



BOMAG

FAYAT GROUP

Operating Instruction Maintenance Instruction

Original Operating Instructions

BW 71 E-2



S/N 101 620 29 1001>

Single-drum vibratory roller

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BOMAG manufactures machine for earth, asphalt and refuse compaction, stabilizers/recyclers as well as milling machine and finishers.

BOMAG's vast experience in connection with state-of-the-art production and testing methods, such as lifetime tests of all important components and highest quality demands guarantee maximum reliability of your machine.

This manual comprises:

- Safety regulations
- Operating instructions
- maintenance instructions
- Trouble shooting

Using these instructions will

- help you to become familiar with the machine.
- avoid malfunctions caused by unprofessional operation.

Compliance with the maintenance instructions will

- enhance the reliability of the machine on construction sites,
- prolong the lifetime of the machine,
- reduce repair costs and downtimes.

BOMAG will not assume liability for the function of the machine

- if it is handled in a way not complying with the usual modes of use,
- if it is used for purposes other than those mentioned in these instructions.

No warranty claims can be lodged in case of damage resulting from

- operating errors,
- insufficient maintenance and
- wrong fuels and lubricants.

Please note!

This manual was written for operators and maintenance personnel on construction sites.

Always keep this manual close at hand, e.g. in the tool compartment of the machine or in a specially provided container. These operating and maintenance instructions are part of the machine.

You should only operate the machine after you have been instructed and in compliance with these instructions.

Strictly observe the safety regulations.

Please observe also the guidelines of the Civil Engineering Liability Association "Safety Rules for the Operation of Road Rollers and Soil Compactors" and all relevant accident prevention regulations.

For your own personal safety you should only use original spare parts from BOMAG.

In the course of technical development we reserve the right for technical modifications without prior notification.

These operating and maintenance instructions are also available in other languages.

Apart from that, the spare parts catalogue is available from your BOMAG dealer against the serial number of your machine.

Your BOMAG dealer will also supply you with information about the correct use of our machines in soil and asphalt construction.

The above notes do not constitute an extension of the warranty and liability conditions specified in the general terms of business of BOMAG.

We wish you successful work with your BOMAG machine.

BOMAG GmbH

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Please fill in

.....

Machine type (Fig. 1)

.....

Serial-number (Fig. 1 and 2)

.....

Engine type (Fig. 3)

.....

Engine number (Fig. 3)



Supplement the above data together with the commissioning protocol.

During commissioning our organisation will instruct you in the operation and maintenance of the machine.

Please observe strictly the safety regulations and all notes on risks and dangers!

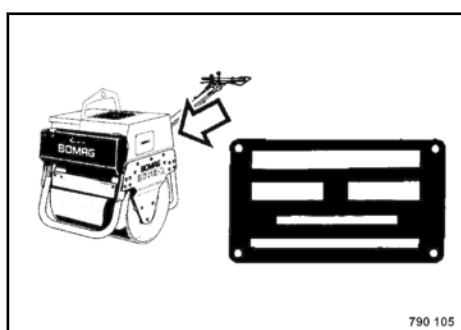


Fig. 1

Foreword

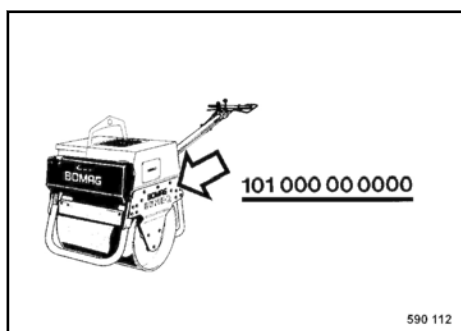


Fig. 2

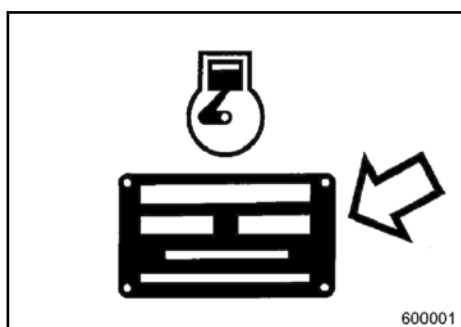


Fig. 3

Technical Data

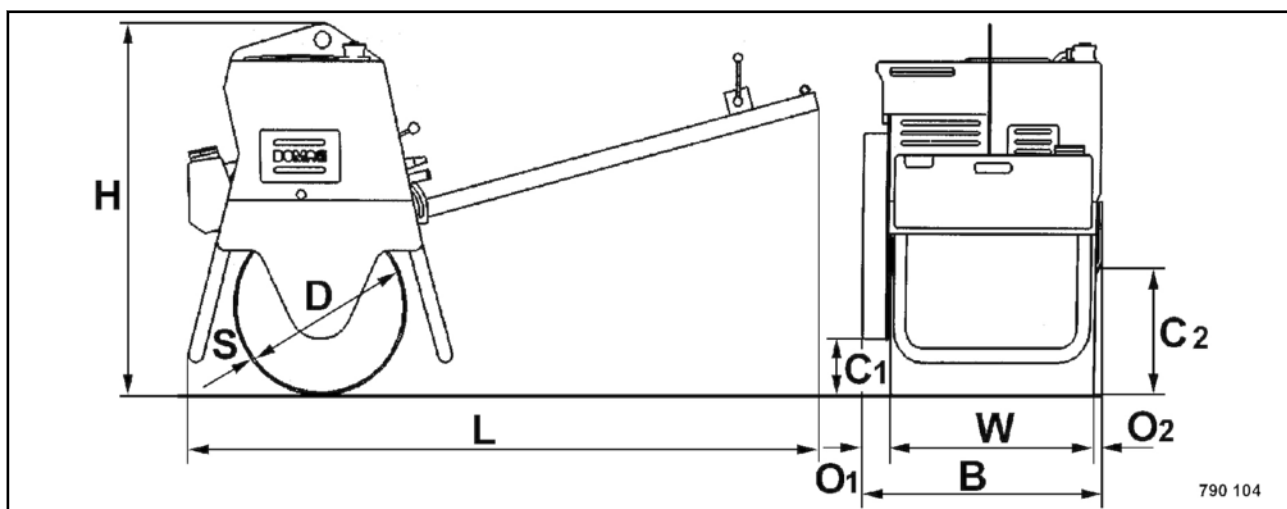


Fig. 4

Dimensions in mm	B	C ₁	C ₂	D	H	L	O ₁	O ₂	S	W
BW 71 E-2	825	190	450	600	1245	2200	115	25	8	710

The right for technical modifications remains reserved			BW 71 E-2
Weights			
Basic weight		kg	471
Operating weight (CECE)		kg	488
Static linear load		kg/cm	7
Travel characteristics			
Travel speed (1) forward/reverse		km/h	0 – 1.6
Travel speed (2) forward/reverse		km/h	0 – 2.5
Max. gradability (soil dependent) without/with vibration		%	25/20
Drive			
Engine manufacturer			Hatz
Type			1B 20
Cooling			Air
Working cycles			4
Number of cylinders			1

Technical Data

The right for technical modifications remains reserved		BW 71 E-2
Rated power ISO 9249	kW	3.4
Nominal speed	rpm	3200
Fuel		Diesel
Drive system		hydrostatic
Starting device		E - starter
Vibration system		
Drive system		mechanical
Frequency	Hz	75
Amplitude	mm	0.43
Centrifugal force	kN	16
Water sprinkler system		
Type of sprinkling		Gravity feed
Water tank capacity	l	25
Filling capacities		
Fuel tank	l	5.1

The following noise and vibration data acc. to

- EC Machine Regulation edition 2006/42/EC

- the noise regulation 2000/14/EG, noise protection guideline 2003/10/EC

- Vibration Protection Regulation 2002/44/EC

were determined during conditions typical for this type of equipment and by application of harmonized standards.

During operation these values may vary because of the existing operating conditions.

Noise value

Sound pressure level on the place of the operator:

$L_{pA} = 84 \text{ dB(A)}$, determined acc. to ISO 11204 and EN 500

Guaranteed sound power level:

$L_{WA} = 108 \text{ dB(A)}$, determined acc. to ISO 3744 and EN 500

Technical Data



WARNING!

Loss of hearing!

Wear your personal noise protection means (ear defenders) before starting operation.

Vibration value

Hand-arm vibration:

Vector total of the weighted effective acceleration in three orthogonal directions:

Weighted total vibration value

$a_{hv} = 5.5 \text{ m/s}^2$ on crushed rock determined acc. to ISO 5349 and EN 500



NOTICE!

Observe the daily vibration load (Industrial safety acc. to 2002/44/EEC).

Safety regulations

General

This BOMAG machine has been built in compliance with the latest technical standard and complies with the applicable regulations and technical rules. However, dangers for persons and property may arise from this machine, if:

- it is used for purposes other than the ones it is intended for,
- it is operated by untrained personnel,
- it is changed or converted in an unprofessional way,
- the safety instructions are not observed.

Each person involved in the operation, maintenance and repair of the machine must therefore read and comply with these safety regulations. If necessary, this must be confirmed by obtaining the signature of the customer.

Furthermore, the following obviously also applies:

- applicable accident prevention instructions,
- generally accepted safety and road traffic regulations,
- country specific safety regulations. It is the duty of the operator to be acquainted with these instructions and to apply these accordingly. This applies also for local regulations concerning different types of handling work. Should the recommendations in these instructions be different from the regulations valid in your country, you must comply with the safety regulations valid in your country.

Intended use

This machine must only be used for:

- Compaction of all types of soils
- Repair work on all types of soil
- Paving of walkways
- Work in trenches (trench roller)
- Underfilling and compaction of hard shoulders
- Compaction of bituminous material (road surface layers)

Unintended use

Dangers may arise from the machine when it is used for purposes other than the one it is intended for.

Any danger caused by intended use is the sole responsibility of the customer or driver/operator, the manufacturer cannot be made liable.

Examples for unintended use are:

- work with vibration on hard concrete, cured bitumen layers or extremely frozen ground
- dragging the machine along as a measure of transportation
- throwing the machine off the transport vehicle
- attaching an additional weight to the machine

It is not permitted to stand or sit on the machine while working.

Any transport ropes fastened to the machine must be removed before operation.

Starting and operation of the machine in explosive environments and in underground mining is prohibited.

Remaining dangers, remaining risks

Despite careful work and compliance with standards and regulations it cannot be ruled out that further dangers may arise when working with and handling the machine.

Both the machine as well as all other system components comply with the currently valid safety regulations. Nevertheless, remaining risks cannot be ruled out completely, even when using the machine for the purpose it is intended for and following all information given in the operating instructions.

A remaining risk can also not be excluded beyond the actual danger zone of the machine. Persons remaining in this area must pay particular attention to the machine, so that they can react immediately in case of a possible malfunction, an incident or failure etc.

All persons remaining in the area of the machine must be informed about the dangers that arise from the operation of the machine.

Regular safety inspections

Have the machine inspected by an expert (capable person) as required for the condition the machine is working under, but at least once every year.

Who is allowed to operate the machine?

Only trained, instructed and authorized persons of at least 18 years of age are permitted to drive and operate this machine. For operation of the machine the responsibilities must be clearly specified and complied with.

Persons under the influence of alcohol, medicine or drugs are not allowed to operate, service or repair the machine.

Maintenance and repair work requires specific knowledge and must therefore only be performed by trained specialists.

Changes and conversions to the machine

Unauthorized changes to the machine are prohibited for safety reasons.

Original parts and accessories have been specially designed for this machine.

We wish to make explicitly clear that we have not tested or approved any parts or accessories not supplied by us.

The installation and/or use of such products may have an adverse effect on the active and/or passive safety.

The manufacturer explicitly excludes any liability for damage caused by the use of non-original parts or accessories.

Damage, deficiencies, misuse of safety installations

Machines which are not safe to operate or in traffic must be immediately taken out of service and shall not be used, until these deficiencies have been properly rectified.

Safety installations and switches must neither be removed nor must they be made ineffective.

Safety regulations

Notes on safety in the operating and maintenance instructions



WARNING!

Paragraphs marked like this highlight possible dangers for persons.



NOTICE!

Paragraphs marked like this highlight possible dangers for machines or parts of the machine.



Paragraphs marked like this contain technical information for the optimal economical use of the machine.



ENVIRONMENT!

Paragraphs marked like this point out practices for safe and environmental disposal of fuels and lubricants as well as replacement parts.

Observe the regulations for the protection of the environment.

Loading/transporting the machine

Use only stable loading ramps of sufficient load bearing capacity. The ramp inclination must be less than the gradability of the machine.

Loading ramps must be free of grease, oil, snow and ice.

Make sure that persons are not endangered by the machine tipping or sliding off.

Use only safe lifting gear of sufficient load bearing capacity. Minimum lifting capacity of lifting gear: see operating weight in chapter "Technical Data".

Loads must only be attached and hoisted by an expert (capable person).

For lifting the machine attach the lifting gear only to the lifting eye provided for this purpose.

Check all lifting and lashing points for damage before lifting or lashing down the machine. Do not use a damaged or in any other way impaired lifting and lashing eyes.

Do not lift or lower the machine jerkily.

The tension must always be effective in vertical direction.

The machine must not swing about when being lifted.

Do not step or stand under suspended loads.

Always use suitable lashing gear on the lifting points to lash down the machine.

Lash the machine down, so that it is secured against rolling, sliding and turning over.

Starting the machine

Before starting

Become acquainted with the equipment, the control elements, the working principle of the machine and the working area.

Wear your personal protective outfit (hard hat, safety boots, etc.). Wear ear defenders.

Before starting the machine check whether:

- the machine shows any obvious faults
- all guards and safety elements are in place
- the controls are fully functional
- the machine is free of oily and combustible material
- all grips are free of grease, oils, fuel, dirt, snow and ice.

Use only machines which are serviced at regular intervals.

Do not use any starting aids like start pilot or ether.

Starting and operation of the machine is closed rooms and trenches

Exhaust gases are highly dangerous! Always ensure an adequate supply of fresh air when starting and operating in closed rooms and trenches!

Driving the machine

Persons in the danger area

Check if there are persons or obstacles in the danger area before starting or resuming work, especially when driving in reverse.

If necessary give warning signals. Stop work immediately, if persons remain in the danger area despite the warning.

Driving

Start the machine only after lowering the steering rod to work position.

Operate the machine only at full engine speed, as otherwise the centrifugal clutch may be destroyed.

Never let the machine run unattended.

In emergency situations and in case of danger operate the emergency stop switch immediately. Resume operation only after eliminating the danger that has led to the actuation of the emergency stop.

When guiding the machine mind your hands and do not hurt yourself on hard objects: Risk of injury!

