OPERATION, PREVENTIVE MAINTENANCE, TROUBLESHOOTING AND SERVICE GUIDE

MODELS 488L and 488-6

NOTICE

THIS GUIDE CONTAINS IMPORTANT OPERATION AND SAFETY INFORMATION AND SHOULD BE KEPT AVAILABLE TO THOSE PERSONNEL INSTALLING AND OPERATING THIS EQUIPMENT.

P/N A6474X210
Revision 6, April / 08

SAFETY PRECAUTIONS AND GUIDELINES

OVERVIEW

Before you operate, maintain or in any other way, use this unit -

READ and STUDY this guide. KNOW how to safely use the unit's controls and what you must do for safe maintenance.

ALWAYS wear or use the proper safety items required for your personal protection.

If you have ANY QUESTIONS about the safe use or maintenance of this unit:
ASK YOUR SUPERVISOR - NEVER GUESS - ALWAYS CHECK

PRE-START INSPECTION

Read this entire guide BEFORE attempting to operate this unit. You should be familiar with the controls and their functions before the unit is energized.

INSPECT your machine by doing a pre-operational inspection. Have any malfunctioning, broken or missing parts corrected or replaced before use.

VERIFY that all maintenance has been performed.

VERIFY that all the instruction and safety labels are in place and readable. These are as important as any other equipment on the machine.

CLEAN any foreign material from the operator's compartment.

THIS Model 488 Series UN-A-TRAC® was shipped from the factory equipped with a protective canopy. This canopy MUST be securely in place before operating the unit.

STARTING

DO NOT operate any levers or pedals from outside the operator's compartment to keep the machine from hitting you or other personnel.

FOLLOW the instructions in the STARTING PROCEDURES section of this guide (page 23).

DO NOT operate any levers or pedals if anyone is in the Hazard Zone (page 21).

BE familiar with the operation of the tape switches and be prepared for the sudden stop when the tape switches are struck.

OPERATING

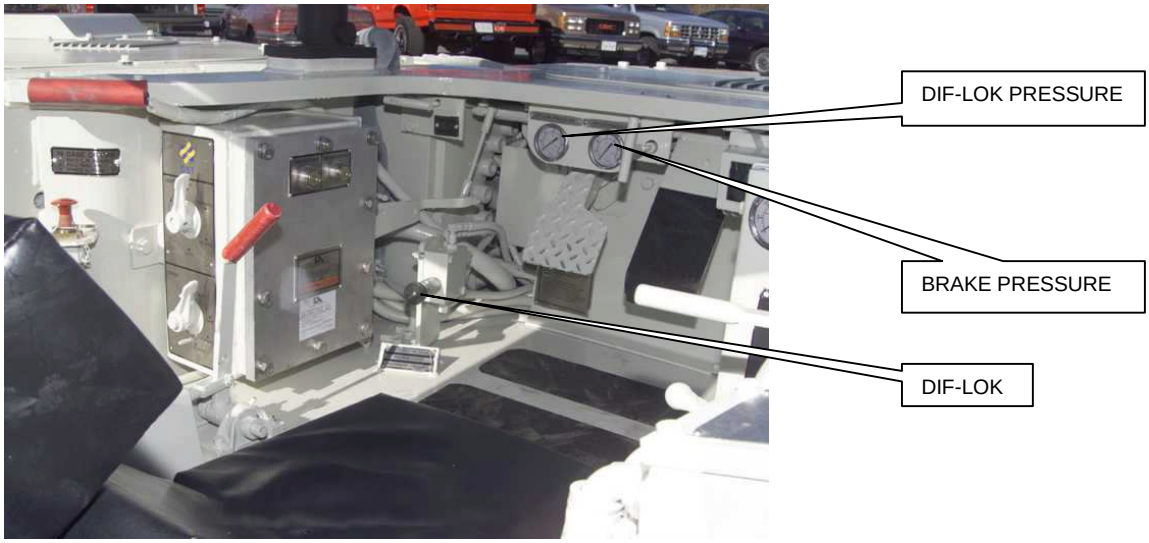
ALWAYS make sure that no person or obstruction is in your line of travel BEFORE starting the unit into motion or in the articulation area when steering the unit.

NEVER climb onto, or climb out of the machine while it is in motion.

DO NOT operate the machine with any part of your body outside of the operator's compartment in order to prevent body parts from being crushed between the machine and objects outside.

USE extreme caution and be observant when working in close quarters or in congested or blind-travel areas. The warning gong should be sounded to alert personnel of your movement.

FIGURE 10 – GAUGE PANEL AND DIF-LOK (OPTIONAL)



DIF-LOK (OPTIONAL)

The operator controlled “DIF-LOK” actuator (Figure 10) is located to the operator’s left and on the floor. When actuated, pushed in, the differential locks are engaged in both the front and rear axles. To release the differential lock, pull out on the push button.

GENERAL HYDRAULIC CONTROL SYSTEM INFORMATION

In the operator's compartment located to the right of the operator’s seat is a group of control levers and gauges (Figure 11). These levers control the steering, bucket position, ejector blade position, winch operation and battery changer system by means of a hydraulic valve bank located behind the panel to the operator's right. The gauges include emergency brake, accumulator, and system pressure. The hydraulic system pressure relief valve is set at the factory at 2000 psi (138 bar), and should not be changed. Should the "SYSTEM PRESSURE" gauge (Figure 11) read more than 2250 psi (155 bar), SHUTDOWN the Model 488-6 and call a maintenance person (see page 29 for Shutdown Procedure).

HYDRAULIC CONTROL PANEL GAUGES	
GAUGE	**PRESSURE READING**
Emergency Brake	1500 – 1800 psi (103 –124 bar)
Accumulator	1500 – 1875 psi (103 – 129 bar)
System Pressure	2250 psi (155 bar)

SHOULD EITHER GAUGE SHOW ABOVE OR BELOW THE PRESSURES LISTED ABOVE, SHUTDOWN THE UN-A-TRAC® AND CALL A MAINTENANCE PERSON (SEE PAGE 29 FOR SHUTDOWN PROCEDURE).

TOWING A DISABLED MACHINE

IT IS NOT POSSIBLE, WITHIN THE SCOPE OF THIS GUIDE, TO ANTICIPATE ALL POSSIBLE ARRANGEMENTS FOR TOWING A DISABLED UNIT. BEFORE ATTEMPTING TO TOW ANY VEHICLE, YOU MUST TAKE ALL POSSIBLE PRECAUTIONS TO PROTECT THE OPERATORS AND ANY ONE AROUND BOTH VEHICLES FROM BEING INJURED BY EITHER THE TOWING VEHICLE, THE TOWING DEVICES OR THE VEHICLE BEING TOWED. THE PRIMARY 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.

1. Couple the towing vehicle securely to the disabled vehicle.

2. Close the valve to tank circuit that is on the hand pump. This isolates the park brake solenoid from the circuit.

3. Begin pumping the hand pump. The building pressure moves the shuttle valve and allows the Automatic (Park) Brake system to be pressurized.

4. The Automatic (Park) Brake is "released" as indicated by the Brake Release gauge.

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.

5. Begin towing the vehicle.

6. 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 directions at all four wheels for additional stability. The brake is "set' by opening the valve on the hand-pump.

