A6474X235
June 2012

Operation Manual

SU488 L and SU488 Scoop

A6474X235 (Operation)

2 Your safety

maintenance, repair

Only persons who have and can demonstrate a special knowledge of hydraulics are allowed to work on the hydraulic system.

Avoid, whenever possible, servicing, cleaning or examining the machine in congested areas.

Avoid, whenever possible, servicing or providing maintenance to the unit unless the wheels are chocked and steering lockout device is connected to prevent accidental movement of the unit.

Do not alter the electrical or hydraulic settings from that indicated in this manual or as set at the factory.

Always replace damaged or lost decals and metal instruction plates.

Disconnect the battery when working with the electrical system, or when welding on the unit to prevent electrical shock.

Be sure the battery area is well ventilated (clear of fumes) when it is necessary to connect battery charger. Fumes from the battery could ignite from a spark and explode.

Always follow all safety procedures of each particular mine when performing maintenance.

It is important that any procedure not specifically recommended in this guide be thoroughly evaluated from the standpoint of safety before it is implemented.

Some illustrations in this manual show guards or cover panels removed for purposes of clarity. Never operate unit without guards or cover panels in place.

Carry out a visual inspection of all the hydraulic components at regular intervals. In particular check that:

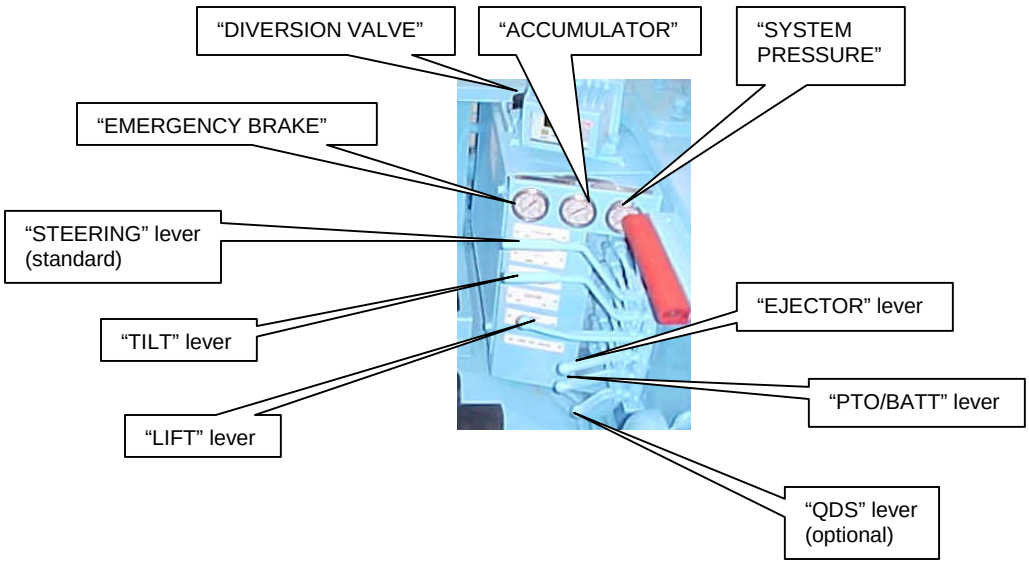
- the hoses are not pinched or trapped,
- the hoses have no bubbles or blisters,
- the hose or outer sheathes of the hose are not abnormally rigid or hard,
- the outer sheath of the hoses is not damaged,
- the connectors are securely inserted into the sockets, and
- the connections are leak-tight.

Ensure that no dirt enters the hydraulic system during repair work. Dirt in the hydraulic system can cause serious damage in the whole system! Flush out the hydraulic lines thoroughly before connecting.

4 Installation

5 Operation

Fig. 14: Hydraulic control system (with vertical lift and/or QDS)



Hydraulic control panel (with vertical lift and/or QDS)

The hydraulic control panel (Fig. 14), located to the left of the operator, has a group of switches that control the following:

IMPORTANT!
For more detailed control handle operating instructions, see Starting procedures in this chapter.

"STEERING"

The "STEERING" control lever is used to steer the machine. To steer left while moving forward (right when moving in reverse), push the steering control lever slowly away from the operator. To turn right while moving forward (left when moving in reverse), pull the steering control lever slowly toward the operator.

"TILT"

The "TILT" control lever is used to control the forks and/or the quick attach bucket. This control lever allows the operator to tilt the forks or bucket either forward or back. To tilt the attachment down, push the lever away from the operator. To tilt the attachment up, pull the lever towards the operator.

"LIFT"

The "LIFT" control lever is used to raise or lower the forks and/or the quick attach bucket. To lower the attachment, push the lever away from the operator. To raise the attachment, pull the lever towards the operator.

Starting procedure with control handle

After reading the previous descriptions and locating each control, the operator is ready to operate the machine. An experienced operator should monitor a new operator's indoctrination to the starting procedure.

CAUTION!
Use caution when traveling down grade, exceeding 5 mph (8 kph) with this machine will result in tram motor failure.

WARNING!
Check the battery connections and the battery covers. They must be in place and locked to be permissible.

WARNING!
Never operate any levers or pedals from outside the operator's compartment. All switches in the operator's compartment must be in the "OFF" position before the battery circuit breaker is moved to the "ON" position.

WARNING!
This unit is equipped with a cab or canopy. Be careful not to hit your head when entering or leaving the operator's compartment. This machine must not be operated without the canopy in place.

General

☞ 1. Disconnect the steering lockout device (Fig. 25).

☞ 2. Sit in the operator's seat and adjust the seat position relative to the foot and hand controls.

WARNING!
Be sure no one is in the Hazard zone (Fig. 23) before operating any levers or pedals.

Never try to adjust the operator's seat while the machine is in motion.

Do not operate the machine with any part of your body outside the operator's compartment to prevent having body parts caught between the unit and outside objects.

☞ 3. The tape panic strip (s) may be pressed at any time to trip the machine circuit breaker, set the park brake, and to de-energize the tram and pump motors.

☞ 4. Stop button "J3" may be pressed at any time to set the park brake, and to de-energize the tram and pump motors (Fig. 24).

Towing a disabled machine

WARNING!
It is not possible, within the scope of this guide, to anticipate all possible arrangements for towing a disabled vehicle, you must take all possible precautions to protect the operators and anyone around both vehicles from being injured by either the towing vehicle, the towing device used (cables, bars, etc.) and the towing vehicle (scoop, tractor, etc.) must be strong and heavy enough to maintain control of both vehicles through all bottom conditions to be encountered at all times. Safety chains or other safety devices must be used in case of failure of the primary towing device. All operators must be alert at all times to prevent either unit from running away or running out of control during towing. The vehicle to be towed must be securely coupled to the towing vehicle before the brakes are released on the disabled unit. The operator of the towing vehicle must be in place in the towing vehicle with the brakes applied before the brakes of the disabled vehicle are released.

- ☞ Couple the towing vehicle securely to the disabled vehicle.
- ☞ Close the valve to tank circuit that is on the hand pump to isolate the park brake solenoid from the circuit.
- ☞ Begin pumping the hand pump. The building pressure moves the shuttle valve and allows the Automatic (Park) Brake system to be pressurized.
- ☞ The Automatic (Park) Brake is released as indicated by the Brake Release gauge.

CAUTION!
For long distance towing, disconnect and remove front and rear drive lines.

WARNING!
At no time during towing should anyone ride in or on the vehicle being towed or stand in between the towing vehicle and the disabled vehicle.

- ☞ Begin towing the vehicle.
- ☞ Once the destination is reached, stop both vehicles and set the parking brake on the disabled vehicle before removing the towing devices. The disabled vehicle should be choked in both direction at all four wheels for additional stability. The brake is set by turning the valve handle on the hand pump to “NORMAL RE-APPLY”.

WARNING!
Failure to set the parking brake on the disabled vehicle before removing the towing device could allow the disabled vehicle to roll away uncontrolled.

