

IMO 9321263
FINISHED PLAN

SHIP NO. **2 2 2 8**

SHIP NAME **APL POLAND**

DWG. NO. **MA8-LA2004F**

LIST NO. **MB-06**



MITSUBISHI HEAVY INDUSTRIES, LTD.
NAGASAKI SHIPYARD & MACHINERY WORKS

ISSUED **MAR. 14, 2008**

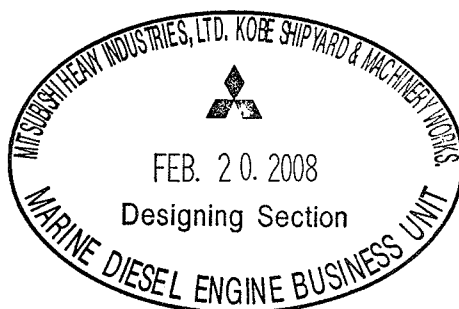


MITSUBISHI
HEAVY INDUSTRIES LTD.

FINAL PLAN

S.No.2228

mitsubishi-sulzer
MAIN DIESEL ENGINE
11RT-flex96C
FINAL DRAWING
S.No.2228



MITSUBISHI HEAVY INDUSTRIES, LTD.
KOBE SHIPYARD & MACHINERY WORKS

Approved by	<i>Mr. M. Nakagawa</i>
Checked by	<i>K. Yoshimura</i>
Designed by	<i>T. (Semi)</i>
Date	Feb. 8, 2008
WSG-1722	

Order No.7-891401

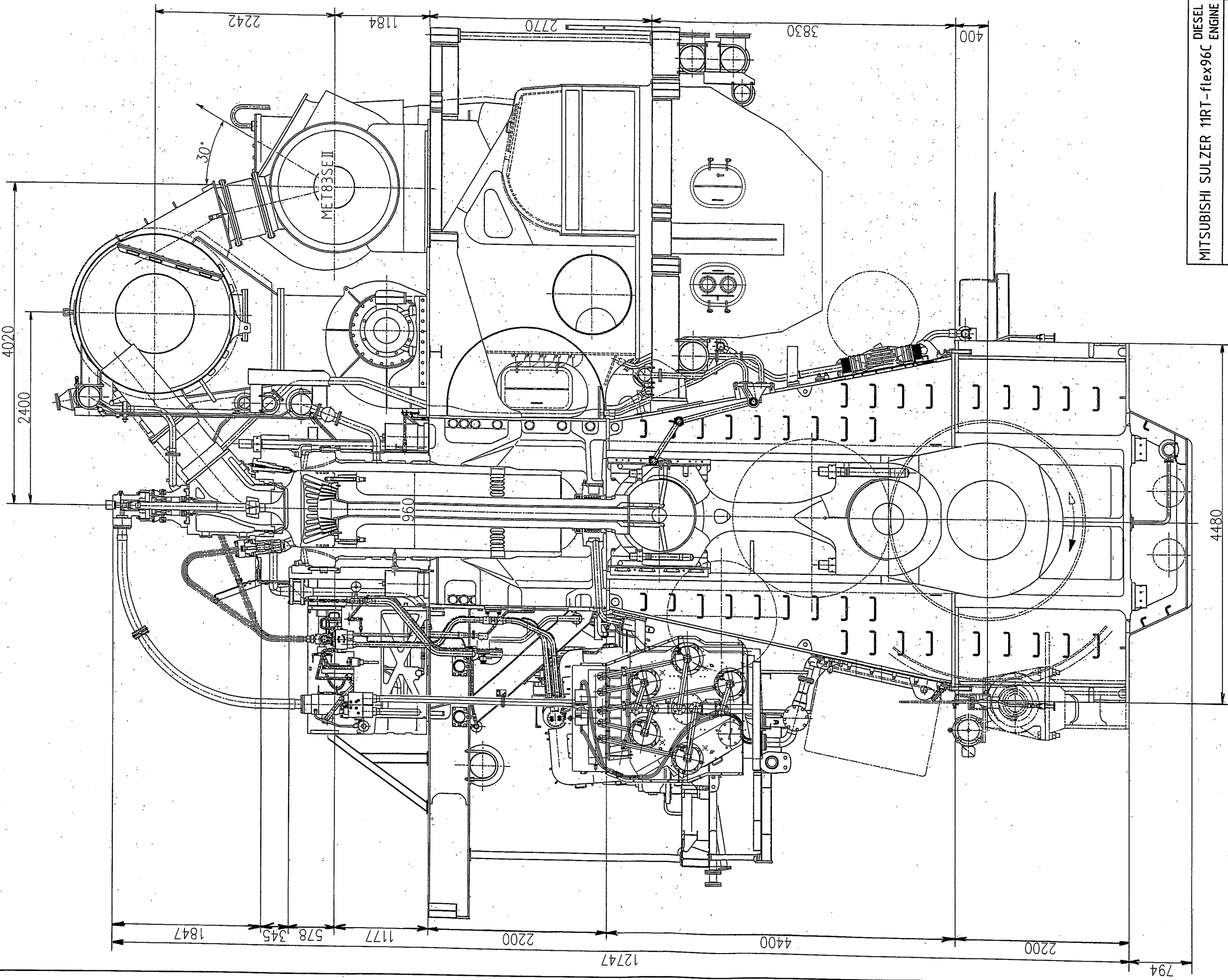
Contents of Final Drawing

Part	Contents
I .	GENERAL DRAWINGS
II .	INSTRUCTION MANUALS

LIST OF GENERAL DRAWING

WSG-1722

Ref. No.	Drawing No.	Name of drawing	Remarks
A	A1-01429	Outline Drawing (MET83SEII X 3)	
B	A1-01430	Sectional Assembly (Cross Section)	
C	A1-01431	Sectional Assembly (Longitudinal Section)	
D	A1-13738	Arrangement of Foundation Bolts and Lub. Oil Outlets	
E	A1-20691	Main Bearing and Thrust Bearing Assembly	
F	A2-01644	Crankshaft Assembly	
G	A2-14640	Axial Damper Assembly	
H	A2-21242	Piston Assembly	
I	A2-40692	Connecting Rod Assembly	
J	A3-00776	Drive Supply Unit Assembly	
K	A3-60917	Exhaust Valve Assembly	
L	A4-60012	Supply Unit Assembly	
M	A5-11294	Shut-off Valve for Starting Air Assembly	
N	A7-02595	Piping Diagram (Main Diesel Engine)	
O	A7-3H423	Arrangement for ECL-SIP Cylinder Lubricator	
P	A7-3H629	ECL System Supply Unit Assembly	
Q	A6-91419	Water Separator	
R	A2-14639	Arrangement of Vibration-proof Stays	

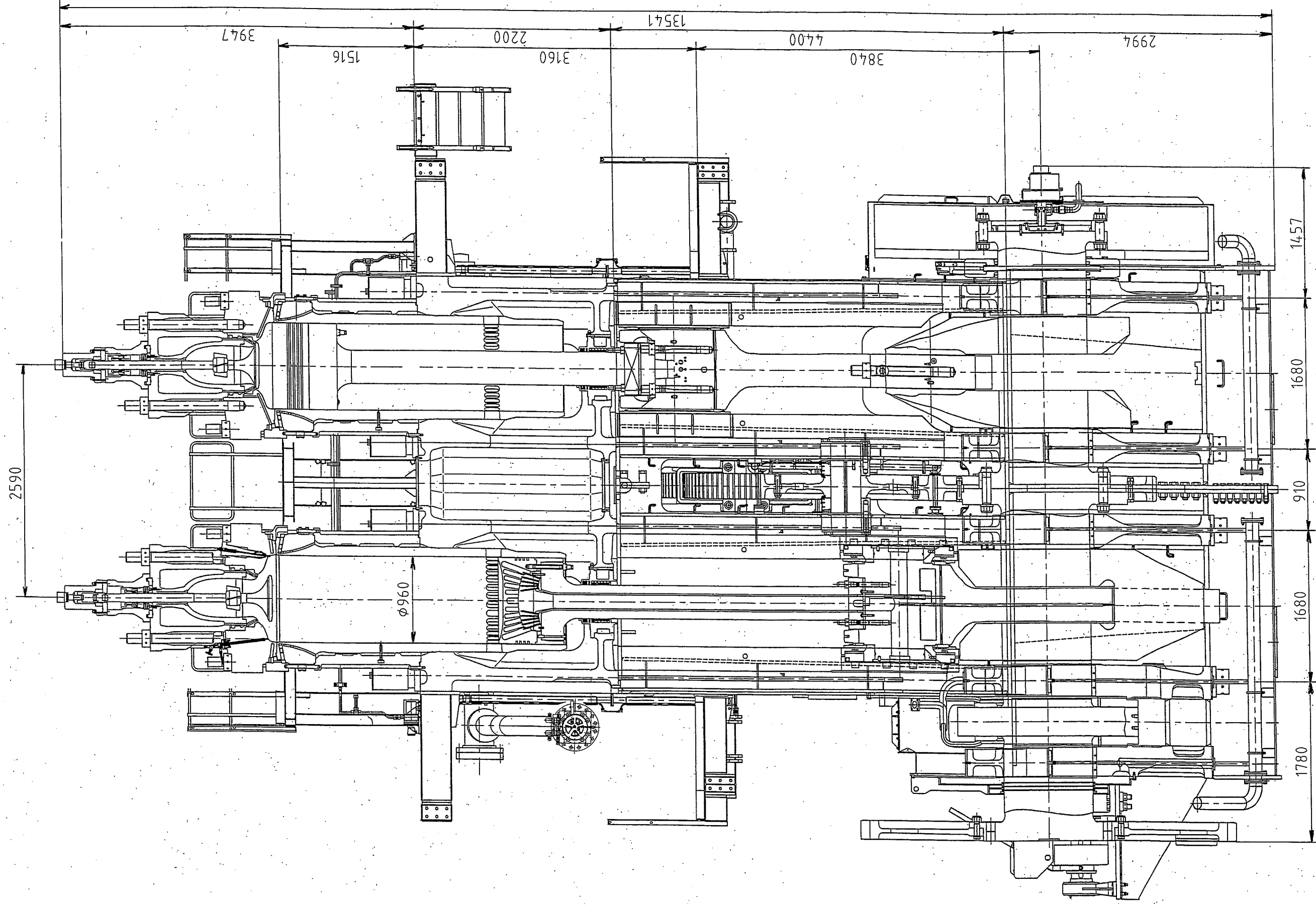


MITSUBISHI SULZER 11RT-flex96C
DIESEL ENGINE

CROSS SECTION

A1-01430

B



MITSUBISHI SULZER 11RT-flex96C
DIESEL ENGINE

LONGITUDINAL SECTION

A1-01431

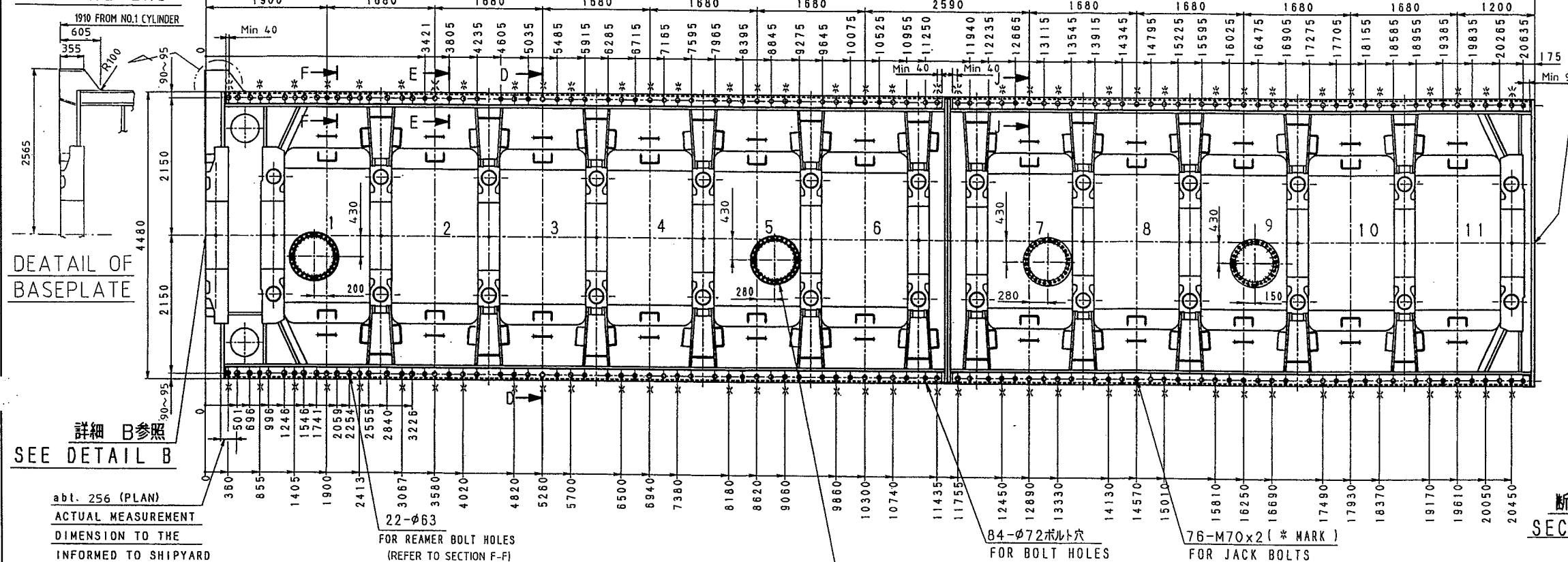
C

断面 A-A
SECTION A-A

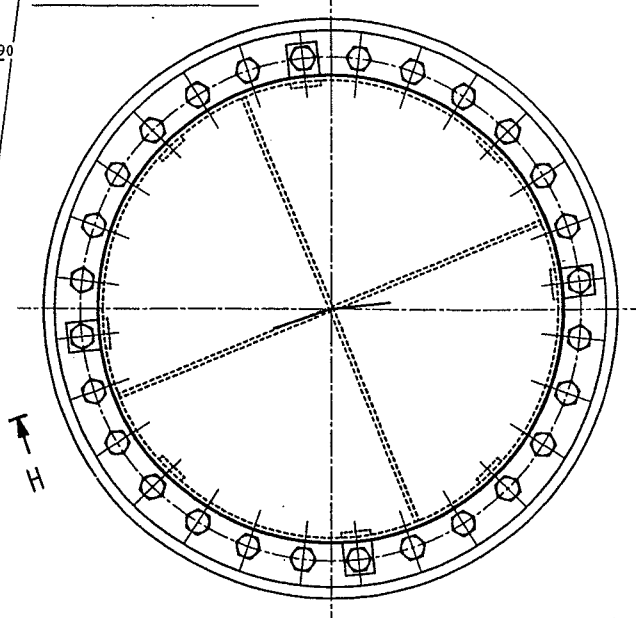
自由端側
FREE END

D

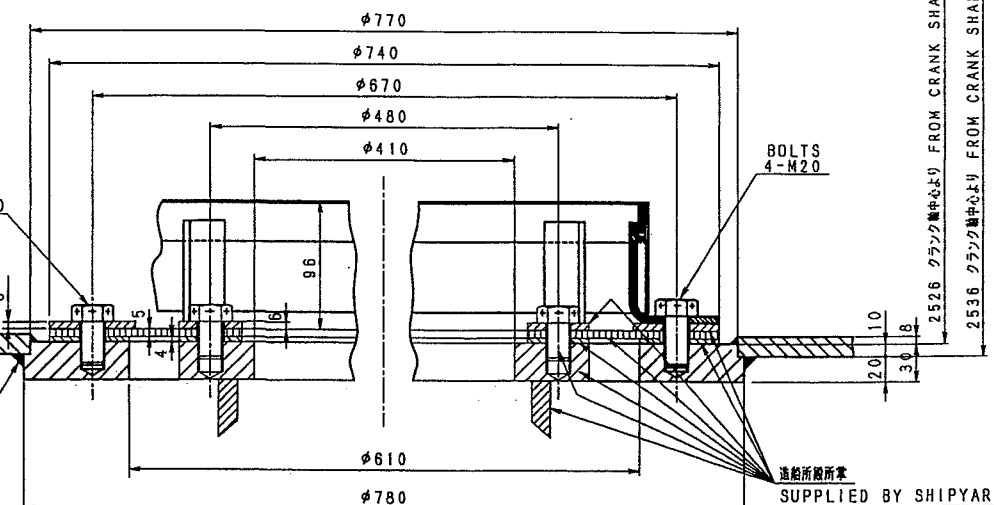
駆動端側
DRIVING END



G 部詳細
DETAIL G

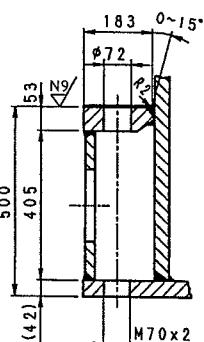


断面 H-H
SECTION H-H

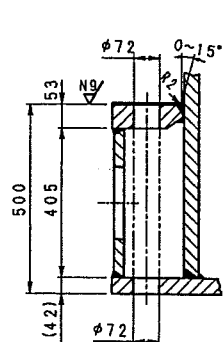


詳細 G参照
SEE DETAIL G

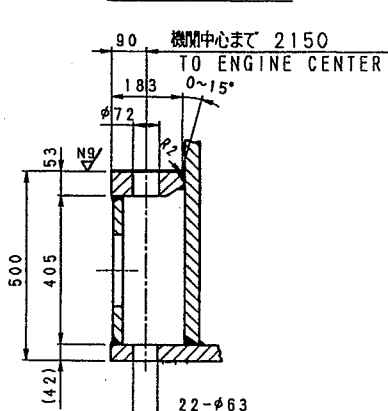
断面 J-J
SECTION J-J
(76ヶ所)
(76 Positions)
PART * MARK



断面 E-E
SECTION E-E
(84ヶ所)
(84 Positions)

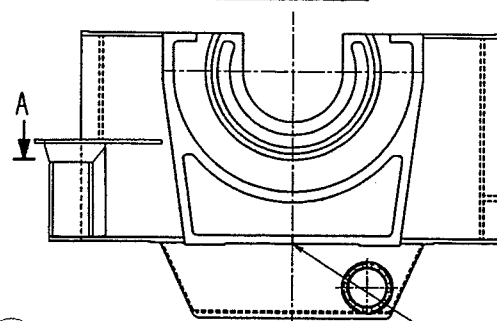


断面 F-F
SECTION F-F
(22ヶ所)
(22 Positions)

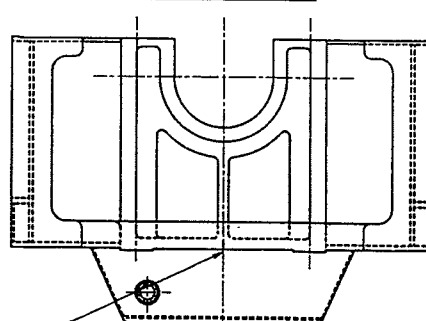


(船内にてφ65H7^{+0.03}/₀マ穴に仕上げる)
(The holes are finished in the ship to φ65H7^{+0.03}/₀)

B 部詳細
DETAIL B

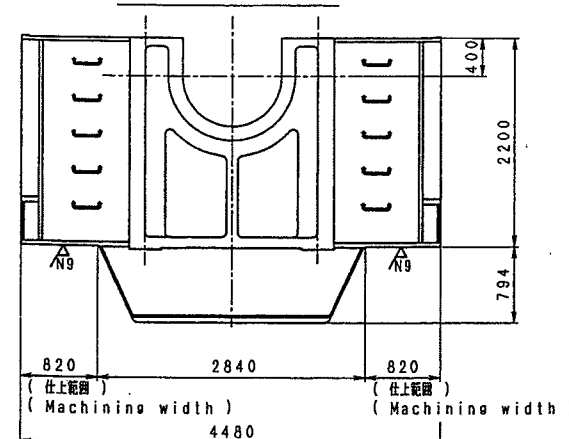


C 部詳細
DETAIL C



マーキング (タガネによる)
MARKING OF CENTER LINE

断面 D-D
SECTION D-D



HOLES FOR REAMER BOLTS AS SHOWN IN SECTION F-F

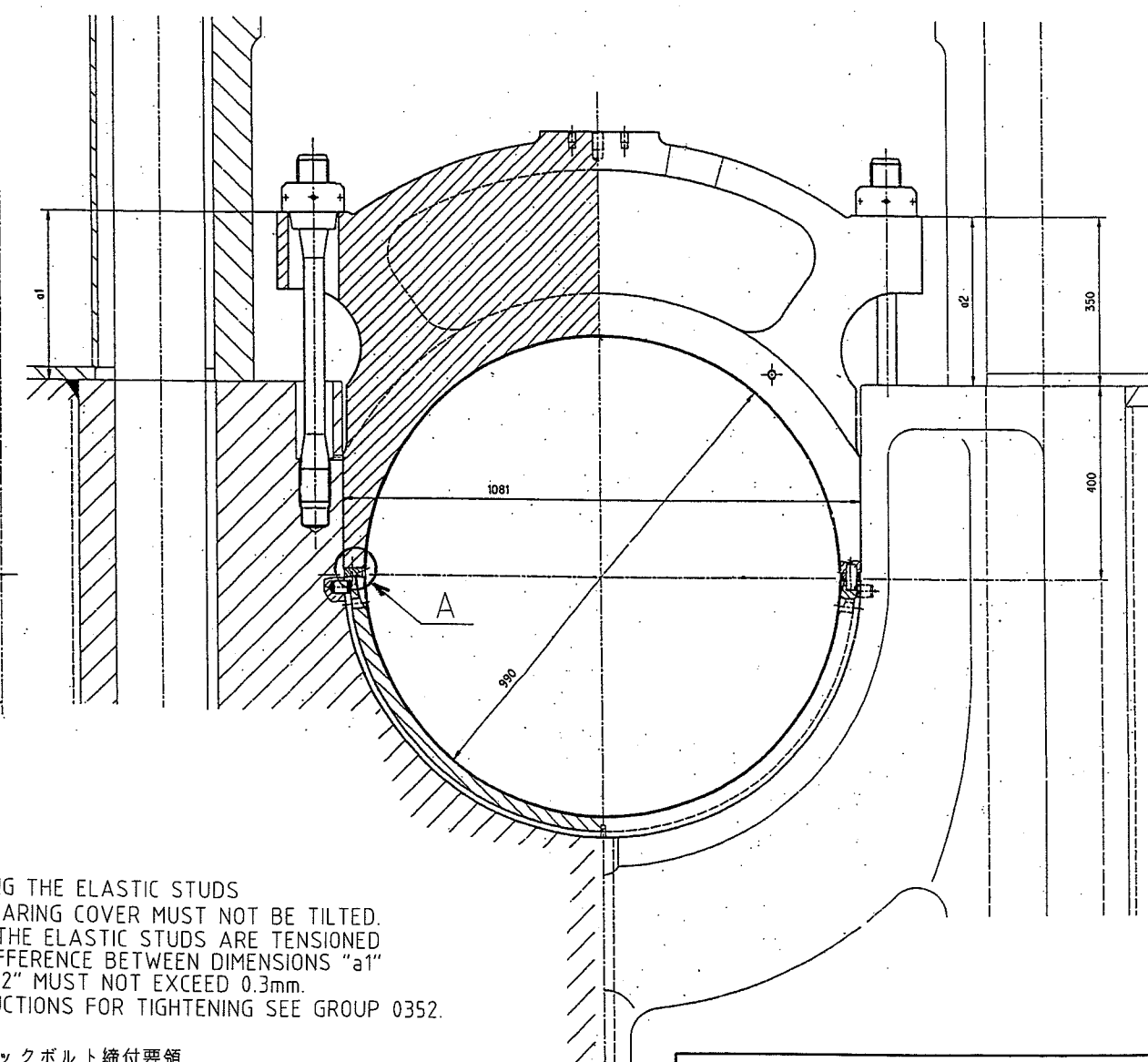
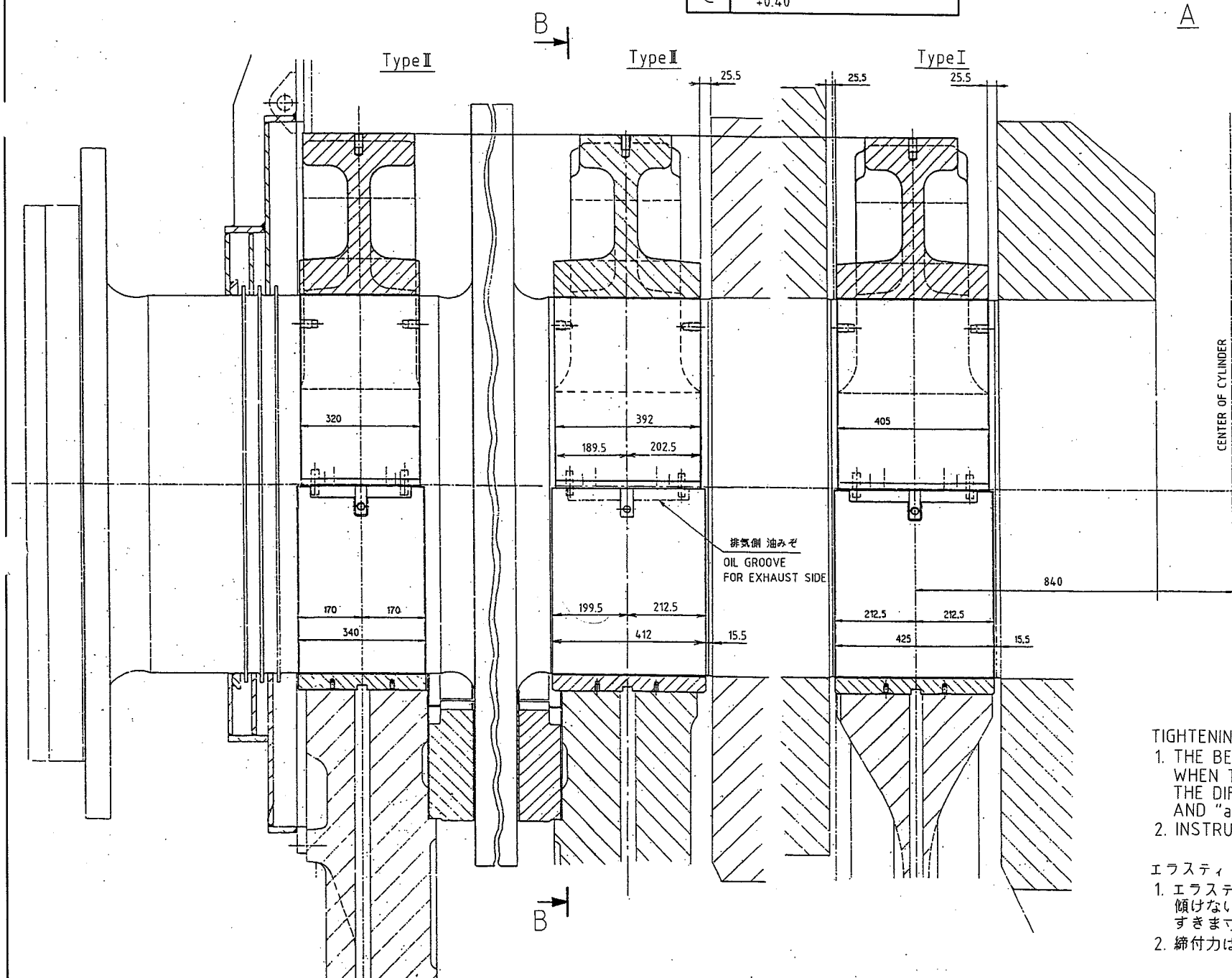
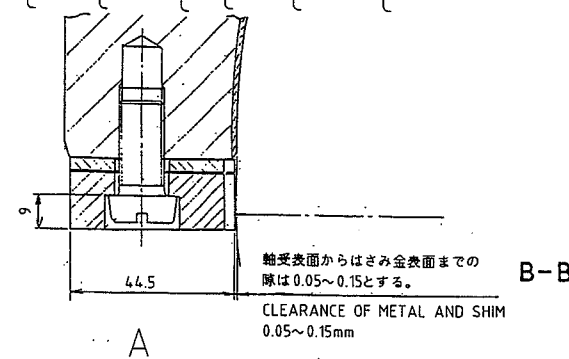
HOLES AS SHOWN IN SECTION E-E AND J-J

MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

ARRANGEMENT OF FOUNDATION BOLTS AND LUB. OIL OUTLETS
台板据付ボルト穴及びL.O.出口穴明図

A1-13738

上図によるエラストックボルト及び タイロッド締付時の軸受クリアランス CLEARANCE WHEN ELASTIC STUDS AND TIE ROD ARE TIGHT ENED	
A	+1.10 +0.80
B	+0.45 +0.39
	(目標値 +0.41) (TARGET +0.39)
C	+0.50 +0.40



1. THE BEARING COVER MUST NOT BE TILTED. WHEN THE ELASTIC STUDS ARE TENSIONED THE DIFFERENCE BETWEEN DIMENSIONS "a1" AND "a2" MUST NOT EXCEED 0.3mm.
2. INSTRUCTIONS FOR TIGHTENING SEE GROUP 0352.

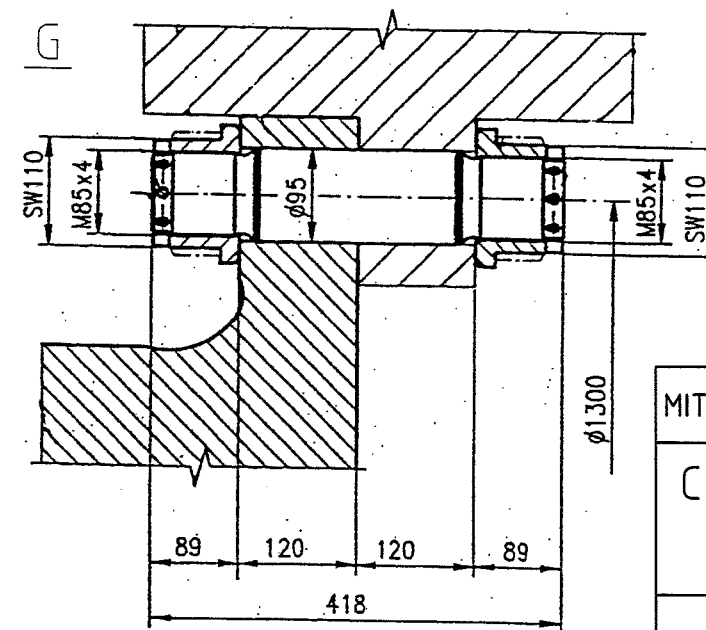
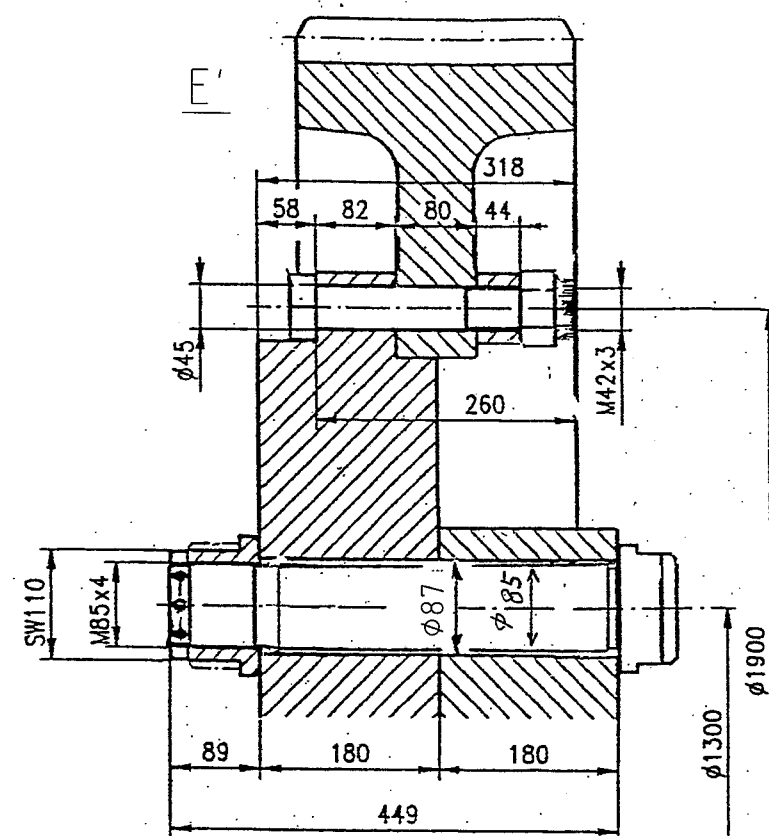
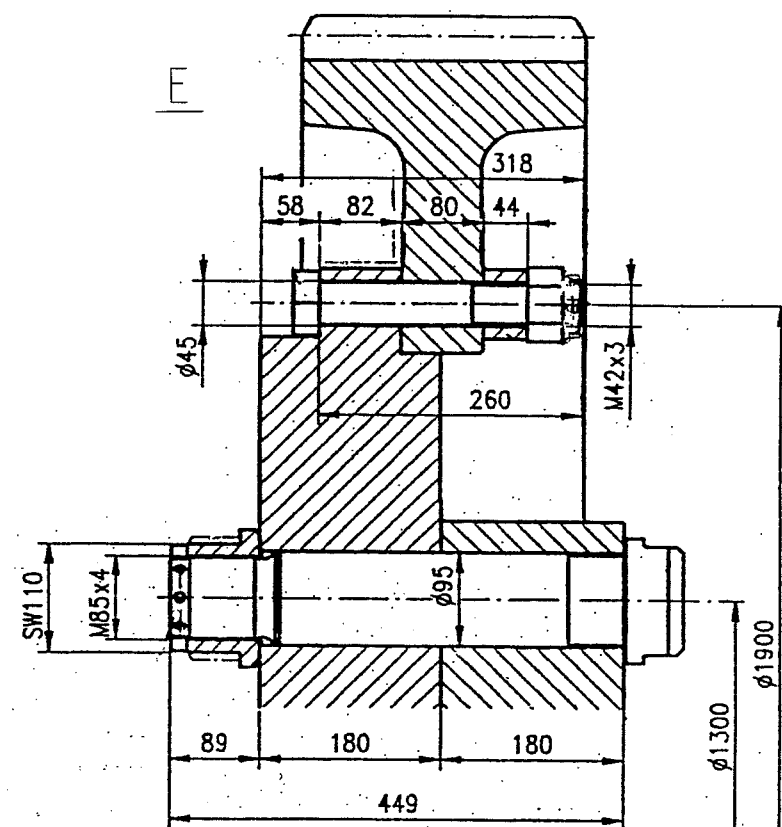
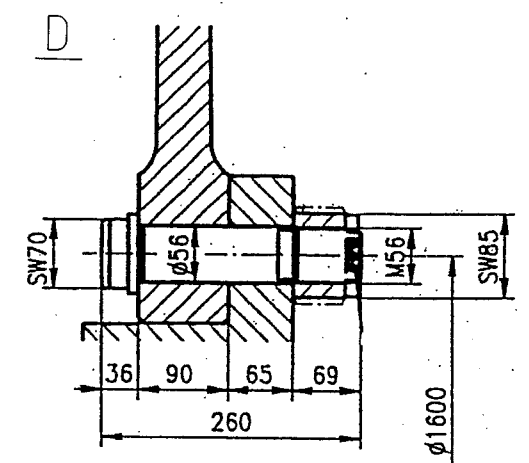
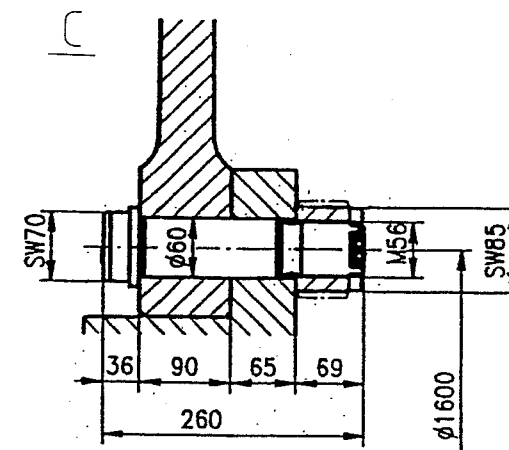
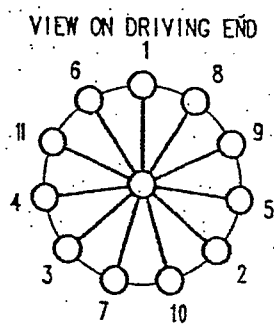
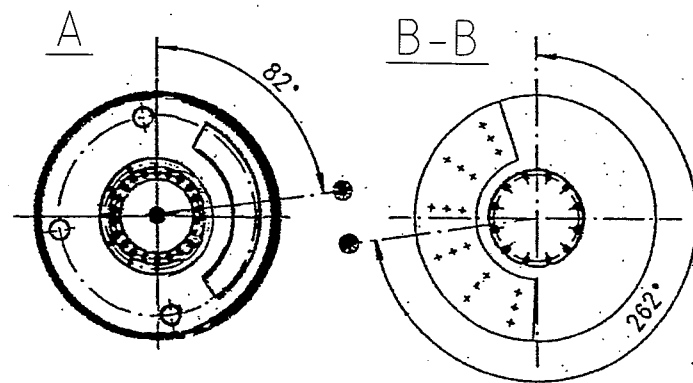
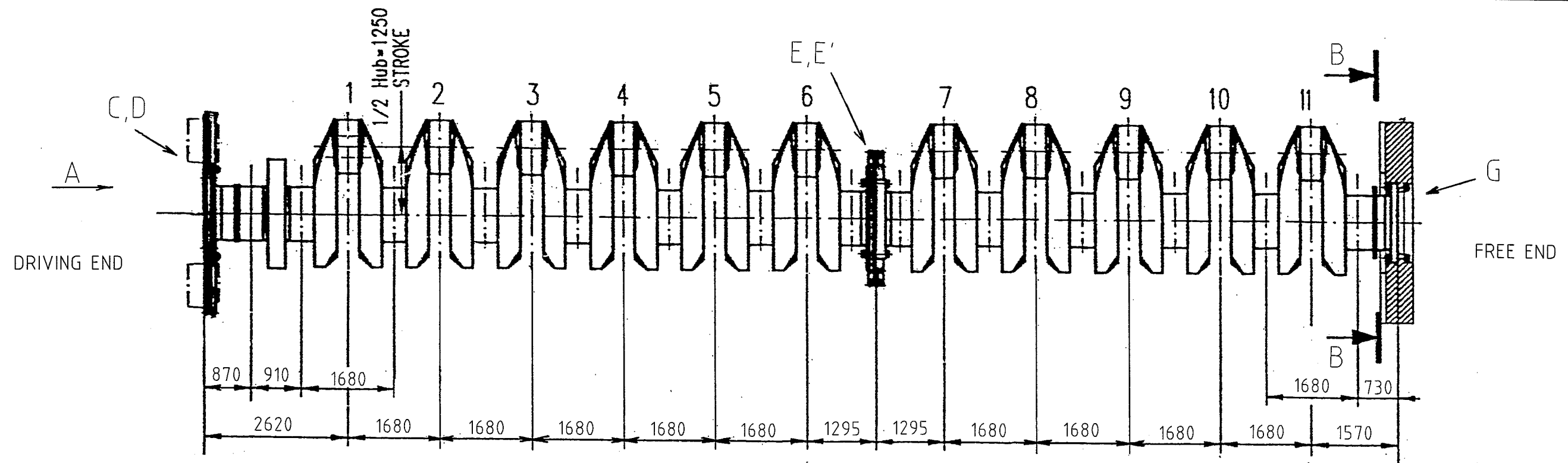
1. エラストティックボルト締付時にはベアリングカバーを傾けない様注意して組立のこと。締付完了時の“a1”と“a2”のすぎます法差は、0.3mmを超えてはならない。
2. 締付力は取扱説明書（保守整備編）グループ0352に従うこと。

MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

MAIN BEARING AND THRUST BEARING ASSEMBLY

主軸受及びスラスト軸受組立

A1-20691

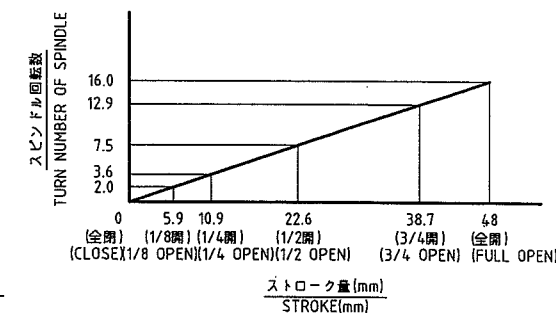
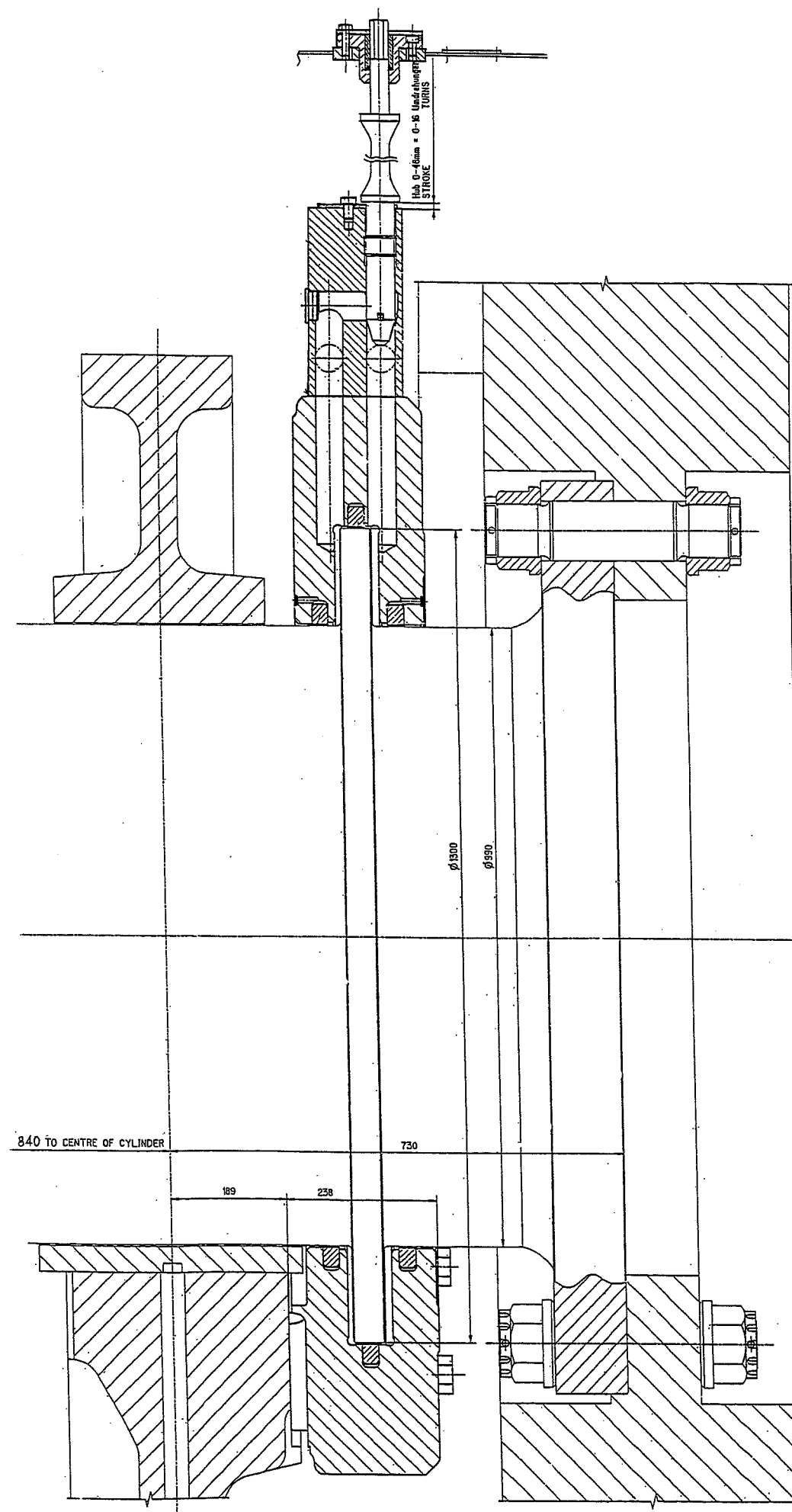
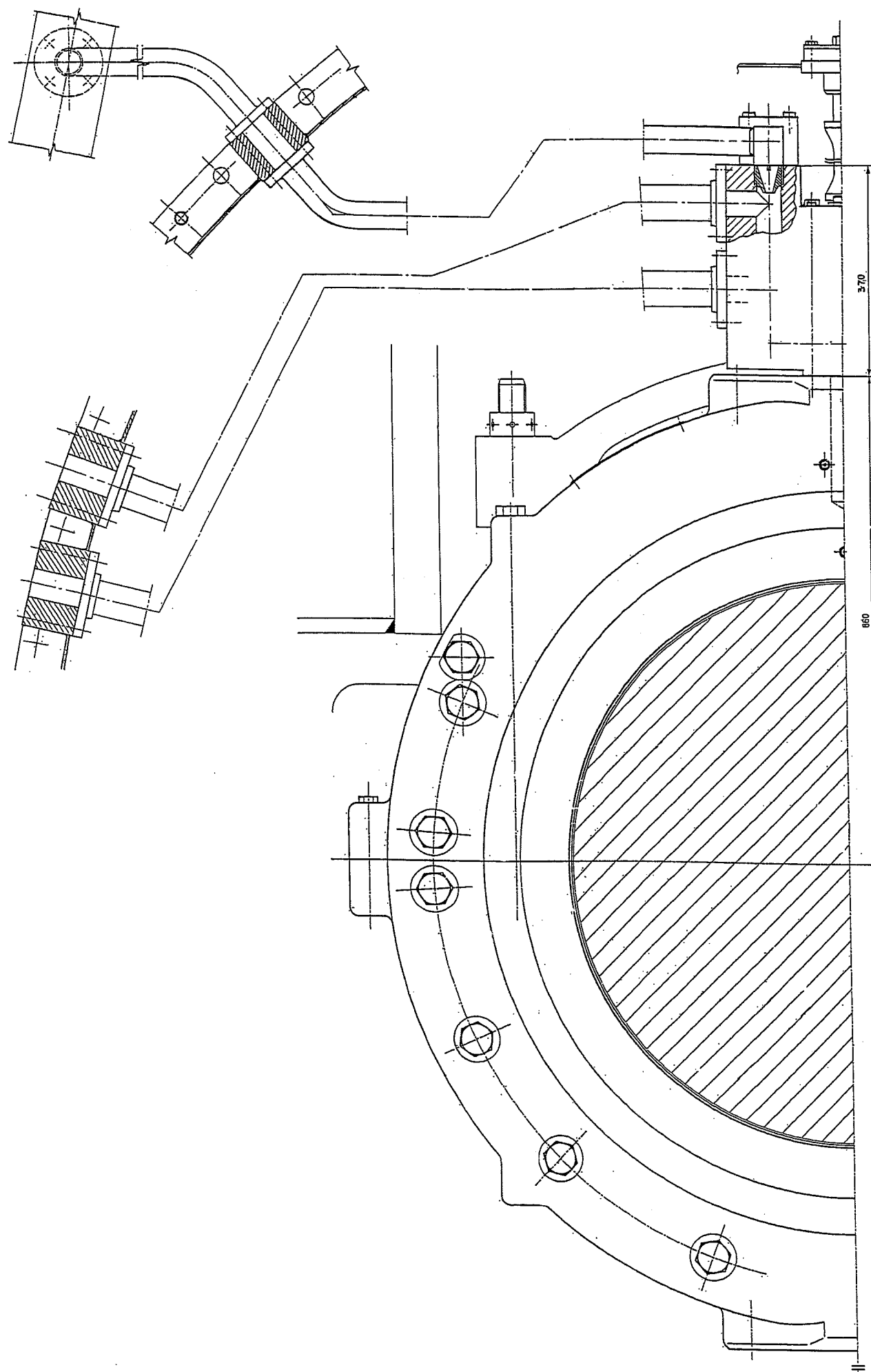


MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

CRANKSHAFT ASSEMBLY

クランク軸組立

A2-01644



ダンパー油量調整要領
ADJUSTMENT OF DAMPER INLET OIL

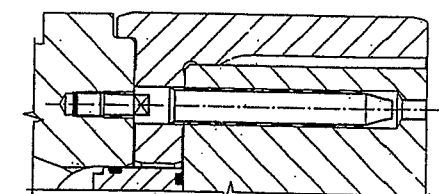
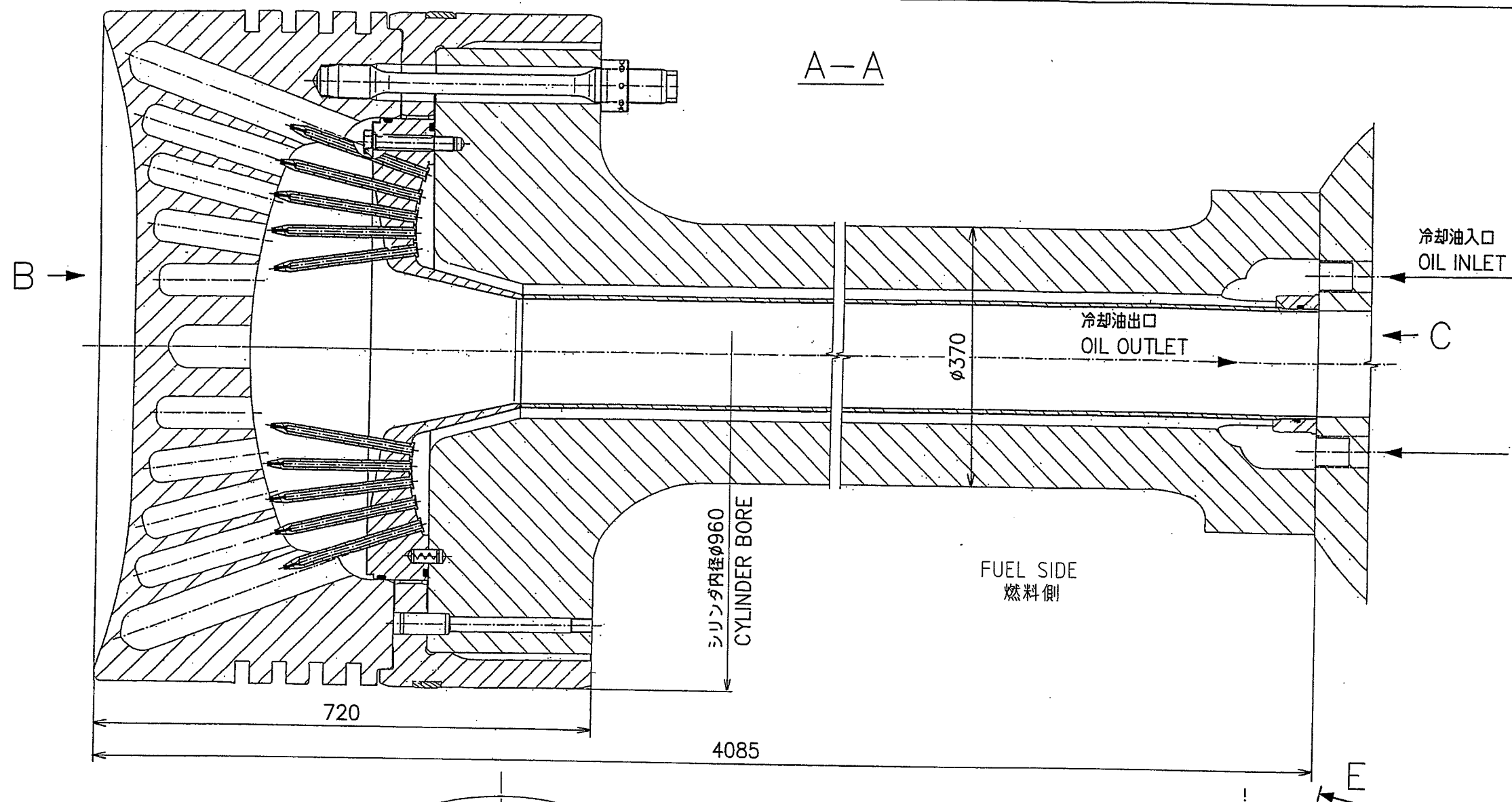
MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

AXIAL DAMPER ASSEMBLY

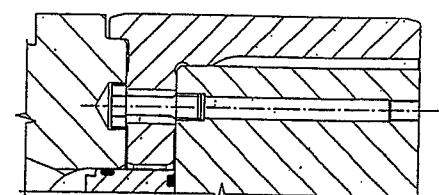
縦振動ダンパー組立

A2-14640

H

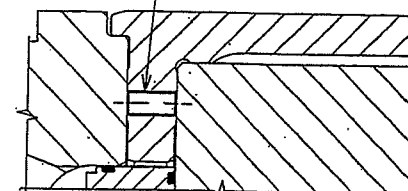


D-D

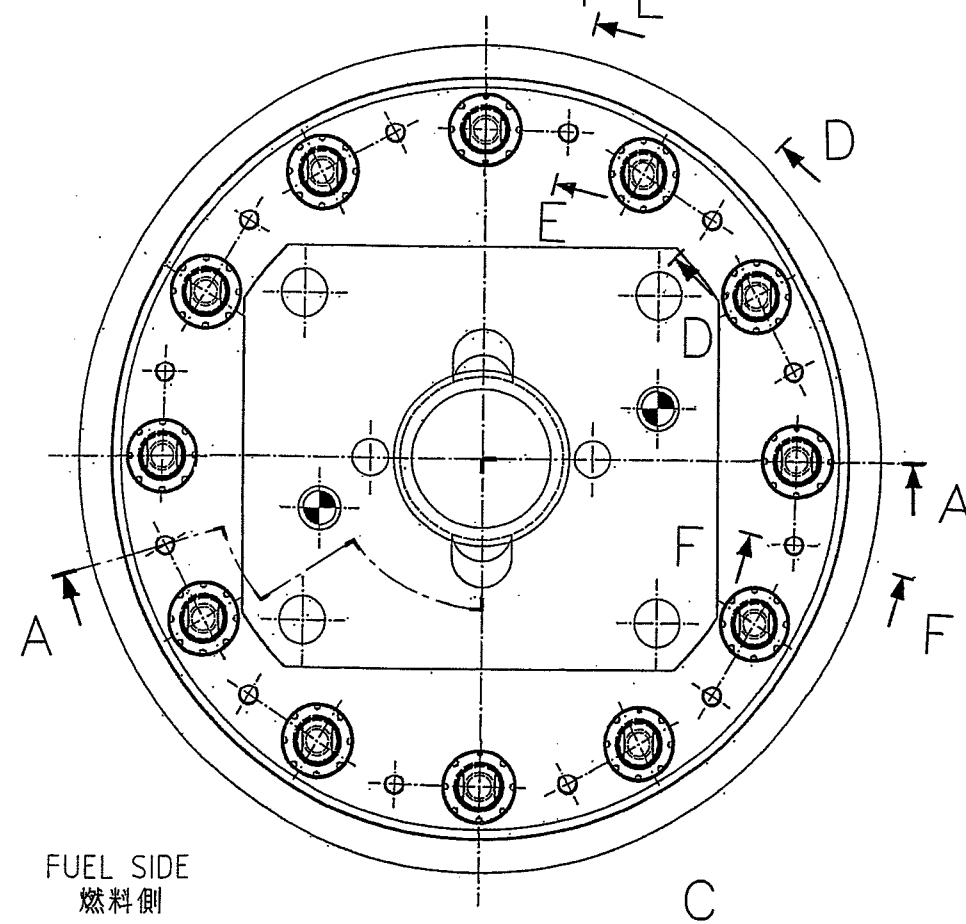
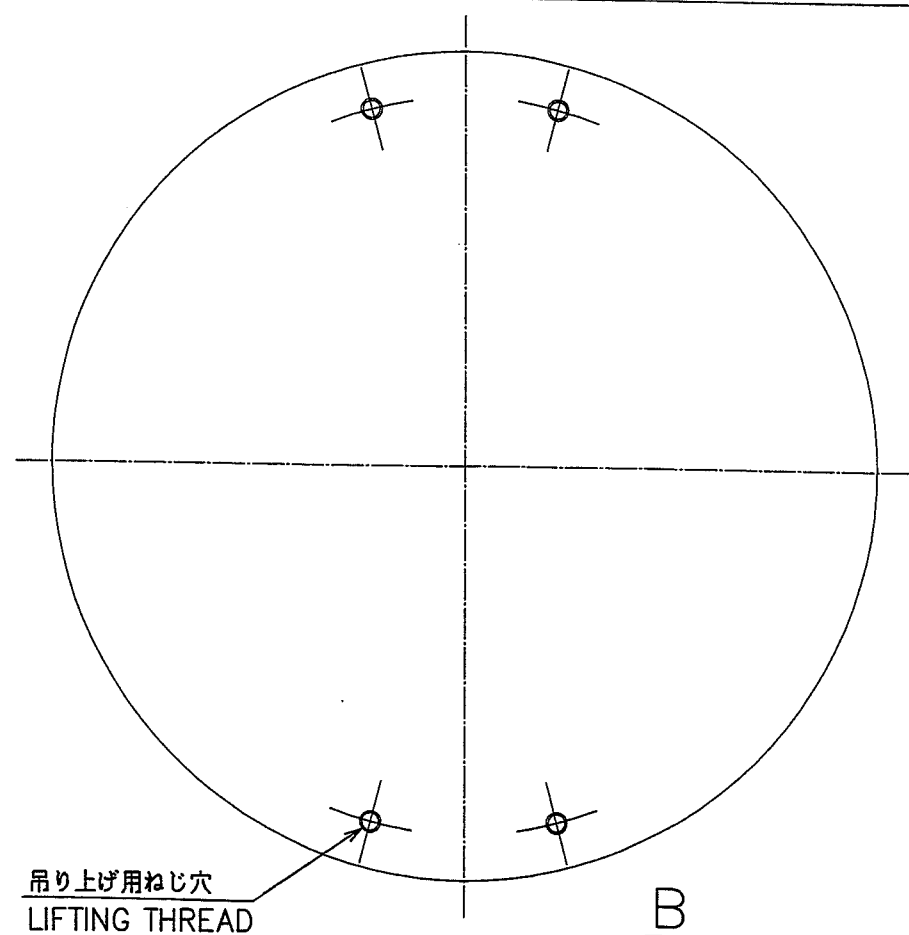


E-E

押し上げボルト用ねじ穴
FOR JACKING SCREW HOLE



F-F

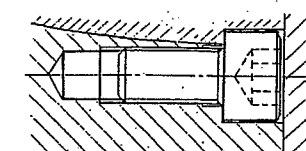
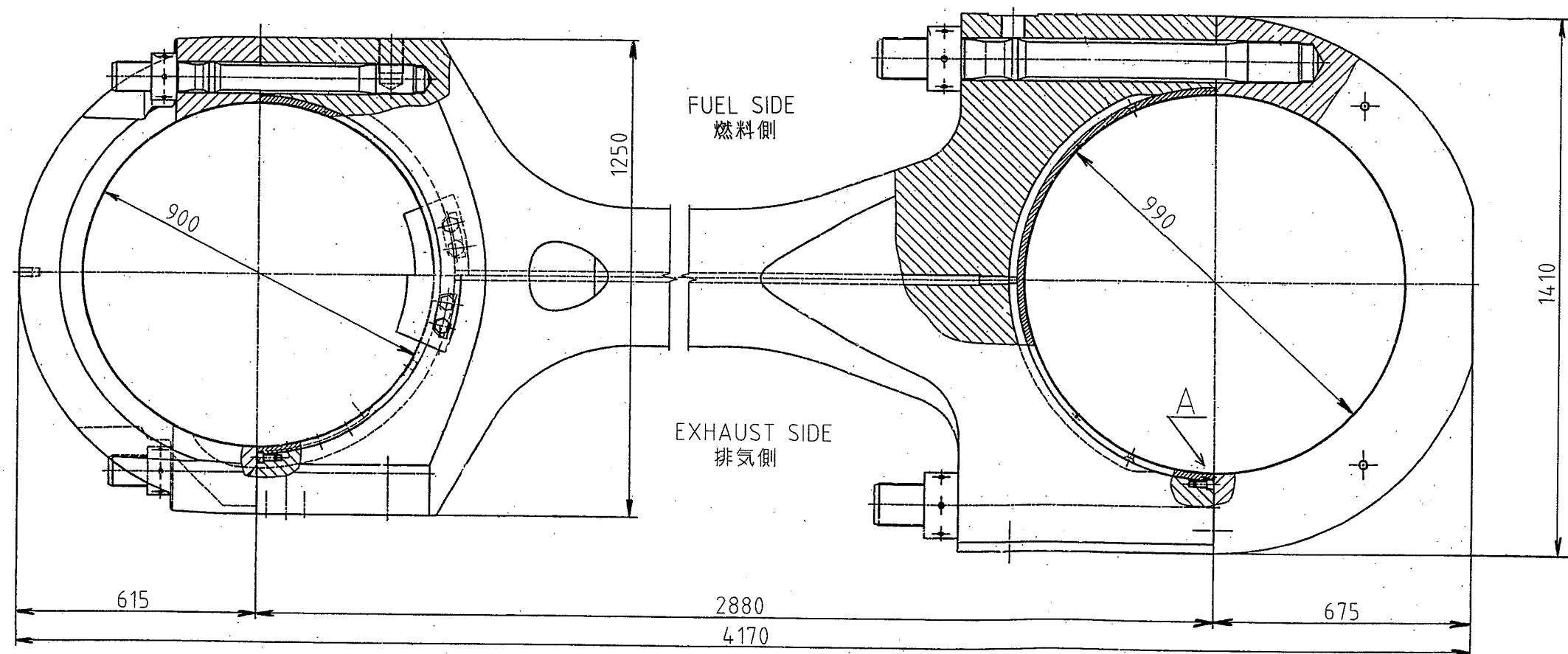
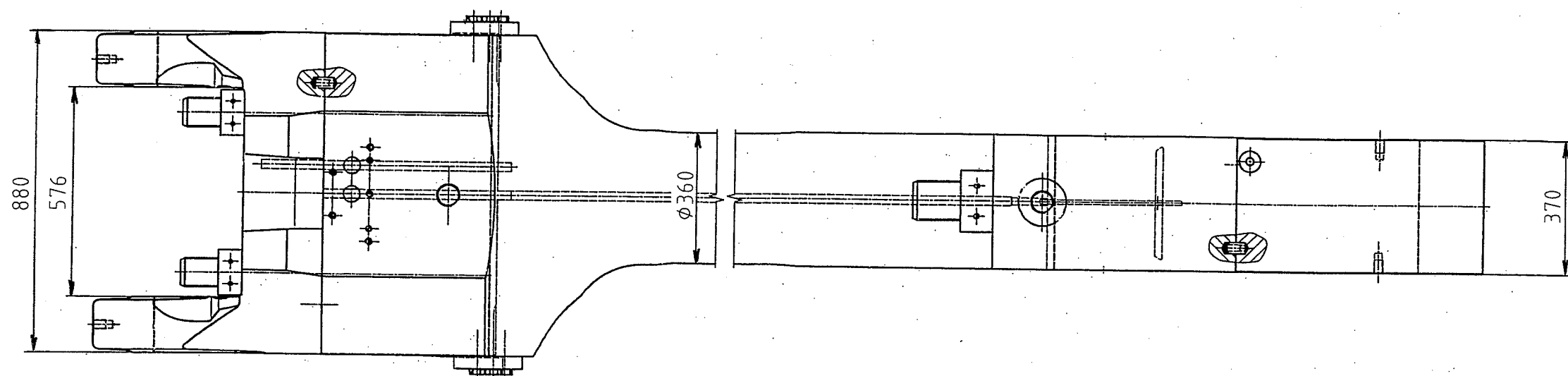


MITSUBISHI SULZER 11RT-flex96C DIESEL
ENGINE

PISTON ASSEMBLY

ピストン組立

A2-21242



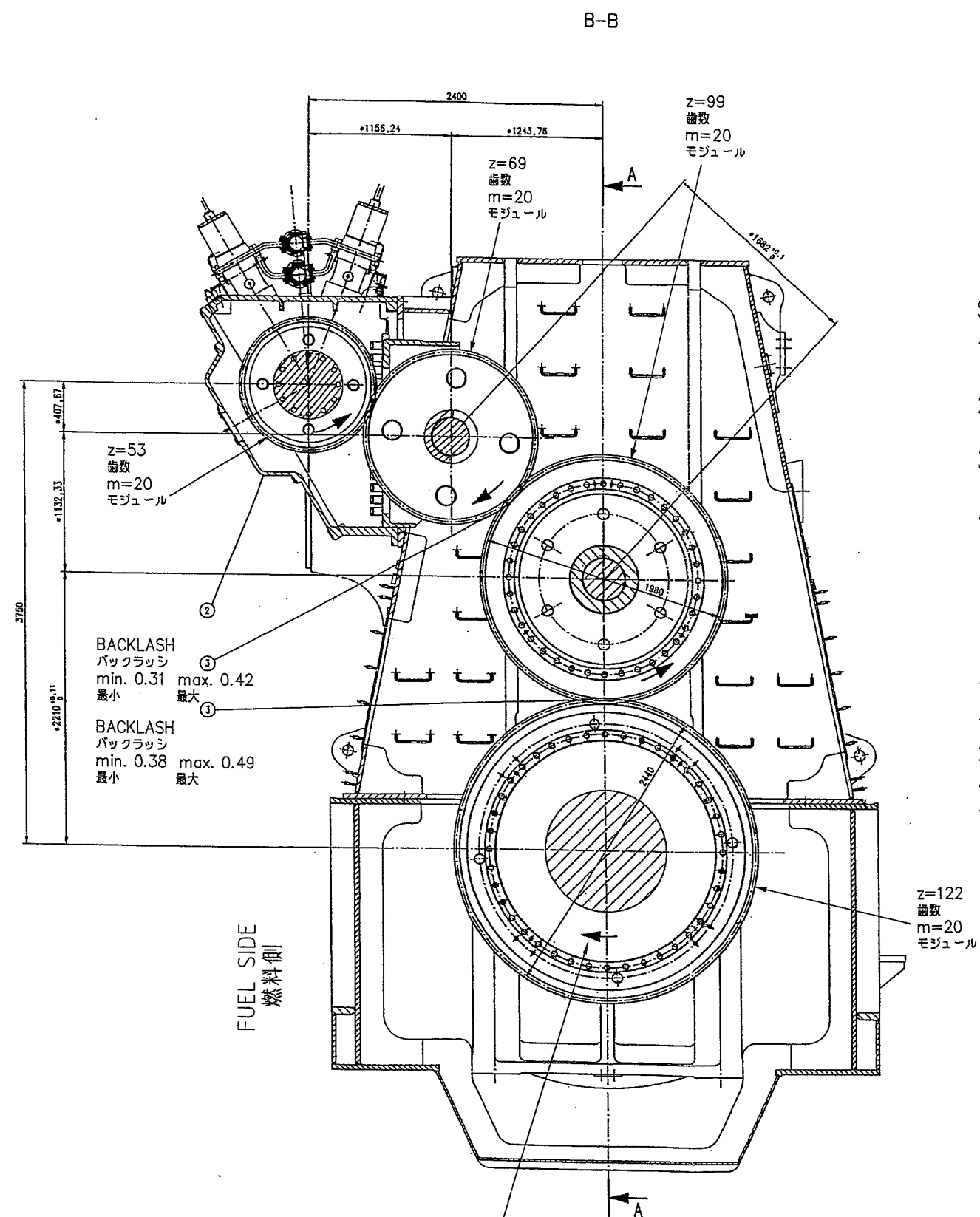
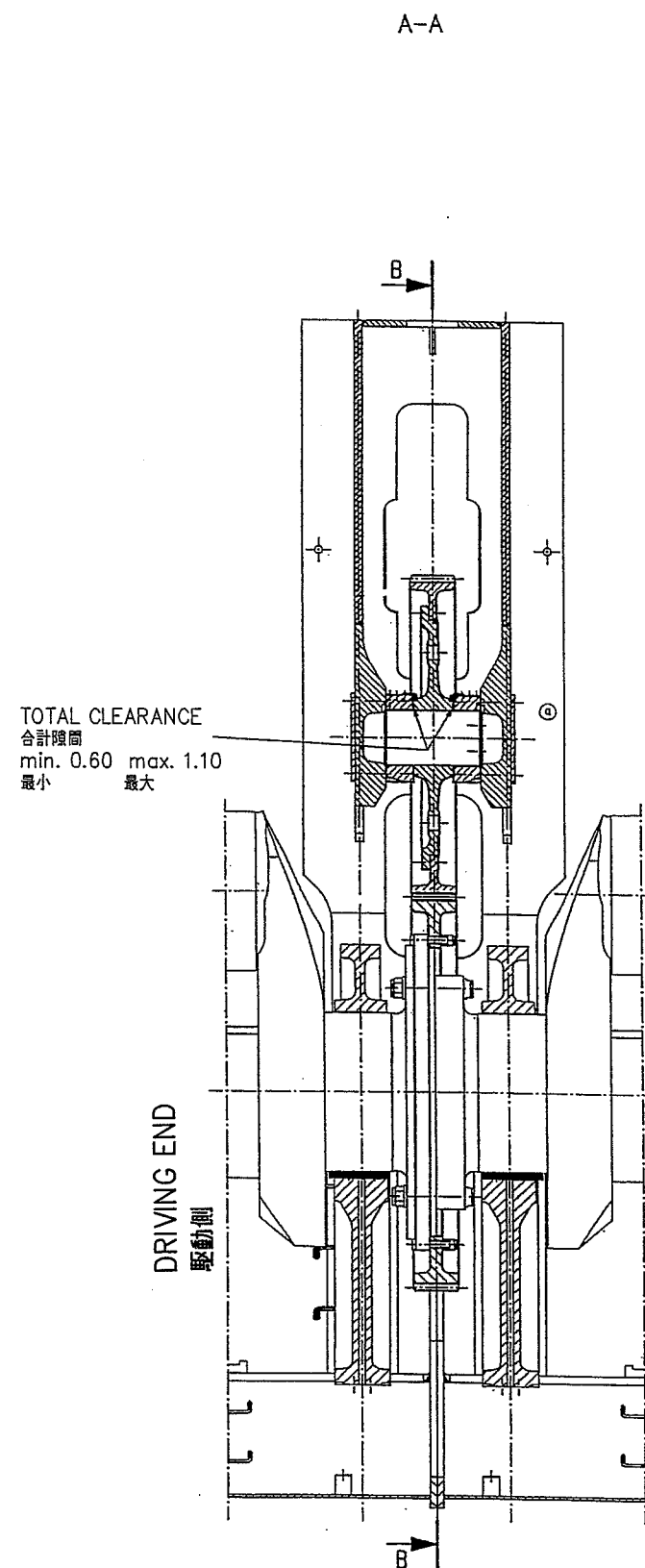
A

mitsubishi sulzer 11RT-flex96C DIESEL ENGINE

CONNECTING ROD ASSEMBLY

連接棒組立

A2-40692



SETTING THE WHEELS OF DRIVE SUPPLY UNIT

1. THE FOLLOWING ITEMS SHOULD BE CARRIED OUT ONLY WITH TIGHTENED TIE RODS.
2. FIT THE SUPPLY UNIT WITH INTERMEDIATE WHEEL.
3. SET INTERMEDIATE WHEELS WITHIN THE SPECIFIED BACKLASHES.
4. THE ADMISSIBLE DEVIATION OF TOOTH PROFILE PARALLELITY AMOUNTS TO MAX. 0.2% ACCROSS THE WIDTH OF THE TOOTH.

サプライユニット駆動歯車の調整

1. 下記の調整はタイロッド締付後に行うこと。
2. サプライユニット付中間歯車と共にコラムへ取付ける。
3. 中間歯車を取付け、歯当り、バックラッシの調整を行う。
4. 歯幅280mm間における各歯面の平行度は0.04mm以下であること。

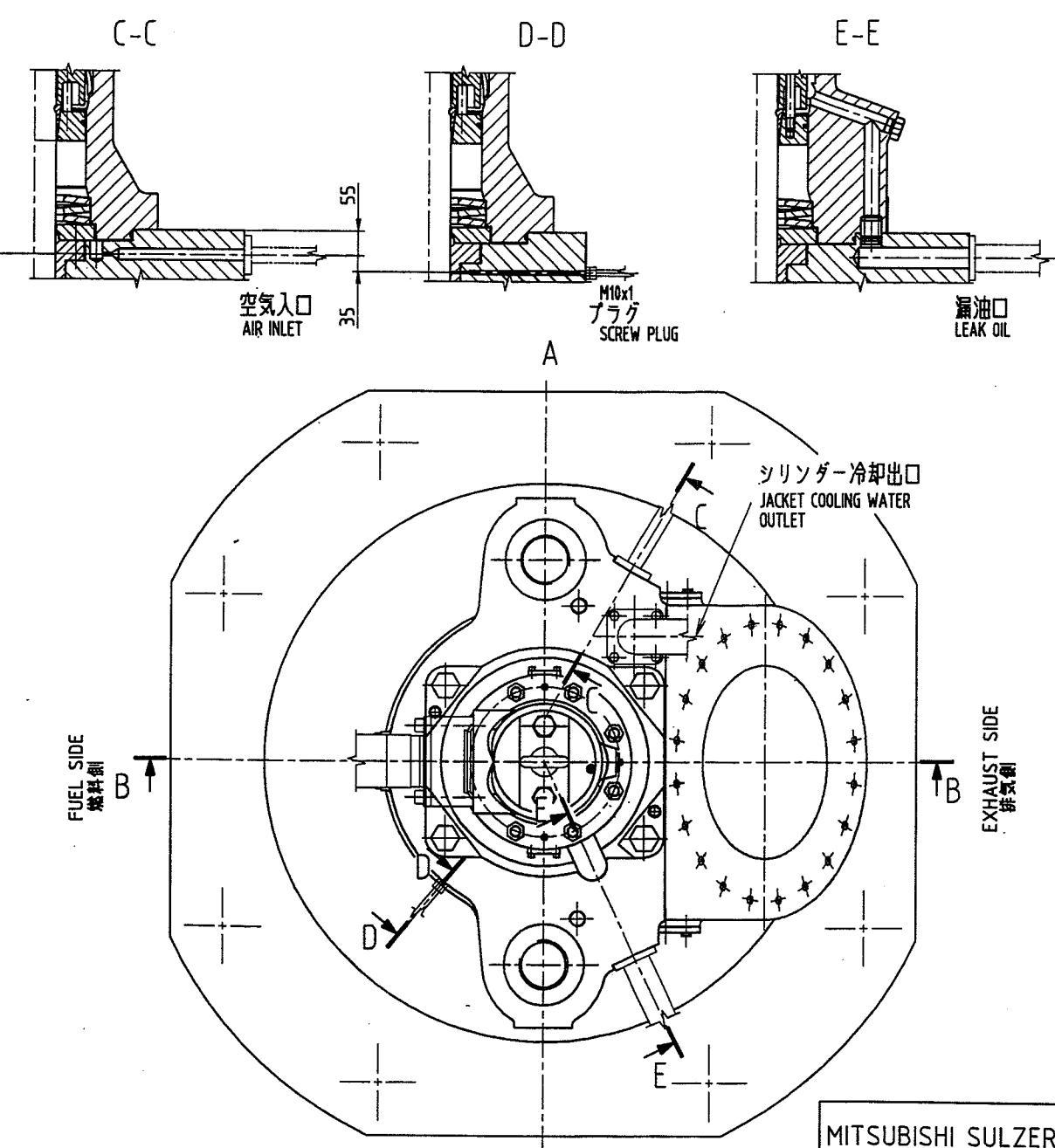
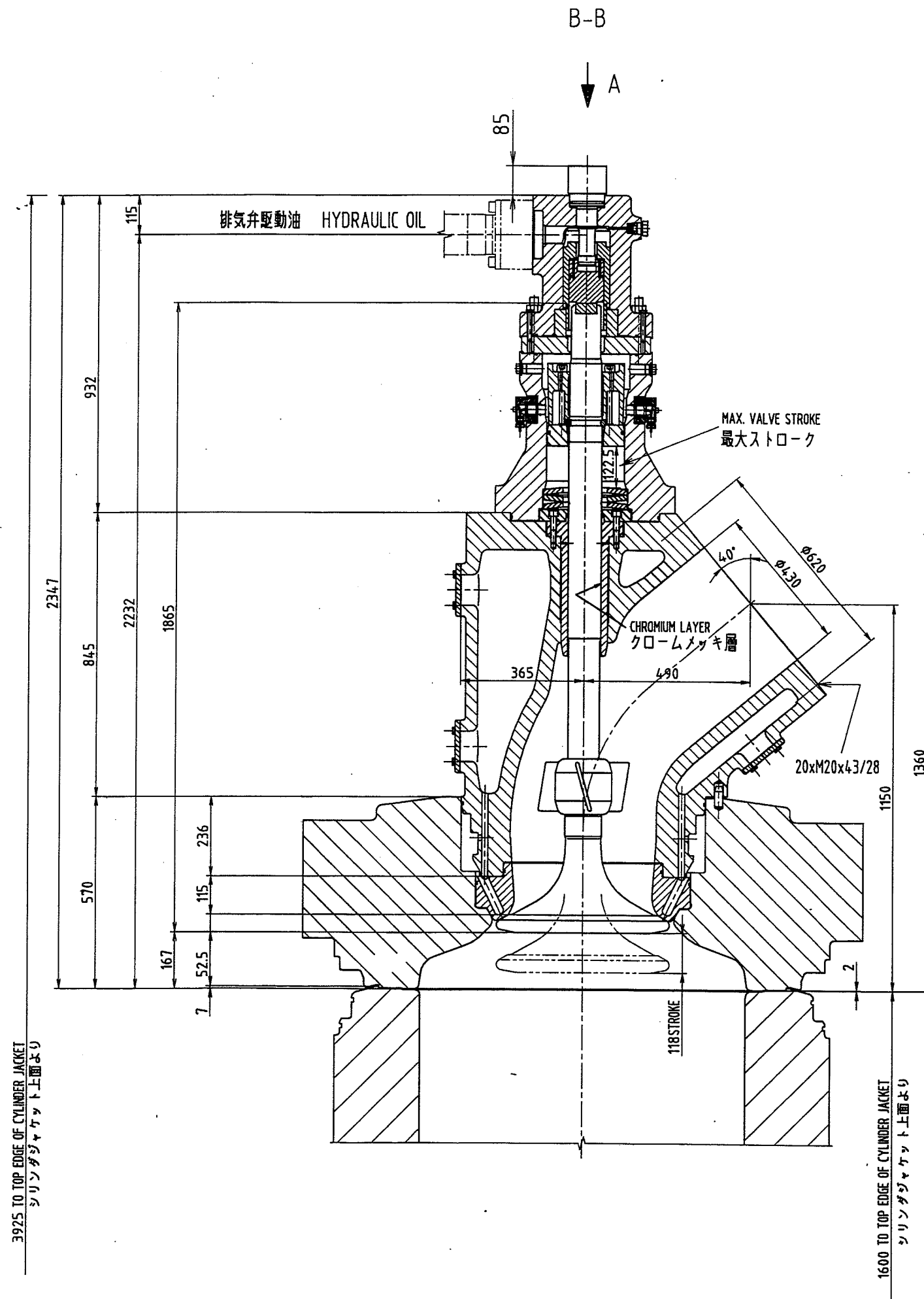
AHEAD FOR RIGHT HAND ENGINE CLOCKWISE ROTATION
右回転-前進
ASTERN FOR RIGHT HAND ENGINE COUNTER CLOCKWISE ROTATION
左回転-後進

MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

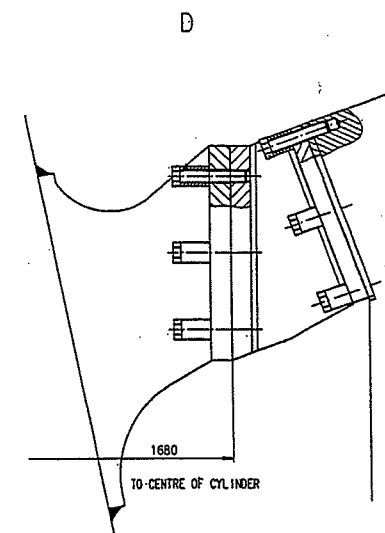
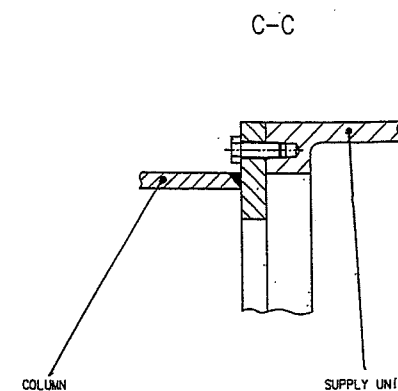
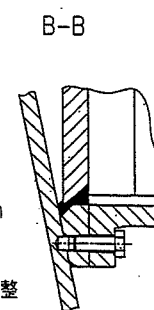
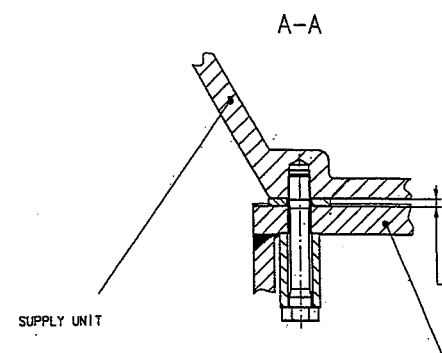
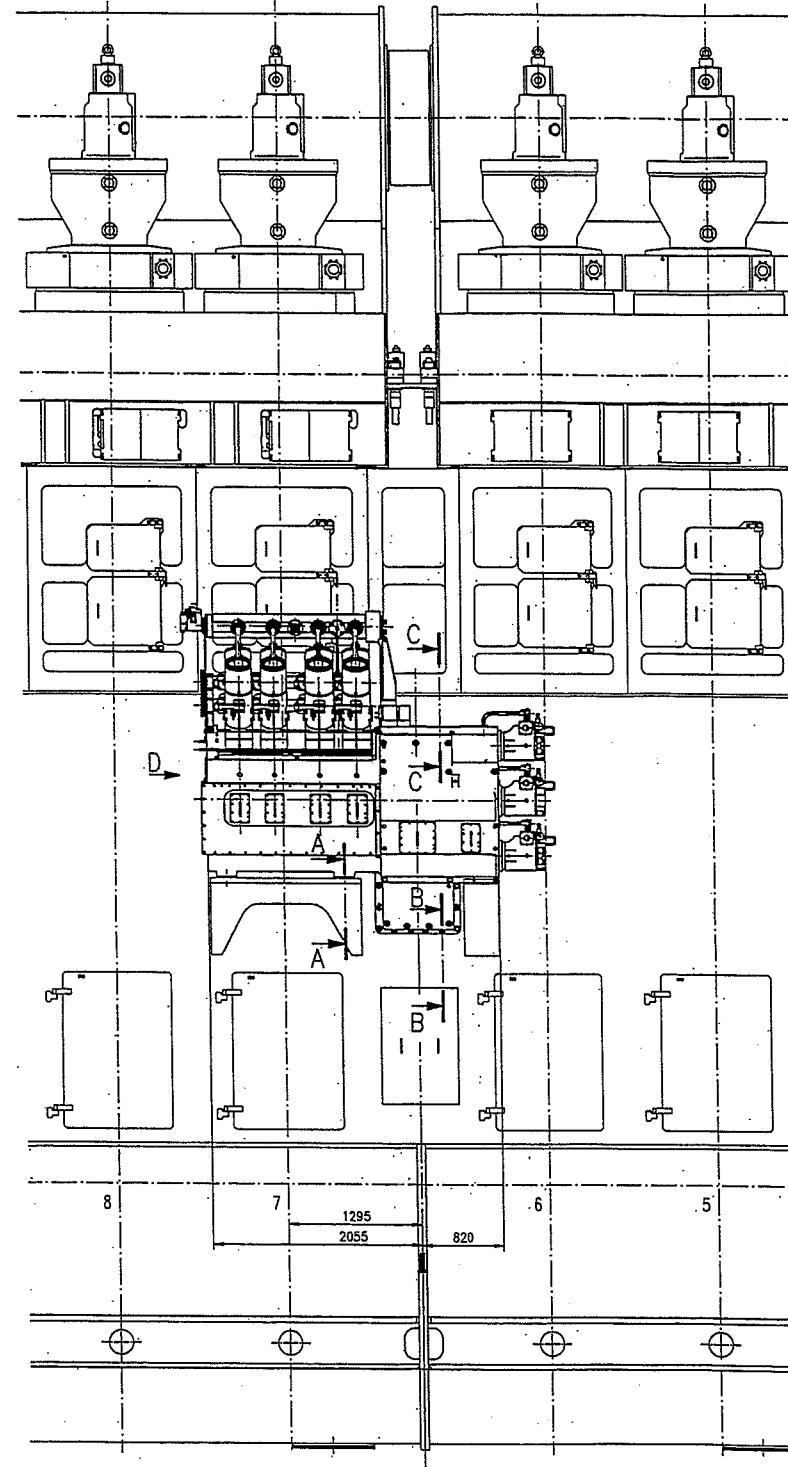
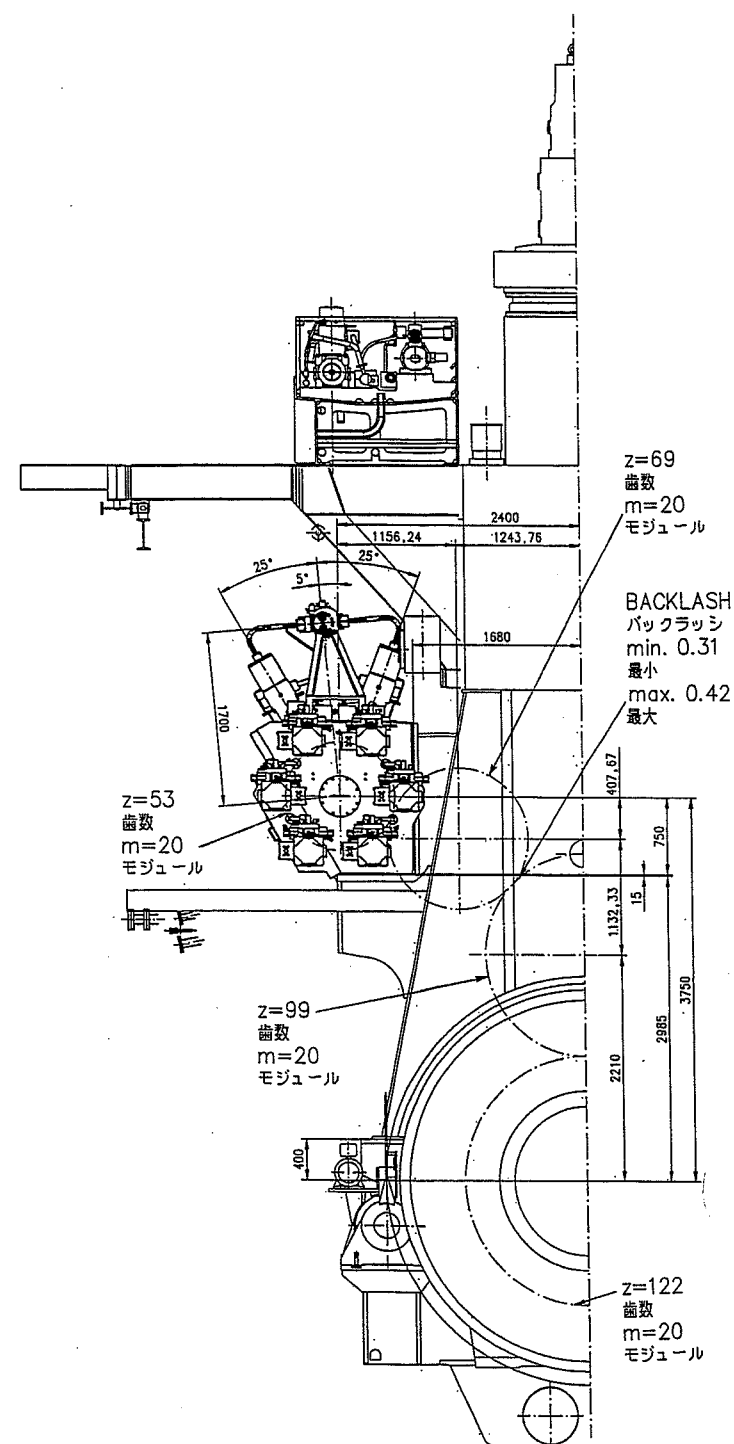
DRIVE SUPPLY UNIT
ASSEMBLY

サプライユニット駆動歯車装置組立

A3-00776



MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE
EXHAUST VALVE ASSEMBLY
排気弁組立
A3-60917



FOR DETAILS OF TIGHTENING
THE SCREWS SEE GROUP 0352

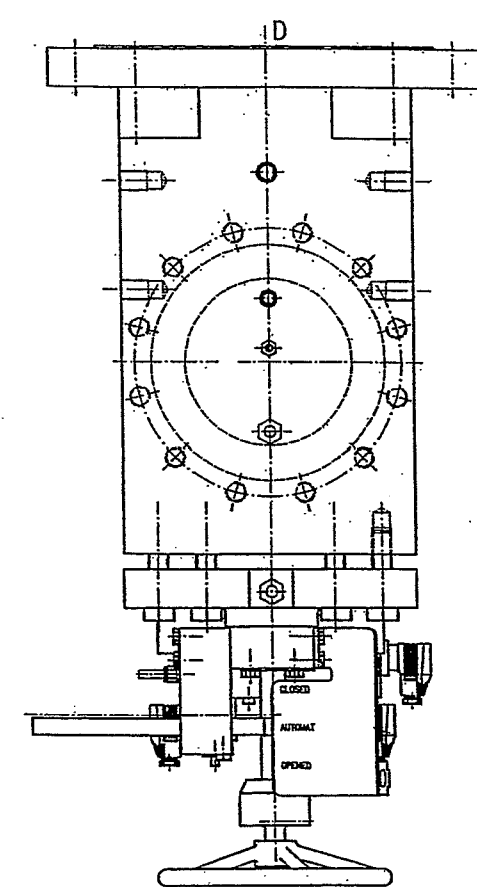
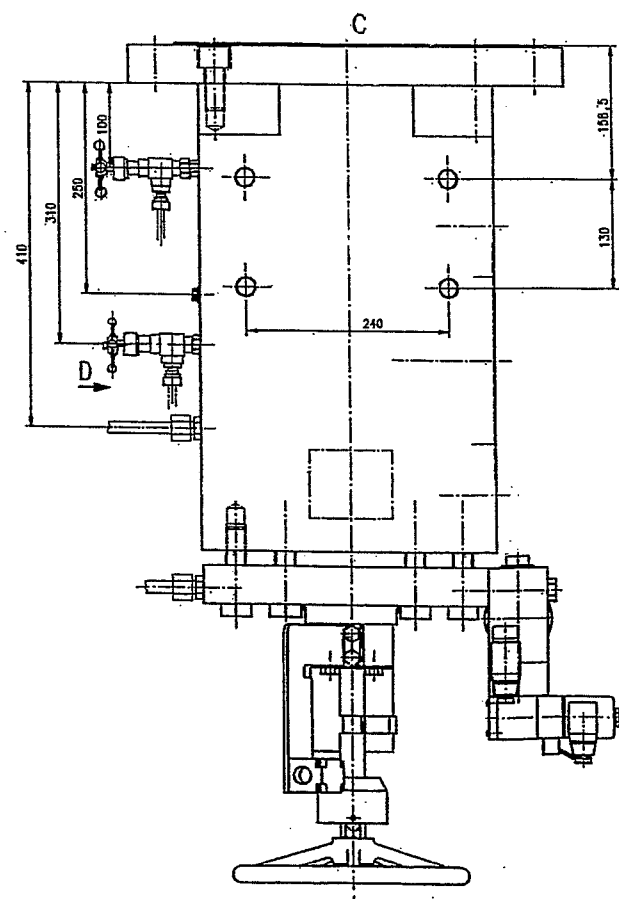
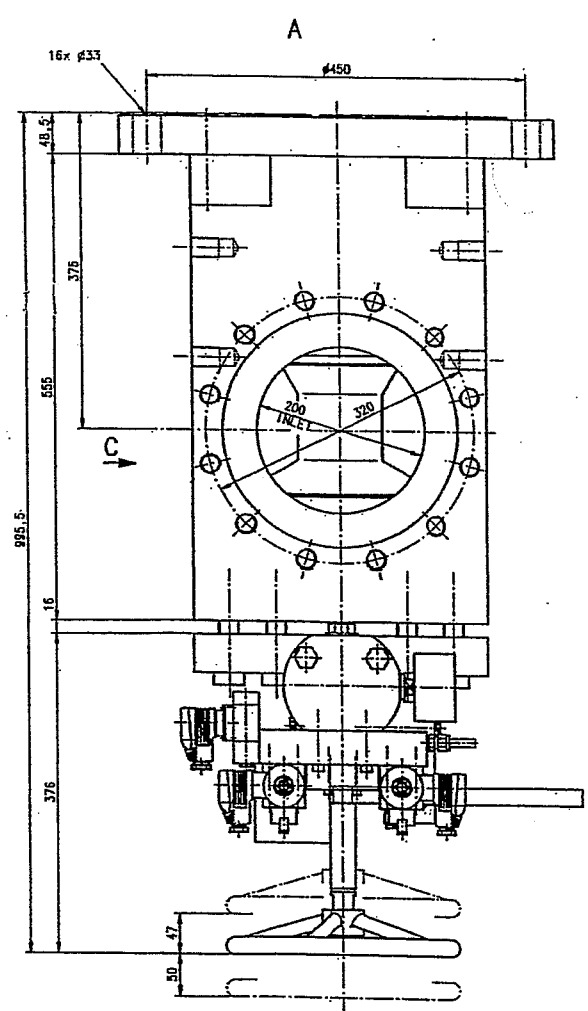
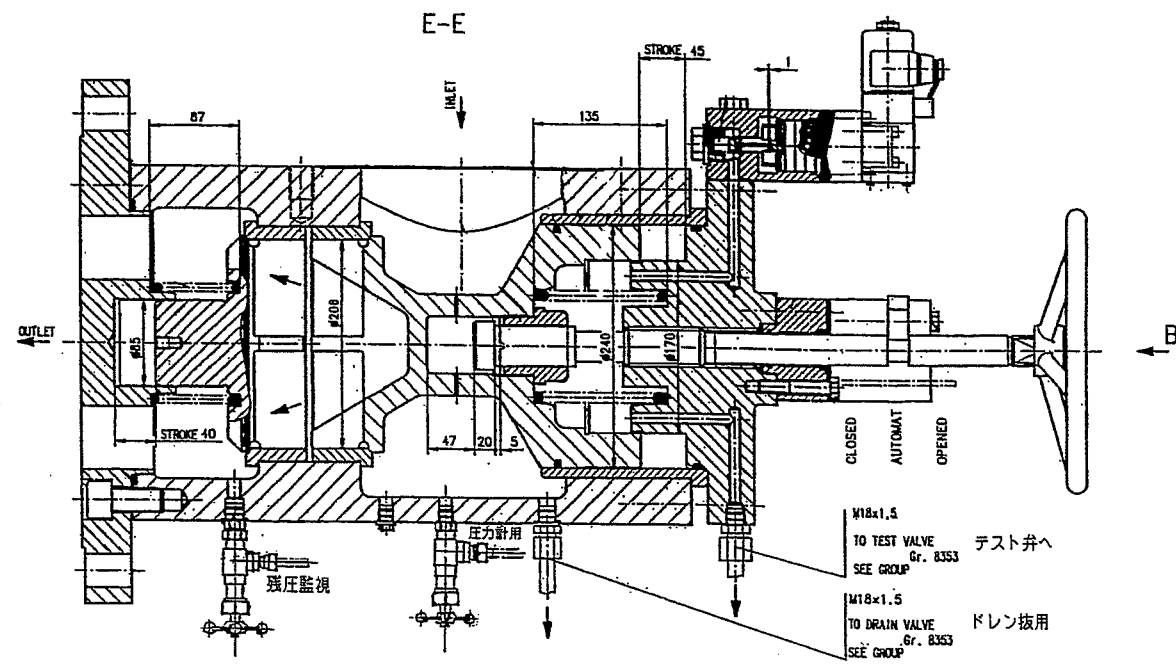
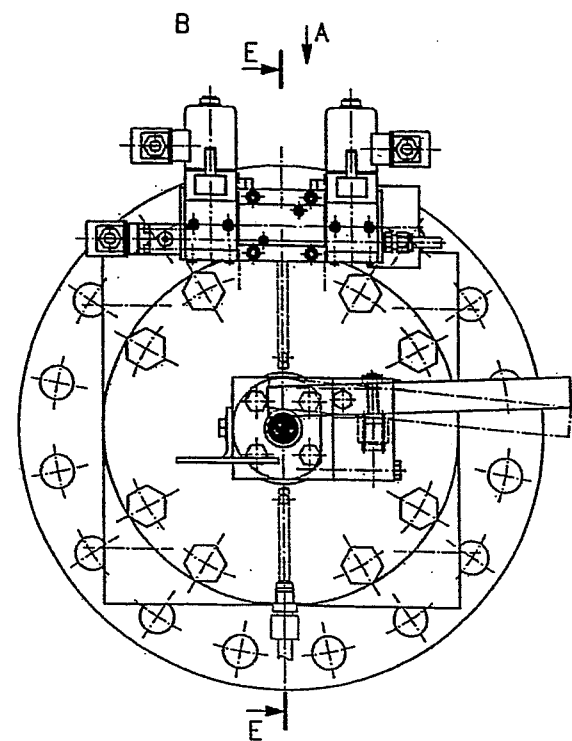
主要ボルト締付力一覧表
(取扱説明書(保守整備編)グループ0352)参照

MITSUBISHI SULZER 11RT-flex96C DIESEL
ENGINE

SUPPLY UNIT ASSEMBLY

サプラユニット組立

A4-60012



MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE

SHUT-OFF VALVE FOR STARTING AIR ASSEMBLY

始動空気遮断弁組立

A5-11294

MITSUBISHI-SULZER 11RT-flex96C TYPE DIESEL ENGINE

諸管線図集

PIPING DIAGRAM

(T/C : MET83SEII x 3台)

CONTENT		REMARKS		PURCHASER		ORDER No.	DATE	MARINE DIESEL ENGINE BUSINESS UNIT DIESEL ENGINE DESIGNING SECTION		
DESCRIPTION	14 PAGE					ITEM No.	REFERENCE			
FIGURE	6 SHEET					長船殿 S. 2225 S. 2226 S. 2227	7-8 ⁹¹¹ ₉₁₂ 70 913	June. 23 2005	APPROVED BY	<i>[Signature]</i>
TOTAL	20 PAGE					S. 2228 S. 2233 S. 2234	7-8 ⁹¹⁴ ₉₁₅ 70 916	June. 23 2005	CHECKED BY	<i>K. H. Hida</i>
						0100	T.H.	DESIGNED BY	<i>M. Sawata K. Shimada</i>	
						0100	T.H.	DRAWN BY	<i>Y. Abe K. Amari</i>	
								ISSUE		
								DATE	June. 20. 2005	
FACTORY	打合図	承認図		機工作		機電品		アサミ	西菱	
	3			3				1	1	
								1	1	
								9		
						DWG. No.		Rev. No.		
						A7-02595		F.		

CONTENTS

1. Name of piping diagram

Drawing number

○ <u>Starting and manoeuvring air</u> 始動及び操縦空気管線図	- 1
○ <u>Pneumatic maneuver. air (e/s)</u> 空気式操縦管線図	- 2
○ <u>Fuel oil</u> 燃料油管線図	- 3
○ <u>Cooling water</u> 冷却水管線図	- 4
○ <u>Lubricating oil</u> 潤滑油管線図 (T/C: MET)	- 5
○ <u>Control and actuating oil</u> 作動油及び排気弁駆動油線図	- 6
○ <u>Piston cooling oil</u> ピストン冷却油管線図	- 7
○ <u>Cylinder lubricating oil</u> シリンダ注油管	- 8
○ <u>Turbo charger (MET83SEIX3)</u> 過給機配管線図	- 9
○ <u>Air cooler cooling water</u> 空気冷却器冷却水管線図	- 10
○ <u>Drain</u> ドレン管線図	- 11
○ <u>Turbo charger and air cooler washing water</u> 過給機空気冷却器洗浄水管線図	- 12
○ <u>Fire extinguishing</u> 火災消火装置管	- 13
○ <u>Oil mist detector</u> オイルミストディテクター管線図	- 14

2. Numbers which written in the mark ○, coincide with the pipe number the shown in the separate pipe arrangement drawing

○ 印内に記入されている番号は別図諸管接続部詳細の番号に合せてあります。

SYMBOLS FOR MAIN ENGINE PIPING DIAGRAM

主 機 関 諸 管 線 図 記 号

SYMBOLS 記 号	NAME	名 称	REMARKS 備 考
	Nominal inner diameter	称 呼 口 径	
	Crossing pipes, connected	連 結 管	
	Crossing pipes, not connected	不 連 結 管	
	To bilge	ビ ル ジ ヘ	
	Boss	ボ ス	 M20 M24x2
	Boss and plug	プラグ付ボス	
	Joint, bossed	ボ ス 継 手	
	Joint, flanged	フ ラ ン ジ 継 手	
	Joint, screwed	ね じ 継 手	
	Tee joint, screwed	T 形 ね じ 継 手	
	Spectacle flange	め が ね フ ラ ン ジ	
	Blank flange	盲 フ ラ ン ジ	
	Orifice	オ リ フ ィ ス	
	Flexible pipe	フ レ キ シ ブ ル パ イ プ	
	Hopper	ホ ッ パ	
	Hopper with cover	ふ た 付 ホ ッ パ	
	Air pipe	空 気 抜 管	
	Loop seal pipe siphon	ル ー プ シ ー ル パ イ プ サ イ フ ォ ン	
	Siphon	サ イ フ ォ ン	

年

日

課

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者

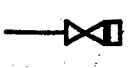
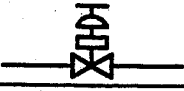
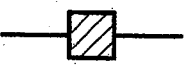
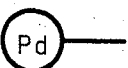
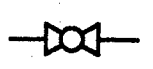
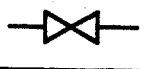
SYMBOLS 記 号	NAME	名 称	REMARKS 備 考
-----	Elect. cable	電 気 配 線	
-----	Outfit line (to be delivered by yard)	造船所殿所掌配管	
	Pressure switch	圧カスイッチ	
	Temperature switch	温度スイッチ	
	Float switch	フロートスイッチ	
	Limit switch	リミットスイッチ	
	Pressure transmitter	圧力変換器	
Bar Type 	Thermometer	温 度 計	
Dial Type 			
on Gauge board 			
Engine side 	Pressure gauge	圧 力 計	
on Gauge board 			
	Level switch	レベルスイッチ	
	U Tube manometer	U字管式圧力計	
	Stop valve	止 め 弁	Globe valve 玉 形 弁
			Angle valve アングル弁
	Thermometer pocket	温 度 計 座 (ポケット付)	
	Three-way cock	三方コック	(1) T形 (T-PORT) (2) L形 (L-PORT)
	Butterfly valve	バタフライ弁	
	Solenoid operated vavle	電 磁 弁	

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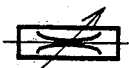
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SYMBOLS 記 号	NAME	名 称	REMARKS 備 考
	Solenoid operated valve (angle)	電 磁 弁	
	Gate valve	仕 切 弁	
	Hose valve	ホ ー ス 弁	
	Hose valve (angle)	ホ ー ス 弁 (アングル)	
	Safety valve	安 全 弁	
	Swing check valve	スイング逆止め弁	
	Swing check valve (angle)	スイング逆止め弁 (アングル)	
	Lift check valve	リフト逆止め弁	
	Diaphragm operated valve (with positioner & handle)	ダイヤフラム操作弁 (ポ ジショナ及びハンドル付)	
	Sight glass	サイトグラス	
	Simplex strainer	単 式 コ シ	
	Duplex strainer	復 式 コ シ	
	Y type strainer	Y形ストレーナ	
	Differential pressure gauge	差 圧 計	
	Reducer	レジューサ	
	Hose coupling	ホ ー ス 継 手	
	Regulating valve	自 動 調 整 弁	
	Cock	コ ッ ク	
	Pressure reducing valve	減 圧 弁	
	Ball valve	ボ ー ル 弁	

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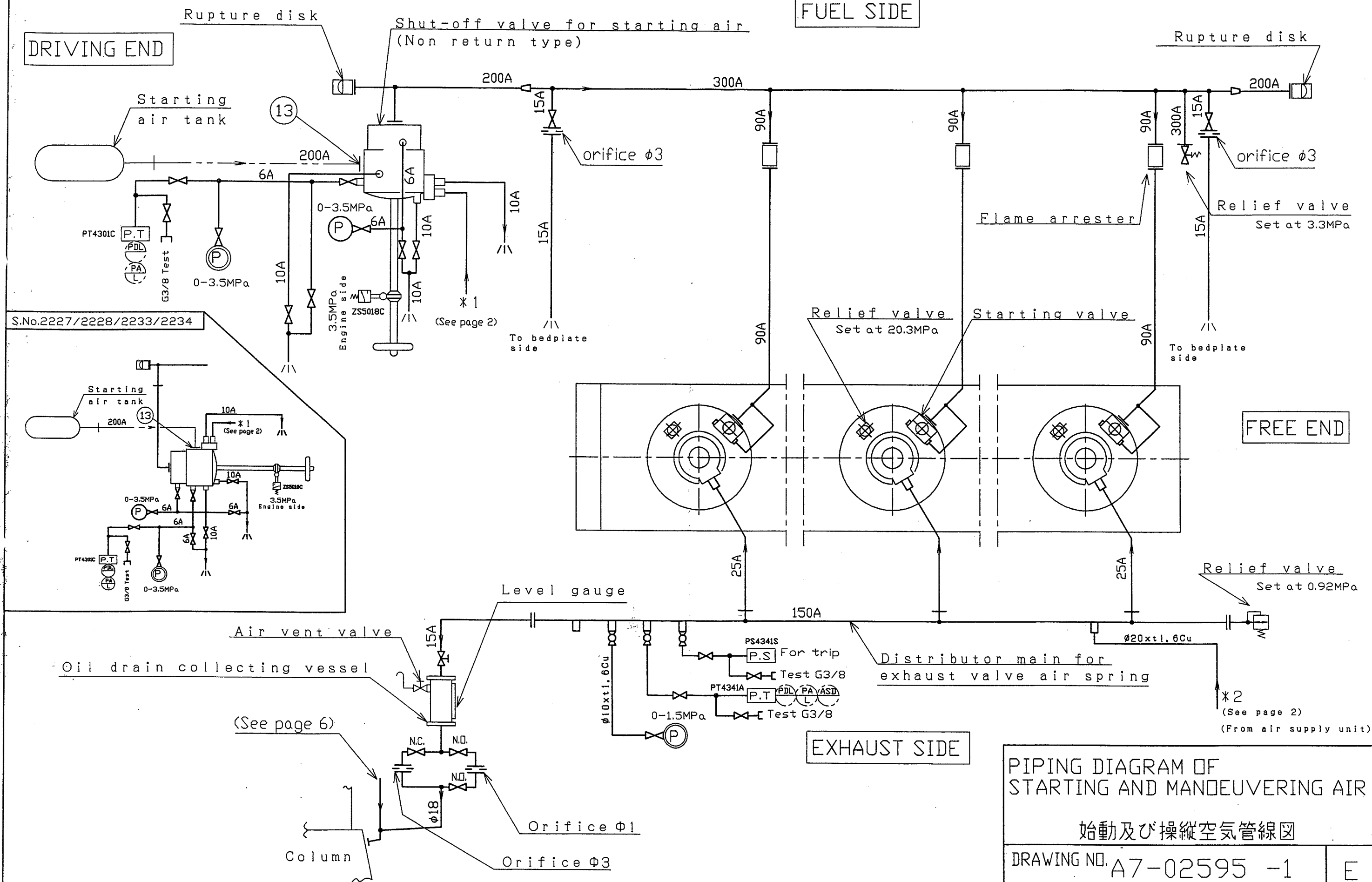
SYMBOLS 記 号	NAME	名 称	REMARKS 備 考
	Remotely indicated	遠隔指示計	
PAC	Pump auto change	ポンプオートチェンジ	
PT	Pressure transmitter	圧力変換器	
PA	Pressure alarm	圧力警報	
PDL	Data logger (pressure)	データロガー (圧力)	
ASD	Auto slow down	自動減速	
TR	Thermometer resister	温度変換器	
TA	Thermometer alarm	温度警報	
TDL	Data logger (temperature)	データロガー (温度)	
FA	Flow alarm	流れ警報	
DPA	Differential pressure alarm	差圧警報	
H	High (high press., high temp., high level)	高圧, 高温, 高液面	HD: 偏差大
L	Low (low press., low temp., low level)	低圧, 低温, 低液面	
WECS	Indicated for WECS	WECS 指示計	
	Dampener	ダンパー	
	Seal pot	シールポット	
	Check valve	チェック弁	
	Relief valve	リリーフ弁	
LKS	Leak sensor	リークセンサ	

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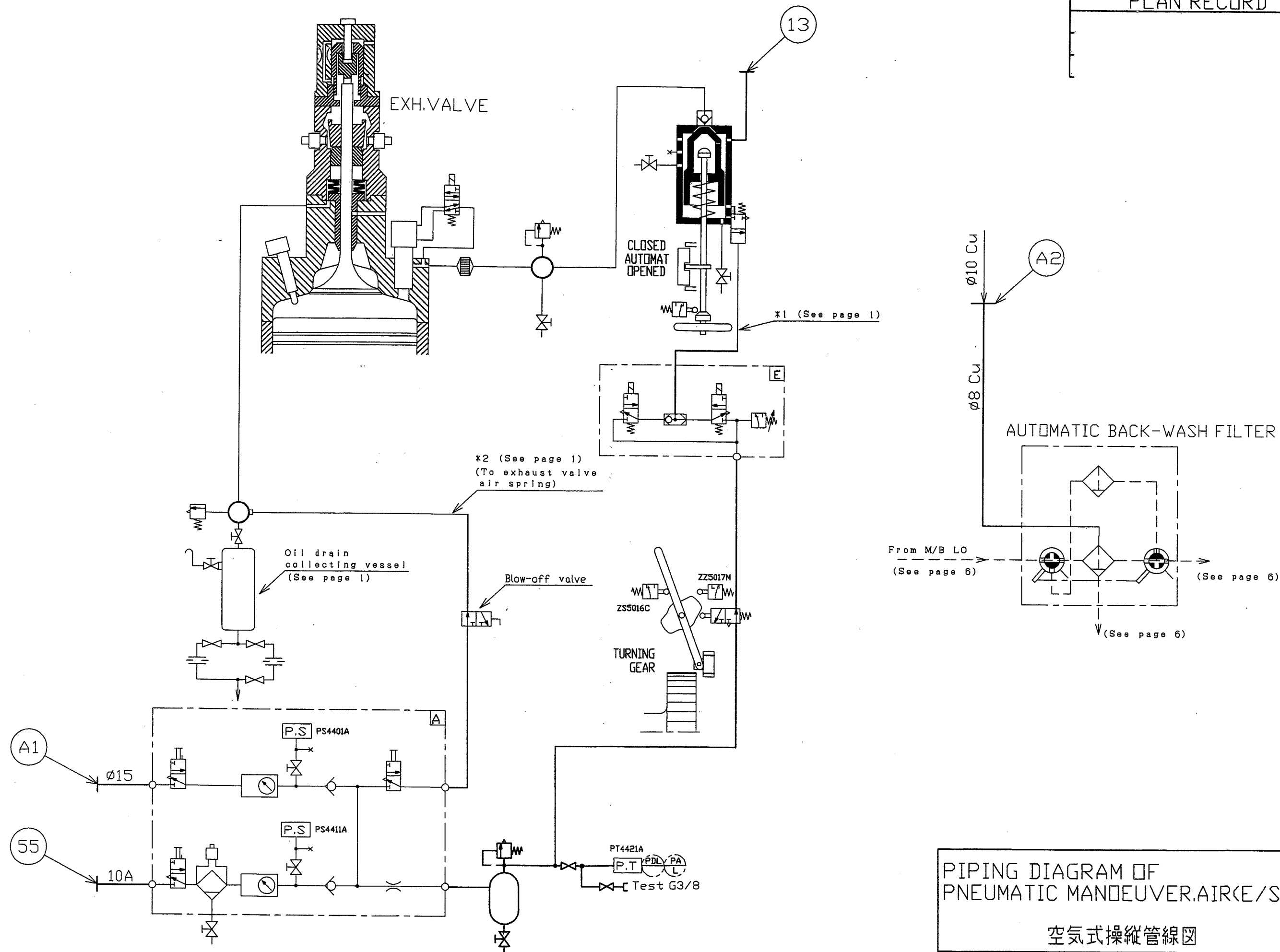


PIPING DIAGRAM OF STARTING AND MANOEUVERING AIR

始動及び操縦空気管線図

DRAWING NO. A7-02595 -1

F

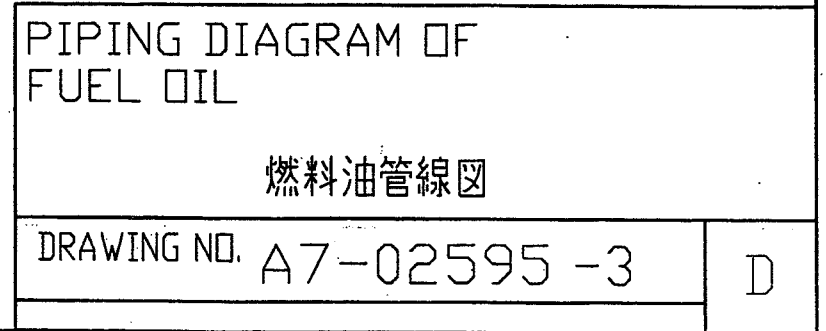


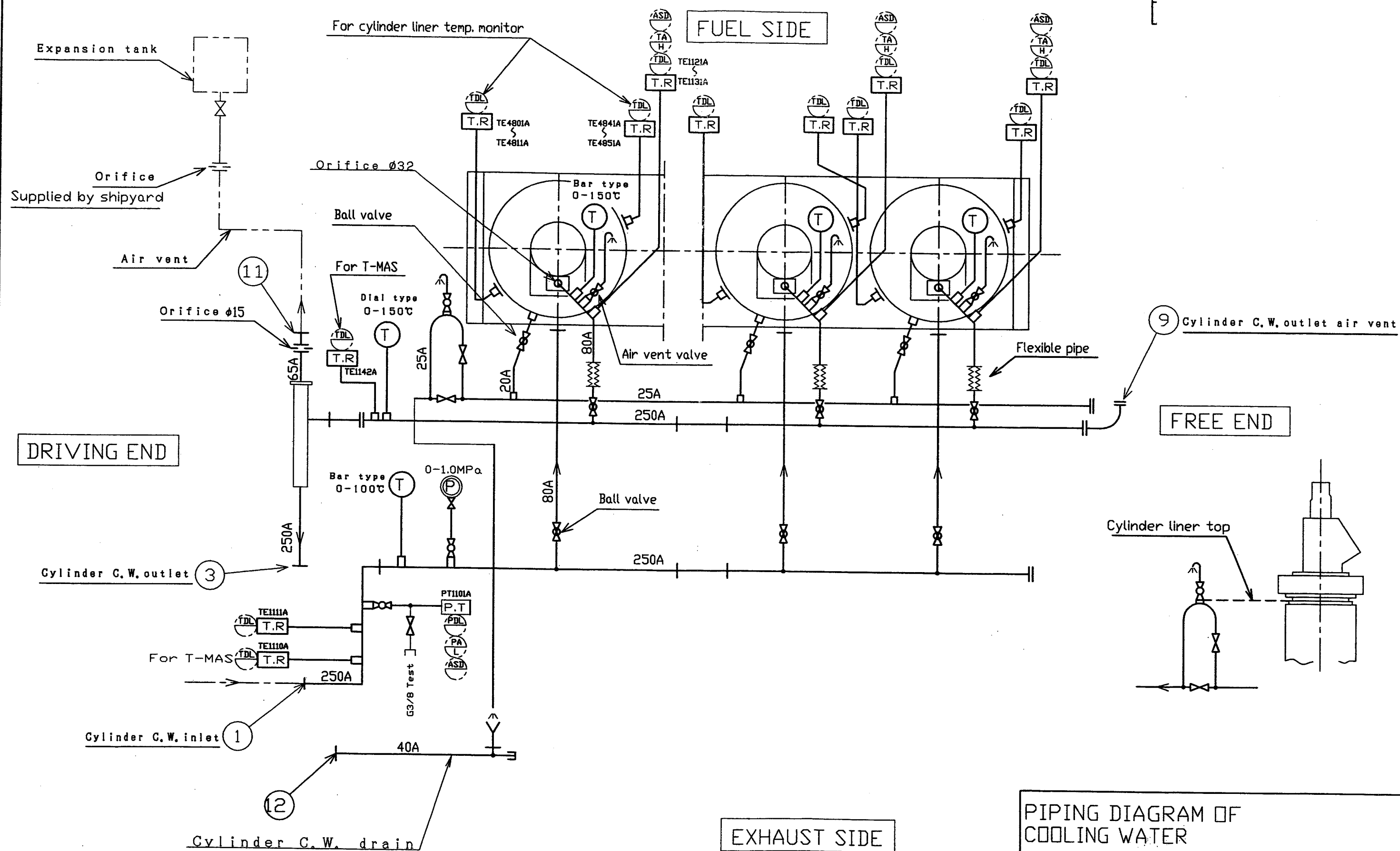
PIPING DIAGRAM OF
PNEUMATIC MANOEUVER AIR(E/S)

空気式操縦管線図

DRAWING NO. A7-02595 -2

D



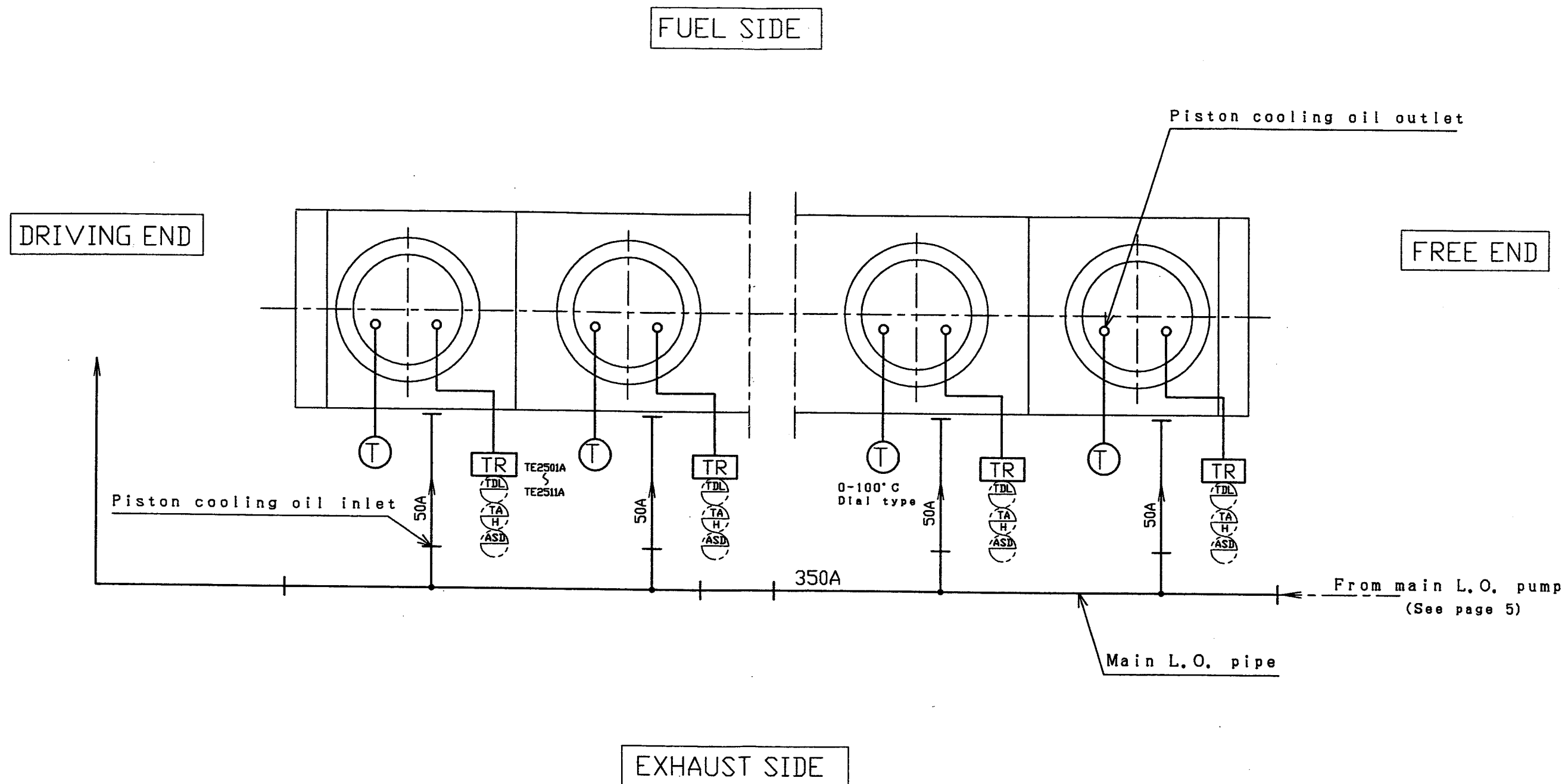


PIPING DIAGRAM OF
COOLING WATER

冷却水管線図(T/C:MET)

DRAWING NO. A7-02595-4

C

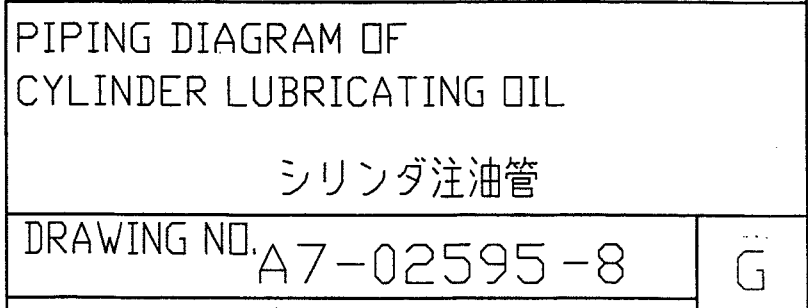


PIPING DIAGRAM OF
PISTON COOLING OIL

ピストン冷却油管線図

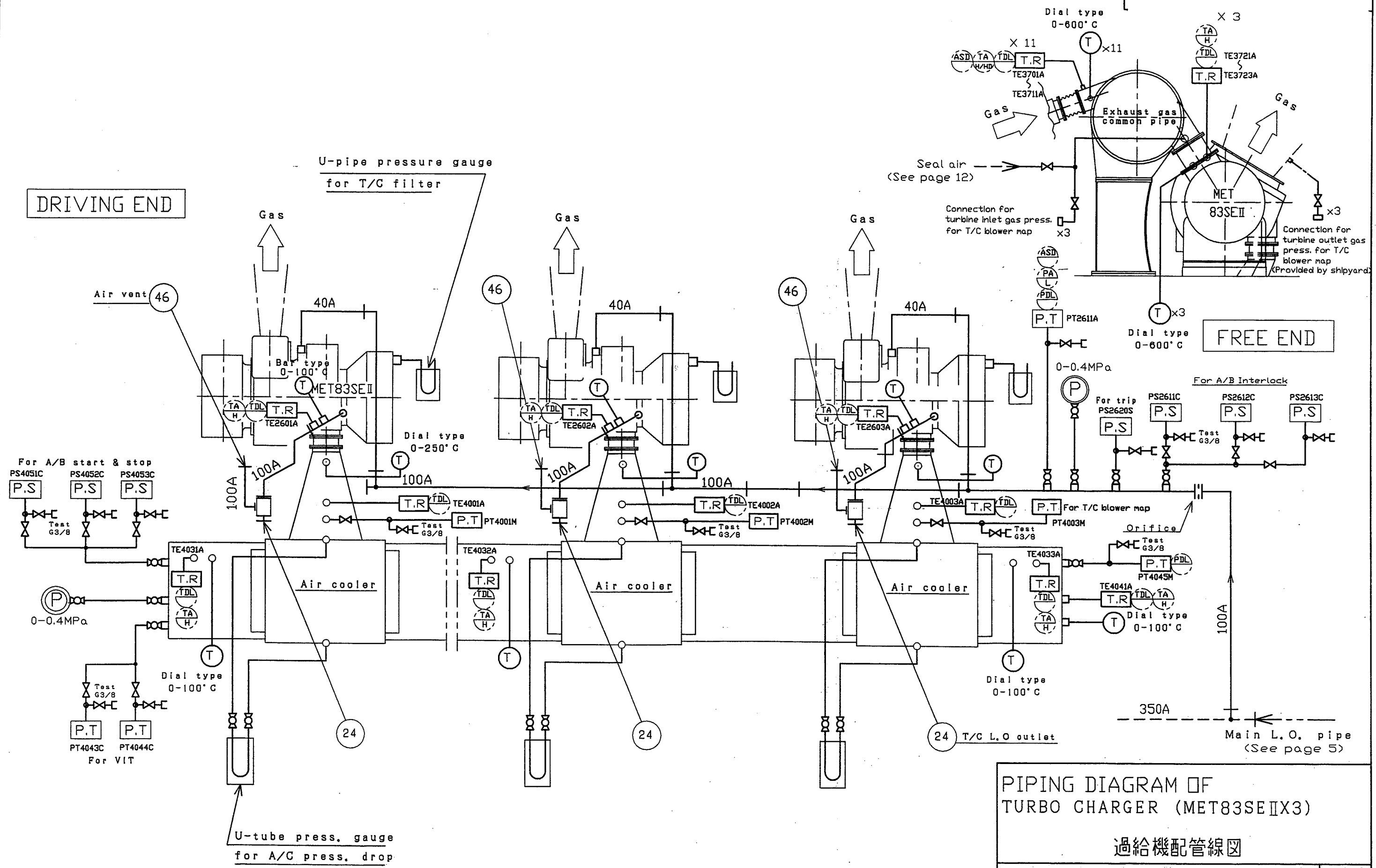
DRAWING NO. A7-02595 -7

A



DRIVING END

FREE END



PIPING DIAGRAM OF TURBO CHARGER (MET83SEIIx3)