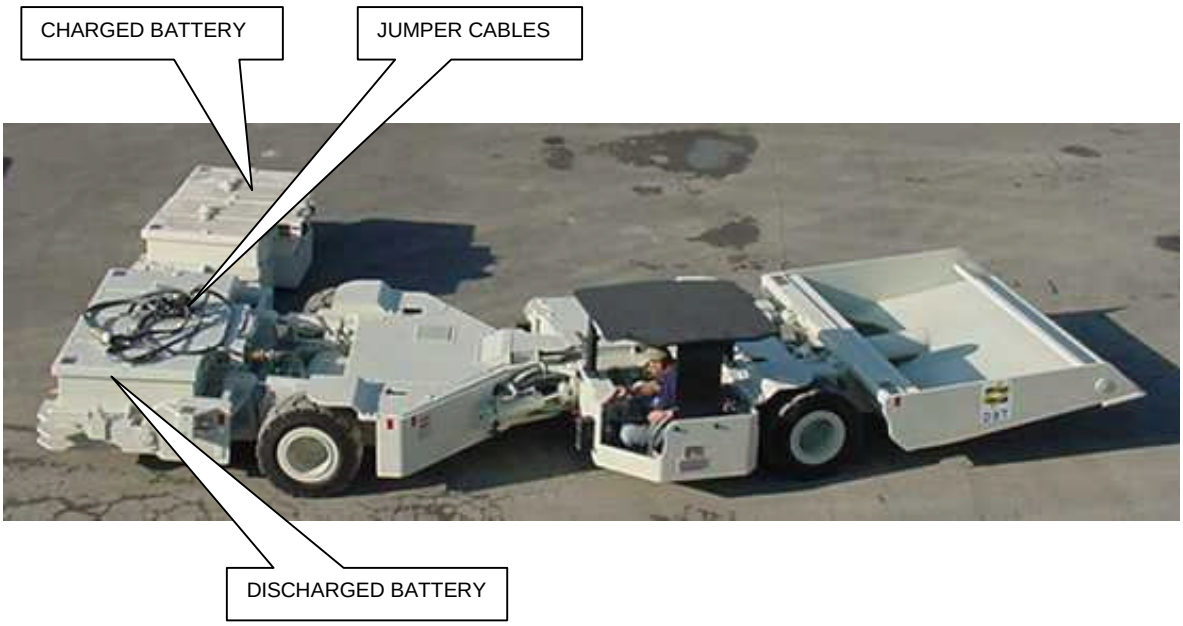
FAILURE TO SET THE PARKING BRAKE ON THE DISABLED VEHICLE BEFORE REMOVING THE TOWING DEVICE COULD ALLOW THE DISABLED VEHICLE TO ROLL AWAY UNCONTROLLED.

BATTERY CHANGE PROCEDURE (GROUND LEVEL)

Two people are needed to change the battery in the UN-A-TRAC®. Since one person may step into the Hazard Zone, the other person (operating the UN-A-TRAC®) must be very careful and look each time before moving any levers or pedals. Take time now to refamiliarize yourself with the Hazard Zone (page 21).

1. Line up the battery end of the UN-A-TRAC® with the place where the battery is to be deposited (Figure 24) (see Starting Procedure, page 23).

FIGURE 24 – BATTERY CHANGE PROCEDURE (GROUND LEVEL)



THE "BATTERY" CHANGE CONTROL LEVER SHOULD NEVER BE OPERATED EXCEPT AT A BATTERY CHANGE STATION OR WHEN ITS NECESSARY TO ADJUST THE BATTERY'S TERRAIN CLEARANCE. IF THE "BATTERY" CHANGE CONTROL LEVER IS OPERATED IN A LOW ROOF AREA, THE BATTERY MAY BE DAMAGED.

2. UnIatch both battery Iatch pins before placing the battery on the ground (Figure 25). If difficulty is encountered in unlatching the latch pins, it may be necessary to gently shake the battery up and down by using the battery "LIFT" control lever.

CRITICAL TORQUE VALUES

Torque values are expressed in lubricated and dry thread values. Lubricated thread torque values should be used any time the bolt threads are covered with oil, grease, anti-seize or thread-locking compounds. Dry thread torque values should be used when threads are completely clean and dry.

CRITICAL BOLT TORQUE VALUES (ft./lbs.) (m-n)

LOCATION	BOLT SIZE	GRADE	DRY	LUBRICATED
Steering Cylinder Pins	7/8 NC	Grade 8	N/A	460
Tire-Wheel Mounting Bolts (John Deere Axle)	3/4-16UNF X 2-1/2"	Grade 8	390 (529 m-n)	300 (407 m-n)
Tire-Wheel Mounting Bolts (Meritor Axle)	9/16 NC X 2-1/4"	Grade 8	160 (217 m-n)	120 (163 m-n)
Tire-Wheel Mounting Bolts (Kessler)	M16 X 1.5 X 60	Class 10.9	232	217
Drive Motor-to-Gearbox Mounting Bolts	3/4NC X 2-3/4"	Grade 5	285 (387 m-n)	170 (231 m-n)

LUBRICANTS, FLUIDS AND CAPACITIES

LOCATION	TYPE OF LUBRICANT	APPROXIMATE CAPACITY	NOTES
Hydraulic Oil	Spec. 100-1 (John Deere or Meritor) Spec. 100-12 (Kessler)	40 Gallons (151.5 l)	1
Speed Reducer (Gearbox)	Spec. 100-6	As Required	
Axle Housing (Meritor) (Kessler)	Spec. 100-6	As Required	2
Planetary Wheel Ends (Meritor) (Kessler)	Spec. 100-6	As Required Each Wheel end	2
Wet Disc Brakes (Meritor) (Kessler)	Spec. 100-12	As Required For Each Brake	2
John Deere Axle	John Deere Hy-Gard Oil	20 Qt. (18.9 l)	5
Winch	API GL-4 or (140) Worm Gear Oil Peragma Grade 8	5 pints (2.36 l)	
SROIB Park Brake	SROIB Oil	2 Qt. (1.89 l)	4
Wet Disc Brake (PT Tech)	Spec. 100-1	As Required	
Multi-Purpose Grease	Spec. 100-3	As Required	3

Notes:

1. With ejector blade completely retracted.
2. The axle housing, brake cooling sumps, and planetary wheel end assemblies do not have a common oil source. Each assembly must be filled separately.

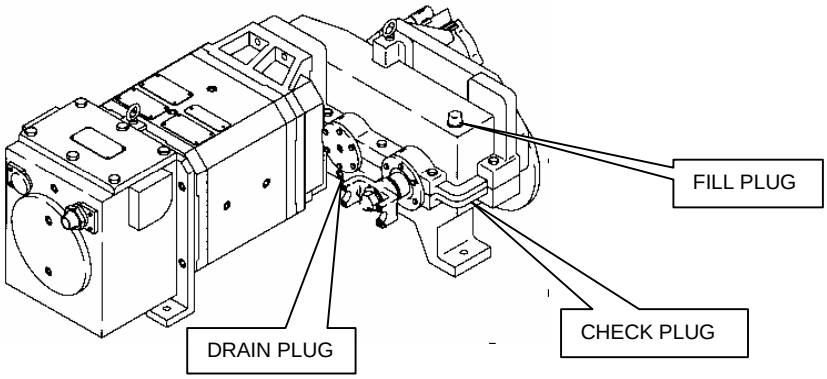
   Make sure the level and fill hole in the planetary wheel end cover is in the proper position. Rotate the wheel end as required to bring the fill hole to either the 3 o'clock or 9 o'clock position.