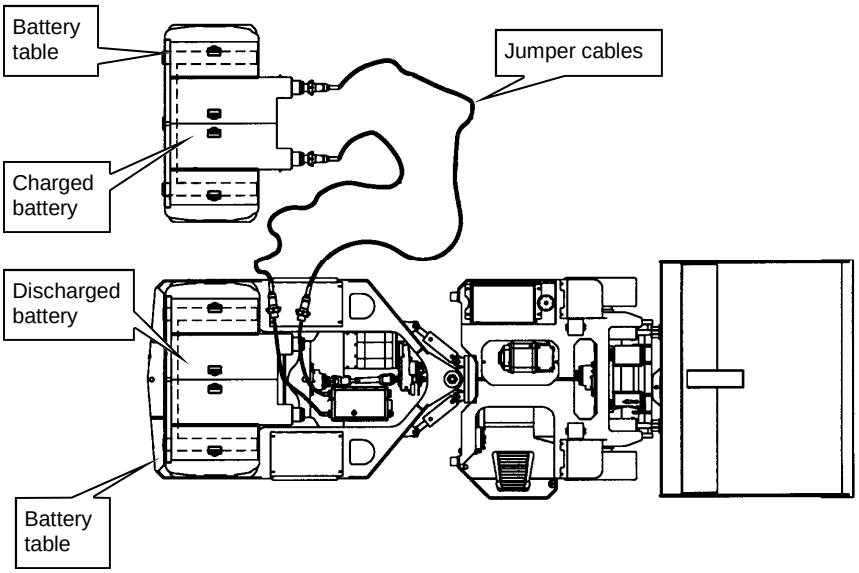
☞ Connect the jumper cable:

☞ Connect the receptacle end of the jumper cable to the machine and connect the plug end of the jumper cable to the fully charged battery (Fig. 39).

☞ Secure the jumper cable connections by using the threaded lock rings. These lock rings must be hand tight but do not have to be padlocked. One person should hold the jumper cable so it will not be damaged or run over when the machine is moved.

☞ Start the machine (see Starting procedure in this chapter).

Fig. 39: Battery change procedure (vertical lift)



Specific lubrication and maintenance procedures

Every shift

electrical cables and conduits
hydraulic hoses and fittings
tires and headlights

Inspect all electrical cables, conduits, hydraulic hoses, fittings, tires, and headlights for signs of wear or damage. Repair or replace any damaged item.

warning tags and reflectors

Visually inspect the condition and readability of all warning tags, labels, and reflectors. Replace all that are found missing or damaged.

tape switches (panic bars)

Check the tape switches (panic bars) located inside the operator's compartment (Fig. 46). Start the machine but do not tram. Strike the tape switch: the machine circuit breaker should trip and the machine should shut down. Repeat with the other tape switch.

Fig. 46: Tape switch (panic strip) location

hydraulic oil level

Check the hydraulic oil level by looking at the sight glass located on the oil tank (Fig. 47). If the oil level is low, add oil:
(Spec. 100-1, if equipped with John Deere or Axle Tech axles)
(Spec. 100-12, if equipped with Kessler axles)

Fig. 47: Hydraulic oil level

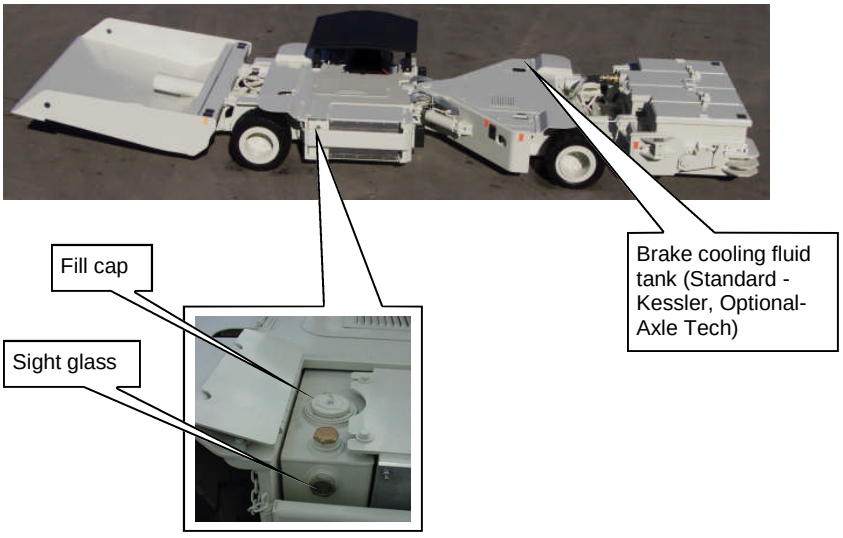
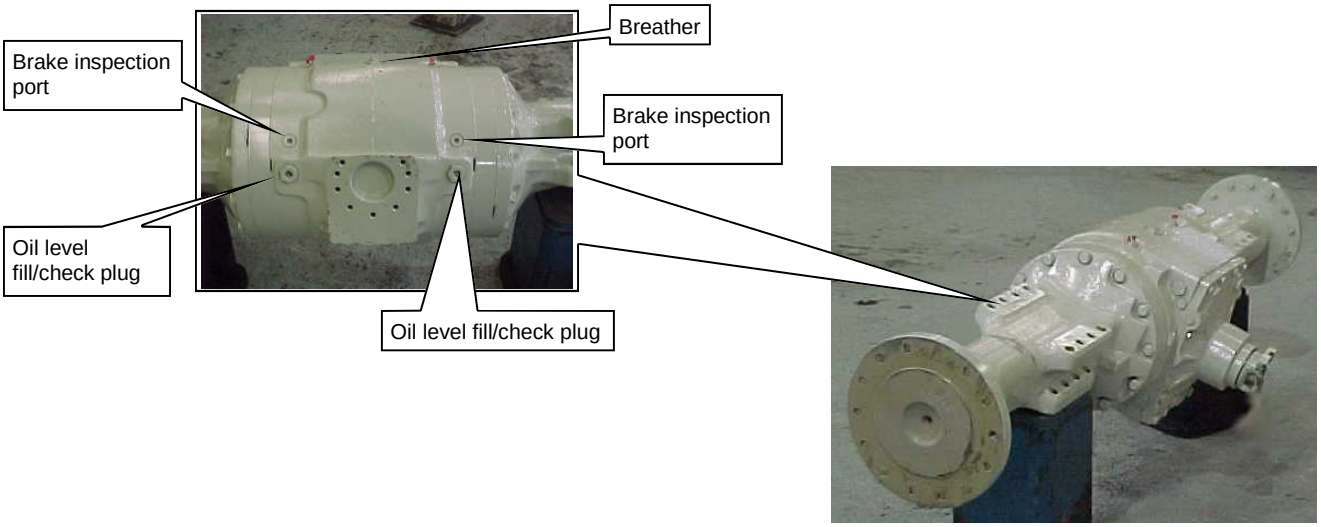


Fig. 64: Axle oil level (John Deere)

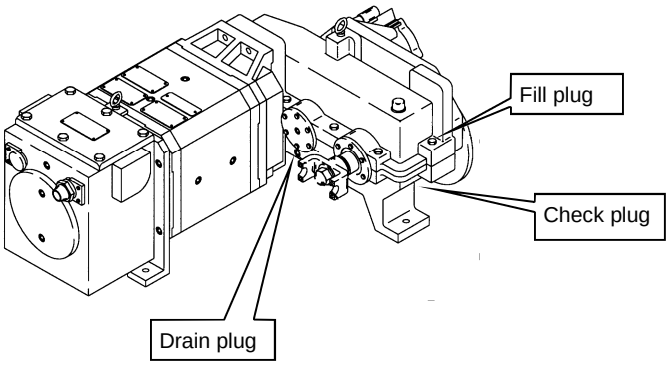


speed reducer (gear case) oil

Check the oil in both speed reducers (Fig. 65).

- ☞ Park the machine on solid level ground.
- ☞ Remove the check plug from the speed reducer (gearbox). The oil level should be kept at the level of the check plug.
- ☞ Should it be necessary to add oil, add the oil (Spec. 100-6) through the fill plug hole slowly until oil flows from the check plug hole. Do not overfill speed reducer.
- ☞ Replaced the check and fill plugs.

