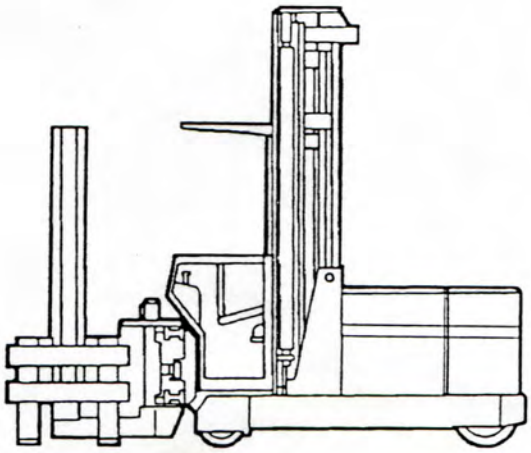
Operator's & Maintenance Manual



OM559
ETA 12/15

1st REVISION

Book No. 2779095

CLARK
Technical
Publications
Lexington, KY
40507-1640

For Handy Reference

RECORD THE FOLLOWING INFORMATION PERTAINING TO YOUR TRUCK

Model No. _____

Serial No. _____

Customer Truck Identification No. _____

Truck Weight, Empty _____

Truck Rated Capacity _____

Truck Gross Weight, Loaded w/Rated Load _____

Special Equipment or Attachments _____

_____

Attachment Weight _____

CONTENTS

ETA-15
(STEINBOCK WA)

LEGEND
Symbols and Nomenclature

For your convenience, I have listed some of the same symbols as shown in Section 1 of the "User Manual". For specific components, please refer to Pages 17, 20, 22, 24, 44, and 47 of the manual.

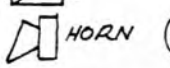
F (Fuses/Circuit Breakers)----------

H (Lights)----------

B (Proximity Switches)----------

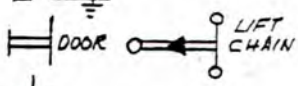
U (Transformers)----------

A (Electrical Components of all Natures)----------



Y (Valves - Hydraulic and Magnetic Brake)----------

S (Switches)----------



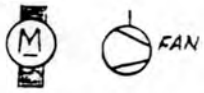
K (Relays) (K1, K2, K10 Large Contactors)----------

R (Resistor)----------

RL (Relays in Steinbock Group Cards)----------

U (24 Volt Converter)----------

M (Motor/Fan)----------



Wire Guide 

 Roller Guide

(200 & 300) in brackets are P.C. signals
Battery Pos. at Battery - Red
Battery Neg. at Battery - Blue
100 Amps = 25 M.V.
All Proximity Switches "ON" till reach that point
0 deg. C = 32 deg. F.
EPROM - Computer Chip - specially programmed
2" = 50.8 mm (use 50mm - close enough)
Pin —▬) Plug

TRUCK DESIGNATIONS

STEINBOCK	CLARK
WA	ETA-15
Truck changed to proportional system and became ETA-15	
WD	ETD
WD designed from EFL	
WM	ETR-10
Smallest truck	
WK	---
WJ	ETR-13
Chassis of WD and electronics from WA	

WA (wire guided) has PHBII System
WD (wire guided) has PHBI System
WM (wire guided) has PHBIV System
WJ (wire guided) has PHBII System

PHB is company name that designed system.
Multiplex unit designed by Steinbock
EEC (regulations, safety devices) similar to UL

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A6	Drive Controller
A7	Hour Meter
A8	Steer System - Electronic
A8.1	End Stage - Steer
A9	Battery Plug
A10	Terminal Post
A11	Battery Check Unit
A11.1	Battery Discharge Indicator
A12	Rack - PHB
A13	Rack - Steinbock
A14	Programmable Logic Controller
A15	Antenna - Front
A16	Antenna - Back
A17	Rotary Pulse Generator
A18	Actual Value Pot.
A19	Target Value Pot.
A20	Module - Voltage Supply
A21	Horn
A22	Buzzer
A23	Module - Diode
A24	Selector - Frequency
A25	Antenna - Middle
A26	
A27	Buzzer
A28	
A29	
A30.1	Transmitter - Multiplex
A31	Hydraulic Control
A32	
A34	
A35	
A36	
A37	
A38	

G.1	Battery (ies)

U.1	Transformer No. 1 - Voltage
U.2	Transformer No. 2 - Voltage

M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
M4	Fan - Pump Motor
M5	Fan - Pulse Control Unit

K1	Contactor - Magnetic Brake
K2	Contactor - Magnetic Brake - Emergency Stop
K3	Contactor - Main
K4	Contactor - Steer
K5	Relay - Fork Spread Solenoid Value Left
K6	Relay - Fork Spread Solenoid Value Left
K7	Relay - Fork Spread Solenoid Value Right
K8	Relay - Fork Spread Solenoid Value Right
K9	
K10	Contactor - Main (Control Circuit)

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

B1 Mast Cut-out - 1
B2 Mast Cut-out - 2
B3 Mast Cut-out - 3
B4 Detection - End of Aisle (right)
B5 Detection - End of Aisle (left)
B6 Aux. Lift (Lowered)
B7 Forks - Rotated Right
B8 Forks - Rotated Left
B8.1 Mast Lift Cut-out
B9 Main Lift - Raise
B10 Main Lift - Lower
B11 Aux. Lift - Raise
B12 Aux. Lift - Lower
B13 Side Shift - Left
B14 Side Shift - Right
B15 Rotate
B16 Damping - Cab
B17 Initiator - Left Outer
B18 Initiator - Right Outer
B19 Initiator - Right Centre
B20 Initiator - Left Centre
B21 Initiator - Right Inner
B22 Initiator - Left Inner
B23 Forks - Left Centre
B24 Forks - Left Inside
B25 Forks - Right Inside
B26 Forks - Right Centre
B27 Forks - Right Outside
B28 Detector - Load
B29
B30
B31
B32
B33
B34
B35
B36
B37
B38
B39
B40

Y1 Valve - Main Lift (Lower)
Y2 Valve - Main Lift (Proportional Valve)
Y3 Valve - Aux. Lift (Proportional Valve)
Y4 Valve - Side Shift (Proportional Valve)
Y5 Valve - Rotate - Proportional Valve
Y6 Brake - Magnetic
Y7 Brake - Magnetic Emergency Stop
Y8 Valve - Solenoid, Fork Spreader
Y9 Valve - Solenoid, Fork Spreader
Y10 Valve - Solenoid, Fork Spread Right
Y11 Valve - Solenoid, Fork Spread Left
Y14 Valve - Aux. Lift - Lower
Y18 Valve - Emergency Lower

F1 Fuse - Pump Motor
F2 Fuse - Traction Motor
F3 Fuse - Steer Motor
F4 Fuse - Control Circuit
F5 Fuse - No. 1 Transformer
F6 Fuse - No. 2 Transformer
F7 Fuse - Rack
F8 Fuse - Rack

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

U.1 Transformer No. 1 Voltage
U.2 Transformer No. 2 Voltage

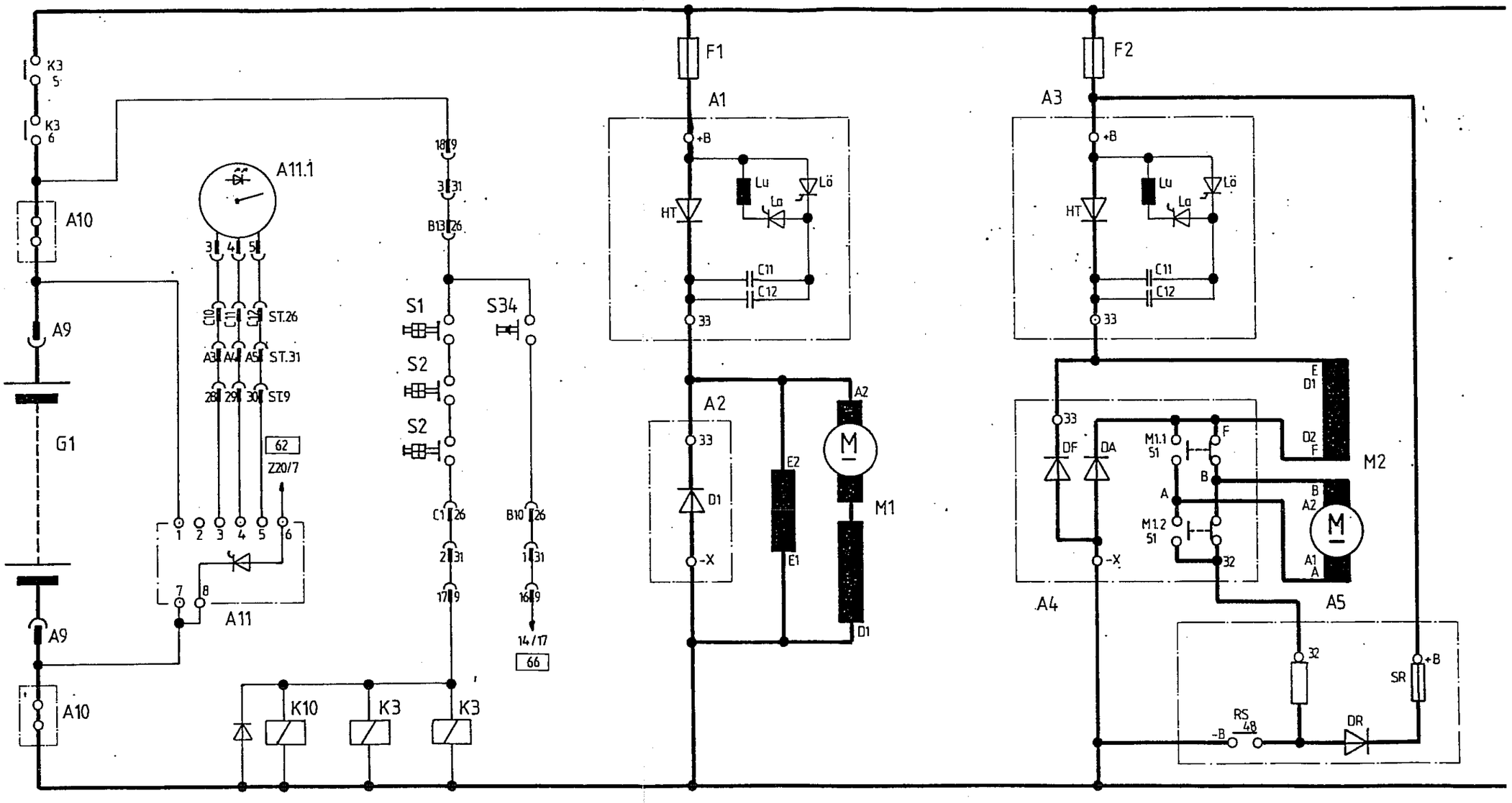
R1 Resistor - Series, Voltage Transformer No. 1
R2 Resistor - Series, Voltage Transformer No. 2

S1 Keyswitch
S2 Switch - Battery Emergency 'Off'
S3 Switch - 10° Steer Angle
S4
S5 Switch - Steer Angle Limit
S6 Switch - Slack Chain Device
S7 Reed Switch - Outer Right
S8 Reed Switch - Centre Right
S9 Reed Switch - Centre Left
S10 Reed Switch - Outer Left
S11 Switch - Forks Right, Without Limit
S12 Switch - Forks Right 1st Limit
S13 Switch - Forks Right End Damping
S14 Switch - Forks Left End Damping
S15 Switch - Forks Left 1st Limit
S16 Switch - Forks Left, Without Limit
S17 Microswitch - Guard Rail, Right
S18 Microswitch - Guard Rail, Left
S19 Reed Switch - Right Inner
S20 Reed Switch - Left Inner
S21 Switch - Override
S22 Push Button - Horn
S23 Switch - Direction "Forward"
S24 Switch - Direction "Reverse"
S25 Dead Man Button on Forward/ Reverse Control
S26 Push Button - Two Hand Control Hydraulic Control Lever
S27 Switch - "Automatic ON" (Steer - Mid Position)
S28 Switch - Lighting Interior
S29 Switch - Patrol Lamp
S30 Switch - Steering Mid-Position
S31 Switch - Working Lights
S32 Dead Man Button - Hydraulic Control (Main Lift)
S33 Sw. Brake Released
S33.1 Brake Released
S34 Push Button - Emergency Lower
S35 Override Sw. - Lift Cut-out
S36 Sw. - Fork Positioning
S37 Switch - Forks, Centre from Left End Damping
S38 Switch - Forks, Centre from Left
S39 Switch, Forks Centre from Right
S40 Switch, Forks Centre from Right End Damping
S41 Switch - Telescopic Table, Centre
S42
S43
S44
S45
S46
S47
S48
S49
S60 Switch - Main Lift
S61 Switch - Aux. Lift
S62 Switch - Side Shift
S63 Switch - Rotate
S64 Switch - Combined Movement Rotate Left
S65 Switch - Combined Movement Rotate Right
S66 Switch - Lower
S67 Switch - Lift
S68 Switch - Slack Chain Device

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

H1	Ind. Lamp - Rotary Patrol Lamp
H2	Ind. Lamp - Cab Lighting
H3	Ind. Lamp - Working Lights
H4	Ind. Lamp
H5	Ind. Lamp - "Automatic ON" (Steer Mid Position)
H6	Ind. Lamp - "Guidance Available"
H7	Ind. Lamp - "Guidance Switched On"
H8	Ind. Lamp - "Mast in Danger Area"
H9	Ind. Lamp - Fork Position
H10	
H11	Lamp - Cab Interior
H15	Ind. Lamp - "Truck in Operational Mode"

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19



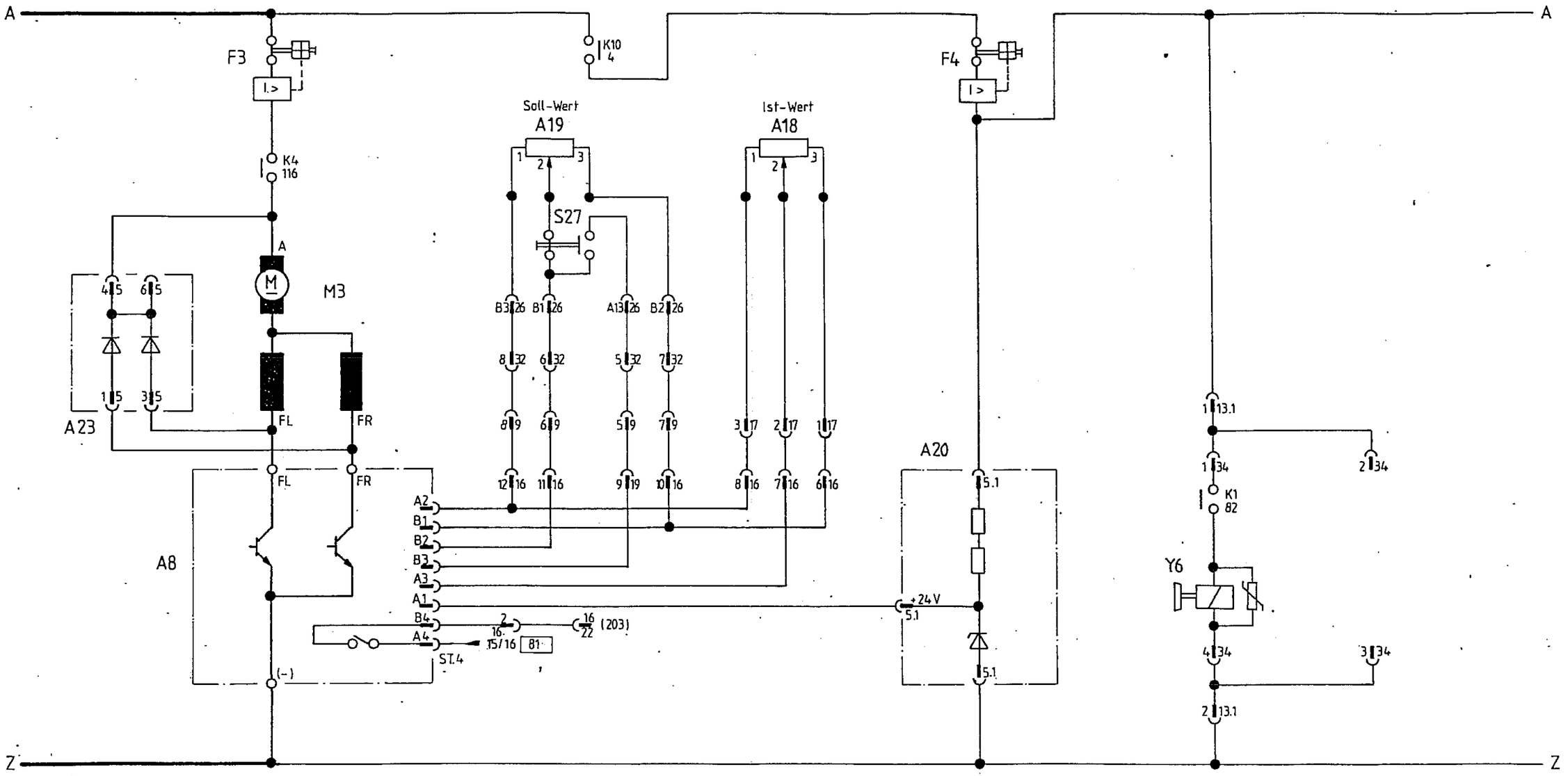
STEINBOCK
BOSS
KD-Schule

Training WA-Schienenführung
mit Proportionalsteuerung
Gruppe 2

LB 426 3691

STEINBOCK	Benennung: Stromlaufplan WA	462303 Sach-Nr.	Bl. 16

Datum 15.9.80 gez. RM



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LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	462303 Sach-Nr.	Bl. 2+ 16 Bl

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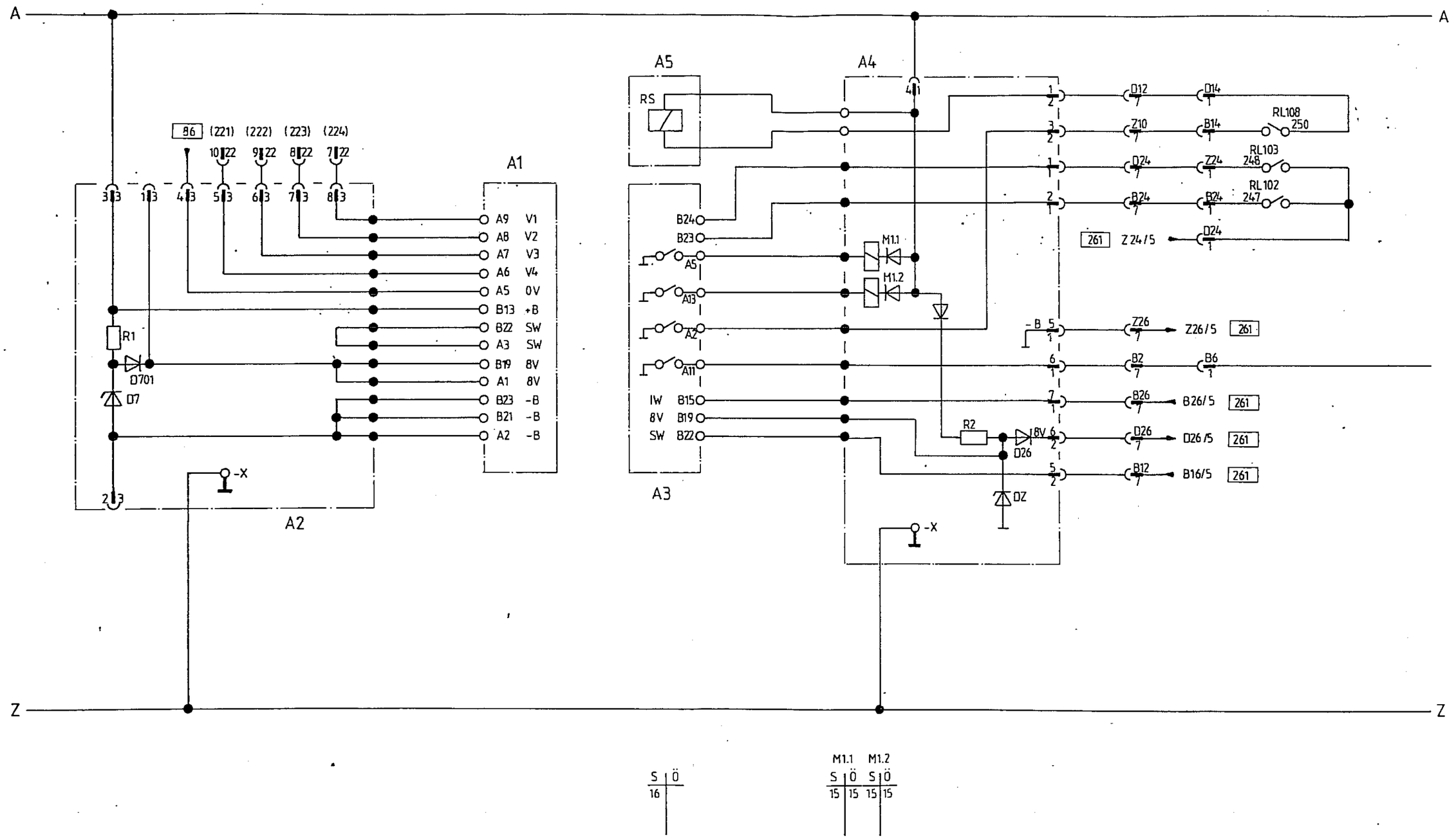

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LB 4263691

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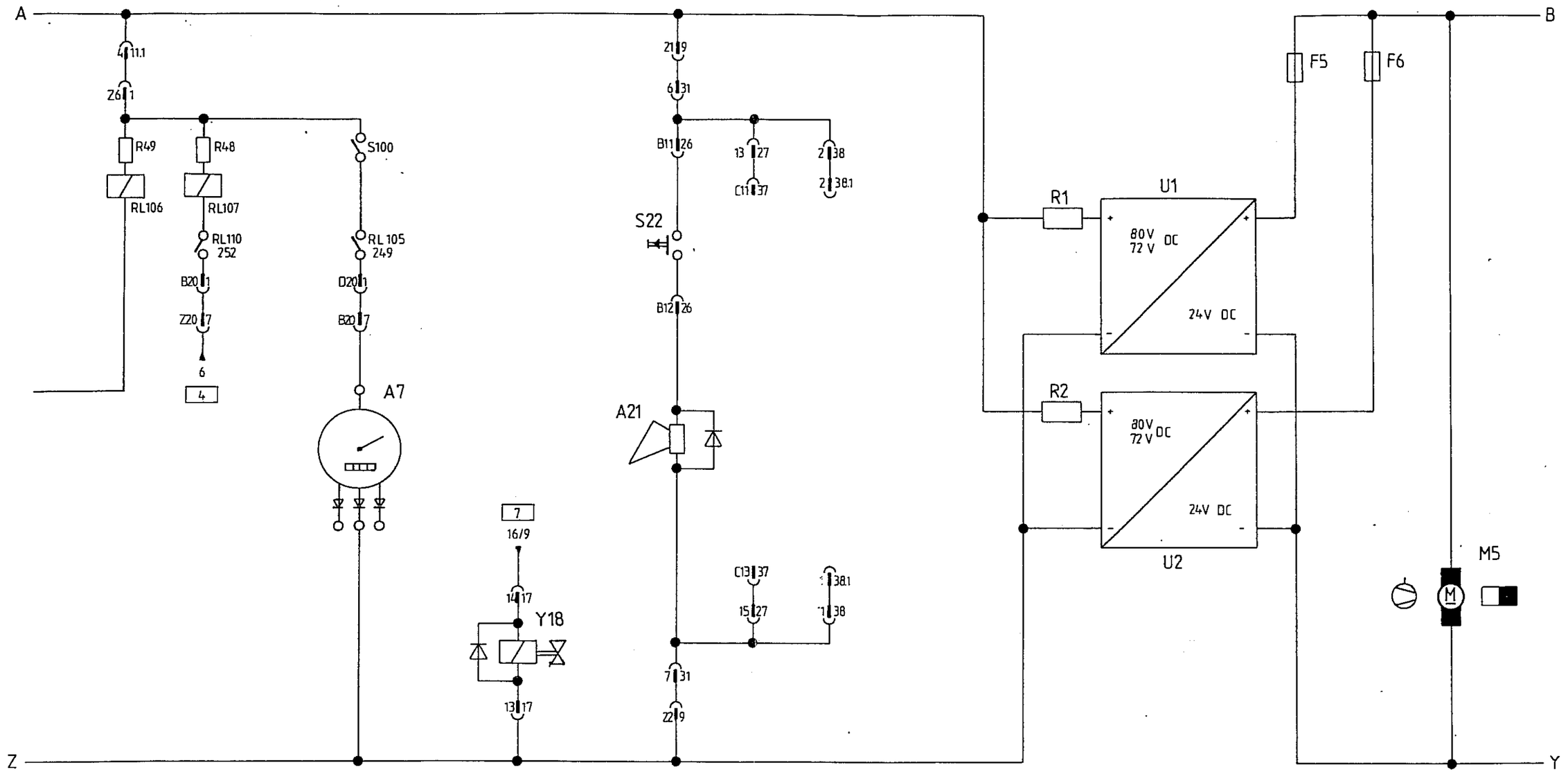


S Ö
245

S Ö
248

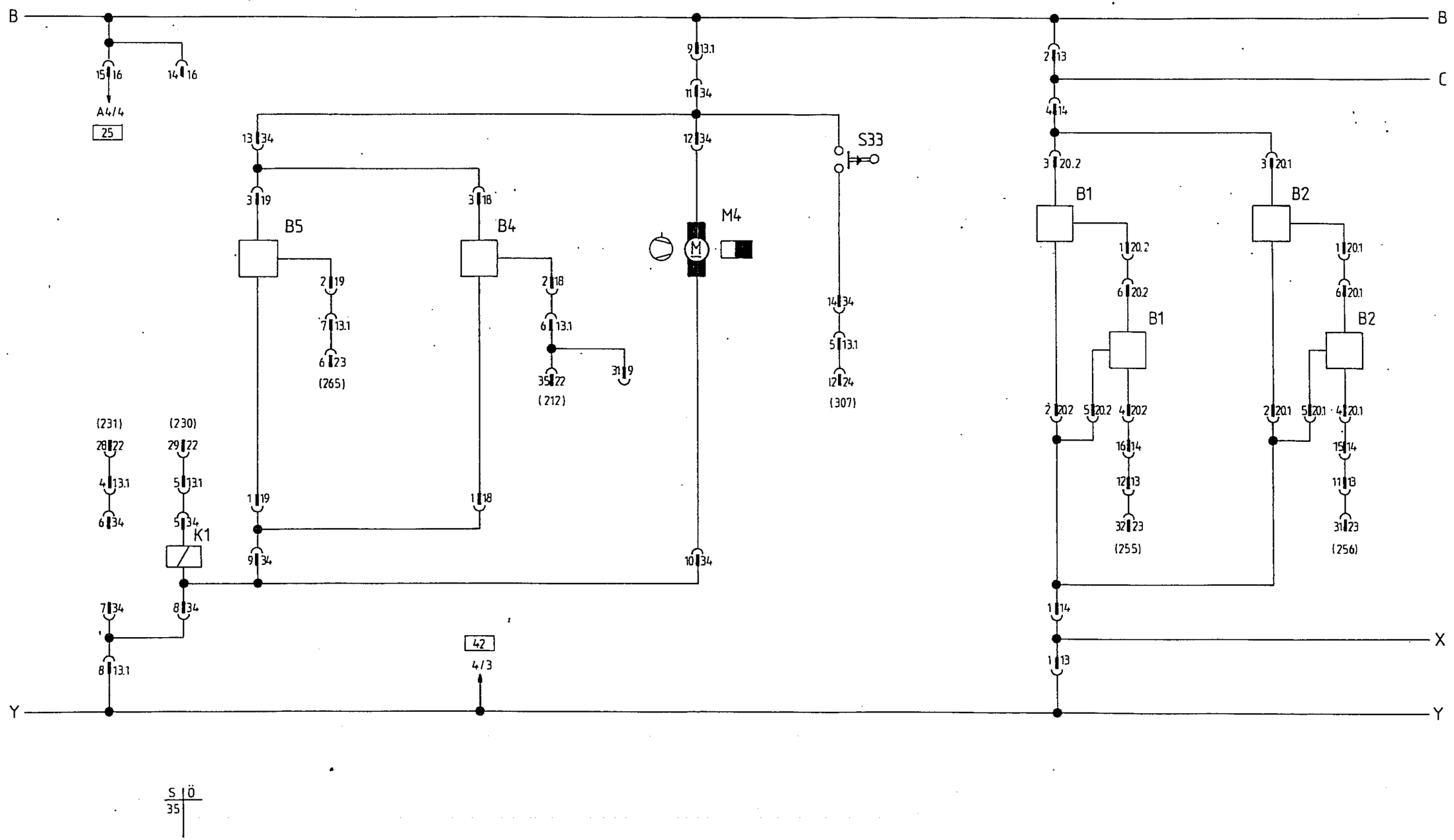
Datum 18.9.89 gez. PM

LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	Sach-Nr. 462303	Bl. 4+ / 16 Bl

SALE

80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99



S | Ö
35

Datum: 18.9.89 gez · PM

LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	Sach-Nr 462303	Bl. 5 + 16 Bl.

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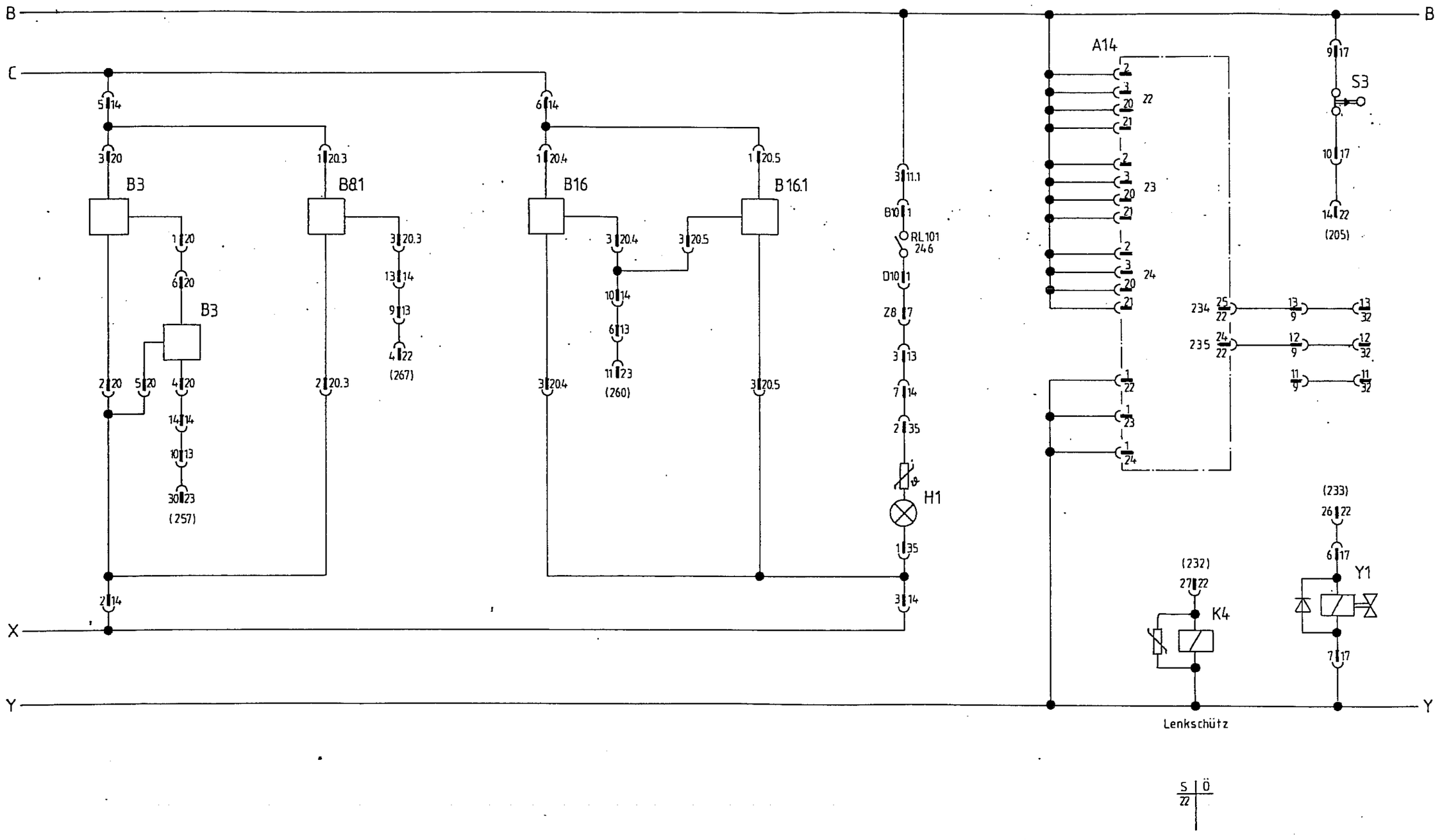

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Datum: 18.9.89 gez PM

Formular Nr. 02 .M 85

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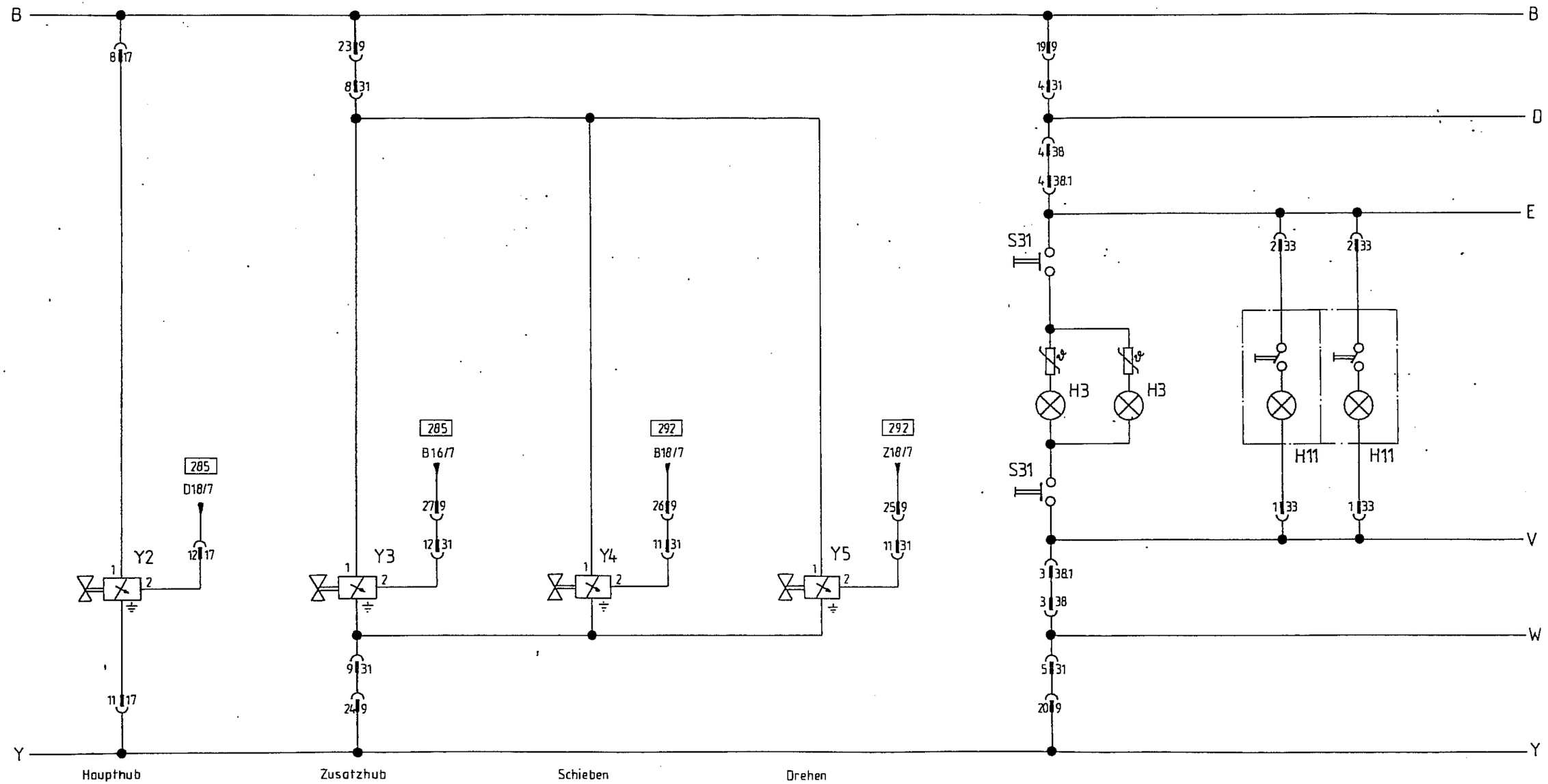

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STEINBOCK	Benennung Stromlaufplan WA	Sach-Nr 462303	Bl 7+ / 16 B

Datum 18.9.89 gez. PM

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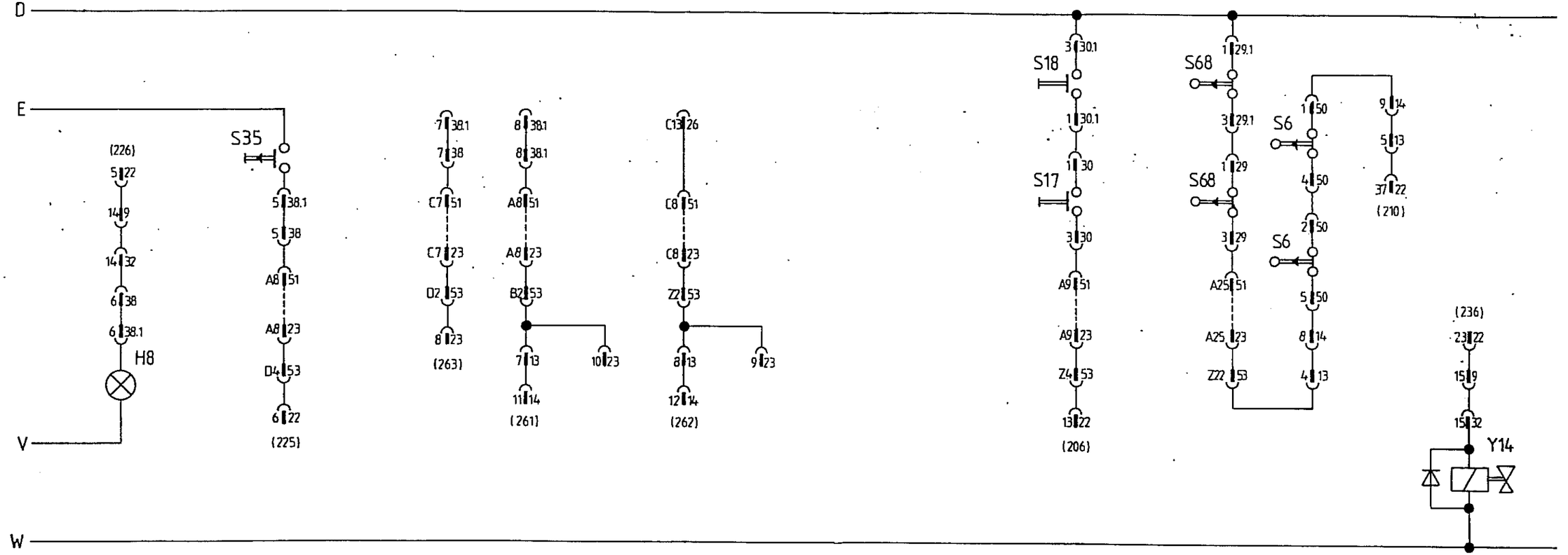

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LB 4263691

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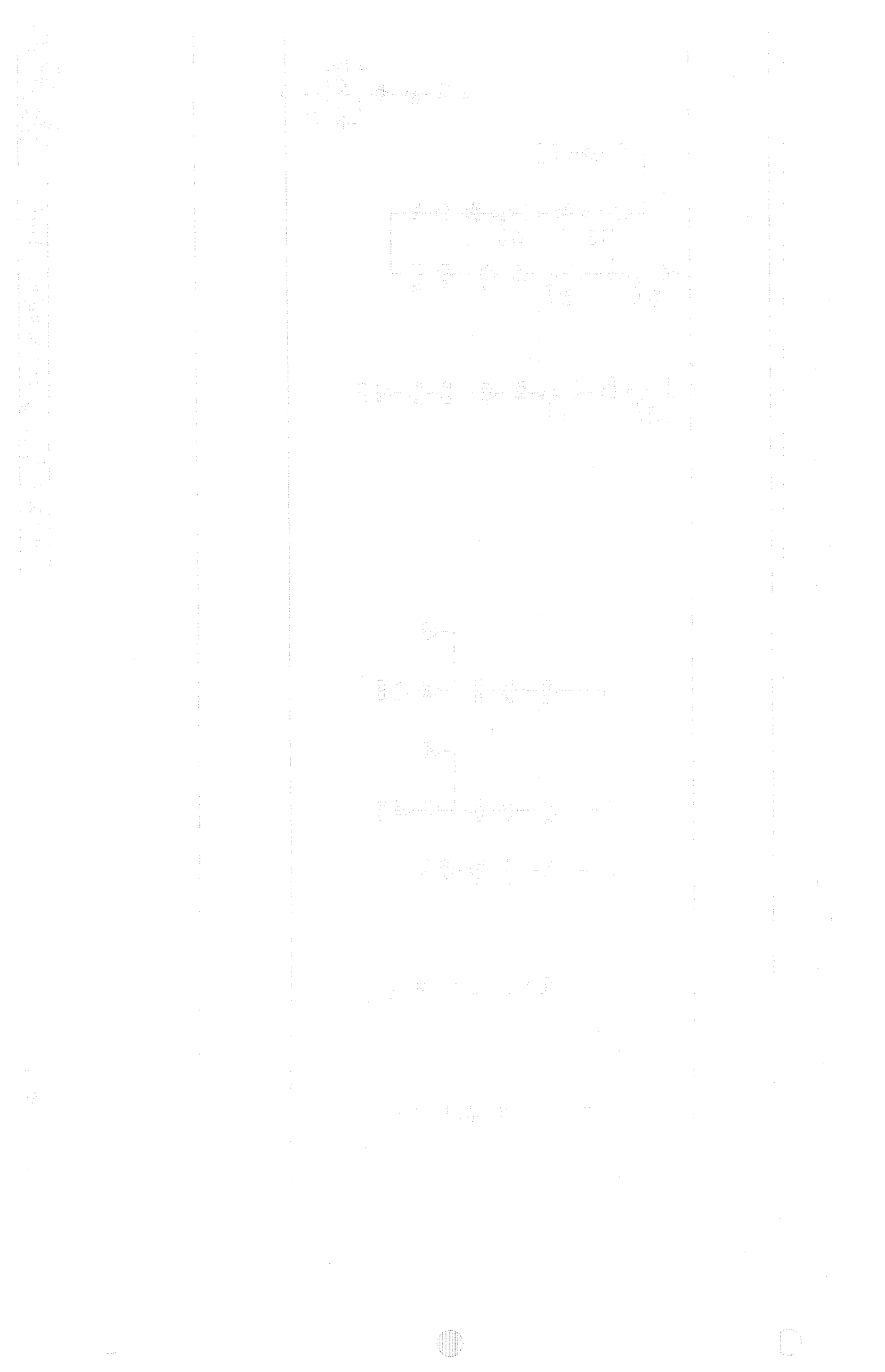

Formular Nr 04 . N 65

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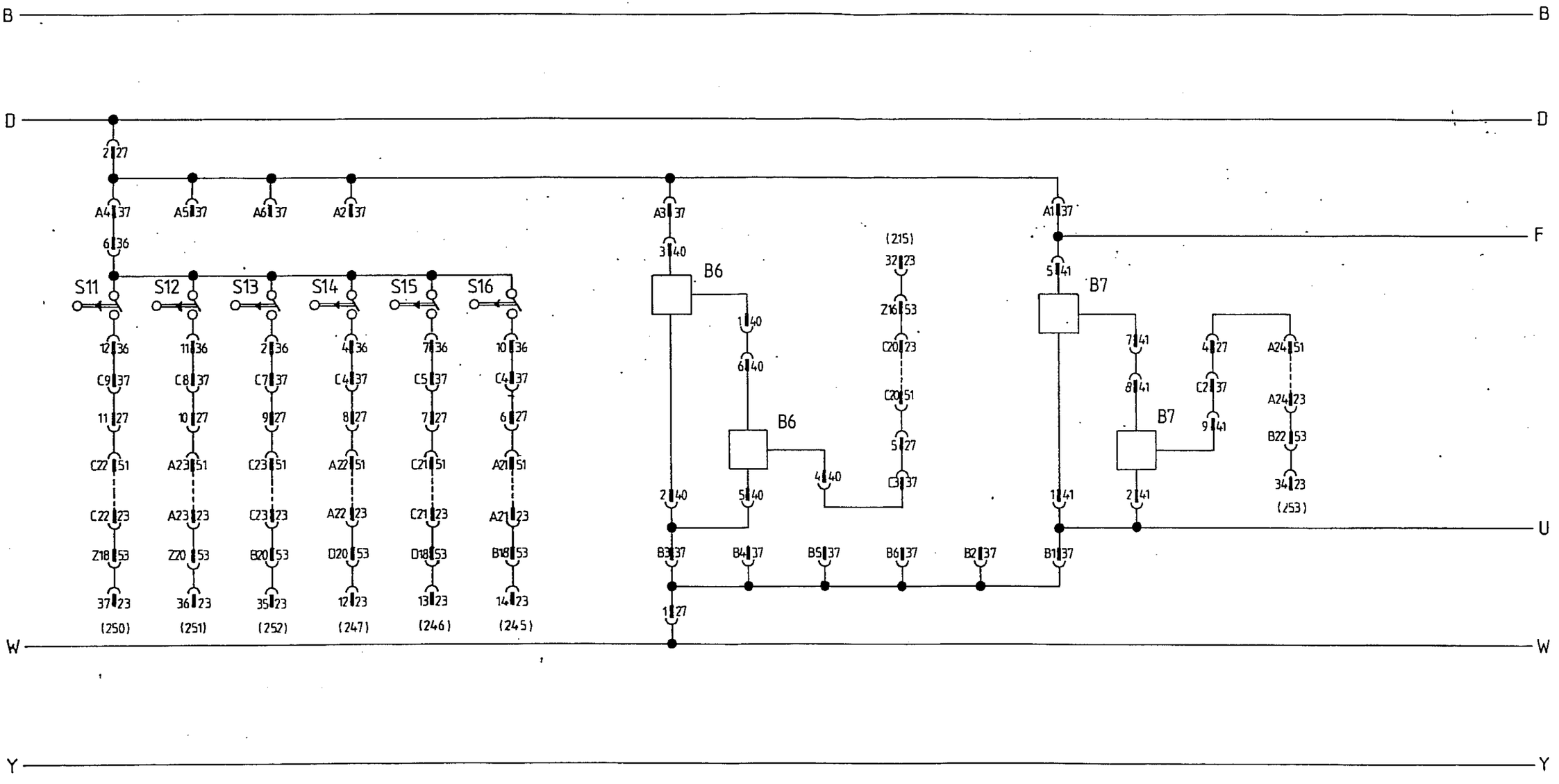

Datum 18.9.89	gez PM			LB 426 3691		
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180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199

B — B

D

F

6|41

B8

10|41

11|41

B8

12|41

3|44

4|41

U

3|27

C1|37

C24|51

C24|23

D22|53

33|23

(254)

A30.1

A1|51

C29/51 4/32 4/9 D24/53 280

C30/51 3/32 3/9 B24/53 280

C31/51 2/32 2/9 Z24/53 280

C32/51 1/32 1/9 D26/53 280

A2|51

W

A2|26

A31

7|10

1|10

S32

S66

S67

k.Störung. ⑤

12VC 10/10

B1 8/10 A9/26 A16/51 A16/23 B14/53 18/24 (301)

B2 5/10 A10/26 C16/51 C16/23 D14/53 17/24 (302)

B3 2/10 A11/26 A17/51 A17/23 D16/53 16/24 (303)

B4 12/10 A12/26 C17/51 C17/23 Z14/53 15/24 (304)

3/10 A5/26 A11/51 A11/23 D8/53 34/22 (213)

6/10 A7/26 C12/51 C12/23 B8/53 30/22 (217)

9/10 A6/26 A12/51 A12/23 Z8/53 31/22 (216)

11/10 A8/26 C15/51 C15/23 B12/53 19/24 (300)

4|10

A1|26

S27

H5

G

T

Y — Y

Hydraulikregler

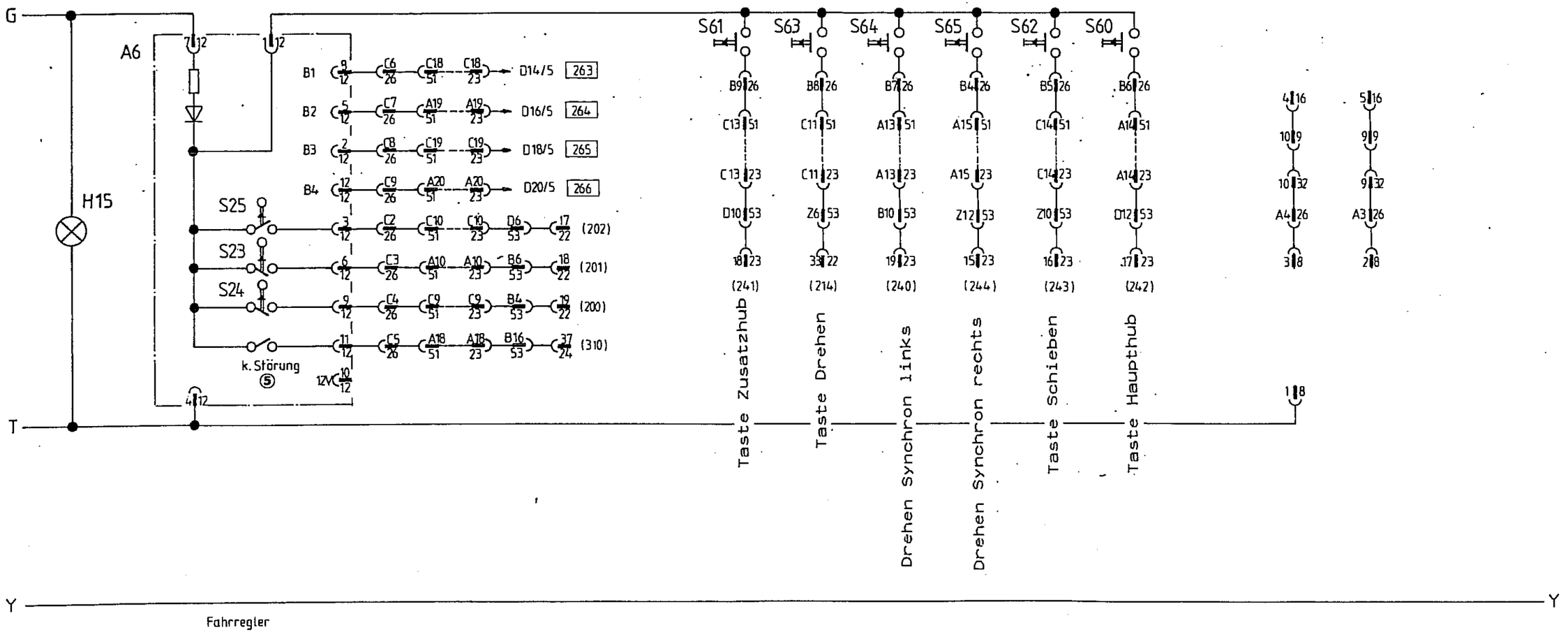
LB 426369.1

Datum: 18.9.89 gez: PM

STEINBOCK | Benennung Stromlaufplan WA | Sach-Nr 462303 | Bl. 10+ 16 Ei

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219

B — B



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LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	462303 Sach-Nr	Bl. 11+ 16 Bl

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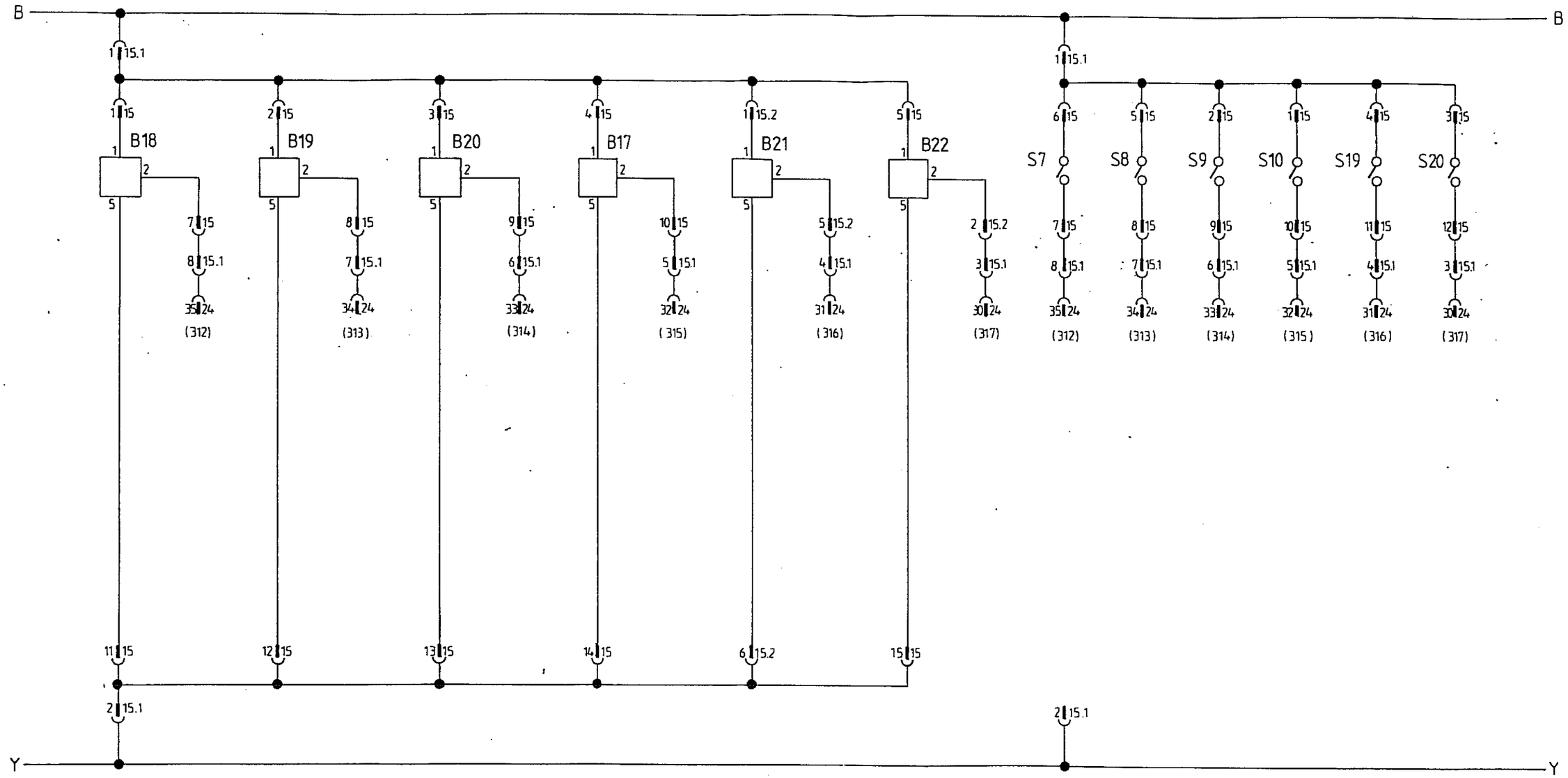

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LB 4263691

STEINBOCK	Benennung Stromlaufplan WA	Sach-Nr. 462303	Bl 12+ / 16 Bl

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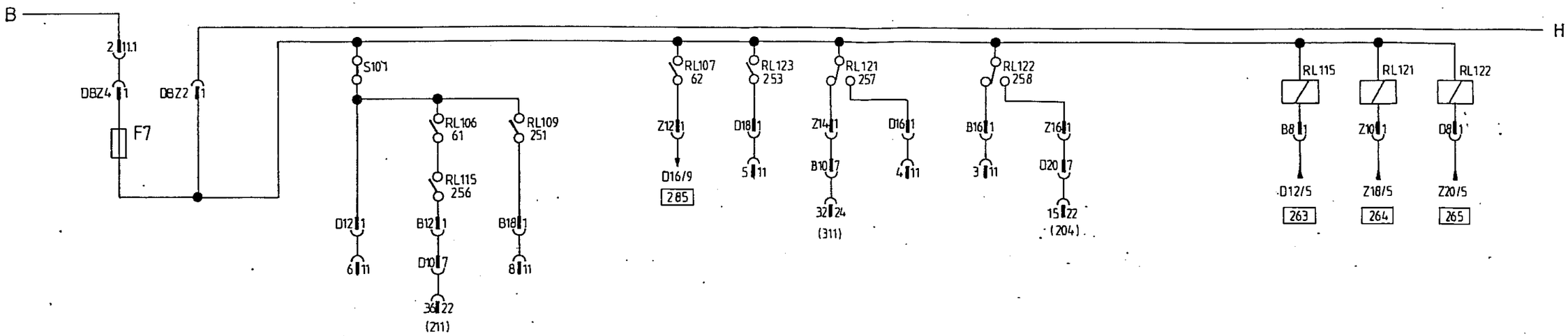

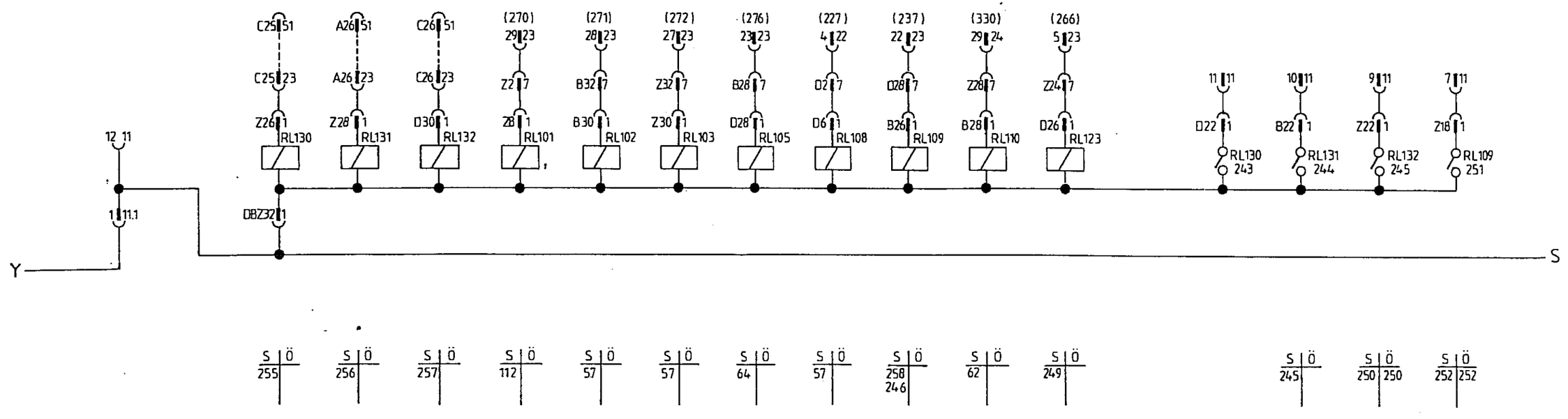

Datum: 18.9.89 gez. PM

LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	462303 Sach-Nr	Bl. 13+ 16 E.

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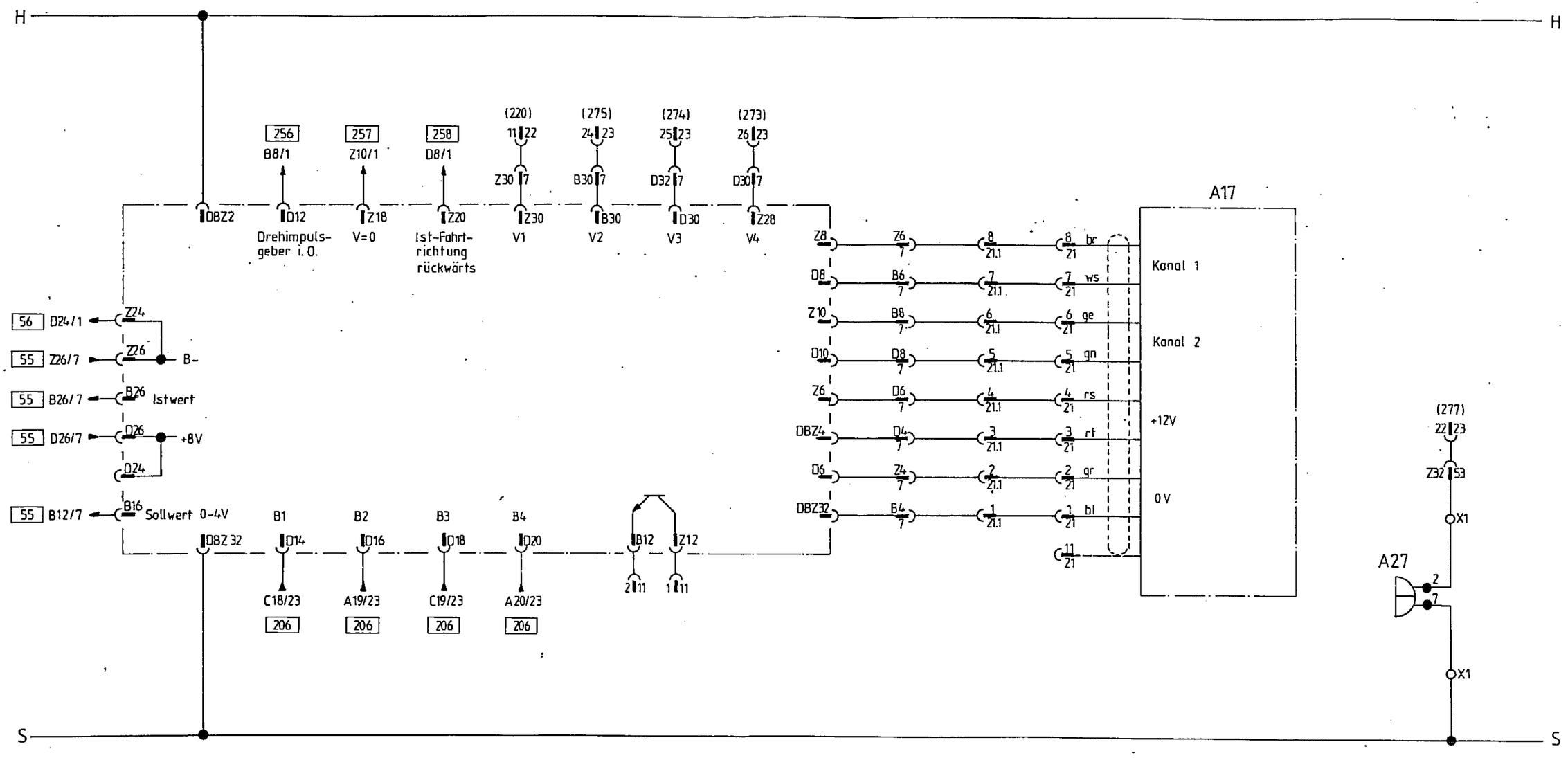

Steckplatz 5
Fahrregelungskarte

Datum: 18.9.89 gez.: PM

LB 426 3691

STEINBOCK	Benennung Stromlaufplan WA	462303 Sach-Nr.	Bl 14 + / 16

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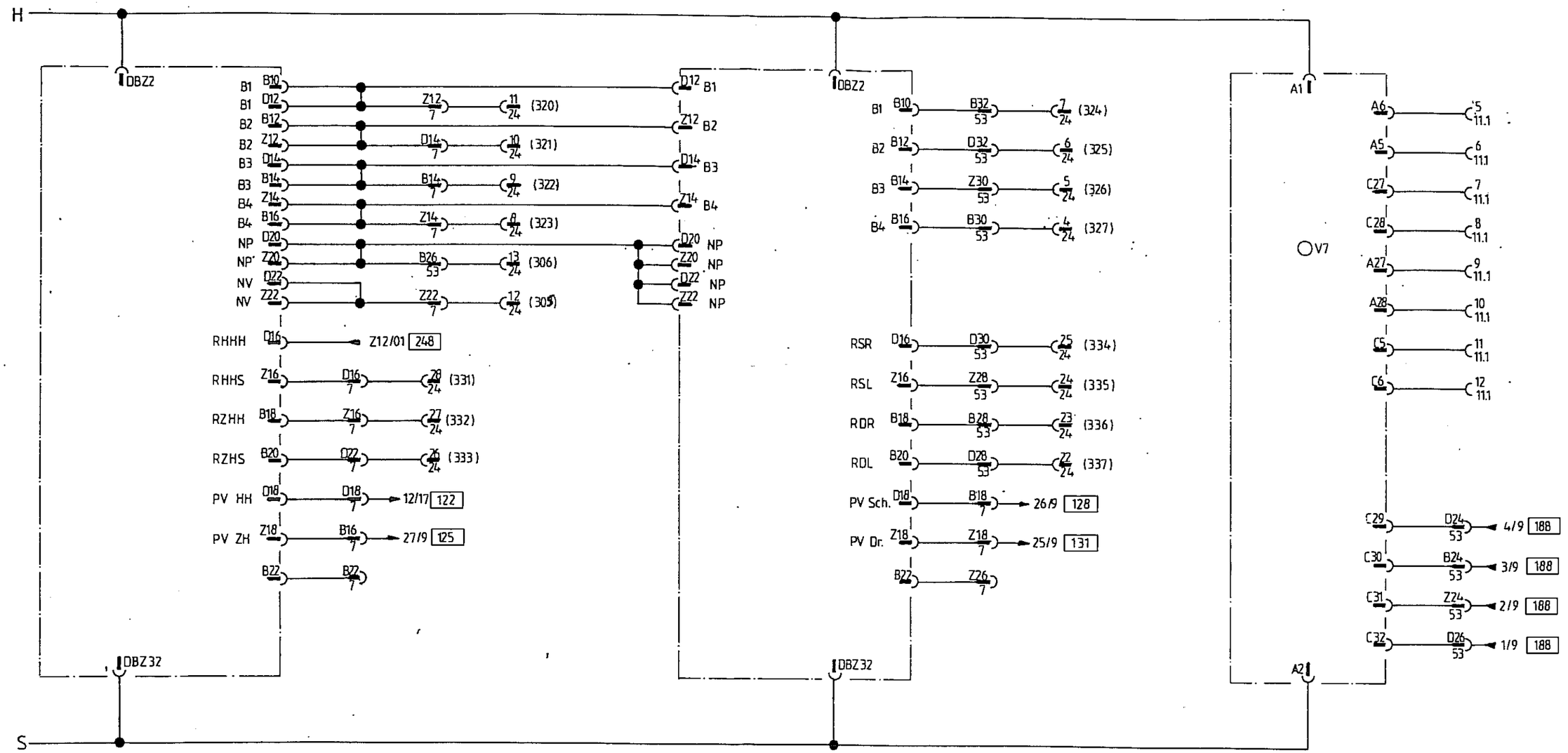


0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

G1 Batterie

U1 1. Spannungswandler
U2 2. Spannungswandler

R1 Vorwiderstand 1. Spannungswandler
R2 Vorwiderstand 2. Spannungswandler

K1 Schütz Magnetbremse
K2 Schütz Magnetbremse Not-Stop
K3 Hauptschütz
K4 Lenkschütz
K10 Hauptschütz Steuerstrom

M1 Pumpmotor
M2 Fahrmotor
M3 Lenkmotor
M4 Lüfter Pumpmotor
M5 Lüfter Impulssteuerungen

F1 Pumpmotorsicherung
F2 Fahrmotorsicherung
F3 Sicherungsautomat Lenkmotor
F4 Steuerstromsicherung
F5 Sicherung 1. Spannungswandler
F6 Sicherung 2. Spannungswandler
F7 Sicherung Baugruppenträger

H1 Rundumleuchte
H3 Arbeitsscheinwerfer
H5 Automatik ein (Lenkung Mittelstellung)
H6 Einspuren möglich
H7 Einspurvorgang läuft
H8 Mast im Gefahrenbereich
H9 Zinkenverstellung
H11 Kabinenbeleuchtung
H15 Gerät betriebsbereit

B1 Mast 1. Abschaltung
B2 Mast 2. Abschaltung
B3 Mast 3. Abschaltung
B4 Gangerkennung rechts
B5 Gangerkennung links
B6 Zusatzhub unten
B7 Gabel rechts geschwenkt
B8 Gabel links geschwenkt
B8.1 Mast Hubabschaltung
B16 Dämpfung Kabine
B17 Initiator links außen
B18 Initiator rechts außen
B19 Initiator rechts mitte
B20 Initiator links mitte
B21 Initiator rechts innen
B22 Initiator links innen

Y1 Ventil Haupthub senken
Y2 Prop-Ventil Haupthub
Y3 Prop-Ventil Zusatzhub
Y4 Prop-Ventil schieben
Y5 Prop-Ventil drehen
Y6 Magnetbremse
Y7 Magnetbremse Not-Stop
Y8 Zinkenverstellung
Y9 Zinkenverstellung
Y14 Zusatzhub senken
Y18 Ventil Notablaß

S1 Schlüsselschalter
S2 Not-Aus Schalter
S3 10° Lenkanschlag
S5 Lenkwinkelbegrenzung
S6 Schlaffkettensicherung
S7 Reedschalter rechts außen
S8 Reedschalter rechts mitte
S9 Reedschalter links mitte
S10 Reedschalter links außen
S11 Gabel rechts ohne Begrenzung
S12 Gabel rechts 1. Begrenzung
S13 Gabel rechts Endlagendämpfung
S14 Gabel links Endlagendämpfung
S15 Gabel links 1. Begrenzung
S16 Gabel links ohne Begrenzung
S17 Fallriegelschalter rechts
S18 Fallriegelschalter links
S19 Reedschalter rechts innen
S20 Reedschalter links innen
S22 Taste Horn
S23 Fahrtrichtungsschalter vorwärts
S24 Fahrtrichtungsschalter rückwärts
S25 Totmannknopf Fahrhebel
S27 Automatik ein (Lenkung Mittelstellung)
S31 Arbeitsscheinwerfer
S32 Totmannknopf Hydraulikhebel
S33 Bremse gelöst
S33.1 Bremse gelöst
S34 Taste Notablas
S35 Überbrückungstaste Hubabschaltung
S36 Zinkenverstellung
S60 Haupthub
S61 Zusatzhub
S62 Schieben
S63 Drehen
S64 Synchron-Drehen links
S65 Synchron-Drehen rechts
S66 Senken
S67 Heben
S68 Schlaffkettensicherung

A1 Leistungsteil Hydraulik
A2 Motorteil Hyd.
A3 Leistungsteil Fahr.
A4 Motorteil Fahr.
A5 Rückspeisemodul
A6 Fahrregler
A7 Betriesstundenzähler
A8 Lenkelektronik
A8.1 Lenkendstufe
A9 Batteriesteckvorrichtung
A10 Klemmsockel
A11 Batteriekontrollgerät
A11.1 Anzeigegerät Batteriekontrollgerät
A12 Baugruppenträger PHB
A13 Baugruppenträger Steinbock
A14 Freiprogrammierbare Steuerung
A15 Antenne vorne
A16 Antenne hinten
A17 Drehimpulsgeber
A18 Istwertpotiometer
A19 Sollwertpotiometer
A20 Spannungsversorgungsmodul
A21 Horn
A22 Summer
A23 Diodenmodul
A24 Frequenzvorwahl
A25 Antenne mitte
A27 Summer BGT
A30.1 Multiplex-Sender
A31 Hydraulikhebel

Datum 21.9.89 gez PM

LB 4263691

STEINBOCK	Benennung Stromlaufplan WA	462303 Sach-Nr.	Bl. 16 / 16 B

SECTION
1

THINK '!SAFETY FIRST!'

1. All repair work must be undertaken with due regard for all Health and Safety at Work regulations which are relevant to the truck in question.

2. In order to prevent accidents when carrying out maintenance or commissioning work on the truck, always observe the necessary safety precautions. Ensure that the truck cannot move accidently or be switched on unintentionally (e.g. on electric trucks, disconnect the battery plug). When working beneath an elevated lifting device (e.g. cab or auxiliary lift mast) it must be secured against accidental lowering.

3. Flammable liquids must not be used for cleaning purposes. Precautions must be taken to prevent the generation of sparks from short circuits e.g. disconnect the battery. If it is intended to clean the truck in a hot water wash, all vulnerable (especially electrical) components must be covered up carefully.

   Clean electric and electronic components using compressed air (not high pressure air) and a metal free brush.

4. When lifting the truck or attachments, using lifting tackle always attach the lifting gear to the lifting points provided for that purpose. If the truck must be jacked up it must be secured against accidental movement (running away or tipping over) by the use of chocks or wooden blocks.

5. Work may be carried out on the electrical system only when the system is in a NO VOLT condition. Functional testing, checking and adjustments of components under voltage loading, must be carried out by experienced, authorised personnel and subject to all relevant safety precautions.

REMOVE RINGS, METAL BRACELETS, ETC PRIOR TO COMMENCING WORK ON ELECTRICAL COMPONENTS. DANGER OF ARCING.

6. After maintenance and/or commissioning, re-install all safety devices and check that they function correctly.

7. When carrying out repairs or when renewing electric or hydraulic components pay close attention to the setting values which are particular to the truck.

8. To prevent damage to systems with electric components e.g. electronic drive control, lift control, these components should be disconnected before commencing arc - welding work.

9. Personnel are forbidden to loiter within the danger area of a lift truck. DANGER AREA is the area in which personnel are at risk from:- movement of the truck; its working equipment; its load handling equipment or load itself. The area also includes that into which loads may fall or into which the working equipment may fall or be lowered.

   It is forbidden to stand or to pass underneath elevated forks or attachments - this applies equally whether the truck is laden or unladen. Holding on to or climbing on any moving parts of the truck (e.g. mast, side shift, carriage, etc.) is forbidden.

10. When carrying out test drives on the truck pay attention to all relevant Operating Instructions, especially those relating to the technical Safety Instructions included there in.

CONTENTS
Section 1
OM559 ETA12/15

NOTE: The following truck model abbreviations found in this manual are listed below with their current equivalent abbreviation:
WA = ETA
WA12 = ETA12
WA15 = ETA15

Addendum to OM559
ETA 12/15

Initial and Routine Service Schedules (page 49)

Operator Service Routines

	Daily or before Shift Changes
2.1 Visual Checks - Motor Running Warning/Indicator Devices	•
3.1 Functional Checks Warning/Indicator Devices	•

Routine Servicing- Mechanic

	Every 250 Hours	Every 500 Hours	Every 1000 Hours	Every 2000 Hours
6.1 Electrical System Warning/Indicator Devices	•	•	•	•

Maintenance Schedules (page 40)

Electrical System

5. Warning/Indicator Devices

At the period stated in the Routine Service Schedules, check that all warning/indicator devices (audible and visual; standard and optional) fitted to the truck are functioning properly.

5.1 Simulate the fault condition or function during which the warning/ indicator device should operate and check that either or both of the following operate;
- warning lights in the instrument panel come on.
- audible warning buzzer sounds.

5.2 If any warning/indicator device is not working properly, correct the fault before beginning work tasks.

Addendum

Operator's / Planned Maintenance & Adjustment Manual

You must be trained and authorized to operate a lift truck.

YOU can prevent accidents!

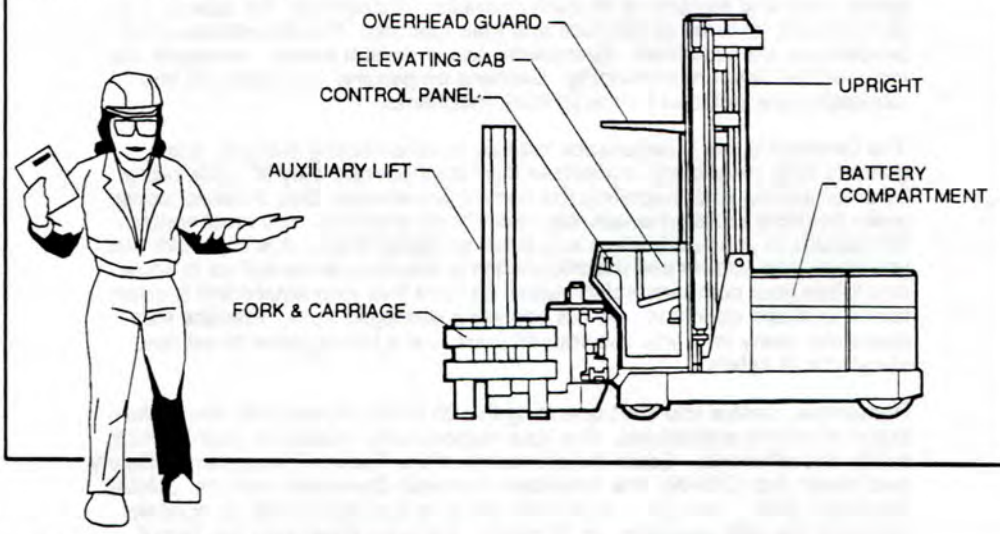
Safe operation is the responsibility of the operator.

First: Learn safe operating rules and your company rules.

Next: Read and understand your Operator's Manual.

Learn about the unit you operate.

KNOW YOUR TRUCK



Then: Practice operating your truck safely.

And: Keep your truck in safe operating condition with correct and timely maintenance.

Breaking these rules will cause serious or fatal injury to yourself and others.

A Message To CLARK Lift Truck Operators

Lift trucks are specialized machines with unique operating characteristics designed to perform specific jobs. Their function and operation is not like a car or ordinary truck. They require specific instructions and rules for safe operation and maintenance.

Safe operation of lift trucks is of primary importance to CLARK. Our experience with lift truck accidents has shown that when accidents happen and people are killed or injured, the causes are:

- OPERATOR NOT PROPERLY TRAINED
- OPERATOR NOT EXPERIENCED WITH LIFT TRUCK OPERATION
- BASIC SAFETY RULES NOT FOLLOWED
- LIFT TRUCK NOT MAINTAINED IN SAFE OPERATING CONDITION

For these reasons, CLARK wants you to know about the safe operation and correct maintenance of your lift truck.

This manual is designed to help you operate your lift truck safely. This manual shows and tells you about safety inspections and the important general safety rules and hazards of lift truck operation. It describes the special components and features of the truck and their function. The correct operating procedures are explained. Illustrations and important safety messages are included for clear understanding. Sections on general maintenance and lubrication are included for the lift truck mechanic.

The Operator's and Maintenance manual is not a training manual. It is a guide to help trained and authorized operators operate their lift truck safely by emphasizing and illustrating the correct procedures. But, it cannot cover every possible situation which may result in an accident. You must watch for hazards in your work areas and avoid or correct them. It is important that you know and understand the information in this manual as well as to know and follow your company safety rules! Be sure that your equipment is maintained in a safe condition. Do not operate a damaged truck. Practice safe operation every time you use your lift truck. Let's join together to set new standards in safety.

Remember, before you start operating this lift truck, be sure that you understand all driving procedures. It is your responsibility to operate your lift truck safely and efficiently. Learn the standards of the Federal Occupational Safety and Health Act (OSHA), the American National Standards Institute (ANSI) Standard B56.1 and your state laws requiring operators to be completely trained in the safe operation of lift trucks. Ask your supervisor for help if you have any questions about training or operation.

CLARK lift trucks are built to take hard work, but not abuse. They are built to be dependable, but they are only as safe and efficient as the operator and the persons responsible for maintaining them. Do not make any repairs to this truck unless you have been trained in lift truck repair procedures and authorized by your employer.

Health And Safety At Work

The health and safety precautions and warnings in the following three sections are important and should be read in conjunction with the other precautions listed throughout this Operator's & Maintenance manual.

The precautions and warnings should be read and understood by all personnel who will be operating or servicing the truck.

Note that the instructions and service routines set out in section 'A' are mandatory and are in addition to the routines laid out in the Maintenance Schedule section of this manual.

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Health and Safety Information

⚠ WARNINGS

All personnel operating, or servicing the truck must be aware of the risks associated with the handling of industrial solvents, lubricants and other materials with which they may come into contact while operating or servicing the truck. The products and hazards most frequently encountered and the precautions for the safe operation and servicing of the truck and the handling and disposal of scrap and waste products, are summarized below.

1. **General**
   Avoid prolonged skin contact with all industrial solvents and lubricants.

   Fluids, fuels, greases and liquified or compressed gaseous products must be stored in proper containers or cylinders which must be clearly labeled or marked to indicate the contents and marked with warning labels.

   After use, dispose of protective clothing in sealed plastic sacks. Mark or label sacks clearly, indicating nature of contents e.g. 'gloves' etc. and possible contaminants 'Asbestos Dust' etc.

   Dispose of the sacks in an approved manner.

2. **Asbestos Dust or Scrap** (e.g. from brake drums, exhaust lagging, heat shields)

   Extremely serious risk to health if the dust is inhaled - even in small amounts. If any risk, use a face mask/respirator.

   ALWAYS wet down dust fragments (e.g. with Safeclean) before collecting waste in plastic sacks marked "ASBESTOS WASTE' for disposal.

   NEVER 'blow out' brake drums with compressed air.

   ALWAYS wear protective clothing.

3. **Man-made Fibers** (e.g. sound insulation)
   Take the same precautions as for handling asbestos.

4. **Fluoroelastomers** - Present in Viton seals, 'O'-rings, Gaskets
   Prefectly safe under normal design conditions, but Viton seals, 'O'-rings etc. decompose at high (above 40°C) temperatures e.g. truck on fire. Residue extremely corrosive and almost impossible to remove from skin.

   ALWAYS wear protective clothing when cleaning off residue from components.

⚠ WARNINGS

5. **Oils and Greases**
   Risk of skin infection; especially to sensitive skins.

   Avoid prolonged skin contact - Use a barrier cream.

   NEVER 'wash' hands in oil.

6. **Paints and Thinners**
   Highly flammable when atomized for spraying. Fumes from thinners will 'creep' along the floor, with risk of ignition. Paint or thinner soaked rags may ignite spontaneously if left in trash bins etc.

   NEVER inhale paint spray or thinner vapor.

   NEVER smoke or have open flames in the vicinity of paint spraying operations.

   ALWAYS wear the correct face mask when paint spraying.

7. **Kerosene and Gasoline**
   Highly flammable; especially gasoline and gasoline vapor.

   Welding or grinding 'empty' tanks is particularly hazardous. Fill with water and drain several times and then fill or partially fill with water to reduce vapor volume to a minimum.

   PROHIBITED in the vicinity; Smoking - Open flame - Bare light.

8. **Diesel Fuel**
   Take similar precautions to those for kerosene and gasoline.

9. **Glues, Adhesives and Solvents**
   Many vapors are flammable and/or toxic if inhaled.

   Non-flammable vapors may decompose at high temperatures to form highly toxic gases e.g. when inhaled through a lighted cigarette.

   Exercise same care as for kerosene and gasoline.

⚠ WARNINGS

10. Industrial Gases Including L.P.G.
Contents of cylinders are toxic, corrosive or flammable.

NEVER smoke or use a bare light when connecting or disconnecting cylinders. Shut main valve when cylinder is not in use.

When parking an L.P.G. engine truck e.g. during lunch breaks, shift changes or overnight, ALWAYS shut the feed valve before leaving the truck.

11. Compressed Air
Tanks filled to pressure higher than the designed maximum pressures will explode.

NEVER override or 'tie down' a safety valve or pressure relief valve.

NEVER direct a compressed air jet against the skin.

Tires which are over inflated are liable to explode.

12. Electricity
Severity of shock depends on current flowing through the body.

Take care to avoid risk of shock in wet/damp environments. Remove rings, watches etc. before working on the electrical system.

220/240 volt mains, which supply operated electrical equipment, must be double insulated. Otherwise check grounding continuity monthly including leads and extensions.

13. Electric Welding 'Flash'
May damage the eyesight if no eye protection is used. 'Side Flash' is also potentially dangerous.

NEVER look at the weld arc.

ALWAYS position a screen to protect bystanders.

ALWAYS use an approve shield or goggles when welding.

⚠ WARNINGS

14. Flame Cutting/Welding
Protect adjacent components, hoses etc. from sparks and hot metal splashes when using oxy-gas cutting (or welding) equipment.

15. Battery Acid
The battery electrolyte contains dilute sulfuric acid which is corrosive. Handle batteries with care and wear the appropriate protecting clothing.

Splashes on skin - Wash with large amounts of clean water.

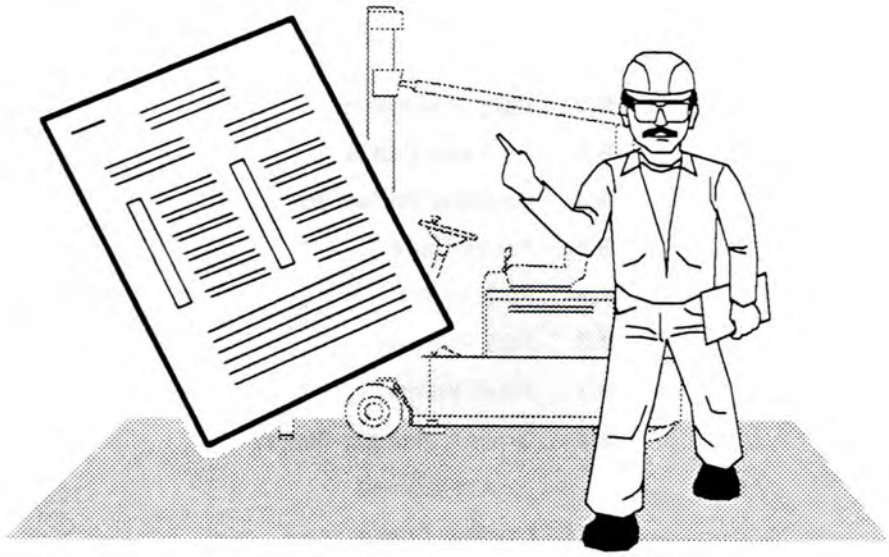
Splashes in eye - Irrigate thoroughly with clean water and seek medical advice immediately.

16. Battery Vapor
Batteries produce an explosive gas.

NEVER smoke or use an open flame when changing or working around batteries.

General Safety Rules

General Safety Rules
Daily Inspection



At the beginning of each shift inspect your truck and fill out a daily inspection sheet.

Check for damage and maintenance problems.

Have problems, even minor ones, repaired before you operate the truck.

Do not make repairs yourself. Lift truck mechanics are trained professionals. They know how to make repairs safely.

General Safety Rules

Do's and Don'ts

DON'T MIX DRUGS OR ALCOHOL WITH YOUR JOB.

DO WATCH FOR PEDESTRIANS

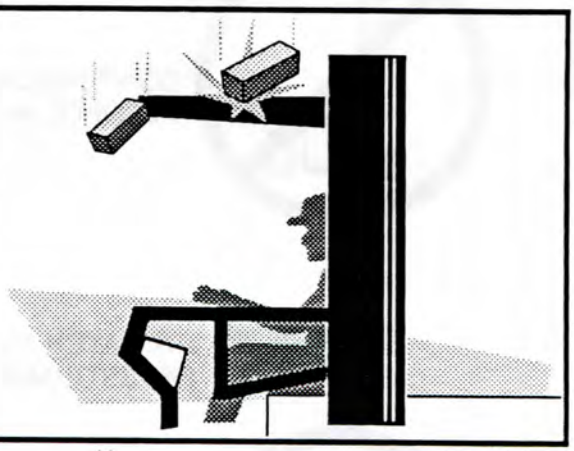
DON'T BLOCK SAFETY OR EMERGENCY EQUIPMENT

DO WEAR SAFETY EQUIPMENT WHEN REQUIRED

DON'T SMOKE IN "NO SMOKING" AREAS

Stay under the overhead guard.

Always keep your body within the confines of the operator's compartment.

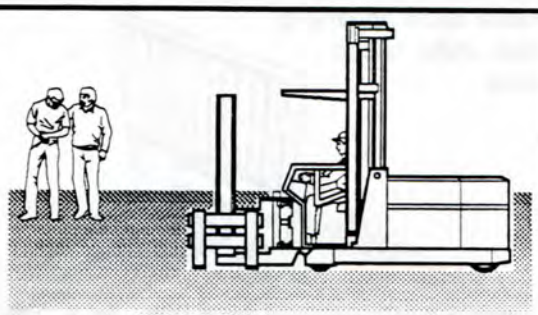


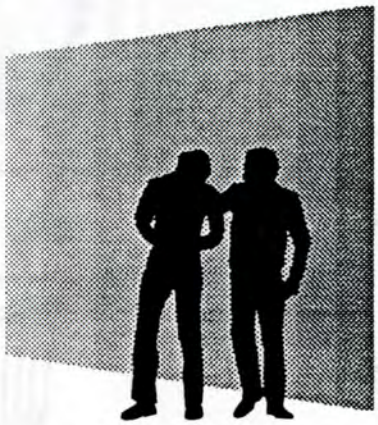
Be especially careful when traveling in reverse and maneuvering in tight areas.

General Safety Rules

Pedestrians

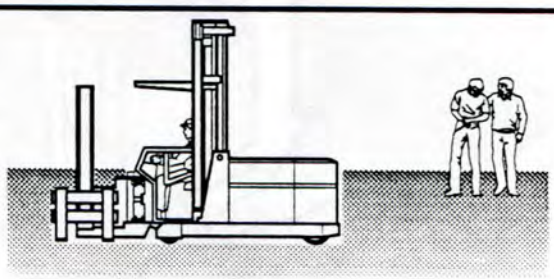
Watch where you are going, look in the direction of travel. Pedestrians may use the same roadway you do when outside the racks. Sound your horn at all intersections or blind spots.





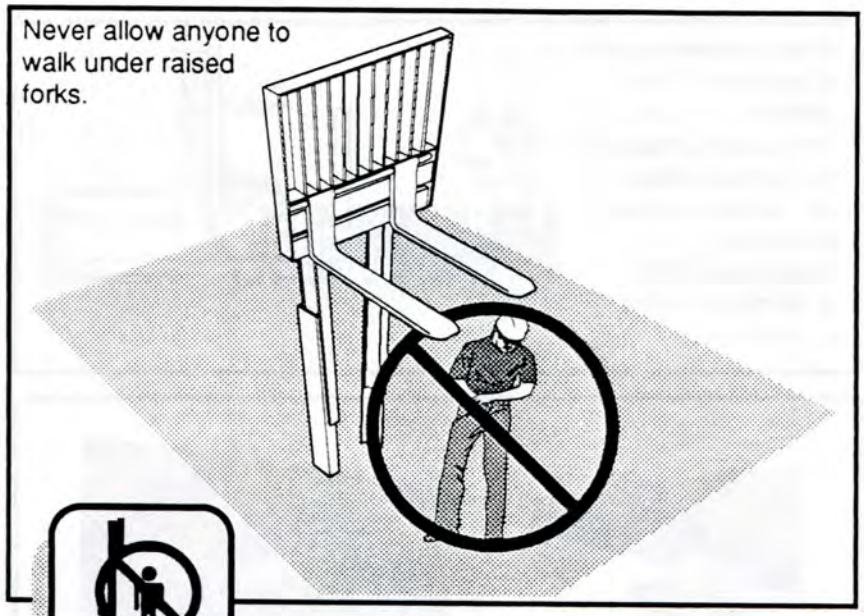
Watch for people in your work area even if your truck has warning lights or alarms. They may not watch for you.

Make people stand back, even when you are parked. Do not operate the reach, rotate or lift controls when people are near.



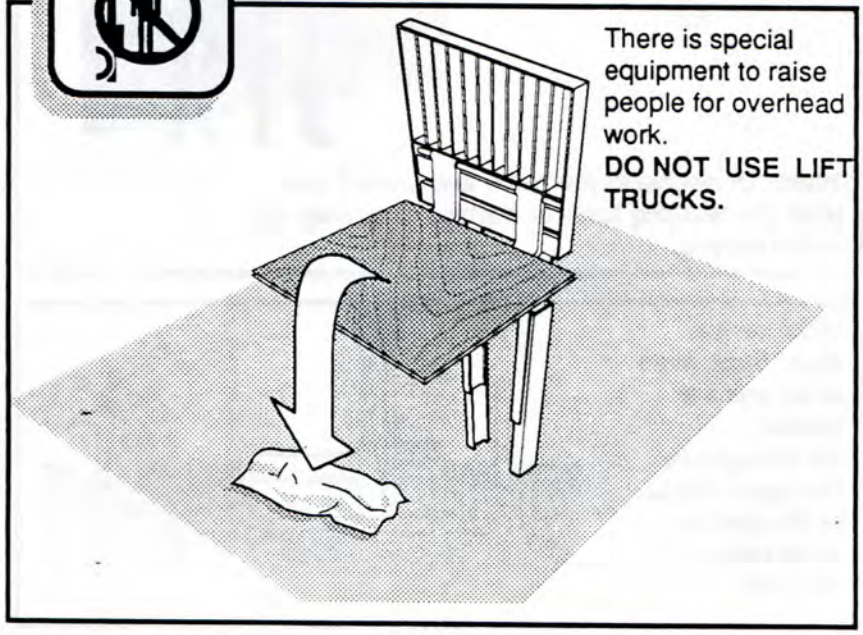
General Safety Rules
Fork Safety

Never allow anyone to walk under raised forks.



DANGER

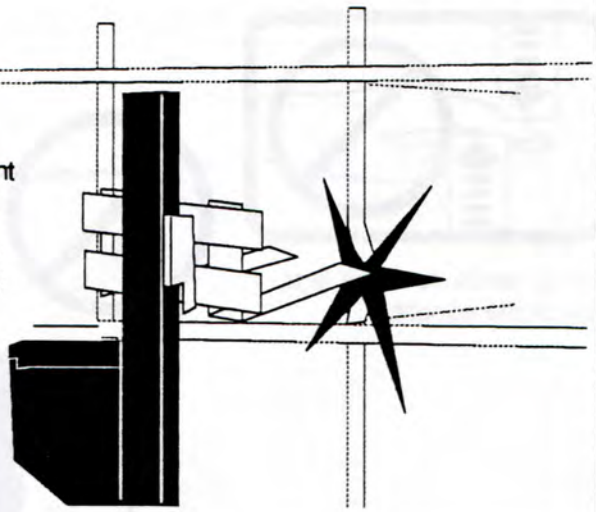
There is special equipment to raise people for overhead work.
DO NOT USE LIFT TRUCKS.



General Safety

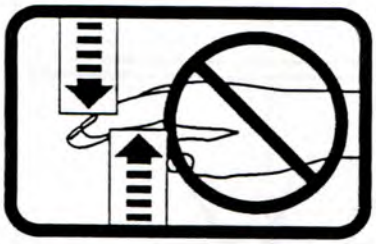
Fork Position

Check the fork alignment to the self/rack opening before entering a rack when truck is not set up with an automatic guide system.



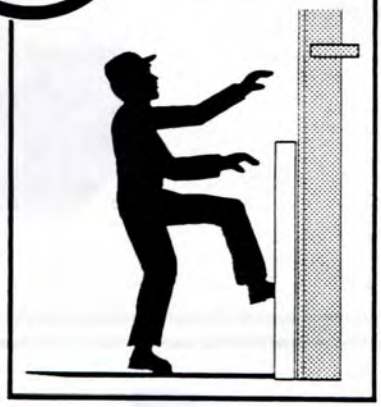
Check clearance before rotating or side-shifting the forks.

Pinch Points



Keep hands, feet and legs out of the upright.

Don't use the upright or reach unit as a ladder.



Never try to repair the upright, carriage, chain or attachment yourself--

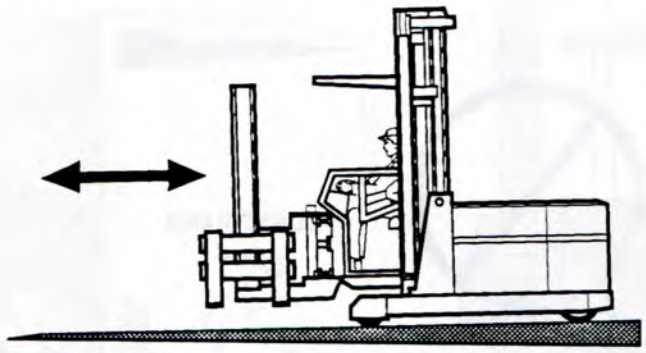
Always get a trained mechanic.

General Safety Rules

Grades, Ramps, Slopes and Inclines

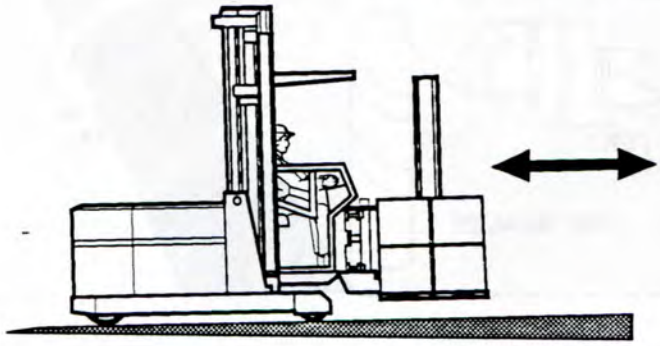
This truck is designed to operate on a flat, level surface. When a grade can not be avoided, follow these instructions in addition to the "Load Handling" procedures.

UNLOADED - FORKS DOWNGRADE



Never turn on a grade.

