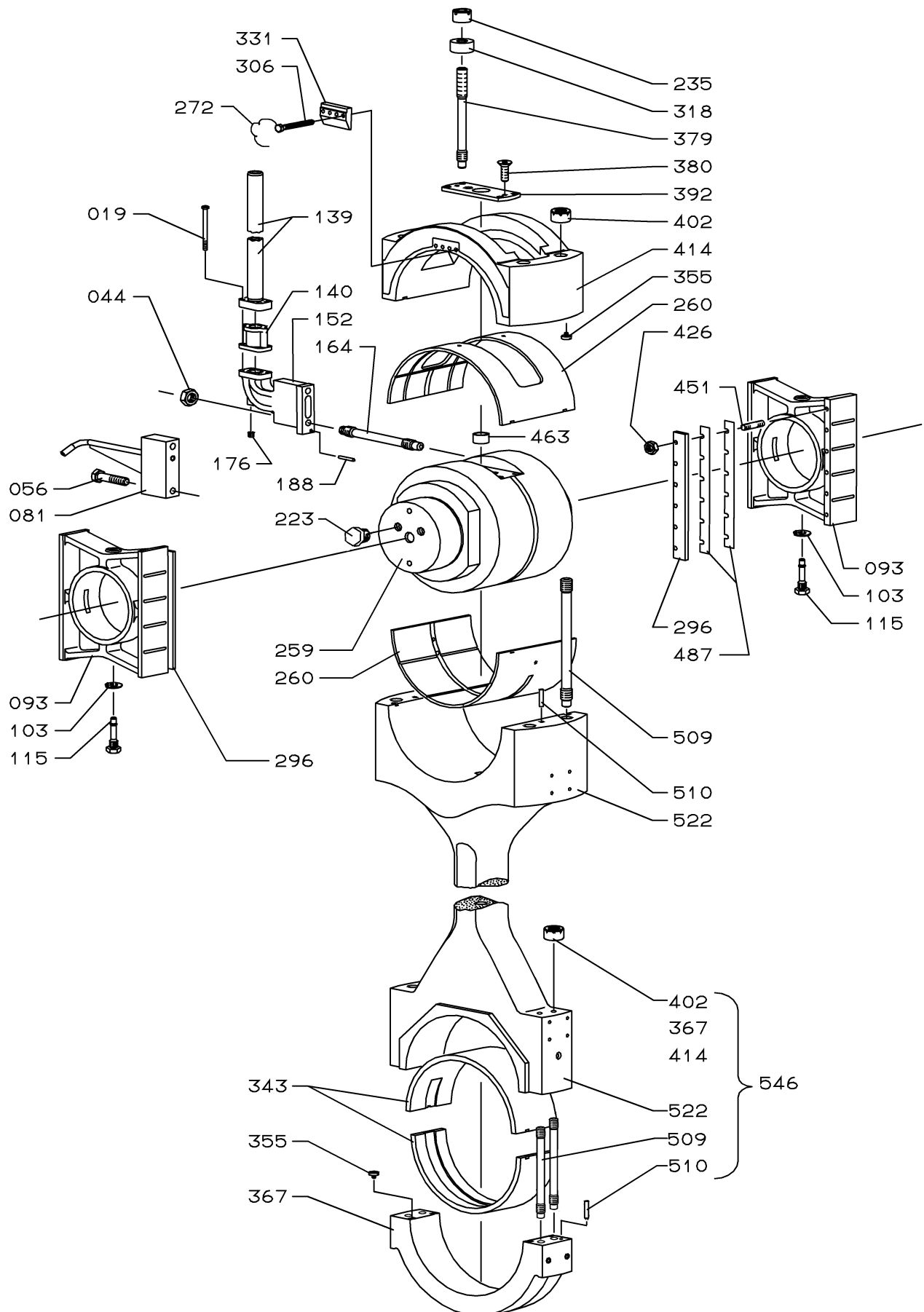
The crosshead bearing is assembled by means of four studs and nuts. The nuts are tightened by means of hydraulic tools.

The crankpin bearing is fitted with bearing shells lined with white metal and assembled by means of four studs and nuts. The nuts are tightened by means of hydraulic tools.

Both the crosshead bearing shells and the crankpin bearing shells are retained in position by means of screws fitted in the bearing housings.

Furthermore, the bearing assemblies are guided by guide pins.

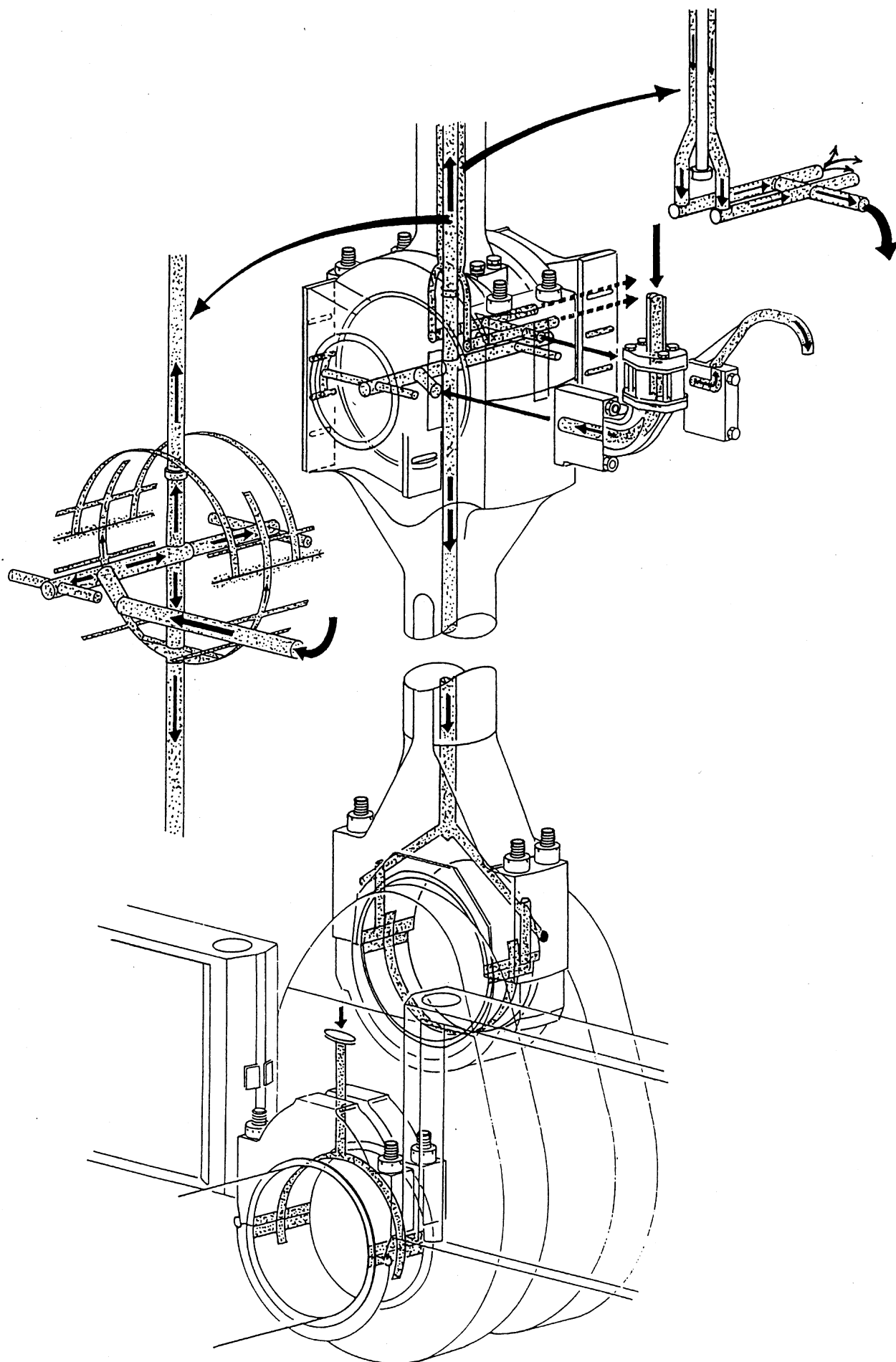




Item No.	Item Description
019	Screw
044	Nut
056	Screw
081	Outlet pipe
093	Guide shoe
103	Lock washer
115	Stop screw
139	Telescope pipe
140	Distance pipe
152	Bracket
164	Stud
176	Plug
188	Guide pin
223	Throttle plug
235	Nut
259	Crosshead
260	Crosshead bearing shell, complete
272	Locking wire
296	Guide strip
306	Screw
318	Washer. 30T
331	Thrust piece
343	Crankpin bearing shell, complete
355	Guide screw
367	Crankpin bearing cap
379	Stud
380	*) Screw, EN59S1030
392	*) Shim, 18T
402	Nut
414	Crosshead bearing cap
426	Self-locking Nut
451	Stud
463	Guide pipe
487	Shims, please state thickness 0.1, 0.15, 0.3, 0.5, 1mm
509	Stud
510	Guide pin
522	Connecting rod
546	Connecting rod, complete
	*) Please state thickness of shim

Item No.	Item Description





Crankshaft

Plate 90501

The crankshaft is semi-built, i.e. the parts are either shrunk or welded together.

The main bearings are lubricated via a main lubricating oil pipe that branches off to the individual bearings, whereas oil for lubricating the crankpin bearings is supplied from the crossheads through bores in the connecting rods.

At the aftmost end of the crankshaft a turning wheel and a thrust collar for the thrust bearing is fitted.

The chainwheel for the camshaft drive is fitted on the thrust collar.

At the foremost end of the crankshaft, a tuning wheel, a torsional vibration damper and a chain wheel drive for the 2nd order moment compensator may be installed.

Axial Vibration Damper

In order to counteract heavy axial vibrations, and any resultant adverse forces and vibrations, the engine is provided with an axial vibration damper on the foremost end of the crankshaft, *see Plate 91211*.

The damper consists of a 'piston' and a slit-type housing located in front of the foremost main bearing. The 'piston' is made as an integrated collar on the foremost main bearing journal, and the housing is mounted on the foremost main bearing support.

The axial movement is damped due to the 'restrictions' incorporated in the bores which interconnect the oil-filled chambers on the two sides of the 'piston'.

Lubricating oil is supplied to both sides of the 'piston' from the main system.

Thrust Bearing

Plate 90505

The thrust bearing serves the purpose of transmitting the axial thrust of the propeller through propeller shaft and intermediate shafts to the ship's hull.

The thrust bearing is incorporated in the aftermost part of the engine bedplate.

The crankshaft is provided with a thrust collar which transmits the thrust to a number of segments mounted in a thrust shoe on either side of the thrust collar.

The thrust shoes rest on surfaces in the thrust bearing housing and are held in place by means of two crossbars. The segments have white metal cast on the wearing faces against the thrust collar.

See also Vol. I, OPERATION, Chapter 708.

The thrust bearing is lubricated from the pressure lubrication system of the engine. The oil is supplied between the segments through spray pipes and spray nozzles.

The thrust bearing is provided with alarm, slow-down, and shut-down devices for low lube oil pressure and high segment temperature. *See also Vol. I, OPERATION, Chapter 701.*

Turning Gear

Plate 90510

The turning gear is attached to the engine bedplate and is driven by an electric motor incorporating a disc brake.

Through a belt drive and a planetary gearing, the motor drives a horizontal shaft equipped with a gear wheel which can be axially displaced by means of a hand wheel, so as to engage with the turning wheel of the engine.



The turning gear is provided with a safety arrangement consisting of a lever which must be lifted before the gear wheel of the turning gear can be made to engage with the turning wheel.

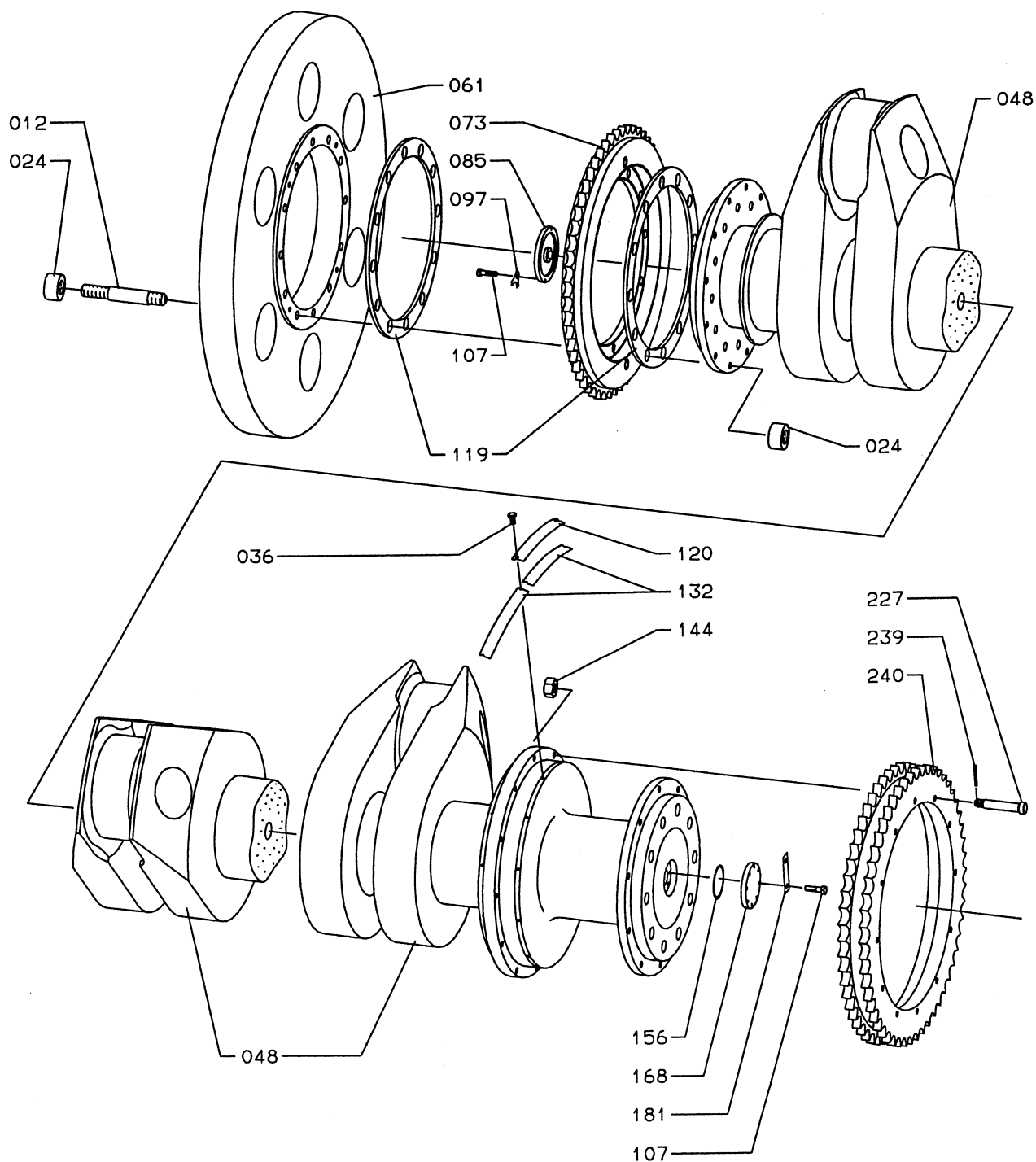
Immediately this lever is lifted away from the **disengaged** position, an interlock valve inserted in the starting air system of the engine is actuated. This interlock prevents starting air from being supplied to the engine as long as the turning gear is in the **engaged** position.

See also Vol. I, OPERATION, Chapter 703.

When the safety lever is in its bottom position, it prevents the gear wheel of the turning gear from engaging with the turning wheel.

Warning !	
Dismantling of working parts:	During any dismantling of working parts of the engine, the turning gear must be in the engaged position in order to prevent outside forces from turning the engine, thus causing injuries to personnel or damage to the machinery. <i>See Vol. II, MAINTENANCE, 'DATA' pages.</i>
Pressure testing of starting valves:	The turning gear must be in the disengaged position during pressure testing of starting valves, as a leaky valve may cause the engine to rotate, and damage the turning gear. <i>See Vol. I, OPERATION, Chapter 703.</i>

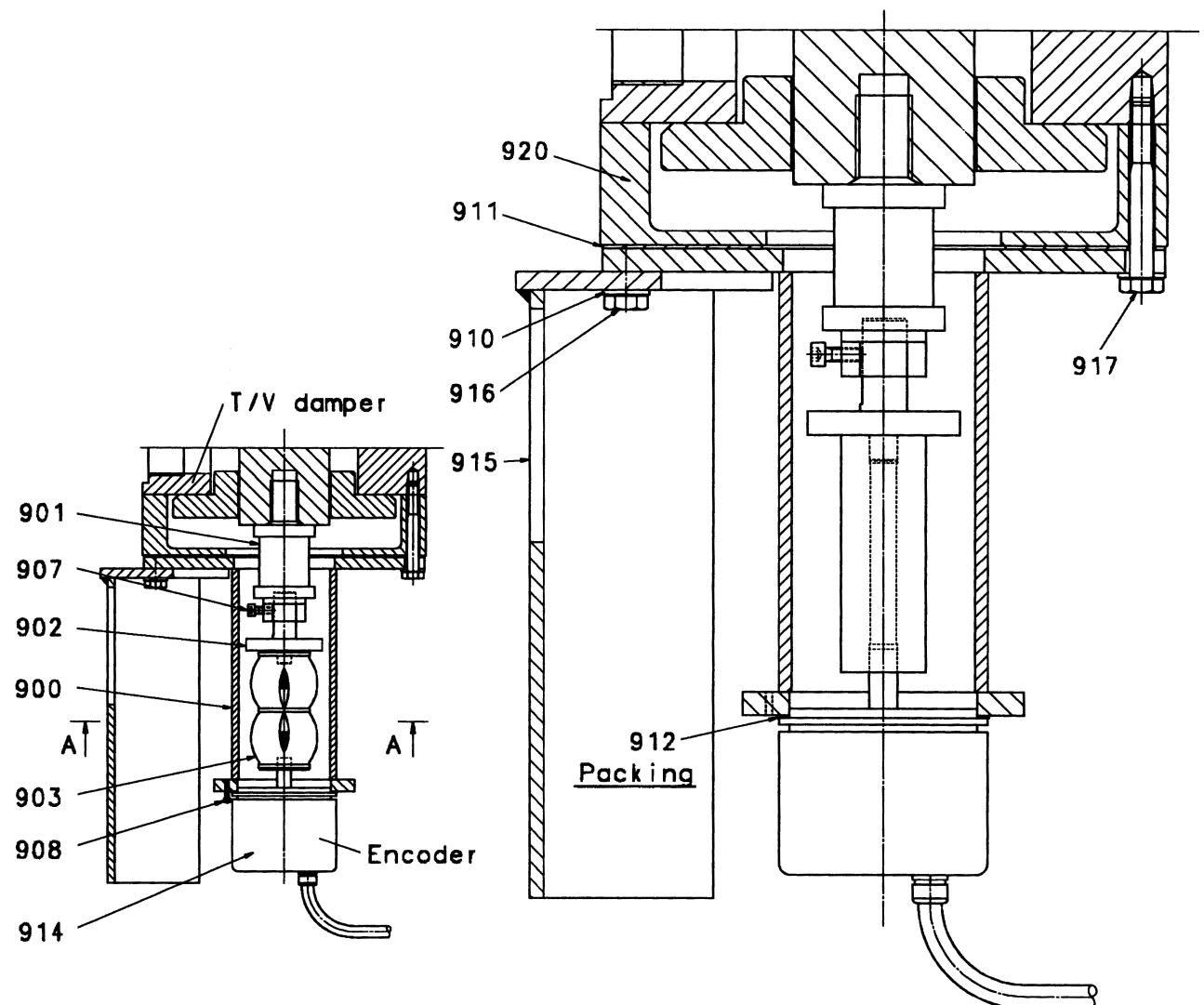
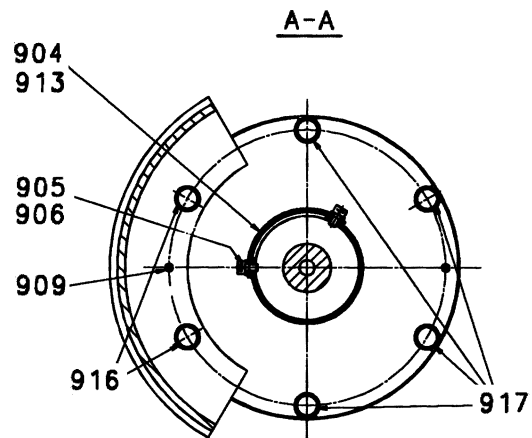




Item No.	Item Description
012	Stud
024	Nut for hydraulic tightening
036	Screw
048	Crankshaft
061	Geislinger damper
073	Chain wheel
085	Flange
097	Lock washer
107	Screw
119	Disc
120	Guard
132	Guard
144	Nut
156	Gasket
168	Cover
181	Locking plate
227	Fitted bolt
239	Split pin
240	Chain wheel

Item No.	Item Description

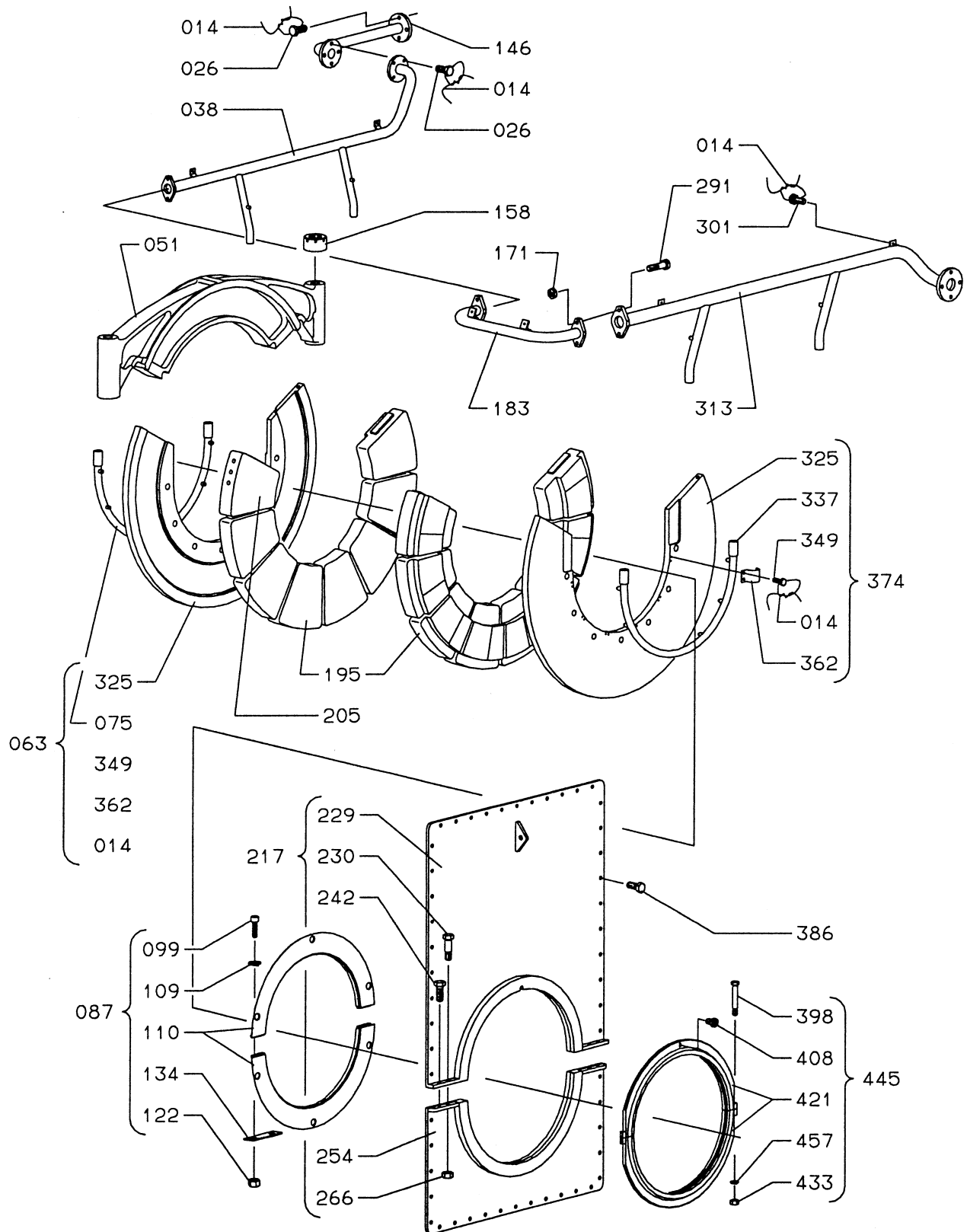




Item No.	Item Description
900	Housing
901	Shaft
902	Shaft
903	Coupling
904	Shield-Lower part
905	Hex. socket head cap screw
906	Spring locks
907	Hex. socket head cap screw
908	Hex. socket head cap screw
909	Spring pin
910	Washers
911	Packings
912	Packing-round
913	Packing material-plate
914	Angle encoder
915	Shield for encoder
916	Hex. screws
917	Hex. screws
920	Cover

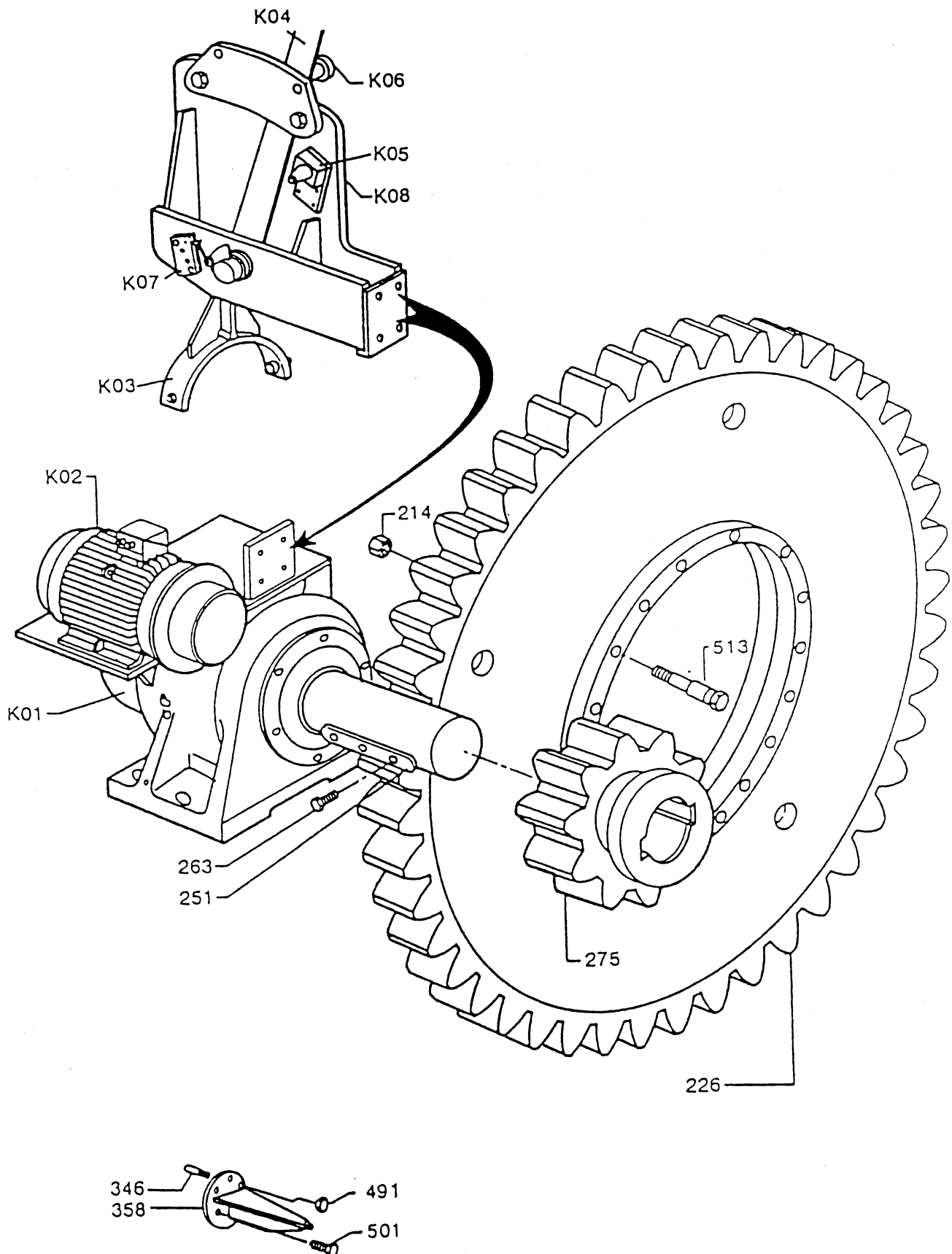
Item No.	Item Description





Item No.	Part Description	Item No.	Part Description
014	Locking wire		
026	Screw		
038	Lub. oil pipe		
051	Stopper		
063	Thrust shoe, complete		
075	Spray pipe		
087	Oil throw ring, complete		
099	Screw		
109	Spring washer		
110	Oil throw ring in 2/2		
122	Nut		
134	Locking plate		
146	Lub.oil pipe		
158	Nut		
171	Self locking nut		
183	Lub.oil pipe		
195	Segment without sensor pockets		
205	Segment with sensor pockets,		
217	Scraper ring housing, complete		
229	Scraper ring housing, upper part		
230	Fitted bolt		
242	Screw		
254	Scraper ring housing, lower part		
266	Nut		
291	Screw		
301	Screw		
313	Lub.oil pipe		
325	Thrust shoe		
337	Spray pipe		
349	Screw		
362	Pipe holder		
374	Thrust shoe, complete		
386	Screw		
398	Fitted bolt		
408	Guide screw		
421	Scraper ring in 2/2		
433	Nut		
445	Scraper ring, complete		
457	Spring washer		





Chain Drive

Plate 90600

The camshaft with cams for operating the fuel pumps, exhaust valves and indicator drives is driven from the crankshaft through a chain drive located at the aft end of the engine.

The chain drive consists of two identical roller chains running on chain wheels fitted on the crankshaft and the camshaft. The chains are kept tightened by means of a chain tightener placed in the chain casing between the crankshaft and an intermediate wheel.

The long free lengths of the chains are guided by rubber-clad guide bars. Lubricating oil is supplied through spray pipes fitted at the guide bars and chain wheels.

The starting air distributor is driven directly from the fore end of the camshaft.

Chain Tightener

The chain tightener consists of a chain wheel mounted on a forked arm in the chain casing. The forked arm is pivoted on a shaft pin and is equipped with a bearing for the chain wheel.

Throughout the chain-tightening procedure, the engine must be turned so that the chain is slack at the side where the chain tightener wheel is fitted.

The chain tightener is operated by a tightener bolt in the free end of the forked arm for the chain wheel. The tightener bolt extends through a pin that is free to turn in the chain casing.

For correct tightening of the chain drive, see *Volume II - MAINTENANCE*.

Camshaft

Plates 90611 – 90613

The camshaft is built together of a number of camshaft sections. The sections are assembled by means of flange couplings which are joined together with fitted bolts and nuts.

In addition to the coupling flanges, the camshaft sections have, for each cylinder:

- one cam for operation of the fuel pump
- one cam for the exhaust valve
- one cam for the indicator drive.

The cam for the indicator drive is in two parts, which are assembled by means of two fitted bolts.

The camshaft is carried in underslung bearing assemblies, which are fitted in the roller guide housings between the cam discs for fuel pump and exhaust valve. The bearings are of the thin-shell type, and the nuts and bearing bolts are designed for hydraulic tightening.

See also Vol. I, OPERATION, Chapter 708.



The coupling flanges and the fuel pump and exhaust valve cams are shrunk onto the shaft by heating. Dismantling of flanges is effected by forcing lubricating oil in between the shaft and the flange, *see Volume II*.

The same procedure is used for turning the fuel cam with a view to adjusting the fuel cam top lift and also when adjusting the camshaft in case the chains have become worn and elongated following retightening.

The camshaft rotation constantly follows that of the crankshaft. When the engine is reversed, the position of the rollers of the individual fuel pump roller guides is being shifted in relation to the respective cam discs, thus altering the fuel pump timing to suit the new direction of rotation.
See Chapter 909.

After the engine has been testrun, the camshaft parts and the cylinder frame will be provided with pin gauge marks, and the necessary pin gauges are delivered together with the engine, enabling the camshaft timing to be checked and readjusted if the parts have been dismantled.

The pin gauges are marked with:

- engine type
- engine number
- point of application
- the distance in mm between the measuring points.

Furthermore, the length of the pin gauges is indicated in the relevant section of the maintenance book (*Volume II*) for the plant.

Indicator Cock

Plate S906-09

Each cylinder cover is fitted with an indicator cock which, through a bore, communicates with the combustion chamber of the cylinder.

Indicator Drive

Plate 90612

An indicator cam is fitted for each cylinder. An indicator drive is arranged above this cam.

The indicator drive consists of a spring-loaded spindle which is able to move up and down, corresponding to the movement of the main piston within the engine cylinder. This motion is transmitted from the indicator cam through a roller at the bottom of the spindle. At the top, the spindle has an eye to which the indicator cord is fastened after the indicator has been mounted on the indicator cock.

During normal running of the engine, the spring-loaded spindle is lifted clear of the indicator cam, the handle of the spindle being in the locked position.

When diagrams are to be taken, the handle is turned 90° whereby the spindle enters a keyway which enables the spindle to be lowered onto the indicator cam. The keyway will guide the spindle during its up-and-down movement.

For use of the indicator, see Vol. I, OPERATION, Chapter 706.

Moment Compensators

2nd order moment

4, 5, and 6-cyl. engines have a 2nd order external moment which might excite vibration of the hull and deckhouse.

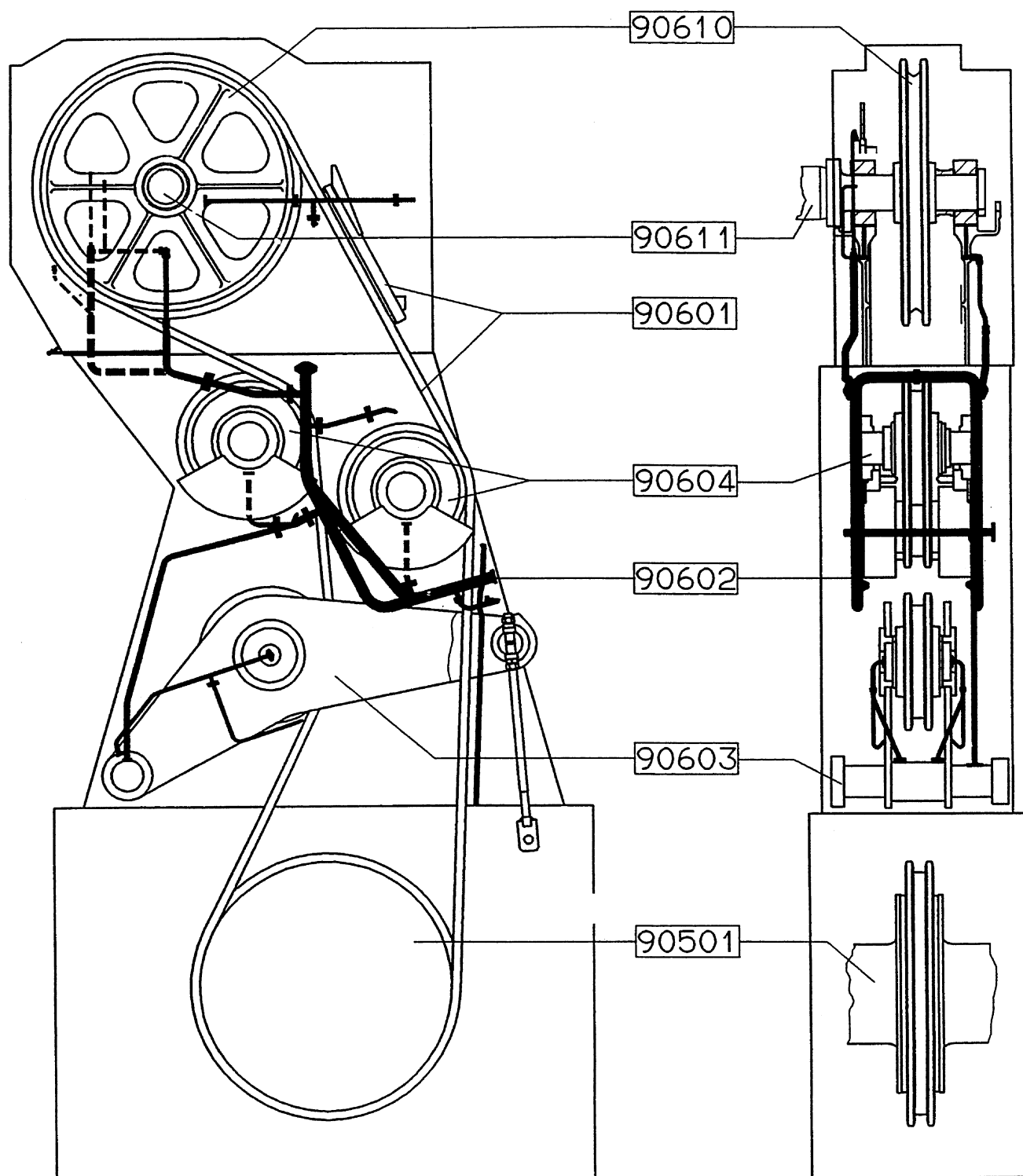
Based on calculations, these cylinder numbers may be provided with flyweights built into the main chain drive.