When working in reverse, especially near the edges of trenches and recesses as well as in front of obstructions steer the machine carefully to eliminate the risk of accidents and injuries.

Always keep a safe distance to excavations and embankments and avoid all activities which could impair the stability of the machine.

Safety regulations

Do not work with vibration on hard concrete, cured asphalt or hard frozen ground.

Do not use the machine to transport persons.

If you recognize unusual noises and the development of smoke, detect the cause and have the fault corrected.

Driving on gradients and slopes

Do not drive on gradients which exceed the maximum gradability of the machine.

Always drive extremely carefully on slopes and always directly up or down the slope, never diagonally. Change to the lower speed range before approaching the inclination.

When driving on gradients the steering rod must always point uphill.

Wet and loose soils reduce the ground adhesion of the machine on gradients and slopes considerably. Higher risk of accidents!

Behaviour in traffic

Match your speed to the working conditions.

Always give way to loaded vehicles.

Keep away from edges and embankments.

Check the effect of vibration

When compacting with vibration check the effect on nearby buildings and underground supply lines (gas, water, sewage, power lines), stop vibratory compaction if necessary.

Never use the vibration on hard (frozen, concrete) ground: Risk of bearing damage!

Parking the machine

Park the machine on horizontal, level, firm ground.

Before leaving the machine:

- return the control lever to neutral position
- apply the parking brake
- shut the engine down, pull the ignition key off
- Do not touch the exhaust, danger of burning
- close the fuel cock, if present
- secure the machine against unintended use

Mark machines, which could be in the way, with a clearly visible sign.

Parking on slopes and inclinations

Secure the machine against rolling, place metal chocks in front of and behind the wheels.

Filling in fuel

Do not inhale any fuel fumes.

Refuel only with the engine shut down.

Do not refuel in closed rooms.

No open fire, do not smoke.

Do not spill any fuel. Catch running out fuel, do not let it seep into the ground.

Wipe off spilled fuel. Keep dirt and water away from the fuel.

A leaking fuel tank can cause an explosion. Ensure tight fit of the fuel tank cover, if necessary replace immediately.

Fire protection measures

Familiarise yourself with the location and the operation of fire fighting equipment. Observe all fire reporting and fire fighting possibilities.

Maintenance work

Comply with the maintenance work described in the operating and maintenance instructions, including the information concerning the replacement of parts.

Maintenance work must only be performed by qualified and authorized persons.

Keep unauthorized persons away from the machine.

Do not touch hot engine parts.

Do not perform maintenance work while the machine is driving or the engine is running.

Park the machine on horizontal, level and firm ground.

Remove the key from the ignition switch.

Working on the engine

Shut the engine down before opening the engine hood.

Drain the engine oil at operating temperature: Danger of scalding!

Wipe off spilled oil, catch running out oil and dispose of environmentally.

Store used filters and other oil contaminated materials in a separate, specially marked container and dispose of environmentally.

Do not leave any tools or other objects, that could cause damage, in the engine compartment.

Working on electric parts of the machine

Before starting to work on electric parts of the machine disconnect the battery and cover it with insulating material.

Do not use fuses with higher ampere ratings and do not bridge fuses. Fire hazard!

Working on the battery

When working on the battery do not smoke, do not use open fire!

Do not let acid come in contact with hands or clothes.

When injured by acid flush off with clear water and seek medical advice.

Metal objects (e.g. tools, rings, watch straps) must not come in contact with the battery poles: Danger of short circuit and burning!

When recharging non-serviceable batteries remove all plugs, to avoid the accumulation of explosive gases.

Safety regulations

Observe the applicable instructions when starting with an auxiliary battery.

Dispose of old batteries according to regulations.

Switch off the charging current before removing the charging clamps.

Ensure sufficient ventilation, especially if the battery is to be charged in a closed room.

Working on the fuel system

Do not inhale fuel fumes.

Avoid open fire, do not smoke, do not spill any fuel.

Catch running out fuel, do not let it seep into the ground and dispose off environmentally.

Cleaning work

Do not perform cleaning work while the motor is running.

Do not use gasoline or other easily inflammable substances for cleaning.

When using steam cleaning equipment cover all electric parts and insulating materials, or do not subject such items to the direct water or steam jet.

Do not guide the water jet directly into air filter, exhaust pipe and air intake.

After maintenance work

After all maintenance work is completed reinstall all guards and safety installations.

Repair

Mark defective machines by attaching a warning note.

Repair work must only be performed by qualified and authorized persons. Use our repair instructions for this work.

Exhaust gases are highly dangerous! Always ensure an adequate supply of fresh air when starting in closed rooms!

Welding

Before starting welding work on the machine disconnect the battery and cover the fuel tank with insulating material.

Test

The safety of compaction equipment must be checked by a specialist as required in dependence on the application and the operating conditions, however at least once every year.

Information and safety stickers/ decals on the machine

Keep safety stickers in good and legible condition (see parts manual) and comply with their meaning.

Replace damaged and illegible stickers/decals.

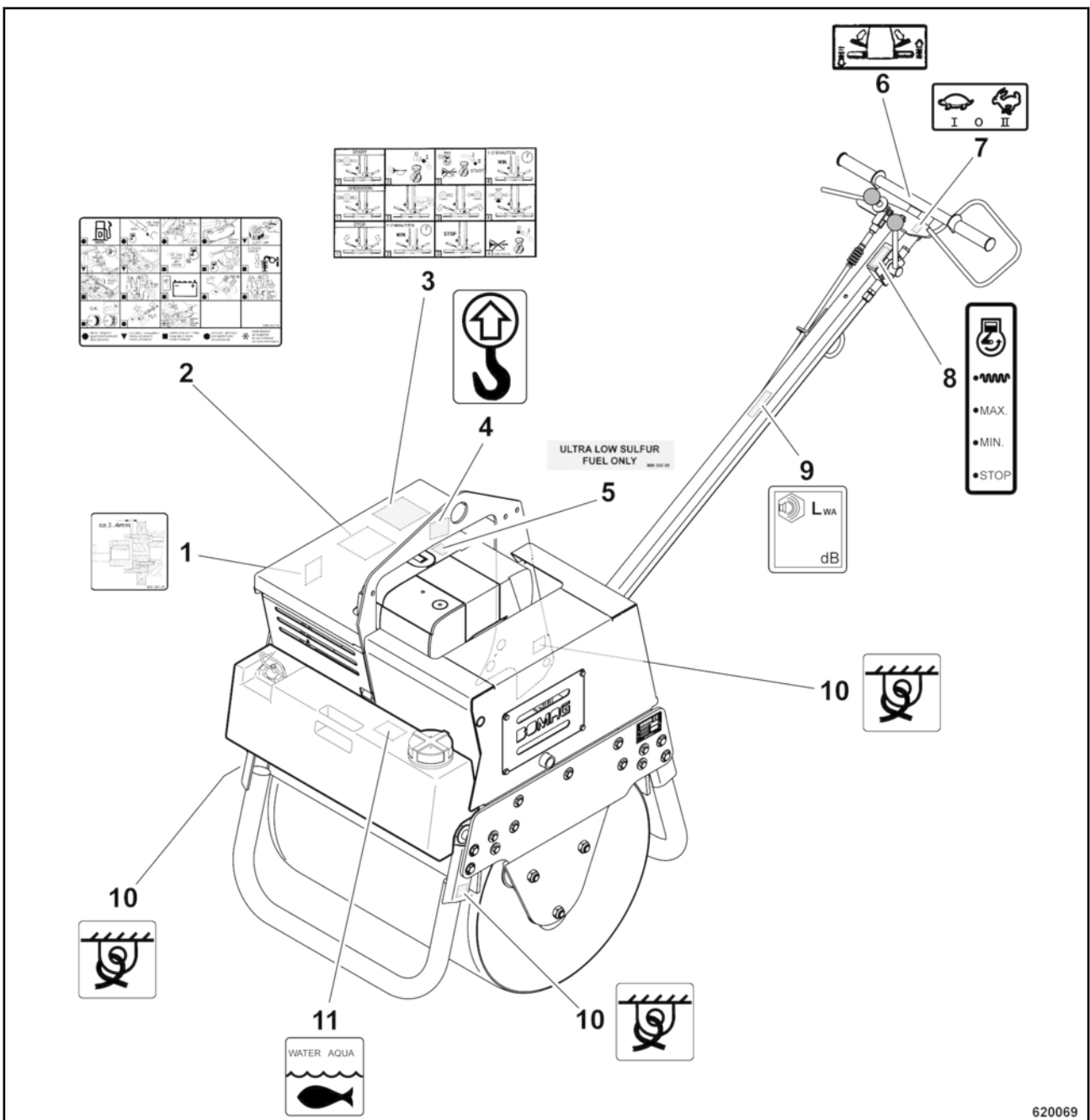
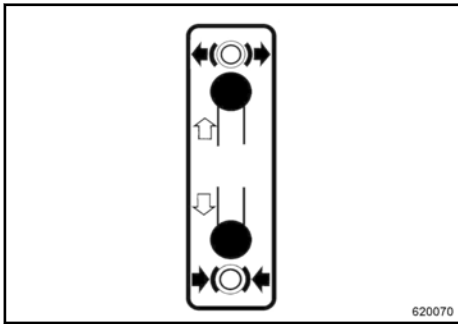


Fig. 5

- 1 Information sticker - Coupling gap
- 2 Maintenance sticker
- 3 Brief operating instructions
- 4 Information sticker - Lifting point
- 5 Information sticker - Ultra-low sulphur fuel
- 6 Operation sticker - Travel lever
- 7 Information sticker - Travel stages
- 8 Information sticker - Engine speed
- 9 Information sticker - Guaranteed sound capacity level
- 10 Information sticker - Lashing point
- 11 Information sticker - Water

Safety regulations



Information sticker - Brake^{Optional equipment}

Fig. 6

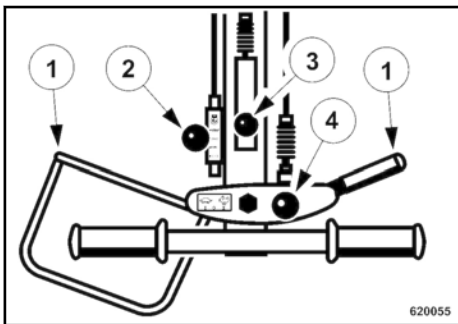
4.1 General notes

If you are not yet familiar with the control and display elements on this machine you should read this section thoroughly before starting any operation on the machine. Here all functions are described in detail.

The section "Operation" contains only brief descriptions of the individual control steps.

4.2 Description of indicators and control elements

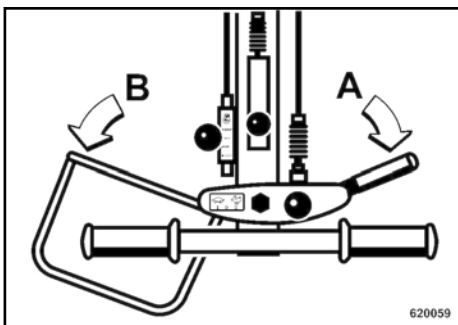
4.2.1 Control elements on steering rod



- 1 Travel lever
- 2 Throttle lever
- 3 Parking brake lever (*optional equipment*)
- 4 Travel stage lever

Fig. 7

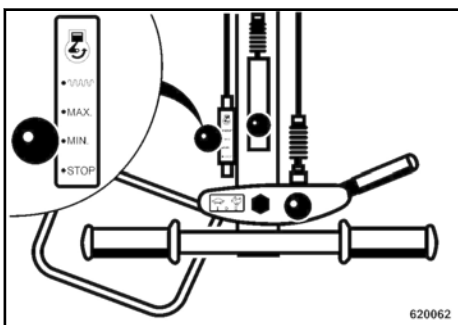
4.2.1.1 Travel lever



Travel lever right (A) backward	Forward travel
Travel lever left (B) backward	Backward travel

Fig. 8

4.2.1.2 Throttle lever



Position "STOP"	Engine off
Position "MIN"	Idle speed position
Position "MAX"	Travel without vibration
Position "Vibration"	Travel with vibration

Fig. 9

Display and control elements – Description of indicators and control elements

4.2.1.3 Parking brake lever

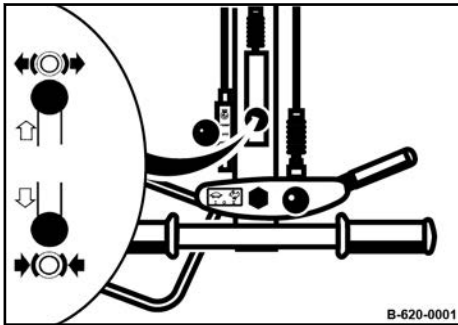


Fig. 10

Position "front"	Parking brake released
Position "rear"	Parking brake closed

4.2.1.4 Travel stage lever

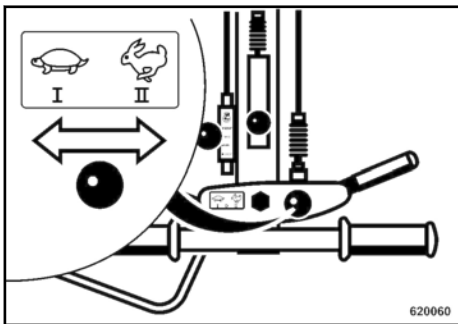


Fig. 11

Position "Left"	Travel range 1
Position "Right"	Travel range 2

4.2.2 Start switch

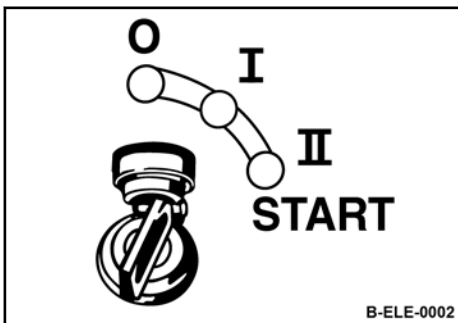


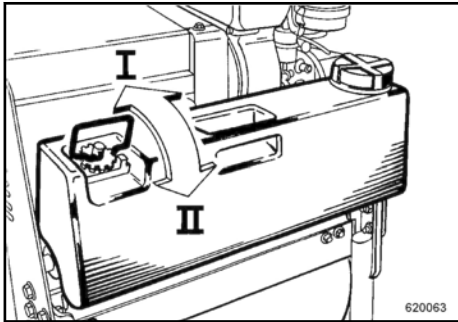
Fig. 12

Position "0"	Ignition off, key can be pulled out. Warning buzzer off.
Position "I"	Ignition on. Warning buzzer on.
Position "II"	Turn further against spring pressure, the engine starts, turn the ignition key back to position "I" once the engine has started. Warning buzzer off.