   When filling the axle housing and planetary wheel ends, allow enough time for the lubricant to fill the various cavities and around component parts in each assembly. Continue adding oil into each assembly until the required oil level is reached
3. Pump grease into fitting until old grease can be observed coming out of component.
4. If the SROIB brake is used as a service brake, sump oil capacity is 4 qt (3.78 l).
5. When bleeding brakes, bleed both ports at the same time.

9. Check the oil level in the speed reducer (gearbox).

A. Remove the check plug from the speed reducer (gearbox) (Figure 42). The oil level should be kept at the level of the check plug.
B. Should it be necessary to add oil, add the oil through the fill plug hole slowly until oil flows from the check plug hole. Do not overfill the speed reducer.
C. Replace the check and fill plug.

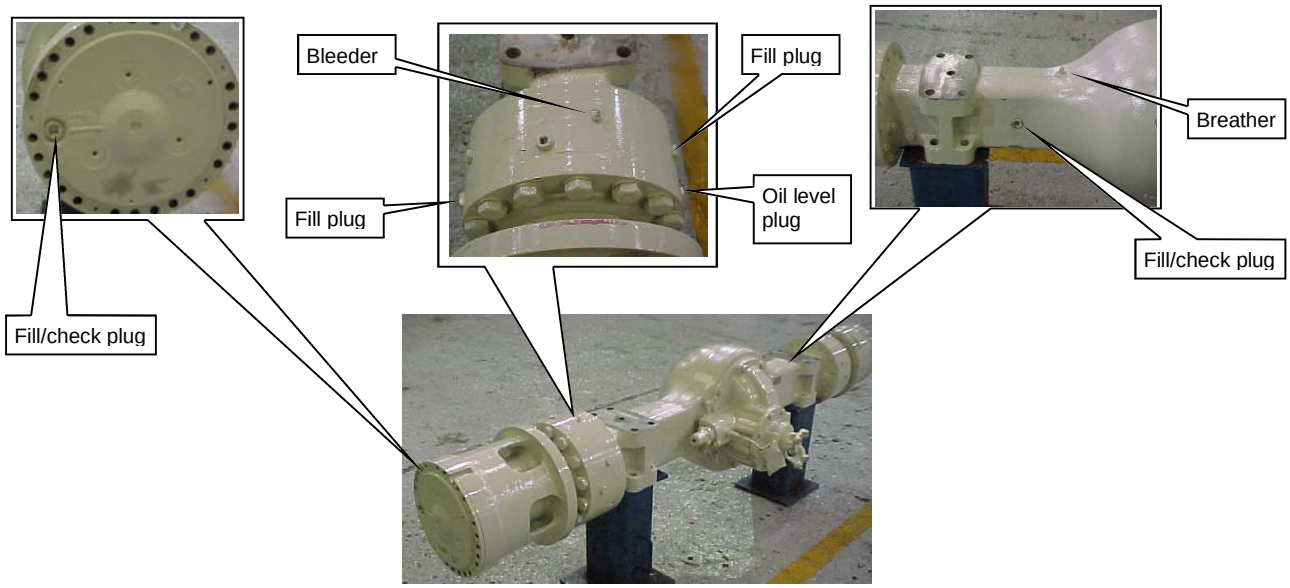
FIGURE 42 – SPEED REDUCER (GEARBOX) OIL LEVEL



10. Check the oil levels of both drive axles. (If equipped with John Deere axles, see Figure 45).

A. Park the UN-A-TRAC® on solid level ground and remove the oil level/fill plugs (Figure 43),
B. Make sure the level and fill hole in the planetary wheel end cover is in the proper position. Rotate the wheel end as required to bring the hole to either the 3 o'clock or 9 o'clock position.
B. The oil should just barely flow out from these holes when full.
C. Should it be necessary to add oil, add the oil through the level/fill plug hole slowly, just until it starts to run back out. Allow time for the oil to travel throughout the axle when filling.

FIGURE 43 – AXLE AND WET DISC BRAKEFILL POINTS (Meritor)



The following lubricants are recommended for use in the UN-A-TRAC®. Other lubricants with equivalent specifications may be used.

	Recommended Lubricant	Specification
Hydraulic Oil (John Deere or Meritor)	Texaco Rando HD68	Spec 100-1
Hydraulic Oil (Kessler)	Mobilfluid 424	Spec 100-12
Heavy-Duty, Multi-Purpose Grease	Texaco EP 1	Spec 100-3
Speed Reducer (Gearbox) Oil	Texaco EP-90 Gear Oil	Spec 100-6
Axle Oil (Meritor or Kessler)	Texaco EP-90 Gear Oil	Spec 100-6
Axle Oil (John Deere)	John Deere Hy-Gard Oil	--------
Wet Disc Brakes (Meritor or Kessler)	Mobilfluid 424	Spec 100-12
SROIB Park Brake	SROIB Oil	--------

LUBRICATION CHART

CLEAN ALL EXCESS OIL AND GREASE FROM THE UN-A-TRAC® AFTER COMPLETING MAINTENANCE PROCEDURES.

ONCE PER WEEK

The following points should be lubricated at the grease fittings with heavy-duty, multi purpose grease.

SYMBOL	LOCATION
•	1. Bucket Pivot Pins (2 Places)
•	2. Bucket Lift Cylinders (Rod End)
•	3. Bucket Lift Cylinders (Base End)
•	4. Steering Cylinders (Rod End)
•	5. Steering Cylinders (Base End)
•	6. Automatic (Park) brake Caliper
•	7. Drive Line Universal Joints
•	8. Drive Line Slip Joints
•	9. Control Levers
•	10. Foot Pedals
•	11. Central Lubrication Fitting Block
•	12. Center Section Assembly
•	13. Winch

MAJOR MAINTENANCE PROCEDURES

CONTACTOR TIP REPLACEMENT

1. Insure electrical power is off and allow a minimum of one minute for capacitors to discharge (see page 69).
2. Change the stationary contactor tips (Figure 53):

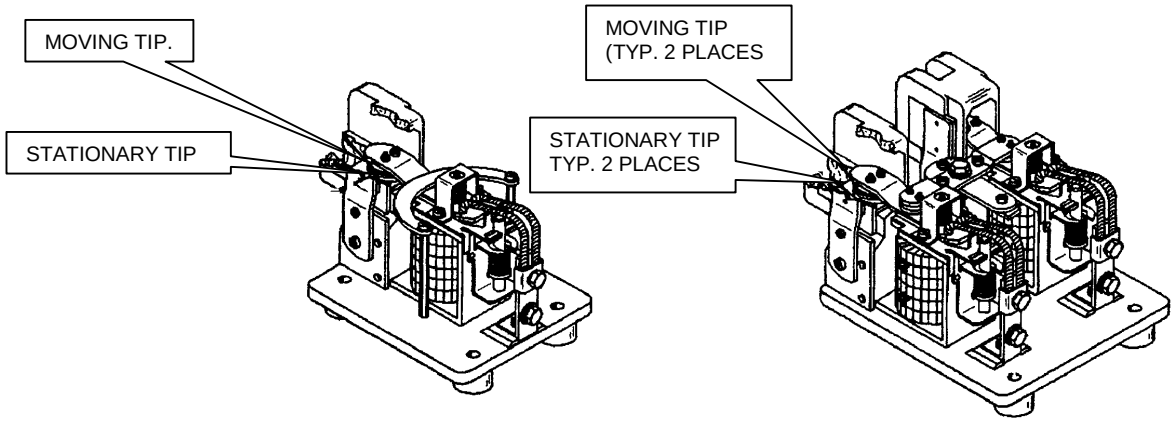
   A. Remove the bolt that holds the old tip in place and remove the old tip.
   B. Position the new tip in place and replace the bolt. Check the placement of the tip to insure that it is correctly positioned and the bolt is tight.
   C. Repeat for all stationary tips.

