LIEBHERR

List of contents

Thorough and regular maintenance and inspection of the

LIEBHERR LTM 1030 TELESCOPIC-BOOM CRANE

are the best guarantee of full serviceability at all times and prolonged trouble-free operation.

Inspections should be carried out regularly, so that minor defects or malfunctions can be identified and put right before they develop into serious faults or cause the break-down of the crane.

If more general repairs should become necessary, please contact our after-sales service organization.

If you are equipped to perform certain repairs yourselves, this manual will provide a useful source of information.

Key to page numbers

To assist you in finding details of various maintenance or repair jobs, the pages have been numered as follows:

Page number within sub-group

Sub-group

Main group

In this example: 2. 5. 01

Crane undercarriage

Steering

The main and sub groups are listed in the Contents.

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Tightening torques

The preload values P_V shown in the table are based on 90% utilization of the bolt yield point σ 0,2.
Tightening torques M_A have been claculated from P_V.

To avoid accidentally exceeding the 90% yield point limit, deduct from the values quoted half of the tolerance margin of the preload gauge or torque wrench being used.

Surface treatment: bolts and nuts without additional treatment, mot lubricated, μ_{tot} = 0,14

Shank bolts with standard metric thread to DIN 13, Sheet 12 standard

Standard thread	Strength rating 8,8				Tightening torque when using lock washers	
	Preload force		Tightening torque			
	P_V kp	P_V N (newton)	M_A kpm	M_A Nm	M_A kpm	M_A Nm
M 5 x 0,8	798	7 827	0,73	7,1	0,88	8,5
M 6 x 1	1 126	11 041	1,26	12,4	1,5	14,8
M 8 x 1,25	2 067	20 267	3,1	30,4	3,7	36
M 10 x 1,5	3 291	32 272	6,2	60,7	7,4	72
M 12 x 1,75	4 798	47 057	10,8	105,6	12,9	126
M 14 x 2	6 590	64 622	17,2	168,3	20,6	201
M 16 x 2	9 071	88 956	26,4	258,6	31	309
M 18 x 2,5	11 022	108 092	36,3	356,4	43	427
M 20 x 2,5	14 173	138 993	51,5	505,2	61	606
M 22 x 2,5	17 720	173 770	69,7	683,3	83	819
M 24 x 3	20 410	200 150	88,9	872,4	106	1 046
M 27 x 3	26 882	263 620	132,2	1 296,4	158	1 555
M 30 x 3,5	32 666	320 339	179,2	1 757,0	214	2 108
M 33 x 3,5	40 735	399 472	243,0	2 383,0	291	2 859
M 36 x 4	47 790	468 658	312,2	3 061,5	374	3 673
M 39 x 4	57 456	563 454	404,8	3 970,4	484	4 764
M 42 x 4,5	65 783	645 106	504,9	4 951,3	604	5 941
M 45 x 4,5	77 046	755 564	630,3	6 180,8	756	7 416
M 48 x 5	86 644	849 683	761,7	7 469,8	913	8 962
M 52 x 5	103 989	1 019 779	980,6	9 616,5	1 176	11 539
M 56 x 5,5	119 913	1 175 942	1 222,1	11 985,1	1 466	14 382
M 60 x 5,5	140 177	1 374 666	1 515,7	14 864,4	1 818	17 836
M 64 x 6	158 575	1 555 086	1 824,4	17 891,3	2 188	21 469

The preload values P_V shown in the table are based on 90% utilization of the bolt yield point $\sigma_{0,2}$.
Tightening torques M_A have been calculated from P_V.

To avoid accidentally exceeding the 90% yield point limit, deduct from the values quoted half of the tolerance margin of the preload gauge or torque wrench being used.

Surface treatment: bolts and nuts without additional treatment, not lubricated, μ_{tot} = 0,14

Shanks bolts with standard metric thread to DIN 13, Sheet 12 standard

Standard thread	Strength rating 10,9				Tightening torque when using lock washers	
	Preload force		Tightening torque			
	P_V kp	P_V N (Newton)	M_A kpm	M_A Nm	M_A kpm	M_A Nm
M 5 x 0,8	798	7 827	0,73	7,1	0,88	8,5
M 6 x 1	1 126	11 041	1,26	12,4	1,5	14,8
M 8 x 1,25	2 067	20 267	3,1	30,4	3,7	36
M 10 x 1,5	3 291	32 272	6,2	60,7	7,4	72
M 12 x 1,75	4 798	47 057	10,8	105,6	12,9	126
M 14 x 2	6 590	64 622	17,2	168,3	20,6	201
M 16 x 2	9 071	88 956	26,4	258,6	31	309
M 18 x 2,5	11 022	108 092	36,3	356,4	43	427
M 20 x 2,5	14 173	138 993	51,5	505,2	61	606
M 22 x 2,5	17 720	173 770	69,7	683,3	83	819
M 24 x 3	20 410	200 150	88,9	872,4	106	1 046
M 27 x 3	26 982	263 620	132,2	1 296,4	158	1 555
M 30 x 3,5	32 666	320 339	179,2	1 757,0	214	2 108
M 33 x 3,5	40 735	399 472	243,0	2 383,0	291	2 859
M 36 x 4	47 790	468 658	312,2	3 061,5	374	3 673
M 39 x 4	57 456	563 454	404,8	3 970,4	484	4 764
M 42 x 4,5	65 783	645 106	504,9	4 951,3	604	5 941
M 45 x 4,5	77 046	755 564	630,3	6 180,8	756	7 416
M 48 x 5	86 644	849 683	761,7	7 469,8	913	8 962
M 52 x 5	103 989	1 019 779	980,6	9 616,5	1 176	11 539
M 56 x 5,5	119 913	1 175 942	1 222,1	11 985,1	1 466	14 382
M 60 x 5,5	140 177	1 374 466	1 515,7	14 864,4	1 818	17 836
M 64 x 6	158 575	1 555 086	1 824,4	17 891,3	2 188	21 469

The preload values P_V shown in the table are based on 90% utilization of the bolt yield point σ 0,2. Tightening torques M_A have been calcualated from P_V.

To avoid accidentally exceeding the 90% yield point limit, deduct from the values quoted half to the tolerance margin of the preload gauge or torque wrench being used.

Surface treatment: bolts and nuts without additional treatment, not lubricated, μtot = 0,14.

Shank bolts with fine metric thread to DIN 13, Sheet 12

Fine thread	Strength rating 8,8				Tightening torque when using lock washers	
	Preload force		Tightening torque			
	P_V kp	P_V N (Newton)	M_A kpm	M_A Nm	M_A kpm	M_A Nm
M 8 x 1	1 814	17 791	2,6	26,2	3,1	31
M 10 x 1,25	2 836	27 799	5,2	51,5	6,2	61
M 12 x 1,25	4 332	42 484	9,5	93,1	11,4	111
M 12 x 1,5	4 070	39 926	9,0	88,3	10,8	105
M 14 x 1,5	5 847	57 343	14,9	146,3	17,8	175
M 16 x 1,5	7 929	77 754	22,6	221,9	27	266
M 18 x 1,5	10 326	101 264	32,9	323,0	39	387
M 20 x 1,5	13 039	127 871	46,0	451,1	55	498
M 22 x 1,5	16 068	157 575	61,5	602,8	73	723
M 24 x 2	18 357	180 025	78,0	765,5	93	918
M 27 x 2	23 823	233 626	114,6	1 124,0	137	1 348
M 30 x 2	30 000	294 196	159,7	1 566,7	191	1 880
M 33 x 2	36 887	361 735	214,1	2 100,0	256	2 520
M 36 x 3	41 304	405 055	265,4	2 602,9	318	3 123
M 39 x 3	49 325	483 715	342,3	3 357,0	410	4 028
M 42 x 3	58 057	569 344	436,3	4 278,9	523	5 134
M 45 x 3	67 499	661 941	541,4	5 309,0	649	6 370
M 48 x 3	77 652	761 507	666,1	6 532,6	799	7 839
M 52 x 3	92 295	905 100	850,7	8 342,5	1 020	10 011
M 56 x 4	103 212	1 012 167	1 035,5	10 154,4	1 242	12 185
M 60 x 4	119 999	1 176 784	1 278,4	12 536,8	1 534	15 044
M 64 x 4	138 048	1 353 790	1 556,6	15 267,2	1 870	18 344

The preload values P_V shown in the table based on 90% utilization of the bolt yield point $\sigma_{0,2}$.
Tightening torques M_A have been calculated from P_V.

To avoid accidentally exceeding the 90% yield point limit, deduct from the values quoted half of the tolerance margin of the preload gauge or torque wrench being used.

Surface treatment: bolts and nuts without additional treatment, not lubricated, μ_{tot} = 0,14

Shank bolts with fine metric thread to DIN 13, Sheet 12

Fine thread	Strength rating 10.9				Tightening torque when using lock washers	
	Preload force		Tightening torque			
	P_V kp	P_V N (Newton)	M_A kpm	M_A Nm	M_A kpm	M_A Nm
M 8 x 1	2 551	25 019	3,7	36,8	4,4	44
M 10 x 1,25	3 986	39 092	7,4	72,5	8,8	87
M 12 x 1,25	6 092	59 743	13,4	130,9	16	157
M 12 x 1,5	5 700	56 000	12,5	122,2	15	146
M 14 x 1,5	8 223	80 638	20,9	205,7	25	246
M 16 x 1,5	11 150	109 342	31,8	312,0	38	374
M 18 x 1,5	14 521	142 402	46,3	454,3	55	545
M 20 x 1,5	18 336	179 819	64,7	634,4	77	761
M 22 x 1,5	22 596	221 590	86,4	847,7	103	1 017
M 24 x 2	25 815	253 160	109,8	1 076,5	131	1 291
M 27 x 2	33 501	328 437	161,2	1 580,7	193	1 896
M 30 x 2	42 187	413 713	224,7	2 203,1	269	2 643
M 33 x 2	51 872	508 689	301,2	2 953,3	361	3 543
M 36 x 3	58 084	569 609	373,3	3 660,4	447	4 392
M 39 x 3	69 364	680 224	481,4	4 720,8	577	5 664
M 42 x 3	81 643	800 640	613,6	6 017,1	736	7 220
M 45 x 3	94 921	930 855	761,4	7 466,1	913	8 959
M 48 x 3	109 198	1 070 869	936,7	9 186,4	1 124	11 023
M 52 x 3	129 789	1 272 797	1 196,3	11 731,5	1 435	14 077
M 56 x 4	145 142	1 423 360	1 456,1	14 279,5	1 747	17 135
M 60 x 4	168 748	1 654 853	1 797,7	17 629,9	2 157	21 155
M 64 x 4	194 130	1 903 767	2 192,1	21 497,6	2 630	25 797

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Ermeto

Tightening torques for screw-in unions

Straight threaded unions = GE (R = inch, M = metric)

	with edge seal				with EOLASTIC sealing ring			
	Type	Thread M or R	Tightening torque (app) kpm	Nm	Type	Thread M or R	Tightening torque (app.) kpm	Nm
Light-duty range	GE 6-LM	M 10 x 1	ca. 2	20	GE 6-LM-ed	M 10 x 1	ca. 1	10
	GE 6-LR	R 1/8 "	ca. 2	20	GE 6-LR-ed	R 1/8 "	ca. 1	10
	GE 8-LM	M 12 x 1,5	ca. 3	29	GE 8-LM-ed	M 12 x 1,5	ca. 2	20
	GE 8-LR	R 1/4 "	ca. 4	39	GE 8-LR-ed	R 1/4 "	ca. 2	20
	GE 10-LM	M 14 x 1,5	ca. 4	39	GE 10-LM-ed	M 14 x 1,5	ca. 3	29
	GE 10-LR	R 1/4 "	ca. 4	39	GE 10-LR-ed	R 1/4 "	ca. 2	20
	GE 12-LM	M 16 x 1,5	ca. 6	59	GE 12-LM-ed	M 16 x 1,5	ca. 3	29
	GE 12-LR	R 3/8 "	ca. 6	59	GE 12-LR-ed	R 3/8 "	ca. 4	39
	GE 15-LM	M 18 x 1,5	ca. 7	69	GE 15-LM-ed	M 18 x 1,5	ca. 4	39
	GE 15-LR	R 1/2 "	ca. 11	108	GE 15-LR-ed	R 1/2 "	ca. 6	59
	GE 18-LM	M 22 x 1,5	ca. 11	108	GE 18-LM-ed	M 22 x 1,5	ca. 6	59
	GE 18-LR	R 1/2 "	ca. 11	108	GE 18-LR-ed	R 1/2 "	ca. 6	59
	GE 22-LM	M 26 x 1,5	ca. 13	128	GE 22-LM-ed	M 26 x 1,5	ca. 7	69
	GE 22-LR	R 3/4 "	ca. 16	157	GE 22-LR-ed	R 3/4 "	ca. 9	88
	GE 28-LM	M 33 x 2	ca. 22	216	GE 28-LM-ed	M 33 x 2	ca. 12	118
	GE 28-LR	R 1 "	ca. 27	265	GE 28-LR-ed	R 1 "	ca. 14	137
	GE 35-LM	M 42 x 2	ca. 36	353	GE 35-LM-ed	M 42 x 2	ca. 20	196
	GE 35-LR	R 1 1/4 "	ca. 40	392	GE 35-LR-ed	R 1 1/4 "	ca. 24	235
	GE 42-LM	M 48 x 2	ca. 50	490	GE 42-LM-ed	M 48 x 2	ca. 30	294
	GE 42-LR	R 1 1/2 "	ca. 50	490	GE 42-LR-ed	R 1 1/2 "	ca. 30	294
Heavy-duty range	GE 6-SM	M 12 x 1,5	ca. 4	39	GE 6-SM-ed	M 12 x 1,5	ca. 2	20
	GE 6-SR	R 1/4 "	ca. 4	39	GE 6-SR-ed	R 1/4 "	ca. 2	20
	GE 8-SM	M 14 x 1,5	ca. 5	49	GE 8-SM-ed	M 14 x 1,5	ca. 3	29
	GE 8-SR	R 1/4 "	ca. 4	39	GE 8-SR-ed	R 1/4 "	ca. 2	20
	GE 10-SM	M 16 x 1,5	ca. 6	59	GE 10-SM-ed	M 16 x 1,5	ca. 4	39
	GE 10-SR	R 3/8 "	ca. 7	69	GE 10-SR-ed	R 3/8 "	ca. 4	39
	GE 12-SM	M 18 x 1,5	ca. 8	78	GE 12-SM-ed	M 18 x 1,5	ca. 5	49
	GE 12-SR	R 3/8 "	ca. 7	69	GE 12-SR-ed	R 3/8 "	ca. 4	39
	GE 14-SM	M 20 x 1,5	ca. 11	108	GE 14-SM-ed	M 20 x 1,5	ca. 6	59
	GE 14-SR	R 1/2 "	ca. 13	128	GE 14-SR-ed	R 1/2 "	ca. 7	69
	GE 16-SM	M 22 x 1,5	ca. 13	128	GE 16-SM-ed	M 22 x 1,5	ca. 7	69
	GE 16-SR	R 1/2 "	ca. 13	128	GE 16-SR-ed	R 1/2 "	ca. 7	69
	GE 20-SM	M 27 x 2	ca. 20	196	GE 20-SM-ed	M 27 x 2	ca. 10	98
	GE 20-SR	R 3/4 "	ca. 21	206	GE 20-SR-ed	R 3/4 "	ca. 11	108
	GE 25-SM	M 33 x 2	ca. 30	294	GE 25-SM-ed	M 33 x 2	ca. 16	157
	GE 25-SR	R 1 "	ca. 32	314	GE 25-SR-ed	R 1 "	ca. 17	167
	GE 30-SM	M 42 x 2	ca. 50	490	GE 30-SM-ed	M 42 x 2	ca. 26	255
	GE 30-SR	R 1 1/4 "	ca. 50	490	GE 30-SR-ed	R 1 1/4 "	ca. 26	255
	GE 38-SM	M 48 x 2	ca. 60	589	GE 38-SM-ed	M 48 x 2	ca. 32	314

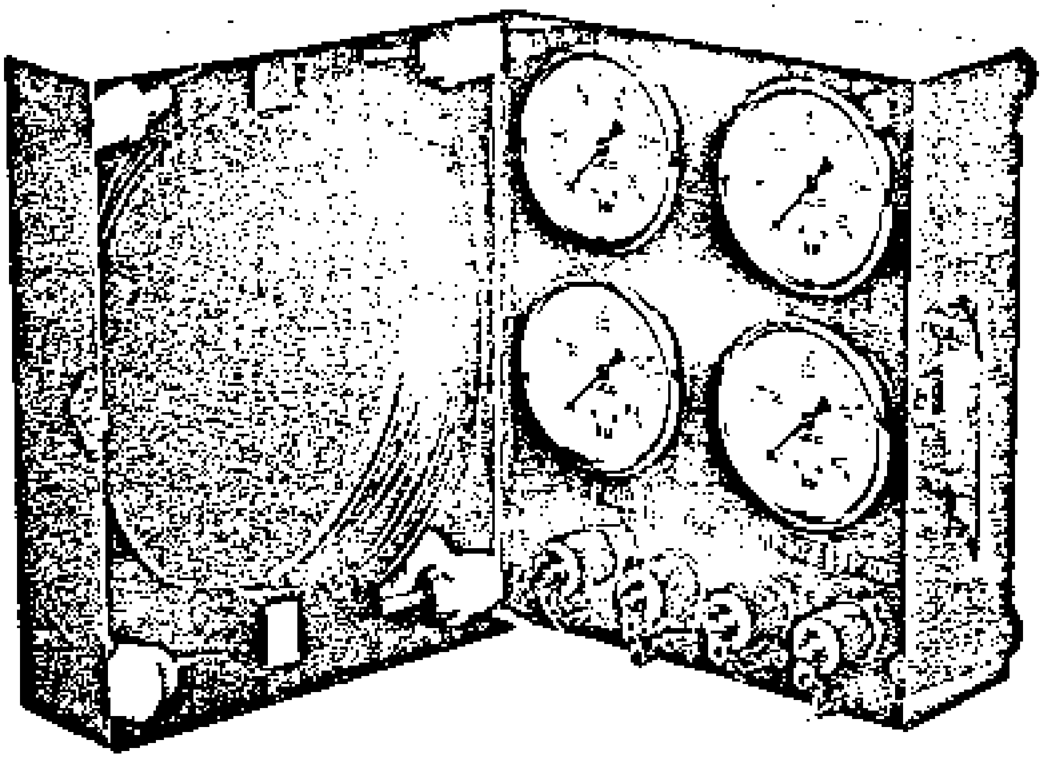
Date Datum	Valable pour série Gültig für Serie	Feuille n° Blatt-Nr. 1.2.03

Tightening torques for screw-in unions

Non-restricted swivel threaded unions = DSVW

Type	Shouldered screw			Screw plug		
	Thread	Torque (app.) kpm	Torque (app.) Nm	Thread	Torque (app.) kpm	Torque (app.) Nm
DSVW 6, 5, 6, 8-LLR DSVW 6 - LR	R 1/8 "	1,75	17	M 14 x 1	3,5	34
DSVW 8, 10-LR DSVW 6, 8-SR	R 1/4 "	4,00	39	M 18 x 1	6,0	59
DSVW 12-LR DSVW 10, 12-SR	R 3/8 "	6,00	59	M 22 x 1,5	9,0	88
DSVW 15, 18-LR DSVW 14, 16-SR	R 1/2 "	10,00	98	M 26 x 1,5	13,0	128
DSVW 22-LR DSVW 20-SR	R 3/4 "	17,50	172	M 35 x 1,5	24,0	235
DSVW 28-LR DSVW 25-SR	R 1 "	25,00	245	M 40 x 1,5	28,0	275
DSVW 35-LR DSVW 30-SR	R 1 1/4 "	31,00	304	M 50 x 1,5	35,0	343
DSVW 42-LR DSVW 38-SR	R 1 1/2 "	36,00	353	M 55 x 1,5	45,0	441
DSVW 4, 5-LLM	M 8 x 1	1,50	15	M 12 x 1	3,0	29
DSVW 6, 8-LLM DSVW 6-LM	M 10 x 1	1,75	17	M 14 x 1	3,5	34
DSVW 8-LM DSVW 6-SM	M 12 x 1,5	3,00	29	M 16 x 1	4,0	39
DSVW 10-LM DSVW 8-SM	M 14 x 1,5	4,00	39	M 18 x 1	6,0	59
DSVW 12-LM DSVW 10-SM	M 16 x 1,5	5,50	54	M 22 x 1,5	9,0	88
DSVW 15-LM DSVW 12-SM	M 18 x 1,5	7,50	74	M 24 x 1,5	11,0	108
DSVW 14-SM	M 20 x 1,5	9,50	93	M 26 x 1,5	13,0	127
DSVW 18-LM DSVW 16-SM	M 22 x 1,5	12,00	117	M 28 x 1,5	16,0	157
DSVW 22-LM	M 26 x 1,5	18,00	177	M 32 x 1,5	22,0	216
DSVW 20-SM	M 27 x 2	19,00	186	M 35 x 1,5	24,0	235
DSVW 28-LM DSVW 25-SM	M 33 x 2	24,00	235	M 40 x 1,5	28,0	275
DSVW 35-LM DSVW 30-SM	M 42 x 2	30,00	294	M 50 x 1,5	35,0	343
DSVW 42-LM DSVW 38-SM	M 48 x 2	36,00	353	M 55 x 1,5	45,0	441

1.2.03



Type 4-M

Ident. No. 5003 062

This measuring and monitoring device enables four different independent pressure readings to be taken.

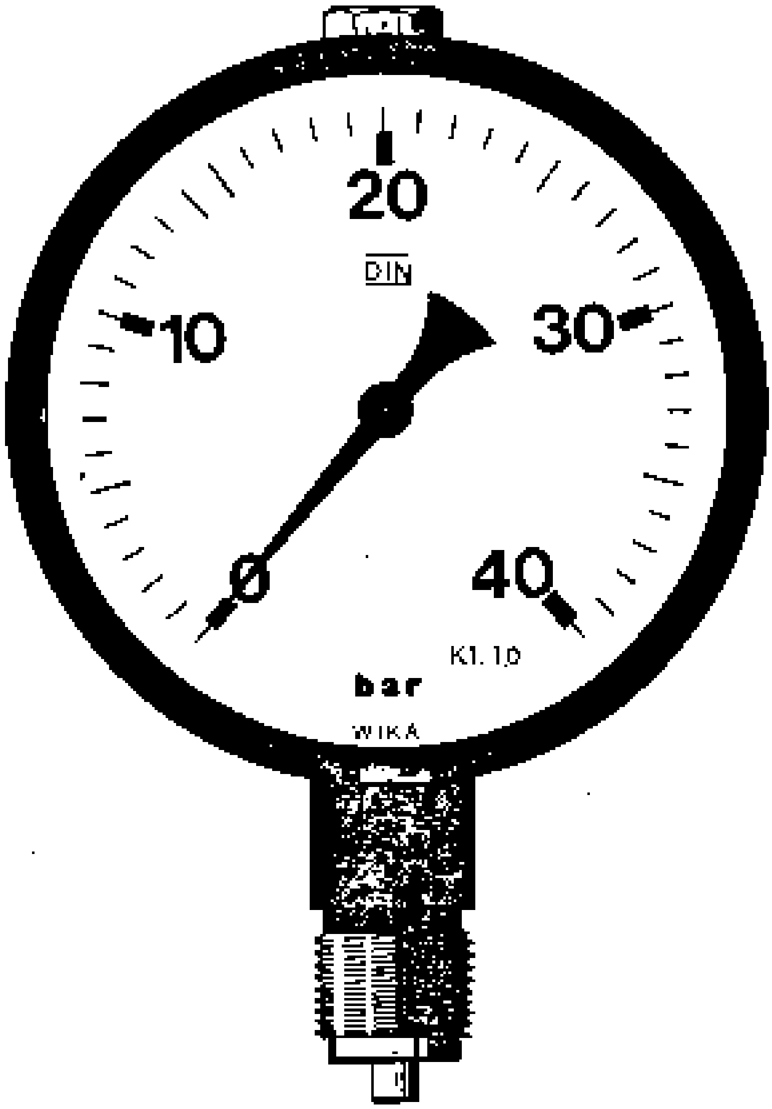
4 63 mm diameter glycerin-filled pressure gauges are installed in a sheet-steel case (200 x 160 x 100 mm).

Pressure gauge dial ranges: 1 x 10, 1 x 60, 2 x 400 bar.

Device is supplied with 4 measuring hoses:

3 x 1.50 m long
1 x 2.00 m long.

Pressur



Pressure range		Ident. No.
0 - 6 bar		7500 015
0 - 10 bar	glycerin-filled	5002 865
0 - 40 bar	glycerin-filled	7500 001
0 - 60 bar	glycerin-filled	5002 867
0 - 250 bar	glycerin-filled	5002 932
0 - 400 bar	glycerin-filled	7500 002
0 - 600 bar	glycerin filled	5002 866

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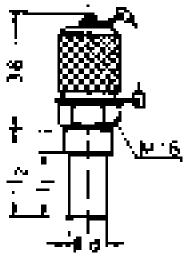
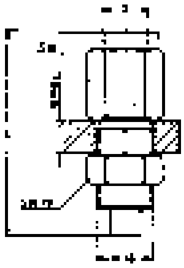
'Mini-Mess' measuring system



Item 1

Measuring union

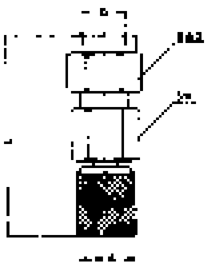
Nom. dia. 6 mm	Ident. No. 7002 476
Nom. dia. 10 mm	Ident. No. 7002 404



Item 2

Pressure gauge union

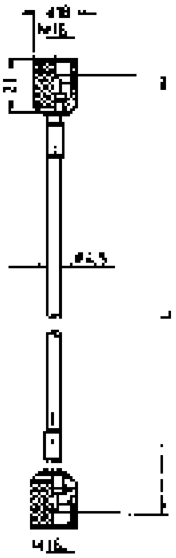
R 1/2" connecting thread	Ident. No. 7002 436



Item 3

Direct pressure gauge union

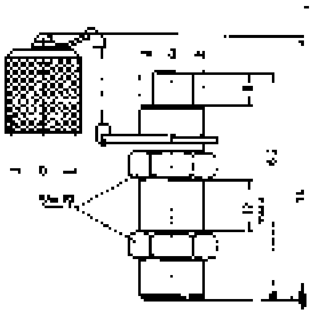
R 1/2" connecting thread	Ident No. 7002 435



Item 4

High pressure hose

Length 1 000 mm	Ident Nr. 7002 437
Length 1 500 mm	Ident No. 7002 475



Item 5

Bulkhead screw coupling

M 18 x 1.5 mm connecting thread	Ident No. 7361 295

1 =

2 = Pressure gauge connection

3 = Direct pressure gauge union

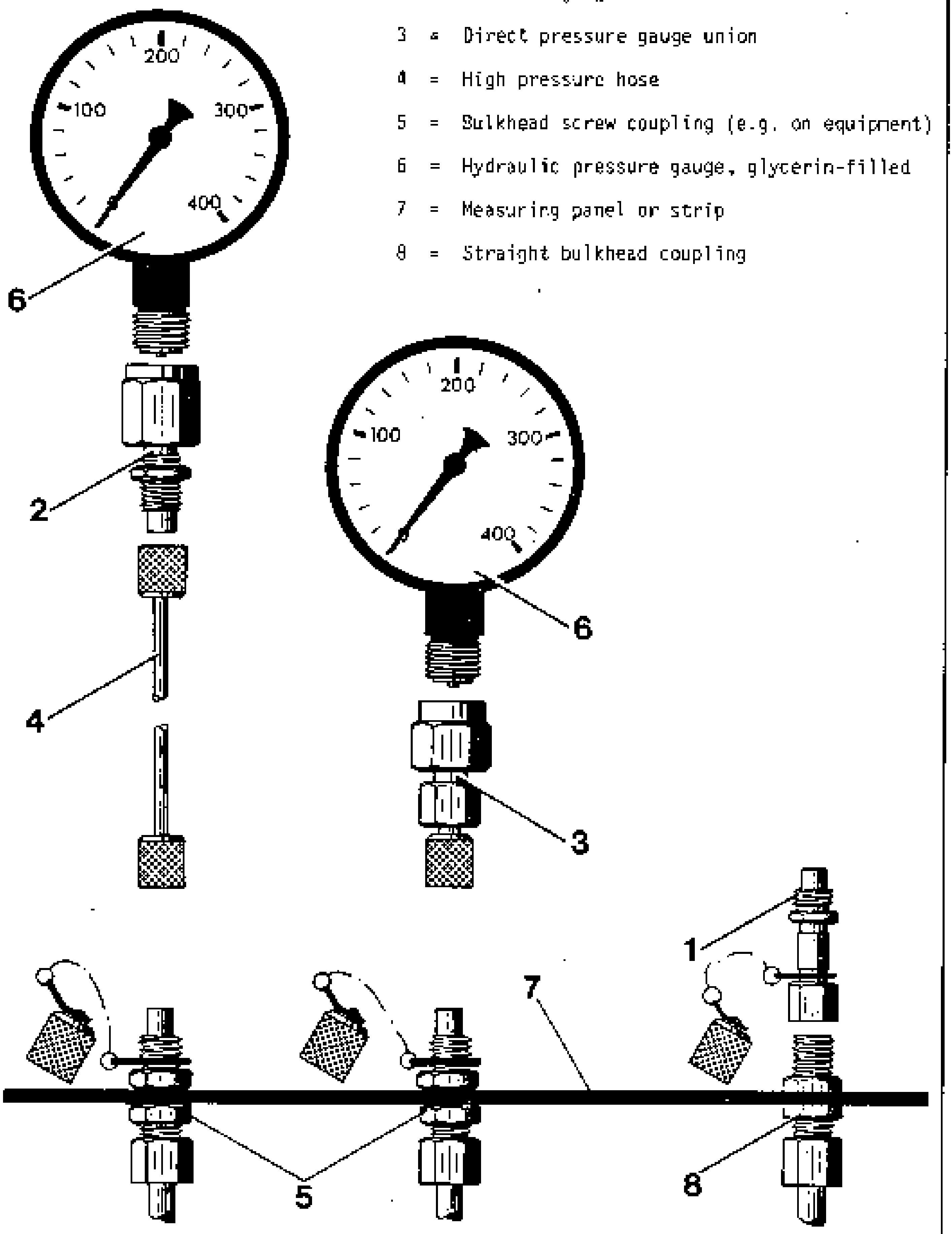
4 = High pressure hose

5 = Bulkhead screw coupling (e.g. on equipment)

6 = Hydraulic pressure gauge, glycerin-filled

7 = Measuring panel or strip

8 = Straight bulkhead coupling



1.3.02

Practical hints on welding fine-grain structural stells

If welding becomes necessary for any reason, please note the following:

It has been found in practice that N-A-XTRA need only be preheated from a plate thickness of 20 mm upwards. The preheat temperature should be 80° to 160°C. In the case of more highly stressed elements such as butt joints it is best to preheat from a plate thickness of 15 mm upwards.

The intermediate pass temperature should be between 100° and 140°C, but should never exceed 180°C. Weld in several thin passes in order to control heat penetration. A rule of thumb is 1000 Joules per mm of plate thickness. If these welding recommendations are complied with, subsequent heat treatment will not normally be needed.

If assembly aids have to be welded into position on various components, always use soft Kb (basic-coated or low-hydrogen) electrodes; the seam length should be at least 100 mm. Such assembly aids must not be knocked off; instead the tack weld seam should be ground away.

When welding plates thicker than 12mm together, the root pass should be made with a soft basic-coated electrode such as Kb IX s GHH Ultra, or with a non-alloyed inert gas rod such as Autrod 65; K 56. This will provide a high degree of root intermixing and ensure that no hardness peaks occur, since these rods are always of lower strength. Admixture with the parent metal none the less provides the necessary weld strength.

When welding fine grain structural steels (N-A-XTRA 70, HSB 55 C, HSB 77 V) to RSt-37.2 or to RRSt-52.3, use an Mn-Si alloyed welding rod or a suitable basic-coated electrode (Carbofil 2 - Oerlikon, Kb IX s GHH Ultra). The alloying ensures a ductile joint with strength at least equal to that of the structural steel. For welded joints of this type exposed to severe loads, preheating from 80° to 160°C is recommended.

Welding

When welding two sections of N-A-XTRA 70, HSB 55 C or HSB 77 V together, use an Ni-Mo alloyed inert gas rod (e.g. Autrod NiMo, Union MoNi, Union NiMoCr). These achieve the same strengths in the welded joint as the equivalent fine-grain structural steel.

When using electrodes, the Tenacito (Kb XII s), Tenacito 65 (Kb XIII s) and Tenacito 75 (Kb) types have provided suitable.

When using electrodes, build up the passes as described below:

Root	:	Tenacito (Kb XII s)	- an extremely crack-resistant and ductile electrode
Interpass	:	Tenacito 65 (Kb XIII s)	- an NiMo alloyed electrode
Cover	:	Tenacito 75 (Kb type)	- an NiMoCr alloyed electrode

- Before welding, basic-coated (Kb) electrodes must be dried in a drying cabinet at approx. 300°C for 5 hours.

Rod guiding

In practice, it is not always possible to maintain uniform gap widths when preparing seams for welding. In order to achieve thorough root penetration, the rod must be pressed into the gap with the gun while executing a slight oscillating movement.

Weld seam preparation

Special attention must be devoted to correct seam preparation. Plates must be stored at not less than +5°C for approx. 36 hours prior to flame cutting.

Flame cutting scale must be removed, and any zinc primer coating also ground away in the weld seam area.

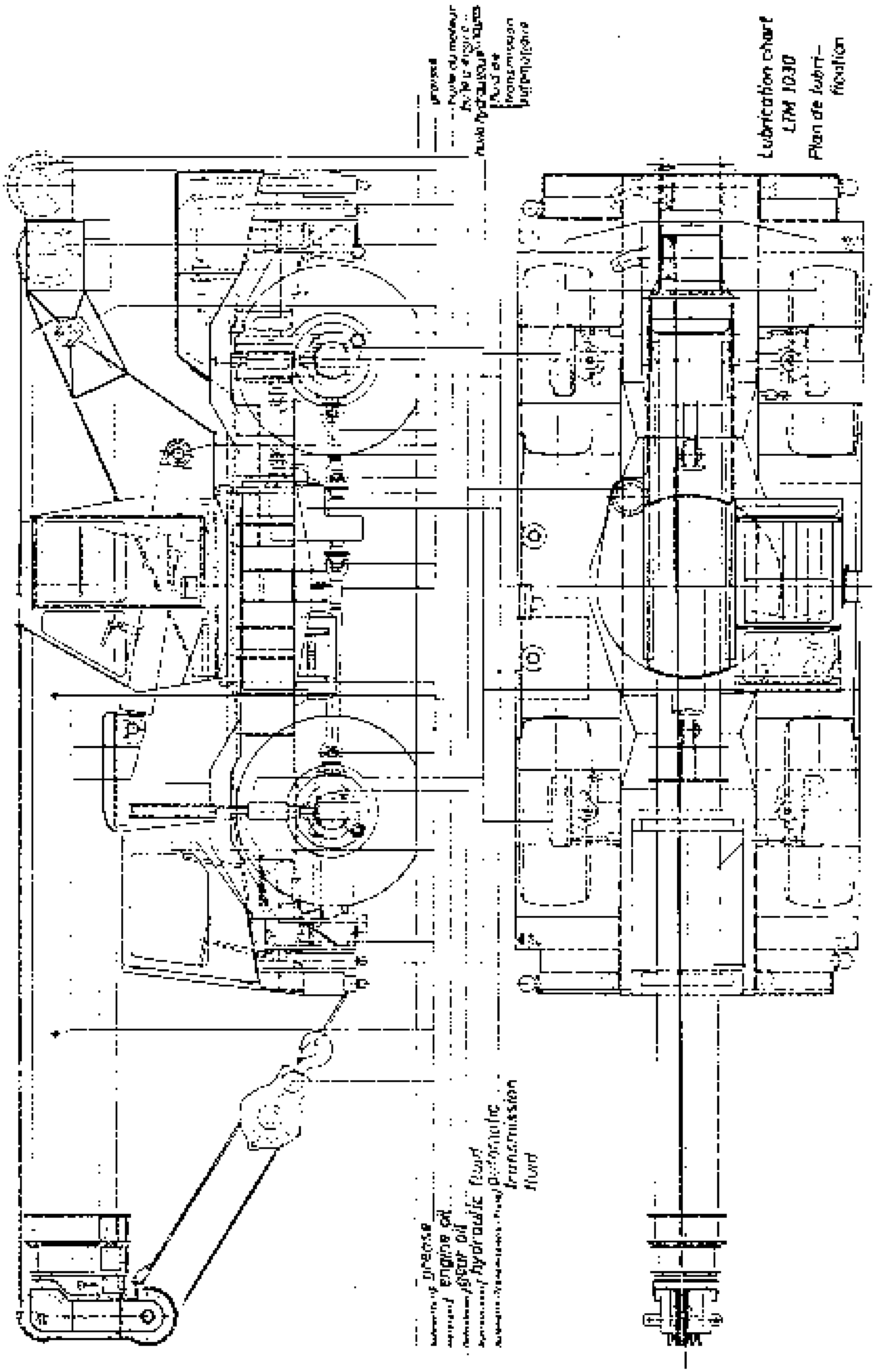
Seam aperture gap angle for electrode welding 55° to 60°.
Seam aperture gap angle for inert gas welding 45°.

Warning:

Welding must only be carried out by trained and qualified welders.

Lubrication chart

Lubrication point	Type	Specification
Engine	SAE-HDC- 15W - 40	MIL-L-2104 C
Converter reversion transmission 6 WG 180	ATF	Type C - 3
Axles	SAE 90 EP GL 5	MIL-L-2105 B
Power steering	ATF	Type C - 3
Hydr. outrigger	ATF	Type C - 3
Crane hydraulic	ATF	Type C - 3
Luffing gear and slewing gear	SAE 90 EP GL 5	MIL-L-2105 B
All lubrication points, prop. shaft and slewing gear bearing	all purpose, NLGI 2 Lithium	K2K DIN 51825
Open gear and bolts (slewing gear bolts)	spray AVIA BOS Fluid	only obtainable from LWE
Main boom glide shoes outrigger-supporting	AVIA 906 LS	only obtainable from LWE


Lubrication chart
LTM 1030
Plan de lubrification
grease
engine oil
gear oil
hydraulic fluid
automatic transmission fluid

Filling capacities

OM 402 diesel engine

Engine oil	:	app.	18 l
Water	:	app.	50 l

OM 403 diesel engine

Engine oil	:	app.	22 l
Water	:	app.	60 l

Fuel tank

Diesel oil	:	app.	300 l

Convertor reversing transmission 6 WG 180

Hydraulic fluid	:	app.	26 l

Axles - gear oil

Axle drive gear	:	app.	15 l
Wheel drive gear	:	app.	2 l

Hydraulic power steering

Hydraulic fluid	:	app.	19,5 l

Hoisting gear (winch)

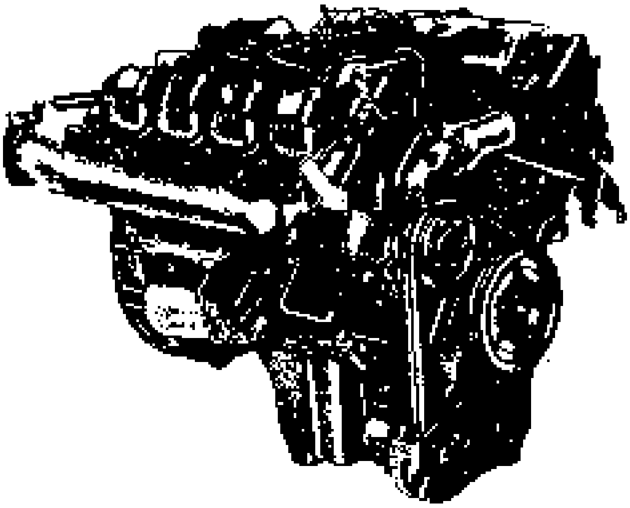
Gear oil	:		1,4 l

Slewing gear

Gear oil	:		1,5 l

Dates of engine

Type of engine	OM 402
Number of cylinders	8
Bore	125 mm
Stroke	130 mm
Total piston displacement	12 760 cm³
Injection order	1-5-7-2 6-3-4-8
Idling speed	app. 600 1/min
Rated speed	2500 1/min
Engine output	256 PS / 188 KW at 2500 1/min
Max. torque	834 Nm at 1400 1/min
Weight	app. 850 kg



Position of
type plate
(see arrow)

Note:
Since engines of various designs and types can be installed, certain external components and auxiliaries may differ in design and location as well (for instance, the intake or exhaust manifolds).
Since the illustrations in this manual can only relate to one type of engine, it is possible that the engine installed on your crane differs in certain details from that shown here.

Components

1 Oil filling

2 Oil dipstick

3 Balance reservoir - cooling water

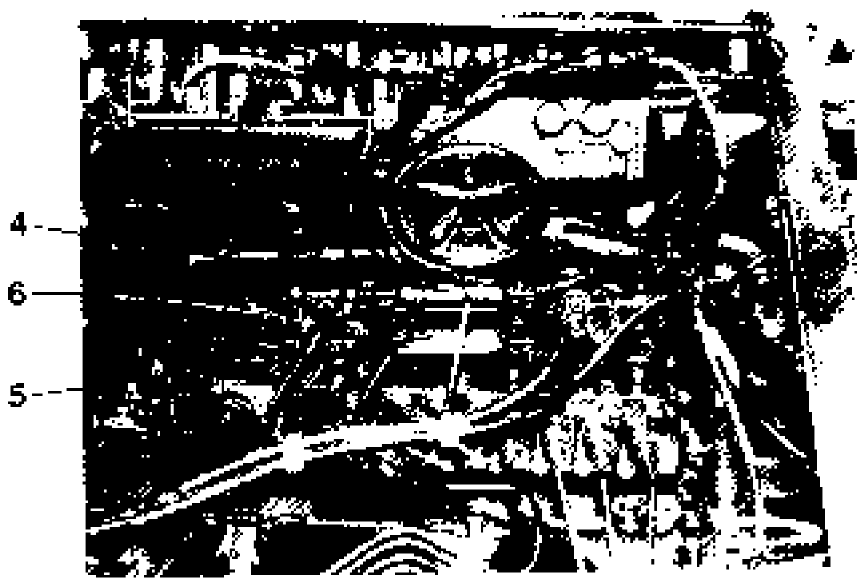
3a Level control unit (cooling water)

4 Working cylinder (engine stop)

5 Working cylinder (engine-torque limiter)

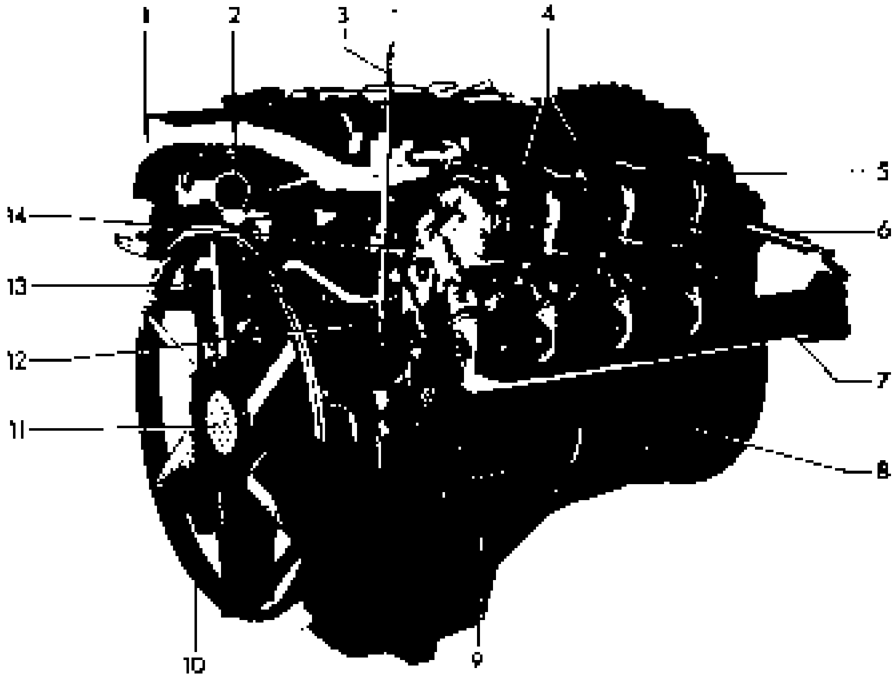
6 Mechanical engine-stop

7 Steering pump

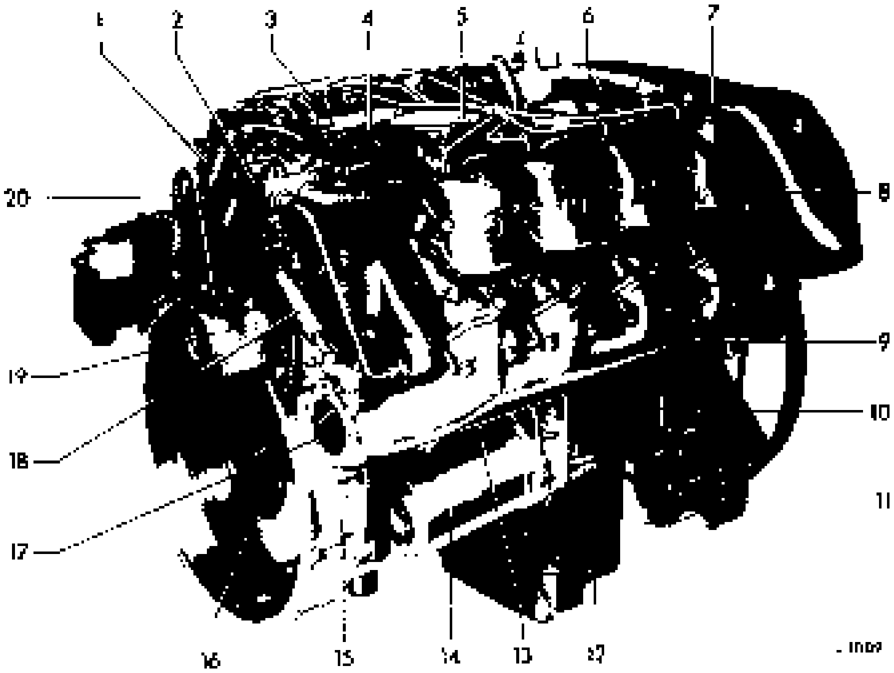


Engine components – OM 402

1 Intake manifold
2 Cooling water outlet
3 Oil dipstick
4 Injection lines
5 Cylinder head cover
6 Air cylinder, exhaust brake
7 Exhaust manifold, left
8 Starter
9 Left-hand front engine support
10 Fan guard
11 Viscous-drive fan
12 Control linkage
13 Water pump pulley
14 Cylinder head



1 Two-stage fuel filter
2 Air compressor
3 Injection pump
4 Fuel precleaner
5 Oil separator
6 Front suspension lug
7 Oil filler plug
8 Cylinder head cover
9 Right-hand exhaust manifold
10 Right-hand front engine support
11 Three-phase generator
12 Oil pan
13 Engine oil heat exchanger
14 Oil filter
15 Timing gear case
16 Flywheel
17 Exhaust brake valve
18 Exhaust brake air cylinder
19 Power steering pump
20 Rear suspension lug



Checking valve clearance

Valve clearance adjustment
1 Feeler gauge
2 Box wrench
3 Screwdriver
4 Adjustment screw
5 Lock nut

The check should be made with the engine cold (at the earliest 20 minutes after stopping engine).

Remove cylinder head covers.

Fasten turning device to the timing gear case at the inspection hole using the two threaded holes (see figure 4). This facilitates cranking the engine. Check valve clearance according to firing order.

Turn engine until the piston of the cylinder to be adjusted is at TDC. The intake and exhaust valves must be closed and no load applied to the rocker arms.

The valves on pistons moving the same direction (see table below) overlap.

Check valve clearance between rocker arm and valve stem end.

Nominal valve :	Intake	0,25 mm
	Exhaust	0,35 mm

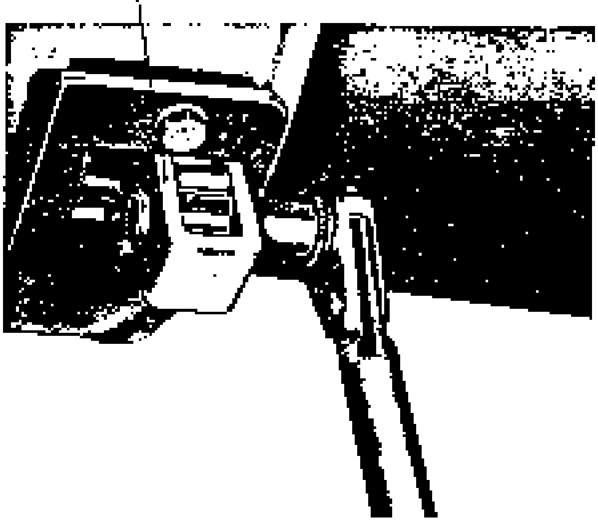
If an adjustment of the clearance is necessary, loosen lock nut and turn adjustment screw until slight resistance is felt when the gauge is passed through with the lock nut tightened.

When the valve checks have been completed, check condition of cylinder head cover gaskets and replace them if necessary. Reinstall cylinder head covers and tighten them (tightening torque 1 kpm = 9,8 Nm).

Firing order and valve overlap

Firing order OM 402	1	5	7	2	6	3	4	8
Valve overlap	6	3	4	8	1	5	7	2

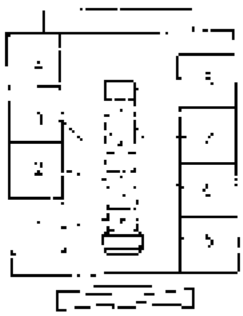
turning device picture 4



Cylinder arrangement with diagram of injection lines

The arrangement of the injection lines is determined by the injection order of the injection pump.

OM 402



Maintenance

Changing engine oil

Drain oil from oil pan while the engine is still warm. To do this, unscrew drain plug at bottom of oil pan (see figure). Check drained oil from time to time for water content and metal chips. If traces of water or metal chips are found lay up engine and repair, if necessary.

Screw in drain plug using new sealing ring. Clean oil filter (description below). Add oil according to specifications into oil pan and into additional oil tank, if any.

Engine oil drain plug (location depending on engine design)

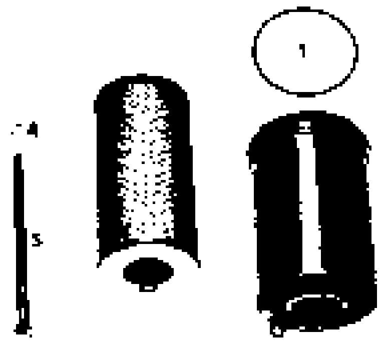
(When adding oil to oil pan, be sure to remember the 3,0 resp. 3,5 liters for the oil filter bowl; refer to technical data on "Capacities")

Crank engine with starter until the oil pressure gauge indicates pressure. While doing this, press shut-off button or place injection pump lever in stop position, otherwise the engine may start.

Allow engine to idle for a short period and check for leaks, including oil filter. Switch off engine. After approximately 5 minutes check engine oil level and add oil up to upper dipstick mark, if necessary.

Renew paper main flow filter element

If the oil filter of the engine is provided with a paper main flow filter element (identified by a sticker on oil filter housing, if attached) replace element during each oil change (every 200 hours of operation).



1 Sealing ring
2 Filter bowl
3 Full-flow filter
4 Sealing ring
5 Middle-screw

Remount

Unscrew oil drain plug and drain oil. Loosen oil filter screw and remove filter bowl with paper main flow filter element.

If metal chips are found in oil filter, find cause and recondition engine, if required. Clean oil drain plug and filter bowl in benzine.

Installation

Replace all sealing rings. Insert new paper main flow filter element into filter bowl, face with coil spring in direction of bowl bottom. Position filter bowl against filter carrier, with oil drain plug in downward direction, press against carrier and turn oil filter screw manually several times, then tighten with socket wrench. Note tightening torque.

(Include 3,0 or 3,5 liters of oil for filter housing when filling oil pan).

Description

The ZF WG 180 'Hydromedia' transmission consists of a hydrodynamic torque converter followed by a multi-ratio power-shift gearbox with integral transfer box.

The HN 320 converter transmission is flanged directly to the engine (for connection, see 2.2.05).

The converter transmission consists of a Size 320 hydrodynamic torque converter with converter lock-up clutch (WK). An engine-dependent power take-off is provided to drive the power hydraulics pump, and can be engaged or disengaged. The converter transmission also contains the oil pressure pump for the converter and shift circuits, the shift pressure valve, the converter safety valve and the converter pressure-retention valve.

Power is transmitted to the power-shift converter transmission by a propeller shaft. The reversing power-shift gearbox has 6 forward and 3 reverse ratios. Auxiliaries attached to the trans-mission include an emergency steering pump, a speedometer drive output and the output to the front wheels, which can be engaged and disengaged.

Transmission ratios

	1st	2nd	3rd	4th	5th	6th
Forward	5.986	3.904	2.594	1.602	1.178	0.768
Reverse	5.926	2.594	1.178			

Gear shifts are performed electro-hydraulically, from a single-lever switch (SG-65).

Important instructions for starting up the torque converter

1. Check transmission oil level with the engine idling and the transmission at its normal operating temperature:

   a) Up to the lower mark at temperature < 40°C

   b) Up to the upper mark at temperature > 80°C

2. Comply with the specified oil change intervals, including filter renewal.

   The first oil change is due after 100 hours of actual operation. Each subsequent oil change should be carried out after 1000 hours of operation, or at least once a year.

   Oil content: app. 26 liters
   For oil grade and specification, see table of lubricants.

3. When starting the engine, always move the gear lever to neutral first. Release the parking brake before attempting to drive the vehicle away from a standstill.

4. Never allow the vehicle to roll freely with the gear lever in neutral.

5. When reversing, reduce engine speed: reversing should normally be attempted only in 1st or 2nd reverse gears.

6. During normal driving, no gears should be omitted when shifting up or down.

7. Towing-away speed must never exceed 10 km/h; do not tow the vehicle for a distance greater than 10 km.

8. When driving the vehicle, watch the transmission operating temperature reading all the time: it should be 80 - 110°C.

   The temperature may rise to max. 120°C for brief periods without giving cause for alarm.

9. Check the shift pressure (13 - 15 bar).

1. Converter operating principle

The converter uses the 'Trilok' principle, that is to say at high turbine speeds it acquires the characteristic and therefore also the high efficiency of a fluid coupling.
The converter is rated in accordance with engine power output, so that optimum operating conditions are ensured for each specific application.

The torque converter consists of three principal components:

Pump wheel or impeller

Turbine wheel

Stator (reaction element)

These three bladed wheels are arranged in a ring so that the liquid flows through them in the order stated. The ZF converter and shift pump delivers a continuous flow of oil to the converter. The oil is used to obtain the torque conversion effect (to multiply the engine output torque), and at the same time the return flow of oil dissipates heat from the converter.

Oil flowing out of the impeller enters the turbine wheel and is deflected by its blades. Depending on the amount of deflection, the turbine wheel and therefore the output shaft encounter a reaction moment of increasing magnitude.
The stator which follows the turbine in the oil circuit has the function of deflecting the outgoing flow from the turbine a second time, so that it flows back into the impeller. This second deflecting action of the oil flow exerts a reaction moment on the stator. The ratio between the turbine and pump moments is defined as the torque conversion or multiplication factor. The higher the difference in running speeds between impeller and turbine at any given time, the greater the multiplication factor.

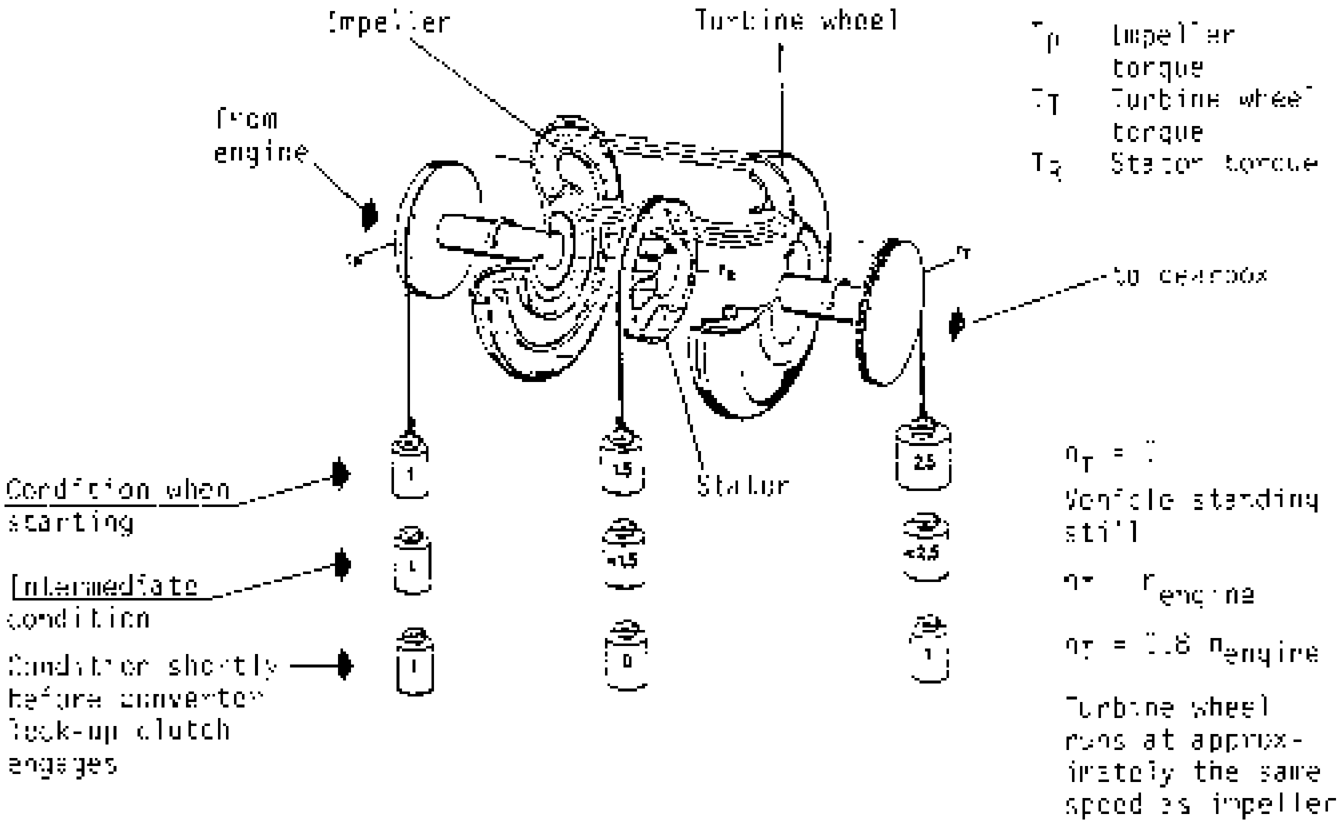
Accordingly, maximum torque multiplication is available when the turbine wheel is at a standstill. As the output shaft increases, the amount of torque multiplication drops.

The torque converter adjusts the multiplication factor steplessly and automatically to match the output speed to the output torque demanded in various operating phases.

when the turbine wheel's speed reaches approx. [illegible] of the impeller's speed, the multiplication ratio drops to 1, that is to say turbine moment is the same as impeller moment. From this point on, the converter operates similarly to a fluid coupling.

A stator freewheel improves efficiency at higher speeds by resisting torque through the transmission casing in the torque multiplication phase, but running freely in the fluid-coupling mode.

Operating principle of hydrodynamic torque converter (schematic)



A built-in brake freewheel is intended to provide a positive link between the input shaft and the turbine wheel shaft (output from converter) when the vehicle is overrunning the engine, for instance when descending a gradient. This device enables the braking effect of the engine to be made use of.

If a converter lock-up clutch is provided, it will be engaged as speed rises at the point when the torque multiplication ratio has dropped to approx. 1, so that continuing operation of the torque converter would not increase the vehicle's performance (tractive effort).

When the converter lock-up clutch (WK) is closed (engaged), slip between impeller and turbine wheels in the converter is eliminated, so that hydraulic losses in the converter are reduced to zero.

2. Power-shift reversing gearbox

The multi-ratio reversing gearbox, of countershaft pattern, can be shifted under load by means of constant-mesh gears (running on antifriction bearings) and hydraulically-actuated multi-plate clutches.

The gearwheels, bearings and clutches are lubricated with oil that has been passed through an oil cooler.

The 6-speed reversing gearbox has 6 multi-plate clutches. When a gear shift is made, the appropriate clutch-plate cluster is compressed together by a plunger which moves axially in response to a flow of oil at high pressure. A coil spring returns the clutch plate cluster to its original position when the oil pressure is removed, so that the clutch disengages. For the layout of the gearbox and details of the clutches engaged when each gear is selected, see the back of page 2.2.07.

The following items of auxiliary equipment are attached to the reversing gearbox: cut-in device for front wheel drive, control valve plate, speedometer drive, emergency steering pump and inductive transmitter head.

3. Control of gearbox (electro-hydraulic shift)

The gear-type pump (3) which supplies oil to the torque converter and for the gear shift is mounted in the converter transmission on an input shaft running at engine speed. The pump has an output rating of Q = 25 liters/min at engine speed n = 1000/min. The pump draws in oil through a coarse-pitch strainer from the oil pan of the reversing gearbox. After pressure has been built up in the pump, the oil is discharged through a pressure-side filter connected by a pressure pipe to the transmission, but installed separately. From the filter the oil passes to the shift pressure valve (4).

The oil, at shift pressure, is directed to the pressure control valve and the 4 solenoid valves.

The pressure control valve regulates pressure build-up in the clutches during the gear shift operation. As the changeover takes place, pressure drops for a short period, but builds up again to 13 - 14 bar when the shift action has been completed.

This procedure is designed to cushion the gear shifts.

The solenoid valves or the shift valves are energized to direct oil at high pressure to the multi-plate clutches. All shift positions are located by detents with spring-loaded balls.

The shift pressure valve (4) limits maximum shift pressure and allows the full flow of oil to reach the converter and lubricating circuits. A safety valve is incorporated into the feed line to the converter to protect it against abnormally high internal pressures (valve opens at approx. 8.5 bar).

Inside the torque converter the oil is used to transmit power from the engine by the hydrodynamic principle (see section on 'Torque converter').

To prevent cavitation, the converter must always be completely filled with oil. This is achieved by a converter pressure retention valve downstream from the converter, with an opening pressure of apo. 2.5 bar. Oil leaving the converter passes to an oil cooler, and thence to the reversing gearbox lubricating circuit, with the result that all lubricating points receive cool oil.

<u>Actuation of the 4 solenoid valves</u>

The hydraulic circuit diagram shows how the solenoids are allocated to the individual gear ratios. Depending on the gear selected, different solenoids are energized.

In principle, the electrical gear shift system can be described as follows:

From the vehicle's electric power supply the current flows via an interface in the switchgear cabinet to the travel-control switch, and from there to the hydraulic control plate on the reversing gearbox (for details, refer to electrical circuit diagram).

The travel control incorporates a time delay for movement between stages, and a down-shift inhibit circuit.

The converter lock-up clutch (WK) operates automatically. It is engaged and disengaged by a pressure control and solenoid operation valve, actuated by an electric speed-sensing switch by way of an electronic module. The running speed is sensed on the turbine wheel side by a gear wheel (46 teeth, ratio 1.21) and inductive transmitter.

The inductive transmitter is needed to detect turbine wheel running speed so that the converter lock-up clutch and the down-shift inhibit circuit can be energized as necessary. It is easily accessible on the transmission and incurs no mechanical wear in operation.
The transmitter is connected to the electronic module by a cable with 3-pin bayonet plug.

Converter auxiliaries - summary

1. Torque converter with converter lock-up clutch (WK)

1a) Power take-off, engine-dependent (for support pump)

1b) Power take-off, with clutch (for main crane operating pump)

2. Shift and converter supply pump

3. Shift pressure valve (13 - 15 bar)

4. Connection for suction pipe from WG gearbox (M 45 x 1.5 mm)

5. Connection for pressure pipe to filter

6. Connection for pressure pipe from filter and to WG gearbox (valve control plate)

7. Connection to oil cooler (M 26 x 1.5 mm)

8. Connection for return line to WG gearbox (M 22 x 1.5 mm)

9. Temperature sensor (max. converter outlet temperature 120 °C)

10. Solenoid switching valve (for WK lock-up clutch)

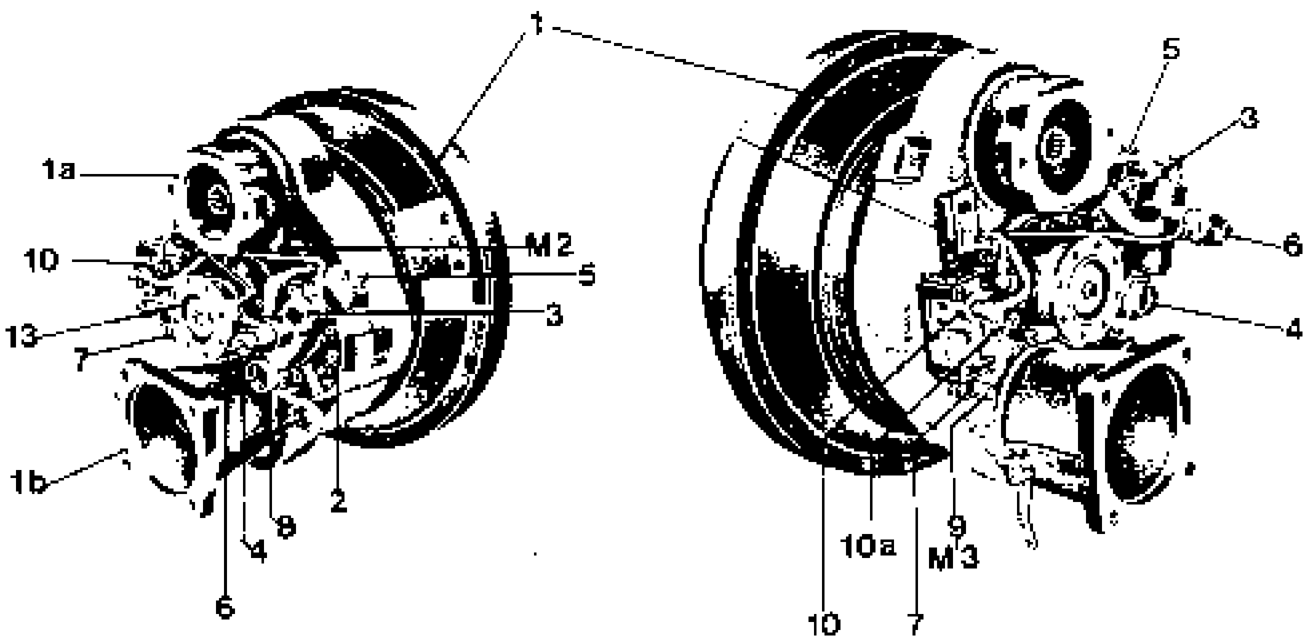
10a) Socket for Cannon plug (WK)

Pressure testing points

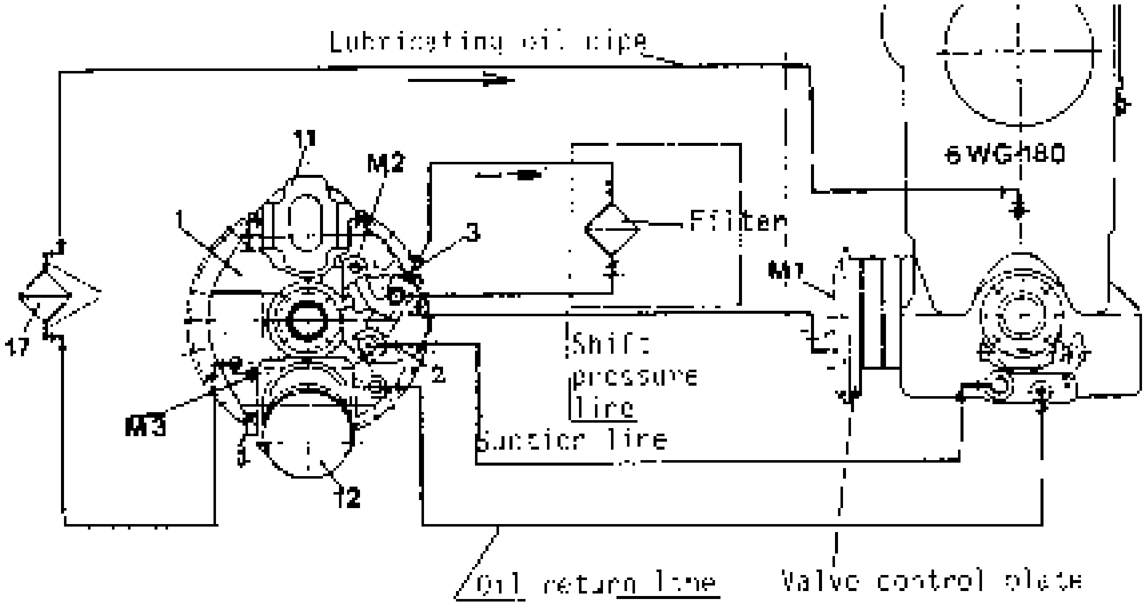
M 1 Shift pressure, 13 - 15 bar (M 10 x 1 mm test union on valve control plate)

M 2 Converter safety valve (opening pressure 8.5 bar)

M 3 Converter pressure retention valve (opening pressure 2.5 bar)



Oil circuit – converter



Converter – stripping down

1. Drain oil from converter and reversing gearbox at drain plug.
2. Take off the hydraulic equipment-supply pumps (11) and (12).
3. Detach the propeller shaft from output flange (13).
4. Mark the hydraulic hoses and unscrew them from the converter.
5. Disconnect the electrical wiring from the temperature sensor (9) and the solenoid shift valve (10).
6. Expose the assembly opening (14) on the converter casing.
7. Disconnect the converter from the engine by removing bolts (15) through the assembly opening (14).
8. Release the converter casing (unscrew bolts (16)).
9. Using an assembly rope and a hoist or crane, lower the converter transmission from the vehicle.

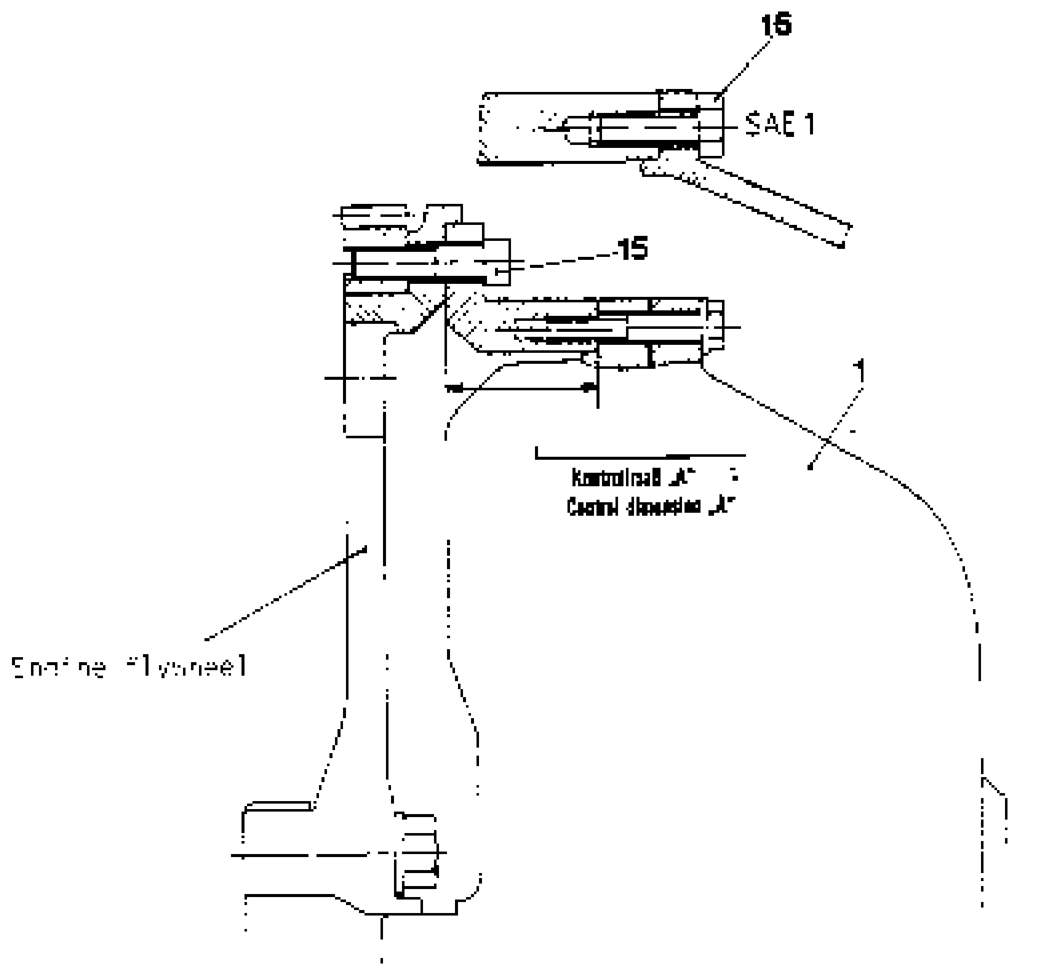
Assembly

Follow the above instructions in the reverse order.

Attaching the converter

Note:

Before the converter is attached to the engine, check dimension 'A'.

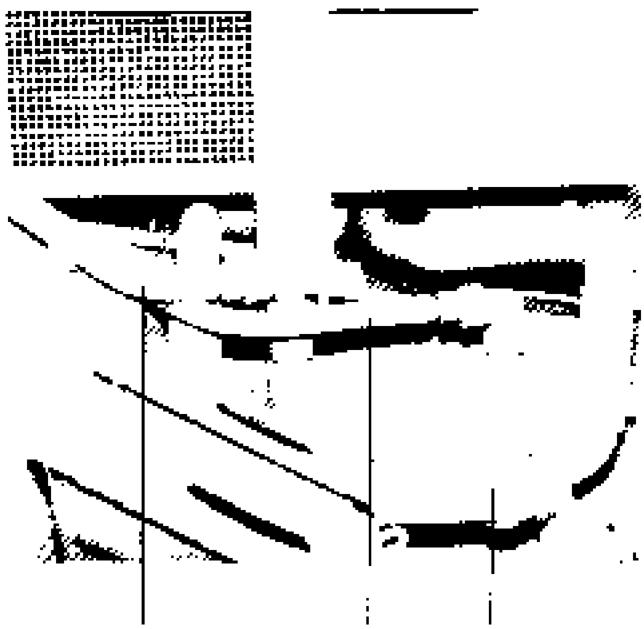


CONVERTER MOUNTING - rigid connection with intermediate block:

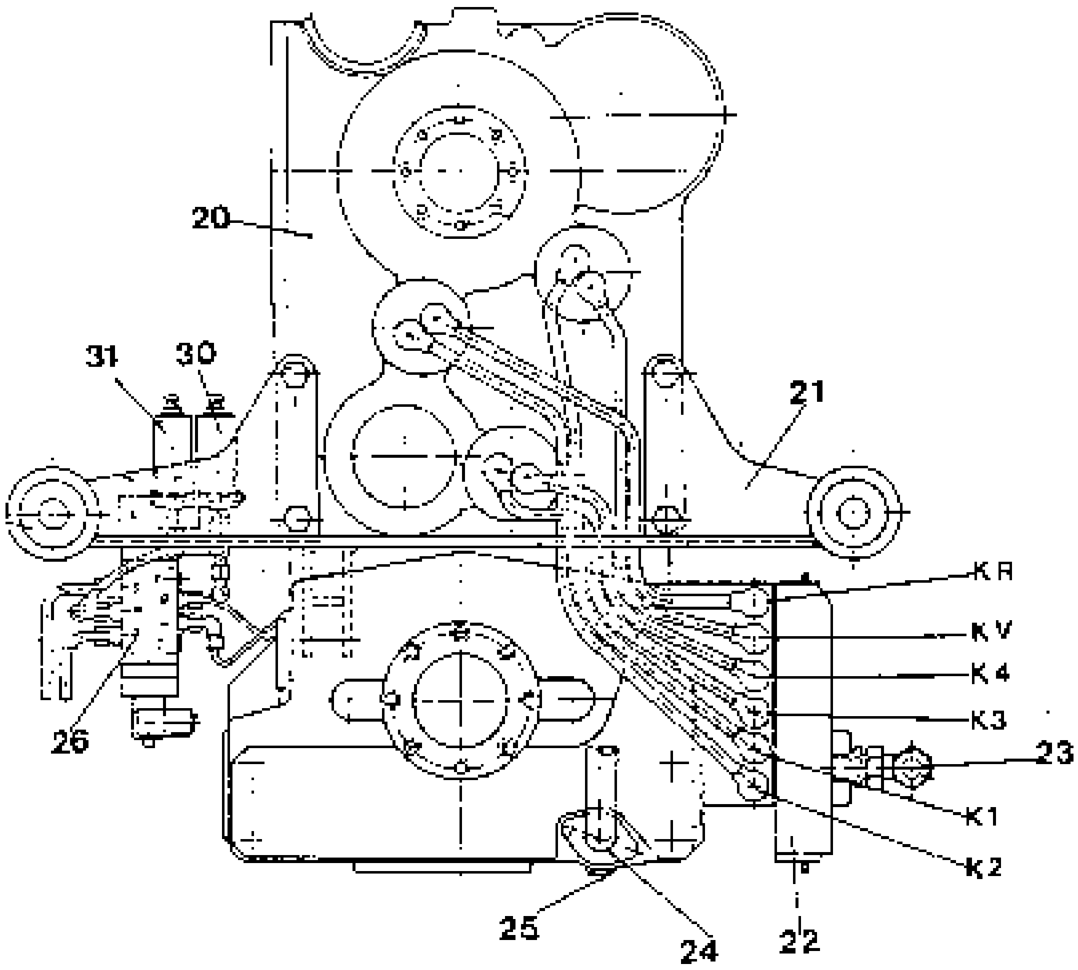
ZF cast converter in WG 200 converter transmission, with converter lock-up clutch)

Engine	SAE connection	Control dimension 'A'
Daimler-Benz OM 402	SAE 1	46.2 ± 0.5 mm

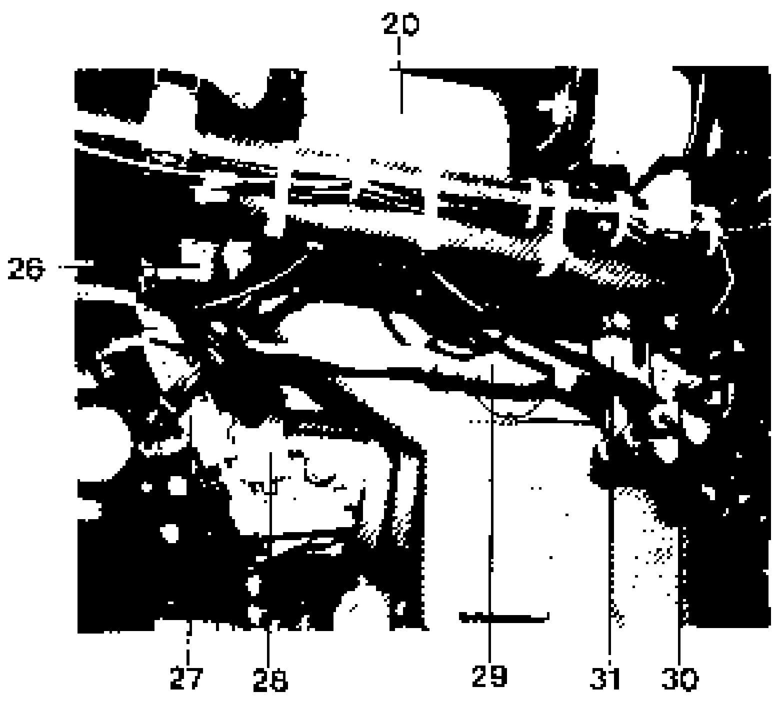
11	Hydraulic pump (supports)	A	Filter inlet
12	Hydraulic pump (crane operation)	B	Filter outlet
13	Output flange	C	Oil cooler inlet
17	Oil cooler (heat exchanger)	D	Oil cooler outlet
18	Oil filter (pressure-side)		
19	Oil filler pipe and level check		



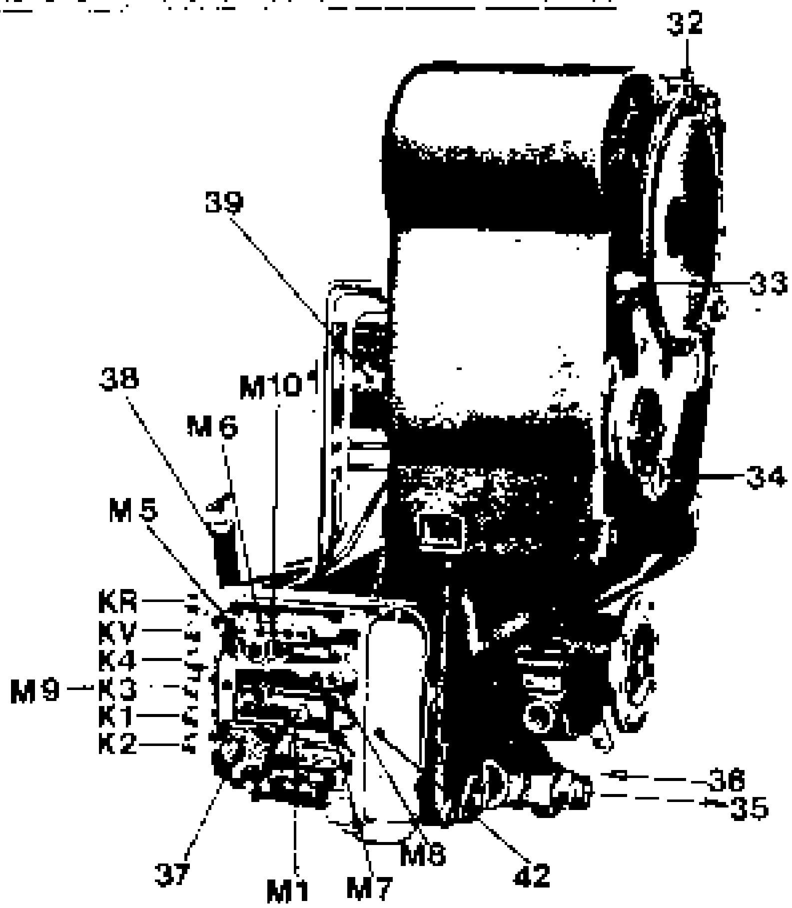
Reversing transmission with auxiliaries



Item	Designation
20	Reversing transmission
21	Transmission mounting
22	Valve control plate
23	Union for pressure-side filter (cut-in pressure 13 — 15 bar)
24	Oil filler union
25	Drain plug
26	Solenoid valve for front wheel drive cut-in
27	Pneumatic ram for front wheel drive cut-in
28	Micro-switch (front wheel drive engaged)
29	Speedometer drive
30	Solenoid valve to engage differential lock
31	Solenoid valve to lock rear wheel steering out of action



Reversing transmission with auxiliaries



Valve control plate -27-

Oil pressure measuring points:

M1 - shift pressure = 13 — 15 bar

M5 - KV = forwards

M6 - KR = reverse

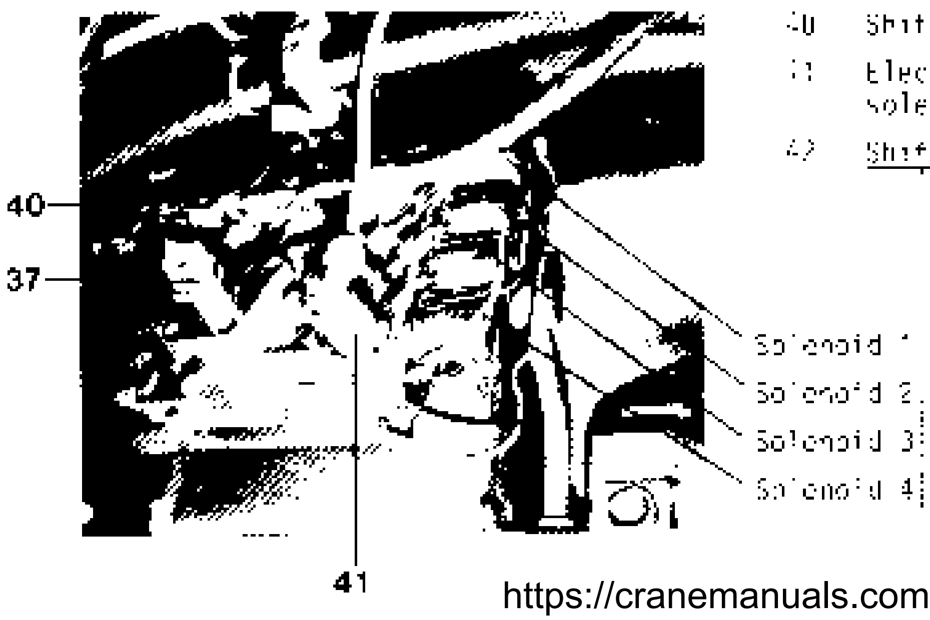
M7 - K1 = 1st gear

M8 - K2 = 2nd gear

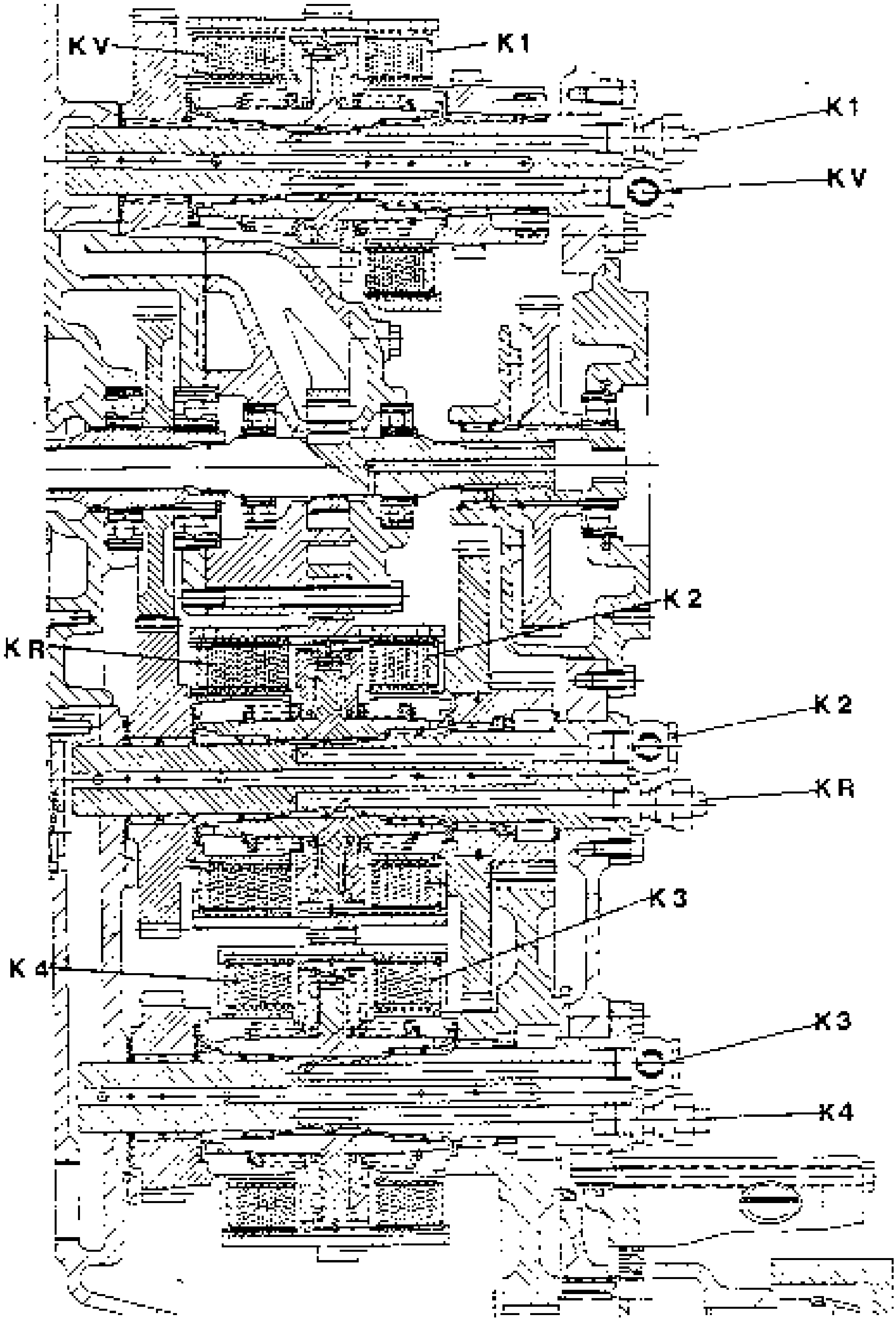
M9 - K3 = 3rd gear

M10 - K4 = 4th gear

Item	Designation
32	Transmission breather
33	Inductive transmitter connection (16)
34	Oil cooler union (M26 x 1.5 mm)
35	Suction pipe union (to PR 500)
36	Return pipe union
37	Union for pressure-side filter
38	Oil filler tube
39	Emergency steering pump
40	Shift pressure switch
41	Electrical connection for shift solenoid
42	Shift solenoid

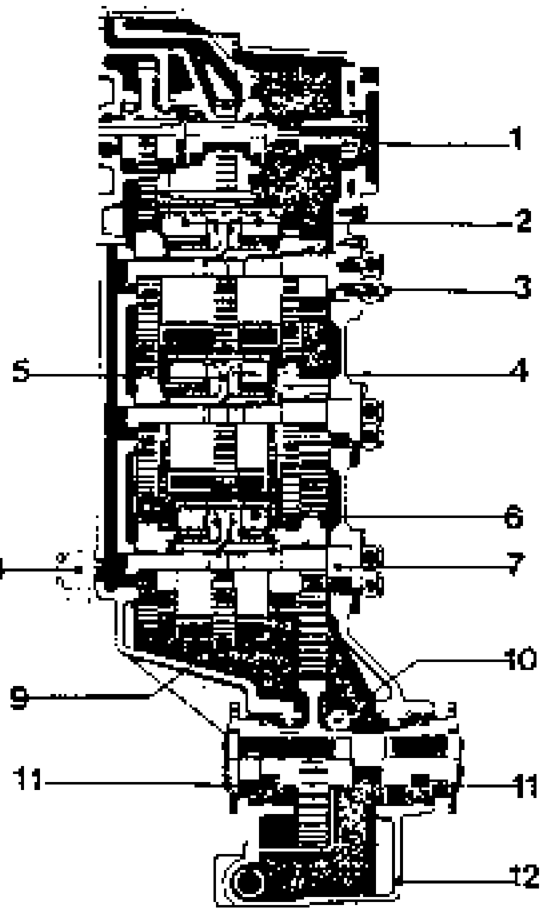


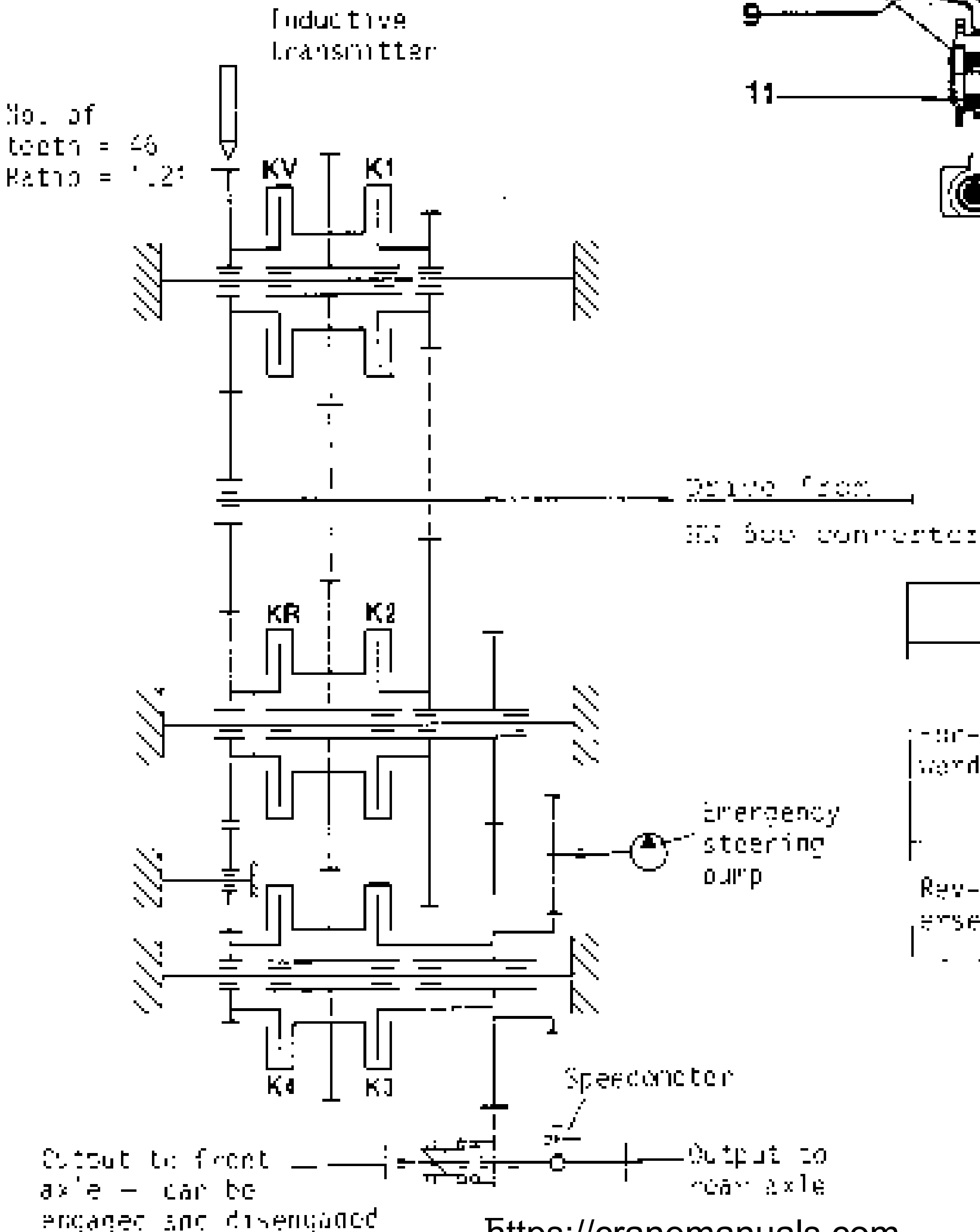
Reversing gearbox - sectioned drawing



6WG 180 transmission - operating schematic

Item	Designation
1	Drive from converter
2	Reversing/shift clutch
3	Oil pressure feed
4	Plunger
5	Plunger carrier
6	Inner and outer plates
7	Gearbox shafts
8	Lubricating oil feed
9	Clutch drum
10	Speedometer drive
11	Outputs
12	Transmission casing





	Ratio	Clutch
Forward	1	KV and K1
	2.	K4 and K1
	3.	KV and K2
	4	K4 and K2
	5.	KV and K3
	6	K4 and K3
Reverse	1	KR and K1
	2.	KR and K2
	3	KR and K3

Electro - hydraulic shift

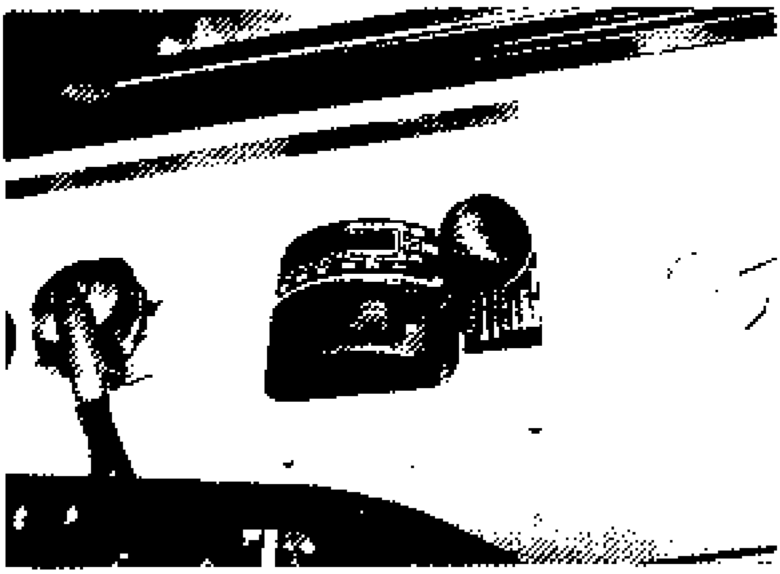
Functioning

The controller SG-6S has following shift positions:

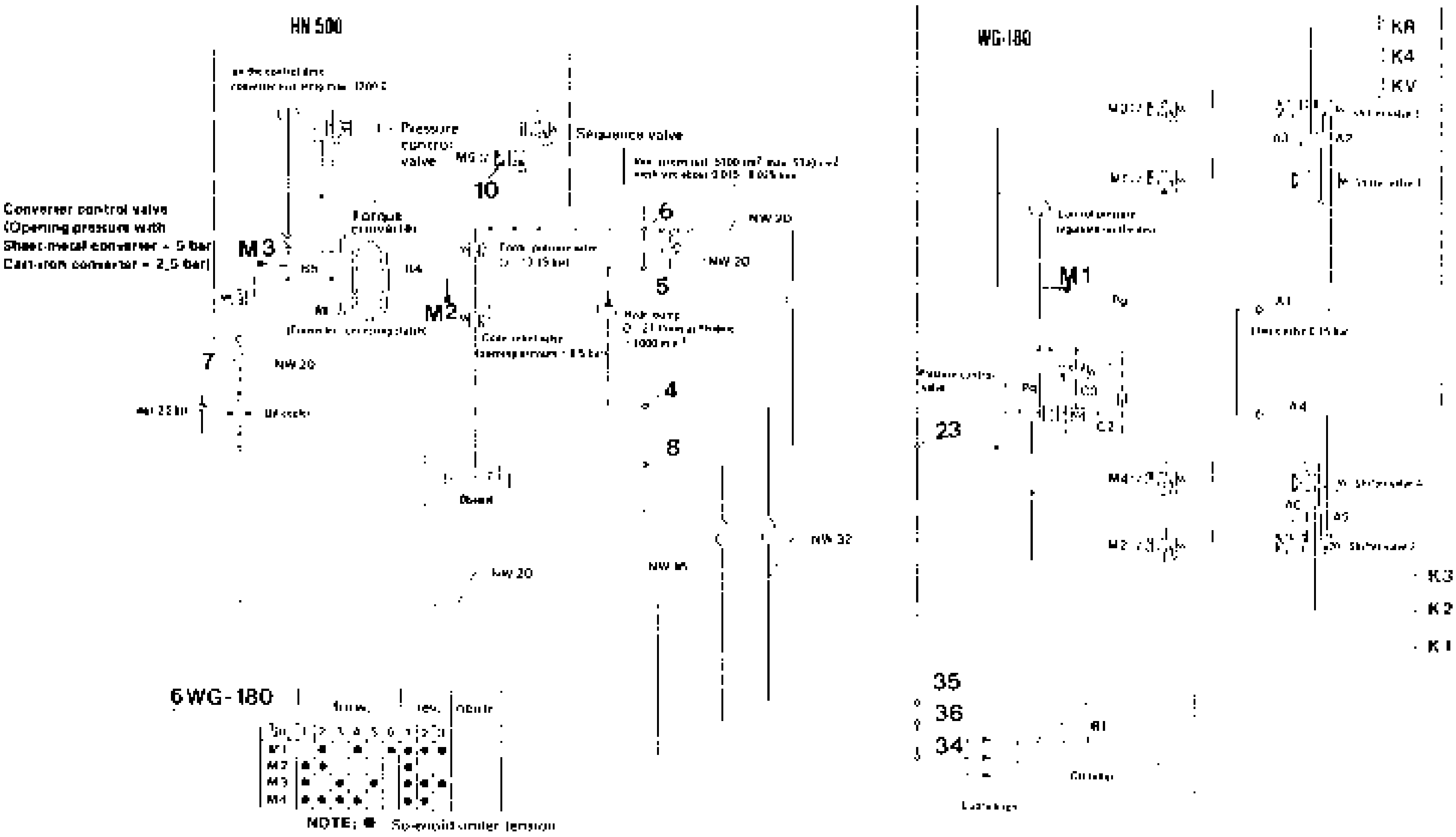
6 for forward ratios (V)
3 for reverse ratios (R)
1 for vehicle -stop- (N)

Controller (Position)	Solenoid under tension	Multi plate clutch closed
Ratio V 1	M2; M3; M4	KV and K1
Ratio V 2	M1; M2; M4	K4 and K1
Ratio V 3	M3; M4	KV and K2
Ratio V 4	M1; M4	K4 and K2
Ratio V 5	M3	KV and K3
Ratio V 6	M1	K4 and K3
Ratio R 1	M1; M2; M3; M4	KR and K1
Ratio R 2	M1; M3; M4	KR and K2
Ratio R 3	M1; M2	KR and K3
N		K3

Controller SG - 6S



Oil circulation diagram for ZF-Transmissions HN 500 and 4/6 WG-180 with electro-hydraulic shift unit and converter connecting clutch (WK)



Valve control plate

The plate contains the oil channels, valve housing, pressure control valve, solenoid and shift valves.

Stripping down the valve housing

1. Detach the wiring harness at the connecting plug.
2. Remove all machine screws from the crane plate and detach the complete control unit (valve housing 59,5[illegible]).

   Note.
   When performing this work it is advisable to insert two M8 machine screws before removing the housing - see arrows in Fig. 3/2.

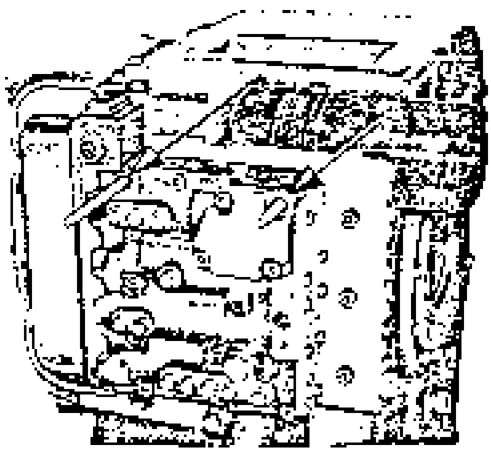


Fig. 3/2

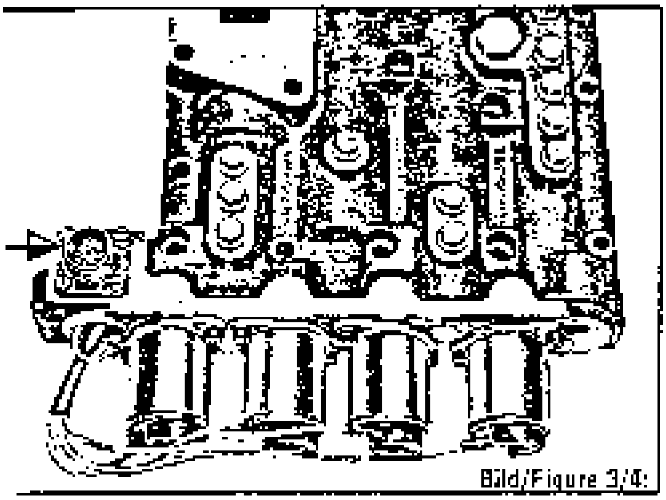
3. Open the clamping stirrup (59,420) and take off the cover (59,460) with O-ring seal installed.
4. Detach the cable shoes of the wiring harness (59,[illegible]) from the solenoid valves (59,350) and disconnect the ground (earth) cable from the valve housing. Remove machine screws (59,440) and detach the wiring harness with sealing ring (59,390) from the valve housing.

   Note:

   First mark the correct installed position of the connecting plug - see arrow in Fig. 3/4.

5. Remove the machine screws (59,363) and take off the solenoid valves (59,350).

6. Remove the loose parts - see Fig. 3/5 - from bores a, b and c of the valve housing.



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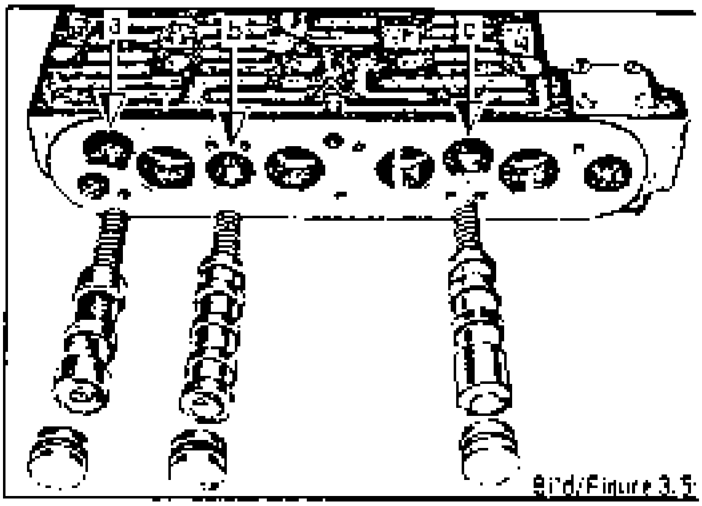
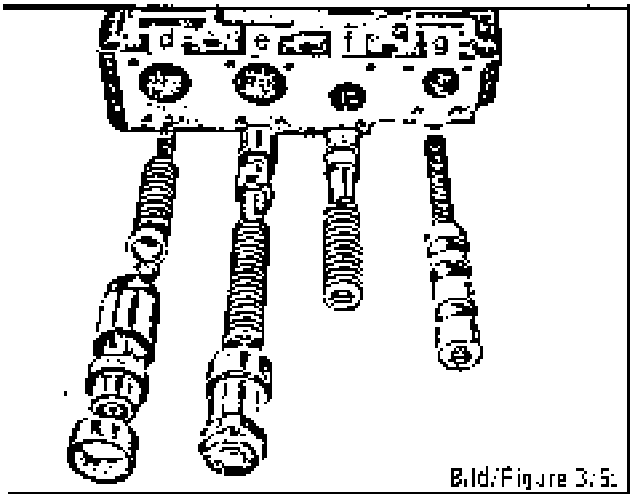


Bild/Figure 3/5:

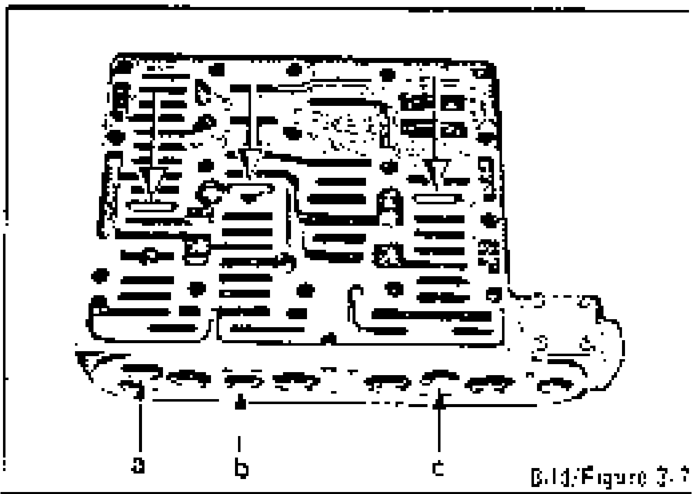
7. On the opposite side of the housing, remove hex bolts (59,340) and carefully take off the cover with gasket.

<u>Warning</u>: cover is spring-loaded.

8. Remove loose parts - see Fig. 3/6 - from bores e, f and g.



Bild/Figure 3/6:



Bild/Figure 3/7

Installing the valve housing

Assembly instructions:

Before installing, check free movement of plungers. Oil the moving parts (plungers and spools) first. Do not re-use old sealing rings (copper rings) after they have been removed. Apply 'Loctite' to threaded rods and setscrews.

Note:
Each plunger and spool can be renewed individually if necessary.

1. Insert stops (59,250 + 160) into bores a and b, and locate with stop plates (59,240 - 170). See Fig. 3/7.

2. Insert stop plate (59,020) only into bore c.

3. Following the assembly order shown in Fig. 3/6, insert into bore d both coil springs (59,030 - 050) and shift pressure plungers (plunger 59,040) with spacing tube (59,060), washers (59,070*) and bushing (59,080) pre-assembled.

   *Note:

   Number of washers depends on shift pressure.

4. Insert pressure control plunger (plunger 59,120), coil spring (59,140) and plunger (59,150) into bore e.

5. Install reset plunger (59,181) with coil spring (59,190) in bore f, and coil spring (59,260) with plunger (59,270) for shift valve 3 in bore g.

6. Attach cover (59,320) with a new gasket (59,330) to the valve housing, and secure with hex bolts (59,340).

   Note:

   During this stage in the work, make quite sure that none of the plungers sticks or jams in the bore of the housing.

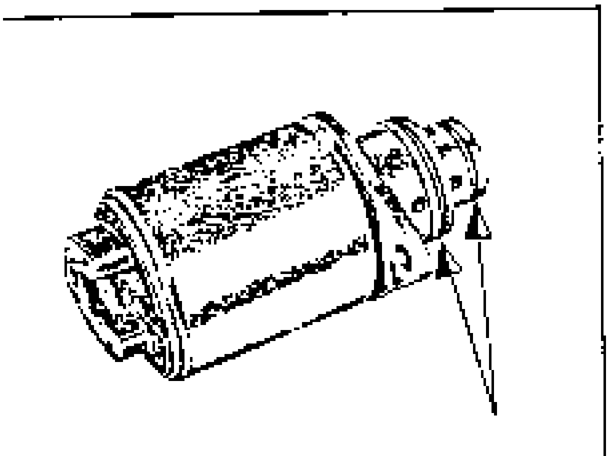
7. Insert coil spring (59,280), plunger (59,290) for shift valve 1 and stop (59,300) with O-ring seal already in position (59,310) into bore a on the opposite side of the valve housing - see Fig. 3/5.

8. Insert coil spring (59,100), plunger (59,090) for shift valve 2 and stop (59,110) with O-ring seal (59,120) into bore b.

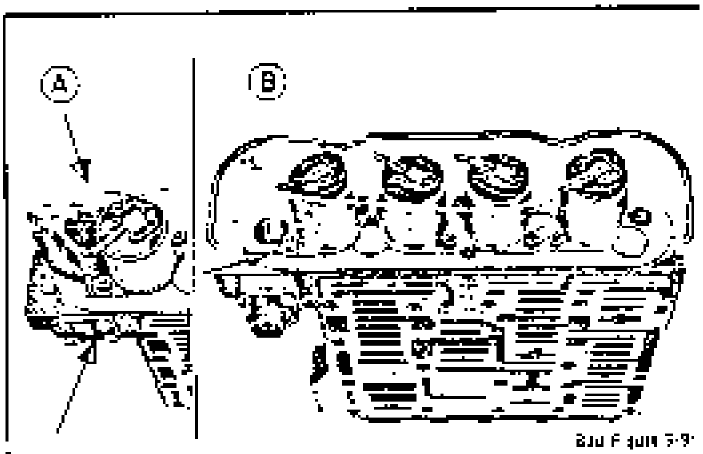
9. Insert coil spring (59,200), plunger (59,210) for shift valve 4 and stop (59,220) with O-ring seal (59,230) into bore c.

Note:

Oil the O-ring seals before installing.
For each solenoid valve (59,350), install the two O-ring seals in the annular grooves on the shaft - see arrows in Fig. 3/8. The seals must be oiled first.



Bild/Figure 3/8:



Bild/Figure 3/9

10. Insert the solenoid valves into the bores on the valve housing. Note correct installed position of cable connections - see Fig. 3/9 - and secure with spring washers and machine screws.

11. Insert wiring harness (59,380) with a new gasket through the bore in the valve housing, and secure with spring washers and machine screws.
Note the varying installed positions of the connecting plug - see arrow on Fig. 3/4.

12. Attach the ground (earth) lead from the wiring harness to the valve housing - see arrow in Fig. 3/4.

13. Connect the various cable shoes on the wiring harness to the solenoid valves (59,350). Make sure that the cable shoes grip tightly.

14. Insert clamping stirrup (59,480) into the holes provided on the valve housing. With O-ring (59,470) inserted, place cover (59,460) on valve housing and secure with clamping stirrup.

15. Offer up the rear gasket (6,150), cover plate (6,140), front gasket (6,150) and complete control unit (valve housing) to the channel plate (6,030), and secure with machine screws (6,150 + 160).

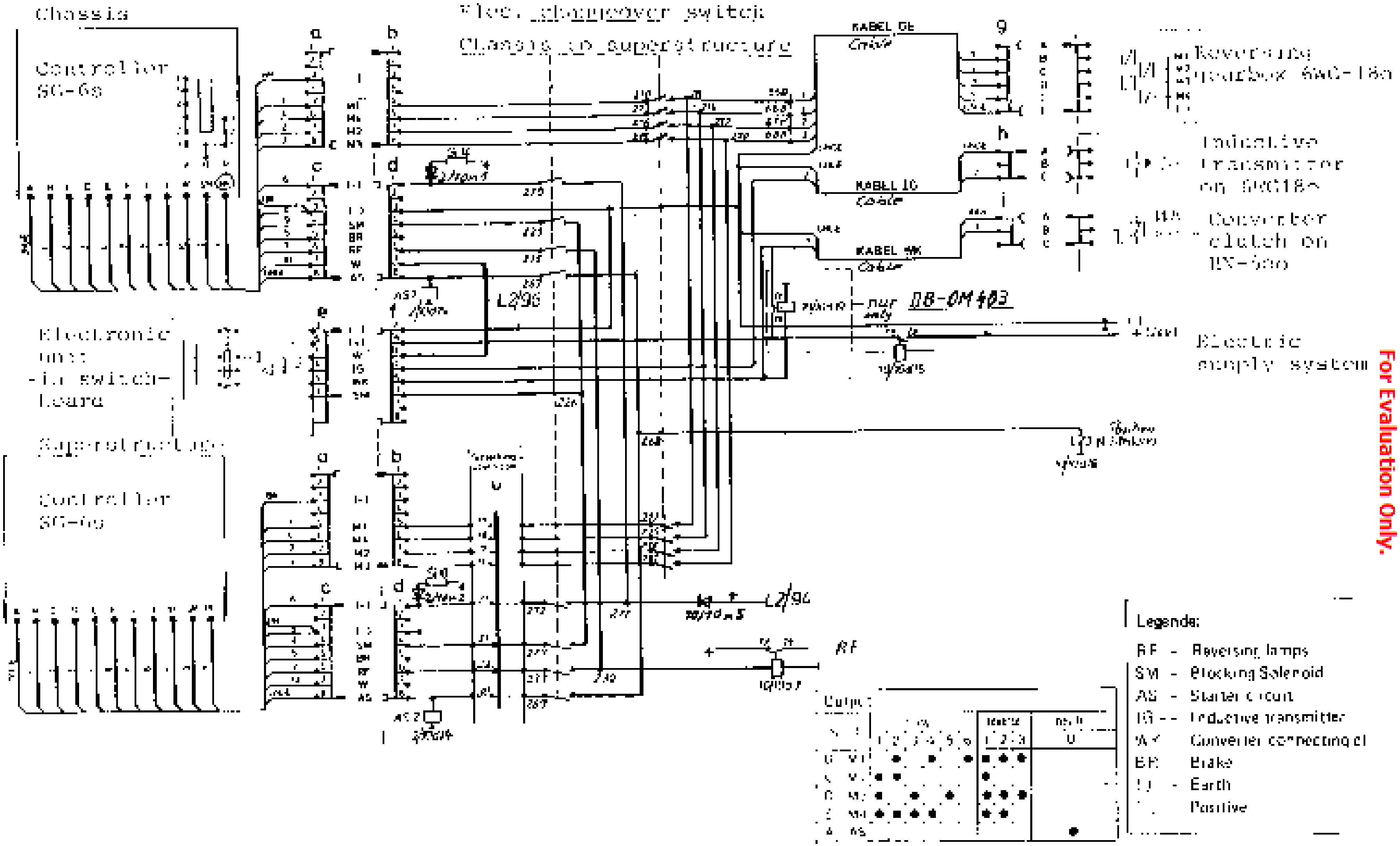
    Note:

    When performing the above work it is good practice to insert two M 8 aligning screws before the components are placed in position.

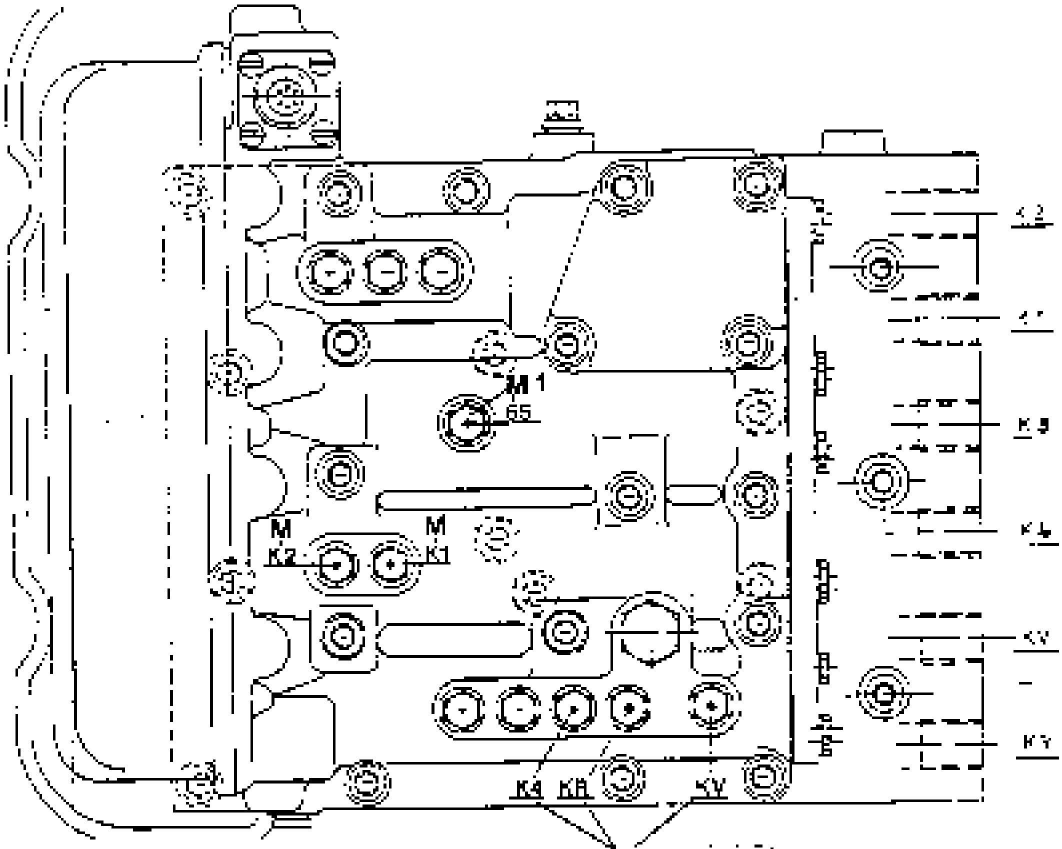
    Renew all gaskets.

    Tighten the retaining bolts in a crosswise (over-center) pattern, to a torque of 2.5 Nm.

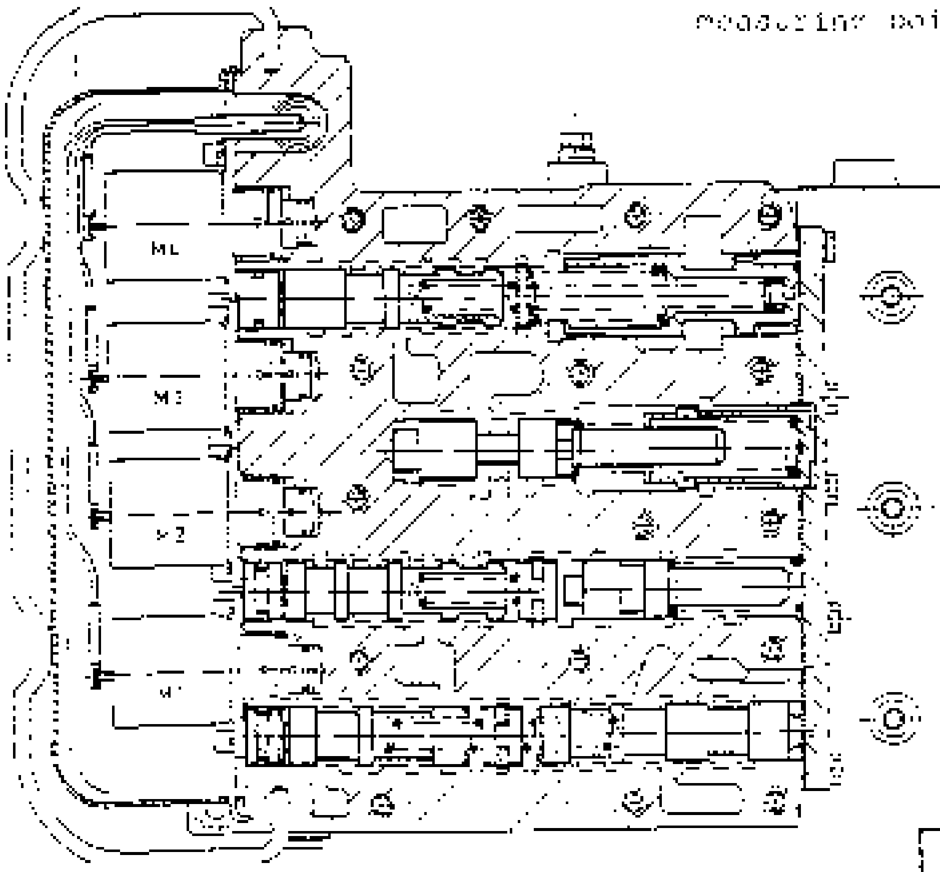
Wiring d... n for 6 WG 180
with electric gearbox and WK control

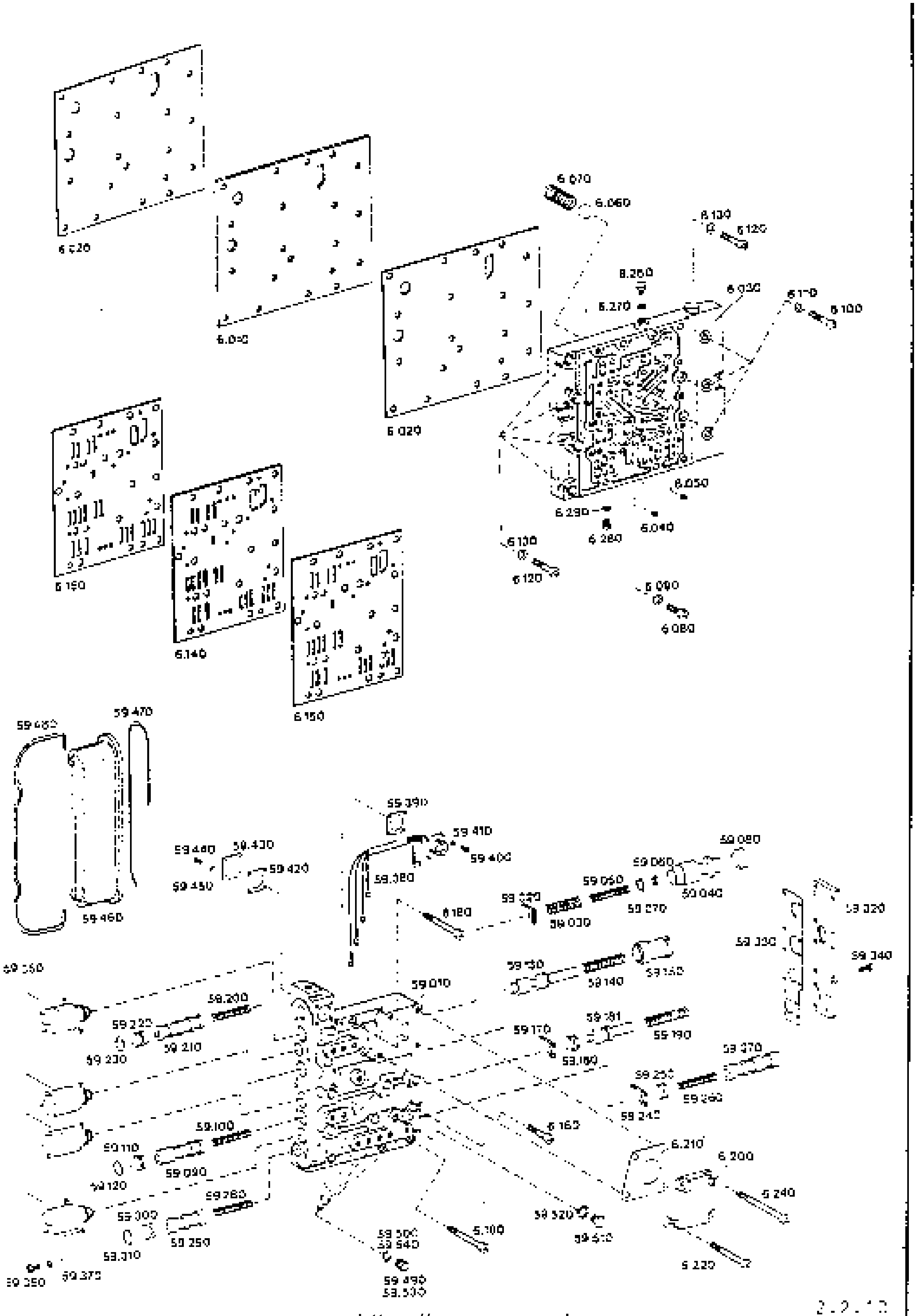


Valve control plate



M = shift pressure measuring points




6 070
6.060
6 130
6 120
6.260
6.270
6 030
6 110
6 100
6 010
6.040
6 020
6 050
6 290
6 280
6.040
6 130
6 120
6 090
6 080
6 190
6.140
6 150
59 480
59 470
59 460
59 440
59 430
59 420
59 450
59 390
59 410
59 400
59 380
59 080
59 060
59 050
59 040
59 070
59 030
6 180
59 320
59 330
59 340
59 150
59 140
59 160
59 010
59 200
59 220
59 210
59 230
59 170
59 180
59 190
59 370
59 250
59 260
59 240
6 160
59 100
59 110
59 090
59 120
6.210
6 200
6 240
59 280
59 300
59 250
59 310
6.300
59 520
59 510
59 540
6 220
59 350
59 370
59 490
59.500

Stripping down drive gears and wheel hub

1. Unscrew the flat-shoulder nuts (43) and take off the wheel rim.
2. Unscrew the oil drain plug (50) at planetary gear carrier (29) and drain the oil.
3. Remove machine screws (54) and pull off brake drum (11) with forcing-off bolts.
4. Before stripping down planetary gear carrier (29), it is advisable to mark its relative position to wheel hub (7).
5. Remove machine screws (53) and pull off planetary gear carrier (29).
6. Snap out circlip (25) and pull off sunwheel (28) with thrust ring (27).
7. Remove machine screw (49) and unscrew shaft nut (41).
8. Pull off annulus (24) with annulus carrier (23) and inner bearing race (47).
9. Carefully pull wheel hub (7) with outer bearing races (47 and 48) and sealing rings (31 and 32) away from stub axle (19).

Installing drive gears

1. Grease taper roller bearing (40) and push wheel hub (7) after precise centering on to stub axle (19), accompanied by bearing outer races (48 and 47) and sealing rings (32 and 31).

2. Push annulus carrier (23) with annulus (24) and inner bearing race (47) on to the splines of stub axle (19).

Adjusting wheel bearings

3. Screw on shaft nut (41) and tighten it while turning wheel hub (7), until the wheel is hard to turn by hand. From this fully-tightened position, slacken off shaft nut (41) by about 10 degrees of angle.

3a. Bearing preload can be checked with a spring balance, and then adjusted by tightening nut (41) gradually.

Total rolling moment 12 – 18 Nm

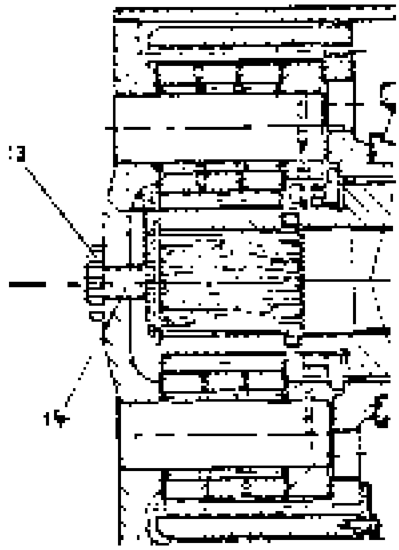
4. Secure shaft nut (41) with machine screw (49) to prevent it from turning.

5. Place thrust ring (27) with sunwheel (28) over the splines on the stub axle, and secure with circlip (25). Push the stub axle in until the circlip is touching the sunwheel and the sunwheel is touching the inner thrust ring.

<u>Adjusting endplay (axial play)</u>

6. Tighten adjusting screw (14) up as far as the contact face on the propeller shaft or stub axle. From this fully tightened position, slacken off by approx. 45 degrees (= app. 0.2 mm). Secure the shaft nut (13) with 'Loctite 242' and tighten.

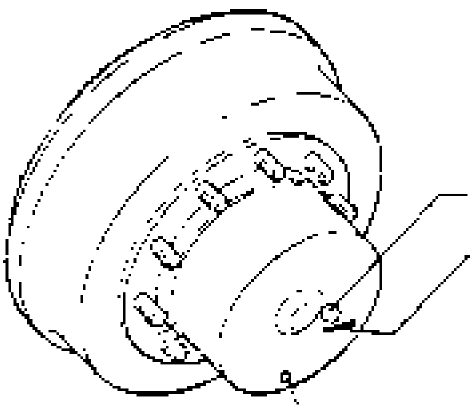
<u>Note</u>: when tightening shaft nut (13), the adjusting screw must be prevented from moving.



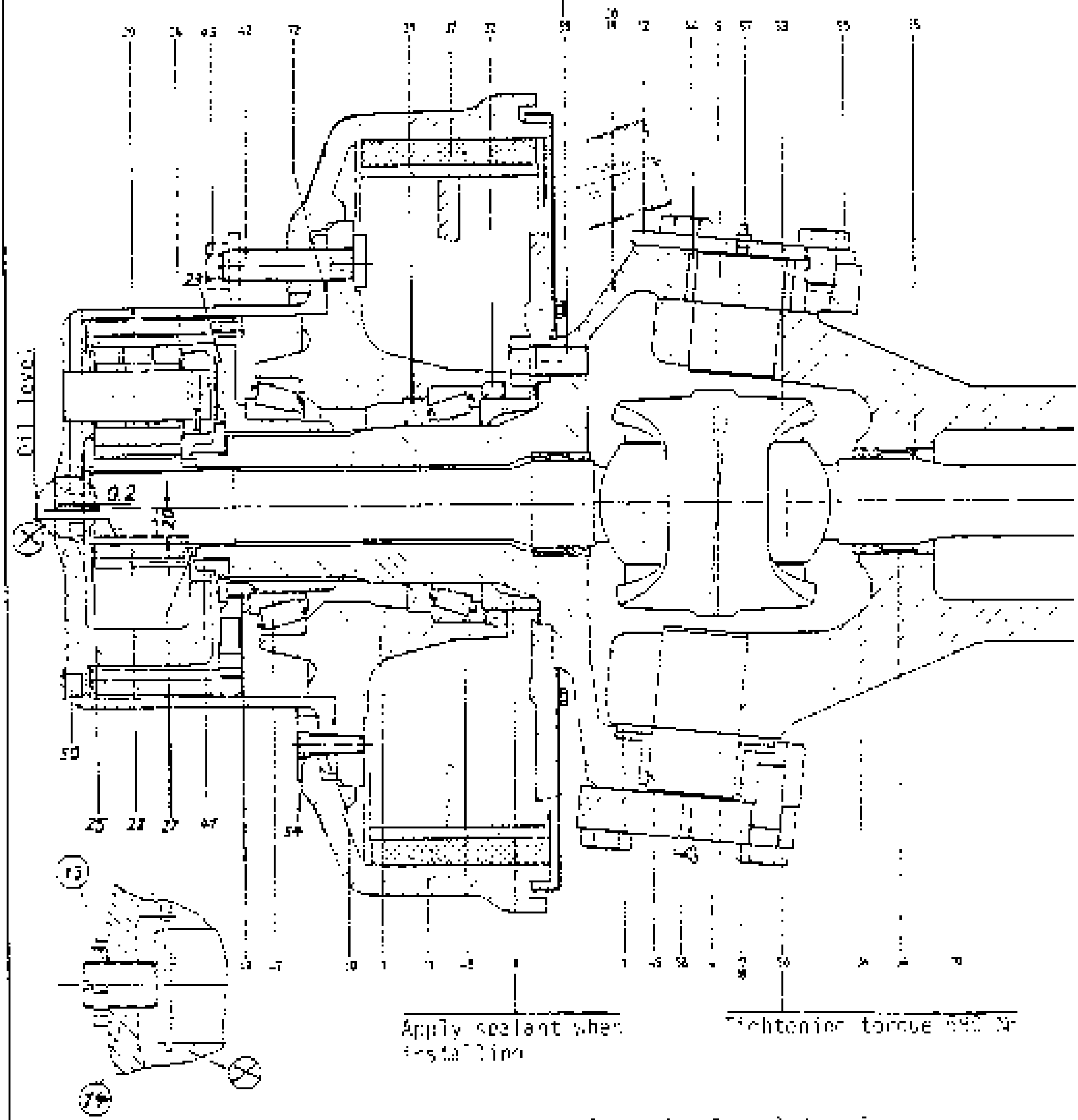
7. Clean the flange face on the planet wheel carrier and the opposing face on the wheel hub, and apply sealant. Push on the wheel hub drive assembly and tighten into position with machine screws (53).

