

REPAIR MANUAL

DIESEL ENGINES : 15 / 18 / 32W



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PREFACE

We congratulate you on your choice of a **FARYMANN** engine and wish you much pleasure with this German quality product.

These operating instructions are based on the latest state of technical development. In preparing them, every effort has been made to avoid errors. However, we accept no liability for any errors of presentation or description, nor for any omissions. Modifications may also occur because of ongoing technical developments. We reserve the right to make modifications without giving prior notice.

Everyone responsible for the installation, commissioning, operation, maintenance or repair of the engines must read and follow the operating instructions and particularly the "**Safety**" chapter.

The engine is built according to the state-of-the-art, and in compliance with recognised safety regulations. Nevertheless, while the engine is in use, there may be physical or mortal dangers to the user or to third parties, and also damage to the engine and to other property. For these reasons, the engine must only be used when it is in perfect technical condition, and when those involved are aware of the dangers and the safety precautions. In particular, malfunctions which could impair safety must be rectified immediately. The engine must only be used as intended. **FARYMANN DIESEL GmbH** is not responsible for damage resulting from incorrect use. Such risk is borne solely by the user.

Correct use also includes following the operating instructions and adhering to the operating, servicing and maintenance conditions. The engine must only be operated and serviced by reliable, trained personnel in compliance with the relevant accident prevention regulations as well as other generally-recognised rules of safety and occupational health.

FARYMANN DIESEL GmbH accepts no liability for any damage resulting from unauthorised conversions or modifications to the engine. Replacement parts must meet the technical requirements specified by **FARYMANN DIESEL GmbH**. This is always guaranteed if original replacement parts are used. Fitting and/or using parts and accessories not supplied by **FARYMANN DIESEL GmbH** may have a detrimental effect on your engine under certain circumstances.

FARYMANN DIESEL GmbH accepts no liability whatsoever for any damage resulting from the use of non-original replacement parts or accessories.

GENERAL INFORMATION

1. General Information, Handling

FARYMANN DIESEL engines type 15/18/32W are 4 stroke, direct injection diesel engines. They are built as single cylinder engines vertical cylinder configuration. The direct injection guarantees an outstanding level of efficiency, with low fuel consumption and excellent cold starting behaviour. Bosch fuel injection equipment is used on all engines. A high-precision centrifugal governor ensures accurate speed (RPMs) and load control. Special modified water-cooled Farymann engines fulfill BSO I/II and EPA – requirements.

1.3 Organisation and Use of this Repair Manual

The descriptions, data and illustrations refer to those assembly and adjustment procedures where **FARYMANN** engines differ from ordinary diesel engines.

- It is assumed that all work on the engine will be carried out by competent staff who have received training.
- Special tools must be available, as described in the manual, together with good-quality standard tools.

1.4 Service

- If you have any further questions about the Repair Manual, we recommend you to contact your nearest **FARYMANN** Service Centre.
- Circular letters and training courses ensure that our service personnel have an answer to every question. Please ask for a list of all our service locations from your own **FARYMANN** Service Centre.

1.5 After Sales - Service: FALKE - Spare Parts Program

"Service, Quality and Progress"

is our motto. This is why we have developed our very own computer-aided "FALKE" Service System.

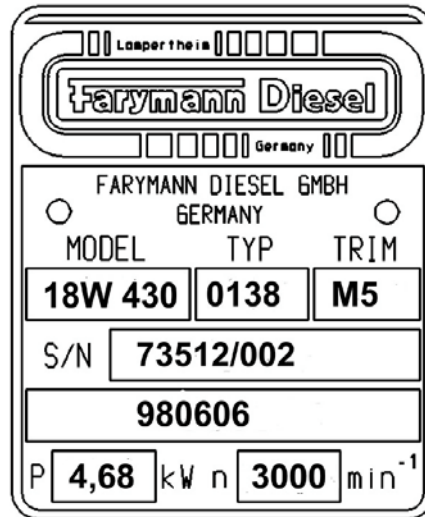
The FALKE System makes it possible for **FARYMANN's** world-wide network of distributors to **satisfy all spare parts and service requirements quickly and reliably, ensuring that we maintain a close relationship with our customers.**

GENERAL INFORMATION

1.6 Engine, Model and Type Designation

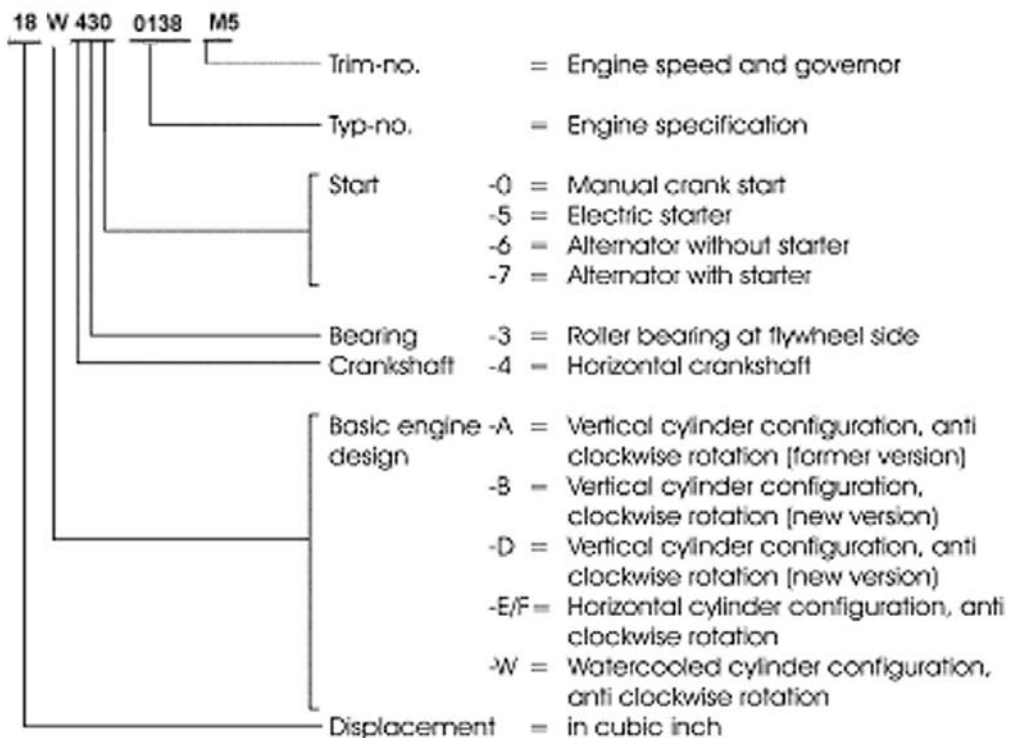
Every engine can be unmistakably identified using the manufacturer's nameplate. As well as the clearly defined 12-digit code number, this refers to the order number (SN) and the date of construction. This information must always be provided when making any enquiries or complaints, etc.

As of July 1985, the consecutive engine number is also imprinted on the crankcase.















As of July 1982, the type designation (a 12-digit code number) is used in addition to the series number (SN = Order Number). (See manufacturer's nameplate).

e.g. **18W430.0138 M5**
98 06 06 **Date of Production**










GENERAL INFORMATION

1.7 Safety Instructions

	Only use transport devices specified by the manufacturer, and only follow hoisting instructions specified by the manufacturer.
	When handling fuels, lubricants and other chemical substances, follow the safety regulations which apply to the product.
	Do not smoke when handling inflammable fuels or lubricants.
	Vapours from lubricating oil or fuel may catch fire if they come into contact with sources of ignition.
	Be careful when handling hot or corrosive fuels, lubricants or other substances (risk of burning or scalding).
	Never carry out maintenance and repair work when the engine is running. Ensure that the engine cannot start unintentionally.
	Before turning the engine over, make sure that nobody is in the danger area. When you have finished working on the engine, always check that the safety devices have been refitted, and that all tools have been removed from the engine.
	Never carry out any work on safety valves (e.g. modification of the spring tension). Defective safety valves must be replaced with new ones.
	When disposing of used fuels, lubricants and filters, follow the regulations which apply locally.
	Before or when you start the engine, check: <ul style="list-style-type: none">– all lines, hoses and screwed connections for leaks;– safety devices for completeness and ability to operate.
	When starting the engine by hand, only use the starting device specified by the manufacturer (starting handle with kick back limiter, recoil starting) and follow the handling instructions. Never use cold starting aids based on ethyl oxide.
	Because of the explosion hazard, it is forbidden to start up a compressed-air start engine with combustible gases (fuel gases) or oxygen, even in an emergency.

GENERAL INFORMATION

1.5 Safety Instructions

	Only operate IC engines in enclosed areas if there is adequate ventilation. Before you start the engine in an enclosed environment, make sure that there is sufficient ventilation.
	Ensure that the engine only slows down to full stop after 10 - 20 seconds!
	If there are any safety devices on the engine, or on the machine into which the engine is built, they must be refitted when the maintenance and repair work has been finished.
	Before starting any work on the electrical components, the power supply to all live parts must be cut off.
	Only carry out maintenance and repair work when the engine parts are in a stable position.
	Liquids ejected under high pressure (such as fuels or oils) may penetrate the skin and cause severe injuries.
	To carry out cleaning work on the engine, always use a non-combustible detergent, or one which has a flash point of more than 65 °C.

CALIFORNIA

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

TECHNICAL DATA

2. Technical Data



Engine Type	15W	18W	32W
Design	vertical		
Number of Cylinders	1		
Bore	75 mm	82 mm	95 mm
Stroke	55 mm	55 mm	74 mm
Cubic capacity (piston displacement)	242 cm ³	290 cm ³	524 cm ³
Direction of rotation (looking at power take-off side)	anti clockwise		
Max. power / 3000 RPM F (DIN 70020)	4,76 kW	5,70 kW	9,74 kW
IFN-ISO (DIN 6271)	4,33 kW	5,20 kW	8,85 kW
ICFN-ISO (DIN 6271)	3,90 kW	4,70 kW	8,00 kW
Max. torque (DIN 70020)	14,4 Nm at 2400 RPM	16,7 Nm at 2400 RPM	30,2 Nm at 2400 RPM
Max. speed	3600 RPM		
Mean piston speed at 3000 RPM	5,5 m/s	5,5 m/s	7,4 m/s
Compression ratio	1 : 20	1 : 19,1 – 22,6	1 : 20
Valve clearance, exhaust valve	0,2 mm		
intake valve	0,2 mm		
Tank capacity	---	---	---
Lubricating oil volume (sump capacity)	1,0 l	1,0 l	1,6 l
Lubricating oil consumption	1,0 g/kWh		
Starter motor rated voltage	12 V		
Battery capacity required	55Ah		
Weight	37 kg	37 kg	75 kg
Cooling water requirement	7 – 8 l/min		
Permissible tilt during operation :			
Longitudinal	15 °		
Lateral	15 °		

TECHNICAL DATA

2.1 Construction Data, Consumptions and Pressures

		Technical Data		Table 1
Engine Type		15W	18W	32W
Construction data	dimen- sion			
System	*	four stroke		
Combustion Procedure	*	direct injection		
Cooling System	*	Water-cooled		
Design / Configuration	*	1-cylinder / vertical		
Bore	(mm)	75	82	95
Stroke	(mm)	55	55	74
Displacement	(cm ³)	242	290	524
Compression Ratio	*	1 : 20,0	1 : 19.1 - 1 : 22,6	1 : 20,0
Temperatures	dimen- sion			
Permissible air intake temperature (max.)	(°C)	50		
Permissible exhaust gas temperature (max)	(°C)	580		
Permissible cooling air temperature (max.)	(°C)	50		
Permissible fuel temperature (max.)	(°C)	80		
Permissible lub. oil temperature (max.)	(°C)	130		
Consumptions (at IFN Output)				
Specific fuel consumption, 3000 RPM	(g/kWh)	305	300	255
Fuel tank content	(l)	NO		
Feed pump (max. lift)	(mm)	300		
Fuel	*	to DIN 51 601 / ASTM D 975-77 + 2D/BS 28669 1970 A1 + A2		
Specific lub. oil consumption	(g/kWh)	1		
max. lub. oil capacity	(g/l)	1100 / 1,25	1100 / 1,25	1380 / 1,56
Topping up volume lower-upper mark	(g/l)	200 / 0,226	200 / 0,226	240 / 0,270
Lub. Oil quality	*	HD oil: minimum quality CC; better, CD quality (API-spec.) and multigrade oils		
Pressures				
Injector setting	(bar)	200	200	175
Oil pressure (max.)	(bar)	5		
Permissible air intake vacuum	(kPa)	2		
Permissible exhaust gas back pressure	(kPa)	5		

TECHNICAL DATA

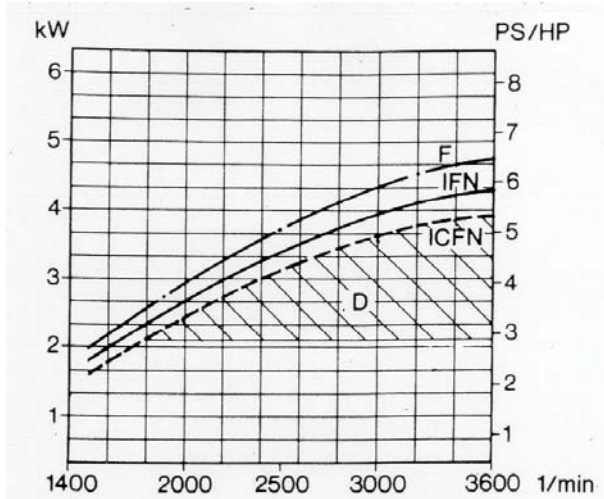
2.1 Construction Data, Consumptions and Pressures

		Technical Data								Table 2			
Engine Type		15W				18W				32W			
Adjustment Data													
Valves, Inlet / Outlet	(mm)	0,2 all											
Inlet opens BTDC	*	5,3° - 7,5° = 12 - 17 mm				5,3° - 7,5° = 12 - 17 mm				5,2° - 7,5° = 14 - 20 mm			
Exhaust closes ATDC	*	4,4° - 6,7° = 10 - 15 mm				4,4° - 6,7° = 10 - 15 mm				4,5° - 6,7° = 12 - 18 mm			
Flywheel diameter	(mm)	258				258				308			
Injection pump: end of delivery, plunger with control edge "above"													
Engine RPMs	(min ⁻¹)	1500	1800	2000	2500	1500	1800	2000	2500	1500	1800	2000	2500
End of delivery BTDC	(mm)		17	18	19		17	18	19	28	28	28	32
Engine RPMs	(min ⁻¹)	2800	3000	3300	3600	2800	3000	3300	3600		3000	3300	3600
End of delivery BTDC	(mm)	21	22	25	28	21	22	25	28	36	40	40	46
Injection pump: start of delivery, plunger with control edge "below" (engines for generator and pump drive)													
Engine RPMs	(min ⁻¹)	1500	1800	3000	3600	1500	1800	3000	3600	1500	1800	3000	3600
Start of delivery BTDC	(mm)	*	*	39	41	*	*	39	41	42	42	60	73
Valve clearance (cold) inlet and outlet valve	(mm)	0,2											
Repair Data		Dimension											
Inlet valve Recedes by:	(mm)	0,1 - 0,2				0,1 - 0,2				0,1 - 0,2			
Exhaust valve Recedes by:	(mm)	0,1 - 0,2				0,1 - 0,2				0,1 - 0,2			
Piston protrudes by:	(mm)	0,63 - 0,93				0,63 - 0,93				0,65 - 0,98			
Gap measurement	(mm)	0,47 - 0,82				0,47 - 0,82				0,43 - 0,85			
Piston ring joint	(mm)	0,2 - 0,8				0,2 - 0,8				0,2 - 0,8			
Crankshaft plain bearing clearance - new condition	(mm)	0,02 - 0,05				0,02 - 0,05				0,02 - 0,06			
Crankshaft plain bearing clearance - wear limit	(mm)	0,08				0,08				0,09			
Connecting rod plain bearing clearance - new condition	(mm)	0,03 - 0,06				0,03 - 0,06				0,03 - 0,08			
Connecting rod plain bearing clearance - wear limit	(mm)	0,11				0,11				0,12			
Crankshaft end play	(mm)	0,05 - 0,15				0,05 - 0,15				0,05 - 0,15			

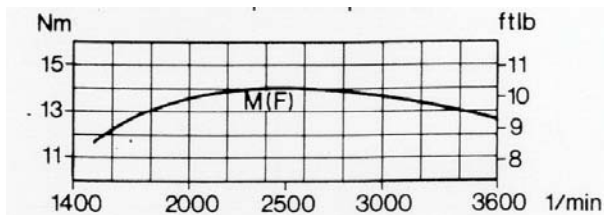
TECHNICAL DATA

2.2 Output, Torque, Consumption

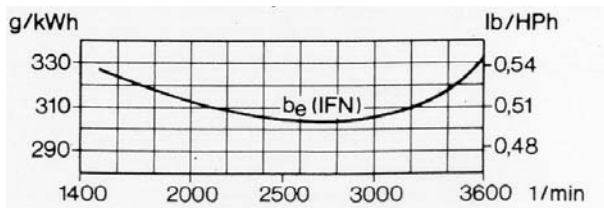
15W Leistung / Output / Puissance / Potencia



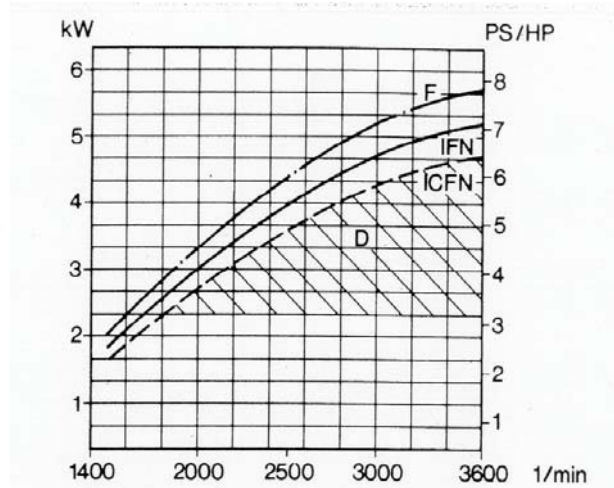
Drehmoment / Torque / Couple / Par



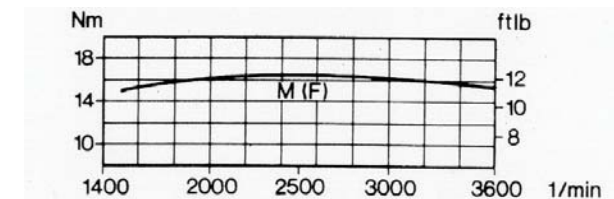
Verbrauch / Consumption / Consommation / Consumo



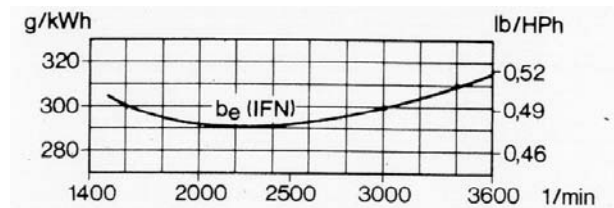
18W Leistung / Output / Puissance / Potencia



Drehmoment / Torque / Couple / Par



Verbrauch / Consumption / Consommation / Consumo



DIN ratings

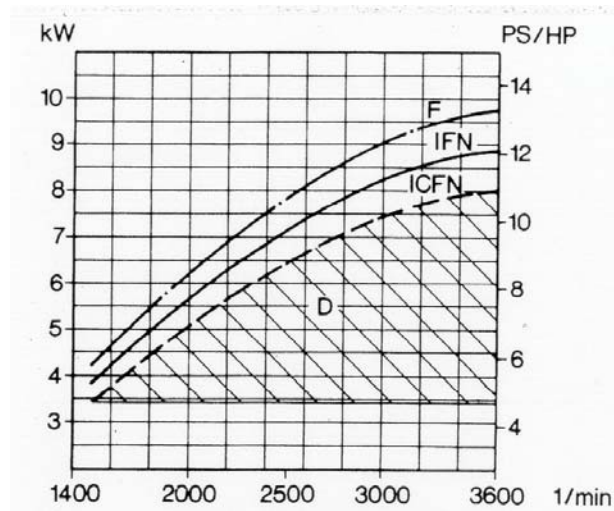
- F Vehicle rating: intermittent duty at variable speed and load.
- IFN-ISO DIN-ISO 3046 Blocked useful performance for intermittent loads.
- ICFN-ISO DIN-ISO 3046 Standard performance, blocked continuous useful performance for constant RPMs and constant load.
- D Continuous operation: - contact factory for use beyond the limits indicated.
- Decrease of approx. 1% for every 100 m altitude and approx. 2% for every 5°C above 20°C
- Rating certified within tolerance of 5% after engine has been run in with standard air filter and exhaust muffler.

TECHNICAL DATA

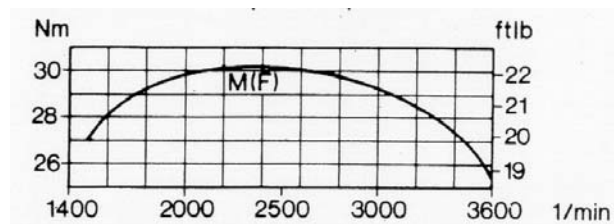
2.2 Output, Torque, Consumption

32W Leistung / Output /
Puissance / Potencia

The values shown are related to the optimal load setting at the corresponding nominal engine speed.