THE BOLTS USED TO FASTEN THE STATIONARY CONTACTOR TIPS IN PLACE ARE SPECIALLY SIZED TO PREVENT THE CONTACTOR TIP FROM GROUNDING TO THE CONTACTOR COIL. IF REPLACEMENT BECOMES NECESSARY, IT IS IMPORTANT TO USE BOLTS AND WASHERS IDENTICAL TO THE ORIGINAL ONES. ALL CONNECTIONS MUST BE TIGHT BEFORE THE UNIT IS PUT BACK INTO SERVICE.

3. Check for grounding between the stationary tips and either terminal of the contactor coil by using a volt/ohm meter set on R x 1. Correct any shorts if found.
4. Change the moving contactor tips (Figure 53).

   A. Remove the two (2) nuts that secure the tip and remove the old tip.
   B. Position the new tip and secure with new nuts. Check the placement of the tip to insure that it is correctly positioned and the nuts are tight.
   C. Repeat for all moving tips.

FIGURE 53 – CONTACTOR TIP INSPECTION AND REPLACEMENT



SINGLE-POLE CONTACTOR DOUBLE POLE CONTACTOR

SERVICE MANUAL

FOR KESSLER AXLES

72.4665.3

KESSLER & CO. GMBH & CO. KG
73453 Abtsgmünd
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Edition 09 / 2005

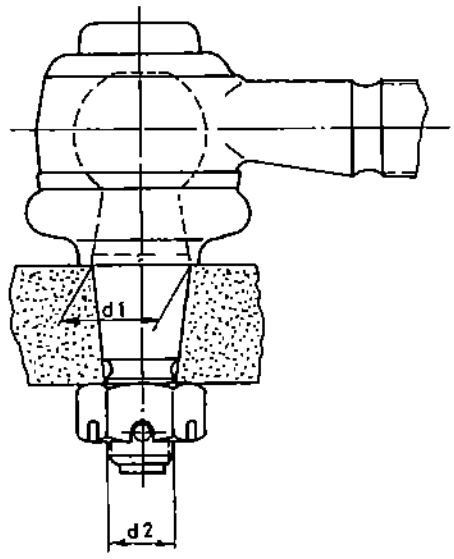
Lubricants and lubrication intervals

Lubrication point	Lubricant	Remarks	Lubrication intervals 1.)				
			after 100Bh 1000Km	every 500Bh 5000Km	every 1000Bh 10000Km	min. 1x Year	min. 1x in 2 Years
Drive assembly	Hypoid – gear oil per MIL-L – 2105 B / API GL 5 Hypoid – gear oil in multi – range characteristic per MIL-L – 2105 C / D / API GL 5 SAE 90 or multi grade oils for normal external temperature SAE 75 W – 90 ; SAE 75 W – 85 for external temperature lower – 10° C SAE 140 or multi grade oils for external temperature over + 30° C	Oilchange Check oil level at control points monthly	⊕		⊕	⊕	
Wheel hub planetary gear drive			⊕		⊕	⊕	
Interaxle differential			⊕		⊕	⊕	
Drop gear / Gear boxes			⊕		⊕	⊕	
Wheel bearing oil lubricated			⊕		⊕	⊕	
Multi disk parking brake	Hydraulicoil ISO VG 32		⊕		⊕	⊕	
Steering knuckle bearing	Multi – use grease lithium saponified groove penetration per NLGI 2 f. e. Fuchs Renolit MP 150		⊕	⊕			
Steering knuckle bearing		maintenance reduced			⊕	⊕	
Universal joint		if provided for	⊕	⊕			
Track rod		if provided for	⊕	⊕			
Steering cylinder -ball head / -spherical plain bearing		if provided for	⊕	⊕			
Cardan shaft intermediate bearing		if provided for			⊕	⊕	
pinion bearing		if grease lubricated	⊕		⊕	⊕	
Brake shaft bearing		Attention ! 2.)	⊕	⊕			
Brake shoe bearing		Attention ! 2.)	Lightly greased at brake shoe new assembly				
Wheel bearing		if grease lubricated	Change grease at wheel hub disassembly				⊕
Wet disk brake	see chapter -7-	**external cooled** oilchange	dependent on tank volume / cooling system / operation conditions				
		not external cooled oilchange	⊕		⊕	⊕	

(Bh = Hours of operation)

1.) Whichever occurs first .
2.) The bearing point is to be lightly lubricated only , to avoid the penetration of grease in the interior of the brake (use only hand operated grease gun and remove surplus grease !) .
Check regularly the brake shafts and if need correct the lubrication intervals (danger of overheating !).

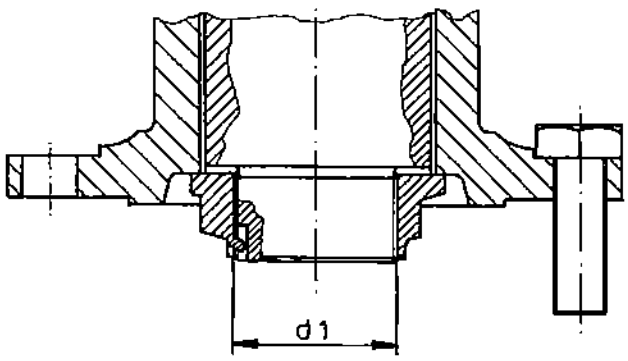
Tightening torques for castle nuts on ball joints for track rods and ram cylinders



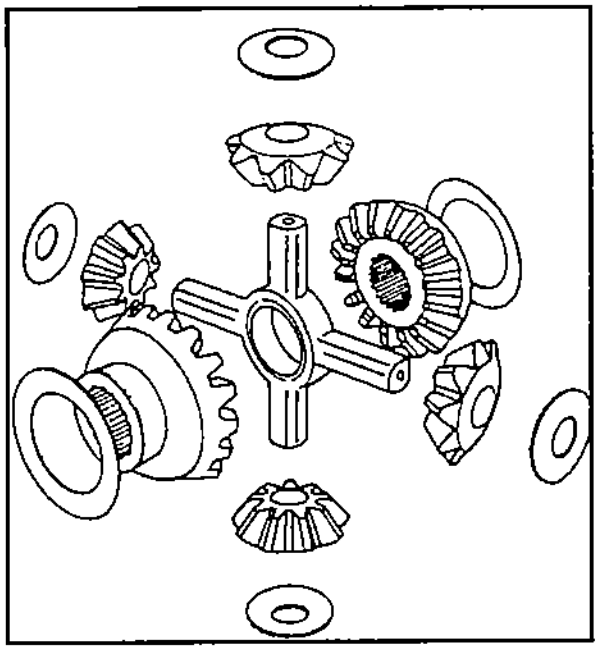
Cone size d1 (mm)	Thread d2 (mm)	Torque (Nm)
26	M 20 x 1,5	200 - 220
30	M 24 x 1,5	280 - 300
32	M 27 x 1,5	290 - 320
38	M 30 x 1,5	340 - 360
45	M 39 x 1,5	410 - 430

The tightening torques of the different thread dimensions of the joints are applicable for nuts of quality S6 .