8. Install the brake drum (11) and secure with machine screws (54).

9. Add gear oil at Item -C- (when mark -D- is horizontal), until the oil level reaches the underside of the filler hole.



Wheel drive gears - rear axle

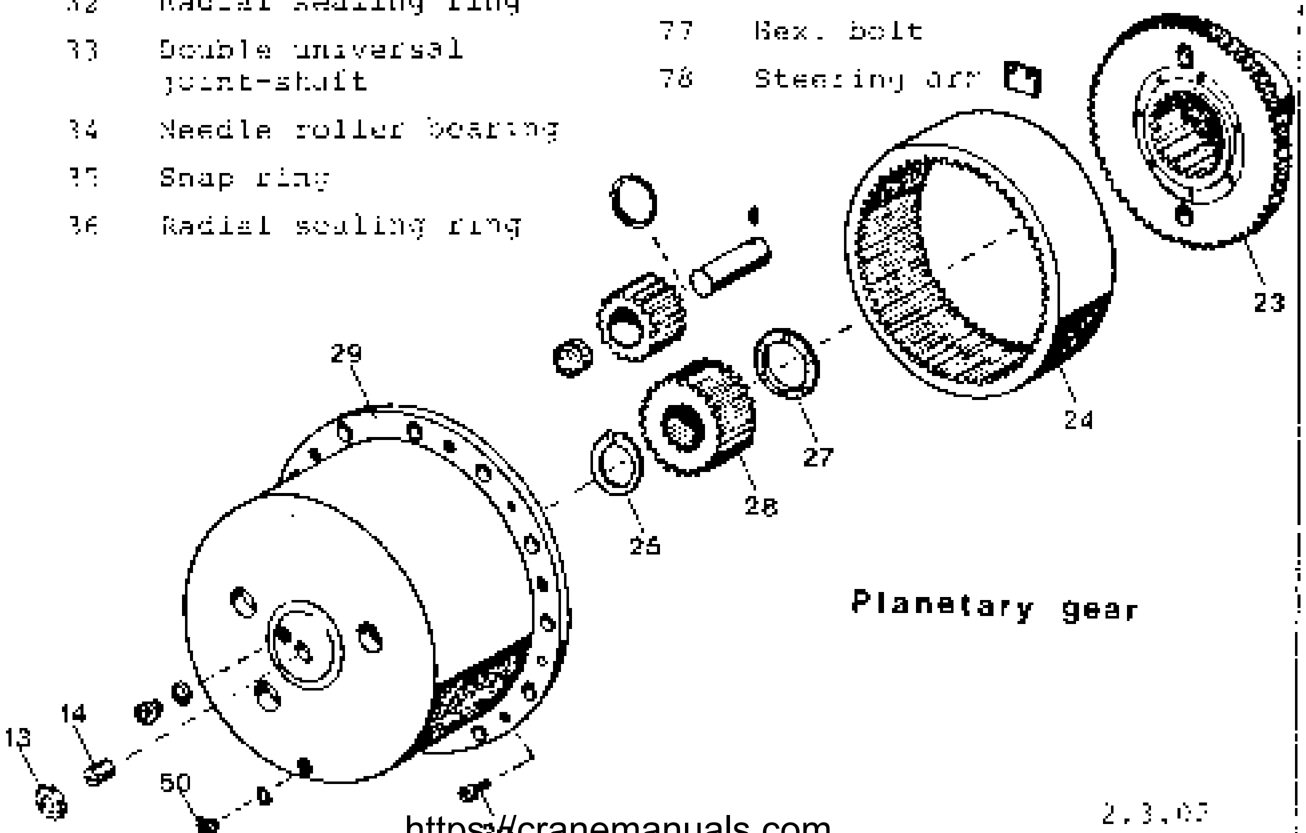


Total rolling moment
12 - 18 Nm

Items 4 + 5 cooled to low temperature before installing

Wheel drive gears – front- and rear axles

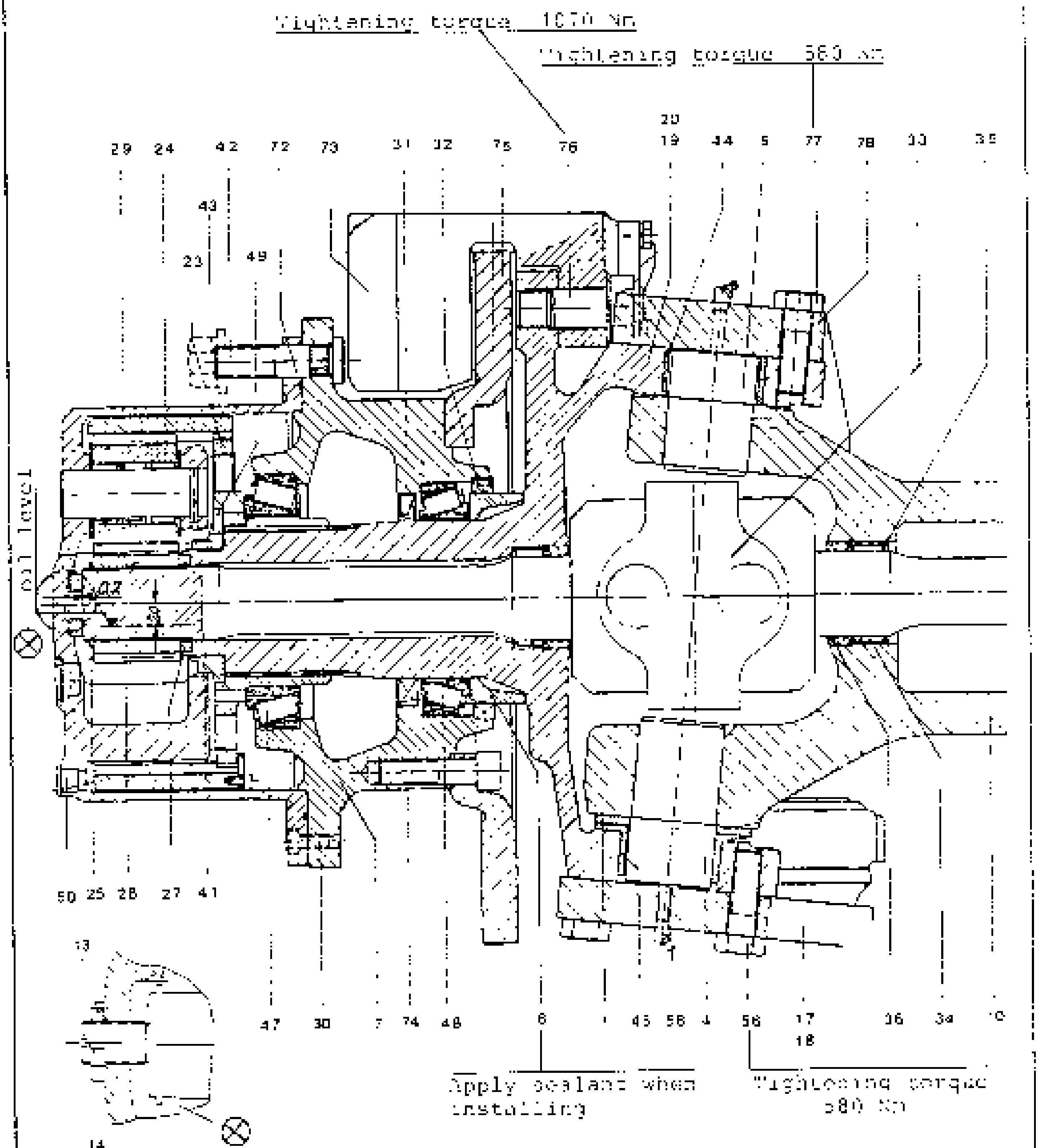
1 Thrust washer
4 Kingpin, lower
5 Kingpin, upper
7 Wheel hub
8 Spacing ring
10 Axle housing
11 Brake drum
12 Cover
13 Counter nut
14 Adjusting screw
17 Track rod arm
18 Track rod arm
19 Stub axle
20 Stub axle
23 Annulus carrier
24 Annulus
26 Circlip
27 Thrust ring
28 Sun wheel, 22 theeth
29 Planetary gear carrier
30 Machine screw
31 Radial sealing ring
32 Radial sealing ring
33 Double universal joint-shaft
34 Needle roller bearing
35 Snap ring
36 Radial sealing ring
37 Brake (leading and trailing shoe)
41 Shaft nut
42 Wheel stud
43 Flat-shoulder nut
44 Bearing bushing, upper
45 Bearing bushing, lower
47 Taper roller bearing
48 Taper roller bearing
49 Machine screw
50 Screw plug
53 Machine screw
54 Machine screw
55 Hex. bolt
56 Hex. bolt
57 Grease nipple
58 Grease nipple
59 Hex. bolt
72 O-ring
73 Brake anchor plate
74 Machine screw
75 Brake disc
76 Hex. fitting bolt
77 Hex. bolt
78 Steering arm



Planetary gear

2.3.02

Wheel drive gears - front axle



Items 4 + 5 cooled to low temperature before installing

Total rolling moment
12 - 18 Nm

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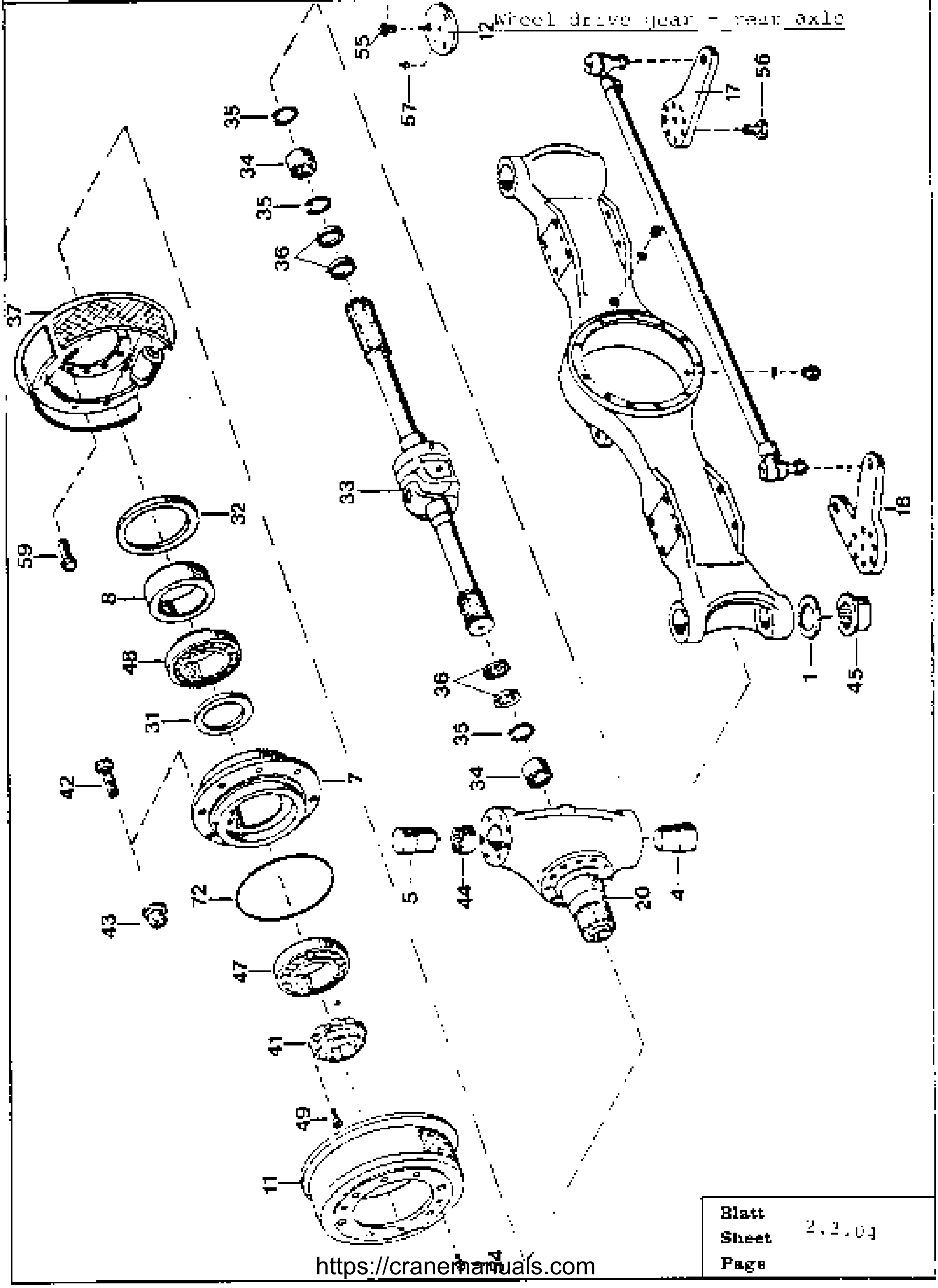
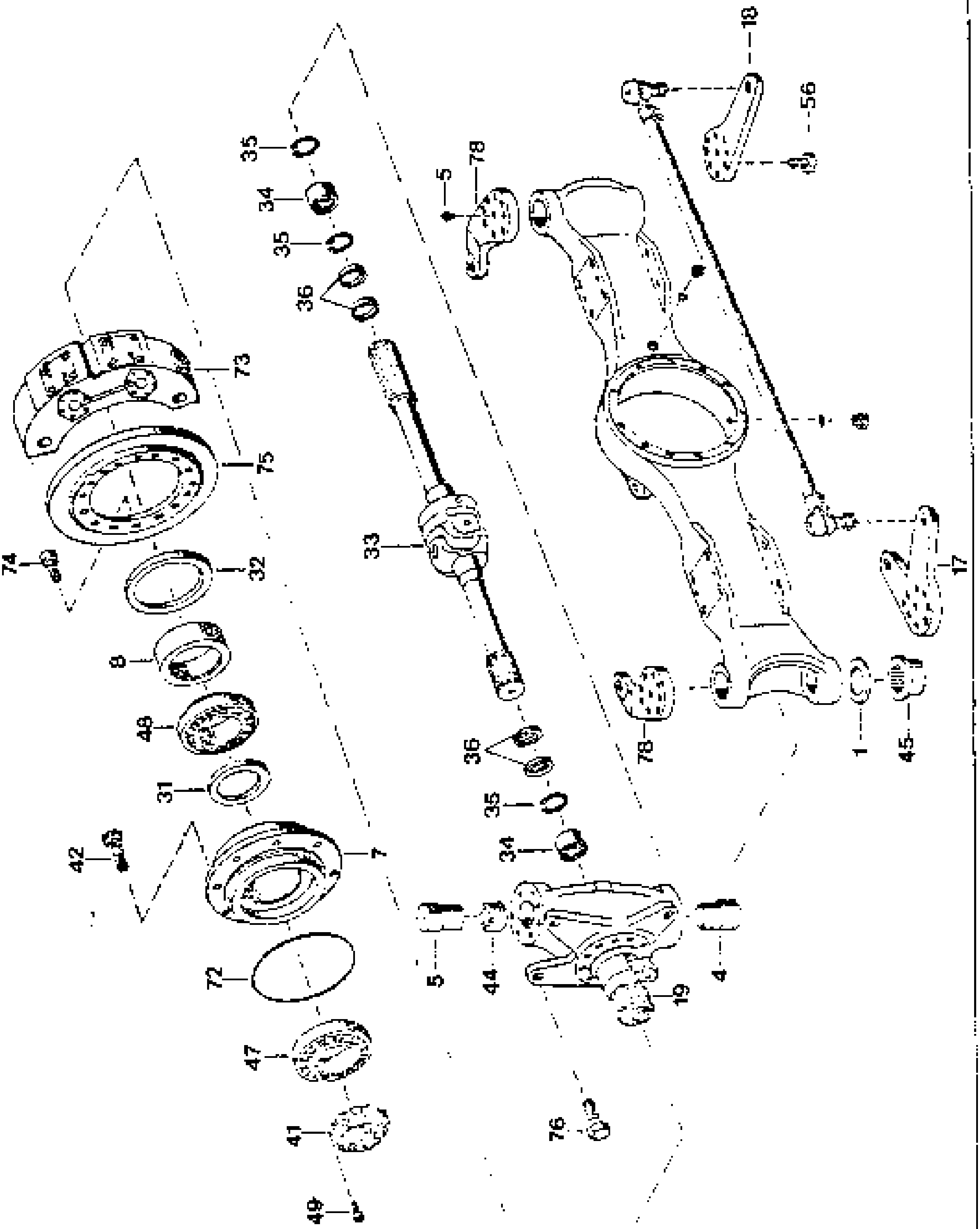
Axles

Wheel drive gear - rear axle



Blatt Sheet Page	2.2.04

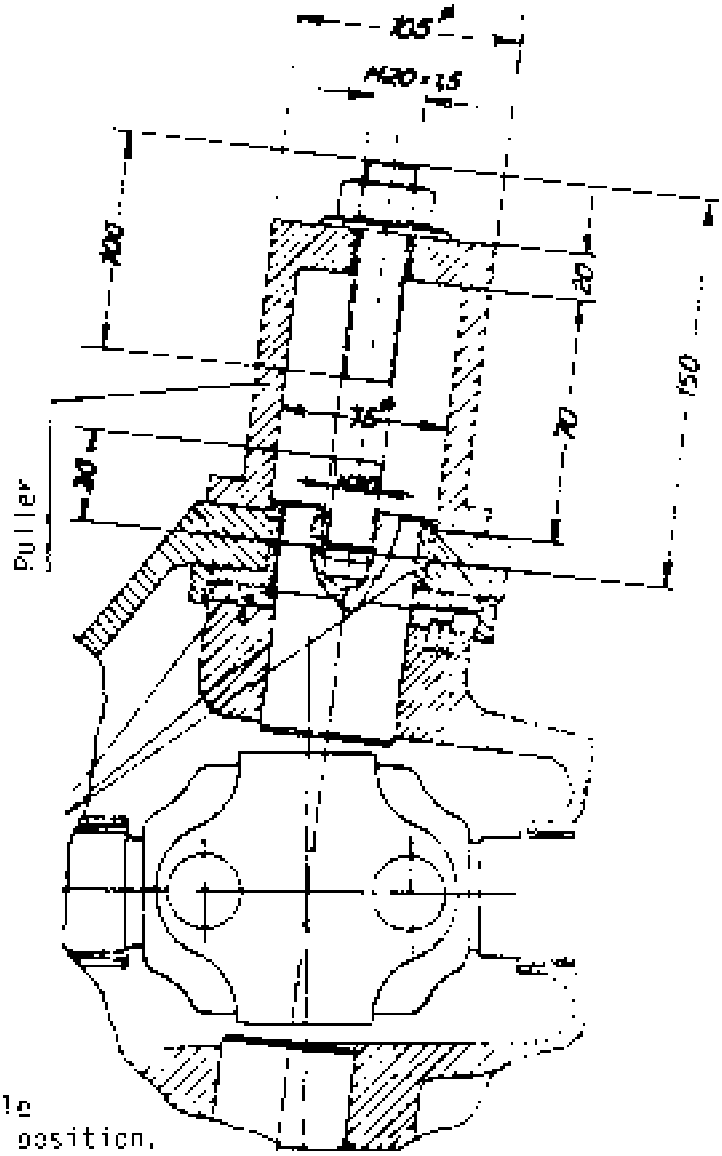
Wheel drive gear -



Stub axles

Removing and installing kingpins

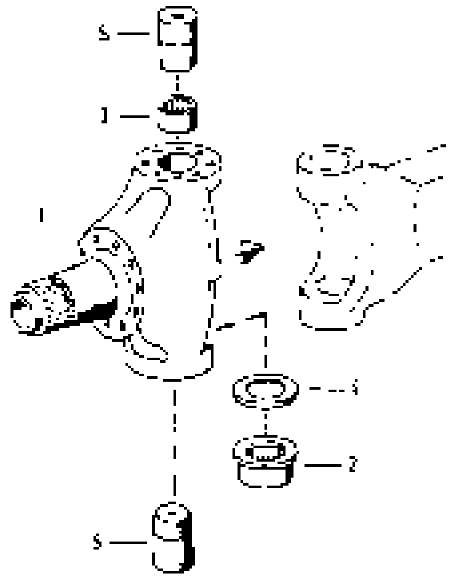
Stripping down



The kingpins can only be removed with a suitable puller (see illustration). This should consist of a forcing-off bolt and a dome.
The puller bolt is screwed into the M 20 tapped hole (pitch 2.5 mm) in the kingpin. The recommended puller thread is of fine metric pattern, pitch 1.5 mm. If the kingpin still proves very difficult to remove, it can be eased by careful heating of the pivot eyes on the axle end fork.

Assembly

1. Insert bearing bushing with collar into lower kingpin pivot bore, and press in with a suitable rod or arbor through the upper bore.
2. Drive or press in the upper bearing bushing with a suitable rod or arbor.
3. Slide the stub axle over the axle fork, with the thrust washer in position.
4. Before pressing in the kingpins, the bores in the front axle ends and the kingpins should be coated with 'Molykote' powder or paste.
5. Install the kingpins with a suitable press.
6. After attaching the steering arms, lubricate the bearing points with anti-friction bearing grease as indicated in the lubricating chart.

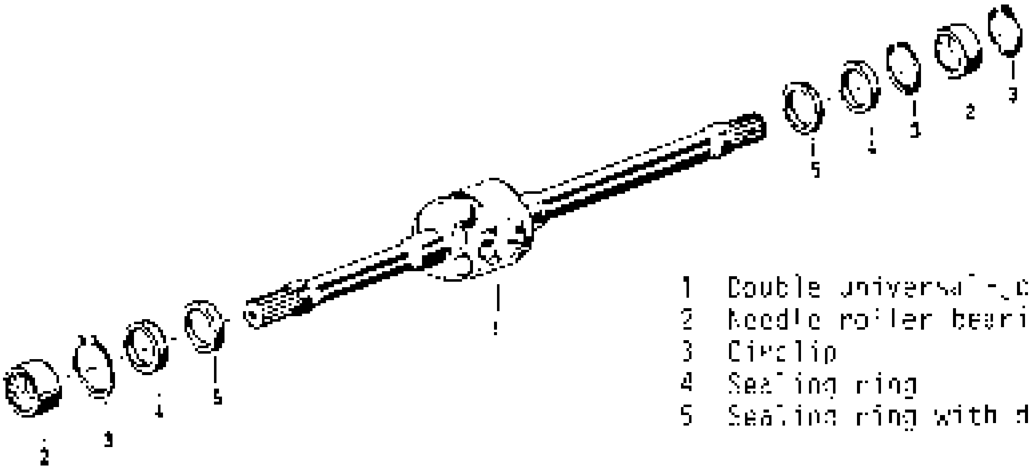


Components

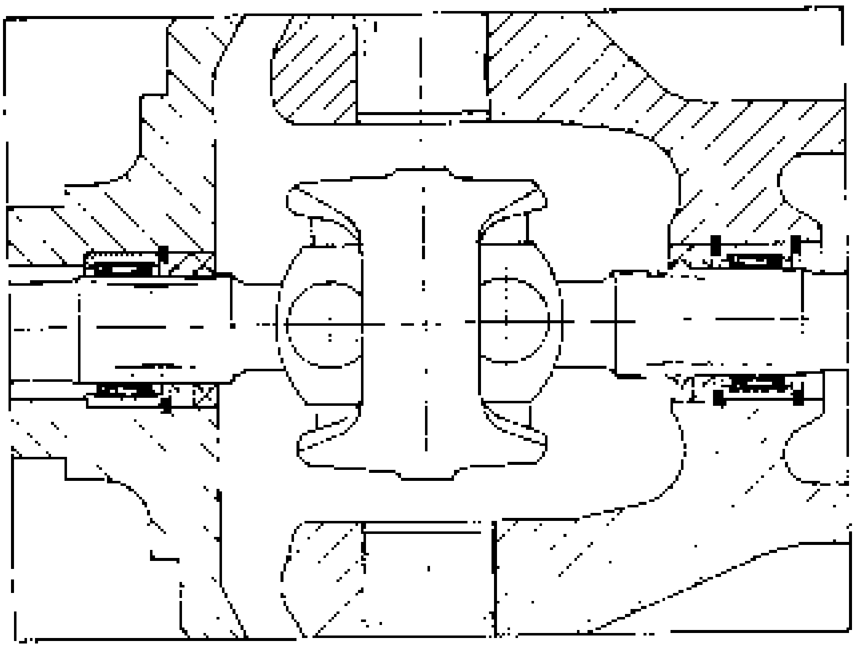
1 Stub axle
2 Bearing bushing with shoulder
3 Bearing bushing
4 Thrust washer
5 Kingpin, upper
6 Kingpin, lower

Installing double universal-joint shaft with bearings

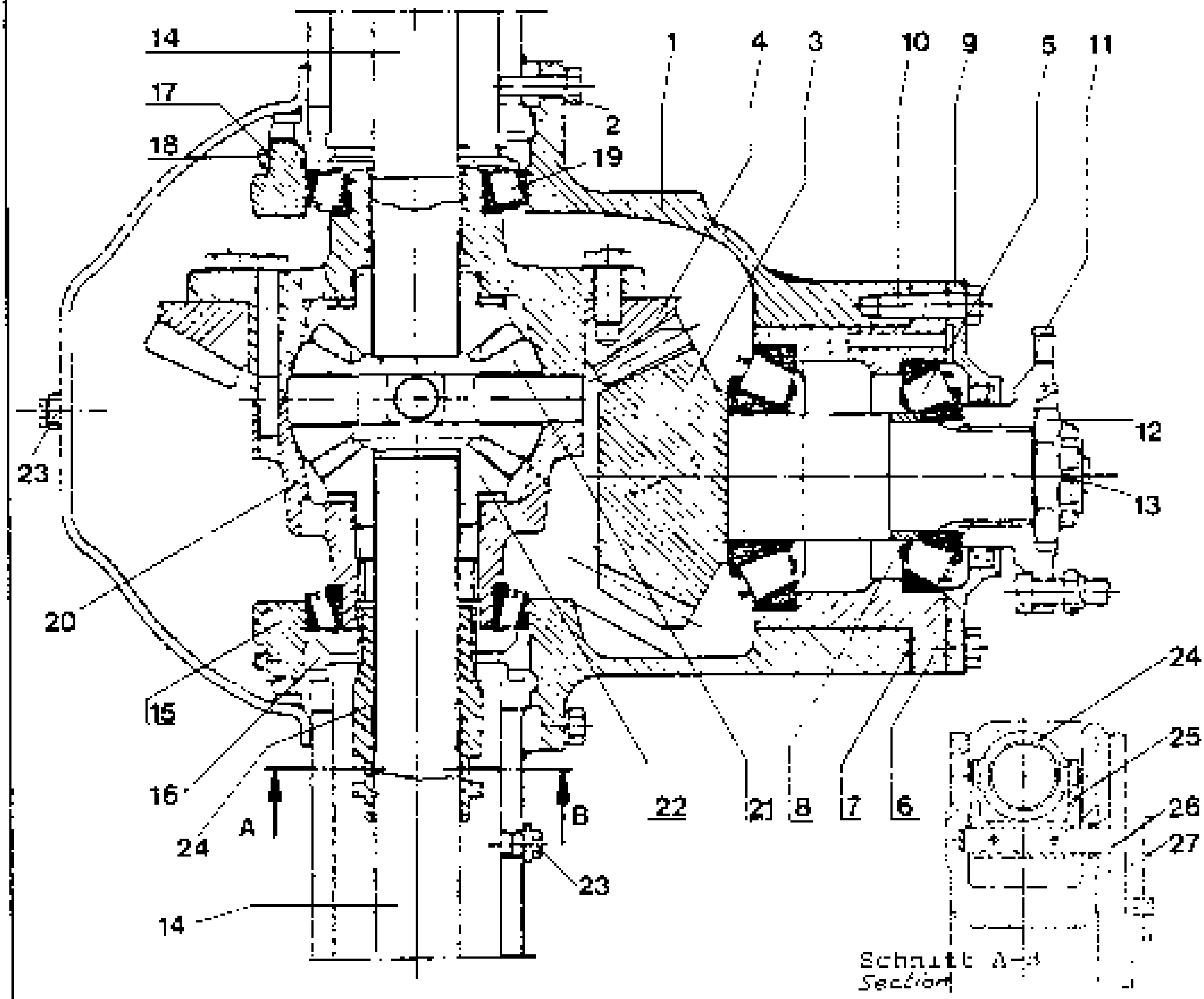
Make sure that the needle roller bearings are well greased before installing; in addition, the annular cavity between needle roller bearing and radial shaft seal should be packed with grease.
Installation of the double universal-joint shaft must be undertaken with great care: the sealing lips on the shaft sealing rings, the needle roller bearings and their races must not be accidentally damaged. Note that the sealing lips must face toward the needle roller bearing. It must be possible to slide the drive shaft in by hand until it meshes with the splines in the differential. The shaft must never be driven in.



1 Double universal-joint shaft
2 Needle roller bearing
3 Circlip
4 Sealing ring
5 Sealing ring with dust lip



Axle drive gear front- and rearaxle



1. Drive housing
2. Hex.bolt
3. Bevel pinion
4. Crown wheel
5. Tapper roller bearing
6. Bearing bush
7. Shims
8. Distanz ring
9. Cover
10. Hex.bolt
11. Drive flange
12. Castellated nut
13. Split pin
14. Drive axle
15. Bearing stirrups
16. Adjusting nut
17. Keeper plate
18. Hex.bolt
19. Tapper roller bearing
20. Differential housing
21. Differential bevel gear
22. Axle drive bevel gear
23. Oil filler and level check screw.

Connection of differential pawl

24. Sliding sleeve
25. Selector clamp with fulcrum pad
26. Selector shaft
27. Selector lever

Final drive - stripping down

1. Remove the left and right drive axle (see "Removing stub axle").

2. Detach drive shaft from flange (11).

3. Unscrew hex. bolts (2) and remove the complete drive assembly from the drive housing.

4. After bending off keeper plates (17) unscrew hex nut (15) and remove bearing stirrups (14). The differential case complete with crown wheel can be removed.

5. After removing split pin (13) and castellated nut (12) drive flange (11) can be taken off.

6. Unscrew hex nut (10) and remove bevel pinion (3) complete with taper roller bearing (5), bearing bush (6) and cover (9).

Final drive - assembly

Adjusting and assembly of bevel pinion into the drive-housing

1. Clamp the bevel pinion (3) in a vice, using soft jaws.

2. Attach the taper roller bearing (5) with distant ring (8) and the bearing bush (6).

3. Assemble drive flange (11) and castellated nut (12).

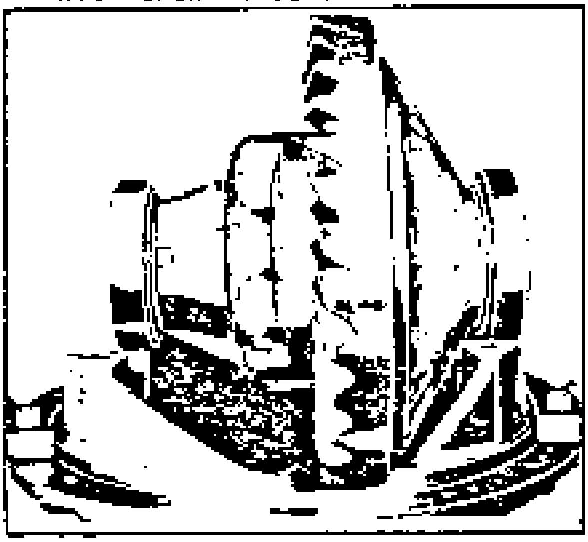
4. Tighten castellated nut (12) turning the bearing bush (6) all the time until a bearing preload of 1,1-2,3 Nm is reached.

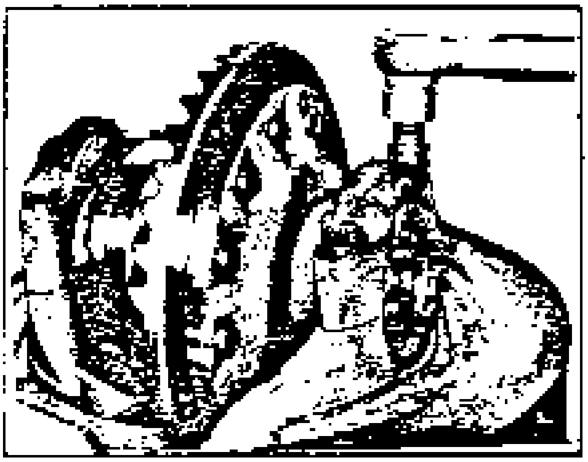
5. Apply sealant on the contact face between the cover (9), bearing bush (6) and the drive housing (1). Install bevel pinion (3) complete with bearing sleeve (6), shims (7) and cover (9) in the drive housing (1).

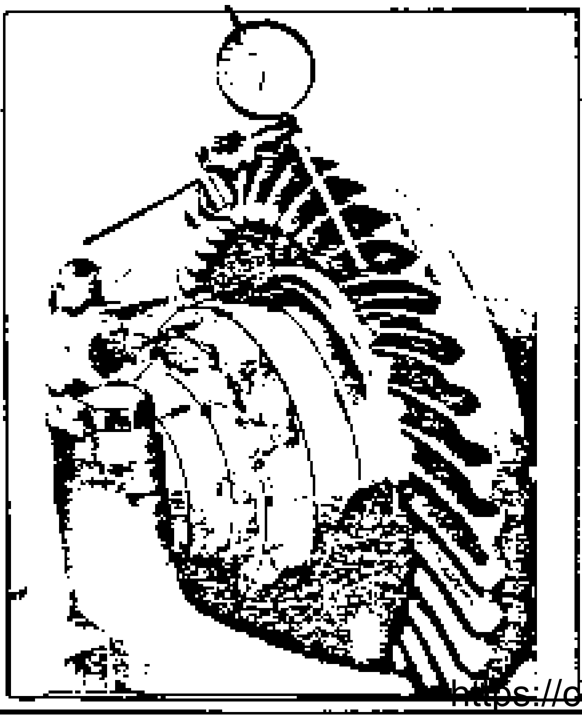
6. Attach bearing sleeve (6) and cover (9) on drive housing (1) with screws (10).

Assembly of final drive (single-stage)

Installing differential with crown wheel:







1. Install the outer taper roller bearing races and place in the final drive housing with the pre-assembled differential.

2. Place the stirrup over the taper roller bearing and secure with the hex bolts (note marks on bearing stirrup and housing). Tighten adjusting nuts at both sides.

3. Continue to tighten the adjusting nuts until a tooth backlash of app. 0.3 mm is obtained.

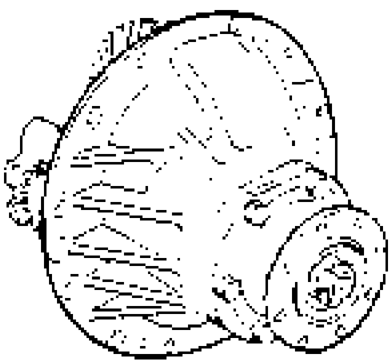
4. Before securing the adjusting nuts, check bearing preload. Rolling resistance should be 2.9 — 4.0 Nm. Secure the adjusting nut with 'Loctite' or a keeper plate.

Adjusting tooth backlash and bearing preload:

5. Apply the dial gauge at a right angle to the tooth flank on the crown wheel.

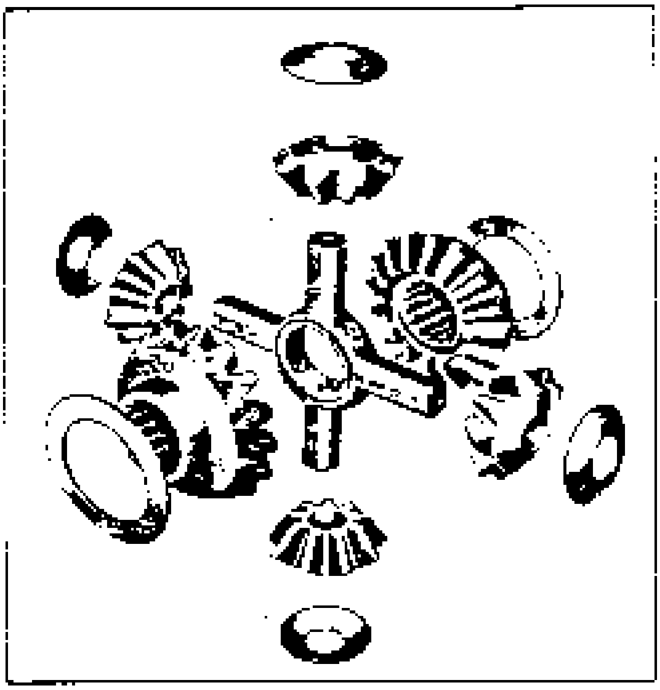
6. Prevent the input bevel pinion from turning, and tighten the adjusting nuts by equal amounts alternately to move the differential away from the input pinion until the correct tooth backlash is obtained.

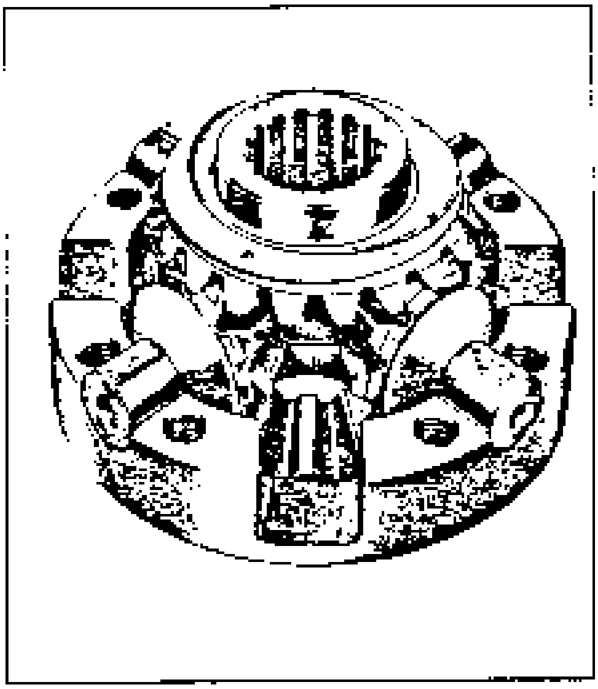
Since the adjusting nuts cannot be secured in all positions, the final bearing preload may be slightly higher or lower than intended. In this case, the adjusting nuts can be unscrewed or tightened further by max. 1/2 notch to enable them to be secured.



Complete final drive assembly (single-stage)

(see sectioned drawings of final drive assemblies)





Before installation starts, all components must be clean and oiled. If the differential bevel pinion has no bushing, the spider must be coated with 'Molykote' paste.

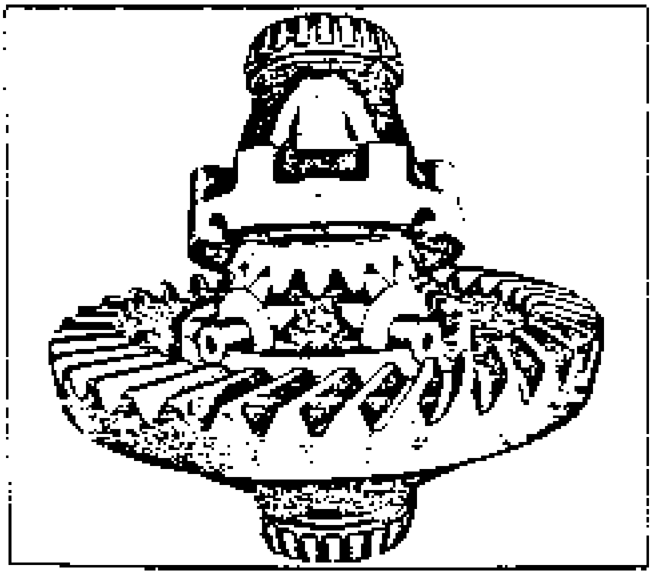
1. Place the output shaft gear with thrust washer in the differential housing.

2. Install the differential spider with the differential bevel pinions and ball-pattern washers already attached.

3. Install the output shaft gear and thrust washer.

4. Install the differential housing, noting the positioning marks. Tighten the retaining bolts with a torque wrench.

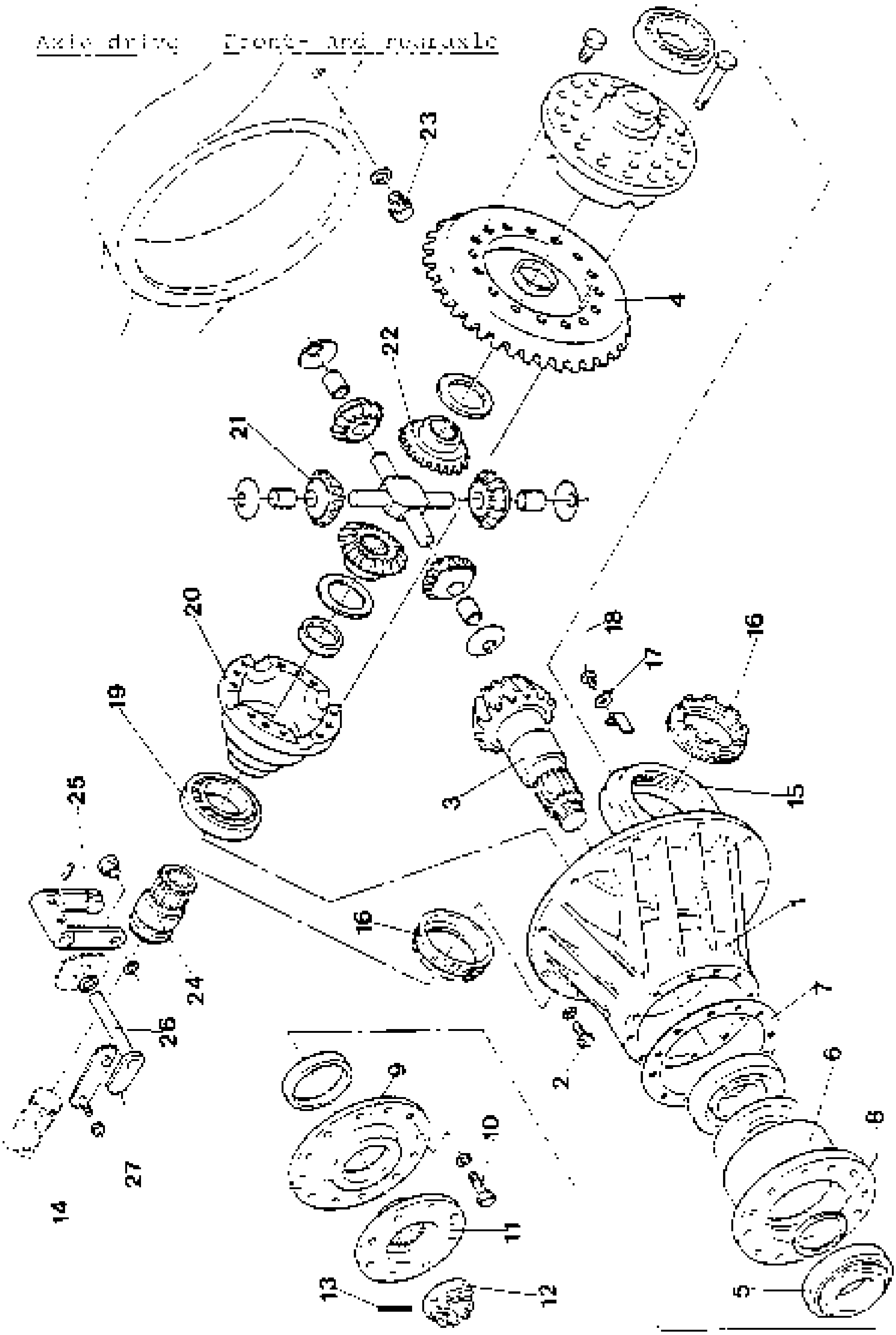
5. Attach the crown wheel to the differential housing and drive in with light blows round the circumference. Tighten the crown wheel bolts with a torque wrench.



6. Heat both taper roller bearings to approx. 80°C, and drive in with a suitable sleeve (heat in an oilbath or on a hotplate).

Disassembly takes place in the opposite working sequence to that described here.

Axle drive Front- and rearaxle



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General lubricating instructions

(applicable to all Kessler differential axles)

For oiling and greasing intervals, see Sheet 2.3.10.

For contents, see Sheet 1.6.01.

(Note that the quoted quantities when filling are only approximate.)

Oil changes:

Position the vehicle horizontally.

The oil should only be changed after the vehicle has been driven for some time, and the oil is warm.

Clean all lubrication points before opening them up.

Remove the oil drain plugs on the final drive, on the wheel hubs and, if provided, on the countershaft housing or inter-axle differential.

The oil drain plug must be pointing down at the wheel hubs.

Drain the oil.

Insert the oil drain plugs again, and tighten.

Remove the oil filler plugs and the oil level checking plug from the final drive, wheel hubs and (if appropriate) from the countershaft housing or inter-axle differential) - see overleaf.

Add the oil.

Watch the oil level at the overflow screw (level check plug).

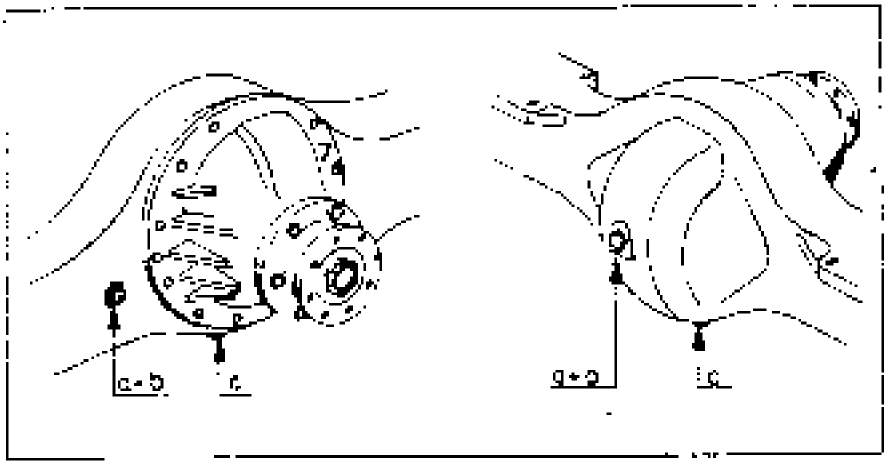
Wait several minutes.

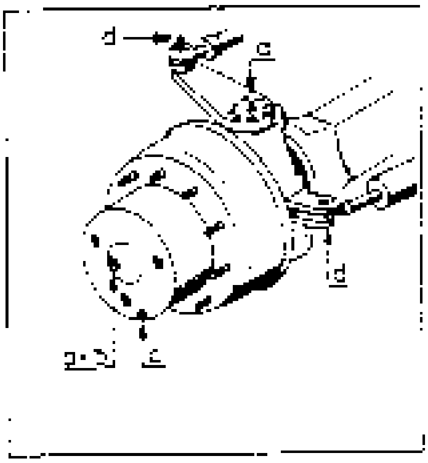
If the oil level has dropped in the meantime, add more oil and wait for the level to remain constant.

Subsequent lubrication: See lubricating intervals on Sheet 2.3.10.

Lubricating points

Fig. 1





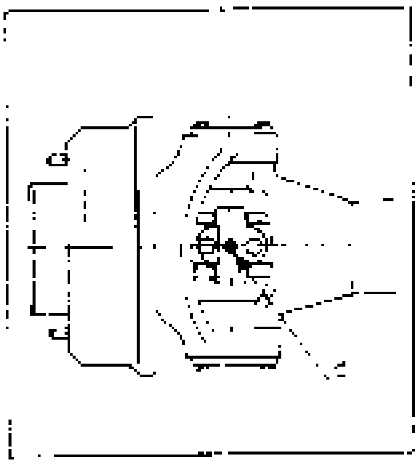


Fig. 2 Fig. 3

a = oil filler plug

b = oil level check plug

c = oil drain plug

d = grease nipple (for high pressure gun)

Fig. 1 Final drive

Fig. 2 Wheel hub with planetary gears

Fig. 3 Lubrication point on propeller shaft

Maintenance and lubricating instructions for driven (differential) axles

Lubrication service			Inspection		Maintenance interval		
Hours of operation:			50	100	500	1000	
Lubricating point	Lubricant	Remarks	1st Insp. 500-1000	2nd Insp. 2500	Every 5000 km	Every 10000 km	Once a year
Final drive Driven wheel hubs Inter-axle differential	Hypoid gear oil SAE 90 to specification MIL-L-2105 B	Oil change:		o		o	o (at least)
		Oil level check (overflow)	o	o	o		
Kingpin pivots	Ultra-high pressure grease		o	o	o		
Ball joints, track rod, steering rod, steering ram	Multipurpose grease			o	o		
Brake shaft bearings	Multipurpose grease	xx (deleted)		o		o	
Fork end pins	'Molykote' grease	(deleted)		o		o	o
Wheel bearings	Antifriction bearing grease (penetration: 2)	Long-term lubrication; renew only when axles are stripped down					

Maintenance service		Hours of operation: 50	100	500	1000	
		Inspection		Maintenance interval		
Checking and maintenance points	Remarks	1st Insp. 500-1000	2nd Insp. 2500	Every 5000 km	Every 10000 km	Once a year
Wheel bearings	Check wheel hub taper roller bearings, adjust if necessary		o			o
Wheel nuts	Check and tighten if necessary (tighten after app. 50 km if a wheel was changed)	o	o	o		
Castellated nuts, bolts at drive flange, nuts on axle retaining bolts	Check, tighten if necessary	o	o		o	
Brakes	Check, adjust if necessary; lining thickness is visible at inspection holes x	o		o		o (at least)
Steering and track rod arms	Check, tighten if necessary		o			o
Crownwheel, support (thrust) bolt	Adjust					o

x = Further inspections needed according to vehicle utilization

xx = Use only a small amount of grease at this point to prevent it from penetrating the brake

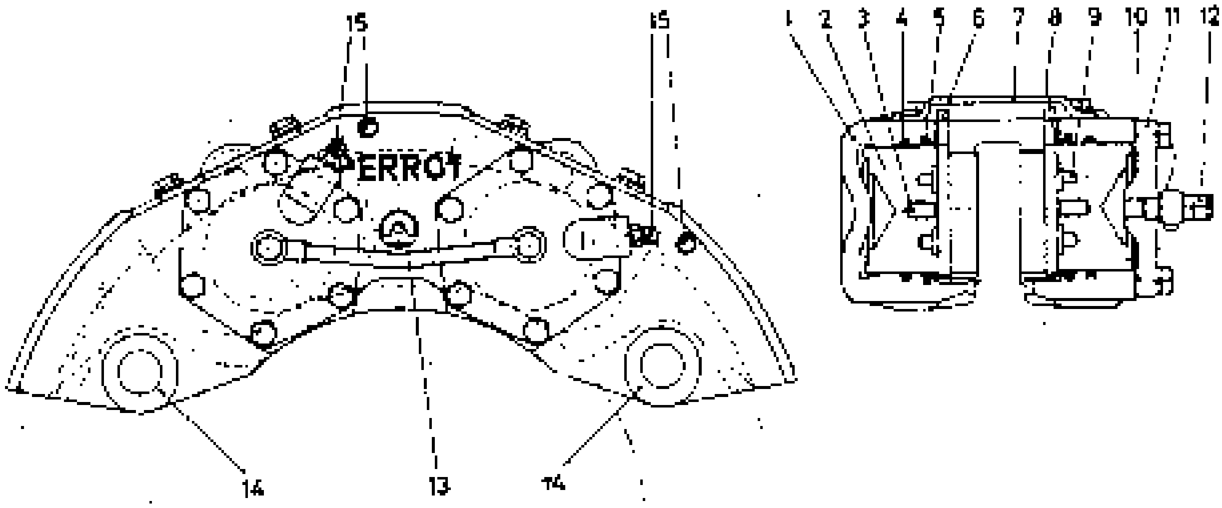
(Check by lubricating only with the brake drum removed, in conjunction with six-monthly brake maintenance routines)

Front-axle disc brakes

Operating principle:

The front wheels are braked by hydraulically-actuated disc brakes.

Construction:



Description:

The disc brake is built up on the caliper (1), which is secured to cast-iron lugs (14) on the stub axle or steering knuckle by means of two through-bolts. Each brake caliper has two pairs of pistons (2) working in opposed directions.

Pistons (2) run in cylinder bores in brake caliper (1), and have a lathe-turned recess (8) on the endface in contact with the brake pad backplate (6), containing six opposed blind holes (9). An M 12 tapped hole (3) is provided centrally in the endface of piston (2).

The cylinders, which take the form of blind bores in brake caliper (1) on one side and through bores on the other, are sealed by square-section sealing rings (4). To prevent dirt from entering, scraper (5) is installed at the free ends of the cylinders.

The cylinder in the form of a through-bore is sealed by cover (11) with sealing ring (10).

The brake pad backplates (6) are inserted from the outside into brake caliper (1), bear against it radially and are prevented from falling out or excessive contamination with dirt by cover (7).

Union (12) for the brake pipe is in the center of cover (11). On brake calipers with two pairs of pistons, the second pair is connected to the hydraulic circuit by means of pipe (13). Brake caliper (1) is bled at bleed valves (15). The cylinders are linked hydraulically by drillways in the brake caliper, so that all pistons are exposed to oil pressure simultaneously.

When the brakes are applied, the preload cylinder is exposed to air pressure by operation of the pedal valve (see description of air brakes). The preload cylinder in turn operates master brake cylinders in circuits I and II (depending on the nature of the brake application). These exert hydraulic pressure on the pistons in the wheel brake cylinders. The pistons press against the brake pad backplates, which move forwards and apply the pads to the brake discs. Since these are rigidly attached to the drive shafts, the vehicle is braked. The braking moment varies according to the pressure built up at the braking valve. Since the disc brake pistons are opposed, the pads are pressed with equal force against the disc even if pad wear is uneven, with the result that braking effort is exerted uniformly on both sides of the brake disc.

When the brake application is terminated, hydraulic pressure decays in the cylinders and the brake pads with backplates are withdrawn from the discs.

Maintenance

The disc brake installation should be inspected every 4 000 to 5 000 km of distance covered.

1. Check brake fluid level in the reservoirs (restore level only with brake fluid to SAE J 1703 specification).

2. Check remaining brake pad thickness.

3. Examine the brake discs for score-marks.

Repairs

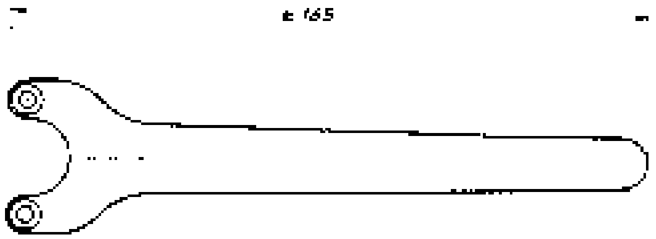
a) Removing brake pads with backplates

- Remove cover (7).

- Using a suitable hook, pull the old brake pad backplates out of their bores.

- Clean the section of the pistons protruding from the scraper ring with water, cleaning-grade gasoline or methylated spirit to remove dirt.

- To turn the pistons, use the pinhole wrench shown here.



- Using a suitable tool, force the pistons back into the cylinders so that the new, thicker brake pad backplates can be installed.

Warning: as the pistons are forced back brake fluid will be expelled into the reservoir, and may overflow.

- Install the new brake pads with backplates, attach cover (7) and secure it.

- Bleed the brakes (see "Bleeding brakes").

b) Brake disc

- Inspect for score-marks and runout.

- Each side may be skimmed (remachined) by max. 1 mm.

- Surface roughness 6 µm.

- Permissible face runout 0.1 mm.

- Deviation from parallel max. 0.05 mm.

Remachining worn or scored brake discs on driven axles

On driven axles, particularly those with planetary hubs, removal of the brake discs for skimming is a time-wasting process. As a result, down-time for brake reconditioning becomes unacceptably long. On the other hand, scored or worn brake discs will cause excessive pad wear unless skimmed in good time. On vehicles which travel at fairly high speeds, such wear patterns can lead to differences in the braking action at the left and right of the vehicle, particularly on the front axle, and even to skidding and loss of control.

You are therefore recommended to skim the brake discs not later than the second brake pad renewal. This can be achieved with specially developed brake pads made from abrasive material (DPS Order No. 12 851 009 for piston diameter 85 mm, pattern to suit the vehicle's brake pad backplates). The procedure, which can of course only be applied to driven axles, is as follows:

1. Jack up the axle (the entire vehicle in the case of vehicles with all-wheel drive).

2. Take off the wheels and remove one pair of opposing brake pad backplates on each side.

3. Clean the pistons as described in a) above, and force them back until a pair of abrasive brake pads can be installed.

4. Engage the drive to this axle and run it at the highest practicable speed. Depress the brake pedal lightly (excessive pressure will slow the wheels to a standstill).

5. The abrasive coating on the pads, which has been specially developed for this purpose, will remove worn areas and score-marks from the discs.

   Although it is not possible to achieve the surface roughness of 6 µm specified for new brake discs by this skimming method, the difference can be neglected, since a few applications of new brake pads will in any case polish the brake discs to the necessary extent.

6. Note that brake discs with lateral runout and/or excessive wear on each side (exceeding 1 mm per side) cannot be skimmed by the above method.

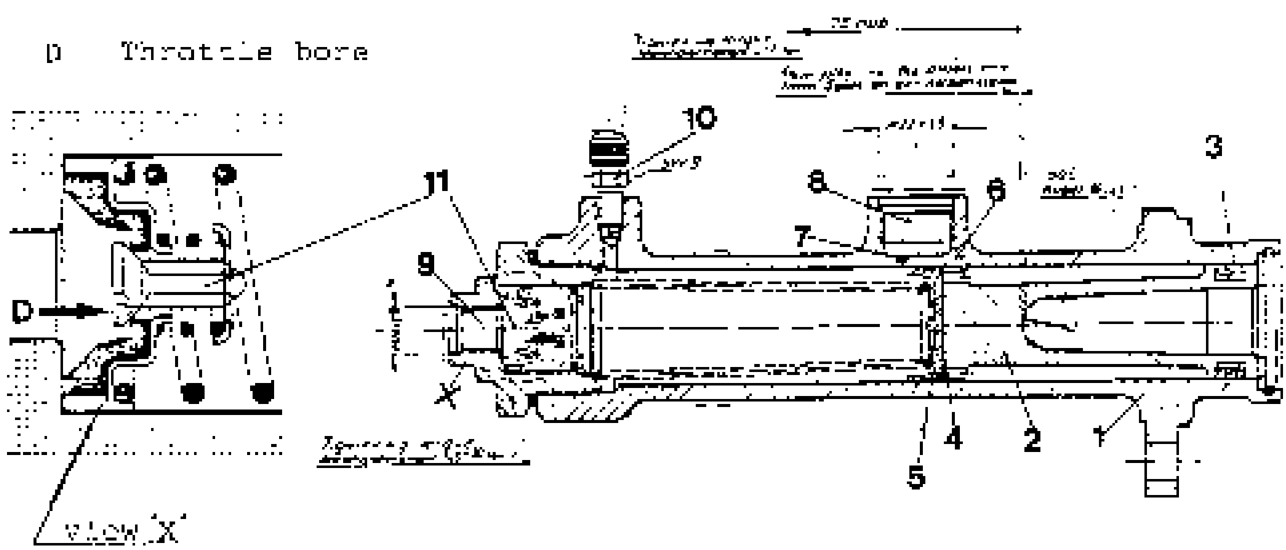
c) Complete reconditioning of disc brakes

- Detach the brake pipes.
- Remove the retaining bolts and take off the brake caliper.
- Detach cover (7) and take out the brake pad backplates.
- Remove pipe (13) and cover (11).
- Take the piston out of the through cylinder bore.
- Insert an M 12 bolt into the piston in the blind cylinder bore and pull it out.
- Remove the scraper.
- Remove the sealing rings.
- Clean dirt and corrosion away from the scraper groove.
- Clean the brake caliper, cylinders and connecting bores with methylated spirit.
- Install new sealing rings, using assembly fluid, paste or brake fluid.
- Insert new scrapers with the special lubricant.
- Install cover (11), using new sealing rings (10), and secure.
- Attach pipe (13).
- Attach the brake caliper and tighten the through bolts (grease them first).
  Tightening torque: M 27 x 2 mm bolts = 107 kpm
  (use only factory-approved replacement through bolts).
- Bleed the brakes and inspect for leaks.

General information

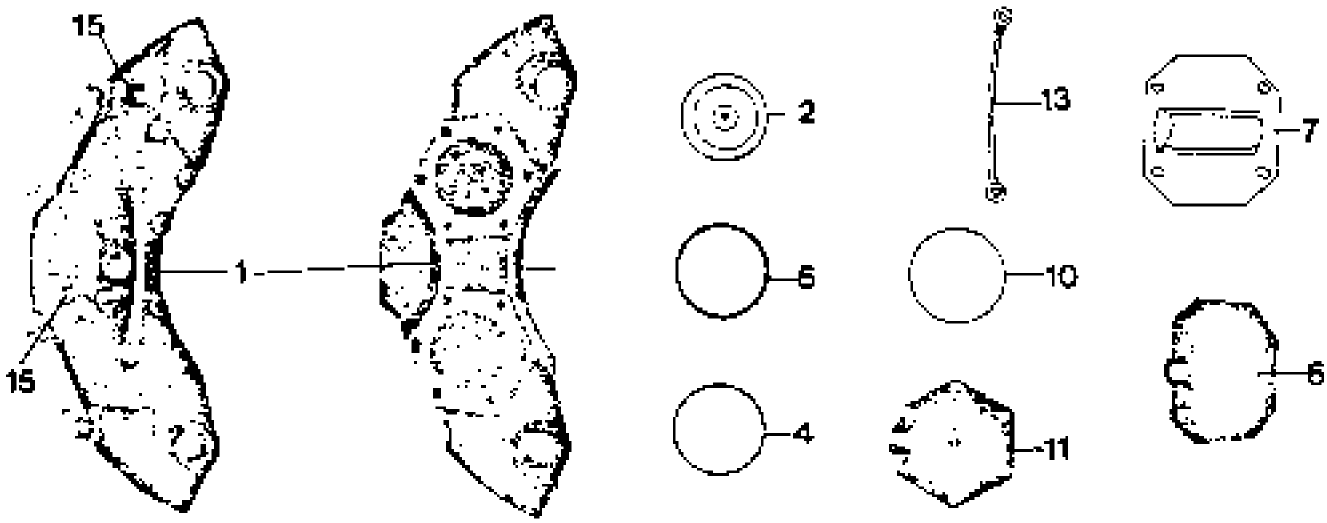
Brake pads	Jurid 241
Pad thickness	18 mm
Brake fluid	Must comply with SAE J 1703 specification.
Sealing rings	Renew after not more than 2 years' operation.

D Throttle bore



1. Brake cylinder
2. Piston
3. Secondary junk ring
4. Filling washer
5. Primary junk ring
6. Filling bore
7. Compensating bore
8. Connection - brake fluid
9. Connection - disc brake cylinder
10. Bleeder valve
11. Special bottom valve

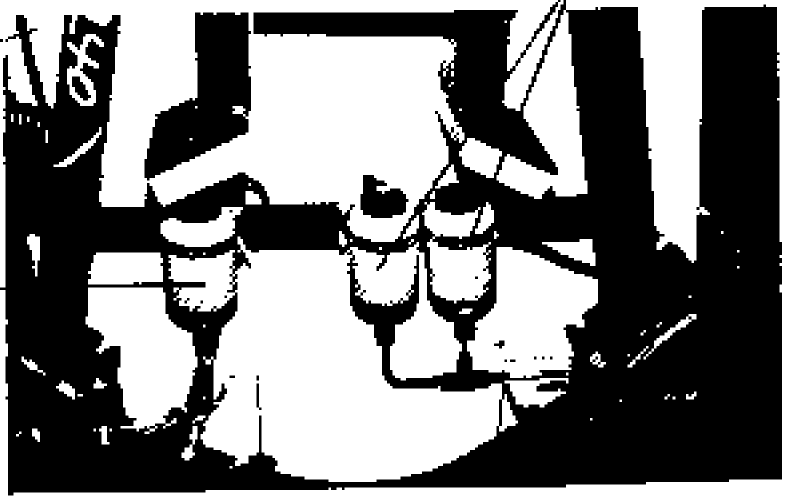
Disk brake

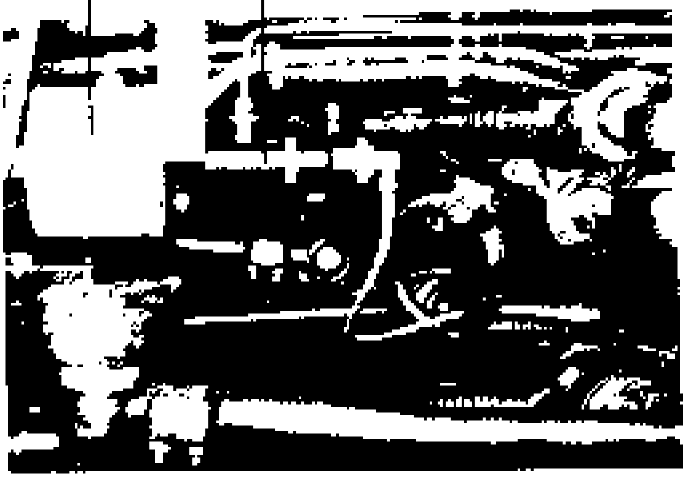


1. Brake anchor plate
2. Piston
4. Gasket ring
5. Oil seal
6. Brake lining plate
7. Cover
10. O-ring
11. Cover
13. Oil tube
15. Bleeder valve

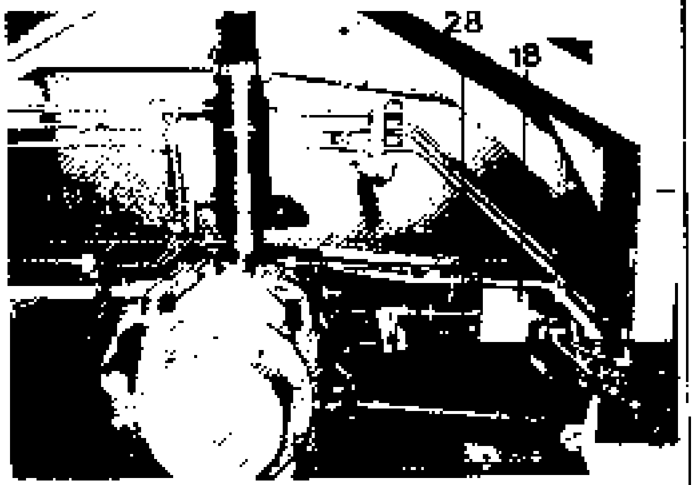
Disc brake - front axle

List of components





travel direction - left -



travel direction - right -

wheel -inside- right

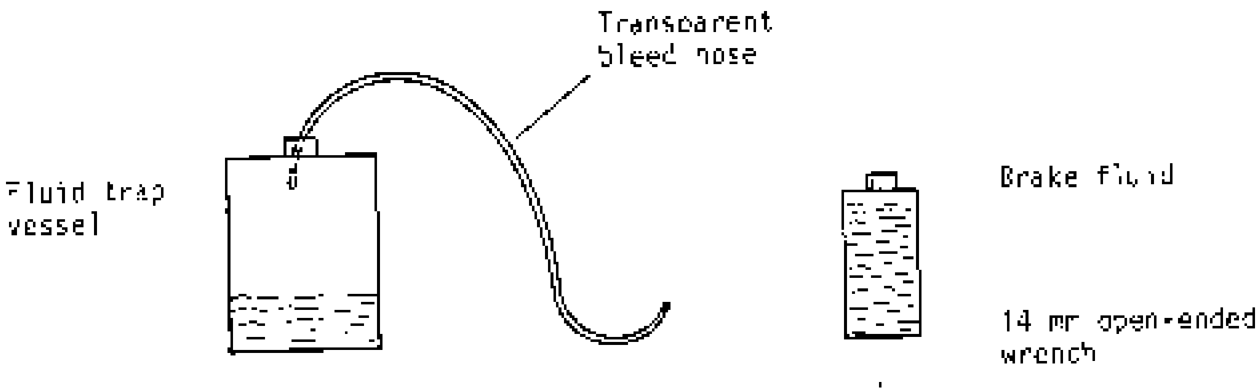
Bleeding the hydraulic brakes (front axle)

(without special bleeding apparatus)

Before bleeding the hydraulic brake circuits, the reservoir for the brake system air pressure must be fully pressurized (max. 8 bar). This is achieved by running the diesel engine or charging from an outside source through the coupling head provided at the front of the vehicle, under the bumper.

The bleeding operation requires two mechanics, one to operate the brake pedal valve and the other to attend to the bleed screws.

Equipment required:



Brake circuit I

1. Fill the reservoir (27) with brake fluid until the level is app. 2 cm (0.8 in) below the rim.
2. Connect the transparent bleed hose to bleed valve (A) on the master cylinder (28). Insert the free end of the bleed hose in the fluid trap vessel.
3. Build up maximum air braking pressure at the pedal valve. Open the bleed valve by app. 1/2 turn, then close again. Release the brake pedal valve to lower air braking pressure to zero.
4. Bleed the wheel brake cylinders individually at their bleed valves in the order A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11 and A 12 (see diagram). The procedure is as described in 3. above.
5. Add more brake fluid to the reservoir if necessary during bleeding.

Brake circuit II

1. Fill reservoir (30) with brake fluid to app. 2 cm (0.8 in) below the rim.

2. Connect the bleed hose to bleed valve (B) on master brake cylinder (31). Lead the free end of the bleed hose to a fluid trap vessel.

3. Follow the same procedure as for brake circuit I.

4. Bleed the wheel brake cylinders individually at their bleed valves in the order B1, B2, B3, B4 (see diagram), using the procedure described in 3. above.

5. See procedure for brake circuit I.

Note: Do not re-use brake fluid pumped out of the system.

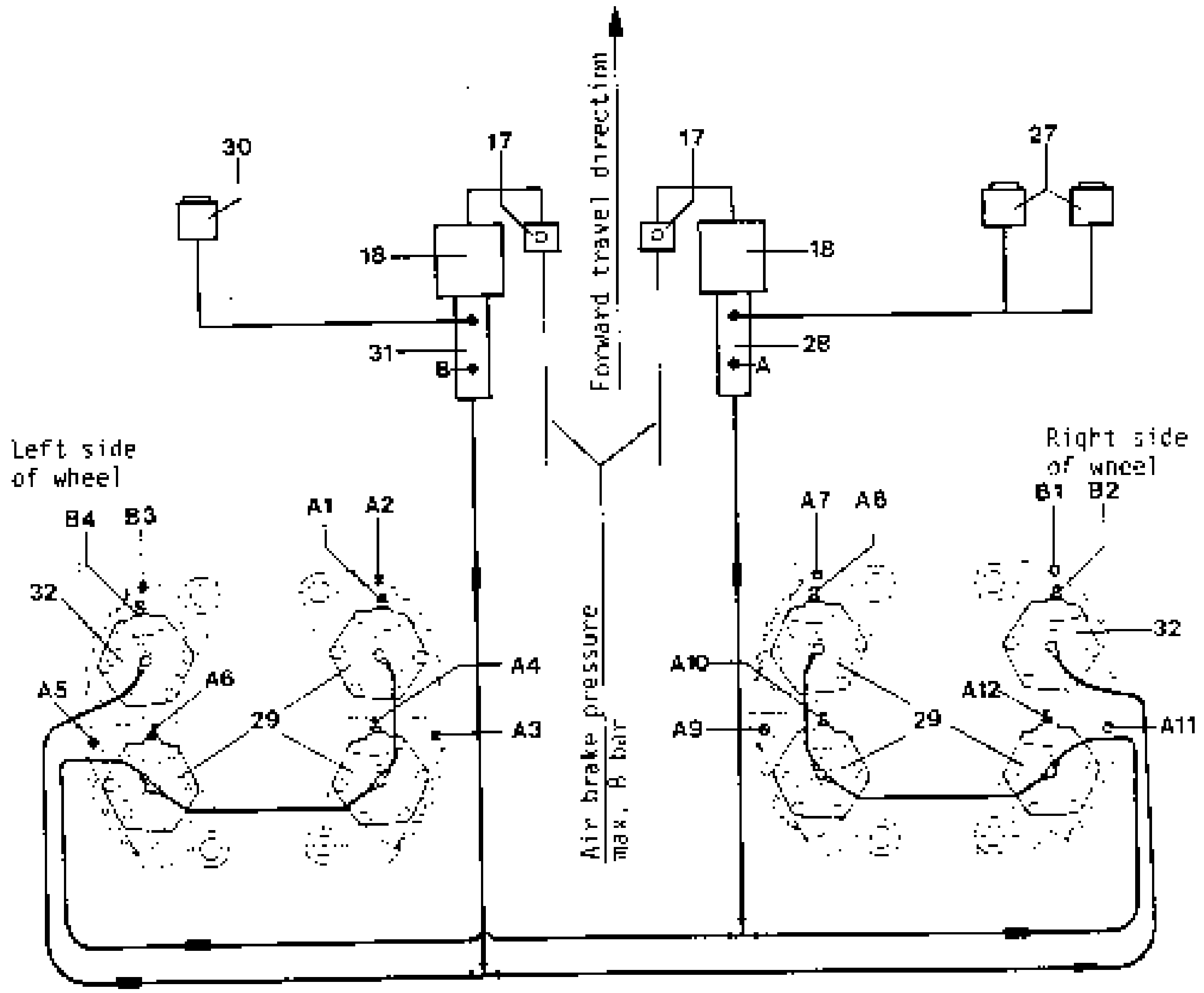
Diagram (bleeding procedure and sequence)

Brake circuit II

30 Reservoir
31 Master cylinder, bleed valve B
32 Wheel brake cylinders (4), bleed valves B1 - B4

Brake circuit I

27 Reservoir
28 Master cylinder, bleed valve A
29 Wheel brake cylinders (12), bleed valves A1 - A12



Bleeding hydraulic brakes (front axle)
(with ATE bleeding device)

Brake circuit I

1. Screw the end cap of the charging line on to reservoir (27).

2. Adjust the bleeding device to a charging pressure of 2 bar, and open the shutoff tap.

3. Attach the transparent bleed hose to the bleed valve, and run its free end into a fluid trap vessel.

4. Bleed the disc brake cylinders individually by opening the bleed valves by app. 1/2 turn. The opening sequence is A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11 and A12 (see diagram). As soon as the brake fluid emerges from the end of the hose free from air bubbles, close the valve again.

Brake circuit II

1. Screw the end cap of the charging line on to reservoir (30).

2. See brake circuit I.

3. See brake circuit I.

4. Bleed the disc brake cylinders in the order B1, B2, B3 and B4 (see diagram).

Note:
Use only brake fluid to SAE J 1703 specification.

Wheel brakes - rear axle

Operating principle

The wheel brakes are operated by two combined spring-loaded and diaphragm cylinders and spreader mechanisms. The service brakes are actuated only by the diaphragm cylinders and the auxiliary and parking brake by the spring-loaded section of the mechanism. If air pressure is lost, the spring-loaded parking brake can be released mechanically (see 'Tristop' - cylinder).

Brake released clearance (air gap) does not have to be adjusted (see description of spreader mechanism).

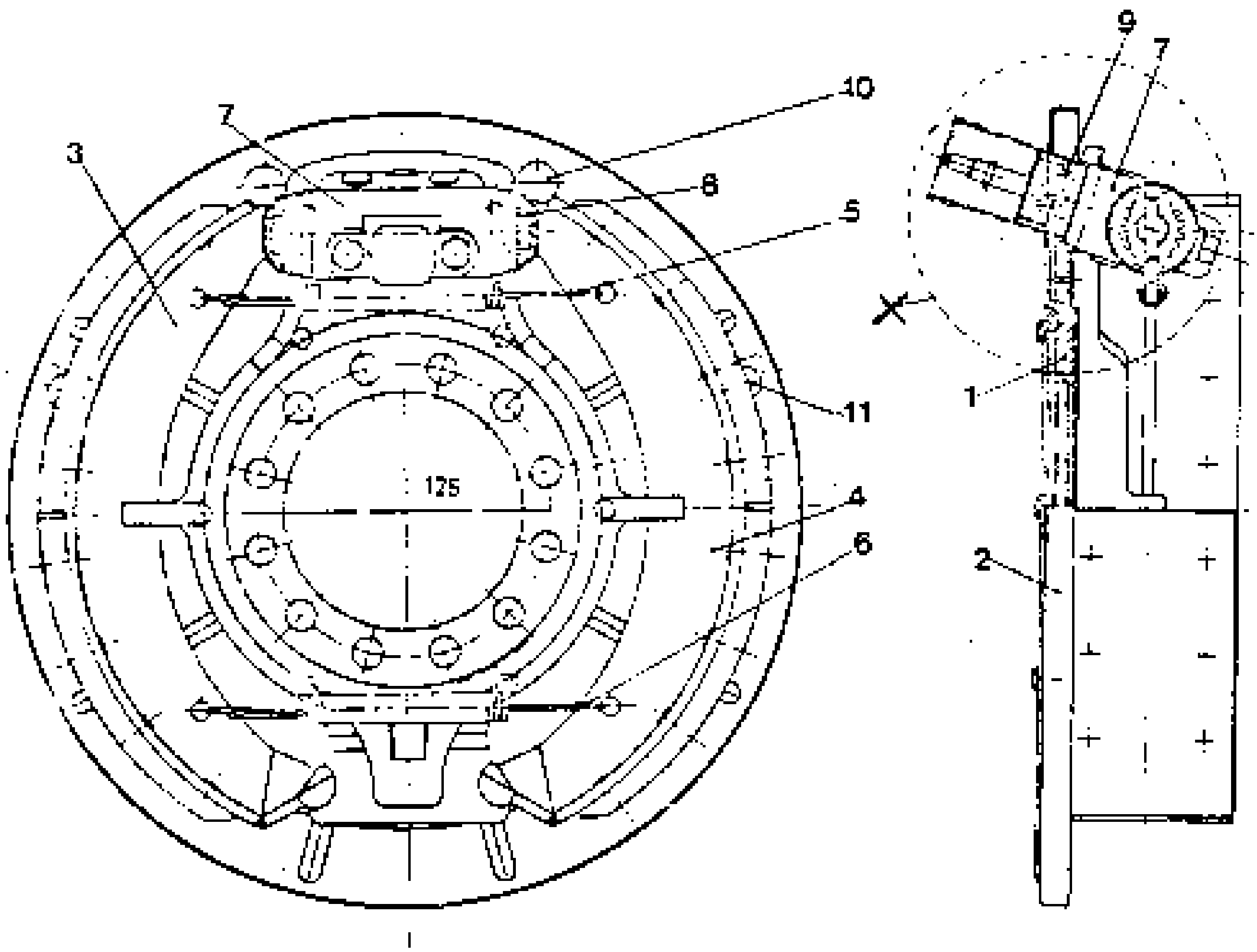
If the brake shoes are relined, note that the new linings must be bonded on with adhesive as well as riveted.

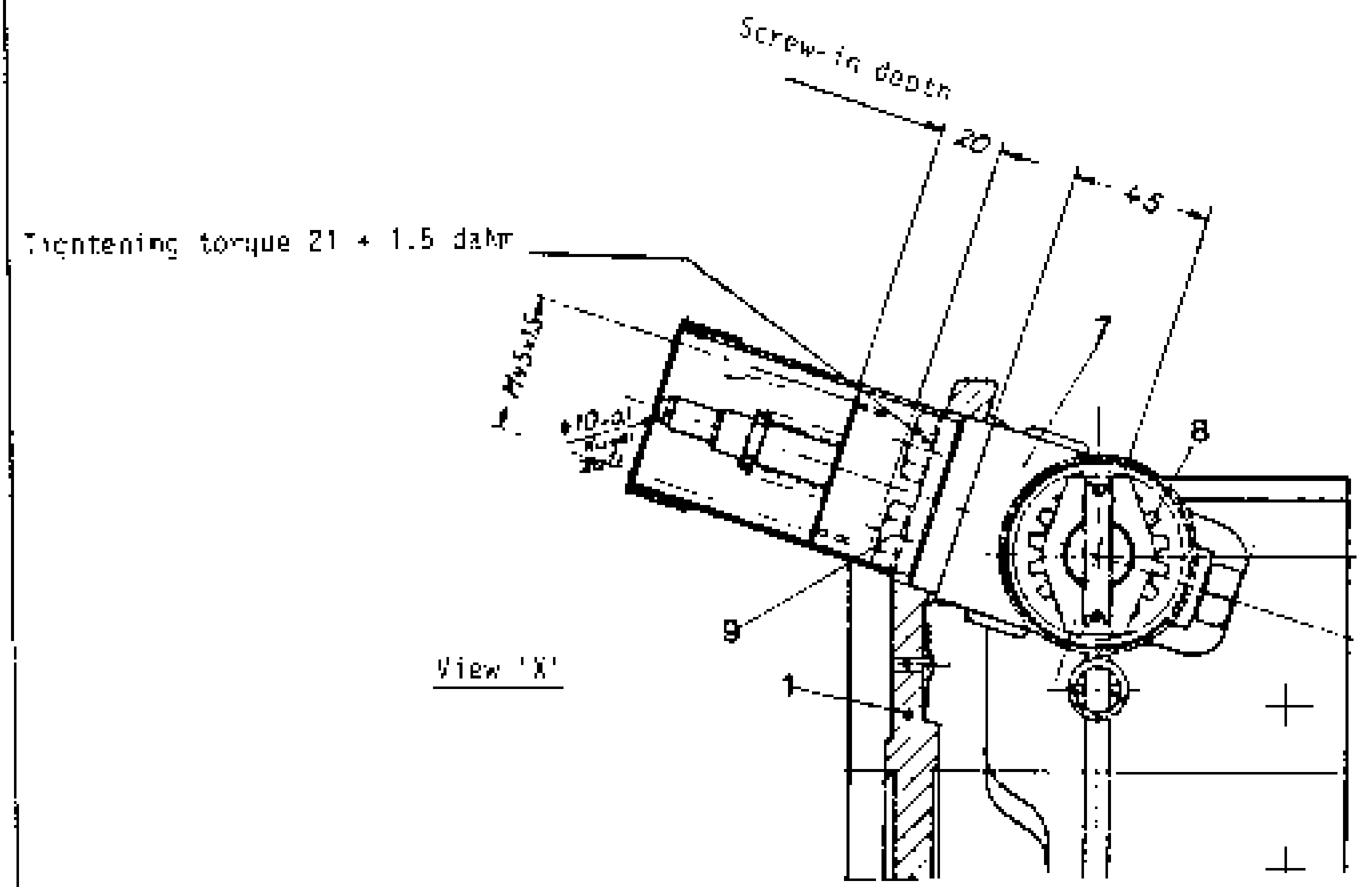
Quality of brake shoes: Ferodo AM 14

Leading and triling shoe drum brake with spreader mechanism

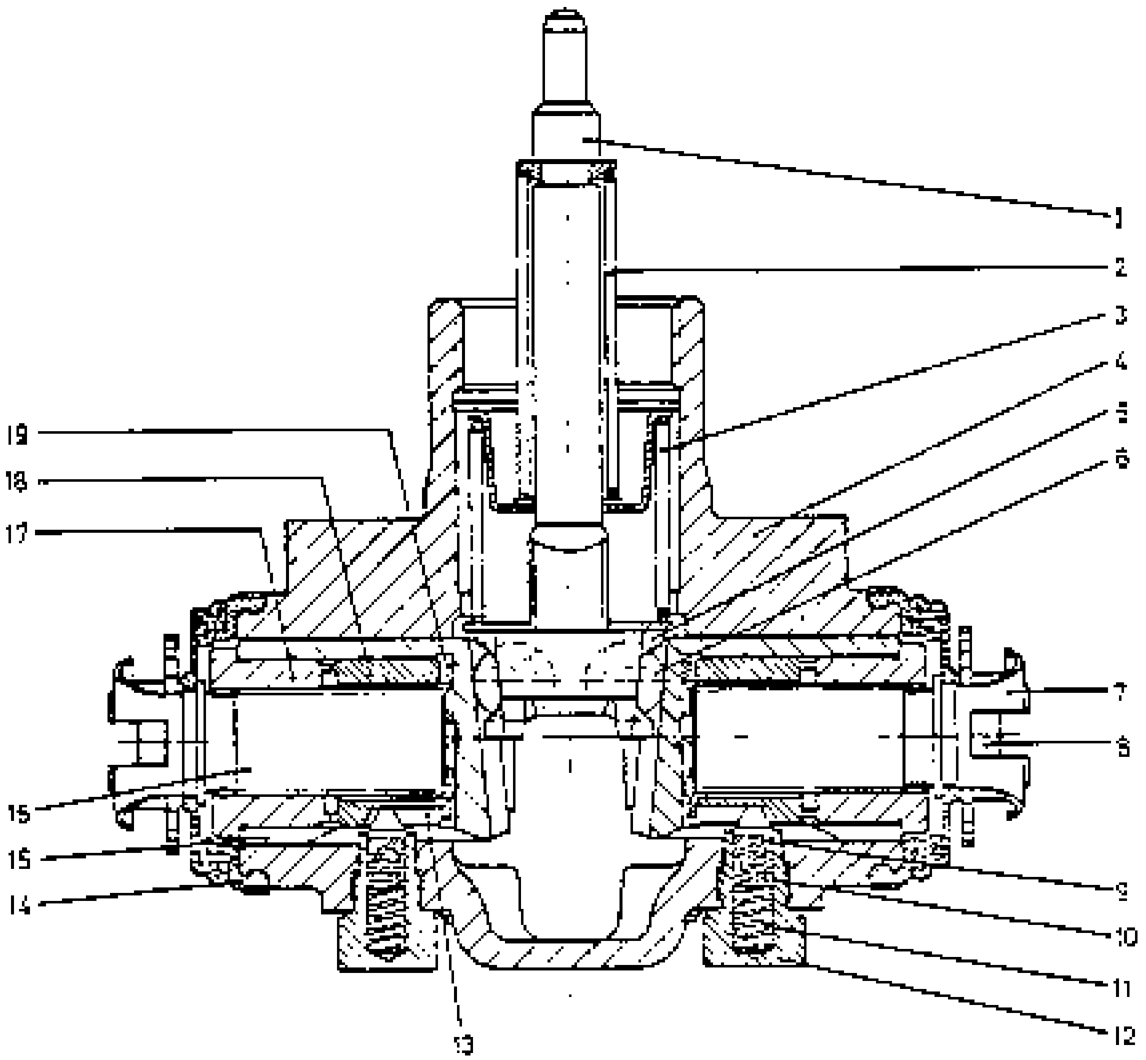
Item	designation
1	Brake backplate
2	Brake shield plate
3	Brake shoe, complete
4	Brake shoe, complete
5	Tension spring
6	Tension spring
7	Spreader device
8	Adjusting pinion
9	Hex. bolt
10	Access hole for releasing brake adjuster
11	Brake lining wear inspection hole

Leading and trailing shoe brake with spreader mechanism





Description and Service Instructions for PERROT-Expander-Unit



The housing (4) of the expander unit is bolted to the brake spider. The wedge (1) with the cage (5) and the balls (6) form an assembly. The wedge rod is held in its initial position by the wedge retracting springs (2 + 3). The balls (6) are engaged in corresponding ball races in the wedge and plungers (15), which are set in bores of the housing (4) rectangular to the wedge.

Axles

The plungers incorporate the automatic adjustment devices . The ring (18) can rotate in the plunger (15). It has a trapezoidal grove (13), which runs like a thread with a high pitch. The adjustment screw (16), screwed into the nut (17) extends into the ring (18) with its free end; the nut (17) is pivoted in the plunger (15). The ring (18) and the nut (17) are connected by radial serrations under the load of the curved spring washers (19).

On the adjustment screw (16) with the star wheel a thrust piece with a slot (8) is situated. The leaf spring (7) keeps the thrust piece (8) to the adjustment screw (16) and secures the star wheel against rotation.

The screw (12) is screwed into the housing (4). The pin (9) engages under the load of the coil springs (10 + 11) the grove (13) of the ring (18) while the cylindrical shaft of the screw (12) engages the axial guiding slot of the plunger (15) and prevents a turning of the plunger. The rubber cap (14) seals the housing (4) against penetrating mud.

Actuation

For braking the push rod (1) is applied by the actuating cylinder. According to the actuation forces the wedge (1) is pushed deeper in between the balls (6). The balls are roling, guided by the cage (5) in the ball races of the plunger. spread the plungers and push the brake shoes against the shoe retaining springs outward to the drum. The brake output depends on the level of the actuation forces. According to drum rotation the first brake shoe is the leading and the second brake shoe the trailing one. The abutment forces of the brake shoe act on the abutment of the spider.

The stroke of the plunger (15) depends on the space between brake lining and brake drum. According to the plunger stroke the ring (18) is turned by the pin (9) engaging the grove (13). If the space lining to drum of the leading brake shoe is wide enough the rotation of the nut (17) with the radial serrations suffices to spring into the next tooth. Is the braking finished the shoe retaining springs draw back all parts into their initial position. The ring (18) is turned back by the pin (9) and the grove (13) during the plunger moves back and turns the nut (17) which screws the adjustment screw (16) out according to the pitch of the serration. The brake is readjusted.

Service and repair

1. New supplied brakes are assembled ready for fitting. There is no need of adjusting the brake.

2. If the brake lining has run into the drum caused by drum wear it is necessary to rescrew the adjustment screws (16) over the starwheel by using a screw driver.

3. After relining the brake shoes and fitting the drum again, adjust the brake shoes by turning the star wheels.

4. Further maintenance is not necessary at normal re-lining. In case of repair take notice of.

5. At least every 2 years dismantle the expander unit totally and examine all parts for wear. If necessary, repair the expander unit by using the repair kits according to the spare parts list. At reassembling grease all moving parts with grease Shell Grease 16, and fit the expander unit to the spider.

6. Fitting the boster or spring chamber use a plastic sealing material, which is used for sealing gear-boxes, engine housings etc. in order to get tight the bolted joint. To fix the position of the air-or spring chamber use the counter unit.

When checking parts, note in particular:

Sealing caps 14

Face serrations on nuts 17

Face serrations and adjusting groove on rings 18

Corrugated spring washer 19

Ball tracks on thrust block 1 and plunger 15

Balls 6

Sliding faces in cage 5

Score-marks in housing 4 or on plunger 15

Pin 9

Preload at coil springs 2 + 3

Renew parts if in doubtful condition.

7. Brake cylinder assembly

Screw the brake cylinder fully into the spreader assembly, then unscrew by not more than 180 degrees, depending on the position of the compressed-air unions. Secure brake cylinder with nut to prevent it from turning.

Description

1. Air from compressor (1) passes through pressure regulator (4), which automatically limits pressure to between 0.0 and 8.1 bar, and flows to the four-circuit protection valve (6).

The four circuit protection valve (6) operates in the same way as a flow relief valve. It has provision for limited return flow (opening pressure = app. 5,5 bar), guaranteed). Air reaches the brake circuit I + II via the two reservoirs (7 + 8) and the motor-vehicle brake valve (10). Air for the handbrake circuit III flows via reservoir (19) to handbrake valve and via changeover valve (23) to the overload protection valve (25). Also air from reservoir (19) passes through the overload protection valve (25) to the spring loaded section of the 'Tristop' cylinder (26).

2. Braking position - brake circuit I + II (foot brake)

When the driver presses down on the pedal of the motor-vehicle brake valve (10), the inlet valve opens and air from the reservoir flows via changeover valve (13) to the relay valves (14 + 15), which opens the air passage to the diaphragm sections of 'Tristop'-cylinders (26) and the servo unit (18).

The force built up in the diaphragm cylinder (26) and the servo unit (18) applies the vehicle's wheel- and disc brakes hydro-pneumatically. When pressure on the motor-vehicle brake valve (10) pedal is released, the diaphragm cylinders and the servo unit are exhausted by way of relay valve (14 + 15).

3. Braking position (handbrake)

When handbrake valve (21) is operated, the control line to the overload protection valve (25) is exhausted. The reservoir pressure present below the control piston of overload protection valve (25) causes the outlet valve to open. This exhausts the spring-loaded section of the 'Tristop'cylinders (26), and the vehicle's wheel brakes are applied by the springs.

When the handbrake valve (21) is returned to the 'off' position, air enters the control line to the overload protection valve (25). This valve is re-set, and air from the reservoir can then flow again to the spring-loaded section of the 'Tristop' cylinder (26). It overcomes the spring force and releases the wheel brakes.

Identification of equipment connections on air brake systems

Key:

On the equipment, the connections are identified by numerals. The numerals of the identification provide information as to the function of the union on the equipment. The identification consists of a single digit or two digits.

The meanings of the first numerals are:

	Former designation		
0		-	Inlet union
1	(V)	-	Energy input
2	(Z)	-	Energy output
3		-	Connection to atmosphere
4	(S)	-	Control connection (input)
5		-	not in use
6		-	not in use
7		-	Connection for antifreeze
8		-	Lubricating oil union) for compressor
9		-	Coolant connection

A second digit is used if several similar unions or multiple circuits are present.

The meaning of the second numeral is selected from one upward, with no gaps.

Exceptions to this free-selection principle are the numerals

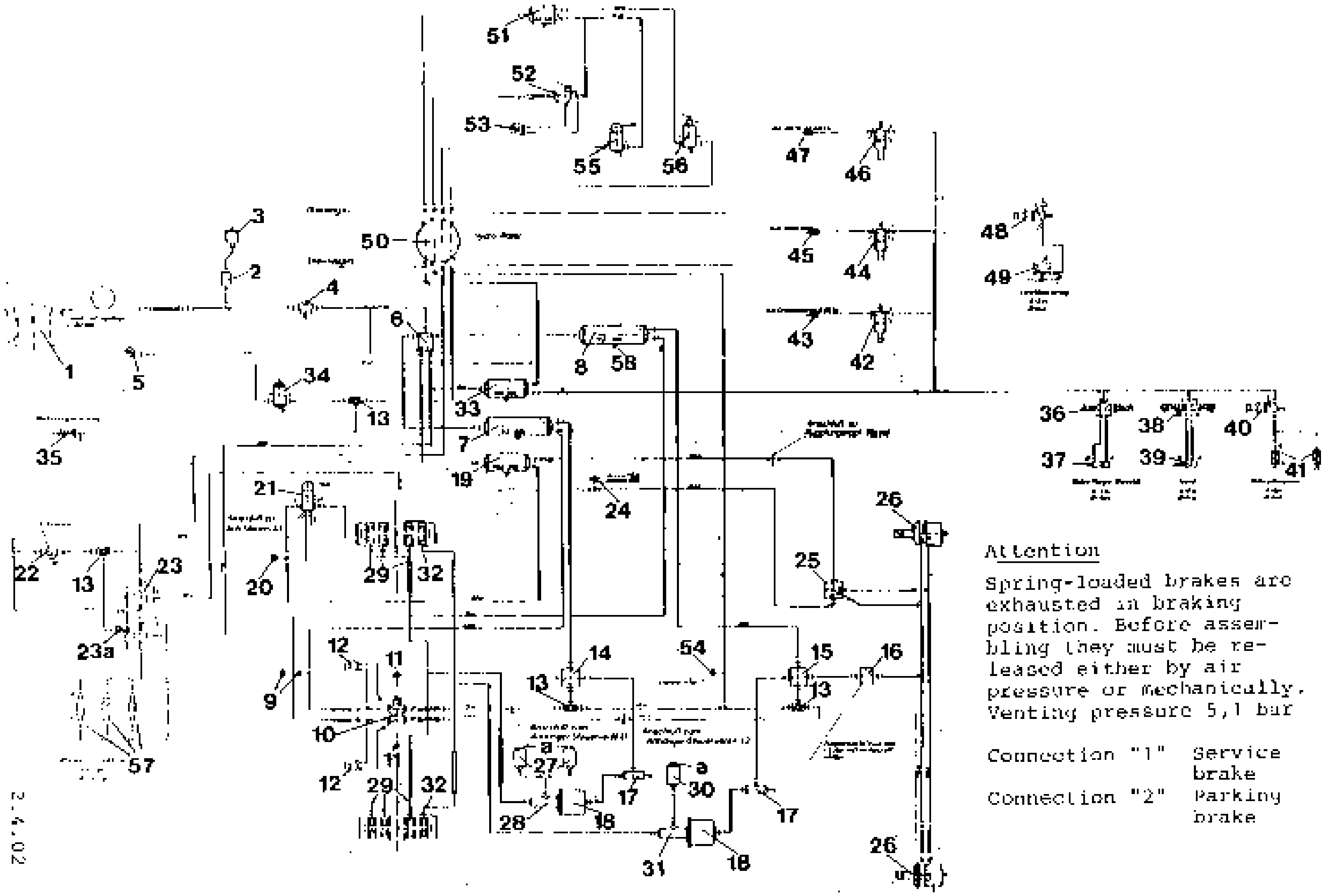
81 =	Lubricating oil inlet	91 =	Coolant inlet
82 =	Lubricating oil outlet	92 =	Coolant outlet

Several identical connections from a single chamber are not differentiated, and receive the same numerical code.

If a connection is required to preform more than one function, it is identified by two 'first' numerals. These are seperated by a hyphen (e.g. 1-2 tire inflator union - pressure regulator).

The identification code is marked on the equipment next to the unions concerned, and is also shown in the brake circuit diagrams next to the various pipe unions.

Compressed air diagram – brake system



Attention

Spring-loaded brakes are exhausted in braking position. Before assembling they must be released either by air pressure or mechanically. Venting pressure 5,1 bar

Connection "1"	Service brake
Connection "2"	Parking brake

List of components

Brake system - chassis

1. Air presser
2. Anti-freezer pump (autom.)
3. Anti-freezer tank
4. Pressure regulator with tire inflating union
5. Coupling head (reservoir)
6. Four-circuit protection valve

Service brake system

7. Reservoir tank - brake circuit I
8. Reservoir tank - brake circuit II
9. Pressure switch - reservoir pressure, circuit I + II (switch off)
10. Motor vehicle - brake valve
11. Pressure switch - brake pressure, circuit I + II (switch on, brake light)
12. Manometer - reservoir and brake pressure, circuit I + II
13. Two-way valve
14. Relay valve, circuit I (front axle)
15. Relay valve, circuit II (front- and rear axle)
16. Pressure limiting valve (adjusted pressure = 4,0 bar)
17. Regulating valve
18. Servo unit
19. Reservoir tank - hand brake circuit III
20. Pressure switch - reservoir pressure circuit III (switch off)
21. Hand brake valve
22. Flow relief valve with limited return flow, 5,5 bar
23. 4-way-ball tap block/changeover, chassis
23a Changeover - lock
24. Pressure switch - handbrake (switch off 5 bar)
25. Overload protection valve - hand brake circuit III - rear axle
26. Spring loaded section - brake cylinder (tristopcylinder)

Brake system - front axle

27. Brake fluid tank - circuit I
27a Level indicator - circuit I
28. Main brake cylinder - circuit I
29. Disc brake cylinder - circuit I (12 pieces)
30. Brake fluid tank - circuit II
30a Level indicator - circuit II
31. Main brake cylinder - circuit II
32. Disc brake cylinder - circuit II (4 pieces)

Ancillary air-operates consumers - chassis

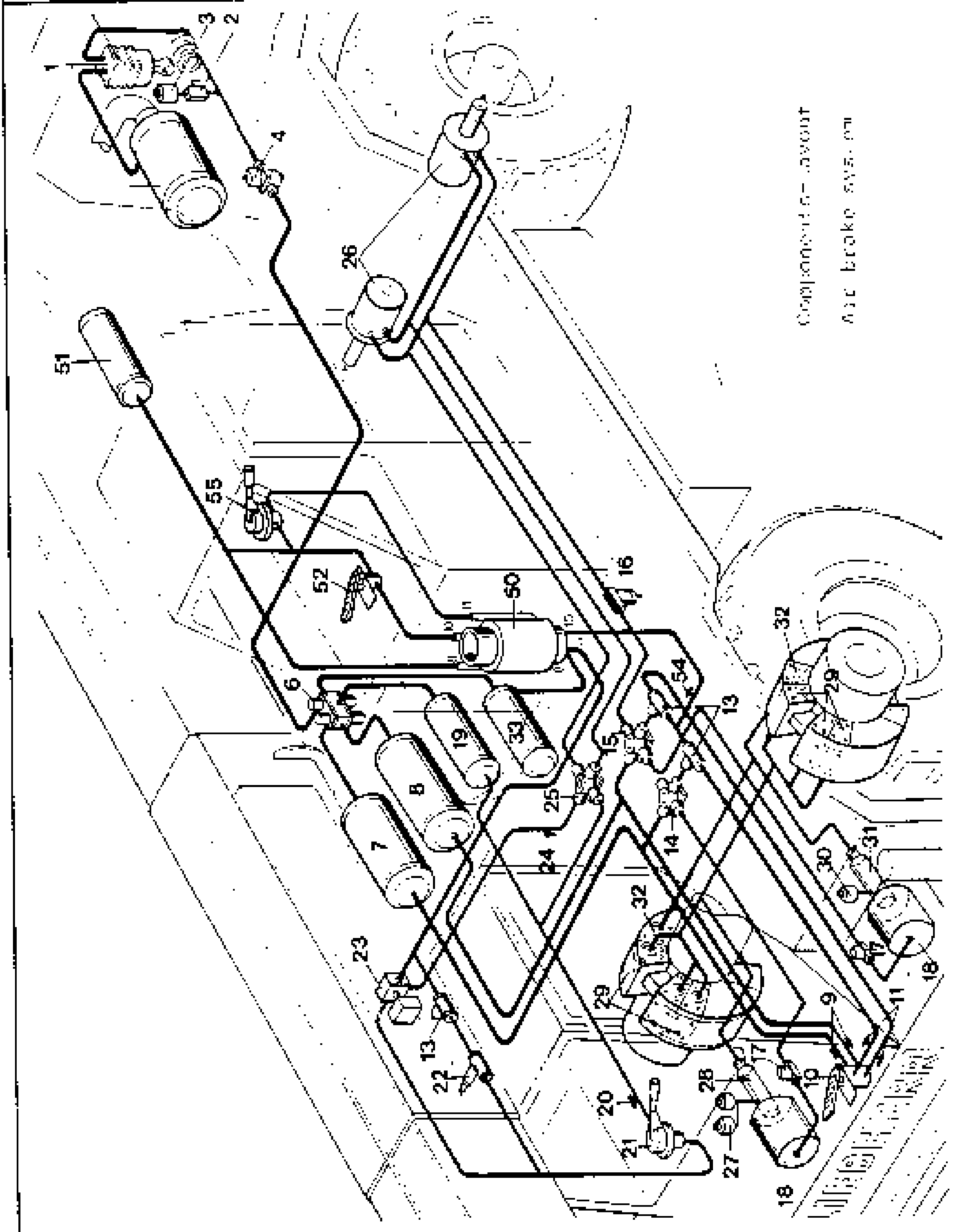
33. Reservoir tank
34. Precision control valve - engine speed control
35. Working cylinder - engine speed control
36. Solenoid valve for crane operation (hydr. pump)
37. Pneumatic ram for crane operation
38. Solenoid valve for front axle drive
39. Pneumatic ram for front axle drive
40. Solenoid valve for differential lock
41. Working cylinder for differential lock
42. Solenoid valve for engine torque limitation
43. Working cylinder for engine torque limitation
44. Solenoid valve for engine cutout
45. Working cylinder for engine cutout
46. Solenoid valve for engine brake
47. Working cylinder for engine brake
48. Solenoid valve for rear axle - steering lock
49. Working cylinder for steering lock

Ancilliary air operated consumers - superstructure

50. Air rotary connector between chassis and superstructure
51. Reservoir tank
52. Brake valve
53. Manometer reservoir - and brake pressure
54. Pressure switch - brake pressure (switch on - brake light)
55. Handbrake valve
56. Precision control valve - engine speed control
57. Changeover valve for steering - superstructure
58. Automatic moisture condensate drain valve

LIEBHERR

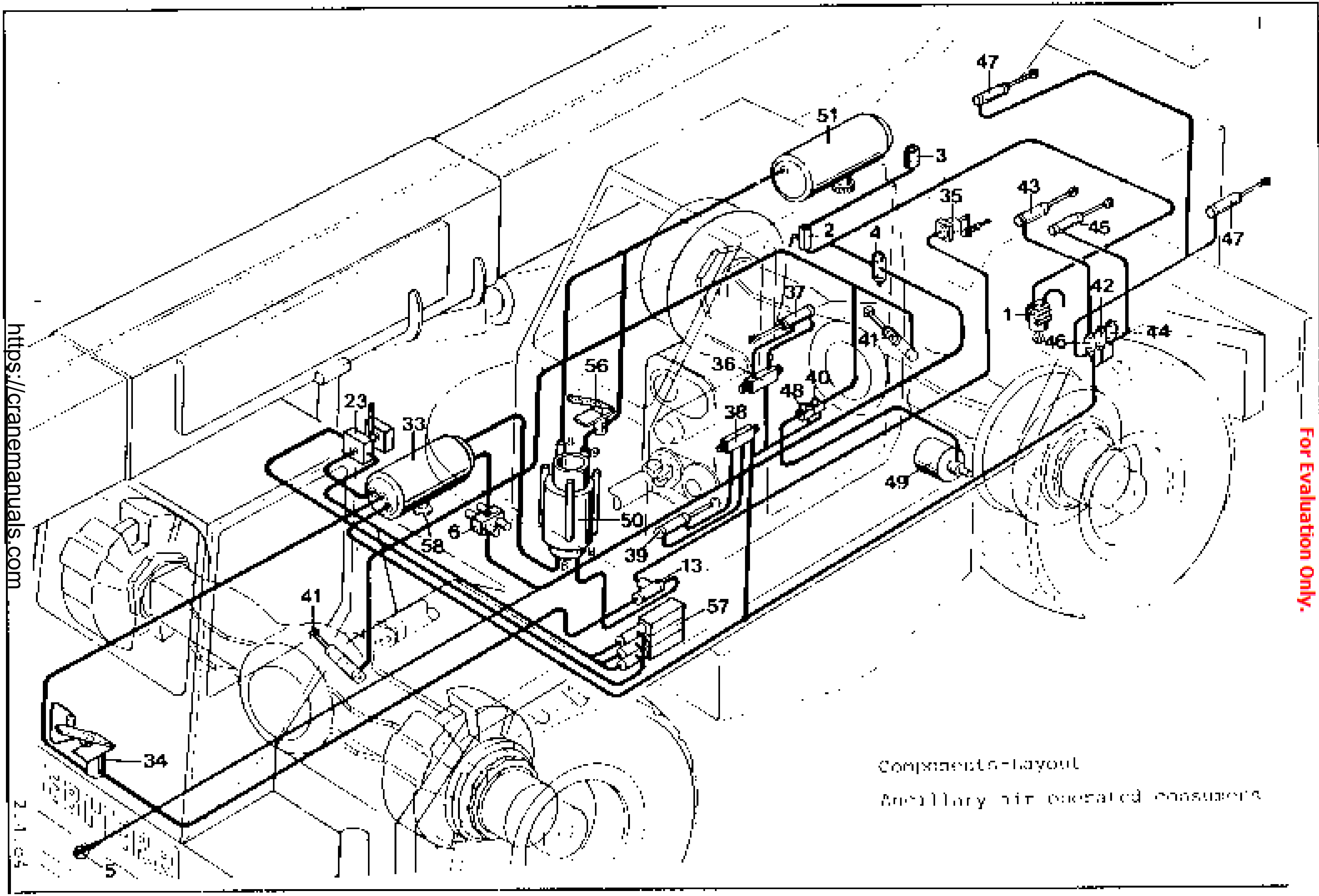
Air brake system



Components layout

Air brake system

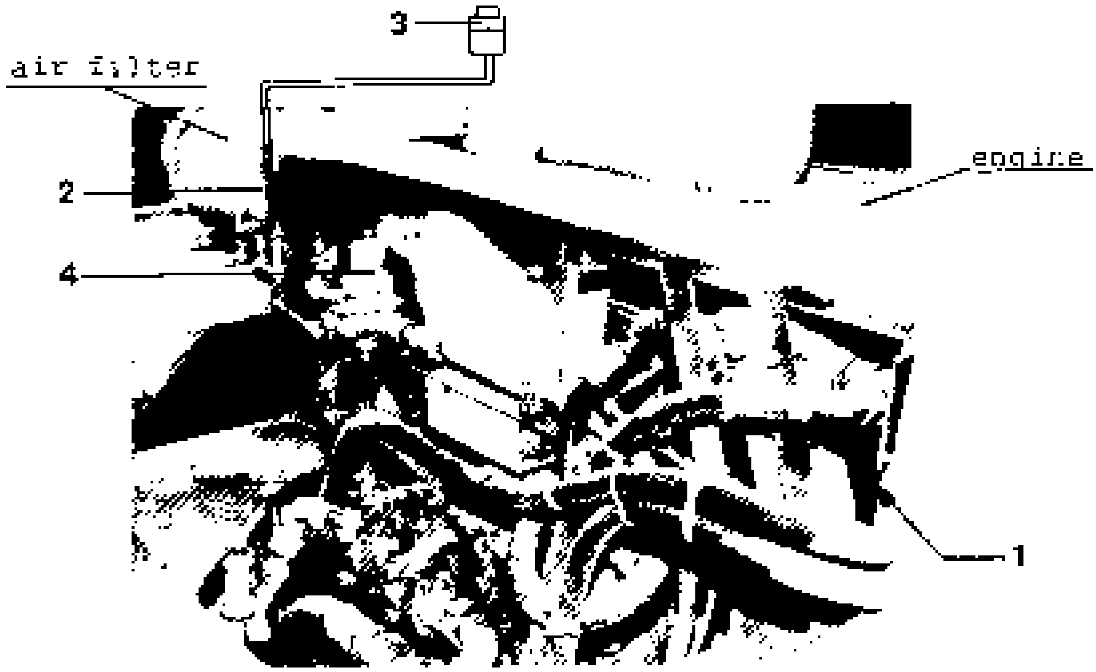
Blatt Sheet Page	2.1.04



Components-layout
Ancillary air operated consumers

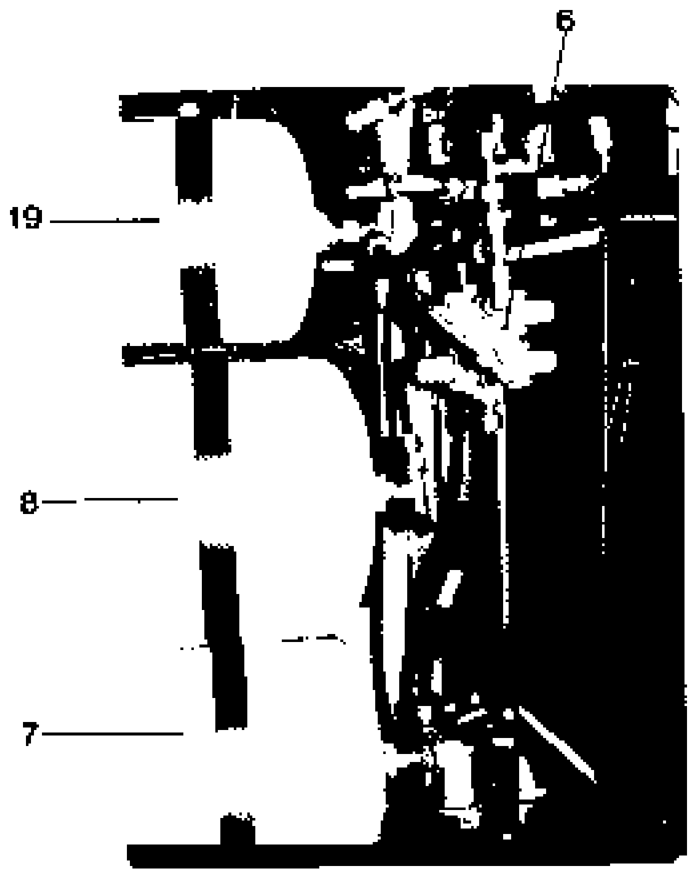
2.1.64

Components - Layout

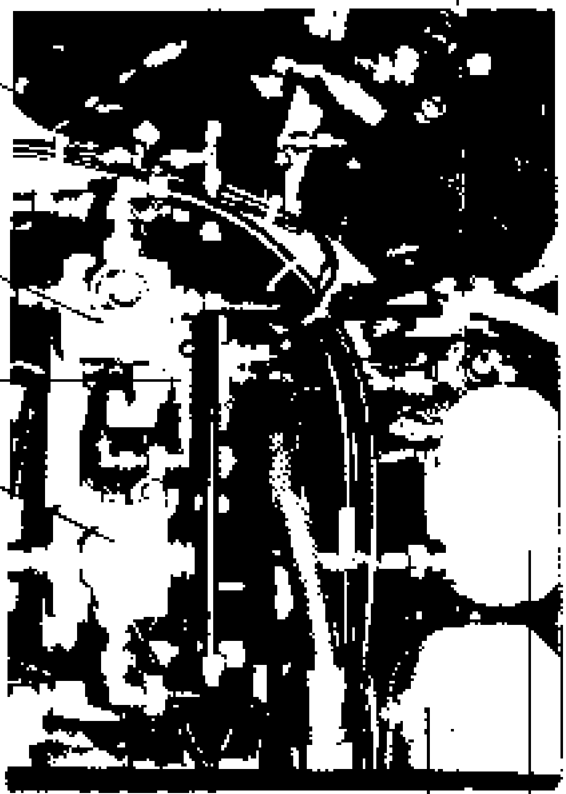


drive direction

right side
(view from below)



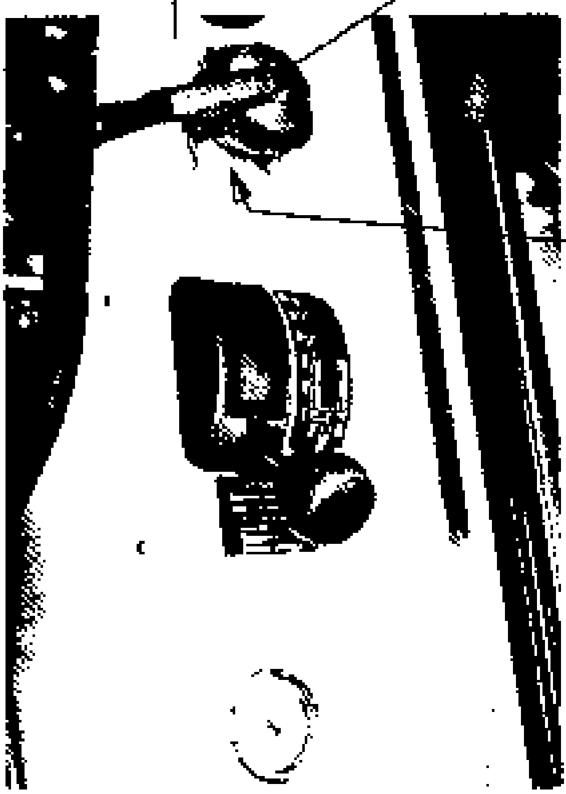
Components - Layout



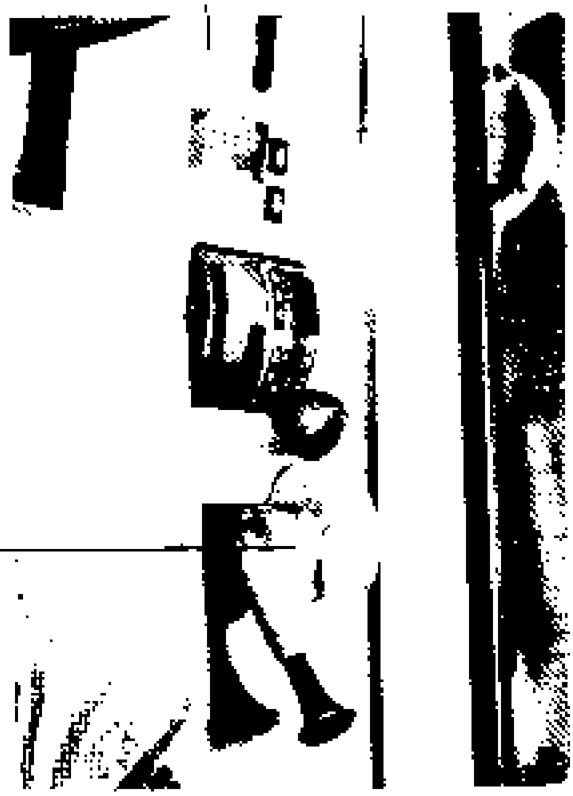
drive direction

right side
(view from below)

cabin - chassis



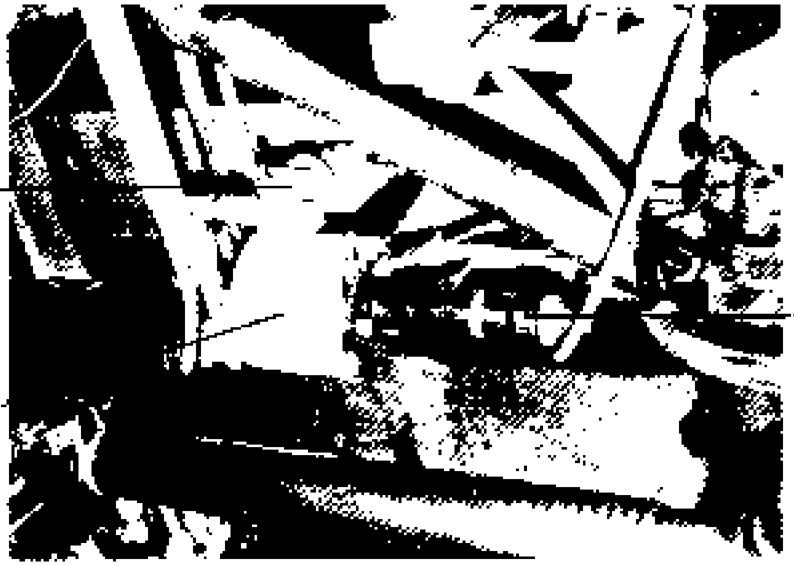
cabin - superstructure



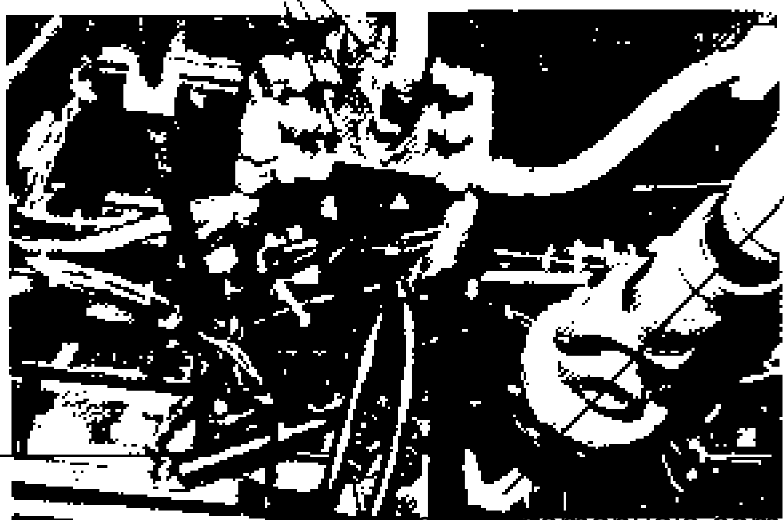
Components - Layout

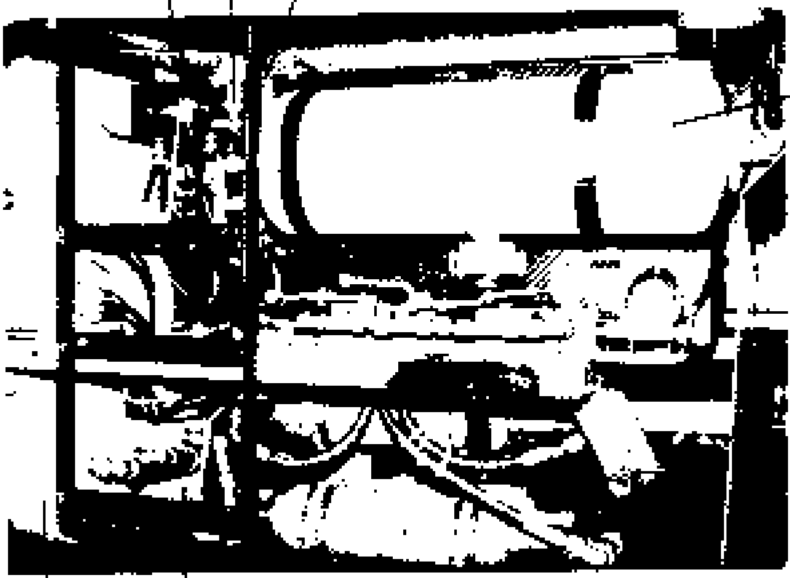
drive direction

right side
(view from below)



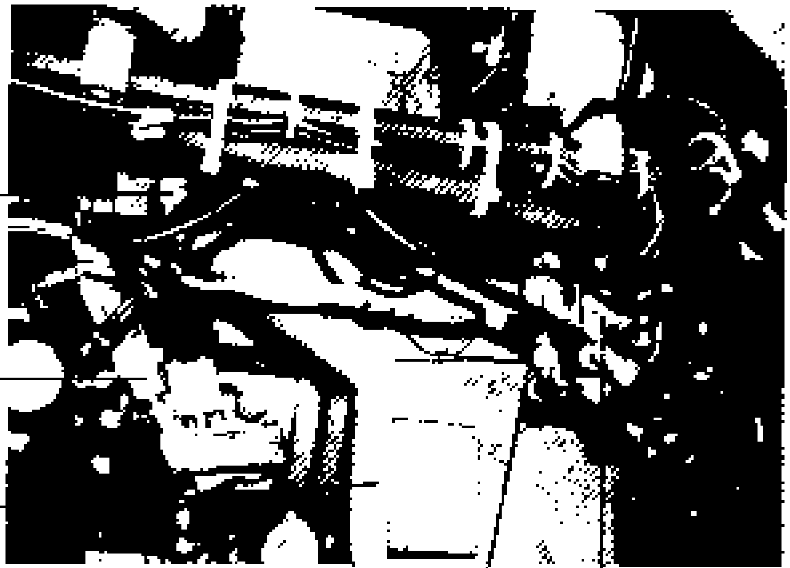
view
from ahead





drive direction →

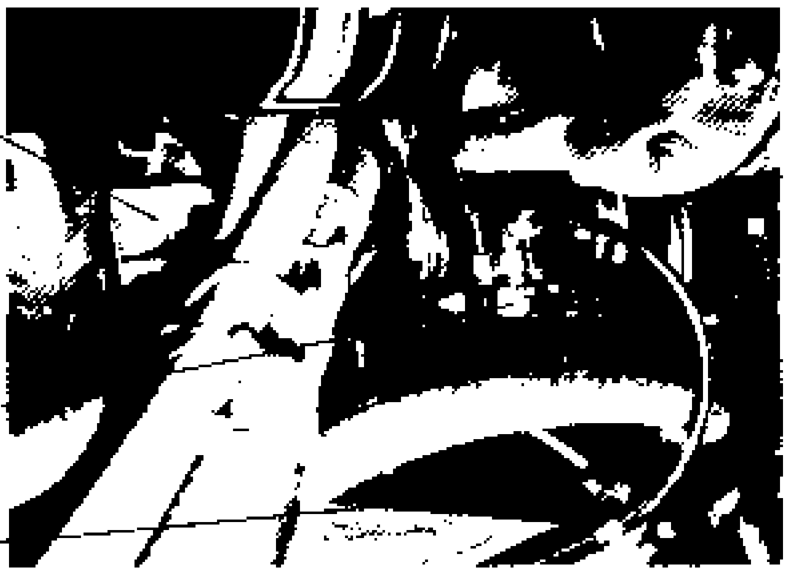
right side



← drive direction

left side

ZF-reversing transmission



Hydr.pump (crane operation)

← drive direction

right side (view from below)

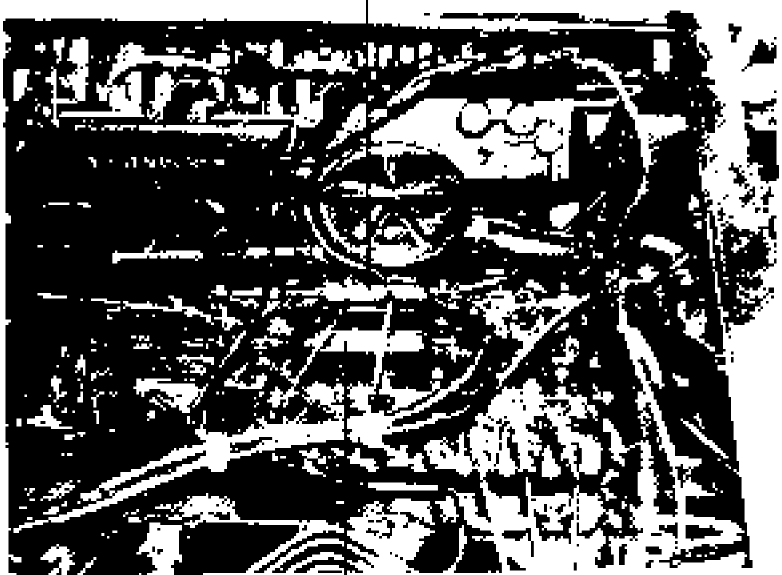
Components - Layout

rear axle -left side
(view from below)

46 42 44

49

45

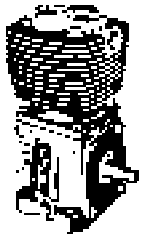
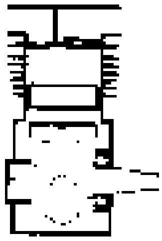


43

drive direction

Single cylinder compressor

Pos. 1

Funktion:

Production of compressed air for road vehicles and static systems.

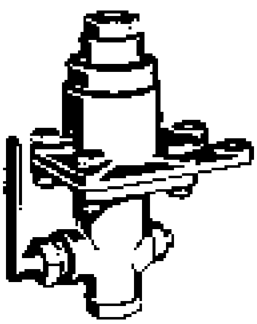
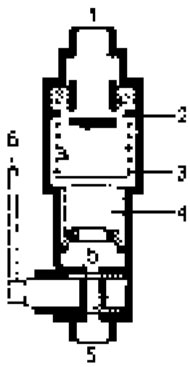
Operation:

The pulley on the end of the crankshaft is rotated by a vee-belt driven off the verhicle's engine. This rotation causes the connecting rods to move the pistons. As the piston travels townwards clean air from either the engine Air Cleaner or the Moist Air Filter (or alternatively an Oil Bath Air Cleaner) is drawn in through the Inlet Valve. As the piston moves upwards, the Inlet Valve closes, and air is pumped through the Delivery Valve into the Reservoir.

The type of lubrication depends on the construction of the compressor, and can be Splash or pressure fed.

Antifreeze pump

Pos. 2

Automatic antifreeze dispenser pump

Purpose:

To prevent the valves, pipes and cylinders from freezing.

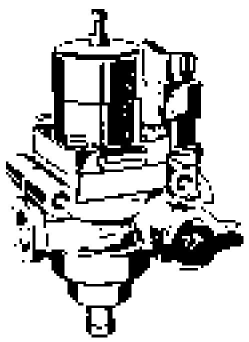
Operating principle:

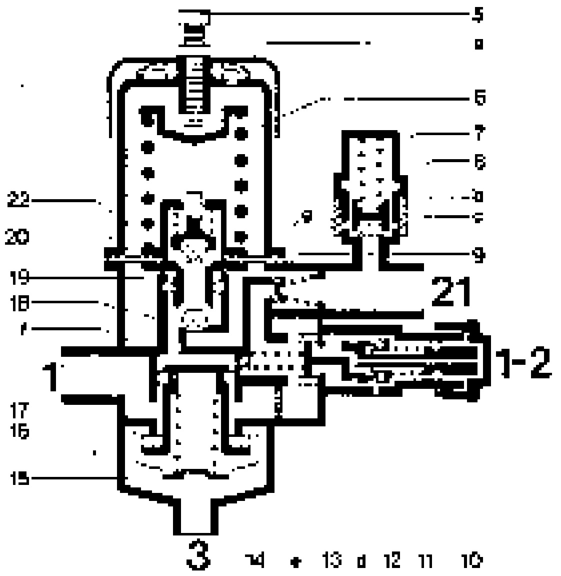
If the pressure regulator is working off-load, there is no system pressure in space b, which is connected to the pressure line by way of union 5. Piston (4) is held down at the limit of its travel by spring (3). There is a connection via union 1 and bores (2) between the liquid tank and space a, which is filled with the antifreeze (ethyl alcohol or methylated spirit).

When the pressure regulator switches to the recharging setting, the pressure in space b moves the piston (4) against the coil spring (3), so that bores (2) are closed. Part of the antifreeze in space a is forced past the lower part of piston (4) into space b. From there it passes through union 5 with the airflow into the compressed air system.

At temperatures above + 5°C, the antifreeze pump should be put out of action by turning lever (6) to a horizontal position.

Pressure regulator





PRESSURE REGULATOR WITH AIR CLEANER AND TIRE INFLATING UNION

Purpose:

Automatic control of working pressure within the air brake circuit and prevention of pipe and valve contamination by dirt.

Operating principle:

a) Pressure regulator

The air supply from the compressor flows into space e via union 1 and the air cleaner (14). When check valve (9) opens, the air can reach the reservoirs and space g by way of the pipe leading from union 21.

A force then builds up in space g and acts on the underside of piston (19) and diaphragm (20). As soon as this force exceeds the coil spring (6) preload setting (controlled by screw (5)), diaphragm (20) expands upwards and draws piston (19) with it. Outlet (22) closes and inlet (18) opens, so that the air pressure in space g can reach space f.

The pressure which then builds up in space f forces piston (17) down against the force exerted by coil spring (15). Outlet (16) opens, and air from the compressor can escape through vent (3) to atmosphere. The resulting pressure drop in space e closes check valve (9), so that pressure is retained within the system.

The air compressor idles until system pressure falls below the pressure regulator's cut-in point. At the same time pressure drops in space g below piston (19) and diaphragm (20). Coil spring (6) is then able to force them down again. This closes inlet (18) and opens outlet (22), so that air from space f can escape to atmosphere through vent hole a. The force of coil spring (15) moves piston (17) up and closes outlet (16). The air drawn from the compressor by way of replenishment again flows through air cleaner (14) into space e, opens check valve (9) and pressurizes the system until the regulator cutout pressure is reached.

b) Tire inflating union

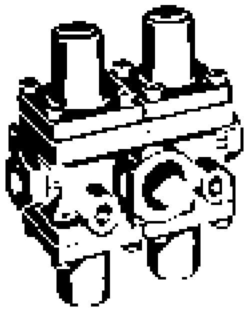
After unscrewing wingnut (10) the collar nut of the tire inflating hose can be screwed on. This moves plunger (11) to the left, and interrupts the connection between space e and union (21). Air from the compressor then flows from space e through bore (12) in plunger (11) and into the tire inflating hose. If pressure in the hose rises beyond 9 – 10 bar, safety valve (13) opens and the air escapes through the vent passage to atmosphere. Note that before a tire is inflated from this union the pressure in the air reservoir must be lowered beyond the regulator cut-in pressure, since air cannot be drawn off when the compressor is idling.

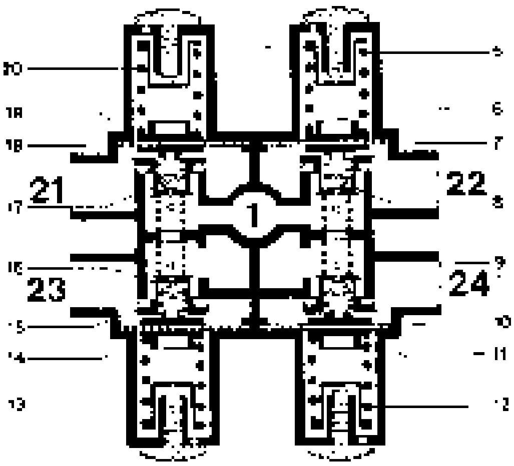
c) Safety valve

Compressed air reaches the space below valve block (8) by way of bore c. When the preset safety valve opening pressure is reached, valve block (8) is forced up, overcomes the force exerted by spring (7) and permits the excess air pressure to escape through vent passage b to atmosphere.

FOUR-CIRCUIT PROTECTION VALVE

Pos. 6





Purpose:

To retain pressure in the intact brake circuits in the event of one or more circuits of a four-circuit air system failing.

The four circuits are arranged in parallel, and are pressurized equally. The protection valve has bypass passages in all four circuits, to permit the brake system to be pressurized again from zero pressure if a circuit should fail.

Operating principle:

The compressed air flowing from the pressure regulator to union 1 of the protection valve passes through bypass passages a, b, c and d and past check valves (8, 9, 16 and 17) to the four air brake circuits. At the same time, pressure builds up under valves (7, 10, 15 and 18), and opens these valves when the preset opening pressure (the guaranteed pressure) has been reached. This action causes diaphragms (6, 11, 14 and 19) to be raised, after overcoming the force exerted by coil springs (5, 12, 13 and 20). Compressed air flows via unions (21 and 22) to the air reservoirs for service brake circuits 1 and 2, and via unions (23 and 24) to circuits 3 and 4. Circuit 3 is used to supply the motor-vehicle auxiliary and parking brake system and the trailer brakes, and circuit 4 to supply additional air-operated equipment.

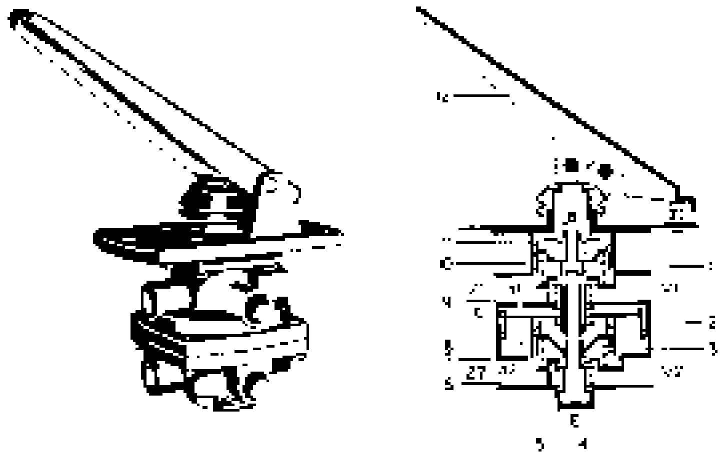
If any circuit (for example circuit 1) should fail, air will flow out of the three remaining circuits until the dynamic closing pressure of the valves in the defective circuit is reached. The force of coil springs (5, 12, 13 and 20) closes valves (7, 10, 15 and 18). If air is drawn off at circuits 2, 3 and 4, so that the pressure drops, these circuits are pressurized again up to the preset opening pressure for the defective circuit.

Pressure safeguarding of intact circuits functions similarly if any of the other circuits should fail.

If a circuit has failed (e.g. circuit 1), and the vehicle has stood for a lengthy period, so that pressure in the intact circuits has fallen to zero, compressed air flows initially into all four circuits via bypass passages a, b, c and d when the brake system is refilled with air. In the intact circuits, pressure builds up under diaphragms (11, 14 and 19) and has the effect of lowering the opening pressure of valves (7, 10 and 18).

As pressure continues to rise at union 1, the valves (7, 10 and 15) open. Circuits 2, 3 and 4 are then pressurized up to the preset opening pressure of the defective circuit 1, and this pressure setting is retained safely.

Dual foot valve



With Treadle 461 307 (Dual Concentric Valve)

Operation:

Through operating the treadle (12) (or respectively lever or plunger), the graduating piston (1) moves downwards closing the exhaust valve (10) and opening the inlet valve (9). In proportion to the pedal effort, air than flows from reservoir port (V) to port (Z) and to the brake chambers on the 1st circuit and/or respectively to the trailer control unit.

Pressure builds up in cavity (a) and air passes through bore (8) to build up the same pressure in cavity (b) below the relay piston (2) controlling the 2nd circuit in the lower half of the valve. The relay piston (2) travels downwards against the spring (6) taking the piston (3) with it. Exhaust valve (4) closes and inlet valve (5) opens. Ais passes from port (V_2) to (Z_2) and charges the brake chambers in the 2nd circuit to a pressure corresponding to that in chamber (b).

The pressure in cavity (a_2) is controlled by spring (6) and is always slightly lower then that in cavities (a) and (b).

As the pressure builds up in cavity (a_1) on the underside of the graduating piston (1) it moves upwards against the rubber spring (11) until forces balance across the piston (1). At this point, the inlet valve (9) and exhaust valve (10) close (laps-off).

Similary, the pressure in cavity (a_2) plus the force of spring (8) acting below pistons (3) and (2) move the 2nd circuit into the lapped-off condition (e.g. inlet valve (5) and exhaust valve (4) close).

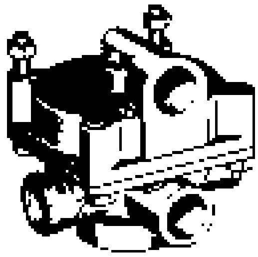
With maximum braking piston (1) sits on its lower stop, so that the exhaust valve (10) is closed, and inlet valve (9) remains open. The maximum pressure acting on the relay piston (2) in cavity (b) moves it to its lower stop along with piston (3), and the exhaust valve (4) closes and inlet valve (5) remains open. In this condition ports Z and Z_2 deliver maximum pressure.

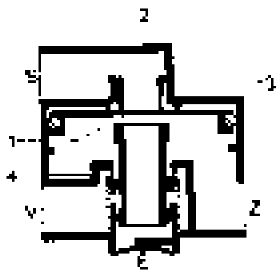
To release the brakes (i.e. exhausting both circuits) the reverse procedure occurs and is fully graduable. A common exhaust (E) serves both circuits.

If circuit (2) fails, circuit (1) will operate as described. If circuit (1) fails, the air control on relay piston (2) fails also, and the 2nd circuit will be controlled mechanically as described in the following paragraph.

When the pedal is depressed, the piston (1) moves downwards and contacts with the stem (7) attached to piston (3). With further teadle movement, piston (3) moves downwards, closing the exhaust valve (4) and opening the inlet valve (5). The 2nd circuit can now function independently from 1st circuit, and piston (3) now takes over as the graduating piston.

Relay valve





Pos. 14
15

Relay valve

Purpose:

Rapid venting and exhausting of compressed air cylinders and couplings. Reduction in response time and pressure build-up period on motor vehicles.

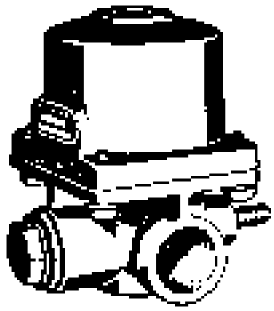
Operating principle:

The air reservoir is connected to union V. If the control pipe connected to union S is at zero pressure, inlet (4) is closed and outlet (1) open. The cylinders connected to union Z are then exhausted.

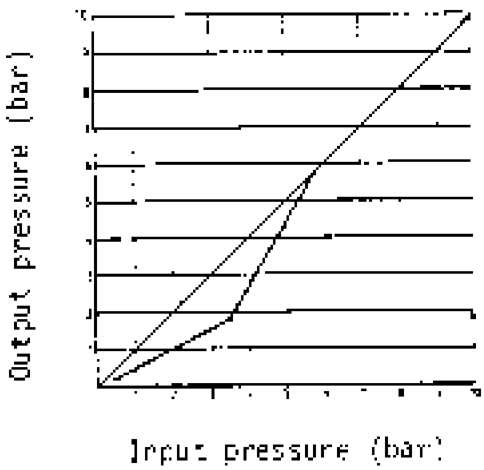
As soon as compressed air from the brake or air inlet valve passes theough the control pipe to union S and space (2) above piston (3), the piston is forced down. It then closes outlet (1) and opens inlet (4), so that compressed air from the reservoir can reach the cylinders through union Z. At the same time, pressure builds up under piston (3) and raises it, as soon as the outlet-side pressure rises slightly above the control pressure. Inlet (4) then closes and the relay valve is in its final setting.

If control line pressure drops partially, the higher pressure in the cylinders presses up piston (3) and opens outlet (1) until the excess cylinder pressure has escaped through air outlet E. If the control line is fully exhausted, the cylinders are evacuated in the same manner. Air outlet E contains a rubber disc which increases the outlet cross-section as air escapes, but in the rest position prevents dirt and dust from entering the valve.

Adapter valve



975 002



Characteristic

Purpose:

The adapter valves reduce pressure from the main vehicle's braking valve in the partial brake application range. This prevents over-braking of the front axle on account of the reduced dynamic axle load transfer experienced under partial braking. The adapter valve also acts as a quick-release valve.

Pattern:

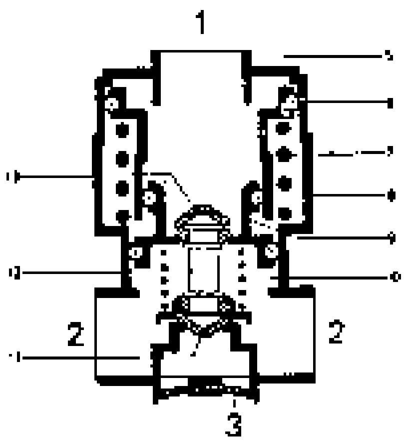
Adapter valve with pressure reduction as shown (see 'Characteristic')	Input pressure at union 1	Output pressure at union 2

Application:

For the front axle.

Operating principle of adapter valve

a) Partial brake application: When union (1) is exhausted of air, piston (5) is retained by the force of spring (7) in its uppermost position and cannot itself exert any force. However, differential piston (9), which is also exposed to air pressure, is forced down together with duplex valve (12), so that outlet valve (11) closes and inlet valve (13) opens. The compressed air at union (1) can then reach unions (2) and the brake cylinders connected to them.



However, at the same time the flow pressure builds up under differential piston (9), and opposes the force on the upper surface of the piston. When the forces are in equilibrium, out pressure reduction is taking place, piston (9) is raised again and inlet valve (13) closed, so that a partial brake application is obtained.

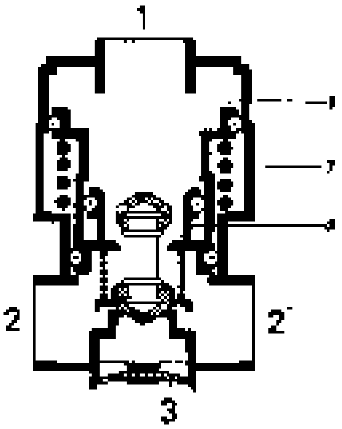
Adapter valve - operating principle

b) Influencing pressure reduction:

If pressure at union (1) exceeds a pre-determined value (see 'Characteristic'), piston (5) acts to the force at differential piston (9) after overcoming spring loading (7). This has the effect of reducing the pressure reduction, which was previously proportional.

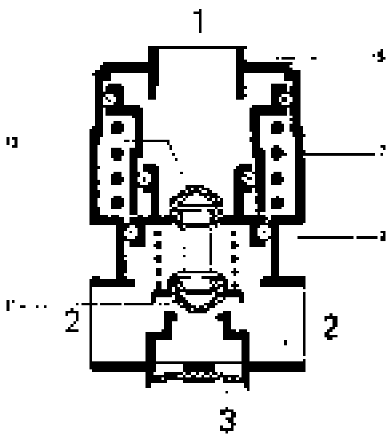
c) Full application:

After an input pressure of 5.3 bar has been reached, the pressure-reducing effect is eliminated, and the input pressure is passed on at a ratio of 1 : 1.

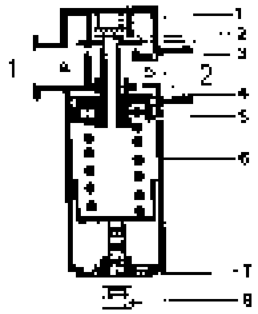


d) Released position:

If pressure is exhausted at union (1), the pressure remaining at unions (2) can raise pistons (9) and (5) again, taking into account the force of spring (7). As a result the inlet valve (13) closes and the outlet valve (14) opens. The brake cylinders are then rapidly exhausted via vent (3).



Pressure limiting valve



Pos.16

Pressure limiting valve

475010

Purpose:

To limit output pressure.

Operating principle:

Compressed air allowed to reach high-pressure union 1 and space a flows through inlet (4) and space b to low-pressure union 2. At the same time, pressure reaches piston (5), but this is initially held in its upper position by spring (6).

If pressure in space b reaches the level preset for the low-pressure side of the system, piston (5) overcomes the force exerted by coil spring (6) and moves down, together with valves (1) and (3), so that inlets (2) and (4) are closed.

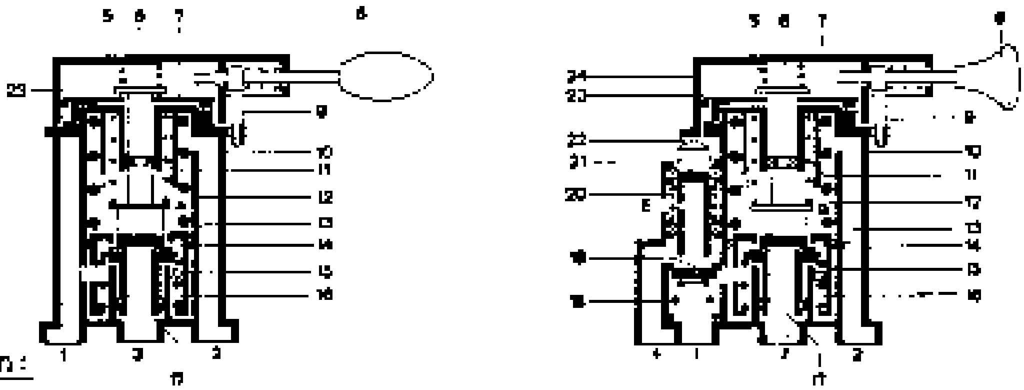
If pressure in space b rises beyond the preset value, piston (5) moves further down and thus opens the outlet of valve (1). Excess compressed air escapes through piston (5) and air cum valve (7) to atmosphere.

If pressure drops as a result of leakage in the low-pressure line, piston (5) raises valve (1) as a result of the reduced pressure acting on it. Inlet (2) opens and the corresponding amount of compressed air is fed in to restore the pressure.

When union 1 is exhausted, pressure is higher in space b, so that valve (3) and valve (1) which is resting on it are raised. Inlet (4) opens, and the low-pressure line is exhausted via space a and the item of equipment connected to union 1. Pressure having been relieved at piston (5), this is moved back to its limit of travel by coil spring (6).

The preset pressure limiting value can be varied within predetermined limits by altering the preload exerted by coil spring (6); this is done by turning adjusting screw (8).

Hand brake valve



Function:

Graduable control of the secondary and parking brakes when spring brake actuators are used. Depending on the type, it can control a holding brake in conjunction with the service actuators.

Operation:

Running position (brakes off)

In the running condition, air from the secondary reservoir enters port (1) and passes through the open inlet valve (13) into chamber (a). From here it is delivered through port (2) to the spring portion of the spring brake actuator. The exhaust valve (14) remains closed.

Secondary position

When the handle (8) is rotated, the lug (23) turns the cam (7) in the same direction, and the cam follower moves upwards, assisted by the slope on the cam. As the cam (7) moves upwards, it lifts the stem (6) against the load in springs (11) and (15) until the inlet valve (13) closes and the exhaust valve (14) opens. The graduating spring (12) holds the graduating piston (15) in its lowest position.

The air in the spring chamber of the spring brake actuator connected to port (2) exhausts back through chamber (a) to the port (4) and into atmosphere, whilst full reservoir pressure is retained in chamber (b). There is now a pressure difference between chambers (a) and (b), and the higher pressure below in the graduating piston (15) pushes it, the spring (16) and valve (17) upwards against the load in spring (12). Depending on the position of the stem (6), which depends on the position of the handle (8), the upward movement of the graduating piston (15) will be halted as the exhaust valve (14) closes.

The valve will lap-off during partial brake applications as the exhaust valve (14) closes, leaving a residual pressure in the spring chamber.

When the handle (8) is rotated to the stop (25) the stem (6) will be lifted clear of the graduating piston (15) such that the exhaust valve (14) cannot close, with the result that the spring chambers exhaust completely.

If the handle is released when moving from the "off" position to the full secondary brake piston, it will return to the brakes off position again and the spring chambers will be re-charged.

Parking brake

To operate the parking brake, the handle (8) should be moved to the full secondary braking piston, and then moved a little further. The peg (9) drops into the detent and will hold the handle (8) in this position, and the spring chambers will remain at zero pressure.

To release the parking brake, the handle (8) must be pulled outwards until it clears the stop (25). It will move back to the brakes off position without any manual assistance.

As the handle (8) reutrns, the cam (7) will be pushed downwards by the spring (5) and the stem (6) will therefore travel downwards. The stem (6) closes the exhaust valve (14) and opens the inlet valve (13). Air flows from chamber (b) through the open Inlet valve (13) to chamber (a) and on to the spring chamber of the spring brake actuator via port (2). As the pressure builds up in chamber (a) the graduating piston (15) will be pushed downwards again. The inlet valve (13) remains open. The pressure delivered at port (2) now equals the input pressure at port (1).

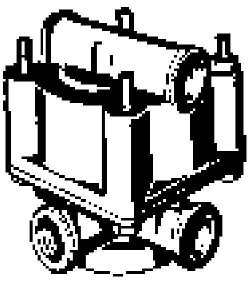
Holding brake position

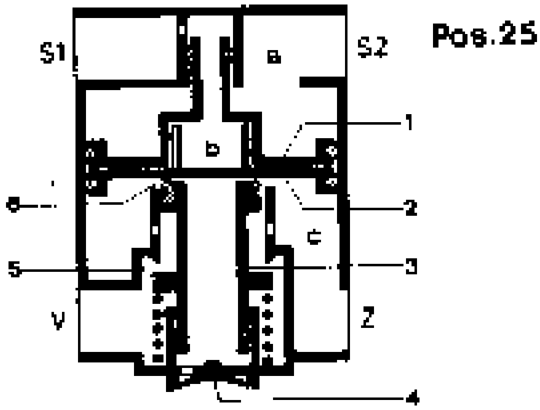
To make the operation of the hand brake valve easier for drivers of buses, an extra handle position can be incorporated to give a holding brake such that the service chambers can be pressurised.

To move the handle (8) to the holding bake position, pull the handle outwards and turn it to the left over the stop, and then release it. The peg (9) drops into the detent and handle (8) is held in this position. As the handle (8) is turned, the sloping face (22) on the underside of the handle cover (24) pushes the plunger (21) downwards against spring (20). It pushes the valve (19) dowwards and opens the way-through from port (1) through chamber (d) to port (3). Chamber (c) remains at zero pressure. Air flows from port (3) through a double check valve into the service brake system; the pressure is not graduable.

In order to release the holding brake, hte handle (8) should be pulled outwards and returned to the brakes off position. The springs (20) and (18) push the valve (19) and plunger (21) upwards. Valve (19) closes and the plunger (21) lifts away from valve (19) so that air in the service chambers exhausts back through port (3), chambers (d) and (c), and excapes through the exhaust (E).

Relay valve





Relay valve (overload protection valve)

Purpose:

Avoiding the addition of forces in the combined spring-loaded and diaphragm brake cylinders ('Tristop' cylinders) if the service and spring-loaded parking brakes are applied at the same time, and therefore protecting the mechanical brake linkage components against overloading. In addition, the valve ensures rapid venting and exhausting of the spring-loaded cylinders.

Operating principle:

Released (driving) position

In the released position, space a is supplied continuously with air via union S 2 from the handbrake valve. The air pressure is therefore exerted on piston (1), which together with piston (2) keeps outlet (6) closed and, by pressing down valve body (3), inlet (5) open. As a result, union Z receives the full reservoir pressure from union V. The spring-loaded cylinders connected to union Z are supplied with air and the spring-loaded brakes (parking brake) are therefore released.

Service brakes applied alone

When the main vehicle brake valve is actuated, compressed air flows via union S 1 to space b above piston (2). On account of the opposing forces in spaces a and c , the pressure that builds up in space b does not affect the operation of the relay valve. The spring-loaded section of the 'Tristop' cylinder therefore remains exposed to air pressure and released, whereas the diaphragm section, which is vented directly from the main vehicle brake valve, begins to operate.

Operation of spring-loaded parking brake alone

When the handbrake valve is operated, it partly or completely exhausts space a . This removes most or all of the load on piston (1), which is moved up by piston (2), on which the reservoir pressure in space c is acting. This opens outlet (6), but the accompanying movement of valve body (3) keeps inlet (3) closed. The result is that, depending on the amount of handbrake lever movement, the spring-loaded cylinders are exhausted via union Z, valve body (3) and air outlet valve (4), and the wheel brakes are applied.

In the case of an auxiliary brake operation, outlet (6) closes after the exhausting phase, when pressure equilibrium has been created in spaces a and c . The relay valve is thus closed. If the spring-loaded parking brake system, however, is operated outlet (6) remains open.

Simultaneous operation of service and spring-loaded parking brakes

a) Service brake application with spring-loaded brake cylinders exhausted (operated)

The air has been exhausted from the spring-loaded cylinders. If the service brake is now applied in addition, compressed air flows via union S 1 into space b and strikes piston (2). Since space c is at zero pressure, the piston moves down, closes outlet (6) and opens inlet (5) by means of valve body (3). Compressed air can now flow from V through space c to Z and the spring-loaded cylinders. The spring-loaded parking brake is released, but only to the same extent as service brake pressure rises. In other words, the two braking forces are not added together.

The pressure build-up in space c raises piston (2) as soon as the pressure reached at Z becomes greater than the pressure in space b . Inlet (5) then closes and the relay valve is in the closed setting.

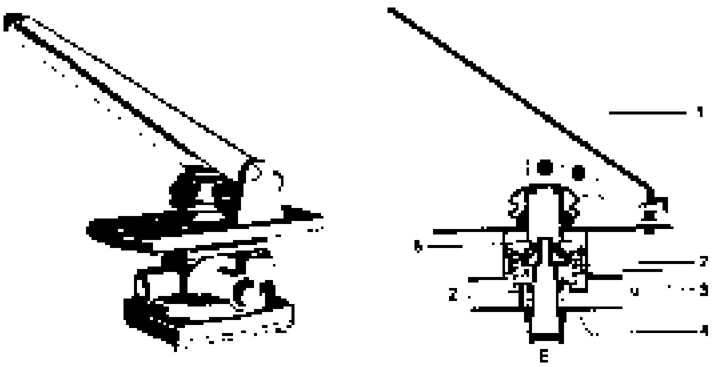
b) Application of the spring-loaded parking brake with the service brake already in use

If a partial service brake application has been made, space b will be exposed to air pressure. If the spring-loaded section is now also vented, that is to say pressure in space a is lowered, the higher pressure in space c pushes the two pistons (1) and (2) up, so that the valve body (3) also moves up, closes inlet (5) and opens outlet (6). Depending on the service brake pressure value, air then escapes from the spring-loaded parking brake cylinders at union Z via air outlet valve (4) until the pressure in space b again predominates, and piston (2) closes outlet (6). The relay valve is then in the closed (final) position again.