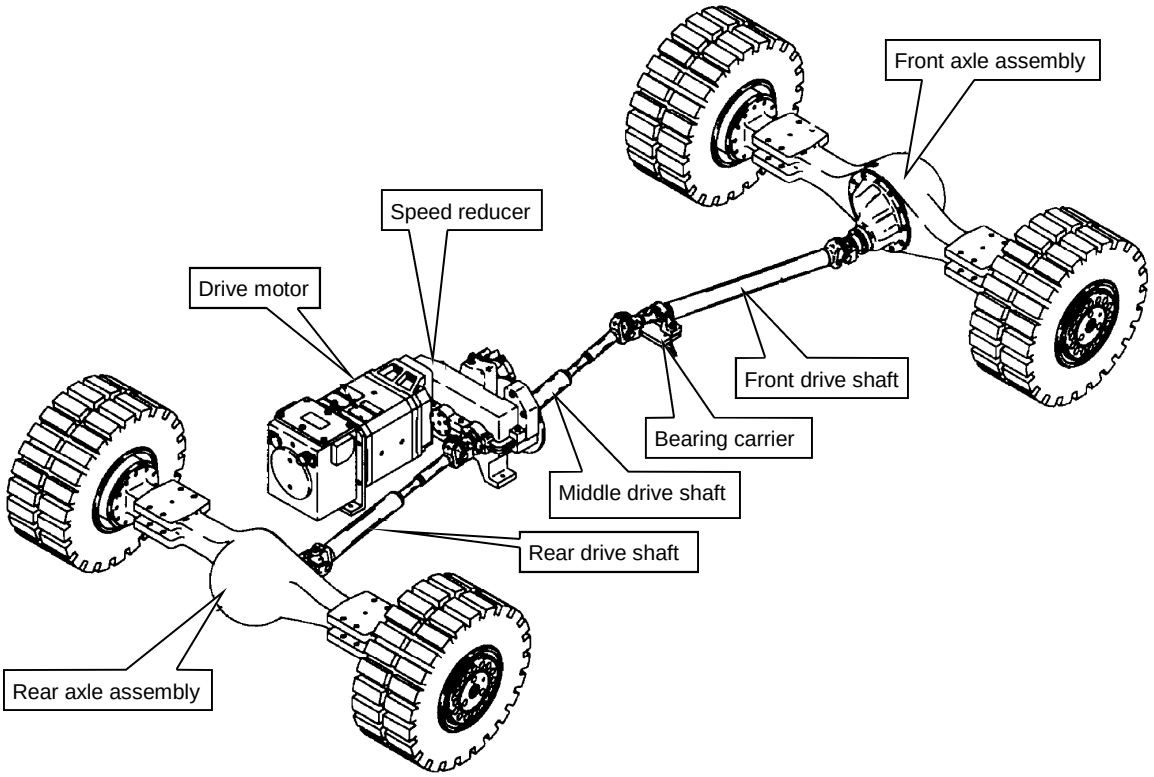
Fig. 65: Speed reducer (gear case) oil



Drive motor/gearbox (speed reducer) removal and replacement

WARNING!
Power must be removed by unplugging the battery plugs before servicing the motor.

Fig. 77: Drive train components



The following procedures reference Fig. 77.

Drive motor

- ☞ Remove the motor inspection cover and disconnect the power cables to the motor. Unpack the motor gland and completely remove the wiring and conduit from the motor.
- ☞ Attach a crane or hoist, capable of lifting the motor, to the eyebolt on top of the motor and take up any slack in hoist chain.
- ☞ Remove the four (4) bolts that attach the motor to the gearbox.
- ☞ Lift the motor out of the unit.
- ☞ Cover the reducer opening to prevent foreign matter from entering the gearbox.

Brakes

Table 6: Brakes troubleshooting

Trouble, symptom or cause	Probable cause	Test, check and/or remedy
brakes slow to apply	☞ No gas charge in accumulator.	☞ Check gas charge.
	☞ Defective brakes.	☞ Check brakes.
	☞ Hydraulic lines or fittings leaking.	☞ Check for leaks and repair.
	☞ Pedal linkage out of adjustment.	☞ Adjust linkage.
	☞ Damaged hydraulic brake lines.	☞ Check lines for dents that restrict flow of oil.
brakes won't release	☞ Pedal linkage out of adjustment or binding.	☞ Check for proper adjustment and binding.
	☞ Defective brakes.	☞ Check brakes .
	☞ Defective brake valve.	☞ Replace brake valve.
insufficient brakes	☞ No oil or low level in tank.	☞ Check oil level in tank.
	☞ Pedal linkage out of adjustment.	☞ Adjust linkage.
	☞ Brake line mashed.	☞ Check lines and replace.
	☞ No gas charge in accumulator.	☞ Check gas charge.
	☞ Defective brakes.	☞ Check brakes.
	☞ Brake valve defective.	☞ Replace valve.
brakes will not release completely	☞ Defective brakes.	☞ Check brakes.
	☞ Pedal linkage out of adjustment.	☞ Adjust pedal linkage.
	☞ Air in brakes.	☞ Bleed brakes.
	☞ Defective brake valve.	☞ Replace brake valve.
	☞ Back pressure on return line too high.	☞ Remove restriction.
excessive braking	☞ Defective brakes.	☞ Check brakes.
	☞ Defective brake valve.	☞ Replace brake valve.

Tightening torques

IMPORTANT!
Due to the application of fasteners being subject to great stresses and heavy or extreme vibration, it is imperative that all bolts be applied with an adequate amount of torque. For this reason this list of recommended torque settings for different types and sizes of fasteners used has been compiled.
The tightening torques stated in the spare parts lists have to be observed, as well, for installation and maintenance.

Set screws

Table 10: Set screws (Socket long-lok)

Nominal diameter	Recommended torque setting
#6	6 in-lbs
#8	9 in-lbs
#10	13 in-lbs
¼”	30 in-lbs
5/16”	5 ft-lbs
3/8”	8 ft-lbs
7/16”	11 ft-lbs
½”	16.7 ft-lbs

Table 11: Set screws (Socket standard steel)

Nominal diameter	Recommended torque setting
#6	9 in-lbs
#8	16 in-lbs
#10	30 in-lbs
¼”	6 ft-lbs
5/16”	12 ft-lbs
3/8”	18 ft-lbs
7/16”	29 ft-lbs
½”	43 ft-lbs
5/8”	100 ft-lbs
¾”	146 ft-lbs
7/8”	199 ft-lbs
1”	262 ft-lbs

Table 22: Invert emulsion hydraulic fluid (Spec. 100-5)

	Supplier	Brand name
1	Unocal 76	FR Fluid
2	Conoco Inc.	FR Hydraulic Fluid
3	Atlantic Richfield Company	Duro FR-HD
4	Brooks Oil Company	Brooks Fire Resistant Hydraulic Fluid B
5	Cincinnati – Vulcon Company	Vulcon FR Fluid #1
6	Cities Service Oil Company	Citgo Pacemaker Invert FR Fluid
7	Century Oils Limited	Aquacent Light
8	Fiske Bros. Refining Company	Lubriplate HO-Retard
9	Getty Oil Company (Veedol, Tidewater)	Veedol Auburn FRH
10	Gulf Oil Company	FR Fluid
11	E.F. Houghton	Houghto-Safe 5046 Houghto-Safe 5046W
12	Century Lubricating Oils	Hulsafe 600
13	Imperial Oil and Grease	Astrol 587
14	Mobil Oil Corporation	Pyrogard D
15	National Oil and Chemical Co.	Erifon 1, 2, and 3
16	Pennzoil	Maxmul FRP/G
17	Quaker Chemical Company	Quintolubric 958 Series Quintolubric 958 Series
18	Henery E. Sanson and Sons MFGE Company	Hydra-Mul Premium Emulsion Fluid
19	Southwest Grease and Oil Company, Inc.	Invert Emulsion Fire Resistant Hydraulic Fluid
20	Southwest Petroleum Corp.	Swepco Fire Resistant Hydraulic oil #718
21	Standard Oil Company of Ohio (Boron Sohio)	Staysol FR
22	Sun Oil Company	Sunsafe F
23	Tower Oil Company	Safoil Anti-Wear Hydraulic Fluid
24	Wynn Oil Company	Hydra-Safe Heavy Medium
25	Lubrication Engineers	6455 Monolec Fire Resistant Hydraulic Fluid
26	Hydrotex	HY-Guard

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March 2012

Operation and Troubleshooting Manual

Model BUC2000
Dual and Single Motor Solid State Controller

2 Your safety

Operation

This chapter contains important information on the operation and troubleshooting of the model BUC2000 Dual and Single Motor Controller.

Read this chapter carefully and thoroughly. In particular, observe the safety instructions in Chapter 2 “Your safety”.

History

In the early 1970's, the introduction of solid state speed controls for battery-powered underground mining equipment led the way in mining innovation. Solid state controls increased the range and reliability of the battery powered vehicles along with providing smooth, stepless acceleration. Even with solid state speed control, direction change was achieved with the use of electromechanical contactors. These contactors provided an endless source of maintenance problems and consumed excessive amounts of valuable controller-box space. Also, most solid state controllers of the past utilized an electromechanical "bypass" contactor to connect the motor directly to the batteries which caused more contactor problems.

In the 1980’s, contactorless motor controller (X90) was developed to be used exclusively on Cat underground mining equipment. The X90 system used a dual-field motor in combination with SCRs (Silicone Controlled Rectifier) to achieve solid state direction change.