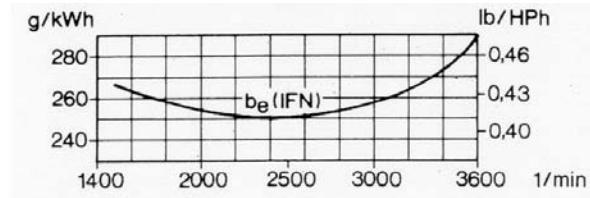


Drehmoment / Torque /
Couple / Par



TECHNICAL DATA

Verbrauch / Consumption /
Consommation / Consumo



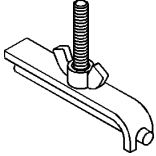
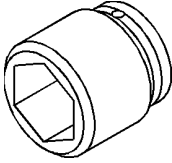
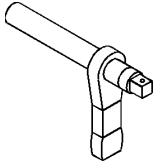
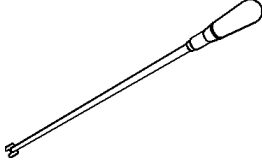
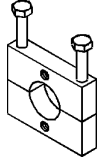
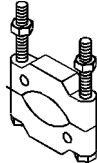
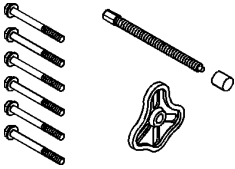
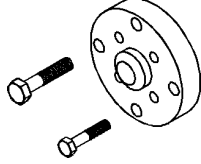
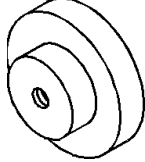
TECHNICAL DATA

2.3 Screws - Tightening Torques, Sealing and Adhesive Materials

		Technical data		Table 1
Engine type		15W	18W	32W
Tightening torques				
Cylinder head torque / wrench width	(Nm) (mm)	30- 33 / 13	30 - 33 / 13	52 - 56 / 17
Rocker bracket torque / wrench width	(Nm) (mm)	*	*	*
Bearing cover torque / wrench width	(Nm) (mm)	30 - 33 / 13	30 - 33 / 13	30 - 33 / 13
Connecting rod torque / wrench width	(Nm) (mm)	30- 33 / 13	30- 33 / 13	52 - 56 / 17
Nozzle holder torque / wrench width	(Nm) (mm)	20 - 23 / 13	20 - 23 / 13	20 - 23 / 13
Injection pump torque / wrench width	(Nm) (mm)	8 – 12 / 10	8 – 12 / 10	20 - 23 / 13
Delivery valve torque / wrench width	(Nm) (mm)	34 - 39 / 22	34 - 39 / 22	34 - 39 / 22
Flywheel torque / wrench width	(Nm) (mm)	8 – 12 / 10	8 – 12 / 10	390 - 410 / 46
Speed governor torque / wrench width	(Nm) (mm)	55 - 60 / 14	55 - 60 / 14	55 - 60 / 14
Maximum operation angles				
Longitudinal (in dir. of crankshaft)	(deg.)	15	15	15
Transverse	(deg.)	15	15	15
Sealing and adhesive materials				
Text Code		Type		
A		Loctite 573		
B		Loctite 270		
C		Loctite 415		

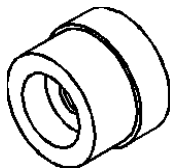
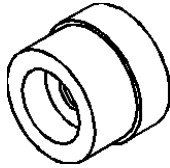
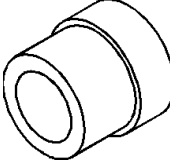
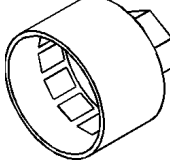
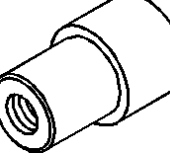
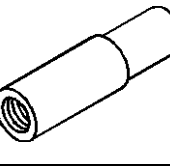
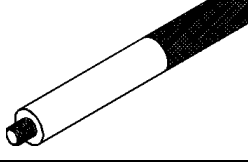
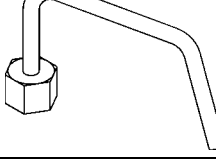
TECHNICAL DATA

2.4 Tools

Part No.	Description	Use	
748.115.6	Fuel line clamp	to clamp fuel supply lines	
748.130.2	Hexagonal socket wrench, 36 mm	for flywheel nuts	
748.128.4	Drive wrench	for use with socket wrench, 748.154.2	
748.108.5	Special screw driver	to adjust governor spring nuts	
748.132.6	Crankshaft race puller	use with part no. 748.136.2 to pull off main bearing race from crankshaft	
748.137.2	Crankshaft gear wheel puller	use with part 748.136.2 to pull off crankshaft gear wheel	
748.136.2	Puller plate	use with parts 748.132.6 and 748.137.2	
748.122.6	Flywheel puller	to loosen flywheel	
748.119.4	Bearing driver	to press in crankshaft roller bearing and shaft seal	

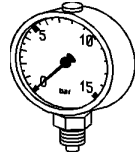
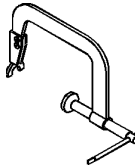
TECHNICAL DATA

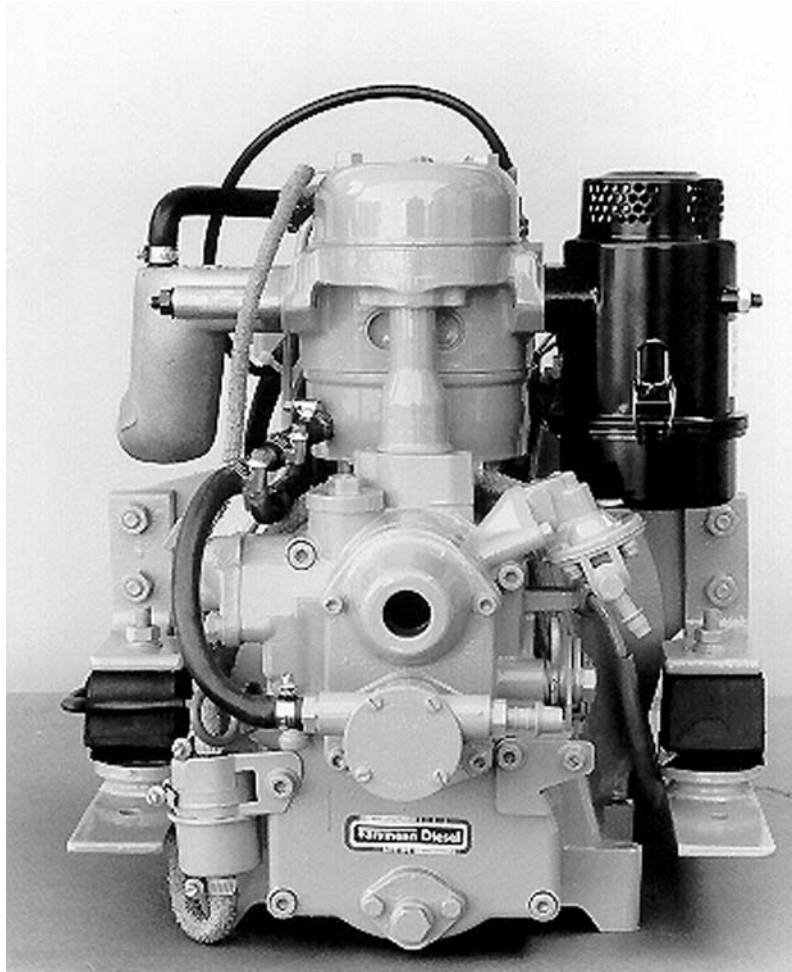
2.4 Tools

748.120.4	Bearing driver	to press the crankshaft bearing bushes in and out	
748.121.4	Bearing driver	to press the camshaft in and out	
748.124.4	Bearing driver	to press out the crankshaft roller bearing	
748.173.2	Oil filter wrench	to remove the full flow oil filter	
748.172.4	Bearing driver	to press the little end bearing bush in and out (connecting rod)	
748.129.4	Bearing driver	to press the regulator shaft bearing bush in and out	
37E/43E: 748.125.4 43F: 748.211.4	Guide punch	to press the valve guides in and out	
748.117.6	Drop tube	to measure the injection timing	

TECHNICAL DATA

2.4 Tools

748.126.2	Oil pressure gauge	to measure the oil pressure	
748.131.5	Valve spring lifter	to remove and fit the valve springs	



2.5 Technical Description

Diesel engine models 15W / 18W / 32W are water-cooled, single-cylinder, four-stroke diesel engines with direct injection. The engines have oil pressure forced lubrication. The fuel injection pump and the valves are controlled by the camshaft which is driven by the crankshaft. The fuel injection pump (self-venting fuel system) is driven directly while the valves are driven by push rods and rockers. An electric starter and a manual starting device are provided to start the engine. The engines are equipped with an automatic decompression system and a manual forced starting enrichment quantity.

Special modified water-cooled Farymann engines fulfill BSO I/II and EPA – requirements.

2.6 Applications

Diesel engine models 15W / 18W / 32W are suitable for the following applications:

- Marine generating sets
- Marine propulsion engines
- Vehicle cooling systems
- Military Equip. (APU, ...)

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RE-ASSEMBLING PROCEDURES

3. Dismantling and Assembly Procedures on the Basic Engine

3.1 Basic Requirements

- The aim of this Repair Manual is to provide help with carrying out repairs to the engine.

The requirements for this are as follows:

- Trained specialist staff (of at least the minimum legal age);
- and a workshop where the necessary equipment, standard tools and special tools are available
- A well-lit, unrestricted working area, free from dirt and swarf, will make the work considerably easier.
- Clean the engine thoroughly before dismantling it.
- Attention must be paid to all the information and warning notices which have been affixed.
- Particular care is called for in the vicinity of rotating, moving or hot parts.



This symbol is used whenever failure to comply precisely with instructions or procedures may cause accidents which can result in injuries or death.



This symbol is used whenever failure to comply precisely with instructions or procedures may cause damage to the engine.



Advice and tips about special features when handling the engine.

RE-ASSEMBLING PROCEDURES

3.2 DISMANTLING PROCEDURES

1. Drain lubrication oil :

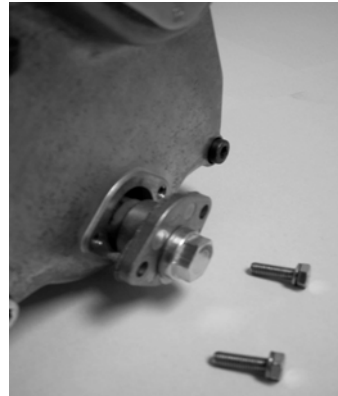
Place suitable container under the drain hole.
Remove 2 screws and copper washers, remove
oilscreen.



Caution

Clean oilscreen carefully.

**Replace if any deformations or other dam-
ages.**



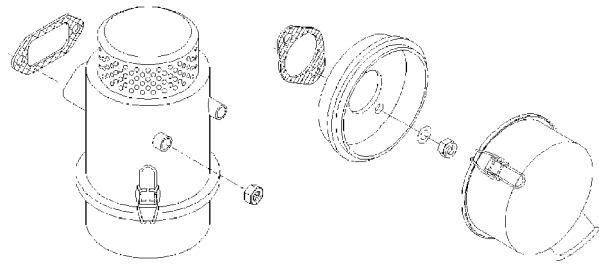
2. Air cleaner

Engines installed in Generating Sets

Aircleaner-assy done from equipment manufac-
turer. Follow instructions of the operating man-
ual.

Marine propulsion engines

There are different versions of aircleaner and
noise damper in use. In each case remove the
2 selflocking nuts and pull of the assy.
Discard gasket and replace filter element if ex-
isting.



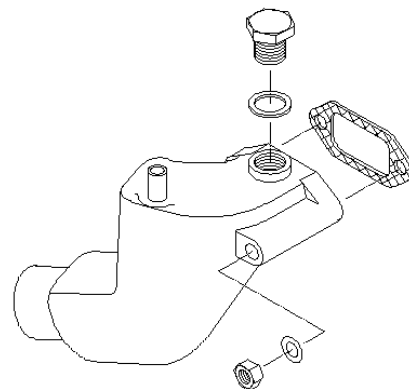
3. Muffler / Exhaust manifold

Engines installed in Generating Sets

Muffler-assy done from equipment manufac-
turer. Follow instructions of the operating man-
ual.

Marine propulsion engines

Special watercooled exhaust manifold.
Remove 2 hex-nuts and washers.
Discard gasket.
Replace clamp of the water-line if necessary.



RE-ASSEMBLING PROCEDURES



4. Fuel lines, fuel filter

Remove banjo bolts, copper washers from injection pump and injector. If existing – remove fuel filter bracket, setscrews and spring washers.

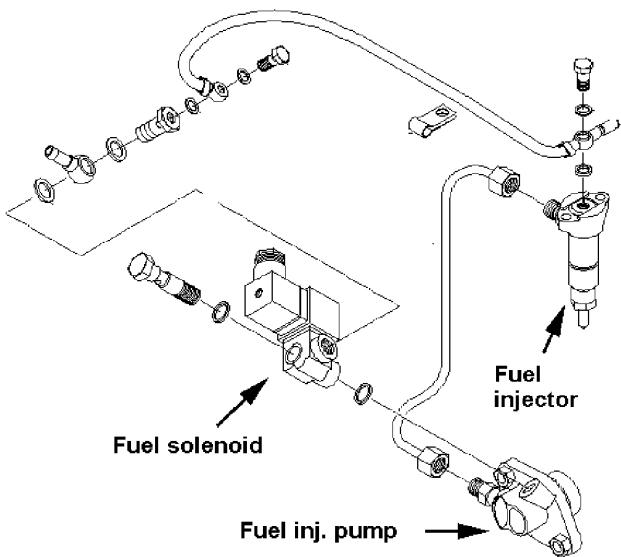
Close ports of injection pump and injector with banjo bolts to prevent dirt.



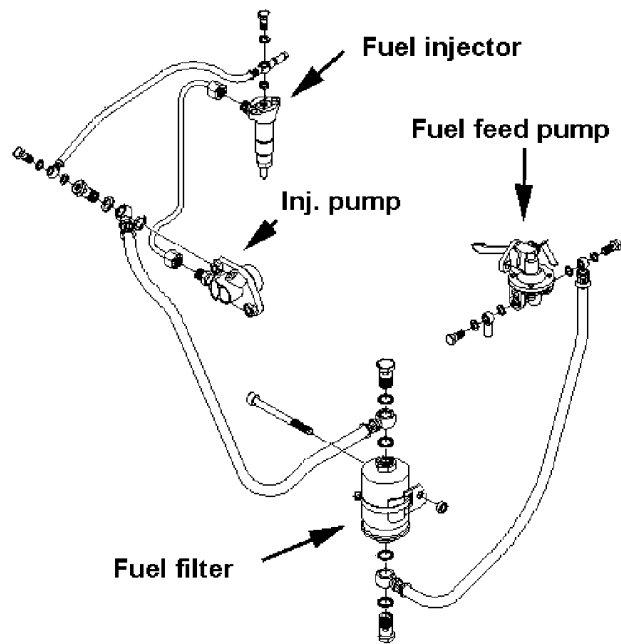
Caution

Use only original fuel filter and fuel persisted fuel lines for replacement.

Example : Fuel system Genset engine



Example : Fuel system Propulsion engine



RE-ASSEMBLING PROCEDURES

5. High pressure fuel line :

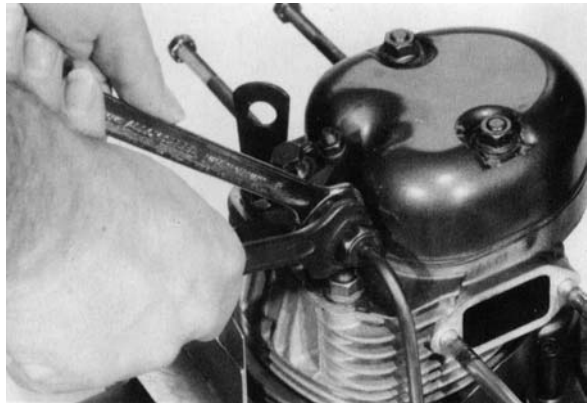
Loosen the high pressure fuel line by holding a 14 mm wrench on the delivery valve while unscrewing the fuel line fitting.

Loosen the high pressure line at the injector in the same way.



Check taper ends of the high pressure line for damage or wear.

Replace if necessary.



6. Fuel injector :

Remove hex nuts and lock washer from injector clamp. Pull out injector.



Sticking injector : Use a soft faced hammer and tap slightly.

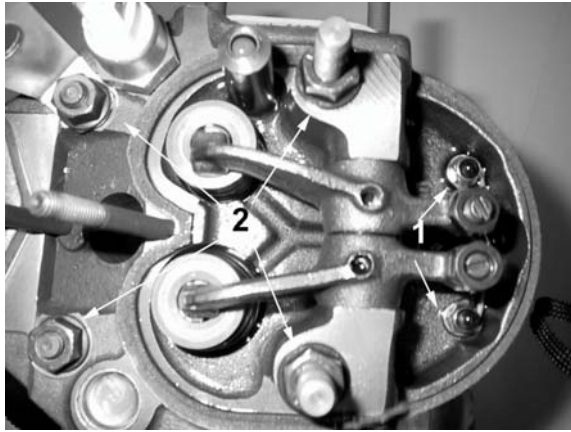
OR : Take an old high pressure line to pull the injector out.

Check injector and cylinder head bore for the copper washer ! Copper washer has to be replaced in all cases !



RE-ASSEMBLING PROCEDURES

7. Cylinder head :



Remove the valve cover by removing the lock nuts and the plastic washers. If necessary tap the cover lightly with a soft faced hammer. Discard plastic washers and valve cover gasket.

Remove the 2 locknuts and washers (1) holding the protection tube retaining spring.

Loosen the 4 cylinder head nuts (2) using a torque wrench.



Drive out the rocker arm bolt with a drift pin and a hammer.

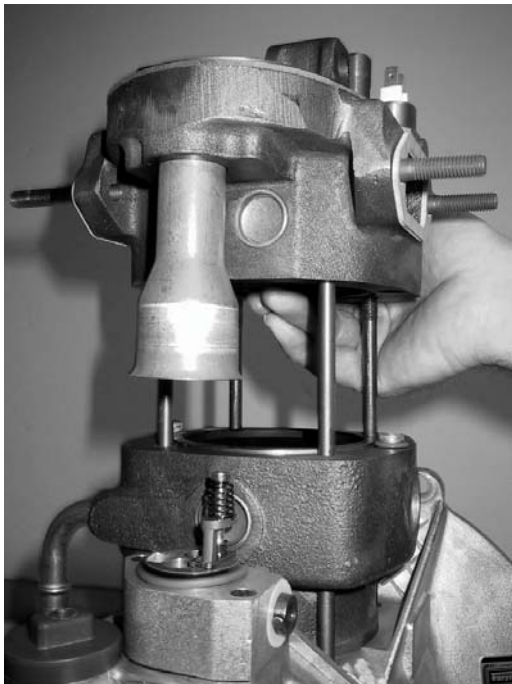
Remove rocker arms and push rods.

Check rocker arm bushings for wear.

Replace bushings if necessary.

Check push rods for bending and wear at the taper ends

Replace if necessary..



Remove the cylinder head nuts and cylinder head. Remove the protection tube.

Remove cylinder head gasket using a screwdriver.

Check valves, valve seat and valve guide for wear or damage. Replace if necessary.

Check blanking plugs (water cooling room) for leakage.



Caution

Use a valve spring compressor to remove the valves.

Valve guides can be easily removed with a valve guide driver (refer to Special Tool List !)

RE-ASSEMBLING PROCEDURES

8. Decompression release

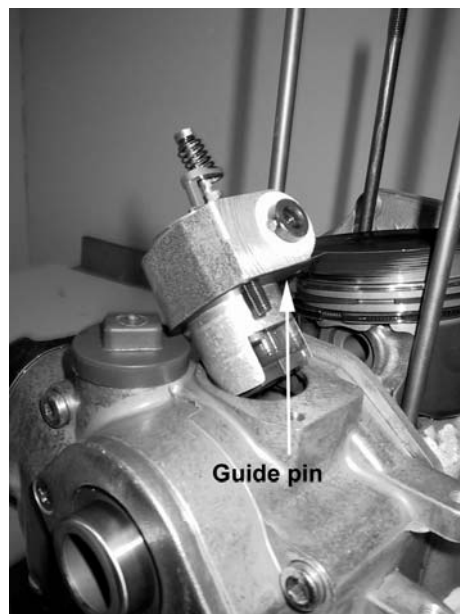
Remove 2 screws and pull the decompression Release out of the gearhousing.

Check gasket and o-seal. Replace if necessary.



Caution

Take care not to loose the guide pin !
With missing guide pin shaft will move out when engine is in operation !



9. Cylinder

Rotate the flywheel until the piston the bottom of ist stroke. Carefully slide the cylinder up of the studs.

Check o-seals of water-overflow-jackets. Re-
place if necessary.



Caution

If the repair doesn't require replacement of piston and liner, leave the liner on the piston.
Pull up liner so far that piston pin bore is free ->
See next step.



RE-ASSEMBLING PROCEDURES

10. Piston

Rotate the flywheel until the piston is in TDC – position. Use a needle nose plier to remove the piston pin retainer.

With a drift pin gently hammer piston pin out of the piston (from flywheel-side).



Caution

If the piston pin is sticking you've to remove the complete piston and conrod assy. Remove piston pin on the work bench.



11. Conrod

Turn the flywheel until piston is in BTC–position. Put the engine down on flywheel-side. Remove the crankcase bottom plate by unscrewing the 6 head screws.

Discard gasket.