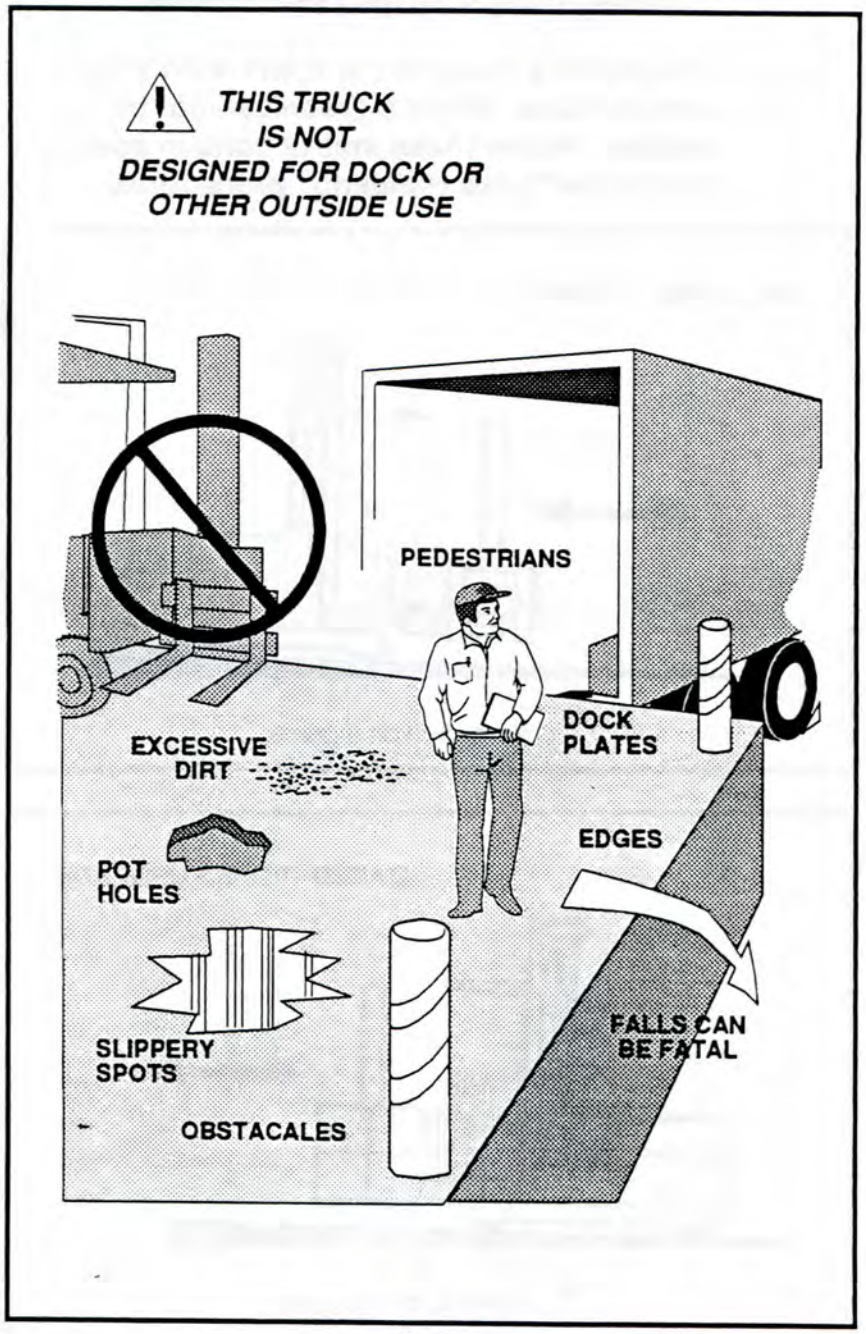
LOADED - FORKS UPGRADE



Never turn on a grade.

General Safety Rules

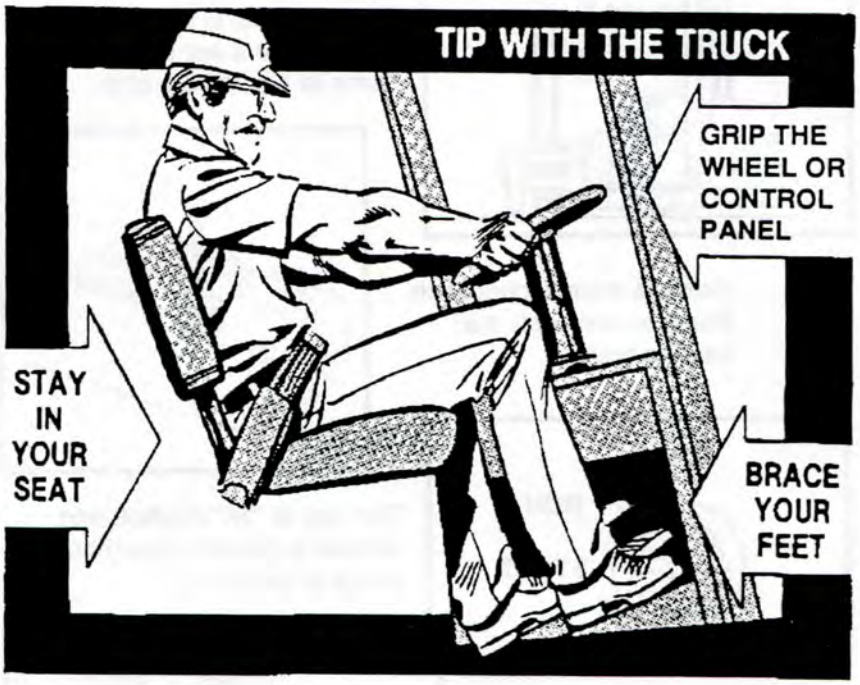
Loading Docks



General Safety Rules

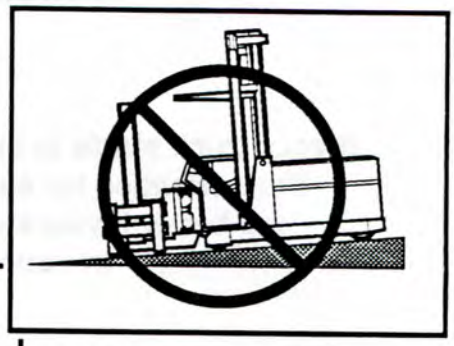
Don't Jump

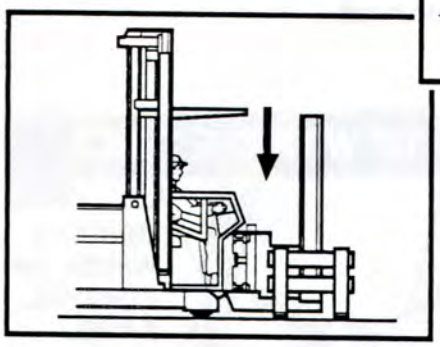
If your truck starts to tip over, <u>do not jump!!!</u>
Your chances for survival in a tip-over
are better if you stay with the truck,
in your seat.



Parking

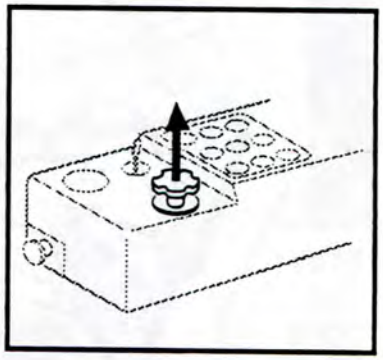
Never park on a grade. If parking on a grade can not be avoided, chock the wheels to prevent rolling.

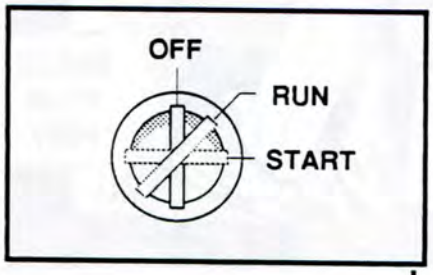




Swing in forks to their base position and lower cab completly. Come to a complete stop.

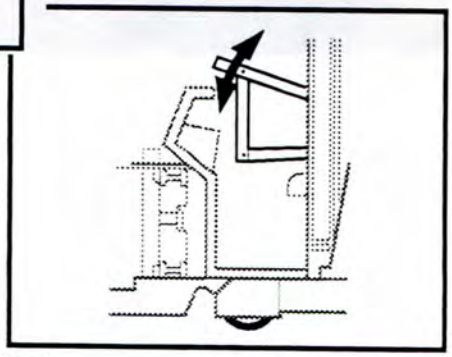
Release drive control knob. Doing so will apply the parking brake.





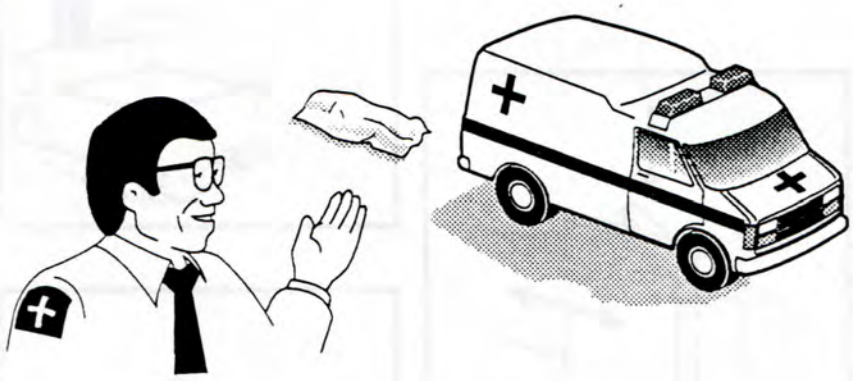
Turn key to "off" position and remove to prevent unauthorized usage of the truck.

Lift guard rail and step from truck. Lower guard rail back into position.



General Operating Hazards

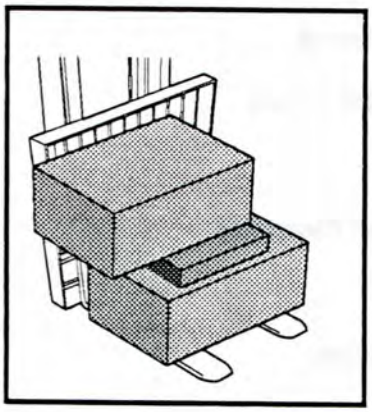
Index



This section shows hazards that may cause you, or someone around you, to be killed or badly hurt. As the operator, you must look for other hazards. Get your boss to help you identify and avoid those hazards.

General Operating Hazards

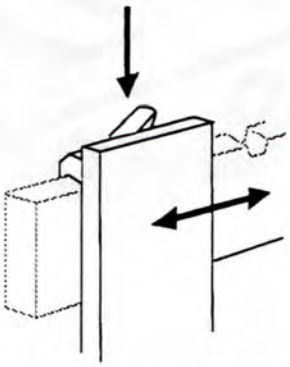
Loose Loads



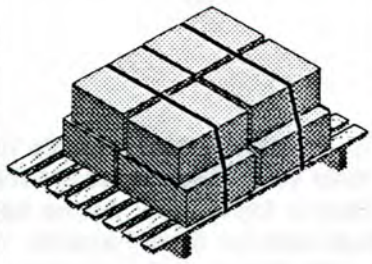
⚠ WARNING:
Loose Loads
Never carry loose or uneven material.

Load should be centered and stable.

Forks and upright do not tilt back to help keep load on forks.



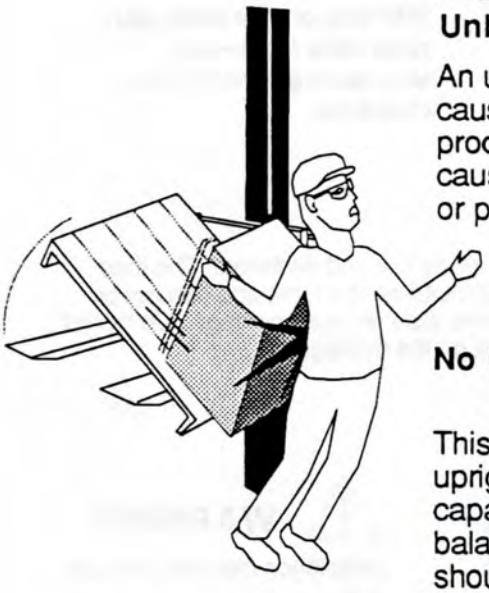
Forks should be adjusted on the hanger shafts to obtain maximum support and balance of the load. Don't forget to secure fork locking pins after adjusting forks.



Stack and band loose material.

General Operating Hazards

Unbalanced Loads



⚠ WARNING

Unbalanced Loads

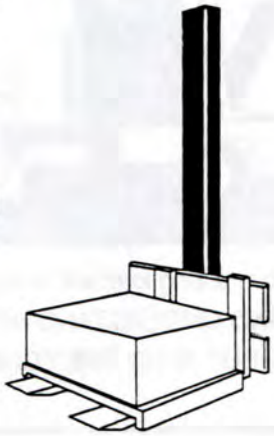
An unbalanced load could cause damage to the product, rack or truck, or cause injury to the driver or pedestrians.

No Upright Tilt or Carriage Tilt

This truck does not have upright or carriage tilt capabilities to help stabilize (or balance) the load. Extra care should be taken in doing operations such as lifting, rotating or traveling.

Load weight should be equally balanced on the forks. If necessary, rearrange load before picking up and moving with load.

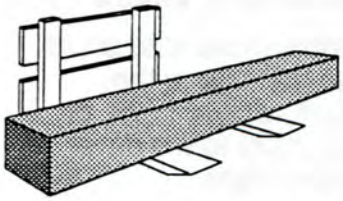
Follow the load capacity rating plates on your truck carefully.



General Operating Hazards

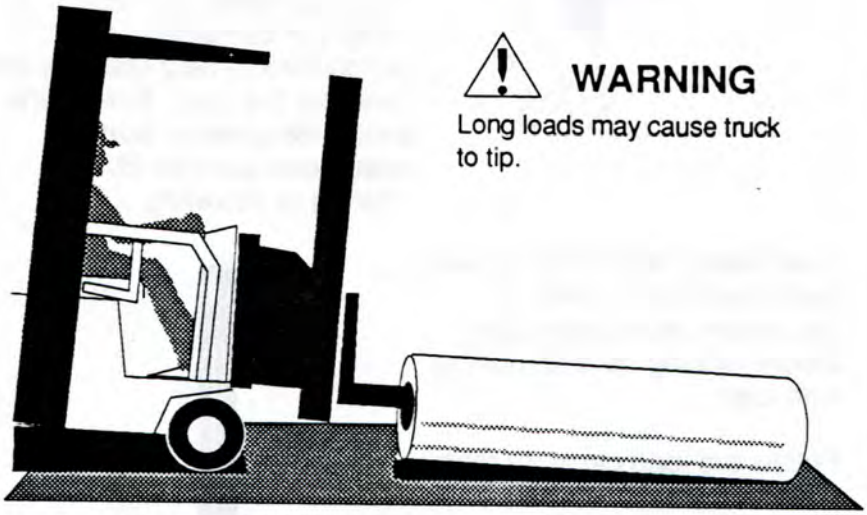
Long and Wide Loads

⚠ WARNING
Long and Wide Loads



With long or wide loads you need more room –so– slow down and watch your clearance.

Keep wide loads low and centered. The load must be balanced on the forks and can not be wider than the aisle or rack openings. Do not let the load rest on the outrigger.



⚠ WARNING

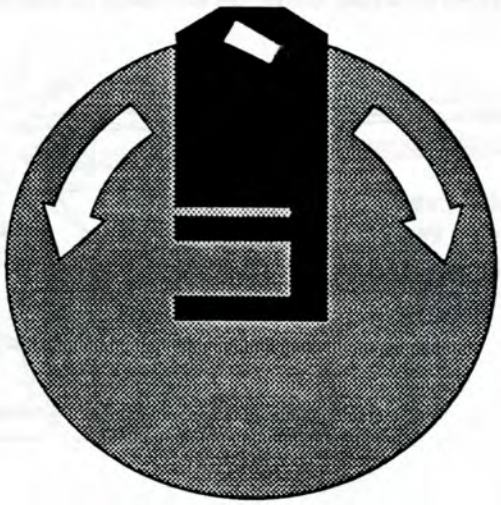
Long loads may cause truck to tip.

Remember, a long load will reduce the capacity of the truck. KNOW AND UNDERSTAND NOT ONLY YOUR TRUCK LOAD RATING, BUT ALSO THE FORK AND ATTACHMENT RATINGS.

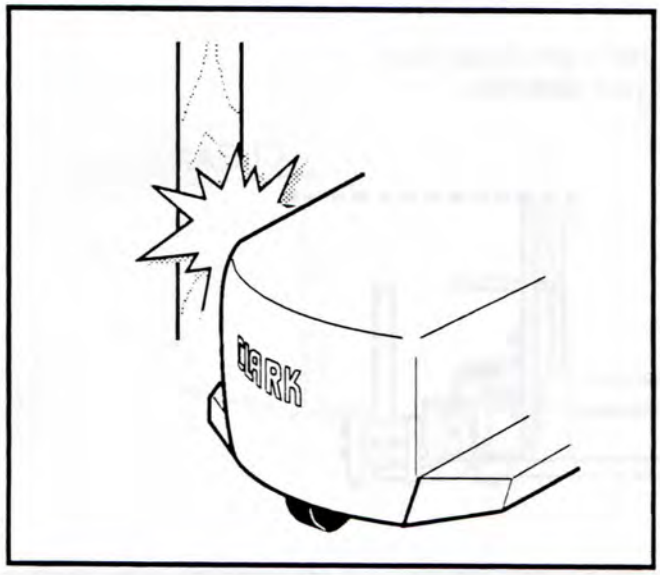
General Operating Hazards

Rear Swing

WARNING: Rear Steering

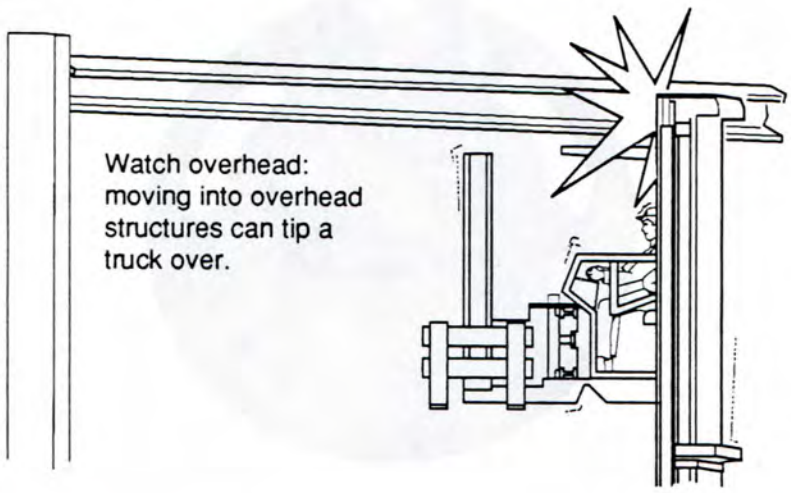


Be aware of rear end swing and be alert to prevent rear end swing damage to material in your operating area.



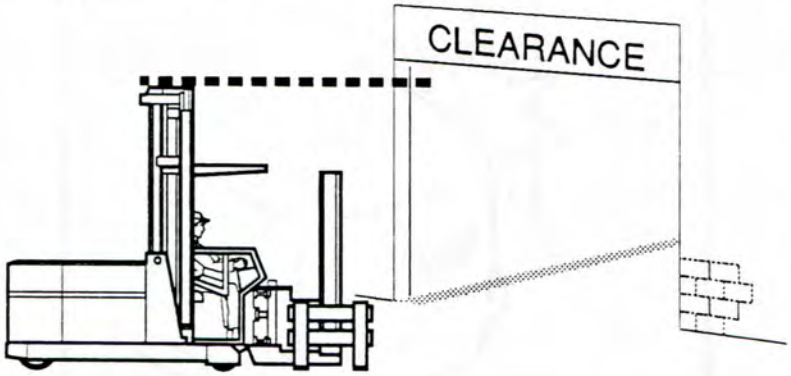
Low Overhead Clearance

⚠ WARNING: Low Overhead Clearance



Watch overhead:
moving into overhead
structures can tip a
truck over.

Know the height of your truck.
Check your clearance.



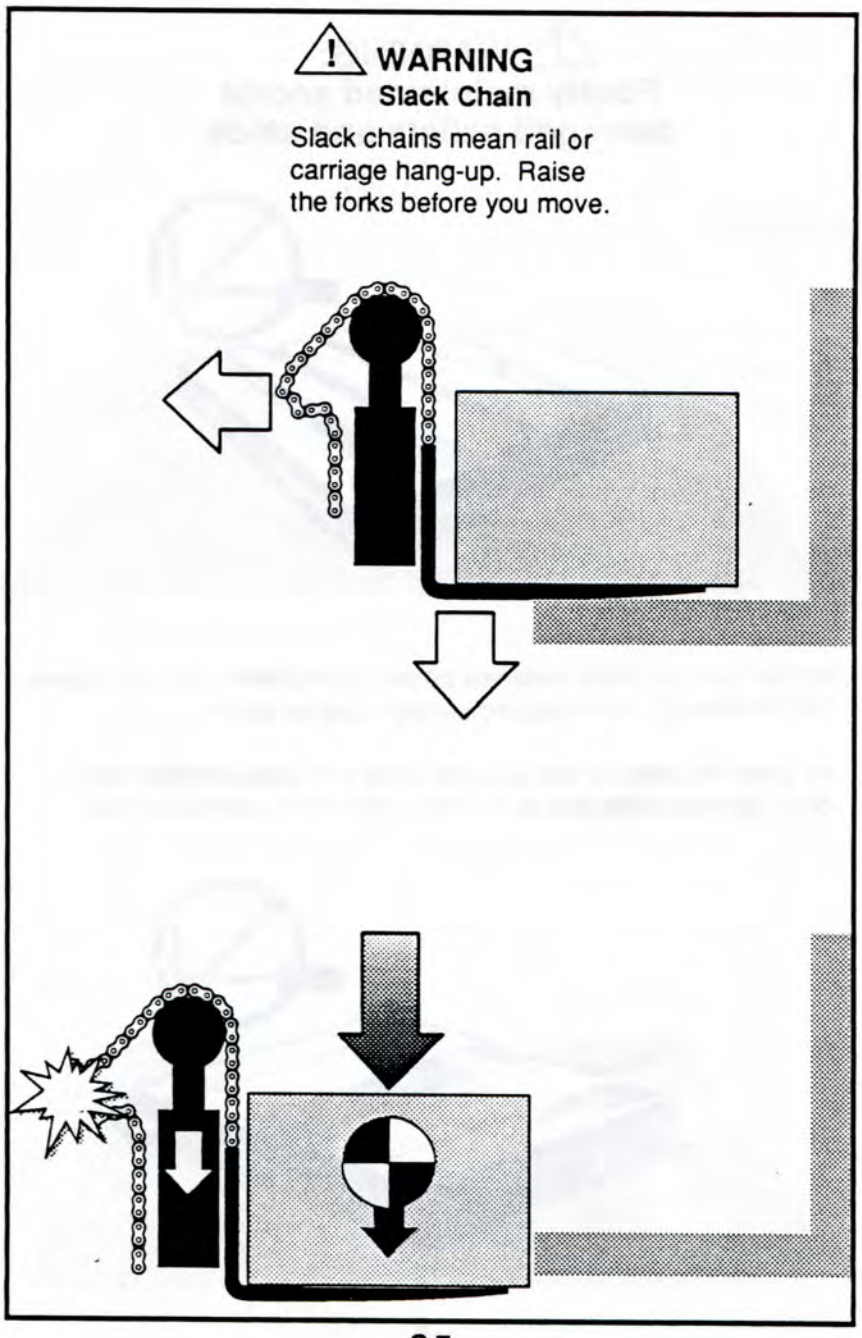
General Operating Hazards

Chain Slack

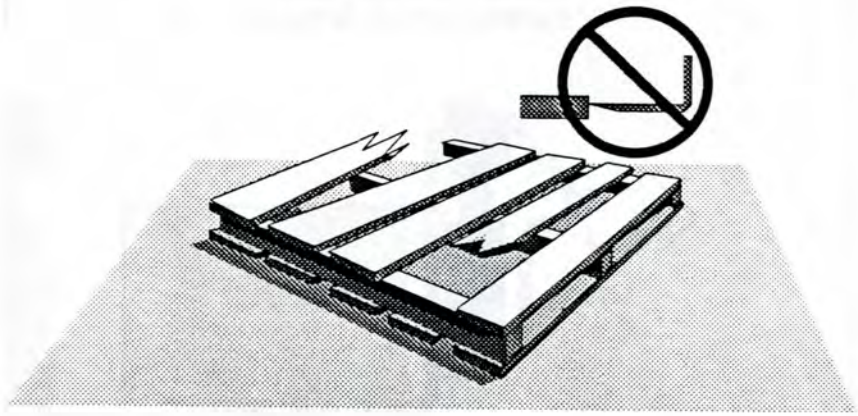
⚠ WARNING

Slack Chain

Slack chains mean rail or carriage hang-up. Raise the forks before you move.

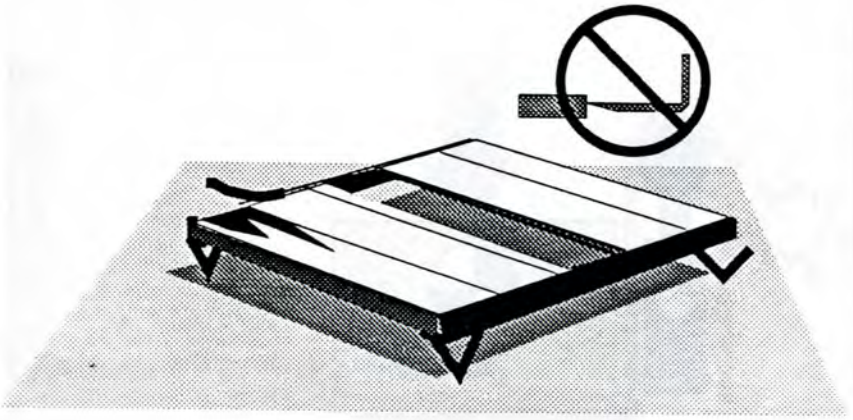


⚠ WARNING:
Poorly maintained and/or damaged pallets and skids



Do not move or store materials on damaged pallets or skids. Items can fall through them causing severe injury or death!

Be sure the pallet or skid you are using is in good condition and does not have defective or missing components and fasteners.



FOREWORD

This User Manual contains the information required to operate and service the truck on a routine basis. It includes brief operating instructions, wiring diagrams, lubrication chart and service routines which constitute the MINIMUM requirements to maintain the truck in good working order when operating in a normal working environment. Operation under extreme or strenuous conditions (e.g. in extremes of temperature or humidity; in cold stores) may require shorter intervals between routine services.

While this manual may contain general information on driving the truck, it must not be considered a substitute for formal driver training and it is assumed that the truck will only be operated by a driver properly and formally trained on lift trucks, and on this truck model in particular. Similarly, the manual can only contain a brief synopsis of the maintenance checks and it is assumed that the truck is maintained by a service mechanic trained and competent on this truck model.

Every endeavour is made to ensure the information contained in this Manual is correct at the date of publication.

HEALTH AND SAFETY

In the interest of Health and Safety a lift truck should only be operated by fully trained and competent lift truck drivers with due regard to local codes of practice and regulations regarding operator training, use, and maintenance of frontlift and sidelift trucks.

It is the user's responsibility to ensure that any safety or warning devices, that may be fitted, are maintained in good operating condition at all times and that local Health and Safety regulations are strictly observed. To assist the user in this matter, maintenance and service contracts are offered by Clark Service Organization.

It is the user's responsibility to ensure that the Main Lift (elevating cab) system is examined and regularly tested in conformity with the regulations GOVERNING THE USE OF PERSONNEL LIFTS AND HOISTS. This examination must be carried out by a qualified inspector or a Clark service engineer.

SERVICING

The efficiency, life and safety of a truck is dependent upon the routine servicing and maintenance it receives. The operator should be fully trained to ensure that all routine checks, are carried out correctly.

No Service Manual can cover every item. It is assumed that, at routine service, the truck is checked over by a trained and competent lift truck service mechanic.

When repairs or replacements are necessary, it is important that only genuine parts are used and that the work is undertaken by Factory trained Engineers, or as detailed in the relevant repair manual by maintenance personnel trained and competent on this truck model.

TERMS

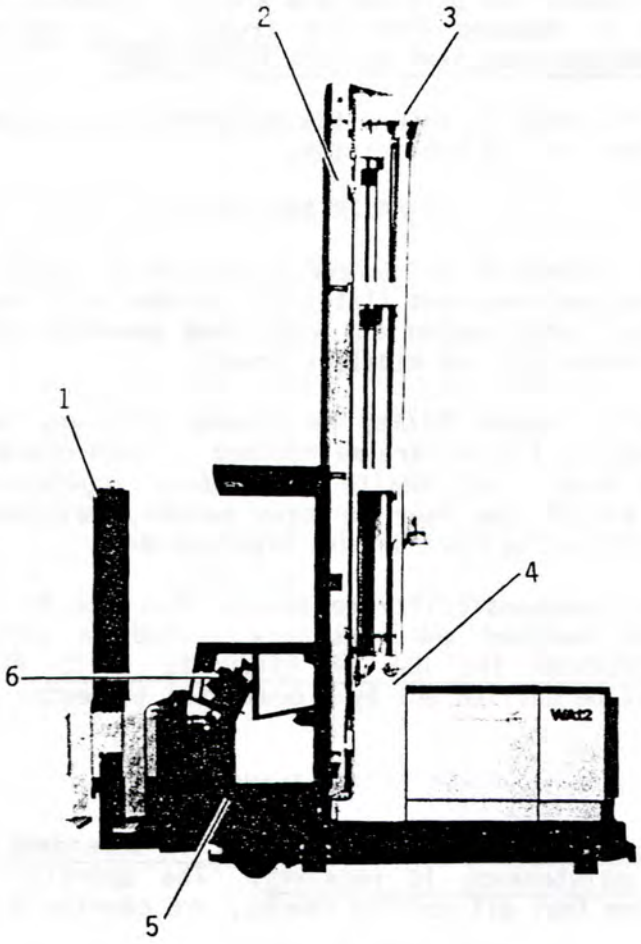
When the terms left hand and right hand are used they are in relation to the normal operating position of the driver.

APPLICABILITY

This User Manual is applicable to the following trucks:-

Model

WA12-WA15



WA Series Stacker/Order Picker

Key

1. Auxiliary Lift
2. Lift Cylinder
3. Mast
4. Chassis
5. Elevating Cab
6. Control Consol

⚠ SAFETY WARNINGS AND PRECAUTIONS ⚠

IT IS MOST IMPORTANT TO OBSERVE STRICTLY THESE WARNINGS AND PRECAUTIONS.

NEVER USE THE TRUCK IN AN OVERLOAD CONDITION: Always check capacity, load centre and height limitation on mast or attachment data plate.

NEVER carry passengers.

NEVER drive the truck if any fault indication audible warning device is operating.

NEVER spread the truck forks to overhang the end of a plate carriage; and always engage fork position catches.

NEVER smoke or hold a naked flame near a charging battery.

CAUTION:- DO NOT ATTEMPT SERVICING OR REPAIRS BEYOND THE SCOPE OF THIS USER MANUAL WITHOUT REFERENCE TO THE REPAIR MANUAL.

WARNING:- NO SERVICING SHOULD BE CARRIED OUT ON THE HYDRAULIC SYSTEM UNTIL THE CHASSIS OR RELEVANT COMPONENT HAS BEEM SUITABLY SUPPORTED OR RESTRAINED.

WARNING:- PEDESTRIAN ACCESS IS FORBIDDEN TO AISLES WHERE MAN ALOFT TRUCKS (ELEVATING CAB) ARE OPERATING.

Keep the aisles free from obstructions and remove fallen articles immediately.

When loading the shelves, always ensure that components do not protrude into the aisles (beyond the pallet profile).

Access to the aisles and approach areas is restricted to authorised personnel only. THROUGH TRAFFIC IS PROHIBITED.

NEVER override any safety device or cut-out.

On leaving the truck, always remove the key from the keyswitch to prevent unauthorised operation of the vehicle.

WARNING:- UNDER NO CIRCUMSTANCES SHOULD ANY TRUCK EVER BE OPERATED UNLESS THE DRIVER IS IN THE NORMAL DRIVING POSITION AND ABLE TO REACH ALL THE USUAL CONTROLS.

WARNING:- RAISE DRIVE WHEELS CLEAR OF THE GROUND WHEN MAKING TESTS THAT MAY CAUSE THE DRIVE TO BE ENGAGED.

WARNING:- ENSURE THAT ALL ACCESS PANEL LOCKS OR CATCHES ARE FULLY ENGAGED, TO ENSURE PANELS DO NOT SWING OPEN DURING TRUCK OPERATION AND CAUSE INJURY TO PERSONS.

FRONT AND LATERAL STACKER/ORDER PICKER

1. DESCRIPTION

The Front and Lateral Stacker is a powered lift truck built to DIN 15140 Standards.

The truck is operated from an elevating cab which accommodates one operator. The carriage is equipped with forks and is articulated to rotate through 90° to either side of the line of travel.

Using the mast lift (auxiliary lift), the full height of the warehouse can be utilised and the loading position is always at a convenient working level (i.e. operator position relative to load).

The Truck is designed to operate in narrow aisles between racks and is specially built to travel with elevated loads.

When the truck is operating outside the aisles, i.e. Free Ranging, it operates as a frontlift truck and the lift height is limited to 1.7m (5ft 7in).

The essential floor conditions are:-

(a) A flat, level surface conforming to the truck manufacturer's specification and having a load carrying capacity compatible with the combined weight of the truck, load and driver.

(b) An area free of foreign bodies and obstructions which would impede the operation of the truck or render the truck unstable or unsafe to operate.

2. RATING PLATES

Capacity in relation to fork position, lift height and load centre.

The rating plates on the truck give the load capacity of the truck on level ground in relation to fork attitude (lateral or longitudinal), lift height and load centre.

The truck Serial No. will be found on the plate bearing the truck designation.

Adjacent to the operating position is a plate warning that the truck is 'Licenced to carry one person only'.

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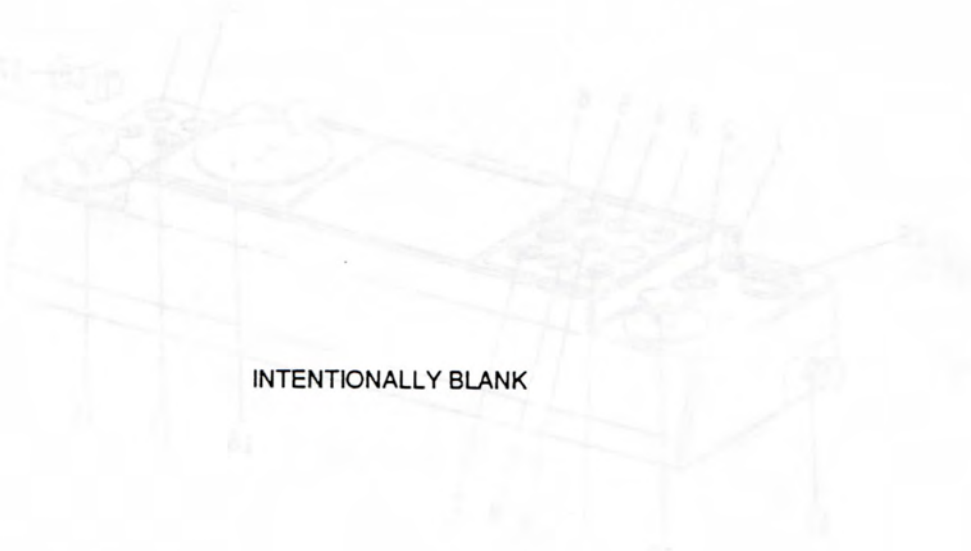

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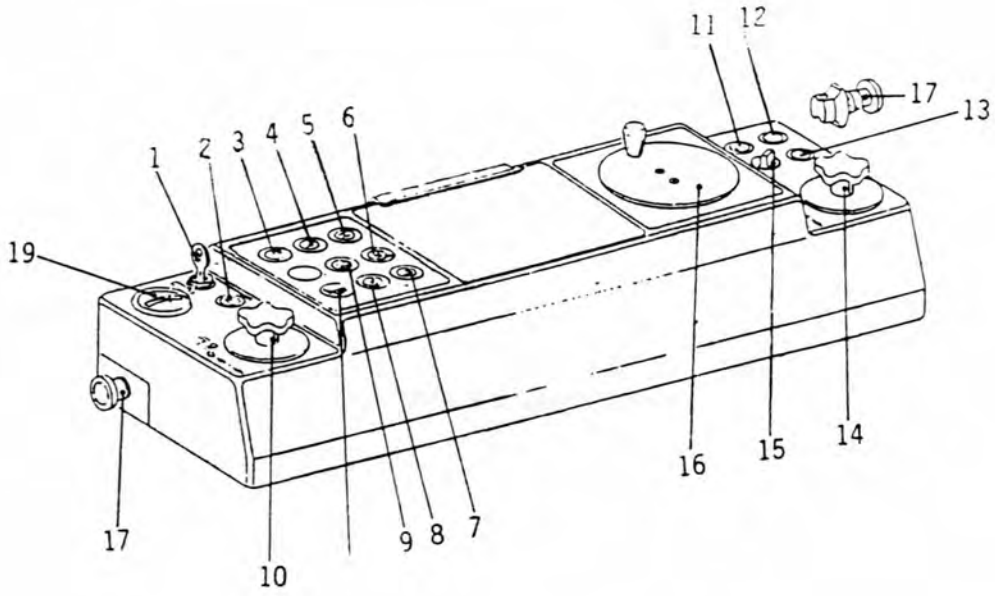


Fig. 1 Controls for Truck with Wire Guidance Control System (1)

1. Key Switch
2. Indicator Lamp - 'Power On'
3. Push Button - 'Emergency Lower'
4. Push Button - 'Combined Movement' Sideshift and Rotate Right
5. Push Button - 'Combined Movement' Sideshift and Rotate Left
6. Push Button - 'Sideshift' Left and Right
7. Push Button - 'Main Lift' Raise and Lower (2)
8. Push Button - 'Auxiliary Lift' Raise and Lower (3)
9. Push Button - 'Rotate Forks' Left/Right
10. Drive Control - Forward/Reverse - Deadman Switch
11. Indicator Lamp - 'Guidance Switched On'
12. Indicator Lamp - 'Guidance Locked On'
13. Indicator Lamp - 'Guidance Available'
14. Hydraulic Control - Deadman Switch
15. Switch ON/OFF - Wire Guidance System
16. Steer Control
17. Emergency Battery Cut-out Switch
18. Push Button - 'Horn'
19. Battery Discharge Indicator

(1) Truck guidance in the Aisle by means of a transmitter, receiver and guide wire in the floor.

(2) Main Lift - Raising and Lowering of Cab and Carriage.

(3) Auxiliary Lift - Raising and Lowering of Carriage only - not cab.

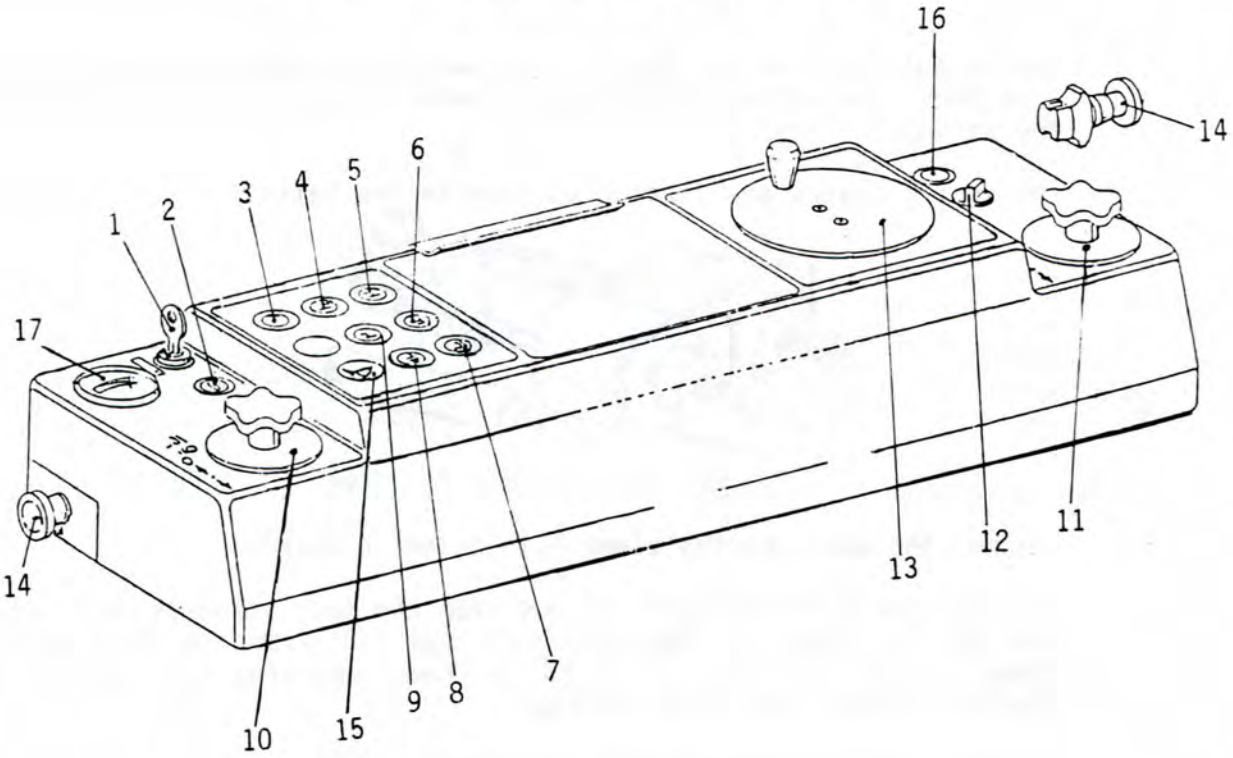


Fig. 2 Controls for Truck with Rail Guidance System (1)

1. Key Switch
2. Indicator Lamp - 'Power On'
3. Push Button - 'Emergency Lower'
4. Push Button - 'Combined Movement' Sideshift and Rotate Right
5. Push Button - 'Combined Movement' Sideshift and Rotate Left
6. Push Button - 'Sideshift' Left/Right
7. Push Button - 'Main Lift' Raise and Lower (2)
8. Push Button - 'Auxiliary Lift' Raise and Lower (3)
9. Push Button - 'Rotate Forks' Left/Right
10. Drive Control - Forward/Reverse - Deadman Switch
11. Hydraulic Control - Deadman Switch
12. Switch ON/OFF - Centralised Steering
13. Steer Control
14. Emergency Battery Cut-out Switch
15. Push Button - 'Horn'
16. Indicator Lamp - 'Steer Wheel Centralised'
17. Battery Discharge Indicator

(1) Truck guidance in the Aisle by means of Guide Rails.

(2) Main Lift - Raising and Lowering of Cab and Carriage.

(3) Auxiliary Lift - Raising and Lowering of Carriage only - not cab.

1. Before putting into service a truck which has been delivered without a battery, the spring brakes must be made ready for use by tensioning the spring.

   The spring brakes are located underneath the battery.

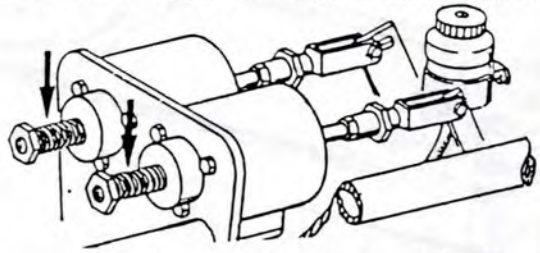


Fig. 3 Spring Brake Adjustment

2. Slacken the mast bearing clamp (1) (do not remove).

3. Using suitable lifting gear to position the mast assembly vertically. Line up the notch on the eccentric cap (2) with the mast bearing clamp. Insert packing pieces (3) in lower mounting (if applicable). Tighten the mast and mast bearing.

   The mast tilt has been factory adjusted as follows:-

   Fore and aft 0-1° backward tilt.

   0° at right angles to line of travel.

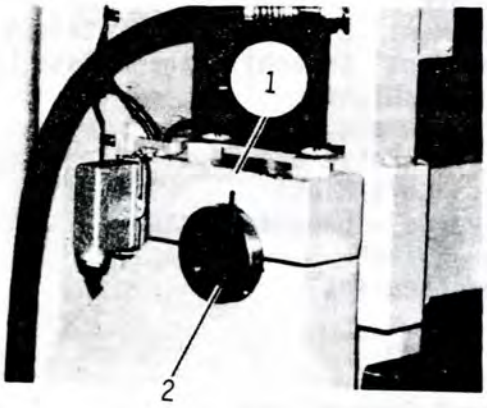


Fig. 4

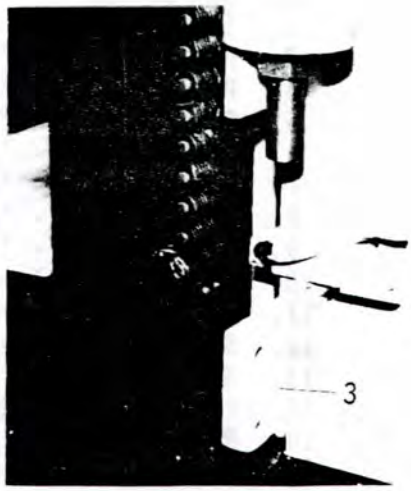


Fig. 5

Mast Adjustment

4. Using suitable lifting tackle sling the articulated reach unit from centre, and attach it to the upper rail of the elevating operator cab and fasten it with four screws (4). (Nuts and washers on cab side).

5. Connect up the hydraulic hoses according to the colour coding (6). Connect electric plug (5) to socket.

6. Attach forks to carriage and secure with roll pins.

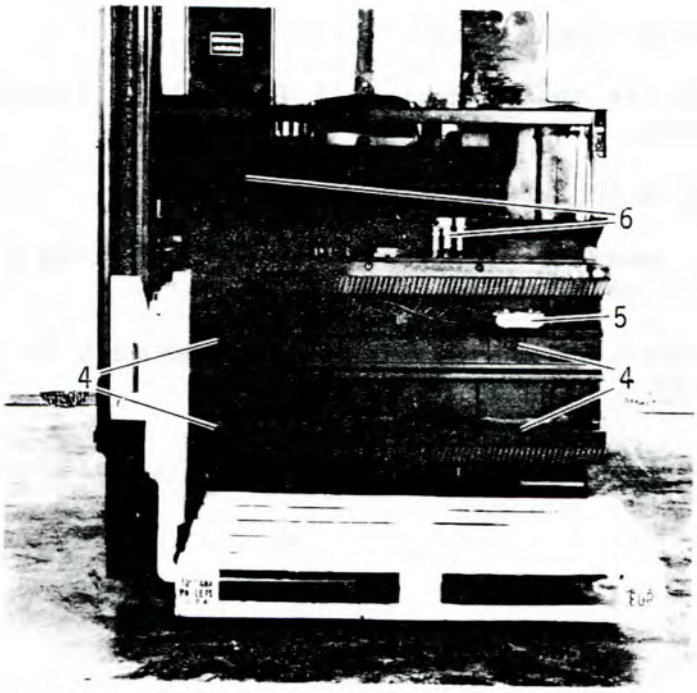


Fig. 6 Mounting Articulated Reach Unit

ADJUSTMENTS

7. ADJUSTING THE DRIVER'S SEAT

7.1 Pull the lever (1 Fig. 7) outward and move the seat forward or backward into the desired position and then release the lever.

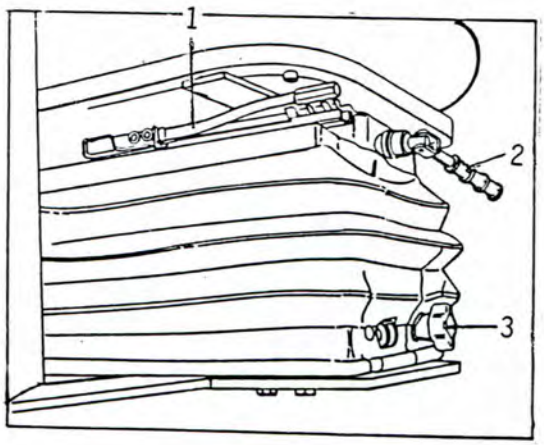


Fig. 7 Seat Adjustment

7.2 Driver Weight Adjustment.

Move the lever (2 Fig. 7) into the position corresponding to the driver's weight (with the seat unoccupied).

7.3 Height Adjustment.

Rotate the handwheel (3 Fig. 7) to adjust the height of the seat.

8. ADJUSTING THE CONTROL PANEL

The control panel can be tilted, forward or backward, to accommodate the driving position, standing or seated.

To adjust panel, rotate the hand wheel underneath the panel and adjust the angle to suit.

1. DRIVING AND BRAKING OUTSIDE AISLES

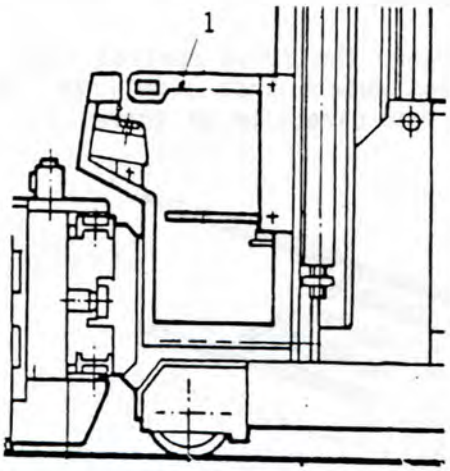


Fig. 8 Guide Rails

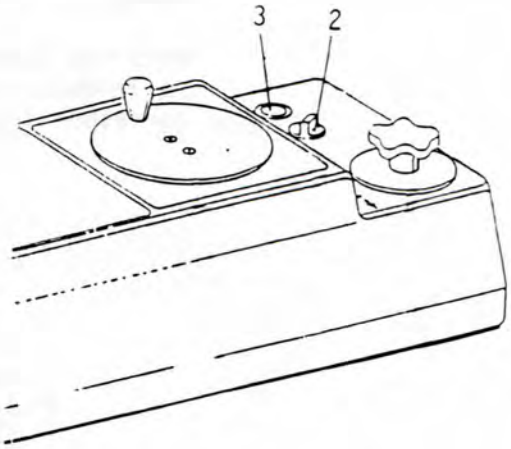


Fig. 9 Controls

On rail guided vehicles manual steering is inoperative if the Centralised Steering Switch (2 Fig. 9) is in the 'ON' position, indicator (3 Fig. 9) illuminates i.e. turning the steer control (13 Fig. 2) does not alter the position of the steer wheel.

In order to return to manual steering it is necessary to move the Centralised Steering Switch (2 Fig. 9) to the 'OFF' position. The indicator lamp (3 Fig. 9) must be extinguished.

1.1 Driving.

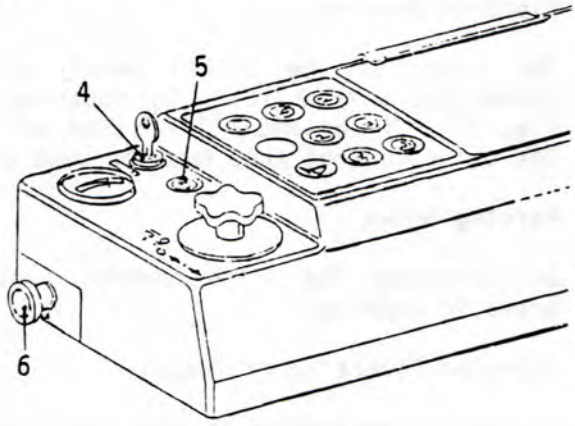


Fig. 10 Controls

Lock both the guard rails (1 Fig. 8) in position.

Insert the switch key (4 Fig. 10) and turn it fully clockwise. Release both Emergency OFF switches (6 Fig. 10), by turning in direction of arrow; the indicator lamp (5 Fig. 10) illuminates.

Lower the auxiliary lift completely and raise cab until the forks are clear of the floor.

With the left hand push down the drive control knob (7 Fig. 11) to release the brakes and rotate knob slowly in the direction corresponding to the desired direction of travel.

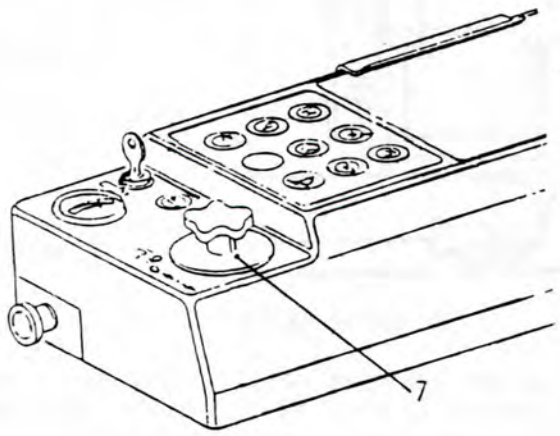


Fig. 11 Drive Controls

Control the drive speed by rotating of the drive control either forward or back to increase or decrease the speed. With the right hand operate the steer control.

1.2 Electric Braking.

The truck may be braked gently using the motor, e.g. when travelling with a load, by rotating the drive control knob (7 Fig. 11) to the neutral positon or in the opposite direction. The drive control knob must be kept depressed.

1.3 Parking Brake.

On releasing the drive control knob (7 Fig. 11) the parking brake is applied.

1.4 Changing Direction of Travel.

To ensure the safety of the load change of direction of travel should be made only at low speed.

2. DRIVING AND BRAKING WITHIN THE AISLES

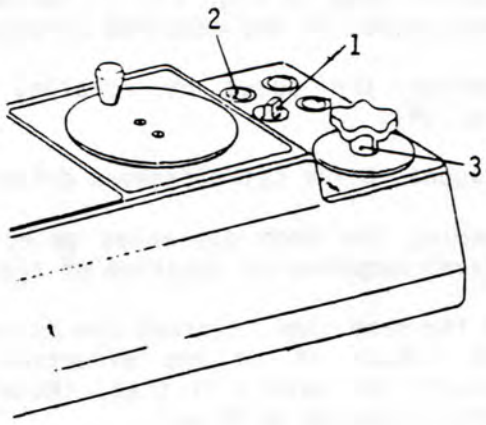


Fig. 12 Driving Controls

Rail guidance system trucks are equipped with sensors which interupt the drive current as the truck moves along the aisle.

2.1 Driving.

On rail guided trucks, after entering the aisle, turn the selector switch (1 Fig. 12) to 'ON'. The steer wheel (road wheel) assumes the direct ahead position and indicator lamp (2 Fig. 12) illuminates. The manual steer function is inoperative.

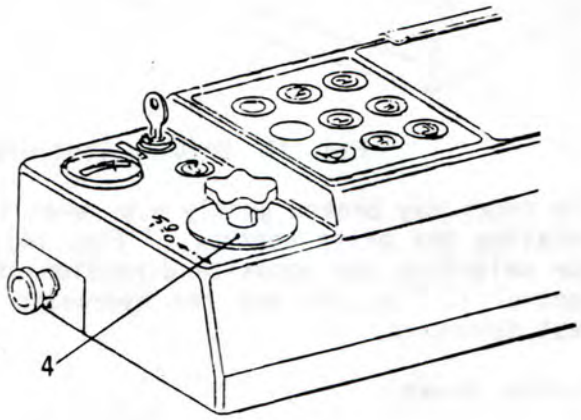


Fig. 13 Driving Controls

With the right hand, prepare to drive by pressing down the hydraulic control knob (3 Fig. 12) without rotating the control knob (Two handed control).

Using the left hand, release the brake by depressing the drive control knob (4 Fig. 13) - (Two Hand Control) and slowly rotate the control in the required direction of travel.

Control the speed by rotating the drive control knob (7 Fig. 14).

2.2 Diagonal Drive (simultaneous drive and 'LIFT' or 'LOWER'.

Keeping the knob depressed select the direction and speed of travel required by rotation of the drive control (7 Fig. 14).

At the same time, depress the hydraulic control knob (8 Fig. 14) and rotate it in the direction corresponding to 'Lift' or 'Lower' the main lift (cab) (Rotate clockwise to Lower; Rotate anti-clockwise to Raise).

2.3 Electric Braking.

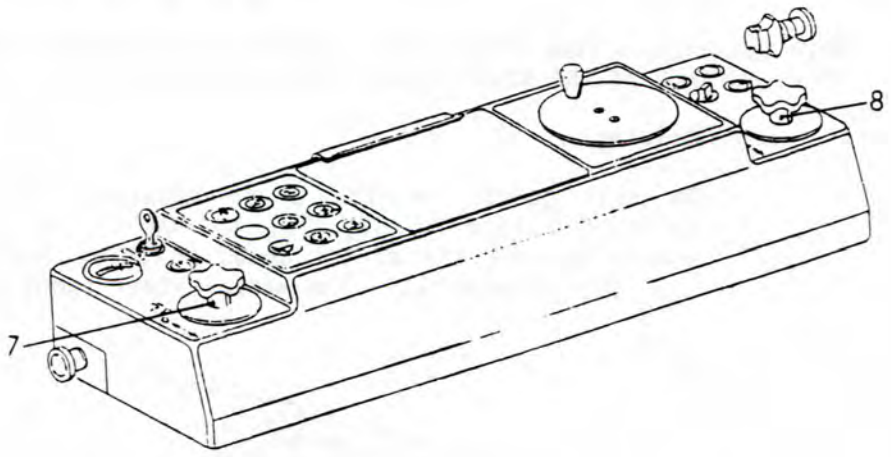


Fig. 14 Driving Controls

The truck may braked gently e.g. when travelling under load, by rotating the drive control (7 Fig. 14) to the neutral position (or selecting the opposite direction of travel) with the drive control (7 Fig. 14) and the hydraulic control (8 Fig. 14) are kept depressed.

2.4 Parking Brake.

Releasing either the drive control (7 Fig. 14) or the hydraulic control knob (8 Fig. 14) activates the brakes.

2.5 Changing Direction of Travel.

See Driving and Braking outside the Aisles.

3. TRACKING - WIRE GUIDANCE SYSTEM

3.1 Check that stationary transmitter for the inductive system guide wire is switched on.

The inductive guidance installation incorporates a guide wire in the form of a continuous loop laid in the floor. Both ends of the loop are connected to the transmitter.

The transmitter generates a small current, with a closely controlled frequency, in the guide wire.

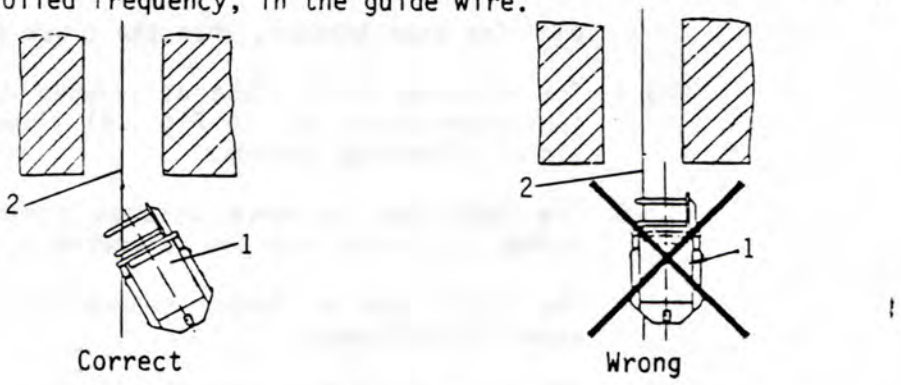


Fig. 15 Tracking

3.2 Driving with manual steering selected drive the truck (1 Fig. 15) towards the guide wire (2 Fig. 15) at an angle until the indicator 'Guidance Available' (3 Fig. 16) illuminates.

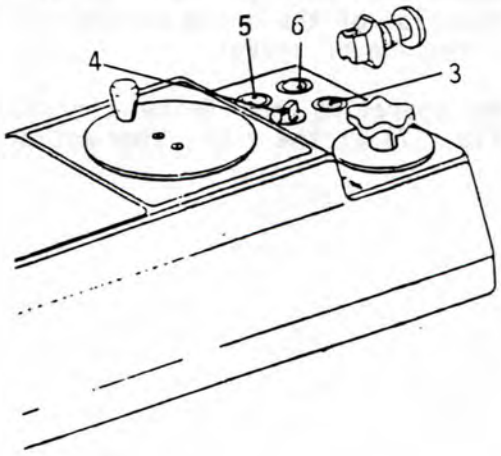


Fig. 16 Tracking

NOTE:- The articulated reach unit must be in the base position (i.e. forks rotated inwards and carriage shifted fully to one side), otherwise guidance will not be available and automatic 'Emergency Stop' will occur.

The approach angle must be between 10° and 30°.

3.3 Before the leading antenna crosses over the guide wire, turn the Automatic Steer ON/OFF switch (4 Fig. 16) to 'ON'. The indicator lamp 'Guidance Switched On' (5 Fig. 6) will illuminate. It is not necessary to bring the truck to a halt (when changing direction). Tracking can be initiated while the truck is moving forward or in reverse.

The Leading Antenna is:-

a) The front antenna, when the truck is travelling forward.

b) The rear antenna, when the truck is travelling in reverse.

3.4 The tracking takes place at reduced speed. The indicator lamp 'Guidance Locked On' (6 Fig. 16) illuminates and the accoustic signal 'Tracking' sounds.

3.5 The inductive guidance assumes control of the steering and swings the truck onto the guidewire.

The driver can no longer control the steering by turning the steer control wheel.

After the truck has travelled approx 1.4m the tracking process is concluded automatically. The indicator lamp (6 Fig. 16) 'Guidance Locked On' is extinguished and the accoustic tracking signal is silenced.

3.6 Depress and hold down the drive control (7 Fig. 17) and the hydraulic control (8 Fig. 17) knobs. (Two hand control). Rotation of the drive control (7 Fig. 17) controls the speed and direction of travel.

By operating the drive control and hydraulic control (7, 8 Fig. 17) at the right time motion is uninterupted.

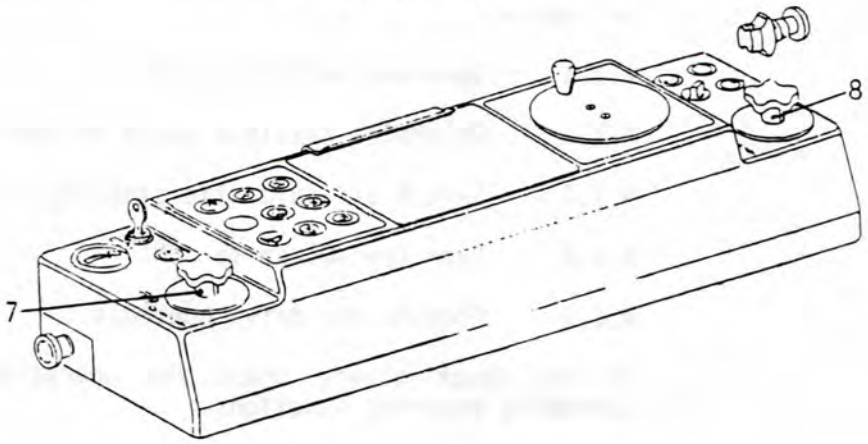


Fig. 17 Controls

3.7 On switching direction from 'Forward' to 'Reverse' travel, the truck travels for approx 0.7m at tracking speed without audible or visual indication.

3.8 In order to drive 'off the wire' the truck must be brought to a halt briefly and the ON/OFF Switch for Inductive Guidance turned to OFF.

ATTENTION:- Switching over from Automatic to Manual steering may be iniated only after the truck has cleared the aisles completely.

WARNING:- IF THE STEER CONTROL IS TURNED WHILE THE TRUCK IS OPERATING UNDER WIRE GUIDANCE (AUTOMATIC STEER) CONTROL, THE REAR WHEEL WILL BE POSITIONED AUTOMATICALLY AT THE CORRESPONDING ANGLE AS SOON AS THE TRUCK IS SWITCHED OVER TO MANUAL STEERING.

THEREFORE EXERCISE EXTREME CARE WHEN DRIVING ON, AFTER SWITCHING TO 'MANUAL STEER'!

4. DRIVE MONITORING FUNCTIONS AND SAFETY DEVICES. WIRE GUIDED VEHICLE.

Should the leading antenna leave the effective range of the guide wire an 'Emergency Stop' is initiated immediately.

If the vehicle is driven exactly parallel to the guide wire no 'lock on' occurs and the visual and audible 'Tracking' signals will operate continuously and warn the driver.

4.1 Automatic Emergency Stop.

In the event of one of the monitoring functions tripping, i.e. steering control, steer system, vehicle guidance, safety circuitry or the electronic system, the safety devices bring the vehicle to a halt.

Before operating the vehicle after an Emergency Stop proceed as follows:-

4.1.1 Turn key switch to 'OFF'.

4.1.2 Determine possible cause of Emergency Stop.

4.1.3 Switch off automatic steering if engaged.

4.1.4 Turn key switch to 'ON'.

4.1.5 Operate the drive controls.

If the truck moves, check the operation of the manual and automatic steering functions.

5. DRIVE MONITORING FUNCTIONS AND SAFETY DEVICES. WIRE GUIDED AND RAIL GUIDED SYSTEM TRUCKS

5.1 In case of emergency - press the 'Emergency - OFF' button. Automatic application of the brakes follows.

It is sufficient to press either of the two 'Emergency' buttons.

The 'Emergency OFF' button is released by turning it clockwise (in the direction of the arrows).

5.2 Drive Cut-out (Special Option).

If the drive is cut-off after a certain lift height is reached and it is necessary to reposition the truck in relation to the shelves, in order to pick up or set down a load, press the push button, 'Drive Cut-out Override' and manipulate the 'Drive' control as described under 'Driving' (see 1.1 Page 17). This allows the truck to be 'Inched' into position.

5.3 Lift Height Restriction (Special Option).

Where structural conditions require the lift height to be limited for reasons of safety, a lift height restriction facility may be incorporated.

The lift height cut-out can be overridden by pressing the push button 'Lift Height Cut-out Override'.

It is possible thus, to lift to a height above the 'Lift Height Cut-out' point.

After each lowering action the Lift Height Restriction is re-imposed.

NOTE:- The 'DRIVE CUT-OUT OVERRIDE' and 'LIFT HEIGHT RESTRICTION OVERRIDE' push buttons are located on the loadguard - front right hand corner.

6. LIFT - LOWER - SIDESHIFT - ROTATE. OUTSIDE THE AISLES

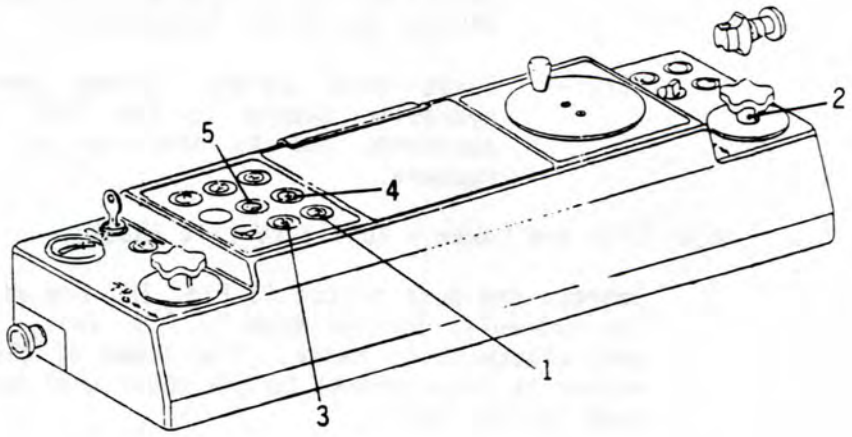


Fig. 18 Lift/Lower Sideshift/Rotate

6.1 Lift and Lower - Main Lift (Cab).

Depress the push button (1 Fig. 18) and simultaneously rotate the hydraulic control knob (2 Fig. 18) - clockwise to lower, anti-clockwise to raise. The speed of the lifting or lowering action is proportional to the rotational movement of the control knob (2 Fig. 18).

For maximum lift speed the auxiliary lift (mast) must be lowered fully and the reach unit must be in the base position*. If the reach unit is not in the base position* the lifting speed is reduced.

Lift Height - Main Lift maximum 2.5m with the auxiliary mast fully lowered.

Lift Height - Main Lift maximum 0.5m with the auxiliary mast raised.

Maximum lowering speed can be obtained only if the reach unit is in the base position*.

NOTE:- Lowering action is obtainable only when the truck is operational (i.e. switched on).

* In the Base Position, the reach unit is retracted to one side and the forks are rotated inwards. (i.e. towards the centre).

WARNING:- IF THE MAIN LIFT (CAB) IS RAISED TO MAXIMUM HEIGHT, ALWAYS OPERATE THE HYDRAULIC CONTROL GENTLY TO LOWER, OTHERWISE THE BURST HOSE SAFETY VALVES WILL OPERATE AND A 'LOCK UP' CONDITION WILL OCCUR. SHOULD THIS HAPPEN ROTATE THE CONTROL KNOB ANTI-CLOCKWISE AND THEN GENTLY ROTATE IT CLOCKWISE TO LOWER THE LOAD ONCE THE VALVES HAVE RESET THEMSELVES.

NOTE:- Burst hose safety valves are installed in the hydraulic supply to the lift cylinders to prevent accidents and to minimise oil loss should a hose rupture.

6.2 Lift and Lower - Auxiliary Lift (Mast).

Depress the push button (3 Fig. 18) and at the same time rotate the hydraulic control knob (2 Fig. 18):- clockwise to lower - anti-clockwise to raise. The speed of the lifting or lowering action is proportional to the rotational movement of the control knob (2 Fig. 18).

Auxiliary Lift. LIFT action is only available if the main lift (cab) is lowered fully or is no higher than 0.5m (approx. 1ft 7 3/4in).

6.3 Sideshift (Reach Unit).

Depress the push button (4 Fig. 18) and at the same time rotate the hydraulic control knob (2 Fig. 18):- clockwise to sideshift to right - anti-clockwise to sideshift to the left.

Speed of travel to left or right is proportional to the rotational movement of the control knob (2 Fig. 18).

6.4 Rotation (Carriage).

Depress the push button (5 Fig. 18) and at the same time rotate the hydraulic control knob (2 Fig. 18):- clockwise to rotate to the right - anticlockwise to rotate to the left.

Speed of rotation is proportional to the rotational movement of the hydraulic control knob (2 Fig. 18).

NOTE:- No rotational movement is possible if the forks are fully extended.

6.5 Combined Sideshift Movement of the Reach Unit and Rotation of the Forks.

The reach unit shifts sideways and at the same time the carriage (forks) rotates.

The speed of rotation is constant.

The speed of the sideshift movement is proportional to the rotational movement of the hydraulic control knob.

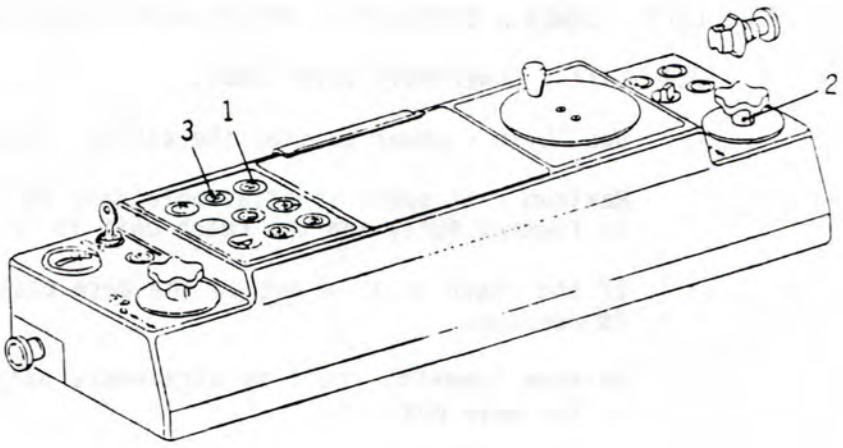


Fig. 19 Combined Movement

Depress the push button (1 Fig. 19) and at the same time, push down and rotate the hydraulic control knob (2 Fig. 19) clockwise. The forks rotate clockwise as the rach unit sideshifts to the left.

Depress the push button (3 Fig. 19) and at the same time, push down and rotate the hydraulic control knob (2 Fig. 19) anti-clockwise. The forks rotate anti-clockwise and reach unit sideshifts to the right.

7. LIFT - LOWER - SIDESHIFT - ROTATE WITHIN THE AISLES

7.1 Lift - Lower Main Lift (Cab).

See 'Lift - Lower outside the aisles' (Para 6.1 Page 25).

Maximum lift speed is attainable only if the auxiliary lift mast is lowered fully and the reach unit is in the base position.

If the reach unit it <u>not</u> in the base position the lifting speed is reduced.

Maximum lowering speed is attainable only if the reach unit is in the base position.

NOTE:- Lowering function is available only if the truck is operational (key switch in the ON position).

The Lift Height is not dependent on the position of the auxiliary lift.

7.2 Lift - Lower (Auxiliary Lift).

See 'Lift - Lower outside the aisles'. (Para 6.2 Page 26).

Lifting and Lowering functions are independent of the position of the main lift (cab).

7.3 Sideshift and Rotate.

See 'Sideshift and Rotate outside the aisles'. (Para 6.3, 6.4 Page 26).

7.4 Diagonal Travel (Combined Drive and Lift).

See 'Driving and Braking within the aisles' (Para 2 Page 19).

To avoid undue mechanical and hydraulic stresses move the corresponding control lever to the neutral position as soon as any hydraulic pressure relief valve operates.

The movement of the reach unit and forks can be controlled sensitively by manipulation of the hydraulic control knob.

The rotating patrol lamp is set in operation automatically as lowering commences.

8. LIFT MONITORING FUNCTIONS AND SAFETY DEVICES OUTSIDE/WITHIN THE AISLES

8.1 When necessary the Main Lift (Cab) may be lowered manually in two ways:-

8.1.1 From the cab. Depress the push button (1 Fig. 20) (EMERGENCY LOWER).

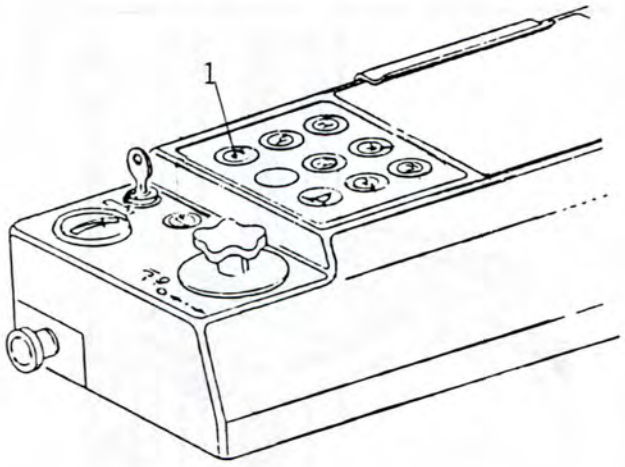


Fig. 20 Emergency Lower (Cab)

8.1.2 From the floor. Raise the rear cover and open the valve (2 Fig. 21).

The controls must be in the neutral position. Otherwise depress the button (3 Fig. 22) before opening the valve (2 Fig. 21).

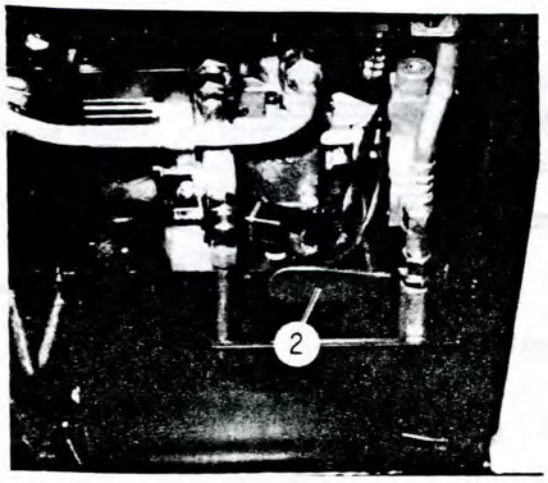


Fig. 21

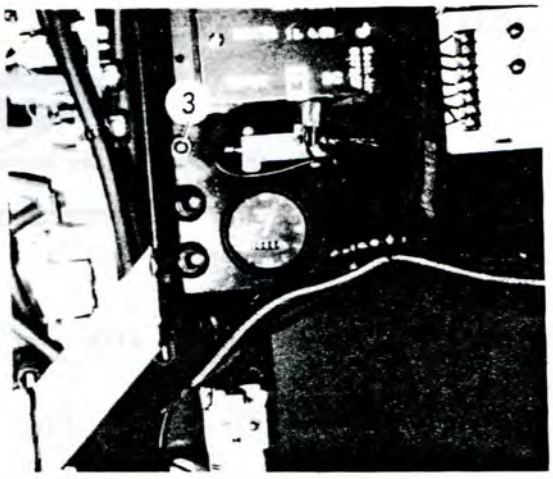


Fig. 22

SAFETY SYSTEMS AND LIFT MONITORING FUNCTIONS WITHIN AND OUTSIDE THE AISLES

8.2 Trucks having a Cab Lift Height in excess of 2.5m are equiped with an escape device, by means of which the cab may be evacuated, should a situation arise in which it is not possible to lower the cab by either of the methods described in Para 8.1.

8.2.1 Extend the support arm (1 Fig. 23) outwards over the front of the loadguard.

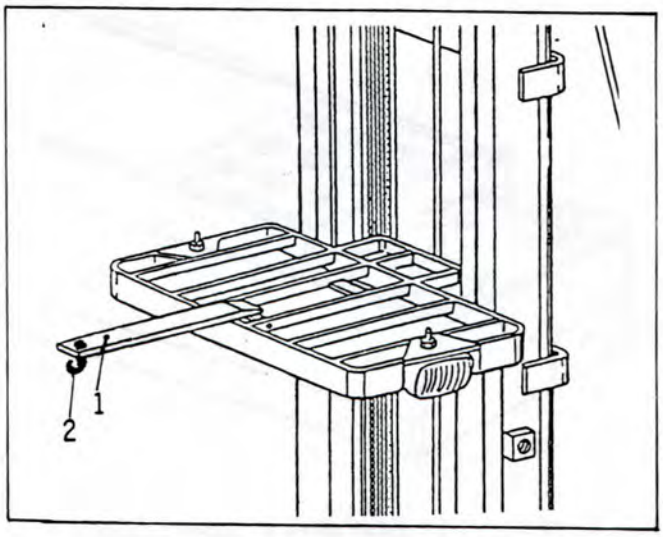


Fig. 23 Escape Device Anchor Point

8.2.2 Attach the cable eye equipment (Fig. 24) to the attachment point (2 Fig. 23).

WARNING:- THE INSTRUCTIONS FOR USE OF THE ESCAPE DEVICE MUST BE FOLLOWED CAREFULLY.

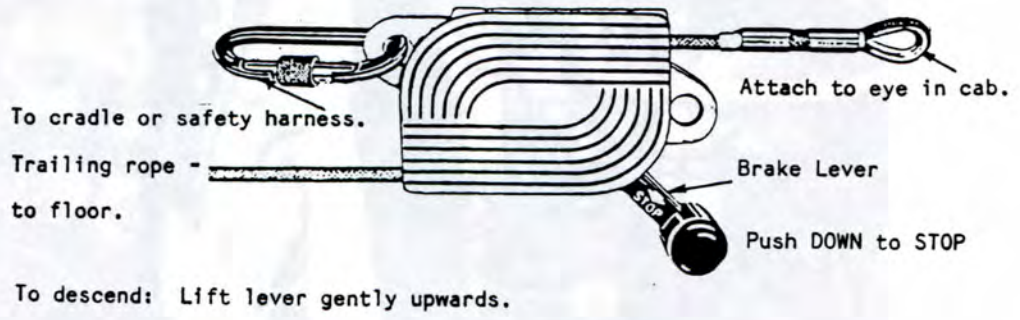


Fig. 24 Escape Device (Typical)

NOTE:- The driver must be instructed in the use of the escape device.

The escape procedure must be practiced at regular intervals. The practice descent should be made from a low height i.e. 1-2m (39.4-78.8ins).

1. PICKING UP A LOAD

1.1 Ensure that load does not exceed the rated capacity of the truck as stated on the rating plate.

The lifting capacity depends on the position of the forks, lift height and centre of gravity of the load.

1.2 Approach the stacking place slowly and raise the forks to the height of the pallet.

1.3 Check that the fork centres correspond with the openings in the pallet.

The fork centres are adjustable and the forks must be secured with the lock pins at ALL TIMES.

1.4 Forks Rotated Left or Right.

1.4.1 Move the forks slowly into the pallet until the backs of the forks rest against the pallet or load.

1.4.2 Raise the load slightly and retract the forks fully. Lower the load if outside or leaving aisles.

1.5 Forks Parallel with Centre Line of Truck.

1.5.1 Inch the truck forward so that the forks enter the pallet slowly until the backs of the forks contact the pallet or load.

1.5.2 Raise the load slightly and reverse the truck away at inching speed and then bring the reach unit into the base position and lower the load.

1.6 Make sure that the way is clear and drive off.

1.7 Unrestricted ground conditions are essential for trouble free operation with loads at great heights.

2. TRAVELLING WITH LOAD

2.1 Outside the shelf lanes, travel across the floor with load as low as possible but with good ground clearance.

2.2 Always transport the load on both arms. When handling heavy loads make sure that the forks are evenly loaded.

2.3 Travel at a uniform speed. Do not stop suddenly except in Emergency. The use of regenerative braking is recommended for smooth control see page 16, 17.

2.4 Reduce speed when negotiating sharp corners.

3. SETTING DOWN THE LOAD

3.1 Stop at the stacking position and raise the load to the desired shelf level.

3.2 Move the load into the shelf and lower until the forks are free of the load.

3.3 Retract forks fully and lower or raise (articulated reach unit).

3.4 Check that the way is clear and drive off.

4. PARKING THE FRONT AND LATERAL STACKER DURING BREAKS

4.1 Lower forks to the floor. Choose a parking place where no one can trip over the lowered forks.

4.2 If the truck is parked on an incline, use chocks to prevent rolling.

4.3 Remove the safety key to prevent use by unauthorised personnel.

WARNING:- Observe all Safety Regulations.

5. OPERATION OF THE FRONT AND LATERAL STACKER IN WINTER

To safeguard the truck battery do not leave the truck in the open when not in use. Park in a heated area.

Before operating the truck after a prolonged stoppage, operate the lift several times without load to warm up the hydraulic oil.

1. TRANSMISSION

1.1 Draining the Oil.

1.1.1 Place a container under the transmission.

1.1.2 Remove the drain plug (2 Fig. 24) on the underside of the transmission and drain oil.

1.2 Filling the transmission.

1.2.1 Replace drain plug (2 Fig. 24) and tighten.

1.2.2 Remove filler/level plug (1 Fig. 24) from the top of the transmission.

1.2.3 Using clean transmission oil, fill the transmission to the oil level hole (1 Fig. 24).

1.2.4 Replace and tighten the filler/level plug.

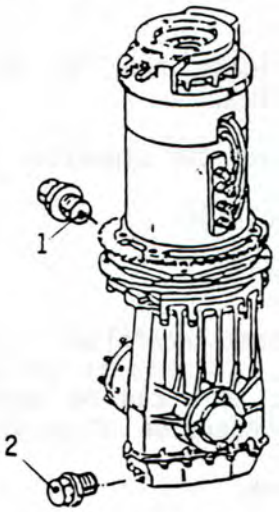


Fig. 24 Changing Transmission Oil

2. HYDRAULIC SYSTEM

2.1 Cleaning the Breather Filter.

The breather filter and the hydraulic oil filter are accessible when the rack (3 Fig. 25) is swung aside. This necessitates removal of the screw (4 Fig. 25) and disconnection of the cable (5 Fig. 25) from the drive motor.

Unscrew the breather/filter and dipstick (1 Fig. 26) and clean using a solvent or pressure air.

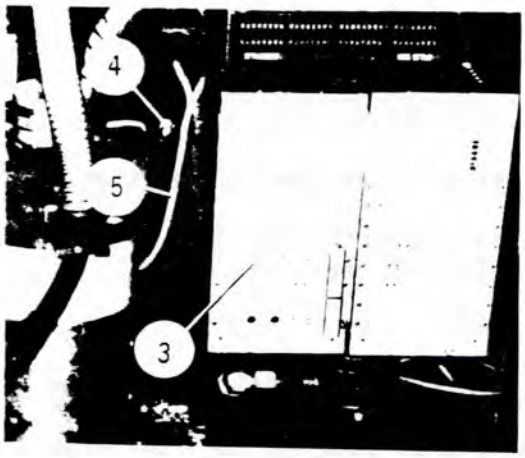


Fig. 25 Access to Hyd. Tank

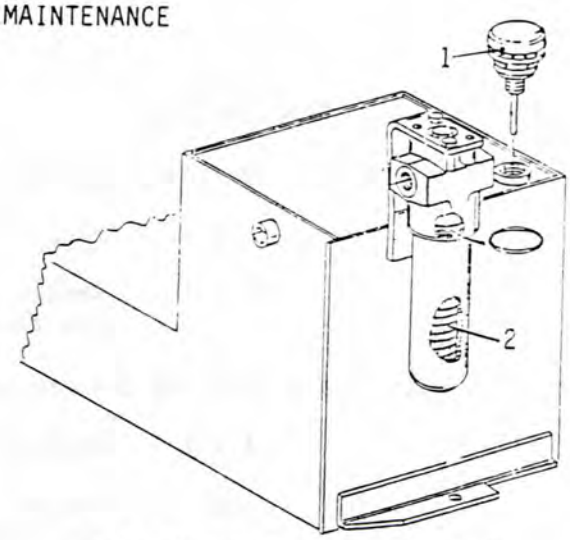


Fig. 26 Hydraulic Oil Tank

2.2 Renewing the Hydraulic Oil Filter.

2.2.1 Unscrew the hydraulic oil filter cannister (2 Fig. 26) and renew the filter cartridge. Fit also a new 'O' Ring.

2.2.2 Lubricate the 'O' Ring with hydraulic oil before fitting.

2.2.3 Replace the cannister taking care not to overtighten.

3. CHANGING THE HYDRAULIC OIL

3.1 Draining the Oil.

Remove the breather/filter (1 Fig. 26) and suck out the hydraulic oil. If this is not practical (e.g. no suction pump available) the tank can be emptied by removing the oil drain plug from the underside of the hydraulic oil tank.

3.2 Filling the Tank.

3.2.1 Replace the oil drain plug.

3.2.2 Remove the breather/filter (1 Fig. 26) and pour in clean, new hydraulic oil until the level reaches the upper mark on the dipstick.

3.2.3 Replace the breather/filter cap.

3.3 Checking the Hydraulic Oil Level.

3.3.1 With the cab (and auxiliary lift mast) fully lowered check that the hydraulic oil level is between the max. and min. marks on the dipstick (1 Fig. 26).

Top up with new hydraulic oil if necessary.

4. DISASSEMBLY OF THE HYDRAULIC PUMP ASSEMBLY

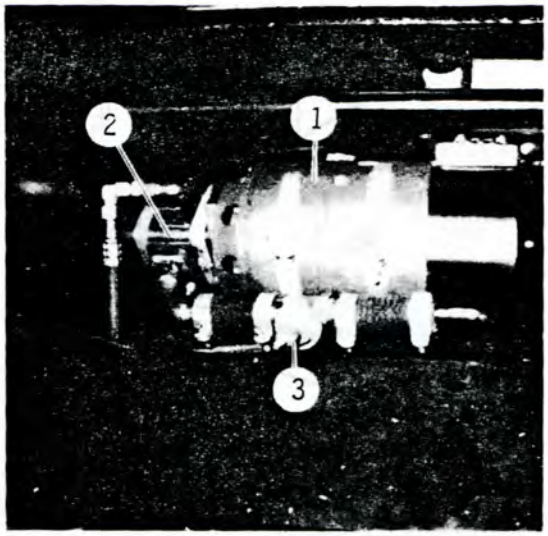


Fig. 27 Hydraulic Assembly

4.1 Before removal of either the hydraulic pump motor (1 Fig. 27) or the hydraulic pump (2 Fig. 27) the stop valve (3 Fig. 27) between the assembly and the tank must be shut.

4.2 Allow the hydraulic pump empty the hydraulic pipes by operating one of the hydraulic controls for a <u>short</u> period.

WARNING:- THE HYDRAULIC PUMP MUST NOT BE ALLOWED TO RUN DRY.

BEFORE PUTTING THE TRUCK BACK INTO SERVICE, MAKE SURE THAT THE STOP VALVE (3 FIG. 27) IS OPEN.

5. BRAKE FLUID

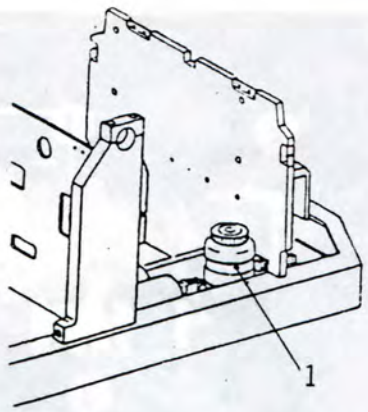


Fig. 28 Brake System Reservoir

The fluid in the brake system (factory filled) must be renewed no later than two years after delivery due to aging and the loss of the original properties of the brake fluid.

The brake fluid reservoir (1 Fig. 28) is located underneath the battery and the level should be maintained 2cm below the cap. Always use the recommended brake fluid.

The brake system must be kept free from leaks.

1. FORKS

1.1 All forks must be tested by an approved inspector, at least once per year.

1.2 The forks are forged from high grade steel and on no account may they be re-worked - either hot or cold.

Damaged or distorted forks must be returned to the supplier for rectification.

2. ROLLERS - LUBRICATION (MAST, CARRIAGE, CHAIN)

All mast assembly rollers are provided with grease nipples and must be charged with grease at the scheduled intervals.

3. LIFT CHAINS

Clean and lubricate chains (see para 3.1 and 3.2).

WARNING:- INADEQUATE LUBRICATION LEADS TO CORROSION OF PINS AND LINKS THEREBY REDUCING CHAIN LIFE WITH CONSEQUENT RISK OF CHAIN FAILURE.

NOTE:- It is essential that lift chains, be maintained in a free well lubricated condition.

If a truck is steam cleaned between service schedules:-

DO protect chains from splashes and backwash from powerful steam jets unless dip lubrication is intended.

DO lubricate pins, linkages and lift chains before putting the truck back into service.

DO remove and lubricate chains by dipping, immediately after steam cleaning.

NOTE:- The link plates are of a high tensile strength material and hydrogen embrittlement resulting from corrosion may lead to delayed failure at unexpectedly low stress.

It is imperative, therefore, that lift chains are not left unlubricated and unprotected.

DO lubricate and protect chains immediately after cleaning by thorough application of a coating of lubricant.

3.1 Clean and lubricate chains in situ:-

With chains in situ, wipe to remove surface dirt and liberally apply fresh, clean Mobil P.M.S. 220 oil with a brush, commencing at the highest point.

3.1.1 If Mobil P.M.S. 220 oil is unavailable fresh clean S.A.E. engine oil may be used as a chain lubricant. However, Mobil P.M.S. 220 oil has superior water repellent properties and is the preferred chain lubricant. The SAE 30 engine oil, although acceptable should not be considered as a preferred alternative to P.M.S. 220 oil.

3.1.2 S.A.E. Engine Oil Only.

The use of Acheson Anti-wear additive in a ratio of 1 part additive to 20 parts S.A.E. 30 engine oil, will improve the load bearing capacity of the lubricant.

Alternatively use a recommended penetrating aerosol lubricant, that is water and dust repellent, at the 250 hour service routine.

If an aerosol spray is used Rocol Lift Truck Chain Spray is recommended.

3.2 Removal and lubrication of chains.

Index mark ends and remove chain(s) from truck. Clean chains before soaking in lubricant for one hour, checking for good penetration.

Remove chain(s) from soak bath, allow excess lubricant to drain off and refit to truck turned over and end to end according to index marks.

Lubricate chains anchors and pins before and after fitting chains.

It is not sufficient to lubricate only bearing surfaces.

ALL surfaces must be protected from corrosion at all times.

NOTE:- Where trucks are operating in hostile environments (chemically polluted or salt laden atmospheres or dusty conditions), consult the truck manufacturer or your nearest depot or distributor for recommended special lubricants and service schedules.

NOTE:- When parked up for long periods, chains should be protected with Esso Ban 396 or other reasonably viscous lubricant with good adhesive properties.

NOTE:- Some of the fluids mentioned above give off noxious and hazardous vapours. Appropriate safety precautions must be observed when using them.

3.3 Checks.

Visually check chain rivet heads, pulley and anchors for signs of damage and replace as necessary.

3.4 Adjustments.

Check chain adjustment, with the truck on level ground and mast vertical; the forks should just ground when the mast is fully closed, i.e. cab down. Slacken the locknut on the adjustable chain anchors rotate the adjuster nut to obtain the adjustment tighten the locknut, then raise and lower the cab several times to check adjustment.

3.5 Ensure that chains are of equal tension and that the carriage is square within the mast.

NOTE:- Too frequent need for adjustment may indicate a rapidly wearing chain, that may be through lack of lubrication or consistent overloads.

3.6 Inspection.

Clean and examine the lift chain for wear as follows.

3.6.1 Wear caused by running over sheaves:- The reduction in plate depth should not be more than 5% of the original depth.

3.6.2 Extension of the chain (stretch):- This must not exceed 2% to be measured over portions of 7 pitches at a minimum of three separate locations. The length of chain being measured must be held taut.

3.6.3 Bearing pin heads for wear and outer link plates for hole elongation or cracks.

3.6.4 Link plates and pins for corrosion, particularly inner faces of link plates.

Renew chain if any of the above conditions apply.

3.7 Chain Renewal.

Chains which are fitted in pairs must be renewed in pairs. Only in this way is it possible to guarantee the chains are equally loaded.

The chain anchor pins (connecting the chain to the chain anchor) must be renewed at the same time as are the chains. When renewing chains use only original spares obtainable from your local CLARK Service Organisation or Distributor.

NOTE:- The Inspection (Para 3.6) may be carried out only by an approved, competent Service Engineer, e.g. under the terms of a Service Agreement.

1. BATTERY CARE

Refer to "Battery Maintenance" in the Appendix of Section 1, for further safety instructions.

1.1 Measure the density of the battery electrolyte with a hydrometer. Check the electrolyte density daily.

Open the battery compartment cover.

Separate the battery connector.

Remove the plugs from the cells and, using a hydrometer, measure the electrolyte density. (See Table)

If necessary put the battery on charge. Any cell which shows a significantly lower charge than the others is defective.

Measurements made within one hour of topping up with distilled water will be inaccurate.

If checks show that cells are deeply discharged cease truck operation - further use will damage the battery.

TABLE 1

Specific Gravity	Cell Voltage at No Load	Charge State
g/cm^3	V	%
1.26	2.10	100
1.23	2.07	90 Normal
1.195	2.035	60 Discharge
1.16	2.00	40
1.125	1.93	0 Deep Discharge

1.2 Check electrolyte level daily; maintain level at 5mm above cell plates by topping up as necessary with distilled water.

Distilled water evaporates more rapidly at temperatures above 40°C necessitating frequent level checks.

Battery capacity drops considerably, below freezing point. At temperatures below -20°C the battery may freeze.

Rule of Thumb.

Every degree Centigrade lower than an electrolyte temperature of +27°C is equivalent to a drop in capacity of 1% (e.g. -20°C = 47% reduction in Capacity).

1.3 Clean the battery surface regularly. Leave the battery caps in position while cleaning with water or mild soda solution and dry off using pressure air.

Breather holes in the caps must be unobstructed to allow escape of gases caused by charging.

1.4 Check the battery terminals and cell connectors for firm seating and tightness. Battery posts and cell connectors should be coated lightly with acid free and acid resistant grease (e.g. vaseline).

Terminal connections must be firm and tight as loose connections may increase contact resistance causing cell connectors and terminals to fuse.

Consult battery manufacturers maintenance and operating instructions.

WARNING:- BEFORE COMMENCING WORK ON THE ELECTRICAL SYSTEM PRESS THE EMERGENCY OFF BUTTON AND TURN OFF KEYSWITCH.

To avoid danger of short circuits never lay any metallic object on the battery.

1.5 Battery Discharge Indicator.

Fig. 29

The indicator needle of the instrument moves over an internationally agreed coloured scale from 'Fully Charged' to 'Discharged'. The green segment of the scale indicates 'Battery Charged' and the red zone 'Battery Discharged'.

Fig. 30

A flashing LED display illuminates to give warning when discharge is within 5% of the critical 80% discharge point. This informs the driver that the battery must be changed over or alternatively must be put on charge.

Fig. 31

When the pointer reaches the red scale point a control function operates which locks out the lift function, preventing further lift action and protecting the battery from reaching a deep discharge condition.

For reasons of safety, the lift circuit lock out action only occurs after a lift operation is concluded i.e. after the lift control is returned to the neutral position.

The lift cut out action is factory adjusted to occur at the 80% battery discharge point.

Do not routinely or persistently continue to work the truck until the lift circuit lock out action occurs. This is bad operating practice which results in frequent deep discharge of the battery and consequent damage to the battery.

2. VISUAL CHECKS

Check the terminal boards and the fan impellors for cracks, damage, broken fan blades.

Damaged fans are inefficient (due to being unbalanced) and should be replaced as should damaged terminal boards.

Check field and armature windings for signs of overloading, (overheating) such as discoloured, brittle or burnt insulation, unsoldered commutators or terminal posts. Motors showing these signs are unfit for service.

If cleaning reveals signs of oil or grease (usually a paste of oil, oil vapour, viscous oil with dust or carbon debris), trace and rectify the cause of the contamination (e.g. faulty radial seals, oil leaks from the hydraulic system etc.).

IMPORTANT NOTE!

Rapid brush or commutator wear is usually due to the action of oil. Oil or grease is combusted in the sparks from the brushes leaving a deposit of ash which, acting abrasively may cause brushes to wear out well before normal replacement time.

After cleaning the brush gear check that the brushes move freely in their guides when the springs are raised.

Check that the brush gear is properly mounted.

If any of the brushes sticks in the brush gear do not attempt to file down or rub down with emery paper. Renew all of the brushes in the set as the originals have been severely overheated.

Brushes with unsoldered leads have been overheated, - change all the brushes in the set and check the commutator.