Today, a BUC2000 motor controller has been developed. The BUC2000 system uses IGBTs (Insulated Gate Bipolar Transistors) to achieve motor control and direction change. Unlike an SCR, an IGBT is turned ON and OFF via a gating electronic signal. This eliminated commutating capacitor banks and coils. The microprocessor based BUC2000 Logic Card provides complete motor control and drives both a Diagnostic Dashboard Display along with a hand held Calibrator/ Diagnostic Unit.

The IGBT switch operates so fast that it can connect and disconnect the motor in less than 1/1700 second. This is such a short time period that the dual-field motor does not have time to move. Each time the IGBT switch closes and reopens, the full battery voltage is applied to the motor terminals for about 1/1700 second. This is commonly referred to as a "pulse." (Fig. 1)

The IGBT speed control works by feeding to the motor a rapid series of pulses. The number of pulses per second determines the average voltage at the motor terminals. (Fig. 2)

There is an LED on the logic card which serves as an indicator of the status of the controller. The following diagnostics shall apply:

LED on Controller operational

LED off Power-up fault – check display or calibrator. If all is blank, then replace logic. Check control wiring. possible shorted driver board, UVR, or "W" relay.

1 Flash **Personality CRC EEPROM Error.**
Using the hand-held calibrator, change a password to any number then recycle power – should clear, otherwise replace logic.

2 Flash **Procedure FAULT**
FS1 closed before power on or 2 Directional Fault. Recycle FS1 through neutral to clear.

3 Flash **IGBT permanently low (IGBT Short Circuit FAULT).**
This includes IGBT short circuit or IGBT open circuit. This fault shuts down all modes. Recycle FS1 through neutral to clear.

4 Flash **Motor neither low nor high (Breaker Open FAULT).**
This includes breaker open circuit or IGBT open circuit. This fault shuts down all modes. Recycle FS1 through neutral to clear.

5 Flash **Motor permanently high. (Breaker welded FAULT)**
This includes breaker welded. This fault shuts down all modes. Recycle "KEY" to clear.

6 Flash **Faulty TRACTION accelerator.**
Includes the accelerator greater than 15% at power on and wire-off. If wire-off occurs during active function then the motor speed will set to zero. This fault auto clears.

7 Flash **Battery voltage FAULT.**
This includes battery below a predetermined value. Recycle FS1 through neutral to clear.

8 Flash **Thermal cut-back (Over-Temperature FAULT).**
This includes heat sink temperature above 95° C.

NOTICE!
As temperature rises above 95° C, the controller will limit the current to 300 amps (maximum), regardless of demand.

9 Flash **UVR coil over-current FAULT (Coil short circuit FAULT).**
Cleared with "KEY" recycled.

10 Flash **Brake on FAULT**
Fault will occur when directional and FS1 are energized without releasing brake. Recycle FS1 through neutral to clear.

12 Flash **Current Transducer FAULT.**
Occurs when current output is read during power-up or if no current is read during drive above 50% demand. "KEY" recycle to clear.

15 Flash **Current Transducer FAULT.**
Occurs when current output is read during power-up or if no current is read during drive above 50% demand. "KEY" recycle to clear.

Table 5: Traction test display

Display name	Calibrator display	Range/Notes
“ACCELERATOR PERCENT DEMAND”	“ACCELERATOR x%”	0-100%
“ACCELERATOR VOLTAGE”	“ACCELERATOR xV”	0.0 V-5.0 V
“FORWARD SWITCH”	“FORWARD OPEN”	OPEN/CLOSED
“REVERSE SWITCH”	“REVERSE OPEN”	OPEN/CLOSED
“FS1 SWITCH”	“FS1 OPEN”	OPEN/CLOSED
“CONFIGURATION JUMPER 1”	“CONFIG 1”	OPEN/CLOSED
“CONFIGURATION JUMPER 2”	“CONFIG 2”	OPEN/CLOSED
“BRAKE INPUT”	“BRAKE ON”	OPEN/CLOSED
	“PTA LEVEL”	HIGH/LOW
“CIRCUIT BREAKER INPUT”	“CB AUX SW”	OPEN/CLOSED
	“I MAX SW”	
“SOFTWARE VERSION”	“SOFTWARE X.XXX”	VX.XXX
“DISPLAY STATUS”	“STATUS LOCK (or ROTATE)”	LOCK / ROTATE (ROTATE)
“SELECT DASHBOARD DISPLAY STATUS”	“STATUS #”	0-4 (Battery voltage, pump current, motor current, battery voltage) (0)
“DISPLAY CONTRAST”		0-127 (33)

Table 6: Traction BDI display

Display name	Calibrator display	Range/ Notes	Adjustable with password
“RESET CELL LEVEL”	“RESET xV CELL”	1.85V-2.50V (2.04V)	X
“EMPTY CELL LEVEL”	“EMPTY xV CELL”	1.00V-1.99V (1.70V)	X
“WARNING LEVEL”	“WARNING X%”	0%-90% (20%)	X

Note 1: Values in parentheses are default values.
Note 2: When the last status (Traction test or Traction BDI) is displayed, the display will go back to the first status and scroll through again.

Fig. 24: Calibrator unit

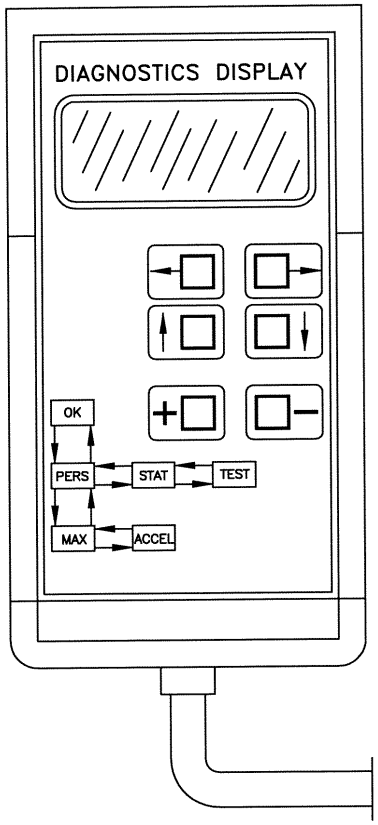
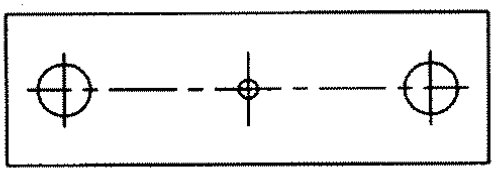


Fig. 25: BUC2000 pump motor shunt



Panel measurements

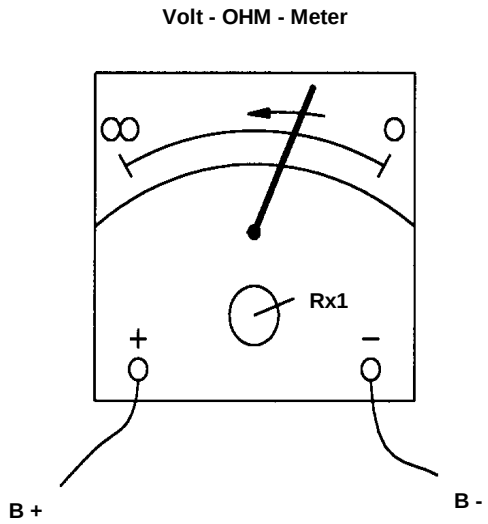
Before taking readings, the meter should be in DC volts (and appropriate range) and the following system conditions must be met:

- All connections attached, and power applied.
- Main circuit breaker on.
- Master switch or control handle in the “PARK” or “PARK BRAKE APPLIED” position.
- Accelerator NOT depressed (FS1 open).

  B+ to B-: Battery Voltage
  B- to AA: Battery Voltage
  B- to S1L, S4L, S1R, & S4R: Battery Voltage

If the breaker is off and the diagnostics button has been pushed, the readings should be:

B+ to B-: > 35 VDC
B- to AA: > 35 VDC
B- to S1L, S4L, S1R, & S4R: > 35 VDC



For your information

Our service

If you need to order spare parts or if technical problems occur, please contact our after-sales service personnel or contact us direct.