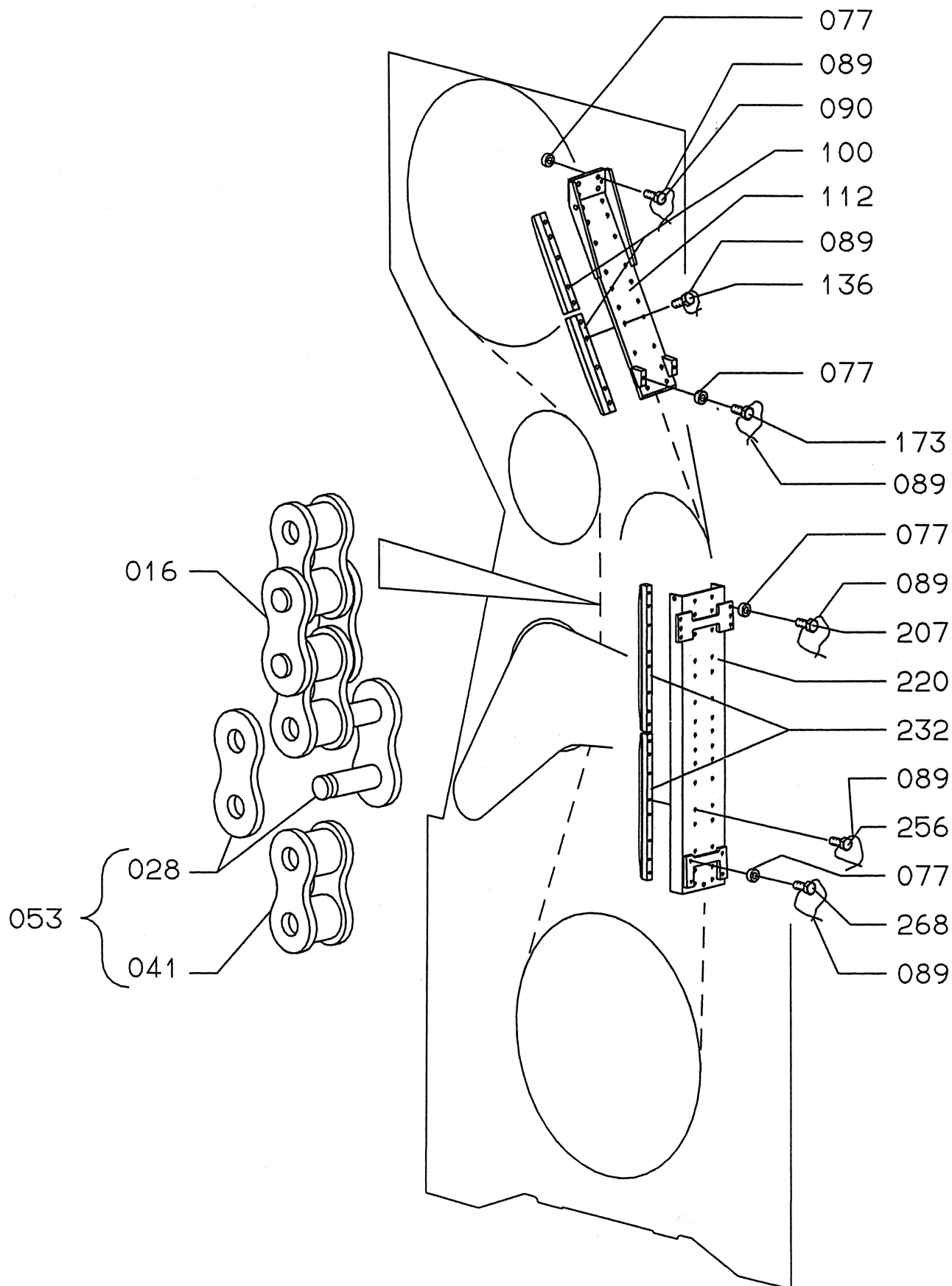
Flyweights may also be built into a second chain drive, which is driven from the fore end of the crankshaft. The chain drive is equipped with a spring-loaded chain tightener, which may be equipped with a hydraulic damper.



Optionally, an electrically driven compensator can be installed outside the engine



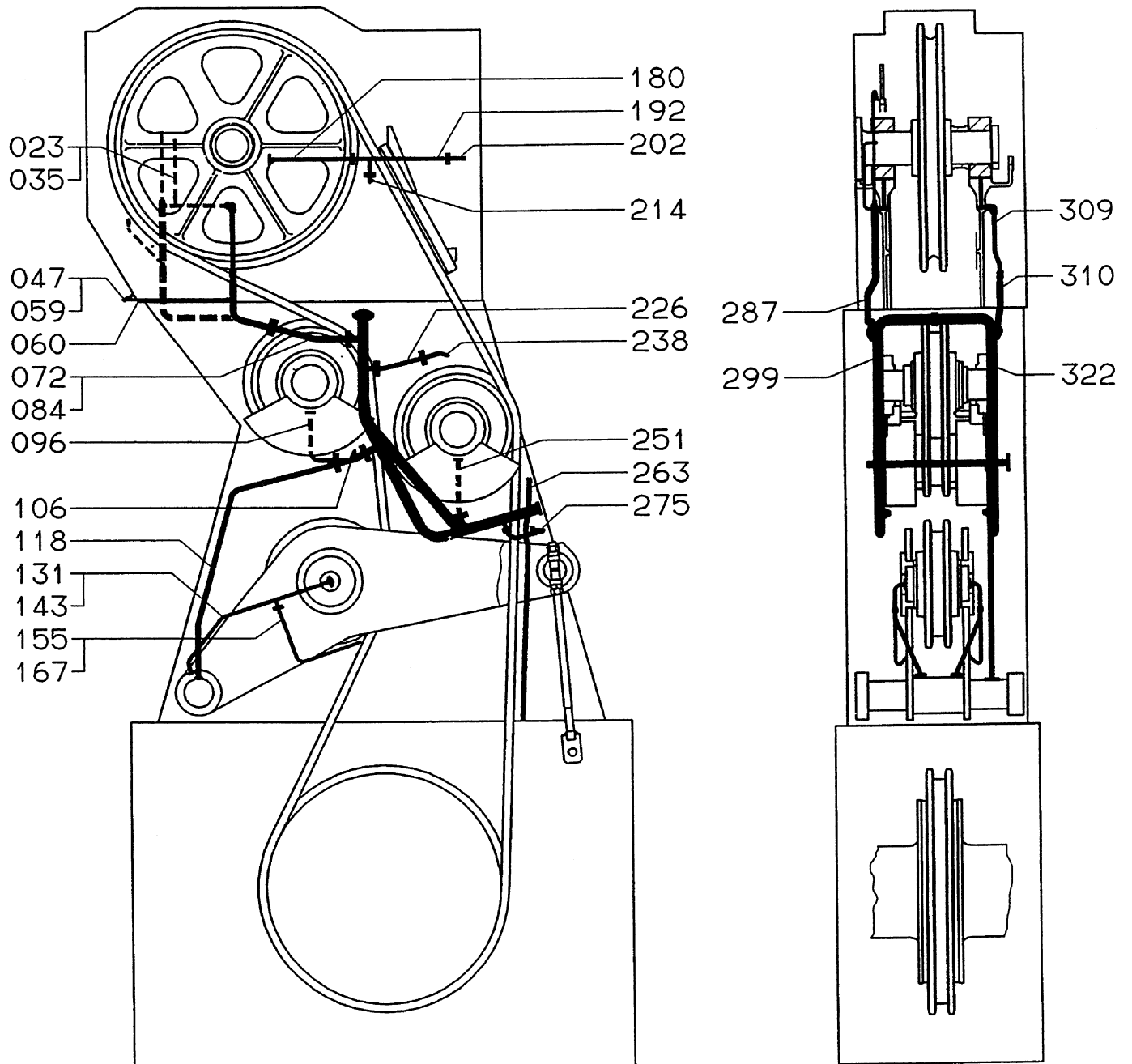




Item No.	Part Description
016	4½" Chain, complete
028	Outer link
041	Inner link
053	Chain link, complete
077	Adjusting washer
089	Locking wire
090	Screw
100	Guidebar
112	Beam for guidebar
136	Screw
173	Screw
207	Screw
220	Beam for guidebar
232	Guidebar
256	Screw
268	Screw

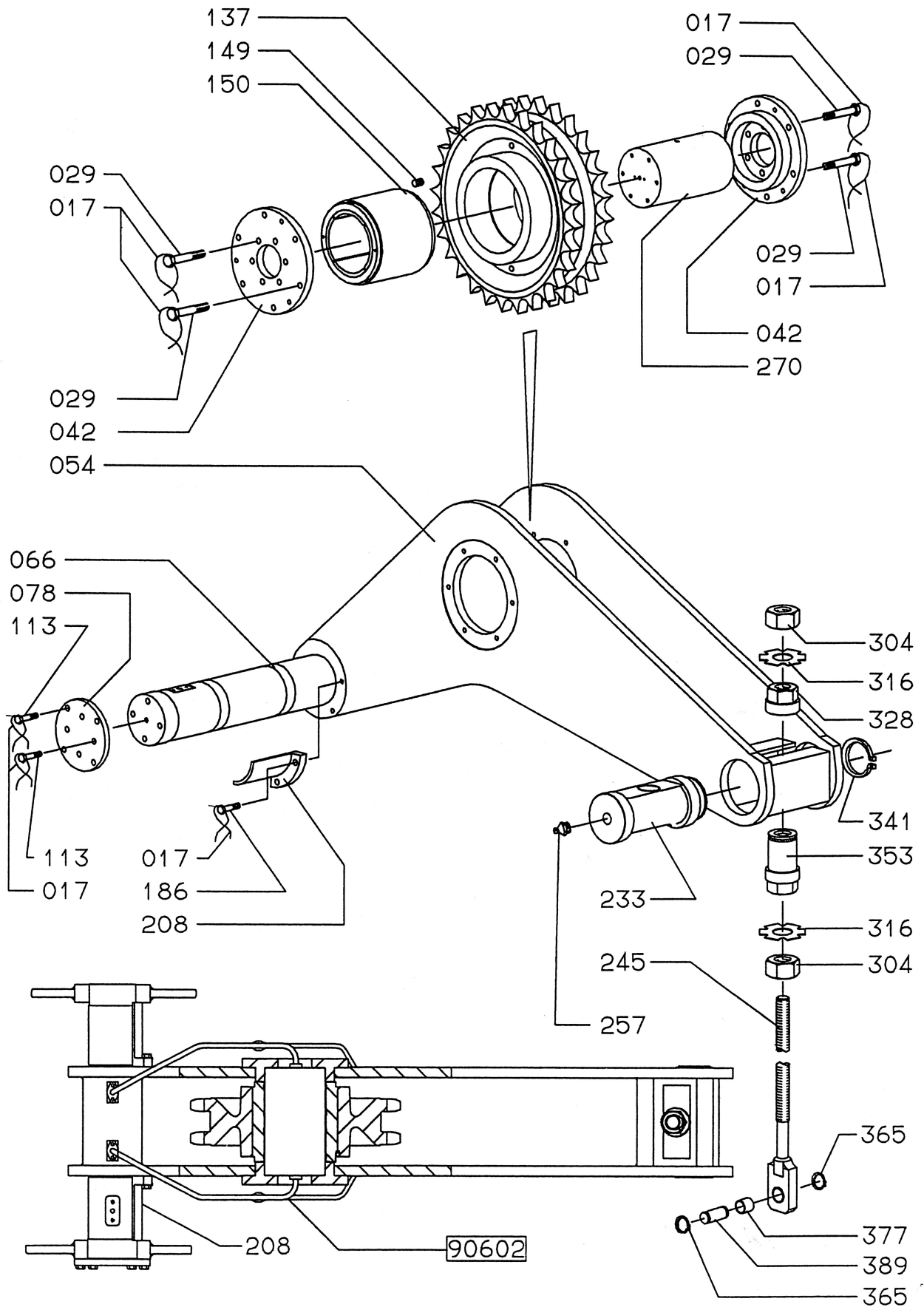
Item No.	Part Description





Item No.	Item Description

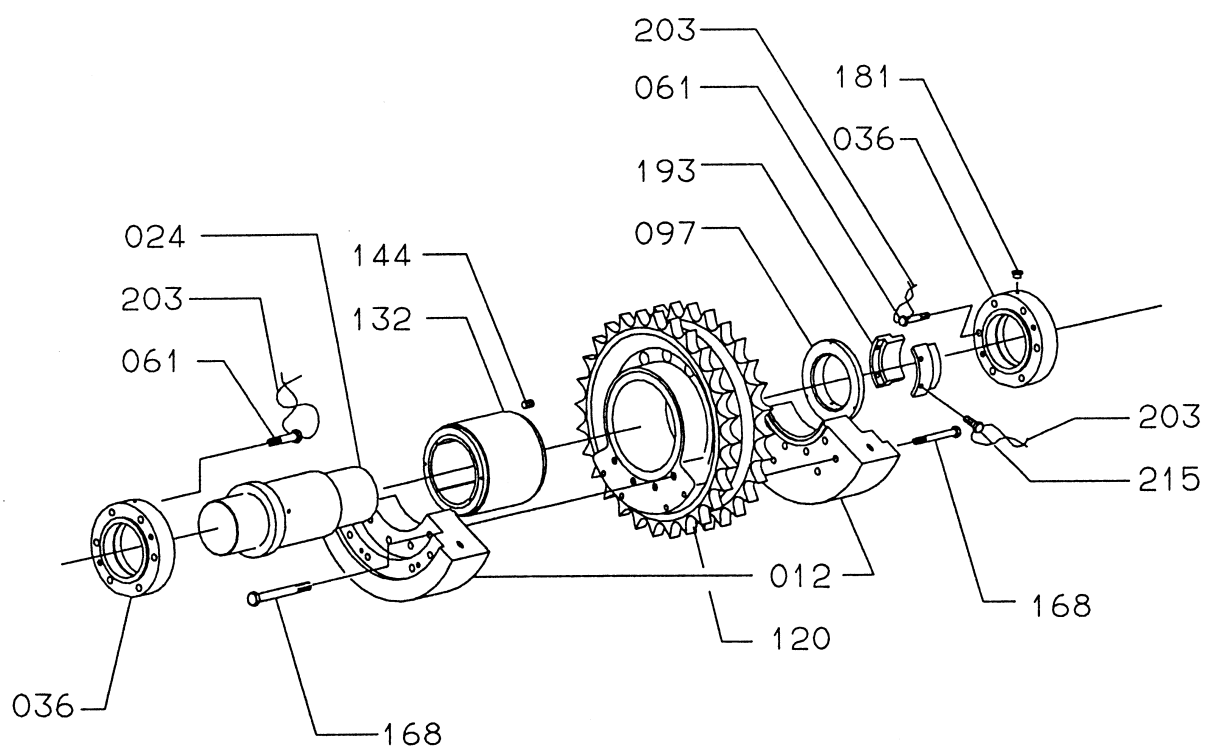
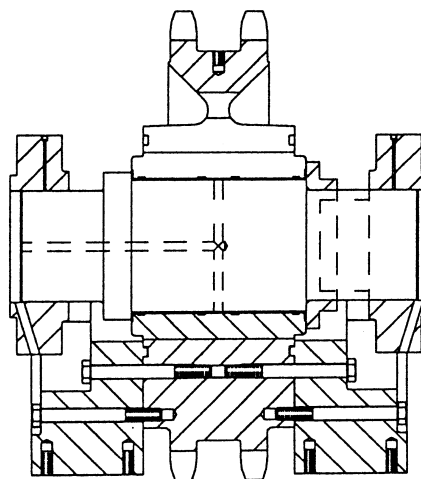
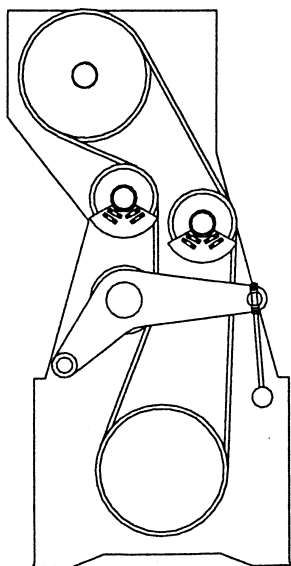




Item No.	Item Description
017	Locking wire
029	Screw
042	Flange bearing
054	Bracket
066	Shaft
078	Flange
113	Screw
137	Chain wheel
149	Cup point screw
150	Bearing bush
186	Screw
208	Distance piece
233	Shaft
245	Tightening bolt
257	Grease nipple
270	Shaft
304	Nut
316	Locking plate
328	Guide nut
341	Retaining ring
353	Guide nut
365	Retaining ring
377	Bushing
389	Shaft

Item No.	Item Description

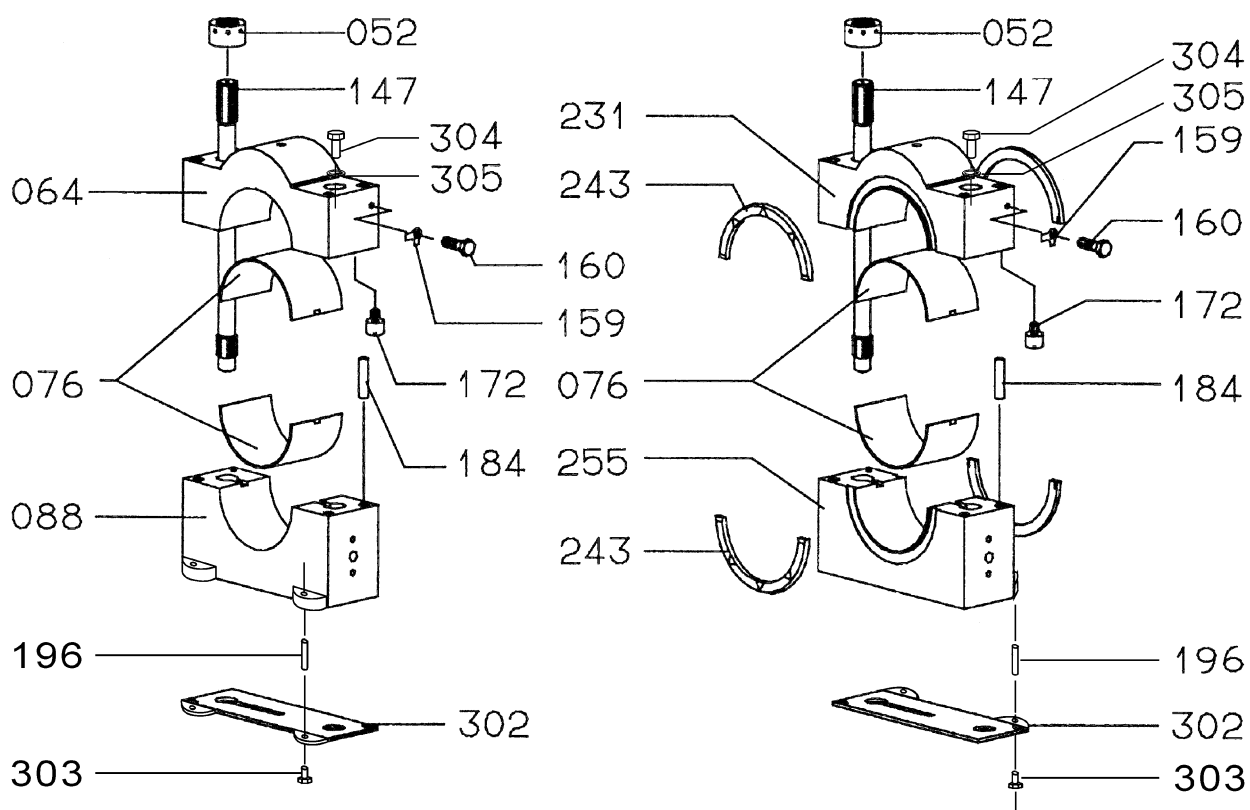
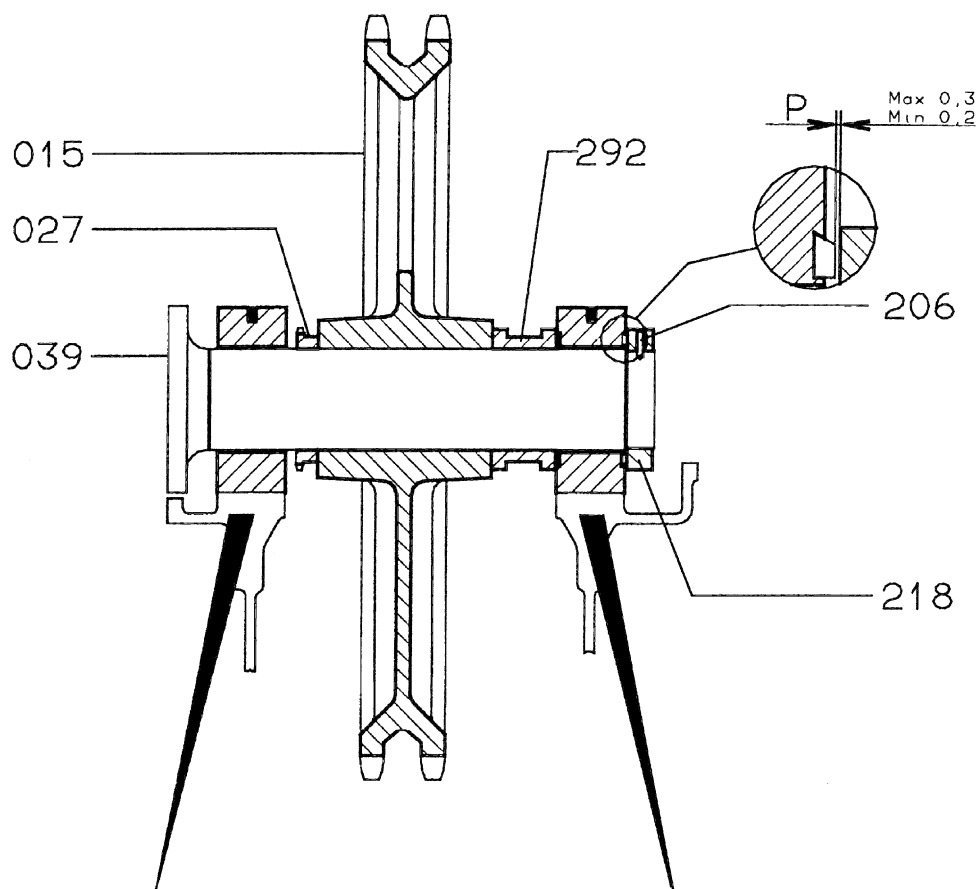




Item No.	Item Description
012	Flyweight
024	Shaft
036	Flange bearing
061	Screw
097	Bushing
120	Chain wheel
132	Bushing
144	Cup point screw
168	Screw
181	Plug
193	Distance piece
203	Locking wire
215	Screw

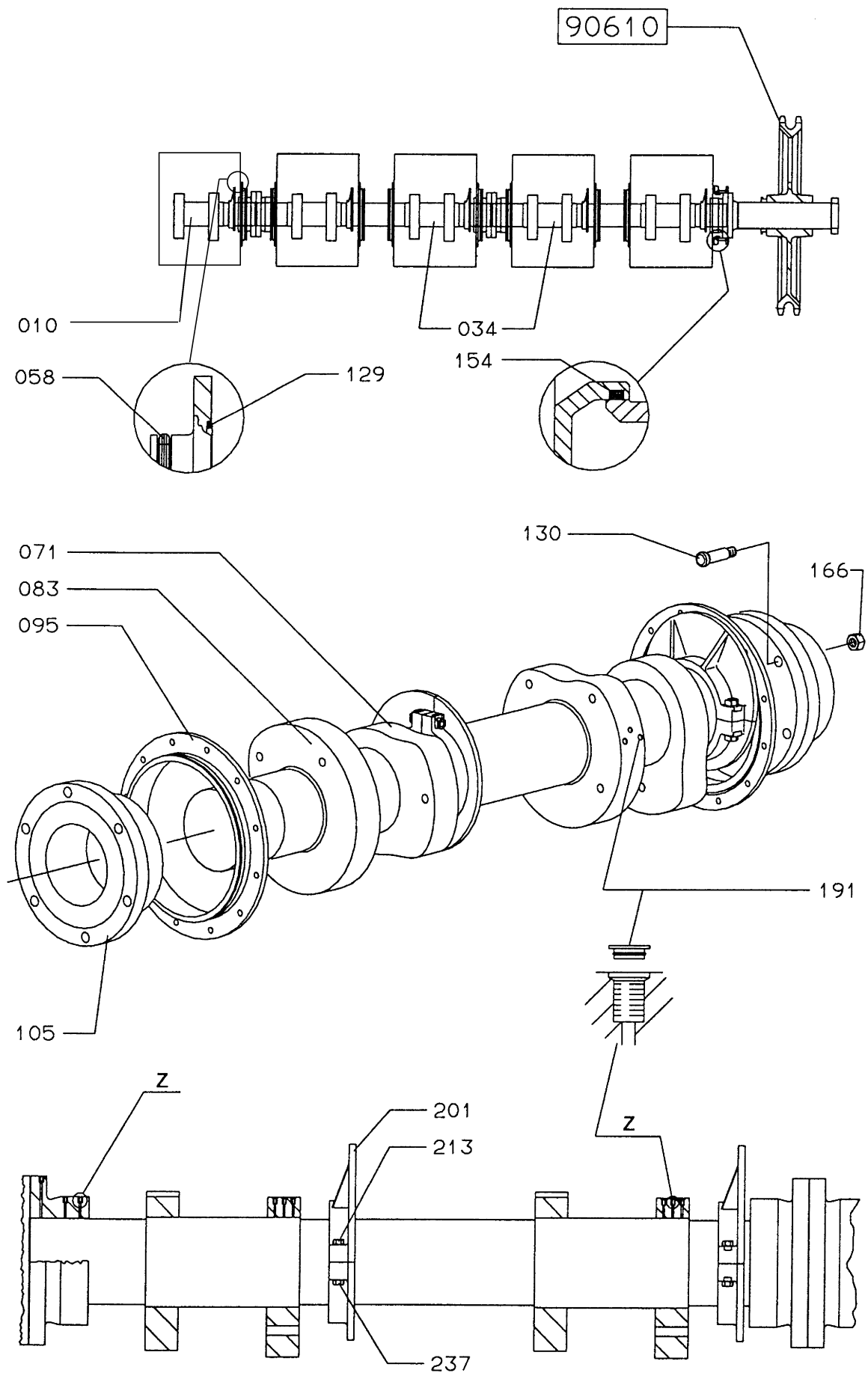
Item No.	Item Description





Item No.	Part Description	Item No.	Part Description
015	Chain wheel		
027	Chain wheel		
039	Shaft		
052	Nut		
064	Bearing, upper part		
076	Bearing shell in 2/2		
088	Bearing, lower part		
147	Stud		
159	Lock washer		
160	Screw		
172	Guide screw		
184	Guide pin		
196	Guide pin		
206	Guide pin		
218	Disc		
231	Guide bearing, upper part		
243	Guide ring		
255	Guide bearing, lower part		
292	Disc		
302	Shim		
303	Plug screw		
304	Hex. socket screw		
305	Spring washer		

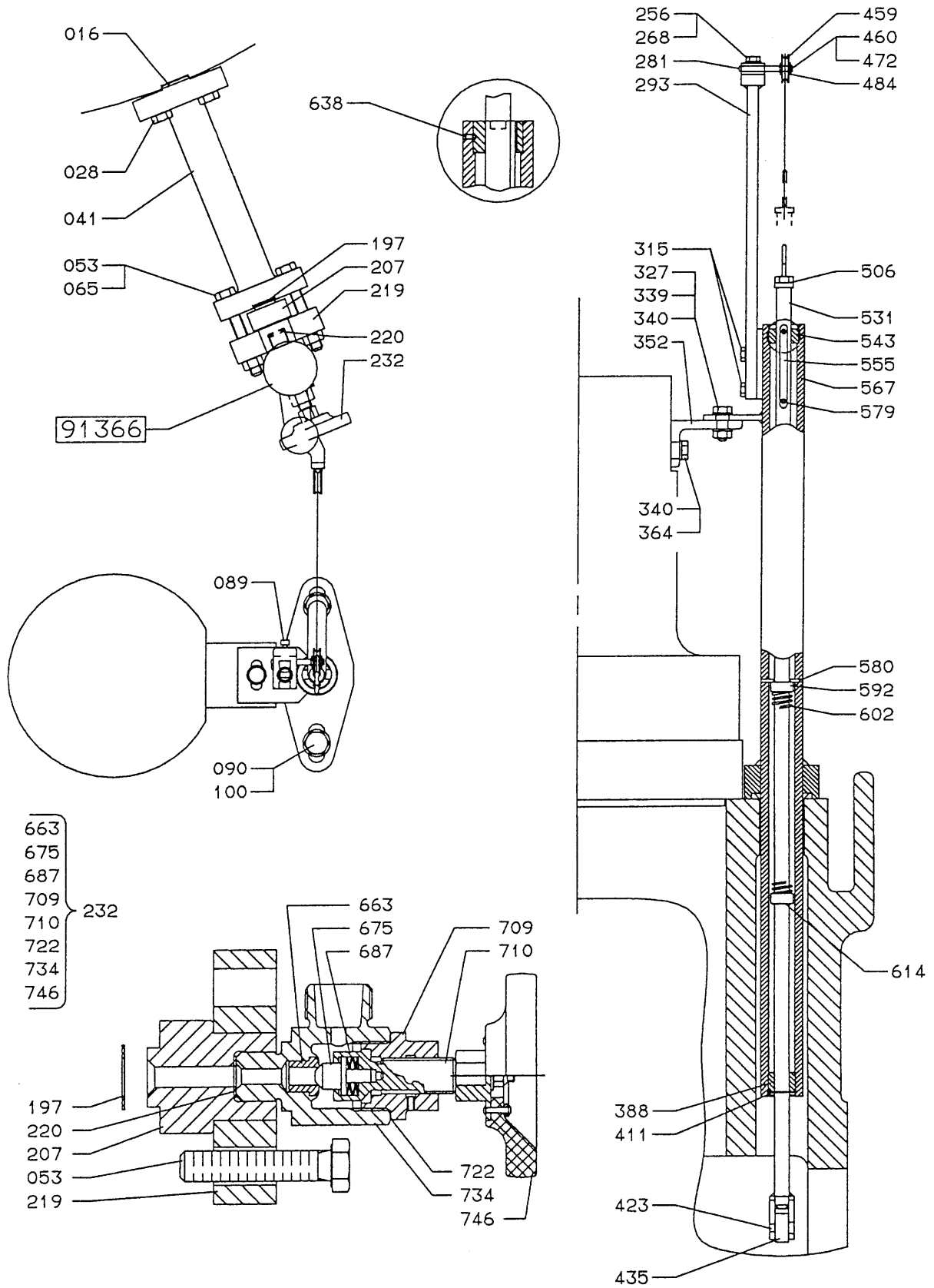




Item No.	Part Description
010	Camshaft, fore part
034	Camshaft, intermediate part
058	O-ring
071	Exhaust cam
083	Fuel cam
095	Sealing flange
105	Coupling
129	O-ring
130	Fitted bolt
154	O-ring
166	Self-locking nut
191	Plug
201	Indicator cam
213	Self-locking nut
237	Fitted bolt

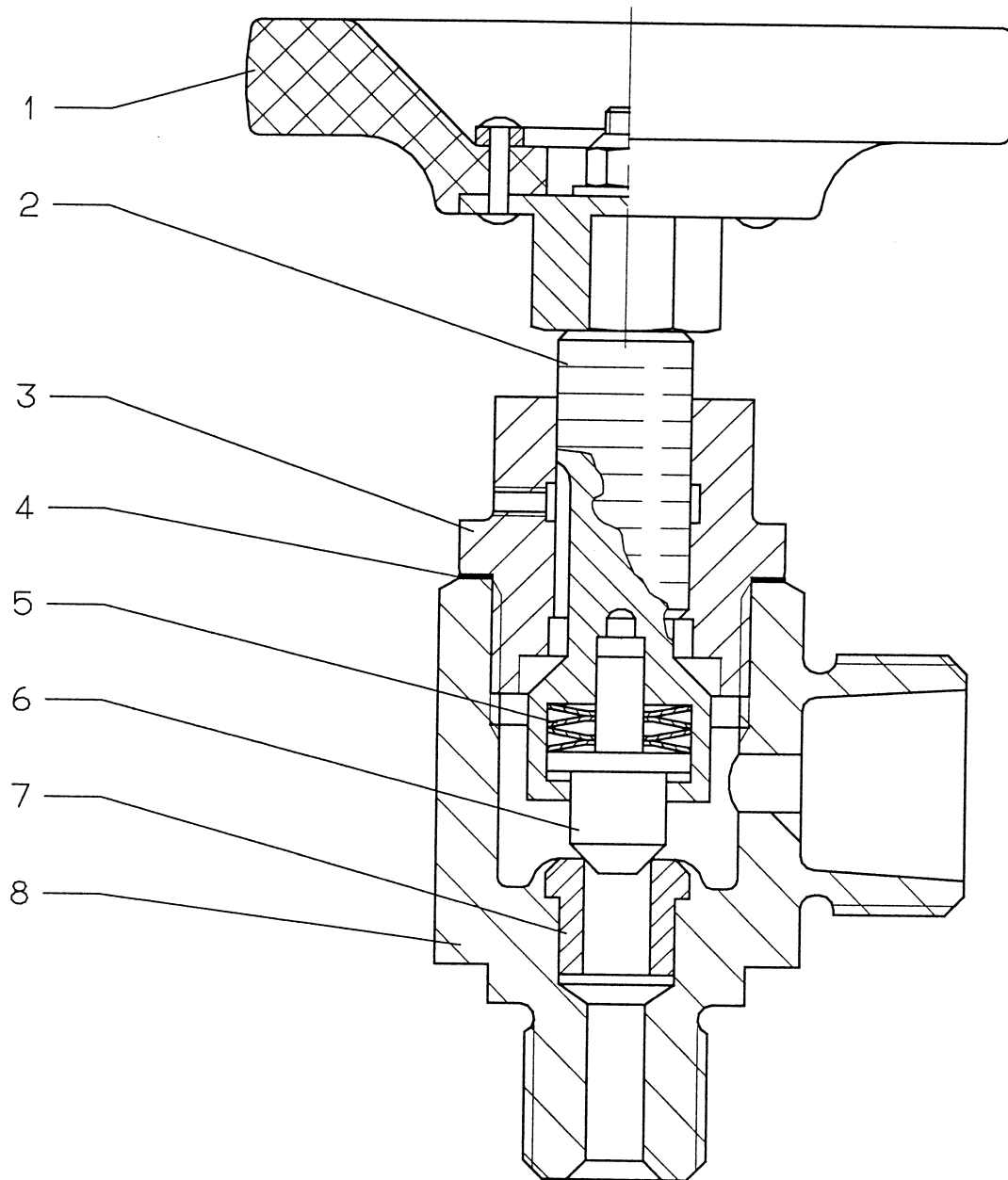
Item No.	Part Description





Item No.	Part Description	Item No.	Part Description
016	Packing	734	Valve housing
028	Screw	746	Hand wheel
041	Extension		
053	Screw		
065	Nut		
089	Screw		
090	Screw		
100	Washer		
197	Packing		
207	Extension		
219	Flange		
220	Packing		
232	Indicator valve, complete		
256	Screw		
268	Washer		
281	Bracket		
293	Bracket		
315	Screw		
327	Screw		
339	Nut		
340	Washer		
352	Bracket		
364	Screw		
388	Liner		
411	Circlip		
423	Shaft		
435	Roller		
459	Guide roller		
460	Shaft		
472	Circlip		
484	Washer		
506	Eye bolt		
531	Roller guide		
543	Liner		
555	Key		
567	Housing		
579	Screw		
580	Spring pin		
592	Liner		
602	Spring		
614	Cylindrical pin		
638	Screw		
663	Valve seat		
675	Valve cone		
687	Disc spring		
709	Spring guide		
710	Spindle		
722	Gasket		



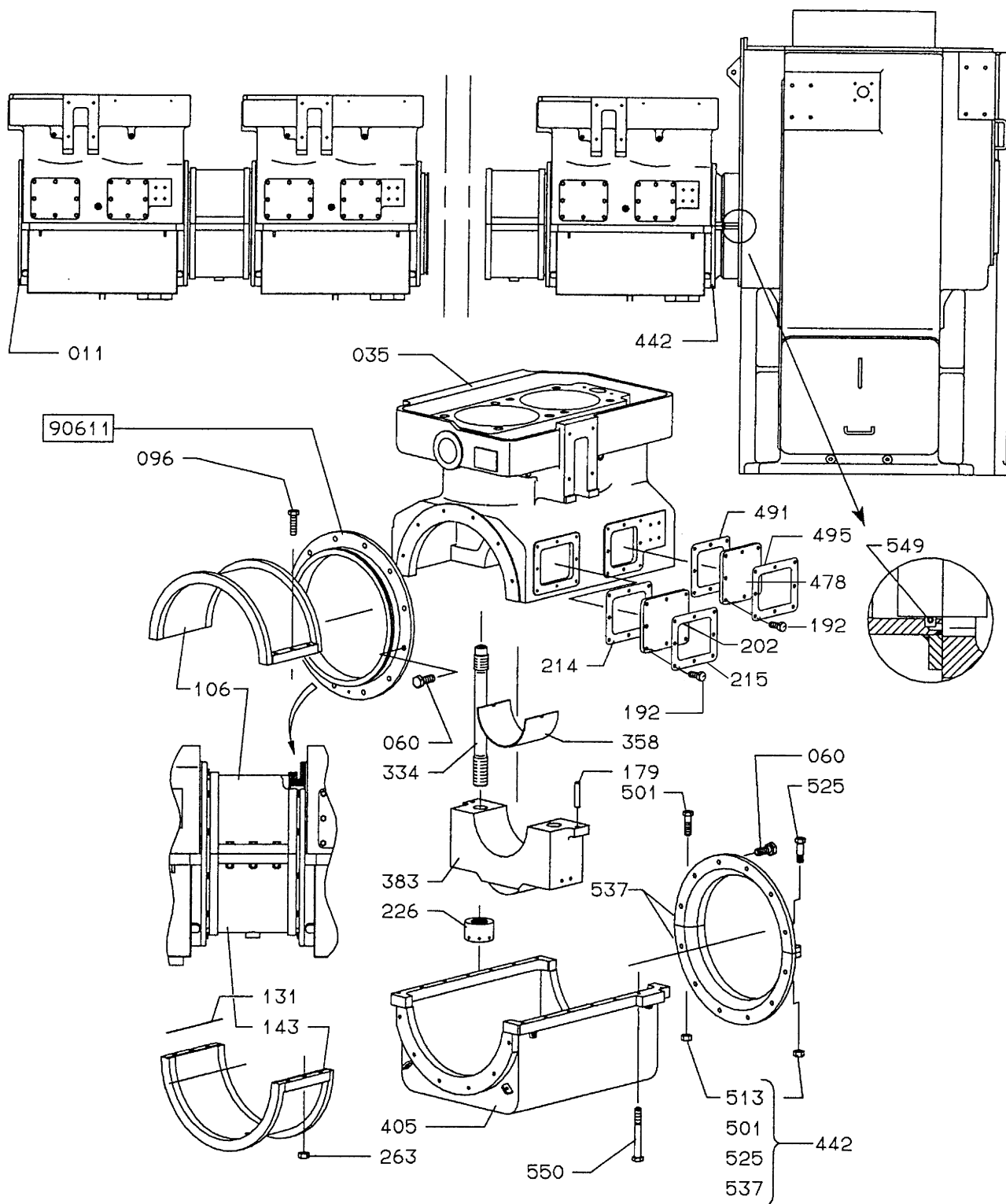


Operating Instructions

When opening the indicator valve, the spindle must be screwed right back to the stop in order to avoid burns and carbon in the guide.