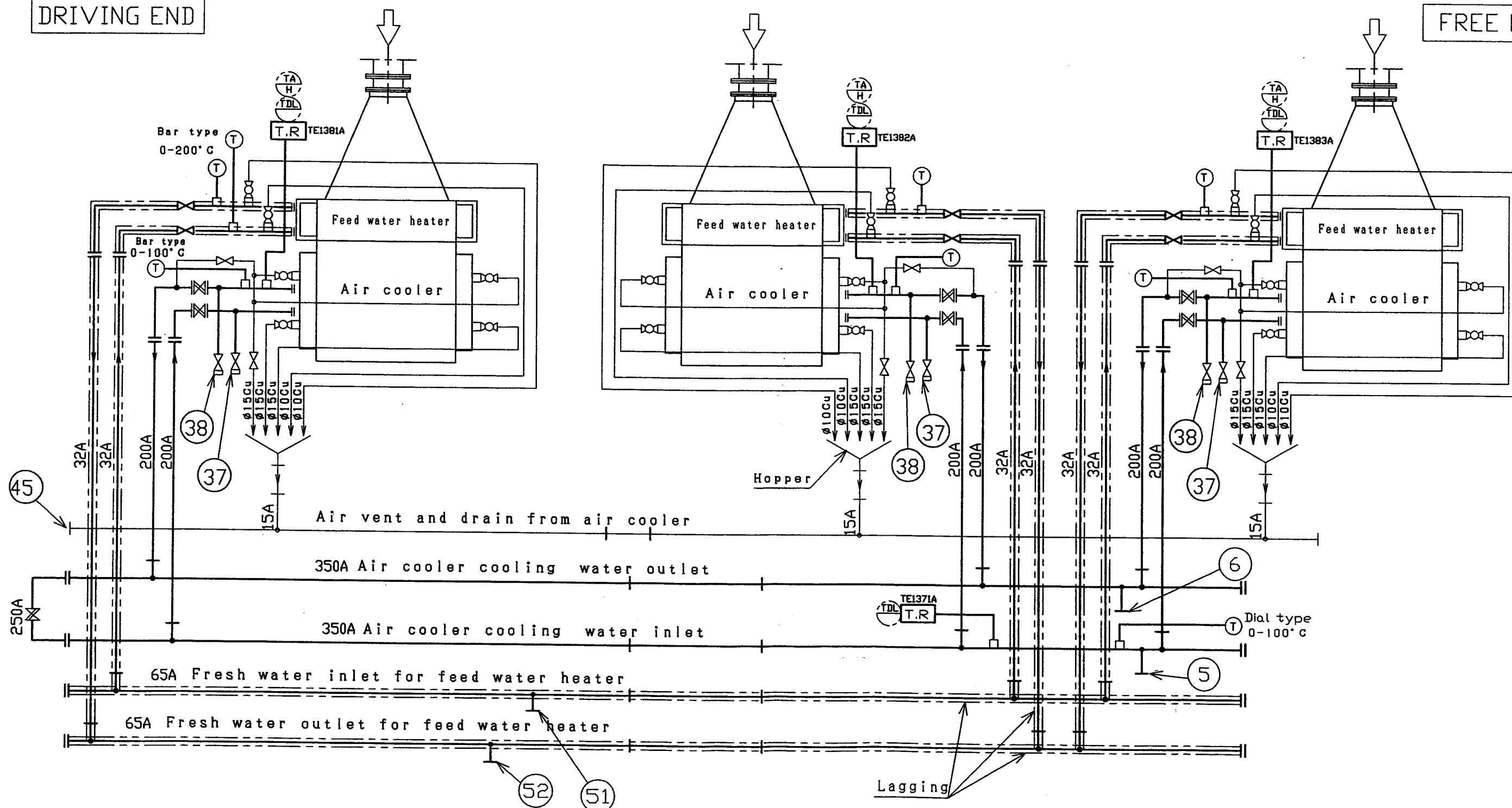
過給機配管線図

DRAWING NO. A7-02595-9

D

DRIVING END

FREE END



PIPING DIAGRAM OF
AIR COOLER COOLING WATER
空気冷却器冷却水管線図

DRAWING NO. A7-02595-10

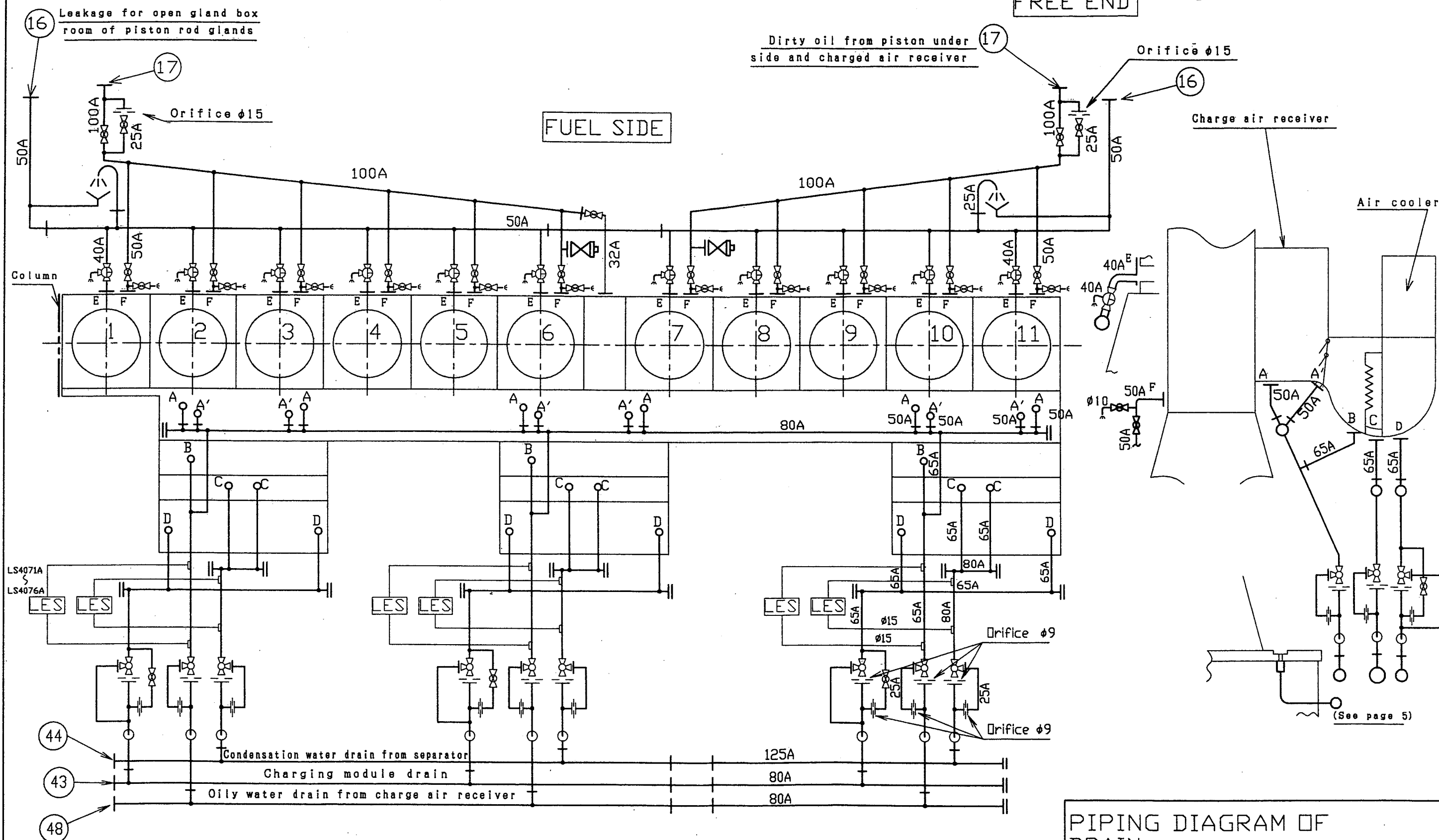
C

DRIVING END

FREE END

FUEL SIDE

EXHAUST SIDE

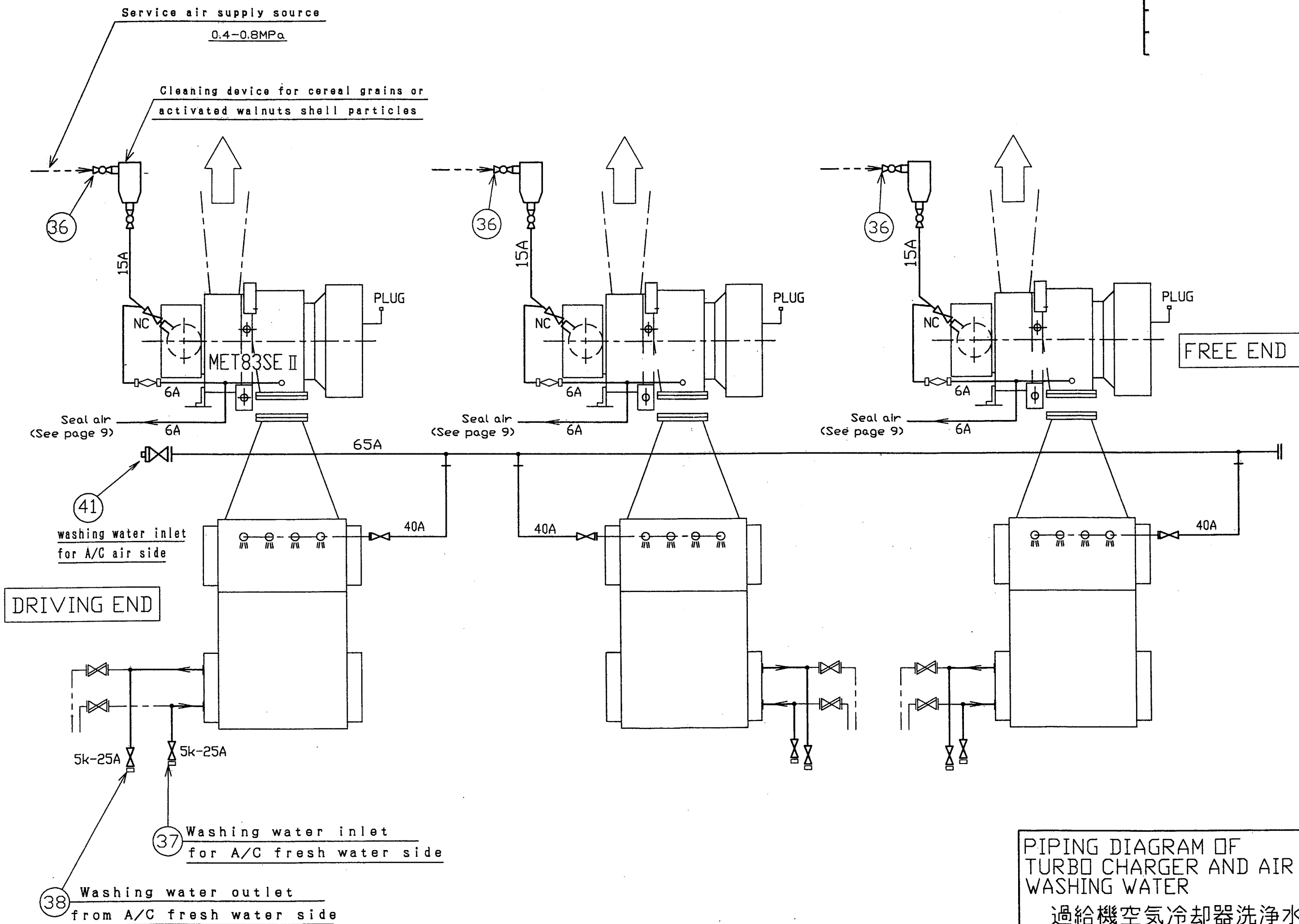


PIPING DIAGRAM OF DRAIN

ドレン管線図

DRAWING NO. A7-02595-11

F



PIPING DIAGRAM OF
TURBO CHARGER AND AIR COOLER
WASHING WATER

過給機空氣冷却器洗淨水管線図

DRAWING NO. A7-02595 -12

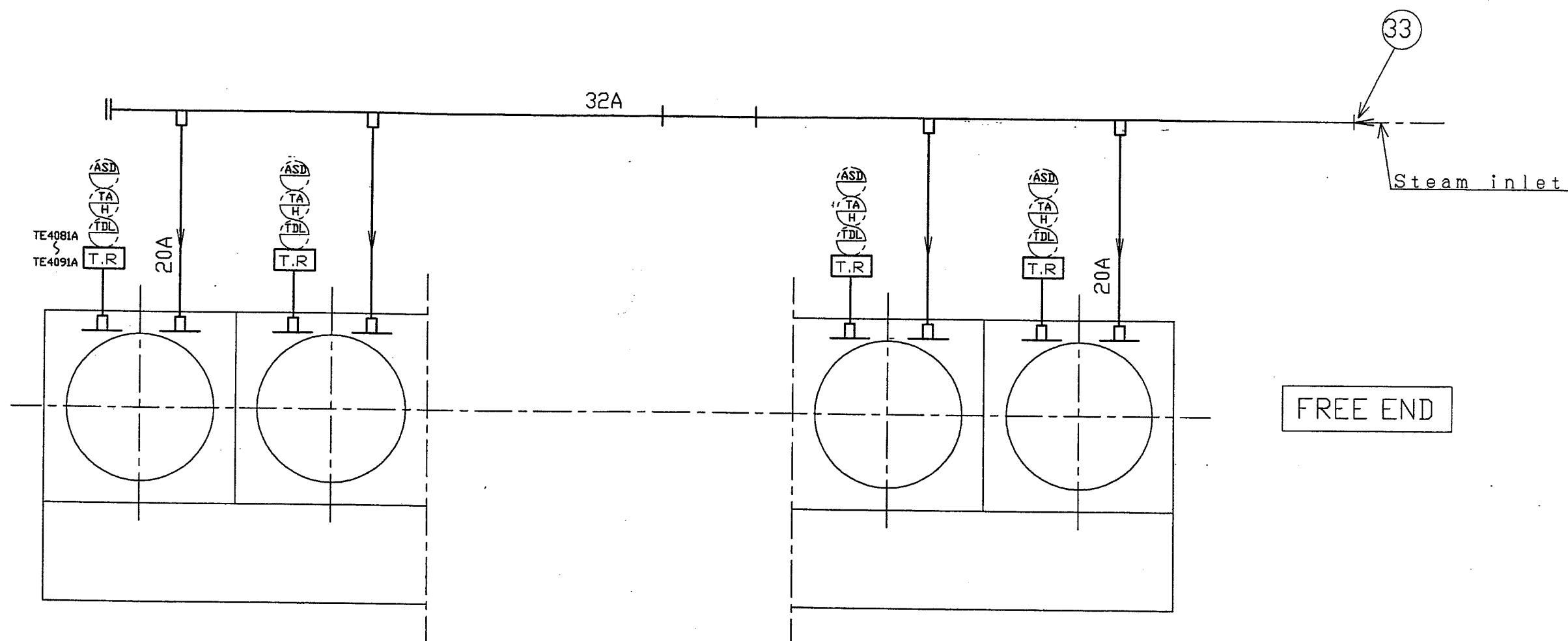
1

FUEL SIDE

DRIVING END

FREE END

EXHAUST SIDE



PIPING DIAGRAM OF
FIRE EXTINGUISHING

火災消火装置管線図

DRAWING NO. A7-02595 -13

D

FUEL SIDE

For S.No. 2233/2234
Electronic Type

Gear case

DRIVING END

FREE END

15A

20A

Oil mist detector
AS2401A
XS2411A

Drain
To gear case

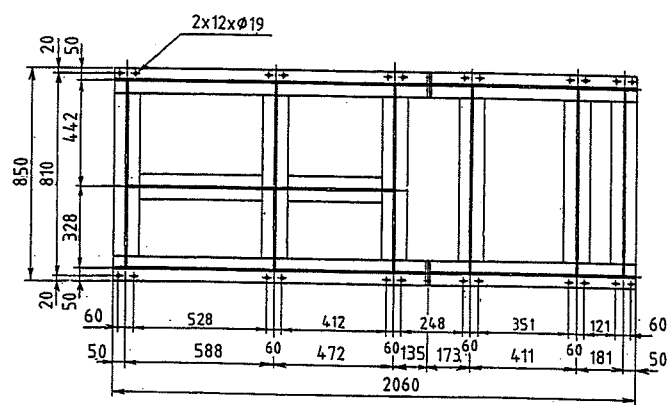
EXHAUST SIDE

PIPING DIAGRAM OF
OIL MIST DETECTOR

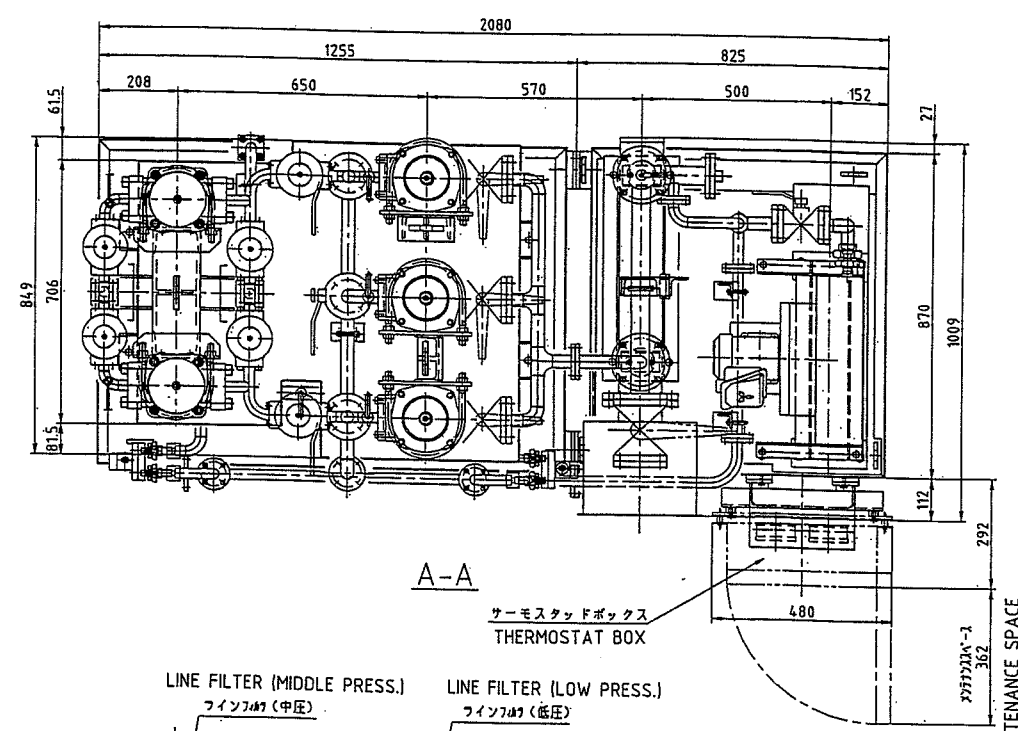
オイルミストディテクター管線図

DRAWING NO. A7-02595-14

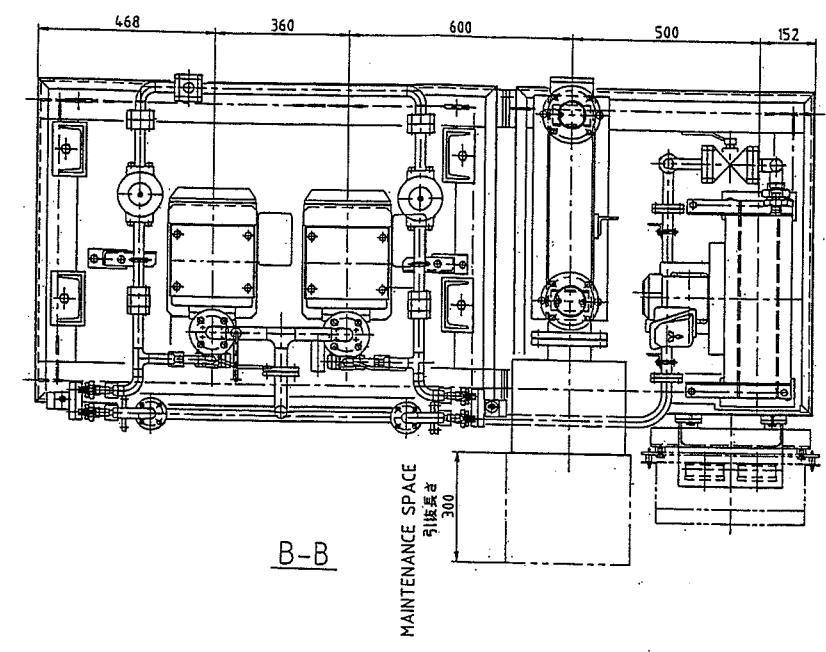
E



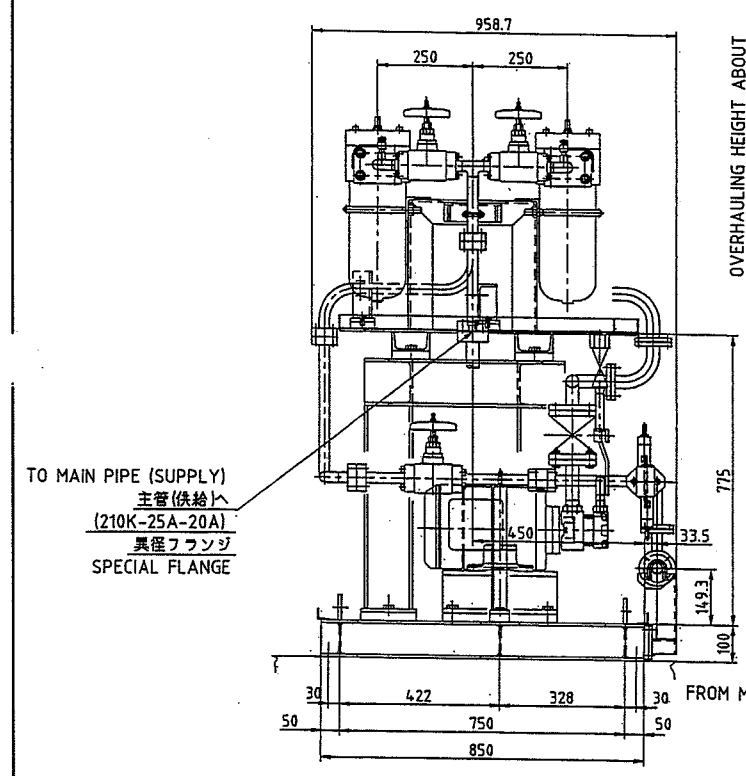
E-E



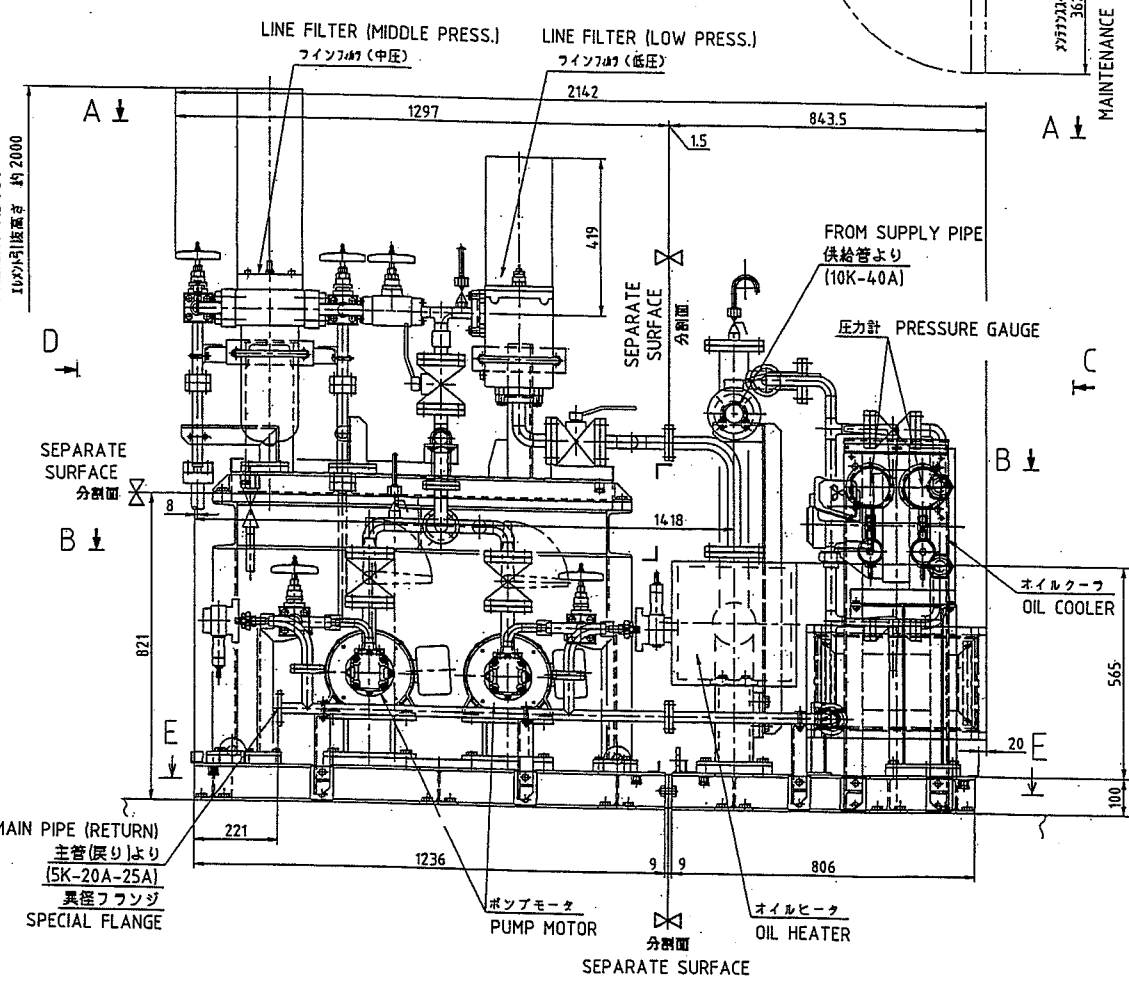
A-A



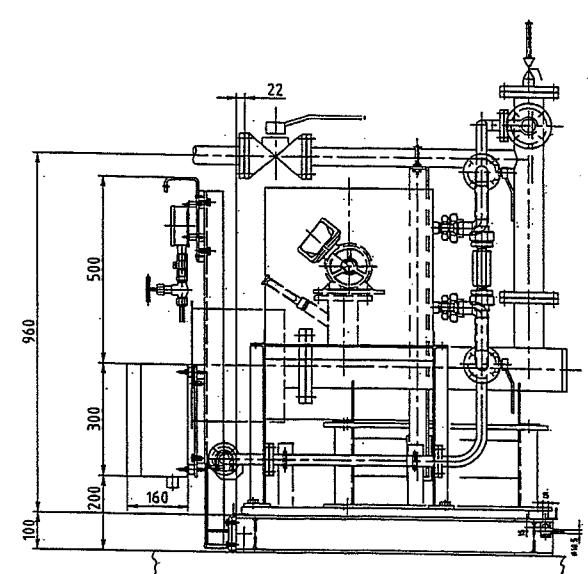
B-B



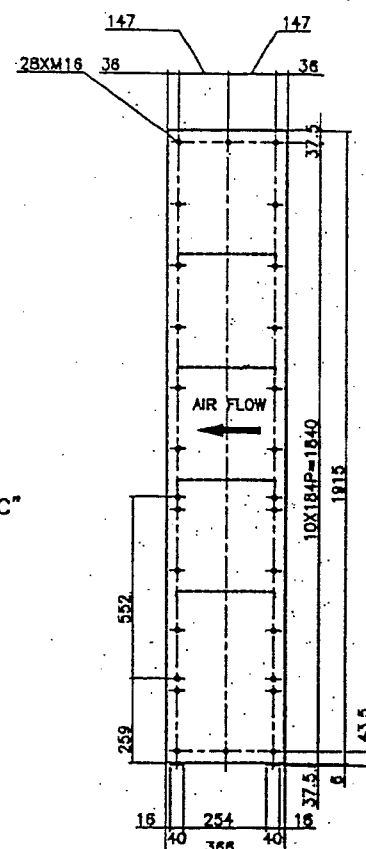
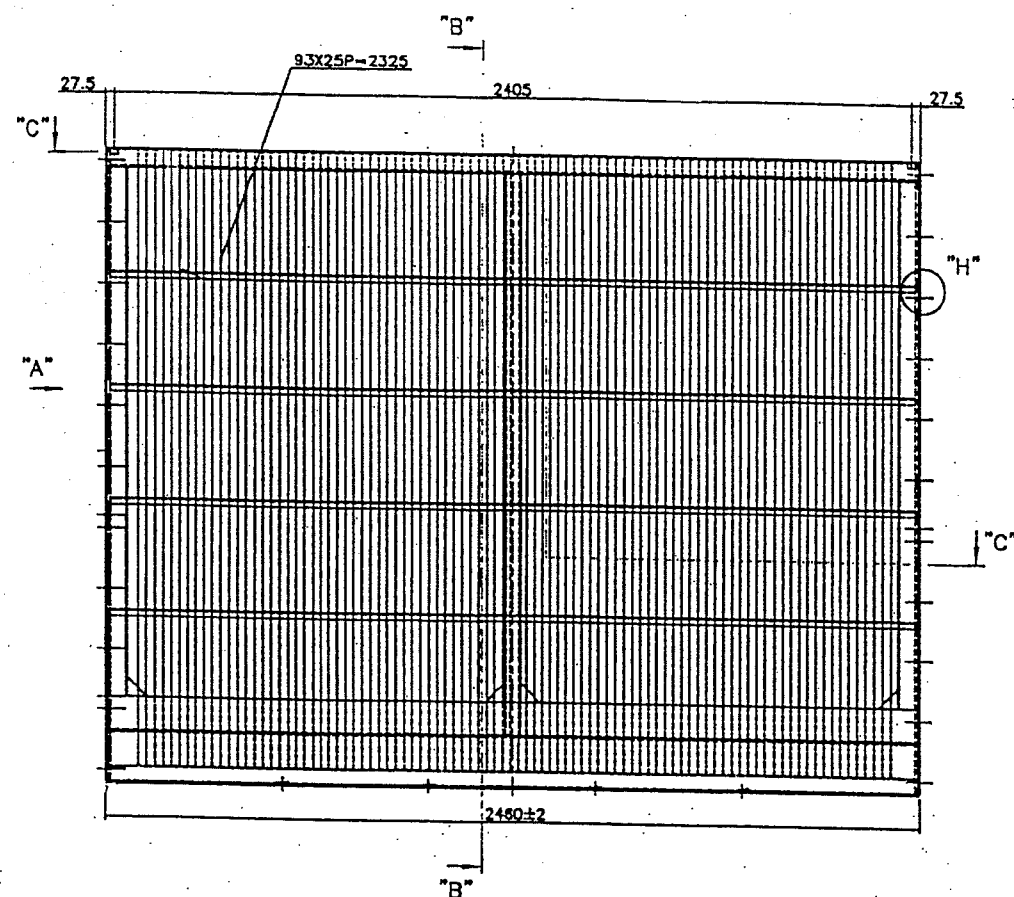
矢視 D
VIEW D



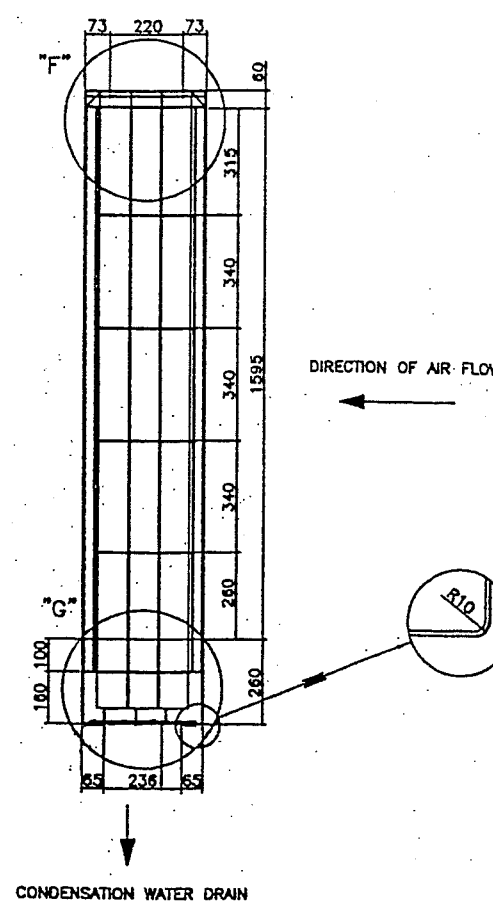
矢視 C
VIEW C



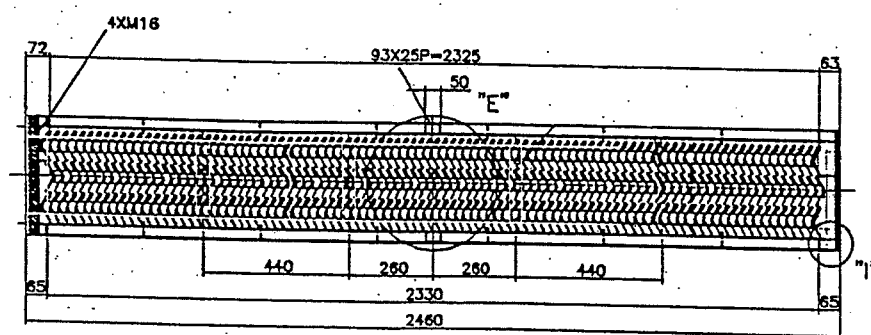
MITSUBISHI SULZER 11RT-flex96C DIESEL ENGINE
ECL SYSTEM SUPPLY UNIT
ASSEMBLY
ECL装置補機ユニット組立
A7-3H629



VIEW "A"

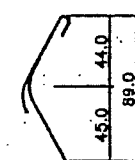


SECTION "B-B"

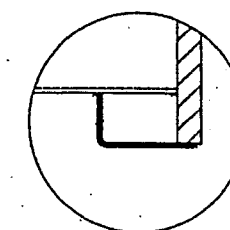


SECTION "C-C"

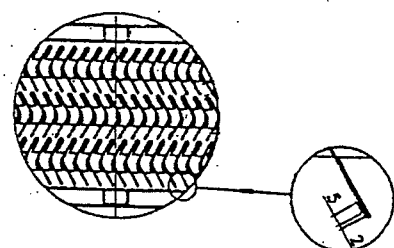
AIR FLOW



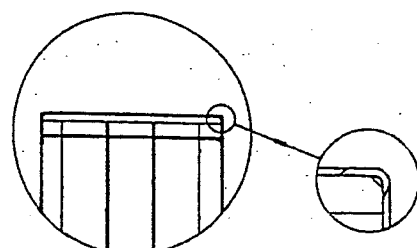
ELIMINATOR DETAIL



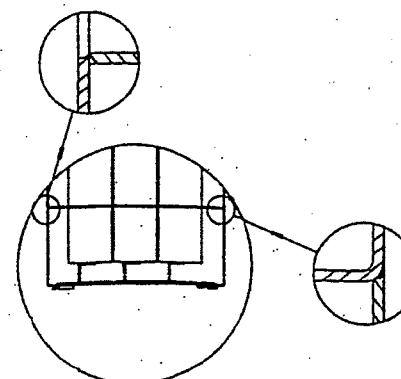
DETAIL "I"



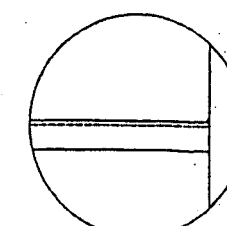
DETAIL "E"



DETAIL "F"



DETAIL "G"



DETAIL "H"

mitsubishi sulzer 11RT-flex96C DIESEL
ENGINE

WATER SEPARATOR

ウォーターセパレーター

A6-91419

**MITSUBISHI-SULZER
MAIN DIESEL ENGINE
11RT-flex96C
INSTRUCTION MANUAL
S.No.2228**



**MITSUBISHI HEAVY INDUSTRIES, LTD
KOBE SHIPYARD & MACHINERY WORKS**

LIST OF INSTRUCTION MANUAL

WSG-1722 1/2

Ref. No.	Drawing No.	Name of instruction manual	Remarks
1	UJG-20071186	Test and Inspection Record	
2	WSS-1116	Technical File for Verification for Control of NOx Emission	
3	Tz-EM83-0037	Exhaust Gas Turbocharger (MET83SEII)	
4	WSG-1595	Operation and Maintenance Manual for Turning Gear with Motor	NRTE-10000B
5	WSG-1399	Instruction Manual for AB-1 Type Indicator Valve	
6	WSG-1585	Operation Manual for Air Cooler and Heater	
7	WSG-1681	Instruction Manual for Automatic Back-wash Filter	
8	WSG-1584	Instruction Manual for Fuel Valve Test Device	
9	WSG-1587	Operation Manual Exhaust Valve Seat Grinding Machine & Working Rig	HK-600GS-F
	WSG-1589	Operation Manual Exhaust Valve Spindle Grinding Machine	HK-600GV-F
10	WSG-1126	Instruction for Use of Engine Indicator M2 Type	
11	WSG-1611	Instruction Manual for RIKEN Air Driven High Pressure Pump	
12	WSG-1407	Operation and Service Manual for RIKEN Hand-operated Hydraulic Pump	
13	WSG-1601	ECL Supply Unit / Instruction Manual for Suction Filter	
	WSG-1603	ECL Supply Unit / Instruction Manual for Line Filter	
14	WSG-1593	ECL Supply Unit / Operation Manual for QT Pump with Motor	
15	WSG-1597	ECL Supply Unit / Instruction Manual for Elect. Heater	
16	WSG-1599	ECL Supply Unit / Instruction Manual for Oil Cooler	
17	WSG-1640	Instruction Manual for ECL-SIP Valve Test Device	

LIST OF INSTRUCTION MANUAL

WSG-1722 2/2

Ref. No.	Drawing No.	Name of instruction manual	Remarks
		mitsubishi-sulzer 11RT-flex96C DIESEL ENGINE OPERATING INSTRUCTION	Separate Volume
		mitsubishi-sulzer 11RT-flex96C DIESEL ENGINE MAINTENANCE MANUAL	"
		mitsubishi-sulzer 11RT-flex96C DIESEL ENGINE CODE-BOOK	"
		mitsubishi-sulzer ENGINE SERVICE BULLETIN	"
		mitsubishi-sulzer 11RT-flex96C DIESEL ENGINE ELECTRICAL EQUIPMENT INSTRUCTION MANUAL	"
		MAIN ENGINE REMOTE CONTROL SYSTEM PNEUMATIC PARTS	"
		MG-800 GOVERNOR SYSTEM	"

TEST & INSPECTION RECORD

FOR

MITSUBISHI SULZER

MAIN DIESEL ENGINE, TYPE 11 RT-flex 96C

Contents	Sheet No.
1. Specification	1
2. Performance Curve	2
3. Shop Test Record	3-1, 2, 3, 4, 5, 6, 7, 8, 9, 10
4. Power Diagram	4
5. Governor Adjustment	5-1, 2
6. Setting Table	6
7. Clearance & Dimension Table	7-1, 2
8. T/C Blower map	8

										Result	Good		
CONTENT		REMARKS				PURCHASER		ORDER No.	DATE	MACHINERY & ELECTRONIC EQUIPMENT QUALITY ASSURANCE SECTION QUALITY ASSURANCE DEPARTMENT			
DESCRIPTION	19 PAGE							ENGINE No.	REFERENCE				
FIGURE	SHEET							MHI Nagasaki	7-891401			APPROVED BY	<i>M. Minami</i>
TOTAL	20 PAGE							Shipyard S.No. 2228	3928			CHECKED BY	<i>T. Honda</i>
(incl. cover)												DRAWN BY	<i>S. Hirooka</i>
						DATE	Aug. 21, 2007						
ADDRESSEE		船主殿	造船所殿	WCH	NK	テ設	機工作	テ管	テサ技	控	DWG. No.		Rev.No.
		3	3	Pdf	1	2	2	1	1	1	UJG-20071186		0

SpecificationClient : Messrs. Mitsui O.S.K LinesShip No. : 2228 of MHI-Nagasaki ShipyardEngine No. : 3928Order No. : 7-891401Engine Type Mitsubishi Sulzer 11RT-flex96CNominal Power : 62,920 kW at 102 min⁻¹Cylinder Bore : 960 mm Piston Stroke : 2,500 mmWater Brake : Zöllner 22nGuaranteed specific fuel consumption rate : 167.9 gr/kWh + 3 % margin
at 85 % load based on lower calorific value of 42700 kJ/kg & ISO conditionTurbo-charger Type : MET 83SE II GV3J35DCD75K2 × 3Sets.
Serial No. : 30628 , 30629 , 30630Air cooler : Type : CH6S-1903F/R240B/4 × 3Sets.
Serial No. : 07-A070 , A071 , A072

Fuel oil :	Grade :	<u>Diesel oil(A oil)</u>
	Lower calorific value :	<u>42100</u> kJ/kg
	Viscosity at 50 °C :	<u>2.849</u> cSt
	Specific gravity at 15/4°C :	<u>0.8634</u>

Bearing Oil :	Viscosity at 40 °C :	<u>97.67</u> cSt
---------------	----------------------	------------------

Cylinder Oil :	Viscosity at 40 °C :	<u>229.2</u> cSt
	Specific gravity at 15/4°C :	<u>0.9120</u>

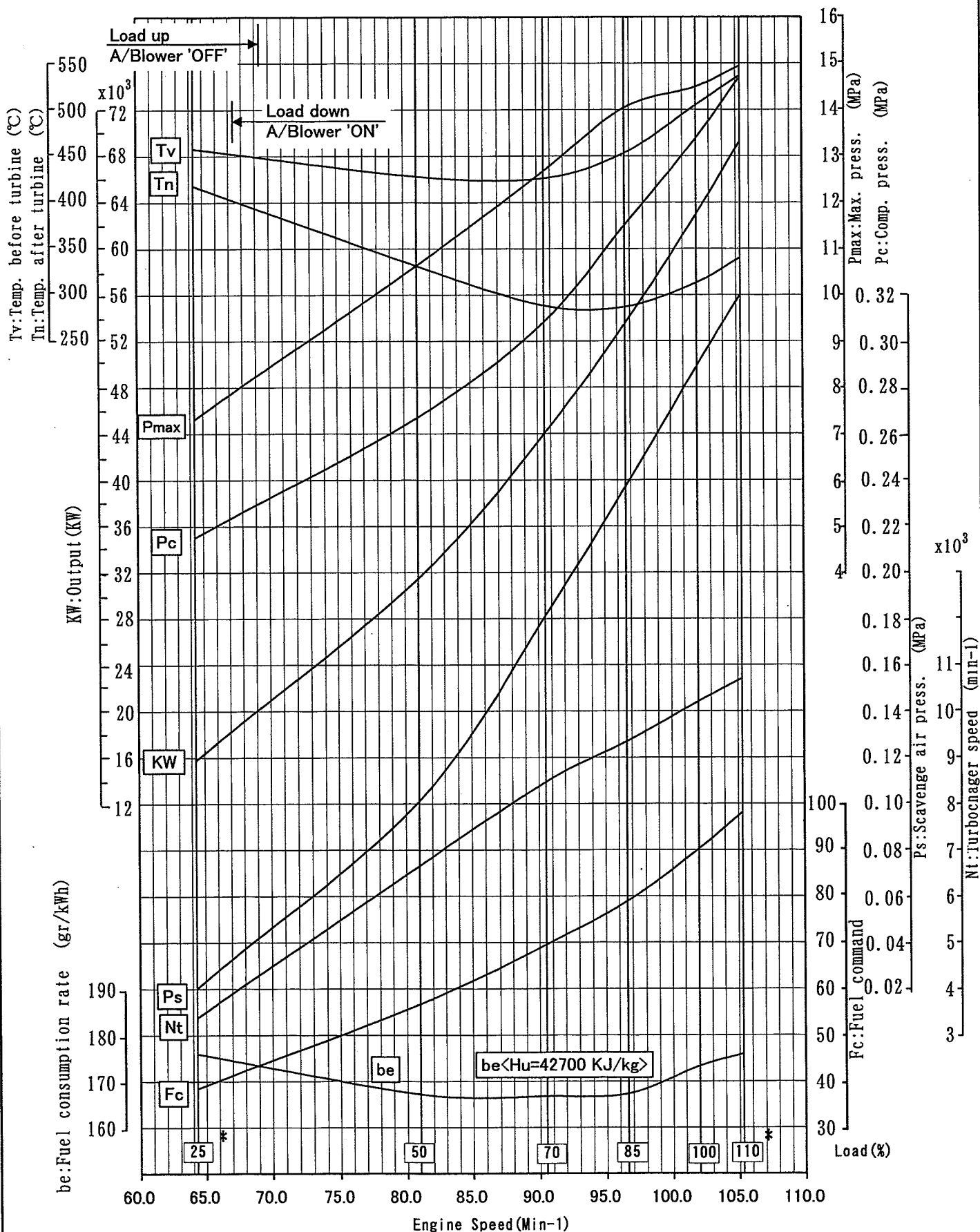
PERFORMANCE CURVE

11RT-flex96C (62920 kW X 102 min⁻¹)
 Eng. No 3928
 S. No. 2228 of MHI-Nagasaki Shipyard

Turbocharger spec. : MET 83SE II GV3J35DCD75K2 ×3Sets.

Barometric pressure : 1005.0-1005.5 hPa Room temperature : 26.0-28.0 °C

Remark : The records with * mark at 25% and 110% load were taken in the preliminary test.



Calculation of Fuel Oil Consumption of 11RT-flex96C Type Diesel Engine
FOR MHI Nagasaki Shipyard S.No.2228

Date : Jul. 5, 2007

1. Calculation formula ;

a) Net fuel oil consumption rate : (gr/KWh)

$$be = \frac{(Q - D) \times 1000}{KW}$$

b) Correction of fuel oil consumption rate based on lower calorific value of 42700 KJ/kg : (gr/KWh)

$$be = be \times \frac{Hu}{42700}$$

Result / Load		85%
Weight of consumed fuel oil : Q	kg/h	9153.8
Fuel oil drain : D	kg/h	77.30
Weight of net consumed fuel oil : Q-D	kg/h	9076.50
Engine speed : N	min-1	96.6
Weight to water brake : F	N	553.62
Output	KW	53480
Fuel oil consumption rate with lower calorific value of actually applied fuel oil : Hu = 42100 KJ/Kg	gr/KWh	169.7
Specific fuel oil consumption rate based on lower calorific value : Hu = 42700 kJ/kg	gr/KWh	167.3
Specific fuel oil consumption rate based on ISO reference condition	gr/KWh	166.5
Guaranteed specific fuel oil consumption rate (Hu=42700 KJ/kg & ISO condition)	gr/KWh	167.9 + 3 % margin at 85 % load

H. Ishida

Manager of Designing Section,
Marine Diesel Engine Business Unit,
MHI Kobe Shipyard & Machinery Works

MITSUBISHI -SULZER		SHOP TEST RECORD		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹			Client : Messrs. Mitsui O.S.K Lines			Ship No. : 2228 of MHI-Nagasaki Shipyard			Engine No. : 3928			Order No. : 7-891401			Sheet No. : 3 - 2		
General	Measuring time	min	30			30			60			30									
	Load percentage	%	50			70			85			100									
	Engine power / Engine speed (designed)	kW , min ⁻¹	31,460			81.0			44,045			90.6			53,480						
	Mean effective press. / VIT / FQS	Mpa , Pos	1.19			-0.8			0			1.47			-2.3						
	Fuel command / Governor input	% / V	56.70			6.89			69.60			7.73			78.90						
	Engine power / Engine speed (Measured)	kW , min ⁻¹	31,460			81.0			43,996			90.5			53,480						
	Fuel oil consumption (42100 KJ/kg)	kg / h	5334.40			7442.20			9076.50			11061.20									
	Spec. fuel oil consumption (42700 KJ/kg)	gr / kWh	167.2			166.8			167.3			173.3									
	Auxiliary blower		OFF			OFF			OFF			OFF									
Cyl.oil consumption (Setting at 100%load : 1.2gr/psb) mode2	l/h.gr/kWh	63.54			1.84			79.95			1.66			92.42							
Scavenge air	Turbocharger speed No. 1/2/3	min ⁻¹	6670			6665			6640			8470			8490						
	Scavenge air pressure	MPa	0.101			0.181			0.237			0.289									
	Barometric pressure / Room temp.	hPa , °C	1005.5			26.0			1005.5			27.0			1005.0						
	Temp. after air receiver	°C	30			36			42			47									
	Air filter resistance No. 1/2/3	kPa	0.21			0.20			0.15			0.40			0.35						
	Press. drop air cooler No. 1/2/3	mm	95			132			90			125			165						
	Suction air temp. No. 1/2/3	°C	32.5			31.0			29.0			34.0			33.0						
	Temp. before air cooler No. 1/2/3	°C	106			106			103			155			155						
	Temp. after air cooler No. 1/2/3	°C	30			29			28			35			35.5						
	Air cooler C. W. inlet temp. No. 1/2/3	°C	25			33			39			43									
Exhaust Gas	Air cooler C. W. outlet temp. No. 1/2/3	°C	35			35			34			52			53						
	Exhaust back pressure No. 1/2/3	mm	50			40			43			140			150						
	Temp. before turbine No. 1/2/3	°C	415			445			425			411			445						
	Temp. After turbine No. 1/2/3	°C	340			330			325			288			292						
	Temp. After cylinder Average	°C	339			336			355			397									
	No. 1/2/3	°C	340			340			340			340			335						
	No. 4/5/6	°C	330			328			340			330			330						
	No.7/8/9	°C	358			323			340			345			320						
	No.10/11	°C	345			345			-			342			340						
	Cylinder Pressure	Maximum / Compression press. Average	MPa	10.63			7.35			12.67			9.41			14.04					
No. 1		MPa	10.50			7.40			12.70			9.40			14.00						
No. 2		MPa	10.60			7.30			12.70			9.50			14.00						
No. 3		MPa	10.60			7.40			12.50			9.40			14.00						
No. 4		MPa	10.75			7.40			12.75			9.40			14.05						
No. 5		MPa	10.50			7.40			12.60			9.40			14.00						
No. 6		MPa	10.70			7.40			12.70			9.30			14.05						
No. 7		MPa	10.50			7.30			12.60			9.50			14.00						
No. 8		MPa	10.60			7.30			12.80			9.30			14.15						
No. 9		MPa	10.75			7.40			12.80			9.50			14.20						
No. 10		MPa	10.70			7.30			12.75			9.50			14.00						
No. 11		MPa	10.75			7.25			12.50			9.30			14.00						
System	Fuel oil rail / Servo oil rail / Control oil rail	MPa	60.0			13.0			20.0			59.9			14.3						
	Bearing / Crosshead / Air spring for E/V	MPa	0.530			1.070			0.710			0.520			1.070						
	Piston / Cylinder / T/C bearing	MPa	0.530			0.342			0.160			0.520			0.340						
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp	Mpa , °C	8.0			0.040			52.0			8.05			0.060						
	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.	°C	45.0			45.0			46.5			44.0			44.0						
	Turb. bearing oil outlet temp. No. 1/2/3	°C	54			54			54			60			60						
	Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	45			59.5/59.5/59/59/59/59/59/59/59/59			44			61/61.5/61/61/61/61/61/61/61/61			44						
	Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	66			75/75/75/75/75/75/75/75/76/76			64			75/76/75/76/76/75/75/75/76/76			64						
	Fuel oil inlet press. / temp.	MPa , °C	1.06			30			0.98			29			0.96						
	Place and date of shop test : Jul. 5, 2007 Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department M.H.I. Kobe Shipyard & Machinery Works		MITSUBISHI HEAVY INDUSTRIES, LTD.  Manager of Diesel Engine Designing Section, Marine Diesel Engine Business Unit																		

MITSUBISHI -SULZER		SHOP TEST RECORD (Internal Test)		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹			Client : Messrs. Mitsui O.S.K Lines			Ship No. : 2228 of MHI-Nagasaki Shipyard			Engine No. : 3928			Order No. : 7-891401			Sheet No. : 3 - 3		
General	Measuring time	min	15			15															
	Load percentage	%	100 (One (1)FOP cut-off)			79 (Two (2)FOP cut-off)															
	Engine power / Engine speed (designed)	kW, min ⁻¹	62,920 102.0			49,707 94.3															
	Mean effective press. / VIT / FQS	Mpa, Pos	1.86 -0.10 0			1.59 -1.80 0															
	Fuel command / Governor input	% / V	89.90 8.78			75.10 8.08															
	Engine power / Engine speed (Measured)	kW, min ⁻¹	62,981 102.1			49,707 94.3															
	Fuel oil consumption (42700 KJ/kg)	kg / h	10913.60			8301.60															
	Spec. fuel oil consumption (42700 KJ/kg)	gr / kWh	173.3			167.0															
Scavenge air	Auxiliary blower		OFF			OFF															
	Cyl.oil consumption (Setting at 100%load : 1.2gr/psb) mode2	l/h.gr/kWh	113.20 1.64			90.10 1.65															
	Turbocharger speed No. 1/2/3	min ⁻¹	10150 10150 10104			8999 9001 8970															
	Scavenge air pressure	MPa	0.290			0.212															
	Barometric pressure / Room temp.	hPa, °C	1005.0 25.6			1005.0 27.0															
	Temp. after air receiver	°C	43.5			42.5															
	Air filter resistance No. 1/2/3	kPa	0.71 0.68 0.45			0.52 0.49 0.37															
	Press. drop air cooler No. 1/2/3	mm	145 200 160			130 165 135															
Exhaust Gas	Suction air temp. No. 1/2/3	°C	32.0 30.0 27.5			34.0 31.5 30.5															
	Temp. before air cooler No. 1/2/3	°C	206 205 200			172 172 166															
	Temp. after air cooler No. 1/2/3	°C	45 45 44			38 38.5 37.5															
	Air cooler C. W. inlet temp. No. 1/2/3	°C	38.5			32.5															
	Air cooler C. W. outlet temp. No. 1/2/3	°C	76 76 74			58 58 56															
	Exhaust back pressure No. 1/2/3	mm	280 300 155			160 170 100															
	Temp. before turbine No. 1/2/3	°C	472 505 485			422 450 432															
	Temp. After turbine No. 1/2/3	°C	308 302 305			290 283 283															
Cylinder Pressure	Temp. After cylinder Average	°C	380			339															
	No. 1/2/3	°C	385 375 383			350 335 335															
	No. 4/5/6	°C	372 377 380			332 333 341															
	No.7/8/9	°C	390 370 382			350 325 340															
	No.10/11	°C	390 378 -			345 340 -															
	Maximum / Compression press. Average	MPa	14.46 13.42			13.65 10.74															
	No. 1	MPa	14.40 13.40			13.50 10.70															
	No. 2	MPa	14.40 13.30			13.60 10.70															
	No. 3	MPa	14.45 13.50			13.60 10.80															
	No. 4	MPa	14.50 13.30			13.70 10.80															
	No. 5	MPa	14.40 13.40			13.60 10.80															
System	No. 6	MPa	14.50 13.40			13.70 10.70															
	No. 7	MPa	14.40 13.50			13.60 10.70															
	No. 8	MPa	14.60 13.50			13.70 10.70															
	No. 9	MPa	14.50 13.50			13.80 10.80															
	No. 10	MPa	14.55 13.40			13.80 10.70															
	No. 11	MPa	14.40 13.40			13.60 10.70															
	Fuel oil rail / Servo oil rail / Control oil rail	MPa	79.80 19.00 20.00			71.10 15.30 20.00															
	Bearing / Crosshead / Air spring for E/V	MPa	0.520 1.100 0.720			0.500 1.060 0.750															
	Piston / Cylinder / T/C bearing	MPa	0.520 0.340 0.183			0.500 0.340 0.160															
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp	Mpa, °C	8.0 0.060 51.0			8.0 0.050 52.0															
System	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.	°C	44.0 44.0 46.5			44.0 44.0 46.5															
	Turb. bearing oil outlet temp. No. 1/2/3	°C	66 66 65			63 63 63															
	Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	44 63.5/64/63/63/63/63/62.5/63/62.5/63/62.5			44 62.5/63/62/62/62/61.5/62/62/62															
	Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	59 73/74/74/74/73/73/73/73/73/73			60 71/72/72/72/72/72/72/72/72															
	Fuel oil inlet press. / temp.	MPa, °C	0.88 27			0.96 28															
Place and date of shop test : Jul. 3, 2007 Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department M.H.I. Kobe Shipyard & Machinery Works				MITSUBISHI HEAVY INDUSTRIES, LTD.  Manager of Designing Section, Marine Diesel Engine Business Unit																	

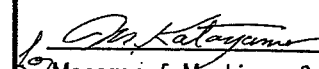
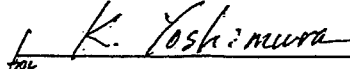
MITSUBISHI HEAVY INDUSTRIES, LTD.
KOBESHIPYARD & MACHINERY WORKS

RESULT OF INSPECTION

Client. Messrs. Mitsui O.S.K. Lines	Works Order. 7891401	Ship Number. S2228 of MHI Nagasaki Shipyard
Job Mitsubishi-Sulzer 11RT-flex96C	Name of Article _____	Drawing Number. _____
Machine Number. 3928	Quantity. _____	Material. _____
Heat Number. _____	Date of Inspection. 2007-07-03 & 2007-07-05	Place of Inspection. Assembly Shop
Subject. Fuel pump rack position		

Item	FOP rack Position		
		F 側	A 側
79%load of Two(2)FOP cut-off (Carried out on July 3, 2007)	Pump側	8.5	8.5
	Exh側	8.5	8.5
100%load of One(1)FOP cut-off (Carried out on July 3, 2007)	Pump側	9.0	9.0
	Exh側	9.0	9.0
100%load of shop test (Carried out on July 5, 2007)	Pump側	8.5	8.5
	Exh側	8.5	8.5

MITSUBISHI -SULZER		SHOP TEST RECORD Internal Test		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹			Client : Messrs. Mitsui O.S.K Lines			Ship No. : 2225 of MHI-Nagasaki Shipyard			Engine No. : 3925			Order No. : 7-891101			Sheet No. : 3 - 5				
General	Measuring time		min	20			15																
	Load percentage		%	25			110																
	Engine power / Engine speed (designed)		kW , min ⁻¹	15,730 64.3			69212 105.3																
	Mean effective press. / VIT / FQS		Mpa , Pos	0.74 0.6 -0.4			1.98 0.60 0																
	Fuel command / Governor input		% / V	38.10 5.1			96.70 7.97																
	Engine power / Engine speed (Measured)		kW , min ⁻¹	15,730 64.3			69,212 105.3																
	Fuel oil consumption (42200 KJ/kg)		kg / h	2788.1			12451.4																
	Spec. fuel oil consumption (42700 KJ/kg)		gr / kWh	175.2			177.8																
	Auxiliary blower			ON			OFF																
Scavenge air	Cyl.oil consumption		l/h,gr/kWh	38.12 2.21			140.90 1.86																
	Turbocharger speed No. 1/2/3		min ⁻¹	3285 3288 3285			10598 10577 10544																
	Scavenge air pressure		MPa	0.020			0.313																
	Barometric pressure / Room temp.		hPa , °C	1001.5 32.0			1015.5 30.0																
	Temp. after air receiver		°C	39.5			47																
	Air filter resistance No. 1/2/3		kPa	0.05 0.03 0.05			1.40 2.00 1.20																
	Press. drop air cooler No. 1/2/3		mm	20 35 30			125 220 145																
	Suction air temp. No. 1/2/3		°C	38.0 36.5 36.5			39.5 44.5 32.0																
	Temp. before air cooler No. 1/2/3		°C	53 55 55			235 245 235																
Exhaust Gas	Temp. after air cooler No. 1/2/3		°C	33 33 30.5			45 47 46																
	Air cooler C. W. inlet temp. No. 1/2/3		°C	28.5			39																
	Air cooler C. W. outlet temp. No. 1/2/3		°C	30 30 30			79 79 80																
	Exhaust back pressure No. 1/2/3		mm	5 3 5			280 460 400																
	Temp. before turbine No. 1/2/3		°C	445 454 448			520 550 540																
	Temp. After turbine No. 1/2/3		°C	400 410 395			330 350 340																
	Temp. After cylinder Average		°C	379			426																
	No. 1/2/3		°C	380 395 365			425 425 430																
	No. 4/5/6		°C	382 372 395			410 435 435																
Cylinder Pressure	No.7/8/9		°C	370 375 382			415 430 420																
	No.10/11		°C	385 370 -			440 420 -																
	Maximum / Compression press. Average		MPa	7.27 4.56			14.47 14.20																
	No. 1		MPa	7.20 4.60			14.60 14.20																
	No. 2		MPa	7.20 4.60			14.60 14.30																
	No. 3		MPa	7.20 4.60			14.40 14.30																
	No. 4		MPa	7.20 4.60			14.30 14.20																
	No. 5		MPa	7.40 4.60			14.60 14.20																
	No. 6		MPa	7.30 4.50			14.50 14.20																
	No. 7		MPa	7.20 4.50			14.50 14.20																
	No. 8		MPa	7.20 4.60			14.50 14.20																
System	No. 9		MPa	7.30 4.50			14.40 14.10																
	No. 10		MPa	7.30 4.50			14.50 14.20																
	No. 11		MPa	7.50 4.60			14.30 14.10																
	Fuel oil rail / Servo oil rail / Control oil rail		MPa	59.80 10.70 20.10			80.00 19.10 19.90																
	Bearing / Crosshead / Air spring for E/V		MPa	0.530 1.020 0.720			0.540 1.170 0.730																
	Piston / Cylinder / T/C bearing		MPa	0.530 0.320 0.177			0.540 0.280 0.174																
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp.		Mpa , °C	8.0 0.058 53.0			8.0 0.044 52.0																
	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.		°C	43.5 43.5 44.0			42.0 42.0 42.5																
	Turb. bearing oil outlet temp. No. 1/2/3		°C	45 45 45			67 67 67																
Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11		°C	43.5 55/54/54/55/55/55/54/54/54/54/54			42 60/60/60/60/60/60/60/59/59/59																	
Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11		°C	58 66/64/65/65/65/66/66/65/65/65/65			60 76/76/76/76/76/76/76/76/76/76																	
Fuel oil inlet press. / temp.		MPa , °C	0.96 36			0.94 32																	
Place and date of shop test : Aug. 11, 2006 & Aug. 18, 2006				MITSUBISHI HEAVY INDUSTRIES, LTD.																			
Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department				Manager of Machinery & Electronic Equipment										Manager of Diesel Engine Designing Section,									
M.H.I. Kobe Shipyard & Machinery Works				QA Section, Quality Assurance Department										Diesel Engine Department									

MITSUBISHI -SULZER		SHOP TEST RECORD Internal Test		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹		Client : Messrs. Mitsui O.S.K Lines		Ship No. : 2225 of MHI-Nagasaki Shipyard		Engine No. : 3925		Order No. : 7-891101		Sheet No. : 3 - 6		
General	Measuring time	min	20 (No.3T/C cut off)			20 (No. 7Cyl. Cut out)										
	Load percentage	%	66			50										
	Engine power / Engine speed (designed)	kW , min ⁻¹	41,527 88.8			31460 81.0										
	Mean effective press. / VIT / FQS	Mpa , Pos	1.41 -1.4 0			1.19 -1.0 0										
	Fuel command / Governor input	% / V	66.30 6.79			66.10 6.25										
	Engine power / Engine speed (Measured)	kW , min ⁻¹	41,527 88.8			31,460 81.0										
	Fuel oil consumption (- KJ/kg)	kg / h	-			-										
	Spec. fuel oil consumption (42700 KJ/kg)	gr / kWh	-			-										
	Auxiliary blower		OFF			OFF										
Cyl.oil consumption (Setting at 100%load : 1.3gr/psh)	l/h.gr/kWh	-			-											
Scavenge air	Turbocharger speed No. 1/2/3	min ⁻¹	9610 9593 -			7114 7069 7060										
	Scavenge air pressure	MPa	0.228			0.110										
	Barometric pressure / Room temp.	hPa , °C	999.0 30.0			998.0 32.0										
	Temp. after air receiver	°C	41			36										
	Air filter resistance No. 1/2/3	kPa	0.55 0.71 -			0.20 0.22 0.23										
	Press. drop air cooler No. 1/2/3	mm	300 330 -			90 140 110										
	Suction air temp. No. 1/2/3	°C	35.5 35.5 -			37.5 38.0 38.0										
	Temp. before air cooler No. 1/2/3	°C	190 195 -			123 127 120										
	Temp. after air cooler No. 1/2/3	°C	39.5 40 -			34 35 33										
	Air cooler C. W. inlet temp. No. 1/2/3	°C	34			30										
Exhaust Gas	Air cooler C. W. outlet temp. No. 1/2/3	°C	66 66 -			42 42 42										
	Exhaust back pressure No. 1/2/3	mm	80 120 -			85 63 62										
	Temp. before turbine No. 1/2/3	°C	440 450 -			465 455 445										
	Temp. After turbine No. 1/2/3	°C	280 290 -			368 345 335										
	Temp. After cylinder Average	°C	374			389										
	No. 1/2/3	°C	370 390 365			405 375 380										
	No. 4/5/6	°C	365 365 380			400 380 420										
	No.7/8/9	°C	380 370 389			- 380 385										
Cylinder Pressure	No.10/11	°C	385 355 -			375 390 -										
	Maximum / Compression press. Average	MPa	13.45 11.49			9.58 7.98										
	No. 1	MPa	13.50 11.50			9.60 8.10										
	No. 2	MPa	13.30 11.50			9.70 8.00										
	No. 3	MPa	13.40 11.50			9.20 7.80										
	No. 4	MPa	13.50 11.50			9.40 7.90										
	No. 5	MPa	13.40 11.40			9.70 8.00										
	No. 6	MPa	13.50 11.50			9.50 7.90										
	No. 7	MPa	13.50 11.50			- -										
	No. 8	MPa	13.40 11.40			9.70 7.90										
	No. 9	MPa	13.50 11.50			9.70 8.00										
	No. 10	MPa	13.40 11.50			9.70 8.10										
System	No. 11	MPa	13.50 11.60			9.60 8.10										
	Fuel oil rail / Servo oil rail / Control oil rail	MPa	60.0 13.6 20.1			60.0 13.6 20.1										
	Bearing / Crosshead / Air spring for E/V	MPa	0.510 1.150 0.730			0.520 1.070 0.730										
	Piston / Cylinder / T/C bearing	MPa	0.510 0.320 0.180			0.520 0.320 0.132										
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp.	Mpa , °C	8.0 0.040 52.0			8.0 0.030 52.0										
	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.	°C	43.0 43.0 43.5			43.0 43.0 44.5										
	Turb. bearing oil outlet temp. No. 1/2/3	°C	62 62 -			52 52 52										
	Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	43 57.5/57.5/57.5/57.5/58/58/57.5/58/58/58/58			43 57.5/57.5/58/58/57.5/57.5/-/58/58/58/58										
	Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	59 70/70/70/69/70/69/69/70/70/70/70			59 69/69/69/70/70/69/-/70/70/70/70										
	Fuel oil inlet press. / temp.	MPa , °C	0.90 34			0.82 34										
Place and date of shop test : Aug. 17, 2006 Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department M.H.I. Kobe Shipyard & Machinery Works			MITSUBISHI HEAVY INDUSTRIES, LTD.  Manager of Machinery & Electronic Equipment QA Section, Quality Assurance Department									 Manager of Diesel Engine Designing Section, Diesel Engine Department				

Miscellaneous Test

Governor Test Power dropped from 100%:

Engine speed increased from 102 min⁻¹ to 106.3 min⁻¹
 N = 4.3 min⁻¹ 4.2 % of nominal speed

Overspeed Trip Test: Safety device stops the engine at 112.0 min⁻¹
109.8 % of nominal speed

Lowest Revolution Test: Engine running with 10.0 min⁻¹ for 3min.

Automatic Emergency Trip Test:

- Main Bearing Lub. Oil (0.46 ±0.005): 0.460 MPa • Turbo-Charger Lub. Oil (0.07±0.005): 0.07 MPa
- Exhaust Valve Air Spring (0.45 ±0.005): 0.450 MPa

Starting and Reversing Test: Ahead-Astern, starting air press. Drops during 8 consecutive
 starts from 2.45 Mpa to 0.50Mpa ; air bottle capacity 12 m³

cal maneuvering : Good

Factory Acceptance Test (WECS)

- Software verification: Good
- Injection rail valve and sensor function test: Good
- Exhaust rail valve and sensor function test: Good
- Power supply failure FCM-20 and loss of one cylinder: Good
- Emergency stop test: Good
- Crank angle sensor function test: Good
- Engine failure and communication test: Good
- Shipyards requirement test
- TDC sensor function test: Good
- WECS Excessive engine speed function test: Good

MITSUBISHI HEAVY INDUSTRIES, LTD.

KOBE SHIPYARD & MACHINERY WORKS

RESULT OF INSPECTION

Client. Messrs. Mitsui O.S.K. Lines	Works Order. 7891401	Ship Number. 2228 of MHI Nagasaki Shipyard
Job Mitsubishi-Sulzer 11RT-flex96C	Name of Article _____	Drawing Number. _____
Machine Number. 3928	Quantity. 1 Eng.	Material. _____
Heat Number. _____	Date of Inspection. July 5, 2007	Place of Inspection. Assembly Shop

Subject.

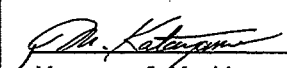
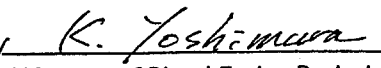
Measurement of Drain From Piston Rod Stuffing Box

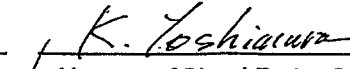
Unit gr.

Load (%)	Cyl. No. Time (min)	1	2	3	4	5	6	7	8	9	10	11		Total
85	60	0	0	0	0	2	0	2	0	2	2	0		8
100	30	0	0	1	2	2	2	0	0	0	0	0		7

機電品質保証課

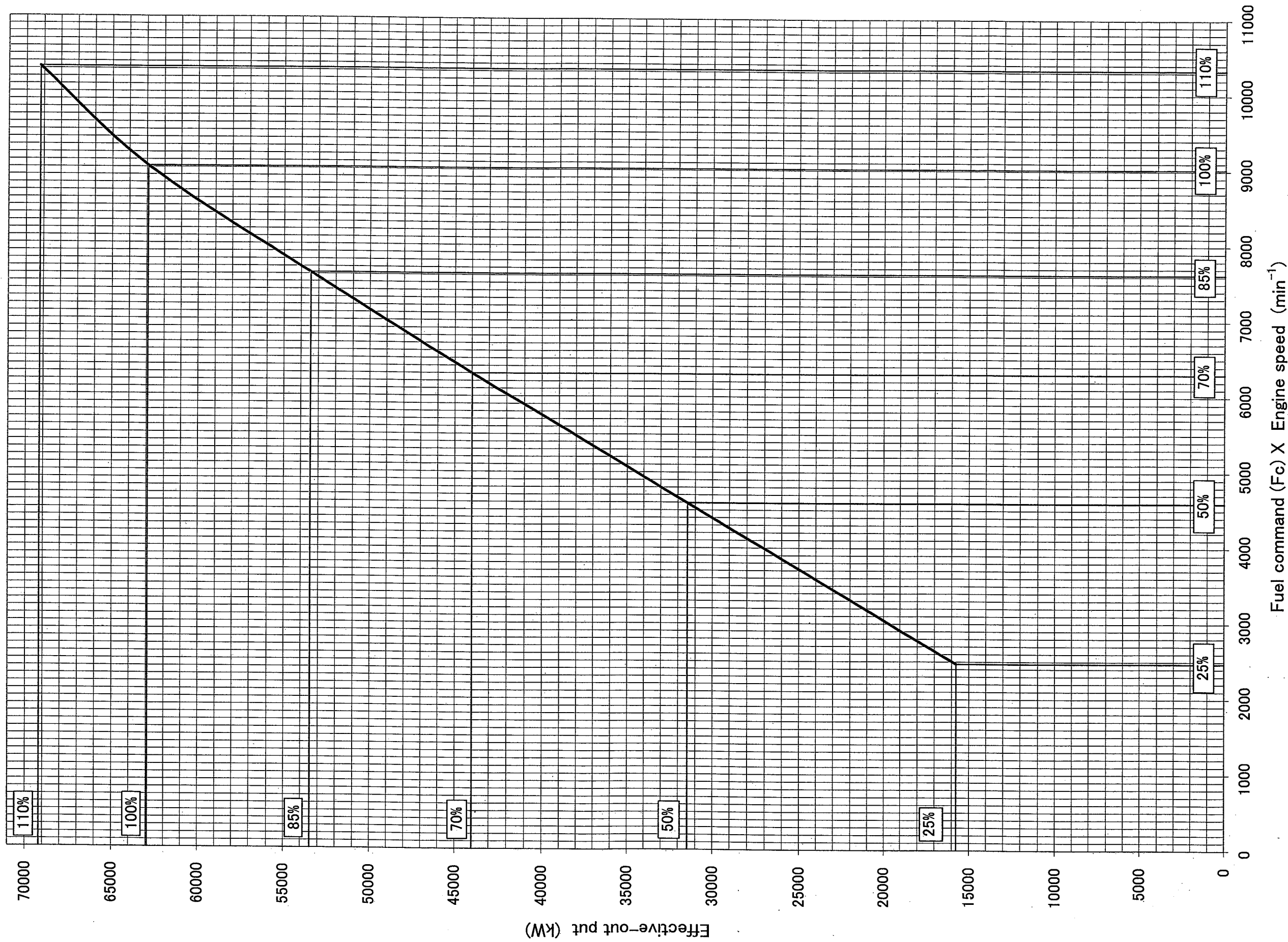


MITSUBISHI -SULZER		SHOP TEST RECORD NOx Regulation(Economy mode)		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹		Client : Messrs. Mitsui O.S.K Lines		Ship No. : 2225 of MHI-Nagasaki Shipyard		Engine No. : 3925		Order No. : 7-891101		Sheet No. : 3 - 9																								
General	Measuring time	min	20			20			20			20																										
	Load percentage	%	25			50			75			100																										
	Engine power / Engine speed (designed)	kW , min ⁻¹	15,730			64.3			31,460			81.0			47,190			92.7			62,920			102.0														
	Mean effective press. / VIT / FQS	Mpa , Pos	0.74			0.6			-0.4			1.17			-1.1			-0.4			1.54			-2.8			-0.4			1.86			-0.8			-0.4		
	Fuel command / Governor input	% / V	38.10			5.1			56.10			6.2			72.30			7.1			88.10			7.7														
	Engine power / Engine speed (Measured)	kW , min ⁻¹	15,730			64.3			31,421			80.9			47,190			92.7			62,920			102.0														
	Fuel oil consumption (42200 KJ/kg)	kg / h	2788.1						5354.1						8023.5						10948.5																	
	Spec. fuel oil consumption (42700 KJ/kg)	gr / kWh	175.2						168.4						168.0						172.0																	
	Auxiliary blower		ON						OFF						OFF						OFF																	
Cyl.oil consumption (Setting at 100%load : 1.2gr/psh)	l/h.gr/kWh	38.12			2.21			64.11			1.86			95.30			1.84			121.30			1.76															
Scavenge air	Turbocharger speed No. 1/2/3	min ⁻¹	3285			3288			3285			6549			6541			6523			8685			8684			8673			10065			10055			10020		
	Scavenge air pressure	MPa	0.020						0.090						0.185						0.271																	
	Barometric pressure / Room temp.	hPa , °C	1001.5			32.0			1001.0			32.0			1001.0			32.0			1000.0			32.5														
	Temp. after air receiver	°C	39.5						35						40						45.5																	
	Air filter resistance No. 1/2/3	kPa	0.05			0.03			0.05			0.20			0.19			0.20			0.47			0.53			0.50			0.79			0.85			0.83		
	Press. drop air cooler No. 1/2/3	mm	20			35			30			85			120			100			120			170			125			125			195			135		
	Suction air temp. No. 1/2/3	°C	38.0			36.5			36.5			39.0			37.50			36.5			38.5			40.5			37.5			39.5			39.5			37.0		
	Temp. before air cooler No. 1/2/3	°C	53			55			55			107			111			110			167			175			172			216			225			217		
	Temp. after air cooler No. 1/2/3	°C	33			33			30.5			32			33			31			37.5			39			38			42			44			43		
	Air cooler C. W. inlet temp. No. 1/2/3	°C	28.5						28						34						39																	
Air cooler C. W. outlet temp. No. 1/2/3	°C	30			30			30			38			38			38			56			56			56			75			75			75			
Exhaust Gas	Exhaust back pressure No. 1/2/3	mm	5			3			5			90			55			50			150			190			175			220			380			310		
	Temp. before turbine No. 1/2/3	°C	445			454			448			445			455			440			440			459			442			485			502			500		
	Temp. After turbine No. 1/2/3	°C	400			410			395			352			365			348			299			319			295			310			329			310		
	Temp. After cylinder Average	°C	379						367						362						400																	
	No. 1/2/3	°C	380			395			365			370			380			360			365			368			353			402			401			402		
	No. 4/5/6	°C	382			372			395			365			365			384			352			365			380			390			402			415		
	No.7/8/9	°C	370			375			382			355			355			370			355			360			362			390			398			400		
No.10/11	°C	385			370			-			375			355			-			373			351			-			414			388			-			
Cylinder Pressure	Maximum / Compression press. Average	MPa	7.27			4.56			10.53			7.10			12.97			9.66			14.53			12.94														
	No. 1	MPa	7.20			4.60			10.60			7.20			13.00			9.80			14.60			13.00														
	No. 2	MPa	7.20			4.60			10.60			7.20			13.00			9.80			14.55			12.95														
	No. 3	MPa	7.20			4.60			10.50			7.00			13.00			9.80			14.50			13.00														
	No. 4	MPa	7.20			4.60			10.50			7.10			13.00			9.60			14.45			12.90														
	No. 5	MPa	7.40			4.60			10.50			7.10			13.00			9.50			14.50			12.90														
	No. 6	MPa	7.30			4.50			10.50			7.10			13.00			9.60			14.50			13.00														
	No. 7	MPa	7.20			4.50			10.50			7.10			13.00			9.60			14.55			12.90														
	No. 8	MPa	7.20			4.60			10.50			7.00			13.00			9.75			14.55			13.00														
	No. 9	MPa	7.30			4.50			10.60			7.10			13.00			9.50			14.50			12.80														
	No. 10	MPa	7.30			4.50			10.50			7.10			12.90			9.60			14.50			12.90														
No. 11	MPa	7.50			4.60			10.50			7.10			12.80			9.75			14.60			13.00															
System	Fuel oil rail / Servo oil rail / Control oil rail	MPa	59.80			10.70			20.10			60.00			13.00			20.00			61.00			14.90			20.00			79.50			18.90			20.00		
	Bearing / Crosshead / Air spring for E/V	MPa	0.530			1.020			0.720			0.520			1.030			0.720			0.530			1.040			0.720			0.520			1.060			0.720		
	Piston / Cylinder / T/C bearing	MPa	0.530			0.320			0.177			0.520			0.320			0.135			0.530			0.320			0.145			0.520			0.310			0.162		
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp.	Mpa , °C	8.0			0.058			53.0			8.0			0.045			54.0			8.0			0.035			53.0			8.0			0.030			52.0		
	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.	°C	43.5			43.5			44.0			43.5			43.5			44.0			43.0			43.0			44.5			43.0			43.0			44.5		
	Turb. bearing oil outlet temp. No. 1/2/3	°C	45			45			45			52			52			52			60			60			60			66			66			66		
	Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	43.5			55/54/54/55/55/55/54/54/54/54			43.5			57/57/57/57/57/58/57/57/57/57			43			59/59/59/59/59/59/59/59/59/59			43			60.5/60.5/60.5/61/61/61/61/61/61														
	Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	58			66/64/65/65/66/66/65/65/65/65			59			67/67/66/67/66/67/66/66/66/66			59			69/69/69/69/69/69/69/69/69/69			59			73/73/73/73/73/72/73/72/73/73/73														
Fuel oil inlet press. / temp.	MPa , °C	0.96			36			0.92			36			0.88			34			0.75			32															
Place and date of shop test : Aug. 18, 2006		MITSUBISHI HEAVY INDUSTRIES, LTD.																																				
Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department		 Manager of Machinery & Electronic Equipment QA Section, Quality Assurance Department  Manager of Diesel Engine Designing Section, Diesel Engine Department																																				
M.H.I. Kobe Shipyard & Machinery Works																																						

MITSUBISHI -SULZER		SHOP TEST RECORD NOx Regulation(Low Nox mode)		Engine type : 11RT-flex96C 62,920 kW X 102 min ⁻¹		Client : Messrs. Mitsui O.S.K Lines		Ship No. : 2225 of MHI-Nagasaki Shipyard		Engine No. : 3925		Order No. : 7-891101		Sheet No. : 3 - 10		
General	Measuring time	min	20		20		20		20							
	Load percentage	%	25		50		75		100							
	Engine power / Engine speed (designed)	kW , min ⁻¹	15,730		64.3		31,460		81.0		47,190		92.7		62,920 102.0	
	Mean effective press. / VIT / FQS	Mpa , Pos	0.74	0.9	-0.4	1.17	-0.5	-0.4	1.54	-3.5	-0.4	1.86	-2.5	-0.4		
	Fuel command / Governor input	% / V	38.20		5.07		57.60		6.24		74.60		7.1		91.80 7.7	
	Engine power / Engine speed (Measured)	kW , min ⁻¹	15,730		64.3		31,460		81.0		47,190		92.7		62,920 102.0	
	Fuel oil consumption (42230 KJ/kg)	kg / h	2834.5		5503.4		8289.4		11415.2							
	Spec. fuel oil consumption (42700 KJ/kg)	gr / kWh	178.2		173.0		173.7		179.4							
Scavenge air	Auxiliary blower		ON		OFF		OFF		OFF							
	CyLoil consumption(Setting at 100%load : 1.15gr/psh)	l/h.gr/kWh	32.92	1.91	62.38	1.81	90.11	1.74	117.83	1.71						
	Turbocharger speed No. 1/2/3	min ⁻¹	3321	3323	3318	6865	6855	6826	8961	8949	8910	10283	10274	10211		
	Scavenge air pressure	MPa	0.023		0.105		0.206		0.292							
	Barometric pressure / Room temp.	hPa , °C	1011.0	30.5	1010.0	31.0	1010.0	31.5	1010.0	32.0						
	Temp. after air receiver	°C	37.5		34		40		46							
	Air filter resistance No. 1/2/3	kPa	0.03	0.04	0.03	0.22	0.23	0.23	0.54	0.60	0.60	0.83	0.93	0.90		
	Press. drop air cooler No. 1/2/3	mm	30	35	35	100	135	115	120	190	140	115	230	120		
Exhaust Gas	Suction air temp. No. 1/2/3	°C	37.0	35.5	34.5	37.0	37.0	35.0	38.5	42.0	35.0	41.0	45.5	35.5		
	Temp. before air cooler No. 1/2/3	°C	52	53	55	113	116	115	175	185	175	223	233	222		
	Temp. after air cooler No. 1/2/3	°C	32	32	30	32	33	31	38	40	39	42.5	44	42		
	Air cooler C. W. inlet temp. No. 1/2/3	°C	29		28.5		35		39.5							
	Air cooler C. W. outlet temp. No. 1/2/3	°C	30	30	30	40	40	39	59	59	58	76	76	75		
	Exhaust back pressure No. 1/2/3	mm	12	10	6	80	70	60	130	200	200	220	390	325		
	Temp. before turbine No. 1/2/3	°C	440	442	440	433	444	430	445	455	447	505	515	510		
	Temp. After turbine No. 1/2/3	°C	392	401	388	333	349	329	291	310	289	320	335	320		
Cylinder Pressure	Temp. After cylinder Average	°C	371		349		361		411							
	No. 1/2/3	°C	372	389	352	350	355	345	362	365	361	412	415	410		
	No. 4/5/6	°C	372	362	388	345	345	360	359	360	375	402	415	427		
	No.7/8/9	°C	360	365	380	340	345	355	350	359	361	400	415	412		
	No.10/11	°C	380	360	-	363	340	-	372	348	-	422	394	-		
	Maximum / Compression press. Average	MPa	7.27	4.71	9.60	6.61	11.73	14.02								
	No. 1	MPa	7.20	4.70	9.80	6.60	11.70	14.10								
	No. 2	MPa	7.20	4.70	9.50	6.70	11.75	14.00								
System	No. 3	MPa	7.10	4.70	9.60	6.55	11.85	14.00								
	No. 4	MPa	7.20	4.70	9.60	6.70	11.85	13.95								
	No. 5	MPa	7.40	4.70	9.60	6.50	11.60	14.00								
	No. 6	MPa	7.40	4.70	9.60	6.50	11.60	14.00								
	No. 7	MPa	7.30	4.60	9.75	6.70	11.80	14.05								
	No. 8	MPa	7.30	4.70	9.50	6.60	11.75	14.00								
	No. 9	MPa	7.10	4.65	9.60	6.60	11.80	14.00								
	No. 10	MPa	7.40	4.80	9.60	6.70	11.70	14.10								
System	No. 11	MPa	7.40	4.90	9.50	6.60	11.60	14.00								
	Fuel oil rail / Servo oil rail / Control oil rail	MPa	59.50	10.70	20.20	59.80	13.00	20.00	59.90	15.20	20.00	70.00	19.00	20.00		
	Bearing / Crosshead / Air spring for E/V	MPa	0.520	1.010	0.720	0.500	1.000	0.720	0.500	1.050	0.720	0.520	1.080	0.720		
	Piston / Cylinder / T/C bearing	MPa	0.520	0.320	0.159	0.500	0.320	0.132	0.500	0.320	0.143	0.520	0.310	0.162		
	Cyl. Lub. Oil Press. (before/after Regulator)/Cyl. Lub. Oil temp.	Mpa , °C	8.0	0.060	52.0	8.0	0.050	52.0	8.0	0.040	52.0	8.0	0.030	52.0		
	Lub.oil / Turb. bearing oil inlet temp./Thrust bearing temp.	°C	43.0	43.0	43.0	43.5	43.5	44.0	43.0	43.0	44.0	43.0	43.0	44.0		
	Turb. bearing oil outlet temp. No. 1/2/3	°C	45	45	45	52	52	52	61	61	61	68	68	68		
	Piston cooling oil inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	43	53/53/53/53/53/53/53/53/53/53	43.5	57/57/57/57/57/57/57/57/57/57	43	59.5/59.5/59.5/59.5/59.5/60/60/60/60/59	43	60/60/60/60/60/60/60/60/60/60						
Cyl. Cooling water inlet / outlet temp. No.1/2/3/4/5/6/7/8/9/10/11	°C	59	67/67/67/66/66/67/67/67/67/66/66	59	67/67/67/67/67/67/67/67/67/67	59	69/69/69/69/69/69/69/69/69/70	59	74/74/74/74/74/74/74/74/74/74							
Fuel oil inlet press. / temp.	MPa , °C	0.95	36	0.88	34	0.84	32	0.80	32							
Place and date of shop test : Aug. 21, 2006			MITSUBISHI HEAVY INDUSTRIES, LTD.													
Assembly Shop, Power Plant, Machinery & Electronic																
Equipment Manufacturing Department																
M.H.I. Kobe Shipyard & Machinery Works																
			 Manager of Machinery & Electronic Equipment QA Section, Quality Assurance Department										 Manager of Diesel Engine Designing Section, Diesel Engine Department			

POWER DIAGRAM

11RT-flex96C (62920 KW X 102 min-1)
Eng.No. 3928 Ship No. 2228 of MHI-Nagasaki Shipyard
Fuel oil: Low Calorific Value : 42100 kJ/kg
Specific Gravity at 15/4°C: 0.8634
Viscosity at 50°C: 2.849 cSt



GOVERNOR ADJUSTMENT

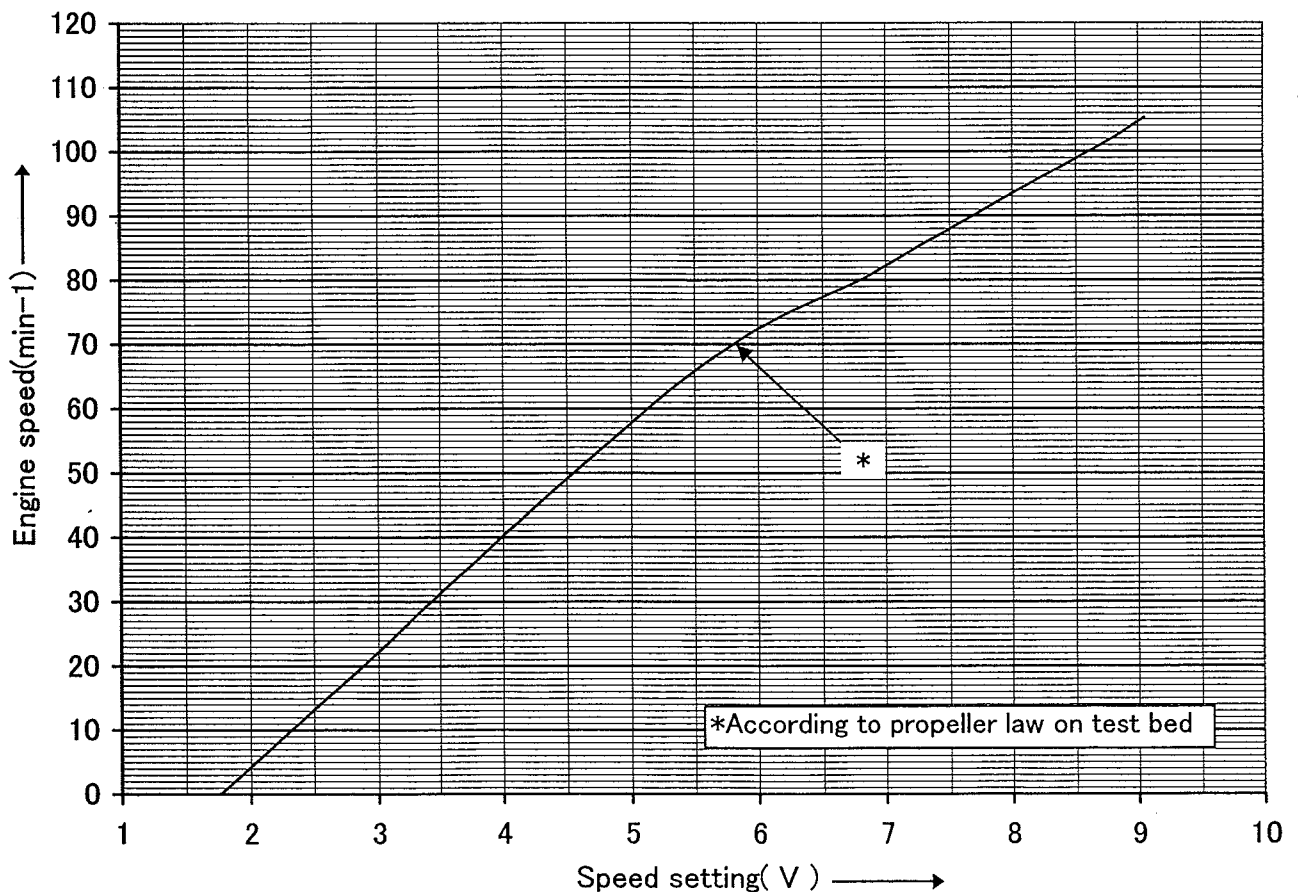
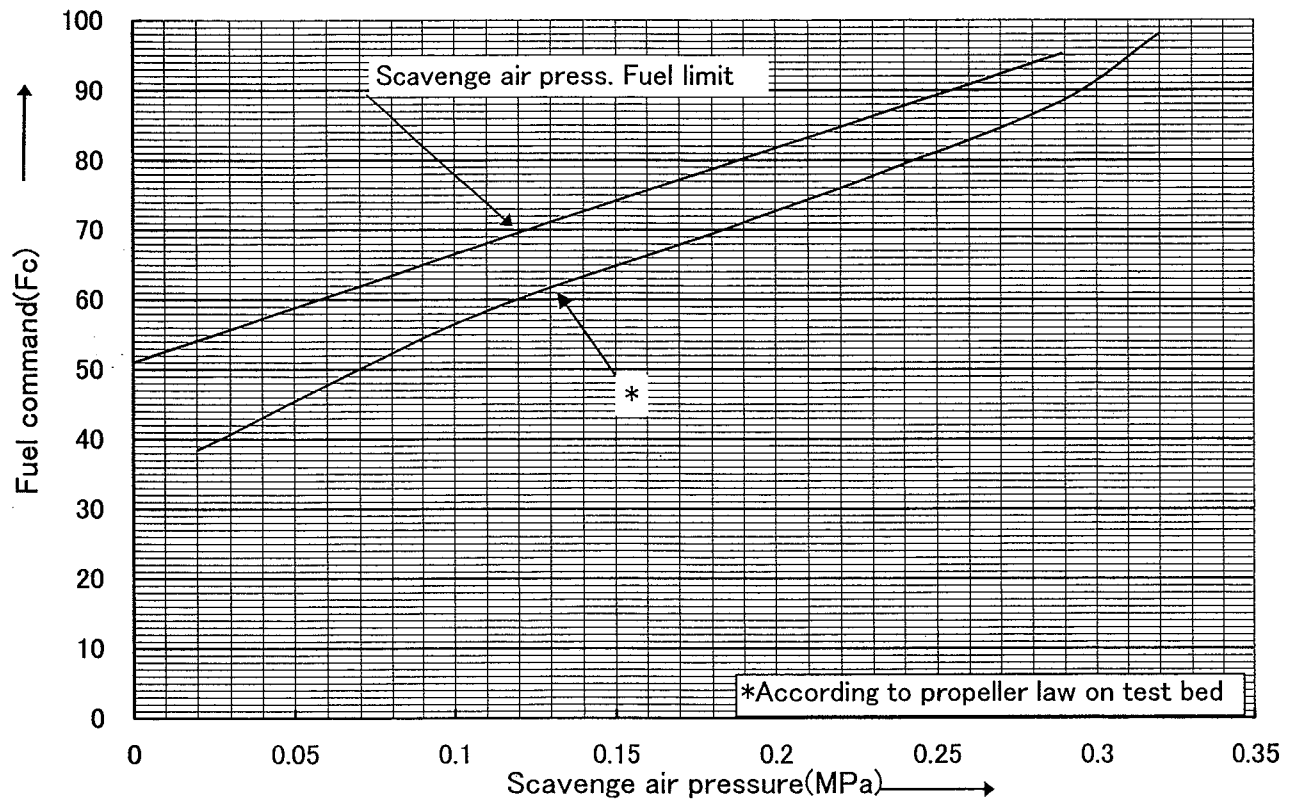
11RT-flex96C (62920 KW X 102 min⁻¹)

Eng. No. 3928

S. No. 2228 of MHI-Nagasaki Shipyard

Governor Specification : NABTESCO Electronic Governor

MG- 800



GOVERNOR ADJUSTMENT

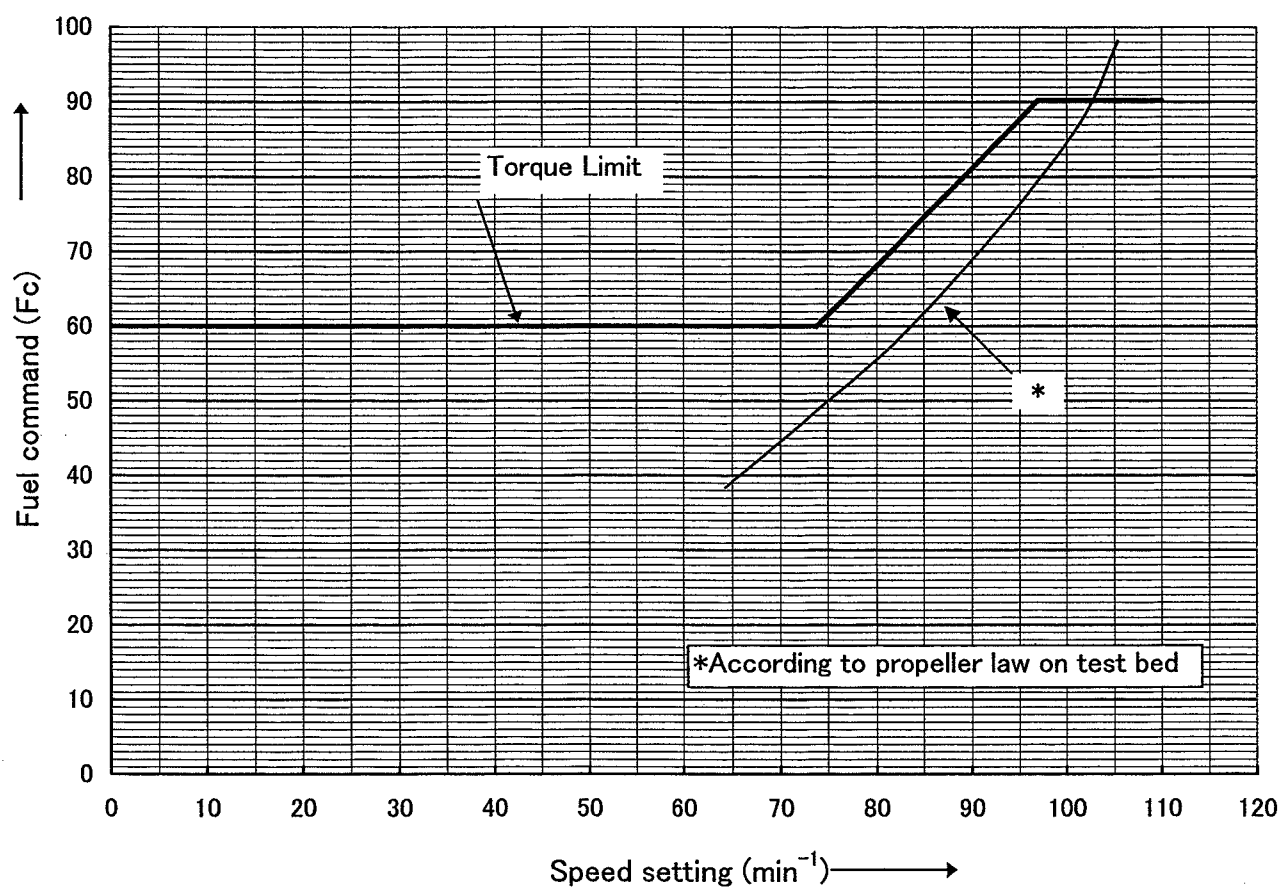
11RT-flex96C (62920 KW X 102 min⁻¹)

Eng. No. 3928

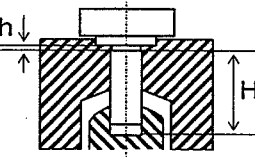
S. No. 2228 of MHI-Nagasaki Shipyard

Governor Specification : NABTESCO Electronic Governor

MG- 800



SETTING TABLE		sheet A	11	RT-flex	96C
Manufacturer :	MHI Kobe Shipyard	Order No. :	7-891401	Eng. No. :	3928
				Cyl.diam. :	960 mm
				Stroke :	2500 mm
Installation : 2228 of MHI Nagasaki Shipyard					
Nominal power :	62920 kw	Nominal speed :	102 min ⁻¹		
Firing order : 1 - 6 - 11 - 4 - 3 - 7 - 10 - 2 - 5 - 9 - 8					
Turbo-charger : Manufacturer : MITSUBISHI HEAVY INDUSTRIES, LTD. TOKYO JAPAN					
Type :	MET83SEII ×3sets.	Spec. :	GV3J35DCD75K2	Serial No.	30628, 30629, 30630
externally lubricated					
Air cooler : Manufacturer : SUCTION GAS ENGINE MFG. Co., LTD					
Type :	CH6S-1903F/R240B/4 ×3sets.	No. :	07-A070, 07-A071, 07-A072		
Auxiliary fan : Manufacturer : OSAKA BLOWER MFG. Co., LTD					
Type : TBMS-9611RTA ×3sets.					
Electric motor : Manufacturer : ABB Motors CE					
Type : M2CA 280SMA2B35 ×2sets.					
Frequency :	60Hz	Voltage	440V	Power	105Kw
Supply unit : Manufacturer : WHA YOUNG CO., LTD.					
Rail unit : Manufacturer : Diesel United CO., LTD.					
Opening pressure of fuel over pressure safety valve : 125 MPa					
Fuel valves and high pressure pipes :					
Drwg. No. :	A3-51106-26 MF959M	No. of holes	1	2	3
Needle lift :	1.6 mm	Hole diam. mm	1.425	1.375	1.350
Opening pressure :	37.5 MPa	α (deg)	15	13	12
Remarks :		β (deg)	-14	6	19
High pressure pipe diameter : to the injection valve : inside : φ9 mm, outside : φ20 mm					
Engine control software Allowed ID number					
Soft ware package(IMO SW-N0) : LN-BE9801					
IMO relevant parameters : (IMO CRC VALUE) : 0xF4A1 (IMO DATA LENGTH) : 736 (VERSION) : 31 (BUILT) : 072 (BLV) : 1.02					

Cylinders : Cyl. liner drwg. No. : A1-61132, A1-61133, A1-61134												Sheet No.
Cyl.cover drwg. No. : A1-70447												6
Piston crown drwg. No. : A2-21191												
Distance b is measured between top surface of piston and upper edge of cylinder liner (Piston at T.D.C., gasket removed)												
On test bed	Cyl.No.	1	2	3	4	5	6	7	8	9	10	11
	Distance b incl.shims mm	-6.52	-6.52	-5.97	-5.72	-6.17	-6.12	-5.97	-6.02	-5.87	-6.22	-6.42
	Compression shim mm	0	0	0	0	0	0	0	0	0	0	0
	Compression press. at 25% output (Scav.air press 0.025 MPa)	4.60	4.60	4.70	4.70	4.60	4.55	4.60	4.60	4.70	4.70	4.70
Combustion press. at 100% output (Fuel Command 88.00 %)		14.55	14.50	14.50	14.40	14.50	14.50	14.45	14.55	14.50	14.45	14.50
Relief valve opening pressure for working cylinder : 20.3MPa												
Piston rings : Manufacturer : RIKEN CO., LTD.												
Type : No.1~2=RIK29V No.3~4=RIK47												
Pressure pipe diameter inside : φ45 mm outside : φ75 mm												
Exhaust valve : Manufacturer : NZK CO., LTD												
Damping unit :	Cyl. No.	1	2	3	4	5	6	7	8	9	10	11
	Remark :											
	Distance H mm	188.00	187.80	187.90	187.80	187.90	187.80	187.90	187.80	188.05	188.00	187.75
Shims h mm		1	1	1	1	1	1	1	1	1	1	1
Exhaust valve Driving unit of rail unit : Manufacturer Diesel united Co., Ltd.												
	Cyl. No.	1	2	3	4	5	6	7	8	9	10	11
	Distance H mm	73.92	73.95	73.96	73.89	73.89	73.95	73.93	73.95	73.99	73.95	73.95
Cylinder No.												
Exhaust valve	Open at CMC (Angle)	114.5										
	Close at CMC (Angle)	223.5										
	Closing offset (Angle)	+0.8	-0.4	+0.2	+0.2	+0.2	+0.2	-0.4	+0.8	-1.0	+0.8	+0.2
Fuel oil	Injection begin standard value (Angle)	+0.5										
	Injection begin offset value (Angle)	+0.5	0	+0.3	0	0	-0.5	0	-0.5	-0.5	-0.5	-0.5

MITSUBISHI-SULZER CLEARANCE and DIMENSION

Order No.
7-891401

Engine No.
3928

Engine Type
11RT-flex96C

Ship No.
2228 of MHI Nagasaki Shipyard

Client

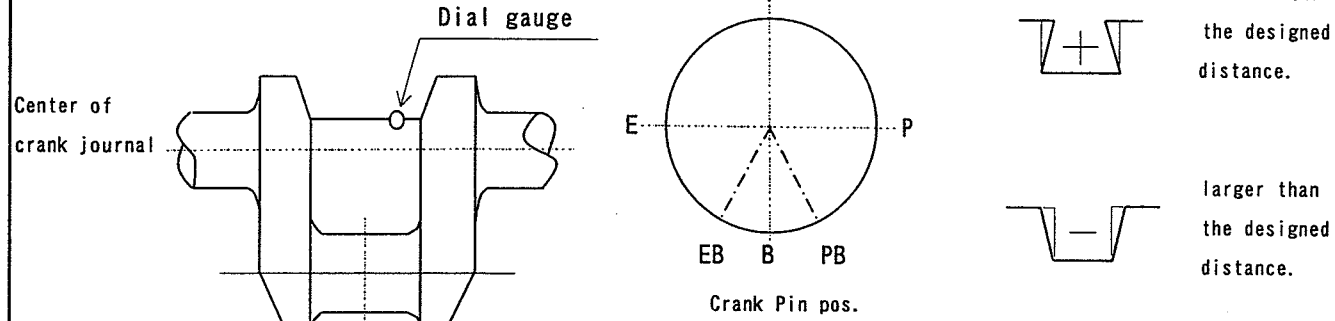
Rated Output 62920 KW
Rated Speed 102 min⁻¹
Cylinder Bore 960 mm
Piston Stroke 2500 mm

Cylinder No.				Thrust		1		2		3		4		5		Gear		6		7		8		9		10		11																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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MITSUBISHI-SULZER CLEARANCE AND DIMENSION

Order No. 7-891401 Engine Type 11RT-flex96C
Engine No. 3928 Ship No. 2228 of MHI Nagasaki Shipyard

CRANK DEFLECTION



Cyl. No.	1	2	3	4	5	6	7	8	9	10	11	12
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after rubbing up Date : May 15, 2007 Crank Case Temp. 15 °C

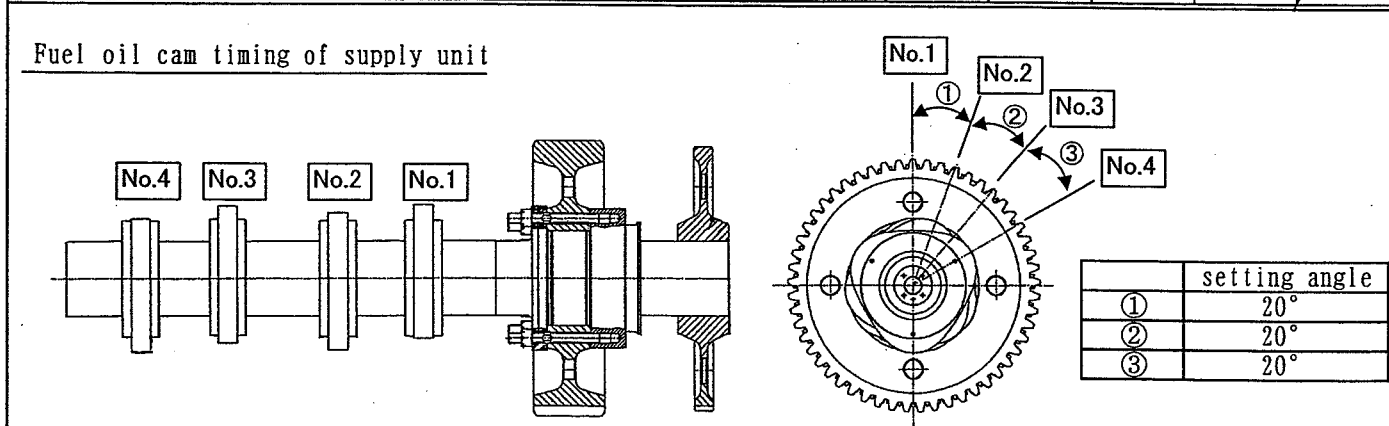
Crank Pin Position	T	B	E	P	1	2	3	4	5	6	7	8	9	10	11	12
T	+19	-11	-2	+9	+2	+5	+5	-8	-11	+3	+11					
B	0	0	0	0	0	0	0	0	0	0	0					
E	+13	-3	-1	0	-3	+2	+12	-4	-7	-2	+4					
P	+4	-6	-1	+8	+4	+1	-6	-5	-5	+4	+7					

before shop test with water brake. Date : June 11, 2007 Crank Case Temp. 27 °C

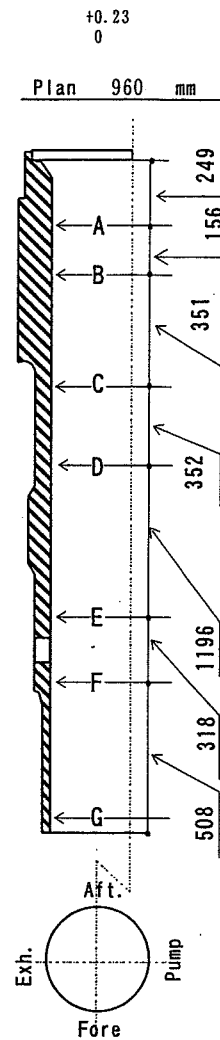
Crank Pin Position	PB	P	T	E	EB	1	2	3	4	5	6	7	8	9	10	11	12
PB	0	0	0	0	0	0	0	0	0	0	0						
P	+10	+4	+6	-3	+4	+3	+1	+3	+4	+13	+9						
T	+10	+2	+3	+4	-6	-5	-9	-6	-3	+16	+8						
E	+9	+8	+5	+4	-6	+1	+6	+1	+3	+10	+7						
EB	0	0	0	0	0	-1	+1	0	0	-1	0						

Hot condition Date : July 2, 2007 Crank Case Temp. 46 °C

Crank Pin Position	PB	P	T	E	EB	1	2	3	4	5	6	7	8	9	10	11	12
PB	0	0	0	0	0	0	0	0	0	0	0						
P	+18	0	+12	+10	+7	+2	+4	+2	+3	+9	+5						
T	+19	-6	+9	+6	-4	0	-3	-7	-1	+9	+1						
E	+16	+5	+10	+2	-5	-5	+14	+2	+4	+8	+3						
EB	0	0	0	0	0	0	+3	+2	+2	+2	+2						



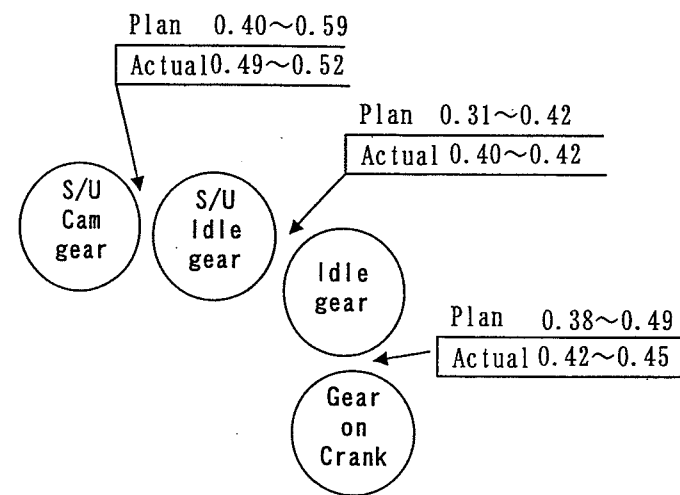
CYLINDER LINER INSIDE DIAMETER BEFORE SHOP TEST



Measuring unit in 1/100 mm

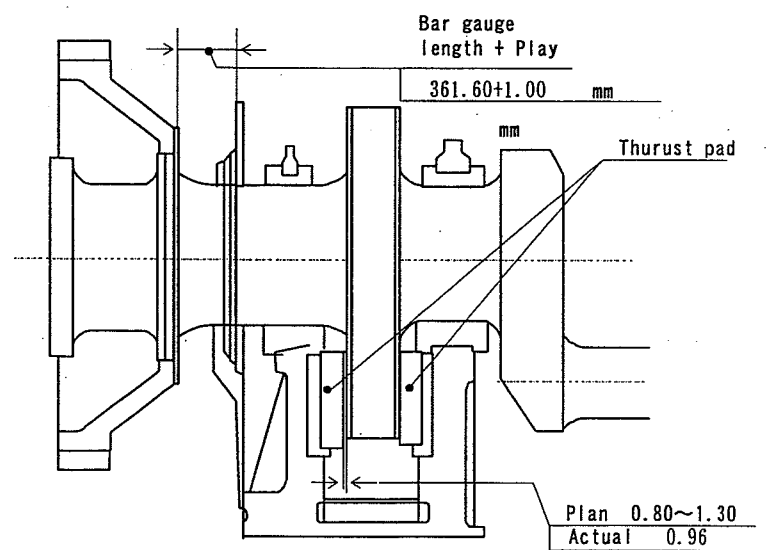
Cyl. No.	1	2	3	4	5	6	7	8	9	10	11	12
Wall Temp.	20.0 °C											
Pos.	Exh. - Pump / Fore - Aft.											
A	+17.0 +16.0	+15.0 +18.0	+14.0 +12.0	+15.0 +16.0	+13.0 +15.0	+17.0 +14.0	+16.0 +15.0	+14.0 +12.0	+6.0 +9.0	+13.0 +13.5	+8.0 +6.0	
B	+19.0 +17.0	+16.0 +18.0	+14.0 +13.0	+17.0 +17.0	+13.0 +15.0	+17.0 +15.0	+17.0 +15.0	+15.0 +13.0	+8.0 +10.0	+13.5 +15.0	+8.0 +7.0	
C	+20.0 +19.0	+18.0 +20.0	+17.0 +15.0	+19.0 +15.0	+15.0 +14.0	+19.0 +18.0	+18.0 +19.0	+16.0 +15.0	+8.0 +12.0	+17.0 +19.0	+10.0 +8.0	
D	+20.0 +19.0	+16.0 +18.0	+15.0 +16.0	+20.0 +16.0	+15.0 +15.0	+19.0 +18.0	+18.0 +19.0	+16.0 +15.0	+9.0 +11.0	+17.0 +17.5	+7.0 +7.0	
E	+21.0 +22.0	+18.0 +17.0	+18.0 +19.0	+20.0 +21.0	+14.0 +17.0	+21.0 +19.0	+19.0 +15.0	+17.0 +18.0	+8.0 +9.0	+20.0 +20.0	+8.0 +8.0	
F	+21.0 +23.0	+14.0 +14.0	+13.0 +16.0	+18.0 +19.0	+13.0 +14.0	+16.0 +17.0	+19.0 +18.0	+15.0 +15.0	+5.0 +6.0	+17.0 +17.0	+5.0 +5.0	
G	+16.0 +20.0	+14.0 +10.0	+11.0 +15.0	+17.0 +21.0	+8.0 +12.0	+11.0 +12.0	+16.0 +16.0	+14.0 +17.5	+3.0 +6.0	+14.0 +17.5	+3.0 +3.0	
H												
I												
J												

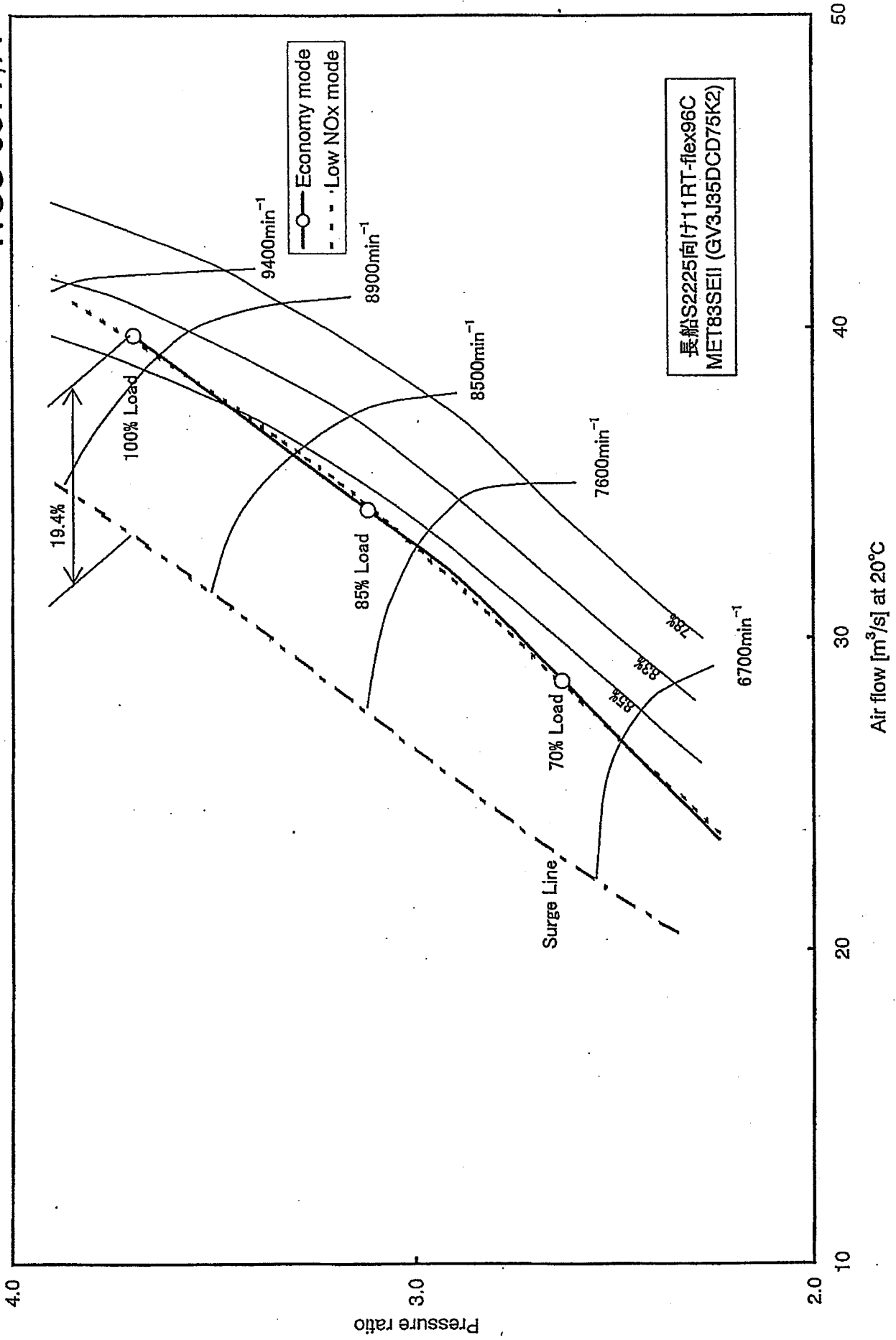
DRIVING GEAR BACKLASH



*S/U : Supply Unit

THRUST PAD CLEARANCE





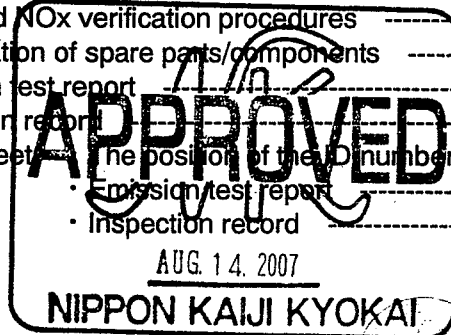
FOR APPROVAL**S.No.2228**

TECHNICAL FILE
FOR
VERIFICATION FOR CONTROL OF NOx EMISSION

Engine Manufacturer	Model Number	Engine Serial Number	Test Cycle(s)	Rated Power Rated Speed
Mitsubishi Heavy Industries, Ltd.	11RT-flex96C	3928	E3	62,920kW 102 min ⁻¹

Content**Sheet No.**

1. Particulars of the engine -----	1
2. List of components and setting that influence the NOx emission -----	2
3. Allowed components and settings -----	3
4. Engine group definition -----	4
5. Engine performance data -----	5
6. On-board NOx verification procedures -----	5
7. Specification of spare parts/components -----	6
8. Emission test report -----	6
9. Inspection record -----	6
Attached sheet -----	7
• Emission test report -----	12
• Inspection record -----	18



Approval No.

07KB1106TF



CONTENT		REMARKS	PURCHASER	ORDER No.	DATE	DIESEL ENGINE DESIGNING SECTION	
DESCRIP TION	6 PAGE					MARINE DIESEL ENGINE BUSINESS UNIT	
FIGURE	37 SHEET					APPROVED BY	M. Nakagawa
Total	44 (incl. Cover)					CHECKED BY	K. Yoshimura
						DESIGNED BY	T. Igarashi
FACTORY NK 4						DRAW BY	
						ISSUE	
						DATE	Jul. 19, 2007
						DWG.No.	WSS-1116
						Rev.No.	

1. Particulars of the engine

Engine Manufacturer		Mitsubishi Heavy Industries, Ltd.
Name of engine (engine family or group, if applicable)		11RT-flex96C
Engine serial number		3928
Engine type and specification of all engine within a engine family or group		RT-flex96C
Combustion cycle		2 stroke cycle
Cylinder number and configuration		11
Bore x Stroke		960mm x 2500mm
Rated output		62,920 kW (85,580 PS)
Rated speed		102 min ⁻¹
Type of combustion chamber		Open-chamber
Method of air aspiration		Constant pressure turbocharging system with exhaust turbocharger(s)
Construction of cylinder		Jacket type / Bore cooling
Fuel Injection system		Direct injection
Fuel type		Marine Diesel Oil / Heavy Fuel Oil
Other NOx Reducing Device	Exhaust gas re-circulation	N.A.(Not Applicable)
	Water/emulsion injection	N.A.
	Air injection	N.A.
	Charge cooling system	N.A.
	Exhaust after-treatment	N.A.
Date of engine build		Jul. 5,2007
Place of pre-certification survey		Mitsubishi Heavy Industries, Ltd. Kobe Shipyard & Machinery Works
Date of pre-certification survey		Jul. 6,2007
Applicable NOx Emission limit(g/kWh) (regulation 13 of Annex VI)		17.0 g/kWh
Parent Engine's actual NOx Emission Value(g/kWh)		16.67 g/kWh (Low NOx mode : OFF)
		12.59 g/kWh (Low NOx mode : ON)

2. List of components and settings that influence the NOx emission

The following list summarizes all components and settings, which must be respected to comply with the Annex VI to Marpol 73/78 of the IMO.

Item	Component or Setting	Cyl.	Check-value	Allowed ID No.
<i>Engine control hardware</i>	Flex Control Module	1-11	Supplier Type	Wärtsilä FCM-20
	Software package		ID-number	LN-BE9801
<i>Engine control software</i>	IMO relevant parameters		IMO CRC VALUE * ----- IMO DATA LENGTH *	0xF4A1 ----- 736
	Low NOx mode		OFF / ON	OFF or ON
<i>Injection system</i>	Injection nozzle	1-11	ID-number	MF959M
	Injection control block	1-11	ID-number	LN-BF5500
	Firing pressure (average)		at 100% load	max. 14.53 barG
<i>Combustion chamber</i>	Piston head	1-11	ID-number	M9PH-1 or LN-AH3000
	Piston rod	1-11	ID-number	M9PR-1 or LN-AH3200
	Cylinder cover	1-11	ID-number	M9CC-1 or LN-BF2000
	Cylinder liner	1-11	ID-number	M9CL-1 or LN-AH2100
	Compression shim (Compression ratio)	1-11	Shims thickness or ID-Number	0 mm (N.A.) or —
	Housing of partition device (Exhaust valve unit)	1-11	ID-number	LN-BF5600
	Exhaust valve upper housing	1-11	ID-number	M9UH-1 or LN-BF2700
	Exhaust valve housing	1-11	ID-number	M9EV-1 or LN-BF2710
<i>Turbocharger system</i>	Turbocharger		Number, Type Specification	(See Sheet 10)
<i>Scavenge air cool. system</i>	Scavenge air cooler (SAC)		ID-number	(See Sheet 10)

* These values are finalized at shoptest at each engine and may be different from that of parent engine.

3. Allowed components and settings

The following list summarizes the allowable range of adjustments.

If any adjustment, parts replacement and modifications are carried out, they shall be verified compliance with this list.

And they shall be recorded chronologically in an engine's record book of engine parameters.

3.1 Fuel Oil Injection System

Injection timing	Allowable range of adjustments	Remarks
	Injection begin offset value* ± 1.0 degree CA (each cylinder) ± 0.5 degree CA (average of all cylinder) FQS setting** ± 1.0 degree CA	* Injection timing In order to even up the combustion pressure for each cylinder, the injection timing should be adjusted according to the actual combustion pressure. ** FQS setting In order to correct the combustion pressure due to the fuels with poor/rich ignition quality, FQS setting should be changed. The actual combustion pressure should be adjusted based on the shop test record as attached from sheet 42 to sheet 43. Note: The averaged combustion pressure Pmax must not exceed 14.53MPa.

4. Engine group definition

Identical engines, with the same particulars, are included in the same group.