Caution

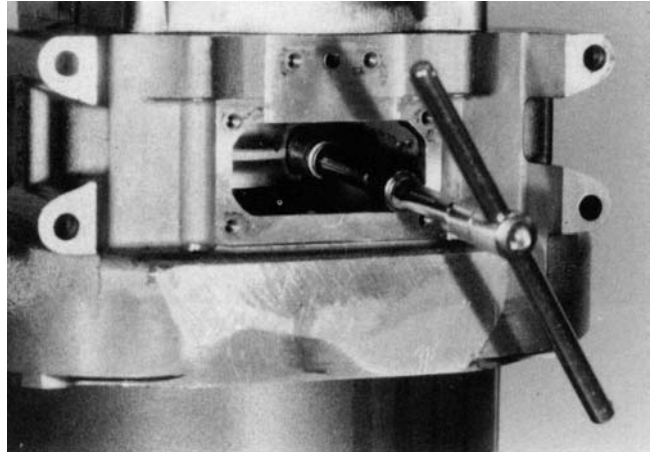
If the screws are very tight tap them with a hammer and and drift pin.



When reusing the conrod bearings you have to mark the bearing shells and the corresponding parts of the conrod. This ensures that the bearing runs in the same position again after installation.

Use a 13 mm socket to remove the hex nuts. Pull out the conrod big end using a plier.

RE-ASSEMBLING PROCEDURES



12. Crankhandle guide

Remove the 2 crankhandle guide screws. Pull of the guide in a twisting motion.



13. Gear end cover

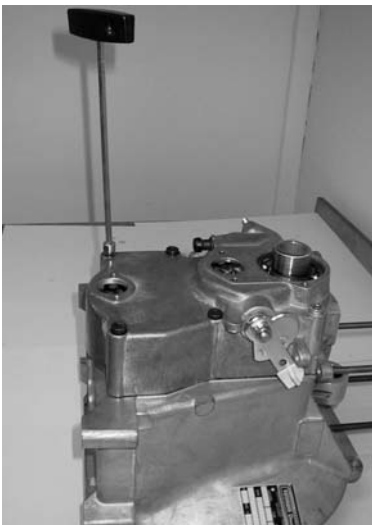
Remove the 6 allen screws and pull off the gear end cover. If necessary tap with a soft faced hammer.



Caution

While removing the gear end cover the gear of the camshaft could stick on the governor-body.

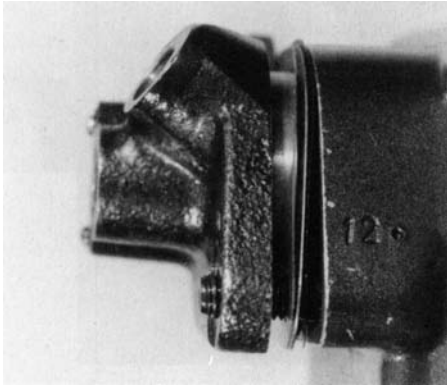
¼ turn of the flywheel will free it !



14. Injection pump

Move acceleration lever to full speed position.

RE-ASSEMBLING PROCEDURES

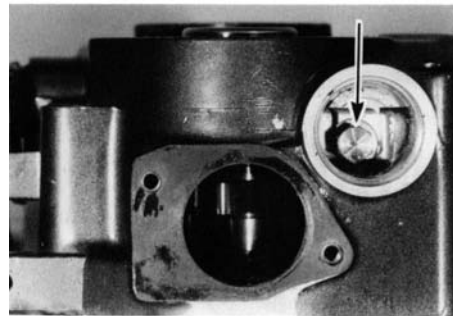


Remove the 2 hex nuts and lock washers. Pull off the inj. Pump. If necessary turn the flywheel to decrease force from the camshaft-side.



Leave gasket and shim on the gear end housing. Re-install hex nuts and lock washers on their studs.

To remove the injection pump camfollower unscrew fixing screw (arrow) through oil filling bore.



15. Camshaft

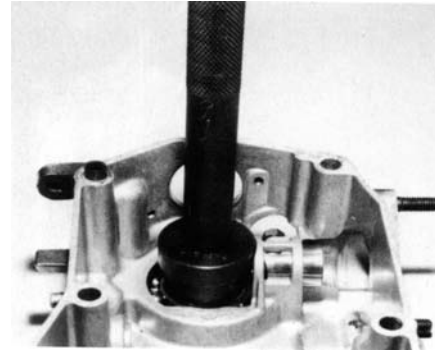
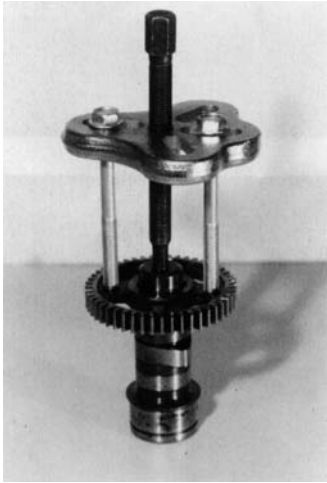
Remove the circlip lock ring fixing the camshaft in the gear end cover. Press out the camshaft using a driver (see special tool list).

To pull off the camshaft gear wheel use puller or press.

After removing the camshaft the roller bearing can be pressed out from the inside of the cover using a special driver.

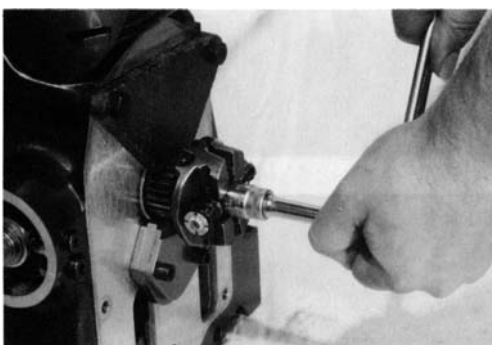
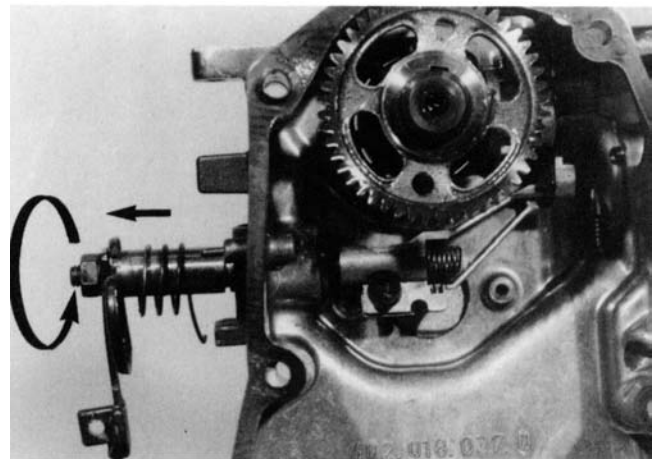


RE-ASSEMBLING PROCEDURES



16. Speed control assembly

Remove the retaining ring from the eccentric shaft using a pliers. Pull the ecc. shaft outwards till the ratchet plate is free from the compression pin. Unhook the outer torsion spring from the boss (use a pliers and watch out for your fingers). Hold the inner control lever and twist acceleration lever down to stop-position till the inner torsion spring is without tension. Then pull eccentric shaft out of control lever and bearing bush.



17. Governor

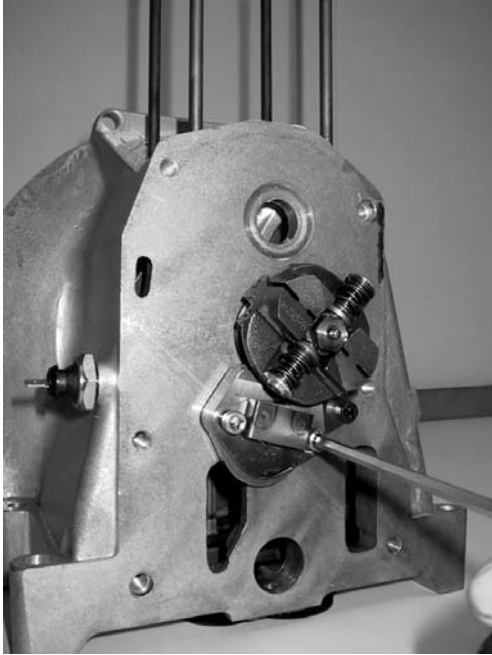
Install holding device (special tools)
Remove governor pin from governor.
Spread flyweights with a screwdriver and use 14 mm socket to unscrew governor.



Caution

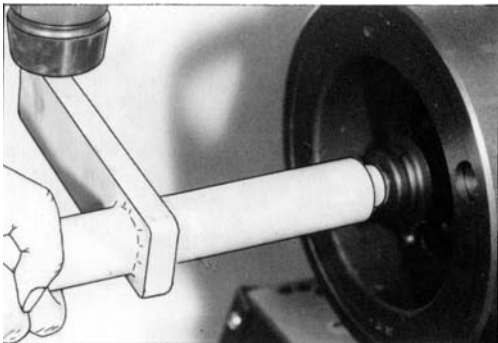
Governor mounted with left-hand-thread !

RE-ASSEMBLING PROCEDURES



18. Oil pump

Remove the oil pump and valve bracket by unscrewing the 3 mounting screws.
Discard gasket.



19. Flywheel

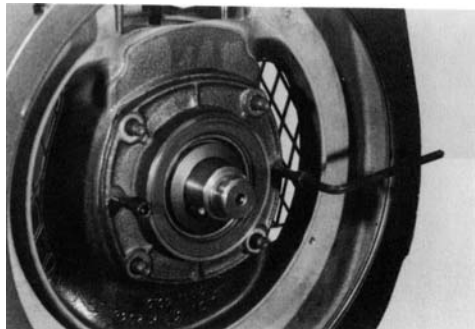
Remove the oil pump and valve bracket by unscrewing the 3 mounting screws.
Discard gasket.

Leave the flywheel nut on the shaft. Install flywheel puller and turn the screws until the flywheel breaks loose from the crankshaft taper. Remove the puller, flywheel nut and flywheel.

20. Main bearing housing

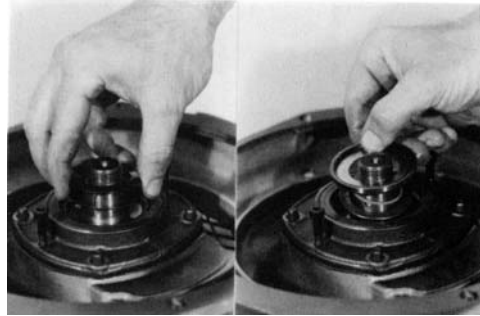
Remove the 4 main bearing housing nuts and washers.

Next install 2 screws M6 x 30 into the thread holes. Screw them in until the housing breaks loose.



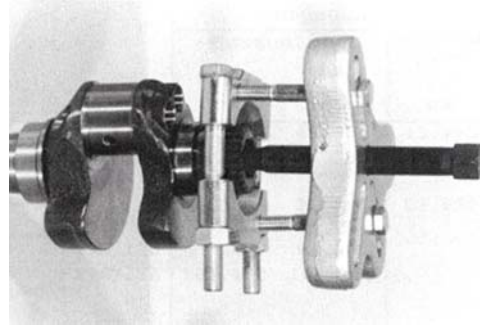
RE-ASSEMBLING PROCEDURES

Remove the key, belleville washers, angle ringe, o-ring and thrust washer.

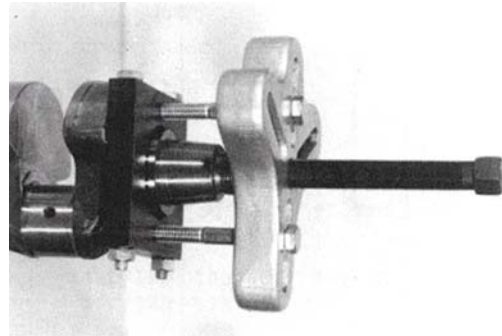


21. Crankshaft

Remove the crankshaft from the crankcase, being careful not to drag the crankshaft gear on the main bearing bushing. Use a puller to pull of the crankshaft gear.



In case the roller bearing needs replacement, replace also the inner race, which is shrunk fit on to the crankshaft. Use race puller to pull off the inner race.

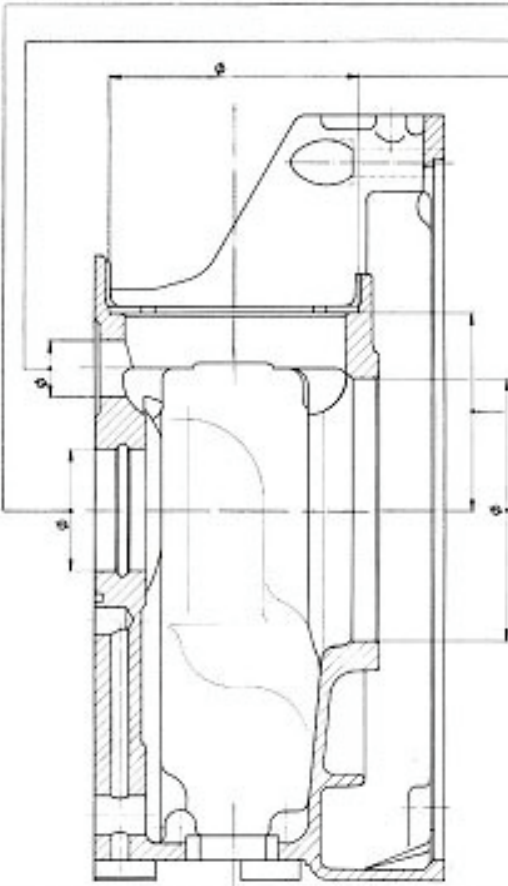
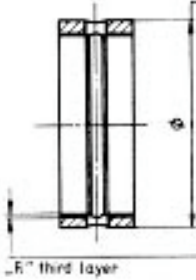


**The engine is now completely stripped down.
Clean all parts with diesel fuel or other suitable cleaning agent.
Check parts for damaga, wear and tear.
Replace is necessary.**

MEASUREMENT TABLE, WEAR

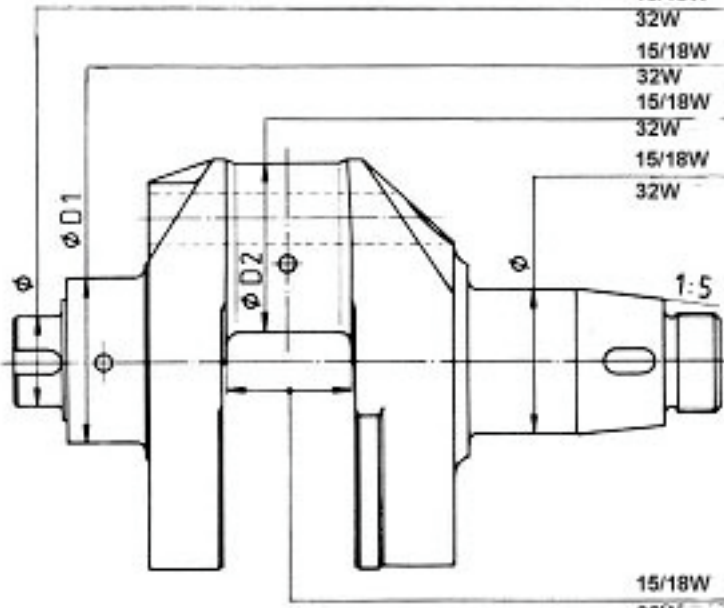
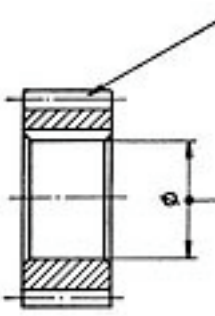
4. MEASUREMENT TABLE- WEARING PARTS

4.1 CRANKCASE

Part. Description	Dimension			
	Original max. mm	min. mm	max. Limit mm	
Crankcase 	15/18W 32W	45.971 46.016	45.955 46.000	45.985 46.030
		22.020	21.990	22.990
	15/18W 32W	95.035 104.100	95.000 104.100	
	15/18W 32W	75.050 92.050	74.950 91.950	74.900 91.900
	15/18W 32W	100.004 128.004	99.982 127.979	
Main bearing bush 	15/18W 32W	46.105 46.075	46.065 46.035	inner diameter not fixed can only be checked when bush is pressed into crankcase via the bearing play, radial play: 0.02 0.06 0.09 0.02 0.06 0.09
	15/18W 32W			

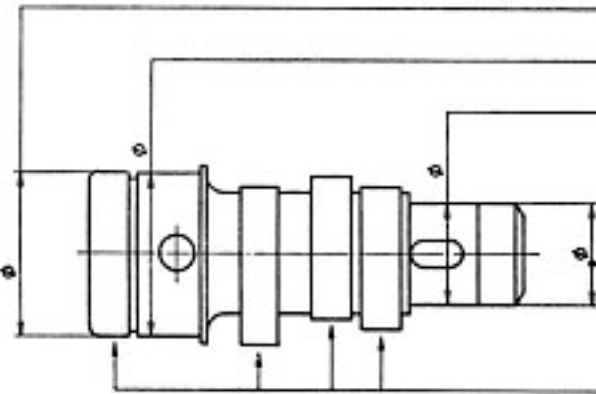
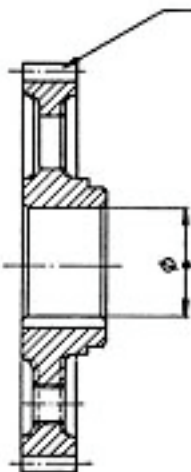
MEASUREMENT TABLE, WEAR

4.2 CRANKSHAFT

Part. Description	Dimension																																								
	Original max. mm	min. mm	max. Limit mm																																						
Crankshaft 	15/18W	22.029	22.008	*																																					
	32W	22.029	22.008	*																																					
	15/18W	40.080	40.060	*																																					
	32W	41.010	39.990	*																																					
	15/18W	40.030	40.020	*																																					
	32W	47.960	47.940	*																																					
	15/18W	35.023	35.015	*																																					
	32W	45.020	45.009	*																																					
	15/18W	30.200	30.130	30.300																																					
	32W	30.250	30.180	30.350																																					
Radial Bearing play	D1	0.020	0.050	0.080																																					
	D1	0.020	0.060	0.090																																					
	D2	0.030	0.060	0.110																																					
	D2	0.030	0.060	0.120																																					
Regrind Stages The crank pin and journal can be reground in 2 stages of 0.25 mm each and fitted with under size bearings																																									
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>∅ D1</th> <th>∅ D2</th> <th colspan="2">D1 corresponding D2 bearing</th> <th></th> </tr> </thead> <tbody> <tr> <td rowspan="2" style="text-align: center;">1</td> <td style="text-align: right;">39.830</td> <td style="text-align: right;">39.780</td> <td rowspan="2" style="text-align: right;">775.033.4</td> <td rowspan="2" style="text-align: right;">470.009.4</td> <td rowspan="4" style="text-align: center;">15/18W</td> </tr> <tr> <td style="text-align: right;">39.810</td> <td style="text-align: right;">39.770</td> </tr> <tr> <td rowspan="2" style="text-align: center;">2</td> <td style="text-align: right;">39.580</td> <td style="text-align: right;">39.530</td> <td rowspan="2" style="text-align: right;">775.034.4</td> <td rowspan="2" style="text-align: right;">470.012.4</td> </tr> <tr> <td style="text-align: right;">39.560</td> <td style="text-align: right;">39.520</td> </tr> <tr> <td rowspan="2" style="text-align: center;">1</td> <td style="text-align: right;">40.985</td> <td style="text-align: right;">47.710</td> <td rowspan="2" style="text-align: right;">775.035.4</td> <td rowspan="2" style="text-align: right;">470.019.4</td> <td rowspan="4" style="text-align: center;">32W</td> </tr> <tr> <td style="text-align: right;">39.740</td> <td style="text-align: right;">47.460</td> </tr> <tr> <td rowspan="2" style="text-align: center;">2</td> <td style="text-align: right;">40.735</td> <td style="text-align: right;">47.690</td> <td rowspan="2" style="text-align: right;">775.036.4</td> <td rowspan="2" style="text-align: right;">470.020.4</td> </tr> <tr> <td style="text-align: right;">39.490</td> <td style="text-align: right;">47.440</td> </tr> </tbody> </table>		∅ D1	∅ D2	D1 corresponding D2 bearing			1	39.830	39.780	775.033.4	470.009.4	15/18W	39.810	39.770	2	39.580	39.530	775.034.4	470.012.4	39.560	39.520	1	40.985	47.710	775.035.4	470.019.4	32W	39.740	47.460	2	40.735	47.690	775.036.4	470.020.4	39.490	47.440				
	∅ D1	∅ D2	D1 corresponding D2 bearing																																						
1	39.830	39.780	775.033.4	470.009.4	15/18W																																				
	39.810	39.770																																							
2	39.580	39.530	775.034.4	470.012.4																																					
	39.560	39.520																																							
1	40.985	47.710	775.035.4	470.019.4	32W																																				
	39.740	47.460																																							
2	40.735	47.690	775.036.4	470.020.4																																					
	39.490	47.440																																							
Crankshaft gear 	22.000	19.970	Tooth edges smooth, no scoring and wear.																																						
Heat gear to 90-100°C to obtain shrink-fit.																																									

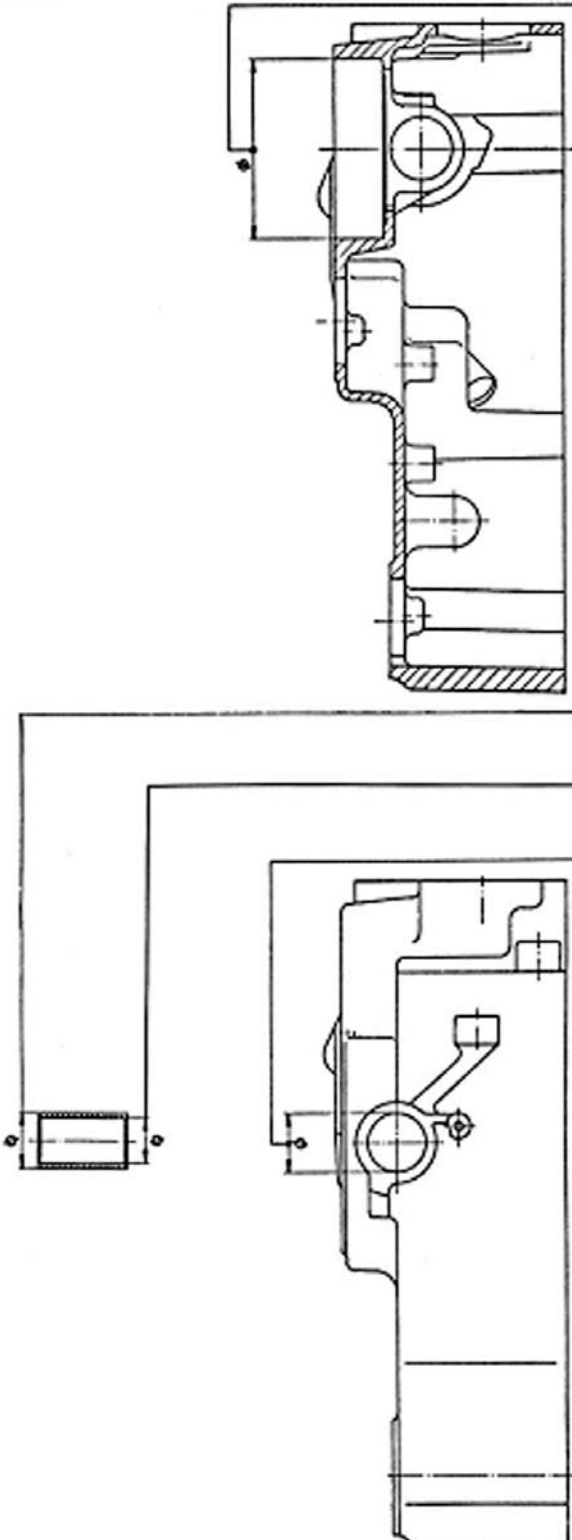
MEASUREMENT TABLE, WEAR

4.3 CAMSHAFT

Part. Description	Dimension		
	Original max. mm	Original min. mm	max. Limit mm
<p>Camshaft</p> 	34.850	34.800	34.750
	35.018	35.002	
	22.031	22.022	
	21.930	21.910	21.860
			renew if scored
<p>Camshaft gear</p> 	22.000	21.980	<p>Tooth edges smooth, no scoring and wear.</p>
			Heat gear to 90-100°C to obtain shrink-fit.