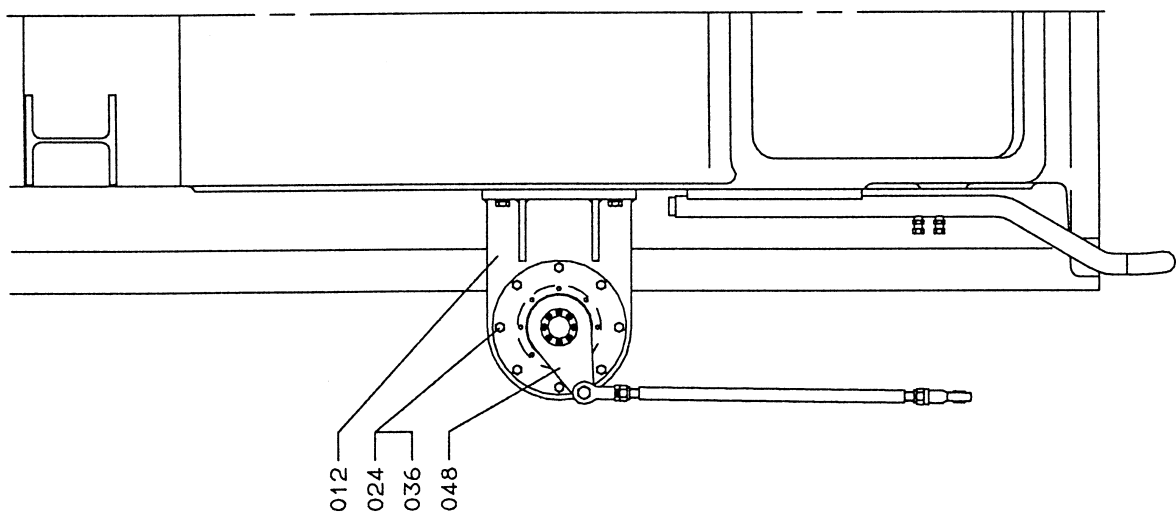
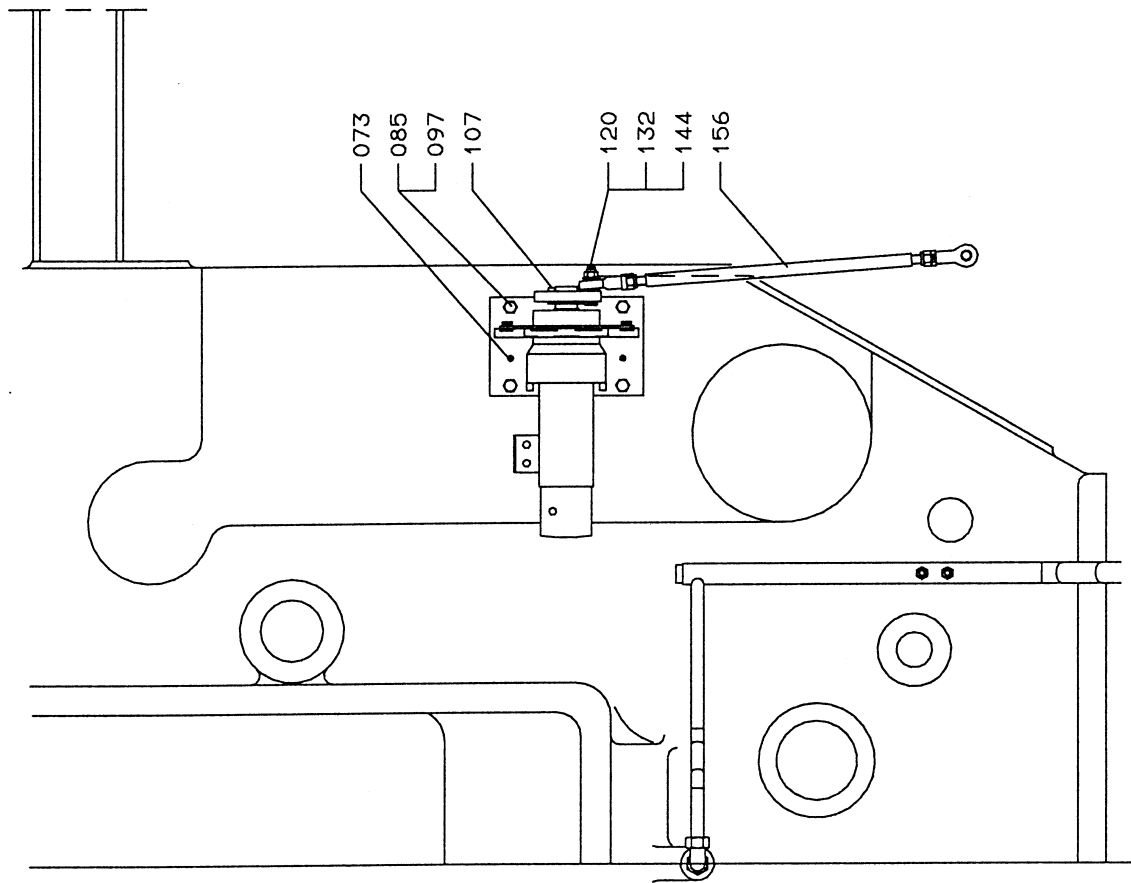
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|------------------|------------------|
| 1. Hand wheel | 5. Disc springs |
| 2. Spindle | 6. Valve cone |
| 3. Spindle guide | 7. Valve seat |
| 4. Gasket | 8. Valve housing |





Item No.	Part Description	Item No.	Part Description
011	End cover		
035	Housing		
060	Screw		
096	Screw		
106	Shield, upper part		
131	Rubber cord		
143	Shield, lower part		
179	Guide pin		
192	Screw		
202	Cover		
214	Gasket		
215	Guide plate		
226	Nut		
263	Nut		
334	Stud		
358	Bearing shell		
383	Bearing cap		
405	Oil pan		
442	Flange, complete		
478	Cover		
491	Gasket		
495	Guide plate		
501	Screw		
513	Nut		
525	Fitted bolt		
537	Flange in 2/2		
549	Spring		
550	Screw		

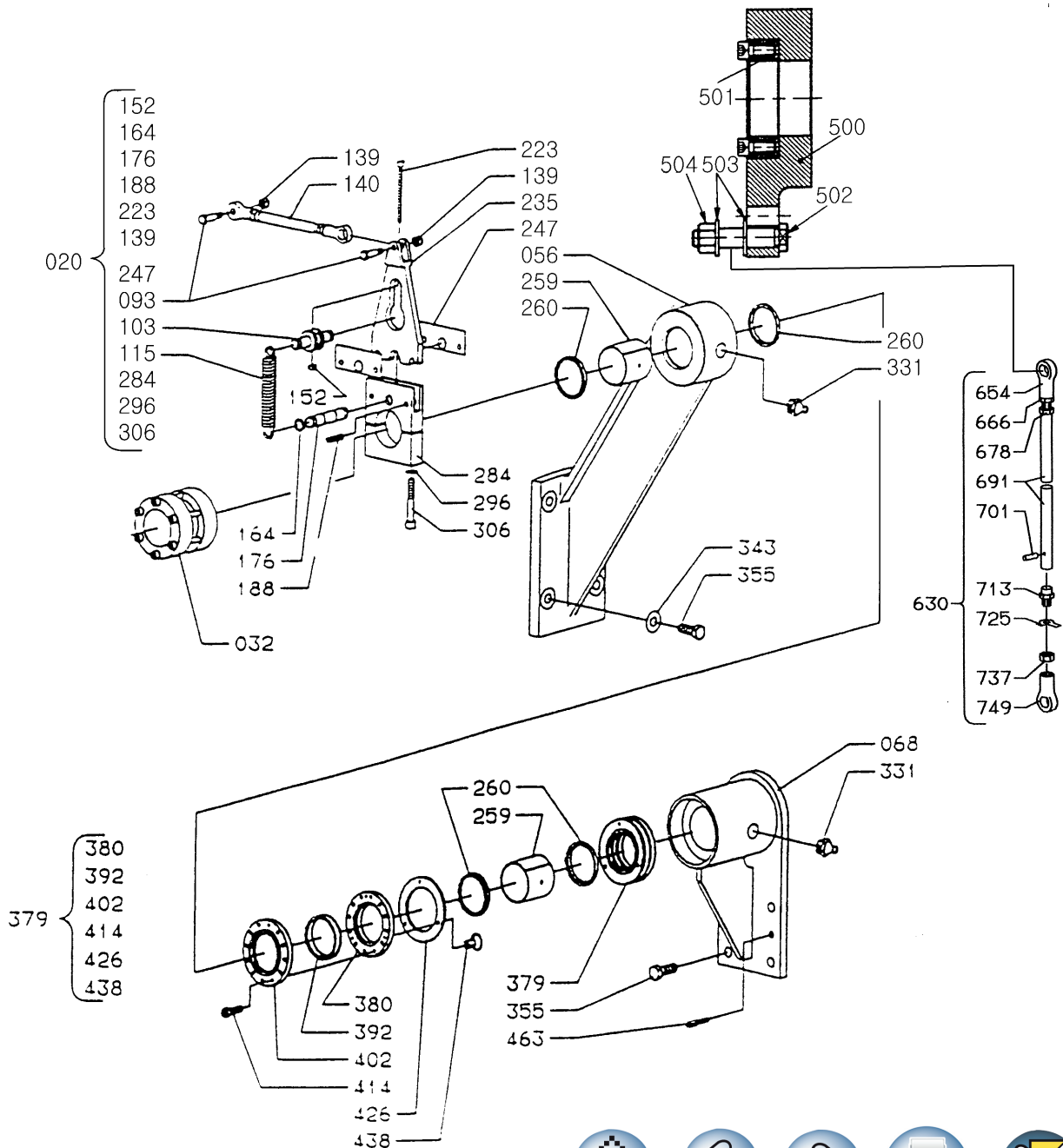
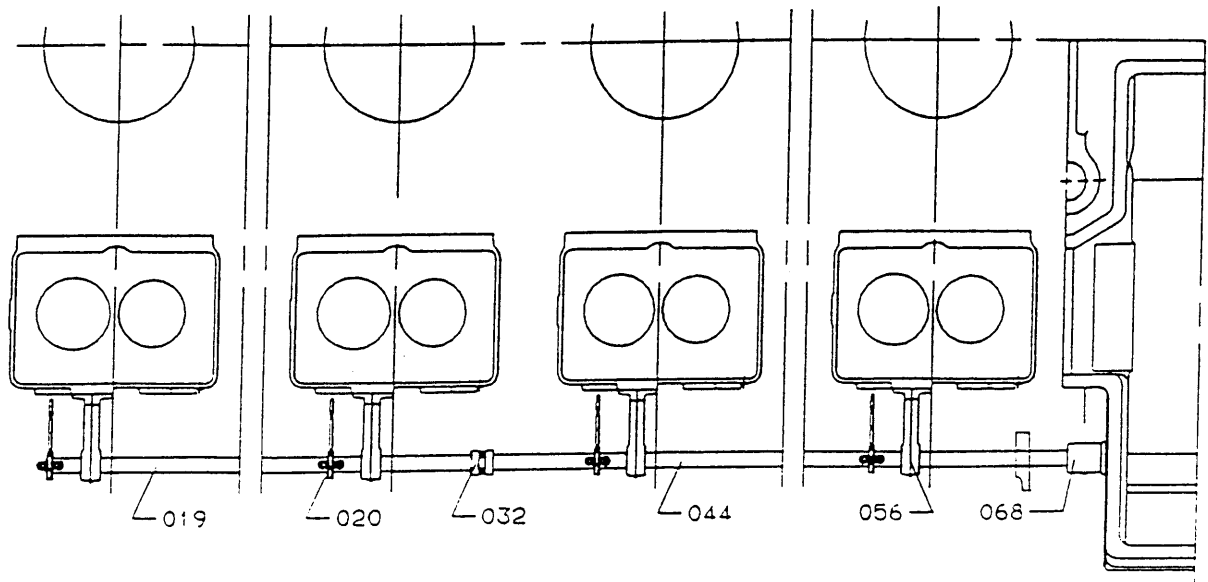




Item No.	Part Description
012	Bracket
024	Screw
036	Spring washer
048	Screw
073	Guide pin
085	Screw
097	Spring washer
107	Electrical governor
120	Fitted bolt
132	Washer
144	Self-locking nut
156	Pull rod

Item No.	Part Description

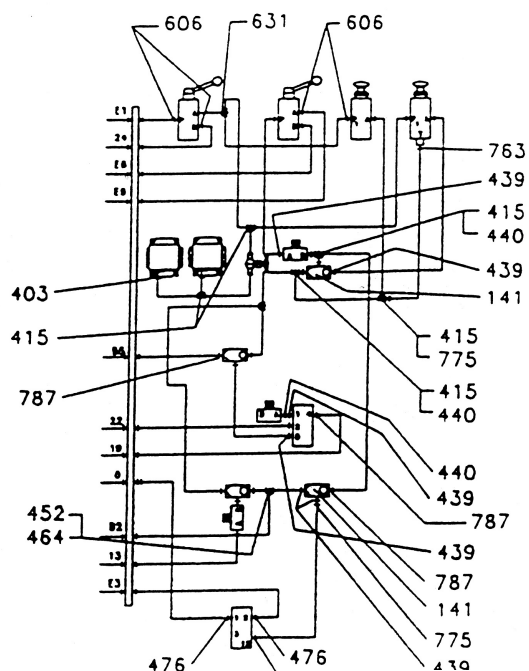
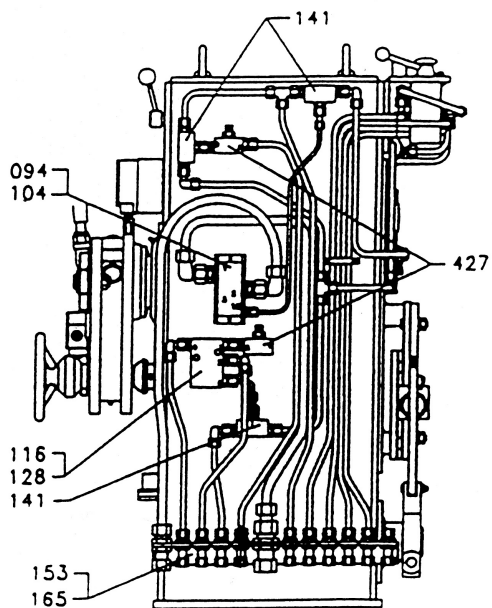
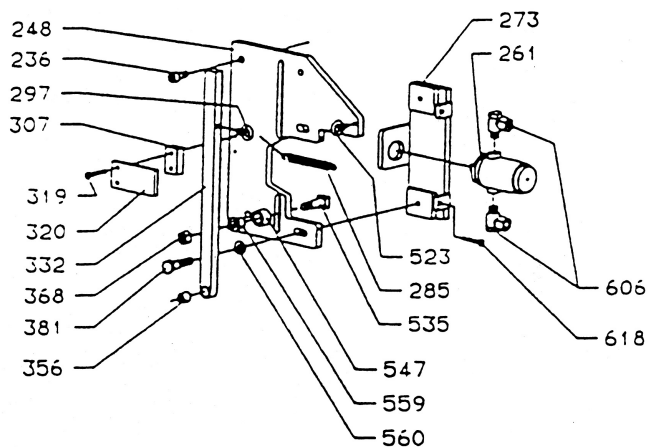
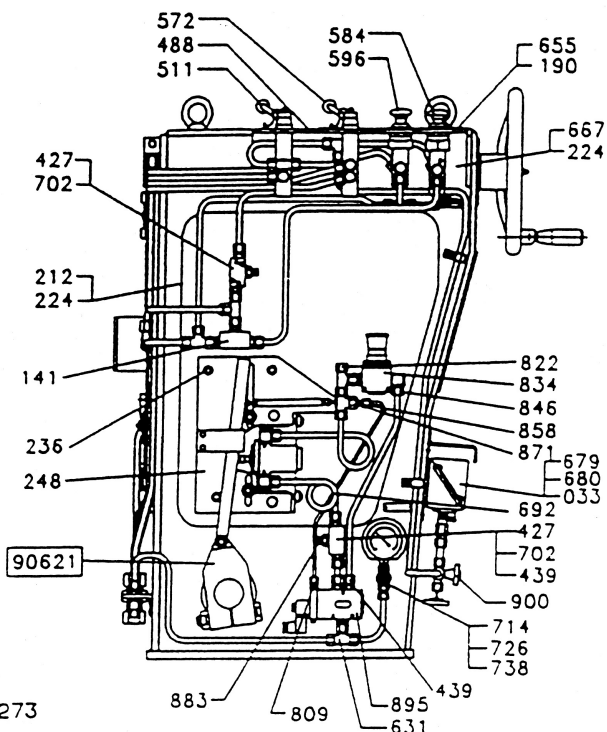
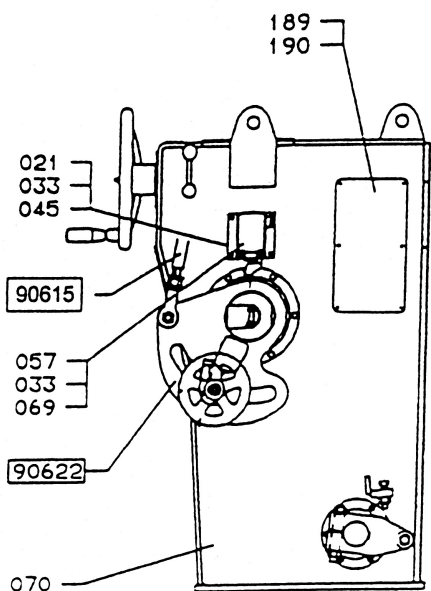




Item No.	Item Description
019	Regulating shaft
020	Resilient arm, complete
032	Split coupling
044	Regulating shaft
056	Bracket
068	Bracket
093	Fitted bolt
103	Shaft
115	Spring
139	Nut
140	Pull rod, complete
152	Nut
164	Circlip
176	Shaft
188	Pin
223	Spindle
235	Lever
247	Disc
259	Bushing
260	Sealing ring
284	Arm holder
296	Disc
306	Screw
331	Grease nipple
343	Disc
355	Screw
379	Flange bearing, complete
380	Flange
392	Split coupling
402	Flange
414	Screw
426	Thrust flange
438	Screw
463	Guide pin
500	Clamping arm
501	Split coupling
502	Fitted bolt
503	Washer
504	Self - locking nut
630	Pull rod, complete
654	Pull rod head, right
666	Nut, right
678	Pull rod end, right

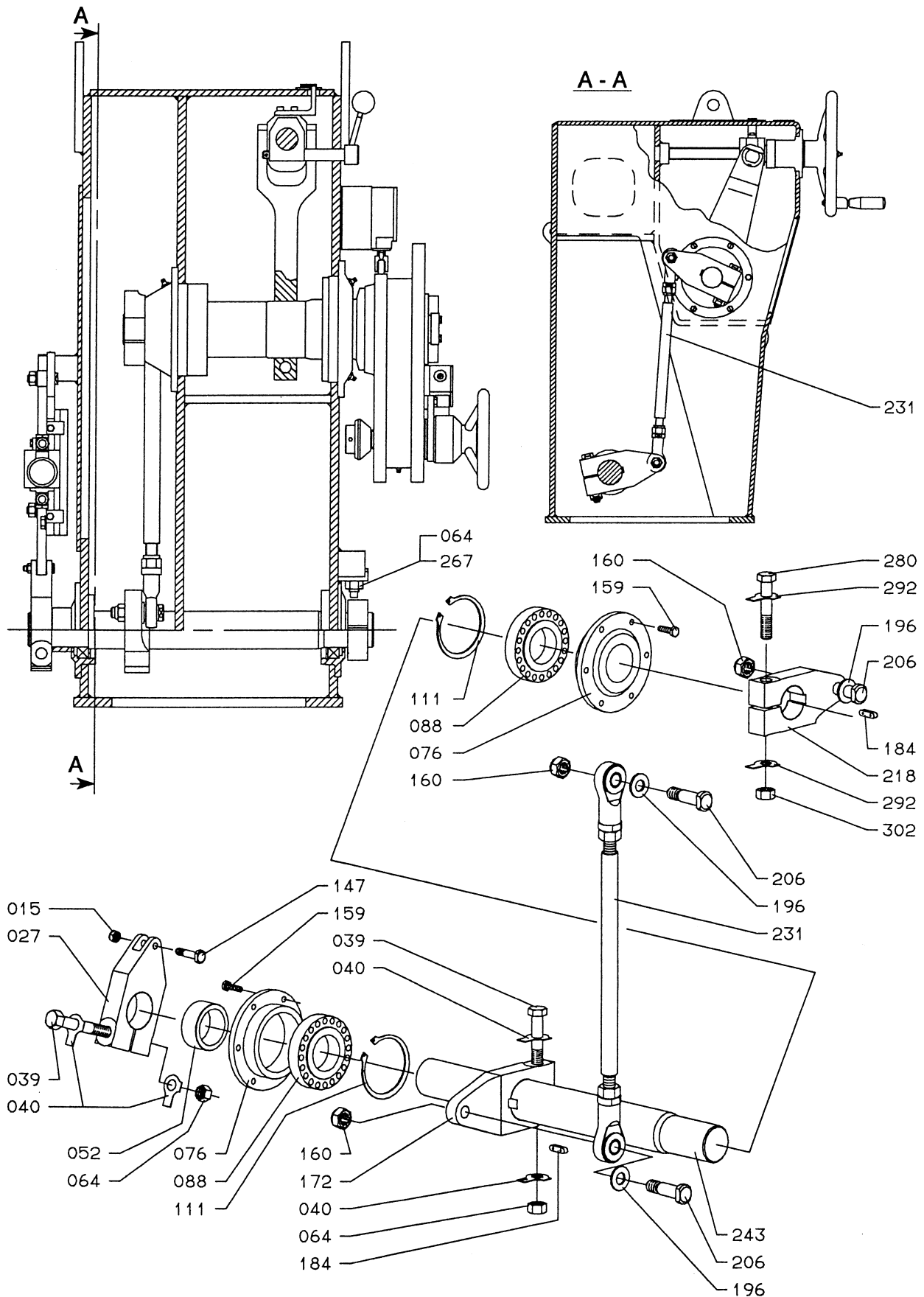
Item No.	Item Description
691	Pull rod tube
701	Pin
713	Pull rod end, left
725	Lock washer
737	Nut, left
749	Pull rod head, left





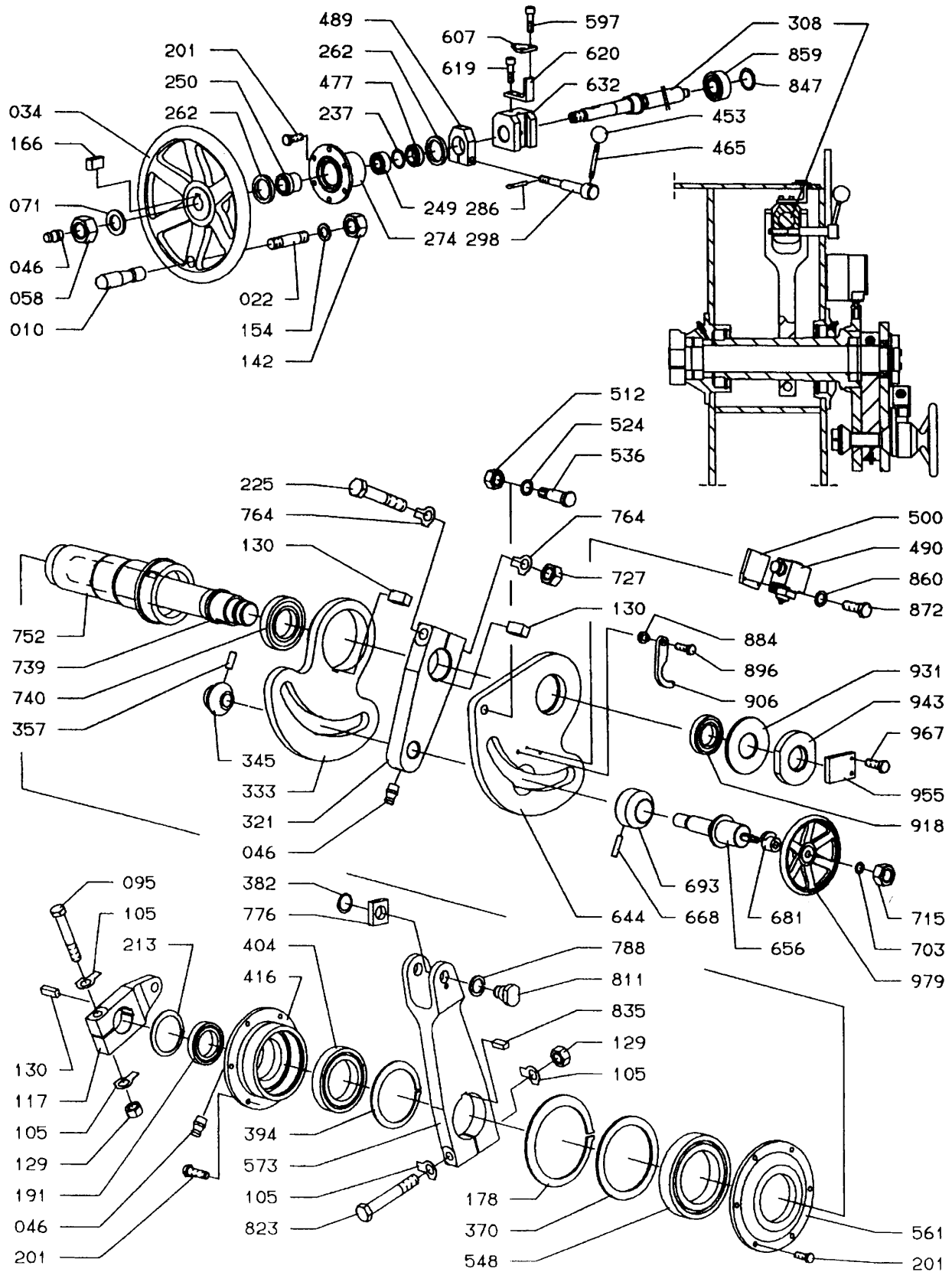
Item No.	Part Description	Item No.	Part Description
021	Bracket	606	Banjo coupling
033	Spring washer	618	Screw
045	Screw	631	Tee coupling
057	Switch	655	Name plate
069	Screw	667	Bracket
070	Console	679	Pressure switch
094	3/2-way valve	680	Screw
104	Screw	692	Pipe
116	3/2-way valve	702	Screw
128	Screw	714	Pressure gauge
141	Non-return valve	726	Coupling
153	Terminal plate	738	Needle v/v
165	Screw	763	Banjo coupling
189	Cover	775	Reducing union
190	Screw	787	Elbow coupling
212	Plate for pneumatics	809	Coupling
224	Screw	822	Tee coupling
236	Screw	834	Regulating valve
248	Bracket	846	Banjo coupling
261	Regulating valve	858	Reducing union
273	Bracket	871	L-coupling
285	Spring	883	Pipe
297	Eye screw	895	Solenoid valve
307	Distance piece	900	3-way test valve
319	Screw		
320	Plate		
332	Lever		
356	Bushing		
368	Nut		
381	Screw		
403	Coupling		
415	Tee coupling		
427	Non-return valve		
439	Coupling		
440	Screwed connection		
452	Tee coupling		
464	Reducing union		
476	Elbow coupling		
488	Name plate		
511	Valve "Remote-Emergency"		
523	Eye Screw		
535	Fitted bolt		
547	Bushing		
559	Bushing		
560	Washer		
572	Valve "Ahead-Astern"		
584	Stop valve		
596	Start valve		





Item No.	Part Description	Item No.	Part Description
015	Self-locking nut		
027	Clamping arm		
039	Screw		
040	Lock washer		
052	Distance piece		
064	Nut		
076	Flange bearing		
088	Ball bearing		
111	Circlip		
147	Fitted bolt		
159	Screw		
160	Self-locking nut		
172	Clamping arm		
184	Key		
196	Washer		
206	Fitted bolt		
218	Clamping arm		
231	Pull rod, complete		
243	Shaft		
267	Stop screw		
280	Screw		
292	Lock washer		
302	Nut		

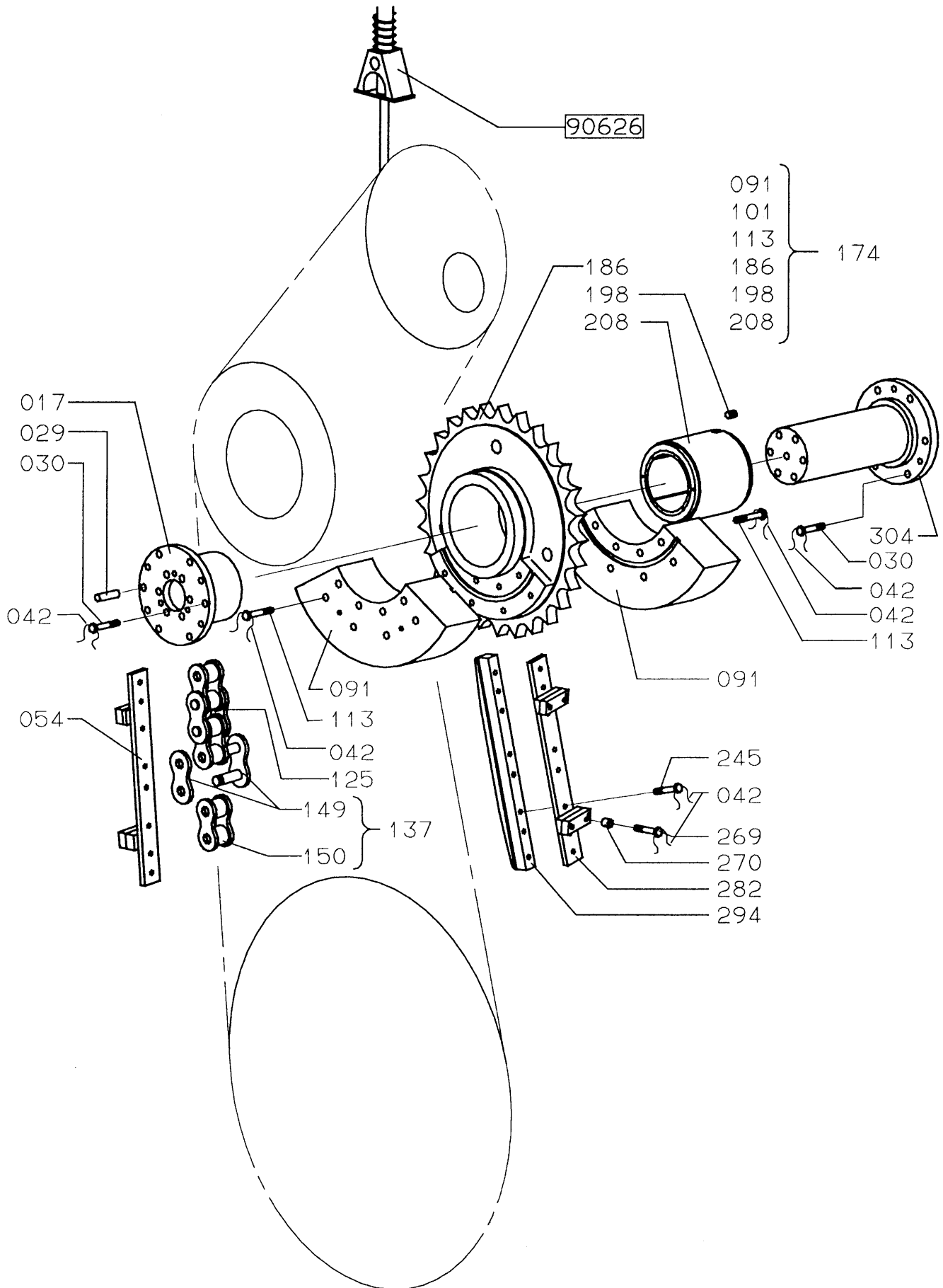




Item No.	Item Description
010	Handle
022	Stud
034	Hand wheel
046	Grease nipple
058	Self-locking nut
071	Washer
095	Screw
105	Lock washer
117	Clamping arm
129	Nut
130	Key
142	Self-locking nut
154	Spring lock
166	Key
178	Circlip
191	Ball bearing
201	Screw
213	Circlip
225	Screw
237	Circlip
249	Ball bearing
250	Thrust ring
262	Sealing ring
274	Flange bearing
286	Split pin
298	Shaft
308	Spindle
321	Lever
333	Lever
345	Cone
357	Guide pin
370	Disc
382	Circlip
394	Circlip
404	Ball bearing
416	Flange bearing
453	Ball handle
465	Stud
477	Thrust ring
489	Clamping piece
490	Switch
500	Distance piece
512	Self-locking nut
524	Washer
536	Fitted bolt
548	Ball bearing
561	Flange bearing
573	Forked lever
597	Screw
607	Pointer

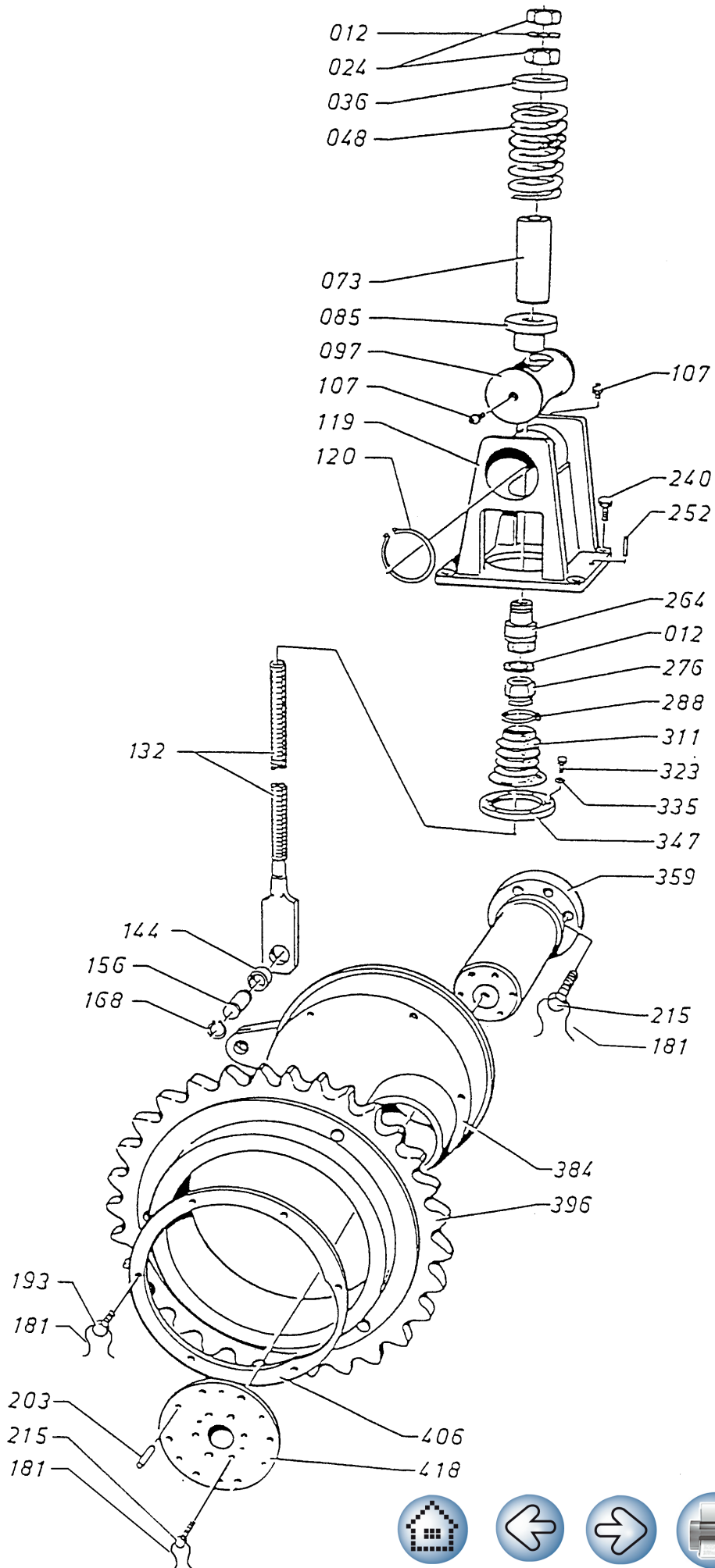
Item No.	Item Description
619	Screw
620	Angle lever
632	Special nut
644	Lever
656	Cone
668	Stop screw
681	Impact socket
693	Roller
703	Washer
715	Self-locking nut
727	Nut
739	Shaft
740	Ball bearing
752	Shaft
764	Lock washer
776	Slide shoe
788	Lock washer
811	Special screw
823	Screw
835	Key
847	Circlip
859	Ball bearing
860	Spring washer
872	Screw
884	Bushing
896	Screw
906	Blocking arm
918	Ball bearing
931	Thrust ring
943	Nut
955	Locking plate
967	Screw
979	Impact hand wheel





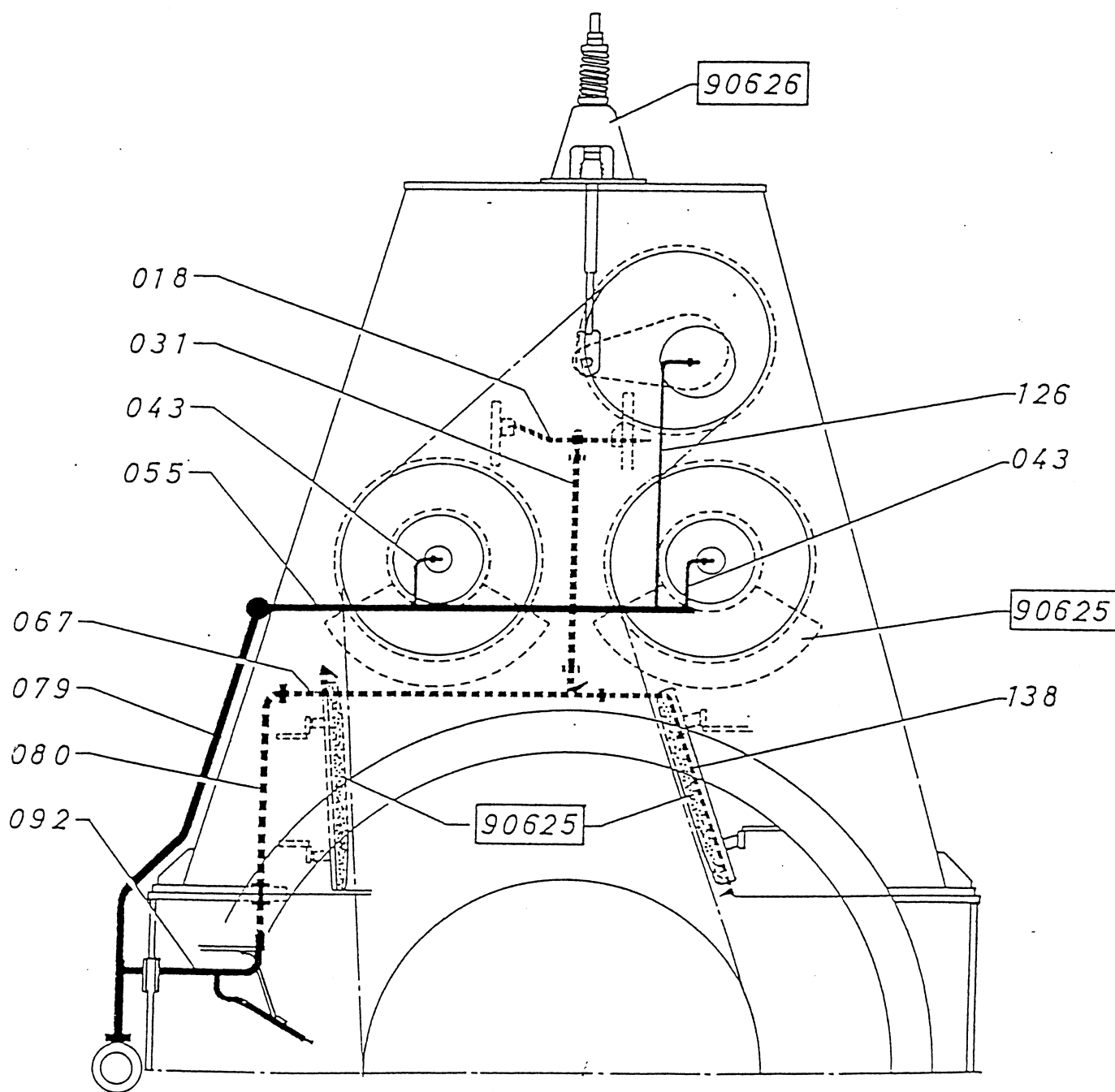
Item No.	Part Description	Item No.	Part Description
017	Flange bearing		
029	Guide pin		
030	Screw		
042	Locking wire		
054	Beam for guide bar		
091	Flyweight		
113	Screw		
125	4.1/2" chain, complete		
137	Chain link, complete		
149	Outer link		
150	Inner link		
174	Flyweight, complete		
186	Chain wheel		
198	Cup point screw		
208	Bushing		
245	Screw		
269	Screw		
270	Adjusting washer		
282	Beam for guide bar		
294	Guide bar		
304	Shaft		





Item No.	Part Description	Item No.	Part Description
012	Lock washer		
024	Nut		
036	Thrust flange, upper		
048	Spring		
073	Distance pipe		
085	Thrust flange, lower		
097	Shaft		
107	Grease nipple		
119	Housing for tightening bolt		
120	Circlip		
132	Tightening bolt		
144	Bushing		
156	Pin		
168	Circlip		
181	Locking wire		
193	Screw		
203	Guide pin		
215	Screw		
240	Screw		
252	Guide pin		
264	Neck nut		
276	Neck nut		
288	Hose clamp		
311	Bellow gland		
323	Screw		
335	Spring washer		
347	Flange		
359	Shaft		
384	Eccentric		
396	Chain wheel		
406	Flange		
418	Flange		





Item No.	Part Description
018	Spray pipe
031	Lubricating pipe
043	Lubricating oil pipe
055	Lubricating pipe
067	Lubricating pipe
079	Lubricating pipe
080	Lubricating pipe
092	Spray pipe
126	Lubricating oil pipe
138	Spray pipe

Item No.	Part Description



Starting Air System

The starting air system consists of the manoeuvring system and the starting air components.