Do not use brushes which have damaged edge(s) or broken brushes, as this may indicate a damaged commutator or protruding lamination(s).

If brush wear is excessive, the wires or springs may rub on the brush gear. The brush does not sit squarely on the commutator, causing excessive arcing and consequent scorching at both the commutator and brush gear, resulting in motor failure.

Always renew all the brushes in the set, never singly. Go by the shortest brush.

Positive brushes wear slightly faster than negative brushes.

3. COMMUTATOR

The surface of the commutator should be smooth over all and grey/black in appearance. It should not be worn, scored or out of round. Look for protruding laminae (broken brush edges).

Worn or scored commutators must be dressed (reconditioned). On no account file or rub down the commutator with a file or emery cloth.

The life of the brushes is dependent, not only on the motor loading but mainly on the condition of the commutator.

The commutator should be reconditioned no later than after the third brush set is installed.

4. PULSE CONTROL UNIT

4.1 Operation of the pulse control system which is of modular design employing semi-conductor units, is free from wear, apart from that in the reversing contactors, accelerator switch and the limit switch.

4.2 The pulse control unit is protected by a plastic cover from mechanical damage and acid fumes evolved during battery charging.

Pulse control unit faults should be rectified only by a Factory Trained Service Engineer.

4.3 Cleaning.

When cleaning the truck do not direct water or steam jets onto the edges of the pulse control cover gasket.

The pulse control unit MUST be kept dry; therefore clean with a brush or pressure air.

CAUTION:- BECAUSE OF THE DANGER OF SHORT CIRCUITS OR ARCING, MAKE SURE THAT THERE ARE NO FOREIGN BODIES, ESPECIALLY METAL OBJECTS, IN THE PULSE CONTROL UNIT.

DAILY CHECKS PRIOR TO OPERATION

1. Ensure battery is fully charged and electrolyte level is 6 mm above the battery cell plates.

2. Check that all controls function correctly and that no operation of the machine is possible if either of the two cab door arms is raised.

3. Check all instruments are functioning correctly.

4. Carry out an operational brake system check, by driving the truck in the aisle (with guidance switched on if wireguided) at 1/4 speed and then releasing the drive control deadman button completely. The machine must come to a total halt within a distance of 500 mm (maximum).

   NOTE:- 1/4 speed can be accurately attained by rotation of the forks to the forward direction (placed centrally on the sideshift carriage) prior to driving.

5. Check that manual steering control operates correctly and that full lock-to-lock rotation of the rear wheel occurs.

   Also on railguide trucks only, check that the centralised steer switch forces the rear wheel to the straight ahead position when pressed and the lamp is illuminated.

6. Check that the tracking audible warning and lamp operate correctly upon attaining wireguidance and that the 'guidance switched on' lamp illuminates at all other times when using the machine on wireguidance (wireguidance systems only).

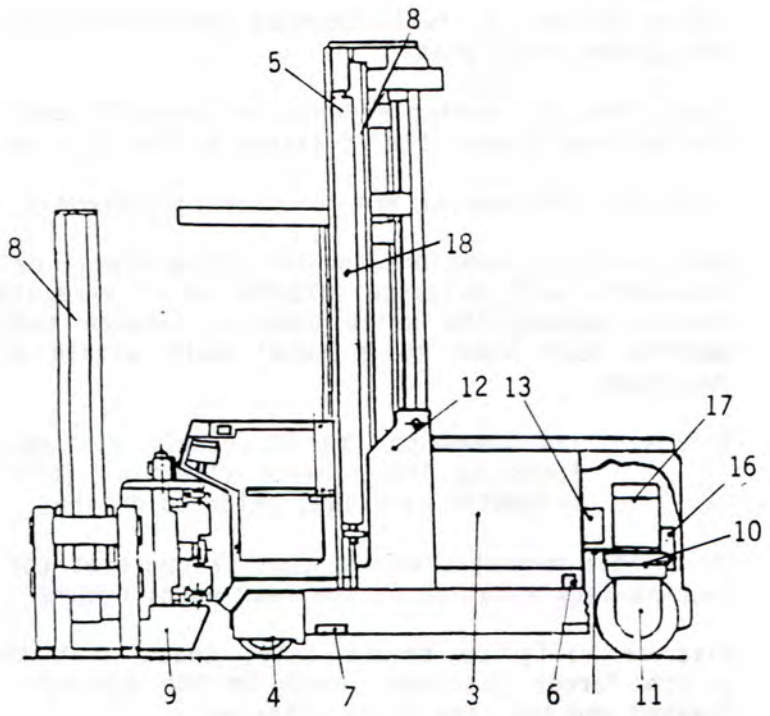
7. Visually check that all of the side guide rollers are round and undamaged (rail guidance systems only).

8. Ensure that the forks are spaced evenly on the carriage and that the retention catches operate correctly.

9. Visually check that no damage to components (hydraulic hoses, cables etc.,) exists, that may present a safety hazard if the machine is used.

10. Ensure operating areas and aisles are free of debris and obstructions.

If any of the above checks indicates that the machine may be faulty (or if any doubt exists), the machine must not be operated and the problem must be notified to the department responsible for maintenance so that immediate action can be taken to rectify the fault.



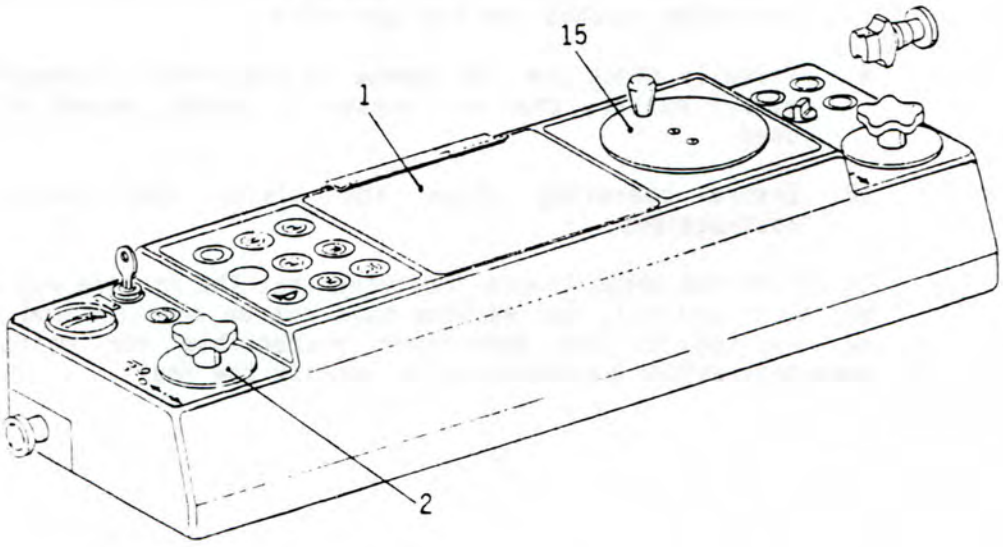


Fig. 32 Reference Points - Maintenance and Inspection Schedules

INITIAL AND ROUTINE SERVICE SCHEDULES

SECTION 1 - INITIAL SERVICE

At the first 125 hours running time carry out the normal operators 125 hour routine (section 2 refers) plus the additional initial servicing below.

It is the responsibility of truck owners/users to ensure servicing is carried out at the due times. If assistance is required, contact your nearest Dealer/Distributor who will be pleased to arrange a service or maintenance contract.

1. AT INITIAL 125 HOURS

   1.1 Adjust wheel brakes and parking brake if necessary.

   1.2 Check specific gravity of battery cells. If necessary give equalising charge.

   1.3 Check that battery terminals are tight, clean and protected by a film of petroleum jelly.

NOTE:- CHECK AND TIGHTEN ROAD WHEEL NUTS DAILY FOR THE FIRST THREE DAYS OF OPERATION.

INTENTIONALLY BLANK

SECTION 2 - OPERATOR SERVICE ROUTINES

The following Daily and 125 hour service routines are intended to be carried out by the Operator.

Attention to these routines will minimise down time by locating defects at an early stage before they can develop into costly failures, thus ensuring the safe operation of the Truck.

The asterisk (*) indicates the interval that the check should be made.

NOTE:- The 125 hour routine includes the daily check.

	1.	DAILY or SHIFT CHANGE	125 HOURS	LOCATION/REMARKS
	VISUAL CHECKS - STATIC			
	Hydraulic - oil level	*		16. Forks fully lowered truck on level ground.
	Hydraulic cylinders		*	5/9. Wipe off accumulated oil traces.
	Hydraulic - tank breather		*	
	Wheel Nuts - for damage & slackening	*		4/11.
+	Wheel Nuts - check & tighten		*	4/11.
	Tyres - for damage	*		4/11.
	Lift Chain anchor condition		*	8/9.
	Lift Chain - clean, examine for signs of wear or fatigue		*	8/9.
	Mast - check structure for alignment and damage.		*	8. Report any signs of damage or distortion at once.
	Forks - examine for bending & damage (indicating overloading)		*	
	Hoses over mast - for damage	*		
	Hose tension over mast & adjust		*	8.
	Brakes - Master Cylinder Reservoir		*	6. Check and top up. Report if top up required.
	Brakes - check system for leaks	*		
	Battery - general condition of terminals and case		*	3.
	Battery - electrolyte level		*	3.

\+ This check may be relaxed after 2 months if wheel nuts are always found tight.

	DAILY or SHIFT CHANGE	125 HOURS	LOCATION/REMARKS
2. VISUAL CHECK			
Battery - acid level and charge level	*		3.
Oil/Fluid leaks	*		Report at once.
Side Guide Rollers - for roundness and damage	*		7. Rail guidance trucks only.
Lift and Lower - Operation	*		
3. FUNCTIONAL CHECKS			
Check the operation of all controls, indicators and interlocks	*		1.
Brakes	*		2. Carry out brake check before work commences.

SECTION 3 - ROUTINE SERVICING - MECHANIC

The following routine services should be carried out by or under the supervision of a trained Mechanic.

The asterisk (*) indicates when the action is to be carried out.

NOTE: The 500 hour routine includes the 250 hour, the 1000 includes both 500 and 250 and so on.

ITEM	Every 250 HOURS	Every 500 HOURS	Every 1000 HOURS	Every 2000 HOURS		LOCATION/REMARKS
1. ORDER PICKER						
Operation	*	*	*	*		Check complete operation of Truck.
2. CHASSIS & SUPERSTRUCTURE						
Chassis	*	*	*	*		Check for damage or weld cracks.
Hinges, Catches	*	*	*	*		Lubricate Oil can.
Guide Rollers (Rail Guidance Trucks only)	*	*	*	*	7 +	Check clearances between guide roller and guide rails.
3. STEER						
Steer Chains	*	*	*	*	14	Check tension. Clean and lubricate.
Toothed Belt	*	*	*	*		Inspect.
Check clearance and steering lock		*	*	*	15	
4. DRIVE						
Transmission/Traction Motor	*	*	*	*	10	Grease cross roller bearing.
Transmission	*	*	*	*	11	Check oil level
Transmission		*	*	*	11	Check visually for oil leaks.
5. BRAKE SYSTEM						
Lining Clearances	*	*	*	*	4	Check and adjust brake lining clearance. Ensure brakes do not bind.
Brake - Master Cylinder Reservoir	*	*	*	*	6	Check and top-up.
Magnetic Brake (On Traction Motor)	*	*	*	*		Check disc.
	*	*	*	*		Check brake lines for leaks, corrosion and chafing.
System				*	6	Change brake fluid.

+ Clearance between guide rollers and guide rail should be 0.5mm (0.0.2 ins). The rollers must not bind.

	ITEM	Every 250 HOURS	Every 500 HOURS	Every 1000 HOURS	Every 2000 HOURS		LOCATION/REMARKS
6.	ELECTRICAL SYSTEM						
	Battery	*	*	*	*	3	Check security and mounting.
	Battery - Electrolyte	*	*	*	*	3	Check spec. gravity and level. Ensure equalising charge not required.
	Battery Terminals	*	*	*	*	3	Tighten, clean and smear with petroleum jelly.
	Cell Connectors	*	*	*	*	3	Check condition.
	Cables and Wiring Looms	*	*	*	*	12	Check for damage to insulation.
	Fuses	*	*	*	*	13	Check condition and security.
	Pulse Control System	*	*	*	*	13	Clean using pressure air or a brush.
	Electric Motors - Hydraulic Pump, Steer		*	*	*	17	Check brushes for wear and and freedom of movement.
	Overmast Cables				*	8	Renew cables.
	Attachment Cables				*	8	Renew cables.
+	Rotary Impulse Transmitter Cable				*	13	Renew cable.
7.	HYDRAULIC SYSTEM						
	Hydraulic Oil	*	*	*	*	16	Check oil level, forks fully lowered, truck on level ground.
	Tank Breather		*	*	*	16	Clean breather.
	Suction Filter		*	*	*	16	Remove, clean and refit.
	Pump, Valves and Cylinders	*	*	*	*	16/18	Check for leaks. Check security and condition.
	Relief Valves		*	*	*		Check operation.
	Connections	*	*	*	*		Check for leaks; tighten if necessary; change seals if leaks persist.
	Hoses and Pipes	*	*	*	*		Check for external damage which could cause failures.
	Hydraulic Cylinders					16/18	Wipe off accumulated oil traces.

+ NOTE: The rotary impulse transmitter cable is in two sections. One section which is connected internally to the impulse transmitter and terminates in the plug clipped on the motor housing. A fault in this section necessitates renewal of the rotary impulse transmitter and cable. The section of cable with a plug at each end connects the impulse transmitter to the rack and flexes as the transmission rotates. Renew this section at 2000 hour service.

ITEM	Every 250 HOURS	Every 500 HOURS	Every 1000 HOURS	Every 2000 HOURS		LOCATION/REMARKS
8. MAST AND MECHANISM						
Mast	*	*	*	*	8	Check structure for alignment and damage (Check welds in vicinity of any damage).
Lift - Action	*	*	*	*	8	Check if lift is limited by lift cylinder(s).
Running Surfaces	*	*	*	*	8	Grease running and lateral contact surfaces of guide rollers in mast sections.
Guide Rollers (Rail Guidance Trucks)	*	*	*	*	7	Grease bearings.
Guide Rollers - Mast	*	*	*	*	5/8	Grease all lubrication points.
Guide Rollers - Mast	*	*	*	*	5/8	Check for wear and damaged bearings. Replace if necessary. Pack replacement roller/bearings with grease. Shim as necessary.
Lift Chains	*	*	*	*	5	Check rivet heads for wear and damage. Check that tensions are equal.
Lift Chains		*	*	*	5	Check for excessive wear and stretch.
Lift Chains		*	*	*	5	Clean and lubricate in situ.
Lift Chains				*	5	Remove, clean, check for stretch; dip lubricate and turn end for end.
Safety Chain				*	5	Check safety chain is unworn, lubricated and in good condition.
Chain Anchors	*	*	*	*	8	Check for damage and wear.
Chain Rollers	*	*	*	*	8	Check for wear.
Chain Rollers	*	*	*	*	8	Lubricate - 1 nipple recessed in well of roller.
Lift Cylinder	*	*	*	*	5	Check if the lift of the mast is limited by the lift cylinder.

SAFETY CHECK

NOTES 1. Change transmission oil at least every two years.

2. On running in a new or reconditioned transmission, change transmission oil after 20 operational hours.

3. After changing an hydraulic pump, flush system to clean and then change the oil.

4. Worn or damaged components on the Mast and Mechanism may be indications that the truck is being overloaded.

5. Change hydraulic oil at least every two years.

SECTION 4 - ROUTINE SAFETY CHECKS - MECHANIC

The following safety checks should be carried out by or under the supervision of a trained mechanic as part of each 250 hour service routine.

NOTE:- The control programme is specific to the truck/application and may include additional safety features not covered by this schedule. Therefore, prior to carrying out these checks, the engineer should familiarise himself with the truck programme and modify the schedule as necessary.

1.	End of Aisle Detection	
	1.1 Wire Guidance Systems	Drive out of aisle (over floor magnets) - Check that speed is reduced.
	1.2 Rail Guidance Systems	Drive out of aisle (past ends of guide rails) - Check that speed is reduced.
2.	Inductive Loop	Drive off guide wire. Check that truck stops on leaving wire.
3.	Dead Man's Buttons	Check that hydraulic functions and drive inoperative when button(s) is (are) released.
4.	Emergency - Battery Cut-out	Check (a) Truck is inoperative until push button is released (Push and turn clockwise). (b) Brakes apply if button is pushed while truck is in motion.
5.	Cab Guard Rails	Check that truck is inoperative unless BOTH guard rails are down.
6.	Speed Restriction	Check that speed of travel is reduced according to height of elevation. Refer to programme.
7.	Height Selector	Check correct operation at all pre-set heights.
8.	Lift Height Limit	Check that truck is immobilised when height limit is reached.
9.	Emergency Cab Lowering	Check that cab descends when (a) 'Emergency Lower' button in cab is depressed. (b) Manual valve on control block is opened. Refer to page 22.

INITIAL AND ROUTINE SERVICE SCHEDULES

CAB SECURITY SAFETY CHECKS

The following checks must be carried out to ensure that the man aloft security is adequate and conforms to safety requirements regarding efficiency, correct working order and states of repair:-

1. Slacken off the slack chain device sensors and check that the cab lowering control is inhibited.

2. Put a load on to the forks (full rated load).

3. Tension the safety chain until the main chains are slack (load 100 mm above ground).

4. Engineer stands in cab area.

5. Slacken safety chain (sprung loaded) so that main chains take the load again.

   NOTE:- The safety chain must not take any load in normal conditions.

6. Re-adjust slack chain device, ensuring that the sensor is adjusted to give a 3 mm gap between the sensor and the metal target.

7. Remove load.

SERVICE PRODUCTS

1. GENERAL

Prior to greasing bearings, clean off all deposits of dirt from grease nipples.

Apply grease gun to grease nipple until fresh grease exudes from the bearing.

NOTE:- All grease nipples must be greased after each time the truck is cleaned by high pressure steam jets.

2. GREASE POINTS

Front Wheel Bearings.

Multi-Purpose - Lithium - Grease KP 2 K(N) DIN 51 502 Pt. No. D015504.

Multi-Purpose - Lithium - Grease KPF 2 K DIN 51 502 Pt. No. D014506.

Lift Chains and Chains on Articulated Reach Unit.

In environments with high humidity (e.g. breweries, dairies, meat or fish processing) the use of a water repellent grease (e.g. Kluber - Hydrokapilla NBU30 dispersion 20 TCN) is recommended.

In dusty environments (e.g. sawmills, ceramics industry and brickworks) a lubricant which forms a dry elastic lubricating film which prevents clogging by dust or dirt (e.g. Kluber - Contractor S 150 denso GA).

3. HYDRAULIC SYSTEM

Multigrade Oils.

Also known as HV Oil to Draft DIN 51.524 T3 Pt. No. D030575.

These so called High - VI - Hydraulic Multigrade Oils are preferred. It is desirable that oils with detergent and dispersant additives be used.

The oils are available as HV 32 or HV 68 oils.

Mineral Oil (Rape Seed Oil) Details on Request.

Single Grade Oil.

Hydraulic Oil H-LPD 46* (ISO - VG 46, DIN 51 510) Pt. No. D044979.

NOTE:- Max. Kinetic Viscosity = 1000 mm^2/S
Min. Kinetic Viscosity = 10 mm^2/S
Optimum Kinetic Viscosity = 30 mm^2/S

* As DIN 51 525 with improved lubricating properties and additives to increase wetting action and detergent properties.

CAPACITIES, FUSES AND SETTINGS

1. CAPACITIES

1.1 Hydraulic Oil Tank approx. 70.0 litre (123 imp. pts) hydraulic oil*.

1.2 Transmission approx. 5.0 litre (8.8 imp. pts) gear oil.

1.3 Hydraulic Brake System approx. 0.2 litre (0.35 imp. pts) brake fluid.

* As the total system capacity varies according to the lift height of the truck, the correct volume is indicated by the dipstick.

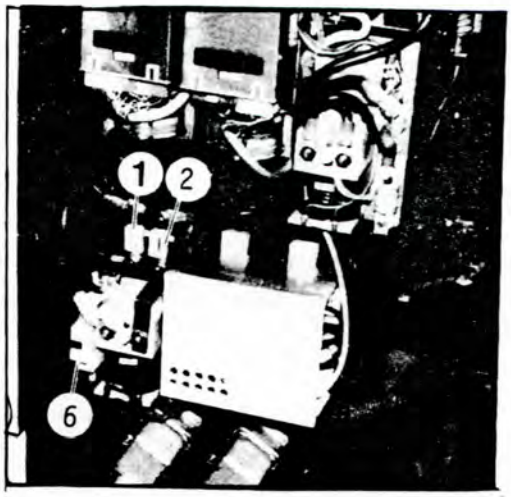


Fig. 33

Fig. 34

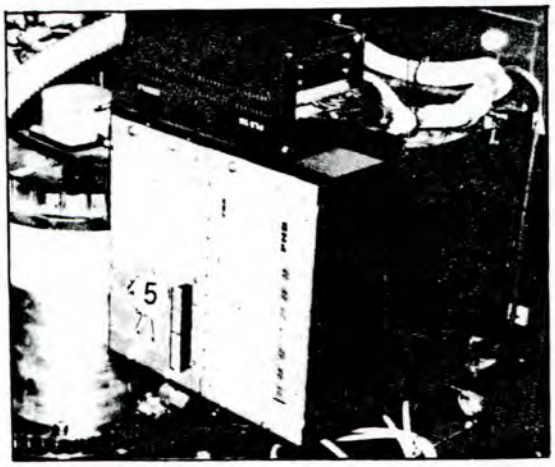


Fig. 35

2.1 Traction Motor (1 Fig. 33) 160A.

2.2 Hydraulic Pump Motor (2 Fig. 33) 250A.

2.3 Control Circuit - Automatic Fuse (3 Fig. 34) 80V, 16A.

2.4 Control Circuit - Glass Tube Fine Fuse (4 Fig. 34) 24V, 10A (MT).

2.5 Rack (PHB) - Automatic Fuse (5 Fig. 35) 2 x 3.25A.

2.6 Steer Motor - Automatic Fuse (6 Fig. 33) 25A.

3. SETTINGS

3.1 Hydraulic Lift - Pressure Relief Valve.

The pressure relief valve setting is dependent on the mast lift height and therefore cannot be defined here.

Should the need arise, consult your nearest Boss Service Centre or Distributor.

3.2 Wheel Nut Torque Loadings.

3.2.1 Front Wheels 160Nm (180 lbf ft).

3.2.2 Drive Wheel 160Nm (180 lbf ft).

3.2.3 Attachment Screws - Drive Wheel Outer Conical Rim 49Nm (36 lbf ft).

ANCILLARY EQUIPMENT

General

The front and lateral stacker/order picker is suitable for use with an attachment.

It is possible for example to fit an attachment in place of the articulated reach unit or to mount it on the forks.

So that the truck can operate with an hydraulic attachment the truck must be equiped with an additional hydraulic control system - or have such a system installed (modify truck).

When using a truck with an auxiliary hydraulically operated attachment ensure that the pressure limiting valve is adjusted correctly.

Installation

Whenever an attachment is installed it should always be mounted centrally.

Generally, most attachments hang on the upper rail of the carriage or articulated reach unit and are secured with the parts supplied (e.g. clamps, through bolts etc.).

Hydraulically operated attachments must be connected to the hydraulic control system. The union nuts at the free ends of the attachment hoses screw into the union fittings on the truck.

Couplings always must be screwed up tightly (Relieve system pressure by stopping the hydraulic pump motor and operating the auxilliary controls in both direction) so that ferrules seat correctly giving full flow and tight connections.

When not in use, cap the end fittings of the hoses. The fixed parts of the couplings have spring loaded caps. Ensure that these protective covers seat properly to protect the hydraulic system from the ingress of dirt.

If the sideshift or rotational movement of the attachment is erratic bleed the system.

TROUBLE SHOOTING CHART

The following trouble shooting chart will facilitate tracing and retifying faults. (Consult also operating instructions supplied by the accessory manufacturers).

Hydraulic System

Symptom	Fault/Remedy
1. Truck does not lift or lifts slowly, unladen or fully laden, when hydraulic control knob is fully rotated.	- Hydraulic Pump defective. - Pressure relief valve not functioning. - Lift cylinder seal defective.
2. Raised load drops by itself.	- Faulty Control Valve. - Leak in system pipe work. - Lift Cylinder seals leaking.
3. The articulated reach unit rotates or shifts slowly or not at all, laden or unladen, on full operation of the hydraulic control knob.	- Hydraulic pump defective. - Pressure relief valve not functioning. - Hydraulic lift cylinder seals defective.
4. When lowering is interupted, the load bounces.	- Air in lift cylinder.

Brake System

Symptom	Fault/Remedy
1. Brakes do not act evenly.	- Brakes not correctly adjusted.
2. Despite correct adjustment brakes do not act evenly.	- Brake linings oily/glazed.

Brake System

Symptom	Fault/Remedy
	- Brakes wet (e.g. after washing truck).
	- Gaiter on brake cylinder defective or missing.
3. Brakes extert uneven pressure.	- Clearances between drum and lining not equal.
	- Brake linings wholly or partly worn.
	- Surfaces of brake linings are off-set inwards or outwards. (look for scoring of the leading or trailing edges of brake linings).
4. Brakes over heat and block.	- Breather port in master cylinder blocked.
	- No play in master cylinder piston rod.

Electrical System

Symptom	Fault/Remedy
1. Vehicle does not move off when direction control knob is operated.	- Traction motor fuse blown.
	- Control current overload has tripped.
	- Control current overload (in logic rack) has tripped.
	- Control current fuse blown.
	- Direction relay contacts or coil burnt out.
	- Traction motor brushes worn.
	- Electronic traction lead terminals are loose or burnt.
	- Switch contactor leads or traction motor leads are damaged.

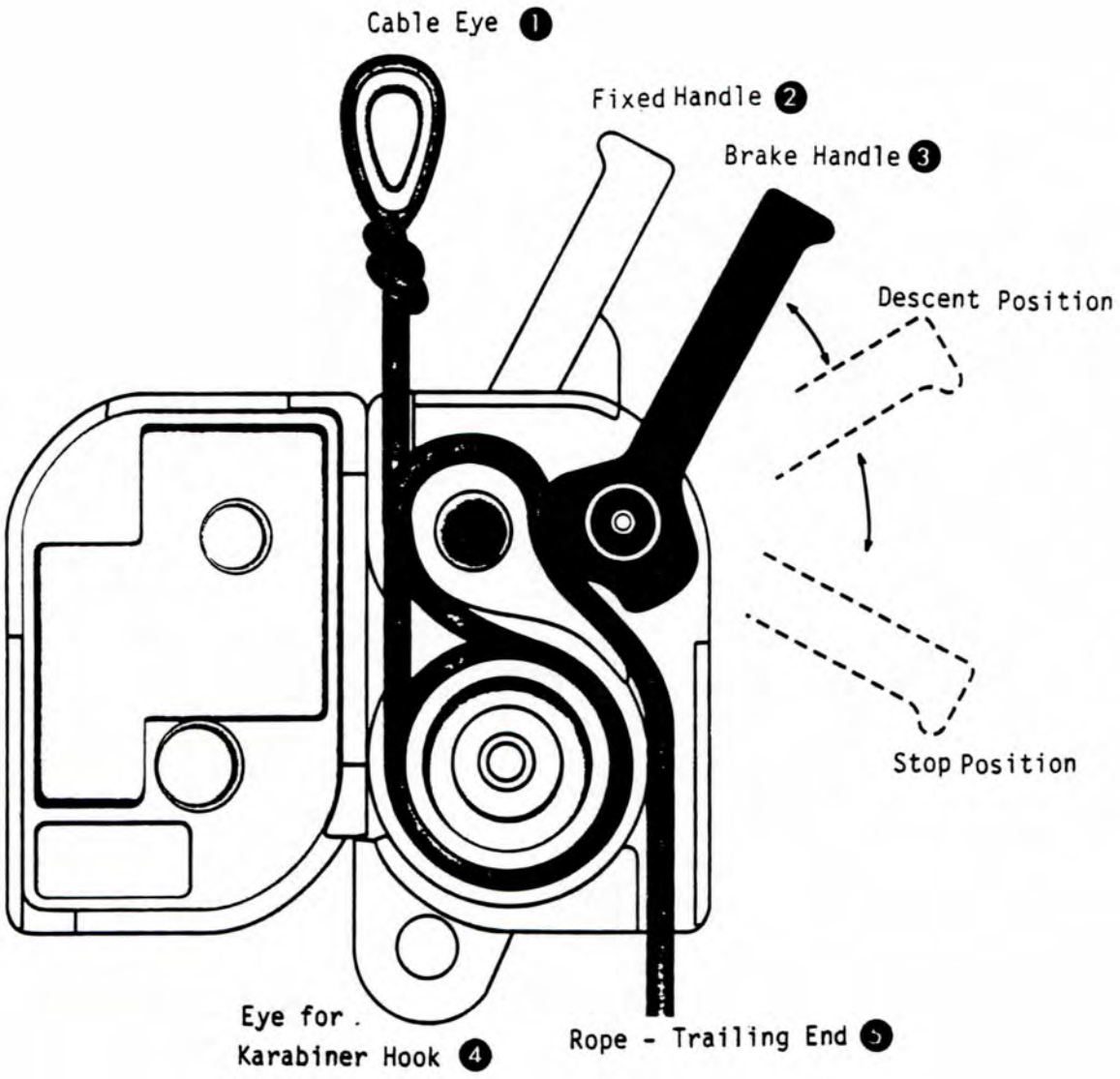
Symptom	Fault/Remedy
	- Battery is discharged.
	- One of the battery cell connectors is loose.
	- Voltage transformer is faulty.
	- Standard relay card is faulty.
	- Wire guidance control card is faulty. (Wire guide trucks only)
	- Pulse control is faulty.
	- Drive control is faulty.
	- Traction motor is faulty.
	- Electronic drive control safety contactor has tripped.
2. No Lift on operation of hydraulic control knob.	
	- The Battery is excessively discharged. The battery protection unit has tripped power circuit.
	- Hydraulic pump motor fuse blown.
	- Hydraulic pump motor brushes are worn.
	- Hydraulic pump motor is faulty.
	- Connections to power supply cables loose or burnt.
3. Rotation of hydraulic control knob does not shift articulated reach unit.	
	- Hydraulic pump motor fuse blown.
	- Hydraulic pump motor brushes are worn.
	- Hydraulic pump motor is faulty.

Symptom	Fault/Remedy
	- Connections to power supply cables loose or burnt.
	- Battery cell connector is loose.
	- Hydraulic pump motor leads damaged.
	- Control circuit overload has tripped.
	- Control circuit overload (in rack) has tripped.
	- A control circuit fuse has blown.
	- Voltage transformer is faulty.
	- The standard relay card is faulty.
	- Hydraulic interface card is faulty.
	- Pulse control is faulty.
	- The proximity switch on the articulated reach unit control knob is faulty.
4. Operation of 'hydraulic' control knob does not cause the articulated reach unit to rotate.	
	- Hydraulic pump motor fuse is faulty.
	- Hydraulic pump motor brushes are worn.
	- Hydraulic pump motor is faulty.
	- Cable connections are loose or burnt out.
	- Battery cell connector is loose.
	- Hydraulic pump motor leads are damaged.

Symptom	Fault/Remedy
	- A control circuit overload has tripped.
	- A control circuit overload in the rack has tripped.
	- A control circuit fuse has blown.
	- The voltage transformer is faulty.
	- The standard relay card is faulty.
	- The hydraulic interface card is faulty.
	- The pulse control unit is faulty.
	- The proximity switch in the hydraulic sideshift/rotate control is faulty.
	- Central electrics control fuse has blown.
	- The voltage transformer is faulty.
	- The standard relay card is faulty.
	- The relay card in the hydraulic pump motor control unit is faulty.
	- The pulse control is faulty.
5. The Battery discharges too quickly.	
	- Battery is silted up.
	- Battery is oxidised.
	- Earth fault in the battery or in the electrical system.

APPENDIX

ESCAPE DEVICE



ESCAPE DEVICE

The following important instructions must be observed carefully at all times.

1. Attach the cable eye (1) to a suitable fixed anchor point by means of a Karabiner hook.

   Ensure the rope does not run over any sharp edges.

2. Lay out the harness: Leg Harness - BLUE, Chest Harness - RED. The attachment ring must be in front of the body; step into the leg harness - pass the elastic braces over the shoulders.

3. Fasten the harness to the eye (4) on the escape device with a Karabiner hook.

4. Throw down the loose end(s) of the rope allowing it to run out of the stowage pouch provided.

   Avoid slack in the rope.

5. With one hand hold the rope below the escape device and with the other hand hold the brake lever (3) tight against the stop handle (2).

6. To start the descent, slowly release the brake lever (3).

7. Pay out the loose end (5) through the hand.

8. If the brake lever (3) is released, the escape device will STOP of its own accord.

IMPORTANT NOTES

ESCAPE PROCEDURE MUST BE PRACTICED REGULARLY.

The escape device must not be opened except by the manufacturer or by an authorised person.

After a descent the rope must be retracted i.e. ready for use again. To do this; hold the escape device and bring the brake lever to the mid-position. At the same time use the other hand to pull the loose end of the rope back to the "start" position. The assistance of a second person will facilitate this operation.

USE ONLY CLARK APPROVED REPLACEMENT ROPES WHEN RENEWAL IS NECESSARY.

SERVICE LIFE OF THE ROPE IN THE ESCAPE DEVICE

The service life of rope is dependent on two factors:-

1. Service Induced Ageing.

   By this is meant wear damage to the rope from

   a) mechanical causes,
      crushing, abrasion, cutting effect, etc.

   b) thermal causes,
      ambrient temperatures, in use or in storage.

2. Ageing while in Store.

   By this is meant changes in the physical properties of the rope, especially due to molecular change while the rope is stored, unused, in clean conditions.

In assessing the suitability of the rope for its purpose, the following recommendations are made in the light of current information.

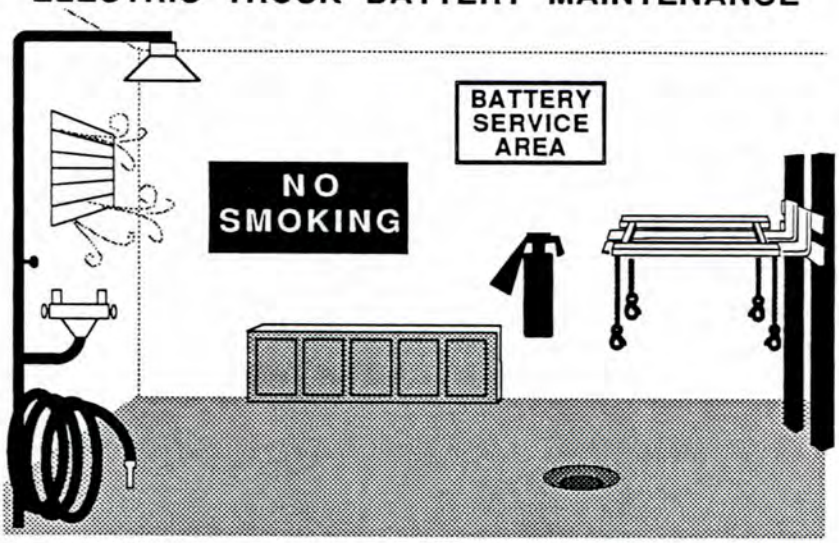
- The service life of the rope depends on its suitability for the purpose intended.
- To determine if a rope is still serviceable examine it for visible signs of wear.
- A rope can be regarded as fit for use as long as the inner part (core) of the rope is not visible and as long as the rope does not exhibit any irregularities, such as cuts, swelling, etc.
- The two elements of the rope have contrasting colours in order to facilitate checking for wear. The outer sheath is blue; the core is white.
- With regard to ageing in store, we recommend that the rope is renewed 6 years from the date of delivery, irrespective of the frequency of use.
- The polyamide core sheath rope can be washed if it is heavily soiled after use. Use a mild detergent wash at 30°C (80°F).

CONTENTS

Battery

Battery Maintenance

ELECTRIC TRUCK BATTERY MAINTENANCE



Battery charging installations must be located in areas designated for that purpose. These areas must be kept free of all non-essential combustible materials.

Facilities must be provided for:

- flushing spilled electrolyte
- fire protection
- protecting charging apparatus from damage by trucks
- adequate ventilation for dispersal of fumes from gassing batteries.

When handling acid concentrates greater than 50 percent acid (above 1.400 specific gravity) an eye wash fountain must be provided.

A conveyor, overhead hoist, or equivalent material handling equipment must be provided for handling batteries.

Changing and Charging Electric Truck Batteries

Battery maintenance is recommended to be performed not by the operator, but by a trained mechanic.

⚠ WARNING

Electric truck batteries are heavy and awkward to handle. They are filled with a very hazardous chemical solution. On charge, they give off hydrogen and oxygen which, in certain concentrations, are explosive. Electric truck batteries are also costly, so before you remove, service, or install a truck battery, consult the BATTERY MANUFACTURER, SUPPLIER or your SERVICE MANUAL for more recommendations and instructions on handling and charging battteries. Carefully read the following recommendations and instructions.

Battery Maintenance

Preperations for Battery Removal and Handling

1. Check the designated service and charging area for fire protection, and be sure all sources of ignition are cleared from the area. DO NOT SMOKE. Be sure all previous noted equipment is in the area, in good repair, and working properly.

If the battery is to be serviced, be sure there are provisions to flush and neutralize spillage and to disperse (ventilate) fumes from gassing batteries on charge. And be sure there are provisions for handling electrolyte.

2. Before attempting to remove or charge a storage battery, the truck should be positioned in the designated battery service area and the parking brake applied so the truck cannot move.

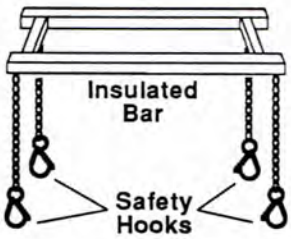
3. If the battery to be handled is not equipped with its own cover, cover the battery when handling, with a non-conductive (insulating) material, e.g., plywood or heavy cardboard, before attaching the lifting device.

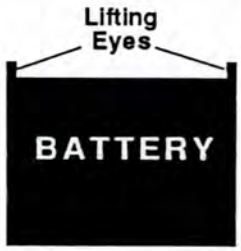
4. Use an approved lifting device with an insulated spreader bar, to remove and transport a truck battery. Be sure the hoist and lifting chains are equipped with safety hooks.

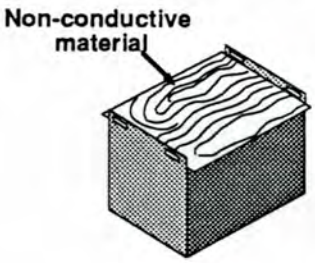
5. Chain hoists or power battery hoists must be equipped with load-chain containers to accumulate the excess lifting chain.

6. Keep all tools and other metallic objects away from the terminals.

7. Ready the battery storage location; either on an approved battery rack or on







WARNING
BATTERY SERVICE

Battery service must be done by trained and authorized personnel. Battery acid can cause severe burns and injury.

Battery Maintenance

Battery Care and Maintenance

DO NOT SERVICE BATTERIES UNLESS YOU ARE TRAINED AND AUTHORIZED TO DO SO.

Refer to the BATTERY MANUFACTURER or SUPPLIER for their recommended procedures or see your SERVICE MANUAL for other important information.

Battery Service Records

A record of battery service and maintenance should be kept to obtain the best service life from your battery and truck.

How To Get Maximum Life From a Battery

1. Follow normal battery maintenance procedures, re-charging before 80% discharged and with periodic equalizing charges.

2. Don't add acid to a battery. Only a person trained and qualified to do battery maintenance should determine if this is necessary.

3. Lift battery only with a correctly constructed lifting device which will not put pressure on the battery case.

4. Keep open flames, tools, and metal objects away from the top of battery to prevent short circuits and explosions.

5. Check the battery electrolyte level before each charging. Add water if the top of the separator or plates are visible.
   DO NOT OVERFILL !

6. Do not overcharge.

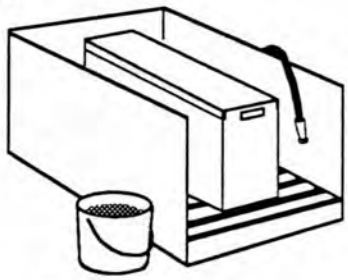
7. KEEP BATTERY CLEAN AND DRY. Wash down as needed.

8. Keep battery service records.

Battery Cleaning

NEVER WASH THE BATTERY WHEN IT IS IN THE TRUCK.

The easiest and most satisfactory method of cleaning a battery is to wash it occasionally with a low-pressure cold water spray. The top can also be washed off with a solution of baking soda and water (add a box of baking soda to a pail of water and stir until dissolved) and rinse with clean water. It is good practice to have this solution available around a battery room at all times.



IMPORTANT–
During cleaning, the battery vent caps MUST be tightly in place.

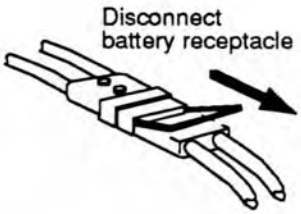
Battery Maintenance

Battery Removal

Refer to the BATTERY MANUFACTURER or SUPPLIER for their recommended procedures or see your SERVICE MANUAL for other important information.

Before removing the battery, follow the guidelines in the "Preperations for Battery Removal and Handling" section in this manual.

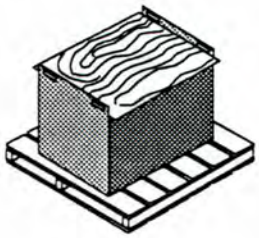
1. With key removed from key-switch, tip control panel forward and use chain and hook (attached to dash area) to secure panel in the up position. Raise the seat deck and hook it to the overhead guard.



2. Disconnect the battery receptacle and place them so they will not interfer with the removal of the battery.

3. Open both side panels of the truck.

4. With the correct lifting equipment, attach the safety hooks to the lifting eyes of the battery and carefully remove the battery.



5. Place battery on an approved battery rack or on a wooden pallet.

Battery Installation

1. Use only a lead-acid battery with the voltage and ampere-hour rating specified for the truck.

2. When changing batteries on electric trucks, replacement batteries must be of the service weight that falls within the minimum/maximum range specified on truck nameplate.

3. Be sure truck is properly positioned and parking brake applied.

4. Handle battery only with approved lifting device as previously described.

5. Install the battery correctly in the truck and secure it in position.

NOTICE -- Some trucks are equipped with battery stops or blocks. Others do not require them. If the truck being serviced has battery stops or blocks, be sure none are missing or damaged. Replace them, as necessary. If they are an adjustable type, be sure they are correctly adjusted and tightened.

Battery Maintenance

Battery Charging Precautions

1. Persons maintaining storage batteries must wear protective clothing such as face shield, long sleeves, and gloves.

2. Hydrogen emissions from charging batteries are flammable. No smoking shall be allowed in the charging area. Do not check the electrolyte level with an open flame. Do not allow open flame, sparks or electric arcs in battery charging area.

DANGER
EXPLOSIVE GASES

Do not smoke or have open flames or sparks in battery charging areas or near batteries. An explosion can cause injury or death.

WARNING
SULFURIC ACID

The battery contains corrosive acid which can cause injury. If acid contacts your eyes or skin, flush immediately with water and get medical assistance.

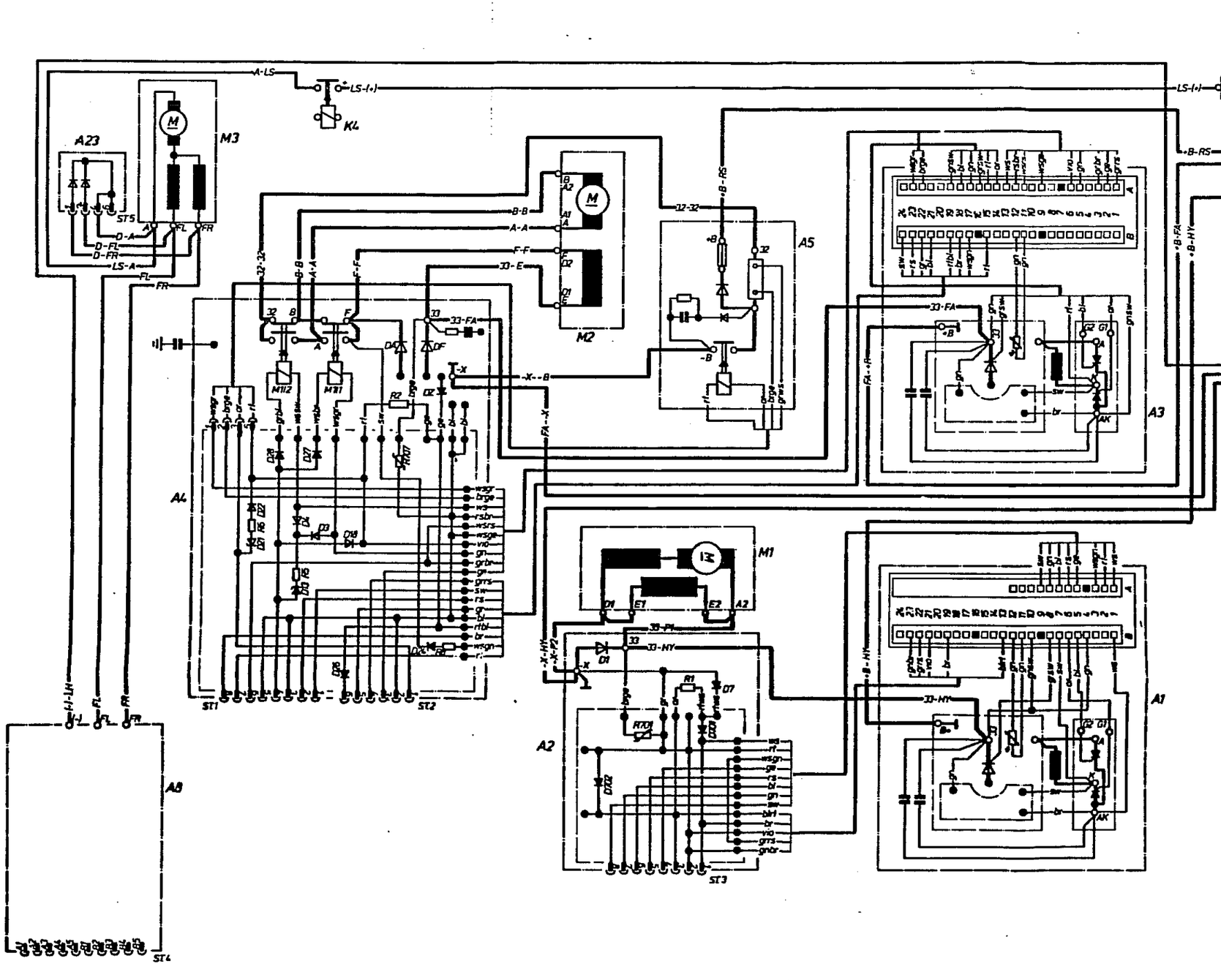
3. When charging batteries, the vent caps must be kept in place to avoid electrolyte spray. Care must be taken to assure that vent caps are open (clean) and functioning. The battery compartment cover and side panel must be open to dissipate heat and gas.

CAUTION

If batteries discharge rapidly during normal operation or do not charge to the correct specifications, contact a qualified battery service technician to check the battery for you.
DO NOT add electrolyte or attempt to service the battery when it is in this condition.

SECTION
2

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 46519	Gerät: Equipement: V8 Equipement:	Geräte-Gruppe: 2 Nr. 31 Group of equipement: 2 No. 31 Groupe de equipement: No.
Bemerkung: Remark: Remarque:			Schaltplan Leistungsteile Proportionalsteuerung ohne Isostatik-Führung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dos



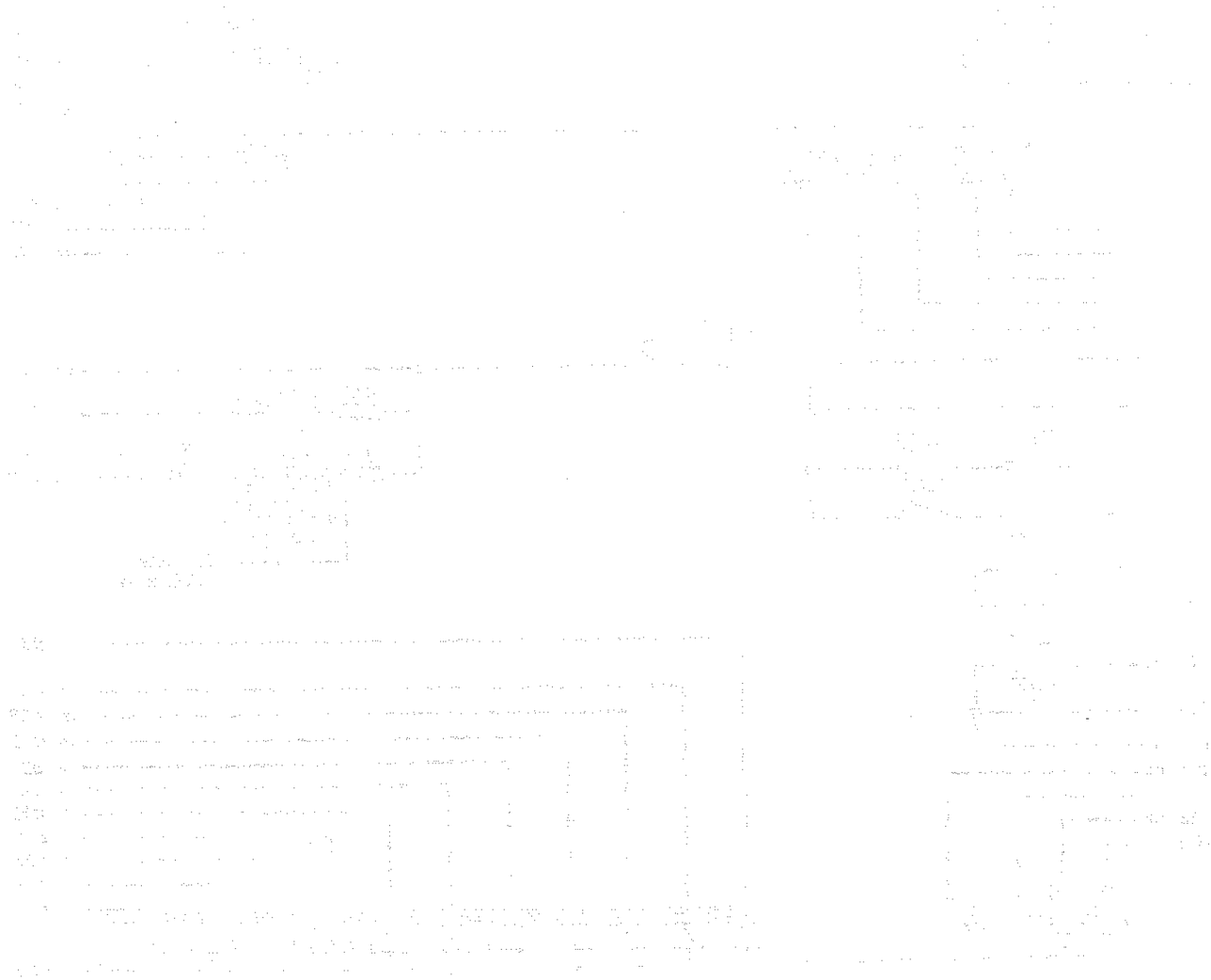
G1 Batterie

F1 Pumpmotorsicherung
F2 Fahrmotorsicherung
F3 Sicherungsautomat Lenkmotor

M1 Pumpmotor
M2 Fahrmotor
M3 Lenkmotor

K3 Hauptschütze
K4 Lenkschütz

A1 Leistungsteil Hydr.
A2 Motorteil Hydr.
A3 Leistungsteil Fahr.
A4 Motorteil Fahr.
A5 Rückspeisemodul
A8 Lenkelektronik
A8.1
A9 Batteriesteckvorrichtung
A10 Klemmsockel
A23 Diodenmodul



STEINBOCK BOSS ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 4602226	Gerät: Equipement: V4 Equipement:	Geräte-Gruppe: Group of equipement: 3 Groupe de equipement:	Nr No. 33 No.
Bemerkung: Remarks: Remarque:		Schaltplan Fahrschalter Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dos	

F1 Pumpmotorsicherung
F4 Steuerstromsicherung
F5 Sicherung 1. Spannungswandler
F6 Sicherung 2. Spannungswandler

M5 Lüfter Inputssteuerungen

R1 Vorwiderstand 1. Spannungswandler
R2 Vorwiderstand 2. Spannungswandler

U1 1. Spannungswandler
U2 2. Spannungswandler

K3 Hauptschütz
K4 Lenkschütz
K10 Hauptschütz Steuerstrom

A2 Motorteil Hyd.
A4 Motorteil Fahr.
A7 Betriessstundenzähler
A10 Klemmsockel
A11 Batteriekontrollgerät
A13 Baugruppenträger Steinbock
A14 Freiprogrammierbare Steuerung

Schaltplan 460228
Schaltplan 460223
Schaltplan 460227
Schaltplan 460227
Schaltplan 460227
Schaltplan 460227

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLÉCTRIQUE	SN 460227	Gerät: / Equipement: V6 / Equipement:	Geräte-Gruppe: / Group of equipement: 3 / Groupe de equipement:	Nr. / No 23 / No.
Bemerkung: / Remark: / Remarque:			Schaltplan Fahrantrieb Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachers dot	

Schaltplan 460226

Schaltplan 460226

Schaltplan 460223

Schaltplan 460226

Schaltplan 460226

Schaltplan 460226

Y1 Ventil Haupthub senken
Y2 Prop-Ventil Haupthub
Y6 Magnetbremse
Y7 Magnetbremse Not-Stop
Y18 Ventil Notablaß

B1 Mast 1. Abschaltung
B2 Mast 2. Abschaltung
B3 Mast 3. Abschaltung
B4 Gangerkennung rechts
B5 Gangerkennung links
B8.1 Mast Hubabschaltung
B17 Initiator links außen
B18 Initiator rechts außen
B19 Initiator rechts mitte
B20 Initiator links mitte
B21 Initiator rechts innen
B22 Initiator links innen

A8 Lenkendstufe
A8.1 Lenkelektronik
A12 Baugruppenträger PHB
A15 Antenne vorne
A16 Antenne hinten
A17 Drehimpulsgeber
A18 Istwertpotiometer
A20 Spannungsversorgungsmodul
A25 Antenne mitte
A27 Summer BGT

S3 10° Lenkanschlag
S5 Lenkwinkelbegrenzung
S6 Schlaffkettensicherung
S7 Reedschalter rechts außen
S8 Reedschalter rechts mitte
S9 Reedschalter links mitte
S10 Reedschalter links außen
S19 Reedschalter rechts innen
S20 Reedschalter links innen
S 33 Bremse gelöst
S 33.1 Bremse gelöst

H1 Rundumleuchte

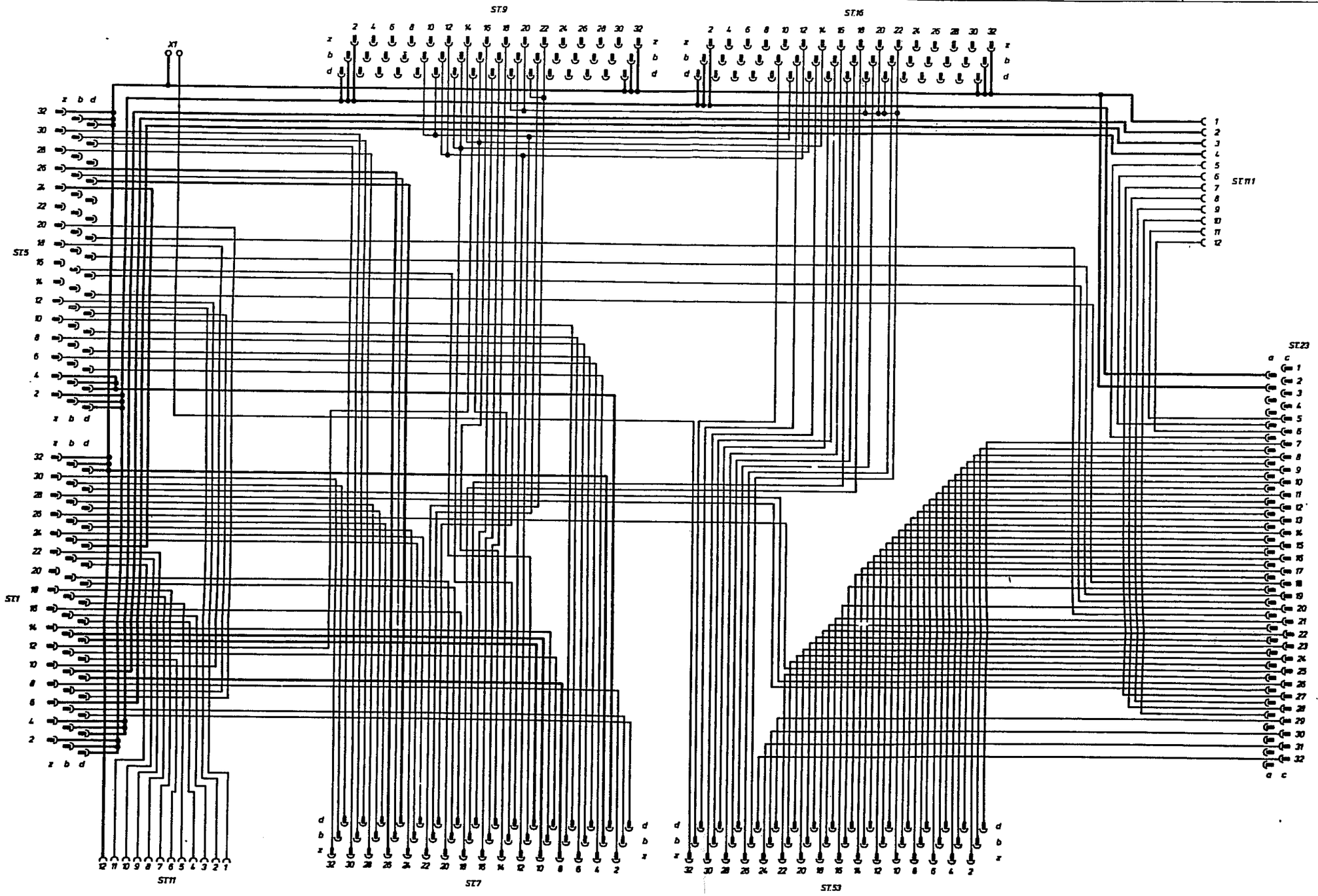
H4 Lüfter Pumpmotor

K1 Schütz Magnetbremse
K2 Schütz Magnetbremse Not-Stop
K4 Lenkschütz

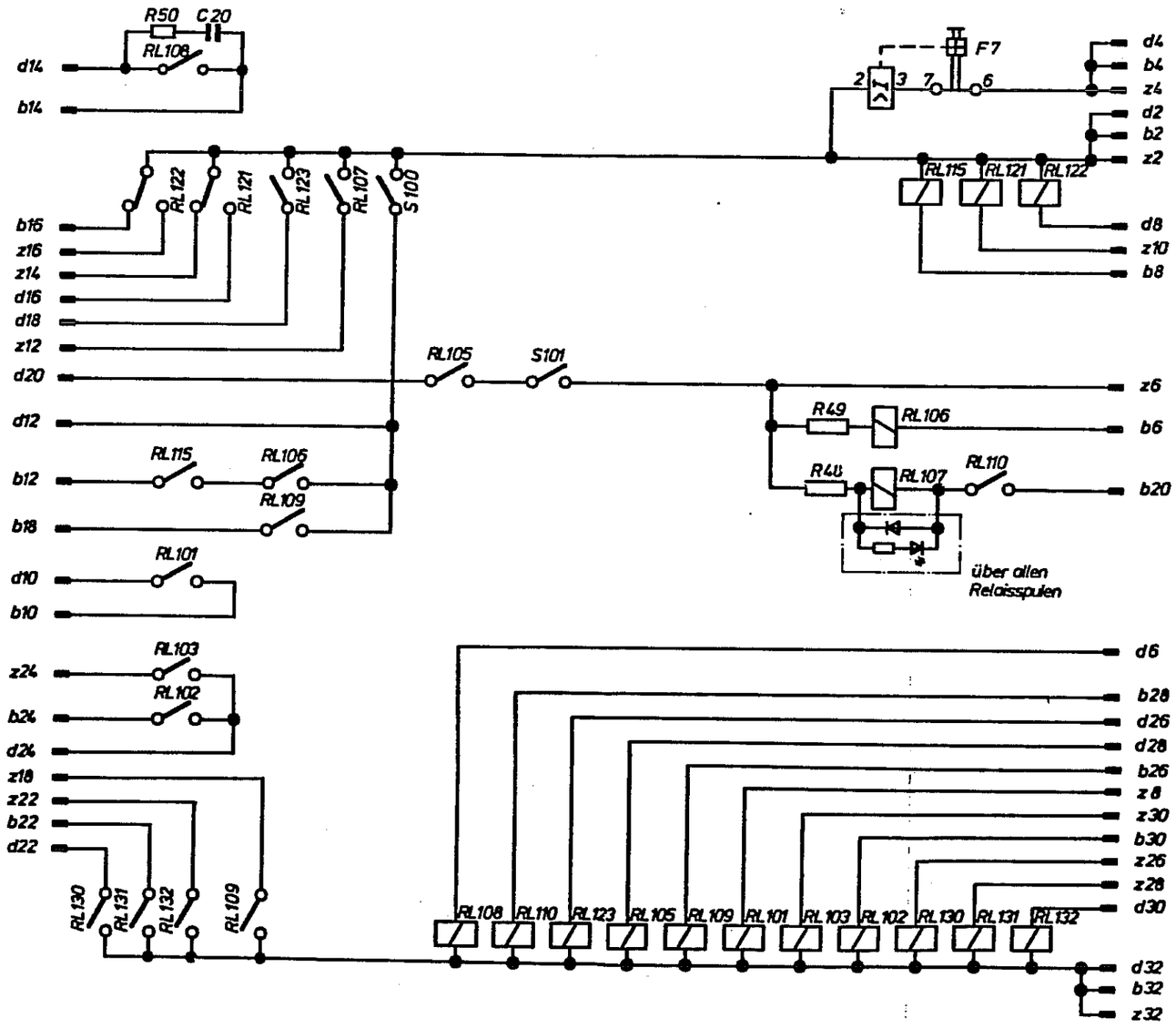
STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 480238	Gerät: Equipement: Equipement: V8	Geräte-Gruppe: Group of equipement: 3 Groupe de equipement:	Nr No. 34 No.
Bemerkung: Remark: Remarque:			Kabelplan Kabine Propertimaisteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dos	

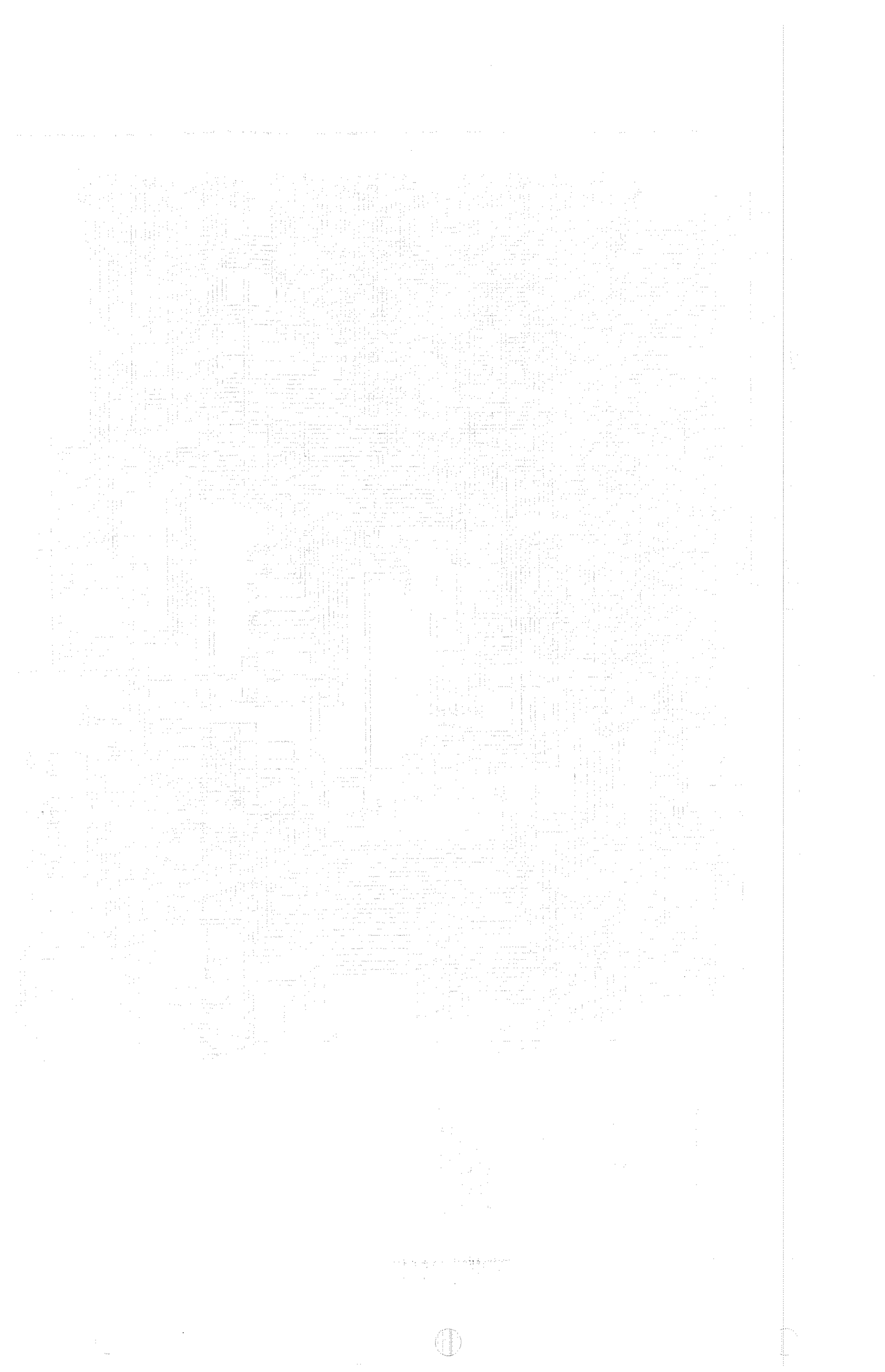
A6	Fahrregler	H3	Arbeitsscheinwerfer	S1	Schlüsselschalter
A11.1	Anzeigegerät Batteriekontrollgerät	H5	Automatik ein (Lenkung Mittelstellung)	S2	Not-Aus Schalter
A19	Sollwertpotiometer	H6	Einspuren möglich	S11	Gabel rechts ohne Begrenzung
A21	Horn	I'	Einspurvorgang läuft	S12	Gabel rechts 1.Begrenzung
A22	Summer	H8	Mast im Gefahrenbereich	S13	Gabel rechts Endlagendämpfung
A30.1	Multiplex-Sender	H9	Zinkenverstellung	S14	Gabel links Endlagendämpfung
A31	Hydraulikhebel	H11	Kabinenbeleuchtung	S15	Gabel links 1.Begrenzung
		H15	Gerät betriebsbereit	S16	Gabel links ohne Begrenzung
Y3	Prop-Ventil Zusatzhub			S17	Fallriegelschalter rechts
Y4	Prop-Venhl schieben			S18	Fallriegelschalter links
Y5	Prop-Ventil drehen			S22	Taste Horn
Y8	Zinkenverste..ung	B6	Zusatzhub unten	S23	Fahrtrichtungsschalter vorwärts
Y9	Zinkenverstellung	B7	Gabel rechts geschwenkt	S24	Fahrtrichtungsschalter rückwärts
Y14	Zusatzhub senken	B8	Gabel links geschwenkt	S25	Totmannknopf Fahrhebel
				S27	Automatik ein (Lenkung Mittelstellung)
				S31	Arbeitsscheinwerfer
				S32	Totmannknopf Hydraulikhebel
				S34	Taste Notablas
				S35	Überbrückungstaste Hubabschaltung
				S36	Zinkenverstellung
				S60	Haupthub
				S61	Zusatzhub
				S62	Schieben
				S63	Drehen
				S64	Synchron-Drehen links
				S65	Synchron-Drehen rechts
				S66	Senken
				S67	Heben
				S68	Schlaffkettensicherung

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHEMA DE CONNEXIONS ELÉCTRIQUE	SN 000223	Gerät: Equipement: WA Equipement:	Geräte-Gruppe: Nr. Group of equipement: 3 No. 25 Groupe de equipement: No.
Bemerkung: Remark: Remarque:			Schaltplan Bus-Platte BGT Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dot



STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLÉCTRIQUE	SM 480313	Gerät: Equipement: V4 Equipement:	Geräte-Gruppe: Group of equipement: II Groupe de equipement:	Nr. No. 28 No.
Bemerkung: Remark: Remarque:			Schaltplan Relaiskarte Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées des	





Key to Wiring Diagram 461 519 Power Circuit (Rail Guidance System)

G	Battery
F1	Fuse - Pump Motor
F2	Fuse - Traction Motor
F3	Fuse - Automatic (Steer Motor)
M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
K3	Contactor - Main
K4	Contactor - Steer
A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feedback
A8	Electronic Control - Steer
A8.1	
A9	Connector - Battery Plug
A10	Socket - Terminal
A23	Module - Diode

Key to Wiring Diagram 460 226 Drive Control Switch

F1	Fuse - Pump Motor
F4	Fuse - Control Circuit
F5	Fuse - Voltage Transformer No.1
F6	Fuse - Voltage Transformer No.2
M5	Fan - Cooling (Pulse Control Unit)
R1	Series Resistor - Transformer No.1
R2	Series Resistor - Transformer No.2
U1	Transformer No.1 - Voltage
U2	Transformer No.2 - Voltage
K3	Contactor - Main
K4	Contactor - Steer
K10	Contactor - Main Control Circuit
A2	Motor Unit - Hydraulic
A4	Motor Unit - Traction
A7	Hour Meter
A10	Socket - Terminal
A11	B.D.I.
A13	Rack - Steinbock
A14	Control Unit - Programmable Logic Controller

Key to Wiring Diagram 460 227 (Truck)

Y1	Valve - Lower Cab
Y2	Valve - Proportioning (Cab)
Y6	Brake - Magnetic
Y7	Brake - Emergency Stop
Y18	Valve - Emergency Lowering
B1	Switch - No.1 Mast Cut-out
B2	Switch - No.2 Mast Cut-out
B3	Switch - No.3 Mast Cut-out
B4	Switch - Aisle Recognition Right
B5	Switch - Aisle Recognition Left
B8.1	Switch - Lift Cut-out (Mast)
B17	Proximity Switch - Left Outer
B18	Proximity Switch - Right Outer
B19	Proximity Switch - Right Middle
B20	Proximity Switch - Left Middle
B21	Proximity Switch - Right Inner
B22	Proximity Switch - Left Inner
A8	End Stage - Steer
A8.1	Steer Unit - Electronic
A12	Rack - PHB
A15	Antenna - Front
A16	Antenna - Rear
A17	Transmitter - Rotary Impulse
A18	Potentiometer - Actual Valve
A20	Modul - Voltage Supply
A25	Antenna - Middle
A27	Buzzer
S3	Switch - 10° Steer Stop
S5	Switch - Steer Angle Limit
S6	Switch - Slack Chain Device
S7	Reedswitch - Right Outer
S8	Reedswitch - Right Middle
S9	Reedswitch - Left Middle
S10	Reedswitch - Left Outer
S19	Reedswitch - Right Inner
S20	Reedswitch - Left Inner
S33	Switch - Brake Released
S33.1	Switch - Brake Released
H1	Patrol - Lamp - Rotary
M4	Fan - Cooling (Pump Motor)
K1	Contactor - Magnetic Brake
K2	Contactor - Magnetic Brake Emergency Stop
K4	Contactor - Steer

Key to Wiring Diagram 460 228 Cab

A6	Control - Drive
A11.1	Indicator - BDI
A19	Potentiometer - Target Valve
A21	Horn
A22	Buzzer
A30.1	Sender - Multiplex
A31	Control Lever - Hydraulic
H3	Lights - Working
H5	Indicator Lamp - 'Automatic ON' Steering Mid Position
H6	Indicator Lamp - 'Tracking Available'
H7	Indicator Lamp - 'Tracking'
H8	Indicator Lamp - 'Mast in' Danger Zone'
H9	Indicator Lamp - 'Position Forks'
H11	Lamp - Cabin Interior
H15	Indicator Lamp - 'Truck Ready for Operation
B6	Proximity Switch - 'Aux. Lift Down'
B7	Proximity Switch - 'Forks Shifted Right'
B8	Proximity Switch - 'Forks Shifted Left'
Y3	Valve - Proportioning - Aux. Lift
Y4	Valve - Proportioning - Side Shift
Y5	Valve - Proportioning - Rotate
Y8	Valve - Fork Positioning
Y9	Valve - Fork Positioning
Y14	Valve - Lowering (Aux. Lift)
S1	Keyswitch
S2	Switch - Emergency Battery Cut-Out
S11	Switch - Forks Right - No Limit
S12	Switch - Forks Right - 1st Limit
S13	Switch - Forks Right End Position Damping
S14	Switch - Forks Left End Damping
S15	Switch - 1st Limit. Forks Left
S16	Switch - Forks Left. Without Limit
S17	Switch - Guard Rail (Right)
S18	Switch - Guard Rail (Left)
S22	Push Button - Horn
S23	Switch - Direction 'Forward'
S24	Switch - Direction 'Reverse'
S25	Deadman Button - Drive Control Lever
S27	Switch - 'Automatic Steer ON' (Steering - Mid Position)
S31	Switch - Working Lights
S34	Push Button - 'Emergency Lower'
S35	Push Button - 'Lift Cutout Override'
S36	Switch - Fork Positioning
S40	Switch - Cab Lift
S61	Switch - Aux. Lift
S62	Switch - 'Sideshift'
S63	Switch - 'Rotate Forks'
S64	Switch - Combined Movement Left
S65	Switch - Combined Movement Right
S66	Switch - Lower
S67	Switch - Lift
S68	Switch - Slack Chain Device

Group 2

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Valve Control

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A6	Drive Controller
A7	Hour Meter
A8	Steer System - Electronic
A8.1	End Stage - Steer
A9	Battery Plug
A10	Terminal Post.
A11	Battery Check Unit
A11.1	Battery Discharge Indicator
A12	Rack - PHB
A13	Rack - Steinbock
A14	Programmable Logic Controller
A15	Antenna - Front
A16	Antenna - Back
A17	Rotary Pulse Generator
A18	Actual Value Pot.
A19	Target Value Pot.
A20	Module - Voltage Supply
A21	Horn
A22	Buzzer
A23	Module - Diode
A24	Interference Filter
A25	Antenna - Middle
A26	
A27	Buzzer
A28	
A29	
A30.1	Multiplex - Transmitter
A31	Hydraulic Control
A32	
A34	
A35	
A36	
A37	
A38	

G.1	Battery (ies)

U.1	Transformer No. 1 - Voltage
U.2	Transformer No. 2 - Voltage

M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
M4	Fan - Pump Motor
M5	Fan - Pulse Control Unit

K1	Contactor No. 1 - Magnetic Brake
K2	Contactor No. 2 - Magnetic Brake Emergency Stop
K3	Contactor - Main
K4	Contactor - Steer
K5	Relay - Fork Spread Solenoid Value Left
K6	Relay - Fork Spread Solenoid Value Left
K7	Relay - Fork Spread Solenoid Value Right
K8	Relay - Fork Spread Solenoid Valve Right
K9	
K10	Contactor - Main (Control Circuit)

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Valve Control

B1 Mast Cut-out 1
B2 Mast Cut-out 2
B3 Mast Cut-out 3
B4 Detection - End of Aisle (right)
B5 Detection - End of Aisle (left)
B6 Aux. Lift (Lowered)
B7 Forks - Rotated Right
B8 Forks - Rotated Left
B8.1 Mast Cut-out - Main Lift
B9 Main Lift - Raise
B10 Main Lift - Lower
B11 Aux. Lift - Raise
B12 Aux. Lift - Lower
B13 Side Shift - Left
B14 Side Shift - Right
B15 Rotate
B16 Damping - Cab
B17 Initiator - Left Outer
B18 Initiator - Right Outer
B19 Initiator - Right Middle
B20 Initiator - Left Middle
B21 Initiator - Right Inner
B22 Initiator - Left Inner
B23 Forks - Left Centre
B24 Forks - Left Inside
B25 Forks - Right Inside
B26 Forks - Right Centre
B27 Forks - Right Outside
B28 Detector - Load
B29
B30
B31
B32
B33
B34
B35
B36
B37
B38
B39
B40

Y1 Valve - Main Lift (Lower)
Y2 Valve - Main Lift (Proportional Valve)
Y3 Valve - Aux. Lift (Proportional Valve)
Y4 Valve - Side Shift (Proportional Valve)
Y5 Valve - Proportional Valve - Rotate
Y6 Brake - Magnetic
Y7 Brake - Magnetic Emergency Stop
Y8 Valve - Solenoid, Fork Spreader
Y9 Valve - Solenoid, Fork Spreader
Y10 Valve - Solenoid, Fork Spread Right
Y11 Valve - Solenoid, Fork Spread Left
Y14 Valve - Aux. Lift (Lower)
Y18 Valve - Emergency Lower

F1 Fuse - Pump Motor
F2 Fuse - Traction Motor
F3 Fuse - Steer Motor (Automatic Fuse)
F4 Fuse - Control Circuit
F5 Fuse - No. 1 Transformer
F6 Fuse - No. 2 Transformer
F7 Fuse - Rack
F8 Fuse - Rack

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Valve Control

U.1 Transformer No. 1 Voltage
U.2 Transformer No. 2 Voltage

R1 Resistor - Series, Voltage Transformer No. 1
R2 Resistor - Series, Voltage Transformer No. 2

S1 Keyswitch
S2 Switch - Battery Emergency 'Off'
S3 Switch - 10° Steer Angle
S4
S5 Steer Angle Limit
S6 Slack Chain Device
S7 Reed Switch - Outer Right
S8 Reed Switch - Centre Right
S9 Reed Switch - Centre Left
S10 Reed Switch - Outer Left
S11 Switch - Forks Right, Without Limit
S12 Switch - Forks Right 1st Limit
S13 Switch - Forks Right End Damping
S14 Switch - Forks Left End Damping
S15 Switch - Forks Left 1st Limit
S16 Switch - Forks Left, Without Limit
S17 Microswitch - Guard Rail, Right
S18 Microswitch - Guard Rail, Left
S19 Reed Switch - Right Inner
S20 Reed Swtich - Left Inner
S21 Switch - Override
S22 Push Button - Horn
S23 Switch - Direction "Forward"
S24 Switch - Direction "Reverse"
S25 Dead Man Button on Forward/ Reverse Control
S26 Push Button - Two Hand Control Hydraulic Control Lever
S27 Switch - "Automatic ON" (Steer Mid Position)
S28 Switch - Lighting Interior
S29 Switch - Patrol Lamp
S30 Switch - Steering Mid-Position
S31 Switch - Working Lights
S32 Dead Man Button - Hydraulic Control (Main Lift)
S33 Brakes Released
S33.1 Brakes Released
S34 Push Button - Emergency Lower
S35 Override Switch - Lift Cut-out
S36 Fork Positioning
S37 Switch - Forks, Centre from Left End Damping
S38 Switch - Forks, Centre from Left
S39 Switch, Forks Centre from Right
S40 Switch, Forks Centre from Right End Damping
S41 Switch - Telescopic Table, Centre
S42
S43
S44
S45
S46
S47
S48
S49
S60 Switch - Main Lift
S61 Switch - Aux. Lift
S62 Switch - Side Shift
S63 Switch - Rotate
S64 Switch - Combined Movement Rotate Left
S65 Switch - Combined Movement Rotate Right
S66 Switch - Lift
S67 Switch - Lower
S68 Switch - Slack Chain Device

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Valve Control

H1	Ind. Lamp - Rotary Patrol Lamp
H2	Ind. Lamp - Cab Lighting
H3	Ind. Lamp - Working Lights
H4	Ind. Lamp
H5	Ind. Lamp - "Automatic ON" (Steering Mid Position)
H6	Ind. Lamp - "Guidance Available"
H7	Ind. Lamp - "Guidance Switched On"
H8	Ind. Lamp - Mast in Danger Area
H9	Ind. Lamp - Fork Position
H10	
H11	Lighting - Cab
H15	Ind. Lamp - Truck in Operational Mode

Group 2

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Valve Control

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A6	Drive Controller
A7	Hour Meter
A8	Steer System - Electronic
A8.1	End Stage - Steer
A9	Battery Plug
A10	Terminal Post
A11	Battery Check Unit
A11.1	Battery Discharge Indicator
A12	Rack - PHB
A13	Rack - Steinbock
A14	Programmable Logic Controller
A15	Antenna - Front
A16	Antenna - Back
A17	Rotary Pulse Generator
A18	Actual Value Pot.
A19	Target Value Pot.
A20	Module - Voltage Supply
A21	Horn
A22	Buzzer
A23	Module - Diode
A24	Interference Filter
A25	Antenna - Middle
A26	
A27	Buzzer
A28	
A29	
A30.1	Multiplex - Transmitter
A31	Hydraulic Control
A32	
A34	
A35	
A36	
A37	
A38	

G.1	Battery (ies)

U.1	Transformer No. 1 - Voltage
U.2	Transformer No. 2 - Voltage

M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
M4	Fan - Pump Motor
M5	Fan - Pulse Control Unit

K1	Contactor No. 1 - Magnetic Brake
K2	Contactor No. 2 - Magnetic Brake Emergency Stop
K3	Contactor - Main
K4	Contactor - Steer
K5	Relay - Fork Spread Solenoid Value Left
K6	Relay - Fork Spread Solenoid Value Left
K7	Relay - Fork Spread Solenoid Value Right
K8	Relay - Fork Spread Solenoid Valve Right
K9	
K10	Contactor - Main (Control Circuit)

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Valve Control

B1 Mast Cut-out 1
B2 Mast Cut-out 2
B3 Mast Cut-out 3
B4 Detection - End of Aisle (right)
B5 Detection - End of Aisle (left)
B6 Aux. Lift (Lowered)
B7 Forks - Rotated Right
B8 Forks - Rotated Left
B8.1 Mast Cut-out - Main Lift
B9 Main Lift - Raise
B10 Main Lift - Lower
B11 Aux. Lift - Raise
B12 Aux. Lift - Lower
B13 Side Shift - Left
B14 Side Shift - Right
B15 Rotate
B16 Damping - Cab
B17 Initiator - Left Outer
B18 Initiator - Right Outer
B19 Initiator - Right Middle
B20 Initiator - Left Middle
B21 Initiator - Right Inner
B22 Initiator - Left Inner
B23 Forks - Left Centre
B24 Forks - Left Inside
B25 Forks - Right Inside
B26 Forks - Right Centre
B27 Forks - Right Outside
B28 Detector - Load
B29
B30
B31
B32
B33
B34
B35
B36
B37
B38
B39
B40

Y1 Valve - Main Lift (Lower)
Y2 Valve - Main Lift (Proportional Valve)
Y3 Valve - Aux. Lift (Proportional Valve)
Y4 Valve - Side Shift (Proportional Valve)
Y5 Valve - Proportional Valve - Rotate
Y6 Brake - Magnetic
Y7 Brake - Magnetic Emergency Stop
Y8 Valve - Solenoid, Fork Spreader
Y9 Valve - Solenoid, Fork Spreader
Y10 Valve - Solenoid, Fork Spread Right
Y11 Valve - Solenoid, Fork Spread Left
Y14 Valve - Aux. Lift (Lower)
Y18 Valve - Emergency Lower

F1 Fuse - Pump Motor
F2 Fuse - Traction Motor
F3 Fuse - Steer Motor (Automatic Fuse)
F4 Fuse - Control Circuit
F5 Fuse - No. 1 Transformer
F6 Fuse - No. 2 Transformer
F7 Fuse - Rack
F8 Fuse - Rack

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Valve Control

U.1 Transformer No. 1 Voltage
U.2 Transformer No. 2 Voltage

R1 Resistor - Series, Voltage Transformer No. 1
R2 Resistor - Series, Voltage Transformer No. 2

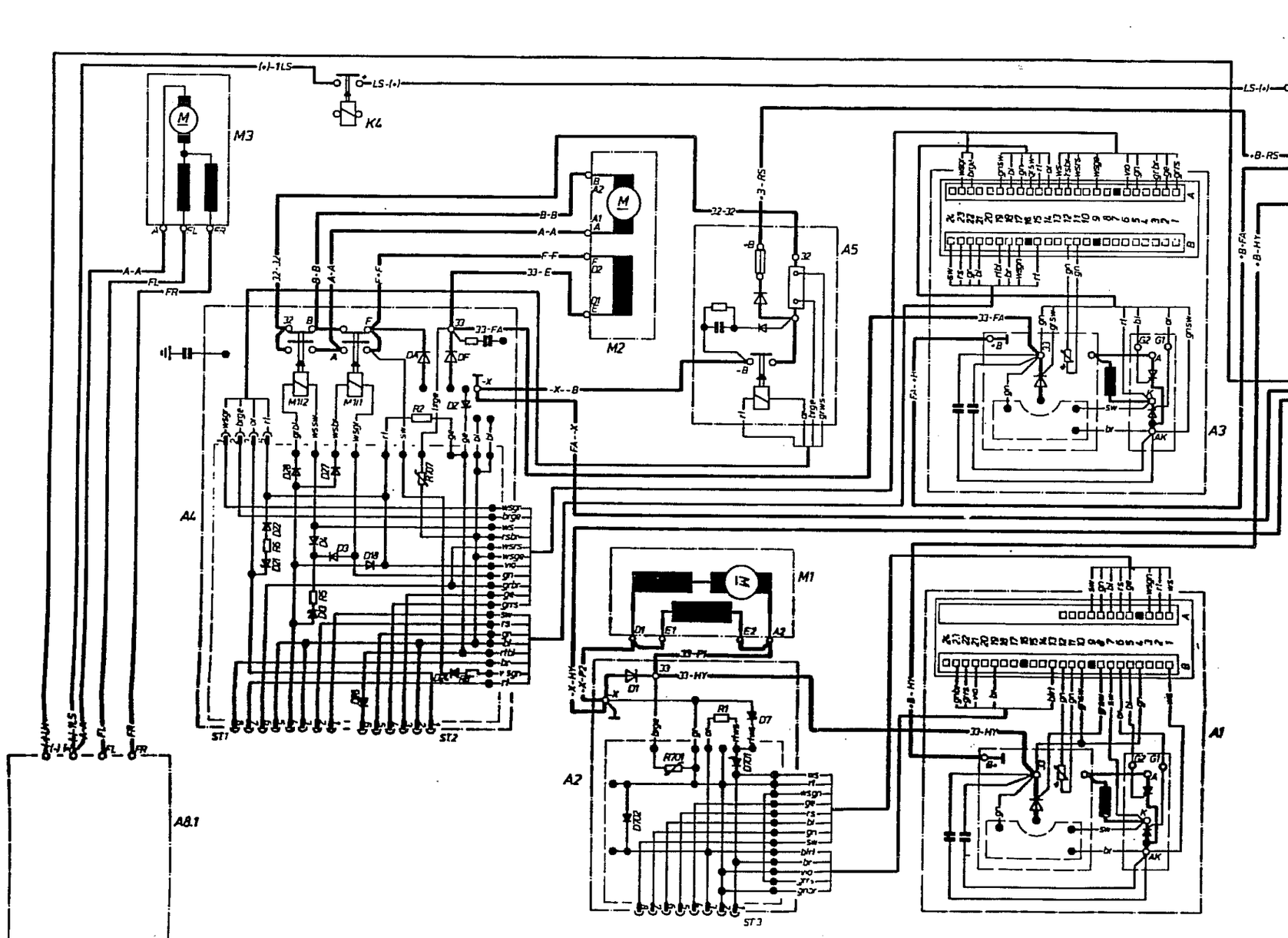
S1 Keyswitch
S2 Switch - Battery Emergency 'Off'
S3 Switch - 10° Steer Angle
S4
S5 Steer Angle Limit
S6 Slack Chain Device
S7 Reed Switch - Outer Right
S8 Reed Switch - Centre Right
S9 Reed Switch - Centre Left
S10 Reed Switch - Outer Left
S11 Switch - Forks Right, Without Limit
S12 Switch - Forks Right 1st Limit
S13 Switch - Forks Right End Damping
S14 Switch - Forks Left End Damping
S15 Switch - Forks Left 1st Limit
S16 Switch - Forks Left, Without Limit
S17 Microswitch - Guard Rail, Right
S18 Microswitch - Guard Rail, Left
S19 Reed Switch - Right Inner
S20 Reed Swtich - Left Inner
S21 Switch - Override
S22 Push Button - Horn
S23 Switch - Direction "Forward"
S24 Switch - Direction "Reverse"
S25 Dead Man Button on Forward/ Reverse Control
S26 Push Button - Two Hand Control Hydraulic Control Lever
S27 Switch - "Automatic ON" (Steer Mid Position)
S28 Switch - Lighting Interior
S29 Switch - Patrol Lamp
S30 Switch - Steering Mid-Position
S31 Switch - Working Lights
S32 Dead Man Button - Hydraulic Control (Main Lift)
S33 Brakes Released
S33.1 Brakes Released
S34 Push Button - Emergency Lower
S35 Override Switch - Lift Cut-out
S36 Fork Positioning
S37 Switch - Forks, Centre from Left End Damping
S38 Switch - Forks, Centre from Left
S39 Switch, Forks Centre from Right
S40 Switch, Forks Centre from Right End Damping
S41 Switch - Telescopic Table, Centre
S42
S43
S44
S45
S46
S47
S48
S49
S60 Switch - Main Lift
S61 Switch - Aux. Lift
S62 Switch - Side Shift
S63 Switch - Rotate
S64 Switch - Combined Movement Rotate Left
S65 Switch - Combined Movement Rotate Right
S66 Switch - Lift
S67 Switch - Lower
S68 Switch - Slack Chain Device

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Valve Control

H1	Ind. Lamp - Rotary Patrol Lamp
H2	Ind. Lamp - Cab Lighting
H3	Ind. Lamp - Working Lights
H4	Ind. Lamp
H5	Ind. Lamp - "Automatic ON" (Steering Mid Position)
H6	Ind. Lamp - "Guidance Available"
H7	Ind. Lamp - "Guidance Switched On"
H8	Ind. Lamp - Mast in Danger Area
H9	Ind. Lamp - Fork Position
H10	
H11	Lighting - Cab
H15	Ind. Lamp - Truck in Operational Mode

SECTION
3

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 461330	Gerät: Equipment: Equipement:	Geräte-Gruppe: Group of equipement: 3 Groupe de equipement:	Nr. No. 16 No.
Bemerkung: Remark: Remarque:			Schaltplan Leistungsteile als Isometrie-Führung Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dos	



G1 Batterie

F1 Pumpmotorsicherung
F2 Fahrmotorsicherung
F3 Sicherungsautomat Lenkmotor

M1 Pumpmotor
M2 Fahrmotor
M3 Lenkmotor

K3 Hauptschütze
K4 Lenkschütz

A1 Leistungsteil Hydr.
A2 Motorteil Hydr.
A3 Leistungsteil Fahr.
A4 Motorteil Fahr.
A5 Rückspeisemodul
A8
A8.1 Lenkendstufe
A9 Batteriesteckvorrichtung
A10 Klemmsockel
A23

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 460226	Gerät: Equipement: BA Equipement:	Geräte-Gruppe Nr. Group of equipement: 3 No 15 Groupe de equipement: No.
Bemerkung: Remark: Remarque:			Schaltplan Fahrschalter Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées des

F1 Pumpenhotsicherung
F4 Steuerstromsicherung
F5 Sicherung 1. Spannungswandler
F6 Sicherung 2. Spannungswandler

M5 Lüfter Impulssteuerungen

R1 Vorwiderstand 1. Spannungswandler
R2 Vorwiderstand 2. Spannungswandler

U1 1. Spannungswandler
U2 2. Spannungswandler

K3 Hauptschütz
K4 Lenkschütz
K10 Hauptschütz Steuerstrom

A2 Motorteil Hyd.
A4 Motorteil Fahr.
A7 Betriesstundenzähler
A10 Klemmsockel
A11 Batteriekontrollgerät
A13 Baugruppenträger Steinbock
A14 Freiprogrammierbare Steuerung

Schaltplan 460228
Schaltplan 460223
Schaltplan 460227
Schaltplan 460227
Schaltplan 460227
Schaltplan 460227

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 460227	Gerät: Equipement: WA Equipement:	Geräte-Gruppe Group of equipment: 3 Groupe de equipment:	Nr. 16 No No.
Bemerkung: Remark: Remarque:			Schaltplan Fahrsteg Projektionssteuerung	Positionsbezeichnungen: Siehe Rückseite Marking of positions: see back Repère de position: détachons dos	

Schaltplan 460226

Schaltplan 460226

Schaltplan 460223

Schaltplan 460226

Schaltplan 460226

Schaltplan 460226

Schaltplan 460226

Bei Kurvenfahrt Leitung Z2b ST.11 Pin 11 auf Pin 12 umstecken

Y1	Ventil Haupthub senken
Y2	Prop-Ventil Haupthub
Y6	Magnetbremse
Y7	Magnetbremse Not-Stop
Y18	Ventil Notablaß
B1	Mast 1. Abschaltung
B2	Mast 2. Abschaltung
B3	Mast 3. Abschaltung
B4	Gangerkennung rechts
B5	Gangerkennung links
B8.1	Mast Hubabschaltung
B17	Initiator links außen
B18	Initiator rechts außen
B19	Initiator rechts mitte
B20	Initiator links mitte
B21	Initiator rechts innen
B22	Initiator links innen
A8	Lenkendstufe
A8.1	Lenkelektronik
A12	Baugruppenträger PHB
A15	Antenne vorne
A16	Antenne hinten
A17	Drehimpulsgeber
A18	Istwertpotiometer
A20	Spannungsversorgungsmodul
A25	Antenne mitte
A27	Summer BGT
S3	10° Lenkanschlag
S5	Lenkwinkelbegrenzung
S6	Schlaffkettensicherung
S7	Reedschalter rechts außen
S8	Reedschalter rechts mitte
S9	Reedschalter links mitte
S10	Reedschalter links außen
S19	Reedschalter rechts innen
S20	Reedschalter links innen
S33	Bremse gelöst
S33.1	Bremse gelöst
H1	Rundumleuchte
M4	Lüfter Pumpmotor
K1	Schütz Magnetbremse
K2	Schütz Magnetbremse Not-Stop
K4	Lenkschütz

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN: 460228	Gerät: Equipement: WA Equipement:	Geräte-Gruppe: 3 Nr. 17 Group of equipement: No. Groupe de equipement: No.
Bemerkung: Remark: Remarque:			Schaltplan Kabine Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachées dos

A6 Fahrregler
A11.1 Anzeigegerät Batteriekontrollgerät
A19 Sollwertpotiometer
A21 Horn
A22 Summer
A30.1 Multiplex-Sender
A31 Hydraulikhebel

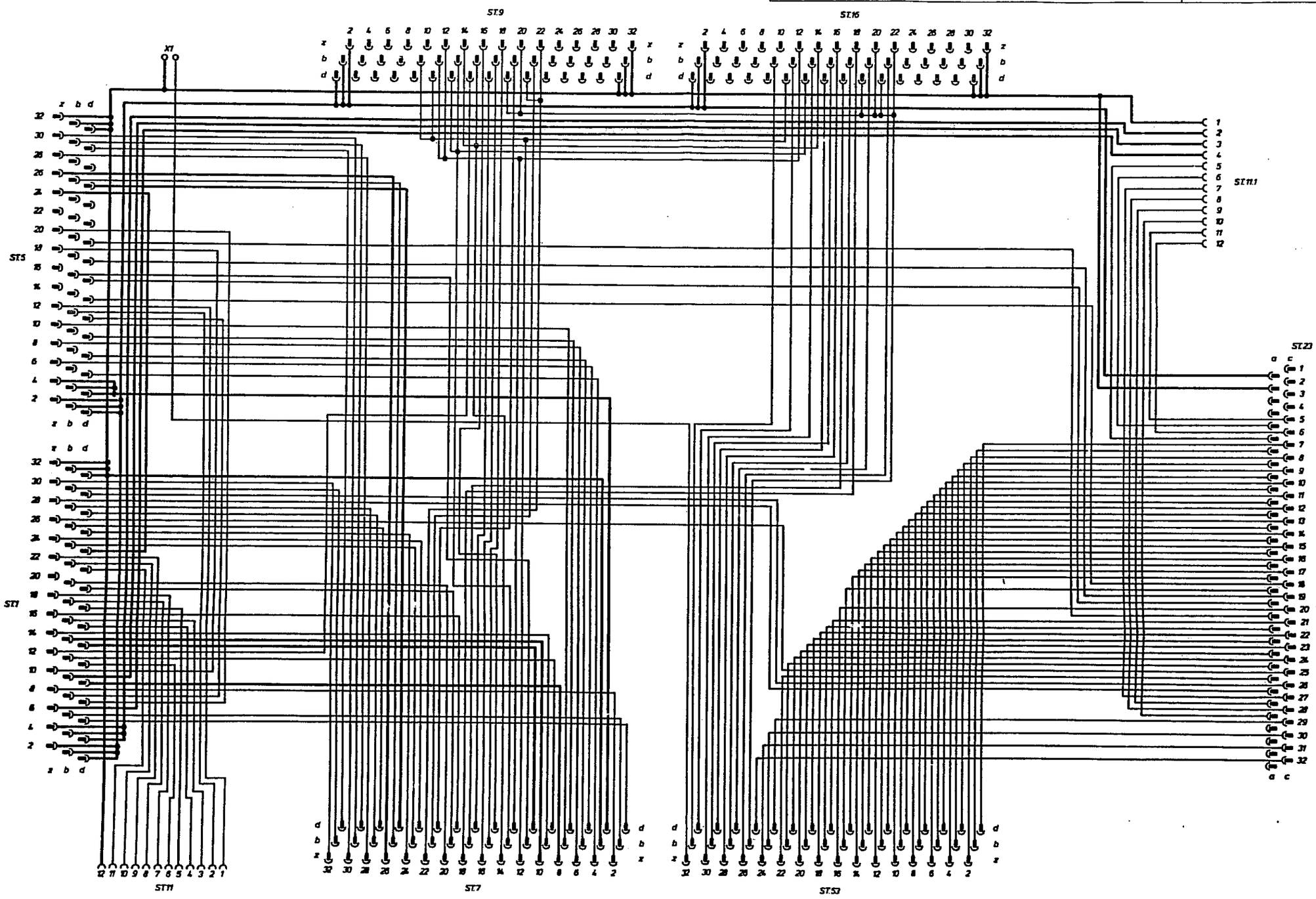
Y3 Prop-Ventil Zusatzhub
Y4 Prop-Ventil schieben
Y5 Prop-Ventil drehen
Y8 Zinkenverstellung
Y9 Zinkenverstellung
Y14 Zusatzhub senken