The starter switch is designed with a re-start lock. The ignition key must first be turned back to position "0" before a new starting attempt can be made.

4.2.3 Lever for water sprinkling system



Position "I"	Water sprinkling system on
Position "II"	Water sprinkling system off

Fig. 13

5.1 General

If you are not yet acquainted with the controls and indicating elements on this machine you should thoroughly read chapter "Indicators and control elements" before starting work.

All indicators and control elements are described in detail in this chapter.

5.2 Tests before taking into operation

The following inspections must be carried out before each working day or before a longer working period.



WARNING!

Danger of accident!

Please observe strictly the safety regulations in the corresponding section of this instruction manual!

Park the machine on ground as level as possible.

Cleaning the machine.

Check:

condition of engine and machine

fuel tank and fuel lines for leaks

screw joints for tight fit

air intake area for cleanliness

neutral setting of travel system (the vibratory roller must not move forward or backwards when the travel direction lever is in middle position)



For a description of the following tasks refer to the chapter "Daily maintenance".

engine oil level, top up if necessary

fuel level, top up if necessary

gear oil level, top up if necessary

water level, top up if necessary

5.3 Adjusting the steering rod



In order to achieve an optimal working position the steering rod must be adapted to the size of the operator.

Rest the machine on the front support.

Hold the steering rod.

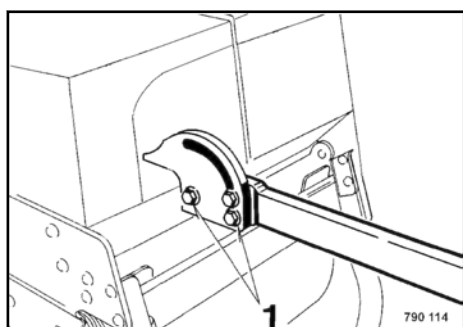


Fig. 14

Slacken the hexagon screws 1 ↗ Fig. 14, adjust the steering rod and retighten the screws.

5.4 Starting the engine



WARNING!

Exhaust gases are extremely dangerous!

Always ensure an adequate supply of fresh air when starting and operating in closed rooms and trenches!



WARNING!

Danger of accident!

Before starting make sure that there are no persons in the danger area of engine or machine and that all safety installations are in place.

Do not use starting aid sprays or other inflammable fluids for starting.

Always hold on to the machine.

Always keep an eye on a running machine.



WARNING!

Loss of hearing!

Wear your personal noise protection means (ear defenders) before starting operation.

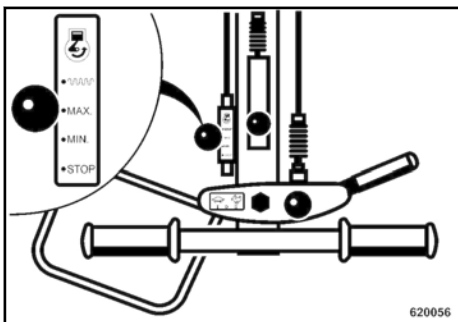


Fig. 15

Set the throttle lever ↗ Fig. 15 to position "MAX".

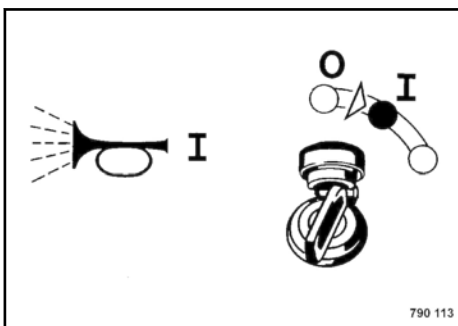


Fig. 16

Turn the ignition key to position "I" ↗ Fig. 16, the warning buzzer sounds.

Operation – Starting the engine

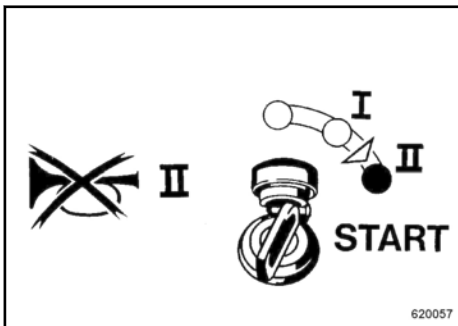


Fig. 17

Turn the ignition key further to position "II" ↪ Fig. 17 to start the engine.

As soon as the engine runs, return the ignition key to position "I". The warning buzzer stops.



NOTICE!

Starting attempts should not exceed 30 seconds uninterrupted or max. 3 times 10 seconds. After this time allow the starter to cool down to ambient temperature.

If the engine has not started after these attempts, determine the cause.



The starter switch is designed with a re-start lock. For a new starting attempt turn the ignition key first back to position "0".

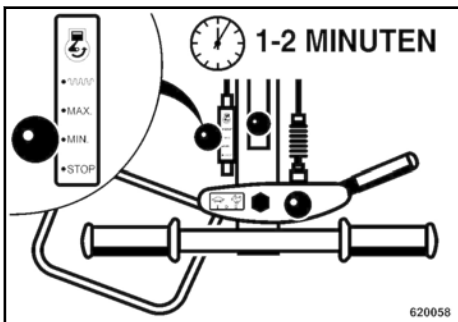


Fig. 18

Set the throttle lever to position "MIN" ↪ Fig. 18.

Run the engine warm for approx. 1 to 2 minutes in idle speed.



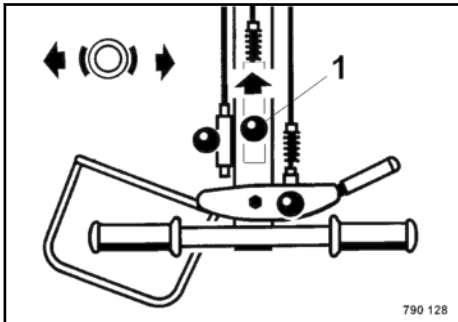
Operation of the vibratory roller can be started as soon as the engine responds to short throttle commands.



NOTICE!

When the engine is running leave the ignition key in position "I".

5.5 Releasing the parking brake **Optional equipment**



Release the parking brake lever (1) ↵ Fig. 19 and engage it in position "Parking brake released".

Fig. 19

5.6 Driving the machine



WARNING!

Soil conditions and weather influences impair the gradability of the machine.

Do not drive on gradients exceeding the maximum gradability of the machine!

Before starting to drive make sure that the drive range is absolutely safe.

Drive the machine only with a correctly adjusted steering rod. Guide the machine only by the steering rod.

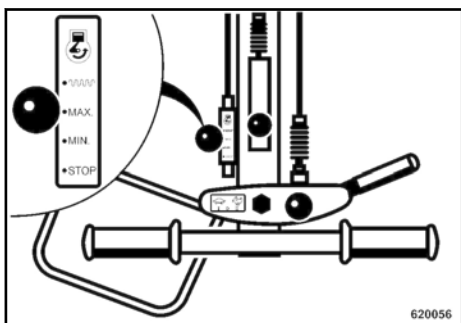


Fig. 20

Set the throttle lever ↗ Fig. 20 to position "MAX".

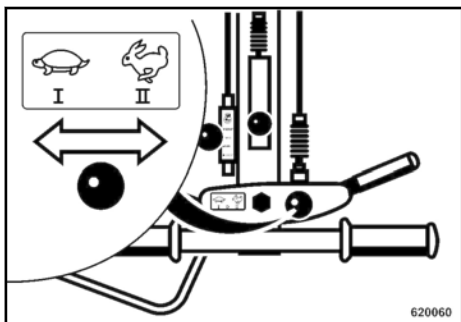


Fig. 21

Operate the travel range selector lever ↗ Fig. 21 and choose travel range I (position "Left") or travel range II (position "Right").

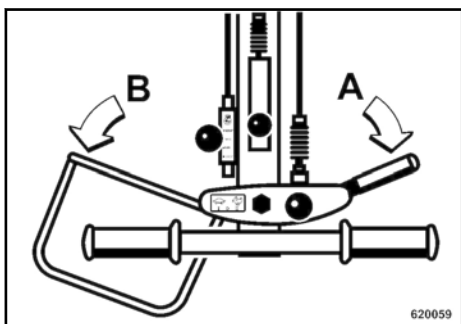


Fig. 22

Shift the travel direction lever ↗ Fig. 22 to the desired travel direction.

Position A	Forward travel (infinite)
Position B	Backward travel (infinite)

**WARNING!**

Actuate the travel direction lever only slowly, because the roller may start erratically and the steering rod may hit up or down when moving it too quickly.



If the machine operator contacts an obstruction when travelling in reverse, the safety control handle will be pressed to forward travel.

**WARNING!**

Do not use the machine if the safety control is defective.

The travel direction lever moves slowly back to neutral position when released. The machine is automatically braked.

**NOTICE!**

For short breaks you should always return the throttle lever to position "MIN" (idle speed).

Changing direction (cornering)

Change the direction of travel by sideways pulling or pushing on the steering rod handles.

5.7 Switching the vibration on and off



WARNING!

Risk of damage!

When compacting with vibration you must check the effect of nearby buildings and underground supply lines (gas, water, sewage, electric power), if necessary stop compaction with vibration.



NOTICE!

Danger of bearing damage!

Do not activate the vibration on hard (frozen, concrete) ground.



NOTICE!

Vibration at standstill causes transverse ruts, therefore:

Only switch the vibration when the machine is driving.
Switch the vibration off before stopping the machine.

Switching the vibration on

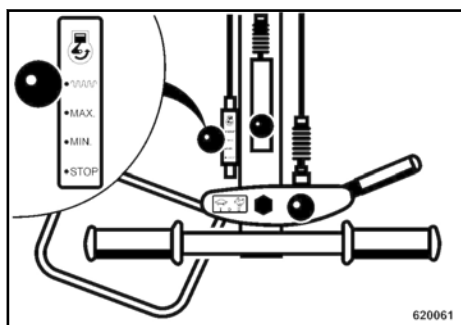


Fig. 23

Move the machine forward and back.

Set the throttle lever ↩ Fig. 23 to position "Vibration".

Operation – Switching the vibration on and off

Switching the vibration off

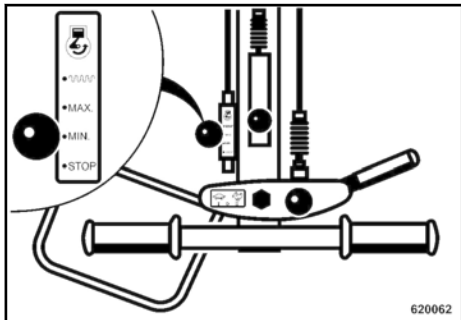


Fig. 24

Set the throttle lever ↪ Fig. 24 to position "MAX" or "MIN".

The vibration will come to a stop after a short while.



NOTICE!

For short breaks you should always return the throttle lever to position "MIN" (idle speed).

5.8 Switching the gravity sprinkling system on and off

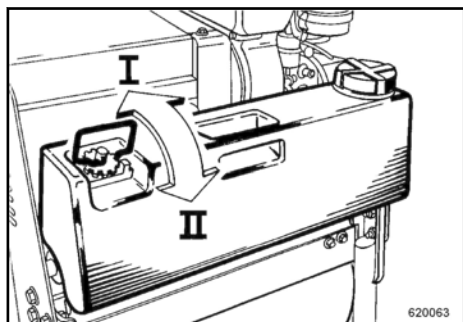


Fig. 25

Shift the lever ↵ Fig. 25 to position "I" to switch on.

Shift the lever to position "II" to switch off.



NOTICE!

If there is a risk of frost the water sprinkler system must be emptied or filled with an anti-freeze mixture.

5.9 Applying the parking brake **Optional equipment**

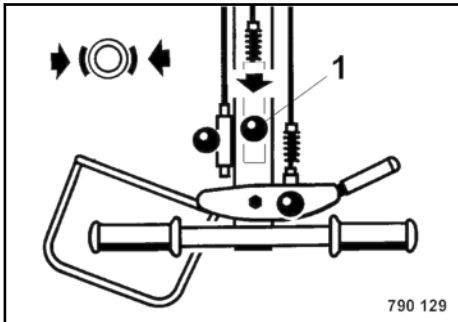


Fig. 26



NOTICE!

Apply the parking brake only after the machine has stopped.

Pull the parking brake lever (1) ↖ Fig. 26 back and engage it in position "Parking brake applied".

Operation – Shutting down the engine

5.10 Shutting down the engine



WARNING!
Danger of accident!

When parking on slopes apply suitable measures (e.g. wheel chocks) to block the machine against rolling away .



NOTICE!

Do not shut the engine down all of the sudden from full speed, but let it idle for a while for temperature equalization.

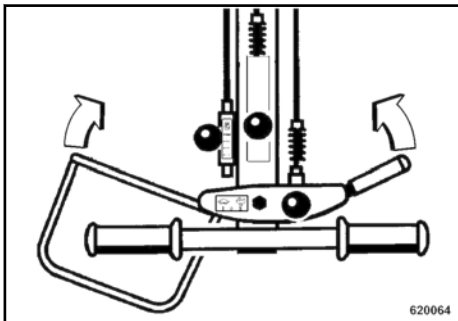


Fig. 27

Slowly release the travel lever ↪ Fig. 27.

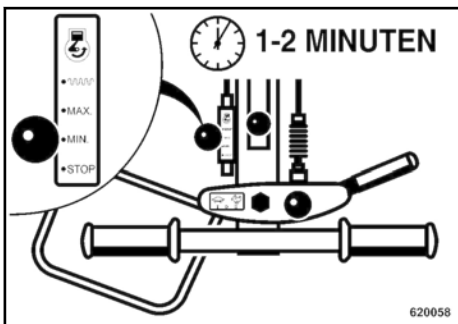


Fig. 28

Shift the throttle lever ↪ Fig. 28 to position "MIN" (idle speed) and let the engine run for a short while for temperature equalization.

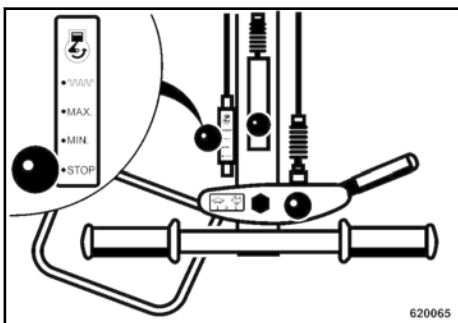


Fig. 29

Set the throttle lever ↪ Fig. 29 to position "STOP".

The warning buzzer sounds.