The following items are described:

- Manoeuvring System
- Main Starting Valve
- Starting Air Distributor
- Starting Valve

Manoeuvring System

See also Vol. 1, OPERATION, Chapter 703.

The manoeuvring system is of electric/pneumatic design. It is designed for:

- Control from engine side control console.
See also Chapter 906
- Remote control from engine control-room and/or bridge.

The system consists of two or three sub-systems:

- The **regulating system**
- The **reversing system**
(only reversible engines)
- The **safety system**.

Regulating system:

By means of the regulating system it is possible to start, stop and control the engine.

The START and STOP functions are controlled pneumatically.

Speed-setting during remote control:

During remote control, the speed-setting is controlled by the control handle on the manoeuvring console, which sends a signal to the governor system.

The engine speed depends on the magnitude of the signal. The governor system will maintain this speed independently of the engine load.

Speed-setting during manual control:

During control from the engine side control console, the governor is disconnected from the fuel pumps, and the speed control is effected through the regulating handwheel. See also Vol. 1, OPERATION, Chapter 703 and plate 90620.

Reversing system : (reversible engines)

The reversing system contains two pneumatic valves (AHEAD and ASTERN). These valves control the actuation of the starting air distributor and the air cylinders for reversing the fuel pump rollers.

Safety system :

The safety system is separately supplied with air and is controlled by the engine monitoring system (with separate power supply). In case of shut-down, the safety system leads an air signal to the puncture valve on each fuel pump, thereby cutting-off the delivery of high-pressure fuel oil, after which the engine stops.

The safety system is connected during all modes of engine control.

Main Starting Valve

Plate 90702

The main starting valve is interposed in the starting air main pipe.

The main starting valve consists of a large ball valve and, optionally, a smaller ball valve which is fitted as a by-pass for the large valve. Both valves are operated by means of pneumatic actuators.

If the smaller ball valve is installed, an adjusting screw will be mounted for setting the slow-turning speed.



Furthermore, a non-return valve is incorporated which prevents blow-back in the event of excessive pressure in the starting air line.

The main starting valve is equipped with a blocking device consisting of a plate which, by means of a handwheel, can be made to block the actuators.

The ball valves and their actuators are, together with the non-return valve and blocking device, built together to form a unit.

On receipt of telegraph order 'Finished with engine', move the blocking device to the BLOCKED position.

To avoid alarm, move the telegraph handle into STOP position.

Warning !

During all inspections of the engine, the blocking device of the main starting valve must be in the BLOCKED position.

The only exception is when the starting valves are tested for tightness, in which case the blocking device of the main starting valve must be in the WORKING position and the shut-off valve for the starting air distributor must be in the CLOSED position

See Vol.1, OPERATION, Chapter 703, 'Operations after arrival in port'.

Function : (slow-turning option)

The ball valve actuators are controlled by means of pneumatic valves.

Start during control from
engine side control console:

Both valves open simultaneously.

Start during manual control
from control room:

If the engine has been stopped for 30 minutes or more, it is advisable to slow-turn the engine. This is done by activating the

slow-turning switch on the manoeuvring console which by means of a solenoid valve, prevents the large ball valve from opening.

Start during remote control from bridge:

Has the engine been at a standstill for more than 30 minutes?

Yes	The small ball valve opens. When the crankshaft has rotated at least one revolution, also the large ball valve opens. This safeguards the engine against damage caused by any liquid in the combustion chamber.
No	Both valves open simultaneously.

Setting of 'Slow-turning' (option)

During 'slow-turning', the engine speed can be set by means of the 'slow-turning' adjusting screw.

The speed should be kept as low as possible, however, so that the engine still runs smoothly.

Starting Air Distributor

Plate 90703

The starting air distributor is fitted to the camshaft housing and is driven directly from the fore end of the camshaft. It controls the starting valves 90704.

The starting air distributor consists of a circular housing with a number of radially fitted slide valves for control of the starting valves of the individual cylinder. These slide valves are controlled by a single starting disc, which is bolted directly onto the camshaft. The starting disc is provided with a recess which has an inner contour for AHEAD and, for reversible engines, an outer contour for ASTERN.



During STOP and running, the slide valves are kept in the neutral position by means of springs 237 and spring guides 249: the springs force the slide valves outwards, and keep them in contact with the spring guides which, in turn, are kept in contact with liners 250.

During starting, the slide valves are actuated by the supply of control air, whereby the force of spring 237 is overcome, and the guide pins of the valve slides are pressed against the contour of the starting disc. The engine now rotates on starting air, and the sequence for activating and deactivating the starting valves is controlled by the contour of the starting disc.

When the starting sequence has finished, the distributor is vented and the guide pins of the slides return to the neutral position in the centre of the recess of the starting disc.

Starting Valve

Plate 90704

The starting valve (spring-loaded) is fitted on the cylinder cover. It is controlled by control air from the starting air distributor 90703 .

Function:

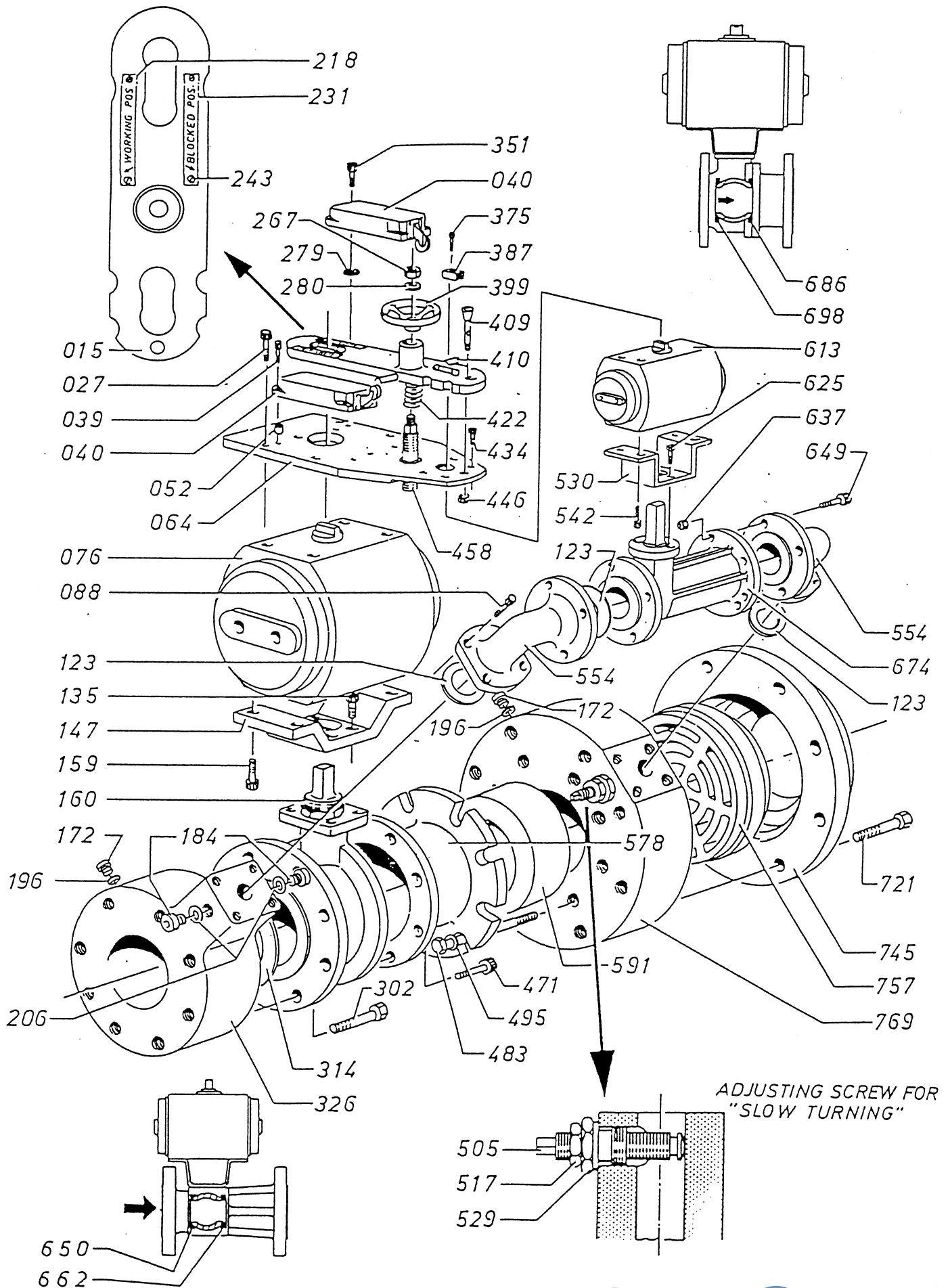
When the main starting valve is open, chamber **P** of the starting valve is pressurised through the starting air pipe.

The starting valve is kept closed by the spring. When chamber **U** above the piston of the starting valve is pressurised with control air from the starting air distributor, the starting valve opens, and starting air now flows from the starting air pipe to the cylinder.

When the starting period is finished, chamber **U** is vented through the vent pipe of the starting air distributor, and the starting valve will close.

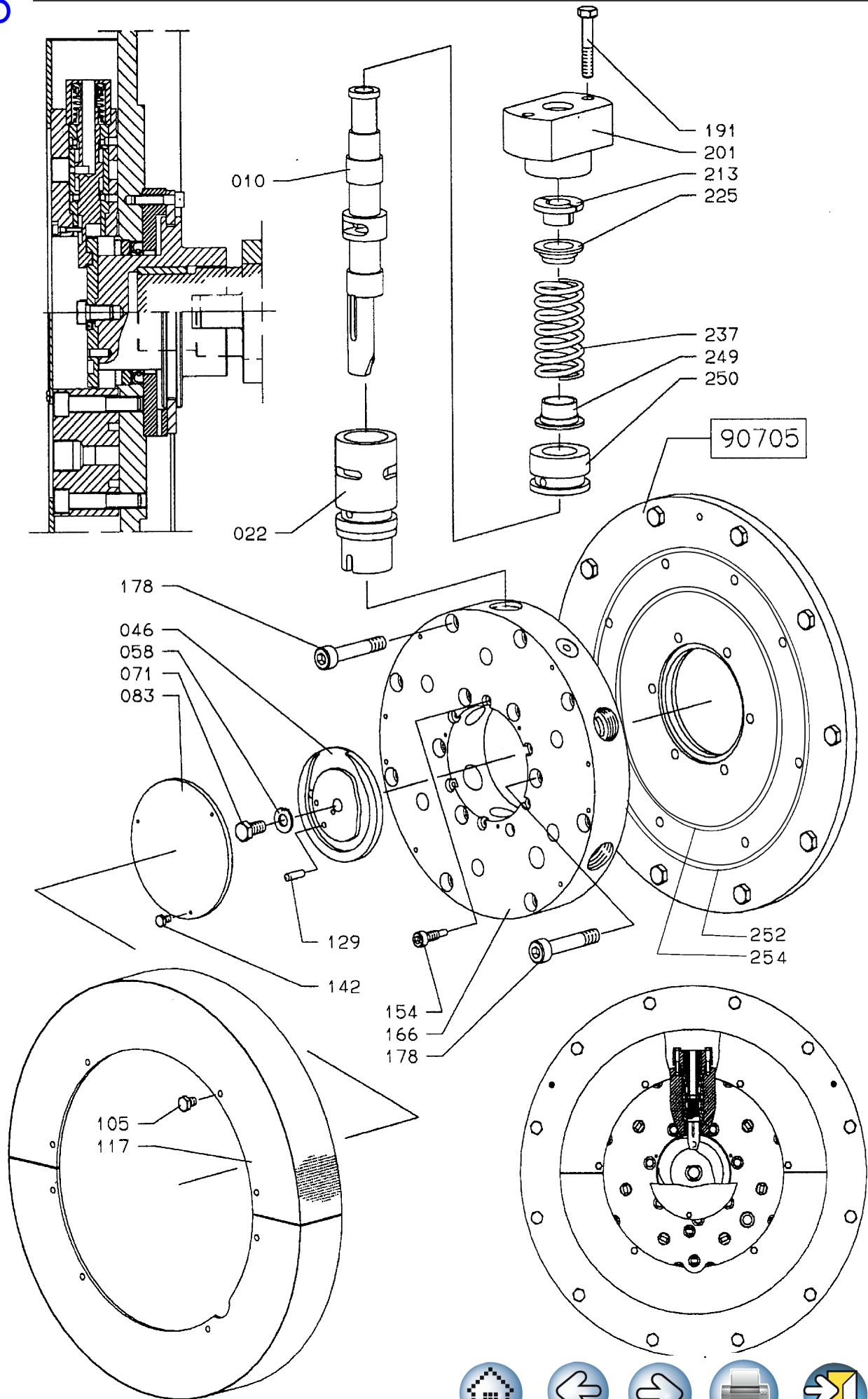
Venting of the starting air in chamber **P** and the starting air pipe takes place slowly through small holes in the starting air pipe.





Item No.	Part Description	Item No.	Part Description
015	Securing plate	613	Actuator
027	Screw	625	Screw
039	Screw	637	Nut
040	Switch	649	Screw
052	Distance pipe	650	Up stream seat
064	Plate	662	Down stream seat
076	Actuator	674	Spherical valve
088	Screw	686	Down stream seat
123	Gasket	698	Up stream seat
135	Screw	721	Screw
147	Intermediate piece for actuator	745	Housing
159	Screw	757	Non-return valve
160	Spherical valve	769	Housing
172	Plug screw		
184	Plug screw		
196	Gasket		
206	Gasket		
218	Name plate		
231	Name plate		
243	Screw		
267	Nut		
279	Washer		
280	Washer		
302	Screw		
314	Gasket		
326	Intermediate piece		
351	Screw		
375	Screw		
387	Locking piece		
399	Handwheel		
409	Pin		
410	Pin		
422	Spring		
434	Screw		
446	Nut		
458	Spindle		
471	Screw		
483	Screw		
495	Washer		
505	Valve spindle		
517	Nut		
529	Reducing nipple		
530	Intermediate piece		
542	Screw		
554	Starting air pipe		
578	Intermediate piece		
591	Distance ring		

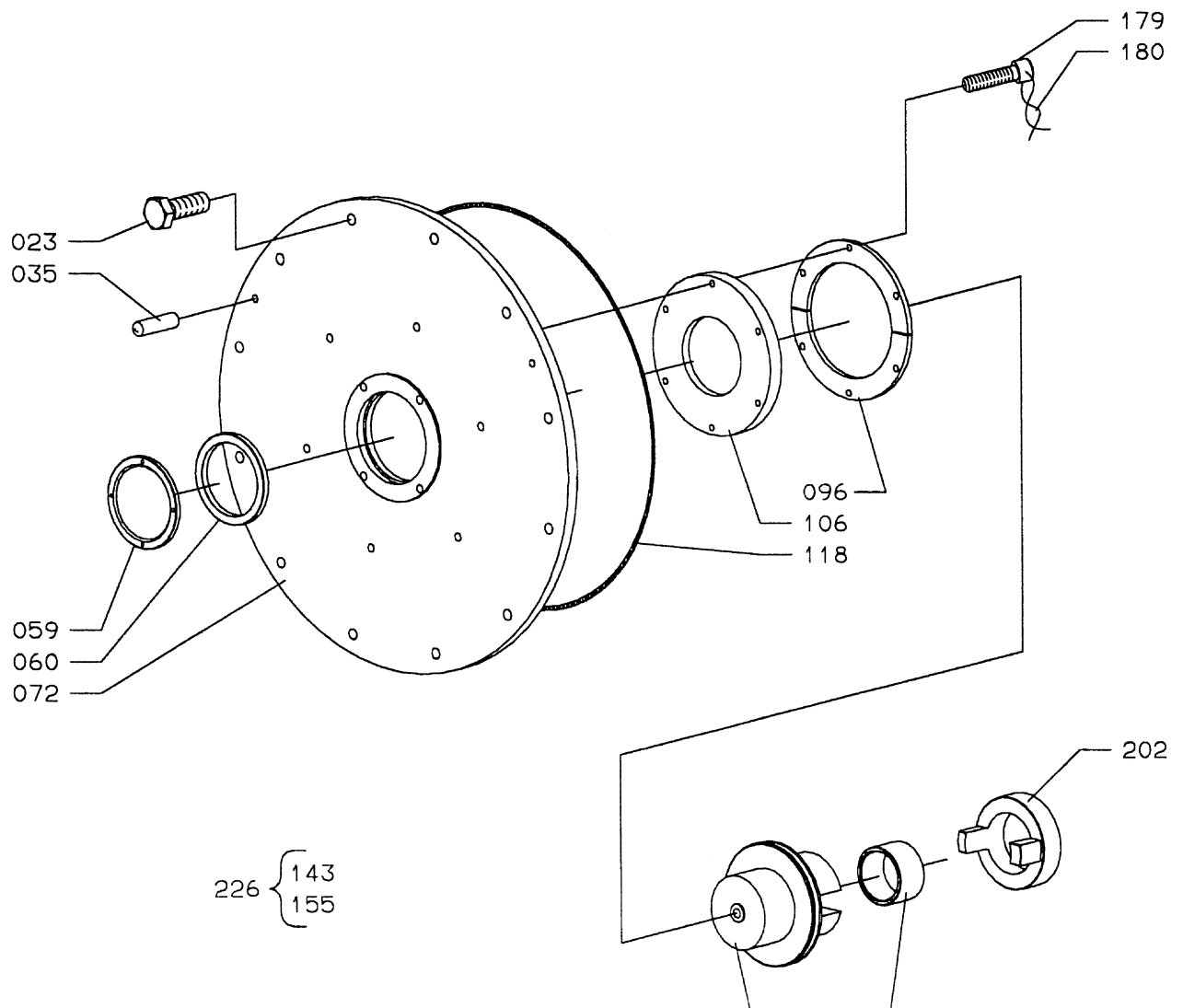
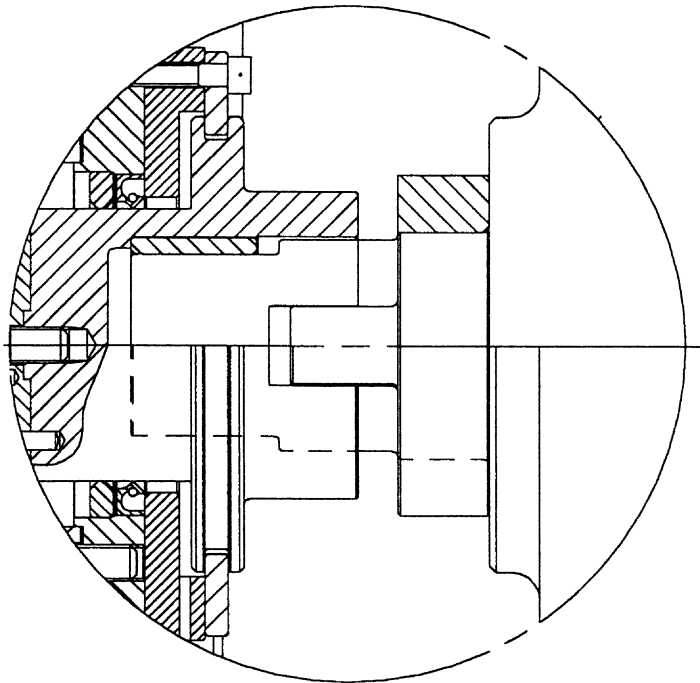




Item No.	Item Description
010	Piston valve slide
022	Liner
046	Starting cam
058	Locking wire
071	Screw
083	Cover
105	Screw
117	Cover
129	Pin
142	Screw
154	Guide screw
166	Housing
178	Screw
191	Screw
201	Flange
213	Locking ring
225	Spring guide
237	Spring
249	Spring guide
250	Linder
252	O-ring
254	O-ring

Item No.	Item Description

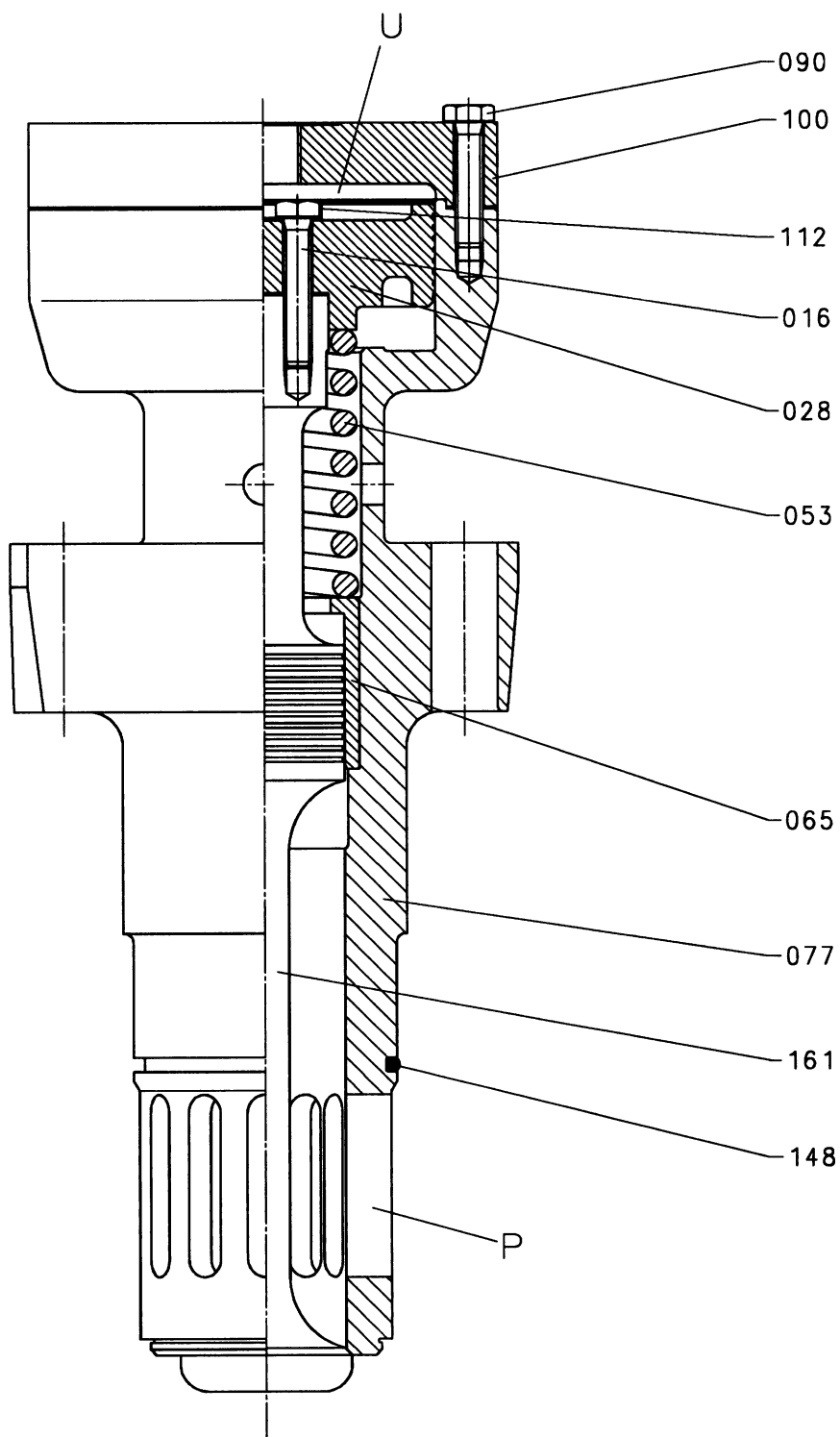




Item No.	Item Description
023	Screw
035	Pin
059	Disc
060	Searling ring
072	Bearing bracket
096	Guide disc in 2/2
106	Bearing bracket
118	O-ring
143	Sleeve
155	Claw coupling
179	Screw
180	Locking wire
202	Claw coupling
226	Claw coupling, complete

Item No.	Item Description





Item No.	Part Description	Item No.	Part Description
016	Screw		
028	Piston		
053	Spring		
065	Bushing		
077	Valve housing		
090	Screw		
100	Cover		
112	Locking plate		
148	Sealing ring		
161	Spindle		



General

Plate 90801

Each cylinder is equipped with an exhaust valve, which is mounted in a central bore in the cylinder cover. The valve housing is attached by means of four studs and nuts to form a gas-tight seal against a seat in the cylinder cover. The nuts are designed for tightening by means of hydraulic tools.

Valve housing

The valve housing has an exchangeable bottom piece provided with a hardened, conical seat for the valve spindle.

The bore for the valve spindle is provided with an exchangeable spindle guide.

The valve housing is water cooled. The cooling water is passed to the valve housing from the cylinder cover through a water transition. The water is discharged from the top of the valve housing.

The discharge pipe incorporates an orifice to restrict the cooling water flow through the exhaust valve housing.

On the front of the valve housing there is a cleaning cover through which the cooling water space can be checked and cleaned.

Spindle

The valve spindle is of the Nimonic type. Heat treatment of the seat area provides the required hardness.

On the lower cylindrical part of the valve spindle a vane wheel is fitted which causes the valve spindle to rotate while the engine is running.

To enable checking the functioning of the exhaust valve while the engine is running, a 'lifting/rotation check rod' is mounted on top of the hydraulic cylinder on the exhaust valve.

Spindle rotation is indicated by regular changes in the top and bottom positions of

the check rod during testing.

At the top of the spindle, two pistons are fitted:

1) Air piston

The piston serves to close the exhaust valve. The piston is locked to the spindle by a two-piece conical ring.

2) Hydraulic piston

The piston serves to open the exhaust valve.

The hydraulic piston has two piston rings and a damper arrangement, designed to dampen the closing of the valve.

Caution !

After overhauling of the exhaust valve, it is important to check the damper, to avoid knocking. This is done by means of a special bridge gauge.
See Vol. II, MAINTENANCE, Procedure 908-2.

The hydraulic piston is operated through a piping which communicates with a corresponding hydraulic piston in the actuating gear above the camshaft. This piston is, through the roller guide, actuated by the exhaust cam on the camshaft.

Air cylinder

The air cylinder is mounted on top of the valve housing. Air to close the exhaust valve is supplied below the piston through a non-return valve and a bore in the sealing air control unit.

A safety valve is mounted in the bottom of the cylinder.

Two sealing rings are mounted in the bottom of the air cylinder housing. A drain hole **D** between these rings reveals when the



sealing is not sufficient.

Note !

Be sure to use the correct type of sealing rings in connection with HVOF-coated spindles. These spindles are marked with 'HVOF' at the top.

Hydraulic cylinder

The hydraulic cylinder is mounted on the air cylinder on top of the exhaust valve housing by means of studs and nuts.

The exhaust valve is opened by the valve spindle being pressed down by the hydraulic piston in the hydraulic cylinder.

A throttle designed for deaerating the oil system is fitted at the top of the cylinder.

Oil which escapes through this throttle is led through a duct to the space around the air cylinder and is drained off through a bore **X**, together with leakage oil from the piston.

Sealing air

Plates 90801 – 90802

A sealing air arrangement is fitted around the spindle shaft under the bottom of the air cylinder. The sealing air is introduced below the sealing rings. The sealing air will prevent the exhaust gas and particles from penetrating upwards and wear-out the running surfaces and polluting the pneumatic system of the valve gear.

Sealing air is supplied from the air cylinder via a sealing air control unit, Plate 90802.

The oil mist content in the air from the air cylinder improves the service condition of the sealing rings.

The sealing air control unit contains a valve which automatically cuts off the air flow

when the engine is in FINISHED WITH ENGINE status, and a filter housing.

From the sealing air control unit the air is led to the sealing air arrangement through an orifice pipe.

Hydraulic Valve Actuating Gear

Plates 90805 – 90806

The exhaust valve is actuated by a cam on the camshaft through a hydraulic transmission.

A roller guide is kept in contact with the cam by the action of a helical spring which is fixed between the roller guide and the hydraulic cylinder so that the roller of the roller guide will follow the cam on the camshaft.

The hydraulic cylinder is attached to the camshaft housing by four studs, two of which are long enough to permit the spring of the roller guide to be gradually relieved during dismantling of the components.

The roller guide is prevented from turning by means of a guide block.

A piston, which is enclosed in the hydraulic cylinder, rests on a thrust piece in the neck of the roller guide and is locked to the roller guide by a bayonet lock.

The hydraulic cylinder on the camshaft housing is connected to the hydraulic cylinder on the exhaust valve by means of a high-pressure pipe.

Oil is supplied from the main lubricating oil system through a non-return valve in the top of the hydraulic cylinder.

Leakage oil from the hydraulic cylinder on the exhaust valve is drained through a pipe connection to the baseplate of the hydraulic cylinder on the camshaft housing. From there the oil is drained off through a bore to the camshaft housing.



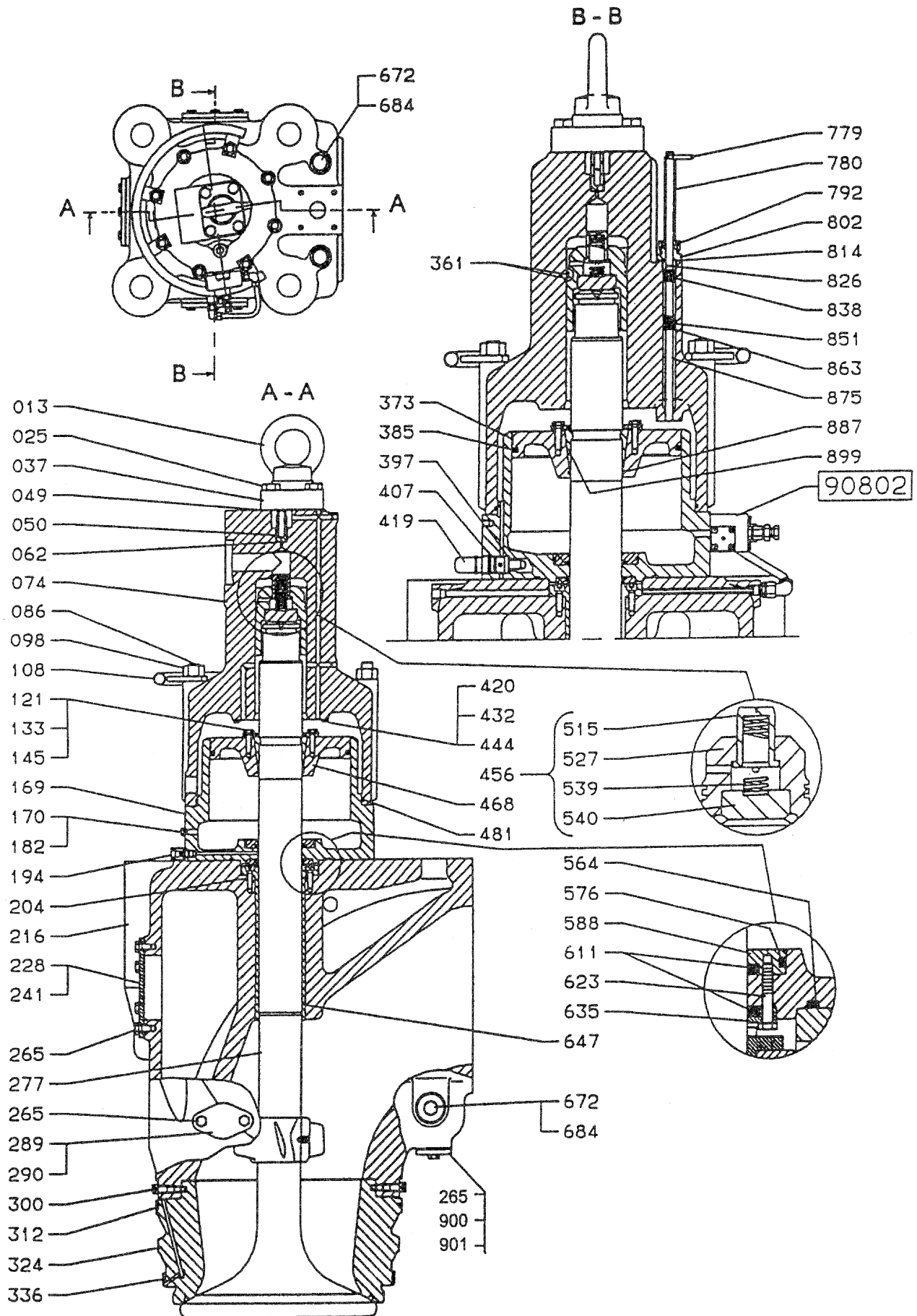
A special tool is delivered, which is able to retain the roller guide in its top position and thus put the exhaust valve out of action.

See Vol. II, MAINTENANCE, Procedure 908-5.

Another special tool is delivered, which is able to retain the exhaust valve spindle in the open position.

See Vol. II, MAINTENANCE, Procedure 908-6.