Since pressure in space c cannot be lower than in space b even if the handbrake valve is opened fully and pressure at union S 2 drops to zero, the spring-loaded parking brake only operates to the extent permitted by the service brake pressure at any given moment. As a result, the two braking forces are not added together.

When the service brake is released and the spring-loaded parking brake remains applied, pressure drops in space b ; pressure in space c then predominates and moves piston (1) up. Outlet (6) is opened and union Z exhausted via valve body (3) and air outlet valve (4).

Single foot valve



Operation:

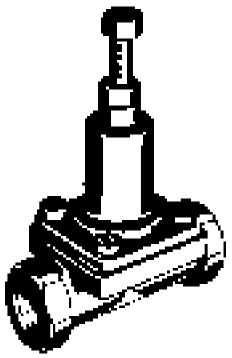
As the treadle or respectively lever or plunger is depressed, the force is transmitted onto the guarding piston (2), which moves downwards closing the inlet valve (3) and opening exhaust valve (4). This allows air to flow from reservoir port (V) to Port (2) and on to the brake chambers and trailer control unit, the pressure depending on whether a partial or full brake application is required.

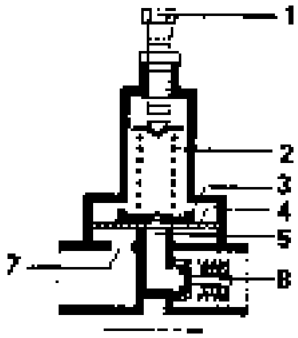
This same pressure builds up below piston (2) and it moves upwards against the rubber spring (5) until the forces balance. The valve is then lapped-off (i.e. Inlet valve (4) and exhaust valve (3) are closed).

When piston (2) reaches the bottom stop, Cavity (a) and port (2) are at maximum pressure, and the inlet valve (4) remains open (full braking).

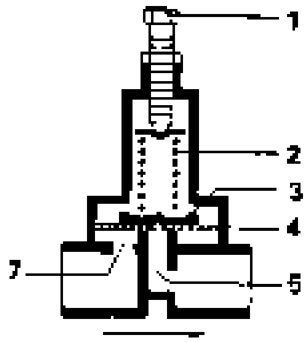
The piston (2) will move upwards in small steps as the brake pedal is released and a partial release of pressure in cavity (a) will occur as air escapes through the exhaust valve (3) and the exhaust port (E) until the valve laps-off again (i.e. the force of the air pressure below the piston (2) balance with the force in the rubber spring (5).

When piston (2) is in its uppermost position, brakes are fully released again. Inlet valve (4) is closed, exhaust valve (3) is opened, and port (2) is fully exhausted.





Without return flow



With limited return flow

Flow relief valve without return flow

The airflow to ancillary air-operated equipment (doors, auxiliary/parking brakes, servo clutch etc.) is released only after the calculated operating pressure for the brake system has been reached at the final air reservoir.

Flow relief valve with limited return flow

The compressed airflow to the trailer or to ancillary air-operated items (e.g. the auxiliary/parking brake system) is released only after the calculated brake operating pressure has been reached in the final reservoir. In addition, the main vehicle brake circuits are protected against pressure drop if the trailer reservoir line is broken or opened.

If pressure drops in the service brake reservoirs, partial return flow of compressed air takes place until the closing pressure (dependent on the flow relief pressure) is reached.

Operating principle

On all flow relief valves, compressed air enters the valve body in the direction shown by the arrow, and passes under diaphragm (4) through bore (7). The diaphragm is pressed against its seat by locating spring (2) and piston (3). When the flow-relief pressure is reached, the force of spring (2) is overcome, diaphragm (4) lifts away from its seat and bore (5) is exposed. Air then reaches the reservoirs or consumers in the direction of the arrow, either directly or after check valve (8) has opened.

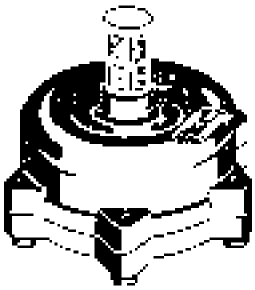
On the flow relief valve without return flow, it is not possible for the air to flow back since check valve (8) is kept closed by the higher pressure in the second reservoir.

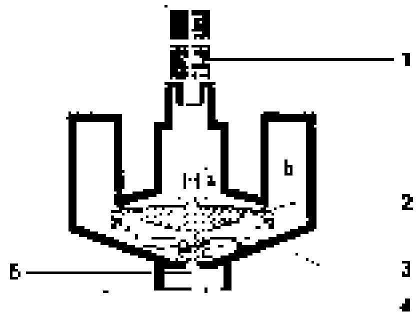
On the flow relief valve with limited return flow, air can flow back until the diaphragm (4) closing pressure is reached. At this point, spring (2) acts on piston (3) to force the diaphragm (4) down on to its seat, and thus prevents further pressure equalization in the opposite direction of flow to the arrow.

On all versions, flow-relief pressure can be corrected by turning adjusting screw (1). Turning to the right (clockwise) increases the flow-relief pressure; turning to the left (counterclockwise) reduced it.

Condensation drain valve

Pos. 58





Automatic condensate drain valve:

Purpose:

To protect the compressed air system against the entry of moisture condensate, by automatically draining the moisture off at the air reservoir.

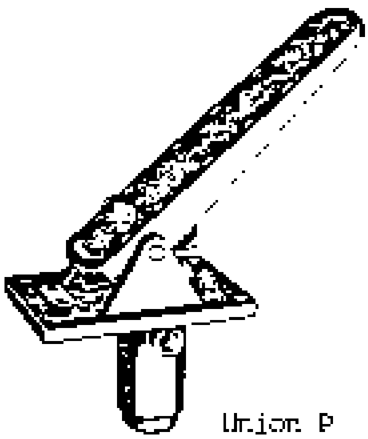
Operating principle:

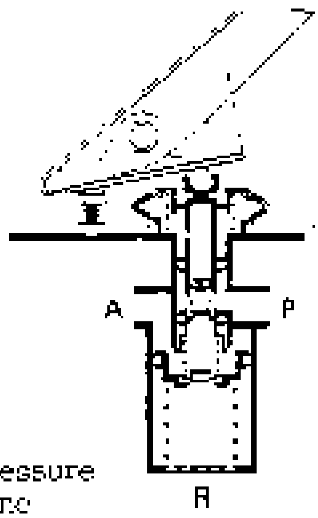
When the air reservoir is charged, the compressed air enters space a via filter (1) and acts on valve body (3). This lifts clear at its periphery from inlet (2). Compressed air, complete with any moisture condensate it contains, then flows out of the reservoir into space b, and the moisture condensate collects above outlet (4). When pressure equilibrium is restored between the two spaces, valve body (2) closes inlet (2).

If pressure drops in the air reservoir - for example when the brakes are applied - the pressure in space a will also fall, whereas the full pressure remains present initially in space b. This higher pressure in space b acts from below on valve body (3) and lifts it clear of outlet (4). As a result, moisture condensate is expelled by the trapped air in space b .

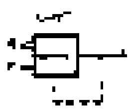
Precision control valve

Pos. 56



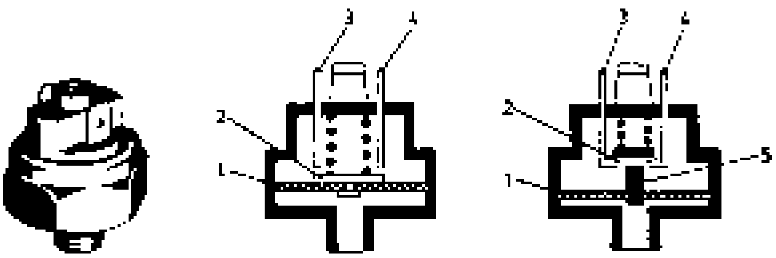


schematic diagram



Union P = Pressure line
Union A = Operating line
Passage R = Vent

Pressure-sensing switch



Type E =
normally closed
(off)

Type A =
normally open
(on)

Pressure-sensing switches:

Purpose:

Depending on the version used, to switch electrical equipment or bulbs on or off.

Operating principle:

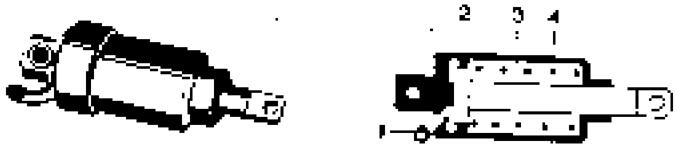
Version 'E' (normally off): when the switching pressure is reached, diaphragm (1) together with contact plate (2) is raised, and poles (3) and (4) connected together.

When the pressure drops again, the connection is interrupted.

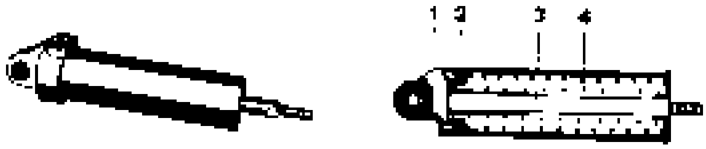
Version 'A' (normally on): when the switching pressure is reached, diaphragm (1) is raised together with the plunger. Plunger (5) lifts contact plate (2), and the connection between poles (3) and (4) is interrupted.

When the pressure drops, the connection is remade.

Actuating rams



421410



421411

Actuating ram:

Purpose:

To shut off the diesel injection pump or operate the throttle flap valve for the engine (exhaust) brake.

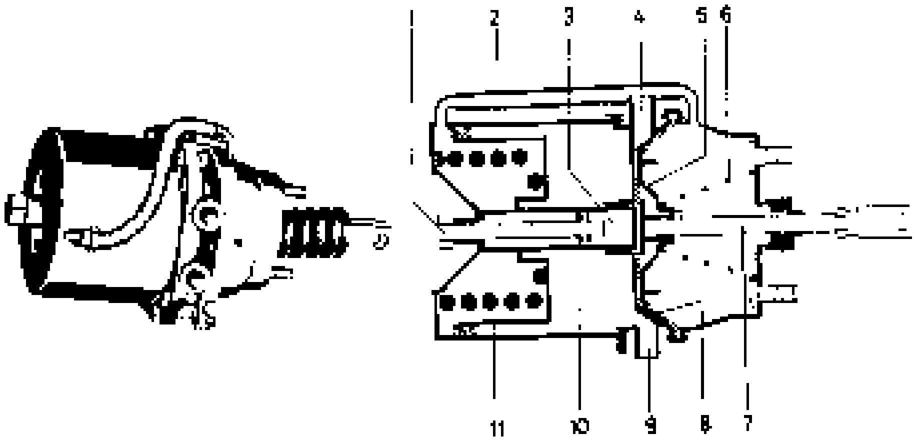
Operating principle:

Compressed air from the three-way valve or three-way solenoid valve flows through union 1 to the actuating ram cylinders. It strikes piston (2), overcomes the force exerted by coil spring (4) and extends piston rod (3).

On actuating ram 421410, the force acting on piston (2) is transmitted to the operating lever for the injection pump, and moves this from the idle to the stop position. The accelerator pedal linkage is connected to the actuating ram in such a way that the accelerator cannot be operated if the exhaust brake on the engine is in use.

On actuating ram 421411, the force at the piston is transmitted to the flap valve in the exhaust manifold downpipe, and closes it. The build-up of back pressure in the exhaust system brakes the rotation of the engine and thus slows the vehicle down.

When the rams are exhausted, piston (2) is returned to its initial position by coil springs (4).



'Tristop' cylinder

Purpose:

Combined spring-loaded and diaphragm cylinders are used to apply the braking force to the wheel brakes. They consist of a diaphragm section for the service brake and a spring-loaded section for the auxiliary and parking brakes. Special features are excess stroke and a mechanical release device for the spring-loaded section.

Operating principle:

1. Service brakes

When the service brakes are applied, compressed air enters space a through union 4, strikes diaphragm (8) and presses out piston (5) against the force exerted by the spring (6). By way of piston rod (7), the force exerted on diaphragm (8) thus operates the linkage with slack adjuster and the wheel brakes. When space a is exhausted, spring (6) acts on piston (5) and returns the diaphragm (8) to its initial position, so that the brakes are released.

The diaphragm cylinder section acts entirely indeoendently of the spring-loaded section.

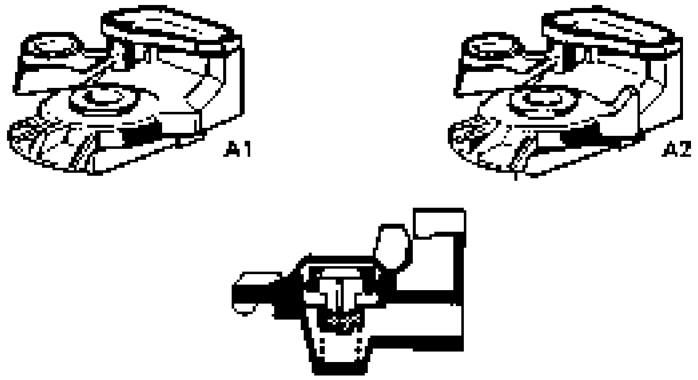
2. Spring-loaded parking brake and auxiliary brake)

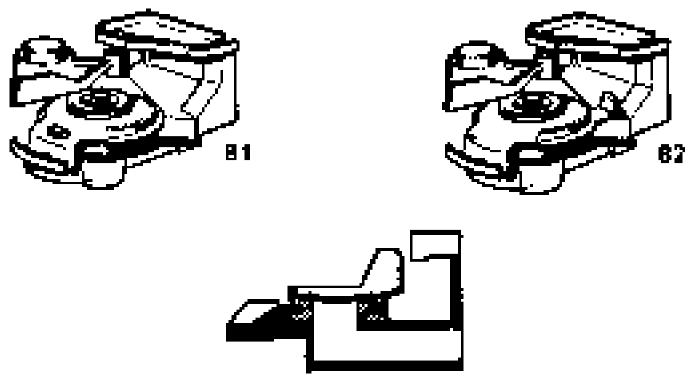
If an auxiliary brake application is made, the pressure in space b is partly or fully exhausted by way of union 9. The drop in pressure in space b releases the spring force to act on piston (11), piston rods (3) and (7) and the linkage with slack adjuster, and thus apply the wheel brakes.

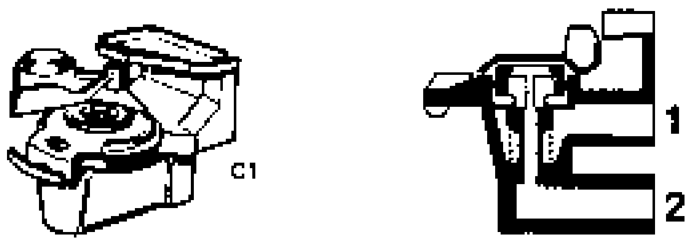
Maximum spring-loaded braking force is obtained when space b is fully exhausted. Since in this situation the braking force is obtained entirely mechanically, from spring (2), the spring-loaded section of the cylinder can be used not only as an auxiliary service brake but also as a parking brake.

To release the brake, pressure is allowed to build up again in space b .

Coupling heads







Coupling heads for twin-pipe brake systems

Description:

Coupling head patterns A1, B1 and C1 for reservoir lines have a red cap and an axial device to prevent incorrect attachment.

Versions A2 and B2 for the brake lines have a yellow cap and an anti-confusion device at the side.

Versions B and C incorporate a valve to shut off the compressed air flow when the matching coupling head is not attached.

Coupling heads

Operating principle:

To connect the two halves of the coupling together, the coupling head on the hose is attached to the matching head on the main vehicle by intersecting the guides on the heads and turning. At the end of the turning movement the two coupling heads are firmly linked together. The protective devices built into the heads prevent accidental connecting of the wrong hoses.

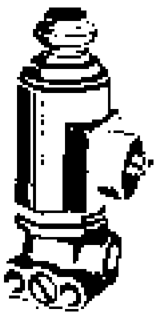
- Coupling C1 with A1, B1 with A1 and B2 with A2:

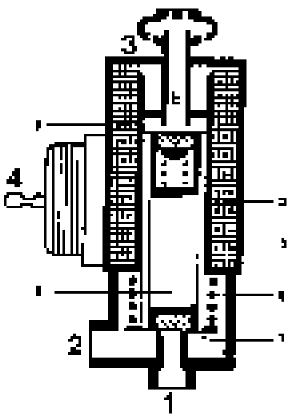
  During the coupling action the sealing ring on the Type A coupling head opens the valve in the Type B or C head, so that the two air lines are connected together pneumatically and the coupling joint is sealed. When the coupling is separated, the valve closes automatically.

- Coupling A2 with A2:

  On identical coupling heads without valve, sealing is obtained by the pressure with which the two sealing rings make contact.

3/2-way solenoid valve





Pos. 40
42
44
46
48

Purpose: Allows air to enter a working line when the solenoid is energized.

Operating principle: The reservoir line from the compressed air reservoir is connected to union 1. The armature of the solenoid, which forms the valve body, keeps the inlet closed as a result of the force exerted on it by the coil spring. When the solenoid coil is energized, the armature moves up, the outlet is closed and the inlet opened. Air from the reservoir can then flow from union 1 to union 2 and reach the working line.
When the current flow through the solenoid coil is interrupted, the spring forces the armature back to its initial position. This closes the inlet, opens the outlet and exhausts the working line by way of space a, bore b and vent 3.

Explanation

The front axle is steered by two different systems.

A = Mechanical steering linkage with hydraulic power assistance (undercarriage)

B = Hydraulic steering from the cab on the crane superstructure, using a hydrostatic system (Servostat Type 8444).

System A - description

Mechanical steering takes place from steering wheel (1), through bevel gears (2), universal-joint shaft (3) and steering box (4). From the steering box, the steering movement is transmitted via idler lever (5) and steering rod (6) to the track rod arm (7). Hydraulic power assistance is provided (see description of 'Semi-block hydraulic power steering').

For safety reasons, two hydraulic power steering assistance circuits are provided.

1. Main hydraulic circuit I
2. Auxiliary hydraulic circuit II

If the main steering pump (9) should fail, cut-in valve (14) automatically switches over to auxiliary circuit II.

An indication of flow in main circuit I is provided by valve (11) as soon as the engine has been started.

Flow indication for auxiliary circuit II is provided by valve (13), but only above a road speed of 10 km/h.

The system is protected by the following valves:

a) Flow limiting valve (10) in main hydraulic circuit I (30 liters/min)

b) Flow limiting valve (12a) integrated into emergency steering pump (12) (25 liters/min)

c) Pressure limiting valve (15) for both circuits (fixed setting of 100 bar).

Checking pressure:

- Connect the pressure gauge to test point M1 (see Fig. 3).

- Insert a plate app. 20 mm (0.8 in) thick at the mechanical stop, and turn the steering to the full left or right lock position.

Adjusting work

1. Mechanical steering lock limits

The angular limits of steering movement (mechanical steering) must be adjusted at the axle in accordance with the appropriate installation drawing (see Drawing 5).

The lock angle when the steering is turned to the left is 27 degrees.

The lock angle when the steering is turned to the right is 22 degrees.

Adjustment takes place at the stop, item C (see Fig. 1), by welding on or grinding away.

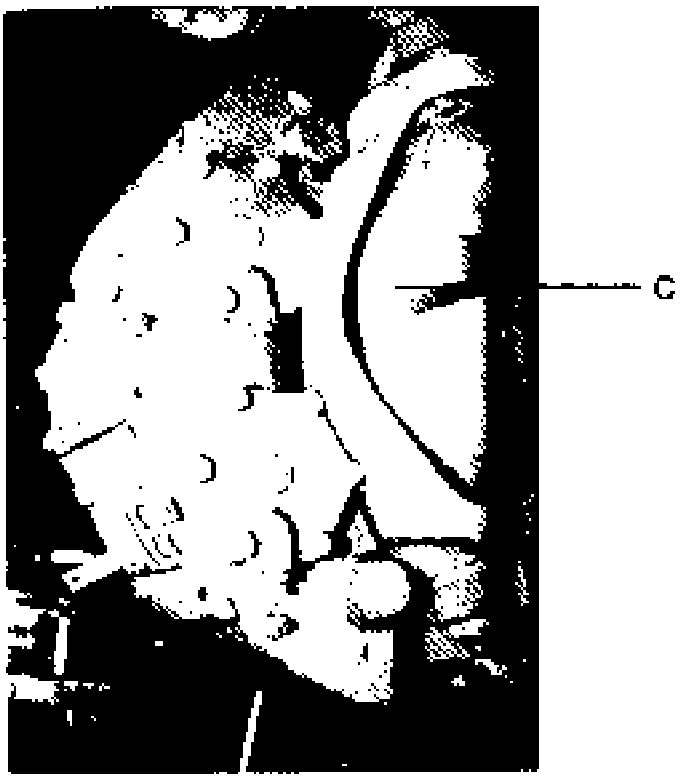


Fig. 1

2. Hydraulic steering - lock angle limits

The limits of movement for the hydraulic steering are adjusted at valve bushing -A- for left turns and valve bushing -B- for right turns. See description of semiblock power steering.

Connect the test pressure gauge to measuring point M1 (see Fig. 3).

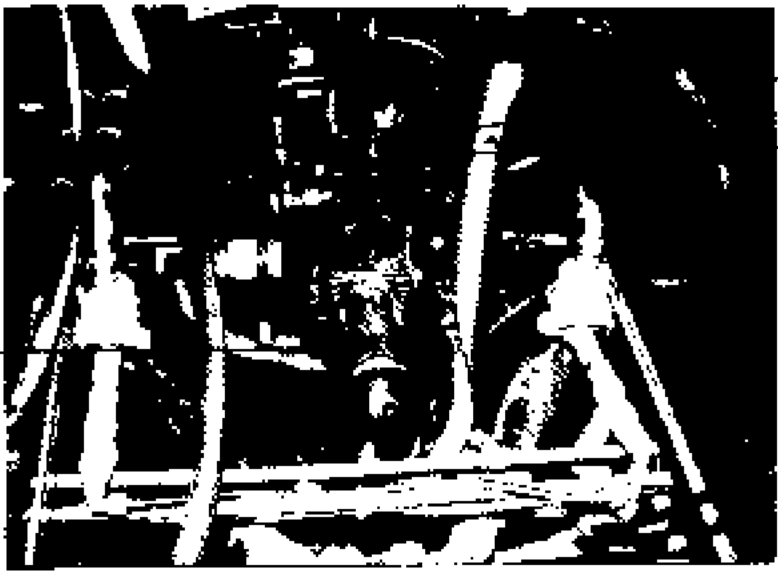


Fig. 2

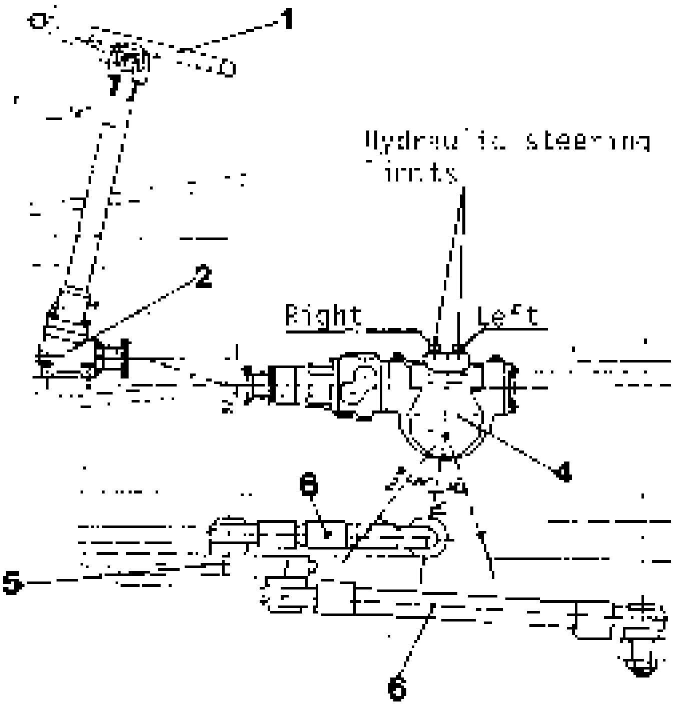
Fig. 3

3. Central (straight-ahead) position of steering

Turn the steering wheel from full left to full right lock, then back to the center.

Check the mark on steering drop arm (4b) in relation to the steering shaft (see Fig. 6). In this position the road wheel (Item D) must be pointing straight ahead.

Adjust if necessary at the steering rod (5).



Drawing 4

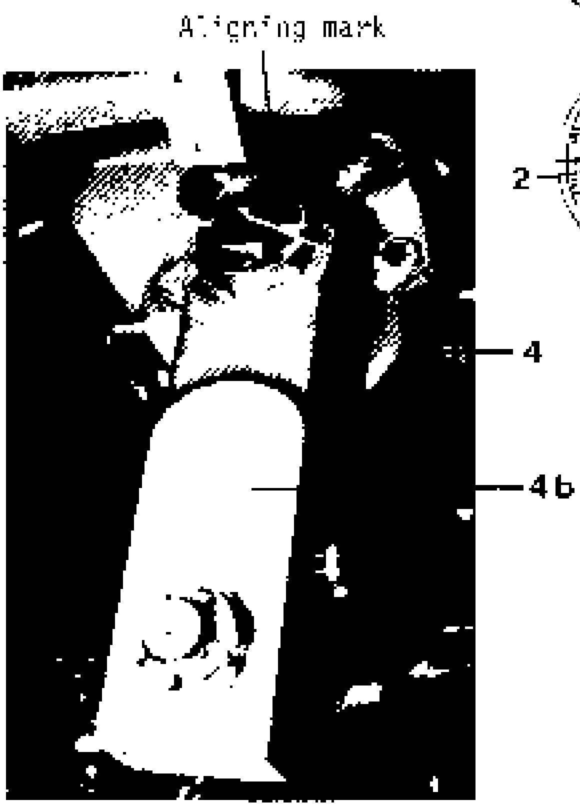
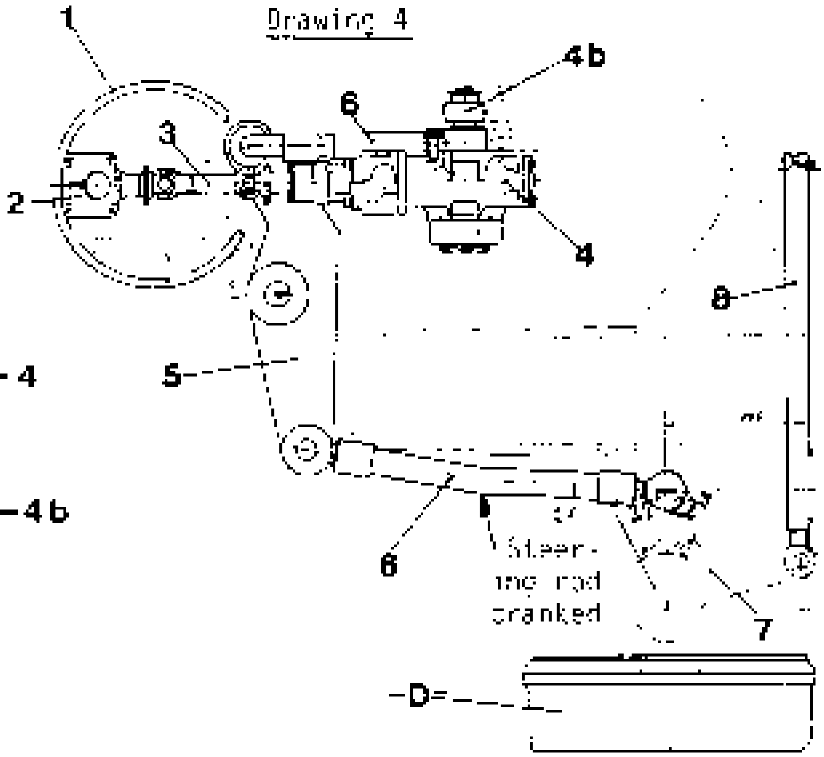


Fig. 6



Drawing 5

4. Adjusting track (toe-in)

Toe-in is adjusted at track rod (8).

Correct toe-in value is 0 - 1 mm.

Measure parallel to the vehicle's longitudinal axis.

Maintenance

For oil garde and oil quantity, see sheets 1.5.01 and 1.6.01.

Oil changes

a) Initial oil change including filter after 5000 km or 100 hours of operation.

b) Subsequently, every 80 000 km or 2500 hours of operation.

Check oil level

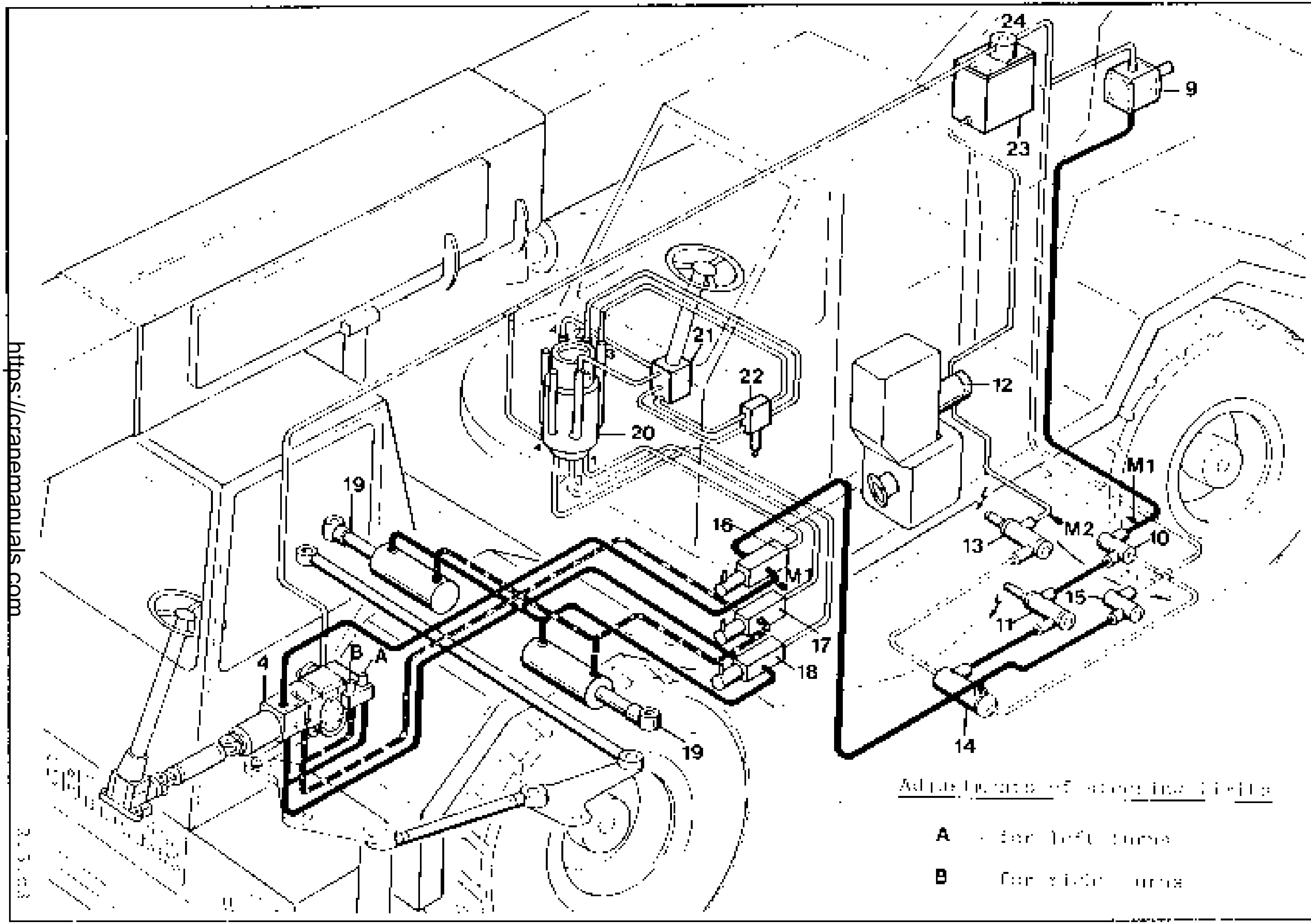
The oil level should be checked at intervals of 5 000 to 6 000 kilometers (travel distance) or 100 to 120 hours of operation. Check oil level with the engine running. It must remain steady at the upper mark in the oil filler orifice. After stopping the engine, the oil level should not rise by more than 1 to 2 cm (0.4 to 0.8 in). If this amount is exceeded, it is an indication that air is still trapped in the oil.

Bleeding

Relief the load on the steered axles by raising the vehicle on its hydraulic outrigger supports.

When the engine running, turn the steering wheel several times from one full-lock position to the other, to expel air from the rams. Watch the oil level while doing this. Add oil immediately if it drops. Continue this procedure until the oil level remains steady at the upper mark in the oil filler orifice, and no further air bubbles rise in the oil tank when the steering wheel is turned.

Components-Layout Steering-Frontaxle



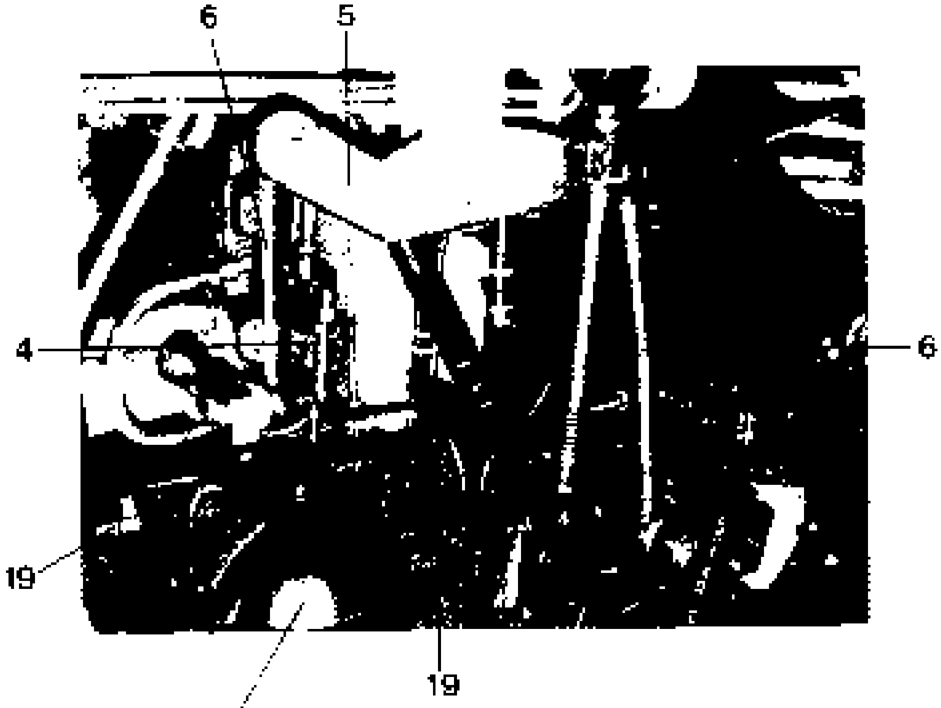
Adjustment of steering limits

A - for left turns

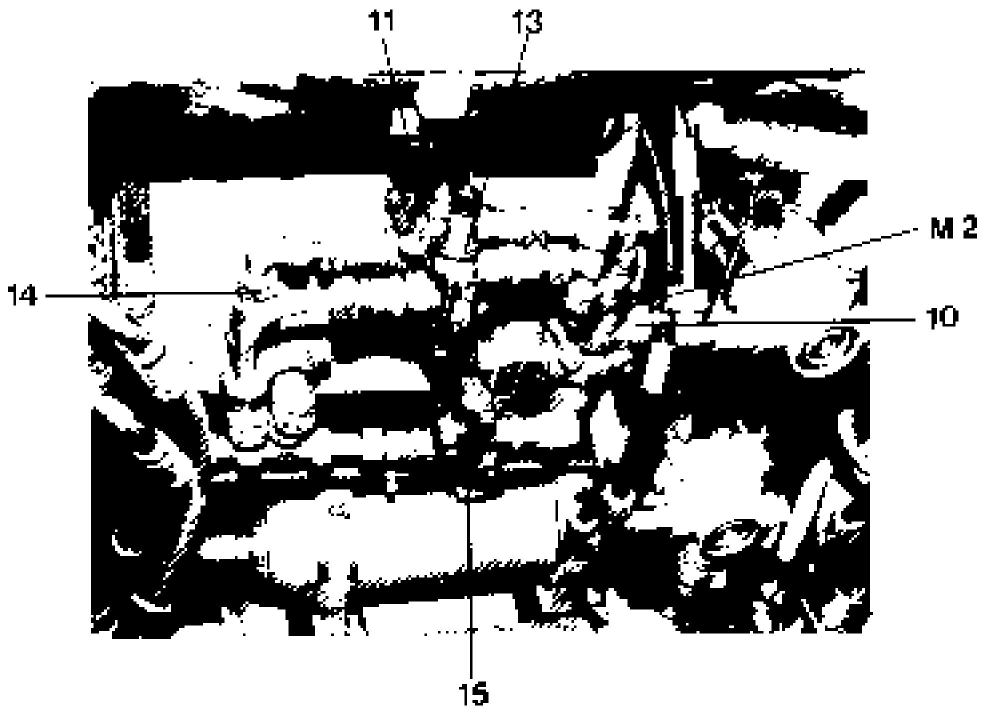
B - for right turns

Component

Drive direction

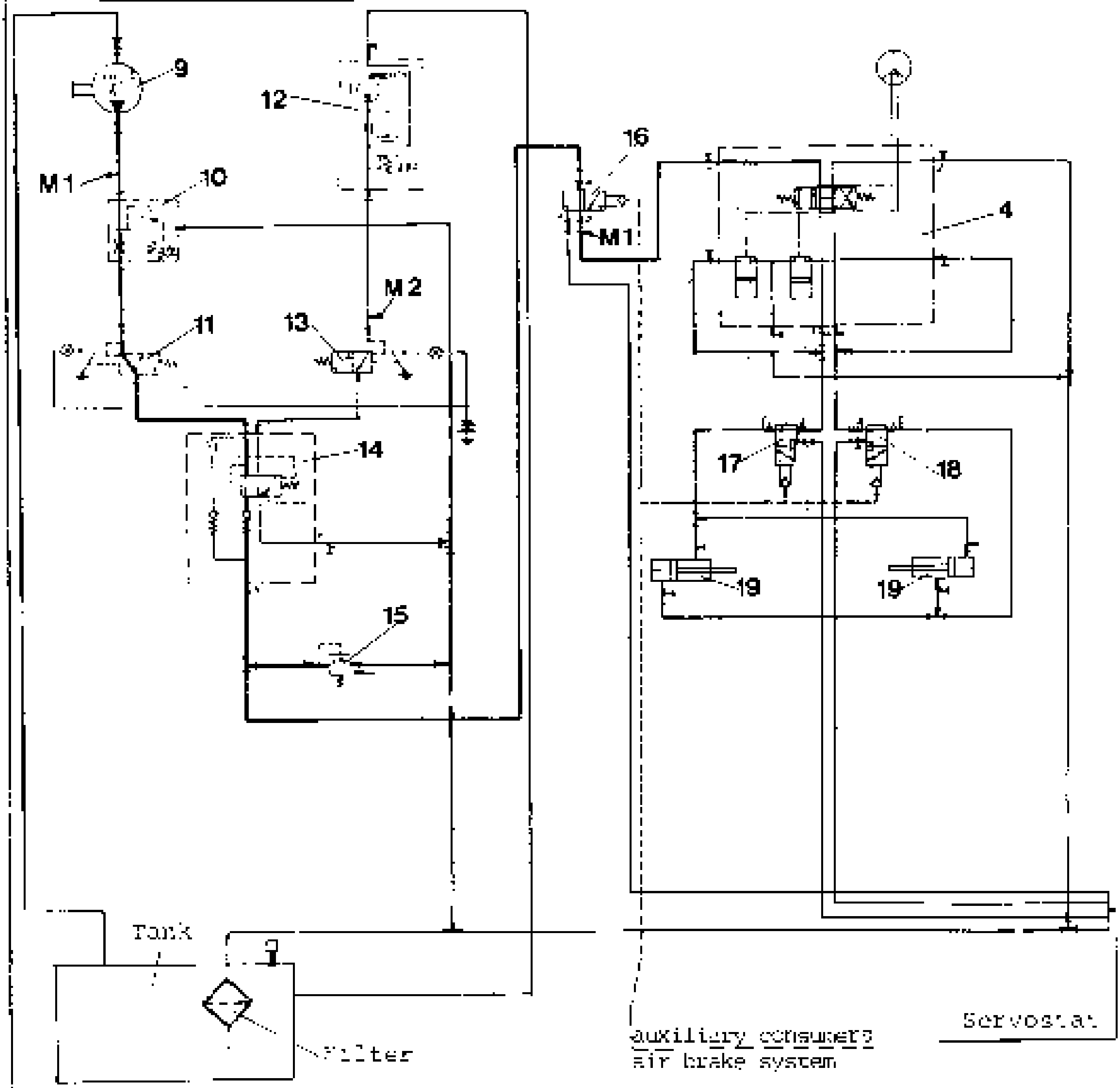


Front axle



Drive direction

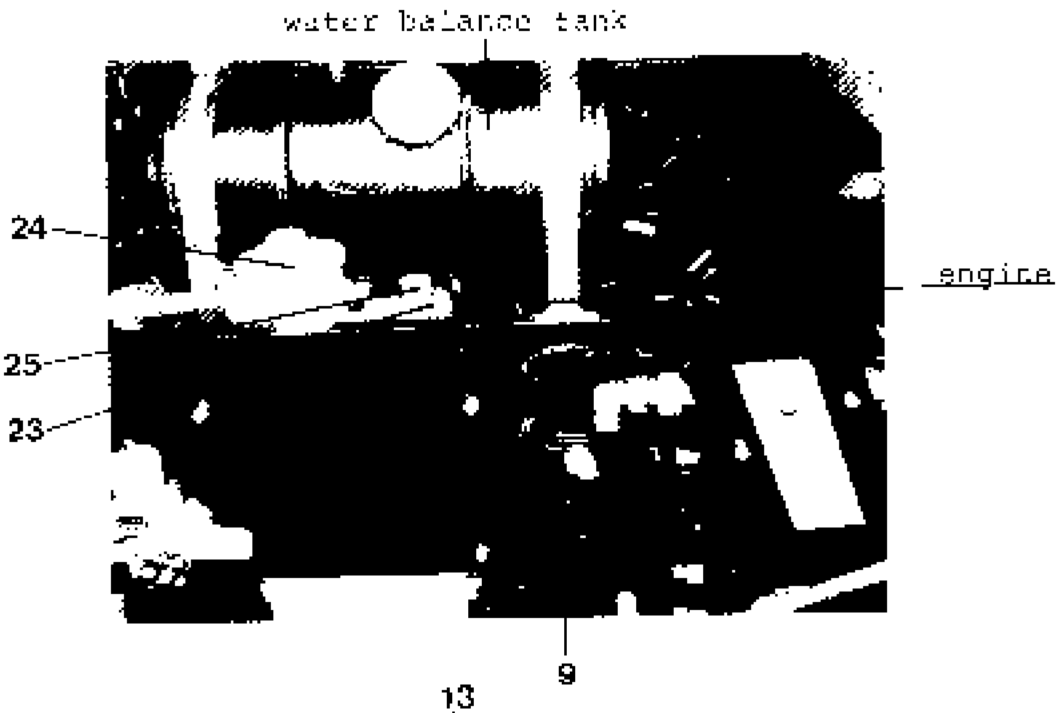
Hydraulic circuit diagram - semi integral power steering gear

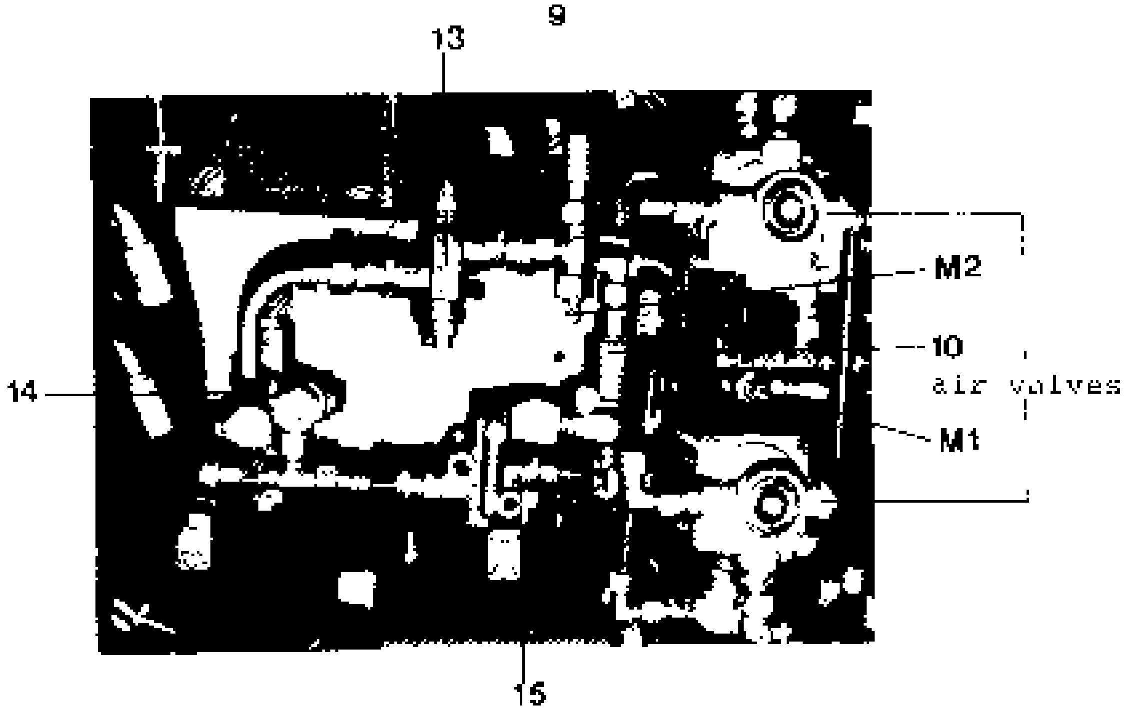


List of components

4. ZF-Semi-integral power steering gear
9. Main steering pump
10. Flow control valve (circuit I)
11. Flow indicator (circuit I)
12. Auxiliary steering pump
13. Flow indicator (circuit II)
14. Cut-in valve
15. Pressure relief valve
16. 4/2 way valve (pump pressure-changeover from chassis to superstructure)
17. 4/2 way valve (operating pressure - changeover from chassis to superstructure - left turn steering)
18. 4/2 way valve (operating pressure - changeover from chassis to superstructure - right turn steering)
19. Steering ram

Components - Layout





M1: Measuring point - main circuit I

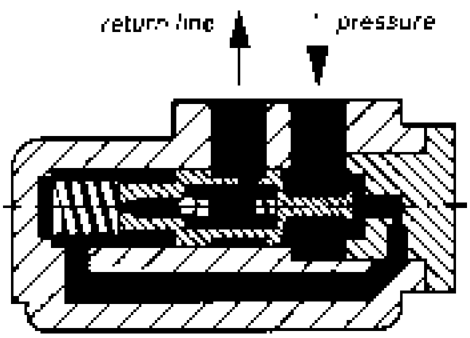
M2: Measuring point - Auxiliary circuit II

23 Tank
24 Filter
25 Bleeder
(oil dip road)

Valves - sectional drawings with description

Pressure relief valve (Pos. 15)

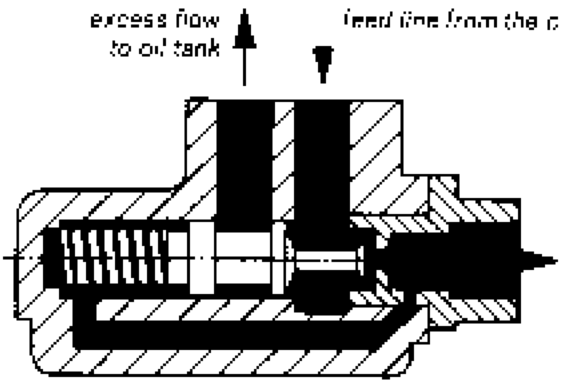
These are used to regulate maximum pressure in the hydraulic system and protect it against overloading.
This pilot-operated pattern of valve can be supplied with a fixed pressure limit between 35 and 100 bar.
The pressure limiting valve contains a valve piston, the front and rear faces of which are both exposed to the ruling pressure until the pressure limit is reached.
This is achieved by an orifice in the housing. If the pressure exceeds the spring loading of the ball valve in the valve piston, oil is able to flow out. The resulting pressure differential displaces the piston and opens the return passage.



By-pass pressure relief valve, Type 7753

Flow control valves (Pos. 10)

The valves act by limiting oil flow, and thus ensure that above a preset supply flow the consumer item receives only a more or less constant flow of oil, regardless of upward fluctuations in the supply flow. The pressure difference at an orifice, which is dependent on the flow rate, is used to displace a control piston and thus to divert excess oil feed back to the return line.



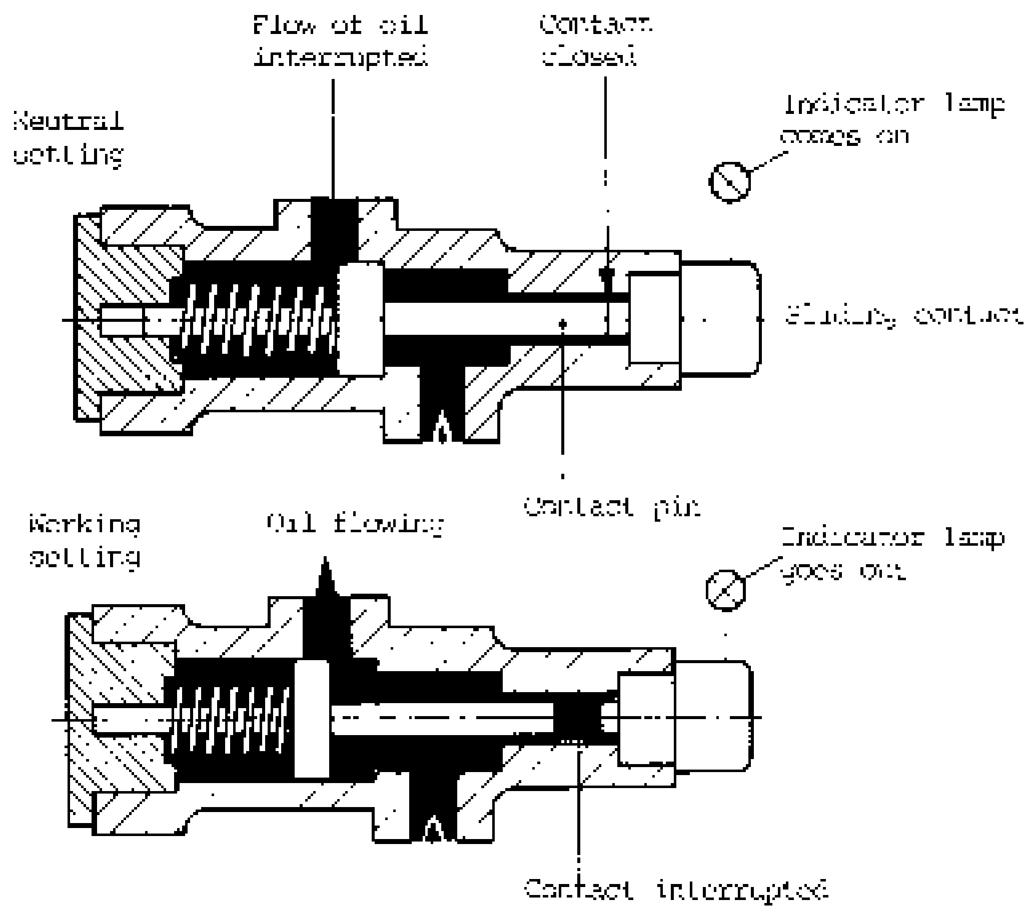
By-pass flow control valve, Type 7720

Valves - sectional drawings with description

Flow indicators (Pos. 11 + 13)

To provide the driver with a facility for checking the oil flow of the main pump and the emergency steering pump, the installation of a flow indicator between hydraulic oil pump and stand-by valve is recommended. An indicator lamp will light up when the hydraulic oil pump does not deliver oil. The flow indicator can also be fitted to systems without emergency steering pump.

The flow indicator consists mainly of a housing, a spring-loaded piston and an electrical contact maker. The ball is forced by the oil flow toward the left against the spring. This will interrupt the contact and the warning light goes out. The max. permissible rate of flow of these valves is 100 dm³/min, i.e. 200 dm³/min.



Flow indicator type 7760

Stand-by valves

The stand-by valve is provided with a control valve installed in the housing. In neutral position of the valve, the oil flow coming from an emergency steering pump flows into the line towards the steering gear (fig.10 bottom). The starting delivery flow of the main pump will overcome the preload of the spring. The control valve slides towards the stop and opens the supply line of this pump towards the steering gear. The oil flow of the emergency steering pump will then flow through the return duct into the oil tank (fig. 10 top). Stand-by valves are designed for a max. flow of 80 to 200 dm³/min per pump.

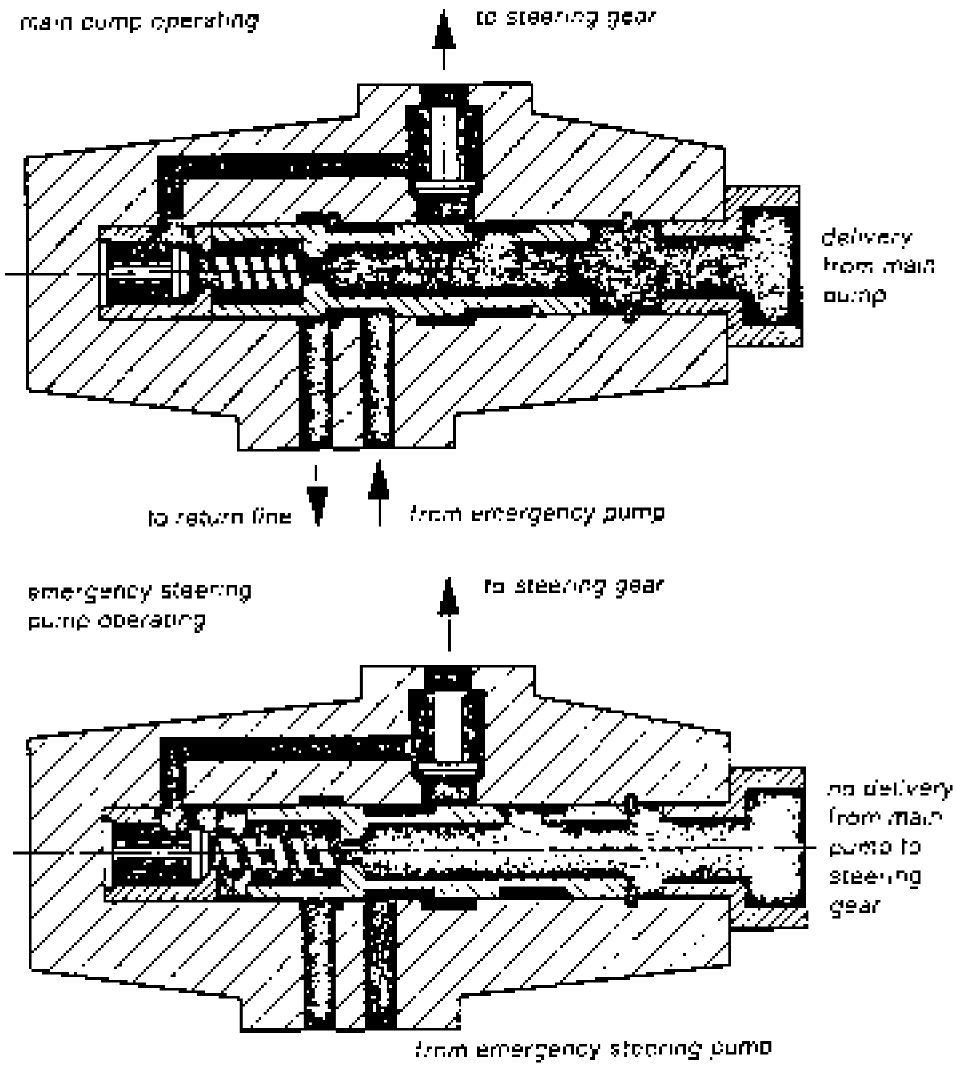


Fig.10 Stand-by valve, type 7734

Design and Functioning

Design:

The ZF semi-integral power steering gear contains a complete mechanical steering gearbox in which the power is transmitted from the input shaft to the steering nut and from the steering nut to the sector shaft.

The hydraulic control valve is arranged above the steering nut, central to the input shaft and attached to the steering gear housing as an integral part.

For hydraulic assistance, two power cylinders are required which are attached to the steering axle of the vehicle and connected to the valve of the steering gear by means of high pressure hoses and pressure pipes.

By means of a ball joint, the piston rod of the power cylinder is connected to the upper track arm.

The hydraulic oil required for the steering operation is supplied by an engine-driven pressure oil pump whose max. pressure and delivery rate are definitely set. The delivery of the pump has to be determinded in such a way that even at idling speed of engine an adequate steering speed at full hydraulic assistance is guaranteed. The delivery flow should not be much higher at max. speed, if possible. For this reason, a flow limiting valve with a suitable setting is required.

The max. pressure is [illegible] bar.

Functioning:

When the steering wheel, which is rigidly connected to input shaft and worm, is turned the steering nut will at first offer resistance to the rotary motion. When this resistance is greater than the preload of the centering springs, the worm will yield in axial direction and with it the valve sleeve, which is carried on the worm free-of-play.

When the valve sleeve is moved out of neutral position, the valve control grooves are moved out of their positions. As a result, the pressure oil is directly only to one side of the power cylinder, which can act in either direction. Due to the pressure differential in the power cylinder, an axial force is acting on the piston rod. The direction of movement of the piston rod is controlled so as to follow the movement of the steering linkage, which is created when the steering wheel is turned, and to support the steering movement.

When the steering wheel is released, the centering springs ensure that the valve returns to neutral position.

On the other hand, if a force acts on the steering linkage from the direction of the wheels, while the driver is holding the steering wheel in its position, the worm is again displaced axially. But the hydraulic assistance acts the other way in this case and absorbs the shock, helping the driver.

If a force is, however, transmitted to the steering gear from the direction of the wheels while the steering wheel is released - e.g. in a bend - the worm is not displaced axially, due to the preload of the springs, but is forced to carry out a rotary movement.

The preload of the centering springs is therefore essential for the return motion of the steering gear.

Functioning and adjustment of hydraulic steering limiter

Functioning of hydraulic steering limiter

In the housing cover, two valve sleeves (190) are incorporated which accomodate 1 valve spool (193) each. Both valve spools are connected to a pendulum (201) by means of a connecting rod. This pendulum is fixed to a drive pin (204). The drive pin is rotably mounted in the housing cover and carries a second pendulum (181) at is rear end. This pendulum is screwed to a gear segment (182) which is in constant mesh with the tooth lock washer (183) attached to the sector shaft (60). With this arrangement, one valve spool is moved upwards and the other one downwards, when the sector shaft (60) is turned.

The valve sleeves are provided with control ports which the respective position of the pierced valve spools will permit the pressure oil to flow from the inlet lines to the return line. Fig. III shows the flow of the pressure oil from the lefthand pressure passage of the valve housing (86) in a pipeline to the grooves of the lefthand valve sleeve (190) from where it can flow through the valve spool bore to the return line. The righthand pressure passage of the valve housing is connected to the righthand vavle sleeve, which is closed. When the sector shaft is turned clockwise (see Fig. III Piston moving to the right) the lefthand valve spool will move downwards. After a given travel of the valve spool, which can be varied by screwing the valve sleeve in or out, a control port in the valve sleeve will be opened through which the pressure oil in the lefthand cylinder can flow to the return line. Thereby, the position of the steering valve is not altered. Simultaneously, the righthand valve spool moves upwards and the control port in the righthand valve sleeve remains closed.

If the sector shaft is turned anti-clockwise, the righthand valve spool will move downwards. The control port in the righthand valve sleeve in thereby opened after pre-determined travel so that the pressure oil can flow from the righthand pressure passage to the return line.

When the steering limiter valve has been opened, the steering gear can be turned still further at increased manual effort and heavily reduced hydraulic assistance up to the wheel stop in the steering gear or in the power cylinder (e.g. if the drag link is disconnected).

Functional Diagram of a ZF Semi-Integral Power Steering Gear and Diagrammatic View of the Hydraulic Steering Limiter

Fig. 1: Steering gear in neutral position
Steering limiter valve closed

A = Oil tank
B = Pressure oil pump
C = Flow limiting valve
D = Pressure limiting valve

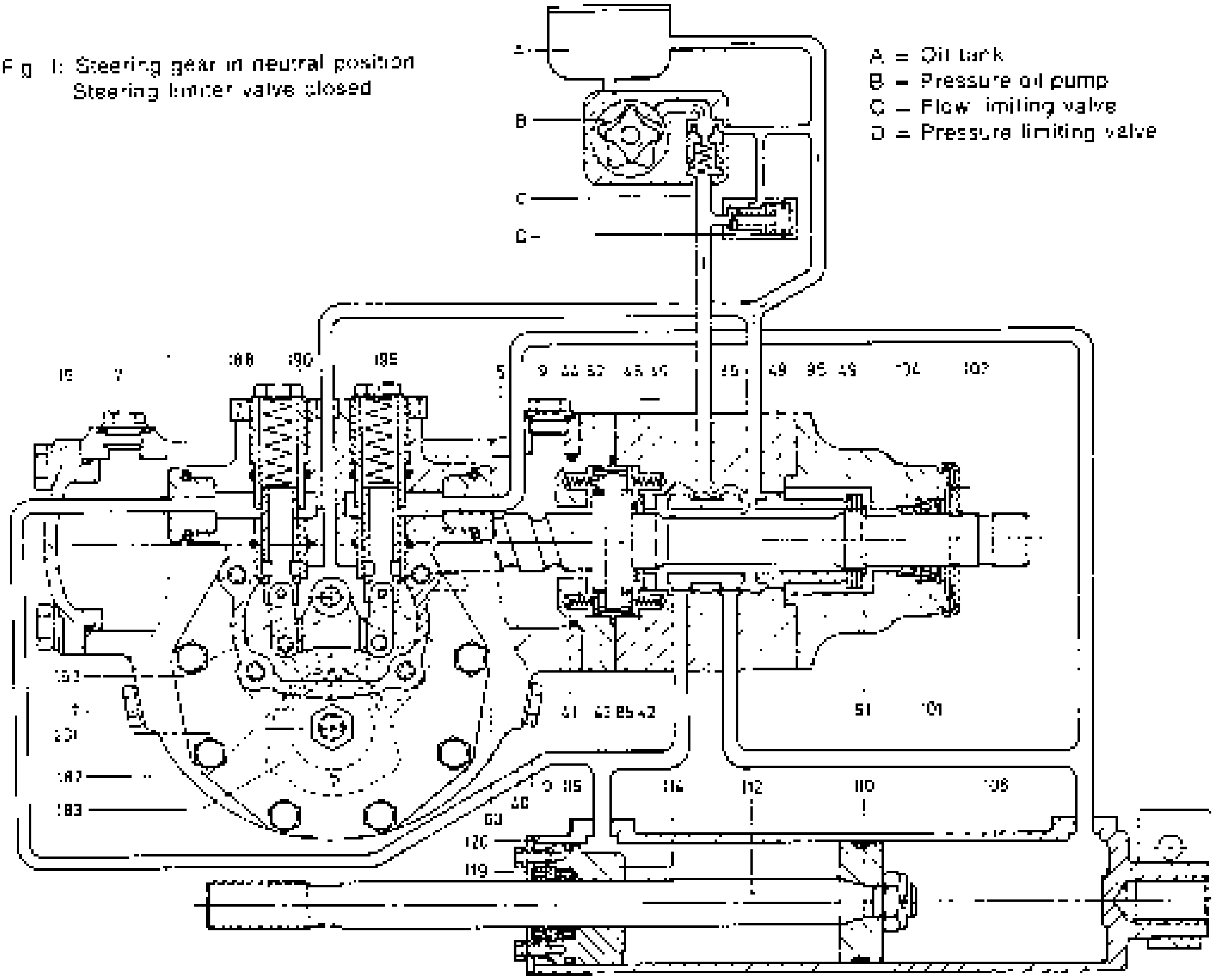


Fig. II. Piston moving to the right
Steering valve in working position
Steering limiter valve still closed

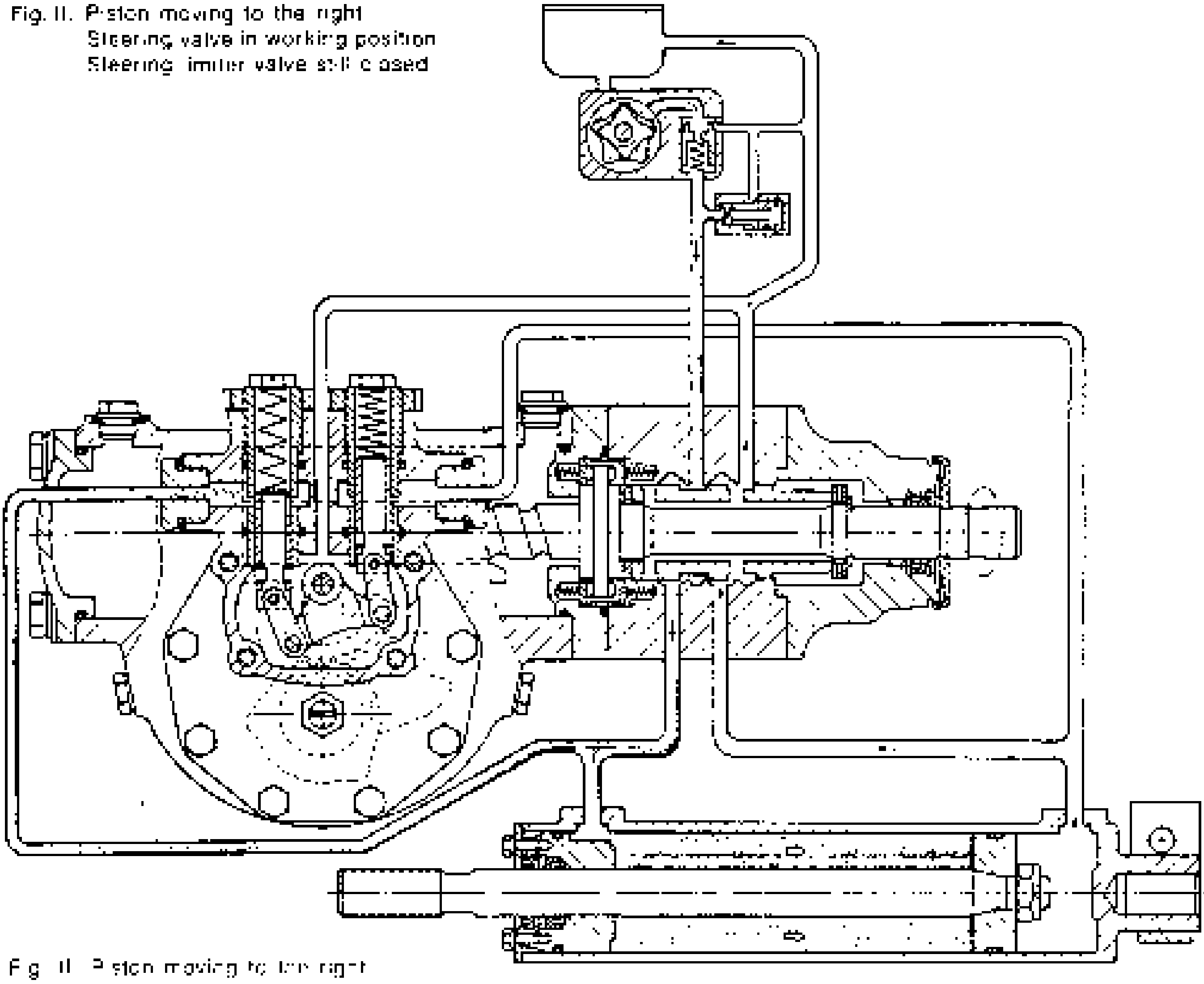
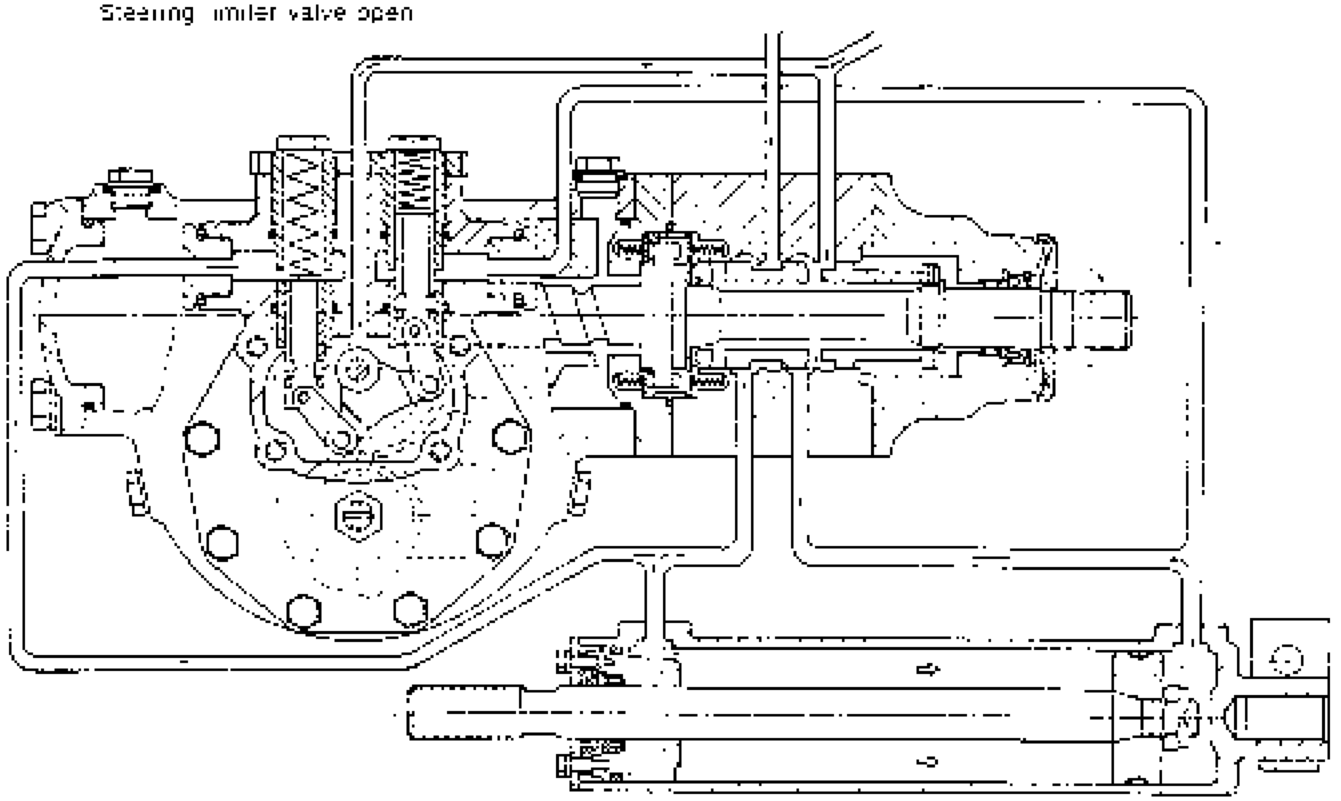


Fig. II Piston moving to the right
until shortly before final lock
Steering limiter valve open



Adjustment of the Hydraulic Steering Limiter in the Vehicle by Means of a Pressure Gauge:

A pressure gauge is screwed into the pressure line between pump and steering gear (see adjustment works, Fig.3 -M1-).

Jack up the steering axle with the hydraulic supports so that the steering axle is slightly unloaded.

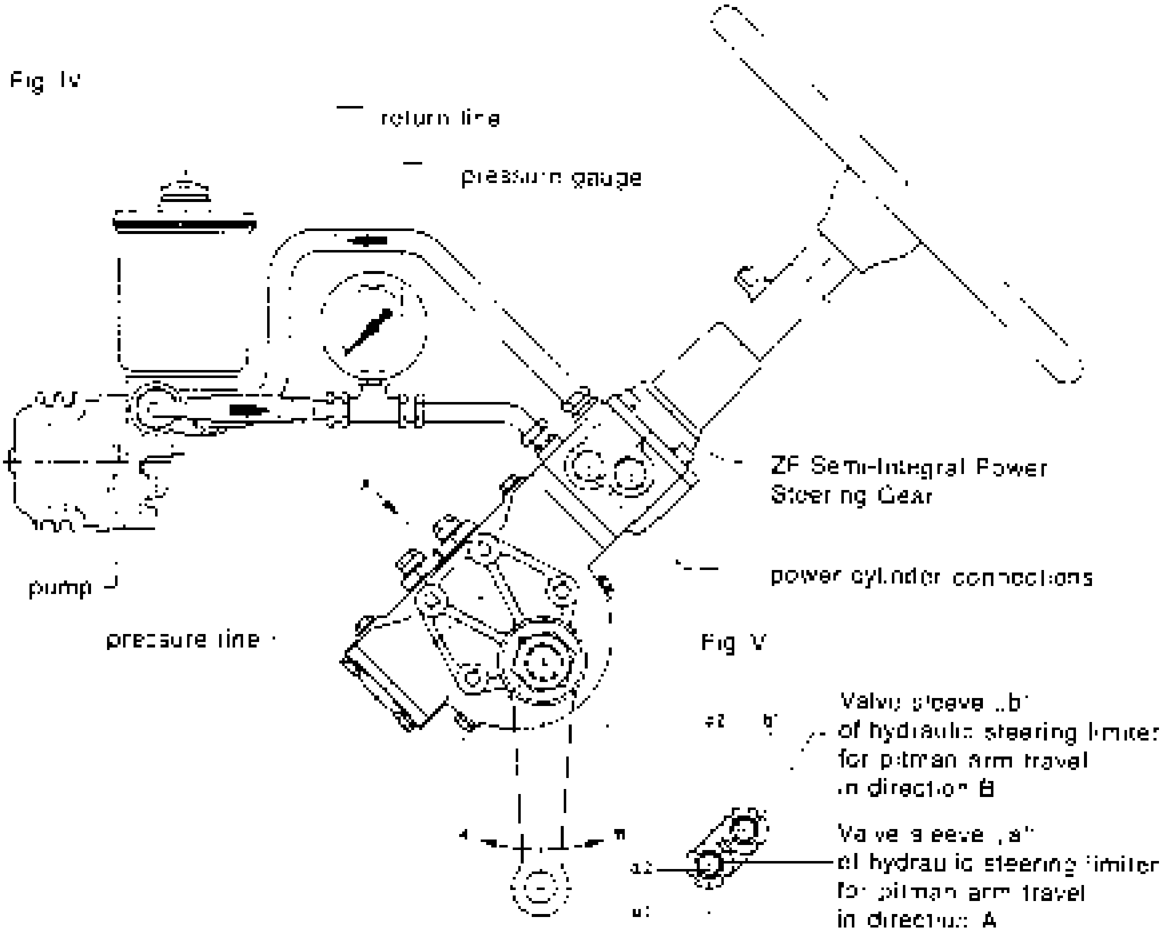
If the steering wheels are placed on turntables the steering axle must be loaded.

With the engine running, turn the steering gear, without excessive manual effort, against wheel stop. While doing so, a second mechanic must hold a spacer place of 2 or 3 mm thickness between the wheel stop members, so that a small reserve is left. When the stop has been reached, continue for a short moment (max. 5 seconds) to turn the steering wheel - so as to overcome the re-adjusting force of the steering valve -, until a dead stop is reached. For this a steering wheel rim effort of about 100 to 200 N (10 to 20 kp) is required, depending on the size of hydraulic reaction. In this position, the pressure gauge must indicate an oil pressure of approx. 29 bar. The adjustment is corrected by loosening the lock nut (a1 or b1 respectively) and turning the corresponding valve sleeve (a2 or b2) in or out. While doing so, release the steering wheel so that only the flow pressure builds up during this job. Then tighten lock nut a1 or b1. The adjustment for the second wheel stop is made in the same manner.

Valve (a2) and lock nut (a1) in Fig.V have to be adjusted when the pitman arm as shown in Fig. IV moves in direction "A".Analogously, valve (b2) and lock nut (b1) are adjusted when the pitman moves in direction "B".

Adjustment of the Hydraulic Steering Limiter

Fig IV



After the adjustment has been made as described above, power assistance should be available up to shortly before wheel stop. The adjustment made is suitable checked by turning the steering gear, with the vehicle normally loaded and while driving slowly, up to the point where the power assistance is cut off. In this position, there should be a gap of approx. 1 to 3 mm between the wheel stop members. At the same time, this check makes it possible to determine the thickness of the spacer plates to be fitted.

If the pressure drops too early when the pitman arm is turned in direction "A" or "B", the valve sleeve (a2 or b2 respectively) has to be screwed outwards.

If the pressure drops too late, the valve sleeve (a2 or b2, respectively) must again be screwed somewhat in.

List of components - Steering box

Group Housing:

1 Locking ring
2 Shaft sealing ring
3 Bearing bushing
4 Bearing bushing
5 Housing
6 Sealing ring
7 Closing plug
8 Sealing ring
9 Closing ring
11 Oval head notched pin
12 Type rating plate

Group End Cover:

15 O-ring
16 End cover
17 Washer
18 Hex. screw

Group Housing cover:

20 O-ring
21 Housing cover
22 Washer
23 Hex.screw, 25 mm long
24 Hex. nut

Group Worm, Input Shaft, Steering Nut:

40 Piston
41 Compression ring
42 Thrust washer
43 Thrust needle cage
44 Worm/input shaft
46 Washer
48 Valve sleeve
49 Washer
51 Locking ring
56 Ball
57 Ball recirculating tube half
58 Circlip
59 Hex. screw

Group Sector shaft:

60 Sector shaft
61 Guide washer
62 Adjusting screw
63 Locking ring
67 Castle nut
68 Cotter pin

Group Valve Housing:

80 O-ring
81 Cheese head screw
82 Intermediate cover
83 O-ring
84 Shaft sealing ring
85 Spacer ring
86 Valve housing

Group End Flange, Jacket Tube, Fittings and Small Parts:

94 O-ring
95 End flange/Jacket tube flange
96 Washer
97 Cheese head screw

List of Compo[nents]

Group End Flange, Jacket Tube, Fittings and Small Parts:

98 Locking ring
100 Shaft sealing ring
101 Shaft sealing ring
102 Protective cap
103 Bearing ring
104 Needle cage
105 Supporting washer

Group Hydraulic Steering Limiter:

180 Fitted screw
181 Pendulum
182 Gear segment
183 Tooth lock washer
184 Washer
185 Pressure pin
186 Compression ring
187 Drive pin
188 Groove nut/Hex. nut
189 Valve sleeve
190 Valve sleeve
191 O-ring
192 O-ring
193 Valve spool
194 Valve spool
195 Compression spring
196 Hex. screw, 80 mm long
197 Washer
198 Hex. screw, 20 mm long
199 Valve cover
200 O-ring
201 Pendulum
202 Fitted screw
203 Hex. screw, 70 mm long
204 Drive pin/cyl. pin
205 Woodruff key

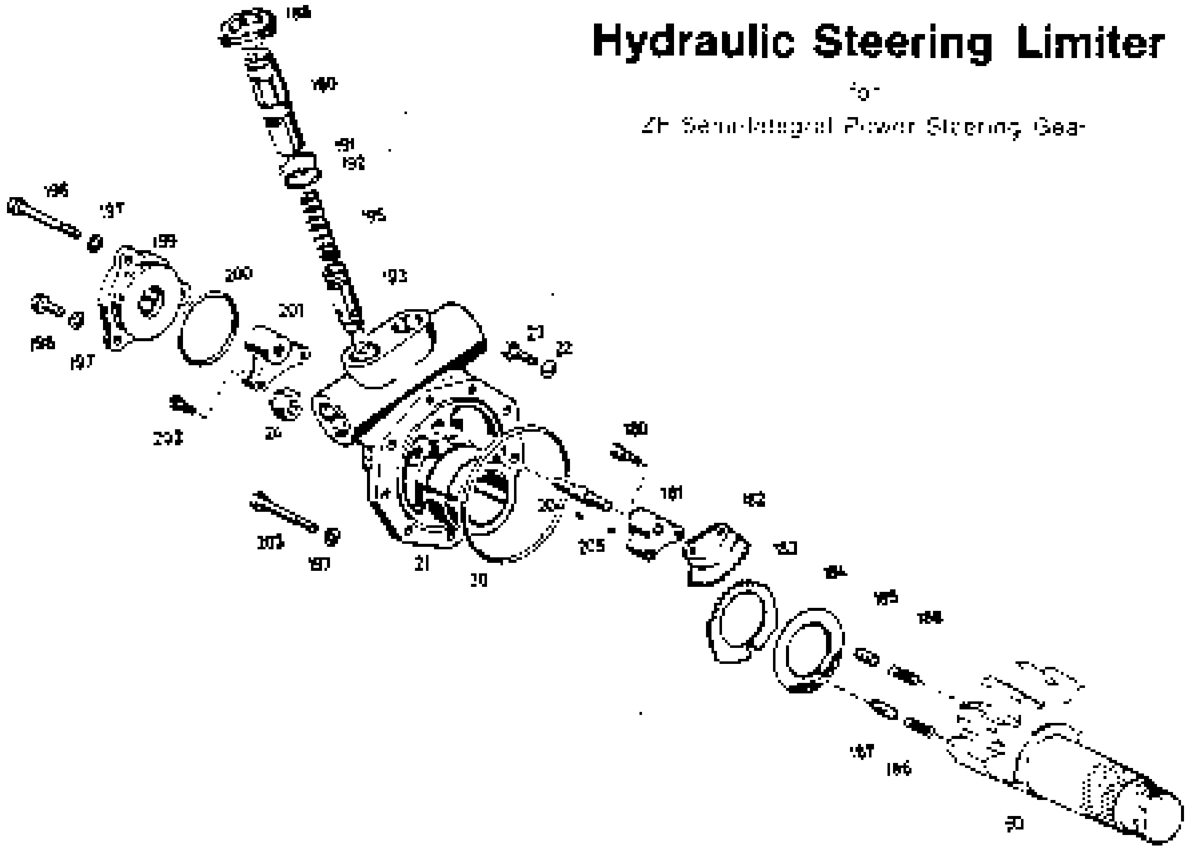
Group Miter Gear:

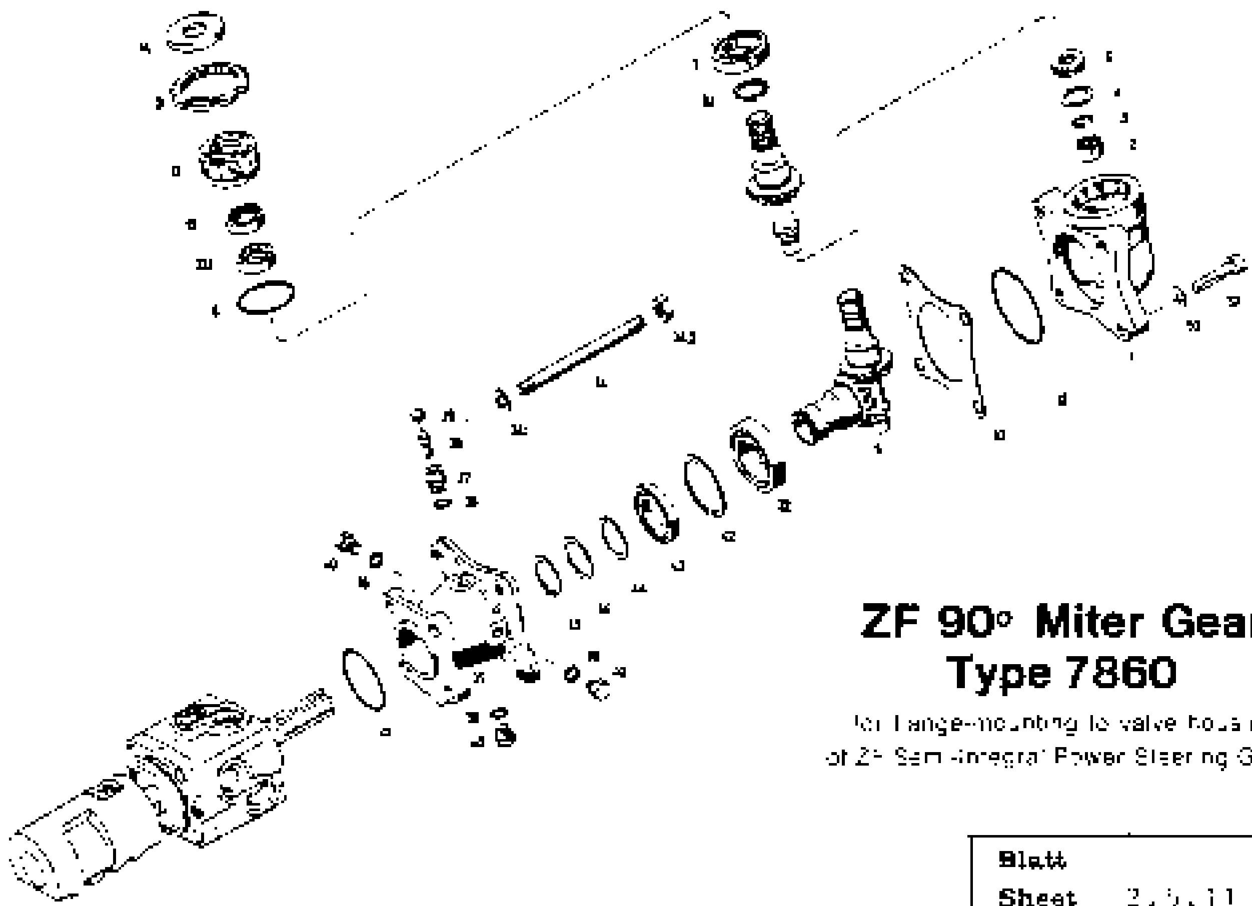
1 Housing
2 Needle bush
3 Circlip
4 Shim
5 Deep groove ball thrust bearing
6 Bevel gear set
6.1 Locking ring
7 Ball bearing
8 O-ring
10 Shaft sealing ring, outer
10.1 Shaft sealing ring, inner
12 Adjusting screw
13 Groove nut
14 Protective cap
30 Shim
32 Deep groove ball bearing
33 O-ring
34 Stud
34.1 Washer
34.2 Hex. nut
35 Intermediate flange
36 Sealing ring
37 Bleeder body
38 Bleeder screw
39 Closing cap
40 Closing plug
41 O-ring
42 Locking ring
43 Deep groove ball bearing
44 Washer
45 Locking ring
50 Washer
52 Cheese head screw

Hydraulic Steering Limiter

for

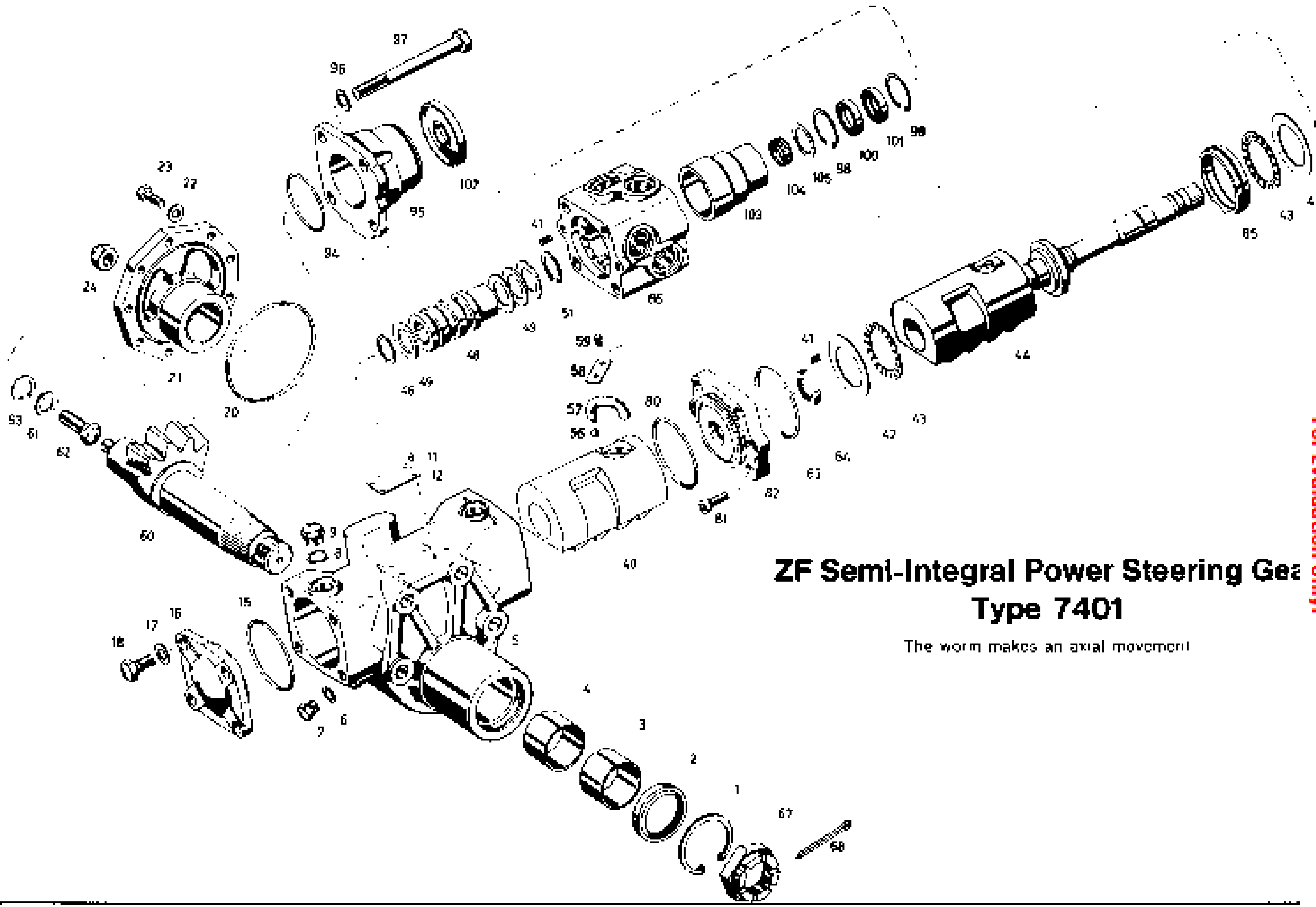
ZF Semi-Integral Power Steering Gear





ZF 90° Miter Gear Type 7860

for flange-mounting to valve housing
of ZF Semi-integral Power Steering Gears



ZF Semi-Integral Power Steering Gea

Type 7401

The worm makes an axial movement

Description -6- (Servostat)

The ZF-hydrostatic power steering system is a hydraulic servo-steering system with hydrostatic transmission of steering power on steered wheels. No mechanical connection between steering wheel and steering linkage will be required.

The vehicle can also be steered manually without hydraulic support, e.g., when towed. In this case the handpump which is operated from the steering spindle act as a steering power unit.

ZF - Servostat

In neutral position of control valve, ducts L and R of working cylinder are separated from ducts HP1 and HP2 of hand pump (16 and 17). The steering system can therefore not be moved from the direction of the steered wheels.

Design

The ZF-hydrostatic power steering comprises:

a) a hand pump (stator 16 and rotor 17) which delivers in counterclockwise and clockwise directions of rotation,

b) a valve piston (11), which is adjusted axially,

c) a double-acting hose-safety valve (3) to restrict oil pressure which may occur in lines (L and R) toward working cylinder,

d) two bypass valves (2), through which the oil pump may suck oil from return flow, when steering without hydraulic support becomes necessary,

e) a check valve (5) (overflow valve without return flow) in pressure line connection (P),

f) a pressure limiting valve (4), which restricts the delivery pressure of the engine-driven pump (6) to required max. value. (Optionally, the steering system is supplied without pressure restriction),

g) a locking valve (14), installed in pressure line between ducts P1 and P2. With the control valve wide open, locking valve will oppose any automatic return of steered vehicle wheels and will thereby maintain the steering direction established by steering wheel.

Functioning

Hand pump

Rotor (17) of hand pump is driven by universal shaft (15), which is connected to steering wheel by means of steering spindle (9). The rotor is supported in internal teeth of stator (16) and completes a planetary motion when turned. This motion is in opposite direction to rotation of steering spindle and proceeds at 6-fold angular speed.

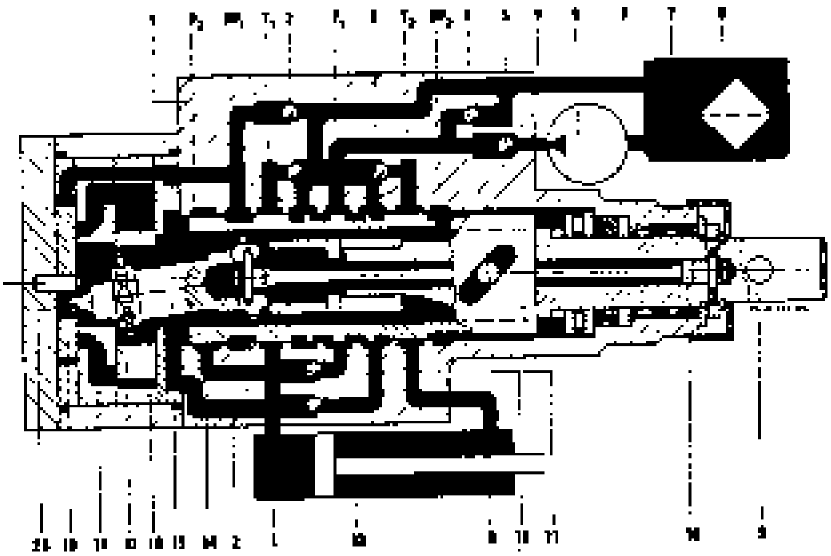
The control disc (19) is driven by the drive pin (20) of the universal shaft. As a result, the control disc is syncronized with the rotor, so that the simultaneously rotating suction and pressure zones of the hand pump are connected to fixed feed or drain ducts in steering case without interruption.

Control valve

The control valve consists of the steering case (1) and the valve piston (11) which is rotatingly and axially slidingly supported in case. When steering spindle (9) is turned, the valve piston is shifted in accordance with direction of rotation of steering spindle from center piston in axial direction to the left or right, and is simultaneously also turned by the steering spindle. This axial movement between steering spindle and universal shaft (15) is attained by the elasticity of the torsion bar. The torsion bar (18) is coupled, on the one hand to the universal shaft by means of drive pins, and on the other hand to the steering spindle. A tooth system connects the universal shaft torsionally rigid to valve piston. Displacement of piston will control the oil flow from pressure oil pump to hand pump and from there to pertinent side of working cylinder.

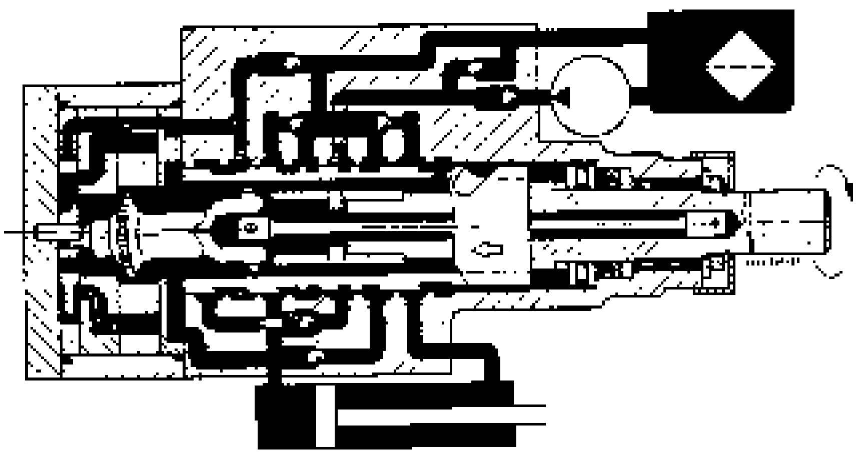
Diagrammatic illustration of hydrostatic power steering system ZF-servostat type 8440 to 8445, closed version

Neutral position of valve

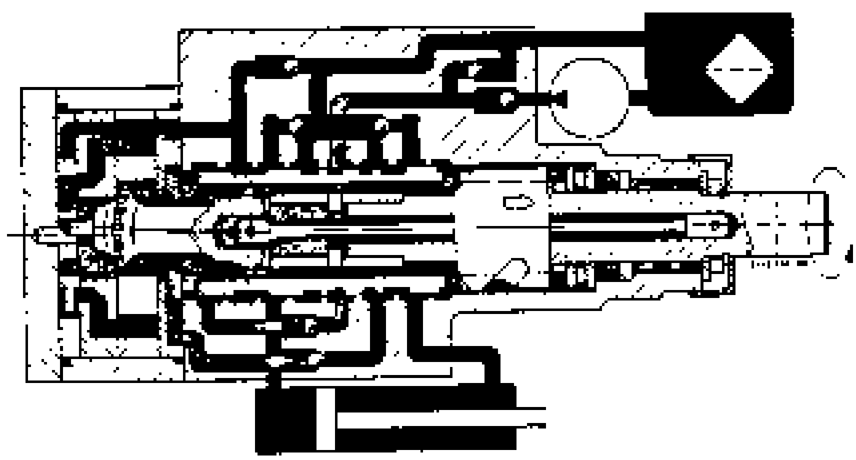


- Return oil or oil circulation in neutral position
- Pressure oil toward intake end of hand pump
- Pressure oil toward working cylinder
- enclosed oil (indefinite pressure)

Clockwise rotation of steering wheel



Counterclockwise rotation of steering wheel



1 Steering case
2 Bypass valve
3 Hose-safety valve
4 Pressure limiting valve
5 Check valve
6 Pressure oil pump
7 Oil tank
8 Oil filter
9 Steering spindle
10 Torsion bar
11 Valve piston
12 Drive pin
13 Working cylinder
14 Locking valve
15 Universal shaft
16 Stator
17 Rotor
18 Control disc
19 Control disc
20 Drive pin

P1) P2)	=	Pressure ducts
HP1) HP2)	=	Pressure ducts of hand pump
T1) T2)	–	Return ducts
P	=	Pressure line (pump)
T	=	Return line (tank)
R	=	Line for working cylinder: Pressure surface when turning steering wheel clockwise
L	=	Line for working cylinder Pressure surface when turning steering wheel counterclockwise

Neutral position of control valve

When steering wheel is released, the valve piston (11) will enter a neutral position. This will permit the delivery flow established by the pressure oil pump (6) to flow from pressure duct P_1 to the return ducts T_1 and T_2 at the left and right there of and from there to the oil tank (7). The oil in the other ducts and in hand pump is not moving. In the closed version, the control ducts for working cylinder L and R have no connection to hand pump ducts HP_1 and HP_2. The built-in, double-acting hose-safety valve (3) prevents excessively high pressure peaks in the steering system, which may be established by impact-blows while driving.

Valve in working position

When steering wheel is turned, the universal shaft (15) is set into motion via steering spindle (9) and torsion bar (10). Teeth of spindle will enter internal rotor of hand pump and take rotor along. The delivery flow established thereby will move, when steering wheel is turned counterclockwise, via control plate (18) and control disc (19) to ring grooves HP_1 and L and from there to the working cylinder (13). The oil pressure required in cylinder for steering will resist the rotation of rotor (17). As a result, the angle of rotation of steering spindle will be larger than that of the rotor and of valve piston (11). Valve piston will rotate in relation to steering spindle only during a simultaneous axial movement. This is effected by a drive pin (12), which is attached in steering spindle and runs in the diagonally located groove of the valve piston.

When the valve piston is shifted axially to the right inside housing (turning steering wheel counterclockwise), duct P_2 will open. The oil can then move from engine-driven pump (6) to suction end of hand pump. From pressure end of hand pump the oil will flow through duct HP_1 and L to left side of working cylinder. The right side is connected to return flow by opening of control edge between duct R and T_2.

When driving around a righthand bend, i.e., when steering wheel is turned clockwise, valve piston will move toward the left. This will connect the following ducts to each other:

a) P_2 with HP_1 = the pressure oil of the power steering pump can flow to suction end of hand pump.

b) HP_2 with P = the oil of hand pump flows to working cylinder

c) L with T_1 = the oil discharged by working cylinder flows into return duct

When steering without hydraulic oil support of the engine-driven pump, i.e., when the vehicle is towed, the driver should generate the oil pressure required to change the driving direction by means of hand pump. This requires a higher actuating force than necessary when steering with support of pressure oil pump.

Maintenance

a) Oil change

Change oil once a year together with main inspection jobs on vehicle; for vehicles which are less often used, at the latest every two years. Make sure of absolute cleanliness when changing oil.

Note: Jack up steering axle until the wheels are free turnable) before oil change (jack up with hydr. support of crane)

b) Filter cartridge

Replace filter cartridge in oil tank.

Exchange filter cartridge when changing oil of steering system.

Lubricate filter bracket prior to inserting new filter cartridge.

c) Filling oil and venting

The hydrostatic power steering system and the pump are filled with oil through filler neck on oil tank, the latter is filled with oil up to rim. Then the engine is cranked for a short moment with starting motor. The oil level will drop; consequently oil must be added continuously so that the oil tank can never be sucked empty by the pump.

When the oil tank is filled up to upper mark on oil dipstick, keep engine running. Then turn steering wheel as quickly as possible toward one side to displace steering axle, that is, until on side of working cylinder is filled with pressure oil. Watch oil level and keep adding oil as long as required. Then turn steering wheel toward the other side, until piston rod of working cylinder is moving in that direction. Again supplement oil level.

Then turn steering wheel toward both sides to full lock. Repeat until no more air bubbles are rising in oil tank. Fill air tank again with oil up to upper mark. Lower steering axle. Then turn wheels, which are now under load, once again to the left and right to full lock to check.

Stop engine. Oil level may rise slightly in the oil tank 1 to max. 2 cm. Any additional rising of oil level indicates that there are still air bubbles in oil.

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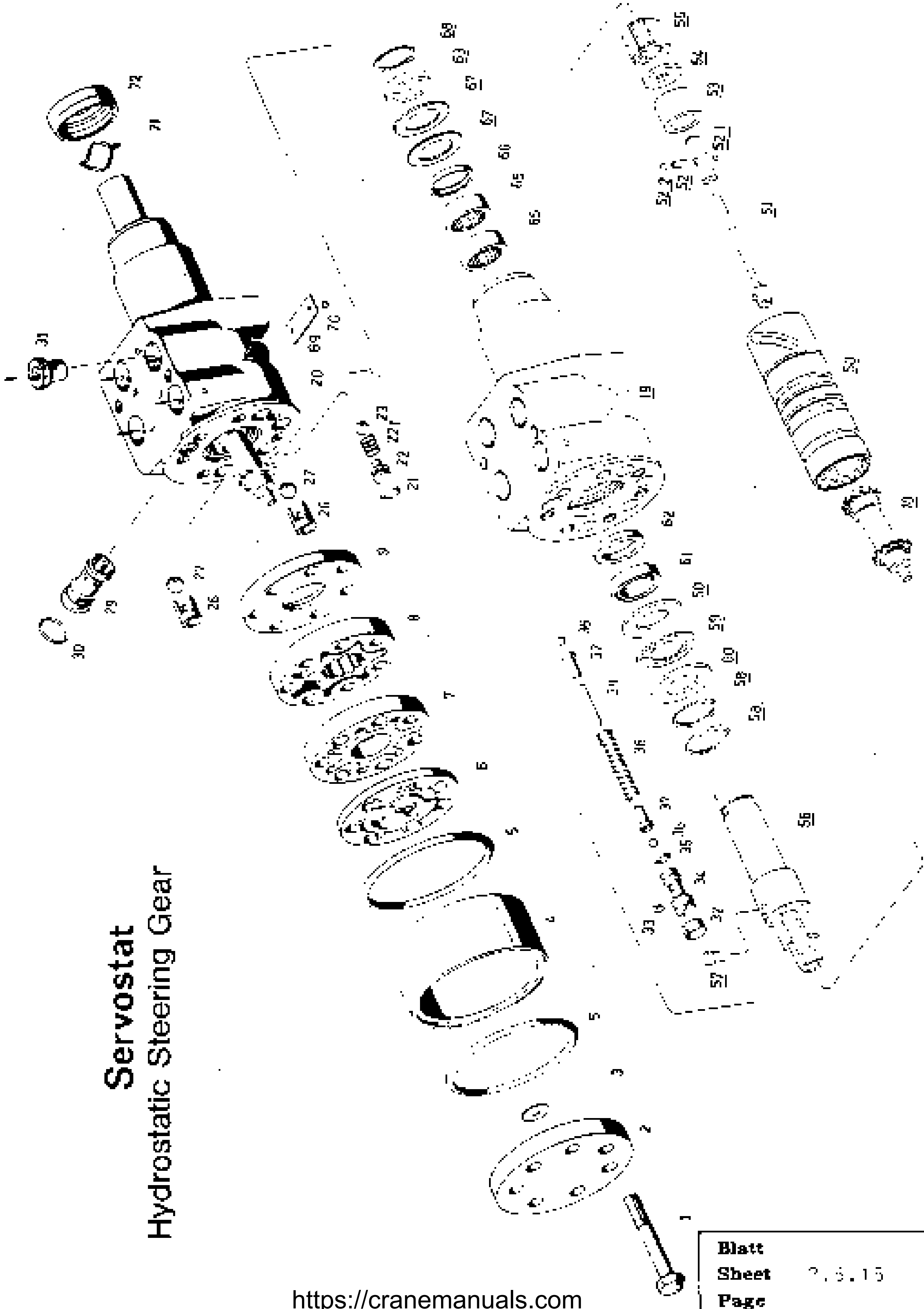

Servostat
Hydrostatic Steering Gear

Servostat

Item	Designation	Item	Designation
1	Hex. screw	50	Valve piston
2	Cover	51	Torsion bar
		52	Needle
3	Thrust washer	52.1	Small ball
4	Pipe	52.2	Large ball
5	Sealing ring	53	Spring tube
6	Control disc	54	Adjusting disc
7	Control plate	55	Drive ring
8	Rotor set	56	Steering spindle
		57	Drive pin
9	Cover plate	58	Washer
10	Universal shaft		
19	Housing single component	59	Axial needle bearing
20	Housing compl.	60	Washer
21	O-ring	61	Shaft sealing ring
22	Plug	62	Supporting washer
22.1	Compression spring	63	Ring
23	Ball		
26	Ball guide	65	Needle sleeve
27	Ball	66	Shaft sealing ring
29	Valve insert	67	Washer
30	O-ring	68	Locking ring
31	Valve	69	Type rating plate
32	Sealing tape	70	Oval head notched pin
33	Plug	71	Snap ring
34	Valve seat	72	Protective cap
35	O-ring		
36	Ball		
37	Valve body		
38	Compression spring		
39	Needle		

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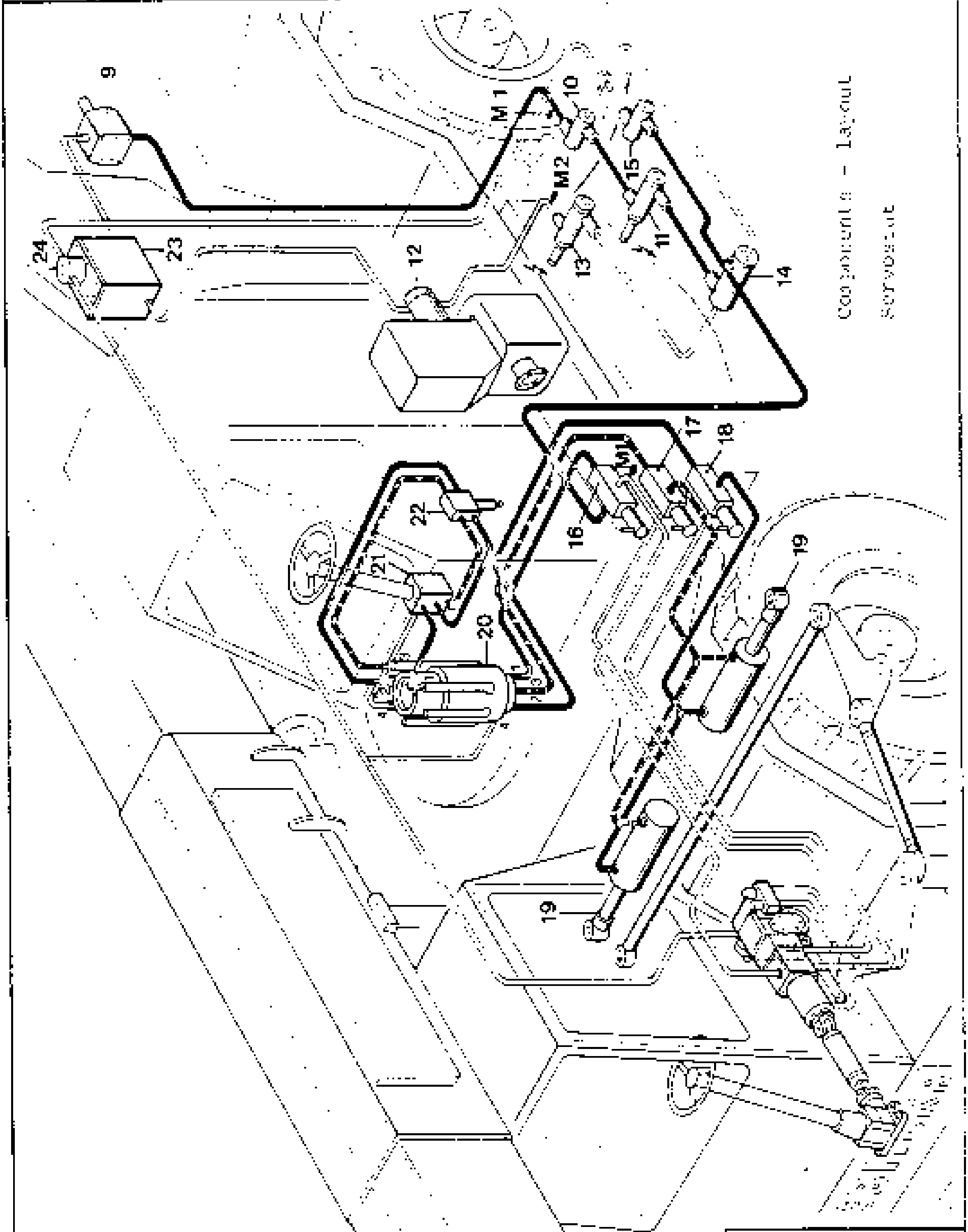
Steering

Components – Layout
Servosteering



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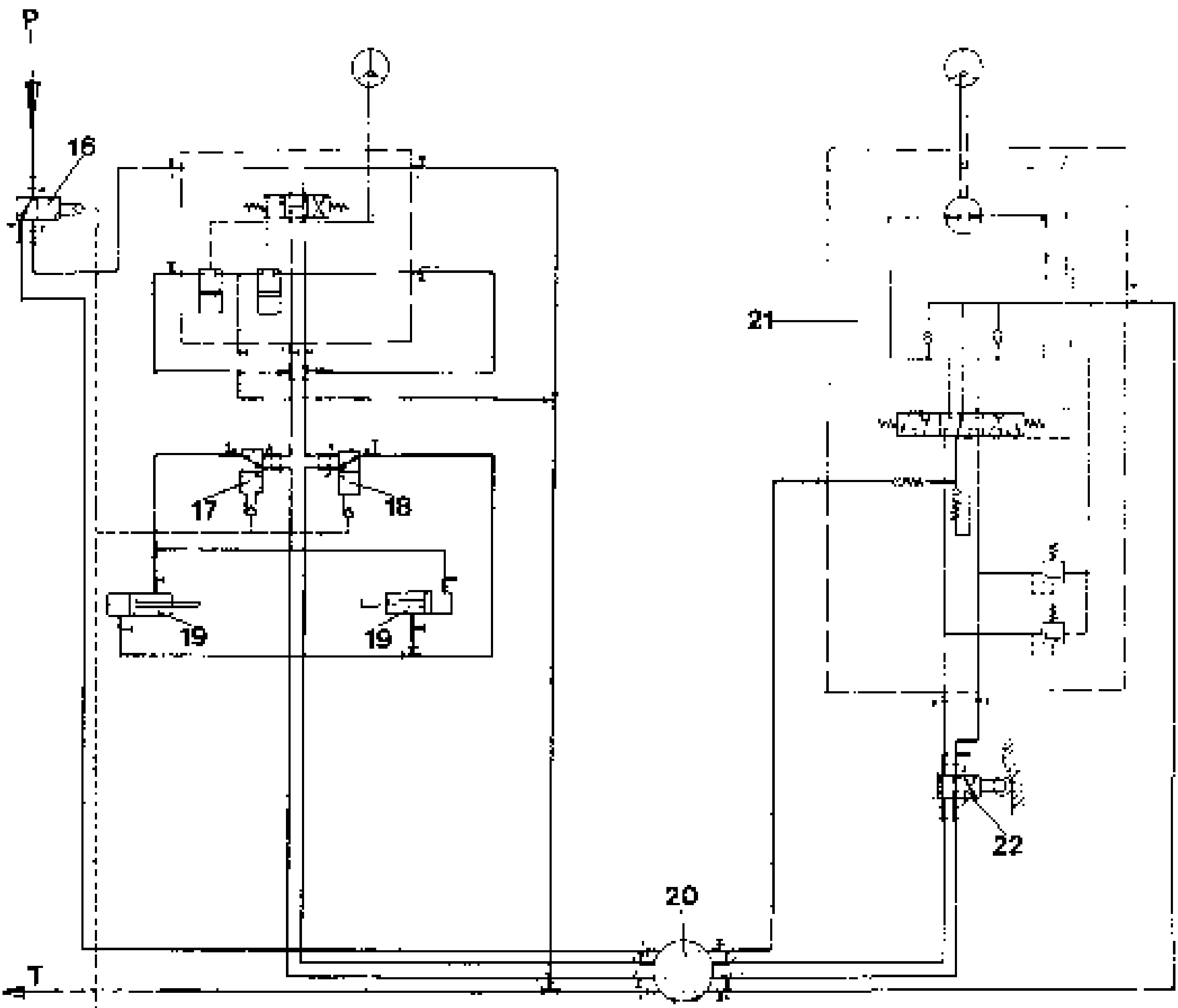
Hydraulic Circuit



Auxiliary consumers
air brake system

List of Components

20. Rotary connection
21. Servostat
22. Steering direction - changeover valve

Connections on Servostat				Connections on rotary connector
T	-	Return line from servostat to tank	=	4
P	=	Pressure line from pump	=	1
R	=	Pressure line for steering right turns		2
L	=	Pressure line for steering left turns		3

The support system consists of sliding outrigger arms (25), support jacks (11) and rams to extend the outrigger arms (12). The system is intended to support the vehicle firmly during crane operations.

Support jacks - removing and installing

1. Extend the outrigger arms (25) slightly.
2. Remove pin (27).
3. Unscrew the hydraulic hoses (28). Protect the unions against the ingress of dirt.
4. Take off the support jack (11).

To install, follow the above instructions in the reverse order.

Note:

Make sure that the hydraulic hoses (28) are not twisted when attaching them to the support jack (11).

Sliding outrigger arm rams - removing and installing

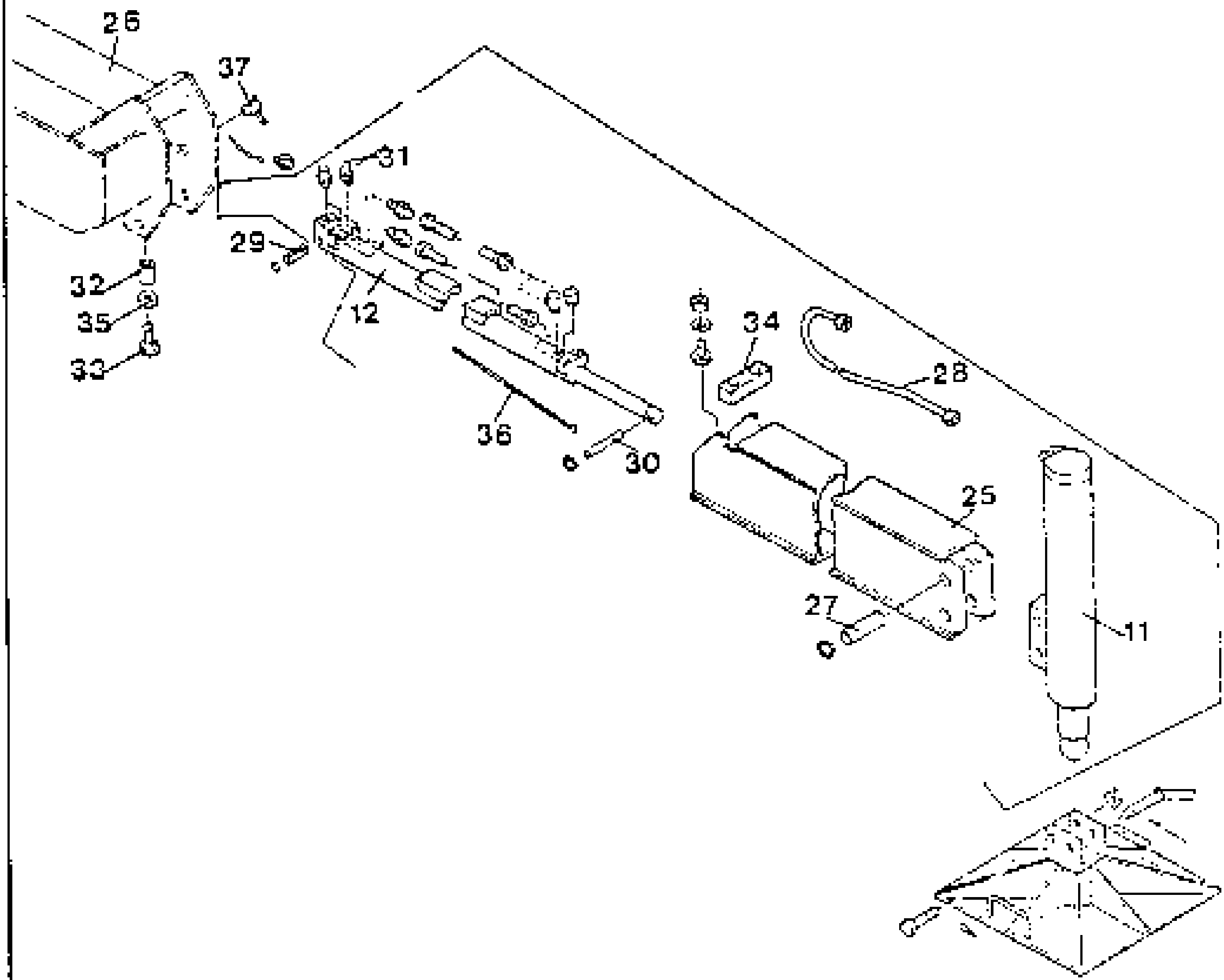
1. Take off the support jack (11) - see above.
2. Raise the sliding outrigger arm (25) slightly, slacken off adjusting screws (33) and press down sliding blocks (32).
3. Mark the hydraulic hoses (31) to identify them, and unscrew at point A (prevent dirt from entering the open unions).
4. Remove pin (29).
5. Using a second crane or hoist, remove sliding outrigger arm (25) from its box (26).
6. Remove sliding outrigger ram (12) with hydraulic hoses (28) and (31), after taking out pin (30).

To install, follow the above instructions in the reverse order.

Adjusting the sliding outrigger arm bearings

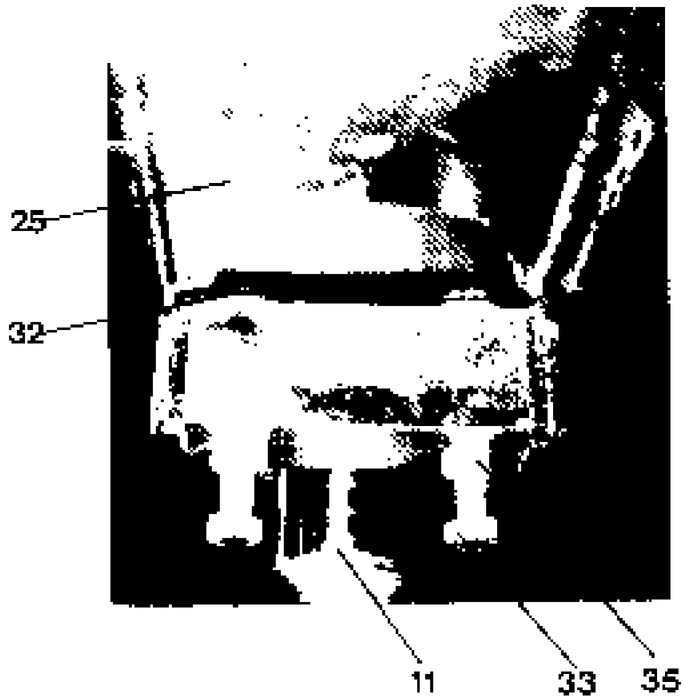
When sliders (32) and (34) are worn down, play between the sliding outrigger arm (25) and the outrigger box (26) - item 3, in the extended position - will become excessive, and the bearings must be adjusted. This is done by tightening the adjusting screws (33). If no further adjustment is possible, sliders (32) and (34) must be renewed.

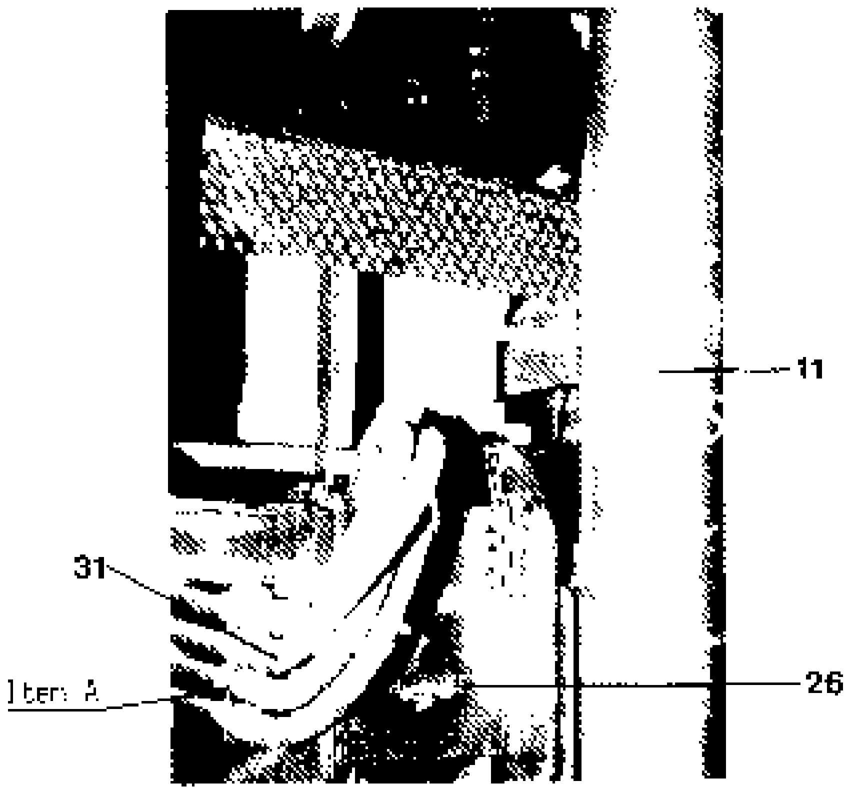
General arrangement of components

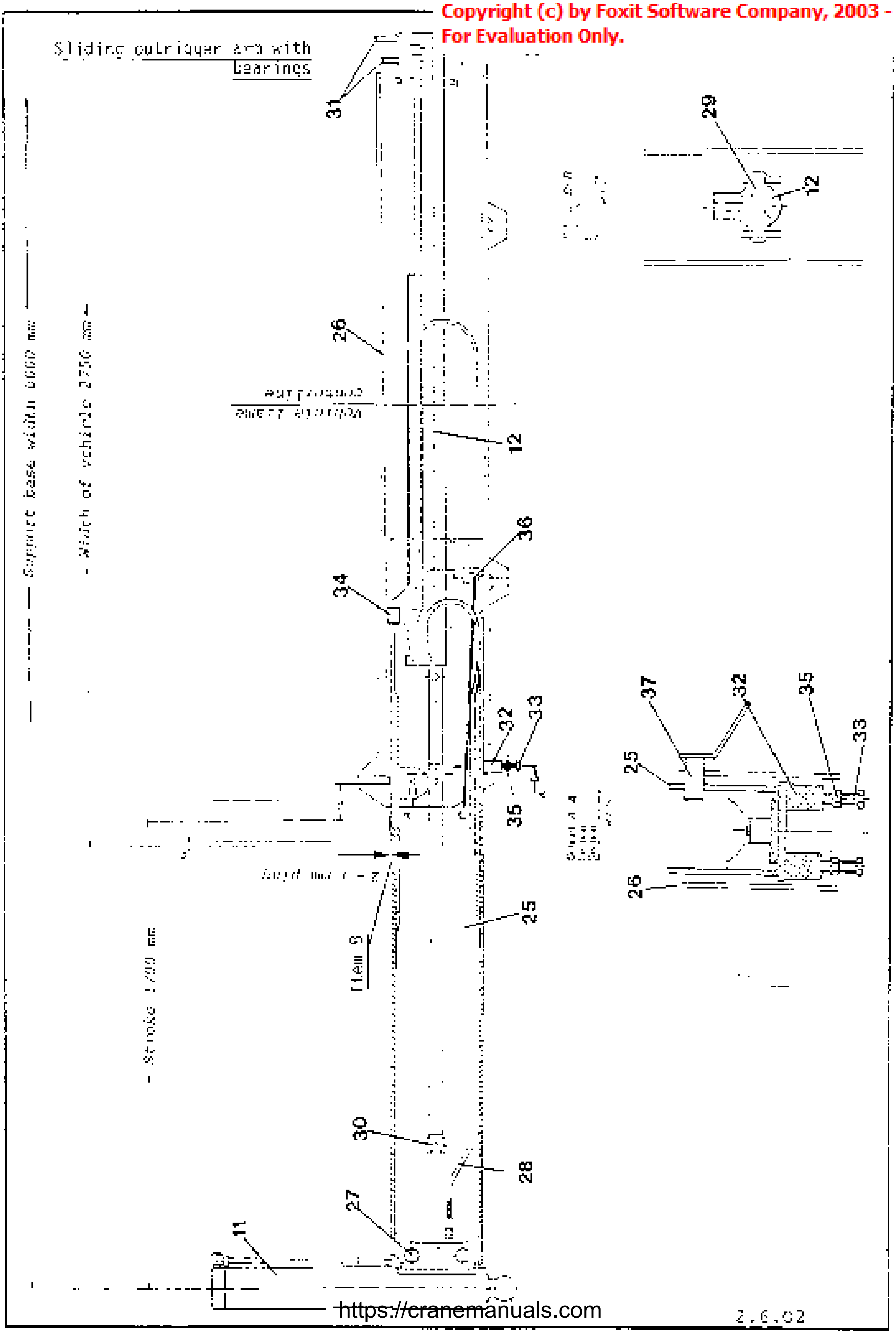


List of components

11. Support jack
12. Sliding outrigger ram
25. Outrigger arm
26. Outrigger arm box
27. Pin
28. Hydraulic hoses
29. Pin
30. Pin
31. Hydraulic hoses
32. Sliders (lower)
33. Adjusting screws
34. Slider (upper)
35. Locknut
36. Holder (for hose guidance)
37. Pin (to secure arm when extended)






Sliding outrigger arm with bearings
31
29
12
26
12
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25
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25
Item 9
30
28
27
11
2.6.02

Hydraulic circuit for outrigger supports

Description

The gear type pump (1) is driven directly from the diesel engine through the torque converter, and delivers oil through discharge-side filter (2) to the rotary spool valve.

When the rotary spool valve (3) is in the neutral position, oil returns from it via check valve (4) to tank (14).

When a working movement is initiated (e.g. extending the sliding outrigger arms), the rotary spool valve (3) is actuated in parallel with the the control valve (6) or (9). Operation is electrical, from push buttons in the cab or at the left or right control panels, wired to solenoid valves. Oil at high pressure can then flow from pump (1) via filter (2), spool valve (3) and control valve (6) or (9) to the hydraulic rams (12). The return flow of oil passes through the control valve (6) or (9) and thence back to tank (14).

Pressure settings

M1: 185 bar - max. primary pressure for support jacks (11)

185 bar - max. primary pressure for rear-wheel steering rams (17)

M2: 90 bar - max. pressure for extending sliding outrigger arms

Primary pressure

1. Connect a pressure gauge to measuring point M 1.
2. Change position of ball tap block (hydr. axle suspension) (see hydr. axle suspension item 4,)!
3. Run the support jack out or in to its full extent.
4. Set pressure limiting valve (3a) on rotary spool valve (3) to 185 bar.

Pressure setting for extending outrigger arms

1. Connect a pressure gauge to measuring point M1.
2. Change position of ball tap block (hydr. axle suspension) (see hydr. axle suspension item 1,)!
3. Extend the outrigger arm ram fully.
4. Set pressure limiting valves (4) to 90 bar.

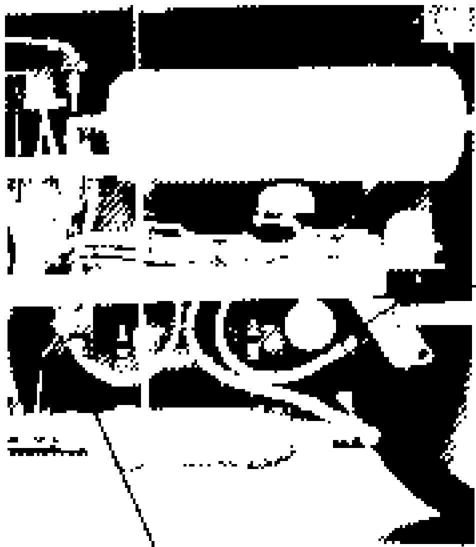
Maintenance

Maintenance work consists of checking the oil level once a week in the hydraulic fluid tank with the hydraulic rams retracted, and lubricating the sliding outrigger arm bearings.

At least once a year, the hydraulic fluid should be examined and renewed if necessary. At the same time, the pressure-side filter (2) should be renewed.

Oil level

14



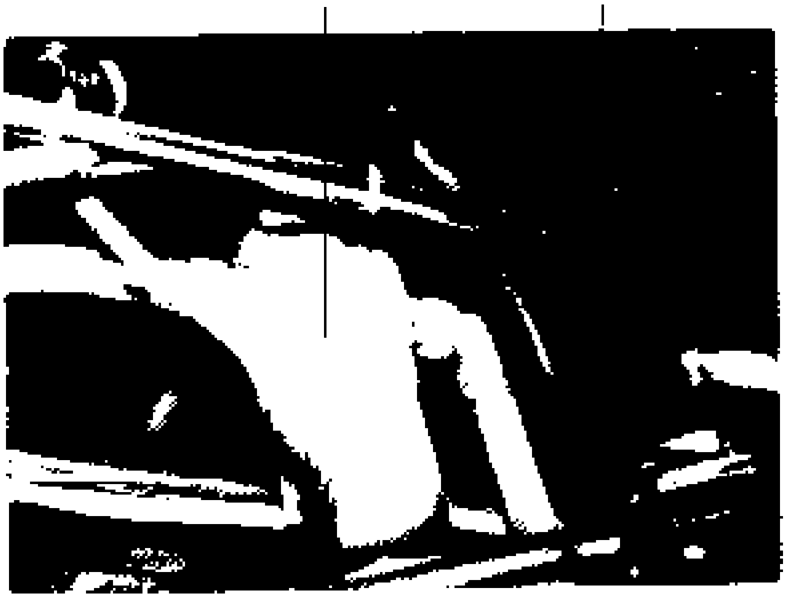
M1

Oil tap block

2

Frame -inside-

Rear-right-



List of components

Hydraulic system for supports

Item	Designation
1	Gear-type pump
2	Pressure-side filter
3	Rotary spool valve
3a	Pressure limiting valve (185 bar)
4	Pressure limiting valve (90 bar)
5	Control valve (solenoid-operated multi-way valve) for front right support
6	Control valve for right sliding outrigger arms
7	Control valve for front left support
8	Control valve for rear right support
9	Control valve for left sliding outrigger arms
10	Control valve for rear left support
11	Support jack
12	Sliding outrigger arm ram
13	Shutoff valve (suction line)
14	Hydraulic fluid tank
20	Pressure take-off for hydr. axle suspension

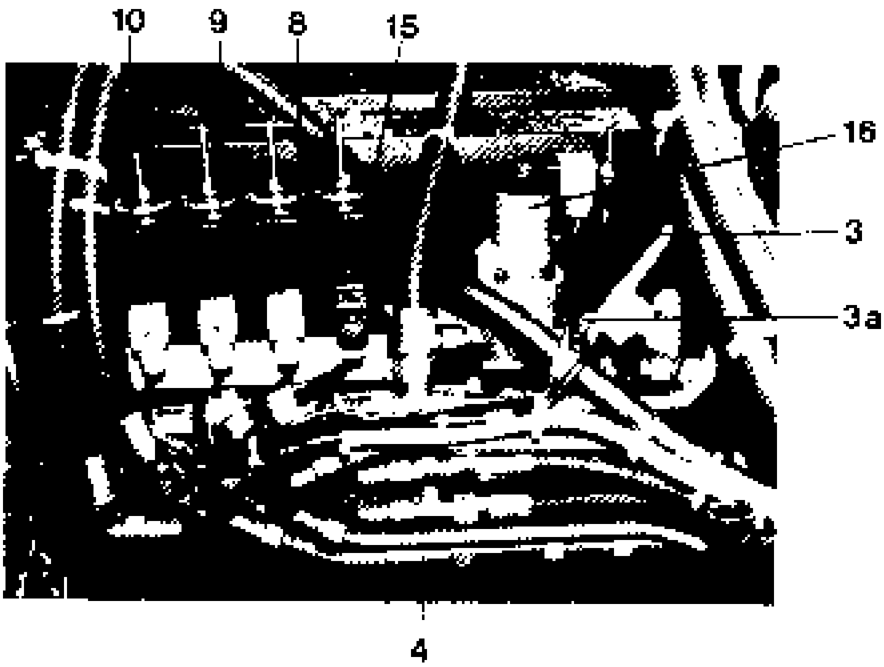
Hydraulic system for rear-wheel steering

Item	Designation
15	Steering control valve
16	Multi-way solenoid valve
17	Steering ram
18	Pneumatic ram for locking rear-wheel steering
19	Micro-switch for floating position of rear-wheel steering

M 1: Measuring point for support circuit
Measuring point for rear-wheel steering

List of components

Rear cylinder



Front cylinder :

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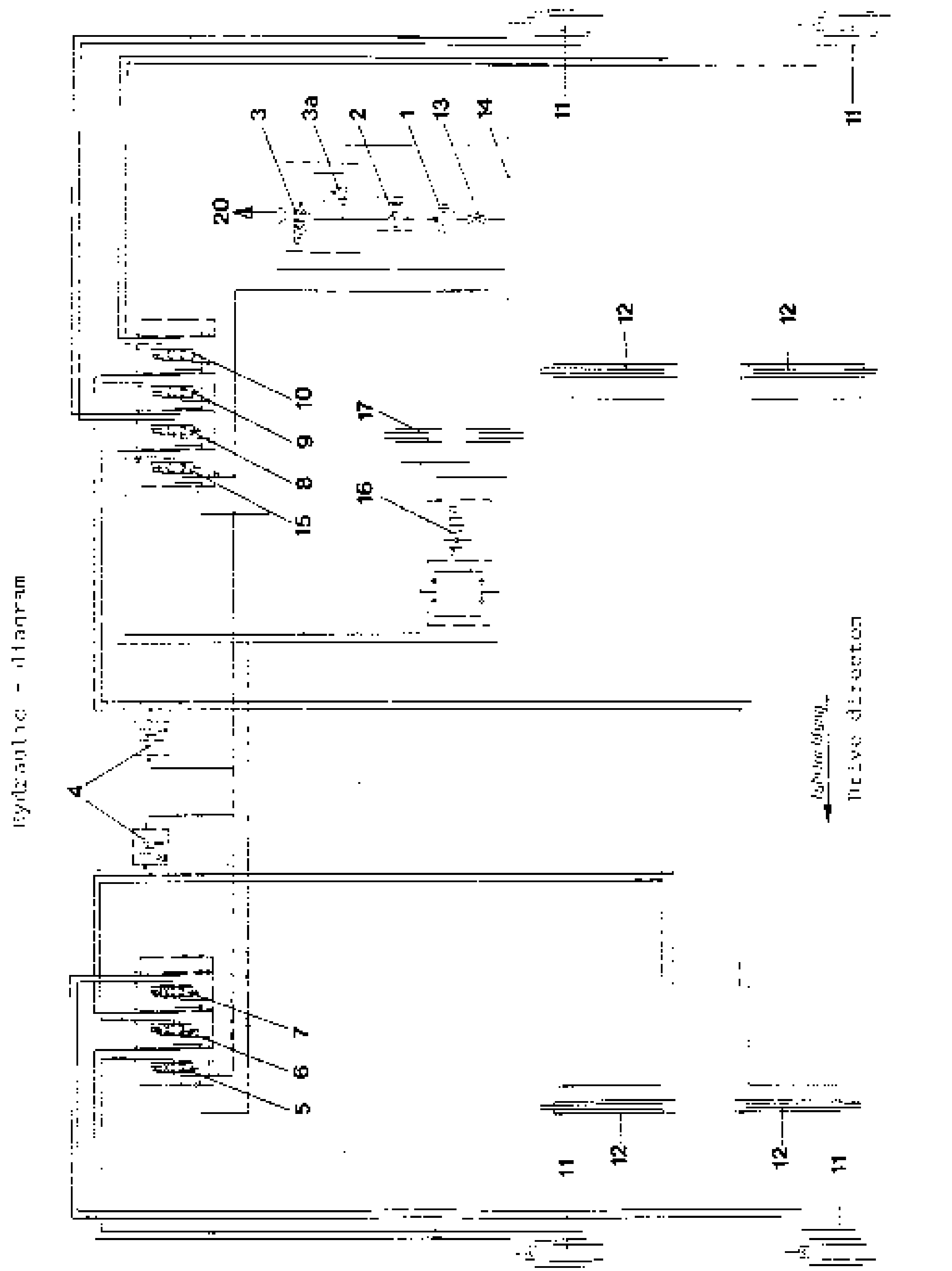
Support



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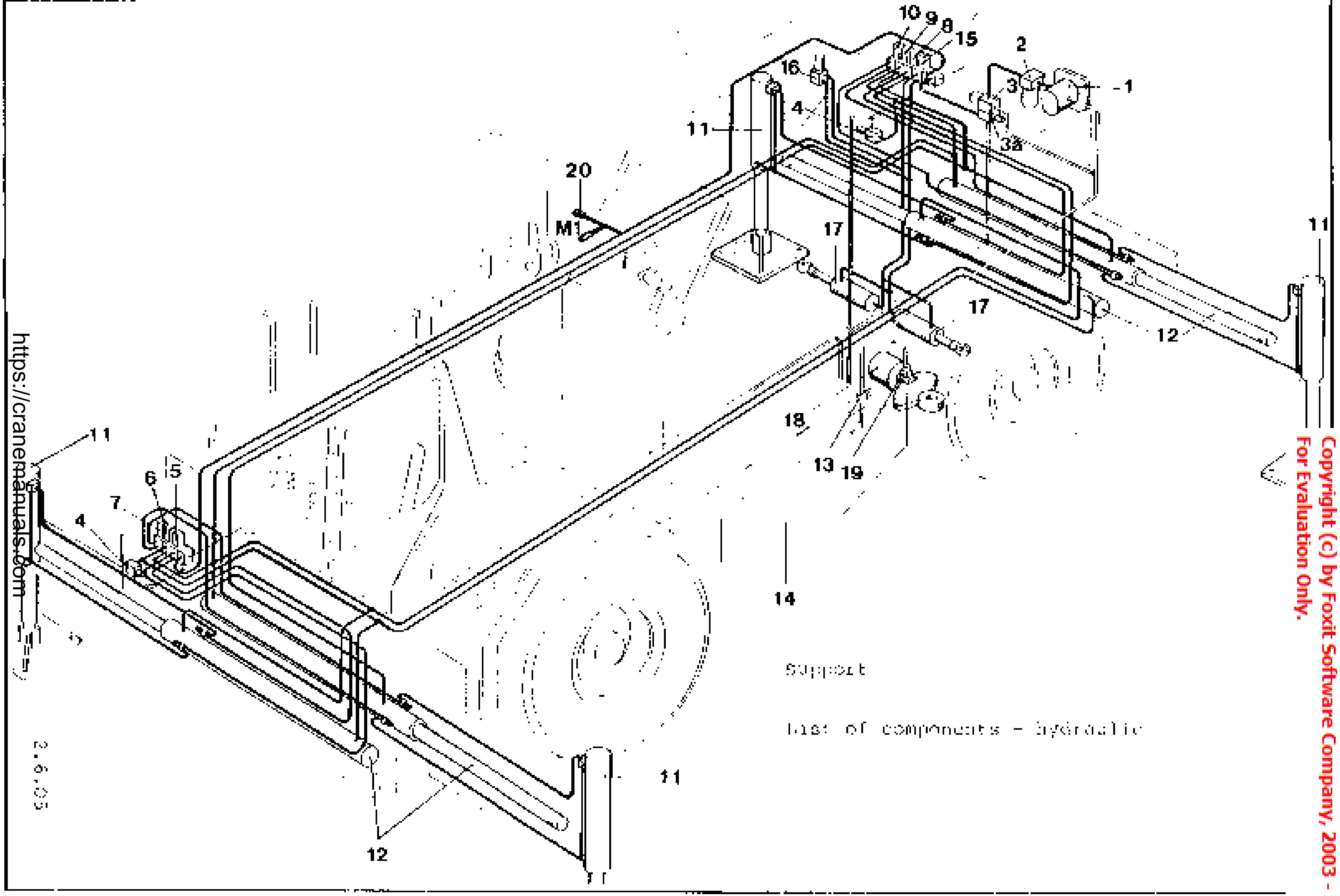


Support

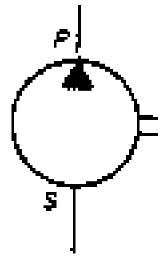
List of components - hydraulic

2.6.05

High pressure-gear pump

The gear pump belongs in the constant-flow pump category, that is to say its discharge rate is proportional to the running speed.

Symbol



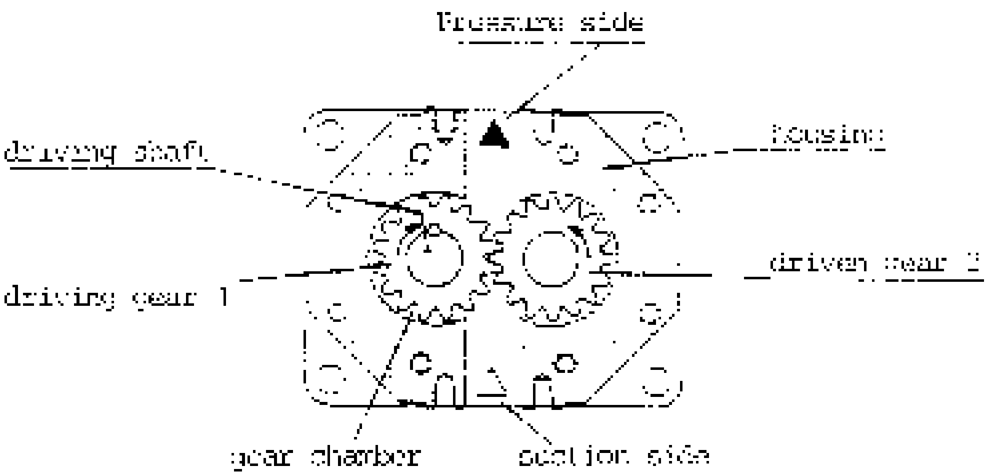
High pressure-gear pump

Operating principle:

The gear pump comprises mainly a housing, in which a pair of gears run with such low axial and radial play, that the unit is practically oil-tight.