Tightening torque of the adjusting nut resp. slotted nut at flanges resp. gearwheels ect.



Thread d1 (mm)	Torque (Nm)
M 24 x 1,5	360
M 30 x 1,5	450
M 36 x 1,5	540
M 42 x 1,5	850
M 45 x 1,5	850
M 48 x 1,5	850
M 52 x 1,5	950
M 64 x 1,5	1050 - 1100

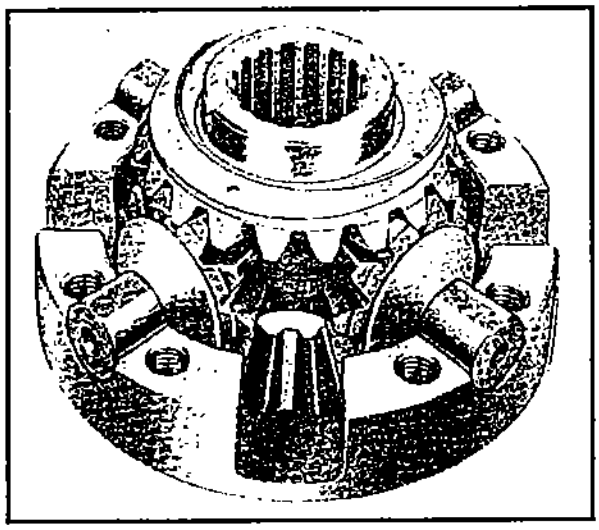


Assembly of the Differential

Before assembly all of the bevel gears and the thrust rings should be well oiled.

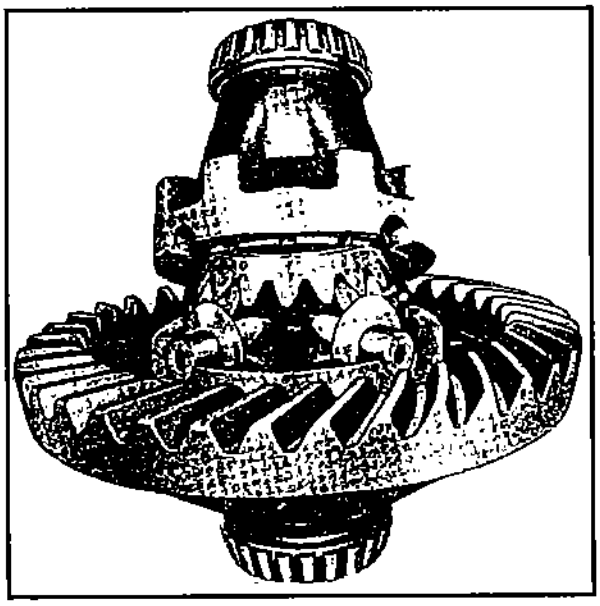
1. Place one differential side gear with the side gear thrust washer in the differential case.

2. Install the spider with differential gears and differential pinion thrust washers in the differential case.



3. Install the other differential side gear and side gear thrust washer. (At variants with Nospin differential install the Nospin diff. instead of the differential gears)

4. Install the other half of the differential case over the assembly and observe the alignment marks, tighten the differential case bolts. Secure with Loctite 262.



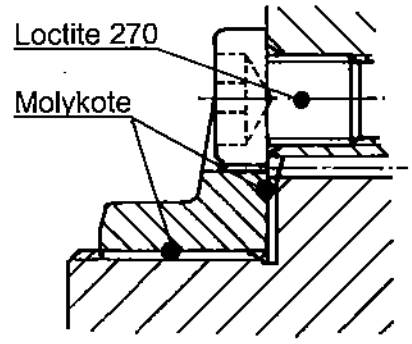
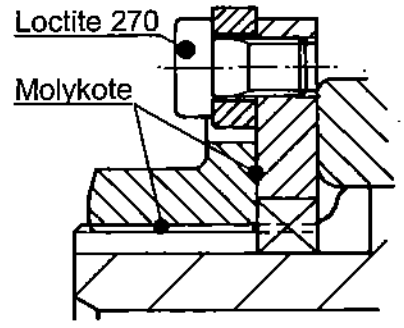
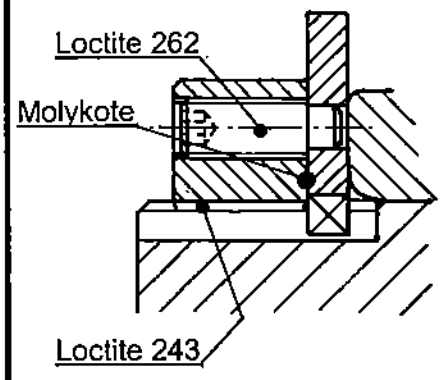
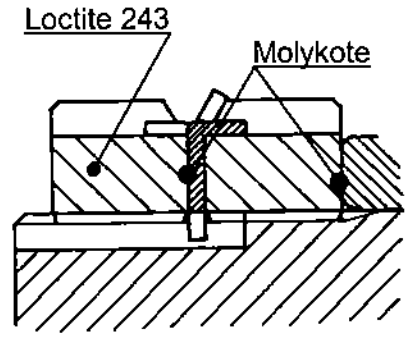
5. Check that all differential pinions can rotate easily.

6. Coat the contact surface of the ring gear with Loctite 270 and install the ring gear on the differential case by tapping lightly on the circumference. Tighten the ring gear bolts. Secure with Loctite 262.

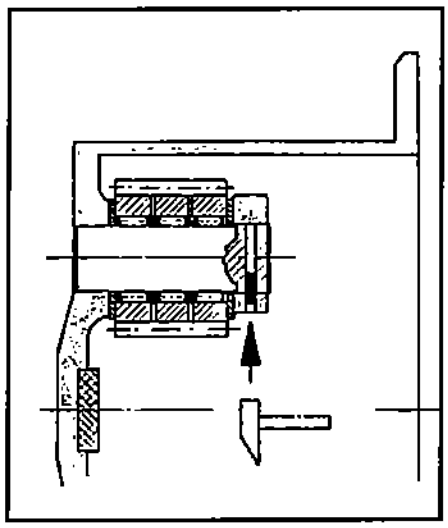
7. Heat the two taper roller bearings to about 100°C and install them by using a sleeve.