: The range of the engine group

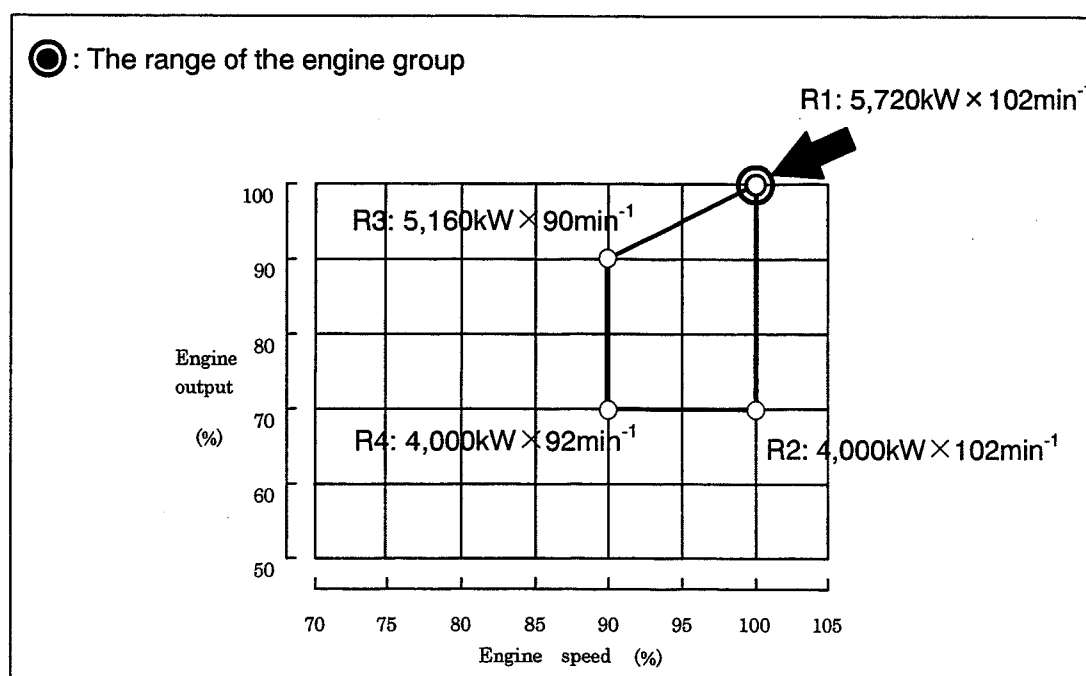
4.1 Particulars(common items of engine group)

Engine manufacturer		Mitsubishi Heavy Industries, Ltd.
Name of engine group		RT-flex96C Group A
Engine type and specification of all engine within a engine group		From 6 to 14RT-flex 96C 5,720kW / cyl. $\times 102\text{min}^{-1}$
Combustion cycle		2 stroke
Cylinder number and configuration		From 6 cyl. to 14 cyl.
Displacement per one cylinder		Bore 960 mm / Stroke 2500 mm
Type of combustion chamber		Open chamber
Method of air aspiration		Constant pressure turbocharging system with exhaust turbocharger(s)
Method of cooling		Water / Oil cooled
Fuel injection system		Direct injection
Fuel type		Marine diesel oil / Heavy fuel oil
Others	Exhaust gas re-circulation	N.A.
	Water/emulsion injection	N.A.
	Air injection	N.A.
	Charge cooling system	N.A.
	Exhaust after-treatment	N.A.

4.2 Use of engine(test cycle to be applied)

Use of engine	Propeller low operated main propulsion engine
Test cycle to be applied	Type E3

4.3 The range in an engine group covered by the parent engine (Only for reference)



5. Engine performance data

5.1 Test-bed performance parameters

The following list is the measured 'standard' performance parameters, and shall be recorded in the final test on test-bed.

Standard Performance Parameters

	Load percentage (%)	25	50	75	100
General data	Measuring time (min)				
	Engine power (kW)				
	Engine speed (rpm)				
	Mean-effective pressure (MPa)				
	Specific fuel-oil consumption (g/kWh)				
	VIT/ FQS position (Pos.)				
Scavenging air	Turbocharger speed (rpm)				
	Scavenging-air pressure (MPa)				
	Barometric pressure (kPa)				
	Ambient temperature (deg. C)				
	Humidity (%)				
	Temp. before compressor (deg. C)				
	Temp. before air-cooler (deg.C)				
Cyl	Temp. after air-cooler (deg.C)				
	Compression pressure (MPa)				
	Cylinder maximum pressure (MPa)				
Exh Gas	Exhaust back pressure (Pa)				
	Temp. after cylinder (deg. C)				
	Temp. before turbine (deg. C)				
	Temp. after turbine (deg. C)				
Fuel	Fuel command (%)				
	Inlet Fuel pressure (MPa)				
	Inlet Fuel temp. (deg. C)				

5.2 Test-bed ambient and gaseous Emission parameters

The test report required in 5.10 of the technical code shall be recorded

The test records of 5.1 and 5.2 are referred to chapter8, chapter9 and attached sheets.

6. On- board NOx verification procedures

On-board NOx verification procedure shall be determined one of the following methods:

- (1) Engine parameter check method in accordance with NOx technical code Chapter 6.2.
- (2) Simplified measurement method in accordance with NOx technical code Chapter 6.3.
- (3) The direct measurement and monitoring method in accordance with NOx technical code Chapter 2.3.4, 2.3.5, 2.3.7, 2.3.8, 2.3.11, 2.4.4 and 5.5

7. Specification of spare parts/components

Specification of spare parts/components that influence NOx emissions shall be in accordance with chapter2 and chapter3 (From sheet 2 to Sheet 3).

If any modification is made to their parts/components, technical documentation that certifies compliance with the NOx limits shall be prepared.

When their replacement and modification are carried out, they shall be recorded chronologically in an engine's record book parameters.

The guarantee to receive the correct component can only be achieved by ordering the new component from the engine manufacturer.

8. Emission test report (set out in Appendix 5 of Technical Code)

Refer to attached emission test record. (From Sheet 12 to Sheet 17)

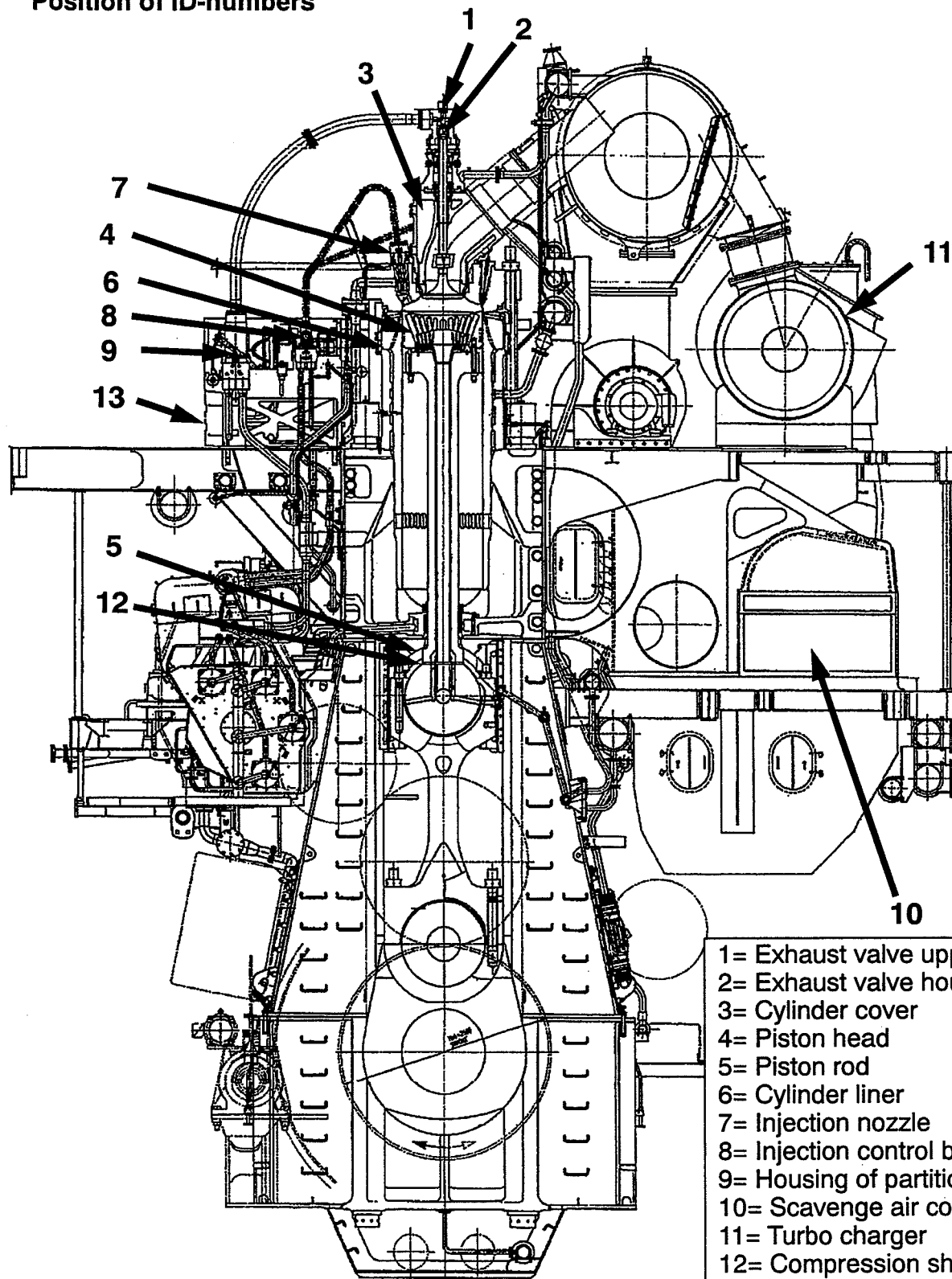
9. Inspection Record

Refer to attached inspection record.

- The record chart of the emission measurement as a part of the emission test report :From Sheet 18 to Sheet 39
- Analytical results of fuel oil :From Sheet 40 to Sheet 41
- Shop test record (the relevant engine's performance, including the engine's rated speed and rated power) :From Sheet 42 to Sheet 43

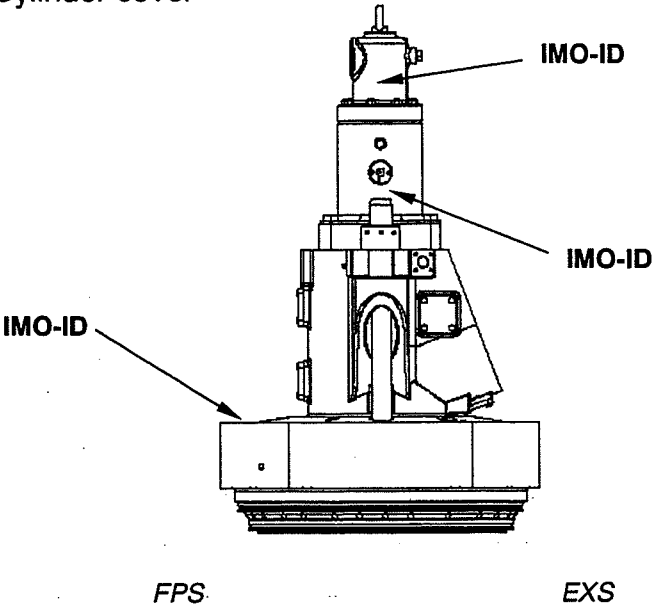
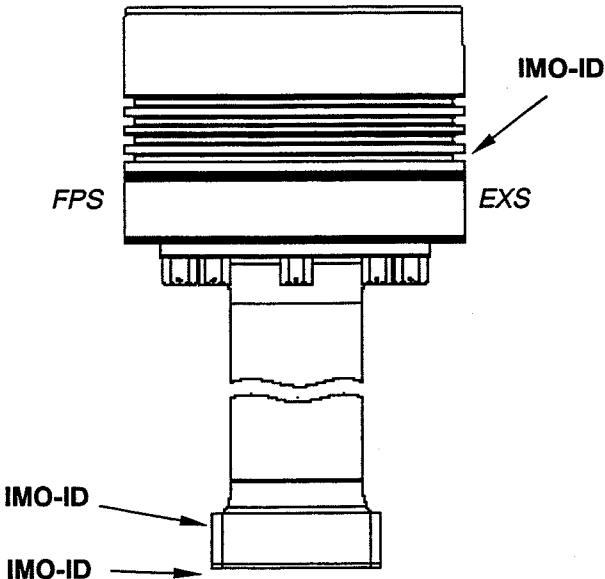
Appendices to On Board Verification Procedure

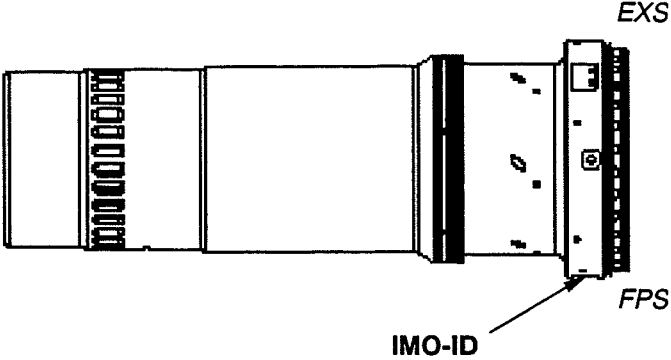
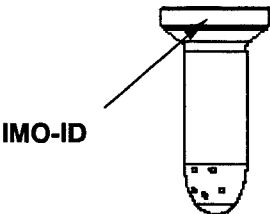
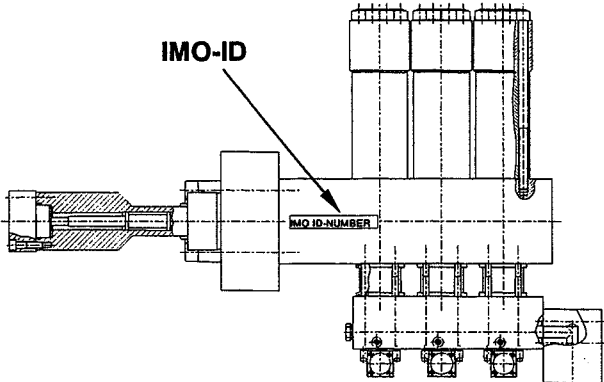
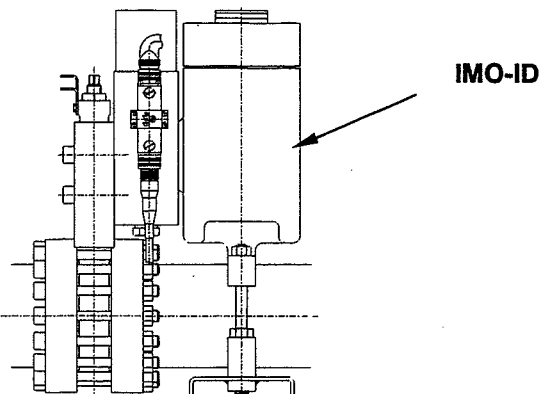
Position of ID-numbers

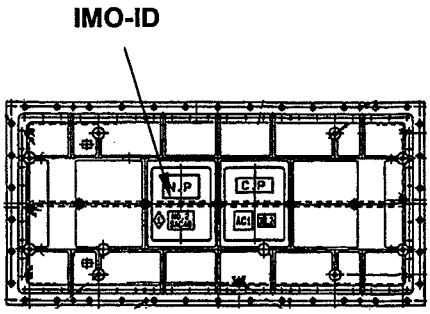
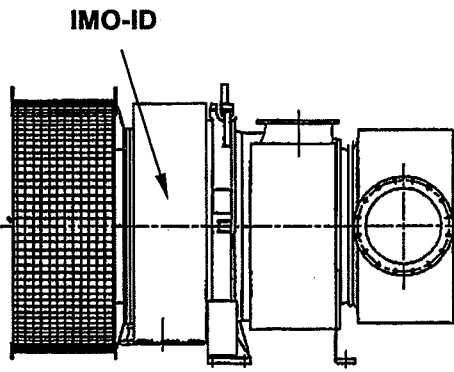


- 1= Exhaust valve upper housing
- 2= Exhaust valve housing
- 3= Cylinder cover
- 4= Piston head
- 5= Piston rod
- 6= Cylinder liner
- 7= Injection nozzle
- 8= Injection control block
- 9= Housing of partition device
- 10= Scavenge air cooler
- 11= Turbo charger
- 12= Compression shim
- 13= Flex control module;
WECS-9520 control box with
FCM-20 inside

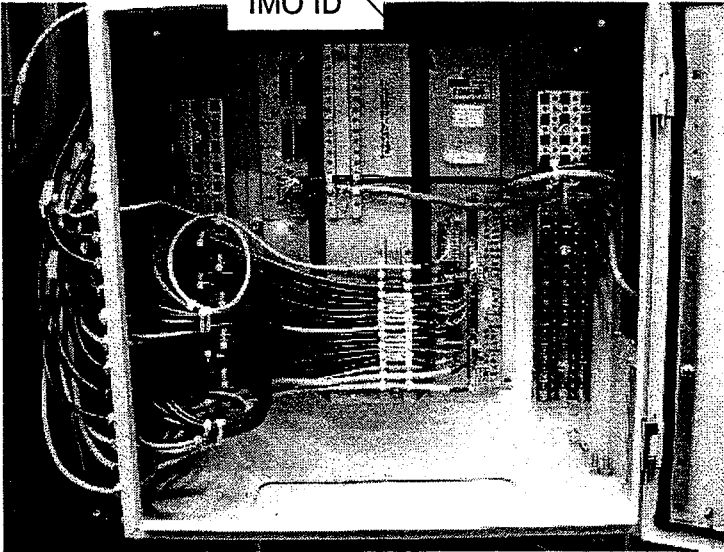
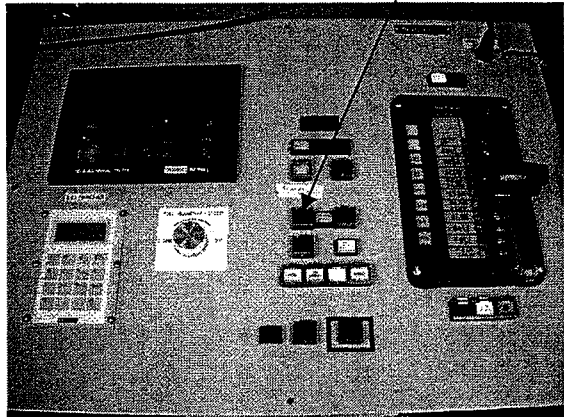
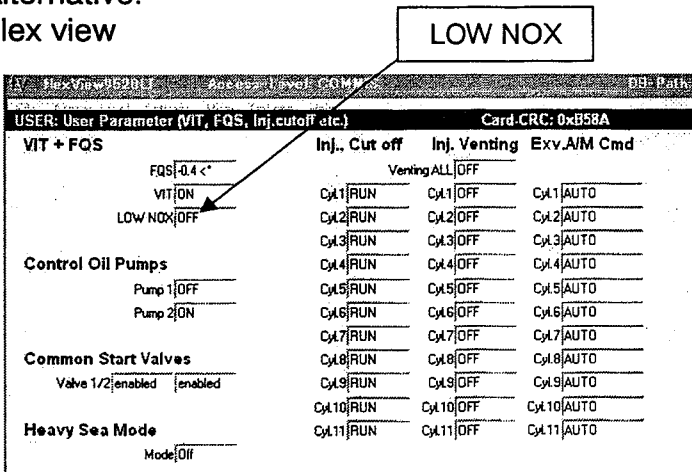
MITSUBISHI HEAVY INDUSTRIES, LTD.

No.	Location of IMO-ID No.	Allowed ID No.
1 2 3	Exhaust valve upper housing Exhaust valve housing Cylinder cover 	<u>Exhaust valve upper housing</u> M9UH-1 or LN-BF2700 <u>Exhaust valve housing</u> M9EV-1 or LN-BF2710 <u>Cylinder cover</u> M9CC-1 or LN-BF2000
4 5 12	Piston head Piston rod Compression shim 	<u>Piston head</u> M9PH-1 or LN-AH3000 <u>Piston rod</u> M9PR-1 or LN-AH3200 <u>Compression shim</u> — or 0 mm (N.A.) (measured in millimeters)

No.	Location of IMO-ID No.	Allowed ID No.
6	Cylinder Liner 	<u>Cylinder liner</u> M9CL-1 or LN-AH2100
7	Injection nozzle 	<u>Injection nozzle</u> MF959M
8	Injection control block 	<u>Injection control block</u> LN-BF5500
9	Housing of partition device (Exhaust valve unit) 	<u>Housing of partition device</u> LN-BF5600

No.	Location of IMO-ID No.	Allowed ID No.		
		Cylinder No	Sets	Allowed ID No.
10	Scavenging air cooler 	6	2	SAC47
			2	or SAC48
		7	2	SAC47
			2	or SAC48
		8	2	SAC47
			2	or SAC48
		9	3	SAC47
			3	or SAC48
		10	3	SAC47
			3	or SAC48
11	Turbocharger 	6	2	MET83SE
			2	or MET83MA
		7	2	MET83SE
			2	or MET83SEII or MET83MA
		8	2	MET83SEII
			2	or MET83MA
		9	3	MET83SE
			3	or MET83MA
		10	3	MET83SE
			3	or MET83MA
		11	3 *	MET83SEII *
			3	or MET83MA
		12	3	MET83SEII
			3	or MET83MA
		14	4	MET83SE
			4	or MET83SEII or MET83MA

*: This specification is applied on the engine

No.	Location of IMO-ID No.	Allowed ID No.
13	Flex control module  IMO ID	FCM-20
	Control room  LOW NOX MODE Alternative: Flex view  LOW NOX	OFF or ON

Emission test report (set out in Appendix 5 of Technical Code)—Low NO_x mode: OFF

Engine	
Manufacturer	Mitsubishi Heavy Industries, Ltd.
Engine type	11RT-flex96C
Group identification	RT-flex96C Group A
Serial number	Eng.No. 3925
Rated speed	102 min ⁻¹
Rated power	62,920 kW
Static injection timing (Cylinder No.)	0.6 deg.CA ATDC
Electronic injection control	Yes
Variable injection timing	Yes
Variable turbocharger geometry	No
Bore / Stroke	Bore 960mm / Stroke 2500 mm
Nominal compression ratio	13.3
Compression shim thickness	0 mm
Mean effective pressure, at rated power	1.86 MPa
Maximum cylinder pressure, at rated power	14.5 MPa
Cylinder number and configuration	Number : 11 In-Line
Auxiliaries	—
Specified ambient conditions:	
Maximum seawater temperature	36 °C
Maximum charge air temperature, if applicable	60 °C
Cooling system spec. intermediate cooler	Yes: Water cooled
Cooling system spec. charge air stages	2
Low/high temperature cooling system set points	25 / 36 °C
Maximum inlet depression	3 kPa
Maximum exhaust back pressure	5 kPa
Fuel oil specification	Marine Diesel Fuel Oil
Fuel oil temperature	approx. 30 °C
Lubricating oil specification	Used for marine internal combustion engine equivalent SAE50 (Nippon Mitsubishi Oil CLS15)
Application/Intended for:	
Customer	Mitsui O.S.K. Lines
Final application/installation, Ship	MHI-Nagasaki Hull No.2225
Final application/installation, Engine	Main engine
Emissions test results:	
Cycle	E3 test-cycle
NO _x	16.67 g/kWh
Test identification	Pre-certification Test of the Engine
Date/time	18-Aug-2006 8:00~15:00
Test site/bench	Mitsubishi Heavy Industries, Ltd. Kobe Shipyard & Machinery Works, Diesel Engine Assembly factory / No.3 bench
Test number	IMO-1, -2, -3 and -4
Surveyor	
Date and Place of report	18-Aug-2006/ Mitsubishi Heavy Industries, Ltd.
Signature	

Emission test report (set out in Appendix 5 of Technical Code) —Low NO_x mode: ON

Engine	
Manufacturer	Mitsubishi Heavy Industries, Ltd.
Engine type	11RT-flex96C
Group identification	RT-flex96C Group A
Serial number	Eng.No. 3925
Rated speed	102 min ⁻¹
Rated power	62,920 kW
Static injection timing (Cylinder No.)	0.6 deg.CA ATDC
Electronic injection control	Yes
Variable injection timing	Yes
Variable turbocharger geometry	No
Bore / Stroke	Bore 960mm / Stroke 2500 mm
Nominal compression ratio	13.3
Compression shim thickness	0 mm
Mean effective pressure, at rated power	1.86 MPa
Maximum cylinder pressure, at rated power	14.5 MPa
Cylinder number and configuration	Number : 11 In-Line
Auxiliaries	—
Specified ambient conditions:	
Maximum seawater temperature	36 °C
Maximum charge air temperature, if applicable	60 °C
Cooling system spec. intermediate cooler	Yes: Water cooled
Cooling system spec. charge air stages	2
Low/high temperature cooling system set points	25 / 36 °C
Maximum inlet depression	3 kPa
Maximum exhaust back pressure	5 kPa
Fuel oil specification	Marine Diesel Fuel Oil
Fuel oil temperature	approx. 30 °C
Lubricating oil specification	Used for marine internal combustion engine equivalent SAE50 (Nippon Mitsubishi Oil CLS15)
Application/Intended for:	
Customer	Mitsui O.S.K. Lines
Final application/installation, Ship	MHI-Nagasaki Hull No.2225
Final application/installation, Engine	Main engine
Emissions test results:	
Cycle	E3 test-cycle
NO _x	12.59 g/kWh
Test identification	Pre-certification Test of the Engine
Date/time	21-Aug-2006 8:00~14:00
Test site/bench	Mitsubishi Heavy Industries, Ltd. Kobe Shipyard & Machinery Works, Diesel Engine Assembly factory / No.3 bench
Test number	IMO-11, -12, -13 and -14
Surveyor	
Date and Place of report	21-Aug-2006/ Mitsubishi Heavy Industries, Ltd.
Signature	

Engine Group Information *

Engine Group Information (Common specifications)	
Combustion cycle	2 stroke cycle
Cooling medium	Water / Oil
Method of aspiration	Constant pressure turbocharging system with exhaust turbocharger(s)
Fuel type to be used on board	Marine Diesel fuel oil / Heavy fuel oil
Combustion chamber	Open chamber
Valve port configuration	Cylinder head
Valve port number	1 per cylinder
Fuel system type	Direct injection

Miscellaneous features:	
Exhaust gas recirculation	N.A.
Water injection / emulsion	N.A.
Air injection	N.A.
Charge cooling system	N.A.
Exhaust after - treatment	N.A.
Exhaust after - treatment type	—
Dual fuel	N.A.

Engine Group Information (Selection of parent engine for test bed test)				
Family/Group Identification	Group			
Method of pressure changing	Constant pressure turbocharging system with exhaust turbocharger(s)			
Charge air cooling system	Water cooled			
Criteria of the selection (specify)	Maximum NOx emission			
Number of cylinder				From 6 to 14 cylinder
Max. rated power per cylinder (kW/cyl.)				5,720
Rated speed (min ⁻¹)				102
Injection timing (range)				Timing retard side from 0.6 deg. CAATDC
Max. fuel parent engine				Marine Diesel Fuel Oil
Selected parent engine				Parent
Application				E3 mode

* If applicable

Calibration result of zero and span before after the test

Zero					
	NOx(ppm)	O ₂ (%)	CO(ppm)	CO ₂ (%)	THC(ppm)
Before test	0	0.01	1.3	0	0.03
After test	0	0	0.8	0	0.014
Deviation	0%	0.04%	0.2%	0%	0.0032%

Span					
	NOx(ppm)	O ₂ (%)	CO(ppm)	CO ₂ (%)	THC(ppm)
Span gas	2376	23.69	239.9	9.556	473.7
Before test	2391	23.72	239.2	9.56	472
After test	2360	23.62	238.3	9.55	474
Deviation	1.24%	0.4%	0.36%	0.1%	0.4%

Test Cell Information *

Exhaust Pipe	
Diameter	2000 mm
Length	Approx. 100 m
Insulation	Yes
Probe location	Common exhaust manifold between No.1 T/C and No.2 T/C outlet
Remark	—

Measurement equipment	Manufacturer	Model	Measurement Ranges	Calibration	
				Span gas conc.	Deviation
Analyzer					
NOx Analyzer	Shimadzu corp.	NOA8000	0-2500ppm	2376ppm	±2%
CO Analyzer	Horiba, Ltd.	VIA510-CO	0-250ppm	239.9ppm	±2%
CO ₂ Analyzer	Horiba, Ltd.	VIA510-CO2	0-10%	9.556%	±2%
O ₂ Analyzer	Shimadzu corp.	POT8000	0-25%	23.69%	±2%
HC Analyzer	Thermo Electron	MODEL 51	0-500	473.7ppm	±2%
Speed	Nabco, Ltd.	FE-90	±150rpm		±2%
Power, if applicable	—	—	—		—
Fuel Flow	Kubota corp.	—	Full:1600kg		±2%
Air flow	—	—	—		—
Exhaust flow	—	—	—		—
Temperatures					
Coolant	Yamazaki keiryoki mfg.	YKS-400	0-100°C		±2°C
Lubricant	Yamazaki keiryoki mfg.	YKS-400	0-100°C		±2°C
Exhaust gas	Nesstech co.	TUL-HSP-S	0-600°C		±15°C
Inlet air	Nesstech co.	TUS-2S-M	0-100°C		±2°C
Intercooled air	Nesstech co.	TUS-2S-M	0-100°C		±2°C
Fuel	Nesstech co.	TUS-2S-M	0-200°C		±2°C
Pressures					
Exhaust gas	(Manometer)	—	kPa		—
Scavenging pressure	Kobata Gauge	BVU1/2 × 100	0 – 0.4MPa		±5%
Atmospheric	Satokeiryoki co	7610-20	930-1070hPa		±0.5%
Vapor pressure					
Intake air	calculated	—	kPa		—
Humidity					
Intake air	Nihon Keiryoki	JC-5070			±3%

Fuel Characteristics

Fuel type			Marine Diesel Fuel Oil		
Fuel properties:			Fuel elemental analysis		
Density (at 15°C)	868.6	kg/m ³	Carbon	86.3	% mass
Viscosity (at 50°C)	2.836	mm ² /s	Hydrogen	12.3	% mass
			Nitrogen	0.01	% mass
			Oxygen	0.52	% mass
			Sulphur	0.87	% mass
			LHV/Hu	42.20	MJ/kg

* If applicable

Measurement results of emissions and calculation of NOx values according to IMO guidelines
Low NOx mode : OFF

Engine Type	11RT-flex96C
Engine No.	3925
Test Cycle	E3

Test No.			IMO-1	IMO-2	IMO-3	IMO-4
Load	L	%	25	50	75	100
Date of measurement			18-Aug-06	18-Aug-06	18-Aug-06	18-Aug-06
Time of measurement			11:10	11:37	12:15	12:54
Power	P	kW	15730	31421	47190	62920
Speed	n	min ⁻¹	64.3	80.9	92.7	102.0
Mean effective pressure	Pme	MPa	0.74	1.17	1.53	1.86
Fuel command	FC	%	38.1	56.1	72.3	88.1
VIT/FQS position		Pos.	+0.6/-0.4	-1.1/-0.4	-2.8/-0.4	-0.8/-0.4
Fuel flow	GFUEL	kg/h	2788.1	5354.1	8023.5	10948.2
Ambient Data:						
Atmospheric pressure	Pb	kPa	100.15	100.10	100.10	100.00
Intake air temperature	Ta	°C	32.0	32.0	32.0	32.5
Intake air humidity	Ra	%RH	70.0	70.0	70.0	70.0
Vapor pressure of suction air	Pa	kPa	4.75	4.75	4.75	4.89
Abs humidity of suction air	Ha	g/kg	21.37	21.38	21.38	22.04
Scavenging Data:						
Scavenging pressure (relative)	Pc	kPa	20	90	185	271
Temperature after charge air cooler	Tsc	°C	32.17	32.00	38.17	43.00
Referenced temperature of intercooled air	Tscref	°C	32	33	38	39
Vapor pressure of scavenging air	Psc	kPa	4.80	4.75	6.68	8.62
Abs humidity of scavenging air	Hsc	g/kg	25.87	15.95	14.93	14.80
Fuel Properties:						
Carbon content of fuel	BET	%mass	86.3	86.3	86.3	86.3
Hydrogen content of fuel	ALF	%mass	12.3	12.3	12.3	12.3
Sulphur content of fuel	GAM	%mass	0.87	0.87	0.87	0.87
Nitrogen content of fuel	DEL	%mass	0.01	0.01	0.01	0.01
Oxygen content of fuel	EPS	%mass	0.52	0.52	0.52	0.52
Gaseous Emissions Data:						
NOx concentration (dry)	NOXD	ppm	2127.0	1832.9	1315.2	1229.7
CO concentration (dry)	COD	ppm	12.46	13.76	14.27	13.70
CO2 concentration (dry)	CO2D	%vol.	6.114	5.165	4.800	5.200
O2 concentration (dry)	O2D	%vol.	100.15	71.49	60.33	75.81
HC concentration (dry)	HCD	ppm	5.57	5.32	11.53	14.55
NOx humidity correction factor	KHDIES	—	1.172	1.093	1.075	1.062
Dry/Wet correction factor	Kwr	—	0.9198	0.9268	0.9296	0.9257
Exhaust mass flow	gexhw	kg/h	100342	226297	363708	459615
Exhaust gas volume flow rate on wet basis	VEXHW	m3/h	79164	178646	287189	363177
Exhaust gas density	EXHDENS	kg/m3	1.2675	1.2667	1.2664	1.2655
NOx mass flow	NOxmass	g/h	372674	677391	769730	894937
CO2 mass flow	CO2mass	g/h	8738045	16715354	24993689	34061490
CO mass flow	COMass	g/h	9104	14659	19973	31549
NOx specific	NOx	g/kWh	23.69	21.56	16.31	14.22

(Method 2, Universal, Carbon/Oxygen-balance)

Caluculation of E3-cycle

Load			25%	50%	75%	100%
NOx mass flow	NOx mass	g/h	372674	677391	769730	894937
Power	P	kW	15730	31421	47190	62920
NOx specific	NOx	g/kWh	23.69	21.56	16.31	14.22
Weighting factor			0.15	0.15	0.5	0.2
					E3 cycle	16.67 g/kWh

Measurement results of emissions and calculation of NOx values according to IMO guidelines

Low NOx mode : ON

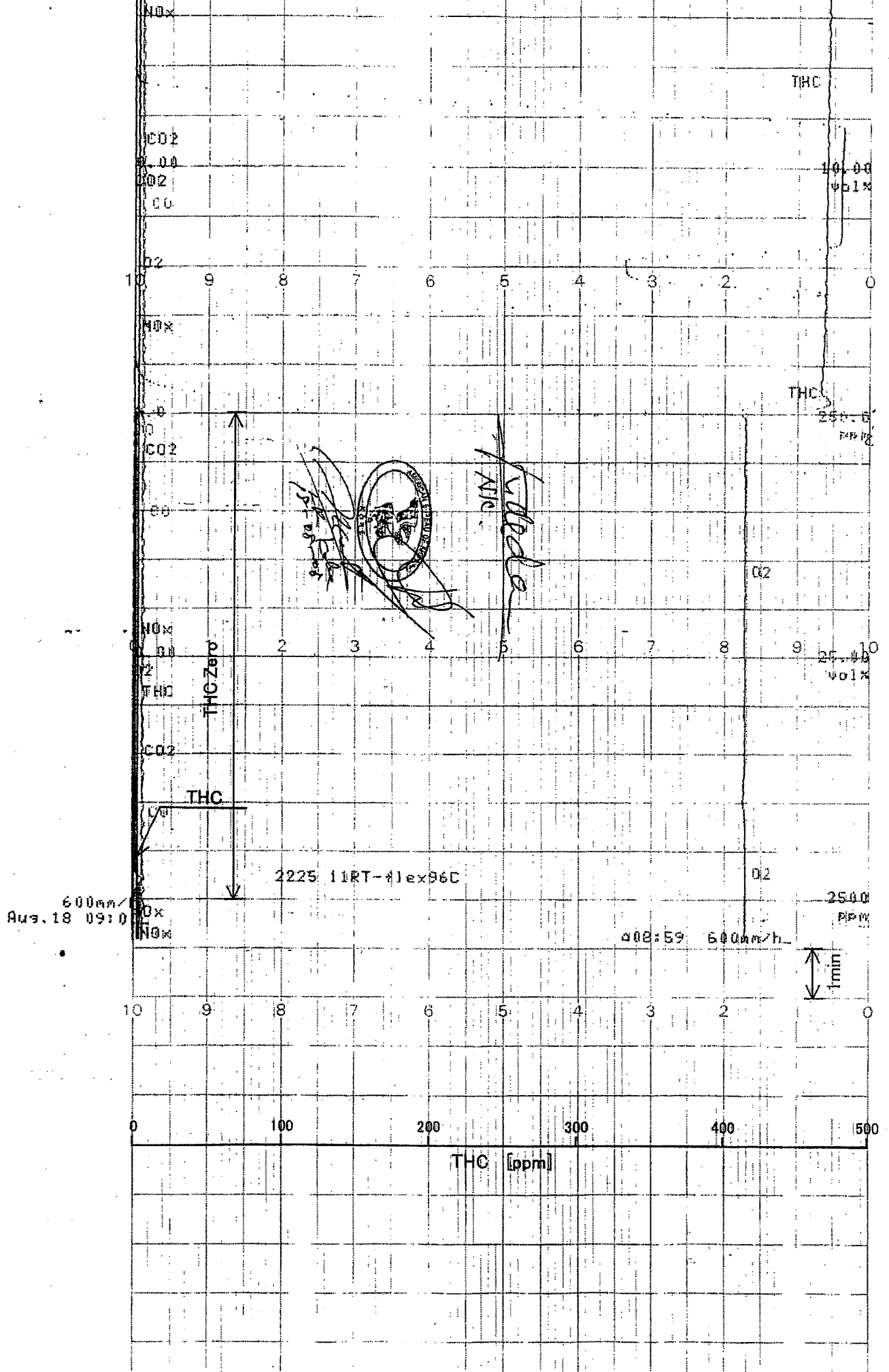
Engine Type	11RT-flex96C
Engine No.	3925
Test Cycle	E3

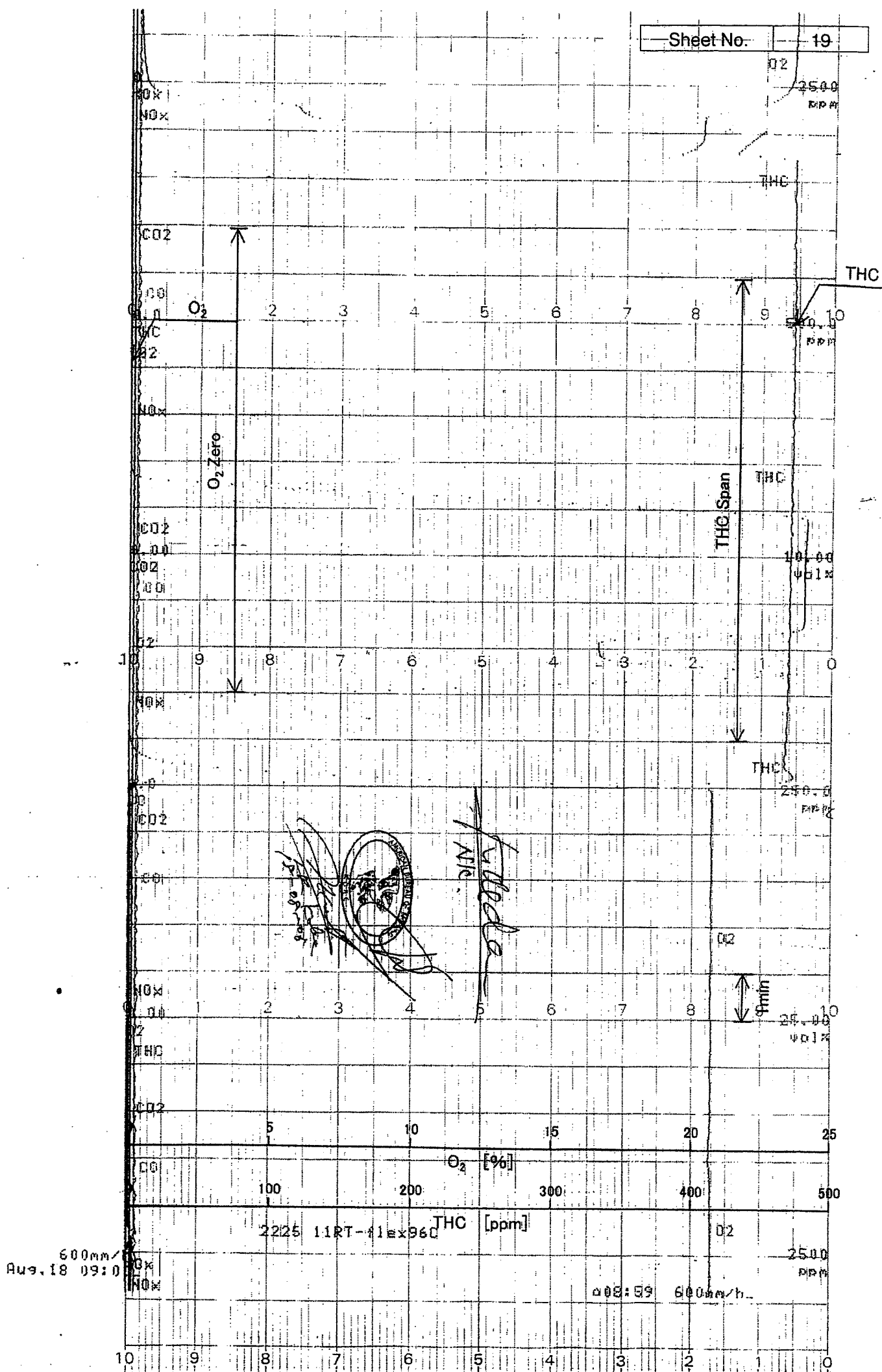
Test No.			IMO-11	IMO-12	IMO-13	IMO-14
Load	L	%	25	50	75	100
Date of measurement			21-Aug-06	21-Aug-06	21-Aug-06	21-Aug-06
Time of measurement			10:18	10:52	11:26	12:00
Power	P	kW	15730	31460	47190	62920
Speed	n	min ⁻¹	64.3	81.0	92.7	102.0
Mean effective pressure	Pme	MPa	0.74	1.17	1.53	1.86
Fuel command	FC	%	38.2	57.6	74.6	91.8
VIT/FQS position		Pos.	+0.9/-0.4	-0.5/-0.4	-3.5/-0.4	-2.5/-0.4
Fuel flow	GFUEL	kg/h	2834.46	5503.44	8289.36	11415.24
Ambient Data:						
Atmospheric pressure	Pb	kPa	101.10	101.00	101.00	101.00
Intake air temperature	Ta	°C	30.5	31.0	31.5	32.0
Intake air humidity	Ra	%RH	68.5	67.0	66.5	63.0
Vapor pressure of suction air	Pa	kPa	4.36	4.49	4.62	4.75
Abs humidity of suction air	Ha	g/kg	18.95	19.10	19.51	19.00
Scavenging Data:						
Scavenging pressure (relative)	Pc	kPa	23	105	206	292
Temperature after charge air cooler	Tsc	°C	31.33	32.00	39.00	42.83
Referenced temperature of intercooled air	Tscref	°C	32	33	38	39
Vapor pressure of scavenging air	Psc	kPa	4.58	4.75	6.99	8.55
Abs humidity of scavenging air	Hsc	g/kg	23.82	14.69	14.48	13.83
Fuel Properties:						
Carbon content of fuel	BET	%mass	86.4	86.4	86.4	86.4
Hydrogen content of fuel	ALF	%mass	12.2	12.2	12.2	12.2
Sulphur content of fuel	GAM	%mass	0.85	0.85	0.85	0.85
Nitrogen content of fuel	DEL	%mass	0.01	0.01	0.01	0.01
Oxygen content of fuel	EPS	%mass	0.55	0.55	0.55	0.55
Gaseous Emissions Data:						
NOx concentration (dry)	NOXD	ppm	1845.4	1217.2	937.1	889.6
CO concentration (dry)	COD	ppm	12.61	14.31	14.56	13.76
CO2 concentration (dry)	CO2D	%vol.	6.049	4.825	4.650	5.190
O2 concentration (dry)	O2D	%vol.	95.62	97.99	81.80	145.10
HC concentration (dry)	HCD	ppm	8.10	8.59	9.05	9.82
NOx humidity correction factor	KHDIES	—	1.131	1.072	1.064	1.048
Dry/Wet correction factor	Kwr	—	0.924	0.9329	0.9336	0.9302
Exhaust mass flow	gexhw	kg/h	103147	248288	387573	480016
Exhaust gas volume flow rate on wet basis	VEXHW	m3/h	81074	195357	305172	377547
Exhaust gas density	EXHDENS	kg/m3	1.2723	1.2709	1.2700	1.2714
NOx mass flow	NOxmass	g/h	321063	485964	580356	668544
CO2 mass flow	CO2mass	g/h	8900661	17190121	25881348	35629551
CO mass flow	COmass	g/h	8918	22125	28846	63382
NOx specific	NOx	g/kWh	20.41	15.45	12.30	10.63

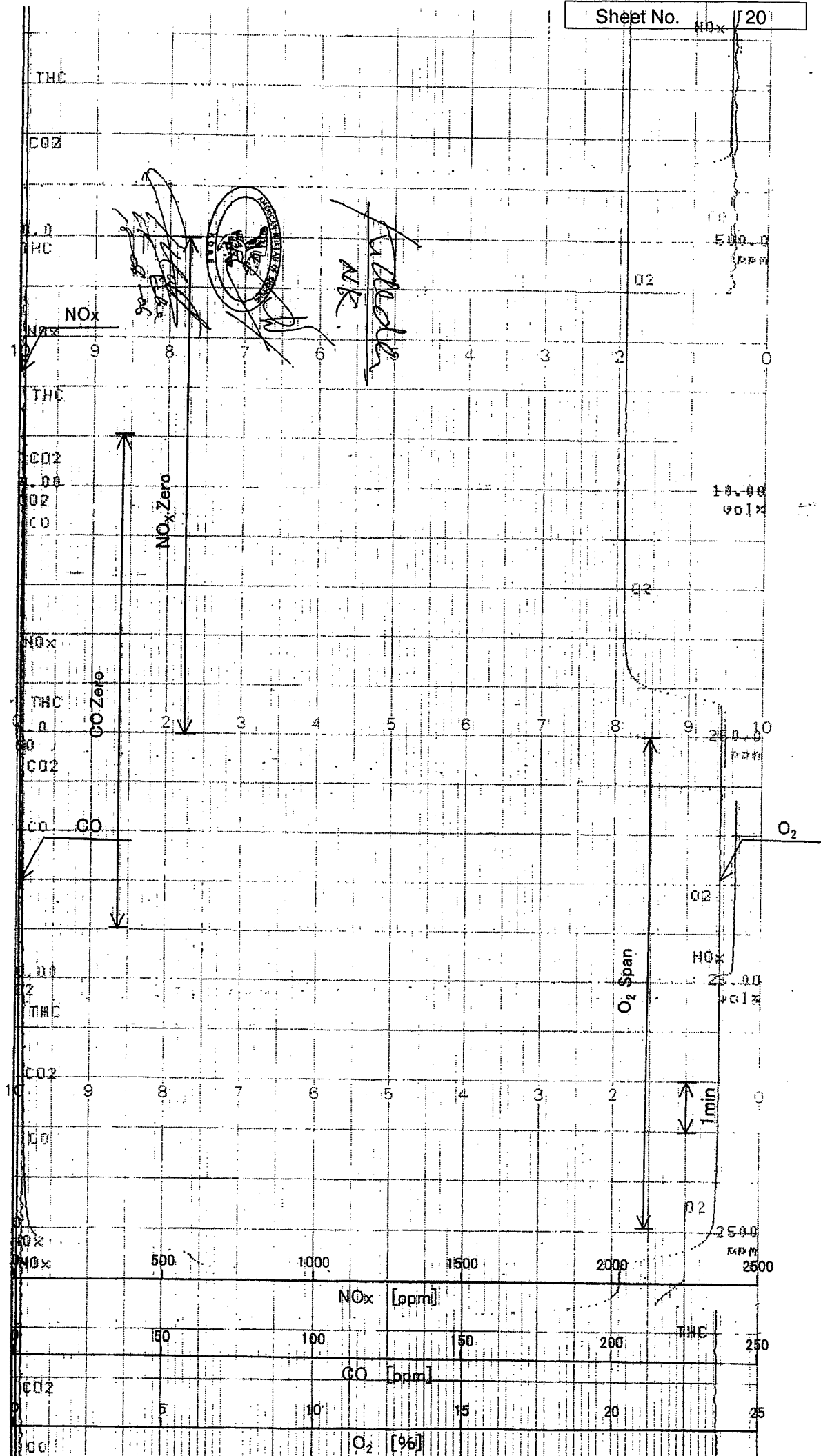
(Method 2, Universal, Carbon/Oxygen-balance)

Calculation of E3-cycle

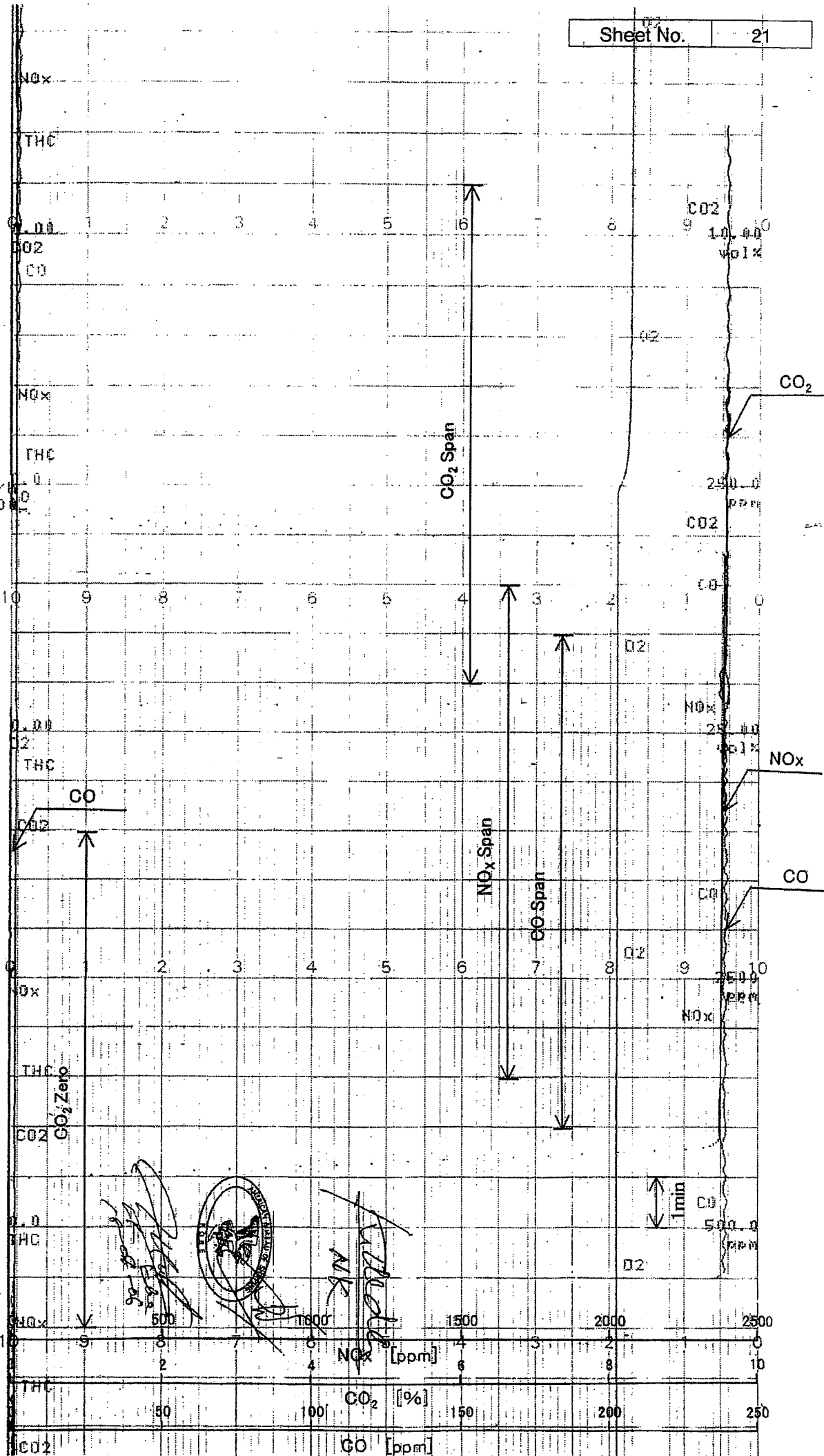
Load			25%	50%	75%	100%
NOx mass flow	NOx mass	g/h	321063	485964	580356	668544
Power	P	kW	15730	31460	47190	62920
NOx specific	NOx	g/kWh	20.41	15.45	12.30	10.63
Weighting factor			0.15	0.15	0.5	0.2
				E3 cycle	12.59	g/kWh

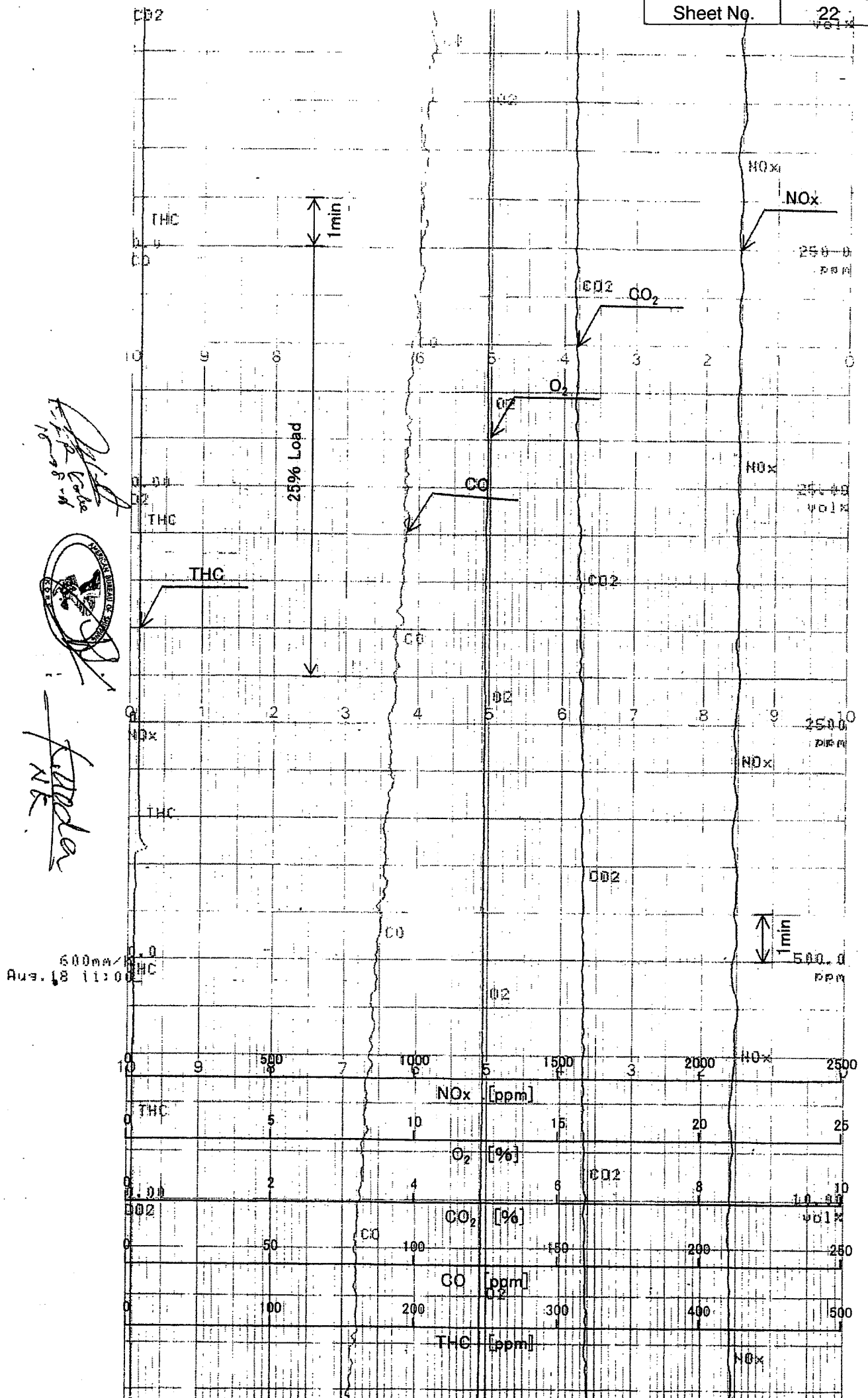


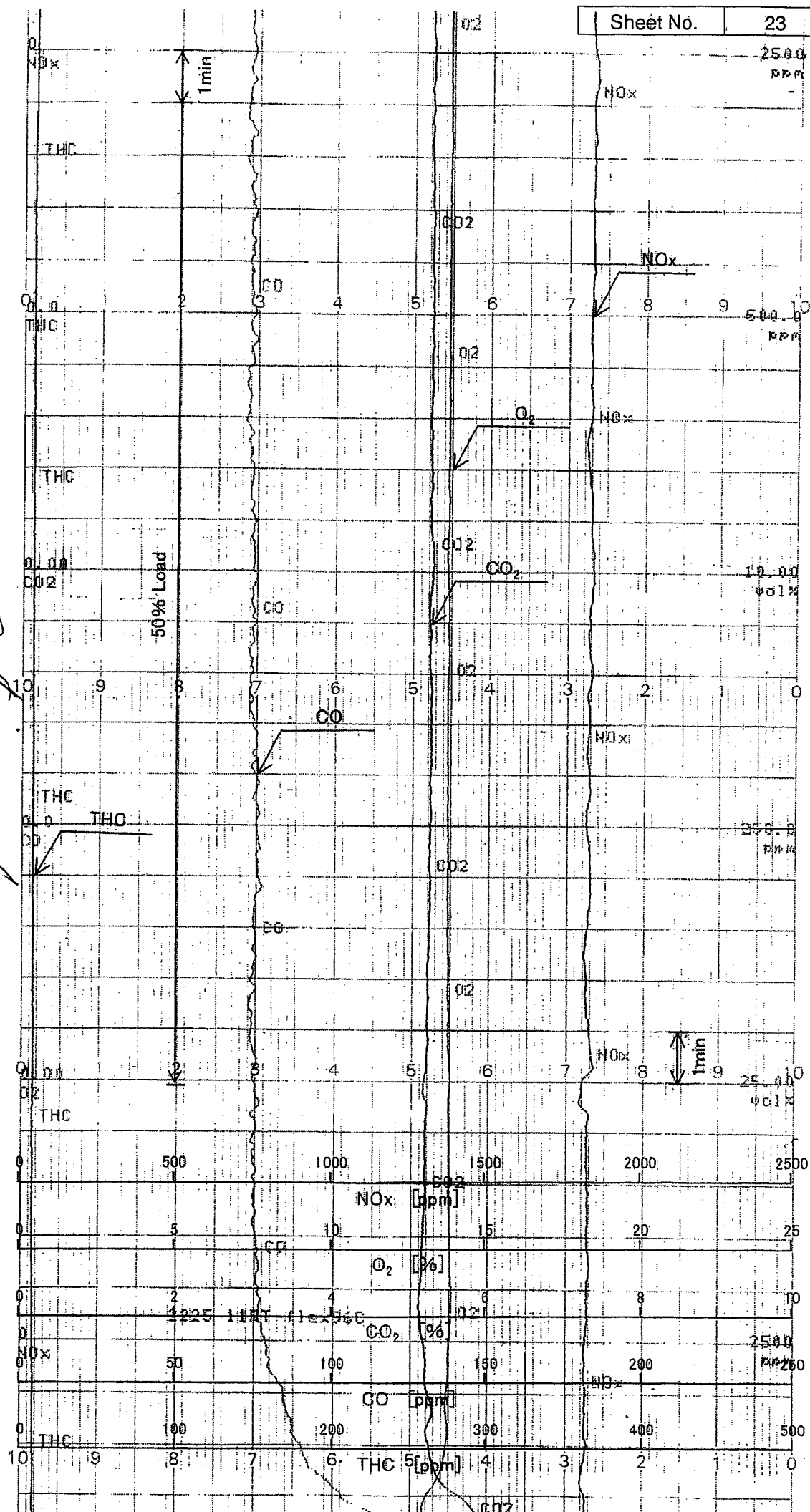




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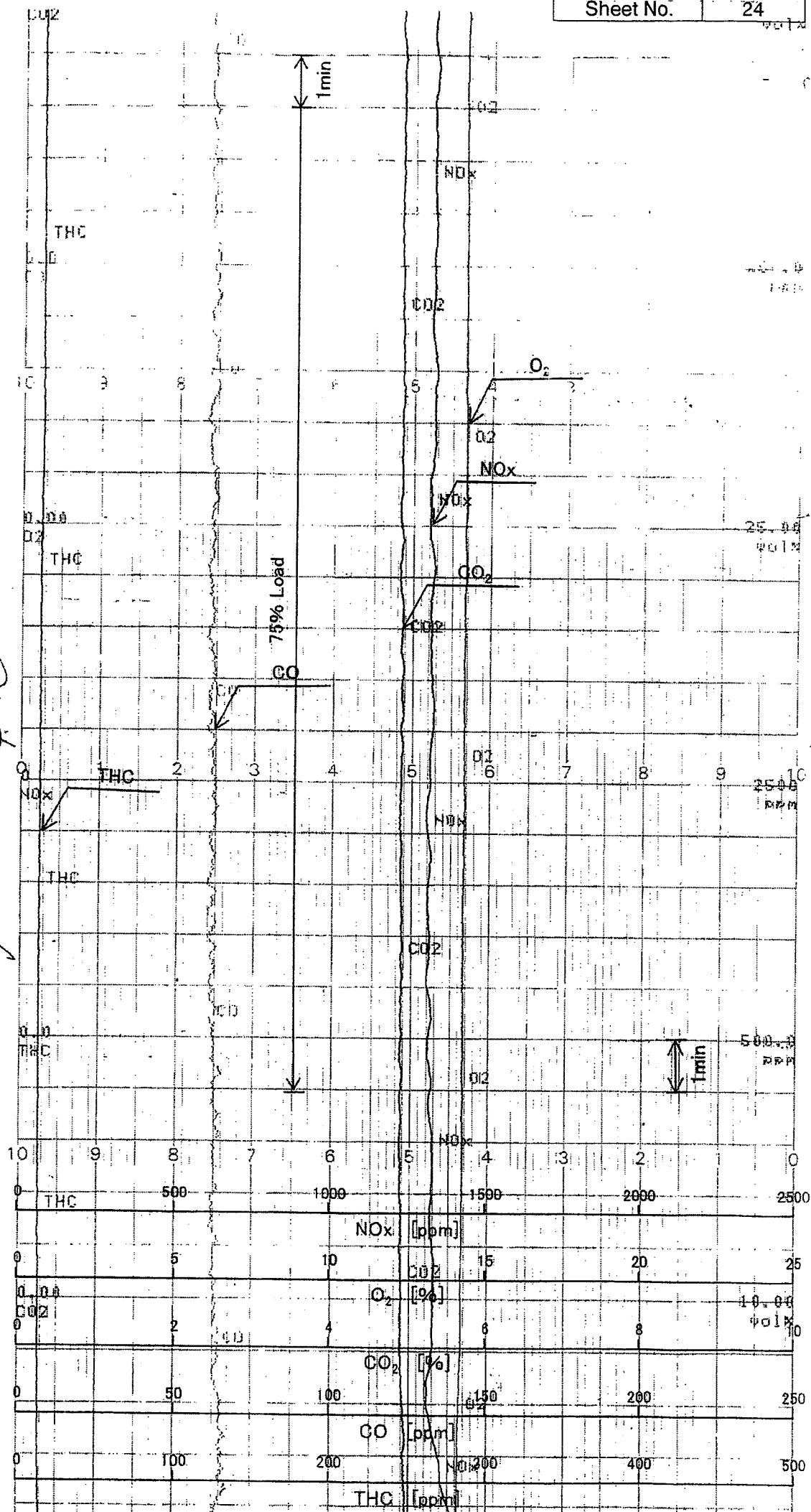


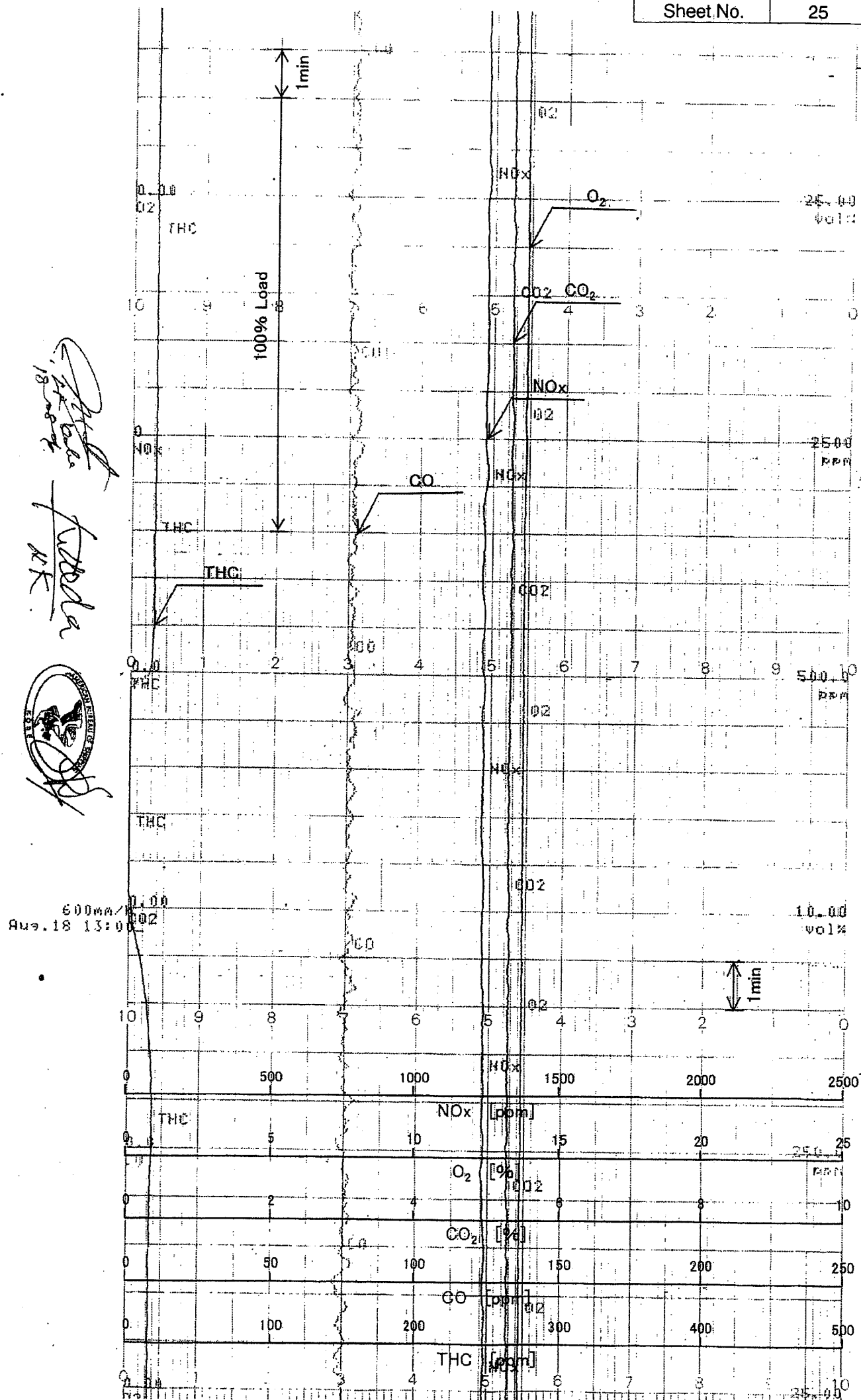
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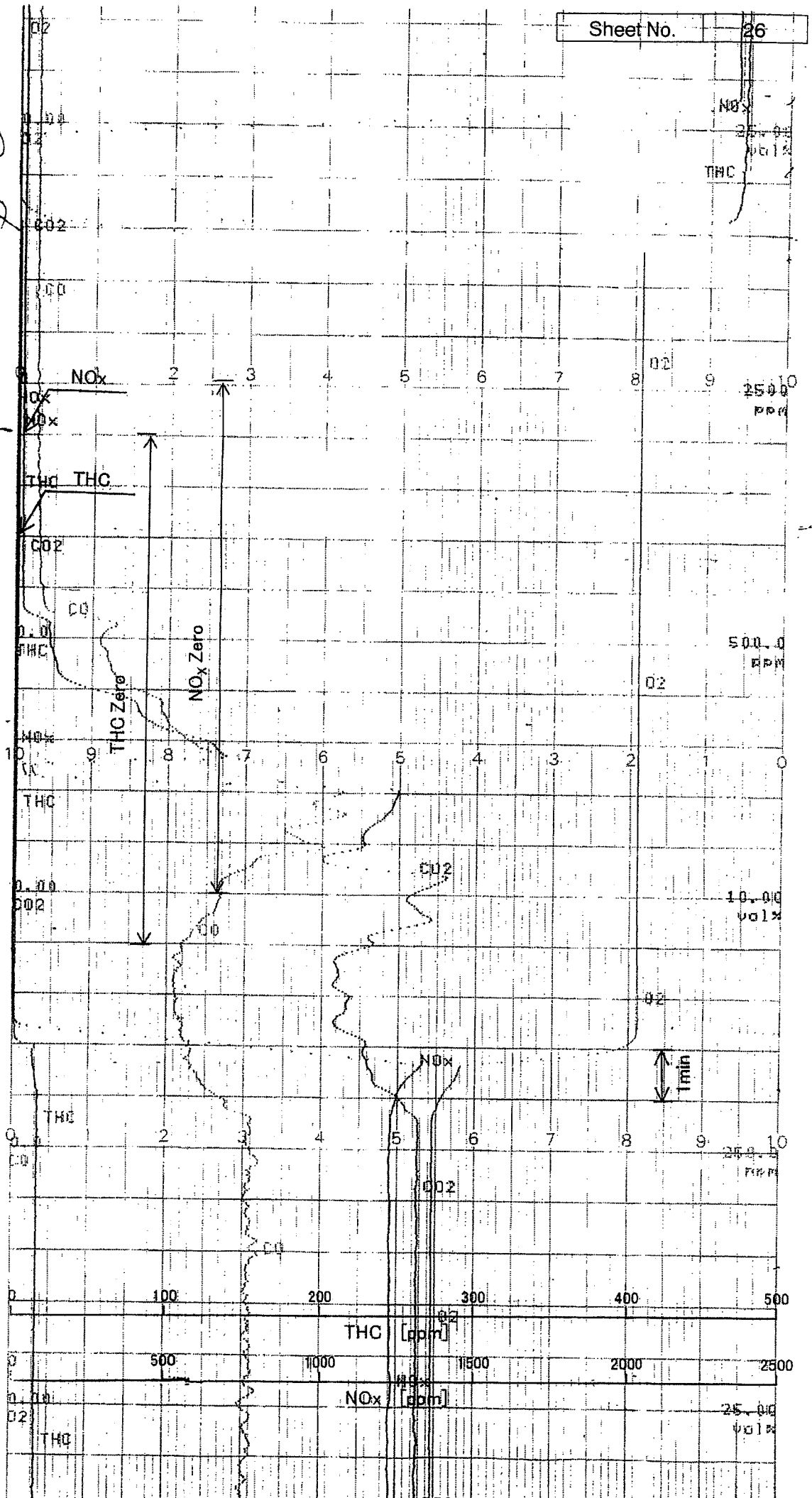


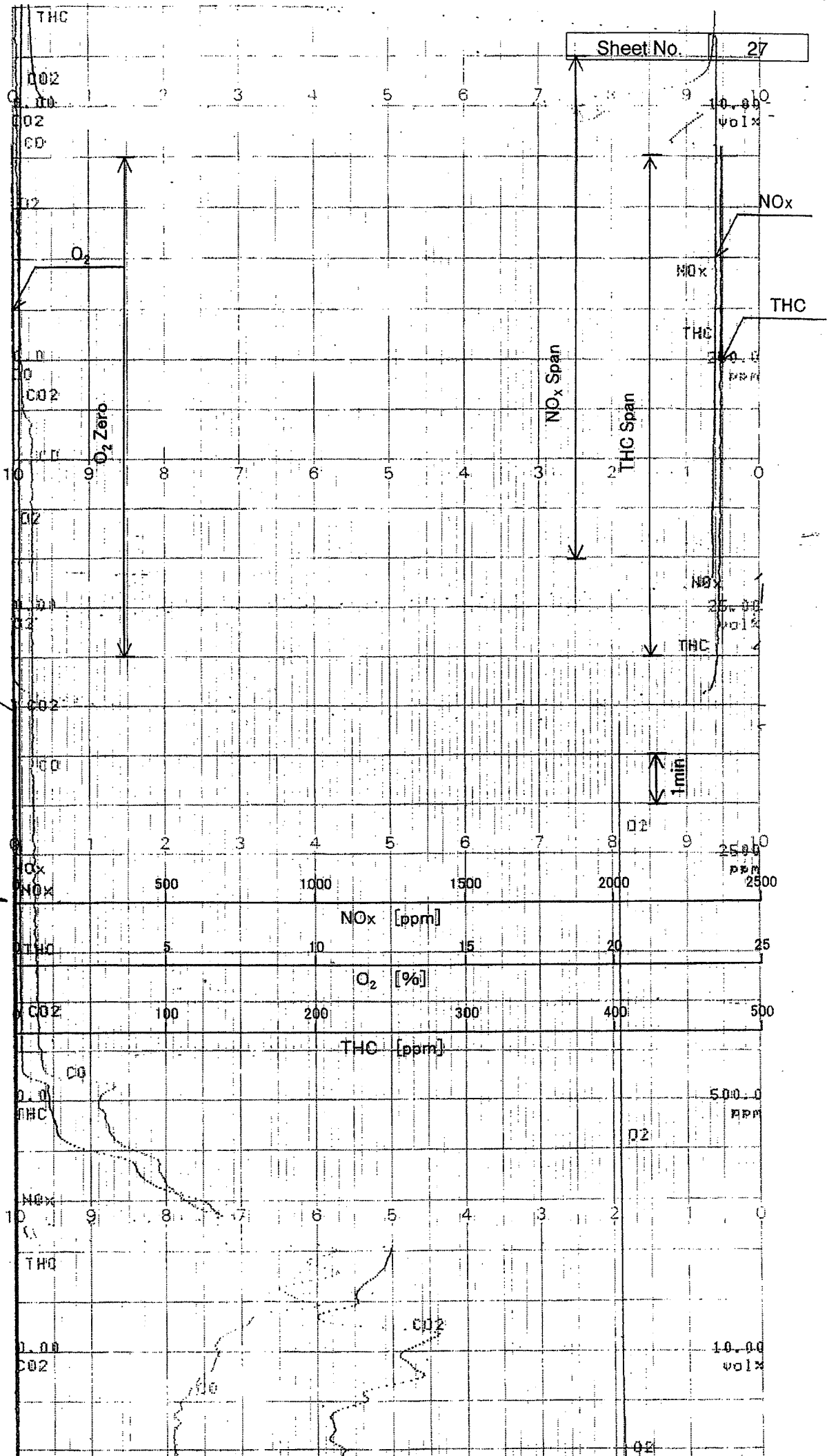


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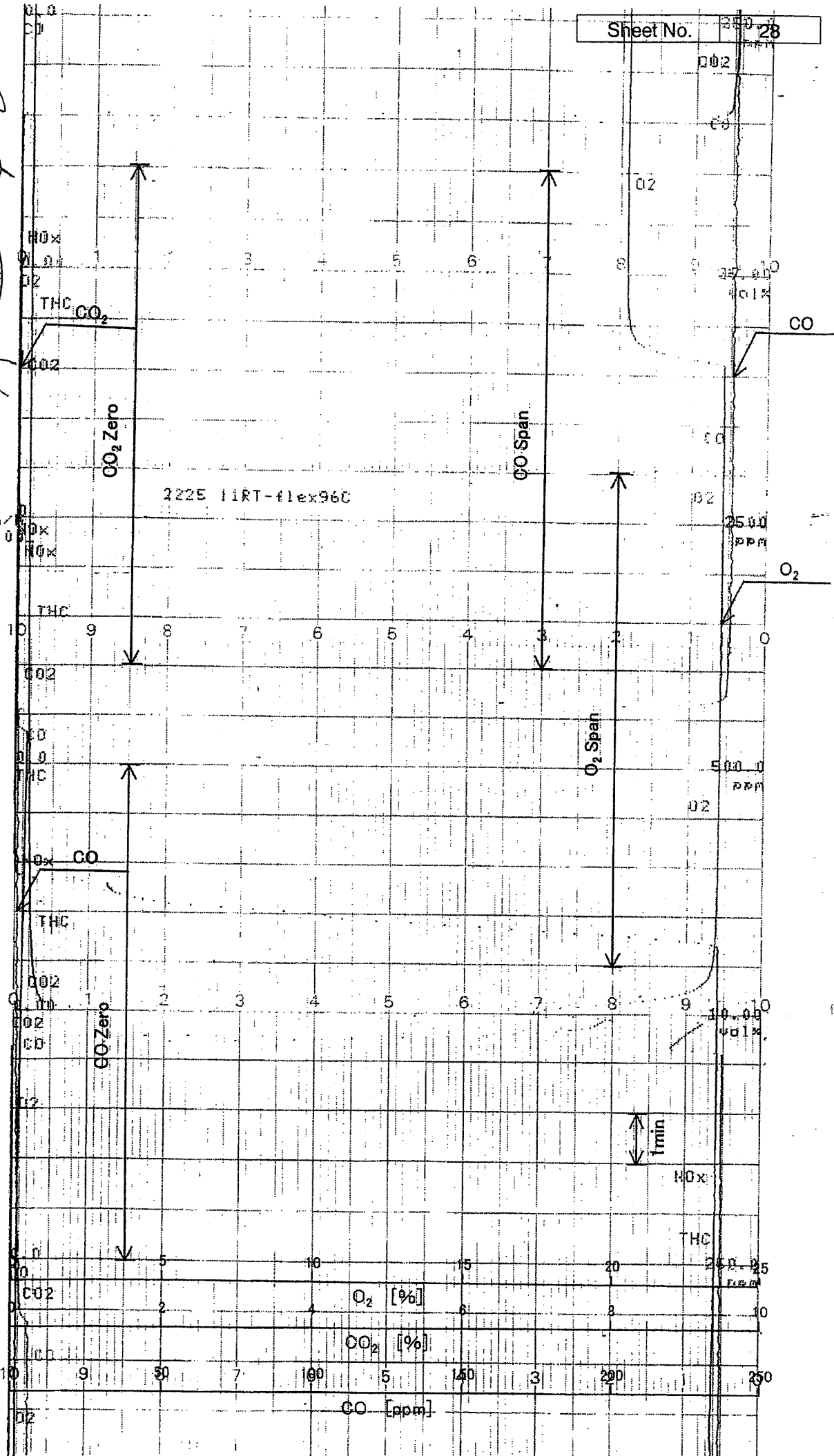


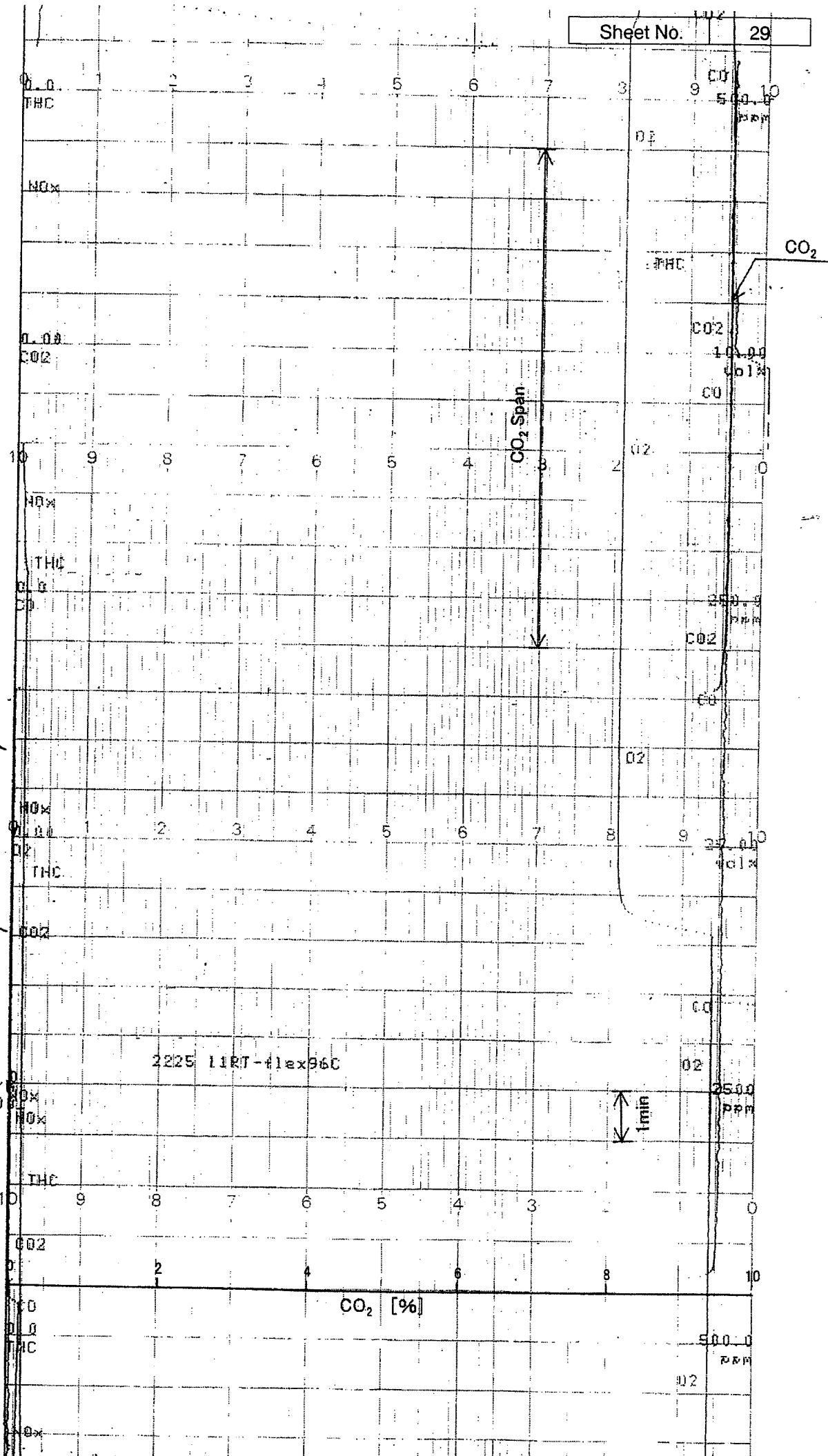
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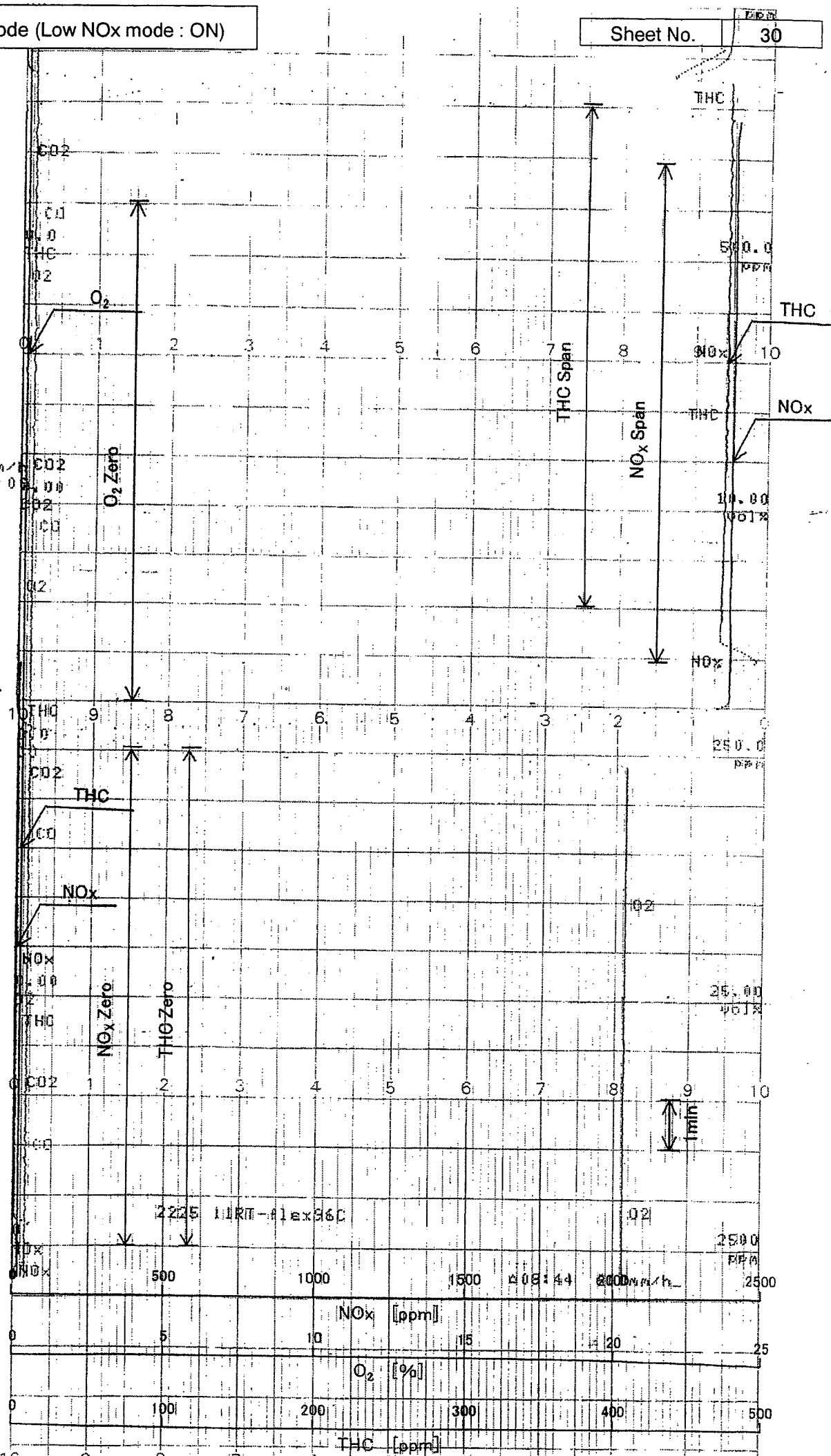


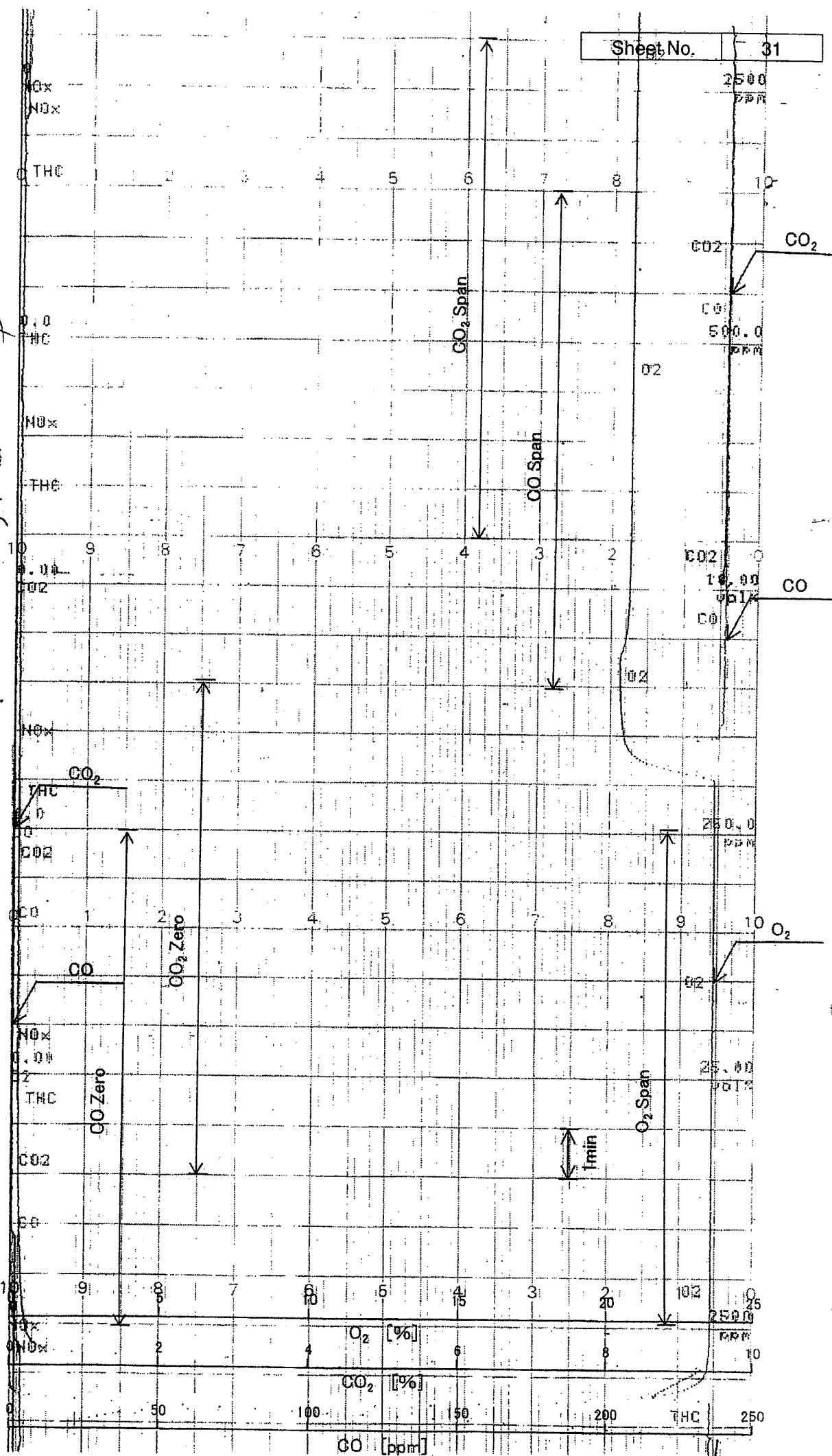
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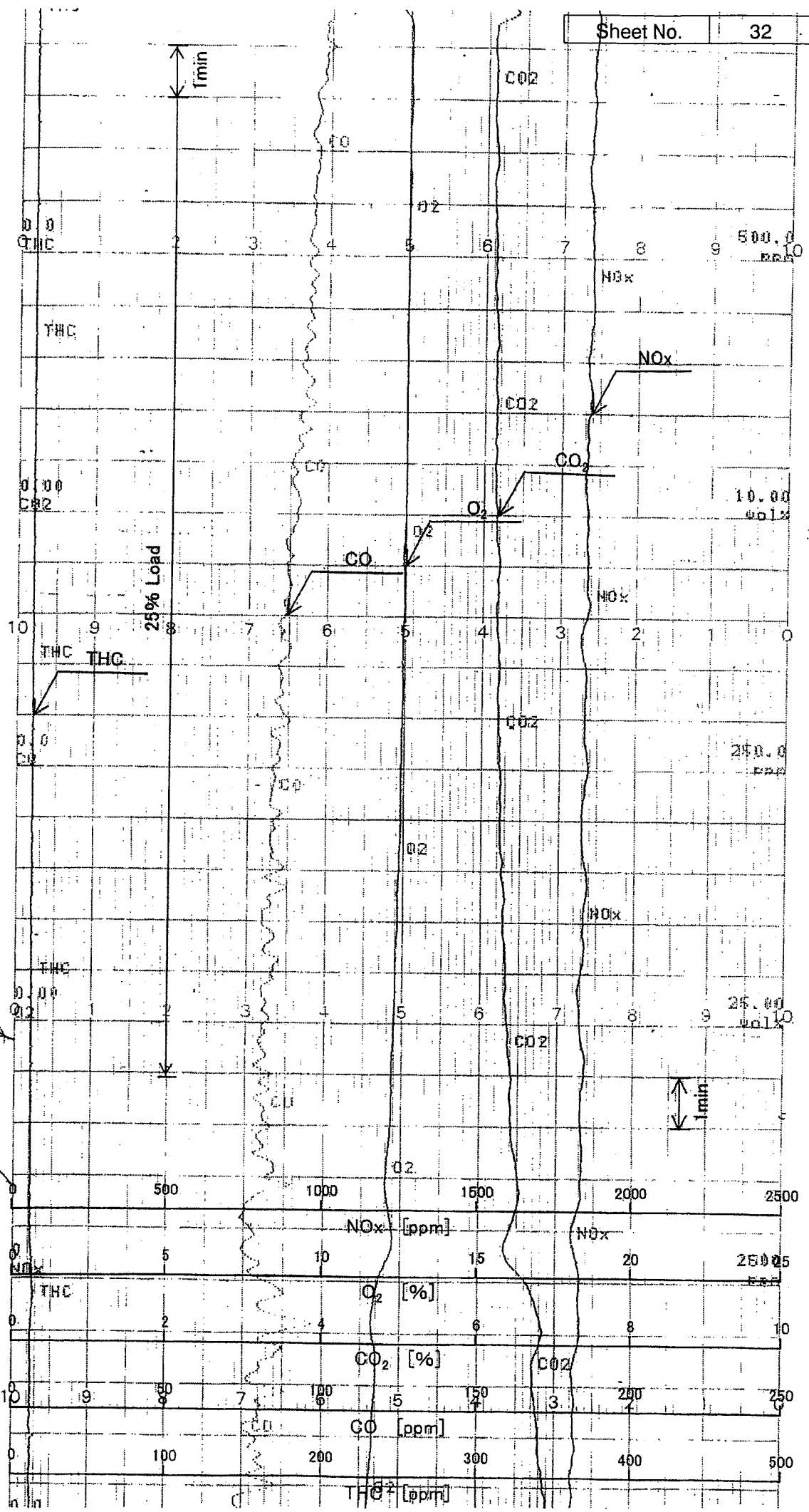




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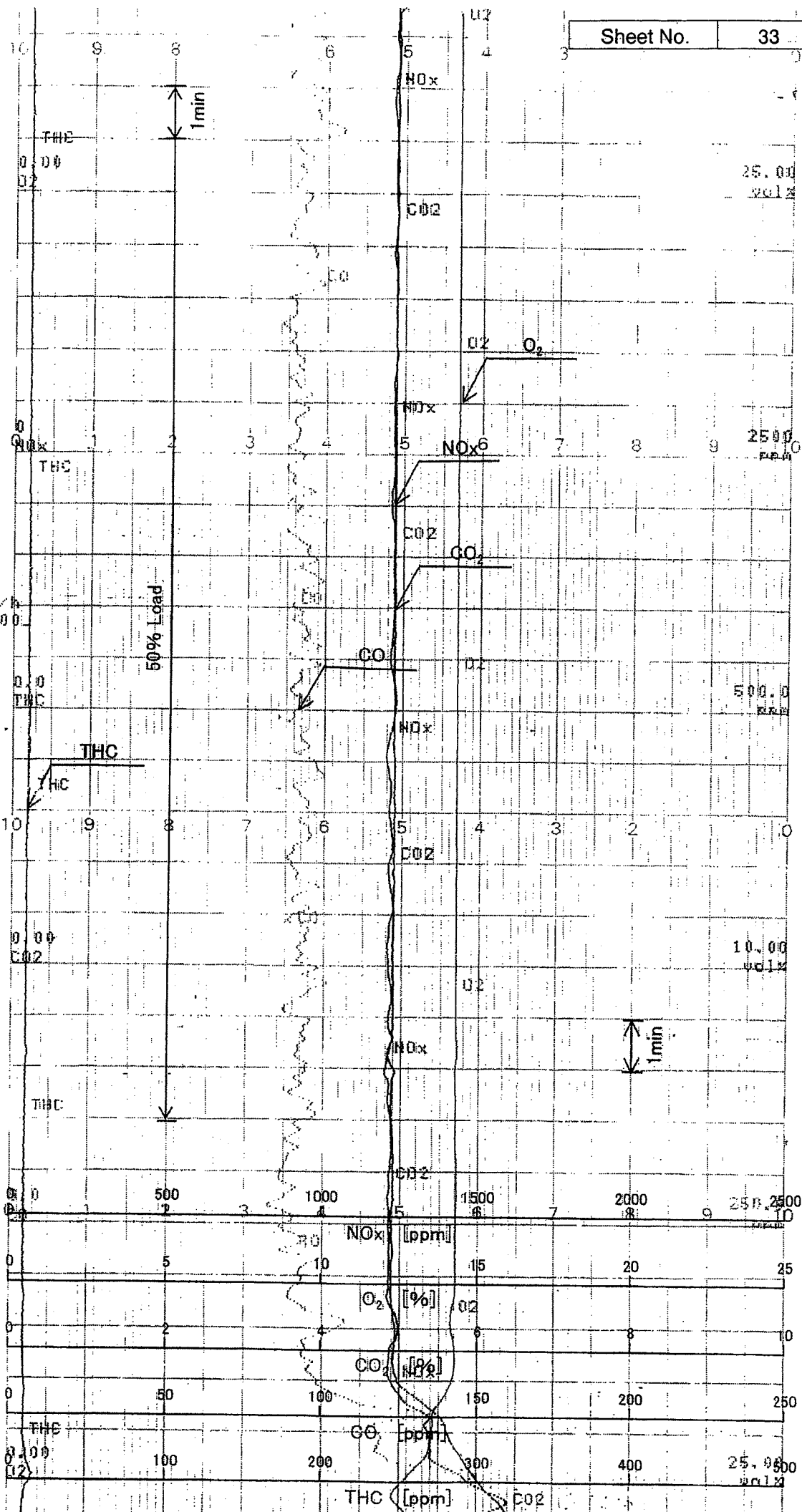
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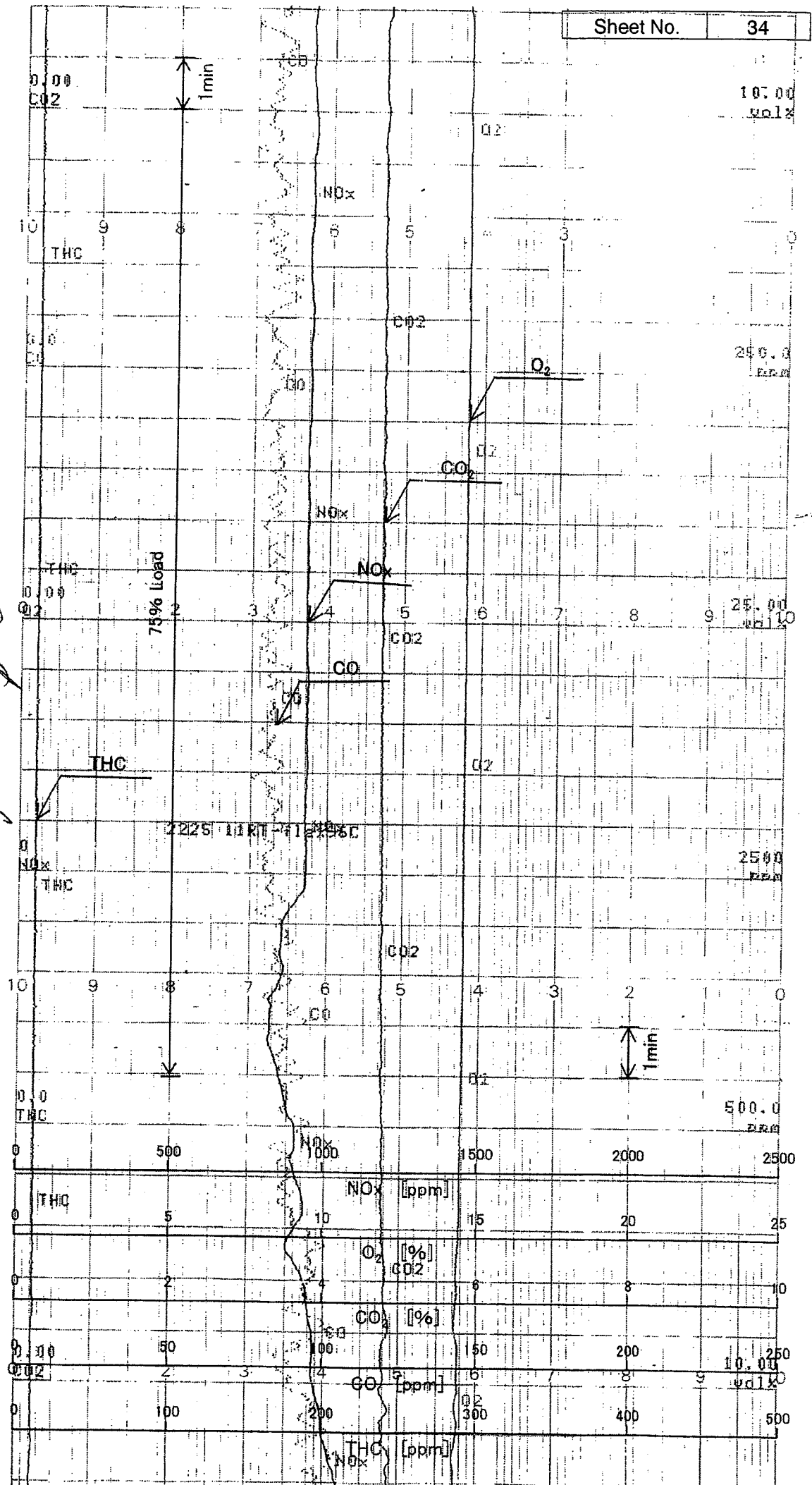
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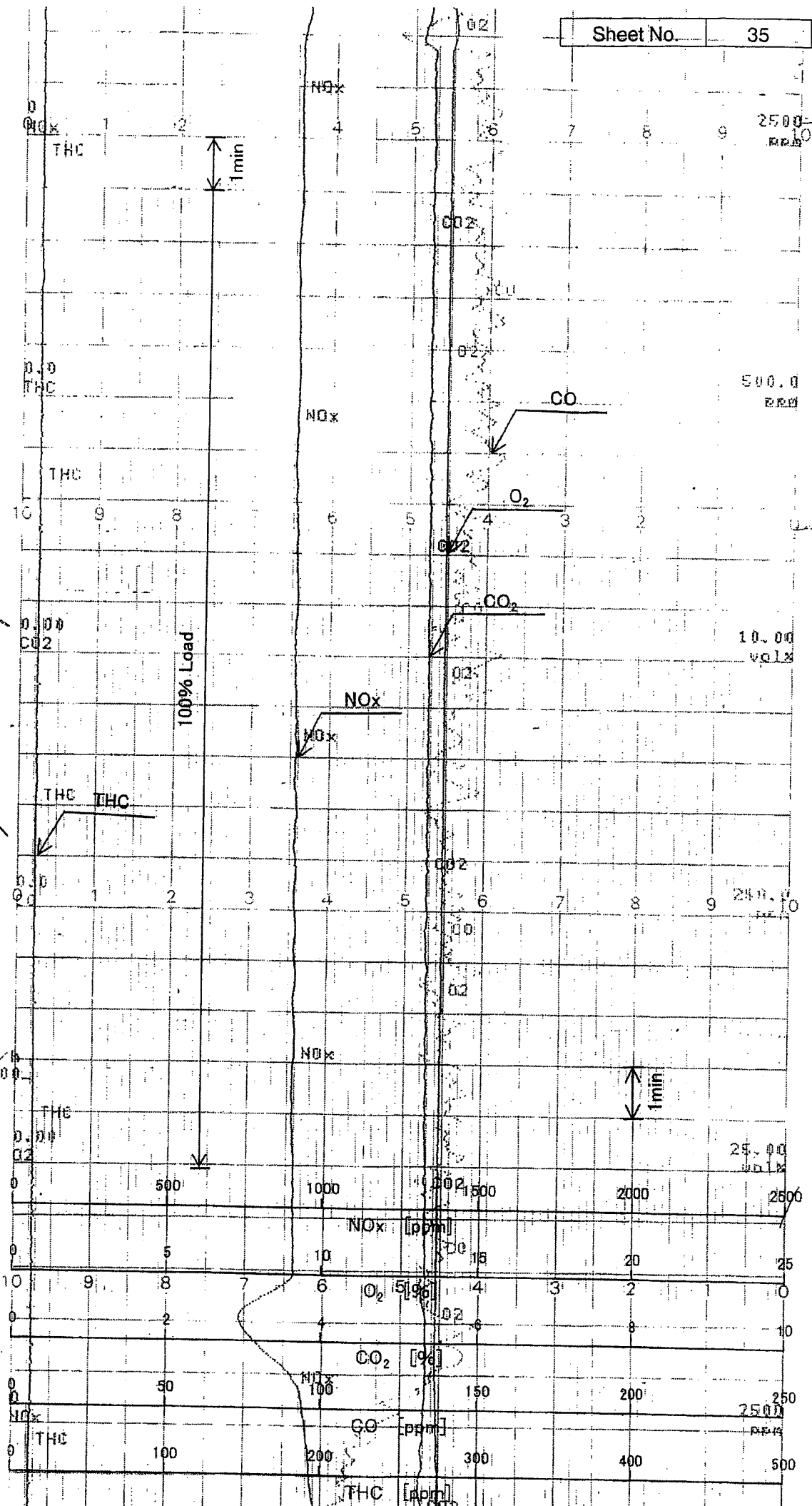




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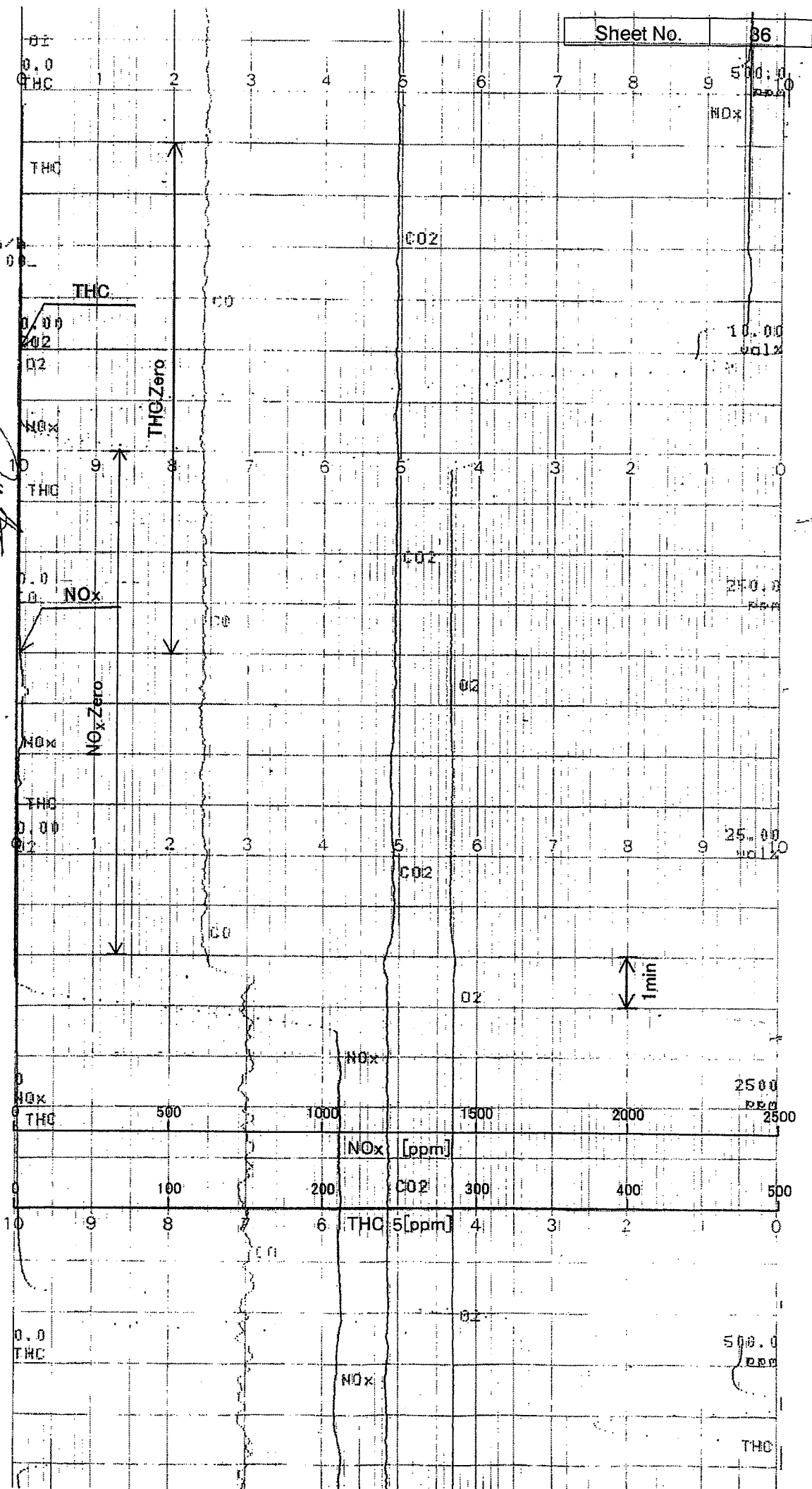


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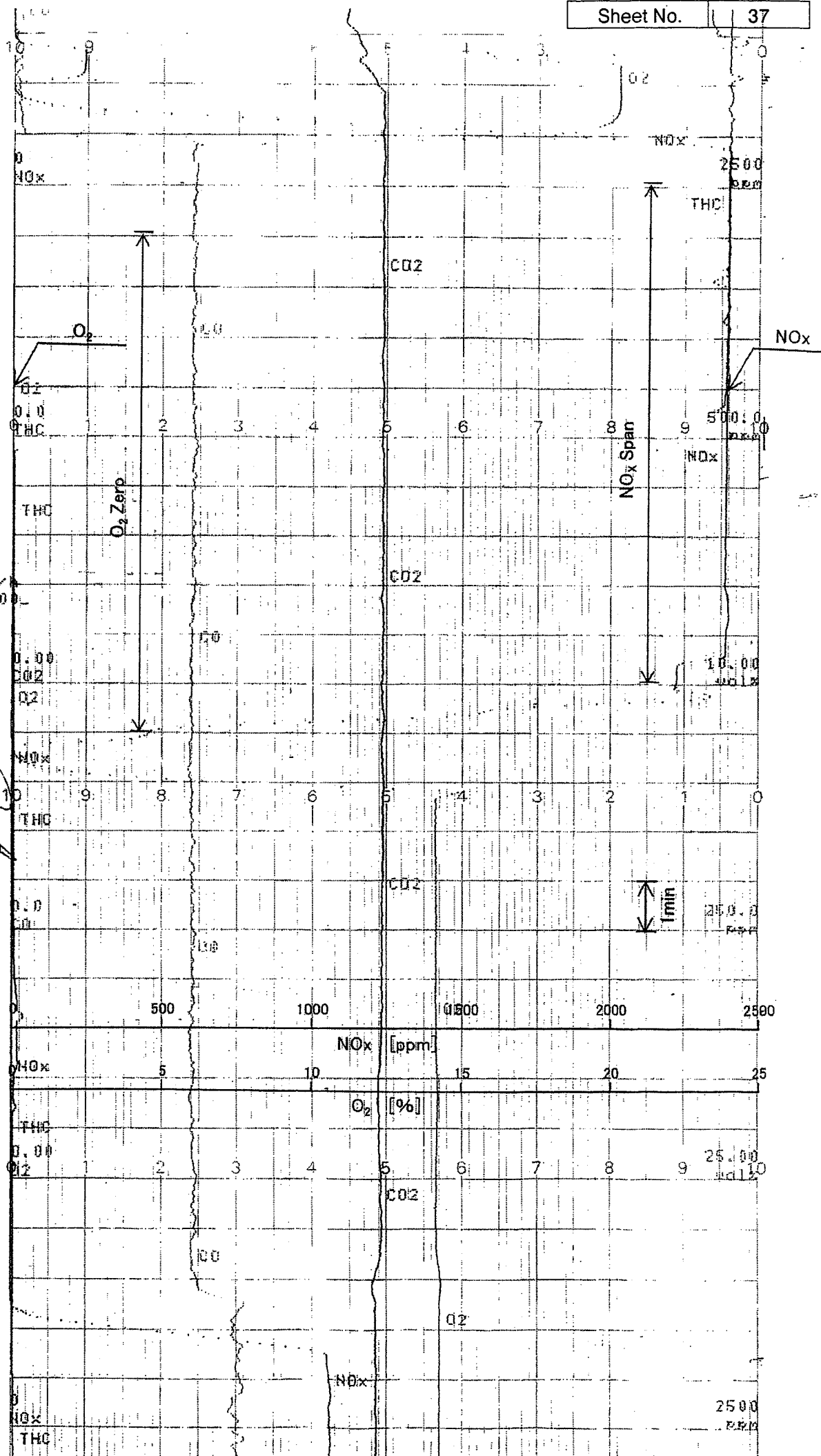


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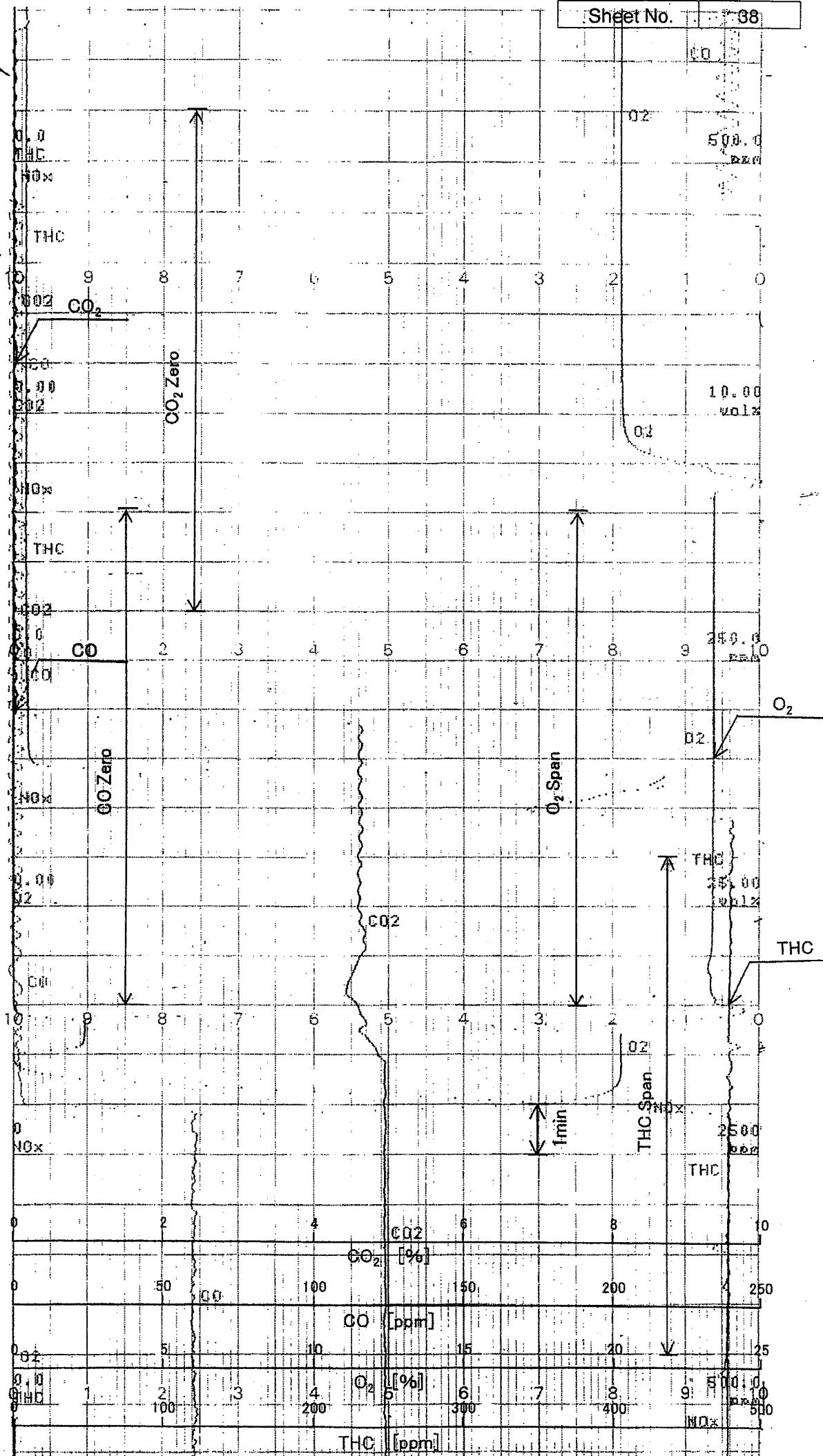
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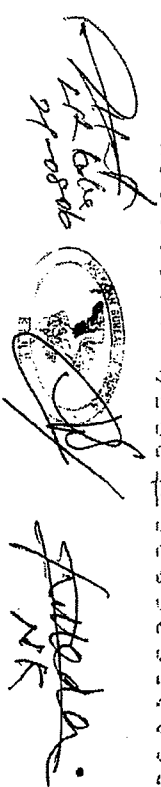
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Chemical Examination Report

Test No. 20065061

AUG. 18. 2006

Analytical Results of Fuel Oil used for Shop Test11RT-flex96C Type Main Diesel Engine Hull No. 2225 of MHI-Nagasaki Shipyard

Item		Unit	Light Marine Fuel Oil	Analytical Method
Density	15°C	g/cm³	0.8686	JIS K2249
Kinematic Viscosity	50°C	mm²/s	2.836	JIS K2283
Water Content		vol %	< 0.01	JIS K2275
Specific Energy	gross	MJ/kg	44.98	JIS K2279
Specific Energy	net		42.20	
Ultimate Analysis				
Carbon	wt %	86.3	ASTM D5291	
Hydrogen		12.3		
Nitrogen		0.01	JIS K2609	
Oxygen		0.52	JIS M8813	
Sulphur		0.87	JIS K2541	
M. Muraguchi M. MURAGUCHI Chemist Chemical Laboratory R. Matsubara R. MATSUBARA Acting Manager Chemical Laboratory				
				20065061 3/3

TAKASAGO RESEARCH & DEVELOPMENT CENTER
MITSUBISHI HEAVY INDUSTRIES LTD

Chemical Examination Report

Test No. 20065068

AUG. 21. 2006

Analytical Results of Fuel Oil used for Shop Test11RT-flex96C Type Main Diesel Engine Hull No. 2225 of MHI-Nagasaki Shipyard

Item		Unit	Light Marine Fuel Oil	Analytical Method
Density	15°C	g/cm ³	0.8695	JIS K2249
Kinematic Viscosity	50°C	mm ² /s	2.834	JIS K2283
Water Content		vol %	< 0.01	JIS K2275
Specific Energy	gross	MJ/kg	44.99	JIS K2279
Specific Energy	net		42.23	
Ultimate Analysis				
Carbon		wt %	86.4	ASTM D5291
Hydrogen			12.2	
Nitrogen			< 0.01	JIS K2609
Oxygen			0.55	JIS M8813
Sulphur			0.85	JIS K2541

M. Muraguchi

M. MURAGUCHI
Chemist
Chemical Laboratory

H. Nakagawa

H. NAKAGAWA
Acting Manager
Chemical Laboratory

20065068 3/3

TAKASAGO RESEARCH & DEVELOPMENT CENTER

MITSUBISHI HEAVY INDUSTRIES LTD

108

MITSUBISHI -SULZER		SHOP TEST RECORD NOx Regulation (Low Nox mode)		Engine type : 11RT-flex86C 62,920 kW X 102 min ⁻¹		Client : Messrs. Mitsui O.S.K. Lines		Ship No. : 2225 of MHI-Nagasaki Shipyard		Engine No. : 3925		Order No. : 7-891101		Sheet No. : 3	
Measuring time		min		20		20		20		20		20		20	
Load percentage		%		25		50		75		100					
Engine power (Engine speed (designated))		kW, min ⁻¹		15,730		64.3		31,460		81.0		47,190		102.0	
Mean effective press. / VIT / FDS		MPa, Pos		0.74		0.9		1.17		-0.5		-0.4		-0.4	
Fuel consumption / Governor input		% / V		38.20		5.07		57.60		6.24		74.60		7.7	
Engine power / Engine speed (Measured)		kW, min ⁻¹		15,730		64.3		31,460		81.0		47,190		102.0	
Fuel oil consumption (42200 KJ/kg)		kg / h		2834.5				5503.4				8289.4		11415.2	
Space fuel oil consumption (47100 KJ/kg)		gr / kWh		178.2				173.0				173.7		179.4	
Auxiliary blower		ON		OFF		OFF		OFF		OFF		OFF		OFF	
Cyclic consumption (reference at 100000 110000 110000)		l/hp/Wh		32.92		1.91		82.38		1.81		90.11		1.74	
Turbocharger speed No. 1/2/3		min ⁻¹		3321		3323		3318		6865		8855		8826	
Scavenging air pressure		MPa		0.023				0.105				0.206			
Barometric pressure / Room temp.		hPa, °C		1011.0		30.5		1010.0		31.0		1010.0		32.0	
Temp. after air receiver		°C		37.5				34				40		46	
Air filter resistance No. 1/2/3		hPa		0.03		0.04		0.03		0.23		0.54		0.83	
Press. drop air cooler No. 1/2/3		mm		30		35		35		115		120		115	
Suction air temp. No. 1/2/3		°C		37.0		35.5		34.5		37.0		35.0		35.0	
Temp. before air cooler No. 1/2/3		°C		52		53		55		113		116		115	
Temp. after air cooler No. 1/2/3		°C		32		32		30		32		33		31	
Air cooler C. W. inlet temp. No. 1/2/3		°C		29				28.5				35		39.5	
Air cooler C. W. outlet temp. No. 1/2/3		°C		30		30		40		40		59		58	
Exhaust back pressure No. 1/2/3		mm		12		10		6		80		70		60	
Temp. before turbine No. 1/2/3		°C		440		442		440		433		444		430	
Temp. After turbine No. 1/2/3		°C		392		401		388		333		349		329	
Temp. After cylinder Average		°C		371				349				361		411	
No. 1/2/3		°C		372		389		352		350		355		345	
No. 4/5/6		°C		372		382		388		345		345		360	
No. 7/8/9		°C		360		365		380		340		345		355	
No. 10/11		°C		380		360		-		363		340		-	
Maximum / Compression press. Average		MPa		7.27		4.71		9.60		6.61		11.73		14.02	
No. 1		MPa		7.20		4.70		9.80		6.80		11.70		14.10	
No. 2		MPa		7.20		4.70		9.50		6.70		11.75		14.00	
No. 3		MPa		7.10		4.70		9.60		6.55		11.85		14.00	
No. 4		MPa		7.20		4.70		9.60		6.70		11.85		13.95	
No. 5		MPa		7.40		4.70		9.60		6.50		11.60		14.00	
No. 6		MPa		7.40		4.70		9.60		6.50		11.60		14.00	
No. 7		MPa		7.30		4.60		9.75		6.70		11.80		14.05	
No. 8		MPa		7.30		4.70		9.50		6.60		11.75		14.00	
No. 9		MPa		7.10		4.65		9.60		6.80		11.80		14.00	
No. 10		MPa		7.40		4.80		9.60		6.70		11.70		14.10	
No. 11		MPa		7.40		4.90		9.50		6.60		11.60		14.00	
Fuel oil rate / Servo oil rate / Control oil rate		MPa		59.50		10.70		20.20		59.80		13.00		20.00	
Bearing / Crankshaft / Air spring for C/V		MPa		0.520		1.010		0.720		0.500		1.000		0.720	
Piston / Cylinder / I/C bearing		MPa		0.520		0.320		0.159		0.500		0.320		0.143	
Cyl. Lub. Oil Press. before/after regular/Cyl. Lub. Oil Temp		MPa / °C		8.0		0.060		92.0		8.0		0.050		52.0	
Lub. oil / Turb. bearing oil inlet temp./Thrust bearing temp.		°C		43.0		43.0		43.0		43.5		44.0		44.0	
Turb. bearing oil outlet temp.		°C		45		45		45		52		52		61	
Piston cooling oil inlet / outlet temp. No. 1/2/3/4/5/6/7/8/9/10/11		°C		43		43		43		43		43		43	
Cyl. Cooling water inlet / outlet temp. No. 1/2/3/4/5/6/7/8/9/10/11		°C		59		59		59		59		59		59	
Fuel oil inlet press. / Temp.		MPa / °C		0.95		36		0.88		34		0.84		32	
Place and date of shop test : AUG. 21. 2008															
Assembly Shop, Power Plant, Machinery & Electronic Equipment Manufacturing Department															
M.H.I. Kobe Shipyard & Machinery Works															
Manager of Machinery & Electronic Equipment															
QA Section, Quality Assurance Department															
Diesel Engine Designing Section,															
Diesel Engine Equipment															
MITSUBISHI HEAVY INDUSTRIES, LTD.															
K. Teshima															
Manager of Machinery & Electronic Equipment															
QA Section, Quality Assurance Department															
Diesel Engine Designing Section,															
Diesel Engine Equipment															

FINAL PLAN

METurbo

Hull Number : 2228

Engine Number : 3928

**Mitsubishi Exhaust Gas Turbocharger
Model MET83SEII
Instruction Manual**

Serial Number : 30628, 30629, 30630

 **mitsubishi HEAVY INDUSTRIES, LTD.**

Tz-EM83-0037

Name of Instruction Manual	Mitsubishi Exhaust Gas Turbocharger		
Document No.			
Rev.	Date of issue	Contents	Revised by
1	October 2006	Revised "Table3-3 Turbocharger Overhaul Intervals". • Changed the table on the whole. • Added the notes.	Yoshihisa Ono

Contents

Section 1	Turbocharger Basics
Section 2	Operation
Section 3	Maintenance
Section 4	Disassembly and Re-assembly
Section 5	Inspection of Components
Section 6	Attached Diagrams and Tables
Section 7	Cleaning Procedures for Compressor and Turbine during Operation

Meanings of Cautionary Icons

 : Indicates items that should be carefully observed to prevent problems.

 : Indicates that the turbocharger should not be touched due to high temperature.

Section 1 MET Turbocharger Basics

1. Introduction
2. Turbocharger Structure
3. Proper Handling

1. Introduction

Because the turbocharger runs automatically as a result of the energy contained in exhaust gas from the engine, it does not usually require any special manipulation when the engine is operating normally. However, the turbocharger plays an essential role in supplying combustion air to the engine, and it is therefore important to maintain its performance in order to ensure the performance and reliability of the engine itself.

A turbocharger is a turbomachine with a high speed rotor. Consequently, because of the immense rotational energy of the rotor during operation, improper handling can result in substantial damage to the equipment, as well as the possibility of human injury.