H3 Arbeitsscheinwerfer
H5 Automatik ein (Lenkung Mittelstellung)
H6 Einspuren möglich
H7 E .spurvorgang läuft
H8 Mast im Gefahrenbereich
H9 Zinkenverstellung
H11 Kabinenbeleuchtung
H15 Gerät betriebsbereit

B6 Zusatzhub unten
B7 Gabel rechts geschwenkt
B8 Gabel links geschwenkt

S1 Schlüsselschalter
S2 Not-Aus Schalter
S11 Gabel rechts ohne Begrenzung
S12 Gabel rechts 1.Begrenzung
S13 Gabel rechts Endlagendämpfung
S14 Gabel links Endlagendämpfung
S15 Gabel links 1.Begrenzung
S16 Gabel links ohne Begrenzung
S17 Fallriegelschalter rechts
S18 Fallriegelschalter Links
S22 Taste Horn
S23 Fahrtrichtungsschalter vorwärts
S24 Fahrtrichtungsschalter rückwärts
S25 Totmannknopf Fahrhebel
S27 Automatik ein (Lenkung Mittelstellung)
S31 Arbeitsscheinwerfer
S32 Totmannknopf Hydraulikhebel
S34 Taste Notablass
S35 Überbrückungstaste Hubabschaltung
S36 Zinkenverstellung
S60 Hauptlhub
S61 Zusatzhub
S62 Schieben
S63 Drehen
S64 Synchron-Drehen links
S65 Synchron-Drehen rechts
S66 Senken
S67 Heben
S68 Schlaffkettensicherung

STEINBOCK BOSS	ELEKTRO-SCHALTPLAN ELECTRIC WIRING DIAGRAM SCHÉMA DE CONNEXIONS ÉLECTRIQUE	SN 460833	Gerät: Equipement: V4 Equipement:	Geräte-Gruppe: No. Group of equipement: 3 No. 18 Groupe de equipement: No.
Bemerkung: Remark: Remarque:			Schaltplan Bau-Platte Baugruppenträger Proportionalsteuerung	Positionsbezeichnungen: siehe Rückseite Marking of positions: see back Repère de position: détachers dos



Key to Wiring Diagram 461520

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A8	
A8.1	End Stage - Steer
A9	Connector - Battery Plug
A10	Terminal Block
A23	
F1	Fuse - Pump Motor
F2	Fuse - Traction Motor
F3	Overload - Steer Motor
K3	Contactor - Main
K4	Contactor - Steer
M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer

Group 3

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A6	Drive Controller
A7	Hour Meter
A8	Steer System - Electronic
A8.1	End Stage - Steer
A9	Battery Plug
A10	Terminal Post
A11	Battery Check Unit
A11.1	Battery Discharge Indicator
A12	Rack - PHB
A13	Rack - Steinbock
A14	Programmable Logic Controller
A15	Antenna - Front
A16	Antenna - Back
A17	Rotary Pulse Generator
A18	Actual Value Pot.
A19	Target Value Pot.
A20	Module - Voltage Supply
A21	Horn
A22	Buzzer
A23	Module - Diode
A24	Selector - Frequency
A25	Antenna - Middle
A26	
A27	Buzzer
A28	
A29	
A30.1	Transmitter - Multiplex
A31	Hydraulic Control
A32	
A34	
A35	
A36	
A37	
A38	

G.1	Battery (ies)

U.1	Transformer No. 1 - Voltage
U.2	Transformer No. 2 - Voltage

M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
M4	Fan - Pump Motor
M5	Fan - Pulse Control Unit

K1	Contactor - Magnetic Brake
K2	Contactor - Magnetic Brake - Emergency Stop
K3	Contactor - Main
K4	Contactor - Steer
K5	Relay - Fork Spread Solenoid Value Left
K6	Relay - Fork Spread Solenoid Value Left
K7	Relay - Fork Spread Solenoid Value Right
K8	Relay - Fork Spread Solenoid Value Right
K9	
K10	Contactor - Main (Control Circuit)

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

B1 Mast Cut-out - 1
B2 Mast Cut-out - 2
B3 Mast Cut-out - 3
B4 Detection - End of Aisle (right)
B5 Detection - End of Aisle (left)
B6 Aux. Lift (Lowered)
B7 Forks - Rotated Right
B8 Forks - Rotated Left
B8.1 Mast Lift Cut-out
B9 Main Lift - Raise
B10 Main Lift - Lower
B11 Aux. Lift - Raise
B12 Aux. Lift - Lower
B13 Side Shift - Left
B14 Side Shift - Right
B15 Rotate
B16 Damping - Cab
B17 Initiator - Left Outer
B18 Initiator - Right Outer
B19 Initiator - Right Centre
B20 Initiator - Left Centre
B21 Initiator - Right Inner
B22 Initiator - Left Inner
B23 Forks - Left Centre
B24 Forks - Left Inside
B25 Forks - Right Inside
B26 Forks - Right Centre
B27 Forks - Right Outside
B28 Detector - Load
B29
B30
B31
B32
B33
B34
B35
B36
B37
B38
B39
B40

Y1 Valve - Main Lift (Lower)
Y2 Valve - Main Lift (Proportional Valve)
Y3 Valve - Aux. Lift (Proportional Valve)
Y4 Valve - Side Shift (Proportional Valve)
Y5 Valve - Rotate - Proportional Valve
Y6 Brake - Magnetic
Y7 Brake - Magnetic Emergency Stop
Y8 Valve - Solenoid, Fork Spreader
Y9 Valve - Solenoid, Fork Spreader
Y10 Valve - Solenoid, Fork Spread Right
Y11 Valve - Solenoid, Fork Spread Left
Y14 Valve - Aux. Lift - Lower
Y18 Valve - Emergency Lower

F1 Fuse - Pump Motor
F2 Fuse - Traction Motor
F3 Fuse - Steer Motor
F4 Fuse - Control Circuit
F5 Fuse - No. 1 Transformer
F6 Fuse - No. 2 Transformer
F7 Fuse - Rack
F8 Fuse - Rack

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

U.1 Transformer No. 1 Voltage
U.2 Transformer No. 2 Voltage

R1 Resistor - Series, Voltage Transformer No. 1
R2 Resistor - Series, Voltage Transformer No. 2

S1 Keyswitch
S2 Switch - Battery Emergency 'Off'
S3 Switch - 10° Steer Angle
S4
S5 Switch - Steer Angle Limit
S6 Switch - Slack Chain Device
S7 Reed Switch - Outer Right
S8 Reed Switch - Centre Right
S9 Reed Switch - Centre Left
S10 Reed Switch - Outer Left
S11 Switch - Forks Right, Without Limit
S12 Switch - Forks Right 1st Limit
S13 Switch - Forks Right End Damping
S14 Switch - Forks Left End Damping
S15 Switch - Forks Left 1st Limit
S16 Switch - Forks Left, Without Limit
S17 Microswitch - Guard Rail, Right
S18 Microswitch - Guard Rail, Left
S19 Reed Switch - Right Inner
S20 Reed Switch - Left Inner
S21 Switch - Override
S22 Push Button - Horn
S23 Switch - Direction "Forward"
S24 Switch - Direction "Reverse"
S25 Dead Man Button on Forward/ Reverse Control
S26 Push Button - Two Hand Control Hydraulic Control Lever
S27 Switch - "Automatic ON" (Steer - Mid Position)
S28 Switch - Lighting Interior
S29 Switch - Patrol Lamp
S30 Switch - Steering Mid-Position
S31 Switch - Working Lights
S32 Dead Man Button - Hydraulic Control (Main Lift)
S33 Sw. Brake Released
S33.1 Brake Released
S34 Push Button - Emergency Lower
S35 Override Sw. - Lift Cut-out
S36 Sw. - Fork Positioning
S37 Switch - Forks, Centre from Left End Damping
S38 Switch - Forks, Centre from Left
S39 Switch, Forks Centre from Right
S40 Switch, Forks Centre from Right End Damping
S41 Switch - Telescopic Table, Centre
S42
S43
S44
S45
S46
S47
S48
S49
S60 Switch - Main Lift
S61 Switch - Aux. Lift
S62 Switch - Side Shift
S63 Switch - Rotate
S64 Switch - Combined Movement Rotate Left
S65 Switch - Combined Movement Rotate Right
S66 Switch - Lower
S67 Switch - Lift
S68 Switch - Slack Chain Device

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

H1	Ind. Lamp - Rotary Patrol Lamp
H2	Ind. Lamp - Cab Lighting
H3	Ind. Lamp - Working Lights
H4	Ind. Lamp
H5	Ind. Lamp - "Automatic ON" (Steer Mid Position)
H6	Ind. Lamp - "Guidance Available"
H7	Ind. Lamp - "Guidance Switched On"
H8	Ind. Lamp - "Mast in Danger Area"
H9	Ind. Lamp - Fork Position
H10	
H11	Lamp - Cab Interior
H15	Ind. Lamp - "Truck in Operational Mode"

Key to Wiring Diagram 460 227 (Truck)

Y1 Valve - Lower Cab
Y2 Valve - Proportioning (Cab)
Y6 Brake - Magnetic
Y7 Brake - Emergency Stop
Y18 Valve - Emergency Lowering

B1 Switch - No.1 Mast Cut-out
B2 Switch - No.2 Mast Cut-out
B3 Switch - No.3 Mast Cut-out
B4 Switch - Aisle Recognition Right
B5 Switch - Aisle Recognition Left
B8.1 Switch - Lift Cut-out (Mast)
B17 Proximity Switch - Left Outer
B18 Proximity Switch - Right Outer
B19 Proximity Switch - Right Middle
B20 Proximity Switch - Left Middle
B21 Proximity Switch - Right Inner
B22 Proximity Switch - Left Inner

A8 End Stage - Steer
A8.1 Steer Unit - Electronic
A12 Rack - PHB
A15 Antenna - Front
A16 Antenna - Rear
A17 Transmitter - Rotary Impulse
A18 Potentiometer - Actual Valve
A20 Modul - Voltage Supply
A25 Antenna - Middle
A27 Buzzer

S3 Switch - 10° Steer Stop
S5 Switch - Steer Angle Limit
S6 Switch - Slack Chain Device
S7 Reedswitch - Right Outer
S8 Reedswitch - Right Middle
S9 Reedswitch - Left Middle
S10 Reedswitch - Left Outer
S19 Reedswitch - Right Inner
S20 Reedswitch - Left Inner
S33 Switch - Brake Released
S33.1 Switch - Brake Released

H1 Patrol - Lamp - Rotary

M4 Fan - Cooling (Pump Motor)

K1 Contactor - Magnetic Brake
K2 Contactor - Magnetic Brake Emergency Stop
K4 Contactor - Steer

Key to Wiring Diagram 460 228 Cab

A6	Control - Drive
A11.1	Indicator - BDI
A19	Potentiometer - Target Valve
A21	Horn
A22	Buzzer
A30.1	Sender - Multiplex
A31	Control Lever - Hydraulic
H3	Lights - Working
H5	Indicator Lamp - 'Automatic ON' Steering Mid Position
H6	Indicator Lamp - 'Tracking Available'
H7	Indicator Lamp - 'Tracking'
H8	Indicator Lamp - 'Mast in' Danger Zone'
H9	Indicator Lamp - 'Position Forks'
H11	Lamp - Cabin Interior
H15	Indicator Lamp - 'Truck Ready for Operation
B6	Proximity Switch - 'Aux. Lift Down'
B7	Proximity Switch - 'Forks Shifted Right'
B8	Proximity Switch - 'Forks Shifted Left'
Y3	Valve - Proportioning - Aux. Lift
Y4	Valve - Proportioning - Side Shift
Y5	Valve - Proportioning - Rotate
Y8	Valve - Fork Positioning
Y9	Valve - Fork Positioning
Y14	Valve - Lowering (Aux. Lift)
S1	Keyswitch
S2	Switch - Emergency Battery Cut-Out
S11	Switch - Forks Right - No Limit
S12	Switch - Forks Right - 1st Limit
S13	Switch - Forks Right End Position Damping
S14	Switch - Forks Left End Damping
S15	Switch - 1st Limit. Forks Left
S16	Switch - Forks Left. Without Limit
S17	Switch - Guard Rail (Right)
S18	Switch - Guard Rail (Left)
S22	Push Button - Horn
S23	Switch - Direction 'Forward'
S24	Switch - Direction 'Reverse'
S25	Deadman Button - Drive Control Lever
S27	Switch - 'Automatic Steer ON' (Steering - Mid Position)
S31	Switch - Working Lights
S34	Push Button - 'Emergency Lower'
S35	Push Button - 'Lift Cutout Override'
S36	Switch - Fork Positioning
S40	Switch - Cab Lift
S61	Switch - Aux. Lift
S62	Switch - 'Sideshift'
S63	Switch - 'Rotate Forks'
S64	Switch - Combined Movement Left
S65	Switch - Combined Movement Right
S66	Switch - Lower
S67	Switch - Lift
S68	Switch - Slack Chain Device

Group 3

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

A1	Power Unit - Hydraulic
A2	Motor Unit - Hydraulic
A3	Power Unit - Traction
A4	Motor Unit - Traction
A5	Module - Feed Back
A6	Drive Controller
A7	Hour Meter
A8	Steer System - Electronic
A8.1	End Stage - Steer
A9	Battery Plug
A10	Terminal Post
A11	Battery Check Unit
A11.1	Battery Discharge Indicator
A12	Rack - PHB
A13	Rack - Steinbock
A14	Programmable Logic Controller
A15	Antenna - Front
A16	Antenna - Back
A17	Rotary Pulse Generator
A18	Actual Value Pot.
A19	Target Value Pot.
A20	Module - Voltage Supply
A21	Horn
A22	Buzzer
A23	Module - Diode
A24	Selector - Frequency
A25	Antenna - Middle
A26	
A27	Buzzer
A28	
A29	
A30.1	Transmitter - Multiplex
A31	Hydraulic Control
A32	
A34	
A35	
A36	
A37	
A38	

G.1	Battery (ies)

U.1	Transformer No. 1 - Voltage
U.2	Transformer No. 2 - Voltage

M1	Motor - Pump
M2	Motor - Traction
M3	Motor - Steer
M4	Fan - Pump Motor
M5	Fan - Pulse Control Unit

K1	Contactor - Magnetic Brake
K2	Contactor - Magnetic Brake - Emergency Stop
K3	Contactor - Main
K4	Contactor - Steer
K5	Relay - Fork Spread Solenoid Value Left
K6	Relay - Fork Spread Solenoid Value Left
K7	Relay - Fork Spread Solenoid Value Right
K8	Relay - Fork Spread Solenoid Value Right
K9	
K10	Contactor - Main (Control Circuit)

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series Trucks with Proportional Control Valve

B1 Mast Cut-out - 1
B2 Mast Cut-out - 2
B3 Mast Cut-out - 3
B4 Detection - End of Aisle (right)
B5 Detection - End of Aisle (left)
B6 Aux. Lift (Lowered)
B7 Forks - Rotated Right
B8 Forks - Rotated Left
B8.1 Mast Lift Cut-out
B9 Main Lift - Raise
B10 Main Lift - Lower
B11 Aux. Lift - Raise
B12 Aux. Lift - Lower
B13 Side Shift - Left
B14 Side Shift - Right
B15 Rotate
B16 Damping - Cab
B17 Initiator - Left Outer
B18 Initiator - Right Outer
B19 Initiator - Right Centre
B20 Initiator - Left Centre
B21 Initiator - Right Inner
B22 Initiator - Left Inner
B23 Forks - Left Centre
B24 Forks - Left Inside
B25 Forks - Right Inside
B26 Forks - Right Centre
B27 Forks - Right Outside
B28 Detector - Load
B29
B30
B31
B32
B33
B34
B35
B36
B37
B38
B39
B40

Y1 Valve - Main Lift (Lower)
Y2 Valve - Main Lift (Proportional Valve)
Y3 Valve - Aux. Lift (Proportional Valve)
Y4 Valve - Side Shift (Proportional Valve)
Y5 Valve - Rotate - Proportional Valve
Y6 Brake - Magnetic
Y7 Brake - Magnetic Emergency Stop
Y8 Valve - Solenoid, Fork Spreader
Y9 Valve - Solenoid, Fork Spreader
Y10 Valve - Solenoid, Fork Spread Right
Y11 Valve - Solenoid, Fork Spread Left
Y14 Valve - Aux. Lift - Lower
Y18 Valve - Emergency Lower

F1 Fuse - Pump Motor
F2 Fuse - Traction Motor
F3 Fuse - Steer Motor
F4 Fuse - Control Circuit
F5 Fuse - No. 1 Transformer
F6 Fuse - No. 2 Transformer
F7 Fuse - Rack
F8 Fuse - Rack

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

U.1 Transformer No. 1 Voltage
U.2 Transformer No. 2 Voltage

R1 Resistor - Series, Voltage Transformer No. 1
R2 Resistor - Series, Voltage Transformer No. 2

S1 Keyswitch
S2 Switch - Battery Emergency 'Off'
S3 Switch - 10° Steer Angle
S4
S5 Switch - Steer Angle Limit
S6 Switch - Slack Chain Device
S7 Reed Switch - Outer Right
S8 Reed Switch - Centre Right
S9 Reed Switch - Centre Left
S10 Reed Switch - Outer Left
S11 Switch - Forks Right, Without Limit
S12 Switch - Forks Right 1st Limit
S13 Switch - Forks Right End Damping
S14 Switch - Forks Left End Damping
S15 Switch - Forks Left 1st Limit
S16 Switch - Forks Left, Without Limit
S17 Microswitch - Guard Rail, Right
S18 Microswitch - Guard Rail, Left
S19 Reed Switch - Right Inner
S20 Reed Switch - Left Inner
S21 Switch - Override
S22 Push Button - Horn
S23 Switch - Direction "Forward"
S24 Switch - Direction "Reverse"
S25 Dead Man Button on Forward/ Reverse Control
S26 Push Button - Two Hand Control Hydraulic Control Lever
S27 Switch - "Automatic ON" (Steer - Mid Position)
S28 Switch - Lighting Interior
S29 Switch - Patrol Lamp
S30 Switch - Steering Mid-Position
S31 Switch - Working Lights
S32 Dead Man Button - Hydraulic Control (Main Lift)
S33 Sw. Brake Released
S33.1 Brake Released
S34 Push Button - Emergency Lower
S35 Override Sw. - Lift Cut-out
S36 Sw. - Fork Positioning
S37 Switch - Forks, Centre from Left End Damping
S38 Switch - Forks, Centre from Left
S39 Switch, Forks Centre from Right
S40 Switch, Forks Centre from Right End Damping
S41 Switch - Telescopic Table, Centre
S42
S43
S44
S45
S46
S47
S48
S49
S60 Switch - Main Lift
S61 Switch - Aux. Lift
S62 Switch - Side Shift
S63 Switch - Rotate
S64 Switch - Combined Movement Rotate Left
S65 Switch - Combined Movement Rotate Right
S66 Switch - Lower
S67 Switch - Lift
S68 Switch - Slack Chain Device

Comprehensive Key to Wiring Diagrams and Ladder Diagrams
WA Series with Proportional Control Valve

H1 Ind. Lamp - Rotary Patrol Lamp
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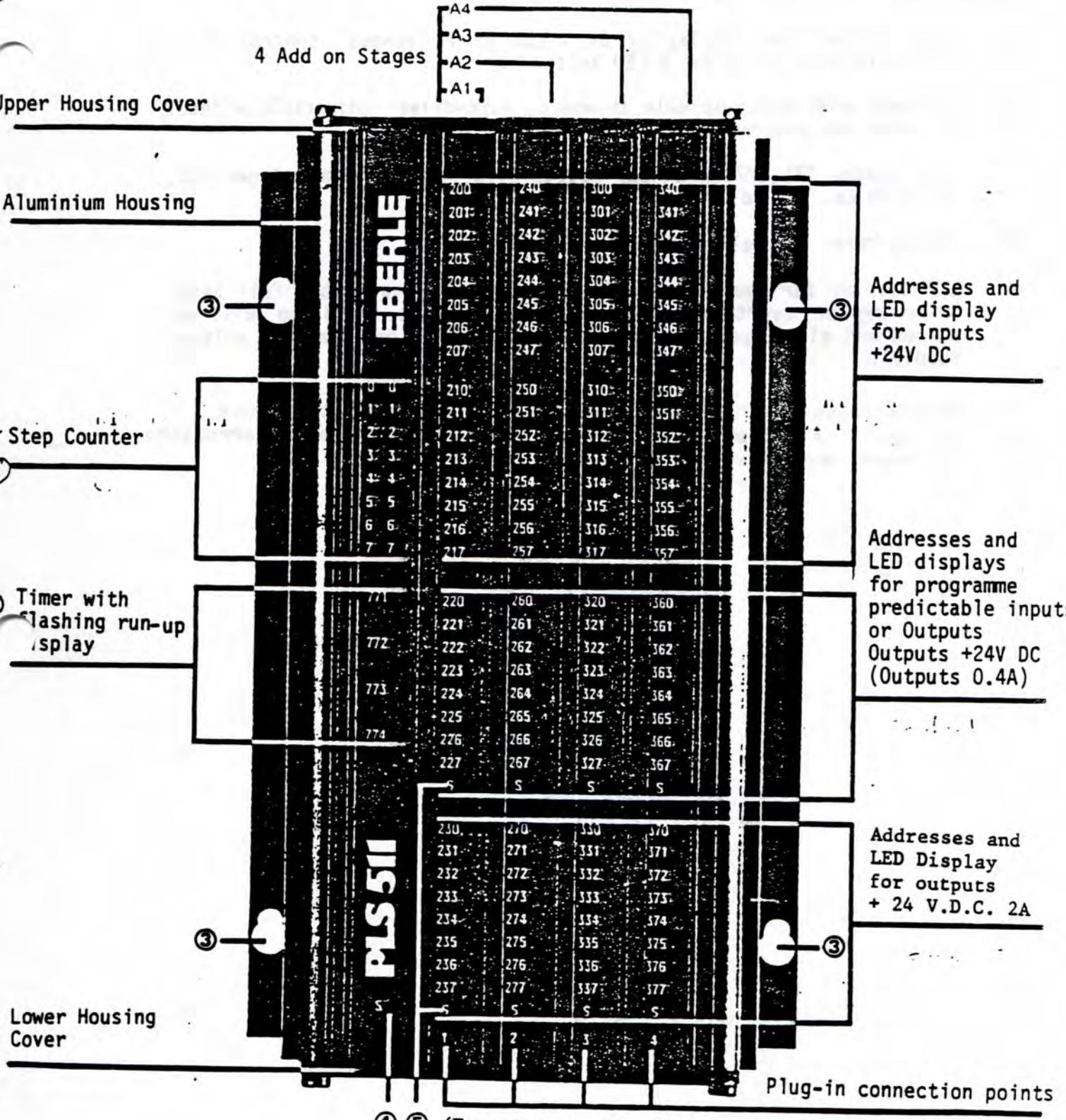
H8 Ind. Lamp - "Mast in Danger Area"
H9 Ind. Lamp - Fork Position
H10
H11 Lamp - Cab Interior
H15 Ind. Lamp - "Truck in Operational Mode"

SECTION

4

PC



④ ⑤ (For correct operation of the processor card plug-in point 1 must be connected to a supply voltage + 24v D.C.)

Explanation of Illustration

1. Step counter for display of 64 steps of a 'runout' control (left 8 LED: Valence 10; right 8 LED Valence 1).

2. 4 Timers with multi-spindle trimmers, screwdriver adjustable without altering the programme.

   Time stages 771, 772 with ca. D.1 to 10.0 sec. and Time stages 773, 774 with ca. 1.0 to 100 sec.

3. Tixing holes for wall mounting.

4. LED display for fault indication, tripping activated by 'Fail Safe' switching or overtemperature signal. A fault condition will be stored and all outputs switched out. (Reset by breaking the voltage supply).

5. LED indicator for short-circuit is recorded and all outputs belonging to the group are switched off(resetting by interrupting the power supply).

2.2 Electrical Construction.

The electronic and mechanical components are widely standardised and consequently are renowned for reliability and capacity.

The P.L.S.511 is consistently incorporated in C-MOS- Technik with the well known advantages.

- Ideal static freedom from interference ca 50% of operating voltage.
- Good dynamic freedom from interference due to the relatively slow process speed and high operating voltage (10V).
- Well dimensioned circuits with negligible 'cross-talk' and reflections.
- Negligible circuit requirements resulting in no thermal stress and no cooling requirement.
- Wide operating voltage range hence simple supply units.

2.3 The processor card (or Central Unit) includes the Bit-processor with RAM work store (marker) which is required for the sequential programming. In addition there is also the indicating step counter, the 16 Binary Counters, four adjustable analogue time stages, pulse? stages, the temperature monitor, the fail safe switch which monitors the regular function of the Bit-processor and the voltage reset switching.

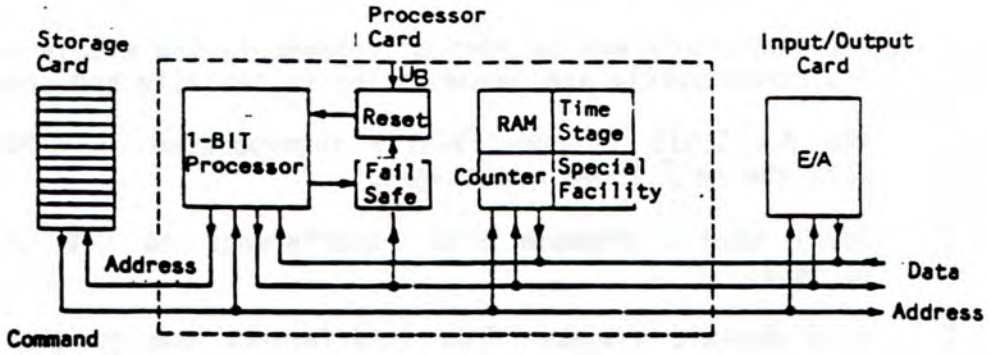
Under working conditions the process the fault (indicator) lamp is illuminated when:-

- Temperature of the housing > 70°C ± 10%.
- Logic Error Function.
- Pulse drop.
- Faulty (Deficient) Storage module.
- Empty Storage Module (without programme).

The fault (indicator) lamp can be reset by dropping the operating voltage to < 14V, provided that the fault has been eliminated.

The Processor card is permanently bonded to the Bus-Card and can only be refurbished by the supplier.

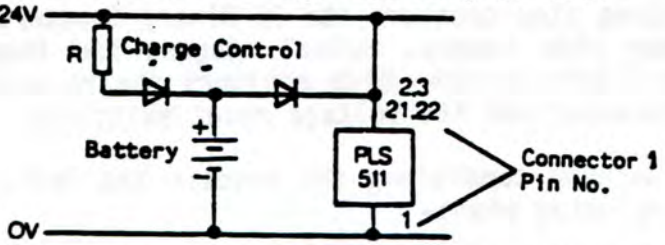
The method of operation and the address zone (address range) of the processor are described in detail in Chapter 6.



After connection of the 24V operating voltage the processor runs through a neutralising cycle; all '-' designated Addresses are set at 0; all '-N' designated addresses are set at 1.

Status maintenance of Voltage Drop.

If the control status remains unchanged by a voltage drop, the 24V operating voltage must be connected to plug-in point 1 (connection for address range 200-237) on 12V.



With 12V operating voltage the time is stopped, the programme will not run. All outputs are switched out. The status of the Markers and counters remain unchanged. The time stage is stopped not reset.

Current consumption ca 25mA + 3mA for every input channel which is switched on.

e.g. To maintain the condition for 72 hours (approx 3 days) if the current consumption of the ?PLS? is 40m A the power requirement will be 2.88 Amp hours.

Recommended - Nickel/Cadmuim Batteries of 4 Amp hours.

The value of the compensating resistance R may be calculated using the equation R = Operating Voltage - 12V ÷ (Trickle) Charging Current.

The Input/Output Cards.

On the Input/Output cards these are:-

0 16 inputs in positive Logic for +24 Volts DC, each input is indicated by an LED.

The switching status of each input will be stored in the memory at the start of the Programme.

The input delay amounts to ca. 10ms.

After a change in switching status the memory store has a dead time of ca 10ms during which time the switching status remains stable, so that contact chatter and voltage surges are effectively suppressed. Input channels up to ca 200ms. can be introduced without any special measures being taken.

0 8 fixed outputs in positive Logic for +24V D.C., each output being indicated by a Light Emitting Diode.

The short circuit switching for 8 outputs is stored and indicated by LED.

24V operating voltage must be switched off to reset the short circuits. The outputs are NOT protected against overloading.

0 8 programme predictable inputs or outputs for +24V D.C., whose switching status is indicated by an LED.

Inputs operate as already described.

Outputs are current limited. If the limit is more than ca. 80ms a short circuit will occur and the 8 group output wise?? disconnected and indicated. The inputs continue to function. The outputs are NOT protected against overloading. Each Input/Output Card must have its own +24V and OV.

Supply - There is no internal link.

The input/output cards are permanently bonded to the Bus Cards; and can only be refurbished by the supplier.

The EPROM Storage Card SK2.

On the Storage Card, near the C-MOS-EPROM is the Programme Counter.

One plug is provided for connection to the Bus Card for normal use, the second is for programming by means of the Programme Unit PG2.

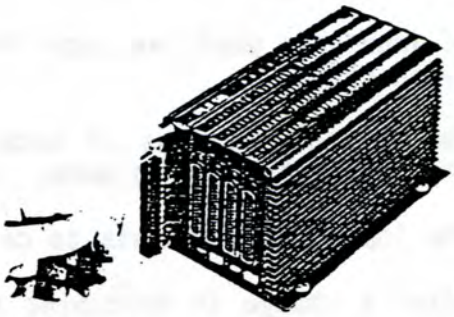
There are two extension stages.

1K x 12 and 2K x 12.

The storage Capacity is at the disposal of the _____ programme.

The Storage Card may be exchanged after removing the cover from the housing.

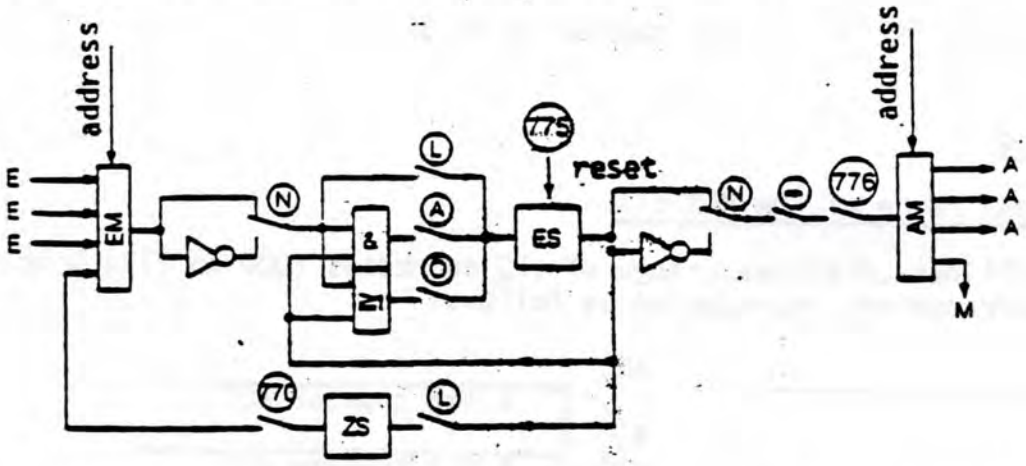
Removal of the lower housing cover using Allen Key



Removal of the EPROM storage card SK2 with extractor

1 The programming language

The function of the PLS 511 is determined by a program written into a memory. This program is a list of commands which the PLS 511 processor cyclic processes 320 times per second (with a 1k memory). The programming is at its simplest if the operating method of the realised bit processor in the PLS 511 is known.



A command basically consists of an instruction (operator) and an address (operand).
A particular input is selected by the input multiplexer (EM) using the address, on a particular output by the output multiplexer (AM) using the address.
The instruction specifies how the data of the selected address is to be processed.

Therefore with the instruction:

A — The switching condition of the selected address is combined with the switching condition of the result memory (ES) "AND" - and the result is entered again in the result memory.

O — As for A, but linked with "Or" -

L — The switching condition of the selected address is put directly into the result memory (ES).
The previously available content of the result memory (ES) is entered in the buffer memory (ZS)

= — The selected address (eg. output) is set at the switching condition of the result memory (ES).

N — in combination with one of the above instructions carries out the instruction inverted.

Example:
```
  L 210
  O 211
 AN 212
  = 230
```

The command L210 switches the EM to the input 210, the switching condition ("0" or "1") of which is taken directly into the ES via the switch (N) (as drawn) and (L) (closed).
The time taken to process a command (command cycle time) is approx. 3µs.
The command "O 211" switches the EM to the input 211, the switching condition of which is connected with the switching condition of the ES via the switch

It must be noted that with each program cycle a counting pulse is created provided the assignment is "1". Step control is brought about by a pulse program (see programming examples 8.1.11 with 8.1.13).

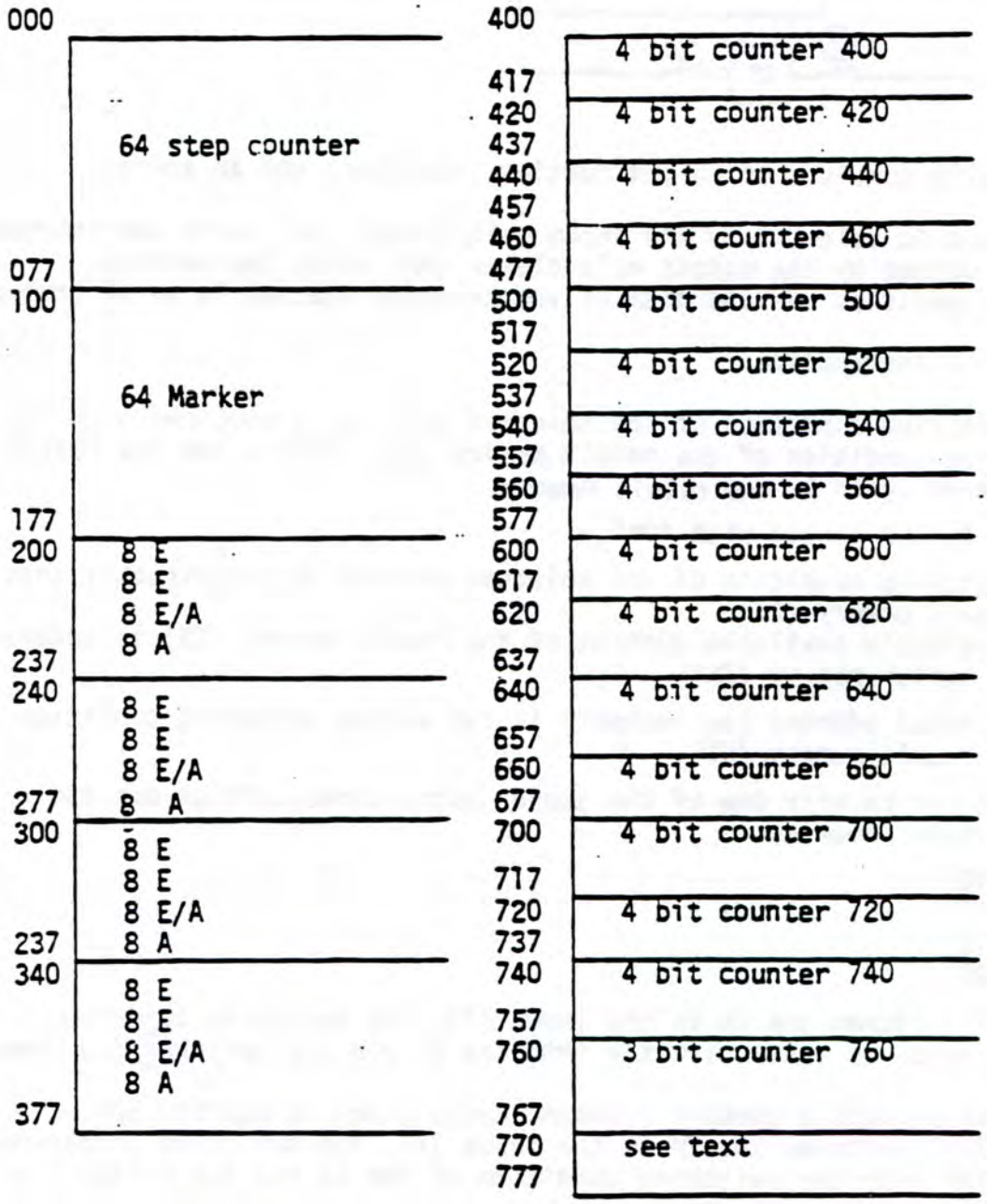
The step counter condition can be queried with the instructions L, A, O. The query results in "1" if the counter condition agrees with the queried address.

eg: "L036" results in "1" if the counter is at 36.

7. Addressing

7.1 The address range of the PLS 511

The PLS 511 has an address range of 512 addresses (000 to 777) with a fixed arrangement represented as follows:



Only Training

Programme

Ref Number 424754

Date 15 January 1985

Prepared by Peter Maier

STA 3

Revision Status (A) P4887

Revised Functions for Ref. No.

Description Inductive Guidance

Warning!

For Training only

Translator's NOTE

Memory Locations without functions or any other information have been omitted for brevity but each page is treated separately.

0001	L206	Input		Latching Relay
0002	=775			
0004	L213	Input		Deadman's Button Hydraulic Lever Main Lift
0005	0260	Input		Corrector Button (Override)
0006	ON106	Marker		Vehicle in Motion
0007	0207	Input		Tracking Speed
0012	A202	Input		Deadman's Button Drive Lever
0013	A101	Marker		Safety Switching
0016	=230	Output		Contactor Magnetic Brake
0023	LN256	Input		Initiator Mast 2.5m
0024	A227	Output		0-10° Switch 8V for Drive sender
0025	0233	Output		Valve Fast Lower Main Mast
0026	0234	Output		Valve Slow Lower Main Mast
0026	ON104	Marker		Truck in Motion
0035	=270	Output	RL101	Patrol Light
0046	L255	Input		Initiator Mast 0.5m
0047	AN215	Input		Aux. Lift 'Down'
0050	L256	Input		Initiator Mast 2.5m
0051	A215	Input		Auxilliary Lift 'Down'
0052	0770			
0053	AN217	Input		Initiator 'Lower' Main Lift
0054	AN216	Input		Initiator 'Lift' Main Lift
0055	0104	Marker		Vehicle in Motion
0060	=111	Marker		

0063	L257	Input		Initiator Mast 3.5m
0064	0260	Input		Corrector Button (or Reset)
0070	A111	Marker		
0071	A230	Output		Contactor 1. Magnetic Brake
0072	A231	Output		Contactor 2. Magnetic Brake
0073	A211	Input		Rotary Impulse Transmitter, Safety Switching
0074	AN214	Input		Two Hand Control - Hydraulic
0075	AN240	Input		Initiator 'Lift' Aux. Lift
0076	AN241	Input		Initiator 'Lower' Aux. Lift
0077	AN242	Input		Initiator Shift Right
0100	AN243	Input		Initiator Shift Left
0101	A244	Input		Initiator Rotate
0102	A130	Marker		Drive Delay 1 second
0105	=102	Marker		Interlock - Drive
0110	L102	Marker		Interlock - Drive
0111	A200	Input		Direction of Travel Forward
0112	AN201	Input		Direction of Travel Backward
0116	=272	Output	RL102	Direction of Travel Relay Forward
0121	L102	Marker		Interlock - Drive
0122	A201	Input		Direction of Travel - Backward
0123	AN200	Input		Direction of Travel - Forward
0127	=271	Output	RL103	Direction of Travel Relay - Backward
0132	L271	Output		Direction of Travel Relay - Backward
0133	0272	Output		Direction of Travel Relay - Forward
0135	=227	Output	RL108	0°-10° Switch 8V for Drive Sender
0140	L215	Input		Initiator Aux. Lift Down

0141	A256	Input	Initiator Mast 2.5m
0143	LN215	Input	Initiator Aux. Lift - Down
0144	A255	Input	Initiator Mast 0.5m
0146	0770		
0151	AN201	Input	Direction of Travel 'Backward'
0152	AN200	Input	Direction of Travel 'Forward'
0155	0104	Marker	Vehicle in Motion
0160	=110	Marker	
0163	L214	Input	2 - Handed Control - Hydraulic
0164	0202	Input	Deadman's Button - Drive Lever
0170	A110	Marker	
0171	A216	Input	Initiator - Lift Main Lift
0172	AN240	Input	Initiator - Lift Aux. Lift
0173	AN241	Input	Initiator - Lower Aux. Lift
0174	AN242	Input	Initiator - Shift Right
0175	AN243	Input	Initiator - Shift Left
0176	A244	Input	Initiator - Rotate
0177	AN217	Input	Initiator - Lower Main Lift
0203	=103	Marker	Interlock - Main Lift Hydraulics

0223	L103	Marker	Interlock Main Lift Hydraulics
0224	A100	Marker	Accessory in Base Position
0225	AN222	Output	Lift Speed V2 (Main Lift slow and Aux. Lift)
0226	AN223	Output	Stroke Speed V3 (shift)
0227	AN224	Output	Stroke Speed V4 (Rotate and End Position Cushion)
0233	=221	Output	Lift Speed V1 (Main Lift - Fast)
0236	L104	Marker	Vehicle in Motion
0237	0255	Input	Initiator Mast 0.5m
0243	A214	Input	2 Handed Control - Hydraulics
0244	A204	Input	Initiator - Lift Aux. Lift
0245	AN216	Input	Initiator - Lift Main Lift
0250	L103	Marker	Interlock - Mainlift Hydraulics
0251	AN100	Marker	Accessory in Base Position
0254	0770		
9255	AN223	Output	Stroke Speed V3 (Shift)
0256	AN224	Output	Stroke Speed V4 (Rotate and End Position Cushion)
0257	AN242	Input	Initiator - Shift Right
0260	AN243	Input	Initiator - Shift Left
0261	A244	Input	Initiator - Rotate
0262	AN200	Input	Direction of Travel Forward
0263	AN201	Input	Direction of Travel Backward
0264	AN241	Input	Initiator - Lower Aux. Lift
0265	AN217	Input	Initiator - Lower Main Lift
0271	=222	Output	Strok Speed V2 (Main Lift Slow and Aux. Lift)
0276	L214	Input	2 Handed Control Hydraulics
0277	0202	Input	Deadman's Button Drive Lever

0303	A217	Input	Initiator - Lower Main Lift
0304	A105	Marker	
0305	AN216	Input	Initiator - Lift Main Lift
0306	AN240	Input	Initiator - Lift Aux. Lift
0307	AN241	Input	Initiator - Lower Aux. Lift
0310	AN242	Input	Initiator - Shift Right
0311	AN243	Input	Initiator - Shift Left
0312	A244	Input	Initiator - Rotate
0316	=234	Output	Valve - Main Lift Slow Lower
0321	LN200	Input	Direction of Travel Forward
0322	AN201	Input	Direction of Travel Backward
0323	0104	Marker	Vehicle in Motion
0327	=105	Marker	
0330	L776		Time Base 1 sec.
0331	AN401		Counter Status
0332	=401		Count On
0333	LN234	Output	Valve - Slow Lower - Main Mast
0334	=400		Zero Counter
0335	L401		Counter Status
0336	A100	Marker	Accessory in Base Position
0337	=233	Output	Valve - Fast Lower Main Lift
0341	L776		Time Base 1 sec.
0342	AN421		Counter Status
0343	=421		Count On
0344	LN213	Input	Deadman's Button, Hydraulic Lever - Main Lift
0345	AN260	Input	Corrector Button (Reset?)
0346	A104	Marker	Vehicle in Motion
0347	AN207	Input	Tracking Speed
0350	ON202	Input	Deadman's Button Drive Lever (Direction)
0351	=420		Zero Counter
0352	L421		Counter Status
0353	=130	Marker	Travel Delay 1 sec.

0363	L214	Input	2 Handed Control Hydraulics
0364	A241	Input	Initiator - Lower Aux. Lift
0365	AN216	Input	Initiator - Lift Main Lift
0366	AN217	Input	Initiator - Lower Main Lift
0367	AN240	Input	Initiator - Lift Aux. Lift
0370	AN242	Input	Initiator - Shift Right
0371	AN243	Input	Initiator - Shift Left
0372	A244	Input	Initiator - Rotate
0373	AN200	Input	Direction of Travel
0374	AN201	Input	Direction of Travel
0400	=236	Output	Valve - Lower Aux. Lift
0405	L254	Input	Forks - Rotated, Left
0406	ON246	Input	Forks - Base Position, Left
0412	AN245	Input	Forks right without Limit
0413	A243	Input	Initiator - Shift Left
0414	A214	Input	2 Handed Control Hydraulics
0415	AN202	Input	Deadman's Button Drive Lever
0416	AN242	Input	Initiator - Shift Right
0417	AN241	Input	Initiator - Lower Aux. Lift
0420	AN240	Input	Initiator - Raise Aux. Lift
0421	AN216	Input	Initiator - Raise Main Lift
0422	AN217	Input	Initiator - Lower Main Lift
0423	AN201	Input	Direction of Travel - Backward
0424	AN200	Input	Direction of Travel - Forward
0430	=235	Output	Valve - Shift Left
0435	L253	Input	Forks - Rotated Right
0436	ON251	Input	Forks - Right Limit 1.

0442	AN250	Input	Forks - Right without Limit
0443	A242	Input	Initiator - Shift Right
0444	A214	Input	2 Handed Control Hydraulics
0445	AN202	Input	Deadman's Button Hydraulics
0446	AN243	Input	Initiator - Shift Left
0447	AN241	Input	Initiator - Lower Aux. Lift
0450	AN240	Input	Initiator - Lift - Aux. Lift
0451	AN216	Input	Initiator Lift - Main Lift
0452	AN217	Input	Inhibitor Lower - Main Lift
0453	AN201	Input	Direction of Travel Backward
0454	AN200	Input	Direction of Travel Forward
0460	=237	Output	Valve - Shift Right
0465	L237	Output	Valve - Shift Right
0466	0235	Output	Valve - Shift Left
0473	AN224	Output	Stroke Speed V4 (Rotate and End Position Cushion)
0477	=223	Output	Stroke Speed V3 (Shift)
0504	L254	Input	Forks - Rotated Left
0505	A253	Input	Initiator - Shift Left
0506	A247	Input	Forks - Left End Position Cushion
0507	A235	Output	Valve - Shift Left
0513	L253	Input	Forks - Rotated Right
0514	A242	Input	Initiator - Shift Right
0515	A252	Input	Forks - End Position Cushion
0516	A237	Output	Valve - Shift Right
0517	0770		

0523	L254	Input	Forks - Rotated Left
0524	A242	Input	Initiator - Shift Right
0525	A252	Input	Forks - Right with End Position Cushion
0526	A237	Output	Valve - Shift Right
0527	0770		
0533	L253	Input	Forks - Rotated Right
0534	A243	Input	Initiator - Shift Left
0535	A247	Input	Forks - Left with End Position Cushion
0536	A235	Output	
0537	0770		
0543	L252	Input	Forks - Right with End Position Cushion
0544	A243	Input	Initiator Shift Left
0545	A214	~~Input~~	2 Handed Control Hydraulics
0546	0770		
0553	L247	Input	Forks - Right with End Position Cushion
0554	A242	Input	Initiator - Shift Right
0555	A214	Input	2 Handed Control Hydraulics
0556	0770		
0563	L243	Input	Initiator - Shift Left
0564	A247	Input	Forks - Left End Position Cushion
0565	A235	Output	
0566	0770		
0573	L242	Input	Initiator - Shift Right
0574	A252	Input	Forks - Right End Position Cushion
0575	A237	Output	Valve - Shift Right
0576	0770		

0603	L243	Input	Initiator - Shift Left
0604	A252	Input	Forks - Right End Position Cushion
0605	A235	Output	Valve Shift Left
0606	0770		
0613	L242	Input	Initiator - Shift Right
0614	A247	Input	Forks - Left End Position Cushion
0615	A237	Output	Valve - Shift Right
0616	0770		
0623	L122	Marker	
0624	A214	Input	2 Handed Control Hydraulics
0625	AN244	Input	Initiator Rotate
0626	AN202	Input	Deadmans Button Drive Lever
0627	AN200	Input	Direction of Travel Forward
0630	AN201	Input	Direction of Travel Backward
0631	AN216	Input	Initiator - Lift Main Lift
0632	AN217	Input	Initiator - Lower Main Lift
0633	AN240	Input	Initiator - Lift Aux. Lift
0634	AN241	Input	Initiator - Lower Aux. Lift
0635	0770		
0647	=224	Output	Stroke Speed V4 (Rotate and End Position Cushion)
0654	LN254	Input	Forks - Rotated Left
0655	ON245	Input	Forks - Left without Limits
0657	LN253	Input	Forks - Rotated Right
0660	ON250	Input	Forks - Right without Limits

0661	A770			
0666	=122	Marker		
0730	=N775			
0731	L266	Output		Direction Switch Backward or Coming from Backward
0732	0200	Input		Direction of Travel - Forwards
0733	AN201	Input		Direction of Travel - Backward
0734	=266	Output	RL123	Direction Switch Backward or Coming from Backward
0735	L203	Input		Steering Order
0736	=232	Output		Steer Contactor
0741	L212	Input		Automatic 'ON' (Movement Detection)

0746	=104	Marker		Vehicle in Motion
0752	L206	Input		Latching Relay
0753	ON206	Input		Latching Relay
0762	=276	Output	RL105	Hour Counter
0766	L246	Input		Forks Limit 1 Left
0767	A253	Input		Forks Rotated Right
0771	L251	Input		Forks Limit 1. Right
0772	A254	Input		Forks Rotated Left
0774	0770			
0777	=100	Marker		Accessory in Base Position*
1005	LN257	Input		Initiator Mast 3.5m
1006	A260	Input		Corrector Button (Reset)
1007	0207	Input		Tracking Speed
1012	=220	Output	RL114	Tracking Speed
1016	L100	Marker		Accessory in Base Position
1017	AN275	Output		Speed of Travel V3 (2.5 km/h)
1020	AN274	Output		Speed of Travel V2 (4 km/h)
1021	AN220	Output		Tracking Speed

Translator's Note

* The truck is in the base position when the articulated reach unit is shifted to the right with forks rotated left.

1025	=273	Output	RL111	Speed of Travel V1 (8 km/hr)
1030	LN104	Marker		Vehicle in Motion
1031	AN215	Input		Initiator Aux. Lift 'Down'
1033	ON255	Input		Initiator Mast 0.5m
1036	AN220	Output		Tracking Speed
1037	A275	Output		Speed of Travel V3 (2.5m km/hr)
1043	=274	Output	RL112	Speed of Travel V2 (4.0 km/hr)
1050	LN205	Input		Switch 10° Steer End Stop
1051	AN255	Input		Initiator Mast 0.5m
1053	LN205	Input		Switch 10° Steer End Stop
1054	AN215	Input		Initiator Aux. Lift 'Down'
1056	0770			
1060	ON256	Input		Initiator Mast 2.5m
1061	ON100	Marker		Accessory in Base Position
1063	AN220	Output		Tracking Speed
1067	=275	Output	RL113	Speed of Travel V3 (2.5m km/hr)
1072	L211	Input		Rotary Impulse Transmitter Safety Switching
1073	A203	Input		Steering in Order
1076	=101	Marker		Safety Switching
1102	L101	Marker		Safety Switching
1105	=231	Output		Contactor 2 Magnetic Brake

Co-ordination list SPS Type PLS 511 S WA - Proportional Control Valve

Circuit roll.	Wire	
253	K123	=266 = Target Value - Direction of Travel
246	H1	=270 = Rotating Patrol Light
247	K102	=271 = Direction of Travel Relay - Fwd.
248	K103	=272 = Direction of Travel Relay - Rev.
269	FGV4	=273 = Speed of Travel V4
268	FGV3	=274 = Speed of Travel V3
267	FGV2	=275 = Speed of Travel V2
249	A7	=276 = Hour Meter
296	KSHY	=300 = No Fault on Hydraulic Control
296	EHB1	=301 = B1 Hydraulic Control
296	EHB2	=302 = B2 Hydraulic Control
296	EHB3	=303 = B3 Hydraulic Control
296	EHB4	=304 = B4 Hydraulic Control
286	NV	=305 = Reset Values
286	NP	=306 = Reset Pump Motor
91	S33	=307 = Brakes Released
207	KSFH	=310 = No Fault on Drive Control
250	K121	=311 = V = 0 (Open when Stationary)
222	S7	=312 = Reed Switch - Right Outer/B18 = 312 = Proximity Switch Right Outer
224	S8	=313 = Reed Switch - Right Centre
226	S9	=314 = Reed Switch - Left Centre
228	S10	=315 = Reed Switch - Left Outer/B17 = 315 = Proximity Switch Left Outer
286	HHB1	=320 = B1 Main Lift Aux. Lift Side Shift
286	HHB2	=321 = B2 Main Lift Aux. Lift Side Shift
286	HHB3	=322 = B3 Main Lift Aux. Lift Side Shift
286	HHB4	=323 = B4 Main Lift Aux. Lift Side Shift
293	DB1	=324 = B1 Rotate
293	DB2	=325 = B2 Rotate
293	DB3	=326 = B3 Rotate
293	DB4	=327 = B4 Rotate
252252	RHHH	=330 = Main Lift - Lift
285	RHHS	=331 = Main Lift - Lower
285	RZHH	=332 = Aux. Lift - Lift
285	RZHS	=333 = Aux. Lift - Lower
293	RSR	=334 = Shift - Right
293	RSL	=335 = Shift - Left
293	RDR	=336 = Rotate - Right
293	RDL	=337 = Rotate - Left

Co-ordination list SPS Type PLS 511 S WA - Proportional Control Valve

Circuit

roll. Wire

253	K123	=266 = Target Value - Direction of Travel
246	H1	=270 = Rotating Patrol Light
247	K102	=271 = Direction of Travel Relay - Fwd.
248	K103	=272 = Direction of Travel Relay - Rev.
269	FGV4	=273 = Speed of Travel V4
268	FGV3	=274 = Speed of Travel V3
267	FGV2	=275 = Speed of Travel V2
249	A7	=276 = Hour Meter
296	KSHY	=300 = No Fault on Hydraulic Control
296	EHB1	=301 = B1 Hydraulic Control
296	EHB2	=302 = B2 Hydraulic Control
296	EHB3	=303 = B3 Hydraulic Control
296	EHB4	=304 = B4 Hydraulic Control
286	NV	=305 = Reset Values
286	NP	=306 = Reset Pump Motor
91	S33	=307 = Brakes Released
207	KSFH	=310 = No Fault on Drive Control
250	K121	=311 = V = 0 (Open when Stationary)
222	S7	=312 = Reed Switch - Right Outer/B18 = 312 = Proximity Switch Right Outer
224	S8	=313 = Reed Switch - Right Centre
226	S9	=314 = Reed Switch - Left Centre
228	S10	=315 = Reed Switch - Left Outer/B17 = 315 = Proximity Switch Left Outer
286	HHB1	=320 = B1 Main Lift Aux. Lift Side Shift
286	HHB2	=321 = B2 Main Lift Aux. Lift Side Shift
286	HHB3	=322 = B3 Main Lift Aux. Lift Side Shift
286	HHB4	=323 = B4 Main Lift Aux. Lift Side Shift
293	DB1	=324 = B1 Rotate
293	DB2	=325 = B2 Rotate
293	DB3	=326 = B3 Rotate
293	DB4	=327 = B4 Rotate
252252	RHHH	=330 = Main Lift - Lift
285	RHHS	=331 = Main Lift - Lower
285	RZHH	=332 = Aux. Lift - Lift
285	RZHS	=333 = Aux. Lift - Lower
293	RSR	=334 = Shift - Right
293	RSL	=335 = Shift - Left
293	RDR	=336 = Rotate - Right
293	RDL	=337 = Rotate - Left

SECTION
5

PHB - AUTOPILOT 2

Description of Functions

Contents

1. VEHICLE COMPONENTS

1.1 Brake.

This is switched on and off by means of buttons and acts as a parking brake when the vehicle is stationary. If the brake is released and the driver does not move off, the brake automatically locks on after 10-15 seconds. When driving with the continuous alarm (without holding circuit e.g.) this time function can be switched out. In the event of a malfunction the brake is applied automatically. The brake may be released only if there is no malfunction.

1.2 Steer Motor.

The rear wheel is steered by an electric motor. This motor is controlled by a contactor and an 'End Stage' (power amplifier).

This motor can only be brought into action when the brake is released. If the brake is applied while the vehicle is in motion, the motor will be controlled until the vehicle comes to rest.

1.3 The rotary impulse transmitter of the drive motor is used to determine drive speed and direction of travel. These signals are evaluated on a plug-in board in the sub-assembly rack and are required for the switching on of the antennae and other functions.

1.4 Potentiometers:- 'Target Value' and 'Actual Value'.

The 'Target Value' potentiometer sets the steer angle of the steering wheel. The steering attitude of the rear wheels is detected by the 'Actual Value' potentiometer.

1.5 Antennae for Inductive Guidance.

An antenna is attached to the front and one to the rear of the vehicle. By this means the position of the vehicle, in relation to the guide wire, is determined by the control electronics. Evaluation is made by the leading antenna:-

i.e. for forward drive, by the front antenna.
for reverse drive, by the rear antenna.

1.6 Controls.

The inductive Guidance System incorporates:-

One Switch - 'Automatic Off-On'.

One Indicator - 'Tracking Possible'.

One Indicator - 'Automatic On'.

One Indicator - 'Tracking in Progress'.

One Audible Signal.

2. DRIVE

The brake must be released.

The following speed stages are incorporated:-

V4 - Tracking speed.

V3 - 2.5 Km per hour.

V2 - 4 Km per hour.

V1 - 8 Km per hour.

3. STEERING

Two methods of operation are possible:-

'Manual Steering' and 'Automatic Steering'.

The driver switches (from one method to the other) by means of the switch 'Automatic - OFF-ON' (Automatik-Aus-Ein).

3.1 Manual Steering.

The steering angle is set by the potentiometer (target value) which is driven by the steering wheel.

The electronic control then sets the rear wheel to the predetermined angle (detected by the actual value potentiometer). There is no mechanical linkage between the steering wheel and the rear wheel.

If the steering wheel is turned when the steering motor is switched off or when the 'Auto-Off-On' switch is 'On' the steering motor will move to the corresponding position when switched 'On' or when the 'Auto-Off-On' switch is changed over.

3.2 Automatic Steering. (Indicator 'Automatic On')

Turning of the steering wheel by the driver does not affect the steering. Any corrective action required to the steering is determined by signals from the leading antenna.

To change over to 'Automatic Steering' (See Para 4). (Description of tracking process).

To leave the guide wire, the driver must stop briefly and then move the toggle-switch to 'Automatic-Off'. If this change over is made while the vehicle is driving the signal 'Automatic-On' will be stored until the vehicle comes to a halt. Only then will the 'Automatic-On' indicator cancel.

4. DESCRIPTION OF THE TRACKING PROCESS

4.1 The driver uses manual steering to drive the truck at reduced speed until the 'Tracking Possible' display lights up [corresponds to 'Level Correct' signal (Pegel rechtig)].

4.2 The driver switches to 'Automatic Steering'. (It is not necessary to stop to do this).

4.3 The tracking process is triggered automatically i.e.

4.3.1 Drive speed is limited to V-4.

4.3.2 Monitor 'y30' (and 'y50') is not functioning.

4.3.3 Driver receives a visual indication and an audible signal (buzzer) for 'Tracking Process On'.

4.3.4 The rear wheel of the vehicle is set straight.

The vehicle must not be parallel to the guide wire. The switchover (from manual to auto-steer) must be made before the operative coil crosses over the guide wire.

4.4 The driver drives on and the leading antenna crosses the guide wire ('h = 0').

4.4.1 At this moment the controller takes over the vehicle.

4.4.2 The vehicle swings on to the guide wire.

4.4.3 In reverse travel, the control amplification is reduced until the end of the tracking process.

4.4.4 Exception.

If tracking occurs in the 'y = 30' range, the automatic steering takes over immediately, there is no straightening of the rear wheel but the tracking process comes into action as described in Para 4.3.1 to Para 4.4.3.

4.5 After travelling for approx. 0.7m, measured at the drive wheel (4.4 'y = 0') the tracking process terminates automatically. The measurement only applies if the rear antenna is within the zone 'y = 50'. If the offset is greater the counter is reset.

At this point:-

4.5.1 Monitor 'y = 30' is activated.

4.5.2 Maximum drive speed is available (with mast lowered).

4.5.3 The display is cancelled and the (Tracking Process) buzzer is silenced.

4.6 This automatic tracking process is initiated automatically upon:-

4.6.1 Switching from manual to automatic steering.

4.6.2 Changing direction of travel from forward to reverse (without buzzer and display).

4.7 Monitoring Functions while Tracking:-

4.7.1 If the leading antenna leaves the established level range an ' Emergency Stop' is triggered immediately.

4.7.2 If the vehicle is travelling exactly parallel to the guide wire, there is no 'switch off'.

The 'Tracking Process ON' signal, however, remains on to warn the driver.

4.8 Both forward and reverse tracking are possible. However, because of the steering geometry, in reverse travel a long traverse is covered before the front axle of the vehicle locates in the centre of the aisle.

5. SAFETY DEVICES

If a monitoring function responds, an 'Emergency Stop' is triggered and the brakes are automatically applied. In 5.1 and 5.2.

5.1 Steering End stages in order (see Para 6.2 Indicator 13).

Monitoring of the steering end stage, steering contactor and steer fuse (power circuit).

If this monitor trips, the vehicle main switch (Battery master switch) or the steer fuse must be opened and then closed to reset the monitor.

5.2 Steering Control in order (see Para 6.2 Indicator 10).

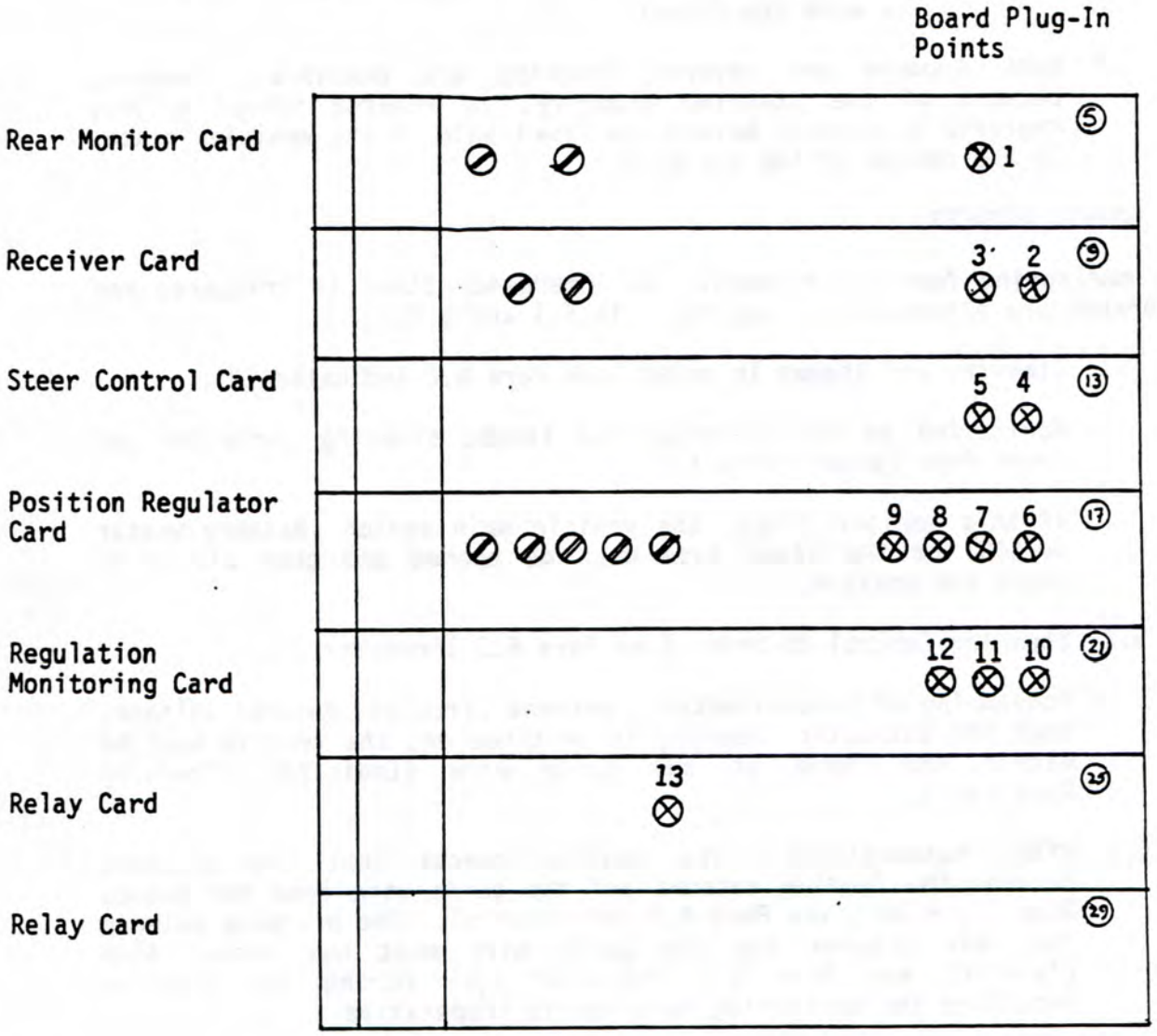
Monitoring of potentiometers, antenna circuits, control voltage. When the automatic steering is switched on, the vehicle must be within the field of the guide wire (Indicator 'Tracking Possible').

5.3 With 'Automatic-On', the monitor checks that the distance between the leading antenna and the guide wire does not exceed 30mm ('y = 30', see Para 6.2 Indicator 5). The distance between the rear antenna and the guide wire must not exceed 50mm ('y = 50, see Para 6.2 Indicator 1). During the tracking procedure the monitoring function is inoperative.

5.4 Cable to rotary impulse transmitter is in order (LED 5 Plug-in point .09).

6. RACK (for SUB-ASSEMBLIES) II WA (EKL)

6.1 Indicators on the front bars of the plug - in boards in the rack.



6.2 Indicator Functions (Sub-Assembly Rack II WA).

LED No	Function corresponding to the illuminated indicator
1.	Distance between the rear antenna and the guide wire is less then 50mm.
2.	Rear antenna connected.
3.	Level available (Antenna in the guide wire field).
4.	Distance between the leading antenna and the guide wire is less than 100mm.
5.	Distance between the leading antenna and the guide wire is less than 30mm.
6.	Manual Steering system connected.
7, 8.	Relevant end stage is triggered.
9.	Steering System connected (Signal from 'Brake Released').
10.	No malfunction in steering control system:- Checks made as follows:- Steering control system supply voltage. Potentiometer 'Target Value' (for Manual Steering). Potentiometer 'Actual Value' (position of rear wheel). Receiver, steering controller, position controller cards are plugged in. Level available for 'Automatic Steer ON'. Antennae are in order. Steering Control limit switches are not actuated.
11.	The tracking process for switching directions is finished.
12.	The tracking process for automatic steering is finished.
13.	Steering - End stage is in order. This monitor reacts to a fault in the position controller output or in the end stage. It also responds if the steering safeguard (automatic fuse) trips or if the steering contactor drops out.

8. GUIDE WIRE

The inductive guidance system comprises a guide wire in the form of a continuous loop, embedded in the floor. Both ends of the loop are connected to a transmitter.

The transmitter generates, in the guide wire, a small current of accurately defined frequency.

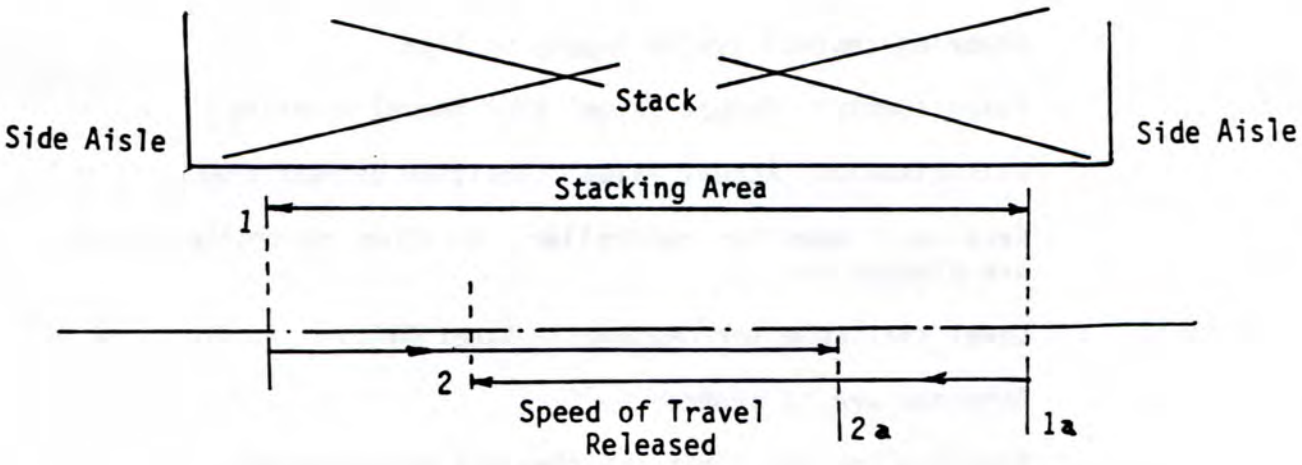
9. OPTIONAL EXTRA FEATURES

9.1 Limitation of speed of travel at End of Movement ('SA-1').

With automatic steering, the speed is limited automatically outside the stacking area. The speed of travel is released by a switching magnet (1) only when the vehicle enters the stacking area.

On leaving the aisle a second switching magnet (2) overrides the 'speed of travel', the truck brakes until it reaches the travel speed stage.

This function is available at both ends of the travel sequence and in both directions of travel.



PHB - Autopilot II WA12I WA15J

Circuit Diagram Dwg No. 050324 4401

Legends and Keys for Pages 1 - 6

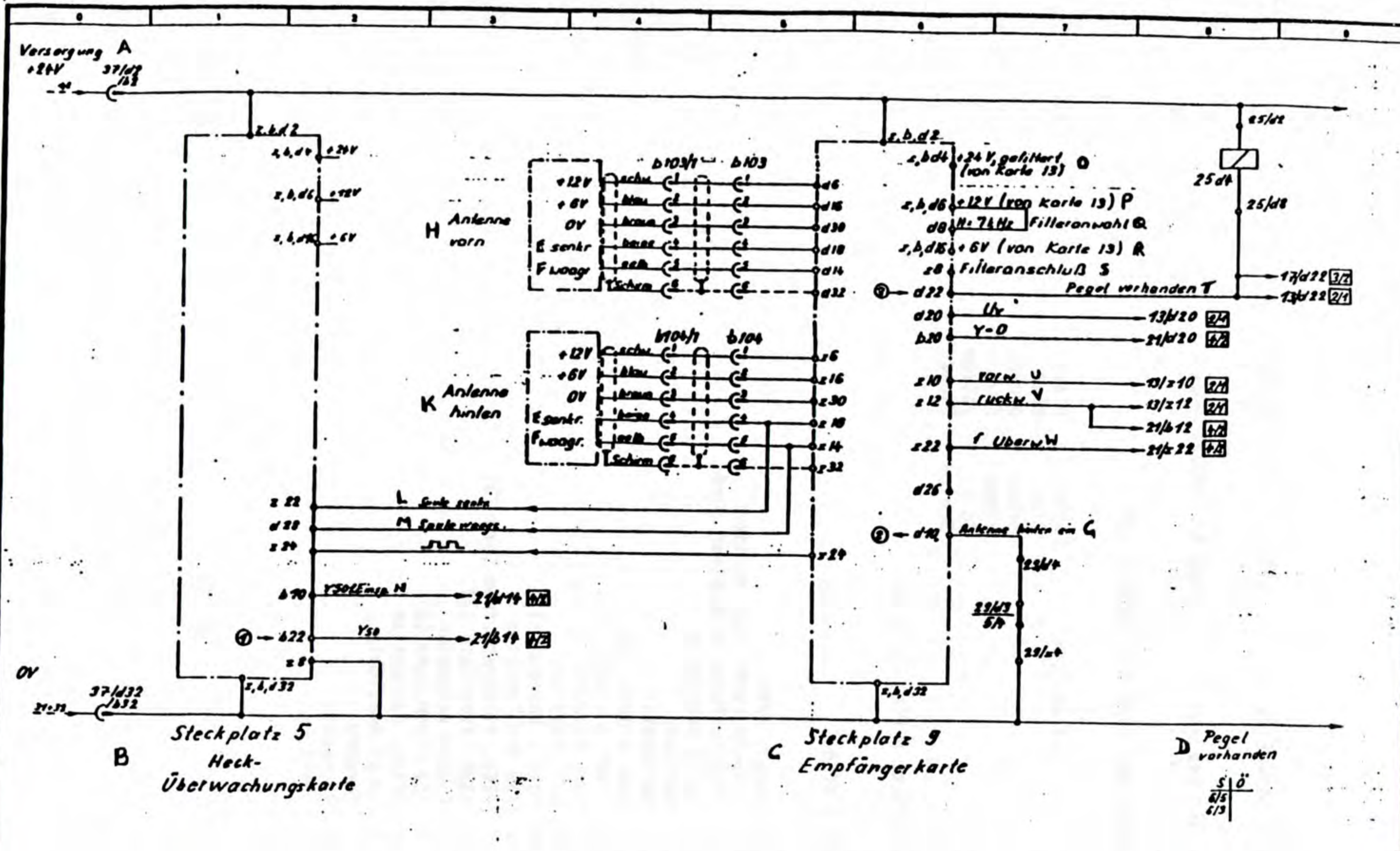
NOTE Colour Code

Schw = black
Blau = blue
Braun = brown
Biege = fawn
Gelb = yellow
Schirm = Screen

Steckplatz = Plug-in Point

Page 1 of 6

A = Supply +24V
B = Plug-in Point Rear Monitor
C = Plug-in Point 9 Receiver Card
D = Level available
E = Vertical
F = Horizontal
G = Rear Antenna On
H = Front Antenna
K = Rear Antenna
L = Coil Vertical
M = Coil - Horizontal
N = Y50 for Tracking
O = +24V, filtered (from Card 13)
P = +12V (from Card 13)
Q = Filter selection
R = +6V (from Card 13)
S = Filter Connection
T = Level Available
U = Forward
V = Backward
W = Monitor


Versorgung A
+24V
37/d2
OV
37/d32
B
Steckplatz 5
Heck-
Überwachungskarte
H Antenne vorn
K Antenne hinten
+12V
+6V
OV
E senkr.
F waagr.
b103/1
b103
b104/1
b104
L Spule senkr.
M Spule waagr.
Y50
C
Steckplatz 9
Empfängerkarte
+24 V, gefiltert (von Karte 13) O
+12 V (von Karte 13) P
Filteranwahl Q
+6V (von Karte 13) R
Filteranschluß S
Pegel vorhanden T
vorw. U
rückw. V
f Überw. W
Antenne hinten ein G
25d4
25/d8
25/d2
D Pegel vorhanden

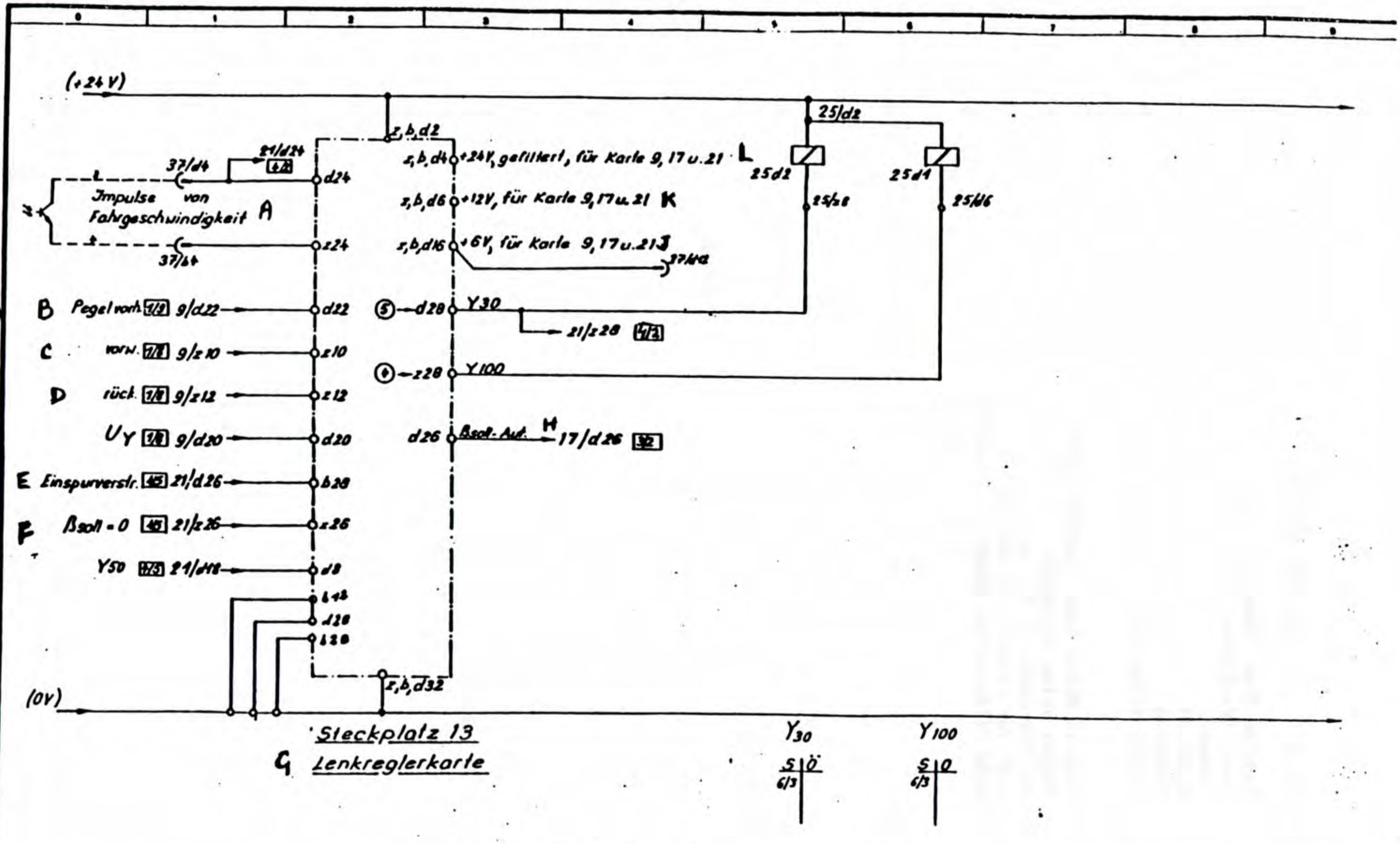
Bezeichnung	PHB-Autopilot II Stromlaufplan	WA12J WA15J	Gruppe
Zeichnungsnummer	0 5 0 3 2 4 4 4 0 1	Format	Blatt-Nr. 1 Blattzahl 6

Aus-gabe	Änderung	Tag	Name
	5/d4, 5/d8, 23/z4	15.2.84	Bs

	Tag	Name
Bearb.	2.2.84	Bc
Gepr.		
Norm		

A = Impulse from 'Speed of Travel'
B = Level Available
C = Forward
D = Backward
E = Tracking
F = Target Value = 0

G = Plug-in Point Steer Control Card
H = Target value Automatic
J = +6V for Cards 9, 17, and 21
K = +12V for Cards 9, 17 and 21
L = +24V filtered for Cards 9, 17 and 21



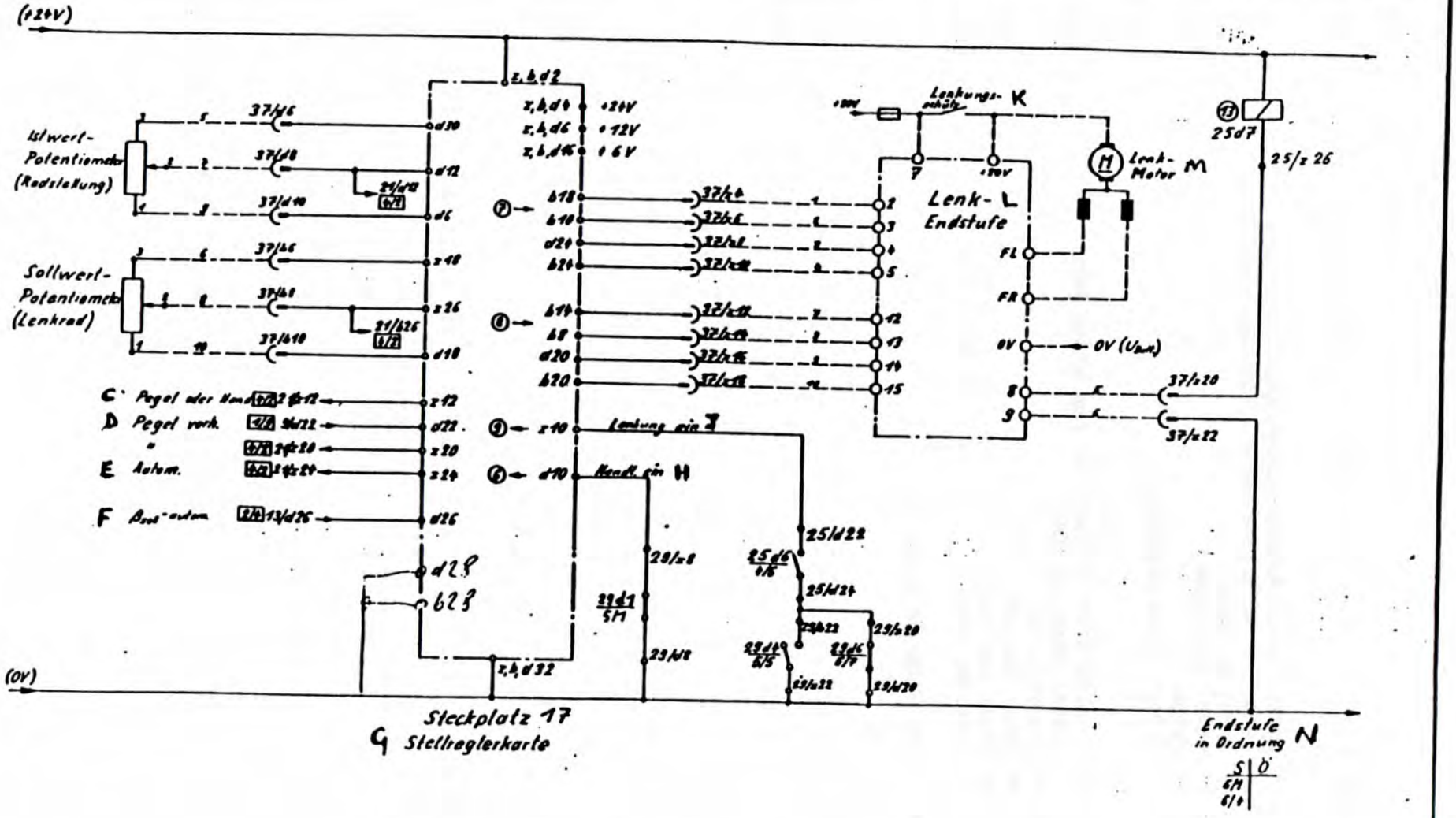
Bezeichnung	PHB-Autopilot II	Zeichnungs-Nr. 050 324 44 01	Blatt-Nr. 2
	Stromlaufplan		
Bearb. 2.8.84 Br	PHB TRANSPORT UND LAGERSYSTEME GMBH	Auftrags-Nr.	

Dwg 050 324 4401

A = Actual Value Potentiometer (Wheel Position)
B = Target Value Potentiometer (Steering Wheel)
C = Level or Hand
D = Level Available
E = Automatic
F = Target value automatic

G = Plug-in Point 17 Position Regulating Card
H = Manual Steering 'ON'
J = Steering 'ON'
K = Steer Contact
L = Steer End Stage
M = Steering Motor

N = End Stage in Order

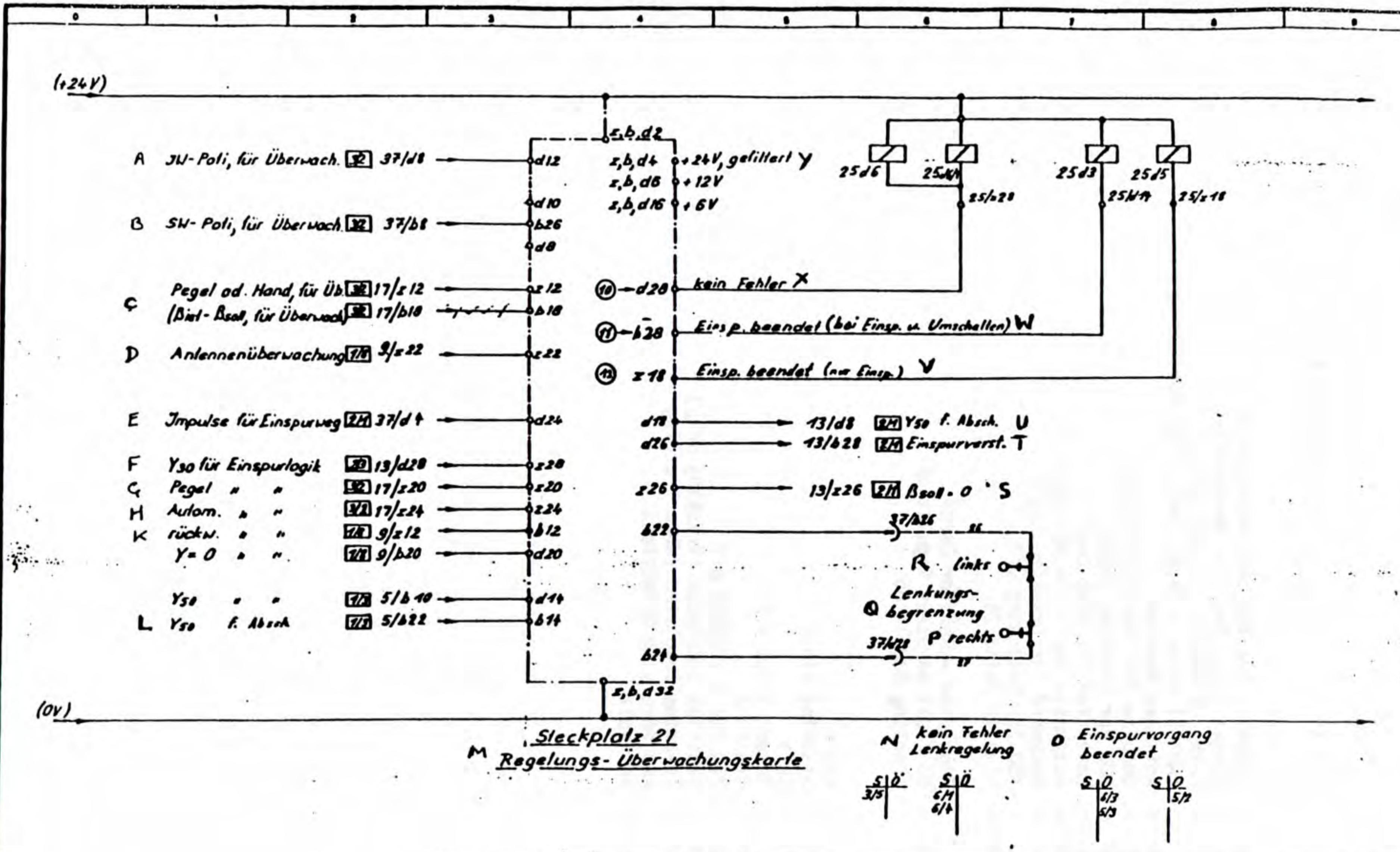


Auftrags-Nr:	Bezeichnung	PHB-Autopilot II Stromlaufplan	Gruppe
	PHB Transport- und Lagersysteme GmbH	Zeichnungsnummer 0 5 0 3 2 4 4 4 0 1	Format / Blatt-Nr. 3

A = Actual Value Pot. for Monitoring
B = Target Value Pot. for Monitoring
C = Level or Manual for Monitoring
(Actual Value - Target Value for Monitoring)
D = Antennae Monitor
E = Impulse for Tracking Channel
F = Y30 for Tracking Logic
G = Level for Tracking Logic
H = Automatic for Tracking Logic
K = Backward for Tracking Logic
L = Y50 for Switching Off
M = Plug-in Point 21

Regulator - Monitor Cards
N = No Fault on Steer Regulation
O = Tracking Completed

P = Right
Q = Steering Limit
R = Left
O = Target Value = 0
T = Tracking
U = Y50 for Switching Off
V = Tracking Completed (Tracking Only)
W = Tracking Completed (When Tracking
and Reversing Direction)
X = No Fault



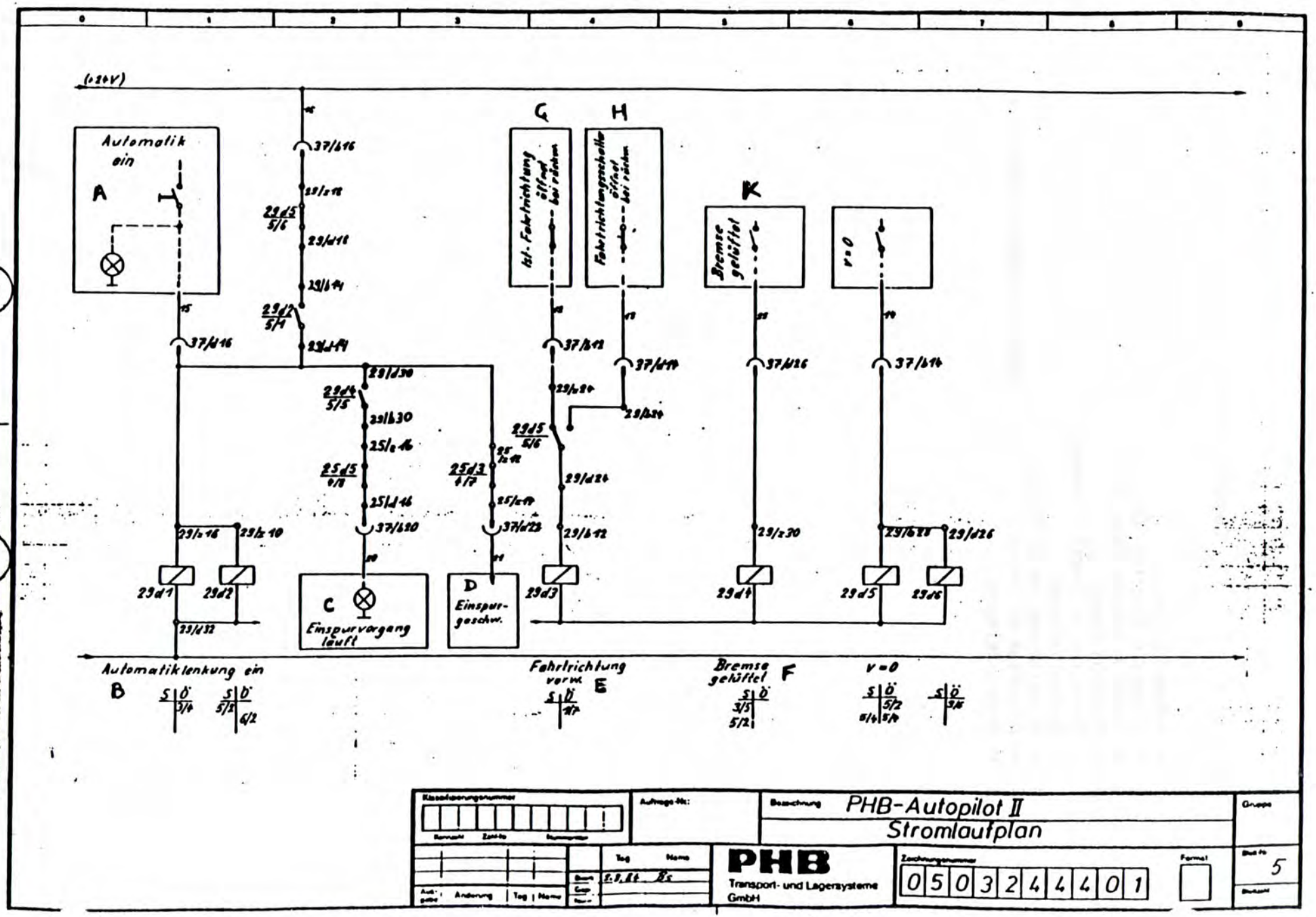
Bezeichnung	Zeichnungs-Nr.	Blatt-Nr.
PHB-Autopilot II Stromlaufplan	050 324 44 01	4

Ausgabe	Änderung	Tag	Name	Ausgabe	Änderung	Tag	Name		Tag	Name
					Akt. 18	3.6.85	Hr.	Bearb.	2.8.84	Bs
								Gepr.		
								Norm		

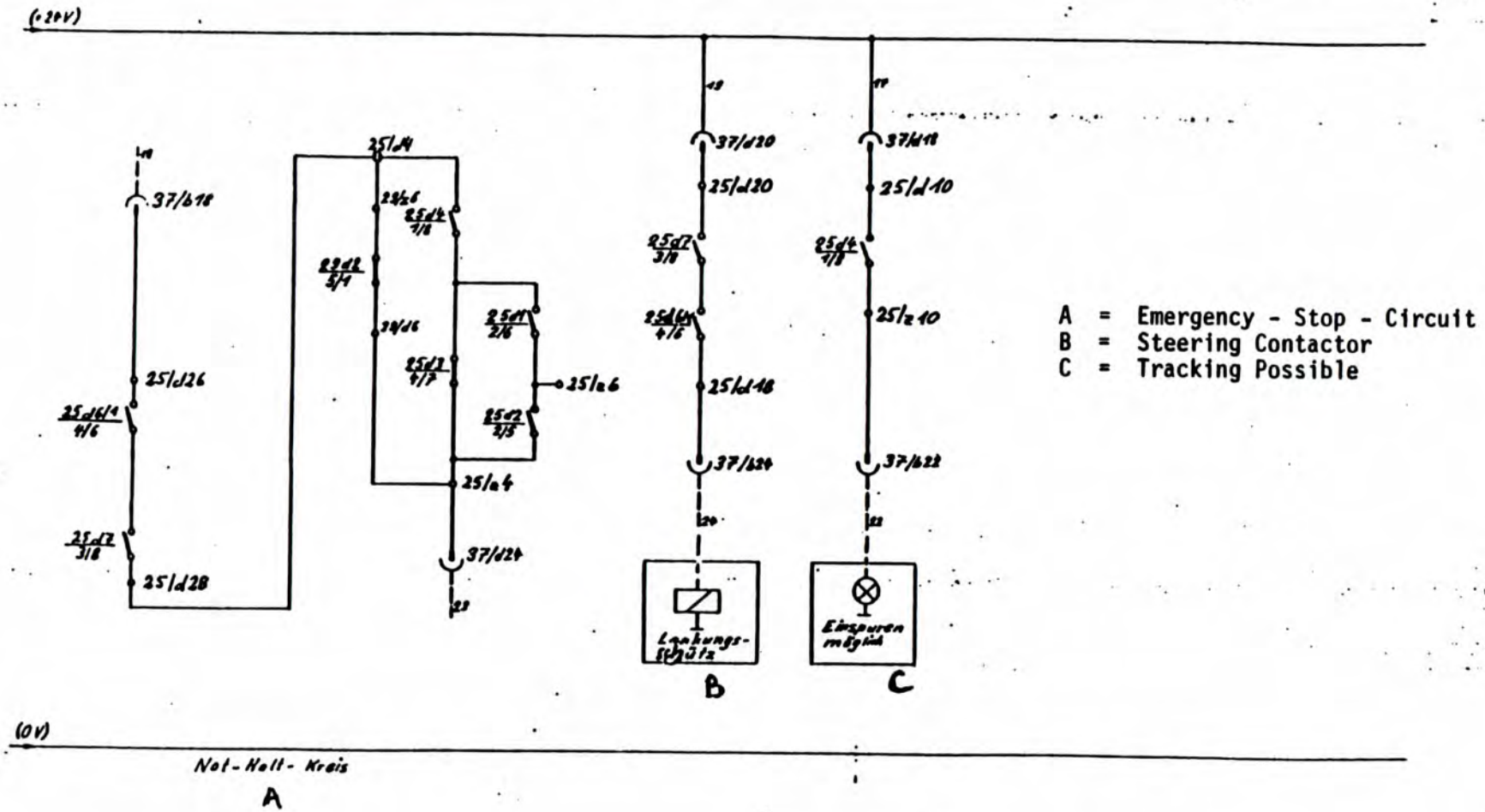
PHB
TRANSPORT- UND LAGERSYSTEME GMBH

Auftrags-Nr.