Operation – Shutting down the engine

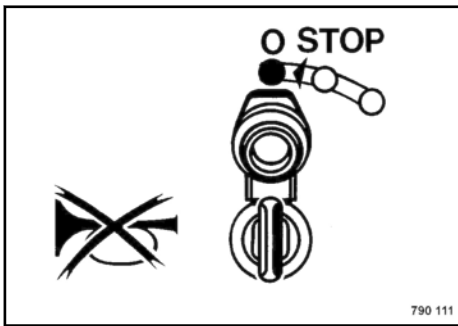


Fig. 30

Turn the ignition key to position "0" and pull it out ↵ Fig. 30.

The warning buzzer no longer sounds.

5.11 Loading/transport



WARNING!

Danger of accident! Life hazard!

Use only stable loading ramps of sufficient load bearing capacity. The ramp inclination must be less than the gradability of the machine.

Loading ramps must be free of grease, oil, snow and ice.

Make sure that persons are not endangered by the machine tipping or sliding off.

Use only safe lifting gear of sufficient load bearing capacity. Minimum lifting capacity of lifting gear: see operating weight in chapter "Technical Data".

For lifting the machine attach the lifting gear only to the lifting eye provided for this purpose.

Check all lifting and lashing points for damage before lifting or lashing down the machine. Do not use a damaged or in any other way impaired lifting and lashing eyes.

Do not lift or lower the machine jerkily.

The tension must always be effective in vertical direction.

The machine must not swing about when being lifted.

Do not step or stand under suspended loads.

Always use suitable lashing gear on the lifting points to lash down the machine.

Lash the machine down, so that it is secured against rolling, sliding and turning over.

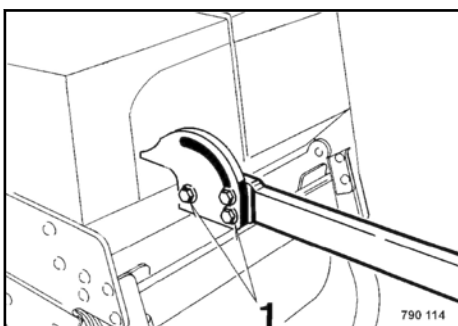
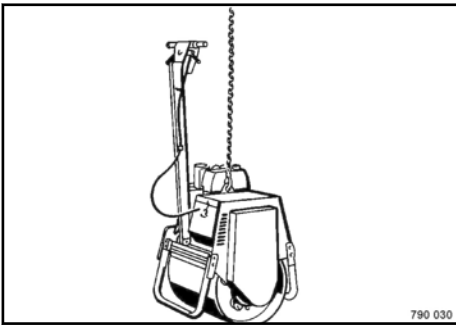


Fig. 31

After driving the machine onto the transport vehicle slacken the hexagon screws (1) ↪ Fig. 31, tilt the steering rod to vertical position and retighten the hexagon screws again. Rest the machine on the front support.

Lash the machine down to the transport vehicle, so that it is secured against rolling, sliding and turning over. Fasten the lashing tackle at the marked lashing points.



When loading the machine attach the lifting tackle to the hooks and eyes on the frame ↗ Fig. 32.

Fig. 32

5.12 Machine with support wheelOptional equipment

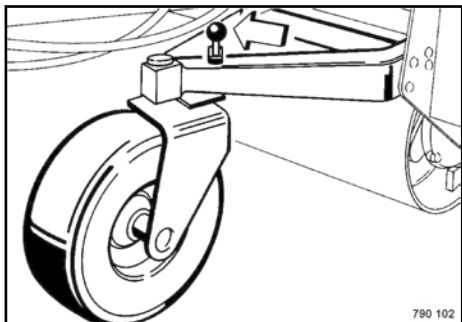



Fig. 33

Press the lever  Fig. 33 down, the support wheel is locked. Steering to forward only.

Pull lever up, steering is no longer locked.

6.1 General notes on maintenance

When performing maintenance work ensure strict compliance with the respective safety instructions and particularly the safety regulations mentioned in the corresponding section of these operating and maintenance instructions.

Thorough maintenance of the machine guarantees far longer safe functioning of the machine and prolongs the lifetime of important components. The effort needed for this work is only little compared with the problems that may arise when not observing this rule.

Always clean machine and engine thoroughly before starting maintenance work.

For maintenance work stand the machine on level ground.

Do not touch hot engine parts.

Perform maintenance work only with the engine shut down.



ENVIRONMENT!

During maintenance work catch all oils and fuels and do not let them seep into the ground or into the sewage system. Dispose of oils and fuels environmentally.

Keep used filters in a separate waste container and dispose of environmentally.

Notes on the fuel system

The lifetime of the diesel engine depends to a great extent on the cleanliness of the fuel.

Keep fuel free of contaminants and water, since this will damage the injection elements of the engine.

Drums with inside zinc lining are not suitable to store fuel.

The fuel drum must rest for a longer period of time before drawing off fuel.

Under no circumstances must the drum be rolled to the tapping point just before drawing out fuel.

When choosing the storage place for fuel make sure that spilled fuel will not harm the environment.

Do not let the hose stir up the slurry at the bottom of the drum.

Do not draw off fuel from near the bottom of the drum.

Residues in the fuel drum must not be used.

Notes on the performance of the engine

On diesel engines both combustion air and fuel injection quantities are thoroughly adapted to each other and determine power, temperature level and exhaust gas quality of the engine.

Maintenance – General notes on maintenance

If your engine has to work permanently in "thin air" (at higher altitudes) and under full load, you should consult our customer service or the customer service of the engine manufacturer.

Frequent causes of faults

Operating errors

Incorrect, inadequate maintenance

If you cannot locate the cause of a fault or rectify it yourself by following the trouble shooting chart, you should contact our customer service department.

6.2 Fuels and lubricants

6.2.1 Engine oil

6.2.1.1 General

Modern diesel engines put high demands on the lubrication oil used. The engine powers that have continuously increased over the past few years lead to higher thermal loads for the lubrication oil. Apart from that, the lubrication oil is additionally loaded by contamination because of the reduced lubrication oil consumption and the prolonged lubrication oil change intervals.

For this reason it is necessary to follow the requirements and recommendations in these operating instructions in order not to reduce the lifetime of the engine.

Engine oils of the same specification can generally be mixed among each other. However, mixing of engine oil should be avoided, because the poorest characteristics of a mixture will always prevail.

The use of additives for lubrication oils is not permitted.

The lubrication oil quality has a considerable influence on the lifetime, performance and thus the economy of the engine. The following is generally valid: the better the lubrication oil quality, the better its properties.

6.2.1.2 Oil quality

Lubrication oils are classified according to their performance and quality class.

The following lubrication oil specifications are permitted:

- API CD/CE/CF/CF-4/CG-4 or higher quality
- ACEA B2/E2 or higher quality

6.2.1.3 Oil viscosity

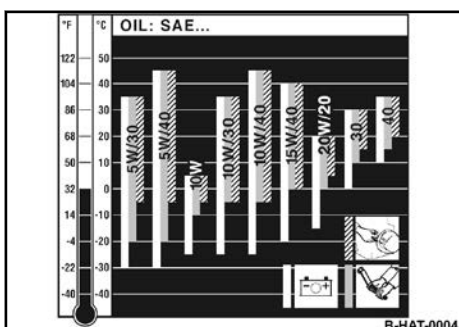


Fig. 34

Since lubrication oil changes its viscosity with the temperature, the ambient temperature at the operating location of the engine is of utmost importance when choosing the viscosity class (SAE-class).

Optimal operating conditions can be achieved by using the oil viscosity chart as a reference.

6.2.1.4 Oil change intervals

Annually or every 250 operating hours.



When changing to a higher alloyed oil quality after a longer period of operation, it is recommended to perform the first oil change of the higher quality oil already after 25 operating hours.

6.2.2 Fuel

6.2.2.1 Fuel quality

The following fuel specifications are permitted:

- EN 590
- ASTM D 975 Grade 1-D/2-D
- BS 2869 A1/A2

With respect to the percentage (ppm) of sulphur the fuel used in the engine must comply with all relevant exhaust emission regulations in the area of use of the engine.

6.2.2.2 Winter fuel

For winter operation use only winter diesel fuel, to avoid clogging because of paraffin separation.

At very low temperatures disturbing paraffin separation can also be expected when using winter diesel fuel.

Diesel fuels suitable for temperatures down to -44 °C (-47 °F) are available for Arctic climates.



NOTICE!

Danger of engine damage!

- The admixture of petroleum and the addition of "flow enhancing additives" (fuel additives) is not permitted.

6.2.2.3 Storage

Even traces of zinc, lead and copper can cause deposits in the injection nozzles, especially in modern Common-Rail injection systems.

Zinc and lead coatings in refuelling systems and fuel lines are not permitted.

Copper containing materials (copper lines, brass items) should be avoided, because they can cause catalytic reactions in the fuel with subsequent depositing in the injection system.

6.2.3 Lubrication grease

For lubrication purposes use an EP-high pressure grease, lithium saponified (penetration 2), acc. to DIN 51502 KP 2G.

6.3 Table of fuels and lubricants

Assembly	Fuel or lubricant		Quantity approx.
	Summer	Winter	Attention
			Observe the level marks
Engine			
- Engine oil	API CD/CE/CF/CF-4/CG-4		approx. 0.9 litres
	SAE 5W/30 (-5°C to +35°C)		
	SAE 5W/40 (-5°C to +45°C)		
	SAE 10W/30 (-5 °C to +35 °C)		
	SAE 10W/40 (-5 °C to +45 °C)		
	SAE 10W/40 (0 °C to +40 °C)		
	SAE 30 (+15 °C to +30 °C)	SAE 10W (-5 °C to +5 °C)	
	SAE 40 (+20 °C to +35 °C)		
- Fuel	Diesel	Winter diesel fuel (-12 °C)	5.1 l
Hydrostatic transmission	as engine oil		to oil level mark
Gearbox	as engine oil		to oil level mark
Water tank	Water	Water with anti-freeze agent	25 l
Drive shaft bearing	EP-high pressure grease, lithium saponified (penetration 2)		as required
Chain	Grease		as required
Shifting gate	Grease		as required

6.4 Running-in instructions

6.4.1 General

The following maintenance work must be performed when running in new machines or overhauled engines:



NOTICE!

Danger of engine damage!

- Up to approx. 250 operating hours check the engine oil level twice every day.

Depending on the load the engine is subjected to, the oil consumption will drop to the normal level after approx. 100 to 250 operating hours.

6.4.2 After 25 operating hours

Change the engine oil ↪ *Chapter 6.10.1 'Changing the engine oil and cleaning the oil filter' on page 73.*

Check, adjust the valve clearance ↪ *Chapter 6.9.5 'Checking, adjusting the valve clearance' on page 70.*

Check engine and machine for leaks.

Retighten the fastening screws on air filter exhaust, fuel tank and other attachments.

Retighten the bolted connections on the machine.

Check the vibration drive V-belts.

6.5 Maintenance table

No.	Maintenance works	Page
Daily maintenance		
6.6.1	<i>Clean the machine</i>	56
6.6.2	<i>Checking the engine oil level</i>	56
6.6.3	<i>Check the fuel level</i>	57
6.6.4	<i>Checking the Gear Oil Level</i>	58
6.6.5	<i>Fill the water tank</i>	58
Weekly maintenance		
6.7.1	<i>Check, clean the water separator</i>	59
Monthly maintenance		
6.8.1	<i>Air filter maintenance</i>	60
6.8.2	<i>Cleaning the cooling fins and the cooling air intake openings</i>	61
6.8.3	<i>Greasing the drive shaft bearings</i>	62
6.8.4	<i>Checking the oil level in the hydrostatic transmission</i>	62
Half-annual maintenance		
6.9.1	<i>Clean the exhaust screen</i>	63
6.9.2	<i>Checking, tensioning, replacing the travel system V-belt</i>	64
6.9.3	<i>Checking, tightening, replacing the vibration V-belt</i>	67
6.9.4	<i>Checking the battery condition, greasing the poles</i>	68
6.9.5	<i>Checking, adjusting the valve clearance</i>	70
6.9.6	<i>Checking the screw joints on the diesel engine</i>	72
Annual maintenance		
6.10.1	<i>Changing the engine oil and cleaning the oil filter</i>	73
6.10.2	<i>Replace the fuel filter</i>	75
6.10.3	<i>Checking, greasing and tightening the chain</i>	76
6.10.4	<i>Check the rubber buffers</i>	78
As required		
6.11.1	<i>Water sprinkler system, maintenance in the event of frost</i>	79
6.11.2	<i>Adjusting the Scrapers</i>	79
6.11.3	<i>Cleaning, greasing the control unit</i>	80
6.11.4	<i>Tightening Torques for Screws with Metric Unified Thread</i>	80
6.11.5	<i>Conserving the Engine</i>	80

6.6 Daily maintenance

6.6.1 Clean the machine



NOTICE!

Perform cleaning work only after the engine has cooled down and with the engine stopped.

Dirty operating conditions, particularly lubrication oil and fuel deposits on the cooling fins of the engine and the cooling air intake opening have an adverse effect on the cooling of the engine. You should therefore immediately seal any oil or fuel leaks near fuel tank, cylinder or cooling air intake and subsequently clean the cooling fins.

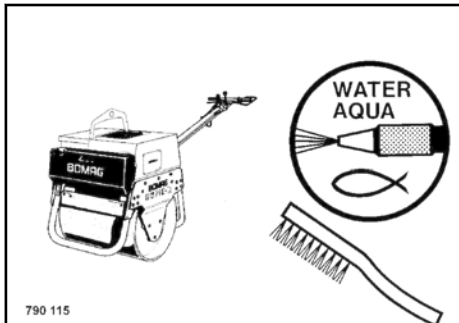


Fig. 35



NOTICE!

Do not guide the water jet directly into the cooling air openings of the recoil starter, into the dry air filter or on electrical equipment ↪ Fig. 35.

After wet cleaning run the engine warm to evaporate all water residues and to avoid corrosion.

6.6.2 Checking the engine oil level



NOTICE!

Danger of engine damage!

- +Use only oil of the permitted specification ↪ *Chapter 6.2.1 'Engine oil' on page 50.*

Protective equipment: ■ Protective gloves

Park the machine on level and firm ground.

Shut down the engine.

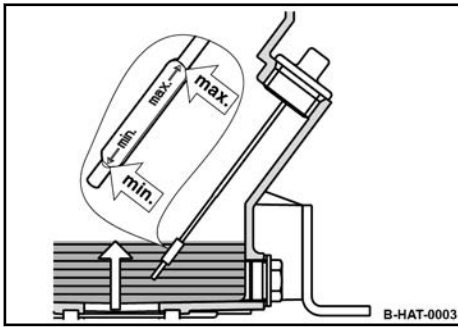


Fig. 36

Clean the area around the oil dipstick.