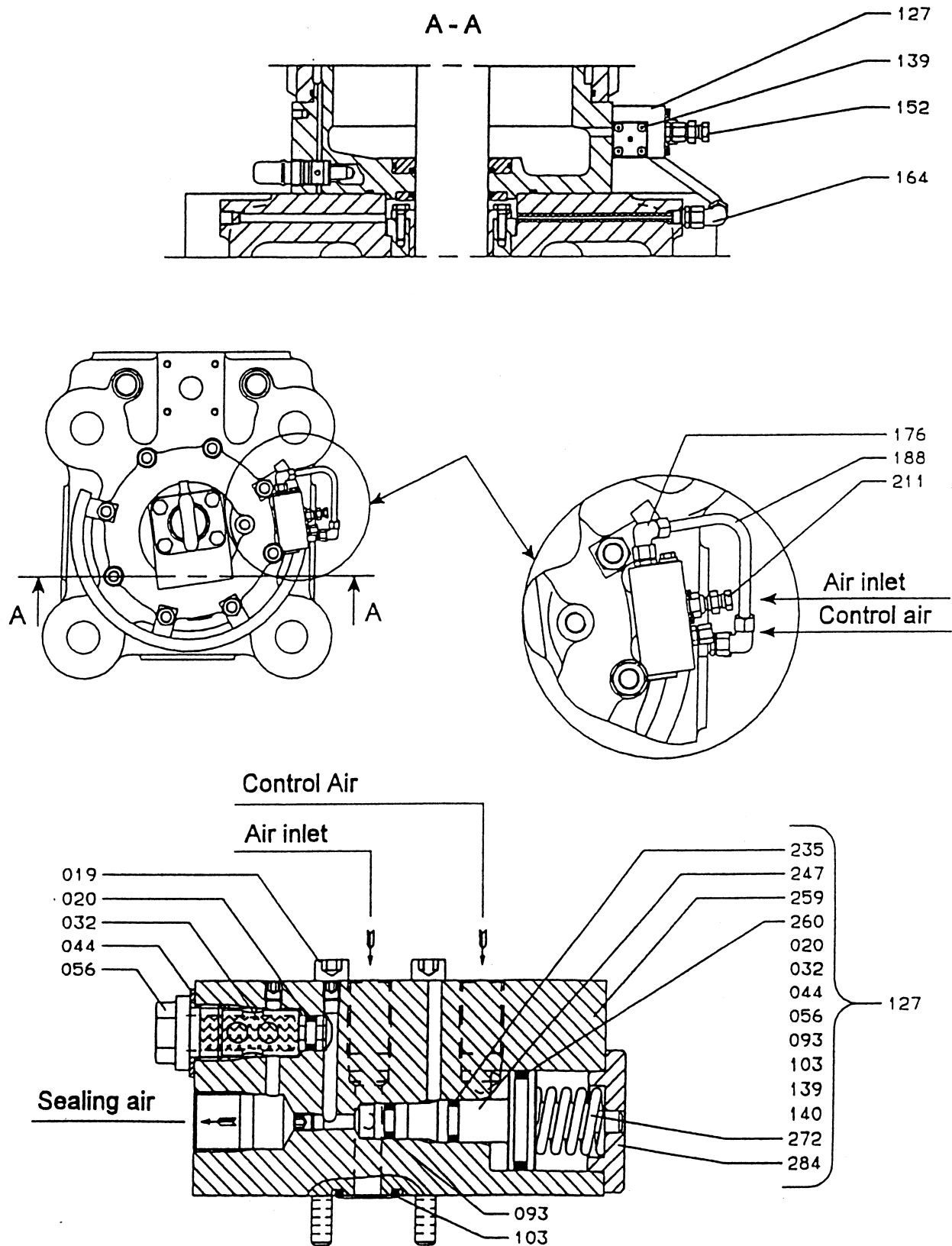




Item No.	Part Description
013	Lifting eye bolt
025	Screw
037	Lifting attachment
049	Gasket
050	Orifice
062	Gasket
074	Oil cylinder
086	Stud
098	Nut
108	Safety strap
121	Disc
133	Screw
145	Lock washer
169	Air cylinder
170	Plug screw
182	Gasket
194	Ball cock
204	Screw
216	Valve housing
228	Cover
241	Gasket
265	Screw
277	Valve spindle
289	Flange
290	Gasket
300	Stop screw
312	O-ring
324	Valve seat
336	O-ring
361	Piston ring
373	Guide ring
385	Sealing ring
397	Gasket
407	O-ring
419	Safety valve
420	Disc
432	Screw
444	Lock washer
456	Piston, complete
468	Piston
481	Sealing ring
515	Damper piston
527	Piston
539	Spring
540	Disc. please state height 24 mm
564	O-ring
576	O-ring

Item No.	Part Description
588	Flange
611	Sealing ring
623	Screw
635	Flange
647	Bushing
672	Gasket
684	Plug screw
779	Pin
780	Guide
792	Union nut
802	Screwed connection
814	Gasket
826	O-ring
838	Spring
851	Spring retainer
863	Spring pin
875	Rotation check rod
887	O-ring
899	Conical ring in 2/2

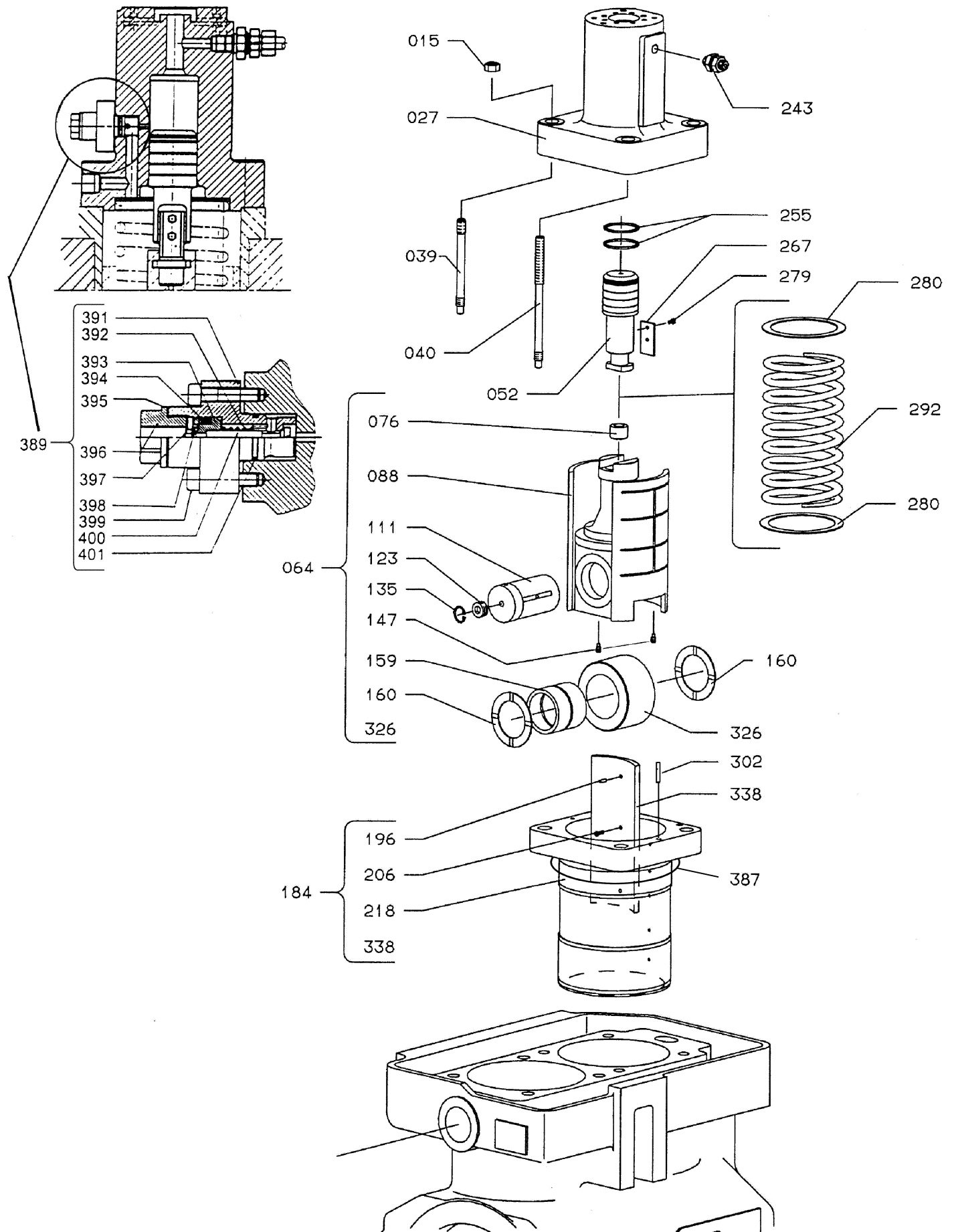




Item No.	Item Description
019	Screw
020	O-ring
032	Filter plate
044	Packing
056	Filter, complete
093	O-ring
103	O-ring
127	Sealing air control, complete
139	Screw
152	Coupling
164	Orifice pipe
176	Elbow coupling
188	Pipe
211	Non-return valve
235	O-ring
247	Valve spindle
259	Valve housing
260	Sealing ring
272	Spring
284	Cover

Item No.	Item Description





Item No.	Item Description
015	Nut
027	Oil cylinder
039	Stud
040	Stud
052	Piston
064	Roller guide, complete
076	Thrust disc
088	Roller guide
111	Shaft-pin for roller
123	Plug
135	Circlip
147	Screw
159	Bushing
160	Disc
184	Bushing for roller guide
196	Cylinder pin
206	Screw
218	Bushing
243	Non-return valve
255	Piston ring
267	Disc
279	Screw
280	Disc
292	Spring
326	Roller
338	Guide block
387	O-ring
389	Puncture valve
391	Hosing
392	Spring
393	Piston
394	Sealing ring
395	Packing ring
396	Socket
397	Nuts
398	Locking washer
399	Screw
400	Spindle
401	Sealing ring

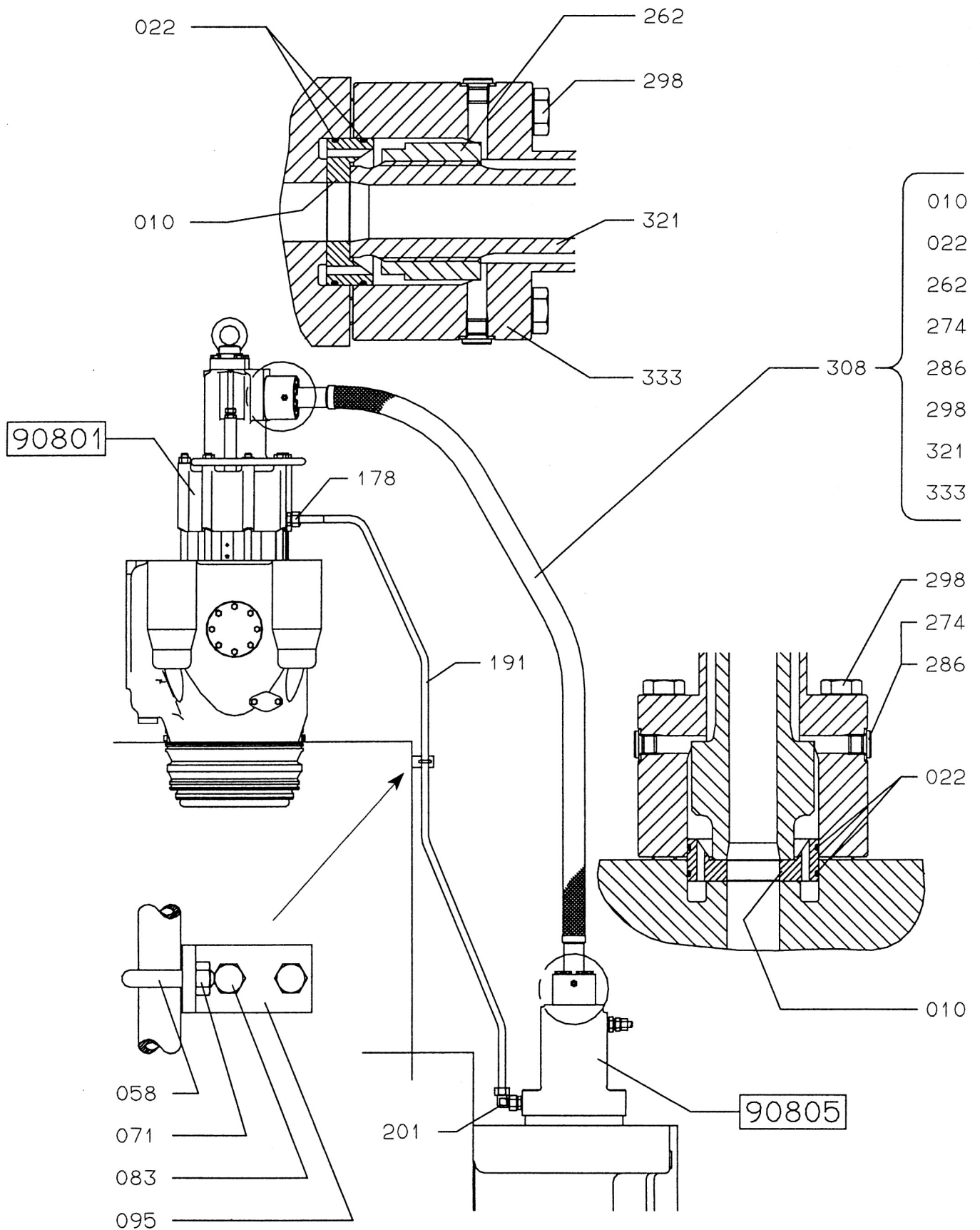
Item No.	Item Description







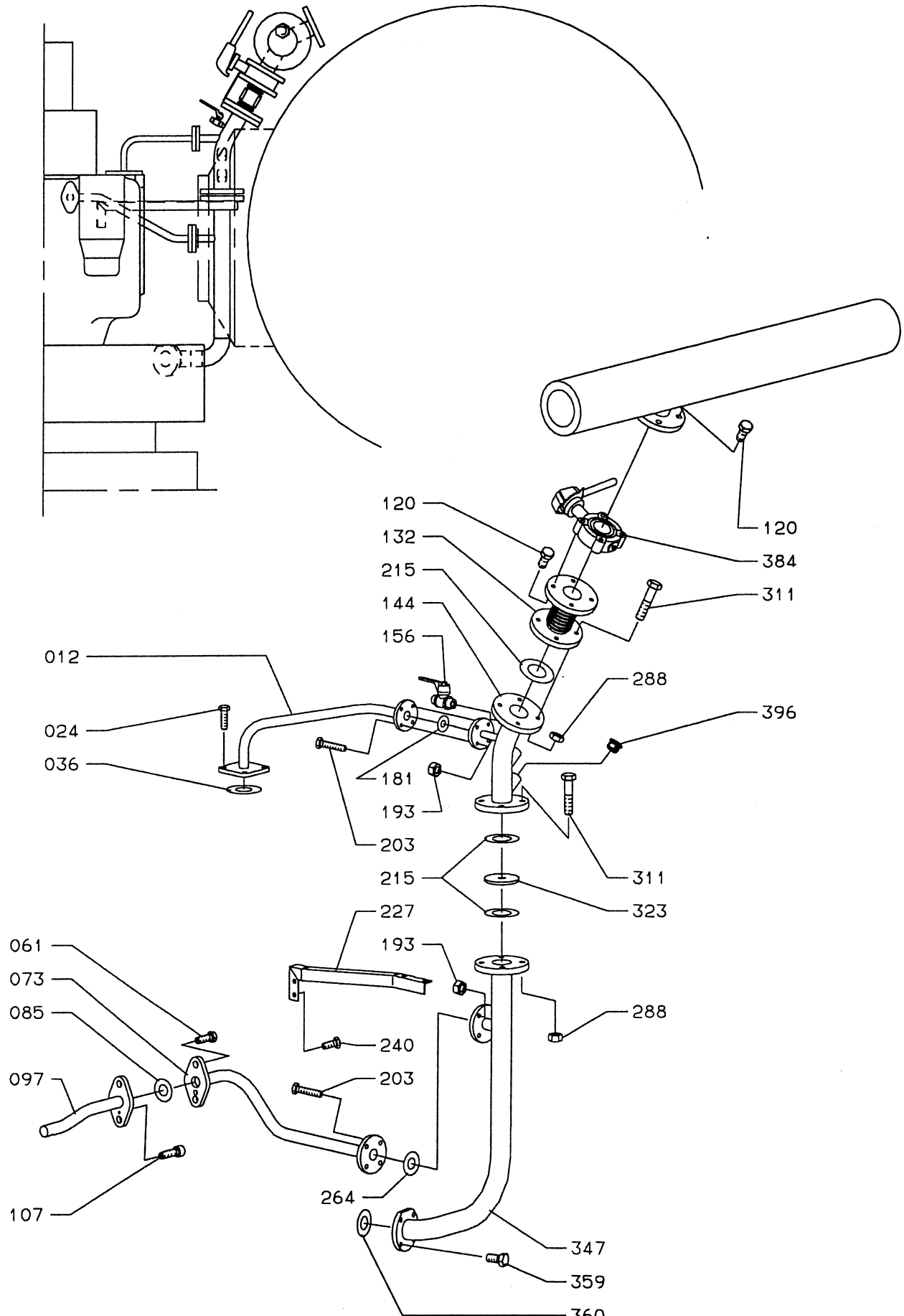




Item No.	Part Description
010	Sealing disc
022	Sealing ring
058	Clamp
071	Nut
083	Screw
095	Support
178	Union
191	Drain pipe
201	Elbow union
262	Thrust bushing
274	Plug screw
286	Gasket
298	Screw
308	High-pressure pipe, complete
321	High-pressure pipe
333	Flexible hose

Item No.	Part Description





Item No.	Part Description	Item No.	Part Description
012	Outlet pipe		
024	Screw		
036	Gasket		
061	Screw		
073	Inlet pipe		
085	Gasket		
097	Inlet pipe		
107	Screw		
120	Screw		
132	Compensator		
144	Outlet pipe		
156	Ball valve		
181	Gasket		
193	Nut		
203	Screw		
215	Gasket		
227	Support		
240	Screw		
264	Gasket		
288	Nut		
311	Screw		
323	Orifice plate		
347	Outlet pipe		
359	Screw		
360	Gasket		
384	Butterfly valve		
396	Plug screw		



Fuel Pump

Each engine cylinder is equipped with its own VIT (Variable Injection Timing) fuel pump, which is mounted on the roller guide housing over the camshaft section corresponding to the cylinder concerned.

The square base of the fuel pump housing is provided with a groove to receive any leaking oil, which is subsequently drained off through a drain pipe.

Two bores are provided in the base for toothed racks. The upper rack serves to adjust the injection timing via the timing guide, and the lower rack controls the quantity of fuel oil delivered by the pump via the regulating guide.

At the top, the pump housing is closed by a top cover, which incorporates a puncture valve. The cover is attached by means of nuts and studs fitted in the pump housing. A locating pin fitted at the top of the pump housing ensures correct positioning of the parts.

The underside of the top cover is fitted with a suction valve which also functions as a guide for the pump barrel. A sealing ring is fitted in the lower part of the suction valve, to seal between barrel and suction valve.

Oil is supplied through a flanged connection on the front of the pump housing. A corresponding flange on the back of the housing is fitted with a shock absorber which neutralizes the shock caused when the plunger uncovers the cut-off holes at the end of each delivery stroke.

The shock absorber consists of a cylinder with a spring-loaded plunger which is pressed back when the surplus oil from the delivery chamber is forced out into the inlet space round the pump barrel.

Two plug screws are fitted in the pump housing opposite the cut-off holes of the barrel. The oil jets which are ejected through the cut-off holes at the end of the delivery stroke, hit the plug screws, which

can be replaced when they are eroded.

Pump Barrel and Timing Guide

The pump barrel is guided at the top and bottom of the pump housing. Three low-friction sealing rings are fitted in grooves in the barrel to seal between barrel and housing. The barrel is provided with a drain bore between the two sealing rings in the lower end.

The pump barrel has a threaded lower end which fits into the internal threads of the timing guide.

The timing guide has a gear rim to mesh with the upper toothed rack at the base of the pump housing. The gear rim and toothed rack are marked with lines enabling the parts to be positioned correctly after disassembly. The toothed rack is linked to a servo-air cylinder which is controlled by the position of the regulating shaft. The position of the upper toothed rack determines the vertical position of the barrel relative to the plunger through the threaded connection.

In this manner the initial moment of fuel oil injection into the cylinder can be adjusted by the servo-air cylinder.

The pump barrel is prevented from turning by means of a guide screw mounted on the front of the pump housing.

Pump Plunger and Regulating Guide

The pump plunger is fitted within the barrel and ground accurately to form an oil-tight seal. Barrel and plunger must always go together and cannot be replaced individually.

During the travel of the plunger, two cut-off holes in the barrel are covered and uncovered. This function, in conjunction with the turning of the plunger effected by the regulating gear, serves to regulate the amount of oil injected into the engine cylinder.



The pump plunger is provided with a guide block designed to travel in the milled key-way in the regulating guide. At the bottom it has a foot which rests on a thrust disc in the bayonet joint at the roller guide neck. A clearance of approx. 0.1 mm between the plunger foot and the roller guide permits the plunger to turn in the roller guide.

The regulating guide has a gear rim which engages with the lower toothed rack at the base of the pump housing. The gear rim and toothed rack are marked with lines enabling the parts to be positioned correctly after disassembly. The toothed rack is linked together with the regulating gear of the engine through a spring-loaded connection. Thus, in the event of a sticking pump plunger, the regulating gear for the remaining fuel pumps will not be blocked.

Puncture Valve

A puncture valve is fitted in the top cover of the pump. The puncture valve consists of a piston which communicates with the control air system of the engine. In the event of actuation of the shut-down system, or the "Fuel Oil Leakage Alarm System", (option) or when STOP is activated, compressed air is supplied to the top of the piston, causing the piston with pin to be pressed downwards and 'puncture' the oil flow to the fuel valve. As long as the puncture valve is activated, the fuel oil is returned through bores to the pump housing, and no injection takes place.

Fuel Oil System

The fuel oil is supplied through a pipe on the front of the pump housing from the electrically driven circulating pump. The oil pressure is kept constant by means of the overflow valve, *Plate 90915*, which is located between the main fuel oil supply line to the pumps and the return line. The fuel pump and the fuel valves are designed for circulation of warm oil, enabling them to be preheated during standstill and in between the fuel oil injections.

Fuel Oil Injection

During the suction stroke the spring-loaded suction valve opens and the delivery chamber is filled with oil.

As soon as the plunger has covered the cut-off holes in the pump barrel during its upward movement, injection commences through the fuel valves. The vertical position of the cut-off holes thus controls the injection timing. Injection will last until the cut-off holes are uncovered by the oblique cut-off edges, following which the oil is forced through two milled grooves at the side of the plunger and out through the cut-off holes of the barrel during the rest of the stroke.

Fuel Pump Actuating Gear

A roller guide housing containing the fuel pump, the exhaust valve actuating gear and the indicator drive, is bolted on to the side of the cylinder frame.

In regard to design and functioning, the fuel pump roller guide is completely different from the exhaust valve roller guide (Chapter 908).

The roller guide for each fuel pump incorporates an angularly displaceable reversing link.

The fuel pump is actuated by a cam on the camshaft. The movement is transmitted through the roller guide to the plunger in the barrel of the pump housing which – through the high-pressure pipes – is connected with the fuel valves on the cylinder cover.

The roller guide is forced downwards by the action of two helical springs fixed between the roller guide and the pump base, so that the roller of the roller guide follows the cam on the camshaft. The pump base is attached to the camshaft housing by four studs.

The thread on two of these is long enough to permit the gradual easing of the roller



guide springs when dismantling the components. The plunger rests on a thrust piece in the neck of the roller guide and is locked to the roller guide by a bayonet lock. The roller guide itself is prevented from turning by means of a guide block mounted in the liner of the housing.

The top of the roller guide neck is located inside the pump base and is equipped with a cap which is fitted with a sealing arrangement. This cap, together with a sealing bush that is shrunk into the pump base, form a labyrinth to prevent fuel oil from entering the camshaft lube oil.

Each roller guide housing is provided with a manually operated lifting device which can lift the roller guide roller free of the fuel cam. The lifting device is mounted on the side of the roller guide housing.

For operation of the lifting device, see the instruction book, Volume II, Procedure 909-5.

Reversing mechanism

Reversing is achieved by shifting the roller in the fuel pump drive mechanism at each cylinder. The link connecting the roller guide and roller is provided with a reversing arm, and a pivot is mounted at the top end of the reversing arm. The pivot travels in a reversing guide connected to an air cylinder. The link is self-locking in either the AHEAD or ASTERN position without the aid of external forces. Each cylinder is reversed individually, and the reversing mechanism is activated by compressed air.

Fuel Oil High-Pressure Pipes

Plate 90913

All high-pressure pipes in the system are provided with flexible, steelwire-armoured hoses or a protective outer pipe. The space between the high-pressure pipe and the protective hose/pipe communicates, through drilled passages in the flanges, with a drain bore in the pump top cover.

Fuel Oil Leakage Alarm (Option)

Each fuel pump is, via drain pipes, connected to a common drain tank, which incorporates a level switch. The drain tank is also equipped with an overflow pipe, which has a small drain bore below, whereby oil from small leakages can be drained to the outlet, without actuating the level switch.

In the event of pipe fractures or major leakages in the system, the aforementioned bore will not be large enough to allow the increased oil quantity to pass, and the oil level in the drain tank will rise until it reaches the level of the overflow pipe. The rising oil level will cause the level switch to actuate an alarm.

Alternatively, the drain pipes of each fuel pump can be connected to a diaphragm valve, which sets off alarm and activates the puncture valve in order to stop the fuel oil flow from the pertaining cylinder.

Fuel Valve

The fuel valve consists of a valve head and a valve housing. Fitted within the valve housing is a non-return valve and a spindle and spindle guide with a pressure spring, and a nozzle.

The spindle may be provided with a cut-off slide. When the fuel valve is fitted in the cylinder cover, the valve parts are tightened together by the pressure from the securing nuts.

Functioning

The functioning of the fuel valve is as follows:

The electrical fuel oil primary pump circulates preheated oil through the fuel pump and fuel valve. The fuel oil passes through the fuel valve, leaving through a circulation bore and the return oil pipe on the valve head.

When the pressure at the beginning of the fuel pump's delivery stroke has reached the predetermined pressure, the circulating bores



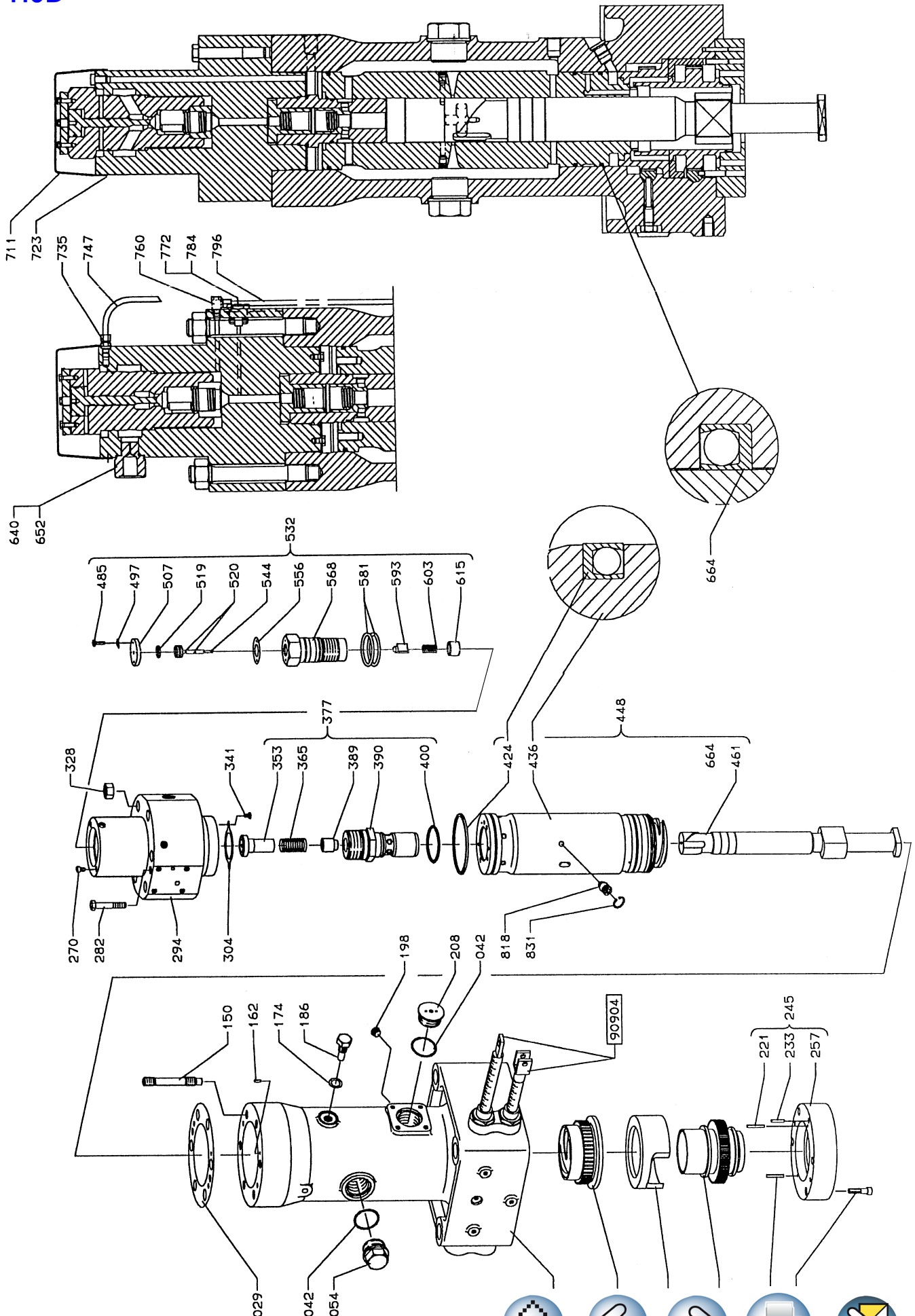
is closed.

When the pressure has reached the predetermined opening value for the fuel valve, the spindle will be lifted and oil injected through the nozzle into the engine cylinder.

On completion of the fuel pump's delivery stroke, the valve spindle is pressed against its seat and injection now ceases.

Then the circulating bore is uncovered, and oil starts to recirculate through the valve.

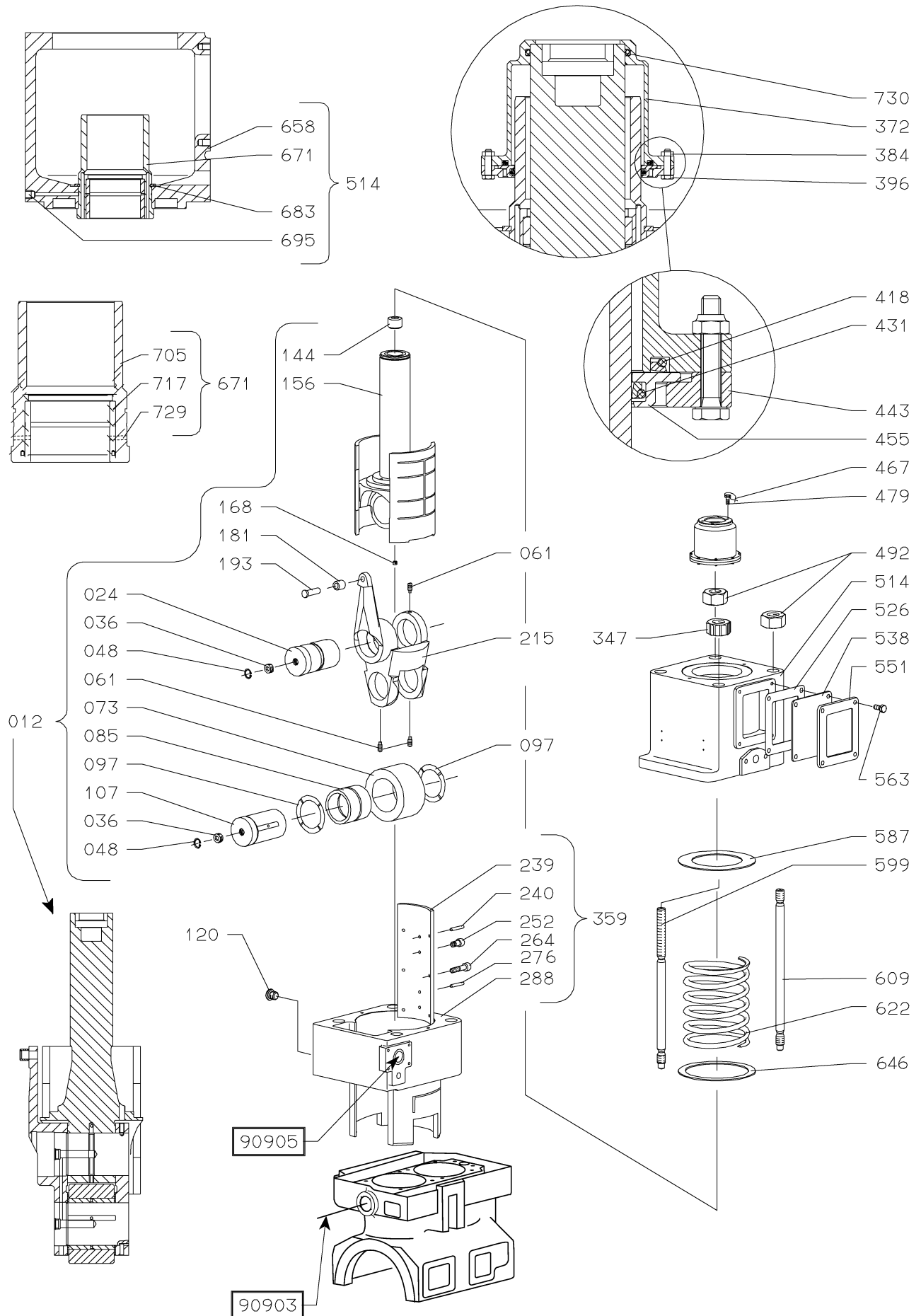




Item No.	Part Description
029	Packing
042	Gasket
054	Plug screw
078	Pump housing, complete
091	Timing guide
101	Sleeve
113	Regulating guide
125	Guide pin
137	Screw
150	Stud
162	Guide pin
174	Gasket
186	Guide screw
198	Plug screw
208	Throttle plug
221	Guide pin
233	Guide pin
245	Guide bushing, complete
257	Guide bushing
270	Screw
282	Screw
294	Top cover
304	Lock washer
328	Nut
341	Screw
353	Spring guide
365	Spring
377	Suction valve, complete
389	Slide
390	Valve thrust piece
400	Sealing ring
424	Sealing ring
436	Pump barrel
448	Pump barrel, complete
461	Plunger
485	Screw
497	Lock washer
507	Cover
519	Sealing ring
520	Sealing ring
532	Puncture valve, complete
544	Air piston
556	Gasket
568	Valve housing
581	O-ring
593	Slide
603	Spring
615	Spring guide
640	Throttle plug

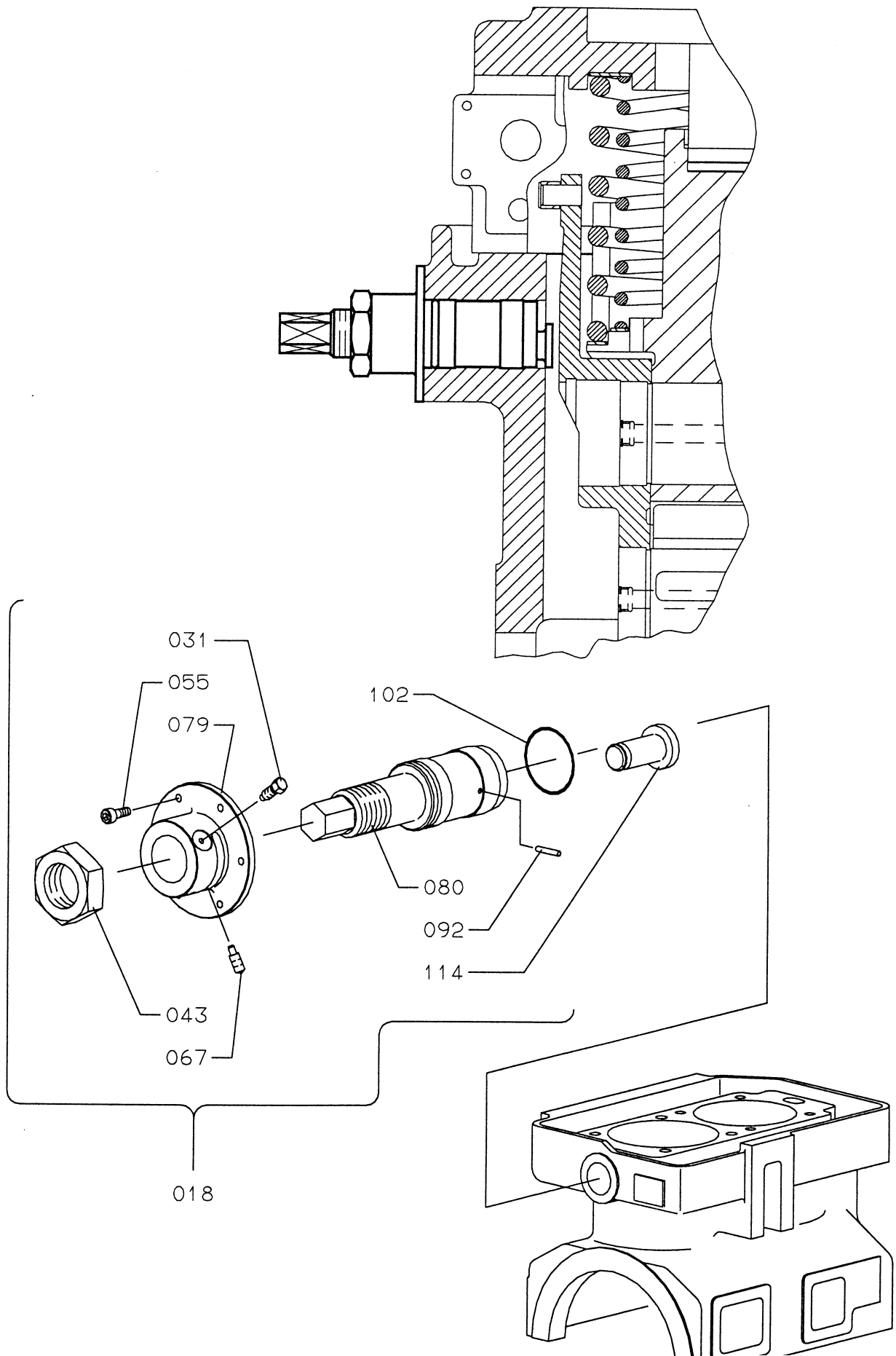
Item No.	Part Description
652	Gasket
664	Sealing ring
711	Protective cap
723	Screw
735	Coupling
747	Pipe, L=950
760	Banjo coupling
772	Plug screw
784	Disc
796	Pipe, L=670
818	Orifice plug
831	Circlip