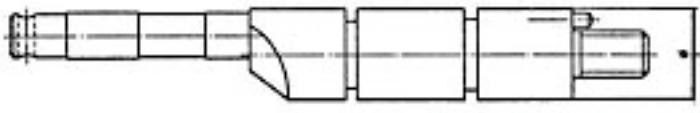
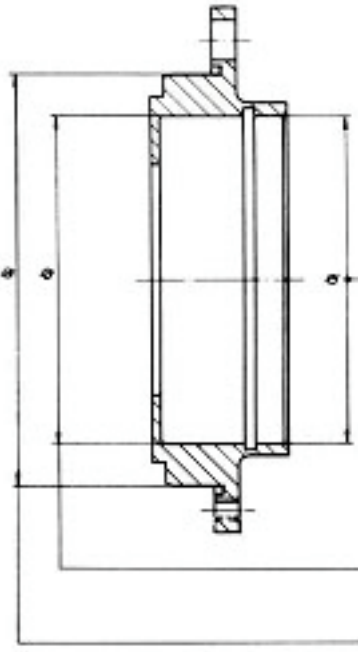
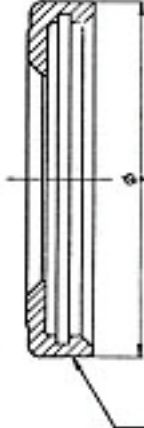
MEASUREMENT TABLE, WEAR

4.4 GEAR COVER

Part. Description	Dimension		
	Original max. mm	min. mm	max. Limit mm
Gear cover 	61.991	61.961	
	20.074	20.054	
	16.142	16.092	
	16.100	16.080	16.150
	20.020	20.010	

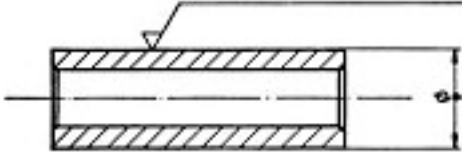
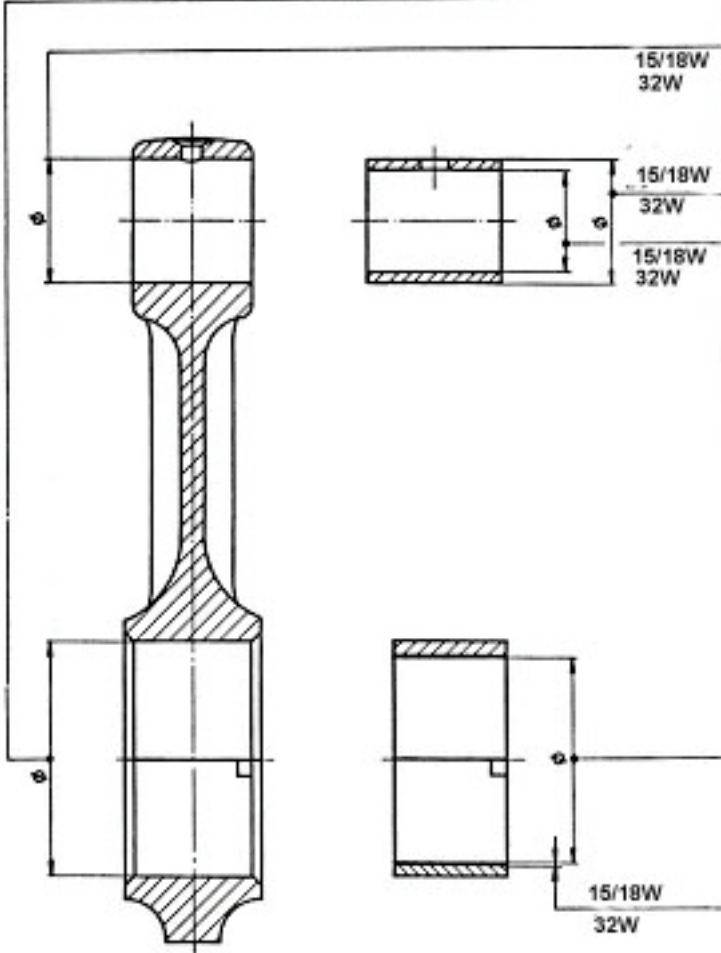
MEASUREMENT TABLE, WEAR

4.5 SHAFTS, BEARINGS

Part. Description	Dimension		
	max. mm	Original min. mm	max. Limit mm
Excentric shaft 	16.056	16.045	16.000
Main bearing housing 	15/18W 32W	80.046 99.982	80.000 99.967
	15/18W 32W	79.986 99.982	79.967 99.967
	15/18W 32W	100.035 128.027	100.013 128.008
Angle ring 	15/18W 32W	60.000 65.000	59.810 64.810
			renew if scored

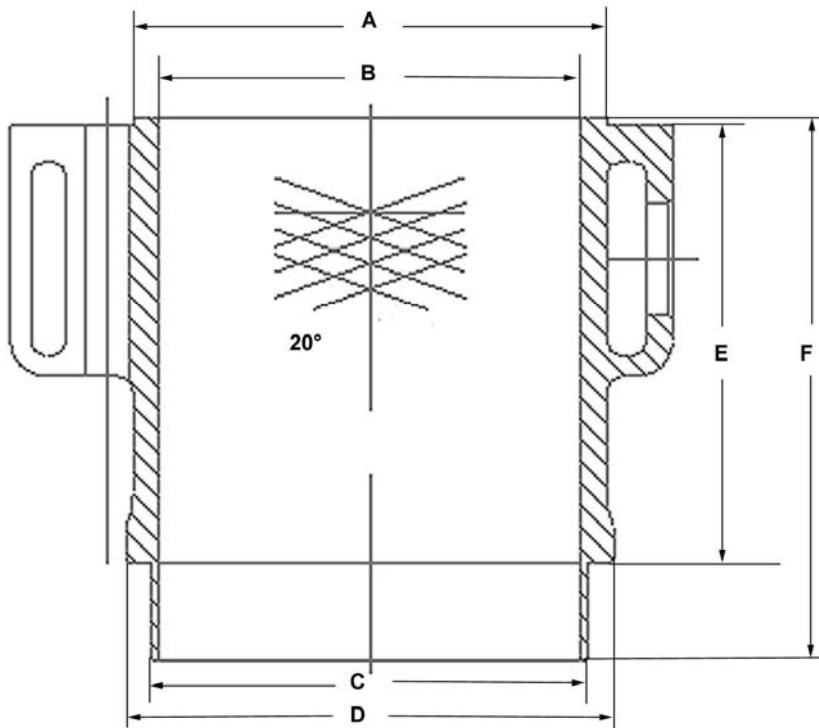
MEASUREMENT TABLE, WEAR

4.6 CONNECTING ROD

Part. Description	Dimension				
	Original max. mm	min. mm	max. Limit mm		
Piston pin 	22.000	21.996	renew if scored		
	26.000	25.996			
Connecting rod with bearings 	15/18W 32W	43.666 51.619	43.650 51.600	renew if scored	
	15/18W 32W	24.986 29.013	24.974 29.000		
	15/18W 32W	25.075 29.075	25.035 29.035		
	15/18W 32W	22.050 26.109	22.030 26.045		
	15/18W 32W	0.030 0,030	0.060 0,060		0.110 0.120
	inner diameter only to be checked via radial bearing play: Both bearing shells will have to be renewed when the galvanically applied layer "R" wears off (recognisable on shiny gold-bronze color) and/or when scoring appears around circumference.				
	0.030 0.060 0.110 0,030 0,060 0.120				
	Both bearing shells will have to be renewed when the galvanically applied layer "R" wears off (recognisable on shiny gold-bronze color) and/or when scoring appears around circumference.				
	0.030 0.060 0.110 0,030 0,060 0.120				
	Both bearing shells will have to be renewed when the galvanically applied layer "R" wears off (recognisable on shiny gold-bronze color) and/or when scoring appears around circumference.				

MEASUREMENT TABLE, WEAR

4.7 CYLINDER LINER

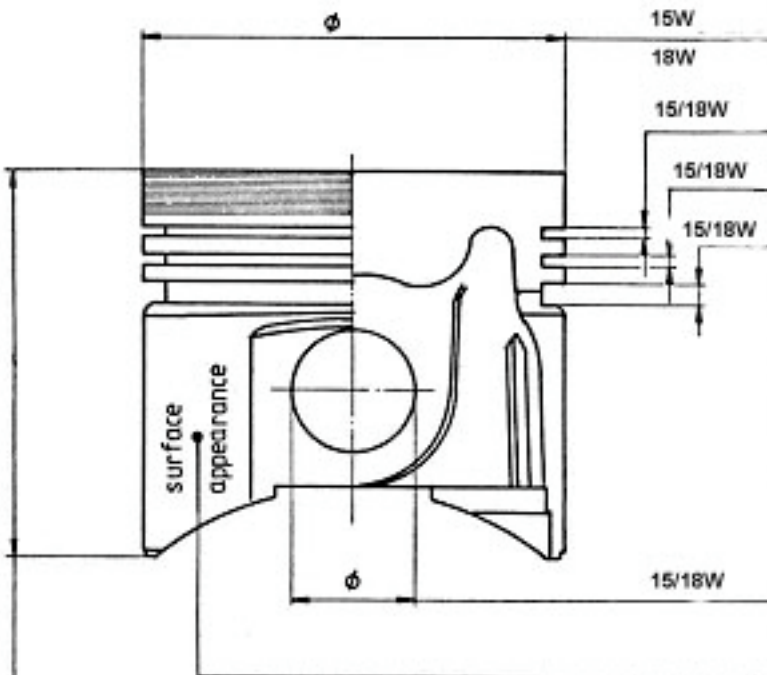
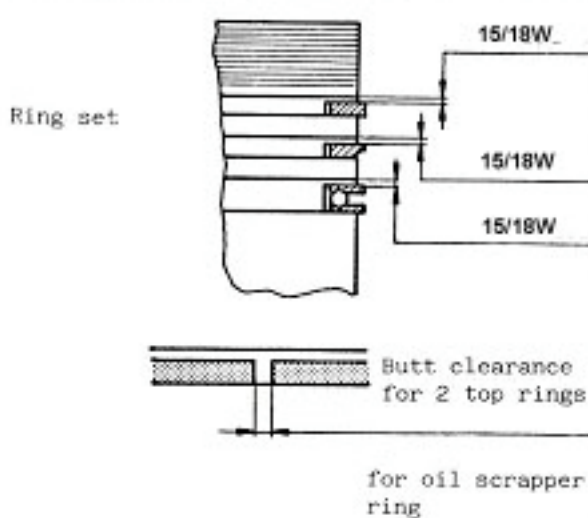


Dimensions :

	15W	18W	32W
A	92 -0,05	92 -0,05	109,2 -0,1
B	75,050 - 75,030	82,050 - 82,030	95,040 - 95,020
C	78,8 -0,1	85,0 -0,2	100,5 -0,2
D	95 -0,036 /-0,071	95 -0,036 /-0,071	117 -0,1 / -0,15
E	86,75 -0,025	86,75 -0,025	111,2 -0,025
F	105,75 -0,1	105,75 -0,1	138,2

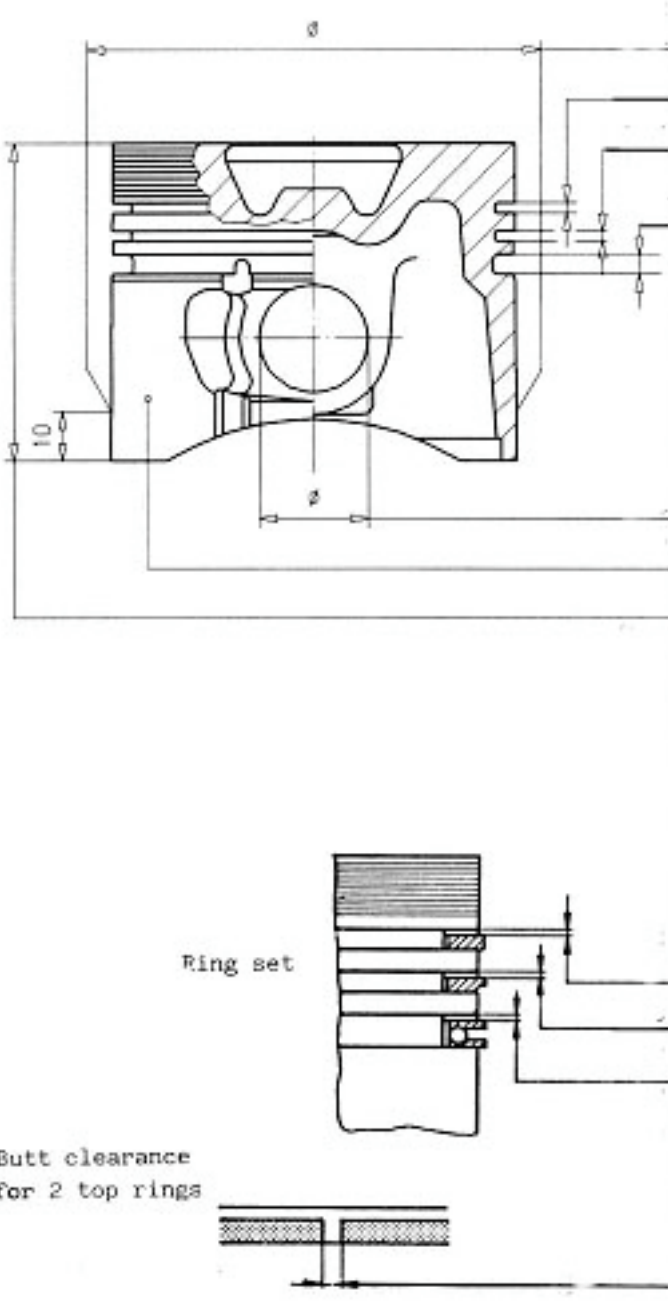
MEASUREMENT TABLE, WEAR

4.8 PISTON 15/18W

Part. Description	Dimension				
	max. mm	Original min. mm	max. Limit mm		
Piston 15W / 18W 	15W	74.967	74.953		
	18W	81.967	81.953		
	15/18W	2.120	2.100		
	15/18W	2.070	2.050		
	15/18W	4.040	4.020		
	15/18W	22.010	22.004		
	15/18W	64.200	64.800	renew if longitudinally scored	
	15/18W	0.145	0.110		0.17
	Ring set 	15/18W	0.092	0.060	0.14
		15/18W	0.065	0.030	0.11
Butt clearance for 2 top rings		0.500	0.300	1.0	
for oil scrapper ring		0.500	0.250	1.0	
Butt clearance are caused by piston ring wear and wear of cylinder liner surface. We recommend always to exchange cylinder liner, piston and rings together.					

MEASUREMENT TABLE, WEAR

4.9 PISTON 32W

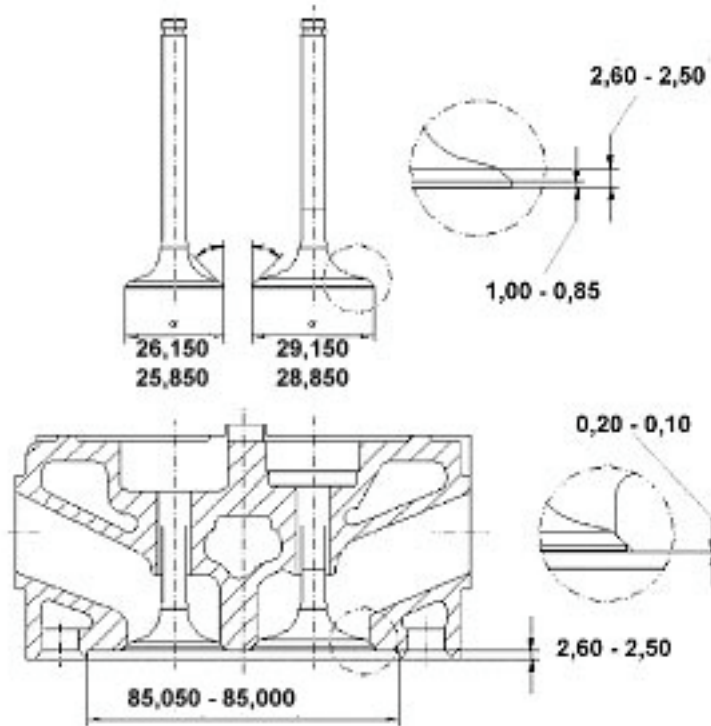
Part. Description	Dimension		
	max. mm	Original min. mm	max. Limit mm
Piston 32W 	94.947	94.933	
	2.100	2.080	
	2.060	2.040	
	4.060	4.040	
	26.008	26.003	renew if longitudinally scored
	79.250	78.795	
			0.15
			0.13
			0.13
			1.1
		1.1	

Butt clearance are caused by piston ring wear and wear of cylinder liner surface. We recommend always to exchange cylinder liner, piston and rings together.

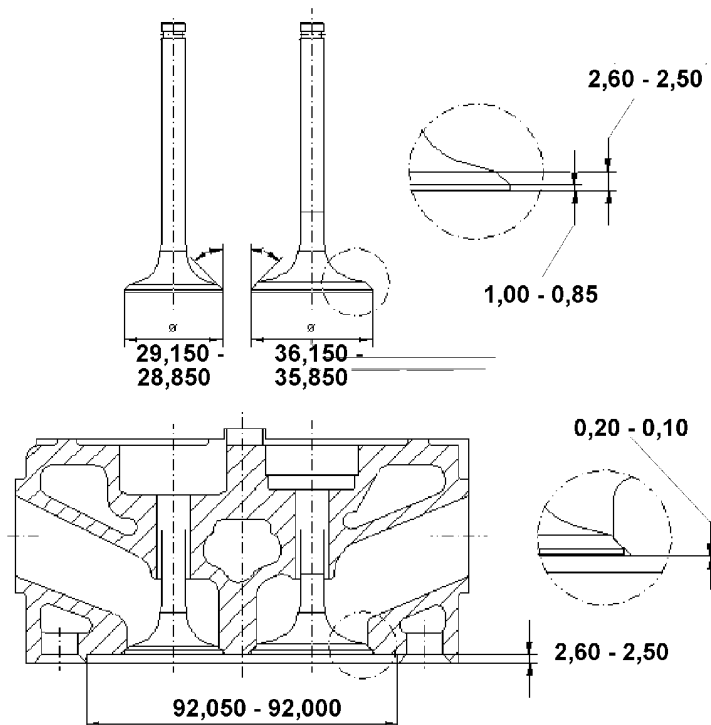
MEASUREMENT TABLE, WEAR

4.10 CYLINDER HEAD 15/18W

Cylinder head 15W



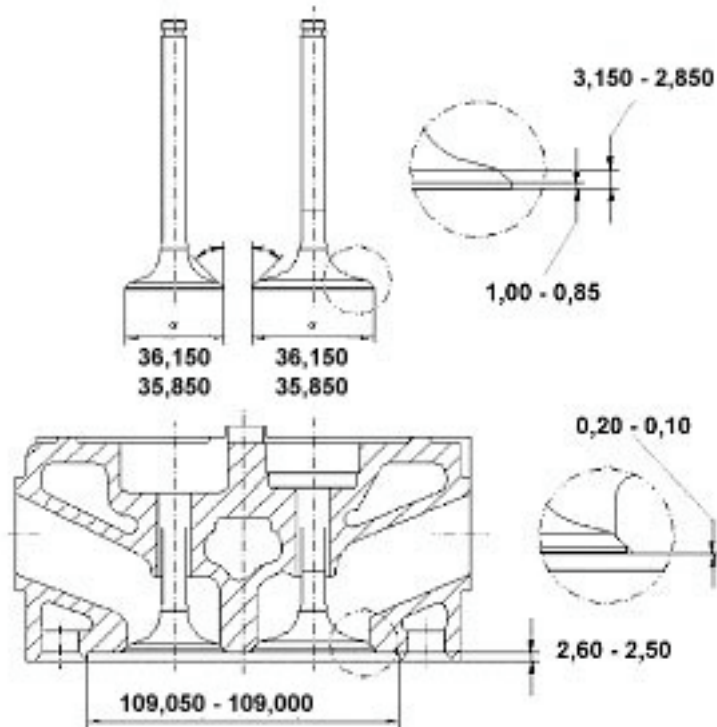
Cylinder head 18W



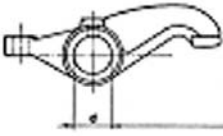

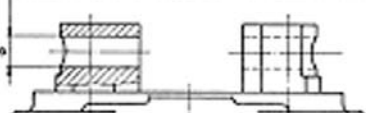
MEASUREMENT TABLE, WEAR

4.11 CYLINDER HEAD 32W

Cylinder head 32W



Rocker arm 15/18/32W

Part Description	Dimension		
	Original max. mm	min. mm	Max. Limit mm
	12,018	12,000	12,000
	11,964	11,958	11,952
	12,010	12,000	12,000

REASSEMBLY PROCEDURES

5. ENGINE REASSEMBLY

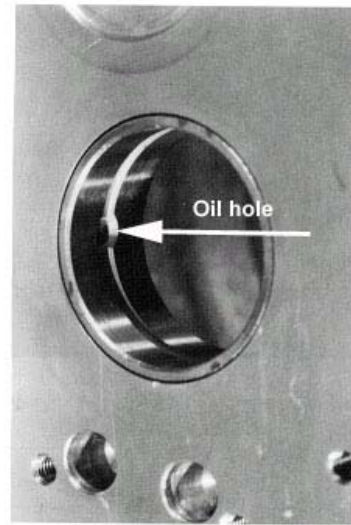
1. Crankcase

Press the bearing bush with a suitable driver.