Service address

Beckley, WV
200 George Street, Suite 4
Beckley, WV 25801
Phone: (304) 256-5927
Fax: (304) 256-5928

Craig, CO
400 Mack Lane
Craig, CO 81625
Phone: (970) 824-3249
Fax: (970) 824-8851

Duffield, VA
P.O. Box 847
6808 Fraley Avenue
Duffield, VA 24244
Phone:(276) 431-7000
Fax: (276) 431-2464

Houston, PA
2045 West Pike Street
Houston, PA 15342
Phone: (724) 743-1200
Fax: (724) 743-1201

Carrier Mills, IL
9580 State Route 13 West
Carrier Mills, IL 62917
Phone: (618) 982-9000
Fax: (618) 982-9912

Oak Hill, WV
P.O. Box 60
843 Lochgelly Road
Oak Hill, WV 25901
Phone: (304) 469-3302
Fax: (304) 465-0450

Pulaski, VA
4041 Wurno Road
Pulaski, VA 24301
Phone: 540-980-4530
Fax: 540-980-6211

Washington, PA
255 Berry Road
Washington, PA 15301
Phone: (724) 743-1200
Fax: (724) 228-2177

Paonia, CO
P.O. Box 566
719 Second Street
Paonia, CO 81428
Phone: (970) 527-3151
Fax: (970) 527-6846

MAJOR HAZARDS

AREA WHERE HAZARD CAN OCCUR	HAZARD WHAT CAN HAPPEN IF PRECAUTIONS AND SAFEGUARDS ARE NOT OBEYED	SAFEGUARDS HOW TO AVOID THE HAZARD
ELECTRICAL (A.C. Input, Charger, Battery)	Electrical shock could cause irreparable injury or death.	All electrical systems should be maintained by certified electricians. The a.c. input and charger plug should be disconnected before servicing the charger.
	Charging a battery of a size different than that shown on the charger nameplate could cause the battery to burst, or cause damage to the battery or charger.	Chargers should be matched to the size batteries in use at each particular mine.
BATTERY	The battery produces lethal amounts of power whether connected to the machine or charger, or not.	The battery should be maintained by qualified personnel. (Refer to "INSTALLATION, USE, MAINTENANCE, AND REPAIR OF MINE POWER STORAGE BATTERIES," PART NUMBER A6474X26, for complete instructions).
	Battery covers could fall crushing hands or arms.	Be sure cover supports are in place when working on battery.
	Battery hold-down clamps could crush fingers.	Keep fingers away from hold-down clamps.
	Batteries produce explosive gases that could be ignited causing burns or explosions.	Batteries should be well vented before servicing particularly if welding or burning on the battery. Batteries should be maintained by qualified personnel.
	Batteries contain strong acid that could cause severe burns if spilled or splashed on body parts or in the eyes.	Protective clothing, gloves, and eyewear must be worn when working on batteries. Batteries should be maintained by qualified personnel.

RATINGS AND SPECIFICATIONS

Output Ratings

D.C. Voltage

The LA Series Mine Chargers are factory set to finish at approximately 2.5 volts/per cell for lead acid batteries. The chargers are available in 32 cell (64 volt) or 64 cell (128 volt) output.

Output Current

(Refer to table 1).

Regulation

The charge rate is dependent on the state of charge of the battery. Automatic a.c. line voltage compensation regulates the d.c. output and maintains the charging curve.

INPUT CURRENT AND BATTERY CAPACITIES

CHARGER MODEL	APPROX. AC CURRENT DRAW (3-PHASE) 480VAC / 575VAC	BATTERY AMPERE-HOUR CHARGING CAPACITY	OUTPUT RATING
LA5	26 - 22	550	90 AMPS
LA6	32 - 27	680	110 AMPS
LA8	41 - 34	800	140 AMPS
LA10	52 - 44	1050	180 AMPS
LA12	61 - 51	1200	210 AMPS
LA 14	70 - 59	1400	240 AMPS

TABLE 1

Input Ratings

A.C. VOLTAGE

Taps are provided for three phase a.c. input voltages of 480 or 575 Vac with an a.c. input voltage range of +/-10% of nominal.

Input Frequency Range

57 to 63 Hz. (60 HZ nominal).

Input Current & Battery Capacities

(Refer to TABLE 1)

Typical Electrical Specifications

(Refer to TABLE 1)

During shipping, an a.c. wire may rub against the d.c. lugs, terminals, etc. and cause a short. These problems may be eliminated by very carefully inspecting the wiring to make certain the a.c. wires are not touching the d.c. wiring. If no wires are touching, then it is possible that the primary and secondary of the transformer is shorted. Disconnect the secondary of the transformer from the diodes. Measure with ohmmeter from input terminal to one of the isolated secondary leads. If there is an ohmmeter indication, there is an insulation breakdown between primary and secondary windings. The transformer should be replaced.

4. Check the input terminals to ground and check the output terminals ground. If the meter indicates full scale deflection, a wire is touching a metal part of the unit. Look for wires that are near any metal part and inspect for possible breakdown caused by shipping. The heatsink of the diodes and the control unit are insulated from ground through the mounting legs.

Troubleshooting and Replacing Power Silicon Diodes

If a portable multimeter is used, set the switches on "ohms", "d.c.", and " Rx1 " scale.

1. Isolate one end of the diode by disconnecting the wires attached to the nipple (or pigtail) end of the diode (only one end of the diode must be disconnected).
2. Clip one lead of the ohmmeter to the anode lead of the diode. Clip the other ohmmeter lead to the cathode.
3. Note the ohmmeter reading. Then reverse the leads to the diode. Again, note the ohmmeter reading. If the diode is good, the meter will indicate a high resistance in one direction, and a low resistance with the leads reversed. If the diode is shorted, the meter will read full scale, or zero ("O") resistance with the leads in either direction. If the diode is "open", the ohmmeter needle will not indicate or it will show infinite resistance in either direction, indicating an open circuit.
4 All diodes must be checked in the event that more than one diode is defective.
5. If the diode is defective, remove it from the heatsink. Clean and smooth the heatsink surface, then using an electrically conductive grease, apply to the new diode and replace it in the heatsink.

Checking Capacitors

When checking capacitors, be sure all power is turned off and the battery is disconnected. Momentarily short circuit the capacitor leads to assure complete discharge. Connect the meter test leads to the capacitor leads or terminals and observe indicated resistance.

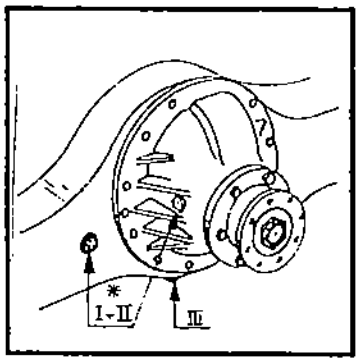
A good capacitor will indicate an initial low resistance and gradually increase as the capacitor charges. The final resistance of a good capacitor is usually several hundred thousand ohms approaching a megohm.

Initial high resistance approaching infinity indicates an open capacitor. Initial and continued low resistance readings indicate a shorted capacitor.

When ordering replacement parts, drawings, or schematics, always give model number, serial number and a.c. input voltage.

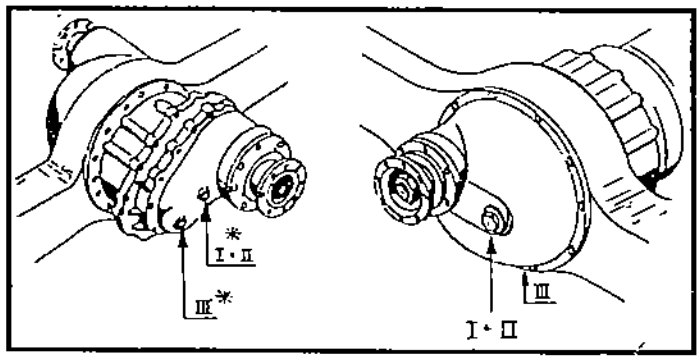
Lubrication points

The binding lubrication points has to be taken from the according installation drawing of the axle .



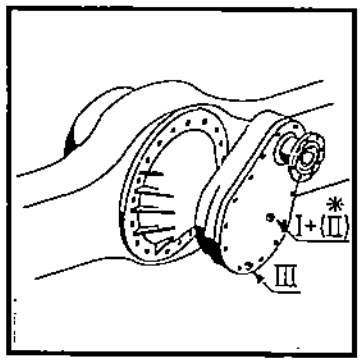
Single drive assembly

* The position is dependent from the respective axle version .



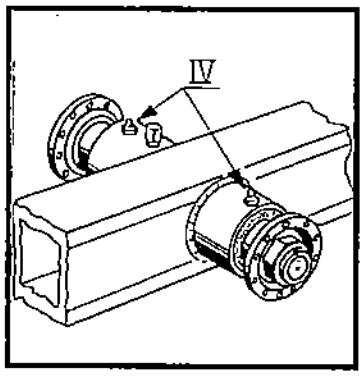
Drive assembly with throughdrive

* Version with interaxle differential
fill 1,5 litre oil at I + II * for first - time filling and for refilling !