Pull the dipstick out, wipe it off with a lint-free, clean cloth and reinsert it until it bottoms.

Pull the dipstick back out.



NOTICE!

Danger of engine damage!

- Do not overfill with engine oil.

The oil level must always be between the "MIN"- and "MAX"-marks. If the oil level is too low, top up oil to the "MAX" mark immediately.

6.6.3 Check the fuel level



WARNING!

Fire hazard!

When working on the fuel system do not use open fire, do not smoke, do not spill any fuel.

Do not refuel in closed rooms.

Shut down the engine.



WARNING!

Health hazard!

Do not inhale any fuel fumes.



ENVIRONMENT!

Catch running out fuel, do not let it seep into the ground.

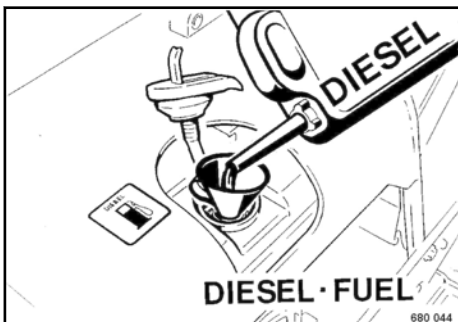



Fig. 37

Clean the area around the quick release filler cap, remove the filler cap  Fig. 37.



NOTICE!

Contaminated fuel can cause malfunction or even damage of the engine.

For quality and quantity of fuel refer to the "table of fuels and lubricants".

Maintenance – Daily maintenance

Fill in fuel through a funnel with screen.

Close the tank again.

6.6.4 Checking the Gear Oil Level

i *Park the machine on level ground so that the engine is in a horizontal position.*

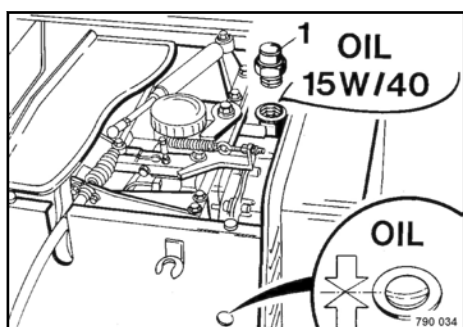


Fig. 38

Check the oil level in the sight glass.

If necessary top up gear oil through the filler neck 1

↪ Fig. 38.

For quality of oil refer to the table of fuels and lubricants.

6.6.5 Fill the water tank



NOTICE!

Dirty or contaminated water can block the nozzles!

Fill only with clean water.

If there is a risk of frost observe the special service instructions in chapter "water sprinkler system, maintenance in case of frost".

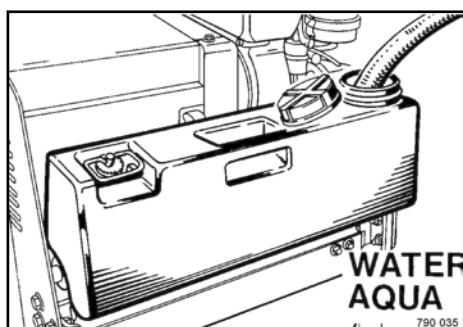


Fig. 39

Open the cover ↪ Fig. 39 and fill in water.

Close the cover again.



Make sure that the ventilation bore in the filler cap is free.

The water tank can be taken off.

6.7 Weekly maintenance

6.7.1 Check, clean the water separator

**WARNING!****Fire hazard!**

When working on the fuel system do not use open fire, do not smoke. Do not spill any fuel.

Shut down the engine.

**WARNING!****Health hazard!**

Do not inhale any fuel fumes.

**ENVIRONMENT!**

Any fuel must be caught and disposed of in an environmentally friendly manner.



The inspection interval for the water separator depends on the water proportion in the fuel and the care that is exercised when refuelling.

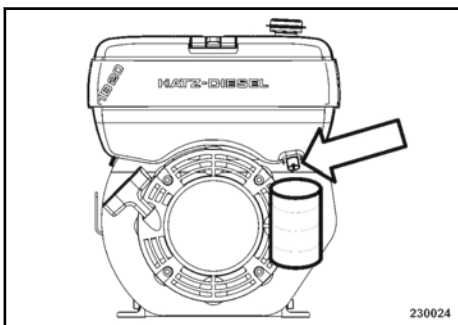



Fig. 40

Place the transparent container  Fig. 40 under the drain plug.

Loosen the screw for approx. 3 to 4 turns and collect running out water/fuel.



Since water is heavier than diesel fuel, water will run out before the fuel. This can be noticed by a clearly visible parting line.

When only fuel comes running out, tighten the drain plug again.

6.8 Monthly maintenance

6.8.1 Air filter maintenance



Contamination of the air filter depends mainly on the proportion of dust in the intake air, if necessary clean several times a day.



NOTICE!

Danger of engine damage!

- Do not start the engine after having removed the air filter.
- If necessary, the air filter may be cleaned up to six times. The air filter must be replaced at the latest after half a year or 500 operating hours respectively.
- Cleaning does not make sense if the air filter element is covered with a sooty deposit.
- Do not use gasoline or hot fluids to clean the filter element.
- After cleaning the air filter must be inspected for damage using a torch.
- Do not continue to use a damaged air filter element. If in doubt use a new air filter.

Protective equipment: ■ Working clothes
■ Protective gloves
■ Safety goggles

Park the machine in secured condition.

Allow the engine to cool down.

Remove the air filter cover (3).

Unscrew the knurled nut (2) and pull out the air filter (1).

Clean the air filter cover.

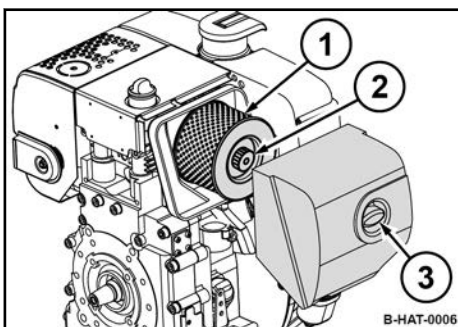


Fig. 41



NOTICE!

Danger of engine damage!

- Avoid the infiltration of dirt into the air intake opening.
- Do not clean the air filter housing with compressed air.

Clean the filter housing with a clean, lint-free cloth.

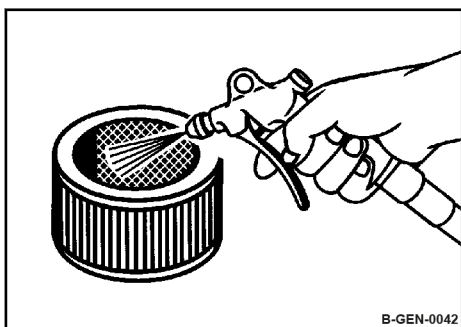


Fig. 42



CAUTION!

Danger of eye injuries caused by particles flying around!

- Wear your personal protective equipment (safety gloves, protective working clothes, goggles).

Blow the air filter out with dry compressed air (max. 5 bar (73 psi)) from inside to outside by moving the gun up and down inside the element, until it is free of dust.

Examine the air filter with a torch for cracks and holes.

Replace the air filter if it is damaged.

Insert the air filter (1) carefully into the filter housing and fasten it with the knurled nut (2).

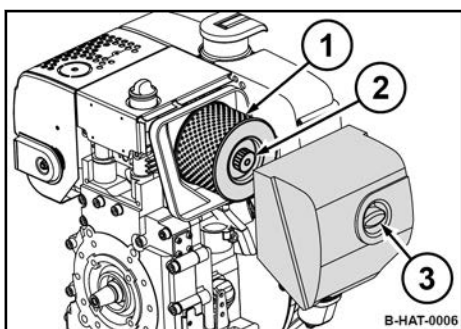


Fig. 43



NOTICE!

Danger of engine damage!

- Ensure correct fit of air filter cover and seal.

Assemble the air filter cover (3).

6.8.2 Cleaning the cooling fins and the cooling air intake openings

- Protective equipment:
- Working clothes
 - Protective gloves
 - Safety goggles

Park the machine in secured condition.

Allow the engine to cool down.

Loosen dried on dirt with a suitable brush from all cooling fins and cooling air intake openings.

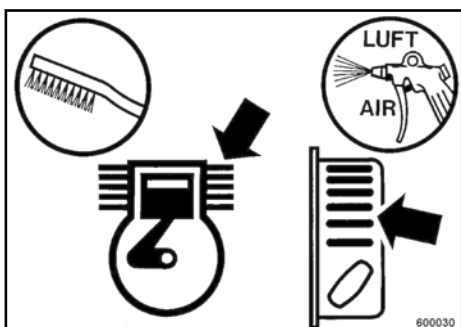


Fig. 44



CAUTION!

Danger of eye injuries caused by particles flying around!

- Wear your personal protective equipment (safety gloves, protective working clothes, goggles).

Blow cooling fins and cooling air intake openings out with compressed air.

In case of damp or oily contamination you should consult our customer service department.

6.8.3 Greasing the drive shaft bearings

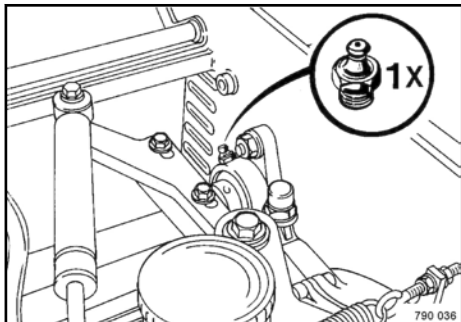


Fig. 45

Clean the grease nipples ↪ Fig. 45 and lubricate with high pressure grease from the grease gun.

For quantity of grease refer to the table of fuels and lubricants.

6.8.4 Checking the oil level in the hydrostatic transmission

i *Park the machine on level ground so that the engine is in horizontal position.*

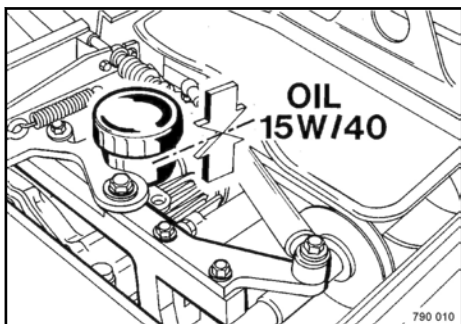


Fig. 46

Check the oil level in the tank ↪ Fig. 46.

Take the rubber grommet out of the oil tank before refilling.

For quality of oil refer to the table of fuels and lubricants.

6.9 Half-annual maintenance

6.9.1 Clean the exhaust screen



WARNING!

Danger of burning!

During and after operation the exhaust system is very hot. Perform this work only after the machine has cooled down.

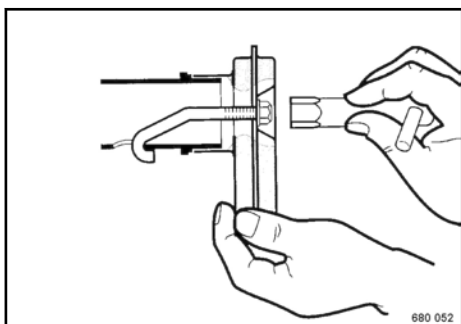


Fig. 47

Loosen the fastening nuts ↪ Fig. 47 and remove the exhaust screen with the fastening strap.

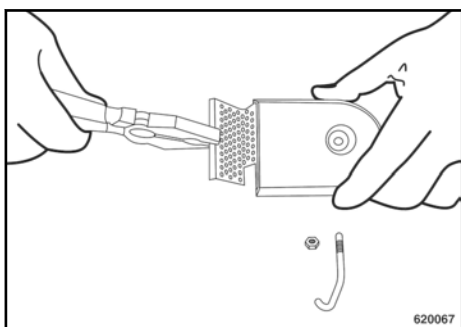


Fig. 48

Take off the fastening nut and the fastening strap, then pull out the screen insert ↪ Fig. 48.



WARNING!

Danger of injury!

Wear gloves when cleaning.

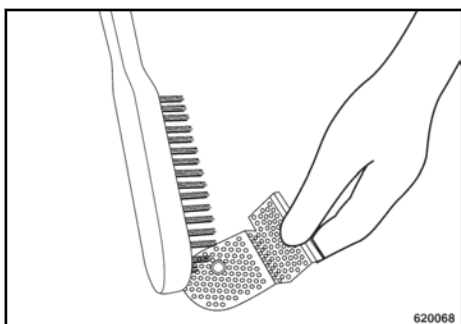


Fig. 49

Remove deposits from the screen insert with an appropriate wire brush ↪ Fig. 49.

Check the screen insert for cracks and damage, replace if necessary.

Maintenance – Half-annual maintenance

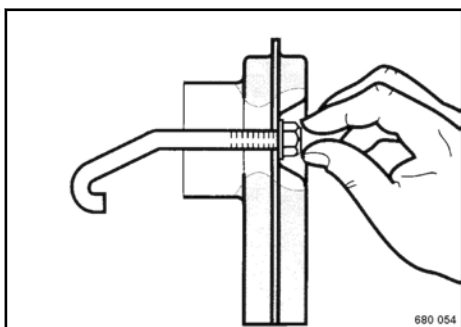


Fig. 50

Re-assemble screen insert and fastening strap and screw the fastening nut if for approx. one turn ↪ Fig. 50.

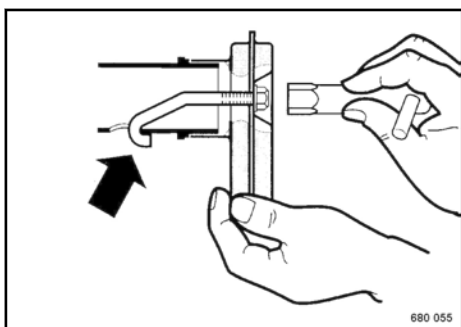


Fig. 51

Slide on the exhaust screen with fastening bow ↪ Fig. 51. Hook the fastening bow into the bore and tighten the fastening nut.

6.9.2 Checking, tensioning, replacing the travel system V-belt

Checking the V-belt

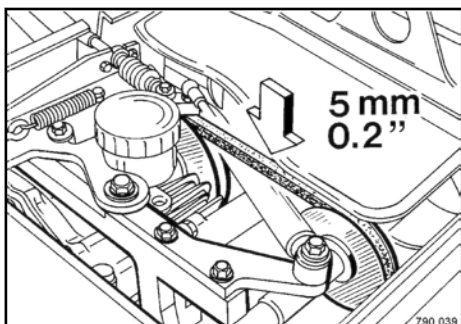


Fig. 52

Check the condition and tension of the V-belt ↪ Fig. 52, replace the V-belt if damaged.

Compression measurement: approx. 5 mm.