This manual is intended to provide users with an understanding of the structure of the Mitsubishi MET turbocharger, appropriate maintenance procedures, and proper response in the rare event of malfunctioning. Accordingly, this manual should always be placed in a location where it can be easily accessed from the vicinity of the turbocharger. Also, all personnel concerned with the engine to which the turbocharger is attached should carefully read this manual and understand its content. If the content requires further clarification, please direct inquiries as follows, quoting the serial number of the turbocharger in question.

Technical Support:

Turbocharger Designing Section

Marine Machinery Design Department

Nagasaki Shipyards, Mitsubishi Heavy Industries, Ltd.

Tel: +81-(0)95-821-2145

Fax: +81-(0)95-821-2279

E-mail : ATTR999@mhi.co.jp

2. Turbocharger Structure

2.1 Exhaust gas energy and air compression

A turbocharger is a device that utilizes the energy contained in exhaust gas from the engine in order to produce compressed air, which it returns to the engine for use in the combustion of fuel. Thus, a turbocharger consists of a turbine for the conversion of exhaust gas energy into motive force, together with an air compressor driven by this force.

Exhaust gas released from the engine is channeled to the turbocharger inlet casing (26, 27), and after being expanded and accelerated by means of a nozzle ring (22), it comes into contact with the turbine blades (61). This serves to efficiently convert the energy into rotational motive force.

A turbine blade wheel and compressor impeller are positioned at either end of the rotor, and the motive force of the turbine directly drives the compressor impeller. As the compressor impeller rotates, external air is channeled through the silencer (50) to the impeller (66), and is accelerated to obtain high velocity and pressure. The high level of energy contained in the air exiting the impeller is recovered in the form of pressure as it passes through the diffuser (45). Then, after passing through the scroll (40, 44), air having the required pressure and flow volume is sent to the engine.

The ratio consisting of a) the energy obtained by pressurization of the surrounding air, divided by b) the energy lost as the exhaust gas passes through the turbocharger turbine, is known as the turbocharger efficiency, and this is a basic measure of turbocharger performance. Fouling and wear affecting the turbine and compressor are causes of reduced efficiency, and these factors can result in failure to deliver air having the requisite pressure and flow volume to the engine. It is therefore important to perform periodic maintenance of the turbocharger in order to maintain its performance.

2.2 Bearings and lubrication

In operation, the rotor rotates at very high speeds, and the bearings that support it are specially designed to prevent the occurrence of harmful vibration. In particular, vibration is inhibited by the distinct internal shape journal bearings (70, 75) that support the mass of the rotor, as well as by the lubricant layer formed between the journal bearing periphery and the housing.

The pressure of the exhaust gas and air that act on the turbine blades and compressor impeller produce force on the rotor in the axial direction (thrust), which is countered by the thrust bearings (71, 73). Because this thrust acts on the compressor side during normal operation, the thrust bearing on the compressor side is larger than that on the turbine side.

The lubricant is externally supplied to the turbocharger at a specified pressure and temperature. Engines are normally equipped with instrumentation for the monitoring of turbocharger lubricant pressure and temperature, as well as apparatus for the protection of the turbocharger in the event of abnormalities. For more detailed information, please refer to the engine manual.

The lubricant head tank is integrated with the upper part of the turbocharger bearing pedestal (30). This allows lubrication to continue for about 20 minutes in the event that the lubricant supply is cut off for some reason and/or the engine stops. This lubrication is sufficient to prevent damage of the bearings in the time it takes for the rotor to come to a complete stop.

2.3 Lubricant and exhaust gas seals

Oil labyrinths (35,37) are used to seal the lubricating oil so as to prevent leakage from the turbocharger, while a gas labyrinth (24) is used to seal the exhaust gas within the turbine discs. Sealing air is also channeled from the scroll to prevent oil and gas leakage from inside the turbine discs.

During periods of low load on the engine, the scroll can be subject to negative pressure due to the suction of air from the engine side. This creates negative pressure in the air channels for the sealing air noted above, and a vacuum breaker is therefore installed along the sealing air channel in order to prevent oil from being sucked out.

3. Proper Handling

3.1 Turbocharger modification and changes to specifications

The turbocharger to which this manual refers has been set so as to deliver optimal performance in conjunction with the engine to which it is attached. Accordingly, any modification or changes to specifications may negatively affect the performance of not only the turbocharger, but also the performance and reliability of the engine itself. For this reason, we strongly advise against such action without the approval of MHI. If and when screws from the turbocharger main unit are used to fasten other components, or when other components are welded to the turbocharger main unit, please be sure to consult with MHI first.

No parts or components other than genuine parts supplied by MHI should ever be used with the turbocharger.

3.2 Disassembly and re-assembly

No special training is required for persons who have experience with the disassembly of general large-scale equipment. For such persons, careful reading of this manual should be sufficient to enable disassembly and re-assembly of the turbocharger. However, the disassembly and re-assembly processes require hazardous operations such as the suspension of heavy objects. Operators should have the skills and knowledge required to perform these operations safely, and operations must be conducted under appropriate safety supervision. MHI assumes no responsibility for injuries and/or damage to the turbocharger and peripheral equipment in the event of accidents occurring during turbocharger disassembly and re-assembly.

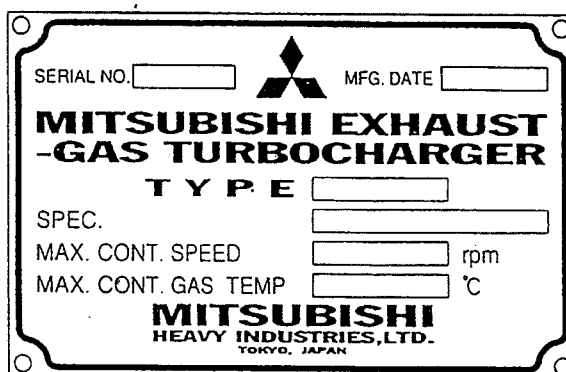


3.3 Allowable turbocharger temperature and speed

The allowable turbocharger temperature and speed (rpm) are stated on the main nameplate (see Fig. 1-1). These values are not exceeded during normal operation. However, particular care is required under the following circumstances, as the allowable values may be exceeded, possibly resulting in serious damage or accidents.



1. Occurrence of turbocharger surging (phenomenon in which reverse flow of air from the compressor is accompanied by intermittent loud noise)
2. Leakage of air and/or exhaust gas
3. Excessive exhaust gas energy due to irregular combustion in the engine (e.g. fire in scavenge air- or exhaust gas receiver)



1-1-1-0-0-00-0

Fig. 1-1 Turbocharger main nameplate

3.4 Service and repairs

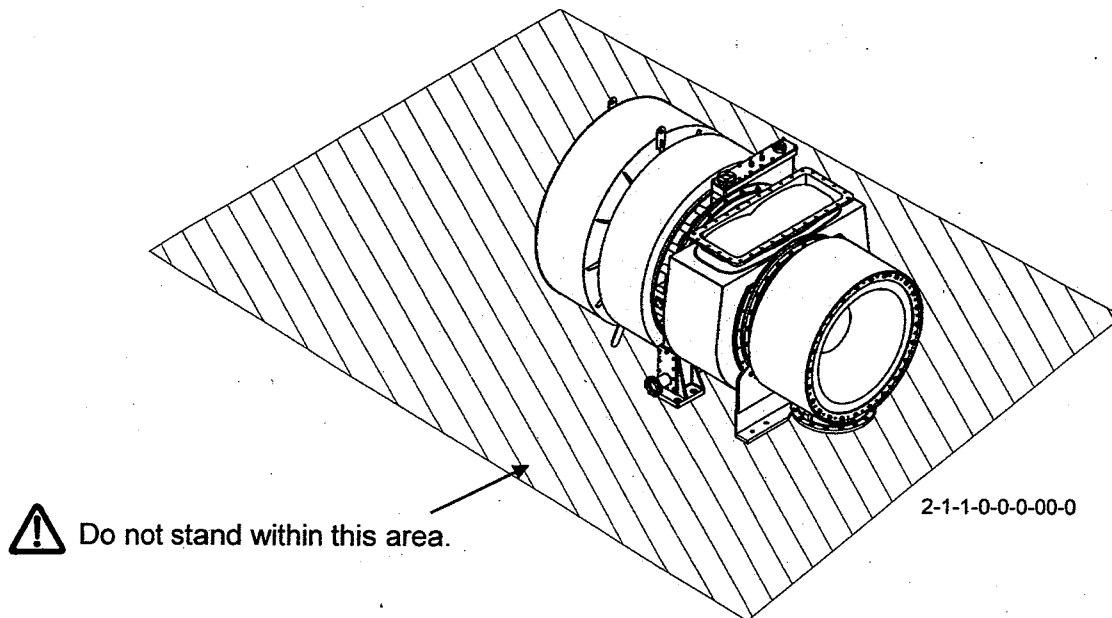
As noted in the Attachments (Section 6, Subsection 7), MHI-authorized turbocharger service companies are located throughout the world. These organizations include engineers who possess the skills and knowledge required for the maintenance of the turbocharger described in this manual. If disassembly and re-assembly should pose any difficulties, these service companies can also be called upon.

Section 2 Operation

1. Safety During Operation
2. Inspection Before and After Startup

1. Safety During Operation

The rotational speed of the compressor impeller and turbine wheel of the turbocharger exceed the speed of sound, and the associated energy is very high. Accordingly, standing in the area indicated below should be avoided unless there is a specific reason to do so. When approaching the turbocharger to perform measurements, inspection, etc., these actions should be completed in the minimum possible time.



Also, the silencer air inlet port sucks in large amounts of air and, in the event of sudden surging, there is a possibility of the reverse flow of high-pressure air from the silencer. In such cases, proximity to the silencer could result in the loss of balance and major injury; particular caution is thus required. When approaching the turbocharger, care should be taken that pens and other small objects about one's person are not sucked in. Such objects should either not be carried, or else affixed firmly using a string or cord so as to prevent ingestion into the turbocharger.

The noise level in the vicinity of the turbocharger is high, and earplugs or other appropriate protective gear should be used when approaching.



The turbocharger scroll and the turbine side casing are hot, and should never be touched without protection.

The turbocharger parts remain hot in a period after the engine has been stopped; hence care should also be taken here.



It is possible for various reasons that exhaust gas could leak from the exhaust gas piping connected to the turbocharger, or from the turbocharger main unit. In such cases, there is a risk that the turbocharger would suck in exhaust gas through the silencer, with the result that insufficient air would be supplied to the engine, and that the temperature of the compressor impeller would rise, thus leading to damage of compressor wheel material and ultimately breakage of the compressor wheel and other parts of turbocharger. Also, the breathing of exhaust fumes for a prolonged period may cause health problems.

Accordingly, if the smell of exhaust gas is noticed in the vicinity of the turbocharger, the origin of the leak should be confirmed and the engine stopped as soon as possible to enable the appropriate response.



In the event of lubricating oil leakage from the lubricant tubing connected to the turbocharger, particularly in the high-pressure inlet tubing, there is a risk of ignition and fire due to the discharge of lubricant. If such leakage occurs, the engine should be stopped immediately and corrective actions taken to eliminate the leakage.

2. Inspection Before and After Startup



2.1 Before startup

Be sure to complete the following inspection and other listed steps.

	Inspection item	Inspection content	Notes
1	Lubricant inlet oil pressure	Oil pressure showing on the engine side gauge within the specified value?	See Table 2-2
2	Lubricant inlet oil temperature	Oil temperature showing on the engine side gauge within the specified value?	See Table 2-2
3	Air filter	Any damage to air filter or obvious blockage?	See Page 5-11
4	Turbocharger underside	Any Oil leakage?	See Page 6-2
5	Lubricant inlet and outlet tubing	Any Oil leakage?	See Page 6-2
6	Heat-resistant lagging	Any peeling or other damage?	
7	Lubricant filter	Any abnormal rise in differential pressure?	



2.2 After startup

	Inspection item	Inspection content	Notes
1	Lubricant inlet oil pressure	Oil pressure showing on the engine side gauge within the specified value?	See Table 2-2
2	Lubricant inlet oil temperature	Oil temperature showing on the engine side gauge within the specified value?	See Table 2-2
3	Exhaust gas, air piping	Any exhaust gas or air leakage?	
4	Turbocharger underside	Any Oil leakage?	See Page 6-2
5	Turbocharger main unit	Any abnormal vibration or noise?	
6	Exhaust gas temperature	Any significant difference compared to past measurement values, at similar engine load ?	
7	Scavenging air pressure	Any significant difference compared to past measurement values, at similar engine load ?	
8	Turbocharger rpm	Any significant difference compared to past measurement values, at similar engine load ?	
9	Bearing pedestal side surfaces	Is air blowing normally? Does blown air contain oil mist?	

Section 2 Operation

Table 2-2 Utilization standards for lubricating oil

	Min.	Standard	Max.
Lubricant inlet oil pressure MPa (At turbocharger center height) kg/cm ² bar	0.06 0.6 0.6	0.06~0.15 0.6~1.5 0.6~1.45	0.15 1.5 1.45
Lubricant inlet oil temperature, °C	25	35~50	55
Lubricant outlet oil temperature, °C	-	-	85
Oil supply time following engine stop, min.	30	-	-

2-2-1-0-0-0-00-0

Note: Please be sure to use lubricating oil having properties that satisfy the conditions shown in the following table (Table 2-3)

Table 2-3 Lubricating oil properties

Type			Spec. for new oils		Spec. for in-service oils	
			Engine oil	Turbine oil*	Engine oil	Turbine oil*
Viscosity grade			SAE#20,30,40	VG68,100	SAE#20,30,40	VG68,100
Kinematic viscosity ν	40°C	mm ² /s	—	61.2~110	0.85IV**< ν <1.3IV	0.95IV< ν <1.05IV
	100°C	mm ² /s	5.6~16.3	—	0.85IV< ν <1.3IV	0.95IV< ν <1.05IV
Flash point	COC method	°C	> 190	> 190	> IV—15	> IV—15
Pour point	°C		< -10	< -10	< -10	< -10
Water content	wt%		< 0.01	< 0.01	< 0.2	< 0.1
Total base number (TBN)	mgKOH/g		—	—	> 0.25IV	—
Total acid number (TAN)	mgKOH/g		—	< 0.3	—	< IV+0.3
Pentane insoluble (B method)	wt%		< 0.01	—	< 0.1	—
RBOT life	min.		—	> 250	—	> 0.25IV
Sludge resistance	—		—	<100mg/kg@ 25%RBOT	—	—

* : Use the independent L.O. system (Used only for turbocharger(-s))

2-3-1-0-0-0-00-0

** : IV = Initial Value

Section 3 Maintenance

1. Monitoring of the Turbocharger Operating State
2. Turbocharger Overhaul Intervals
3. Compressor and Turbine Cleaning During Operation

1. Monitoring of the Turbocharger Operating State

Temperature, pressure, and turbocharger speed, etc. related to the turbocharger should be recorded at regular intervals in accordance with guidelines for such record-keeping established by the engine manufacturer or independently by the user. These records are important in ascertaining the normal operating state of the turbocharger. In particular, changes in scavenge air pressure, turbocharger speed, and exhaust gas temperature are reflective of changes in turbocharger performance, and should be periodically measured and recorded.

The temperature of the air sucked into the turbocharger silencer will have a significant impact on the above-noted measurement values. For accurate evaluation of turbocharger performance it is necessary to measure inlet temperature near the silencer, preferably at several points around the circumference.

The silencer is equipped with a manometer for measuring the pressure downstream from the air filter (see Fig. 3-1). This pressure serves as an indicator of the state of dirtiness of the air filter. Note that the air filter must be cleaned or replaced before this pressure exceeds 2.0 kPa (200 mmAq). Air filter blockage can cause insufficient air-supply to the engine, and can also be a cause of surging.

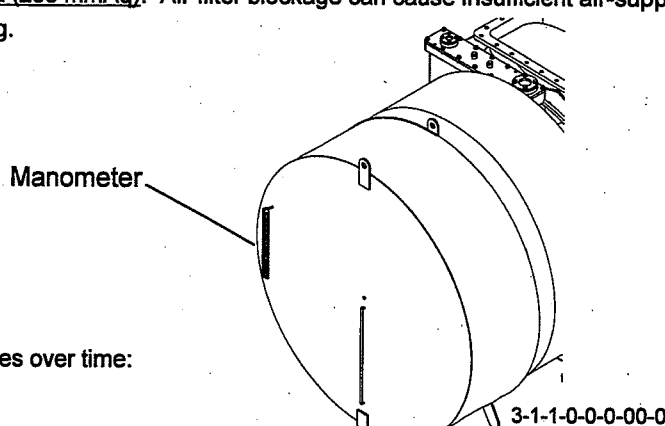


Fig. 3-1 Manometer location

2. Turbocharger Overhaul Intervals

Turbochargers are subject to the following changes over time:

Wear-down of the bearings

Fouling of the rotor, nozzle, etc.

Wear of the turbine blades, nozzle, gas labyrinth, oil labyrinths, and gas outlet guide.

Among these items, the progress of bearing wear is not apparent from factors such as engine performance, and there is no way to accurately confirm this other than inspection of the bearings. If bearing wear is allowed to reach the point of seizure, major damage will be caused to the turbocharger rotor and other components.

Because bearing wear occurs mainly due to the inclusion of contaminant in the lubricating oil, the influence of the lubricant supply system on bearing lifetime is substantial. The least amount of wear can be expected with an independent L.O. system dedicated solely to the turbocharger, or with a system that is shared only by equipment external to the engine such as reduction gear etc.. In addition, the use of a 30 micron continuous back-flushing type lubricant filter dedicated to the turbocharger is effective in prolonging the lifetime of the bearings.



It is also envisioned that foreign matter introduced during installation work on the turbocharger may not be fully removed by flushing. Accordingly, regardless of the lubricant supply system being used, the initial thrust bearing inspection should be performed within 5,000 hours. In the event that this inspection reveals wear or sliding damage to the thrust bearings, it will be necessary to inspect the journal bearings as well.

If the lubricant properties are kept in good condition and bearing wear is not allowed to progress, the risk of bearing failure is greatly reduced.

Normally, bearing wear will progress very slowly if an independent L.O. supply is used, such that bearing inspections conducted during turbocharger overhauls will be sufficient. However, when the overhaul interval is substantially extended, turbocharger performance will tend to gradually decline due to fouling of the internals and wear-down of the turbine blades and nozzle. This will necessarily have a negative impact on engine performance. It is therefore important from the standpoint of maintaining turbocharger performance to undertake regular inspection and cleaning of at least the turbine side. Mitsubishi MET model turbochargers are designed for easy inspection of the turbine side, simply by removing the gas inlet inside casing (see Fig. 3-2).

For recommended turbocharger overhaul intervals, please refer to Table 3-3.

Section 3 Maintenance

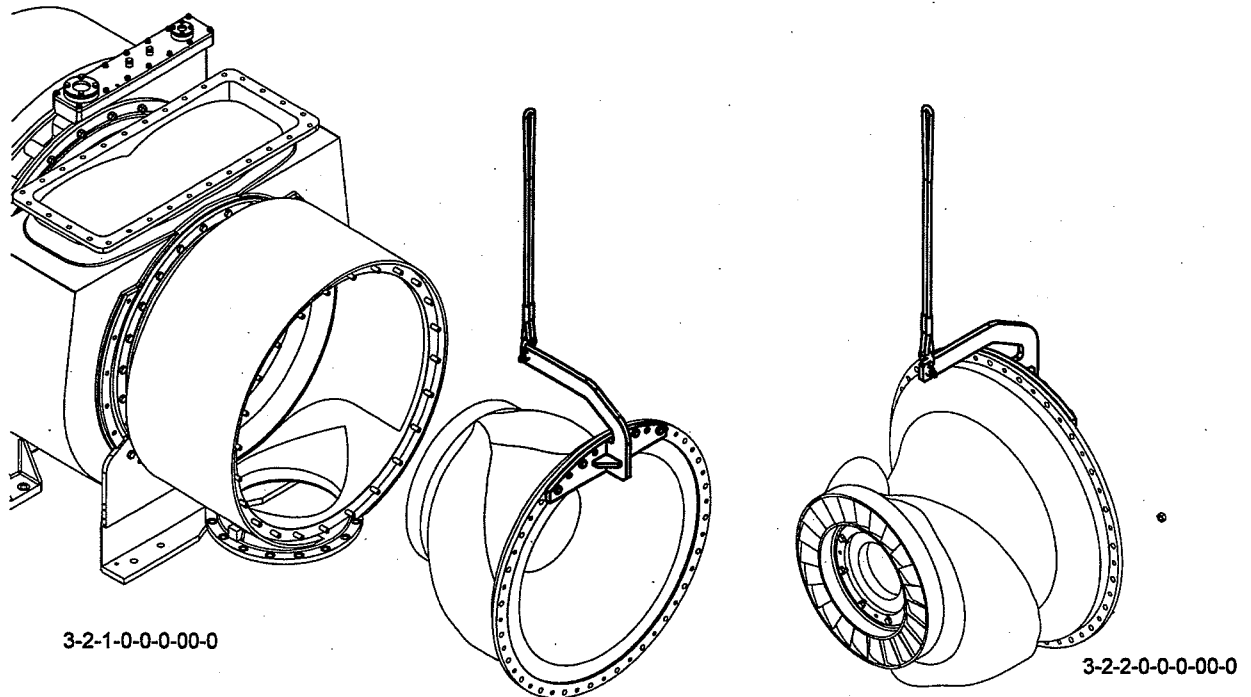


Fig. 3-2 Turbine blade and nozzle inspection/cleaning, facilitated by removal of the gas inlet inside casing

Table 3-3 Turbocharger overhaul intervals

		Initial check of bearings (Compressor side)	Turbine inspection, and manual cleaning	Overhaul
MET 90MA,SE 83MA,SEII,SE	Interval (Hours)	Approx. 8,000 Hrs after ship's delivery	Every 15,000 – 25,000	Every 30,000 – 35,000
MET 71MA,SEII,SE 66MA,SEII,SE 60MA	Interval (Hours)	Approx. 8,000 Hrs after ship's delivery	Every 12,000 – 15,000	Every 25,000 – 30,000
MET 53MA,SEII,SE	Interval (Hours)	Approx. 7,000 Hrs after ship's delivery	Every 10,000 – 13,000	Every 22,000 – 27,000
MET 42MA,SEII,SE 33MA,SEII,SE	Interval (Hours)	Approx. 6,000 Hrs after ship's delivery	Every 10,000 – 13,000	Every 20,000 – 25,000

3-3-1-0-0-0-00-2

NOTICE

- Overhaul includes cleaning and inspection for turbine side and bearing inspection.
- Turbine inspection and cleaning can be performed by removal of gas inlet inner casing only (except MET42 and MET33)
- Initial thrust bearing inspection is recommended to ensure no damage by remained particles in the oil pipe during assembling work.
- Required time for bearing inspection and overhaul is valid for turbocharger with standard silencer. If the turbocharger has air intake housing, it may take longer.

3. Compressor and Turbine Cleaning During Operation

MET turbochargers can be equipped with a compressor side water washing device, and/or a turbine side dry cleaning device. For cleaning procedures, please refer to Section 7.

Compressor side water washing should always be performed within the designated turbocharger speed range. This speed is lower than for normal operation, and it is necessary during washing to reduce engine load. It is desirable to do this when coming into or leaving port. Compressor side water washing conducted at high speeds will result in excessive stress on the compressor impeller blades, and can cause serious damage to the blades.



Section 4 Disassembly and Re-assembly

1. Disassembly

2. Re-assembly

Section 4 Disassembly and Re-assembly

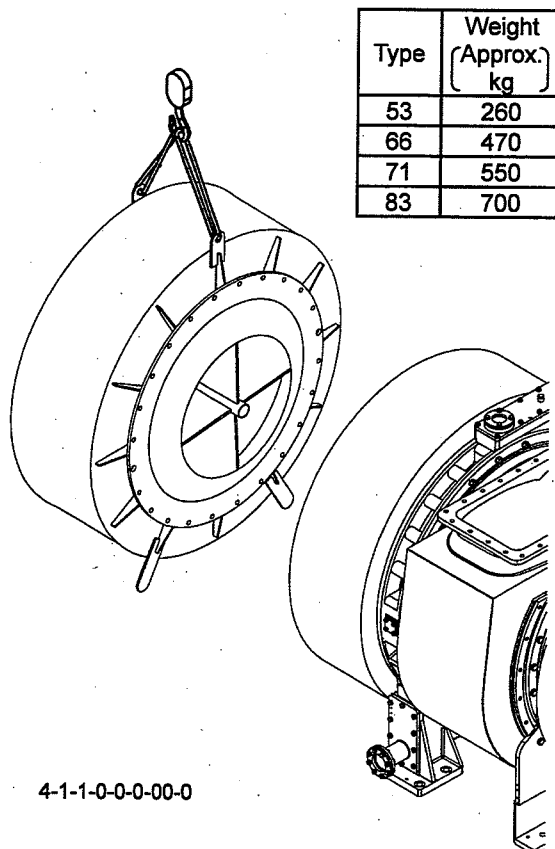


Fig. 4-1 Procedure for removing the silencer

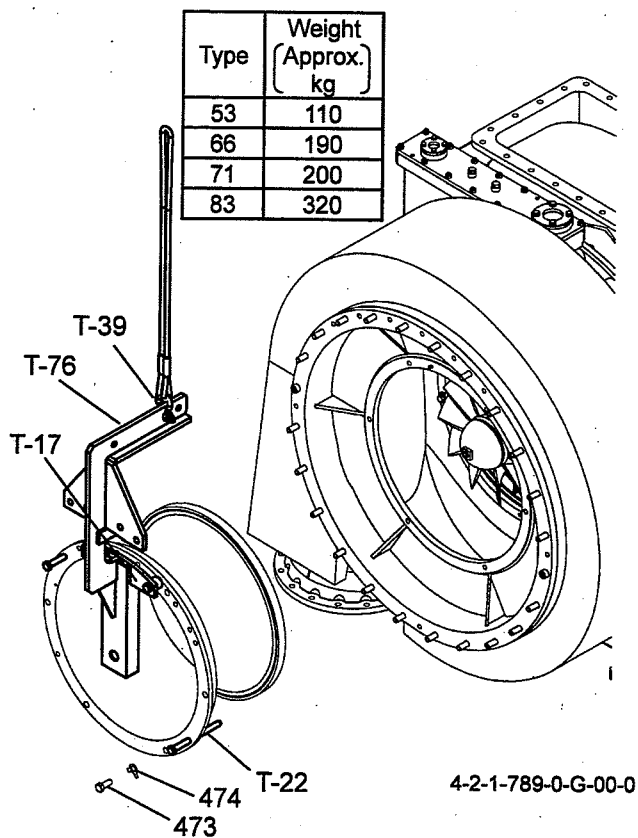


Fig. 4-2 Procedure for removing the air inlet guide

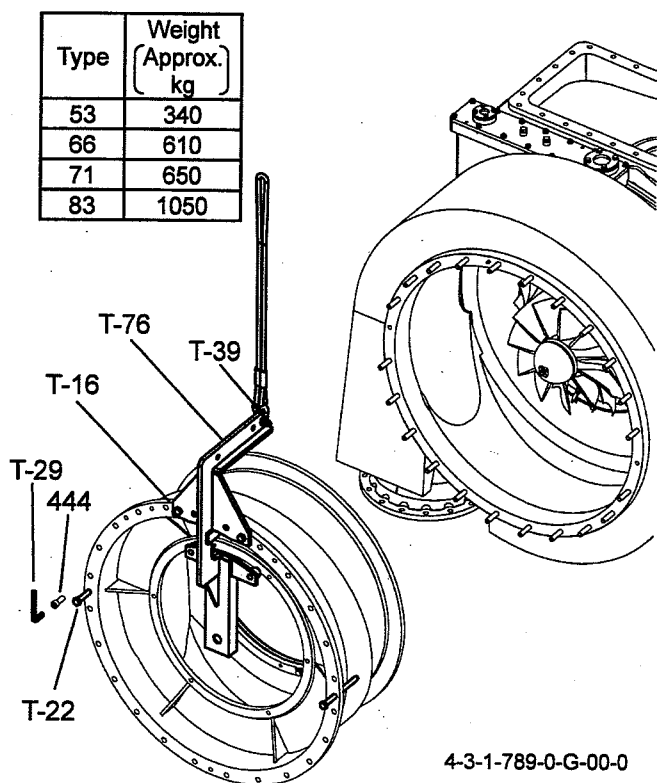
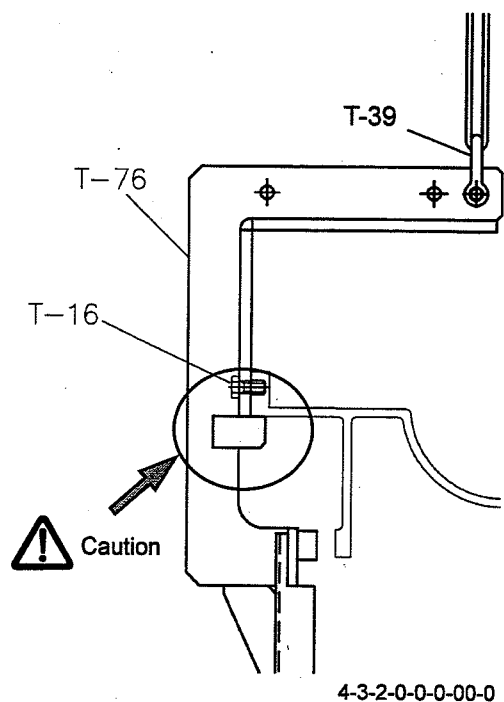


Fig. 4-3 Procedure for removing the scroll



1. Disassembly

1.1 Removing the silencer

First, remove the tachometer cable from the terminal box. Then, after disconnecting the cable attached to the engine side, remove the silencer in accordance with Fig. 4-1. Fasten the disconnected cable with tape or other means to prevent it from getting in the way during the work. Secure the removed silencer in a safe location, using rope or other means to prevent it from falling over or rolling.

1.2 Removing the air inlet guide

Before removing the air inlet guide 47, be sure to measure the clearance (A) between the air inlet guide and the impeller.

Attach slinging device T-76 to the flange on the air guide casing using bolts T-17 (see Fig. 4-2). Then remove the pipe to which the tachometer cable is affixed, the bracket, etc.

While slowly turning lifting screw T-22 to screw it into the threaded hole in the flange of the air inlet guide, pull off the air inlet guide.

Exercise caution so that the air guide casing does not come into contact with the impeller blades.

1.3 Removing the scroll

Attach slinging device T-76 to the flange on scroll 44 using bolt T-16. Be sure to confirm that the slinging device and the scroll are tightly attached together (see Fig. 4-3).

Remove hex bolt 444 using hexagon headed spanner (hex key, Allen wrench) T-29. Then screw the two lifting screws T-22 into the threaded holes on the left and right of the flange. Be sure that the screw depth of the bolts on the left and right is the same.

Do NOT use a compressed air driven wrench or other power tool to screw in the lifting screws.



Attach shackle T-39 to the arm of slinging device T-76, and lift slowly using a wire rope suspended from a chain block. The chain block should be suspended from a strong beam, etc. capable of supporting a load of at least the weight of inner scroll 44, as indicated in the table on the drawing. The wire ropes must also be of sufficient strength to support this load.

Screw in lifting screws T-22 further, and pull out scroll 44. Secure the scroll in a suitable location using rope, etc. so that it does not roll. Diffuser 45 is attached to the scroll. When moving and/or temporarily storing the scroll, exercise caution so as not to damage diffuser 45.



Upon removal of the scroll, the air outlet leading to the engine side will be uncovered. Be sure not to drop any objects or to step inside this opening. In the event that an object is dropped inside, refer to the engine manual in order to open the appropriate section of the engine for retrieval.

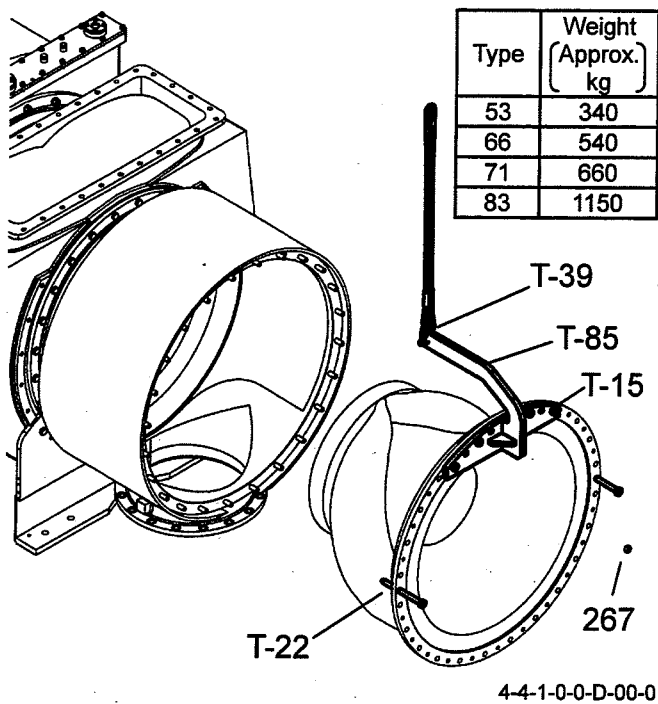


Fig. 4-4 Procedure for removing
the gas inlet inner casing

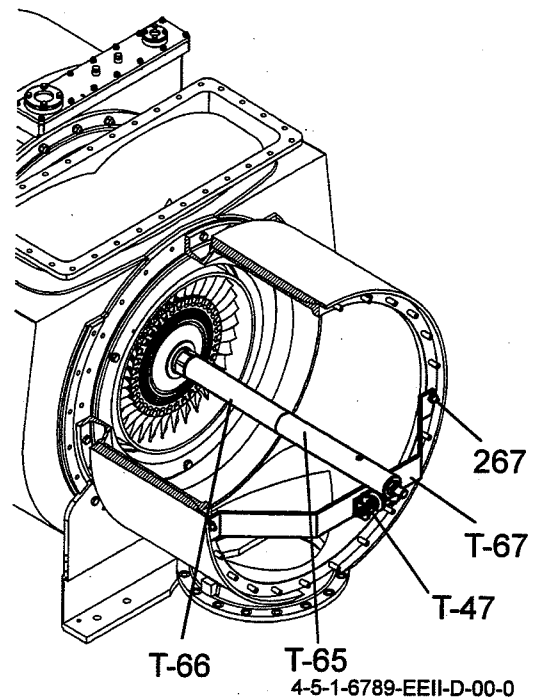
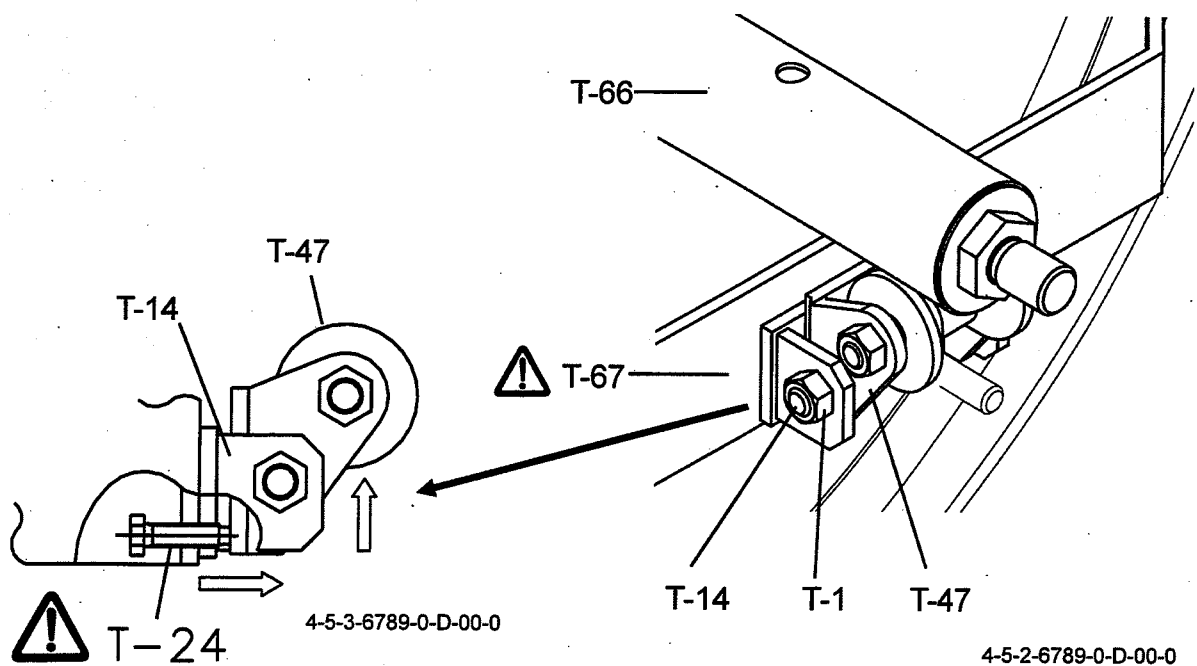


Fig. 4-5 Procedure for attaching the stay to
the gas inlet outer casing



Section 4 Disassembly and Re-assembly

1.4 Removing the gas inlet inner casing

When performing inspection and cleaning only with respect to the turbine blades and nozzle, please be sure to follow the instructions below.

First, remove the heat-resistant lagging from the mounting flange on the gas inner inside casing.



Be sure to remove all of the nuts 267 from the gas inlet inner casing and mounting flange. Next, screw the two lifting screws T-22 into the threaded holes on the left and right of the flange. Be sure that the screw depth of the bolts on the left and right is the same (see Fig. 4-4).

Do NOT use a compressed air driven wrench or other power tool to screw in the lifting screws.

When the gas inlet inner casing protrudes about 10mm, attach slinging device T-85 to the flange on the gas inlet inner casing using bolts T-15. Attach shackle T-39 to the arm of slinging device T-85, and lift slowly using a wire rope suspended from a chain block.



The chain block should be suspended from a strong beam, etc. capable of supporting a load of at least the weight of gas inlet inner casing, as indicated in the table on the drawing. The wire ropes must also be of sufficient strength to support this load.

Exercise caution when suspending the gas inlet inner casing so that it does not crack.

Screw in lifting screws T-22 further, and pull out the gas inlet inner casing. Secure the casing in a suitable location so that it does not roll. If removing the nozzle, it would be advisable to place it with the flange side down.

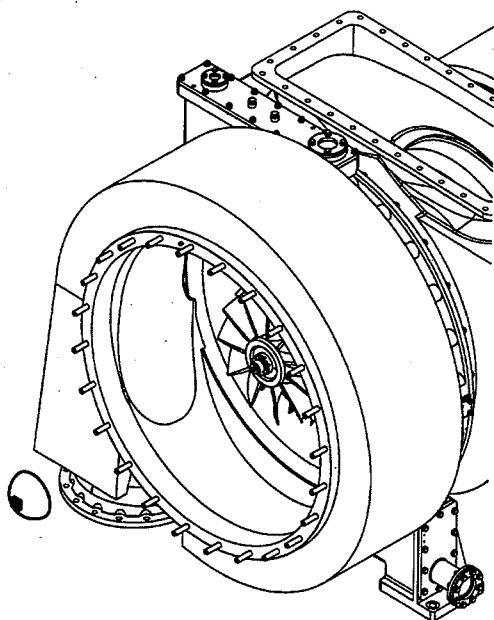
Measure the clearance (L) between the gas outlet guide and the tips of the turbine blades. Also measure thrust clearance (H). Please refer to Subsection 2-10 for measurement procedures.

Perform the installation illustrated in Fig. 4-5 with respect to the gas inlet outer casing, using stay T-67 and nut 267, and roller support T-47 and nut T1, bolts T14. Next, screw pulling out tube T-65, T-66 into the end of the rotor shaft.

Prior to this, remove any dirt or foreign matter from the threaded hole in the end of rotor shaft using compressed air, etc. Insert lifting screws T-22 into pulling out tube T-65, T-66, and fasten with nut 267. This serves to prevent the rotor shaft from slipping in turbine-side direction when loosening the impeller.

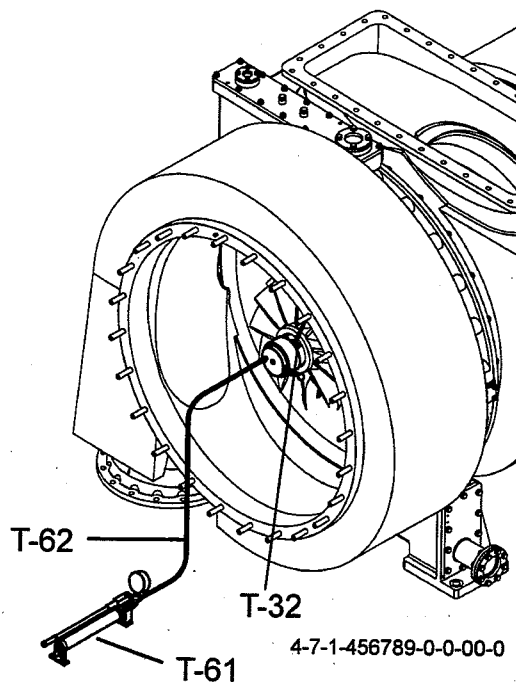


Section 4 Disassembly and Re-assembly



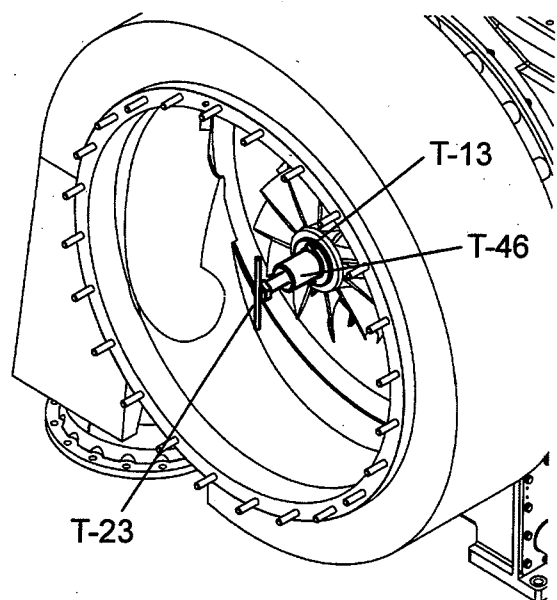
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Fig. 4-6 Procedure for removing the impeller end cap



4-7-1-456789-0-0-00-0

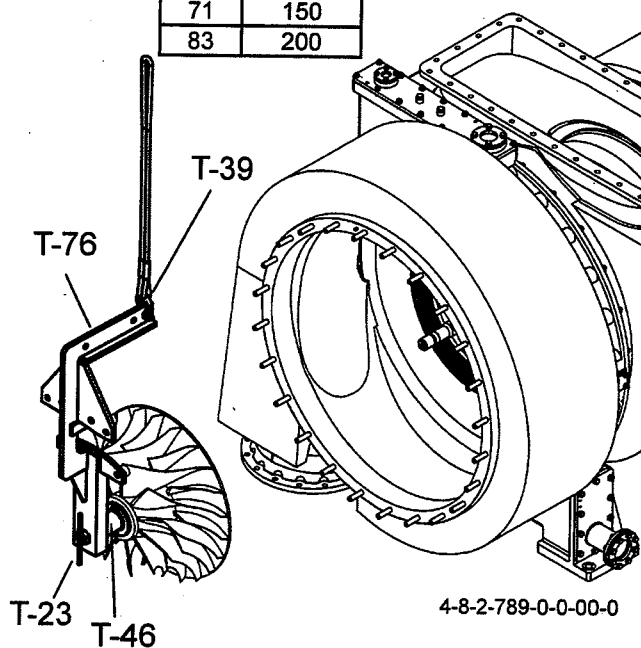
Fig. 4-7 Procedure for removing the impeller fastening nut



4-8-1-56789-0-0-00-0

Fig. 4-8 Procedure for removing the impeller

Type	Weight (Approx.) kg
53	70
66	110
71	150
83	200



4-8-2-789-0-0-00-0

Section 4 Disassembly and Re-assembly

1.5 Removing the impeller

Remove the impeller end cap and the fastening nut as illustrated in Fig. 4-6.

If a depth gauge is available, the measurement value obtained for distance S from the edge of the nut to end of the shaft, as well as that for the deflection of the rotor shaft end, will be useful as references during re-assembly.



Screw the hydraulic jack into the shaft end. In order to prevent the hydraulic jack from falling and damaging the impeller, support the weight of the jack with your hands until it is fully screwed in. After it has been screwed in, be sure to give the jack one reverse turn. Also, be sure to confirm that the ram of the jack has been retracted (see Fig. 4-7).

After placing the hydraulic pump on a flat surface, connect the hose to the jack and move the jack handle up and down by hand until the hydraulic pressure reaches the stipulated value. The hydraulic pressure can be confirmed using the pressure gauge attached to the pump. For the impeller tightening torque, please refer to Table 4-7.

Insert rod T-32 through the slot of the hydraulic jack into the hole in the periphery of the shaft nut, and loosen the nut by turning counter-clockwise several revolutions. Then, open the escape valve on the hydraulic pump to lower the pressure, and tighten the ram of the hydraulic jack by hand. After carefully removing the jack from the shaft, remove nut 67.

There are cases in which the nut may not loosen even when the hydraulic pressure of the jack reaches the designated level. In such cases, first lower the pump pressure, and then raise it again to 120% of the designated level and again attempt to loosen the nut. Also, in the event that the engine has just been stopped and the impeller temperature is still high, it will not be possible to loosen the nut at the designated pressure due to the effect of impeller heat expansion. In this case, cool the impeller by evenly applying compressed air.

Remove impeller fastening nut 67, and screw the protection bolt into the end of the rotor shaft. Attach impeller removal fittings T-46 and T-23 to the boss of the impeller 66 using bolt T-13. While holding the impeller 66 with one hand, slowly turn handle T-23 with the other hand, and pull out the impeller.

When the impeller has been pulled out to a certain extent using the handle, it can then be pulled out the rest of the way with your hands. After removing handle T-23, use tape to thinly cover the treaded part of the rotor shaft for protection. Now use handle T-23 to screw slinging device T-76 into impeller draw-out tube T-46. Attach shackle T-39 to the arm of slinging device T-76, and lift slowly using a wire rope suspended from a chain block. With the chain block supporting the weight, carefully remove the impeller, and store it horizontally in a safe location.

Table 4-7 Hydraulic pressure value

	SD	SE	SEII
MET33	33.3 [MPa] 340 [kg/cm ²]	59.8 [MPa] 610 [kg/cm ²]	—
MET42	34.3 [MPa] 350 [kg/cm ²]	39.2 [MPa] 400 [kg/cm ²]	—
MET53	58.8 [MPa] 600 [kg/cm ²]	62.8 [MPa] 640 [kg/cm ²]	50.0 [MPa] 510 [kg/cm ²]
MET66	58.8 [MPa] 600 [kg/cm ²]	63.7 [MPa] 650 [kg/cm ²]	51.0 [MPa] 520 [kg/cm ²]
MET71	—	53.9 [MPa] 550 [kg/cm ²]	57.8 [MPa] 590 [kg/cm ²]
MET83	68.6 [MPa] 700 [kg/cm ²]	65.7 [MPa] 670 [kg/cm ²]	62.9 [MPa] 640 [kg/cm ²]
MET90	—	68.6 [MPa] 700 [kg/cm ²]	—

4-7-2-0-0-00-0

1.6 Removing the support and thrust collar

The claw clutch of sleeve 64 will be visible upon removal of the impeller. Screw threaded bar T-21 into the threaded hole in the claw clutch, and pull out sleeve 64.

Remove restraining bolt 363 from support 361. Attach guide bar T-52, screw lifting screws T-22 into threaded holes in the flange on the support, and pull out the support. Attached to the support are compressor side oil labyrinth 37 and compressor side thrust bearings 73.

When storing the support, place the thrust bearing side up, and exercise sufficient caution so as not to damage the metal surfaces of the thrust bearings during storage.

Thrust collar 63 will be visible upon removal of the support; remove this thrust collar by hand. As the clearance between the thrust collar and the shaft is narrow, remove the collar slowly and carefully.

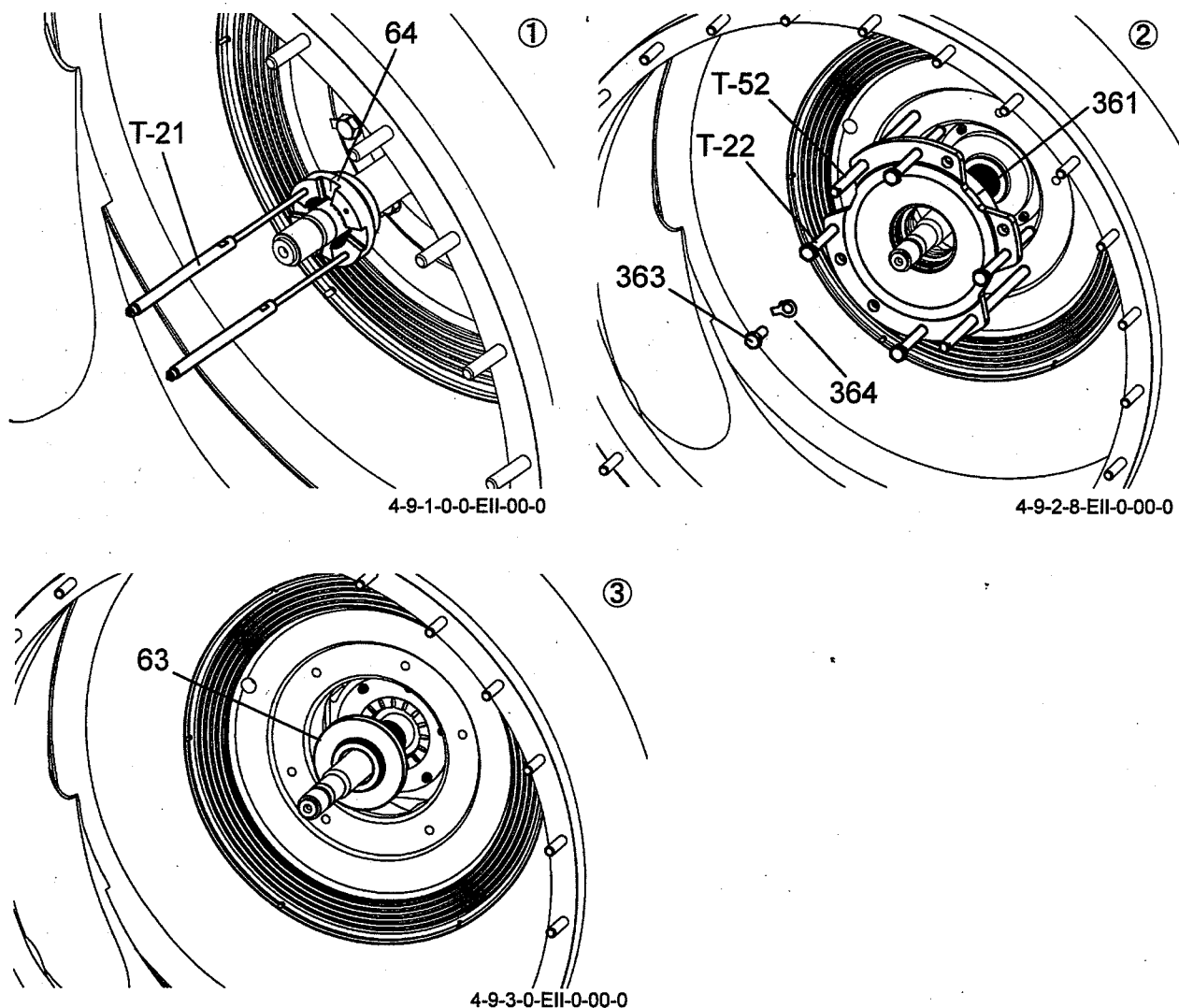


Fig. 4-9 Procedure for removing the sleeve, support, and thrust collar

Section 4 Disassembly and Re-assembly

1.7 Removing the rotor

Confirm that there are no burrs, defects, dirt, or foreign matter on support T-87 and protection tube T-63. If there are any burrs or damage, repair will be required. Attach support T-87 to the compressor side of the rotor shaft, and screw in protection tube T-63. T-35 is a handle for the purpose of screwing in T-63. Be sure to remove this afterwards.

Screw pulling out tube T-65, T-66 into rotor shaft from the turbine side, pull by hand, and pull out to stay T-67.

Place wire rope around large-diameter part of the disc side of the rotor shaft. Do not place it around the journal part of the shaft. Suspend the wire rope using a chain block, hoist, etc. Then, while stabilizing it using your hands, move it to a safe location for storage.

While storing the rotor shaft, remove pulling out tube T-65, T-66 and, so as to avoid contact between the turbine blades and the floor, set it on wooden blocks, etc.



When tilting the rotor shaft (as illustrated by [4] → [5]), attach a nut to the end of the rotor shaft and tilt it using a nylon sling, rope, etc. so that it does not slip. (Please do not use wire. Also, do not use an eyebolt on the end of the shaft.)

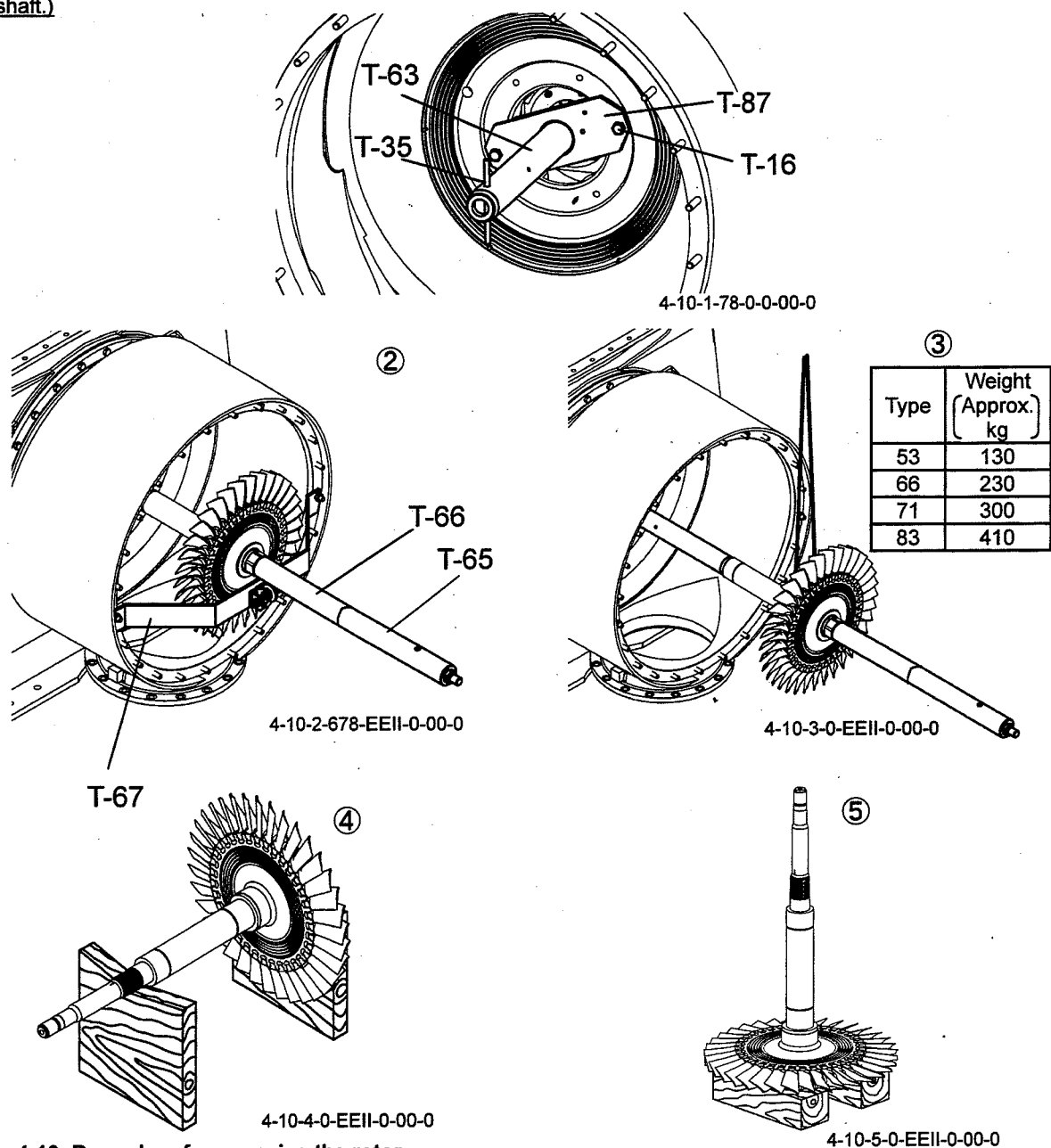


Fig. 4-10 Procedure for removing the rotor

Section 4 Disassembly and Re-assembly

1.8 Removing the bearings and labyrinths

(1) Turbine side journal bearings 75, gas labyrinth 24, and turbine side oil labyrinth 35

It is not normally necessary to remove gas labyrinth 24, but, in case removal is required, first remove the restraining bolts 241, and then screw the bolt into the threaded hole to slowly lift off and remove the labyrinth.

To remove the turbine side oil labyrinth, first remove restraining gas labyrinth 24, and then affix support T-87 to the oil labyrinth by means of bolt T-11. Using lifting screw T-25, lift off the oil labyrinth.

After removing the turbine side labyrinth, it will be possible to easily remove the turbine side journal bearings using threaded bar T-21.

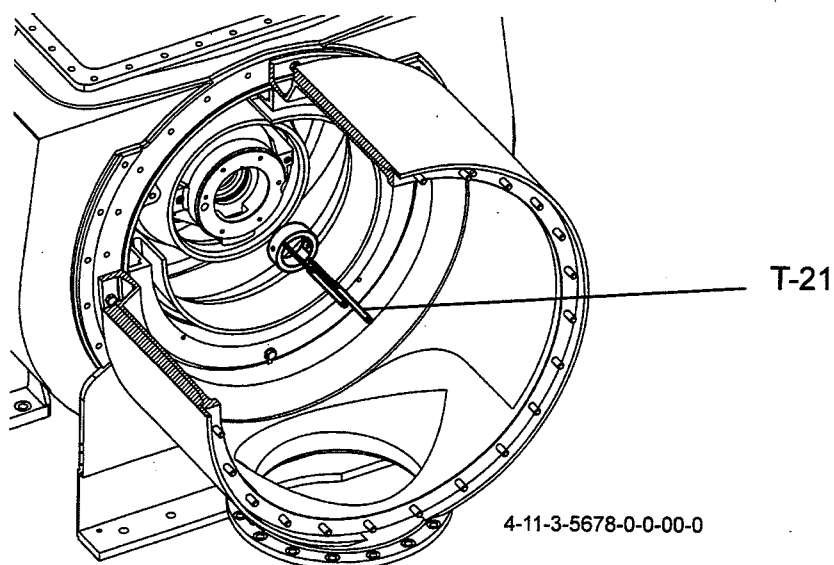
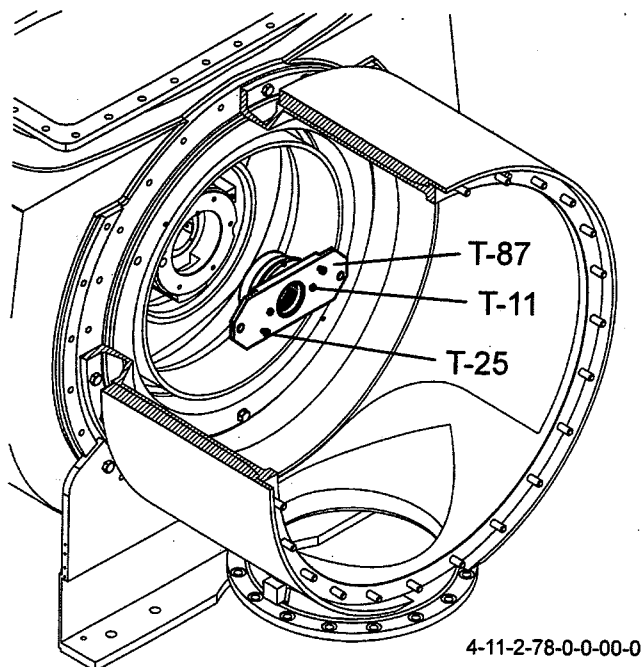
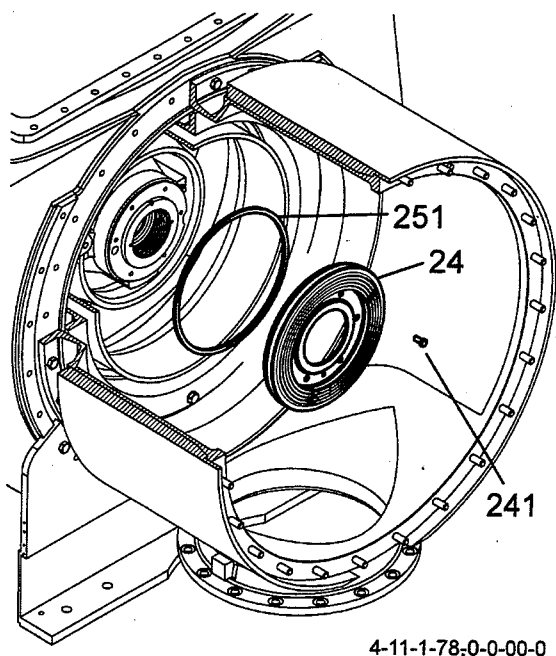


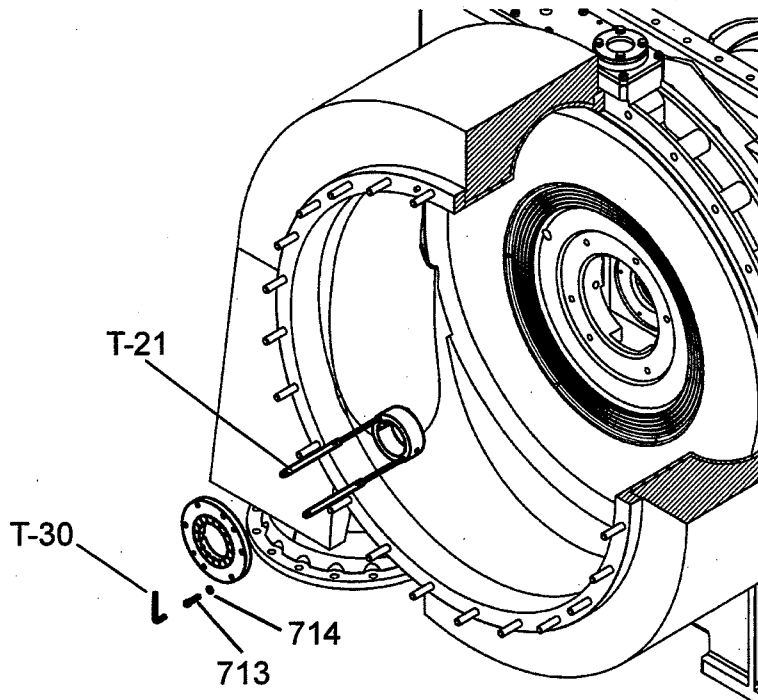
Fig. 4-11 Procedure for removing the turbine side journal bearings, oil labyrinth, and slinger

Section 4 Disassembly and Re-assembly

(2) Turbine side thrust bearings 71 and compressor side journal bearings 70

Use hexagonal headed spanner (hex key, Allen wrench) T-30 to remove hex bolt 713, and then remove the turbine side thrust bearings by hand.

The compressor journal bearings can be removed using threaded bar T-21



4-12-1-5678-0-0-00-0

Fig. 4-12 Procedure for removing the turbine side thrust bearings and the compressor side journal bearings

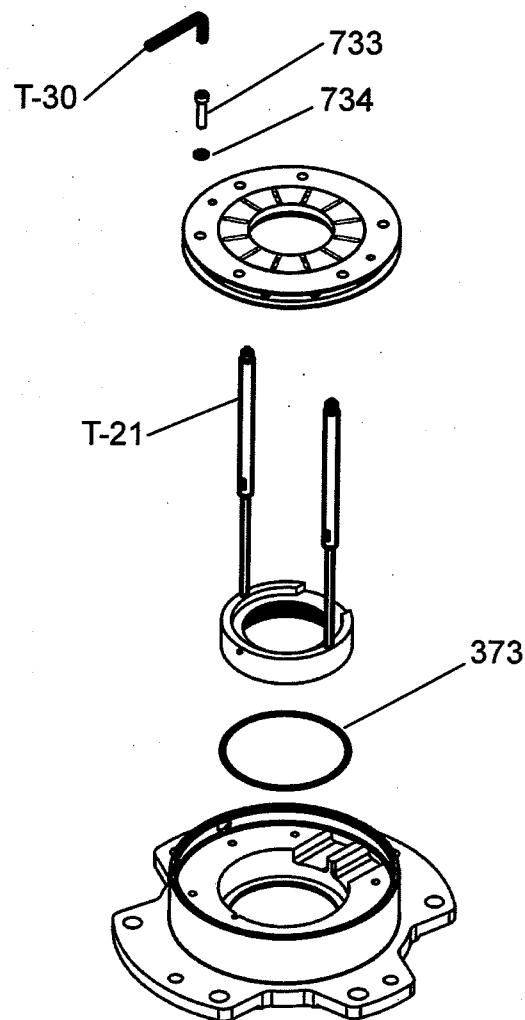
Section 4 Disassembly and Re-assembly

(3) Compressor side thrust bearings 73 and compressor side oil labyrinth 37

Use hexagonal headed spanner (hex key, Allen wrench) T-30 to remove hex bolt 733, and then screw the same bolt 733 into the threaded hole in the compressor side thrust bearings. Lift off the bearings.

In some cases, adjustment liner 771 will also be attached.

After removing the compressor side thrust bearings, use removal fitting T-21 to pull off the compressor side oil labyrinth.



4-13-1-8-EII-0-00-0

Fig. 4-13 Procedure for removing the compressor side thrust bearings and oil labyrinth

Section 4 Disassembly and Re-assembly

1.9 Removing the nozzle and gas outlet guide

Remove restraining bolts 225, and screw bolt 225 into the threaded hole for lifting located in the inner ring of the nozzle 22. If bolt 225 proves difficult to loosen, spray with commercially available penetrant, or gently heat the inner ring of the nozzle. The nozzle bolts are made of stainless steel. Please be sure to store them so that they can be distinguished from other similar items.

It is not normally necessary to remove gas outlet guide 23 for cleaning. However, in case of replacement due to wear, etc., remove restraining bolts 234, and lift off.

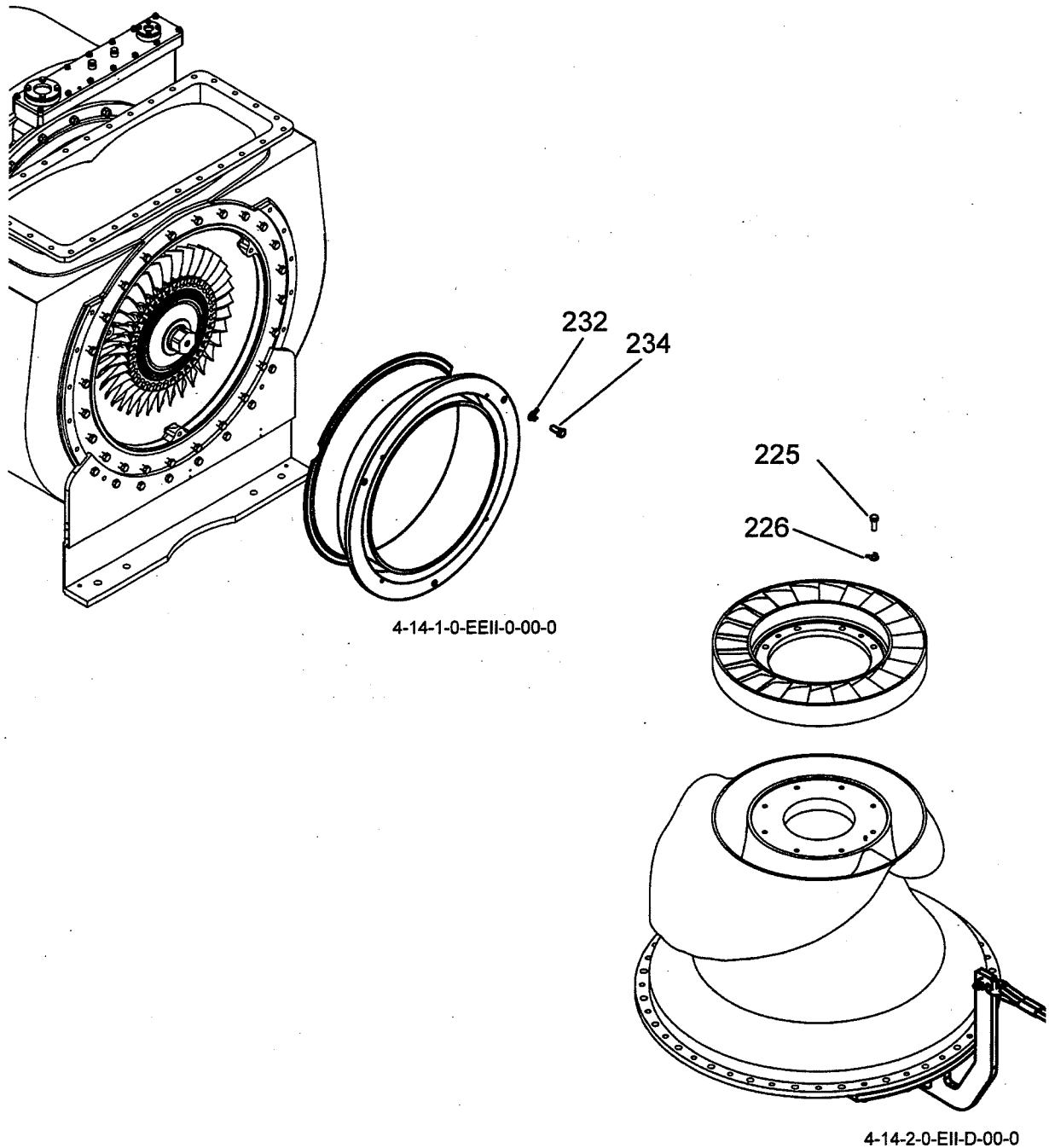
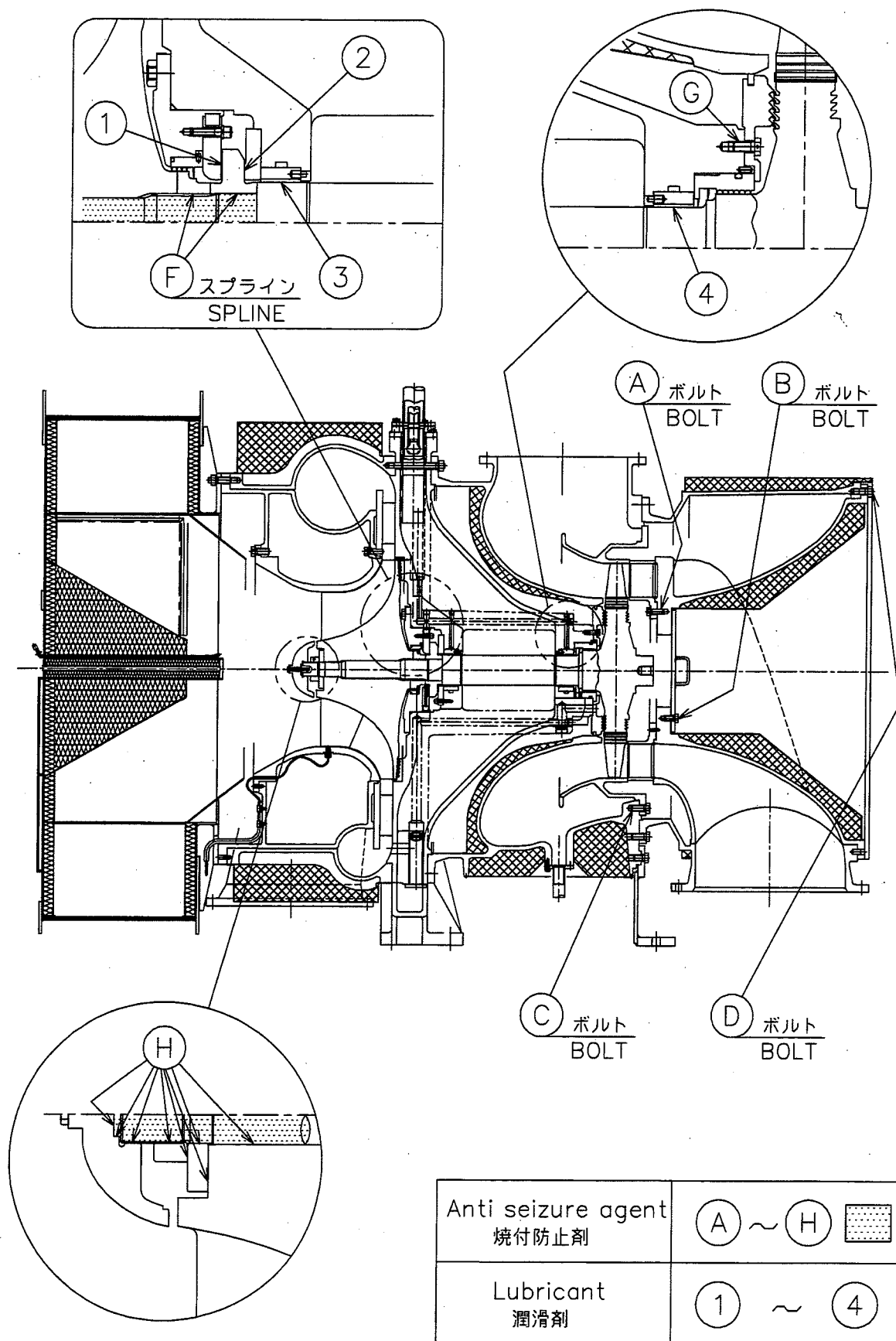


Fig. 4-14 Procedure for removing the nozzle and gas outlet guide

Section 4 Disassembly and Re-assembly



4-15-2-0-0-DG-00-0

Fig. 4-15 Locations for application of anti-seizure agent

2. Re-assembly

Refer to Section 3 for parts inspection procedures following disassembly.

The order of re-assembly is essentially the reverse of that for disassembly, but there are points deserving of caution. Mistakes in re-assembly, use of components other than genuine MHI parts, and use of worn parts can cause not only loss of turbocharger performance, but also accidents leading to human injury. As parts inspection procedures are listed in Section 3, please use this section as a reference in determining whether parts can be reused or not.

Before starting re-assembly work, please be sure to read this subsection carefully and understand its content. In case any point(s) is/are unclear, suspend work and contact MHI or an authorized service company for confirmation.

2.1 Replacement of worn parts

Replace all tongued washers, O-rings, gaskets, lock plates, and stainless steel wires with new ones. Do NOT reuse these parts.

2.2 Tightening the nozzle restraining bolt

Because nozzle restraining bolt 225 is easily subject to seizure, it should be coated with anti-seizure agent, and care should be exercised so as not to over-tighten it.

2.3 Coating with anti-seizure agent

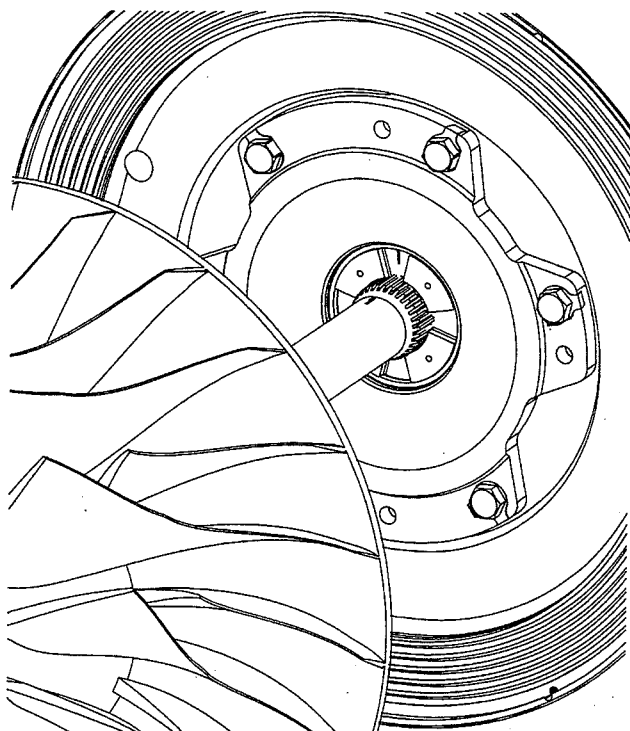


Coat the locations indicated in Fig. 4-15 with anti-seizure agent. The items specified in the following table are suitable.

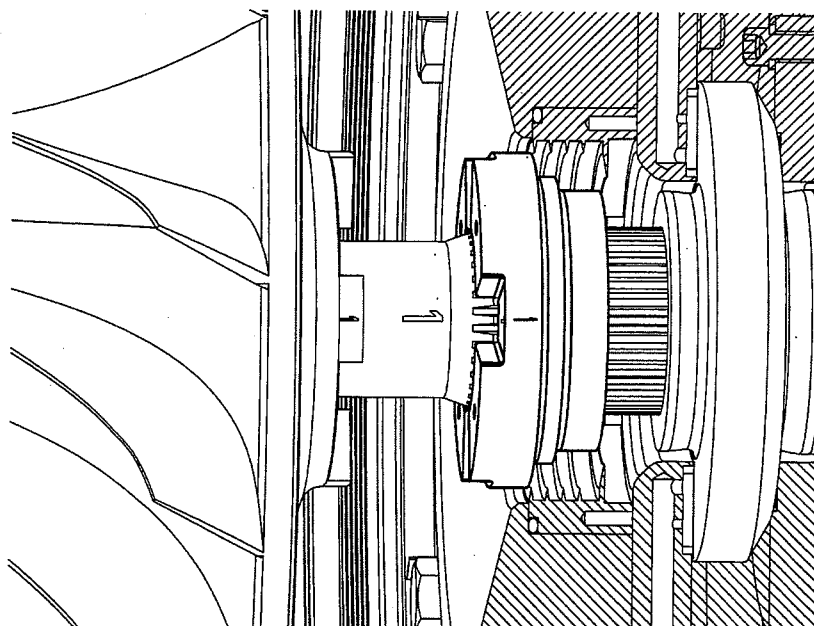
Anti-seizure agent	Coating location
MOLYKOTE 1102 GASCOCK GREASE	E,F,H
MOLYKOTE 1000 PASTE	A,B,C,D,G

4-15-1-0-0-0-00-0

Section 4 Disassembly and Re-assembly



4-16-1-0-EII-0-00-0



4-16-2-0-EII-0-00-0

Fig. 4-16 Procedure for confirming the engagement between the impeller and the claw clutch of the sleeve

Section 4 Disassembly and Re-assembly

2.4 Bearing re-assembly

Prior to inserting any of the bearings in the turbocharger, use compressed air, etc. after cleaning to completely remove all dirt and other foreign matter from the metal surfaces and lubricant grooves.



Before inserting any of the bearings, be sure to lightly coat them with lubricant.

When inserting bearings, use clean bare hands; do not use gloves, etc.

2.5 Inserting the rotor

After installing the compressor side journal bearings, turbine side thrust bearings, turbine side journal bearings, turbine side slinger, and turbine side oil labyrinth, insert the rotor shaft into the pedestal. At this time, make sure that the rotor shaft protection tube is still attached. Completely remove all dirt and other foreign matter from the rotor shaft protection tube and rotor shaft surface, and sufficiently coat the area over which the bearings will pass (from the protection tube periphery along the rotor shaft) with lubricating oil.



Completely remove all dirt and other foreign matter from the rotor shaft protection tube and rotor shaft surface, and sufficiently coat the area over which the bearings will pass (from the protection tube periphery along the rotor shaft) with lubricating oil.

Exercise sufficient care so as to avoid damage to the turbine side oil labyrinth fins when inserting the rotor.



Confirm that the rotor protection tube is free from all dirt and foreign matter. Any damage can cause damage to the journal bearings, rendering them unusable.

2.6 Inserting the support

After inserting the rotor shaft into the pedestal, remove the rotor shaft protection tube. Insert the rotor shaft through the thrust collar, and attach the support.

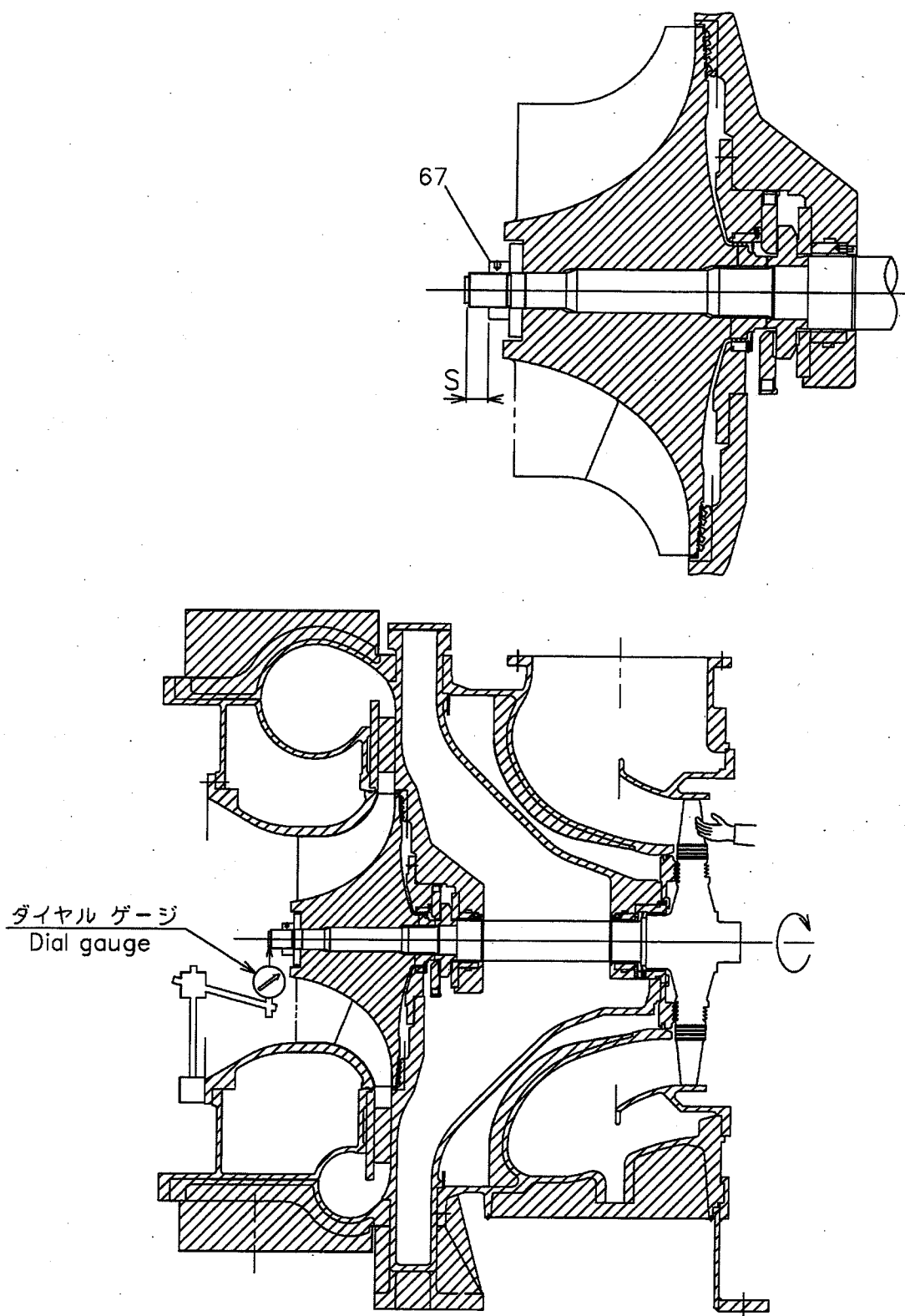
2.7 Installing the impeller

The impeller features a claw clutch on the back side that interfits with the sleeve, and precise engagement must be confirmed.



Match-up markings are engraved on the rotor shaft, sleeve, and impeller. Adjust the positions of the sleeve, rotor shaft, and impeller so that these match-up markings are in alignment.

In order to facilitate visible confirmation of the engagement between the sleeve and impeller, pull sleeve 64 forward before placing the impeller on the shaft, and push the impeller on while observing its back surface. This will enable precise engagement.



4-17-1-0-0-0-00-0

Fig. 4-17 Procedure for measuring rotor deflection

2.8 Fastening the impeller

If the impeller is insufficiently secured, the load on the claw clutch increases, which can cause damage to the impeller. Please be sure to fasten the impeller in accordance with this subsection.

When the engagement between the impeller and the sleeve has been confirmed, and the impeller has been pushed all the way in by hand, screw nut 67 onto the end of the shaft, also by hand.

Next, screw the hydraulic jack into the end of the shaft.

Here, confirm that the impeller is at room temperature. Tightening at a high temperature may result in loosening during operation



Raise the hydraulic pressure to the designated level, and turn nut 67 using bar T-32 until it stops. Then, after first reducing the hydraulic pressure, raise the pressure again to the designated level. Check whether the nut can be turned further. For the impeller tightening torque, please refer to below table.



Measure the distance between the edge of nut 67 and the end of the shaft, using slide (vernier) calipers or a depth gauge, and compare the value with that obtained before disassembly. If the difference is 0.1mm or greater, please consult with MHI.

2.9 Rotor shaft deflection

After fastening the impeller, turn the rotor shaft counter-clockwise by hand, and confirm that it rotates smoothly and without any contact noise.



Next, measure the deflection of the end of the rotor shaft using a dial gauge. Deflection of 0.10mm or more indicates the inclusion of foreign matter on the contact surfaces of the impeller, sleeve, thrust collar, and/or rotor shaft, causing inclination of the rotor shaft. Remove the impeller again, and confirm the above-noted contact surfaces. Re-measure the deflection of the end of the rotor shaft prior to fastening the impeller.

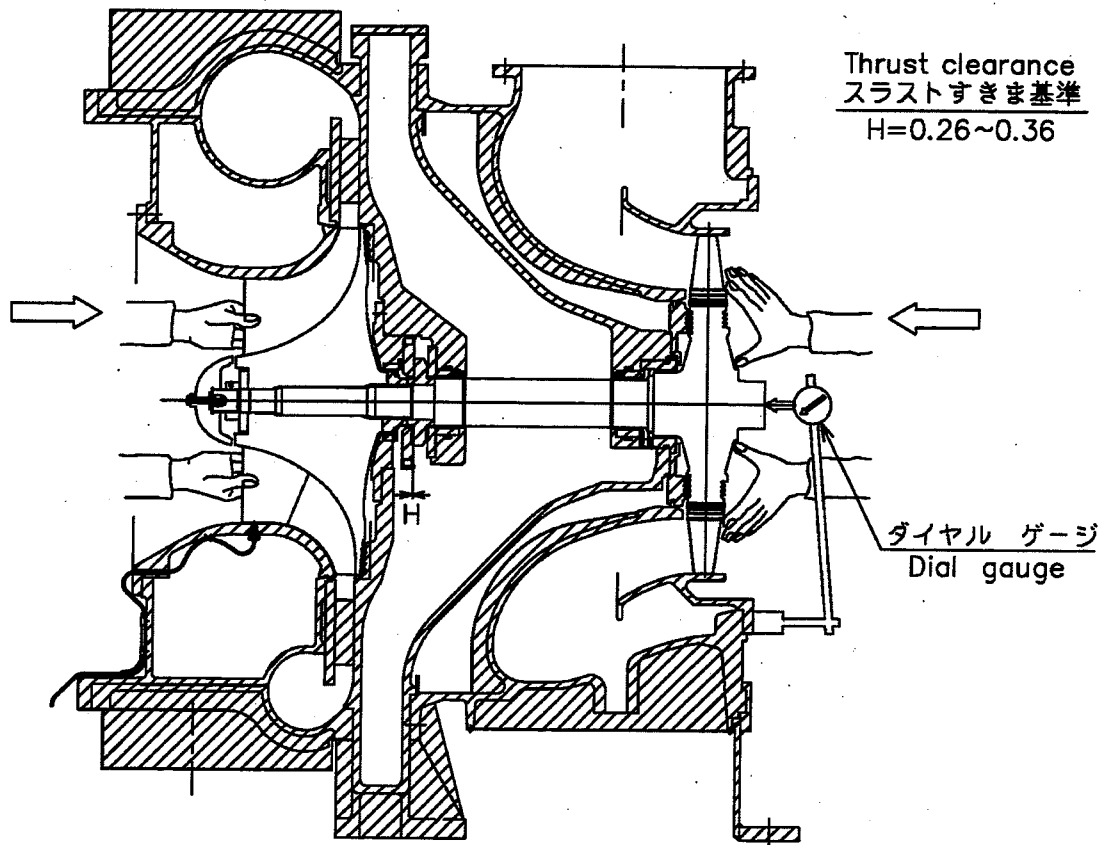
	SD	SE	SEII
MET33	33.3 [MPa] 340 [kg/cm ²]	59.8 [MPa] 610 [kg/cm ²]	—
MET42	34.3 [MPa] 350 [kg/cm ²]	39.2 [MPa] 400 [kg/cm ²]	—
MET53	58.8 [MPa] 600 [kg/cm ²]	62.8 [MPa] 640 [kg/cm ²]	50.0 [MPa] 510 [kg/cm ²]
MET66	58.8 [MPa] 600 [kg/cm ²]	63.7 [MPa] 650 [kg/cm ²]	51.0 [MPa] 520 [kg/cm ²]
MET71	—	53.9 [MPa] 550 [kg/cm ²]	57.8 [MPa] 590 [kg/cm ²]
MET83	68.6 [MPa] 700 [kg/cm ²]	65.7 [MPa] 670 [kg/cm ²]	62.9 [MPa] 640 [kg/cm ²]
MET90	—	68.6 [MPa] 700 [kg/cm ²]	—

4-17-2-0-0-0-00-0

2.10 Measuring the thrust clearance of the rotor



After confirming the shaft deflection, apply the dial gauge in the axial direction and measure the axial movement of the rotor when pushed by hand (i.e., the thrust clearance). Confirm that the clearance is the same as before disassembly. The thrust clearance should normally be in the range of 0.26~0.36mm. In the event that the value is outside this range, remove the impeller, and confirm that there is no foreign matter on the contact surfaces of the impeller, sleeve, thrust collar, and/or rotor shaft. Please consult with MHI in cases where the thrust clearance value cannot be obtained in the designated range.



4-18-1-0-0-G-00-0

Fig. 4-18 Procedure for measuring the thrust clearance

Measuring the respective clearances



After installing the air guide casing, measure the impeller blade tip clearance A and the turbine blade tip clearance L. Refer to the clearance table in Section 6 for acceptable values.

Section 5 Parts Inspection and Cleaning

1. Bearings
2. Rotor Shaft
3. Compressor Impeller
4. Pedestal-related
5. Turbine Blades
6. Nozzle
7. Air Filter

1. Bearings

Bearing wear proceeds as the bearing metal is abraded by foreign matter in the lubricating oil. Hardly any bearing wear occurs when the lubricant layer is extremely thick compared to the size of the foreign particles, but wear proceeds quickly when the particle size is about the same as the lubricant film.

In cases where system oil from the engine is used as the lubricant for the turbocharger, a suitable lubricant filter is installed on the engine side to remove damaging particles. However, smaller particles cannot be completely removed, and these induce bearing wear.

Accordingly, maintaining the engine lubricating oil in good condition is important from the standpoint of the turbocharger bearings. For more detailed information, please refer to the engine manual.

1.1 Thrust bearings

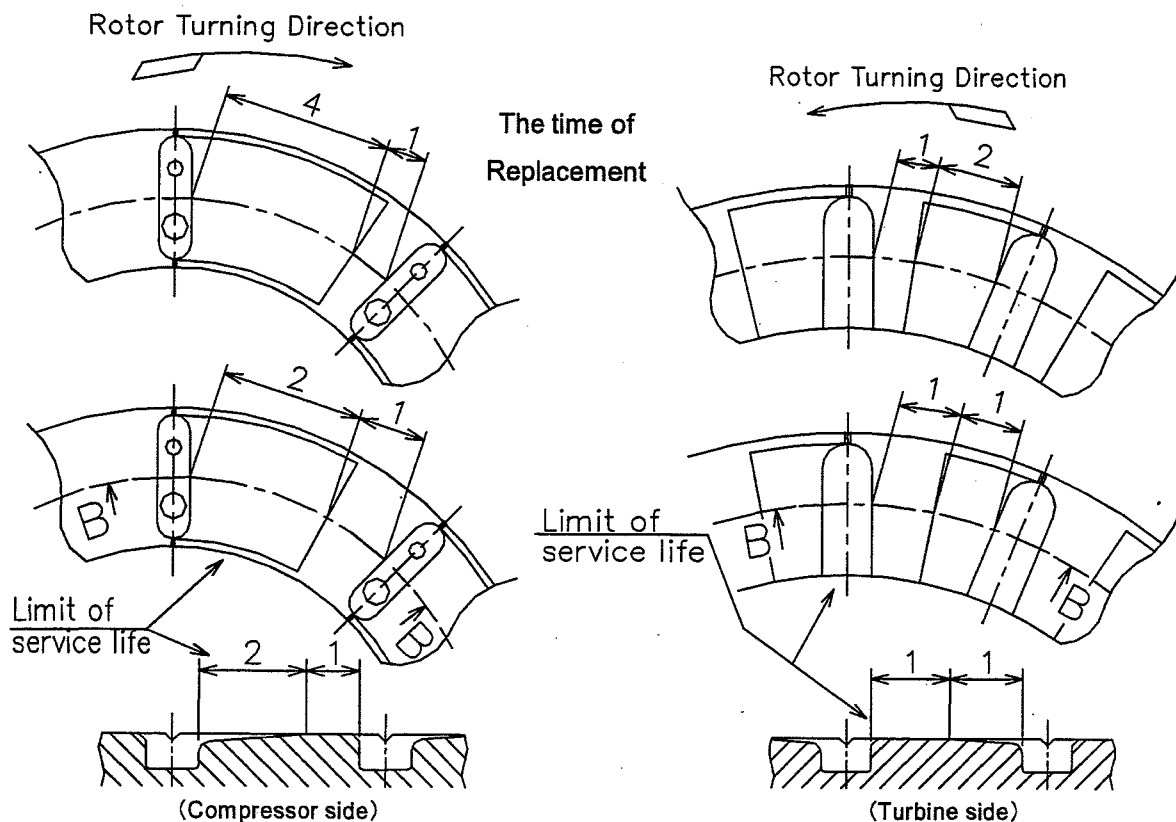
Thrust bearings are of the tapered land type, consisting of a tapered part and a flat part. Oil is pulled into the wedge-shaped opening formed between the thrust collar and the tapered part of the bearings by means of the rotating action of the thrust collar, thus creating oil pressure that supports the thrust load. When the thrust bearings become worn, the ratio occupied by the flat part increases.

The limit of service life for thrust bearings is as follows:

Length of tapered part: Length of flat part = 2:1 (Compressor side, See figure below)
= 1:1 (Turbine side, See figure below)

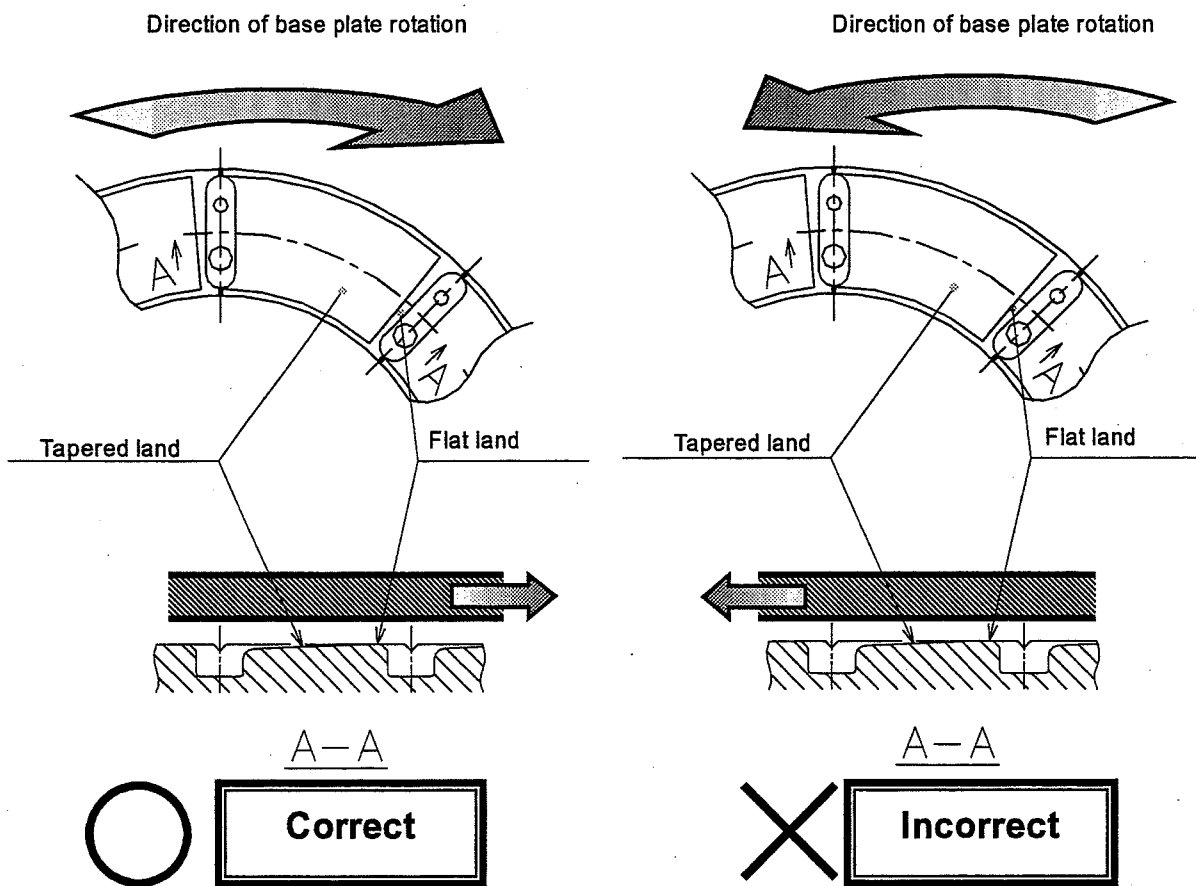
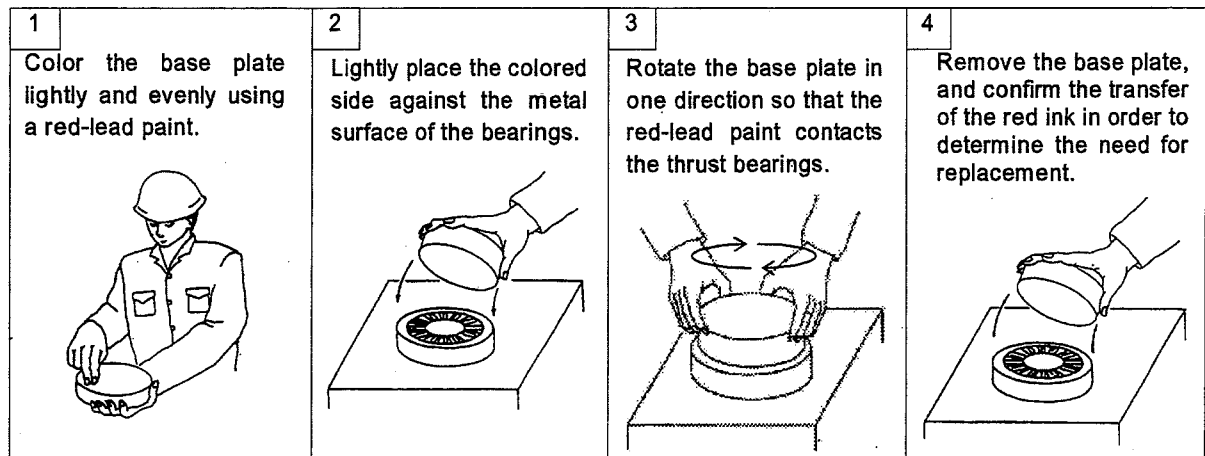
However, even if the ratio has not yet reached 2:1 (compressor side) or 1:1 (turbine side), the bearings should be replaced when it is anticipated that the ratio will reach 2:1 (compressor side) or 1:1 (turbine side) before the next inspection.

Regarding the inspection procedure for the ratio of the tapered part to the flat part, please refer to Fig. 5-1.



5-1-1-0-0-01-0

Section 5 Parts Inspection and Cleaning



5-1-2-0-0-01-0

Fig. 5-1 Inspection procedure for the tapered:flat part ratio

In the event that a long, deep scratch of 20mm in length or greater are evident on the thrust bearing metal surface, or if multiple deep scratches add up to a total length of 50mm or more, the thrust bearings should be replaced with new ones.

Any visible exfoliation or cracking of the thrust bearing metal surface also indicates the need for replacement.

2.2 Journal bearings

After removing the rotor, insert it through the journal bearings and, using a dial gauge, measure the clearance between the inner surface of the journal bearings and the rotor shaft, with the upper side of the inner surface against the shaft. Compare the measured results with the clearance standard table presented in Section 6. Also, be sure not to affix the dial gauge to the rotor when performing the measurement (as magnetic force will remain on the rotor shaft).

If the clearance is greater than the allowable value, it will be necessary to confirm whether the rotor shaft and/or the journal bearings have become worn. Please refer to Subsection 2 below in determining whether the rotor shaft has become worn.

If it is confirmed that the rotor shaft is not worn, and the clearance is greater than the allowable value, the journal bearings should be replaced with new ones.

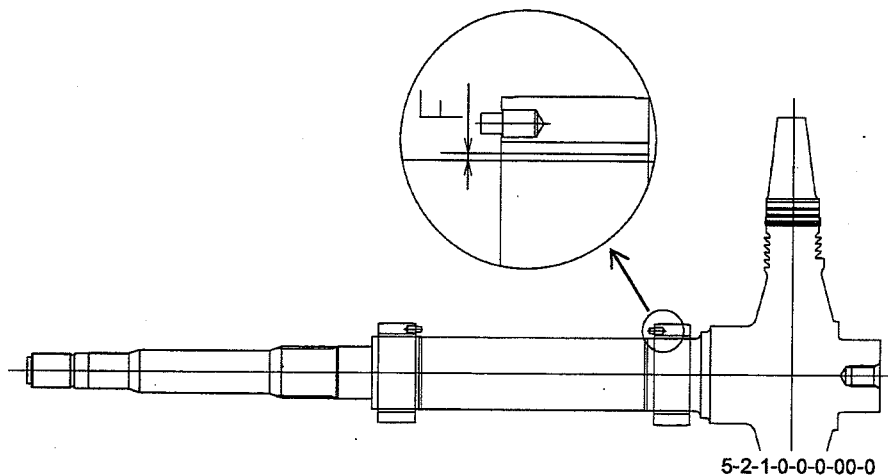


Fig. 5-2 Procedure for measuring the clearance between the journal bearings and the rotor shaft

Lock pin

A pin for locking is located on the journal bearings. If the pin diameter has been worn by 20% or more, or if it is damaged, the journal bearings should be replaced with new ones.

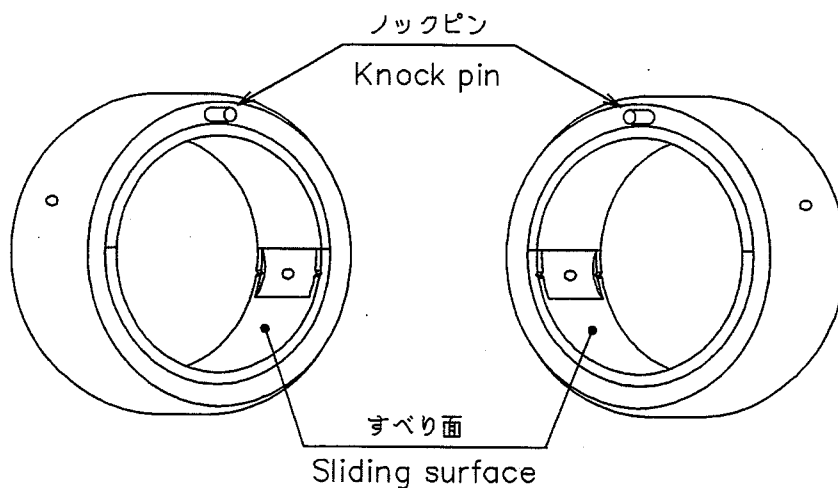


Fig. 5-3 Journal bearing lock pin

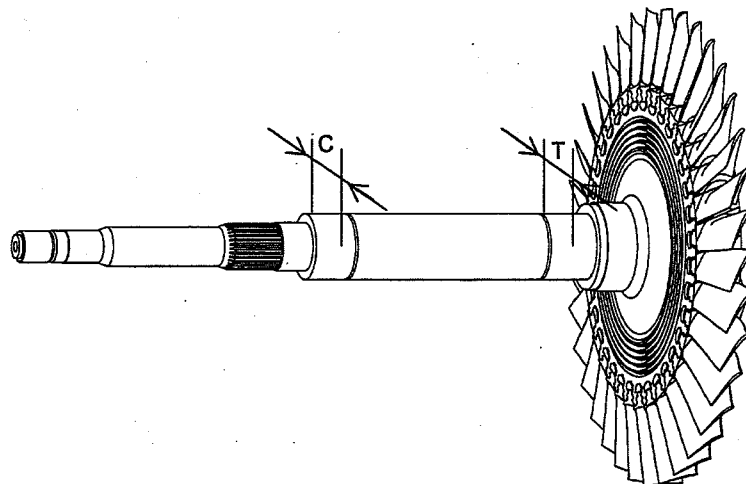
2. Rotor Shaft

The part of the rotor shaft that slides against the journal bearings is known as the journal part, and the shaft side is also subject to wear.

Close observation of the rotor shaft will reveal the sliding width relative to the journal bearings. Wear on the journal part of the shaft is determined by measuring the diameters of the journal bearing sliding parts and the areas outside (C and T).

If the outer diameter of the sliding part is at least 0.02mm less than the diameter of the adjacent area outside, please consult with MHI.

Note that the diameter of the center part of the shaft is slightly less than the journal part at the time of manufacture.



5-4-1-0-EEII-0-00-0

Fig. 5-4 Confirmation of the outer diameters of the rotor shaft and journal parts

3. Compressor Impeller

3.1 Inspection

Confirm that there are no abnormalities such as cracking on the claw clutch on the back side. It is strongly recommended to undertake dye check inspection on the back side of the compressor impeller, as well as all surfaces of the blades. If any defects are detected, the impeller should be replaced with a new one.

Light contact with the labyrinth fins on the back side of the impeller is not a problem, and the impeller may continue to be used.

Similarly, light contact between the impeller blade tips and the air guide casing (such that a metallic luster is exhibited) is not a problem, and the impeller may continue to be used. However, if contact results in burrs on the blade tips, please consult with MHI.

In the event that the leading edges of the impeller blades are indented from collision with a foreign object, please note the location and size, and contact MHI for consultation.

3.2 Cleaning

The impeller is made of heat-resistant aluminium alloy. Cleaning should be performed with a soft object such as a sponge, with surface dirt removed using kerosene or warm water. Do NOT use a wire brush or any similar hard object.

When using commercially available cleanser, be sure to confirm that it will not have any negative effect on aluminium material.

4. Pedestal-related

4.1 Sealing air passage

There is an inlet for sealing air located in the vicinity of the diffuser blades on the pedestal compressor side.

Confirm that there is no evidence of lubricant leakage into the sealing air channel.

Confirm that air flows through the sealing air channel out the turbine side when general service air is fed in.

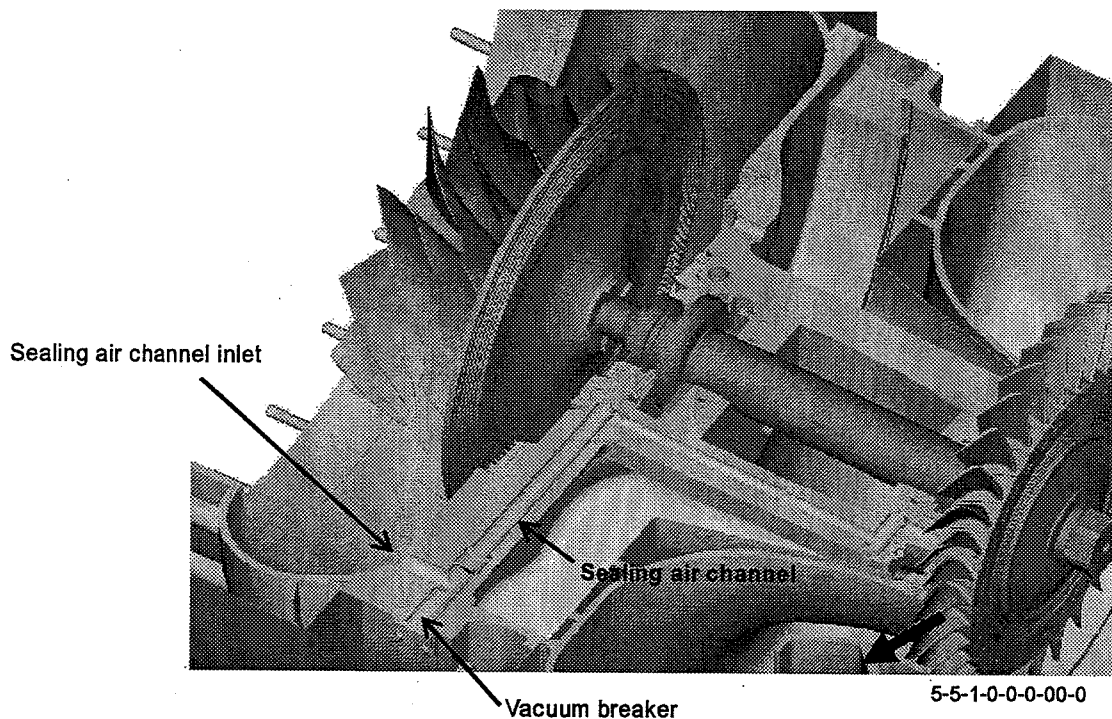


Fig. 5-5 Sealing air channel inlet

4.2 Vacuum breaker

The vacuum breaker is attached to the side of the pedestal. Remove the bolt to pull out the vacuum breaker, and confirm that there is no abnormality with the valve disc and that the valve operates smoothly.

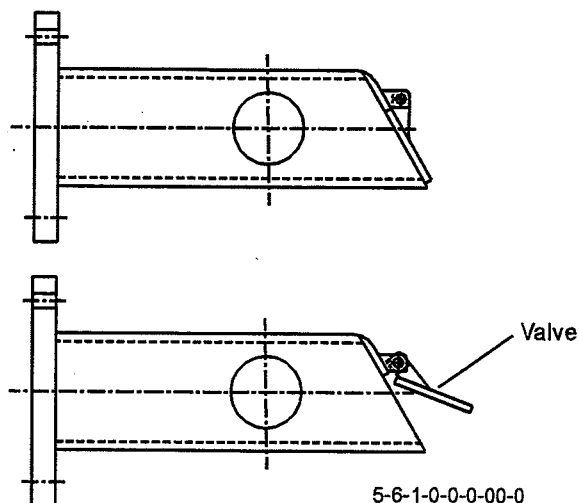


Fig.5-6 Vacuum breaker inspection

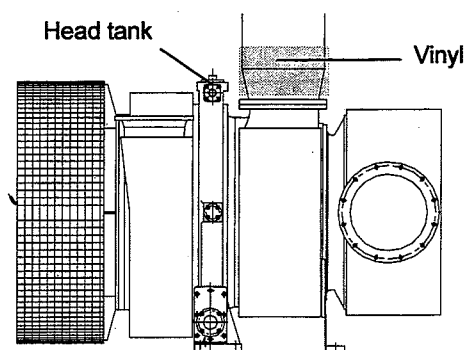
Section 5 Parts Inspection and Cleaning

4.3 Head tank

MET turbochargers contain a head tank built into the pedestal. Refer to the following subsections for the procedure and cautionary points with respect to cleaning the inside of the head tank.

4.3.1 Preparation for cleaning

In order to ensure that foreign matter does not enter inside the tank from the gas outlet duct, etc., wrap the duct using vinyl or other suitable material.



5-6-2-0-0-0-00-0

4.3.2 Cleaning procedure

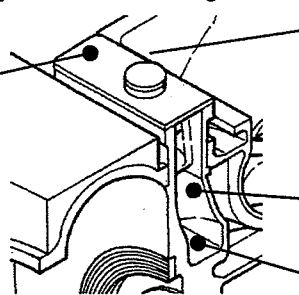
Remove the head tank cover-lid.

Wipe out any remaining oil from the tank using a sponge or clean waste rags, etc.

If contamination is severe, use a spatula or similar object to remove it from the walls of the tank.

Wipe up any remaining contaminants using clean rags, etc.

Head tank cover-lid



5-6-3-0-0-0-00-0

If the packing material becomes damaged when removing the cover-lid, replace it with new material.
Use sealant bond to affix the cover-lid and the new packing.

Do NOT use a wire or nylon brush to wipe up contaminants. (This is because bristle ends can break off and introduce new contamination.)

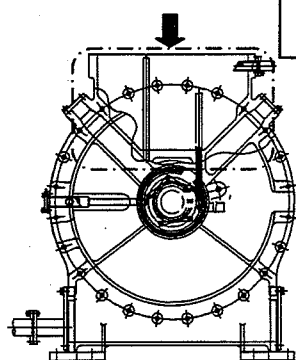
When cleaning, take care that contaminants do not enter L.O. channels ① and ② (see the diagram below).

4.3.3 Recovery

Blow out the L.O. channels with compressed air, as well as blowing out any dirt between the channels.

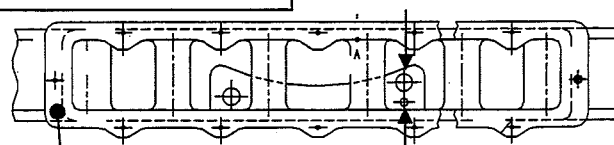
Clean the flange surface of the pedestal, making sure that foreign matter does not enter between the packing and the pedestal flange surface.

Verify again that there are no contaminants left inside the tank, and replace the cover-lid. (Do not use sealant bond to coat the pedestal side and the packing.)



Inside of pedestal head tank (view from directly above)

L.O. channel①



L.O. channel②

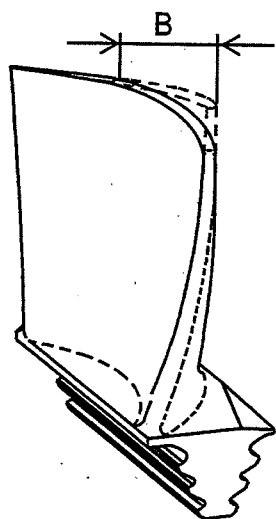
- Flange surface is clean
- No sealant bond

5-6-4-0-0-0-00-0

5. Turbine Blades

5.1 Wear-down of turbine blade tips

Although turbine blade tip wear does not immediately lead to turbocharger damage, it does cause a gradual deterioration of turbocharger performance, thus raising the temperature of engine exhaust gas, and increasing the rate of fuel consumption. Consequently, if the turbine blades appear as illustrated in Fig. 5-7, the turbine blades should be replaced at a suitable opportunity such as dry dock. Turbine blade replacement requires specialized technology and equipment; please consult with a service company authorized by MHI.



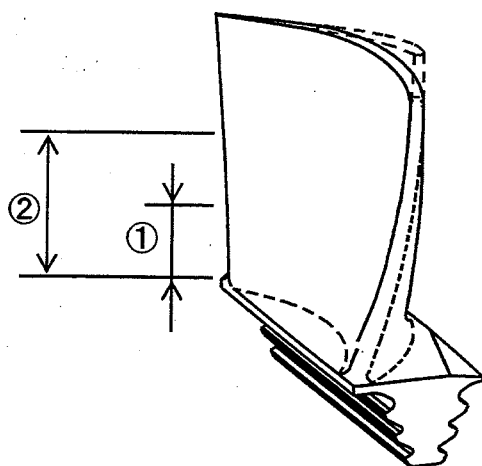
Model	B(mm)
33SD/SE/SEII	10
42SD/SE/SEII	12
53SD/SE/SEII	16
66SD/SE/SEII	20
71SE/SEII	21
83SD/SE/SEII/SEIII	24
90SE	27

5-7-1-0-0-0-00-0

Fig. 5-7 Standards for replacement due to turbine blade tip wear

5.2 Wear-down of turbine blade trailing edges

When the turbine blades are subjected to long-term use, there are cases in which the trailing edges (rather than the tips) become worn. If the trailing edges become thin, and unevenness is caused by corrosion of the surface, cracks may appear that can lead to turbine blade breakage. If the thicknesses of the turbine blade trailing edges reach the values indicated in Fig. 5-8, the turbine blades should thus be replaced.



Model	SD			SE/SEII/SEIII		
	Measurement position (mm)	Allowable thickness (mm)		Measurement position (mm)	Allowable thickness (mm)	
33	① 12.5	0.4		① 14.4	0.6	
	② 25.0	0.3		② 28.8	0.3	
42	① 15.5	0.5		① 17.8	0.7	
	② 31.0	0.4		② 35.6	0.4	
53	① 19.6	0.6		① 22.6	0.8	
	② 39.3	0.4		② 45.2	0.4	
66	① 24.5	0.7		① 28.1	0.9	
	② 49.0	0.5		② 56.2	0.5	
71	① -	-		① 30.4	1.0	
	② -	-		② 60.9	0.5	
83	① 31.0	1.0		① 35.6	1.1	
	② 62.0	0.6		② 71.2	0.6	
90	① -	-		① 39.3	1.2	
	② -	-		② 78.6	0.7	

Fig. 5-8 Standards for replacement due to turbine blade trailing edge wear

5-8-1-0-0-0-01-0

5.3 Non-destructive testing of turbine blades

Because the turbine blades used in MET turbochargers are made of magnetic material, magnetic particle examination can be conducted. Periodic magnetic particle examination is recommended during turbine blade inspections. Particularly in cases where the trailing edges have become thin but the blades cannot be immediately replaced, magnetic particle examination must be carried out.

Non-destructive testing should be undertaken by persons who are fully experienced in test procedures.

5.4 Turbine blade cleaning

Hard carbon deposits on turbine blades not only reduce performance, but are also a cause of surging as well as shaft vibration and bearing damage due to imbalance.

To clean, dip the blade into a suitable container filled with warm water in order to peel off the deposited scale. The addition of a commercially available cleanser is effective, but it should be confirmed that the cleaning agent used will not corrode the rotor shaft or turbine blade materials. It is important to remove the scale in a uniform manner.

Dry sufficiently after cleaning, and coat with rust-preventing oil for anti-rust treatment during the recovery period.

Even in cases where the carbon is hard and difficult to remove, do NOT use a chisel or similar tool.

Exercise sufficient caution so that the warm water does not come into contact with skin.

5.5 Contact between the turbine blade tips and the gas outlet guide

The clearance between the turbine blade tips and the gas outlet guide is normally set to the minimum distance at which there is no contact, but sudden changes in engine load, surging, etc. can result in cases where the turbine blade tips touch the casing. As long as the trailing edges of the turbine tips are lightly and uniformly touching the gas outlet guide, this will have almost no effect on rotor shaft balance, and the turbocharger can continue to be used in this state.

5.6 Turbine blade abnormalities

If and when the following abnormalities are observed, discontinue use and immediately consult with MHI.

- Excessive contact by the turbine blade tips
- Indentations from collision by the turbine blades with a foreign object
- Wave by the turbine blade trailing edges
- Turbine blade misalignment in the axial direction

6. Nozzle

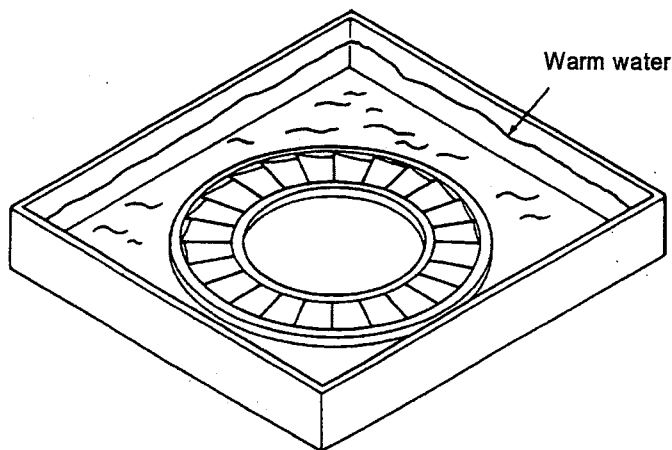
6.1 Cleaning the nozzle ring

As with the turbine blades, use warm water to remove contaminants from the nozzle ring.

Avoid striking with a chisel, hammer, etc. will cause deformation of the nozzle blades, which is likely to induce surging and/or a reduction in performance.

Exercise sufficient caution so that the warm water does not come into contact with skin.

Dry sufficiently after cleaning, and coat with rust-preventing oil for anti-rust treatment during the recovery period.



5-9-1-0-0-0-00-0

Fig. 5-9 Cleaning method for the nozzle ring

6.2 Inspecting the nozzle ring

Conduct nozzle inspection with the nozzle placed horizontally and stably, in a well-lit location.

After cleaning, visually inspect the nozzle ring while, observing the following:

Uniform removal of contaminants from the nozzle blades

Formation by the nozzle blade trailing edges of a continuous line, with no bending, etc.

Uniform evidence of contact between the nozzle outer ring and the gas outlet guide

No cracks in the weldment

If and when abnormalities are discovered, please consult with MHI.

If the nozzle is installed on the gas inlet (inside) casing, there may be clearance between the nozzle outer ring and the gas inlet casing. This is not a problem, however, as exhaust gas is sealed by the contact surface between the gas outlet guide and the nozzle outer ring.

7. Air Filter

Items with respect to which care should be taken in cleaning the air filter (round silencer) are noted below.

7.1 Cleaning period

Cleaning should always be conducted when the filter pressure loss exceeds 200 (mmAq), or at least once every two months.

7.2 Cleaning method (see Fig. 5-10)

Dissolve a cleaning agent in lukewarm water, and lightly wash using hands after soaking the filter for 2~3 hours.

A washing machine, etc. should not be used, as this will damage the fibers.

Be careful not to rub the filter too strongly, either with a brush or against other filters.

After washing, dry sufficiently before re-use by placing in a shaded location with good airflow.

Dirt collection effectiveness may decline if the filter is used before it has been allowed to dry fully.

7.3 Point for special caution

Exercise sufficient and constant caution so that the fibers do not stand up on end.