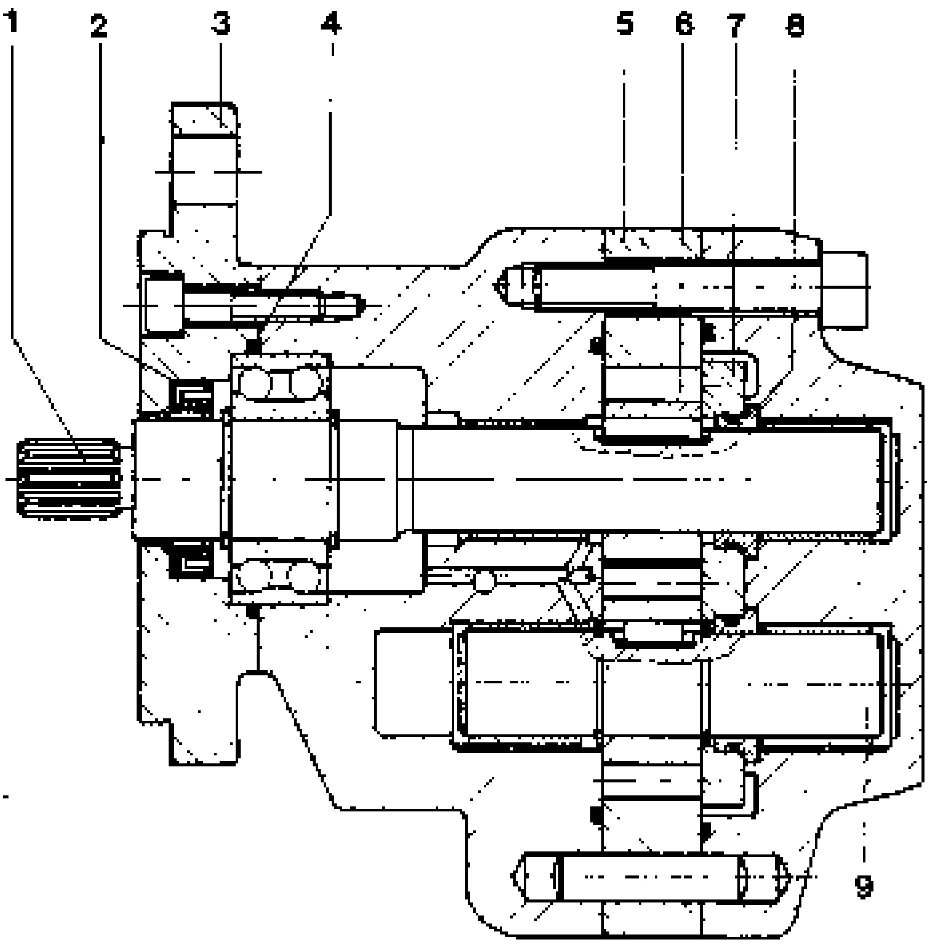
Gear 1 is driven in the direction of the arrow, and causes gear 2 to move with it in the opposite direction.

Functional diagram - gear pump



The suction side is connected to the tank. The rotary movement causes the gears to separate, so that the gear spaces are free. The negative pressure caused by this and the atmospheric pressure on the fluid level in the tank cause fluid to run from the tank to the pump. The fluid fills the gear spaces, which form closed chambers with the housing during further movement, and is pushed to the pressure side. The gears then interlock once more and push the fluid from the gear chambers.

The gears which would come into contact with one another prevent return flow from the pressure chamber to the suction chamber. It can be seen from the functional diagram that the gears close the the spaces before these are completely empty. Without unloading in the remaining chambers, very high pressures would occur, which would result in hard pulsating running of the pump. For this reason, unloading bores are arranged at this position on the side of the bearing blocks. The socalled "compressed fluid" is thus fed into the pressure side. The pressure side is connected to the hydraulic system.



Item	Designation
1	Drive shaft
2	Shaft sealing
3	Flange
4	O-ring
5	Housing
6	Gear
7	Bearing blocks
8	Sealing sleeve
9	Driven shaft

On pumps with only <u>one</u> direction of discharge, the correct direction of rotation is shown by an arrow.

The larger-diameter union is the suction (inlet) side, the smaller-diameter union the discharge (outlet) side.

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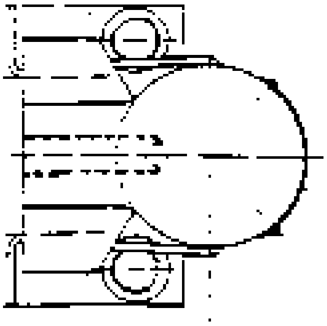
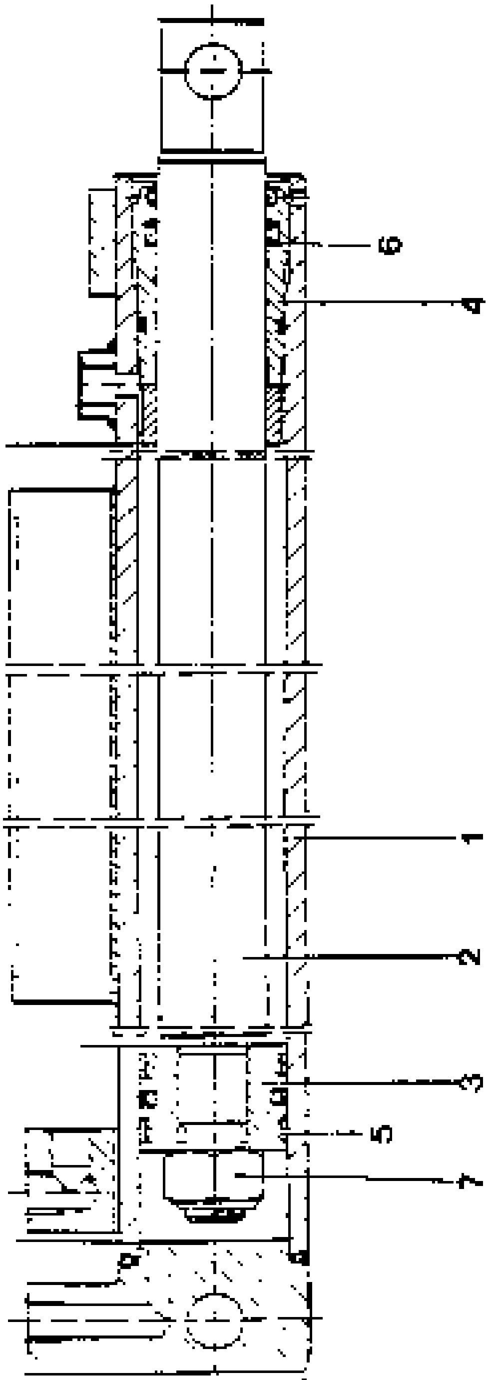
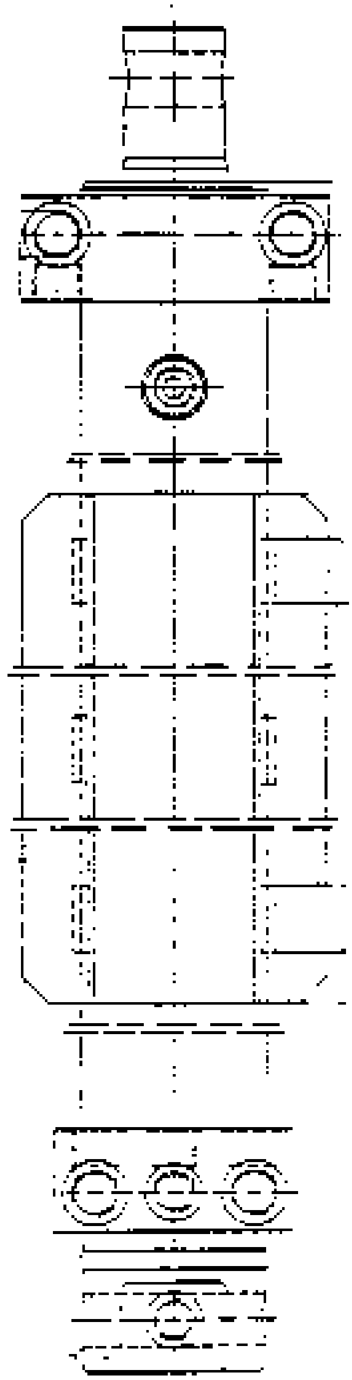
Support

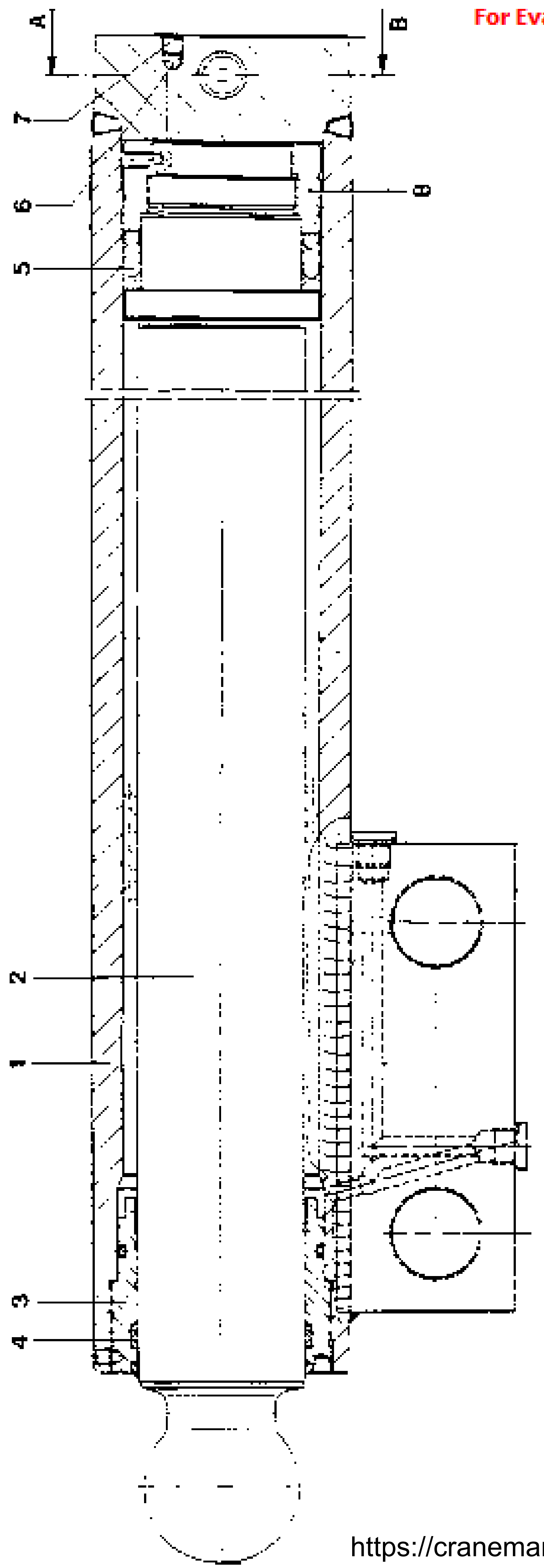
Rams for gliding outrigger arms

1 Cylinder
2 Piston rod
3 Piston - guide ring
4 Piston rod bearing
5 Piston sealing
6 Piston rod sealing
7 Nut



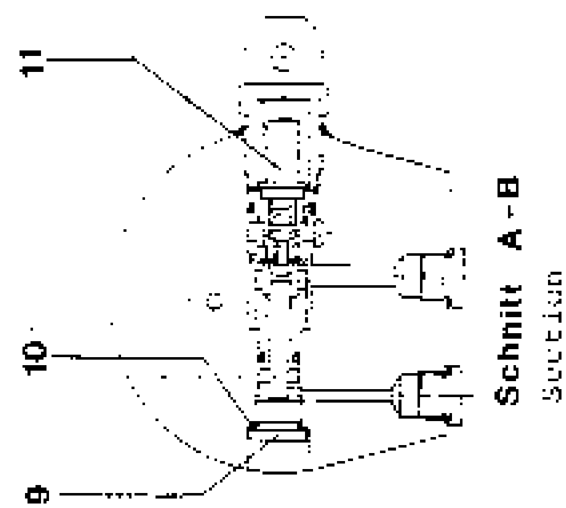






Support jacks

1 Cylinder
2 Piston rod
3 Piston rod bearing
4 Piston rod sealing
5 Piston sealing
6 Ball
7 Threaded rod
8 Piston rod head
9 Screw
10 Sealing ring
11 Inhibit valve



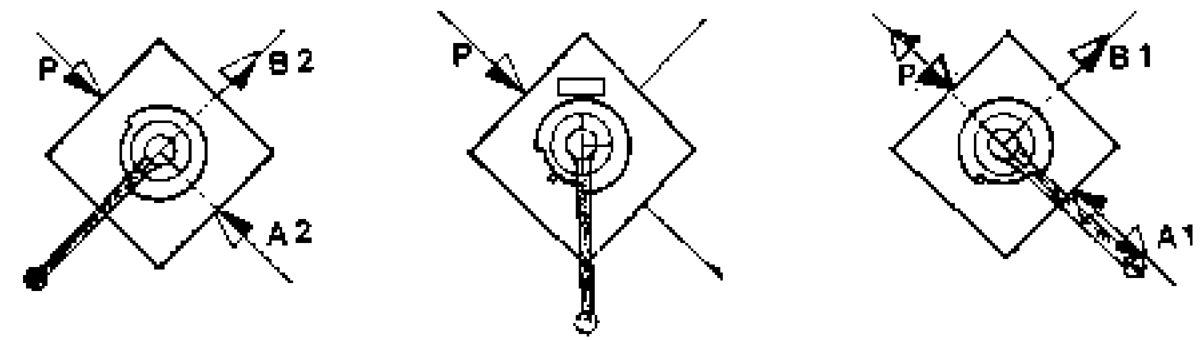
Operating principle

Both axles are sprung hydraulically, using bag-type reservoirs (10). The system is charged by a hydraulic pump (1) driven directly from the diesel engine, via pressure-side filter (2), recirculating spool valve (3), ball locking valves (4 - 9), bag-type reservoirs (10) and locking rams (11).

The suspension can be locked rigidly by moving ball taps (9).

Operation of ball-valve locking taps

Ball tap -4-



P = Pump pressure from recirculating spool valve

A1 = Charging pressure to ball taps 5 - 8

B1 = Charging pressure to gauge and measuring point M1

A2 - Suspension pressure from ball taps 5 - 8

B2 Suspension pressure to gauge and M1

Position 1:

Through-flow passages blocked.

Position 2:

Through flow is unobstructed.

a) For charging the hydraulic system
b) For draining the oil
c) To pressure gauge and measuring point M1 (reading off pump pressure)

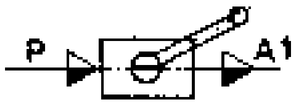
Position 3:

a) Through flow for pump pressure blocked
b) Suspension pressure can reach pressure gauge.

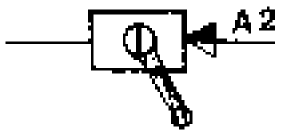
Description of ball-valve locking taps

Ball taps 5, 6, 7 and 8

Charging position (open)



Closed position



P = Pump pressure from ball tap -4-

A1 = Charging pressure to bag-type reservoirs (10) and hydraulic rams (11)

A2 = Suspension pressure

"Charging" (open) position

Through flow

a) to charge hydraulic system

b) to drain the oil

c) to check suspension pressure

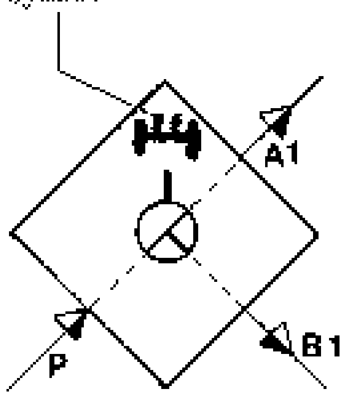
"Closed" position

Through flow blocked.

Ball taps 9

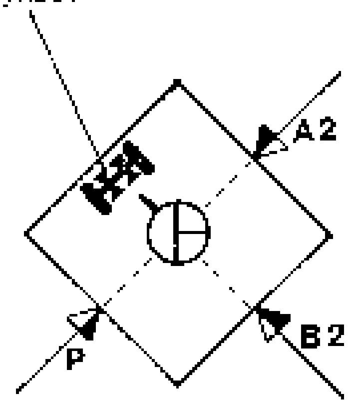
"Charging/suspension" position

Symbol



Blocked position

Symbol



P = Charging or suspension pressure

A1 Suspension pressure at piston crown face in ram cylinder

B1 = Suspension pressure at ring face in ram cylinder

A2 = Trapped pressure at piston face

B2 = Trapped pressure at cylinder ring face

Description of ball taps -9-

"Charging/suspension" position

Through flow

a) to charge the hydraulic rams (piston and cylinder sides)
b) to connect the hydraulic fluid flow from the ram to the bag-type reservoir.

"Blocked" position

Flow from cylinder to bag-type reservoir and connection between piston and cylinder-barrel faces in ram are both blocked.

Control of hydraulic suspension - road travel

1. Rocker switch (A) on the control panel is used to reset the recirculating spool valve from the oil circuit position (B) to the suspension position (C). Telltale lamp (D) comes on.

2. Move ball tap (4) to position II.

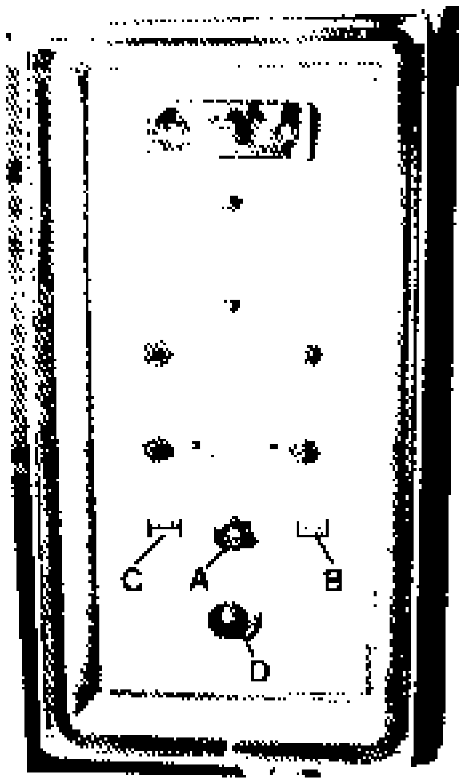
3. Move ball tap (9) to the position in which the suspension is in operation.

4. Open ball taps (5 - 9) in pairs (front axle, rear axle) and raise the vehicle (E). When the correct height for road travel has been reached, close ball taps (5 - 9).

5. Check that all four rams are correctly positioned. Align individually if necessary. The settings are correct when mark (E) on the measuring rod has reached mark (F) on the ram.

6. Move ball tap (4) to position I.

7. Reset rocker switch (A) to the recirculating position.



Control panel
(on the right, looking forwards)

Checking suspension pressure

Pressure in the hydraulic system should be app. 90 bar.

1. Set ball tap (4) to position III.
2. Open ball taps (5 - 8).
3. Read off pressure at gauge (12).

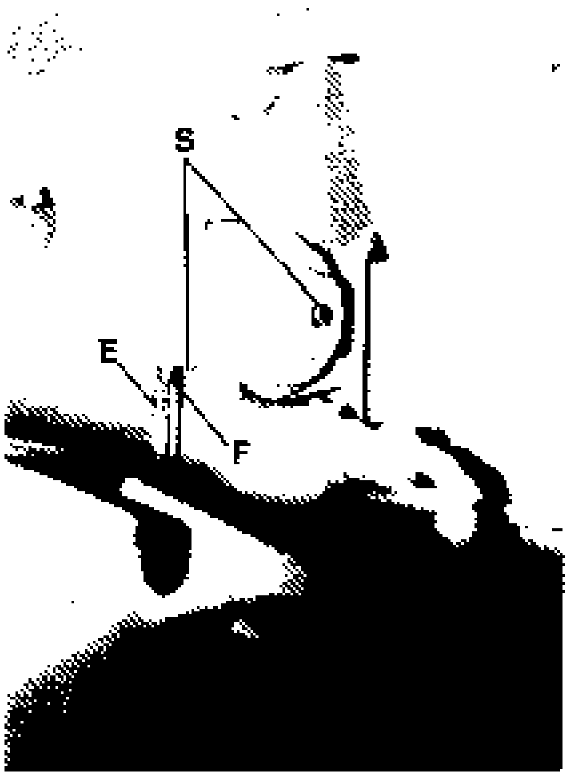
Adjusting pressure

See 'Supports' (2.5.03).

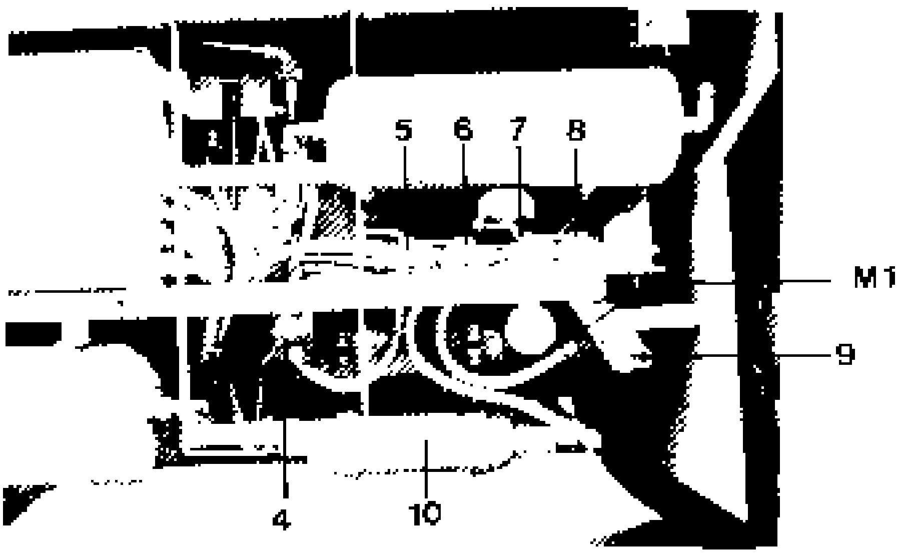
Maintenance

a) Once a week, lubricate the locking ('Festolock') ram pivot bearings at grease nipples -S- (top and bottom).

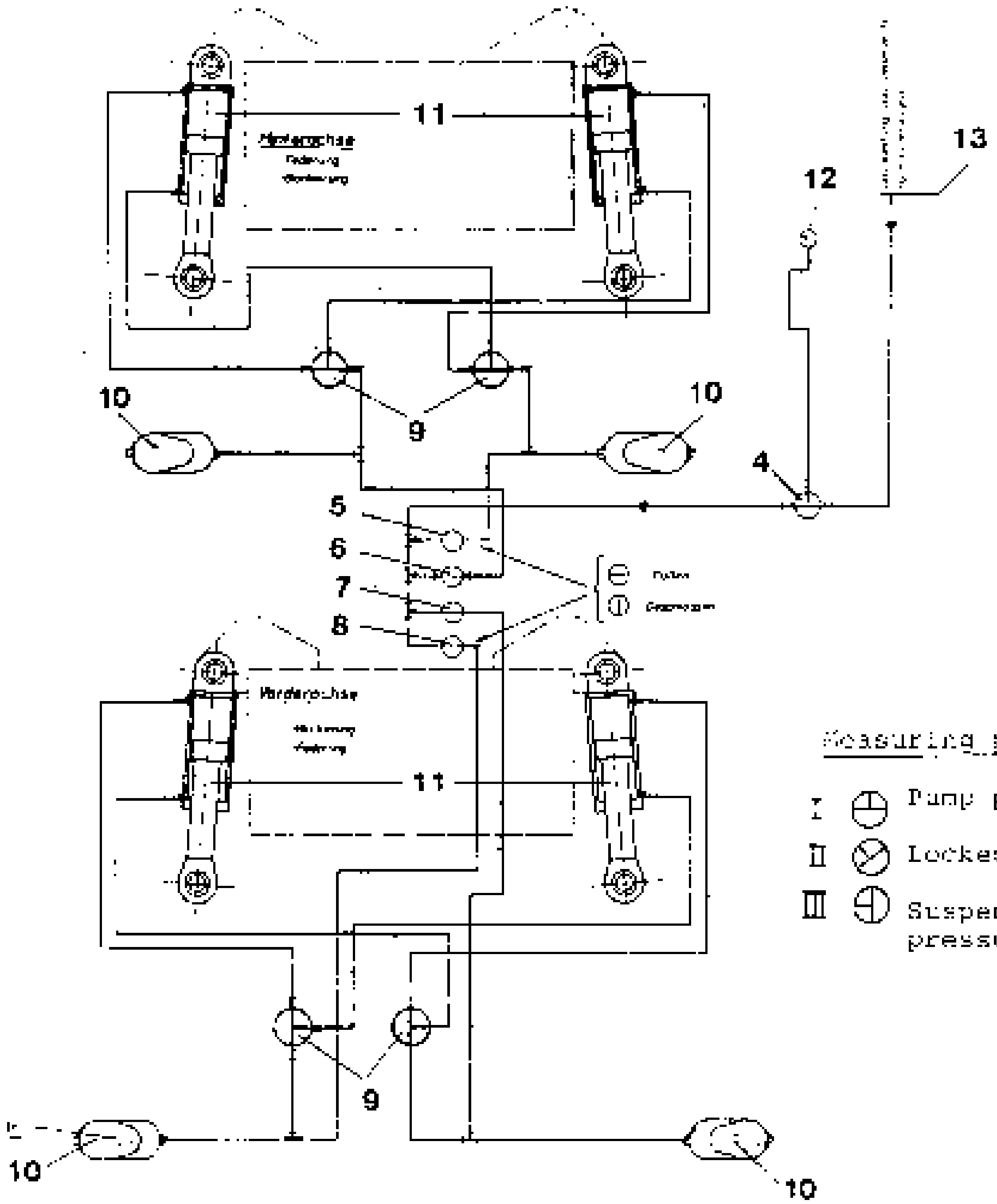
b) Once a year, check the bag-type reservoirs (see description of bag-type reservoirs).



General view of components



Hydraulic circuit diagram



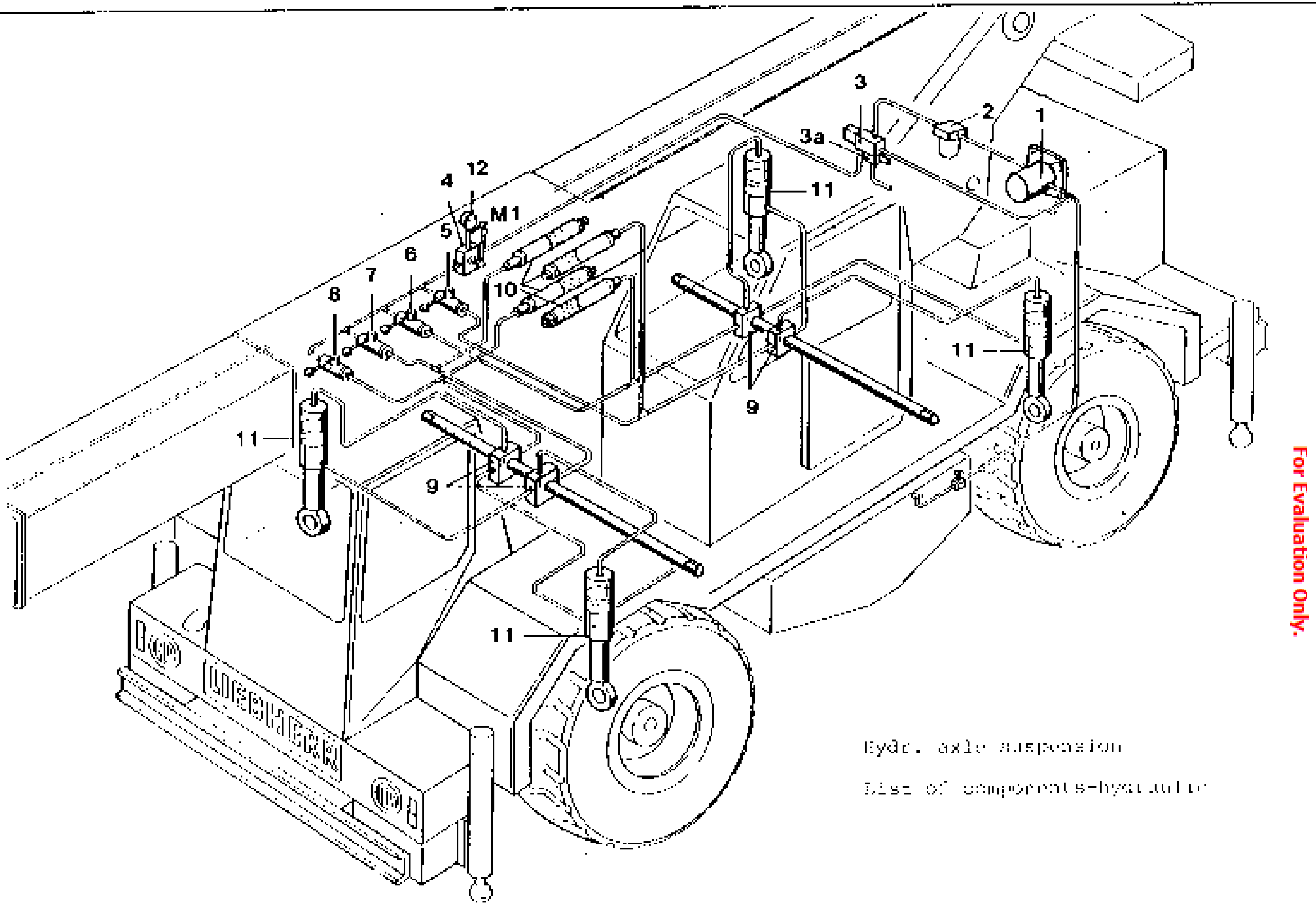
Measuring positions

I	⊕	Pump pressure
II	⊘	Locked
III	⦶	Suspension pressure

List of components

1	Gear type pump	4-9	Ball tap block
2	Pressure side filter	10	Bladder accumulator
3	Rotary spool valve	11	Axle suspension
3a	Pressure limiting valve	12	Pressure gauge
		13	Pressure take-off for hydr. circuit -supports-

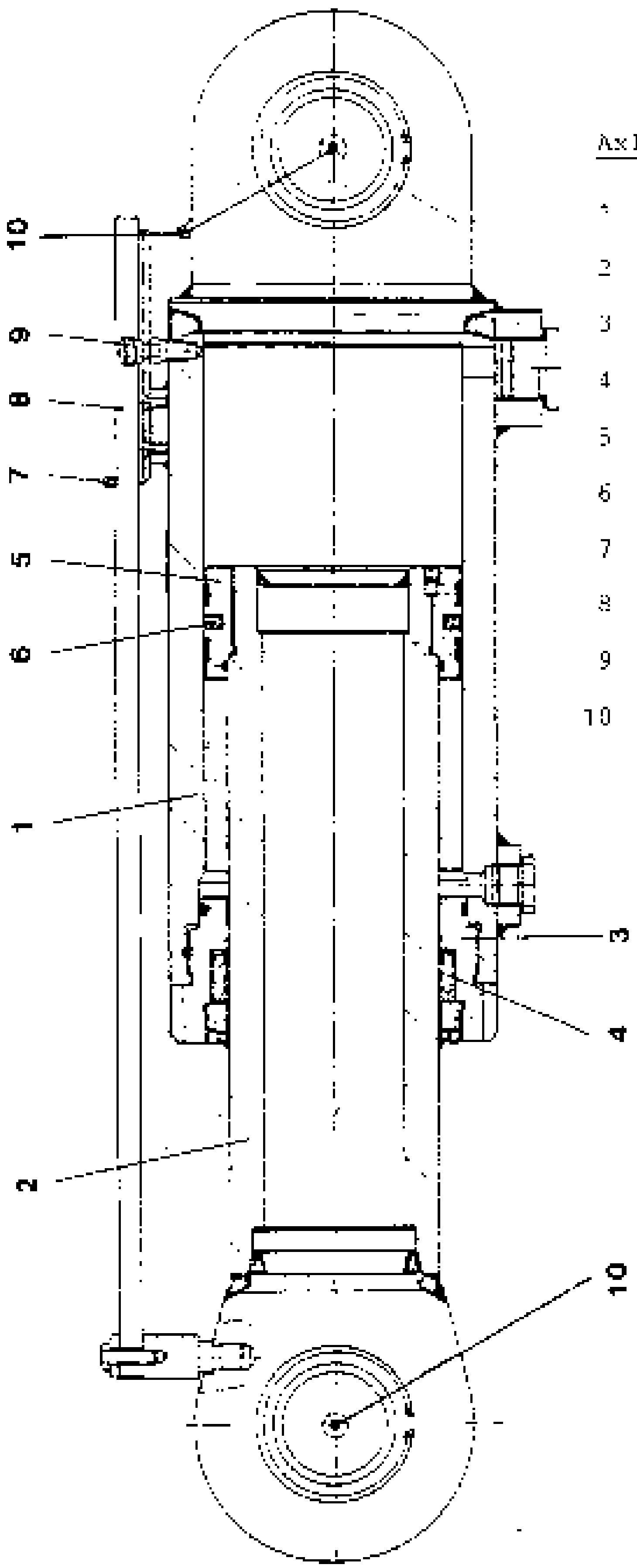
M1: Measuring point for hydr. axle suspension



Hydr. axle suspension

List of components-hydraulic

2.7.03



Axle suspension - cylinder

1 Cylinder
2 Piston rod
3 Piston rod bearing
4 Piston rod sealing
5 Piston - guide ring
6 Piston sealing
7 Measuring mark
8 Measuring rod
9 Bleed valve
10 Grease nipple

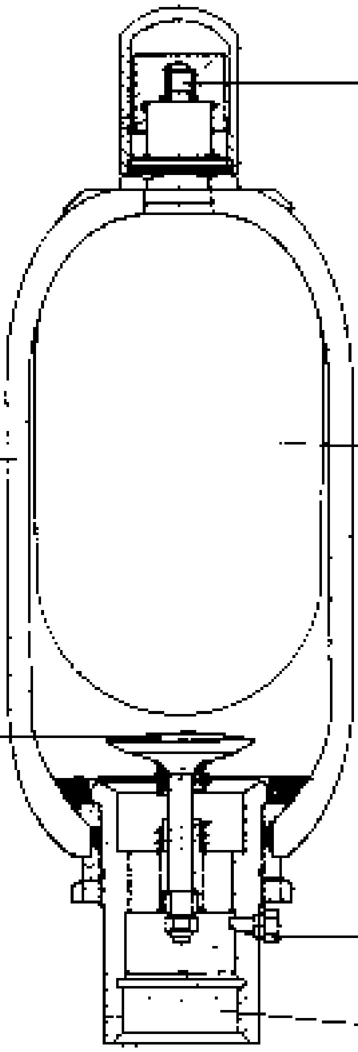
BLADDER ACCUMULATOR

A hydraulic accumulator serves to take into store a volume of fluid under pressure and to release it again, is required. The pressure accumulator can carry out many tasks in a hydraulic circuit.

In a bladder accumulator, the nitrogen and fluid are separated by a closed flexible bladder. The gas is inside the bladder.

The bladder accumulator comprises:

1 steel container
2 accumulator bladder
3 plate valve
4 fluid connection
5 gas valve
6 vent screw



Operating principle:

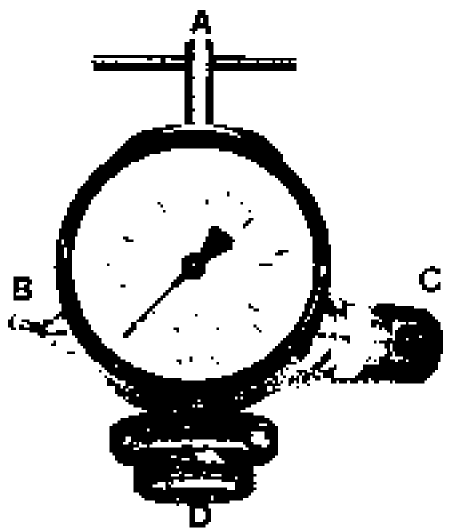
The accumulator bladder (2) initially stressed (prefill pressure 35 bar) with gas via gas valve (5) completely fills the steel container (1) and closes the plate valve (3).

If the pressure in the hydraulic system becomes equal to the initial gas stress, fluid then flows into the accumulator by means of the plate valve (3) and compresses the nitrogen in the bladder (2). The gas volume is decreased by the fluid intake volume.

Testing of the bladder accumulator

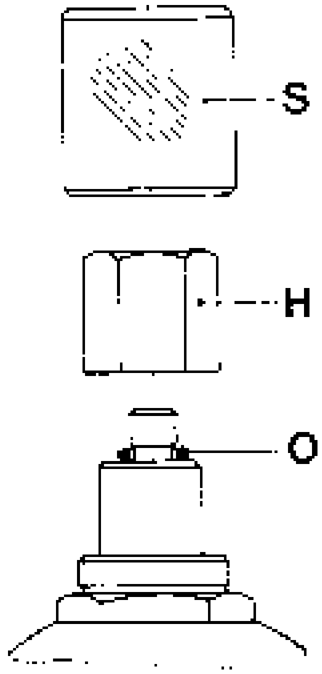
For this purpose use the gauging device for bladder accumulators -picture 1-.

The device is a screwed fitting with attached pressure gauge, check valve at the filling connection, built-in relief valve and a valve spindel for opening the check valve in the gas valve of the accumulator for pressure control.



Picture 1:

Filling and gauging device for bladder accumulator



Picture 2:

Filling and gauging connection

Testing:

Prior to each testing, topping-up or refilling of nitrogen, the hydro-accumulator is to be isolated from the pressurized system by means of a shut-off valve and is to be completely relieved from the liquid side.
Unscrew protective cover (S) and cap nut (H). Do not remove O-ring (O).
Screw adapter (D) by hand upon the accumulator gas valve.
Testing: Open the check valve of the bladder accumulator by screwing in valve screw (A). The pressure gauge now indicates the accumulator precharge pressure. (Note: Loss of pressure approx. 2 bar on each testing procedure).

Pressure reduction

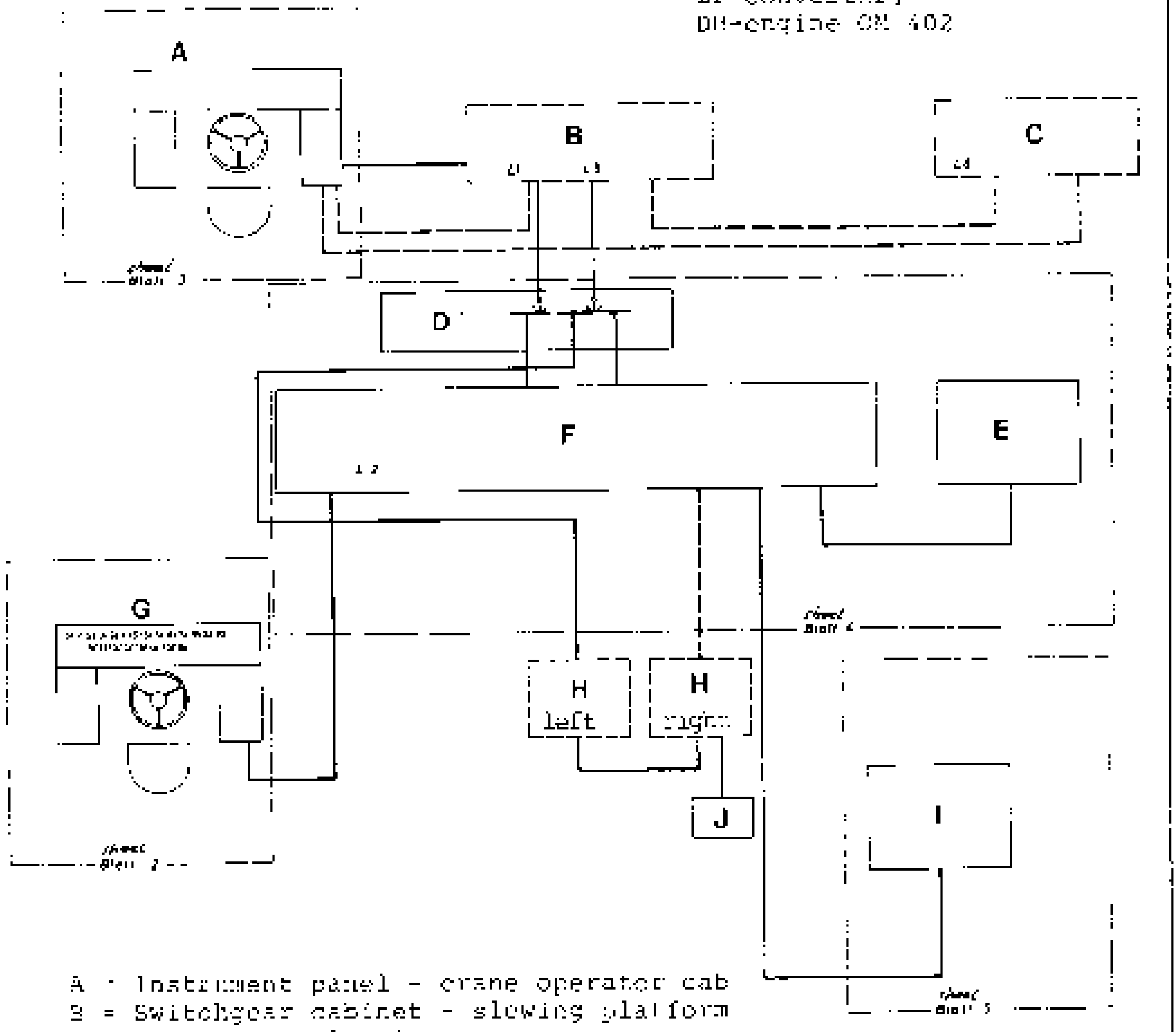
Carefully open the valve screw (B). Nitrogen escapes to the outside.

Pressure increases

Use only nitrogen for charging the accumulator bladder. Never use oxygen! Danger of explosion!

General arrangement

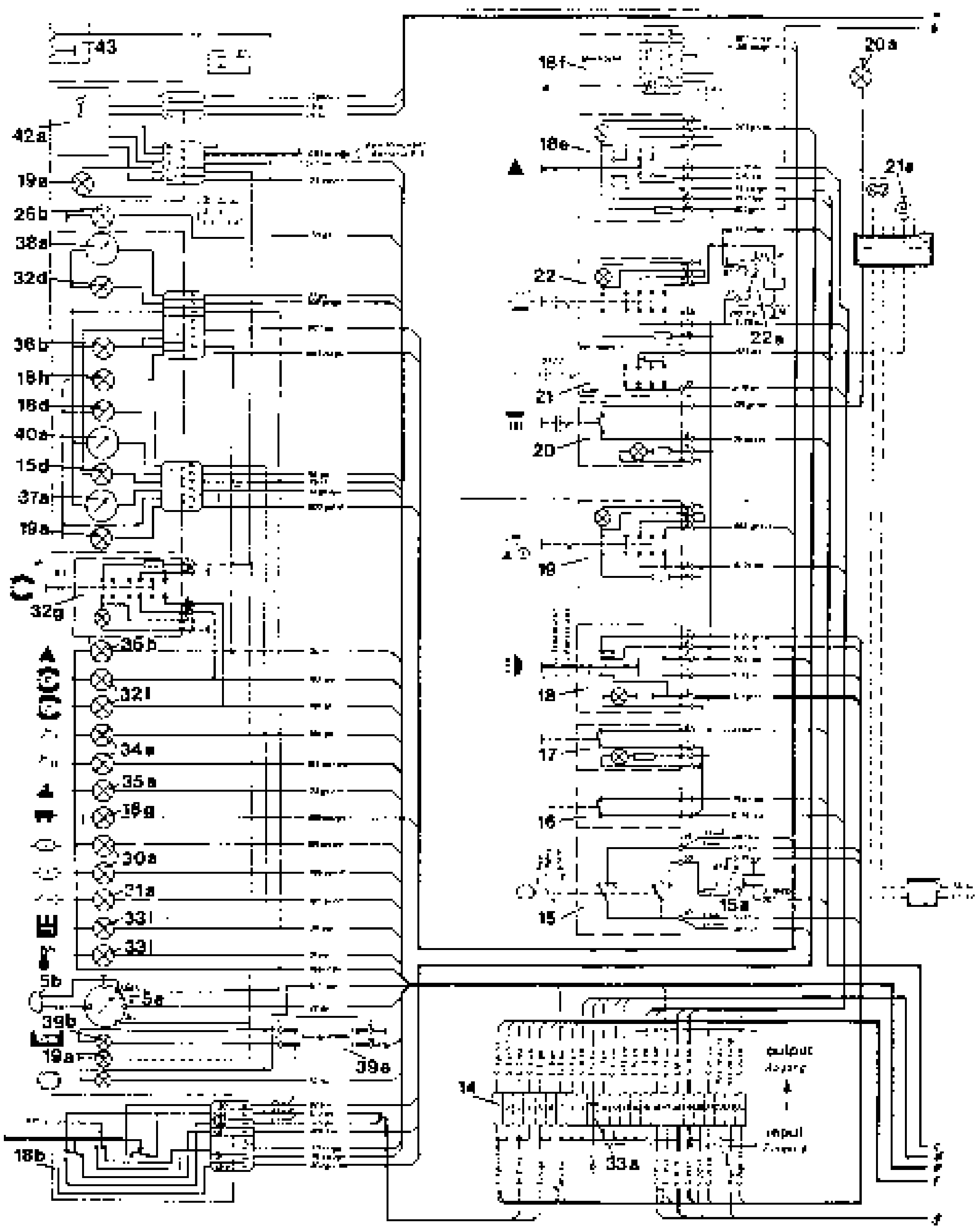
road version with
ZF-converter,
DB-engine OM 402



A = Instrument panel - crane operator cab
B = Switchgear cabinet - slewing platform
C = SLI - central unit
D = Rotary connector
E = Instrument panel - engine
F = Switchgear cabinet - chassis
G = Instrument panel - cab
H = Control panel - supports
I = Vehicle electrical system - general
- engine, valves, limit switches etc. -
J = Solenoid valve

Vehicle electrical system

Chassis - sheet 2



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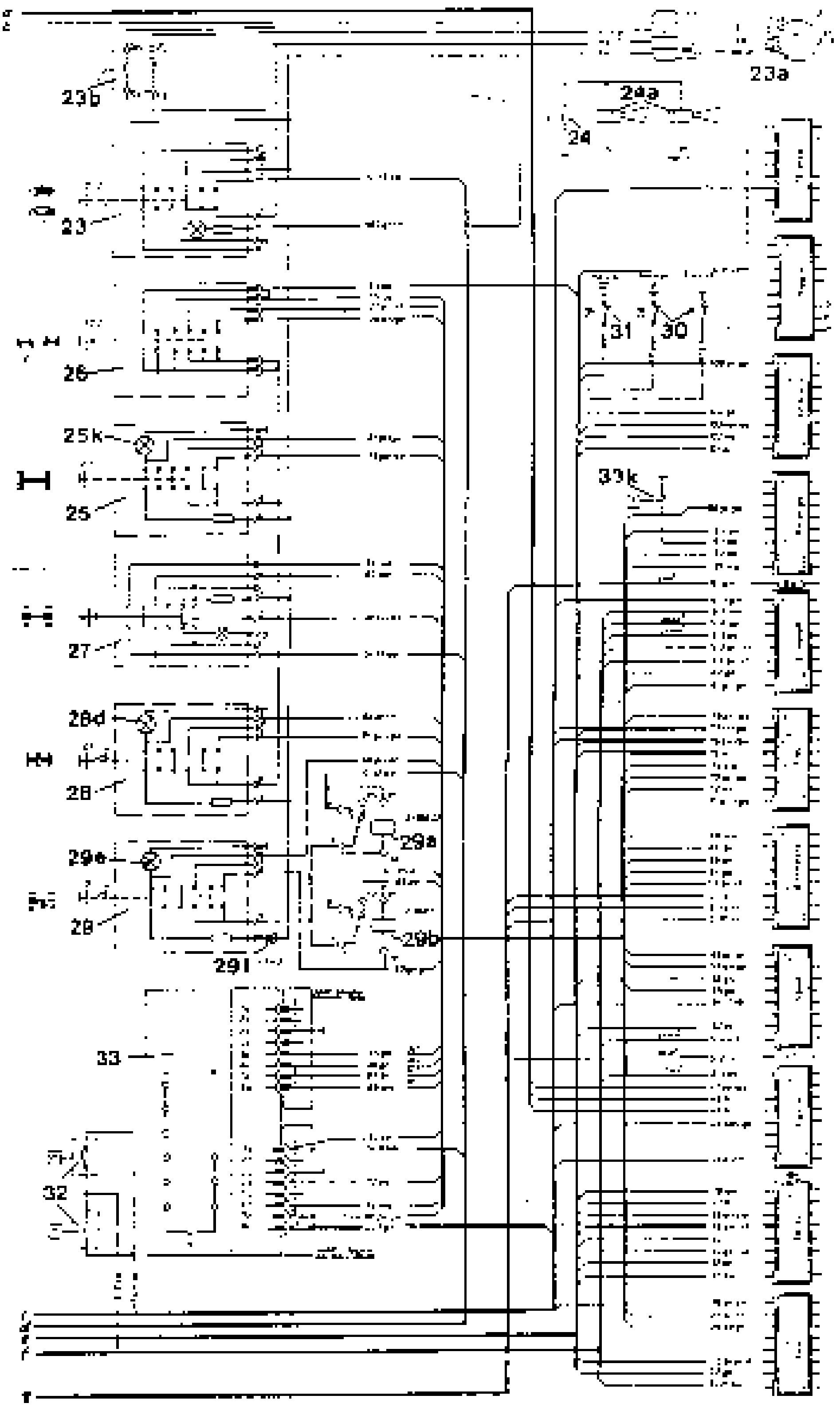
Vehicle electrical system

Chassis - sheet 2



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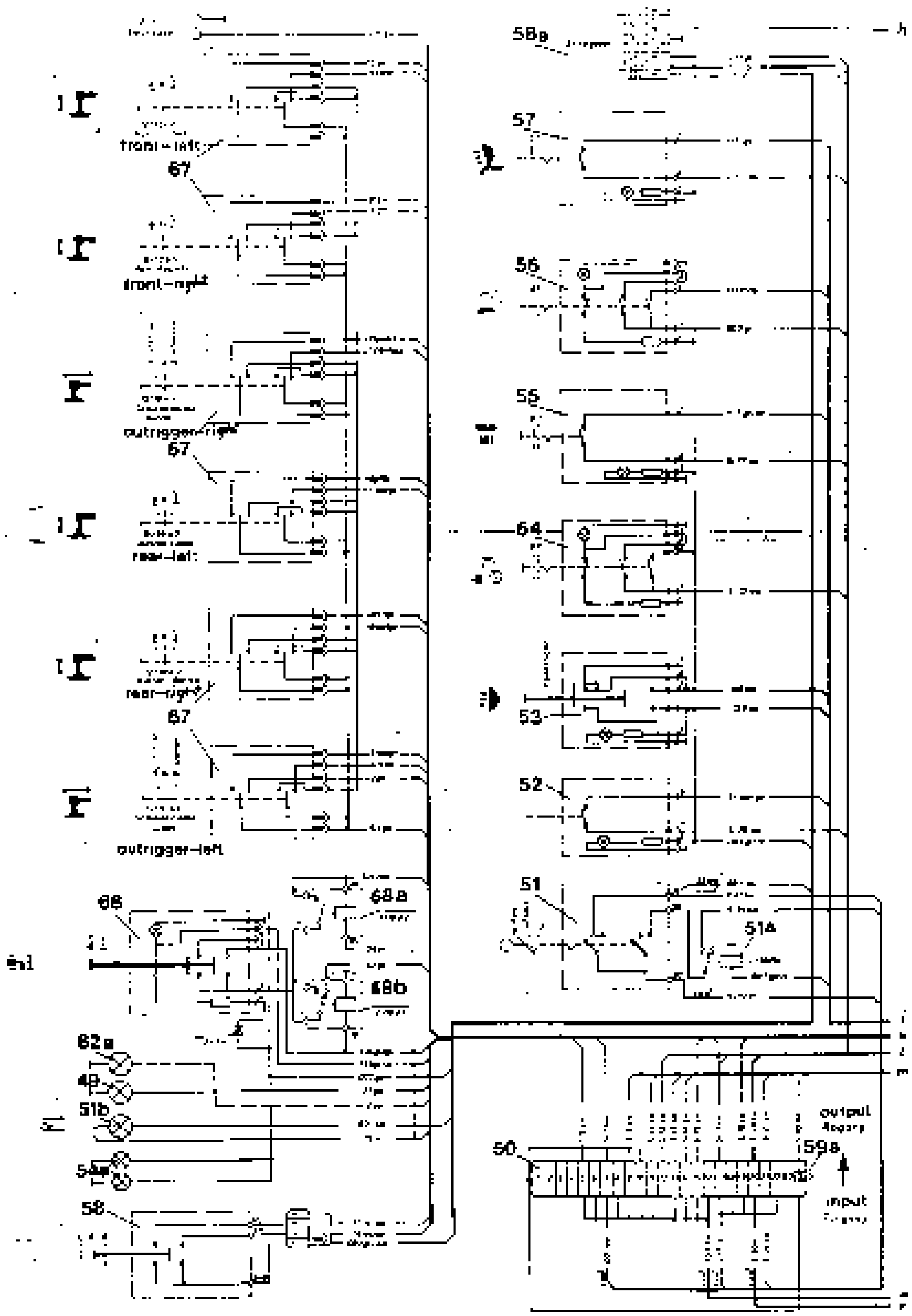
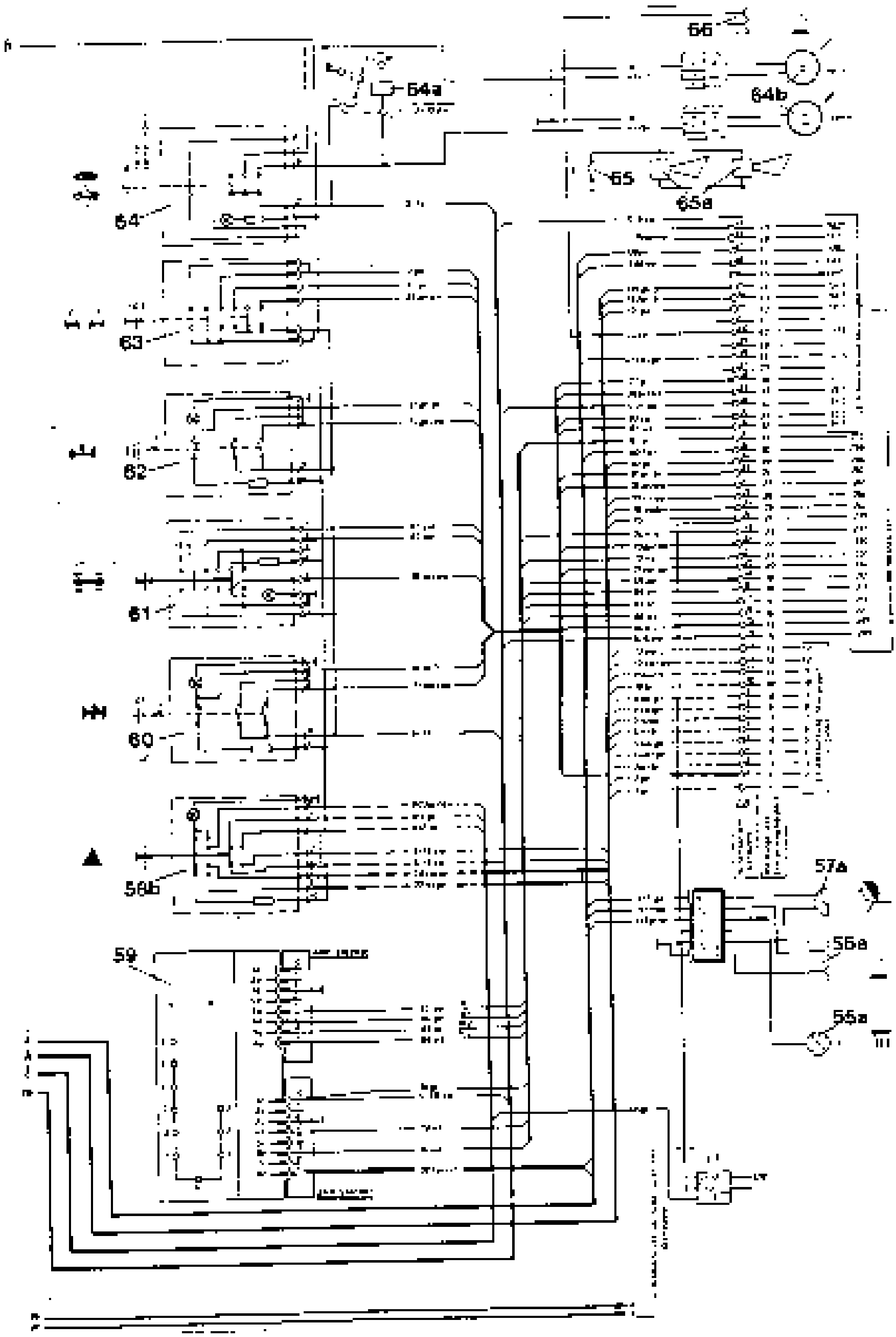
Vehicle electr

Superstructure - sheet 3

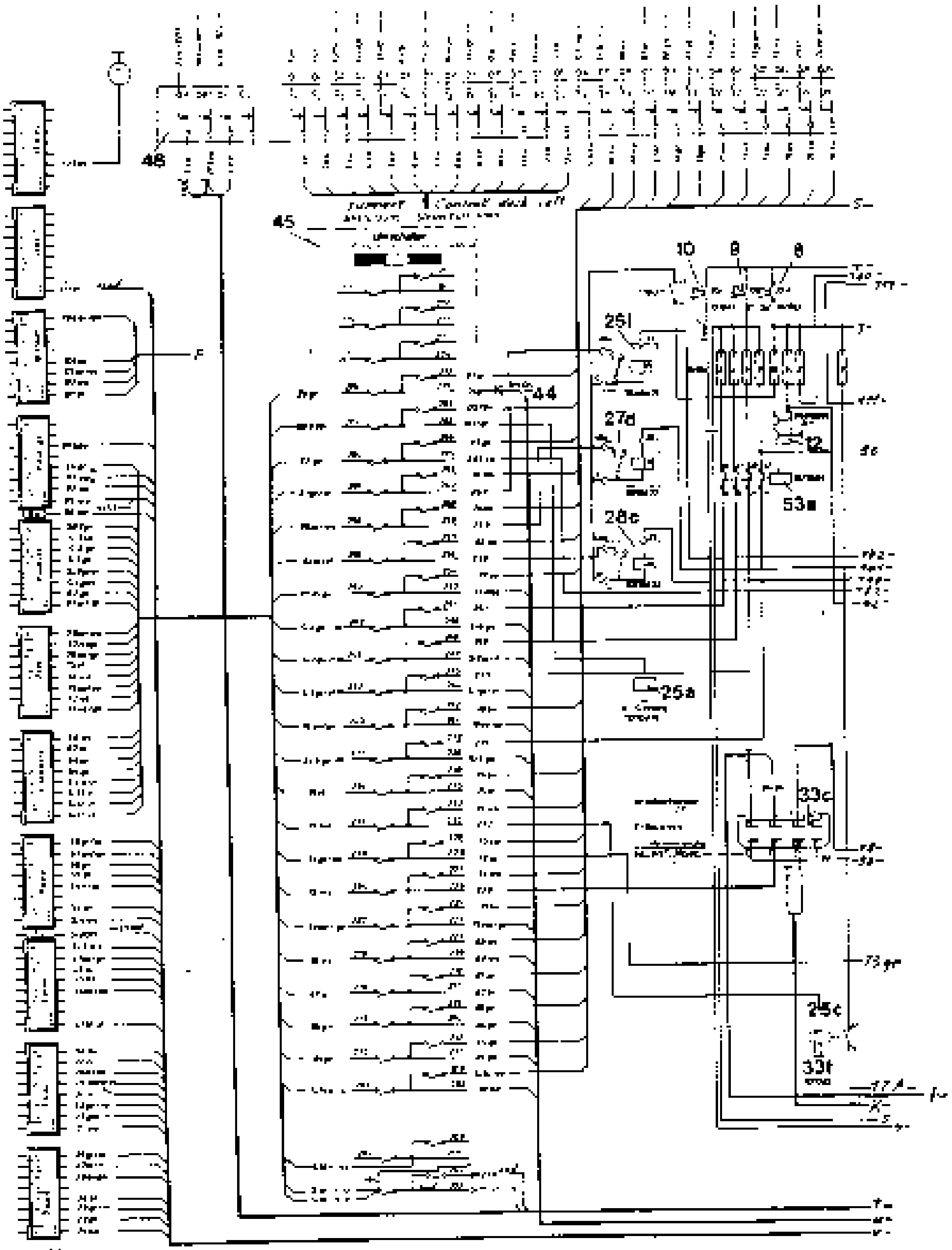


Superstructure – Sheet 3



Vehicle electrical system

Chassis - Sheet 4



2.8.03

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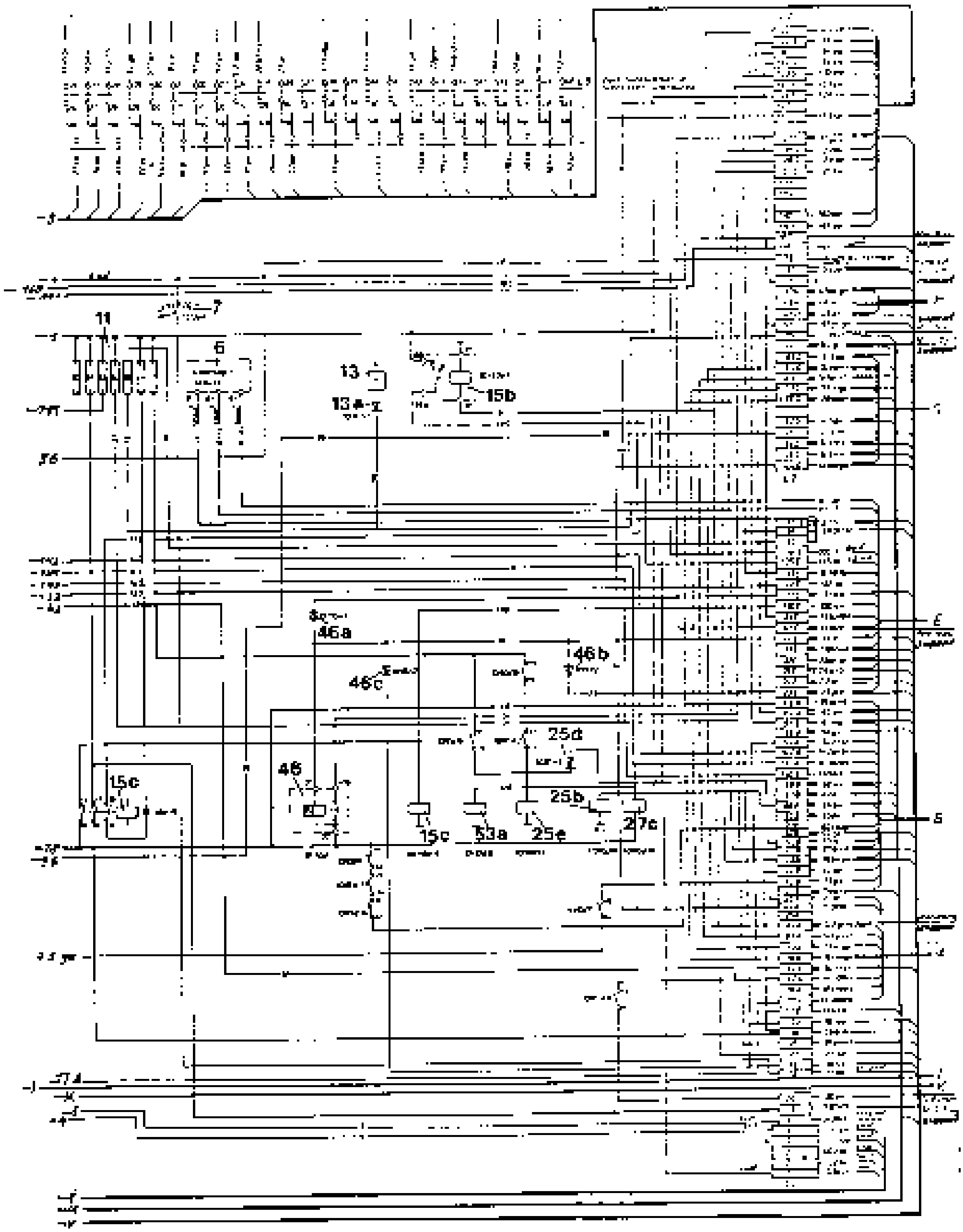
Vehicle electrical system

Chassis - Sheet 4



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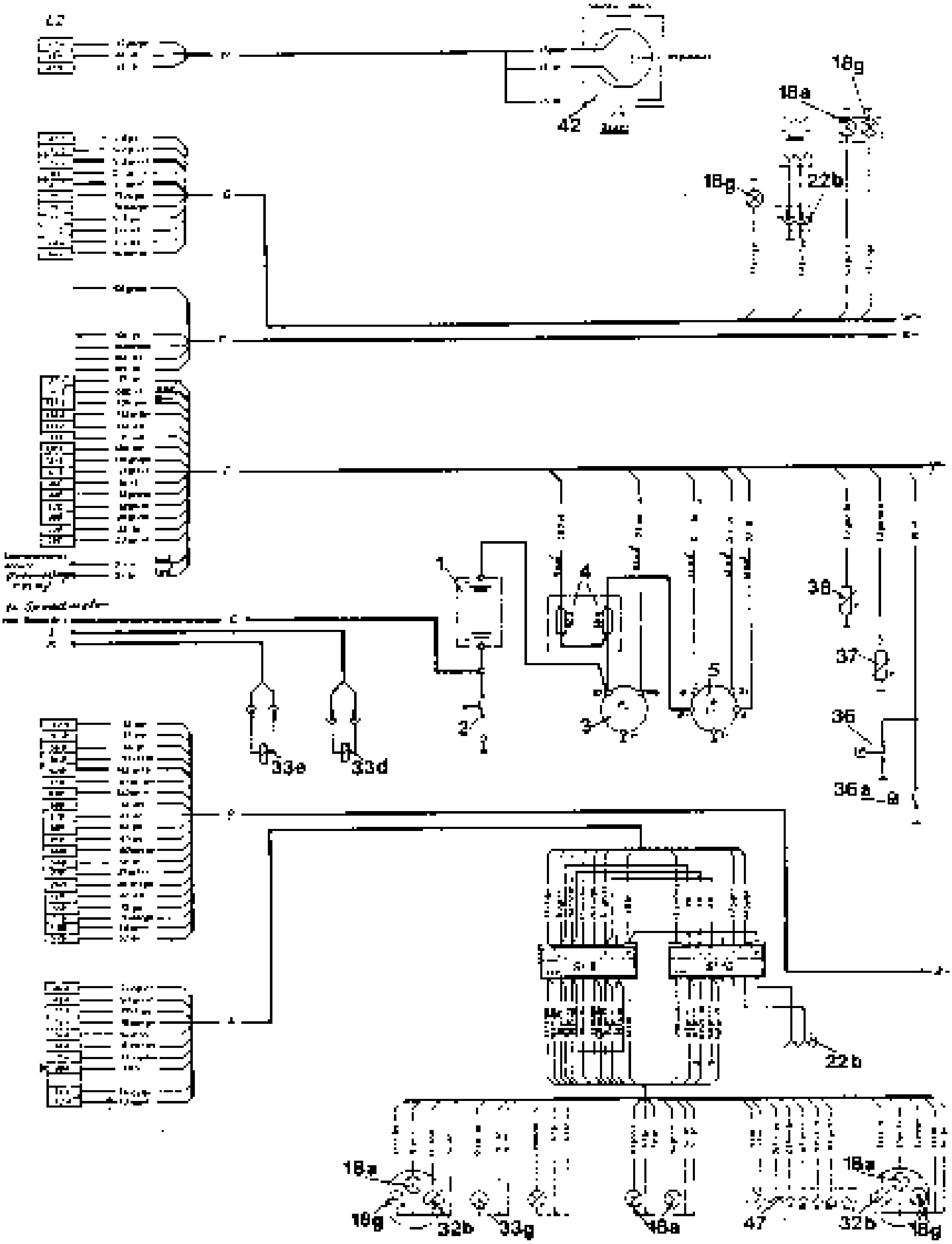
2.8.04

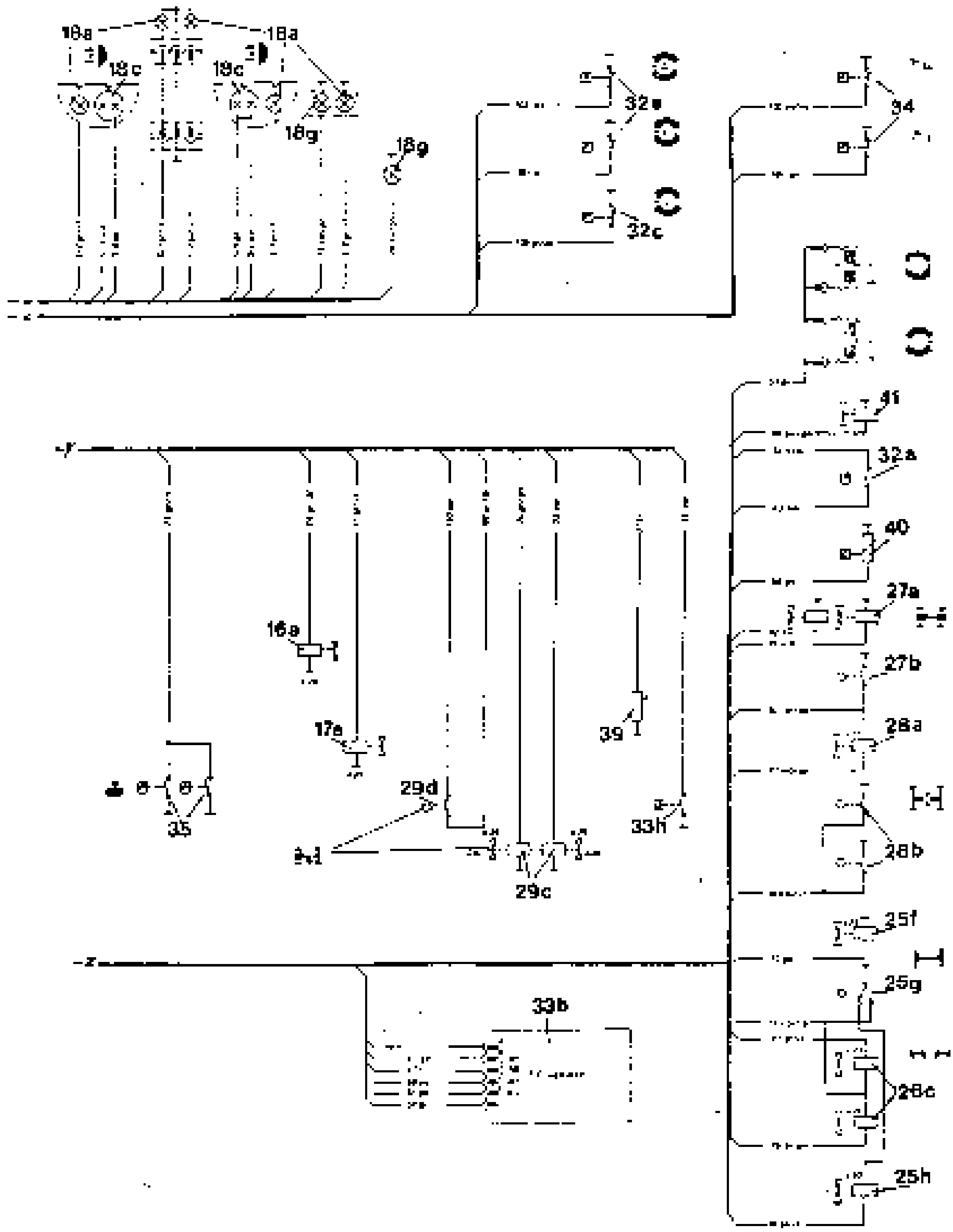
Vehicle electrical system

Chassis - Sheet 3

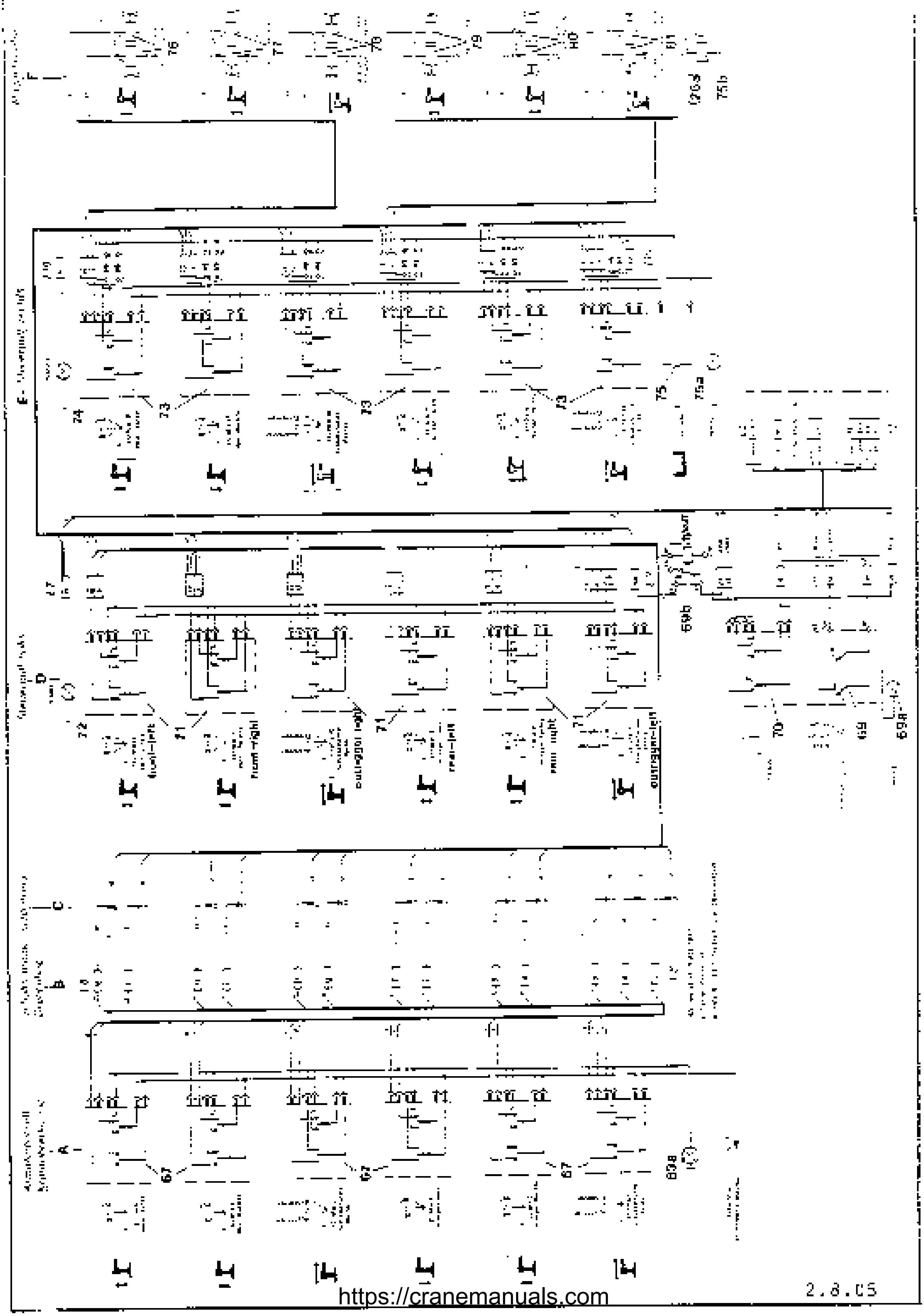


2.8.04

Chassis - Sheet 5

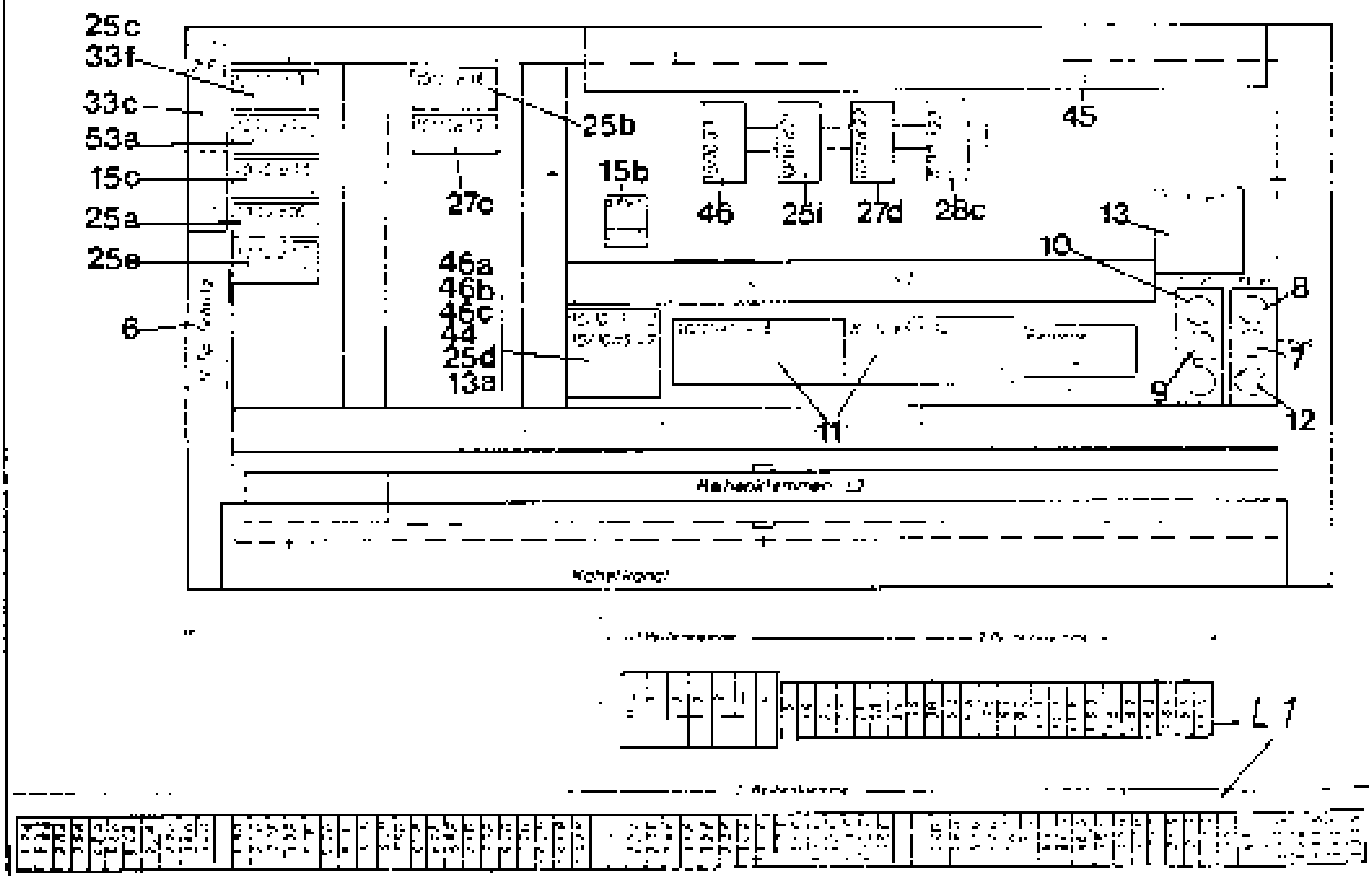


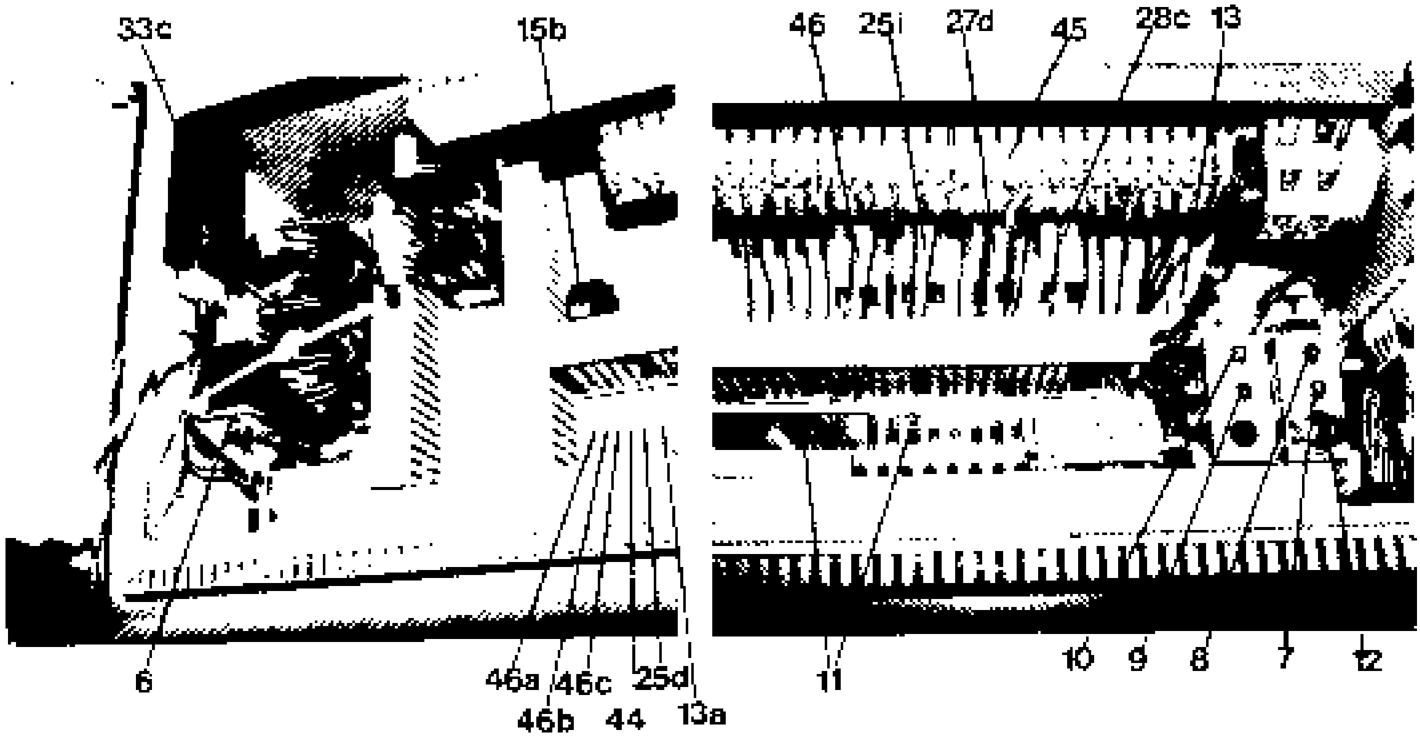
Electr. system



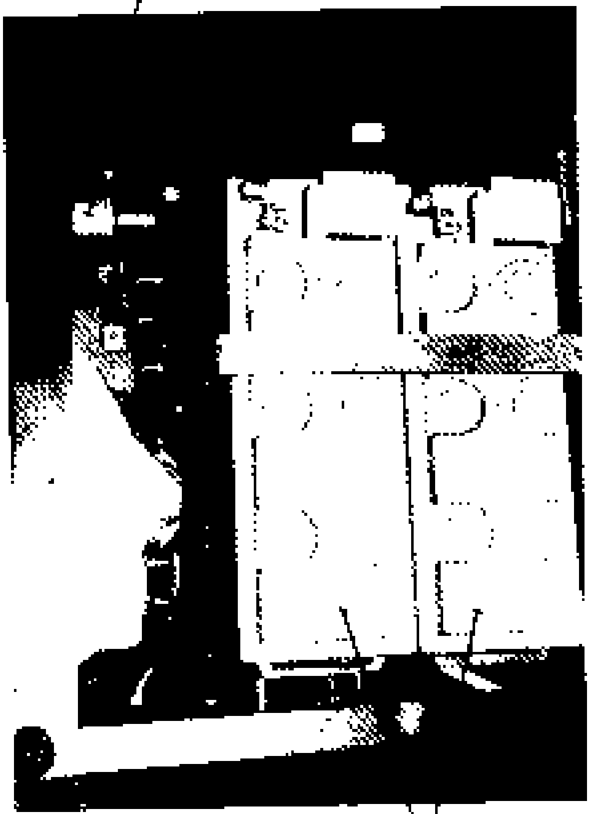
2.8.05

Switchgear cabinet - chassis





El. components - layout



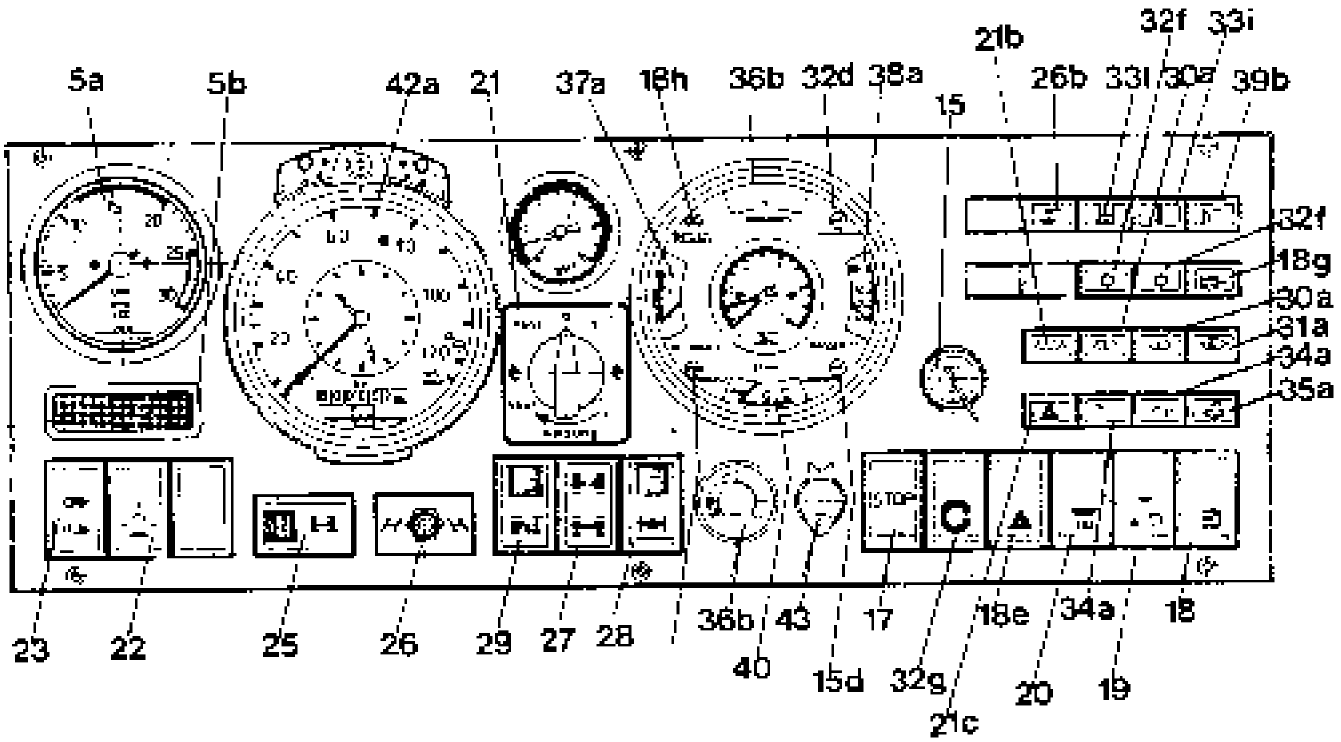
front left

converter HN 500

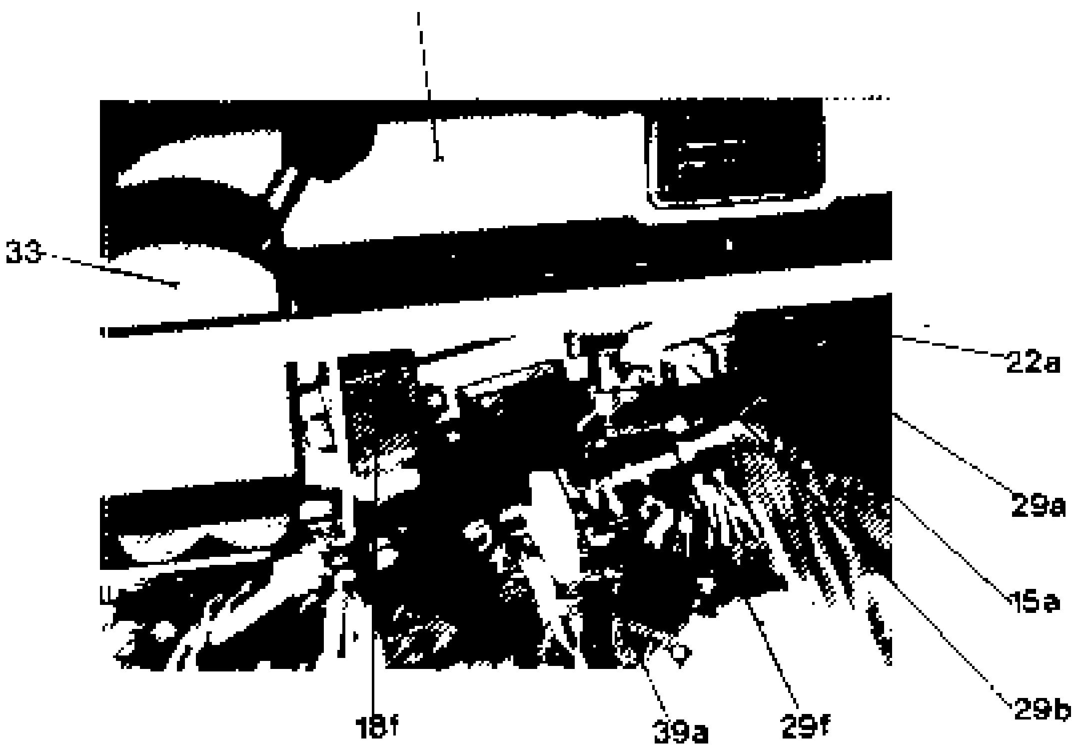
cab - chassis

Components - Layout

Instrument panel - chassis

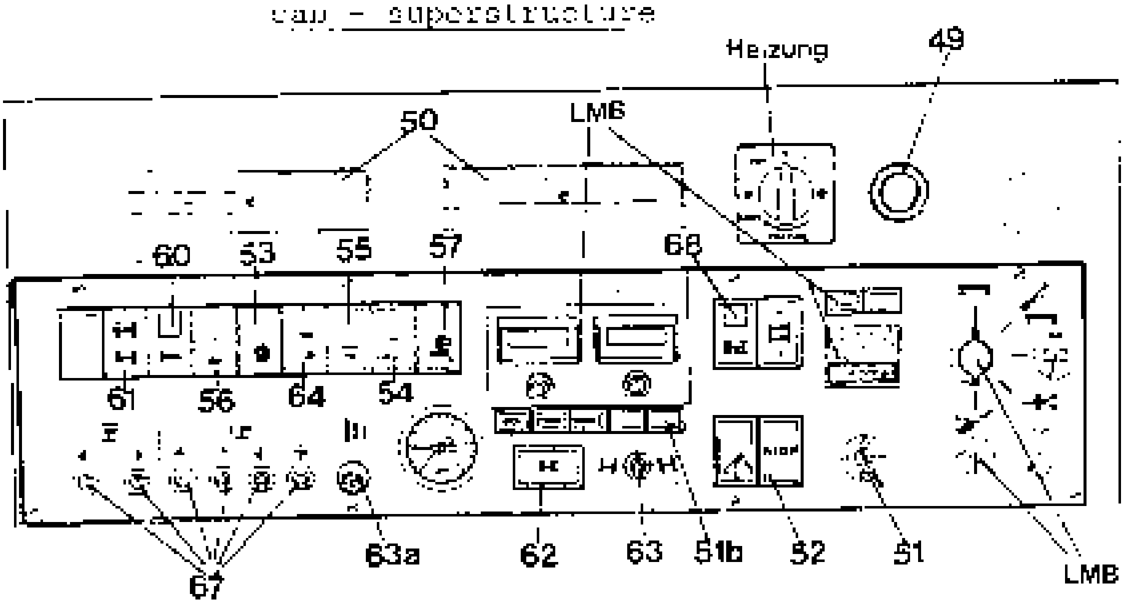


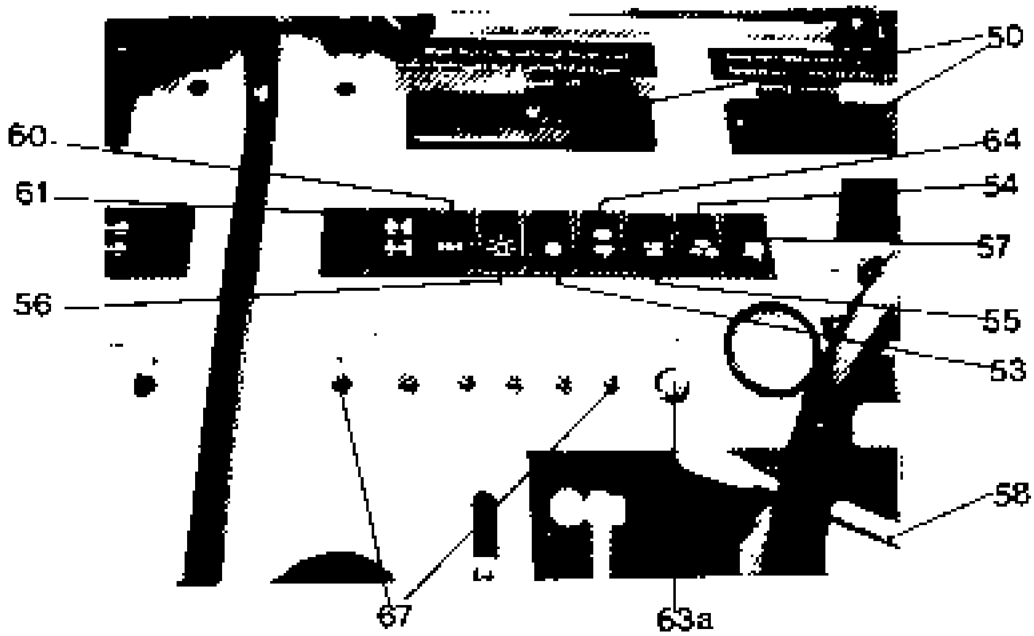
cab - chassis

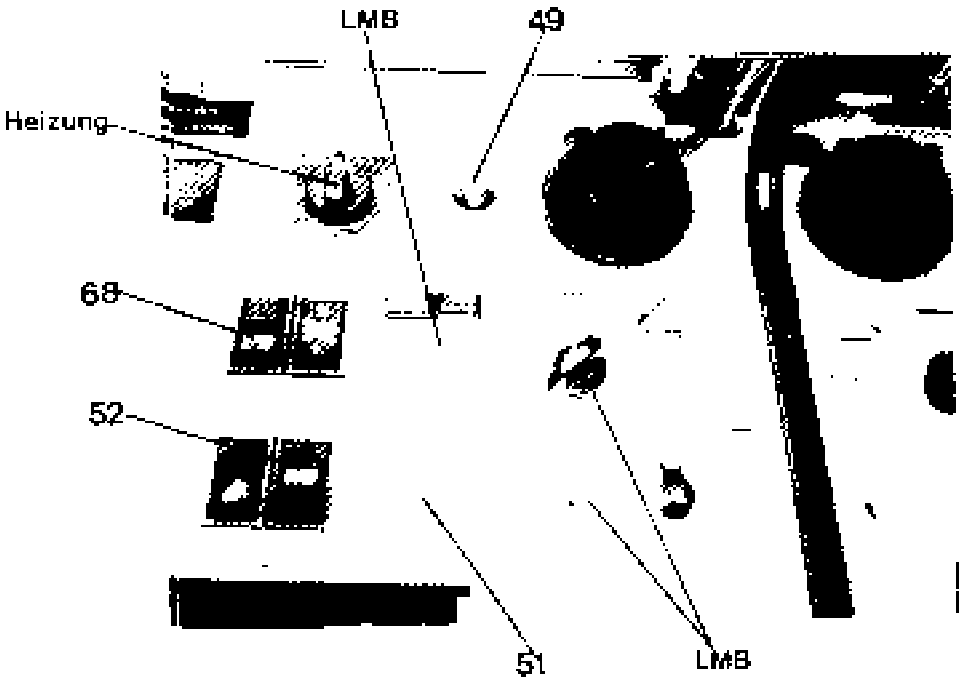


Components - [illegible]

cab - superstructure







2.8.87

List of components – vehicle chassis

Item	Designation	Function	Location
1	Battery	General power supply (24 V)	Front left, behind bumper
2	Battery master switch	Interrupts earth (ground) circuit from battery to vehicle	Front left, in box
3	Starter motor	Starting the engine	On engine
4	Main battery fuse (50 A)	Protecting complete electrical system	On engine
5	Alternator	Generating electric current	On engine
5a	Running speed indicator	Indicates engine speed	Instrument panel
5b	Buzzer	Overspeed warning	Instrument panel
6	Overvoltage protection	Trips if voltage rises too high	Switchgear cabinet
7	Automatic circuit breaker, 30 A	Additional heating, lower cab	Switchgear cabinet
8	Automatic circuit breaker, 30 A	General control system	Switchgear cabinet
9	Automatic circuit breaker, 30 A	Driving lights, superstructure, and rotating beacon	Switchgear cabinet
10	Automatic circuit breaker, 30 A	Additional heating, upper cab	Switchgear cabinet
11	Fuse box 1C/1Ce1-e16	8 A fuses	Switchgear cabinet
12	24 V socket	For connecting live end cable	Switchgear cabinet
13	Operating hours meter	—	Switchgear cabinet

Item	Designation	Function	Location
13a	Zener diode 10/10a7	Operation hours meter	Switchgear cabinet
14	Fuse box	8 A fuses	Cab
15	Ignition/start switch	Switching on control system and starting engine	Instrument panel
15a	Relay 2/10d15	Starter circuit	Cab
15b	Relay 10/10c1	Starter circuit	Switchgear cabinet
15c	Relay 10/10d15	Control circuit on	Switchgear cabinet
15d	Telltale lamp	Alternator operation	Instrument panel
16	Foot switch	Engine (exhaust) brake	Floor of cab
16a	Solenoid valve	Engine (exhaust) brake	see Sheet 2.4.07 (Item 46)
17	Push button switch	Engine cutout	Instrument panel
17a	Solenoid valve	Engine cutout	see Sheet 2.4.07 (Item 44)
18	Light switch	Side (parking) and headlights	Instrument panel
18a	24 V bulbs	Side and marker lights	Headlights, rear lights, marker lights
18b	Turn indicator and dip switch	Low (dipped) and high (main) headlight beams, flashing turn indicators	Cab (on steering column)
18c	24 V bulbs	Low and high headlight beams	Headlights
18d	24 V bulb	High beam telltale	Instrument panel
18e	Hazard warning flasher switch	Hazard warning system and positive (+) connection for flashing turn indicators	Instrument panel
18f	Flasher relay	Turn indicators and hazard warning flashers	Cab
18g	24 V bulbs	Turn indicators and hazard warning flashers	Front, rear and side flashing turn indicators
18h	24 V bulbs	Turn indicator repeaters	Instrument panel

List of components - vehicle chassis

Item	Designation	Function	Location
19	Push button switch	Instrument lighting	Instrument panel
19a	24 V bulbs	Instrument lighting	Instrument panel
20	Push button switch	Interior light	Instrument panel
20a	24 V bulb	Interior light	Cab
21	Push button switch	Heater blower	Instrument panel
21a	Electric motor	Heater blower	Below instrument panel
22	Push button switch	Rotating beacon	Instrument panel
22a	Relay 27/10d16	Rotating beacon	Cab
22b	3-pin socket	Rotating beacon	Cab and rear support mount
23	Push button switch	Windshield wipers	Instrument panel
23a	Electric motor	Windshield wipers	Below instrument panel
23b	Foot switch	Windshield washer	Lower part of cab
24	Push (knob)	Horn	Steering column
24a	Horn	Audible warning signal	At front, below cab
25	Push button switch	Rear axle lock release	Instrument panel
25a	Relay 10/10d15	Contact 23-24 for relay 10/10d17 (in N position only)	Switchgear cabinet
25b	Relay 10/10d18	Contact 13/14 for relay 10/10d17 for forward gears 1 - 4 and reverse gears 1 - 2 only)	Switchgear cabinet
25c	Relay 15/10d3	Contact 23-24 for relay 10/10d17 (reverse gear only)	Switchgear cabinet

Item	Designation	Function	Location
25c	Blocking diode 10/10d6	Positive (+) from travel control switch only in 1 - 2 forward gears and reverse gear 1	Switchgear cabinet
25e	Relay 10/10d17	Rear axle lock release, only in forward gears 1 and 2 or reverse; 'N' position	Switchgear cabinet
25f	Solenoid valve	Rear axle lock release (rear-wheel steering lock)	see Sheet 2.4.06 (back), Item 48)
25g	Micro-switch	Earth (ground) for solenoids, rear-wheel steering and floating position solenoid (steering ram)	see Sheet 2.6.04, Item 19
25h	Solenoid valve	Floating position, steering ram	see Sheet 2.6.04 (back), Item 16
25i	Relay 10/10d21	Rear axle lock release telltale lamp	Switchgear cabinet
25k	Telltale lamp	Rear-wheel steering in use	Push button switch
26	Push button switch	Rear-wheel steering	Instrument panel
26a	Recirculating valve	Hydraulic pressure cut-in for rear-wheel steering	see Sheet 2.6.04 (back), Item 3
26b	Telltale lamp	Recirculating valve in action	Instrument panel
26c	Solenoid valves	Rear-wheel steering	see Sheet 2.6.01 (back), Item 15
27	Push button switch	All-wheel drive	Instrument panel
27a	Solenoid valves	All-wheel drive on/off	see Sheet 2.2.05, Item 26
27b	Micro-switch	Earth (ground) for relay 10/10d19 - 10/10d22 and for differential lock solenoid valve	see Sheet 2.2.06, Item 28

List of components – vehicle chassis

Item	Designation	Function	Location
27c	Relay 10/10d19	(for reduced volume - engine)	Switchgear cabinet
27d	Relay 10/10d22	All-wheel drive telltale lamp	Switchgear cabinet
27e	Telltale lamp	All-wheel drive engaged	Push button switch
28	Push button switch	Differential lock	Instrument panel
28a	Solenoid valve	Differential lock	see Sheet 2.2.06, Item 30
28b	Micro-switch	Earth (ground) for relay 10/10d13	Front and rear axles
28c	Relay 10/10d23	Differential lock telltale lamp	Switchgear cabinet
28d	Telltale lamp	Differential lock engaged	Push button switch
29	Push button switch	Crane hydraulics on/off	Instrument panel
29a	Relay 2/10d22	Switch-on interlock (with engine running)	Cab
29b	Relay 2/10d11	Crane hydraulics off	Cab
29c	Bistable solenoid valve	Crane hydraulics on/off	At base of converter
29d	Micro-switch	Positive (+) voltage for telltale lamp	At base of converter
29e	Telltale lamp	Crane hydraulics on	Push button switch
29f	Blocking diode 2/1n2	—	Cab
30	Pressure switch	Monitoring reservoir pressure, brake circuits I and II	see Sheet 2.4.06, Item 9
30a	Telltale lamp	Reservoir pressure, brake circuits I and II	Instrument panel

Item	Designation	Function	Location
31	Pressure switch	Reservoir pressure, handbrake circuit III	see Sheet 2.4.05 (back), Item 20
31a	Telltale lamp	Reservoir pressure, handbrake circuit III	Instrument panel
32	Brake light switch (brakes operated from lower cab)	Positive (+) supply for brake light	see Sheet 2.4.06, Item 11
32a	Brake light switch (brakes operated from upper cab)	Positive (+) supply for brake light	see Sheet 2.4.03 (back), Item 54
32b	24 V bulbs	Brake lights	In rear light clusters
32c	Pressure switch	Handbrake telltale	see Sheet 2.4.03 (back), Item 24
32d	Telltale lamp	Handbrake applied	Instrument panel
32e	Pressure switch	Brake fluid level monitoring	Fluid reservoir for disc brakes
32f	Telltale lamp	Brake fluid level	Instrument panel
32g	Test switch	For telltale lamp	Instrument panel
33	Travel control switch	Preselecting gear ratios	Cab
33a	Blocking diode 2/1Cr1	Positive voltage to travel control switch	Cab fuse box
33b	Valve control board	Electrical circuit, solenoid valves Y1 - Y4	see Sheet 2.2.06 (back), Item 22
33c	Electronic module	Lock-up clutch (WK) operation	Switchgear cabinet
33d	Inductive transmitter	Lock-up clutch (WK) operation	see Sheet 2.2.06 (back), Item 33
33e	Solenoid valve	Lock-up clutch (WK) operation	see Sheet 2.2.04, Item 10
33f	Relay 10/1Cd3	Contact 13-14 for reversing (back-up) light (reverse gear only)	Switchgear cabinet
33g	24 V bulb	Reversing (back-up) light	Rear bumper

List of components - vehicle chassis

Item	Designation	Function	Location
33h	Temperature warning transmitter contacts	Earth (ground) to warning lamp and relay 10/10c1	see Sheet 2.2.04, Item 9
33i	Warning lamp	Converter temperature	Instrument panel
33k	Pressure switch (warning contact switch)	Earth (ground) to warning lamp and relay 10/10c1	see Sheet 2.2.06 (back), Item 40
33l	Warning lamp	Converter shift pressure	Instrument panel
34	Pressure switch	Earth (ground) to telltale lamp - steering circuits I and II	see Sheet 2.5.04 (back), Items 11 and 13
34a	Telltale lamp	Steering circuits I and II	Instrument panel
35	Vacuum switch	Earth (ground) to telltale lamp	Air cleaner
35a	Telltale lamp	Air cleaner	Instrument panel
36	Warning contact switch (engine)	Earth (ground) to warning light - oil pressure	On engine
36a	Warning contact switch (engine)	Earth (ground) to warning light - temperature	On engine
36b	Warning light	Engine temperature and oil pressure	Instrument panel
37	Oil pressure sensor (engine)	Oil pressure indication	On engine
37a	Oil pressure gauge	Indicating oil pressure	Instrument panel
38	Temperature sensor (engine)	Indicating temperature	On engine
39	Probe	Coolant level	Cooling water tank

Item	Designation	Function	Location
39b	Telltale lamp	Coolant level	Instrument panel
40	Fuel level sensor	Fuel level	In diesel oil (fuel) tank
40a	Fuel gauge	Fuel level in tank	Instrument panel
41	Solenoid valve	Reduced volume - engine	see Sheet 2.4.07, Item 42
	Note: Solenoid valve for reduced volume (engine) operates only in forward gears 1 and 2 or reverse gear, without all-wheel drive engaged.		
42	Sensor	Tachometer	see Sheet 2.2.06, Item 29
42a	Tachograph	Distance and speed display	Instrument panel
43	24 V socket	For connecting plug	Instrument panel
44	Blocking diode 10/10n5	—	Switchgear cabinet
45	Changeover switch	Power supply from lower cab or from upper cab	Switchgear cabinet
46	Flasher relay 10/10d1	Positive (+) voltage to warning lamp for upper crane cab	Switchgear cabinet
46a	Blocking diode 10/10n1		Switchgear cabinet
46b	Blocking diode 10/10n2		Switchgear cabinet
46c	Blocking diode 10/10n3		Switchgear cabinet
47	Socket, 7-pin	Trailer	Rear bumper
48	Slipring assembly	Power connections between chassis and superstructure	Center of slewing ring

List of components - superstructure

Item	Designation	Function	Location
49	Warning light	Engine and converter temperature Engine and converter oil pressure Air cleaner monitoring	
50	Fuse box	8 Amp fuses	Crane operator's cab
51	Ignition/start switch	Control system on, starting engine	Instrument panel
51a	Relay 2/10d14	Starter circuit	Below instrument panel
51b	Charge telltale lamp	—	Instrument panel
52	Push button switch	Engine cutout	Instrument panel
53	Light switch	Driving lights	Instrument panel
53a	Relay 10/10d14	Driving lights	Chassis switchgear cabinet
54	Instrument lighting	—	Instrument panel
55	Push button switch	Interior light	Instrument panel
55a	Interior light	—	Crane operator's cab
56	Push button switch	Rotating beacon	Instrument panel
56a	Socket	Rotating beacon	At top of cab
57	Push button switch	Work area light	Instrument panel
57a	Work area light	—	Front of cab
58	Turn indicator switch	Left/right flashing turn indicators	Instrument panel

Item	Designation	Function	Location
58a	Flasher relay	Turn indicators and hazard warning flashers	Below instrument panel
58b	Hazard warning flasher switch	Hazard warning	Instrument panel
59	Travel control switch	Gear selection	Crane operator's cab
59a	Blocking diode 2/10m2	—	Cab fuse box
60	Push button switch	Axle differential lock	Instrument panel
61	Push button switch	All-wheel drive	Instrument panel
62	Push button switch	Rear axle lock release	Instrument panel
63	Push button switch	Rear-wheel steering	Instrument panel
63a	Telltale lamp	Recirculating valve in action	Instrument panel
64	Push button switch	Windshield wipers	Instrument panel
64a	Relay 2/10d4	Windshield wipers	Below instrument panel
64b	Electric motor	Windshield wipers	Front and top of cab
65	Push (knob)	Horn	Steering column
65a	Horns	Audible warning signal	Lower front of cab
66	Socket, 2-pin	Rotating beacon (from chassis)	At rear of boom
67	Push button switch	Supports	Instrument panel
68	Push button switch	Crane hydraulics on	Instrument panel
68a	Relay 2/10d2	Switch-on interlock	Below instrument panel
68b	Relay 2/10d1	Crane hydraulics off	Below instrument panel

List of components - supports

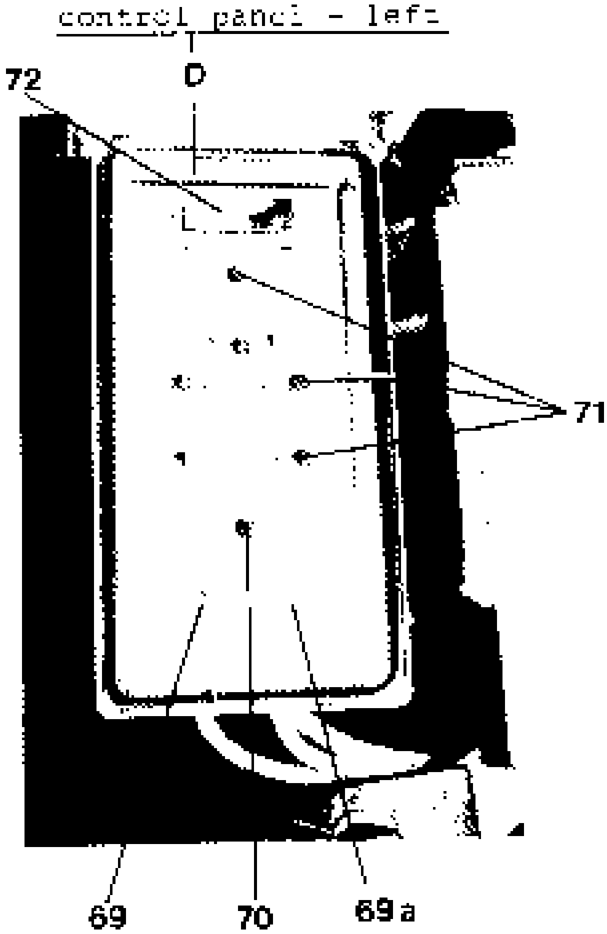
A = Crane operator's cab, instrument panel
B = Switchgear cabinet on slewing platform
C = Slipring
D = Left control panel
E = Right control panel
F = Solenoid valves

Item	Designation	Function	Location
69	Ignition/start switch	Starting the engine	Left control panel
69a	Charge telltale lamp	Monitoring charge from alternator	Left control panel
69b	Relay 11/10d1	Control system on	Left control panel
70	Push button switch	Engine cutout	Left control panel
71	Push button switch	Supports	Left control panel
72	Light	Switchgear cabinet illumination	Left control panel
73	Push button switch	Supports	Right control panel
74	Light	Switchgear cabinet illumination	Right control panel
75	Push button switch	Recirculating valve on	Right control panel
75a	Telltale lamp	Recirculating valve on	Right control panel
75b	Solenoid valve	Recirculating valve	see Sheet 2.6.04 (back), Item 3
76	Solenoid valves	Front left support	see Sheet 2.6.04 (back), Item 7

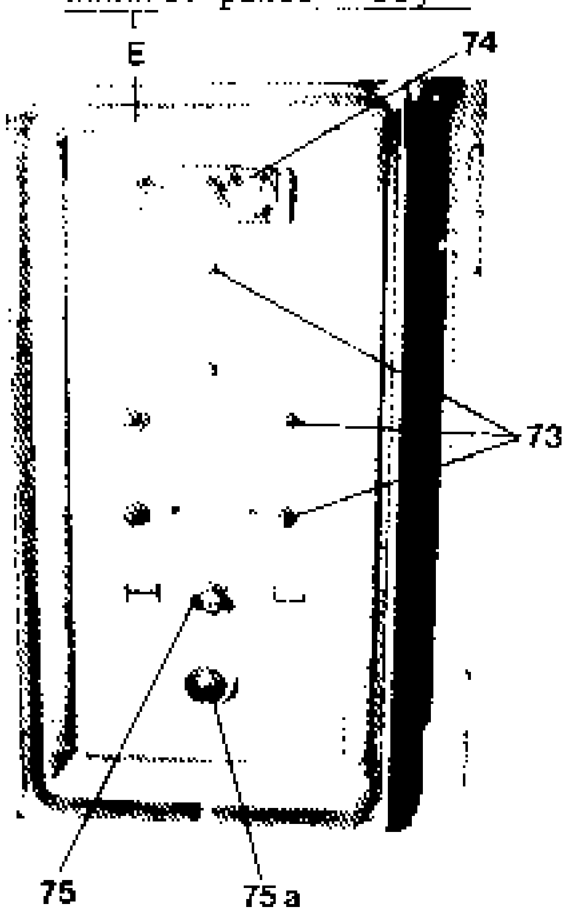
Item	Designation	Function	Location
77	Solenoid valves	Front right support	see Sheet 2.6.04 (back), Item 5
78	Solenoid valves	Right sliding outrigger arms	see Sheet 2.6.04 (back), Item 6
79	Solenoid valves	Rear left support	see Sheet 2.6.04 (back), Item 10
80	Solenoid valves	Rear right support	see Sheet 2.6.04 (back), Item 8
81	Solenoid valves	Left sliding outrigger arms	see Sheet 2.6.04 (back), Item 9

Components - layout

control panel - left



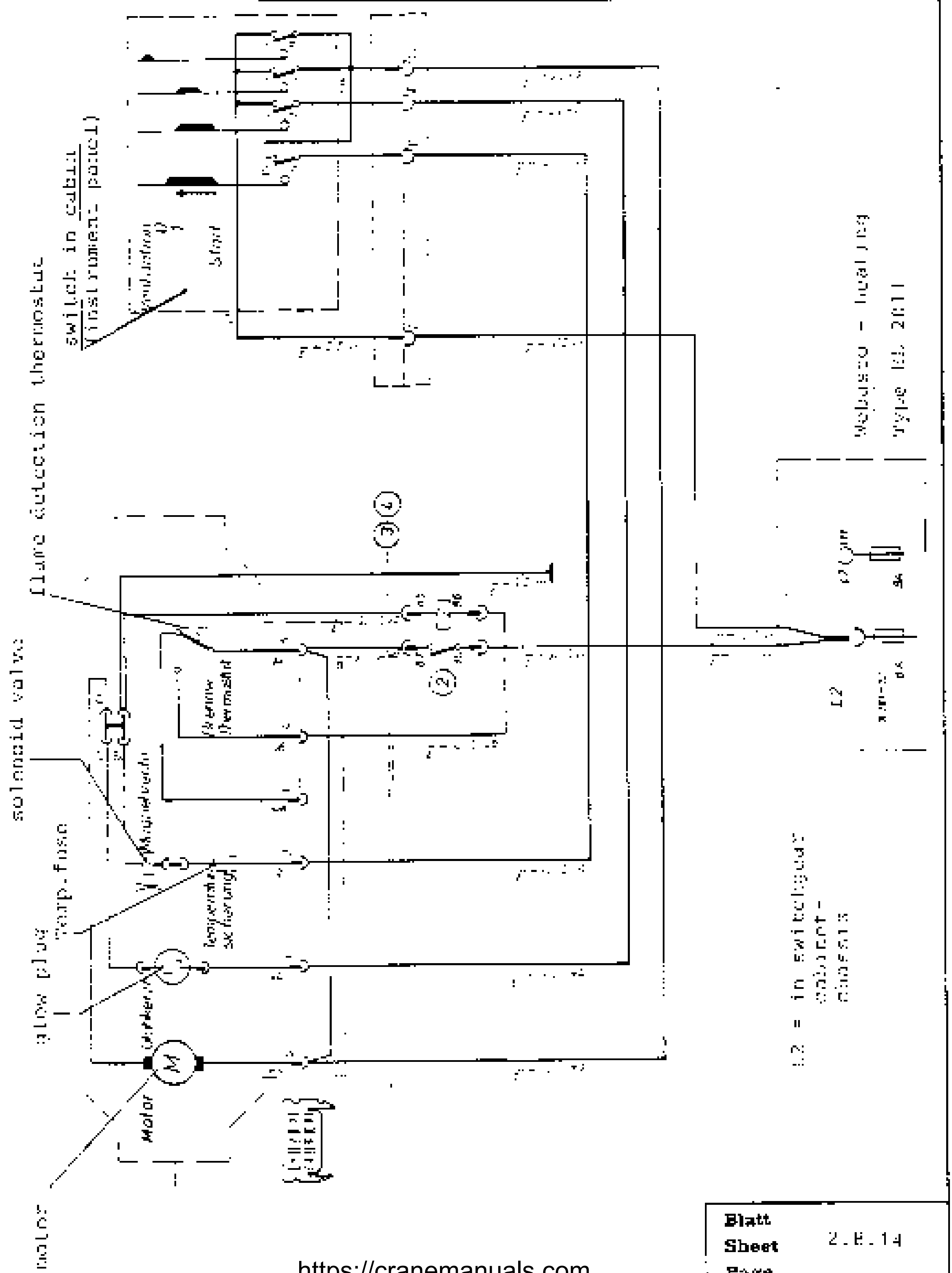
control panel - right



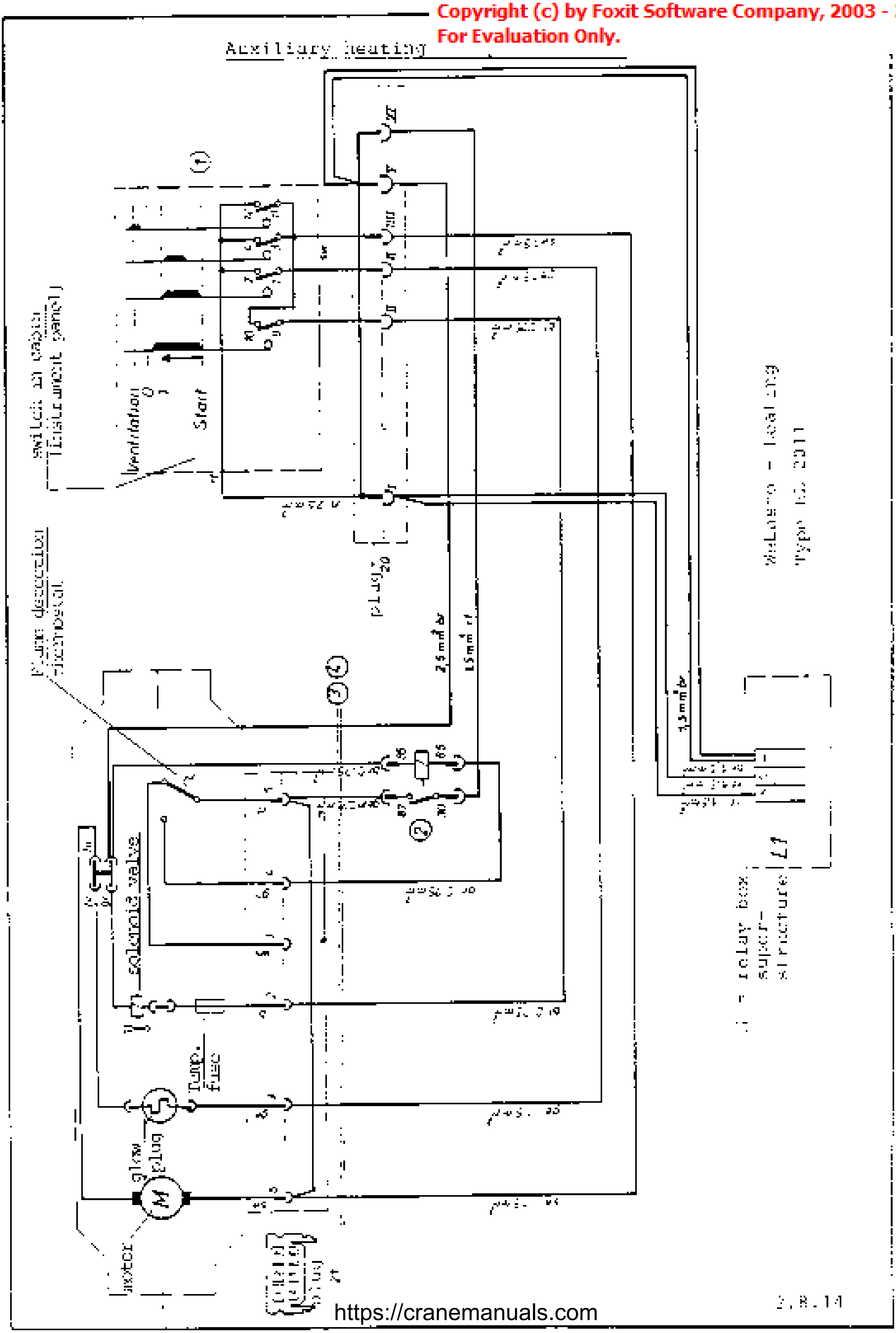
LIEBHERR

Vehicle electrical system

Auxiliary heating - chassis



Blatt Sheet Page	2.8.14


Auxiliary heating
switch in cabin
(instrument panel)
Ventilation
0
1
Start
plug 20
2,5 mm² br
1,5 mm² rt
Flame detection
thermostat
solenoid valve
Temp. fuse
glow plug
motor
Webasto - heating
Typ HL 2011
1,5 mm² br
relay box
super-
structure
2.8.14

Operating principle

When the telescoping ram (4) is extended, the cylinder barrel moves telescopic section I (2) of the boom out. At the same time, telescopic section II (3) is pulled out by tapes (5) passing over rope pulleys (7).

When telescoping ram (4) is retracted, the cylinder barrel presses on stop pin (10) and pushes in telescoping section I (2) of the boom. At the same time, telescopic section II (3) is retracted by return ropes (8) attached to pivot section (1), and running over rope pulleys (9).
Telescopic section III (5) is a mechanical boom extension. It is pulled out or pushed in by a rod, and pinned to telescopic section II (3).

Maintenance

1. Every week, lubricate the sliding faces of telescopic sections I (2), II (3) and III (5), and the six grease nipples (25) for the upper bearing shoes (24). The 6 grease nipples are reached through holes (26) when telescopic boom sections I (2), II (3) and III (5) are fully extended.

2. Check bearing plates (27) for wear. Renew worn plates.

   a) Take off the telescopic-section guide plates (17).

   b) Raise telescopic sections I (2), II (3) and III (5) with a second crane or hoist.

   c) Remove the adjusting washers (20), pin (22) and eccentric center journal (23), and take off bearing shoes (18) and (19).

   d) Renew the bearing plates (27).

   e) Install the bearing shoes (18) and (19) again.

   f) Adjust the telescoping guides (for adjustment procedure, see 'Telescopic-section guides').

3. Adjust the return rope (8) setting if necessary. (For procedure, see 'Boom assembly'.)

<u>Telescopic-section guides - adjusting</u>

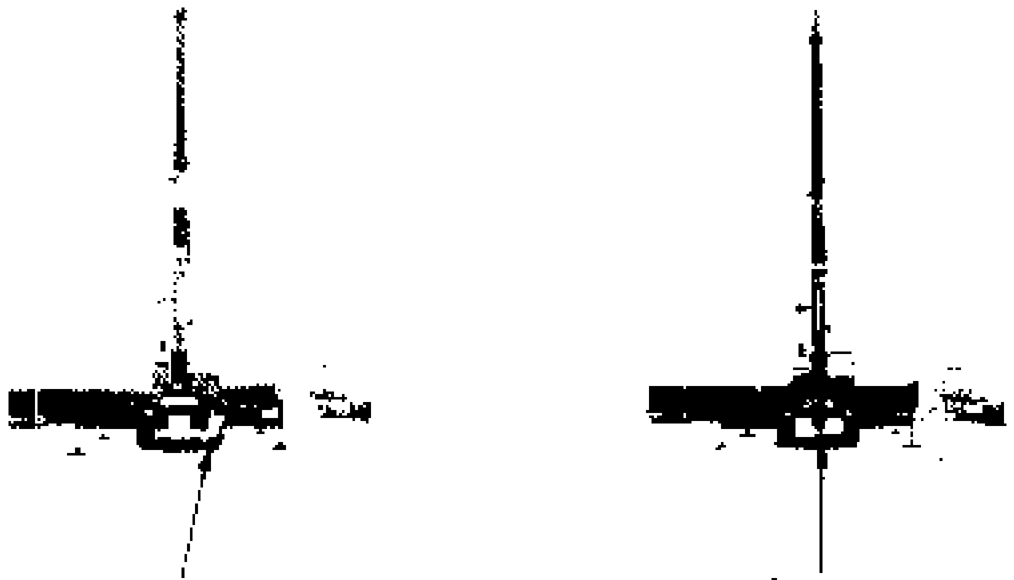
When fully extended, telescopic sections I (2), II (3) and III (5) must be in a straight line in relation to the longitudinal axis of the boom pivot section (1).

1. Adjust the guides and supports uniformly at the left and right bearing shoes (18).
   A - Adjust guides by turning the eccentric sleeve.
   B - Adjust contact (support) by turning the adjusting screws (28).

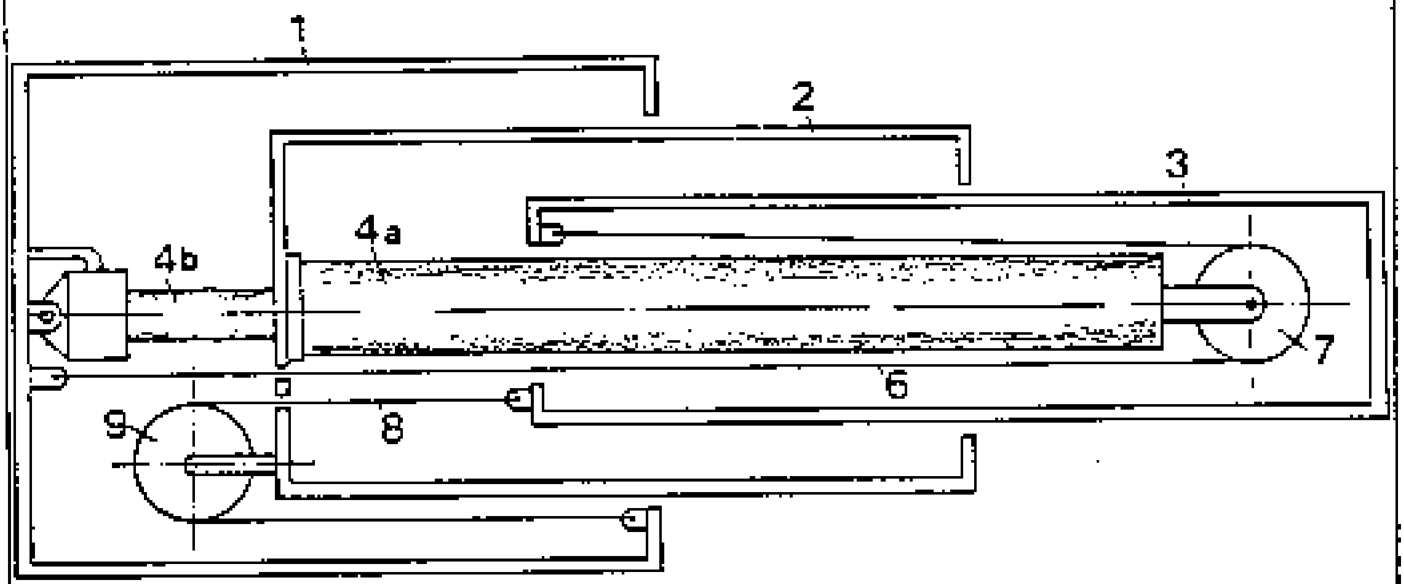
2. Adjustment of boom centering (straight-line position of guides) is at the eccentric center journal (23).

   To check the setting: extend all telescopic sections fully (see page 3.1.02, illustrations).

Adjusting telescopic boom sections



Operating schematic - telescopic boom for LTM 10



6) Extending rope with pulley

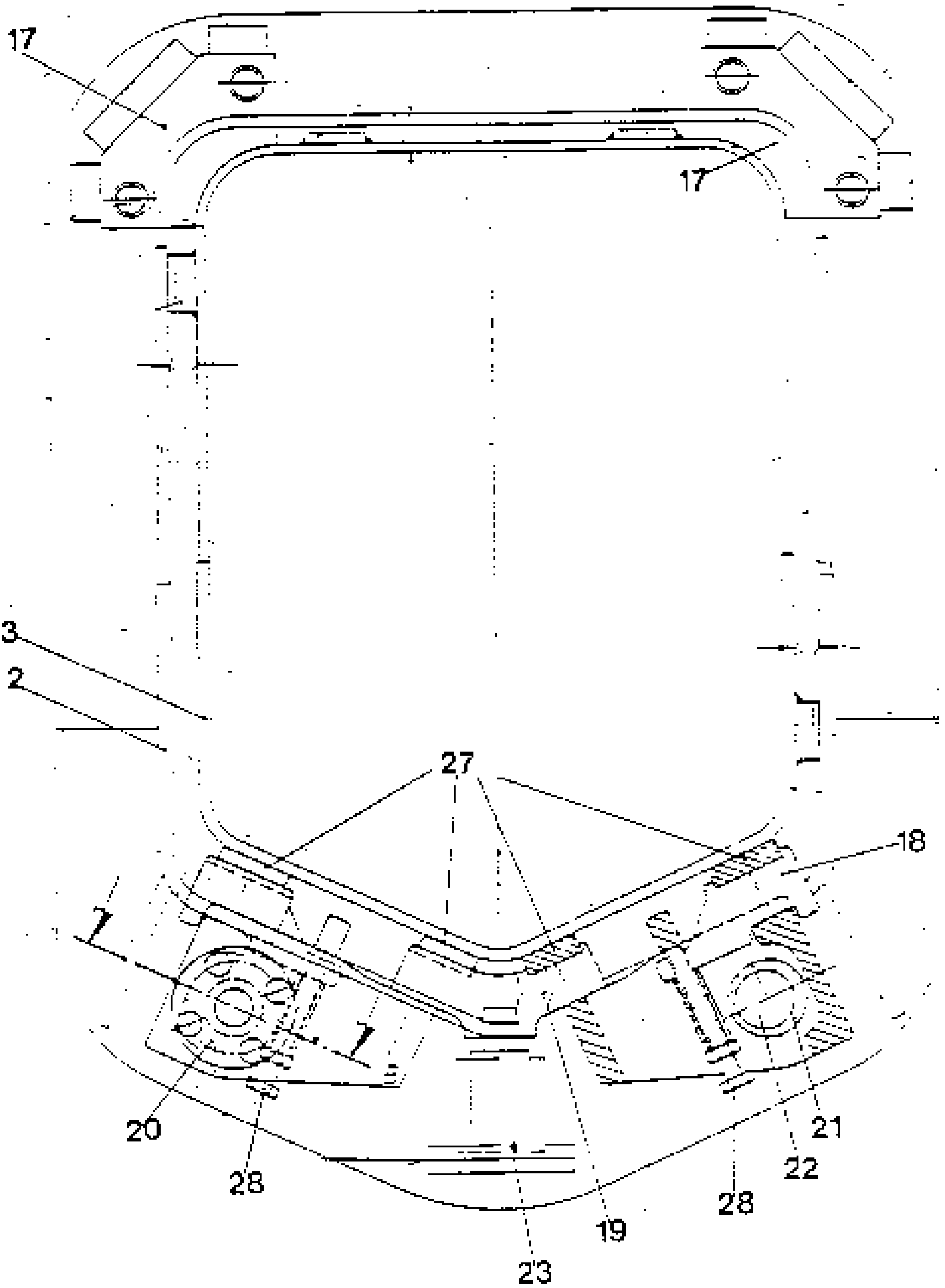
8) Retracting rope with pulley

4a) Cylinder } of telescoping ram

4b) Piston } of telescoping ram

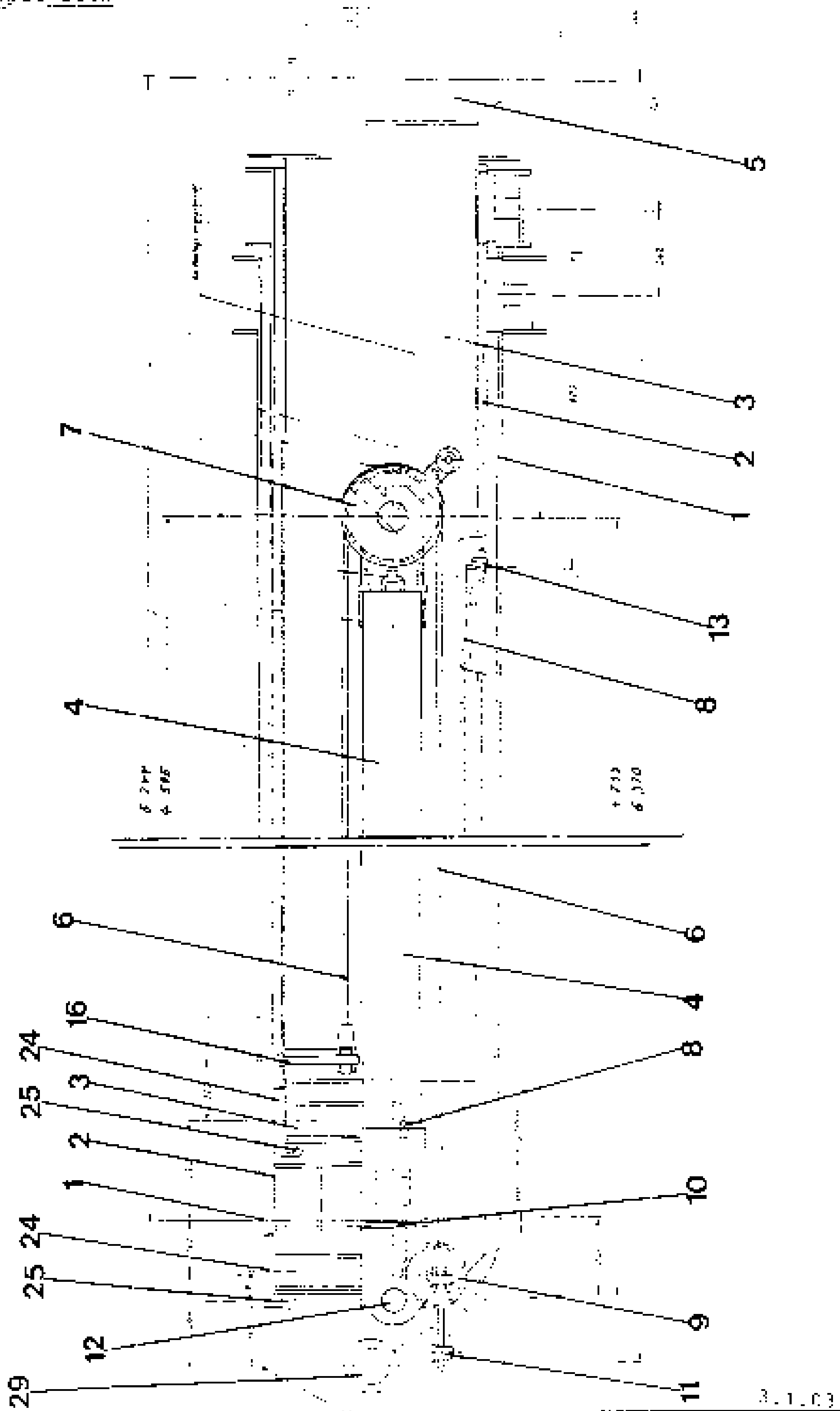
Telescopic boom

Item	Designation
1	Boom pivot section
2	Telescoping section I
3	Telescoping section II
4	Telescoping ram
5	Telescoping section III
6	Flat ropes
7	Rope pulleys
8	Return ropes
9	Return rope pulleys
10	Stop pin
11	Rope retaining pin
12	Telescopic ram retaining pin
13	Nuts
14	Rope guard
15	Support
16	Rope retaining pin
17	Guide plates
18	Bearing shoe, outer
19	Bearing shoe, center
20	Adjusting washers
21	Eccentric sleeve
22	Pin
23	Eccentric center journal
24	Bearing shoe, upper
25	Grease nipple
26	Opening for grease nipple on bearing shoe 24
27	Slider pads, polyamide
28	Adjusting screws
29	Retaining pin for pivot section
30	Retaining pin for luffing ram
31	Luffing ram
33	Limit switch for junction box
34	Length detector - rope guide
35	Length detector rope
36	Slewing platform
37	Support bracket
38	Angle indicator
40	Strain gauge
41	Length and angle indicator



Date Datum	Valable pour série Gültig für Serie	Feuille n° Blatt-Nr.

Telescopic boom



3.1.03

Dismantling the boom

1. Remove rope from hook block.

2. Extend telescopic boom by app. 40 cm and relieve tension on return ropes (8), then retract boom by app. 10 cm.

3. Unscrew the limit switch junction box (33) and run back with the length detecting rope (35) as far as the rope guide (34) on the boom pivot section (1).

4. Remove the telescoping-section guide plates (17).

5. Mark the adjusting washers (20) for the eccentric sleeves (21) and eccentric center journal (22).

6. Using a second crane or hoist, raise telescopic sections I (2) and II (3), and remove bearing shoes (18) and (19).

7. Disconnect the strain gauge (40) and length detector (41).

8. Take off the angle indicator (38).

9. With the second crane, raise the luffing ram (31) slightly, remove pin (30) and stow the ram in a convenient place.

10. Attach the boom complete in this form to two rope slings, and raise slightly with the second crane (see Fig. X).

11. Unscrew the hydraulic hoses from the telescoping ram (4) at the changeover valve.

    Warning: prevent dirt from entering open unions.

12. Remove pin (29) from boom pivot section (1).

13. Raise the complete boom with the second crane and place it on the assembly fixture.

14. Remove pin (11) retaining the tail ropes.

15. Remove pin (12) retaining the telescoping ram.

16. Remove telescoping sections I (2), II (3) and III (5) complete with telescoping ram (4) and the flat ropes (6) and return ropes (8) from boom pivot section (1).

17. Detach the rope guard (14) at left and right.

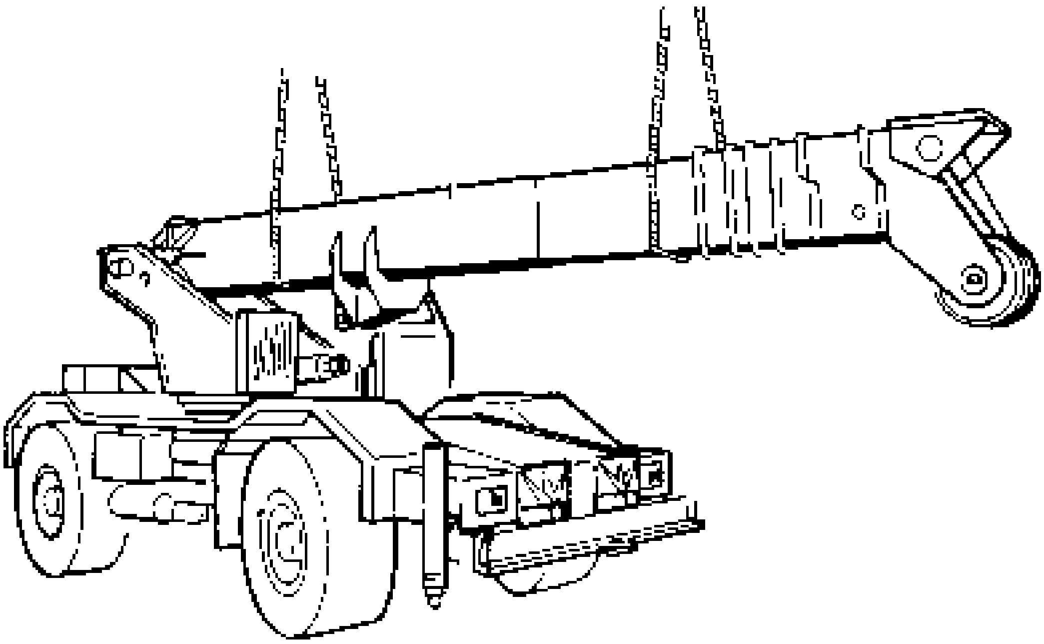
18. Remove stop pin (10). Raise the ram slightly, detach supports (15) at left and right and lower the ram (4).

19. Remove telescoping sections II (3) and III (5) with ram (4), flat ropes (6) and return ropes (8) from telescoping section I (2).

20. Remove pin (16) for retaining the flat ropes.

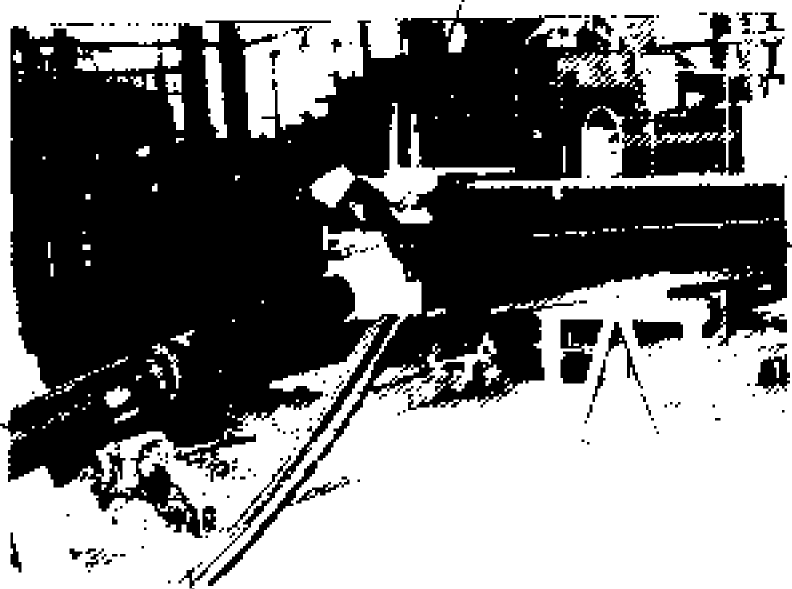
21. Remove telescoping ram (4) with flat ropes (6) from telescoping section II (3).