Drop gear D 51 / D 108

* II only at version with separately oil space .



Cardan shaft intermediate bearing

I = Oil fitl plug
II = Oil level control plug
III = Oil drain plug
IV = Grease nipple

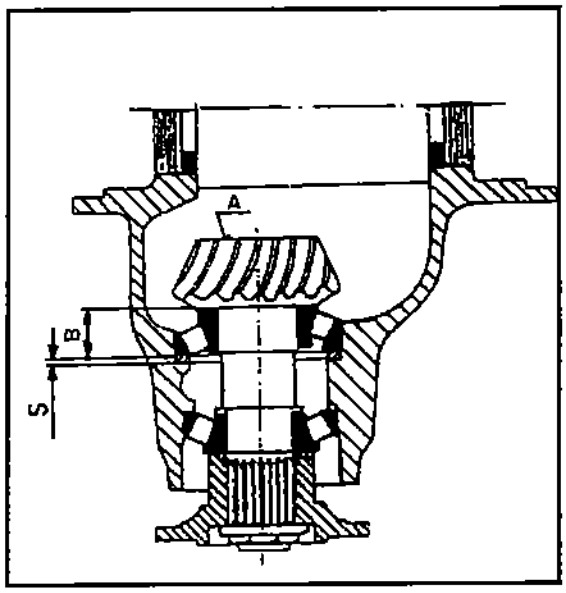
Tightening torques (Nm)

$\mu = 0{,}14$

Metric standard thread						
	Screw	Nut	Screw	Nut	Screw	Nut
Thread	8.8	8	10.9	10	12.9	12
M 4	3,0		4,4		5,1	
M 5	5,9		8,7		10	
M 6	10		15		18	
M 8	25		36		43	
M 10	49		72		84	
M 12	85		125		145	
M 14	135		200		235	
M 16	210		310		365	
M 18	300		430		500	
M 20	425		610		710	
M 22	580		830		970	
M 24	730		1050		1220	
M 27	1100		1550		1800	
M 30	1450		2100		2450	
Metric fine pitch thread						
	Screw	Nut	Screw	Nut	Screw	Nut
Thread	8.8	8	10.9	10	12.9	12
M 8 x 1	27		39		46	
M 10 x 1	55		81		95	
M 10 x 1,25	52		76		90	
M 12 x 1,25	93		135		160	
M 12 x 1,5	89		130		155	
M 14 x 1,5	145		215		255	
M 16 x 1,5	225		330		390	
M 18 x 1,5	340		485		570	
M 20 x 1,5	475		680		790	
M 22 x 1,5	650		920		1050	
Brake caliper dowel screws (greased !)						
M 20 x 1,5	400 + 100					
M 27 x 2	900 + 100					
Nut for steering stop = 300 Nm						

Regard reduced tightening torque for galvanized bolts and nuts !

Adjustment drive pinion distance



To obtain the proper tooth flank contact, adjust the axial position of the drive pinion with the thickness of the adjustment disk. The necessary thickness of the adjustment disk for first time assembly can be obtained by measurement (see calculation example). The final thickness of the adjustment disk can be fixed during the checking of gear meshing at the assembled drive assembly (see page „Adjustment of gear meshing of Gleason gears").

*) A = Set value for correct pinion support. This dimension is written on the end face of the pinion in millimetre. It indicates the deviation from the theoretic distance (setpoint dimension).

**) B = Measured width of the taper roller bearing.

Calculation example to ascertain the thickness S from the adjustment disk :

A = + 0,10 ; B = 37,95

S = 3,00 mm (theor.)
+ 0,05 mm → B = 0,05 mm smaller than B theor.
= 3,05 mm
- 0,10 mm → drive pinion value A
= **2,95 mm** → necessary thickness of the adjustment disk

Fit corresponding disk and outer rings of the taper roller bearings.

*) **Hint :** If value A is positive (f. e. + 0,1) the adjustment disk has to be 0,1 mm thinner than theor. S. If value A is negative (f. e. – 0,1) the adjustment disk has to be 0,1 mm thicker than theor. S.

) **Hint : If measure B is positive (f. e. 38,05) the adjustment disk has to be 0,05 mm thinner than theor. S. If measure B is negative (f. e. 37,95) the adjustment disk has to be 0,05 mm thicker than theor. S.

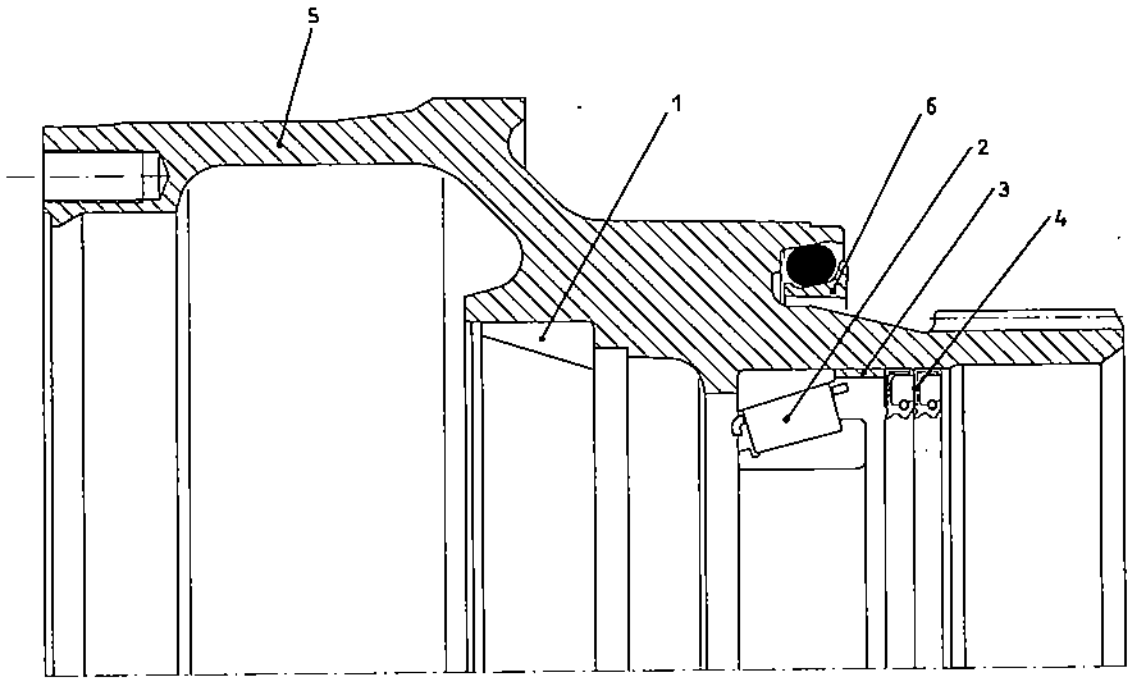
Prepare wheel hub

Press in outer rings of taper roller bearings (1 + 2), do not hammer them.
Install inner ring of taper roller bearing (2).
Install the distance ring (3).
Press the radial seal rings (4) with Loctite 572 (rubber cage) resp. Loctite 270 (steel cage) applied into the wheel hub (5). Fill the radial seal rings with bearing grease.
Install the face seal (6) into the wheel hub (5) (see 5.8).

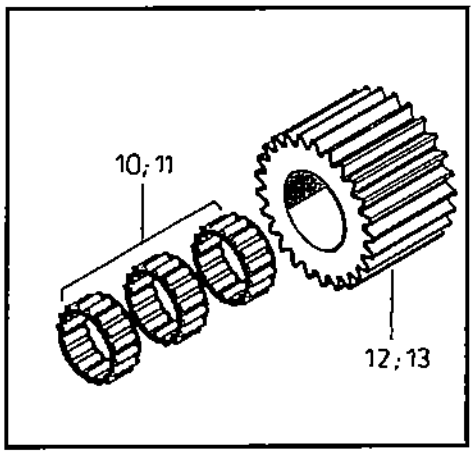
Mount wheel hub

Push the pre - assembled wheel hub (5) parallel onto the axle spindle resp. steering knuckle.

Attention: Be carefully do not damage the radial seal rings (4).