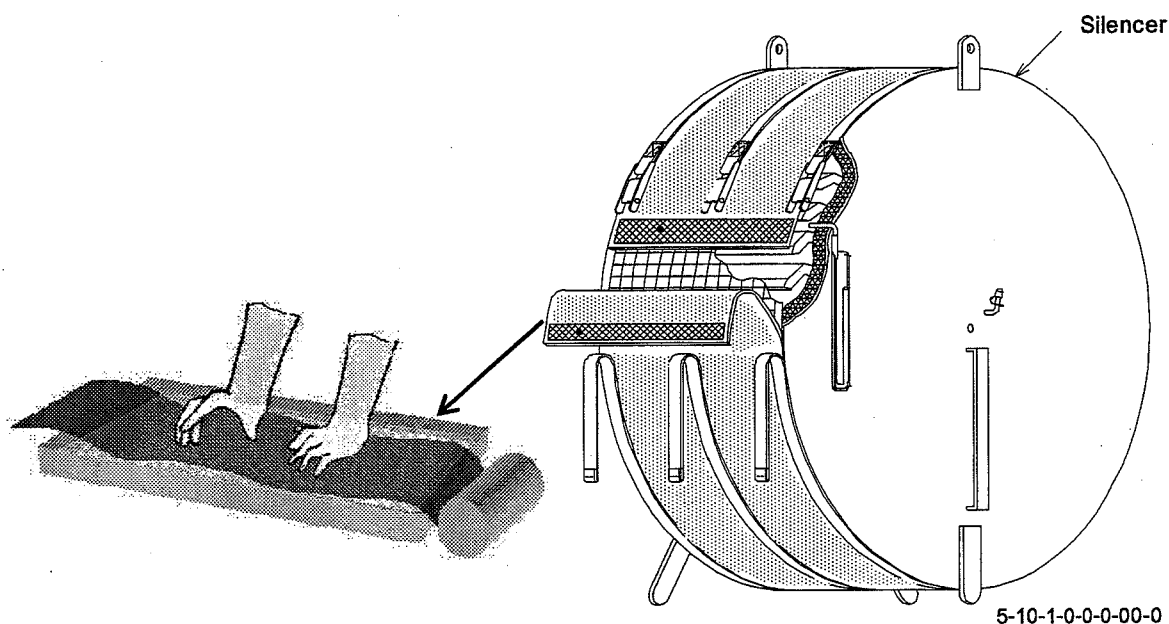


Fig. 5-10 Procedure for washing silencer filter

Section 5 Parts Inspection and Cleaning

Section 6 Attached Diagrams and Tables

1. Turbocharger Troubleshooting
2. Clearance Table
3. Rotor Locking Procedure
4. Dimension and Weight Table of Main Parts
5. Cross-sectional Diagrams and Part Numbers
6. Part Numbers and Names
7. MHI Contact Information
8. MET Turbocharger Authorized Service Organizations

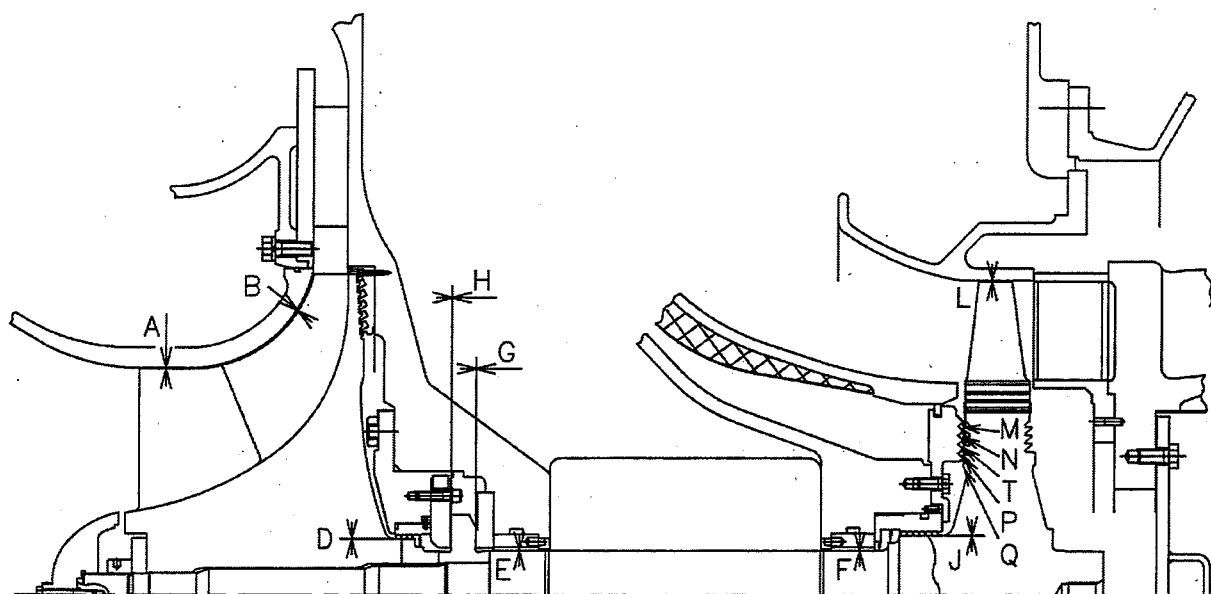
Section 6 Attached Diagrams and Tables

1. Turbocharger Troubleshooting

Problem	Immediate action	Cause	Remedy
Compressor surging	Reduce speed to load at which surging stops. If necessary, open air cooler inspection hole to stop surging (be careful of elevated exhaust temperature).	Air filter contamination	Remove and clean air filter
		Turbine side contamination	Overhaul and clean turbine side
		Turbine blade wear damage	Replace turbine blades (consult with MHI)
		Air cooler contamination	Refer to engine manual
		Exhaust gas protection grill blockage	Refer to engine manual
		Problem with fuel pump	Refer to engine manual
		Exhaust gas boiler contamination	Refer to vessel manual
		Problem with engine room air circulation	Check circulation fan operation
Oil leakage from main unit and/or oil mist mixed with discharged air	Confirm whether there is any abnormal vibration. If so, reduce speed to load at which vibration is alleviated, and immediately overhaul turbocharger.	Excessive inlet lubricant pressure	Adjust oil pressure at orifice, etc.
		Problem with air bleeder piping	Confirm size of air bleeder piping Confirm that there is no inclination where oil has accumulated
		Loose impeller	Confirm whether impeller is fastened at designated pressure
		Vacuum breaker sticking	Overhaul vacuum breaker
		Oil labyrinth damage	Overhaul turbocharger, inspect parts, and clean channels
		Bearing damage	
		Sealing air channel blockage	Confirm size of oil return tubing Confirm whether interim valves are closed
Exhaust gas mixed with discharged air	If amount of exhaust gas is low, continue using turbocharger until next overhaul. If amount is high, and where gas is ingested from the turbocharger silencer such that intake air temperature is higher than the engine room temperature by 10°C or more, reduce speed of engine immediately and overhaul turbocharger as soon as possible.	Problem with oil return tubing ¹⁾	
		Gas sealing ring wear/damage	Remove rotor and replace sealing ring
		Sealing air channel blockage	Remove rotor, check sealing air channel, and clean
Abnormal vibration and/or noise from main unit	Reduce speed to load at which vibration is alleviated, and overhaul turbocharger as soon as possible.	Gas labyrinth damage ¹⁾	Remove rotor and replace gas labyrinth
		Turbine blade and/or compressor impeller damage	Overhaul turbocharger
Abnormally high turbocharger speed. Speed increases regardless of engine load.	If both scavenge air pressure and exhaust gas temperature are high, or if exhaust temperature is abnormally high, reduce engine load and inspect turbocharger and engine as soon as possible. Do not approach turbocharger. If scavenge air pressure and exhaust gas temperatures are normal, reduce engine load and test output signal from turbocharger tachometer.	Bearing damage ¹⁾	Remove rotor and inspect bearings
		Abnormal engine combustion, e.g. fire in scavenge air- or exhaust gas receiver	Stop engine and inspect according to engine manual
		Substantial scavenge air leakage	Identify location of scavenge air leakage and implement countermeasures
		Abnormality with tachometer	Confirm rpm from frequency of signal in tachometer in junction box near turbocharger. Identify problem point and replace part(s).
High exhaust gas temperature	Reduce engine load to point at which engine reaches allowable temperature, and inspect engine.	Turbocharger internal contamination	Overhaul turbocharger and clean
		Refer to Subsection 5	Refer to Subsection 5
Failure of turbocharger to start up	Inspect turbocharger.	Blockage due to combustion residue on turbine blade tips	Clean turbine side
		Blind plate for turbocharger shutdown extending into gas inlet	Remove blind plate

If the problem is not resolved by means of the action(s) recommended in the above table, or in the event that turbocharger overhaul cannot be performed, please consult with MHI.

2. Clearance Table



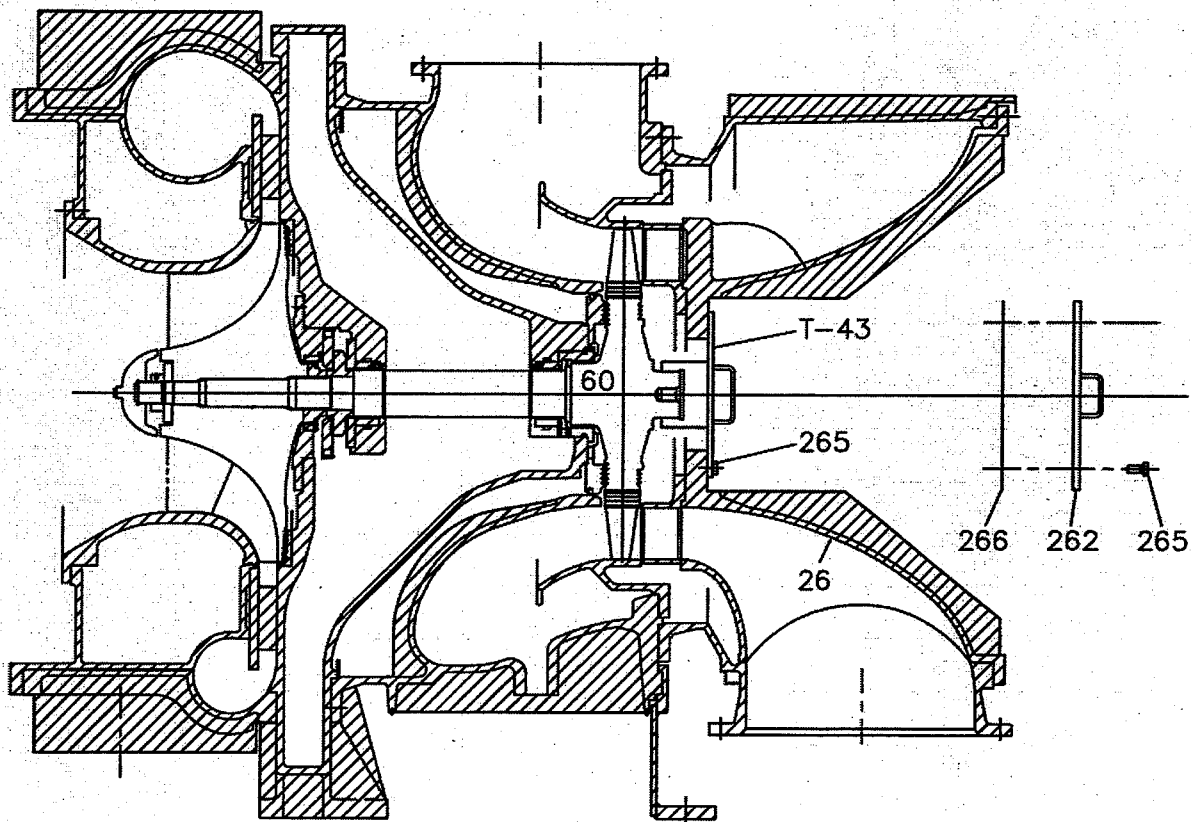
POINT \ TYPE		MET83SEII	
		DESIGN	LIMIT
A		0.60~1.80	2.00
B		2.40~2.60	2.80
D		0.05~0.70	0.75
E=F		0.46~0.54	0.60
G		0	—
H		0.26~0.36	—
J		0.05~0.70	0.80
L	Top	1.15~1.70	2.00
	Starboard Port	1.30~1.85	2.15
	Bottom	1.45~2.00	2.30
M=N=T=P=Q		0.10~0.80	0.95

- Note: Thrust clearance H indicated represents the standard value to refer to when renewing the thrust bearing and is not the value to be used as yardstick for evaluating the bearing wear.

- Note: スラスト隙間Hはスラスト軸受換装時の隙間基準であり、スラスト軸受の摩耗判断のための数値ではありません。

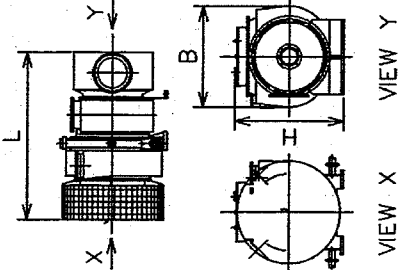
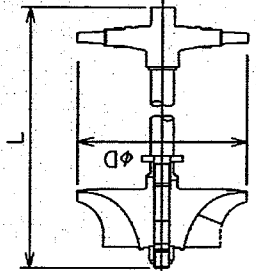
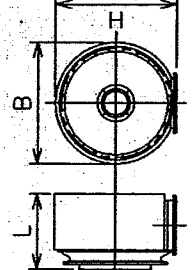
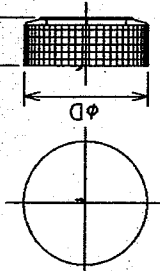
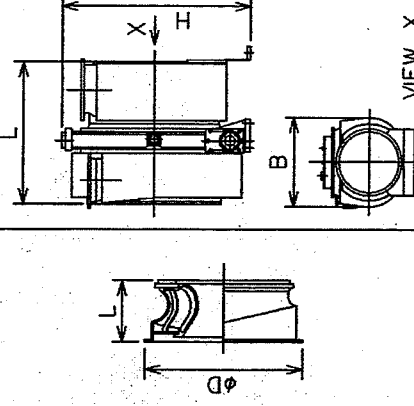
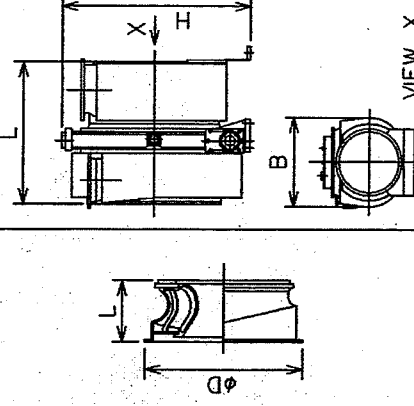
6-1-1-8-EII-0-00-1

3. Rotor Locking Procedure



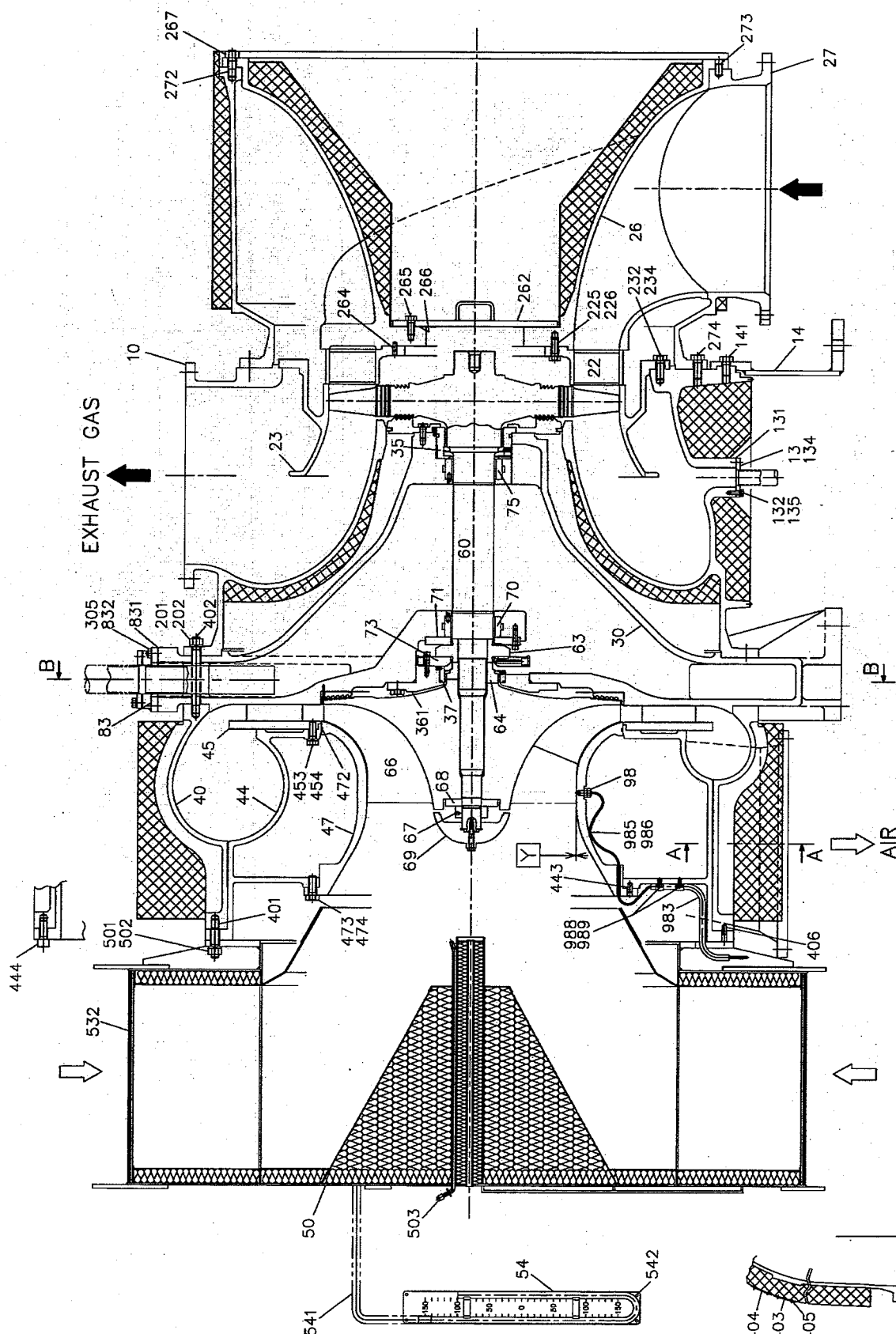
6-1-2-0-0-GD-00-0

4. Dimension and Weight Table of Main Parts

DIMENSION AND WEIGHT TABLE OF MAIN PARTS MET-SEII					(mm)	
	T/C COMPLETE 過給機完備品	ROTOR COMPLETE ロータ完備品	GAS INLET CSG ガス入口ケーシング	SILENCER サイレンサ	INNER SCROLL & AIR INLET GUIDE うず内室 + 空気案内ケーシング	OTHER CSGS 残りのケーシング (うず外室+機受台+ガス出口)
						
	L x B x H	L x ϕ D	L x B x H	L x ϕ D	L x ϕ D	L x B x H
MET83SEII	3520 x 2155 x 2190 11200kg	1600 x ϕ 1000 600kg	1029 x 1635 x 1747 2020kg	760 x ϕ 2130 700kg	735 x ϕ 1650 1370kg	1756 x 2155 x 2190 6560kg
MET71SEII	2876 x 1800 x 1810 7040kg	1300 x ϕ 800 440kg	833 x 1275 x 1312 1150kg	630 x ϕ 1730 550kg	602 x ϕ 1420 850kg	1437 x 1800 x 1810 4050kg
MET66SEII	2830 x 1713 x 1745 6180kg	1300 x ϕ 800 330kg	822 x 1275 x 1312 950kg	630 x ϕ 1730 470kg	579 x ϕ 1280 800kg	1391 x 1713 x 1745 3630kg
MET53SEII	2308 x 1390 x 1463 3620kg	1000 x ϕ 600 190kg	661 x 1090 x 1080 600kg	540 x ϕ 1380 260kg	465 x ϕ 1030 450kg	1115 x 1390 x 1463 2120kg

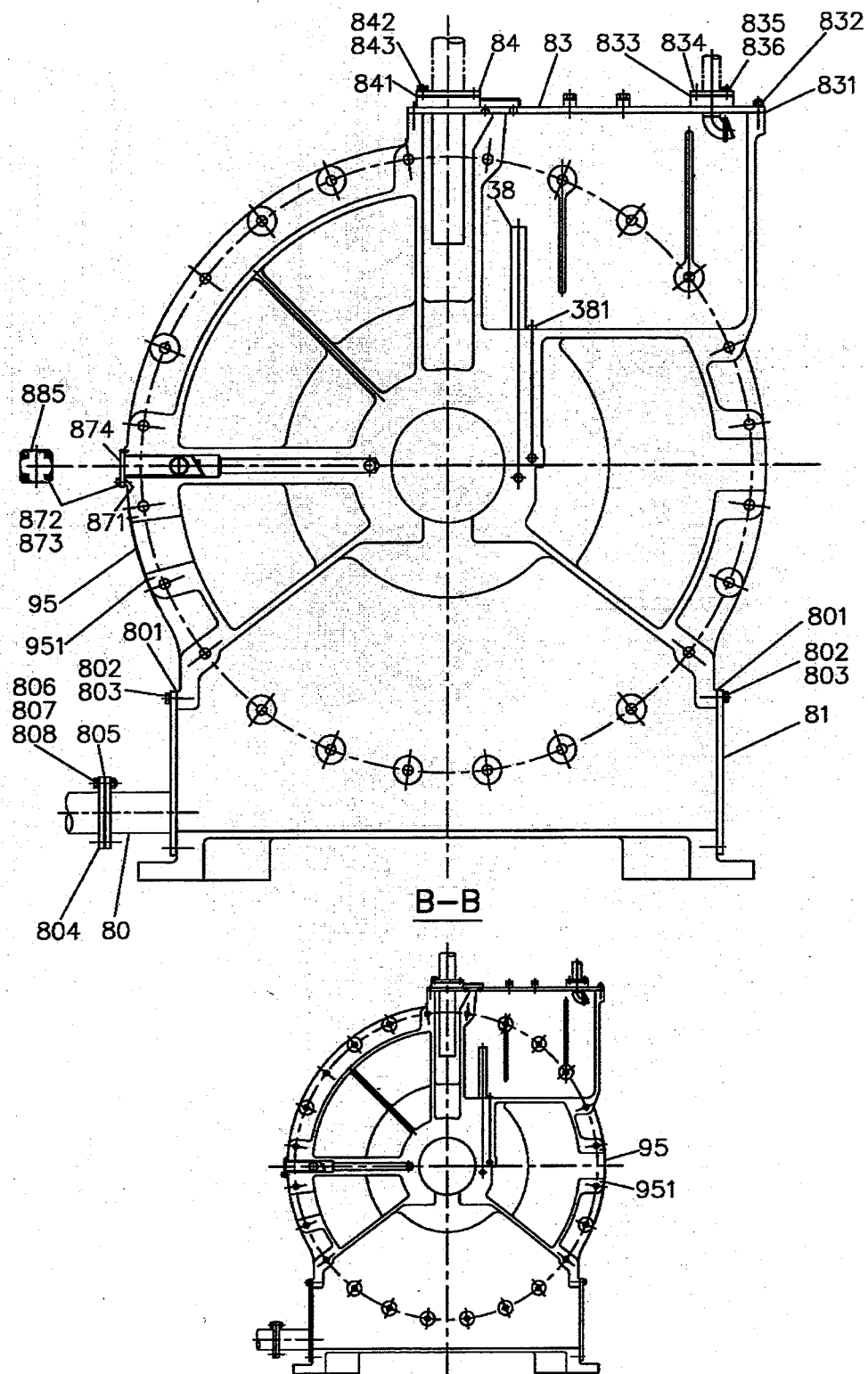
6-2-1-0-EII-0-00-0

5. Cross-sectional Diagrams and Part Numbers (1/3)



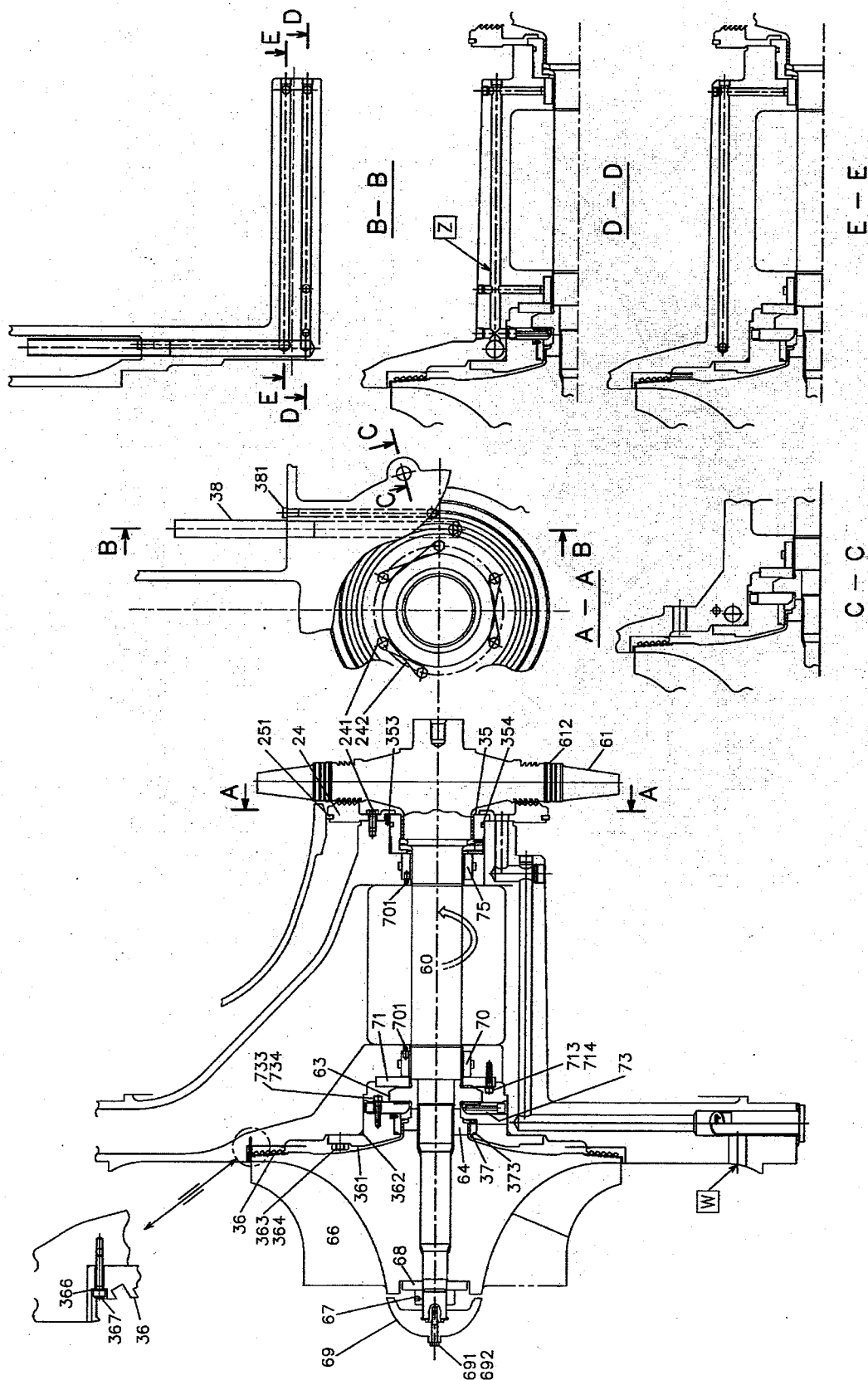
6-3-1-8-EII-DG-00-0

5. Cross-sectional Diagrams and Part Numbers (2/3) - Pedestal Periphery



6-3-2-8-EII-0-00-0

5. Cross-sectional Diagrams and Part Numbers (3/3) - Rotor Periphery



6-3-3-8-EII-0-00-0

Section 6 Attached Diagrams and Tables

6. Part Numbers and Names

Part No.	Part Name	Part No.	Part Name	Part No.	Part Name
10	Hxhaust gas outlet casing	40	Outer scroll	80	Flange
13	Flange	401	Stud bolt	801	Packing
131	Packing	402	Stud bolt	802	Spring washer
132	Bolt	403	Name plate	803	Bolt
134	Blank flange	404	Number plate	804	Flange
135	Spring washer	405	Driving-fit screw	805	Packing
14	Panting plate	406	Spring pin	806	Bolt
141	Bolt	44	Inner scroll	807	Nut
201	Nut	443	Spring pin	808	Spring washer
202	Spring washer	444	Hexagon-socket-headed bolt	81	Flange
22	Nozzle	45	Diffuser	83	Flange
225	Bolt	453	Bolt	831	Packing
226	Tongued washer	454	Spring washer	832	U-nut
23	Gas outlet guide	47	Air inlet guide	833	Packing
232	Tongued washer	472	O-ring	834	Flange
234	Bolt	473	Bolt	835	Bolt
24	Gas labyrinth packing	474	Tongued washer	836	Spring washer
241	Bolt	50	Silencer	84	Flange
242	Stainless-steel wire	501	Spring washer	841	Packing
251	Gas seal ring	502	Nut	842	Bolt
26	Gas inlet inner casing	531	Gum cap	843	Spring washer
262	Blind flange	532	Air filter	871	Packing
264	Parallel pin	54	Manometer	872	Bolt
265	Bolt	541	Vinyl tube	873	Spring washer
266	Packing	542	Oval head screws	874	Vacuum breaker
267	Nut	58	Band	885	Spring pin
27	Gas inlet outer casing	60	Rotor shaft	95	Blank Cover
272	Stud bolt	61	Turbine blade	951	Machine screw
273	Parallel pin	612	Blade stopper	98	Gap sensor
274	Bolt	63	Thrust collar	983	Conduit tube
30	Bearing pedestal	64	Sleeve	985	Band
305	Stud bolt	66	Impeller wheel	986	Machine screw
35	Oil labyrinth packing (turbine-side)	67	Locking nut	988	Bolt
353	Spring pin	68	Washer	989	Stainless steel wire
354	O-ring	69	Cap		
36	Air labyrinth	691	Bolt		
361	Support	692	Tongued washer		
362	O-ring	70	Journal bearing (compressor-side)		
363	Bolt	701	Pin		
364	Tongued washer	71	Thrust bearing (turbine-side)		
366	Washer	713	Hexagon-socket-headed bolt		
367	Hexagon-socket-headed bolt	714	Spring washer		
37	Oil labyrinth packing (compressor-side)	73	Thrust bearing (compressor-side)		
373	O-ring	733	Hexagon-socket-headed bolt		
38	Lube oil inlet pipe	734	Spring washer		
381	Bush	75	Journal bearing (turbine-side)		

6-5-1-8-EII-0-01-0

7. MHI Contact Information

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Section 6 Attached Diagrams and Tables

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Section 7 Cleaning Procedures for Compressor and Turbine during Operation

1. Turbine Dry Cleaning Procedure
2. Compressor Water Washing Procedure

1. Turbine Dry Cleaning Procedure

1.1 Introduction

Low-grade fuel is increasingly being used in diesel engines, and problems are being experienced with fouling of the turbine nozzle and moving blades due to combustion residue, as well as harder deposits.

The introduction of dry cleaning in the cleaning process is recommended as a suitable means of turbine cleaning for non-cooled MET turbochargers designed in response to these circumstances.

1.2 Overview of turbine side dry cleaning method

In the dry cleaning method, solid but soft particles are introduced upstream of the turbine, and are accelerated by means of exhaust gas. The impact force serves to remove deposits from the turbine nozzle, turbine blades, etc.

There is no need to reduce the engine load during cleaning. In addition, there is no thermal shock to the casings of the exhaust gas channels.

As turbine side cleaning is for the purpose of preventing the build-up of turbine contamination, it should be performed periodically.

1.3 Dry cleaning device

1.3.1 Overview of device

Fig. 7.3 presents an overview of the plant solid cleaning apparatus.

1.3.2 Cleaning medium

(1) Types of cleaning medium:

(a) Walnut shell

Diameter: 2.0~2.8mm (marine grit #8)

Note: Milled walnut shell can be sourced from Hikawa Marine Co., Ltd.

(b) Grain (rice, wheat, etc.)

Diameter: Within 3.0mm

(2) Amount of cleaning medium to be used

Table 7.1 shows the initial recommended amounts for the first cleaning, according to the turbocharger model. As an excessive amount can result in surging, the appropriate value should be determined in conjunction with the engine status/condition. In doing so, please refer to Subsection 1.4.4.

Section 7 Cleaning Procedures for Compressor and Turbine during Operation

Table 7.1 Plant solid cleaning apparatus capacities

	33SD 33SE 33SEII 33MA	42SD 42SE 42SEII 42MA	53SD 53SE 53SEII 53MA	60MA	66SD 66SE 66SEII 66MA	71SE 71SEII 71MA	83SD 83SE 83SEII 83MA	90SE 90MA
Amount of solid Cleaning agent (liters/implementation)	0.4	0.7	1.6	2.1	2.6	3.0	3.5	3.5

7-1-1-0-0-0-00-1

1.4 Cleaning procedure

1.4.1 Cleaning interval

Initially, cleaning should be performed at least once every 100 hours. Subsequently, the interval should be adjusted up or down in accordance with performance values such as exhaust temperature, scavenge air pressure, and turbocharger rpm.

1.4.2 Turbocharger rpm during cleaning

The following table indicates limits for turbocharger speed and turbine inlet temperature value during cleaning. If actual values are higher at normal load, then the load should be reduced.

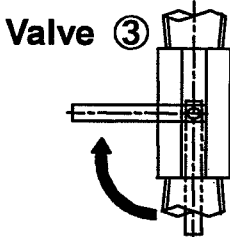
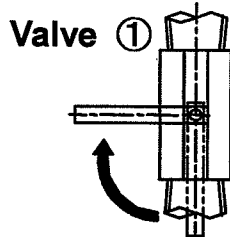
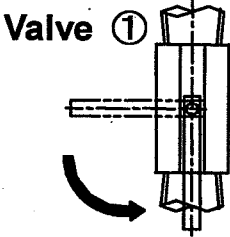
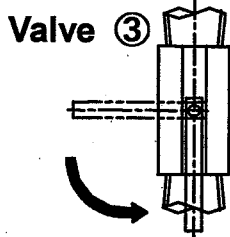
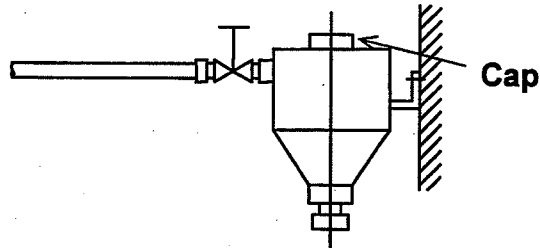
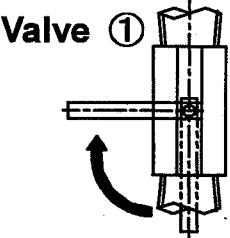
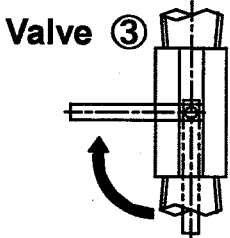
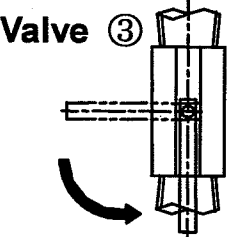
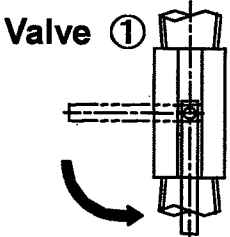
Table 7.2 Allowable maximum speed and turbine inlet temperature during cleaning

MET Item	33SD 33SE 33SEII 33MA	42SD 42SE 42SEII 42MA	53SD 53SE 53SEII 53MA	60MA	66SD 66SE 66SEII 66MA	71SE 71SEII 71MA	83SD 83SE 83SEII 83MA	90SE 90MA
Turbocharger maximum speed (min ⁻¹)	23,300	18,800	14,800	13,300	11,900	11,000	9,400	8,500
Turbine inlet temperature	Within 500 °C							

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Section 7 Cleaning Procedures for Compressor and Turbine during Operation

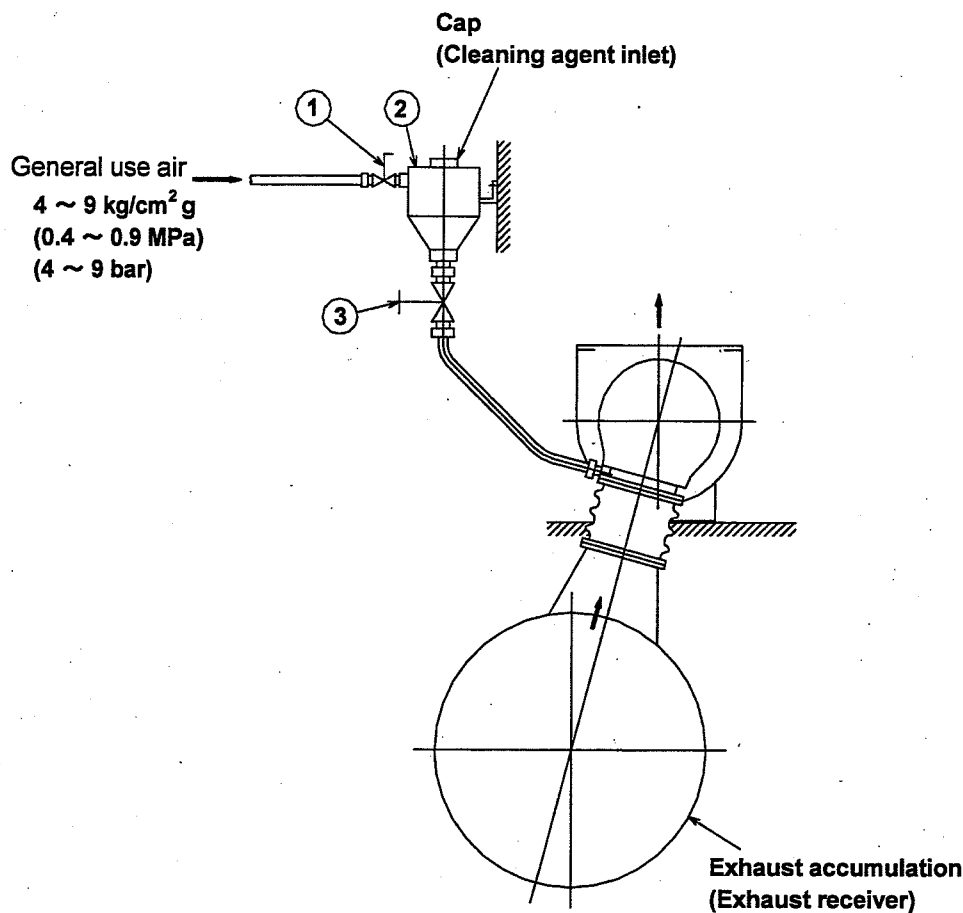
1.4.3 Cleaning procedure (see Fig. 7.3)

Procedure	1	2
1) Open the valves and allow air to flow for 1~2 minutes to cool the equipment.	 Valve ③ Open	 Valve ① Open
2) Close the valves.	 Valve ① Closed	 Valve ③ Closed
3) Place the designated amount of plant solid cleaning medium in tank [2]. Be sure to replace the cap on tank [2].	 Cap	
4) Open the valves and allow air to flow so as to introduce the cleaning medium	 Valve ① Open	 Valve ③ Open
5) Close the valves.	 Valve ③ Closed	 Valve ① Closed

Note: During cleaning, be sure to close the turbocharger gas outlet casing drain.

7-3-1-0-0-00-0

Section 7 Cleaning Procedures for Compressor and Turbine during Operation



7-3-1-0-0-0-00-0

Fig. 7.3 External view of solid matter cleaning apparatus

1.4.4 Repeat cleaning

If the engine performance changes rapidly when the cleaning medium is introduced, for example if severe surging occurs, try cleaning using about half of the recommended amount of cleaning agent in Table 7.1. After confirming that there is no sudden engine performance change, repeat the cleaning process.

After completion of cleaning, and assuming no improvement in performance indicators such as exhaust temperature, scavenge air pressure, and turbocharger speed, repeat the procedure described above. If no change is observed after several repetitions, it will be necessary to undertake overhaul and conventional cleaning.

2. Compressor Water Washing Procedure

If, due to various engine conditions, it proves difficult as a result of severe compressor side contamination to maintain performance until the next scheduled overhaul, follow the procedure below for compressor side water washing.

Observe the procedure presented in Table 7.4 for compressor side water washing.

Please use only natural water, no cleaning agents etc. (see the compressor side washing device illustrated in the diagram below).

Confirm by running water through them that the tank and hose are not obstructed by any foreign matter or objects.

Supply water to the tank a little at a time using a small container. Do not supply directly from a spigot or large container.

Table 7.4 Compressor side washing procedure

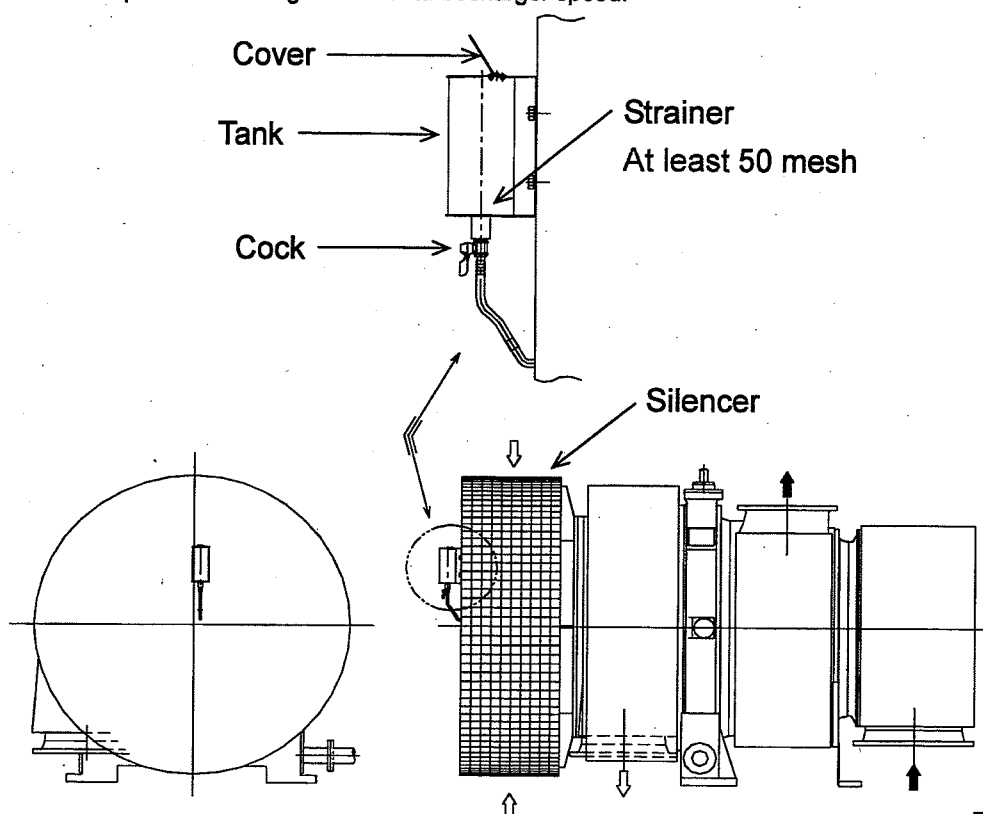
MET model	90SE 90MA	83SD 83SE 83SEII 83MA	71SE 71SEII 71MA	66SD 66SE 66SEII 66MA	60MA	53SD 53SE 53SEII 53MA	42SD 42SE 42SEII 42MA	33SD 33SE 33SEII 33MA
Turbocharger speed (min^{-1})	4500~ 6000	4500~ 6000	5000~ 7000	5500~ 7500	6300~ 8500	7000~ 9500	8500~ 12000	11000~ 15000
Amount of feedwater (liters) (sec.)	3.0 60~120	3.0 60~120	2.75 55~110	2.5 50~100	2.25 45~90	2.0 40~80	1.5 30~60	1.0 20~40

Notes:

7-4-1-0-0-0-00-1

Be sure to keep the turbocharger speed within the designated range during cleaning.

Do NOT perform cleaning at normal turbocharger speed.



7-5-1-0-0-0-00-0

Fig. 7.5 External view of compressor side water washing apparatus.

DRAWING NO.

N36-83M-0166

第コ-ド

PLAN RECORD

ISO METRIC SCREW THREADS

TOTAL WEIGHT

589.024 Kg

REVISIONS

AP-

CHECK-

NO.

DESCRIPTION (DATE)

PROVED

ED

1

CHANGED THE LENGTH OF T-14.
(M24×210 → M24×220).
DELETED THE T-74 (WIRE ROPE).
(2006-04-10 T.H)

M.K

M.T

A4

6 SHEET(S) WITH COVER

TURBOCHARGER DESIGNING SEC.
TURBO & MARINE MACHIN. DESIG. DEPT.

APPROVED M.KimuraCHECKED Y.OnoDRAWN T.Higashikawa

CONFERRED

SCALE

ORDER

ITEM

DRAWING NO.

REV.NO.

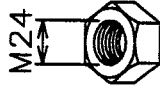
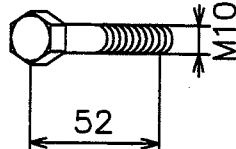
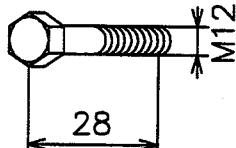
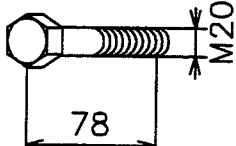
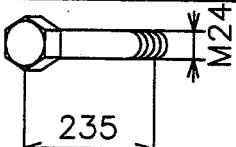
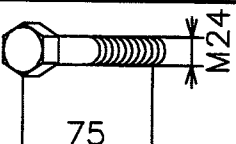
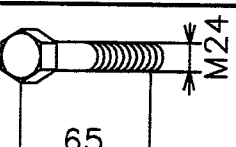
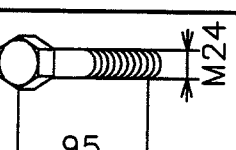
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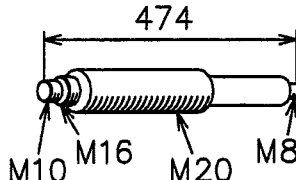
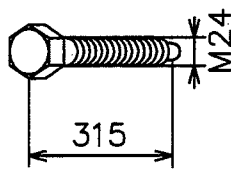
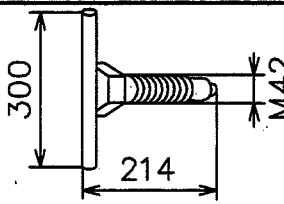
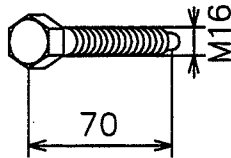
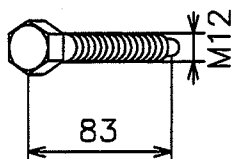
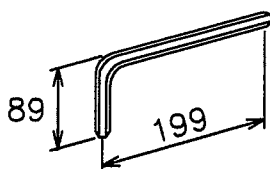
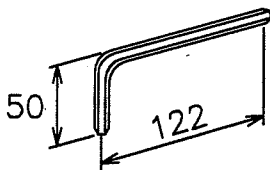
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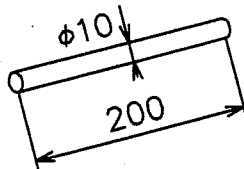
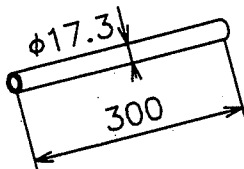
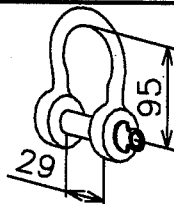
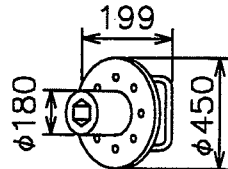
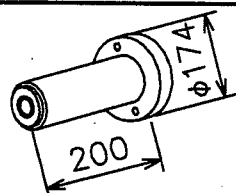
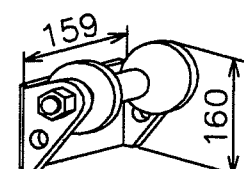
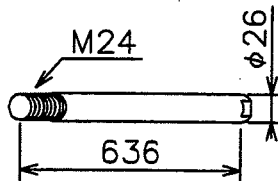


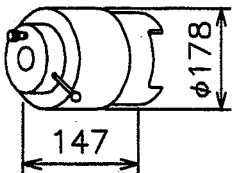
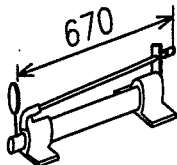
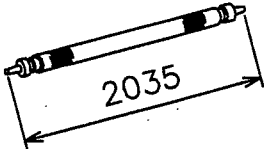
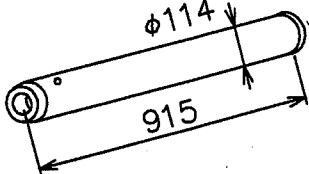
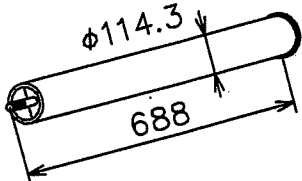
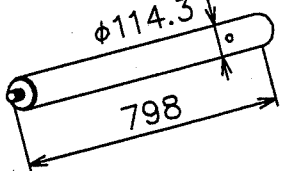
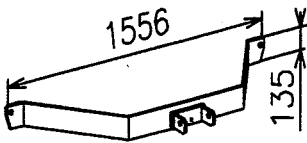
MITSUBISHI HEAVY INDUSTRIES, LTD.
NAGASAKI SHIPYARD & MACHINERY WORKS

DRAWN 2005-06-23 ISSUED

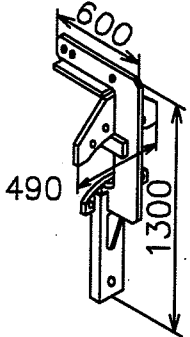
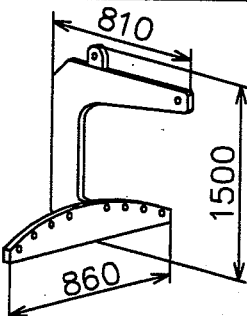
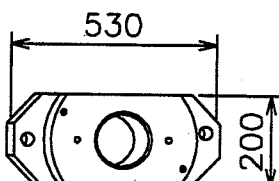
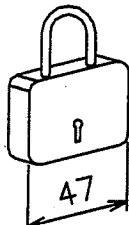
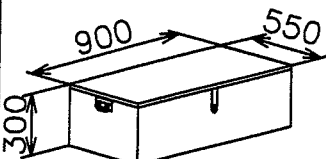
TOOLS				PAGE		1		
Exhaust-gas Turbocharger MET83SEII ()				SHIP NO.				
				BOX NO.				
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP		DRAWING		REMARKS (Kg)
				WORK-ING	SPARE	NO.	PART NO.	
T-1	Hex. Nut 六角ナット M24		Rolled Steel (SS400)	1		150-022-524-1		0.099
T-11	Hex.Bolt 六角ボルト M10×45		Rolled Steel (SS400)	2		101-510-045-1		0.042
T-12	Hex.Bolt 六角ボルト M12×20		Rolled Steel (SS400)	1		101-512-020-1		0.037
T-13	Hex.Bolt 六角ボルト M20×65		Rolled Steel (SS400)	2		101-520-065-1		0.24
T-14	Hex.Bolt 六角ボルト M24×220		Rolled Steel (SS400)	1		N36-989-3018		0.91
T-15	Hex. Bolt 六角ボルト M24×60		Rolled Steel (SS400)	4		101-524-060-1		0.345
T-16	Hex. Bolt 六角ボルト M24×50		Rolled Steel (SS400)	2		101-524-050-1		0.309
T-17	Hex. Bolt 六角ボルト M24×80		Rolled Steel (SS400)	2		101-524-080-1		0.415
MFR'S NAME & ADDRESS		NAGASAKI SHIPYARD & MACHINERY WORKS. MITSUBISHI HEAVY INDUSTRIES,LTD						

TOOLS				PAGE		2		
Exhaust-gas Turbocharger MET83SEII ()				SHIP NO.				
				BOX NO.				
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP		DRAWING		REMARKS (Kg)
				WORK-ING	SPARE	NO.	PART NO.	
T-21	Threaded Bar ねじ棒		Rolled Steel (SS400)	2		N36-989-5006		0.765
T-22	Lifting Screw 押上ボルト M24×300		Rolled Steel (SS400)	4		N36-119-0014		1.18
T-23	Lifting Screw 押上ボルト M42		Rolled Steel (SS400)	1		N36-Y09-5081		2.74
T-24	Lifting Screw 押上ボルト M16×60		Rolled Steel (SS400)	1		N36-119-516-060-1		0.128
T-25	Lifting Screw 押上ボルト M12×75		Rolled Steel (SS400)	2		N36-119-512-075-1		0.083
T-29	Hexagon. Headed Spanner 19 六角棒スパナ		Ch-Mo Steel (SCM435)	1		N36-525-298-019		0.60
T-30	Hexagon. Headed Spanner 10 六角棒スパナ		Rolled Steel (SCM435)	1		N36-525-298-010		0.103
MFR'S NAME & ADDRESS				NAGASAKI SHIPYARD & MACHINERY WORKS. MITSUBISHI HEAVY INDUSTRIES, LTD				

TOOLS				PAGE		3		
Exhaust-gas Turbocharger MET83SEII ()				SHIP NO.				
				BOX NO.				
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP		DRAWING		REMARKS (Kg)
				WORK-ING	SPARE	NO.	PART NO.	
T-32	Handle ハンドル		Cr-Mo Steel (SCM435)	1		N36-989-4002		0.12
T-35	Handle ハンドル		SGP	1		N36-989-6002		0.25
T-39	Shackle MBC 2 シャックル		Carbon Steel (S25C)	1		525-655-102		1.16
T-43	Locking Box ロッキングボックス		Carbon Steel (S45C)	1		N36-Y09-5064		27.7
T-46	Draw-Out Tube 引 抜 管		Carbon Steel Pipe (SGP)	1		N36-Y09-5068		9.21
T-47	Roller support ローラ支え台		Rolled Steel (SS400)	1		N36-Y09-1039		7.309
T-52	Guide Bar ガイド棒		Rolled Steel (SGD290-D)	2		N36-989-3025		2.63
MFR'S NAME & ADDRESS		NAGASAKI SHIPYARD & MACHINERY WORKS. MITSUBISHI HEAVY INDUSTRIES,LTD						

TOOLS				PAGE		4		
Exhaust-gas Turbocharger MET83SEII ()				SHIP NO.				
				BOX NO.				
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP		DRAWING		REMARKS (Kg)
				WORK-ING	SPARE	NO.	PART NO.	
T-60	Hydraulic Jack 油圧ジャッキ		Carbon Steel (S45C)	1		N36-Y00-0022		22.0
T-61	Hydraulic Pump 油圧ポンプ		Cr-Mo Steel (SCM435)	1		N36-Y00-0016		9.0
T-62	Rubber Hose ゴ ム 管		Rubber Pipe	1		N36-Y00-0016-17		0.4
T-63	Rotor Guide Pipe ロータガイド管		PVC	1		N36-Y09-5113		3.82
T-65	Pulling Out Tube ロータ拔出管		Carbon Steel Pipe (SGP)	1		N36-Y09-5092		10.6
T-66	Pulling Out Tube ロータ拔出管		Carbon Steel Pipe (SGP)	1		N36-Y09-5093		12.67
T-67	Stay ス テ ー		Rolled Steel (SS400)	1		N36-Y09-5080		26.5
MFR'S NAME & ADDRESS		NAGASAKI SHIPYARD & MACHINERY WORKS. MITSUBISHI HEAVY INDUSTRIES, LTD						

N36-83M-0166

TOOLS				PAGE		5		
Exhaust-gas Turbocharger MET83SEⅡ ()						SHIP NO.		
						BOX NO.		
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP		DRAWING		REMARKS (Kg)
				WORK-ING	SPARE	NO.	PART NO.	
T-76	Slinging Device つ り 金 具		Rolled Steel (SS400)	1		N36-Y09-5090		69.2
T-85	Slinging Device つ り 金 具		Rolled Steel (SS400)	1		N36-Y09-5105		193.5
T-87	Support サポ-ト		Rolled Steel (SS400)	1		N36-989-5013		18.0
	Pad-Lock 南 京 錠		Brass (BS)	1		N36-940-0001-1		0.10
	Tools Box 要 具 箱		Rolled Steel (SS400)	1		N36-501-0002-3		24.5
MFR'S NAME & ADDRESS		NAGASAKI SHIPYARD & MACHINERY WORKS. MITSUBISHI HEAVY INDUSTRIES,LTD						

OPERATION AND MAINTENANCE MANUAL FOR TURNING GEAR WITH MOTOR

NRTE – 10000 B

MANUAL

				2
				1
2006. 12. 26.	오성룡	. . .	First issued	0
Date	Prepared by	Approved by	Description	Rev.

NARA CORPORATION

CONTENTS

1. GENERAL
2. TRANSPORTATION AND INSTALLATION
3. OPERATION
4. LUBRICATION
5. INSPECTION AND MAINTENANCE
6. DISASSEMBLY AND REASSEMBLY
7. MOTOR
8. BRAKE

NARA Corporation

#1500-11, Dadae-Dong, Saha-gu, Busan, Korea,
Tel:82-(51)-264-3100, Fax:82-(51)-264-3107

1. General

The Turning Gears with Motor("Turning gear" here in after) are designed, manufactured and tested in accordance with KS, AGMA or etc, and have high strength. Even an unskilled operator can handle it easily. However, as improper handling may cause unexpected troubles, read this manual carefully. Normal torque applied to an output shaft should be kept below the rated torque. Continuous operation exceeding normal torque may shorten the service life of gears and bearings, and sometimes cause damage to them.

2. Transportation and Installation.

2-1. Transportation

When lifting Turning gear for transportation, use the eye bolt or lug attached at the top of the casing. In this case, Turning gear should be in the parallel position. The following table shows the weights of Turning gears.

Model	Weight
NRTE – 10000 B	2600 kgf

2-2. Installation

All the Turning gears should be installed in clean, dry place. If there is any excessive dust or moisture around the Turning gears, please consult us. Install Turning gear on a rigid foundation board and fasten fitting bolts and nuts tightly. Improper installation may cause abnormal noise or vibration and shorten the service life of Turning gears and other machinery.

3. Operation

3-1. Prior to initial start

Check the connections whether they are still tight enough, and make sure that none of them have loosened during transportation or storage.

Before starting the Turning gear, check whether the gear unit is properly filled with oil. (center of oil gauge)

3-2. Initial start

- Check the operation of brake and the running direction of motor.
- When the Turning gear is started up for the first time, it should, if possible, run without load at least for two hours, checking abnormal noise, abnormal vibration and any other possible problems. If no irregularities are noticed, increase the load gradually.
- As testing drive, operate it with rated load for 30 minutes. meanwhile, any abnormal noise and abnormal vibration should not be noticed.
Check exceeding heat of bearing(below 90°C).
- Turning gear out of operation for a long time should, if possible, be operated without load for a hour every 3 weeks. If it is impossible, the turning gear must be protected against corrosion.
- If you want to make the Turning gear run in the opposite direction, at first you should stop operating so that the turning gear is not overloaded.

4. Lubrication

4-1. Lubrication system

The general lubrication method of Turning gears is oil bath system, i.e. all components in the gear units are lubricated by splashed oil during operation.

4-2. Oil filling

- Before starting up, all gear units except grease-lubricated types must be filled with oil to the correct level. (Center of oil gauge.)
- The gear oil should be poured into the gear unit through the oil filler plug hole or air vent hole. Only fresh, clean, unspoilt oil must be used.

- The selection of oil depends on oil viscosity according to the normal operating condition with ambient temperatures between -10°C and +50°C. (refer to Table -I.) If ambient temperatures below -10°C and above +50°C or extreme fluctuations of temperatures or external heat sources, please consult us.
- It is permissible to use the equivalent oils of other manufacturers provided in Table -I.

- Lubricant selection table

(Table -I.)

Viscosity ISO-VG (mm ² /s)	Ambient temperature (°C)	M A K E R						
		ARAL	B. P	EXXON	MOBIL	SHELL	FAMM	SK
VG 320	-10°C ~ +50°C	Aral Degol BG 320 BMB 320	BP Energol GR-XP 320	SPARTAN EP 320	Mobilgear 632	Shell Omala Oil 320	Meropa 320	SUPER GEAR EP 320
VG 220	-10°C ~ +50°C	Aral Degol BG 220 BMB220	BP Energol GR-XP 220	SPARTAN EP 220	Mobilgear 630	Shell Omala Oil 220	Meropa 220	SUPER GEAR EP 220
GREASE		Aralub HL 3	BP Ener- Grease L33 LS 2	BEACON 3	Mobilux 2	Shell Alvania Grease R 2	Multifak 2	Y.K.Crown Grease EP2

- Model and Quantity of oil (Type for standard)

MODEL	OIL Q'TY IN REDUCER (l)	GREASE Q'TY IN END SUPPORT(gf)
NRTE – 10000 B	APPROX. 35	APPROX. 500

4-3. Oil change

- It is commonly recommended to change the lubricating oil after 50 operating hours for the first time. Subsequent oil changes must be made once a year, depending on working conditions or ambient temperatures.
- By oil changing, the gear unit should be refilled with the same grade of oil used previously. In that case, previous oil should be removed completely.

- The gear unit is initially filled with FAMM 「Meropa 320」 from the company.

5. Inspection and maintenance

It is recommended that a general inspection routine be established to check periodically the following items.

- 1) Cleanliness
- 2) Lubrication
- 3) Noise and vibration

5-1. Cleanliness

- The exterior of the Turning gear should be kept free from such foreign materials as dirt, oil and grease, or etc. They may build up on the exterior of the Turning gear and impair oil seal, leading to oil leakage.
- The dusty air breather(or air vent) may cause pressure rise inside of gear unit while running. It must be always cleaned and checked whether the filter of it is free of dust and pollutions.

5-2. Lubrication

- Oil filling and change must be carried out in accordance with section 4-3. If it is not kept, the life of Turning gear as well as the life of bearing may be shorten.
- Make sure that the oil level is at the correct height. (Center of oil gauge.)

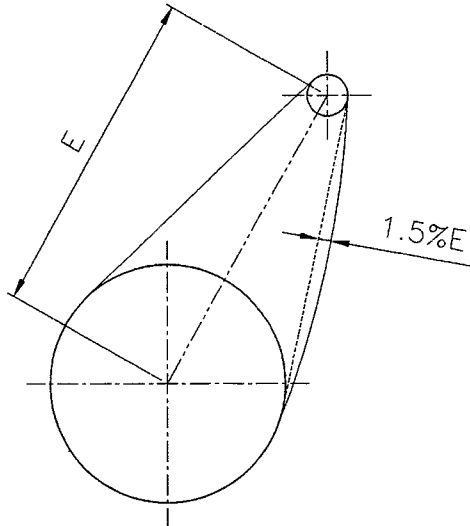
5-3. Noise and vibration

- When any abnormal noise or vibration happens, please consult us.

5-4. Adjustment of Roller chain.

5-4-1. Roller chain has to be tensile-loaded until chain's roller contacts to the root of teeth.

5-4-2. The amount of slack should not be exceeded 1.5% of the center to center distance of sprockets.



Model	1.5%E [mm]
NRTE-10000B	11

6. Disassembly and reassembly

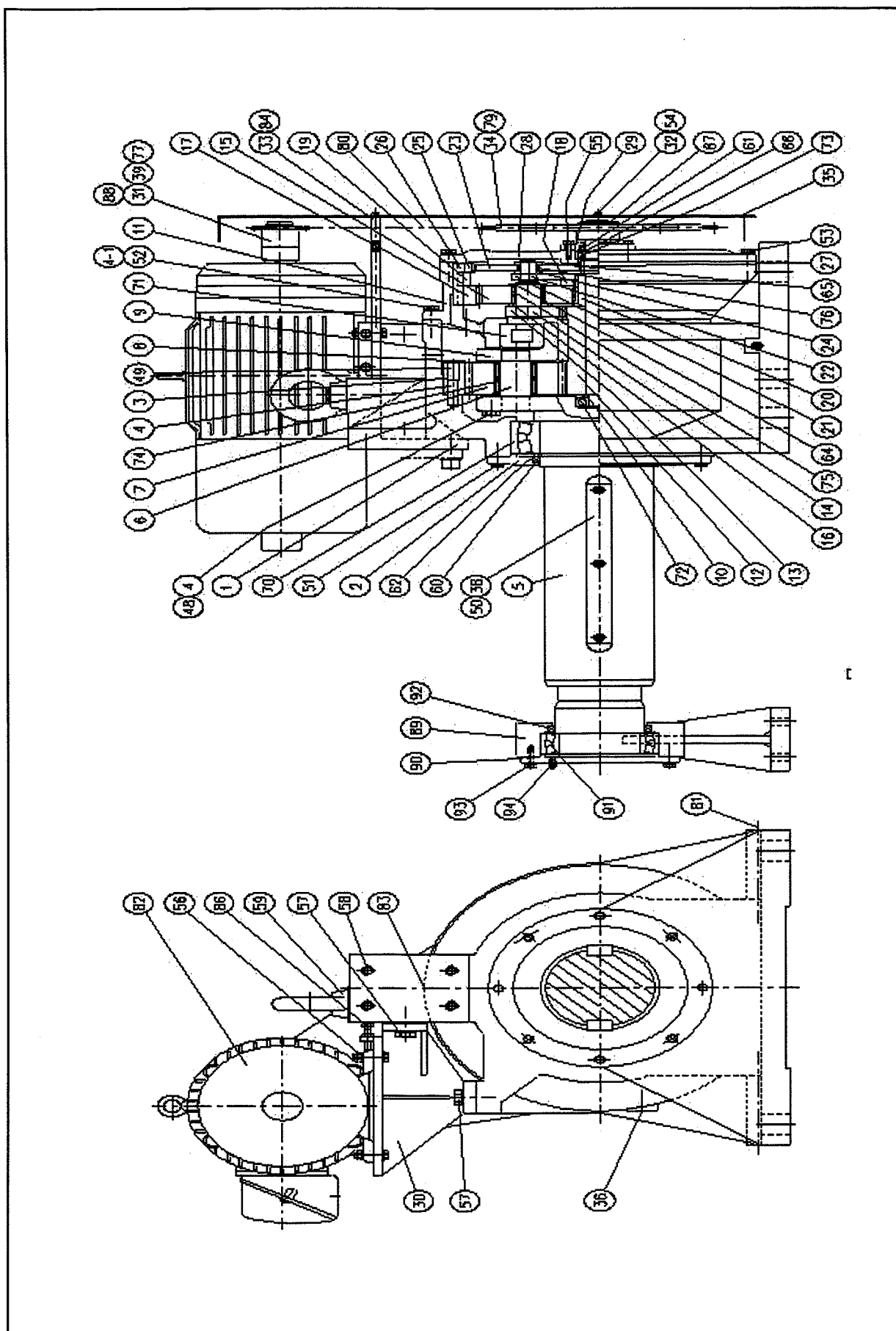
6-1. Disassembly

- Disassemble Turning gear after full comprehension of it's construction in accordance with the attached assembly section drawing.
- Make clear the purpose of disassembly in order to minimize parts to be disassembled.
- If there is no match mark on a part to be disassembled, disassemble Turning gear after marking.
- Never strike parts strongly nor pull them by force.
- If problems occur during disassembly, do not continue disassembly forcibly. Repeat disassembly after careful inspection or consulting us.

6-2. Reassembly

- Carry out reassembling normally in the reverse order of disassembling.
- Reassemble parts after washing them carefully with cleaning oil and applying machine oil or lubrication oil.
- When fitting a new bearing to the shaft, heat it in oil bath maintained of 100°C ~ 120°C and then set.
- Special care is required when fitting oil seals in order to avoid damage to the sealing lips. Damaged oil seals are the cause of leakage. When inserting an oil seal, apply grease to the shaft for smooth installation of seal. If possible, it is recommended to replace the oil seals with new ones.
- After reassembly, make certain whether the motor shaft can be rotated by hand smoothly.

Assembly Drawing (NRTE- 10000 B)



Parts list (NRTE- 10000 B)

Part No.	NAME OF PARTS	Part No.	NAME OF PARTS	Part No.	NAME OF PARTS
1	CASE	29	BEARING COVER (小)	70	ROLLER BEARING
2	BEARING COVER (大)	30	MOTOR BED	71	ROLLER BEARING
3	3RD INTERNAL GEAR	31	SPROCKET (小)	72	BALL BEARING
4	DOWEL PIN	32	SPACER	73	BALL BEARING
4-1	DOWEL PIN	33	SPACER	74	3RD NEEDLE BEARING
5	OUTPUT SHAFT	34	SPROCKET (大)	75	2ND NEEDLE BEARING
6	3RD PIN	35	CHAIN COVER	76	1ST NEEDLE BEARING
7	3RD IDLE GEAR	36	OIL GAUGE	77	KEY
8	3RD COLLAR	38	KEY (大)	79	KEY
9	3RD CARRIER	39	SPACER	80	CHAIN
10	SPACER	48	HEX'BOLT, W	81	DRAIN PLUG
11	GEAR CASE	49	HEX'BOLT, W	82	BRAKE MOTOR
12	3RD SUN GEAR	50	HEX'BOLT, W	83	AIR VENT
13	2ND CARRIER	51	HEX'BOLT, W	84	HEX'BOLT, W
14	2ND PIN	52	HEX'BOLT, W	86	HEX'BOLT, NUT
15	2ND IDLE GEAR	53	HEX'BOLT, W	88	SET SCREW
16	2ND COLLAR	54	HEX'BOLT, W	89	END SUPPORT
17	2ND INTERNAL GEAR	55	HEX'BOLT, W	90	END COVER
18	SPACER	56	HEX'BOLT, NUT, W	91	ROLLER BEARING
19	SPACER	57	HEX'BOLT, W	92	OIL SEAL
20	2ND SUN GEAR	58	WRENCH BOLT, W	93	HEX'BOLT, W
21	1ST CARRIER	59	EYE BOLT	94	GREASE NIPPLE
22	1ST PIN	60	OIL SEAL		
23	1ST IDLE GEAR	61	OIL SEAL		
24	1ST COLLAR	62	SNAP RING		
25	1ST INTERNAL GEAR	64	SNAP RING		
26	KEY (小)	65	SNAP RING		
27	1ST INPUT SHAFT	66	SNAP RING		
28	FRONT COVER	67	SNAP RING		

AB-1 Type indicator valve

Instruction manual

The indicator valve is equipped on the cylinder cover so as to measure the pressure in the cylinder during engine operation. You attach the indicator to the gas taking out part and turn the hexagonal part of the valve guide (3) clockwise, when you measure the pressure in the cylinder.

The valve body (1) is made of special cast iron and threaded on the gas taking out part to permit the indicator being screwed into it. The valve spindle (2) and the valve seat (4) are located midway in a gas passage cut through the valve body.

Since soot and oil adhere to the gas passage of cylinder cover for taking indicator diagram, before attaching the indicator to the valve, open the indicator valve slightly and blow off adhesion particles. The blowing off period should be in once or twice combustion in each cylinder. Keep the Cap (9) on except measuring, so as to protect from the dust.



CAUTION

Keep your body (especially your face and hands) off from the gas outlet of the indicator valve because high pressure gas blows off when opening indicator valve during engine operation.



CAUTION

Don't touch the indicator barehanded when it is running or just after running, because it would be too hot.



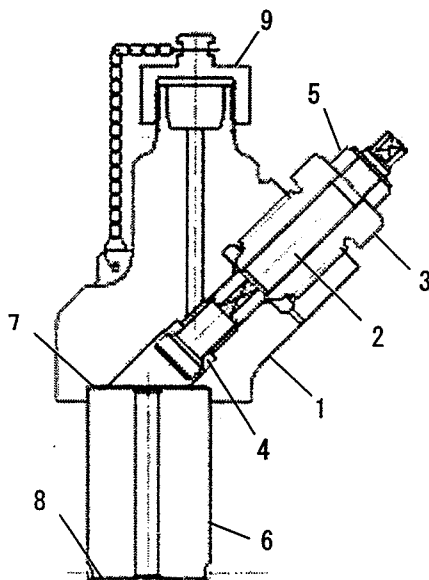
NOTE

Keep the indicator valve fully open when turning, air-running or overhauling.



NOTE

Turn the valve guide (3) when measuring the pressure. Don't turn the U Nut (5). In case you turn the U Nut (5), the gas may be leak.



Name of parts

1. Valve body
2. Valve spindle
3. Valve guide
4. Valve seat
5. U Nut
6. Piece
7. Gasket
8. Gasket
9. Cap



Inspection and adjustment

1. Inspect the indicator valve at regular intervals. (every 2000 ~ 4000h)
2. Taking apart of the indicator. (Refer to Fig.A)
 - ① Take the indicator off from the engine.
 - ② Remove the U nut (5).
 - ③ pull out the valve spindle (2) from the lower side of the valve body (1).
3. Check the seat for contact marks and sulfuric acid corrosion.
If the seat contact is bad, you should lap the seat. (Refer to Fig.B)
If it has corrosion, you have to get the new one.
4. Check the gas path for clogging and sulfuric acid corrosion.
If it has clogging, you should clean the gas path with the compressed air.
If it has corrosion, you have to get the new one.
- ◎ If you need to remove the valve seat, work as follows.
5. Remove the valve seat (4) (Refer to Fig.B)
 - ① Attach the guide (a) with the washer (b) into the valve body (1).
 - ② Use the nut (e) to slide the sleeve (c) and spread the washer (b).
 - ③ Use the valve guide (3) to remove valve seat. (4)
6. Assemble the valve seat (4) (Refer to Fig.C),
 - ① Attach the guide (a) with the washer (d) and the valve seat (4) into the valve body (1).
 - ② Use the nut (e) to Assemble the valve seat (4).
7. Assembly of the indicator.
 - ① Turn the valve guide (3) clockwise to stop. (Full open.)
※In case you assemble the indicator without turning the valve guide (5) to open, the valve seat may be bad condition.
 - ② Insert the valve spindle (2) into the body from the lower side.
 - ③ Fasten the valve spindle (2) and the valve guide (3) with the U nut (5).
※Fasten the U nut (5) tight, so as not to leak the gas.
※Confirm the tightness of U nut (5) with the valve guide (3) is fully open.
 - ④ Install the indicator on the engine.
※Be careful not to exchange between gasket (7) and (8), because their hole are not same.

Tools:

- a. Guide
- b. Piece
- c. Sleeve
- d. Washer.
- e. Nut.

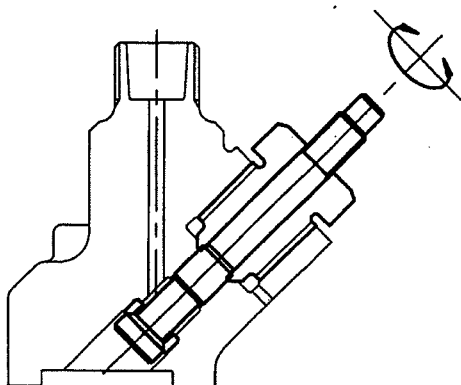


Fig. A

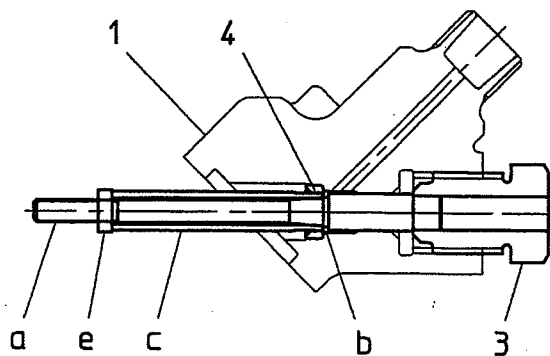


Fig. B

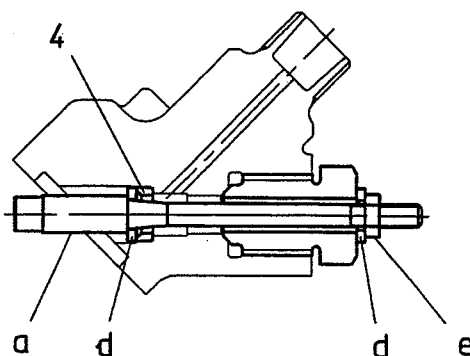


Fig. C

REVISION NOTE		
No.	DATE	P.I.C
◇		
◇		
◇		

OPERATION MANUAL

CHIEF OF DEPT.		MESSRS. MITSUBISHI HEAVY INDUSTRIES CO., LTD. KOBE DOCKYARD	WORK No.
CHIEF OF SEC'	A.Kitahara		
CHECKED BY	A.Kawakubo	11RT-Flex96C SHL6-67/R240B/2 & CH6S-1903F/R240B/4	SO/11-11706
CHECKED BY	K.Minagawa	FOR FRESH WATER	
DRAWN BY	S.Abe	AIR COOLER	DRAWING No.
DATE DRAWN	2007-3-28		B-1754E
SUCTION GAS ENGINE MFG. CO., LTD.			
TOKYO JAPAN		SEC.	DEPT.

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1. SAFETY PROCEDURE

1.1 General

Most accidents which occur during the operation and maintenance of the unit are the result of failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing a situation that is potentially hazardous.

When handling, operating or carrying out maintenance on the unit, operator must use safety engineering practices and observe all relevant local health and safety requirements and regulations.

1.2 Symbols on Safety

The following symbols are displayed on the unit and in the text of the manual to call attention to operations or procedures for the purpose of protecting operators as well as preventing damage to other persons, the unit or other properties in advance.

Indication	Meaning of the indication
 WARNING	It shows the contents related to Riskiness of Death or Heavy Injury in case of Incorrect Operation.
 CAUTION	It shows the contents related to Riskiness of Injury or Damage to the Unit or Other Properties in case of Incorrect Operation.

1.3 Warnings (Fundamental Warnings)

 WARNING
1) In lifting whole unit, use only lifting eye plates (eye bolts) fitted to the side plate (the casing), and do not use any eye plates fitted in headers (water chambers). 2) Carry out lifting operation horizontally, keeping balance. 3) In case of lifting the unit, stay clear of the danger area beneath and around it. Never enter the area.

1.4 Cautions (Fundamental Cautions and Cautions on Handling of The Unit)

⚠ CAUTION

- 1) Do not use the unit for other purposes than specified in the specification or rules.
- 2) Do not touch the unit with high temperature with bare hands during operation.
- 3) Do not touch the fins of the element with bare hands.
- 4) Do not stand in front of drainage or air vent.
- 5) To protect tubes from corrosion, closing or damages, the following procedures should be carried out.

◎Cooling and Feed Water Side

- ① Use only clean fresh water without any foreign particles (e.g. solids of sands, vinyls, small wooden tips etc.) or corrosive components (e.g. ammonia, sulfuretted hydrogen etc.).
- ② Operate the unit with correct volume of fresh water.

Water Velocity Heat Transmission Tube C7060T 0.7~2.5m/s
Avoid abrupt change of fresh water volume during operation.

◎Air Side

Since intake air is exposed to contamination by such corrosive components as sulfurous acid gas and ammonia gas, pay attention to make air intake circumstance clean. Once contaminants are taken into intake air, they are condensed at the drain and cause corrosion to tubes.

2. OUTLINE

The feed water heater is a heat exchanger for heating boiler feed water at the specified temperature with the air supplied to the diesel engine, and boiler feed water flows on the inside of the fin tubes, while the air flows along the outside of the fin tubes.

The air cooler is a heat exchanger for cooling the air supplied to the diesel engine at the specified temperature, and cooling water flows on the inside of the fin tubes, while the air flows along the outside of the fin tubes.

3. CONSTRUCTION (Refer to The Assembly Drawings)

This unit has a combined construction of a feed water heater and an air cooler. Against the current of air, a feed water heater is provided at front side and an air cooler at back side. Their tube bundles are contained in one piece of casing and the tube bundles can be drawn out separately from the casing.

The heat transmission tubes are composed of fin tubes with fins on the outside. Both ends of the heat transmission tubes are installed in the tube sheets by tube expansion. The tube sheets are bolted via gaskets to the casing.

The cooling and feed water inlet header and the cooling and feed water return header are bolted via gaskets to the respective tube sheets.

The header flanges are provided with threaded holes for push bolts, and they can be disassembled easily by use of push bolt.

⚠ WARNING

In case of lifting whole unit, carry out lifting operation keeping balance horizontally, by using eye plates (eye bolts) fitted to side plate (casing). Losing balance may cause dropping.

4. STORAGE

When the air cooler and the feed water heater are not used immediately after installation or are kept for long storage, they should be stored in consideration of the following items.

⚠ CAUTION

In case of long storage, check the air cooler and the feed water heater every three months, because corrosion may occur by storage conditions.

4.1 Management of Air Side

- 1) Execute storage at a clean and dry place.
- 2) Cover the unit by sheet to protect it from dust.
- 3) Storage outdoors or in moist places must be avoided.
- 4) Storage in atmospheres with ammonia or other agents having a bad influence onto copper alloys must be avoided.

4.2 Management of Cooling and Feed Water Side

- 1) The cooling and feed water inlet and outlet flanges should be covered with sheets to prevent entry of dirt, dust etc.
- 2) When anticorrosion paint (or rubber lining, Neoprene coating etc.) has been applied to the header inside, care should be taken not to damage it.
- 3) When the cooler and the heater has been stored or not operated for a long time after trial operation or filling with water, the entire cooling and feed water should be drained from the cooler and the heater.

⚠ CAUTION

When industrial water etc. remains in the heat transmission tubes, it will evaporate and concentrate and become a cause for corrosion (breakage, holes) of the heat transmission tubes because of its corrosive components, so that care is required.

5. INSTALLATION

On the occasion of installation, attention should be paid to following items.

- 1) Nozzles, cooling and feed water piping, and air ducts surface etc. should be jointed correctly, and never joint them in wrong position by force.

⚠ CAUTION

Irregular stress left in connecting surface causes cracks at nozzle base or leaking from joints.

- 2) When the installation method is bad, air may leak from the duct connection surfaces or water may leak from the header flange surfaces, so that sufficient care is required.
- 3) Special care is required for parallelity of the duct connection surfaces and the piping connection surfaces.
- 4) When installation is not made on a support or a duct with sufficient strength, the air cooler and the feed water heater may be destroyed by abnormal vibrations.

6. OPERATION

⚠ CAUTION

- 1) In operation, fluid and various conditions should be ones specified in the specification. Different condition from the design specification causes lower performance and corrosion.
- 2) Be sure to confirm that there are no looseness on connecting bolts and nuts before starting in case of first operation after a long storage.

For operation of the feed water heater and the air cooler, conform to the following sequence.

6.1 Operation at Water Side

6.1.1 Feed Water Heater

⚠ CAUTION

Boiler feed water of same quality as JIS B8223 or higher quality should be used for feed water heater.

1) Starting of Operation

- ① Start the water flow to the feed water heater.

⚠ CAUTION

At the start of the water flow, open the air vent valve (or cock) of the header (water chamber), and vent the air until the air bubbles disappear from the escaping feed water. When this is neglected, air will remain in the feed water inside the feed water heater, which will not only impair the performance, but also may cause accidents during operations, so that special care is required.

- ② When the feed water heater is filled with feed water, close the air vent valve (or cock).
- ③ After confirming the flow volume and pressure of feed water, start the air flow in air side.

2) Confirmations at Initial Stage of Operation and Control While Operating

After the pressure has been raised to the specified pressure, confirm that there are no abnormalities in regard to bolts, nuts and gaskets. If water should be leaking from the gaskets, retighten the bolts and nuts after stopping operation and decreasing pressure and temperature. Concerning the sequence of retightening, refer to the paragraph 7.5.

At the time of operation after a long storage, gaskets might have deteriorated, so that before starting operation, exchange them for spare gaskets.

⚠ CAUTION

- 1) During operation, do not exceed maximum working pressure (design pressure) in feed water heater and connecting tube.
- 2) Control must be exercised in such a way that the flow speed and volume inside heat transmission tube in feed water heater does not exceed maximum allowable value. If the flow speed is too high, erosion of heat transmission tube will be caused, so that be sure to observe the maximum allowable value.

6.1.2 Air Cooler

⚠ CAUTION

Cooling water to be used for air cooler should be used normal fresh water unless otherwise specified in the order sheet.

1) Starting of Operation

- ① Start the water flow to the air cooler.

⚠ CAUTION

At the start of the water flow, open the air vent valve (or cock) of the header (water chamber), and vent the air until the air bubbles disappear from the escaping cooling water. When this is neglected, air will remain in the cooling water inside the air cooler, which will not only impair the performance, but also may cause accidents during operations, so that special care is required.

- ② When the air cooler is filled with cooling water, close the air vent valve (or cock).
- ③ After confirming the flow volume and pressure of cooling water, start the air flow in air side.

3) Confirmations at Initial Stage of Operation and Control While Operating

After the pressure has been raised to the specified pressure, confirm that there are no abnormalities in regard to bolts, nuts and gaskets. If water should be leaking from the gaskets, retighten the bolts and nuts after stopping operation and decreasing pressure and temperature. Concerning the sequence of retightening, refer to the paragraph 7.5.

At the time of operation after a long storage, gaskets might have deteriorated, so that before starting operation, exchange the gaskets for spare gaskets.

⚠ CAUTION

- 1) During operation, do not exceed maximum working pressure (design pressure) in air cooler and connecting tube.
- 2) Control must be exercised in such a way that the flow speed and volume inside heat transmission tube in air cooler does not exceed maximum allowable value. If the flow speed is too high, erosion of heat transmission tube will be caused, so that be sure to observe the maximum allowable value.

6.2 Operation at Air Side

1) Starting of Operation

After confirming that the feed water side and the cooling water side in the feed water heater and the air cooler is under normal operation, start the air side operation with the specified air temperature, pressure and flow volume.

2) Confirmations at Initial Stage of Operation and Control While Operating

Confirm that there is no air leaking from the joints of casing and duct contained in the air cooler and feed water heater.

Be sure to execute control on flow volume, pressure and temperature of air.

After starting operation at air side, check whether or not the connections at water side and air side are positive.

6.3 Repairing Failures

Failure	Possible Cause	Action required
Leaking form gaskets	• Insufficient tightening of bolts and nuts • Creep of gaskets	Additional tightening of bolts and nuts
	Damage of gaskets	Replace of gaskets
Damage of tube		Plug both tube ends
Leaking from tube expansion	Insufficient tube expansion	Expand tube again by expander
High air outlet temperature	• Scale piling up inside tube • Dirt of fin tubes surface	• Clean tube inside • Clean tubes outside

6.4 Stopping of Operation

In case of stopping the unit, stop the air side first, and then stop the water side after supplying water for 20–30 minutes to prevent overheating of the cooling surface. When several days or long period stopping is required, open the drain valve or plug at the lowest part of header and drain water completely from the unit to prevent corrosion or freezing in winter season.

7. MAINTENANCE AND INSPECTIONS

⚠ CAUTION

Do not loosen any bolts and nuts at connecting part, until all pressure of the unit is taken away and then cooling and feed water is completely ejected and temperature goes down. Because there is a risk of water blowing or burn.

7.1 Heat Transmission Capacity

- 1) With use for a long term, the heat transmission performance may drop due to dirt piled up at cooling and feed water side and air side. As the following items are criteria for the confirmation of a performance drop, the performance during operation should be grasped.

- ① Temperature difference between inlet and outlet of air and cooling and feed water

- ② Pressure loss of air side and water side

When lower performance has been confirmed, execute cleaning (refer to the paragraph 7.2, 7.3).

- 2) The air cooler has been designed to have a sufficient cooling effect for improvement of the engine performance, but drain may be caused on the air side by excessive cooling with high humidity in summer or with a low cooling water temperature in winter.

When drain is confirmed, adjust the cooling water flow volume.

7.2 Cleaning of Air Side

- 1) Slight dirt can be removed with compressed air.
- 2) As for dirt due to oil and grease which can not be removed with compressed air, replace the air cooler or the feed water heater and clean it with steam blasts (steam of 3~7kgf/cm², 150°C or less, or hot water and compressed air).
- 3) Chemical cleaning must be carried out only in case it is impossible to clean by the above-mentioned methods. Select the appropriate solution for the material of the heat transmission tubes and precede handling manual by chemical solution manufacturer. Recommended chemical cleaning agent is listed in the paragraph 7.9.

△ CAUTION

Chemical cleaning should be carried out with consultation and instructions by chemical solution manufacturer or chemical cleaning specialist, and should not be carried out individually.

- 4) After finishing cleaning, be sure to clean the element with fresh water and neutralize it if necessary.
- 5) If breaking away or small expansion is recognized in painting of side plate

etc., repair it by using tools etc. and re-paint.

7.3 Cleaning of Cooling and Feed Water Side

Dirts at cooling water side and feed water side is mainly piling up of deposit. As it is the cause of the performance drop, carry out following cleaning procedures.

- 1) Drain away water in the air cooler or feed water heater completely.
- 2) Remove headers from the air cooler or the feed water heater and brush the header inner surface with fresh water. If the flange surface is hard to disassemble on account of sticking, separate them by using push bolts.
- 3) While the inside of tubes is wet, insert the nylon brush into the heat transmission tube and reciprocate it for a few times to remove scales. Do this cleaning to all tubes. After removing scales in the above method, pour hot water or pressured water into tubes to clean remaining particles.
- 4) Chemical cleaning is not recommended. Only in case the above-mentioned cleaning methods are not effective, do chemical cleaning by chemical cleaning agent listed in the paragraph 7.9 in accordance with instructions.

⚠ CAUTION

If chemical cleaning fails, the tubes and others will be damaged, resulting in shortening the life of the unit markedly. If you have no experience in chemical cleaning, consult with or depend on the manufacturers.

7.4 Inspection of Element

At periodical inspection or cleaning, inspecting for following items is required.

- 1) An irregular distortion of an element
- 2) Bending or damages of fins

⚠ CAUTION

Do not touch fins directly with bare hands, or they may cut fingers or hands.

- 3) Irregularity or lacking on other components

7.5 Gaskets and O-rings

Gaskets and O-rings and rubber lining are fitted at every connection of components to sustain air tightness.

⚠ CAUTION

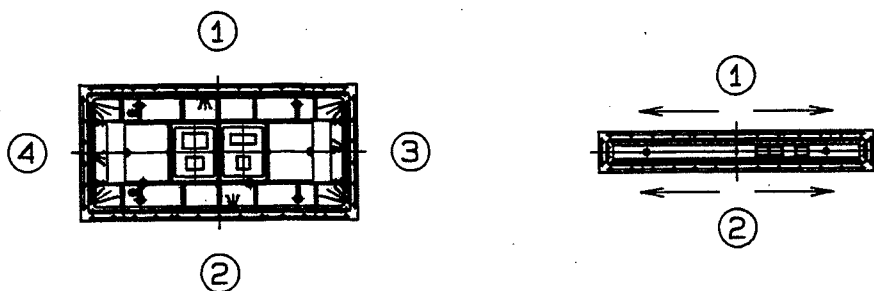
Because of their characteristics and sufficient tightening strength, gaskets and O-rings and rubber lining will not leak with normal operation, but slow creep may occur for gaskets and O-rings and rubber lining with the passage of time during storage without use or at the time of stop, so that the clamping pressure of the gaskets and O-rings and rubber lining may decrease. In order to prevent the leakage troubles for gaskets and O-rings and rubber lining by this phenomenon, the bolts should be retightened.

Execute bolt tightening for air cooler in the sequence of 12 o'clock, 6 o'clock, 3 o'clock, and 9 o'clock as shown in the left drawing. Concerning the sequence of retightening for header of feed water heater, execute bolt tightening in such a way that distributes equally in the direction of left side and right side after starting from 12 o'clock or 6 o'clock of the center line, as shown in the right drawing.

In regard to the tightening torque of setting bolts for header, it is recommended to tighten bolts with approximately 1400 kgfcm in case of air cooler, with approximately 2100~2300 kgfcm in case of feed water heater.

However, on feed water heater, the pressure of the feed water side is high, so that execute bolt retightening in the above sequence after holding the unit in the present condition for about 24 hours after setting of the header.

- 1) Replace gaskets and O-rings at the joint for new ones after disassembling for inspection, cleaning and so on. Even in case of no disassembling, replace gaskets and O-rings at periodical inspection with new ones in order to prevent the leakage by the change with the passage of time.
- 2) Apply gasket paste (non-dry type) to joint gaskets. Plaster gasket paste to both sides of gasket thinly. Careful handling is required so that too much paste may bring contrary effect.



7.6 Repair of Coating on Inside of Header (Air Cooler)

- 1) In case the inside of the header (water chamber) is coated with Neoprene, Hypalon, Tar epoxy etc. for protection against corrosion by the cooling water, the inside coating should be inspected at the time of header disassembly for inspection, cleaning etc., and any damage should be repaired immediately.
- 2) As the coating is applied up to the flange surface, careful handling is required at the time of disassembly so that the surface will not be damaged.

⚠ CAUTION

When operation is continued with damage lining, local corrosion will occur for the damaged part, and the header will be destroyed.

7.7 Use of Blind Plugs for Heat Transmission Tubes

When the heat transmission tube becomes broken because of corrosion or other reason, use the blind plugs in the spare parts tool box to plug both ends of the heat transmission tube.

The blind plugs should be installed according to the following sequence.

- 1) Drain the water completely from the header.
- 2) Remove the header installation bolts (nuts), and remove the header. When removal is difficult, push bolts should be used.
- 3) Drive the blind plugs into both ends of the broken heat transmission tube.

7.8 Disassembly and Reassembly

⚠ WARNING

- 1) Lifting tools of the correct capacity for the total weight of the cooler or the heater should be used. Incorrect lifting tools may cause dropping of the unit, because of detachment of the tools. (Regarding weight of the

unit, refer to the name plate or the assembly drawing.)

- 2) In case of lifting whole unit, use only lifting eye plates (eye plates) fitted to the side plate (the casing), and never enter the danger area beneath the unit. Its area is in danger of dropping of the unit.
- 3) In case of lifting the unit, carry out lifting operation keeping balance horizontally. It is in danger of accident caused by abrupt inclination etc. of the unit.

- 1) Disassembly is required in case of cleaning at the cooling and feed water side and replacement of the gaskets and O-rings. Carry out following procedure.

- ① Remove all pipes and most of connecting nuts to the header but leave approximately four nuts to prevent dropping.
- ② Screw two push bolts into two or four screw holes for jack bolt which are tapped at header flange surface and make a space between the tube sheet and the header.
- ③ In the above step, the header is usually removable from the tube sheet. If it is difficult to remove, insert a thin steel plate into a space jacked up and make a space wider with attention not to damage flange surface.

- 2) In case of reassembly, clean the installing surface of gasket sufficiently and tighten the bolts (or nuts) after reassembling the header. In this time, replace gaskets and O-rings at the joint for new ones.

The bolts (or nuts) for air cooler should be tightened in a sequence of 12 o'clock, 6 o'clock, 3 o'clock, and 9 o'clock as shown in the left annexing drawing of the paragraph 7.5. Concerning the sequence of tightening for header of feed water heater, execute bolt tightening in such a way that distributes equally in the direction of left side and right side after starting from 12 o'clock or 6 o'clock of the center line, as shown in the right annexing drawing of the paragraph 7.5.

In regard to the tightening torque of setting bolts for header, it is recommended to tighten bolts with approximately 1400 kgfcm in case of air cooler, with approximately 2100~2300 kgfcm in case of feed water heater.

- 3) On feed water heater, the pressure of the feed water side is high, so that execute bolt retightening in the above sequence after holding the unit in the present condition for about 24 hours after setting of the header.
- 4) Hydrostatic test after reassembly should be carried out by the hydrostatic test pressure described in the name plate of the unit. In this case, the test pressure should be gradually increased because of possibility for decrease

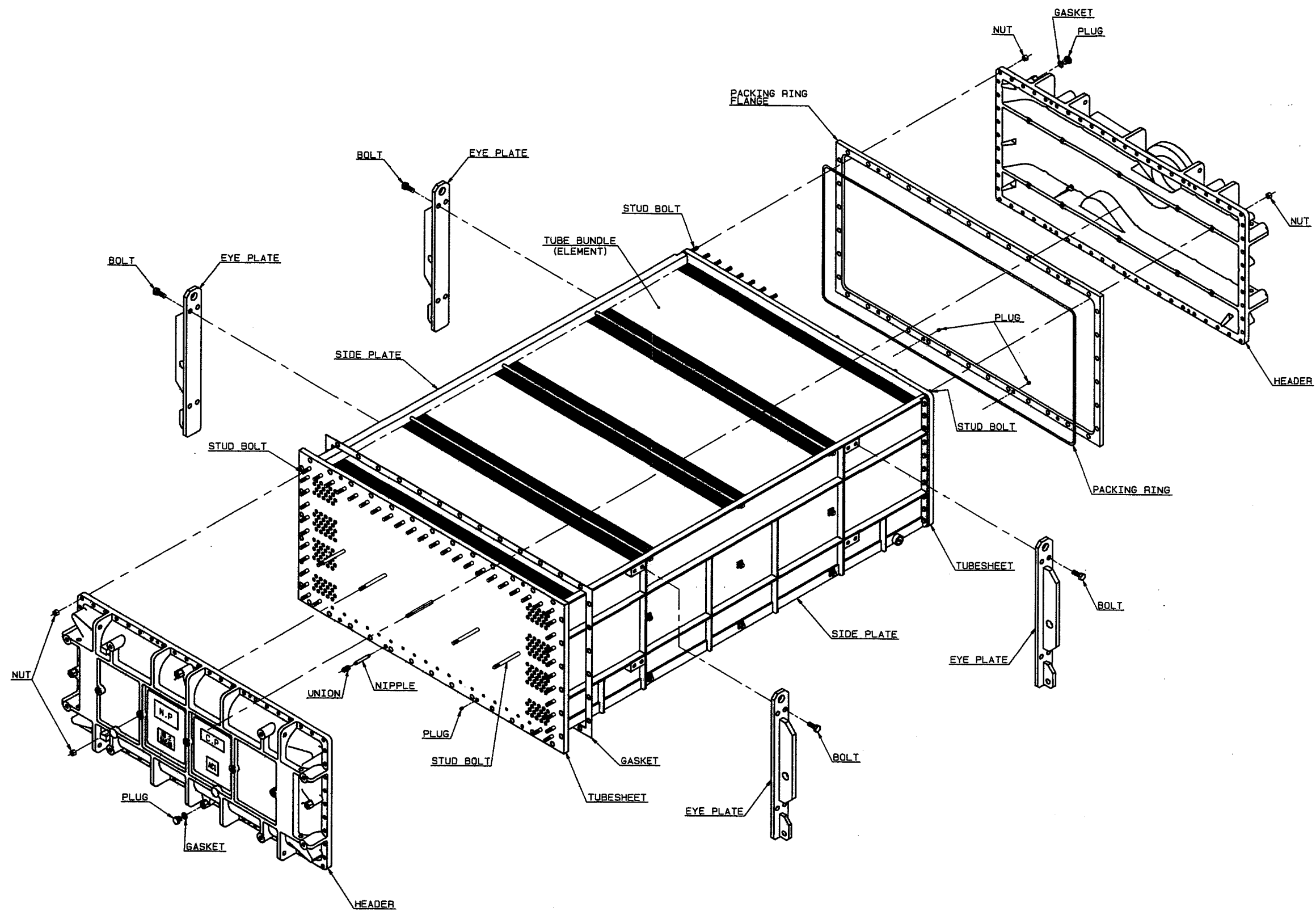
of the thickness of the header inside, and pay attention to the strain of the header.

- 5) Hold the unit in the present conditions more than 24 hours if possible after hydrostatic test, and then retighten all connecting bolts in the above sequence.

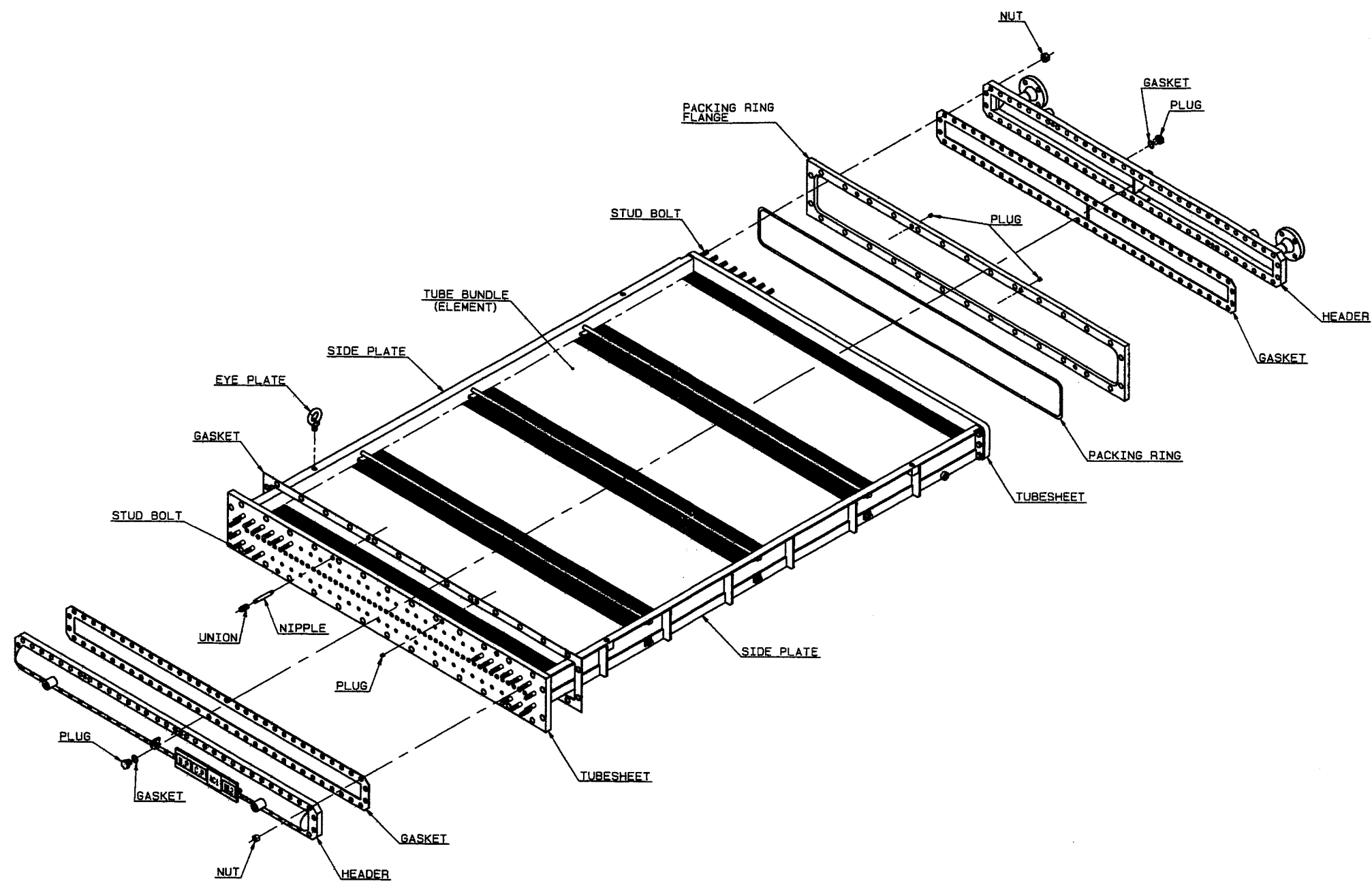
7.9 List of Chemical Cleaning Agent

We recommend you to use the following chemical cleaning agents when chemical cleaning is done.

	Cleaning agents	Maker
COOLING WATER SIDE	NEOS CM305D	NEOS CO., LTD. Sanwa Bldg. 1-27-17, Hamamatsu-cho, Minato-ku, Tokyo, Japan Tel: +81-3-3434-7821, Fax: +81-3-3434-7897
	SAF-ACID	DREW AMEROID JAPAN CO., LTD. Minatoise Bldg. 3-12-1, Kaigandori Naka-ku, Yokoyama-shi, Japan Tel: +81-45-212-4741, Fax: +81-45-212-4754
	MAGNUS-SSS	PARKER CORPORATION Parker Corp. Bldg. 2-22-1, Ningyo-cho Nihonbashi, Chuo-ku, Tokyo, Japan Tel: +81-3-5644-0650, Fax: +81-3-5644-0651
	“SEA SHIELD” SAFE ACID 79116	ONDEO NALCO JAPAN CO., LTD. Higashinihonbashi Sky Bldg. 6F, 1-1-7, Higashinihonbashi, Chuo-ku, Tokyo, Japan Tel: +81-3-5821-5670, Fax: +81-3-5821-5661
	DESCALEX	UNITOR SHIPS SERVICE JAPAN CO., LTD. 12-31, Torihama-cho, Kanazawa-ku Yokohama-shi, Japan Tel: +81-45-775-0011, Fax: +81-45-775-0070
AIR SIDE	NEOS A	NEOS CO., LTD.
	ACC 9	DREW AMEROID JAPAN CO., LTD.
	MG-ACC	PARKER CORPORATION
	“SEA SHIELD” ACC 79101	ONDEO NALCO JAPAN CO., LTD.
	AIR COOLER CLEANER	UNITOR SHIPS SERVICE JAPAN CO., LTD.



MARK	PARTICULARS	MATERIAL	REVISIONS	DATE	REMARKS
	R240B TYPE (AC1)		AE	1/10	
AIR COOLER ASSEMBLY					P-67897
DATE DRAWN	DRAWN BY	CHECKED BY	CHECKED BY	GROUP OF MFG.	GROUP OF DEP'T.
2007-3-28	S. Abe	K. Minagawa	A. Kawakubo	A. Kitahara	
SUCTION GAS ENGINE MFG. CO., LTD.					SEC. DEP'T.



MARK	PARTICULARS	MATERIAL	QUANTITY	REMARKS
	R240B TYPE (AC2)	AE	1/10	
	FEED WATER HEATER ASSEMBLY	P-67899		
DATE DRAWN	DRAWN BY	CHECKED BY	CHECKED BY	DATE OF DEP'T
2007-3-28	S. Abe	K. Minagawa	A. Kawakubo	A. Kitahara
SUCTION GAS ENGINE MFG. CO., LTD.				
SEC. DEP'T.				



INSTRUCTION MANUAL

AUTOMATIC FILTER

6.61.1 series

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Manufactured by

BOLL & KIRCH Filterbau GmbH



DESCRIPTION AND OPERATING INSTRUCTIONS FOR THE BACK-FLUSHING

FILTER TYPE 6.61.1

Commission No.:

3854659/7

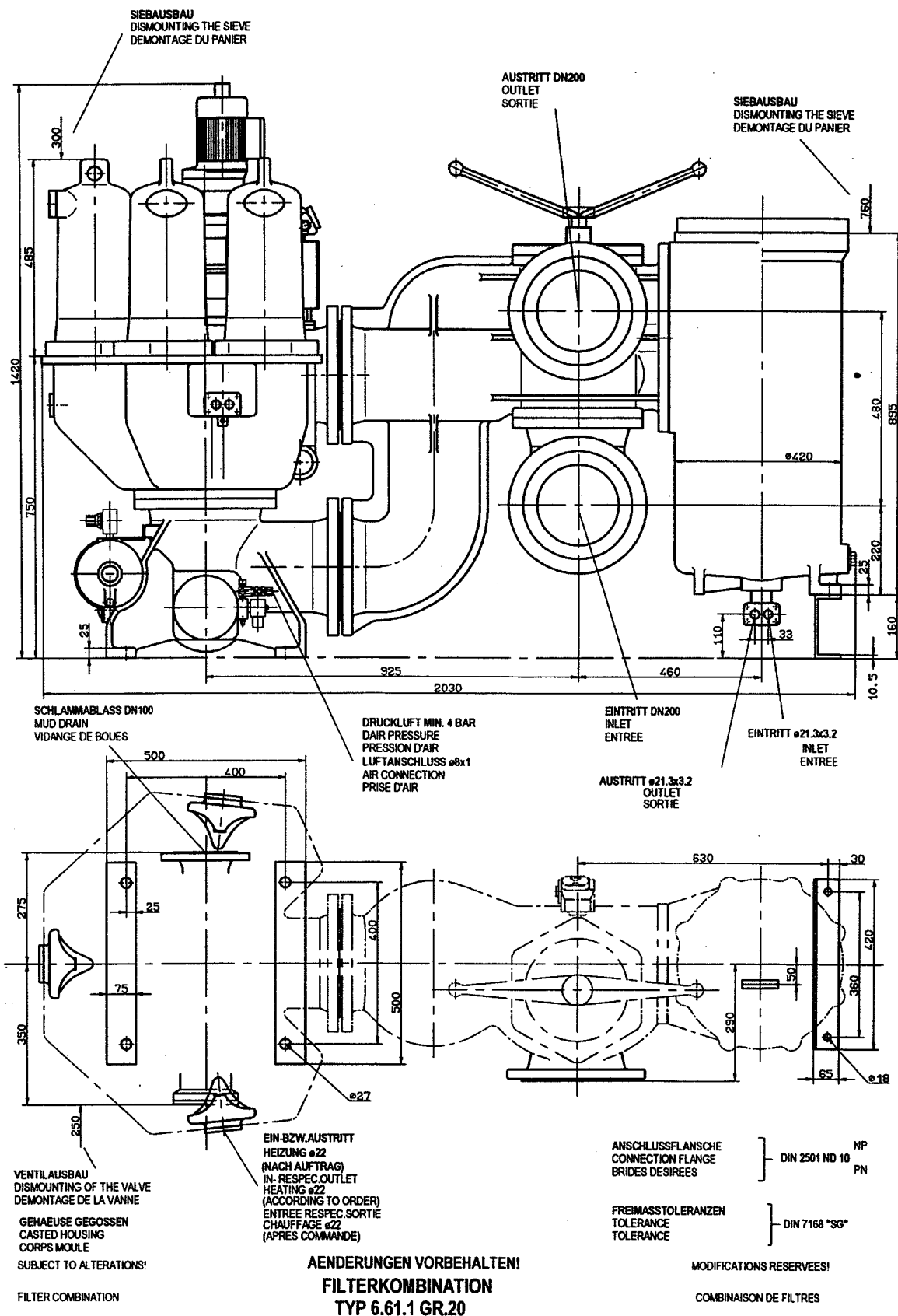
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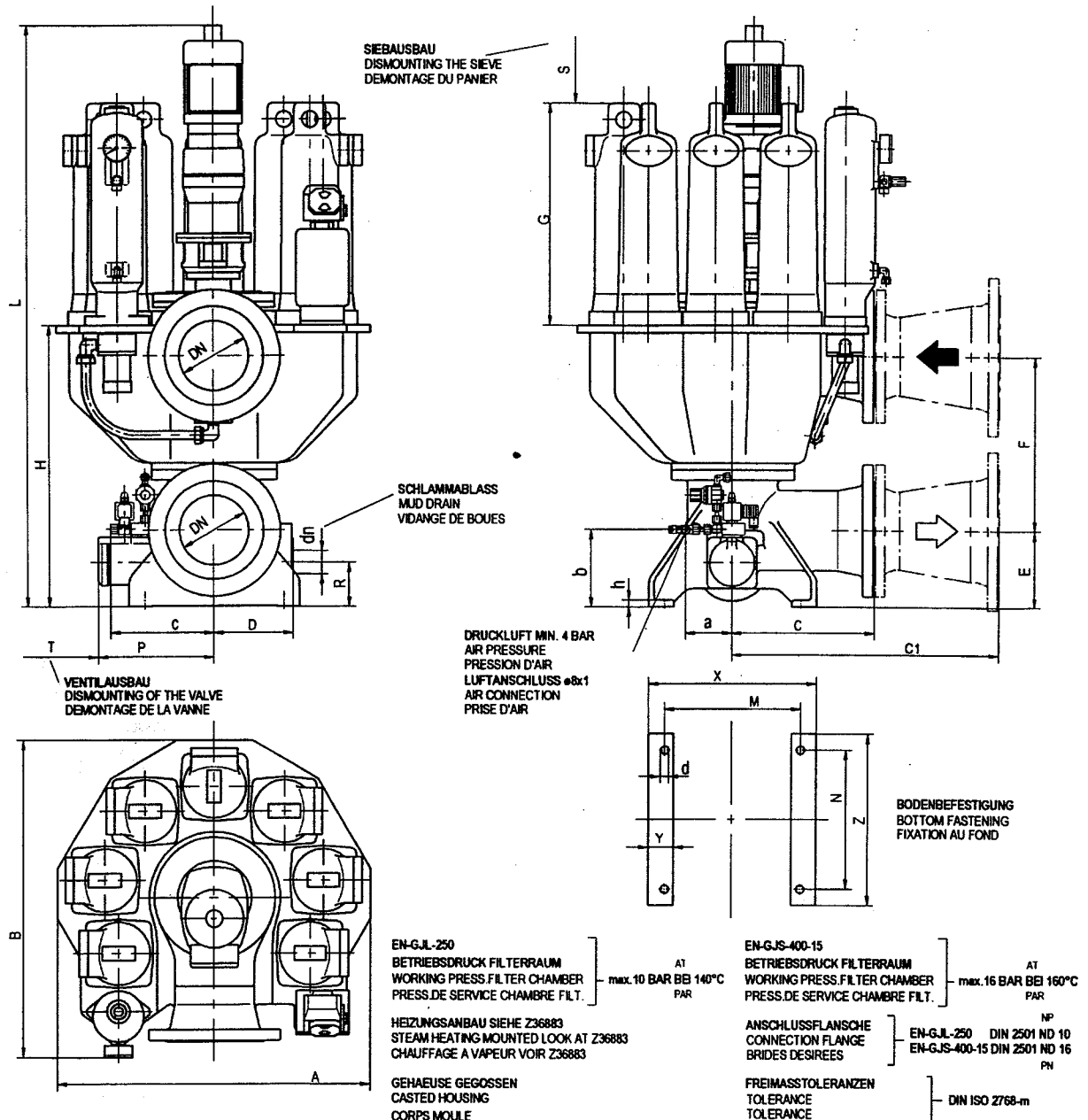
BOLL & KIRCH assumes no liability for any mistakes by any misuse of the product.
We reserve the right to change this description without any prior notice!



Z42915
TYP 6.61.1 GR.20
21.02.2000



Z100292
TYP 6.61
21.06.04



GR.	DN	KAMMER-ANZAHL	A	B	C	C1	D	E	F	G	H	L	M	N	P	R	S	T	X	Y	Z	a	b	c	d	h	dn	GEWICHT KG	INHALT LTR
10	80	4	600	460	200	-	140	135	315	476	515	1110	200	200	250	95	300	200	270	55	270	105	165	225	18	15	50	200	38
	100																											215	
15	150	7	680	690	310	-	170	165	375	476	605	1250	300	300	250	95	300	200	370	55	370	105	165	225	18	15	50	345	71
	200				-	580																						395	
20	200	6	850	750	335	-	275	225	475	485	750	1420	400	400	350	125	300	250	500	75	500	165	165	240	27	25	100	620	150
	250				-	645																						690	
25	250	8	1030	890	400	-	350	250	530	485	800	1535	470	470	350	125	300	250	570	75	570	165	165	240	27	25	100	726	230
	300				-	740																						814	
35	350	11	1200	1150	575	-	400	300	675	485	970	1800	550	550	350	125	300	250	650	80	650	165	165	240	27	25	100	1150	520
	400				-	1075																						1320	

SUBJECT TO ALTERATIONS!
FULLY AUTOMATIC BACK
FLUSHING FILTER

ÄNDERUNGEN VORBEHALTEN!
VOLLAUTOMATISCHER RUECKSPUELFILTER
TYP 6.61

MODIFICATIONS RESERVEES!
FILTRE AUTOMATIQUE

2. General

The fully automatic back-flushing filter is used to filter a variety of fluids, but chiefly for the filtration of fuels, lubricating oils, caustic solutions and emulsions. The filter elements assemblies are cleaned automatically by compressed air assisted back-flushing without interrupting the filtration process. One clean chamber is always held in reserve.

This self-cleaning filter consists basically of the following parts:

The lower housing with connection flange for filter outlet and connection flange for the removal of flushing fluid (sludge discharge).

The change-over system housing with the filter inlet, on which the filter chambers containing the candle elements and the automatic vent are set out. In the centre of the housing is the stop plug with refill bore.

The geared motor.

The air supply with non-return valve, shutt-off valve and pressure regulator.

The safety valve.

The differential pressure indicator Δp_1 .

The flushing valve with manual actuation.

The limit switch.

The EL.-control system in its own switch box separate from the filter.

3. Installation of the Filter

Care must be taken during installation of the filter that the pipelines attached to the filter inlet and outlet are clean and not under tension.

The pipeline selected for the sludge discharge is to be no smaller than the size indicated on the type sheet. To avoid back-pressure arising in the pipe, it is to be laid on a gradient and vented.

The terminal board on the filter is to be connected to the terminal board in the switch cabinet by means of the control system cable (see circuit diagram).

When the filter is used in aqueous media, it is imperative to observe the following:

- 3.1 It must be ensured that the filter does not run dry even after the supply pump has been switched off (owing to hardening of dirt).
- 3.2 If this condition cannot be fulfilled, at least the EL.- control must be designed so that, even when the supply pump is switched off, back-flushing is initiated every 2 hours by a time relay.



Flushing operations into a completely empty chamber for test purposes are permitted without any restrictions. Flushing into a partially filled chamber results in increased loading of the filter candles. Back-flushing for installation (pipe) or control reasons into a filter chamber which is only partially filled is therefore inadmissible.

The filter housings are only designed for internal overpressure in accordance with the AD Information Sheets. Additional external forces and moments at the filter connection flanges are to be avoided (possibly by supporting the supply lines).

When installing the filters, make sure that any oil or fuel which leaks due to improper handling cannot result in a fire or injury.

4. Commissioning

The following requirements must be met for the commissioning of the filter:

- 4.1 Clean and dry compressed air for the control system at between 4 and 10 bar operating pressure, must be available at the open shut-off valve.
- 4.2 Switch on the electricity using the "Main Switch" on the switch box. The "Power" lamp respectively LED-operating display lights up. (Activation of the main switch initiates a back-flushing cycle.)
- 4.3 To check the EL.- control system a back-flushing cycle should now be performed by activating the "Manual" trip on the switch box.
- 4.4 Open the slide valve at the filter outlet. Slowly open the slide valve at the filter inlet (avoiding pipe hammer). A further back-flushing cycle is to be performed using the Manual trip on the switch box. Once the back-flushing operation is completed, the "Flushing" respectively the display "SP.1" lamp goes out. If these conditions are met, the filter is in the start position and is therefore ready for operation.



After completion of a back-flushing cycle, the next backflushing operation can only be initiated (manually or by means of the differential pressure indicator) after a time delay.

This time delay corresponds to the time preset on the time relay "K1A" or the preselected time "PA.5" in the electronic control. It is needed to guarantee that the cleaned filter chamber is filled.

NOTE: *Possible time interval calculation for time-dependent back-flushing*

Let the filter run for 24 hours using the differential pressure and establish the number of back-flushing operations (flushing cycle counter or display).

Calculate the average flushing interval.

Set the flushing interval (shortened by 30%) on the time relay or PA.2.

5. Filtration Phase

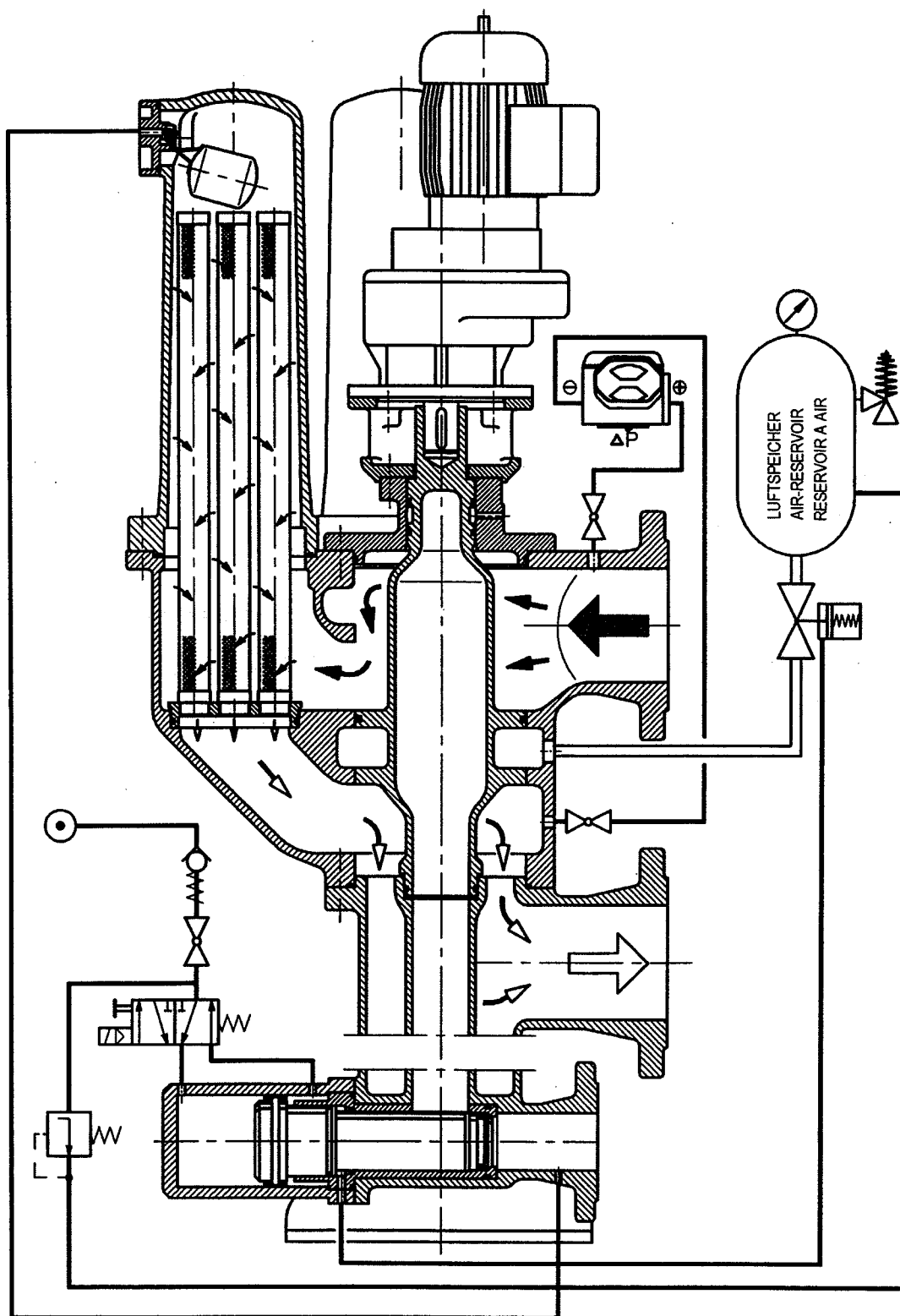
(see Drawing Z 32326 p. 1 or Z 33701 p. 1)

The medium to be filtered flows down into the change-over system housing and passes from there through the chamber inlet and the connected filter chambers to the candle elements. The medium flows through the filter elements from the outside to the inside and the contamination in the medium is retained on the filter mesh of the candle elements. The cleaned fluid passes to the filter outlet.

In this position the air supply (by means of the solenoid valve) keeps the sludge discharge closed and compressed air is maintained in the air receiver ready for the next backflushing cycle.



Z32326 BL.1
TYP 6.61
12.02.98



TYP 6.61

FILTRATIONS-PHASE
FILTRATION-PHASE
PHASE DE FILTRATION

6. Back-Flushing Operation

(See Drawing Z32326 p. 2 or Z33701 p. 2)

The contamination retained on the candle elements produces an increasing pressure differential between the filter inlet and outlet. This difference in pressure is indicated optically on the differential pressure indicator when a set value is reached and an electrical contact triggers the back-flushing.

When the back-flushing cycle is initiated, the geared motor is switched on and the change-over plug rotates from the chamber held in reserve to the filter chamber to be cleaned. Connection of the reserve chamber, together with its clean candle elements, causes an immediate reduction in the pressure differential. When the stop plug reaches the filter chamber to be cleaned the rotation is stopped by means of a cam plate and a limit switch.

The solenoid valve (from the sludge discharge) is then switched electrically and air from the air supply passes to the rear side of the sludge discharge valve shaft. The sludge discharge valve opens and pressure is released from the chamber now shut off. (See Note!)



This allows the compressed air in the upper region of the plug to immediately expand and thus creates additional space for the fluid displaced (by the air) in the backflushing cycle.

While the sludge discharge valve shaft is opening, the control system air reaches the attached flushing valve (once the pressure has been released on the filter chamber). The flushing valve opens and the compressed air from the air receiver dispatches the clean fluid present and pushes it in the counter current direction through the mesh of the screw-in candle elements.



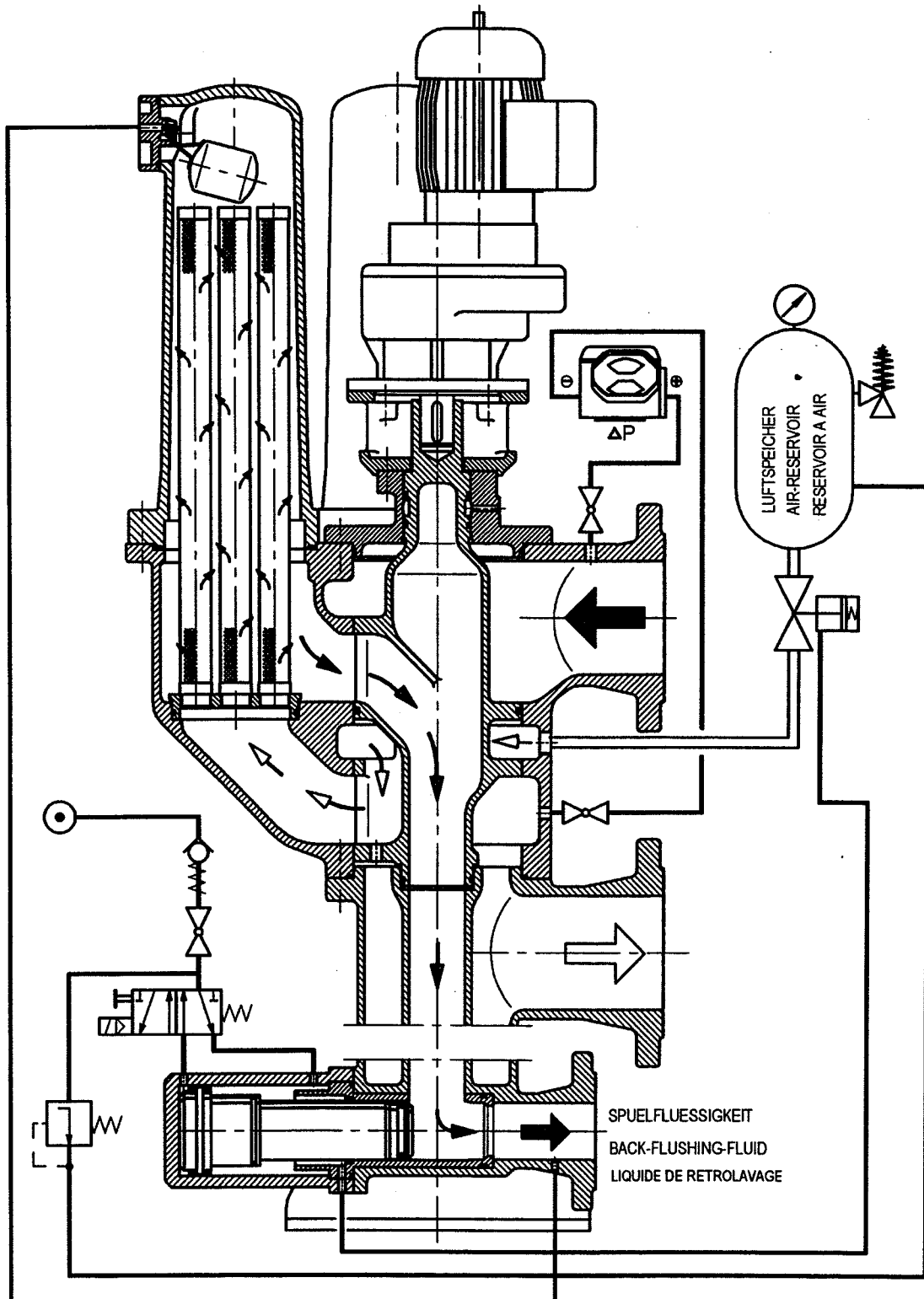
The pressure drop thus generated flushes off the contamination deposited on the mesh and washes it out of the filter housing via the open sludge discharge valve.

The air flow is continued for a short period (flushing period) before the solenoid valve is electrically switched over, causing the sludge discharge valve to close. At the same time the flow of air from the control system to the connected flushing valve is interrupted and thus also stops the flow of the stored back-flushing air. The backflushed filter chamber is now refilled with clean medium through the refill bore until operating pressure is achieved.

Only then is the delay of the electric control cancelled for the next back-flushing operation.