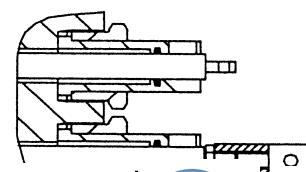
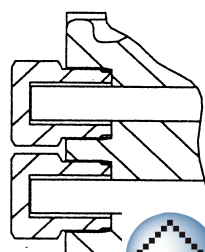
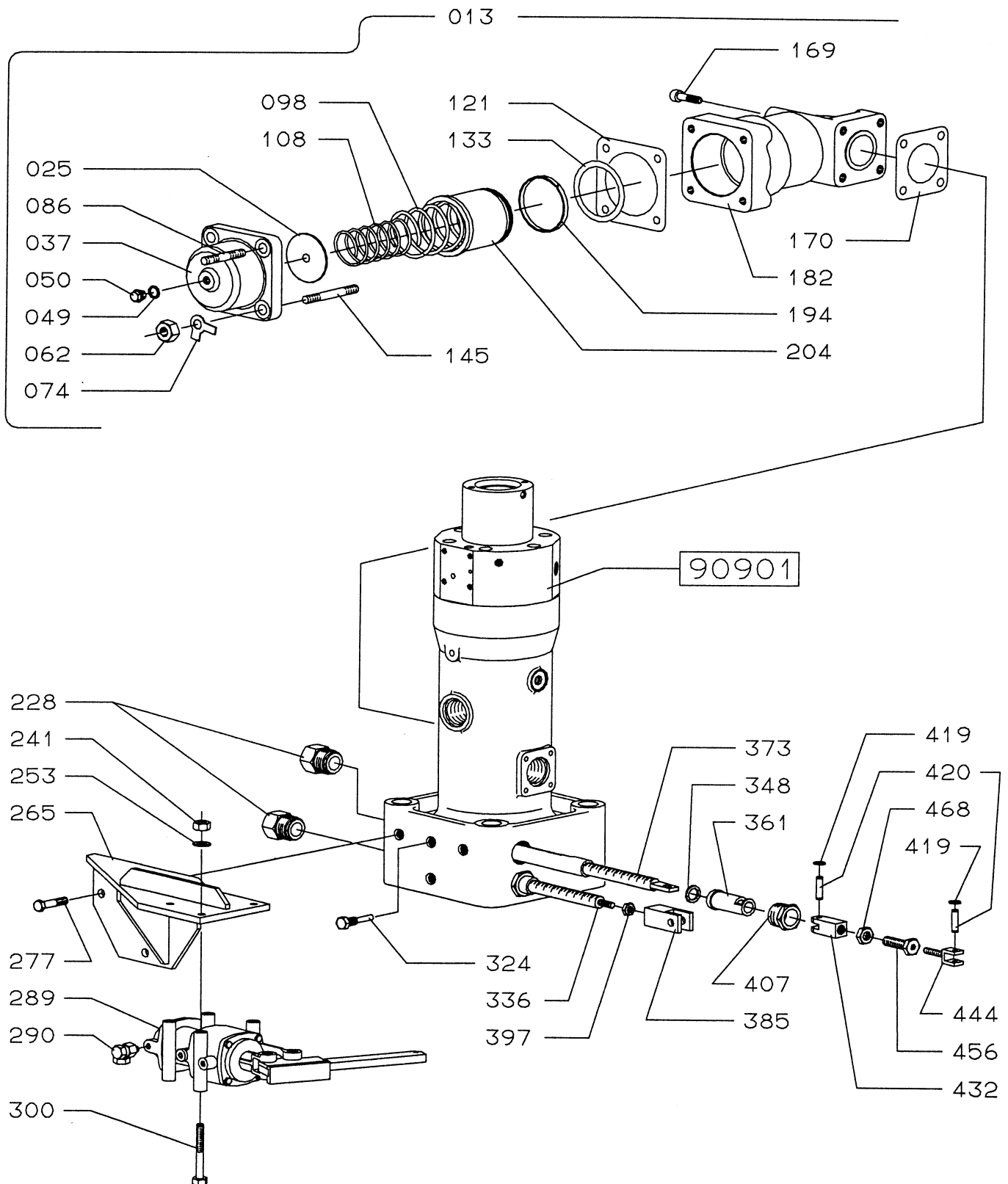
Item No.	Part Description	Item No.	Part Description
012	Fuel pump roller guide, complete		
024	Shaft-pin for link		
036	Plug		
048	Circlip		
061	Stop screw		
073	Roller		
085	Bushing		
097	Disc		
107	Shaft-pin for roller		
120	Guide pin		
144	Thrust disc		
156	Roller guide		
168	Plug		
181	Bushing		
193	Pin		
215	Link for reversing		
239	Guide block		
240	Guide pin		
252	Screw		
264	Screw		
276	Guide pin		
288	Bushing		
347	Nut		
359	Bushing for roller guide		
372	Cap		
384	Self-locking nut		
396	Screw		
418	Scraper ring, axial		
431	Scraper ring		
443	Flange		
455	Holder for scraper ring		
467	Locking wire		
479	Screw		
492	Nut		
514	Pump base, complete		
526	Packing		
538	Cover		
551	Guide plate		
563	Screw		
587	Disc		
599	Stud		
609	Stud		
622	Spring, external		
646	Disc		
658	Pump base		
671	Sealing bush, complete		
683	Retaining ring		
695	Plug screw		
705	Sealing bush		
717	Guide bushing		
729	Cup point screw		
730	Sealing ring		





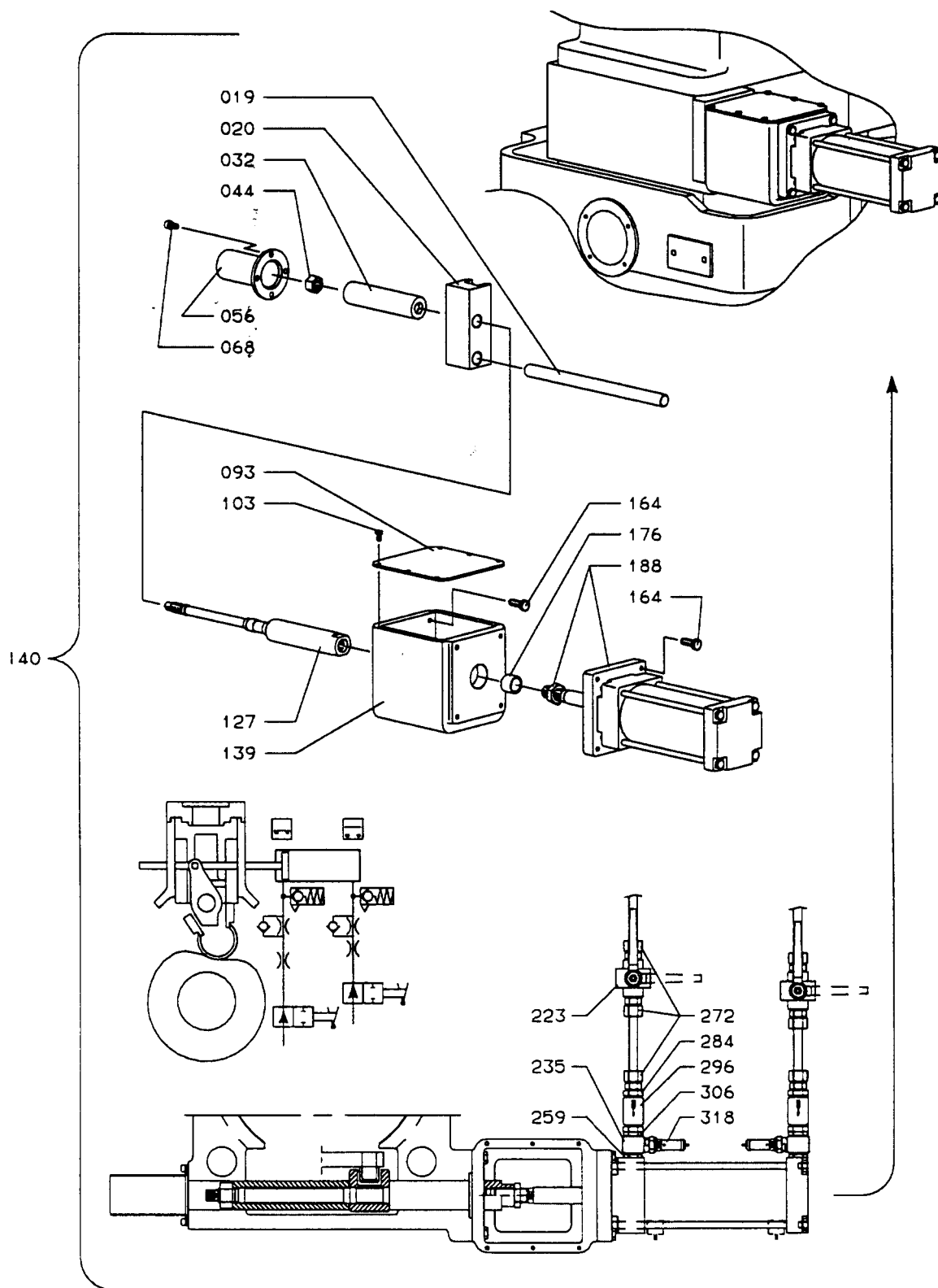
Item No.	Part Description	Item No.	Part Description
018	Lifting tool for roller guide		
031	Screw		
043	Nut		
055	Screw		
067	Guide screw		
079	Flange bearing		
080	Spindle		
092	Spring pin		
102	O-ring		
114	Catch		





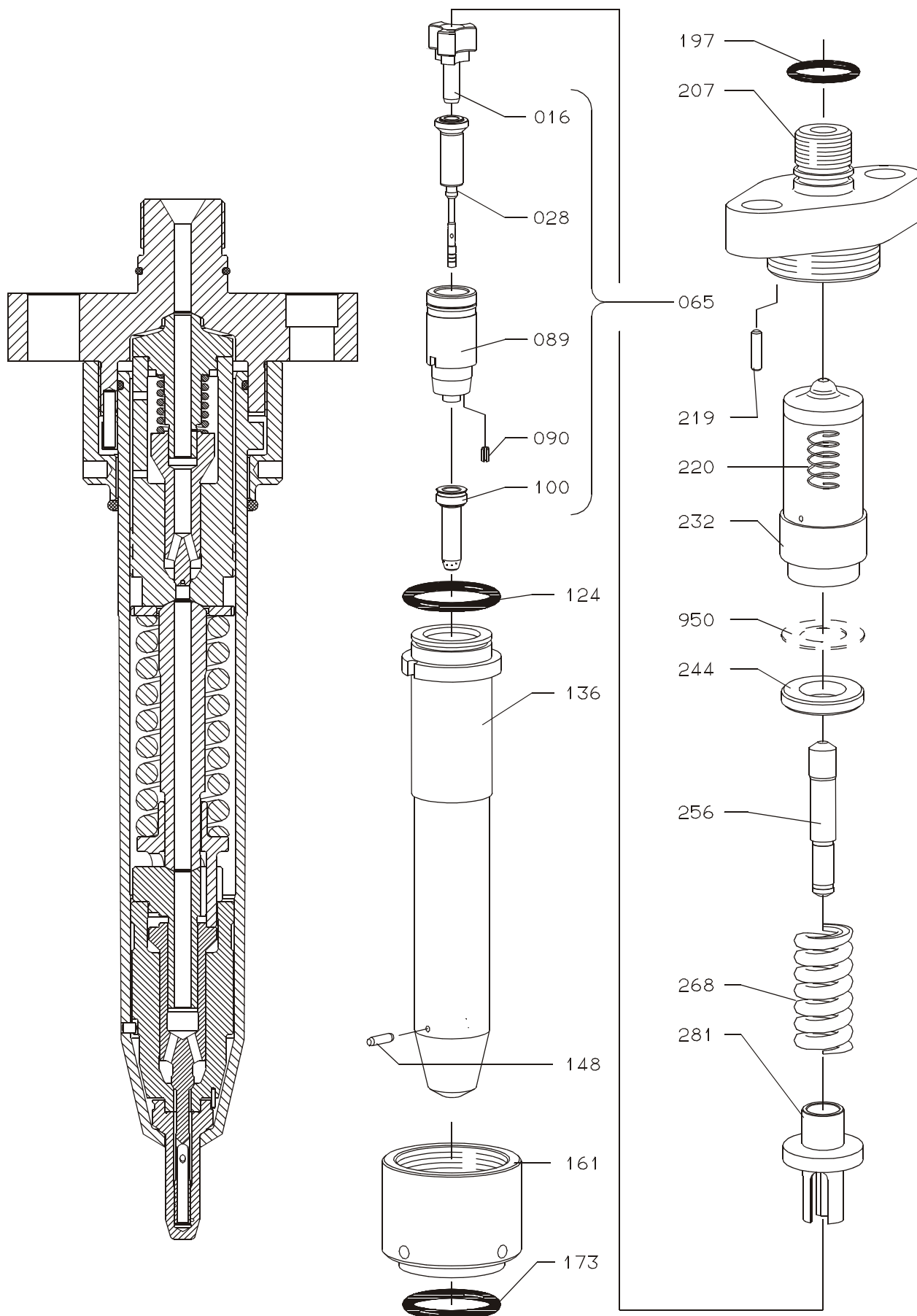
Item No.	Part Description	Item No.	Part Description
013	Shock absorber, complete		
025	Spring guide		
037	Bottom flange, complete		
049	Gasket		
050	Plug screw		
062	Nut		
074	Lock washer		
086	Stud, long		
098	Spring, external		
108	Spring, internal		
121	Gasket		
133	Sealing ring		
145	Stud, short		
169	Screw		
170	Gasket		
182	Housing		
194	Wearing ring		
204	Piston		
228	Plug screw		
241	Nut		
253	Washer		
265	Bracket		
277	Screw		
289	Actuator		
290	Banjo coupling		
300	Screw		
324	Guide screw		
336	Toothed rack for regulation		
348	Felt ring		
361	Pointer		
373	Toothed rack for timing		
385	Forked head		
397	Nut		
407	Union nut		
419	Circlip		
420	Pin		
432	Forked head		
444	Forked head		
456	Adjusting screw		
468	Nut		





Item No.	Part Description	Item No.	Part Description
019	Shaft		
020	Guide for reversing		
032	Distance pipe		
044	Nut		
056	Guard		
068	Screw		
093	Cover		
103	Screw		
127	Bolt		
139	Flange for air cylinder		
140	Reversing mechanism, complete		
164	Screw		
176	Bush		
188	Air cylinder		
223	Ball valve		
235	Branch pipe		
259	Nut		
272	Coupling		
284	Orifice plate		
296	Non-return valve		
306	Nut		
318	Safety valve		

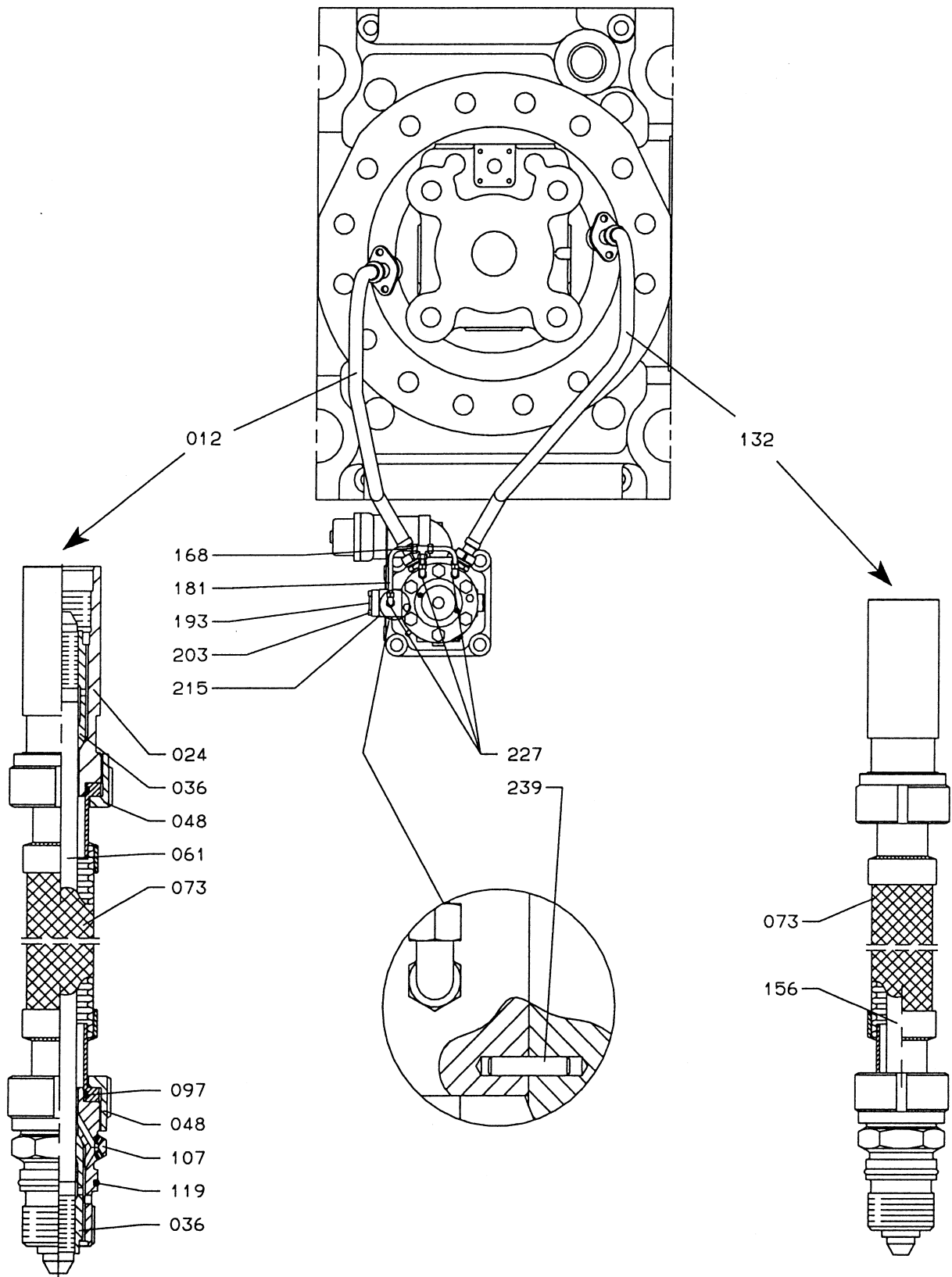




Item No.	Item Description
016	Thrust piece
028	Cut-off shaft
065	Spindle guide, complete
089	Spindle guide
090	Spring pin
100	Nozzle
124	O-ring
136	Holder
148	Guide pin
161	Union nut
173	O-ring
197	O-ring
207	Valve head
219	Guide pin
220	Spring
232	Non-return valve
244	Disc
256	Thrust spindle
268	Spring
281	Thrust foot
950	*) Additional disc, + 23 bar

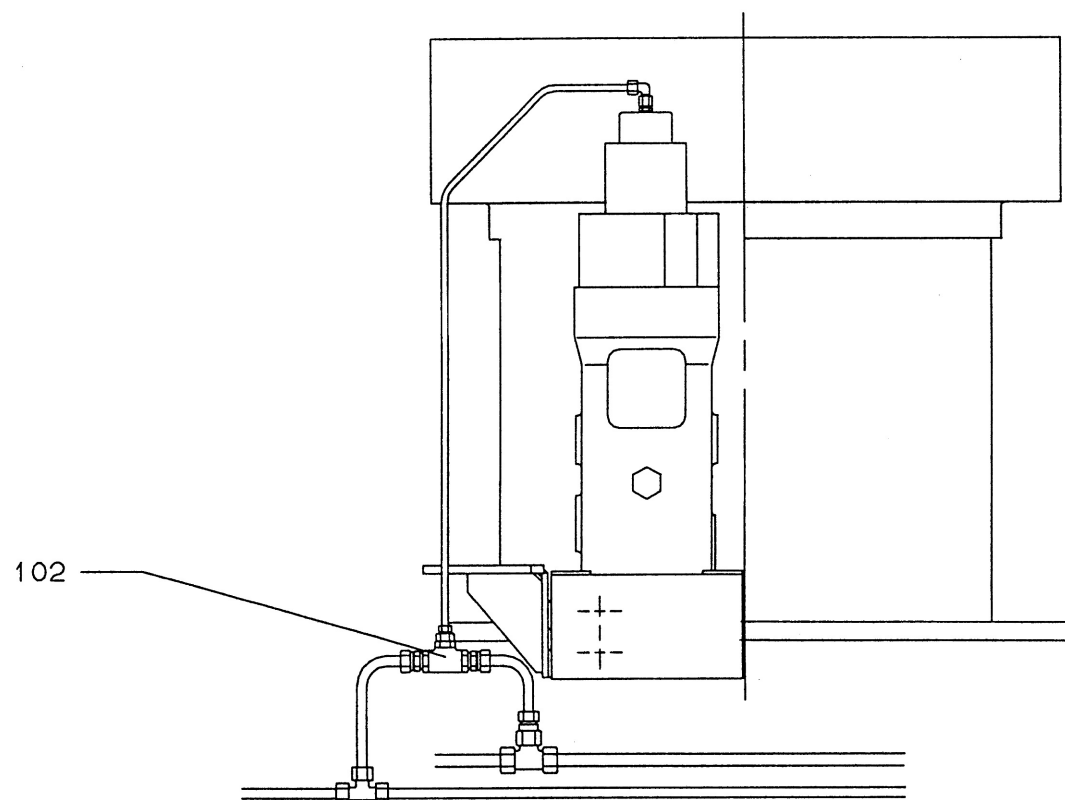
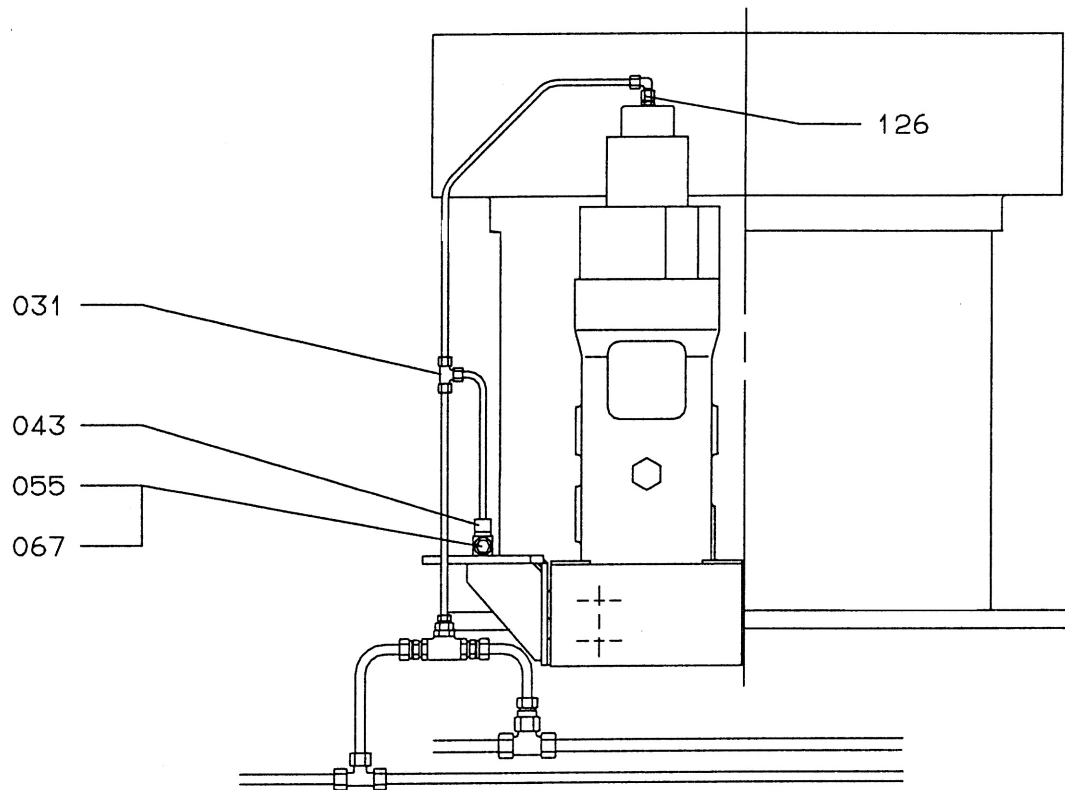
Item No.	Item Description

Notes: *) Optional extras



Item No.	Part Description	Item No.	Part Description
012	High-pressure pipe, complete		
024	Union nipple		
036	Thrust bush		
048	Union nut		
061	High-pressure pipe		
073	Flexible hose, complete		
097	O-ring		
107	Union nipple		
119	O-ring		
132	High-pressure pipe, complete		
156	High-pressure pipe		
168	T-coupling		
181	Pipe		
193	Flange		
203	Screw		
215	Housing		
227	Coupling		
239	Guide pin		

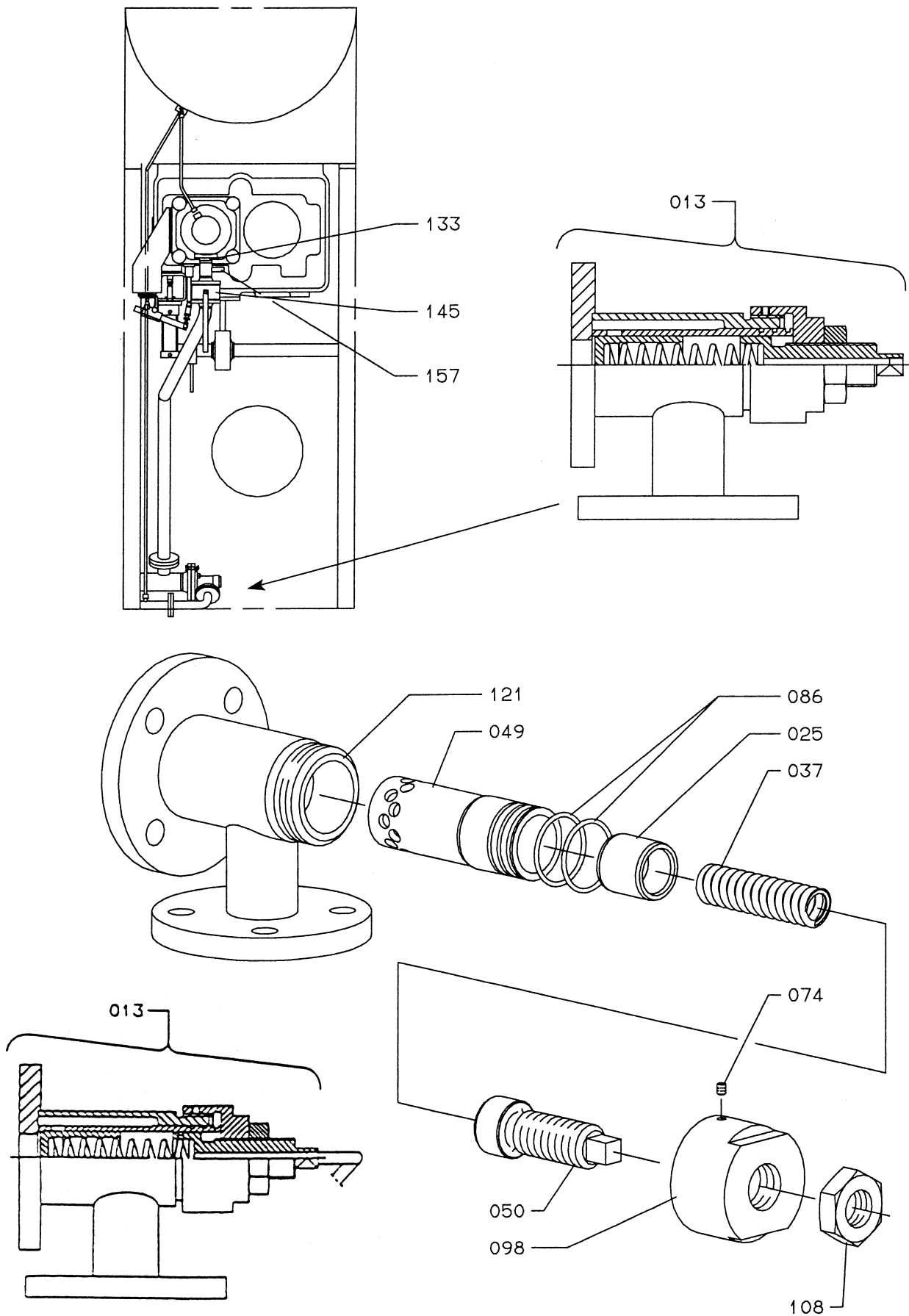




Item No.	Item Description
031	Coupling
043	Coupling
055	Pressur switch
067	Screw
102	Non-return valve
126	Coupling

Item No.	Item Description





Item No.	Part Description
013	Overflow valve, complete
025	Piston
037	Spring
049	Valve housing
050	Spring guide
074	Cup point screw
086	O-ring
098	Union nut
108	Nut
121	Housing
133	Fuel oil pipe
145	Shut-off valve
157	Plug screw

Item No.	Part Description



(Regarding the turbocharger, see the producer's special instructions)

The engine is supplied with scavenge air from one or two turbochargers located on the exhaust side.

The engine exhaust gas drives the turbine wheel of the turbocharger and, through a common shaft, the turbine wheel drives the compressor wheel.

The compressor draws air from the engine room, through the air filters. From the compressor outlet, the air passes through the charging air pipe to the charging air cooler (Plate 91005) where the air is cooled down.

The charging air pipe, with compensator, is insulated and can be clad internally with a sound-absorbing material.

The air cooler is designed to separate condensate from the air. See also 'Charging Air Cooler' in this Chapter.

The air is pressed into the scavenge air receiver through a valve housing mounted in the bottom of the receiver. The valve housing is provided with a number of non-return valves (flap valves), which open by pressure from the turbocharger.

From the scavenge air receiver, the air flows to the cylinder through the scavenge air ports when the piston is in the bottom position. When the exhaust valves open, the exhaust gas is pressed into a common exhaust gas receiver (Plate 91003), from where the gas drives the turbine of the turbocharger with an even and steady pressure.

Scavenge Air Receiver

Plate 91001

The scavenge air receiver is a container having a large volume. The receiver is bolted on to the cylinder blocks.

Scavenge air is collected in the receiver after the air has passed through the cooler, the water mist catcher and the valve housing.

The receiver and the cylinder blocks communicate through circular openings.

The two auxiliary blowers are placed at either end of the receiver. The suction side of the auxiliary blowers is connected to the space below the non-return valves of the valve housing via a suction pipe. The discharge side is connected to the scavenge air receiver.

A non-return valve is installed in the suction pipe of each auxiliary blower, to prevent reversed air flow. *See also item, "Non-return valves", further on.*

The scavenge air receiver is provided with man-hole covers and also a safety valve (Plate 91103).

Running with Auxiliary Blowers

During starting of the engine, and when the engine is running at low load the turbocharger is not able to supply enough air for the engine process. In these cases a pressure switch will automatically start the auxiliary blowers.

When the auxiliary blowers are operating, they draw air from the engine room through the turbocharger's air filter and compressor side.

This enables the turbocharger to maintain a reasonable number of revolutions during starting and at low load.

The air passes through the charging air pipe, the charging air cooler, the water mist catcher, the non-return valve and the suction pipe, to the suction side of the blowers. From the blowers, the air is discharged to the scavenge air receiver.

The non-return valves fitted in the valve housing, in the scavenge air receiver, are now closed due to partial vacuum and gravitation acting on the valve flaps.

A lack of air supply will occur if the non-return valves do not close.



Non-Return Valves

It is of the utmost importance that the non-return valves of the auxiliary blowers always function correctly and move easily. This can be checked by moving the valves manually, e.g. in connection with the regular scavenge part inspections.

The non-return valves protect the blowers and engine during:

- Starting the auxiliary blowers
- Running with auxiliary blowers.

Starting the auxiliary blowers:

- 1) Owing to the relatively high starting current, the blowers start in sequence, with 6-10 seconds in between.

The non-return valve of the blower that has not yet started must be in the closed position to prevent the blower from rotating backwards. Otherwise, there is a risk of burning out the electric motor when it starts.

- 2) If an auxiliary blower fails to start, the non-return valve must be in the closed position. Otherwise, the operating blower will not be able to draw fresh air in through the turbocharger and air cooler. This is due to differences in the air flow resistance.

Running with auxiliary blowers:

In the event of failure of an auxiliary blower during running, the non-return valve must close to ensure the continued supply of fresh air to the engine.

See 'Starting the auxiliary blowers', Item 2, above.

Exhaust Gas Receiver

Plate 91003

From the exhaust valves, the exhaust gas is led to the exhaust gas receiver where the pulsatory pressure from the individual exhaust valves is equalized and led to the turbocharger at a constant pressure.

The exhaust gas receiver is fastened to the seating by flexible supports. Compensators are inserted between the receiver and the exhaust valves, and between the receiver and the turbocharger.

Inside the exhaust gas receiver, a protective grating is mounted before the turbocharger.

For quick mounting and dismantling of the joints between the receiver and the exhaust valves, clamping rings are used to hold the parts together. The exhaust gas receiver and the exhaust pipe are insulated.

The exhaust receiver may be provided with by-pass flanges for:

- Emergency running without turbochargers
- Improvement of fuel consumption at part load
- Turbo Compound system (TCS).

Charging Air Cooler

Plate 91005 L-KM Type

The charging air cooler insert is of the block type. It is mounted in a housing which is welded up of steel plates.

The cooler housing is provided with inspection covers.

The air cooler housing has been prepared for cleaning of the cooler insert without removing it. This is achieved by means of a built-in spray-arrangement.



See also Volume II, 'Maintenance', Chapter 910.

The cooler is designed with an air reversing chamber which has a water mist catcher incorporated. The water mist catcher is built up of a number of lamellas which separate the condensation water from the scavenge air during the passage of the air flow.

The separated water is collected in the bottom of the cooler housing from where it is removed by a drain system.

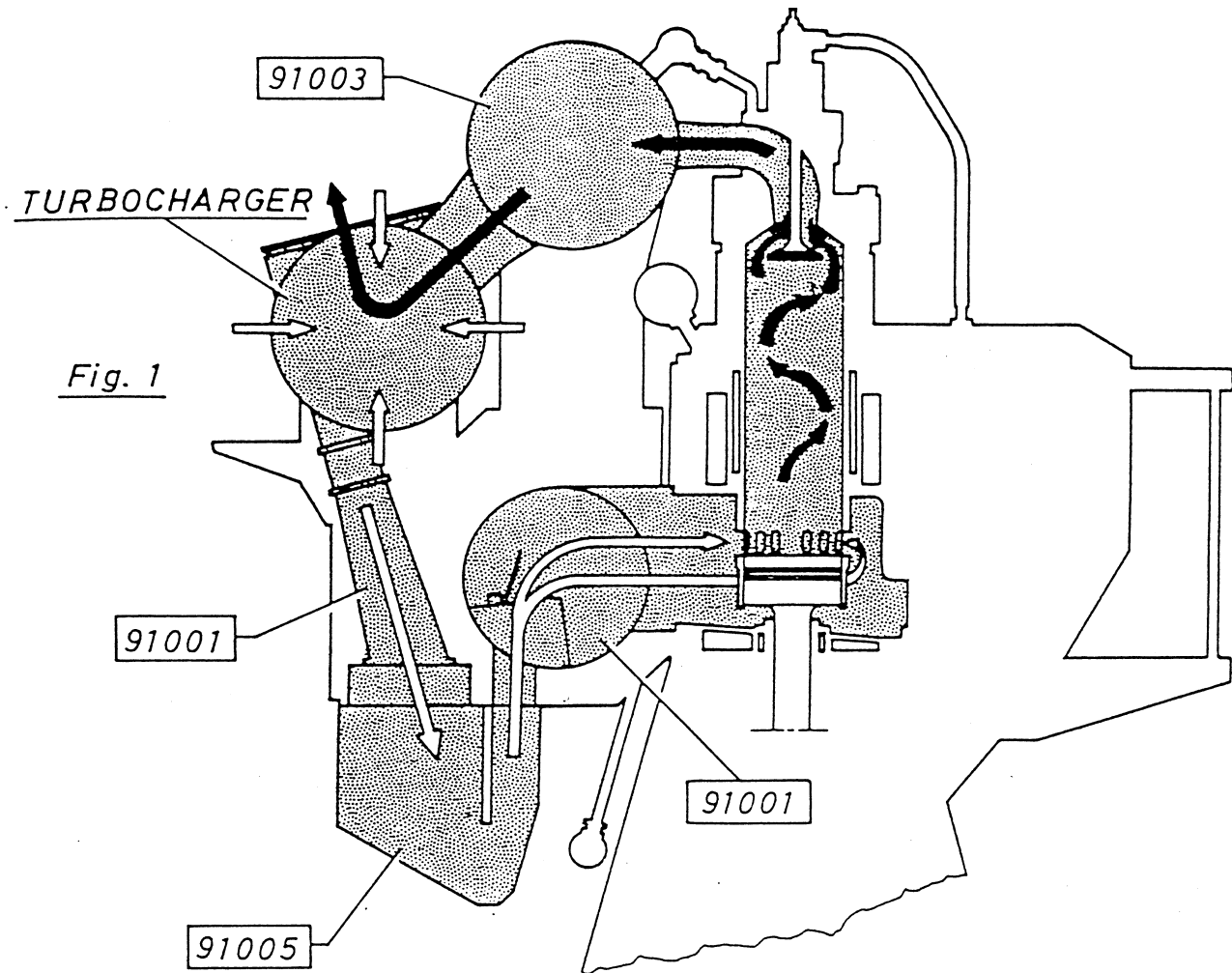
Caution !
It is important to check that the drain functions correctly, as otherwise water droplets may enter the cylinders. <i>See Volume I, OPERATION, Chapter 706, 'Cleaning of Turbochargers and Air Coolers'.</i>

An alarm device for high water level in the drain system is installed.

EI. Panels for Auxiliary Blower

See special instructions supplied by the engine builder.