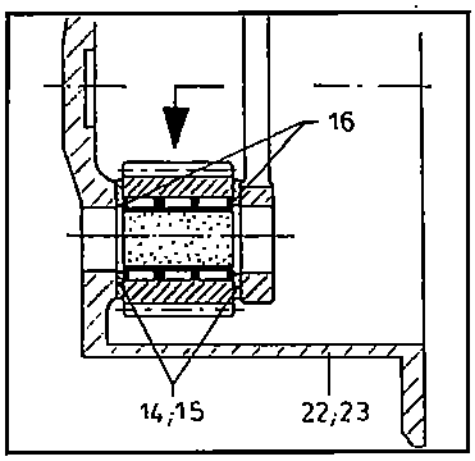


Assembly of planetary gear

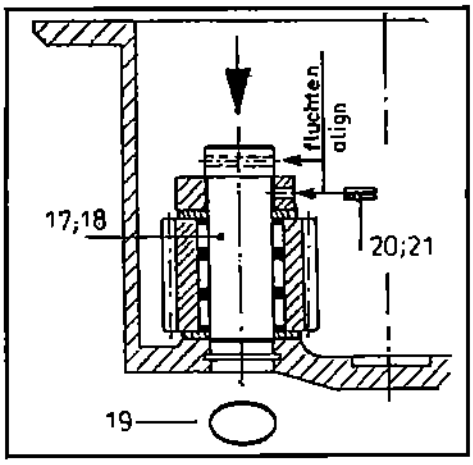


Prepare planetary gear:

Install the needle bearing (10 resp. 11) into the planetary gear (12 resp. 13).



Insert the preassembled planetary gears (12 resp. 13) with needle bearings (10 resp. 11), rings (16) (if present) and thrust disks (14 resp. 15) into the planetary housing (22 resp. 23) (planetary housing in horizontal position).



Place o - ring (19) into the slot of the planetary housing (22). Because of the difference of diameter of 0,1 mm press the planetary pin (17 resp. 18) in direction of arrow. Be sure, that the bore hole of the locking pin in the planetary pin and planetary housing are aligned. After inserting, secure the planetary pin with the locking pin (20 resp. 21).

Finish assembly

- Screw in the bleeder with connection piece and seal ring as well as the screw plugs with seal ring .
- Check brake hydraulic system for leaks (see sheet 7.11.7) .
- **Check the air gap (pressurized) :**

  Measure through the wear inspection hole the distance from the brake carrier to the piston end face , while non actuated brake (piston room pressurized) , actuate the brake (piston room non pressurized) and repeat the measure operation - the difference of the measured distances gives the air gap sL (pressurized) , rated size sL see table .

  Measure through the check hole the distance from brake carrier to the end face , while actuating the brake (piston room non pressurized) and stamp the now ascertained dimension into the brake carrier near by the wear inspection hole .

air gap and wear dimension		
brake type	air gap sL new (pressurized) [mm]	wear dimension [mm]
NLB 4340-FS	1,12 + 1,46	1,6
NLB 7340-FS	3,25 + 0,5 / - 0,5	2,8
NLB 5460-FS	2,4 + 1,0 / - 0,7	2,0
NLB 7460-FS	3 + 0,5 / - 0,1	2,8
NLB 7460-1FS	3 + 0,5 / - 0,1	2,1

  Hint : with increased disk wear and hence it resulting less spring tension the brake torque will be reduced .

- Install o - ring (brake carrier / axle spindle resp. steering knuckle) free of torsion and loops (inapplicable at one-piece design brake carrier) .
- Install the complete brake on the axle (coat the contact surface with Loctite 270) (inapplicable at one-piece design brake carrier) .
- Mount face seal see chapter 5.8 .
- **Centering of the discs :**

  The centering of the inner discs at wet disk brake dimension x340 has to be relized at wheel hub mounting by the wheel hub itself , to this the disc set has to be released by hydraulic pressure .

  The centering of the inner discs at wet disk brake dimension x460 has to be realized by using a center tool (see chapter 3.6) , to this the disc set has to be released by hydraulic pressure .

  After centering clamp the disc set by releasing the hydraulic pressure (spring load effect) .

  Hint : To safe the centering of the disc set in case of disassembly the wheel hub , the hydraulic pressure should be released , so the disc set will be clamped (spring load effect) .

6. Technical data

7. For your information

Your safety

This chapter provides vital information for your safety.
Pay special attention to this chapter. The safety instructions and rules of procedure will help you to avoid hazardous situations and to perform the necessary work as safely as possible.

state of the art

This battery has been manufactured in accordance with the state of the art and generally recognized safety standards and regulations.
You and others can nevertheless be exposed to dangerous situations e.g. as a result of environmental influences or battery damage.

Do not make any alterations or modifications which could impair the safety of the battery. All modifications and changes must be approved.

Use only original spare parts. Note that the use of parts from other manufacturers will void the guarantee.

In addition to this operating manual be sure to also observe the respective legal provisions and regulations in your country.

Observe the safety and accident prevention regulations:

- of the mine,
- of the Mine Inspector, and
- of the mining supervisory authorities.

while handling acids

- **The splashing of acid Into the eyes is the most dangerous condition encountered while handling sulfuric acid or electrolyte.** If this should happen, the eyes should immediately be gently flooded with clean, fresh, running water for at least 15 minutes, followed as quickly as possible with a physician's examination. If the person is wearing contact lenses, they should be removed before rinsing the eyes.

WARNING!
Do not use a buffering or neutralizing agent in the eyes without medical approval.

- Acid or electrolyte splashed onto the skin should be washed off under running water. Battery electrolyte will usually only cause irritation of the skin; if a burn develops, it should be treated medically.

- When electrolyte is splashed on clothing, use a weak solution of bicarbonate of soda, as soon as possible, to neutralize the acid.

- A carboy tilter or safety siphon should be provided for handling acid from a carboy container. Use the protective box when moving a carboy. Store acid in a cool place out of the direct rays of the sun. Use only glass, rubber, lead, or acid-resistant plastic containers when storing acid or electrolyte.

- When mixing acid to prepare electrolyte, always pour the acid slowly into the water and stir constantly to mix well. Never pour water Into acid. Never use sulfuric acid solutions which are over 1.400 specific gravity when adjusting battery acid.

- Apply a neutralizing solution, such as bicarbonate of soda and water, when acid is spilled on floor. Clean up affected area promptly. A mixture of one pound of soda to one gallon of water is recommended.

Unpacking upon receipt

Upon receipt of a mine power storage battery, perform the following:

- ☞ It is important first to examine the exterior of the packing for wet spots on bottom or sides which may indicate leaking jars. Inspect also for physical damage to battery package because the battery could be affected as well. Report any damage to your supervisor.
- ☞ Make certain that the package is right side up, with skid mounts resting firmly on floor.
- ☞ Use a forklift truck or crane of sufficient capacity to remove the packaged battery from the truck or freight car. If a crane is employed, be sure the sling is secured against the bottom of the skid and not around the skid mounts.