Radsicherungsmutter

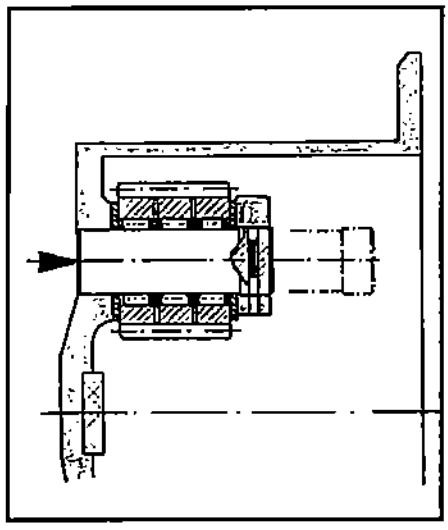
Wheel safety nut

Bezeichnung Designation	Ausführung Version	Sicherung / Bemerkungen Security / Remarks
Wellenmutter mit Zylinderschraube **Shaft nut with cheese head screw**		Zylinderschraube Cheese head screw & Loctite 270
Wellenmutter mit Zylinderschraube und Buchse **Shaft nut with cheese head screw and bushing**		Zylinderschraube Cheese head screw & Loctite 270
Wellenmutter mit Gewindestift **Shaft nut with set screw**		Gewindestift Set screw & Loctite 243 / 262 Gewindestift nach dem Anziehen ca. ½ Umdrehung zurückdrehen Back off set screw ½ rotation after tightening
Wellenmutter mit Kontermutter **Shaft nut with counter nut**		Sicherungsblech & Kontermutter Security spline & counter nut & Loctite 243

Disassembly of planetary gear



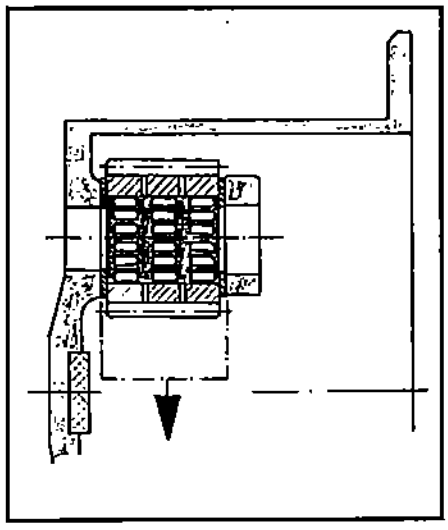
Knock the locking pin (20 resp. 21) completely to the inner side of the planetary pin.



Press the planetary pin in direction of arrow out of the planetary housing.

Attention:

Because of the difference of diameter of 0,1 mm do not press the planetary pin against the direction of arrow out of the planetary housing, to prevent damaging the bore.



Remove the planetary gears with the thrust disks and needle bearings.

Disassembly brake

WARNING !

Before commencing work on the brake , ensure that no unintended machine movement can happen when the braking effect is removed .
- Danger to life ! - .

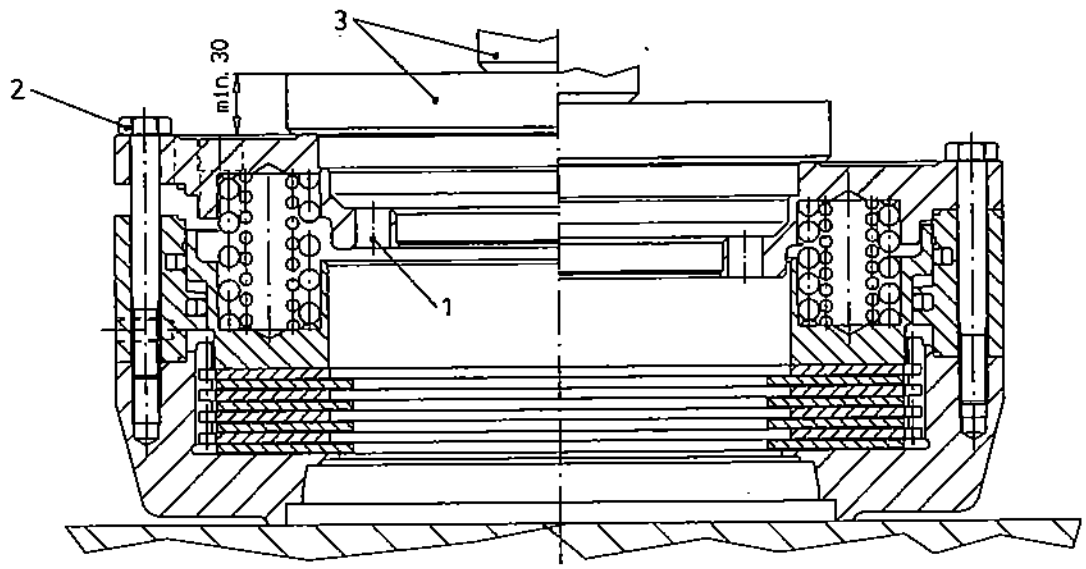
- The complete brake can be removed from the axle spindle resp. steering knuckle after unscrewing of the screws (1) (inapplicable at one-piece design brake carrier) .
  Hint : To safe the centering of the disc set in case of disassembly the wheel hub , the hydraulic pressure should be released , so the disc set will be clamped (spring load effect) .
- The disassembly of the brake has to be realized in reverse sequence .

DANGER !

The brake is under spring tension . Parts could become loose and fly out suddenly if improper brake assembly resp. disassembly .
- Danger to life ! -
The loading resp. unloading of the springs must not be realized by the brake housing screws , it has to be made with a suitable press and device .

Preferably the assembly / disassembly should be done by Kessler & Co .

- Before unscrewing the screws (2) of the brake , the brake has to squeeze together by using a press and device (3) , which are suitable for the brake preload (see warning label) .
  After removing of all screws lift the press ram slowly till the springs are released .



SYMBOLS AND SPECIAL NOTATIONS

Throughout this manual there are specific notations that are either **UPPERCASE BOLD**, UNDERLINED or *ITALICIZED* for the primary purpose of emphasis. Please pay special attention to such statements as they regard safety or critical maintenance installation information.

You will also see the following:

NOTICE: *THIS NOTATION DENOTES A REFERENCE TO PREVIOUSLY STATED INSTRUCTIONS.*

IMPORTANT: *THIS SYMBOL DENOTES THAT SPECIAL ATTENTION MUST BE ADHERED TO IN THE ATTACHED STATEMENT.*

CAUTION: *THIS SYMBOL DENOTES THAT FAILURE TO COMPLY WITH THE ATTACHED STATEMENT COULD RESULT IN A CUT, BRUISE OR ABRASION.*

WARNING: *THIS SYMBOL DENOTES THAT FAILURE TO COMPLY WITH THE ATTACHED STATEMENT COULD RESULT IN A LOST TIME ACCIDENT.*

DANGER: *THIS SYMBOL DENOTES THAT FAILURE TO COMPLY WITH THE ATTACHED STATEMENT COULD RESULT IN A SERIOUS INJURY OR FATALITY.*

Section IV. Principles of Operation

1-6. Fundamentals of Cycling

A cycle is a discharge followed by a charge. During the charge, the electrical energy supplied by the charger causes an electromechanical reaction within the battery. This restores the active materials to a fully charged condition.

a. **The Fully Charged Cell or Battery -** The positive and negative plates (electrodes) are separated from each other and immersed in electrolyte. In the fully charged condition, the active material of the positive plate is lead dioxide and that of the negative plate is sponge lead. The electrolyte is a solution of sulfuric acid and water that normally varies in a specific gravity from 1.280 to 1.295. The combination produces a voltage of approximately 2 volts on open circuit. This voltage potential results from the fundamental characteristic of a storage battery which dictates that when two electrodes of dissimilar metals are immersed in suitable electrolyte, and a circuit is closed between the two, electrons begin to flow. A fully charged cell should normally have an on-charge voltage of from 2.45 to 2.70 volts when charging at the finish rate.