AUXILIARY BLOWER SYSTEM

Fig. 2

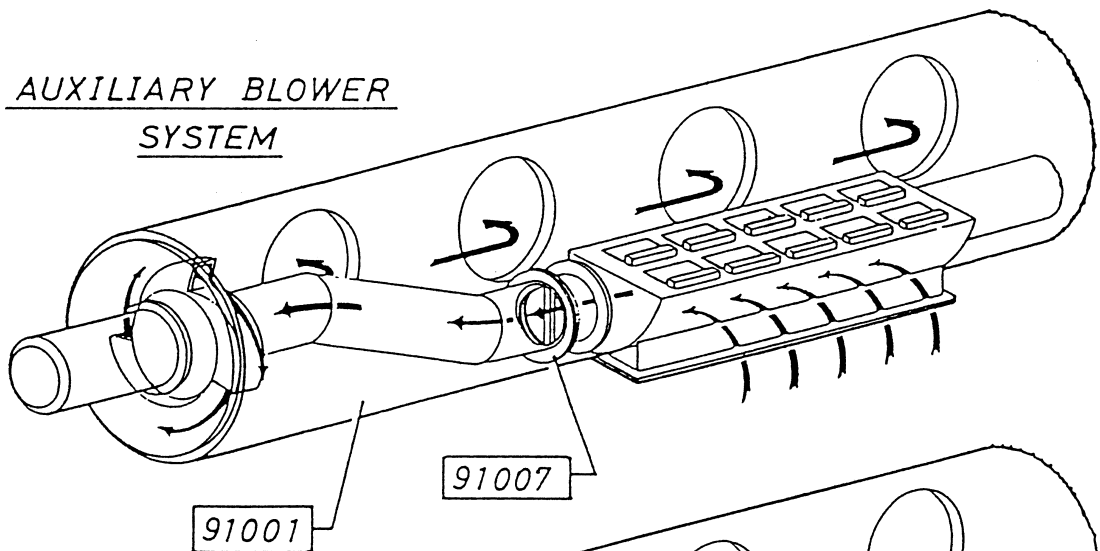
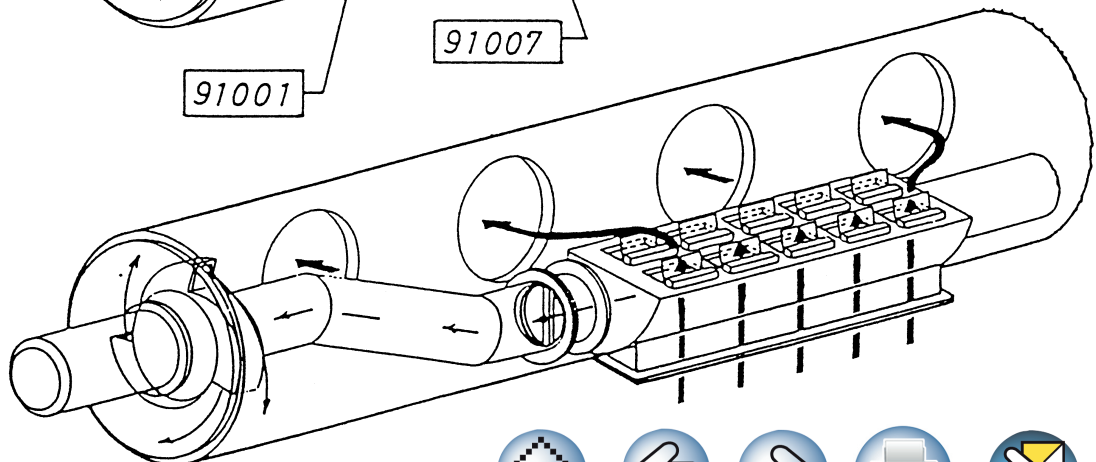
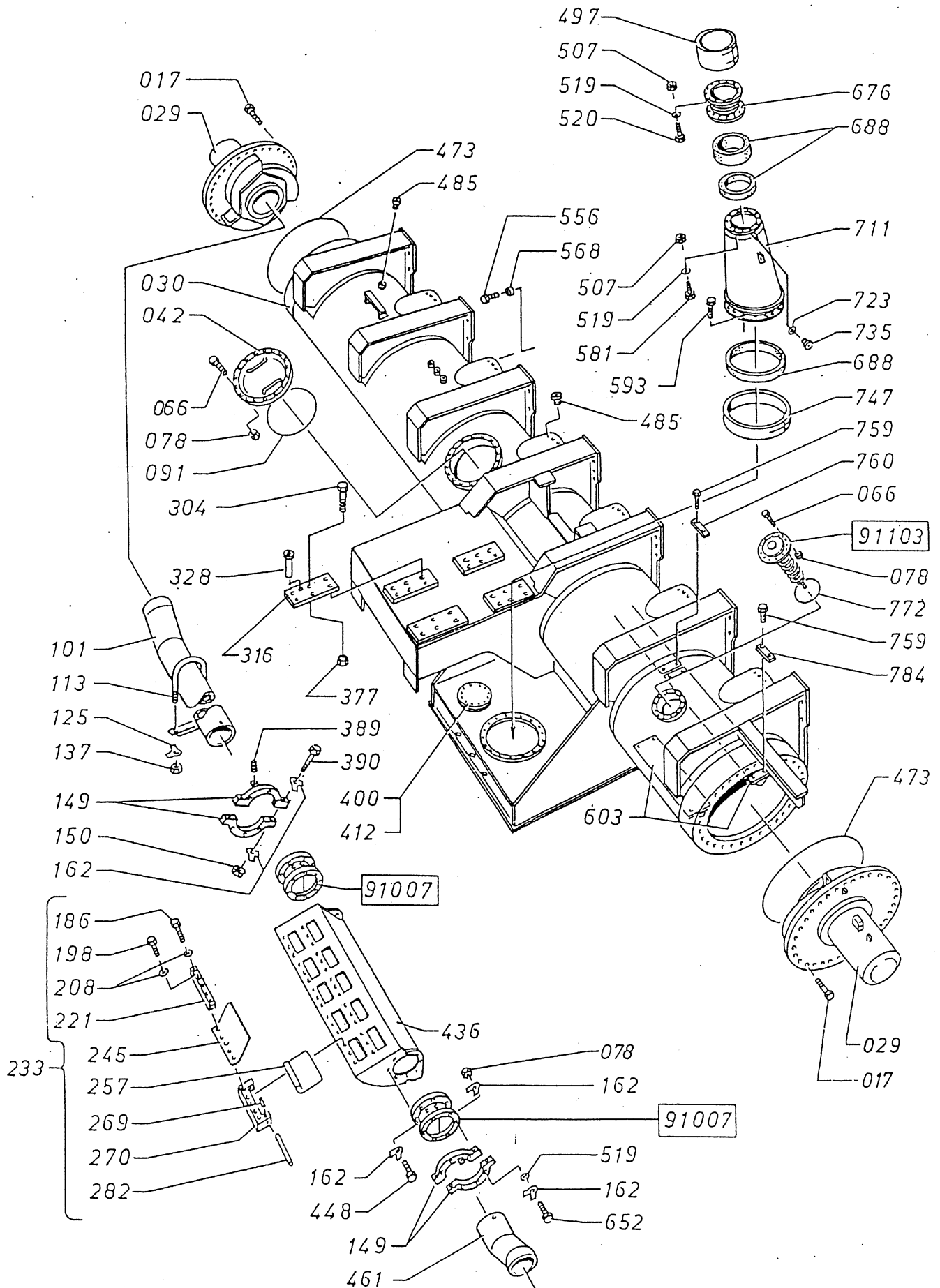


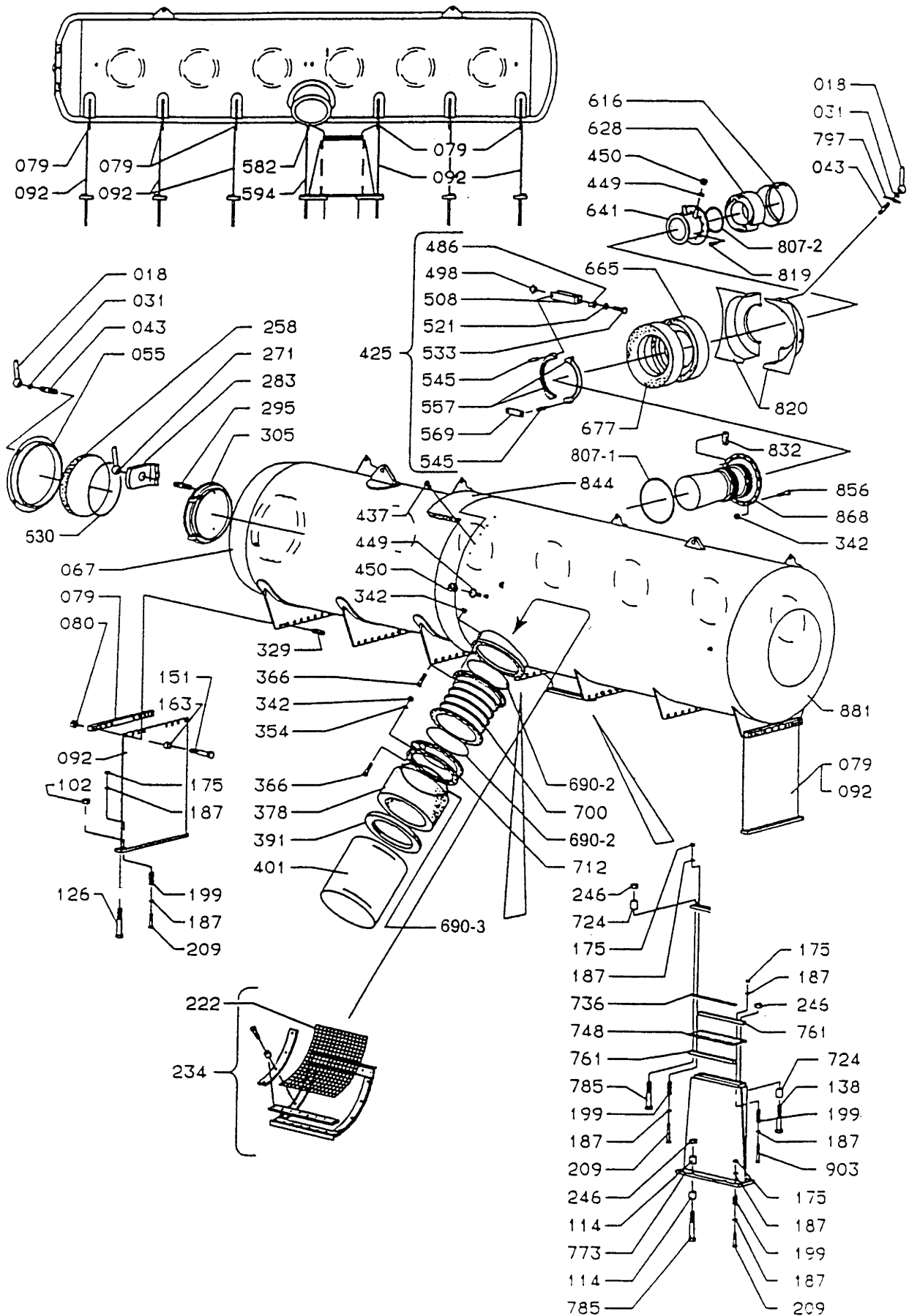
Fig. 3





Item No.	Part Description	Item No.	Part Description
017	Screw	652	Screw
029	Auxiliary blower	676	Compensator
030	Scavenge air receiver	688	Insulation material
042	Cover	711	Charging air pipe
066	Screw	723	Gasket
078	Nut	735	Plug screw
091	Packing	747	Cover plate
101	Suction pipe	759	Screw
113	Clamp	760	Locking plate
125	Lock washer	772	Gasket
137	Nut	784	Locking washer
149	Disc, special		
150	Nut		
162	Lock washer		
186	Screw		
198	Screw		
208	Spring washer		
221	Clamp		
233	Non-return valve, complete		
245	Stop plate		
257	Valve flap		
269	Spring pin		
270	Support		
282	Shaft		
304	Screw		
316	Shim		
328	Guide pin		
377	Nut		
389	Guide screw		
390	Screw		
400	Cover		
412	Screw		
436	Valve box		
448	Screw		
461	Suction pipe		
473	Packing		
485	Plug screw		
497	Cover plate		
507	Nut		
519	Washer		
520	Screw		
556	Screw		
568	Distance pipe, L=60		
581	Screw		
593	Screw		
603	Foot plate		

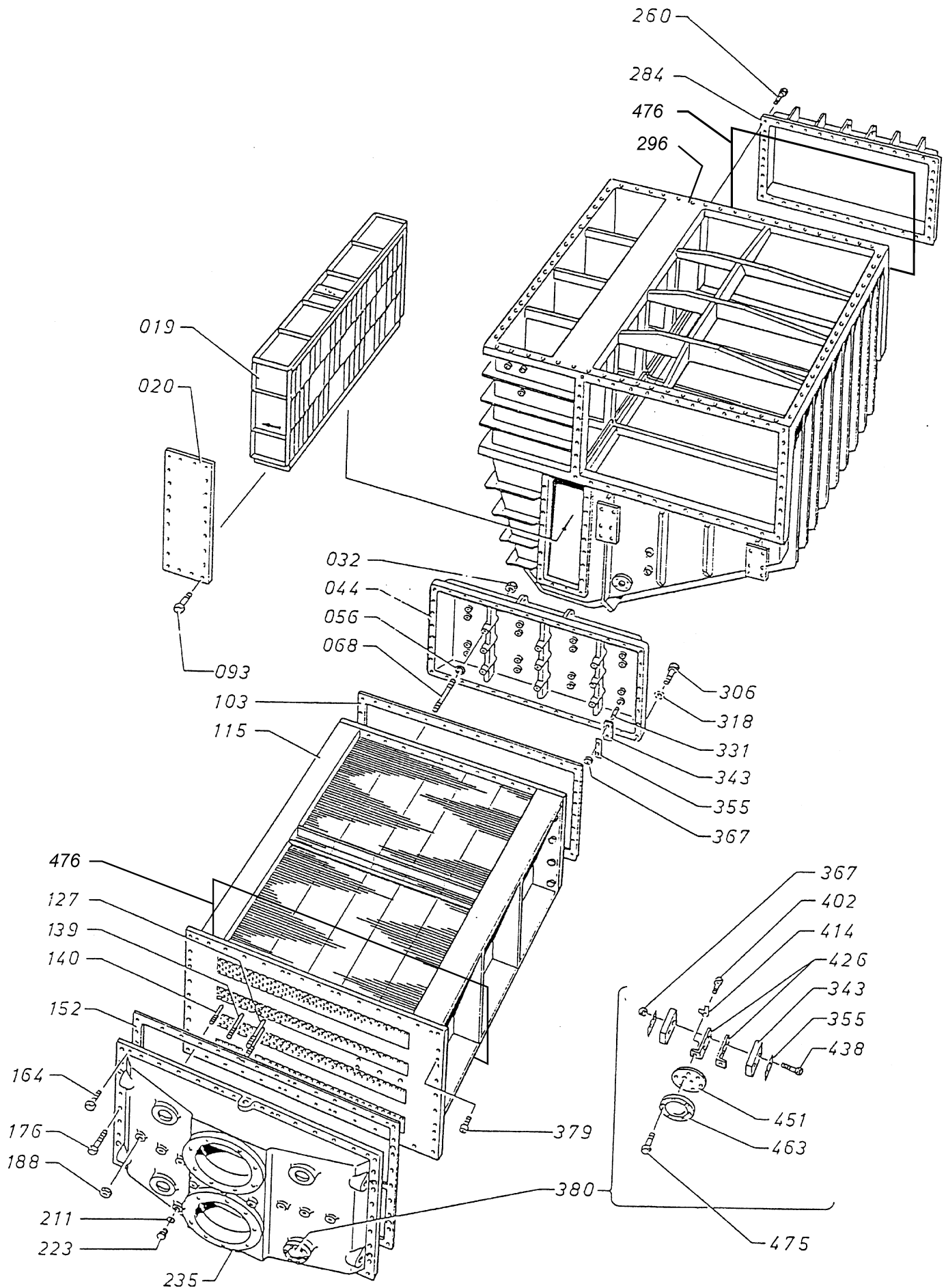




Item No.	Part Description	Item No.	Part Description
018	Wing nut	616	Insulation cover
031	Washer	628	Insulation material
043	Stud	641	Exhaust pipe
055	Cover	665	Glass fibre cloth
067	Exhaust receiver	677	Insulation material
079	Clamp	700	Compensator
080	Nut	712	Gas inlet
092	Support	724	Distance pipe, L=45
102	Nut	736	Shim
114	Distance pipe, L=25	748	Spring plate
126	Screw	761	Clamp
138	Screw	773	Support
151	Screw	785	Screw
163	Distance pipe, L=30	797	Plate
175	Nut	819	Screw
187	Washer	820	Insulation plate
199	Spring pin	832	Support
209	Screw	844	Insulation material
222	Wire gauze	856	Screw
234	Grid, complete	868	Compensator
246	Nut	881	Insulation cover
258	Insulation material	903	Screw
271	Wing nut	690-2	Packing Exhaust gas
283	Clamp	690-3	Packing Exhaust gas
295	Stud	807-1	Packing Exhaust gas
305	Cover	807-2	Packing Exhaust gas
329	Spring pin		
342	Nut		
354	Washer		
366	Screw		
378	Insulation material		
391	Insulation material		
401	Insulation cover		
425	Flange clamp, complete		
437	Screw		
449	Gasket		
450	Plug screw		
486	Lock washer		
498	Special nut		
508	Lock		
521	Nut		
530	Packing Exhaust gas		
533	Screw		
545	Pin		
557	Flange clamp in 2/2		
569	Link		
582	Clamp		
594	Support		

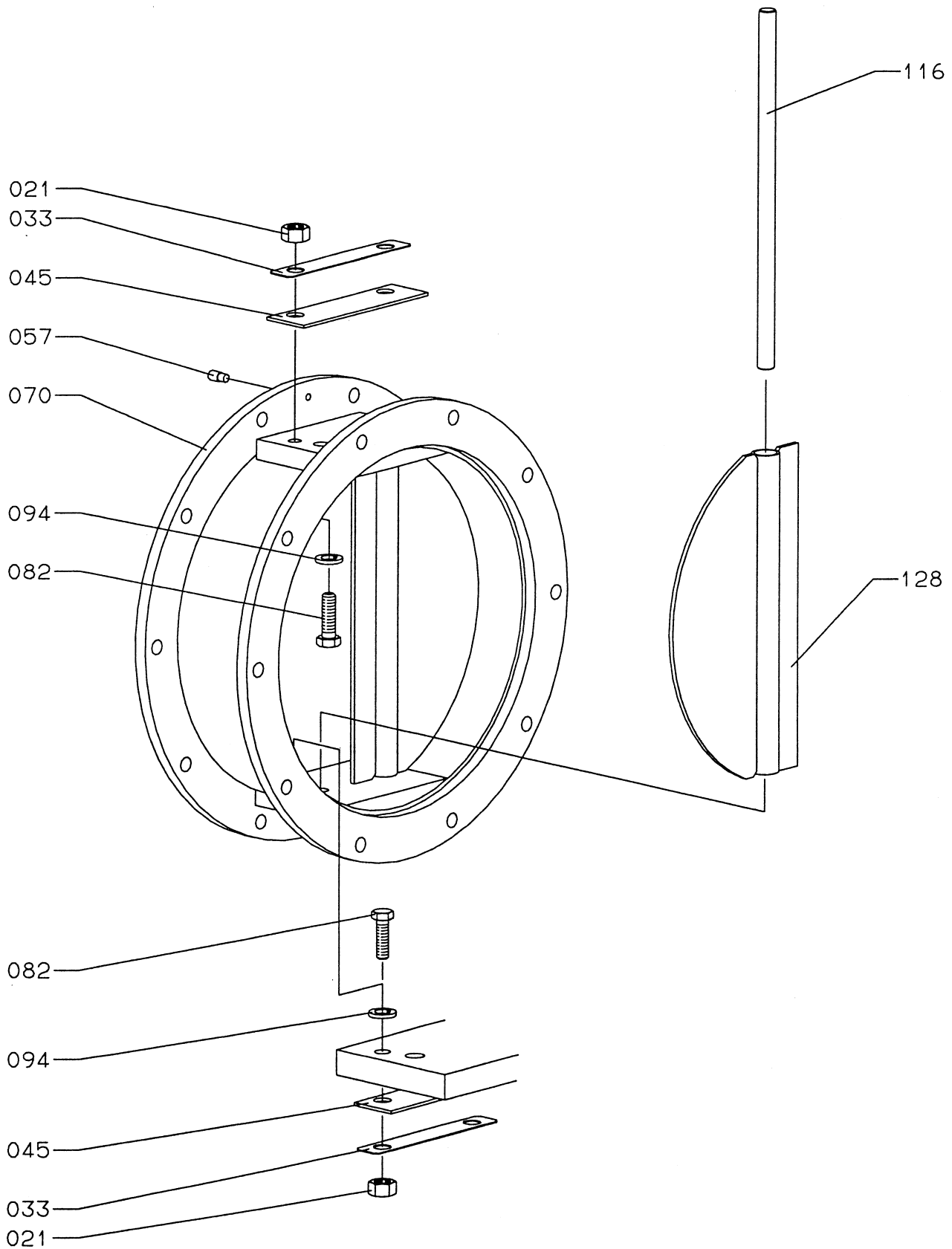
*) The screws EN61X and EN61Y are special screws for hot joints, they are marked with a "T", and must not be used elsewhere





Item No.	Part Description	Item No.	Part Description
019	Water mist catcher		
020	Cover		
032	Nut		
044	Reversing chamber		
056	Washer		
068	Stud		
093	Screw		
103	Gasket		
115	Cooler block		
127	Stud		
139	Stud		
140	Stud		
152	Gasket		
164	Screw		
176	Screw		
188	Nut		
211	Gasket		
223	Plug screw		
235	End cover		
260	Screw		
284	Cover		
296	Cooler housing		
306	Screw		
318	Lock washer		
331	Stud		
343	Iron block		
355	Locking plate		
367	Nut		
379	Screw		
380	Cleaning cover, complete		
402	Screw		
414	Lock washer		
426	Support		
438	Screw		
451	Gasket		
463	Cleaning cover		
475	Screw		
476	Gasket		





Safety Valves, Cylinder Cover

Each cylinder cover is provided with a spring-loaded safety valve which is set to open at a pressure somewhat higher than the maximum firing pressure in the cylinder.

Relief Valves

On the exhaust side of the engine a number of spring-loaded relief valves are fitted, which will open in the event of an excessive pressure arising in the crankcase, for instance as a result of the ignition of oil mist.

Warning !

Keep the areas around the relief valves free of oil, grease, etc. to prevent the risk of fire caused by the emitted hot air/gas in the event that the relief valves open.

Regarding how to:

- avoid evaporation of the lubricating oil in the crankcase,
- detect oil mist in the crankcase using an 'Oil Mist Detector'.

see Vol. I, OPERATION, Chapter 704.

Warning !

Do not stand near crankcase doors or relief valves – nor in corridors near doors to the engine room casing in the event of an **alarm** for:

- a) oil mist
- b) high lube oil temperature
- c) no piston cooling oil flow, or
- d) scavenge box fire

Alarms b, c and d should be considered as pre-warnings of a possible increasing oil mist level.

See also our Service Letter SL97-348/ERO.

Note !

In the event that a crankcase explosion has occurred, the complete flame arrester of the relief valves must be replaced.

Safety Valve, Scavenge Air Receiver

The scavenge air receiver is fitted with a safety valve which is set to open should the pressure in the scavenge air receiver exceed a value somewhat higher than the normal scavenge air pressure of the engine.

In some cases it may be necessary to open the valve manually, see Vol. I, Chapter 704, "Turbocharger Surging".

Safety Cap in Starting Air Line

Each starting valve inlet pipe is provided with a safety cap. The safety cap consists of a bursting disc enclosed by a perforated cylinder and a perforated cover in order to protect any bystanders, in the event of a burst.

The cover is provided with a check plate, which shows if the bursting disc has been damaged.

If the bursting disc of the safety cap is damaged due to excessive pressure in the starting air line, overhaul or replace the starting valve which caused the burst, and mount a new disc.

If a new disc is not available immediately, turn the cover in relation to the cylinder, in order to reduce the leakage of starting air.

Note !

Mount a new bursting disc and return the cover to the open position at the first opportunity.



Safety Valves – Relief Valves

Each cylinder cover is provided with a spring-loaded safety valve which is set to open at a pressure somewhat higher than the maximum firing pressure in the cylinder.

On the exhaust side of the engine a number of spring-loaded relief valves are fitted, which will open in the event of an excessive pressure arising in the crankcase, for instance as a result of ignition of oil vapour.

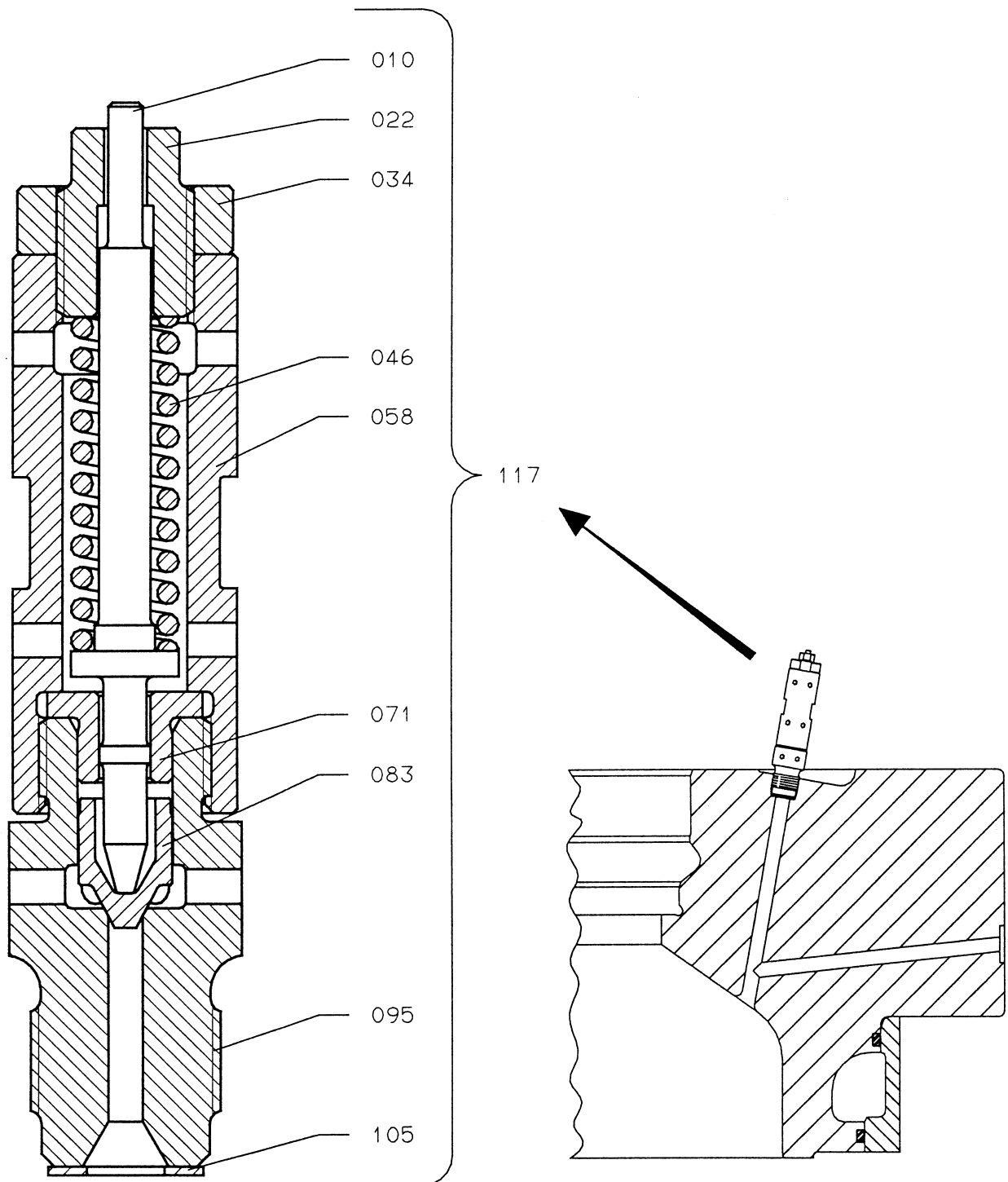
The scavenge air receiver is fitted with a safety valve which is set to open should the pressure in the scavenge air receiver exceed a value somewhat higher than the normal scavenge air pressure of the engine.

It may in some cases be necessary to open the valve manually, *see Vol. I, Chapter 704, "Turbocharger Surging"*.

Each starting valve inlet pipe is provided with a safety cap. The safety cap consists of a bursting disc enclosed by a mantle in order to protect any bystanders, in the event of a burst due to excessive pressure in the starting air line.

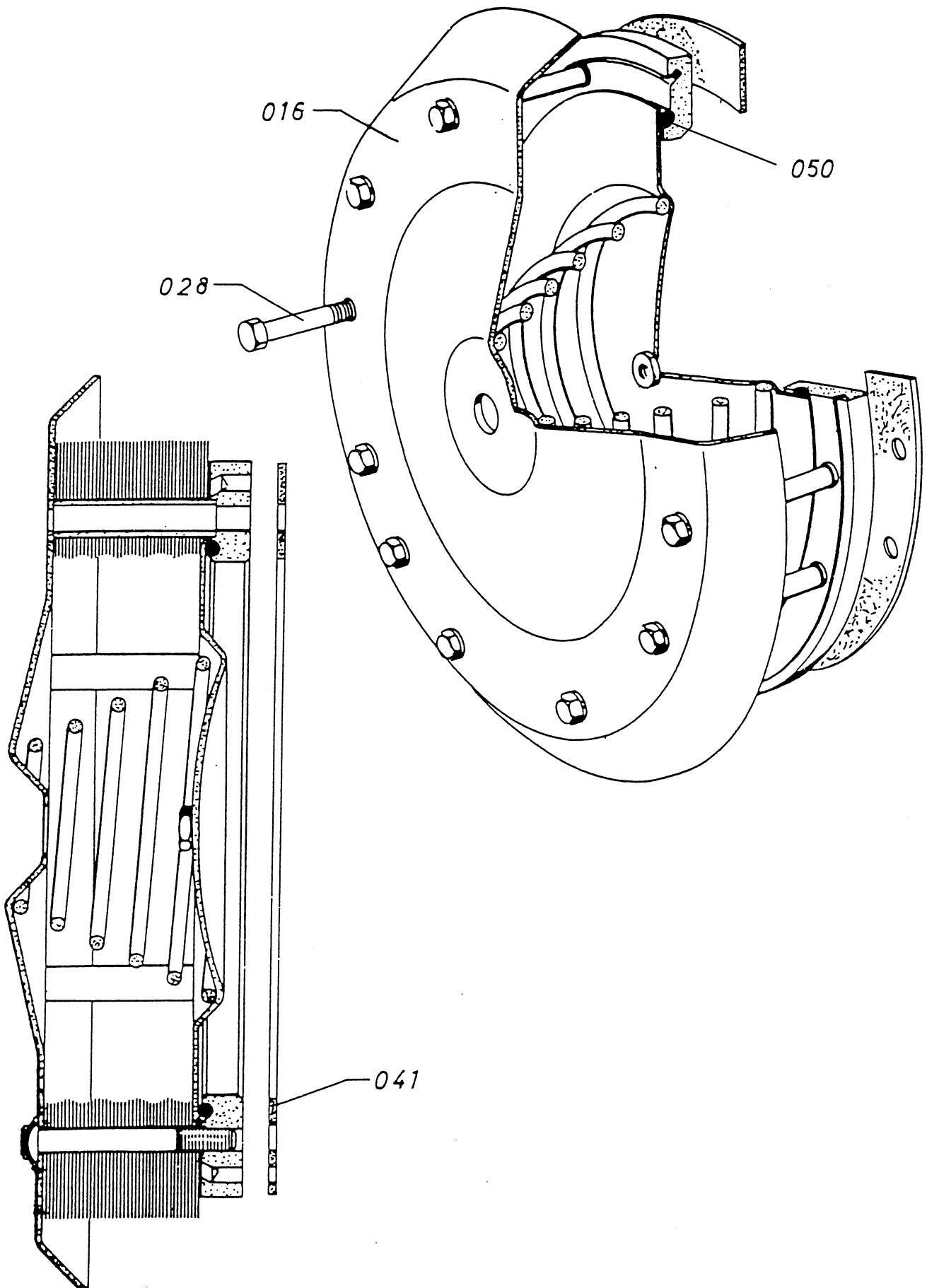
Furthermore, the mantle is provided with a check plate, which shows if the bursting disc has been damaged.





Item No.	Part Description	Item No.	Part Description
010	Spindle		
022	Spring retainer		
034	Lock nut		
046	Spring		
058	Valve housing		
071	Stop ring		
083	Valve flap		
095	Valve guide		
105	Gasket		
117	Safety valve, complete		

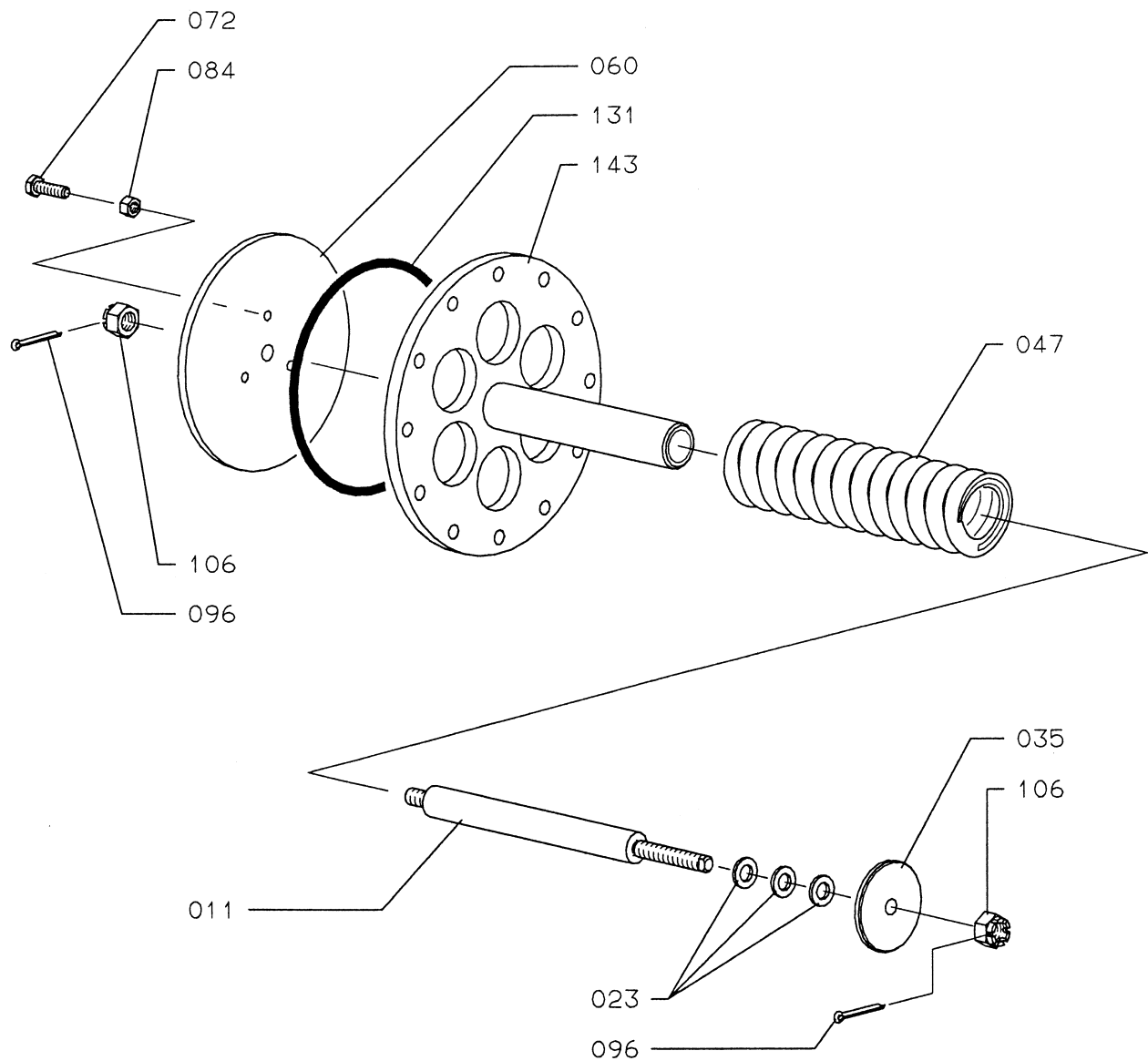
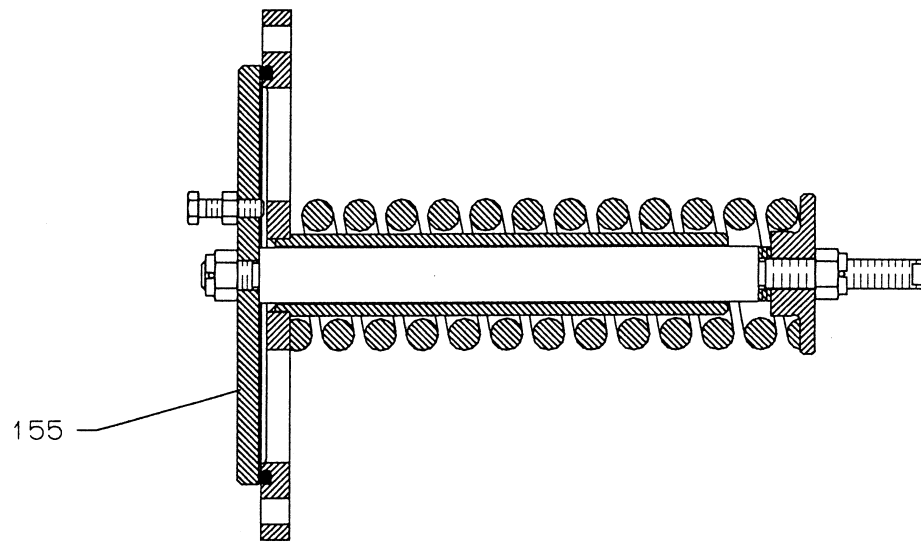




Item No.	Item Description
016	Relief valve
028	Screw
041	Gasket
050	O-ring
	<i>Please state type of relief valve, when ordering spare parts.</i>

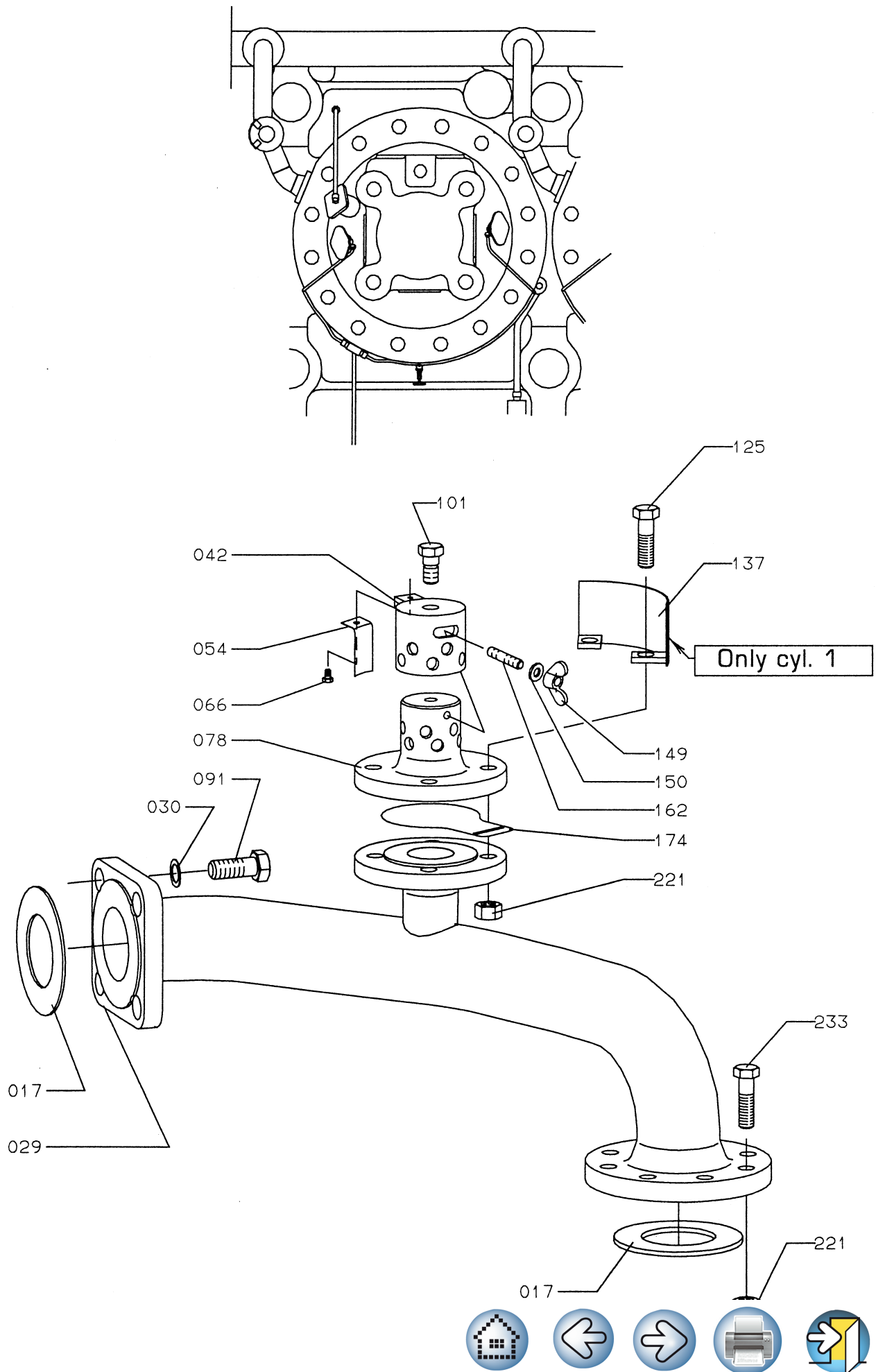
Item No.	Item Description





Item No.	Part Description	Item No.	Part Description
011	Spindle		
023	Washer		
035	Spring retainer		
047	Spring		
060	Valve flap		
072	Screw		
084	Nut		
096	Split pin		
106	Castle nut		
131	Seal		
143	Valve seat		
155	Safety valve, complete		





Item No.	Part Description	Item No.	Part Description
017	Gasket		
029	Starting air pipe		
030	Washer		
042	Bursting cap		
054	Check plate		
066	Screw		
078	Perforated cylinder		
091	Screw		
101	Screw		
125	Screw		
137	Protecting guard only cylinder 1		
149	Wing nut		
150	Washer		
162	Stud		
174	Bursting disc		
221	Nut		
233	Screw		



Bedplate, Framebox, etc.