Fig. X



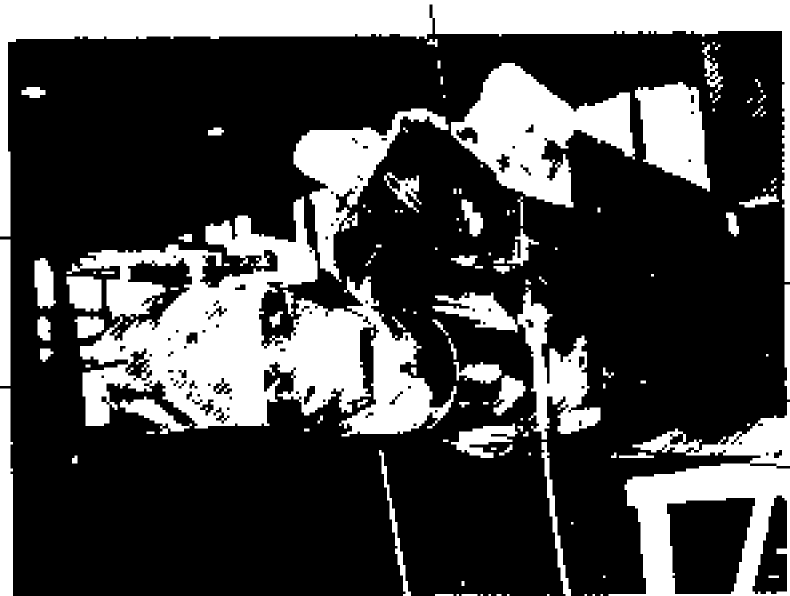
Beam assembly

1. Install telescoping ram (4) with flat ropes (6) in telescoping sections I (3) and II (5).



When inserting ram (4), note angled position of items (4) and (3).

2. Secure flat ropes (6) with pin (16) to telescoping section I (3), and retain with keeper.

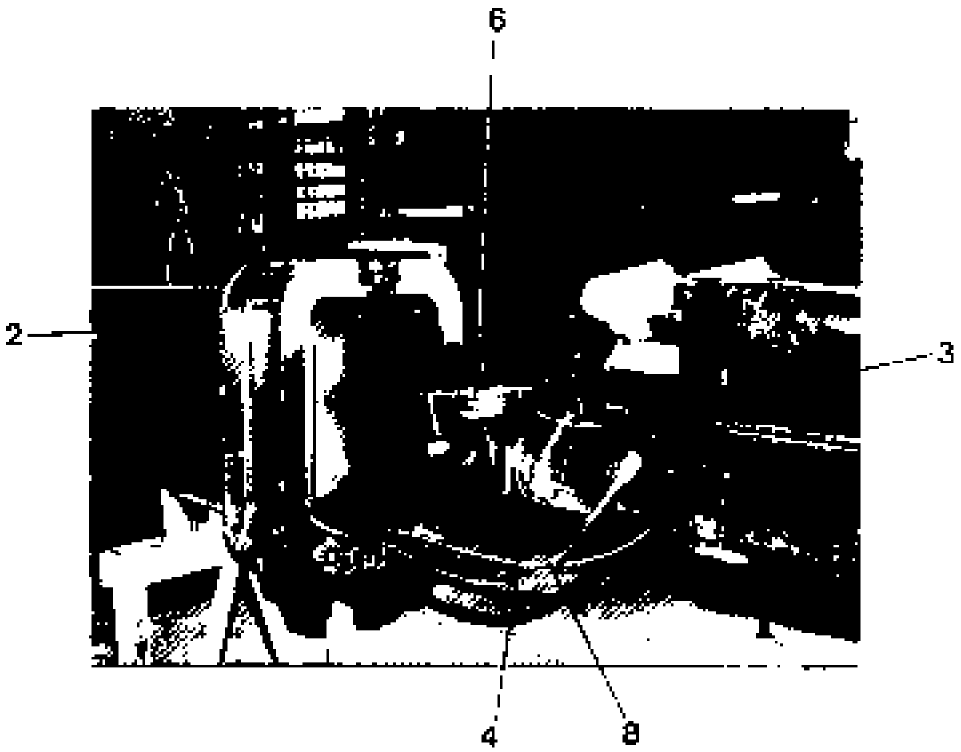


Assembly aid when inserting telescoping section II (3) into section I (2):

a) Attach flat ropes (6) at top of telescoping ram (4).

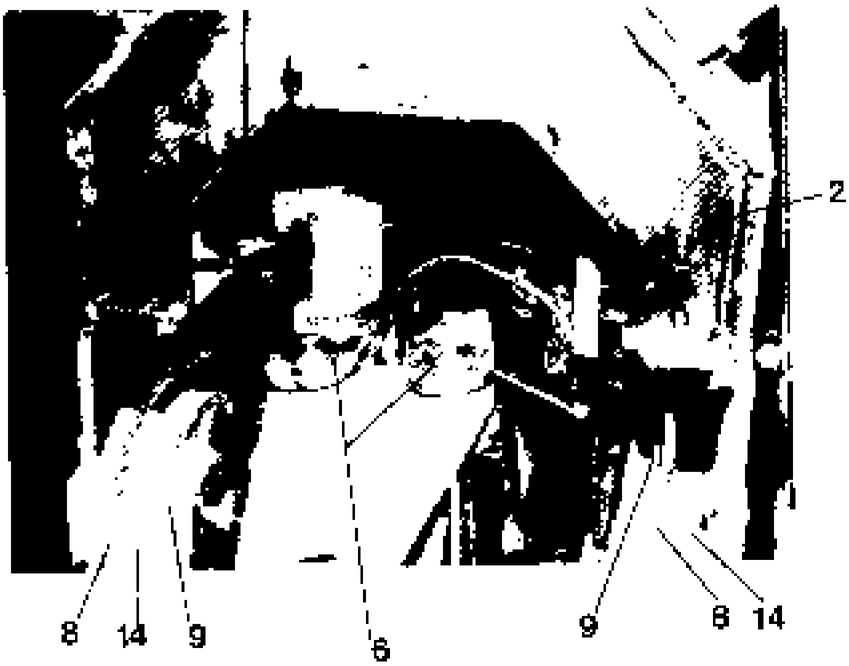
b) Place telescoping ram (4) on assembly plate (A).

3. Push telescopic section II (3) into telescopic section I (2) with return ropes (8).

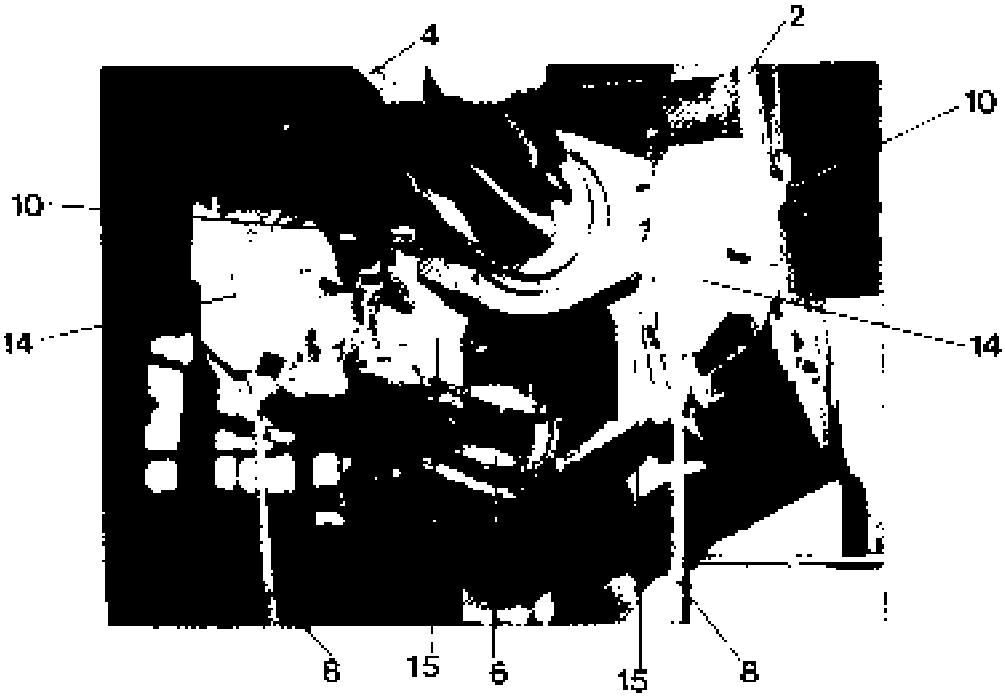


4. Place return ropes (8) on rope pulleys (9). Install rope guard (14) at left and right.

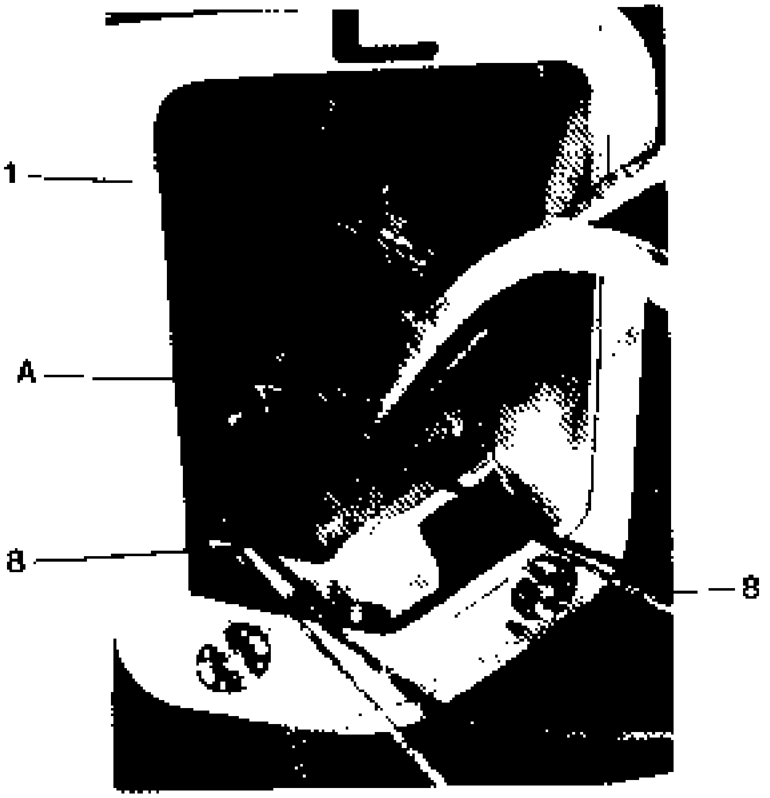
   Make sure that the ropes run correctly.



5. Raise telescoping ram (4) with the second crane or hoist. Set down the flat ropes (6) and remove assembly plate (A). Install supports (15) and stop pin (10). Secure pin (10) with 4 bolts.

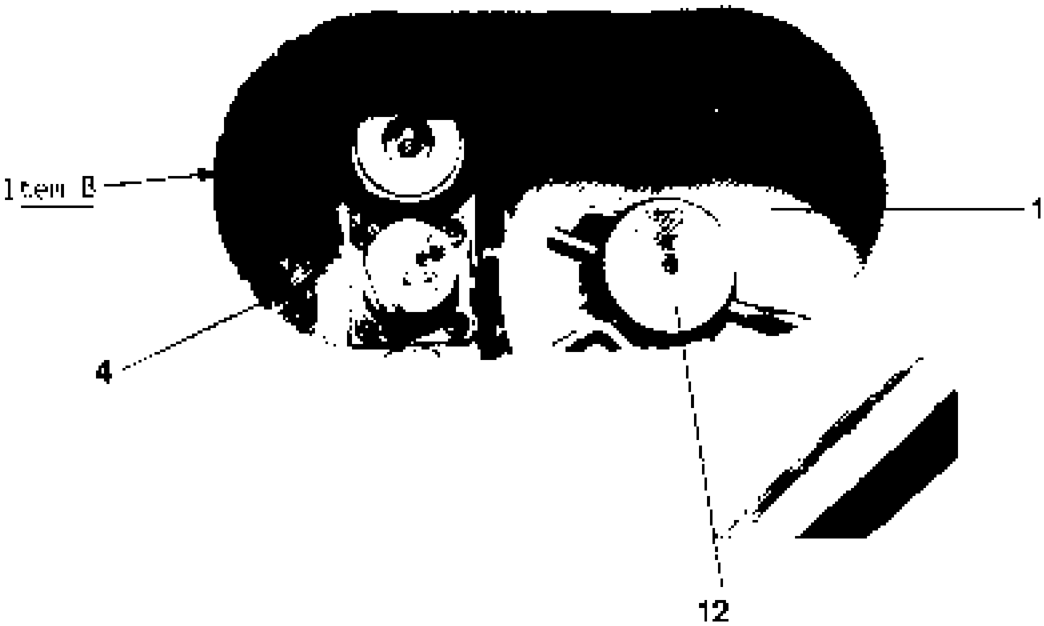


6. Insert return ropes (8) into rope guide (Item A) on boom pivot section (1), and screw on nuts (13).

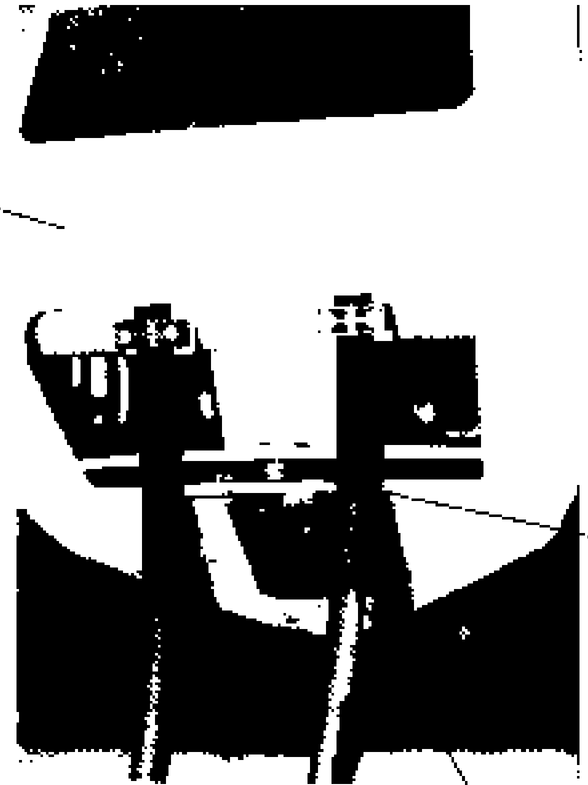


7. Insert telescoping sections I (2), II (3) and III (5) into boom pivot section (1).

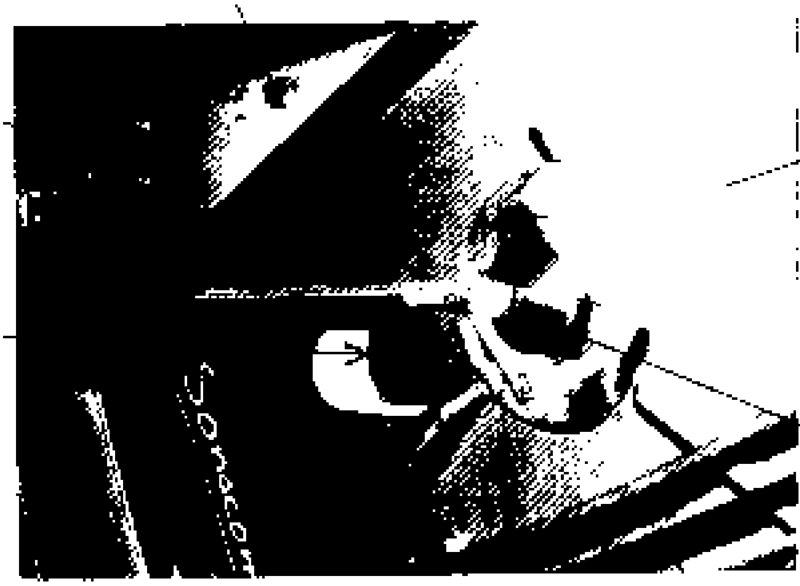
8. Insert pin (12) for telescoping ram (4) and secure with a split pin.



9. Using a special tool (Item C), pull flat ropes (6) into the holder on the boom pivot section (1). Secure with pin (11) and insert split pin as keeper.



10. Raise the complete boom with the second crane, secure to slewing platform (36) with pin (29), and secure. Attach keeper plate.



11. Set the boom down on its support bracket (37).

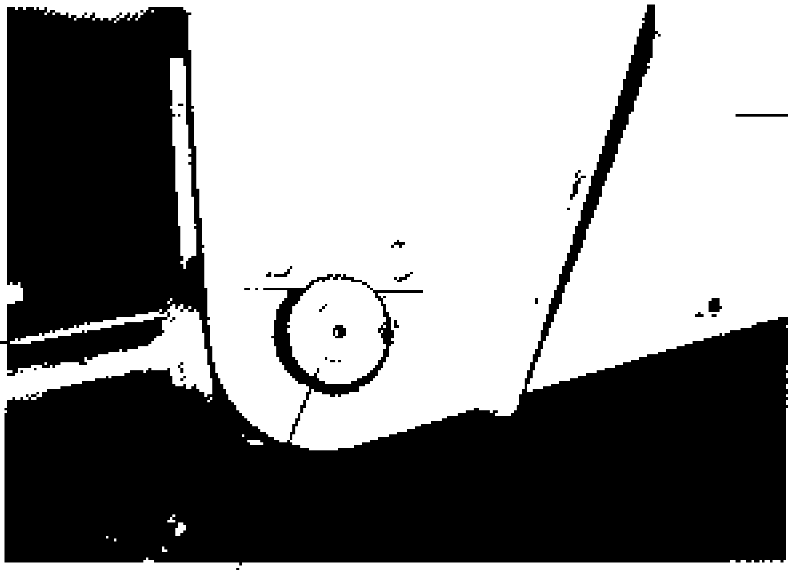
12. Attach the angle indicator (38).

13. Screw on the hydraulic hoses for the telescoping ram at the changeover valve.

14. Attach the luffing ram (31) with pin (30) to the boom pivot section (1), and secure.

1

31



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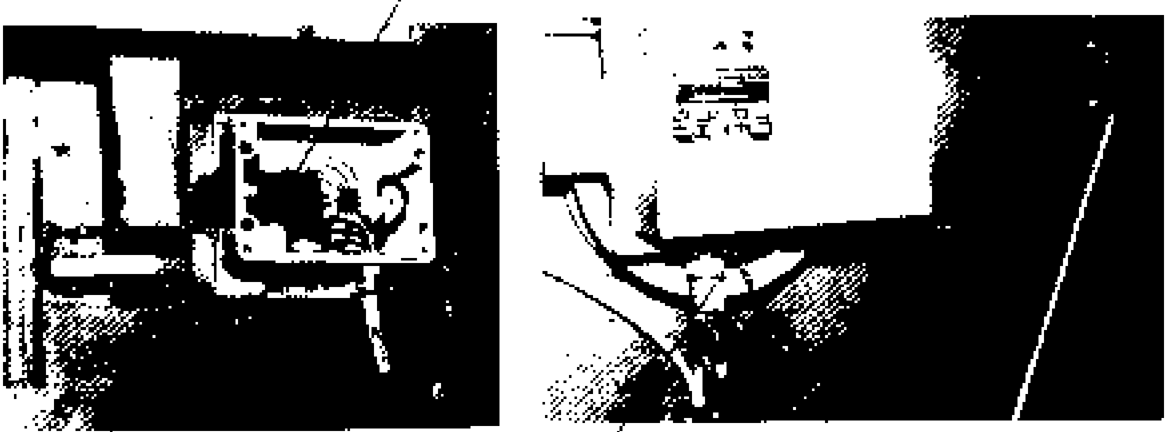
15. Connect the wiring to the strain gauge (40) and the length detector (41).

40



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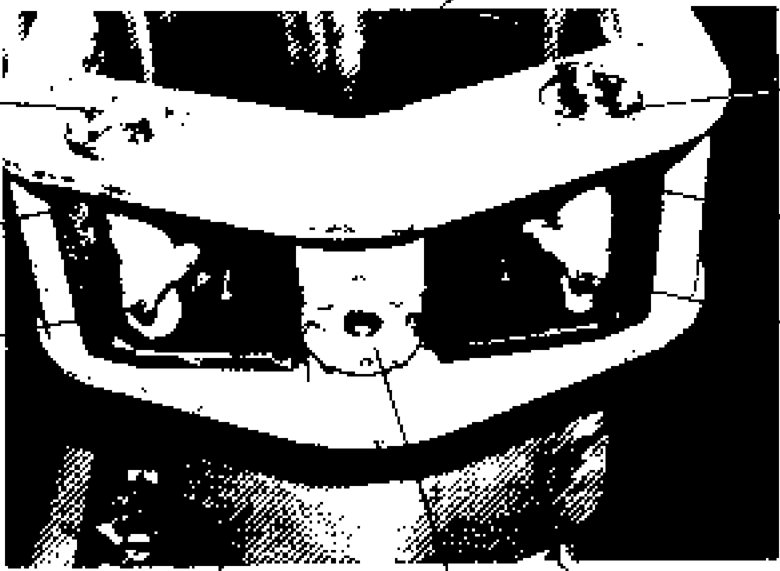
16. Raise telescoping sections I (2) and II (3) with the second crane, and attach bearing shoes (18) and (19).

    Note identifying marks.



17. Lower the telescoping sections on to the bearing shoes.

18. Attach length detecting rope (35) with its drum (42) and junction box (33) to telescoping section III (9).

19. Reeve the hook block.

20. Extend the telescopic boom by app. 20 cm, and tauten the return ropes (8) at nuts (13).

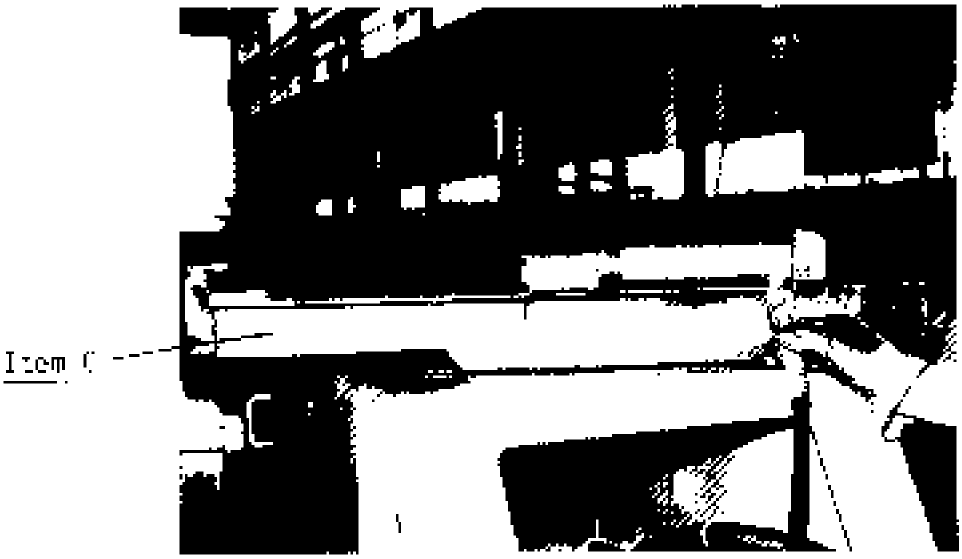
Warning:

- tauten only sufficiently for telescoping section I (2) to reach its stop before telescoping section II (3) when retracting the boom.
- if after this adjustment the return ropes are still not taut when the boom is extended (inspect through holes provided when boom sections have been extended), check movement synchronization and adjust if necessary.
- Synchronization of movement is corrected by welding a plate on to the stop for telescoping section I, or grinding away the stop for telescoping section II.

Note:

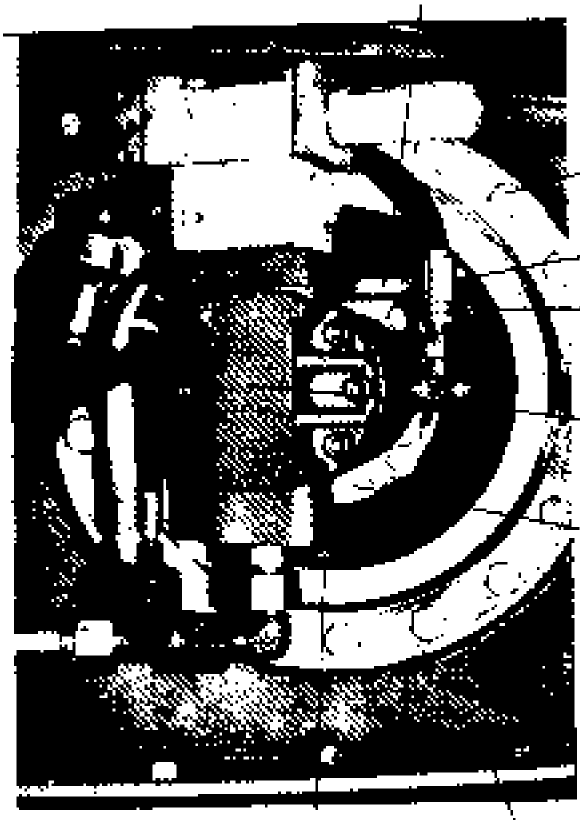
If the stops for telescoping sections I or II are altered, the preset dimension for the auxiliary jib mount will also be changed.

This must be noted when the lattice fly jib is attached.

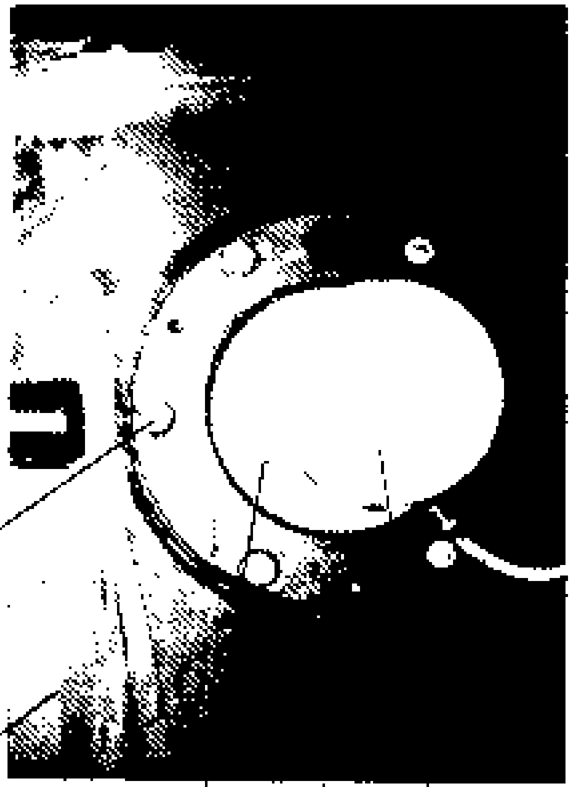


Rope winch mounting

View from left



View from right



Type KSW 350 F 352

Maintenance

Apart from lubricating at the specified lubricating points (70) and (69), the rope winch needs no routine maintenance.

Removal

1. Uncoil the hoisting rope (40) and release its attachment clip (14).
2. Detach the lower hoisting limit switch (46).
3. Unscrew the hydraulic motor (3) at the motor flange, and pull off.
4. Unscrew the brake release hose (4) at the pressure-side filter (93). Plug open unions to prevent dirt from entering.
5. Take off rope guard (47) and contact roller (48).
6. Raise the rope winch (2) slightly with another crane or hoist.
7. Remove bolts (26) and press off flange (10) with three bolts.
8. Remove bolts (27) and lift the rope winch (2) away from its mountings on the slewing platform (24).

For installation, follow the above instructions in the reverse order

Note:

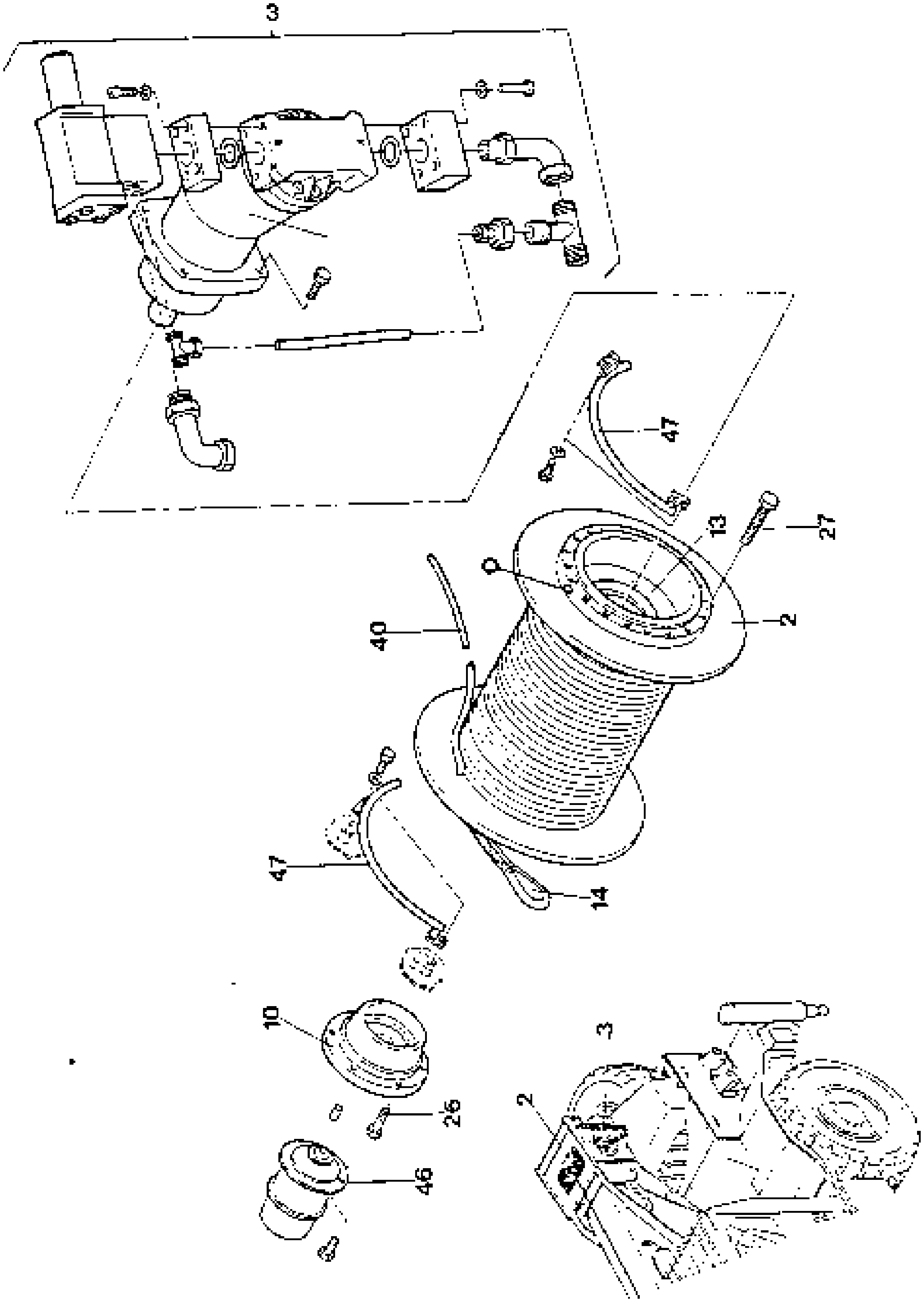
When the rope winch (2) is being installed, the '0' mark must face upwards.

After installation, the lower hoisting limit switch (46) must be adjusted.

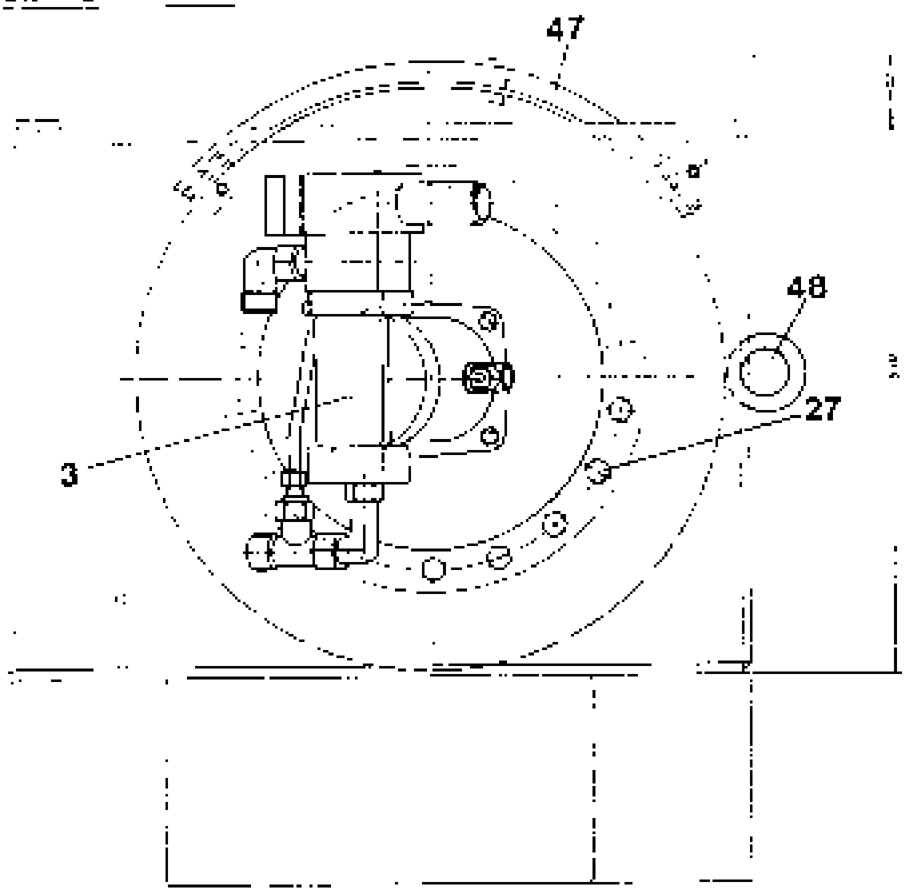
Remove the cover from the limit switch casing.

Adjust the trip movement (switch-off) at the contact switch so that lowering movements are halted when three safety turns of rope are still present on the winch drum.

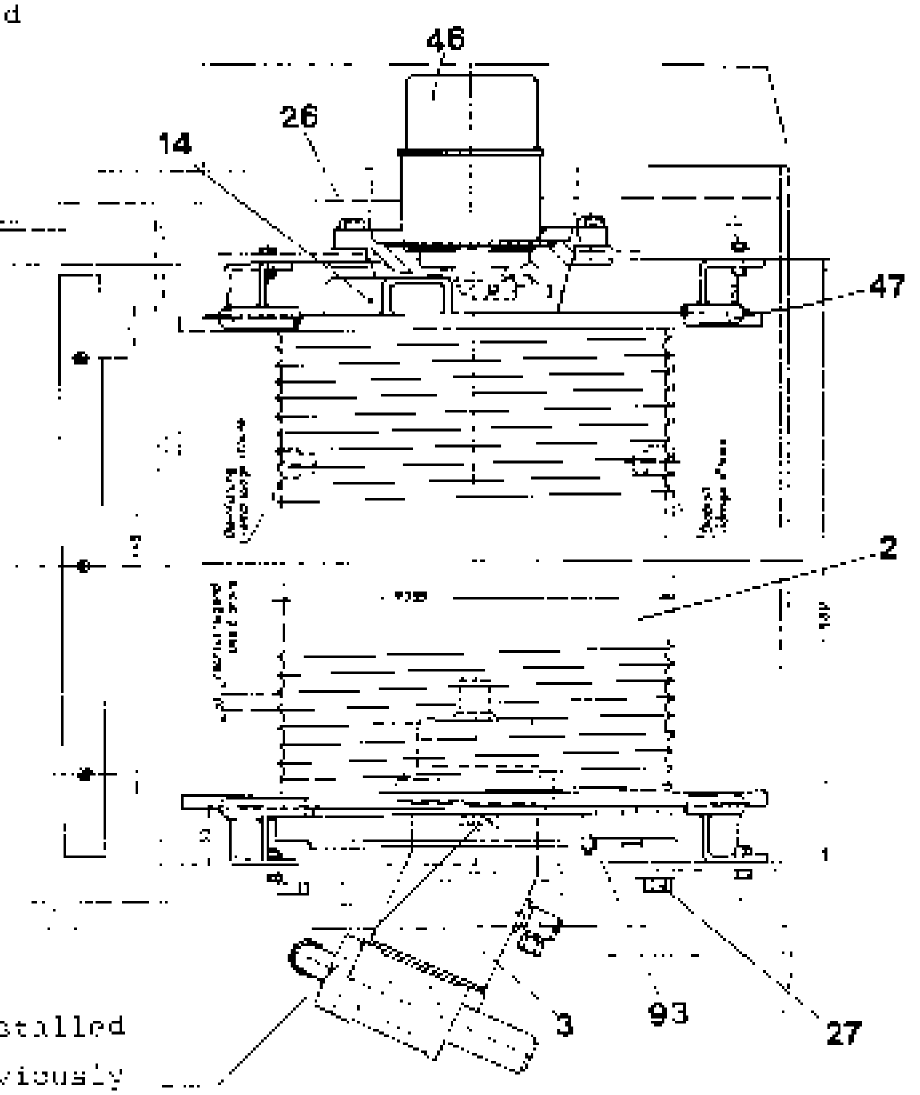
Rope winch – components



Rope winch - A



Screws item 26 and 27 locked with Loctite 270



Note correct installed position as previously marked

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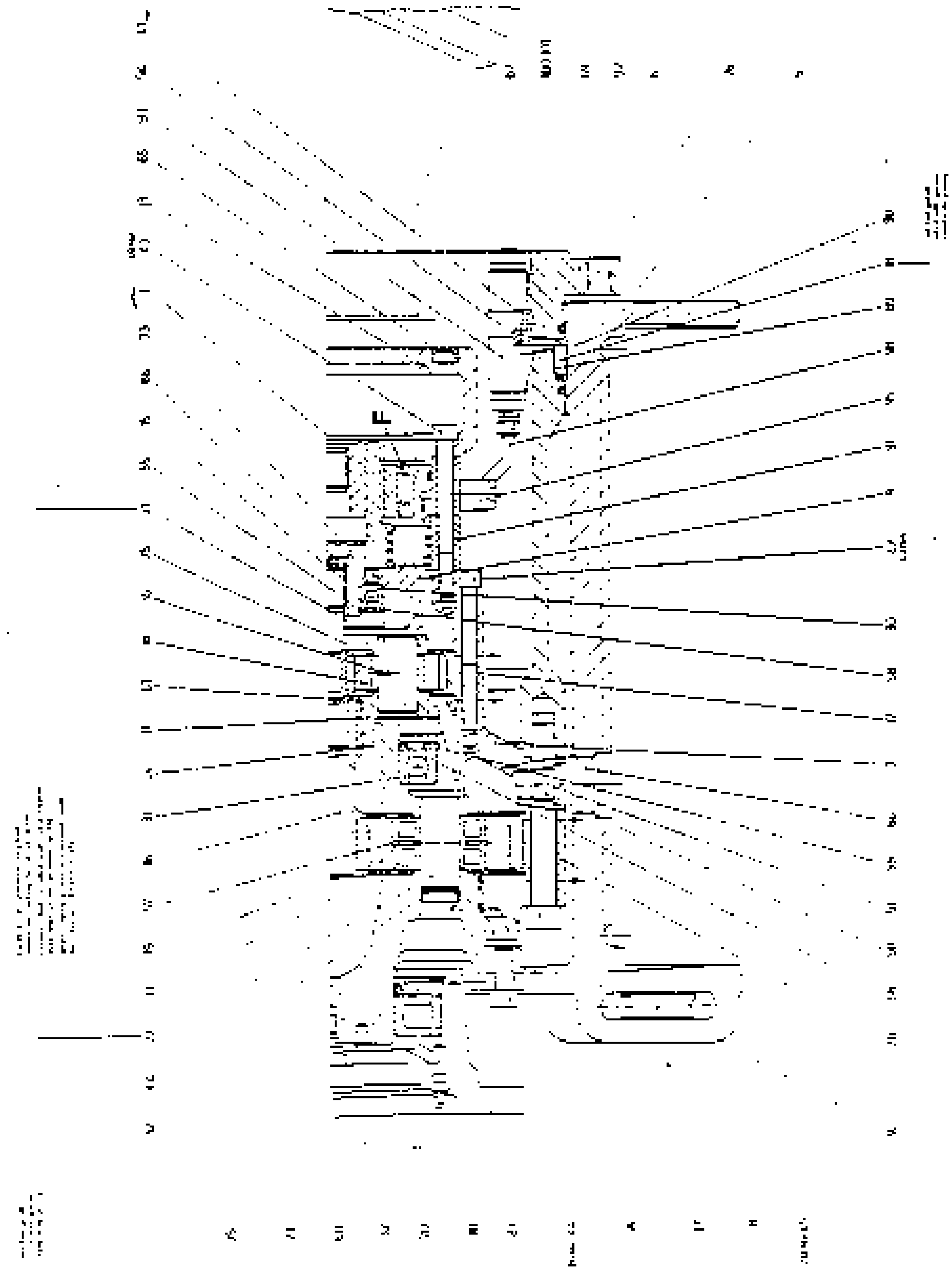
Rope winch

Type RSW 350 II 252



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3.2.03

Type KSW 350 H 352 winch

Item	Designation
1	Driving sleeve
5	Rope drum
6	End housing
7	Intermediate housing
8	Bearing ring
9	Brake flange
10	Flange
11	Planetary gear carrier
12	Planetary gear carrier
13	Motor flange
14	Rope wedge
15	Sunwheel, M=2.5, 12 teeth
16	Planet wheel, M=2.5, 23 teeth
17	Annulus, M=2.5, 60 teeth
18	Sunwheel, M=3.5, 29 teeth
19	Planet wheel, M=3.5, 29 teeth
20	Annulus, M=3.5, 72 teeth
21	Planet wheel shaft
22	Planet wheel shaft
23	Cover
25	Washer 26.7 x 41 x 1
30	Deep-groove ball bearing 6009
31	Deep-groove ball bearing 6019
32	Roller bearing 20217
33	Roller bearing NJ 305E
35	Needle roller bearing
37	Cage, BH 3020 0637
38	Cage, BH 7024 0995
41	Hex bolt, M8 x 16 - 8.8
42	Machine screw, M10 x 100 - 8.8
43	Machine screw, M10 x 110 - 8.8
44	Machine screw, M12 x 30 - 8.8
45	Machine screw, M16 x 130 - 8.8
50	VS. screw, M22 x 1.5 - 5.8
51	Sealing ring
54	Circlip, 44 x 1.75
55	Circlip, 45 x 1.75
56	Circlip, 95 x 3
57	Circlip, 62 x 2
58	Circlip, 75 x 2.5
59	Circlip, 145 x 4
60	Circlip, 150 x 4
61	Snap ring, SW 43
64	Cover
65	Plug
66	Plug
67	Plug
69	Grease nipple
70	Grease nipple
73	Shaft sealing ring, 50 x 68 x 8 NB
74	Shaft sealing ring, A 210 x 250 x 15 NB
75	Felt strip, white
86	Shim washer, 15 x 22 x 1
87	Shim washer, 25 x 36 x 2
89	Steel strip
90	Steel strip
91	Multi-disc brake
92	Threaded union, 6E SLN
93	Pressure-side filter
94	Hose clip
96	Threaded union, 5Va SLN
98	Pipe
100	Type plate

Multi-disc brake

Construction

The spring-loaded multi-disc brake consists primarily of the fixed, internally-splined element, the moving, externally-splined element and the alternating externally- and internally-splined plates which engage with the above elements, together with the springs.

Operating principle

At zero pressure, the plates are acted upon by the concentrically mounted springs, so that they cannot perform any relative movement. The brake is held on solely by the mechanical energy of the springs.

When pressure is applied (15 – 18 bar), the brake is released. The springs are compressed, so that the load on the plates is relieved and they can move freely in relation to one another.

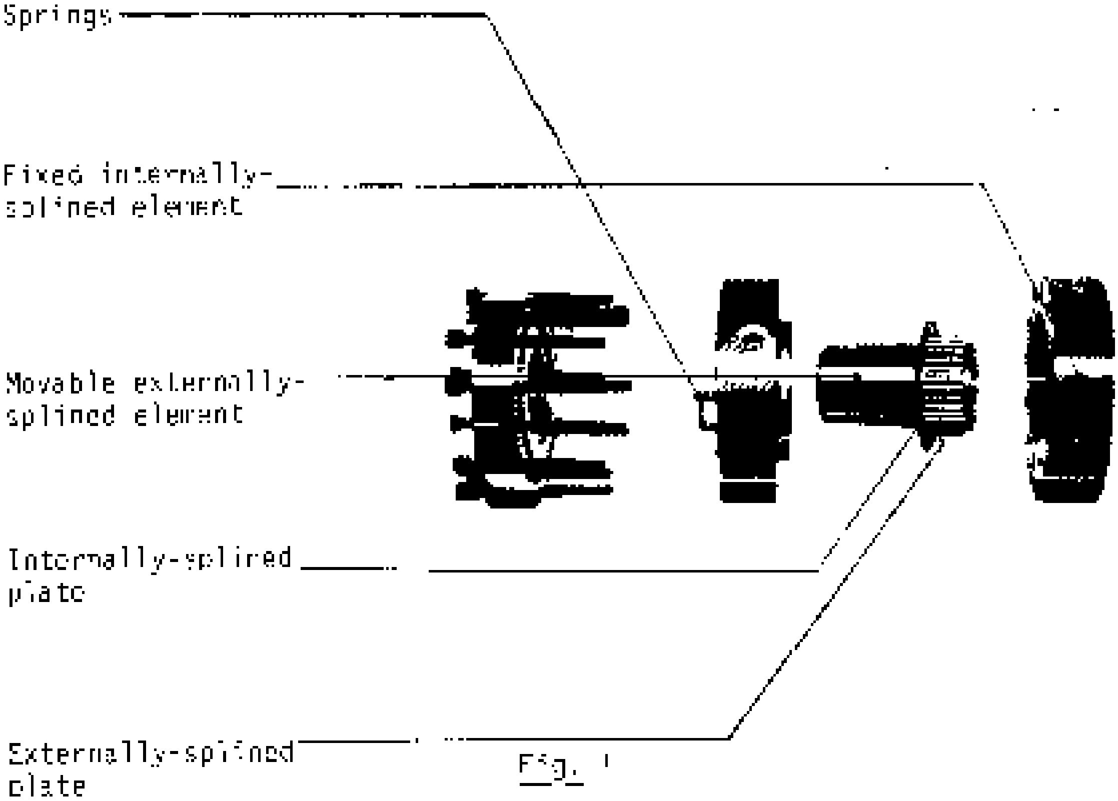


Fig. 1

Hoisting brake

Multi-disc brake

Maintenance

The brake is self-adjusting for wear. If operated at high pressure and applied frequently, slight oil leakage at the plunger seals is unavoidable.
Check and drain the leak-off oil by unscrewing check valve (8).

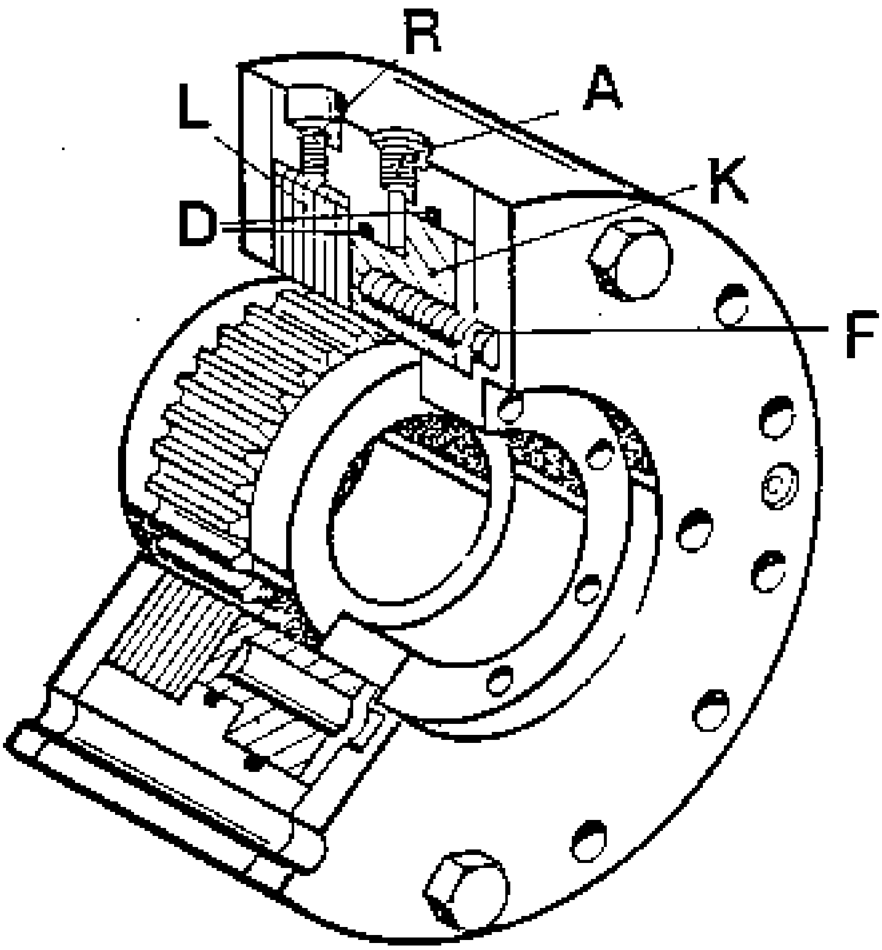
Removal

1. Unscrew the hydraulic motor (3) from motor flange (13), and pull off.
2. Unscrew brake release hose (4) from the pressure-side filter (93). Prevent dirt from entering exposed unions.
3. Detach filter (93) and mounting (94).
4. Remove two opposite bolts (43) and screw in two longer M10 x 120 mm assembly bolts.
5. Unscrew bolts (43) in a crosswise sequence across the center of the unit.
   Warning: Motor flange cover (13) could fly off because of the force exerted by springs (F).
6. Absorb the spring pressure by unscrewing the 2 assembly bolts uniformly.
7. Remove brake (91) complete with motor flange (13).

Installation

1. Insert plates into brake (91), noting correct positions of internally- and externally-splined plates.
2. Secure brake (91) and motor flange (13) to hoisting gear transmission with 2 M10 x 120 mm assembly bolts.
3. Screw in bolts (43) and tighten in a crosswise (over-center) sequence to a torque of 49 Nm.
4. Take out the 2 assembly bolts and insert and tighten the remaining two bolts (43).
5. Attach pressure-side filter (93) with mounting (94) to rope winch.
6. Attach hydraulic motor (3) to motor flange (13).
7. Screw brake release hose (4) to filter (93).

Spring-loaded multi-disc brake



A = Connection for working pressure

R = Check (non-return) valve

F = Springs

D = Sealing rings

K = Plungers

L = Plates

Spring-loaded multi-plate brake

1. Possible malfunctions

a) Internal leakage

b) Plates worn

c) Plungers sticking

d) Blocked sack filter in working-pressure line

2. Troubleshooting

a) Oil escaping from check valve

b) Braking action becomes less effective

c) Brake cannot be released

d) see c)

3. Remedial action

a) Install a new or exchange brake assembly

b) see a)

c) Free plungers; renew (exchange) if necessary

d) Clean filter; renew if necessary

Removal

1. Prevent the slewing platform from turning accidentally (lower the boom on to its support).
2. Remove bolts (40) and take off hydraulic motor (2) (mark its installed position).
3. Unscrew the brake release hose from multi-disc brake (85).
4. Mark transmission (1) in relation to frame, and take out bolts (3).
5. Force off transmission (1) at flange with four bolts, and lift out with a second crane or hoist.

Installation

1. Using the second crane, lower the transmission (1) absolutely vertically into the mounting on the slewing platform (note correct installed position as previously marked).
2. Secure with bolts (3), but do not tighten them fully as yet.
3. Check tooth backlash and adjust if necessary (see 'Adjustment'). Tooth backlash must not be less than 0.15 mm.
4. Tighten bolts (3) with a torque wrench in a crosswise pattern (correct tightening torque 77 Nm).
5. Screw the brake release hose on to the brake.
6. Attach hydraulic motor (2) and secure with 4 bolts (40).

   Note:
   a) Grease the drive pinion lightly with 'Molykote'.
   b) Apply sealant ('Atmosit') to the contact face when installing.
7. Check the oil level.

Tooth backlash - adjustment

The clearance between the teeth on the slewing gear ring and on the drive pinion (65) must be correct. The minimum value is 0.15 mm. Measure at the point marked (1) on the slewing ring. Use a feeler gauge, lead strip or copper wire.
While adjusting, turn the slewing gear transmission (1) to left or right.

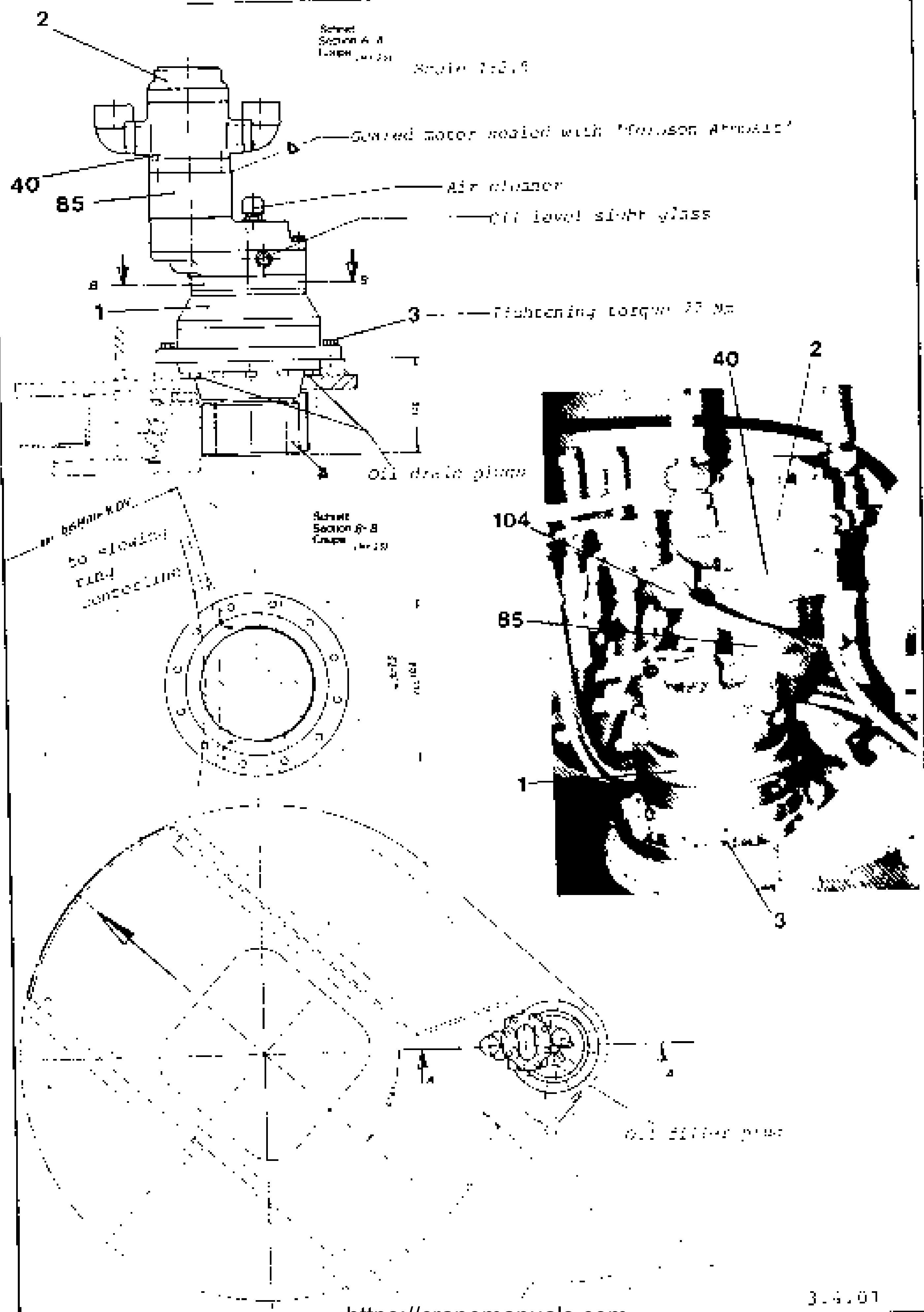
1. Remove bolts (3) and turn transmission (1) to left or right by 1 hole.
2. Check tooth backlash again.
3. If correct, tighten bolts (3).

After this adjustment, tooth backlash should be finally checked at 4 - 5 different points.

Slewing brake

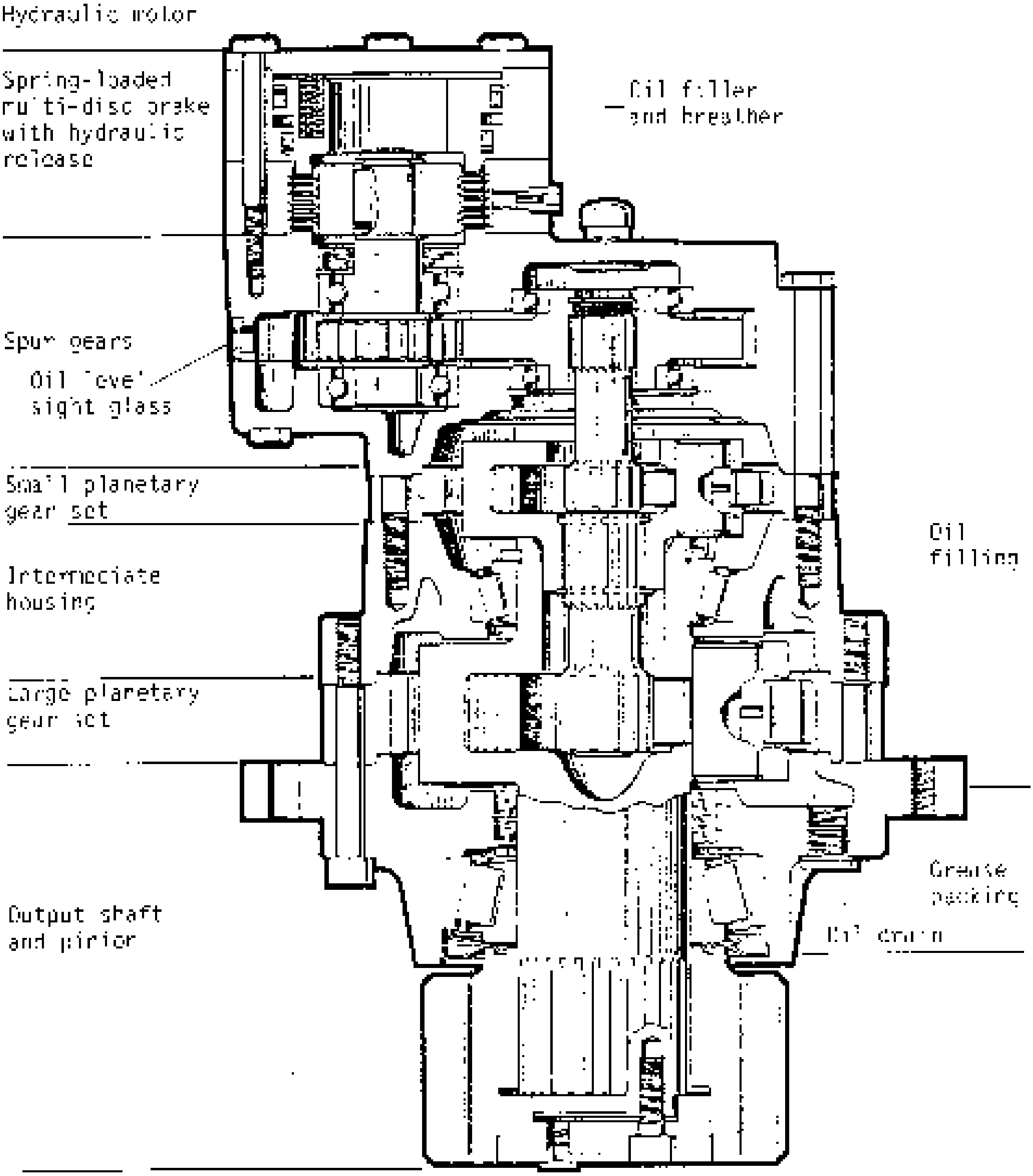
The slewing brake requires no routine maintenance. For its design and operating principle, refer to the hoisting brake.

Slewing gear transmission – installed position



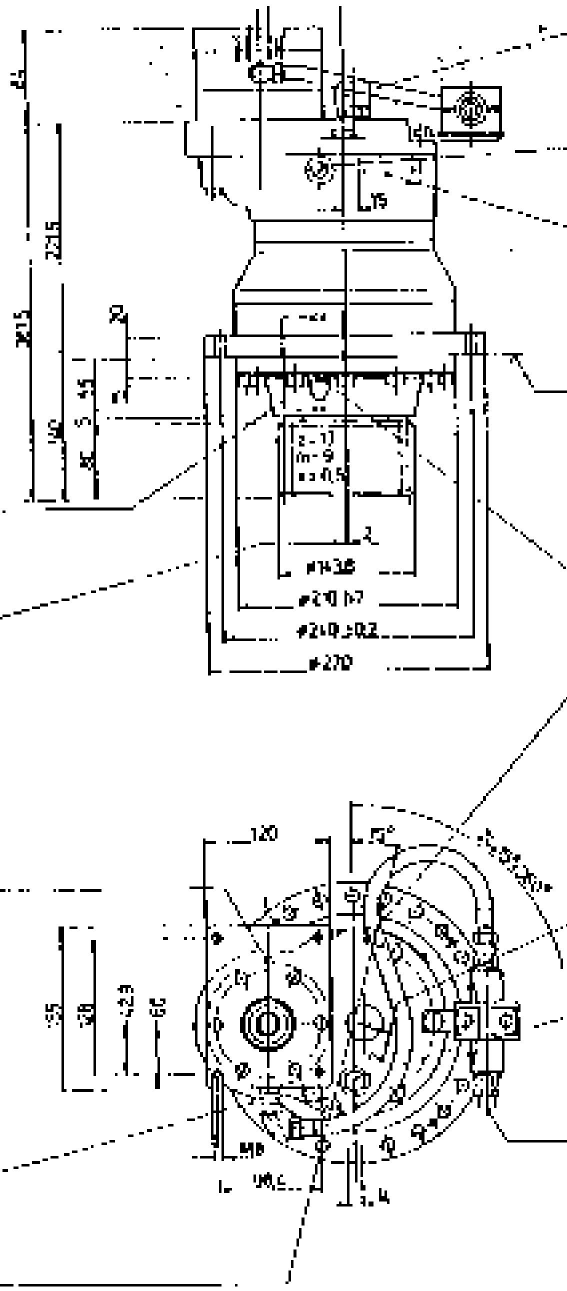
Maintenance:

The slewing gear transmission is splash-lubricated. Before use, it must be filled to the mark on the oil sight glass with SAE 90 gear oil to MIL-L 2105 B specification. The lower support bearings are packed with 3D DIN 51825 anti-friction bearing grease. They are lubricated for life, and the grease need not be replenished or renewed.
Check oil level once a week.
Change the oil after 200, 1000 and 2000 hours of operation, but at least once a year.



Slewing gear tra

Driving motor	:	Vickers GMC 4-25-E6F-10
Brake	:	Type 790-10-021
Ratio	:	80/1
Max. output torque	:	4130 Nm
Max. speed of drive motor	:	2500 1/min
Oil filling	:	1,5 l
		SAE 90 EP MIL-L-2105 B



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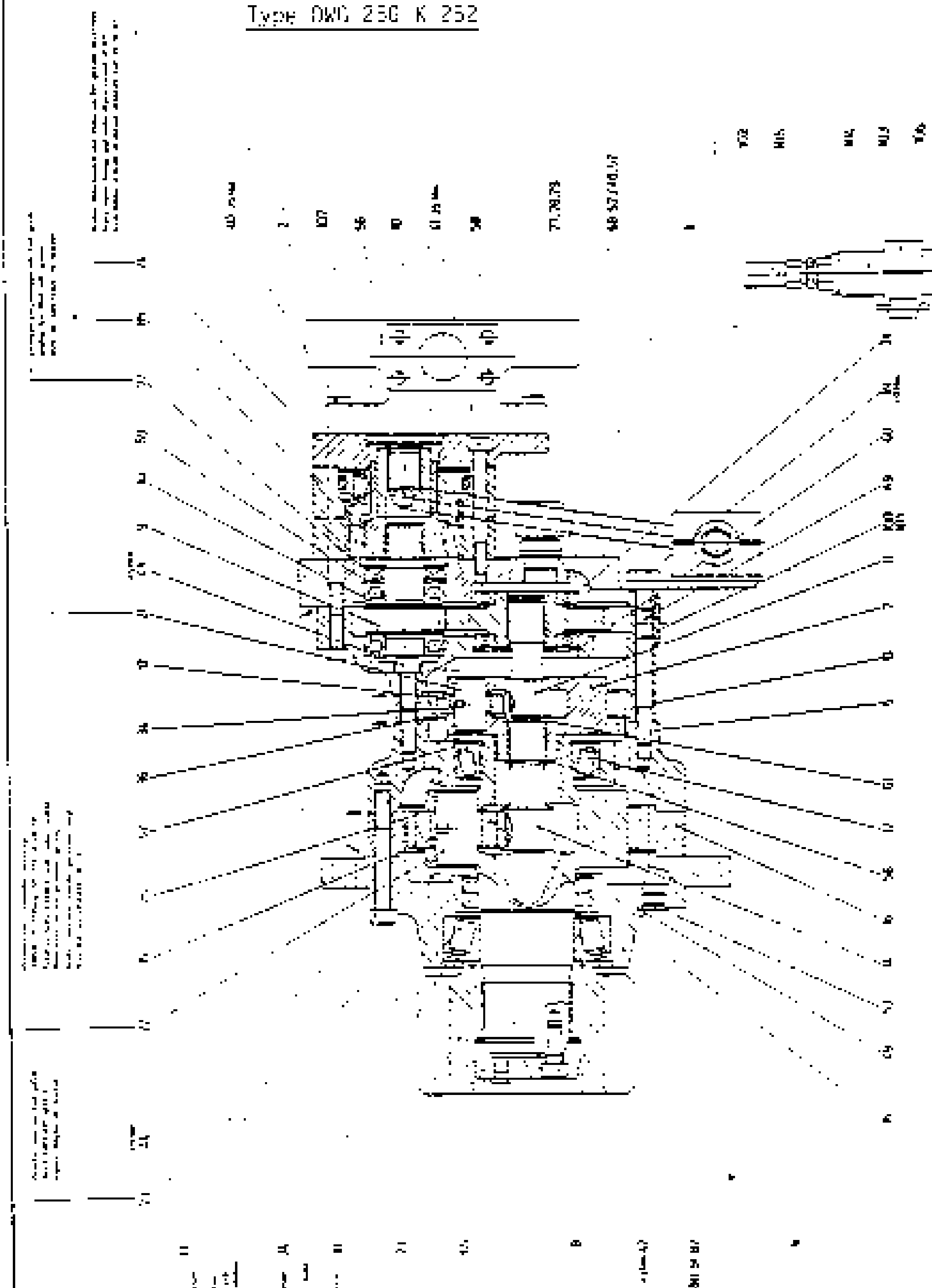
Slewing gear transmission

Type DWG 250 K 252



Bearing adjustment - taper roller bearings
Axial preload - friction moment 5 - 10 Nm
Sealed with 'Loctite 601'
All bolt threads secured with 'Loctite 242'

Slewing gear transmission

Type DWG 250 K 252

Item	Designation
1	Housing cover
2	Driving sleeve
5	Intermediate housing
6	End housing
7	Planet wheel carrier
8	Planet wheel carrier
9	Pinion shaft M=2/24 teeth
10	Spur gear M=2/54 teeth
11	Sunwheel M=2/12 teeth
12	Planet wheel M 2/23 teeth
13	Annulus M=2/60 teeth
14	Sunwheel M=2.5/12 teeth
15	Planet wheel M=2.5/23 teeth
16	Annulus M=2.5/60 teeth
17	Drive pinion M=9/13 teeth
21	Planet wheel shaft
22	Planet wheel shaft
23	End disc
24	Motor flange
25	Washer 25.7 x 41 x 1
30	Deep-groove ball bearing
31	Deep-groove ball bearing
32	Taper roller bearing
33	Taper roller bearing
34	Needle roller bearing
35	Needle roller bearing
36	Thrust washer
39	Hex bolt M10 x 110-8.8
40	Hex bolt M8 x 35-8.8
41	Machine screw M8 x 85-8.8
42	Machine screw M10 x 25-8.8
43	Machine screw M10 x 55-8.8
44	Machine screw M10 x 80-8.8
49	VSL screw M10 x 1.5
53	Sealing ring
56	Circlip 24 x 1.2
57	Circlip A60 x 3
58	Circlip 23 x 1.2
59	Circlip 62 x 2
60	Circlip 68 x 2.5
61	Snap ring SW 24
65	Plug
66	Protective plug
68	Air inlet/vent filter
69	Oil sight glass
72	Shaft sealing ring 25 x 52 x 7AS
73	Shaft sealing ring 62 x 85 x 10S
74	'Nilos' ring
77	Washer 16 x 22 x 0.2
78	Washer 16 x 22 x 0.5
79	Washer 16 x 22 x 1.0
80	Washer 56 x 70 x 0.1
81	Washer 56 x 70 x 0.3
82	Washer 56 x 70 x 1
85	Multi-plate brake
100	Type plate
102	Brake release hose
103	Holder
104	Pressure-side filter
105	Threaded union GE 8LM
106	Threaded union GE 10LM
107	Threaded union EVW 8LM

Maintenance

Apart from regular lubrication with special grease (see 1.5.01 for details), the slewing connection needs no routine maintenance.

If the slewing movement becomes stiff or jerky, the unit must be renewed (exchanged).

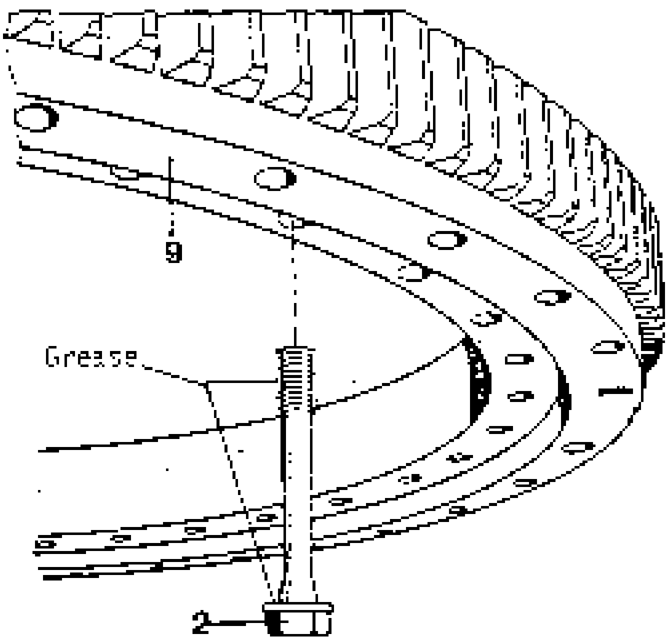
Removal

1. Take off the slewing platform (see 3.6.01).
2. Unscrew the bolts in a crosswise pattern, and remove them.
3. Remove the slewing ring downwards.

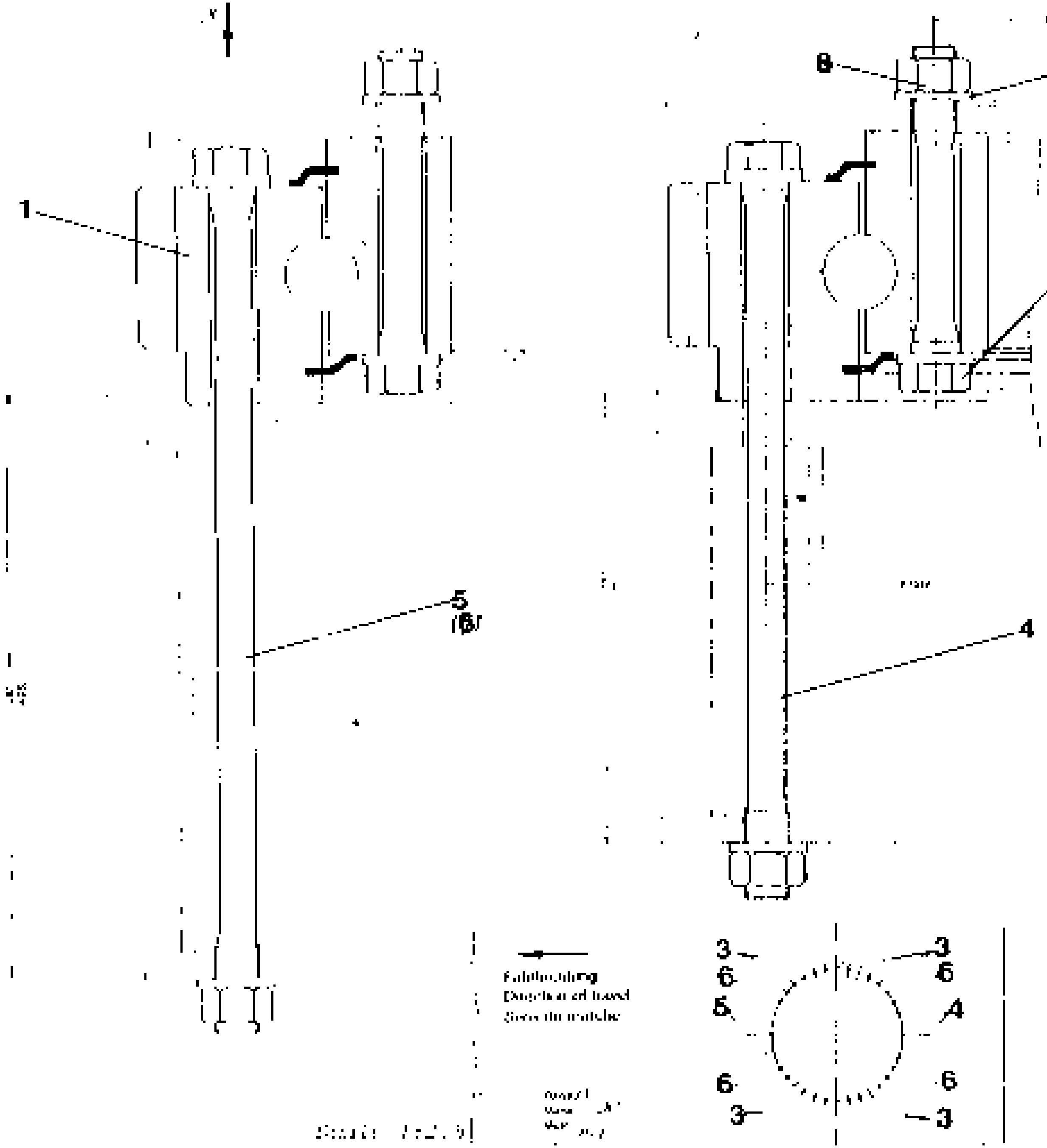
Installation

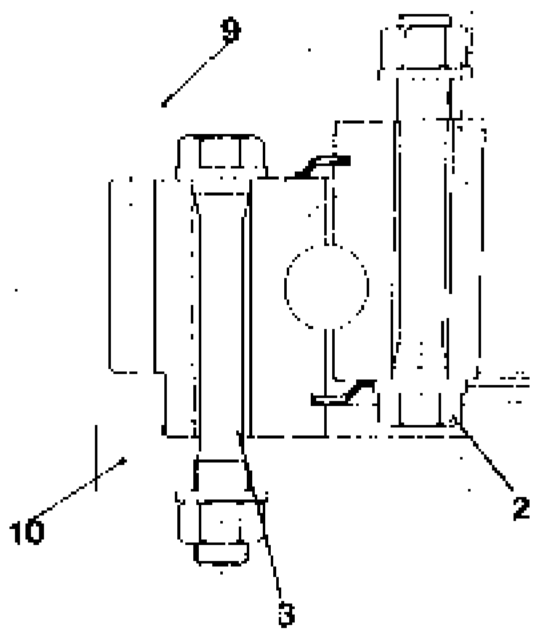
If correct and reliable operation are to be achieved, the ball slewing ring and its contact face must be absolutely clean and flat.

1. Offer up the slewing ring (1) to the slewing platform (9) from below. Apply grease to the threads and contact faces of bolts (2).



Ball slewing ring



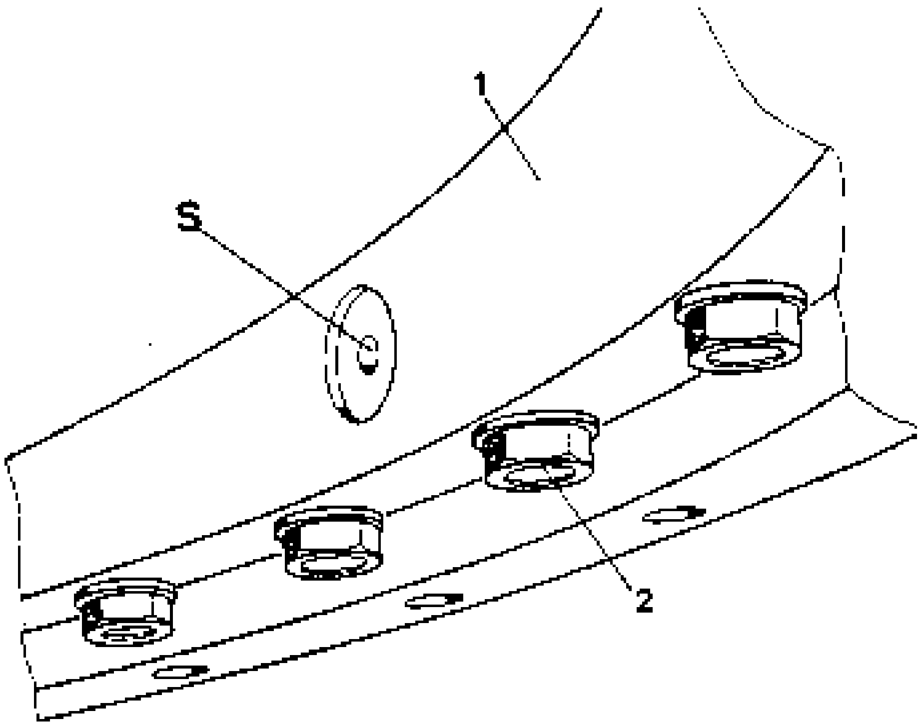


Item	Qty.	Designation	
1	1	Ball slewing ring	
2	36	Expansion bolts M20 x 145	10g
3	18	Expansion bolts M20 x 145	10g
4	5	Expansion bolts M20 x 255	10g
5	5	Expansion bolts M20 x 610	10g
6	8	Expansion bolts M20 x 625	10g
		Tightening torque 400 Nm	
7	72	Washers 21 DIN 6916	C45
8	72	Nuts M20 DIN 6916	
9		Slewing platform	
10		Undercarriage	

2. Insert bolts ([illegible]), screw on nuts (8) with washers (7) and tighten, but not fully as yet.

   Warning:

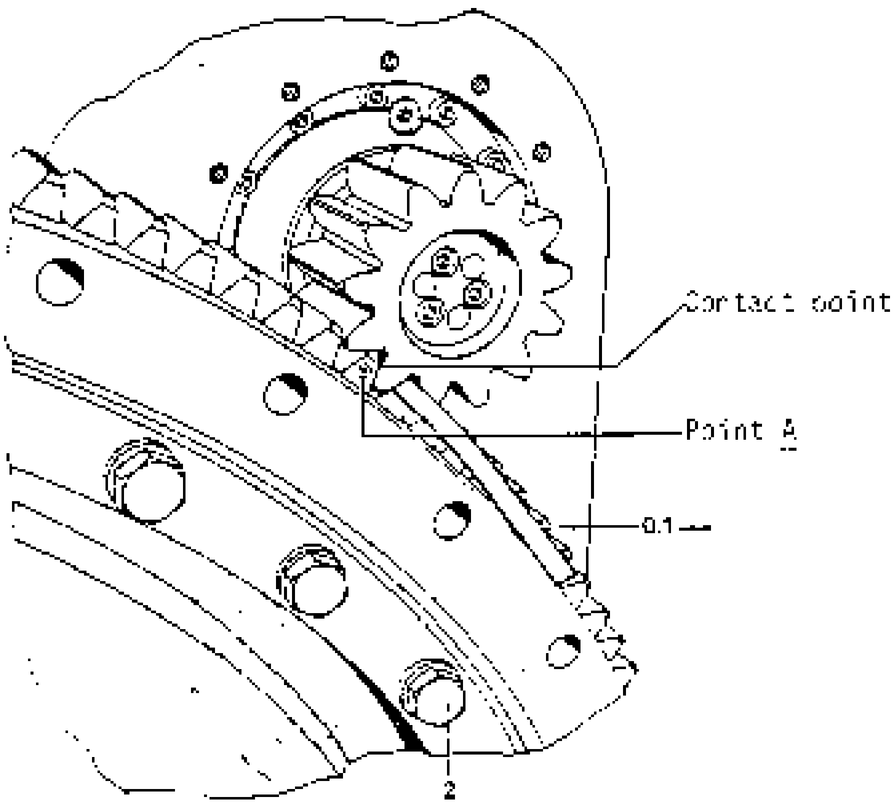
   Hardness reliever S must be at 90 degrees to the slewing platform longitudinal axis (either to left or right, looking forwards).



3. Check tooth backlash and adjust if necessary.

   a) Turn point A on the slewing ring, marked (1), until it is against the slewing gear transmission.

   b) When checking clearance, tooth (+) on the ball slewing ring must be in contact with one side of the pinion (see contact point). There must be 0.1 mm of clearance on the other side, measured with a feeler gauge.



4. Tighten the expansion bolts (2) in a crosswise pattern (i.e. first one bolt, then the next on the opposite side of the ring), using a torque wrench. Tightening torque = 460 Nm.

5. After tightening, check expansion of some of the bolts (2). Expansion bolt stretch must be ~0.4 mm (see table overleaf).

   Example: a) Measure expansion bolt (2) before tightening; length = 145.0 mm.

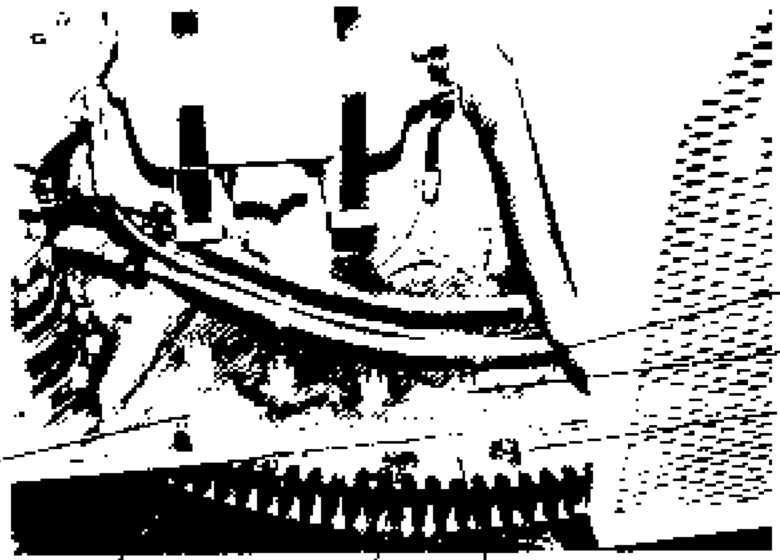
   b) Measure expansion bolt (2) when tightened to a torque of 460 Nm; length = 145.4 mm.

6. After tightening bolts (2), tooth backlash must also be checked at various points. It should be 0.1 — 0.3 mm.

   Warning:

   Tooth backlash must not be less than 0.1 mm.

7. Insert all bolts (3, 4, 5 and 6) at position C into the outer gear ring in the correct sequence, while turning the slewing ring (1). For correct bolt positions, see view 'X' (back of Sheet 3.5.01).

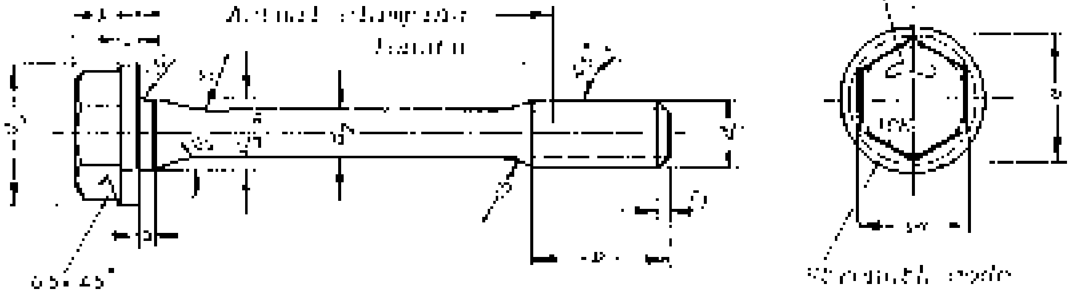


8. Mount the slewing platform (9) with slewing ring (1) on the crane undercarriage (10) — see 3.6.02.

   Note:

   Before installing, position the outer gear ring correctly as shown in view 'X' (back of Sheet 3.5.01).

Hexagon expansion bolts with shoulder and large width over flats, for high-tensile connections



Thread d_1	M 14	M 16	M 20	M 22	M 24	M 27	M 30	M 33	M 36	M 39	M 42	M 48	M 56x
Thread length b	30	35	40	45	50	55	60	65	70	80	85	95	110
d_2	14	14	17,5	19,5	21	24	26,5	29,5	32	35	37,5	43	52
d_3 - 0,1	14	17	22	24	26	29	32	35	38	41	44	51	59
d_4	30	35	40	45	50	55	60	65	65	70	75	85	[illegible]
sw	22	27	32	36	41	46	50	55	55	60	65	75	[illegible]
e	24,49	30,14	35,72	39,98	45,63	51,28	55,80	61,31	61,31	66,96	72,61	83,91	[illegible]
k	14	15	18	20	22	24	27	30	32	34	36	38	[illegible]
a	5	5	5	6	6	7	8	9	10	11	12	14	14
c	5	5	5	6	6	7	8	9	10	11	12	12	12
z_1	2	2	2,5	2,5	3	3	3,5	3,5	4	4	4,5	5	5
Stretch when tightening						10,9	≈	0,300	mm per 100 mm calculated clamping length				
						8,8	≈	0,213	mm per 100 mm calculated clamping length				
Tightening torque 10,9	21	24	46	62	80	115	155	203	286	33[illegible]	424	620	105
Tightening torque 8,8	15	17	32	44	57	81	110	[illegible]	203	238	294	441	73

SKA 2818

Detaching the slewing platform

- Remove the boom (see 'Removing boom').
- Remove the floor panel from the cab.
- While turning the slewing platform (9), unscrew and take out all but 2 bolts (3, 4, 5 and 6) at positions A and B. The remaining 2 bolts should be at the left and right sides looking in the direction of travel.

Fig. 1

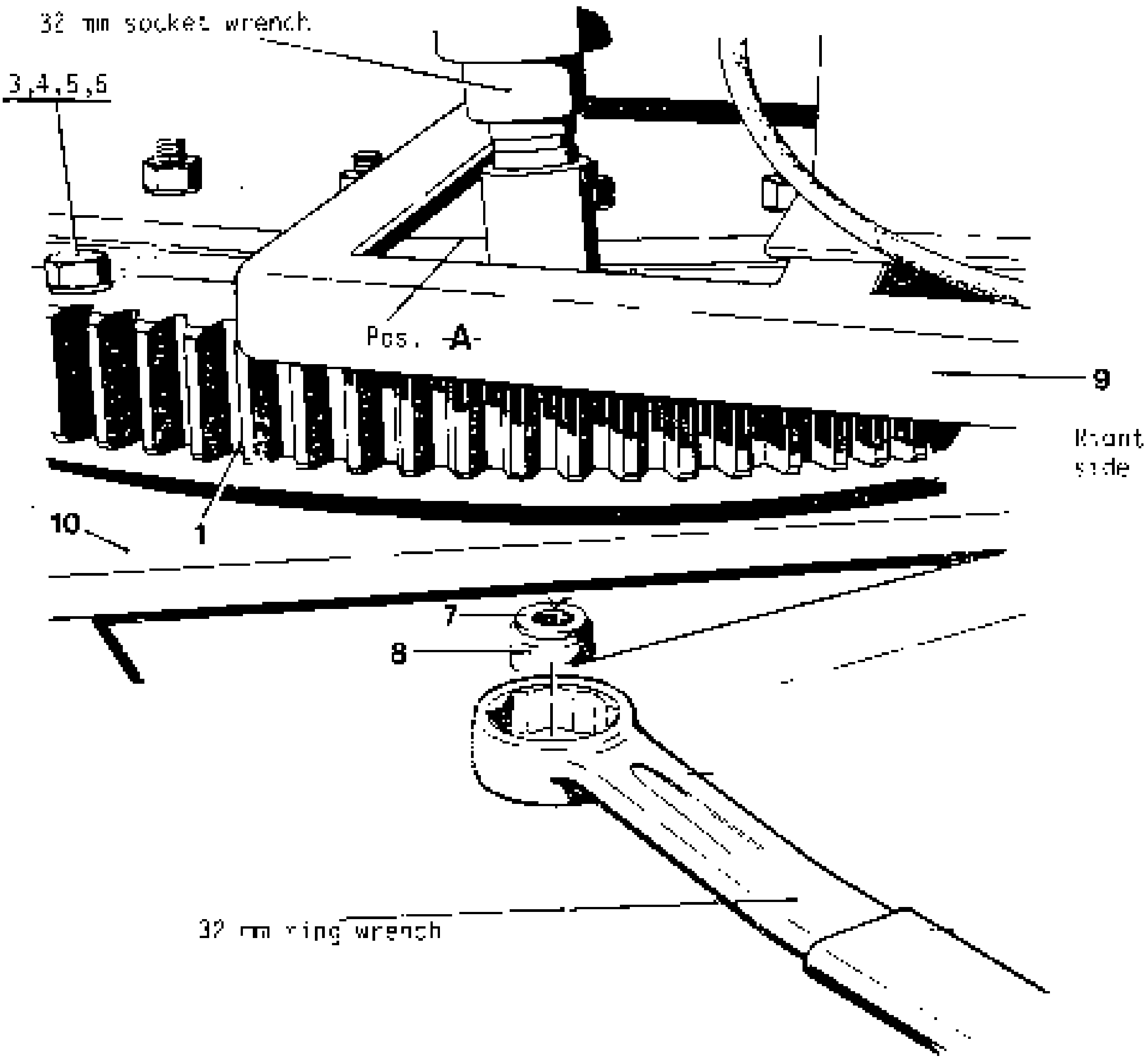
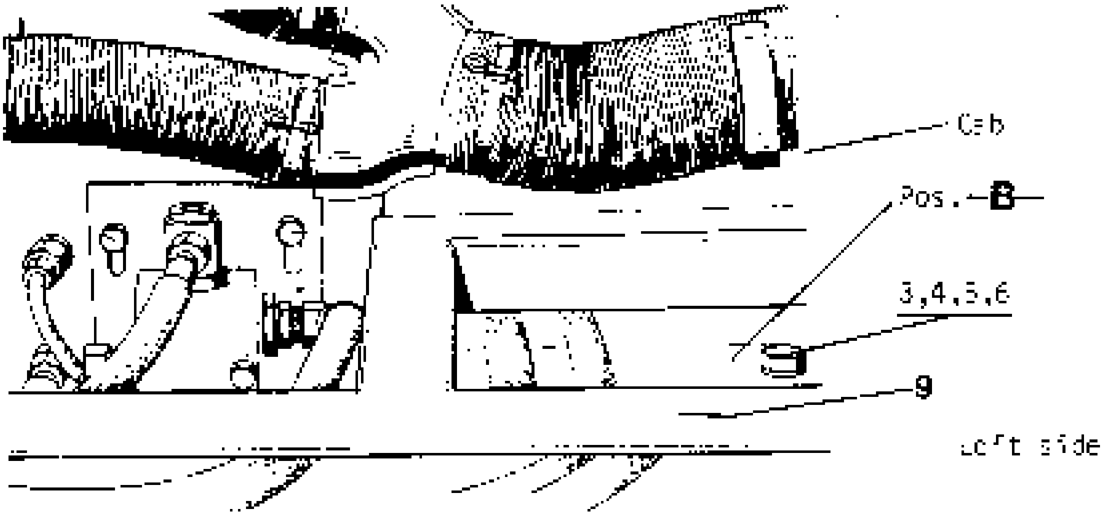


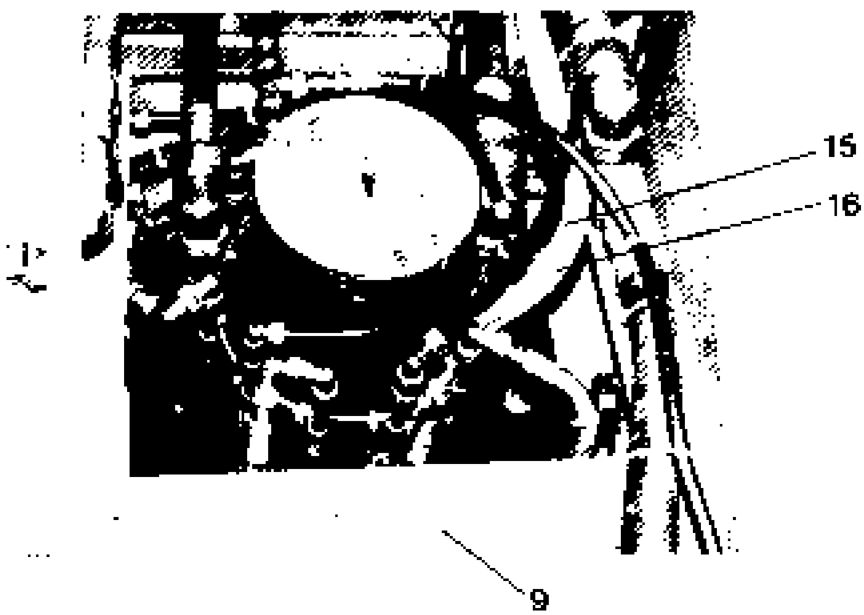
Fig. 2



- Set the slewing platform (9) along the direction of travel. Check that the remaining 4 bolts can be reached with the 32 mm socket wrench insert.

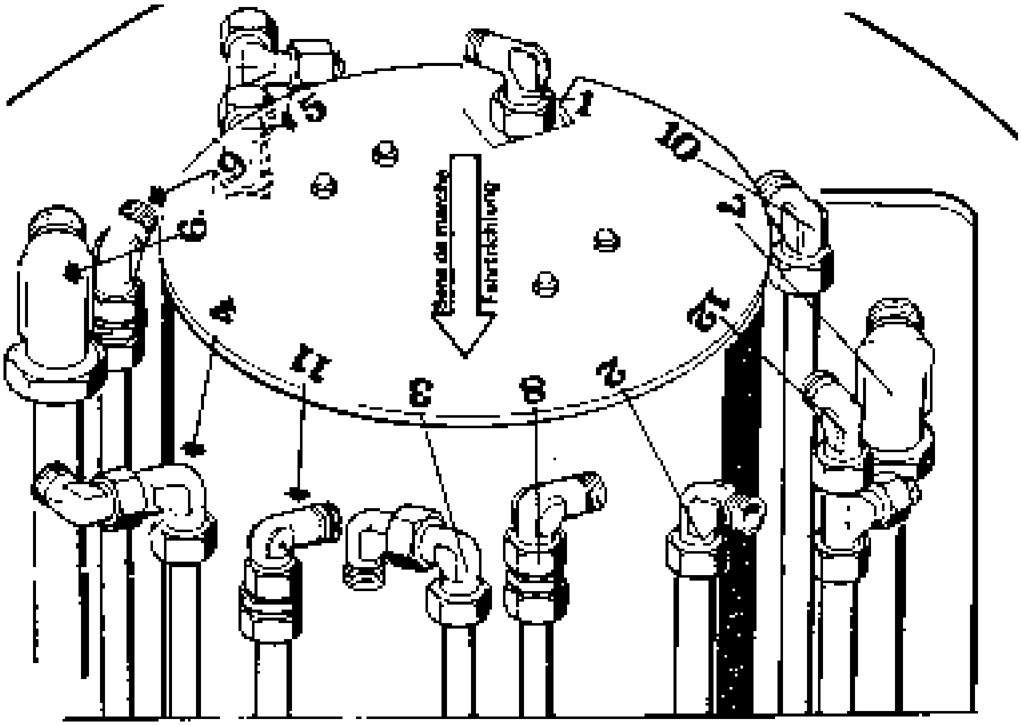
- Disconnect the electric leads (15) and (16) in the switch-gear cabinet (slewing platform - 9).

Fig. 3



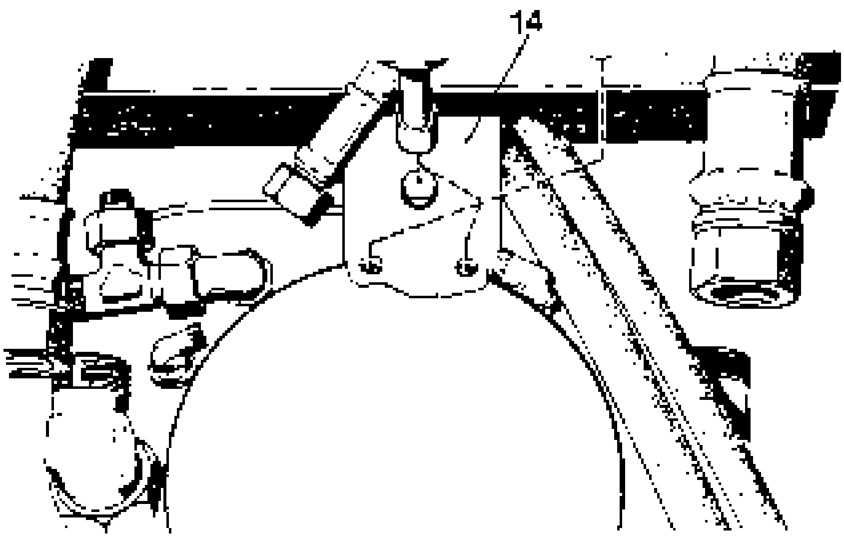
- Mark the pipe connections at the rotary connector, Fig. 4, on both sides, to enable them to be identified later.
- Unscrew the hydraulic and air lines 1 - 12 (prevent dirt from entering the open ends).

Fig. 4



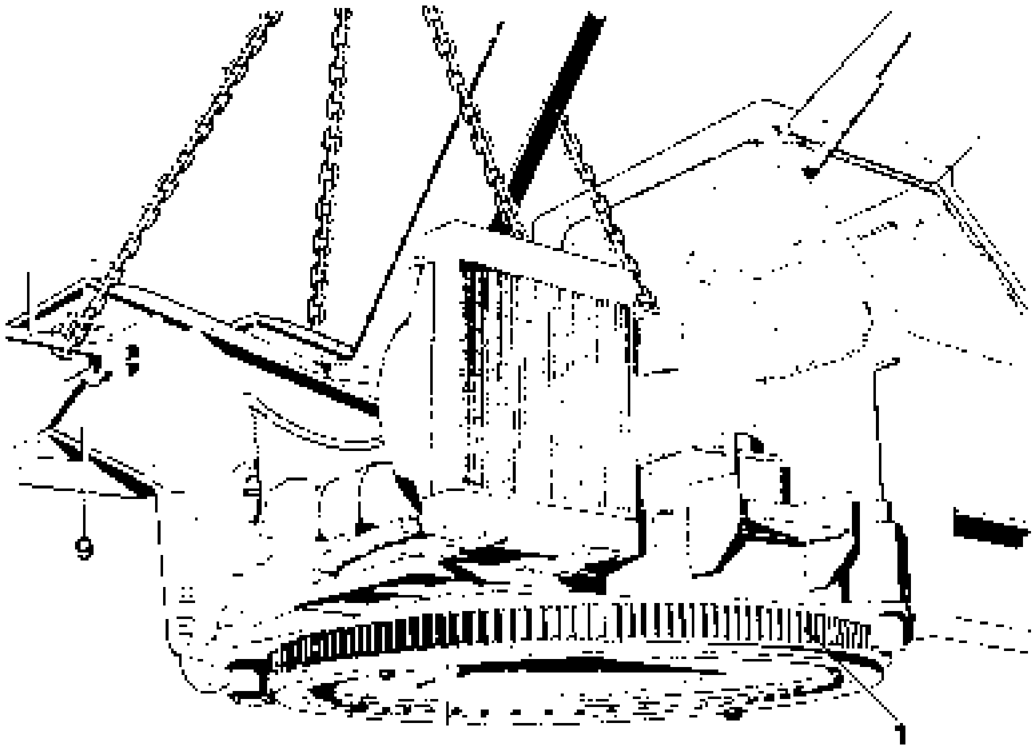
- Take off the rotor actuating element (14).

Fig. 5



- Raise the slewing platform (9) slightly with a second crane and lifting tackle.
- Unscrew and remove the remaining 4 expansion bolts at positions A and B.
- Lift the slewing platform (9) off the undercarriage (10) with the second crane or hoist and suitable lifting tackle.

Fig. 6

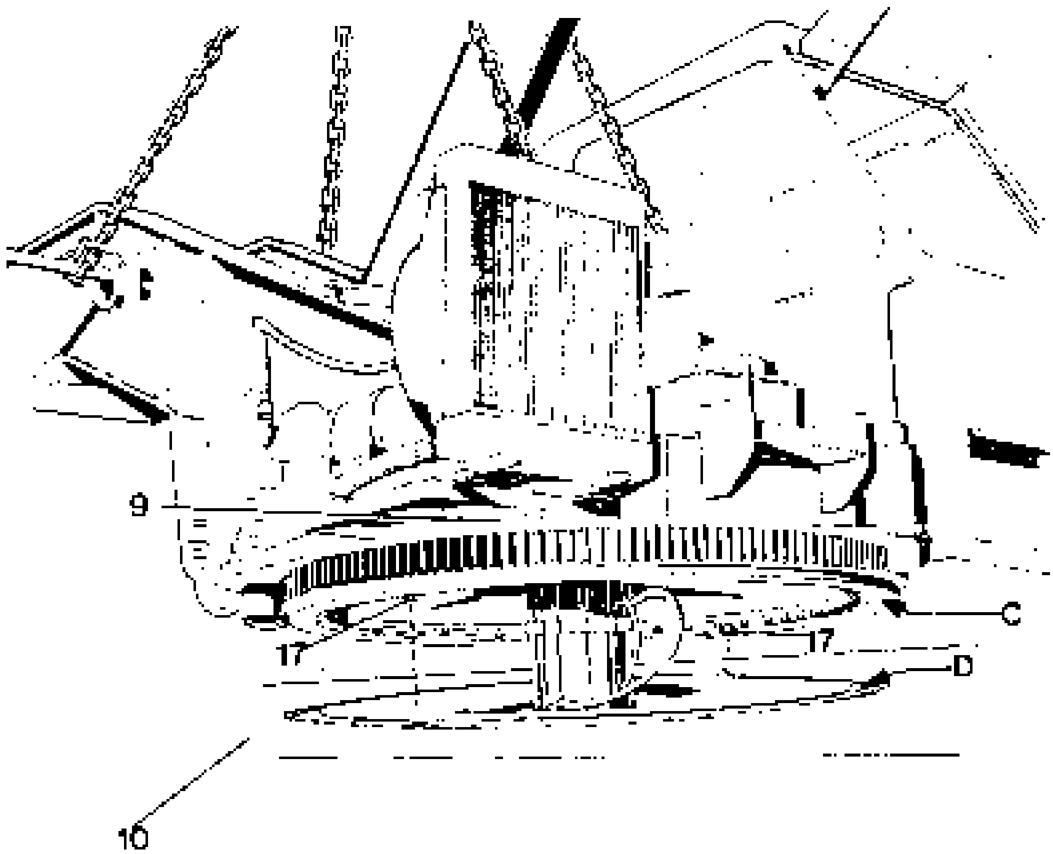


The slewing platform is installed again by following the removal instructions in the reverse order of work.

Note also the following points:

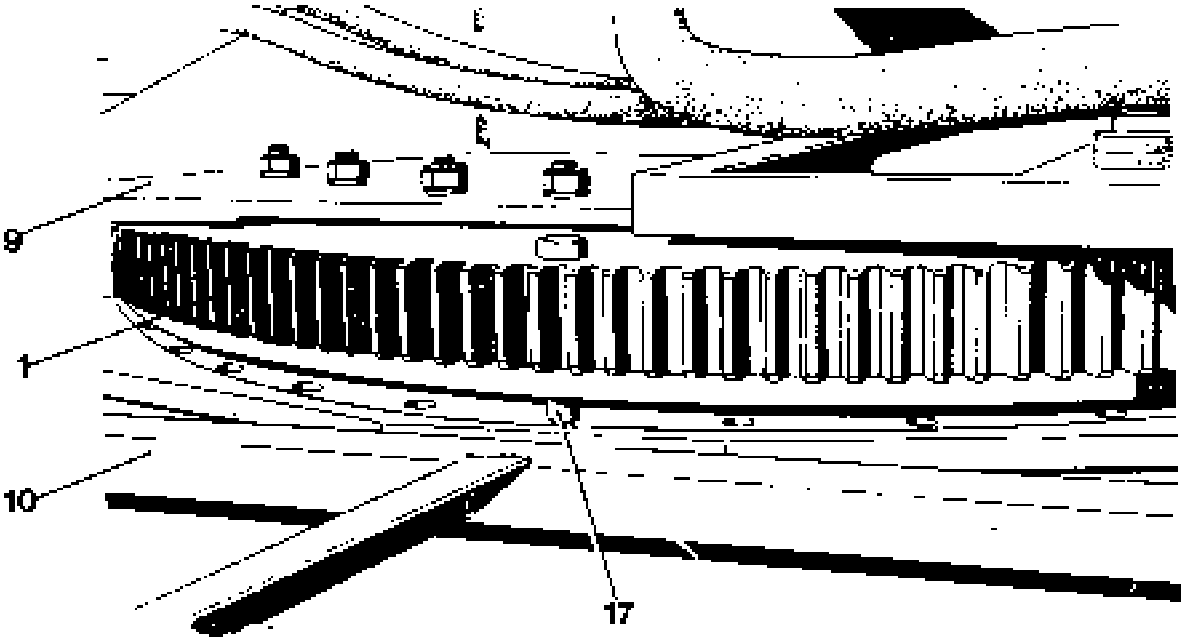
- Clean faces C and D before mounting the slewing platform.
- Make sure that the slewing platform is suspended absolutely horizontally before it is lowered into contact with the undercarriage.

Fig. 7



- When installing, center the bolt holes on the slewing ring (1) and the undercarriage (10) by inserting 2 centering pins (17).

Fig. 8



- After securing the slewing platform with four expansion bolts (3) – 2 at left, 2 at right – the remaining expansion bolts (3, 4, 5 and 6) should be inserted and tightened in the correct order (see Fig. 9) while turning the slewing platform.

  Tightening torque = 460 Nm.

  Note: grease the threads and contact faces of the bolts and nuts.

Fig. 9

Construction

The rotary connector consists of a hydraulic (1) and a pneumatic (2) section, and also an electrical slipring assembly (3).

Operating principle

The hydraulic section of the rotary connector (1) links the hydraulic pipes 1 - 7 from the undercarriage to the slewing platform; the pneumatic section links the compressed-air lines 8 - 12 .

Slipring assembly (3) connects the upper and lower electrical circuits.

a) Supply lead 13 = power supply to switchgear cabinet on slewing platform.

b) Supply leads 14 and 15 - power supply to switchgear cabinet on undercarriage for travel movement (14) and to left switch panel for supports (15).

Rotary connector (1)

Hydraulic circuits 1 - 4 for steering.

1 = Pressure (discharge) line from pump, P_{max} = 120 bar (to servostat)

2 = Pressure (discharge) line from servostat to steering rams for right turns

3 = Pressure (discharge) line from servostat to steering rams for left turns

4 = Return line from servostat to tank

Hydraulic lines 5 - 7 for crane operating movements:

5 = Oil leak-off return pipe to tank

6 = Discharge (pressure) line, P_{max} app. 260 bar, from pump to flow distributor

7 = Return pipe from oil cooler to tank

Rotary connector (2)

Air lines 8 - 12 for travel movements.

8 = Air line from reservoir to vehicle brake valve and pressure gauge

9 = Compressed air line from engine regulating valve (master) to slave cylinder for engine speed control

10 = Braking pressure line from vehicle brake valve to foot brake relay and brake light switch

11 = Braking pressure line from handbrake valve to handbrake relay

12 = Air line from reservoir to handbrake valve and engine regulating valve

Rotary connector - removal

- Top the boom fully with the luffing gear.
- Mark the line connections on the rotary connector at both sides (bottom and top) - see Sheet C2, back.
- Unscrew the hydraulic and air lines (make sure that dirt cannot enter the open unions).
- Disconnect electrical leads 5, 12 and 13 in the slewing platform switchgear cabinet. For terminal identification, see 'Vehicle electrical system'.

- Disconnect the electrical leads for 13 and 14 in the undercarriage switchgear cabinet, and electrical lead 15 in the control panel for the left supports. For terminal identification, see 'Vehicle electrical system'.

- Unscrew bolts (17) and remove the rotor actuating element (16).

- Mark the correct installed position of the rotary connector and take out bolts (18).

- Pull the complete rotary connector with electrical leads 13 , 14 and 15 upwards out of the crane undercarriage.

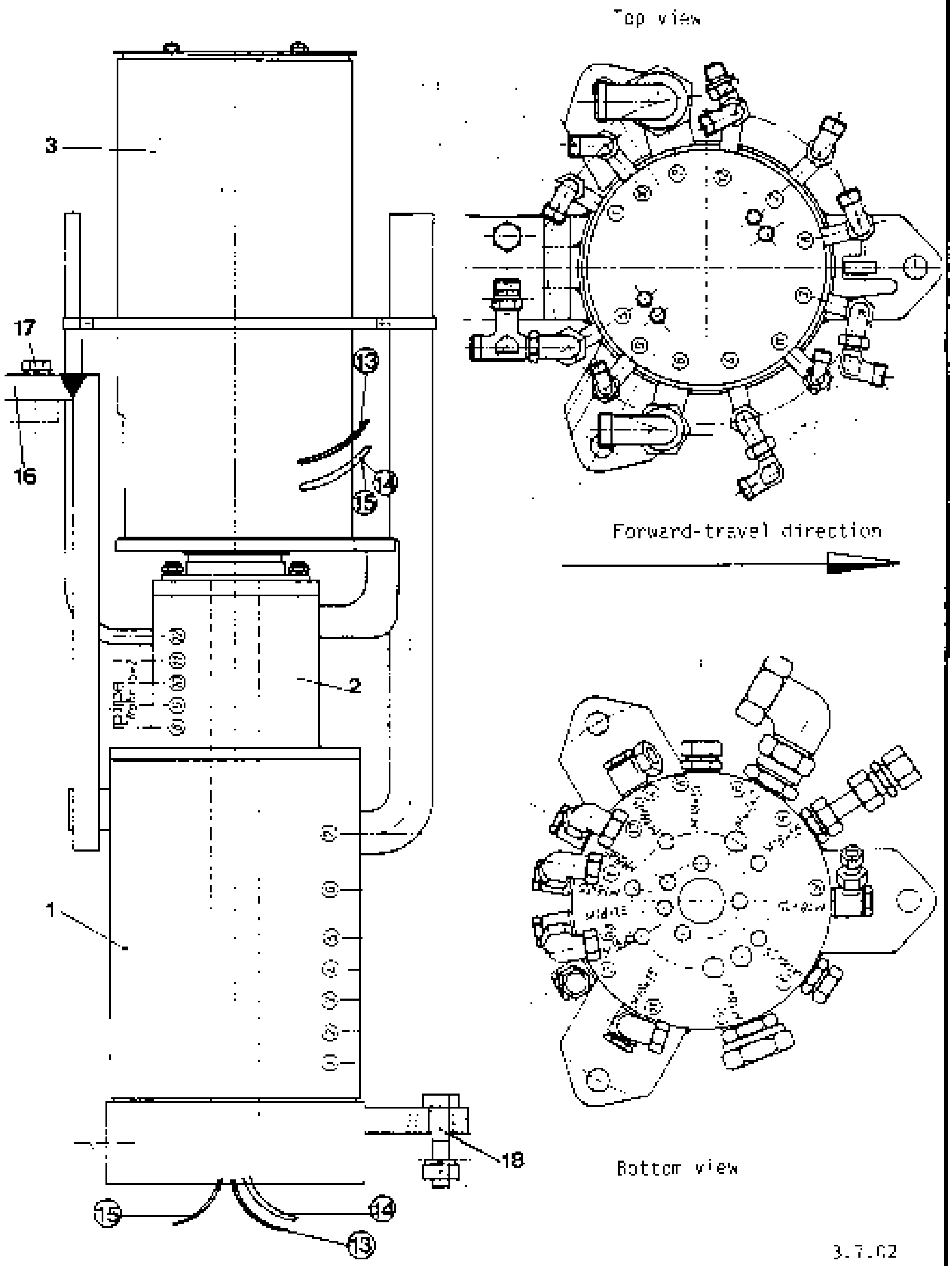
Installation is by following the removal instructions in the reverse order.

Note:

- Note the installed position marks made on removal.

- After inserting and attaching the electrical leads 13 , 14 and 15 at the slewing platform switchgear cabinet, the undercarriage switchgear cabinet and the support control panel, the entry holes must be closed off with sealant.

Rotary connector be superstructure — details of installation and connections



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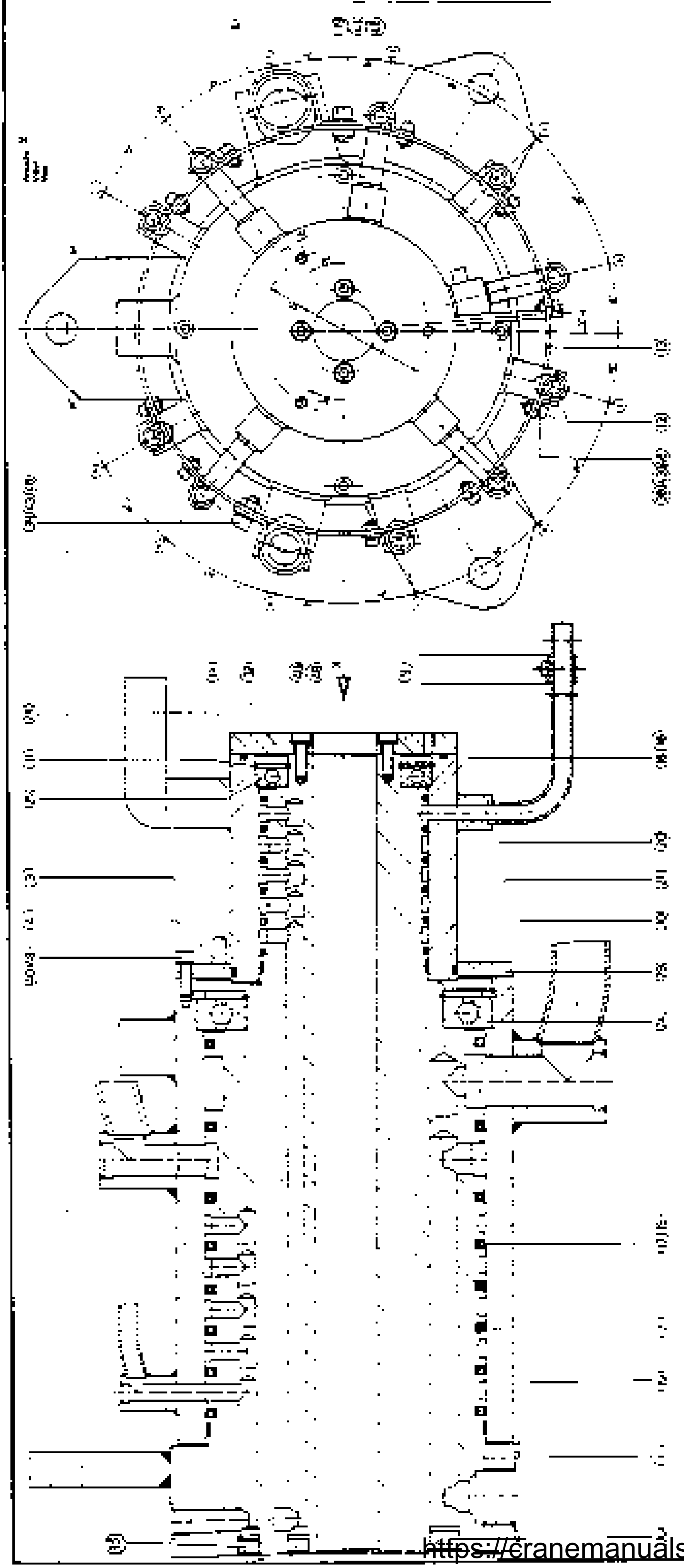
Rotary connector

Item	Designation
1	Stator, complete
2	Rotor (hydraulic)
3	Rotor (pneumatic)
4	Cover
5	Cover
10	Pipe clip
11	Pipe clip
12	Pipe clip
13	Ring
14	Type plate
15	O-ring 183.52 x 5.33
16	O-ring 107.55 x 3.53
17	'Turcon-Glyd' ring
18	'Turcon-Glyd' ring
19	Piston guide ring
20	Piston guide ring
21	O-ring 135.89 x 5.33
24	Deep-groove ball bearing 16028
25	Deep-groove ball bearing 16016
29	Circlip 210 x 5
30	Snap ring
31	Snap ring
32	Snap ring
35	Screw plug M16 x 1.5
36	Screw plug M22 x 1.5
38	Machine screw M8 x 16 - 8.8
39	Machine screw M8 x 20 - 8.8
40	Machine screw M8 x 25 - 8.8
43	Hex nut M8
45	Taper pin
48	Lock washer

3.7.03

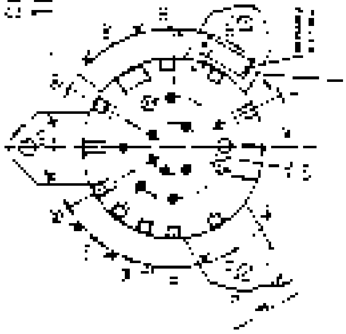
Rotary connector



Working pressure: passages
1 to 4 and 6 = max. 320 bar
Passages 5 and 7 = max. 50 bar
Passages 8 to 12 = max. 8 bar
Speed of rotation: max. 15/min

Stamp the passage number on rotor and stator for all connections, using 10 mm high letters.

● Installed with 'Loctite 572'. Thread must first be absolutely free from grease and oil. Min. hardening time 12 hours.



drilled 2 Ø, 8 deep on assembly

3.7.03

General information

The hydraulic system on the LTM 1030 crane is divided basically into three separate open circuits. The entire hydraulic system is supplied with oil from a single pump. The axial-piston pump (1) is driven by the diesel engine which also propels the crane. The oil discharged at high pressure from the pump passes through the hydraulic rotary connector (2) between the crane under carriage and superstructure, and then to gear-type flow distributor (3), where the oil flow is divided into three different and separate part-flows which pass to the various items of hydraulic equipment.

The hydraulic control system for the various crane movements is explained in detail below.

Description of various crane functions

Hoisting gear

The axial piston pump (1) driven by the diesel engine discharges oil through flow distributor (3a) to the manual control block (4). If the control lever for the hoisting gear is in neutral, the oil diverted into the hoisting gear circuit at the flow distributor (3a) flows back against the circuit pressure of app. 6 bar to the tank. The system is preloaded to this pressure. If the control lever for the hoisting-gear spool valve is moved in the 'lift' direction, oil at high pressure passes from control block (4) via bypass check valve of lowering brake valve (7) to the hoisting winch hydraulic motor (6). At the motor, the system pressure builds up according to the load. The connection between the recirculating valve in control block (4) and the hydraulic fluid tank is interrupted. At the same time, limit switches on control lever (4) energize solenoid valve (11) for hoisting brake (9) on valve block (10). Valve (11) opens and allows oil at high pressure to reach hoisting brake (9). This opens, and the motor begins to run in the 'lift' direction. Oil displaced by the motor flows via control block (4), check valve block (41), oil cooler (42) and return-line filter (43) to the tank. Maximum pressure when lifting a load is limited to 305 bar by a pressure limiting valve (4a) installed in control block (4). Hoisting speed is proportional to control lever movement away from neutral.

Hoisting gear

If the control lever for the hoisting gear spool valve (4) is moved in the 'lower' direction, oil at high pressure passes from the control block (4) to the lowering side of the hydraulic motor at the hoisting winch. At the same time, this pressure is present at the X-line of the lowering brake (7), which is released. As the lever-operated spool valve (4) is opened further, the solenoid valve (11) is actuated electrically via the limit switches on the lever and release the brake (9). The load on the hoisting winch then turns the motor in the lowering direction.

The oil displaced by the motor returns to the tank through the variable restrictor in lowering brake (7) and manual control block (4). The lowering speed is proportional to the distance by which the lever at the control block is moved. It is controlled by the variable restrictor in lowering brake valve (7), by connecting the lowering brake via the X-line to the lowering line of the manual control valve block, and opening the lowering brake valve in proportion to the pressure present. To halt the load, the lever is returned to neutral. This trips the limit switch on the manual control block, so that solenoid valve (11) is deenergized, the braking pressure is lost and the lowering brake is applied. This principle ensures that the load cannot drop suddenly even if, for example, a hose should split.

The lowering line incorporates a pressure limiting valve (6) to prevent pressure from exceeding 130 bar during a lowering movement.

To halt the lowering movement when the hoisting-movement limit switch or the load-moment limiter trip, solenoid valve (5) is provided in the X-line of the control block. When either the hoisting limit switch or the load moment limiter trip, solenoid valve (5) is de-energized, and permits pressure to escape from control block (4) to the tank. This destroys the high pressure in the hoisting gear circuit, so that no further movements are possible. A movement in the opposite direction, that is to say a movement designed to reduce the effective load, must be selected to re-energize solenoid valve (5), so that the bleed to the tank can be closed and the desired movement performed.

To avoid cavitation in the hydraulic motor during lowering, the hoisting gear return side is pre-loaded. If pressure in the lowering line drops to app. 0,5 bar, the check valve in union C of check valve block (10) opens. This supplies additional oil to the lowering side of the motor.

High-speed hoisting

In order to permit higher speeds to be achieved when lifting only slight loads, the hoisting gear has provision for high-speed operation. When the 'High-speed hoisting' switch in the cab is operated, solenoid (13) on valve block (10) is energized and permits oil at high pressure to flow via restrictor (17) to the high-speed valve (18). Valve (18) is actuated hydraulically and allows additional oil normally diverted by flow distributor (36) into the luffing gear circuit to enter the hoisting gear circuit instead. This almost doubles the volume of oil reaching the hoisting motor, which therefore runs at approximately twice the normal speed. The hoisting gear is still controlled as described in 'hoisting gear'.
When the high-speed switch is turned off, solenoid (13) on control block (10) is de-energized and the multi-way valve (18) then separates the hoisting and luffing oil circuits again. A restrictor (17) with nozzle is installed to motify the switching period of valve (18). Note that when high-speed hoisting is in use, no luffing or telescoping movements are possible.

Control pressure

To supply pressure to valve block (10), for hoisting brake (11), telescoping/luffing changeover (12) and high-speed circuit (13) for hoisting gear and (14) for luffing gear pressure from slewing gear circuit will be taken. This pressure is present, after lowering to 22 bar in pressure limiting valve (11) at valve block (10). In order to keep the control pressure constant a pressure storage reservoir (15) is connected in the pressure line, (prefill pressure 10 bar).

Luffing gear

Control of luffing and telescoping movements of the crane boom is by means of the control block (20). Choice of either boom luffing or telescoping movement is made at multi-way valve (22). If this is in its normal position, the crane's luffing and telescoping gear is provided by axial-piston pump (1) via rotor (2) and flow distributor (36).

Luffing gear

When the control lever is in neutral, pump (1) discharges oil back to the tank, against the circuit pressure of app. 6 bar.

If the control lever for the luffing gear is moved in the 'topping boom' direction, oil at high pressure flows from control block (20) via multi-way valve (22) and the bypass check valve on lowering brake valve (23) into the space above the piston of luffing ram (24), and extends the ram. At the same time, the pressure exerted by the load at control block (20) causes the return flow to the tank to be interrupted.

Oil expelled from the annular space in the ram flows back to the tank via check valve block (41) and oil cooler (42). Pressure in the ram during topping movements is limited to 305 bar by the pressure limiting valve (20a) integral with control block (20). Luffing speed is proportional to the amount of control lever movement away from neutral.

If the control lever is moved in the 'lowering boom' direction, oil from control block (20) passes via multi-way valve (22) to the X-line of lowering brake valve (23), which it opens. Oil displaced from the space above the ram piston flows via multi-way valve (22), control block (20) and check valve block (41) to the tank. Since the return circuit is preloaded, the annular space in the ram cylinder is replenished with oil. As a result, only slight pressure (app. 2 bar) builds up in the annular space, and the luffing ram is retracted by the weight of the boom.

To actuate the lowering brake (23), the feed line incorporates a preload valve (25), which is set to the lowering brake's minimum opening pressure. It is followed in the circuit by restrictor valve (26), which ensures sensitive control of lowering brake.

Pressure oil flows through restrictor (26) only after preload valve (25) has opened. The flow resistance of the restrictor rises as the flow from control block (20) increases. As a result, the opening pressure in the X-line of the lowering brake (23) also rises. The higher the opening pressure at the lowering brake, the farther the restrictor in the lowering brake is opened and the higher the boom lowering speed. This ensures that luffing speed is proportional to control lever movement both when topping and when lowering the boom. To ensure system protection during boom lowering, pressure limiting valve (27) is set to 40 bar.

Luffing gear

To halt the luffing movement, the control lever is returned to neutral. This cuts off the flow of oil to ram (24), the lowering brake is applied and the boom can no longer drop accidentally. To prevent any movement likely to increase the load moment (boom lowering, extension of telescopic boom) when the load moment limiter has tripped, a solenoid valve (21) is installed in the X-line of manual control spool valve (20). During regular operation, this valve is energized when the control system is switched on, and the flow to the tank is interrupted. When the load moment limiter trips, solenoid valve (21) is de-energized, and the valve re-opens the flow to the tank. This breaks down the high-pressure circuit through the luffing gear spool valve, so that no further movement is possible. If, however, a movement calculated to reduce load moment is selected, that is to say boom topping or telescopic retracting, solenoid valve (21) is re-energized, the bleed to the tank is interrupted and the desired movement can be performed.

Telescoping

Telescoping movement of the boom is controlled by the same spool valve (20) as the luffing gear. A changeover switch in the crane operator's cab energizes the telescoping movement changeover solenoid (12) on the valve block (10) and switches over multi-way valve (22) hydraulically. This establishes a connection from the luffing gear control block (20) to telescoping ram (30).

When the telescopic boom is extended, oil at high pressure from control block (20) flows via multi-way valve (22), the bypass check valve and the lowering brake valve (30a) integrated into the telescoping ram to the ram space above the piston, and extends the ram. The oil displaced from the annular space below the piston returns to the tank via multi-way valve (22) and control block (20). Ram extending pressure is limited to 215 bar by pressure limiting valve (29).

Telescoping

When the telescoping ram is retracted, oil flows from control block (20) via multi-way valve (22) to the annular space in the ram cylinder, below the piston. The resulting pressure opens the lowering brake valve (30a) integrated into the ram cylinder. Oil displaced from the space above the piston flows through the variable restrictor in the lowering brake valve (30a), multi-way valve (22), control block (20) and check valve block (41) to the tank. The telescopic boom is then retracted. Its speed of retracting movement depends on the restrictor cross-section in the lowering brake valve, which in turn is related to the pressure applied to the valve. Since this pressure varies according to oil flow, the result is proportional movement of the telescopic boom in response to control lever deflection away from neutral. Pressure build-up when retracting the boom is limited to 200 bar by pressure limiting valve (28).

When the telescoping movement is halted, and the control lever is in neutral, no further oil flows to the ram. The lowering brake valve closes and prevents the telescopic boom from retracting accidentally (e.g. in the event of a hydraulic hose splitting).

High-speed luffing/telescoping

A high-speed circuit is provided for situations in which higher luffing or telescoping speeds are desirable. Note however that when the high-speed luffing/telescoping mode is selected, the hoisting gear is out of action.

When the 'High-speed luffing/telescoping' switch in the cab is operated, solenoid (14) on valve block (10) is energized, and permits oil at high pressure to flow via restrictor (31) to high-speed valve (32). Valve (32) is actuated hydraulically, and permits the oil flow normally diverted by flow distributor (3a) to the hoisting gear circuit to enter the luffing gear circuit. This mode than doubles the volume of oil reaching the luffing gear circuit, and thus enables either luffing or telescoping speed to be more than doubled as well. Control of the luffing/telescoping gear remains as described unter 'Luffing' and 'Telescoping'.

High-speed luffing/telescoping

When the high-speed movement switch is turned off, solenoid (14) at valve block (10) is de-energized, and multi-way valve (32) separates the hoisting and luffing circuits again. The switching time for valve (32) can be varied by restrictor (31) with nozzle.

To prevent any pressure peaks at the flow distributor when selecting high-speed movement, pressure limiting valves (19) and (33) are installed.

Slewing gear

The oil diverted at flow distributor (3c) for the slewing circuit passes to the slewing control lever block (34). If the control lever remains in neutral, the pump returns the oil to the tank at the circuit pressure of app. 6 bar. If the slewing spool valve control lever is moved to the 'Slew to left' or 'Slew to right' position, the solenoid valve (38) is actuated via the limit switches and release the slewing gear brake. At the same time oil at high pressure flows through the bypass check valve on the duplex lowering valve (35) to the appropriate side of the hydraulic motor (36) and causes the motor to rotate. In the control lever block (34) the return flow of oil to the tank is interrupted by the recirculating valve (6 bar), and the load pressure builds up at the spool valve. When this pressure build-up is detected at the X-line of brake valve (35) in the motor return line, the restrictor in brake valve (35) is opened and oil displaced from motor (36) flows via the restrictor in brake valve (35), control block (34) check valve block (41) and oil cooler (42) in the tank.

When the control lever is returned to neutral, the oil supply to the motor (36) is interrupted. Duplex brake valve (35) closes as the pressure in the X-line drops. At same time, pressure at control block (34) returns to the normal circuit pressure of 6 bar, and the solenoid valve (38) returns to neutral via the limit switches on the lever. The spring loading on slewing gear brake takes effect and applies it.

Slewing gear

Motor (36) and therefore the entire slewing gear is thus secured by hydraulic pressure but mechanically braked, so that external loads cannot cause an accidental slewing movement. The pressure limiting valves in duplex brake valve (35) protect the motor in the pressurized hydraulic circuit and prevent sudden pressure peaks from occuring. Maximum-pressure protection for the slewing gear is by means of a pressure limiting valve (34a) integrated into control block (34).

The crane's slewing speed is proportional to the amount of lever movement at control block (34).

The above description applies to 'slewing to left' and also in an equivalent manner to 'slewing to right'.

Oil cooler

To keep oil temperature in the crane's hydraulic system to within acceptable limits, an oil cooler (42) is installed in the return line from check valve block (41). The cooling fan is driven by hydraulic motor (42a) which uses the oil flow to the slewing gear and is therefore in series with the slewing motor.

At low outside temperature, oil cooling is unnecessary. In this case the oil flow used to drive the cooling fan motor (42a) is cut off. This is achieved by resetting the ball tap (39) to divert the oil away from hydraulic motor (42a) and directly to the slewing gear control block (34). To avoid overloading the flow distributor (3c) as the ball tap is moved, pressure limiting valve (40) is incorporated in the pipe.

1. Main axial-piston pump

2. Hydraulic rotor (rotary connector)

3. Gear-type flow distributor
   a) Hoisting gear
   b) Luffing/telescoping gear
   c) Slewing gear

4. Manual control valve for hoisting gear

4a Pressure limiting valve (305 bar)

5. Main solenoid valve for hoisting gear

6. Hoisting motor

7. Lowering brake valve for hoisting gear

8. Pressure limiting valve for lowering hoisting gear (130 bar)

9. Hoisting brake

10. Valve block

11. Solenoid valve for hoisting brake (release)

12. Solenoid valve for changeover (luffing/telescoping)

13. Solenoid valve for high-speed hoisting movement

14. Solenoid valve for high-speed luffing/telescoping movement

15. Pressure storage reservoir

16. Pressure reducting valve for control circuit pressure (22 bar)

17. Restrictor in high-speed hoisting circuit

18. Multi-way valve for high-speed hoisting movement

19. Pressure limiting valve for hoisting gear (primary protection, 315 bar)

20. Manual control valve for luffing/telescoping gear

20a Pressure limiting valve (305 bar)

21. Main solenoid valve for lufting/telescoping gear

22. Multi-way valve for changeover luffing/telescoping

23. Lowering brake valve for luffing gear

24. Luffing ram

24a Pressure pick-up - (SLI)

25. Pressure limiting valve for boom lowering (luffing gear) 14 bar

26. Restrictor valve for lowering boom, 28 bar

27. Pressure limiting valve for lowering boom, 40 bar

28. Pressure limiting valve for retracting telescopic boom, 200 bar

29. Pressure limiting valve for extending telescopic boom, 215 bar

30. Telescopic ram

31. Restrictor for high-speed luffing/telescoping

32. Multi-way valve for high speed luffing/telescoping

33. Pressure limiting valve for luffing/telescoping gear (primary protection, 215 bar)

34. Manual control valve for slewing gear

34a Pressure limiting valve (110 bar)

35. Duplex brake valve for slewing gear

36. Slewing motor

37. Slewing brake

38. Solenoid valve - slewing gear brake (release)

39. Ball tap

40. Pressure limiting valve for slewing gear (primary protection, 160 bar)

41. Check valve block in return line to tank (2 bar)

42. Oil cooler

42a Fan motor for oil cooler

43. Return-line filter

44. Hydraulic fluid (oil) tank

45. Suction line shutoff valve (axial-piston pump)

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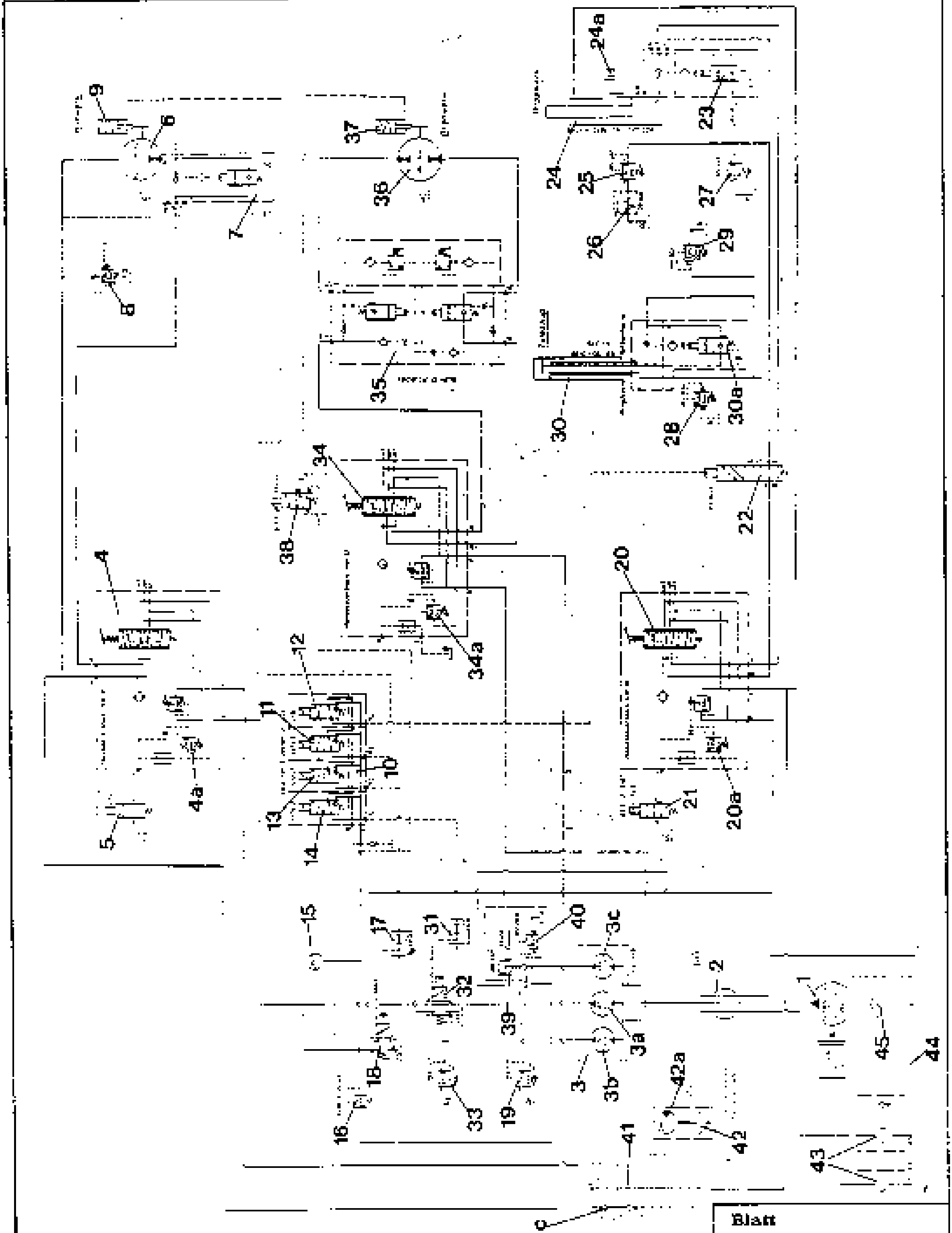
Hydraulic circuit diagram



Blatt Sheet Page	4.2.02

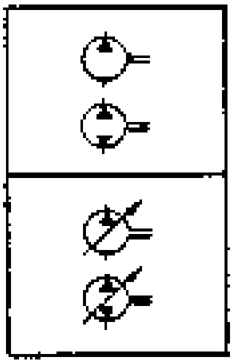
Pumps

Constant pump
1 direction of flow

2 directions of flow

Variable displacement pump
1 direction of flow

2 directions of flow



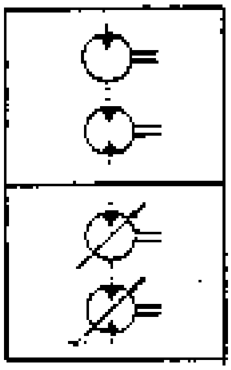
Motors

Constant motor
1 direction of flow

2 directions of flow

Variable motor
1 direction of flow

2 directions of flow



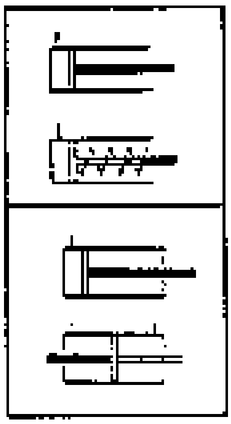
Cylinder

Single action cylinder
Retraction over external force

Retraction per return spring

Double action cylinder
One sided piston rod

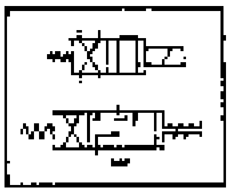
Two sided piston rod



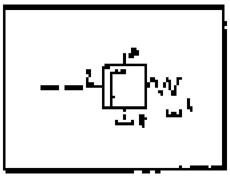
Valve control

4/2 way-valve with solenoid control
and retraction spring

4/3 way-valve with hand-control
and spring centered.

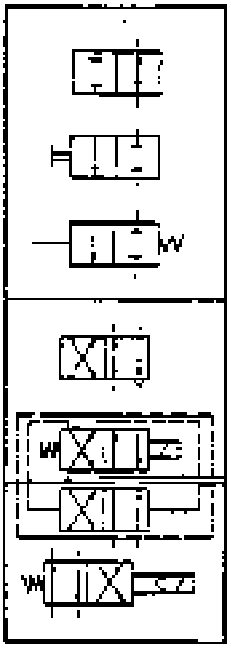


Parts are shown by capital letters



Z = control line
P = pressure line
R = backflow line
L = leckage line

Way valves



Possible flow into two directions

Control by hand

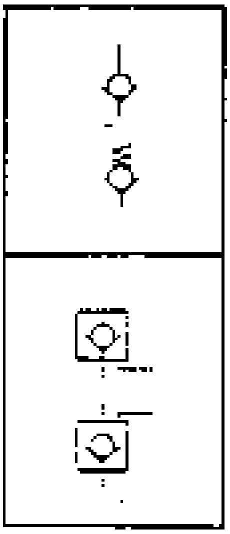
Control by pressure against reduction spring

4/2 way-valve with one air releasing

Assembled with pre-control valve, with solenoid control against contraction spring, detailed symbol

Simple symbol

Lock valves



Non-return valve

Locking, if output pressure is higher as input pressure

With counter pressure, by ex. spring locking if output pressure is higher as or equal input pressure.

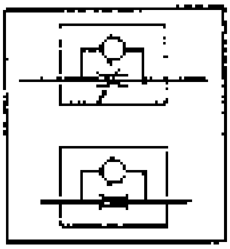
Remote controlled non-return valve, locking if output pressure is higher as input pressure, but remote control may cancel the locking.

Locking, if output pressure is higher as or equal input pressure, but remote control may cancel the flow.

Throttle non-return valve

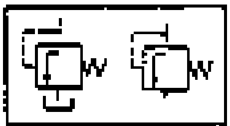
Throttle valve with flow in one direction and throtteling in the other direction.

P.e. throttle adjustable



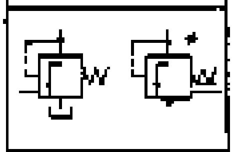
Pressure valves

Pressure releave valve
Valve to limit the pressure on the input by opening on the output against counter force.

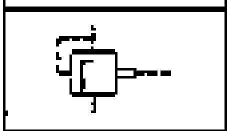


Pressure relief valve
Yet with remote control affecting the counter force.

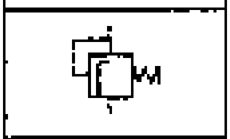
The remote control amplifies the counter force.



Pressure sequence valve
The input pressure is limited the avalue proportional to the control pressure.

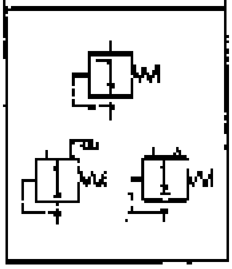


Changeover valve
Against the spring force becomes the output open to give the way free to other devices.



Pressure regulating valve
The output pressure is kept constant independent from a higher input pressure

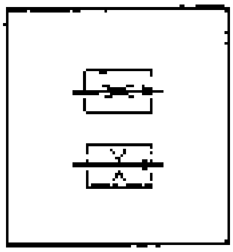
- without leggage
  (over controls are not equalized)
- with leggage
  (over controls becomes equalized)



Flow valve

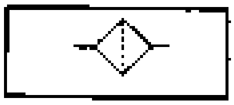
Throttle valve
Flow valve with internal restriction flow and pressure falls are according to the viscosity.

Valve with constant short restriction, flow and pressure falls are nearly independent from the viscosity.



Filter

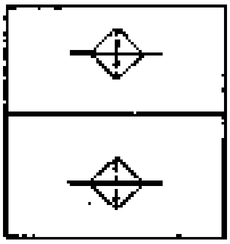
Device to separate from dirt particulars



Heat exchanger

Pre-heater
Device to heat the hydro-liquid or air. The pointers indicates the input of heat.

Cooler
Device to cool the hydro-liquid. The pointers indicates the output of the heat.