Z32326 BL.2
TYP6.61
12.02.98



TYP 6.61

RUECKSPUELPHASE
BACK-FLUSHING-PHASE
POSITION DE LAVAGE A
CONTRE-COURANT



Operating and Installation Manual

Electronic Control Box

Type 2200

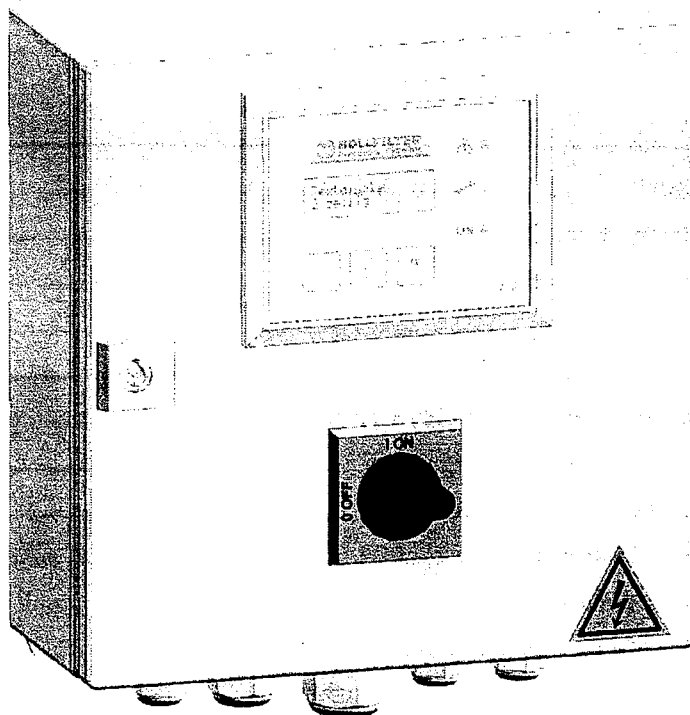


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1 General Information

Safety Instructions

Incorrect installation of the control box Type 2200 or interfaced equipment can result in failure of the control box, serious personal injury or even fatal injuries. Therefore please observe the following points in addition to the general safety regulations for equipment in industrial electrical installations:

- Installation of the control box Type 2200 may only be carried out by qualified electricians in accordance with the provisions of IEC 364, DIN VDE 0105 for electrical power installations.
- All the laws, regulations, ordinances and specifications for the erection of electrical power installations applicable at the installation location must be observed.
- Adjustments to equipment with protection class IP00 without covers may only be carried out by qualified electricians with the equipment switched off and in compliance with the local safety and accident prevention regulations.
- The control box Type 2200 may only be employed in the approved operating range.



2 Components of the Control Box and Cabinet

2.1 Power Section

2.1.1 Incoming Feeder Supply

Incoming feeder supply L1-L2-L3 directly to the 4-pole master switch.

2.1.2 Motor Controller

Motor connection U-V-W directly to the motor contactor.

2.1.3 Voltage Supply

Primary voltages 0 - 220 V, 380 V, 400 V, 440 V, 500 V, 550 V

Secondary voltages

0 V AC - 230 V AC

Solenoid voltage 230 V AC

0 V AC - 115 V AC

Solenoid voltage 115 V AC

0 V DC - 24 V DC

Solenoid voltage 24 V DC

0 V AC - 20 V AC

Supply voltage to control pcb

2.1.4 Fuses

Fuses in the control box

F1 to F3 each 1 A

Fuses on the control pcb

Fuse F1 0.8 A slow-blow

Fuse F2 2.0 A slow-blow

2.2 Control Box Displays and Functions

2.2.1 Display and Operating Elements

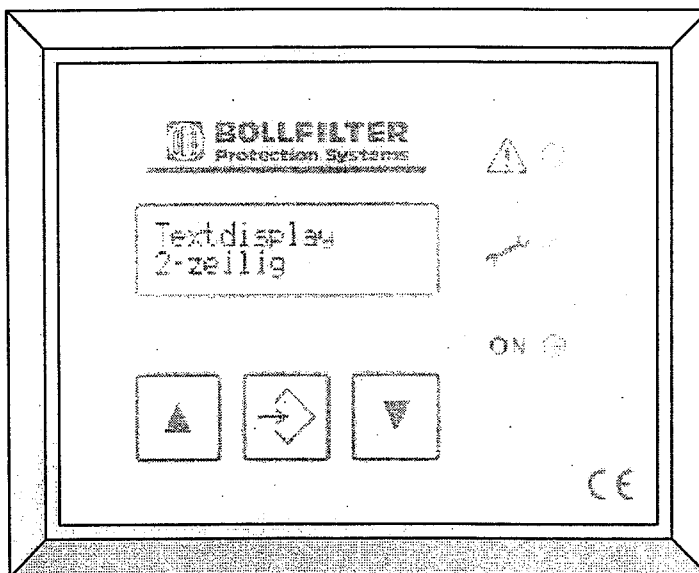
1 text display, 2 lines each with 16 characters

1 LED, green, "ON"

1 LED, yellow, "Service"

1 LED, red, "Alarm"

1 membrane keypad, 3 keys



2.3 Inputs and Outputs on Controller pcb

2.3.1 Optocoupler Inputs (E1 - E5), Terminals 31 - 40

2.3.2 Live Relay Outputs

Outputs VE1 - VN1 to VE3 - VN3

Terminals 8 - 13

The connections and designations vary, depending on the filter type, and can be found in the respective control cabinet circuit diagrams.

2.3.3 Potential free Relay Outputs

Outputs A1 - A15 Messages 1 - 5 (change-over)

Terminals 16 - 30

The connections and designations vary, depending on the filter type, and can be found in the respective control cabinet circuit diagrams.

3 Operation

3.1 Text Messages

Messages in "Operation" Mode

The green LED lights up when the mains voltage is switched on if the control box Type 2200 is in the operating mode ("Operation" mode).

Text display after switching on:

" Boll & Kirch " Company designation

" xxxxxxxxxxxx " Program number

After a few moments, the parameterised controller type is displayed in the second line:

" 6.18/6.19/6.44 "	Controller type 0	→ wiring diagram Z46140
" 6.23/6.24 "	Controller type 1	→ wiring diagram Z46141
" 6.60 "	Controller type 2	→ wiring diagram Z46142
" 6.60 Alarm DP "	Controller type 3	→ wiring diagram Z46142
" 6.60.07 "	Controller type 4	→ wiring diagram Z46143
" 6.60.07 AL. DP "	Controller type 5	→ wiring diagram Z46143
" 6.61 "	Controller type 6	→ wiring diagram Z46144
" 6.61 Alarm DP "	Controller type 7	→ wiring diagram Z46144
" 6.61.07 "	Controller type 8	→ wiring diagram Z46145
" 6.61.07 AL. DP "	Controller type 9	→ wiring diagram Z46145
" 6.62 "	Controller type 10	→ wiring diagram Z46146
" 6.62 Alarm DP "	Controller type 11	→ wiring diagram Z46146
" 6.64 "	Controller type 12	→ wiring diagram Z46147
" 6.64 Alarm DP "	Controller type 13	→ wiring diagram Z46147
" 6.64.07 "	Controller type 14	→ wiring diagram Z46148
" 6.64.07 AL. DP "	Controller type 15	→ wiring diagram Z46148

In "Operation" mode, the following text is displayed:

" forced fl. 00:01 " Remaining time until automatic flushing 00 h 01 min
" C - F - Q " Key instructions (see below)

Key **C**: When pressed, displays the number of flushing cycles.

Key **F**: When pressed, initiates a manual flushing cycle.

Key **Q**: When pressed, acknowledges alarm messages.

When a flushing cycle is started, the following messages appear in the first line of the display, depending on the source:

" Mains flushing " When flushing is initiated by "Mains voltage ON"
" Manual flushing " When flushing is initiated with key F
" forced flushing " When flushing is initiated by a back-flushing timer control
" DP flushing " When flushing is initiated via differential pressure back-flushing filter

When a flushing cycle is started, the following messages appear in the second line of the display, depending on the source, e.g.:

" Flush. time 3S" Remaining flushing time
" After bl. t. 3S" Remaining after-blowing time

Note: 3S means that the remaining flushing or after-blowing time is 3 seconds.

When key C is pressed, the following message appears on the display:

" No.of flushes "
" XXXXXX cycles " Number of flushing cycles

The number of flushing cycles is stored and is safe against mains power failure.

3.1.2 Alarm Messages

- The red alarm LED comes on with every alarm message.
- All alarm messages are stored and are safe against mains power failure.
- In the second line of the text display, the alarm message is displayed alternately with the operating messages every 2 seconds
- When key Q is pressed, the alarm messages are deleted, but only on condition that the cause of the alarm has been remedied. If the alarm condition is not eliminated, the alarm messages appears again.

Alarm messages on the text display:

At alarm "Motor fault"	" Motor fault "
At "Differential pressure to high Filter 100%"	" DP too high "
At "Differential pressure too high flushing oil conditioning 100%"	" Cartridge alarm "

When flushing frequency monitoring is switched on:

"DP alarm back-flushing triggered by differential pressure 75%"	" DP alarm "
---	--------------

3.2 *Setting and Operation*

3.2.1 Setting Level – Parameter Selection and Viewing

In order to call up setting level "*Parameter selection and viewing*", press the keys ∇ and Δ simultaneously until the green LED goes out (approx. 3 seconds). The upper display line shows the parameter, the lower line the parameter value. All the parameters can now be displayed in turn by repeatedly pressing the Δ or ∇ key.

3.2.2 Setting Level – Parameter Editing and Saving

In order to call up setting level "*Parameter editing and saving*", press the middle key until the green LED starts to flash (approx. 3 seconds). The parameter can now be changed by repeated pressing of the Δ or ∇ key. To save the set value and return to the setting level "*Parameter selection and viewing*", press the middle key until the green LED goes out (approx. 3 seconds).

3.2.3 Return to the Operating Level

To return to the operating level, press the keys ∇ and Δ simultaneously until the green LED comes on (approx. 3 seconds).

3.3 *List and Descriptions of Parameters*

3.3.1 P0 Filter Type

Variable in increments of 1	Range 0 - 15
Works setting	Default value 0
Text display, line 1	" P0 Filter type "
Text display, line 2	" 6.18/6.19/6.44 "

3.3.2 P1 Multiple Flushing

Note: This parameter is **only** visible with filter type P0 = 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Variable in increments of 1	Range 1 - 99
Works setting	Default value 1
Text display, line 1	" P1 multiple fl. "
Text display, line 2	" XXX chambers "

3.3.3 P2 Timer-controlled Back-flushing

Variable in 1 hour increments	Range 0 - 59 h
Works setting	Default value 2 h
Text display, line 1	" P2 forced flush."
Text display, line 2	" XXX hours "

3.3.4 P3 Timer-controlled Back-flushing

Variable in 1 minute increments	Range 0 - 59 min
Works setting	Default value 0 min
Text display line 1	" P3 forced flush."
Text display line 2	" XXX minutes "



3.3.5 P4 Back-flushing Time

Note: This parameter is **not** visible with filter type P0 = 1.

Variable in 1 second increments	Range 5 - 100 s
Works setting	Default value 20 s

Text display, line 1	" P4 flushing time "
Text display, line 2	" XXX seconds "

3.3.6 P5 Filling time

Note: This parameter is **not** visible with filter types P0 = 0 and P0 = 1.

Variable in 10 second increments	Range 10 - 600 s
Works setting	Default value 180 s

Text display, line 1	" P5 Filling time "
Text display, line 2	" XXX seconds "

3.3.7 P6 After-blowing Time

Note: This parameter is **only** visible with filter types P0 = 4, 5, 8, 9, 14, 15.

Variable in 1 second increments	Range 5 - 100 s
Works setting	Default value 30 s

Text display, line 1	" P6 After blow t. "
Text display, line 2	" XXX seconds "

3.3.8 P7 Delay Time – Cartridge Alarm

Note: This parameter is **only** visible with filter types P0 = 4, 5, 8, 9, 14, 15.

Variable in 10 second increments	Range 10 - 600 s
Works setting	Default value 30s

Text display, line 1	" P7 Cartridge al. "
Text display, line 2	" XXX seconds "

3.3.9 P8 DP Alarm (Flushing Frequency Monitoring)

Note: This parameter is **only** visible with filter types P0 = 3, 5, 7, 9, 11, 13, 15.

Variable: ON / OFF

Works setting

Default value "ON"

Text display, line 1

" **P8 DP alarm** "

Text display, line 2

" **OFF** "

or

Text display, line 2

" **ON** "

3.3.10 P9• Motor Fault

Note: This parameter is **only** visible with filter types P0 = 0, 6, 7, 8, 9, 12, 13, 14, 15.

Variable in 0.01 A increments

Range 0.10 to 0.99 A

Works setting

Default value 0.4 A

Text display, line 1

" **P9 Motor fault** "

Text display, line 2

" **0000 mA** "

3.3.11 P10 Back-flushing Time

Note: This parameter is **only** visible with filter type P0 = 1, Type 6.23/6.24.

The parameter is not required with the setting P0 ≠ 1.)

Setting: For ND 32 = 1 / ND 40 = 2 / ND 50 = 3 (ND = Nominal diameter)

A certain control time from a table is assigned, depending on the nominal diameter.

Variable in increments of 1

Range 0 to 2

Works setting

Default value ND 32 = 2 s

Text display, line 1

" **P10 flush. time** "

Text display, line 2

" **ND=XX =XX sec** "



3.3.12 P11 Language

The user can choose between English, French, German and Spanish.

Works setting = 0 (German)

Text display, line 1 “ P11 Language ”

Text display, line 2 “ D German ”

3.3.13 P12 Test Code

Note: This parameter is **only** visible with filter type P0 = 0.

The test code switches the control box to a test mode that is accessible only for authorised persons.

Variable in increments of 1 Range 0 - 250

Works setting Default value 0

Text display, line 1 “ P12 Testcode ”

Text display, line 2 “ XXX ”



4 Control Procedure, System Functions

4.1 Master Switch – Operating Feedback Contact

When the master switch is in position ON, the contact is closed (made).

4.2 Control Voltage Monitoring

As soon as the master switch is actuated, the mains supply voltage has been switched ON and the control box is functioning correctly, the green ON LED lights up and the "Control voltage monitoring" relay is energised. In the event of an operating voltage failure or blown fuse on the control pcb, no LED comes on and the "Control voltage monitoring" relay is no longer energised.

4.3 Motor Fault

If the measured motor current exceeds the set nominal value for parameter P9, a message appears on the display and a potential free message is sent to the relay outputs. The motor and back-flushing are immediately switched off. After remedying the fault, the operator has to cancel the alarm message by pressing key Q.

4.4 Differential Pressure Too High – Flushing Oil Conditioning – Cartridge Alarm

The signal generator is a pressure switch contact that is connected to the optocoupler input "Differential pressure indicator DP too high Flushing oil conditioning". If the condition exists for longer than the time set with parameter P7, an alarm message appears on the display. After remedying the fault, the operator has to cancel the alarm message by pressing key Q.

4.5 DP Too High – Back-flushing Filter (100%)

The signal generator is a pressure switch contact that is connected to the optocoupler input "Differential pressure indicator DP too high Back-flushing filter". If the condition exists for longer than 2 seconds, an alarm message appears on the text display and the red alarm LED lights up. After remedying the fault, the operator has to cancel the alarm message by pressing key Q.

4.6 Key C (Number of Flushing Cycles)

When key C "Number of flushing cycles" is pressed, the number of flushing cycles performed appears on the display for 3 seconds.

4.7 *Multiple Flushing*

The parameterised number of chambers is flushed at each flushing command.

4.8 *DP Alarm (Flushing Frequency Monitoring)*

If a "DP flushing" is activated before expiry of the time set for "Timer-controlled back-flushing" , a message appears on the display (yellow LED – Service).



5 Description and Function of the Controllers

5.1 Controller 6.18 / 6.19 / 6.44

Inputs

Pressure switch "DP reached – Back-flushing filter" → 75%

Pressure switch "DP too high – Back-flushing filter" → 100%

Outputs

Motor

Flushing valve

Potential free contacts

- | | |
|--|----------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Motor fault" | Output A4, A5, A6 |
| 3) Alarm "Motor fault" | Output A7, A8, A9 |
| 4) Message "Flushing active" | Output A10, A11, A12 |

Description of functions

The function of the filter is described in the operating manual.

A flushing cycle is triggered by :

- 1) The F key
- 2) Expiry of the automatic flushing time
- 3) Pressure switch "DP reached – Back-flushing filter"

Points of particular note

- All alarms are displayed, signalled via potential free contacts and stored.
- If the controller is in parameterisation mode, manual triggering of a flushing cycle will not be accepted.
- If the parameter "Controller type" is changed, the functions are restarted.

5.2 Controllers of Type 6.23 / 6.24

Inputs 6.23 und 6.24

Pressure switch "DP reached – Back-flushing filter" → 75%

Pressure switch "DP too high – Back-flushing filter" → 100%

Outputs 6.23 and 6.24

Flushing valve

Potential free contacts and messages 6.23 and 6.24

- | | |
|---------------------------------------|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Alarm "Maximum DP reached" | Output A4, A5, A6 |

Description of functions 6.23 and 6.24

The function of the filter is described in the operating manual.

A flushing cycle is triggered by :

- 1) The F key
- 2) Expiry of the automatic flushing time.
- 3) Pressure switch „DP reached – Back-flushing filter“

Points of particular note

- All alarms are displayed, signalled via potential free contacts and stored.
- If the controller is in parameterisation mode, manual triggering of a flushing cycle will not be accepted.
- If the parameter "Controller type" is changed, the functions are restarted.

5.3 Controllers of Type 6.60

Inputs 6.60 and 6.60 Alarm DP (Flushing Frequency Monitoring)

Limit switch "Position reached"

Pressure switch "DP reached – Back-flushing filter" → 75%

Pressure switch "DP too high – Back-flushing filter" → 100%

Additional inputs with 6.60.07 (Flushing oil conditioning)

Pressure switch "DP too high – Flushing oil conditioning" → 100%

Outputs 6.60 and 6.60 Alarm DP

Flushing valve

Chamber valve

Additional outputs with 6.60.07 and 6.60.07 Alarm DP

After-blowing valve

Potential free contacts and messages 6.60

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault: Alarm "Maximum differential pressure reached" | Output A4, A5, A6 |

Potential free contacts and messages 6.60 Alarm DP

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault: Alarm "Maximum differential pressure reached" | Output A4, A5, A6 |
| 3) Alarm "Back-flushing triggered by DP" | Output A7, A8, A9 |

Potential free contacts and messages 6.60.07

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Cartridge" (DP alarm – Flushing oil conditioning) | Output A4, A5, A6 |

Potential free contacts and messages 6.60.07 Alarm DP

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Cartridge" (DP alarm – Flushing oil conditioning) | Output A4, A5, A6 |
| 3) Alarm "Back-flushing triggered by DP" | Output A7, A8, A9 |

Description of functions 6.60

The function of the filter is described in the operating manual.

A flushing cycle is triggered by :

- 1) Switching on the mains voltage supply
- 2) The F key
- 3) Expiry of the automatic flushing time.
- 4) Pressure switch "DP reached – Back-flushing filter"

Additional functions with 6.60 Alarm DP (Flushing frequency monitoring)

If a flushing cycle is triggered via the pressure switch "DP reached – Back-flushing filter" before expiry of the automatic flushing time, a DP alarm will be triggered (flushing frequency alarm).

Points of particular note

- All alarms are displayed, signalled via potential free contacts and stored.
- If the controller is in parameterisation mode, manual triggering of a flushing cycle will not be accepted.
- If the parameter "Controller type" is changed, the functions are restarted.

6.4 Controllers of Type 6.61

Inputs 6.61 and 6.61 Alarm DP (Flushing frequency monitoring)

Limit switch "Position reached"

Pressure switch "DP reached – Back-flushing filter" → 75%

Pressure switch "DP too high – Back-flushing filter" → 100%

Additional inputs with 6.61.07 and 6.61.07 Alarm DP (Flushing oil conditioning)

Pressure switch

DP too high – Flushing oil conditioning → 100%

Outputs 6.61 and 6.61 Alarm DP

Flushing valve

Motor

Additional outputs with 6.61.07 and 6.61.07 Alarm DP

After-blowing valve

Potential free contacts and messages 6.61

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of: | Output A4, A5, A6 |
| Alarm "Maximum differential pressure reached" and | |
| Alarm "Motor fault" | |

Potential free contacts and messages 6.61 Alarm DP

- | | |
|--|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Motor fault" | Output A4, A5, A6 |
| 3) Alarm "Back-flushing triggered by DP" | Output A7, A8, A9 |

Potential free contacts and messages 6.61.07

- | | |
|--|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Motor fault" and
Alarm "Cartridge" (DP alarm – Flushing oil conditioning) | Output A4, A5, A6 |

Potential free contacts and messages 6.61.07 Alarm DP

- | | |
|--|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault, consisting of:
Alarm "Maximum differential pressure reached" and
Alarm "Motor fault" and
Alarm "Cartridge" (DP alarm – Flushing oil conditioning) | Output A4, A5, A6 |
| 3) Alarm "Back-flushing triggered by DP" | Output A7, A8, A9 |

Description of functions 6.61

The function of the filter is described in the operating manual.

A flushing cycle is triggered by :

- 1) Switching on the mains supply voltage.
- 2) The F key.
- 3) Expiry of the automatic flushing time.
- 4) Pressure switch "DP reached – Back-flushing filter".

Points of particular note

- In the case of flushing by switching on the mains supply voltage and with the limit switch open, a flushing cycle starts directly with the flushing valve.
- If the controller is in parameterisation mode, manual triggering of a flushing cycle will not be accepted.
- If the parameter "Controller type" is changed, the functions are restarted.

5.5 Controllers of Type 6.62

Inputs 6.62

Limit switch "Position reached"

Pressure switch "DP reached – Back-flushing filter" → 75%

Pressure switch "DP too high – Back-flushing filter" → 100%

Outputs 6.62

Flushing valve

Chamber valve cycled

Potential free contacts and messages 6.62

- | | |
|---|---------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault: Alarm "Max differential pressure reached" | • Output A4, A5, A6 |

Potential free contacts and messages 6.62 Alarm DP (Flushing frequency monitoring)

- | | |
|---|-------------------|
| 1) Alarm "Control voltage monitoring" | Output A1, A2, A3 |
| 2) Group fault: Alarm "Max differential pressure reached" | Output A4, A5, A6 |
| 3) Alarm "Back-flushing triggered by DP" | Output A7, A8, A9 |

Description of functions

The function of the filter is described in the operating manual.

A flushing cycle is triggered by :

- 1) Switching on the mains supply voltage.
- 2) The F key.
- 3) Expiry of the automatic flushing time.
- 4) Pressure switch "DP reached – Back-flushing filter".

Points of particular note

- In the case of flushing by switching on the mains supply voltage and with the limit switch open, a flushing cycle starts directly with the flushing valve.
- If the controller is in parameterisation mode, manual triggering of a flushing cycle will not be accepted.
- If the parameter "Controller type" is changed, the functions are restarted.

5.6 *Controllers of Type 6.64*

The controller type has the same function as the controller types 6.61 , 6.61 Alarm DP, 6.61.07 and 6.61.07 Alarm DP.

Points of particular note

A relief valve is connected in parallel with the flushing valve.

Additional output

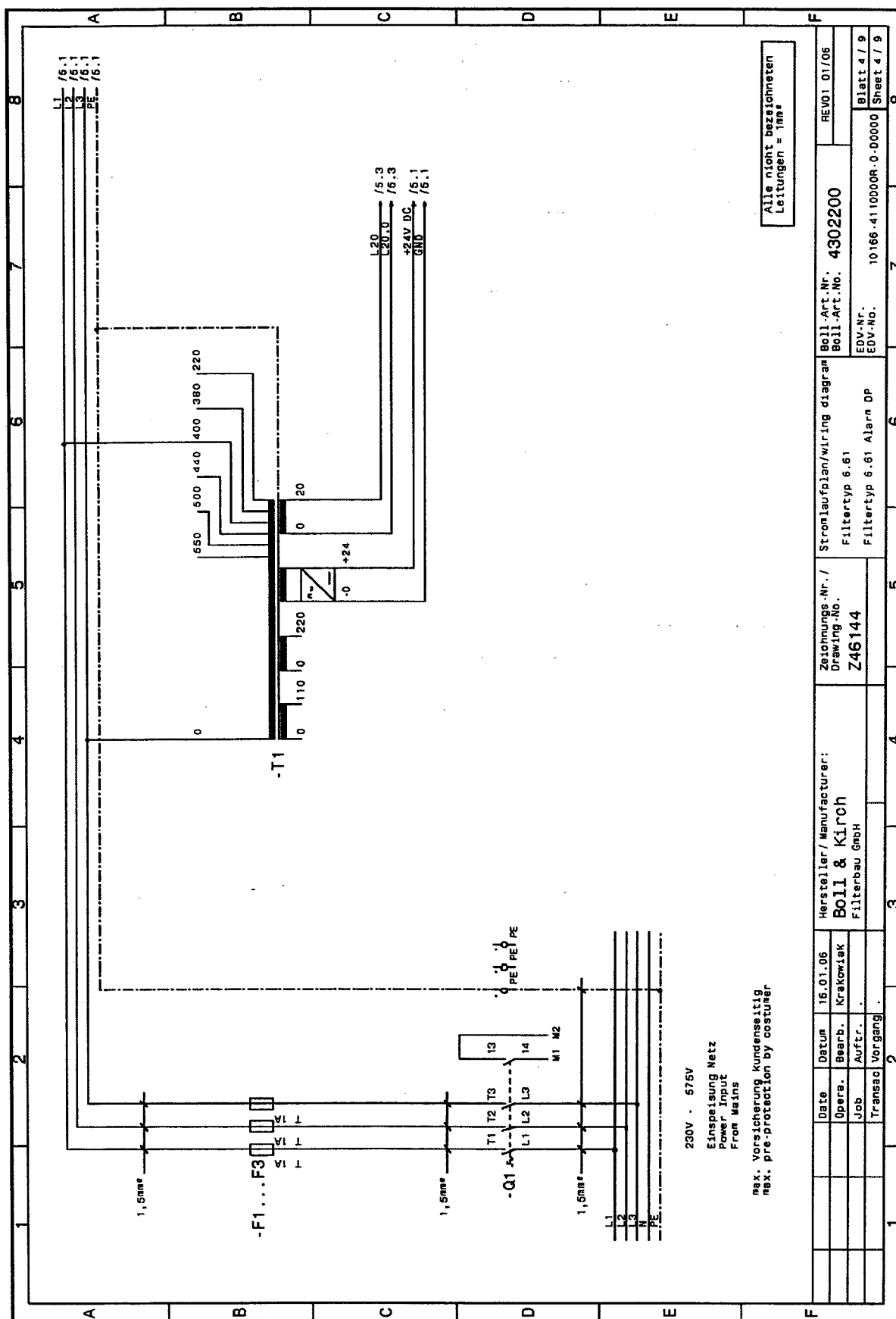
Relief valve

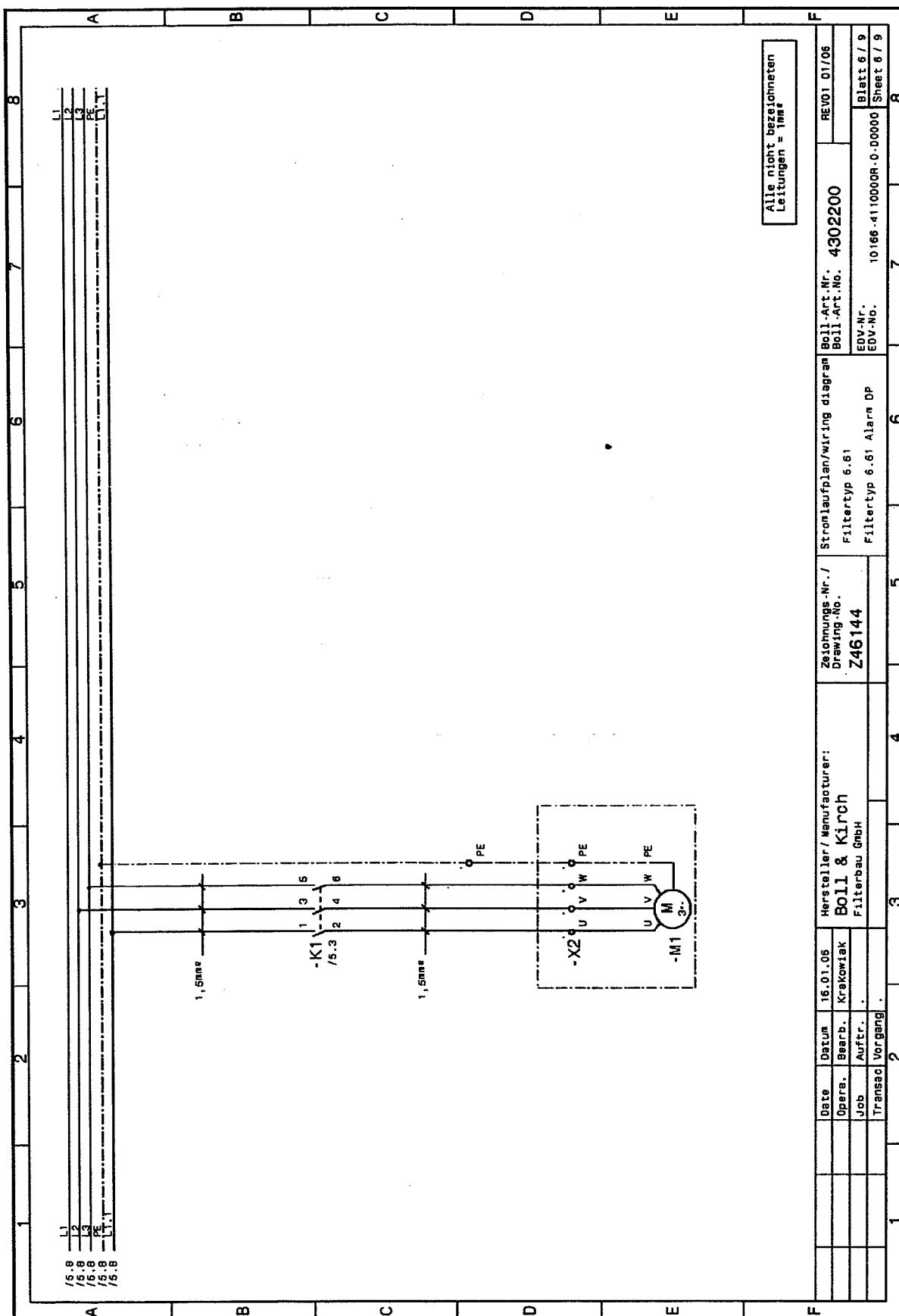
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E P L A N - DECKBLATT E P L A N - COVER HERSTELLER: manufacturer: Boll & Kirch Filterbau GmbH Siemensstraße 10-14 50143 Kerpen																																																																																																																															
Anlage: plant: Vollautomatischer Rückspülfilter Typ 6.61 Typ 6.61 Alarm DP fully automatic back flushing filter type 6.61 type 6.61 Alarm DP																																																																																																																															
Verdrahtungsfarben: color of transmission: Hauptstromkreis/main power : schwarz/black Steuerstromkreis/control power : rot/red Fremdspannung/extern voltage : orange/orange Schutzleiter/ground : grün-gelb/green-yellow																																																																																																																															
<table border="1"> <tr> <td colspan="2">Date</td> <td colspan="2">Datum</td> <td colspan="2">16.01.06</td> <td colspan="2">Hersteller/Manufacturer:</td> </tr> <tr> <td>Oper.</td> <td></td> <td>Bearb.</td> <td></td> <td colspan="2">Krakowiak</td> <td colspan="2">Boll & Kirch</td> </tr> <tr> <td>Job</td> <td></td> <td>Auftr.</td> <td></td> <td colspan="2"></td> <td colspan="2">Filterbau GmbH</td> </tr> <tr> <td colspan="2">Transac</td> <td colspan="2">Vorgang</td> <td colspan="2"></td> <td colspan="2"></td> </tr> <tr> <td colspan="2">1</td> <td colspan="2">2</td> <td colspan="2">3</td> <td colspan="2">4</td> </tr> <tr> <td colspan="2">5</td> <td colspan="2">6</td> <td colspan="2">7</td> <td colspan="2">8</td> </tr> <tr> <td colspan="4">Zeichnungs-Nr./ Drawing No.</td> <td colspan="4">Deckblatt/cover</td> </tr> <tr> <td colspan="4">Z46144</td> <td colspan="4">Filtertyp 6.61</td> </tr> <tr> <td colspan="4">Filtertyp 6.61 Alarm DP</td> <td colspan="4">Boll-Art.Nr.: 4302200</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">Boll-Art.No.</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">EDV-Nr.: 10166-4110000R-0-00000</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">EDV.No.</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">Blatt 1 / 9</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">Sheet 1 / 9</td> </tr> <tr> <td colspan="4"></td> <td colspan="4">REV01 01/06</td> </tr> </table>								Date		Datum		16.01.06		Hersteller/Manufacturer:		Oper.		Bearb.		Krakowiak		Boll & Kirch		Job		Auftr.				Filterbau GmbH		Transac		Vorgang						1		2		3		4		5		6		7		8		Zeichnungs-Nr./ Drawing No.				Deckblatt/cover				Z46144				Filtertyp 6.61				Filtertyp 6.61 Alarm DP				Boll-Art.Nr.: 4302200								Boll-Art.No.								EDV-Nr.: 10166-4110000R-0-00000								EDV.No.								Blatt 1 / 9								Sheet 1 / 9								REV01 01/06			
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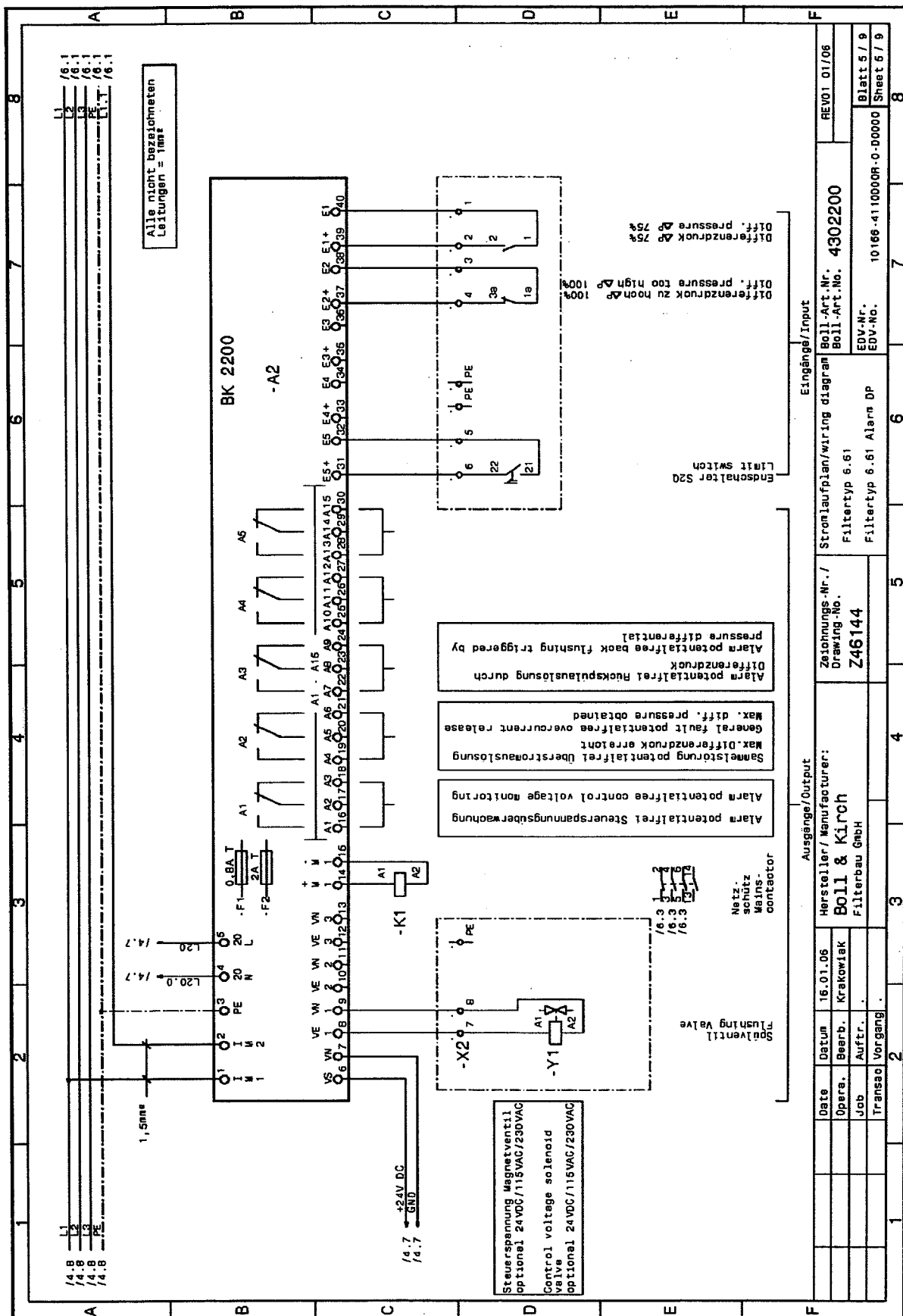


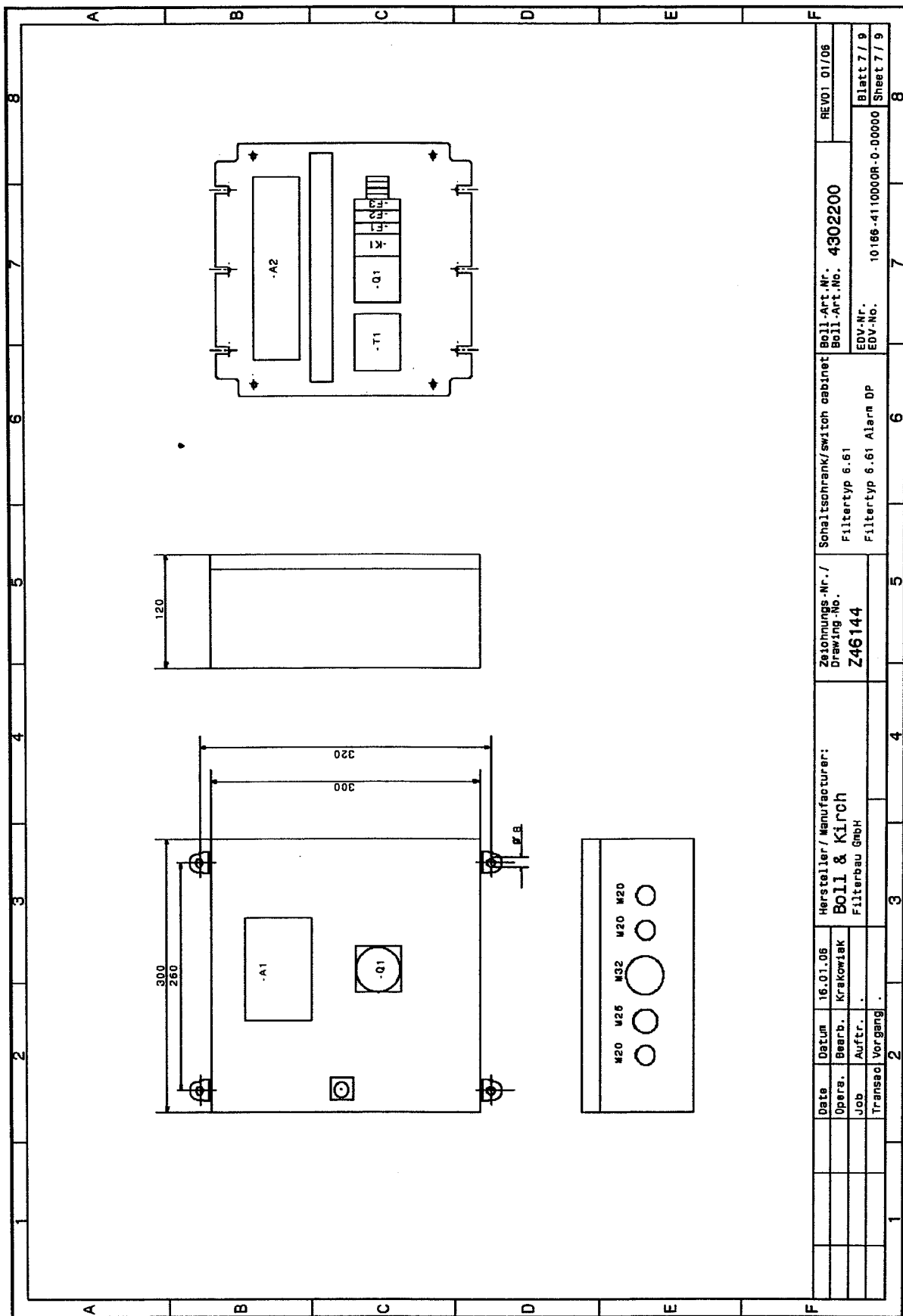
1	2	3	4	5	6	7	8
Spannungen voltages Betriebsspannung : operating voltage 3/PE 50-60Hz, 230-575V +/- 5% Steuerspannung : control power Optional 230V AC 115V AC 24V DC Verdrahtung Ausführung der Schaltanlage nach: VDE 0660 Teil 5 IEC 439 Bestimmungen für fabrikfertige Schalt- gerätekombinationen mit Nennspannung bis 750V Nennspannung : 450/750V nach VDE 0110 - Schutzart IP 65 Umgebungstemperatur max. 55°C Die Verdrahtung erfolgt flexibel. Alle nicht gekennzeichneten Leitungen werden in H07V-K / bei Leistungsverdrahtung 1,5qmm, bei Steuerleitungen 1qmm verlegt. Die Verdrahtung erfolgt von oben nach unten bzw. von links nach rechts. gemäß den Stromlaufplänen. wiring cabinet built after : VDE 0660 part 5, IEC 439 spezification for factory cabinets with rated voltage unit 750V rated voltage : 450/750V rated isolation voltage : 450/750V according to VDE 0110, protection IP 65 are with H07V-K / by power wiring 1,5qmm, by control circuit 1qmm. The wiring is from above to down or from left to right. following the circuit diagram. HINWEISE advices Schaltanlage switchboard plant RAL 7035 Kabelinführung : transmission instruction ☐ oben above ☒ unten down Hauptschalter: main switch ☒ vorne/front ☐ links/left ☐ rechts/right Kundenvorschriften : client orders ☐ ja yes ☒ nein no Schranksockel : cabinet base ☐ ja yes ☒ nein no ☐ 100mm ☐ 200mm ☐ 300mm							
Hersteller / Manufacturer: Boll & Kirch Filterbau GmbH				Zeichnungs-Nr. / Drawing No. Z46144		Allgemein/general Filtertyp 6.61 Filtertyp 6.61, Alarm DP	
Date		Datum 16.01.06		Ball.-Art.Nr. Ball.-Art.No. 4302200		REV01 01/06	
Opera.		Bearb. Krakowiak		EDV-Nr. EDV.No. 10166-4110000R-0-00000		Blatt 2 / 9 Sheet 2 / 9	
Job		Auftr.					
Transcl		Vorgang					

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Date	Datum	16.01.06	Hersteller / Manufacturer:	Zeichnungs-Nr. / Drawing No.	Schaltschrank/switch cabinet	Boll-Art.Nr. 4302200	REV01 01/06
Oper.	Bearb.	Krakowiak	Boll & Kirch	Z46144	Filtertyp 6.61	Boll-Art.No.	
Job	Auftr.		Filterbau GmbH		Filtertyp 6.61 Alarm DP	EDV-Nr.	Blatt 7 / 9
Transp.	Vorgang					EDV.No.	Sheet 7 / 9
						10166-4110000R-0-00000	



Blatt : 1
Sheet : 1

Materialliste Materials list

Nr. No.	Anz. Num.	Kennzeichnung Labelling	Benennung Description	Hersteller Manufacturer	Typ / Art.-Nr. Type / Art.-No.	Boll & Kirch Art.No.	Kenngröße Parameter
1	1	-A1/-A2	Filtersteuerung (2 Platinen)	RECO	BK 2200	4300121	
1	1	-A1/-A2	Filter control (2 PCB's)	RECO	BK 2200	4300121	
	1		Verbindungskabel		Patchkabel RJ45 Cat6e	4100074	0,5m
	1		Connection cable		Patchkabel RJ45 Cat6e	4100074	0,5m
2	1	-F1...F3	Trennhebel-Sicherungs-Klemme	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
2	1	-F1...F3	Lever-type fuse element	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
	1		G-Sicherungseinsatz	ESKA	632.717	4200146	T 1A, 6,3x32
	1		Unit fuse set	ESKA	632.717	4200146	T 1A, 6,3x32
3	1	-F1...F3	Trennhebel-Sicherungs-Klemme	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
3	1	-F1...F3	Lever-type fuse element	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
	1		G-Sicherungseinsatz	ESKA	632.717	4200146	T 1A, 6,3x32
	1		Unit fuse set	ESKA	632.717	4200146	T 1A, 6,3x32
4	1	-F1...F3	Trennhebel-Sicherungs-Klemme	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
4	1	-F1...F3	Lever-type fuse element	Phoenix Contact	UK 6,3-HESI 3004171	4200147	16 mm
	1		G-Sicherungseinsatz	ESKA	632.717	4200146	T 1A, 6,3x32
	1		Unit fuse set	ESKA	632.717	4200146	T 1A, 6,3x32
5	1	-K1	Leistungsschutz	ABB	BC6-30-10	4200148	4kW/690V, 24V DC
5	1	-K1	Power contactor	ABB	BC6-30-10	4200148	4kW/690V, 24V DC
6	1	-Q1	Hauptschalter	ABB	OT16E3	4200149	25A
6	1	-Q1	Main switch	ABB	OT16E3	4200149	25A
	1		Hilfsschalter 1S	ABB	OA1G10	4200149	
	1		Auxiliary switch block NO	ABB	OA1G10	4200149	
	1		Hauptschaltergriff	ABB	DH2AJ	4200149	
	1		Selector handle	ABB	DH2AJ	4200149	
	1		Verlängerungswelle	ABB	DXSx105	4200149	105 mm
	1		Extended shaft	ABB	DXSx105	4200149	105 mm
7	1	-T1	Transformator	Block	80608014	4200150	220...550V/20,110,220V+24VDC
7	1	-T1	Transformer	Block	80608014	4200150	220...550V/20,110,220V+24VDC
8	2	-X	PE-Klemme	Phoenix Contact	UT 2,5-Quattro-PE	4100073	2,5 mm
8	2	-X	Earth wire terminal	Phoenix Contact	UT 2,5-Quattro-PE	4100073	2,5 mm
9	1	-Z	Gehäuse	Rittal	EB 1556.500	4306540	300 x 300 x 120 mm
9	1	-Z	Switching cabinet	Rittal	EB 1556.500	4306540	300 x 300 x 120 mm
10	1	-Z	Wandbefestigungshalter	Rittal	KL1590.000	4507593	8mm
10	1	-Z	Wall range spacer	Rittal	KL1590.000	4507593	8mm

[illegible]

10. Servicing

Even automatic filters require inspection and servicing at regular intervals. It is to be noted in particular that despite regular back-flushing the filter mesh can become clogged in the course of time, depending on the quality of the medium and the by-pass cleaning available.

Contamination on the mesh can be removed by cleaning the candle element manually using an appropriate solvent (see Section 13). An increase in the clogging on the mesh can be inferred from the progressively shorter intervals between back-flushing cycles. The number of back-flushing cycles can be seen on the "Flushing Cycle Counter" respectively display on the switch box.

To maintain trouble-free operation the following points are to be noted:

- a) All connections are to be regularly checked for leaks.
- b) Candle elements are to be dismantled and inspected initially after 500 flushing cycles, then after 5.000 and later every 10.000 flushing cycles. If, however, a sharp reduction in the intervals between back-flushing cycles should occur, inspection and cleaning should be carried out sooner. If sudden lengthening of the intervals between back-flushing cycles should occur all candle elements must be inspected without fail for damage.



Before the cartridge elements are dismantled, the automatic filter must be completely drained by automatic back-flushing (i.e. all filter chambers). "Manual" activation on the control box. Care must be taken to ensure that the liquid level is below the cartridge element before the element is dismantled.



The candles are subjected to wear through reciprocal loading. It is therefore recommended that a complete candle filter element, the number of candle elements depending on the size of the filter, be kept in stock.



It is expedient to renew all seals when overhauling the filter.



Check the sludge discharge for leaks every 10.000 flushing cycles. No medium should run from the end of the sludge discharge line during the filtration phase (except during the flushing cycle).

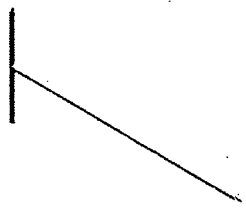
- 10.1 You must close the compressed air supply valve (item 127), then starting a manual backflushing, before you are allowed to removed the manometer (item 72). This well ensure that the compressed air reservoir (item 13) is pressure released.



11. Servicing Tools

The following special tools are supplied for servicing the filter:

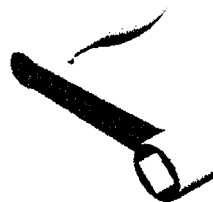
- 11.1 Special key with SW 10 or 14 for dismantling the filter chamber.



- 11.2 Special key for unscrewing the candle elements from the candle holder.



- 11.3 Key for opening the switch box and hand crank for operation during a power failure.



12. Candle Element Cleaning Agent "BOLL CLEAN 2000"

The choice of cleaning medium depends on the type of the contamination. With fuels recipitation of paraffin and asphalt or with lubricating oils mixing of different types of oil can form solid encrustations on the mesh. Effective cleaning of fine meshes is achieved by soaking in "BOLL CLEAN 2000" followed by blasting with compressed air using a cleaning gun.

PRODUCT DESCRIPTION:

BOLL CLEAN 2000 is a fluid cleaning and degreasing agent with a wide range of application. It can be used for practically all cleaning and degreasing purposes.

BOLL CLEAN 2000 cleans rapidly, thoroughly and extremely economically.

Use of BOLL CLEAN 2000 renders safety precautions superfluous.

BOLL CLEAN 2000 has these outstanding characteristics without exhibiting the isadvantages of solvent cleaners.

BOLL CLEAN 2000	is non-flammable
	does not require special marking
	does not have an irritating odour
	is not caustic
	is physiologically unobjectionable
	is biologically degradable
	is registered with the Federal Office
	for the Environment, Reg.-No. 04860019

BOLL CLEAN 2000 can be undercooled or overheated during storage but remains fully usable when returned to normal temperature.

MESH CONTAMINATED WITH HEAVY OIL:

Elements contaminated with heavy oil must be soaked in a standard commercial solvent. After soaking the elements are cleaned in the BOLL & KIRCH Type 5.04 Cleaning Device using BOLL CLEAN 2000 and high pressure pump.



INSTRUCTIONS FOR USE:

Use of BOLL CLEAN 2000 is not restricted to a particular method of cleaning. Depending on the operating conditions, BOLL CLEAN 2000 can be used in a dip bath, in a spraying plant, in steam jetting or in manual application using a cloth, brush or sponge. It can be used warm or cold.

BOLL CLEAN 2000 is miscible with water - even seawater.

Concentration for mesh cleaning: 1 : 2,5

Temperature: up to a maximum of 60 °C

The concentration depends on the type and thickness of the adhesive substance to be removed. When used in concentration below 1 : 30 rinsing is usually not required.

No visible film remains on the surface.

13. Manual Cleaning of the Candle Filter Elements



Before the cartridge elements are dismantled, the automatic filter must be completely drained by automatic back-flushing (i.e. all filter chambers). "Manual" activation on the control box. Care must be taken to ensure that the liquid level is below the cartridge element before the element is dismantled.

- 13.1 Remove the whole filter element assembly. Then soak the filter element assembly, with the openings of the candle elements facing down, in a suitable tank filled with solvent. Detached contaminants can then sink downwards out of the candle.
- 13.2 The soaking time and the relevant solvents are:
- a) In cold BOLL CLEAN 2000 cleaner the maximum soaking time is 24 hours.
 - b) In Filterclean (Vecom) the maximum soaking time is 12 hours.
 - c) In Reiniger B85 (Vecom) the maximum soaking time is 12 hours.
 - d) In gas oil the maximum soaking time is 48 hours.
- 13.3 After soaking remove the whole filter element assembly from the tank and place it on a suitable stand (e.g. perforated sheet metal) with the candle element opening pointing down and allow the solvent to drain.
- 13.4 Now with the cleaning gun supplied blow compressed air through the candles from the inside to the outside.
- 13.5 After this procedure the complete filter element assembly should be immersed in fresh cleaner, with the candle element opening downwards, and rinsed through with an up and down motion.



The washing procedure described in Section 13.5 should only be carried out in a separate tank using clean solvent. The solvent can then be used again for the next soaking procedure.

- 13.6 Allow the filter element assembly to drain again and dry it by blowing compressed air through it again from the inside to the outside.
The manual cleaning procedure described here has produced adequate results (ca. 60 % clean) in similar applications.
- 13.7 Almost 100 % cleaning is only possible manually, in our experience, by using the Type 5.04 High Pressure Cleaning Unit with BOLL CLEAN 2000.
See the separate description "Filter Cleaning Unit Type 5.04".



14. Manual operation of the automatic Filter

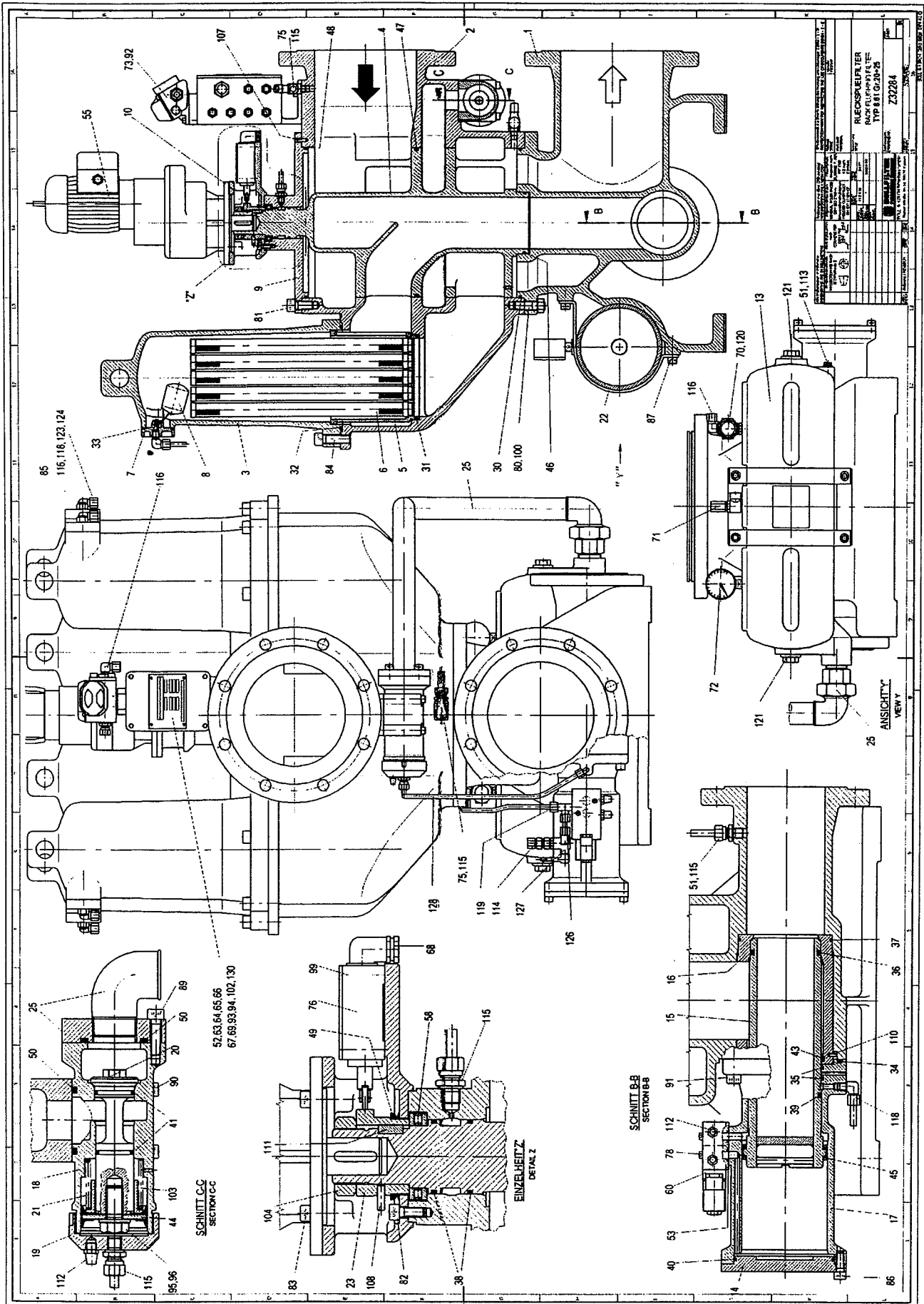
Before operating the filter manually, you have to switch off the main switch on the control box, in the interests of safety (self turning handle will cause violations).

Attach the crank handle supplied to the free end of the motor shaft. By rotating the motor (in either direction) the cam disc is rotated to the next changeover point (i.e. the next filter chamber). The cam and the limit switch must align precisely.

Back flushing is initiated directly by a manual actuation of the flushing valve (with a screw [60] driver). This manual actuation should last 12 seconds.

You have to wait 2 min. before changing over to the next filter chamber, to give time to fill up the backflushed filter chamber.







DOCUMENTATION PARTS LIST

Date 01.03.05
Page 1

Document 0632785
Description automatic filter
6.61.1 Gr.20 DN200
Material EN-JS1030
EN-GJS-400-15
EN 1563
Assembly Z40273+Z32284
Dimension drawing Z42915

Filter room:
max. allowable pressure : 16 bar
max. allowable temperature : 160°C
Heating room:
max. allowable pressure: 14 bar
max. allowable temperature : 200°C
Test pressure : 2 x Calculation pressure

Item	ID no.	Description	Qty	Unit
00001	6531421	housing lower part	1	pcs.
00002	6531420	change-over housing	1	pcs.
00003	5535117	filter chamber	6	pcs.
00003	2000004	stud bolt	12	pcs.
00004	5421473	cock plug	1	pcs.
00005	5058058	candle support	6	pcs.
00006	9905005	star-pleated element according to orde	42	pcs.
00007	5906594	cover	6	pcs.
00007	5218298	nozzle	6	pcs.
00007	6712641	bow	6	pcs.
00007	2000266	slotted cheese head screw	12	pcs.
00008	2610023	float	6	pcs.
00008	2611123	pin	6	pcs.
00008	3530032	threaded pipe fitting	6	pcs.
00009	6231432	cover change over housing	1	pcs.
00010	5427288	motor flange	1	pcs.
00011	6530357	heating chamber	3	pcs.
00011	5000011	counter flange	3	pcs.
00011	2000001	stud bolt	12	pcs.
00011	2004354	stud bolt	3	pcs.
00011	3380049	high pressure gasket	3	pcs.
00011	2100004	hexagon nut	12	pcs.
00011	2000139	hexagon socket head cap screw	3	pcs.
00011	6706265	plate mounting heating chamber	3	pcs.
00013	6534617	air reservoir	1	pcs.
00014	5001487	mud drain valve cover	1	pcs.
00015	5011387	mud drain valve ram	1	pcs.
00016	5032487	mud drain valve cover	1	pcs.
00017	5022487	mud drain housing	1	pcs.
00018	5025610	air valve housing	1	pcs.
00019	5025611	air valve cover	1	pcs.
00020	5005622	air valve ram	1	pcs.
00021	5006622	air valve bushing	1	pcs.
00022	6702366	mounting bow	2	pcs.
00023	5120253	cam disc	1	pcs.



DOCUMENTATION PARTS LIST

Date 01.03.05
Page 20632785 automatic filter
6.61.1 Gr.20 DN200

Item	ID no.	Description	Qty	Unit
00025	5032025	flange air valve	1	pcs.
00025	0603136	tubing	1	pcs.
00025	2503690	angle screwing	1	pcs.
00025	2502511	angle	1	pcs.
00030	3031928	o-ring	1	pcs.
00031	3030068	o-ring	6	pcs.
00032	3030182	o-ring	6	pcs.
00033	3132369	o-ring	6	pcs.
00034	3030080	o-ring	1	pcs.
00035	3532219	gasket	2	pcs.
00036	3030203	o-ring	1	pcs.
00037	3030662	o-ring	1	pcs.
00038	3030063	o-ring	2	pcs.
00039	3030177	o-ring	1	pcs.
00040	3031498	o-ring	1	pcs.
00041	3030060	o-ring	2	pcs.
00043	3544103	stripper	1	pcs.
00044	2785551	seal piston	1	pcs.
00045	2786811	double grooved ring	1	pcs.
00046	3030108	o-ring	1	pcs.
00047	3030087	o-ring	1	pcs.
00048	3031928	o-ring	1	pcs.
00049	3542193	truarc inverted ring	1	pcs.
00050	3030074	o-ring	2	pcs.
00051	3270002	gasket	4	pcs.
00052	3380199	flat gasket	1	pcs.
00053	3040224	o-ring	2	pcs.
00055	4500100	gear motor	1	pcs.
00058	2708948	cylindrical roller bearing	1	pcs.
00060	4105912	connector plug	1	pcs.
00060	2656655	solenoid valve	1	pcs.
00060	4206553	coil	1	pcs.
00060	2614072	sound absorber	1	pcs.
00063	5950196	connection box	1	pcs.
00064	8450198	cover for connection box	1	pcs.
00065	4105616	clamp	15	pcs.
00065	4105617	clamp	6	pcs.
00065	4100015	distance plate	3	pcs.
00066	2000258	slotted cheese head screw	2	pcs.
00067	4105805	mounting rail	1	pcs.
00068	4160351	angle cable screwing	1	pcs.
00068	4160349	reducing ring	1	pcs.
00069	4160350	cable gland	4	pcs.
00069	4160349	reducing ring	4	pcs.
00069	4100104	cable gland	1	pcs.
00069	4160351	angle cable screwing	4	pcs.
00069	4160349	reducing ring	4	pcs.
00069	4870017	plug	1	pcs.
00070	2650017	high pressure control device	1	pcs.
00071	2660005	safety valve	1	pcs.
00072	2600044	pressure gauge	1	pcs.
00073	9902572	differential pressure indicator acc. t	1	pcs.



DOCUMENTATION PARTS LIST

Date 01.03.05
Page 30632785 automatic filter
6.61.1 Gr.20 DN200

Item	ID no.	Description	Qty	Unit
00075	2560063	angle ball valve	2	pcs.
00076	4200062	limit switch	1	pcs.
00078	2002155	hexagon socket head cap screw	2	pcs.
00080	2003612	stud bolt	8	pcs.
00081	2000168	hexagon socket head cap screw	8	pcs.
00082	2000131	hexagon socket head cap screw	4	pcs.
00083	2000132	hexagon socket head cap screw	4	pcs.
00084	2000279	hexagon socket head cap screw	30	pcs.
00085	2100006	hexagon nut	12	pcs.
00086	2000143	hexagon socket head cap screw	6	pcs.
00087	2000153	hexagon socket head cap screw	4	pcs.
00089	2000145	hexagon socket head cap screw	4	pcs.
00090	2001539	hexagon socket head cap screw	4	pcs.
00091	2000156	hexagon socket head cap screw	4	pcs.
00092	2000122	hexagon socket head cap screw	2	pcs.
00093	2000131	hexagon socket head cap screw	2	pcs.
00094	2000261	slotted cheese head screw	2	pcs.
00095	2000095	hexagon screw	1	pcs.
00096	2200009	disc	1	pcs.
00099	2000967	hexagon socket head cap screw	2	pcs.
00100	2100012	hexagon nut	8	pcs.
00102	2003587	threaded flange screw	4	pcs.
00103	2307527	pressure spring	1	pcs.
00104	5002790	shaft nut	1	pcs.
00107	2300123	Straight Pin	1	pcs.
00108	2308746	half-round groove pin	1	pcs.
00110	2300007	Spring Type Straight Pin	1	pcs.
00111	2400109	feather key	1	pcs.
00112	2614171	sound absorber	3	pcs.
00113	2000187	screwed sealing plug	1	pcs.
00114	2608775	non return valve	1	pcs.
00115	2500024	screwing	6	pcs.
00116	2500025	screwing	6	pcs.
00116	2500025	screwing	2	pcs.
00118	2500029	screwing	2	pcs.
00119	2507461	screwing	1	pcs.
00120	2500005	threaded pipe fitting	1	pcs.
00121	2002908	screwed sealing plug	2	pcs.
00121	3276803	gasket	2	pcs.
00123	2505339	screwing	4	pcs.
00124	2500258	screwing	1	pcs.
00126	2500083	screwed socket	1	pcs.
00127	2560356	angle ball valve	1	pcs.
00128	0602646	tubing set	1	pcs.
00130	9401690	type plate	1	pcs.
00131	9407569	label: "in / out"	1	pcs.
00131	9400997	label: "on / off"	1	pcs.
00131	9407396	label: "mud drain"	1	pcs.
00131	9402898	label	1	pcs.
00131	9405704	label: " ... 2 lugs ... "	2	pcs.
00131	9403614	label: "compressed air connection"	1	pcs.
00131	9404642	label: "Delta P differential pressure"	1	pcs.



DOCUMENTATION PARTS LIST

Date 01.03.05
Page 40632785 automatic filter
6.61.1 Gr.20 DN200

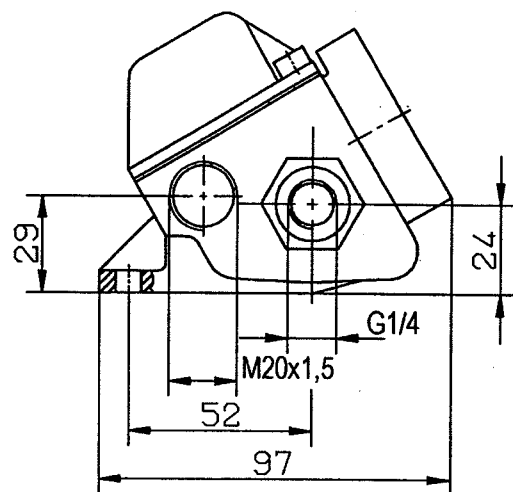
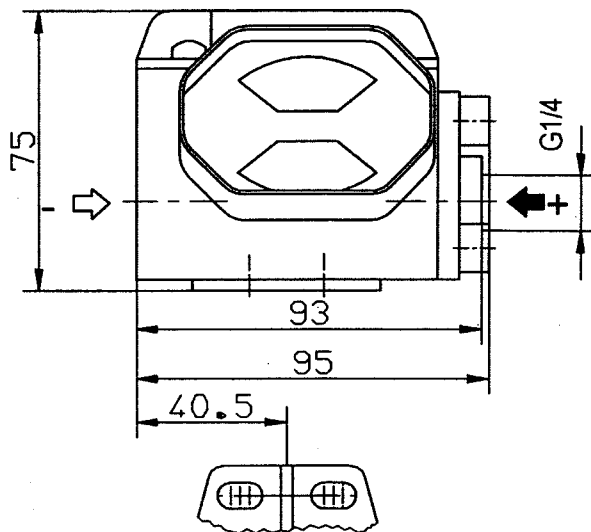
Item	ID no.	Description	Qty	Unit
00140	4300000	control box according to order	1	pcs.
00150	6705031	key	1	pcs.
00150	6705032	key for unscrewing the filter element	1	pcs.
00150	2300808	crank handle	1	pcs.
00150	5700725	guiding bolt	2	pcs.
00300	5135687	adapter	1	pcs.
00302	5533649	angle inlet	1	pcs.
00303	6133815	cock casing cover	1	pcs.
00304	6320064	cock plug	1	pcs.
00305	6136092	housing	1	pcs.
00306	0303000	steam heating tube	1	pcs.
00307	7203893	threaded rod	1	Unit
			1.000	mm
00308	1300001	candle instert acc. to order	1	pcs.
00309	8650055	key	1	pcs.
00310	6700112	bottom fastening	1	pcs.
00311	6436235	cover	1	pcs.
00320	2000010	stud bolt	16	pcs.
00322	2000009	stud bolt	12	pcs.
00323	2000009	stud bolt	8	pcs.
00324	2000011	stud bolt	8	pcs.
00325	2000124	hexagon socket head cap screw	2	pcs.
00326	2000046	hexagon screw	2	pcs.
00327	2300024	Spring Type Straight Pin	1	pcs.
00330	2100008	hexagon nut	16	pcs.
00331	2100008	hexagon nut	8	pcs.
00332	2100008	hexagon nut	12	pcs.
00334	2100008	hexagon nut	8	pcs.
00335	2100003	hexagon nut	2	pcs.
00336	2100007	hexagon nut	2	pcs.
00337	2100035	hexagon nut	1	pcs.
00340	0203221	pressure compensation	1	pcs.
00341	2560063	angle ball valve	2	pcs.
00343	9902572	differential pressure indicator acc. t	1	pcs.
00344	2000187	screwed sealing plug	1	pcs.
00345	2000193	screwed sealing plug	1	pcs.
00346	2000189	screwed sealing plug	1	pcs.
00350	2500024	screwing	4	pcs.
00360	3380076	high pressure gasket	2	pcs.
00361	3540024	gasket	1	pcs.
00362	3031065	o-ring	2	pcs.
00364	3033860	o-ring	1	pcs.
00365	3031077	o-ring	1	pcs.
00366	3034406	o-ring	1	pcs.
00370	3270002	gasket	1	pcs.
00371	3270008	gasket	1	pcs.
00372	3270004	gasket	1	pcs.

Überarbeitet am : 25.11.04

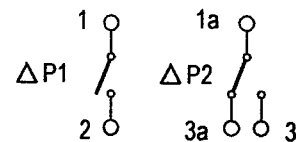
Überarbeitet von : Bogda



Z45550
TYP4.36.2
09.01.06



CIRCUIT DIAGRAM



SPECIFICATION:
PROTECTION CLASS: IP 65

ELECTR. DATA:	SWITCHING VOLTAGE	V $\approx$ MAX.=	250	220
	FREQUENCY	HZ MAX.=	0-60	0-60
	SWITCHING CURRENT	A MAX.=	1	0.8
	MAKING AND/OR BREAKING CAPACITY			
		WVA MAX.=	60/60	40/60

MATERIAL : GD - ALUMINIUM
RATING : MAX. PRESSURE 100 BAR
MAX. TEMPERATURE 150°C

RANGES OF PRESSURE DIFFERENTIAL: DELTA P =

0 - 0.5 BAR	} TO BE SPECIFIED WHEN ORDERING
0 - 0.8 BAR	
0 - 1.2 BAR	
0 - 2.0 BAR	
0 - 3.0 BAR	

DESCRIPTION:

THE PURPOSE OF THIS DEVICE IS THE MEASUREMENT, AND VISUAL INDICATION OF THE DIFFERENCE IN PRESSURE BETWEEN TWO POINTS, AND THE ESTABLISHMENT OF AN ELECTRICAL CONTACT WHEN THE PRESSURE DIFFERENTIAL ATTAINS A SPECIFIED FIGURE.

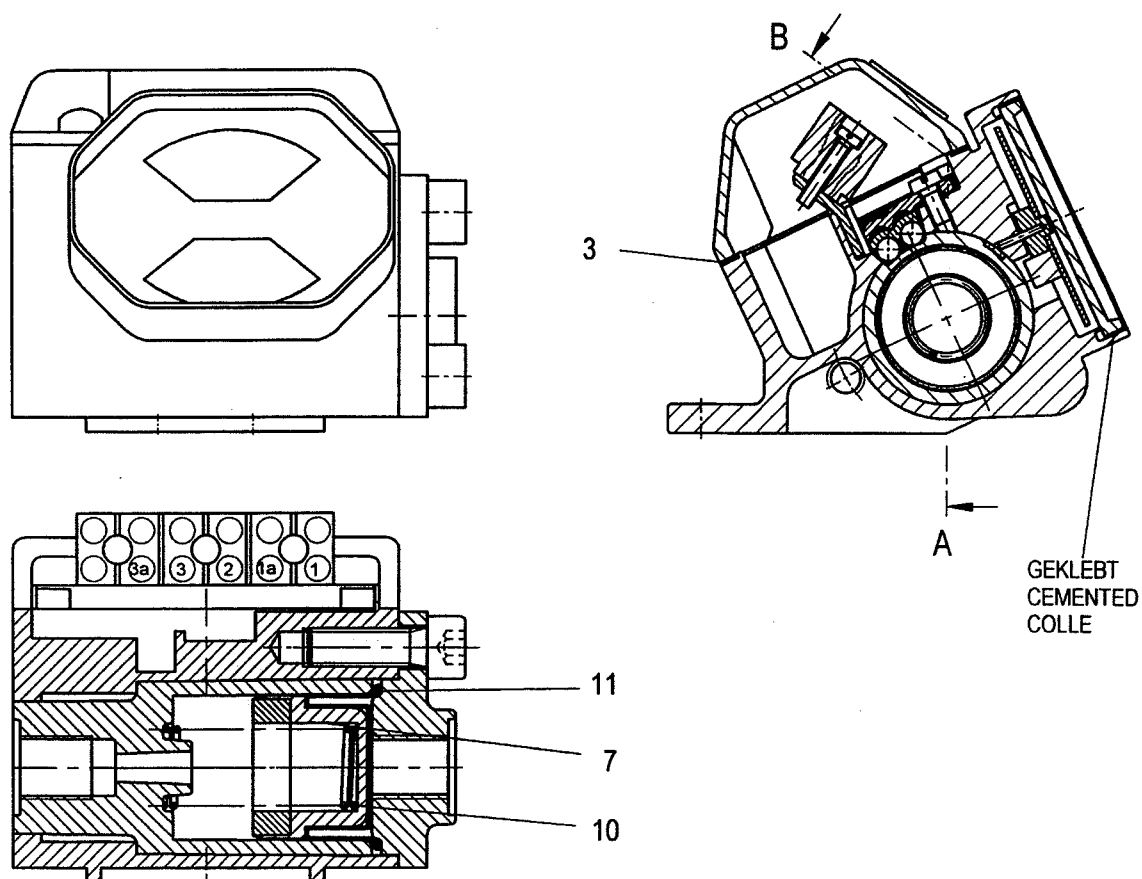
METHOD OF OPERATION:

A PLUNGER SEALED BY A DIAPHRAGM SEPARATES THE SPACE UNDER PRESSURE INTO TWO CHAMBERS. A PRE-LOADED SPRING CAUSES THE PLUNGER TO TAKE UP ITS ZERO POSITION WHEN THE PRESSURE DIFFERENCE DELTA P IS ZERO. AS THE PRESSURE DIFFERENCE INCREASES (DELTA P > 0), THE PLUNGER IS FORCED TO MOVE AGAINST THE SPRING. AT THE SAME TIME, AN INDICATOR DISC IS MOVED MAGNETICALLY, AND THEREFORE VIRTUALLY WITHOUT FRICTION, AND THE TWO REED CONTACTS ARE ACTUATED.

THE RED SEGMENT OF THE INDICATOR DISC IS VISIBLE OVER A PRESSURE RANGE EQUAL TO APROX.50-100% DELTA P. THE FIRST REED CONTACT IS ACTUATED AT 75% DELTA P1, AND THE SECOND AT 100% DELTA P2.

DIFFERENTIAL PRESSURE CONTACT INDICATOR TYPE 4.36.2

Z21434
TYP 4.36.2+4.46.2
11.02.94



A - B

BEI BESTELLUNG ANGEBEN
TO BE MENTIONED IN CASE OF ORDER
A MENTIONNER LORS DE LA COMMANDE

AUFTR.NR.:
ORDER NO.
NO DE COMMANDE

TYP 4.36.2

11	ROLLMEMBRAN	DIAPHRAGM	DIAPHRAGME	
10	FEDER	SPRING	RESSORT	
7	KOLBEN	PISTON	PISTON	
3	DICHTUNG	GASKET	JOINT	
POS.NR.	BEZEICHNUNG	DESIGNATION	DESIGNATION	

SPARE PARTS
DRAWING

ERSATZTEILZEICHNUNG
ZUM TYP 4.36.2 UND 4.46.2

PLAN DES PIECES
DE RECHANGE



Bei Service- und Ersatzteilbedarf wenden Sie sich bitte an das Stammhaus oder an unsere Niederlassungen, Vertretungen oder Service-Stellen.
If you need service or spares for our products please contact our head office or our branch-offices, agencies or service-stations.



Europa / Europe

Deutschland/Germany

Zentrale / Headquarters

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● United Arabian Emirates

① ② Middle East

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P.O. Box 4832
Dubai
Tel.: +971-4-3243240
Fax.: +971-4-3243786
E-Mail: sales@emirates.net.ae



HANMI POWER

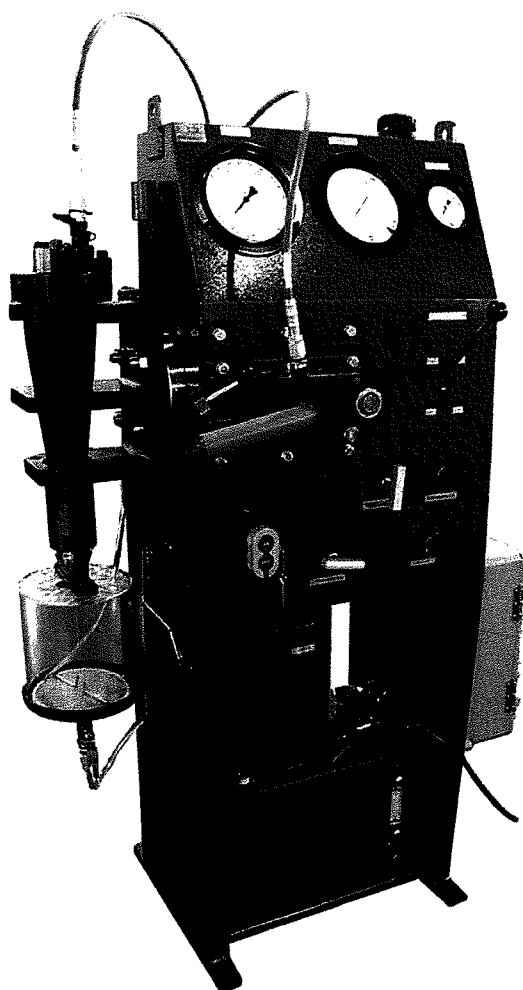
VTU-2100F RT-flex96C

MANUAL NO. : VTU-2100F-2.2(2007.03).MHI

INSTRUCTION MANUAL

FUEL VALVE TEST DEVICE

MODEL : VTU-2100F



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Tel. +82 51 305 2512~4 / Fax. +82 51 301 1721
E-mail : hm131@kornet.net Hm132@kornet.net



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5. CLEANING OF OIL FILTERS	PAGE 8
6. LUBRICATION INSTRUCTION	PAGE 8
C. OUTLINE OF THE VTU-2100F	PAGE 9

APPENDIX

- GENERAL ASSEMBLY (DWG NO. M12-5110-1.1)
- DIMENSION OF OUTLINE (DWG NO. M12-5111-1.1)
- STAND & SPANNER (DWG NO. M12-5112-1.0)
- ASSEMBLY OF BOOSTER (DWG NO. M10-3200-1.0)
- TOOLS (DWG NO. M12-5114-1.0)
- SPARE PART (DWG NO. M12-5115-2.0)
- JIG & ACCESSORY (DWG NO. M12-3116-1.0)
- CONTROL BOX (DWG NO. M12-5120-0.1)



A. SPECIFICATION

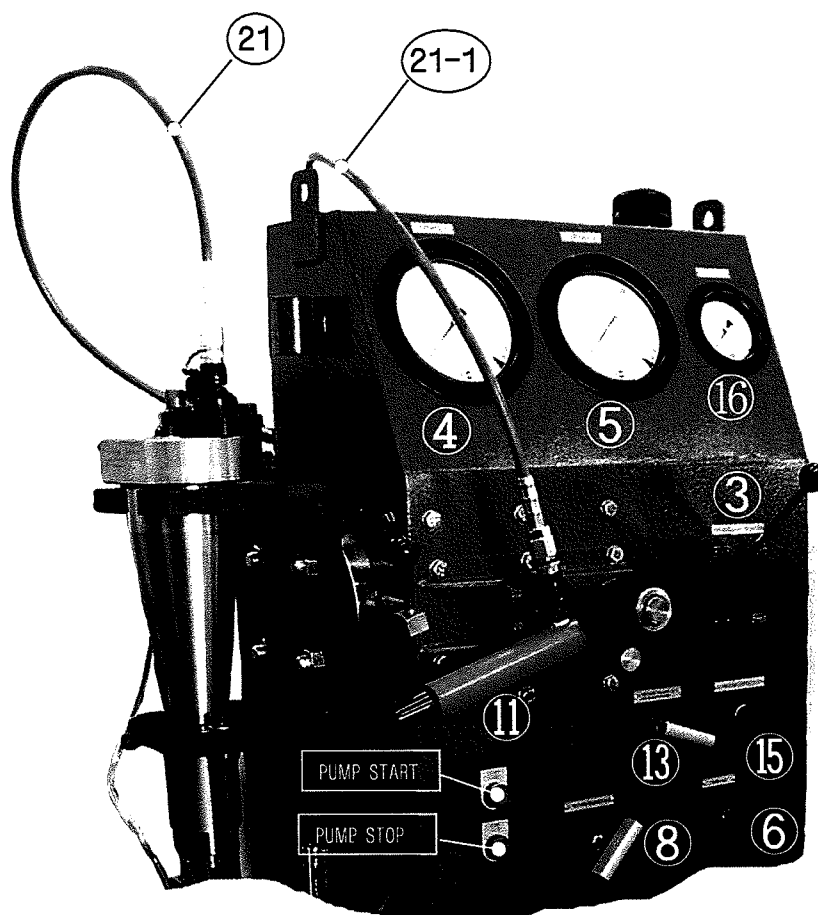
- | | |
|--------------------------|--|
| 1. Model No. | : VTU-2100F |
| 2. Voltage / Frequency | : 3ph x 440V x 60Hz |
| 3. Electric PUMP | |
| Delivery flow | : 4.4L/min at 1720 rpm |
| Stroke volume | : 2.62cm ³ / rev. |
| Electric motor | : 3.7kw x 440V x 60Hz |
| Oil tank capacity | : 20 Liter |
| Pressure setting | : Pressure relief valve. Pre - set 400bar
Cartridge valve M22 x 1.5 |
| 4. Air booster pump | |
| Outlet pressure | : 1500bar at 7bar air input |
| Max. flow at no pressure | : 0.5Liter/min |
| Pumping speed | : APPROX. 417 cycle/min. at 7bar air input |
| Displacement per cycle | : 1.2cm ³ |
| Oil tank capacity | : Approx. 6Liter |
| 5. Electric motor | : Increased Safety Exp. -proof
3.7kw 112S V1, Eg3
4Pole, 3Phase, 440V, 60Hz, IP54, F-CLASS |
| 6. Panel | : Flameproof Combination Stations |
| 7. Switch | : Flameproof Push Button Switches |
| 8. Weight | : Approx. 200kg |



HANMI POWER

VTU-2100F RT-flex96C

MANUAL NO. : VTU-2100F-2.2(2007.03).MHI



(Figure 1. Unit Layout)

- ③ Hydraulic Control Valve
- ④ Pressure Gauge (0~1000bar / 100Mpa)
- ⑤ Pressure Gauge (0~1600bar/160Mpa)
- ⑥ Relief Valve (355bar/35.5Mpa)
- ⑧ Pressure Release valve
- ⑪ Torque Cylinder
- ⑬ Pressure Release Valve for Booster Pump
- ⑮ Pressure Control Valve
- ⑯ Air Pressure Gauge (0~10bar/1.0Mpa)
- ⑰ Hydr. Hose for Fuel Valve
- ⑰-1 Hydr. Hose for Torque Cyl'd/F.O Relief Valve / Cyl'd cover Safety Valve



B. OPERATING INSTRUCTION

The VTU-2100F ensures the correct testing of SULZER Diesel RT-flex fuel valve.

All numbers in the test refer to the numbers found on the VTU-2100F front panel (see the figure 1, Unit Layout illustrated overleaf.)

1. PREPARATION

Before connect the air line to the unit, check the oil tank is filled with clean hydraulic oil (viscosity 7~10 Cst at 50° c).

Place the lever of the hydraulic control valve ③ is "NEUTRAL" position.

Turn the Pressure control valve ⑮ anti-clockwise until the handle of the regulator is smooth.

2. OPERATING THE PUMP UNIT

- Connect the electric power source of 3×440V×60Hz to the control box.
 - Connect the compressed air pressure of 5~8 bar to the unit marked "AIR INLET".
 - To avoid contamination of the pump, it is essential that an effective air filter and water separator is inserted in the air line.
- A lubro unit should however be avoided. See lubrication instruction.

WHEN OPERATING THE ELECTRIC PUMP

- Place the lever of the hydraulic control valve ③ to "NEUTRAL" position.
- Pump start switch "ON", and then electric pump will be operated.
- To vent the air in pump and the high pressure pipe lines, maintain this pumping during 1~2 minutes.
- Pressure gauge ④ indicates 0 bar.
- Pump stop switch "ON", and then electric pump will be OFF.

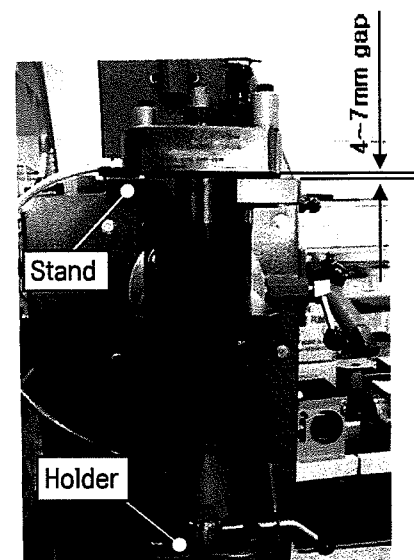
WHEN OPERATING THE AIR BOOSTER PUMP

- Open the pressure release valve ⑬ 2~3 turns anti-clockwise.
- Increase the air pressure to 3~4 bar by turning the Pressure control valve ⑮ clockwise.
- The pump will be operated.
- Maintain this pumping during 1~2 minutes to vent the air in the high pressure pipe lines.
- Decrease the air pressure by turning the Pressure control valve ⑮ anti-clockwise until the air pressure gauge ⑯ indicates 0 bar.
- Now every preparation for test of each valve and operating torque cylinder has finished.



3. TEST PROCEDURE OF FUEL VALVE

- Install the Holder to the mounting stand by two bolts.
- Install the fuel valve to the mounting by two bolts.
- After assembling, 4~7mm gap to be performed between stand upper side and fuel valve flange lower side.
(Refer to Figure 2.)
- Connect the hydraulic hose ② to the valve.
(If it is difficult to connect hydraulic hose owing to remaining pressure in the hose, remove the pressure by turning pressure release valve ⑧ 2~3 turn anti-clockwise.)



(Figure 2. Install the fuel valve)

OPENING PRESSURE

- Close the pressure release valve ⑧ firmly by turning clockwise
- Pump start switch "ON", and then electric pump will be operated.
- Move the handle of the hydraulic control valve ③ to "OPENING TEST" (3A) position.
- At that time check the opening pressure which is read on pressure gauge ④ is correct.
- Move the handle of the hydraulic control valve ③ to "NEUTRAL" position.
- Pump stop switch "ON", and then electric pump will be OFF.

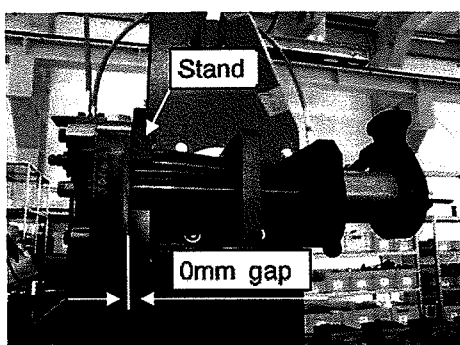
LEAKAGE OF THE FUEL VALVE

- Close the pressure release valve ⑧ firmly by turning clockwise.
- Pump start switch "ON", and then electric pump will be operated.
- Move the handle of the hydraulic control valve ③ to "LEAK TEST" (3B) position.
- The pressure gauge ④ will indicator approx. 355bar by pressure relief valve control.
Check that there is no leak at the atomizes.
- Confirm the lever of the hydraulic control valve ③ to "NEUTRAL" position.
- Pump stop switch "ON", and then electric pump will be OFF .

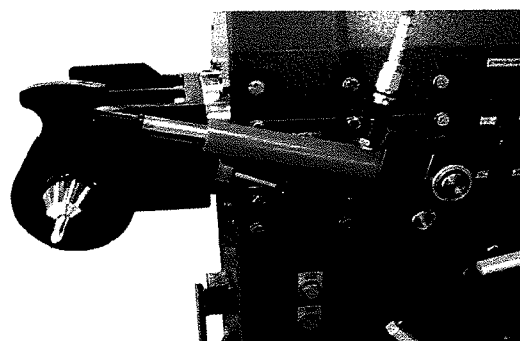


DISMANTLING OF CAP NUT

- Separate the holder from mounting stand.
- Rotate the mounting stand horizontally which the fuel valve is installed, And fix it by the fixing pin.
- After assembling, 0mm gap to be performed between stand upper side and fuel valve flange lower side. (Refer to Figure 3.)
- Insert the spanner to the fuel valve as shown fig. 4.



(Figure 3. Install the fuel valve)



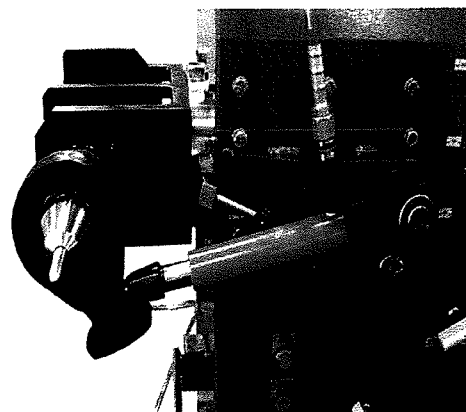
(Figure 4. Dismantling)

- Push the spanner by the torque cylinder as follows.
 - a) Close the pressure release valve ⑬ firmly by turning clockwise.
 - b) Confirm the pressure gauge ⑯ indicates 0 bar. If not, turn the Pressure control valve ⑮ anti-clockwise.
 - c) Confirming the top of the torque cylinder is correct position of the spanner, increase the pressure slowly by turning the Pressure control valve ⑮ clockwise until the pressure gauge ⑤ indicates max. 450 bar.
 - d) Open the pressure release valve ⑬ firmly by turning anti-clockwise.
 - e) Decrease the air pressure by turning the Pressure control valve ⑮ anti-clockwise until the pressure gauge ⑯ indicates 0 bar.



ASSEMBLY OF CAP NUT

- Insert the spanner to the fuel valve as shown figure 5.
- Push the spanner by the torque cylinder as follows.
 - a) Close the pressure release valve ⑬ firmly by turning clockwise.
 - b) Confirm the pressure gauge ⑯ indicates 0 bar. If not, turn the Pressure control valve ⑮ anti-clockwise.
 - c) Confirming the top of the torque cylinder is correct position of the spanner, increase the pressure slowly by turning the Pressure control valve ⑮ clockwise until the pressure gauge ⑤ indicate 420 bar. (Tightening - Nut : SW-70)
(Be careful in order not to add than 420 bar. (SW-70) If not the fuel valve may be damaged.)
 - d) Open the pressure release valve ⑬ firmly by turning anti-clockwise.
 - e) Decrease the air pressure by turning the Pressure control valve ⑮ anti-clockwise until the pressure gauge ⑯ indicates 0 bar.
 - f) After every test of the fuel valve, separate it from the mounting stand.

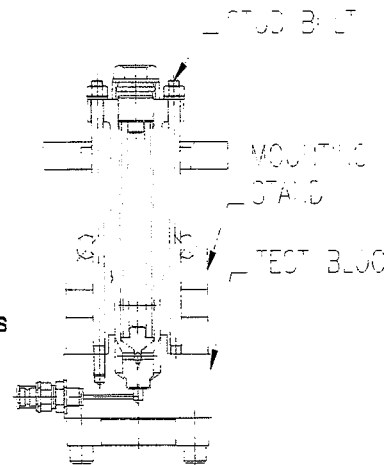


(Figure 5. Assembly)

4. TEST OF THE OTHER VALVES

CYL' COVER SAFETY VALVE

- Install the Test block to the mounting stand by two bolts.
- Install the safety valve to the mounting test block.
(Refer to. Figure 6)
- a) Connect the high pressure hose ②①-1 to the test block.
- b) Close the pressure release valve ⑬ firmly by turning clockwise.
- c) Confirm the pressure gauge ⑯ indicator 0bar. If not, turn the pressure control valve ⑮ anti-clockwise.
- d) Increase the air pressure slowly by turning the pressure control valve ⑮ clockwise watching the pressure gauge ⑤ and the valve.
- e) When the valve opens and hydraulic oil comes out from it, read the pressure.
- f) Open the pressure release valve ⑬ firmly by turning anti-clockwise.
- g) Decrease the air pressure by turning the pressure control valve ⑮ anti-clockwise until the pressure gauge ⑯ indicator 0bar
- h) After every test of the valve, separate it from the mounting stand.



(Figure 6. cyl' cover safety valve)

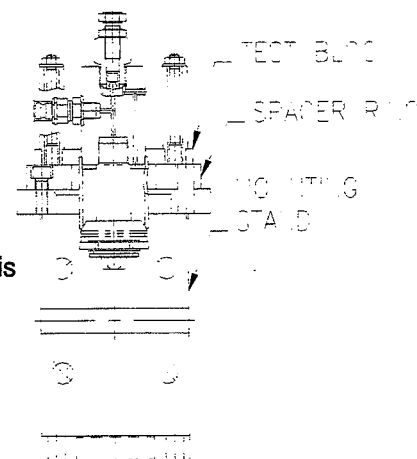


F.O RELIEF VALVE

- Install the F.O relief valve to the mounting test block.
- Install the spacer ring to the mounting stand by two bolt.
- Install the Test block to the mounting stand by two bolts.

(Refer to. Figure 7)

- a) Connect the high pressure hose (21-1) to the test block.
- b) Close the pressure release valve (13) firmly by turning clockwise
- c) Confirm the pressure gauge (16) indicator 0bar. If not, turn the pressure control valve (15) anti-clockwise.
- d) Increase the air pressure slowly by turning the pressure control valve (15) clockwise watching the pressure gauge (5) and the valve.
- e) When the valve opens and hydraulic oil comes out from it, read the pressure.
- f) Open the pressure release valve (13) firmly by turning anti-clockwise.
- g) Decrease the air pressure by turning the pressure control valve (15) anti-clockwise until the pressure gauge (16) indicator 0bar
- h) After every test of the valve, separate it from the mounting stand.



(Figure 7. F.O relief valve)

5. CLEANING OF OIL FILTERS

The mesh filter which is found in the filler cap has to be removed and cleaned when the fuel oil has a tendency of slow flow.

The oil filter (17) which is found in the outlet from the oil vessel is of the "thraw-away" type, which should be removed and substituted by a new filter, when the old one has clogged, and the filter should under all circumstances be changed at least once every six months. Please note that before removing this filter, the oil vessel should be empty completely, which is easily done by operating the pump unit without a fuel valve.

6. LUBRICATION INSTRUCTION

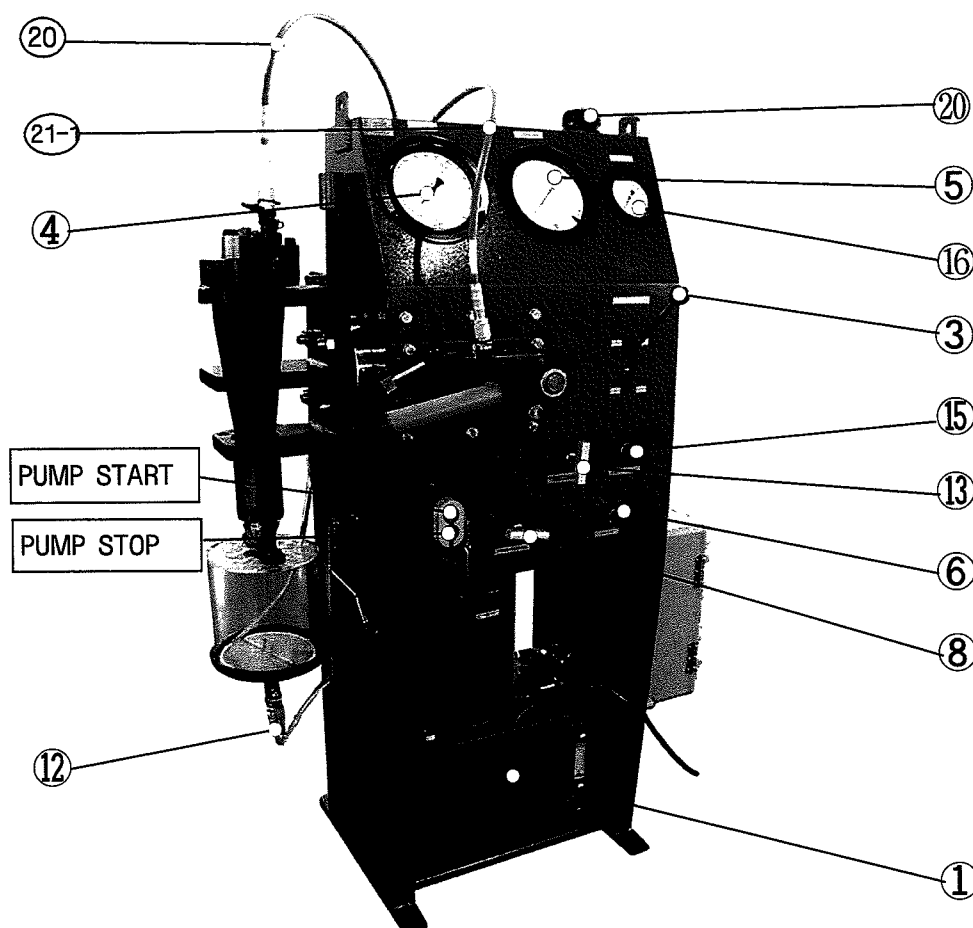
WARNING : AVOID AIRLINE LUBRICATION. The pump has been pre-lubricated and a lubro unit will decrease the efficiency of the pump.

Air valves should be lubricated periodically. Remove exhaust fittings and valve spool and apply a thin coat of the supplied grease.

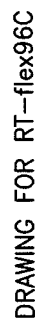
If primary air drive section is dismantled, always apply a thin coat of the grease to entire inner surface of cylinder tube and plunger o-rings

**HANMI POWER****VTU-2100F RT-flex96C**

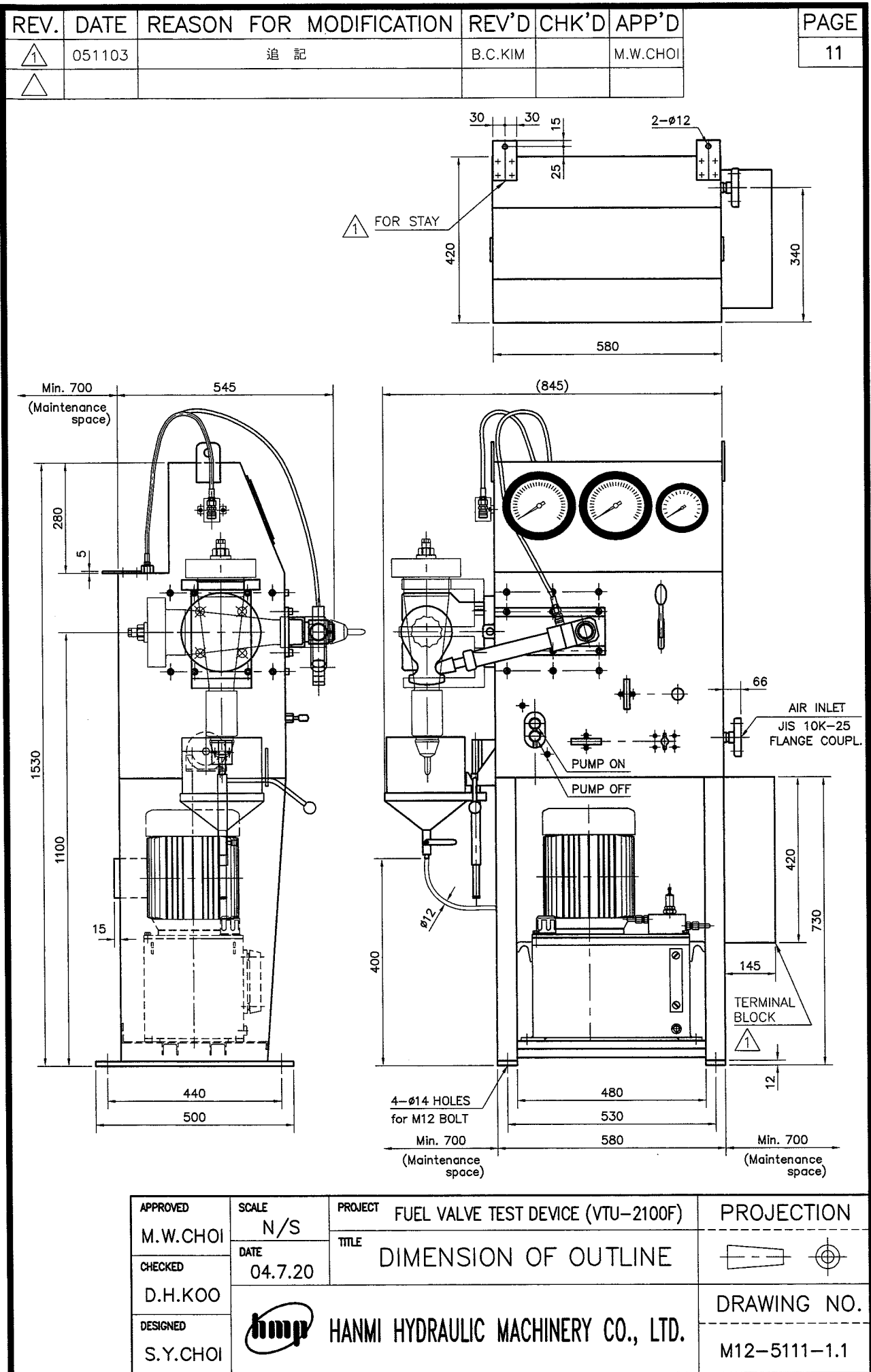
MANUAL NO. : VTU-2100F-2.2(2007.03).MHI

C. OUTLINE OF THE VTU-2100F

Pos.1 Electric Pump	(12-5200-0.0)	Pos.12 Ball Valve	(HM-VTU-12)
Pos.2 Booster Pump	(10-3200-0.0)	Pos.13 Pressure Release Valve for Booster Pump	(HM-VTU-13)
Pos.3 Operating Valve for Working	(HM-VTU-03)	Pos.14 Air Filter (inside VTU-2100 unit)	(HM-VTU-14)
Pos.4 Operating Valve for Leak Test	(HM-VTU-04)	Pos.15 Pressure Control Valve	(HM-VTU-15)
Pos.5 Pressure Gauge (0~1600bar/160Mpa)	(HM-VTU-05)	Pos.16 Air Pressure Gauge (0~10bar/1.0Mpa)	(HM-VTU-16)
Pos.6 Relief Valve (355bar)	(HM-VTU-06)	Pos.17 Oil Filter (inside Oil tank)	(HM-VTU-17)
Pos.7 Check Valve (inside VTU-2100 unit)	(HM-VTU-07)	Pos.18 Oil tank (inside VTU-2100 unit)	(12-3001-2.1)
Pos.8 Pressure Release Valve	(HM-VTU-08)	Pos.19 Oil Level Gauge	(HM-VTU-19)
Pos.9 Booster (0.75L)	(12-3021-0)	Pos.20 Filler Cap with Strainer	(HM-VTU-20)
Pos.10 Distributor	(HM-VTU-10)	Pos.21 Hydr. Hose for Fuel Valve	(HM-VTU-21)
Pos.11 Torque Cylinder	(33-1000-0.0)	Pos.21-1 Hydr. Hose for Torque Cyl'd/F.O Relief valve	(HM-VTU-21-1)



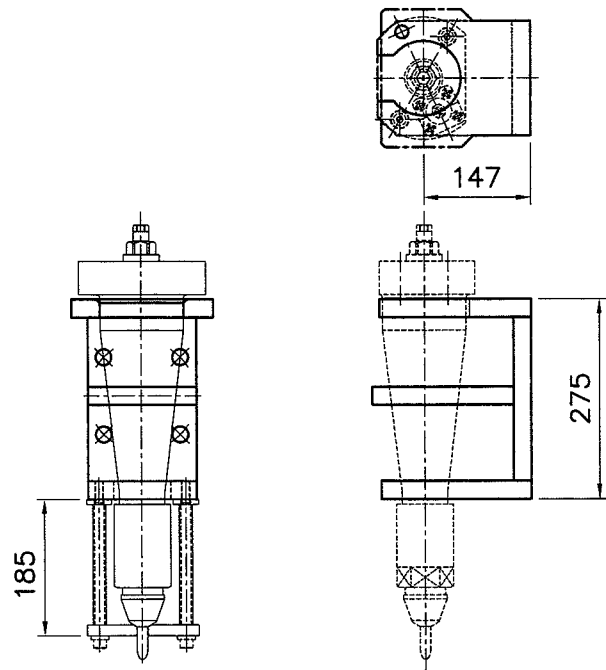
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REV.	DATE	REASON FOR MODIFICATION	REV'D	CHK'D	APP'D



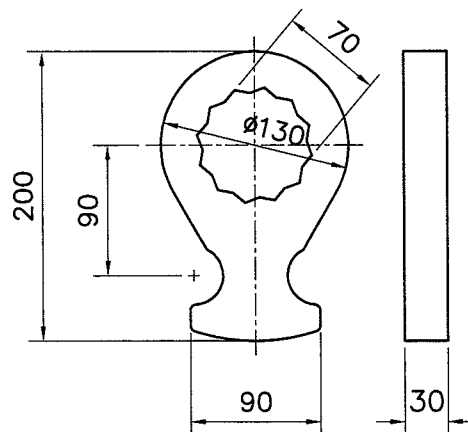
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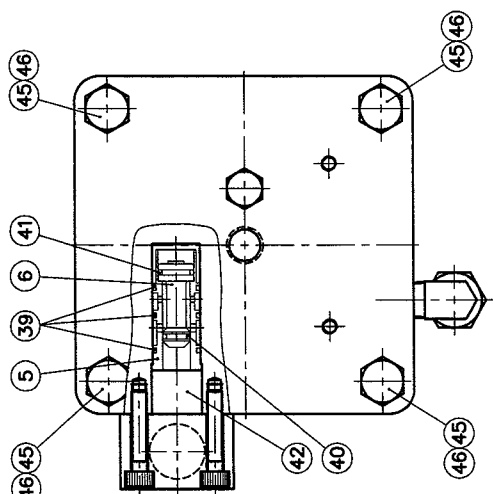
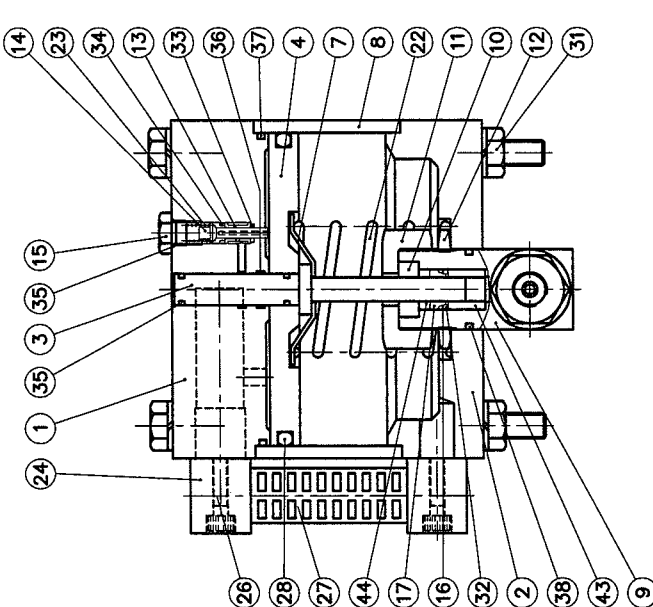
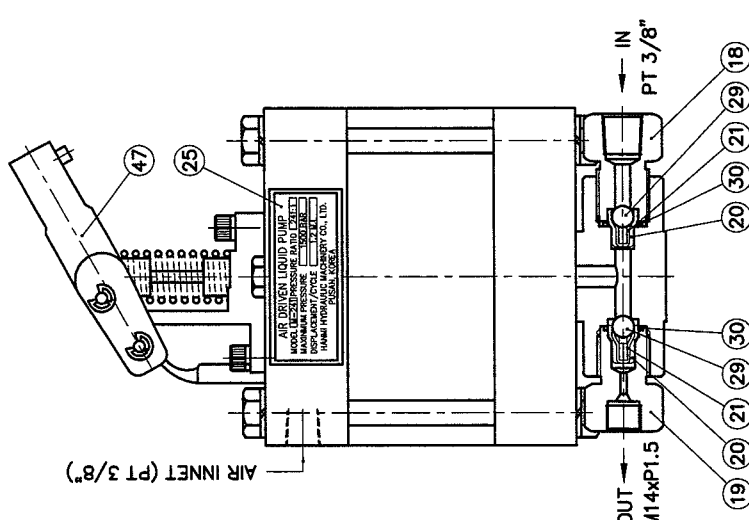


SUPPORT ANGLE
FOR INJECTION NOZZLE SUPPORTING STAND

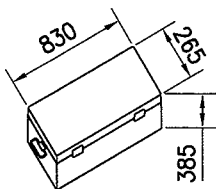
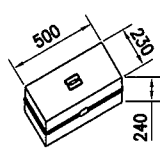
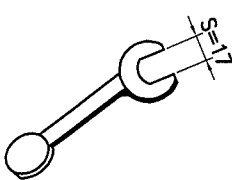
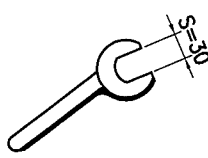
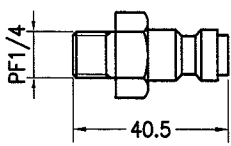
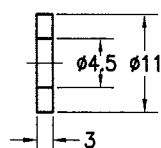


SPANNER
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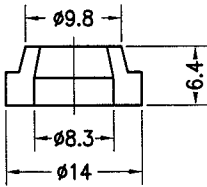
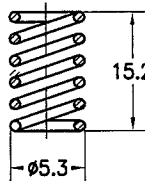
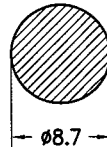
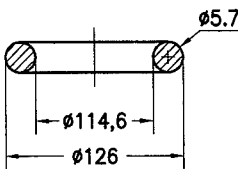
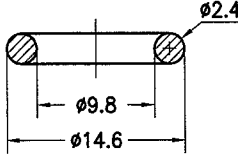
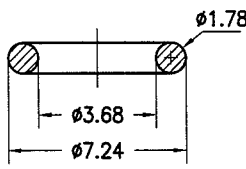
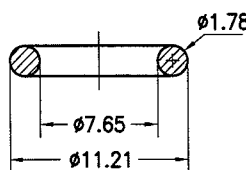
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B.C.KIM	060818	STAND & SPANNER RT-flex96C	DRAWING NO.
DESIGNED	HANMI HYDRAULIC MACHINERY CO., LTD.		M12-5112-1.0
D.H.GU			

PAGE 13								* ASS'Y WEIGHT : APT. 6 Kg	
47	LEVER FOR HAND PUMPING	10-3247-0.0	1	1					
46	HEX. BOLT	10-3246-0.0	4	4					
45	SPRING WASHER	10-3245-0.0	8	8					
44	RING	10-3244-0.0	1	1					
43	RING	10-3243-0.0	1	1					
42	SPOOL COVER RING	10-3242-0.0	1	1					
41	O-RING	10-3241-0.0	1	1					
40	O-RING	10-3240-0.0	1	1					
39	O-RING	10-3239-0.0	3	3					
38	O-RING	10-3238-0.0	1	1					
37	O-RING	10-3237-0.0	1	1					
36	O-RING	10-3236-0.0	1	1					
35	O-RING	10-3235-0.0	3	3					
34	O-RING	10-3234-0.0	1	1					
33	O-RING	10-3233-0.0	1	1					
32	O-RING	10-3232-0.0	1	1					
31	HEX. NUT	10-3231-0.0	1	1					
30	O-RING	10-3230-0.0	1	1					
29	BALL	10-3229-0.0	1	1					
28	O-RING	10-3228-0.0	1	1					
27	SILENCER	10-3227-0.0	1	1					
26	WRENCH BOLT	10-3226-0.0	2	2					
25	NAME PLATE	10-3225-0.0	1	1					
24	SPOOL COVER	10-3224-0.0	2	2					
23	SPRING	10-3223-0.0	1	1					
22	SPRING	10-3222-0.0	1	1					
21	SPRING	10-3221-0.0	2	2					
20	RETAINER	10-3220-0.0	2	2					
19	OUY CHECK BODY	10-3219-0.0	1	1					
18	IN CHECK BODY	10-3218-0.0	1	1					
17	PACKING SEAL	10-3217-0.0	1	1					
16	RING	10-3216-0.0	1	1					
15	PLUG	10-3215-0.0	1	1					
14	PILOT VALVE	10-3214-0.0	1	1					
13	TUBE	10-3213-0.0	1	1					
12	GLAND NUT	10-3212-0.0	1	1					
11	GLAND NUT	10-3211-0.0	1	1					
10	BUSH	10-3210-0.0	1	1					
9	H.P. CYLINDER	10-3209-0.0	1	1					
8	AIR CYLINDER	10-3208-0.0	1	1					
7	SPRING SUPPORT	10-3207-0.0	1	1					
6	SPOOL	10-3206-0.0	1	1					
5	SLEEVE	10-3205-0.0	1	1					
4	AIR PISTON	10-3204-0.0	1	1					
3	H.P. PISTON	10-3203-0.0	1	1					
2	BOTTOM CAP	10-3202-0.0	1	1					
1	TOP CAP	10-3201-0.0	1	1					
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M.W.CHOI		DATE 04.8.28		TITLE ASSEMBLY OF BOOSTER		1		M10-3200-1.0	
CHECKED		D.H.KOO		HANNI HYDRAULIC MACHINERY CO., LTD.		1		A3(257x420)	
DESIGNED		S.Y.CHOI		HANNI HYDRAULIC MACHINERY CO., LTD.		1		A3(257x420)	
REV. DATE		REASON FOR MODIFICATION		REV'D CHK'D APP'D		1		A3(257x420)	
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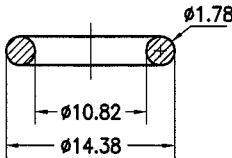
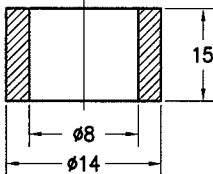
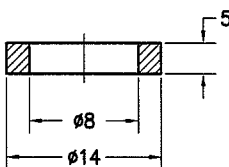
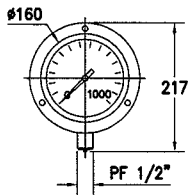
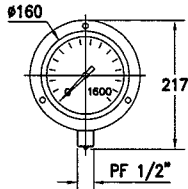
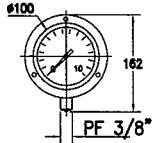
TOOLS

REV.		DATE		FUEL VALVE TEST DEVICE					PAGE	
△									14	
△				TYPE : VTU-2100F						
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NO.	NAME	SKETCH	MATERIAL /WEIGHT	SUPPLY PER SHIP			DRAWING NO.	REMARK		
				STAND- -ARD	ADDIT- -ION	TOTAL				
1	KEEPING BOX		ALUMINUM /4.4kg	1	-	1				
1-1	TOOL BOX		PLASTIC /0.5kg	1	-	1				
1-1-1	COMBINATION SPANNER		TOOL STEEL /0.16kg	1	-	1				
1-1-2	SINGLE OPEN ENDED SPANNER		TOOL STEEL /0.25kg	1	-	1				
1-1-3	+ DRIVER		- /0.06kg	1	-	1				
1-1-4	MALE COUPLER		STEEL /0.06kg	1	-	1				
1-1-5	DISC		COPPER /0.002kg	1	-	1				
MANUFACTURER'S NAME			 HANMI HYDRAULIC MACHINERY CO., LTD.							

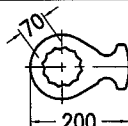
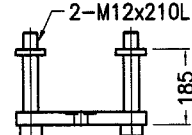
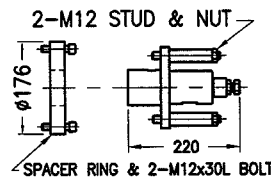
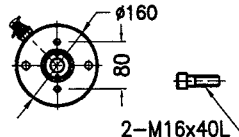
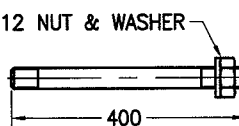
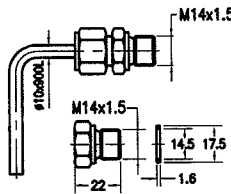
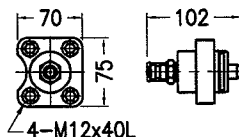
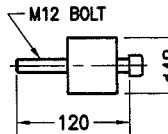
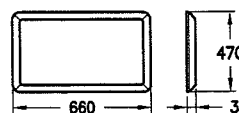
SPARE

REV.		DATE	FUEL VALVE TEST DEVICE				PAGE	
△							15	
△			MODEL : VTU-2100F					
			DWG. NO.		M12-5115-2.0 (1/2)			
NO.	NAME	SKETCH	MATERIAL /WEIGHT	SUPPLY PER SHIP			DRAWING NO.	REMARK (WEIGHT) Kg
				STAND- -ARD	ADDIT- -ION	TOTAL		
1-1-6	PACKING SEAL		UHMWPE /0.001kg	1	-	1	10-3217 -0.0	
1-1-7	SPRING		SUS304 /0.001kg	2	-	2	10-3221 -0.0	
1-1-8	BALL		STEEL /0.003kg	2	-	2	10-3229 -0.0	
1-1-9	O-RING		N.B.R /0.013kg	1	-	1	10-3228 -0.0	
1-1-10	O-RING		N.B.R /0.001kg	1	-	1	10-3232 -0.0	
1-1-11	O-RING		N.B.R /0.001kg	1	-	1	10-3233 -0.0	
1-1-12	O-RING		N.B.R /0.001kg	1	-	1	10-3240 -0.0	
MANUFACTURER'S NAME		 HANMI HYDRAULIC MACHINERY CO., LTD.						

SPARE

REV.		DATE	FUEL VALVE TEST DEVICE					PAGE	
△			MODEL : VTU-2100F					16	
△									
			DWG. NO.		M12-5115-2.0 (2/2)				
NO.	NAME	SKETCH	MATERIAL /WEIGHT	SUPPLY PER SHIP			DRAWING NO.	REMARK (WEIGHT) Kg	
				STAND- ARD	ADDITION	TOTAL			
1-1-13	O-RING		N.B.R /0.001kg	1	-	1	10-3241 -0.0		
1-1-14	RING		BC3 /0.014kg	1	-	1	10-3243 -0.0		
1-1-15	RING		BC3 /0.005kg	1	-	1	10-3244 -0.0		
1-2	PRESSURE GAUGE 0~1000bar/100MPa		MAKER /1.1kg	1	-	1	M12-3000 -04		
1-3	PRESSURE GAUGE 0~1600bar/160MPa		MAKER /1.2kg	1	-	1	M12-3000 -05		
1-4	PRESSURE GAUGE 0~10bar/1.0MPa		MAKER /0.6kg	1	-	1	M12-3000 -16		
MANUFACTURER'S NAME			 HANMI HYDRAULIC MACHINERY CO., LTD.						

JIG & ACCESSORY

REV.		DATE	FUEL VALVE TEST DEVICE VTU-2100F					PAGE	
△								17	
△									
			TYPE : RT-flex96C			DWG. NO.		M12-3116-1.0	
NO.	NAME	SKETCH	MATERIAL	SUPPLY PER SHIP			REMARK		
				STAND- ARD	ADDITION	TOTAL			
1-5	SPANNER		STEEL /2.2kg /3.1kg	1	-	1	FOR CAP NUT DISMANTLING & ASSEMBLY		
1-6	HOLDER FOR FUEL VALVE INJECTION TEST		STEEL /1.3kg	1	-	1			
1-7	TEST BLOCK FOR FUEL PUMP RELIEF VALVE		STEEL /4.8kg /3.4kg	1	-	1			
1-8	TEST BLOCK FOR CYL' COVER SAFETY VALVE		STEEL /8.7kg	1	-	1			
1-9	STUD BOLT FOR ADJUSTING DEVICE		STEEL /0.36kg	2	-	2	TO USE CYL COVER SAFETY V/V CLAMPING		
1-10	HEXAGON HEAD PLUG WITH FLANGE AND GASKET		VINYL STEEL /0.092kg	1	-	1			
			STEEL /0.037kg	1	-	1			
1-11	ADAPTER FOR HYDRAULIC HOSE FOR FUEL VALVE		STEEL /1.3kg	1	-	1			
1-12	TENSION WASHER CAGE		STEEL /0.23kg	2	-	2			
2	OIL TRAY		ALUMINUM /1.4kg	1	-	1			
MANUFACTURER'S NAME			 HANMI HYDRAULIC MACHINERY CO., LTD.						

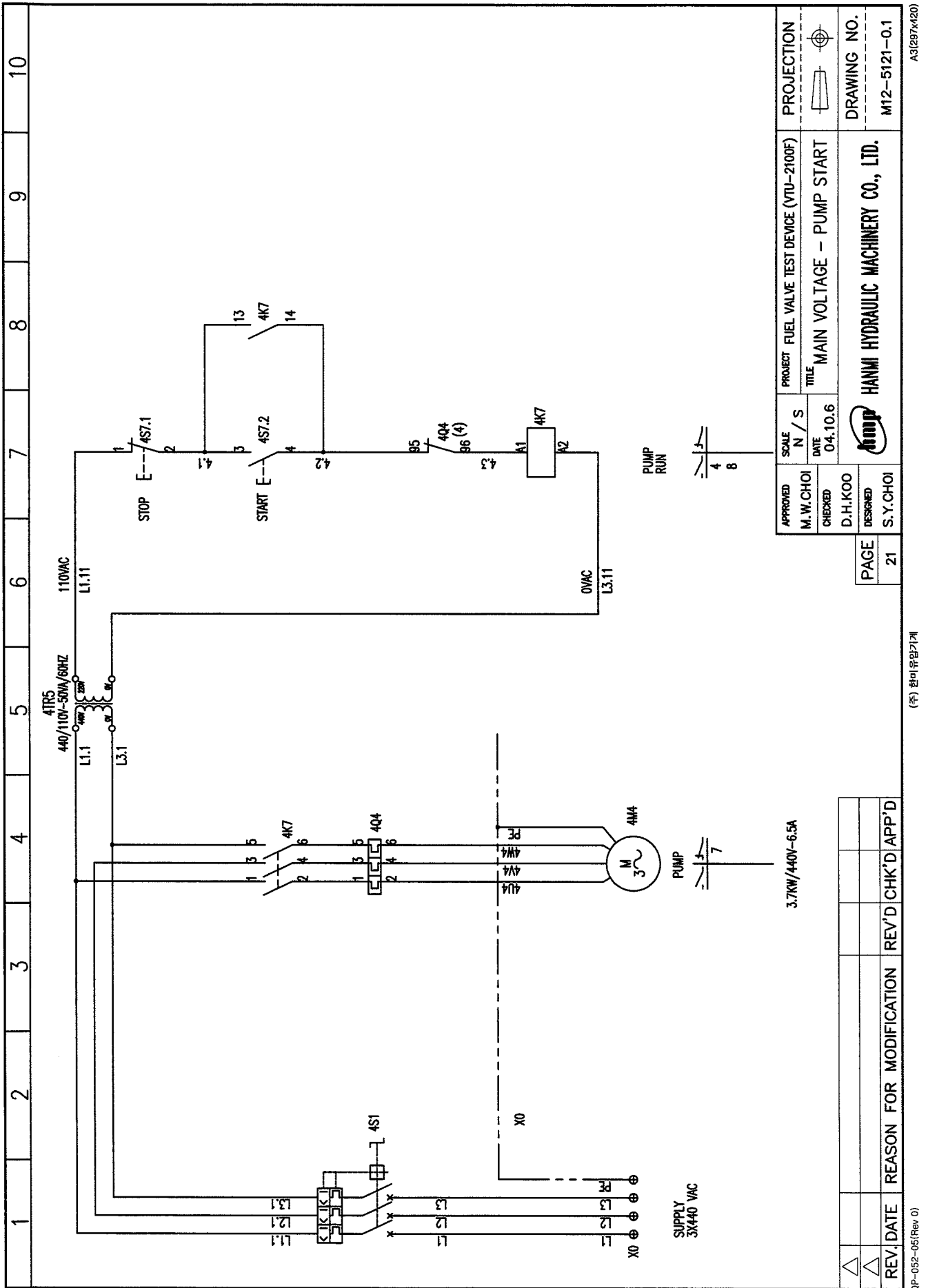
1	2	3	4	5	6	7	8	9	10
Project: CONTROL BOX FOR FUEL VALVE TEST DEVICE (VTU-2100F) Supply: 3Ph x 440V + 60Hz Drawing no.....: M12-5120-0.1									
△									
△									
REV	DATE	REASON FOR MODIFICATION	REV'D	CHK'D	APP'D				
						SCALE N / S DATE 04.10.6		PROJECT FUEL VALVE TEST DEVICE (VTU-2100F) TITLE TITLE	
APPROVED M.W.CHOI		CHECKED D.H.KOO		DESIGNED S.Y.CHOI		DRAWING NO. M12-5118-0.1		PROJECTION 	
						PAGE 18		DRAWING NO. M12-5118-0.1	
						HANI HYDRAULIC MACHINERY CO., LTD.		A3(297x420)	

(주) 한미유압기계

QP-052-05(Rev 0)

Contents

A3(297x420)



A3(297x420)

(주) 한미유압기계

KAWAMURA SYSTEM
EXHAUST VALVE SEATGRINDING MACHINE
&
WORKING RIG

MODEL: HK-600GS-F

HK-600GSS-F

FOR SULZER RT-flex96C

INSTRUCTION MANUAL

GENERAL

Please study carefully the instruction manual before use of the equipment.