Caution

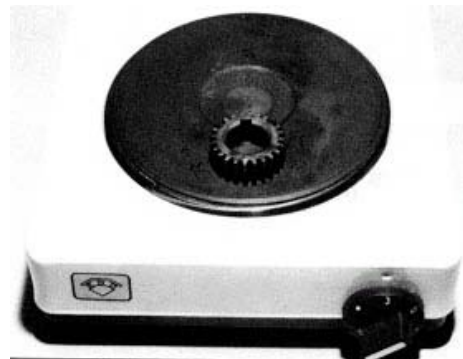
Take care that the joining line of the bearing bush is located as shown and that the oil holes in the bushing and in the crankcase bore are properly lined up.



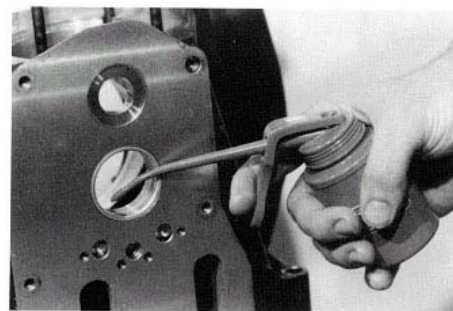
2. Crankshaft

To install the crankshaft gear and the inner race of the roller bearing heat up the parts to a temp. Of 90°C - 100°C (195 – 210 °F).

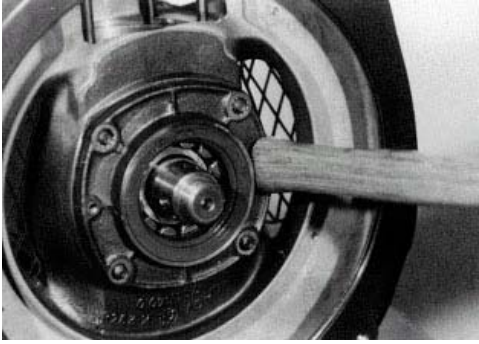
-> use oil bath or electric heater plate.



Oil the bearing bush and slide crankshaft into the crankcase. Take care not to damage the bearing bush with the gear teeth.



REASSEMBLY PROCEDURES



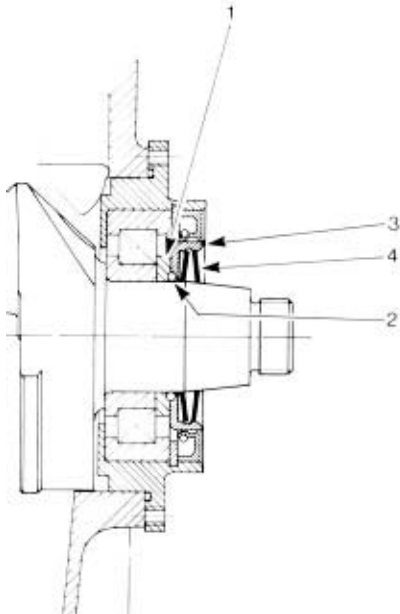
3. Main bearing housing

Press the outer race of the driver into the bearing cover. Insert the retaining ring with pliers. Press the oil sealing ring into the housing using the correct driver. Don't use grease for assembly. Insert o-ring in the bearing housing and put onto studs.

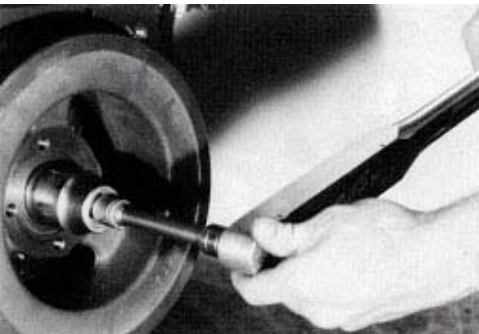


Caution

Bearing housing can only be fitted in one position. Tap lightly with a soft faced hammer to seat the cover. Torque down the fastening nuts crosswise.



Assemble the thrust washer (1) and o-ring (2), followed by the angle ring (3) and the two Belleville washers (4) exactly as shown.



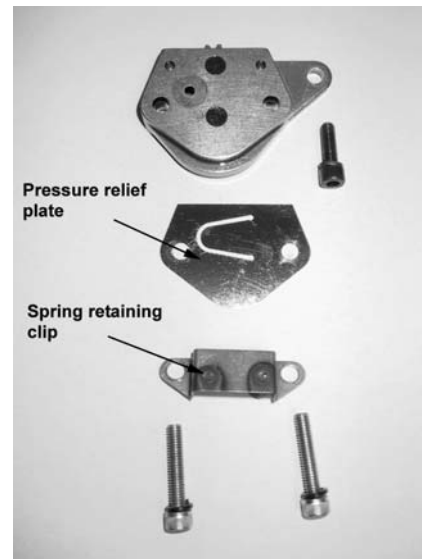
4. Flywheel

Clean crankshaft and flywheel taper free of oil or grease. Insert flywheel key and slide flywheel onto the crankshaft taper. Assemble flywheel retaining nut and tighten to specified torque.

REASSEMBLY PROCEDURES

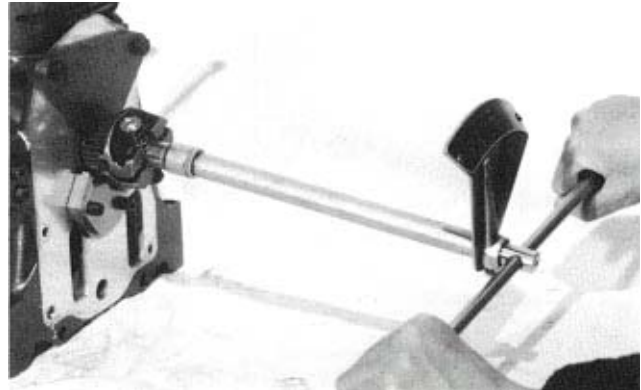
5. Oilpump

Reassemble oilpump with thin pressure relief plate, spring retaining clip and gasket. Before tightening the screws to specified torque pull the pump downwards. The clearance in the screw holes allows a sufficient backlash between crankshaft gear and pump gear.



6. Governor

Install holding device (special tools) on crankshaft or fix crankshaft with a hammer stick. Make sure that governor and crankshaft threads are free of oil and grease. Apply a couple of drops of Loctite 270 (or similar) on the governor thread. Torque the governor down according the torque table.



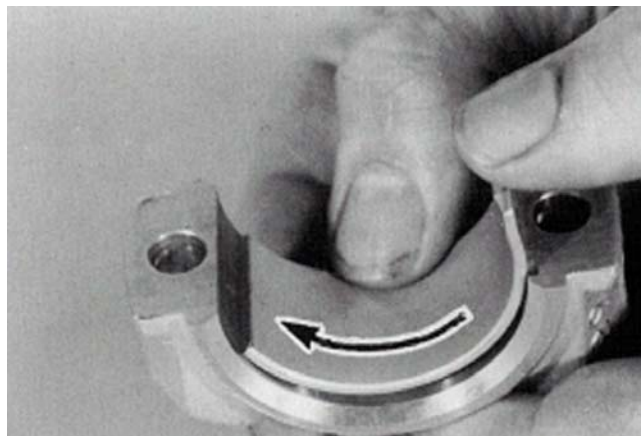
Attention

Governor with lefthand thread ! Spread flyweights to mount the socket of the torque wrench.

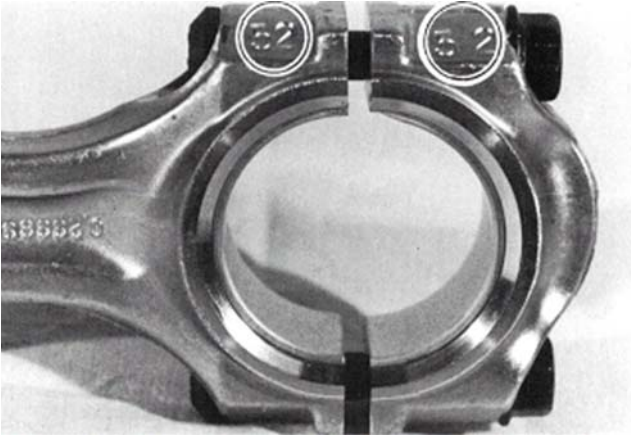
For correct governor setting refer to section Adjustments !

7. Connecting rod

To install new bearing shells, take a shell half and lay it to approx. $\frac{3}{4}$ into the cap. Now press the bearing in a sliding move onto its seat. The bearing lip must fit into the groove in the cap. Install the bearing shell on the rod-side in the same way.

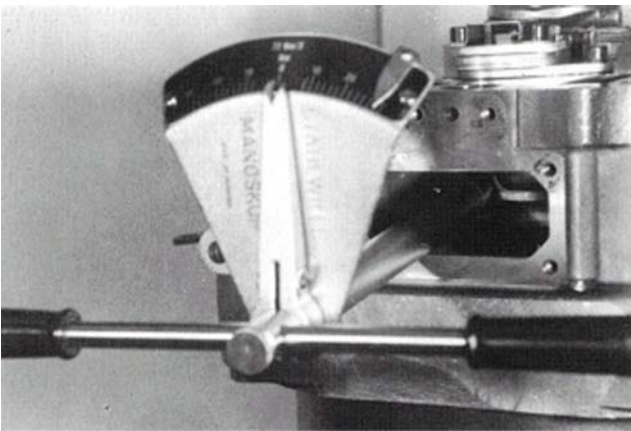


REASSEMBLY PROCEDURES



Notice the stamped numbers on conrod and cap – side . These are matching marks i.e. identical numbers must be on rod and cap.

Oil the bearing shells and install conrod into the crankcase until it seats on the crank pin. Insert conrod cap through the bottom inspection cover



The stamped numbers must be aligned on the same side of the rod but it is not important which engine side the numbers face. Tighten the conrod nuts to the specified torque and reinstall crankcase cover.



8. Camshaft

Heat the camshaft gear wheel in an oil bath or an electric heater plate to 90-100 °C (195-210 °F). Thrust gear onto the camshaft using a suitable length of pipe and a hydraulic press.



The timing mark must face towards cam side of assembly.

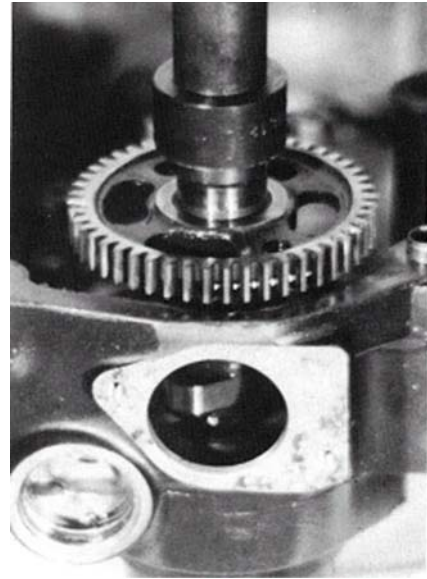


Press the camshaft bearing into the gear end cover using a driver.

REASSEMBLY PROCEDURES

Now press the camshaft with a driver into the bearing. Use another driver as counter pressure piece for the bearing. Make sure that the bearing seats fully against the seat flange. Insert retaining ring. Install camfollower for the injection pump and tighten the fixing screw.

Every time install a new o-ring on the camshaft prior to pressing the camshaft into the bearing.

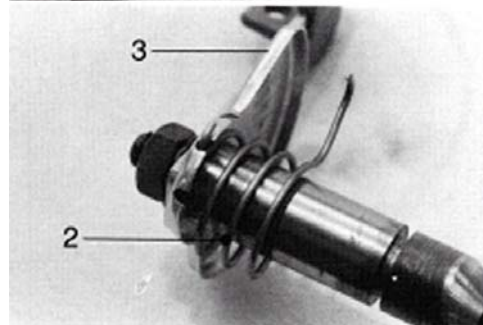
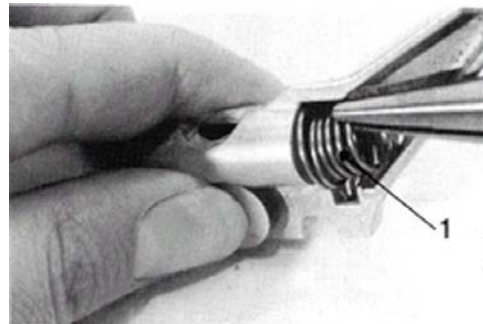


9. Governor control

Insert ratched pin and spring into the hole in the gear end housing.

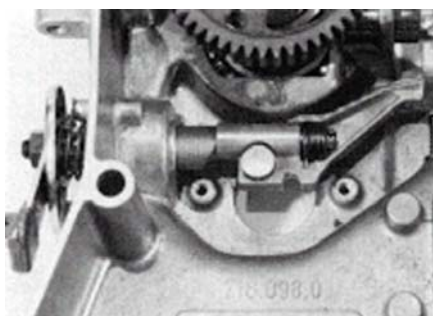
Put the return spring (1) into small hole of the control lever.

Move the torsion spring (2) over the eccentric shaft and hook spring leg in the space in the middle of the ratched plate (3).



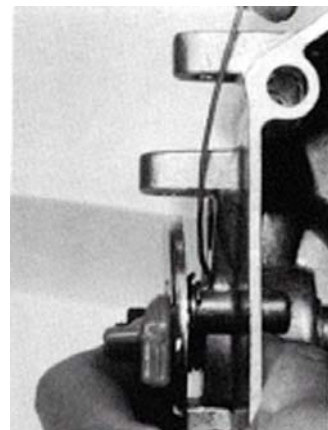
Slide the eccentric shaft through the bearing bush in the housing and into the control lever.

Turn the acceleration lever downwards ("stop") until spring leg of the return spring can be moved into the notch of the eccentric shaft end. (Figure c).



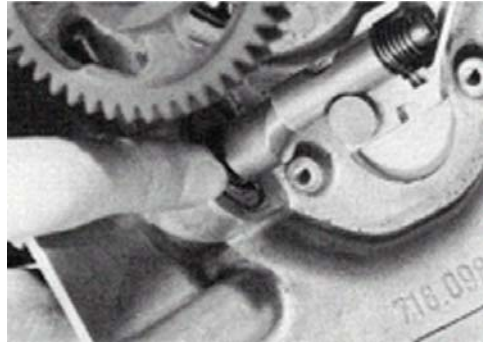
Push in eccentric shaft and clip ring spring into

Use a wire loop to move and hook torsion spring leg to the boss of the gear end housing. (Figure d)



REASSEMBLY PROCEDURES

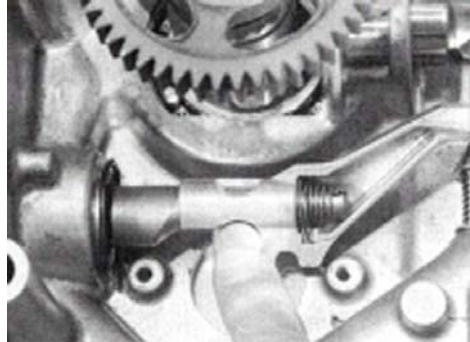
the notch of the eccentric shaft.



Attention

Initiate performance test.

The tension of the return spring must be acting against the pressure onto the seting screw.



Speed control - Stationary

The outer torsion spring pulls the acceleration lever from the stop-position back into idle-position.

Speed control – Vehicle / Bowden cable

The outer torsion spring pulls the acceleration lever into stop-position.

Speed control – Generator

The outer torsion spring pulls the acceleration lever into full-speed-position.

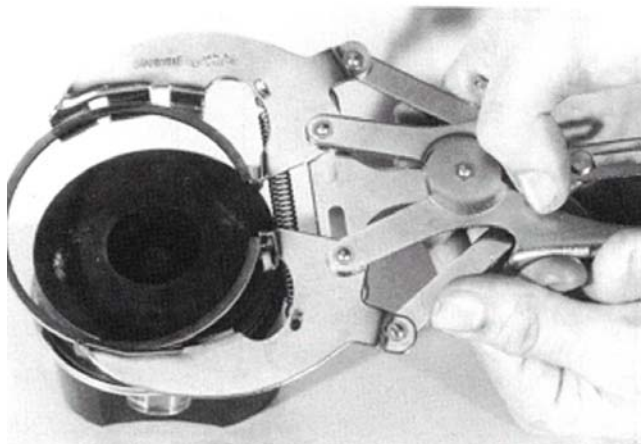


Attention

The spring tension may be altered by hooking the spring leg into one of the neighboured notches !

10. Piston

Install the piston rings using a ring expander. Imprinted sign has to be on top.



REASSEMBLY PROCEDURES



Oil the ring and piston skirts. Check that piston ring gaps are 120 degrees offset. Compress rings with ring compressor. Lay the cylinder down on the bench with bottom facing up. Install piston from bottom side of the cylinder. Never tap on the piston crown.



Never try to install piston through top of the liner as liner is slightly tapered. Push in the piston so far that the piston pin bore is slightly above edge of cylinder.

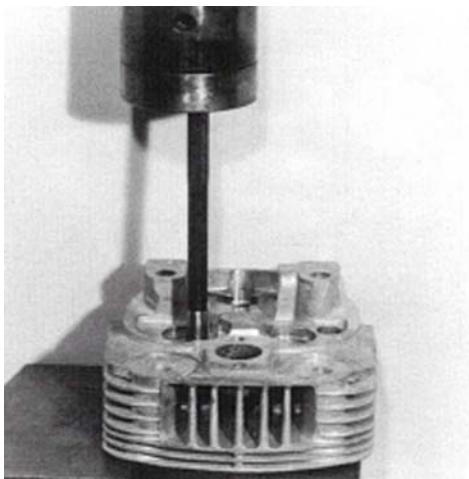


Slide the piston and cylinder over the studs.

For 18W / 32W only :

The arrow-sign (or crankshaft-sign) stamped on the piston top must point towards the fly-wheel.

Align the piston and connecting rod bores. Push the piston pin in and insert the retaining ring. Push the cylinder down until it seats firmly onto the engine crankcase.



11. Cylinder head

Press the valve guides into the cylinder head using a driver. Special care is necessary to ensure that the guide is exactly vertical before pressing in.



Before pressing in the exhaust valve guide, assemble the two small washers and retainer ring.

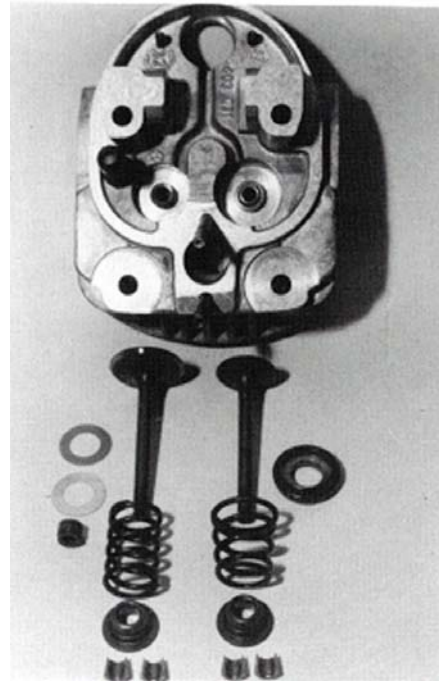
Note : Picture shows air cooled cylinder head !

REASSEMBLY PROCEDURES

Grind in the valves. The rotocap and the conical shaped spring belong to the exhaust valve. The two thin steel washers must be under the cylindrical spring of the inlet valve. Fit new sealing cap onto the inlet valve guide. Before fitting the rotocap check for proper function : Spin the cap, if rattling sound or hard movement -> replace.

NOTE :

32W engine => There's no difference between inlet and exhaust valve spring !



Fit cylinder head gasket and slide cylinder head down onto the cylinder. Fit spring washers and cylinder head nuts. On the shorter stud – intake side –fit the tote bracket and cylinder head nut without washer.