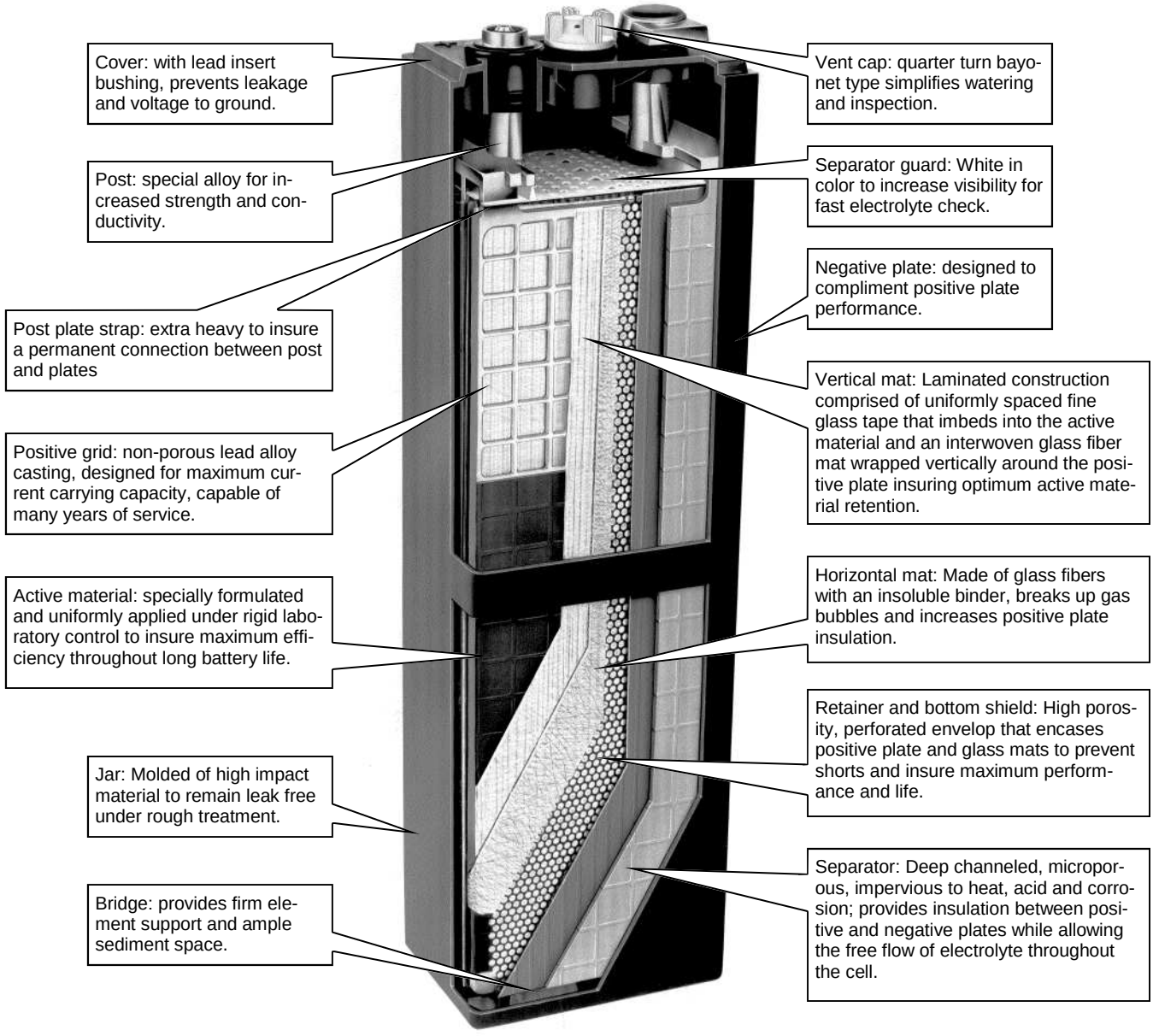
WARNING!
Lifting devices used to move batteries must be capable of carrying the weight stamped on the battery case. Keep all persons and body parts from under the batteries when they are lifted.

- ☞ Move the crated battery to the uncrating area and remove packaging, including any wrapping or other protection provided to the battery terminal cable connectors.
- ☞ Inspect battery and report any damage to your supervisor.
- ☞ Use a properly insulated lifting beam of adequate capacity to lift the battery, by means of an overhead hoist, from the battery skid.

When lifting batteries, always use a device which exerts a vertical pull on the lifting eye or tab. If a chain must be used, it should be in combination with a lifting beam with provision for adjusting lifting hook centers to the exact length of the tray. Any method of lifting which tends to squeeze or stretch the battery tray may distort it and could damage jars or disturb cell seals.

A piece of rubber sheet or other insulating material, temporarily laid on the battery while lifting, will prevent any possible short circuits from chains or hooks. As an additional precaution against accidental shorting, the lifting beam hooks should be electrically insulated from each other.

Fig. 1: Cell



Mine batteries incorporate every feature required by today's mines. They are designed by engineering technology and built by master battery craftsmen according to strict quality control guidelines.
These batteries are the finest available to meet today's mining requirements, and our precision construction provides new equipment performance throughout a long life.

Preparation for Use

Establishing battery requirements

The number of batteries required for service depends primarily upon the number of 8-hour shifts in effect. Normally, for operation on a single-shift basis, the minimum number of batteries required will be the same as the number of operating machines and the batteries need not be removed from the unit for charging. For operation on a 2- or 3-shift basis, the minimum number of batteries required will be twice the number of operating machines and it will, therefore, be necessary to exchange discharged batteries for charged batteries at the end of each work shift. Whenever possible, it is recommended that more than the minimum number of batteries be available for multiple-shift operation, providing at least an 8-hour cooling period after charging. In an emergency, any one battery can be used for two 8-hour shifts during a 24-hour period, but this procedure, repeated regularly, will cause high electrolyte temperatures and could seriously affect service life. Therefore, where 3-shift operation is normal, 3 batteries will be required per machine.

Acid to water proportions

Sulfuric acid to water proportions required to make electrolyte are given in Table 3.

Charged and wet batteries

Charged and wet batteries are shipped with cells filled and fully charged. Prepare these batteries for use as follows:

WARNING!
Proper eye and body protection must be worn at all times when servicing batteries to prevent electrical shock and contact with battery acid. Clean and neutralize any acid spill immediately.

- ☞ Examine battery to see if electrolyte has been accidentally spilled. If so, clean and neutralize any spillage with a cloth that has been dipped in a bicarbonate of soda solution. Rinse area with clear water.

- ☞ Remove vent caps and check the electrolyte level in each cell. Measure and record the specific gravity, electrolyte temperature, and individual open circuit voltage of each cell. Note any irregularities.

- ☞ Check to make sure that all cells are properly connected and that terminal connections are tight. If there are irregularities in the electrolyte levels or specific gravity readings, or if the battery has been in storage for more than 30 days, it should be given a freshening charge to assure that every cell is at a fully charged state.

- ☞ Recheck electrolyte levels after charging and after gassing has stopped. Again, measure and record specific gravity and electrolyte temperatures. If irregularities in electrolyte specific gravity readings still exist, call your service representative.

Troubleshooting

In addition to the required routine maintenance, storage batteries may, at some time during their service life, require more extensive or unusual care. Such care should be given as soon as it has been determined that a problem exists or that trouble may be developing. This section deals with the means of identifying existing or impending problems and offers possible solutions.

The Troubleshooting Chart, Table 6, defines the most common problems which could occur during a battery's lifetime. If the suggested operational remedies are ineffective, it may be assumed that there is an internal problem and it will be necessary to disassemble the cell or cells to inspect the elements and sediment well. If the cause of the problem can only be corrected by completely replacing cells or the battery, this information should be reported to the person in authority.

Table 6: Storage battery troubleshooting chart

Symptoms	Probable Cause	Possible Remedy
battery overheats during charge	☞ 1. Malfunctioning charging equipment.	☞ 1. Replace or repair defective charger parts (timer, voltage sensitive relay, control board, etc.)
	☞ 2. Charging equipment out of adjustment.	☞ 2. Adjust start or finish charging rates.
	☞ 3. Defective or weak cell(s).	☞ 3. Replace/repair problem cells.
	☞ 4. Battery worn out and beyond economical repair.	☞ 4. Replace battery.
	☞ 5. High resistance connection within battery.	☞ 5. Check for hot wires, cells, intercell connectors, charging plugs, etc. Repair or replace defective component(s).
	☞ 6. Low electrolyte level.	☞ 6. Add water to just cover separator protector when discharged.
	☞ 7. Battery charge in the vehicle with battery compartment closed or the tray cover closed.	☞ 7. Open compartment during charge or charge battery of the unit with the tray cover opened.
	☞ 8. Battery of 100° F when placed on charge.	☞ 8. Allow battery to cool below 90° F before charging.

- ☞ Raise the element to clear the top of the jar. Do not, unless absolutely necessary, expose an element to air longer than five minutes. Oxygen in the air combines with the active material in the negative plates, causing them to oxidize and heat. If the exposure persists, negative plates will discharge.

  - ☞ While the element is out of the jar, check the sediment well in the bottom of the jar. If it is full of shed material, the cell will probably have to be replaced.

  - ☞ Inspect plate and separator edges while the element is suspended. A more thorough inspection of separators, plate insulation, grids, and active materials may be indicated. If so, proceed as follows:

    - ☞ Remove the element from the jar.

    - ☞ Lay the element on its side on a clean non-metallic surface with the plates at right angles to the table surface so the element can be fanned slightly to permit the removal of separators, always on negative side.

    To reinstall the separator:

    - ☞ Make certain that the flat side of the separator is against the negative plate and the ribbed side is facing the positive.

    - ☞ Push up until they are flush with the bottom of the element and they project equally on each side of the plates.

- ☞ Before installing an element in a previously used jar, wash out any sediment which may have accumulated in the bottom of the jar and clean all compound from around the inside of the top edge.

- ☞ Clamp the element, if necessary, when reinstalling it in the jar. Make certain that the element is entering the jar properly and that the plates are at right angles to the plate support ribs in the bottom. When installing an element with a cell cover attached, use a putty knife to guide the lip of the cover past the top edges of the jar.