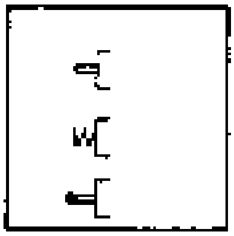


Mechanical operation

with push button

with spring

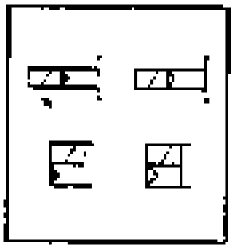
with a roller



Combined operation

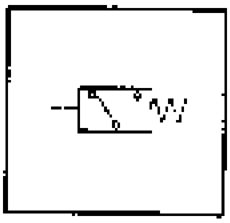
with solenoid and pre-control valve

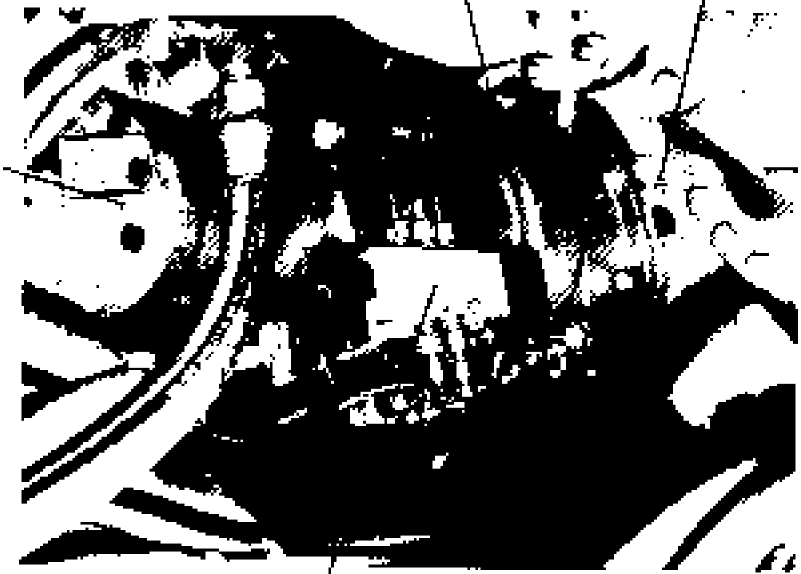
with solenoid or pre-control valve

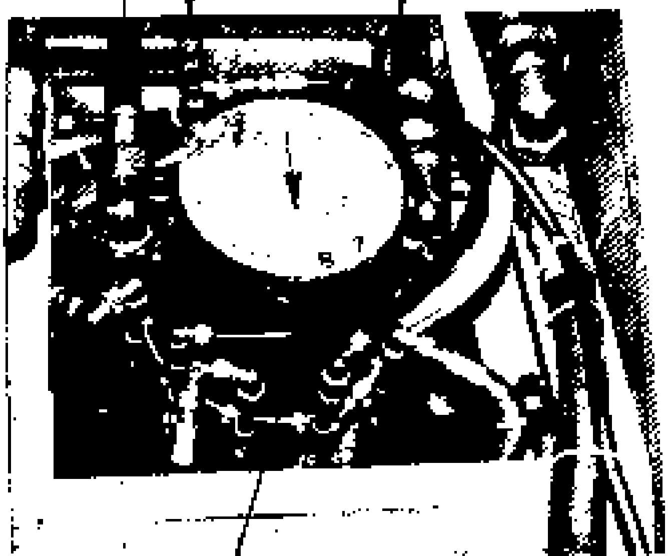


Pressure switch

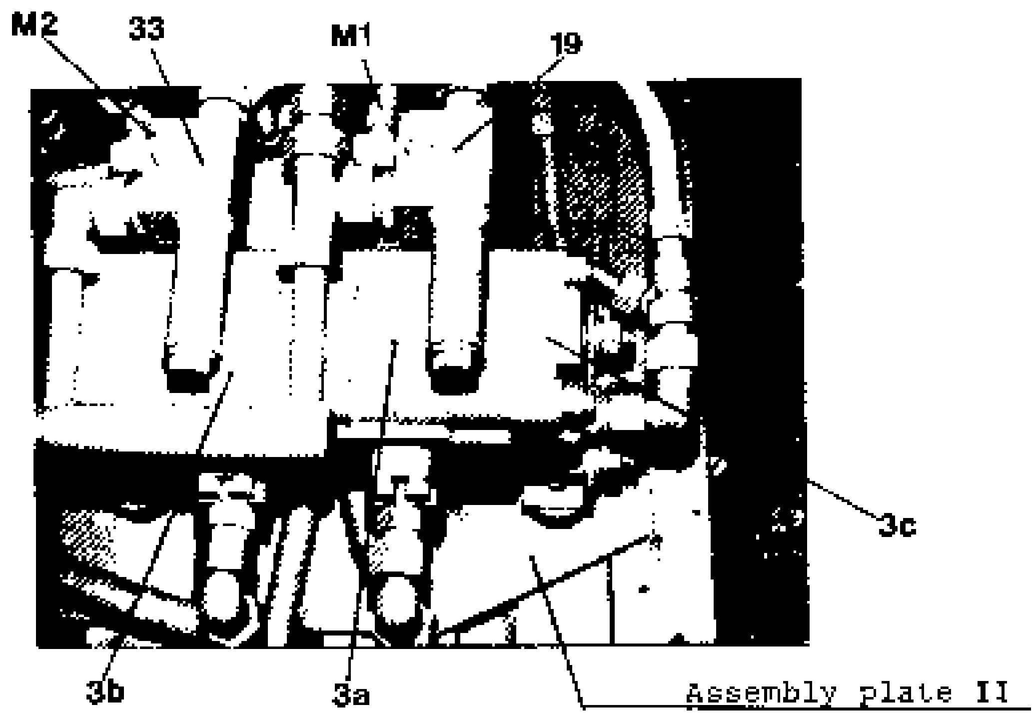
Device, with electrical contacts.
They get closed or opened by pressure.

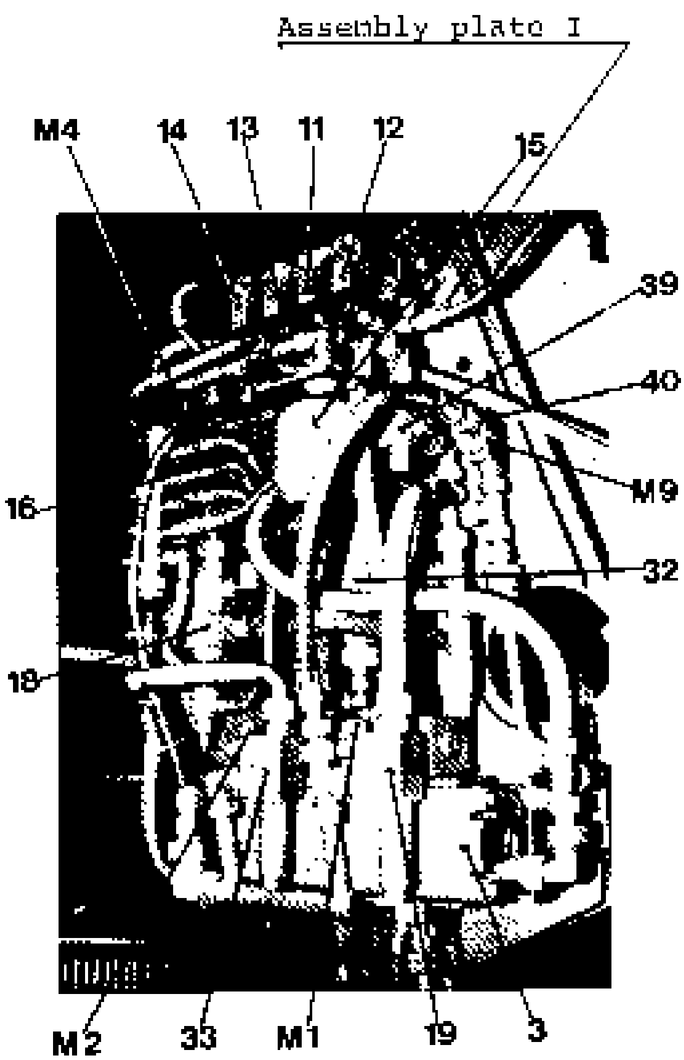


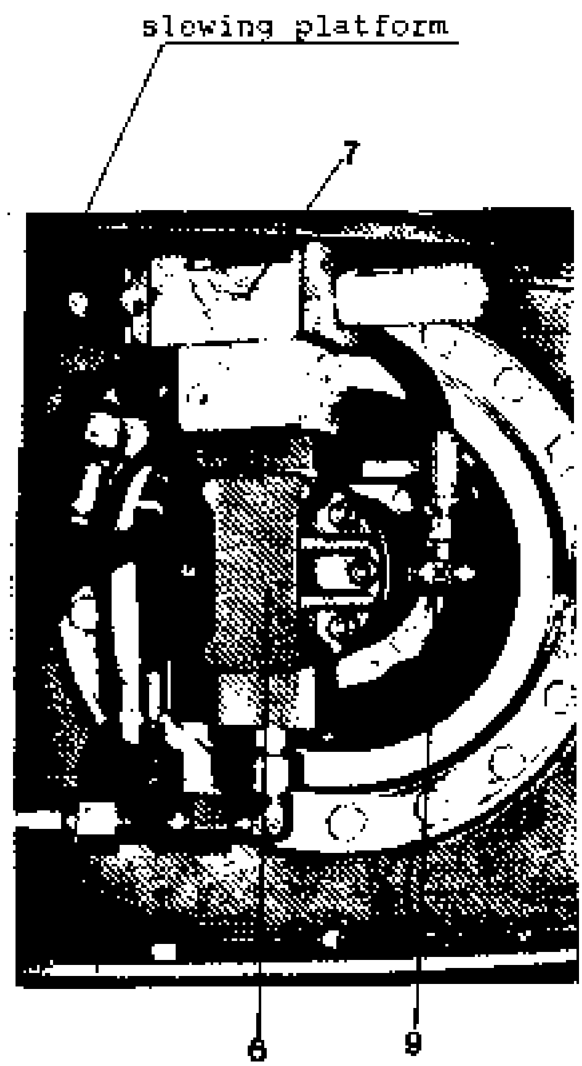

converter
engine
axial piston pump
rear axle
switch valve; pump on-off

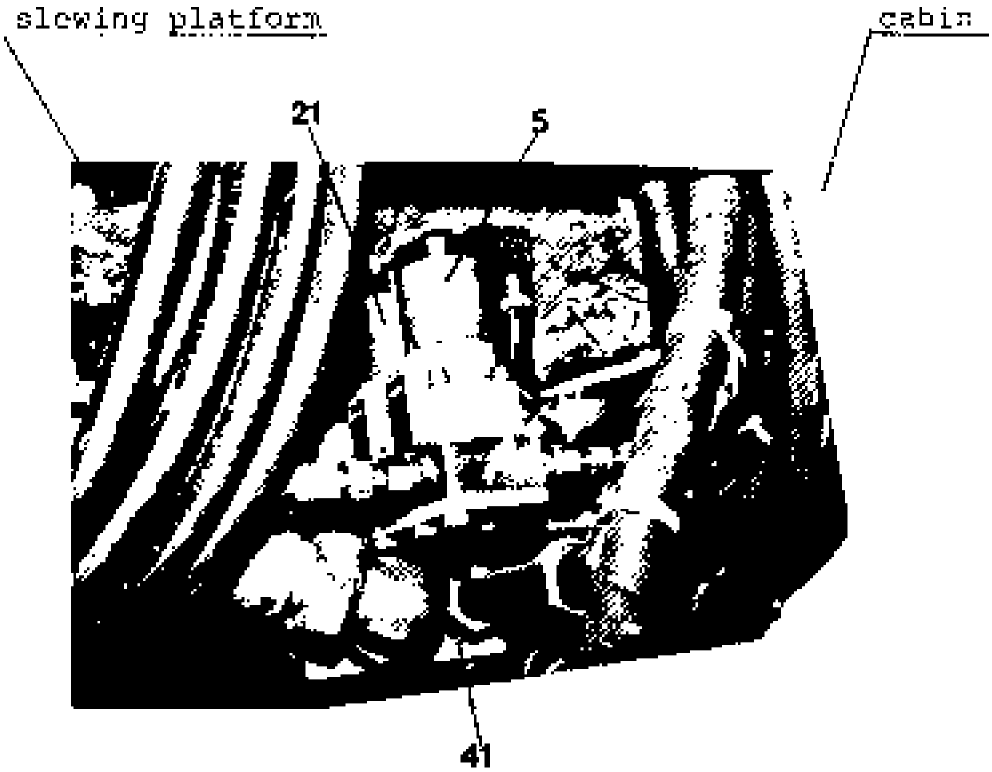

flow distributor
return-line to tank
slewing platform
rotary connector

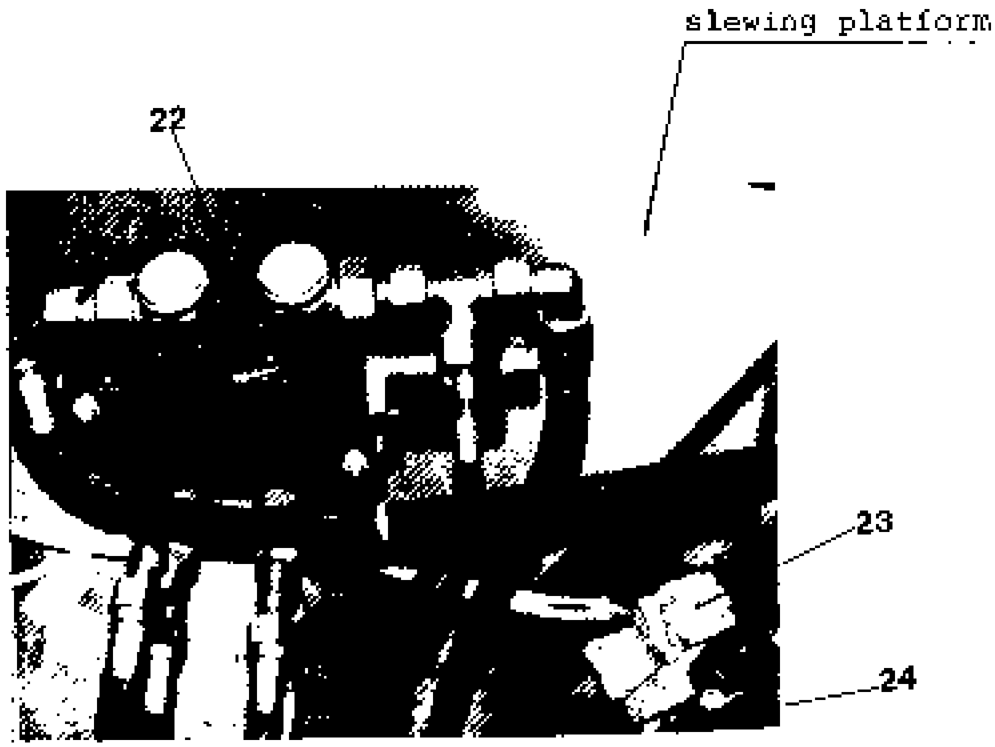
Hydraulic c

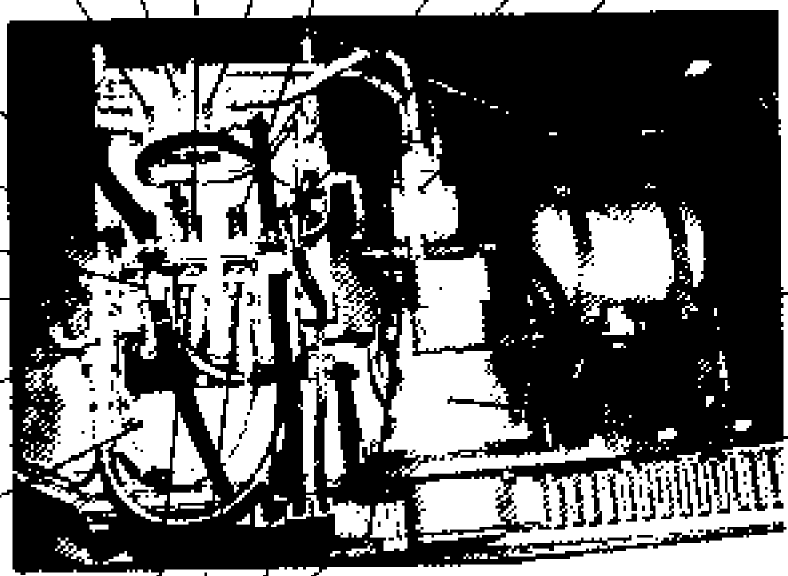

M2
33
M1
19
3c
3b
3a
Assembly plate II

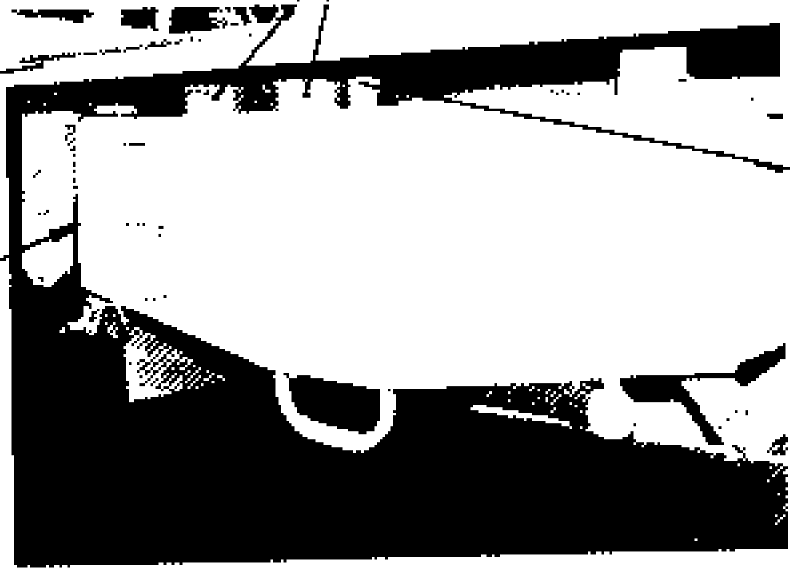

Assembly plate I
M4
14
13
11
12
15
39
40
M9
32
16
18
M2
33
M1
19
3

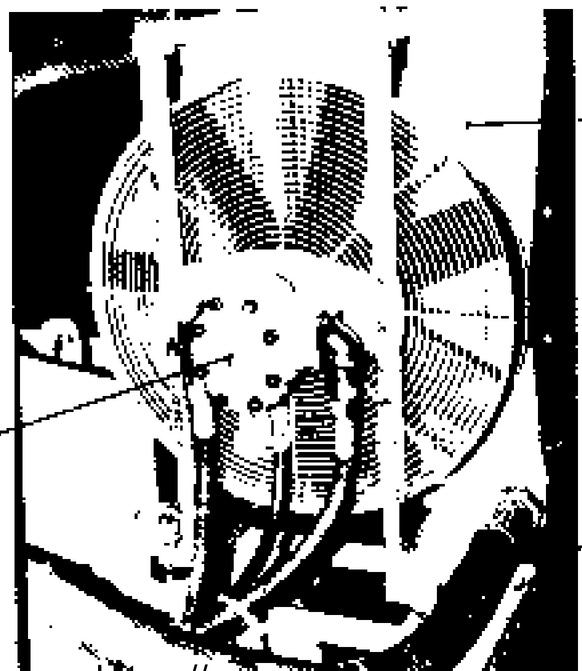

slewing platform
7
6
9


slewing platform
cabin
21
5
41

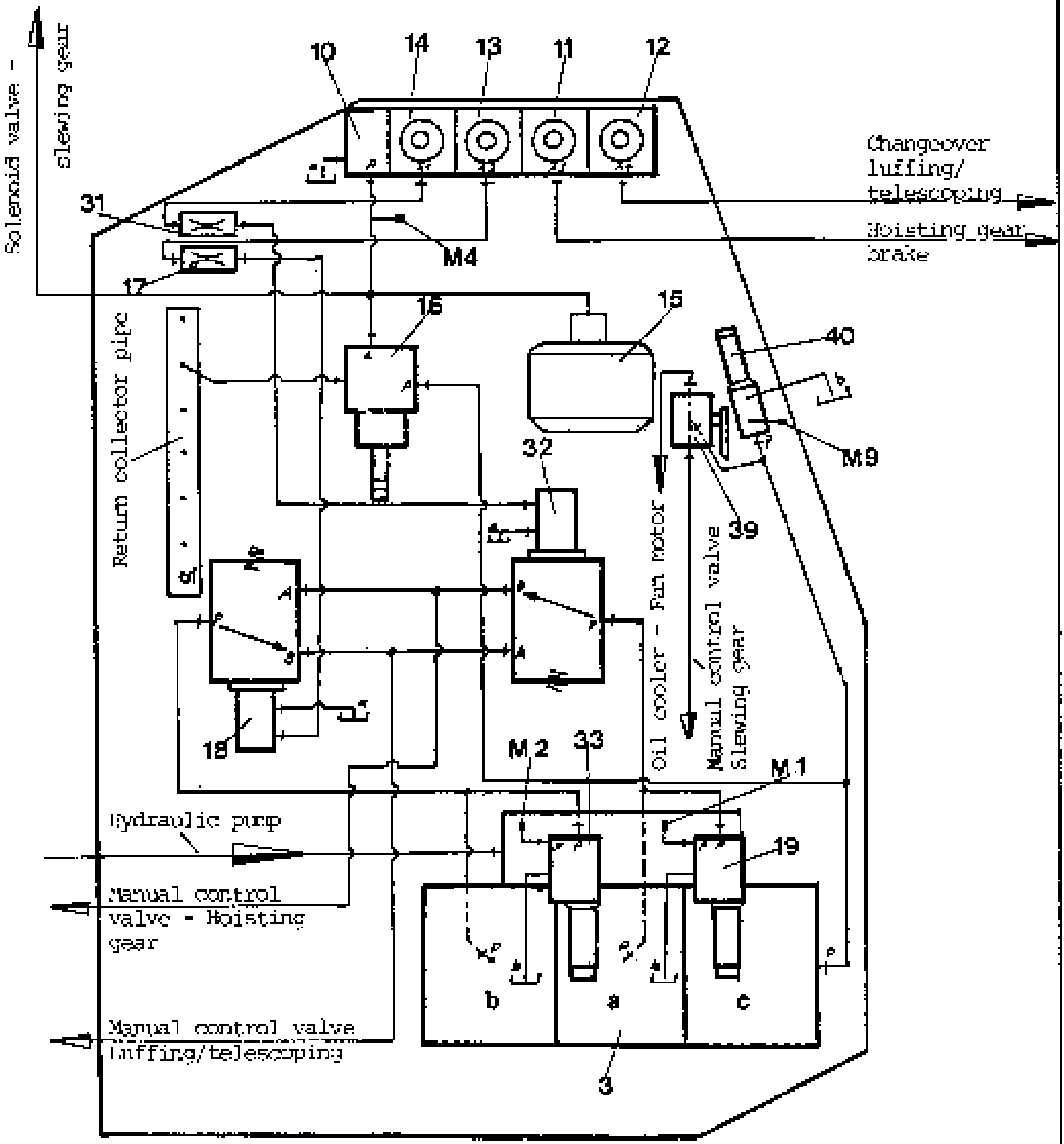

slewing platform
22
23
24


M10
35
28
M11
27
38
B
36
29
25
M7
M5
26
assembly plate II
slewing platform
slewing gear
M8
M6
M3
37
42


chassis
air bleeding-tank
oil level check


42
42a
slewing platform

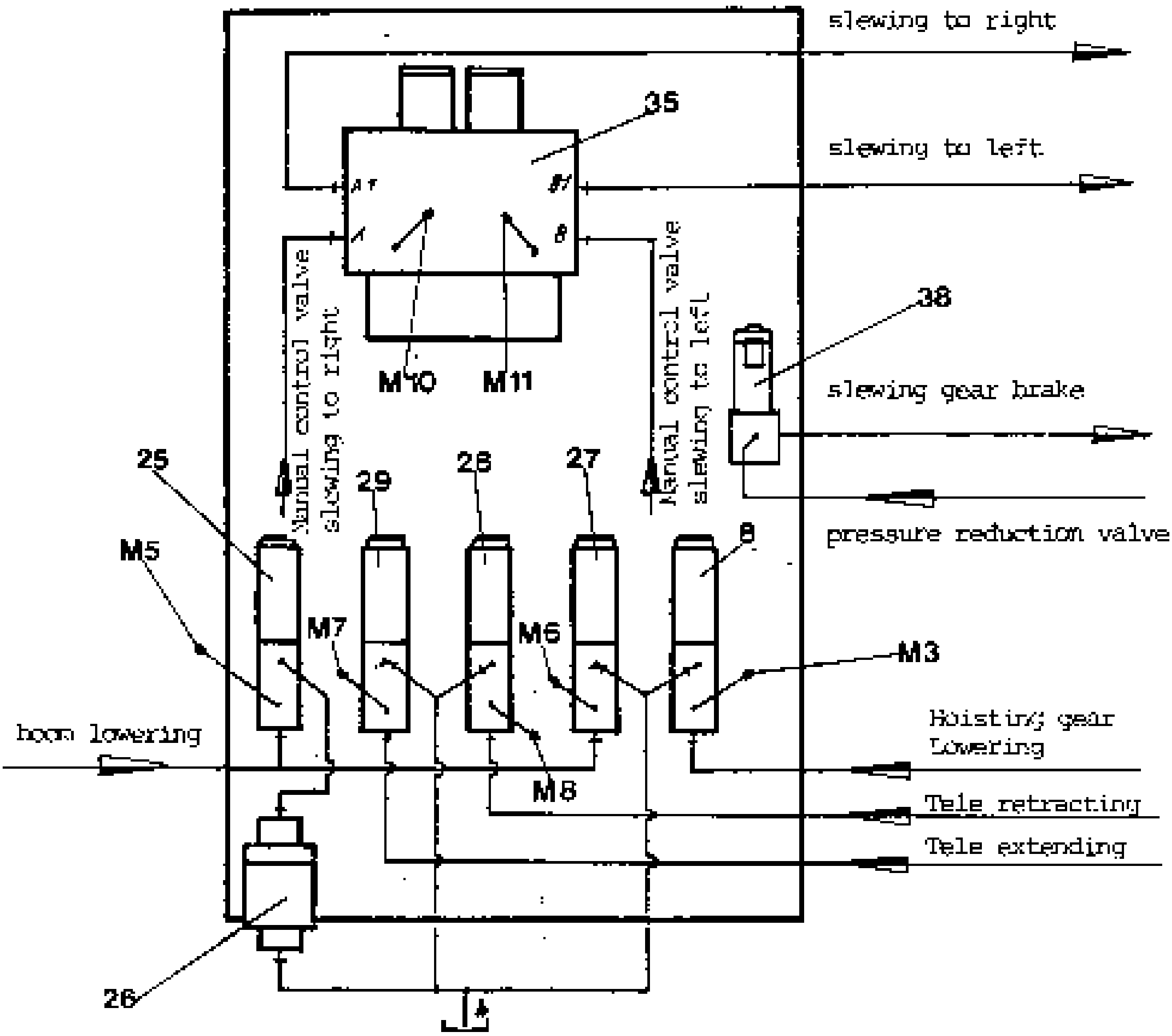
Assembly plate I



a = Return-line connection - tank

b = Return-line connection - oil cooler

Assembly plate II



b - Return-line connection - oil cooler

1. Axial-piston pump
2. Hydraulic rotor (rotary connector)
3. Flow distributor, section 'a'
4. Manual control valve with pressure balance and pressure limiting valve (305 bar)
5. Main solenoid valve
6. Hydraulic motor
7. Lowering brake valve
8. Pressure limiting valve for lowering movement (130 bar)
9. Multi-disc brake
10. Valve block
11. Solenoid valve for brake
13. Solenoid valve for high-speed movement
15. Pressure storage reservoir (10 bar)
16. Pressure reducting valve, control circuit pressure (22 bar)
17. Restrictor for high-speed movement
18. Multi-way valve for high-speed movement
19. Pressure limiting valve, primary protection (315 bar)
41. Check valve block with replenishing valve for lowering movements
42. Oil cooler
43. Return-line filter
44. Hydraulic fluid (oil) tank
45. Shutoff valve for suction line
46. Filter
47. Return collector pipe

Pressure settings

M 1 : Primary protection = 315 bar

M 2 : Primary pressure, lifting = 305 bar

M 3 : Primary pressure, lowering = 130 bar

M 4 : Control circuit pressure, brake release = 22 bar

All pressure adjustments are to be performed with the engine idling.

Primary protection

1. Lock the hoisting brake on (remove solenoid valve cap 11).
2. Connect a pressure gauge to measuring point M1 (with engine stopped).
3. Turn pressure limiting valve at manual control valve (4) to fully closed position initially, then slacken off by app. 1/2 turn.
4. Move control lever (4) in the 'lift' direction.
5. Set pressure limiting valve (19) to 315 bar.

Primary pressure - lifting

1. Lock the hoisting brake on.
2. Connect a pressure gauge to measuring point M1.
3. Move the control lever in the 'lift' direction.
4. Set the pressure limiting valve on the manual control valve (4) to 305 bar.

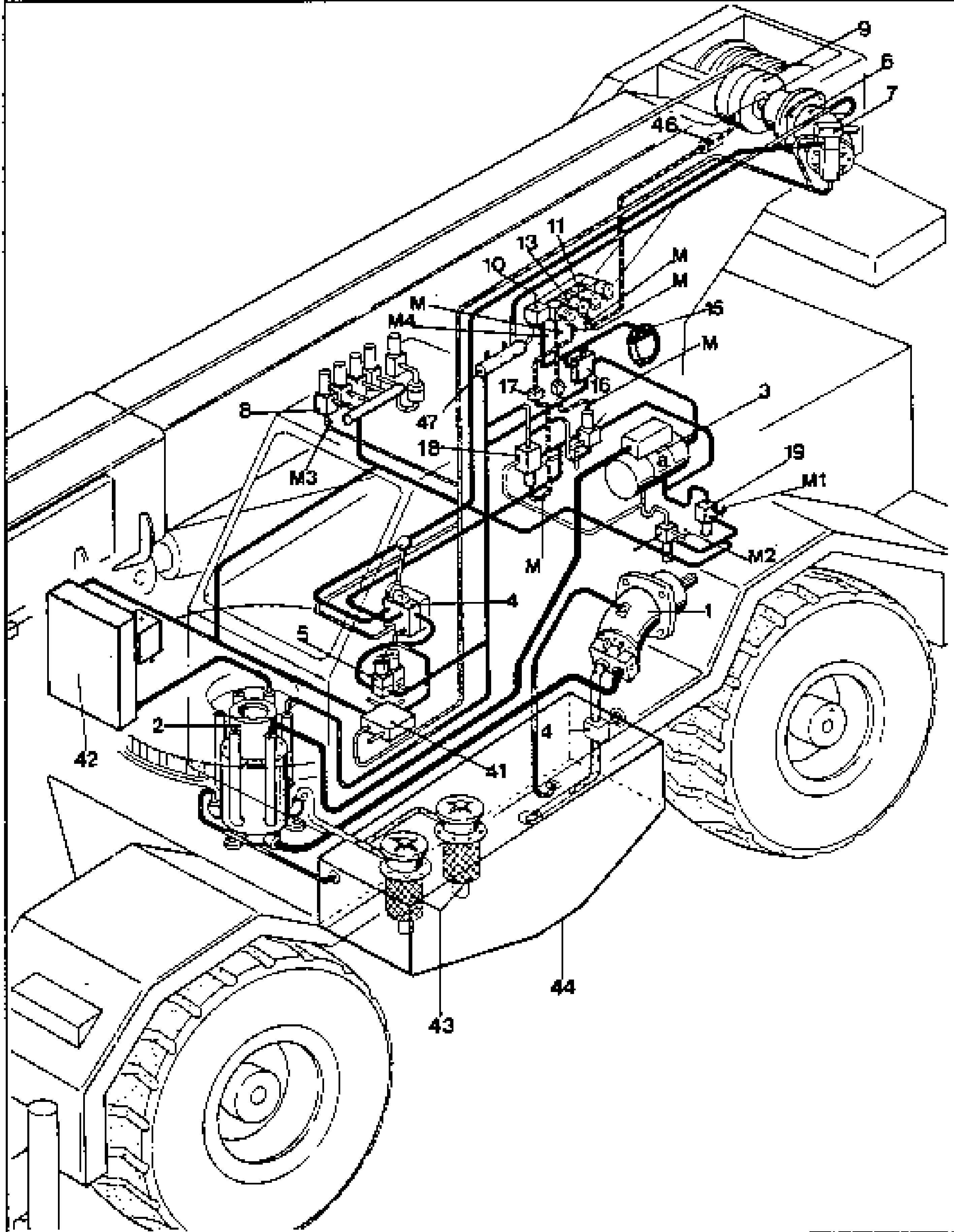
Primary pressure - lowering

1. Lock the hoisting brake on.
2. Connect pressure gauge to measuring point M3.
3. Move control lever (4) in the 'lower' direction.
4. Set pressure limiting valve (8) to 130 bar.

Control-circuit pressure - brake release

1. Connect pressure gauge to measuring point M4.
2. Advance control lever (4) with the brake applied.
3. Set pressure reducing valve (16) to 22 bar.

Hydraulic components - hoisting gear



4.4.05

1. Axial-piston pump
2. Hydraulic rotor (rotary connector)
3. Flow distributor, section 'b'
10. Valve block
14. Flow control valve, high-speed movement
15. Pressure storage reservoir (10 bar)
16. Pressure reducing valve, control pressure (22 bar)
20. Manual control valve with pressure balance and pressure limiting valve (305 bar)
21. Main solenoid valve
22. Multi-way valve
23. Lowering brake valve
24. Luffing ram
25. Pressure limiting valve, 14 bar
26. Restrictor valve, 28 bar
27. Pressure limiting valve, 40 bar
31. Restrictor for high-speed movement
32. Multi-way valve for high-speed movement
33. Pressure limiting valve, primary protection (315 bar)
41. Check valve block, 2 bar
42. Oil cooler
43. Return line filter
44. Hydraulic fluid (oil) tank
45. Shutoff valve, suction line
47. Return collector pipe

Pressure settings

M 2 : Primary protection 315 bar

M 2 : Primary pressure, boom topping = 305 bar

M 4 : Control pressure, high-speed = 22 bar

M 5 : Lowering brake opening pressure (min.) = 14 bar

M 5 : Lowering brake opening pressure (max.) = 28 bar

M 6 : Primary pressure, boom lowering - 40 bar

All pressure adjustments must be performed with the engine idling.

Primaray protection

1. Connect pressure gauge to measuring point M2 (with engine stopped).
2. Close pressure limting valve on manual control valve (20) completely at first, then slacken off by 1/2 turn.
3. Top the boom to its fullest extend and keep the control valve open.
4. Set the pressure limiting valve (33) to 315 bar.

Primary pressure, boom topping

1. Connect pressure gauge to measuring point M2.
2. Top the boom to its fully extend and leave control valve (20) open.
3. Set the pressure limiting valve on control valve (20) to 305 bar.

Primary pressure, boom lowering

1. Connect pressure gauge to measuring point M6.
2. Lower the boom to its fully extend.
3. Tighten pressure limiting valve (25) fully at first, then slacken off by 1/2 turn.
4. Move manual control valve (20) to 'boom lowering'.
5. Set the pressure limiting valve (27) to 40 bar.

Control circuit pressure, high-speed movement

For adjustment, see 'hoisting gear'.

Lowering brake opening pressure

1. Connect pressure gauge to measuring point M5.
2. Open variable restrictor valve (26) fully.
3. Move manual control valve (20) to 'boom lowering'.
4. Set pressure limiting valve (25) to 14 bar (min. pressure).
5. Close restrictor valve (26) until a pressure setting of 28 bar (maximum pressure) is obtained.

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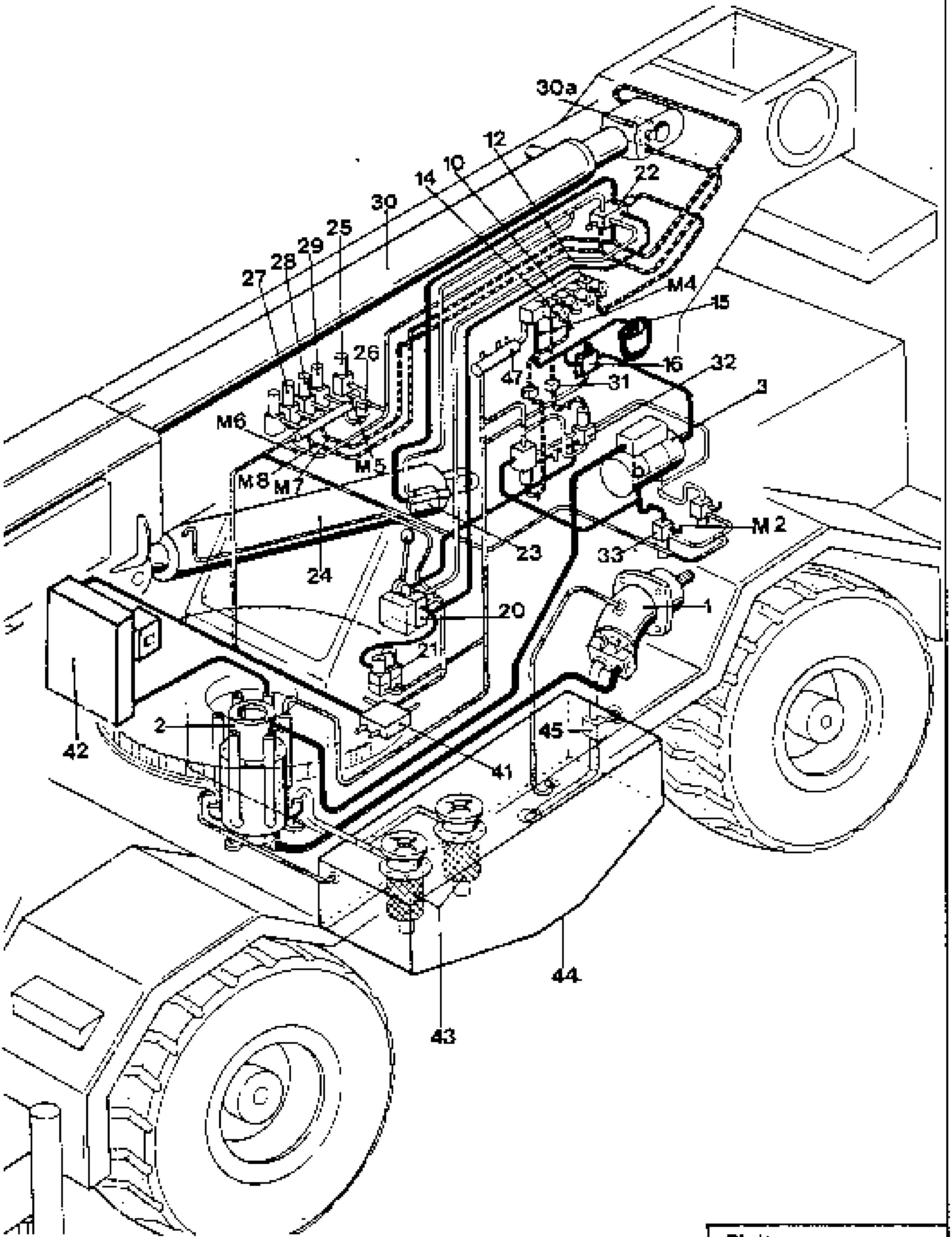
Hydraulic components - luffing/telescoping gear



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Sheet	4.4.07
Page	

4.4.07

1. Axial-piston pump
2. Hydraulic rotor (rotary connector)
3. Flow distributor, section 'b'
10. Valve block
12. Solenoid valve for changeover to telescoping
14. Solenoid valve for high-speed movement
15. Pressure storage reservoir (10 bar)
16. Pressure reducing valve, control pressure (22 bar)
20. Manual control valve with pressure balance and pressure reducing valve (305 bar)
21. Main solenoid valve
22. Multi-way valve, changeover luffing/telescoping
28. Pressure limiting valve, retracting telescopic boom (200 bar)
29. pressure limiting valve, extending telescopic boom (215 bar)
30. Telescopic ram
31. Restrictor, high-speed movement
32. Solenoid valve, high-speed movement
33. Pressure limiting valve, primary protection (315 bar)
41. Check (non-return) valve block, 2 bar
42. Oil cooler
43. Return-line filter
44. Hydraulic fluid (oil) tank
45. Suction-line shutoff valve
47. Return-side collector pipe

Pressure settings

M 2 : Primray protection = 315 bar
For adjustment, see luffing gear

M 4 : Control-circuit pressure, high-speed movement and changeover to telescoping = 22 bar
For adjustment, see hoisting gear

M 7 : Primary pressure, extending boom = 215 bar

M 8 : Primary pressure, retracting boom = 200 bar

All pressure-setting adjustments must be made with the engine running at idle speed.

Primary pressure, boom extension

1. Connect pressure gauge to measuring point M7.
2. Extend the telescopic boom fully and keep the control valve (20) open.
3. Set pressure limiting valve (29) to 215 bar.

Primary pressure, boom retraction

1. Connect pressure gauge to measuring point M8.
2. Retract the telescopic boom fully.
3. Set pressure limiting valve (28) to 200 bar.

1. Axial-piston pump
2. Hydraulic rotor (rotary connector)
3. Flow distributor, section 'c'
15. Pressure storage reservoir (10 bar)
16. Pressure reducing valve - control pressure (22 bar)
34. Manual control valve with pressure balance and pressure limiting valve (110 bar)
35. Duplex brake valve with slewing-movement damping and pressure limiting valves (100 bar)
36. Slewing motor
37. Multi-disc brake
38. Solenoid valve - slewing gear brake (release)
39. Ball tap
40. Pressure limiting valve, primary protection (160 bar)
41. Check (non-return) valve block, 2 bar
42. Oil cooler
42a Fan motor for oil cooler
43. Return-line filter
44. Hydraulic fluid (oil) tank
45. Suction-line shutoff valve
46. Filter

Pressure settings

M 9 : Primary protection = 160 bar
M 10 : Primary pressure, slewing to right = 110 bar
M 11 : Primary pressure, slewing to left = 110 bar

All pressure setting must be adjusted with the engine running at idle speed.

Primary protection

1. Connect pressure gauge to measuring point M9.
2. Lock the slewing brake on (take off solenoid valve connection plug -38-)
3. Switch off - oil cooler drive
4. Tighten the pressure limiting valves at the manual control valve (34) and the slewing damping valve (35) fully at first, then slacken off by 1/2 turn.
5. Adjust pressure limiting valve (40) to 160 bar.

Primary pressure, slewing to right

1. Connect pressure gauge to measuring point M10.
2. Lock the slewing brake on.
3. Tighten the pressure limiting valve (34a) on manual control valve (34) fully at first, then slacken off by 1/2 turn.
4. Set the pressure limiting valve on slewing damping valve (35) to 120 bar)
5. Set the pressure limiting valve (34a) at manual control valve (34) to 110 bar.

Primary pressure, slewing to left

1. Connect pressure gauge to measuring point M11.

2. - 5. Follow the same procedure as for 'slewing to right'.

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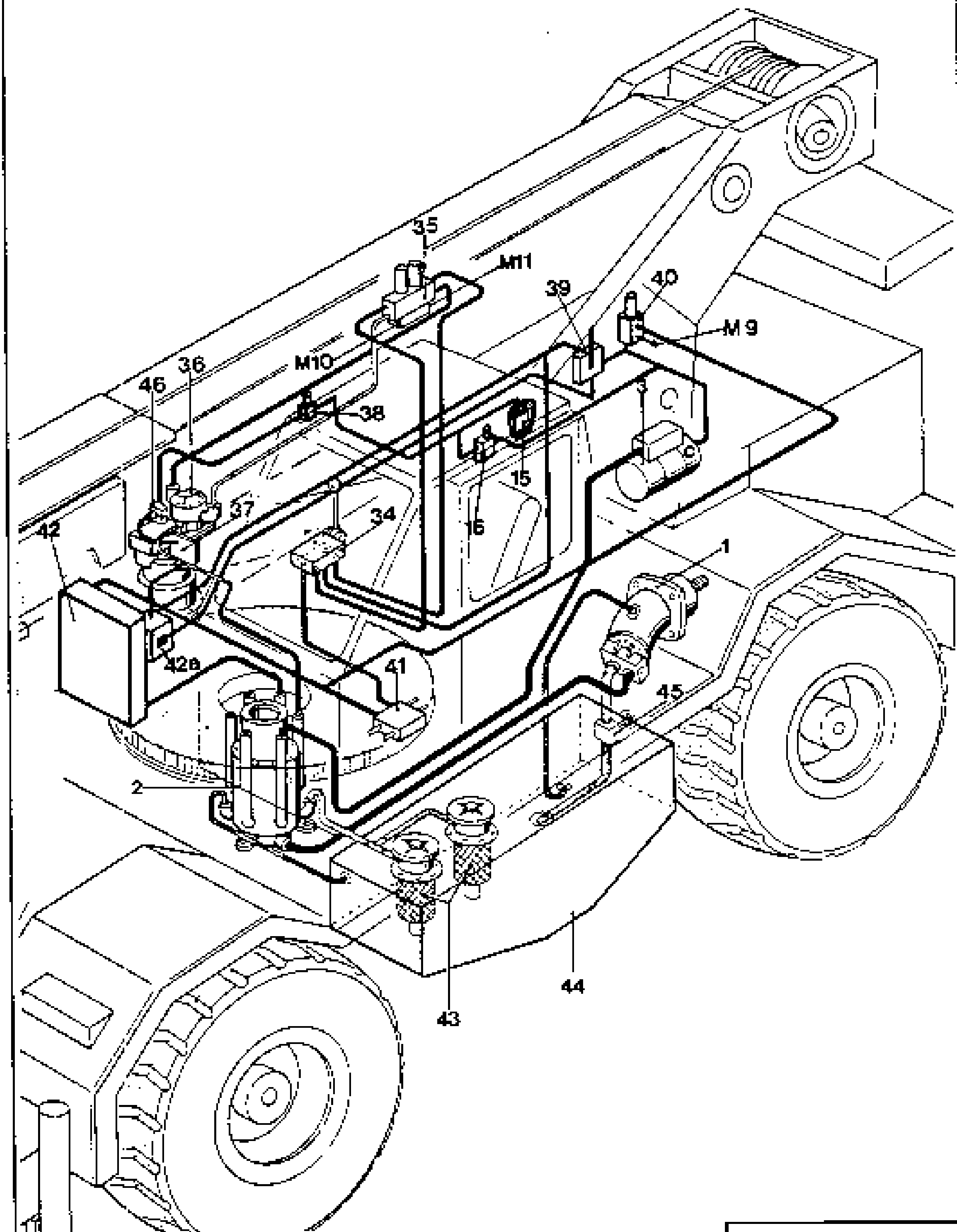
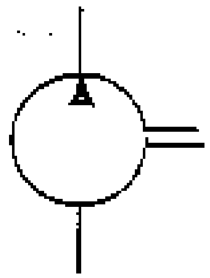
Hydraulic components - slewing gear



Axial piston pump (constant delivery volume)

On the axial-piston pump with constant delivery volume, the delivered flow is proportional to the running speed.



Symbol

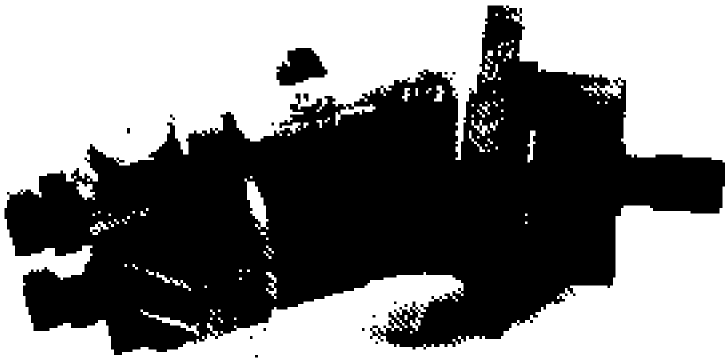
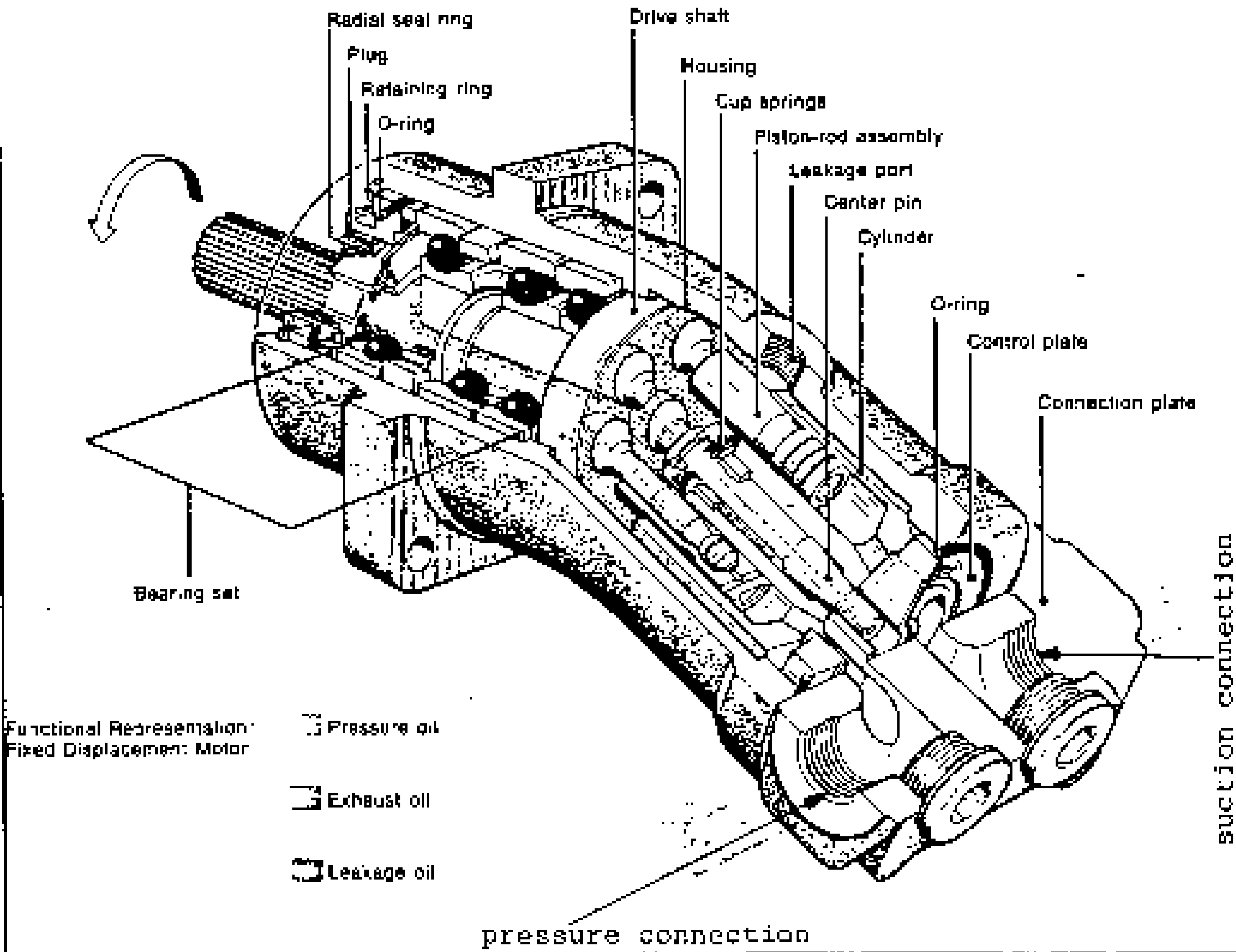


Fig. 1

Fig. 2



Operating principle:

As the drive shaft rotates, the cylinder is also set in motion by seven piston ball-ended rods pivoted in a circle on the drive flange. The cylinder slides over the spherical control plate, into which two kidney-shaped control slots are machined. As rotation proceeds, each of the seven pistons moves from top to bottom dead center in the cylinder bore and thus performs a stroke dependent on the offset angle of the pump.

Piston movement in the cylinder bore from the bottom to the top dead center positions yields the suction stroke (Fig. 3). The volume of oil equivalent to the piston area and stroke is drawn into the cylinder through the suction-side control slot. As the drive shaft continues to rotate, the oil is forced out of the other (discharge side) control slot by the piston, as it moves from top to bottom dead center. The pistons transmit the hydraulic load to the drive shaft endplate (Fig. 4).

The turning movement absorbed by the pump increases with the pressure differential between the high and low pressure sides.

The correct direction of pump rotation to suit the control and connection plate layouts is indicated by an arrow.

Fig. 3

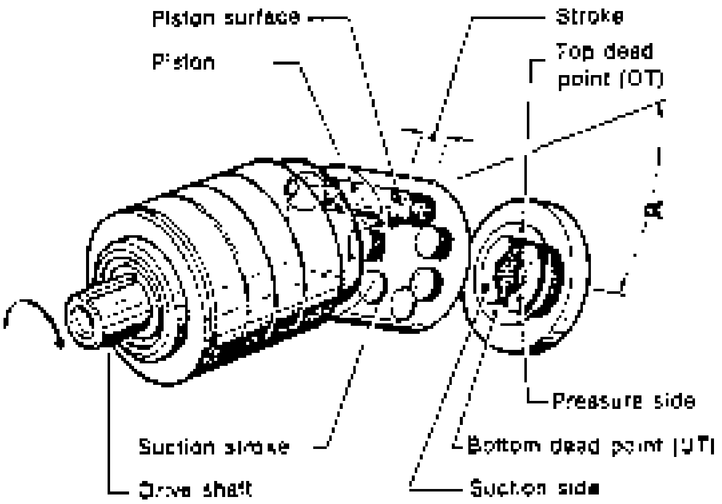
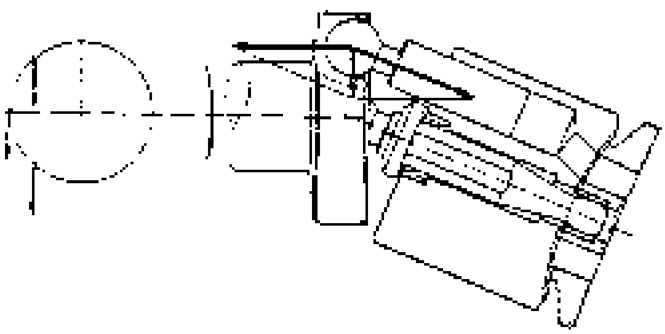


Fig. 4

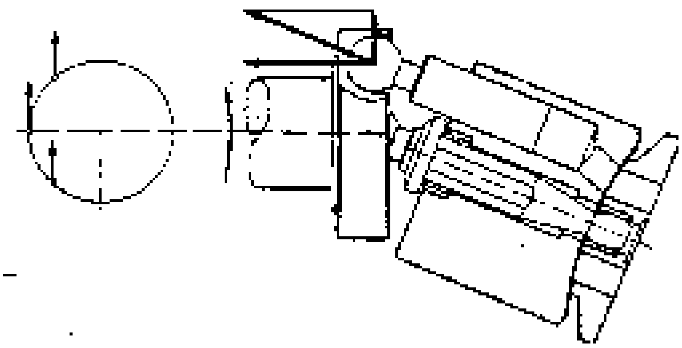


Constant volume pumps are available with fixed offset angles of α = 20° or 25°.

Axial piston motor

The function of the motor is the exact reverse of that of the pump. In this case, pressure oil is forced over the port plate through one of the control slots to the cylinder bores. Three or three and one-half cylinder bores are open adjacent to the kidney shaped control slot (pressure side). The remaining cylinder bores are either open to the other control slot (exhaust side) or partially closed by the control plate. The output torque is developed by the piston force (piston surface and pressure) exserted on the drive shaft (Fig.5).

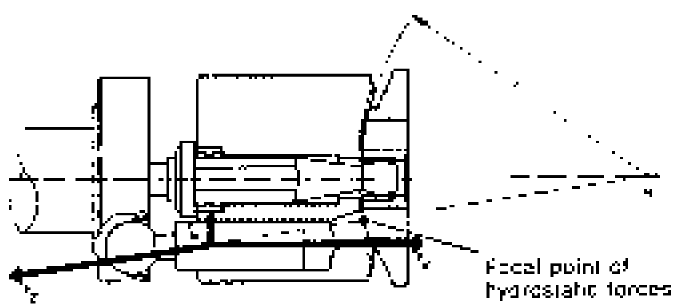
Fig. 5



In both cases, pump or motor operation, the torque works direct onto the drive shaft thanks to the bent axis design.

The pistons load the cylinder with very little side force which results in less wear of parts, higher efficiency and favourable starting momentum. The spherical control plate enables the cylinder to be momentum free supported as all forces on the cylinder are directed to one point (Fig. 6). Side loads are taken-up by the center pin. Lateral displacements due to elastic deformations do not result in higher slippage between the cylinder barrel and control plate.

Fig. 6



F_K = Forces from the piston
F_Z = Force from the hydrostatic pressure field of the cylinder
F_M = Resulting force on the centre pin

During no-flow running and during starting-up stages, the cylinder is pressed onto the control plate by means of the cup springs mounted on the center pin. As the pressure increases, the cylinder is balanced out by hydrostatic forces so that even during high loads, a permanent oil film is maintained between the control surfaces of the cylinder and control plate and the leakage rate is held to an absolute minimum.

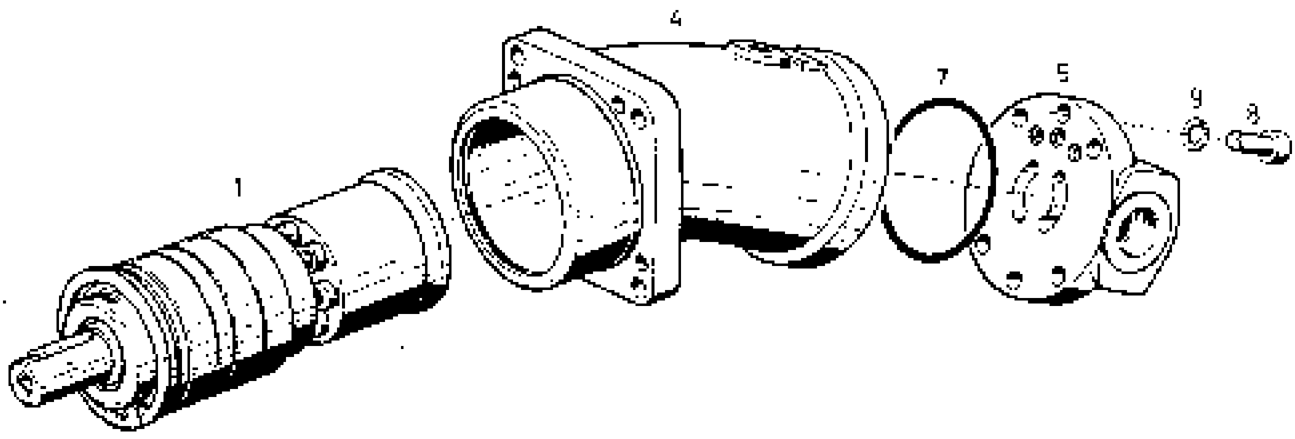
The bearing sets are mounted on tho drive shaft whose function is to absorb the radial and axial forces which occure during operation.

The rotary group is sealed against external leakage by a radial sealing ring and O-rings. The rotary group is held firmly inplace by the snap ring in front of the front cover.

LIEBHERR

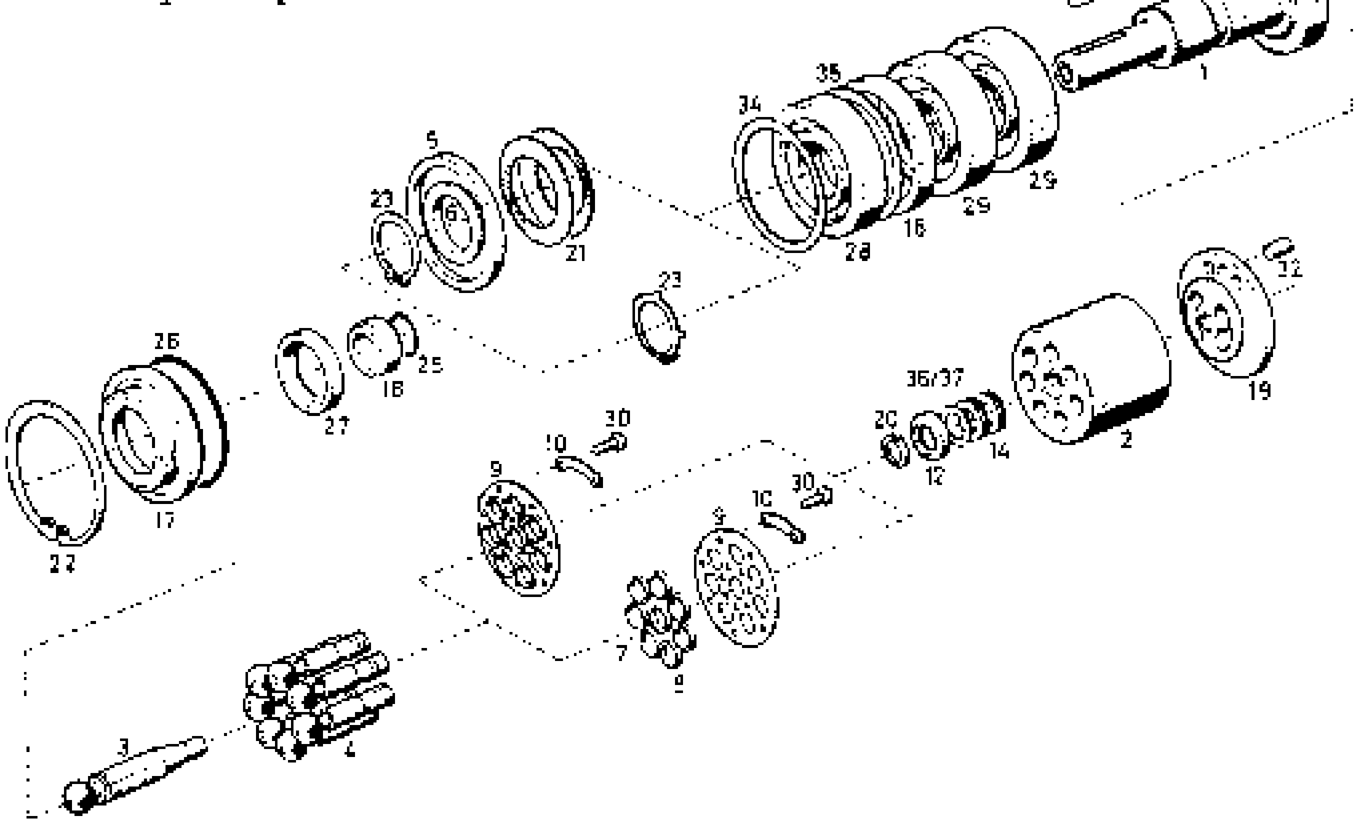
Axial piston pump/motor A2F

Fixed Displacement Pumps/Motors Assembly Group 210



Pos. Item. Pos.	Benennung	Designation	Désignation	Stck. Qty. Qté.
1	Triebwerk (Baugruppe 200)	Rotary Group (Assembly Group 200)	Rotor hydrostatique/ (Groupe 200)	1
4	Gehäuse	Housing	Carter	1
5	Anschlußplatte	Connection Plate	Plaque de raccordement	1
7	O-Ring	O-Ring	Joint torique	1
8	Zylinderschraube	Socket Screw	Vis cylindrique	6
9	Federring	Spring Ring	Rondelle grower	6

Rotary Group Assembly Group 200

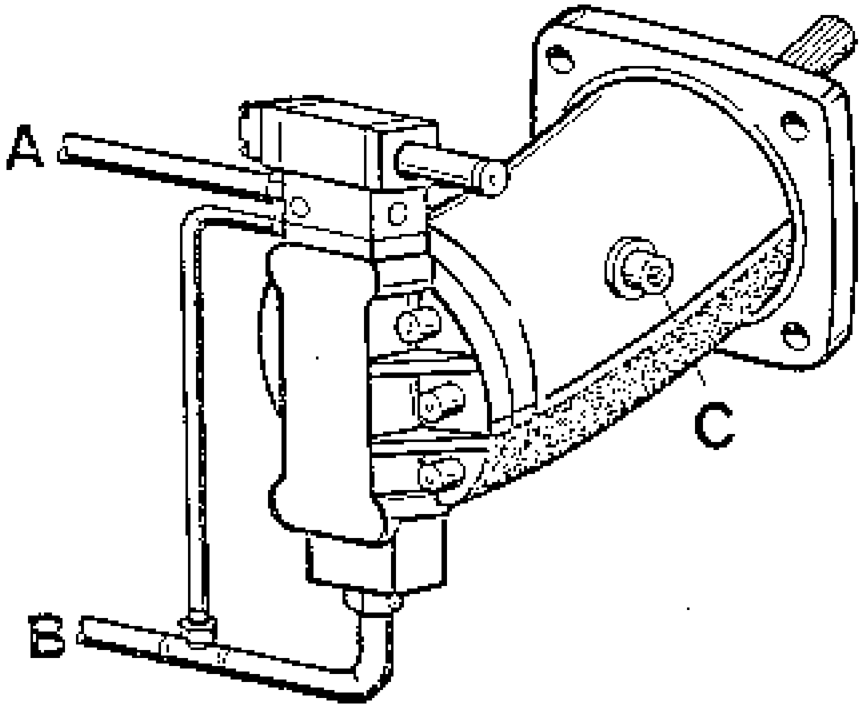


Date Datum	Valable pour série Gültig für Serie	Feuille n° Blatt Nr. 4.5.03

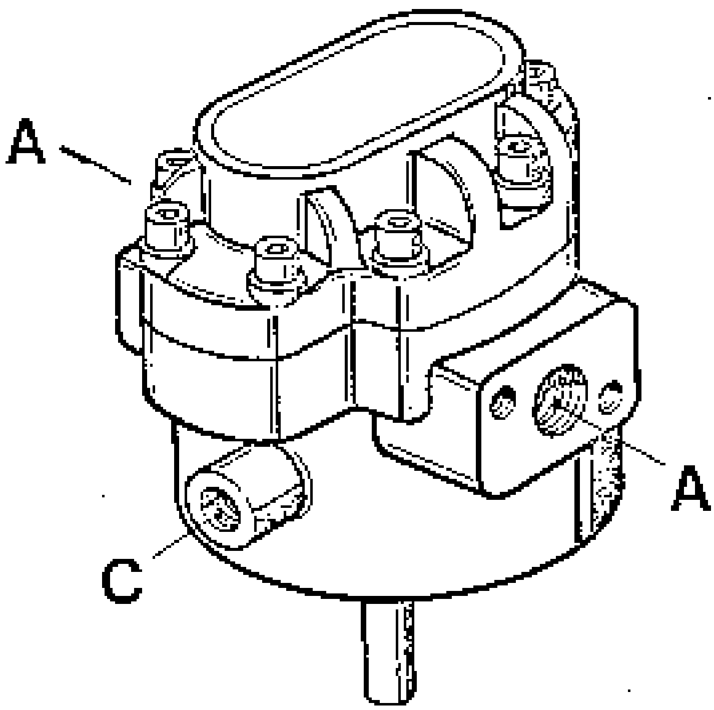
Nenngröße 10 - 12:	ohne Pos. 5, 6, 10 und 21
Nenngröße 23 - 28:	ohne Pos. 5, 6, und 21
Nenngröße 45 - 160:	ohne Pos. 5
Size 10 - 12:	without items 5, 6, 10 and 21
Size 23 - 28:	without items 5, 6 and 21
Size 45 - 160:	without item 5
Module 10 - 12:	sans pos. 5, 6, 10 et 21
Module 23 - 28:	sans pos. 5, 6 et 21
Module 45 - 160:	sans pos. 5

Pos. Item. Pos.	Benennung	Designation	Désignation	Stck. Qty. Qté.
1	Triebwelle	Drive Shaft	Arbre d'entraînement	1
2	Zylinder	Cylinder	Barillet	1
3	Mittelzapfen	Central Pivot	Axe central	1
4	Kolben-Kugelstange	Piston-Piston Rod	Piston-bielle	7
5	Distanzring	Spacer	Anneau entretoise	1
6	Federteller	Spring Collar	Disque de ressort	1
7	Rückzugschale*	Holding Sleeve*	Plaque de retenue*	1
8	Rückzugschale*	Holding Sleeve*	Plaque de retenue*	7
9	Rückzugplatte	Retaining Plate	Plaque de retenue	1
10	Sicherungsblech	Tab Washer	Tôle de sureté	7
12	Federteller	Spring Collar	Disque de ressort	1
14	Tellerfeder	Cup Spring	Ressort Belleville	4
16	Distanzbüchse	Spacer	Bague entretoise	1
17	Verschlußring	Front Cover	Anneau de fermeture	1
18	Laufbüchse	Liner	Douille de glissement	1
19	Steuerplatte	Control Plate	Plaque de distribution	1
20	Ring	Ring	Anneau	1
21	Sonder-Tellerfeder	Cup Spring	Ressort Belleville spécial	2
22	Sicherungsring	Retaining Ring	Anneau d'arrêt	1
23	Sicherungsring	Retaining Ring	Anneau d'arrêt	1
25	O-Ring	O-Ring	Joint annulaire	1
26	O-Ring	O-Ring	Joint annulaire	1
27	Radialdichtring	Radial Seal Ring	Joint radial	1
28	Rillenkugellager	Ball Bearing	Roulement rainuré à billes	1
29	Schrägkugellager	Shoulder Ball Bearing	Roulement à contact oblique	2
30	Sechskantschraube	Hexogan Screw	Vis à tête hexagonale	7**,14
32	Zylinderstift	Pin	Cheville cylindrique	1
33	Paßfeder***	Key***	Ressort d'ajustage***	1
34	Paßscheibe	Shims	Disque d'ajustage	2
35	Paßscheibe	Shims	Disque d'ajustage	1
36	Paßscheibe	Shims	Disque d'ajustage	1
37	Paßscheibe	Shims	Disque d'ajustage	1

* Nur bei Nenngröße 225	* Only for Size 225	* Seulement pour module 225
** Nur bei Nenngröße 12	** Only for Size 12	** Seulement pour module 12
*** Nur bei Triebwelle mit glattem Schaft	*** Only for Keyed Shaft	*** Seulement pour arbre cylindrique



Axial piston motor A = Discharge union - 'lift'
B = Discharge union - 'lower'
C = Leak-off oil union



Gear-type motor A = Discharge union
B = Leak-off oil union

Hydraulic motor

1. Possible causes of faults

a. Drive or transmission failed

b. Wear (internal leakage)

c. Shaft sealing ring leaking or damaged (external leakage).

2. Locating faults

a. Load drops when brake is released, or no movement results when crane movement control lever is operated.

b. Load moves down during working movement (can only be detected at very low hoisting speed).

c. Severe escape of hydraulic fluid into the hoisting drum, not just caused by leakage at the brake.

3. Eliminating faults

a. Renew the hydraulic motor

b. As a.

c. Renew the complete shaft sealing assembly.

Description

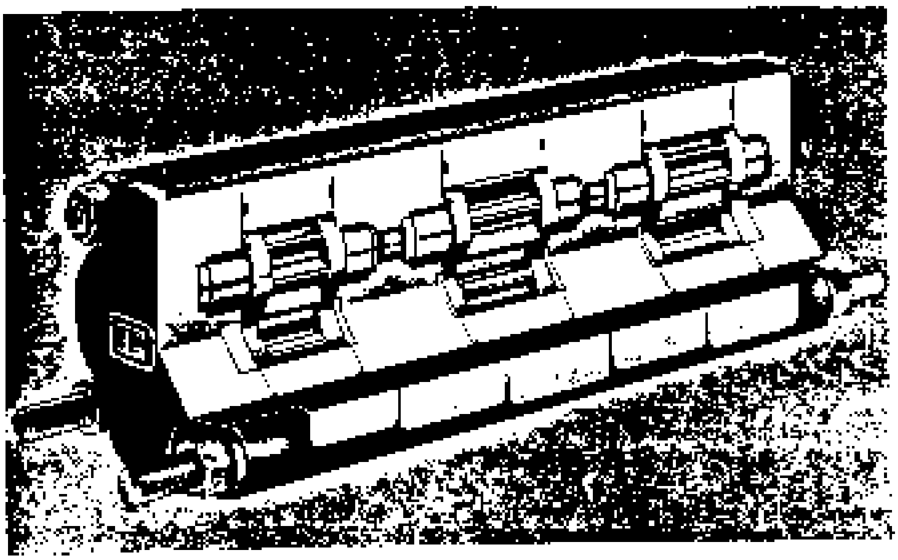
Rotary flow distributors are used to allocate the discharge volume from a single pump to a number of parallel working functions. The energy losses which occur in these units are in all cases lower than if flow distribution were to be carried out by means of pressure-compensated flow regulating valves.

The rotary flow distributor uses the working principle which states that (disregarding losses) the input rating of a pressure medium is the same as its output rating. This principle also explains how pressures can be increased in certain operating circumstances. Pressure increase reduces the cut-in period of the primary pump at maximum pressure and thus prolongs pump operating life.

Rotary flow distributors are suitable for both closed and open circuits. They can be installed at any attitude (horizontal, vertical or angled). The units can be attached directly to the primary pump or anywhere else in the system.

No outer leakoff lines or connecting shafts are needed. To simplify installation, extra-long bolts are provided. The flow distribution ratios are governed by the widths of the gearwheels, which are available in fixed steps.

ype FD 31 B



Construction

The flow distributor is made up of three sections, each to supply one of the hydraulically-powered crane movements.

Section 1 = Hoisting gear (A), Q = 87.6 l/min

Section 2 = Luffing/telescoping (B), Q = 70.0 l/min

Section 3 = Slewing gear (C), Q = 52.4 l/min

These values for Q are based on the maximum input (drive) speed n = 2.625 1/min.

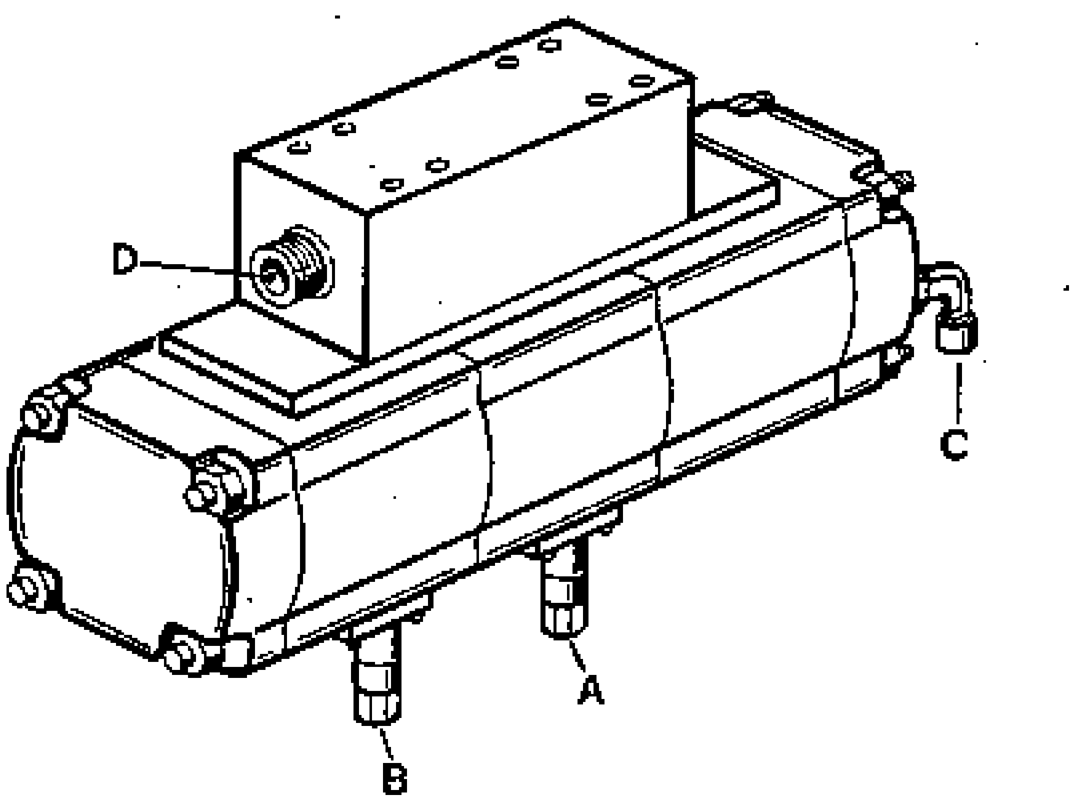
Function

The volume of oil supplied by the hydraulic pump (Q) is allocated to three different functional outputs by the flow distributor.

Input = D

Outputs = A, B and C

All three functions can be operated simultaneously.



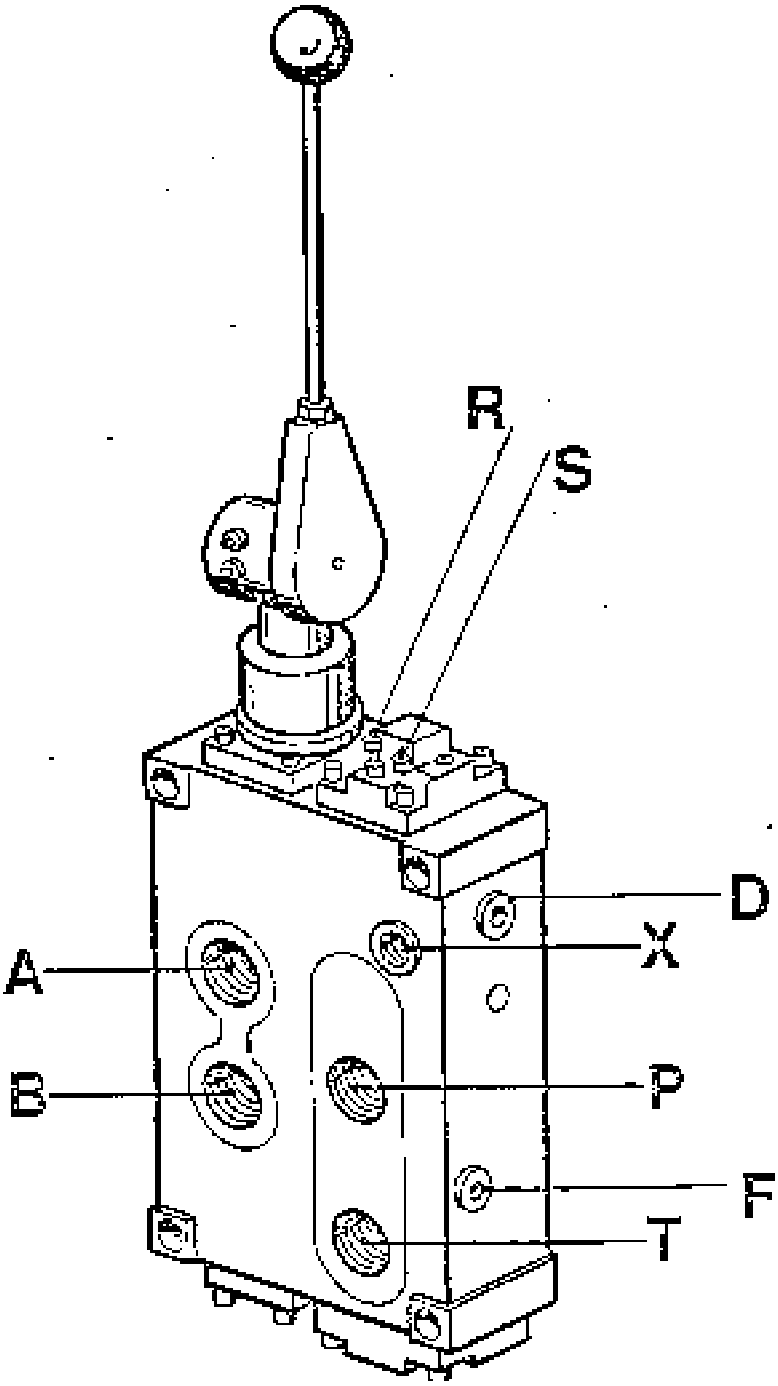
A = Union for hoisting gear

B = Union for luffing gear

C = Union for slewing gear

D = Common supply union from rotary connector

Manual control valve



A = Discharge union - consumer A
B = Discharge union - consumer B
P = Supply union from pump
T = Return line union
X = Control line union - to main valve
F = Filter
D = Nozzle
R = Pressure relief valve adjusting screw
S = Pressure balance adjusting screw

Main control spool valve

1. Possible causes of faults

   a. Filter or nozzle blockes

   b. Pressure relief valve or pressure balance detective

   c. Leakage, split housing

2. Locating faults

   a. No pressure under load

   b. No pressure under load or only low pressure build-up

   c. Visual inspection

3. Eliminating faults

   a. Clean or renew filter / nozzle.

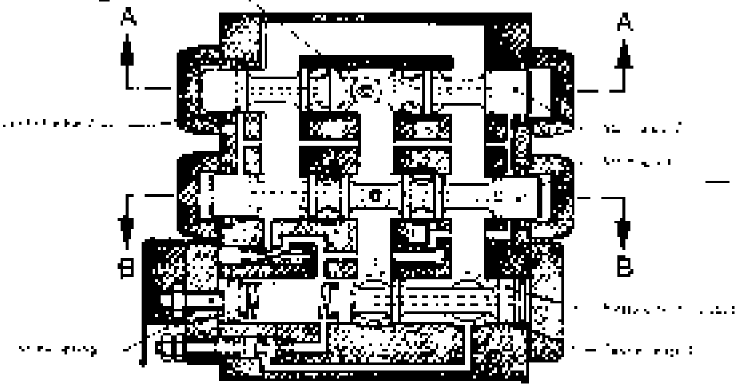
   b. Adjust or renew pressure relief valve.
      Check pressure balance, free plunger if necessary

   c. Renew seals or renew valve assembly.

General description of operation

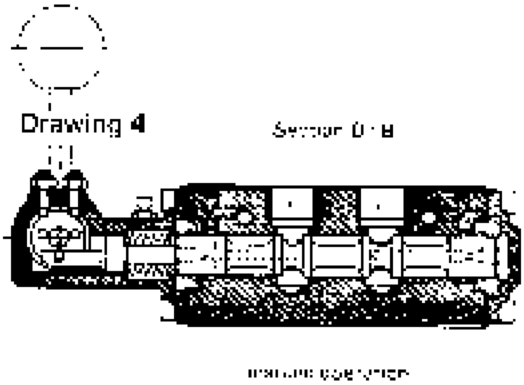
The manual control spoole valve (monobloc) is a propor-tional-travel multi-way valve which controls flow in-dependently of load, that is to say that the speed of the item actuated depends solely on the control factor and cannot be influenced by changes in load. The unit is controlled manually (with hand lever).

Drawing 2



Functional section

Drawing 4



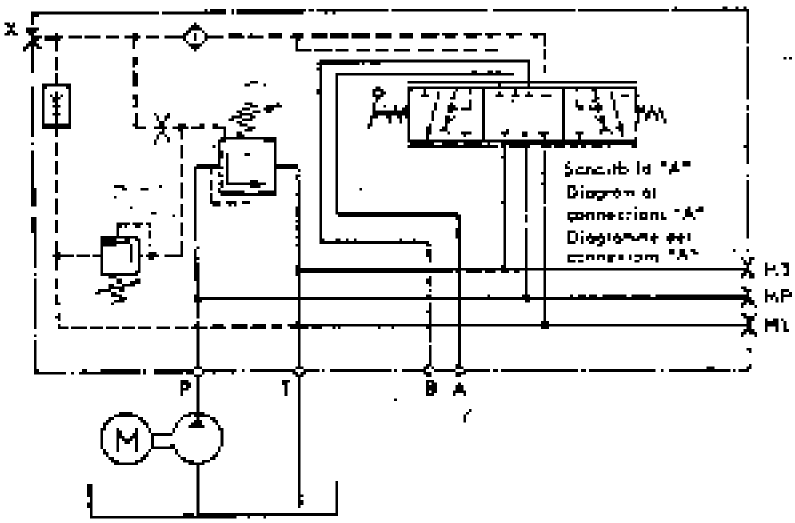
General description of operation

The pump pressure is transferred to the pressure space of the valve via connection P (drawing 2). This pressure puts the load on the r.h. areal side of the pressure balance spool. If there is no consumer unit in operation, all main spools are in centre position (Drawing 2 shows main spool 1 in centre position). In this case the l.h. areal side of the pressure balance spool is only loaded with the tank pressure. The pressure balance spool is moved to the left and oil can flow off from the pump pressure space to the tank via control edge 1. The pump circulation pressure then corresponds only to the spring force of the screw spring (3,6 or 12 bar, depending on the chosen spring). If a con-sumer unit is to be operated, the respective main spool is moved to the respective connected port. In drawing 2 the illustration is such that consumer unit A_2 is loaded via main spool 2. If main spool 2 is moved to the left, control edge 2 opens by way of which load pressure A_2 is put onto the l.h. side of the pressure balance spool. The pump pressure then corresponds to load pressure A_2, plus circulation pressure (3,6 or 12 bar). Then control edge 3 opens and releases flow to the consumer unit. As the pressure difference at control edge 3 between load pressure and pump pressure is always constant (3,6 or 12 bar), we have a stream of conveyance which is independent of the load. Consequently the stream of conveyance is proportional to the input signal.

Way-proportional operation (manual operation)

When actuating one of the main spool a corresponding consumer pressure builts up on the spring side of the MCV-piston via control line. The pressureless circulation is blocked an the pump pressure builds up. The pump pressure then corresponds to load pressure plus circulation pressure (3,6 or 12 bar). As the pressure difference between load pressure and pump pressure is always constant (3,6 or 12 bar) we have a stream of conveyance which is independent of the load an depends of the position of the main spool. The increase of pressure - i.e. pressure drop speeds can be regulated by exchanging the nozzle mounted into the control line. The increase of pressure speed is independent contrary to the pressure drop speed which depends on the existing working pressure. On intermediate positions of the hand lever oil can flow off, with existing load pressure, from the pump pressure space to the tank via control edge of the pressure balance spool.

Diagram MPV with MUV



Legend:

P - Pump connection

T = Tank connection

A
B = Consumer connection

X = Remote pressure control connection

MT- Measuring point for return flow pressure

MP= Measuring point for pump pressure

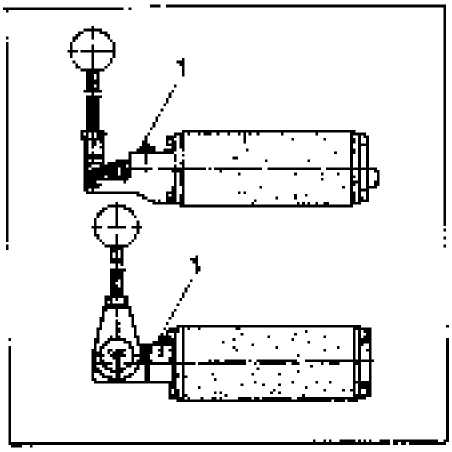
1. INSTALLATION INSTRUCTIONS

Installation position

Installation position for manual valves is optional.

Installation position for hydraulically controlled valves is optional.

2. Lubrication of the lever assembly



The manually controlled valves have to be occasionally lubricated at the grease fitting (1) in the area of the hand lever.
The Barmag valves are lubricated with grease prior to delivery.

3. FILTERING

General

Careful filtration is not only important for a properly operating system, it also prolongs the life-span of the various elements.

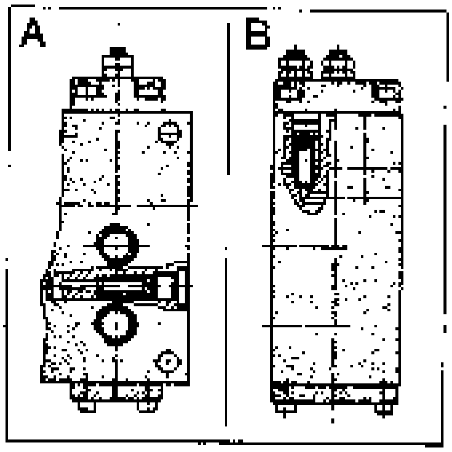
System filtration

The system's main filter should have a rating of 25 µm absolute.

Filters with contamination indication are recommendable.

Oil filling and breathing

The rating of this filter should be equal to or smaller than the main filter to prevent the entry of smaller particles into the system that can be filtered out during operation of the equipment.



Filter insert in the valve (except in NWB)

How to change the filter element

A = Monoblock type

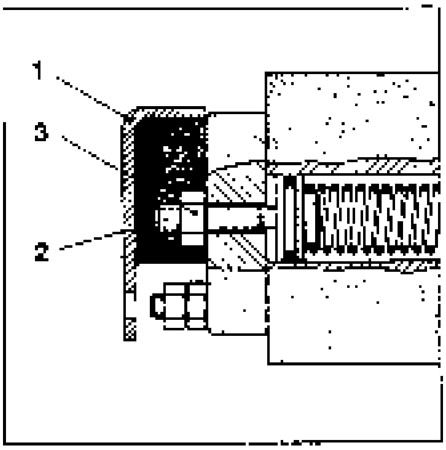
B = Subplate type

4. AIR BLEEDING

General

In order to avoid oscillations, it is necessary to bleed the hydraulic valves.

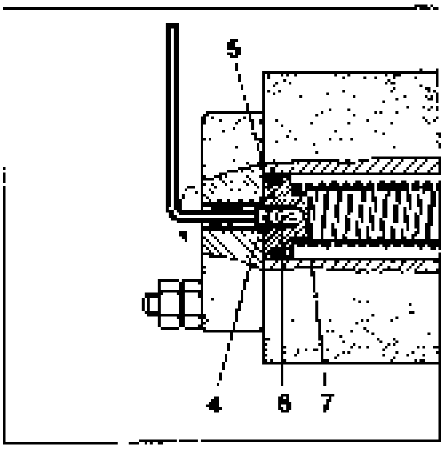
Air bleeding for valves with 3-way flow control (MU)



The bleeding of the valve is carried out via the pressure balance. First, the fabricated sheet metal cover (1) which is held with 2 screws, has to be removed. Then the screw of the pressure balance (2) with lock nut is unscrewed.

Warning!

Before removing the screw (2), the position of the lock nut (3) has to be marked, so that when reassembling, the spring of the pressure balance will receive original compression.



Now, the setscrew (4) in the separator piece (5) is loosened with an Allen wrench whereby the ball (6) releases the bore (7) through which the air can escape.

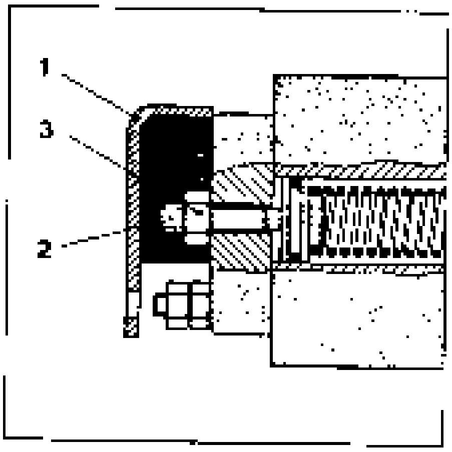
Important!
Only loosen, not unscrew the setscrew (4).

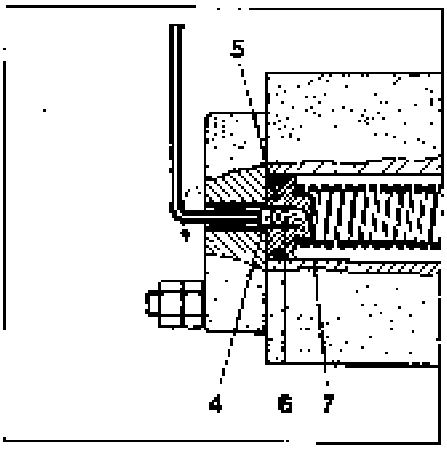
The valve should then be operated in both directions so that the oil can flow into the spring chamber.

For the bleeding procedure it is important to have the valve connected with an actuator; only then can the oil flow through the load-sensing passages.

Since the spring of the pressure balance is relaxed during bleeding, the speed of the actuator is slower than normal and is equivalent to dynamic pressure of the fully opened pressure balance.

Following bleeding the setscrew (4) is tightened and the pressure balance screw (2) with lock nut (3) screwed in.





Air bleeding for valves with 2-way flow control (MD)

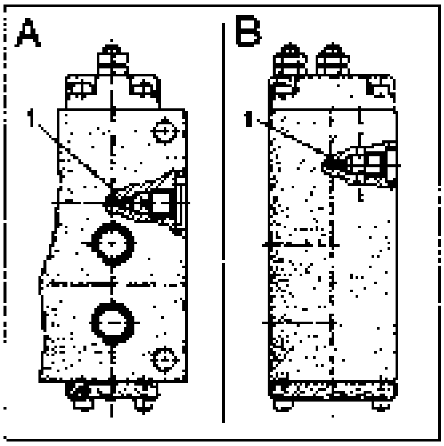
Bleeding process for this model is the same as described under ¯4.

However, before operating, the pressure balance adjustment screw (2) has to be screwed in again; otherwise the P-port would be blocked by the relaxed pressure balance piston.

After bleeding by operating the actuator has been carried out, the pressure balance adjustment screw (2) is screwed out, and the setscrew (4) is tightened and the pressure balance adjustment is screwed back in place.

5. POSSIBILITIES FOR CHANGE IN RESPONSE TIME

Change in response time of the pressure balance



The time of movement of the pressure balance piston is determined by the inbuilt pressure balance jet (1) (see illustration).

Oscillations in the system can be influenced by changing this jet (1).

The valves are equipped with the following standard pressure balance jets :

NW 8 = Jet Ø 0,6 mm
NW 12 = Jet Ø 0,8 mm
NW 18 = Jet Ø 1,0 mm
NW 25 = Jet Ø 1,2 mm

A = Monoblock type

B = Subplate type

6. OPERATING PRESSURE

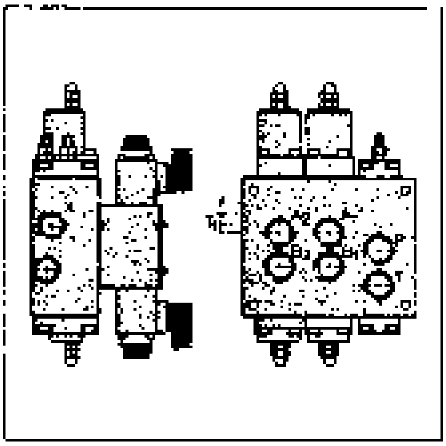
General

Max. permissible pressure is 350 bar (5000 psi) for the ports P, A, B, X.

Max. permissible pressure is 50 bar (725 psi) for port T (tank).

Exception :

In valves with additional tank port T_1 (max. 50 bar, 725 psi) the T port can withstand 350 bar (5000 psi).



Effect of the integral relief valve

Barmag proportional valves are fitted with an integral relief valve.

The valve limits the max. actuator pressure during operation of the main spool.

This simultaneously limits the max. pump pressure in the 3-way pressure compensated flow control.

However, the relief valve does not represent a secondary relief when the valve is in neutral.

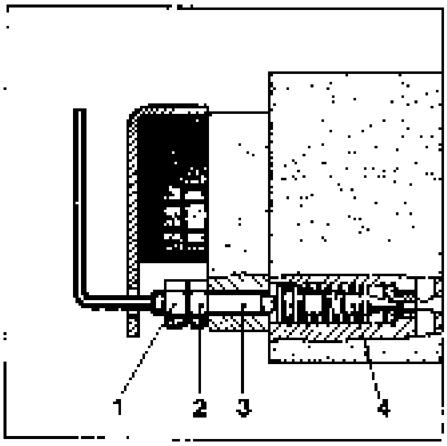
Factory adjustment of the relief valve

If no special pressure setting was requested in the order than the valve is deliveredwith the following pressure settings :

adjusted pressure = 50 bar (725 psi).

The max. pressure setting is 350 bar (5000 psi).

Adjustment of the relief valve



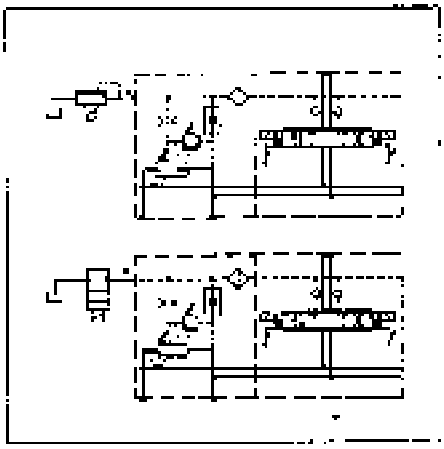
In the diagram you can see the relief valve (4) which is constructed as a cone seat valve.

The initial setting of the adjustment screw (3) is altered with an Allen wrench until the pressure gauge indicates the adjusted pressure.

The setting is locked with the hexagon nut (2).

The hexagon nut (1) is securely attached to the adjustment screw (3) and restricts the max. setting to 350 bar (5000 psi) if not other pressure setting was requested in the order.

Remote control of relief pressure



Through the X port in the opposite illustration the effect of the load pressure in the spring chamber of the pressure balance can be decreased.

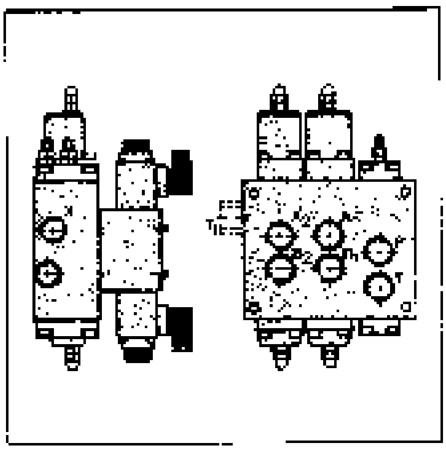
Thereby remote control or disconnection of pressure is possible.

In the pressure balance with 2-way flow control, the flow rate to the actuator can be shut off, i.e. the momentary restriction of load in mobile cranes.

In the pressure balance with 3-way flow control, the pump flow can be directed to the tank.

Warning!
The load can drop via the open main spool if there is no load holding valve in the system.

Specification for remote control of pressure



The size of the relief valves, or the 2/2-way valves is determined by the oil flow which discharges from the "X" port.

This is determined by the size and form of drillings in the main spool and by the load pressure.

Drillings in the main spool :

NW 8 = 2 x Ø 1,0 mm
NW 12 = 2 x Ø 1,5 mm
NW 18 = 2 x Ø 2,0 mm
NW 25 = 2 x Ø 2,5 mm

7. FLOW RATES

Adjustment of flow rates

The flow rate from the pump to the actuators is essentially determined by the open cross section, based on the position of the valve spool and the pressure difference at that spool.

The cross sectional area is determined by the valve control, i.e. electrical, hydraulic or manual input. In addition, the area is influenced by the spool type.

Table of max. flow related to pressure difference

According to the desired flow rate, the valves are fitted with

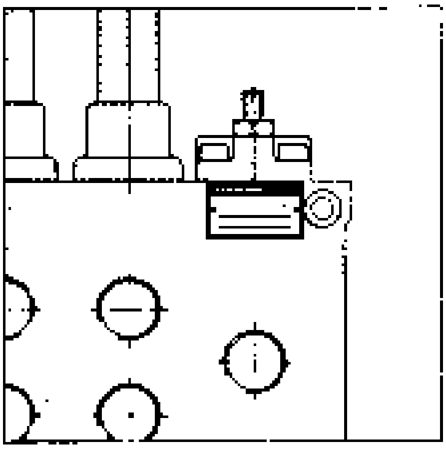
3 bar - (not for electric operation)
6 bar - or
12 bar - spring.

The adjustment of the spring determines the pressure difference at the main spool and, consequently, the flow rate.

The table shows the flow via a standard spool, the max. cross sectional area of which was not factory limited in dependence upon the pressure difference (90° edge).

Nominal size	max. flow rate (l/min) at circulation pressure Δp = 3 bar not with electric operation	Δp = 6 bar	Δp = 12 bar
●6	25	35	50
12	50	70	100
16	100	140	200
25	200	280	400
35*	●	560	800

● not in sliceplate type
* not in monoblock type



Factory setting of the flow rate

Should the desired flow rate deviate too much from the table values, then the spools are factory-set in a way that the area is reduced; however, the max. spool stroke is retained.

Modification of the area at the spool is possible for the flow directions P → A and P → B. Based on this area, the factory precision setting can be changed to the flow rate requested by the customer by adjusting the pressure difference (see 9.4.1.) or the stop (see 9.4.2.).

Details of the flow rates are listed on the decal.

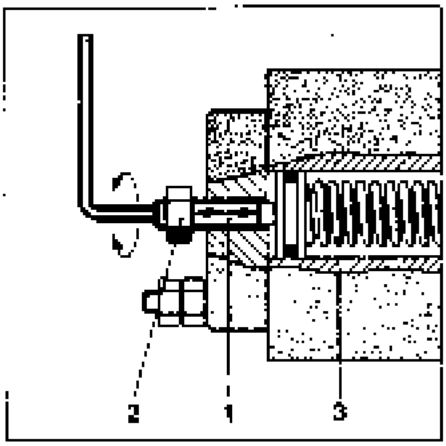
Adjustment of the factory set flow rate

The valves were adjusted by Barmag according to the order agreement.
The following adjustments of flow apply if desired flow is different to that set at the factory.

Change of the flow rate by changing pressure difference

After removal of the fabricated sheet metal cover which is secured by two screws, the lock nut (2) is loosened and the adjustment screw (1) can now be adjusted with an Allen wrench, clockwise, the spring is compressed or counterclockwise relaxed and the flow rate is increased or decreased accordingly for all main spools of the valve.

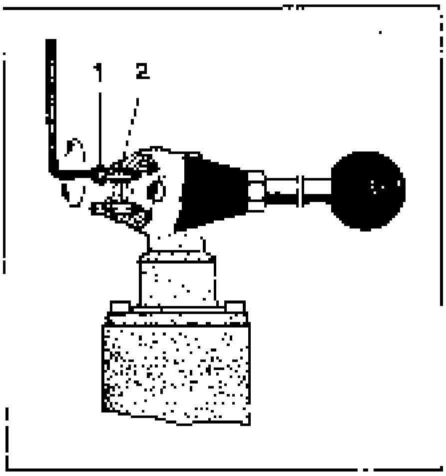
Once the desired flow rate is set, the adjustment screw (1) is locked by the lock nut (2); then the fabricated metal sheet cover is refitted.



Should the adjustment not be sufficient to obtain the desired flow then it is possible to change to a different range by exchanging the pressure balance spring (3).

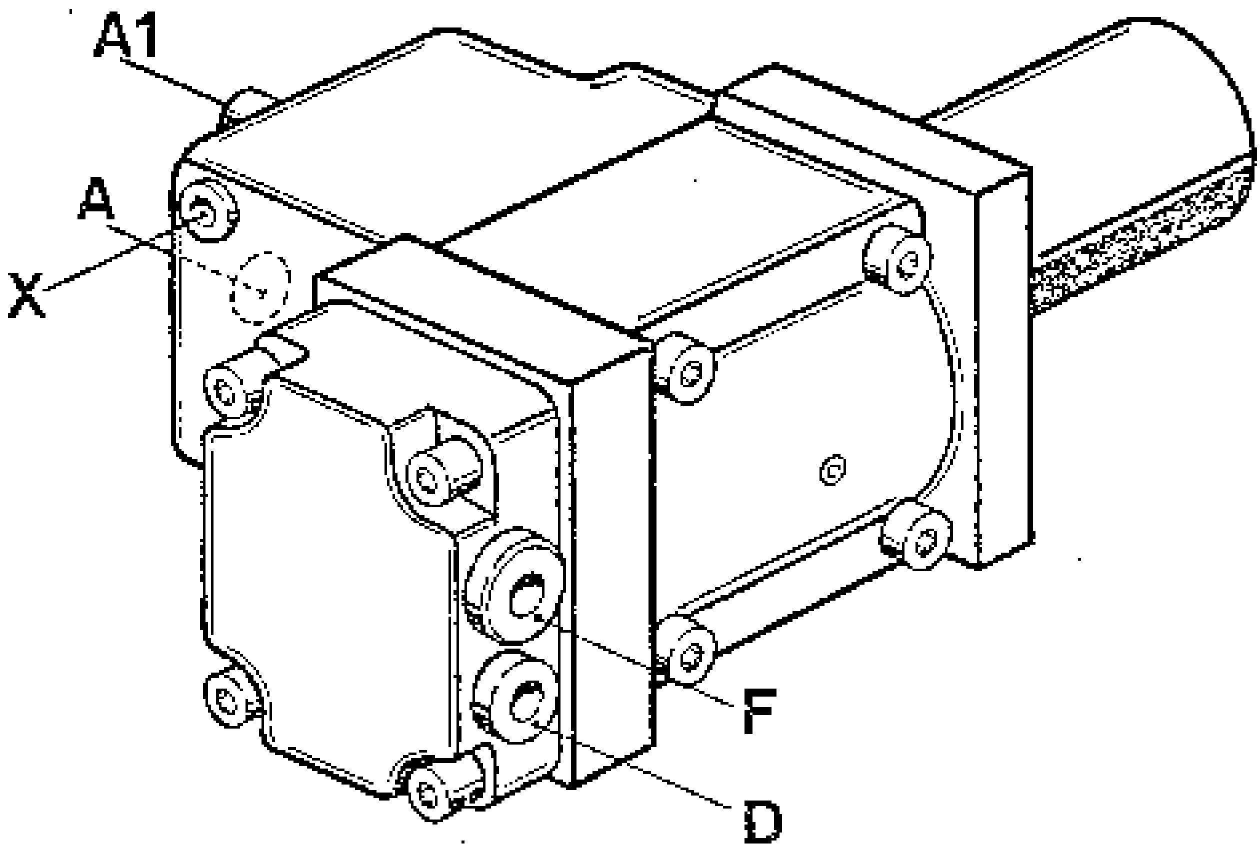
The pressure balance spool is restricted by a mechanical stop.

Change of the max. flow rate to an actuator by spool stroke limiting



Stroke limiting in manually operated valves (in closed handle)

The stroke limiting is adjusted by loosening the lock nut (1) and subsequently the screw is adjusted with an Allen wrench.



A = Working pressure input union

A1= Working pressure output union

X = Control pressure union

F = Filter (end cap)

D = Nozzle

1. Possible causes of faults

   a. Filter or nozzle blocked

   b. Valve plunger jammed or damaged

2. Locating faults

   a. No downward movement is possible

   b. As a.

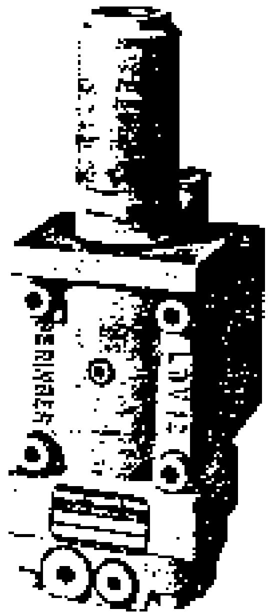
3. Eliminating faults

   a. Clean or renew filter or nozzle

   b. Free valve plunger or renew valve

Lowering brake valve

- **Overcentre Valve incorporating the functions of Check Valve and Pipe Rupture Valve**
- **Low Pilot Pressure – Minimal Power Loss-High Efficiency**
- **Various compact mounting types**
- **Full Safety** even at spring failure, the main spool is still under full control and will close when required
- **Non-Oscillating-Working**, is independent of the thro' flow, by means of a special valve spool which has a long throttle range – very quiet
- **Dampening Jet** is interchangeable and largely independent of the oil viscosity – Fully protected from dirt by a in built Sinter Bronze Filter
- **No port necessary for leakage**



1. Description

Brake valves are used wherever actuating rams or hydraulic motors have a tendency to get ahead of the input oil flow on account of external forces (negative loads) and thus to overrun or overspeed.

The valves are installed in the outlet line from the unit to be protected. The brake valve should be as close as possible to the unit in order to speed up its response. Control oil circuit union X is connected to the feed line of the unit. The valve remains closed until pressure in the feed line exceeds its preset opening pressure. If the pressure in the feed line sinks, that is to say the consumer is tending to overrun the feed flow, the regulating plunger is set back by springs until the oil flow is restricted sufficiently for the opening pressure in the feed line to be reached again.

The control passage contains an easily interchangeable Solex jet, which damps the opening and closing action of the regulating plunger and is largely insensitive to viscosity changes. A built-in sintered bronze filter protects the jet nozzle against blockage with dirt.

When closed, the brake valve plunger forms a hermetic seal on the consumer-equipment side, so that no further shutoff valves or similar need be installed. If the brake valve is flanged directly to the ram or jack cylinder by means of an SAE union, it can also function as a pipe failure safety device; in the event of rupture of the oil line the load is retarded gently. Even if its spring should fail, the valve will still close and is thus 'fail-safe' in design.

For use in hydraulic systems which suffer high pressure peaks when large masses are braked, the brake valve can be delivered with an integral secondary pressure relief valve (shock valve). The multi-way valve upstream of the brake valve must be arranged to connect the two working passages with the return line when in neutral. This circuitry ensures that even if the multi-way valve closes violently the brake valve can still bring the controlled equipment to a standstill smoothly and without jerking.

To bypass the braking effect when lifting a load, the connection plate is equipped with a check valve, which is normally set for an opening pressure of 1 bar. As an alternative, the pressure loss can be raised to 15 bar, for instance to release a hydraulic brake on a hydraulic motor if insufficient load pressure is available.

2. Characteristic data

2.1

Nominal diameters (mm)	Brake valve	12	12	20	20
	Connection plate	12	16	20	25
Nominal flow rates	liters/min at 33 cSt viscosity (4,5°E)	60	100	160	250
Q max*	liters/min at 33 cSt viscosity (4,5°E)	90	150	240	350
Connections A,B	inch	R 1/2"	R 3/4"	R 1"	R 1 1/4"
	metric	M22x1,5	M27x2	M33x2	M42x2

For connection B, valves are supplied as standard if required with SAE flanges.

* Allowing for a higer pressure loss, valves are also suitable for higer flow rates (see 'Flow characteristics', 5.1 and 5.2)

2.3 General information

Pattern	Seat valve with hydraulic pilot circuit
Mounting	Bedplate with O-ring seal
Line connections	Connection block
Installed position	unrestricted

2.4 Hydraulic parameters

Max. working pressure: Connection: A, B, X p = 350 bar

option of:

Valve opening at feed pressure of:		8	10	15	20	25
Valve fully open	Nom. dia.12/16	28	28	33	38	43
	Nom. dia.20/25	26	28	33	38	43

Also available with other opening characteristics for special applications.

Flow direction: regulated from B to A

Bypass check valve: Flow resistance A B from Q_0 to Q_{nom}

Standard version: app. 1...3 bar (see performance graph 5.3)

Special version(V): app. 15...30 bar (see performance graph 5.4)

Hydraulic pressure medium: Mineral oil; for other media, please consult manufacturers (on account of seals to be used)

Pressure medium temperature range: min. - 20° C to max. + 70° C; other temperatures on request

Viscosity range: From 2.8 cSt (1,2°E). to 380 cSt (50°E). The above flow data refer to hydraulic fluid with a viscosity of 4.5°E at normal temperature.

Pilot circuit:

Nom. dia. (mm)	Nozzle dia. (mm) LBV	Control system volume (cm³)
12 16	0,35	4,5
20 25	0,55	10,6

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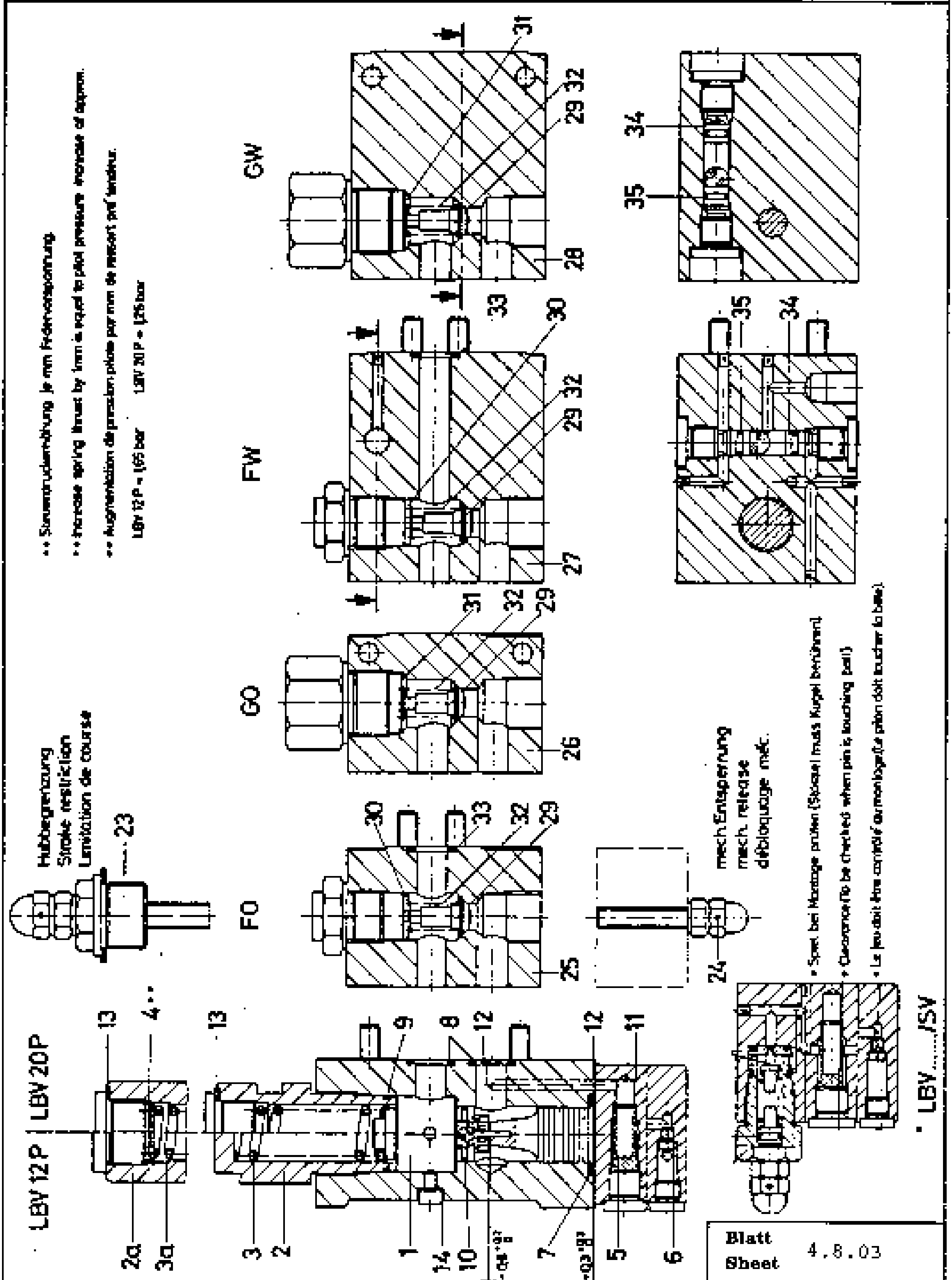
Lowering brake valve



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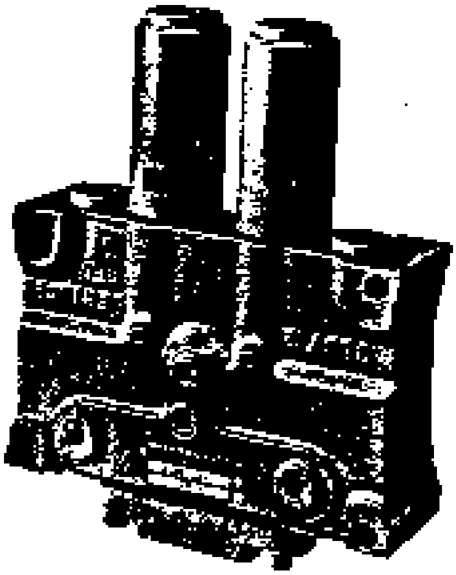
Double brake valve

- **Overcentre valve incorporating the functions**
  of Check Valve and Pipe Rupture Valve
- **Low Pilot Pressure –**
  Minimal Power Loss-High Efficiency
- **Compact mounting**
- **Full Safety even at spring failure,**
  the main spool is still under full control and will close when required
- **Non-Oscillating-Working,**
  is independent of the thro'flow,
  by means of a special valve spool which
  has a long throttle range – very quiet
- **Dampening Jet is interchangeable and largely independent of the oil viscosity –**
  Fully protected from dirt by a in built
  Sinter Bronze Filter
- **No port necessary for leakage**



1. Description

Brake valves are used wherever actuating rams or hydraulic motors have a tendency to get ahead of the input oil flow on account of external forces (negative loads) and thus to overrun or overspeed.

The valves are installed in the outlet line from the unit to the multi-way valve. The duplex brake valve is to be mounted as close as possible to the unit being protected, in order to speed up the valve's response. The valve is closed until pressure in the feed line exceeds the preset opening pressure. When pressure in the feed line sinks, that is to say the consumer equipment is tending to overrun the feed flow, the regulating plunger is set back by a spring until the oil flow is restricted sufficiently for the opening pressure in the feed line to be reached again.

The control system contains two interchangeable Solex jets, which dampen opening and closing action of the regulating plunger and are largely insensitive to viscosity. Built-in sintered bronze filters protect the jets against blockage with dirt.

When closed, the brake valve plungers make a hermetic seal on the consumer side, so that no additional shutoff valves are needed. If the brake valve is attached directly to the ram cylinder, it acts as a pipe failure safety device, and retards the load smoothly if a pipe or hose should rupture between pump and brake valve. Even if its spring should fail, the valve will still close, and thus qualifies as 'fail safe'.

For use in hydraulic systems which suffer from high pressure peaks when large masses are braked, the brake valve can be delivered with integral secondary pressure relief valves (shock valves). The multi-way valve upstream of the brake valve must be arranged so that the two working passages are connected to the return line when in neutral. This circuit will ensure that even if the multi-way valve is closed suddenly the brake valve can still halt the equipment it controls smoothly and without jerking.

To bypass the braking effect when lifting a load, the connection duplex brake valve is equipped with check (non-return) valves, which are normally set for an opening pressure of 1 bar.

2. Characteristic data

2.1	Nominal diameters (mm)		12	16	20	25
2.2	Nominal flow rates	liters/min at 33 c/St (4,5°E) viscosity	60	100	160	250
	Q_{max}*	liters/min at 33 c/St (4,5°E) viscosity	90	150	240	350
	Connections A, B, A_1, B_1	Inch	R 1/2"	R 3/4"	R 1"	R 1 1/4"
		Metric	M22x1,5	M27x2	M33x2	M42x2

Inch threads are to be preferred

* Allowing for a higer pressure loss, valves are also suitable for higer flow rates (see 'Flow characteristics', 5.1 and 5.2).

2.3 General information

Pattern	Seat valve with hydraulic pilot circuit
Line connections	Threaded unions
Installed position	unrestricted

2.4 Hydraulic parameters

Max. working pressure: Connection: A, A_1, B, B_1 p_{max}= 350 bar

Opening pressure: option of:

Valve opening at feed pressure of:		8	10	15	20	25
Valve fully open:	Nom. dia. 12/16	28	28	33	38	43
	Nom. dia. 20/25	26	28	33	38	43

Also available with other opening characteristics for special applications.

Flow direction: Flow control from A_1 to A and from B_1 to B.

Bypass check valve
Flow resistance Q_o to Q_{nom} app. 1...3 bar (see performance graph 5.3)

Hydraulic press medium: Mineral oil; for other media, please consult manufacturers on account of seals to be used.

Pressure medium temperature range: Min. - 20°C to max. + 70°C; other temperatures on request

Viscosity range: From 2,8 c/St (1,2°E) to 380 c/St (50°E). The above flow data refer to hydraulic fluid with a viscosity of 4,5°E at normal temperature.

Pilto circuit:

Nom. dia. (mm)	Nozzle dia. (mm) LBV	Control system vol. (cm³) - 2x
12	0,3	4,5
16	0,4	
20	0,5	10,6
25	0,6	

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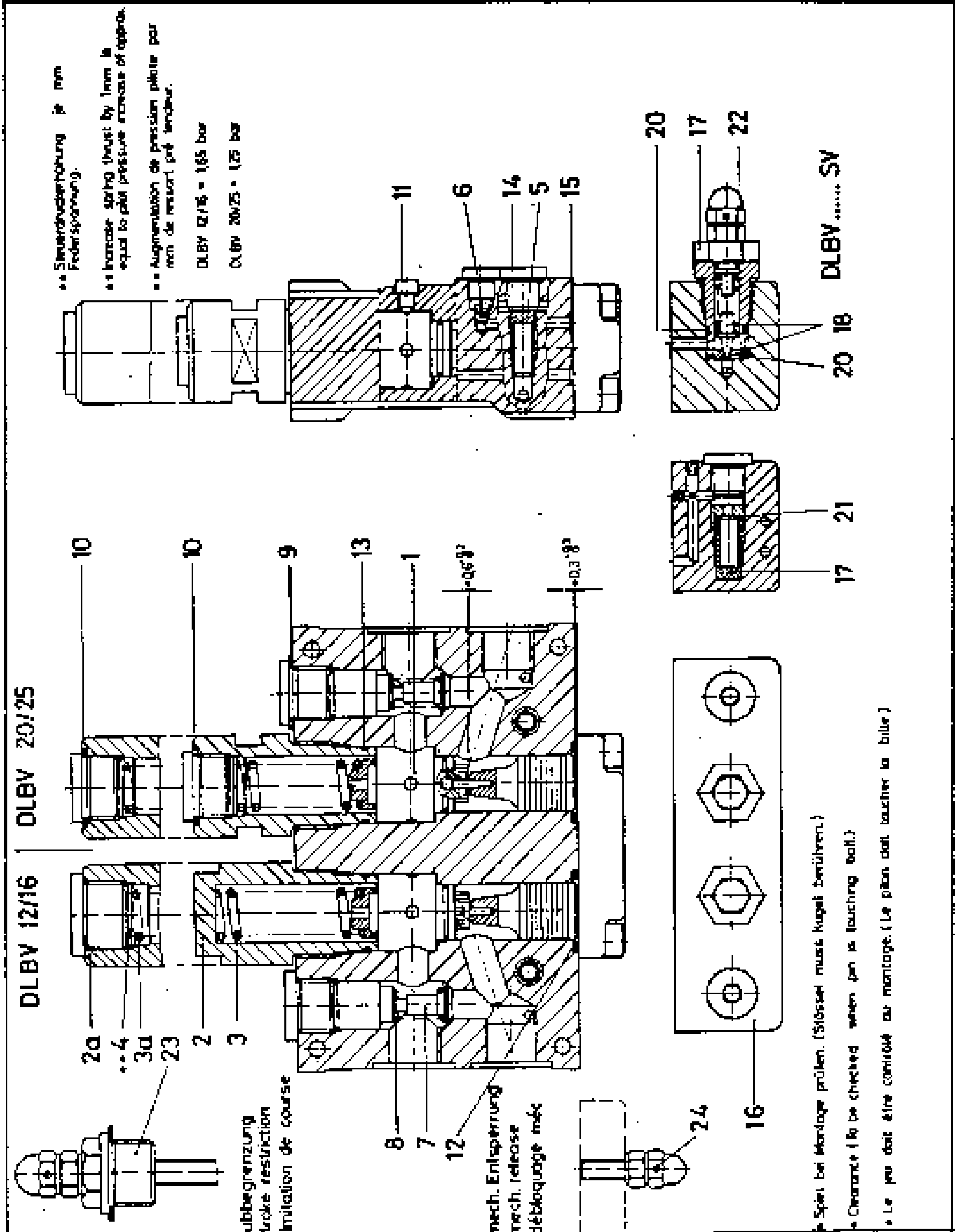
Double brake valve



4.8.05

Spool-pattern multi-way valve

Operating principle	Radial passages enter a housing with a central axial bore at specifically designed intervals, and are provided with external unions for hydraulic lines. The main axial bore contains a spool or plunger with lathe-turned annular oil control grooves. The actuating element (in this case a solenoid or electromagnet) moves the spool to predetermined positions in relation to the passages drilled in the housing, so that the annular grooves either link the passages together or separate and isolate them.
Design features	The unit is straightforward in construction and offers particular advantages where the flow chart is a complex one. The functions can be easily distinguished. Full pressure equalization reduces surface contact pressures and prolongs operating life. In relation to the dimensions of the spool or plunger, the flow cross-sections are large, so that flow resistances are low in relation to the size of the valve. The flow direction can normally be varied and is not governed by the symbol arrows.
Sealing	On account of the annular clearance between the bore wall in the housing and the spool (a few hundredths of a millimeter), there is a constant slight leak-through of oil from the pressurized to the zero-pressure side. Hermetic sealing is possible only with additional equipment (shutoff valves).
Sensitivity to dirt	The large flow cross-sections make the valve relatively insensitive to large dirt particles. However, it is sensitive to micro-particles of suspended dirt, which are trapped in the annular gap together with the leak-through oil and can lead to spool seizure at high pressures.
Permissible working pressures	Depending on design and housing material, 200 – 300 bar. The use of smaller spool sizes and lower pump discharge rates at higher pressures offers few advantages, since the oil leakoff flow means that the percentage of input flow loss can be relatively high.
Use for power hydraulics	The valve is used to supply equipment with a number of actuators (rams) called upon to produce their actuating force primarily during movement; for low to medium pressures and high pump discharge rates.

Seat-pattern multi-way valve

Operating principle	The housing contains one or more valve seats with balls or tapers as the closure components; these are pressed down automatically on to the seats and lifted away from them by plungers. The oil pressure passages lead away ahead of the closure element and after the valve seat in each case. The direction of flow is always from the closure element to the seat side, since this is the only way to control the oil flow (blocked or free passage). In the reverse direction, the check valve action would always be present and flow would continue regardless of the control setting.
Design features	Straightforward, easily followed layout only in the case of 2/2- and 3/2-way valves. More complex flow patterns, for example the 4/3-way valve, are obtained only by means of a complicated construction and major design effort. The flow characteristic is better than with the spool valve, so that despite the reduced valve cross-sections compared with spool valves of the same size, flow resistance is no greater. The directions of flow are pre-determined; pump and consumer equipment must always be connected to the specified unions, or else the control functions will be changed. Overall sizes are limited, since the design cannot be or cannot entirely be relieved of pressure.
Sealing	The contact areas between seat and closure element are ground and lapped for a hermetic seal as required for power hydraulic circuits.
Sensitivity to dirt	Not unduly affected by micro-particle suspended dirt. Larger impurities, however, may become jammed between closure element and seat. However, they are normally only residual material from pipe installation work, and can only penetrate the system if the pipes were not properly cleaned on assembly. In case of doubt, a return-side filter with a particle trap size of 0.06 ... 0.1 mm can be provided to retain such particles. The absence of all clearances makes seizure as on the spool valve impossible.
Permissible working pressures	Depending on design, 400 ... 500 bar.
Use for power hydraulics	2/2- and 3/2-way valves with only one or two valve elements occupy very little space and are superior in terms of relative size to the equivalent spool valves. Since the input flow is normally quite low, and the valves provide a hermetic seal, they are ideal for power-hydraulic applications where leakage would be disadvantageous. In addition, they permit higher operating pressures to be used economically.

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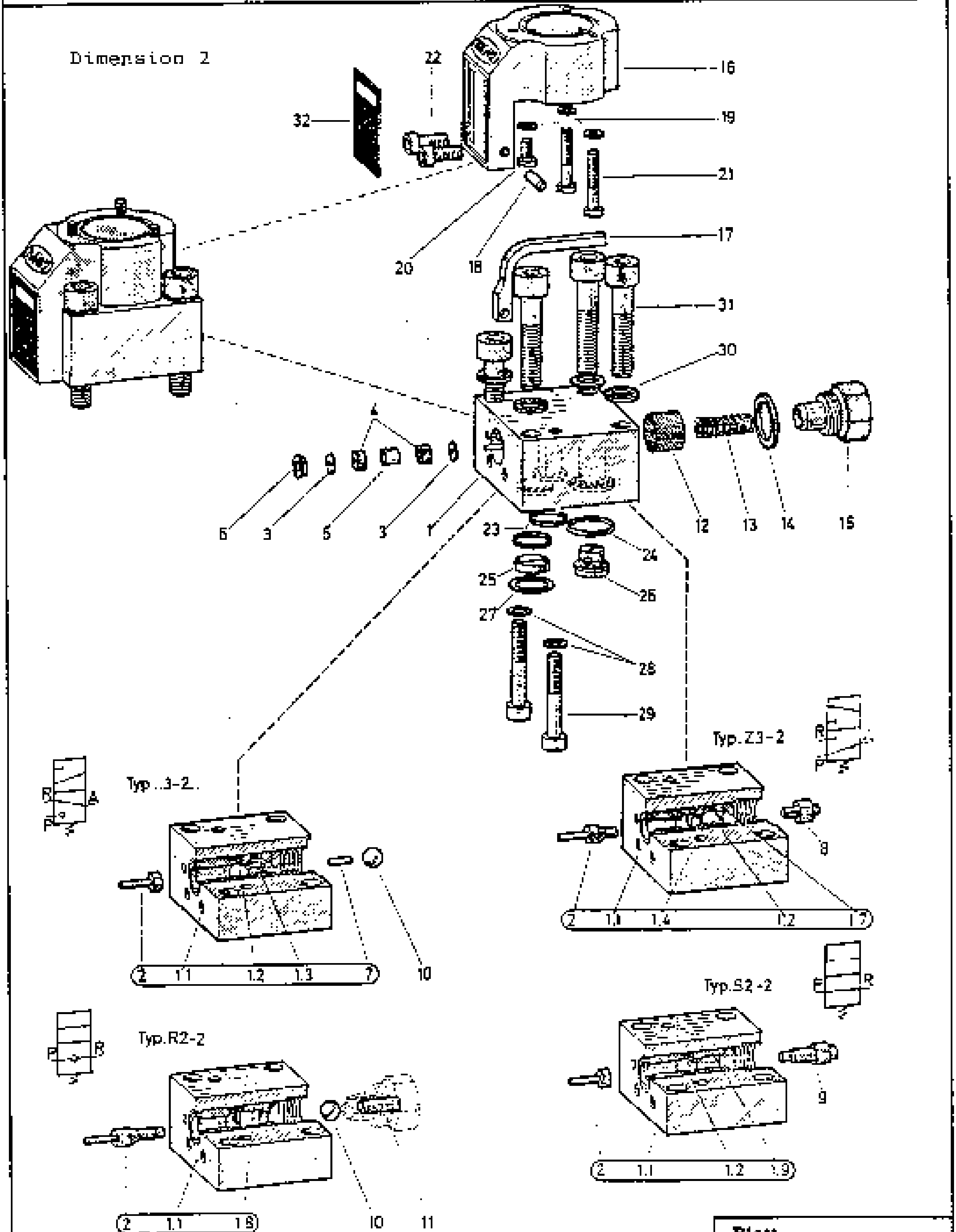
Solenoid valve block

Dimension 2



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4.9.02

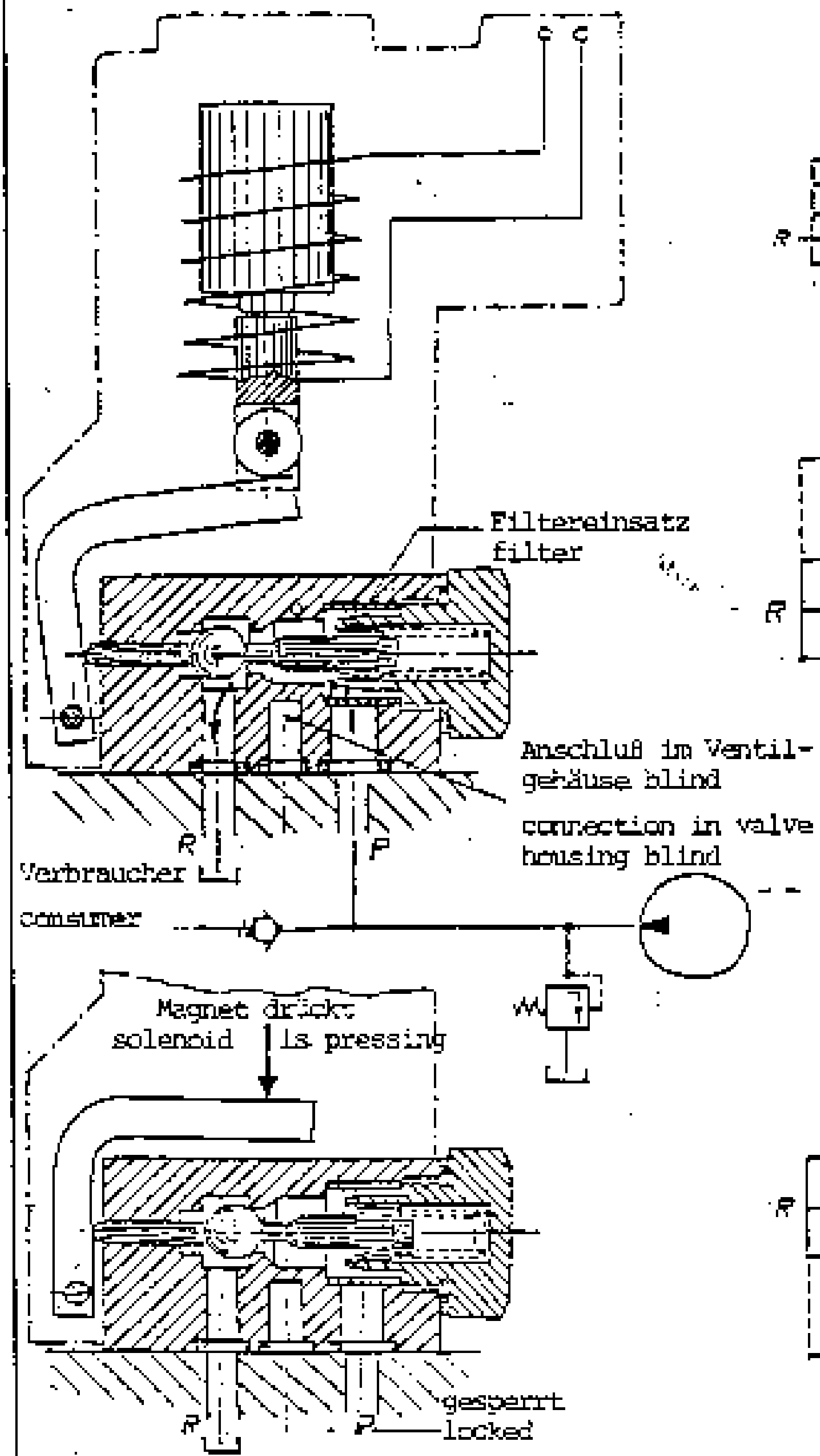
Solenoid valve dimension 2

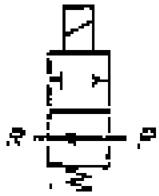
Pos.	designation
1	block complete
2	valve tappet
3	teflon-disc
4	packing ring
5	bush
6	disc
7	bearing needle
8	spring bolt
9	spring bolt
10	ball 8
11	support
12	filter
13	spring
14	soft ivon seal ring
15	locking screw
16	flange for
17	lever DC solenoid
18	INA-bearing needle
19	guarding ring M 4
20	cheese-head screw M 4 x 8
21	cheese-head screw M 4 x 25
22	cheese-head screw M 5 x 12
23	O-ring 10x14,4x2,2
24	O-ring 14x18x2
25	diaphragm
26	non-return valve
27	disc
28	guarding ring M 5
29	cheese head screw M 5 x 35
30	guarding ring M 8
31	cheese-head screw M 8 x 40

4.9.92

Funktionsschema des Magnetventils GS 2-2

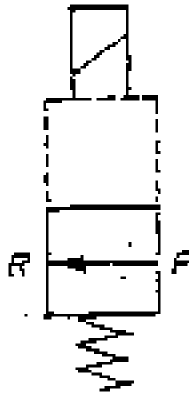
Diagram of solenoid valve GS 2-2





vollständiges Sinnbild

complete principle



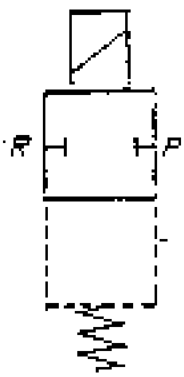
Schalterstellung 0 bei stromlosem Magnet

switch position 0 for currentless solenoid

P frei nach R

P free to R

P	Zulauf	input
R	Ablauf	output



Schalterstellung I Magnet unter Strom

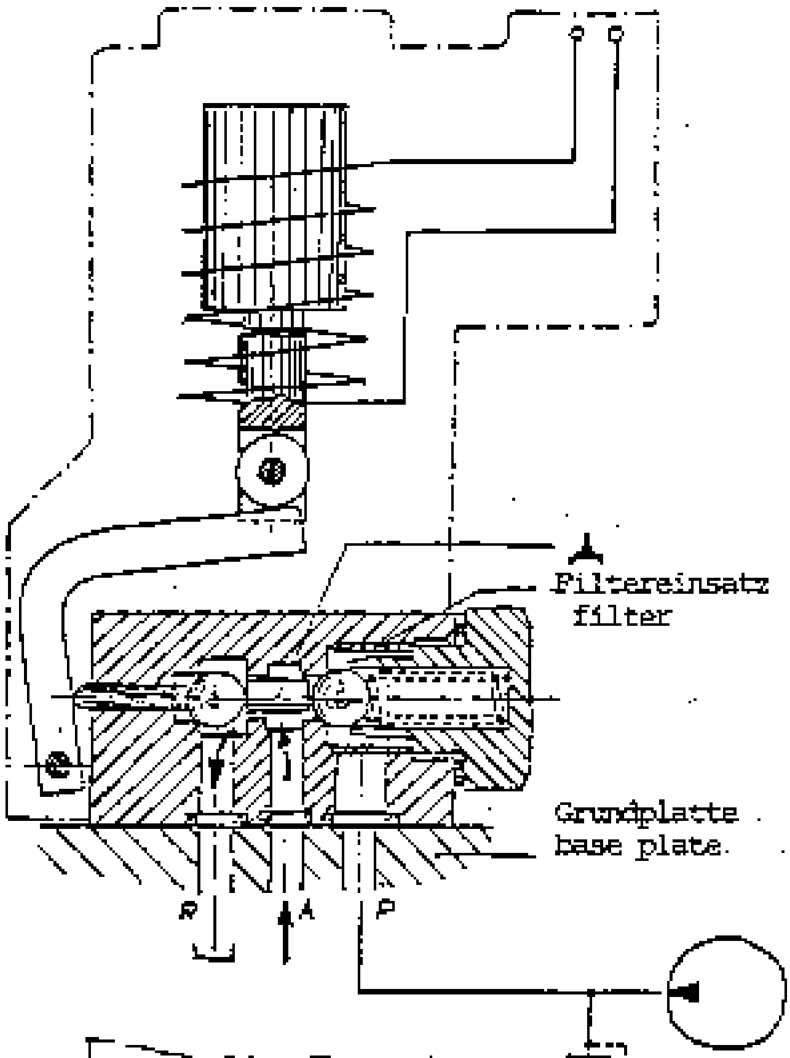
switch position I solenoid is energized

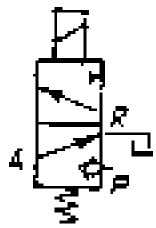
P gegen R gesperrt

P to R locked

Funktionsschema des Magnetventils G 3-2

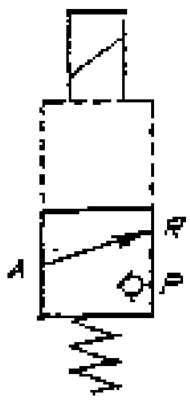
Diagram of solenoid valve G 3-2





vollständiges Sinnbild

complete principle



Schalterstellung 0 bei stromlosem Magnet

switch position 0 for currentless solenoid

P gesperrt

P locked

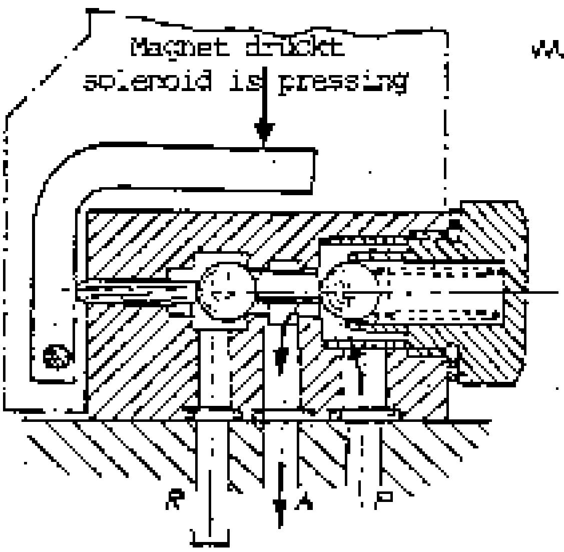
A freier Rücklauf nach R

A free back flow to R

P – Drucköl-Zuleitung
pressure-input

A – Verbraucheranschluß
consumer connection

R – Rückleitung
backline



Schalterstellung I Magnet unter Strom

switch position I solenoid is energized

P freier Durchlauf nach A

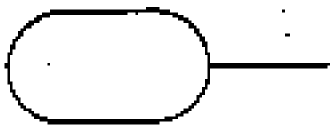
P free to A

R gesperrt

R locked

4.9.03

The pressure storage reservoir is a device to absorb and thus reduce the effects of short-term pressure peaks or losses.



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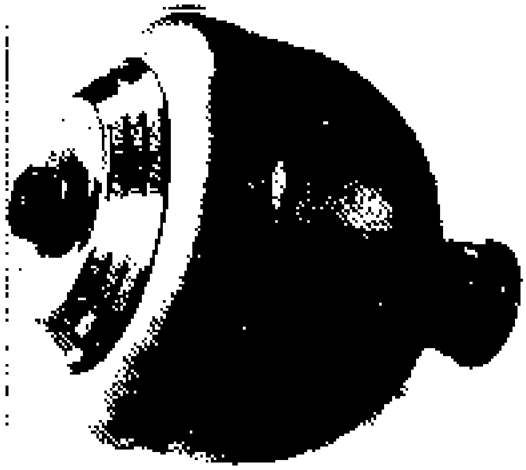


Fig. 1

Operating principle (diaphragm-type pressure storage reservoir):

The gas pressure with which the unit is charged via gas filler 7 causes diaphragm 4 to lie against the lower ball hemisphere 3 (Fig. 2).

If the incoming fluid pressure at pressure medium union 1 exeeds the gas pressure, the gas will be compressed and the diaphragm will lift away from the inner wall of the unit and rise until pressure equilibrium is restored (Fig. 3). As soon as fluid pressure again drops below gas pressure, the diaphragm moves down (the gas expands).

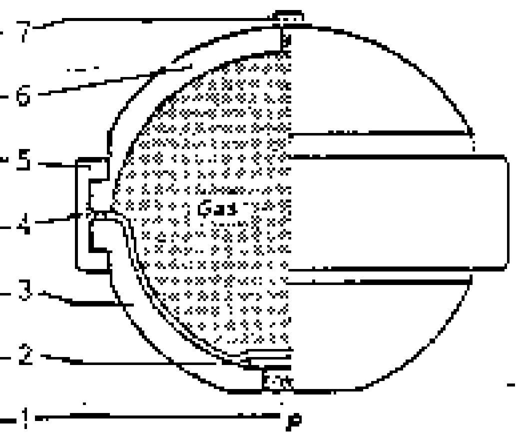


Fig. 2

Sealing plate

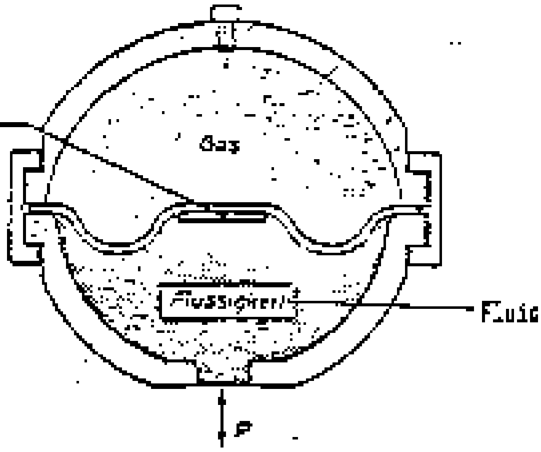
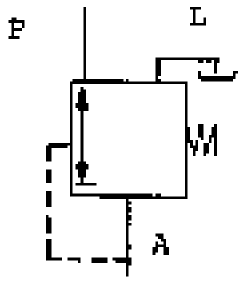


Fig. 3

Sealing plate 2 prevents the diaphragm from being forced out of the reservoir by the gas when fluid pressure = 0 .