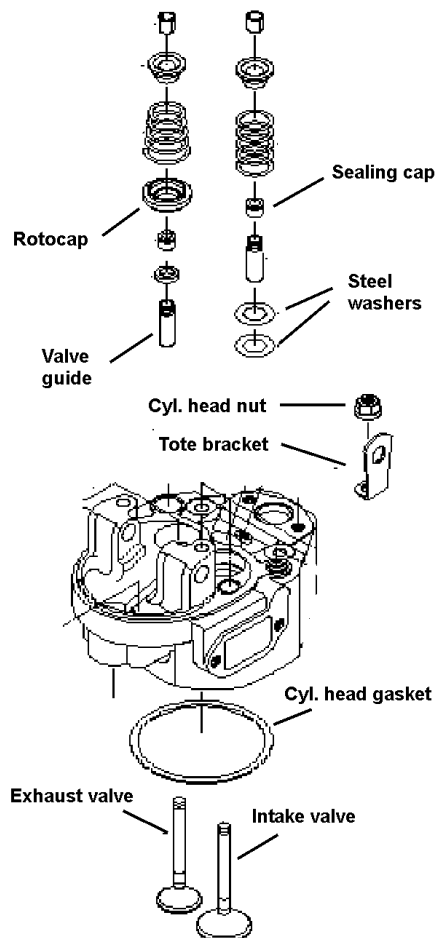


Attention

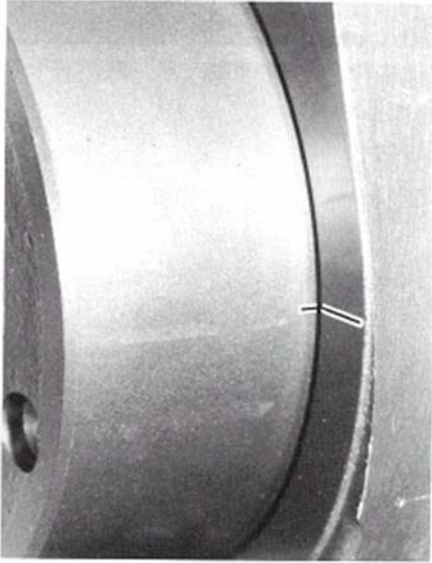
Model 15W doesn't have any cylinder head gasket.

At this stage don't torque down the cylinder head nuts as the rocker arms and push rods still have to be assembled at a later stage !

Recommended torque at this stage : 5 Nm



REASSEMBLY PROCEDURES



12. Gear end cover

To install the gear end cover, first bring the piston to TDC (Top dead center) position by aligning the flywheel timing mark with the TDC mark stamped on the crankcase.

Insert the governor pin into the bore in the governor. Use grease to keep the pin in place.

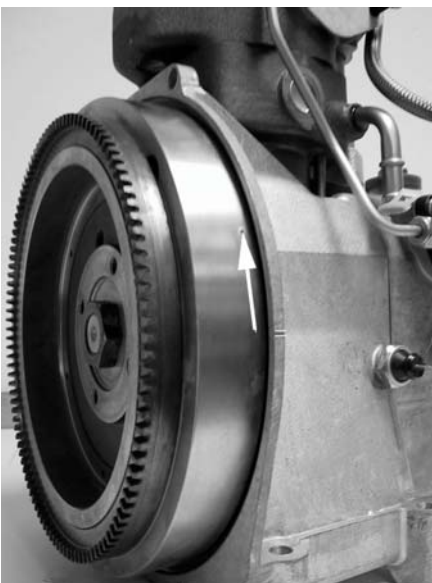


Line up the timing mark on the camshaft gear with the mark on the gear end cover.

Install the gear end cover onto the crankcase being careful not to move the camshaft gear. Remember to place the gasket !

After the cover is installed check the timing marks on the flywheel side. If both marks are within +/- 2mm lining up the timing is correct.

Insert the governor pin into the bore in the governor. Use grease to keep the pin in place.



Occasionally, however, the governor will tighten onto the crankshaft in position that makes it difficult to install the gear end cover. If this happens use the following procedure to install the cover :

Turn the flywheel until its timing mark aligns with approx. 1 o'clock position.

REASSEMBLY PROCEDURES

Move the timing mark on the camshaft gear exactly 3 teeth to the left.

Install the gear end cover. Align the flywheel mark and the crankcase timing mark.

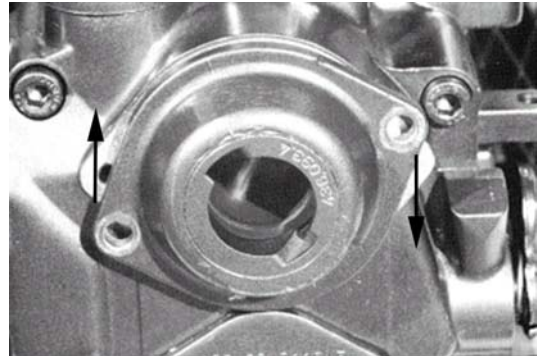
Check timing marks on camshaft gear and gear end cover. The timing is acceptable if these are within 0 – 2 mm to the left side !

Note :

If the camshaft mark is in right side position the valves will come in contact with the piston (hot engine).



Place new o-ring in the flute of the crankhandle support. Lubricate the camshaft and the sealing lips of the oil sealing ring. Don't push the guide straight onto the gear end cover. Instead use a light twisting motion until the guide seats itself. Tighten the screws to specified torque.



13. Decompression device

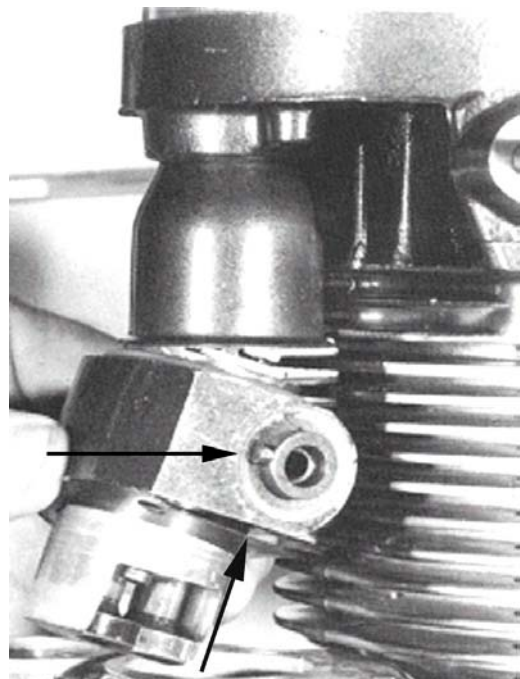
Slide the pushrod tube up into the ist hole in the cylinder head as far as possible. Remember to install a new o-ring in the cylinder head. To grease will help to assemble the tube.

Assemble the decompression device with new o-ring and gasket.

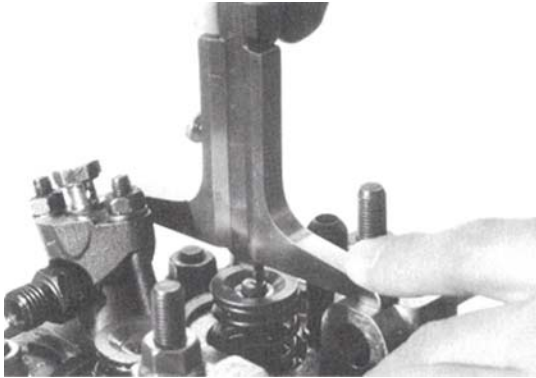


Attention

Before reinstalling the decompression device check if the retaining pin for the shaft is still in place (see arrow).

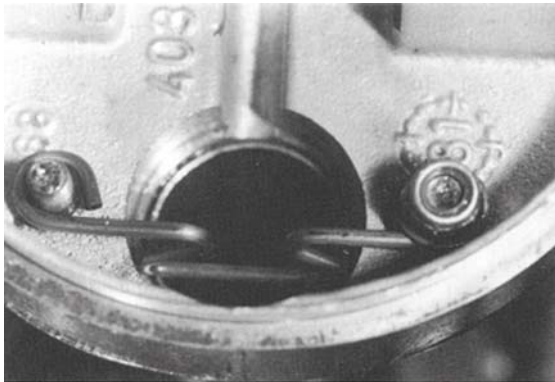


REASSEMBLY PROCEDURES



When a new decompression device is installed the correct function must be checked. To do so install the decompression device with the 0,4 mm thick gasket. Continue with steps 14, 15 and 16. Turn the flywheel approx. 1/8 revolution before TDC and measure with a depth gauge the distance between bracket of the rocker arm shaft and spring collar of the intake valve. Next activate the decompression device and measure the distance again. There must be a difference between the two measurements of about 0,7 – 0,9 mm. If it is less than 0,7 mm you've to disassemble the deco device and replace the 0,4 mm gasket with two 0,3 mm gaskets (all included in the joint set). Carry out the two measurements again.

If the tolerance is more than 1,0 mm replace the 0,4 mm gasket with a 0,3 mm gasket. Carry out the two measurements.



14. Push rods and protection tube

Slide the protection tube down onto the decompression device. Assemble the retaining spring exactly as shown.

Don't tighten the nut yet.

Insert the push rods through the protection tube into top of the decompression device. Both push rods are alike. Intake push rod has to be placed into tapped top hole closest to cylinder.



15. Rocker arms

Place piston to TDC position. Line up rocker arms and push rods.

Oil rocker arm bolt before installing it into the support.



To prevent damage of push rods while torquing the cylinder head nuts, ensure sufficient clearance between setting screws and push rods. Tighten cylinder head nuts in 3 steps to specified torque.

REASSEMBLY PROCEDURES

16. Valve setting

Check that the decompression device is in operating position (pin on 9 o'clock). Set piston on TDC compression stroke. Use a 0,2 mm feeler gauge to control and reset the valve clearance of both valves. (Insert feeler gauge between valve stem and rocker arm). Open the lock nuts of the setting screws to reset clearance. Tighten the nuts while counterhold the setting screws with a screwdriver. Recheck clearance when finished.



Attention

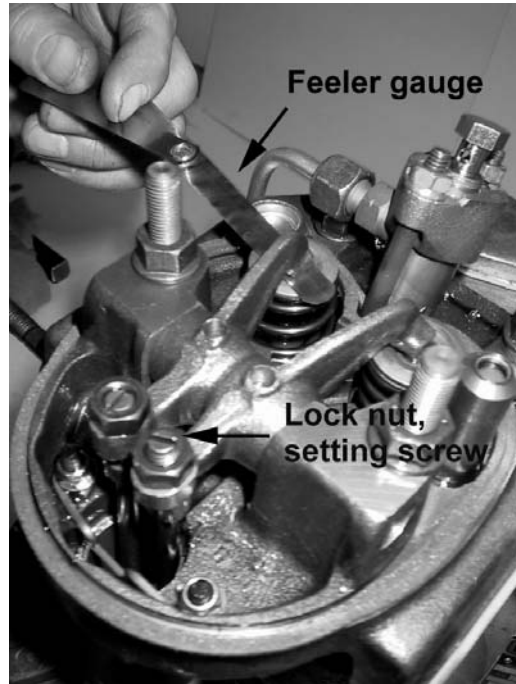
Valve setting on installed engines :

Remove valve cover. Insert a crankhandle and rotate slowly to valve overlapping position.

Remove crankhandle and check drive pin inside the crankhandle guide => vertical position !

Insert crankhandle once again and turn around ½ rotation (drive pin = vertical position again !)

Check and reset the valves.



17. Oil filter => 32W engine, only

Fill up oilfilter with new oil.

Oil the rubber gasket and screw on oilfilter.



Attention

Hand tighten oilfilter only. Don't use tools.

Install oil drain flange (oil screen assy). Fill the engine with new oil up to dipstick mark between upper and lower position. Recheck oil level after first engine start.

18. Fuel injector

Replace the old copper washer located in the cylinder head injector seat.



Attention

Use one washer only !

Make sure that the old one has been removed. Install injector and clamp. Torque the two nuts as specified.

NOTE :

Use only OEM oilfilter !

The recommended filter is special made to be high resistant against vibration shocks !

A special relief valve inside the oilfilter protects your engine against total damage !

NOTE :

On used injectors you've to check the injector pressure and orifices !

If necessary reset pressure setting as specified in the technical tablets !

REASSEMBLY PROCEDURES



19. Injection pump

Place acceleration lever in full load (max speed) position and pull excess fuel button. Place rod of the fuel injection pump to max position. When sliding in the pump, the pin of the rod must grip into the yoke of the control lever. Reinstall the injection pump by using the same number and types of shims as were on the engine before.

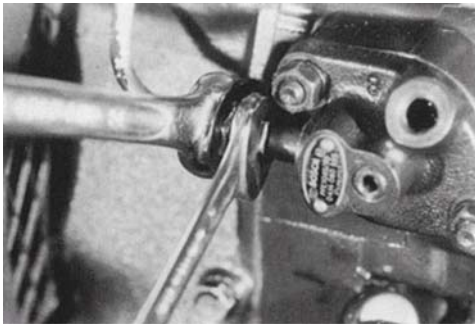
(See chapter -> injection timing !)

First install the paper gasket in any case.



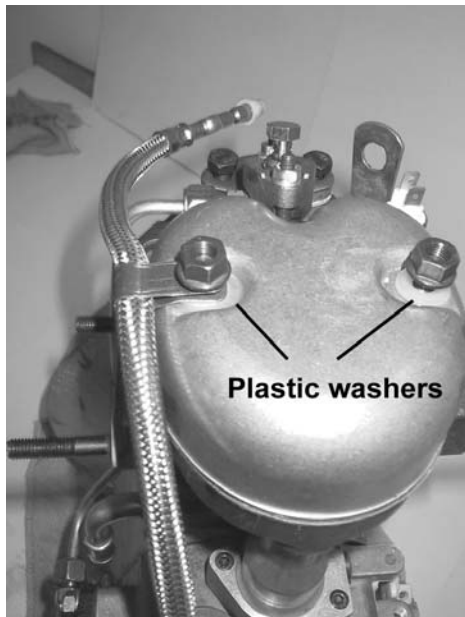
Attention

To check correct assembly of the fuel injection pump turn the acceleration lever to stop-position. Excess fuel button must push back to normal operating position !



20 High pressure fuel line

Install the high pressure fuel line and tighten the union nuts on injector and pump. While tightening nut on injector and pump maintain counter parts with a 14 mm wrench.



21 Valve cover

Install the valve cover gasket and the valve cover taking care the gasket is properly seated on the cylinder head. Insert new plastic washers and tighten to specified torque.

TEST RUN, ADJUSTMENTS

6. Test run, adjustments, checks

1. TEST RUN

The engine is now completely reassembled. Install engine on test bench and carry out test run. The engine does not require a long time running-in program. After a short run according to low specifications the engine is ready for normal operation.

Also the use of special break-in oils or lub. Oil additives are not recommended.



Note

Running-in instruction :

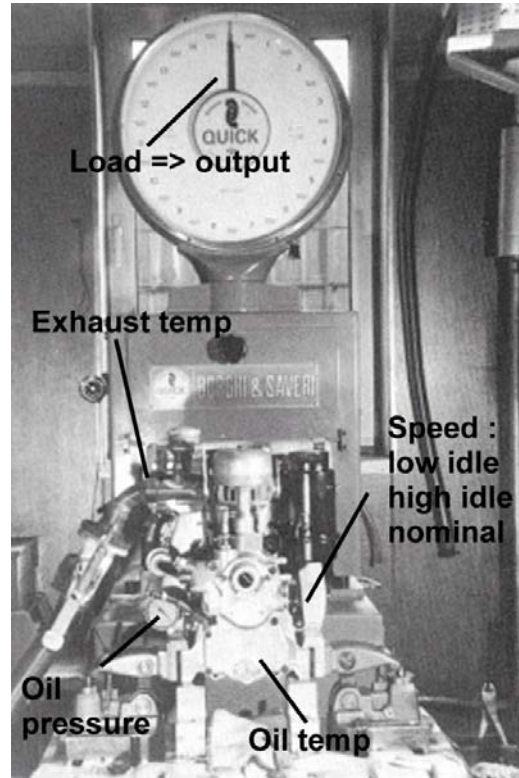
=> 5 min idle speed, no load

=> 10 min half speed, half load

=> 20 min full speed, nominal load => output setting !

=> 2 min idle speed for cooling down

During test run check for proper function, unusual noise and leakages.



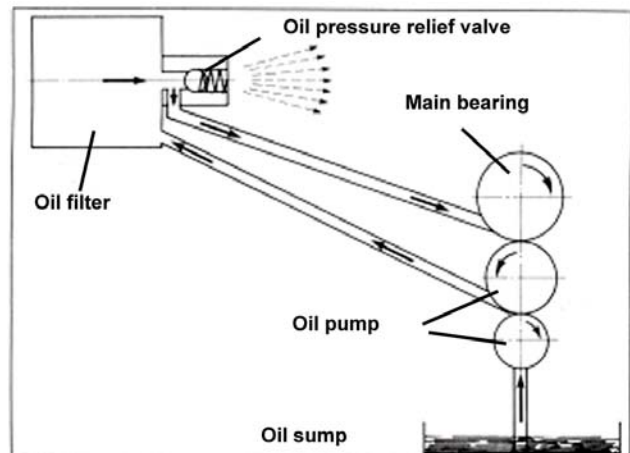
2. Lubrication system, basic info

32W – engines:

A gear pump sucks the oil from the sump and conveys the oil through the oilfilter to the main bearing and conrod bearing. Piston, piston pin, cylinder liner and rocker arms are splash lubricated. Max.oil pressure (4,5 bar) is controlled by a relief valve (mounting support of the oilfilter).

15 / 18W – engines, differences:

Oil strainer instead of oil filter. Oil pump with integrated pressure relief system.



Note

All engines require heavy duty lub oils of at least CC, preferably CD quality. (API classification). For correct viscosity and oil change intervalls refer to **Operating Manual** !

TEST RUN, ADJUSTMENTS

3. Oil pressure check

The oil pressure depends mostly on the wearing conditions of the bearings. Before checking the oil pressure make sure that the oil level is topped and oil with correct viscosity is used.

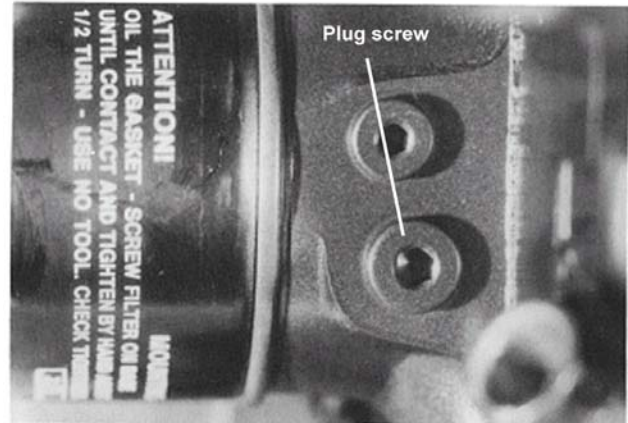
Remove the oil channel plug screw and connect oil pressure gauge with adaptor.

Oil pressure values, hot engine):

Idle speed => min press. 0,5 bar (7 PSI)

Nominal speed => min press. 1,8 bar (23 PSI)

If oil pressure is too low first check the pressure relief valve before starting further dismantling of the engine.



15/18W – engines :

Plug screw located on crankcase side.

4. Fuel system, basic

The fuel flows from the (ext.) tank through the fuel feed pump (option), fuel filter to the injection pump. Higher supplied quantity will flow back via return line. Returning fuel carries heat away from the system.

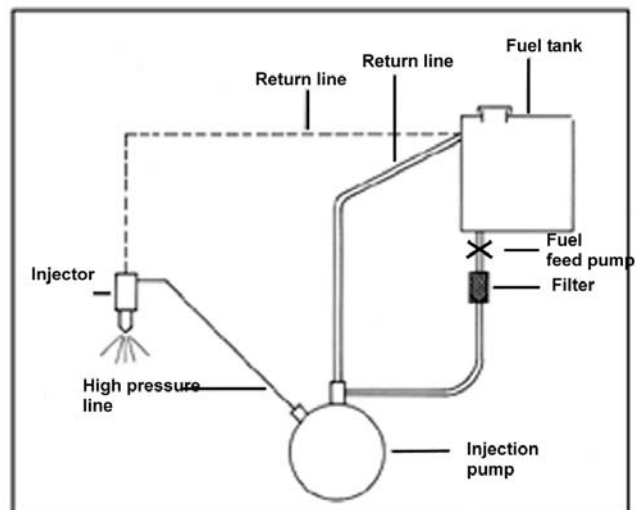
Returning fuel also ensures a constant bleed in the fuel system.

From the injection pump fuel is fed through the high pressure line to the injector. Higher supply will be carried back through the return line.

Injector pressure settings:

15/18W – engines : 200 bar

32W – engines : 175 bar



5. Fuel filter

The fuel filter prevents the entry of dirt into the injection pump. The normal lifespan of a fuel filter is approx. 1000 operating hours, however it depends on the purity of the fuel used.

Prior to changing fuel filter, clean the fuel lines from dirt with a rag. Close off the line between filter and tank with a clamp.

Pull the inlet and outlet line from the filter. Discard the used filter ! Don't try to clean it !

Reassemble and check correct connection.



Watch out for the correct direction of flow (signed on filter Housing).

TEST RUN, ADJUSTMENTS

6. Fuel injector, injector nozzle

The injector nozzle injects the fuel in a fine mist and under a high pressure into the combustion space. Due to the high mechanical and thermal stress, the nozzle requires regular maintenance.

Carbon residues on the nozzle tip are removed with a brass wire brush.

The spray holes can be cleaned with a special needle (Bosch tool).