Following words are about SAFETY. Please keep them surely.

⚠ WARNING There is a possibility that the operator will be seriously hurt or perished by misoperation.

⚠ CAUTION There is a possibility that the operator will get an injury or physical damage by misoperation.

Even the thing described in **⚠ Caution** may cause serious troubles depending upon circumstances.

- ★ Please keep this manual at an accessible place carefully and read it repeatedly at any time.
- ★ Disappeared the manual, please get a copy soon from us or through a sales agent.

ATTENTION FOR SAFETY

WARNING

Please read this manual before use of the equipment and keep the warnings.

- ★ Light enough around the working rig. Arrange the tools in the right position. If a tool, such as a stool will be left at an expected place, an accident will occur.
- ★ Please use an helmet, goggles, breathing filter, hearing protection and safety shoes according to work circumstances.
- ★ Please don't use this machine for other purposes. Otherwise you may have a trouble or accident.
- ★ Please don't remodel this machine. Otherwise a trouble will happen.
- ★ Please don't remove the parts. Please don't take out parts or screws that are not necessary to do so. It will cause troubles.

SAFETY FOR THE GRINDER

WARNING

- ★ You have to wear sensible clothes for the grinding work and have an attention your clothes not get caught in the moving parts.
- ★ A grinding wheel cover is fitted on the grinding machine. Please don't use the machine without the cover. If not, you will be hurt when the grinding wheel damaged.
- ★ At the maintenance, replacement of the grinding wheel or a danger expected, cut off the electric source at the breaker.
- ★ Put the grinder to trial for one minute before grinding work. After replacement of the grinding wheel make a trial for three minutes and confirm the machine is normally operating.
- ★ Use a normal grinding wheel with the specification of over 50 m/s (3,000 m/min) at max surface speed. If not, it will break to accident. (For the dimensions of grinding wheel, refer to the specification sheet.)
- ★ Don't use the side surface of grinding wheel.
- ★ Make sure the grinding wheel not cracked, nor broken. Don't use damaged one.
- ★ There should not be a foreign object between the grinding wheel and the flange surface. Confirm there are labels on the both side surfaces of the grinding wheel. Don't peel the labels off.
- ★ Don't tighten the screw too much strongly to break the grinding wheel.
- ★ Don't use a grinding wheel got wet or flooded in the water or other liquid.
- ★ At the work of fitting or replacement of the grinding wheel an inspection and test operation shall be done by a person specially trained for replacement and trial operation.

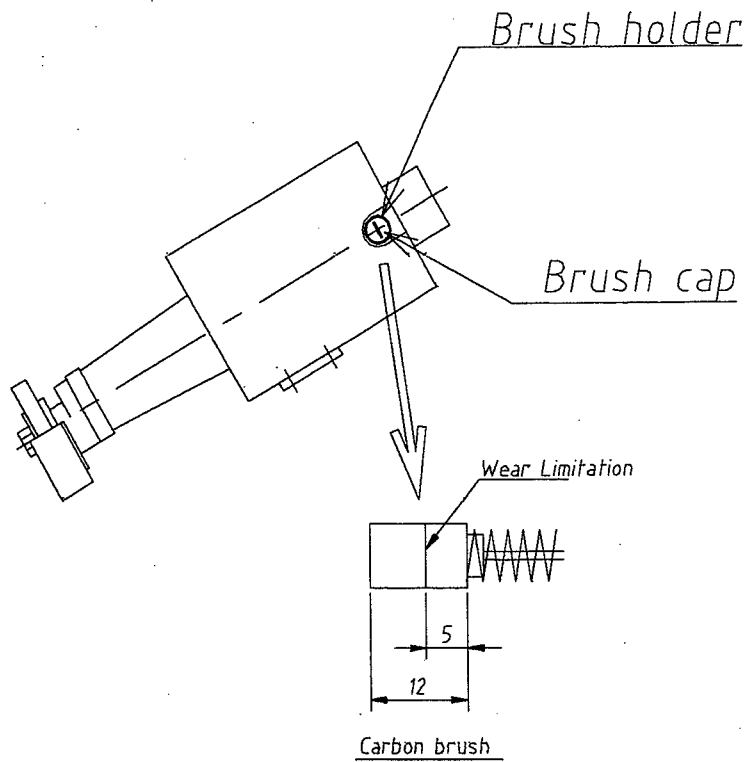
- ★ Keep away from the extended radius of rotating grinding wheel. Heated particles come from at grinding work. Beware of the particles into the eye and of accidental breakage of the grinding wheel.
- ★ Don't force the grinding wheel to the stem. However, there should not be big looseness between the stem and the grinding wheel.

⚠ CAUTION

- ★ In case of switching on the grinder make sure the rotating part of the grinder isn't touching to the seat surface. Otherwise, the grinding wheel will be broken and cause hurt.
- ★ At the first time of switching on the grinder after replacement of grinding wheel with new one, keep away from the grinding wheel for a while.
- ★ Don't push the grinding wheel quickly and strongly on the seat surface. A crack will occur on the grinding wheel and cause damage of it.
- ★ Use goggles, gloves, breathing filter and ear stopple at grinding work.
- ★ Keep flammable things off the grinding machine. A fire will be happened by the heated particles coming from the grinding stone.
- ★ Don't operate the grinder with overload, otherwise troubles will happen. Use the grinder at normal load.

CHECK OF CARBON BRUSH

- ★ There are two carbon brushes on the grinder motor. When the brushes used over the wear limitation, a trouble will happen on the motor. Replace worn brush at about 5 mm worn with new one. Clean the brushes to slide easily in the brush holder. Carbon brushes can be taken out after removed the brush caps by a minus screw driver. (see the Fig. below)



SAFETY FOR THE WORKING RIG

WARNING

- ★ The equipment is made for turning the valve spindle (See Fig.2) or Fuel pump unit (See Fig.6). Don't use it for other purposes.
- ★ On the turning work of the valve cage, valve spindle or fuel pump unit a common attachment is used to set them on the working rig. Don't set them all at once. Only one attachment is supplied to prevent a damage of the worm gear.
- ★ Stopper can be set at the angle of 90 deg. intervals on the working rig. The working rig can be set at other angles for a short time, but the stopper should be used to prevent a damage of the worm gear. According to the situation of balance the worm gear cannot keep the rotation and it will cause accidents.
- ★ The stopper shall be used at fitting work of the cover (A) (B) or the attachment with screws. Otherwise the worm gear will break.
- ★ Fasten tightly the fix bolts for the cover (A) (B) and the attachment. If not, the parts will be broken away and troubles happen.
- ★ Don't stand on the working rig and the rotary parts. The worm gear will be broken and troubles happen. According to the situation of balance the worm gear cannot keep the rotation and it will cause accidents.
- ★ Keep away from the radius of the rotation at the work of turning valve box, valve spindle or fuel pump unit. The worm gear will break and the rotation of the equipment will not stop. Very dangerous. According to the situation of balance the worm gear cannot keep the rotation and it will cause accidents.

- ★ Turn the fuel pump unit after fixed cover (A) and (B) on the working rig from the balance point. (See Fig.1) If not, the worm gear will break and an accident will happen.

According to the situation of balance the worm gear cannot keep the rotation and it will cause accidents.

- ★ At the turning of the working rig both of the cover(A)and cover (B)shall be fixed on it. (See Fig.1)

If the only one of the cover used, it is not easy to turn the handle due to the unbalance.

And if the handle turned by force, the worm gear shall be broken.

If will cause a big trouble.

When the worm gear cannot keep its rotation due to the condition of the balance, an accident will occur.

- ★ In case of reversing don't turn the handle like a flywheel, detaching the hands.

Spinning of the handle not in balance is very dangerous.

Keep the hands on the handle during reversal.

INSPECTION OF WORKING RIG

- ★ Open the gear cover periodically (See Fig.1) and check the gears and the bearings if any damages or abnormal wear on them. If damages found, don't use the working rig and repair or replace the parts from us or through sales route.
- ★ Open the gear cover periodically (See Fig.1) and grease the gears by hands.
Grease: Grease No. 2 basic of Lithium soap.

SPECIFICATION

➤ Grinding wheel revolution	14,000 min-1
➤ Grinding machine revolution	3 min-1
➤ Motor for Grinding wheel	AC100V 60Hz 325W
➤ Motor for Grinding machine	AC100V 60Hz 40W
➤ Grinding angle	30°+2' -0'
➤ Power supply	AC100V 60Hz 1φ

TURNUNG PROCEDURE OF VALVE CAGE AND VALVE SPINDLE

1. Rotate the working rig to get the cover (B) upward. (See Fig.1)
 2. Set the attachment to the cover (B) by hexagonal socket head screws (M16 x 50L, 8pcs.) (See Fig.1)
 3. Fix the stopper for valve spindle on the attachment by hexagonal socket head screws (M10 x 30L, 4pcs.) (See Fig.1)
 4. Rotate the working rig to get the cover (B) downward. (See Fig.2)
 5. Remove two covers (A).
 6. Put the valve cage and valve spindle into the working rig from the top.
 7. Take the valve spindle bottom apart so that the valve spindle can be pull out.
 8. Fix two covers (A) on the working rig by hexagonal socket head screws (M16 x 35L, 8pcs.) (See Fig.2)
 9. Reverse the valve cage and valve spindle by the handle. (See Fig.2)
 10. Take off the stopper for valve spindle.
 11. Pull out the valve spindle. (See Fig.3)
 12. Take off the cover (B) and the attachment.
 13. Take out the exhaust valve seat grinding machine, which is stored at the side of the working rig and insert it into the valve guide located at the bottom of the valve cage. (See Fig.4)
- Note: The seat grinding machine is being fixed by the U bolts (2pcs.) and fix bolts. Before loosen the U bolts and fix bolts, hook the eye-nut at the top of the seat grinding machine by a crane. Keep up the surfaces of the pilot of the seat grinding machine and the valve guide from the dust.

REVERSING PROCEDURE OF FUEL PUMP UNIT

1. Set the positioning pins ($\phi 16 \times 2$ points) of the reversing plate (See Fig.1 & 5) into the holes ($\phi 17 \times 2$ points) of the attachment. (See X-X, Y-Y on Fig.5)
Fix the attachment to the reversing plate with hexagonal socket head screws (M16 x 50L, 8 pcs.). (See Fig.5)
2. Set the positioning pin ($\phi 35 \times 1$ point) of the reversing plate into the positioning hole ($\phi 40 \times 1$ point) of the fuel pump fixture. (See X-X, Z-Z on Fig.5)
Fix the fuel pump fixture with hexagonal socket head screws (M16 x 50L, 6 pcs.). (See Fig.5)
3. Insert the positioning pin ($\phi 25 \times 1$ pce) for the Fuel pump fixture into the hole ($\phi 30$) of the Fuel pump body. (See Fig.5, Z-Z)
Put the Hexagonal screws (M20 x 55L, 2 pcs) into the holes of Fuel pump.
The Fuel pump will be held by the positioning pin ($\phi 25 \times 1$ pce) and the Hexagonal screw (M16 x 60L, 1 pce)
Tighten the Hexagonal screws (M20 x 55L, 2 pce) to fix the Fuel pump. (See Fig. 6)
4. Reverse the fuel pump unit rotating the handle. (See Fig.1)

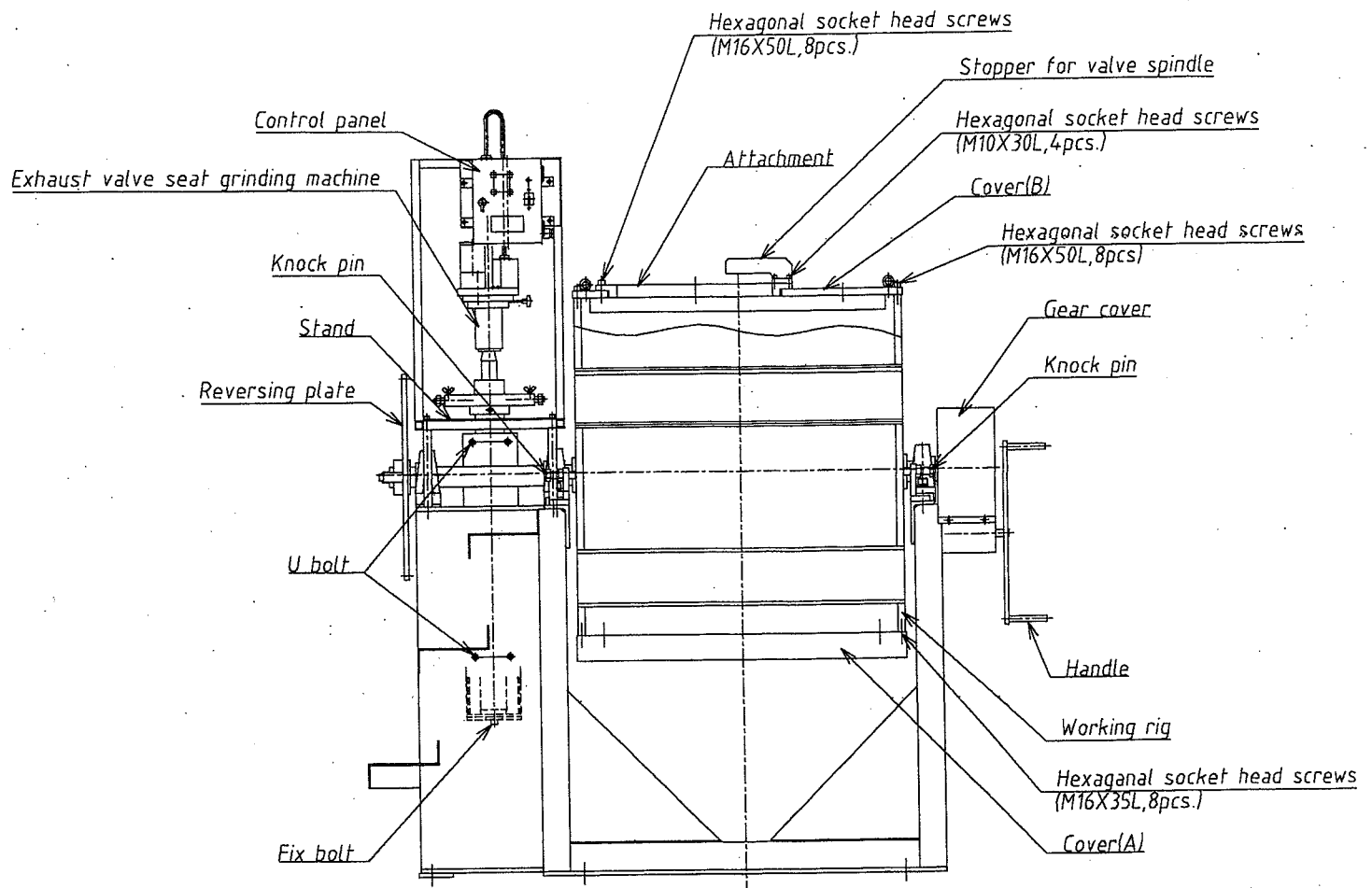


Fig.1

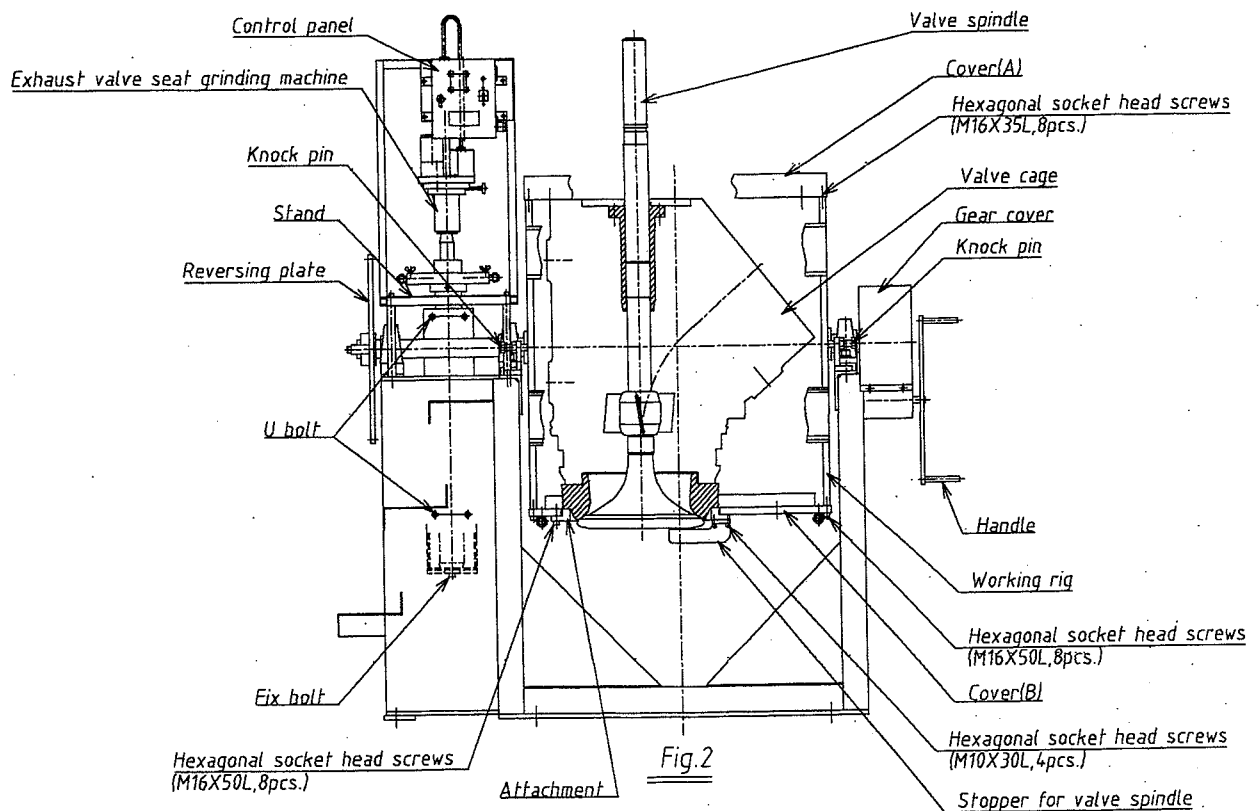


Fig.2

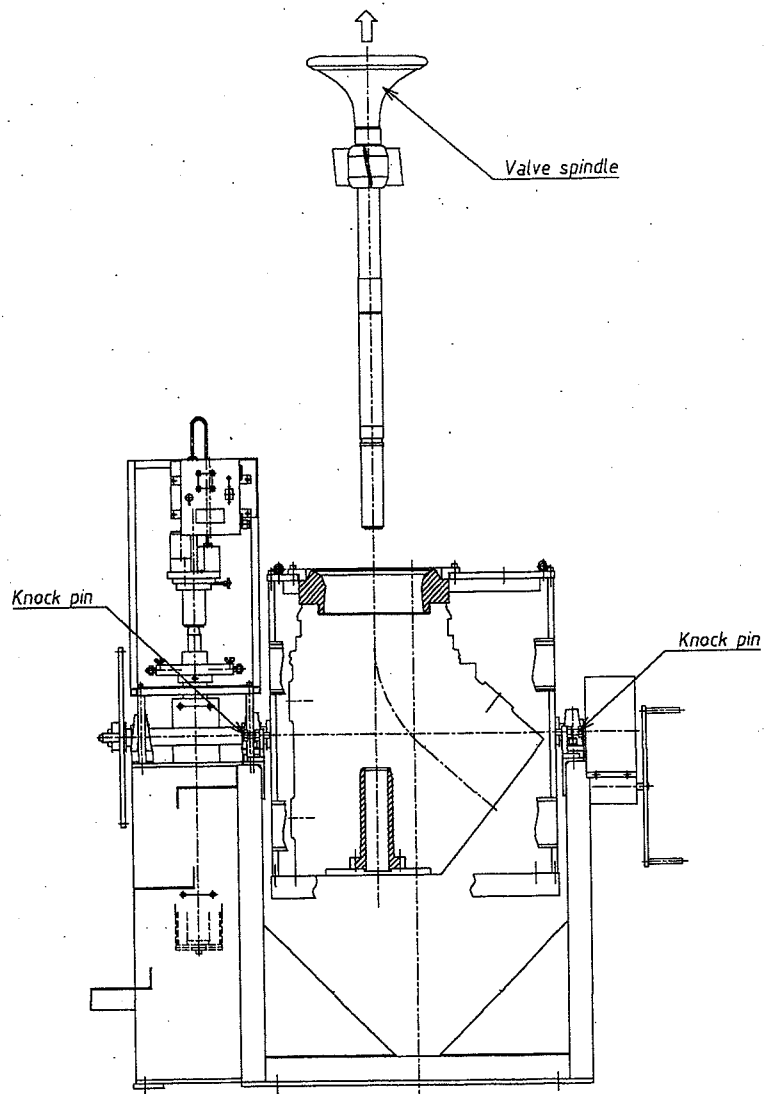


Fig.3

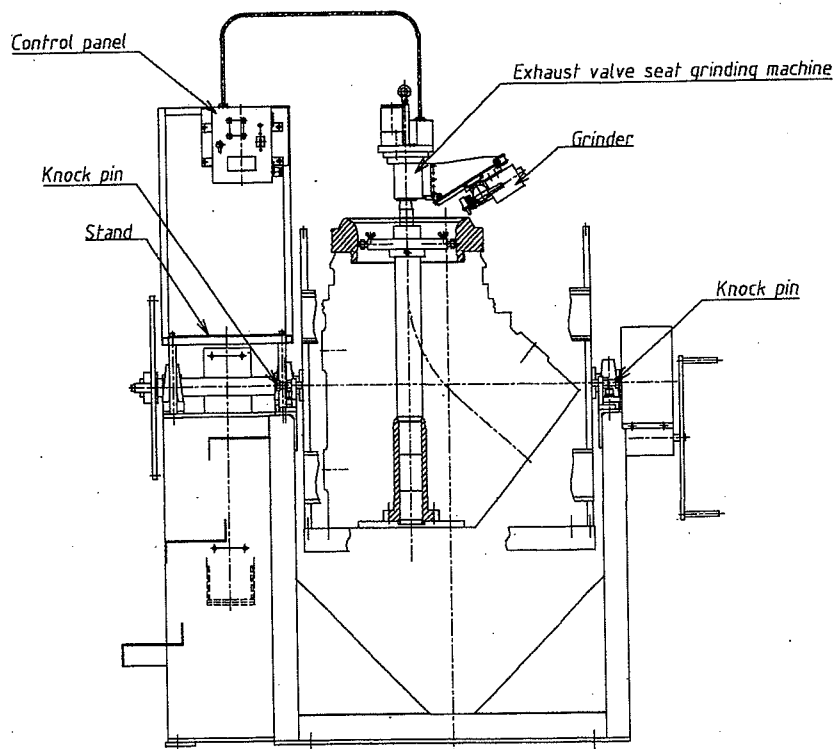
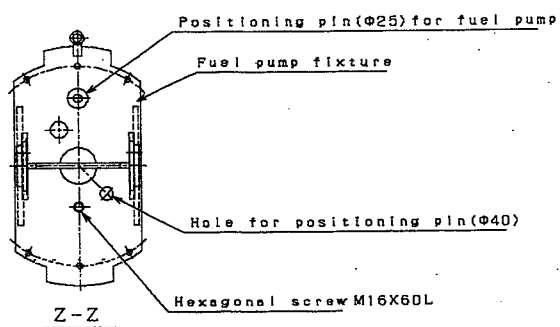
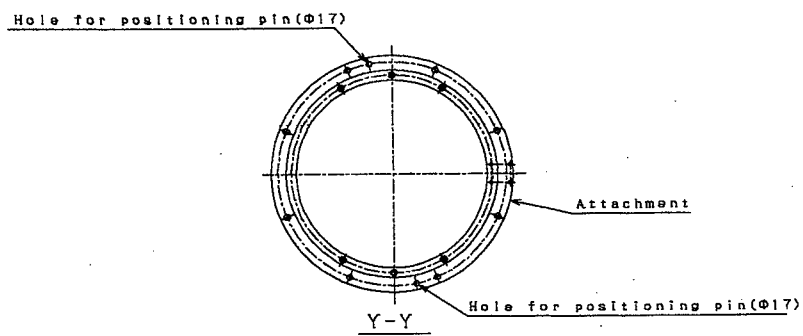
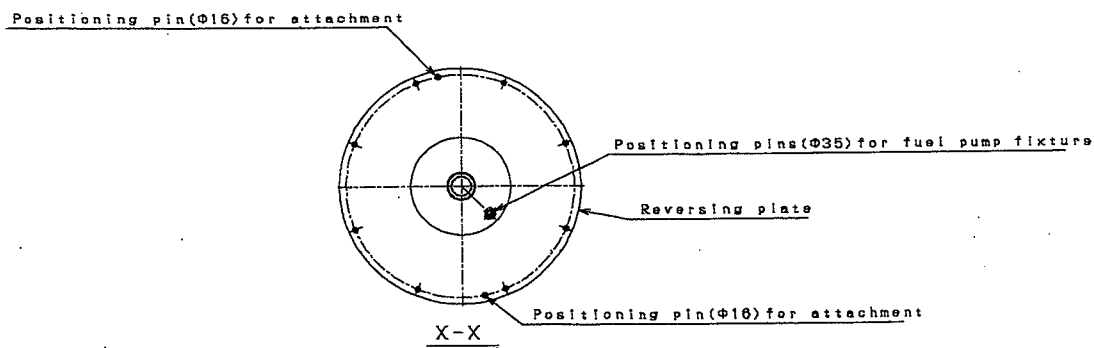
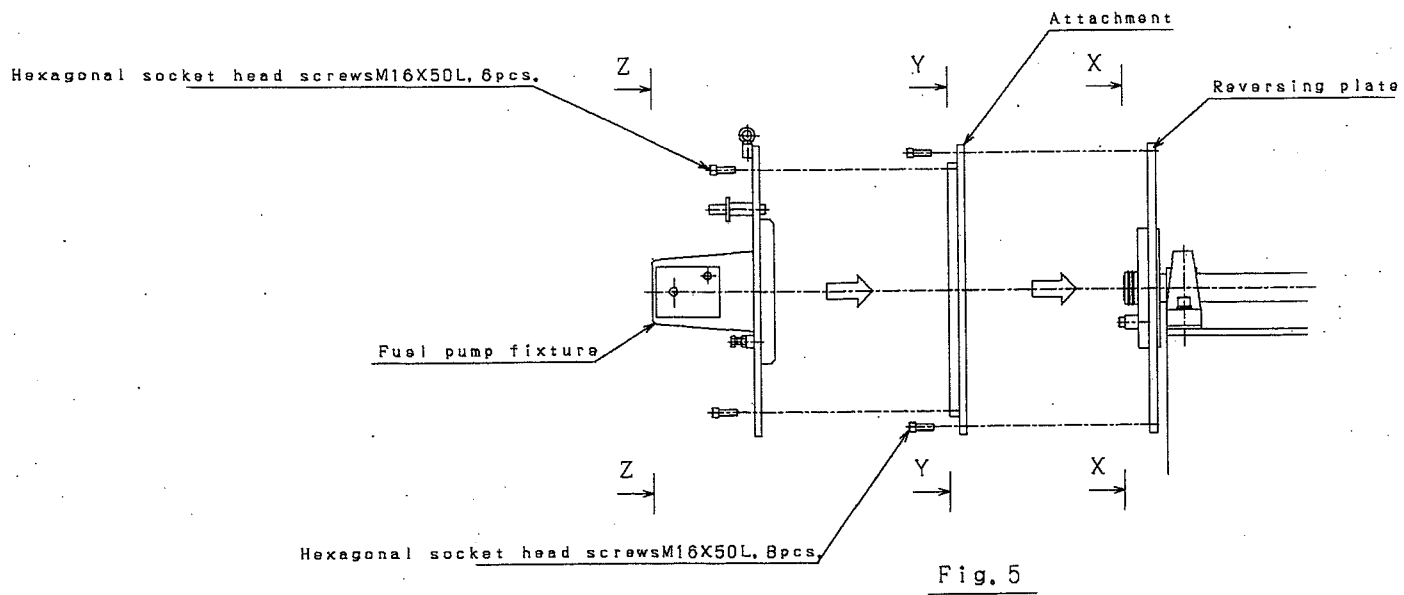
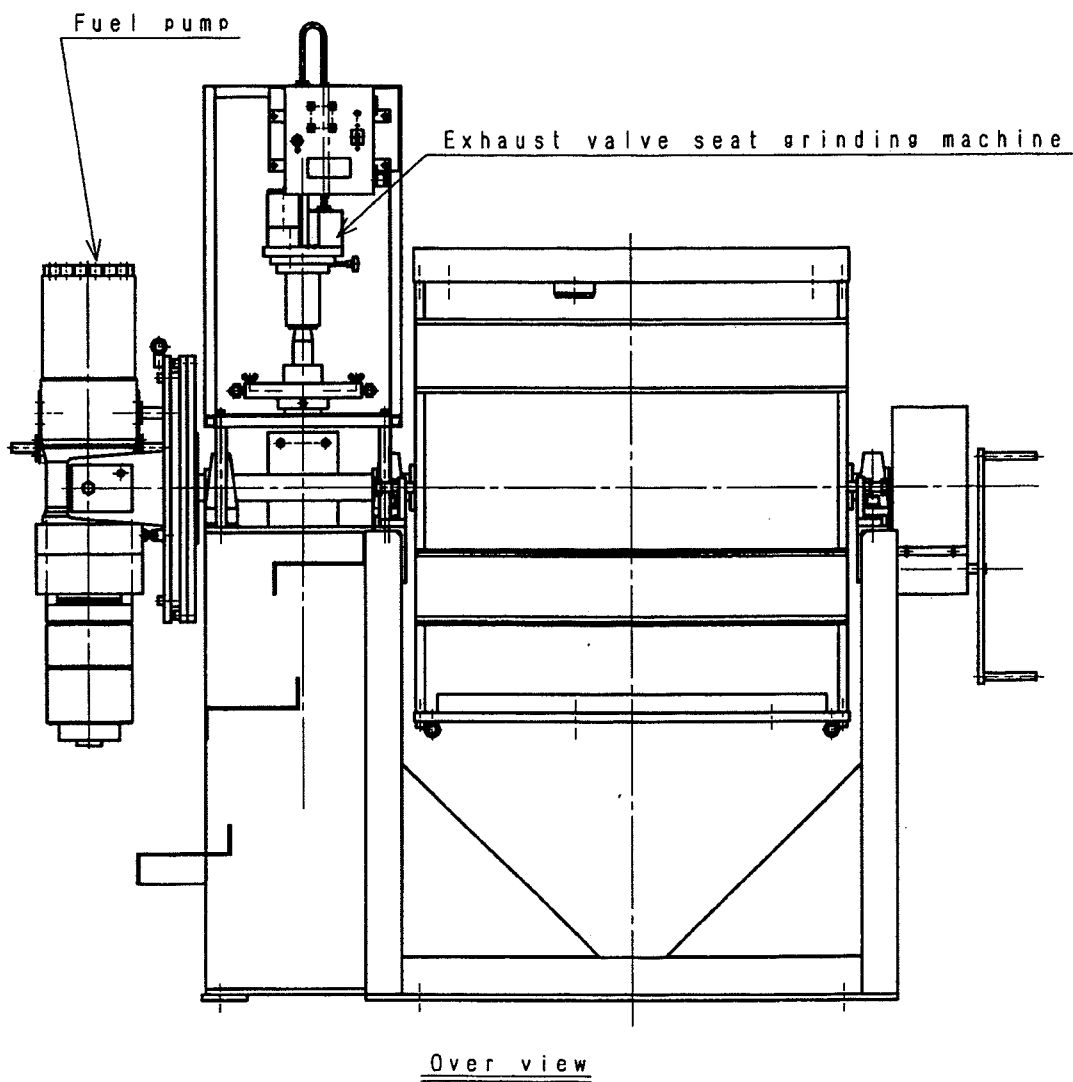
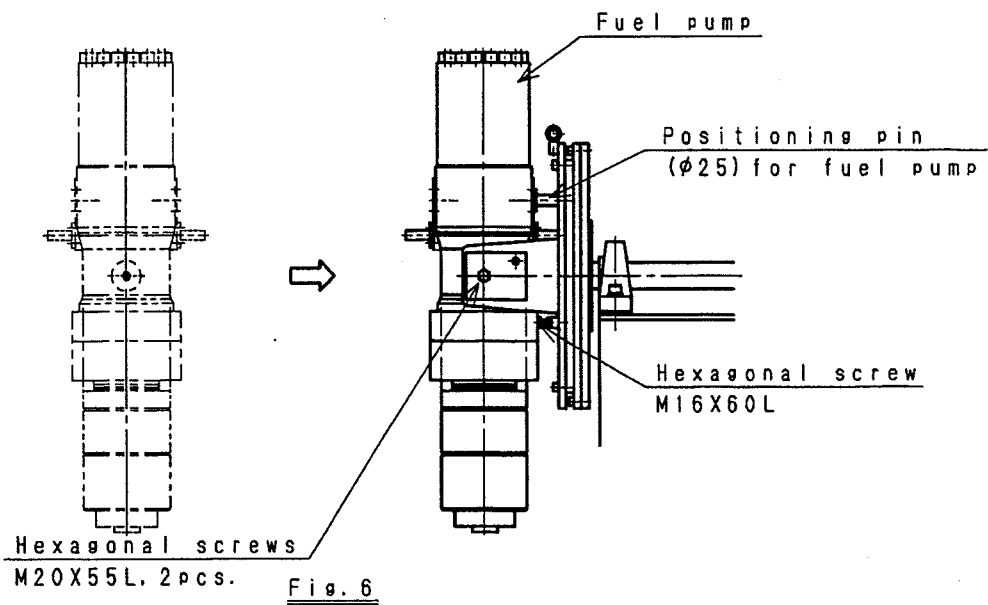


Fig.4



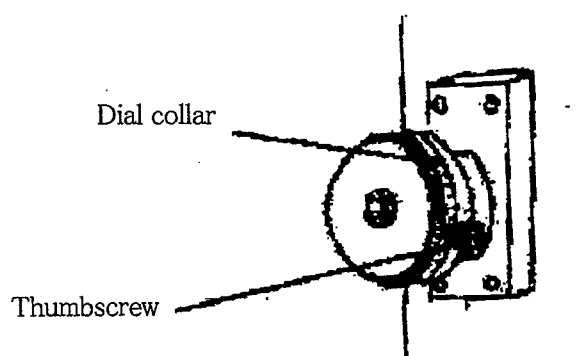


GRINDING PROCEDURE

1. Up / Down slide

When the **[35] up/down handle** is turned clockwise, the grinding wheel moves away from the work and when it is turned counterclockwise, the grinding wheel moves toward the work.

The depth of cut scale on the scale plate shows 0.01m/m per division.



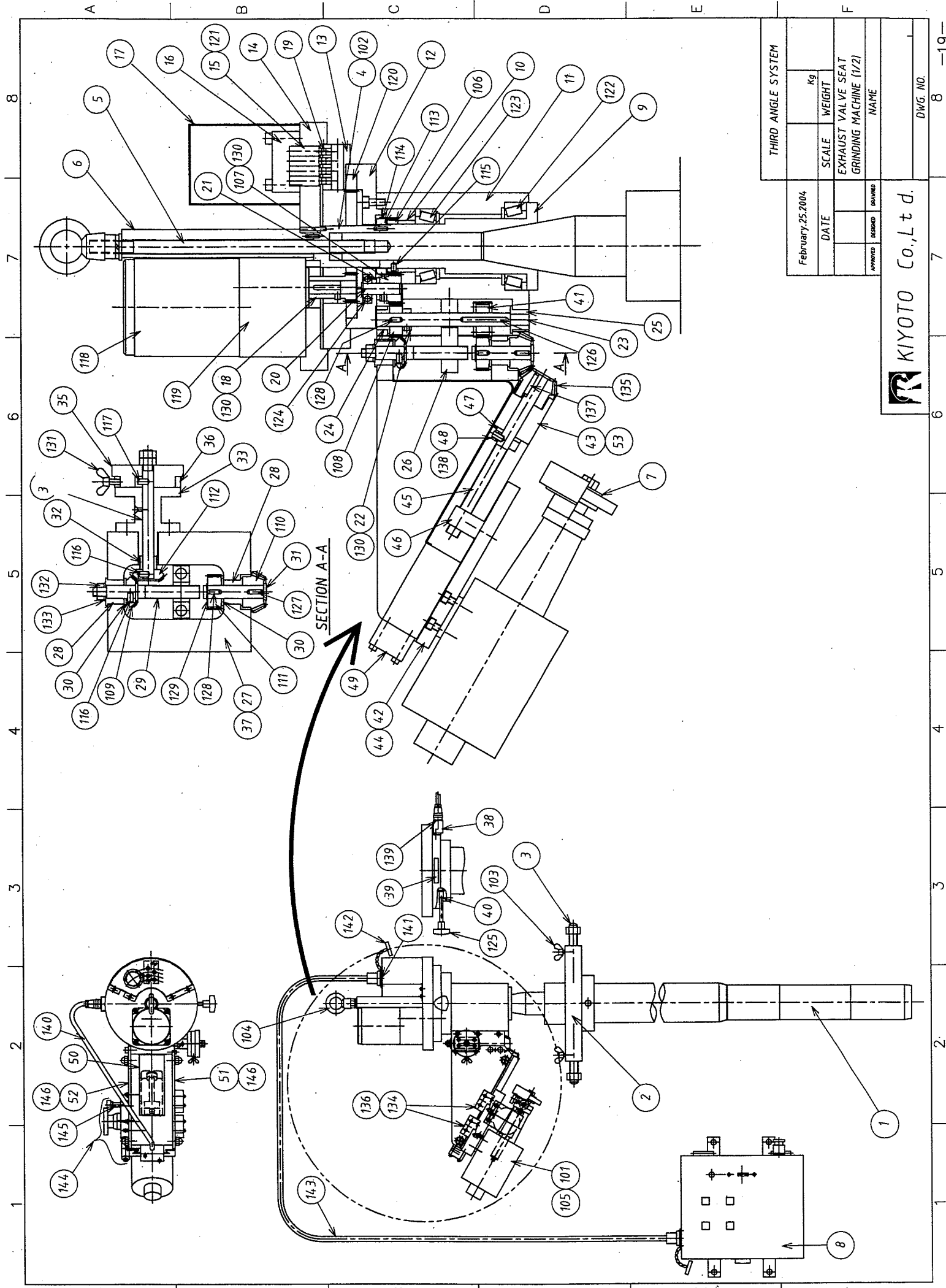
2. Grinding wheel is slid by the turning of the grinding unit.

- ⊙ The grinding wheel can slide by the turning of the grinding machine.
- ⊙ The directions of rotation and slide on the grinding wheel can be changed by two **[134] limit switches** on the grinding unit.
- ⊙ The slide has been adjusted at the factory before delivery and not needed further adjustment.

3. Grinder mounting

- (1) Remove the carbon, etc. struck to the valve seat as preparatory work.
- (2) Thoroughly clean the valve guide so that centering can be performed easily when mounting the grinder.
- (3) After completion of cleaning the valve cage, it shall be placed in a position that valve seat surface is top.
- (4) Insert the grinding machine slowly into the valve cage until the taper part of 【1】 pilot touches the top of the valve guide.
- (5) Loosen the 【125】 knob so that the grinder can be freely turned by hand.
- (6) Fix the magnetic stand of a dial gauge on the grinder body, set the dial gauge, and perform centering.
While turning the grinder by hand, adjust the three 【3】 centering bolts so that dial gauge scale is within 0.02mm.
- (7) After finished the centering work in order to prevent the 【3】 centering bolts coming loose, tighten them with the 【103】 thumbscrews firmly.
- (8) Circulating the grinding machine by hand, the grinding wheel will slide.
Keep the grinding wheel near the seat surface.
- (9) Turn the 【35】 up/down handle counterclockwise and place the grinding wheel against the seat surface.
At this time, set the 【35】 up/down handle 【36】 dial collar to "0" and fix it with the 【131】 thumbscrew.
- (10) Turn the 【35】 up/down handle clockwise and remove the grinding wheel from the seat surface.
- (11) Circulating the grinding machine by hand, move the grinding wheel outside from the seat surface.
- (12) Firmly tighten the 【125】 knob.

- (13) Turn the 【35】 up/down handle counterclockwise about 5 or 6 graduations (0.05 ~ 0.06 mm) from the 0 point set as (9). Switch the motor and grinder ON on the control box.
- (14) Grind the seat surface from outside.
When the grinder returned to outside again and removed from the seat surface, grind again turning the 【35】 up/down handle counterclockwise.
- (15) Repeat this operation several times and check that the entire seat has been rough ground.
- (16) Dress the grinding wheel with the diamond dresser.
(See 4. Grinding wheel dressing.)
- (17) For finish grinding set the depth of cut with 1 – 2 divisions (0.01–0.02m/m) and regrind the seat.



THIRD ANGLE SYSTEM				
February 25, 2004			Kg	
	SCALE		WEIGHT	
	EXHAUST VALVE SEAT			
	GRINDING MACHINE (11/2)			
APPROVED	DESIGNED	NAME		
			DWG. NO.	

7	Co., L t d.	8	—18—
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KIYOTO Co., Ltd.

WSG-1587

A											
146	SPRING PIN	SK5M	4	108	SPUR GEAR	S45C	1	25	BUSH FOR BRG.CASE(LOWER)	BC-6	1
145	DIAMOND DRESSER	—	1	107	SPUR GEAR	—	1	24	BUSH FOR BRG.CASE(UPPER)	BC-6	1
144	DRESSER DEVICE	—	1set	106	SPUR GEAR	S45C	1	23	GEAR SHAFT B	SGD400-D	1
143	CABLE	—	1	105	SOCKET HEAD CAP SCREW	SCM435	4	22	COLLAR C	SGD400-D	1
142	CONNECTOR CAP	—	1	104	EYE NUT	SS400	1	21	COLLAR B	FC200	1
141	CONNECTOR	—	1	103	THUMBSCREW	SS400	3	20	GEAR SHAFT A	SGD400-D	1
140	CABLE	—	1	102	SPRING PIN	SK5M	3	19	CONDUCTION PALTE	CuP	1set
139	CONNECTOR	—	1	101	GRINDER	—	1	18	GEAR B	S45C + SGD400-D	1
138	SET SCREW	SCM435	1					17	COVER A	SS400	1
137	PARALLEL KEY	S45C	1					16	CARBON CASE	BAKELITE	1
136	LIMIT COVER	—	2	53	STUD BOLT	SGD400-D	4	15	CARBON HOLDER	BsBM	4
135	BEVEL GEAR	S45C	1	52	SIDE PLATE B	SS400	1	14	PLATE FOR CABON HOLDER	BAKELITE	1
134	LIMIT SWITCH	—	2	51	SIDE PLATE A	SS400	1	13	ROTATION PLATE	BAKELITE	1
133	FLAT WASHER	SS400	1	50	COVER	SS400	1	12	GEAR CASE (ROUND)	SS400	1
132	U-NUT	SS400	1	49	TERMINAL	BAKELITE	1	11	BEARING CASE A	FC200	1
131	THUMBSCREW	SS400	1	48	COLLAR G	SGD400-D	1	10	COLLAR A	SS400	1
130	SET SCREW	SCM435	3	47	COLLAR F	SGD400-D	1	9	SLEEVE A	SS400	1
129	SNAP RING	SK5M	1	46	NUT A	BC-6	1	8	CONTROL PANEL	—	1set
128	PARALLEL KEY	S45C	2	45	FEED SCREW B	SS400	1	7	WASHER	SGD400-D	1
127	PARALLEL KEY	S45C	1	44	LINER B	S45C	1	6	FIX PIPE FOR SITUATION	SGD400-D	1
126	PARALLEL KEY	S45C	1	43	SLIDE BASE B (MAIN BODY)	FC200	1	5	HANGING BAR	SGD400-D	1
125	KNOB	—	1	42	SLIDE BASE A (MOTOR SIDE)	FC200	1	4	JOINT COLLAR	SS400	1
124	BEARING	—	1	41	GEAR E	S45C + SGD400-D	1	3	CENTERING BOLT	SS400	3
123	BEARING	—	1	40	CHIP	BC-6	1	2	FIX METAL	SS400	1
122	BEARING	—	1	39	STICKER	シール	1	1	PILOT	SS400	1
121	CARBON	—	4	38	BRACKET A	SS400	1	NO	NAME	MATERIAL	QUAN.
120	INTERNAL GEAR	S45C	1	37	LINER C	S45C	1	THIRD ANGLE SYSTEM			
119	GEAR HEAD	—	1	36	DIAL COLLAR	A5052S	1				
118	REVERSIBLE MOTOR	—	1	35	UP/DOWN HANDLE	SS400	1				
117	PIN	S45C	1	34	GEAR SHAFT D	SGD400-D	1				
116	PIN	S45C	2	33	BEARING A	FC200	1				
115	PIN	S45C	1	32	COLLAR E	BC-6	1				
114	ADAPTER WASHER	S45C	1	31	GEAR SHAFT C	SGD400-D	1				
113	ADAPTER NUT	S45C	1	30	COLLAR D	FC200	2				
112	MITER GEAR	S45C	1	29	FEED SCREW A	SGD400-D	1				
111	SPUR GEAR	S45C	1	28	BUSH FOR GEAR CASE	BC-6	2				
110	BEVEL GEAR	S45C	1	27	GEAR CASE(SQUARE)	FC200	1				
109	MITER GEAR	S45C	1	26	METAL A	BC-6	1				
B											
C											
D											
February, 25, 2004								DATE		NAME	
EXHAUST VALVE SEAT GRINDING MACHINE (2/2)								SCALE		WEIGHT	
Kg											
APPROVED								DESIGNED		DWG. NO.	
K								KIYOTO Co., Ltd.			



Kiyoto Co., Ltd.

4. Grinding wheel dressing

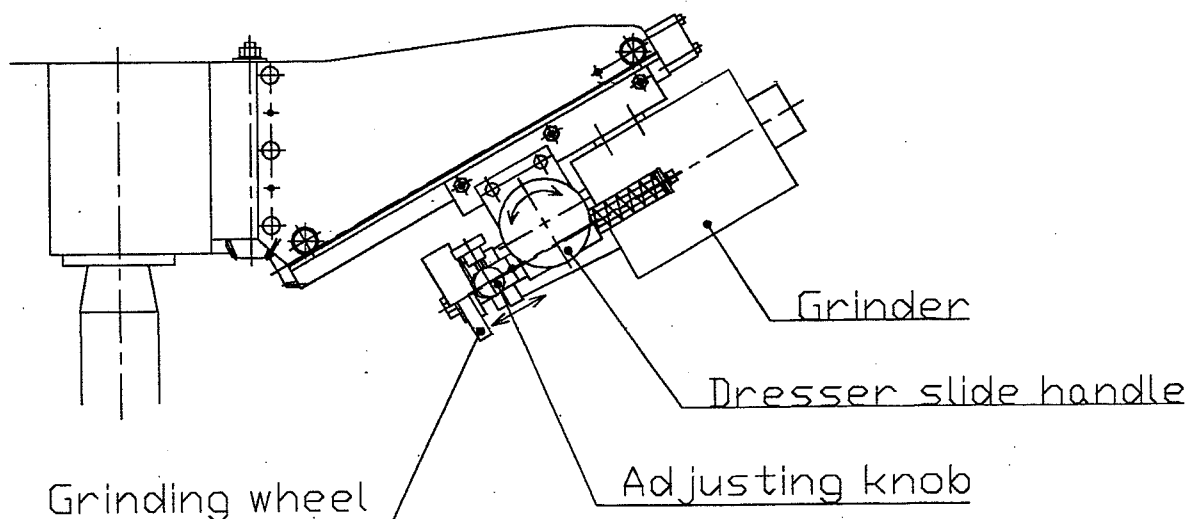
1.) Perform dressing in the following cases :

- (1) When the grinding wheel is changed.
- (2) When the grinding wheel becomes blind.
“Blind” means that the ground surface turns brown during grinding.
- (3) Immediately before finish grinding.

2.) Dressing procedure

- (1) Move the dresser slide handle forward and move the dresser diamond point up to the grinding wheel.
- (2) Adjust the contact of the diamond point and the surface of the grinding wheel with the dresser adjusting knob.
- (3) Fix the dresser with the fixing screw.
- (4) Set the grinder switch to ON.
- (5) Move the dresser slide handle forward and backward and dress the entire surface of the grinding wheel.
- (6) After dressing work, switch OFF the grinder.

«Note» Excessive impact on over-correction may cause a damage on the diamond point or an abnormal wear on the grinding wheel.



AFTER SERVICES AND PARTS SUPPLY

When technical services or parts are needed, please contact the following.

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Mailto : KIYOTO@star.quolia.com

KAWAMURA SYSTEM EXHAUST VALVE GRINDING MACHINE

GRINDING MACHINE

MODEL : HK-600GV-F

SULZER RT-flex 96C

OPERATION MANUAL

GENERAL

Please study carefully the instruction manual before use of the equipment.

Following words are about SAFETY. Please keep them surely.

⚠ WARNING There is a possibility that the operator will be seriously hurt or perished by misoperation.

⚠ CAUTION There is a possibility that the operator will get an injury or physical damage by misoperation.

Even the thing described in **⚠ Caution** may cause serious troubles depending upon circumstances.

- * Please keep this manual at an accessible place carefully and read it repeatedly at any time.
- * Disappeared the manual, please get a copy soon from us or through a sales agent

ATTENTION FOR SAFETY

⚠ WARNING

Please read this manual before use of the equipment and keep the warnings.

- * Light enough around the grinding machine. Arrange the tools in the right position. If a tool, such as a stool will be left at an expected place, an accident will occur.
- * Please use an helmet, goggles, breathing filter, hearing protection and safety shoes according to work circumstances.

- ★ Please don't use this machine for other purposes. Otherwise you may have a trouble or accident.
- ★ Please don't remodel this machine. Otherwise a trouble will happen.
- ★ Please don't remove the parts. Please don't take out parts or screws that are not necessary to do so. It will cause troubles.

SAFETY FOR THE GRINDER

WARNING

- ★ You have to wear sensible clothes for the grinding work and have an attention your clothes not get caught in the moving parts.
- ★ A grinding wheel cover is fitted on the grinding machine. Please don't use the machine without the cover. If not, you will be hurt when the grinding wheel damaged.
- ★ At the maintenance, replacement of the grinding wheel or a danger expected, cut off the electric source at the breaker.
- ★ Put the grinder to trial for one minute before grinding work. After replacement of the grinding wheel make a trial for three minutes and confirm the machine is normally operating.
- ★ Use a normal grinding wheel with the specification of over 50 m/s (3,000 m/min) at max surface speed. If not, it will break to accident. (For the dimensions of grinding wheel, refer to the specification sheet.)
- ★ Don't use the side surface of grinding wheel.
- ★ Make sure the grinding wheel not cracked, nor broken. Don't use damaged one.
- ★ There should not be a foreign object between the grinding wheel and the flange surface. Confirm there are labels on the both side surfaces of the grinding wheel. Don't peel the labels off.

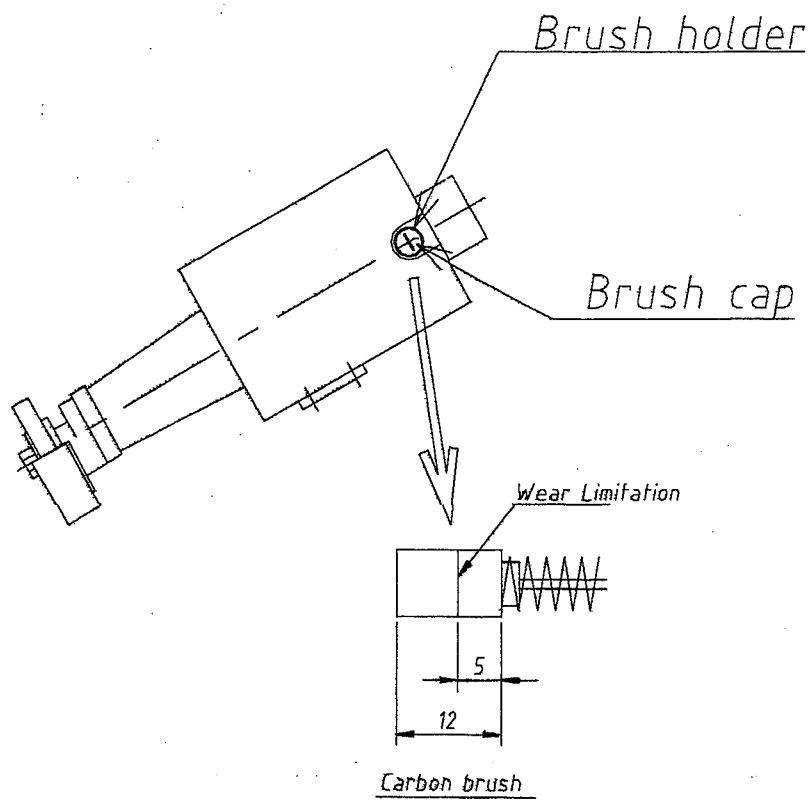
- ★ Don't tighten the screw too much strongly to break the grinding wheel.
- ★ Don't use a grinding wheel got wet or flooded in the water or other liquid.
- ★ At the work of fitting or replacement of the grinding wheel an inspection and test operation shall be done by a person specially trained for replacement and trial operation.
- ★ Keep away from the extended radius of rotating grinding wheel. Heated particles come from at grinding work. Beware of the particles into the eye and of accidental breakage of the grinding wheel.
- ★ Don't force the grinding wheel to the stem. However, there should not be big looseness between the stem and the grinding wheel.

⚠ CAUTION

- ★ In case of switching on the grinder make sure the rotating part of the grinder isn't touching to the seat surface. Otherwise, the grinding wheel will be broken and cause hurt.
- ★ At the first time of switching on the grinder after replacement of grinding wheel with new one, keep away from the grinding wheel for a while.
- ★ Don't push the grinding wheel quickly and strongly on the seat surface. A crack will occur on the grinding wheel and cause damage of it.
- ★ Use goggles, gloves, breathing filter and ear stopple at grinding work.
- ★ Keep flammable things off the grinding machine. A fire will be happened by the heated particles coming from the grinding stone.
- ★ Don't operate the grinder with overload, otherwise troubles will happen. Use the grinder at normal load.

CHECK OF CARBON BRUSH

- ★ There are two carbon brushes on the grinder motor. When the brushes used over the wear limitation, a trouble will happen on the motor. Replace worn brush at about 5 mm worn with new one. Clean the brushes to slide easily in the brush holder. Carbon brushes can be taken out after removed the brush caps by a minus screw driver. (see the Fig. below)



SPECIFICATION

Rotation of Grinder axis	14,000 R.P.M
Rotation of Turntable	5 R.P.M
Size of Grinding Wheel	65Φ × 10t × 12Φ
Electric motor of Grinder	AC100V 60Hz 325W
Electric motor of Turn table	AC100V 60Hz 100W
Electric source	AC100V Φ1 60Hz

GRINDING PROCEDURE

1. Mounting the valve stem

- 1) Remove the carbon stuck from the valve stem with Light oil.
- 2) Detach the front panel from the machine. A scroll chuck with three jaws can be seen.
- 3) Insert the valve stem into the spindle.

2. Centering of the valve

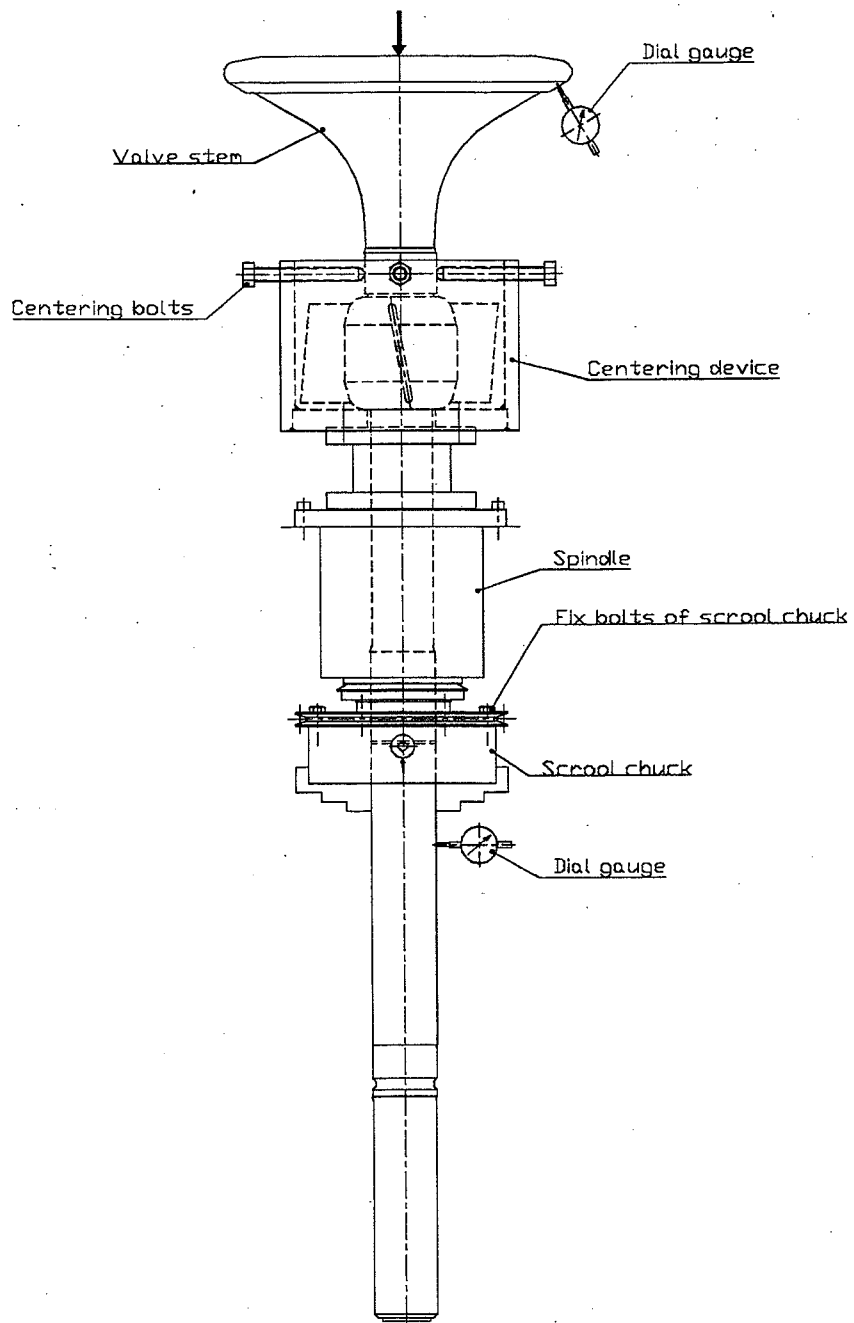
- 1) Put the handle in a hole arrowed on the scroll checks and tighten it.
The valve is correctly centered.
- 2) Switch the motor on. The valve stem rotates.
- 3) Set the dial gauge at the lower of the valve stem as shown below.
Confirm the center deflection is within 0.05 mm. If not, loosen the fix bolts of scroll chuck and adjust the scroll chuck to get the center deflection within 0.05 mm. Tighten the bolts firmly.

Caution : When the above adjustment is not effective, take off the fix bolts of scroll chuck and clean up oil from the both surfaces of the pulley and scroll chuck. Put them back as before and adjust again.

- 4) Set the dial gauge at the seat surface of the valve stem as show below.

Adjust the center deflection to be within 0.05 mm by moving centering bolts.

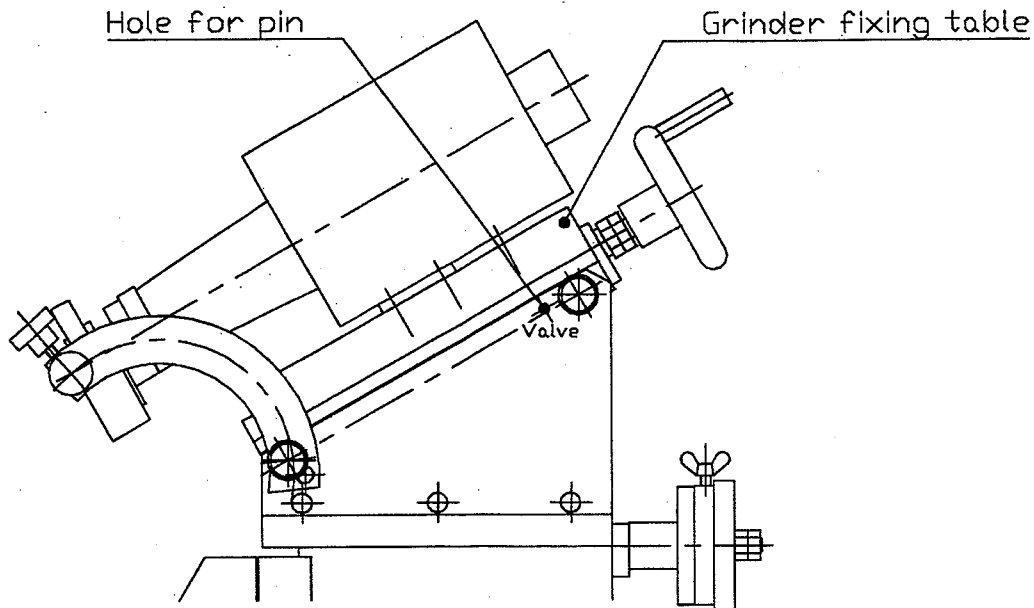
Caution : The centering bolts shall be locked slightly, shall not be tighten firmly.



3. Angle adjustment of Grinder

The angle on the grinder has been adjusted as follows.

VALVE $30^{\circ} \begin{smallmatrix} +20' \\ +18' \end{smallmatrix}$



4. Grinding valve

- 1) Loosen the two bolts fitted on the grinding wheel cover and turn the cover 180°
- 2) Set Grinding Wheel (WA60K)
(The wheel is installed before shipment)
- 3) Dress the grinding wheel.
(See section 8, Dressing for grinding wheel)
- 4) Switch the motor on to rotate the valve stem.
- 5) Position the grinding wheel under the surface to be ground by moving the feed handle of grinder.
- 6) Move the grinding wheel with the up/down-feed handle until it touches to the surface.
- 7) At this contact position, reset the scale for cut grinding wheel to zero. Fix the scale plate by the set screw to avoid its moving during the operation.
- 8) Switch the grinder ON.
- 9) The scale is graduated in 0.005 mm cut per div. Set the scale 0.01 mm (two graduations) or less and perform rough grinding by moving the feed handle for grinder back and forth several times.

Caution :

All cutting operations must be done from outside to inside on the valve seat surface.

There are two ways of surface grinding, Outside-touch and Inside-touch.

Outside-touch is to grind from inside to outside.

Inside-touch is to grind from outside to inside.

10) Confirm all over the seat surface has been ground.

11) Switch the grinder and the motor OFF.

Replace the grinding wheel with the finishing grinding wheel (GC120H)

12) Dress the grinding wheel.

(See Section 8, Dressing for grinding wheel)

13) Position the grinding wheel under the surface to be ground
by moving the feed handle of grinder.

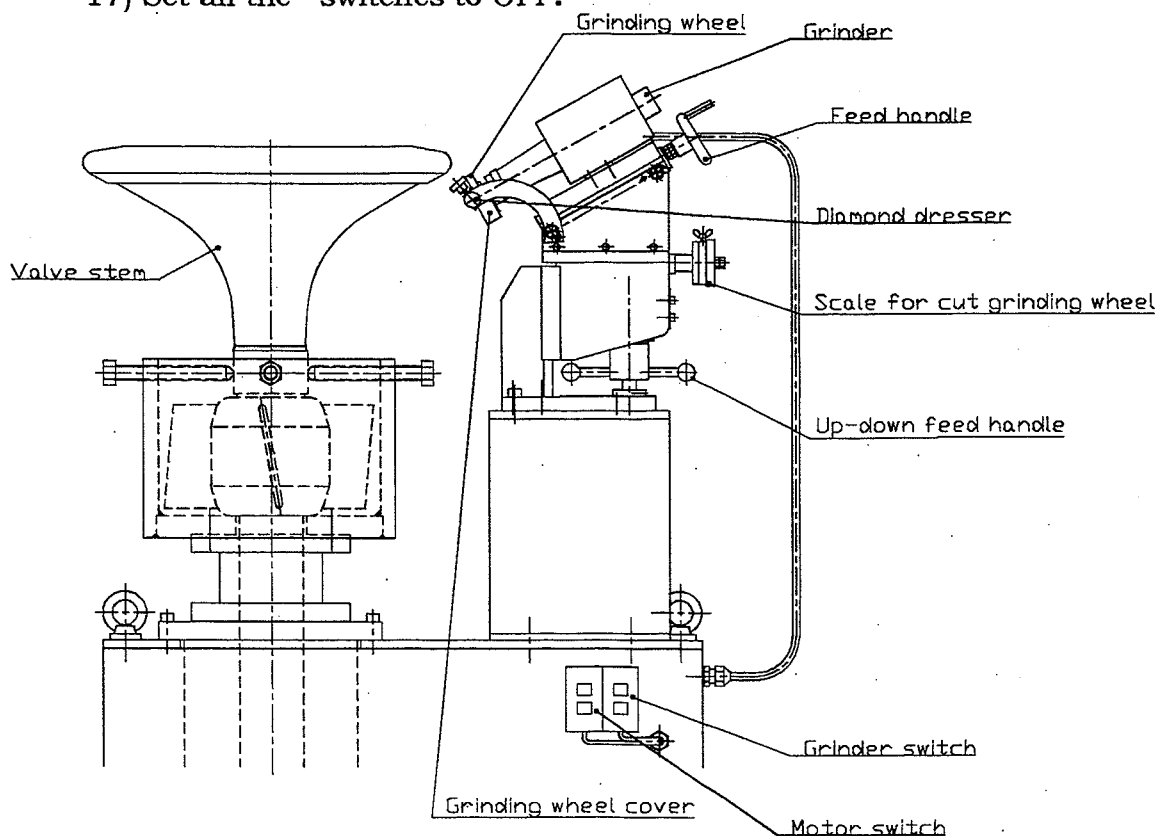
14) Move the grinding wheel with the up/down-feed handle until it touches to the surface.

15) Move the grinding wheel with the feed handle until it touches to the surface and test for grinding slightly.

16) Reset the scale at 0.005mm. (one graduation)

Accomplish finishing cut feeding the grinder slowly from outside to inside by the feed handle in order to get
Inside-touch.

17) Set all the switches to OFF.



5. Dressing for grinding wheel

1) Dressing is required in the following cases.

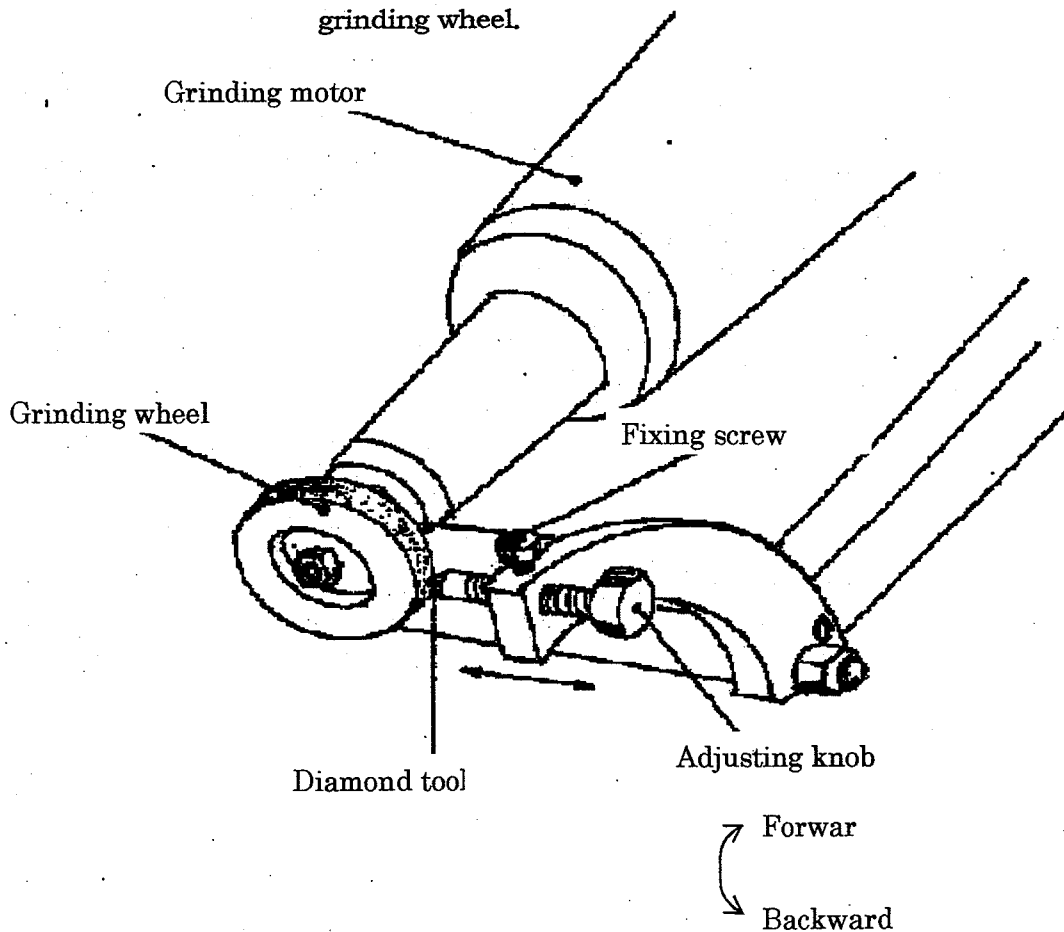
1. The grinding wheel is changed.
2. The grinding wheel is tightened over again.
3. The grinding wheel becomes blind.

" Blind " means that the ground surface turns brown during grinding.

2) Dressing procedure.

1. Move the feed handle for grinder and move the grinding wheel up to the dresser diamond point.
2. Contact the diamond point to the surface of the grinding wheel using the dresser adjusting knob.
3. Set the grinding motor switch to ON.
4. Fix the dresser by the fixing screw.
5. After dressing the entire surface of the grinding wheel, switch OFF the motor.

Note : An excessive force on the diamond point a surplus dressing destroys the diamond point and causes an wear on the grinding wheel.



AFTER SERVICES AND PARTS SUPPLY

When technical services or parts are needed, please contact the following.

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Mailto : KIYOTO@star.quolia.com

INSTRUCTION MANUAL
FOR
USE OF ENGINE INDICATOR
MODEL MM20 & MM30

Ⓜ NAGANO KEIKI CO.,LTD.



A Guide on the Operation of the Engine Indicators type "M₂" and "M₃"

- (1) At the outset of this paragraph we indicate below the standard use of the engine indicators type "M₂" and "M₃" :

Kind	Type "M ₂ "	Type "M ₃ "
Max. r.p.m. of engine	350	600
Recording Drum diameter	40mm	30mm
Indicator Diagram-max. height	50mm	35mm
Indicator Diagram-max. length	90mm	60mm

In other words, the indicator type M₂ is most suited for use on the engine-steam, gasoline or gas power —, internal combustion engine (diesel) and air compressor, all that register 350 revolutions per minute at the maximum. The type "M₃" is intended for use on the high-speed steam engine and moderate-speed internal combustion engine, that are of 600 revolutions per minute. For the engines of higher speed our recommendation is made exclusively on the indicators type "W₃" or "M₅".

We select a spring in the indicator pressure according to a pressure given by the particular engine. Piston liner and scale bear the markings identical to one on the spring, as each marking indicates in terms of figures a height in millimeter on the indicator diagram, equivalent to the pressure 1MPa and also the maximum pressure is denoted by the unit MPa and tolerance of the pressure is accepted at less than 1% of the maximum pressure.

For example, when the following appears on the side of the spring,

$$5.1\text{mm}=1\text{MPa} \quad 6\text{MPa} \quad \text{Piston } \phi \text{ 9.06}$$

it explains that the spring is capable of gauging pressure to an extent of 6MPa with a piston liner 9.06mm, in diameter — and, therefore, the pressure is measured by scaling in terms of 5.1mm to 1MPa in the height of the diagram.

Reference is made to Figure 7. The spring is made secure in its screwed Position (#8) by tightening the Cap (#1). When (#12) is loosened and the upper part of the indicator comes off, the piston liner may be removed by turning it counter-clockwise. The liner driver and extricator (illustrations in Figure 4) are recommended for use.

- (2) The indicator is fitted on to the engine side by means of a valve together with the Cap Nut (#20 in Figure 7). Both the cylinder and the indicator fittings should come to each other and direct as to eliminate the dead space, resistance etc. The indicator should be attached very firmly, as to avoid the vibration of the indicator body when the indicator is connected to the working engine by means of the cord.
- (3) In order to arrange the phase of the indicator drum in line with that of the engine piston, the indicator and crosshead of the engine are connected to each other with a cord. But, when the strokes of a drum in the indicator is less in comparison to those of the engine piston, the engine stroke should be regulated to conform with the indicator. This device is termed as the stroke-reducing device.

Maximum drum stroke is given as 90mm in the case of the indicator type "M₂" and 60mm in that of the type M₃. Naturally, the length of the strokes in the engine has to be adjusted within its limit by the employment of the stroke-reducing device. In the case of engines where their crosshead is absent, it would be necessary to attach a reducing device that would cause the piston functioning on the same phase.

- (4) When the preparation is completed to commence with rotation of the indicator drum in co-ordination with a reciprocating movement of the piston through the application of the stroke-reducing device, the indicator is firstly checked of its proper position and also of non-interference from its cord. Then, the indicator is secured to its place. The elasticity of the cord attributes to a margin of tolerance in the diagram. Care should be taken to see that the cord is made as short as possible, while it must not be stretched, extremely nor rub against something.

When the direction of the cord is not in parallel with the crosshead motion, the cord's inclination changes all the time and the motion of drum would never be in proportion with that of the crosshead.

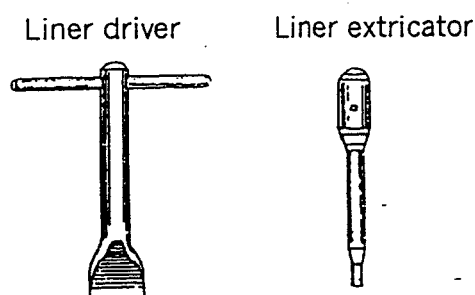


Fig.4

- (5) Fig. 5 illustrated below, shows how a hook is to be attached so as to adjust the length of the cord and also to prevent its slackness.

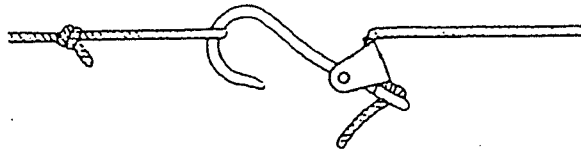


Fig.5

- (6) In the course of operating the indicator presser it is most essential to check from time to time that the drum and the wheel of the stroke-reducing device not to touch the stopper, that regulates rotation. It is vitally important to see that the strokes reciprocate regularly and smoothly. When the drum movement is restricted by the stopper, a projecting portion, such as the one drawn below, would be indicated on the diagram.

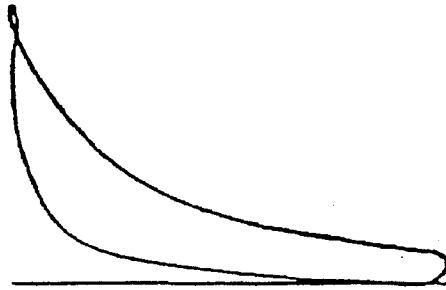


Fig.6

When the force due to the drum spring is weak, and the engine is accelerated more quickly, the cord tends to slacken itself. Therefore, it becomes necessary to adjust the spring accordingly. To regulate the Drum Spring (#24), loosen the Nut (#21) and lift the Part (#22).

After making the Drum Shaft (#26) free, turn it clockwise to strengthen or turn counter-clockwise to weaken as desired. Then, replace it as before.

- (7) When it is ready to record on the diagram, apply oil first to the piston and fix it securely to the main body (#17 in Fig.7) by tightening #12. By neglecting to tighten this part, serious damages have been caused when the upper part of piston blew off as a result of the engine pressure.

For the piston of the low-temperature engine the oil in the oiler attached may be applied equally well on link and other working parts. But, it is advisable to use the cylinder oil on the high-temperature engine regularly.

- (8) When every preparation is complete, paste the recording paper on the drum. Connect the cord after turning the valve handle once or twice to see that the tiny air passage or any connecting tube is not obstructed.

The nib point should be pressed against the recording paper so lightly as to leave a mark of thin line on the diagram. In the event of pressure being hard the point of the nib may tear away the recording paper or it may result in an unnecessary difference in record because of friction. Therefore, it is necessary to adjust the Screw Rod (#43 in Fig.7) correctly before the first of recording.

The Nut (#44) would hold it firm in a suitable position. Thus, the object of recording would be achieved by regulating properly all the time, when the end of the screw Rod (#43), is in contact with the stopper (#45). The nib must not be made very sharp, for it would tear the recording paper. It should be made dull so slightly as to draw a line of sufficient thickness.

In normal case a single indicator diagram is prepared. But, in many instances of gas turbine and other special engines about five recordings are made on the same diagram in order to find an average from several cycles.

After the diagram is removed from the instrument, the entries should be made for its number, date, spring markings, a number of revolutions, loads and remarks.

- (9) Recording paper may be replaced with a new one, after stopping the drum by disconnecting it from the hook.

How to Treat the Indicator

Immediately after the indicator is no more used, the piston liner and Throttle (#49) (in case of Type M₃) should be overhauled and cleaned properly. Lubrication is required on the connecting part of the link, piston, piston rod and drum shaft. Every parts are to be restored to their original position in the box. Exceptional treatment is advised on the lever link mechanism, which merely needs oiling and never be tampered of its screw, etc. The indicator has to be checked one year of its performance. It requires repairs when the difference becomes too serious.

Whether the indicator is functioning perfectly may be checked by means of our pressure tester in the manner described below : (at this time remove Throttle (#49) in case of Type M₃)

1. Presser valve is fitted to the part, where we normally attach the manometer of the tester. To this valve the indicator is screwed on.. The Indicator's piston must be the one with diameter of the kind, indicated on the spring under test.

Pressure is applied with an increase in weight by several stages from atomospheric prcssure to the maximum pressure. At the same time rotate the drum by hand and draw the horizontal lines in indication of different pressures.

Once the maximum pressure is reached, the pressure is to be lessened similarly by stages until it is restored to the former starting position. We gauge the tolerance between the lines on the scale, indicated by the spring markings. The tolerance between the two recorded lines the increased and reduced pressures shows that there are frictions of the piston and lever mechanism. Hence, the tolerance is accepted at the rate less than 1% of the maximum pressure.

2. Next apply the nib point very lightly against the lower part of the drum without rotating it. As the pressure changes from atomospheric pressure to maximum pressure, a line will be drawn perpendicularly. Should it fail to cross the horizontal line, drawn previously, then something is amiss with lever mechanism.
3. The perpendicular line is drawn on the recording paper with a same touch, when the central lines of the piston and drum are running parallel to each other. If they are not parallel, then the line will have different thickness or be drawn in parts.

Prior to recording we must see that the Screw Rod (#43) should contact the Stopper (#45). There should not be any opening between them nor one conducts recording with the Lever (#46) in hand.

4. It is hardly possible to express in value or figure the exact amount of friction between piston and liner or piston rod, lever mechanism, etc. Yet, general idea may be formed from the following test:

Remove the spring, fix the piston, hold the nib in hand and allow the piston rod to slide down lightly. When it slides down smoothly, it is found to be in the best working condition.

As regards the clearance of the piston and liner, there should be a vast difference between the state of static pressure and that of actual operation at high temperature and high speed.

In practice, a slight leakage in the piston is not impeding the function when measuring static pressure.

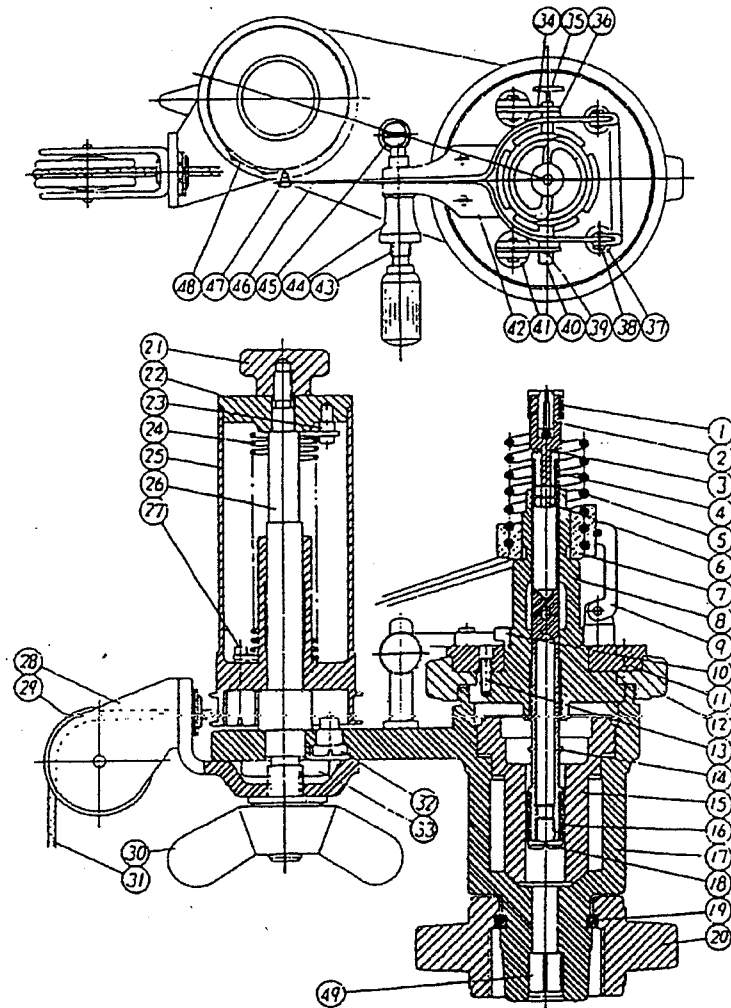


Fig.7 Sectional Views of the Engine Indicators Type "M₂" and "M₃"



AIR-OPERATED OILMATIC PUMP

ON-6-1.5K-S4E

OPERATION AND MAINTENANCE MANUAL

RIKEN KIKI CO., LTD.

WELCOME TO THE WORLD OF RIKEN HYDRAULIC POWER EQUIPMENT !!

This operation manual covers operation procedures, warnings and cautions, and trouble shootings for RIKEN Air-operated Oilmatic Pump Model **ON-6-1.5K-S4E** and its peripherals.

Before operation, you are kindly requested to read this manual carefully, and to understand the contents thoroughly. This manual should be put by yourself before, under, and after operation.

SAFETY INSTRUCTIONS

To use this pump safely, correct operations and periodical checkings shall be requested. Do not operate this pump before you read and understand safety instructions thoroughly shown in this manual. And follow  **CAUTION**, this mark is used to prevent you from causing property losses or damages, also follow  **WARNING**, this mark is used to prevent you from causing personal injury. You should follow these two marked instructions correctly. If unusual conditions happen under operation, cut off the air source, then consult RIKEN or RIKEN's authorized agents.

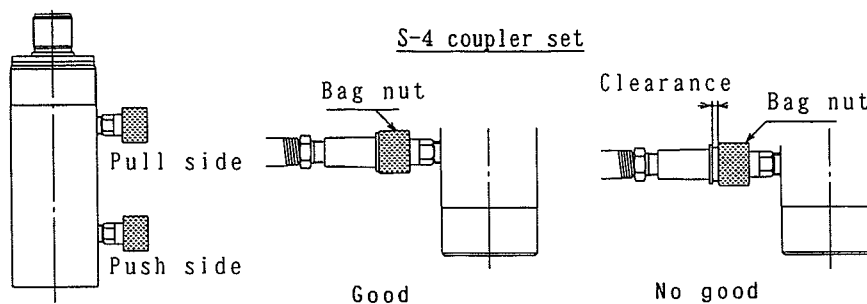
WARNINGS

- (1) Do not use this pump at the place where personal injury or property damage might happen when you scatter the hydraulic working oil through your faults. Do not use this pump around the fire.
- (2) The maximum operating pressure is 150MPa{1530kgf/cm²}. Air pressure safety valve, which works as a safety device, is factory-set at rated pressure. Be sure not to adjust this valve at exceeding this pressure.
- (3) If this pump is used to operate the peripherals, whose operating pressure is less than 150MPa, reduce the set pressure of the air pressure relief valve according to the peripherals' operation pressure. If not, the peripheral(s) might be damaged.
- (4) Taking the accidents into consideration, cut off the air source before the maintenance of this pump.
- (5) Keep away the place from which the high pressure oil is jetting out. The oil may pierce through your hand, and you might be injured heavily.
- (6) If the working oil splashes into your eyes, clean your eyes by fresh water immediately about 15 minutes, then go to doctor. Also clean your skins out by use of the fresh water and the soap.
- (7) Be sure not to touch the hose under pressure. If you touch the hose, and the hose is damaged, the pressure oil will jet out to pierce through your hands.
- (8) The hydraulic hoses are the consumptive items. Even if the results of visual check is accepted, there might be a crack and/or pin hole inside. Even if life time is still left, taking applications into consideration, change hoses periodically.



WARNINGS

- (9) Tighten the bag nut of the couplers (S-4) completely. If not tightened completely, the cylinders do not operate smoothly. If the pull side coupler is not tightened completely, as the pressure of the pull side is almost a double of push side, the couplers, cylinders, and hoses might be damaged, and personal injury may happen.



CAUTIONS

- (1) Use ISO VG46 hydraulic working oil only. Phosphate ester, water-glycol and w/o emulsion oil should not be used. The packing seals will be deteriorated and the equipment will be corroded to cause troubles of this pump. If you would like to use these oil, consult RIKEN or RIKEN's authorized agents.
- (2) The used and old hydraulic working oil should be disposed in accordance with your laws or regulations on anti-pollutions.

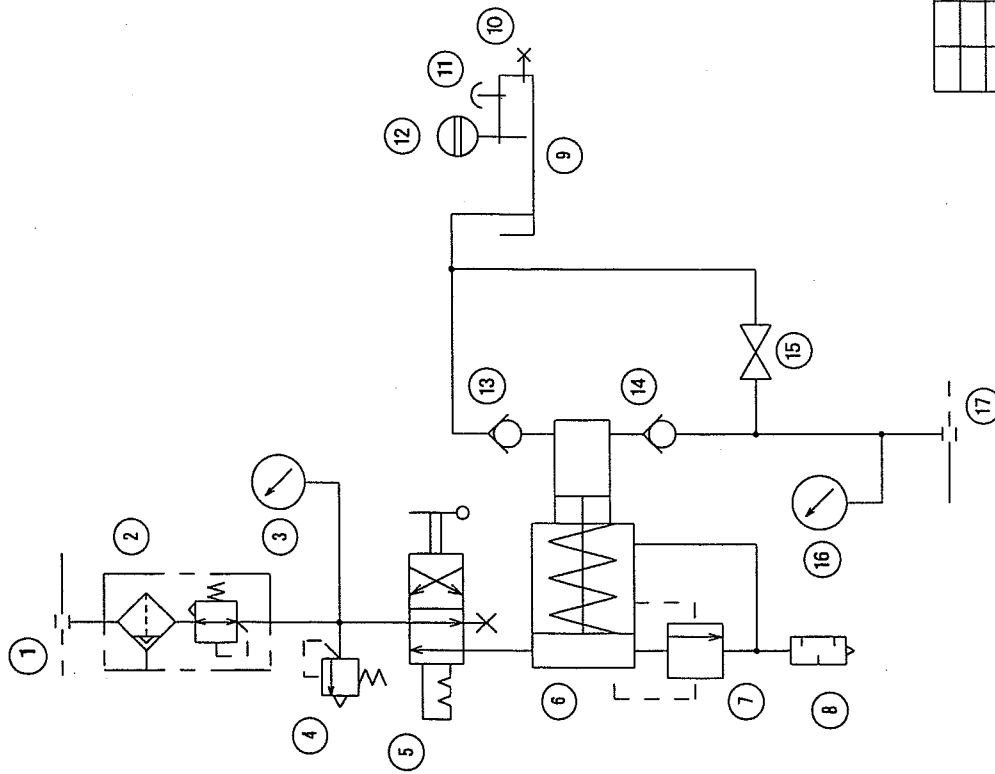
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1. Outlines

- (1) This machine is an air-operated oilmatic pump which generates 150MPa pressure and operates such actuator(s) as cylinder(s).
- (2) This pump should be used indoors. Do not use outdoors or the place where pump is to be drenched.
- (3) The atmosphere temperature should be between 0 ° C to 40 ° C.
- (4) Use RIKEN's genuine peripheral hydraulic power equipment only.
- (5) Use RIKEN's genuine high pressure hoses, high pressure pipes and fittings, whose maximum operating pressure is 150MPa{1530kgf/cm²}.
- (6) Do not use this pump at the place where personal injury or property damage might happen when you scatter the hydraulic working oil through your faults. Do not use this pump around the fire.
- (7) This pump is not under the application of the fire laws.
- (8) Do not modify this pump so as to use for another purpose.

3. Hydraulic and pneumatic circuit



NO.	DESCRIPTION	QTY	REMARKS
1	Air inlet port	1	M4x2
2	Filter regulator	1	SMC:AW20-02H
3	Pressure gauge	1	φ63, 1MPa
4	Relief valve	1	KURODA:P247-02-P
5	Air shut-off valve	1	SMC:VH332-02
6	Pump body	1	
7	Air operation valve	1	
8	Silencer	2	TAIYO:SA2-10
9	Oil reservoir	1	
10	Drain port	1	Rc3/8
11	Air breather	1	MASUDA:MSA-V22
12	Level gauge	1	IMAO:FE-30
13	Suction check valve	1	
14	Discharge check valve	1	
15	Shut-off valve	1	Y-S15B
16	Pressure gauge	1	φ100, 200MPa
17	Oil outlet port	1	CEJN:10 125 6202

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4. Descriptions on each part

- ① **Air inlet port**
To connect the air source and this pump. Equipped with air fitting.
- ② **Air filter regulator**
To control the air pressure to be supplied to this pump.
- ③ **Air pressure gauge**
To measure the air pressure to be supplied to this pump.
- ④ **Relief valve**
To limit the air pressure to be supplied to this pump.
- ⑤ **Air shut-off valve**
To shut off the air to be supplied to this pump.
- ⑥ **Pump body**
To generate a high pressure by use of a reciprocating piston. Equipped with a suction check valve, a delivery check valve, a safety valve, etc..
- ⑦ **Air operation valve**
To operate the air to reciprocate the air piston.
- ⑧ **Silencer**
To reduce the air exhausting noise.
- ⑨ **Oil reservoir**
To store hydraulic working oil.
- ⑩ **Oil drain port**
To drain out the working oil in the reservoir. Port size is Rc3/8(PT3/8).
- ⑪ **Air breather**
To let the air flow into and out from the reservoir, and to prevent the dusts in the air from mixing into the reservoir. Remove this cap, and feed oil from this port.
- ⑫ **Oil level gauge**
To check if the oil volume is enough or not visually.
- ⑬ **Oil suction check valve**
Opens when the piston sucks the oil, and closes when the piston discharges the oil, so that the pump may generate a high pressure.
- ⑭ **Oil discharge check valve**
Opens when the piston discharges the oil, and closes when the piston sucks the oil, so that the pump may generate a high pressure.
- ⑮ **Shut-off valves**
Close this valve to discharge oil, and open it to retract oil to the reservoir.
- ⑯ **Pressure gauge**
To measure the oil pressure to be supplied to this pump.
- ⑰ **Oil output port**
A port from which 150MPa oil is displaced. Equipped with CEJN 10-125-6205 coupler.

- ⑱ Swivel type caster
A rotatable caster.
- ⑲ Fixed type caster
A stationary caster.
- ⑳ Carrying handle
A handle to by which this pump is transported.

5. Specifications

Model:	ON-6-1.5K-S4E
Pressure rating:	Primary stage (Air) - 0.65 to 1 MPa{6.6 to 10.2 kgf/cm ² } Secondary stage (Oil) - 150 MPa{1530 kgf/cm ² }
Piston dia.:	8 mm
Piston stroke:	21 mm approx.
Reservoir capacity:	6 ltrs.
Usable oil:	5 ltrs.
Weight approx.:	28 kgs.
Working oil:	Wear and abraision resistance hydraulic working oil ISO VG46 (SHOWA SHELL TELLUS 46, MOBIL DTE 25, ESSO UNIPOWER SQ46, or equivalent)

6. Cautions

- (1)  **WARNING** The maximum operating pressure is 150MPa{1530kgf/cm²}. Air pressure safety valve, which works as a safety device, is factory-set at rated pressure. Be sure not to adjust this valve at exceeding this pressure.
- (2)  **WARNING** If this pump is used to operate the peripherals, whose operating pressure is less than 150MPa, reduce the set pressure of the air pressure relief valve according to the peripherals' operation pressure. If not, the peripheral(s) might be damaged.
- (3)  **CAUTION** Taking accidents into consideration, cut off the air source before the maintenance of this pump.
- (4)  **CAUTION** Use ISO VG46 hydraulic working oil only. Phosphate ester, water-glycol and w/o emersion oil should not be used. The packing seals will be deteriorated and the equipment will be corroded to cause troubles of this pump. If you would like to use these oil, consult RIKEN or RIKEN's authorized agents.

- (5) The oil temperature should be 5 to 60 ° C.
- (6) Dusts are enemy of hydraulic system. Always keep oil clean, so as to avoid the machine trouble.
- (7) Change working oil at least once a year.

7. How to Install

- (1) Transport this pump by holding ⑳ carrying handle slowly. Fix this pump by use of the stopper of ⑱ swivel type caster.
- (2) Install this pump on a safe and flat place.
- (3) Pump and cylinder(s) are connected by use of high pressure hose(s) or steel pipe(s).

8. Preparation before Operation

(1) How to release the air in the pump

After you change oil, or when the pump sucks air due to lack of oil, air will be mingled into the oil. Then the pressure will not increase or the cabitations may happen, and the cylinder will not operate smoothly. Accordingly, release the air as follows. (Be sure to open air valve under operation.)

(a) Open ⑮ shut-off valve, and operate this pump.

(b) Shift ⑤ air shut-off valve to repeat start and stop operations about 5 to 10 times, so as to release the air.

(2) How to release the air in the pipings

If the air is included in the pipings, the cylinder will not operate smoothly. Release the air from the hoses or steel pipes as follows.

(A) Hose piping

a) Joint S-4R coupler with the hose end coupler S-4H.

b) Take off the cap of ⑪ air breather, and insert the end of the coupler into this hole to feed the discharged oil to the reservoir.

c) Shift ⑤ air shut-off valve to START side, then repeat opening and closing of ⑮ shut-off valve, so as to release the air (Inching). Finally, the air will be released together with oil.

*** To release the air in the cylinder**

If you release the air when the pump, cylinder and hose is connected, extend the cylinder piston fully, then put the cylinder upside down, and operate the cylinder by pumping the oil. Air will be released to the reservoir.

(B) High pressure steel pipe piping

a) Loosen the end of fitting, and open to the air.

b) Repeat inching until the working oil flashes out from the air hole. Especially at the new installation, proceed the pipe flushing.

c)  **CAUTION** Cover the air releasing part with waste cloth.

d) Tighten the end of the fitting.

(3) In case of test run

After loosening the locking nut, turn the handle of ② filter regulator counter-clockwise to open it.

By checking the pressure by use of ⑯ oil pressure gauge, turn clockwise the handle of ② filter regulator to increase the pressure to 50, 100MPa, then check if the abnormal conditions happen or not in the piping. When the required pressure is gained, lock the handle of ② filter regulator.

9. Maintenance

(1) Maintenance before operation

(A) Check the air pressure by use of an air pressure gauge. The air pressure should be 0.65 to discharge 150MPa oil pressure.

(B) After retracting the cylinder piston fully, check if the oil volume is correct or not by use of ⑫ oil level gauge. If the oil volume is not enough, refill oil by taking off the cap of ⑪ air breather.

(C) Operate the pump more than one (1) minute under no load condition, and check if unusual noise, unusual vibration, or other unusual conditions happen or not.

(D) Operate ⑤ Air shut-off valve and ⑮ shut-off valve to increase the pressure of the cylinder, so as to check if unusual conditions happen or not.

(E) Check if any oil leakage from the pipings and equipment happens or not, and shoot the trouble.

(F) Also refer 6. Cautions.

(2) Maintenance under operation

Check the following items, and if unusual conditions happen, stop the pump operation, and shoot the trouble.

(A) Is there any trouble on valve operation and pressure increasing?

(B) Is there any oil leakage from the piping and equipment?

(C) Is there any unusual noise, vibration, or smell?

 **WARNING**

Keep away the place from which the high pressure oil is jetting out.
The oil may pierce through your hand, and you might be injured heavily.

(3) Maintenance after operation

(A) Be sure to cut off the air source.

(B) Check if oil leakage or other unusual conditions exist or not. If exist, shoot the troubles.

(4) To change hydraulic working oil

(A) Change oil at least once a year. Also change oil at the following cases;

- a) Contamination of dusts b) Malodor happens c) Contamination of water, and blooming of oil
- d) Degradation and browning

(B) How to feed oil

- a) Retract the cylinder piston fully.
- b) Check the oil by use of ⑫ oil level gauge.
- c) Refill the oil by taking off the cap of ⑪ air breather.

- | | |
|---|--|
| <p>(B)  WARNING</p> <p>(C)  CAUTION</p> | <p>If the working oil splashes into your eye, clean your eyes by fresh water immediately about 15 minutes, then go to doctor. Also clean your skins out by use of the fresh water and the soap.</p> <p>The used and old hydraulic working oil should be disposed in accordance with your laws or regulations on anti-pollutions.</p> |
|---|--|

10. How to Operate

Shift ⑤ air shut-off valve to START side to operate this pump, and close ⑮ shut-off valve, and open this handle to retract the oil to the reservoir.

To use with a single-acting spring-return cylinder

- (1) Open ⑮ shut-off valve.
- (2) Shift ⑤ air shut-off valve to START side to reciprocate the pump piston.
- (3) Tighten ⑮ shut-off valve.
- (4) cylinder piston advances to increase the pressure and proceed the required job.
- (5) When this sound of "pang-pang" occurs, shift ⑤ air shut-off valve to STOP side instantly. The pump stops operation, and the pressure will be held.
- (6) When you retract the cylinder piston, loosen ⑮ shut-off valve.
- (7) When your job is finished, retract the cylinder piston completely, and stop the air supply.

-  **CAUTION** When unusual conditions or troubles happen, shift ⑤ air shut-off valve to STOP side instantly, so as to stop the pump operation.
- If you should retract the cylinder piston, loosen ⑮ shut-off valve.

11. Trouble Shootings (See Page 16 to 21) (⑨ : See dimensional drawing.)

Troubles	C a u s e s	R e m e d i e s
Pump does not operate.	The air pressure is too low.	Apply air pressure of 0.65MPa{6.63 kgf/cm ² }.
	Abrasion of #21 packing.	Change #21 packing. Clean the part.
	Damage of #19 slipper seal.	Change #19 slipper seal.
	Damage of #8 Spring.	Change #8 spring.
	Damage of #18 base packing.	Change #18 base packing.
Pressure does not rise.	The air pressure is too low.	Apply air pressure of 0.65MPa{6.63 kgf/cm ² }
	The oil volume in ⑨ oil reservoir is too small.	Refill oil.
	Troubles of suction and/or discharge check valves. Trouble of #13 discharge valve seat. Damage of #31 ultra-hard metal steel ball Trouble of #11 suction valve seat. Damage of #37 steel ball	Change steel balls and clean these valve seats.
	Damage of #25 O ring.	Change #25 O ring.

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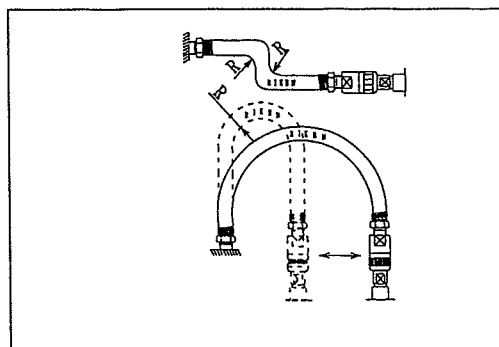


13. Cautions on High Pressure Hoses

* Warnings

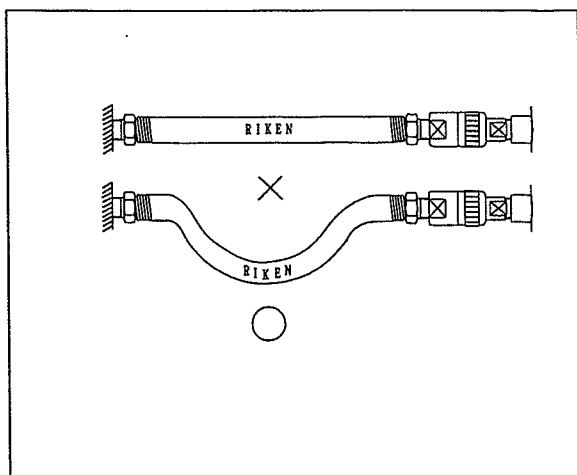
- Use **RIKEN** Brand Hoses for 200MPa{2040kgf/cm²} use only.
- Use the hoses at more than rated bending radius. This is also true when the hoses move.

High pressure hoses	Min. bending radius
UH-※	120 mm

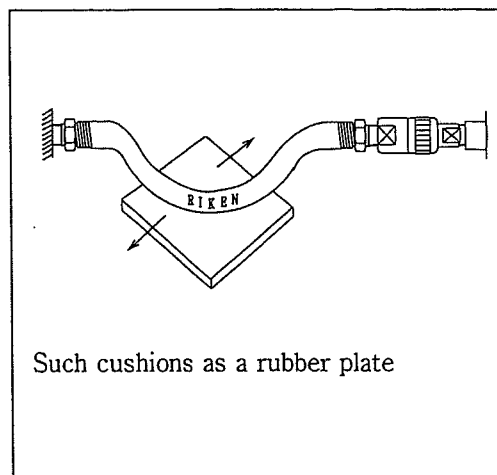
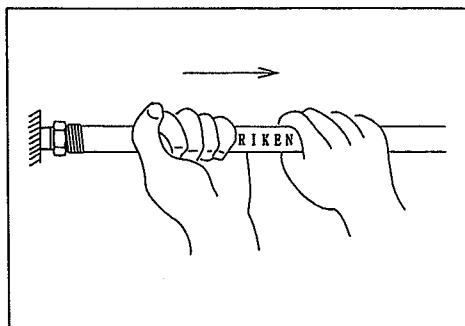


If the high pressure hose touches the floor or the goods, the hose will be rubbed due to the flexibility and the shock caused from the pressure. So, protect the hose by use of supports or cushions.

As the length of the hose changes in accordance with the inner pressure, mount the hose with the hose with flexibility.

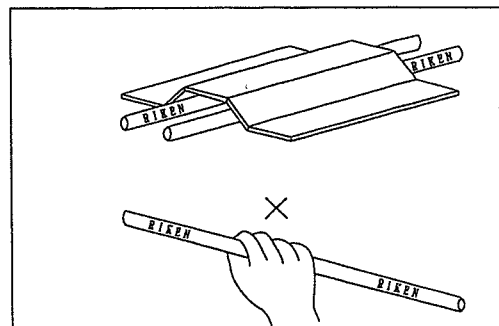


Do not transport the equipment by dragging the high pressure hose.



Such cushions as a rubber plate

Do not pass over the hose by wheels, and do not fall the goods on the hose. Protect the hose by covering over the hose.



WARNING

Be sure not to touch the hose under pressure. If you touch the hose, and the hose is damaged, the pressure oil will jet out to pierce through your hand.

* Maintenance



WARNING

The hydraulic hoses are the consumptive items. Even if the visual check is accepted, there might be a crack and/or a pin hole inside. Even if life time is still left, taking applications into consideration, change hoses periodically.

Check the hoses visually at daily use or once a week. If the following abnormal conditions exist, stop the operation at once, and change hoses or take a particular counter measures.

- * If the oil leaks from the taper thread parts, take out the hose, then use 1 to 2 wraps of tape seals, and tighten again by the required torque. If oil still leaks, change hoses.
- * If there are oil leakage from the thread parts or outer surface of the hose, or the outer surface is uneven or cracked, change the hose with new one.

Repairing Services

Before you ask RIKEN or RIKEN's authorized agents to repair this pump, read this manual carefully. Be sure not to repair this pump by yourself without RIKEN's or RIKEN's authorized agents' approval.

If you require dimensional drawings of this pump, please ask RIKEN's authorized agents.

RIKEN KIKI CO., LTD.

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(NO. ON615KS410701)

RIKEN

手動油圧ポンプ

UP-22M-047

取扱説明書

**HAND-OPERATED HYDRAULIC PUMP
OPERATION AND SERVICE MANUAL**

製造元 理研精機株式会社

総発売元 理研機器株式会社

RIKEN KIKI CO., LTD.



まえがき

このたびは、理研の手動ポンプをお買いあげいただき、誠にありがとうございます。この取扱説明書は、本機の取扱方法、注意事項や故障対策などについて説明してあります。初めてお使いいただく方はもちろんのこと、すでにご使用になられた経験をお持ちの方でも、この説明書をよくお読みになり、内容を十分理解された上で、この説明書を常に手元に置いて本機をご使用ください。

安全に関するご注意

本機を安全にご使用いただくには、正しい操作と定期的な点検が不可欠です。

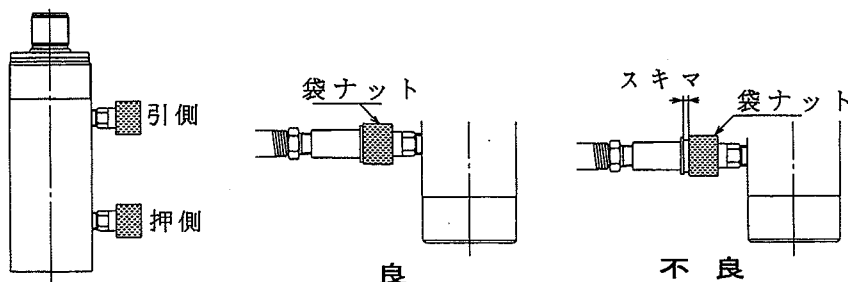
この取扱説明書に示されている安全に関する注意事項をよくお読みになり、十分に理解されるまでは本機の操作を行わないでください。この説明書では、もしお守りいただかないと、人身事故につな

るおそれのある注意事項は  **警告** という見だしのもとに掲げております。また、お守りいた

だかないと、本機の破損や故障につながるおそれのある注意事項は  **注意** という見だしのもとに掲げております。

警告

- (1) 作動油が飛散したとき、重大な被害の生じるおそれのある場所では使用できません。特に、火気の近くでは使用しないでください。
- (2) 本機を改造してはいけません。理研の推奨していない改造は、安全上問題となることがあります。改造する場合は、事前に当社にご相談ください。許可の無い改造には、当社は責任を負いかねます。
- (3) 空気弁を閉じたまま使用されますと、作動油が戻る時に油タンク内部の圧力が上昇し、油タンクが破損し人身事故につながるおそれがあります。
- (4) 規定量以上の作動油を油タンクに戻すと内部圧力が上昇し、油タンクが破損し人身事故につながるおそれがあります。
- (5) シリンダのピストンを出したまま給油しますと、ピストンが戻ったときにタンク内の油があふれ出ることがあります。また、タンクが破損し、人身事故を起こすおそれがあります。
- (6) 高圧安全弁は、150MPaに調節してあります。絶対に 150MPa以上に上げて使用してはいけません。ポンプ、シリンダ、高圧ホースなどが破損し、人身事故を起こすおそれがあります。
- (7) 最高使用圧力150MPa未満の油圧機器にご使用の際は、高圧安全弁を使用する圧力に下げてください。下げないと機器が破損し人身事故のおそれがあります。
- (8) シリンダを用いての重量物のジャッキダウンやワイヤの緊張解除などの際に急激にポンプの圧力を抜きますと、荷が落下したり、はねたりして、人身事故につながるおそれがあります。このような使用の場合には、バルブなどが必要になりますので、事前に当社までご連絡ください。
- (9) シリンダは必ず仕様出力以内でご使用ください。規定圧力以上に内圧が上がりますと、シリンダやホースが破損し事故を起こすおそれがあります。
- (10) シリンダの許容偏荷重は、最大出力の 2.5% です。それ以上の偏荷重がかかると、ピストンが曲がったり、シリンダが転倒したりしてシリンダが破損し、人身事故につながるおそれがあります。
- (11) 加圧時は絶対に超高圧ホースを手で握らないでください。手で握った状態で超高圧ホースが破損すると超高圧の作動油が瞬時に噴き出し、手に穴があくほどのけがをするおそれがあります。
- (12) 超高圧ホースは消耗部品です。外観上は何ら異常が認められない状態であっても、内部に傷やピンホールなどが発生しているかもしれません。寿命までに達しなくても、使用状況などを考慮して定期的に交換してください。何か疑問がありましたら、当社までご連絡ください。
- (13) カップラは、手で袋ナットを根元まで完全に締めてください。図のように隙間が開いていると、シリンダがスムーズに作動しません。複動シリンダ使用時に、引側のカップラが不完全な接続の状態で、押側に圧力をかけると、引側には倍圧がかかり、カップラ、シリンダ、超高圧ホースなどが破損や飛散し、人身事故を引き起こすおそれがあります。



- (14) 作動油が目に入った場合は、清浄な水で最低15分間洗浄した後、医師の手当を受けてください。また皮膚に付着した場合は、水と石鹸で洗ってください。

注意

- (1) 作動油は、一般作動油のISO VG32（昭和シェル石油 テラスオイル C32 又は同等品。）をお使いください。リン酸エステル、水-グリコール、w/oエマルジョン系作動油は使用できません。パッキンの劣化及び機器の腐食などにより、本機が故障します。ご使用の場合には、当社にご連絡ください。
- (2) 廃棄される廃油（作動油）は「産業廃棄物」に該当しますので、自治体の許可を得ている産業廃棄物収集業者、または産業廃棄物処理業者に委託して廃棄してください。

WELCOME TO THE WORLD OF RIKEN HYDRAULIC POWER EQUIPMENT !!

This operation manual covers operation procedures, warnings and cautions, and trouble shootings for RIKEN Hand-operated Hydraulic Pump Model UP-22M-O47 and its peripherals.

Before operation, you are kindly requested to read this manual carefully, and to understand the contents thoroughly. This manual should be put by yourself before, under, and after operation.

SAFETY INSTRUCTIONS

To use this pump safely, correct operations and periodical checkings shall be requested. Do not operate this pump before you read and understand safety instructions thoroughly shown in this

manual. And follow  **CAUTION**, this mark is used to prevent you from causing property

losses or damages, also follow  **WARNING**, this mark is used to prevent you from causing personal injury.

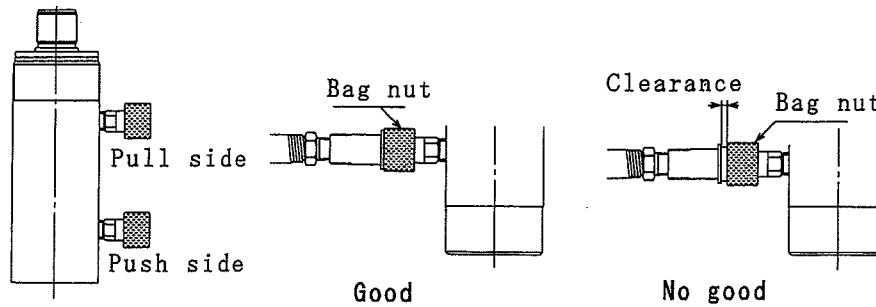
WARNINGS

- (1) Do not use this pump at the place where personal injury or property damage might happen when you scatter the hydraulic working oil through your faults. Do not use this pump around the fire.
- (2) Do not modify this pump. If you should modify, before modification, you should consult RIKEN or authorized agents of RIKEN. We are not in a position to guarantee your modifications without our written approval.
- (3) If you operate this pump with air valve closed, when the working oil returns to the tank, the pressure in the tank will be increased, and the tank might be damaged.
- (4) If you return the oil, exceeding the tank capacity, to the tank, the pressure in the tank will be increased, and the tank might be damaged. Also you might be injured.
- (5) Retract the ram piston fully. If you fill the oil with the ram piston extended, when the ram piston retracts, the oil might flow out from the tank.
- (6) High pressure safety valve is factory-set at 150MPa. Be sure not to use this exceeding this pressure. If you operate this pump exceeding this pressure, this pump itself, ram(s), hose(s), and other peripherals might be damaged, and personal injury may happen.
- (7) If this pump is used to operate the peripherals, whose operating pressure is less than 150MPa, set the high pressure safety valve at the peripherals' operation pressure. If not, the peripheral(s) might be damaged.
- (8) If you release the pressure suddenly from the jacking up rams or wire strands, the loads may fall down or spring. Then personal injury may be caused. Consult RIKEN or RIKEN's authorized agents for these applications. They will recommend you suitable valves.
- (9) Be sure to use the rams not exceeding the rated pressure capacity. If the pressure exceeds the rated capacity, the rams and hoses might be damaged, and personal injury may happen.
- (10) The allowable eccentric load on the ram piston should be under 2.5%. If you apply more than 2.5% eccentric load, the piston might be bent and/or the cylinder tube might be damaged.
- (11) Be sure not to touch the hose under pressure. If you touch the hose, and the hose is damaged, the pressure oil will jet out to pierce through your hands.
- (12) The hydraulic hoses are the consumptive items. Even if the results of visual check is accepted, there might be a crack and/or pin hole inside. Even if life time is still left, taking applications into consideration, change hoses periodically.



WARNINGS

- (13) Tighten the bag nut of the couplers completely. If not tightened completely, the rams do not operate smoothly. If the pull side coupler is not tightened completely, as the pressure of the pull side is almost a double of push side, the couplers, rams, and hoses might be damaged, and personal injury may happen.



- (14) If the working oil splashes into your eyes, clean your eyes by fresh water immediately then go to doctor. Also clean your skins out by use of the fresh waster and the soap.



CAUTIONS

- (1) Use ISO VG32 hydraulic working oil only. Phosphate ester, water-glycol and w/o emersion oil should not be used. The packing seals will be deteriorated and the equipment will be corroded to cause troubles of this pump. If you would like to use these oil, consult RIKEN or RIKEN's authorized agents.
- (2) The used and old hydraulic working oil should be disposed in accordance with your laws or regurations on anti-pollutions.

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1. 概要

- (1) 本機は、シリンダなどの油圧アクチュエータを作動させるための手動油圧ポンプです。
- (2) 屋内仕様になっていますので、雨水のかかるところでは使用できません。
- (3) 周囲温度は、0～40℃にてご使用ください。
- (4) 本機に使用する油圧機器は、理研製品をご選定ください。
- (5) 超高圧ホース、超高圧パイプ及び継手などは、最高使用圧力150MPaのものを御使用ください。
- (6) 作動油が飛散したとき、重大な被害の生じるおそれのある場所では使用できません。特に、火気の近くでは使用しないでください。
- (7) 本機は消防法に適用していません。
- (8) 他の目的に改造しないでください。

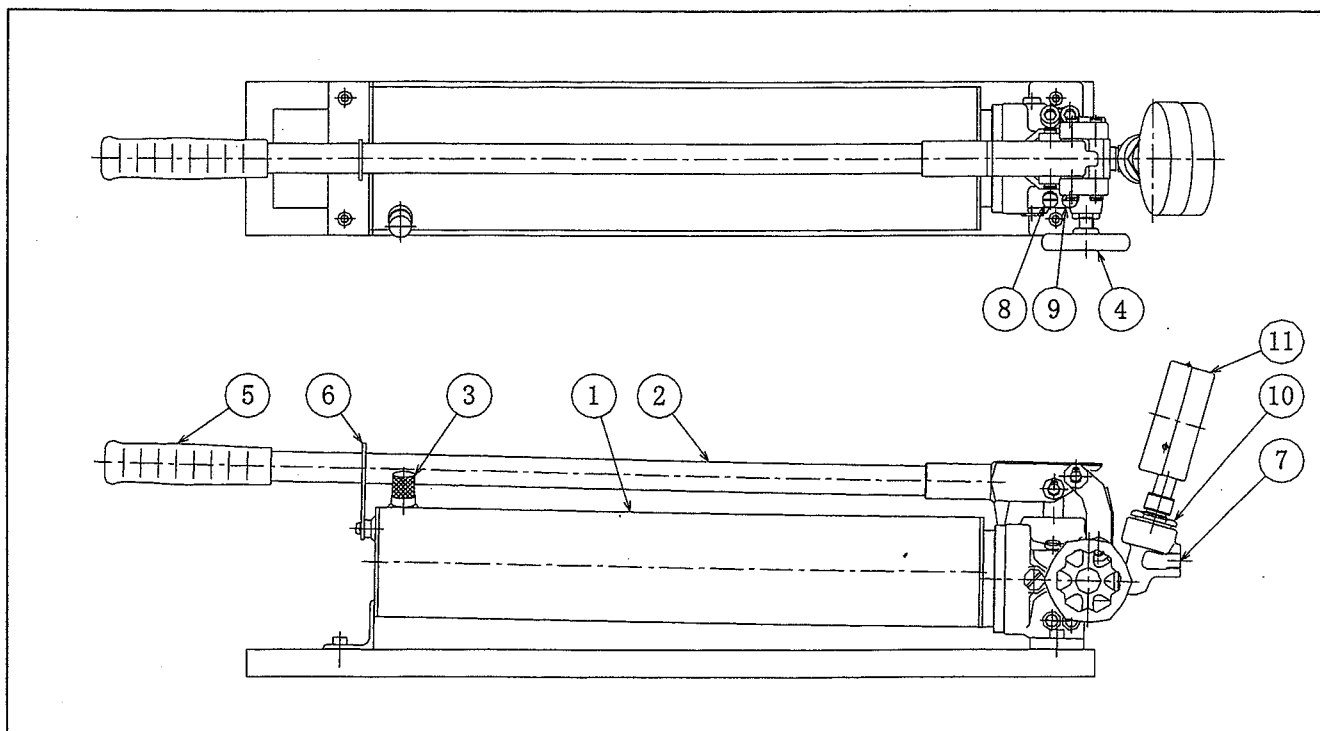
1. Outlines

- (1) This machine is a hydraulic pump which operates such accuator(s) as ram(s).
- (2) This pump should be used indoors. Do not use outdoors or the place where pump is to be drenched.
- (3) The atmosphere temperature should be between 0 to 40℃.
- (4) Use RIKEN's genuine peripheral hydraulic power equipment only.
- (5) Use RIKEN's genuine high pressure hoses, high pressure pipes and fittings, whose maximum operating pressure is 150MPa.
- (6) Do not use this pump at the place where personal injury or property damage might happen when you scatter the hydraulic working oil through your faults. Do not use this pump around the fire.
- (7) This pump is not under the application of the fire laws.
- (8) Do not modify this pump so as to use for another purpose.

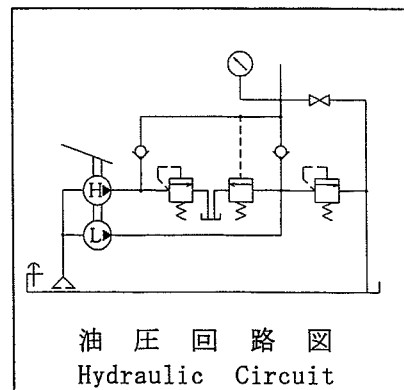
2. 仕様及び各部の名称

SPECIFICATIONS AND PARTS NAME

最高使用圧力	高圧側 低圧側	Max. operating pressure	High pressure side Low pressure side	150MPa 3MPa
吐出量/ストローク	高圧側 低圧側	Output/stroke	High pressure side Low pressure side	1.6 cm ³ 31 cm ³
油タンク容量		Reservoir capacity		6000 cm ³
有効油量		Usable oil		5000 cm ³
概略質量		Weight approx.		23.5 kg
使用作動油	一般作動油 ISO VG32 (昭和シェル石油 テラスオイル C32、又は同等品で、危険物第四類第四石油類に該当いたします。)			
Hydraulic working oil :	ISO VG32 (SHOWA SHELL TELUS C32, MOBIL DTE OIL LIGHT ESSO UNIPOWER 32, or equivalent)			



NO.	名 称	Description
1	油タンク	Reservoir
2	レバー	Operation lever
3	空気弁及び給油口 (レベルゲージ付)	Air valve
4	操作バルブ	Operation valve handle
5	レバー握り	Lever grip
6	レバー掛け	Lever hook
7	吐出口 (M14X1.5)	Oil output port (M14X1.5)
8	高圧安全弁	High pressure safety valve
9	低圧安全弁	Low pressure safety valve
10	圧力計取り付け金具	Pressure gauge adaptor
11	圧力計	Pressure gauge



3. 各部の説明 (○印内の番号は外形図の部品番号です) DESCRIPTION ON EACH PART

- ① 油タンク **Reservoir**
作動油を貯蔵する容器です。
Store hydraulic working oil.
- ② レバー **Operation lever**
上下に作動することにより、油が吐出します。
Deliver oil by pumping vertically.
- ③ 空気弁及び給油口(レベルゲージ付) **Air valve and oil feeding port with oil level gauge**
油タンク内の空気を出入りさせて油の流れをスムーズにします。また、ここから給油します。
Let the air flow into and out from the reservoir, so as to flow oil smoothly.
- ④ 操作バルブ **Operation valve**
開閉操作により油が吐出したり、タンクに戻ったりします。
Let the oil deliver or return to the tank by opening or closing.
- ⑥ レバー掛け **Lever hook**
レバーを固定し、運搬を容易にします。
Fix the lever, so as to carry this pump easily.
- ⑦ 吐出口 **Oil output port**
作動油を吐出させるポートです。
A port which delivers oil.
- ⑧ 高圧安全弁 **High pressure safety valve**
機器や管などの破壊を防止するために、最高圧力を限定する弁です。
Eliminate the maximum pressure, so as to avoid the damages of the equipment and/or the pipings.
- ⑨ 低圧安全弁 **Low pressure safety valve**
シリンダを早送りさせる低圧圧力を限定する弁です。
Eliminate the low pressure, so as to advance the ram fastly.
- ⑩ 圧力計取り付け金具 **Pressure gauge adaptor**
圧力計を取り付ける金具です。
The pressure gauge is mounted on.

4. ご使用上の注意事項 CAUTIONS



警告

本機を改造してはいけません。

理研の推奨していない改造は、安全上問題となることがあります。改造する場合は、事前に当社にご相談ください。許可の無い改造には、当社は責任を負いかねます。



WARNING DO NOT MODIFY THIS PUMP.

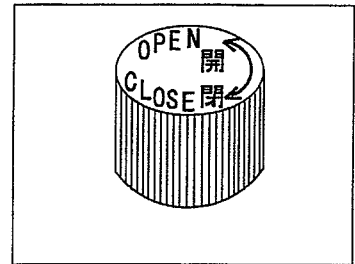
If you should modify, before modification, you should consult RIKEN or authorized agents of RIKEN. We are not in a position to guarantee your modifications without our written approval.

(1) 空気弁の開閉

To open and close the air valve

使用時は、必ず空気弁を開いて使用してください。使用後及び移動時は、閉じてください。空気弁を閉じたまま使用しますと、作動油の吸い込み不良を起こします。

Be sure to open the air valve when in use. Close after use and under transportation. If you operate this pump with air valve closed, the working oil cannot be sucked up smoothly.



 警告

空気弁を閉じたまま使用されますと、作動油が戻る時に油タンク内部の圧力が上昇し、油タンクが破損し人身事故につながるおそれがあります。

 警告

規定量以上の作動油を油タンクに戻すと内部圧力が上昇し、油タンクが破損し人身事故につながるおそれがあります。

 WARNING

If you operate this pump with the air valve closed, when the working oil returns to the tank, the pressure in the tank will be increased, and the tank might be damaged.

 WARNING

If you return the oil, exceeding the tank capacity, to the tank, the pressure in the tank will be increased, and the tank might be damaged. Also you might be injured.

(2) 高圧安全弁の設定

To set the high pressure safety valve

高圧安全弁は、回路の最高使用圧力を限定する弁です。むやみに調整しないでください。

The high pressure safety valve eliminates the maximum pressure in the system. Do not adjust this valve unnecessarily.

 警告

高圧安全弁は、150MPaに調節してあります。絶対に150MPa以上に上げて使用してはいけません。ポンプ、シリンダ、超高圧ホースなどが破損し、事故を起こすおそれがあります。

 警告

最高使用圧力150MPa未満の油圧機器にご使用の際は、高圧安全弁を使用される圧力に下げてご使用ください。下げないと機器が破損します。

 WARNING

High pressure safety valve is factory-set at 150MPa. Be sure not to use this pump exceeding this pressure. If you operate this pump exceeding this pressure, this pump itself, ram(s), hose(s), and other peripherals might be damaged, and personal injury may happen.

 WARNING

If this pump is used to operate the peripherals, whose operating pressure is less than 150MPa, set the high pressure safety pressure at the peripherals' operation pressure. If not, peripheral(s) might be damaged.

○ 高圧安全弁の調節方法 How to adjust the high pressure safety valve

a) 圧力計の取付け

- 1) スパナなどでブッシングの六角部を左へ回して圧力計取り付け金具から外してください。

- 2) スリーブを手で押さえ、メクラ栓の六角部を手で左へ回して外してください。

- 3) スリーブをブッシングにはめ込んでください。ブッシングの六角側より、圧力計をねじ込んでください。スリーブ先端と圧力計ねじ部先端が同じになるまでねじ込みます。

- 4) 圧力計取り付け金具のシート部にコーンが入っていることを確認してください。

- 5) 上記のセット品を圧力計取り付け金具にねじ込みます。このときブッシングが回らなくなる手前で、圧力計を右へ回して見やすい向きにセットしてください。その後圧力計が回らないように手で押さえ、スパナなどでブッシングを締め込んでください。規定トルクは約 70 ~ 90 N・m です。最後に圧力計の六角部をスパナなどで締め付けます。規定トルクは約 50 ~ 60 N・m です。

To mount the pressure gauge

- 1) Turn the hex. part of a bushing counter-clockwise by use of an adjustable wrench to take it out from the pressure gauge adaptor.