The bedplate is made in one or more sections, depending on the number of cylinders. If there are two or more sections, these are joined together with fitted bolts. The bedplate consists of two welded, longitudinal girders and a number of cross girders which support the main bearings. The main bearings, which are of the thick-shell type, consist of steel shells, lined with white metal and coated with a tin-flash layer.

See also Vol. I, OPERATION, Chapter 708.

Each main bearing has two main bearing caps which are each secured by two studs and nuts, designed for tightening by means of hydraulic tools.

The aft end of the bedplate incorporates the thrust bearing as well as the chain drive.

See also Chapter 905.

At the foremost end of the bedplate, an axial vibration damper is fitted. (Plate 91211). Regarding the design and functioning of the axial vibration damper, *See Chapter 905.*

A framebox is bolted on to the top of the bedplate. Like the bedplate, the framebox consists of one or more sections with the chain drive located at the aft end. Together, the bedplate and the framebox constitute the crankcase of the engine.

The framebox is fitted with steel-plate doors for access to the crossheads and to the main and crankpin bearings.

The bedplate, the framebox, and the cylinder frame, which rests on top of the framebox, are tightened together to form one unit by means of through-going stay bolts.

For each cylinder, the framebox is equipped with a slotted pipe in which the piston cooling oil outlet pipe fitted to the cross-head is able to travel. From the slotted pipe the cooling oil is, through an outlet pipe, led to the oil tray of the bedplate.

Equipment for local checking of the cooling oil temperature and flow, and for temperature and flow alarms, is installed in conjunction with the outlet pipe.

See also Vol. I, OPERATION, Chapter 701.

The bedplate of the engine is positioned on either epoxy or cast iron supporting chocks and bolted to the engine seating in the ship by means of long holding-down bolts, which are equipped with distance tubes of cast iron.

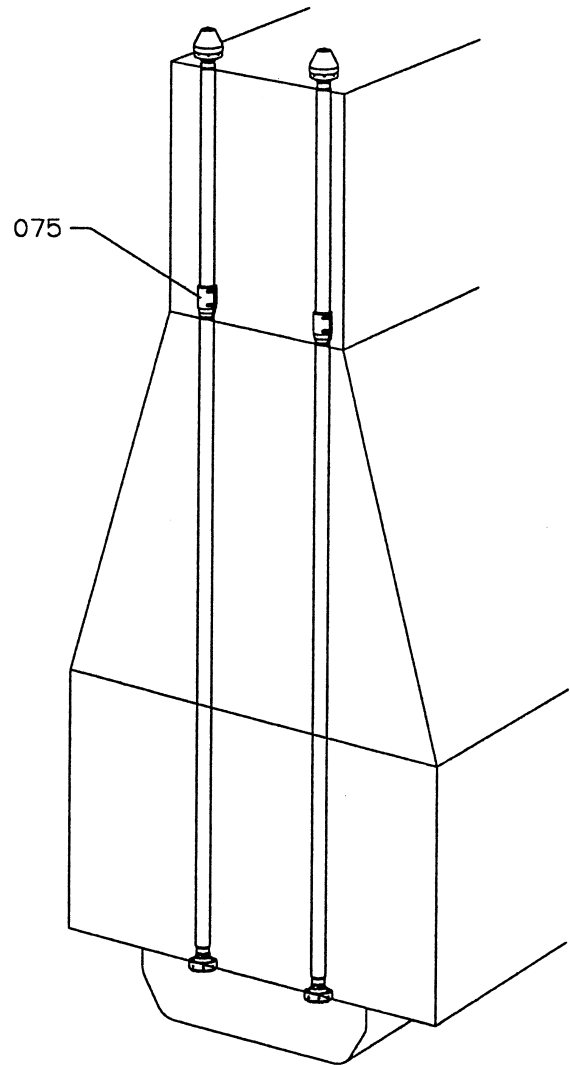
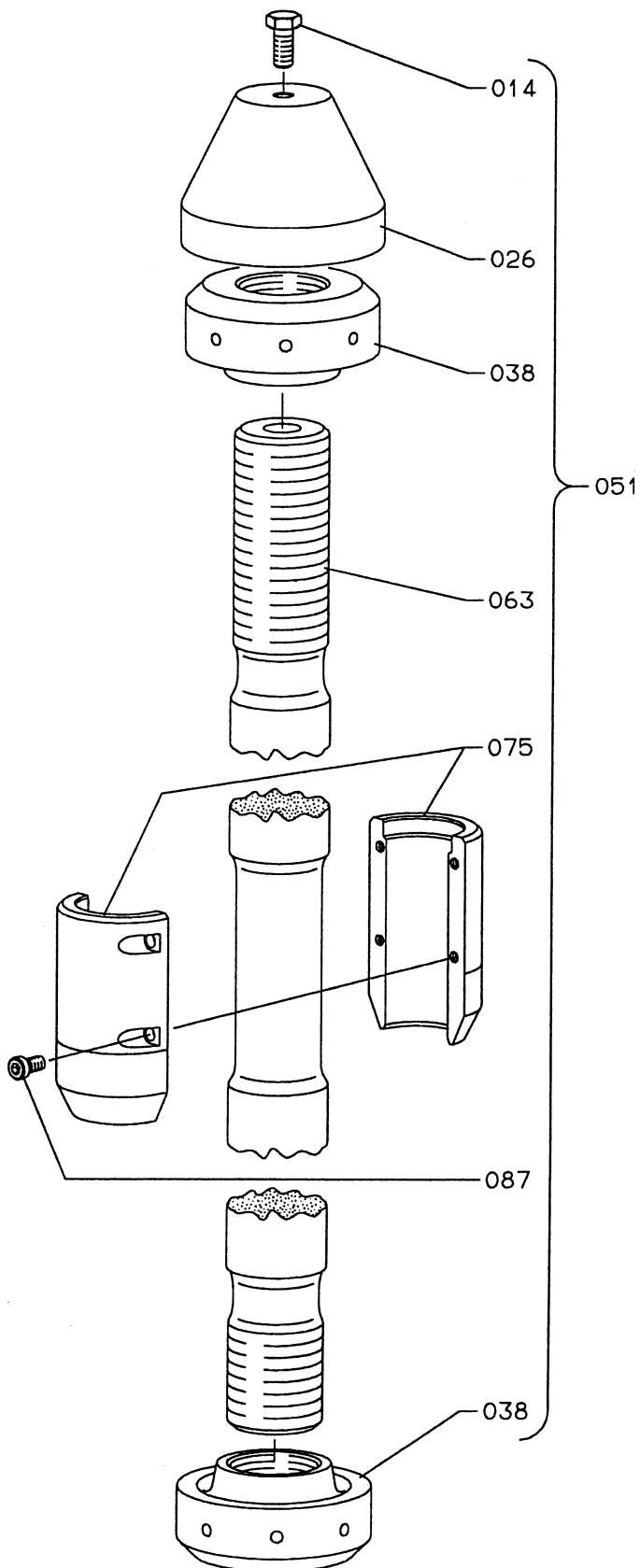
Plate 91215 shows the holding-down bolts, which have spherical washers and nuts with spherical contact face on the lower end of the bolts. The contact faces of the topplate for the spherical washers must be plane.

The engine is secured in the athwartship direction by side chocks fitted in both sides in way of each main bearing. The side-chock liners are tapered 1:100 and are fitted from the aft end at both sides of the engine.

The engine is secured in the fore-and-aft direction by one end chock with one end-chock bolt with spherical washer at the aft end of each of the two longitudinal girders of the bedplate. The end-chock liners have a 1:100 taper and are fitted from above.

Regarding the engine seating for the specific engine, see the supplier's special instructions.

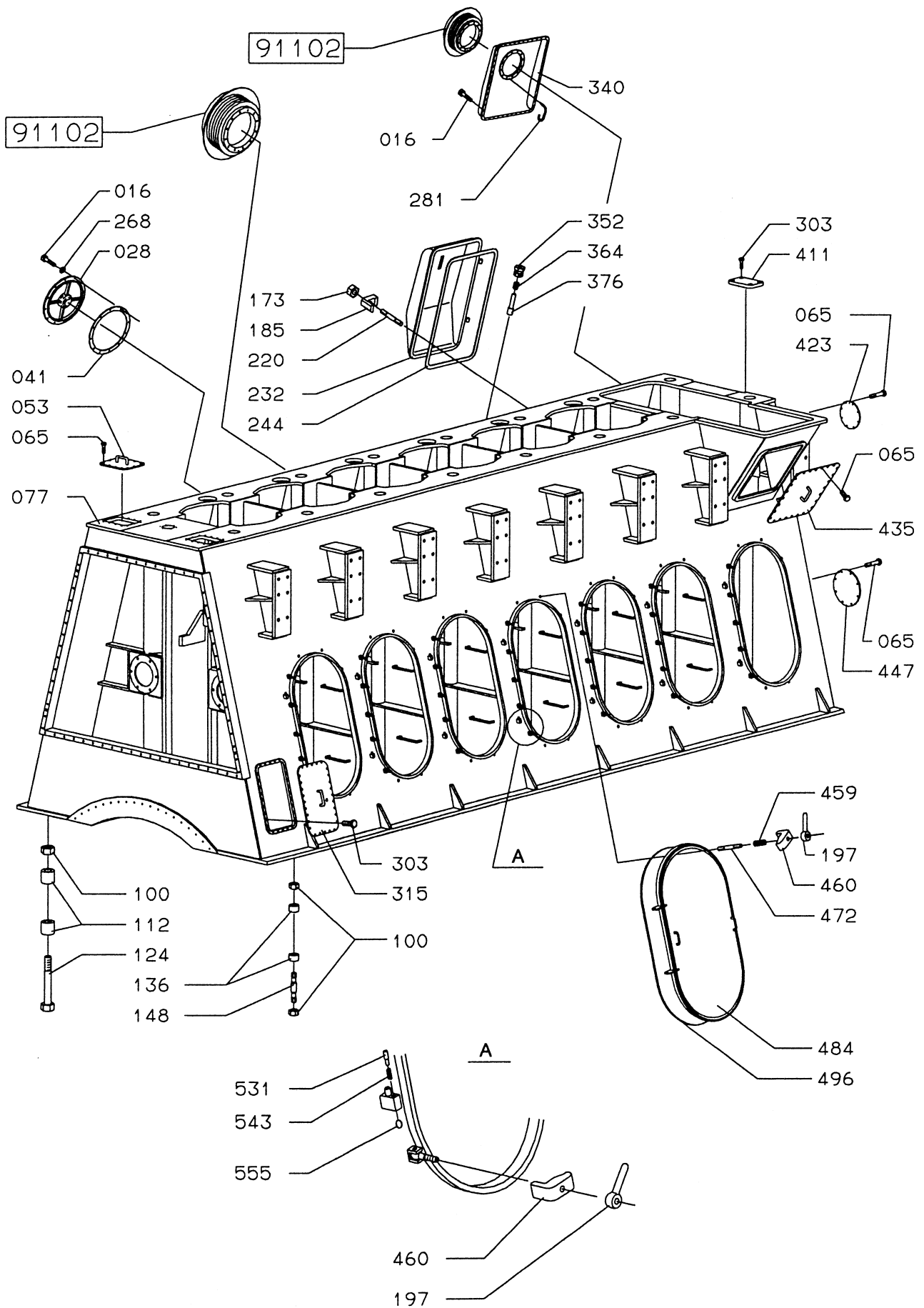




Item No.	Part Description
014	Screw
026	Protective cap
038	Nut, M120x6
051	Stay bolt, complete
063	Stay bolt
075	Neck ring in 2/2
087	Screw

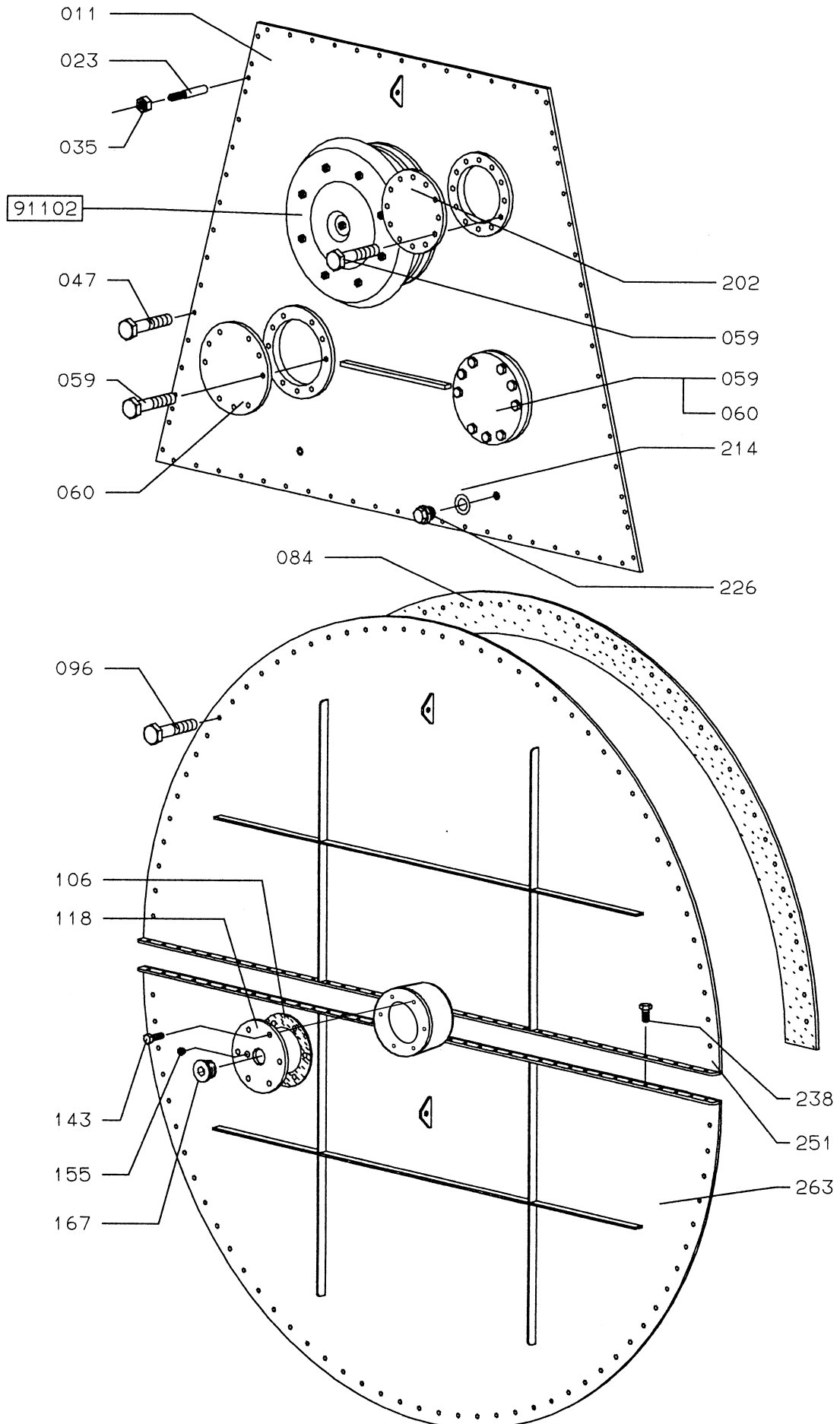
Item No.	Part Description





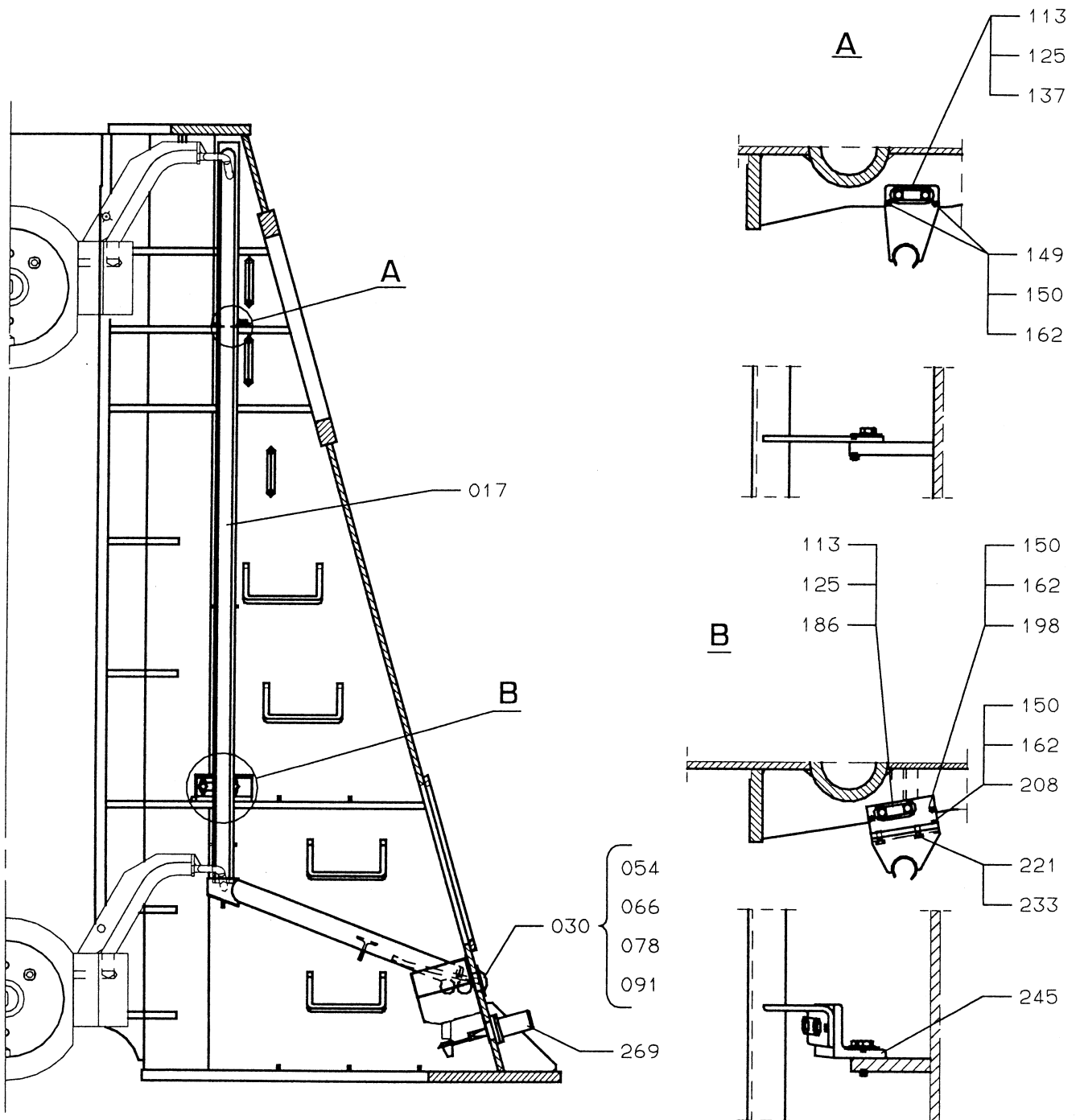
Item No.	Part Description	Item No.	Part Description
016	Screw		
028	Cover		
041	Gasket		
053	Cover		
065	Screw		
077	Frame box		
100	Nut		
112	Distance pipe		
124	Screw		
136	Distance pipe		
148	Fitted stud		
173	Nut		
185	Clamp		
197	Wing nut		
220	Stud		
232	Frame door, rear		
244	Sealing ring		
268	Washer		
281	Drain pipe		
303	Screw		
315	Cover		
340	Door at chain drive, upper		
352	Screw bush		
364	Spring		
376	Locking pin		
411	Cover		
423	Cover		
435	Cover		
447	Cover		
459	Spring		
460	Clamp		
472	Stud		
484	Frame door		
496	Sealing ring		
531	Locking pin		
543	Pressure spring		
555	Key ring		





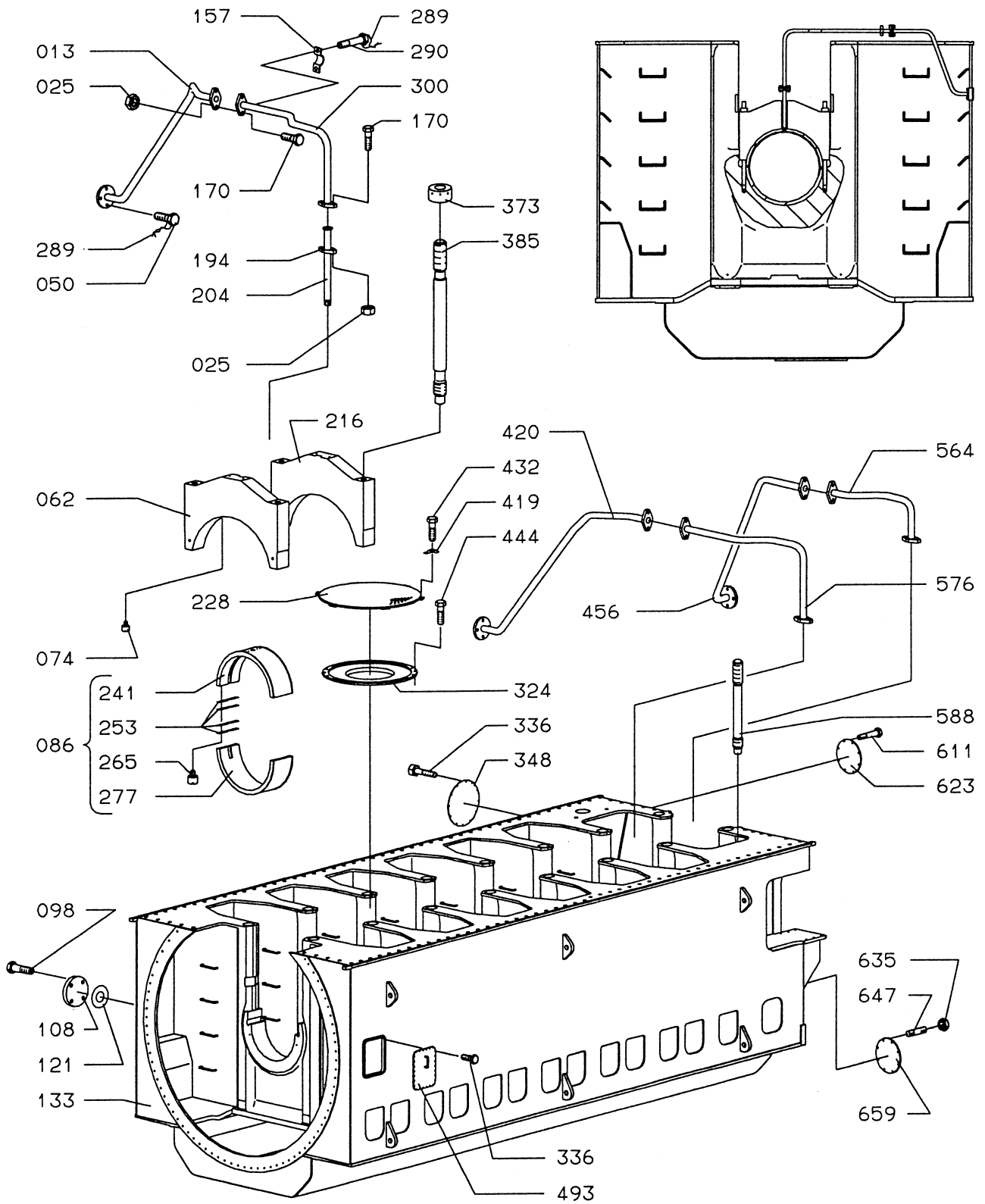
Item No.	Part Description	Item No.	Part Description
011	End shield		
023	Guide pin		
035	Nut		
047	Screw		
059	Screw		
060	Cover		
084	Gasket		
096	Screw		
106	Gasket		
118	Cover		
143	Screw		
155	Plug screw		
167	Plug screw		
202	Cover		
214	Gasket		
226	Plug screw		
238	Screw		
251	End shield		
263	End shield		





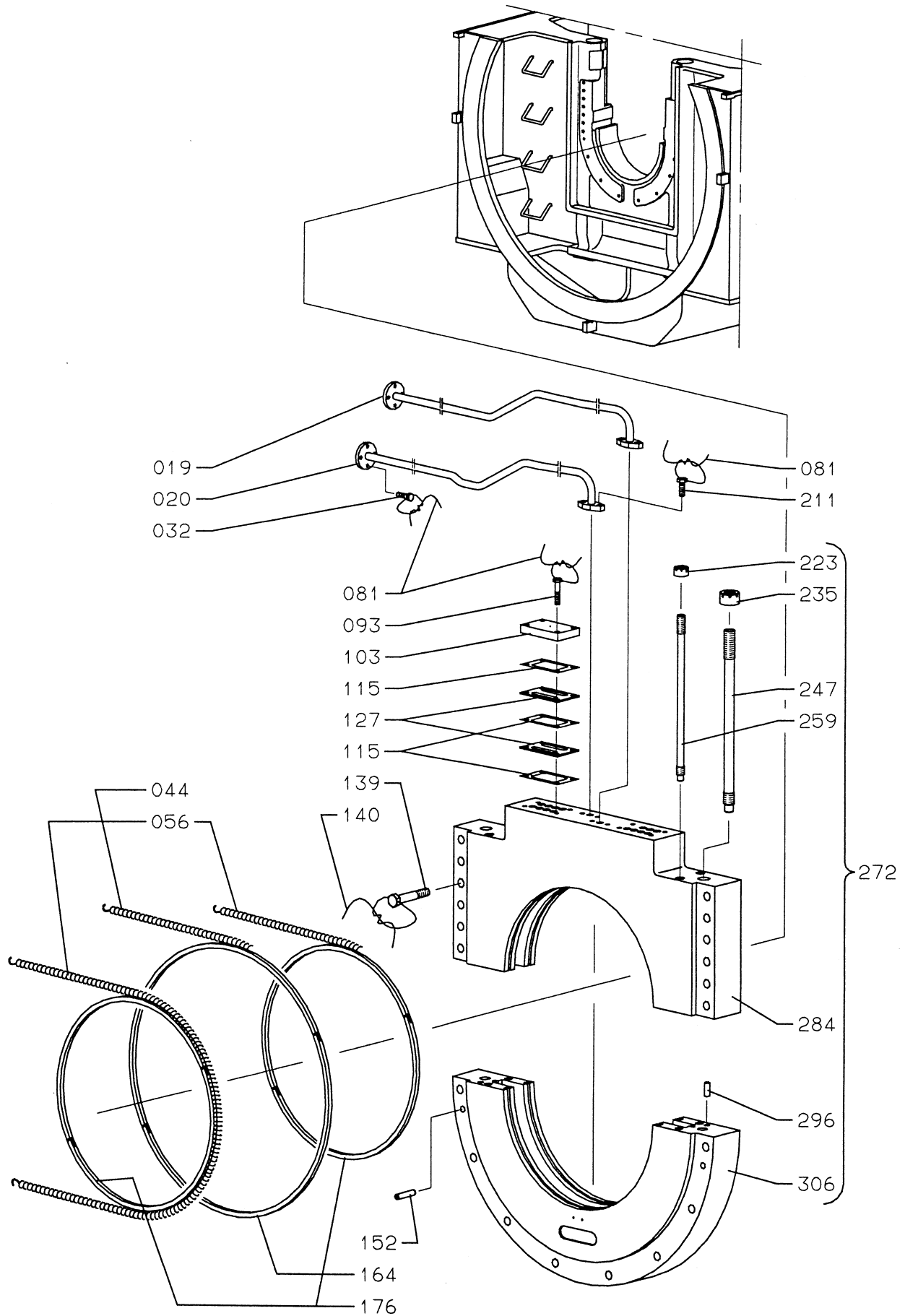
Item No.	Part Description	Item No.	Part Description
017	Slotted pipe		
030	Sight glass, complete		
054	Sight glass		
066	Flange		
078	Packing		
091	Screw		
113	Locking plate		
125	Plate		
137	Screw		
149	Fitted bolt		
150	Locking plate		
162	Nuts		
186	Screw		
198	Fitted bolt		
208	Fitted bolt		
221	Screw		
233	Locking plate		
245	Bracket		
269	Oil flow control		





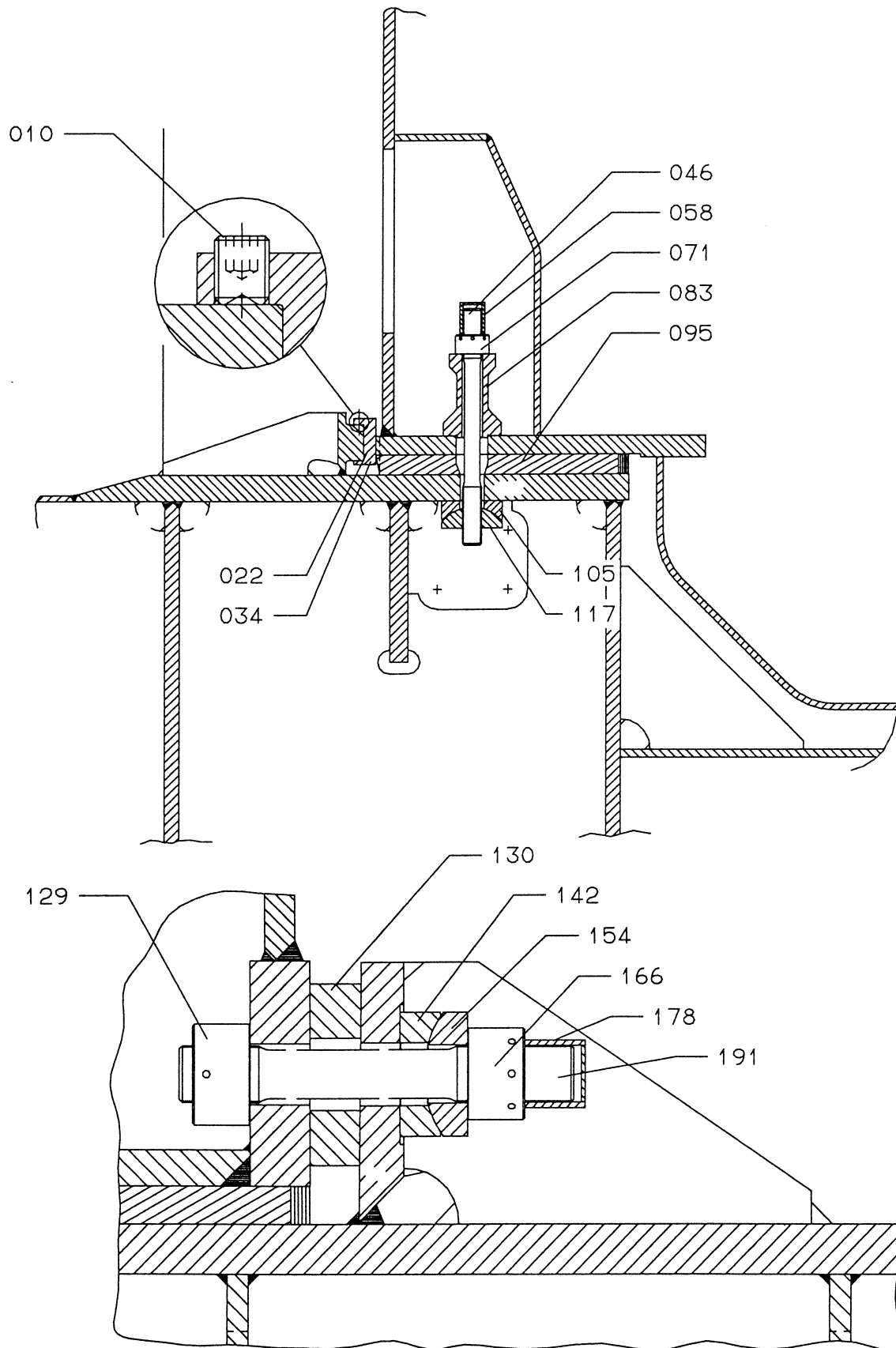
Item No.	Part Description	Item No.	Part Description
013	Lub.oil pipe		
025	Self-locking nut		
050	Screw		
062	Main bearing cap		
074	Screw		
086	Main bearing shell, complete		
098	Screw		
108	Cover		
121	Gasket		
133	Bedplate		
157	Pipe holder		
170	Screw		
194	Flange		
204	Lub.oil pipe		
216	Main bearing cap		
228	Grate		
241	Bearing shell, upper		
253	Shims, please state thickness 0.2-0.3-0.5-1.0 mm		
265	Screw		
277	Bearing shell, lower		
289	Locking wire		
290	Screw		
300	Lub.oil pipe		
324	Cover plate		
336	Screw		
348	Cover		
373	Nut		
385	Main bearing stud		
419	Lock washer		
420	Lub.oil pipe		
432	Screw		
444	Screw		
456	Lub.oil pipe		
493	Cover		
564	Lub.oil pipe		
576	Lub.oil pipe		
588	Stud		
611	Screw		
623	Cover		
635	Nut		
647	Stud		
659	Cover		





Item No.	Part Description	Item No.	Part Description
019	Damper-oil pipe		
020	Damper-oil pipe		
032	Screw		
044	Spring		
056	Spring		
081	Locking wire		
093	Screw		
103	Restriction for damper		
115	Restriction for damper		
127	Restriction for damper		
139	Screw		
140	Locking wire		
152	Guide pin		
164	Oil seal in 2/2		
176	Oil seal in 2/2		
211	Screw		
223	Nut		
235	Nut		
247	Stud		
259	Stud		
272	Axial vibration damper, complete		
284	Damper, upper part		
296	Guide pin		
306	Damper, lower part		





Item No.	Part Description	Item No.	Part Description
010	Cup point screw		
022	Liner, port side		
034	Liner, starboard side		
046	Stud, M 48 x 5		
058	Protective cap		
071	Nut		
083	Distance pipe		
095	Epoxy chocks		
105	Spherical washer		
117	Spherical nut		
129	Nut		
130	Liner		
142	Spherical washer		
154	Spherical washer		
166	Nut		
178	Protective cap		
191	Stud, M 76 x 6		