To check the injection pressure, connect the complete injector to a nozzle tester. Follow operating instructions. The fuel must be ejected evenly atomized without dripping at the specified pressure.



Caution

Keep hands away from nozzle spray ! The spray can penetrate deep into the flesh of your hand and destroy the tissues. Diesel fuel can cause blood poisoning.

If injection pressure is too high or low, it must be corrected by replacing the shims inside the injector valve.

Procedure :

Unscrew the sleeve nut (1), take off the nozzle (2), pressure piece (3), valve cone (4) and pressure spring (5). Replace adjustment shims !

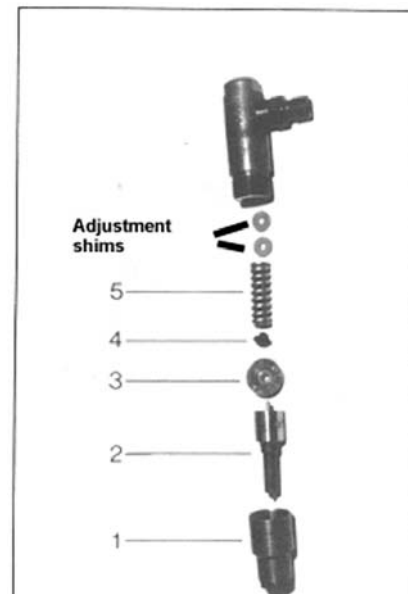
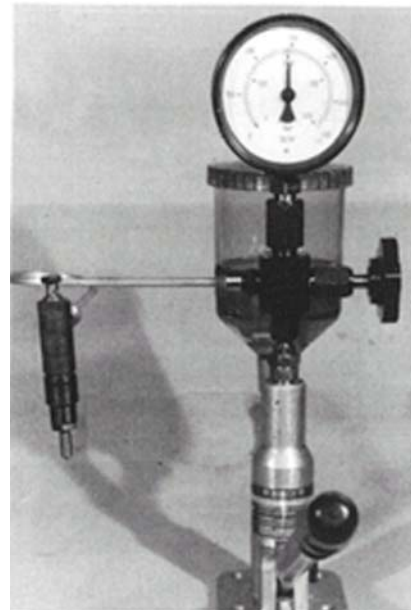
Thicker shim => higher pressure

Thinner shim => lower pressure

An alteration of 0.1 mm (0.004") will bring a change of approx. 10 bar (145 PSI).

When reassembling take care that the pins on the pressure piece are correctly located in nozzle body and nozzle holder. If the nozzle leaks, dribbs or does not atomize properly, change the complete nozzle.

All kinds of repair are not recommended.



TEST RUN, ADJUSTMENTS

7. Excess starting fuel button

For ease of starting all engines are fitted with an excess starting pull button.

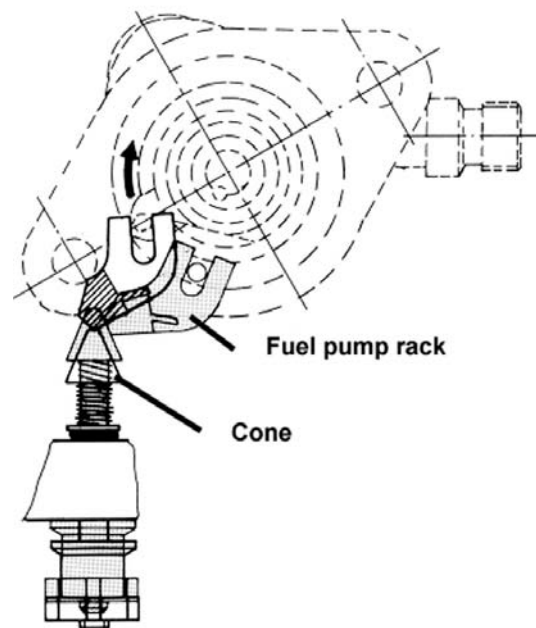
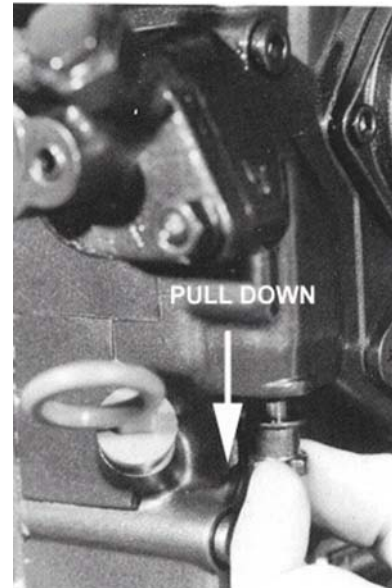
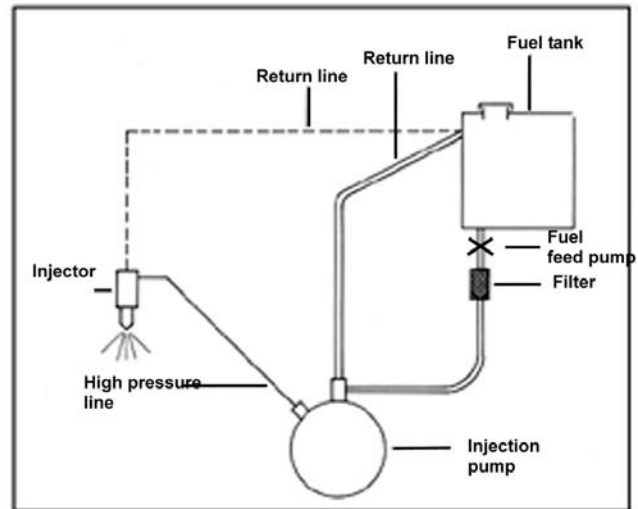
A cone limits the travel of the fuel rack. When the starting fuel button is pulled down prior to start, the cone allows the fuel rack to travel to a higher fuel quantity position.

As soon as the engine reaches its high idle speed the governor moves the fuel rack towards stop, the starting fuel button disengages and returns to its normal operating position.

Therefore it is necessary to start the engine without load in order to reach max rpm. Otherwise the starting fuel button will not disengage and continuously overload the engine.

Also the engine output is adjusted via the cone of the starting fuel button. Depending on the installation depth of the cone the fuel rack travel is shorter (= less output) or longer (= higher output). This output adjustment is done on the factory's test-bench. Under no circumstance—this setting should be altered.

If the excess fuel button or the complete gear cover was renewed, the engine output must be re-adjusted on a test bench.



TEST RUN, ADJUSTMENTS

8. Adjustment of fuel injection timing

The correct setting of the commencement of delivery is a basic requirement for a troublefree function of the engine. As the injection timing is fixed, a check and re-adjustment is only necessary when the engine speed is altered or the camshaft gear was renewed.



Note

Engines for generating sets are set at "begin of delivery" point. Propulsion engines are set at end of delivery "point" !

First crank the engine to compression stroke till TDC mark on the flywheel is approx. at 5 o'clock position. Close fuel supply line. Remove the allen head screw from injection pump head and the copper washer inside. Fit drip tube (=> tools).

Set the acceleration lever at max speed.



Attention

Excess starting fuel button must not be pulled !

Open fuel supply line. Slowly crank the engine rotationwise and observe the drip tube. First the fuel flows free => drips => stops => drips and flows again.

Last drips before stop : begin of delivery point !

First drips after stop : end of delivery point !

The delivery cut-off point is correct when approx. 1 drop per second comes out of the tube.

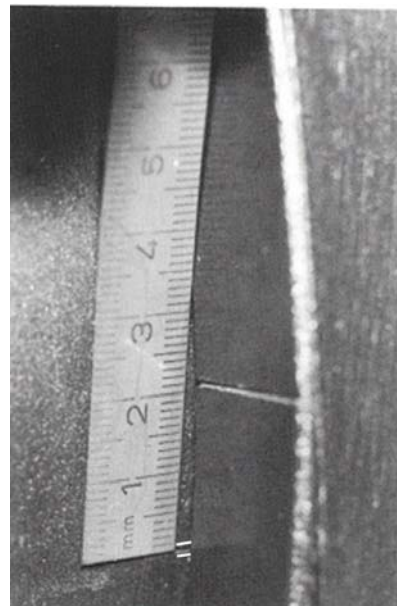
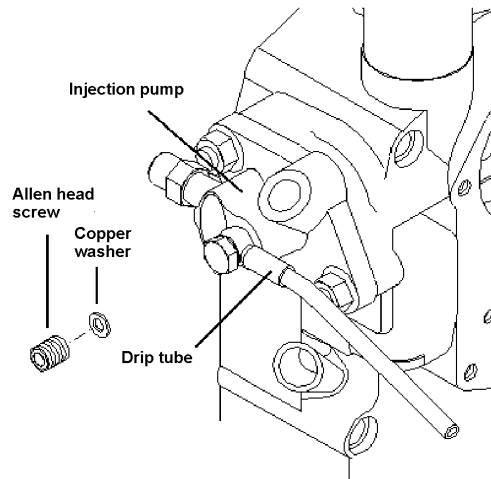
Use a flexible ruler and measure the distance between TDC marks on the flywheel and crankcase. Compare the measured data with the values recommended at the Technical Data Table.

Observe correct flywheel diameter and engine speed !

If the measured value is out of tolerance, re-adjust the commencement of delivery, either by adding or removing adjustment shims.

Adding shims : delayed injection => shorter distance between TDC marks !

Removing shims : advanced injection => longer distance between TDC marks !



TEST RUN, ADJUSTMENTS

If shims have been added or removed the installation depth must be checked.

Measure distance from the mounting flange down to the edge inside the roller tappet. This value plus the thickness of the installed adjustment shims should be between 57,5 mm (2.263") and 59,1 mm (2,327") !

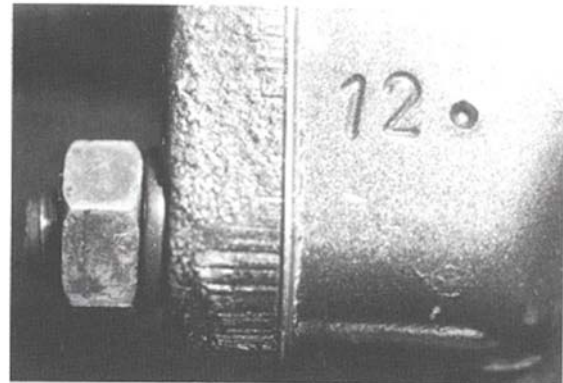
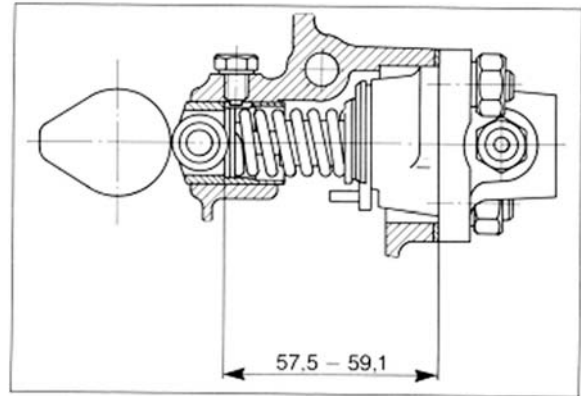
If it is not possible to set the correct injection timing via adjustment shims, then most probably the alignment of the camshaft gear is not correct. Or TDC marks is wrong.



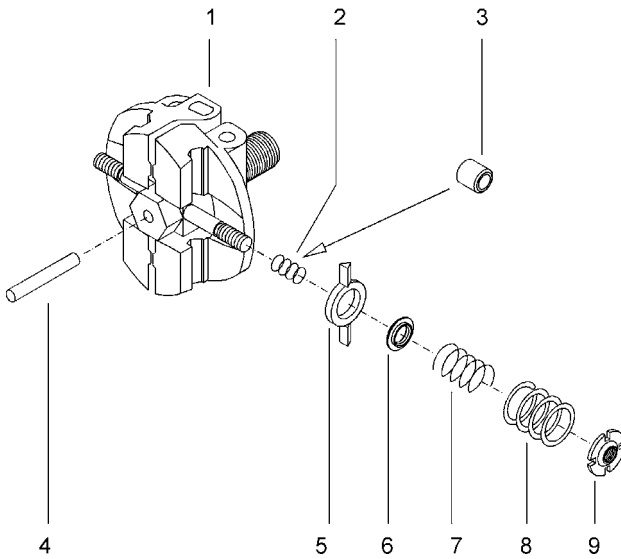
Attention

The thickness of the adjustment shims is stamped on the mounting flange of the injection pump. Example : "12" => 1,2 mm !

This value, however, refers only to the originally fitted pump. When a pump has been changed or the injection timing was altered, the new corrected Thickness should be stamped on !



TEST RUN, ADJUSTMENTS



9. Governor

1. Governor body
2. Governor spring, middle speed range in case of variable speed governor
3. Spacer, instead of item 2, end speed governor
4. Governor pin
5. Spring bridge
6. Guide bush
7. Governor spring, max speed
8. Governor spring, idle speed
9. Cross slotted nut

The purpose of the governor is to maintain the specified speed of the engine. Therefore, centrifugal and resilient spring forces are used to control the amount of fuel injected by the injection pump.

According to the application, there are several types of governor available :

1. Fixed full speed governor

Only one speed is governed. For applications such as generating sets, pumps, ...

2. Idle and full speed governor (2 stage)

Besides the full load speed the idling speed is also governed. For applications with constant speed operation and idle speed relief. Such as compressors, freezer units, ...

3. All speed governor (variable speed)

Governs the complete range of speed from idle up to full speed. For applications such as industrial engines, vehicles, propulsion, ...

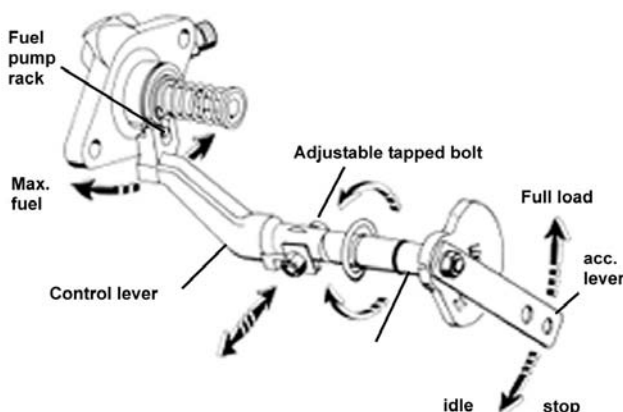
10. Construction and function of governor and control system

The governor consists mainly of two flyweights and a set of springs which counteract the centrifugal force exerted by the flyweights.

The governor is direct assembled to the crankshaft – governor speed synchron with the engine speed. The rotation drives the expands the flyweights => governor pin is pushed via lever transmission till contacting the adjustable tappet bolt of the control lever.

Through this lever the injection pump rack is pushed towards idle / stop position. The control lever pivots on the eccentric regulation shaft.

Due to the control lever pivoting on the eccentric shaft the distance between tapped bolt and governor pin increases when the acceleration lever is moved towards full load position.



TEST RUN, ADJUSTMENTS

A small tension spring assembled to the lever system ensures that there is always contact between the tapped bolt and the governor pin. The fuel pump rack is controlled whenever the engine is running.

More fuel means higher speed, i.e. the governor pin is being pushed out further and pressed against the tapped bolt, resulting in a movement of the control lever / fuel pump rack towards the idle position. Less fuel is injected and the speed drops governor pin moves back and the complete governing loop starts again.

11. Governor setting

Each time the governor has been repaired and / or the gear cover or speed control assy removed and reassembled, the governor must be reset.

Procedure :

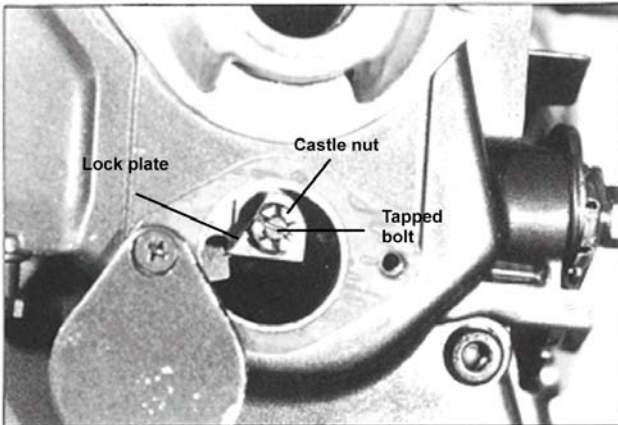
Remove the governor cover plate on the gear housing. Crank the engine until the slot between the governor flyweights is in vertical position. Move the acceleration lever to full speed position. Bend up the lock plate and unscrew the castle nut by holding the tapped bolt with a screwdriver.

Screw out tapped bolt till tapped rests on control lever. Insert a middle sized screwdriver inside the flyweight slot. Impress the flyweights to maximum opening !

Now screw in the tapped bolt until it just come in contact with the governor pin => No play to be felt when pushing onto the control lever with your fingers. Release the flyweights and screw in the tapped bolt $\frac{1}{2}$ a turn further.

Maintain the tapped bolt in this position and tighten the castle nut, bend the lock plate and reassemble the cover plate.

The correct setting of the clearance between tapped bolt and governor pin is essential for the proper function of the engine. If the clearance is too wide the engine can overspeed, is it too small the engine will not reach ist full speed / output.



TEST RUN, ADJUSTMENTS

12. Speed setting

To increase speed tighten the cross slotted nut on the governor shaft. (turn clockwise)..... To reduce speed loosen the slotted nut (turn anti-clockwise).

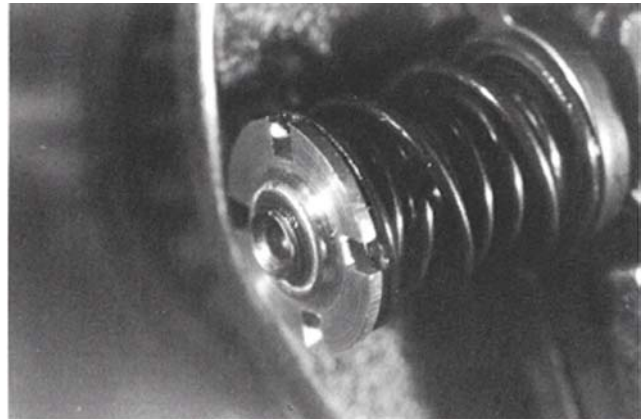
Procedure :

For correct speed setting the use of the governor adjustment tool is recommended ! Don't use other tools (screwdriver, i.e.) not to bend the governor shaft. In all cases the slotted nuts on both sides of the governor weights have to be resetted.

Remove fuel injection pump and fuel lines if necessary. Turn flywheel that the slotted nut is in front of the inj. pump bore. Insert the governor tool and correct speed as required.

$\frac{1}{4}$ of a turn => speed variation of 20 rpm !
Max possible speed variation approx. 100 rpm.

For larger speed change the governor springs must be replaced. Replace the cross slotted nuts whenever a nut has been unscrewed. Every change in speed setting should be controlled on a test bench or – at least – with a revolution counter.



Attention

The cross slotted nut must be at least flat with the end of the governor shaft. Otherwise the self securing effect of the nut is not working. Normally the shaft should protrude out of the cross slotted nut.

TEST RUN, ADJUSTMENTS

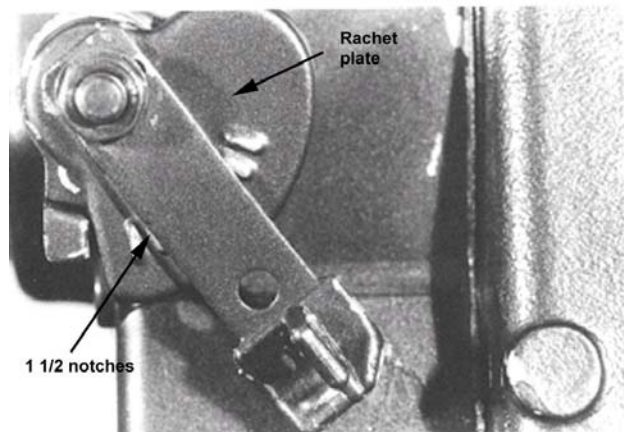
13. Acceleration lever

The acceleration lever is fixed in its position on the eccentric shaft with a pin. The ratchet plate behind the lever is not fixed and only kept in place by the M8 – thread lock nut.

As the ratchet plate is used as a buffer for the engine shut down, the correct position between plate and lever is important. The lower edge of the lever should leave one and a half notches visible.

If more notches are visible the shut of the engine may be hammered or – in badest case – it's not possible to stop the engine with the acceleration lever. If no notch is visible, damages on the eccentric shaft and control lever may occur.

To re-locate the ratchet plate loosen the lock nut, hold acceleration lever and move the plate till correct position. Tighten the lock nut holding the acc. Lever, as otherwise the regulation linkage will be bend.

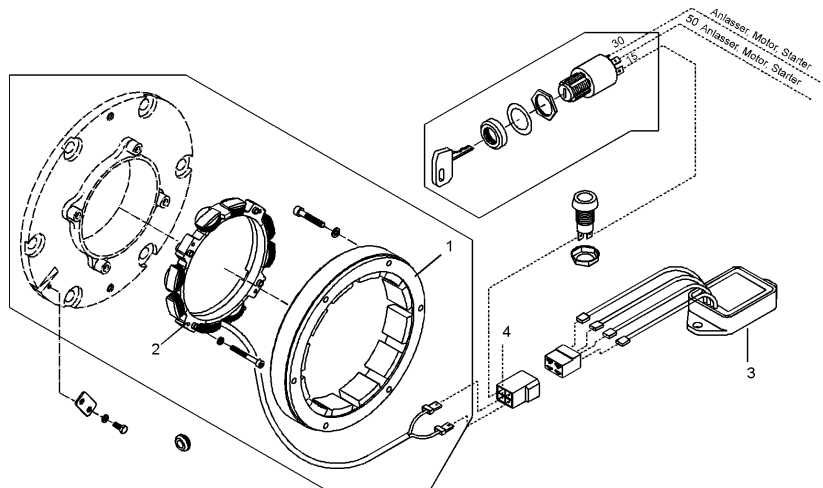


7. Electrical system

7.1 Flywheel – dynamo / Regulator

Operation:

The permanent magnets in the magnet holder (1) on the fly-wheel side induce an alternating voltage in the coils of the stator (2): this voltage is proportional to speed (RPMs). The alternating voltage is rectified in the regulator (3) and continuously regulated to approximately 14.2 - 14.5 V.