The pressure reducing valve is one of the pressure regulating valve group and is intended to bring a high and varying input pressure (e.g. app. 300 bar) to a lower, constant output pressure (e.g. 30 bar).



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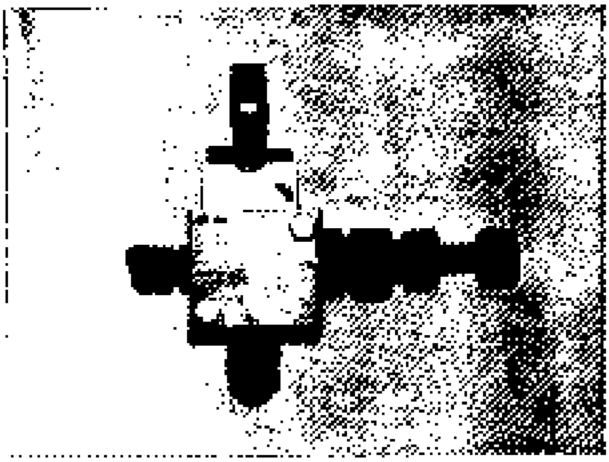


Operating principle:

The main active element in the valve is the piston, which is spring-loaded and forms what is referred to as a pressure balance. The piston is controlled by the flange-mounted initial control valve which is set to the desired output pressure (Fig. 2).

The piston continuously varies the flow cross-section in the main valve in response to changes in input pressure, so that the restrictor resistance rises and falls by the same amount as the input pressure increases or drops. This makes the difference between input pressure and restrictor resistance constant, and thus regulates the output pressure to a constant value too.

The control circuit oil flow needed for regulating movement of the piston is discharged as a leak-off flow externally, via the initial control valve.

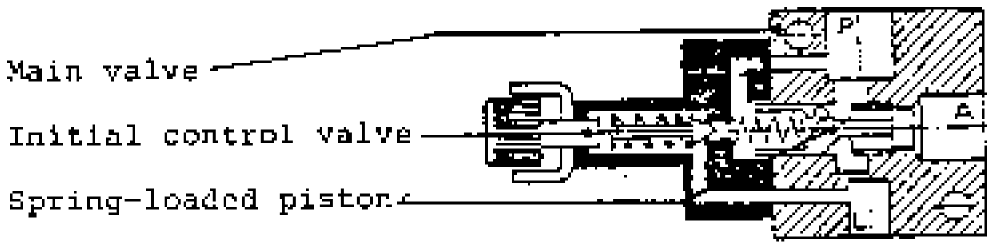


Fig. 2

Selecting output pressure at pressure reducing valve

1. Remove the screw plug.
2. Set the initial pressure valve to the desired output pressure with a screwdriver (Fig. 3).
3. Replace and tighten the screw plug.

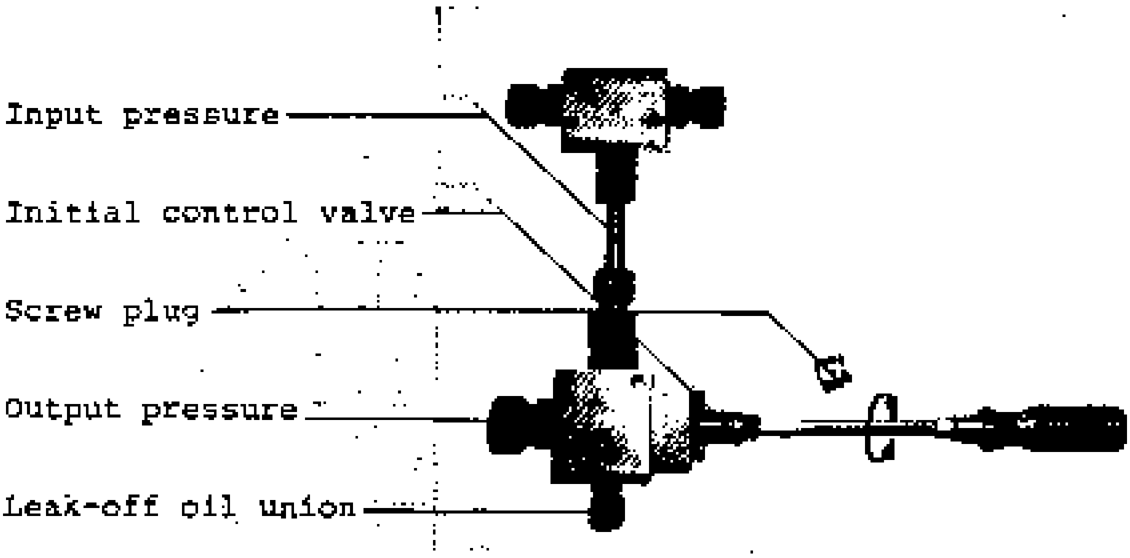
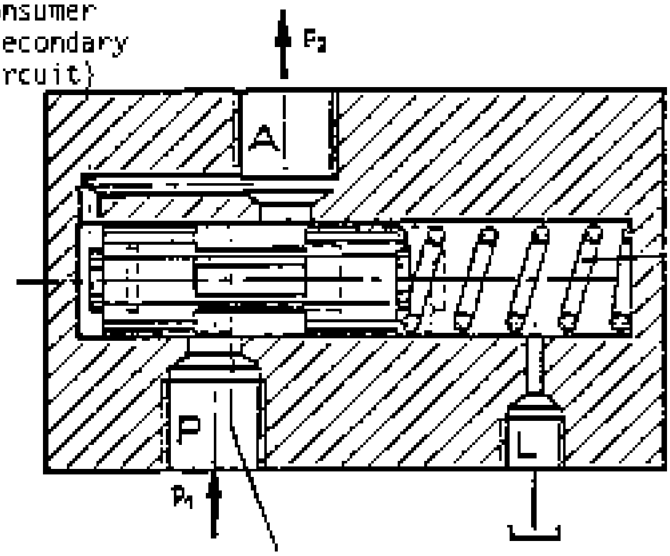


Fig. 3

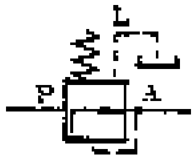
Operating schematics of pressure reducing valves

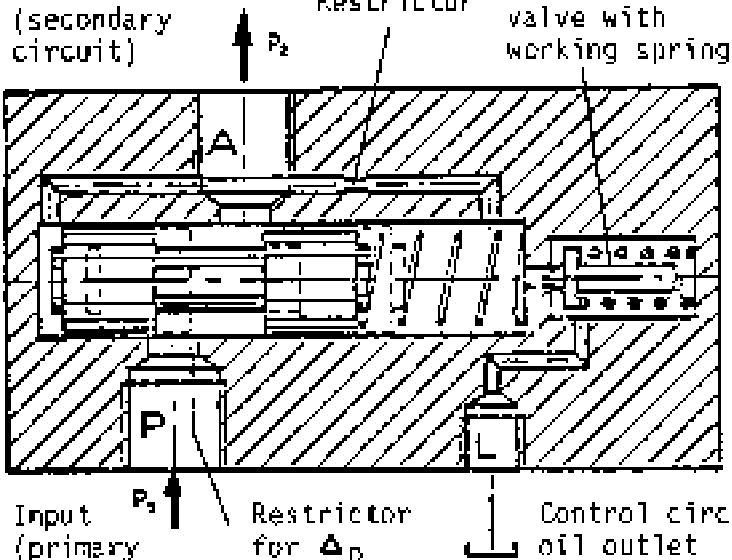


Direct-controlled unit

Pressure in the system displaces the control piston continuously until the working position (shown in broken lines) is reached

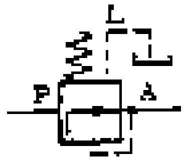
Actuating spring: its preload in the plunger working position governs p_2

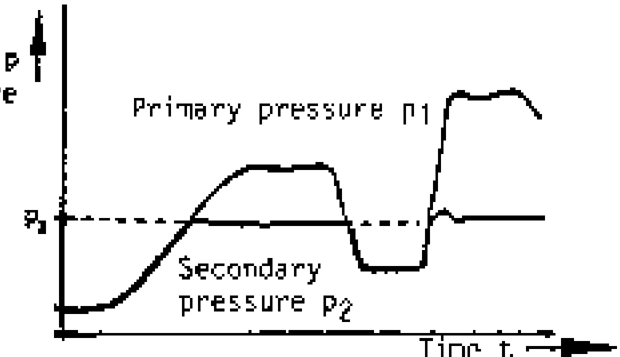




Pilot-controlled unit

Pressure in the system displaces the control piston to the working position (broken lines) when the pilot valve opens on reaching p_2



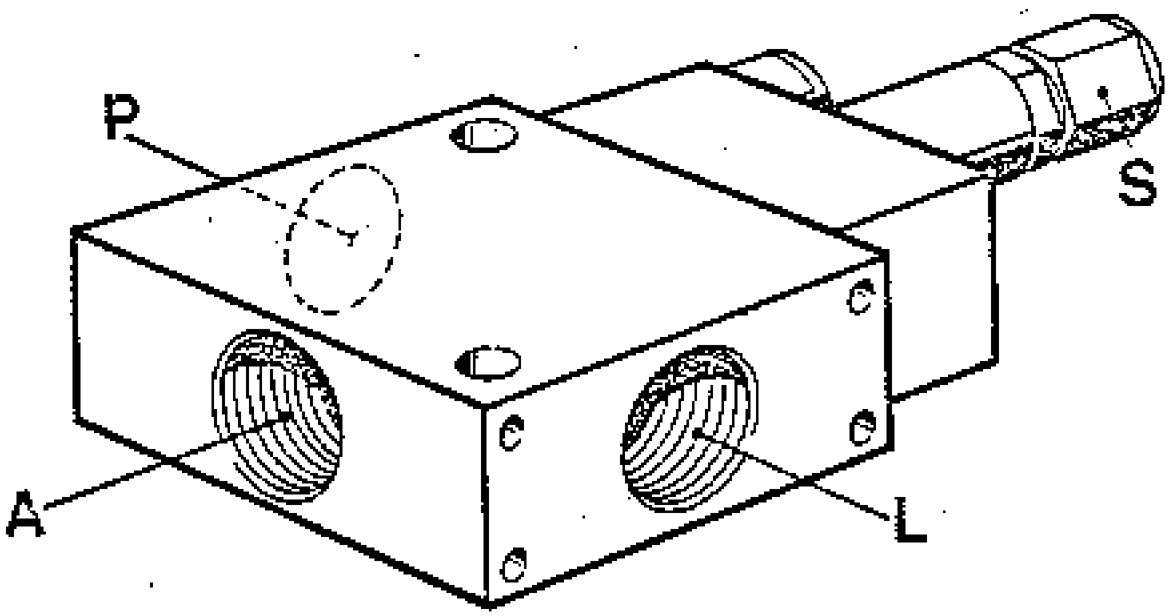


Static pressure equilibrium

$p_2 = p_1 - \Delta p$

p is the variable pressure drop occurring with the spool in working position as a result of continual variation in the inlet cross-section in response to primary pressure p_1 so that $p_2 = p_1 - \Delta p$ = const as long as $p_1 > p_2$.

Pressure reducing valve



A = Union for working pressure (control pressure)
P = Union for pump pressure
L = Leak-off oil union
S = Adjusting screw with cap

1. Possible malfunctions

a) Out of adjustment
b) Valve plunger sticking
c) Leakage

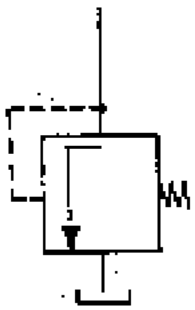
2. Troubleshooting

a) Too low or too high working pressure (control pressure)
b) Loss of working pressure (control pressure)
c) Visual inspection

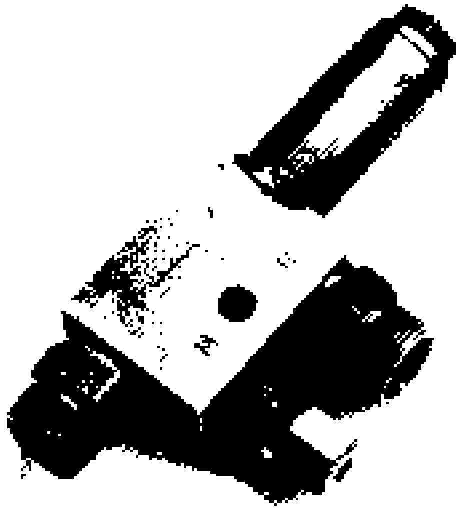
3. Remedial action

a) Re-adjust
b) Remachine plunger or exchange valve
c) Repair seals, exchange if necessary

The pressure limiting valve is included in the pressure regulating valve category. It is used to maintain pressure in a branch of the circuit at a preset constant value.



Symbol



Operating principle:

The pressure limiting valve consists of a cone moving against the force exerted by a spring (Fig. 2).

In normal operating circumstances, working pressure in the branch of the circuit protected by the pressure limiting valve ≤ spring force.

If hydraulic pressure builds up sufficiently to overcome spring loading, the cone lifts away from its seat and allows the oil to flow out at R until the working pressure has dropped to the valve's closure setting.

On most pressure limiting valves the spring preload can be varied, so that the valve's opening point can be raised or lowered within given pressure limits.

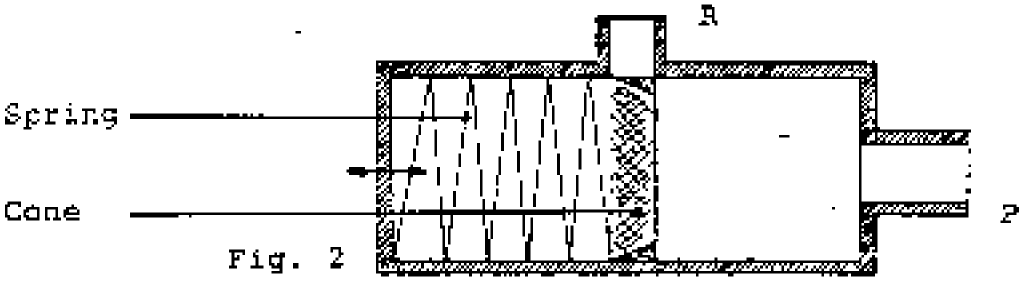
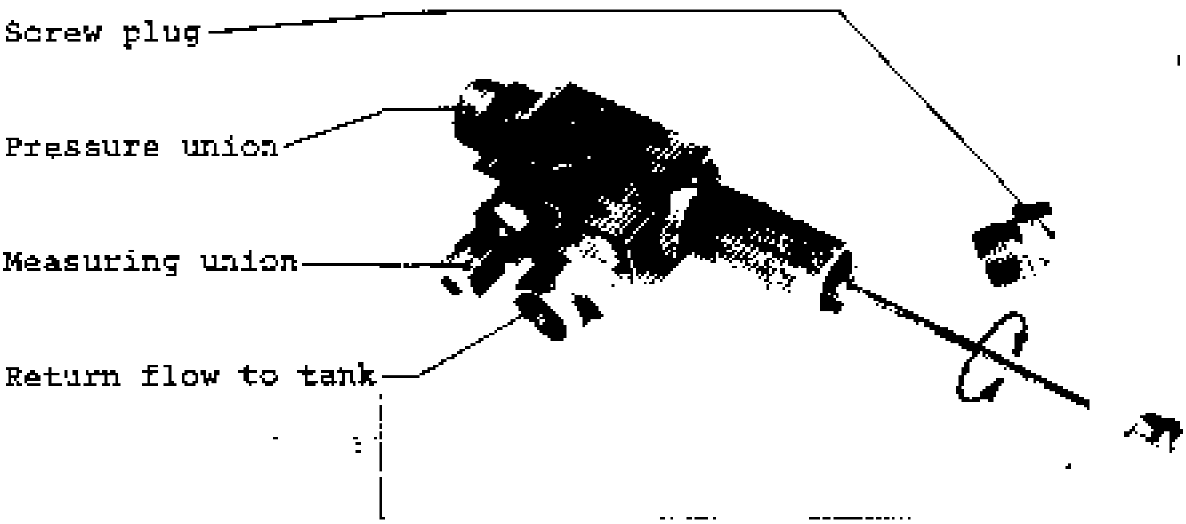


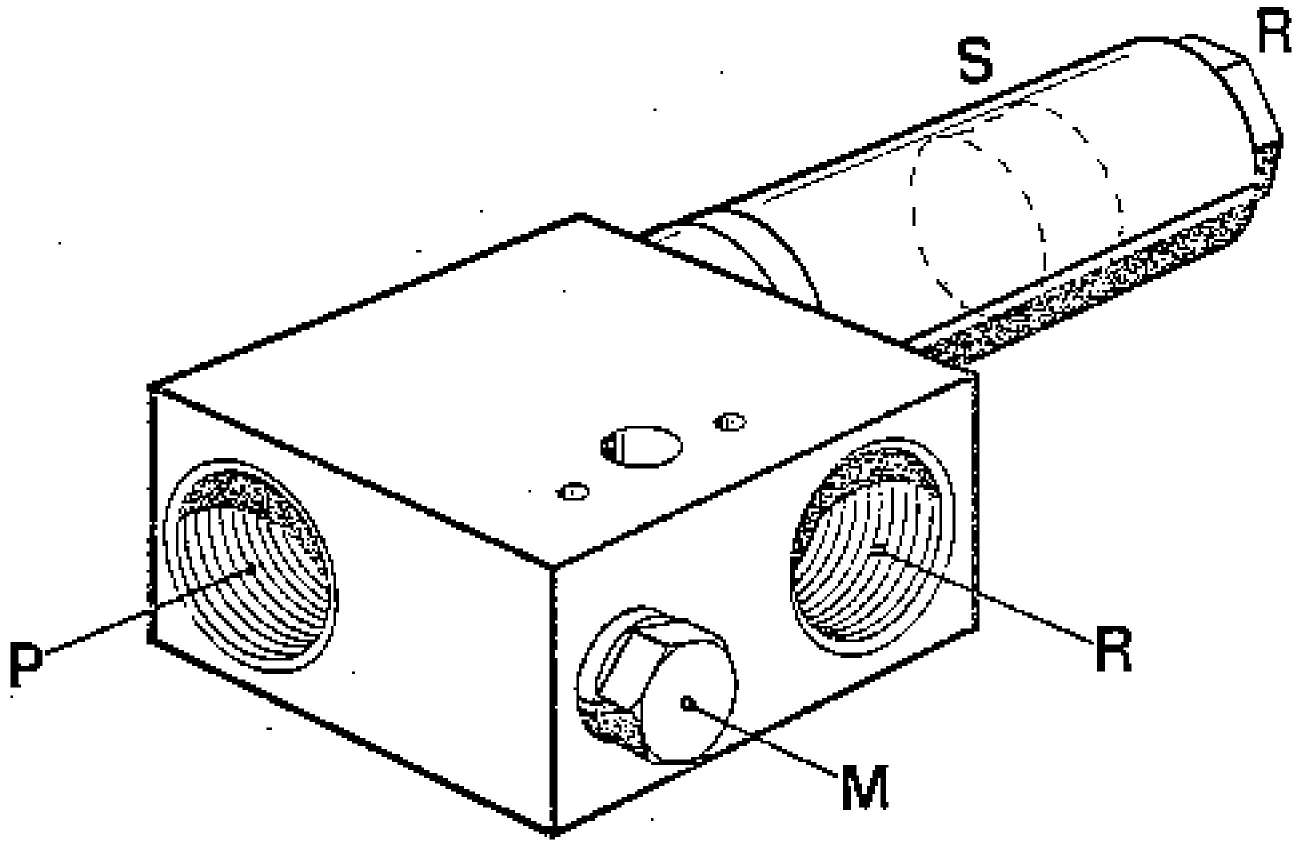
Fig. 2

Resetting blow-off pressure at the pressure limiting valve

1. Remove the screw plug.
2. Set the desired blow-off pressure with a screw-driver.
3. Replace and tighten the screw plug.



Pressure relief valve



P = Pump ressure union
R = Return line union
M = Measuring union
R'= Screw plug
S = Adjusting screw

1. Possible causes of faults

   a. Broken spring

2. Locating faults

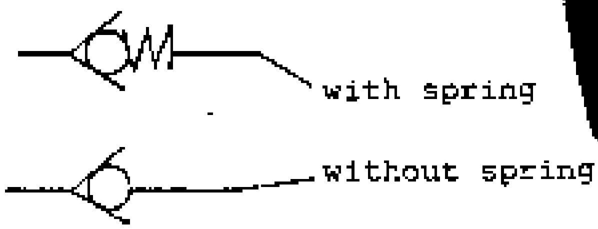
   a. Measure pressure directly at valve.

3. Eliminating faults

   a. Renew the valve

4.9.08

The non-return or check valve is one of the family of blocking or inhibiting valves. It permits the oil flow to pass in one direction only. The pass direction is shown by an arrow. The opening pressure varies according to valve type between 0.5 and 3 bars.



Operating principle:

The main active component is a ball or cone which is spring-loaded against a seat (Fig. 2). Versions without a spring are also used.

If the input pressure at A is greater than the force exerted by the spring, the ball or cone is lifted away from its seat and allows the oil to flow from A to B. If the pressure ratio between A and B then changes, the ball or cone will be pressed back against its seat by the oil and the spring, and will prevent oil flow from B to A.

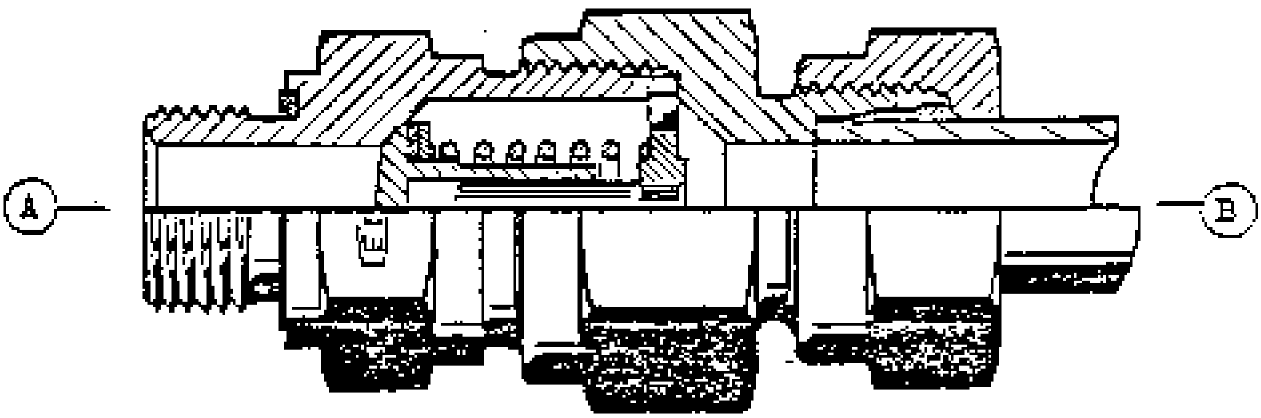
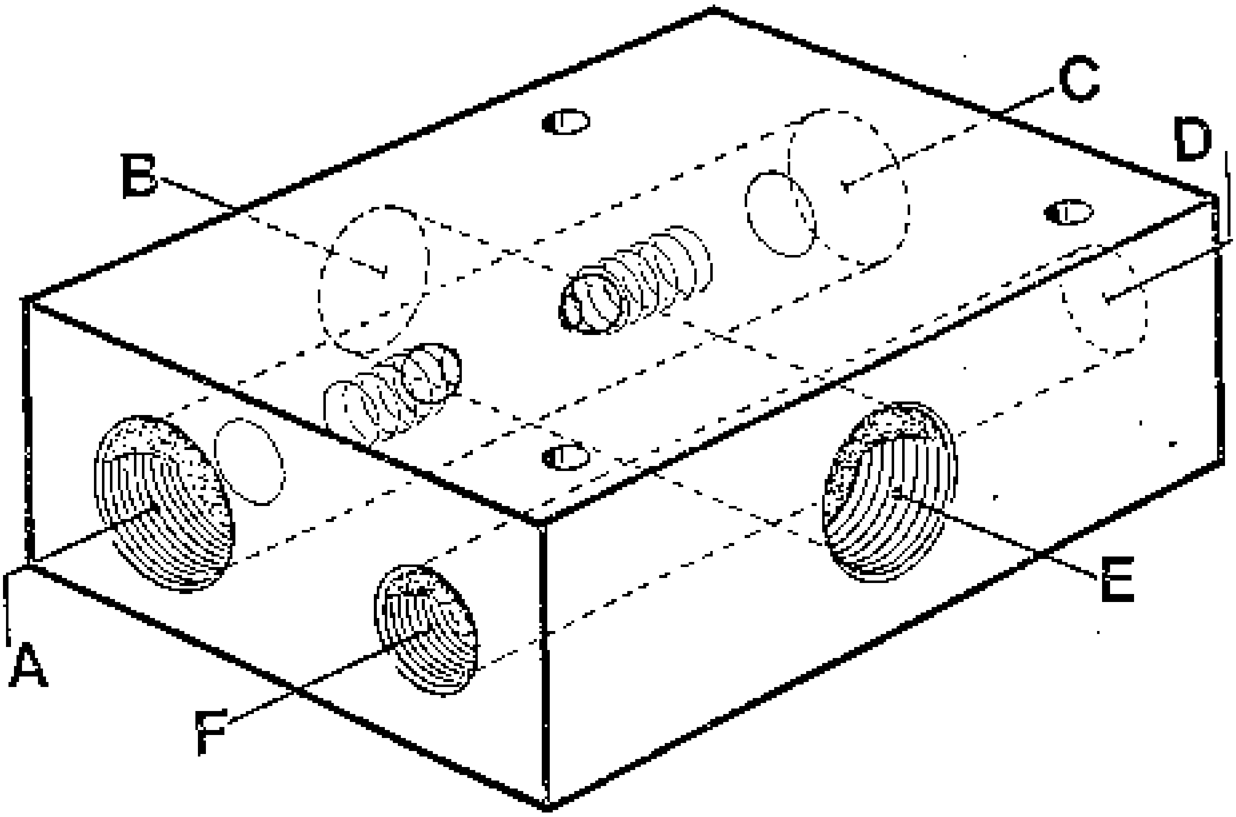
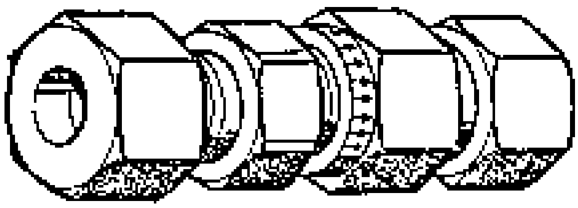


Fig. 2



B/D/F/E = Return connections from manual control valves
A = Return connection to tank
C = Feed connection (level restoring) - lowering hoisting gear
From C to A after B/D/F/E = no flow

Level restoring flow possible in direction of arrows
Valve blocked in opposite direction - no flow



1. Possible causes of faults

   a. Leaking check valve

   b. Broken spring

2. Locating faults

   a. Pressure loss

   b. No back pressure (pressure retention)

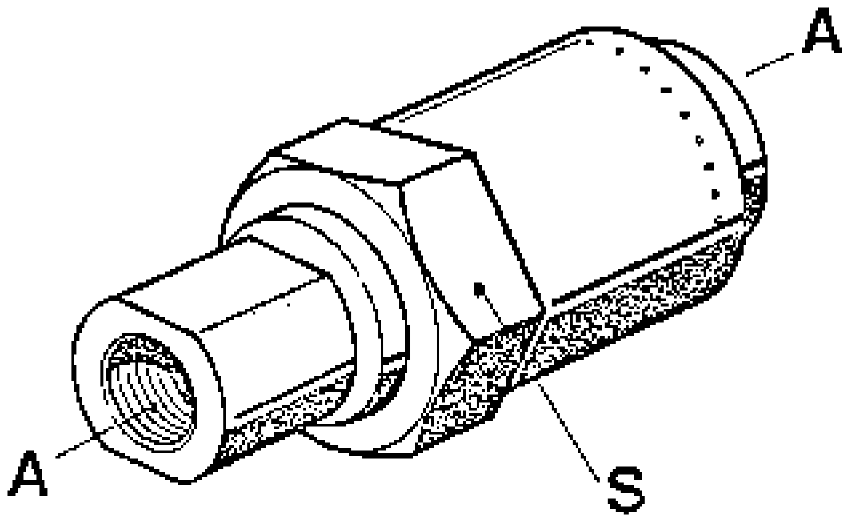
3. Eliminating faults

   a. Grind in the check valves or renew if necessary

   b. Renew spring or complete valve if necessary

LIEBHERR

Variable restrictor valve



A = Input / output
S = Adjusting screw

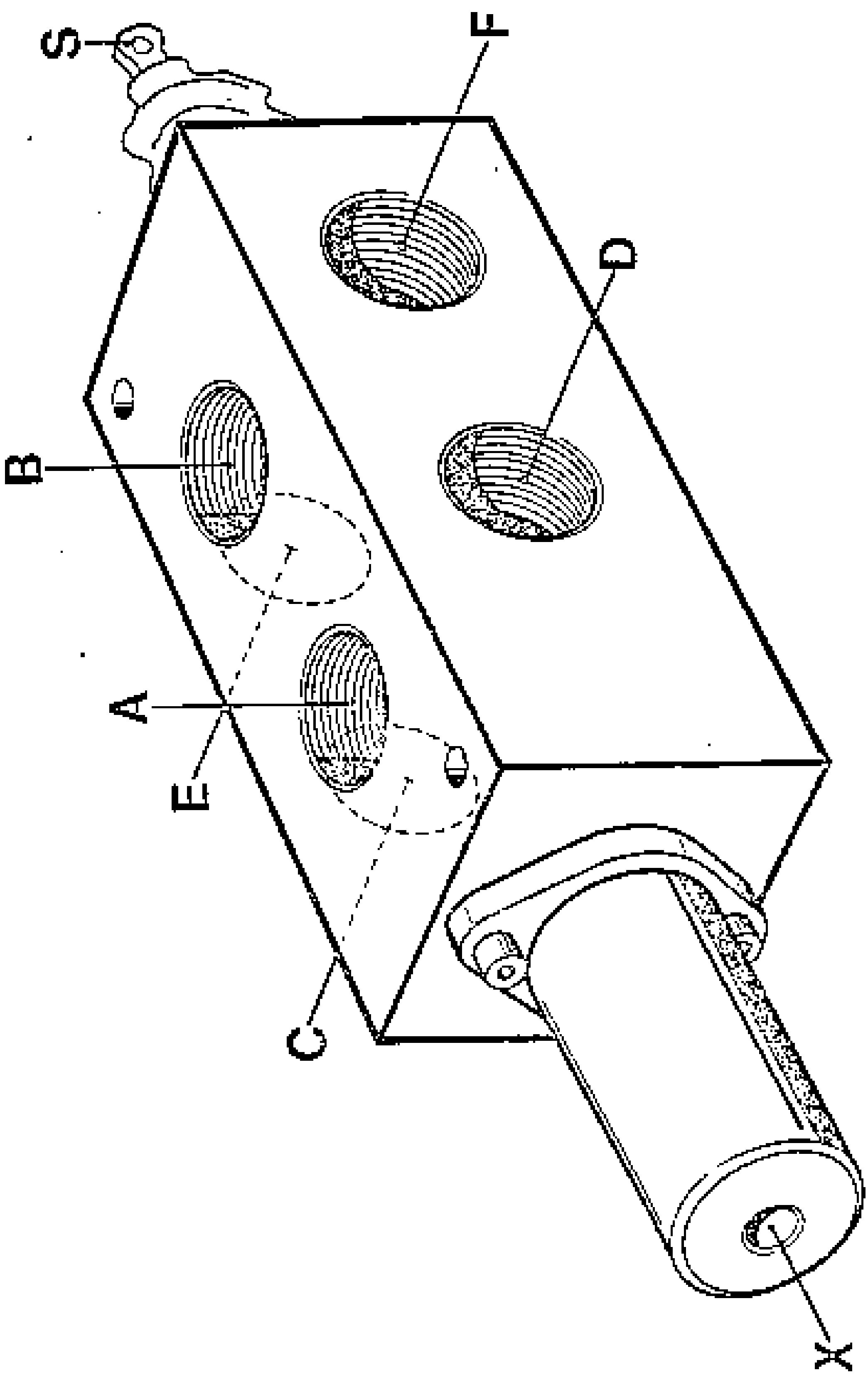
1. Possible causes of faults
   a. Restrictor blocked, or
   b. Restrictor setting incorrect

2. Locating faults
   a. No pressure downstream from restrictor
   b. Too low or too high pressure downstream from restrictor

3. Eliminating faults
   a. Clean or renew the restrictor
   b. Adjust restrictor to correct setting

LIEBHERR

Changeover valve



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A/B = Working pressure union – from manual control valve

D/F = Working pressure union - for telescoping

C/E = Working pressure union - for luffing

X = Control pressure union

S = Emergency manual control

1. Possible causes of faults

   a. No control pressure present

   b. Valve jammed (prevented from moving mechanically)

2. Locating faults

   a. Measure pressure as in HMTO/2

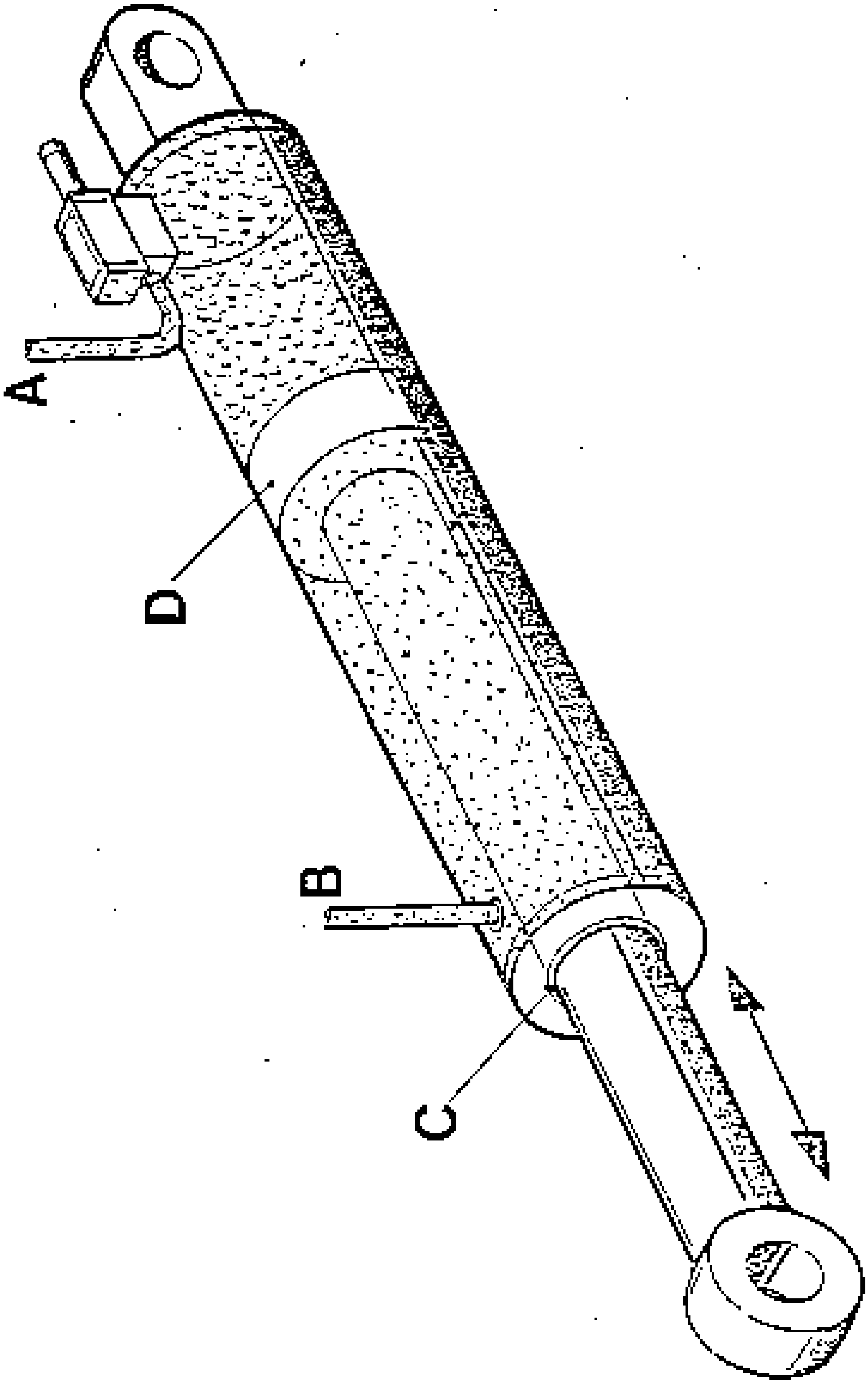
   b. As a.

3. Eliminating faults

   a. Renew the valve

   b. As a.

Luffing ram



A = Connection to piston face (topping boom)
B = Connection to ring face (below piston) (lowering boom)
C = Piston rod seal
D = Piston with seal

Hydraulic cylinders

1. Possible causes of faults

a. Defective piston seal or worn cylinder barrel

b. Defective piston rod seal

2. Locating faults

a. Piston retracts by itself, without movement being selected

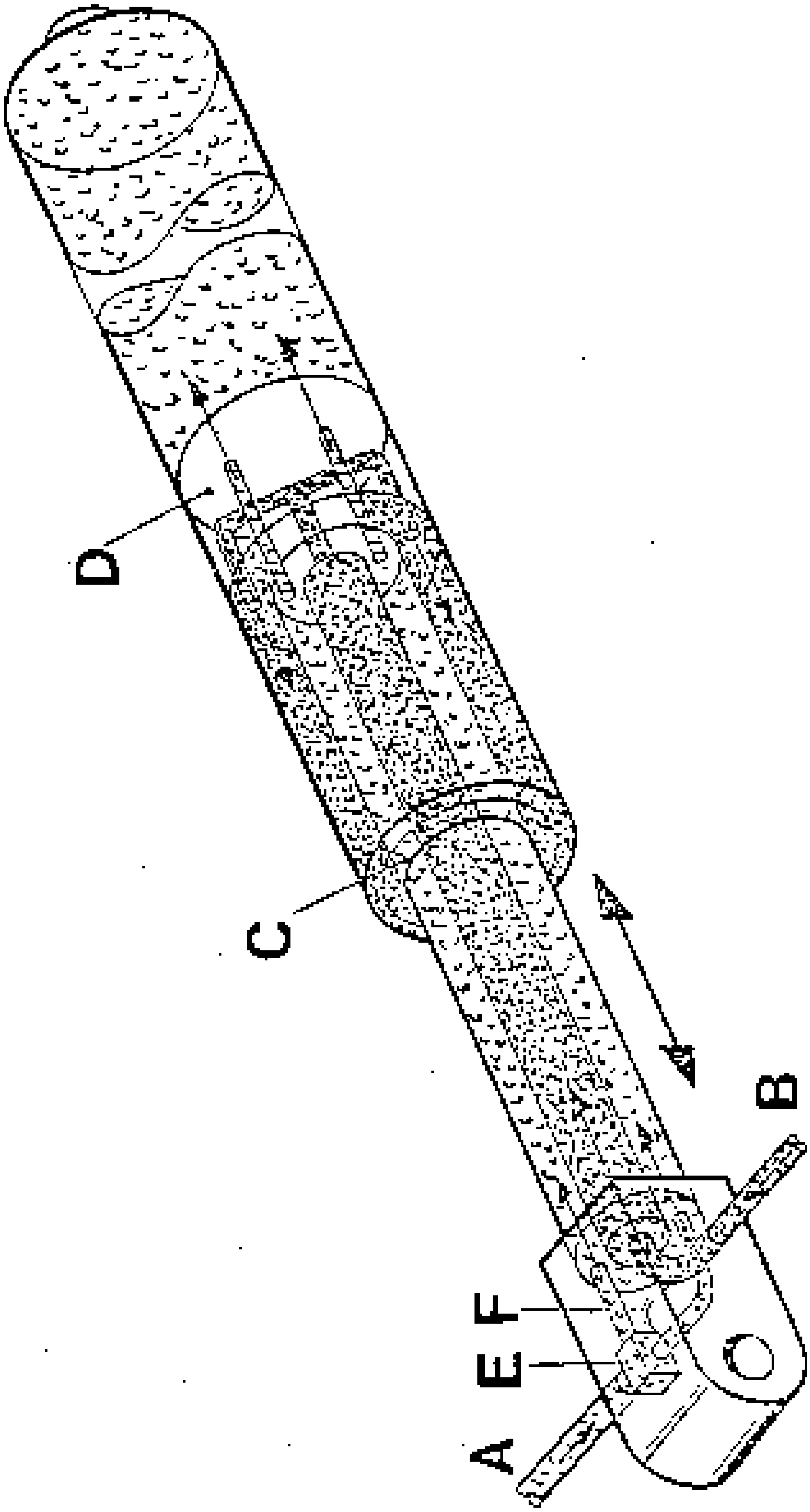
b. External leaks at the point where the piston rod emerges.

3. Eliminating faults

a. In most cases it is good practice to renew the complete ram.

b. See a.

Telescoping ram



A = Connection to piston face (extending boom)
B = Connection to ring face (retracting boom)
C = Piston rod seal
D = Piston with seal
E = Lowering brake valve, integrated into ram head
F = Control passage, for releasing the lowering brake

LIEBHERR

General circuit elements

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Resistor		= or	= or	= or
with tappings		=	=	=
Winding, inductor				= or
with tappings				= or
Capacitor				= or
with tappings				=
Polarized electrolytic capacitor				=
Permanent magnet		=	PM	=
Accumulator cell, battery (long line = positive pole)			=	=
Earth (ground)		=	=	=
Frame or chassis				
Variable in operating state		= = =	= = =	= = =
/ = continuous ⁄ = stepwise Variable for test (pre-set adjustment)		= = =	= = =	= = =
Variable under the influence of a physical quantity		= =	= =	= =
Spark gap				
Surge diverter general			or	=

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Symbol for arc-over or point of insulation breakdown				=
Thermocouple		=		=
Clock				
Converter, transmitter		=		=
Amplifier, general symbol				=
Single-phase, bridge-connected rectifier				
Fuse	or	= or = or	= or or	= or =
Plug and socket device		=		= or
Filament lamp				=
Discharge lamp				

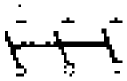
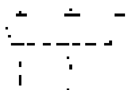
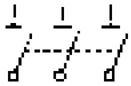
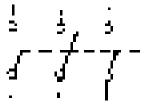
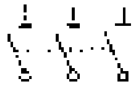
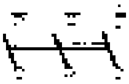
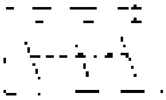
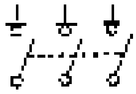
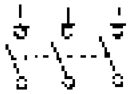
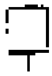
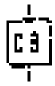
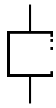
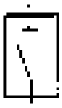
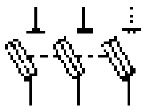
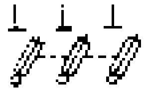
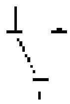
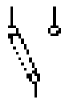
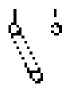
Operating mechanism

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US-CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Manual operating mechanism	old new	new		new
Foot operated mechanism	old new			
Cam operated mechanism	old new		annotated with "cam"	
Pneumatic operating mechanism	old new		PNC	new
Power operating mechanism	old new	new		new
Motor operated mechanism	M old M new		MO	new
Switching mechanism	old new		SW MECH	
Operating element with automatic return on discontinuation of actuating force for contactors, relays, etc.			or or	
Operating coil energized (The arrow denotes the operating state. This deviates from the standard representation)				
Relays with two coils acting unidirectionally	or / or / or			

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Time delay for electro-mechanic operating elements magnetic drop-out delay		or	= or SR or SR	= or
delayed pick up		or	= or SD	= or
delayed pick-up and drop out			= or SA	=
Polarized relay		P	or P	P or =
Remanence relay				or =
Resonance relay		=	or	=
Latching device		latching unlatching		=
Notch	old new		*	=
Device for time delayed operation following actuating force to right	old new		TC or TDC TO or TDO	=
Device for cyclic actuation	old new		*	
			* with annotation	

Switchgear

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US-CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Make contact (NO)	old new	or	or or	or or or
Break contact (NC)	old new	or	or or	or or or
Change-over contact	old new	or	or or or or	or
Change-over contact make-before-break	old new	or	or	or
Time-delayed contacts:				
make, delayed make	old new		TC or TDC	
break, delayed break	old new		TO or TDO	
make, delayed break	old new		TO or TDO	
break, delayed make	old new		TC or TDC	
Contactor	old new			
Three-pole circuit breaker, e.g. a circuit breaker fitted with 3 thermal overcurrent relays and 3 electromagnetic overcurrent relays	old new		or	

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Triple pole isolator	 old  new			
Triple-pole load-break switch	 old  new			
Circuit breaker		 or  or  or 	 or 	  
Isolating circuit breaker				
Isolating fuse				=
Triple-pole fused isolator				=
Isolating link, change-over type				

Switchgear

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Single throw switch manually operated	old new			
Momentary or spring return switches manually operated with 1 NO contact	old new			
with 1 NC contact	old new			
foot operated	old new			
cam operated	old new			
flow speed actuated	old new			
pressure actuated	old new			
temperature actuated	old new			
liquid level actuated	old new			
over/under flow speed	v> / v<			
over/under pressure	p> / p<		P / P	
over/under temperature	ϑ> / ϑ<			
over/under liquid level			L	
over/under speed	n> / n<		SP / SP	
Examples: Momentary switch opens at overspeed	old new		SP	
Momentary switch closes at under temperature	old new			

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Valves (tubes), semiconductor elements

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US-CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Electronic valve, diode		=		=
Electronic valve, triode				=
Single-anode rectifier vessel with mercury cathode (ignitron)		=	=	=
Semiconductor diode	old new	or	or	= =
Limiting diode	old new			
Transistor	pnp npn	= =	= =	= =
Thyristor, general symbol	old new			=
Photo-resistor, bidirectional				
Photo-resistor unidirectional				
Photo-electric cell				
Hall generator				

Voltage, current, frequency

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Direct current	—	=	DC	=
Alternating current	~	=	AC	=
Direct or alternating current (universal)	≂	=		=
Undulating or rectified current		=	=	=
Audio frequencies	≈	=	=	=
Super audio, carrier and radio frequencies	≋	≋	=	≋
Superhigh frequencies				
Square wave pulse positive negative		= =		
Single-phase A.C. e.g. 16 2/3 Hz	1 ~ 16 2/3 Hz	1 ~ 16 2/3 c/s	1 PHASE - 2 WIRE - 16 2/3 CYCLE	1 ~ 16 2/3 Hz 1 ~ 16 2/3 c/s
3-phase A.C.	3 ~ 50 Hz 380 V	3 ~ 50 c/s 380 V	3 PHASE - 3 WIRE - 50 CYCLE - 380 V	=
3-phase A.C. with neutral	3/Mp ~ 50 Hz 380 V		3 PHASE - 4 WIRE - 50 CYCLE - 380 V	3N ~ 50 Hz 380V 3N ~ 50 c/s 380 V
2-conductor D.C.	2-220 V		2 WIRE DC 220 V	=
2-conductor D.C. with neutral	2/Mp - 220 V		3 WIRE DC, 220 V	2 N - 220 V

Tripping devices

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Thermal overload tripping device	or	=	or	=
Magnetic overcurrent tripping device	or			
Undervoltage tripping device	or			
Open-circuit shunt trip coil	or			

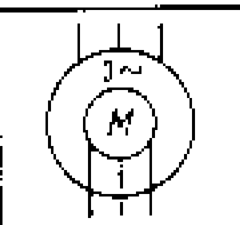
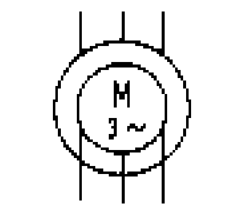
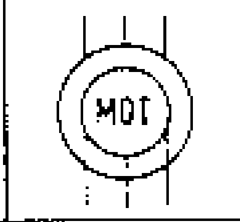
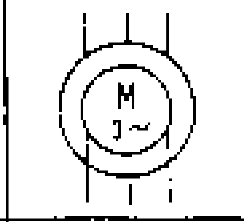
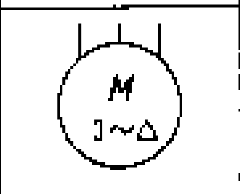
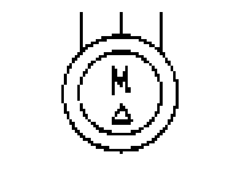
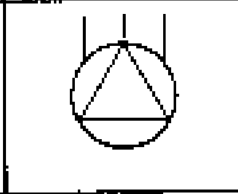
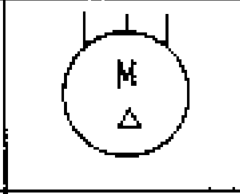
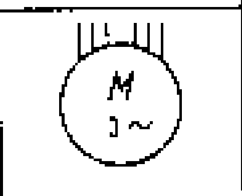
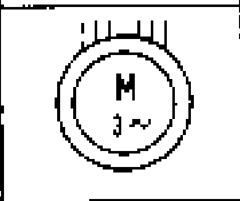
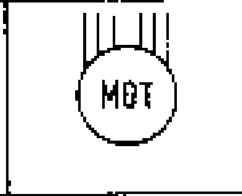
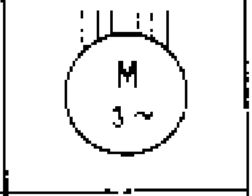
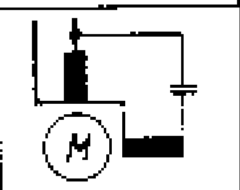
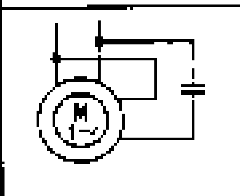
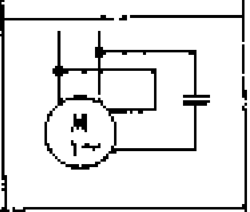
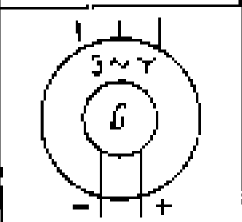
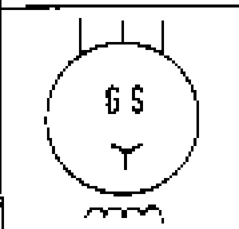
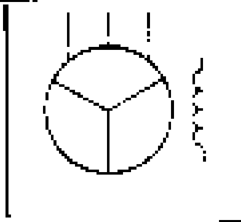
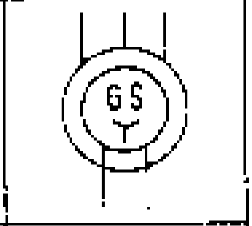
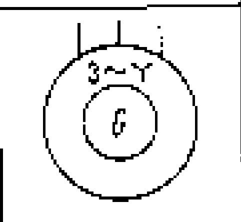
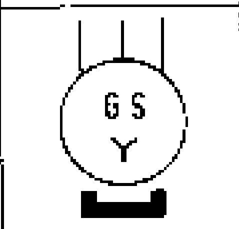
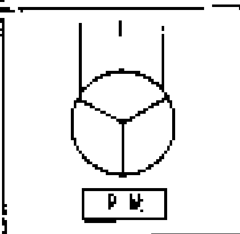
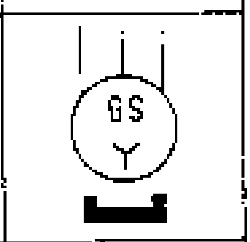
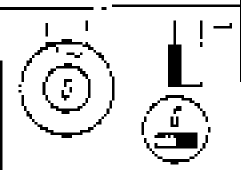
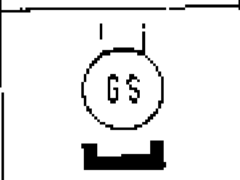
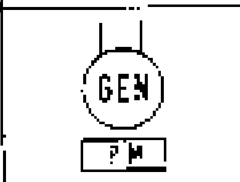
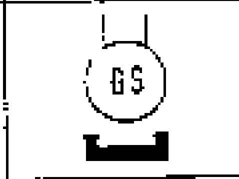
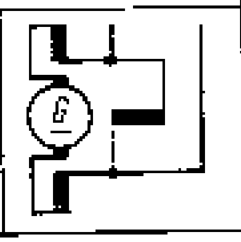
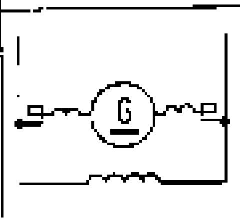
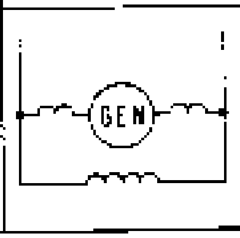
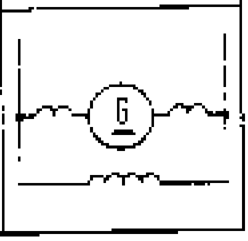
Instruments and meters

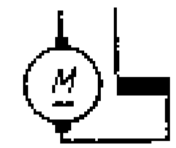
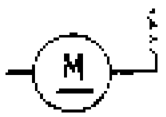
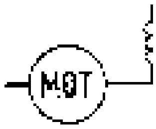
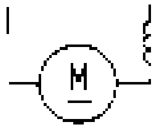
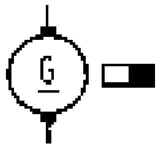
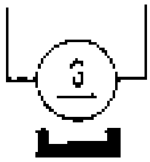
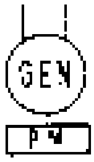
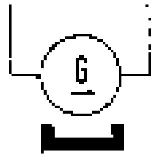
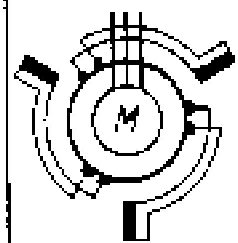
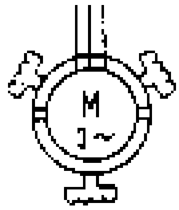
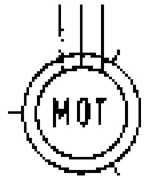
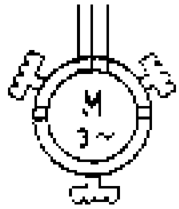
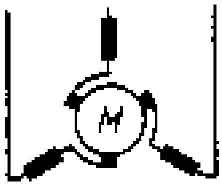
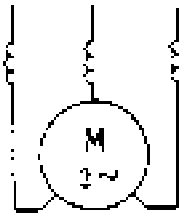
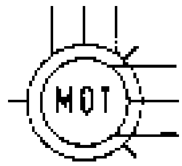
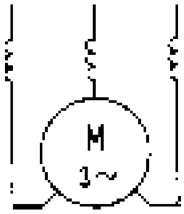
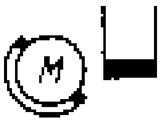
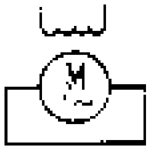
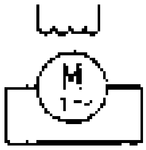
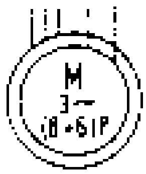
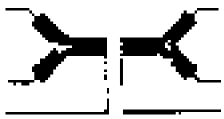
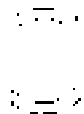
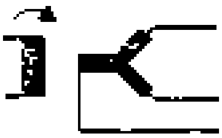
DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Ammeter		=	=	=
Voltmeter		=	=	=
Double voltmeter				
Single-phase A.C. watthour meter				
Single-phase A.C. watthour recorder				
Instrument shunt				

Acoustic and visual signalling devices

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Horn				
Bell		=		=
Siren		=		=
Buzzer				
Pilot light, signalling light		=		=
Semaphore indicator				
Drop annunciator – make contact actuated by the actuating system				
– make contact actuated by the target				

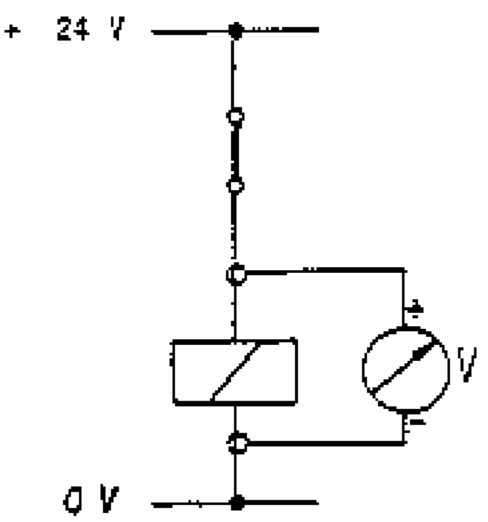
Rotating machines

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
Three-phase induction motor with slipring rotor				
Three-phase induction motor with squirrel cage rotor				
Three-phase induction motor with squirrel cage rotor all six winding ends brought out				
Single-phase induction motor with squirrel cage rotor with starting winding in stator with capacitor				
Three-phase synchronous generator				
Three-phase synchronous generator with permanent magnet excitation				
Single-phase synchronous generator with permanent magnet excitation				
D.C. generator compensating and interpole windings arranged in symmetry with the armature				

DESCRIPTION	GERMAN SYMBOLS	BRITISH SYMBOLS	US/CANADIAN SYMBOLS	INTERNATIONAL SYMBOLS
D.C. series-wound motor				
D.C. generator with permanent magnet excitation				
Three-phase commutator motor with shunt characteristics				
Three-phase commutator motor with series characteristics				
Repulsion motor				
Change-pole squirrel-cage induction motor with 2 separate windings for pole changing from 8 to 6 poles				
Differential synchro (transmitter or receiver)				
Synchro, rotor single-phase stator three-phase				

1. Voltage measurement

To measure voltage, the meter is wired in parallel with the item of equipment to be measured (Fig. 1). Make sure that the polarity is correct. Connect the red measuring lead to (+) and the black lead to (-). Set the polarity reversing switch (if provided) to (+) (Fig. 2).



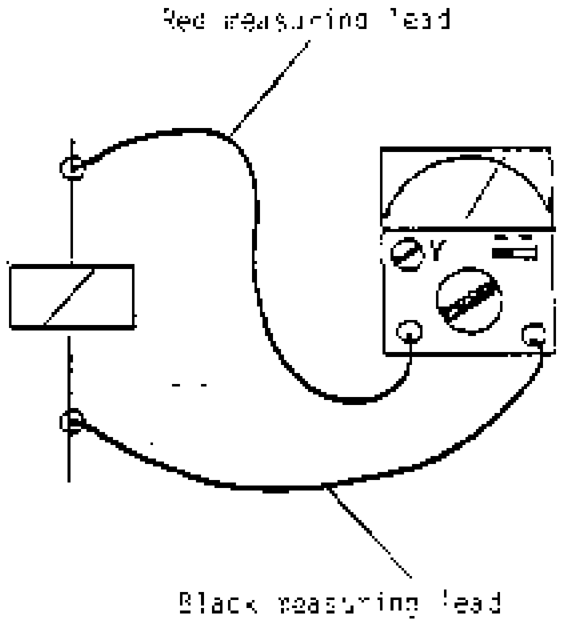


Fig. 1

Fig. 2

To ensure minimum error when measuring, the meter range should be chosen so that the needle moves across to the final third of the scale.

The greater the meter's internal resistance R_i, the more accurate the measurement will be.

2. Current measurement

When measuring current, the meter must be wired in series with the item of equipment being measured (Fig. 3). Make sure that the polarity is correct. Connect the red measuring lead to ⊖ and the black lead to ⊖ . If a polarity reversal switch is provided, set it to ⊕ (Fig. 4).

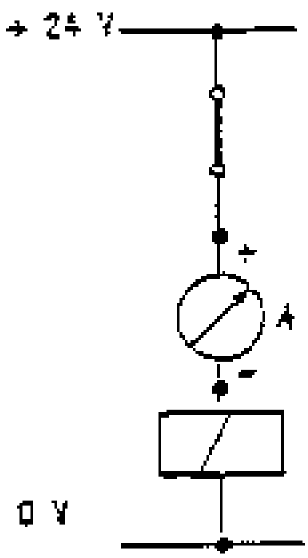


Fig. 3

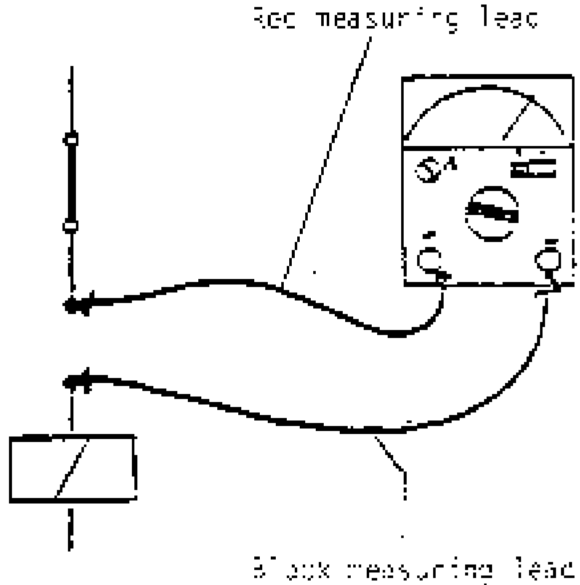


Fig. 4

To ensure minimum error when measuring, the meter range should be chosen so that the needle moves across to the final third of the scale.

The smaller the meter's internal resistance R_i, the more accurate the measurement will be.

3. Measurement of resistance

When measuring resistance, the item of equipment concerned must not be 'live'. It must be disconnected from the remainder of the circuit (Figs. 5 and 6).

If the precise resistance value has to be obtained, the meter must be zeroed before measurement commences. This zeroing process is unnecessary if it is only a question of whether or not the item of equipment has electrical continuity or is resisting the flow of current.

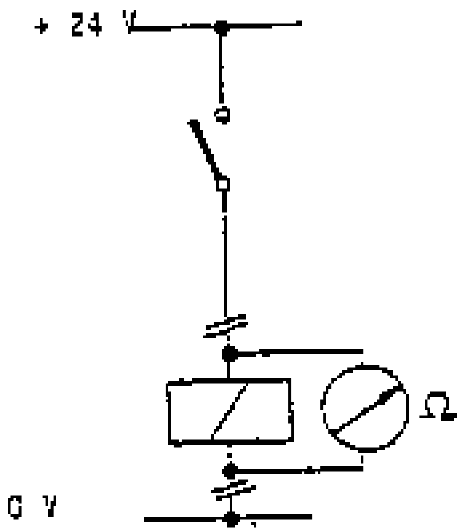


Fig. 5

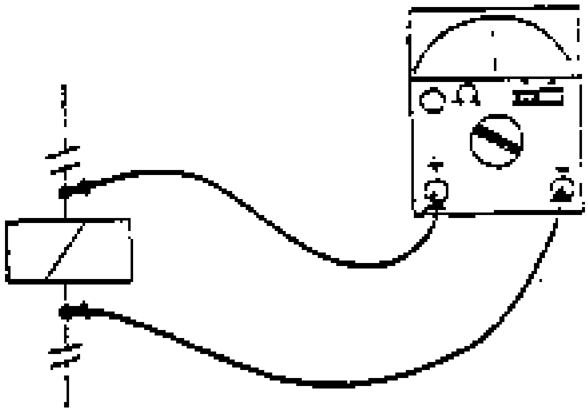
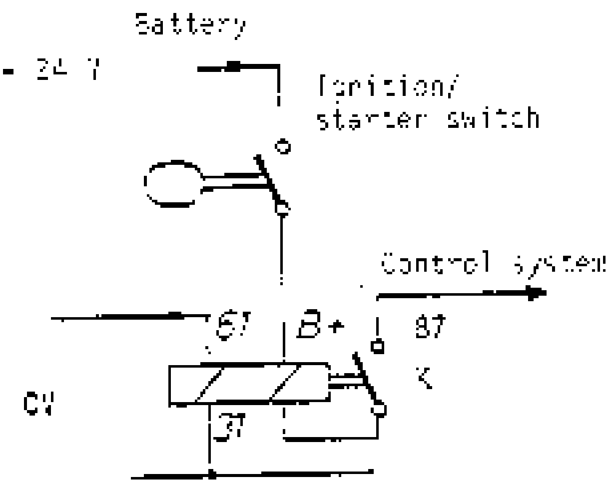
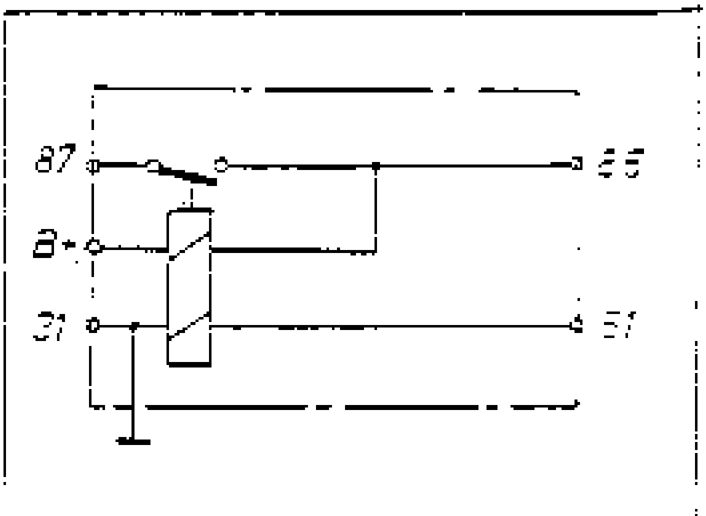


Fig. 6

To keep measuring error to a minimum, choose a meter range which causes the needle to deflect about halfway across the scale.



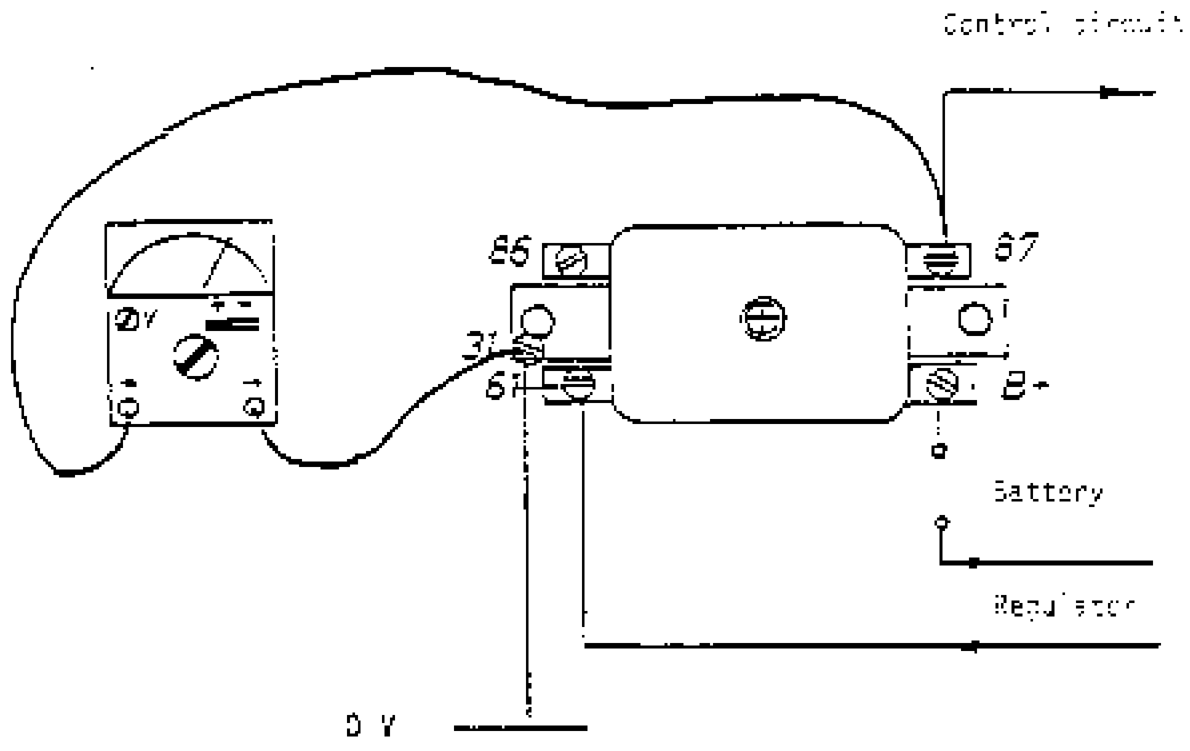


Circuit diagram

When the correct alternator speed is reached, isolating relay 7 is energized by way of voltage winding 1. Contact K closes and allows the battery voltage to reach the control circuit. The current for the control circuit flows via winding 2 (current winding) and boosts winding 1. If the voltage drops in winding 1 as a result of an alternator malfunction, contact K re-opens and the control circuit is de-energized (this is to provide a safeguard against running the battery down completely flat).

Correct operation of this stepping relay cannot be checked visually, but only proved by taking measurements.

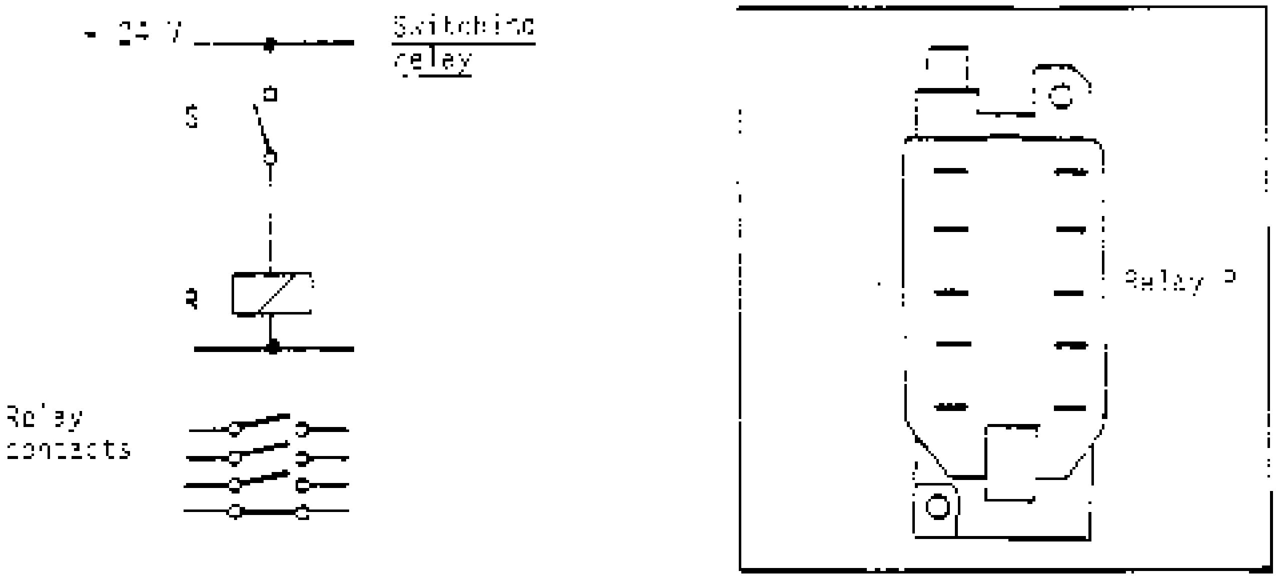
Isolating relay



Voltage measurement (see also [illegible])

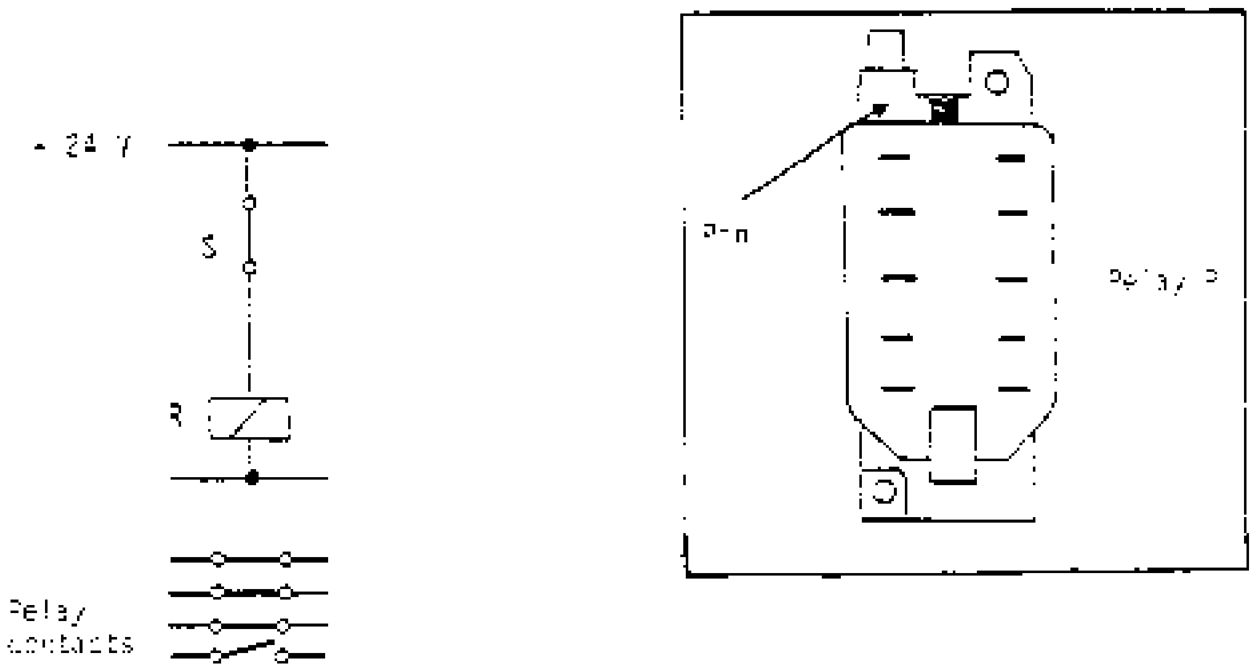
1. Regulator voltage (2[illegible] V - 28 V) — terminal 51
2. Battery voltage (24 V - 2[illegible] V) — terminal B+
3. If the correct voltages are present at terminals 51 and B+, the meter should read 24 V (battery voltage) when connected between terminal 87 and earth (ground).

   If the wire is detached from terminal 51, the reading must drop to 0 V. If the voltmeter shows an unchanged reading of either 0 V or 24 V during both these measurements, the isolating relay is faulty and must be renewed.



Switch contact S open: relay R is not energized. Relay contacts are in the rest position.

Important: Relay contacts are always shown in the rest position on drawings.



Switch contact S closed: relay R is energized. The pin becomes visible. The position of the relay contacts is now the opposite of that shown on the drawings.

Switching relay

If the relay fails to drop off when switch contact 1 is open, or is not energized when the switch contact is closed, it must have developed a fault.

Before undertaking any measurements at the relay and switch contacts, check the working voltage (24 V) at leads A,C,E,F,M and I and ensure that the following fuses have not blown:

Fig. -A-

Item 2 Main fuse on engine (50 Amp.)
see Fig.-A-

Item 3 Main automatic circuit breaker
1/0e1 (25 Amp.)
-in switchgear cabinet-chassis-

Item 14 Automatic circuit breaker
1/8e4 (2 Amp.) for the
load-moment limiter

Item 15 Automatic circuit breaker
1/0e2 (15 Amp.) for supply
to crane-control

in switchgear cabinet-slewing platform

Check also for breaks in the various supply leads to the switch contacts, switches and relays.

Possible faults:

1. Defective switch contact (see also [illegible])

   a. Contact not closing
   b. Contact not opening

   If the switch contact forms part of a relay, the relay will in this case have to be renewed.

2. Defective relay

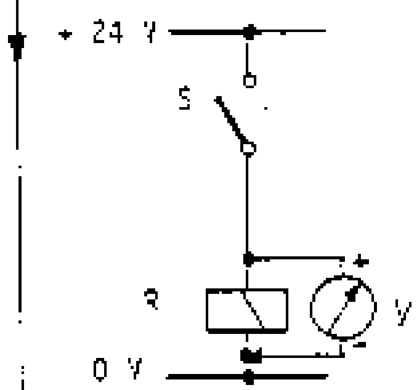
   a. Mechanical malfunction (see 1.)
   b. Electrical malfunction

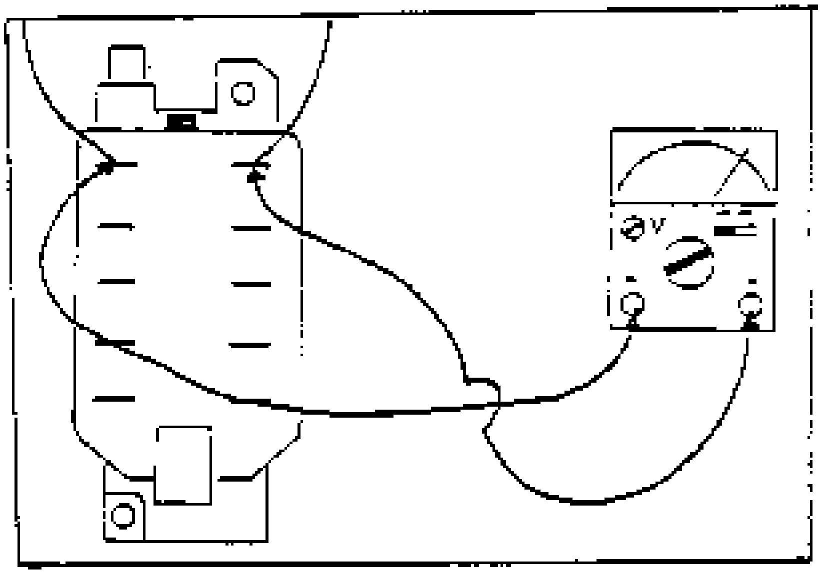
Switching relay

Switch contacts S open

Relay R not de-energized

Voltage measurement (see also 5.2.01)





Voltmeter V reads 24 V

a. Switch contact defective

→ Renew switch or relay

Voltmeter V reads 0 V

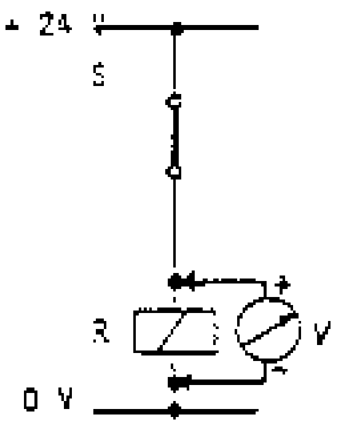
a. Relay blocked (jammed) mechanically

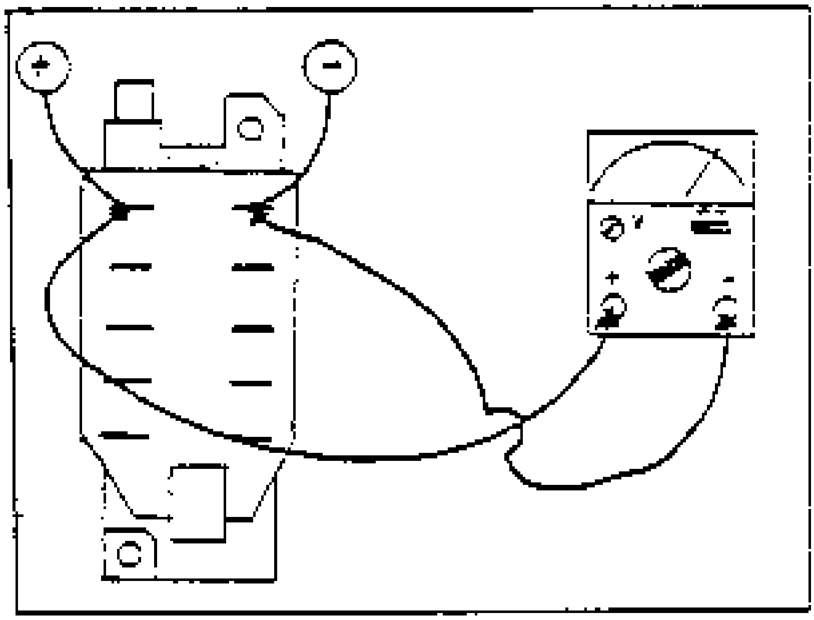
→ Renew relay

Switching relay

Switch contact S closed
Relay R not energized

Voltage measurement (see also 5.2.01)





Voltmeter V reads 24 V

a. Relay winding interrupted

→ Renew relay

b. Relay blocked (jammed) mechanically

→ Renew relay

Voltmeter V reads 0 V

a. Switch contact defective

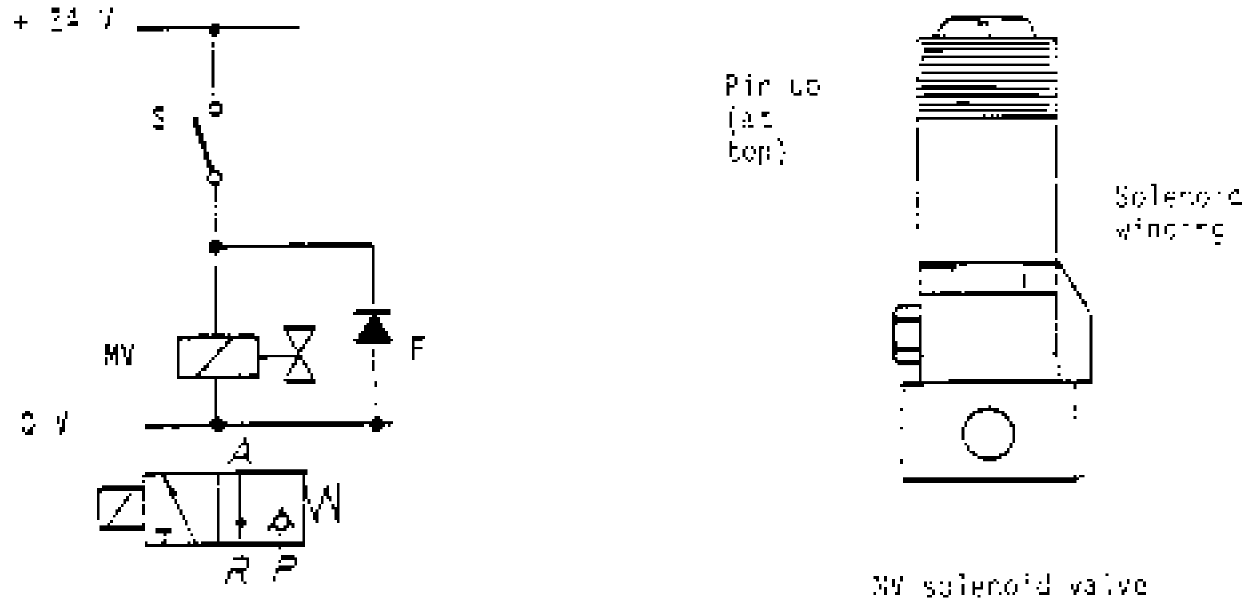
→ Renew switch or relay

b. Supply leads to switch contact
to relay
to 0 V line interrupted

→ Repair break in supply lead

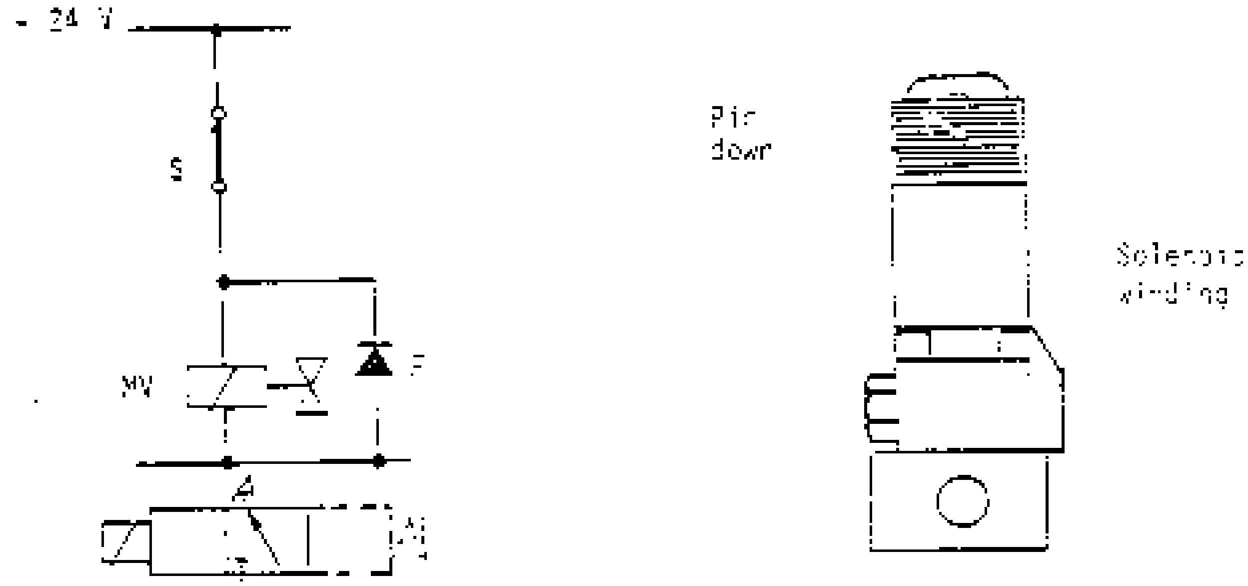
Solenoid valve

F : Freewheeling diode



MV solenoid valve

Switch contact S open: solenoid valve MV is not energized and pin remains in upper position. The pin also serves as an emergency method of hand operation.
Important: Solenoid valves are also shown in the rest (non-energized) position on drawings.



MV solenoid valve

Switch contact S closed: solenoid valve MV is energized. The pin is now retracted, and the solenoid valve setting is the opposite of that shown in the drawings.

Solenoid valve

If solenoid valve MV fails to pick up when switch contact S is closed, or does not drop off to the rest position when the switch contact is open, a fault is indicated.

Before commencing any measurement work on the solenoid valve and the switch contacts, check the working voltage (24 V) at lead A and also the following fuses:

Item 2 (50 Amp.) —— Main fuse,on engine

Item 3 (10/0e1) —— In switchgear cabinet-chassis

Item 14 (1/8c4) —— in switchgear cabinet-slewing platform

Item 15 (1/0c3)

In addition, check for interruptions in the various supply leads to the switch contacts, switches and solenoid valves.

Possible malfunctions:

1. Defective switch contact

   a. Contact does not close

   b. Contact does not open

   If the switch contact forms part of a relay, the relevant relay will have to be renewed in this event.

2. Defective solenoid valve

   a. Mechanical fault

   b. Electrical fault (break in wiring)

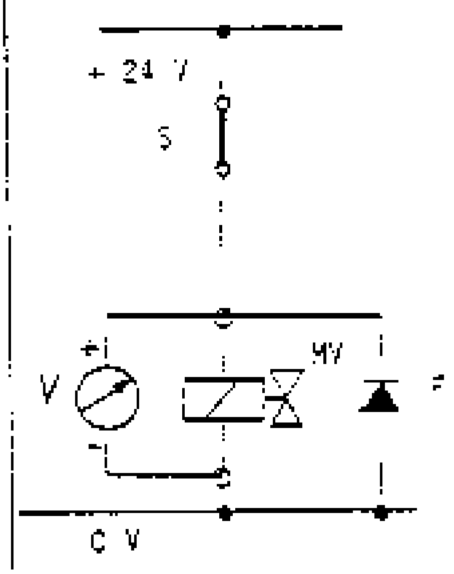
3. Defective freewheeling diode

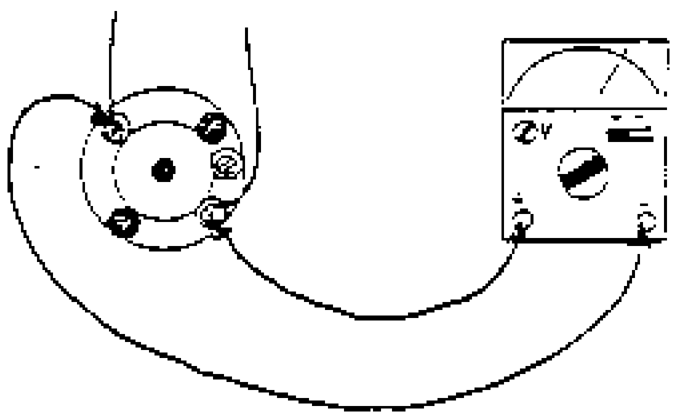
   The freewheeling diode is located in the connecting plug.

Solenoid valve

Switch contact S closed
Solenoid valve MV not energized

Voltage measurement (see also 5.2.01)





Solenoid valve with cap removed

Voltmeter V reads 24 V

1. Solenoid winding interrupted

   → Renew solenoid winding

2. Solenoid valve blocked (jammed) mechanically

   → Renew solenoid valve

Voltmeter V reads 0 V

4. Defective switch contact

   → Renew switch or relay

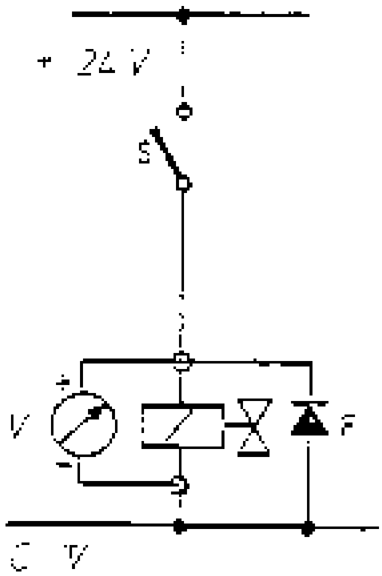
5. Supply leads to switch contact
   to solenoid valve
   to 0 V line interrupted

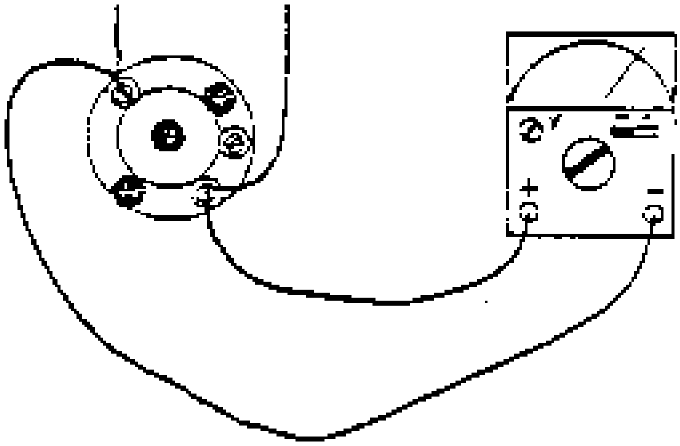
   → Repair break in supply lead

Switch contact S open

Solenoid valve MV has not dropped off

Voltage measurement (see also 5.2.[illegible])





Solenoid valve with cap removed

Voltmeter V reads 24 V

a. Defective switch contact

→ Renew switch or relay

Voltmeter V reads 0 V

a. Solenoid valve blocked (jammed) mechanically

→ Renew solenoid valve

Location

1/	Equipment in switchgear cabinet
2/	Equipment on/in instrument panel
4/	Equipment on crane
10/	Equipment on vehicle

Function

/0	Control
/1	Main hoisting gear
/2	Luffing gear (boom)
/3	Telescoping gear
/4	Slewing gear
/5	Auxiliary hoisting gear
/8	Load-moment limiter and program selection
/10	Vehicle's electrical system

Designation

b	Switch
c	Main contactor (engine)
d	Auxiliary contactor / relay
e	Fuse
g	Meter
m	Motor/generator
n	Diode
r	Resistor
s	Magnet
h	Telltale lamp
u	Slipring assembly

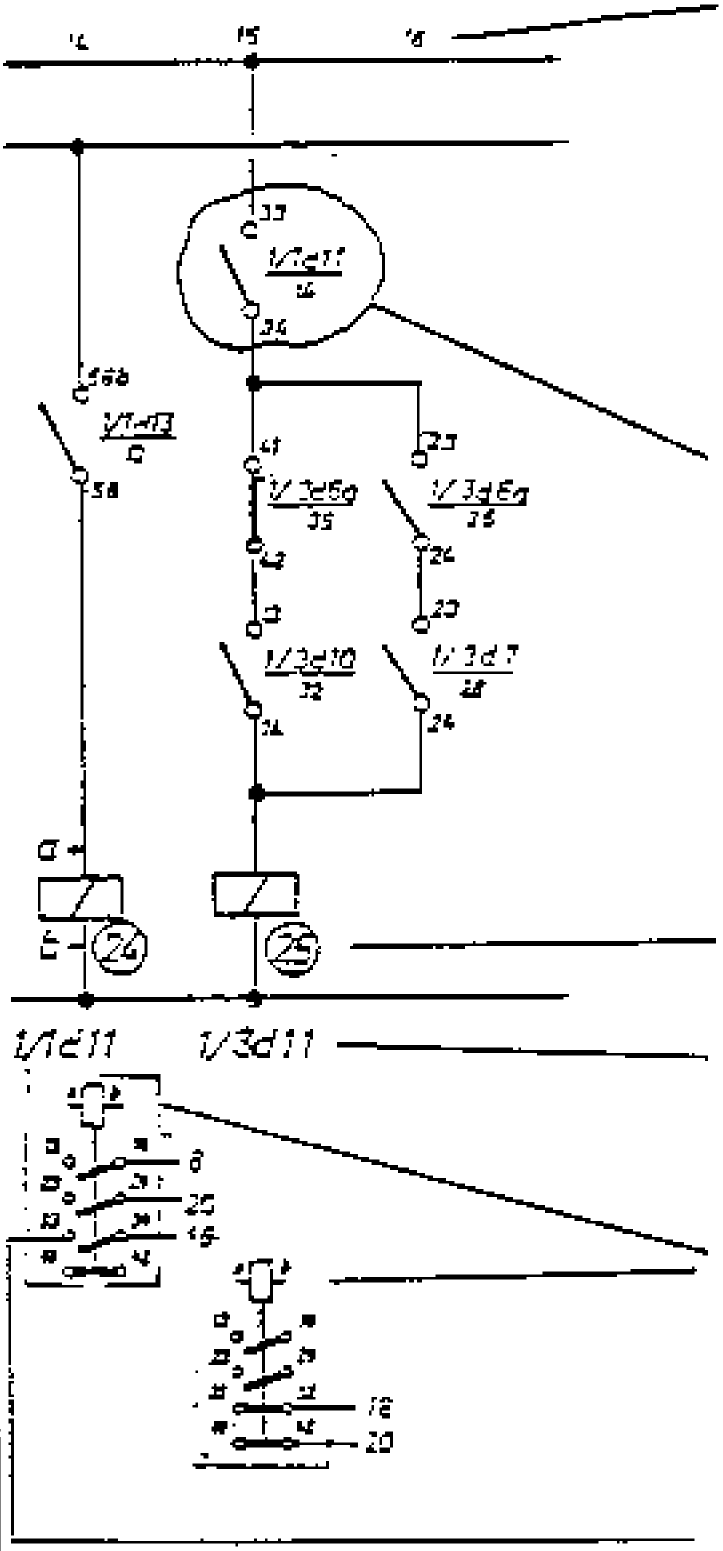
Example:

Final figure

Serial number

1 / 1 d 1

= Relay No. 1 for hoisting gear, in switchgear cabinet



Current flow path number: to speed up their identification, all current flow paths on all circuit diagrams are numbered serially from left to right.

Example: contact 33/34 is part of relay 1/1d11 (Item 24) and located on current flow path 14.

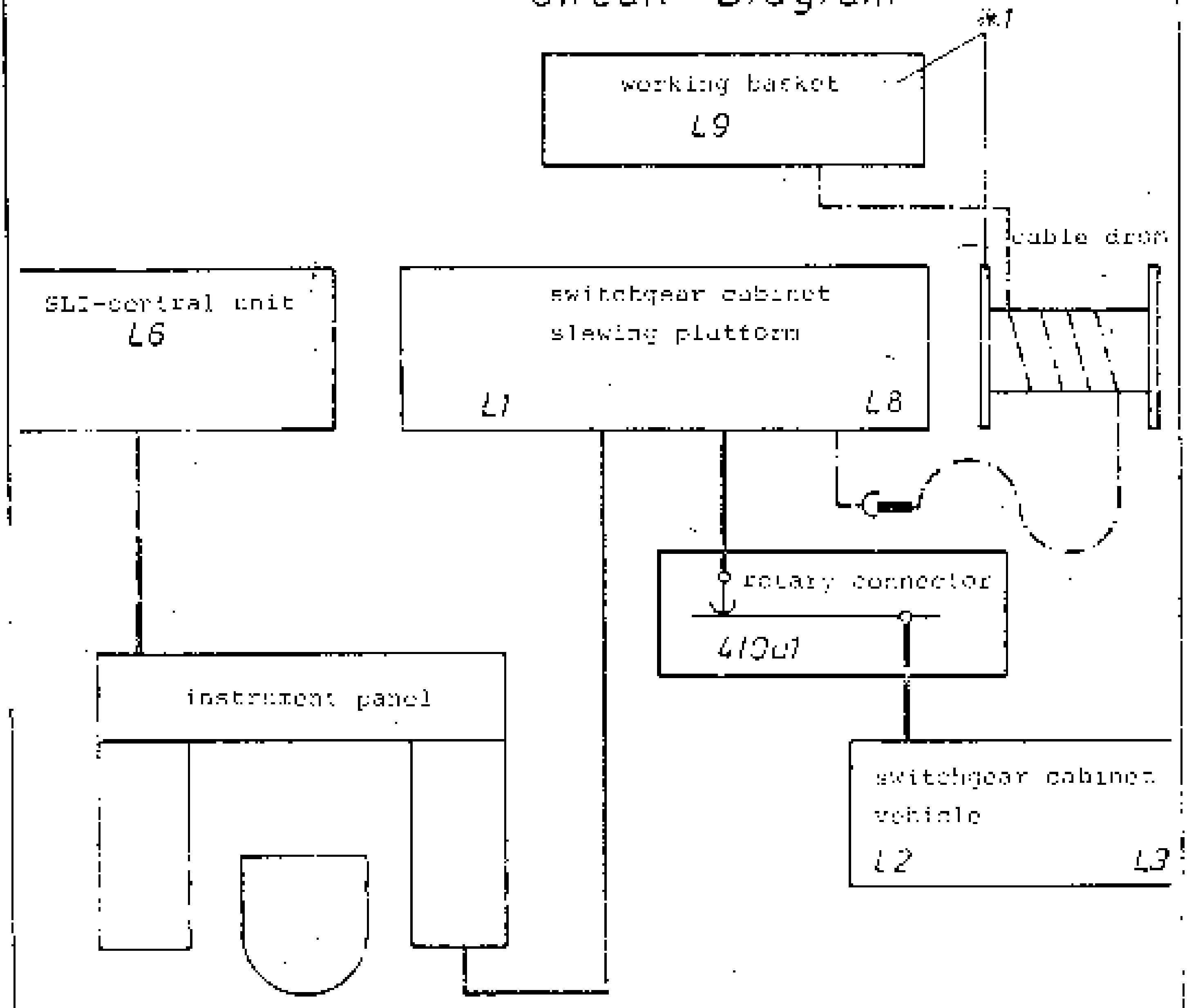
Item numbers

Identification code (see under this heading)

Connection diagram: shows the connection (terminal) numbers of all contacts.

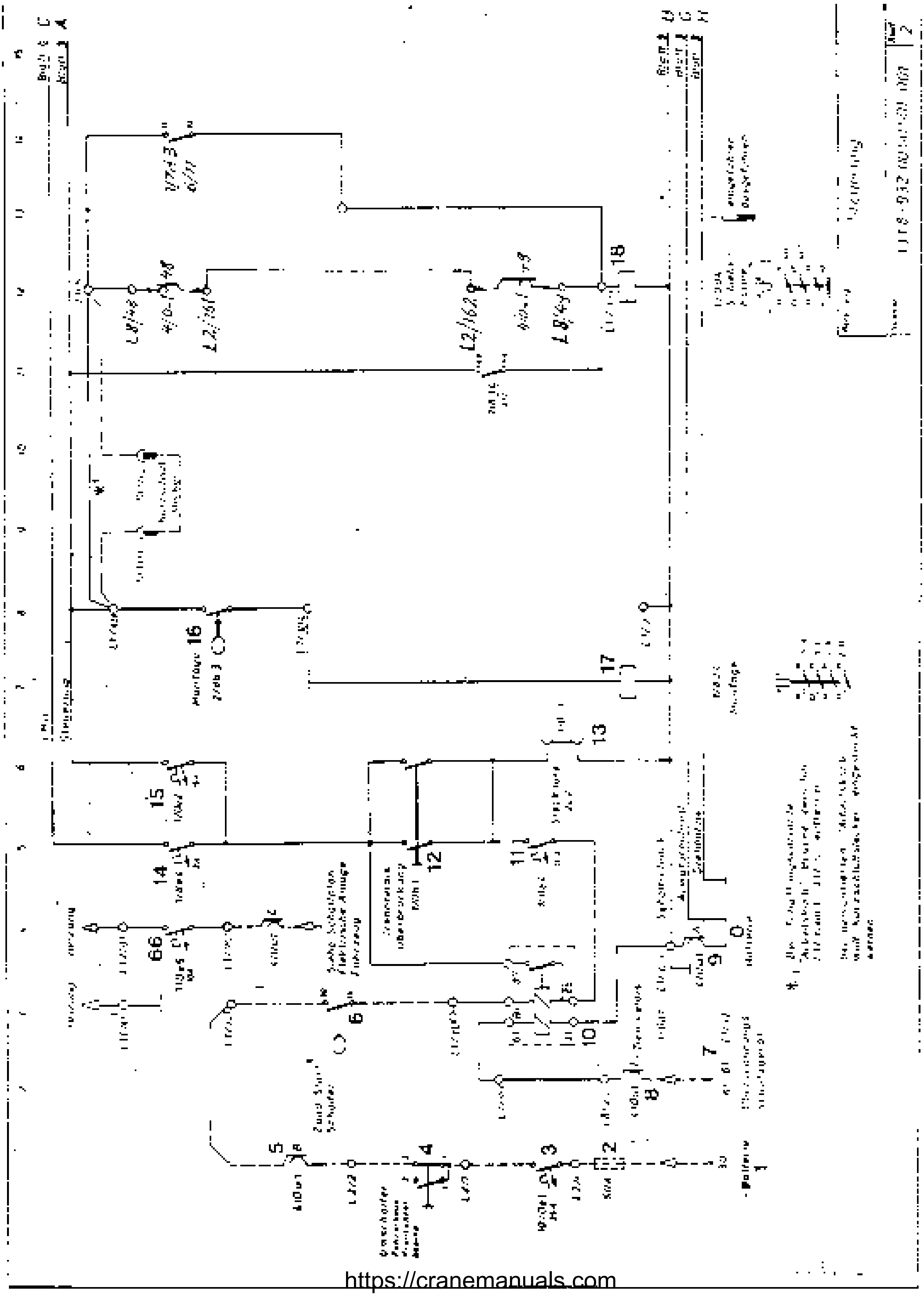
Example: contact 33/34 is located on current flow path 15.
Contacts without a current flow path number are not in use.

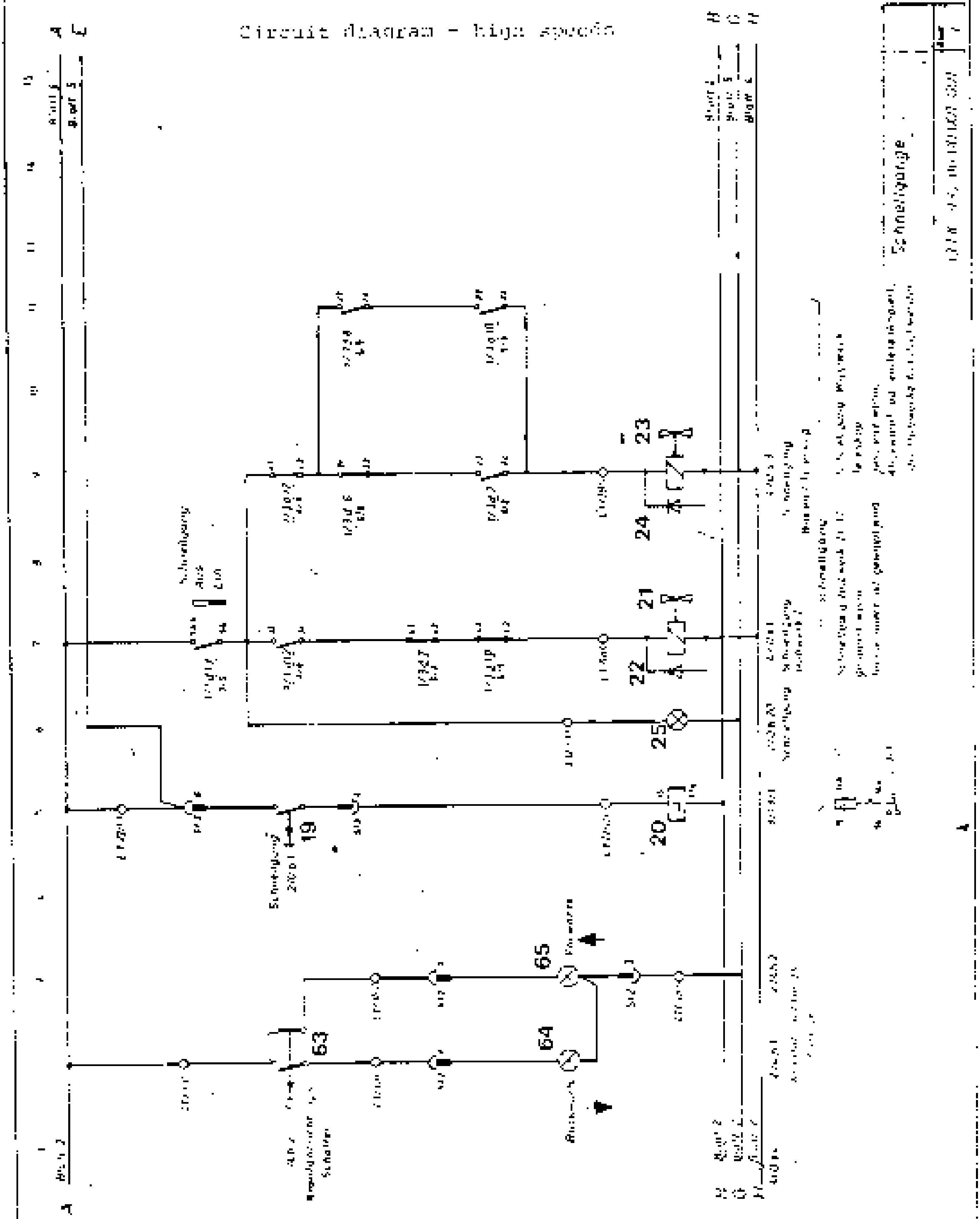
Circuit Diagram



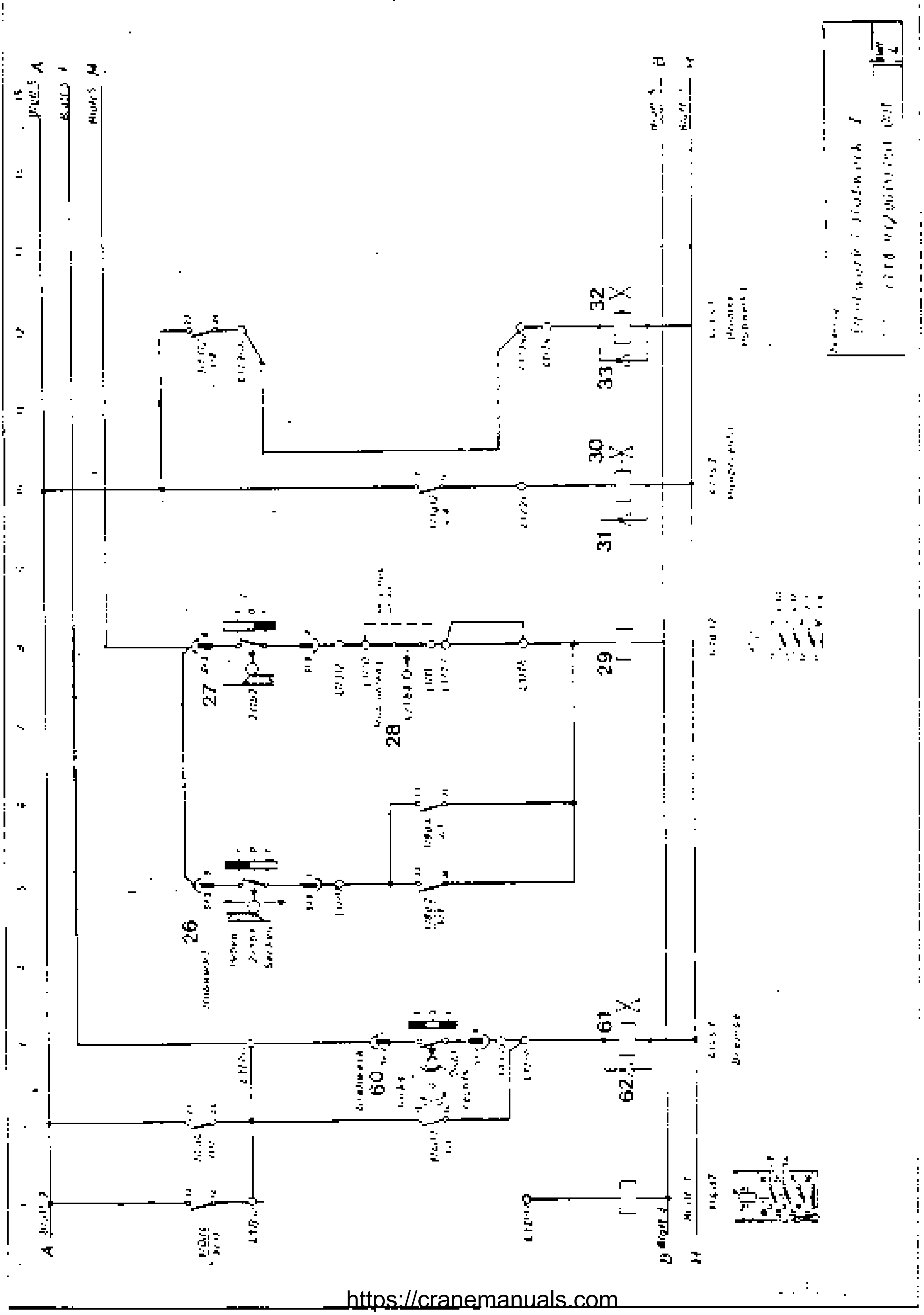
General arrangement (terminal socket)

Circuit diagram




Circuit diagram - high speeds
19
20
21
22
23
24
25
63
64
65

Circuit diagram - slewing- gr



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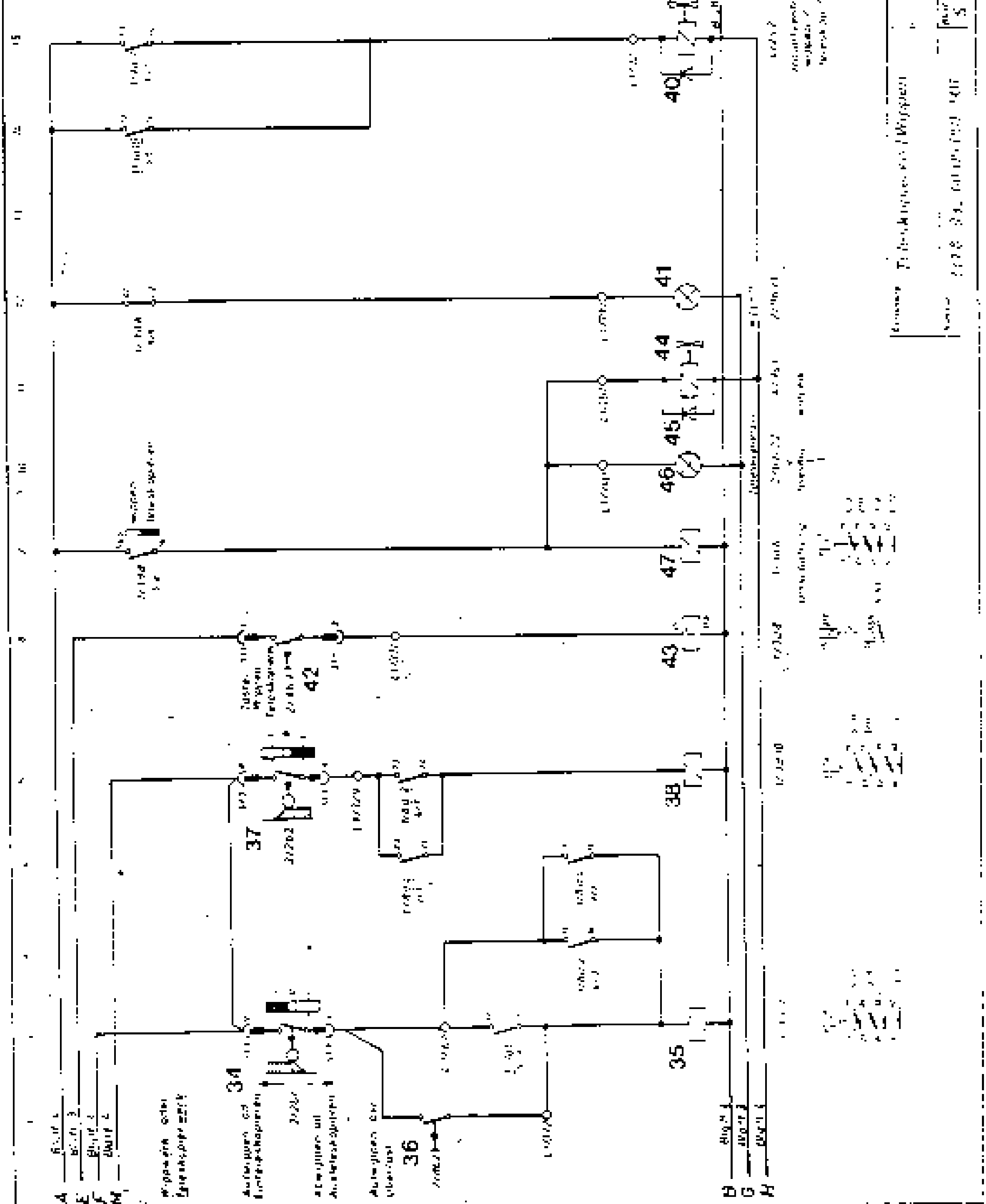
Circuit diagram

Circuit diagram - telescoping/[illegible]



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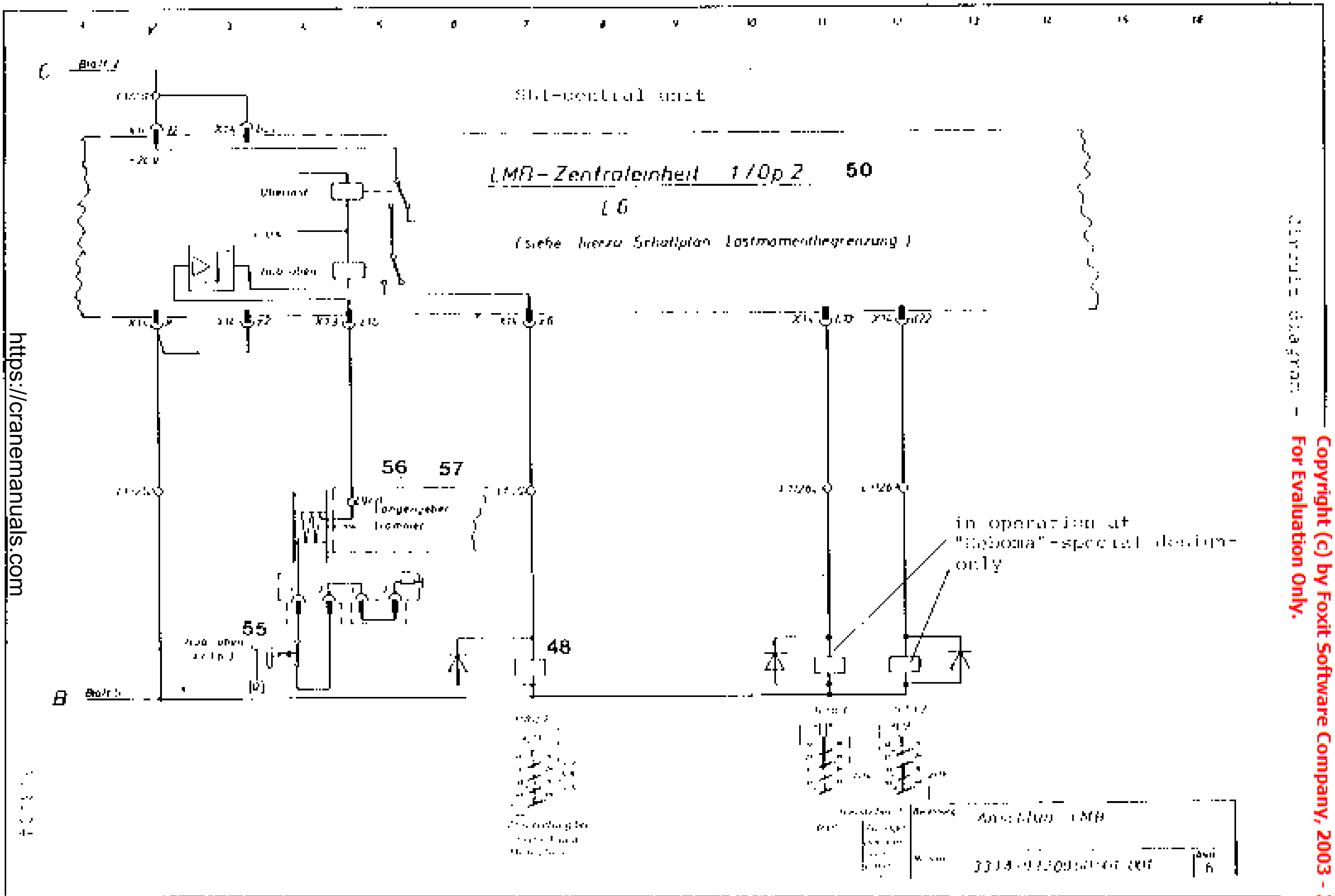

Circuit diagram -
SLI-central unit
LMB-Zentraleinheit 1/0p 2
50
(6
(siehe hierzu Schaltplan Lastmomentbegrenzung)
56
57
55
48
in operation at "Caboma"-special design-only
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B
C
Anschluss LMB

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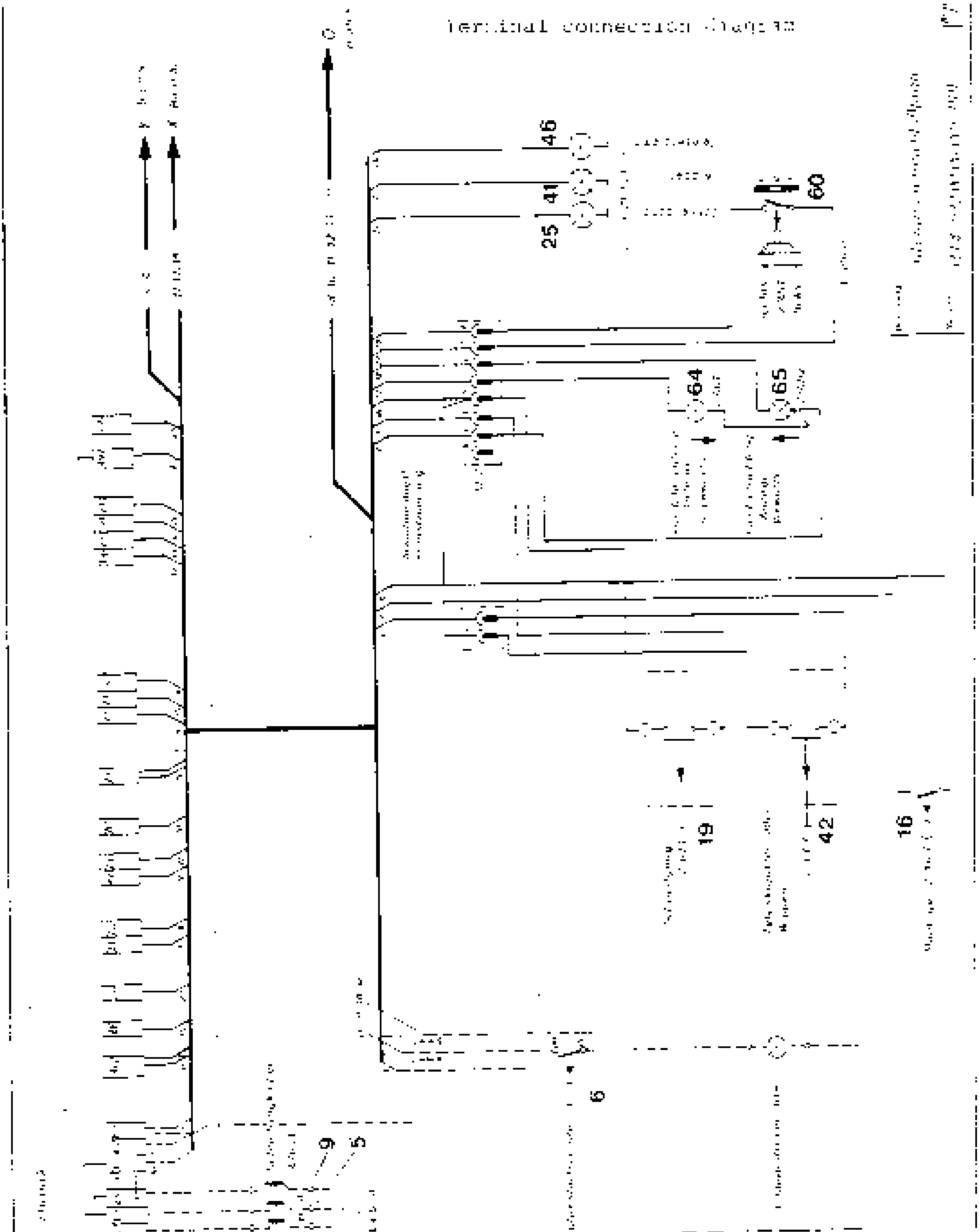
Circuit diagram

Terminal connection diagram



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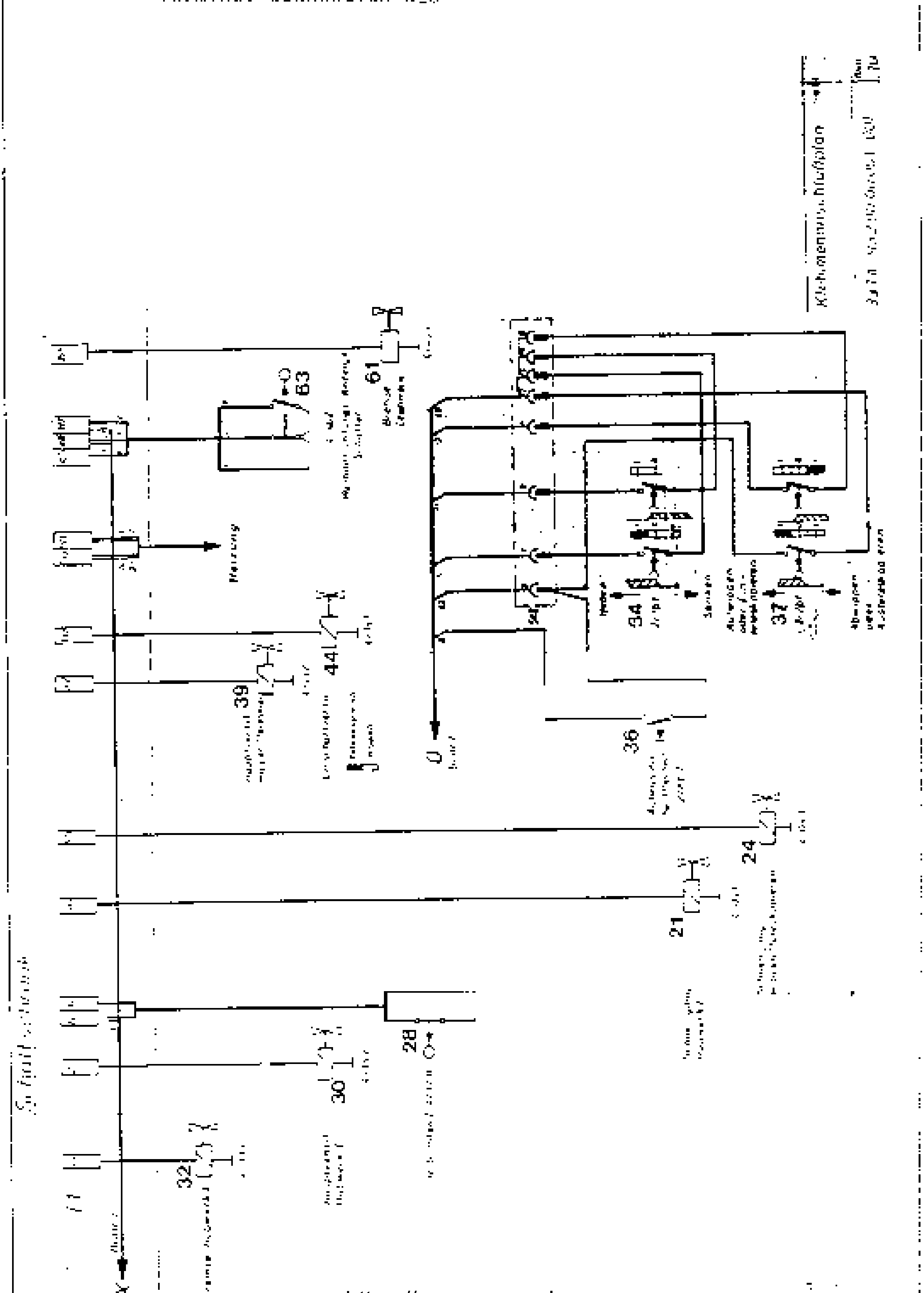
Terminal connection dia



LIEBHERR

El. components layout / control system

Item	Designation	Location
0	battery-ground	switchgear cabinet - slewing platform - right side
1	connecting terminal positive (+)	starter connecting terminal 30)
2	main fuse 50A	on engine - rear left
3	automatic circuit breaker 1U/0e1 -25A (ignition-starter switch)	switchgear cabinet - chassis
4	changeover switch cab/ chassis to superstructure	switchgear cabinet - chassis
5	slipring -B- (U=24V to ignition/starter switch)	slipring unit 4/0u1
6	ignition/starter switch	instrument panel - cab
7	connecting terminal	overvoltage protection switchgear cabinet - chassis item 6 -(connecting terminal 61)
8	slipring -24- (D+)	slipring unit 4/0u1
9	slipring -A- negative (-)	slipring unit 4/0u1
10	isolating relay 1/0d1	switchgear cabinet - slewing platform
11	automatic circuit breaker 1/0e4 -10A (24V-socket)	switchgear cabinet - slewing platform
12	isolating relay - bridging switch 1/0b1	switchgear cabinet - slewing platform
13	24V-socket	switchgear cabinet - slewing platform
14	automatic circuit breaker 1/8e4 - 2A (SLI)	switchgear cabinet - slewing platform
15	automatic circuit breaker 1/0e2 - 15A (crane control)	switchgear cabinet - slewing platform
16	key switch (bridging SLI and hoist "upper unit")	instrument panel - cab

El. components layout / cont.

Item	Designation	Location
17	relay 1/8d4 (bridging SLI and hoist "up")	switchgear cabinet - slewing platform
18	relay 1/0d4 (crane control "on")	switchgear cabinet - slewing platform
19	push button switch/ high speed)	manual control valve (slewing gear)
20	latching relay (high speed on-off)	switchgear cabinet - slewing platform
48	relay 1/8d2 (shut-off at overload and hoist "upper limit")	switchgear cabinet - slewing

Power supply lines

positive (+) :

C : Power supply 24 V / SLI

A : Power supply 24 V / control - switchgear cabinet

E : Power supply 24 V / control - cab

negative (-) :

B : Battery - earth/ground - switchgear cabinet

G : Battery - earth/ground - instrument panel - cab

H : Battery - earth/ground - slewing platform

Item	Designation	Location
21	solenoid valve (high speed)	(see el. diagram)
22	semiconductor diode	solenoid valve connection plug (valve - item 21)
25	telltale lamp -green- (high speed)	instrument panel - cab
26	micro switch "hoisting"	manual control valve - cab
27	micro switch "lowering"	manual control valve
28	lower hoist limit switch	rope winch
29	relay 1/1d12	switch gear cabinet
30	solenoid main valve	see el. diagram
31	semiconductor diode	solenoid valve connection plug (valve - item 30)
32	solenoid valve (hoisting gear brake - release)	see el. diagram
33	semiconductor diode	solenoid valve connection plug (valve - item 32)

Power supply lines

positive (+) :

A : Power supply 24 V control - switchgear

J;M : Power supply 24 V control - cab

negative (-) :

B : Battery - earth(ground) switchgear cabinet

C : Battery - earth(ground) cab

H : Battery - earth(ground) slewing platform

El. components layout / luffing

Item	Designation	Location
23	solenoid valve (high speed)	see el. diagram
24	semiconductor diode	solenoid valve connection plug (valve - item 23)
25	telltale lamp -green- (high speed)	instrument panel
34	micro switch (topping or retracting boom)	manual control valve - cab
35	relay 1/3d7 (topping or retracting boom only)	switchgear cabinet
36	push button switch (topping at overload only)	instrument panel - cab
37	micro switch (topping or extending boom)	manual control valve - cab
39	solenoid main valve	see el. diagram
40	semiconductor diode	solenoid valve connection plug (valve - item 39)
41	telltale lamp -green- (luffing gear)	instrument panel - cab
42	push button switch (changeover luffing to telescoping)	manual control valve
43	latching relay 1/3d8 (at telescoping only)	switchgear cabinet
44	solenoid - changeover valve (luffing to telescoping gear)	see el. diagram
45	semiconductor diode	solenoid valve connection plug (valve - item 44)
46	telltale lamp -green- (telescoping gear)	instrument panel - cab
47	relay 1/3d6 (at telescoping only)	switchgear cabinet

Power supply lines

positive (+) :

A : Power supply 24 V / control - switchgear cabinet

E;F;M : Power supply 24 V / control - cab

negative (-) :

B : Battery earth(ground) / switchgear cabinet

C : Battery earth(ground) / cab

H : Battery earth(ground) / slowing platform

Item	Designation	Location
60	Micro switch (left-right)	manual control valve
61	Solenoid valve (slewing gear brake release)	see el. diagram
62	Semiconductor diode	solenoid valve connection plug (item 52)

Power supply lines

Positive (+) :

P : Power supply 24 V / control -cab

Negative (-) :

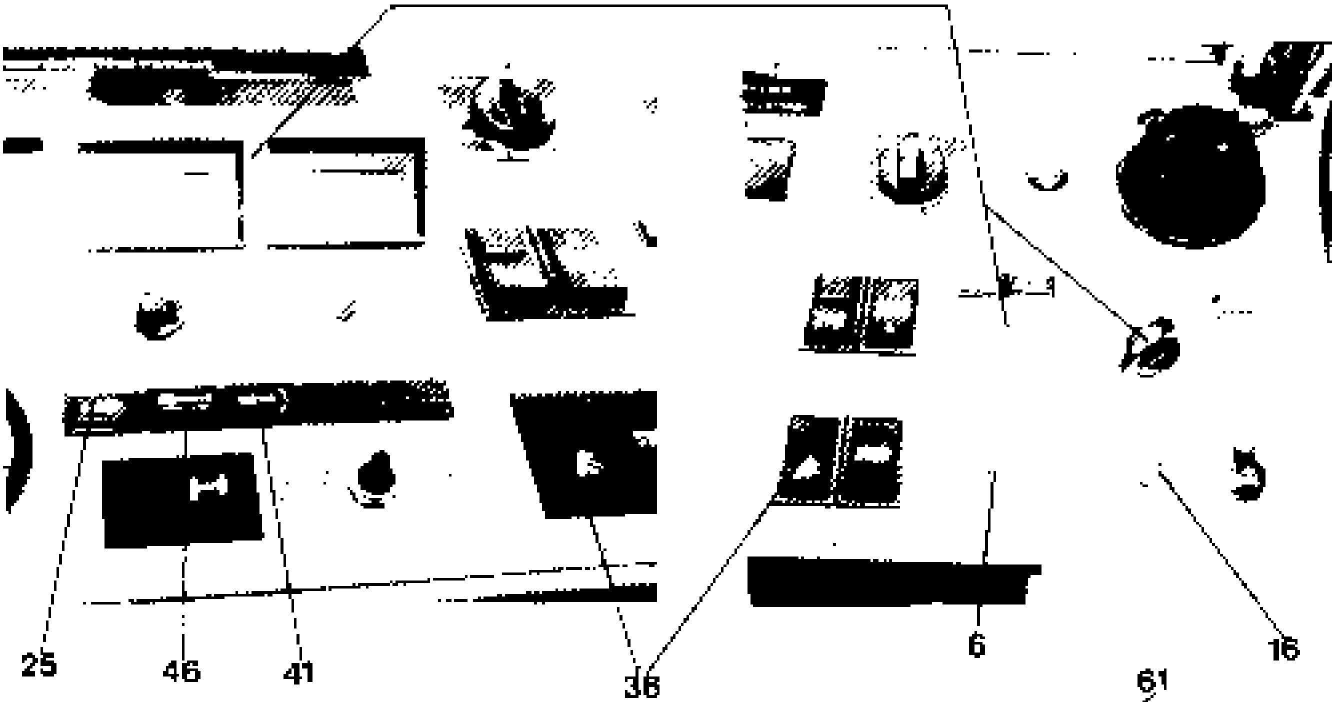
E : Battery-earth (ground / slewing platform

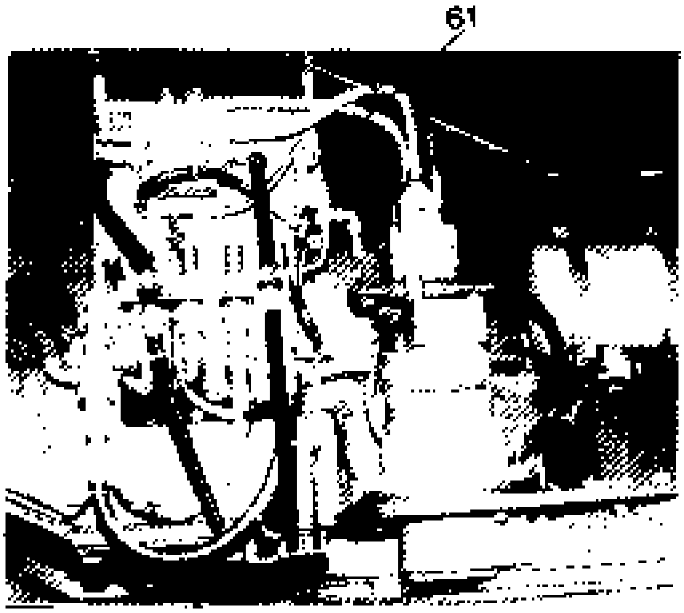
Travel direction indicator at crane operation

A travel direction switch (63) mounted on the slewing platform indicates the position of the cab in relation to the forward travel direction. Two telltale lamps (64 and 65) in the cab show the existing travel direction. (see el. circuit diagram sheet 5.3.03)

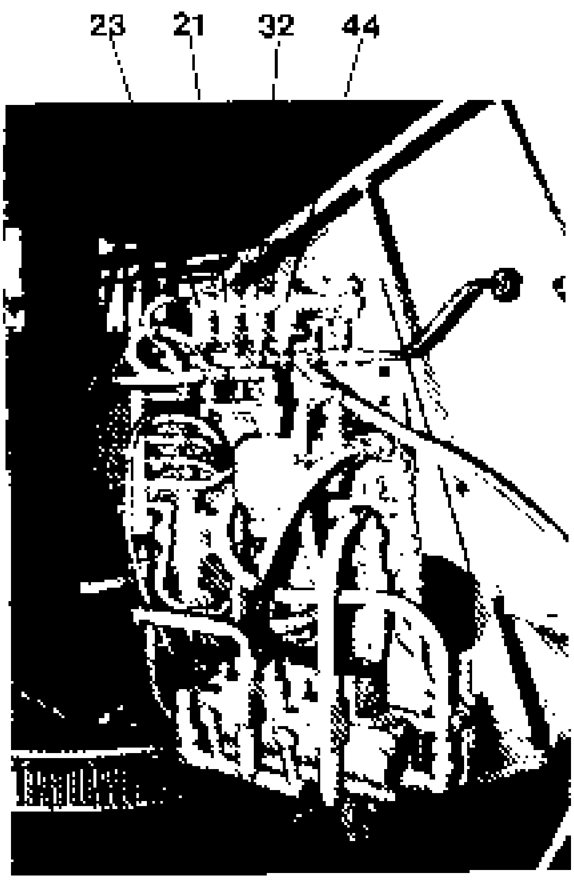
B1. components layout

SLI - indicator unit -51-

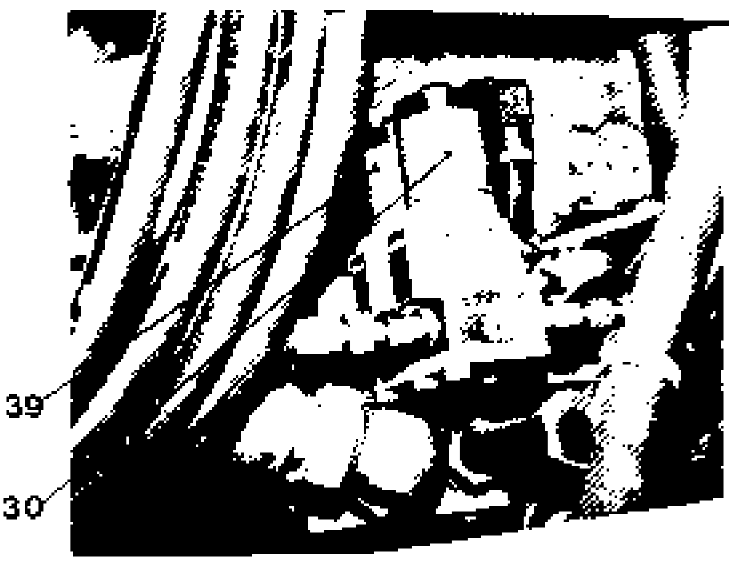




slewing platform - right side

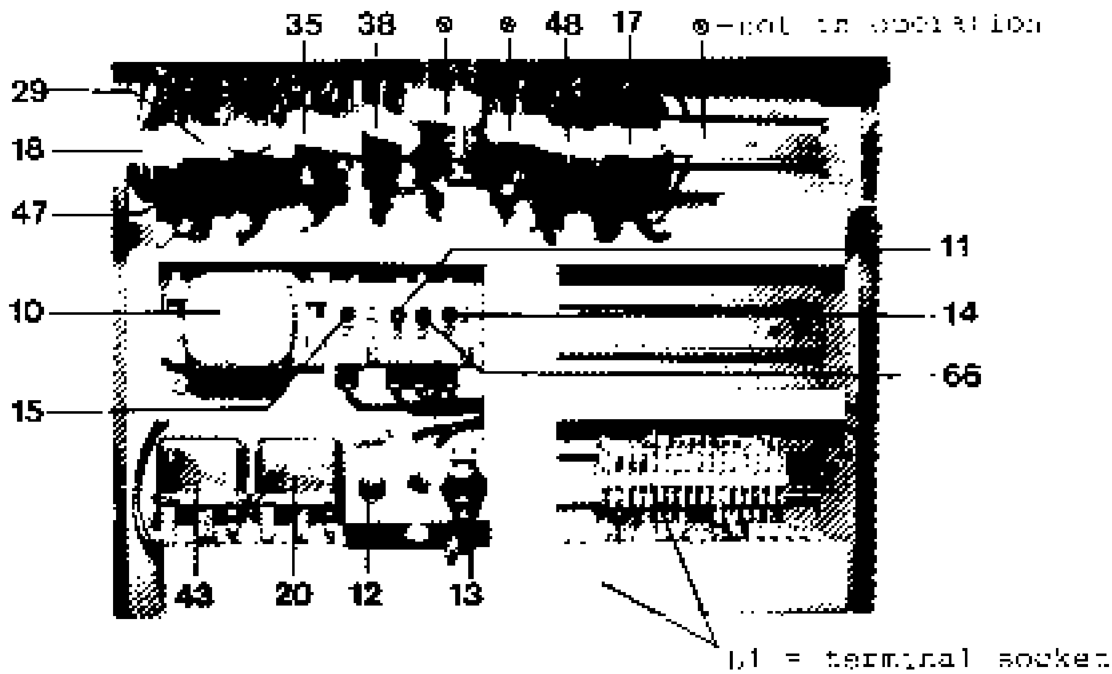


slewing platform - left side



cabin - front (below)

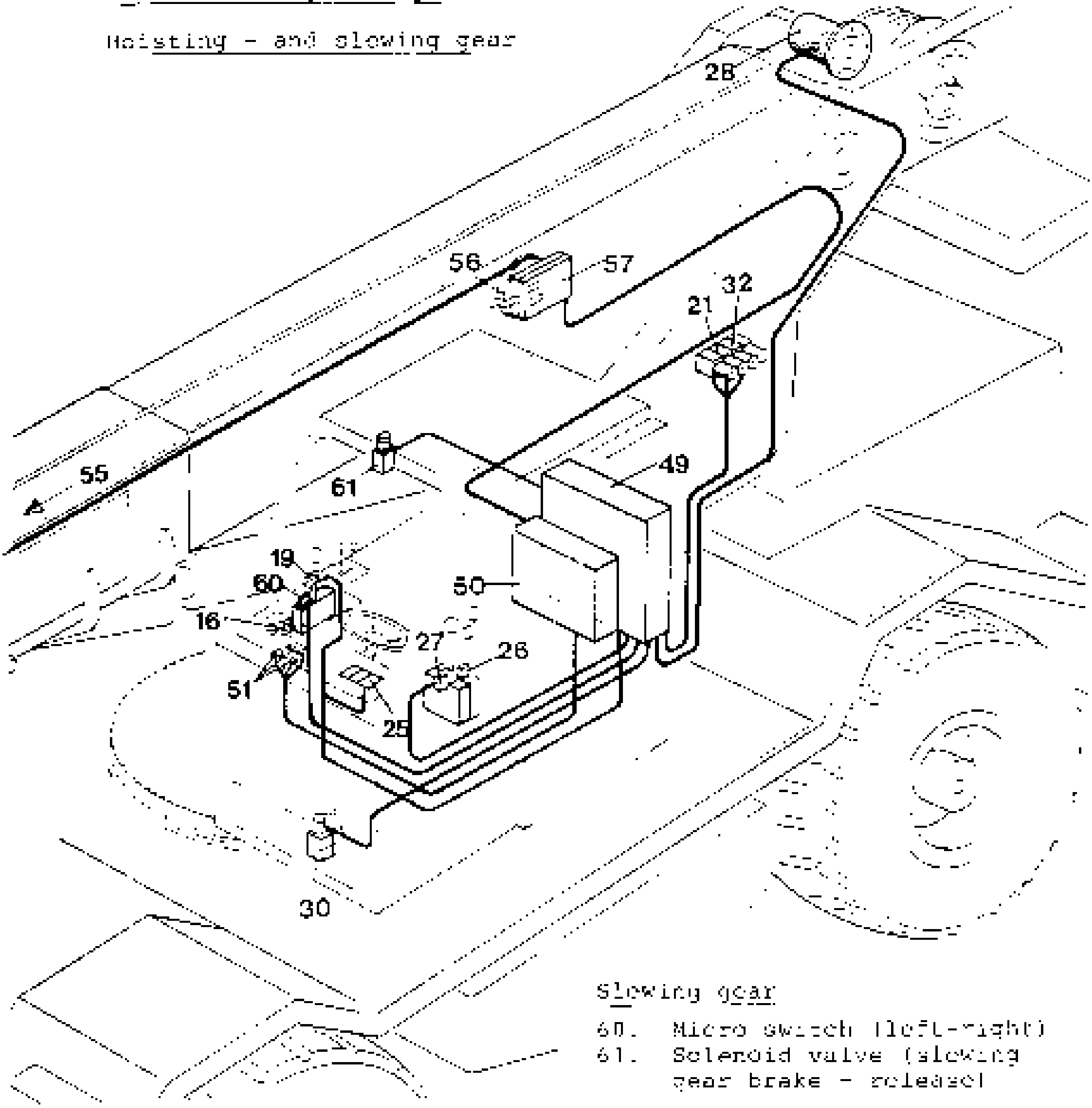
Components-layout - Switchgear cabinet -49-



Item	Designation
10	Isolating relay 1/0d1
11	Automatic circuit breaker 1/0e4 - 10A (fuse protection-24V socket)
12	Bridging-over switch for isolating relay 1/0d1 (Power supply at switch position -off- from the generator, Power supply at switch position -on- from the battery)
13	24V socket (connection for hand lamp)
14	Automatic circuit breaker 1/8e4 - 2A (fuse protection-SLI)
15	Automatic circuit breaker 1/0e2 -15A (crane control)
17	Relay 1/8d4 - bridging-over of SLI and upper hoisting limit switch
18	Relay 1/0d4 - crane control -on
20	Latching relay 1/1d13 (high speed, on-off)
29	Relay 1/1d12 (control - hoisting gear)
35	Relay 1/3d7 (control - "topping" or "retracting boom" only)
38	Relay 1/3d10 (control - "lowering" or "telescoping boom" only)
43	Latching relay 1/3c8 (changeover to "telescoping")
47	Relay 1/3d6 (at "telescoping" only)
48	Relay 1/8d2 - shut off at actuation of SLI or "upper" limit switch
66	Automatic circuit breaker 1/0e5, 10A (auxiliary heating)

El.functioning - diagram

Hoisting - and slowing gear



Slowing gear

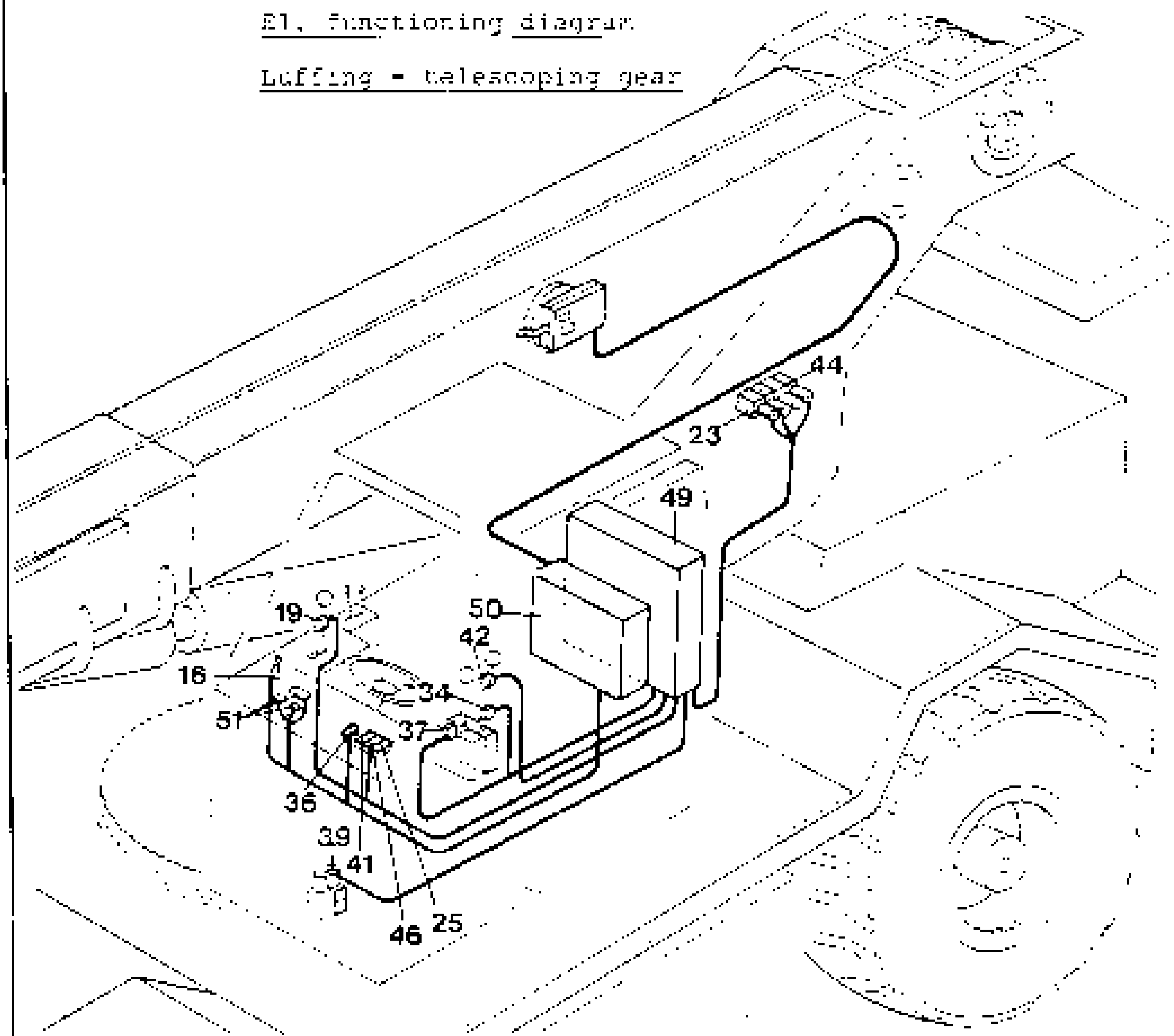
60. Micro switch (left-right)
61. Solenoid valve (slowing gear brake - release)

Hoisting gear

16. Key switch (bridging over SLI/"upper" limit switch)
19. Push button switch (high speed)
21. Solenoid valve (cut-in - high speed)
25. Telltale lamp - green (high speed -on-)
26. Micro switch - hoisting gear "hoisting"
27. Micro switch - hoisting gear "lowering"
28. Lower hoisting gear limit switch
30. Solenoid main valve
32. Solenoid valve (hoisting gear brake - release)
49. El.switch gear cabinet
50. SLI-central unit
51. SLI-indicator unit
55. "Upper" hoisting gear limit switch
56. Length indicator
57. Angle indicator

El. functioning diagram

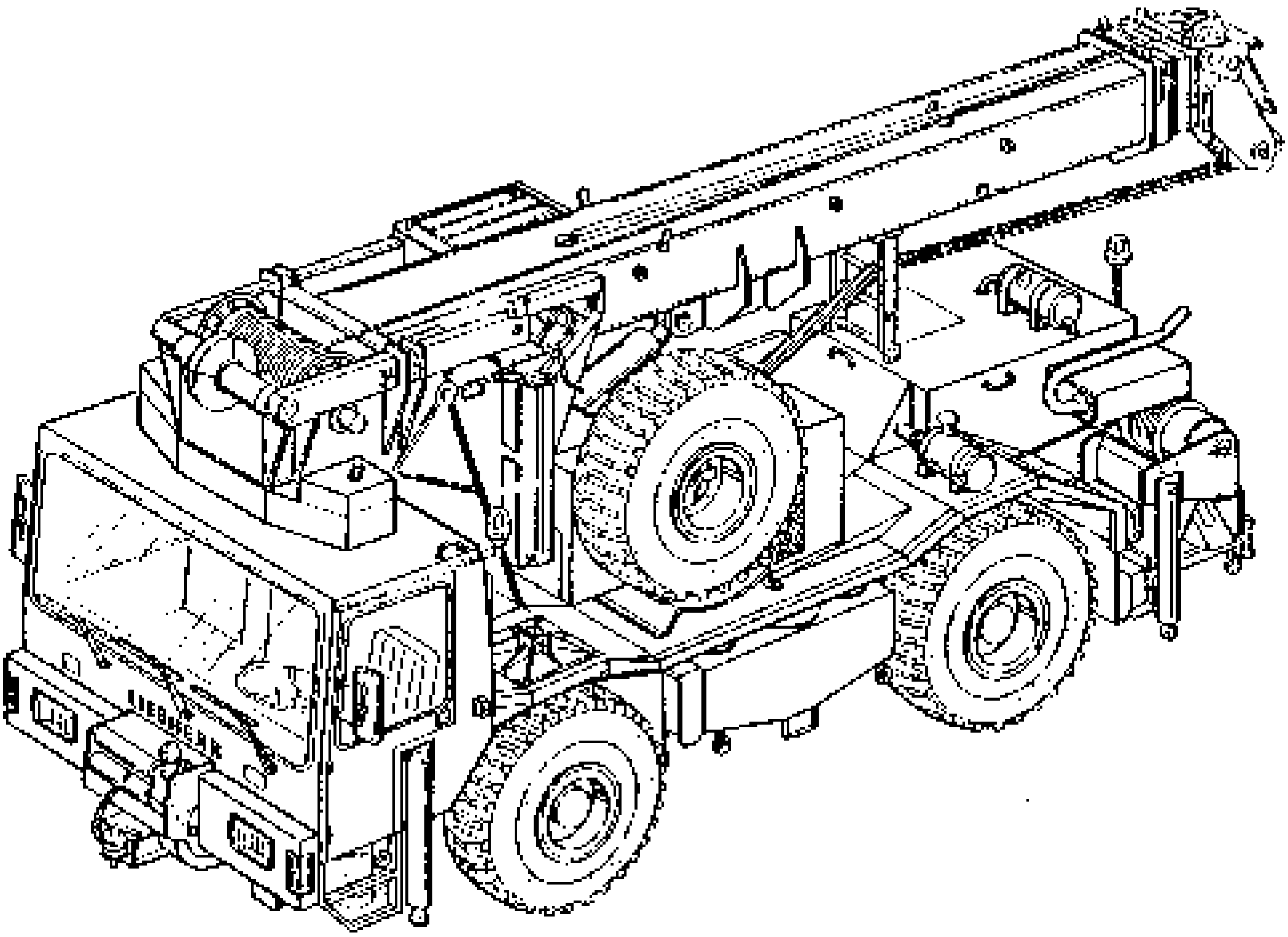
Luffing - telescoping gear



Luffing- and telescoping gear

16. Key switch (SLI - bridging-over)
19. Push button switch (high speed)
23. Solenoid valve (high speed)
25. Telltale lamp (high speed -on-)
34. Micro switch - "topping" or "retracting boom"
36. Push button switch - "topping" (at overload only)
37. Micro switch - "lowering" or "telescoping boom"
39. Solenoid main valve - luffing- and telescoping gear
41. Telltale lamp (green) - luffing gear
42. Push button switch - changeover from luffing - to telescoping gear
44. Solenoid valve - changeover from luffing to telescoping gear
46. Telltale lamp (green) - telescoping gear
49. El.switchgear cabinet
50. SLI-central unit
51. SLI-indicator unit

Special equipment



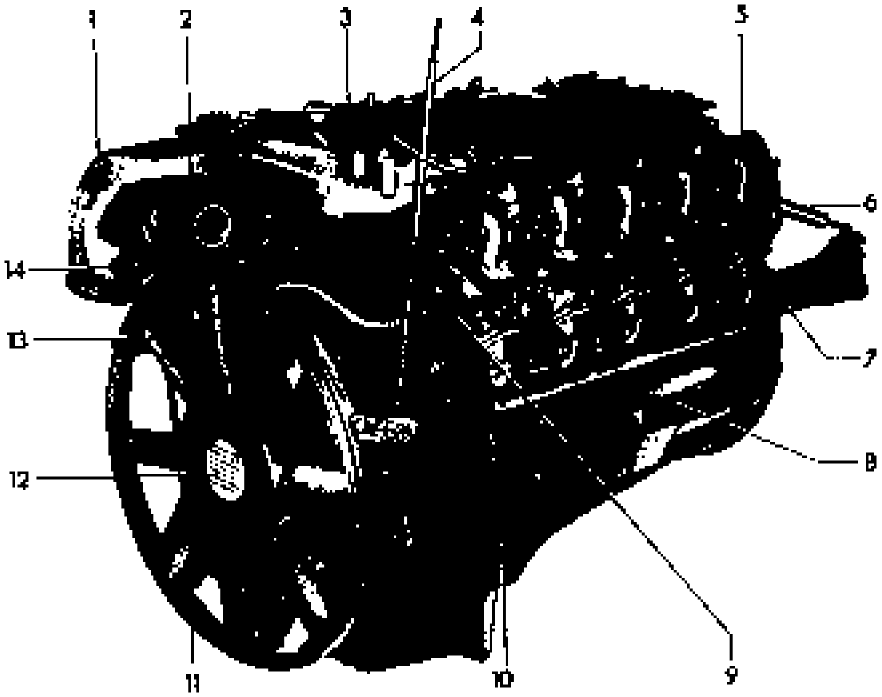
Dates of engine

Type of engine	OM 403
Number of cylinders	10
Bore	125 mm
Stroke	130 mm
Total piston displacement	15.950 cm^3
Injection order	1-6-5-10-2 7-3-8-4-9
Idling speed	app. 600 1/min
Rated speed	2500 1/min
Engine output	320 PS / 235 KW at 2500 1/min
Max. torque	1030 Nm at 1500 1/min
Weight	app. 1000 kg

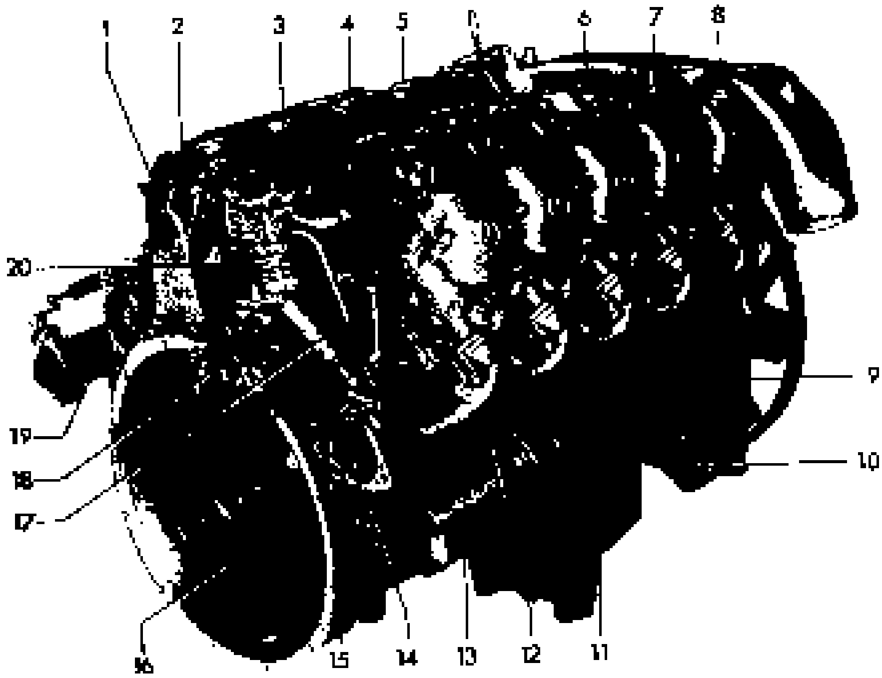
Position of
type plate
(see arrow)

Engine components

1 Intake manifold
2 Cooling water outlet
3 Injection lines
4 Oil dipstick
5 Cylinder head cover
6 Exhaust brake air cylinder
7 Exhaust manifold
8 Starter
9 Cylinder head
10 Left-hand front engine support
11 Fan guard
12 Viscous-drive van
13 Water pump pulley
14 Control linkage



1 Rear suspension lug
2 Two-stage fuel filter
3 Injection pump
4 Fuel precleaner
5 Oil separator
6 Front suspension lug
7 Cylinder head cover
8 Oil filler plug
9 Right-hand front engine support
10 Three-phase generator
11 Oil pan
12 Engine oil heat exchanger
13 Oil filter
14 Exhaust brake valve
15 Timing gear case
16 Flywheel
17 Exhaust brake air cylinder
18 Power steering pump
19 Exhaust manifold
20 Air compressor



Maintenance

Changing engine oil

Drain oil from oil pan while the engine is still warm. To do this, unscrew drain plug at bottom of oil pan (see figure). Check drained oil from time to time for water content and metal chips. If traces of water or metal chips are found lay up engine and repair, if necessary.