Tightening the V-belt

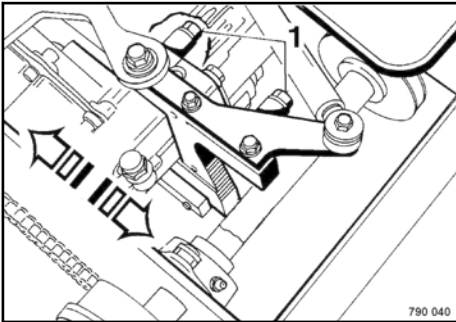


Fig. 53

Loosen the transmission fastening screws (1) ↗ Fig. 53.

Move the transmission, until the correct V-belt tension is achieved.

Tighten the transmission fastening screws.



NOTICE!

After tightening the V-belt you must also check the chain tension, see section "Checking the chain tension, greasing and tightening".

Changing the V-belt

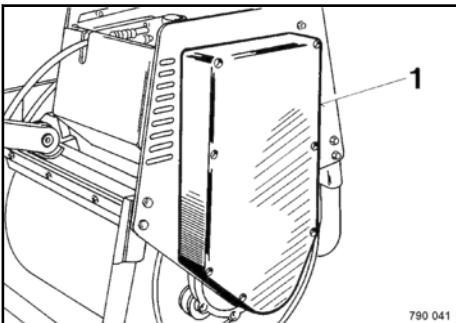


Fig. 54

Loosen the transmission fastening screws (1) .

Push the transmission forward, until the V-belt is relieved.

Remove the guard (1) ↗ Fig. 54.

Maintenance – Half-annual maintenance

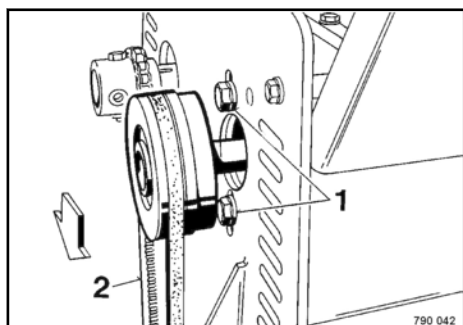


Fig. 55

Relieve the tension of vibration V-belt (2) ↪ Fig. 55 by slackening screw (1) and take it off.

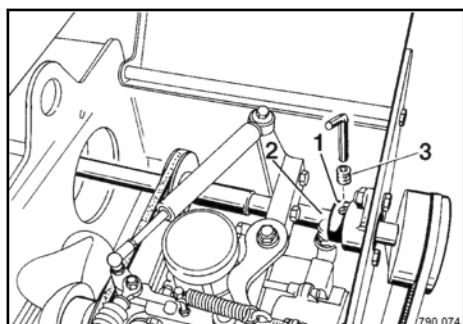


Fig. 56

Clean the sliding surface for clamping ring (1) ↪ Fig. 56 on drive shaft (2).

Loosen grub screw (3).

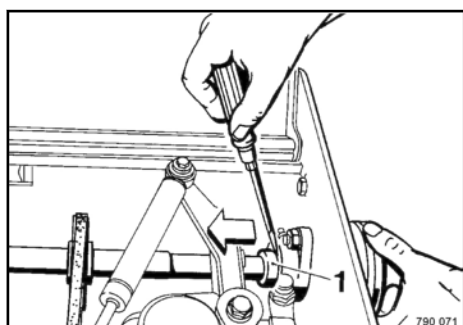


Fig. 57

Press clamping ring (1) ↪ Fig. 57 off the bearing.

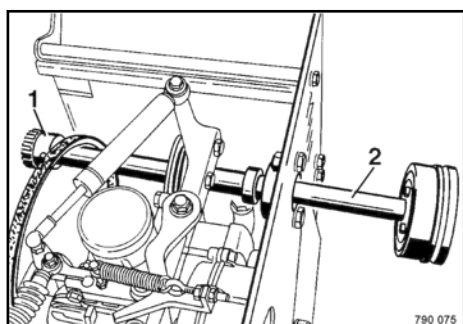


Fig. 58

Pull drive shaft (2) ↪ Fig. 58 out of the flanged coupling, so that the old V-belt can be lifted over the drive shaft.

Cover the teeth on the drive shaft coupling (1) with Molykote grease.

Install the new V-belt and push the drive shaft back.

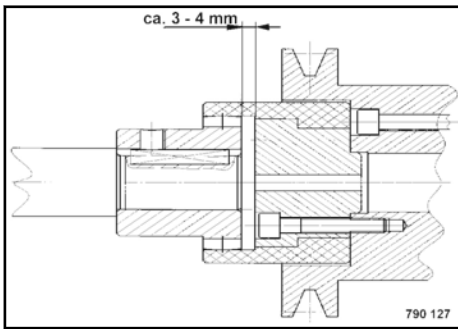


Fig. 59

Ensure an air gap of 3 to 4 mm ↪ Fig. 59.

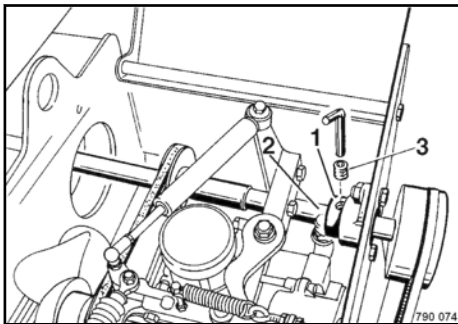


Fig. 60

Push clamping ring (1) ↪ Fig. 60 onto the bearing and fasten it with the grub screw (3).

Tension the new V-belt.

Assemble and tighten the vibration V-belt, see section "Checking, tightening, replacing the vibration V-belt".

Install the guard.

6.9.3 Checking, tightening, replacing the vibration V-belt

Checking the V-belt

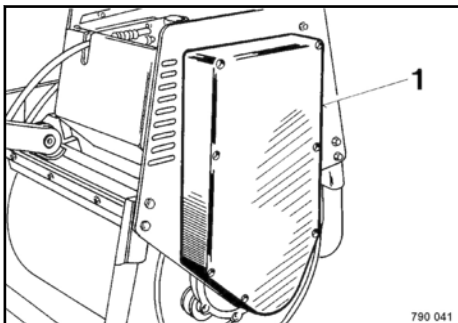


Fig. 61

Remove the guard (1) ↪ Fig. 61.

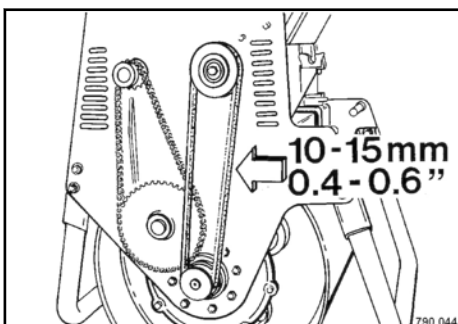


Fig. 62

Check the condition and tension of the V-belt, replace the V-belt if damaged ↪ Fig. 62.

Compression measurement approx. 10 to 15 mm.

Maintenance – Half-annual maintenance

Install the guard.

Tightening the V-belt

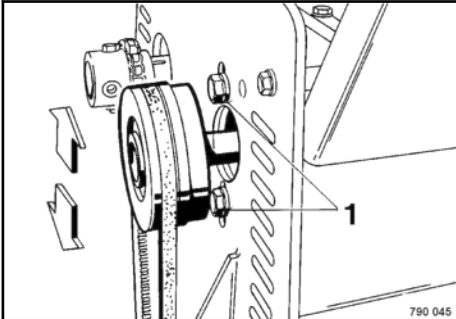


Fig. 63

Tightening the V-belt

Remove the guard

Loosen bearing fastening screws (1) ↪ Fig. 63.

Displace the bearing, until the V-belt has the correct tension; at the same time tighten the bearing fastening screws (1).

Compression measurement approx. 10 to 15 mm.

Install the guard.

Changing the V-belt

Remove the guard

Loosen bearing fastening screws (1) .

Push the bearing down and lift off the old V-belt.

Install the new V-belt and tighten it .

Install the guard.

6.9.4 Checking the battery condition, greasing the poles



WARNING!

Danger of cauterisation !

When working on the battery do not use open fire, do not smoke.

Do not let acid come in contact with skin or clothes.

Wear safety goggles.

Do not lay any tools on the battery.

Fold the battery cover back.

Maintenance – Half-annual maintenance

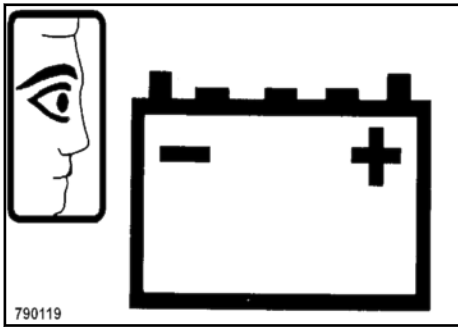


Fig. 64

Non-maintenance free batteries

Remove the battery ↗ Fig. 64 and clean the battery compartment.

Clean the outside of the battery.

Clean battery poles and pole clamps and grease them with pole grease (Vaseline).

Check the fastening of the battery.

Close the cover again tightly after servicing the battery.



NOTICE!

Top up missing fluid with distilled water.

Unscrew the plugs and check the acid level, if necessary top up with distilled water

With control inserts:

Acid level up the bottom of the control inserts.

Without control inserts

Measure the acid level with a clean wooden stick 10 to 15 mm above the upper edge of the lead plate.

With transparent battery housing

The acid level must reach the level mark on the housing.

Maintenance free batteries

Perform only the following points:

Check the battery for cleanliness.

Clean the poles

Tighten the terminal clamps.



NOTICE!

Dispose of the old batteries environmentally.



WARNING!

Development of gas!

For recharging remove the plugs from the battery to avoid the accumulation of highly explosive gases.

6.9.5 Checking, adjusting the valve clearance



NOTICE!

Danger of engine damage!

We recommend to have this work carried out by trained personnel or our after sales service.

- Before checking the valve clearance let the engine cool down.
- After a short test run check the engine for leaks.

Preparations

Protective equipment: ■ Working clothes
■ Protective gloves

Park the machine in secured condition.

Allow the engine to cool down to ambient temperature.

Remove the air filter cover (2).

Remove the cover (1).

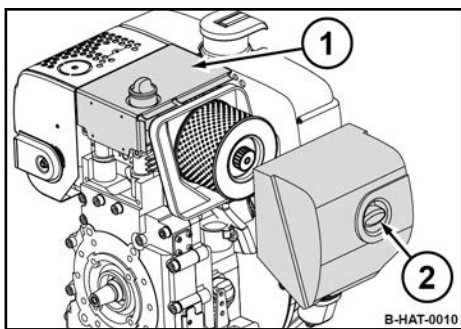


Fig. 65

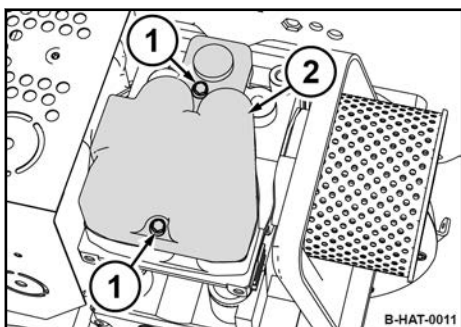


Fig. 66

Unscrew the fastening screws (1).

Remove valve cover (2) with the gasket.

Checking the valve clearance

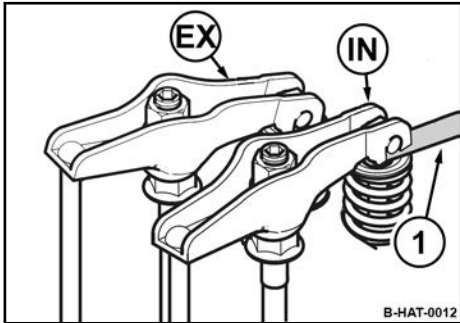


Fig. 67

Valve clearance:

Intake valve (IN)	0.20 mm (0,008 in)
Exhaust valve (EX)	0.20 mm (0,008 in)

Crank the engine until the exhaust valve (EX) is fully open.

Check the valve clearance on the intake valve (IN) with a feeler gauge (1), adjust if necessary.

Crank the engine further, until the intake valve is fully open.

Check the valve clearance on the exhaust valve, adjust if necessary.

Adjusting the valve clearance

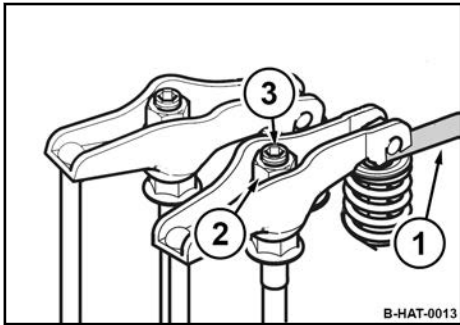


Fig. 68

Loosen screw (3) on the rocker arm.

Regulate the hexagon nut (2) so that the feeler gauge (1) can be pulled through the gap with noticeable resistance after tightening the screw (3).

Final work

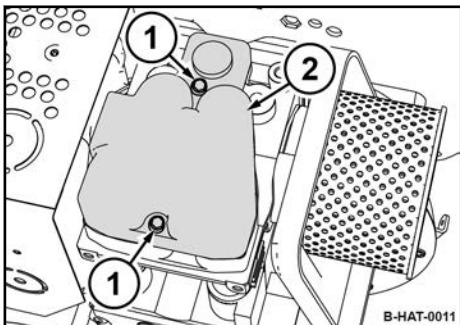


Fig. 69

Install the cylinder head cover (2) with a new gasket.

Tighten the fastening screws (1) evenly.

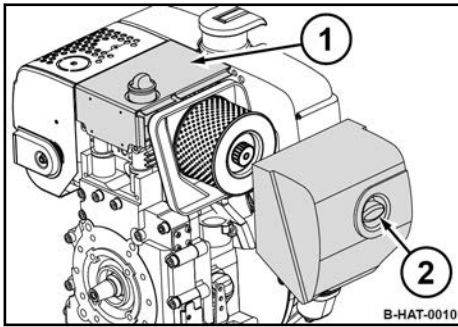


Fig. 70

Assemble the cover (1) and the air filter cover (2).
After a short test run check the valve cover for leaks.

6.9.6 Checking the screw joints on the diesel engine

Park the machine in secured condition.

Allow the engine to cool down.



NOTICE!

Components may get damaged!

- Do not retighten the cylinder head fastening screws.
- Do not retighten or adjust the setscrews on throttle control and injection system.

Check all screw joints on the diesel engine for condition and tight fit, retighten if necessary.

6.10 Annual maintenance

6.10.1 Changing the engine oil and cleaning the oil filter



Change the engine oil at the latest after 250 operating hours.