Connections to the Governor:

- 2x yellow | Generator coils, input, interchangeable
- 1x red | Output, charging current
- 1x brown | Charge control, Terminal 15, ignition lock

Connection to earth is made via the assembly surface.

7.2 Function Tests:

a) Alternating voltage at the coil output

Disconnect the connecting plug (4).

The voltage proportional to speed is measured on the two phases (2x black).

Set values: Graph A, "Idling Voltage without Governor Cut-Out"

b) Coils = single phase to earth

c) Charging current, governor output

Connect a suitable ammeter ($I_{max}=30A$) into the charging circuit (red cable).

The charging current depends on the speed and the state of the battery charge. Graph B, "Charging Current".

d) Charge control circuit

If the electrical system is intact, the charge control indicator must go out in the speed range from 600-800 revolutions/min.

ELECTRICAL SYSTEM

Operating Conditions:

- Permissible operating temperatures: -20 to 70°C (measured on the governor surface)
- An intact earth connection must exist between the governor and the engine, and also between the governor and directly attached external construction (no painted or enamelled assembly surfaces).

7.3 Hazards / Causes of Failure

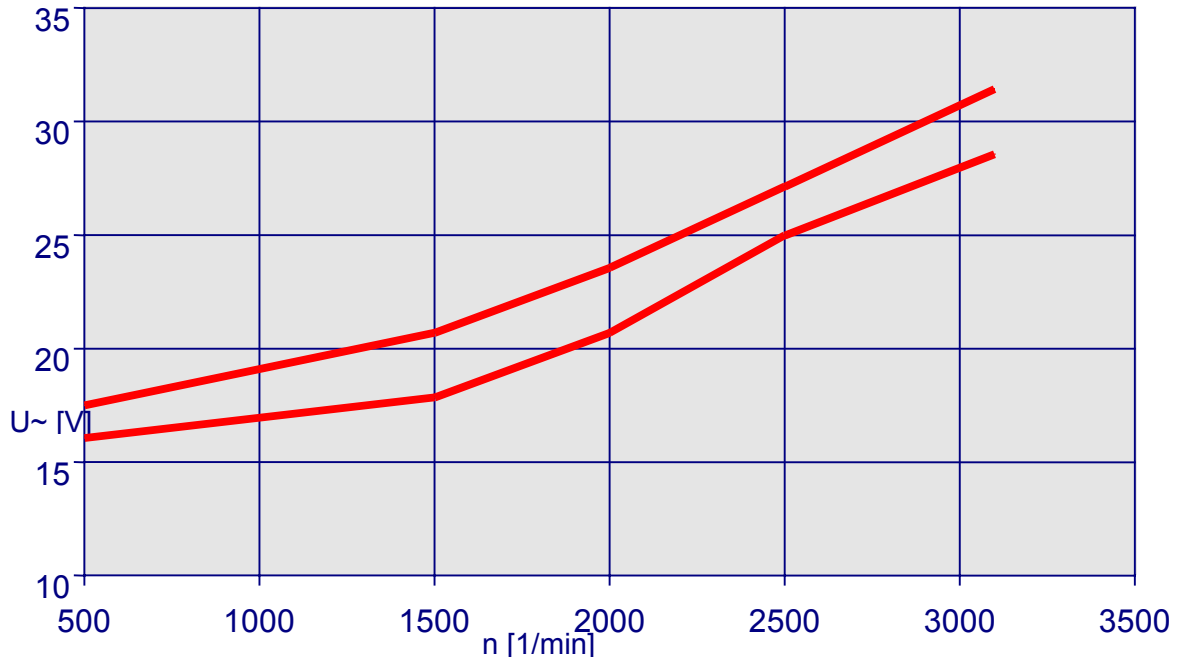
Battery wrongly poled		Damage to charging control circuit
Battery is defective or discharged to minimum		Governor is destroyed in a short time.
Battery is disconnected while the engine is running (load shedding)		Governor is destroyed in a short time.
Charging with start aid cable when battery is defective or discharged to minimum		Governor is destroyed in a short time.
Load shedding when the start aid cable is removed.		
Welding work on the equipment (loosen all plug connections and battery cables beforehand)		Governor is destroyed in a short time.
Manual start with battery disconnected		Governor is destroyed in a short time.
Interruption of the earth connection between the governor housing and the engine		Governor is destroyed over a long period.

ELECTRICAL SYSTEM

7.4 12 V Flywheel – dynamo / regulator, GRAPHS

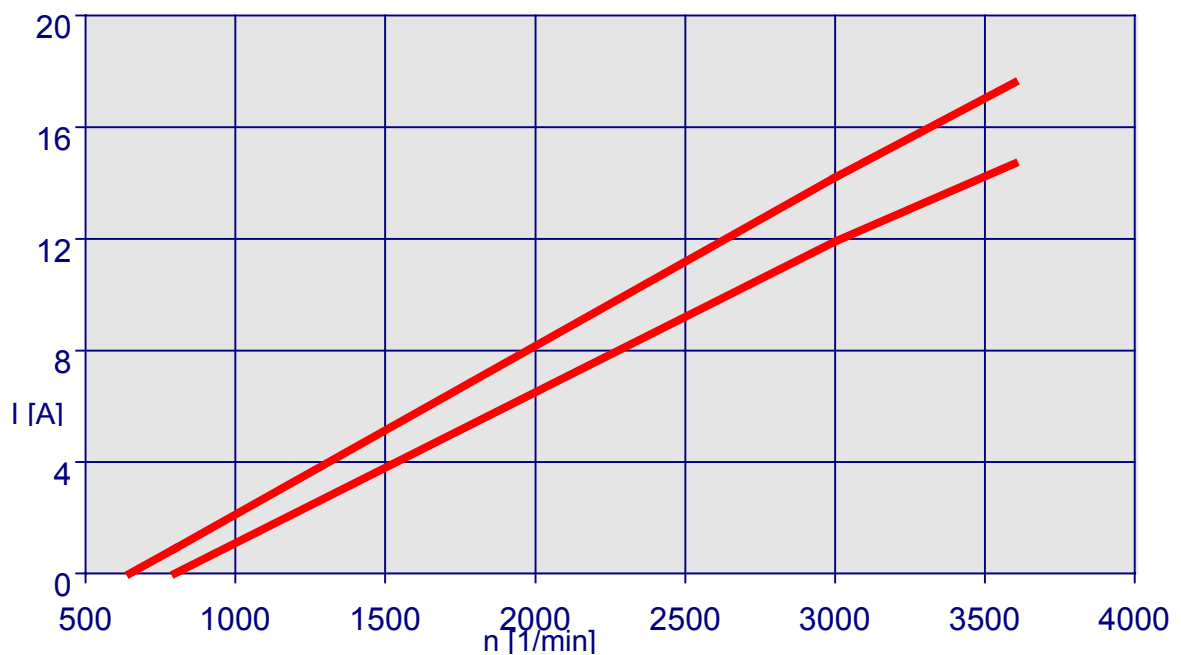
Idling Voltage **without** Governor

Graph A



Charging Current

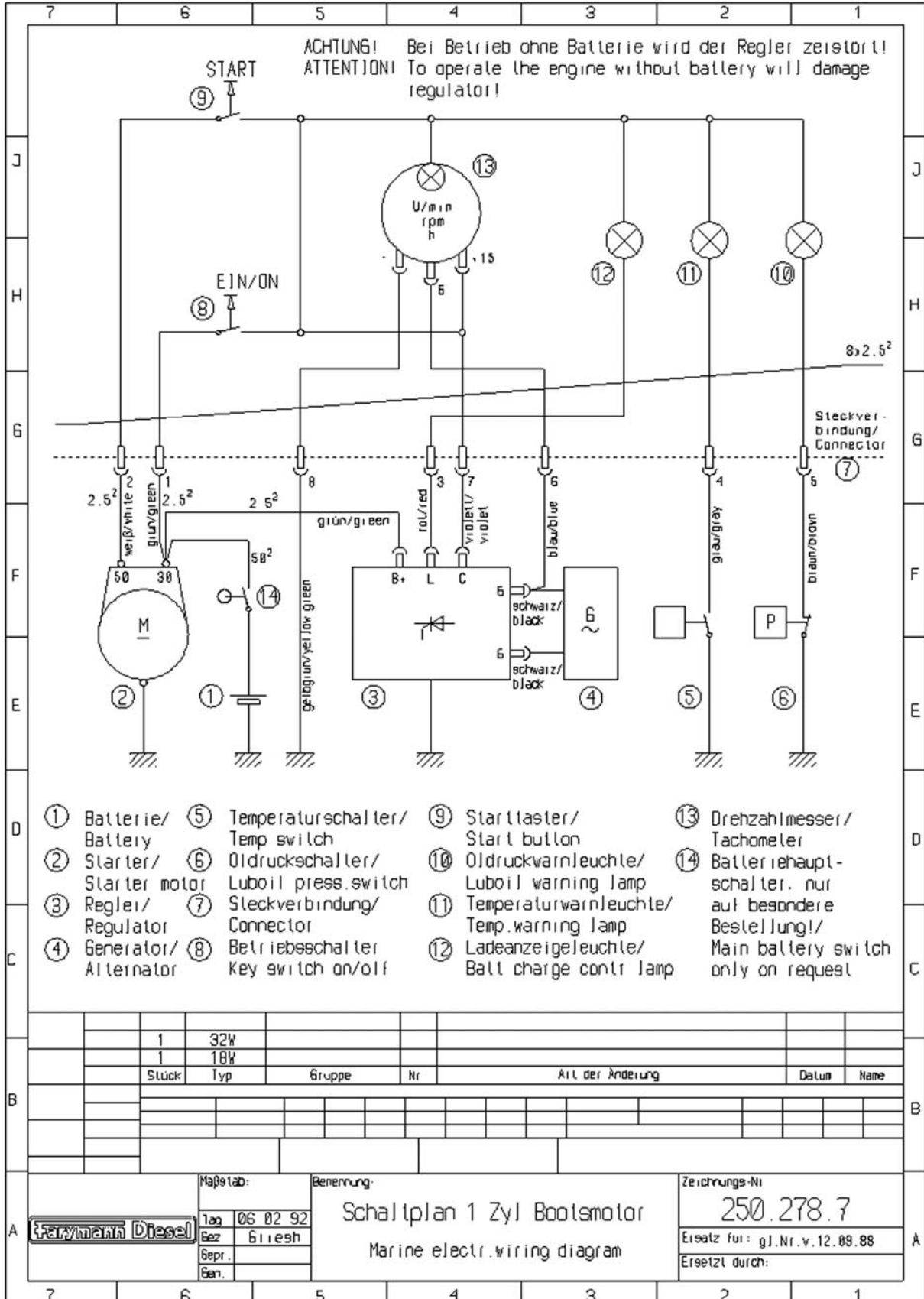
Graph B



ELECTRICAL SYSTEM

7.5 WIRING DIAGRAMS

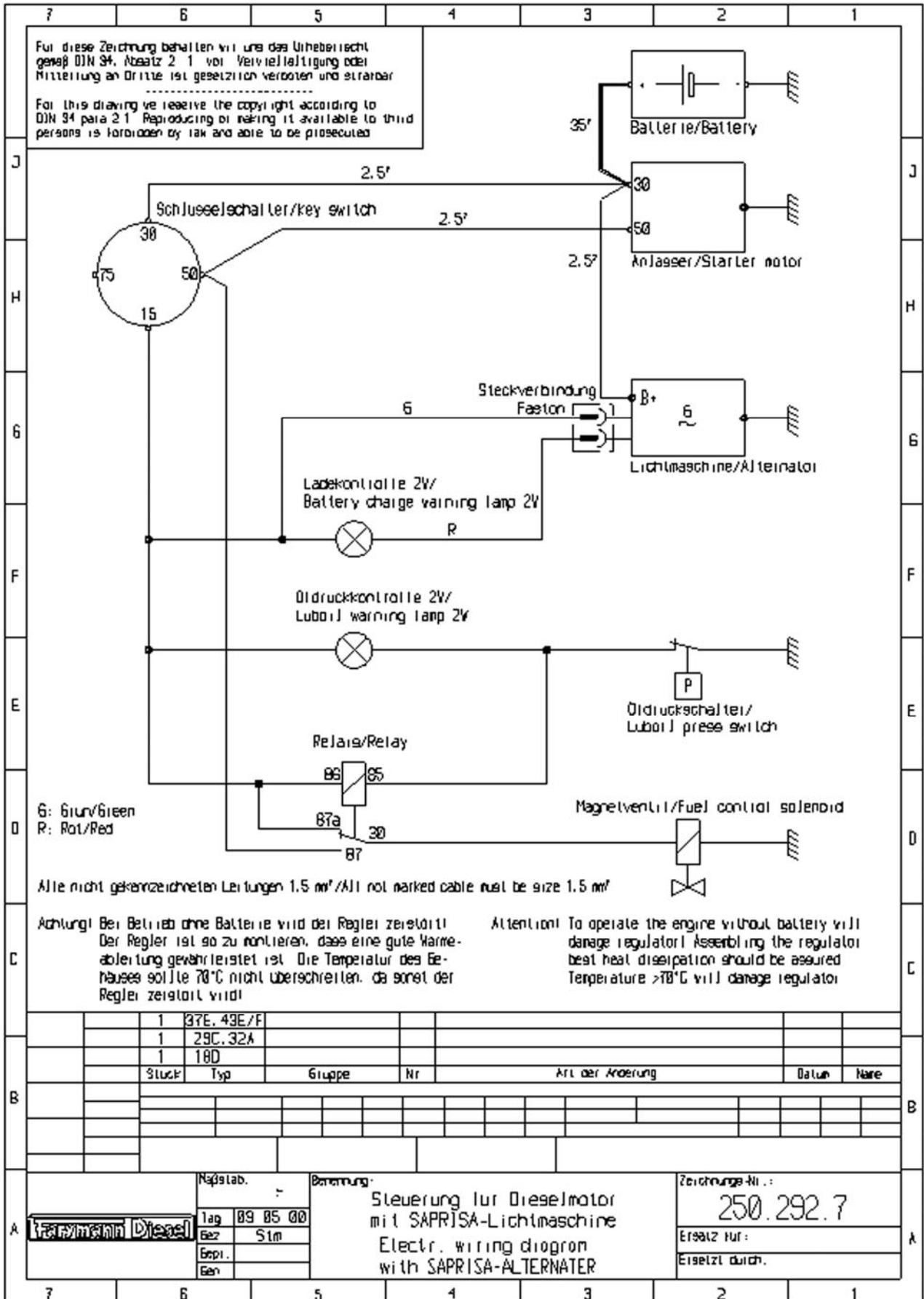
7.5.1 Diagram 1



ELECTRICAL SYSTEM

ELECTRICAL SYSTEM

7.5.3 DIAGRAM 3



TROUBLESHOOTING

8. TROUBLESHOOTING

This section aims to suggest possible causes and remedies for faults. Please note that this list can never be complete. Whenever there is a fault, the guiding principle should be: "Think Before You Act".

8.1 Engine will not start

Reason	Causes	Remedy
<p>If the injection noise (rasping) cannot be heard:</p> <p>Fuel supply failure - turn the engine over by hand cranking, and listen for the characteristic rasping noise in the injector.</p> <p>If the rasping noise can be heard:</p>	<p>No fuel in tank. Acceleration lever at stop. Vent valve in tank cap blocked.</p> <p>Fuel line blocked. Fuel filter clogged. Broken fuel line or leaking connections. Vapor lock (fuel too hot). Paraffin precipitation in fuel (in cold seasons)</p> <p>Faulty injector nozzle. Faulty injector pump.</p> <p>Gasoline instead of diesel in tank. Air intake blocked.</p>	<p>Fill with fuel; no venting needed. Set lever to full load Renew cap</p> <p>Check lines. Renew filter. Renew pipe / tighten connections.</p> <p>Cool the fuel. Drain and flush system, renew fuel filter. Use winter fuel.</p> <p>Check / repair / renew nozzle. Check / repair / renew pump.</p> <p>Drain gasoline, flush and fill with diesel. Check intake system. Change filter insert.</p>
<p>Poor compression</p>	<p>Incorrect valve clearance. Decompression device defective.</p> <p>Leaky valves. Valves sticking. Leaky cylinder head/ cylinder head seal.</p> <p>Piston rings stuck in grooves. Worn cylinder and piston.</p>	<p>Adjust valve clearance. Check / renew decompression device. Check / repair / renew valves. Free valves. Tighten nuts / renew seal.</p> <p>Check / free / renew the rings. Overhaul the engine.</p>
<p>Difficult to crank start the engine</p>	<p>Starting load too high. Lubricating oil too thick. Bearings seized. Piston seized.</p>	<p>Reduce load. Change oil; use correct viscosity. Overhaul engine. Overhaul engine.</p>

TROUBLESHOOTING

8.2 Engine starts but fires intermittently or dies

Poor fuel supply	Fuel filter choked. Fuel line blocked. Leaking fuel lines. Water in fuel. Faulty injector nozzle. Faulty injector pump.	Renew filter. Check lines. Check lines / tighten connections. Drain fuel, fill with clean diesel. Check / repair / renew nozzle. Check / repair / renew pump.
Poor compression	Incorrect valve clearance. Worn valves. Valves sticking. Piston rings stuck in grooves. Worn cylinder and piston.	Adjust valve clearance. Overhaul cylinder head. Free valves. Check / free / renew rings. Overhaul engine.
Faulty intake and exhaust system	Restricted / blocked intake. Restricted / blocked exhaust.	Check / clean / exchange intake system. Check / clean / exchange exhaust system.

8.3 Poor engine performance and / or black smoke

Operating conditions	Engine overloaded. Power reduction due to altitude, and/or increased intake temperature has been ignored.	Reduce load. Fault search on equipment. Better operating conditions.
Poor fuel supply	Gasket under injector nozzle missing, or too many installed. Fuel filter blocked. Faulty injector nozzle. Faulty injector pump.	Install gasket / Correct number of gaskets. Renew filter. Check / repair /renew nozzle. Check / repair / renew pump.
Out of adjustment	Incorrect valve clearance. Incorrect end of delivery. Incorrect valve control timings. Piston installed wrongly.	Adjust valve clearance. Adjust end of delivery. Check gear wheel setting mark. Correct piston installation.

TROUBLESHOOTING

8.4 Poor engine performance and/or black smoke

Dirty engine	Dirty air filter. Excessive oil carbon deposits on piston and cylinder head.	Clean / renew filter. Decoke components / change vent valve.
General Engine Condition	Worn piston rings. Worn piston and cylinder. Worn bearing.	Renew rings / check air filter. Overhaul engine. Overhaul engine.

8.5 Imperfect operating behaviour

Overheating	Engine overloaded. Cooling fins dirty. Cool air intake obstructed. Short circuit of cooling air. Oil level in crankcase is too high. Faulty injector nozzle.	Reduce load. Clean cooling fins. Remove obstruction. Improve cooling air flow (check engine installation). Drain to proper level. Check / repair / renew nozzle.
Knocking Noises	Oil carbon deposits on piston. Injector needle sticking. Advanced ignition. Broken piston rings. Worn piston and cylinder. Worn bearings. Loose flywheel. Gasoline mixture in tank.	Decoke. Fit new nozzle. Check/adjust end of delivery. Fit new rings. Overhaul engine. Overhaul engine. Tighten flywheel nut. Change fuel.
Major fluctuations in speed (RPMs)	Overheating. Air in fuel. Governor sticking or faulty. Fuel filter choked. Regulating lever sticking or faulty.	See above. Check the fuel system for leaks / check the return line. Check / repair / renew governor. Renew filter. Check / renew.
Engine stops suddenly.	Empty fuel tank. Vent valve in tank cap is blocked. Vapor lock (fuel too hot). Choked injection nozzle.	Fill with fuel. Renew tank cap. Cool fuel. Check / repair / renew nozzle.

TROUBLESHOOTING

8.5 Imperfect Operating Behaviour

Engine stops suddenly	Fuel pipe broken. Seized piston. Seized crankshaft bearing.	Renew pipe. Renew piston and cylinder. Repair / renew crankshaft and bearings.
Blue smoke from engine	Oil level in oil bath air filter too high. Faulty vent valve in cylinder head. Sealing ring damaged on intake valve guide. Worn valves / valve guide. Worn piston / cylinder.	Fill to proper level. Renew valve. Renew sealing ring. Overhaul engine. Renew.
White smoke from engine	Ignition too late. Injector nozzle is worn.	Check / adjust end of delivery. Renew nozzle.
Oil pressure warning light on	Oil pressure warning lamp is defective. Oil level is too low. Defective oil pressure switch.	Exchange warning lamp. Measure oil level; if necessary, top up oil. Exchange.
Oil pressure is too low	Overpressure valve is defective. Dirty ball seat in overpressure valve. Oil filter is clogged. Lubricating oil pump is faulty.	Check, clean, exchange if necessary. Check, clean, exchange if necessary. Exchange. Check, clean, exchange if necessary.
Cold starting problems	Acceleration lever not at maximum stop buffer. Lubrication oil too thick. Crank handle defective. Paraffin precipitation in fuel.	Adjust. Change to correct viscosity. Check crank handle. Use winter fuel / and/or drain and flush system. Renew fuel filter.

NOTES

NOTES