Engine oil drain plug (location depending on engine design)

Screw in drain plug using new sealing ring. Clean oil filter (description below). Add oil according to specifications into oil pan and into additional oil tank, if any.

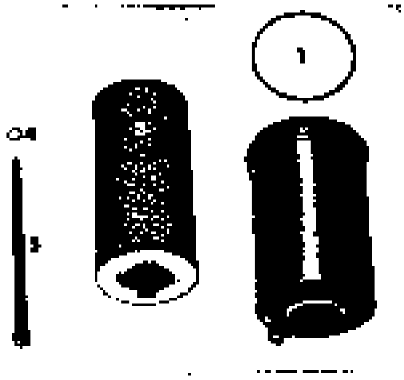
(When adding oil to oil pan, be sure to remember the 3,0 resp. 3,5 liters for the oil filter bowl; refer to technical data on "Capacities")

Crank engine with starter until the oil pressure gauge indicates pressure. While doing this, press shut-off button or place injection pump lever in stop position, otherwise the engine may start.

Allow engine to idle for a short period and check for leaks, including oil filter. Switch off engine. After approximately 5 minutes check engine oil level and add oil up to upper dipstick mark, if necessary.

Renew paper main flow filter element

If the oil filter of the engine is provided with a paper main flow filter element (identified by a sticker on oil filter housing, if attached) replace element during each oil change (every 200 hours of operation).



1 Sealing ring
2 Filter bowl
3 Full-flow filter
4 Sealing ring
5 Middle-screw

Remount

Unscrew oil drain plug and drain oil. Loosen oil filter screw and remove filter bowl with paper main flow filter element.

If metal chips are found in oil filter, find cause and recondition engine, if required. Clean oil drain plug and filter bowl in benzine.

Installation

Replace all sealing rings. Insert new paper main flow filter element into filter bowl, face with coil spring in direction of bowl bottom. Position filter bowl against filter carrier, with oil drain plug in downward direction, press against carrier and turn oil filter screw manually several times, then tighten with socket wrench. Note tightening torque.

(Include 3,0 or 3,5 liters of oil for filter housing when filling oil pan).

Checking valve clearance

Valve clearance adjustment
1 Feeler gauge
2 Box wrench
3 Screwdriver
4 Adjustment screw
5 Lock nut

The check should be made with the engine cold (at the earliest 20 minutes after stopping engine).

Remove cylinder head covers.

Fasten turning device to the timing gear case at the inspection hole using the two threaded holes (see figure 4). This facilitates cranking the engine. Check valve clearance according to firing order.

Turn engine until the piston of the cylinder to be adjusted is at TDC. The intake and exhaust valves must be closed and no load applied to the rocker arms.

The valves on pistons moving the same direction (see table below) overlap.

Check valve clearance between rocker arm and valve stem end.

Nominal valve : Intake 0,25 mm
Exhaust 0,35 mm

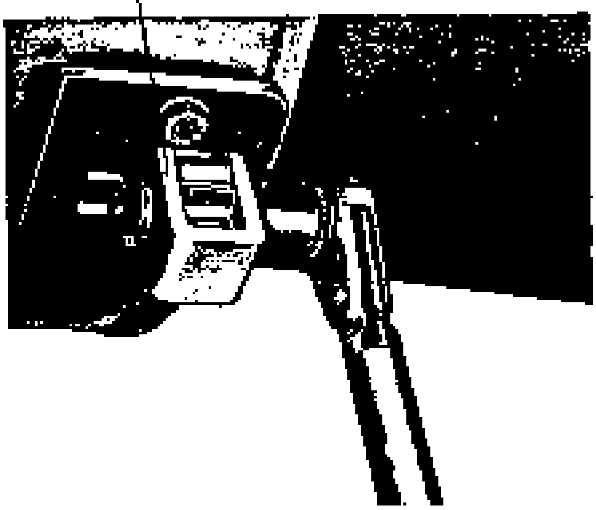
If an adjustment of the clearance is necessary, loosen lock nut and turn adjustment screw until slight resistance is felt when the gauge is passed through with the lock nut tightened.

When the valve checks have been completed, check condition of cylinder head cover gaskets and replace them if necessary. Reinstall cylinder head covers and tighten them (tightening torque 1 kpm = 9,8 Nm).

Firing order and valve overlap

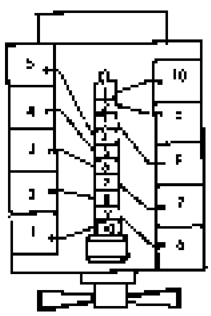
Firing order OM 403	1	6	5	10	2	7	3	8	4	9
Valve overlap	7	3	8	4	9	1	6	5	10	2

turning device picture 4



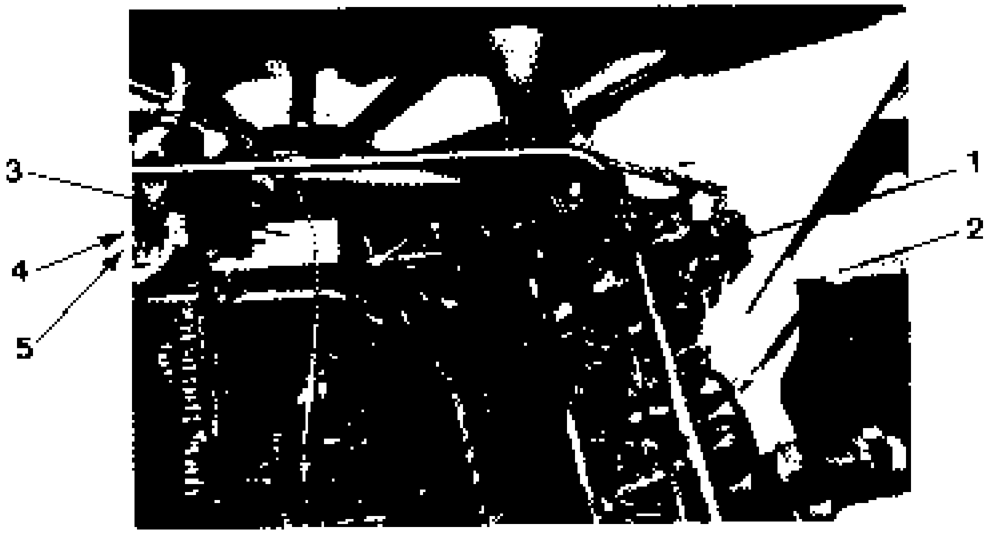
Cylinder arrangement with diagram of injection lines

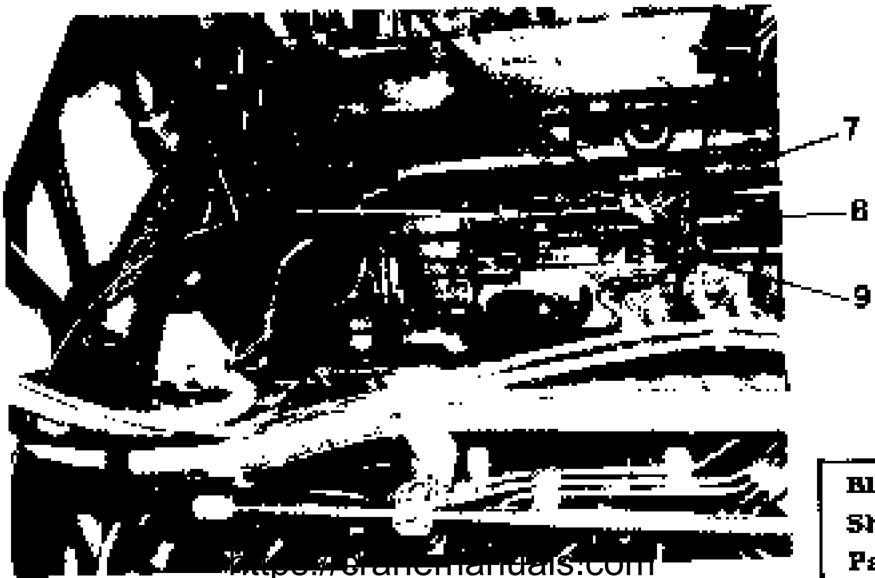
The arrangement of the injection lines is determined by the injection order of the injection pump.



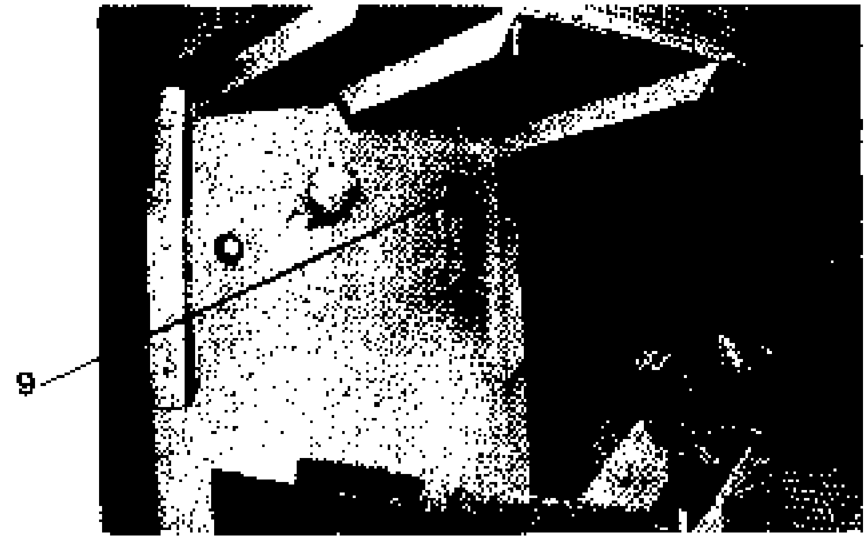
Components - Layout

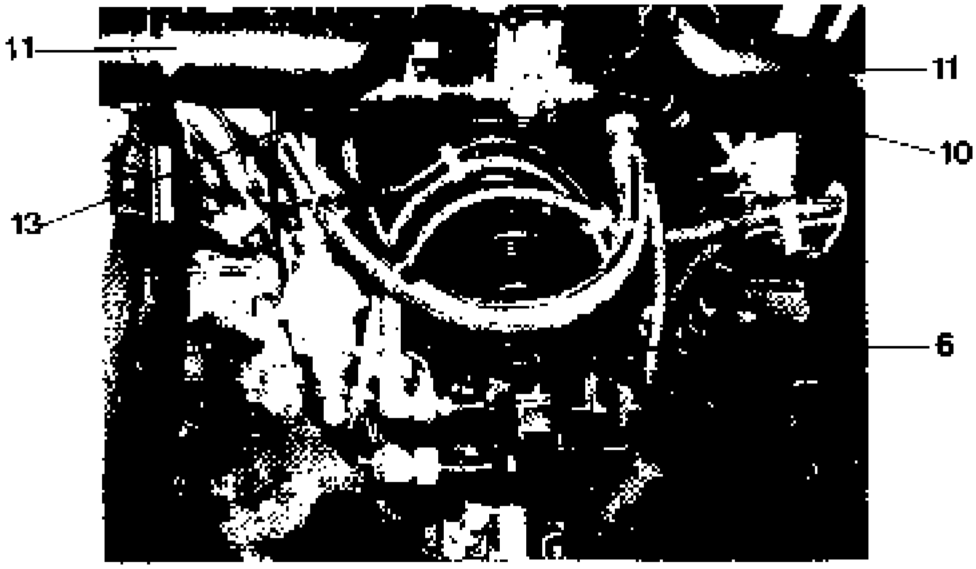
1 Oil filling
2 Oil dipstick
3 Hydr. Motor (Fan)
4 Level restoring valve (non return valve)
5 Pressure limiting valve
6 Hydr. Pump
7 Working cylinder - engine stop
8 Working cylinder - engine torque limiter
9 Mechanical engine stop
10 Steering pump
11 Air filter
12 Oil filter (return line - Fan drive)
13 Battery main fuse





Components - Layout





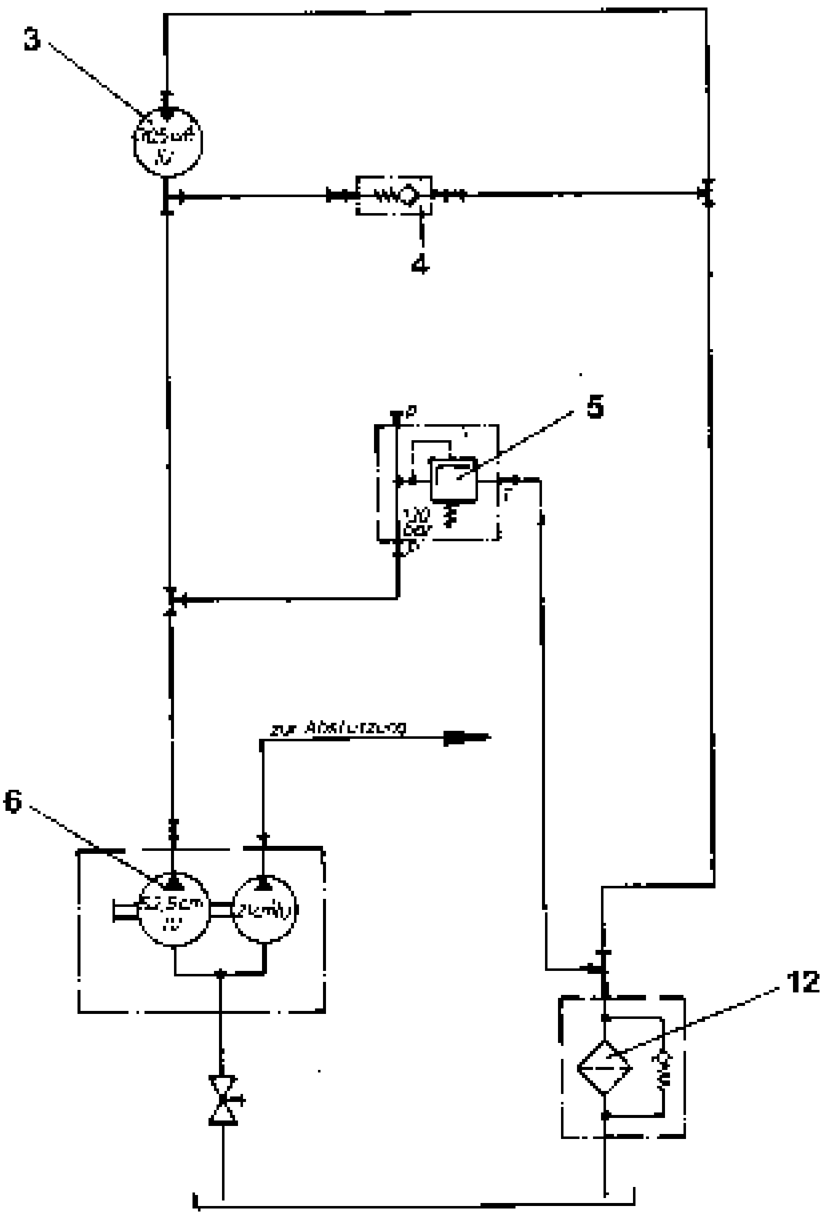
Fan Drive

The fan drive is driven hydrostatically (see hydr. circuit diagram).

The hydraulic pump (6) is driven from the diesel engine and delivers oil to the hydr. motor (3). From there the oil returns via return flow filter (12) to the hydr. tank.

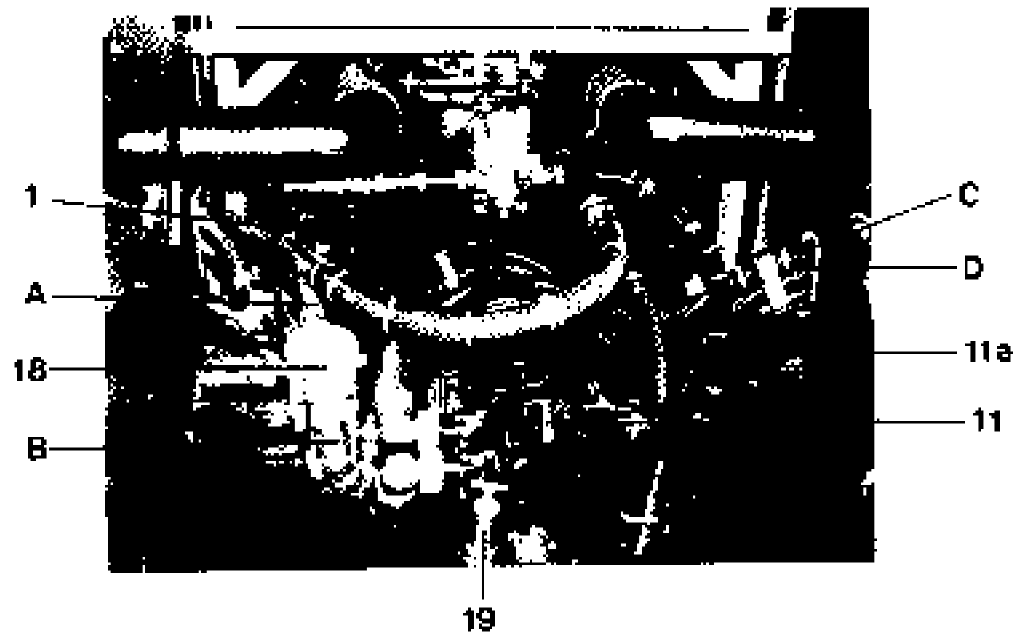
Maintenance

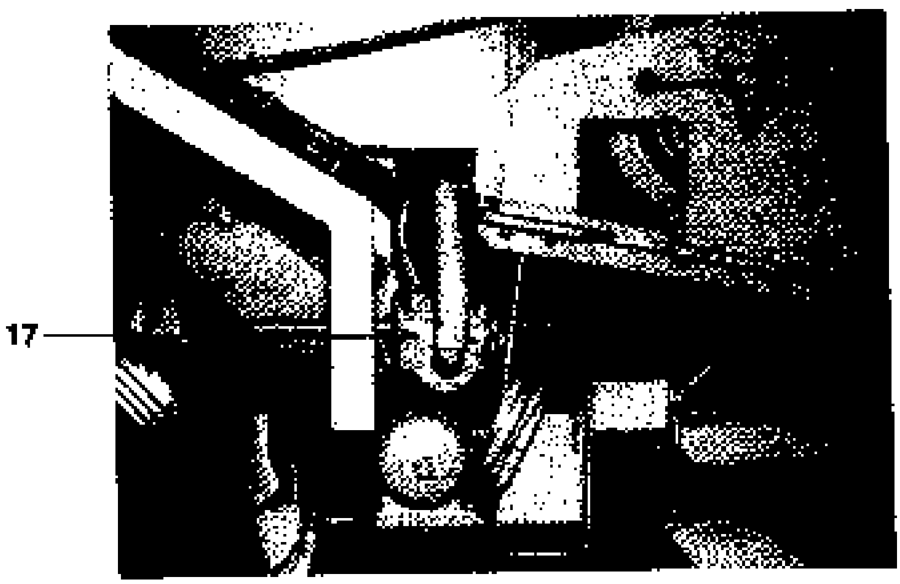
Replace oil filter every 400 h.



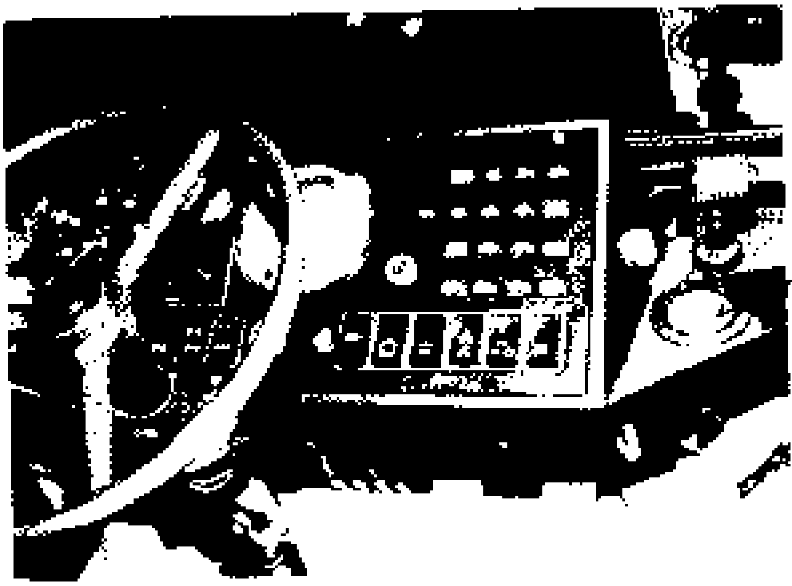
Components - Layout

1	Converter HN 500	A	=	Filler inlet
11	Hydr. pump (supports)	B	=	Filter outlet
11a	Hydr. pump (fan drive)	C	=	Oil cooler inlet
17	Oil cooler (heat exchanger)	D	=	Oil cooler outlet
18	Oil filter (pressure side)			
19	Oil filler pipe and level check			



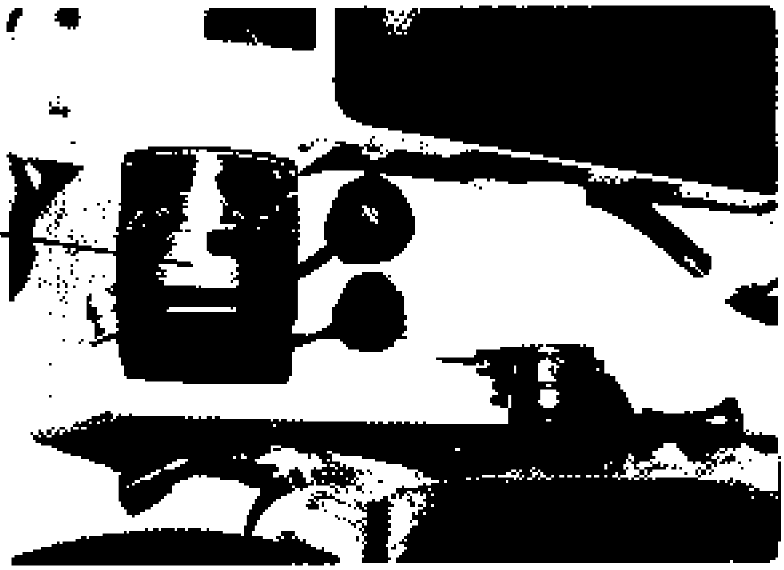


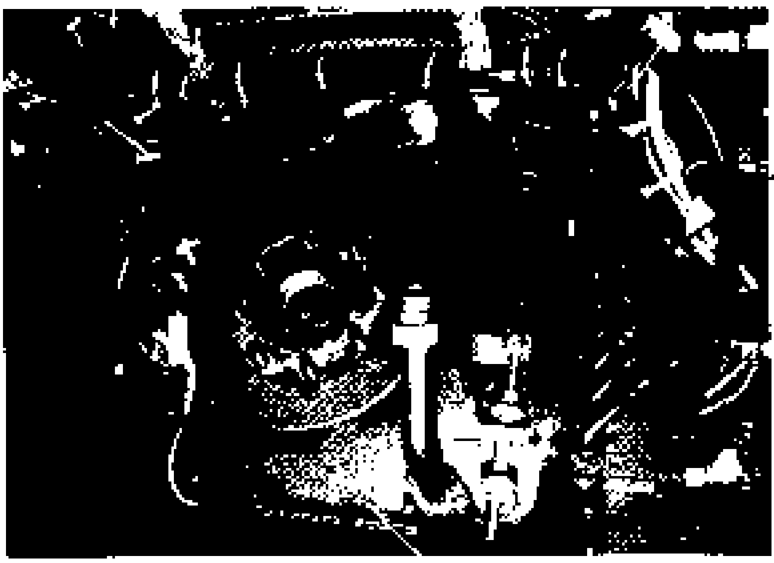
Components



Oil pressure gauge
(converter - shift pressure)

Controller SG-6s





Power-shift reversing gearbox 6 WG 180
- with attached par ing brake

Parking brake system

When handbrake valve is moved in parkingbrake position then additional to the rear axle park (hand) brake the parking brake will be actuated.

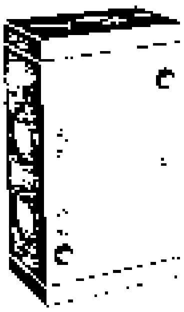
a) through the discbrakes on the front wheels

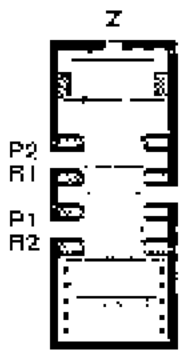
b) through the parking brake (with brake shoes) on the driving shaft to the rear axle.

Components layout and function - see 2.4 -

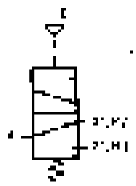
Add. components

item 60 3/2 way valve

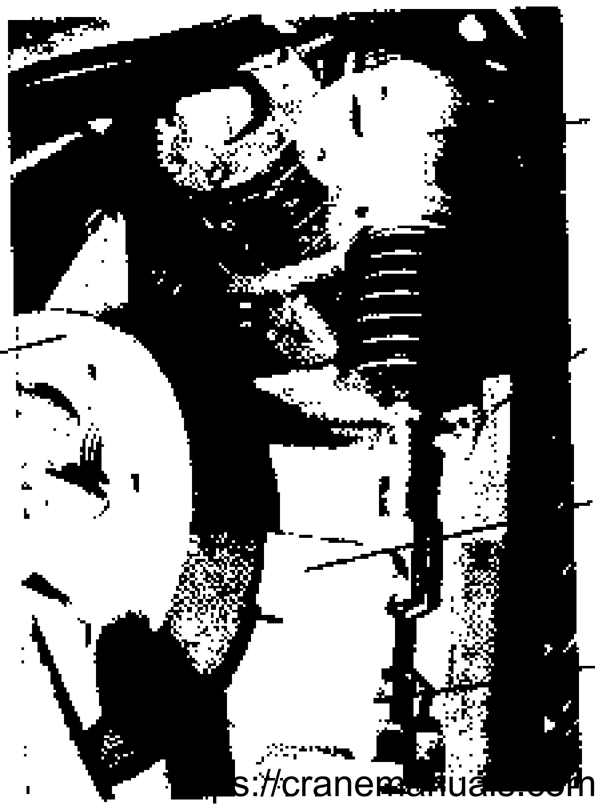




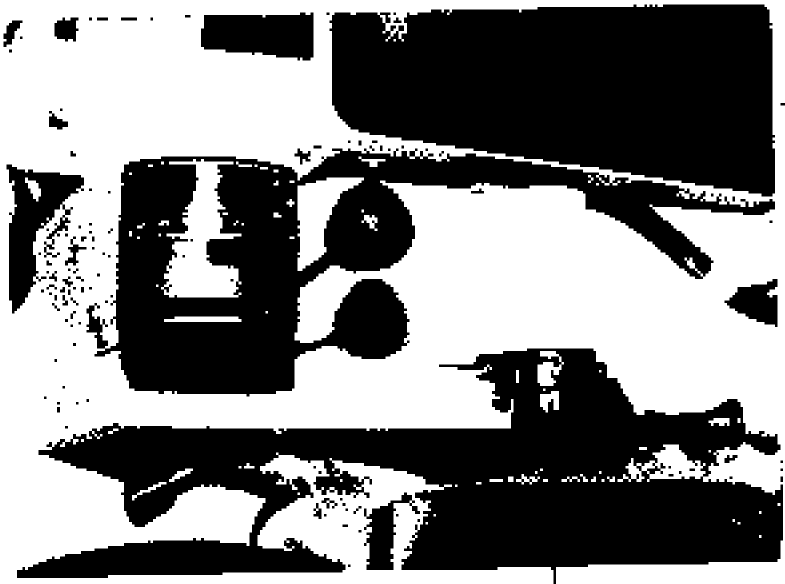
Connection	P1,P2	=	pressure line
"	R1,R2	=	vent
"	A	=	operating line
"	Z	=	control line
Venting valve		=	pressure line on P1
Exhausting valve		=	" " " P2



Components-layout

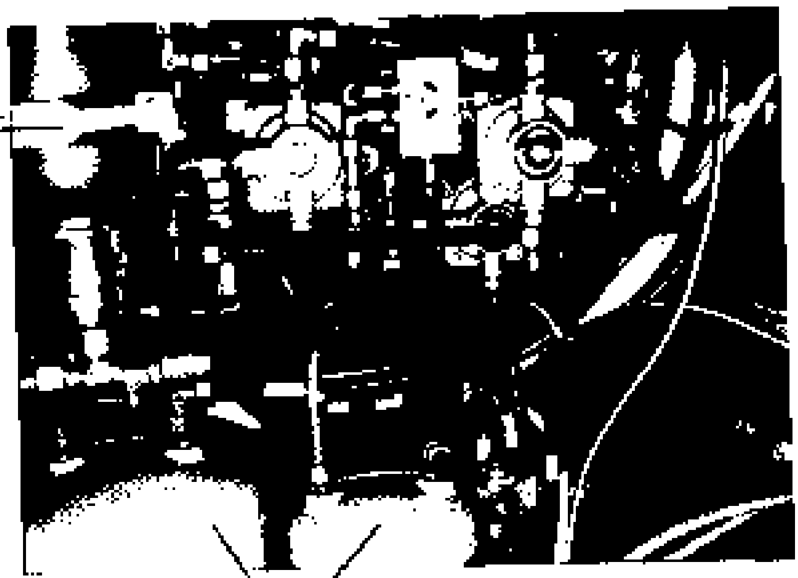


Components - Layout



cab

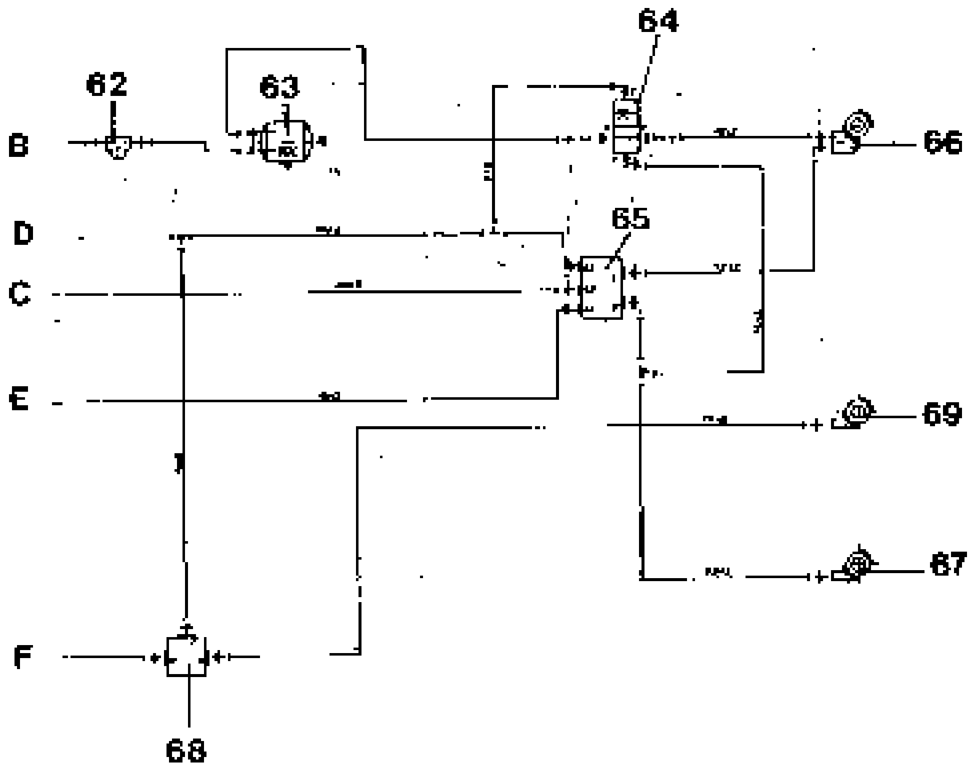
Handbrake valve
(Parkingbrake valve)



Bladder-
accumu-
lator

Reservoirs

Diagram - trailer brake system

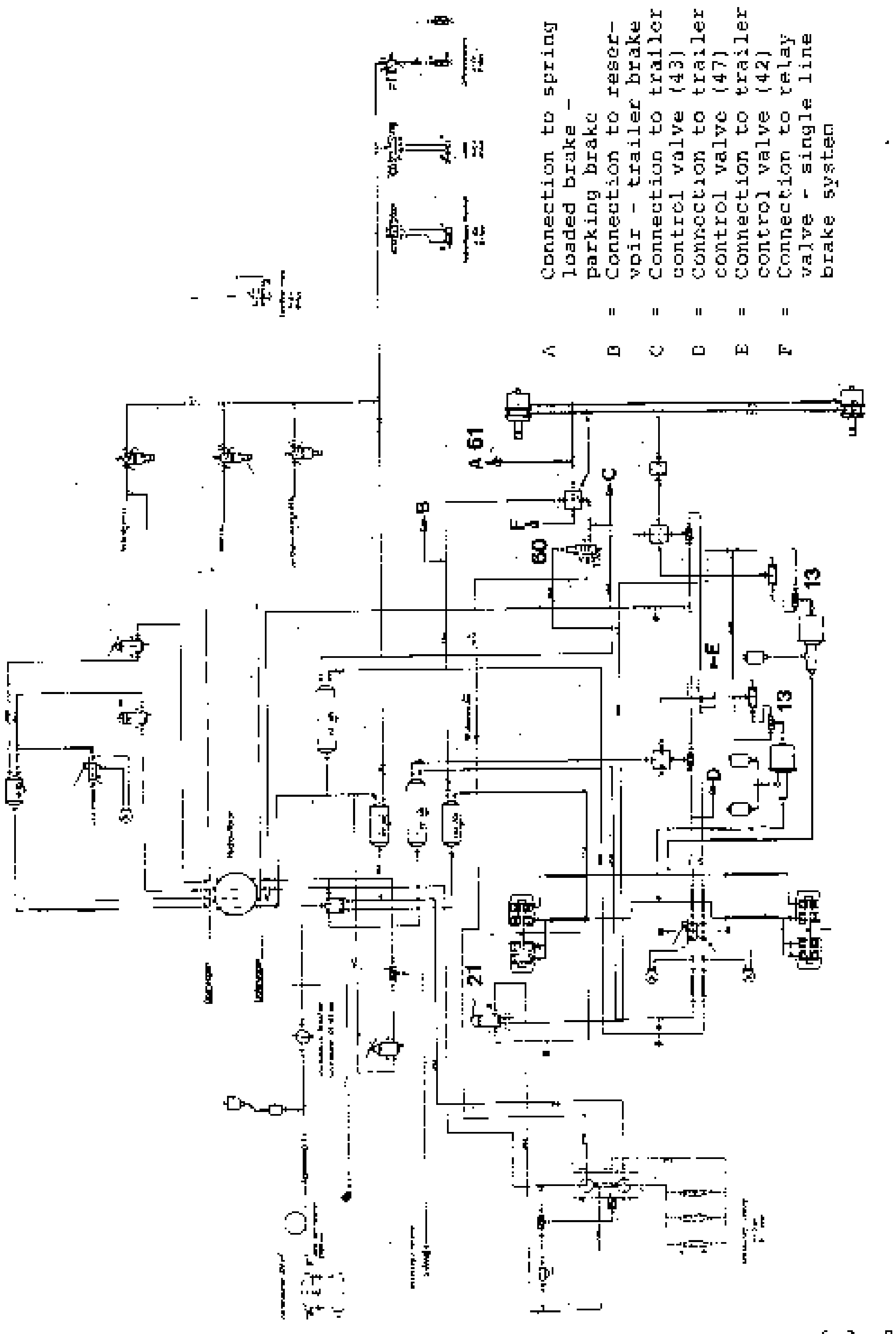


vehicle frame - bottom view

Trailer - brake valves

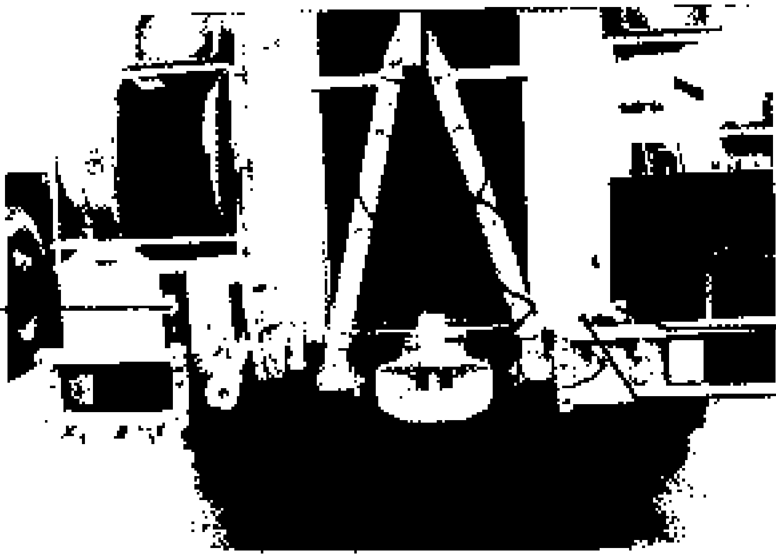
62	Flow relief valve
63	Reservoir tank (trailer brake)
64	2/2 way valve (pneumatic trailer safety valve)
65	Trailer control valve
66	Coupling head - (two line brake system - reservoir)
67	Coupling head - (two line brake system - brake pressure)
68	Relay valve - single line brake system
69	Coupling head - single line brake system

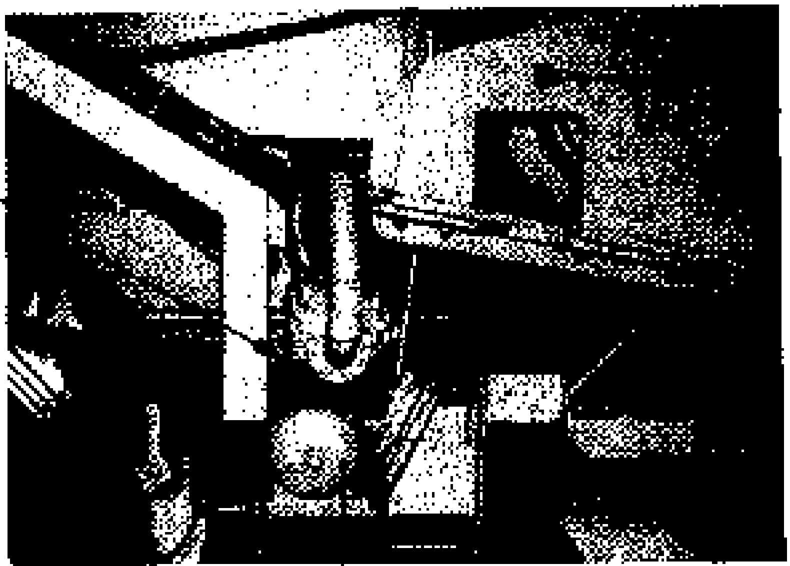
Air brake system



A = Connection to spring loaded brake – parking brake
B = Connection to reservoir – trailer brake
C = Connection to trailer control valve (43)
D = Connection to trailer control valve (47)
E = Connection to trailer control valve (42)
F = Connection to relay valve – single line brake system

Components - Layout



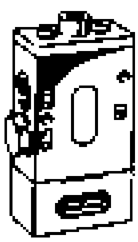


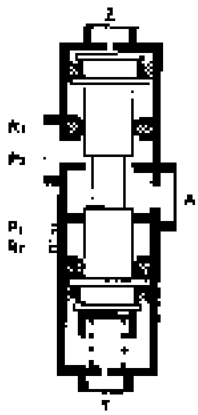
2/2 - way valve

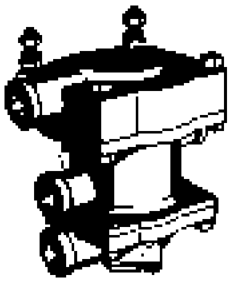
Use: inserted in reservoir line to trailer ahead of the automatic coupling head.

Task: rapid exhausting of the reservoir line to 1.5 bar, provided that the trailer brake line is not coupled when a full brake application is made.

64







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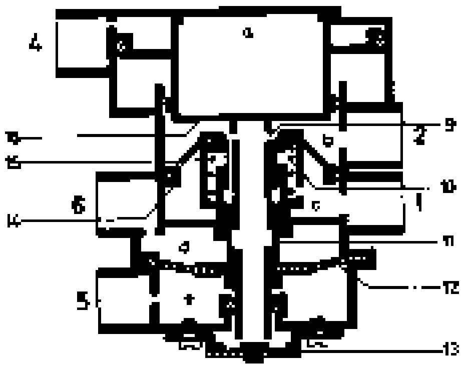


Trailer control valve

Purpose:

To control the twin pipe trailer brake system, in conjunction with the dual circuit main-vehicle brake valve and the handbrake valve for the spring-loaded parking brake cylinders.

Operating principle:

Space c is supplied with air continuously from the reservoir, via union 1. Space d is exposed to reservoir air pressure in the released position from the handbrake valve, via union 6.

Diaphragm (12) is at its lower limit of movement. The trailer brake pipe connected to union 2 is exhausted via outlet (9) and air outlet valve (13).

1. Actuating the dual circuit main-vehicle brake valve

   When the main-vehicle brake valve is operated, compressed air from circuit 1 flows via union 4 to space a above piston (16), and moves the piston down. When piston (16) makes contact with valve (10), outlet (9) is closed; as downward movement continues, inlet (15) is opened. Compressed air can then pass from union 1 to union 2, and build up pressure in the trailer brake pipe in proportion to main-vehicle braking pressure.

   As soon as the pressure in space b has build up the necessary opposing force, piston (16) is raised against the braking pressure in space a. In the case of a partial brake application, the following valve (10) closes inlet (15). The trailer brake control valve is then in the connected position. If a full brake application is made, however, piston (16) keeps inlet (15) open.

Trailer control valve

At the same time as these events are taking place in circuit 1, space e beneath diaphragm (12) is being pressurized through union 5 with air from main-vehicle brake circuit 2. However, since the pressurizing of space b has caused the forces exerted in the opposite direction by piston (14) to predominate, the position of diaphragm (12) does not change.

If brake circuit 1 should develop a fault, so that the main-vehicle brake valve supplies pressure only to union 5 and not to union 4, diaphragm (12) is moved up with piston tube (11) valve (10) and piston (14) as a result of the service brake pressure in space e. Piston (16) is then fixed in position, so that outlet (9) is closed and inlet (15) opened; in this way pressurizing of the trailer brake pipe takes place in proportion to the main-vehicle brake application.

If a partial brake application is made, piston (14) moves down after the intended trailer brake pipe pressure has built up in space b, closes inlet (15) and thus reaches the final setting. In the case of a full brake application, on the other hand, inlet (15) remains open.

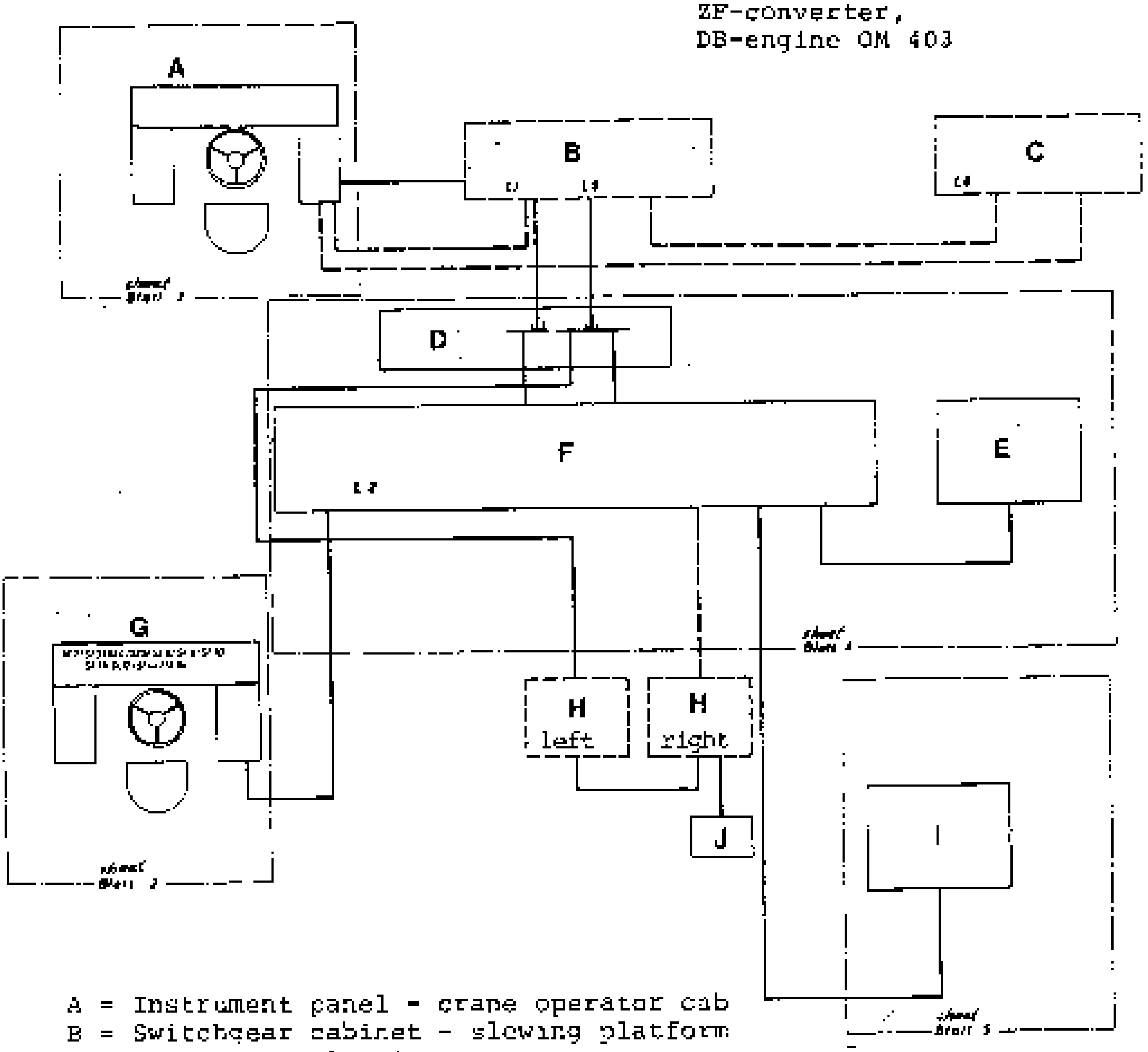
2. Actuation of handbrake valve

Exhausting of the spring-loaded brake cylinders in successice stages via the handbrake valve results in a corresponding loss of air from space d, via union 6. Reservoir pressure in space c then predominates, and moves piston (14) up. After this, air pressure is allowed to reach union 2 in the same manner as for space e when circuit 1 is out of action.

When the control pressure is removed from unions 4 and 5, or when union 6 is again supplied with air pressure, outlet (9) always opens, so that the trailer brake pipe is exhausted via piston tube (11) and air outlet valve (13).

General arrangement

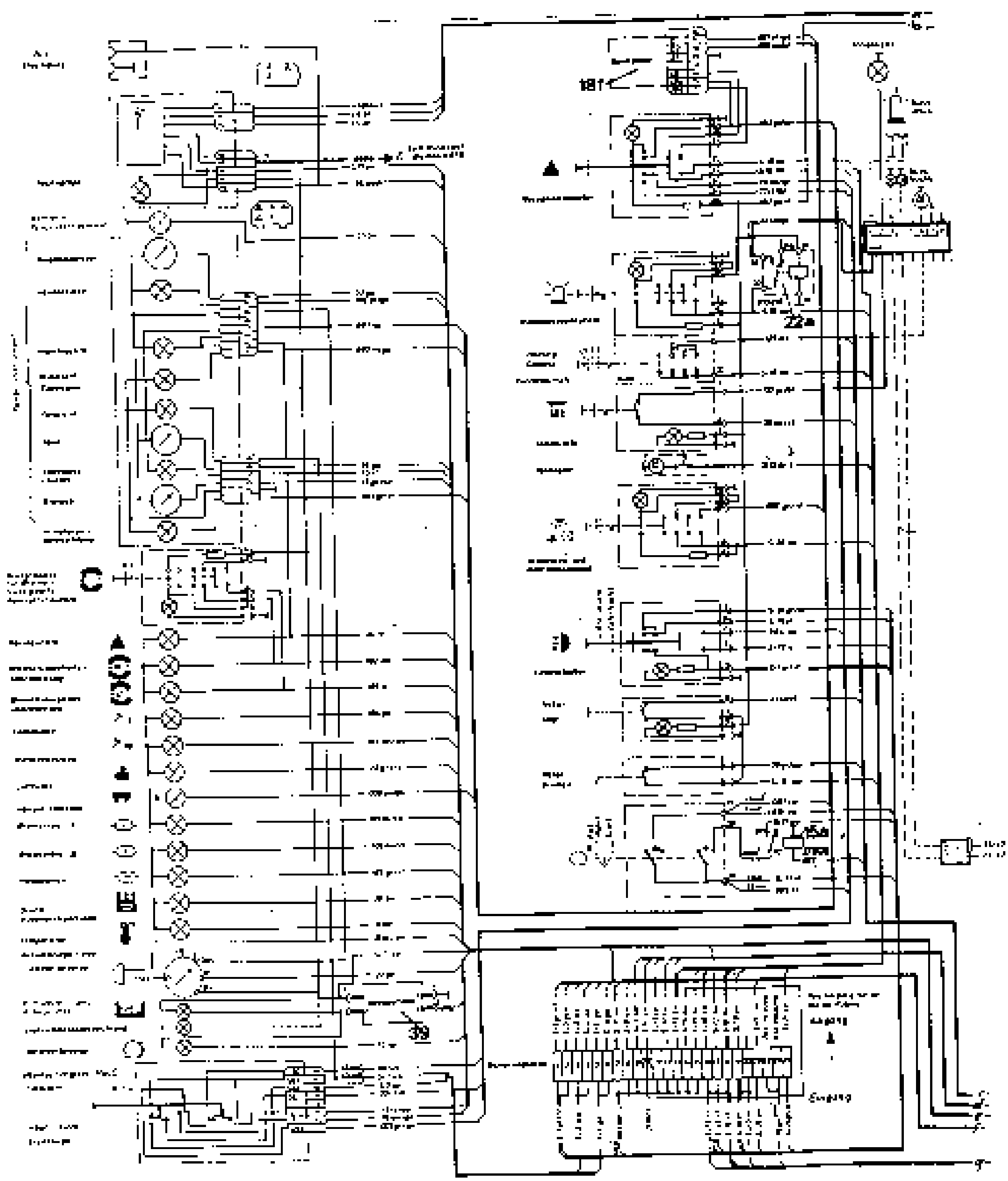
road version with
ZF-converter,
DB-engine OM 403



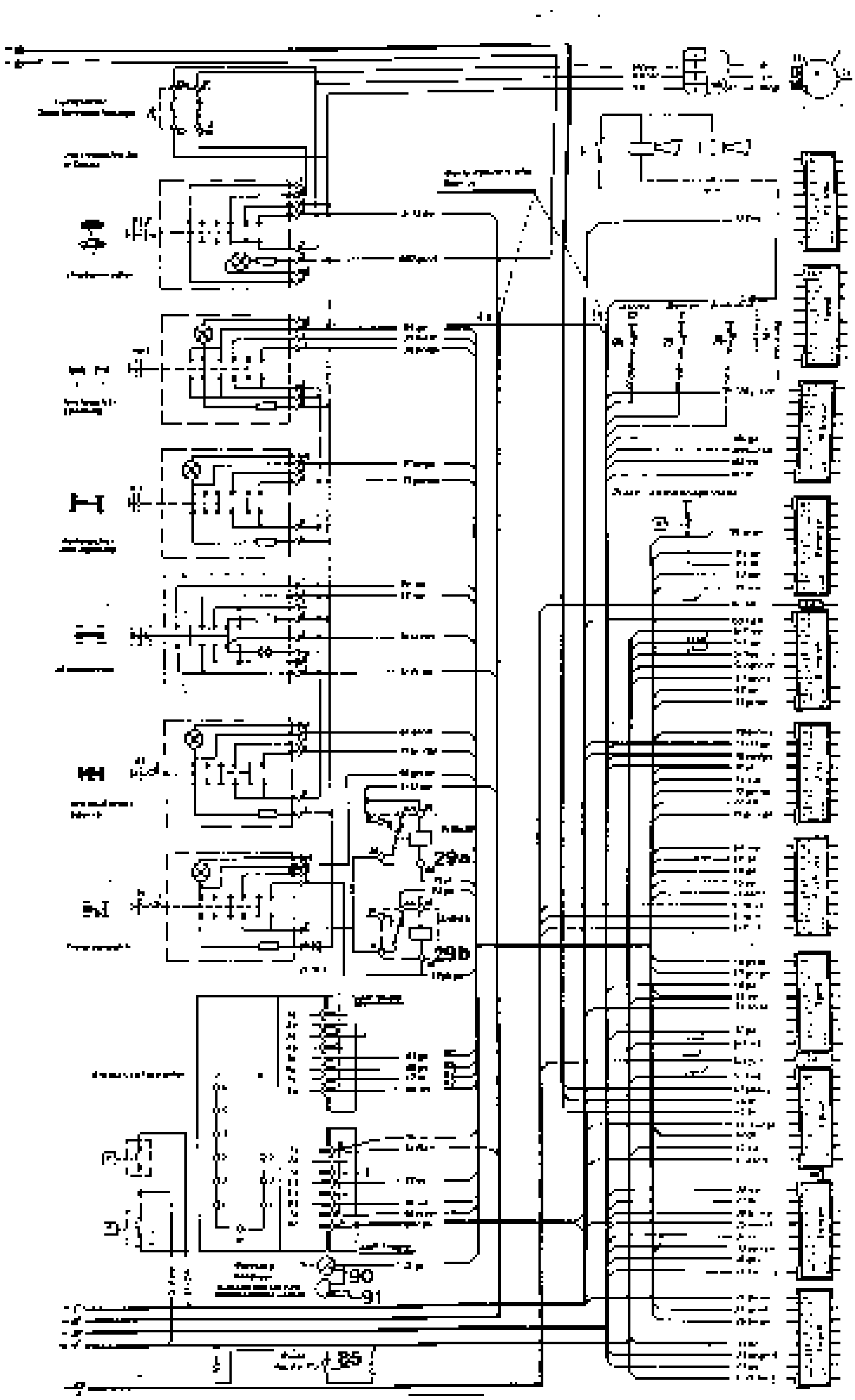
A = Instrument panel - crane operator cab
B = Switchgear cabinet - slewing platform
C = SLI - central unit
D = Rotary connector
E = Instrument panel - engine
F = Switchgear cabinet - chassis
G = Instrument panel - cab
H = Control panel - supports
I = Vehicle electrical system - general
    - engine, valves, limit switches etc. -
J = Solenoid valve

Vehicle electrical system

Chassis - sheet 2

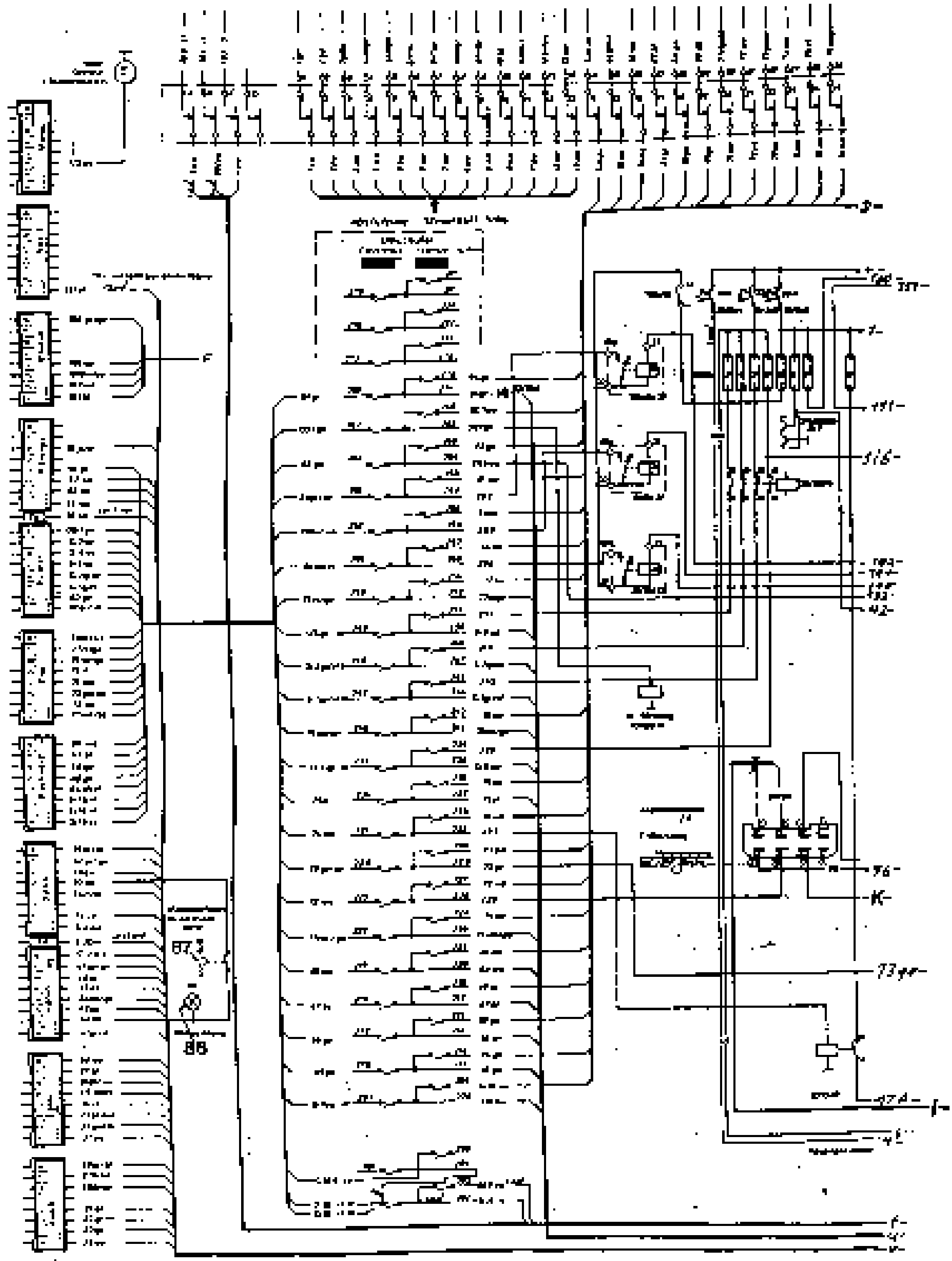


Chassis - sheet 2



Vehicle electrical system

Chassis - sheet 4



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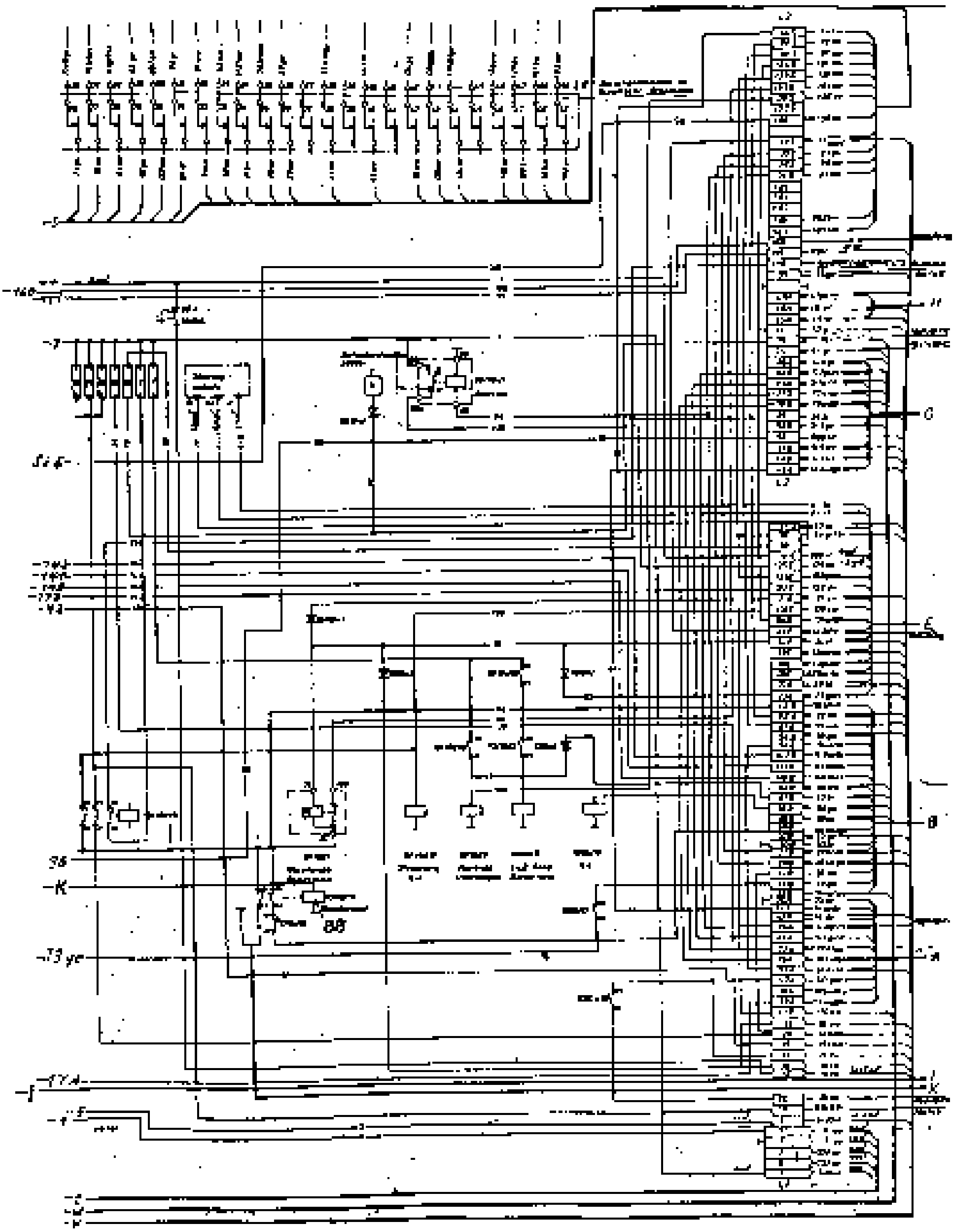
Vehicle electrical system

Chassis - sheet 4



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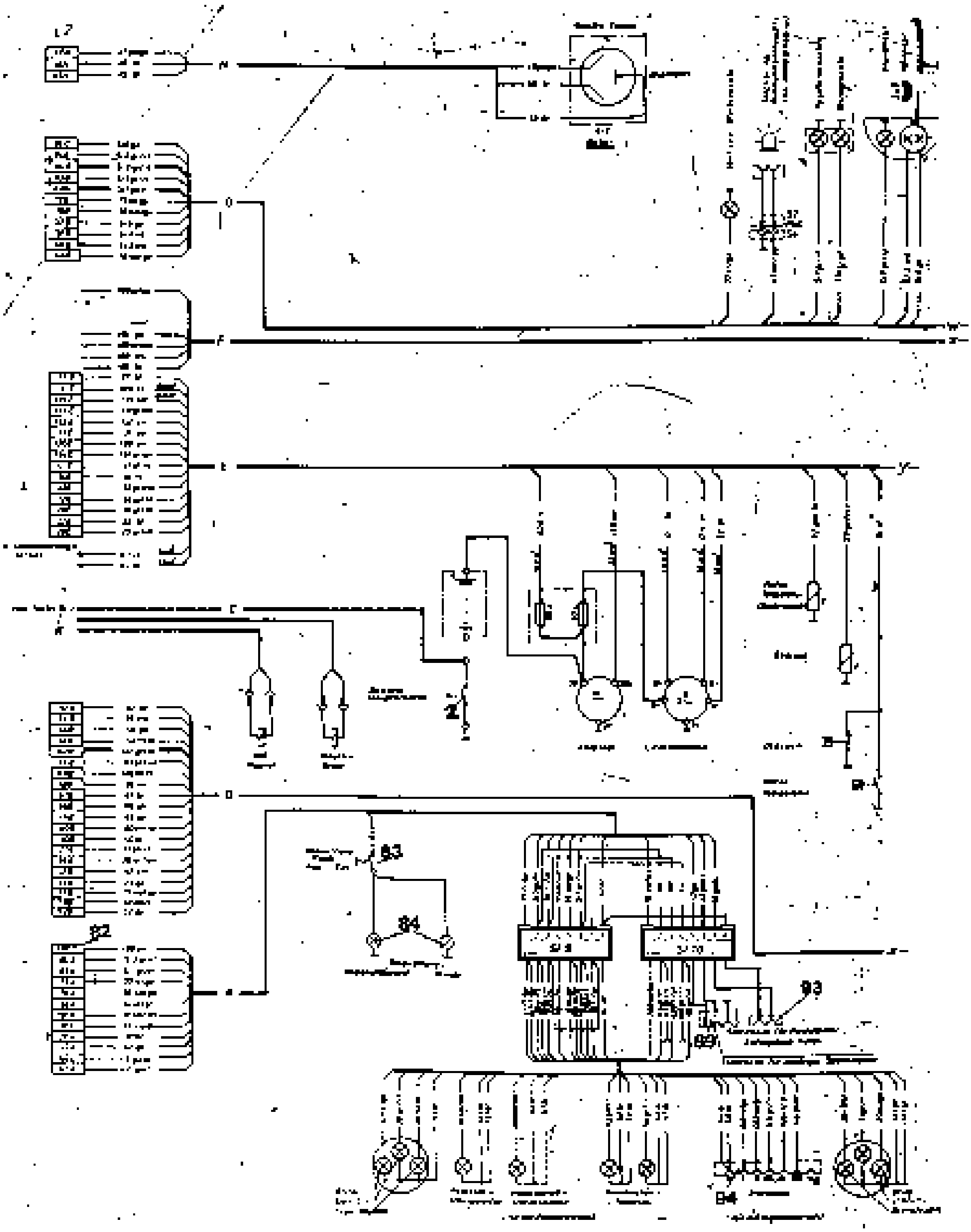
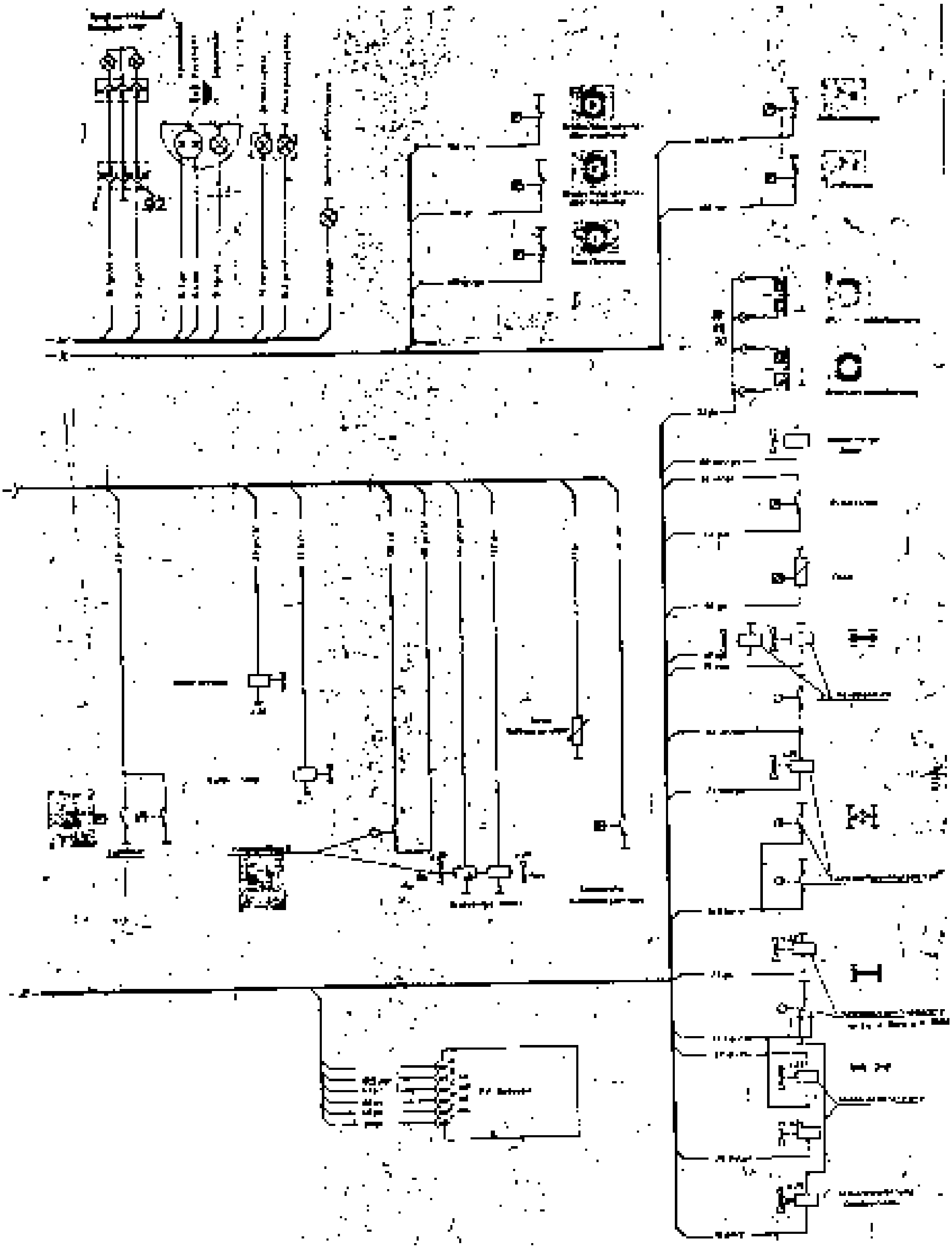
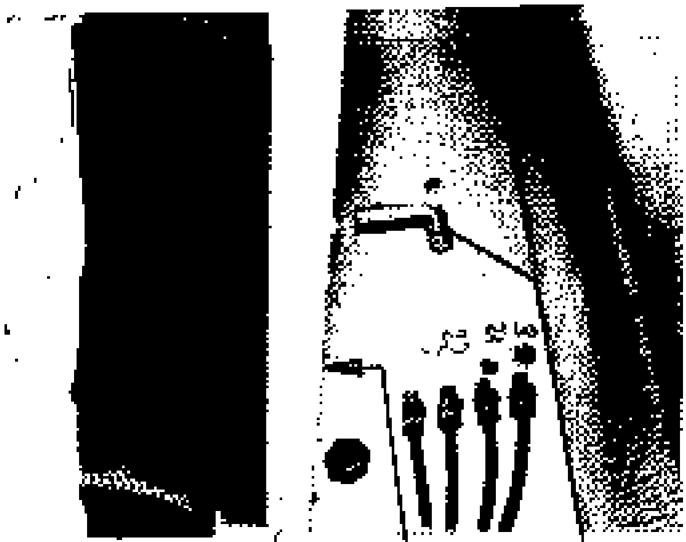
Sheet
Page
6.4.03

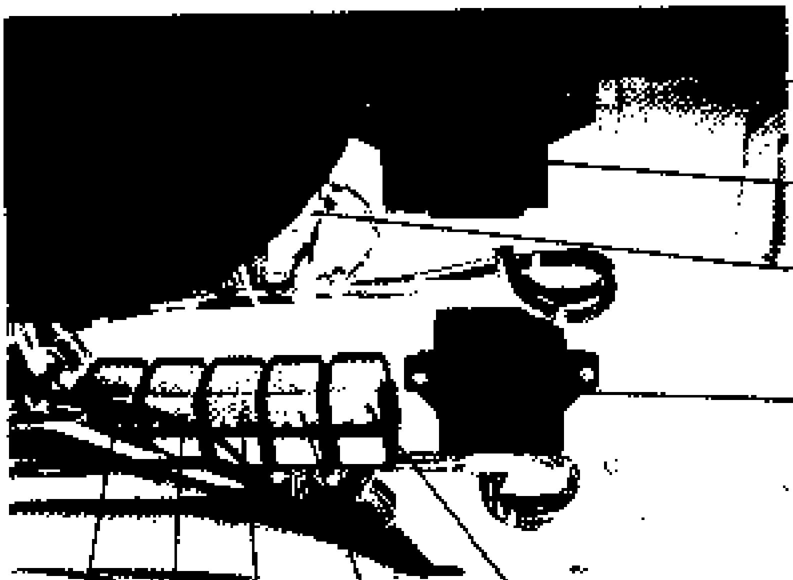
Chassis - sheet 5



Chassis - sheet 5

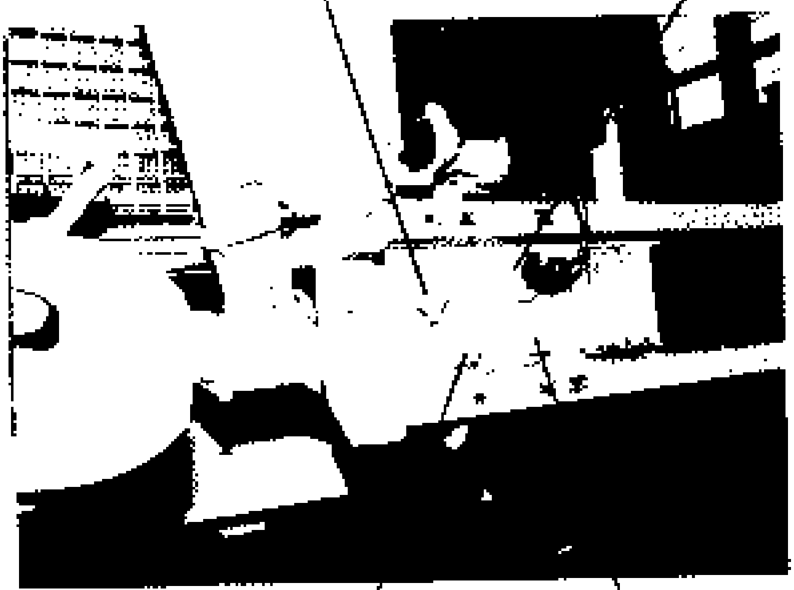






Following components are shown and described on sheet 2.8.01 – 2.8.12

Item	Designation
1	battery 24V
2	battery main switch
15a	relay 2/10d15
18f	flasher relay
22a	relay 2/10d16
29a	relay 2/10d22
29b	relay 2/10d11
29f	blocking diode 2/1n1
39a	level switch (cooling water)



Summary of components

(Version with DM 403 power unit and recovery winch only)

Item	Designation	Function	Location
82	Positive connection	For winch lighting	L2 switchgear cabinet
83	Push button switch	Winch lighting	Rear right
84	Lighting	Control stand and winch	Rear right and rear left
85	Rocker switch	Winch operation, front on/off	Cab (instrument panel)
86	Lighting	Rope winch	Front
87	Contact switch	Recirculating valve on/off (for winch operation)	See Sheet 6.6.02 (back) Item 4a
88	Relay 10/10d14	a) Contact 13-14 (positive) for converter clutch solenoid b) Contact 41-42 for solenoid valve, reduced volume (motor)	Switchgear cabinet

Note:

Solenoid valve (41) for reduced volume (motor) is not in operation during the following shift modes:

a) Travel control switch in 'N' position

b) Converter lock-up clutch (WK) engaged

Item	Designation	Function	Location
89	Socket	Trailer steering limit	Rear bumper
90	Warning lamp	Trailer steering limit	Instrument panel
91	Warning signal	Trailer steering limit	Instrument panel
92	7-pole socket	Marker lights, boom head	Rear bumper
93	3-pole socket	Rotating beacon light	Rear bumper
94	7-pole socket	Trailer electrics	Rear bumper

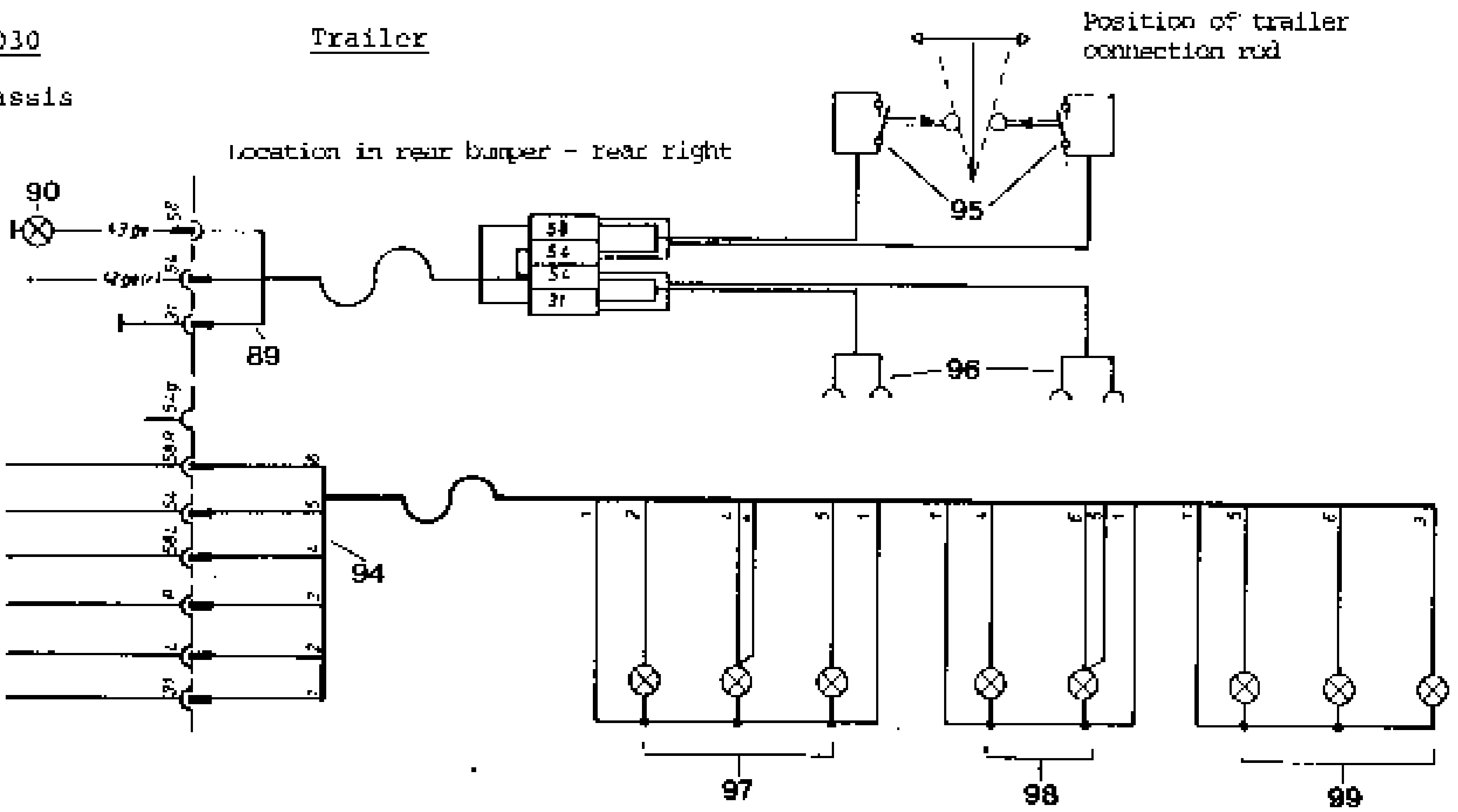
El. system - trailer

cle LTM 1030

Trailer

ystem - chassis

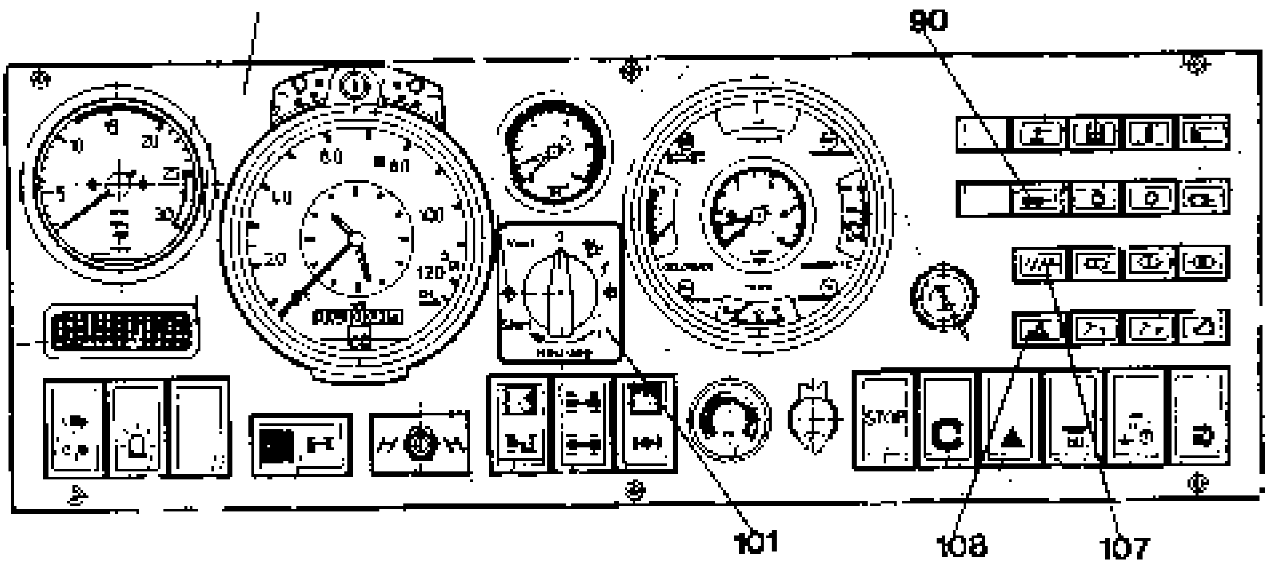
24V=



em	Designation	Function	Location
5	limit switch	stop for steering - indicator in the cab	trailer connection unit
5	24V socket	connection for handlamp	on trailer - side face left and right
7	rear light		rear bumper - left
3	License plate light		rear bumper
9	rear light		rear bumper - right

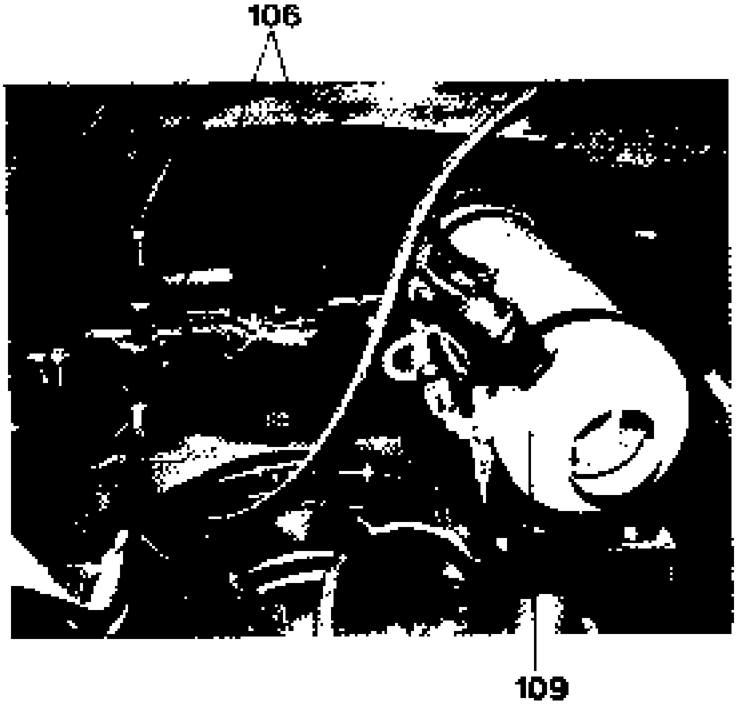
Components - layout

instrument panel - chassis



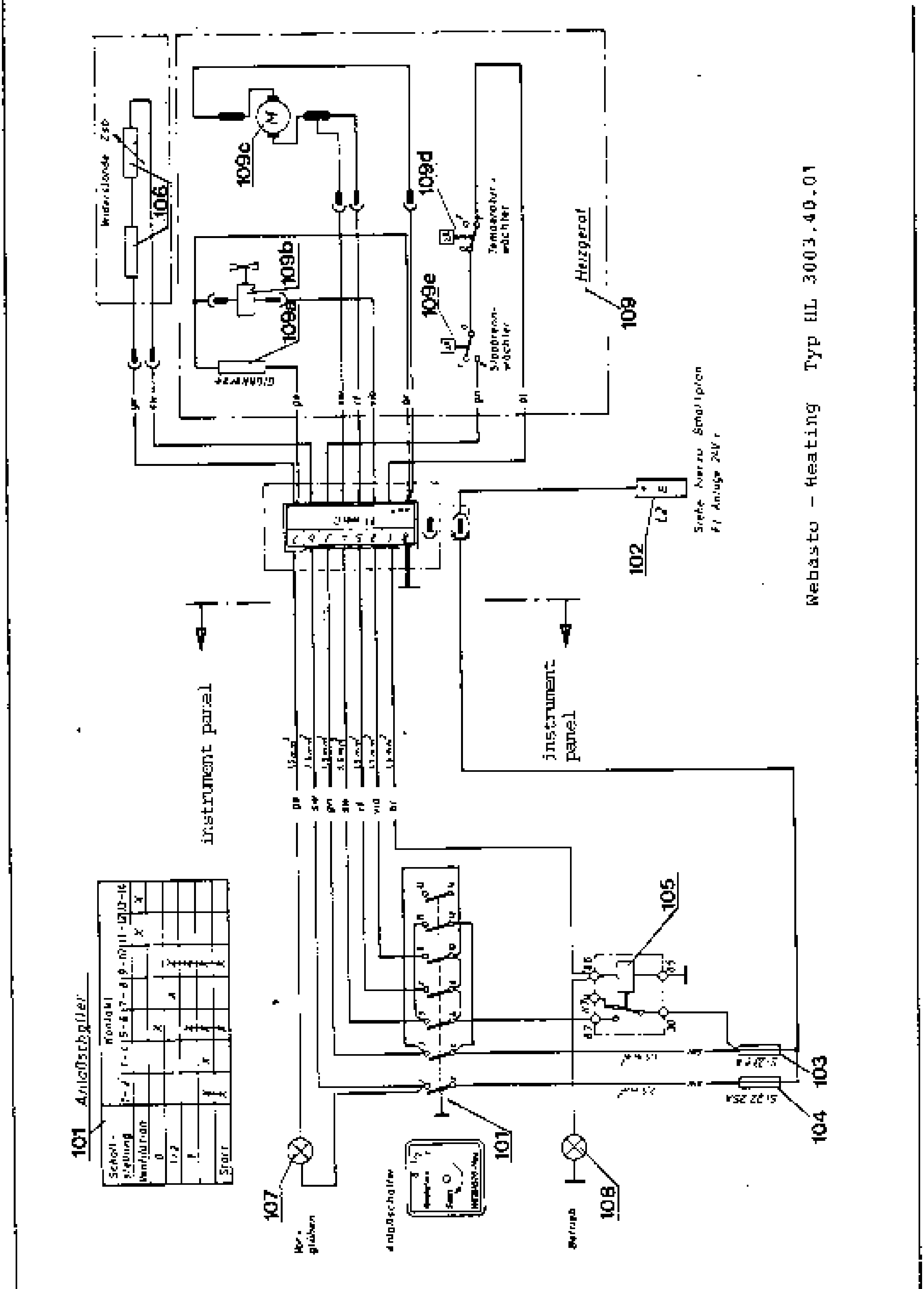
Heating - chassis

Item	Designation
101	starter switch
102	connection - positive (from switchgear cabinet L2)
103	fuse 8A (fuse box-instrument panel)
104	fuse 25A (fuse box - instrument panel)
105	relay (see sheet 6.4.04 -backside-)
106	resistor
107	telltale lamp - glowing
108	telltale lamp - heating "on"
109	Air heater
109a	glow plug
109b	solenoid valve (fuel)
109c	el. motor
109d	temperature fuse
109e	flame detection thermostat



el. circuit diagram see backside

El. circuit diagram -



20.000 H/3 - 367 recovery winch

Description:

The recovery winch is rated for a maximum rope pull of 200 KN (20 000 kg), equivalent to a hydraulic working pressure of 145 bar.
Rope speed can be varied as follows:

a) by increasing engine speed (the normal running speed is approx. 1 300/min)

b) by altering the amount of control lever movement away from neutral.

The winch is driven by an open hydraulic circuit.

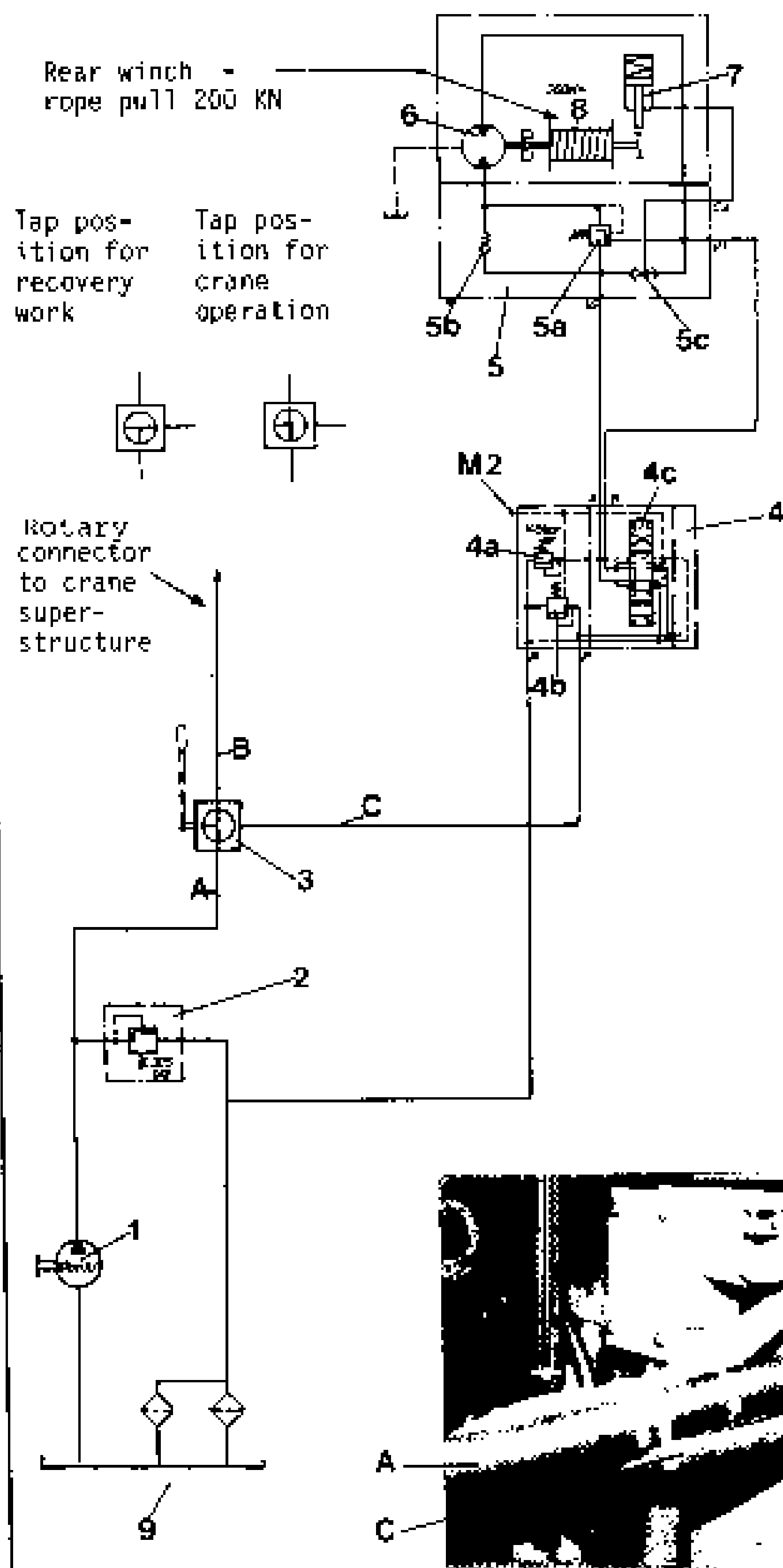
Ball tap (3) is reset manually to charge the hydraulic circuit from the 'crane operation' hydraulic pump (1). When control valve (4c) is in the neutral setting, oil passes through the pressure balance (4b) and flows back to the tank (circulation pressure approx. 5 bar).

When valve (4c) is advanced, oil reaches the braking valve (5) and thence the hydraulic motor (6). At the same time, the spring-loaded multi-disc brake (7) is actuated hydraulically, and released. The winch then rotates.

Control valve (4c) is operated manually (see Fig. 1).

Fig. 1

Hydraulic circuit diagra..



Item	Designation
1	Hydraulic pump (crane operation)
2	Pressure limiting valve - 305 bar (primary protection)
3	Ball tap
4	Control valve block
4a	Pressure limiting valve - 145 bar
4b	Pressure balance
4c	Control valve
5	Load braking valve
5a	Load pressure-limiting valve
5b	Check valve
5c	Brake actuating valve
6	Hydraulic motor
7	Multi-disc brake
8	Rope winch
9	Tank
10	Clutch lever (dog clutch)

Measuring points:

M 1 : Primary pressure (305 bar)

M 2 : Working pressure (145 bar)

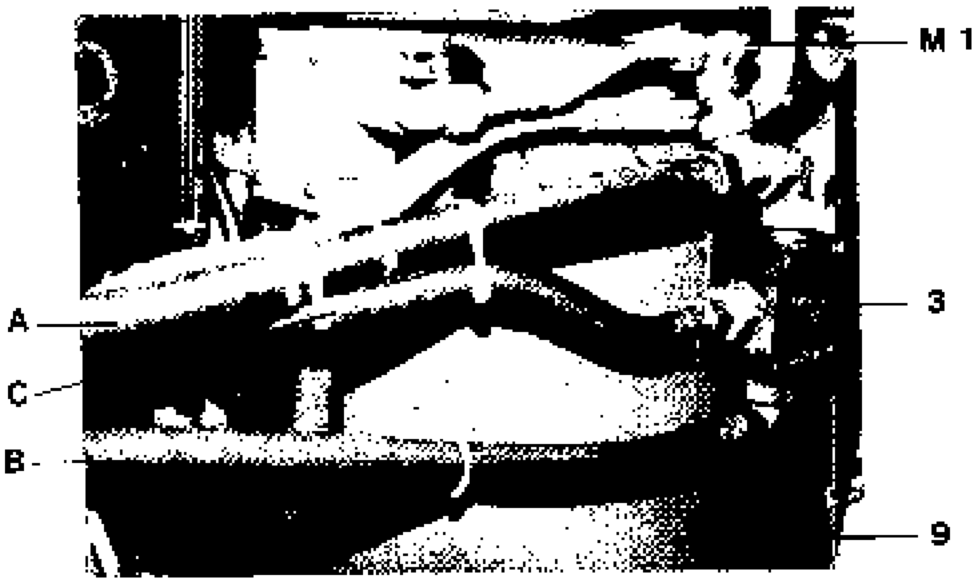


Fig. 2 (from below)

Pressure settings

M 1 : Primary circuit protection - 305 bar

M 2 : Working pressure - 145 bar

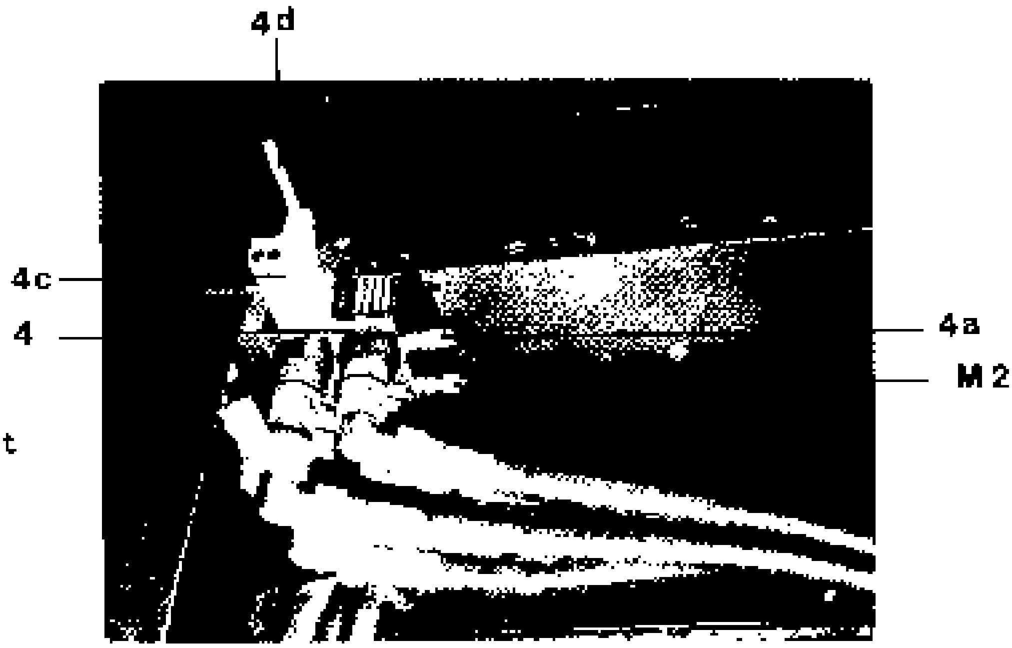
Primary pressure setting

1. Attach pressure gauge to measuring point M 1.
2. Close ball tap (3a).
3. Set pressure limiting valve (2) to 305 bar.

Working pressure adjustment (with tractiometer)

1. Connect pressure gauge to measuring point M 2.
2. Pull wire rope off drum until the lowest (1st) rope layer on the drum surface is reached.

   Warning: leave at least 4 - 5 turns of rope on the drum as a safety precaution.
3. Install a tractiometer (tension measuring device) between the end of the wire rope and a fixed point.
4. Start up the hydraulic system, advance the winch lever (4d) and check the tension developed. Adjust the pressure limiting valve (4a) until the rated rope pull is obtained.
5. Lock and seal the pressure limiting valve adjusting screw (4a).



Rear right

Fig. 3

Working pressure adjustment (without tractiometer)

1. Detach brake pipe from union "C_3" on brake valve (5).

2. Connect pressure gauge to union "C_3" (thread R 1/4").

3. Start up the hydraulic system. Move the winch control lever (4d) and adjust pressure limiting valve (4a) until the working pressure setting of 145 bar is obtained.

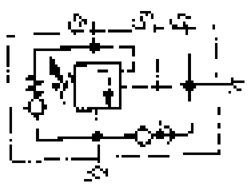
4. Lock and seal the pressure limiting valve adjusting screw (4a).

5. Reconnect the brake pipe to union "C_3" of the brake valve (5).

Load braking valve (5).

The setting of the brake valve is undertaken at the factory, and must not be altered subsequently.

Circuit diagram



Key to connections

C_3 = Brake union
V_2 = Pressure union, winding on
V_2 = Return union when paying out
V_1 = Pressure union when paying out
V_1 = Return union when winding on
C_2 = Pressure union when winding on
C_2 = Return union when paying out
C_1 = Pressure union when paying out
C_1 = Return union when winding on

Function of braking valve

The brake valve has the following functions:

1) Pilot-controlled load lowering valve (5a)

2. Load pressure limiting valve (5a) during lowering

3. Check (non-return) valve (5b)

4. Control valve (5c) for multi-disc brake (7)

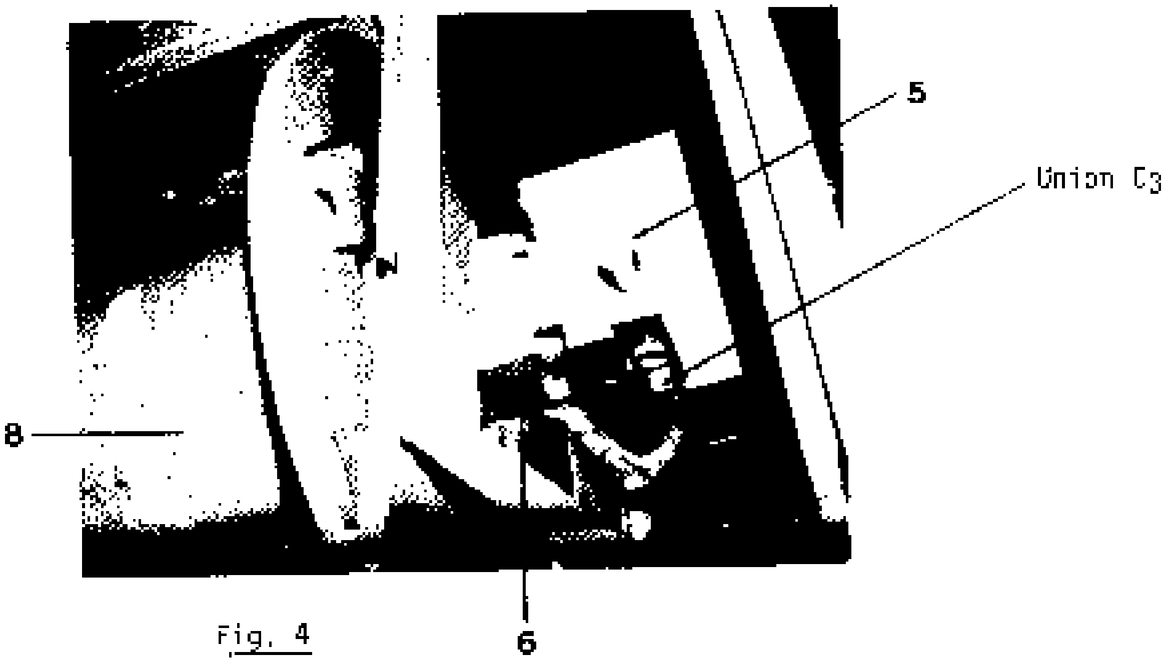


Fig. 4

Maintenance

General instructions:

There are no lubrication points on the rope winch, but two screw plugs are provided on the gearbox side for oil drainage and oil filling. All other lubrication points on the winch assembly should be lubricated at 3-monthly intervals with multipurpose grease.

Hydraulic fluid (oil) and hydraulic circuit filter - see "Crane operation".

Rope winch

Oil grade:	SAE 90 HD
Oil content:	3.5 liters
Oil changes:	at least once a year

Wire rope

Determine maintenance intervals according to the overall load which the rope is called upon to withstand (visual inspection).

Lubrication method:

a) Machine and engine oils have the advantage of penetrating right into the interior of the wire rope, but the oil drips out relatively quickly, so that maintenance is required at more frecuent intervals.

b) Petroleum jelly ('Vaseline') is more effective and has a more lasting effect; the wire rope should be soaked (impregnated) in heated Vaseline, which will then be free-flowing. Vaseline does not drip out after it has cooled down, but remains in place as a uniform coating on all strands of the wire rope, so that extended maintenance intervals become practicable.

c) Other maintenance preparations are sold in aerosol spray cans.

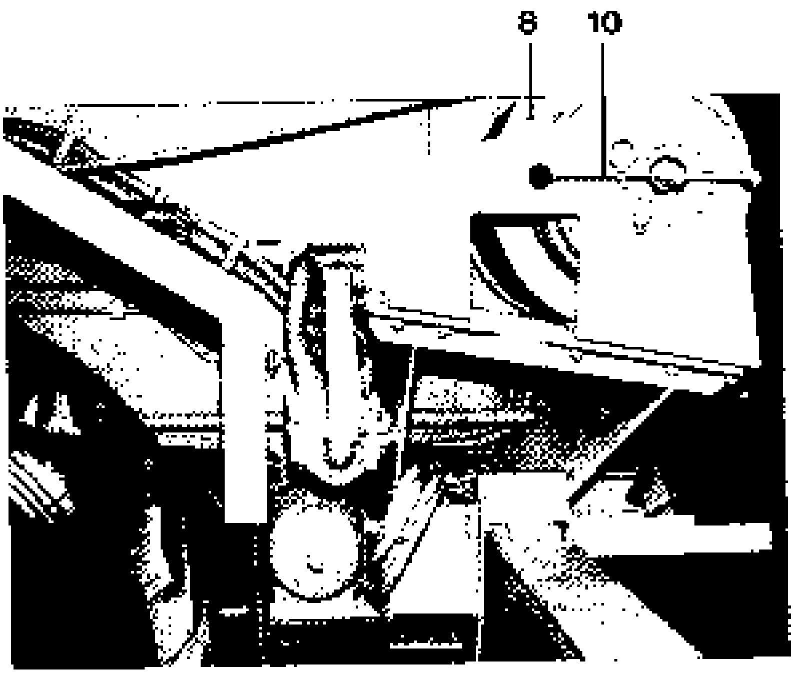


Fig. 5

Hy 10 recovery winch

Description:

The recovery winch is rated at a maximum rope pull of 100 KN (10 000 kg). This is equivalent to a working hydraulic pressure of 150 bar. Rope speed can be varied as follows:

a) By turning handwheel (12) in direction "A" for higher speed or "B" for slower speed.
Note: Maximum working pressure is reached only at a slow rope speed.

b) By increasing engine speed (normal operation is at an engine speed of app. 1300/min.

c) By advancing the control lever increasingly.

The winch is driven by an open hydraulic circuit.

When the manual control valve (4) is operated, contact switch (4a) resets multi-way solenoid valve (3) - the recirculating spool valve - and charges the hydraulic circuit from the outrigger support pump (1).

When the manual control valve (4) is in neutral, the oil flows through the recirculating valve (3) back to the tank. As the valve is moved away from neutral, oil reaches the hydraulic motor (10). At the same time the spring-loaded multi-disc brake (9) is released hydraulically by way of the brake control valve (8). The winch then rotates.

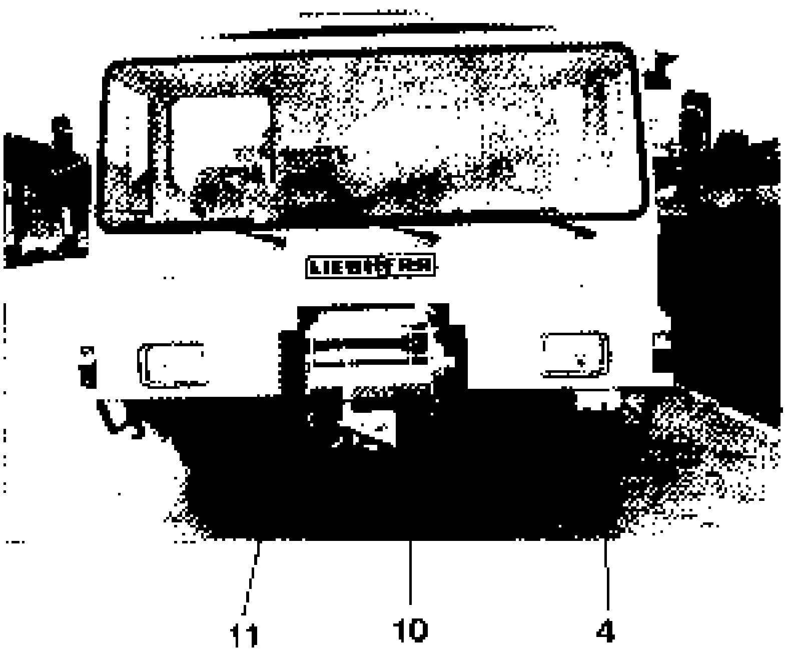
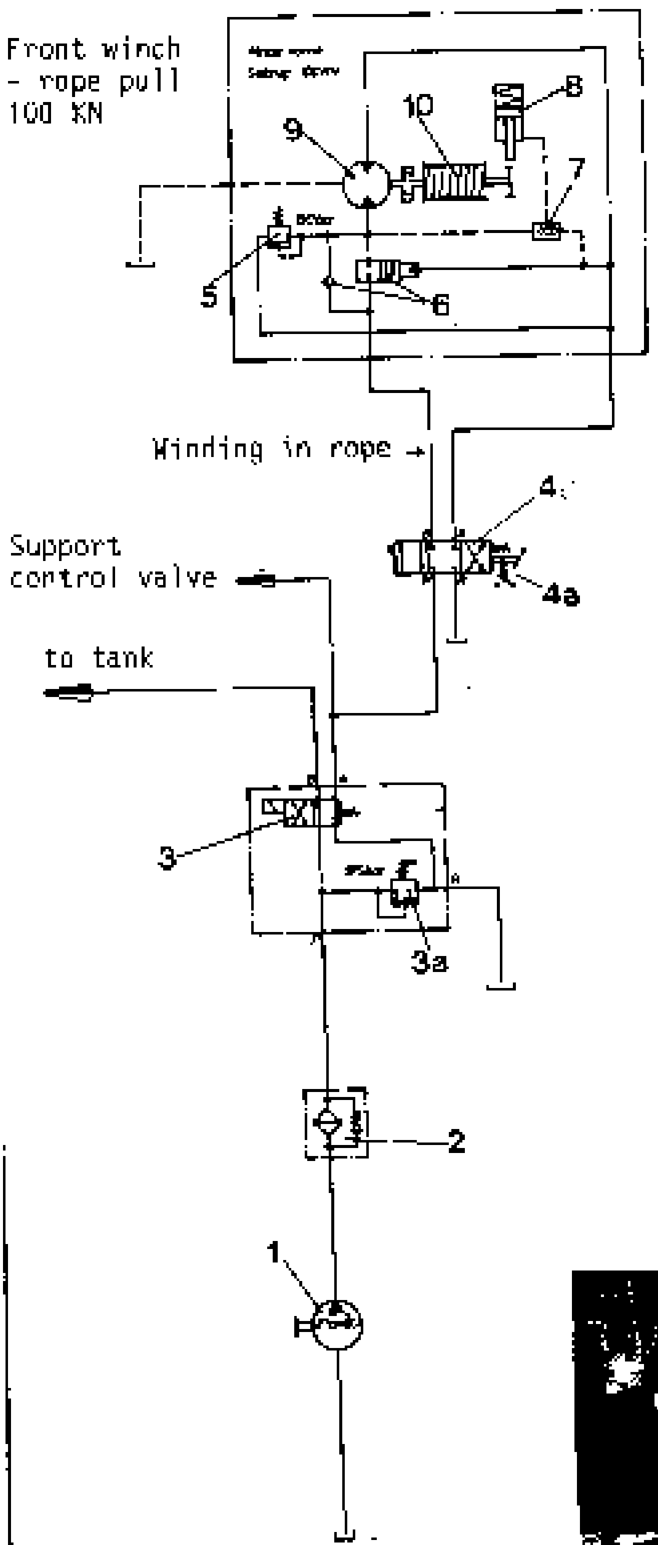


Fig. 1



Item	Designation
1	Hydraulic pump (for supports)
2	Pressure-side filter
3	Multi-way solenoid valve (recirc-ulating spool valve)
3a	Pressure limiting valve - 185 bar (primary pressure retention)
4	Manual control valve
4a	Contact switch
5	Pressure limiting valve - 150 bar
6	Lowering brake valve
7	Brake application (changeover) valve
8	Multi-disc brake
9	Variable-pitch motor
10	Rope winch
11	Handwheel (hydraulic motor control)
12	Epicyclic gear train
13	Clutch lever
14	Lever lock
15	Drum brake (only to be applied when rope is drawn off by hand)
16	Drive chain for rope coiling device
17	Spiral shaft
18	Guide roller cutout
19	Paying-out rollers

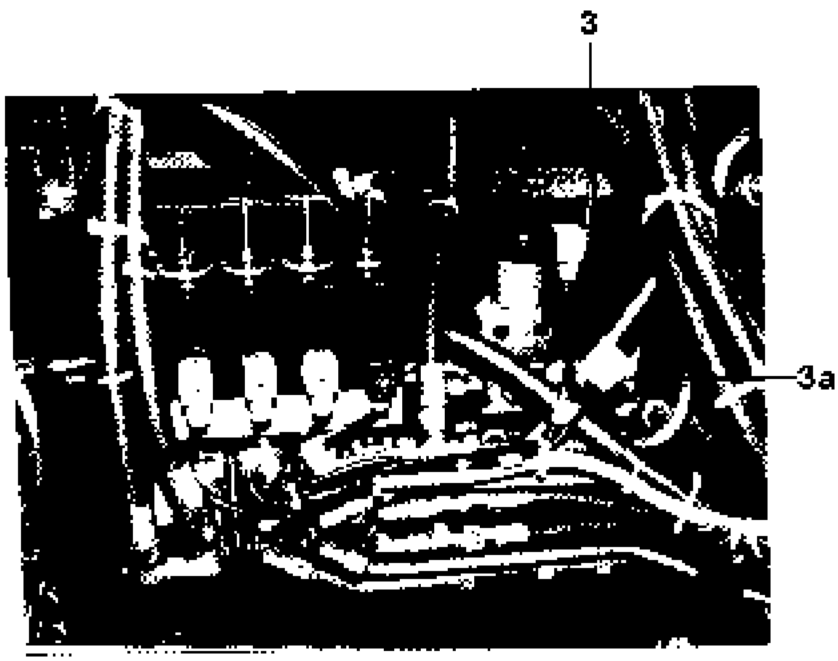


Fig. 2 (rear right)

Layout of components

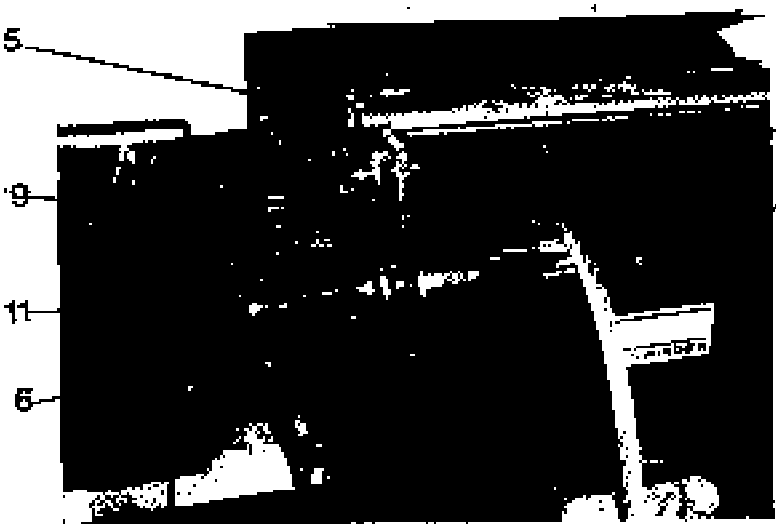
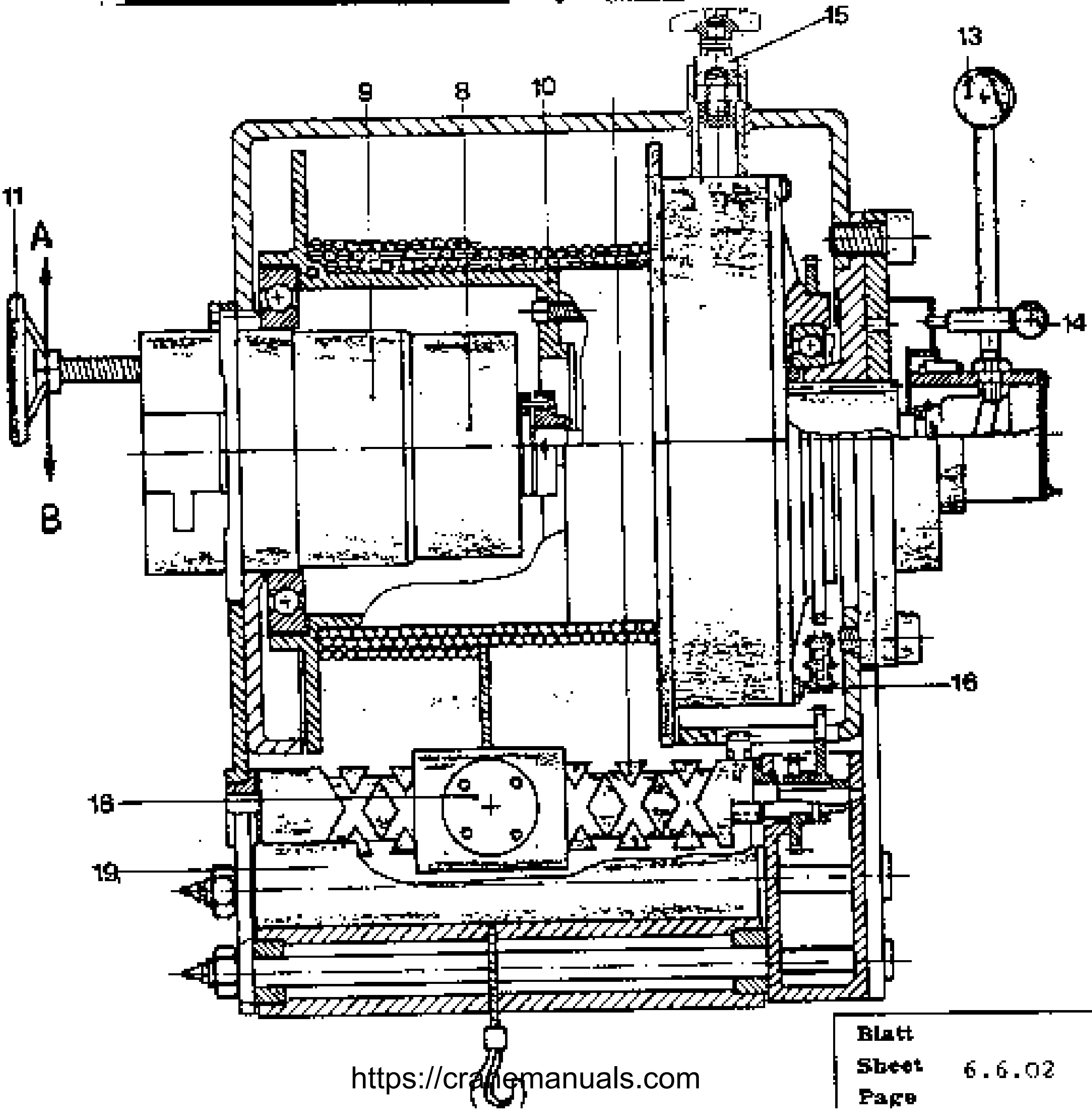


Bild 3



Layout of components

Fig. 4

Pressure settings

1. Pressure limiting valve -3a-
   For adjustment, see Sheet 2.6.03 (primary pressure)

2. Pressure limiting valve -5-
   This pressure limiting valve is preset by the manufacture, and sealed.
   It must not be tampered with.

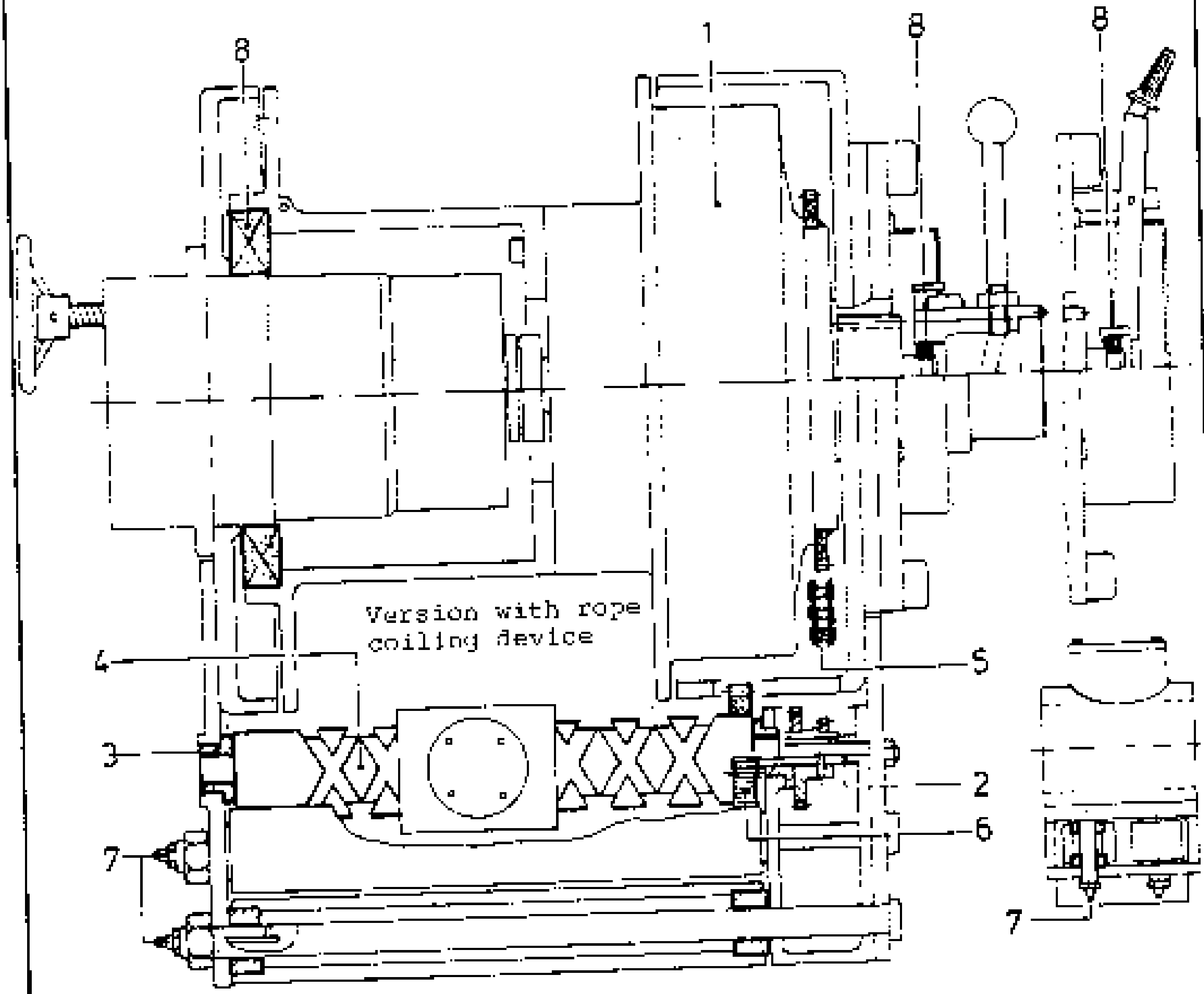
Maintenance

1. For hydraulic fluid and hydraulic filter, see details in "Hydraulic outrigger supports", Sheet 2.6.03 (back).

2. Rope winch with rope coiling device - see Sheet 6.6.03.

3. Wire rope - see Sheet 6.5.03 (back).

Lubrication and maintenance instructions



No.	Designation	SAE 90	HD grease	liters	cm³	Perm. lubr.	Acc. to use	Monthly
1	Gearbox	X		4		X		
2	Pinion shaft		X		10			X
3	Spiral shaft bearings		X		30			X
4	Spiral shaft		X		50		X	
5	Chain		X		30			X
6	Spur gears		X		20			X
7	Paying-out rollers		X		80			X
8	Bearings		X		20	X		

Front recovery winch

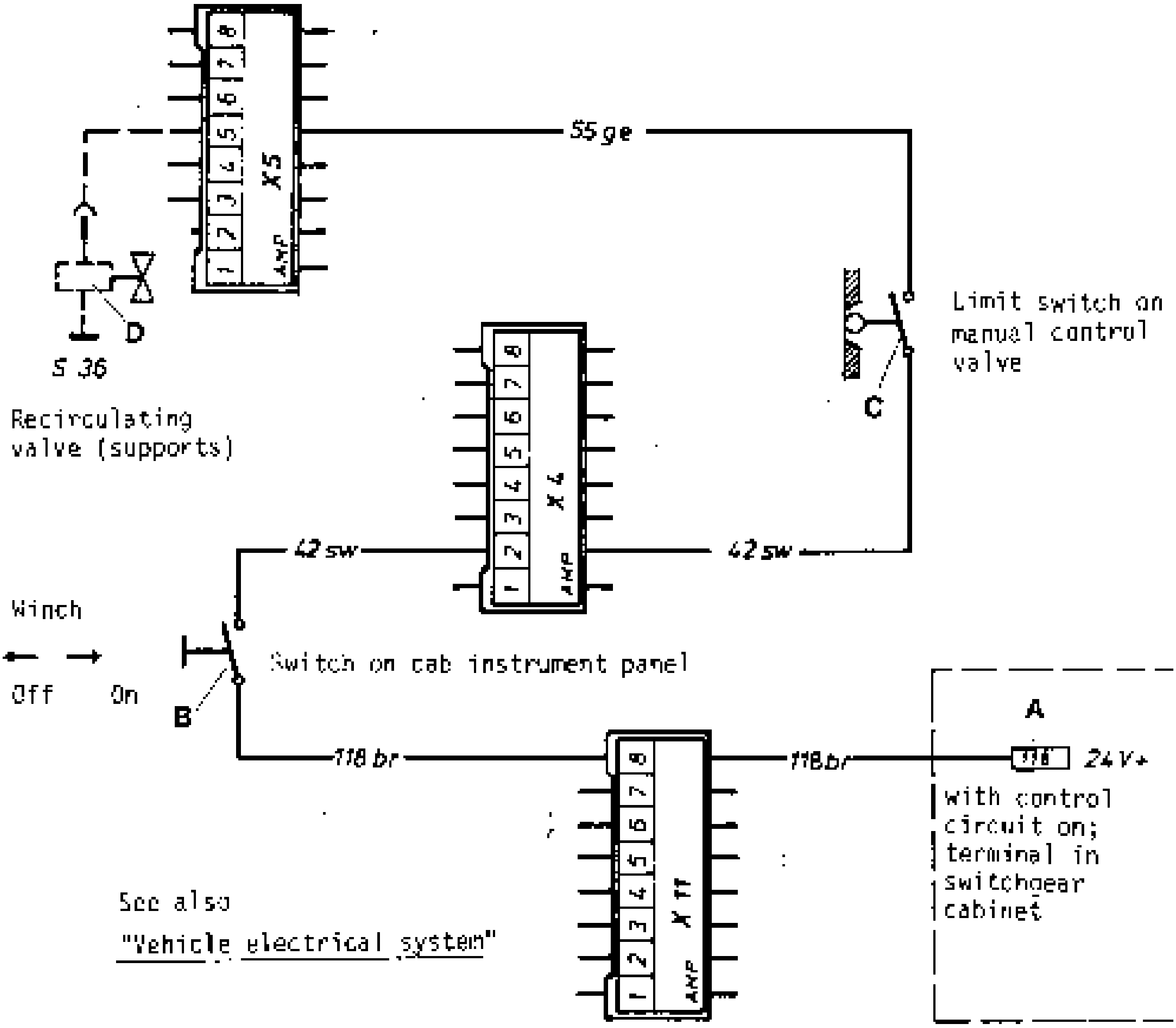
Electrical operation of recirculating spool valve (for precise circuit, see vehicle electrical system).

A = Connecting terminal (+ 24 V) in switchgear cabinet = L ?

B = On/off rocker switch on cab instrument panel

C = Telltale switch (4a) on manual control valve (see Fig. 4)

D = Recirculating valve (3) - see Fig. 2



See also
"Vehicle electrical system"

Color codes for wiring:

ge = yellow
sw = black
br = brown

Instructions:

Attaching rope to winch:

The following precautions must be noted when the rope is to be attached:

Allow the winch to run without the rope in position until the guide roller cutout (18) which moves along the rope coiling device (17) is at its extreme outer limit of movement, at the side of the drum at which the rope has to be attached.

The winch must now be declutched (10) and turned by hand in the direction needed to coil on the rope until the rope attachment hole is at the top of the drum. The intersection points of the spiral grooves on the spiral shaft (17) must then also be at the top. If this is not the case, the drive chain (16) between the winch (10) and the spiral shaft (17) must be detached and the winch or spiral shaft turned further until the intersection points of the spiral grooves agree with the rope attachment point on top of the drum. The chain (16) can then be installed again and tensioned with the chain tensioner provided.

The rope is then inserted between the vertical rollers of the guide (18), pulled up over the rear face of the winch and secured at (10) with stud bolts.

The rope must next be tensioned. The drum should be started up and the first 3 - 4 turns positioned correctly with the aid of a hammer. The full load can now be placed on the rope, and the coiling device should operate correctly.

If the rope tends to overrun forwards, the winch should be turned back by one revolution after detaching the drive chain. If the rope hangs back, the winch should be advanced similarly.

The rope can then be fully wound on at reduced load. A fixed point at a distance away equivalent to the rope length can act as a simulated load, and the vehicle be pulled towards it by the action of the winch. It is also possible to brake or anchor the truck crane itself, to act as a fixed point, and pull another vehicle towards it with the winch and rope.

Note that the rope coiling device will only operate correctly if the rope is kept taut as it is wound on to the drum.