NOTICE!

Danger of engine damage!

- Change the oil only with the engine at operating temperature.
- Use only oil of the permitted specification ↪ *Chapter 6.2.1 'Engine oil' on page 50.*
- Filling quantity: ↪ *Chapter 6.3 'Table of fuels and lubricants' on page 53*

Protective equipment: ■ Working clothes
 ■ Protective gloves
 ■ Safety goggles

Park the machine in secured condition.

Clean the area around the dipstick and pull the dipstick out.

Clean the area around the drain plug.

Draining off engine oil

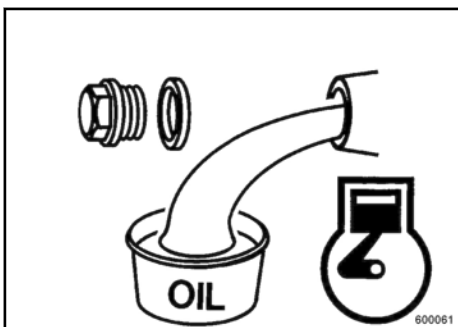


Fig. 71



WARNING!

Danger of burning on hot components!

- Wear your personal protective outfit (protective gloves, protective clothing).

Unscrew the oil drain plug and catch any oil running out.

Clean and screw in the drain plug.

Cleaning the oil filter

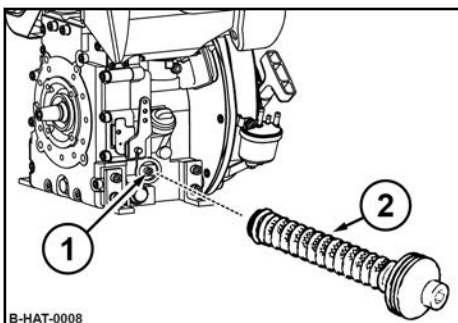


Fig. 72

Loosen the screw (1) for approx. five turns and pull the oil filter (2) out of the housing.

Maintenance – Annual maintenance

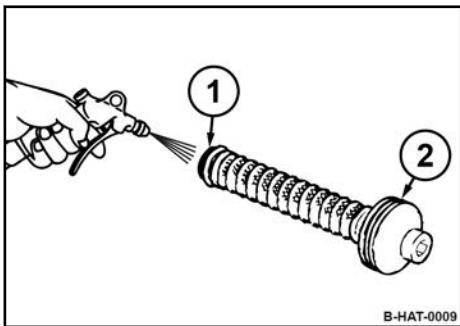


Fig. 73



CAUTION!

Danger of eye injuries caused by particles flying around!

- Wear your personal protective equipment (safety gloves, protective working clothes, goggles).

Blow the engine oil filter out with compressed air from inside to outside.

Check the seal (2) for damage, change if necessary.

Slightly oil the seal rings (1) and (2).

Insert the oil filter (2) into the housing and press it down against the end stop.

Before tightening the screw (1) make sure that the tensioning springs touch the oil filter with both ends.

Tighten the screw.

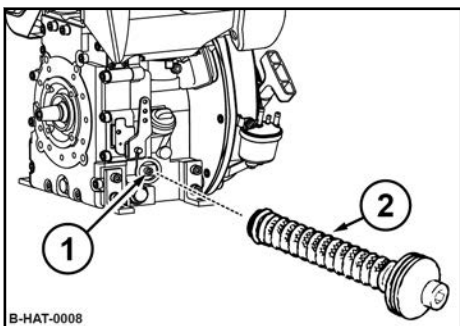


Fig. 74

Filling in engine oil

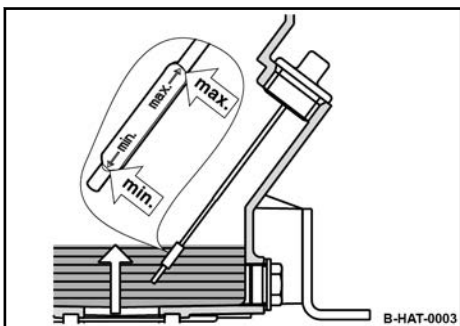


Fig. 75

Fill in fresh oil up to the lower edge of the filler bore.

After a short test run check the oil level on the dipstick, if necessary top up to the top dipstick mark.

Final work

Check oil filter and drain plug for leaks.

Dispose of old oil environmentally.

6.10.2 Replace the fuel filter



WARNING!

Fire hazard!

When working on the fuel system do not use open fire, do not smoke, do not spill any fuel.

Do not refuel in closed rooms.

Shut down the engine.



WARNING!

Health hazard!

Do not inhale any fuel fumes.



NOTICE!

Ensure strict cleanliness to keep dirt out of the fuel lines. Dirt particles can destroy the injection system.

The service interval to change the fuel filter depends on the cleanliness of the fuel. If necessary this service must be performed every six months.



ENVIRONMENT!

Catch running out fuel, do not let it seep into the ground.

Dispose of the used fuel filter environmentally.

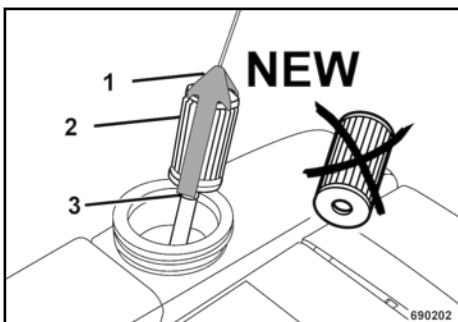


Fig. 76

Open the quick lock on the tank.

Pull the holder (1) ↗ Fig. 76 with the fuel filter (2) by the cord out of the tank.

Pull the fuel hose (3) off the fuel filter

Push the fuel filter out of the holder.

Maintenance – Annual maintenance

Push the new fuel filter into the holder.

Push the fuel hose onto the new fuel filter.



NOTICE!

Do not insert the hose into the tank without a filter.
Danger of contamination!

Insert the holder with the fuel filter into the tank and attach the quick lock.



The fuel system is self bleeding.

6.10.3 Checking, greasing and tightening the chain

Checking, greasing the chain

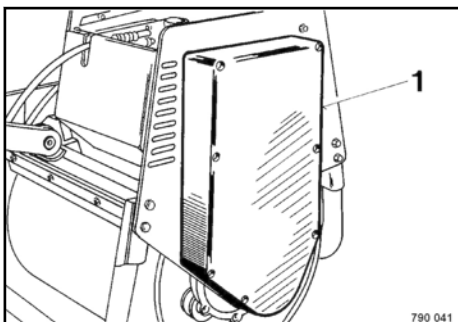


Fig. 77

Remove the guard (1) ↪ Fig. 77.

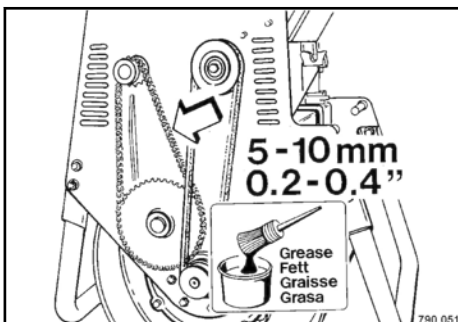


Fig. 78

Check the condition and tightness of the chain ↪ Fig. 78.

Compression measurement at the longest free section: 5 to 10 mm

To grease the chain remove all old grease and apply new grease.

For quantity of grease refer to the table of fuels and lubricants.

Install the guard.

Tightening the chain

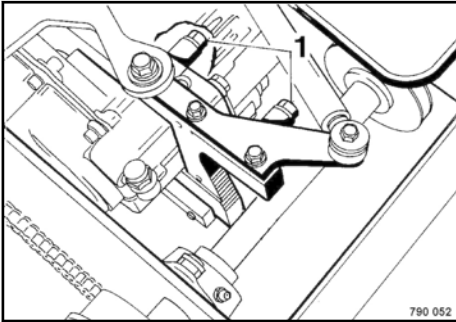


Fig. 79

Remove the guard

Loosen the transmission fastening screws (1) ↪ Fig. 79.

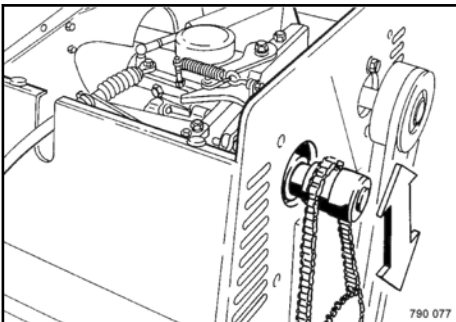


Fig. 80

Displace the transmission ↪ Fig. 80, until the chain has the correct tension; at the same time tighten the transmission fastening screws (1) ↪ Fig. 79.

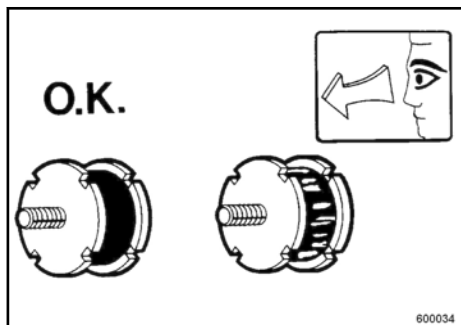
Install the guard.



NOTICE!

After tensioning the chain you must also check the tension of the travel system V-belt, see section "Checking, tightening, replacing the travel system V-belt".

6.10.4 Check the rubber buffers



Check all rubber buffers ↪ Fig. 81 for tight fit, cracks and damage and replace immediately if damaged.

Fig. 81

6.11 As required

6.11.1 Water sprinkler system, maintenance in the event of frost



NOTICE!

If there is a risk of frost the water sprinkler system must be emptied or filled with an anti-freeze mixture.



The water tank can be taken off.

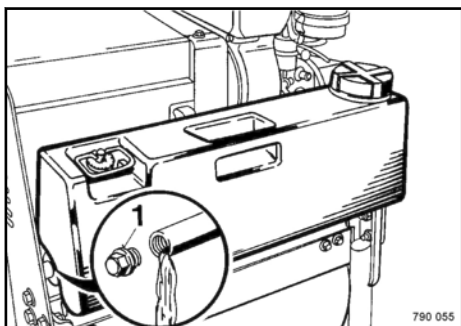


Fig. 82

Empty the water tank, remove the plastic plug (1) ↪ Fig. 82 for this purpose.

Push the plastic plug back on.

6.11.2 Adjusting the Scrapers

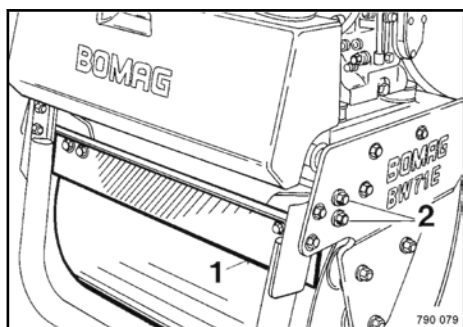


Fig. 83

Loosen the fixing screws 2 ↪ Fig. 83.

Adjust the scraper (1) so that it touches the drum lightly (light bending of the plastic material).

Tighten the fixing screws.

6.11.3 Cleaning, greasing the control unit

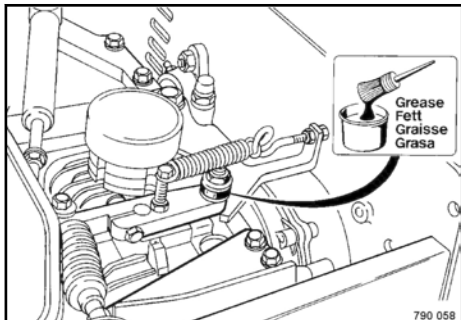


Fig. 84

Clean and grease the control unit ↪ Fig. 84.

For quantity of grease refer to the table of fuels and lubricants.

6.11.4 Tightening Torques for Screws with Metric Unified Thread

Bolt dimensions	Tightening torques* ft - lb		
	8.8	10.9	12.9
M4	2	3	4
M5	4	7	7
M6	7	11	13
M8	18	26	33
M10	37	55	61
M12	65	91	108
M14	101	145	173
M16	156	221	264
M18	213	303	361
M20	304	426	513
M22	413	559	695
M24	524	738	885
M27	774	1092	1308
M30	1047	1482	1770

Fig. 85

* Strength classes for screws with untreated, non-lubricated surfaces. The screw quality is marked on the screw heads:

8.8 = 8 G 10.9 = 10 K 12.9 = 12 K

The values result in a 90% utilization of the screw's yielding point at a coefficient of friction of $\mu_{total} = 0.14$.

The tightening torques are controlled by means of torque wrenches.

The indicated tightening torques do not apply when using an MoS₂ lubricant.



Self locking nuts must always be replaced by new ones after they have been unscrewed.

6.11.5 Conserving the Engine

We recommend the following preserving measures for the engine in order to avoid corrosion, if the machine is to be shut-down for a longer period of time (e.g. over winter).

Clean the engine including the cooling system: With a cold cleansing agent and a water jet, or, even better, with a steam cleaner.

Run the engine to warm it up and shut it down.

Drain the still warm engine oil and fill in anticorrosion engine oil.

If necessary pour the oil out of the oil bath air filter, clean the filter bowl and fill it with anticorrosion oil.

Drain the fuel from the fuel tank, mix it well with 10% anticorrosion oil and fill it back in. Instead of mixing anticorrosion oil with the fuel it is also possible to fill the fuel tank with injection pump testing oil with anticorrosive properties (e.g. Calibration Fluid B).

Run the engine for 10 minutes, so that lines, filter, pump and nozzles are filled with the preserving mixture and the engine oil is distributed to all parts.

After this run remove the valve cover and spray the rocker chamber with a mixture of diesel fuel and 10% anticorrosion oil. Reinstall the valve cover.

Crank the engine several times in order to spray the combustion chamber (knob in "STOP"-position, decompression lever in position "I").

Take the V-belt off and spray the groove of the V-belt pulley with anticorrosion oil. The oil must be removed before restarting the engine.

Close all exhaust and air intake openings thoroughly.



Depending on weather conditions these conserving measures will provide protection for approx. 6 - 12 months.

The conserving oil must be replaced by engine oil according to the API- (MIL) classification before taking the machine into service.

Anti-corrosion oils are those that comply with the MIL-L-21260 or TL 9150-037/2 resp. Nato Code C 640/642.



NOTICE!

A machine with conserved engine must be clearly marked by attaching a clear warning tag.

7.1 General notes

Please observe strictly the safety regulations in the corresponding section of these operating and maintenance instructions.

Malfunctions are frequently caused by incorrect operation of the machine or insufficient maintenance. Whenever a fault occurs you should therefore thoroughly read these instruction on correct operation and maintenance.