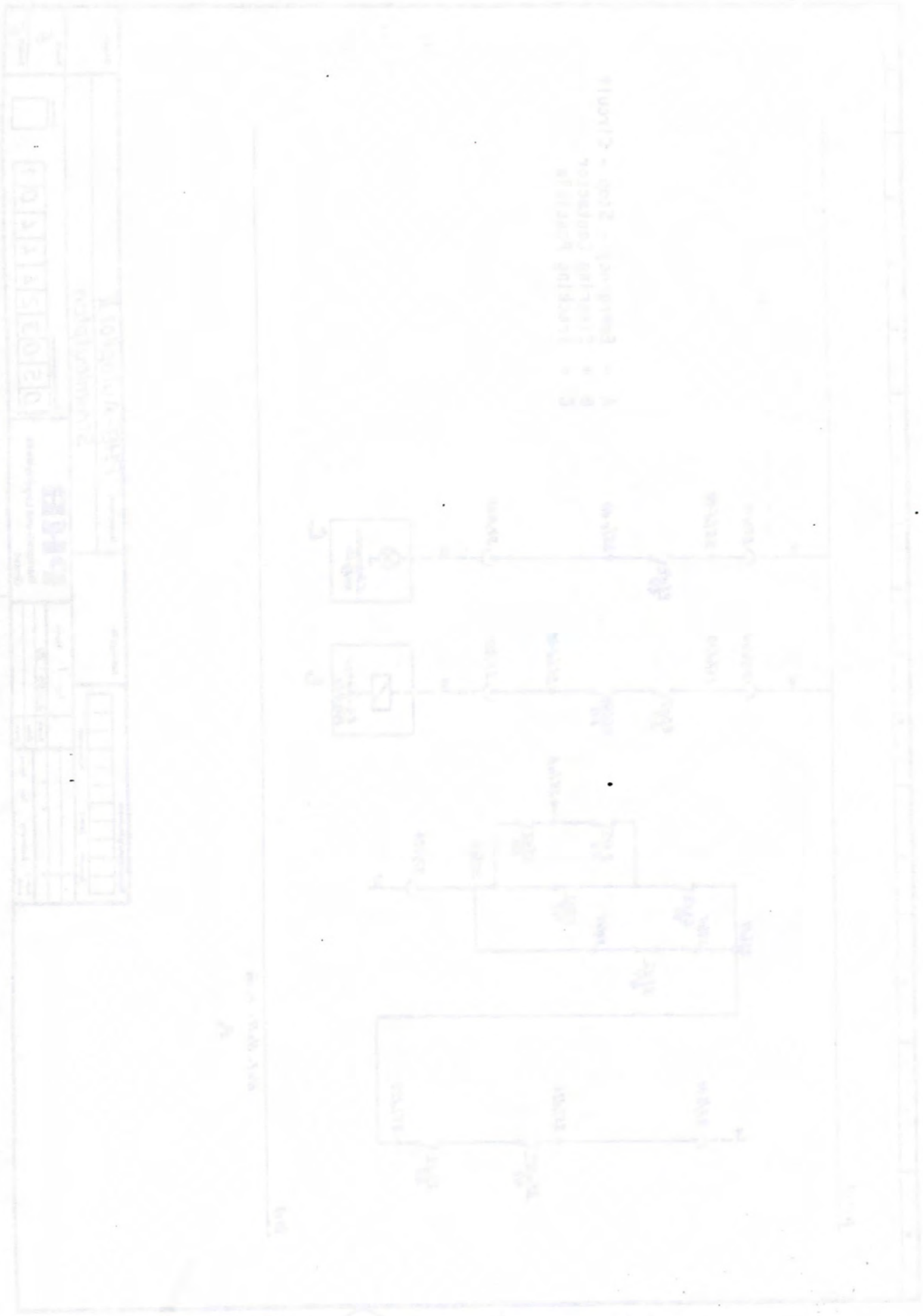
A = Automatic 'ON'
B = Automatic Steering 'ON'
C = Tracking Process Running
D = Tracking Speed
E = Direction of Travel - Forward
F = Brakes Released
G = Actual Direction of Travel)
H = Direction of Travel) Opens on Reverse Travelling
K = Brakes Released)

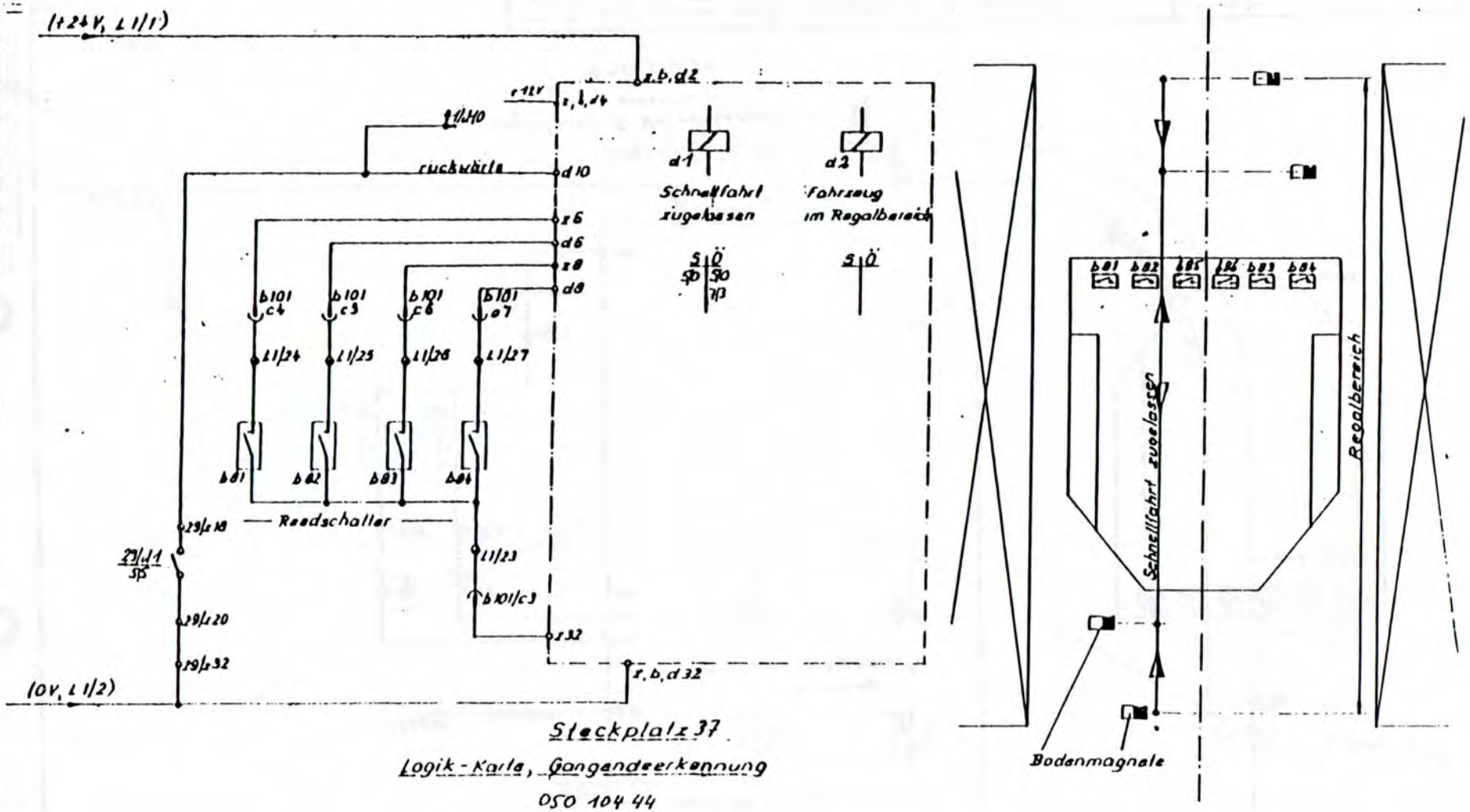


Kassalagerungsnummer	Auftrags-Nr.:	Bezeichnung: PHB-Autopilot II Stromlaufplan	Gruppe
			Blatt-Nr. 5
Änderung	Tag / Name	PHB Transport- und Lagersysteme GmbH	Zeichnungsnummer 0503244401 / Format



Klassifizierungsnummer	Auftrags-Nr.:	Benennung: PHB-Autopilot II Stromlaufplan	Gruppe
Änderung Tag Name	Bearb. 2.1.84 Bc	PHB Transport- und Lagersysteme GmbH	Zeichnungsnummer: 0503244401 Format:	Blatt-Nr. 6 / Blattzahl 6



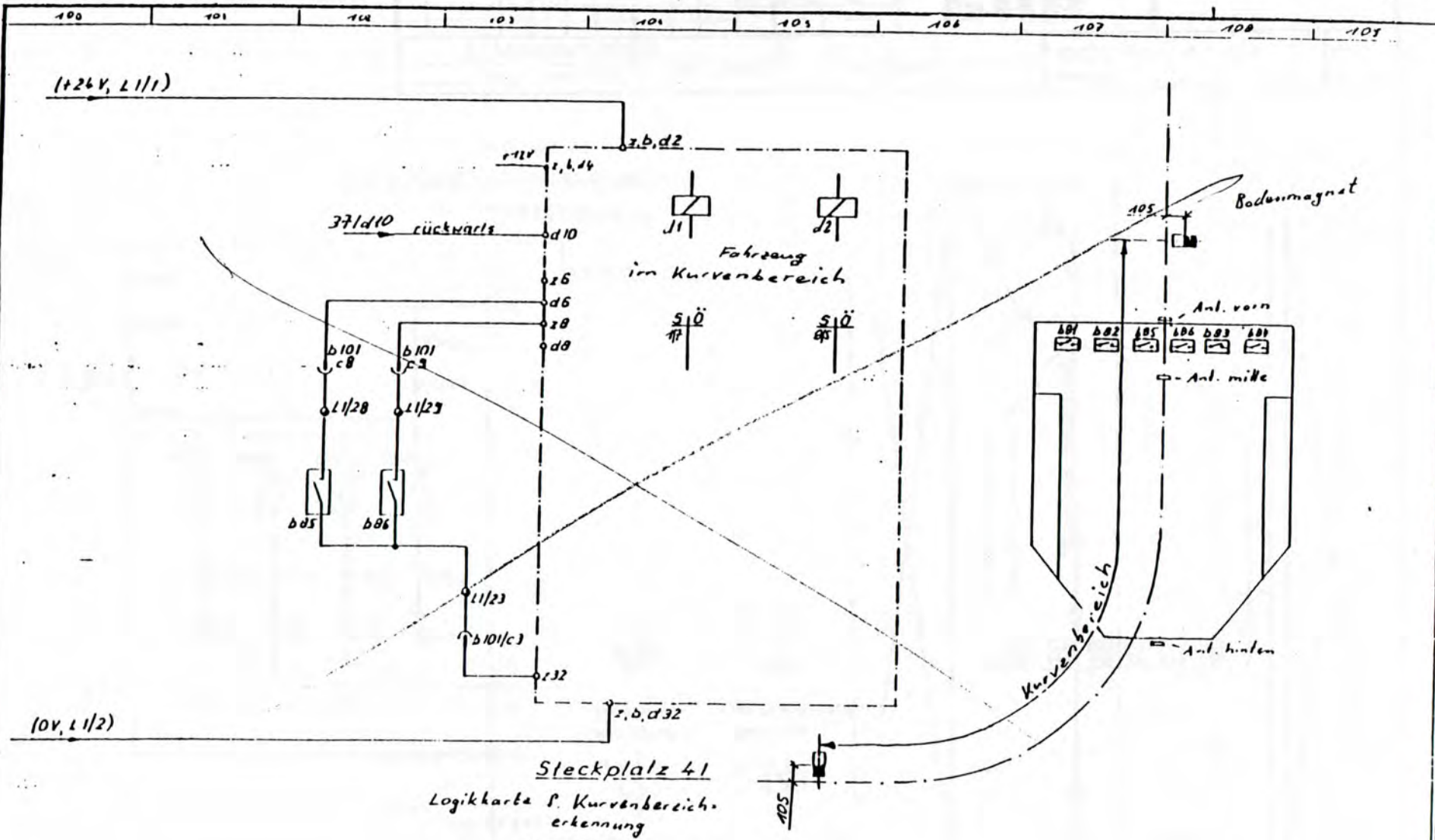


Steckplatz 37

Logik-Karte, Gangendeerkennung

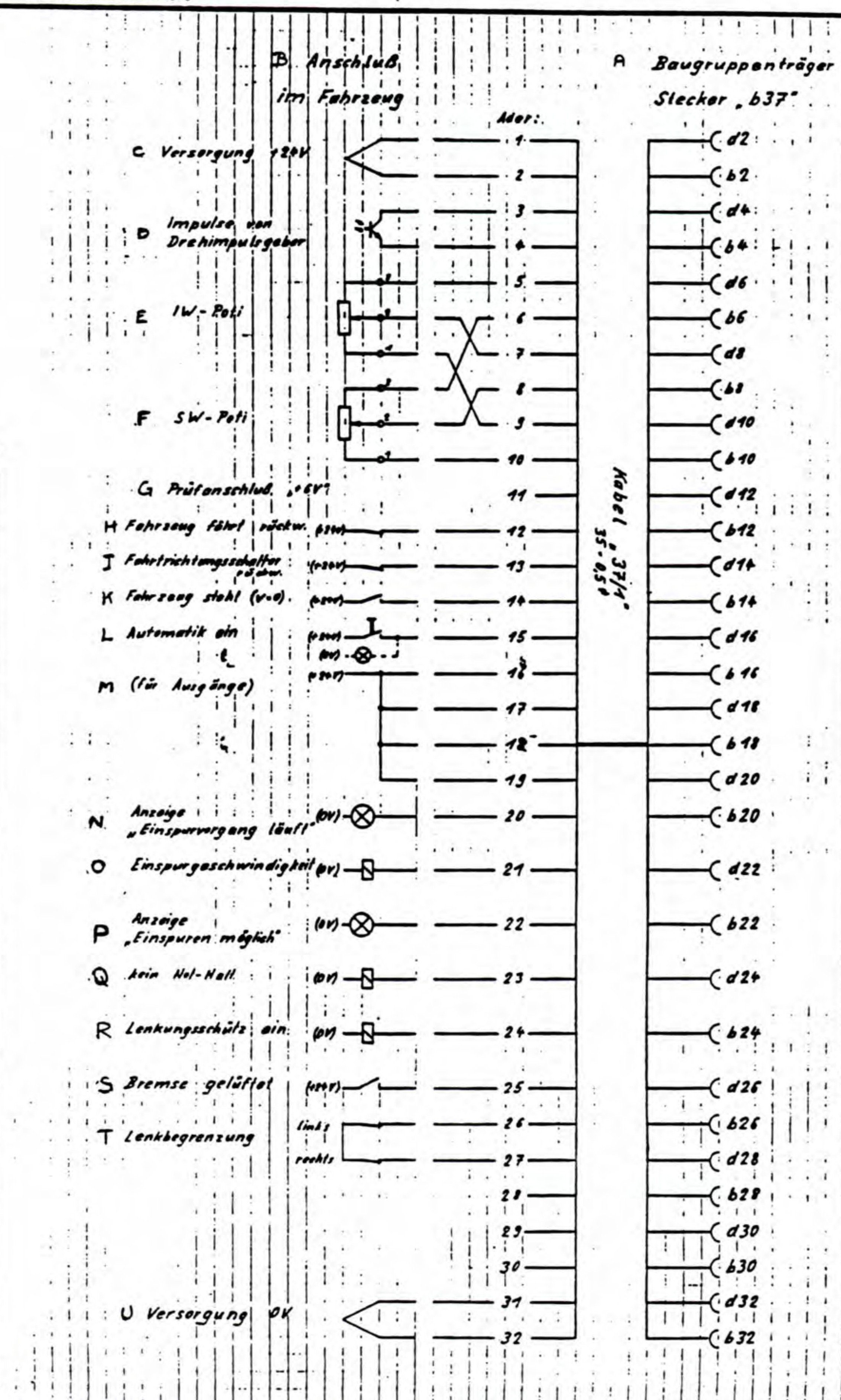
050 104 44

Bezeichnung: PHB-Autopilot I (Sonderausf. f. Kurvenfahrt)		Zeichnungs Nr: 050 347 44 01	Blatt Nr: 9
Stromlaufplan			
Änderung / Tag / Name		PHB TRANSPORT- UND LAGERSYSTEME GMBH	Auftrags Nr:



Bezeichnung: PHB-Autopilot I (Sonderausf. f. Kurvenfahrt) Stromlaufplan			Zeichnungs Nr: 050 347 44 01
	Tag	Name	
	19.6.85		
PHB TRANSPORT UND LAGERSYSTEME GMBH			Auftrags Nr:

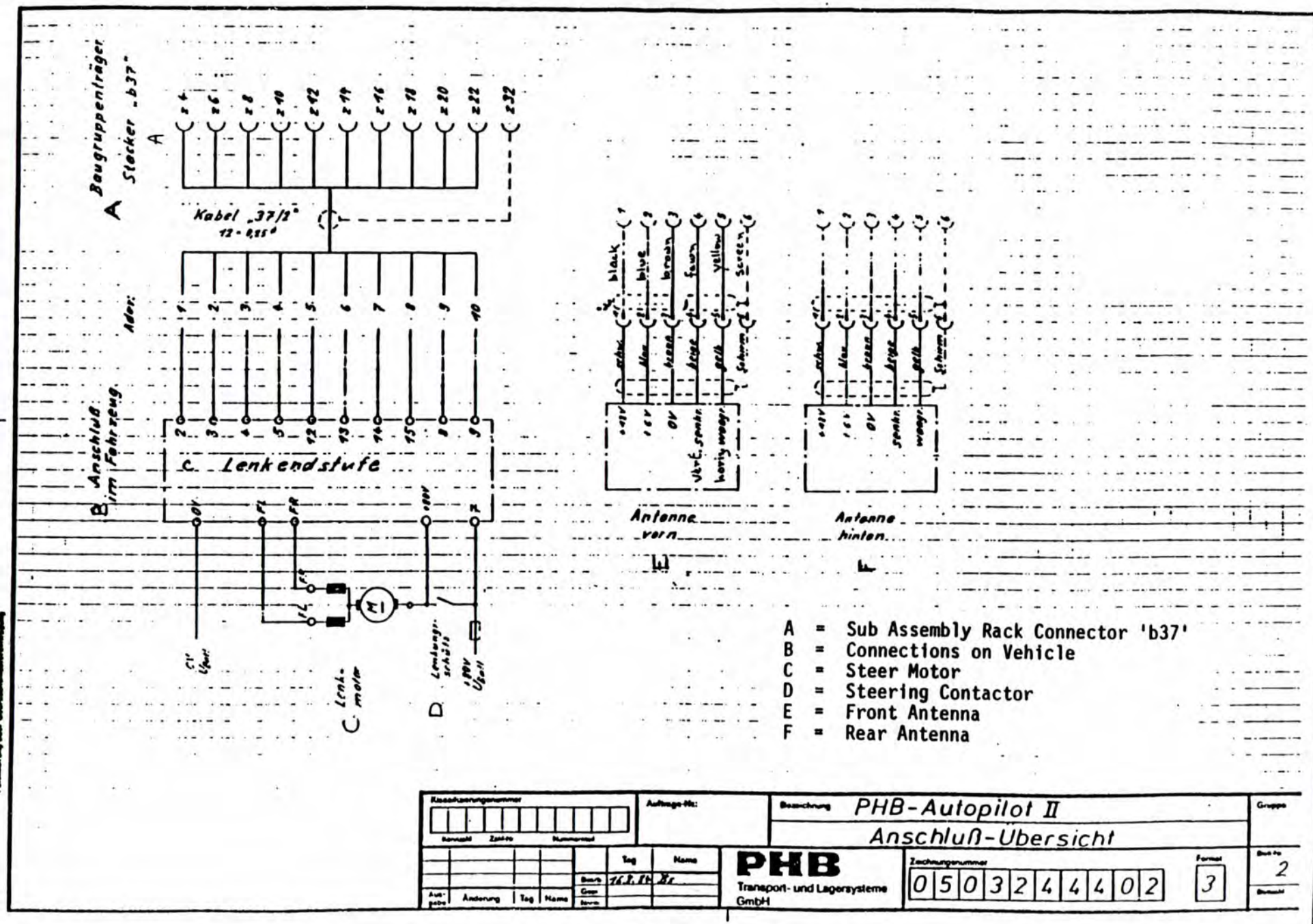
A = Sub Assembly Rack Connector 'b37'
B = Connections on Vehicle
C = Supply +24V
D = Impulse from Rotary Impulse Transmitter
E = Actual Value Pot.
F = Target Value Pot.
G = Check point '+6V'
H = Vehicle travels backward
J = Direction of Travel Switch - Backward
K = Vehicle Stationary (V = 0)
L = Automatic 'ON'
M = for Outputs
N = Indicator 'Tracking Running'
O = Tracking Speed
P = Indicator 'Tracking Possible'
Q = No 'Emergency Halt'
R = Steering Contactor 'ON'
S = Brakes Released
T = Steering Limitation
U = Supply OV

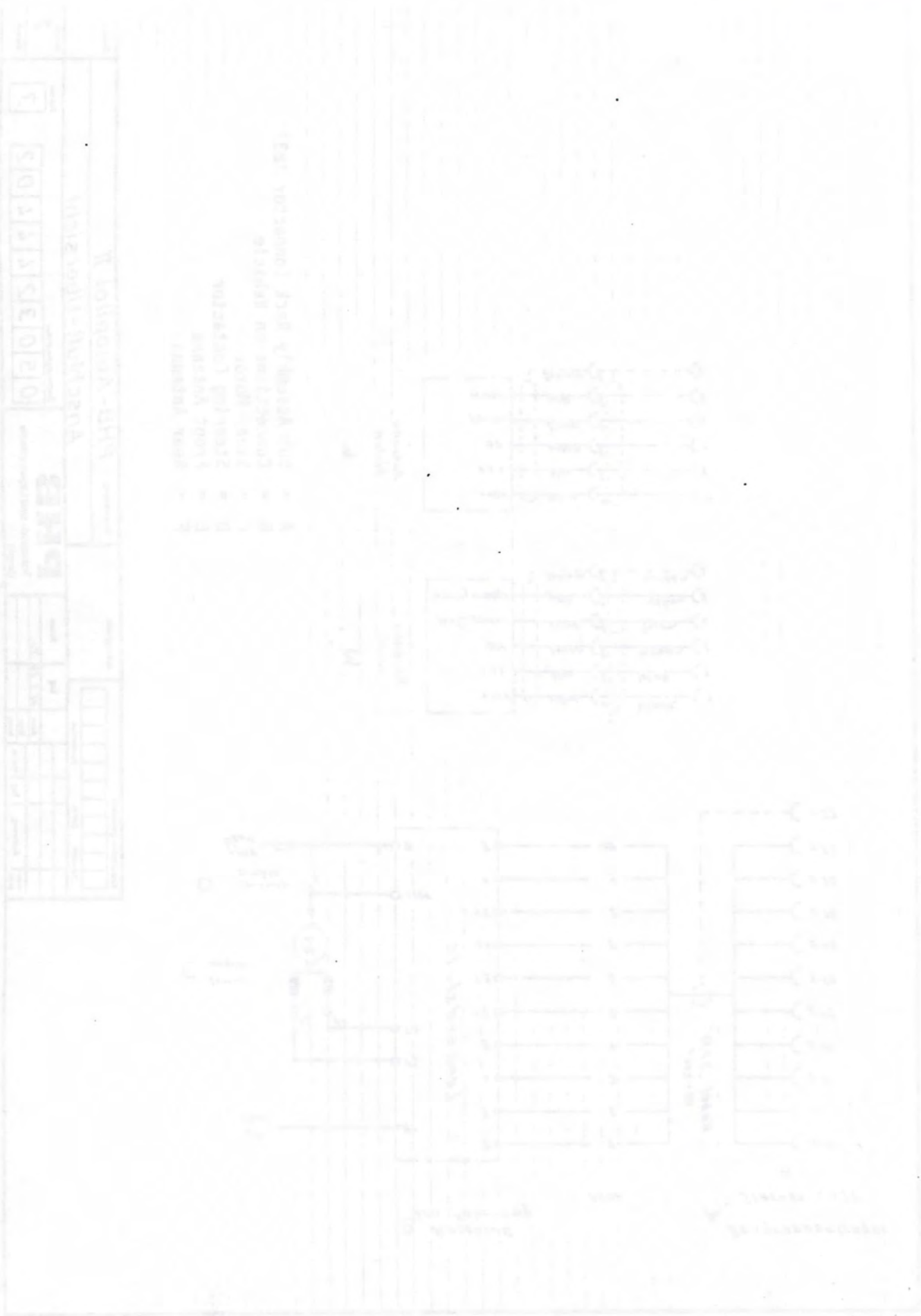

B Anschluß im Fahrzeug
A Baugruppenträger Stecker „b37"
Ader:
C Versorgung +24V
D Impulse von Drehimpulsgeber
E IW-Poti
F SW-Poti
G Prüfanschluß „+6V"
H Fahrzeug fährt rückw.
J Fahrtrichtungsschalter rückw.
K Fahrzeug steht (v=0).
L Automatik ein
M (für Ausgänge)
N Anzeige „Einspurvorgang läuft"
O Einspurgeschwindigkeit
P Anzeige „Einspuren möglich"
Q kein Hol-Halt
R Lenkungsschütz ein
S Bremse gelüftet
T Lenkbegrenzung
links
rechts
U Versorgung 0V
Kabel „37/1" 35-0,5²
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
d2 b2 d4 b4 d6 b6 d8 b8 d10 b10 d12 b12 d14 b14 d16 b16 d18 b18 d20 b20 d22 b22 d24 b24 d26 b26 d28 b28 d30 b30 d32 b32

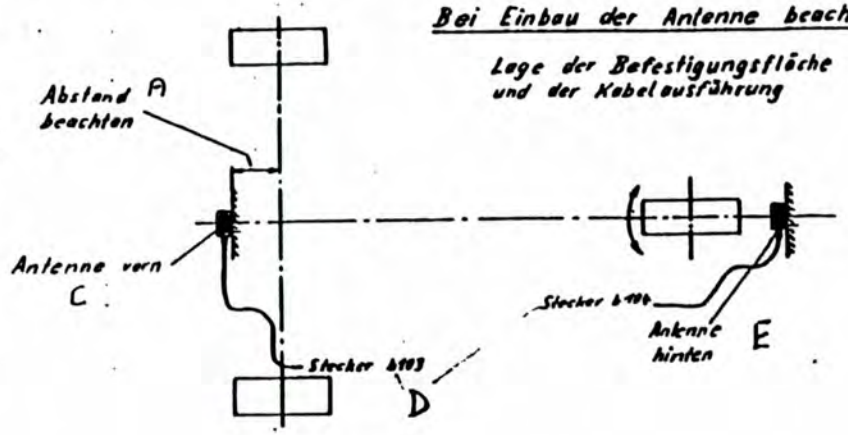
PHB-Autopilot II
Anschluß-Übersicht

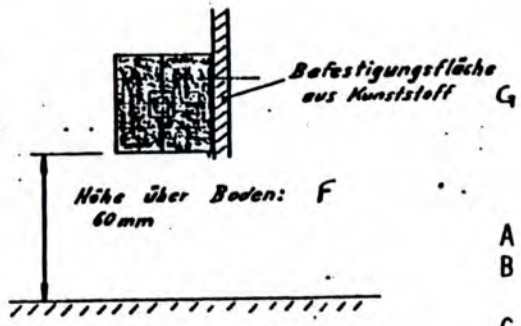
PHB Transport- und Lagersysteme GmbH

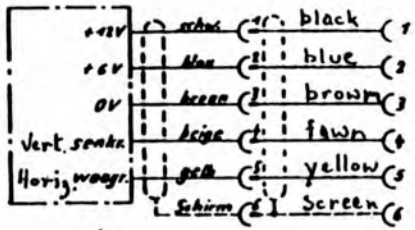
Zeichnungsnummer: 0 5 0 3 2 4 4 4 0 2 | Format: 3 | Blatt Nr. 1 | Blattanzahl 1


A Baugruppenträger
Stecker „b37"
Kabel „37/2"
12 · 0,25²
Ader:
B Anschluß im Fahrzeug
C Lenkendstufe
0V
FL
FR
+12V
Z
C Lenk-motor
D Lenkungs-schütz
+12V Ucoil
Antenne vorn
Antenne hinten
blank
blue
brown
green
yellow
Screen
A = Sub Assembly Rack Connector 'b37'
B = Connections on Vehicle
C = Steer Motor
D = Steering Contactor
E = Front Antenna
F = Rear Antenna
PHB-Autopilot II
Anschluß-Übersicht
PHB
Transport- und Lagersysteme GmbH
0503244402
Format 3
Blatt-Nr. 2









A = Pay Attention to distance
B = When installing antenna pay attention to the position of the mounting surface and the cable installation
C = Front Antenna
D = Connector (Electrical)
E = Rear Antenna
F = Height above Floor 60mm

Kabelbaumzeichnungsnummer	Auftrags-Nr.	Bezeichnung: PHB - Autopilot Antennenanbau	Gruppe
Änderung Tag Name	Bearb. F.Pf. 8.5	PHB Transport- und Lagersysteme GmbH	Zeichnungsnummer 0503244402 Format 3

OPERATIONAL DATA

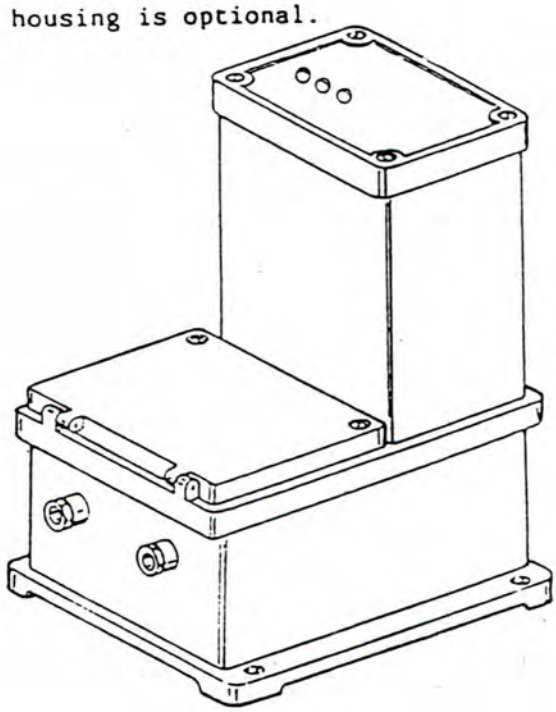
Supply voltage	: 220V ± 15%	Earthing contact type plug
(primary) current consumption	: < 50mA	
Maximum output voltage	: $35V_{ss}$	
Current in guide wire	: 100mA ± 10mA	
Nominal frequency (other nominal frequencies available upon request)	: 7·0019kHz ± 0·1Hz	
Length of guide wire	: up to 1000 m	
Ambient temperature	: 0 - 50°C	

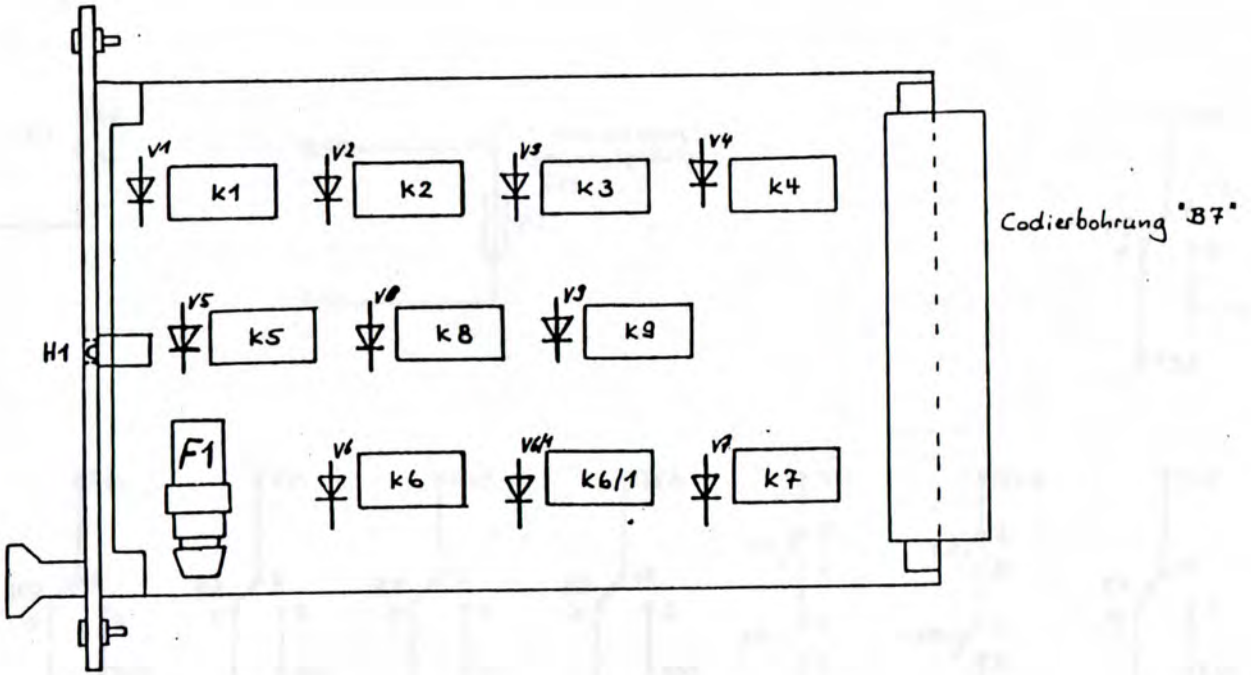
DISPLAY FUNCTIONS

Green light	: Equipment is switched on
Yellow light	: Current is flowing through the guide wire.
Red light	: Impermissible frequency deviation.

The plug and socket layout is given on the inside of the hinged lid.

The siting of the ancillary housing is optional.



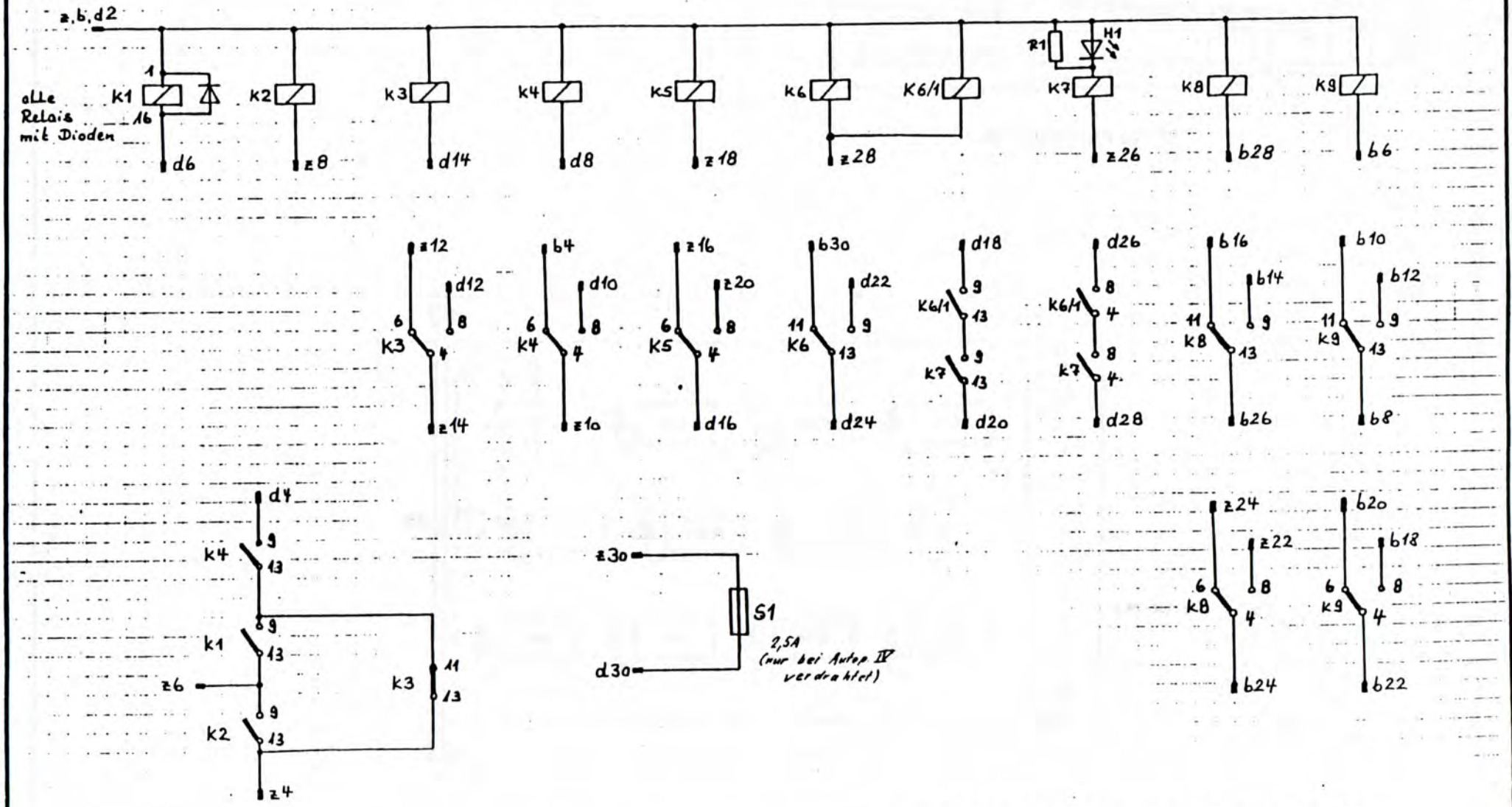


WA STECKPLATZ 25

Für diese Zeichnung behalten wir uns alle Rechte vor		Maßstab 1:1		Klassifizierungsnummer	
				Benennung	Bestückungsplan Relaiskarte A2/1
R1 entf.	20.8.87	Datum	Name		
		Gezeichnet	10.9.87 Ge		
		Geprüft			
		Norm			
		PEB Schwiebertshausen		Zeichnungsnummer	0150131121414014 B
				Format	3

Zust. | Änderung | Datum | Name | Urspr. | Ers. f. | Ers. d.

WA Gruppe 5

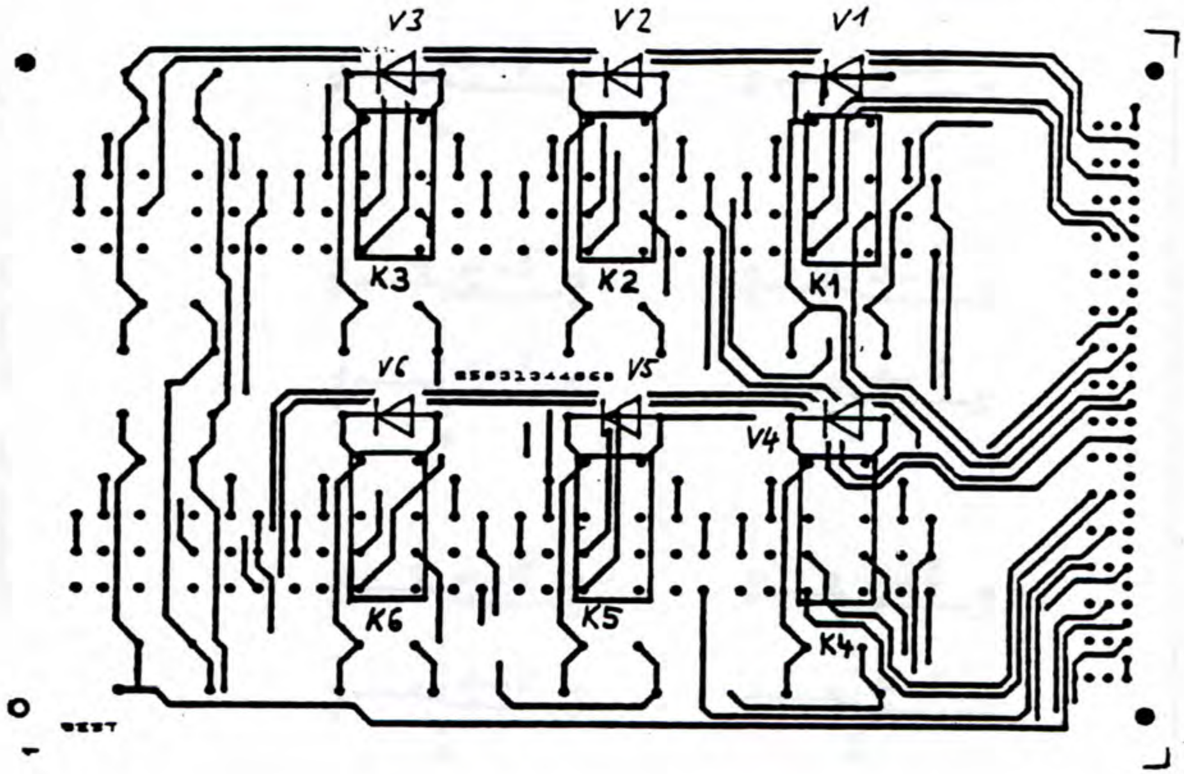


verwendet bei: PHB - Autopilot II u. IV ; Steckplatz 25

Klassifizierungsnummer	Auftrags-Nr	Bezeichnung: Relaiskarte A2/1 Schaltplan	Gruppe
PHB Transport- und Lagersysteme GmbH	Bearb 10.9 Ge	Zeichnungsnummer 0 5 0 3 1 2 4 4 0 1	Format 3
	Änderung Tag Name		Blatt-Nr 1

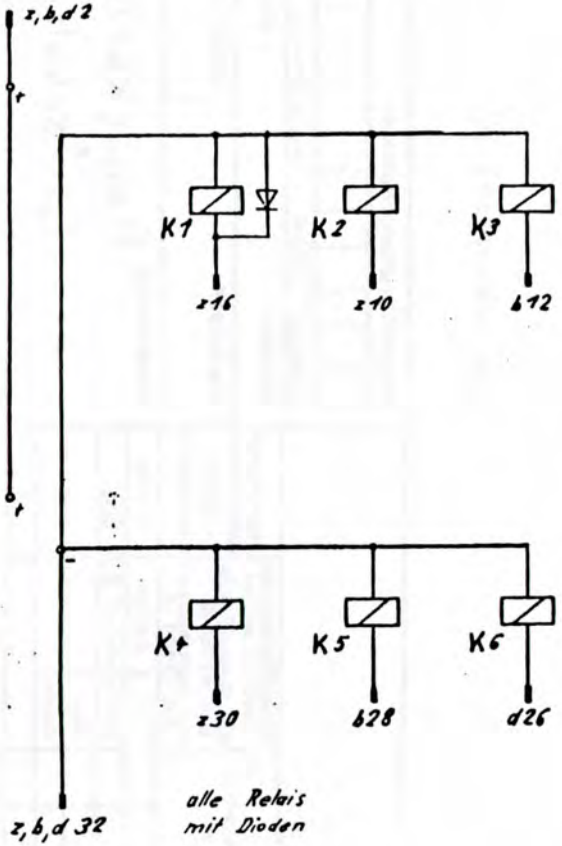
5/14

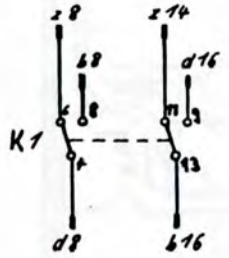
Codierung:
Bohrung „B8'

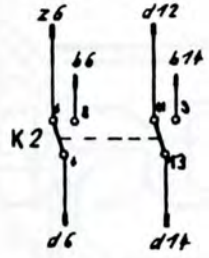


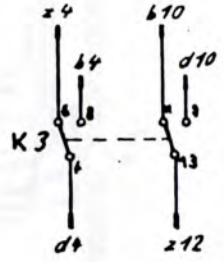
WA STECKPLATZ 29

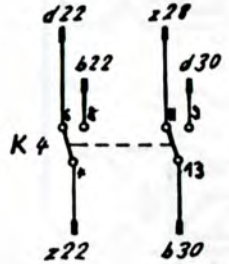
Auftraggeber	Klassifizierungsnummer Kennzahl Zähl-Nr. Nummernteil
Für diese Zeichnung behalten wir uns alle Rechte vor. / Freimaßtoleranzen DIN 7168 mittel für Schweißteile DIN 8570-B für Stahlbauteile DIN 18203-A / Oberflächen ohne besondere Angaben Reihe 2 DIN 3141	Maßstab / Gewicht Werkstoff / Modell- und Gesenk-Nr.
Datum / Name Bearb 10.10.88 Gu Gepr. Norm	Benennung Relaiskarte A2/2 („+" schaltend)
PHB Schwieberdingen	Zeichnungsnummer 05031344 04 / Format / Blatt / Bl.
Zust. Änderung Datum Name Urspr.:	Ers. f.: / Ers. d.:

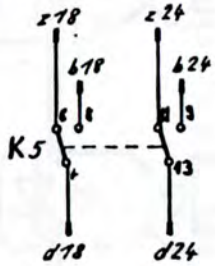


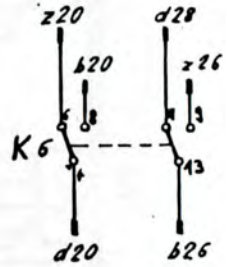






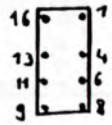






! Pinbezeichnung:

Draufsicht
Pinseite:



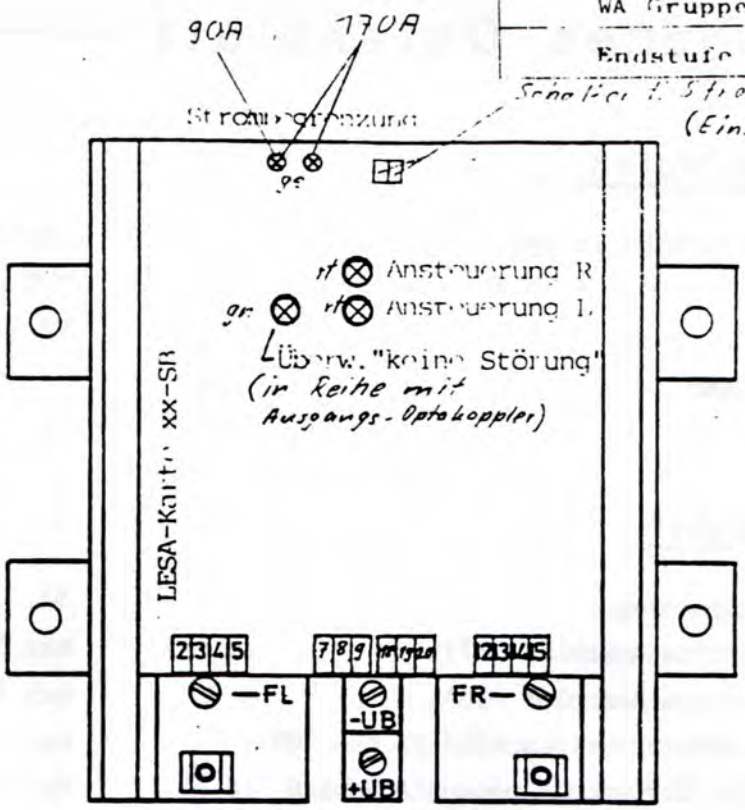
verwendet bei: PHB-Autopilot I u. IV, Stockplatz 29

Klassifizierungsnummer (Kennzahl / Zahlen / Nummernkreis)	Auftrags-Nr.	Bezeichnung: Relaiskarte A213 Schaltplan („t"-schaltend)	Gruppe
Ausgabe / Änderung / Tag / Name	Bearb. 10.10.88 Gu Gepr.	PHB Transport- und Lagersysteme GmbH	Zeichnungsnummer: 0 5 0 3 1 1 3 4 4 0 1 B Format: 3

5/16

WA Gruppe 5

Endstufe



Lenkendstufe 72-80V/SB 050 499 44 .
" 48V/SB 050 500 44 .
" 24V/SB 050 501 44 .

Klemme

: 2	Eingang - Ansteuerung links (PWM-Signal)		(+)
: 3	"	"	(-)
: 4	Eingang - Überwachung links (PWM-Signal)		(+)
: 5	"	"	(-)
: 7	+ UBatt		
: 8	Ausgang - Überwachung	(+)	
: 9	"	(-)	
:12	Eingang - Ansteuerung rechts (PWM-Signal)		(+)
:13	"	"	(-)
:14	Eingang - Überwachung rechts (PWM-Signal)		(+)
:15	"	"	(-)
:18	Eingang *bisher nicht verwendet*		
:19	"		
:20	"		

Schraubanschluß:

+UB (Versorgungsspannung n. Lenkschütz)
-UB (0V ≙ -UBatt)
FL (Feldanschluß links v. Lenkmotor)
FR (Feldanschluß rechts v. Lenkmotor)

Maßstab

Klassifizierungsnummer
Kennzahl Zähl-Nr. Nummernteil

	Datum	Name
Bearb.	5/88	Reichle
Gepr.		
Norm		

Benennung
Anschlußplan
Lenkendstufe XX-SB
(050.499.44/050.500.44/050.501.44)

5/17

Zeichnungsnummer 050499442 3

Format 4

Blatt 1

1 Bl

Technisches Datenblatt

Allgemeine Daten:

Abmessungen (l*b*h) in mm:	180*200*103
Gewicht:	1,7 kg
Schutzart:	IP 00
Steckbaugruppe:	-

Betriebsdaten:

Versorgungsspannung:	55...72/80...110 Vdc
Versorgungsstrom(Anschluß :7):	max 50 mAdc
Versorgungsstrom(Anschluß +UB):	max 0,1 Adc
Impuls-Kollektorstrom(Anschluß FL bzw. FR):	max 90 A_S (intern begrenzt)
Laststrom für Überwach.-Ausgang(Anschluß :8,9)	max 50 mAdc
Steuerströme(Anschlüsse :2-5, :12-15)	min 10 mAdc,max 50 mAdc
Ausgangsleistung:	2*2,0 kW
Umgebungstemperatur:	0-50 °C

Anzeigefunktionen:

Rote Leuchten:	Ansteuerung links/rechts
Gelbe Leuchten:	Einstellung-Strombegrenzung
Grüne Leuchte:	Überwachung"keine Störung"

Weitere Hinweise:

Die Anbaulage ist beliebig.
Anschlußbelegung s. Anschlußplan 050.499.4423 .
Potentialfreie Ein-u.Ausgänge der Steuerplatine.

Zu.	ÄNDERUNG	DATUM	NAME		DATUM	NAME
A	Serie	4/88	Re	Bearb.	5/88	Reichle
				Gepr.		

BAUGRUPPE: Lenkendstufe 72/80 V - SB

ZEICHNUNGSNUMMER/Type: 050.499.4420 A | Bl. 1 | 1 Bl.

Ers.f.: 050 258 44 | Ers.d.:

SECTION
6

WA Proportionalcontrolling

Description of functioning

Group 1

Drive controller 460 279 p.n. 444 010

The drive controller card consists of three operation-groups: rotationimpulse-interface, rotationimpulse generator and rated value generator. In the drive controller card all necessary signals for controlling the traction are produced and worked up.

Blockdiagram see fig. 1

Rotationimpulse-interface.

1. Power-supply

The logic-voltage 12 V is produced by the controller-voltage 24 V (physically separated from the battery-voltage). The logic-voltage 12 V is used as operating-voltage of rotationimpulse-generator as well.

2. Inputchannel-logic

Each of both rotation impulse generator-channels are connected to the input-logic with two separate lines. In the same mode both power-supply lines are fedback to the input. In the input channel-logic, possible broken lines are recognized by verification and reported to the supervision-logic. The chaonel impulses are transformed via "Schmitt-Trigger-components" in correct logic signals (level, stepness of sides).

3. Recognition of direction of rotation

The rotation impulse generator channels are 90° transposed and are valued by their temporal presents. In this way they effect the recognition of direction of rotation. This is notched into the right position, after one time of oscillation at the latest. By a timing logic the frequency of both channels is checked and the V = 0 step is produced. As long as both channels provide a DC-voltage or their frequency is below the step, the signal V = 0 is active and no direction of rotating is intrusioned. (Actual-drive-direction) If the frequency of both channels is above the step, V = 0 is switched off and the respective actual-drive-direction is switched on. To make sure that there is no "twisting" during a very slow rotation speed, the V = 0 step is working with a hysteresis. The active signals are shown at the front plate by LED.

4. Supervision logic

The supervision logic verifies if both channels have correct signals and equal frequency. In this way even a total failure in one channel is recognized. If "broken line" or "trouble of channel" is reported, the troubel memory will be activated and the report "no trouble of impulse generator" is switched off. A total failure of both channels can not be recognized by the supervision logic. In this case the signal V = 0 is still static intrusioned and leads to trouble recognition in the primary controller.

5. + 8. Physical separation of impulses

The channels are physically separated and connected to the impulse output via Optokoppler (wireguidance), respective to the rotational speed generation for f/U-transformation.

Rotational speed generation

6. Power supply

The 8 V (battery-potential) supplied by the drive controller is transformed to 6 V_{Ubatt} power supply.

7. Input circuit

In the input circuit the 4 discrete selectable inputs of speeds (V1 - V4) are physically separated and are led to the amplifier block. The selected speed is indicated at the front plate by LED (see fig. 2).

9. f/U-transformation

The channel impulses are transformed via "Schmitt-Trigger" after physical separation (8). In the following time switch circuit each generator impulse produces a controller impulse with a constant pulse width of 75 qs period (adjustment with P6). This controller impulse can be checked on PIN d22 on the card plug. The following low pass 2. class forms the mean value out of the controller impulse and produces in this way a DC-voltage proportinal to the impulse frequency (≙ the rotational speed of rotation impulse generator). This DC-voltage is led to the switchable amplifier via an impedance transformer.

10. Switchable amplifier, 11. Output buffer

The DC-voltage proportional to the rotational speed is linearly amplified by the following amplifiers. The amplification factor (≙ proportional factor) is controlled by the respectively selected speed. This switchable proportional factor makes it possible to drive different speed keeping the same signal level. The DC-voltage which is determined by the amplification is buffered via the output buffer and is led to the drive controller (V_{act}).

12. Input circuit

The input circuit consists of 4 inputs for the binary rated value (b_1 - b_4). They are physically separated via Optokoppler and are led to the D/A transformer. The present binary rated value is indicated by the corresponding LED on the front plate (see fig. 2).

Input signals level definition (also valid for inputs V_1 - V_4):

HIGH:	+ 24 V (20 V - 28 V)	active
LOW:	0 V ($<$ 4 V)	or open

13. D/A-transformation

In the D/A-transformation the digital rated value is transformed to an analogous signal. Individually valued voltages of the adder are led to the binary local value via analogous switch. The adder adds the present voltages to an analogous rated value signal.

14. Output amplification

The analogous voltage is amplified to the necessary level via an equalizable two-stage amplifier. With P_5 the maximum value is equalized to 4,3 V (U_{rated}).

Fig. 1: Blockdiagram Drive Controller

13.07.1989/TB/OK

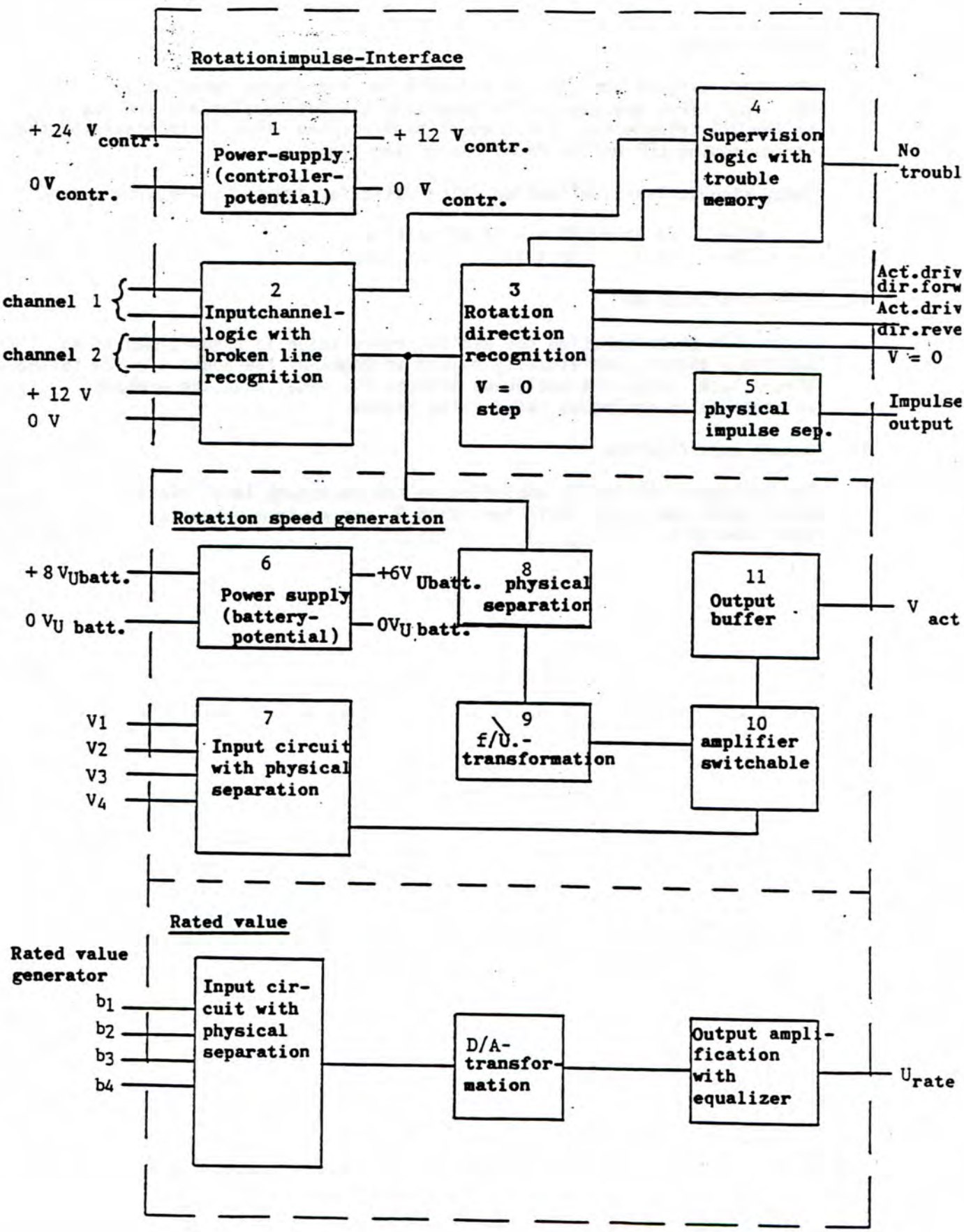
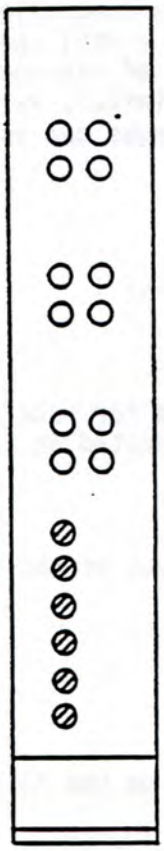


Fig. 2: Front Plate Drive Controller



b1 b2 } Rated value binary
b3 b4 }

V1 V2 } Selected speed
V3 V4 }

no trouble R.I.G. V = 0
Act.drive-direction forward Act.drive-direction reverse

P1 ≙ V1
P2 ≙ V2
P3 ≙ V3
P4 ≙ V4
} V_{higher}

P5 ≙ U_{rate} -Drive controller 4,3 V } already equalized
P6 ≙ Puls period f/U-transformation 74 µs }

WA - Proportionalcontrolling

Description of functioning

Group 1

Proportional-Valve-controlling p.n. 444008.

The proportional valve controller is used for controlling voltage controlled two-way-proportional-valves. The equivalent, analogous controller signal for proportional valves results from a rated value (4 bit width) and from the corresponding signal of direction. The maximum values of the controller signal as well as those of rise (decrease) -ramptime are infinitely variable via potentiometers. One unit consists of two identical ranges and is used to controll two proportional valves.

1. Blockdiagram

The different blocks of functioning are shown in fig. 1

2. Blocks of functioning

The description of the functioning blocks are valid for both ranges, with the exception of the power supply, which is located on range 1.

2.1. Power supply

The three differential voltages are produced out of the supply voltage (U = 24V supply) in the power supply circuit.

- + 7 V Logic supply LOW
- + 12 V Mean stress U supply
- + 17 V Logic supply High

The three operational voltages can be checked on the following PIN's by the plug on the card:-

+ 7 V at Z 4
+ 12 V at Z 6, B 6, D 6
+ 17 V at Z 8.

2.2. Input circuit with direction logic.

The input component consists of 4 inputs for the binary rated value (b1 - b4) and two direction inputs (R 1.1, R 1.2 resp. R 2.1, R 2.2). The inputs are physically separated from the logic via Optokoppler. The reference of the input signals can be made to any potential by removing the bridge "B 1". The standard of the reference is determined with "B 1" to 0 V supply voltage.

Input signals level definition:

HIGH: + 24 V (20 V - 28 V) active,
LOW: 0 V (< 4 V) or open

In HIGH-condition approx. 5 mA input current is passing.

The present rated value is combined with the direction signal and led to the D/A-transformation circuit. Logically there is no valuation of a rated value without direction signal. If there are two direction signals present, then the first selected direction is still active. After finishing the ramptime of the first direction, the second direction becomes active.

2.3. LED-display

The condition of the inputs (active) is shown on the frontplate with LED's. For every input one LED exists. Therefore the signal of the selected rated value is binary and the active direction is shown as a 1-bit information (see fig. 2: frontplate prop-valve-controller).

2.4. D/A-transformation

In the D/A-transformation the digital rated value is transformed to a analogous signal. The binary local-value with the corresponding valued voltage is led to the adder by the analogous switch. The adder calculates the present voltages for analogous rated value.

2.5. Rampgenerator

The analogous rated value signal is led to the rampgenerator. The rampgenerator transforms a square-wave voltage to a trapezoidal voltage with an equal amplitude. The rise- and decrease-time of the trapezoidal voltage is infinitely variable with a poti and makes a soft speed up (slow down) of the corresponding movement of the hydraulic possible.

2.6. Threshold value generation

In this block of function definate threshold values are generated. These values are switched abruptly and do not follow the ramp period. In this way it is possible to jump over the present dead range of the prop. valve. The prop. valve does not enter neither the analogous resolution nor the definate dynamics through the ramp period.

2.7. and 2.8. Maximum values direction 1.1, 1.2 (= direction 2.1, 2.2)

The max. amplitude of the controller voltage is adjustable for each seperate direction via potis. Therefore max. speed of movement is adjustable with regard to the respective functions and the tolerances of the valves are compensated.
(see fig. 3: Characteristic curve of line)

2.9. Signaladdition

In this block the threshold value and the determined rampvoltage are brought together in a controller signal. The resulting characteristic is shown in the fig. 4, 5, 6, 7.

2.10. Amplifications, output of signal, outputs of direction

The controller signal is amplified to its final level via two buffer amplifiers and is led to the card plug pin "d 18" via relays K 1.1 (K 1.2) (Z 18). The output of direction switch is 24 V (positiv), the rated output current is 20 mA and the short circuit current is limited to 120 mA. The individual selected output of direction is active as long as the controller signal is decreased to the definated threshold value.

2.11. Supervision control element

2.12. Display "no trouble"

The levels of both signal output amplifiers are varified in the supervision circuit. They should be in the range of + 4 V to + 20 V. In the moment, when both signal outputs are in the allowed range, the relay K 1 is closed, the signals are switched to the outside and the display "no trouble" is active. In this way troubles in the whole analogous circuit can be recognized and switched off. In case of a short circuit from outside to a controller output, the relay K 1 is brought to a rhythmical clock-frequency.

Fig. 1: Proportional-Valve-Controlling - Block Diagram

10.07.1989/TB/OK

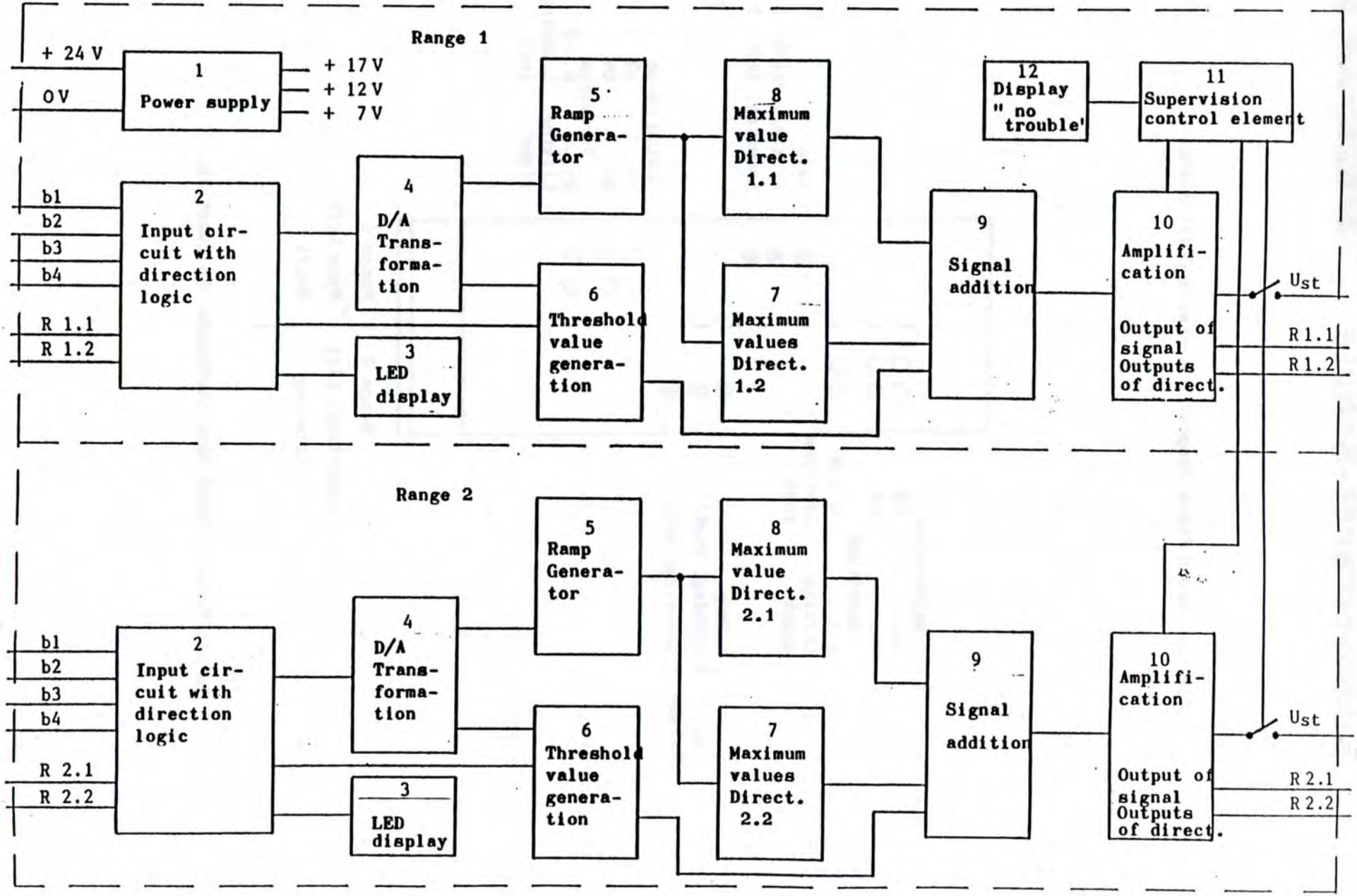
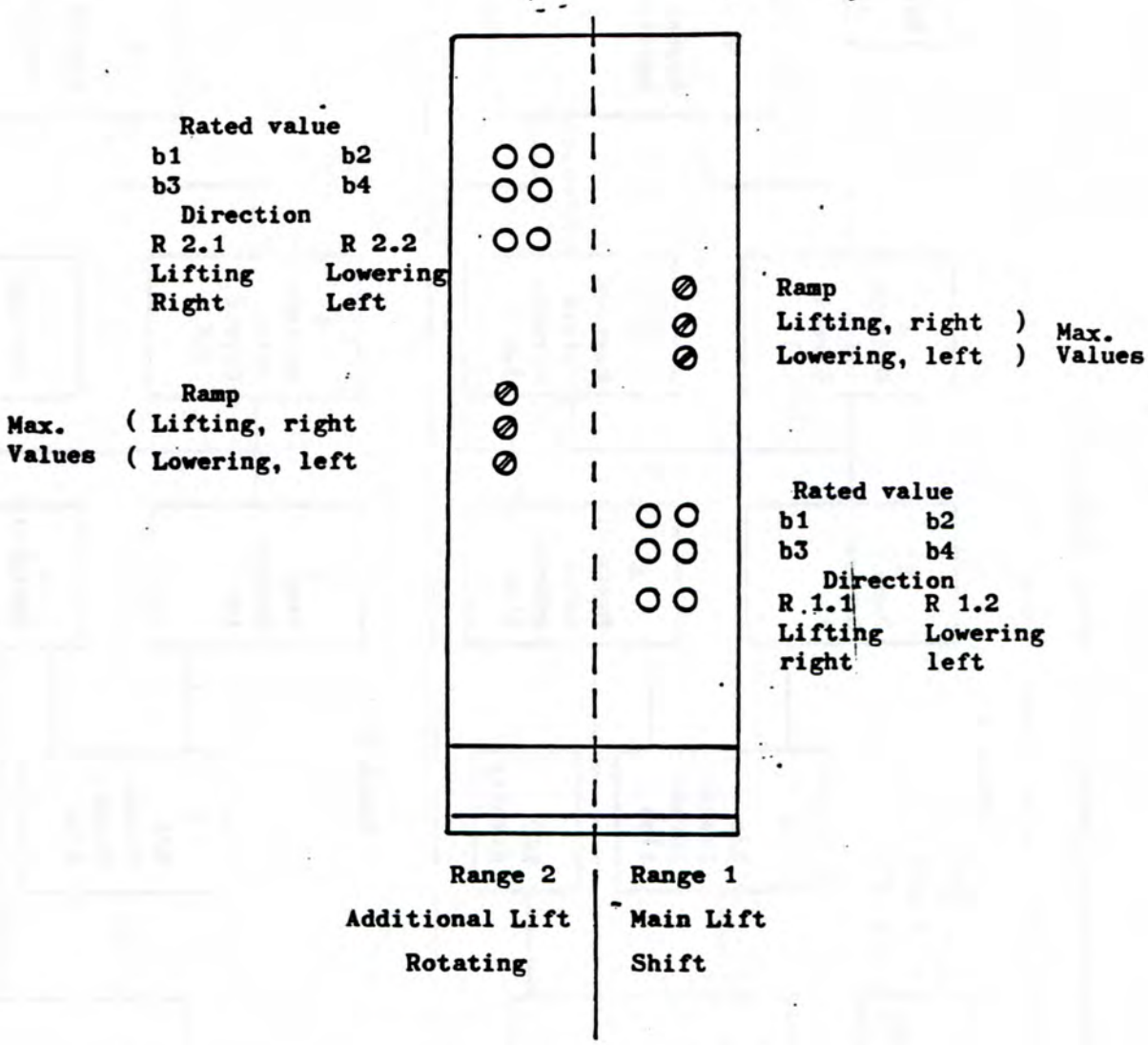


Fig. 2: Front Plate Proportional-Valve-Controlling



On all Potis a right turn increases the function.

PVB with piston manometer, *Open-center PVP* 12.07.1989/TB/OK

Fig 3: Characteristic curve of line of prop.-valve

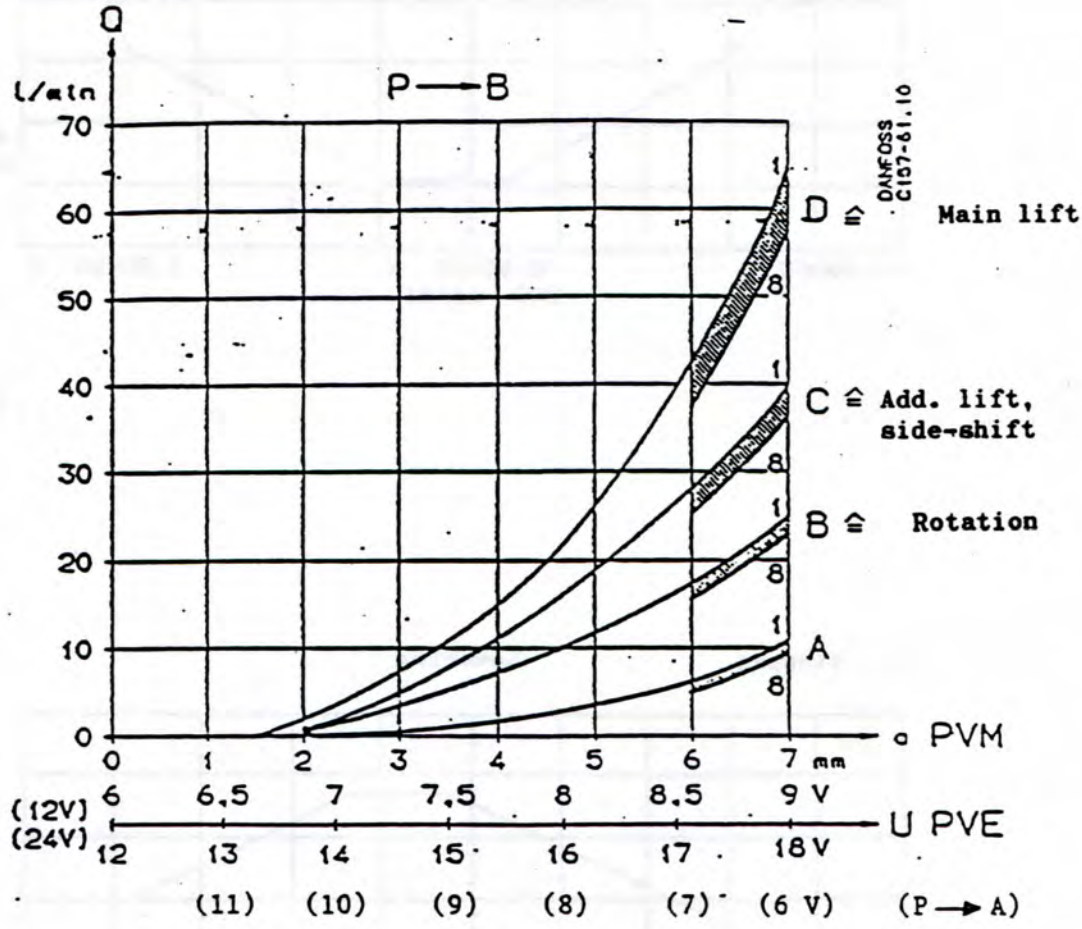
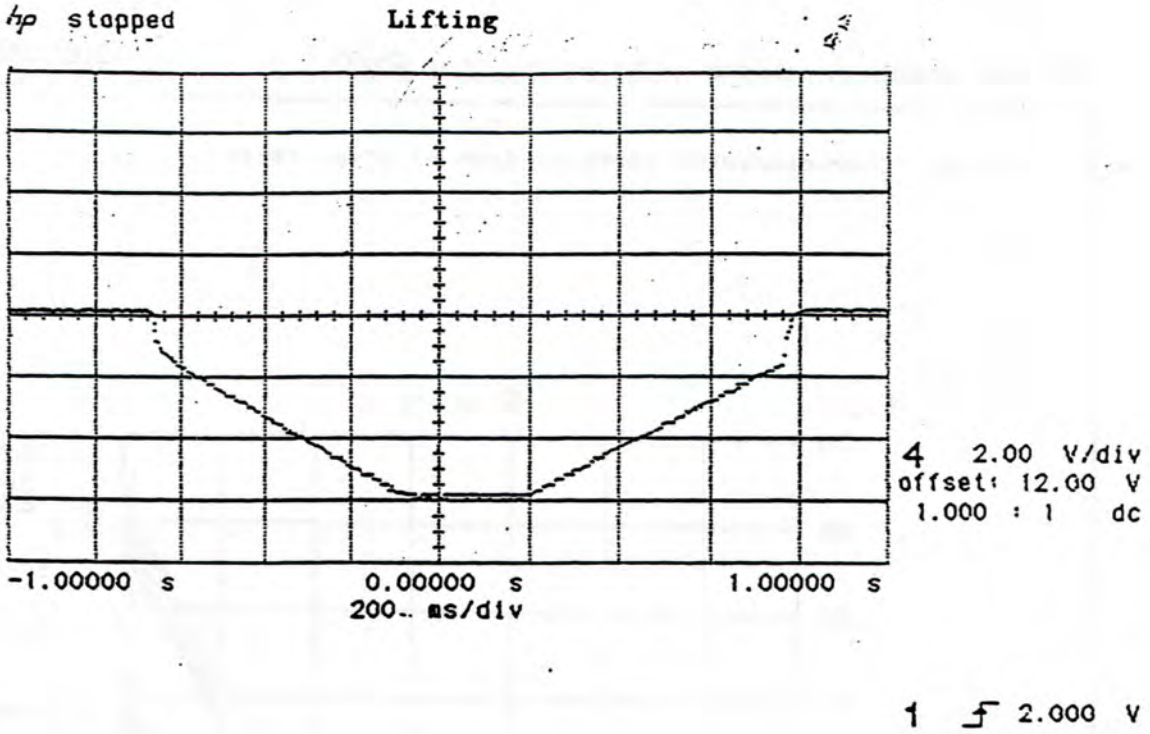


Fig. 4: Signal of characteristic curve Main Lift



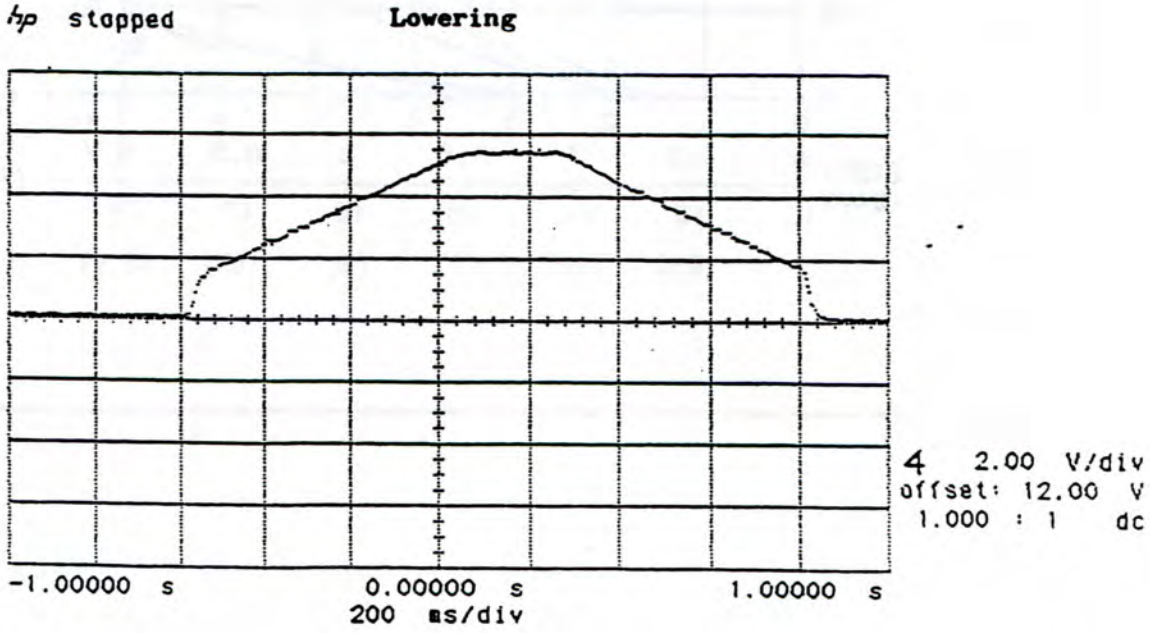


Fig. 5: Signal of characteristic curve Add. Lift

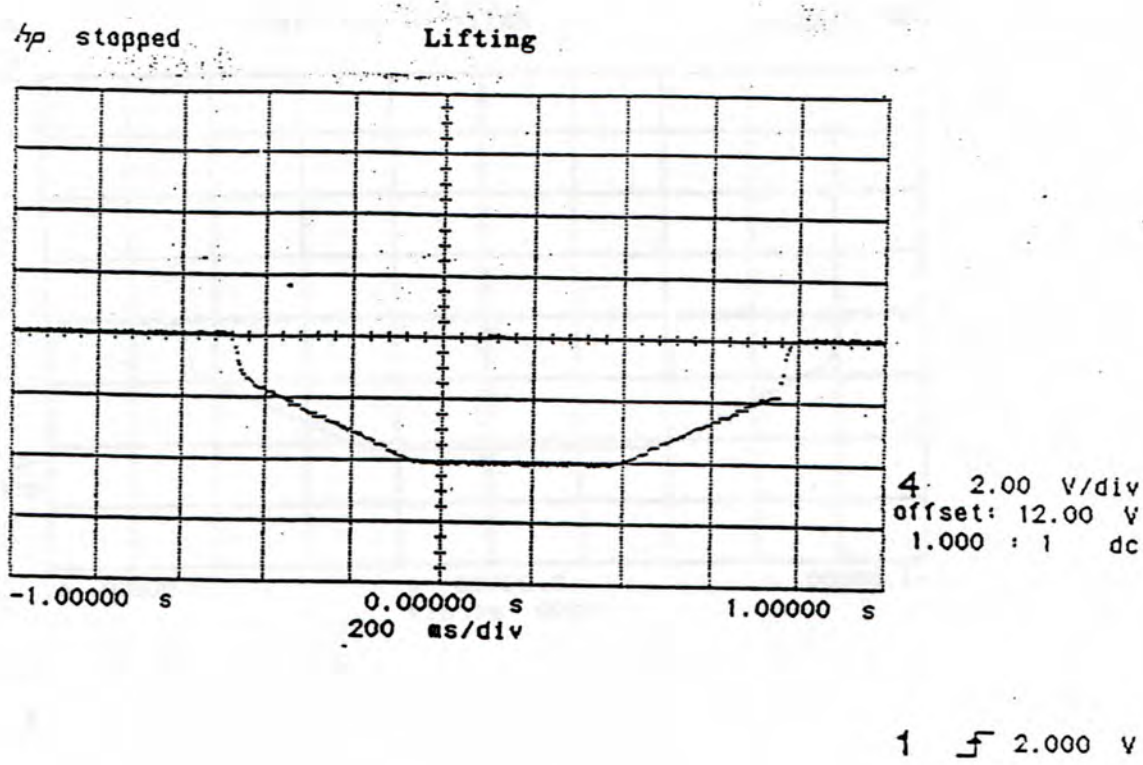
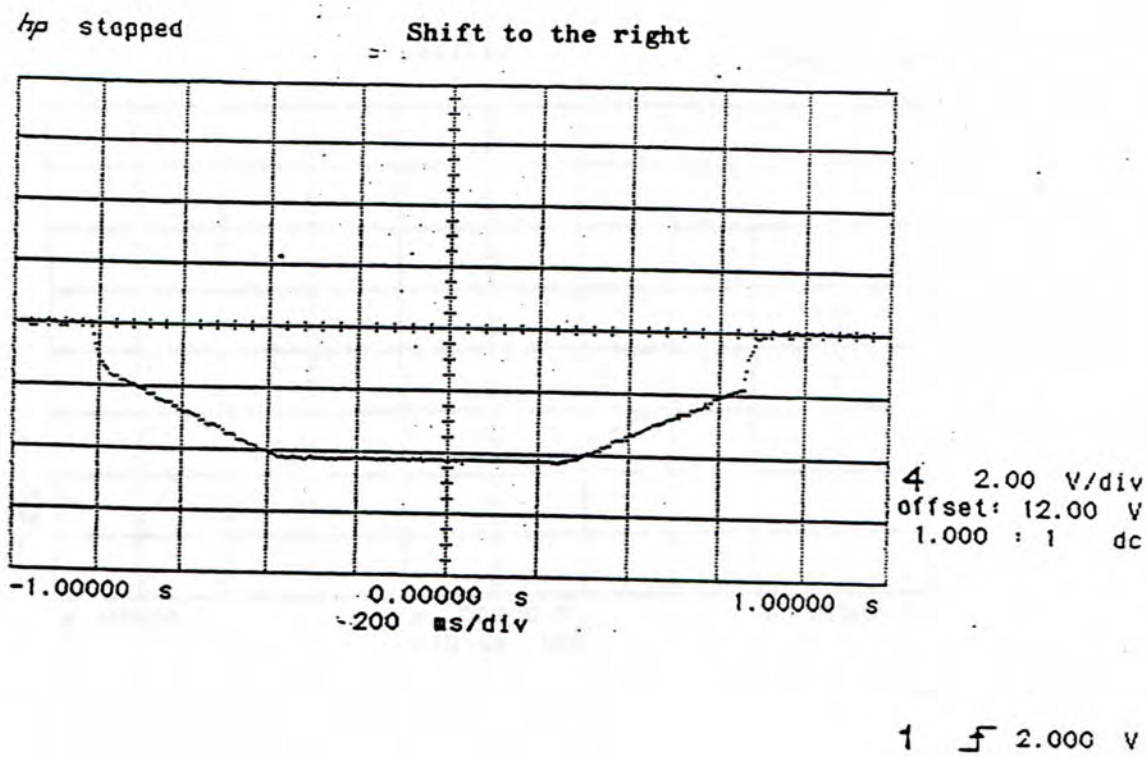


Fig. 6: Signal of characteristic curve of side-shift



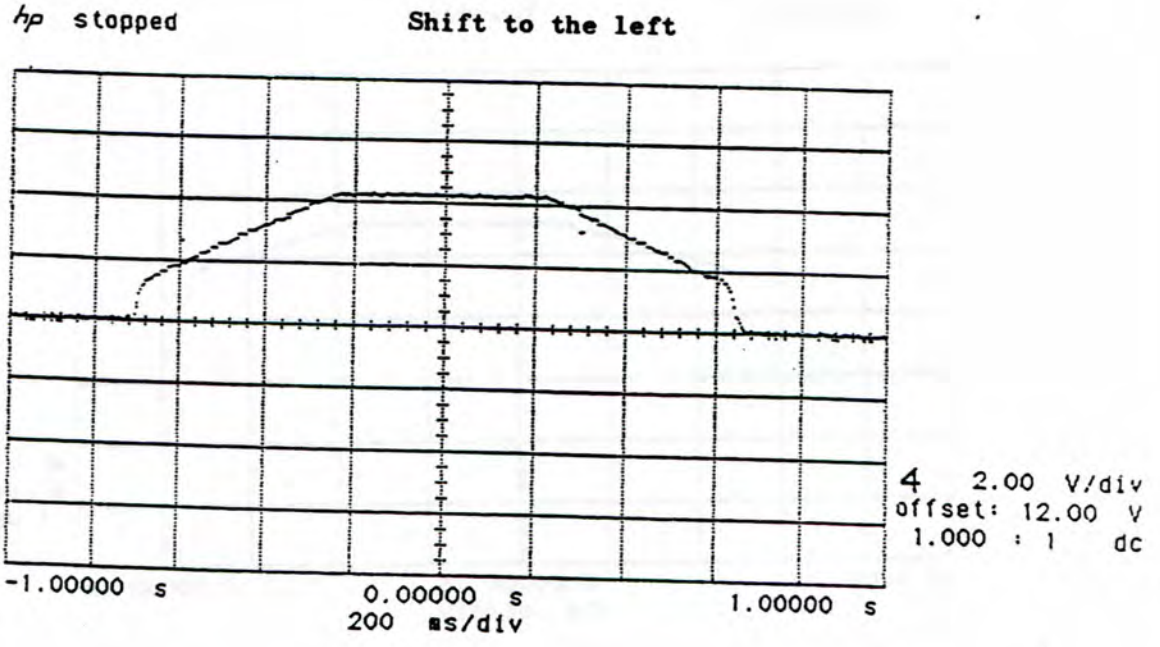
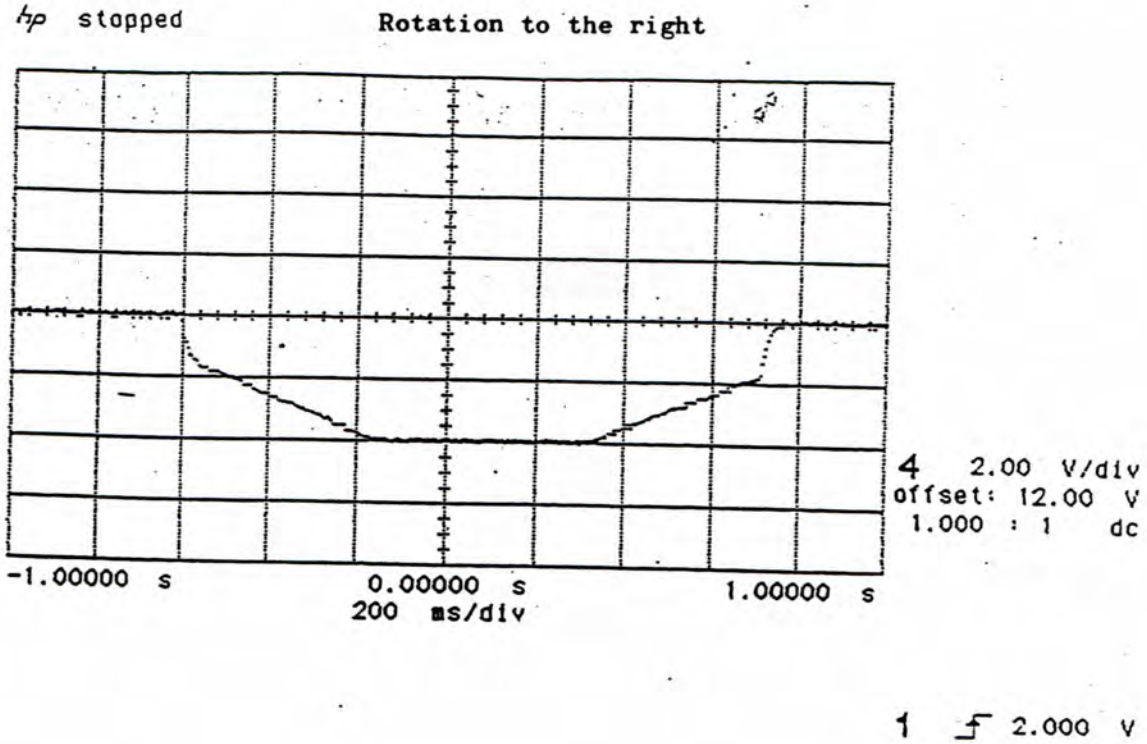
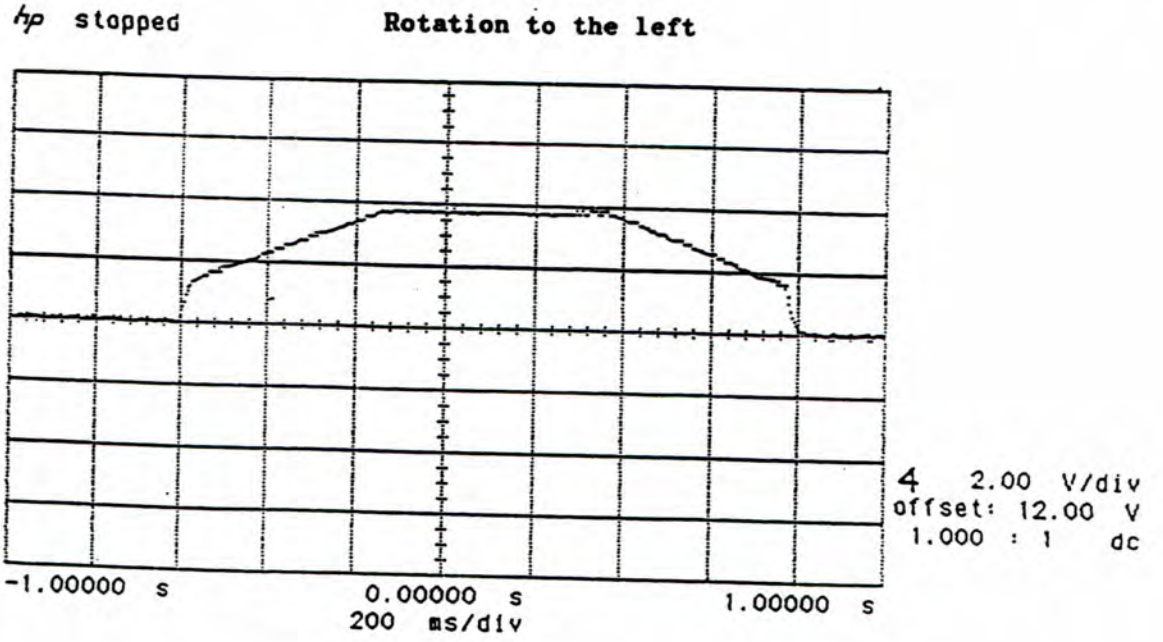


Fig. 7: Signal of characteristic curve of rotating





MULTIPLEX SWITCHING

Serie WA

Group 1

The Multiplex Switching System, which comprises a transmitter and a receiver unit, serves to combine and transfer digital signals. With six lines (signal, pulse, synchronisation, earth and two power lines) a maximum of 56 signals can be transmitted in one direction, by means of timed multiplex switching.

- Description of the Switching System.
The Timed Multiplex System.

The inputs (channels) of the transmitter are checked in sequence by the Multiplexer (Fig. 1.1; Fig. 2) and the status of each is established and transmitted over the signal lines. The interrogation frequency must be at least twice that of the highest probable input frequency, in order to ensure accurate analysis of the signals (Fig 1.1). By this process a signal sequence is created - as in Fig. 1.2.

At the receiver, the de-multiplexer elements splits signal sequence and directs the component parts to be stored in the corresponding outputs (channels) (Fig. 1.3). Control of mutiplexer and de-multiplexer is by means of counters which are driven by a common timing pulse. A synchronisation of the system occurs at the end of each interrogation cycle.

Safety Circuit

Faults in the signal, pulse and synchronisation circuits and in the individual units are identified by a fixed signal sequence transmitted during the interrogation cycle. Should a fault occur, e.g. cable break, it would be indicated within approx. 20 ms.

This condition is indicated by a light emitting diode.

Advantages of the System applied to Warehouse Trucks (e.g. WA)

The system is installed between the cab (transmitter) and the programmable logic controller (receiver). It has the following advantages:-

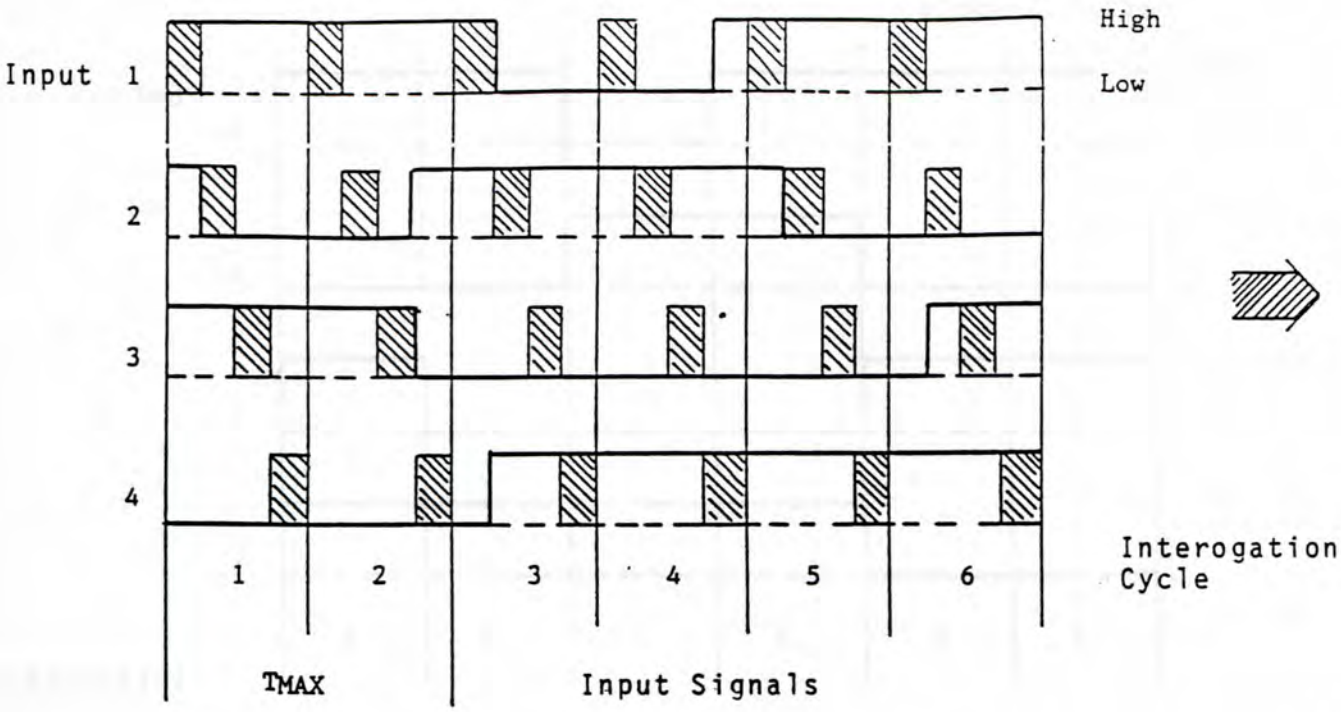
1. One of the flat, over the mast, cables is eliminated.
2. Despite halving the number of cables, the transmission capacity is doubled. (Cab to programmable logic controller)
3. Reduced maintenance especially as the outer flat cable frequently has to be renewed owing to breaks in the cable.
4. Reduced maintenance/repair costs and reduced downtime.
5. It is possible to use the system to monitor the signal channels.
   - If a fault develops an emergency stop braking can be initiated.
6. Because of improved interference supression, shorter impulse sequences e.g. from rotary impulse generators, can be transmitted.
   - More precise distance measurement.