b. **The Discharging Cell or Battery -** While a battery is being discharged or used, lead dioxide and sponge lead combine with sulfuric acid to form lead sulfate within both plates. This action causes the specific gravity of the electrolyte to decrease. As the discharge progresses, individual cell and battery voltages decline, generally in direct proportion to the rate of discharge.

c. **The Discharged Cell or Battery -** As the depth of discharge increases, more sulphuric acid is removed from the electrolyte so the specific gravity decreases and may drop below 1.100 as it approaches the specific gravity of water. Almost all of the active material of both positive and negative plates is converted to lead sulfate, and an effective electromechanical reaction is no longer possible. At this point the battery has reached its discharge limit.

d. **The Charging Cell or Battery -** The charging action begins when the terminals of the battery are connected to an external source of direct current. The electromechanical reaction is reversed and the positive plates, negative plates, and electrolyte start returning to their original charged condition. Charging causes the battery voltage to rise as active materials are restored. A cell being charged may have a voltage of from 2.12 to 2.70 volts depending upon charging rate and time.

e. **General -** Storage batteries do not actually store electrical energy; instead, they accept the electrical energy delivered to them during charging and convert it into chemical energy. During discharging, this chemical energy is reconverted into electrical energy to be used as needed.

To obtain the best performance and life from a mine power storage battery, it should usually be charged after each shift of use or whenever the specific gravity of the electrolyte falls below 1.240. It is very important that proper ventilation be provided during charging to make certain that (1) the hydrogen gas, given off toward the end of the charging process is dissipated (see Chapter 4), and (2) that individual cell electrolyte temperatures, during normal operations, do not exceed 110 degrees F.

1-7. Ampere-Hour Capacity

The electrical capability of a storage battery is usually expressed in ampere-hours. The ampere-hour capacity is the number of ampere-hours which can be delivered under specified conditions of temperature, rate of discharge, and final voltage. Basically, ampere-hours are determined by multiplying the number of amperes which the battery will deliver by the number of hours during which the current is flowing. Total cell or battery capacity then is determined by the size and number of plates which make up

FIGURE 3 – TAKING HYDROMETER READINGS

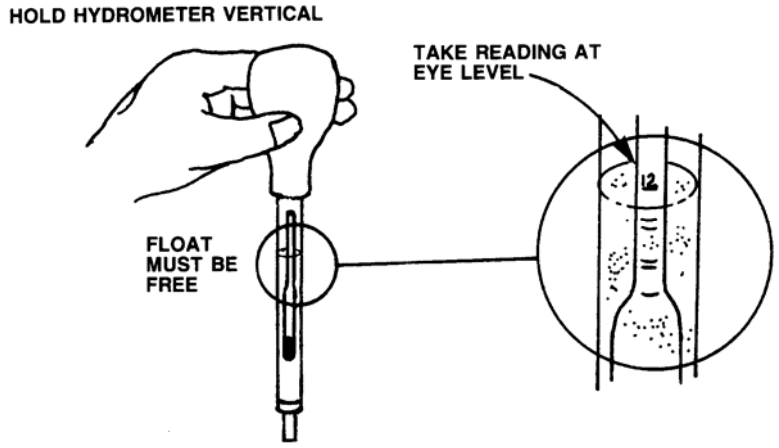


TABLE 3		
SPECIFIC GRAVITY TEMPERATURE CORRECTION CHART		
Electrolyte Temperature (Degrees Centigrade)	**Electrolyte Temperature (Degrees Fahrenheit)**	**Point Correction**
110	230	+11
107	221	+10
104	218	+9
101	212	+8
98	209	+7
95	203	+6
92	198	+5
89	194	+4
86	185	+3
83	180	+2
80	176	+1
77	171	No Correction
74	167	-1
71	158	-2
68	152	-3
65	149	-4
62	140	-5
59	135	-6
56	131	-7
53	128	-8
50	122	-9
47	118	-10
44	113	-11
41	104	-12
38	99	-13
35	95	-14
32	86	-15

Therefore a cell or battery should first be given an equalizing charge as described in Paragraph 2-10c. **Never make a gravity adjustment on a cell which does not gas vigorously while on charge.**

If, after the equalizing charge, the specific gravity of any cell, corrected for temperature, is lower than normal, it should be adjusted in the following manner:

1. Put battery back on charge at the finish rate until cells are actively gassing to provide proper mixing.

2. Remove electrolyte from the low reading cells until level reaches separator protector.

3. Slowly add 1.400 specific gravity sulfuric acid to the cell while it is still gassing.

4. Wait 15 to 20 minutes for the added acid to become thoroughly mixed, then read the specific gravity. If it is still low, repeat the process until gravity is normal. As a guide, every 1/4" of electrolyte that has been removed and replaced by 1.400 acid will cause the specific gravity to rise 4 to 5 points (.004 to .005).

If the corrected specific gravity of any cell is higher than normal, proceed as follows:

1. While the battery is gassing on charge, withdraw from the cell a small amount of electrolyte and replace with approved water.

2. Repeat, if necessary, at 20 to 30 minute intervals until the desired reading is obtained. Every 1/4" of electrolyte which is replaced with water will cause the specific gravity of the cell electrolyte to drop 4 to 5 points (.004 to .005).

NEVER ADD ACID WITH A SPECIFIC GRAVITY HIGHER THAN 1.400. STRONGER ACID COULD PERMANENTLY DAMAGE THE CELL. WHEN MIXING OR CUTTING ACID, ALWAYS ADD THE ACID TO THE WATER. NEVER POUR WATER INTO ACID. A VIOLENT REACTION COULD RESULT WHICH MIGHT CAUSE PERSONAL INJURY. WHEN WORKING WITH ACID, ALWAYS USE A FACE SHIELD OR GOGGLES, RUBBER GLOVES, AND AN ACID RESISTANT APRON.

OPERATION, PREVENTIVE MAINTENANCE, TROUBLESHOOTING AND GUIDE

MODELS BUCYRUS 5, 6, 8, 10, 12 AND 14

BATTERY CHARGERS WITH DIGITAL DISPLAY

THIS GUIDE CONTAINS IMPORTANT OPERATION AND SAFETY INFORMATION AND SHOULD BE KEPT AVAILABLE TO THOSE PERSONNEL INSTALLING AND OPERATING THIS EQUIPMENT.

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THEORY OF OPERATION FERRORESONANT DESIGN

The transformer in a ferroresonant design is non-linear. Its secondary is operated in saturation while the primary is operated in the linear region of the B-H curve.

A magnetic shunt is used to separate the primary and secondary fluxes, which are at different levels. This non-linear operation means that the transformer no longer obeys the turn's ratio laws of the linear transformer. That is, the secondary voltage is no longer a function of the turns ratio times the primary voltage. This means that changes in the primary voltage do not directly affect the secondary voltage value.

The secondary voltage is proportional to the voltage across the resonating winding only. The voltage of the resonating winding is affected by the amount of magnetic coupling to the primary, and by careful selection of magnetic shunts and capacitor values. Thus a battery charging curve can be established. The charging curve is essentially fixed and can only be altered by changes in the transformer design. Under short circuit conditions, the amount of primary to secondary magnetic coupling determines the value of the output current limit.

Rectifiers are added to convert the output of this A.C. regulator into D.C.

The ferroresonant circuit requires a good grade of capacitor in the resonating circuit to improve reliability and a careful design of the transformer. That is the principle of the ferroresonant design.