If you cannot locate the cause of a fault or rectify it yourself by following the trouble shooting chart, you should contact our customer service department.

7.2 Starting with jump wires

i Use this starting procedure if the starter battery is discharged.

Fold the cover back from the battery.

! **NOTICE!**
A wrong connection will cause severe damage in the electric system.
The auxiliary battery must have the same voltage as the starter battery.

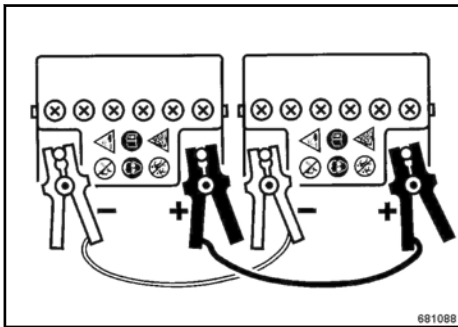


Fig. 86

Join the plus poles on external battery and starter battery with the jump wire ↪ Fig. 86.

Use the second jump start cable to connect the negative poles on external battery and starter battery.

Start the engine as described in the chapter “Starting the engine”.

When the engine is running remove the jump start cable from the two negative poles first and from the positive poles after.

i This work sequence is necessary to avoid short circuit caused by contact between positive and negative cables.

Close the cover.

7.3 Moving the Machine in Case of an Engine Failure

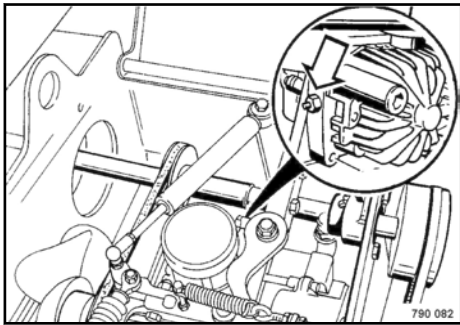



Fig. 87

Push the by-pass valve  Fig. 87 in and move the machine.

7.4 Changing the injection pump



WARNING!
Fire hazard!

When working on the fuel system do not use open fire, do not smoke, do not spill any fuel.



WARNING!
Health hazard!

Do not inhale any fuel fumes.



NOTICE!

Ensure strict cleanliness to keep dirt out of the fuel lines. Dirt particles can destroy the injection system.



ENVIRONMENT!

Catch running out fuel, do not let it seep into the ground.

Disassembly

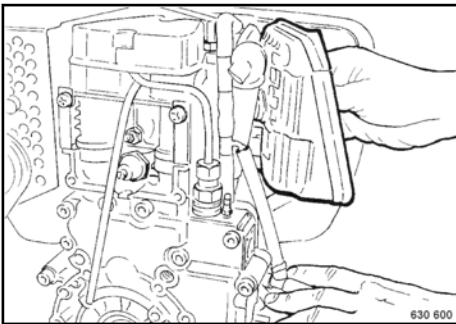


Fig. 88

Remove the air filter console ↪ Fig. 88.

Trouble shooting – Changing the injection pump

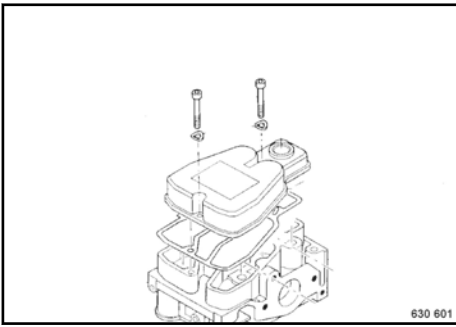


Fig. 89

Remove the valve cover ↪ Fig. 89.

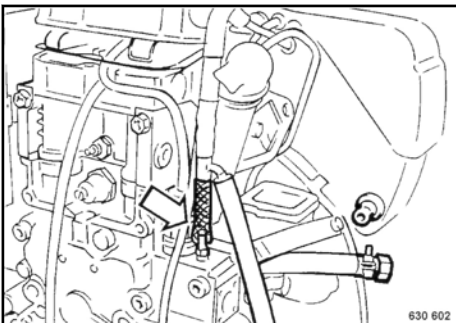


Fig. 90

Pull the fuel hose off the leak oil socket on the pump
↪ Fig. 90.

Place a suitable container under the hose socket to catch
running out fuel.

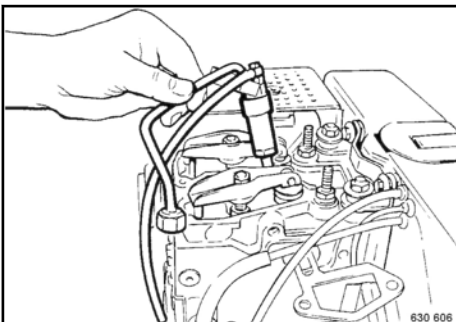


Fig. 91

Remove the injection nozzles ↪ Fig. 91 completely with the
nozzle base.

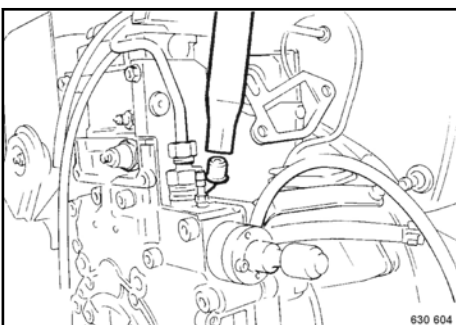


Fig. 92

Disassemble the crankcase ventilation grommet ↪ Fig. 92.

Trouble shooting – Changing the injection pump

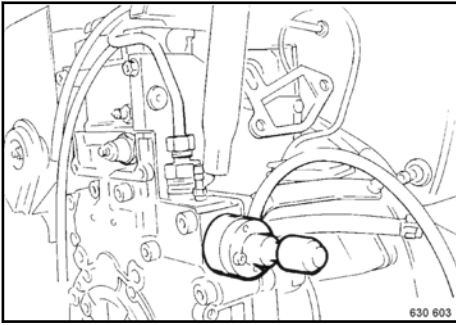


Fig. 93

Unscrew the oil shut-off valve ↪ Fig. 93.

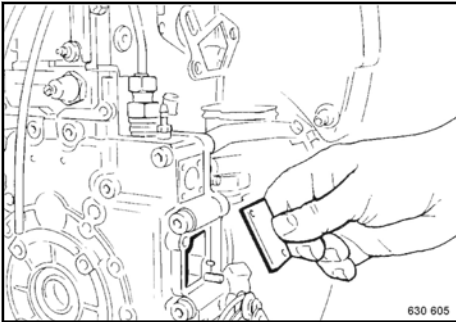


Fig. 94

Remove the cover plate ↪ Fig. 94.

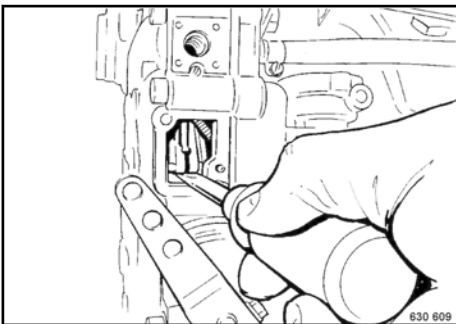


Fig. 95

Unhook pump piston ↪ Fig. 95 from the rocker arm to the injection pump.

Trouble shooting – Changing the injection pump

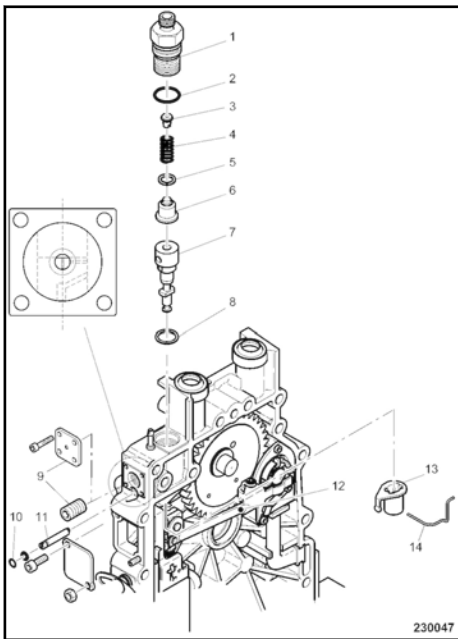


Fig. 96

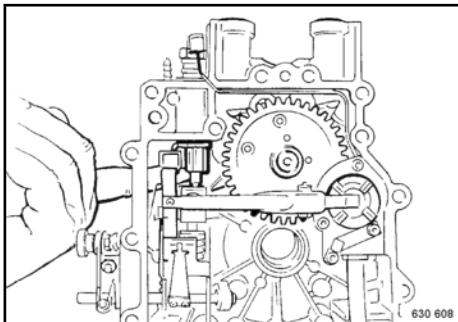


Fig. 97

Inspection / repair

Unscrew the pressure valve holder (1) ↪ Fig. 96 with O-ring (2).

Remove filling piece (3), spring (4), seal ring (5) and pressure valve (6).

Press the pump element ↪ Fig. 97 through the lateral opening up with your fingers and lift it out with a magnetic rod.

Remove shim (8) ↪ Fig. 96.



The control bushing (13) ↪ Fig. 96 is located by the bracket (14) and does not need to be removed.

Check the pump piston for light movement over the entire control range.

Replace damaged or worn parts.

Assembly

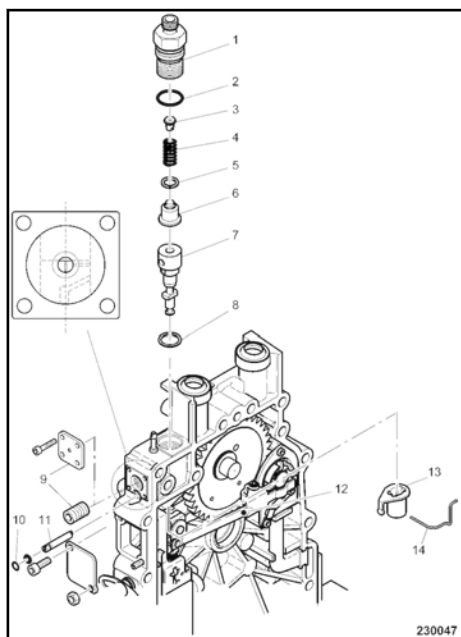


Fig. 98

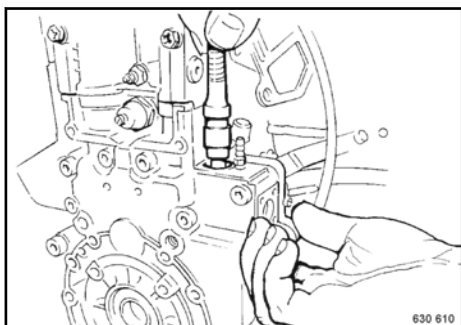


Fig. 99

Assemble shim (8) ↪ Fig. 98.

Insert the pump element ↪ Fig. 99, observe correct positioning of the suction hole (tapered bore) ↪ Fig. 98 and element flag (the number with 400 or 4 belongs to the side that should be opposite the suction hole).

When inserting the element group make sure that the plunger flag also is inserted through the control sleeve (is achieved by turning the regulating sleeve slightly to and fro) and that the eccentric peg (11) also engages in the groove of the element cylinder ↪ Fig. 98.

Hook the pump piston to the rocker arm to the injection pump.

Assemble parts (6...1), tighten pressure valve holder (1) only slightly (approx. 10 Nm).

Turn the throttle lever completely to the right and lock it.

Lift the pump piston by approx. 2 mm.

Now check the position of the starting slot to the suction bore (visible through the bore the plug is screwed into).

Trouble shooting – Changing the injection pump

The starting slot must be arranged centrally to the suction bore, or may be maximum one slot width offset to the left. If this is not the case lift flap (10) with a scriber and correct the position by turning the eccentric (11) accordingly.

If this places the suction bore too far out of centre, the deflection lever (12) is damaged and needs to be replaced.

Tighten the pressure valve holder with the following torque: 30 - 0 - 30 - 0 - 35 ± 2 Nm (tighten - loosen - tighten ...).

Complete the engine.

7.5 Engine problems

Fault description	Cause	Remedy
No or poor starting of engine	Fuel tank empty	Fill in fuel
	No fuel at the injection pump, supply not correct, fuel filter clogged (can be notice if no fuel runs out when the fuel supply line is pulled off)	Check the fuel supply Check the fuel supply line to the engine Check the fuel filter, replace if necessary
	Injection nozzle out of order	Have examined by a specialist
Engine does not start or starts poorly (at low temperatures)	Paraffin separation in the fuel	Check the fuel, if necessary drain the fuel tank and fill in winter fuel
	Insufficiently charged battery	Have examined by a specialist
Engine difficult to crank	Oil with too high viscosity	Drain off oil and fill in oil of correct viscosity
Engine has no compression	Incorrect valve clearance	Have examined by a specialist
	Engine defective	Have examined by a specialist
Engine loses power and speed	Fuel tank empty	Fill in fuel
	Throttle lever does not stay in selected position	Block the throttle control
	Fuel filter clogged	Replace the fuel filter
	Tank ventilation blocked	Check the tank ventilation
Engine loses power and speed, black exhaust smoke	Air filter clogged	Clean the air filter, replace if necessary
	Incorrect valve clearance	Have examined by a specialist
	Injection nozzle defective	Have examined by a specialist
Engine overheating	Lack of cooling air	Clean cooling air inlet and cooling fins
	Function of injection system not correct	Have examined by a specialist
	Too much oil in crankcase	Drain the oil down to the MAX-mark on the dipstick
Engine stops	Fuel tank empty	Fill in fuel
	Fuel filter clogged	Check the fuel filter, replace if necessary
	Tank ventilation blocked	Check the tank ventilation
	Air in the fuel system	Check the fuel system for air Check the bleeding valve
Engine runs with high speed, but no vibration	V-belt	Check the tension, if necessary replace the V-belt

Disposal – Final shut-down of machine

8.1 Final shut-down of machine

If the machine can no longer be used and needs to be finally shut down you must carry out the following work and have the machine disassembled by an officially recognized specialist workshop.



WARNING!

Danger of cauterisation ! Danger of explosion!

When working on the battery do not use open fire, do not smoke!

The battery contains acid. Do not let acid come in contact with skin or clothes!

Wear protective clothing!

Remove the batteries and dispose of in compliance with legal regulations.



ENVIRONMENT!

Catch all fuels and lubricants, do not let them seep into the ground and dispose of in compliance with legal regulations.

Empty the fuel tank.

Drain the lubrication oil from the engine.

Drain off the gear oil.



WARNING!

Danger of explosion!

Parts that previously contained combustible fluids must not be cut with a cutting torch.

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