Technical Data

Supply Voltage	V_{DD}	+ 24 V (15 V to 30 V)
Input Voltage	V_{IL}	0.0 V to 4.0 V
	V_{IH}	10 V to 30 V
Output Voltage	V_{OL}	0 V
	V_{OH}	V_{DD}1.6 V (where I_{OH} = -100 mA)
Output Power	PD, 1 Driver	1.1 W (at 25°C I_{OMAX} = -500 mA)
	1 IC	2.2 W (at 25°C)
Free Wheel Diode,		
Transmission Voltage	V_F	1.5 V
Transmission Current	I_F	350 mA
Input Frequency	f_{IMAX}	750 Hz
Interrogation sequence time t:		0.65 ms to 1.95 ms
Distance - Transmitter to Receiver:	t	$\leq$ 35 m
Transmission Capacity		56 channels in one direction
Ambient Temperature		0°C to +70°C (STANDARD!)

Multiplex Time Cycle Fig. 1

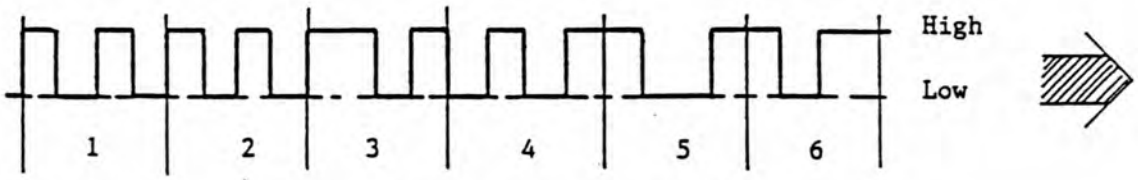
1.1 Input Signals



▨ ≙ Input imposet on the transmission line.

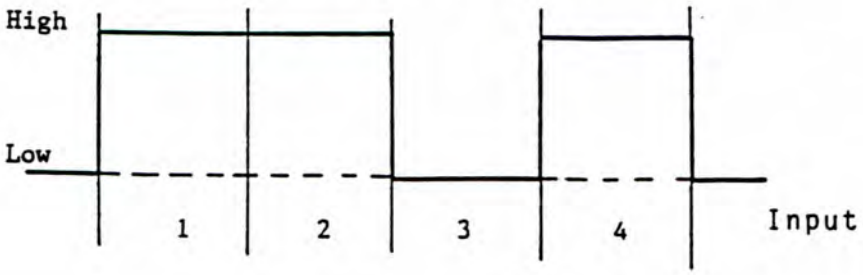
—— ≙ Signal Duration

1.2

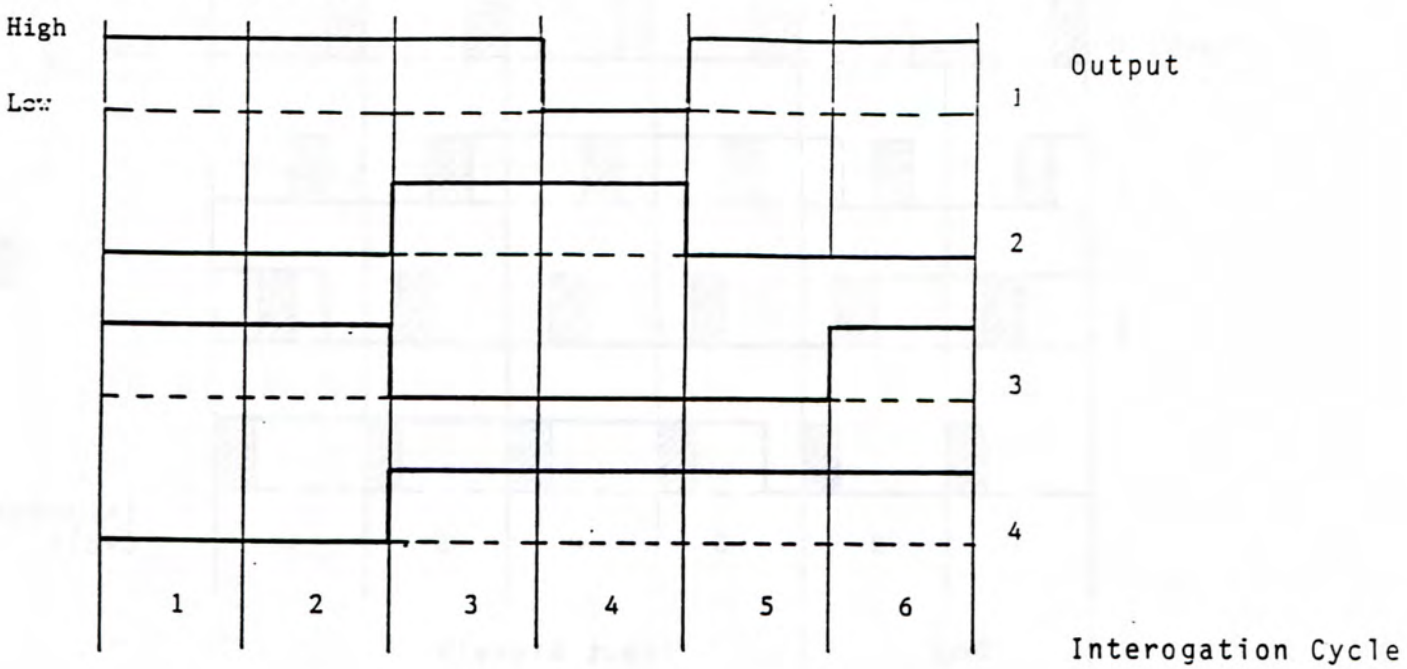


Signal sequence on the transmission line.

Interrogation cycle no.3 enlarged.



1.3 Output Signals



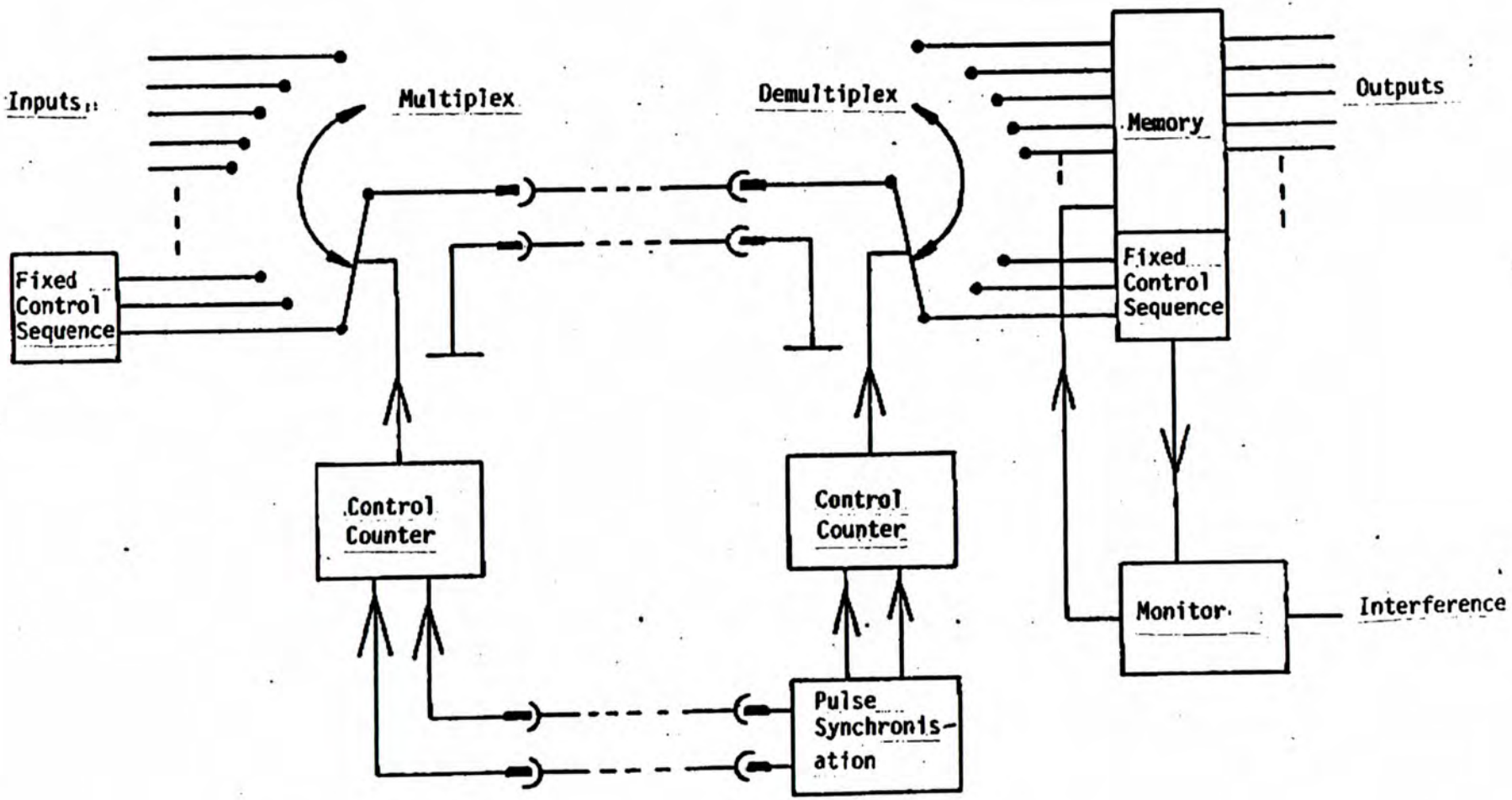
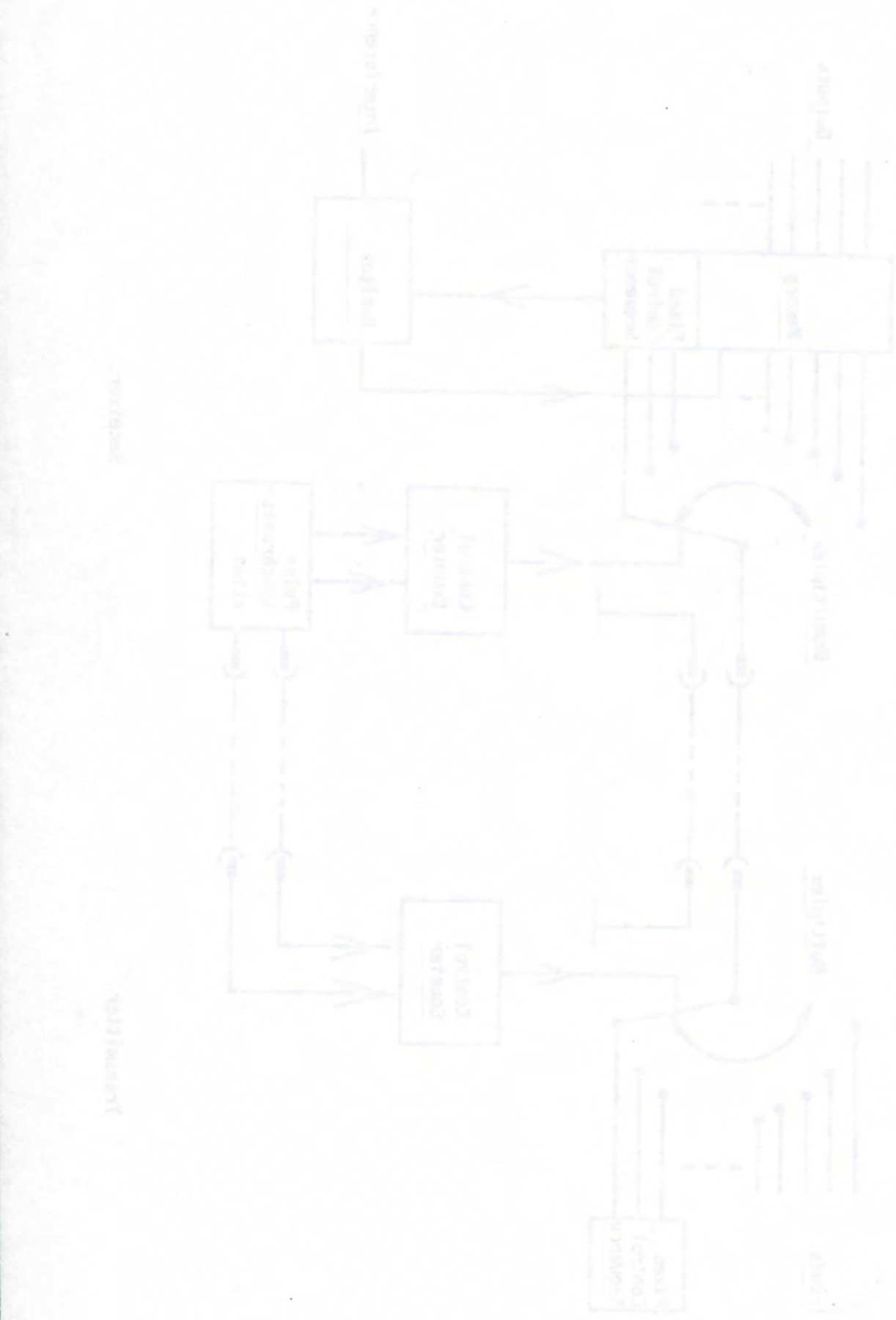
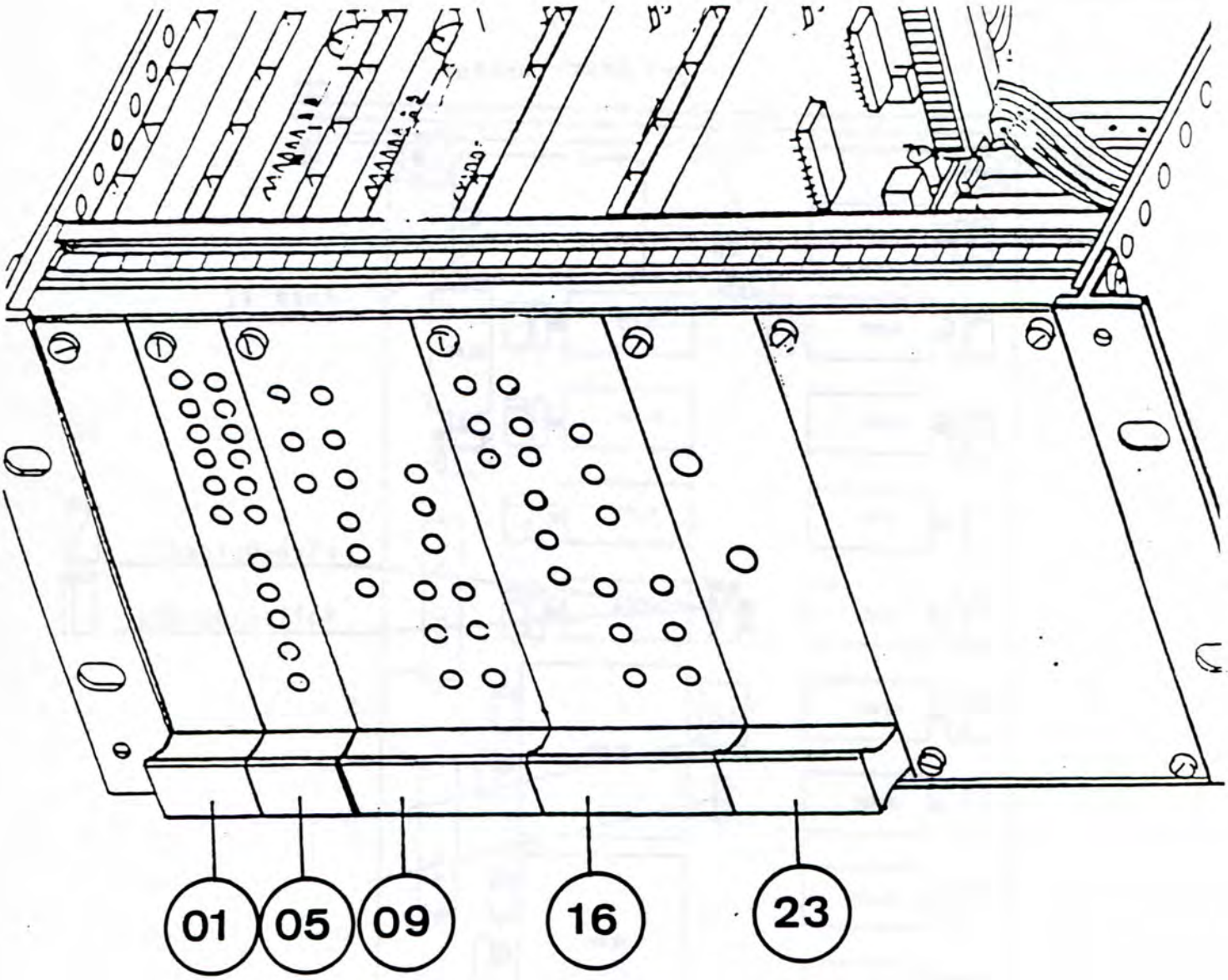

Inputs
Multiplex
Demultiplex
Memory
Outputs
Fixed Control Sequence
Fixed Control Sequence
Control Counter
Control Counter
Monitor
Interference
Pulse Synchronis-ation
Transmitter
Receiver

Fig. 2



WA-Proportionalsteuerung
Sub. Assy. Rack- Steinbock
Group 6

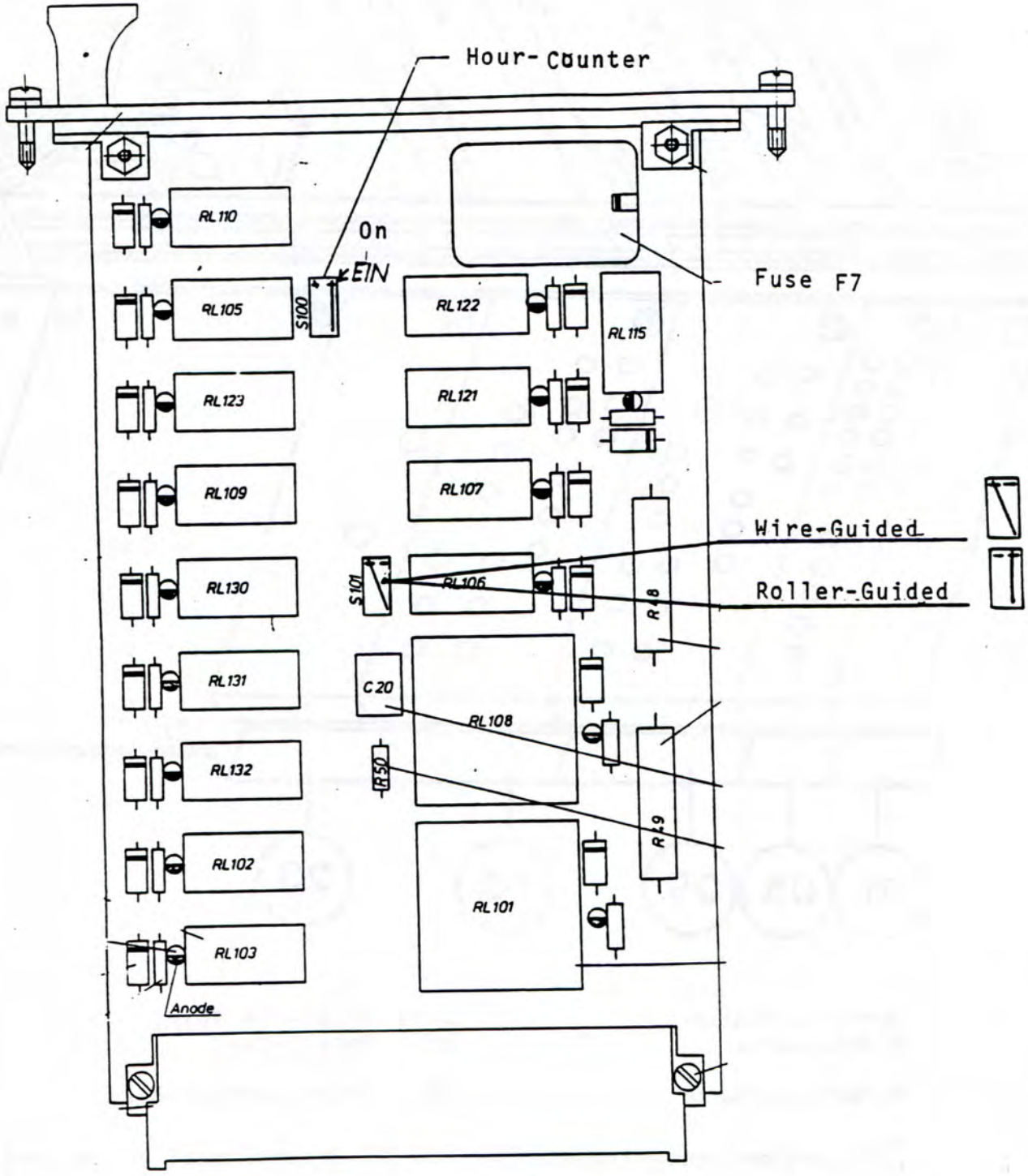


Kartensteckplätze:	Card Plug - in Point
01-Relaiskarte	01 - Relay -Card
05-Fahrreglerkarte	05- Drive Control Card
09-16-Proportionalventil-Steuerkarten	09- 16 Proportional Valve Control Card
23-Multiplex-Empfängerkarte	23- Multiplex -Receiver

WA-Proportionalsteuerung

Relaiskarte Steckplatz 01

Gruppe 6



Drive Control 460279

Commissioning and Check List Ref. 444011

Basically as Description of Functions in Group 1

1. Visual Checks

   Check soldered connections, tinned bridges and check for mechanical damage.

2. Check Supply Voltage

   + 24 V at z, b, d, 2 or at z, b, d, 32
   + 12 V at z, b, d, 4
   + 8 V U Battery at d 24, d 26
   0 V U Battery at z 24, z 26

3. Check Rotary Impulse Generator - Interface

   After inserting the card and connecting the rotary impulse generator correctly, the indicators "No fault on the rotary impulse generator" and "V = 0" must be switched on.

   Turning the rotary impulse generator in a clockwise direction causes the "Actual direction of travel Fwd" to illuminate and the indicator "V = 0" extinguishes. When the impulse generator is stationery the indicator "Actual direction of travel Fwd." is extinguished and "V = 0" is switched on again.

   Turning the impulse generator in an anti-clockwise direction causes the "Actual direction of travel Rev." to illuminate and the indicator "V = 0" to extinguish. When the impulse generator is stationary the indicator "Actual direction of travel Rev." is extinguished again and the "V = 0" is switched on again.

4. Speed of Rotation Signal Generation

   Switch on the inputs V1 to V4 (+ 24 V active) one after the other check the corresponding LED display, see 6/16.

5. Target Value Generation

   Increase the binary target values (b1 - b4) from 0 to maximum value, in stages and check the corresponding LED indicator on the front plate.

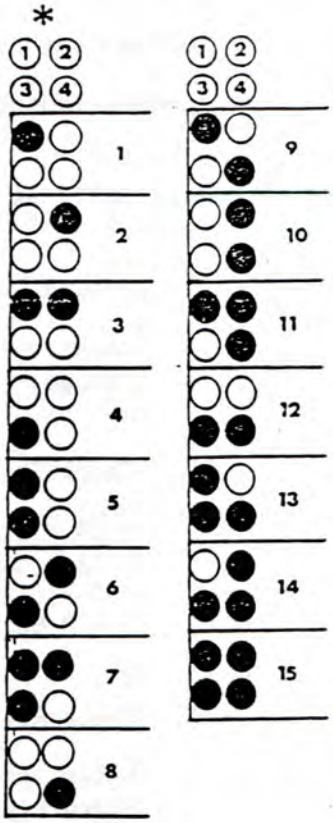
6. Rotary Impulse Generator - Monitor - Checks

   - Switch off truck.
   - Withdraw the plug on the rotary impulse generator.
   - Switch on the truck.
   - Make a "Drive" attempt.
   - The monitor function has operated (LED 9 = extinguished, plug-in point 05).
   - Switch off

WA Proportional Valve Control

Group 6
Commissioning

Drive Control



b1 b2 b3 b4 } Binary Target Value*

V1 V2 V3 V4 } Selected Speed (of Travel)

Rotary Impulse Transmitter -

9 No fault

10 V = 0

11 Actual Direction of Travel FWD.

12 Actual Direction of Travel REV.

P1 ≙ V1
P2 ≙ V2
P3 ≙ V3
P4 ≙ V4 } Increase

P5 ≙ $\underline{V}_{Target}$ - Drive Control

P6 ≙ Pulse Duration for Voltage Conversion } DO NOT ADJUST

	m/sec	km/h	†5m in Sec
V1 = Tracking Speed	4,8-5m	0,75	24-25 S
V2 = V 1/4	1,44	2,5	7,2
V3 = V 1/2	0,9	4,0	4,5
V4 = V max	0,45	8,0	2,25

† Time to Travel 5 m

Proportional Valve Control 460280 and 461253

Commissioning and Check List Ref. 444009

Basically as Description of Functions in Group 1

1. Visual Check

   - Check soldered connections, tinned bridges and check for mechanical damage.

2. Check Supply Voltage

   - Connect card to 24 V supply (+ 24 V at z b d 2, 0 V at z b d 32)
   - Mid voltage 12 V ± 200 mV - check at z, b, d6
   - Logic voltage + 7 V ± 200 mV - check at z 4
   - Logic voltage + 17 V ± 200 mV - check at z 8

3. Check Front Plate Indicators

   - Switch on the inputs b1 - b4 and the direct inputs R1.1, R1.2 (or R2.1, R2.2) one after the other and check the indicator on both sections of the front plate.
   - Check the LED 114 - "No Fault".

4. Balance Section 1

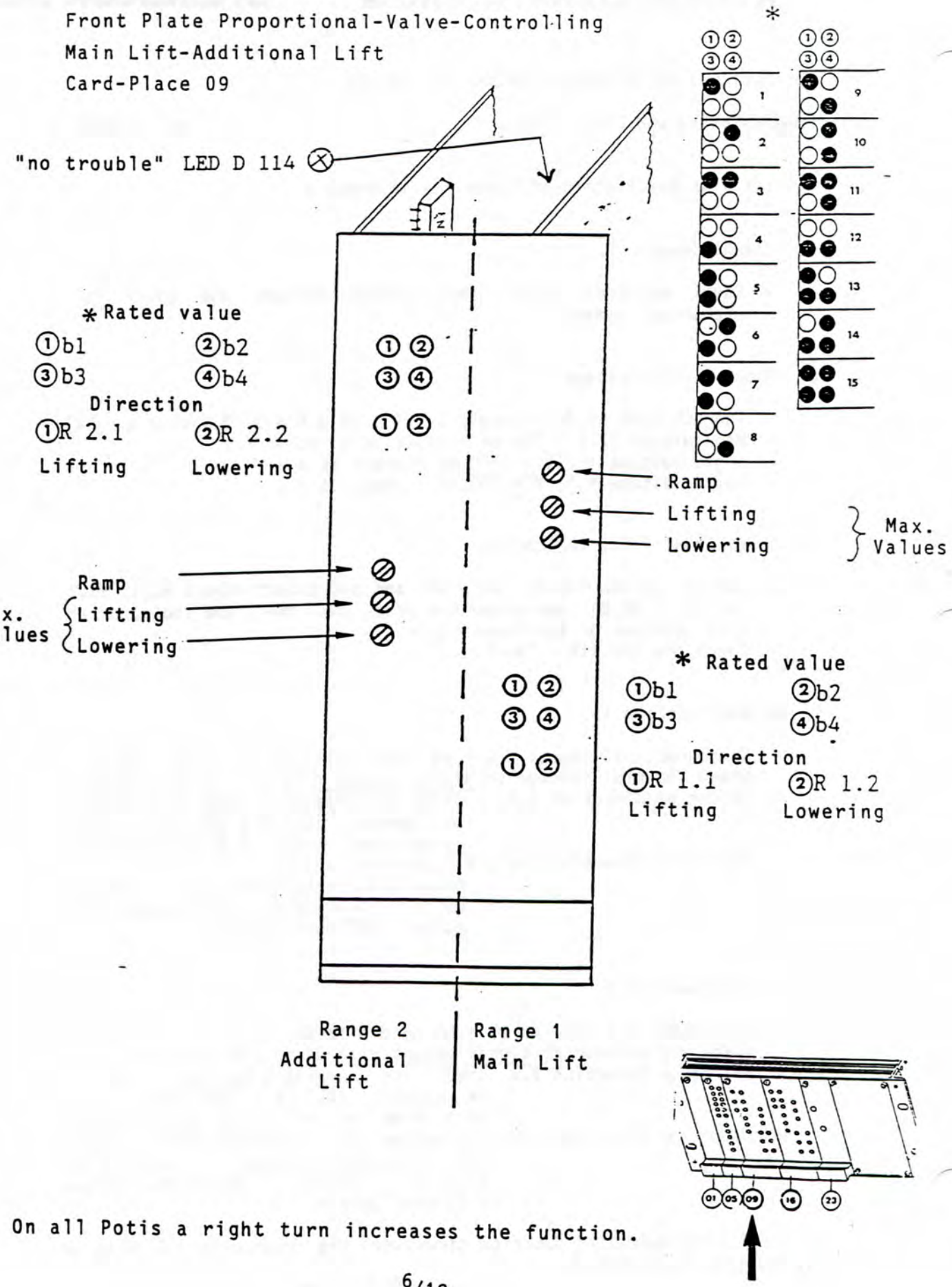
   - Disconnect all inputs b1 - b4 and direction of travel inputs - check the mid voltage at signal output d 18 UM = 12 V ± 200 mV.
   - Switch on Direction 1.1: Check the threshold voltage - should be approx. 10.7 V ± 100 mV, - the associated output z 20 must switch.
   - Switch on Direction 1.2 (R1.1 switched off): Check the treshold voltage - should be 13.3. V ± 100 mV, - the associated output z 22 must switch.

5. Balance Section 2

   - Disconnect all inputs b1 - b4 and direction of travel inputs - check mid voltage at signal output z 18 UM = 12 V ± 200 mV.
   - Switch on Direction 2.1: Check the threshold voltage - should be approx. 10.7 V ± 100 mV - associated output d 20 must switch.
   - Switch on Direction 2.2: (Direction 2.1 switched off). Check the threshold voltage - should be 13.3 V ± 100 mV - associated output d 22 must switch.

Check the hydraulic function times when the hydraulic oil is up to operating temperature.

Front Plate Proportional-Valve-Controlling
Main Lift-Additional Lift
Card-Place 09



On all Potis a right turn increases the function.

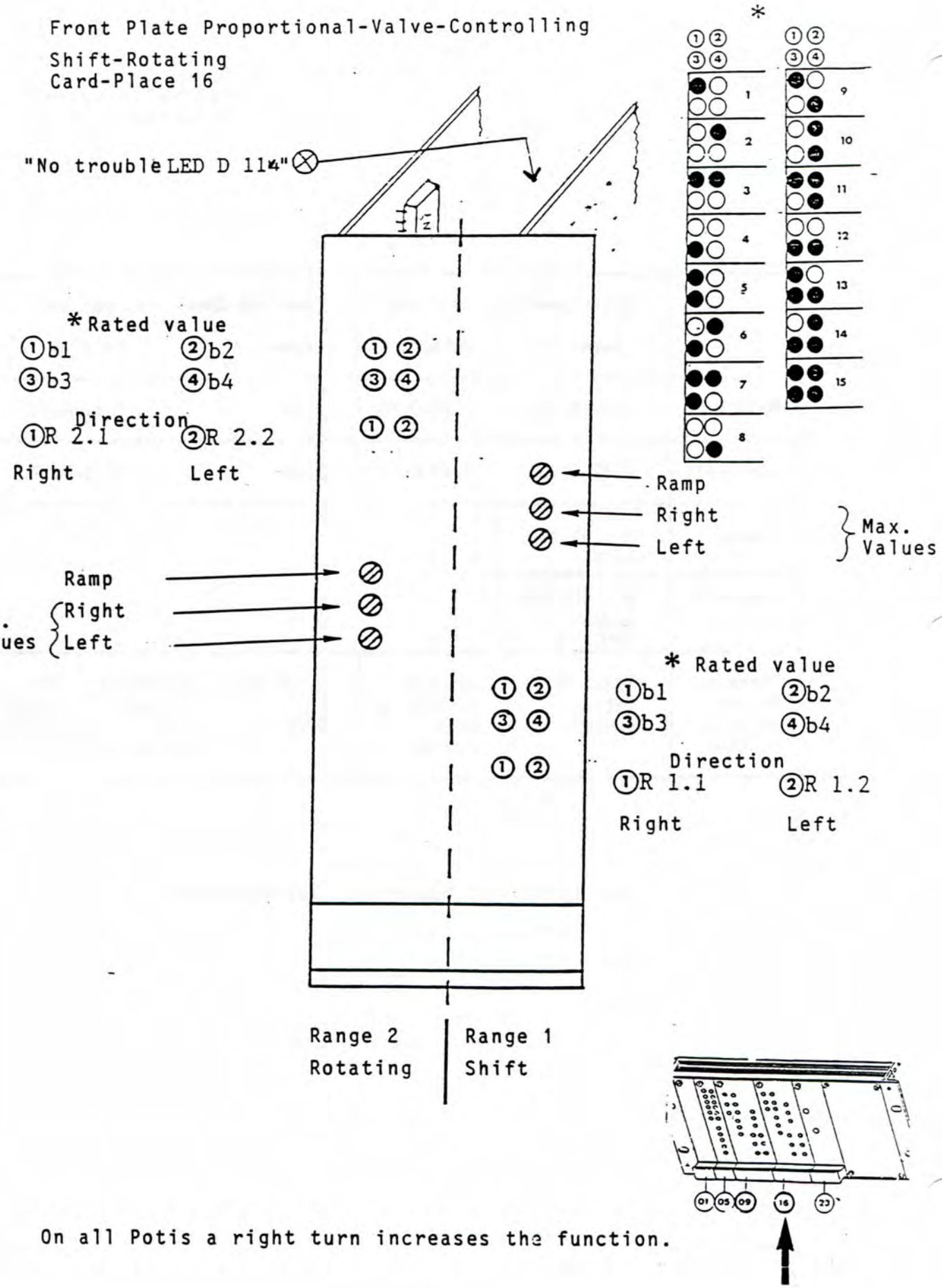
Group 6
Hydraulic-System -
Adjustment Data

	Lift Speed - m. per sec.		Lowering Speed - m. per sec.		
	Laden	Unladen	Laden	Unladen	
Main Lift	0.37-0.40	0.39-0.40	0.03	0.29-0.31	
Aux. Lift	0.17-0.23	0.17-0.23	0.29	0.10-0.17	
Rotate	9 - 11 sec. Laden				
Sideshift	8 - 9.5 sec. Laden sec/m				
Pressure Relief Valve Setting	Valve No.1 PVP (Rear)	200 bar Triplex Mast 220 bar	Valve No.2 PVP (Cab)	20-30 bar higher than Valve No.1	See Groups 10/3/5

WA Series with Proportional Valve Control

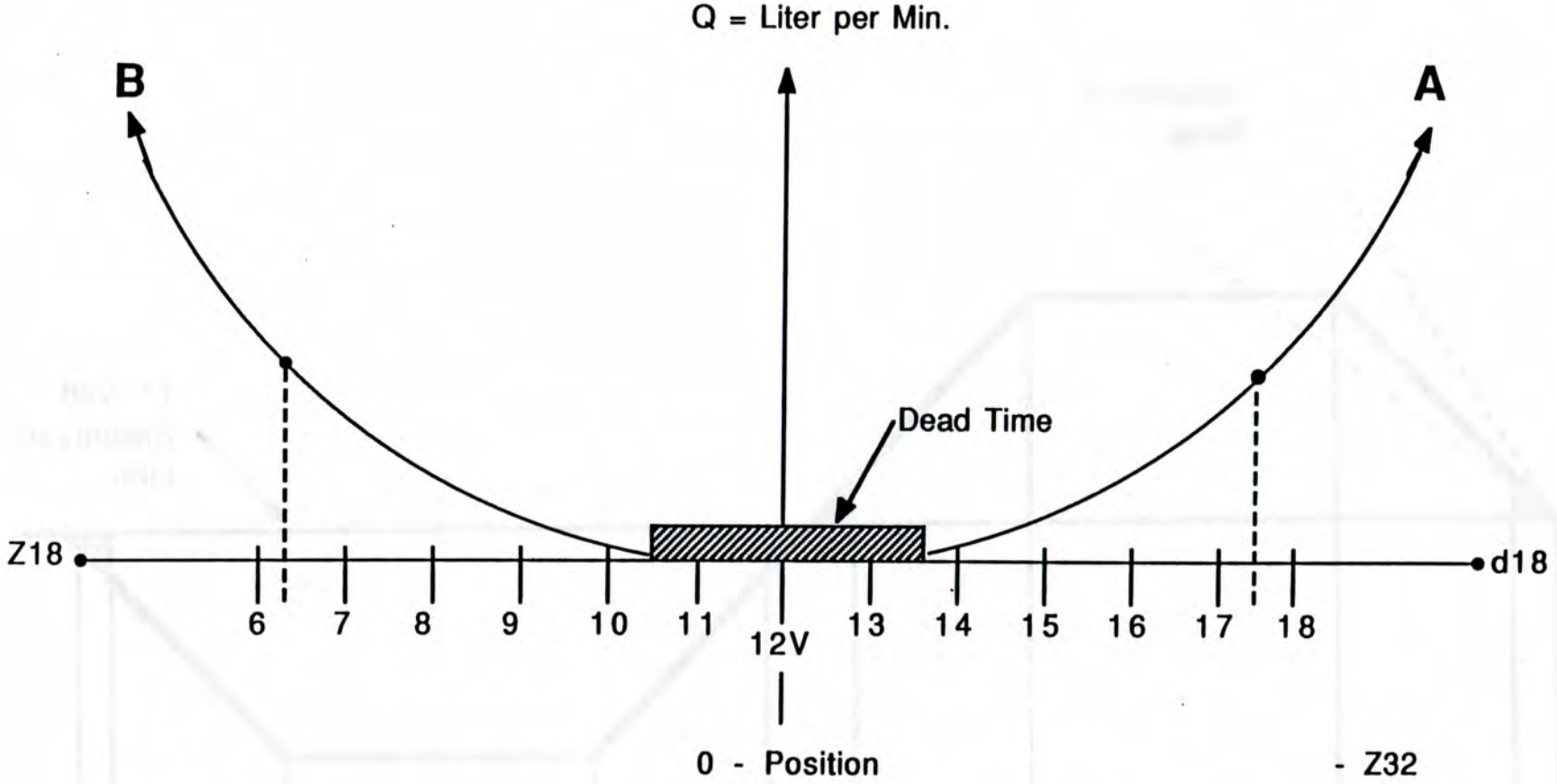
Front Plate Proportional-Valve-Controlling

Shift-Rotating
Card-Place 16



On all Potis a right turn increases the function.

PROPORTIONAL CONTROL VALVE

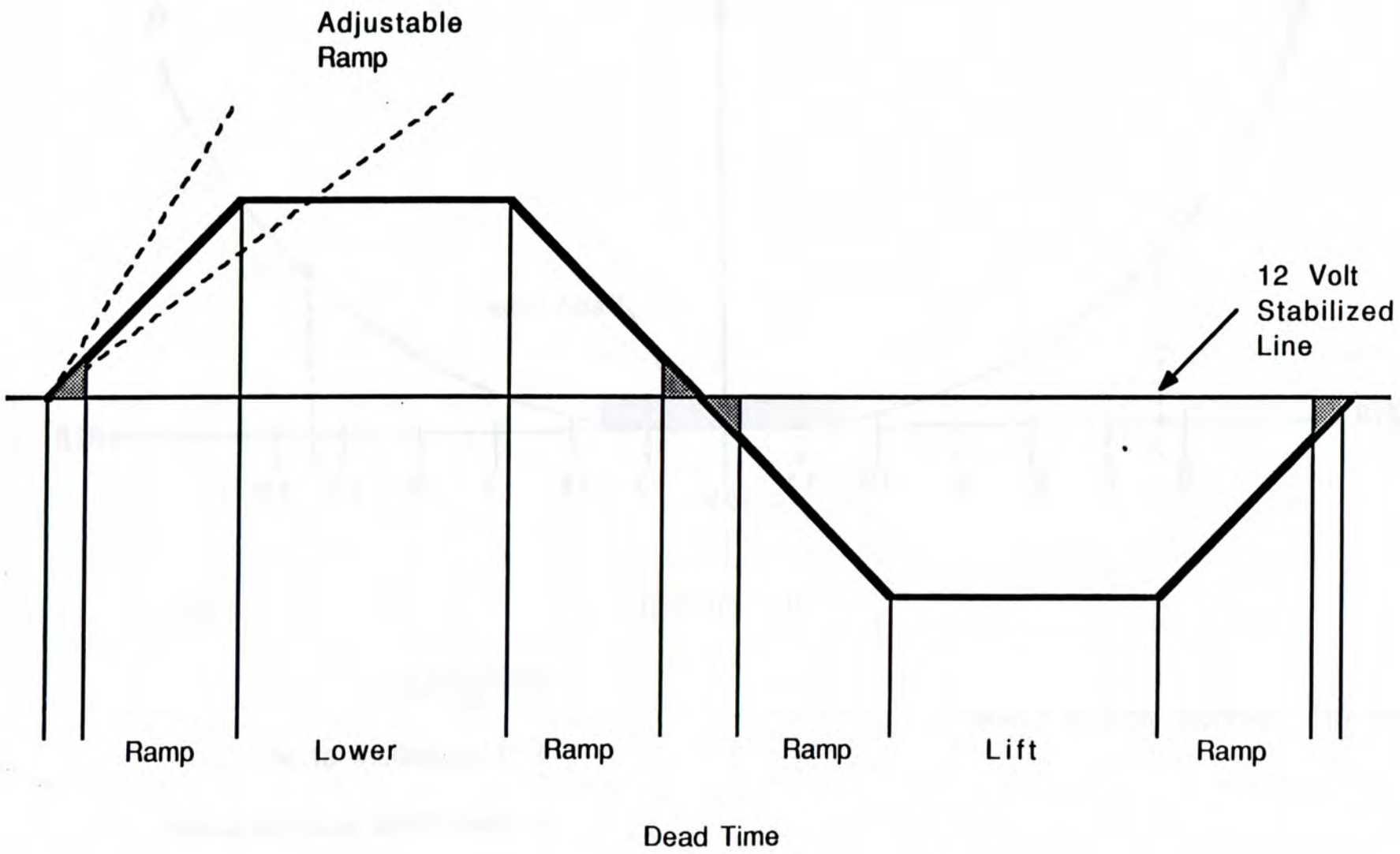


Four BIT Electrical Input is Linear

VARRIABLES

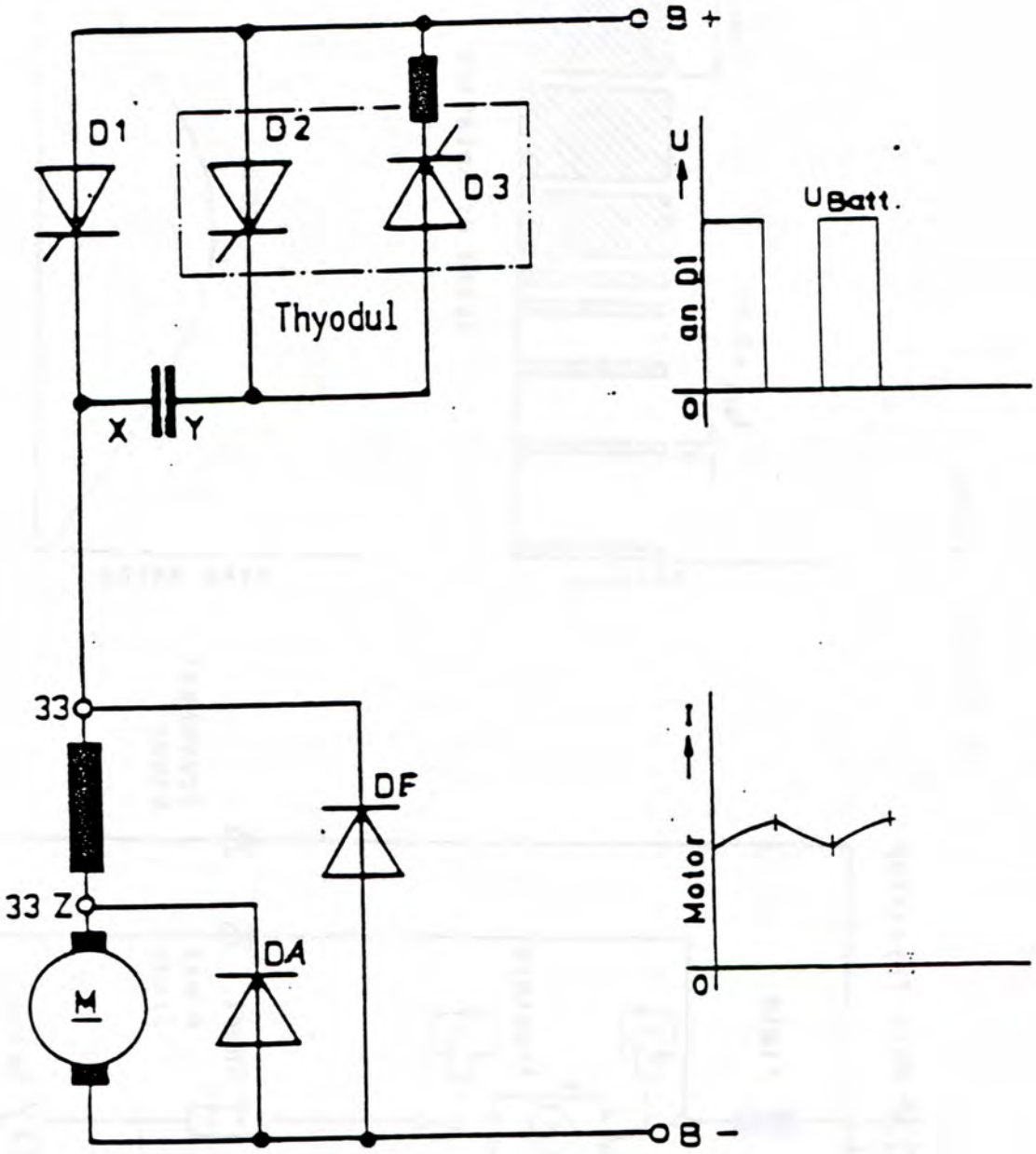
1. Temperature of oil
2. Motor RPM must be correct
3. Valve adjustment

PROPORTIONAL CONTROL VALVE

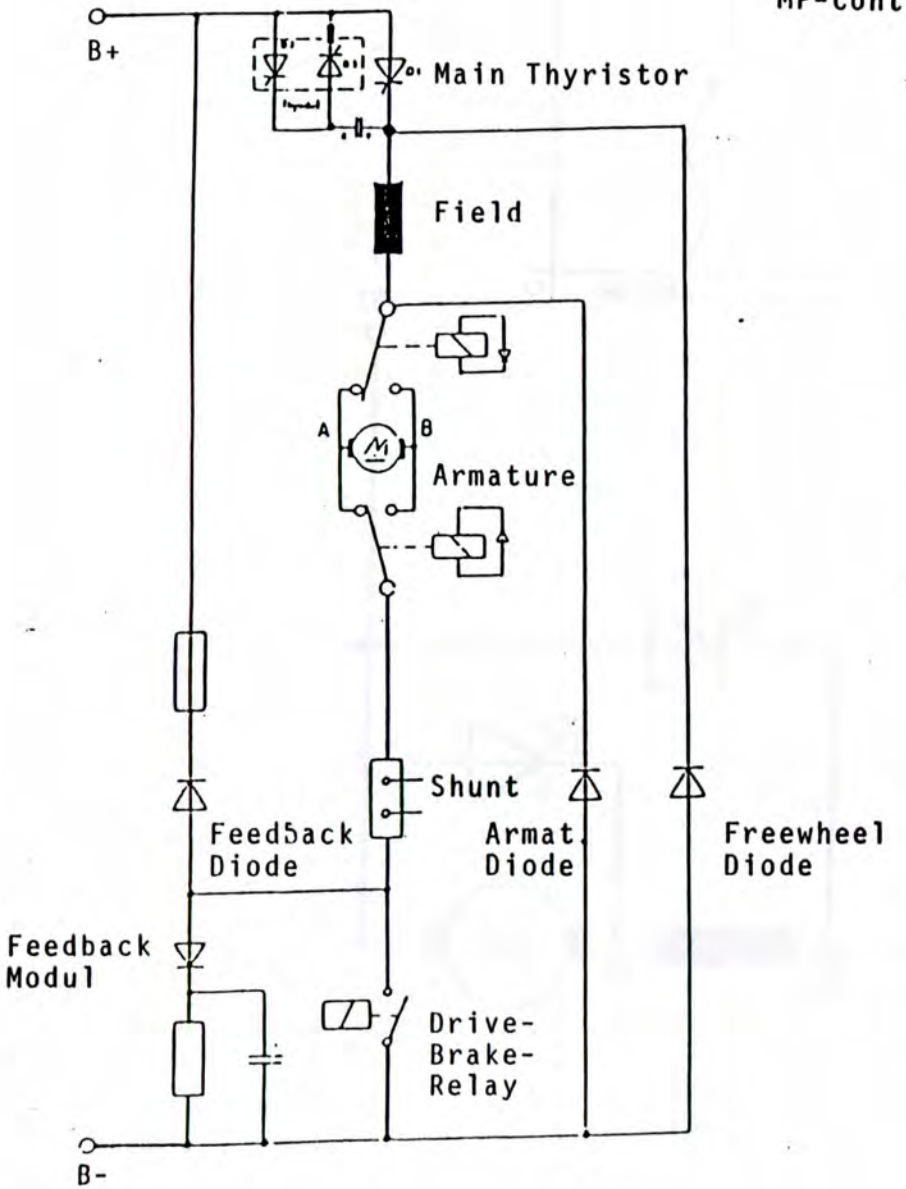


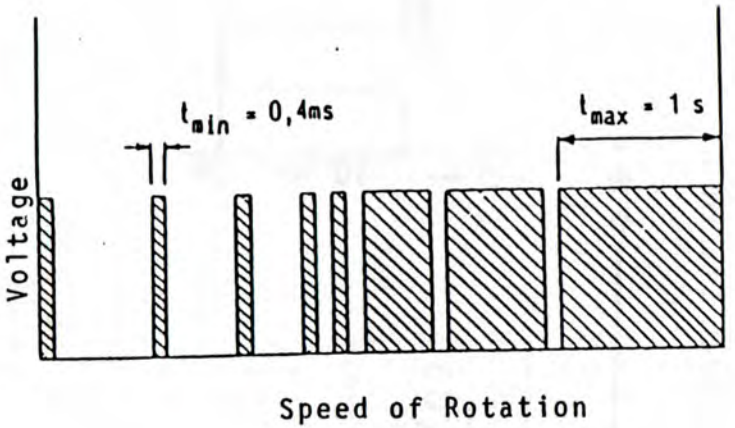
SECTION
7

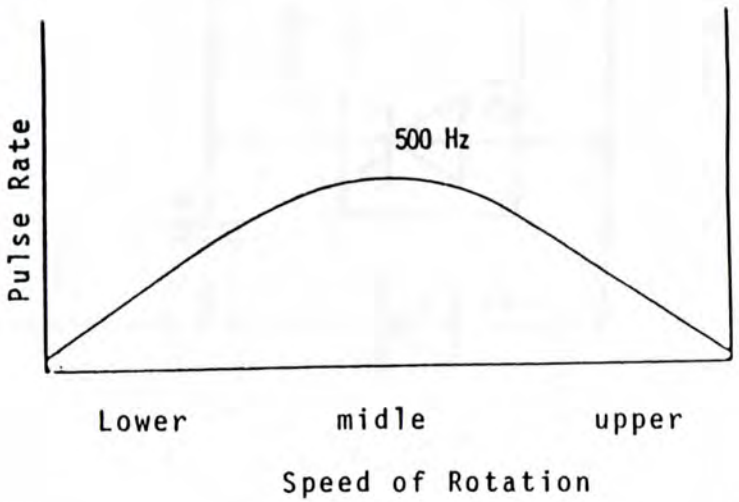
S--PULSE CONTROL SYSTEM



MP-Control System







Evaluation of Faults in LED display for MP Impulse Control Rack Components Indication appears after switch on with the key switch or when the truck is operational (vehicle does not drive).

Before fault finding, jack up the truck (the drive wheels must free to rotate).

0 = LED not illuminated. ● = LED illuminated.

Total No Displayed	LED Display 1st Run-up	LED Display 2nd Run-up	Run-Up Rhythm	Cause of Fault	Remedy
No Indication	0000000000			(8A) Control fuse blown. No Current Supply. Vehicle Main Fuse blown. Change condition indicator faulty	+ Key Switch + Control Fuse + Check vehicle main fuse + Replace change indicator
2 Points	●000000000		Steady display (see also charge condition indicator)	Battery discharged	+ Check Battery connectionsand acid density + Charge Battery.
4 Points	●●●●000000	●●●●000000	Slowly at times on 4 points	Electronic Unit not receiving actual value current. Drive - Brake relay contacts not holding	+ Check shunt and connecting + Leads + Eliminate contact resistance on the contacts of travel - direction power relays. + Replace Electronic control unit + Ensure Drive - Brake relay is mechanically OK + Check Drive and Brake relays electrically (Coil resistance, contact gear)
5 Points	●●●●●00000	●●●●●00000	Slowly at times on 5 points	Gate ? Cathode ? Main Thyristor	+ Check Free wheel diode
6 Points	●●●●●●0000	●●●●●●0000	Slowly at times on 6 points	Fault on Test Cycle	+ Replace Electronics control unit
7 Points	●●●●●●●000	●●●●●●●000	Slowly at times on 7 points	Drive - Brake relay does not release or relay contact sticks	+ Ensure Drive - Brake relay is mechanically OK + Check Relay protective circuit + Replace Relay or feedback brick (Module)

Total No Displayed	LED Display 1st Run-up	LED Display 2nd Run-up	Run-Up Rhythm	Cause of Fault	Remedy
8 Points	●●●●●●●●●o	●●●●●●●●●o	Slowly at times on 8 points	Main thyristor remains in Drive mode (dynamic monitoring)	Check main thyristor for (o = Fault) + Check Thyristor and + condensers (Replace Power Unit) + Change Electronic control unit + Check, Relay contacts and relay return springs
9 Points	●●●●●●●●●●	●●●●●●●●●●	Slowly at times on 9 points	Direction of Travel Switch	+ Examine Direction of travel switch
10 Points	●●●●●●●●●●	●●●●●●●●●●	1. Slowly at times on 10 points 2. Very fast at times on 10 points (Flickering)	Battery discharged (Voltage Down) Drive sender drops voltage on switching on	+ Check Battery connections and check acid density + Change battery + Put drive sender in normal position + Check drive sender mechanics + Replace drive sender
13 Points	●●●●●●●●●●	●●●0000000	Slow. Alternating 10 and then on 3 points	Direction of Travel contactor does not release	+ Inspect Direction of Travel contactor
14 Points	●●●●●●●●●●	●●●●000000	Slow. Alternating 10 and then 4 points	Monitoring of main thyristors on short circuit after switching on the drive switch (static monitoring)	+ Check Main thyristor for o = Fault. (Replace power unit) + Contact resistance or disconnection of the fixed contact of the Direction of Travel Relay. + Disconnection of the power unit resistance or the diode on the feed back brick (module)
15 Points	●●●●●●●●●●	●●●●●00000	Slow. Alternating on 10 points and then on 5 points	Armature diode - free run diode faulty	+ Test free run diode + Test armature diode
16 Points	●●●●●●●●●●	●●●●●●0000	Slow. Alternating on 10 points and then on 6 points	Direction of Travel. Contactor does not pull in.	+ Check Drive contactor
17 Points	●●●●●●●●●●	●●●●●●●●●0	Slow. Alternating on 10 points and then on 7 points	Condenser has short circuit	+ Check the condenser (Replace power unit)
18 Points	●●●●●●●●●●	●●●●●●●●●0	Slow. Alternating on 10 points and then on 8 points	Direction of Travel contactor does not 'make' in the 'normal' position	+ Check the fixed contact of the Direction of Travel contactor
19 Points	●●●●●●●●●●	●●●●●●●●●●	Slow. Alternating on 10 points and then on 9 points	Drive contactor does not pull in	+ Check Drive Contactor + Check wiring to the drive contactor + Replace Interface - Ladder Card

Impulse control system 400 145
Setting and testing instructions

Type: WA 12 - 15,

Impulse control system µP travelling control		Voltage 80/72 V
Bosch	No. 0 196 024 014	Item No. 027 951
Circuit board µP card	No. 2 198 300 299	Item No. 029 982
Interface card	No. 2 198 300 199	Item No. 029 983
MT	No. 0 196 421 007	Item No. 027 949
RS module	No. 0 196 400 020	Item No. 027 950
EPROM 80 V	No. 2 197 328 099	Item No. 029 984
72 V	No. 2 197 328 182	Item No. 029 827
Motor current		I_{max} 350 A ± 10%
Cycle start		0.5 - 0.75 V
Minimum travel control output		0.015 - 0.3 V
Maximum travel control output		4.1 - 4.2 V

Speed reduction V/2 (only for units without inductive guide)
B - to B 7 = Travel reduction V/2

Test:

1. EPROM as per order parts list 80 V or 72 V.

2. Check safety circuit

   a) Static: turn unit off (disconnect power)
   Connect up cable between terminals B + and 33.
   Switch on unit
   Set direction of travel and actuate impulse emitter
   The motor must not turn, contactors do not make, fault display 14P.
   Remove cable again.

   b) Dynamic: switch on unit

   Switch direction of travel and accelerate motor gently with impulse emitter
   Remove control cable G 2 from quenching thyristor (on thyodule).
   All power relays break immediately and do not make again when the impulse emitter is pressed again, fault display 8P.
   Plug in control cable again.

3. Check feed-back system
   a) when changing direction of travel
   b) when releasing the driving pedal
   c) when switching from Vmax to V/2 or V/4
   (if vehicle is so equipped)

   Travel brake contactor breaks, direction contactors are reversed, unit brakes to 0 or to preselected speed.

   Date: 26 August 1985

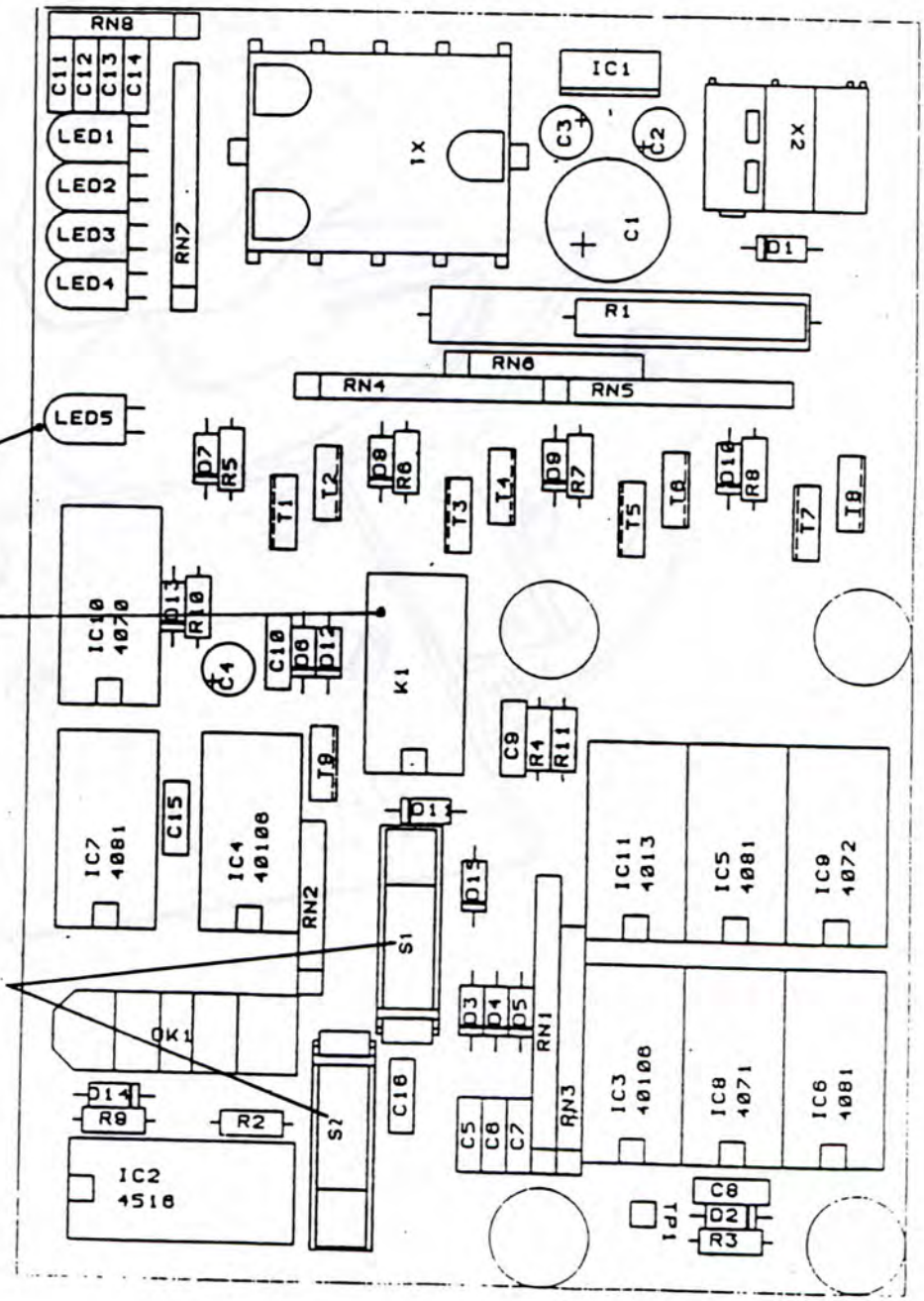
WA Prop. Valve Control
Electronic Equipment Board
Digital Target Value Generator
Group 7

Dezimal-zahlen-wert	LED: 4	3	2	1
0	0	0	0	0
1	0	0	0	●
2	0	0	●	0
3	0	0	●	●
4	0	●	0	0
5	0	●	0	●
6	0	●	●	0
7	0	●	●	●
8	●	0	0	0
9	●	0	0	●
10	●	0	●	0
11	●	0	●	●
12	●	●	0	0
13	●	●	0	●
14	●	●	●	0
15	●	●	●	●

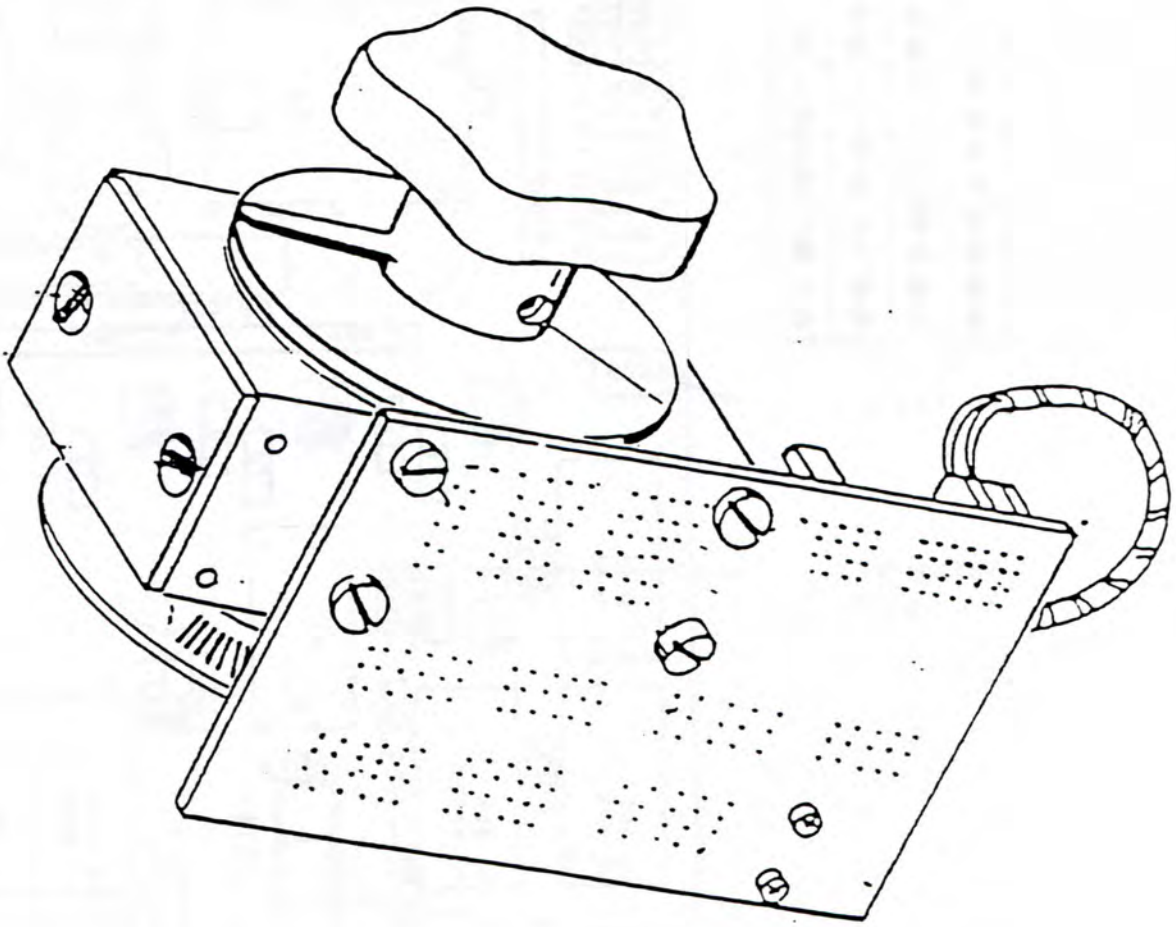
No Fault

Relay K1
No Fault

S1 /S2 Microswitch
for Direction
and Countercontrol

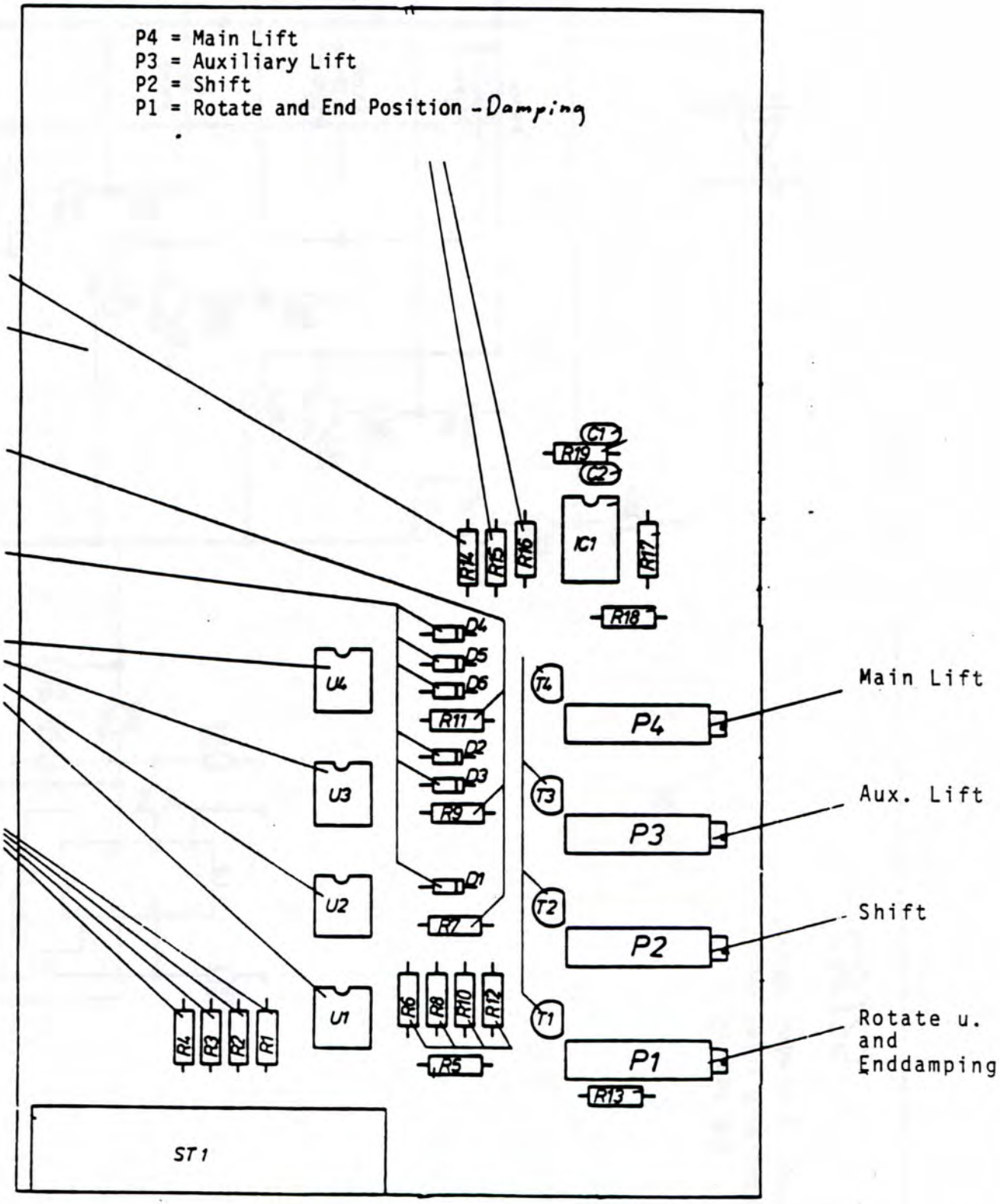


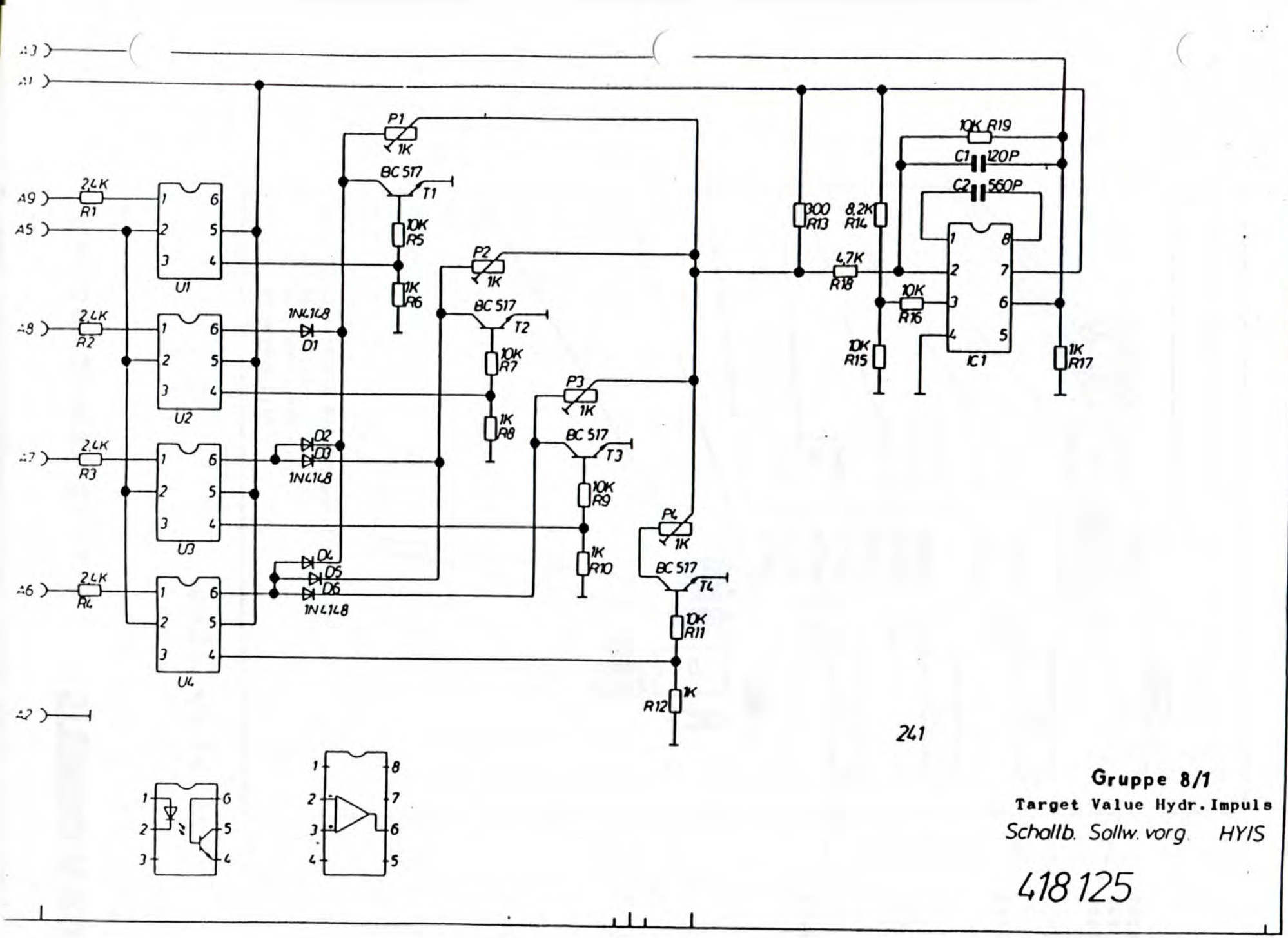
WA Prop. Valve Control
Digital Target Value Generator
4-BIT
Group 7



SECTION
8

Hydr. Interface WA





Gruppe 8/1

Target Value Hydr. Impuls

Schallb. Sollw. vorg. HYIS

418125

Impulse control system 400 144
Setting and testing instructions

Type: WA 12 - 15

Impulse control system - lift control		Voltage 80/72 V
Bosch	No. 0 196 024 011	Item No. 027 441
Circuit boards	No. 2 198 300 118	Item No. 030 976
Hydraulic interface circuit board		Item No. 420 719
MP	No. 0 196 422 011	Item No. 027 867
Hydraulic motor current		$I_{max.}$ 300 A

Adjustable on hydraulic overpressure valve as per hydraulic setting data sheet

Cycle start	0.8 - 0.9 V	
Adjustable on	R 5	Value approx. 270 K
Run-up	Normal	
Adjustable on	R 4	Value approx. 270 K
Max. desired value		4.1 - 4.2 V
Desired value	Lift	4.1 - 4.2 V
	Shift	0.1 - 0.13 m/sec
	Turning	9 - 11 sec
Adjustment potentiometer	Main lift	Potentiometer 4 (from plug side)
Hydraulic interface LP	Shift	Potentiometer 2
	End position cushion and turning	Potentiometer 1
	Main lift, slow and additional lift	Potentiometer 3

Remark:

R 15 with approx. 180 K

Test: desired value 3.6 - 3.8 V impulse control system running at full cycle

Measure: B + and 33 against negative difference =<2 V

Date: 26. 8. 1985

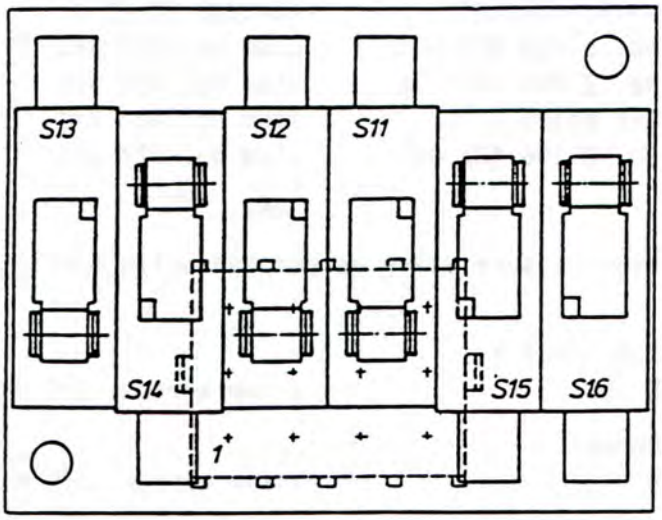
Kundendienst-Schule

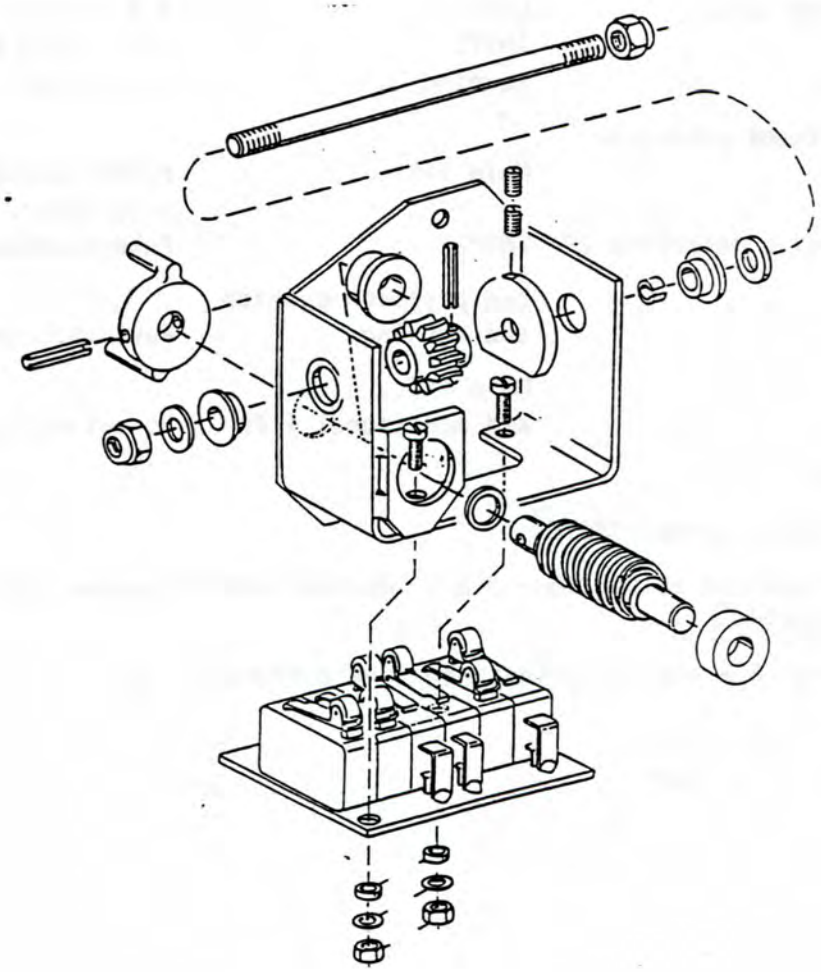
STEINBOCK BOSS

Printed Circuit Board

EEC - Regulations

Nr./No/No	
Serie/Serie/Serie	WA
Mark/Mark/Mark	
Gruppe/Group/Groupe	8
Datum/Date/Date	01.89





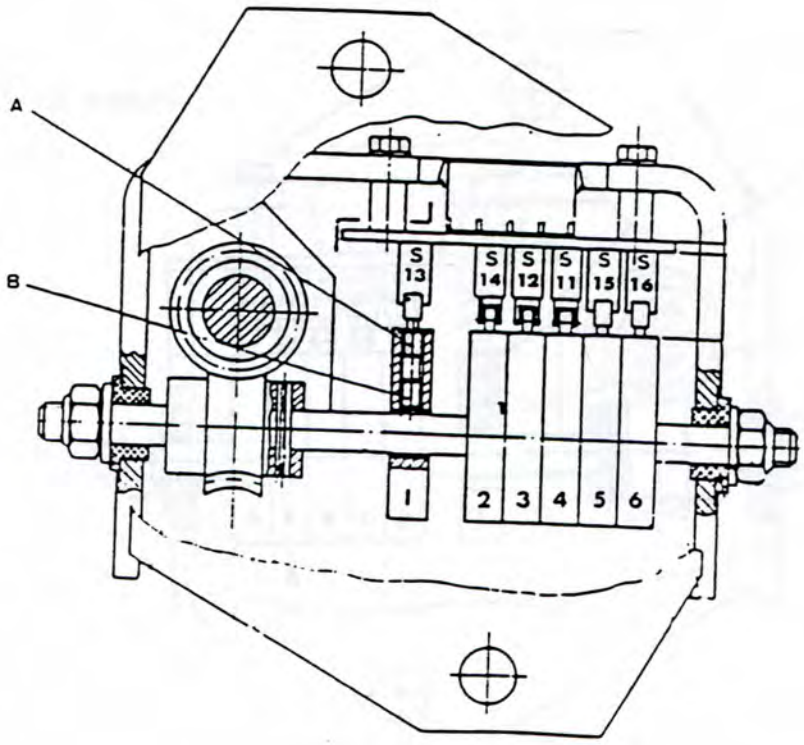
Setting the copier

The locking bolt (see A below) is to be removed (locked with Loctite) and the grub screw (see B below) to be loosened for setting the copier to the respective pointer settings on the appropriate cams 1-6.

Now the cam can be moved into the desired switching position by turning. The switching point must be tested by moving a number of times through the hydraulic "pushing" movement. Not all the cams can be reached to adjust the setting points. The grub screw can be reached by travelling forwards and back so that the cam can be set. After setting lock the locking screw with soft Loctite and turn it until it is flush with the switching curve.

It is important that no path of any great distance is selected when travelling back since otherwise the opened drill hole in the switching cam will damage the microswitch.

After setting the switching cam is to be tested by starting up several times.



1. Travel the swing-push fork into the basic position, left, as shown in Figure 1 and swing the forks to the right.
   Set the switch-off point for pushing to left (fork left, 1st limit switch 15 - PC 246) with switching cam No. 5 (Figure 2) so that the swing-push fork is aligned with the swing-push fork frame.

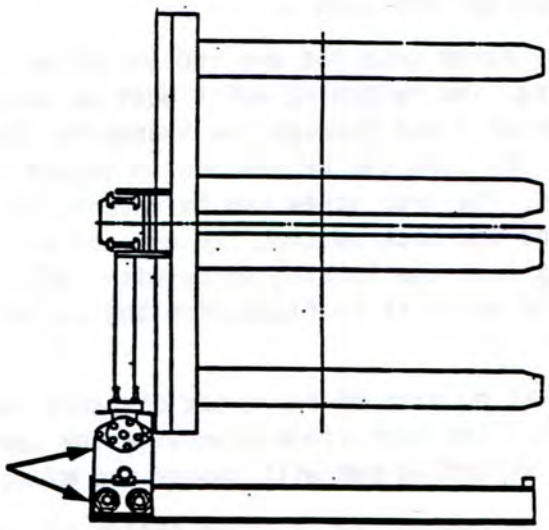


Figure 1
(View from driver's seat downwards)

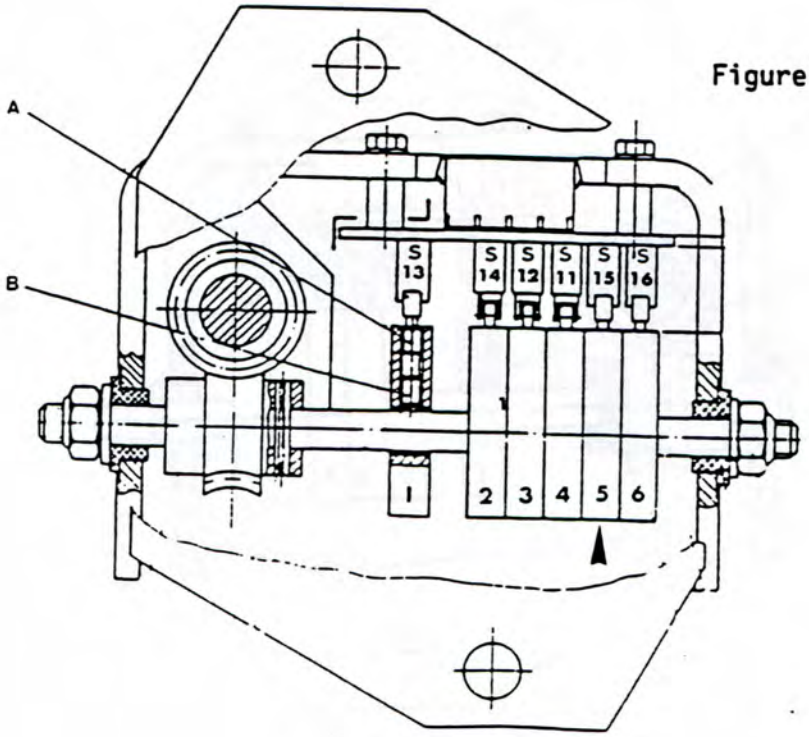


Figure 2

2. Travel swing-push fork 100 mm to the right (Figure 3).
   Set end position cushioning switching point, left,
   - switch 14 - PC 247 (switchover to push speed).
   Set with switching cam No. 2.

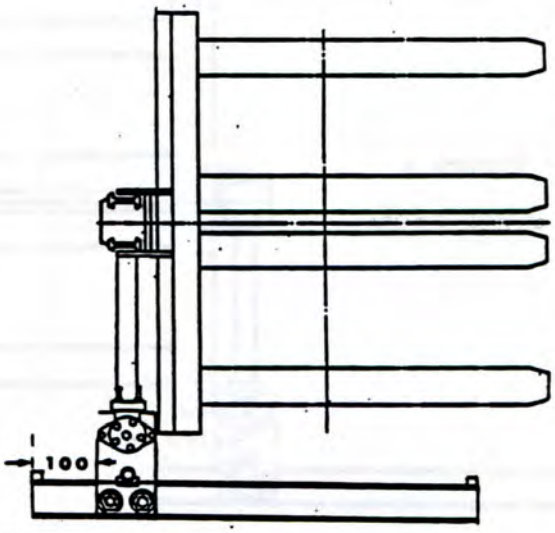
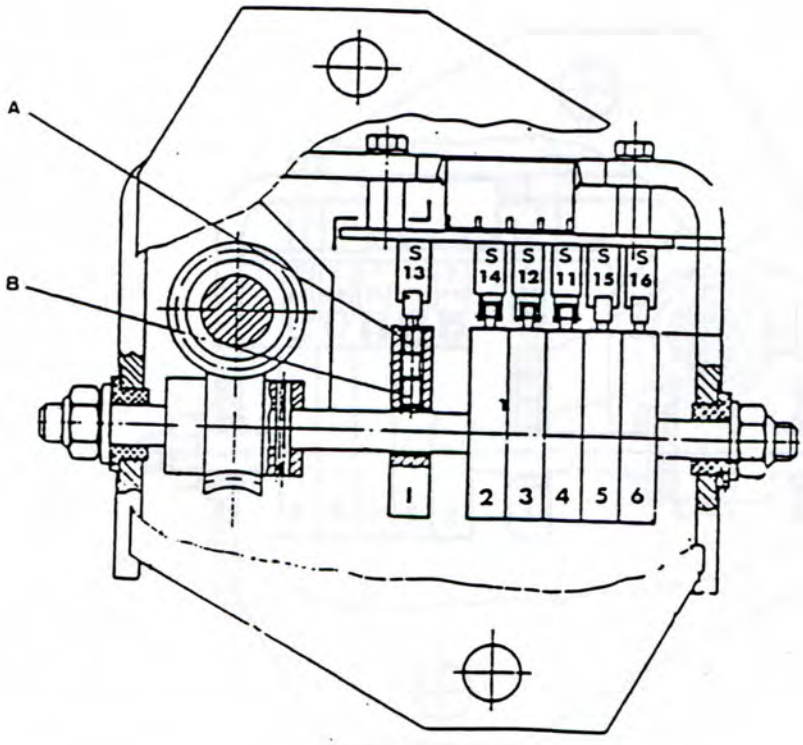
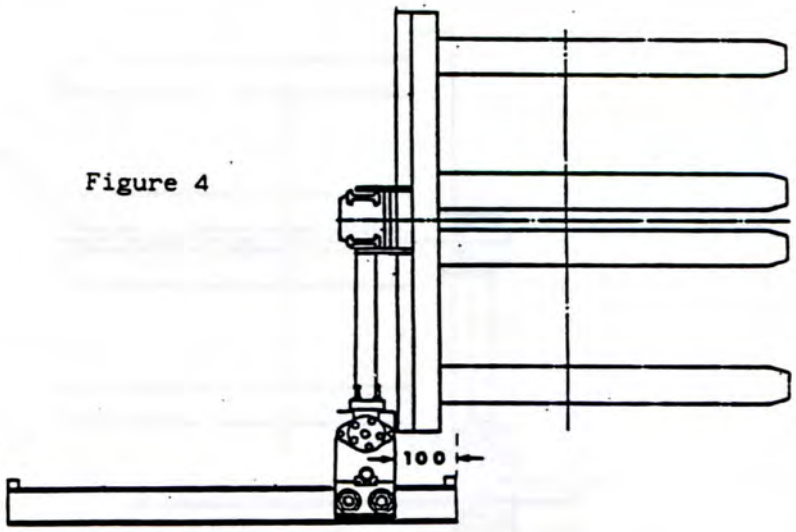


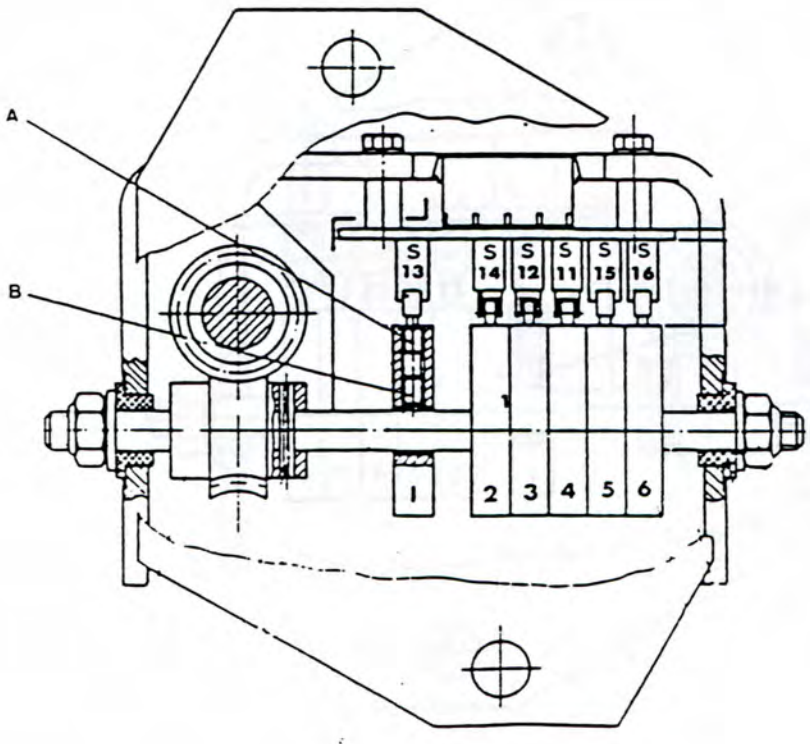
Figure 3



3. Travel swing-push fork 100 mm to the right (Figure 4).
   Set end position cushioning switching point on the right, switch 13 - PC 252.
   Set with switching cam No. 1.

Figure 4





4. Travel the swing-push fork to the right up to the mechanical stop (Figure 5).
   Set right fork switching point without limit switch 11 - PC 250. Set using switching cam No. 4 so that the mechanical stop is just touched.
   A delayed switch off point will prevent any cut-out and this will lead to mechanical stress.

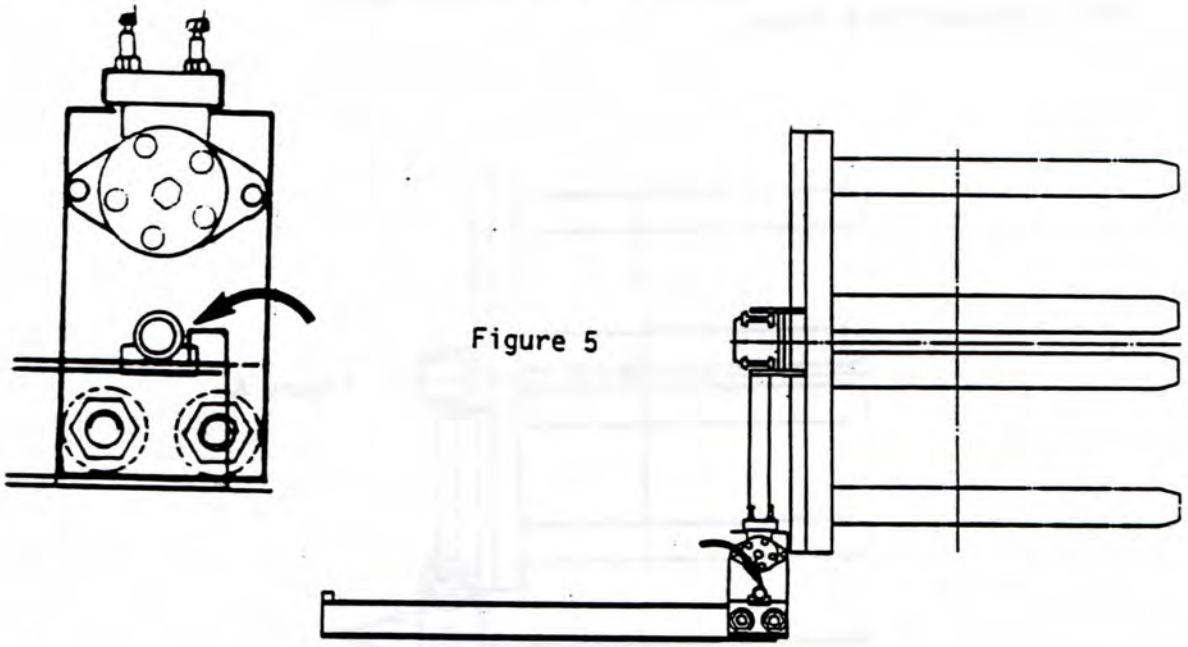
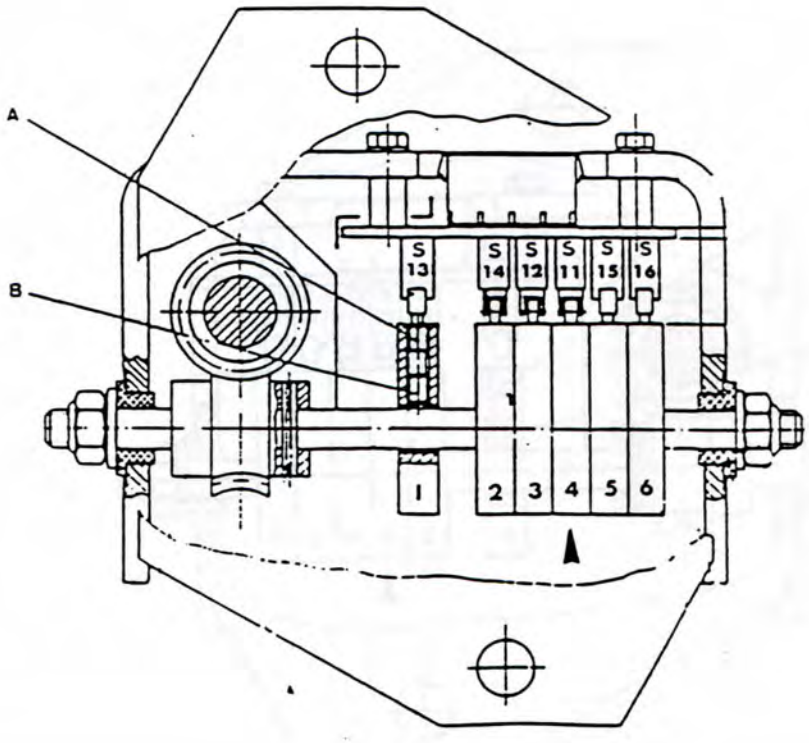


Figure 5



5. Travel swing-push fork to the left until it is inside the cushioning end position and swing the fork to the left.
   Travel the swing-push fork to the right (Fig. 6).
   Set the switch off point for pushing, right, 1st limit switch 12 - PC 251 with switching cam No.3 (Fig. 5) so that the swing-push fork is aligned with the swing-push fork frame.