TROUBLESHOOTING

Troubleshooting should be performed only by trained service personnel or experienced electricians.

HAZARDOUS A.C. AND D.C. VOLTAGES ARE PRESENT WITHIN THE CHARGER'S CABINET.

Equipment: The only equipment required is a multimeter (volt-ohm meter).

General Inspection

On servicing new equipment, before setting up any complicated testing or jumping to any conclusions, give the unit a general inspection. Check the following:

1. Check d.c. output cables, connections, battery type, and number of battery cells with rectifier rating.
2. Check unit specifications with customer order.
3. Check input connections, input voltage and a.c. line breaker size.
4. Check for shipping damage, loose connections, broken wires, etc.
5. Certain failures can be caused by defective batteries and customer loads; make sure batteries and loads are free from defects.
6. Check all safety switches.

IF THE PROBLEM IS FOUND TO BE LOCATED IN THE PRINTED CIRCUIT BOARDS, THE BOARD SHOULD BE REPLACED. NO ATTEMPT SHOULD BE MADE TO REPAIR CIRCUIT BOARDS IN THE FIELD.

Service Information

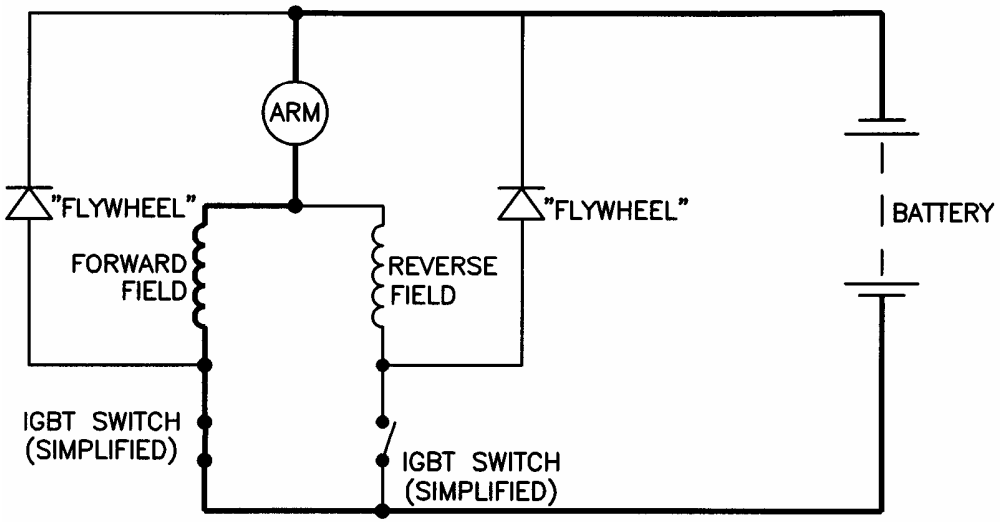
Information you should have when calling in for troubleshooting assistance:

1. Equipment model number and serial number.
2. The actual a.c. input voltage.
3. The d.c. output voltage with and without the battery.
4. Result of the check of a.c. input fuse and d.c. output fuse.
5. The actual d.c. output current and voltage when measured with battery connected to rectifier.

INTRODUCTION

BUCYRUS 2000: Innovative Speed Control by Bucyrus America, Inc.

FIGURE 1 – SIMPLIFIED BUCYRUS 2000 CIRCUIT



In the early 1970's, S&S Corporation lead the way in mining innovation with the introduction of Solid State speed controls for battery-powered underground mining equipment. 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 utilize an electromechanical "bypass" contactor to connect the motor directly to the batteries which caused more contactor problems.

In the 1980's Bucyrus America, Inc., in conjunction with Sevcon, developed a contactorless motor controller (X90) to be used exclusively on Bucyrus equipment. The X90 system used a dual-field motor in combination with SCR's (Silicone Controlled Rectifier) to achieve solid state direction change.

Now Bucyrus America, Inc., in conjunction with Sevcon, has developed the Bucyrus 2000 motor controller. The Bucyrus 2000 system uses IGBT's (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 Bucyrus 2000 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."

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

Fault Message Chart
(Continued)

“LPTA Short”	“P. Up L. PTA Short”	Dual motor Block 1 point “A” short Motor shorted to ground or LEFT IGBT shorted Other electrical component (coil/etc.) shorted or grounded not allowing voltage to come up to or above 64VDC on IGBT panel.
“I. D. Fault”	“Vehicle ID Flt”	Vehicle Configuration ID invalid
“Bad Logic”	“Bad Logic”	Diagnostic point “A” trip failed to disable UVR coil. Faulty logic board.
“R FWD ON”	“Tract R. FWD on”	Diagnostic RIGHT FWD point “A” trip failed to be disabled. . Faulty logic board, shorted motor to ground or shorted IGBT.
“FWD ON”	“Tract FWD on”	Single motor Point “A” trip failed to disable FWD IGBT. Faulty logic board, shorted motor to ground or shorted IGBT.
“R REV ON”	“Tract R. REV on”	Diagnostic RIGHT REV point “A” trip failed to be disabled. Faulty logic board, shorted motor to ground or shorted IGBT.
“REV ON”	“Tract REV on	Single motor Diagnostic REV point “A” trip failed to be disabled. Faulty logic board, shorted motor to ground or shorted IGBT.
“L FWD ON”	“Tract L. FWD on”	Diagnostic LEFT FWD point “A” trip failed to be disabled. Faulty logic board, shorted motor to ground or shorted IGBT.
“L REV ON”	“Tract L. REV on”	Diagnostic LEFT REV point “A” trip failed to be disabled. Faulty logic board, shorted motor to ground or shorted IGBT.
“Drive off”	Drive 0 off Flt”:	Diagnostic test to enable UVR coil driver failed. Faulty logic board.
“R FWD OFF”	“Tract R. FWD off”	Diagnostic RIGHT FWD point “A” trip failed to disable PWMO. Faulty logic board.
“FWD OFF”	“Tract FWD off”	Single motor Diagnostic FWD point “A” trip failed to disable PWMO. Faulty logic board.
“R REV OFF”	“Tract R. REV off”	Diagnostic RIGHT REV point “A” trip failed to disable PWMO. Faulty logic board.
“REV OFF”	“Tract REV off”	Single motor Diagnostic REV point “A” trip failed to disable PWMO. Faulty logic board.
“L FWD OFF”	“Tract L. FWD off”	Diagnostic LEFT FWD point “A” trip failed to disable PWM1. Faulty logic board.
“L REV OFF”	“Tract L. Rev off”	Diagnostic LEFT REV point “A” trip failed to disable PWM1. Faulty logic board.
“BAD LOGIC”	“BAD LOGIC”	Internal error (Software Only) Faulty logic board.

IGBT and Diode Measurements

Before taking readings, the following system conditions must be met:

1. Master switch or control handle in the “OFF” position.
2. Panel disconnected from and isolated from the battery (via main circuit breaker) and battery plugs being disconnected.
3. Motor leads disconnected from panel
4. After power is removed, wait for one (1) minute before making measurements to allow voltage to bleed down

IGBT Measurements

(See Figure 11)

If reading is 0, IGBT is shorted.

There are two IGBT’s wired in parallel; therefore, if one IGBT indicates short, it may be one or both.

FIGURE 11