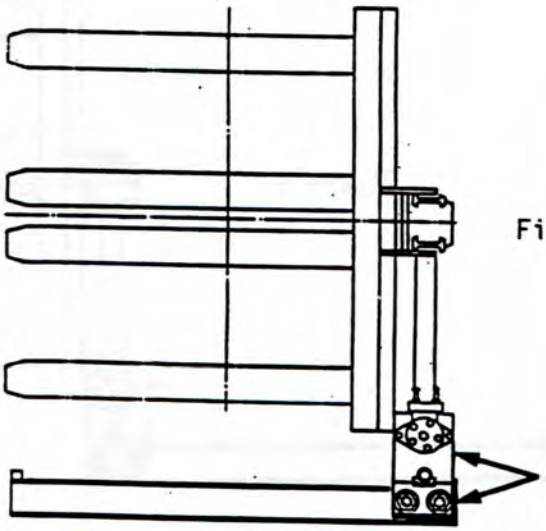
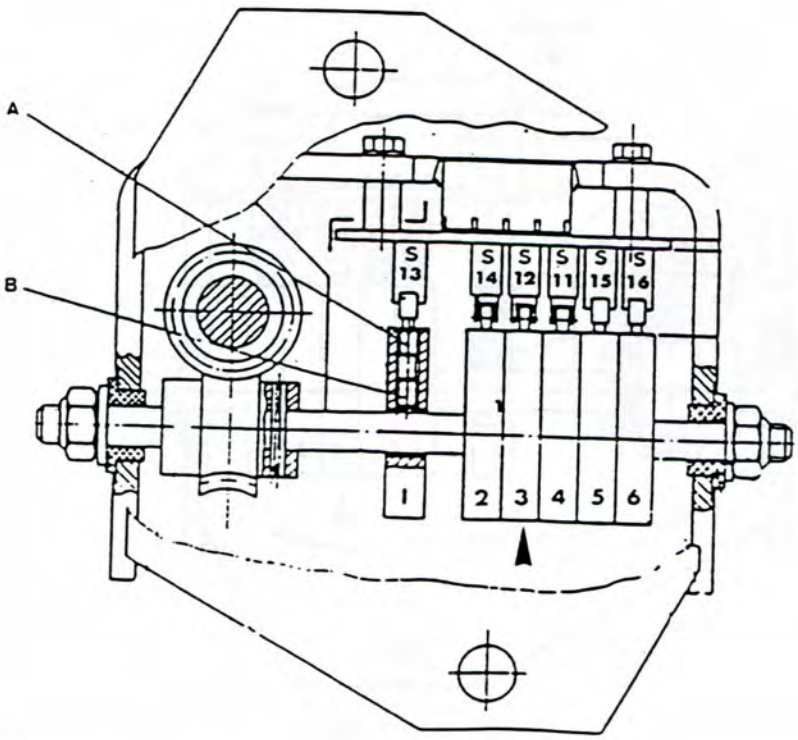
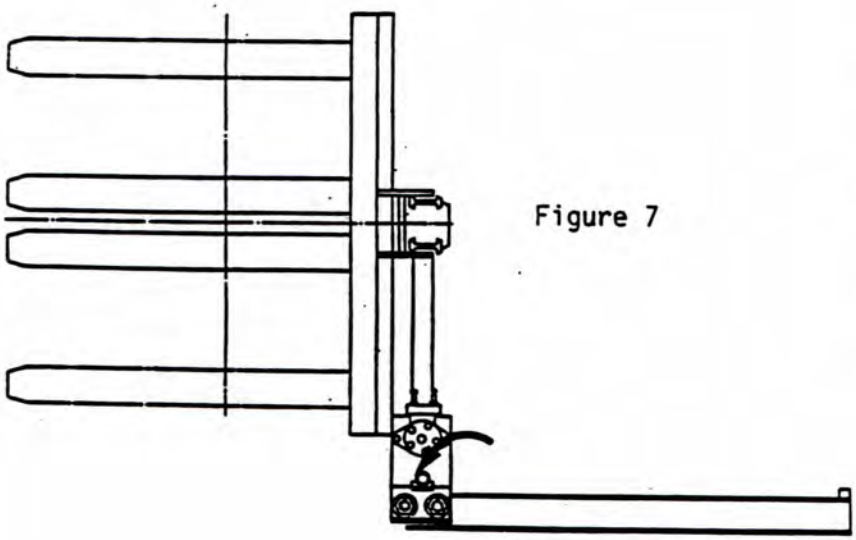


Figure 6



6. Travel the swing-push fork to the left up to the mechanical stop (Fig. 7).
   Set the switching point, left fork, without limit switch 16 - PC 245.
   Set using switching cam No. 6 so that the mechanical stop is just touched.



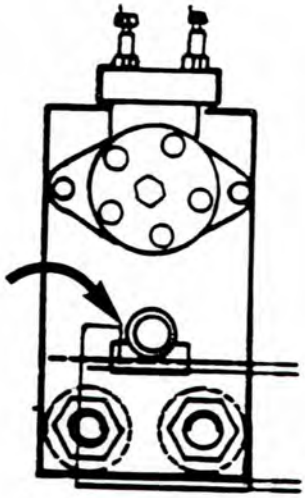
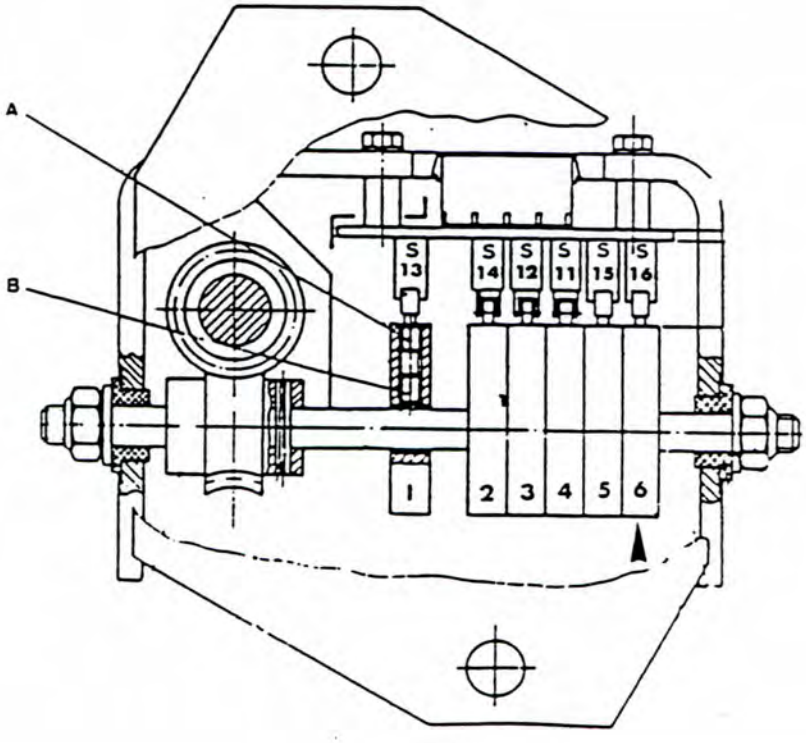
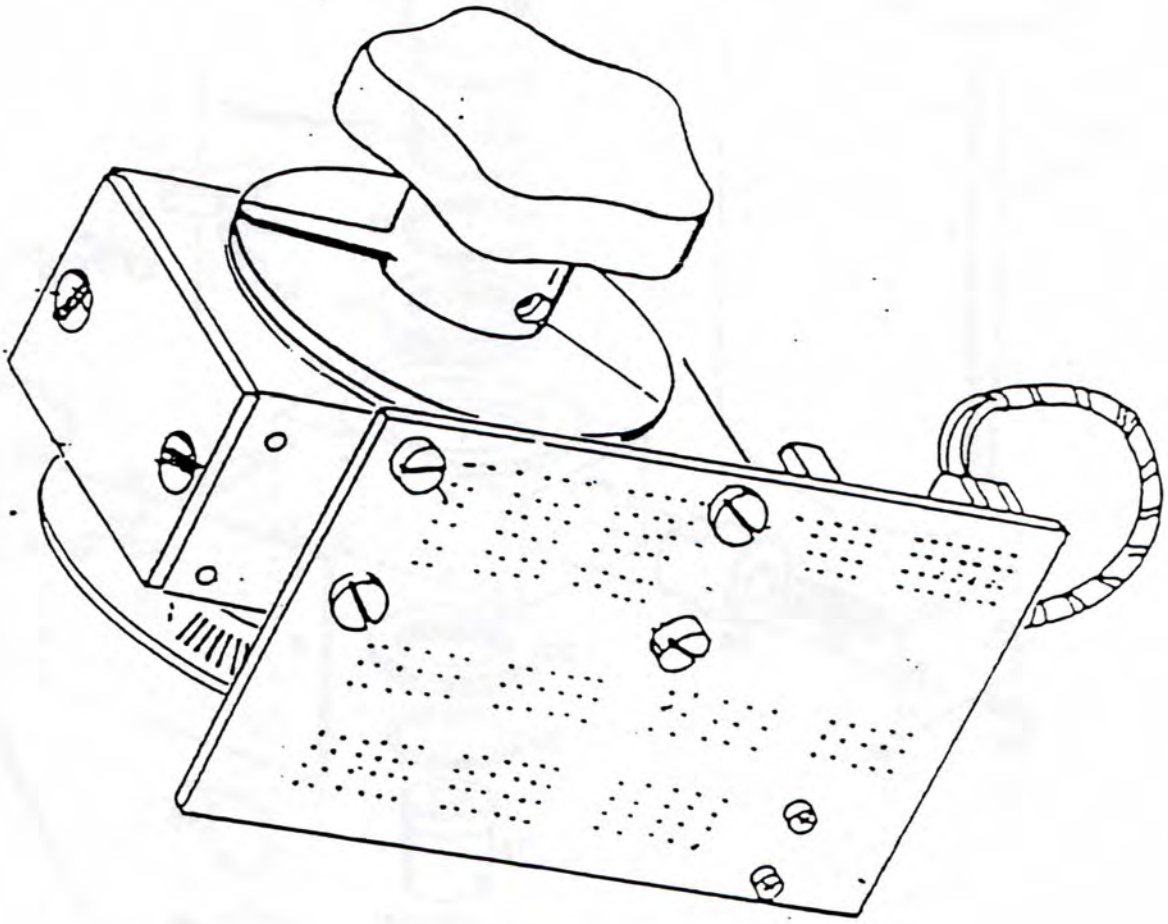
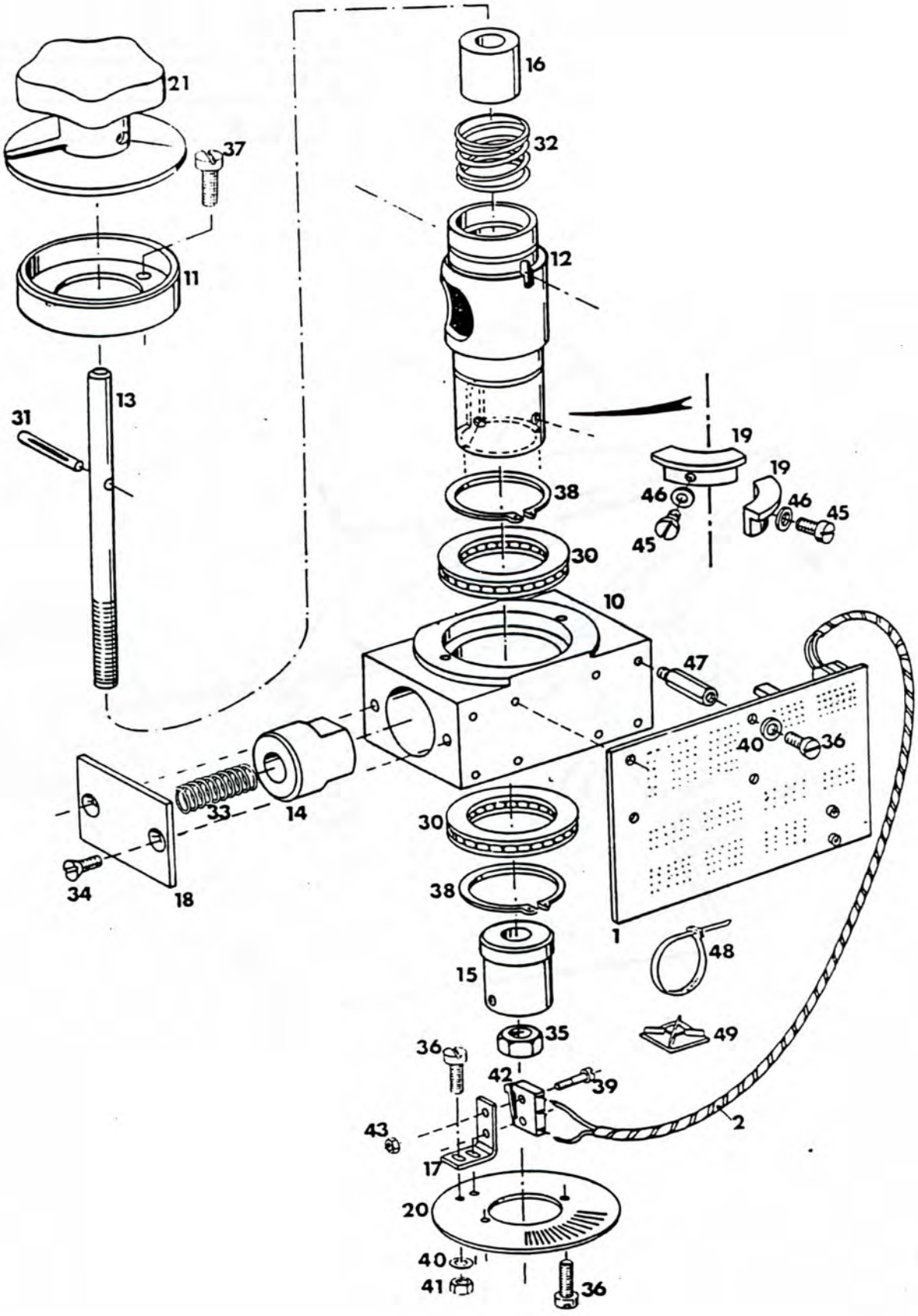


Figure 7



WA Prop. Valve Control
Digital Target Value Generator
4-BIT
Group 8




21
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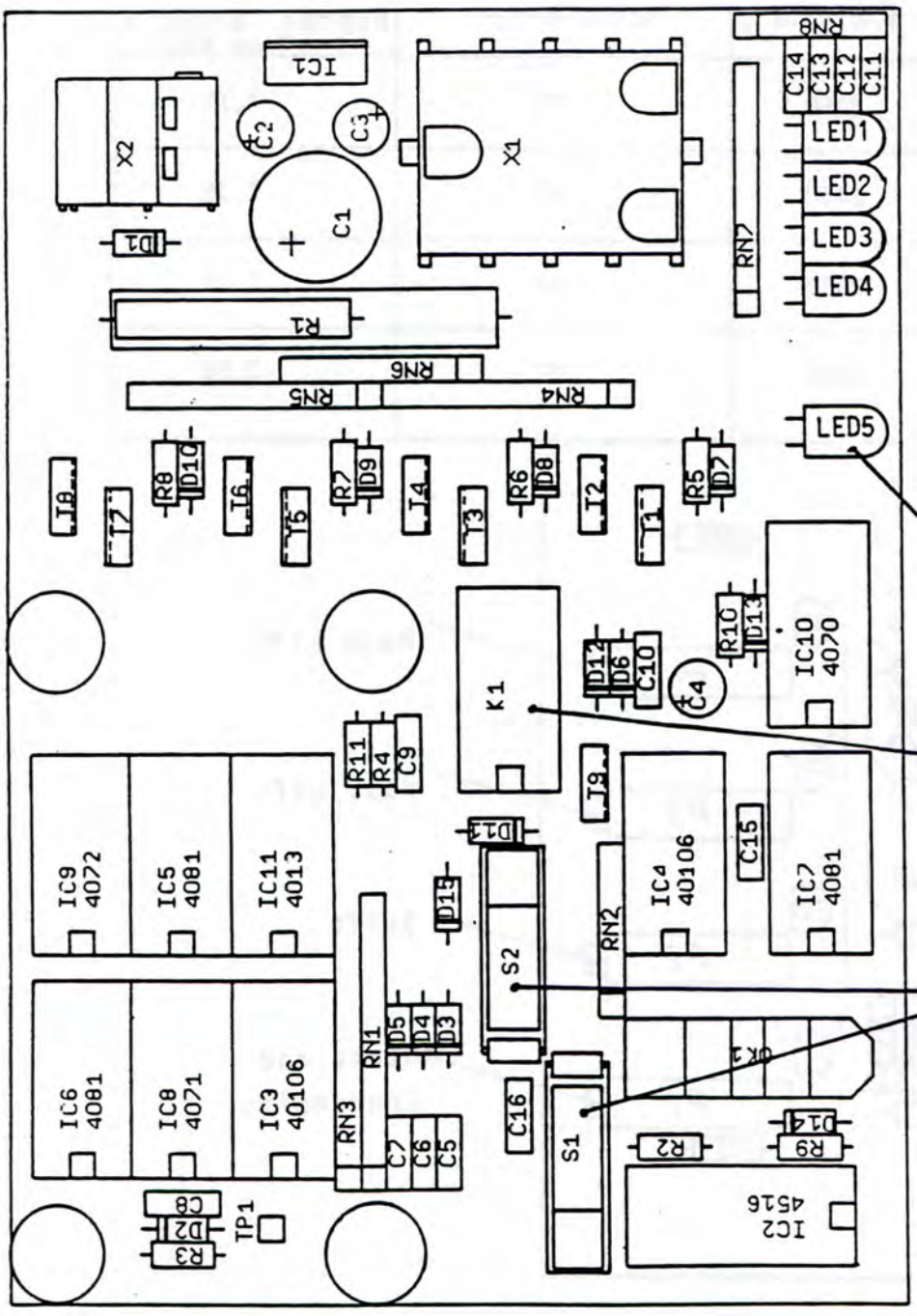
WA-Proportionalsteuerung
Leiterplatte digitaler Sollwert
Hydraulikssteuerung
Gruppe 8



Dezimal-zahlen-wert	LED: 4	3	2	1
0	0	0	0	0
1	0	0	0	●
2	0	0	●	0
3	0	0	●	●
4	0	●	0	0
5	0	●	0	●
6	0	●	●	0
7	0	●	●	●
8	●	0	0	0
9	●	0	0	●
10	●	0	●	0
11	●	0	●	●
12	●	●	0	0
13	●	●	0	●
14	●	●	●	0
15	●	●	●	●

No Fault

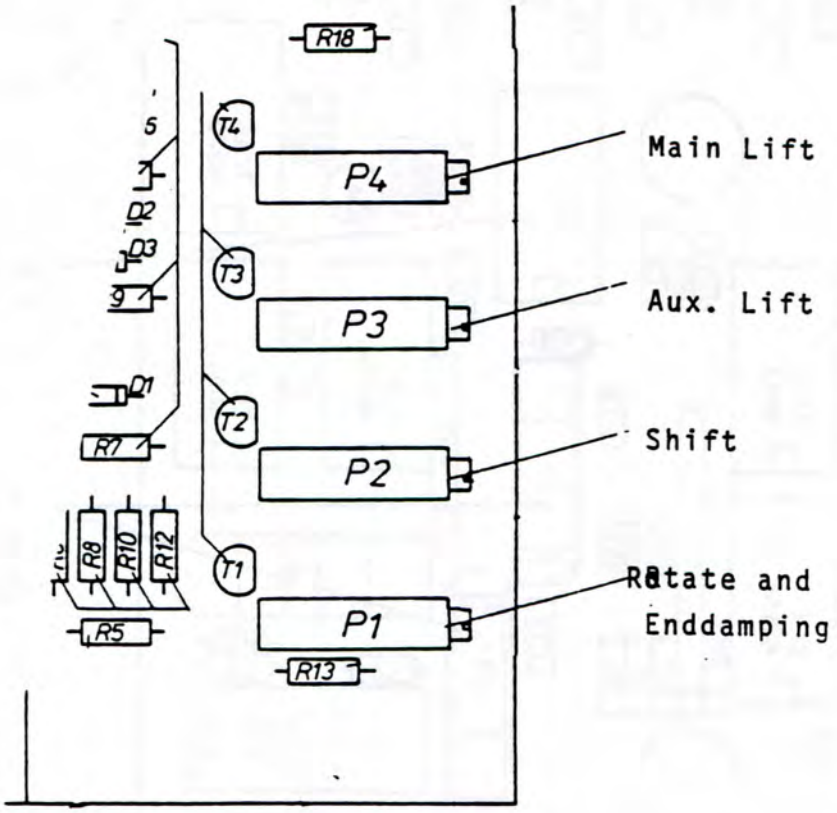
Relay K 1
no Fault

S1/S2 Microswitch
for Direction and
Counter-Control

Serie WA-Prop.
Gruppe 8

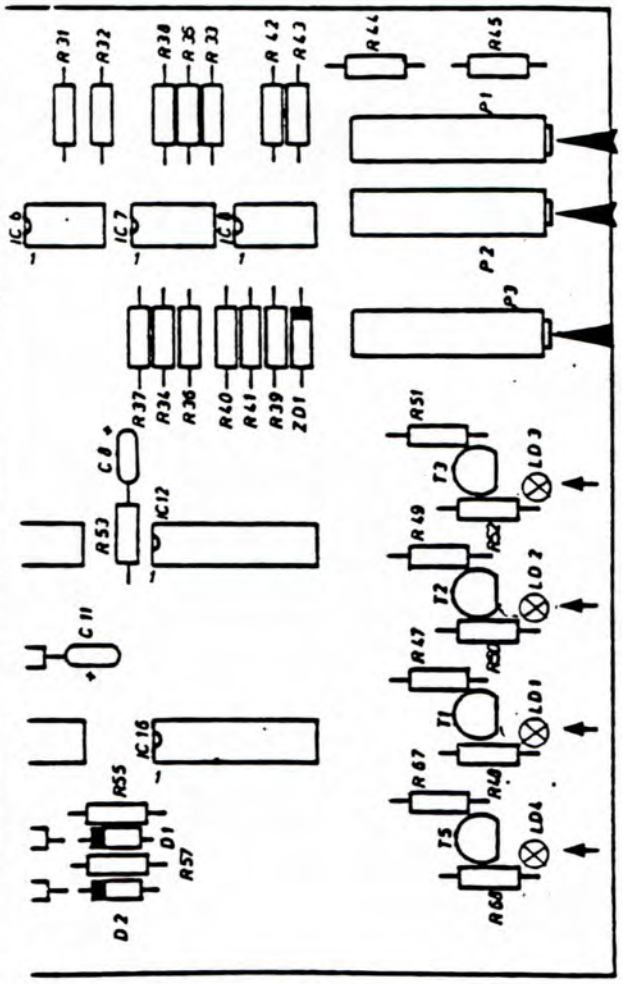
Basicadjusting of Pumpmotorspeed via Hydraulic-Interface-Card

	1°/min±50	Potentiometer	Approx.Target Val. (V an B22)
Main Lift	3050	P4	4,15
Aux. Lift	2450	P3	2,35
Shift	2050	P2	2,09
Rotate and Enddamping	1850	P1	2,09



SECTION
9

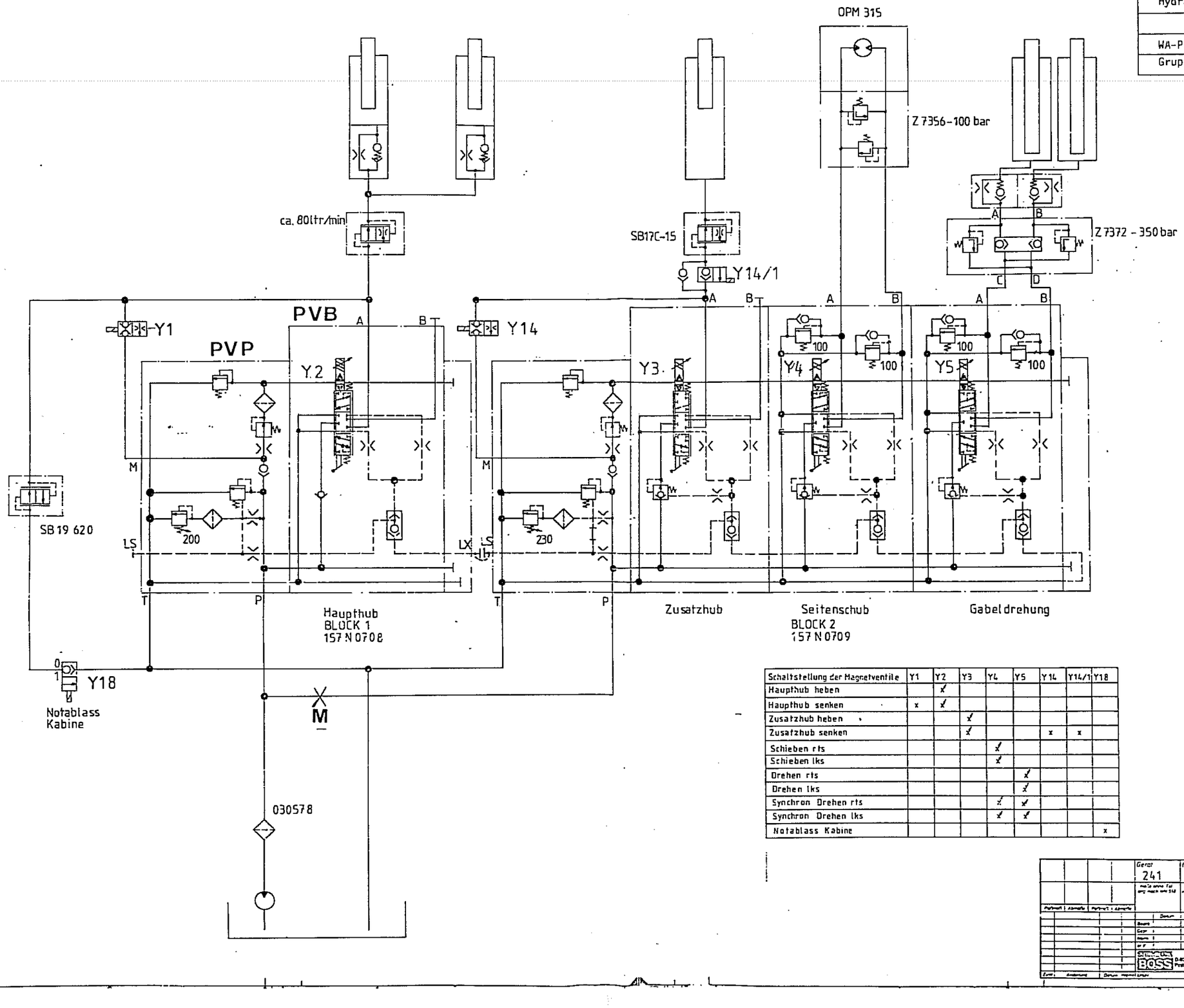
Electrics Circuit - Board Electronic Steer Control	027859



1. Electric Limit - Left
2. Electric Limit - Right
3. Middle
4. End Stage
5. Target Value outwith Zone
6. Actual Value outwith Zone
7. Power Circuit

SECTION
10

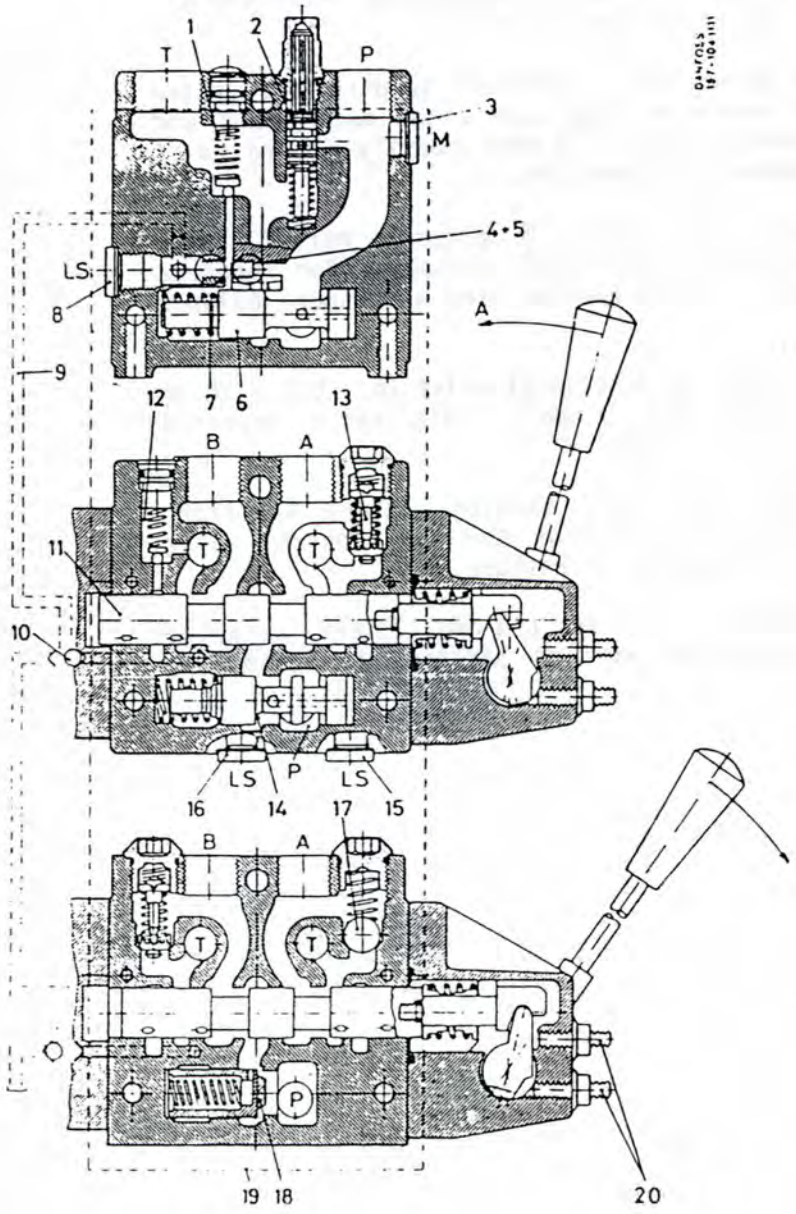
Hydraulikschaltplan
WA-Proportionalsteuerung
Gruppe 10 Nr. 2



Schaltstellung der Magnetventile	Y1	Y2	Y3	Y4	Y5	Y14	Y14/1	Y18
Haupthub heben		x						
Haupthub senken	x	x						
Zusatzhub heben			x					
Zusatzhub senken			x			x	x	
Schieben rts				x				
Schieben lks				x				
Drehen rts					x			
Drehen lks					x			
Synchron Drehen rts				x	x			
Synchron Drehen lks				x	x			
Notablass Kabine								x

Gerät 241	Ersetzt	Änd. Nr. 4 28 2016	
		Werkstoff / Rohteil	Zeichn. / Norm
		Benennung	Hydraulikplan WA12/15
		Nr. 463 971	Änd. Nr.

Proportional Control Valves



Key

1. Pressure Regulating Valve (Control Valve).
2. Pressure Reducer for Pilot Supply.
3. Gauge Test Point.
4. Plug - Open Centre.
5. Orifice - Closed Centre.
6. Inlet Valve (Pressure Balance).
7. Plug - Closed Centre.
8. L.S. Connection.
9. L.S. Impulse Line.
10. Change-Over Valve.
11. Main Spool.
12. L.S. - Pressure Relief Valve.
13. Shock Valve and Make-Up Valve.
14. Piston Valve.
15. L.S. - Port, A - Port.
16. L.S. - Port, B - Port.
17. Top-Up Valve PVLA.
18. Non Return Valve in P Duct.
19. Pilot supply to PVE.

DESCRIPTION

Operation, Open Centre PVP.

After the pump is switched on, if the main spool (11) of the basic section is in the neutral position, oil from the pump flows through the port P, through the inlet valve (6), back to the tank.

When the main spool is actuated, the highest load pressure is transmitted, via the change over valve chain, to the spring chamber behind the inlet valve (6) and the return to tank is completely or partially closed off.

Pump pressure acts on the other side of the inlet valve. If the load pressure exceeds the pre-set value, the pressure regulating valve and the piston valve (14) open and the oil is returned to tank.

In basic sections with piston valve (14), different loading and system pressures are controlled. The pressure drop across the main spool and also the flow rate remains constant even if a more heavily loaded basic section (slice) of the valve assembly is operated.

It is only possible to incorporate adjustable L.S. pressure relief valves (12) in port A and port B, to control individual pressures for separate hydraulic functions, if the basic section incorporates a pressure balance valve.

In a basic section without a pressure balance inlet valve (6), but with an integral non-return valve (18) in the P duct, this valve prevents undesirable back flow of the hydraulic fluid.

By means of load control valves, the basic section without auxiliary functions can be installed in the P circuit as the load control valve controls the movement of the load by negative pressure.

Preset (non-adjustable) make-up and shock valves (13 and 17) are installed in the A and B ports of the individual working sections as protection against overloading.

Electric Operation

Fault Monitoring.

The integral fault monitor built into the PVEH valve should be able to detect quickly any operational fault e.g. main spool sticking because of dirt.

It responds quickly and independently of any operator action and enables the system to be switched off before any uncontrolled movement takes place.

The Fault Monitor responds:-

a) if the main spool is moved further (actual value) than it should be, according to the signal voltage (target value) i.e. if the piston return position is not an analog function of the electrical signal.

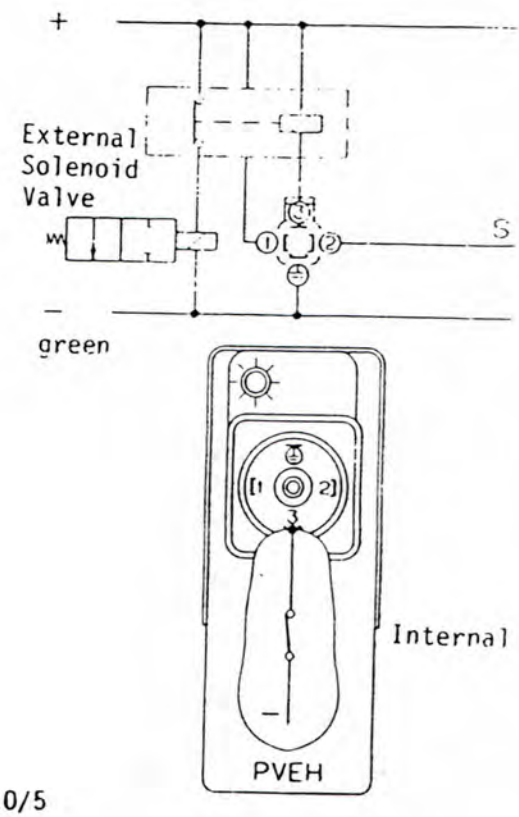
b) when, for instance, there is an internal electrical fault.

c) if the signal voltage is definitely outside the working range (max. value 90% min. value 10% of the supply voltage) e.g. short circuit in the cable to remote control lever (unit).

The fault duration must be more than 500 ms before the fault monitor will respond.

Normal Operation

Normal Operation
Green Lamp Indicates



Sequence when fault is detected.

The supply to the solenoid valve in the PVEH assembly is interrupted and the valves return to their output positions.

The main spool returns, under spring pressure, to its neutral position, provided that there is no contamination to cause sticking.

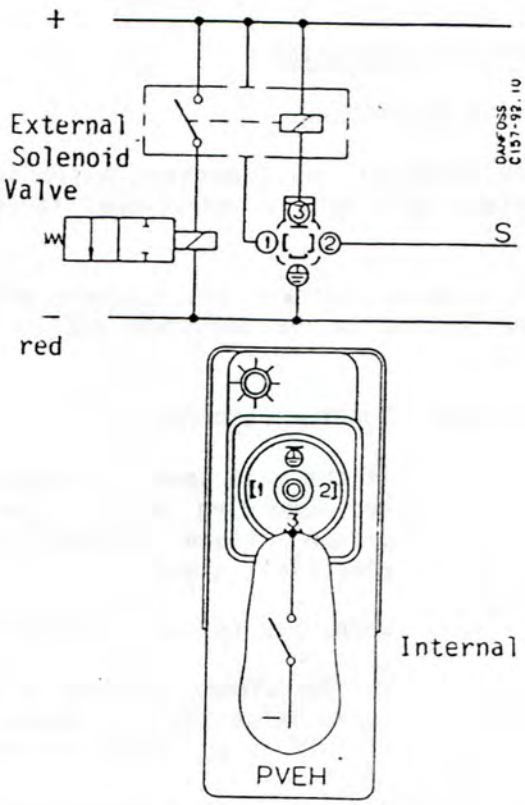
Red lamp indicates.

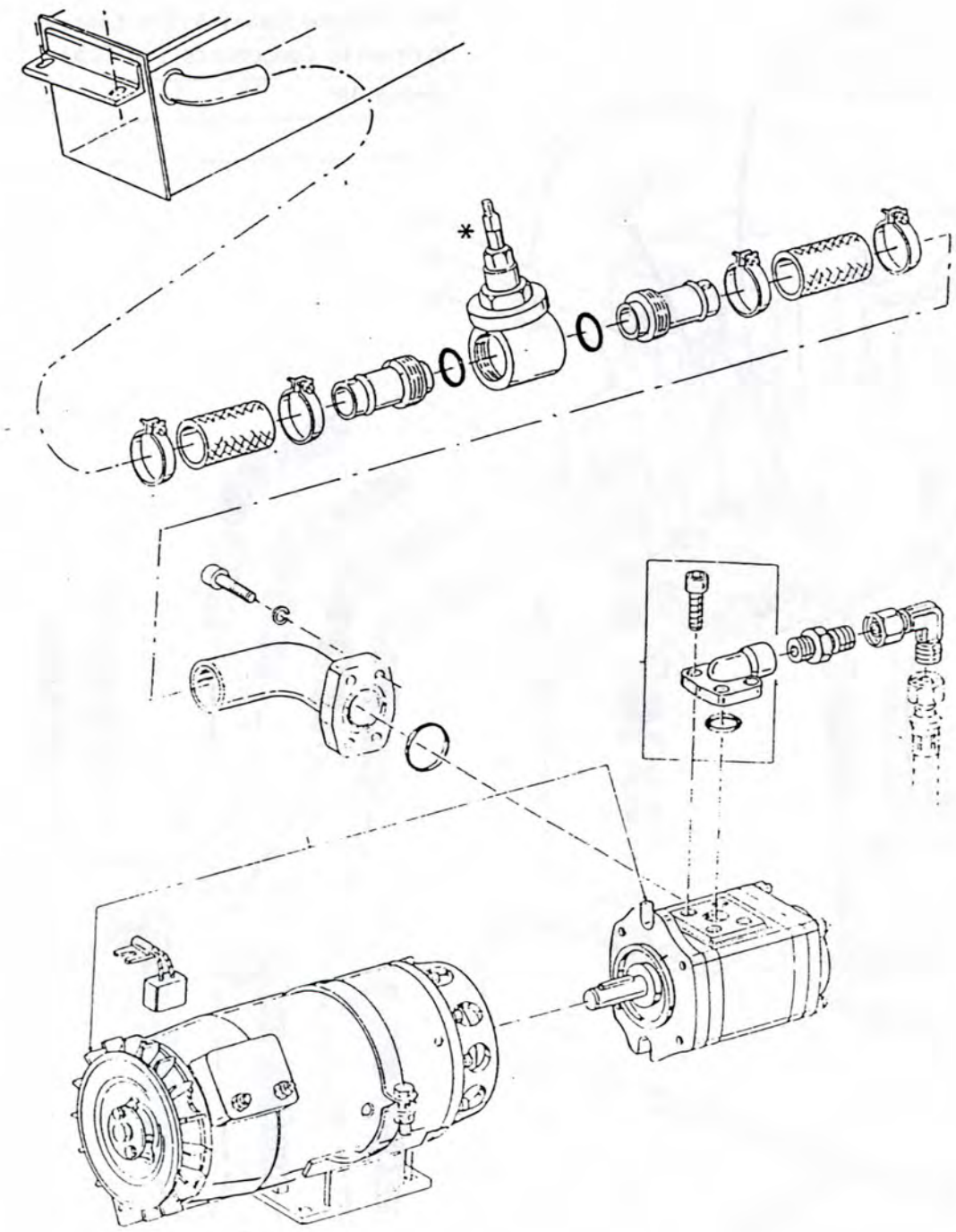
Terminal 3 may be utilised as a sender for a relay.

Starting up after Fault Condition:

Before re-starting again the voltage supply must be interrupted (and then re-connected).

Fault Switching



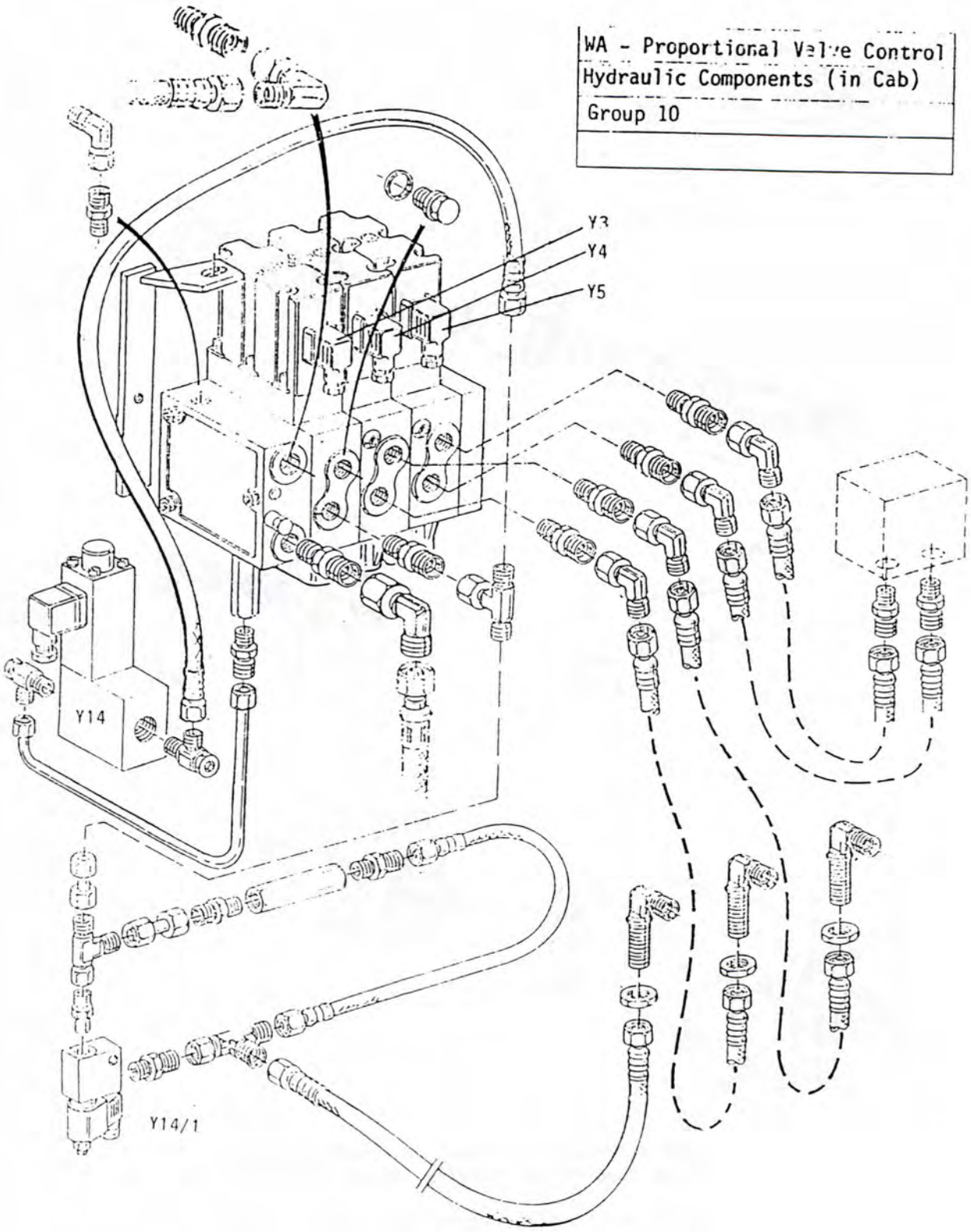


Shut gate valve* before disconnecting pump.
Allow pump to run briefly to empty suction line.

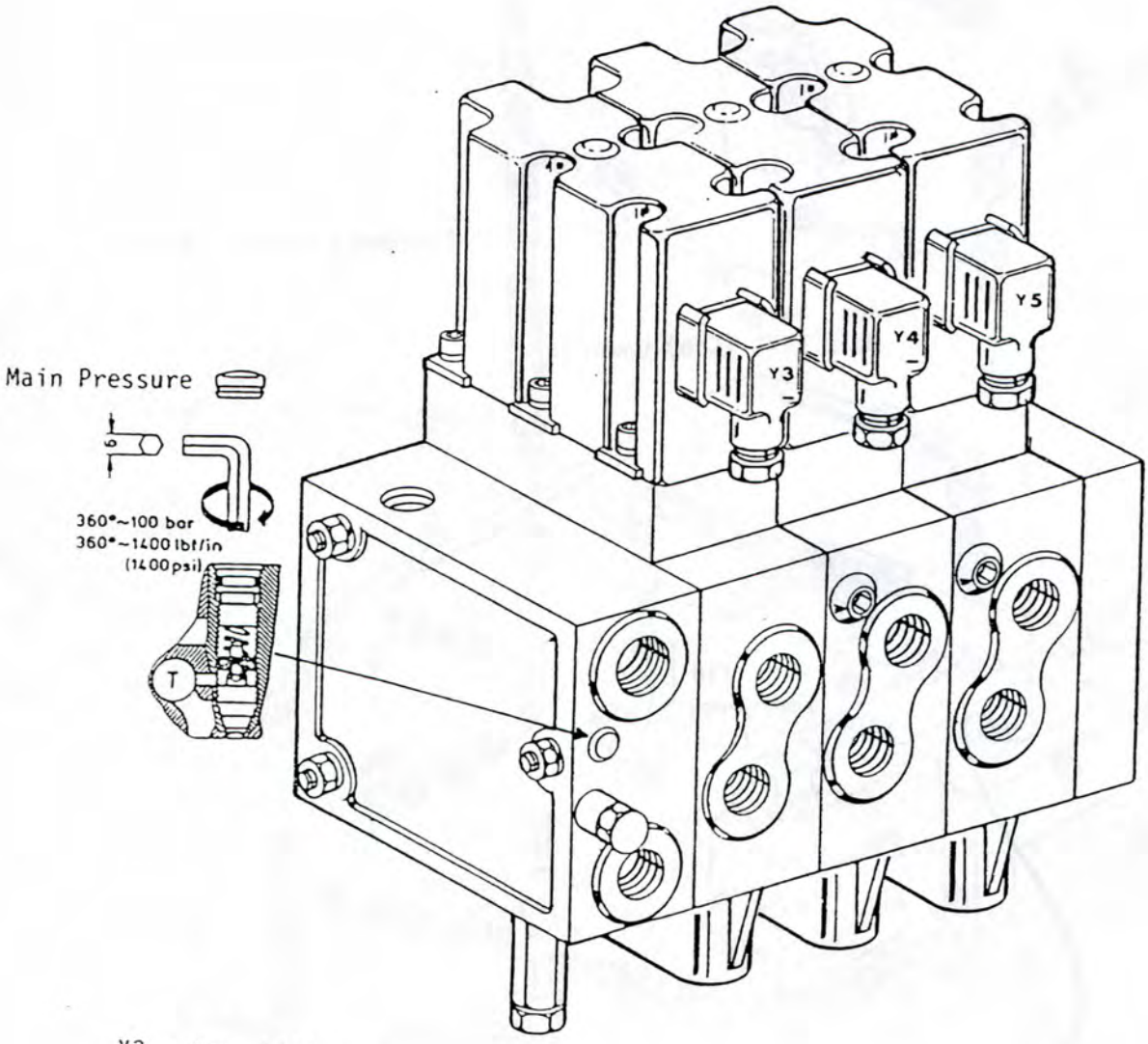
After reassembly, ensure that the gate valve is fully open.

WA - Proportional Valve Control
Hydraulic Pump Assembly with
Gate Valve.

WA - Proportional Valve Control
Hydraulic Components (in Cab)
Group 10



WA - Proportional Valve Control
Proportional Valve (in Cab)
Group 10

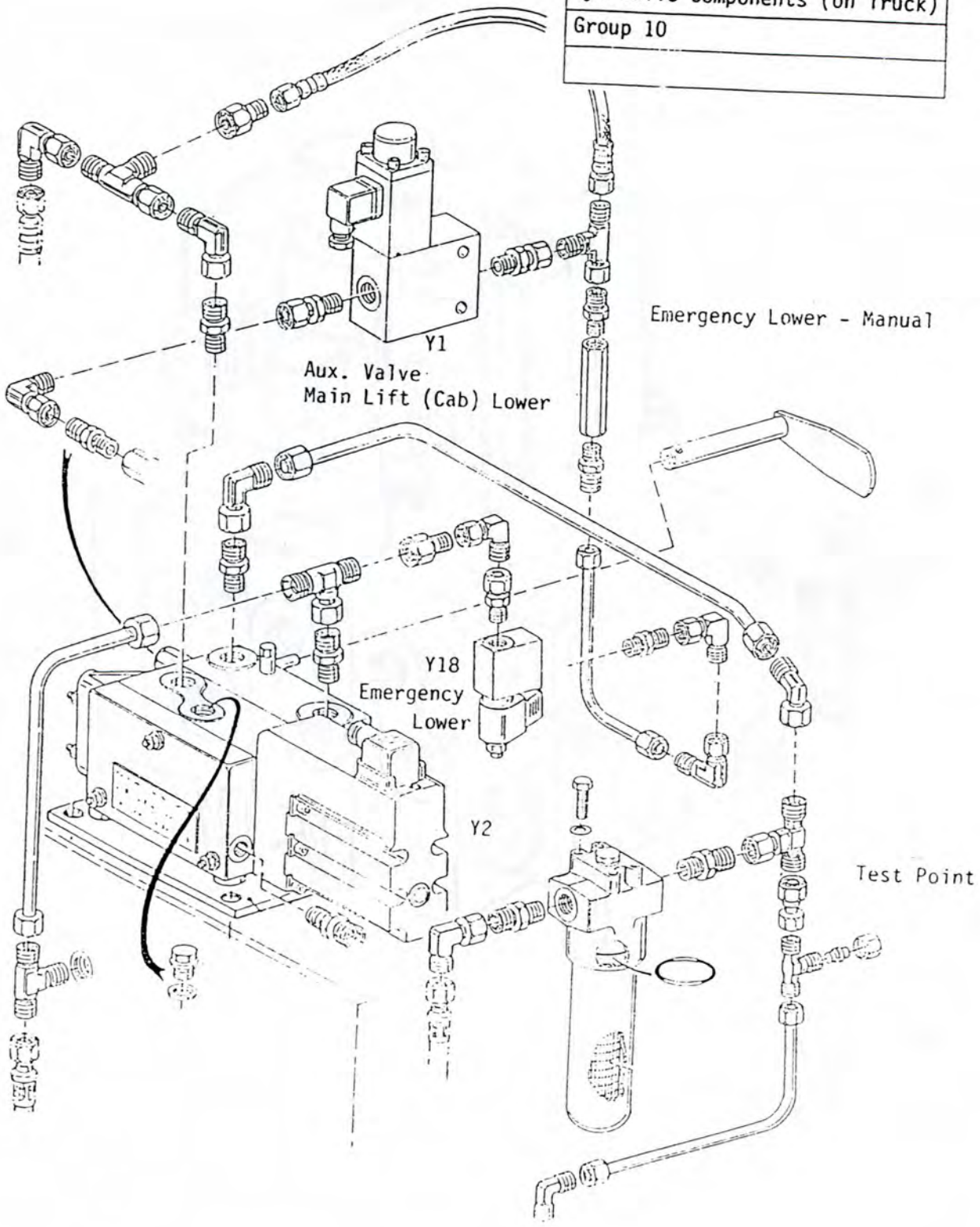


Y3 - Aux. Lift

Y4 - Side Shift

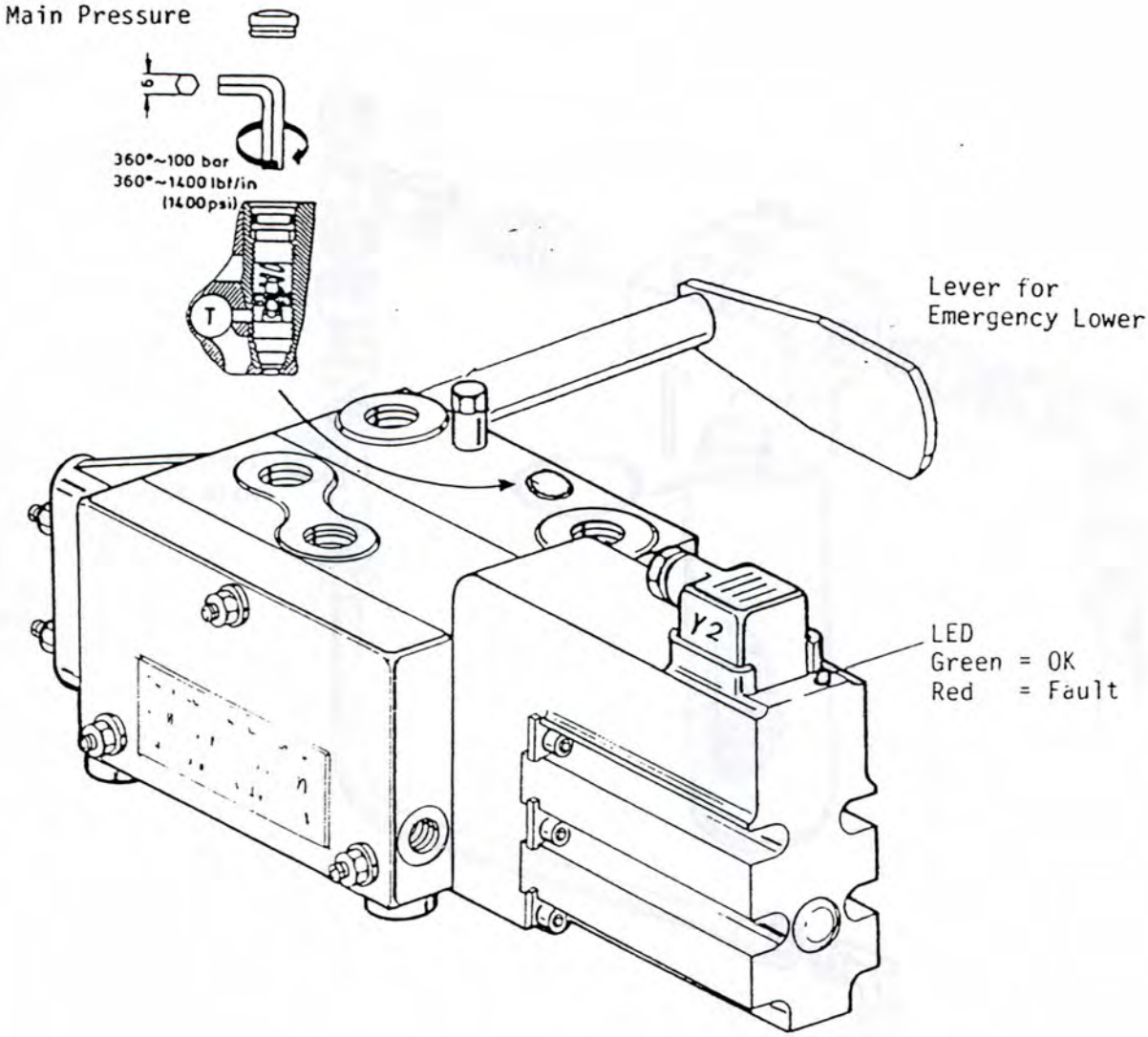
Y5 - Rotate

WA - Proportional Valve Control
Hydraulic Components (on Truck)
Group 10



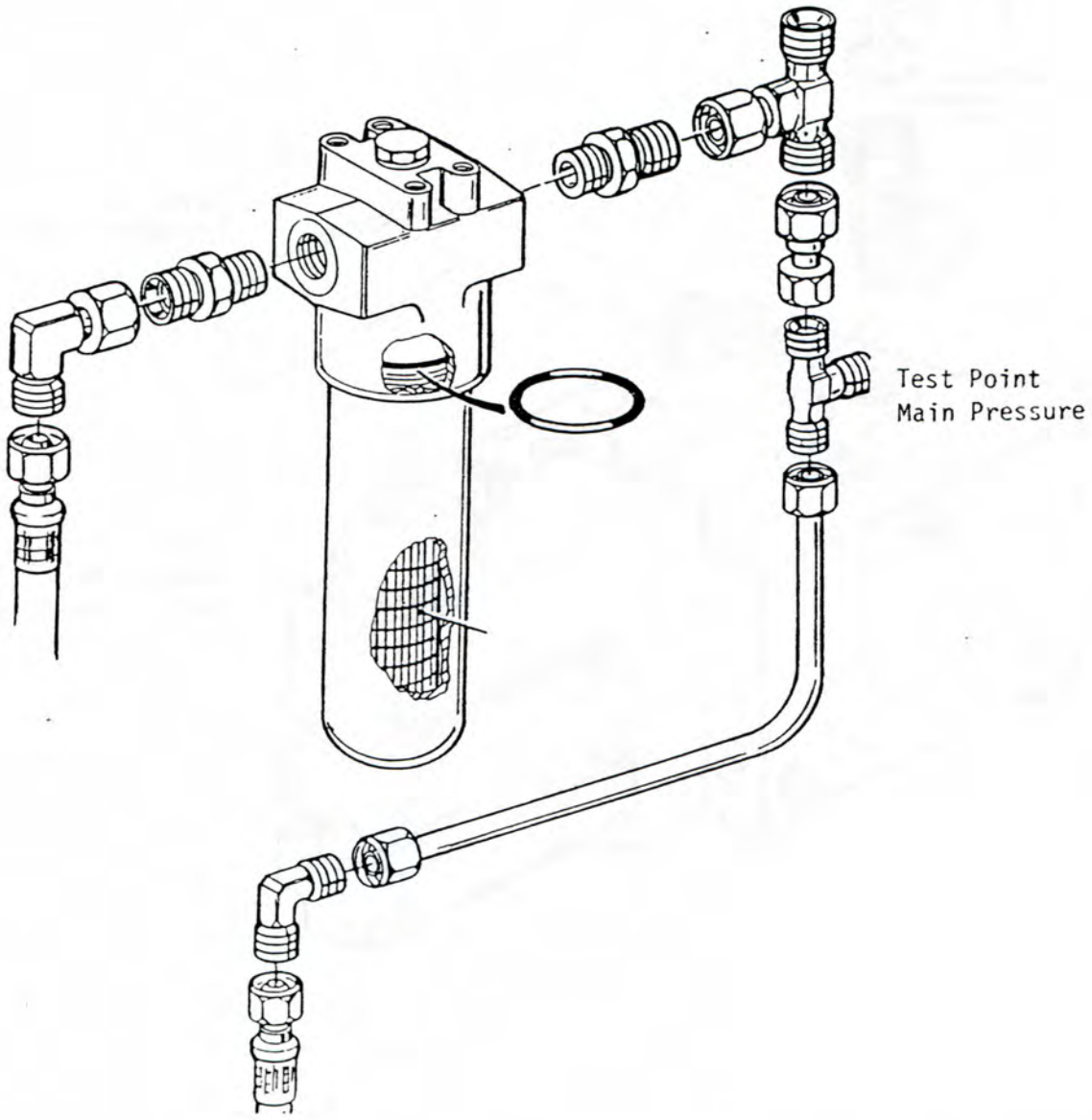
WA - Proportional Valve Control

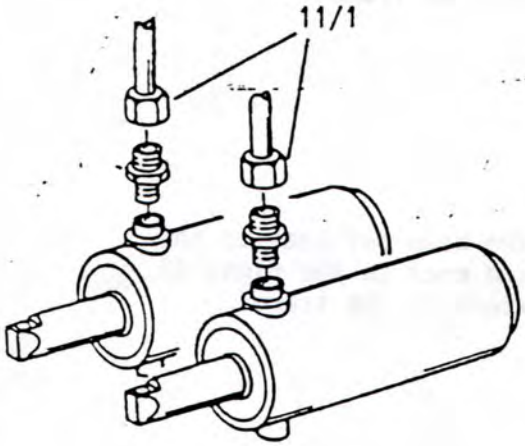
Proportional Valve - Main Lift Y2 Group 10



Pressure Relief Valve Setting	Valve No. 1 PVP (Rear)	Valve No. 2 PVP (Cab)
	200 bar (2900 lbf in²)	20 - 30 bar (290 - 435 lbf in²)
	3 Stage Mast 220 bar (3190 lbf in²)	Higher than Value No. 1

WA - Proportional Valve Control
Hydraulic Filter
Group 10

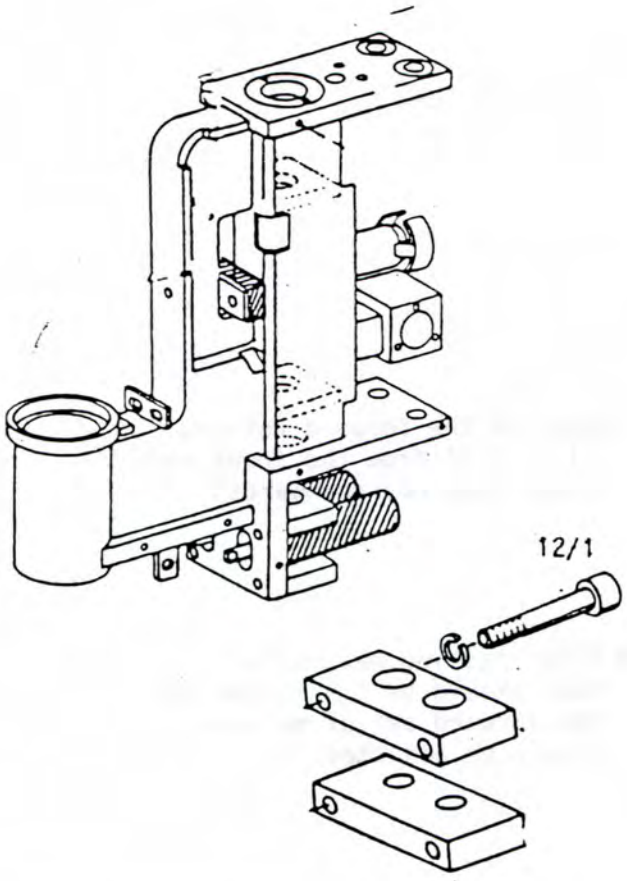




Removal and installation of hydrostatic rotation presses

Removal:

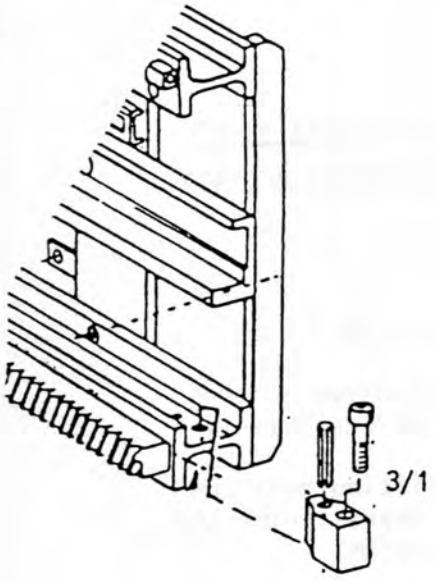
- Remove the roller chain.
- Run the piston rod inwards to the end of its travel.
- Lower the lifting gear completely to depressurise the hydraulic system.
- Operate the emergency cut-out switch.
- Unscrew the hydraulic line (fig. 11/1) from the press.



- Take out the press fixing screws (fig. 12/1) and remove the press.

Note:

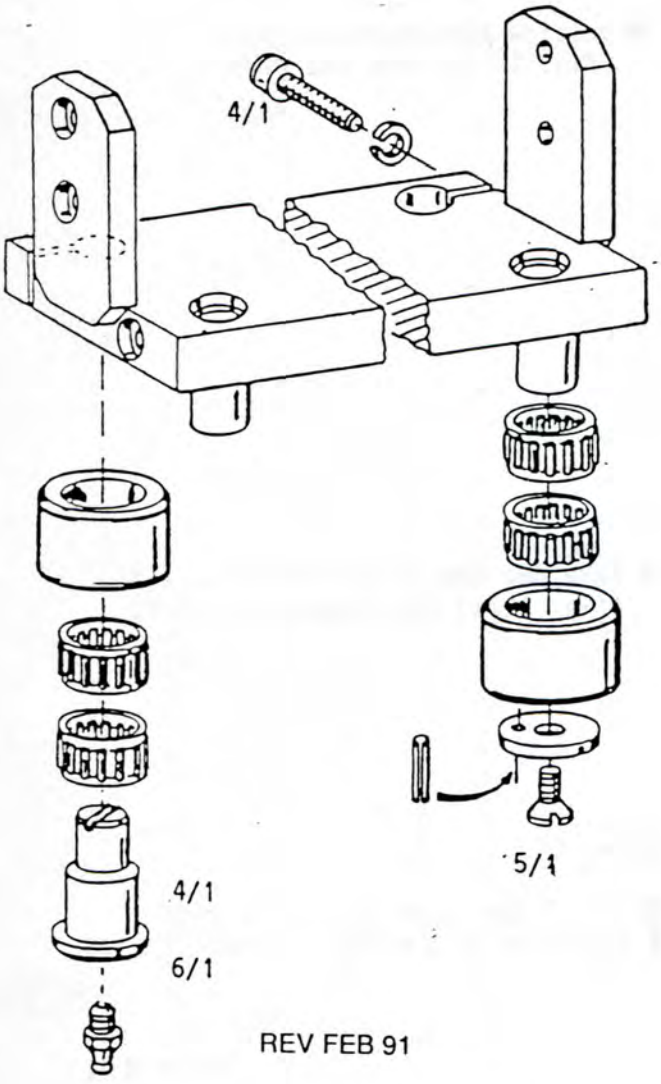
Follow the same procedure when removing the second cylinder.



Replacement of guide carriage rollers

- Unscrew the buffer stops of the guide carriage (fig. 3/1) on the left and right hand sides of the frame.

- Move the beam out once to the left and once to the right to the extent of its travel.



- Unscrew the rear rollers (fig. 4/1) from below with an Allan wrench and withdraw them from the pin.

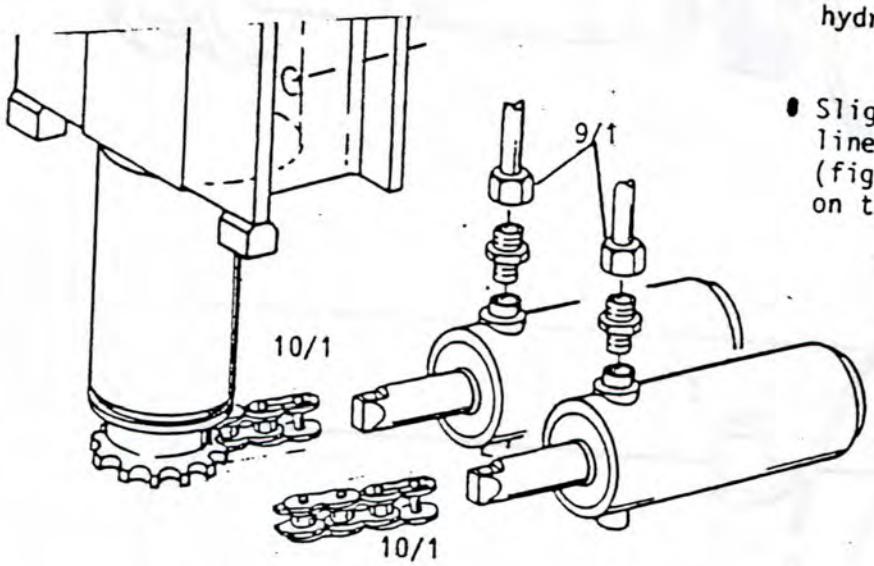
- Unscrew the forward rollers (fig. 5/1) from the front and press them out downwards.

- After fitting new rollers, they should be lubricated and the forward set of rollers should be adjusted.

Removal and installation of roller chains for rotation of articulated unit

Removal:

- Rotate the fork carrier to its mid-position.
- Lower the lifting gear completely to depressurise the hydraulic system.
- Slightly loosen the hydraulic line connection to each cylinder (fig. 9/1) to slacken the tension on the corresponding roller chain.



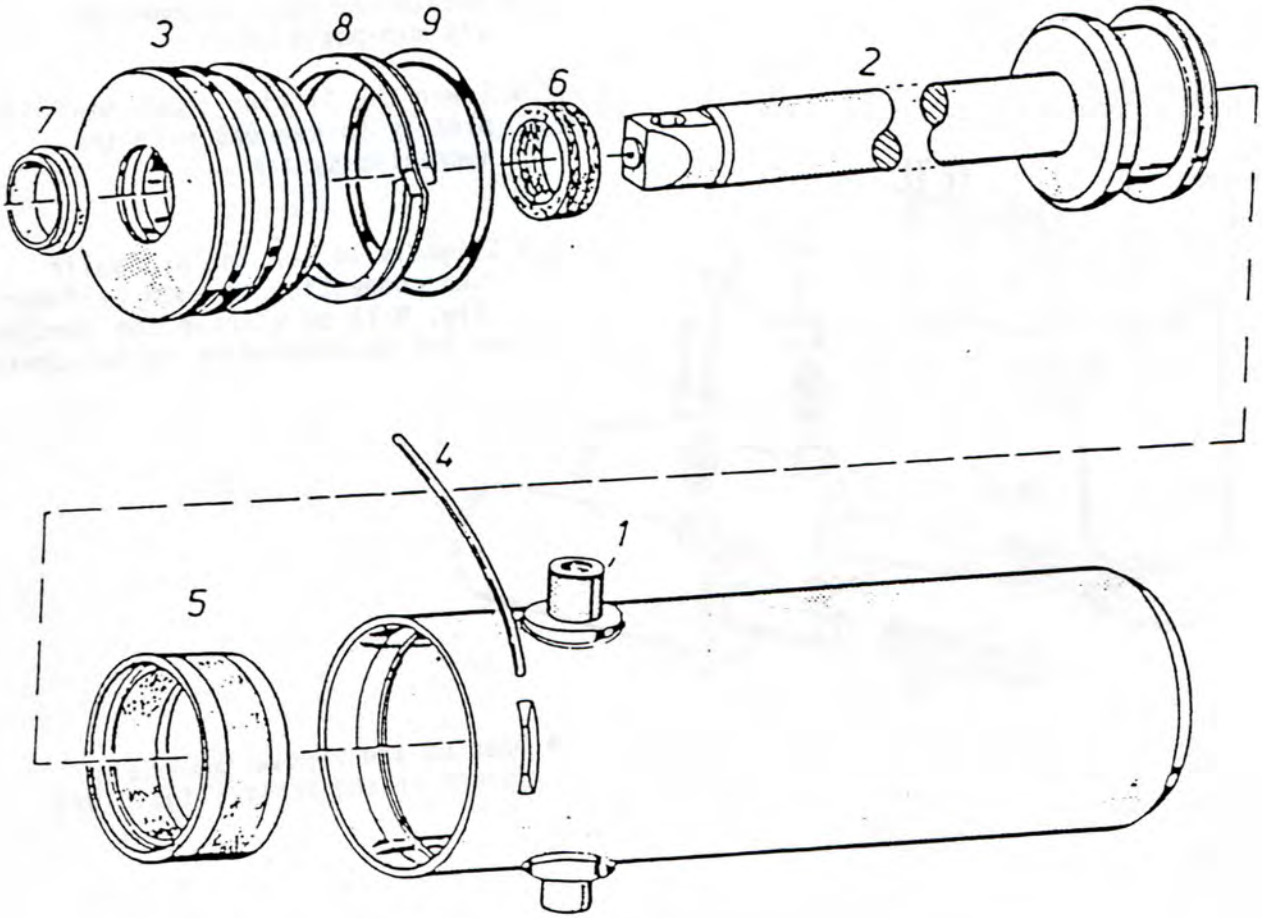
- Open up and remove the chain joints at the press (figs. 10/1,

Installation:

Installation takes place in the reverse order, while noting:

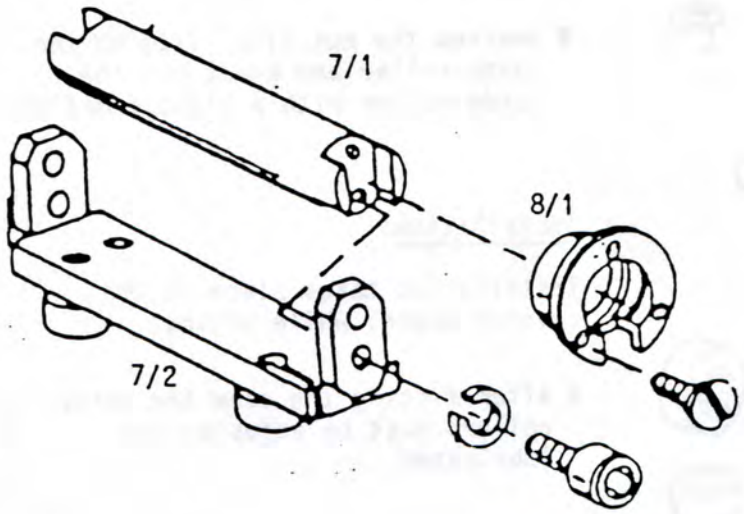
- When fitting roller chain on their sprockets, the hydraulic lines (fig. 9/1) should be opened up.
- When the fork carrier is on its fullest 90° lock to the right or left, the press piston should not be at the end of the available stroke - a further 4 mm of unused stroke remains in the cylinder when the piston is at TDC.

Zylinder Rotate



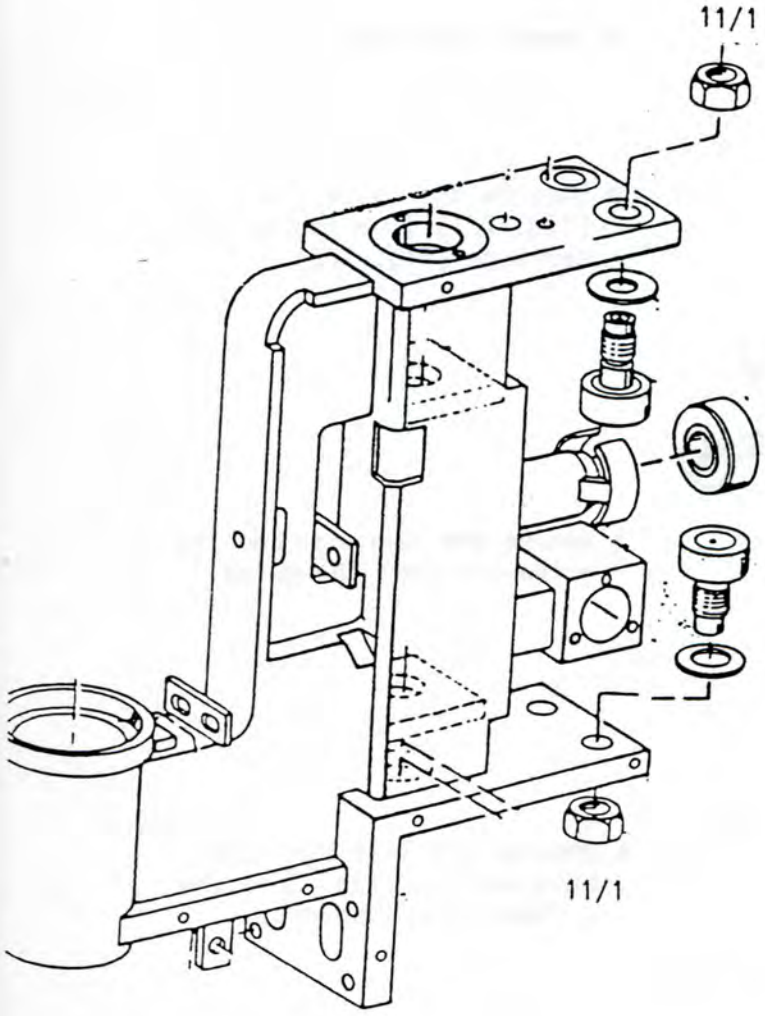
ZYLINDERROHR	1	PIPE
KOLBEN	2	PISTON
VERSCHLUSS	3	LOCK
DRAHT	4	WIRE
DICHTRING	5	SEAL
NUTRING	6	U-RING
ABSTREIFER	7	SKIMMER
SPIRALRING	8	RING
RUNDDICHTRING	9	RING

Replacement of guide carriage bushings



- Remove the beam.
- Unscrew the guide pin (fig. 7/1) from the guide carriage (fig. 7/2).
- Remove the carriage and the guide pin from the guide.
- Unscrew the left and right hand washers (fig. 8/1) and withdraw the bushings.

Installation takes place in the reverse order.



Removal and installation of upper and lower guide rollers

Removal:

- Remove the beam.
- Unscrew the nut (fig. 1/1) on the guide roller and knock out the guide roller with a plastic mallet.

Installation:

Installation takes place in the reverse order, while noting:

- After fitting the beam the guide rollers must be adjusted and lubricated.

Adjustment of guide rollers

- The guide rollers must be adjusted so as to maintain 0.1 - 0.2 mm backlash between the racks and gear wheels.

Note:

Should the cam setting adjustment prove insufficient, spacers should be inserted between the frame and the racks.

- The nuts should then be tightened to a torque of 550 - 600 Nm.
- After adjustment of the guide rollers, all mechanical functions should be tested with and without load. After some 30 - 50 load cycles, the guide rollers should be adjusted as required.

Replacement of racks

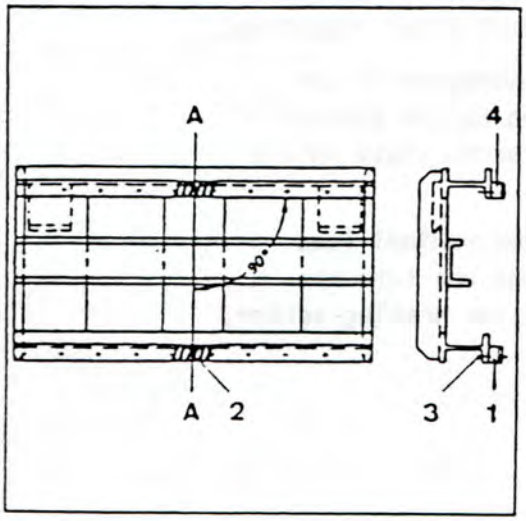


Fig. 14

Installation:

- Center the lower rack (fig. 14/1) on the center pin (fig. 14/2), aligning it parallel to the double T-rail of the frame and tighten the fixing screws (fig. 14/3) evenly to a torque of 80 Nm.

- Fit the upper rack (fig. 14/4) in the same way as the lower rack, taking care to insure that both racks are aligned exactly parallel to one another.

Caution:

Use a back square to insure that the tips of the teeth of the upper and lower racks are within ± 1 mm of perfect alignment with on another at "A" on fig. 14.

If this is not the case, rework either the rack or the frame as necessary.

Hydraulic adjustments:

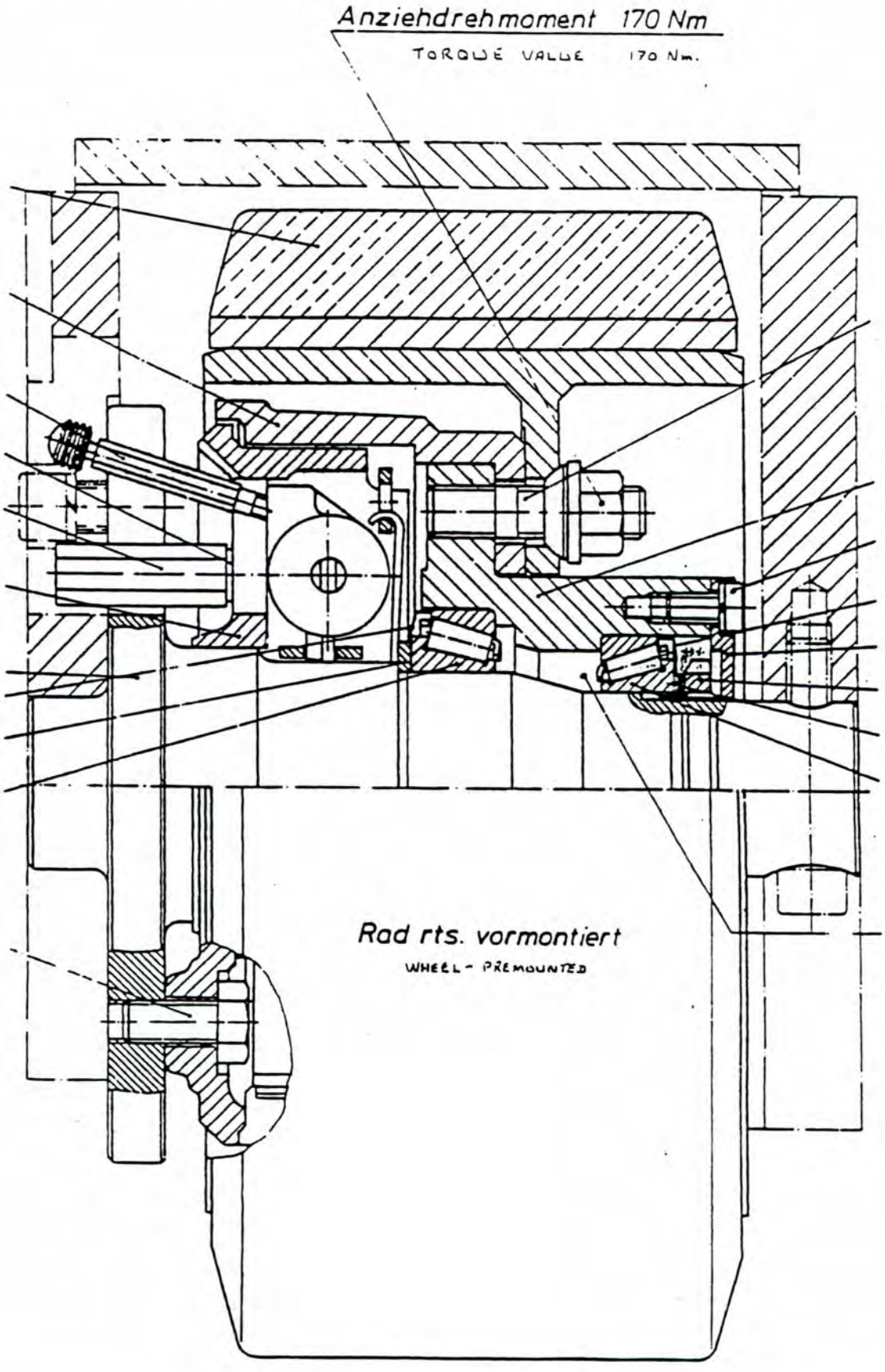
Set the push and swing speed as per setting instructions (see Group 8).

Set the over pressure valves on the oil motor so that when pushing with a nominal load the movement can be stopped by physical force. (Seal valves after adjusting).

Set the pressure limiting valve for swinging on the main control block so that when swinging the nominal load it can be stopped by physical force. (Seal valves after adjusting.)

With the forks in cross position under nominal load check that the load holding valve does not turn the nominal load in the jib when testing the braking action.

SECTION
11


Anziehdrehmoment 170 Nm
TORQUE VALUE 170 Nm.
Rad rts. vormontiert
WHEEL - PREMOUNTED

Brake Magnet Group 11

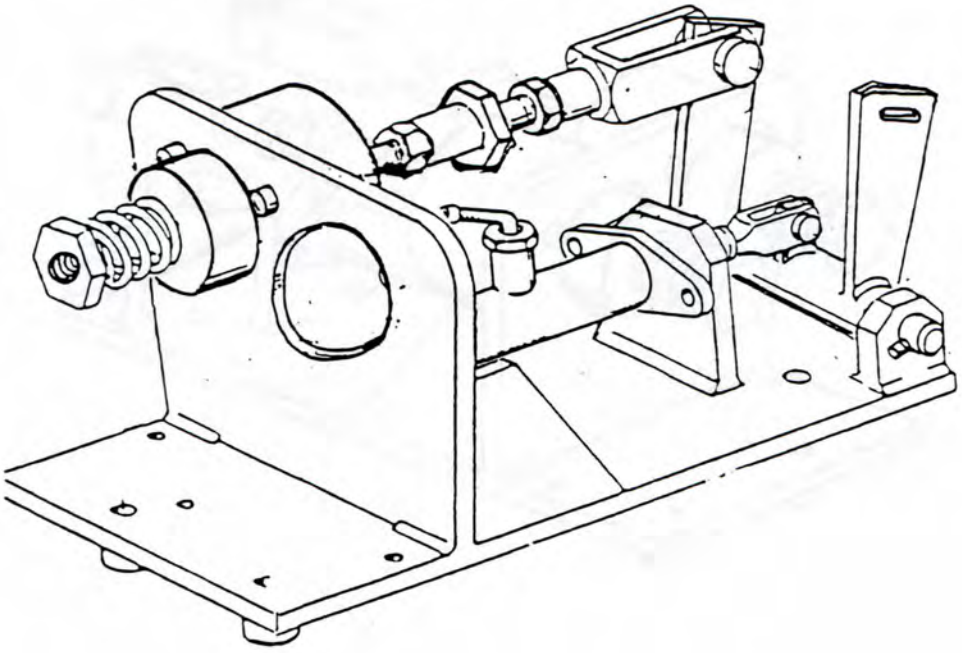
After new or replacement Brake Magnets are fitted use the adjusting nuts and compression springs to achieve the retardation as given below.

WA12 Rail Guidance System WA15	10%

Measure retardation with a Dynamometer

Reminder

When carrying out adjustments to the braking system, ensure that the brake solenoid is fully applied when the control comes on.



Brake Magnet Group 11

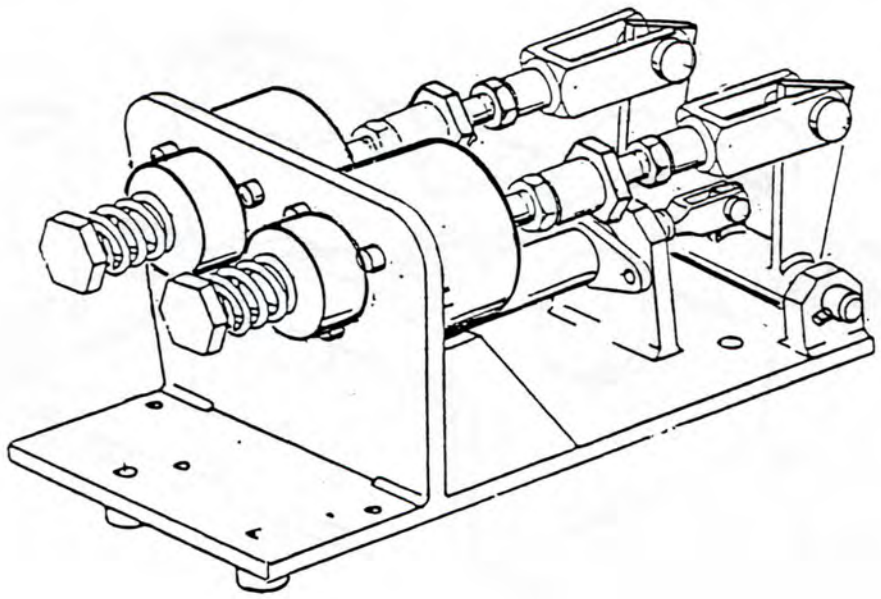
After new or replacement Brake Magnets are fitted use the adjusting nuts and compression springs to achieve the retardation as given below.

WA12 Inductive Guidance System WA15	Brake Retardation 10% Emergency Stop 13%

Measure retardation with a Dynamometer

Reminder

When carrying out adjustments to the braking system, ensure that the brake solenoid is fully applied when the control comes on.



Setting magnetic brake (rail guide 1 braking magnet)

Basic setting:

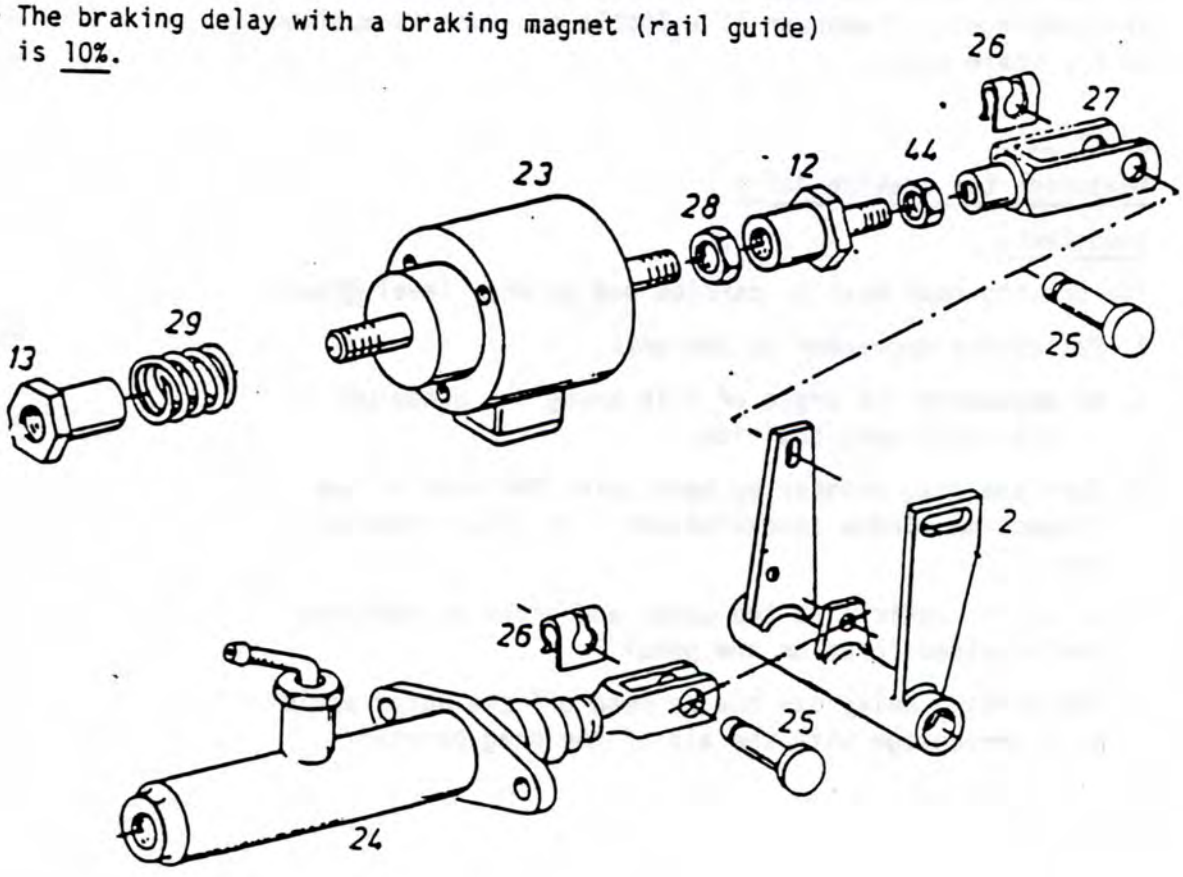
This can only be done if the wheel brake has been preset correctly.

- Remove bolt (25).
  Ensure that the lever (2) moves easily.
- Operate magnetic brake or push the rod mechanically to the stop (stop must be audible).
- Set the switching path on the round piece (12) and fork head (27) so that the the pressure rod on the main braking cylinder (24) has sufficient play via the lever (2) (at least 1 mm).
- Insert bolt (25) and lock with bolt clip (26) (Important: there must be no lateral tension between the fork head and the lever). Carry out a function test by operating electric system.

Set braking delay:

The braking delay is determined with a dynometer, for example SN 028890. Measure with nominal load in fork cross position, load lifted 150 mm and at top forward speed. The required braking delay is produced by the compression spring (29) and set by the round part (13).

- The braking delay with a braking magnet (rail guide) is <u>10%</u>.



OPERATING INSTRUCTIONS FOR DYNOMETER

How it works

The dynometer works on the pendulum principle which mathematically determines non-uniform movements precisely, whether these be caused by acceleration, deceleration or tilting.

At a standstill or when travelling at a uniform speed on a flat surface the pendulum always hangs vertical and is at zero on the scale. Under acceleration it deflects to the right, and under deceleration to the left.

The movements of the pendulum are braked by a special damping system which allows the pointer to indicate the exact value measured reliably.

Since the cushioning medium also acts in the scale chamber it may be that some of the compensation air appears in the form of a small bubble. This has no effect on the function whatsoever and can be moved towards the inside by means of an aperture specially provided for this purpose (on the right half of the scale under the 20% mark). The air bubble must be directed to the front of the hole with the face of the scale held downwards. The bubble will disappear if a little pressure is applied to the scale dial.

Handling

Measuring the braking delay

Important:

The braking test must be carried out on dry, level ground.

1. Fasten the dynometer to the unit.
2. By adjusting the angle of tilt bring the pendulum pointer into zero position.
3. Turn the drag pointer by hand using the knob on the inspection window clockwise until it almost reaches zero.
4. Drive the vehicle at top speed and brake by applying the required force on the pedal.
5. The braking delay can now be read off the outer scale as a percentage with the aid of the drag pointer.

MAGNETIC BRAKE ADJUSTMENTS (2 braking magnet)

Drive Brake Basic Setting

Note the wheel brake assemblies must be adjusted prior to adjusting the brake solenoid.

1. Revmove the pivot pins (25) and (25/1) and ensure brake lever (2) is free.
2. Operate key switch "on" (CAUTION: emergency stop solenoid energises automatically).
3. Operate service brake solenoid (direction lever button), solenoid hits its end stop (audible click).
4. Adjust (12) and clevis (27) to give 1.0 mm free play at master cylinder (24).
   NB (when key switch and brake button on) fit and secure pin (25)
   NB there must be no sideways misalignment in the clevis.
5. Test brake operation by pressing and releasing brake button.

Emergency Stop Brake Adjustment

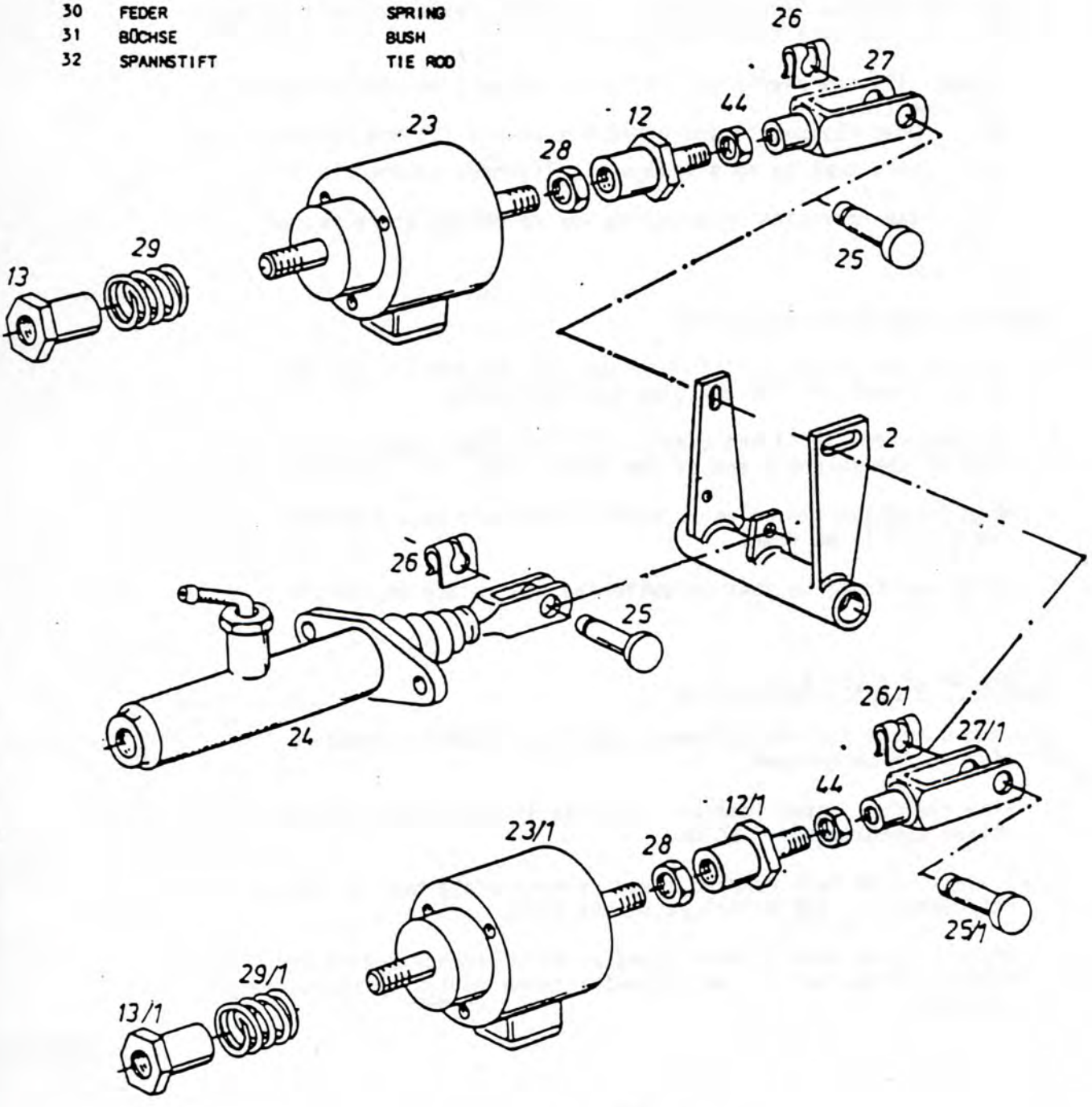
1. Operate key switch "on" (emergency stop solenoid energises.) Solenoid must hit its end stop (audible click).
2. Set adjuster (12/1) and clevis (27/1) so that the pin (25/1) is just free of the solenoid end of the brake lever (2) elongated slot.
3. When energised the solenoid must hit its end stop (audible click) and the pin still be free.
4. Carry out function test by switching key switch on and off.

Adjustment of Brake Retardation

By using a brake retardation meter (eg PT no D028890) brake efficiency can be checked.

1. With the full rated load on the forks in base position and raised approximately 150 mm.
2. Travelling at full forward speed release brake button, adjust retardation to 10% by adjusting nut (13).
3. Travelling at full forward speed press emergency button or switch off key switch, adjust retardation to 13% by adjusting not (13/1).

1	TRÄGER GESCHW.	CARRIER WELDED
2	HEBEL	LEVER
3	KABELSATZ	CABLE KIT
4	DIODE	DIODE
5	DIODE	DIODE
6	GEHÄUSE	HOUSING
11	RUNDTEIL	ROUNDS
12	RUNDTEIL	ROUNDS
13	RUNDTEIL	ROUNDS
20	SECHSKANTSCHRAUBE	HEXAGON SCREW.
21	FEDERRING	SPRING WASHER
22	SCHEIBE	DISK
23	MAGNET	MAGNET
24	ZYLINDER	CYLINDER
25	BOLZEN	BOLT
26	BOLZENSICHERUNG	BOLT PROTECTION
27	GABELKOPF	FORK HEAD
28	SECHSKANTMUTTER	HEXAGON NUT
29	FEDER	SPRING
30	FEDER	SPRING
31	BÜCHSE	BUSH
32	SPANNSTIFT	TIE ROD
33	ZYLINDERSCHRAUBE	CAP SCREW
34	FEDERRING	SPRING WASHER
35	SECHSKANTSCHRAUBE	HEXAGON SCREW
36	FEDERRING	SPRING WASHER
37	SCHÜTZ	CONTACTOR
38	SECHSKANTSCHRAUBE	HEXAGON SCREW
39	SCHEIBE	DISK
40	SCHRAUBE	SCREW
41	RING	RING
42	STUTZEN	STUB
43	RING	RING
44	SECHSKANTMUTTER	HEXAGON NUT



Section 11
Serie WA

GETRIEBE
TRANSMISSION
TRANSMISSION

3. GETRIEBE

3.1 Getriebe aus- und einbauen

Ausbau:

- Gabelzinken herablassen.
- Batteriestecker ziehen.
- Batterie entfernen.
- Radmuttern lockern, Fahrzeug anheben und Muttern mit Rad entfernen.
- Kettenspannung lösen.
- Elektromotor abklemmen und entfernen.
- Getriebeöl ablassen.
- Schrauben von der Getriebeplatte lockern (Fig. 1/1).

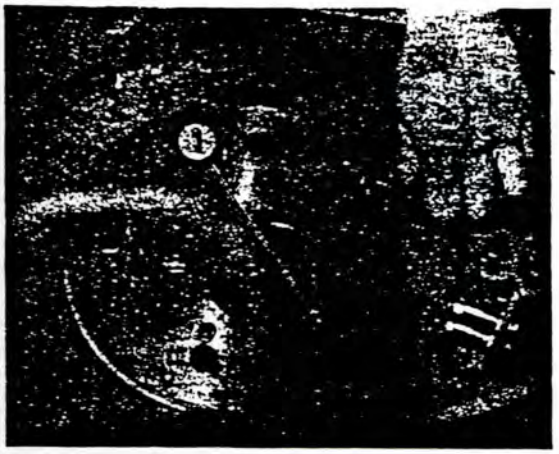


Fig. 1

Achtung:

Geschieht das Anheben mit einer Winde, so ist darauf zu achten, daß das Gerät nicht zu hoch angehoben wird, da es durch die Schräglage von der Winde abrutscht.
Desweiteren ist vorne zu unterkeilen. Vorrutsch-Gefahr!
Die Arbeiten sind grundsätzlich mit zusätzlicher Abstützsicherung durchzuführen.

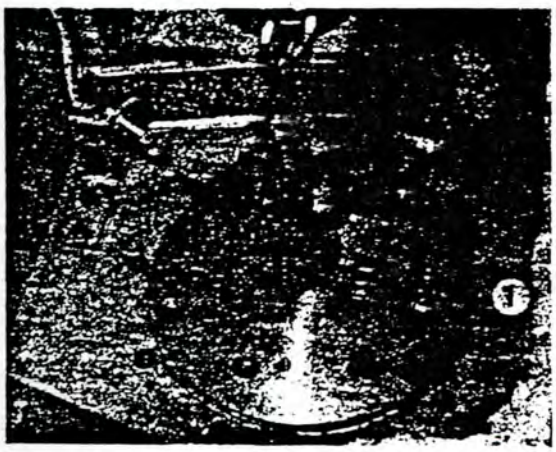


Fig. 2

- Getriebe mit zwei Haken innen einhängen (Fig. 2) und die gelockerten sechs Schrauben (Fig. 2/1) entfernen.

3. TRANSMISSION

3.1 Removal and installation of transmission

Removal:

- Lower fork prongs.
- Pull out battery plug.
- Remove battery.
- Slacken wheel nuts, raise truck and remove nuts and wheel.
- Release chain tension.
- Disconnect and remove electric motor.
- Drain gear oil
- Slacken bolts on transmission plate (Fig. 1/1).

Caution:

If the truck is lifted with a winch, be sure not to lift too high as it may slip off winch as a result of excessive angle of inclination. Furthermore, chock wheels at front, because of risk of sliding forwards. Always work with some form of additional support.

- Attach transmission to 2 hooks at inside (Fig. 2) and remove the 6 loose bolts (Fig. 2/1).

3. TRANSMISSION

3.1 Dépose et pose de la transmission

Dépose:

- Abaisser les fourches.
- Retirer le connecteur de la batterie.
- Déposer la batterie.
- Desserrer les écrous de fixation de la roue, lever le chariot et enlever les écrous et la roue.
- Détendre la chaîne.
- Déconnecter et déposer le moteur de traction.
- Vidanger l'huile de transmission.
- Desserrer les vis de la plaque support de la transmission (fig. 1/1).

Attention:

En cas de levage au treuil, veiller à ne pas lever le chariot trop haut, sous peine de le faire glisser du crochet. Placer des cales devant les roues avant pour éviter tout risque de dérapage. Pour la sécurité, mettre le chariot toujours sur chandelles avant de procéder aux travaux.

- Accrocher la boîte de transmission côté intérieur à 2 crochets (fig. 2) et enlever les 6 vis desserrés (fig. 2/1).

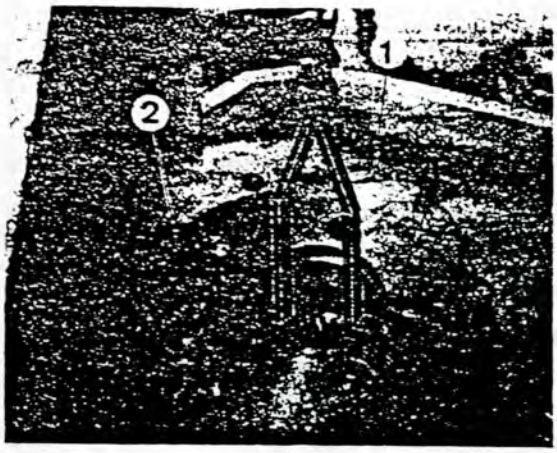


Fig. 3

- Obere Getriebeplatte (Fig. 3/1) mit drei Schrauben (Fig. 3/2) abdrücken.

Achtung:

Auf keinen Fall darf die Getriebeplatte abgedrückt werden, bevor nicht das Getriebe eingehängt bzw. gesichert ist (Fig. 3).

Fig. 4

- Getriebe herablassen und von Hand entfernen (Fig. 4).

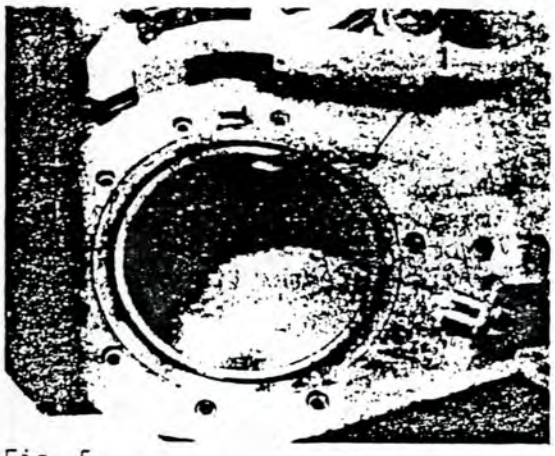


Fig. 5

- Das Kreuzrollenlager kann durch Entfernen der zehn Innensechskantschrauben (Fig. 5/1) demontiert werden.

Achtung:

Bei den Arbeiten am Getriebe darauf achten, daß keine Späne etc. in das Getriebe-Innere fallen. Getriebe nach Abflanschen des Motors abdekken.

- Force off upper transmission plate (Fig. 3/1) with three bolts (Fig. 3/2).

Caution:

Never force off transmission plate before you attach and secure the transmission (Fig. 3).

- Chasser la plaque support (fig. 3/1) de son siège par les trois vis (fig. 3/2).

Attention:

Ne déposer en aucun cas la plaque support avant d'avoir accroché ou immobilisé la boîte de transmission (fig. 3).

- Lower transmission and remove by hand (Fig. 4).

- Abaisser la boîte et l'enlever à la main (fig. 4).

- Disassemble cross roller bearing by removing the ten hexagon socket-head bolts (Fig. 5/1).

Caution:

When working on transmission, ensure that no chips, etc. can drop into interior. Cover transmission after disconnecting the motor.

- Le roulement à rouleaux croisés est démontable après enlèvement des dix vis six pans creux (fig. 5/1).

Attention:

En cas d'intervention sur la transmission, éviter la pénétration de corps étrangers dans le carter. Recouvrir l'ouverture après dépose du moteur.

Der Einbau erfolgt in umgekehrter Reihenfolge. Dabei ist wie folgt zu verfahren:

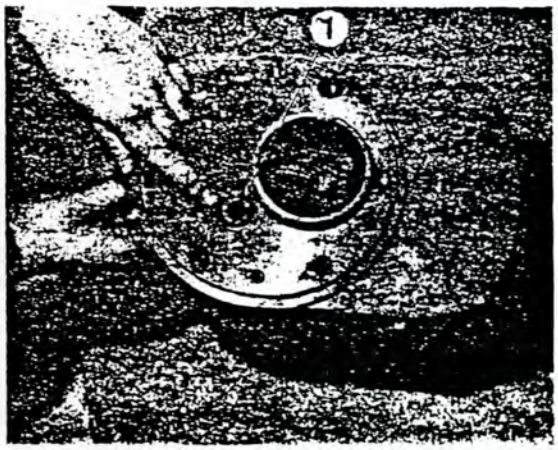


Fig. 6

- Darauf achten, daß der O-Ring (Fig. 6/1) nicht verloren geht.

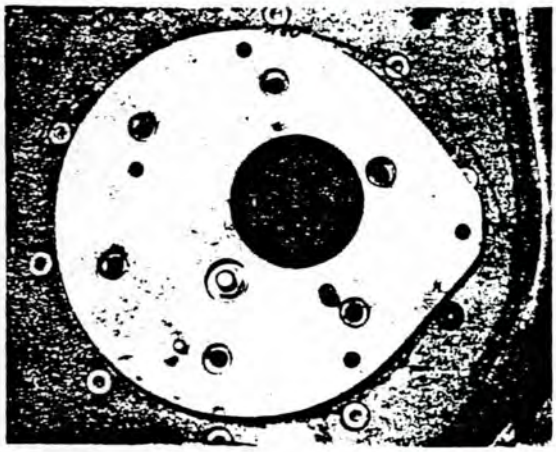


Fig. 7

- Die obere Getriebeplatte einlegen. Dabei muß die nockenförmige Seite der Platte in Fahrtrichtung "rechts" in einer 180°-Stellung zum Anschlag am Kranz (Fig. 7) stehen.

Hinweis:

Schrauben der Getriebeplatte mit Loctite 242 sichern.

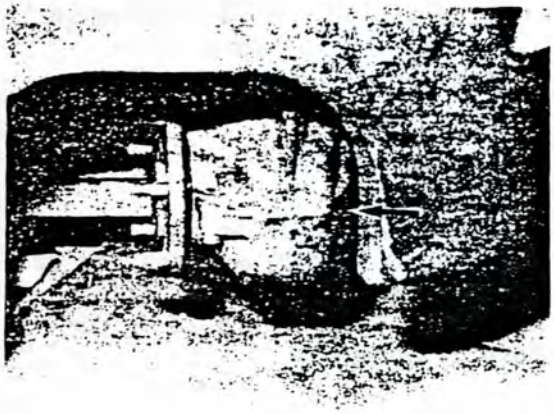


Fig. 8

- Getriebe einhängen. Um eine korrekte Lenkeinstellung zu bekommen, muß sich das Getriebegehäuse in Fahrtrichtung "rechts außen" (Fig. 8) befinden.
  Wird die obere Getriebeplatte am Getriebegehäuse befestigt, ist auf diese Stellungsform unbedingt zu achten.

Hinweis:

Das Anbringen des Getriebes sollte mit zwei Personen durchgeführt werden.

Getriebe mit neuem Getriebeöl auffüllen.

Install in reverse sequence, noting the following points:

- Be sure not to lose the O-ring (Fig. 6/1).

- Insert the upper transmission plate so that, looking straight ahead, the cam-shaped side of the plate is at "right" at a 180° position relative to stop on ring (Fig. 7).

Note:

Secure transmission plate bolts with Loctite No. 242.

- Attach transmission. In order to obtain correct steering adjustment, ensure that transmission housing is at "outer right" (Fig. 8), looking straigth ahead. This positioning must be observed on all accounts when upper transmission plate is being attached to transmission housing.

Note:

The transmission ought to be installed by two people working together.

Fill transmission with new gear oil.

Pour la pose, procéder comme suit:

- Veiller à ne pas perdre le joint torique (fig. 6/1).

- Mettre en place la plaque support. La pointe du nez doit être placée à droite sous un angle de 180° par rapport à la butée de braquage (fig. 7).

Nota:

Freiner les vis de la plaque support au Loctite 242.

- Accrocher la boîte de transmission. Pour obtenir un réglage correct de la direction, la boîte doit se trouver à l'extrême droite (fig. 8). Il est impératif de la fixer sur la plaque support dans cette position.

Nota:

Faire effectuer la pose de la boîte de transmission par 2 personnes.

Remplir la boîte d'huile fraîche.

3.2 Tellerrad komplett ausbauen

- Die Einzelteile und das Gehäuse sind nach dem Ausbau mit Trulit 54 zu reinigen.
- Antriebsrad abschrauben.
- Getriebedeckel abschrauben (Fig. 1/1).

Fig. 1

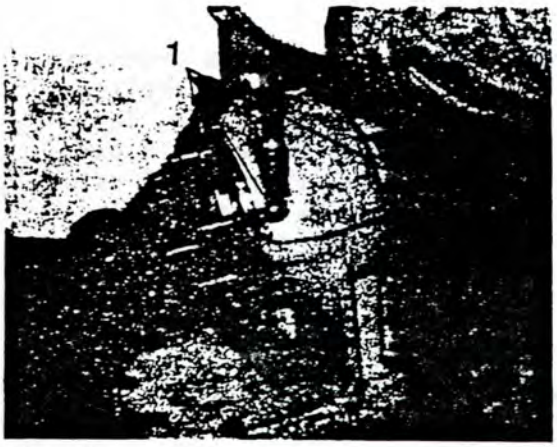


Fig. 2

- Getriebe in einen Schraubstock spannen und die vier Schrauben (Fig. 2/1) vom Bodendeckel lösen sowie die zwei Paßstifte mit einem Durchschlag herausschlagen.

3.2 Removal of ring gear assembly

- Component parts and housing are to be cleaned with Trulit 54 after removal.
- Unscrew drive pinion.
- Unscrew transmission cover (Fig. 1/1).
- Clamp transmission in a vice and release 4 bolts (Fig. 2/1) from bottom cover. Using a drift, additionally knock out the 2 locating pins.

3.2 Dépose de l'ensemble couronne dentée

- Après dépose, nettoyer les pièces et le carter au Trulit 54.
- Déposer la roue motrice.
- Enlever le couvercle supérieur de la boîte (fig. 1/1).
- Serrer la boîte dans un étau, enlever les 4 vis (fig. 2/1) du couvercle inférieur et chasser les 2 goupilles de positionnement.

Fig. 3

- Bodendeckel abheben (Fig. 3).

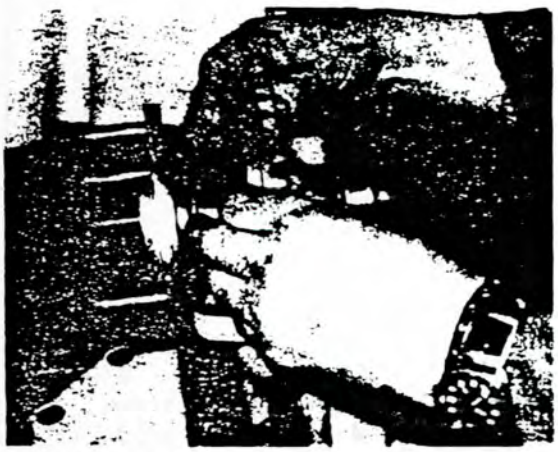


Fig. 4

- Tellerrad vollständig herausnehmen (Fig. 4).

Achtung:

Tellerrad nur in Zusammenhang mit der Kegelritzelwelle austauschen.

- Lift off bottom cover (Fig. 3).

- Withdraw ring gear assembly (Fig. 4).

Caution:

Ring gear must only be exchanged together with bevel pinion shaft.

- Enlever le couvercle inférieur (fig. 3).

- Extraire l'ensemble couronne (fig. 4).

Attention:

Ne remplacer la couronne qu'ensemble avec son pignon d'attaque.

3.3 Tellerrad und Lager auswechseln

Ausbau:

- Kronenmutter entfernen.
- Oberes Lager abziehen.
- Ausgleichscheiben mit Distanzbuchse entfernen.
- Bei einem Austausch des Tellerrades ist zu berücksichtigen, daß das Tellerrad nur im Verbund mit dem Kegelritzel gewechselt werden darf. Die beiden Komponenten sind durch gleiche Numerierung gekennzeichnet (Fig. 5 und 6).

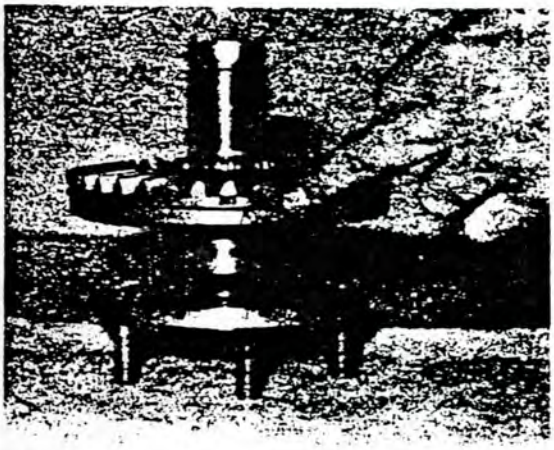


Fig. 5

Fig. 6

- Tellerrad evtl. mit Abzieher abziehen.
- Lager mit Abzieher entfernen.
- Sicherungsring und Dichtring entfernen.

Einbau:

Dichtring aufstecken. Dabei ist auf die richtige Aufsteckseite zu achten.

3.3 Replacement of ring gear and bearings

Removal:

- Remove castle nut.
- Pull off upper bearing.
- Remove shims and spacing bushing.
- If ring gear is to be exchanged, please note that ring gear must always be replaced together with bevel pinion. These two items are identified by identical numbering (Fig. 5 and 6).
- Remove ring gear, using a puller if necessary.
- Remove bearing, using a puller.
- Remove circlip and sealing ring.

Installation:

Fit sealing ring, remembering to attach at the correct side.

3.3 Remplacement de la couronne et de ses roulements

Dépose:

- Dévisser l'écrou à encoches.
- Démonter le palier supérieur avec un extracteur.
- Enlever les cales d'épaisseur et la bague entretoise.
- Noter que la couronne et le pignon sont des pièces appariées à ne remplacer qu'ensemble. Les pièces appariées portent des numéros identiques (fig. 5 et 6).
- Retirer la couronne de son arbre, se servir d'un extracteur si nécessaire.
- Démonter le palier avec un extracteur.
- Rémonter le circlip et le joint à lèvre.

Pose:

Monter la joint à lèvre en position correcte.

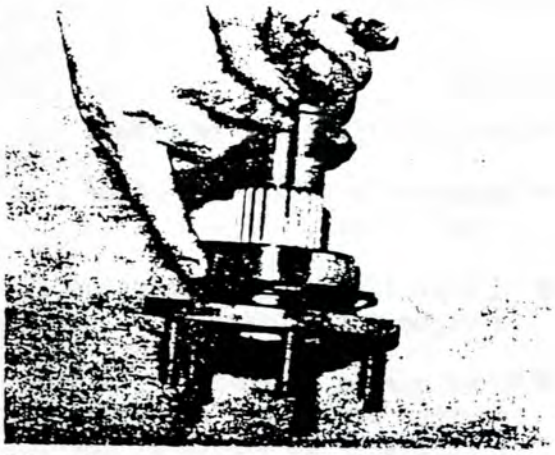


Fig. 7

- Sicherungsring aufstecken (Fig. 7), dann erst das Lager (Fig. 8) mit einer Lagerbuchse aufschlagen bzw. aufpressen.

Fig. 8

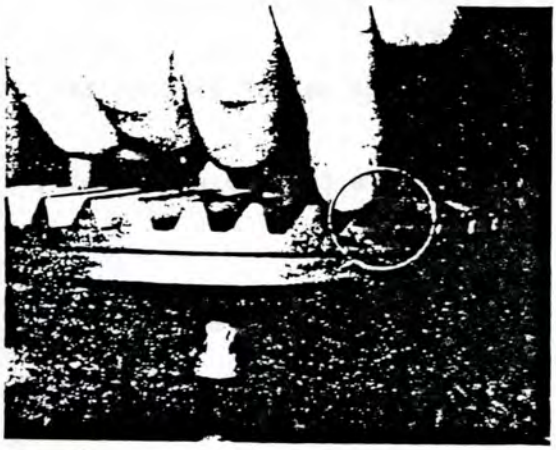


Fig. 9

Achtung:

- Vor dem Aufsetzen des Tellerrades sollte man das Tellerrad auf evtl. Gratbildung überprüfen (Fig. 9). Bei Bedarf abziehen.

- Fit circlip (Fig. 7). Only now drive on or press on the bearing (Fig. 8) with a bearing bushing.

- Monter le circlip (fig. 7). Ensuite, emmancher le roulement à coups de marteau (en intercalant une douille) ou à la presse.

Caution:

- Prior to fitting the ring gear, check for burrs (Fig. 9). Dress if necessary.

Attention:

- Avant montage de la couronne, examiner celle-ci pour bavures (fig. 9). L'ébavurer s'il y a lieu.

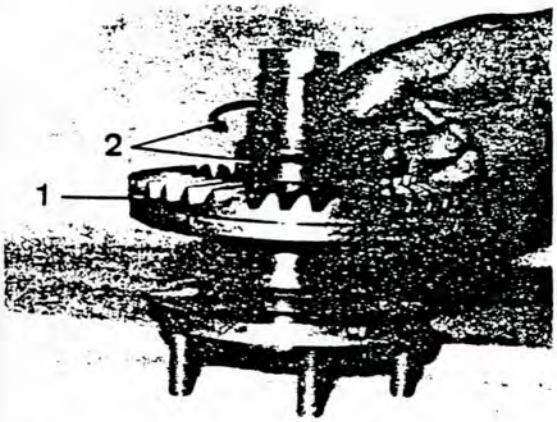


Fig. 10

- Tellerrad (Fig. 10/1), Distanzbuchse (Fig. 10/2) und Sicherungsring aufstecken.

Fig. 11

- Zur Einstellung des Flankenspiels sollten vorab 9 - 10 Stück Ausgleichscheiben von 1/10 mm Stärke aufgesteckt werden (Fig. 11), weitere Beschreibung siehe Flankenspiel und Tragbild am Getriebe.

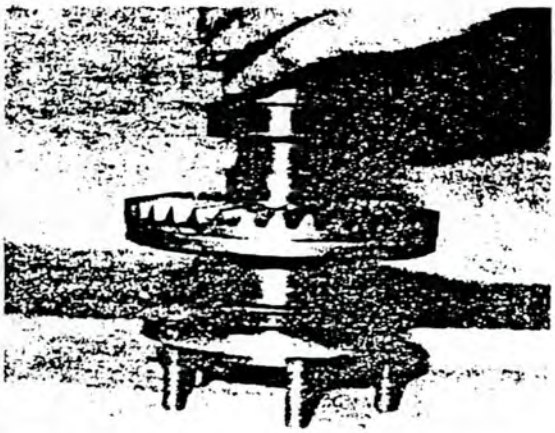


Fig. 12

- Oberes Lager mit einer Lagerbuchse aufsetzen (Fig. 12).

- Fit ring gear (Fig. 10/1), spacing bushing (Fig. 10/2) and circlip.

- Monter sur l'arbre la couronne (fig. 10/1), la bague entretoise (fig. 10/2) et le circlip.

- For advance adjustment of backlash, fit 9 - 10 shims 1/10 mm thick (Fig. 11); for all other details see backlash and contact pattern at transmission.

- Commencer le réglage du jeu de denture par le montage de 9 - 10 cales de 0,1 mm (fig. 11). Voir la suite au paragraphe 3.9.1.

- Install upper bearing with a bearing bushing (Fig. 12).

- Monter le roulement supérieur à l'aide d'une douille (fig. 12).

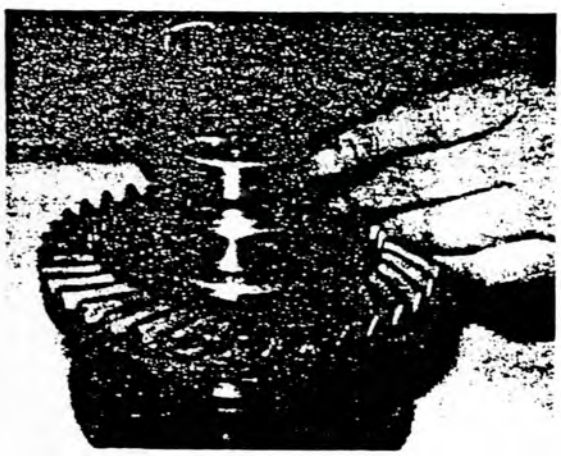


Fig. 13

Kronenmutter aufschrauben (Fig. 13) und festziehen.

3.3.1 Tellerrad, vollständig

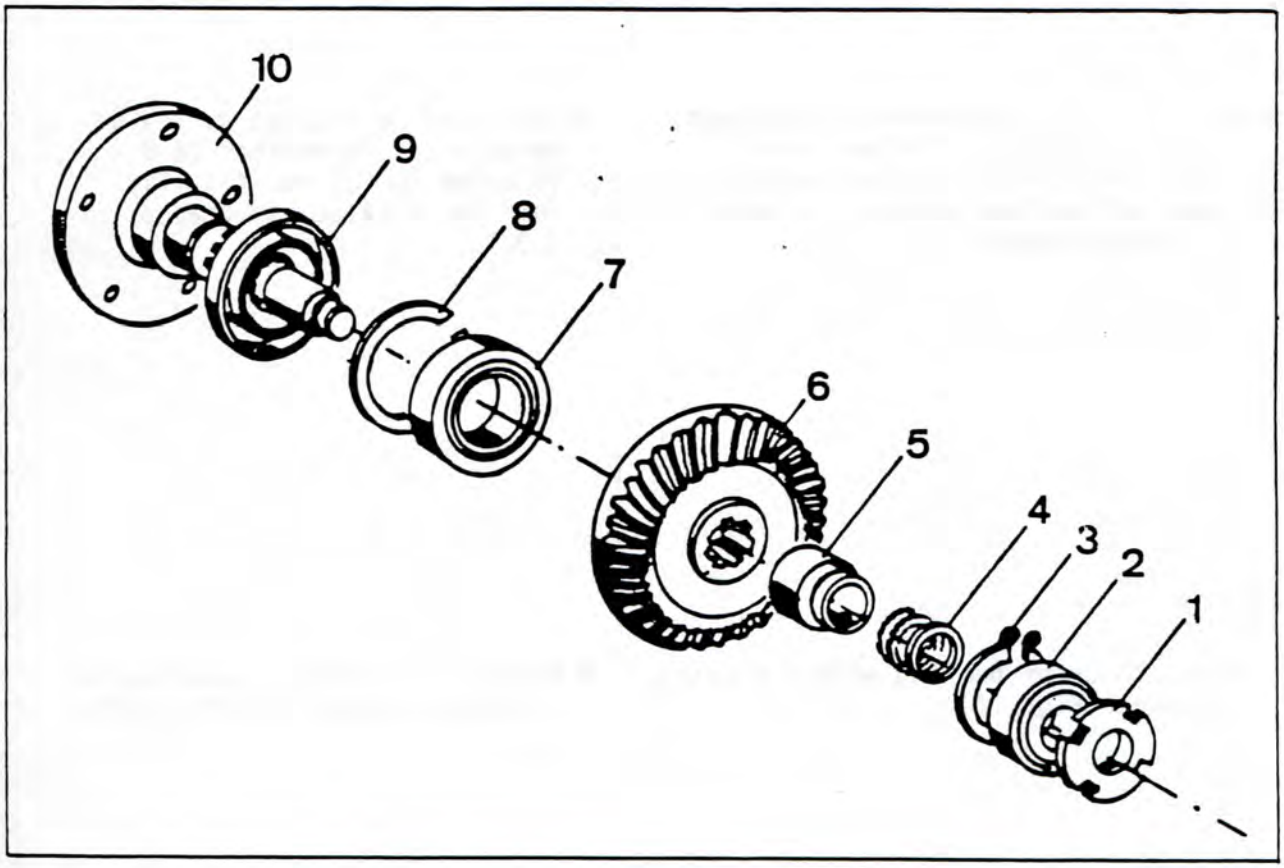


Fig. 14

1 Kronenmutter
2 Kugellager
3 Sicherungsring
4 Ausgleichscheiben
5 Distanzbuchse
6 Tellerrad
7 Zylinderrollenlager
8 Sicherungsring
9 Dichtring
10 Ankerplatte

- Screw on castle nut (Fig. 13) and tighten.

- Visser et serrer l'écrou à encoches (fig. 13).

3.3.1 Ring gear, complete

3.3.1 Ensemble couronne dentée

1 Castle nut
2 Ball bearing
3 Circlip
4 Shims
5 Spacing bushing
6 Ring gear
7 Cylindrical roller bearing
8 Circlip
9 Sealing ring
10 Anchor plate

1 Ecrou à encoches
2 Roulement à billes
3 Circlip
4 Cales d'épaisseur
5 Bague entretoise
6 Couronne dentée
7 Roulement à rouleaux cylindriques
8 Circlip
9 Joint à lèvre
10 Plateau d'arbre

3.4 Stirnrad aus- und einbauen

Ausbau:

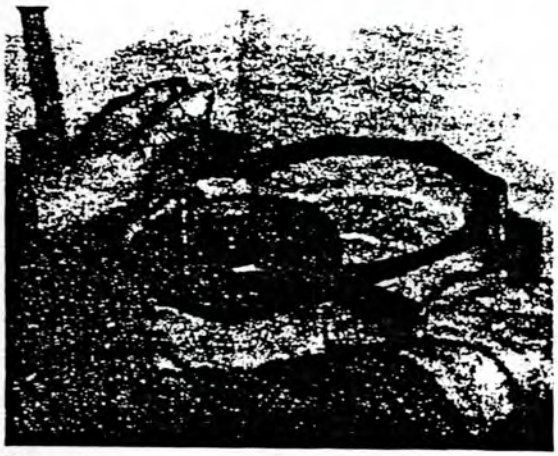


Fig. 1

- Stirnrad von der Ritzelwelle abschrauben. Dabei mit einem Durchschlag das Zahnrad gegen Mitdrehen sichern (Fig. 1).

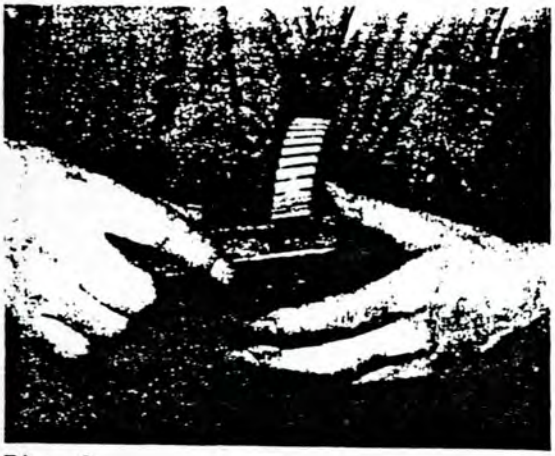


Fig. 2

Einbau:

- Stirnrad auf Gratbildung überprüfen und gegebenenfalls mit einem Abziehstein abziehen (Fig. 2).

Fig. 3

- Stirnrad auf Kegelritzelwelle aufsetzen, dabei mit einem Kunststoffhammer leicht kreisförmig aufklopfen (Fig. 3).

3.4 Removal and installation of spur gear

Removal:

- Unscrew spur gear from pinion shaft, securing gear with a drift to prevent rotation (Fig. 1).

Installation:

- Check spur gear for burrs and, if necessary, dress with a grindstone (Fig. 2).

- Position spur gear on bevel pinion shaft, tapping gently in a circle with a plastic-headed hammer (Fig. 3).

3.4 Dépose et pose de l'engrenage cylindrique

Dépose:

- Immobiliser l'engrenage en rotation par un chasse-goupille et dévisser l'écrou de fixation (fig. 1).

Pose:

- Examiner l'engrenage pour bavures et l'ébavurer à la pierre s'il y a lieu (fig. 2).

- Monter l'engrenage sur son arbre en le frappant légèrement autour de son alésage avec un marteau en plastique (fig. 3).

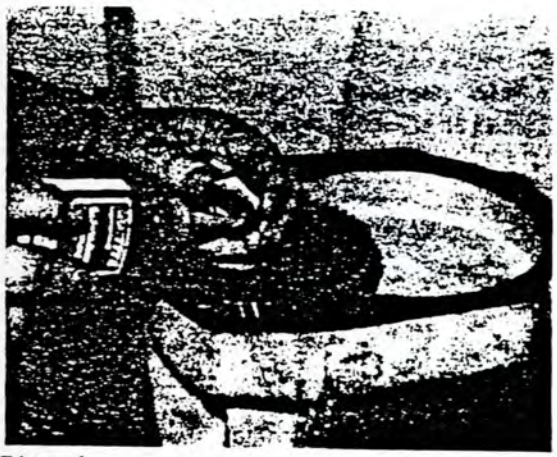


Fig. 4

- Schraube mit Loctite 242 sichern (Fig. 4).

Fig. 5

- Schraube festziehen (Fig. 5).

- Secure screw with Loctite No. 242 (Fig. 4).

- Freiner la vis au Loctite 242 (fig. 4).

- Tighten screw (Fig. 5).

- Serrer la vis (fig. 5).

3.5 Kegelritzelwelle ausbauen

Ausbau:

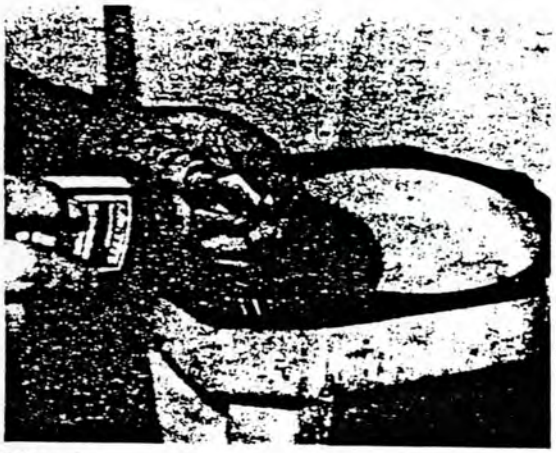


Fig. 1

- Stirnrad (Fig. 1/1) von der Ritzelwelle abschrauben.

Fig. 2

- Sicherungsring abschrauben (Fig. 2 und 3).

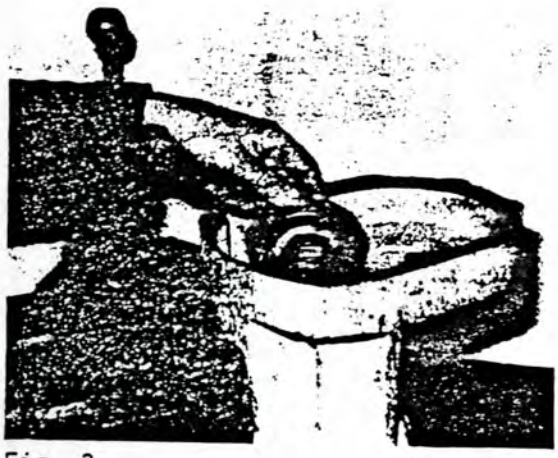


Fig. 3

Achtung:

Kegelritzel niemals einzeln tauschen, nur in Zusammenhang mit dem Tellerrad. Numerierung beachten.

3.5 Removal of bevel pinion shaft

Removal:

- Unscrew spur gear (Fig. 7/1) from pinion shaft.
- Unscrew circlip (Fig. 2 and 3).

Caution:

Never exchange bevel pinion alone, always replace together with ring gear. Note numbering.

3.5 Dépose du pignon d'attaque

Dépose:

- Démonter l'engrenage cylindrique (fig. 1/1) de l'arbre du pignon.
- Déposer la bague d'arrêt (fig. 2 et 3).

Attention:

Ne remplacer le pignon d'attaque qu'ensemble avec la couronne. Observer la numérotation.

Fig. 4

- Kegelritzelwelle (Fig. 4) von unten mit einem Kunststoffhammer vorsichtig herausschlagen.

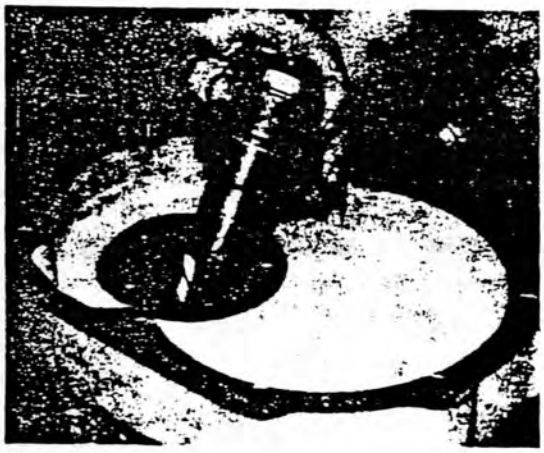


Fig. 5

- Kegelritzelwelle entfernen (Fig. 5).

Einbau siehe Einstellarbeiten am Getriebe.

3.6 Zusammenbau der Kegelritzelwelle

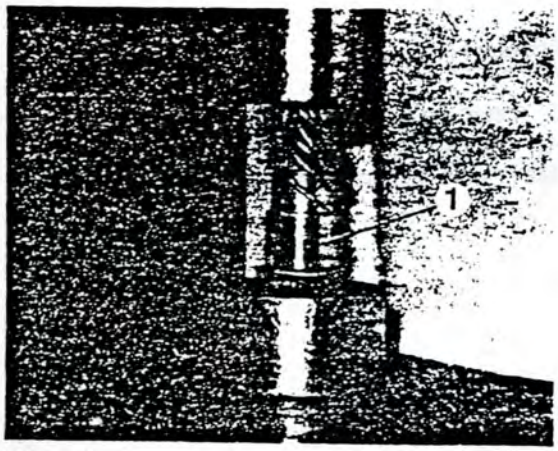


Fig. 6

- Lagerring (Fig. 6/1) aufpressen.

- Using a plastic-headed hammer, carefully drive out bevel pinion shaft (Fig. 4) from below.

- Chasser l'arbre du pignon (fig. 4) de son logement en le frappant à coups légers avec un marteau en plastique.

- Remove bevel pinion shaft (Fig. 5).

- Enlever l'arbre du pignon (fig. 5).

- For installation see adjustments to transmission.

- Pour la pose, se reporter au paragraphe 3.9.

3.6 Assembly of bevel pinion shaft

Press on bearing ring (Fig. 6/1).

3.6 Montage de l'ensemble pignon d'attaque

Emmancher le roulement (fig. 6/1).

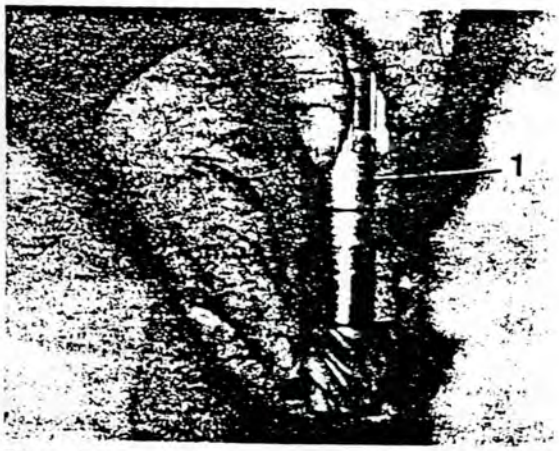


Fig. 7

- Distanzring (Fig. 7/1) aufstecken.

Fig. 8

- Zur Einstellung des Tragbildes und Flankenspiels genügt es nach Erfahrung, vorab fünf Stück 1/10-Paßscheiben aufzustecken (Fig. 8).

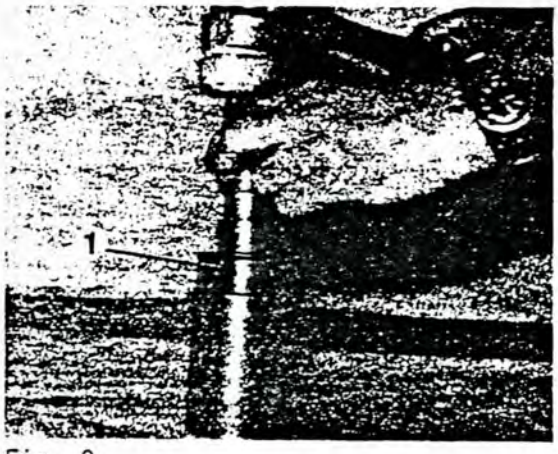


Fig. 9

- Kugellager aufstecken (Fig. 9/1).

- Fit spacing ring (Fig. 7/1).

- Monter la baque entretoise (fig. 7/1).

- For advance adjustment of contact pattern and backlash, it is sufficient to go by experience and fit five 1/10 mm shims (Fig. 8).

- Pour le réglage du jeu de denture et de la portée des dents il suffit en général de commencer par monter 5 cales de 0,1 mm (fig. 8).

- Fit ball bearing (Fig. 9/1).

- Monter le roulement à billes sur l'arbre (fig. 9/1).

3.7 Lager im Getriebegehäuse auswechseln

Ausbau:

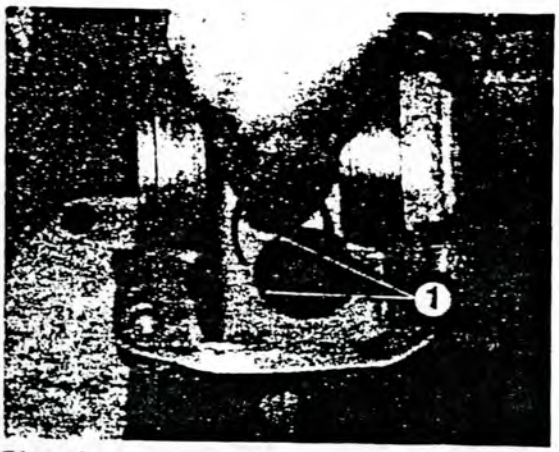


Fig. 1

- Tellerrad-Baugruppe und Kegelritzelwelle entfernen.
- Sicherungsring beidseitig entfernen (Fig. 1/1).


Fig. 2

- Mit einer Lagerbuchse das Lager aus dem Sitz entfernen (Fig. 2 und 3).


Fig. 3

3.7 Replacement of bearing in transmission housing

Removal:

- Remove ring gear assembly and bevel pinion shaft.
- Remove circlip at either side (Fig. 1/1).
- Using a bearing bushing, remove bearing from its seat (Fig. 2 and 3).

3.7 Remplacement des roulements de la transmission

Dépose:

- Déposer les ensembles couronne et pignon.
- Enlever les circlips des deux côtés (fig. 1/1).
- Chasser le roulement de son siège avec une douille (fig. 2 et 3).

Einbau:

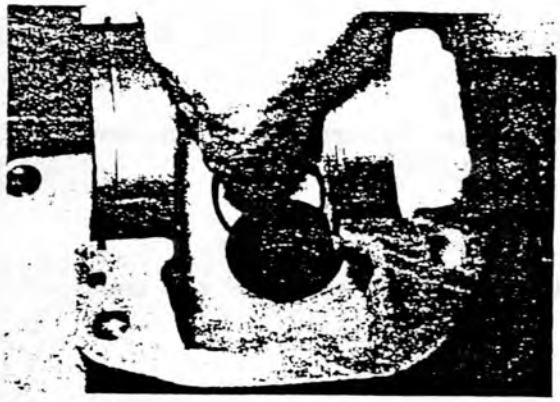


Fig. 4

- Als erstes den unteren Sicherungsring in die Gehäusenut einsetzen (Fig. 4).

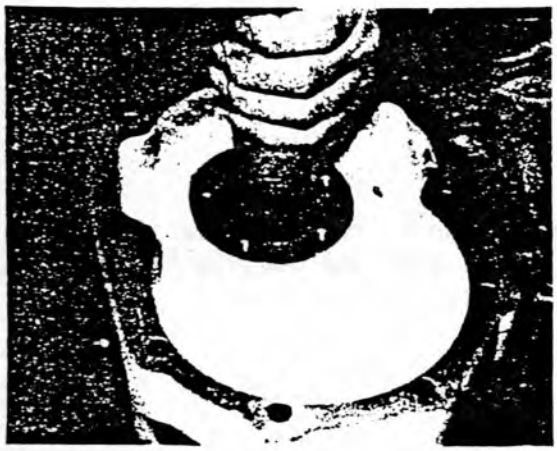


Fig. 5

- Lager mit einer Lagerbuchse auf den Sitz des unteren Sicherungsringes fixieren (Fig. 5).

Hinweis:

Wenn das Lager am Sicherungsring anliegt, ist ein helleres Anschlaggeräusch hörbar. Nicht mehr weiterschlagen, da sonst der Sicherungsring aus der Nut herausgeschlagen wird.

Fig. 6

- Sicherungsring oben einsetzen (Fig. 6).

Installation:

- First introduce the lower circlip into housing groove (Fig. 4).

- Using a bearing bushing, fix bearing on seat of lower circlip (Fig. 5).

Note:

Knocking sound has a higher pitch when bearing contacts circlip. Do not continue knocking because circlip will otherweise be dislodged from groove.

- Insert circlip at top (Fig. 6).

Pose:

- Placer d'abord le circlip inférieur dans sa rainure (fig. 4).

- Emmancher le roulement avec une douille et le faire buter contre le circlip inférieur (fig. 5).

Nota:

L'entrée en contact du roulement et du circlip se traduit par un bruit plus clair des coups de marteau. Cesser alors de frapper, sous peine de faire sortir le circlip de sa rainure.

- Monter le circlip supérieur (fig. 6).

3.8 Kegelritzelwelle einbauen

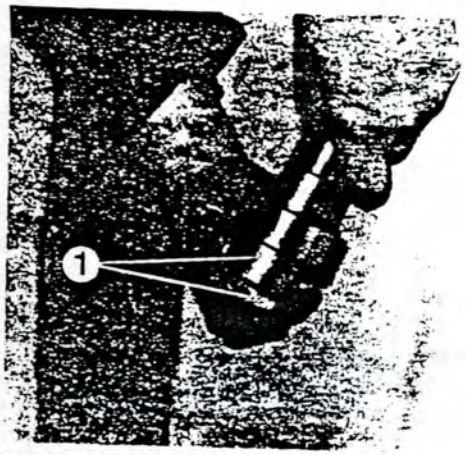


Fig. 1

- Die Kegelritzelwelle ist am Ende mit einer Distanzhülse und Mutter zu versehen (Fig. 1/1), damit beim Einsetzen der Kegelritzelwelle in das Gehäuse das Lager (Fig. 2/1) nicht herausgeschlagen wird.

Fig. 2

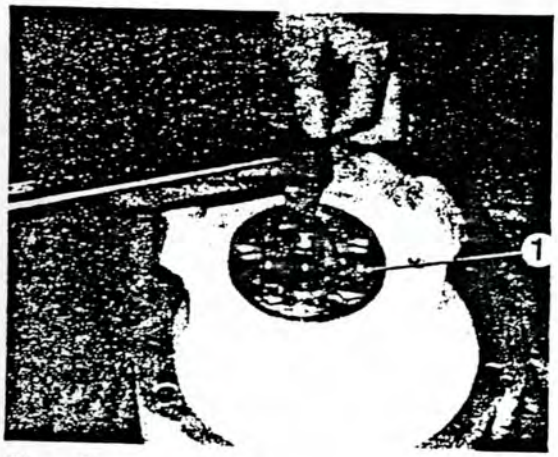


Fig. 3

- Sicherungsflansch (Fig. 3/1) aufschrauben und mit 25 Nm festziehen.

3.8 Installation of bevel pinion shaft

- The end of the bevel pinion shaft bears a spacing sleeve and nut (Fig. 1/1) so that bearing (Fig. 2/1) will not be knocked out when bevel pinion shaft is introduced into housing.

- Screw on retaining flange (Fig. 3/1) and torque to 25 Nm.

3.8 Pose de l'arbre du pignon conique

- Monter une douille entretoise et un écrou sur l'extrémité de l'arbre (fig. 1/1) pour fixer le roulement (fig. 2/1) en translation.

- Monter la bague d'arrêt (fig. 3/1) et serrer les vis à 25 Nm.

Fig. 4

- Kegelritzel zur Mitte-Gehäuse ausmessen (Fig. 4). Hierbei sollte das gemessene Maß dem eingeschlagenen Maß am Zahnrad entsprechen (Fig. 5). Anschließend kann die Mutter und der Stützring von der Welle entfernt werden.

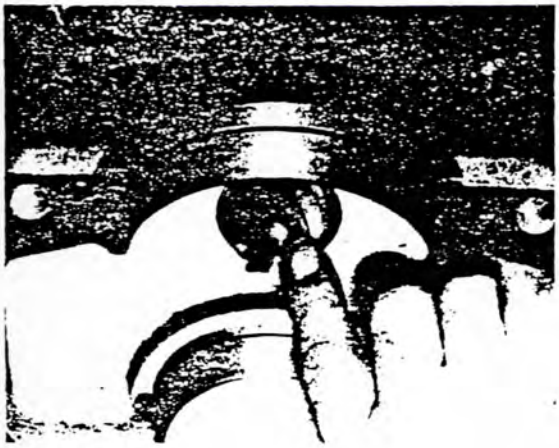


Fig. 5

Bei einem Ober- oder Untermaß ist eine entsprechende Anzahl von Ausgleichscheiben beizufügen bzw. zu entfernen, bis das Sollmaß erreicht ist (Beilegen der Ausgleichscheiben siehe "Zusammenbau Kegelritzelwelle).

Hinweis:

Ein Toleranzwert von 1/10 ± ist erlaubt.

- Measure bevel pinion from centre of housing (Fig. 4). The reading should correspond to amount stamped in gear (Fig. 5). Nut and supporting ring can now be removed from shaft.

If reading is oversize or undersize, add or remove a corresponding number of shims until the correct measurement is obtained (for use of shims see "Assembly of bevel pinion shaft").

Note:

A tolerance of ± 1/10 is allowed.

- Mesurer la distance conique (fig. 4). La cote relevée devrait correspondre à celle inscrite sur le pignon (fig. 5). Si c'est le cas, enlever l'écrou et la bague entretoise de l'extrémité de l'arbre.

Si la distance conique relevée s'écarte de la valeur prescrite, la corriger par adjonction ou enlèvement de cales (pour la mise en place des cales se reporter au paragraphe 3.6).

Nota:

La tolérance sur la distance conique est de ± 0,1 mm.

3.8.1 Flankenspiel einstellen

Um ein dem Toleranzwert entsprechendes Flankenspiel zu erreichen, müssen folgende Bedingungen vorliegen:

- Das Maß Mitte-Gehäuse und Kegelritzel sollte mit dem eingeschlagenen Wert am Kegelritzel übereinstimmen.
- Ca. 9 - 10 Stück 1/10 mm-Ausgleichsscheiben zwischen Tellerrad und vorderem Lager beilegen.

Durchführung der Prüfung:

- Meßuhr gemäß Fig. 1 ansetzen und Tellerrad leicht bewegen.

Fig. 1

Hinweis:

Toleranzwert des Flankenspiels beträgt ± 1/10.

- Sollte das Flankenspiel nicht dem vorgesehenen Toleranzwert entsprechen, so sind je nach Wert Ausgleichsscheiben zu entfernen bzw. hinzuzufügen (Beilegen der Ausgleichsscheibe siehe Tellerrad und Lager auswechseln).

3.8.1 Adjustment of backlash

The following conditions must be satisfied before backlash conforms to tolerance.

- The distance between centre of housing and bevel pinion should agree with value stamped in bevel pinion.
- Insert about 9 - 10 1/10 mm shims between ring gear and front bearing.

Test procedure:

- Apply dial gauge with reference to Fig. 1 and move ring gear slightly.

Note:

Backlash tolerance is ± 1/10.

- Failing specified backlash, remove or add shims accordingly (for addition of shims see replacement of ring gear and bearings).

3.8.1 Réglage du jeu de denture

Les conditions suivantes doivent être remplies pour obtenir le jeu de denture prescrit:

- La distance conique est égale à la valeur inscrite sur le pignon conique.
- 9 - 10 cales de 0,1 mm sont intercalées entre la couronne et le roulement avant.

Vérification du jeu:

- Monter un comparateur suivant la fig. 1 et tourner légèrement la couronne.

Nota:

La tolérance sur le jeu de denture est de ± 0,1 mm.

- Si le jeu de denture relevé est hors tolérances, le corriger par adjonction ou enlèvement de cales (pour la mise en place des cales se reporter au paragraphe 3.3).

3.9 Tellerrad vollständig einbauen

3.9.1 Einstellarbeiten - Tragbild

- Beim Einstellen des Tragbildes ist folgendes zu beachten:
- Flankenspiel sollte dem vorgeschriebenen Toleranzwert entsprechen.
- Da seitlich am Tellerrad eine Markierung angebracht ist, ist nur dort der Zahn mit Tuschierfarbe zu versehen (Fig. 1 und 2).

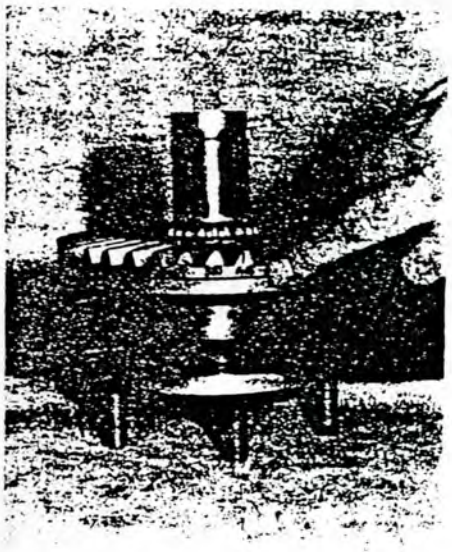


Fig. 1

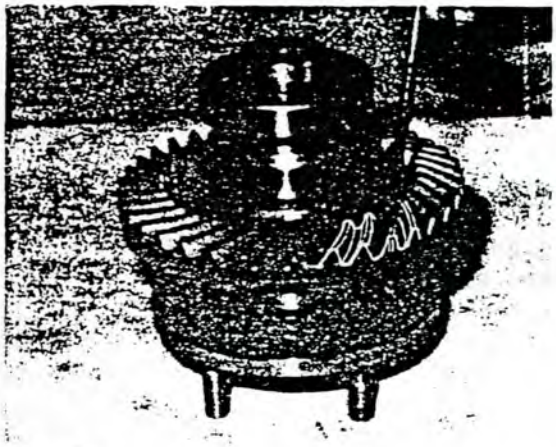


Fig. 2

Fig. 3

Achtung:

Das Tellerrad so ins Gehäuse einsetzen, daß die Markierung am Tellerrad und am Kegelritzel übereinstimmt. Anschließend Sicherungsringe vorne und hinten in ihre Nut von Hand eindrücken (Fig. 3).

3.9 Installation of ring gear assembly

3.9.1 Adjustments - Contact pattern

- Please note the following points on adjustment of contact pattern.
- Backlash should conform to specified tolerances.
- As the side of the ring gear bears a mark, apply Indian ink only to the tooth at that place (Fig. 1 and 2).

Caution:

Introduce ring gear into housing so that marking on ring gear agrees with that on bevel pinion. Finally press circlips by hand into grooves at back and front (Fig. 3).

3.9 Pose de l'ensemble couronne dentée

3.9.1 Réglage de la portée des dents

- Pour le réglage de la portée, observer les points suivants:
- Le jeu de denture doit être dans les tolérances.
- N'appliquer de l'encre qu'à la dent en face du repère sur la circonférence de la couronne (fig. 1 et 2).

Attention:

Monter le couple conique de manière à faire coincider les repères sur la couronne et le pignon d'attaque. Ensuite, pousser les circlips avant et arrière dans leur rainures à la main (fig. 3).

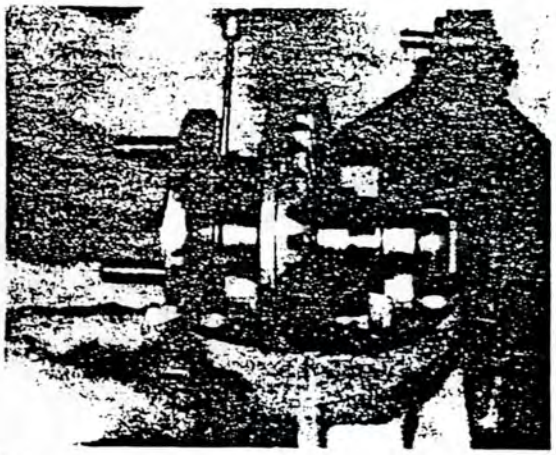


Fig. 4

- Nach dem ordnungsgemäßen Einsetzen der Tellerradbaugruppe ist der Dichtring mit zwei Schraubenziehern an den Sicherungsring anzudrücken (Fig. 4).

Fig. 5

- Bodendeckel kreuzweise festschrauben und an der Ankerplatte mehrmals drehen. Deckel wieder abnehmen und Andruck überprüfen (Fig. 5).

Entspricht das Flankenspiel und das Tragbild den angegebenen Normen, so ist das Tellerrad für Abdichtungsarbeiten aus dem Gehäuse wieder zu entfernen. Danach ist wie folgt zu verfahren:

Fig. 6

- Die Lagerseite für den Dichtring ist mit einem Dichtmittel, z.B. Fluid, zu bestreichen (Fig. 6).

- Having satisfactorily fitted the ring gear assembly, press sealing ring against circlip using two screwdrivers (Fig. 4).

- Après pose correcte de l'ensemble couronne pousser le joint à lèvre contre le circlip avec deux tournevis (fig. 4).

- Fasten bottom cover crosswise and turn repeatedly on anchor plate. Remove cover again and check contact pattern (Fig. 5).

- Serrer les vis du couvercle inférieur en croix et tourner plusieurs fois le plateau d'arbre. Enlever le couvercle et vérifier la portée (fig. 5).

Provided backlash and contact pattern comply with specifications, remove ring gear from housing again for purpose of sealing. Then proceed as follows:

Si le jeu de denture et la portée des dents sont corrects sortier la couronne du carter pour effectuer les opérations d'étanchements. Pour cela, procéder comme suit:

- Bearing side for sealing ring is to be coated with a sealant, e.g. Fluid (Fig. 6).

- Appliquer une pâte d'étanchéité (Fluid p. ex.) à la surface de siège du joint à lèvre (fig. 6).

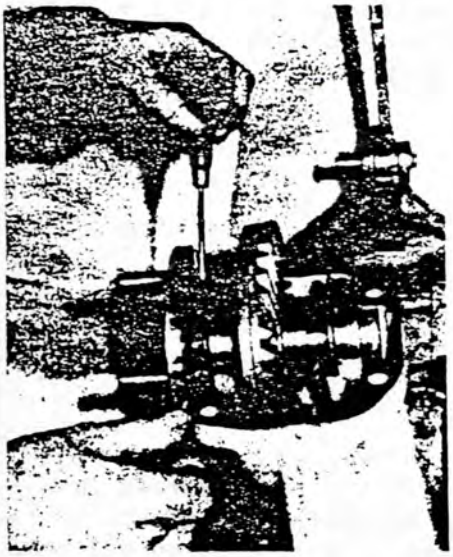


Fig. 7

- Baugruppe wieder einsetzen und den Dichtring am Sicherungsring fixieren (Fig. 7).

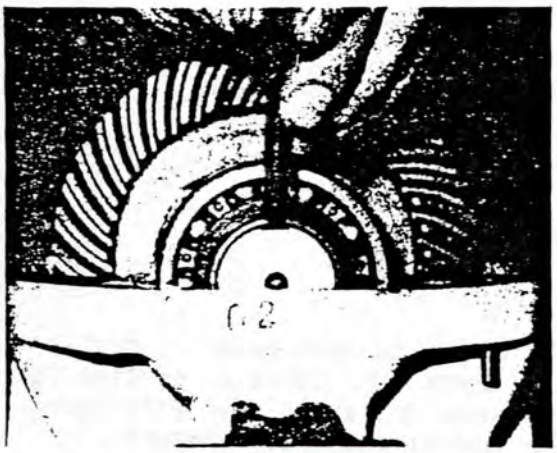


Fig. 8

- Zur Sicherung der Kronenmutter ist diese zu verstemmen (Fig. 8).

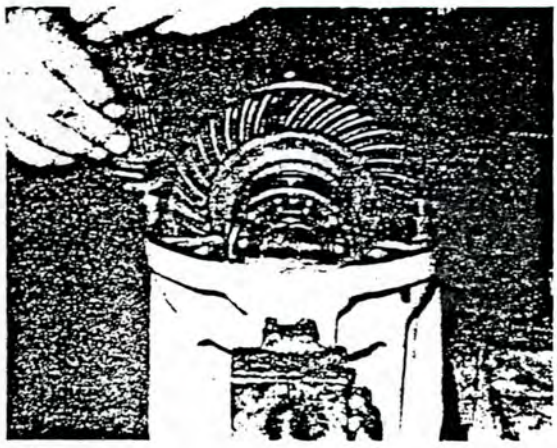


Fig. 9

- Gehäuse mit Dichtungsmittel, z.B. Fluid, versehen und gut verstreichen (Fig. 9).

Achtung:

Dichtfläche sollte vor dem Auftragen des Dichtmittels sauber sein.

- Put back assembly and secure sealing ring at circlip (Fig. 7).

- Remonter l'ensemble couronne et pousser le joint à lèvre contre le circlip (fig. 7).

- Secure castle nut at tab washer (Fig. 8).

- Freiner l'écrou à encoches (fig. 8).

- Apply sealent, e.g. Fluid, to housing and distribute well (Fig. 9).

- Appliquer de la pâte d'étanchéité (Fluid p. ex.) au plan de joint du carter (fig. 9). Bien répandre la pâte.

Caution:

Make sure that sealing surface is clean before sealant is applied.

Attention:

N'appliquer la pâte que sur un plan de joint propre.

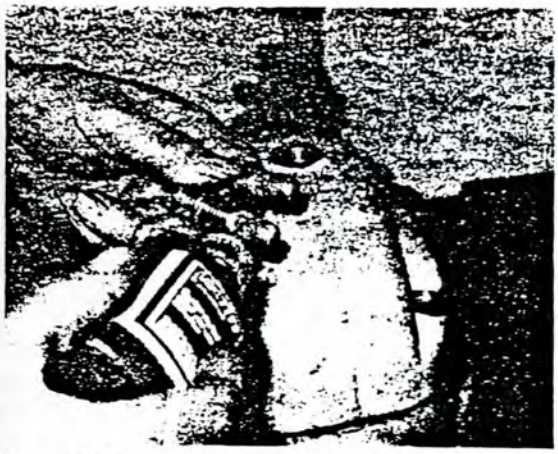


Fig. 10

- Bodendeckel aufsetzen und Schrauben mit Loctite 242 sichern (Fig. 10) und mit 49 Nm festziehen (Fig. 11).

Fig. 11

- Getriebe gemäß Einbaubeschreibung montieren und mit Getriebeöl auffüllen.

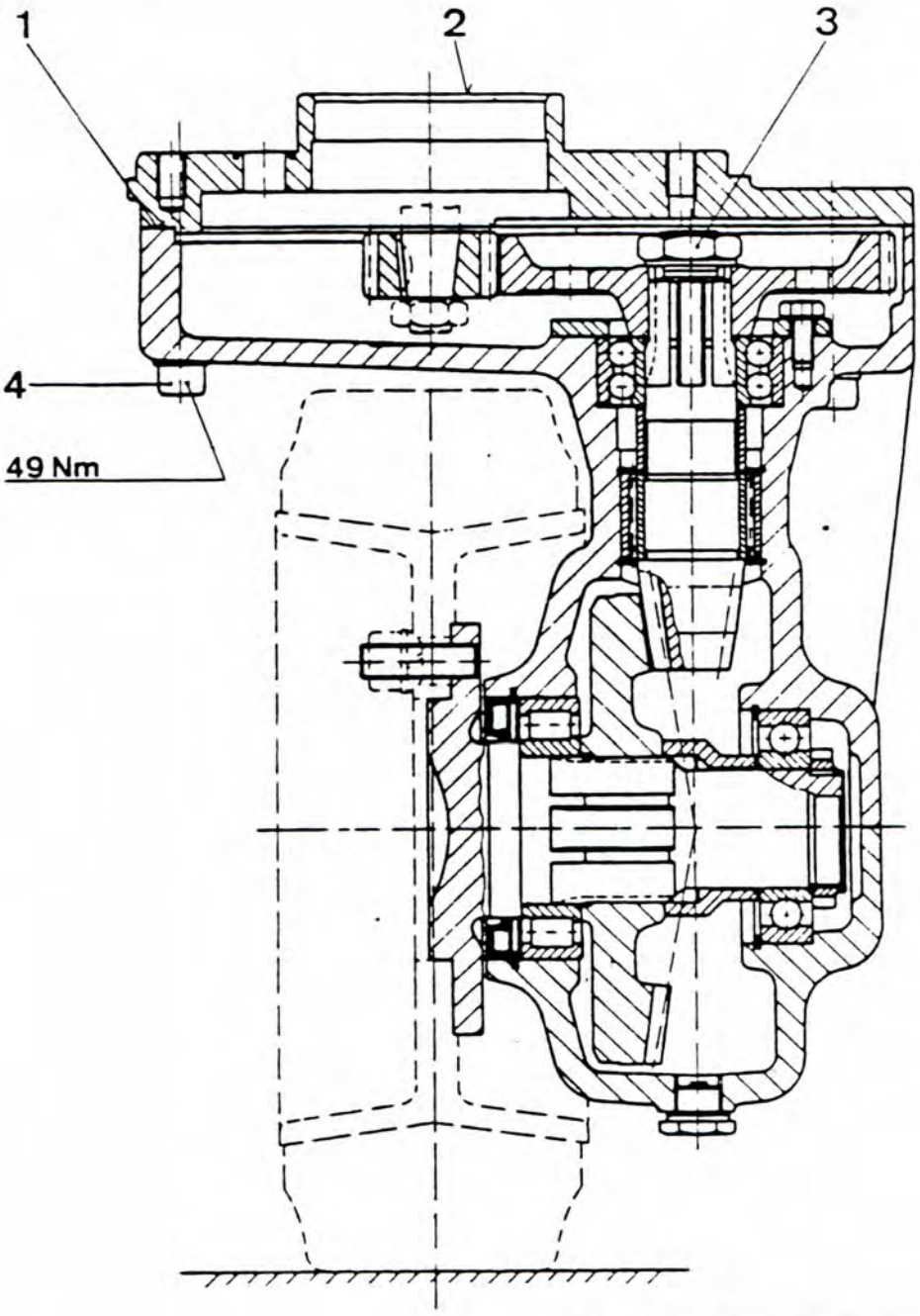
- Fit bottom cover and secure bolts with Loctite No. 242 (Fig. 10), torquing to 49 Nm (Fig. 11).

- Monter le couvercle inférieur, freiner les vis au Loctite 242 (fig. 10) et les serrer à 49 Nm (fig. 11).

- Install transmission with reference to installation description and fill with gear oil.

- Poser la boîte de transmission sur le chariot suivant les instructions et la remplir d'huile.

3.10 Montagezeichnung - Getriebe, vollständig



VERDREHFLANKENSPIEL = 0,11 - 0,18

1 Mit Loctite 573 abgedichtet

2 Bei Lagerung gegen Schmutz abdecken

3 Mit Loctite 242 gesichert

4 Mit Loctite 242 gesichert

3.10 Installation drawing - Transmission, complete

3.10 Ensemble boîte de transmission - plan de montage

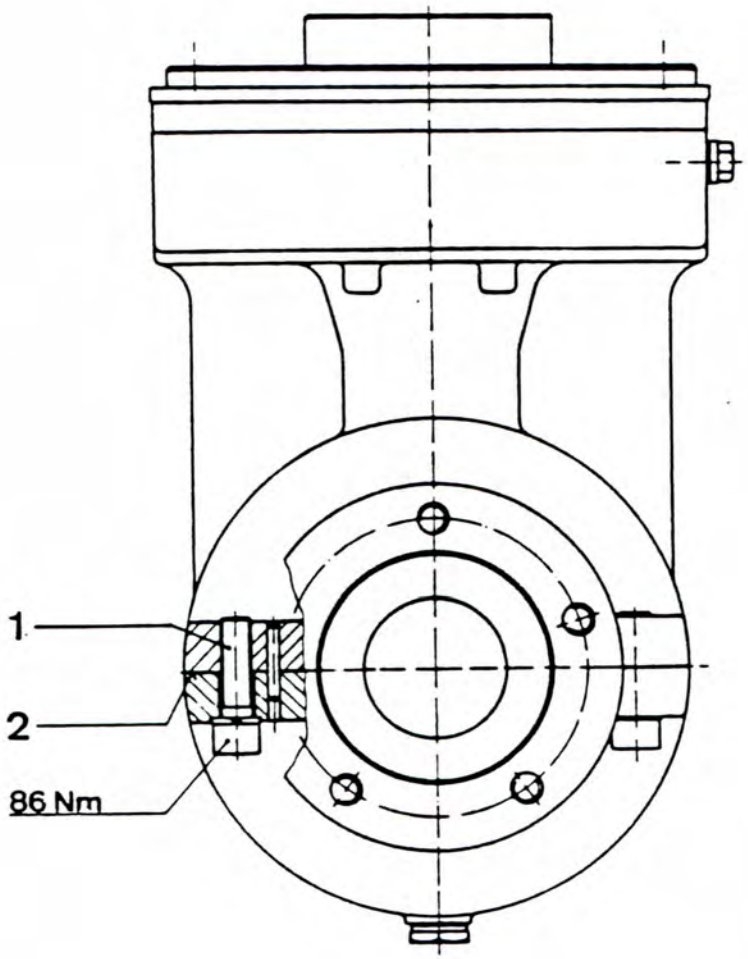
BACKLASH = 0,11 - 0,18

1 Sealed with Loctite No. 573
2 For storage, protect against dirt.
3 Secured with Loctite No. 242
4 Secured with Loctite No. 242

JEU DE DENTURE = 0,11 - 0,18

1 Etanché au Loctite 573
2 A obturer en cas de stockage.
3 Freiné au Loctite 242
4 Freiné au Loctite 242

3.11 Montagezeichnung für unteren Getriebedeckel



1 Mit Loctite 242 gesichert

2 Mit Loctite 573 abgedichtet

3.11 Installation drawing for lower transmission cover

3.11 Montage du couvercle inférieur

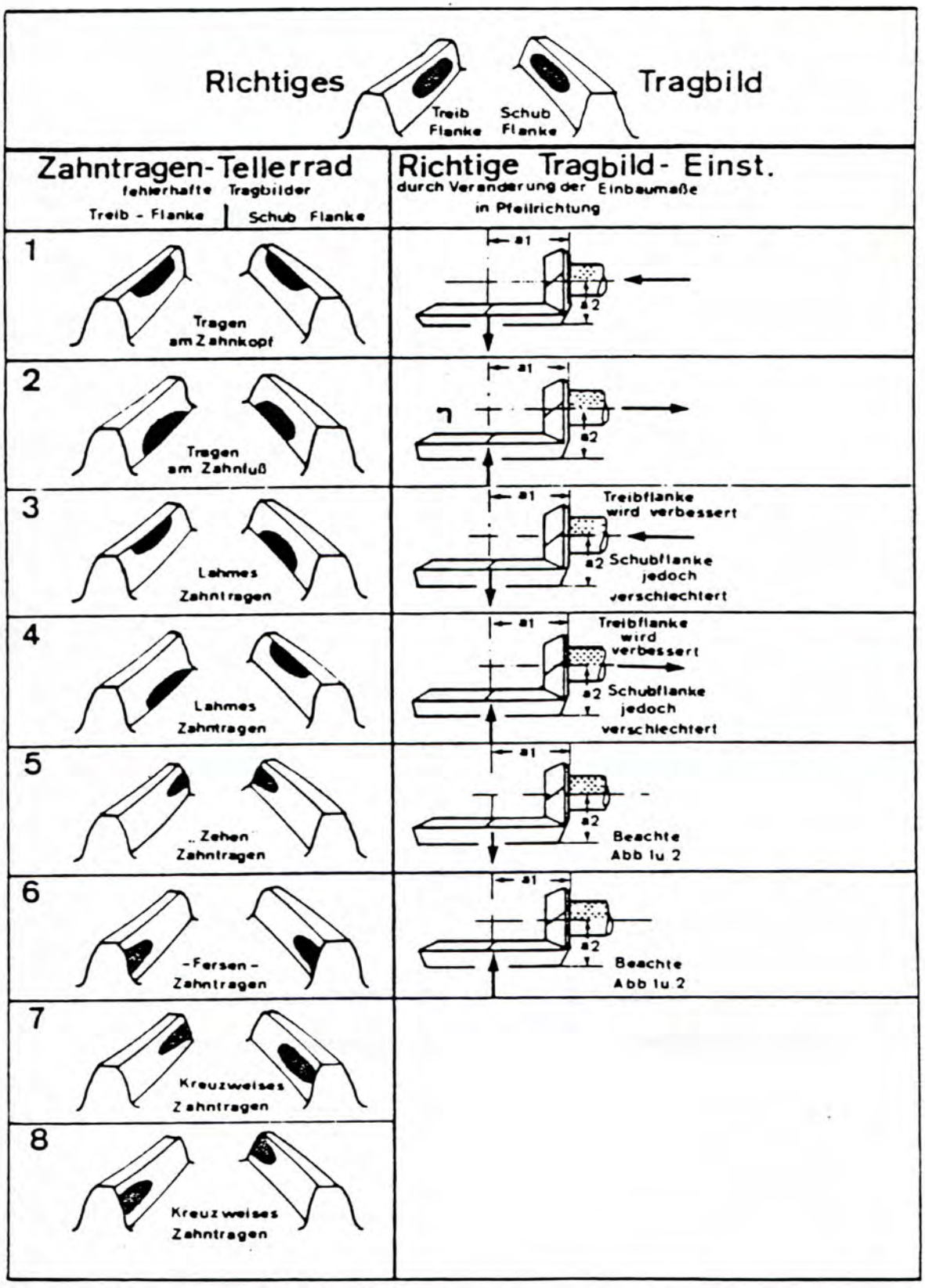
1 Secured with Loctite No. 242

2 Sealed with Loctite No. 573

1 Freiné au Loctite 242

2 Etanché au Loctite 573

3.12 TRAGBILD - DIAGRAMM



3.12 CONTACT PATTERN DIAGRAM

3.12 PORTEE DES DENTS

Richtiges Tragbild	Correct contact pattern	Portée correcte
Treibflanke	Driving face	Flanc tirant
Schubflanke	Driven face	Flanc poussant
Zahntragen-Tellerrad	Ring gear contact pattern	Portée de la couronne
Richtige Tragbild-Einstellung	Correction of contact pattern	Correction de la portée
Fehlerhafte Tragbilder durch Veränderung der Einbaumaße in Pfeilrichtung	Defecting contact patterns by altering the installation dimensions in direction of arrow	Portées défectueuses dans le sens des flèches
Tragen am Zahnkopf	Contact at tooth tip	Portée sur têtes
Tragen am Zahnfuß	Contact at tooth root	Portée sur pieds
Lahmes Zahntragen	Lame tooth contact	Portée sur têtes ou pieds
"Zehen" Zahntragen	Tooth "toe" contact	Portée sur pointes
"Fersen" Zahntragen	Tooth "heel" contact	Portée sur talons
Kreuzweises Zahntragen	Crosswise tooth contact	Portée sur pointes ou talons
Treibflanke wird verbessert	Driving face better	Amélioration sur flanc tirant
Schubflanke jedoch verschlechtert	But driven face worse	Mais aggravation sur flanc poussant
Beachte Abb. 1 und 2	Note Fig. 1 and 2	Voir fig. 1 et 2

SECTION
12

PC CONTROL ON ETA

LED		Description	Switch	Current Way	
200	Input	Directional Switch in Forward	S24	207	
201	Input	Directional Switch in Reverse	S23	207	
202	Input	Deadman's Switch on Drive Knob	S25	207	
203	Input	Steering Circuit In Order	LIN	301	* * *
204	Input	Direction of Travel; Reverse	K122	253	
205	Input	10° Steer Switch Closed	S3	118	* * *
206	Input	Door Latch Switches	S17/S18	153	* * *
207	Input	Tracking Speed	ESG	313	
210	Input	Lift Chain Slack Switches	S6/S68	157	* * *
211	Input	Safety Circuit OK		309	* * *
212	Input	Wire Guidance Switch Closed	S27	198/311	
213	Input	Deadman's Switch on Hydraulic Cont Knob	S32	196	
214	Input	Rotate Button	S63	210	
215	Input	Aux Mast Lowered	B6	171	* * *
216	Input	Hydraulic Control Knob Clockwise	S67	196	
217	Input	Hydraulic Control Knob Counter-Clockwise	S66	196	
220	Output	Tracking Speed	FGV1	266	
221	Output	Pump Motor Speed V4	HGV4	43	
222	Output	Pump Motor Speed V3	HGV3	43	
223	Output	Pump Motor Speed V2	HGV2	43	
224	Output	Pump Motor Speed V1	HGV1	43	
225	Output	Lift Limit Over-ride Switch	S35	143	Optional
226	Output	Mast in Danger Zone Light	H8	141	Optional
227	Output	1 MS Switch (Closes Regen Contactor)	K108	250	
230	Output	1st Magnet Brake Solenoid	K1	82	
231	Output	Emergancy Stop Brake Solenoid	K2	81	* * *
232	Output	Steer Contactor	K4	116	
233	Output	Valve- Main Lift Slow Lower	Y1	118	
236	Output	Valve- Main Lift Fast Lower	Y14	158	
240	Input	Syncronized Left	S64	211	
241	Input	Aux Lift/Lower	S61	209	
242	Input	Main Lift/Lower	S60	214	
243	Input	Side Shift	S62	213	
244	Input	Syncronized Right	S65	212	
245	Input	Forks Left W/O Limitation	S16	166	
246	Input	Forks Left 1st Limitation	S15	165	Note 1 ***
247	Input	Forks Left End Position Cushioning	S14	164	Note 1 ***
250	Input	Forks Right W/O Limitation	S11	161	
251	Input	Forks Right 1st Limitation	S12	162	Note 2 ***
252	Input	Forks Right End Position Cushioning	S13	163	Note 2 ***
253	Input	Forks Rotated Right	B7	176	Note 1 ***
254	Input	Forks Rotated Left	B8	184	Note 2 ***
255	Input	Upright Switch 0.5 Meters	B1	95	* * *
256	Input	Upright Switch 2.5 Meters	B2	98	* * *
257	Input	Upright Switch 3.5 Meters	B3	102	* * *
260	Input	Upright Dampening	B16	108	

265		Asile Detection; Left	B5	*84	
266	Output	Forward Direction	K123	253	
267	Input	Lift Cut-out	B8.1	104	Optional
270	Output	Strobe Light	H1	246	
271	Output	Directional Contactor; Forward	K102	247	
272	Output	Directional Contactor; Reverse	K103	248	
273	Output	Directional Speed; V4	FGV4	269	
274	Output	Directional Speed; V3	FGV3	268	
275	Output	Directional Speed; V2	FGV2	267	
276	Output	Hour Meter	A7	249	
277	Output	Back-up Alarm	A27	279	Optional
300	Input	Hydraulic Control Knob Circuit; OK	KSHY	196	* * *
301	Input	Hydraulic Pump Motor Speed	EHB1	196	
302	Input	Hydraulic Pump Motor Speed	EHB2	196	
303	Input	Hydraulic Pump Motor Speed	EHB3	196	
304	Input	Hydraulic Pump Motor Speed	EHB4	196	
305	Input	Time Delay; Valve	NV	286	
306	Input	Time Delay; Pump	NP	286	
307	Input	Brakes Released	S33	91	
310	Input	Directional Control Knob Circuit; OK	KSFH	207	* * *
311	Input	Speed = 0	K121	250	
312	Input	Reed Switch Right Outside (Regen)	S7	222	Optional
313	Input	Reed Switch Right Middle (V=1/4)	S8	224	Optional
314	Input	Reed Switch Left Middle (V=1/4)	S9	226	Optional
315	Input	Reed Switch Left Outside (Regen)	S10	228	Optional
316	Input	Reed Switch Right Inside (Emer Stop)	S19	237	Optional
317	Input	Reed Switch Left Inside (Emer Stop)	S20	238	Optional
320	Output	Main/Aux/Side Shift - Bit 1	HHB1	286	
321	Output	Main/Aux/Side Shift - Bit 2	HHB2	286	
322	Output	Main/Aux/Side Shift - Bit 3	HHB3	286	
323	Output	Main/Aux/Side Shift - Bit 4	HHB4	286	
324	Output	Rotate - Bit1	DB1	293	
325	Output	Rotate - Bit2	DB2	293	
326	Output	Rotate - Bit3	DB3	293	
327	Output	Rotate - Bit4	DB4	293	
330	Output	Main Mast Lifting	RL110	252	
331	Output	Main Mast Lowering	RHHS	285	
332	Output	Aux Mast Lifting	RZHH	285	
333	Output	Aux Mast Lowering	RZHS	285	
334	Output	Side Shift Right	RSR	293	
335	Output	Side Shift Left	RSL	293	
336	Output	Rotate Right	RDR	293	
337	Output	Rotate Left	RDL	293	
		*** : Initial Test LEDs			
		Note 1: Base Position Left			
		Note 2: Base Position Right			

ETA CHECK LIST / TECHNICAL INFORMATION

PHB - AUTOPILOT 2

Commissioning Checklist

Customer .....

Serial Number.....

Dealership or Customer Commissioning

All functions checked and adjusted according to checklist.

Date..... Name.....

Further checks or adjustments required in connection with wire guidance.

Commissioning on Customer's premises.

Transmitter connected up.

Trial run carried out over the complete circuit.

All functions checked and adjusted according to Check List.

Date..... Name.....

1. GENERAL TESTS AND INSTALLATION INFORMATION

1.1 Chain from steer motor to drive unit taut (very tight - no deflection)

Potentiometer - Drive belt taut.

1.2 Front Antenna:

Height setting (underside 5cm above the floor with antenna horizontal).

Lateral adjustment (antenna at center of vehicle).

Cable undamaged, cable and connector secure.

1.3 Rear Antenna:

Height setting (underside 5cm above the floor with antenna horizontal).

Cable undamaged, cable and connector secure.

1.4 Rotary Impulse Transmitter correctly installed. (Coupler between Motor and Transmitter - ETD only)

1.5 Reed switch for End of Isle Detection installed 2cm above ground.

2. SWITCHING ON THE VEHICLE

Warning: Never Remove or Replace Any Component Unless the Truck is Switched 'OFF".

2.1 The following LEDs must light.

Manual Steer 'ON' .....LED 6, card 17, PHB.

Steer control is in order.....LED 10, card 21, PHB.

Steer End Stage is in order.....LED 13, card 25, PHB.

Rotary Impulse Transmitter OK....LED21,card , PHB (ETR & ETD).
LED 9, card 5, Steinbock (ETA).

Truck Stationary (V=0).....LED18, card , PHB (ETR & ETD).
LED 10, card 5, Steinbock (ETA).

2.2 Hand wheel potentiometer correctly installed. (Rotate hand wheel both directions to stops).
Approx -4 to +4 Volts, measured between points z26-d16 on Position Regulator Card 17, PHB.

2.3 Actual Value Pot, Coarse adjustment.

Approx 0 Volts, measured between points d12-d16 on Position Regulator Card 17, PHB with steer wheel straight..

3. RELEASE BRAKES.
(This will switch 'ON' the steering)
Display-LED 9, card 17 and LED 101, card 14. The steer wheel must assume the "Target Value" position.

Turn the hand wheel clockwise:
- the upper red LED, LED7, on the Position Regulating card, card 17 PHB, should illuminate.

Turn the hand wheel counter-clockwise:
- the lower red LED, LED8, on the Position Regulating card, card 17 PHB, should illuminate.

The steer motor steer to the right and left.

3.1 Check the operation of the steer limit switches. Manual operation of these switches should cause the truck to Emergency Stop (LED10, card 17 PHB 'off'). To reset, switch the truck 'Off'.

3.2 Limit switch correctly adjusted 1 inch before stop (see 4.3A).

3.3 Check cable run and length for rotary impulse transmitter.

3.4 Actual value potentiometer - fine adjustment.

Travel in a straight line in reverse. Align the truck to the guide wire by placing your forehead against the rear windshield, picking a reference point on the truck and drive in reverse guiding the truck so the reference point does not wander from the guide wire. Let the truck coast to a stop.

Adjust the 'Actual Value Pot' to 0.000 volts ±5mV measured between d12 and d16 on the 'Position Regulating ' card, Card 17 PHB. (Important to keep steering from wandering when traveling at a fast speed).

3.5A Measuring between z26 and d16 on the Position Regulating Card, card 17 PHB, rotate the hand wheel until reading is 0.00 volts.

3.5B Now measure between d12 and d16 on the same card, depress the Drive Control Knob and adjust pot P5 to 0.00 volts.

3.5C Drive very slowly in reverse a few inches and then recheck 3.5A & 3.5B.

4. AUTOMATIC STEERING

4.1 Adjusting the "Y" Amplification.

Drive in reverse "on the guide wire" and allow the truck to coast to a stand still. Mark the center of the rear antenna over the guide wire.

Drive in forward "on the guide wire" and allow the truck to coast to a stand still. Mark the center of the front antenna over the guide wire.

Steer the truck manually until the 'offset' between both antennas and the guide wire, both antennas to the same side of the guide wire, is between 3 and 7 cm (1.18 - 2.76 inches) and:-

a) Measure between d20 and d16 on the receiver card, card 09 PHB.

Switch 'ON' the rear antenna, adjust pot P1 on the receiver card until the voltage corresponds to the offset (±10%) i.e. 25 millivolts per millimeter of offset.

EXAMPLE: Measurement from center of antenna to center of guide wire is 68 mm. **68 X 0.025v = 1.7 volts.**

b) Carry out the same measurements and adjustments on the rear monitor card, card 05 PHB.

4.2 Check the Level Signal Switching Threshold.

Adjust pot P2 on the Receiver Card, card 09, to give a Level Switching Point, LED3, at about 6-8 inches offset between the guide wire and the antenna. (Metal particles in the floor may increase the adjustable offset)

4.3 Electronic Steer Angle Limitation.

In manual steering, maximum steer angle (right and left) the cam must come to rest approx 2cm (0.78 - 1.18 inches) before the limit switch . Adjust by means of P1 and P2 on the position regulating card, card 17 PHB.

4.4 Lateral Adjustment of the Front Antenna.

Adjust the front antenna so that the center mark of the antenna is centered to the truck.

4.5 Lateral Adjustment of the Rear Antenna.

With 'Wire Guidance ON', and traveling in reverse, the center of the front antenna must remain on the guide wire. If necessary, adjust the rear antenna so that the front antenna remains on the wire when traveling in reverse. (NOTE: When reversing direction of travel, the steer action should be minimal).

4.6 Correction of Possible Offset Errors. (Only if the center of the rear antenna tracks mostly to one side of the guide wire when traveling in max reverse speed).

Adjust pot P5 on the Position Control Card, card 17 PHB, so that after tracking, the steer actions to the left and to the right are equal, travel in reverse. (Turn pot 1/10 turn at a time if necessary to adjust).

4.7 Optimize Steer Amplification

Adjust pot P3 on the Position Control Card, card 17 PHB, to obtain the narrowest steer movement possible. If the steer action is sluggish during tracking, increase the amplification. CW to increase, CCW to decrease.

4.8 Check switching points Y30 (±10) and Y100 (±30) (indicators 5 & 4, card 13 PHB) This is not adjustable.

4.9 Check Y50 switching point, LED 1, card 05 PHB. The switching point can be set to a lower value if floor conditions permit e.g. 40cm. Adjust pot P2 on the Rear Monitor Card, card 05 PHB.

4.10 Check for proper 'tracking' distance. On wire, stop, reset Automatic switch, drive forward until beeper stops (about 60-70cm). This can not be adjusted.

5. TRAVEL CONTROL (STEINBOCK GROUP)

5.1 Check the function of the indicators for direction of travel on the Drive Control Card, card 05 Steinbock, LED 11 & 12 (forward & reverse).

5.2 V = 0 (speed = 0) Check switching detection. LED10, card 05 Steinbock.

5.3 Adjust Tracking Speed, V1, pot P1 on Drive Control Card, card 05 Steinbock. About 0.2 mm per second (8 ins/sec).

5.4 Adjust speed V2 to specifications. Adjust with pot P2 on card 05 Steinbock.

5.5 Adjust speed V3 to specifications. Adjust with pot P3 on card 05 Steinbock.

5.6 Adjust speed V4 (Maximum speed) to specifications. Adjust with pot P4 on card 05 Steinbock. (Must not exceed 8 km/hr or 2.22 m/sec (5mph or 7.5 ft/sec).

LED Indicators for speed ranges.

V1 = LED 5, card 05 Steinbock

V2 = LED 6, card 05 Steinbock

V3 = LED 7, card 05 Steinbock

V4 = LED 8, card 05 Steinbock

NOTE: See Group 6, page 16 for specifications of travel speeds.

6. CHECK SAFETY MONITOR FUNCTIONS

Checking the safety monitors and switching of the brakes and traction. (Safety Circuit OK is illuminated by LED211 on the PC and LED10, card 21 PHB. LEDs will turn 'OFF' when a problem is detected).

6.1 Disconnect/Unplug one of the antennas.

6.2 Disconnect/Unplug the Actual Value Pot.

6.3 Check Emergency Stop with Y30 - Drive out over end of wire.

6.4 Check Emergency Stop with level - Drive out over wire during tracking process.

6.5 Check the Rotary Impulse Transmitter monitoring. Disconnect the plug from the transmitter - Led 9, card 05 should also turn 'OFF'

7. Final Checks (Test Drive)

7.1 Tracking from left and right.

7.2 Plugging in aisle.

7.3 Change speed of travel in the aisle (Mast Lift Height).

7.4 Steer Manual - Automatic - Manual - Switching.

7.5 Travel with and without load at all speeds. Check for maximum oversteer of the rear antenna when traveling forward.

7.6 End of Aisle Detection (optional).

7.7 Special options.

P.H.B. AUTOPILOT
REPLACEMENT OF COMPONENTS

After dismantling or replacing components, the following items must be checked or re-set.

1. Antenna (front or rear).

   1.2 & 1.3 & 4.1 & 4.5 & 4.6

2. Rotary Impulse Transmitter or Cable.

   1.4 & 5.1 & 6.5

3. Target value potentiometer (on hand wheel).

   2.2

4. Actual value potentiometer or if the steer chain or pot belt are re-tensioned.

   3.4 & 4.3

5. Steer End Stage.

   3.1

6. Rear Monitor Card, card 05 PHB.

   4.1 & 4.9

7. Receiver Card, card 09 PHB.

   4.1 & 4.2 & 4.3 & 4.6 & 6.4 & 7.1

8. Steering Control Card, card 13 PHB.

   4.3 & 4.7 & 4.8 & 6.3 & 7.1

9. Position Control Card, card 17 PHB.

   4.3 & 4.4 & 4.7

10. Control Monitor Card, card 21 PHB.

    3.1 & 4.10 & 6.1 & 6.2 & 7.1 & 7.2

11. Relay Card A2.1, card 25 PHB

    6 & 7

12. Relay Card A2.2, card 29 PHB
    6 & 7

IMPORTANT NOTES

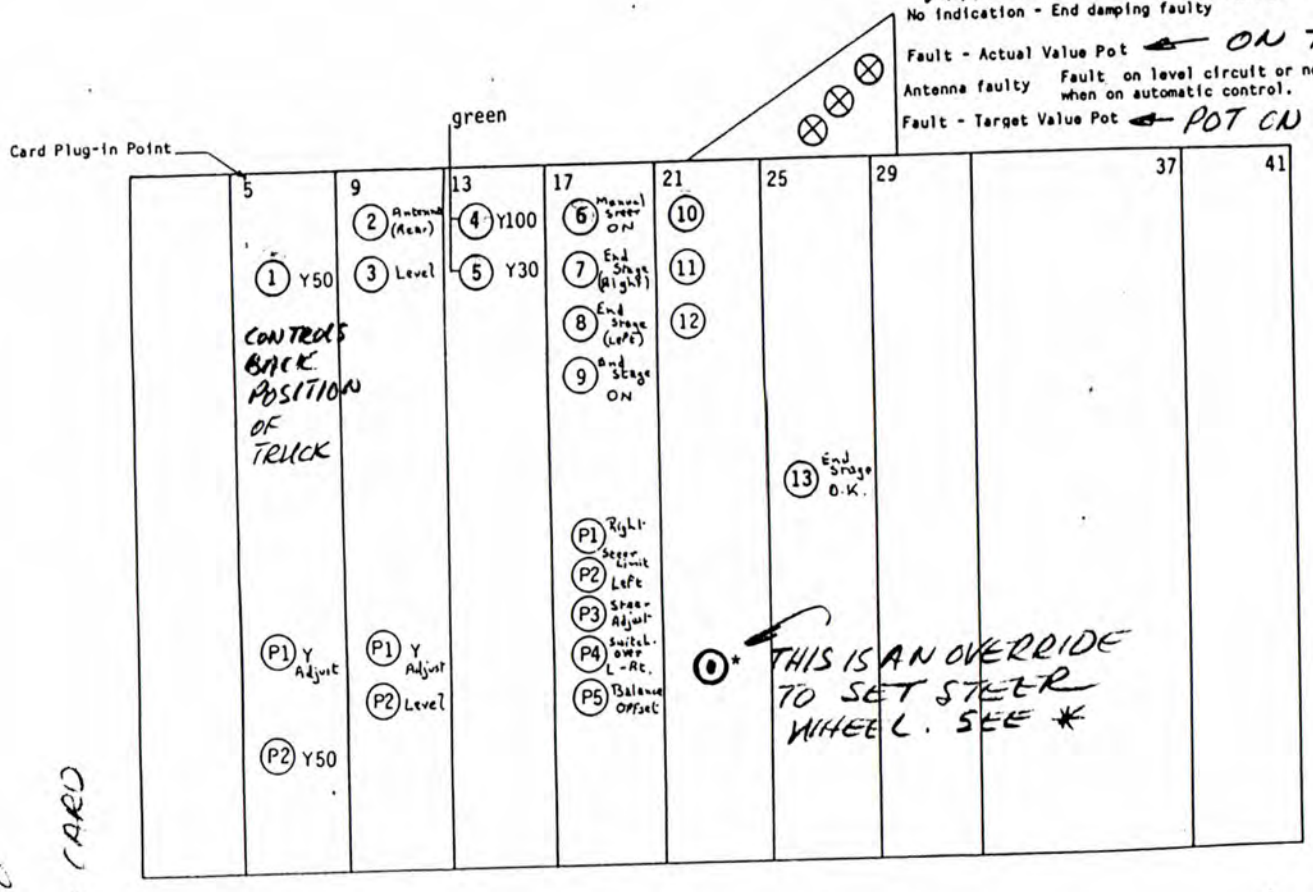
On completion of PM, the following functions must be checked.

1.1 & 1.2 & 1.3 & 1.6 & 4.5 & 4.8 & 6 & 7

As a routine measure, check out the correct operation of ALL functions after carrying out any maintenance on the vehicle.

Only remove or replace components if the battery is disconnected.

THESE ILLUMINATIONS ON ONLY WHEN HAVE FAULT



* Push button for by-passing the limit switch (from card F).

- Override the limit switch only when commissioning or testing.
- Switch off the truck.
- Set target value pot. (steer wheel) in mid position.
- Keep push button * depressed.
- Switch on truck.
- Release brake, steering goes to mid position.

200 MID WA ONLY
500 MID2 NEW CARD
WAS RED IN OLD CARD

ARTIC. REACH UNIT	AUX. LIFT	MAIN LIFT	STEERING	
V max.	Base Position		up to 2.5m	Standard in Aisle
V 4 km/h	Base Position		up to 6.0m	
V 2.5 km/h	Not in Base Position			
V 0			From 6m with * Corrector Button 0.2m/sec	

* (Reset Button)

	ARTIC. REACH UNIT	AUX. LIFT	MAIN LIFT	STEERING	
V max.	Base Position	Lowered Raised	up to 2.5m up to 0.5m		Standard outside Aisle
V 4 km/h	Base Position	Raised	up to 0.5m		
V 2.5 km/h	Not in Base Position	Lowered Raised	0.5-2.5m up to 0.5m	10° Steer Lock 10° Steer Lock	
V 0		Lowered Raised	From 2.5m From 0.5m		

	ARTIC. REACH UNIT	AUX. LIFT	MAIN LIFT	STEERING
V max.	Base Position	Lowered	up to 0.5m	
V 4 km/h	Base Position Base Position	Lowered Raised	0.5-2.5m up to 0.5m	
V 2.5 km/h	Not in Base Position	Lowered Raised	0.5-2.5m up to 0.5m	10° Steer Lock 10° Steer Lock
V 0		Lowered Raised	From 2.5m From 0.5m	

Inductive outside Aisle

	ARTIC. REACH UNIT	AUX. LIFT	MAIN LIFT	STEERING
V max.	Base Position		up to 0.5m	
V 4 km/h	Base Position		up to 2.5m	
V 2.5 km/h	Not in Base Position Base Position		up to 3.5m	
V 0			From 3.5m with * Corrector Button 0.2 km/sec	

Inductive in the Aisle

* (Reset Button)

TIGHTENING TORQUE

Table: in Nm

	6.9	8.8	10.9	12.9
M 4	2,4	2,9	4,1	4,9
M 5	5	6	8,5	10
M 6	8,5	10	14	17
M 8	21	25	35	41
M 10	41	49	69	83
M 12	72	86	120	145
M 14	115	135	190	230
M 16	180	210	295	355
M 18	245	290	405	485
M 20	345	410	580	690
M 22	465	550	780	930
M 24	600	710	1000	1200
M 27	890	1050	1500	1800
M 30	1200	1450	2000	2400

Tightening torques for bolts with metric threads
and head dimensions as in DIN 931, 912, 934...
Friction value μ tot. 0.14