- 2) Hold a sleeve by hand, and turn the hex. part of the blind plug counter-clockwise by hand to take it out.

- 3) Insert the sleeve into the bushing. Screw the pressure gauge from the hex. part of bushing. Screw the gauge until the faces of end of sleeve and end of gauge is even.

- 4) Check if the cone is on the seat of gauge adaptor.

- 5) Screw the above set into the gauge adaptor. The gage is to be faced to you. Hold the gage by hand and fasten the bushing by use of an adjustable wrench. Tightening torque shall be 70 to 90 N・m. Then tighten the hex. part of the gauge by use of an adjustable wrench. The torque shall be 50 to 60 N・m.

）ビスの取り外し

To take out the plug

ドライバーを使って、ビスを左に回して外してください。
Turn the plug counter-clockwise to take out by use of a screw driver.

c) 設定圧力のゼロ（0）化 To set the pressure to zero (0)

ドライバーを使って、調節ねじを左に 2 回転してください。
Turn the adjusting screw counter-clockwise twice by use of a screw driver.

d) 圧力の設定

To set the pressure

操作バルブを右方向に回して閉じてください。調節ねじを右に少し回し、レバーを上下に作動させます。圧力計を見ながら希望する圧力になるまで繰り返してください。

- * 低圧安全弁は絶対に触らないでください。

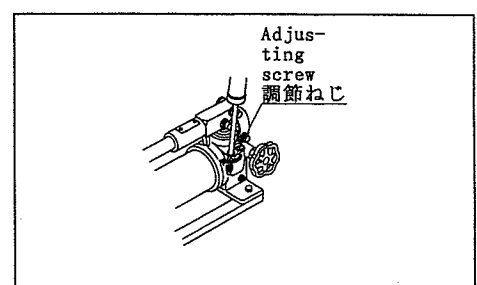
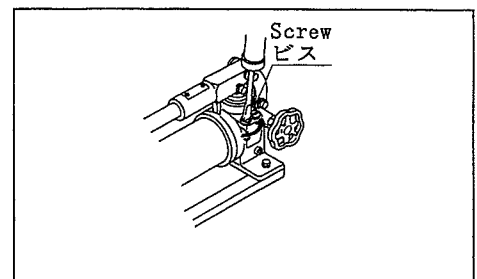
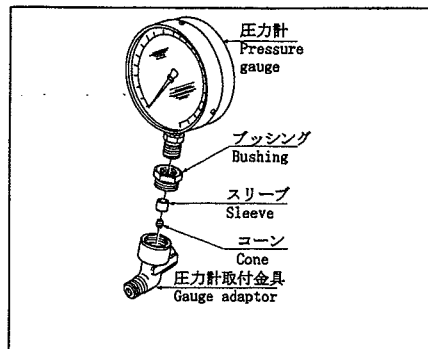
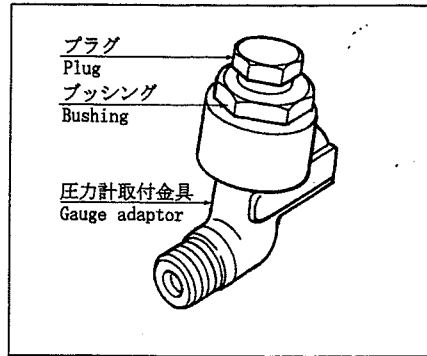
Turn the operation valve clockwise to close. Turn the adjusting screw clockwise a little, then pump the lever. Watch the pressure gauge, and repeat until the required pressure is gained.

- * Be sure not to touch the low pressure safety valve.

e) ビスの取り付け

To tighten the screw

圧力調整が終わりましたら、ビスを元の状態に取り付けてください。
After adjusting the pressure, tighten the screw.



(3) 重量物のジャッキダウン操作 To jack the heavy weights down

シリンダに荷重がかかった状態でのジャッキダウンはゆっくりと行ってください。
Jack the heavy weights down very slowly when the load is held by the cylinder.

警告

シリンダを用いての重量物のジャッキダウンやワイヤの緊張解除などの際に、急激にポンプの圧力を抜きますと、荷が落下したり、はねたりして、人身事故につながるおそれがあります。このような使用の場合には、バルブなどが必要になりますので、事前に当社までご連絡ください。

WARNING

If you release the pressure suddenly from the jacking rams or wire strand rams, the loads may fall down or spring. Then personal injury may be caused. Consult RIKEN or RIKEN's authorized agents for these applications. They will recommend you suitable valves.

4) 関連機器 Peripherals

① シリンダ Rams

- a) 最高出力がシリンダ仕様の70～80%でご使用できるように余裕を持った機種をご選定ください。
Use at 70 to 80% capacity of the ram specifications.

警告

必ず仕様出力以内でご使用ください。規定圧力以上に内圧が上がりますと、シリンダやホースが破損し事故を起こすおそれがあります。

WARNING

Be sure to use the rams not exceeding the rated pressure capacity. If the pressure exceeds the rated capacity, the rams and hoses might be damaged, and personal injury may happen.

- b) ピストンをストロークエンドで突き上げての使用は避けてください。
You are kindly recommended not to apply the pressure after the piston rod is fully extended.
- c) シリンダには、垂直に荷重をかけ、バランスの悪い荷重をかけないでください。
Apply the loads on the ram vertically. Do not apply the eccentric loads.

警告

許容偏荷重は、最大出力の2.5%です。それ以上の偏荷重がかかると、ピストンが曲がったり、シリンダが転倒したりしてシリンダが破損するおそれがあります。

WARNING

The allowable eccentric load should be under 2.5%. If you apply more than 2.5% eccentric load, the piston might be bent and/or the cylinder tube might be damaged.

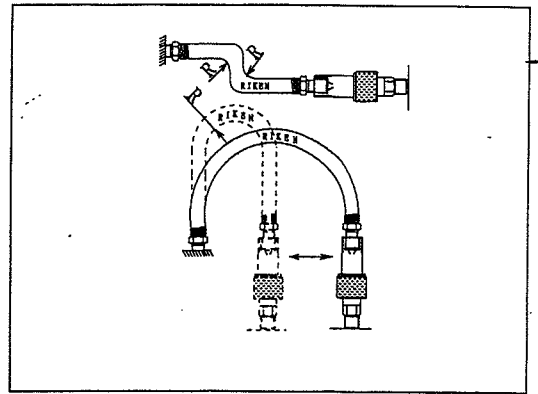
② 超高圧ホース : RIKEN ブランドの150MPa用超高圧ホースをご使用ください。
Ultra-high Pressure Hoses : Use RIKEN Brand Hoses for 150MPa use only.

- a) 規定された最小曲げ半径以上でお使いください。また、超高圧ホースに動きがある場合も、常に最小曲げ半径以上を保つように取り付けてください。

Use the hoses at more than rated bending radius.

This is also true when the hoses move.

超高圧ホースの形式 Hose Model No.	最小曲げ半径 R Min. Bending Radius R
UH-□	120 mm



□ はホースの長さを示します。

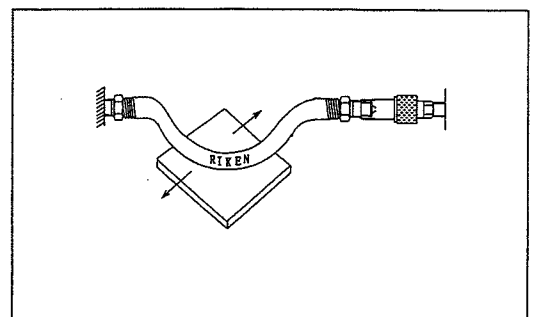
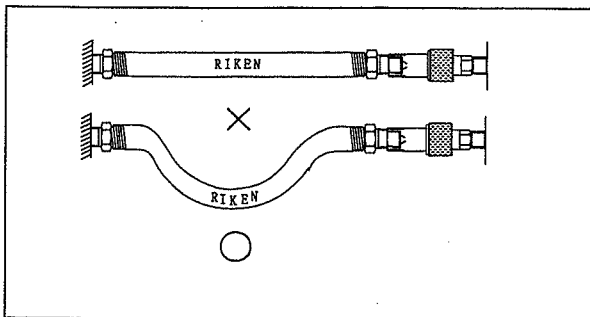
□ shows the length of the hoses.

- b) 超高圧ホースが床面や物に接触している箇所では、加圧時の伸縮、振動で超高圧ホースが擦れますのでサポートをするかクッションをして、超高圧ホース保護してください。

If the high pressure hose touches the floor or the goods, the hose will be rubbed due to the flexibility and the shock caused from the pressure. So, protect the hose by use of supports or cushions.

- c) 内圧により伸縮しますので、たわみを持たせて取り付けてください。

As the length of the hose changes in accordance with the inner pressure, mount the hose with flexibility.



ゴム板などのクッション

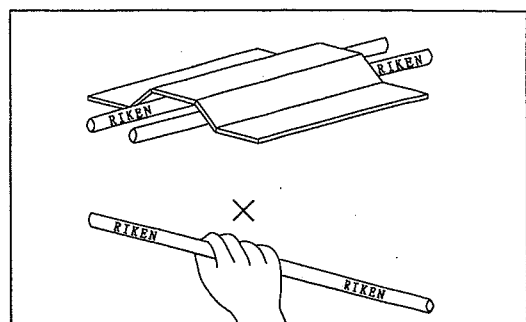
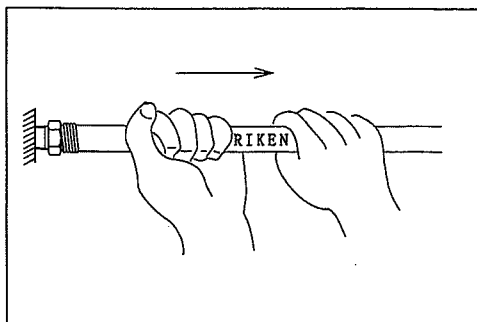
Such cushion as a rubber plate

- d) 超高圧ホースを引っ張って装置を移動してはいけません。

Do not transport the equipment by dragging the hose.

- e) 車両などで踏まないでください。また、超高圧ホース上に重量物を落とさないでください。危険と思われる場合は、必ず超高圧ホースに保護を設けてください。

Do not pass over the hose by wheels, and do not fall the goods on the hose. Protect the hose by covering over the hose.



警告

加圧時は絶対に超高圧ホースを手で握らないでください。手で握った状態で超高圧ホースが破損すると超高圧の作動油が瞬時に噴き出し、手に穴があくほどのけがをすることがあります。

⚠ WARNING

Be sure not to touch the hose under pressure. If you touch the hose, and the hose is damaged, the pressure oil will jet out to pierce through your hand.

f) 使用温度範囲は -40°C ~ $+50^{\circ}\text{C}$ です。

The oil temperature should be between -40°C to $+50^{\circ}\text{C}$.

g) 溶接の火花や火のかかる場所での使用は避けてください。

You are kindly recommended not to use the hose around the place where the welding spats and fires exist.

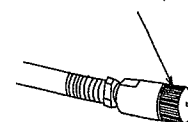
③ カップラ Couplers

カップラを接続するときは、ゴミなどが付いていないことを確認してから行ってください。使用後は、必ずカップラにダスターキャップを付け、ゴミなどの異物が入らないようにしてください。

Before connecting the couplers, clear away the dusts that adhere to the couplers. After usage, mount duster caps on the couplers to prevent the dusts from mixing into the system.

Duster cap

ダスターキャップ

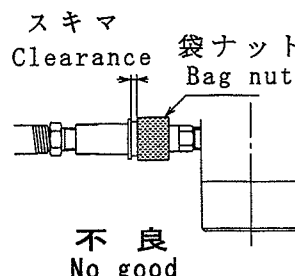
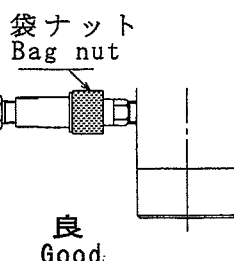
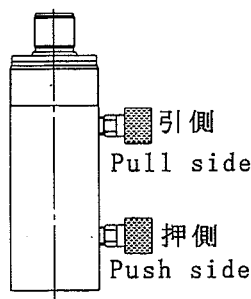


⚠ 警告

カップラは、手で袋ナットを根元まで完全に締めてください。図のように隙間が開いていると、シリンダがスムーズに作動しません。複動シリンダ使用時に、引側のカップラが不完全な接続の状態、押側に圧力をかけると、引側には倍圧がかかり、カップラ、シリンダ、超高圧ホースなどが破損や飛散し、人身事故を引き起こすおそれがあります。

⚠ WARNING

Tighten the bag nut of the couplers completely. If not tightened completely, the rams do not operate smoothly. If the pull side coupler is not tightened completely, as the pressure of the pull side is a double of push side, the couplers, rams, and hoses might be damaged, and personal injury may happen.



④ 作動油 Hydraulic working oil

a) 油タンクの給油は、油量範囲の上限を守ってください。

Be sure not to feed oil exceeding the oil level line shown on oil level gauge.

b) 作動油は年1回以上の交換をお奨めいたします。

Be sure to change oil at least once a year.

5. ご使用前の準備

Preparations before Operation

手動ポンプは通常、シリンダ及び超高圧ホースと組み合わせて使用いたします。また、作業内容によっては、油圧バルブ、圧力計、配管部品などが必要な場合もあります。使用目的に見合った理研の純正品をご使用ください。

The hand pumps are to be used with rams and hoses. According to the applications, hydraulic valves, pressure gauges, and piping materials, too are to be used. Use RIKEN genuine goods.

(1) 超高圧ホース及びカップラの接続

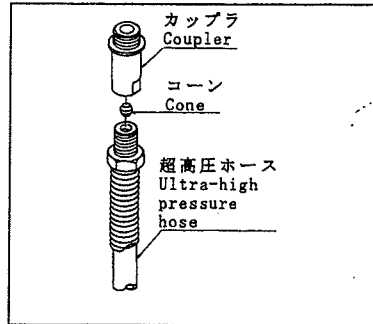
超高圧ホースは、通常ポンプ側に直接ねじ込み、シリンダ側は、カップラ接続にて使用します。

To connect the high pressure hoses and couplers

Normally, the one end of the high pressure hose is screwed in the output port of the pump, another end has a hose side coupler to connect a ram side coupler.

a) カプラの接続

- 1) 超高压ホースの片側の金具(六角部)を万力で固定してください。
- 2) 超高压ホース先端のシート部にコーン(HC-2000)をはめてください。
- 3) 超高压ホース先端のねじ部にカップラをねじ込み、その後スパナなどを使い規定トルク(約100~120N・m)で締め付けてください。

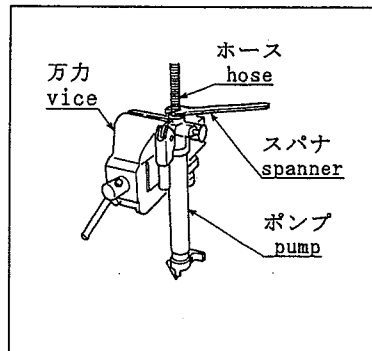


To connect couplers

- 1) Hold the hex. part of hose by use of a vice.
- 2) Insert HC-2000 cone on the seat of the hose end.
- 3) Screw the coupler to the end of hose, then tighten the coupler upto the required torque (100 to 120 N・m).

b) 超高压ホースの接続

- 1) ポンプを万力で固定してください。
- 2) ポンプ先端のメクラ栓(吐出口)をスパナなどで左に回して取り外してください。
- 3) 吐出口のシート部にコーン(HC-2000)が入っていることを確認し、超高压ホース先端部をねじ込み、その後スパナなどにより規定トルク



To connect hoses

- 1) Hold the pump by use of a vice.
- 2) Take out the blind plug of pump output port by use of an adjustable wrench by turning counter-clockwise.
- 3) Check if the cone is installed in the output port, then tighten the hose by the

約 100 ~ 120N・m で締め付けてください。

required torque (100 to 120 N・m).

(2) 超高压ホース内のエア抜き

初めて超高压ホースとシリンダを取り付けて使用される時は、高压ホース内にエアが入っています。シリンダがスムーズに作動しませんので、必ずエア抜きを行ってください。

How to release the air in the ultra-high pressure hoses

The air is included in the new hoses.
As the ram does not operate smoothly, release the air.

a) レバー掛けの取外し

手動ポンプのレバー握り部を手で上から押してレバー掛けを外してください。

b) 空気弁の開放

空気弁を左に回して開いてください。(7 ページ参照)

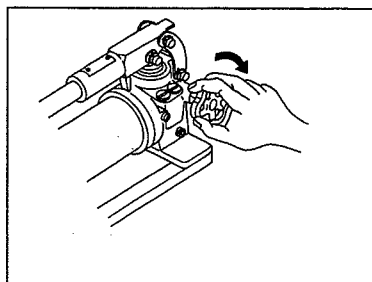
c) 操作バルブの全閉

操作バルブを右に回し、手でしっかり閉めてください。

d) 基本的には、シリンダを取り付ける前に超高压ホースのエア抜きを行います。

* 相手側カップラ(S-4R)を接続します。

* 相手側カップラが無い場合は、ドライバーなどで押します。



To unfasten a lever hook

Unfasten the lever hook by pushing the lever grip.

To open the air valve

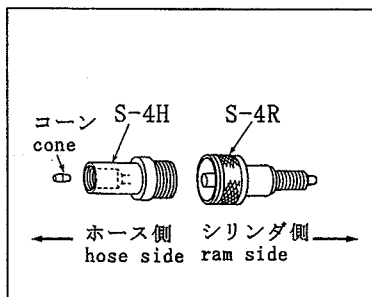
Turn the air valve to open it. (See page 7)

To close the operation valve

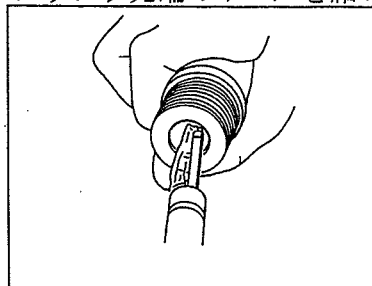
Turn the operation valve clockwise to close it.

Basically, release the air in the hose before connecting to the ram.

* Connect with ram side coupler (S-4R)



カップラ先端のボールを細い



* In case of hose side couplers only, push the steel ball in the coupler by use of a screw driver.

e) レバーの作動

To operate lever

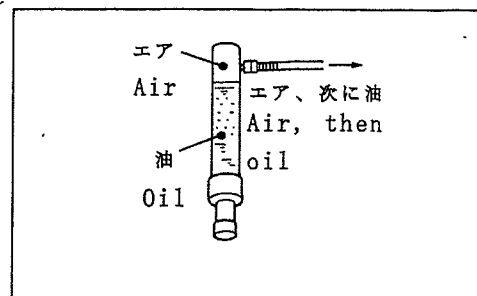
レバー握り部を手で持ち、レバーを上下に作動させます。

エアと油が出始めます。出てきた油にエアの気泡が無くなればエア抜きの完了です。

Hold the lever grip, and pump the lever. Oil and air will flow out. Repeat until the air bubble does not flow out.

- ★ もし、手動ポンプと超高压ホース、シリンダが接続されたまま
でエア抜きをする場合は、シリンダのピストンを全ストローク
出し、シリンダを逆さまにして、操作ハンドルを左に回し
て開いてください。空気から先に抜けていきます。

If you release the air when the hand pump, ram and hose
is connected, extend the ram piston fully, then put the
ram upside down, and turn the operation valve counter-
clockwise to open. Air will be released to the tank.



f) 作動油の補給

To refill the oil

エア抜きが完了したら、作動油を適量まで補給してください。(6. 保守点検をご参照ください。)

After air releasing is over, refill the oil upto the required level. See 6. Maintenance.

6. 保守点検

Maintenance

日常の保守点検を怠りますと故障の原因となります。

(1) 作動油の点検

Maintenance of hydraulic working oil

油量は規定量入っていますか? Is the oil filled upto the required level?

規定量より少ないと、シリンダのピストンが途中から伸びなくなったり、加圧できなくなったりします。

If the oil volume is not enough, the ram piston will not be extended fully, and the pressure
will not be risen.

a) シリンダのピストンの戻し

To retract the ram piston fully



警告

ピストンを出したまま給油しますと、ピストンが戻ったときにタンク内の油があふれ
出ることがあります。また、タンクが破損し、人身事故を起こすおそれがあります。



WARNING

Retract the ram piston fully. if you fill the oil with the ram piston extended,
when the ram piston retracts, the oil might flow out from the tank.

Moreover, the tank might be damaged, and the personal injury might be caused.

b) 空気弁の取り外し

To take out the air valve

空気弁を左に回して取り外してください。

レベルゲージが付いています。

- * 空気弁のねじ部は2カ所あります。最初の
ねじ部がはずれましたら、空気弁を引き上げ、
もう一度左に回してください。

Take out the air valve with oil level gauge.

The air valve has two (2) parts of threads.

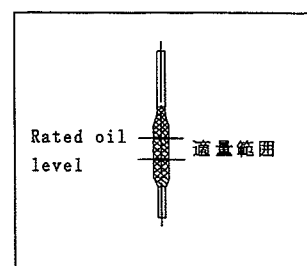
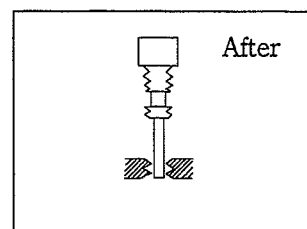
the 1st thread part is loosened, pull

up the air valve, and turn it counter-clockwise.

c) 油量の確認

To check the oil level

オイルレベルゲージに付いている油を布等でふき取ります。給油口に
オイルレベルゲージを差し込み、栓がぶつかるまで中に入れます。も
う1度抜き取り、作動油が油量範囲の間にあるか調べてください。



Clean the oil level gauge by use of waste cloth. Insert the oil level gauge into the oil feeding port until it
touches the screw part. Take it off again to check if the oil level is between the oil level range lines.

d) 油の補給

To refill oil

油量が不足の場合には、給油口より補給してください。油量が適量ならば、オイルレベルゲージを差し込み、空気弁を元の状態にねじ込んでください。

If the oil volume is not enough, refill the oil from the oil feeding port. If enough, insert the oil level gauge and turn it clockwise to close tightly.

作動油は年に1回以上交換してください。

Change oil more than once a year



注意

作動油は、一般作動油のISO VG32（昭和シェル石油 テラスオイル C32又は同等品。）をお使いください。リン酸エステル、水-グリコール、w/oエマルジョン系作動油は使用できません。パッキンの劣化及び機器の腐食などにより、本機が故障します。ご使用の場合には、当社にご連絡ください



CAUTION

Use ISO VG32 hydraulic working oil only. Phosphate ester, water-glycol and w/o emersion oil should not be used. The packing seals will be deteriorated and the equipment will be corroded to cause troubles of this pump. If you would like to use these oil, consult RIKEN or RIKEN's authorized agents.



注意

廃棄される廃油（作動油）は「産業廃棄物」に該当しますので、自治体の許可を得ている産業廃棄物収集業者、または産業廃棄物処理業者に委託して廃棄してください。



CAUTION

The used and old hydraulic working oil should be disposed in accordance with your regulations or laws on anti-pollutions.



警告

作動油が目に入った場合は、清浄な水で最低15分間洗浄した後、医師の手当を受けてください。また皮膚に付着した場合は、水と石けんで洗ってください。



WARNING

If the working oil splashes into your eyes, clean your eyes by the fresh water immediately, then go to doctor. Also clean your skins out by use of the fresh water and the soap.

(2) 超高圧ホースの点検

Maintenance of the hydraulic hoses



警告

超高圧ホースは消耗部品です。外観上は何ら異常が認められない状態であっても、内部に傷やピンホールなどが発生しているかもしれません。寿命までに達しなくても、使用状況などを考慮して定期的に交換してください。何か疑問がありましたら、当社までご連絡ください。



WARNING

The hydraulic hoses are the consumptive items. Even if the visual check is accepted, there might be a crack and/or a pin hole inside. Even if life time is still left, taking applications into consideration, change hoses periodically.

- 日常の使用時、または週1度は超高圧ホースの外観状態をチェックし、下記のような異常がありましたら、直ちに使用を中止し、交換するなどの処置を行ってください。

Check the hoses visually at daily use or once a week. If the following abnormal conditions exist, stop the operation at once, and change hoses or take a particular counter measures.

- * 超高圧ホースのねじ込み部より油漏れがある場合は、一旦外してコーンが所定の位置にあるか、傷などがないかを確認してください。その後超高圧ホースをねじ込み、規定のトルクで締め付けてください。それでも油漏れが止まらない時は、新品と交換してください。

If the oil leaks from the thread parts, take out the hose, then check if the cone is set at the correct position or not. and tighten again by the required torque. If oil still leaks, change hoses.

- * 超高圧ホースの口金や外周よりの油漏れ、または外周にへこみ、傷や膨らみがある場合は、直ちに新品と交換してください。

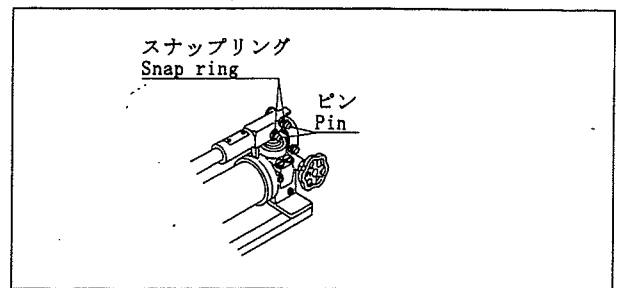
If there are oil leakage from the thread parts or outer surface of the hose, or the outer surface is uneven or cracked, change the hose with new one.

(3) レバー及びピストン摺動部の点検

Maintenance of the lever and piston parts

レバーはしっかり取り付けてありますか？
また、レバー本体とクランク及びピストンを
連結しているピンはしっかり挿入されていま
すか？また、スナップリングは、ピンのみぞ
部にはまっていますか？

Is the lever mounted correctly? Is the
pin which connects the lever body and crank
and piston is inserted correctly at the
groove of pin?



* レバーは取り外しができるようにねじ込み式になっております。使用中に少しずつ緩んでくること
があります。レバーがぐらぐら動き、レバー操作が不安定になります。手でしっかりねじ込んでくだ
さい。レバー本体とクランク及びピストンを連結しているピンにスナップリングが挿入されていないと、
レバー操作中にピンがはずれるおそれがありますので、よく確認してください。

The lever is screwed in the lever body. If the lever is not screwed in tightly, turn it clockwise to tighten. If
the snap ring is not inserted in the pin, the pin might be disconnected under pumping. Check and insert the
snap ring correctly.

(4) 油漏れの点検

Maintenance on oil leakage

外部への油漏れはありませんか？ Is there any outside oil leakage?

* ねじの緩みやパッキンの磨耗などがあると、外部に油漏れが発生します。油漏れが発見されたら、直
ちに修理してください。

If the threads are not tightened, or the packing seals are worn out, oil leaks outside. If
you find out oil leakage, repair instantly.

(5) その他の点検

Maintenance on other parts

シリンダのねじ部は、緩んでいませんか？また、カップラはしっかり接続されていますか？

Are the threads of rams not loosened? Are the couplers connected tightly?

* カップラが緩んでいると、油が流れません。(11 ページ参照)

If the couplers are loosened, the oil would not flow. (See page 11.)

(6) 定期的清掃

Periodical cleaning

* ポンプの故障で最大の原因はゴミです。ポンプや付属機器を清潔に保ち、外部からの異物の混入を防
いでください。

The most possible cause of the pump trouble would be dusts. Keep the pump and peripherals always clean, and
avoid the mixturing of dusts into the hydraulic system.

7. 操作方法

How to Operate

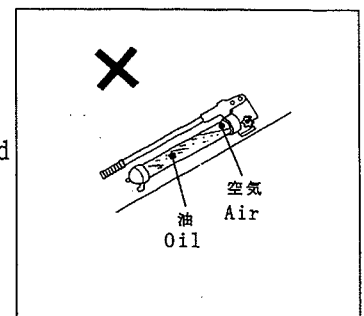
a) 設置場所

Installation place

ポンプは水平で安全な場所を選んで設置してください。安全な場所とは、
周りに障害物が無く、足場が平らで堅固な場所を言います。

ポンプのホース側を上向きにして作動してはいけません。

Install this pump on a flat and safety place. The meaning of "safety place" should
be a place around which dangerous goods or obstacles do not exists, and whose
floor is plain, flat and stable. Do not operate this pump with hose side up.



b) カップラの接続 (11 ページ参照) To connect the couplers(See page 11.)

超高圧ホースとシリンダをカップラで確実に接続してください。

Connect a high pressure hose and a ram with a coupler tightly.

c) レバー掛けの取り外し To unfasten the lever hook

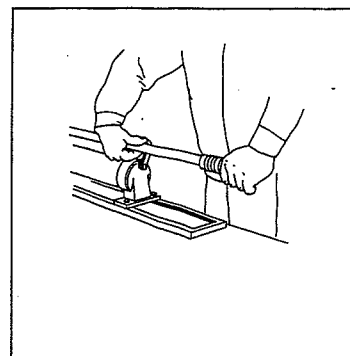
レバー握り部を手で上から押してレバー掛けを外してください。

Unfasten the lever hook by pushing the lever grip.

d) 空気弁の開放 To open the air valve

空気弁を左に回して開いてください。(約2回転)

Turn the air valve counter-clockwise twice to open.



e) 操作バルブの全閉 To close the operation valve

操作バルブを右に回し、手でしっかり締め付けてください。

締め付けトルクは約 3 N・m です。

Turn the operation valve clockwise to close tightly. The tightening torque shall be about 3N・m.

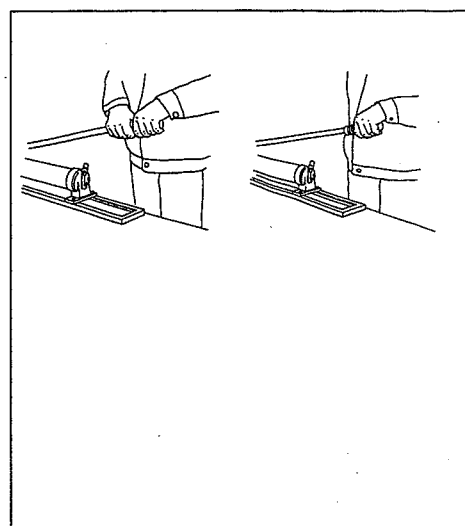
f) レバーの作動 Pumping

レバー握り部を片手で持ち、上下に作動すると、作動油が吐出されます。レバーの荷重が大きくなり、上下作動が困難になってきましたら、レバーをあまり持ち上げないようにして、両手で作動させ所定の圧力まで上下作動を続けてください。

Hold the lever by one hand, and pump to discharge oil.

When lever load is heavy, pull up the lever a little,

and repeat pumping by use of both hands.



g) 作動油の戻し To return the working oil to the tank

所定の作業が終了したら、操作バルブをゆっくりと左に回して開いてください。作動油はシリンダよりタンクに戻ります。

After the required operation, turn the operation valve counter-clockwise slowly to open and to let the working oil return to the tank.

《使い終わったら》

《After the whole required operation completed》

a) 空気弁の全閉 To close the air valve

空気弁を右に回して閉めてください。

Turn the air valve clockwise to close.

b) レバーの固定 To fix the lever by use of lever hook

レバー握り部を上から押して、レバー掛けでレバーを固定してください。

Push the lever grip, and fix the lever by use of the lever hook.

c) カップラの取外しとダスターキャップの取り付け To disconnect couplers and mount duster caps

シリンダから超高圧ホースを外してください。カップラには必ずダスターキャップを付けてください。

Disconnect the high pressure hose from the ram, and mount the duster caps on the couplers.

d) 安全な場所への保管 To store this pump at a safe place

各機器は清掃し、防錆のため湿気が無く、直射日光が当たらず、また火の気のない場所に保管してください。

Clean all the equipments, and store them at a place where no mists exist, no sun shines, and no fire exists.

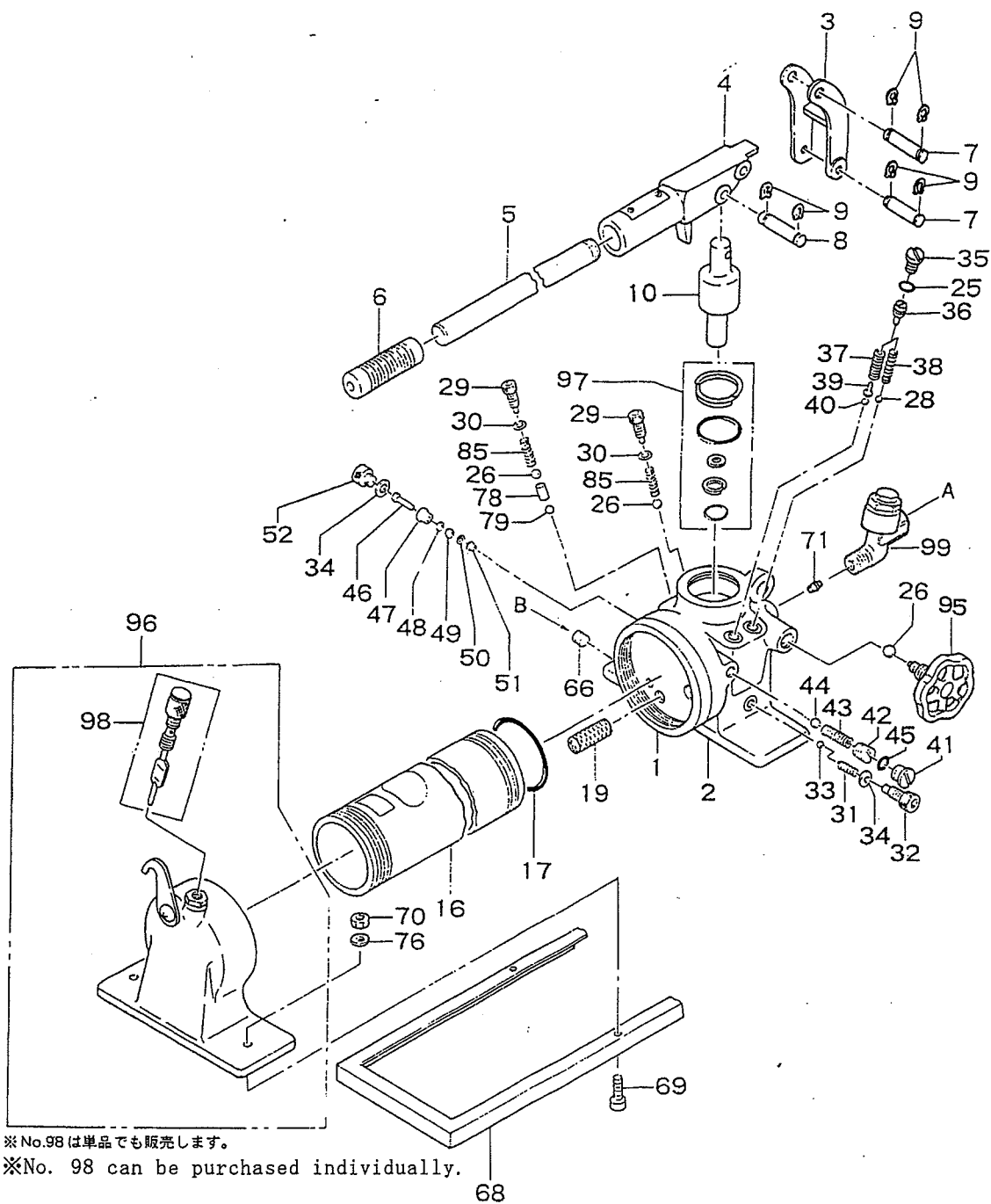
8.故障と対策

Trouble Shootings

状 態 Troubles	原 因 Causes	処 置 Remedies
圧力保持ができない。 Pressure is not held.	超高圧ホースなどの継手部分のねじの緩み よる油漏れ Oil leakage from the loosen thread parts of hoses, pipings and fittings.	ねじを締め込んでください。 Tighten the screws.
作動油が吐出されない。 (シリンダのピストンが出ない) Working oil does not flow out. (Piston of ram does not advance.)	油量不足 Not enough oil volume.	油を適量範囲まで補給してください。 Refill oil upto the required level.
	操作バルブが閉じていない。 Operation valve is not closed tightly.	操作バルブを右に回して締めてください。 Turn the operation valve clockwise to close tightly.
	カップラの袋ナットが緩んで油の通路が遮断されている。 Bag nut of coupler is loosen and the oil flow is blocked.	袋ナットを手で完全に締めてください。圧力が残っているときは、固いのでパイプレンチなどで回してください。 Tighten the bag nut by hand. If the pressure is left, use a pipe wrench.
シリンダのピストンの出が遅い Slow ram speed	超高圧ホース及びシリンダにエアが入っている。 Air is included in the hose and ram.	エア抜きをしてください。(12ページ参照) Release the air.(See page 12)
シリンダのピストンが出たまま戻らない Piston of ram does not re-tract.	カップラの袋ナットが緩んで油の通路が遮断されている。 Bag nut of coupler is loosen and the oil flow is blocked.	袋ナットを手で完全に締めてください。圧力が残っているときは、固いのでパイプレンチなどで回してください。 Tighten the bag nut by hand. If the pressure is left, use a pipe wrench.
	シリンダの戻しスプリングの破損 Damage of return spring of ram.	スプリングを交換するために修理を依頼してください。 Ask RIKEN to repair to change springs.

以上の処置で正常に戻らない場合は、お買いあげ先販売店に連絡し、修理を依頼してください。

Although above remedies have been taken, if the trouble cannot be shot, ask RIKEN or RIKEN's authorized agents to repair the pump.



UP-22M 手動ポンプ 部品表

UP-22M Hand-operated Pump Parts List

部番 No.	名 称	Description	数量 Qty
1	ポンプ本体	Pump body	1
2	本体座	Pump body base	1
3	クランク	Crank	1
4	レバー本体	Lever body	1
5	レバー	Lever	1
6	握り	Grip	1
7	ピン	Pin	2
8	ピン	Pin	1
9	スナップリング	Snap ring	6
10	ピストン	Piston	1
16	油タンク	Reservoir	1
17	Oリング, JIS B2401 G85	O ring, JIS B2401 G85	2
19	ストレーナ	Strainer	1
25	Oリング, AN6227 #7	O ring, AN6227 #7	3
26	スチールボール, $\phi 7.1$	Steel ball, $\phi 7.1$	3
28	スチールボール, $\phi 6.3$	Steel ball, $\phi 6.3$	1
29	六角穴付きボルト	Hex. socket head bolt	2
30	銅ワッシャ	Copper washer	2
31	スプリング	Spring	1
32	六角穴付きボルト	Hex. socket head bolt	1
33	スチールボール, $\phi 7.9$	Steel ball, $\phi 7.9$	1
34	銅ワッシャ	Copper washer	2
35	ビス	Screw	2
36	スプリング調節ビス	Spring adjusting screw	2
37	高圧側スプリング	High pressure side spring	1
38	低圧側スプリング	Low pressure side spring	1
39	ボール受座	Ball seat	1
40	スチールボール, $\phi 4.0$	Steel ball, $\phi 4.0$	1
41	ビス	Screw	1
42	調節ビス	Adjusting screw	1
43	アンローダスプリング	Unloading valve spring	1
44	スチールボール, $\phi 9.5$	Steel ball, $\phi 9.5$	1
45	Oリング, JIS B2401 P14	O ring, JIS B2401 P14	1
46	パイロットピン	Pilot pin	1
47	ガイドカラー	Guide collar	1
48	Oリング, JIS B2401 P4	O ring, JIS B2401 P4	1
49	バックアップリング, P4用	Back-up ring, for P4	1
50	ナイロン リング	Nylon ring	1
51	リング	Ring	1
52	六角穴付きボルト	Hex. socket head bolt	1
66	六角穴付き栓ビス	Hex. socket head screw	1
68	基台	Base	1
69	六角穴付きボルト	Hex. socket head bolt	4
70	六角ナット	Hex. nut	4
71	コーン	Cone	2
76	ばね座金	Spring washer	4
78	コマ	Intermediate column	1
79	スチールボール, $\phi 4.7$	Steel ball, $\phi 4.7$	1
85	スプリング	Spring	2
95	操作バルブ	Operation valve	1
96	右脚セット	Right leg set	1
97	ピストンパッキンセット	Piston packing set	1
98	空気弁	Air valve	1
99	圧力計取り付け金具	Pressure gauge adaptor	1

アフターサービスについて

Repairing Service

サービスを依頼される前に、この取扱説明書をよくお読みいただき、再度点検の上、なお異常があるときは、販売店に修理を依頼してください。安易に分解修理をしないでください。

各ポンプの外形図をご入用の時には、販売店を通じて当社にご請求ください。

Before you ask RIKEN or RIKEN's authorized agents to repair this pump, read this manual carefully. Be sure not to repair this pump by yourself without RIKEN's or RIKEN's authorized agents' approval.

If you require dimensional drawing of this pump, please ask RIKEN's authorized agents.

製造元 **理研精機株式会社**

〒947-0003 新潟県小千谷市滝原町

総発売元 **理研機器株式会社**

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TEL 06-384-2766

FAX 06-368-2333

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TEL 092-411-4440

FAX 092-415-1011

RIKEN KIKI CO., LTD.

24-50, 4-CHOME TAKANAWA
MINATO-KU TOKYO 108-0074 JAPAN

TELEX : RIKENPWR J32359

F A X : 81-3-5488-7022

MODEL VN
SUCTION FILTER

INSTRUCTION MANUAL

Make sure that the user has a copy of this
manual at hand for use as an operating guide.

Taisei Kogyo Co., Ltd.
2-32-2 Wakagi, Itabashi-Ku, Tokyo Japan

TEL: 03-3934-3281
FAX: 03-3936-0030

No. MF006-00-3
JAN 16, 2007

WSG-1601

SAFETY PRECAUTIONS

Thank you for purchasing a VN Suction Filter.

This manual contains information and instructions on correct operation of your equipment. Before using the product, read this manual carefully and be sure you understand the equipment and safety precaution.

Keep this manual where it can be used at any time.



Caution

In this manual, the safety precautions to be taken in case erroneous handling of the product may give rise to a dangerous situation and possibly result in a medium or minor injury or material damage are headed with [Caution] for particular attention.

These instructions must be strictly followed to prevent a serious accident that might otherwise occur.

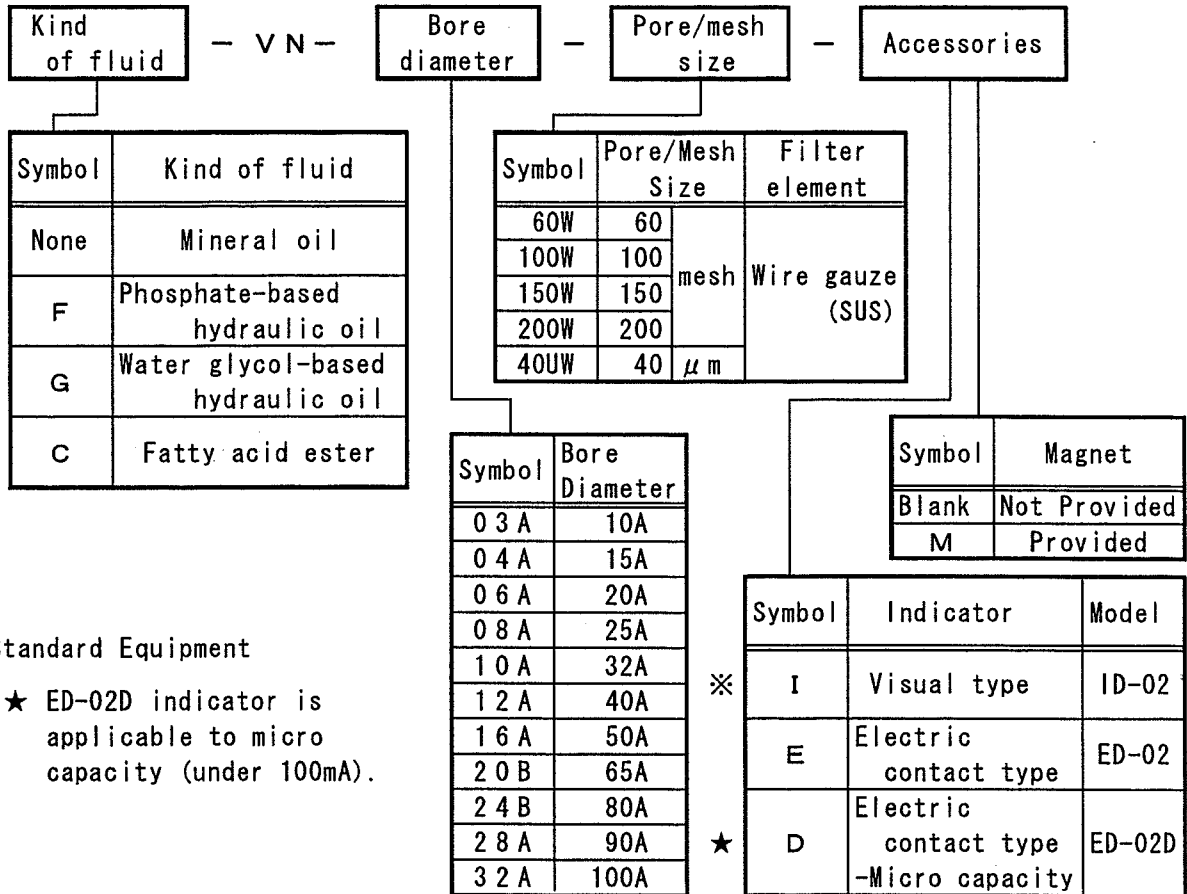
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1. PRODUCT IDENTIFICATION

VN Suction filter with Indicator (For suction line)

2. MODEL CODE DESCRIPTION



⚠ Caution

- * Use pressure gauge or a pressure (differential) switch to monitor the filter element for excessive clogging with sludge to prevent damage.
- * In case of using ED type indicator, standard capacity type is not applicable to Micro capacity application. Micro capacity type is not applicable to Standard capacity application. You must use the right indicator which is corresponded to the electric capacity.

3. PRINCIPAL SPECIFICATIONS

Permissible maximum pressure: 0.5MPa {5kgf/cm²}

(At positive pressure, be based on boost pressure.)

Applicable fluid: Mineral oils

(Note: For phosphate-and water glycol-based hydraulic oils, filters are different in material.)

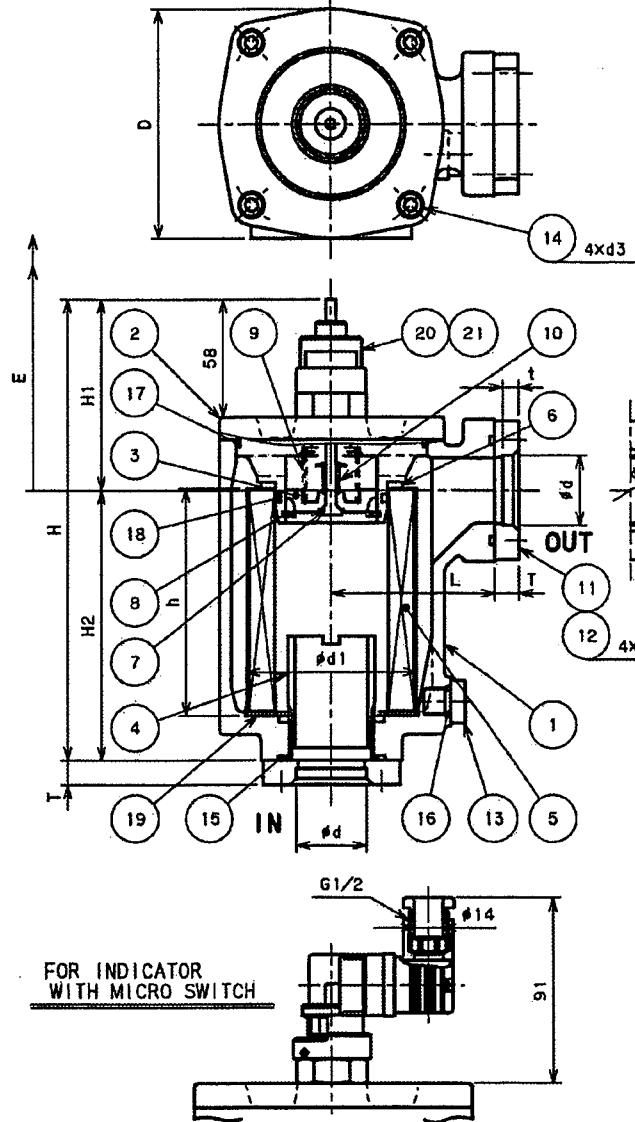
Service temperature range: 0°C ~ 90°C

0°C ~ 120°C (If fluid symbol is F and filter element is wire gauze(W).)

Installation: On the ground or indoors

4. PRODUCT DESCRIPTION

4-1. Dimensions and Component Parts



■ PART LIST

The parts list below shows the component parts of the oil filter for Mineral oil. Component parts of oil filters for other fluids than mineral oil may vary in material, etc.

21	*O-RING	NBR	1	JIS B2401,1A
20	INDICATOR		1	
19	PACKING	NBR	1	
18	*O-RING	NBR	1	JIS B2401,1A
17	*O-RING	NBR	1	JIS B2401,1A
16	*O-RING	NBR	1	JIS B2401,1A
15	*O-RING	NBR	2	JIS B2401,1A
14	CAP BOLT	SCM435	4	
13	DRAIN PLUG	SCM435	1	
12	BOLT	SS400	8	
11	COMPANION FLANGE	SS400	2	
10	SPRING	SWPA	1	
9	SPRING	SWPA	1	
8	STOP RING	SK	1	
7	GUIDE ROD	C3604	1	
6	WAVE WASHER	SK	1	
5	ELEMENT		1	
4	INNER TUBE	SGP	1	
3	VALVE	CAC406	1	
2	UPPER COVER	ADC	1	
1	BODY	AC2B	1	
No.	PART NAME	MATERIAL	QUANTITY	REMARKS

■ Dimensions of Element

and Standard Flow Rates

Symbol Model	Element h	Element d ₁	Element Allowance E	Standard Flow Rate
VN-03A	90	65	240	18L/min
VN-04A				30L/min
VN-06A	110	85	266	45L/min
VN-08A				90L/min
VN-10A	160	100	331	150L/min
VN-12A				205L/min
VN-16A	180	120	368	320L/min
VN-20B	200	140	419	550L/min
VN-24B				730L/min
VN-28A	260	180	559	1070L/min
VN-32A				1310L/min

■ Dimensions

Symbol Model	Bore Diameter	H	H ₁	H ₂	L	D	Companion Flange					Bolt			Weight (kg)
							d	F	P	T	t	d ₂	d ₃	d ₄	
VN-03A	10A	203	87	116	72	90	18	60	56	12	8	9	M8	M8	3.0
VN-04A	15A						22								
VN-06A	20A	227	94	133	80	112	27.5	68	70	12	8	9	M8	M8	5.0
VN-08A	25A						34.5								
VN-10A	32A	285	100	185	95	138	43	82	86	14	9	11	M10	M10	6.0
VN-12A	40A						49								
VN-16A	50A	321	107	214	110	156	61.1	96	102	14	9	14	M12	M12	8.5
VN-20B	65A	348	133	215	105	180	77	122	130	20	14	14	M12	M12	11.0
VN-24B	80A						90								
VN-28A	90A	442	202	240	135	230	102.5	156	166	22	15	18	M16	M16	20.0
VN-32A	100A						115.5								

4-2. Construction and Principle of Operation

The suction filter is composed basically of a body①, an indicator②⑩, an upper cover② equipped with a relief valve③, a filter element⑤, a wave washer⑥, an inner tube④, a drain plug⑬, etc.

The filter is so designed that the hydraulic oil entering from oil inlet with pump is filtered as it passes through the filter element from outside toward the inside. The dirt in the liquid are stored up to the filtering surface.

Continued use of a clogged filter element causes the difference pressure are increased between primary pressure (fluid inlet side) and secondary pressure (fluid outlet side), and that exert a bad influence on the pump.

The suction filter have standard equipment, the indicator(ED-02) can observe clearly from the outside, and the relief valve③ can prevent danger.

• Differential pressure type indicator

Two types of optional indicators are available.

One is a visual type indicator (ID-02/Standard) whose indication turns red from green when its detects a pressure difference in filter element that exceeds preset limit between primary pressure (fluid inlet side) and secondary pressure (fluid outlet side). The other is an electric contact type visual indicator which is applicable to visual type, too.

(ED-02, ED-02D/Optional) that transmits an electric alarm signal.

※ Ref. attached [ID-ED-type indicator instruction manual].

5. TRANSPORTATION



Caution

- * Wire roping and lifting must be done by qualified persons.
- * Be careful not to turn over the oil filter or let it fall from a height.
- Avoid danger

- (1) Rope the wire to fix on the housing body.
- (2) Cover the oil filter to protect against rain in transit.
- (3) Do not turn the oil filter over or fall. Do not impart shocks.

6. STORAGE

If the oil filter is not used immediately, store it with particular attention paid to the following.

6-1. Temporary storage

- (1) Keep it in a clean and dry room.
- (2) If it is stored outdoors or in a humid place, cover it tightly with a vinyl sheet or equivalent.

6-2. Long storage (Only case of Mineral oil)

- (1) Rust preventive disposition at the forwarding;
Spreading the inside to NP-10 rust preventive oil.
- (2) Rust preventive after delivery is effective for 2 or 3 months, in dry room.
In case of keeping for a long time more, open the cover and paint for rust prevention NP-10 equal oil, every 2 or 3 months.
- (3) When using the filter element of resolved or kept over a year, check whether it is normal in hydraulic pressure examination for the maximum service press.

7. INSTALLATION

⚠ Caution

- * Connect pipes oiltight.
- * Never mount on or hang from the oil filter, or it may be damaged or an injury may be suffered.
- * Installation, operation, maintenance and checking must be performed by skilled persons with expertise.
Unqualified persons may cause oil leaks or suffer an injury.

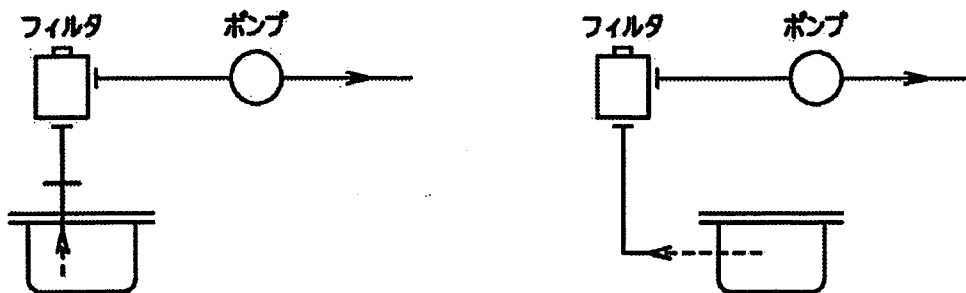
- (1) Location and ambient conditions

Location: Indoors (where little dust raises,
water is not splashed on and there are no flammable)

Ambient temperature: 0°C~80°C

- (2) Before connecting pipes, make sure of the locations of oil inlet and connect pipes correctly.
- (3) Connect pipes to the filter using care so that the housing is not excessively stressed.
- (4) When installing, mount this filter between the pump and the reserver tank by the flange. Before determine the position, consider a space between the pump and the reserver tank.
(This filter is mainly standard that is installed at suction side of the pump.)

Installed outline



8. OPERATION

Caution

- * The oil filter becomes very hot during operation.
Stay away from it to avoid burns.

- (1) Make sure that service conditions are as specified in [3. Principal Specifications] in this manual. And When the filter is pressed to the boost pressure is under 0.5MPa{5kgf/cm²} at positive pressure.
- (2) Starting with a low flow rate, introduce hydraulic oil into the oil filter up to the specified flow rate.
- (3) Check the housing for abnormal noise or vibrations. If any abnormality is detected, stop the pump immediately and check for the cause.

9. MAINTENANCE AND CHECK

9-1. Daily Check

- (1) Check the filter element for clogging periodically through the indicator.
- (2) Check the oil being filtered on a scheduled basis and replace the filter element according to the degree of decline in filtration effect shown by the oil. Continued use of a clogged filter element causes the valve to open to let contaminants flow out of the oil filter, resulting in a malfunctioning system.

9-2. Replacement

Caution

- * Stop the hydraulic unit and ascertain that the filter pressure is zero before replacing the oil filter.
* Keep the oil filter away from anything flammable during replacement work.

- (1) Stop the hydraulic unit, and after ascertaining that the filter pressure is zero, remove the drain plug^⑬ to let remaining oil out of the housing in its entirety.
- (2) Loosen the cap bolts^⑭ and lift off the upper cover^②.
The wave washer^⑥ and filter element^⑤ can be removed together.
- (3) Remove the filter element^⑤ from the cover^②.
- (4) Cleaning makes wire gauze filter elements reusable.
See [9-3 Cleaning Filter Element] for details.
- (5) Replace the "O"rings^{⑮ ⑰ ⑱} and the packing^⑲ with new ones.
Check the sealed surfaces for damage and the inside for dirt, and repair them necessary.
 - Wash out the dirt for the inside wall and bottom of the housing, from the drain hole.
 - In case of cleaning the optional magnet, take off the magnet holder itself turn left by cutting groove on the inner tube. To deassemble, take off the stop ring from the magnet holder. (Please wipe out the stuck iron dust on the surface of magnet with a dust cloth.)
- (6) Assemble parts in the reverse order of removal, (1) (2) (3).

9-3. Cleaning Filter Element

Clean the filter element with light oil (kerosine, gas oil, etc.) in the following manner.

- (1) Shake the filter element in four directions in the cleaning oil.
- (2) Brush the filter element carefully to remove sludge.
- (3) Blow off residual accumulations with an air spray.
- (4) Rinse the filter element well and dry with an air spray.

10. REPLACEMENT PARTS

Keep the following parts available for replacement at any time.

And Replace the "O" rings and packing have © mark with new ones.

■ Spare filter element

P — Kind of fluid — VN — Port diameter — Pore/mesh size

■ "O" Rings and Packing

【 "O" Ring and Packing List 】

Part No Model	15	◎ 16	◎ 17	◎ 18	◎ 19	21
VN-03A	G-30	P-11	G-65	G-35	t2 × ϕ 65/ ϕ 40	P-18
VN-04A						
VN-06A	G-45		G-90	G-50	t2 × ϕ 85/ ϕ 55	
VN-08A						
VN-10A	G-55	P-14	G-100	G-65	t2 × ϕ 100/ ϕ 70	
VN-12A						
VN-16A	G-70		G-125	G-80	t2 × ϕ 120/ ϕ 85	
VN-20B	G-95		G-145	G-100	t2 × ϕ 140/ ϕ 105	
VN-24B						
VN-28A	G-125		G-180	G-140	t2 × ϕ 180/ ϕ 145	
VN-32A						

MODEL UH LINE FILTER INSTRUCTION MANUAL

Make sure that the user has a copy of this manual at hand for use as an operating guide.

Taisei Kogyo Co., Ltd.
2-32-2 Wakagi, Itabashi-Ku, Tokyo Japan

TEL:03-3934-3281
FAX:03-3936-0030

No. MF013-00-2
March 3, 1998

SAFETY PRECAUTIONS

Thank you for purchasing an UH Oil Filter.

This manual contains information and instructions on correct operation of your equipment. Before using the product, read this manual carefully and be sure you understand the equipment and safety precaution.

Keep this manual where it can be used at any time.



Caution

In this manual, the safety precautions to be taken in case erroneous handling of the product may give rise to a dangerous situation and possibly result in a medium or minor injury or material damage are headed with 【 Caution 】 for particular attention.

These instructions must be strictly followed to prevent a serious accident that might otherwise occur.

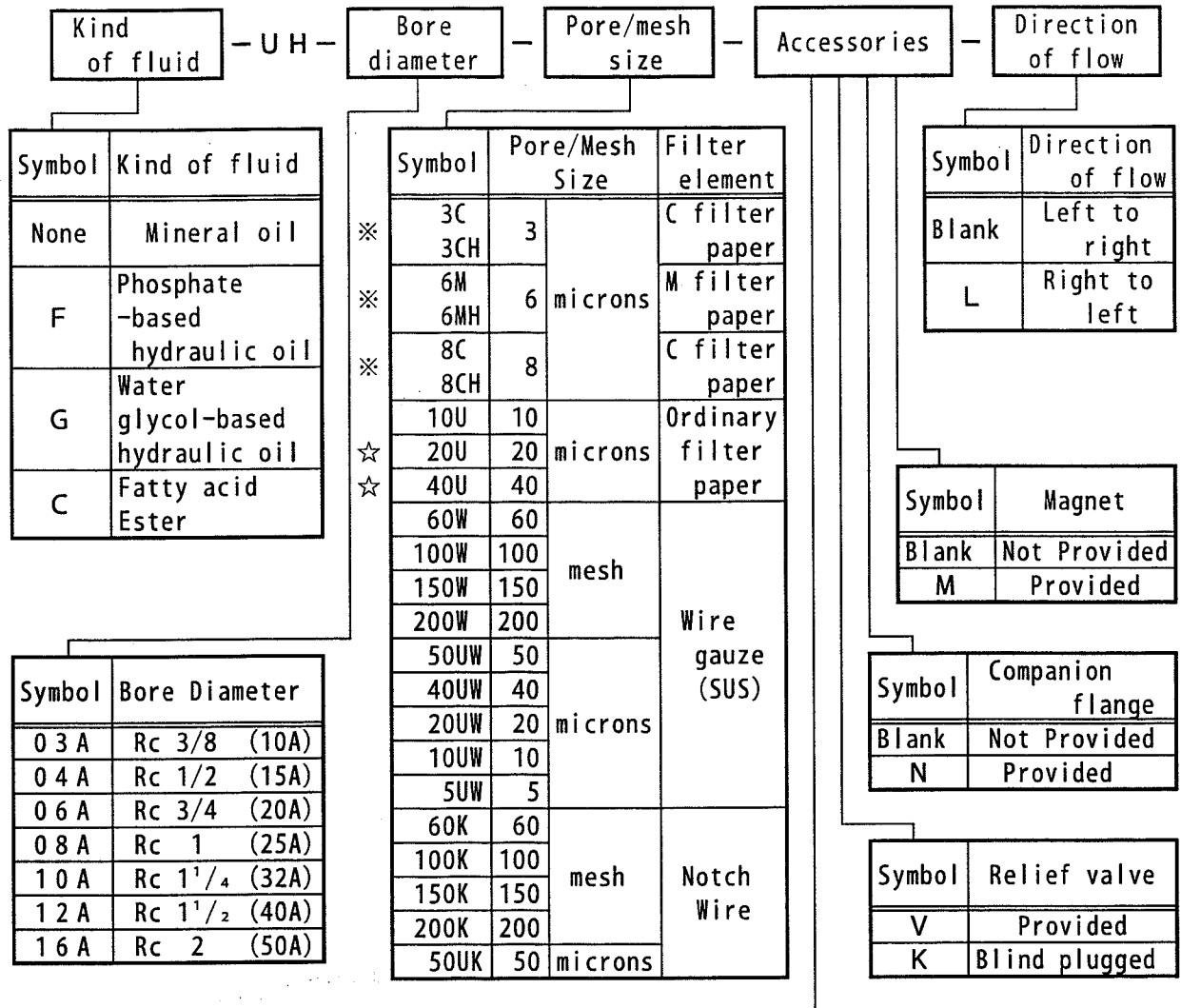
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1. PRODUCT IDENTIFICATION

UH line filter

2. MODEL CODE DESCRIPTION



※ 3C = $\beta_3 \geq 200$
 6M = $\beta_6 \geq 200$
 8C = $\beta_8 \geq 200$

《Note》 H denotes high pressure (21MPa) filter element.

Symbol	Indicator	Model	
		0.03MPa	0.07MPa
I	Visual type	IF-3	IF-7
E	Electric contact type	EF-3	EF-7
★ D	Electric contact type -Micro capacity	EF-3D	EF-7D

☆ Unsuitable for water glycol-based oils.

★ EF-3D/7D indicators are applicable to micro capacity. (under 100mA)

⚠ Caution

- * The filter using a high pressure filter element has no relief valve passage blind plugged. (symbol in mode code:K)
- * If the filter has no relief valve, be sure to use a differential pressure indicator available as an option. In neither case, use pressure gauge or a pressure (differential) switch to monitor the filter element for excessive clogging with sludge to prevent damage.
- * In case of using EF type indicator, standard capacity type is not applicable to Micro capacity application. Micro capacity type is not applicable to Standard capacity application. You must use the right indicator which is corresponded to the electric capacity.

3. PRINCIPAL SPECIFICATIONS

Permissible maximum pressure: 21.0MPa

Applicable fluid: Mineral oils

(Note: For phosphate-and water glycol-based hydraulic oils, filters are different in material.)

Service temperature range: 0°C ~ 90°C

0°C ~ 120°C : If fluid symbol is F and filter element is wire gauze(W). (0°C ~ 90°C with optional EA type indicator installed.)

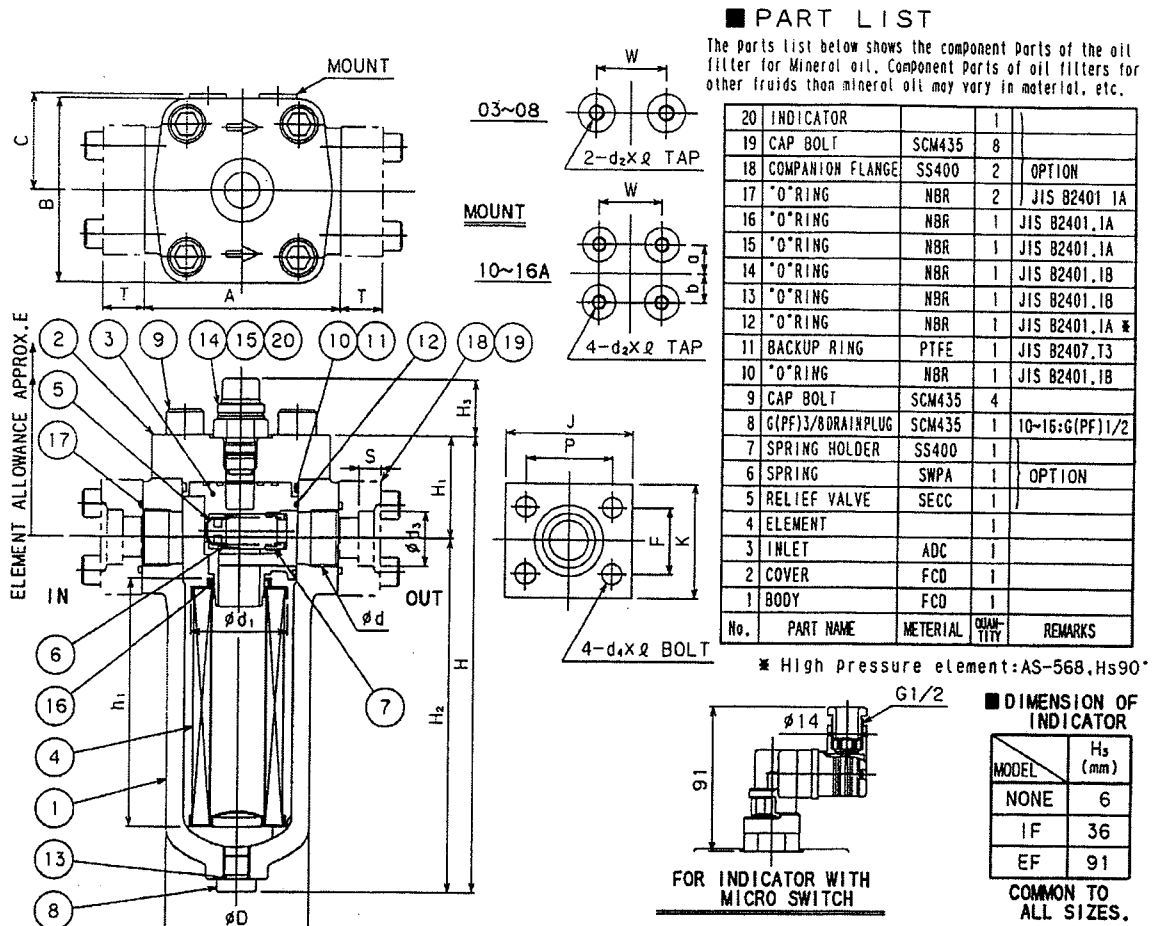
Installation: On the ground or indoors

Element pressure resistance: 0.7MPa(Standard filter element)

21.0MPa(high pressure filter element)

4. PRODUCT DESCRIPTION

4-1. Dimensions and Component Parts



■ Dimensions and Standard Flow Rates

Symbol Model	d	H	H ₁	H ₂	A	B	C	D	W	a	b	d ₂ × 1	※ Weight	Standard Flow Rate
UH-03A	Rc 3/8	206	60	146	120	116	61	92	45			M10 × 15	10.0kg	33L/min
UH-04A	Rc 1/2													55L/min
UH-06A	Rc 3/4	287	65	222	125	116	61	92	45			M10 × 15	12.2kg	106L/min
UH-08A	Rc 1													125L/min
UH-10A	Rc 1 1/4	374	81	293	170	151	78	122	60	20	25	M10 × 15	25.4kg	213L/min
UH-12A	Rc 1 1/2													238L/min
UH-16A	Rc 2	457	91	366	180	170	90	147	64	20	30	M12 × 17	36.6kg	433L/min

※ Weight does not include companion flange.

■ Dimensions of Element and Companion flanges (Optional)

Symbol Model	Element Allowance E	Element		Companion flanges (Optional)							
		h ₁	d ₁	d ₃	S	T	P	F	J	K	d ₄ × 1
UH-03A	200	85.3	62.2	17.8	11	21	48	24	70	52	M10 × 35
UH-04A				22.2							
UH-06A	290	155.3	62.2	27.7	14	27	56	42	82	72	M12 × 45
UH-08A				34.5							
UH-10A	375	204.5	82.2	43.2	16	31	74	52	102	88	M16 × 55
UH-12A				49.1							
UH-16A	450	254.5	102.2	61.1	19	37	90	60	124	100	M18 × 60

4-2. Construction and Principle of Operation

The oil filter is composed basically of a body①, a cover②, an inlet③, a filter element④, etc.

The filter is designed so that the hydraulic oil entering from oil inlet is filtered as it passes through the filter element from outside toward the center. The filtered oil is allowed to flow out from the center of the filter element, pass through the inlet and leave the filter from oil outlet.

The filter is so constructed that taking off the cover②, allows the filter element to be removed from above.

• Relief valve

In response to excessive clogging of the filter element with resultant pressure loss beyond the preset limit, this valve is opened to let the oil bypass the filter element and flow out directly from oil outlet, thereby protecting the filter element against damage. The valve has been set to be activated on a pressure rise of 0.35MPa{3.5kgf/cm²}.

Note that the oil filter equipped with a high pressure element (3CH, 6MH, 8CH) have the relief valve passage blind plugged so that it has no relief valve.

• Differential pressure type indicator (optional)

Two types of optional indicators are available. One is a visual type indicator (IF type) whose indication turns red from green when it detects a pressure difference in filter element that exceeds preset limit between primary pressure (fluid inlet side) and secondary pressure (fluid outlet side). The other is an electric contact type visual indicator which is applicable to visual type, too. (EF type) that transmits an electric alarm signal.

For high pressure elements, IF-7 or EF-7(D) indicator (full red indication for 0.7MPa{7kgf/cm²}) is used.

The EF-3D/7D indicators are applicable to micro capacity (under 100mA), using electric contact type.

※ Ref. attached [IF-EF-type indicator instruction manual]

5. TRANSPORTATION

Caution

- * When lifting the oil filter, screw eyebolts in the mounting taps(d₂) provided in the housing and sling it with wire rope applied through the eyebolts.
- * Wire roping and lifting must be done by qualified persons.
- * Be careful not to turn over the oil filter or let it fall from a height. Avoid danger.

(1) Cover the oil filter to protect against rain in transit.

(2) Do not turn the oil filter over or fall. Do not impart shocks.

6. STORAGE

If the oil filter is not used immediately, store it with particular attention paid to the following.

6-1. Temporary storage

- (1) Keep it in a clean and dry room.
- (2) If it is stored outdoors or in a humid place, cover it tightly with a vinyl sheet or equivalent.

6-2. Long storage (Only case of Mineral oil)

- (1) Rust preventive disposition at the forwarding;
Spreading the inside to NP-10 rust preventive oil.
- (2) Rust preventive after delivery is effective for 2 or 3 months, in dry room.
In case of keeping for a long time more, open the cover and paint for rust prevention NP-10 equal oil, every 2 or 3 months.
- (3) When using the filter element of resolved or kept over a year, check whether it is normal in hydraulic pressure examination for the maximum service press.

7. INSTALLATION

Caution

- * Anchor the oil filter firmly on the foundation using mounting taps provided in the housing.
- * Connect pipes oiltight.
- * Never mount on or hang from the oil filter, or it may be damaged or an injury may be suffered.
- * Installation, operation, maintenance and checking must be performed by skilled persons with expertise.
Unqualified persons may cause oil leaks or suffer an injury.

- (1) Location and ambient conditions
Location: Indoors (where little dust raises,
water is not splashed on or there are no flammable)
Ambient temperature: 0°C~80°C
- (2) Before connecting pipes, make sure of the locations of oil inlet and outlet.
Be sure that the drain plug of the housing faces down. The flow direction of oil is arrow marked on the cover. Ascertain that the direction is correct.
- (3) In installing the oil filter, secure the housing braced up with brackets from foundation to mounting taps.
- (4) Connect pipes to the filter using care so that the housing is not excessively stressed.
- (5) Connection ports without mating flange have JIS B0203 pipe taper female threads (Rc). Before screwing in pipes, make sure that male threads meet specification. An attempt to screw pipe in Rc threads forcibly may result in a damaged housing. Carry out pipe connection using Table1. Recommended Tightening Torques for IN/OUT Rc Threads as a guide.
- (6) When installing, allow sufficient space for maintenance work in future.
Be sure to provide an element allowance enough to enable easy replacement below the housing.

【Recommended Tightening Torques
for IN/OUT Rc Threads as a guide.】

Designation	Thread Size	Tightening Torque
03A	Rc 3/8	40 N·m
04A	Rc 1/2	45 N·m
06A	Rc 3/4	70 N·m
08A	Rc 1	90 N·m
10A	Rc 1 1/4	150 N·m
12A	Rc 1 1/2	200 N·m
16A	Rc 2	250 N·m

Table 1

8. OPERATION

Caution

- * Service pressure (including pressure variations) must not exceed 21.0MPa{21.0kgf/cm²}.
- Use under any higher pressure may result in a damaged filter.
- * The oil filter becomes very hot during operation.
- Stay away from it to avoid burns.

- (1) Make sure that service conditions are as specified in [3. Principal Specifications] in this manual.
When the oil filter is used in a hydraulic system, its selection according to system pressure setting may turn out to be wrong in that the pressure actually imparted to the filter may be higher than the set level.
In the case of use in a hydraulic circuit that undergoes continuous pressure variations, consider, not system pressure setting but circuit peak pressure, to be maximum service pressure.
- (2) Starting with a low flow rate, introduce hydraulic oil into the oil filter up to the specified flow rate.
- (3) Check the housing for abnormal noise or vibrations. If any abnormality is detected, stop the pump immediately and check for the cause.

9. MAINTENANCE AND CHECK

9-1. Daily Check

- (1) Check the filter element for clogging periodically through differential pressure indicator.
- (2) If the oil filter has no indicator connected to it, check the oil being filtered on a scheduled basis and replace the filter element according to the degree of decline in filtration effect shown by the oil. Continued use of a clogged filter element causes the relief valve to open to let contaminants flow out of the oil filter, resulting in a malfunctioning system.
- (3) For filter paper elements, semiyearly replacement is recommended to maintain their performance, regardless of condition.

9-2. Replacement

Caution

- * Stop the hydraulic unit and ascertain that the filter pressure is zero before replacing the oil filter.
- * Keep the oil filter away from anything flammable during replacement work.

- (1) Stop the hydraulic unit, and after ascertaining that the filter pressure is zero, remove the drain plug⑧ to let remaining oil out of the housing in its entirety.
- (2) Remove the cap bolts⑨ and lift off the cover② by rotating to left and right. The inlet③ and filter element④ can be removed together.
- (3) Pull the filter element④ down to remove from the inlet.
- (4) Cleaning makes wire gauze and notch wire filter elements reusable. See [9-3 Cleaning Filter Element] for details.
In the case of filter paper element, replace it with a new one.
- (5) Replace the "O" rings⑩, ⑫, ⑯ and the backup ring⑪ with new ones. The "O" ring⑫ is relatively easy to slip off. Install new "O" ring carefully in the mating groove.
- (6) Insert a new filter element in the inlet③ and assemble parts in the reverse order of removal.
At this assembly, make sure that the filter element has "O" ring⑫ in place and that the flow direction of fluid marked on the cover② is correct.
Tighten the cap bolts⑨ securely to appropriate torque shown in Table 2. [Recommended Lid Bolt Tightening Torques by Bore Diameter].
- (7) Tighten the drain plug⑧ securely to appropriate tightening torque specified below.

【 Recommended Drain Plug Tightening Torques
by Bore Diameter】

Designation	Drain plug tightening torques
03A~08A	40 N·m
10A~16A	50 N·m

【 Recommended Lid Bolt Tightening Torques by Bore Diameter】

Model	U H	Bolt size	tightening torque(N·m)	※Arm Length: L(mm)	
				Lord25~30kg	Load45~50kg
Bore diameter	03A·04A 06A·08A	M16	90~110	420	270
	10A·12A	M22	180~200	720	450
	16A	M24	200~250	890	550

Table 2

- 《Note》 1. The bolts used must be cap bolts of "12.9" under JIS classification by strength.
(Except that M22 and M24 bolts are "10.9" under strength classification.)
2. ※ The figures under "Arm Length: L(mm)" denote the arm lengths of tightening tool. Use them as a guide in tightening.

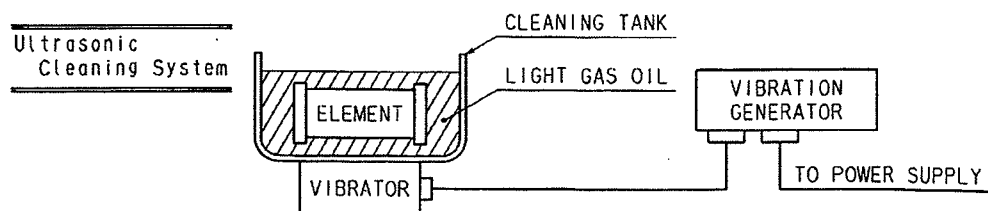
9-3. Cleaning Filter Element

Clean the filter element with light oil (kerosine, gas oil, etc.) in the following manner.

- (1) Shake the filter element in four directions in the cleaning oil.
- (2) Brush the filter element carefully to remove sludge.
- (3) Blow off residual accumulations with an air spray.
- (4) Rinse the filter element well and dry with an air spray.

《Note》

The above way of cleaning is effective for wire gauze filter elements up to 40 microns in mesh size. In the case of wire gauze filter elements below 25 microns, remove surface accumulations mostly by the above method and clean completely by ultrasonic cleaning without fail.



In the cleaning tank, place the top and bottom of the filter element on the vibrator side alternately and clean. While it depends on the capacity of the ultrasonic cleaning equipment and the amount of sludge on the element, the cleaning time should be at least 1 hour.

10. REPLACEMENT PARTS

Keep the following parts available for replacement at any time.
And Replace the seal parts have ◎ mark with new ones.

■ Spare filter element

P —

Kind of fluid

 — UH —

Bore diameter

 —

Pore/mesh size

■ "O"Rings and Backup ring

【 "O"Rings and Backup ring List 】

Part No. Model	◎ 10	◎ 11	◎ 12		13	14	15	◎ 16	17 For companion flange (option)			
			Standard press.	High press.								
UH-03A	G-70	For G-70 Backup ring	G-30	AS568 -123	P-14	P-18	P-14	P-32	G-30			
UH-04A			G-40	AS568 -130								
UH-06A												
UH-08A												
UH-10A	G-95	For G-95 Backup ring	G-55	AS568 -139	P-18			G-45	G-55			
UH-12A			G-65	AS568 -145								
UH-16A	G-110	For G-110 Backup ring										

Operation Manual

QT Pump with motor

HMP-0746E

Please read this manual before you use this pump.

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1. Before use

1) Introduction

Before use, please read this Operation Manual carefully and use QT Pump with motor after you understand all the contents.

- a) This Operation Manual is for correct and safe use of QT Pump with motor.
- b) Please observe method of use and restrictions described in this Operation Manual.
- c) Method of use not described in this Operation Manual and use deviating from the restrictions described in this Operation Manual will result in a risk of human injury and/or damage to property due to stop of function and/or damage of pump, etc..
Do not use QT Pump with motor in a method not described in this Operation Manual and/or deviating from the restrictions described in this Operation Manual.
If you use QT Pump with motor in a method not described in this Operation Manual, it is fully due to your responsibility.
- d) As a result of design change or improvement, the product you bought may differ from the contents described in this Operation Manual.
- e) If you have any question about QT Pump with motor you bought or the contents of this Operation Manual, please do not hesitate to contact us.

2) Comparison with the article

When you receive the QT Pump with motor, please compare your order with model number written in the nameplate of QT Pump and motor.

3) Safety matters

In this Operation Manual, necessary matters to use this QT Pump with motor correctly and safely are marked with the following symbols.

 DANGER	: Serious danger which may result in death or serious injury if not avoided.
 WARNING	: Potential danger which may result in death or serious injury if not avoided.
 CAUTION	: Potential danger which may result in minor or moderate injury or damage to property.

2. Notes concerning safety

1) Notes on mounting, removal and installation of product

For mounting, please hang by means of hanging bolt of motor and just bolt the motor to mounting base by means of mounting holes of feet or flange of motor.

Since not only weight of pump and motor but also motive load during operation will apply to mounting base, it may cause vibration. Therefore, mounting base must be of solid construction.

 DANGER	: When you carry the pump, please do not lift the pump up by hands. Please make sure to use hanging bolt of motor and hang the pump up by whist, etc.. While you hang and carry the product (the product is being hung), please do not approach it.
---	---

- ⚠ WARNING** : When using hanging bolts, please use them after you check they are firmly tightened. After installation of product to the machine, please do not hang up the whole machine by hanging bolts of motor. It may result in damage to hanging bolts, injury due to overturn, and damage of the machine.
- ⚠ WARNING** : Please do not lift up only the pump sides and do not subject it to impact. It may cause trouble.
- ⚠ WARNING** : Personnel having expertise must mount, remove and install the product.
- ⚠ WARNING** : Before mounting, removal and installation, please make sure to turn the power OFF and take action to remove the remaining pressure in the circuit. After operation, since QT Pump, motor and hydraulic fluid may be very hot, please take that action after you check an appropriate temperature (30°C~40°C) is achieved.
- ⚠ WARNING** : Please do not put flammable objects around the motor. It may cause a risk of fire.
- ⚠ WARNING** : Please do not put objects which disturb free air draft around the motor.
It will disturb the cooling and it may cause a risk of explosion, fire or scald due to abnormal heating.
- ⚠ CAUTION** : Please do not get on, beat or apply a force to the product.
It may cause an human injury and/or damage to product.

2) During operation

- ⚠ WARNING** : Please use product within the range of specified operating conditions such as ambient temperature, temperature and viscosity of hydraulic fluid, etc.. If you use beyond this range, it may cause malfunction, damage to product and fire.
- ⚠ WARNING** : In case of power failure, make sure to stop the operation immediately. In case of sudden recovery, the pump and the motor may begin to work and it may cause human injury.
- ⚠ WARNING** : In case of abnormal condition, make sure to stop the operation immediately.
It may cause a risk of electrical shock, human injury and fire.
- ⚠ CAUTION** : Since the pump and the motor becomes very hot during operation, please do not touch them by bare hands.

3) Maintenance

- ⚠ CAUTION** : Please do not disassemble or reconstruct the product without our approval in writing. If the product is disassembled or reconstructed without our approval, since it is beyond the scope of our warranty, we shall not have no responsibility to such disassembly or reconstruction.

3. Notes on handling and use



CAUTION : Please observe the following cautions for handling and use.

1) Explanation of Model No.

a) Motor-mounted type: Feet-mounted type (Horizontal type)

QTM 2 2 - 4 H - 1.5 - 2 R - S**** - **	
Basic type	Design No.
Pump size	Special Spec. No.
2~4	Direction of motor terminal box
Pressure	Viewing from the pump side
1: Low	None: Left
2: Medium	R : Right
3: High	Direction of suction port of pump (See "Fig.1")
Theoretical displacement	Viewing from the pump side
(cm ³ /rev)	1: Up
Options	2: Left
None: Normal	3: Right
specification	Motor output
H : High pressure	1.5: 1.5kW
shaft seal used	2.2: 2.2kW
V : Ester phosphate	3.7: 3.7kW
used	5.5: 5.5kW
W : Water-glycol used	

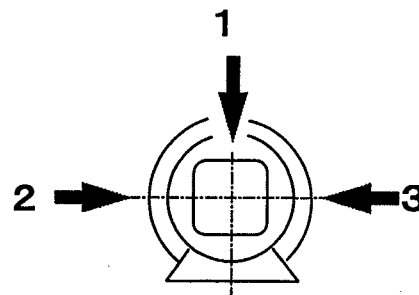


Fig 1. Direction of suction port of pump

b) Motor-mounted type: Flange-mounting type (Vertical type)

QTM 2 2 - 4 - 1.5 - 2 - T - S**** - **	
Direction of suction port of pump	Mounting method of motor
(See "Fig.2")	Flange mounting (Vertical type)
Terminal box on the left,	
viewing from the pump side	
1: Up	
2: Left	
3: Right	

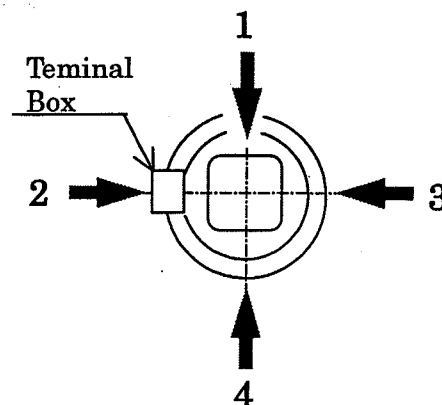


Fig 2. Direction of suction port of pump

2) Suction pressure of pump

- a) Please set the suction pressure of pump to $-0.03 \sim +0.03 \text{ MPa}$ ($-0.3 \sim +0.3 \text{ kgf/cm}^2$) in consideration of increase of viscosity in winter or clogging of filter.
- b) If it exceeds $+0.03 \text{ MPa}$, please specify High pressure shaft seal (proof pressure: $0 \sim +0.2 \text{ MPa}$).

3) Suction filter

- a) Please make sure to install suction filter to pump suction side.
- b) For mesh size, please choose the range of 100~200 meshes according to installation environment and operating conditions of the unit.
- c) For the capacity of filter, please select enough size in consideration of increase of viscosity in winter or clogging of filter.

4) Line and return filter

Generally, for the purpose of protection of the pump, you do not need to install the filter for pressure line and return line. If installation environment of pump is not good or in case of system provided with servo valve, etc., we recommend you install line filter and/or return filter according to hydraulic equipment.

5) Piping

- a) For suction line, please set the flowing speed in the pipe to within 1.5m/sec..
- b) Please make sure that constrained force by piping does not apply to the pump.
- c) For pressure line, we recommend you install air releasing valve.
- d) In order to reduce vibration and noise of the unit and to avoid constraint force on the pump, we recommend you to use rubber hose in pressure line.
- e) Please install the pipes after washed by acid and neutralized in advance.

6) Wiring

 **WARNING** : Please check the voltage and frequency written in nameplate are consistent with those you supply.
It may cause a risk of burn or fire.

 **WARNING** : Please connect the power cable and lead wire of motor according to connection diagram in terminal box or Operation Manual.
Otherwise, it may cause a risk of electric shock and/or fire.

 **WARNING** : Do not bend, pull, or pinch the power cable or lead wire of motor forcibly.
It may cause a risk of electrical shock.

 **WARNING** : Wiring must be conducted by personnel having expertise.
It may cause a risk of burn or fire.

⚠ WARNING : When measuring insulation resistance, do not touch the terminals. It may cause a risk of electrical shock.

⚠ WARNING : Please note motor is not provided with protection device. Please make sure to provide overload protection device. We recommend you also provide protection device other than for overload(earth leakage breaker etc.).

⚠ WARNING : Make sure to ground the earth terminal. Otherwise, it may cause a risk of electrical shock.

a) Power cable

- If the wiring distance is long, because voltage drop becomes high, make sure to use the wire of appropriate diameter.
- Please wire so that the cable is not damaged at cable inlet during operation.

b) Connection of lead wires

- For connection between the power cable and lead wires of motor, please refer to "Fig.3".

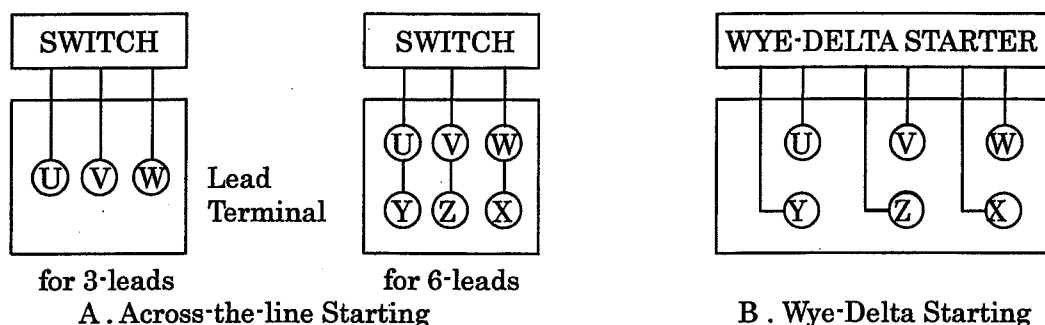


Fig. 3 Connection of lead wires

c) Grounding

You can find earth terminal provided inside the terminal box, then make sure to ground it .

d) Procedure of wiring

- ① Remove the terminal box cover.
- ② Mount the crimp-type terminal lug to power cable and clamp it and lead terminal with bolt-nut.
- ③ Cover the connection with insulation cover, vinyl tape, etc. to provide complete insulation.
- ④ After connection, make sure to mount the terminal box cover in place again.

7) Outlet Pressure

a) Maximum working pressure varies according to combination of pump and motor. Please refer to "Table 1". You can not use the pump at the pressure exceeding maximum working pressure.

b) Surge pressure

When you turn the solenoid valve ON and OFF, surge pressure occurs on pressure line and it will have a bad influence to the pump or other hydraulic equipment. Give your consideration to design of hydraulic circuit to avoid surge pressure possibly.

Table 1. List of combinations of pump and motor

Model No.	Motor output (kW)	50Hz(1500min ⁻¹)		60Hz(1800min ⁻¹)	
		Delivery (L/min)	Maximum working pressure at 100% of motor load MPa(kgf/cm ²)	Delivery (L/min)	Maximum working pressure at 100% of motor load MPa(kgf/cm ²)
QT22-4	1.5	3.4	13.0(133)	5.2	10.6(109)
QT22-5		5.1	10.7(110)	7.1	8.7(89)
QT22-6.3		7.3	8.6(88)	9.6	6.9(71)
QT22-8		10.5	6.7(69)	13.2	5.3(55)
QT31-31.5		44	1.3(13)	53	0.9(9)
QT22-5	2.2	4.3	13.7(140)	6.6	12.7(130)
QT22-6.3		6.8	12.4(127)	9.2	10.1(104)
QT22-8		9.7	9.8(100)	12.6	8.0(82)
QT32-10		12.4	7.6(78)	15.6	6.1(63)
QT32-12.5		16.9	5.9(61)	21.1	4.8(49)
QT32-16		21.9	4.8(49)	26.8	3.7(38)
QT23-5	3.7	4.8	24.5(250)	7.0	21.0(215)
QT23-6.3		7.2	20.7(212)	9.6	16.9(173)
QT23-8		10.0	16.4(168)	12.8	13.2(135)
QT32-10		10.5	13.3(136)	13.1	10.8(111)
QT32-12.5		15.3	10.4(107)	20.0	8.4(86)
QT32-16		20.6	8.4(86)	25.9	6.9(71)
QT31-20		24.7	6.1(63)	31.8	4.9(50)
QT31-25		33.7	4.8(49)	42.0	3.8(39)
QT31-31.5		43.0	3.8(39)	53.6	2.9(30)
QT23-5	5.5	4.4	24.5(250)	6.0	24.5(250)
QT23-6.3		6.1	24.5(250)	8.1	24.5(250)
QT23-8		8.4	24.5(250)	11.2	21.5(220)
QT31-20		24.9	6.8(70)	30.8	6.8(70)
QT31-25		31.7	6.8(70)	39.3	6.2(64)
QT31-31.5		42.3	6.1(63)	52.5	4.9(50)
QT32-10		9.7	13.7(140)	12.9	13.7(140)
QT32-12.5		13.4	13.7(140)	17.4	13.7(140)
QT32-16		17.7	13.2(135)	23.3	10.7(110)
QT33-10		10.4	20.5(210)	14.2	16.9(173)
QT33-12.5		14.9	16.1(165)	19.3	13.2(135)
QT33-16		19.7	13.2(135)	24.9	10.2(105)
QT41-40		51.9	4.6(47)	64.0	3.9(40)
QT41-50		68.8	3.6(37)	84.2	2.9(30)
QT41-63		87.9	2.7(28)	107.0	1.9(20)
QT42-20		24.3	10.2(105)	31.3	8.3(85)
QT42-25		32.0	8.0(82)	40.1	6.4(66)
QT42-31.5		43.1	6.1(63)	53.2	4.9(50)

• This table shows average values at 40mm²/s of viscosity.

• The values marked with * are rated pressure of the pump.

8) Hydraulic fluid

a) Type of hydraulic fluid

Please use hydraulic fluid corresponding to ISO VG46~68 of viscosity grade (more than 90 of viscosity index).

If you use phosphate ester hydraulic fluid, you need to change the sealing material to fluoro rubber. Please mark "V" for option and order.

For use of fire resistant fluid (water glycol, W/O emulsion etc.), please contact us each time.

b) Viscosity

Please use hydraulic fluid within the range of 20~500mm²/s of viscosity.

c) Temperature of hydraulic fluid

Please use hydraulic fluid within the range of 0~60°C of temperature.

d) Pollution degree

Please use clean hydraulic fluid (within class NAS 1638 grade 11).

9) Operation environment



: Please do not use in explosive atmosphere. Otherwise, it may cause a risk of fire and human injury.

Please do not use in unusual environment such as high temperature and high humidity, etc..
Please use under the following conditions.

Ambient temperature: -15~50°C

Relative humidity : 0~95%RH

This product is intended for indoor use.

Please contact us for use under special environment.

4. Notes on operation

1) Cleaning inside the tank

Please clean the inside of tank before putting hydraulic fluid into the tank.

2) Putting hydraulic fluid

- a) Considering the capacity of actuator, please put clean hydraulic fluid sufficiently.
- b) If putting hydraulic fluid by electrical pump, etc., the oil may foam.
In this case, operate the pump after foam fade outs.

3) Confirmation of rotating direction

 **CAUTION** : If operating with reverse rotation, pump function may be impaired.

Please confirm the rotating direction by that of motor fan. The correct rotating direction of motor fan is clockwise.

When checking the rotation, make sure to operate the motor with no load for 5~10 times intermittently. Make sure that operating time of motor during intermittent operation is 0.5~1 second.

4) Start the operation of pump

 **CAUTION** : Please avoid on-load start. On-load start may cause the damage inside the pump.

 **CAUTION** : Please avoid to operate in the condition of no coolant in the pump. it may cause the damage inside the pump.

Before the start of pump, air in suction pipe must be released.

For the first operation of the unit or operation after replacement of hydraulic fluid or cleaning of suction filter, please release the air as follows and start the continuous operation.

a) Start the inching of pump

- ① Check the tank is filled with hydraulic fluid and loosen the adjusting screw of relief valve to let the pressure with no load.
- ② Operate the motor with no load for 5~10 times intermittently. Make sure that operating time of motor during intermittent operation is 0.5~1 second.
- ③ When you repeat inching, noise of suction of air will fade out gradually. After the noise fade outs, start the continuous operation. If noise of suction of air does not fade out, there is a leakage of air in suction pipe.

5) Trial operation

After the start of pump, start the trial operation paying your attention to the following.

- a) When you increase the pressure, please be careful of operation noise of pump.
Check there is no noise of air mixture and increase the pressure gradually.

If noise of air mixture does not fade out, there may be a sealing failure on suction pipe or foams of hydraulic fluid has not disappeared sufficiently.

Please correct the sealing failure and operate again after the foam disappears.

- b) If a big actuator is provided, air may return from actuator to inside of the tank at trial operation. In this case, please release the air from pipe and actuator with low pressure as possible. If a big amount of air returns, please start the trial operation after foams disappear.

- c) In case of unit provided with cooler, water pipes may not be provided at trial operation. In this case, please be careful that temperature of hydraulic fluid increases immediately. Please use the hydraulic fluid with the following range of temperature and viscosity.

Temperature : 0~60°C
Viscosity : 20~500mm²/s

5. Maintenance procedure

Main check items, interval and criterion for determination are shown in "Table 2".

1) Cleaning the suction filter

If you feel operating noise has changed from that when installed, please check the suction filter.

The status of filter clogging varies due to hydraulic equipment and installation environment, etc.. In general, you should check the filter once per 1~3 months.

If suction filter with clogging indicator, please make sure to clean or replace filter element when clogging indicator becomes yellow. When you start the operation after check of filter, please follow Clause 4.4).

2) Control of hydraulic fluid

Hydraulic fluid will deteriorate and be polluted by accumulation of dusts not filtered, sludge resulted from deterioration of hydraulic fluid, ingress of water, etc..

NAS grade is a measure showing pollution degree of hydraulic fluid. The standard of replacement of hydraulic fluid is NAS grade 12. If the pollution becomes worse than this, there will be a risk of trouble on operation of pump. NAS grades of pollution degree are shown in "Table 3".

Table 2 Check items, interval and criterion for determination

Item	Method	Interval	Criterion for determination	Note
A) Oil temperature	Thermometer	Always	More than 20mm ² /s (Less than 60°C for hydraulic fluid, corresponding to ISO VG 46)	Lack of cooling water Deterioration of performance of cooler Sticking of valve, etc.
B) Hydraulic fluid 1) Pollution degree 2) Viscosity 3) Deterioration 4) Water	Analysis	3~4 months 6 months 6 months 3~4 months	Less than NAS grade 11 According to control standard of hydraulic fluid manufacturer.	Replacement is required if remarkably polluted or discolored by visual inspection.
C) Suction filter	Disassemble and check	1~3 months	In case of suction filter with indicator, clean or replace the filter when the indicator is yellow.	If installation environment of system is bad, interval of check should be shortened. If suction filter clogs, operating noise of pump becomes loud.
D) Operating status of pump				
1) Noise of pump	By hearing	1 month	Comparing with initial operating noise, it shall not be louder.	Be careful of loosening of suction pipes by vibration, air mixture by abrasion of pump shaft sealing.
2) Temperature of pump	Thermometer	1 month	Within temperature of hydraulic fluid of suction +15°C	
3) Vibration of pump	Touch	1 month	No abnormal vibration	Check also delivery pipes of pump.
4) Delivery of pump	Speed of actuator	1~3 months	Speed of actuator does not lower.	
E) Pump disassembling check	Return to manufacturer	2~3 years	Abrasion of components	

Table 3 NAS grades of pollution degree

Class	00	0	1	2	3	4	5
Particle Diameter							
5~15 μm	125	250	500	1000	2000	4000	8000
15~25 μm	22	44	89	178	356	712	1425
25~50 μm	4	8	16	32	63	126	253
50~100 μm	1	2	3	6	11	22	45
More than 100 μm	0	0	1	1	2	4	8
Class	6	7	8	9	10	11	12
Particle Diameter							
5~15 μm	16000	32000	64000	128000	256000	512000	1024000
15~25 μm	2850	5700	11400	22800	45600	91000	182400
25~50 μm	506	1012	2025	4050	8100	16200	32400
50~100 μm	90	180	360	720	1440	2880	5760
More than 100 μm	16	32	64	128	256	512	1024

6. Troubleshooting

When the following troubles occur, please stop the motor immediately and check according to "Table 4" and "Table 5".

- 1) Hydraulic fluid is not issued.
- 2) Pressure does not increase.
- 3) Noise of pump or motor is big.
- 4) Pump overheats.



WARNING

: Before check, please make sure to turn the power OFF and remaining pressure in circuit is released.

7. Disassembly, assembly and repair

Please contact us for repairing pump and motor.



CAUTION

: Please do not disassemble or reconstruct the pump and motor without our approval.

If the pump and motor are disassembled or reconstructed without our approval, it is beyond the scope of our warranty and we shall be no responsible for such disassembly or reconstruction.

When you remove the pump from motor for replacement of pump only, or when you connect the pump to motor, please refer to construction of connection of pump and motor in "Fig.4", please remove or connect according to the following.



WARNING

: Before removal of pump and motor, please make sure to turn the power OFF and remaining pressure in circuit is released.

<Removal>

- a) Remove ⑤ Hexagon head bolt.
- b) Pull ① pump and remove it from the motor.

<Connection>

- a) Insert the shaft of ① pump into shaft of ② motor.
- b) Check the position of terminal box of ② motor and that of outlet port of ① pump are correct, then connect the pump to ② motor or ③ middle flange by ⑤ bolt (③ middle flange may not be provided due to combination of pump and motor).

Table 4. Causes and actions to be taken for general troubles on hydraulic equipment

Trouble	Cause	Action
A) Hydraulic fluid is not issued from pump.	Rotating direction of motor is wrong.	Stop the motor immediately, then repair to correct direction. (Rotating direction of motor fan is clockwise.)
	Level of hydraulic fluid is low.	Fill the hydraulic fluid to upper limit of oil level gauge.
	Suction pipe or suction filter clogs.	Clean the suction pipe or suction filter. If the clogging is too terrible, please replace the hydraulic fluid with new one.
	Air is sucked from suction pipe.	Check the amount of hydraulic fluid is appropriate by oil level gauge. Repair the packing of pipe connection or tighten the fitting sufficiently.
	Pump shaft does not rotate.	Check the motor . If it does not rotate, the inside of pump may be damaged.
B) Pressure does not increase.	Set pressure of relief valve is low.	Adjust to correct value by precise pressure gauge.
	Relief valve is stuck.	Disassemble and clean the pressure adjusting part, modify or replace the components.
	There is much leakage inside hydraulic circuit system. (cylinder·valve)	Block the hydraulic circuit in order, check the components and modify or replace the components.
C) Noise of pump	Hydraulic fluid in reservoir becomes cloudy and bubbles mix with it.	Check if air is not sucked from suction pipe.
	Suction pipe or part of suction filter clogs.	Clean suction pipe and suction filter.
	Hydraulic fluid temperature is too low. Viscosity is high.	Keep the hydraulic fluid temperature to appropriate degree. Be careful to pick the hydraulic fluid.
D) Abnormal heat of pump	Abrasion of moving part of pump itself.	Replacement of pump
	Over-pressure	Set the pressure again.
	Oil is not sucked.	See Item A).
E) Remarkable rise of hydraulic temperature	Abnormal increase of internal leakage due to trouble of pump	Replace the pump.
	Cooling water of cooler does not flow.	Let flow the cooling water. Check if the valve opens.
	Cooling pipe of cooler is dirty.	Clean the pipe of cooler.

Table 5. Causes and actions to be taken for general troubles on hydraulic equipment

Trouble	Cause	Action
A) The motor does not start with no load.	The motor is not powered.	Check if it is powered.
	Two of jointing wires are bad.	Modify the bad part.
	Error of operation or contact of switches and actuator.	Check the jointing wires and connection.
B) Abnormal noise	Abrasion damage of bearing. Single phase drive.	Replace the bearing. Check the power supply by voltmeter.
C) Reverse rotation	Wrong wire connection	Change two among three power cables.
D) Fuse is broken.	Coil winding and lead wires are short-circuited. Overload	Check the short-circuited point and repair it. Lower the load to appropriate value.
	Lack of capacity of fuse	Replace with suitable one.
E) Rotation speed does not increase.	Wrong connection of star delta actuator.	Connect properly.
F) Howling	Over-current and heating due to contact of rotor and stator.	Replace and repair the motor.
	The spacing between rotor and stator is not uniform	Replace and repair the motor.
	One phase of coil winding of stator is short-circuited.	Replace and repair the motor.
G) Over-current relay operates. Switch is heating.	Error of picking the relay, lack of capacity of switch. Overload	Replace with suitable one. Lower the load to appropriate value.
H) Overheat	Unbalance of power supply	Contact the electric power company.
	Voltage drop	Contact the electric power company.
	Overload	Lower the load to appropriate value.
I) The speed decreases immediately.	Voltage drop	Contact the electric power company.
	Overload	Lower the load to appropriate value.
	Trouble of star delta actuator	Adjust the contact part.

7	1	name plate
6	1	name plate
5	2	hexagon head screw
4	2	hexagon socket head cap screw
3	1	middle flange
2	1	motor
1	1	gear pump
Parts No.	Q'ty	Description

This drawing shows "QTM22-3.7-2-T-C"

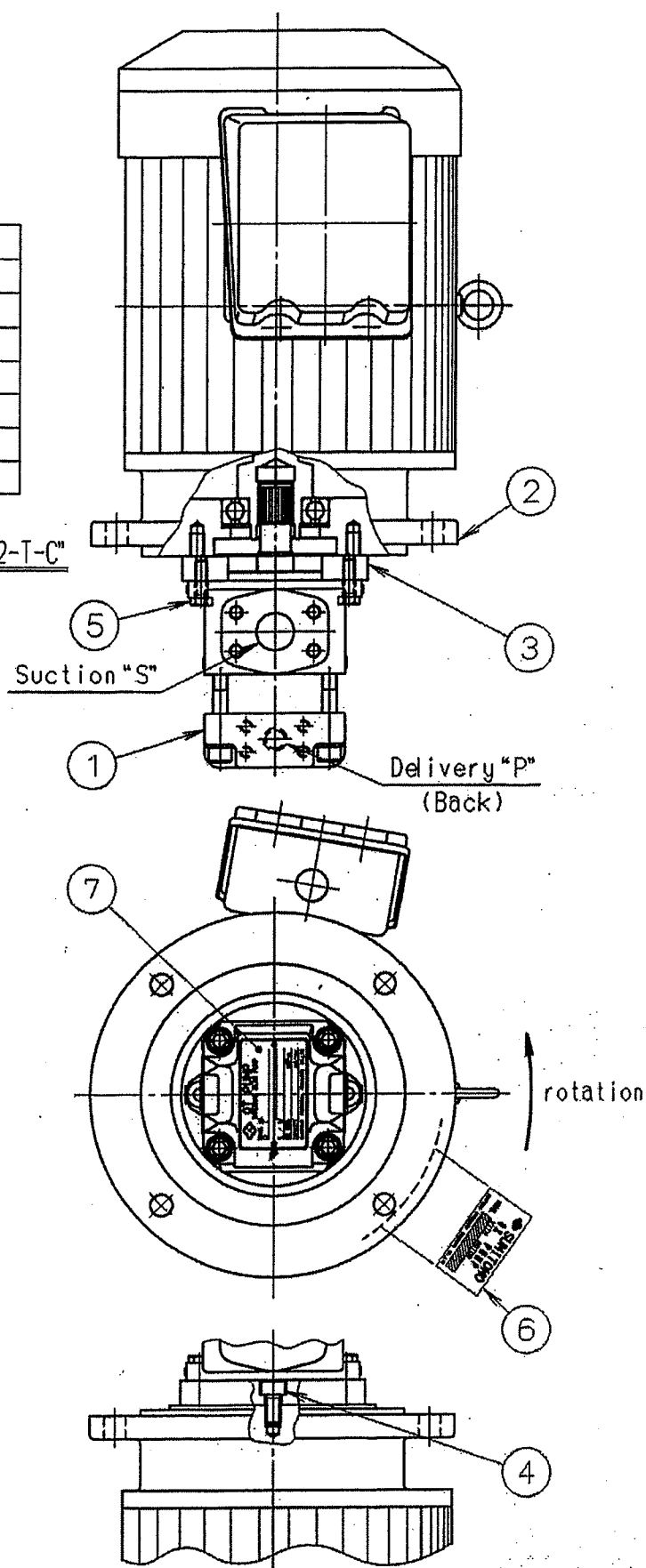


fig4. Construction of connection of pump and motor



INSTRUCTION MANUAL

ELECT. HEATER FOR M/E CYL. OIL

THE ORDERER MITSUBISHI HEAVY INDUSTRIES, LTD.

ORDER NO. _____

APPLICATION DATE _____

ACKNOWLEDGMENT DATE _____

O.D.K

OSAKA DENNETSU KOGYO CO., LTD.

WSG-1597

CYLINDER OIL HEATER INSTRUCTION MANUAL

CHAPTER 1. STRUCTURE

1. MACHINE COMPOSITION

Cylinder oil heater is composed of heater part and control box part.
This heater is installed in the cylinder oil piping line, cylinder oil is heated by heater element inside the body.

2. GENERAL STRUCTURE

2-1. HEATER PART

- Heater element (NH-75573-11) becomes 4KW by setting $0.667\text{KW} \times 6$ Pcs at 1 set.
- When pressure inside the body is beyond 0.5MPa , cylinder oil is discharged automatically with Relief valve (NH-75573-6).
- The adjustment of oil temperature is adjustable with oil temp. Control thermostat in the range of 30~90°C.
- When oil temperature becomes unusual high temperature, Safety thermostat (NH-75573-3) interrupts heater circuit.
It can be adjusted within the range of 30~120°C.
- When drain inside the body is pulled out, it is discharged with Drain attached plug (NH-75573-13).

「Warning ! 」

- You must not pull out drain under the condition which heater has heat to.
A burn may be suffered.
Cut off the power supply, and discharge it under the heater gets cold
- Completely when you pull out drain.

「Attention ! 」

- Use it under the condition that the inside of the body is filled with the Cylinder oil.
A machine may be damaged when it is used by shortage of amount of oil.

2-2. CONTROL BOX

- A switchboard supplies the power supply of this heater.
- A control power supply is supplied by a main power supply through the transformer (NH-75573-19).
- When it is charged with unusual electricity to the circuit, this is interrupted by the Fuse (NH-75573-22).
- "ON", "OFF" of the heater does it with Push button switch (NH-75573-18).

CHAPTER 2. USAGE

1. THE FORMER PREPARATION TO HEATING

- 1-1. It ascertains that there is no looseness in each department installation bolts, connections, and so on.

「Attention ! 」

Adjustment is surely made because an accident and a fire are likely to be caused when a terminal connection bolt and so on continues the heating with an unusual fever by the looseness contact defect.

- 1-2. It ascertains that Cylinder oil inside the body is filled.

2. HOW TO START

- 2-1. A power supply is supplied from the switchboard in the ship to the heater.

At this time, "SOURCE" indicating lamp (NH-75573-16) is turned on.

- 2-2. The temp. Control thermostat (NH-75573-2) and Safety thermostat (NH-75573-3) are set up in fixed temperature.

AS for details of thermostat, attached sheet reference.

「Attention ! 」

When there are few differences in temperature with Control Thermostat for the temperature style, Safety thermostat operates faultily, and Safety thermostat interrupts a power supply circuit.

2-3. A Push button switch (NH-75573-18) "ON" is pushed.

At this time, "AUTO" indicating lamp (NH-75573-25) is turned on.

And, "HEATING" indicating lamp (NH-75573-17) is turned on.

Heater, fevers start.

3. HOW TO STOP

3-1. When, heater is stopped, Push button switch (NH-75573-18) "OFF" is pushed.

3-2. When it isn't used for a long time, Breaker of the switchboard in the ship is cut.

4. HOW TO RUNNING

Control thermostat (NH-75573-2) and temperature, Safety thermostat (NH-75573-3) are set on fixed temperature, and automatic heating Starts when Push button switch (NH-75573-18) "ON" is pushed.

In case of usual, "SOURCE" indicating lamp (NH-75573-16) and "AUTO" indicating lamp (NH-75573-25) are turned on.

Furthermore, when heater is while it is heated, "HEATING" indicating lamp (NH-75573-17) is turned on.

It works with Control thermostat together, and lighting and are repeated in the thing during the operation.

When it with becomes unusual height oil temperature, Safety thermostat (NH-75573-3) works, and a main power supply is interrupted, and "ALARM" indicating lamp (NH-75573-25) is turned on.

"AUTO" indicating lamp (NH-75573-25) turns off the lights.

It this case, because it doesn't automatically, you must push the Switch (NH-75573-18) "ON" is again.

PRODIGY THERMOSTATS

- Application Manual & Explanations -

Thank you very much for your purchase so often of PRODIGY Thermostats. PRODIGY Thermostats are used widely in various industries of the European markets for their excellent performance and durability which are highly evaluated. With regard to the accuracy and reliability of PRODIGY Thermostats, you may use them with confidence as approved by VDE (Germany Electrical Engineering Association), however your correct use is advisable.

TR711/N Series

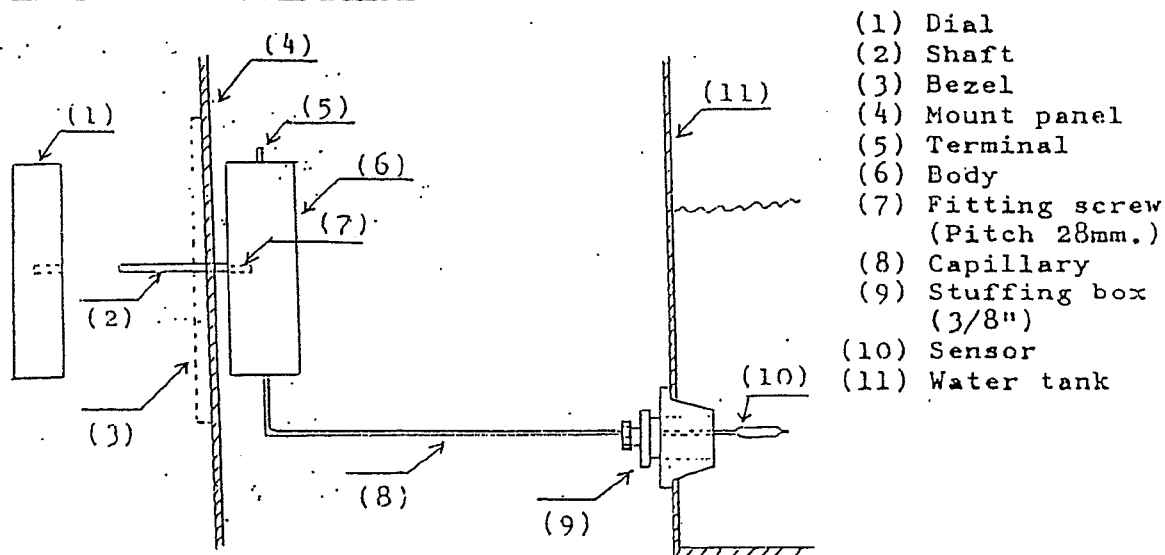
Specifications - Electrical rating: AC 250V. 16 Amps.

Switching: Snap acting - SPST (Single Pole Single Throw) & SPDT (Single Pole Double Throw)

Differential: 3°C - 6°C

Type	Temp. range	Contact	Sensor(DxL)	Capillary L.
TR711/N40	0 - 40°C	SPST/DT	6.0mm x 114mm.	900mm.
→TR711/N90	30 - 90°C	SPST/DT	7.0mm x 63mm.	900mm.
→TR711/N120	30 - 120°C	SPST/DT	6.5mm x 97mm.	900mm.
TR711/N220	40 - 220°C	SPST/DT	6.5mm x 62mm.	900mm.
TR711/N250	30 - 250°C	SPST	3.0mm x 190mm.	900mm.
TR711/N300	50 - 300°C	SPST/DT	3.2mm x 240mm.	900mm.

Installation Schematic



- 1) As shown above, place the body on the mount panel with the fitting screw (Pitch 28mm.), directing the terminal upward.

WSG-1597

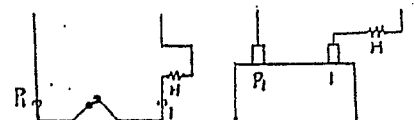
- 2) Turn right the dial to set temperature.
- 3) In case the sensor may be inserted inside a closed tank, use a stuffing box. (Stuffing box is optional and, if required, must be ordered separately.)

Directions

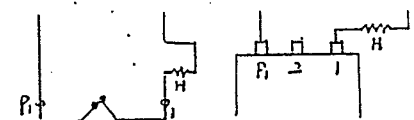
- 1) Do not place the thermostat where there is a shock or ambient temperature rises above 120°C .
- 2) Do not rise above the maximum temperature of the dial for the capillary and sensor.
- 3) The capillary and sensor are the material of copper. (Stainless steel is available on special order.)
In case the capillary and sensor are applied to a corrosive object, use protecting tube of anticorrosive material.
- 4) Do not crush the capillary or do not bend it to an acute angle.
- 5) The electrical rating is for alternating current and resistive loads.

Wiring Diagram

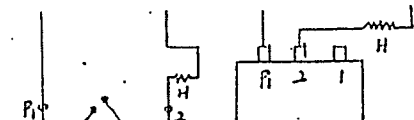
- 1) SPST normally closed circuit:



- 2) SPDT a) normally closed circuit:



- b) normally open circuit:



Adjustment of Temperature

All PRODIGY Thermostats are factory-calibrated with accuracy, therefore there will not be any further adjustment needed, however, if required, it will be advisable to adjust the adjust screw on the back of the unit by means of the following:

- 1) In case the Thermostat works under the calibrated temperature:
 - Turn right the adjust screw. (About 2°C per 1 division)
- 2) In case the Thermostat works over the calibrated temperature:
 - Turn left the adjust screw. (About 2°C per 1 division)

ATK SERIES OIL COOLER AIR COOLED TYPE

INSTRUCTION MANUAL

To the distributor:
Make sure that the end user
receives this manual.

TAISEI KOGYO CO., LTD.

2-32-2 Wakagi Itabashi-Ku,

Tokyo Japan

Tel: 03-3934-3281

FAX: 03-3936-0030

No. /MC249-00-00

Issued/March. 25. 2004

For Safety in Using Your Oil Cooler

Thank you for purchasing the Oil Cooler.

This manual contains necessary instructions to ensure correct use of the product.

Before using the oil cooler, read this manual thoroughly to know everything about it and what to do for safety precautions.

After use, be sure to keep this manual where it is easy to access in case of need.

Safety precautions are given in the boxes marked [△ Caution] in this manual.

Caution

The boxes marked △ Caution contain safety precautions. Failure to observe them could cause medium or minor injury to the user, damage to the equipment or even more serious accident. To prevent it, be sure to follow all given instructions.

The graphic symbols shown in the △ Caution marked boxes represent as follows:

	Prohibited		Unplug power cord		Do as instructed without fail
	Do not contact		Connect grounding wire		
	Do not disassemble		Do not use in wet place		

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1. Product Name: Air Cooled Oil Cooler

2. Model Identification:

ATK - 1552F - * - * - *

2032F

2432F

MODEL	SYMBOL	BORE
1552F	02	Rc 1/4
	04	Rc 1/2
2032F	03	Rc 3/8
	04	Rc 1/2
2432F	03	Rc 3/8

SYMBOL	CONNECTOR
BLANK	NONE
A	ATTACHED

SYMBOL	VOLTAGE
1	AC 100V
15	AC 115V
12	AC 120V
2	AC 200V
22	AC 220V
23	AC 230V

3. Specifications

 Caution	
	* Do not use any other fluids than specified. (Radiator could break down.) * Never use the oil cooler beyond specified maximum allowable working pressure or temperature. (Radiator could break down.) * Do not use the oil cooler for any other purposes than intended. * Being a built-in part, the fan motor cannot be removed and used alone. (An attempt to use it out of the oil cooler could cause an injury.) * Do not use the oil cooler under any other voltage or at any other frequency than rated. (Misuse could cause an electric shock or a fire.)

Specification	
Maximum allowable working temperature	1.0 MPa
Proof test pressure	1.5 MPa
Maximum allowable working temperature	Oil side 150°C , Air side 50°C
Applicable fluids	Ordinary hydraulic fluids

Fan-motor Specification						
Rated voltage	100V, 115V, 120V, 200V, 220V, 230V — 1 ϕ					
Rated frequency	50Hz / 60Hz ONLY					
Type	SYMBOL	Motor code	Nominal input 50/60Hz	Ambient Condition		
				Temp.	Relative Humidity	Use
ATK-1552F ATK-2032F ATK-2432F	1	UZS15D10	35 / 33W	-20°C~ +60°C	RH 20~85%	Ground ; indoor
	1 5	UZS15D15				
	1 2	ZS15D12				
	2 0	UZS15D20				
	2 2	ZS15D22				
	2 3	UZS15D23				

4. Construction

An air cooled type heat exchanger, the oil cooler is so constructed that the oil flowing inside the radiator is cooled by blowing air at it from the outside of the radiator.

5. Transportation

 Caution	
	* When lifting the oil cooler, hook the wire rope securely on two eyebolts located on top of the housing. * Take care to ensure that the wire rope holds securely to the eyebolts. Poor hooking could cause the oil cooler being lifted to fall down. * Hooking and slinging must be done by a qualified person. * Use particular care to prevent the oil cooler from tumbling or falling off in transit.

- (1) Fully cover the oil cooler to protect from rain.
- (2) Do not subject the oil cooler to an undue shock.

6. Installation

 Caution	
	* Do not install the oil cooler where explosive dust or gas is or may be produced. (An explosion or a fire could occur.) * Be sure that the oil cooler housing has a sufficient space around it and is clear of obstacles on the air inlet and outlet port sides. (Performance could be impaired or the fan motor could break down.) * Never attempt to mount on the oil cooler. (It could be damaged or you could be injured.) * Do not install the oil cooler where it may directly contact a flame. (A fire could be caused.)
	* Do not install the oil cooler in a humid place (90% or higher in humidity). (You could receive an electric shock or a fire could be caused.)
	* Installation, operation and maintenance work must be done by technicians. (Work by improper person could cause a fluid leakage or an injury to him.) * Install the oil cooler securely on a firm and solid surface. * Carry out wiring work safely and securely in accordance with the electrical equipment standards and internal wiring rules. (Poor contact or wrong wiring could cause an electric shock or a fire.)

- (1) Install the oil cooler securely on a firm and steady frame.
Provide sufficient space around the oil cooler so that it can be inspected, cleaned and repaired properly.
Be sure that the housing is clear of obstacles on the air inlet and outlet sides.
If there is any obstacle, the quantity of air is reduced to prevent the oil cooler from working as it should. Try to minimize vibrations. Use rubber cushions if necessary.

7. Piping

- (1) Make sure of the air inlet and outlet ports, then connect pipes to them correctly.
- (2) The pipe joint of the radiator is Rc threaded. When a pipe is connected to the radiator, wrap its tip with a seal tape and screw it in to the effective thread depth. (Undue screwing could damage female threads.)
- (3) If piping is unduly vibratory, use a rubber hose or a flexible tube to prevent the transmission of vibrations to the oil cooler housing.

8. Operation

 Caution	
	* The operating pressure must not exceed the specified working pressure level. (Operating under a higher pressure could cause the oil cooler to break down.)
	* To avoid danger of injury, do not put your fingers or any object in the fan motor. * The oil cooler is heated while in operation. Keep away from it when it is operating. (If you touch it, you could suffer a burn.) * Never touch the oil cooler when it is not running but power remains on. (The oil cooler could start without warning to do you an injury. Also, you could receive an electric shock.)
	* Do not tamper the oil cooler in any case. Disassembly and repair must be done by a specialized technician. (Work by improper person could cause a fire, electric shock or injury.)

8-1 Starting

- (1) Check that your working conditions agree with the specifications for the oil cooler.
- (2) Test run the oil cooler to make sure that the motor fan is in the good working condition (direction, vibration and blow-through). Then, introduce oil gradually up to the normal level.

9. Maintenance

9-1 Routine Check

Check the oil cooler routinely for disconnected or loosened grounding wire.

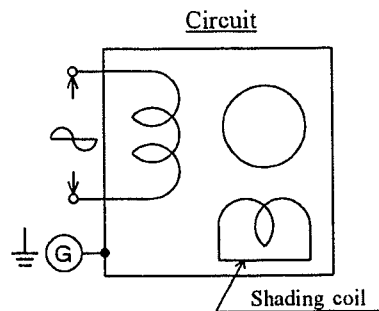
9-2 Periodical Check

Perform a checkup on the oil cooler at least once in every 6 months. We recommend a cleanup before the summer time when the outside temperature rises.

9-3 Wiring

 Caution	
	* Be sure to ground the motor. (It could break down or be short circuited; you could be struck by electricity.)

The motor has an M4 ground terminal screw on its lower part. Be sure to ground the motor using this terminal.



9-4 Cleaning

 Caution	
	* Do not sprinkle water over the oil cooler housing. (A short-circuit failure or electric shock could be caused.)
	* Before cleaning, be sure to unplug the power cord or disengage the circuit breaker on the distribution panel. (Failure to do so could cause an electric shock or an injury.)

- (1) Cleaning radiator grille
Immerse the radiator grille in a hot water solution of appropriate neutral detergent, rinse it and blow compressed air at it to dry. (Make sure that the detergent is entirely removed.)
- (2) Cleaning inside radiator
Circulate washing oil through once, then circulate clean washing oil again.
Since contamination on the oil side is less than elsewhere, cleaning once a year should be enough.
- (3) Repair of radiator fin
If the fin is out of position, the quantity of incoming air is reduced. Correct if necessary.

9-5 Surge Pressure

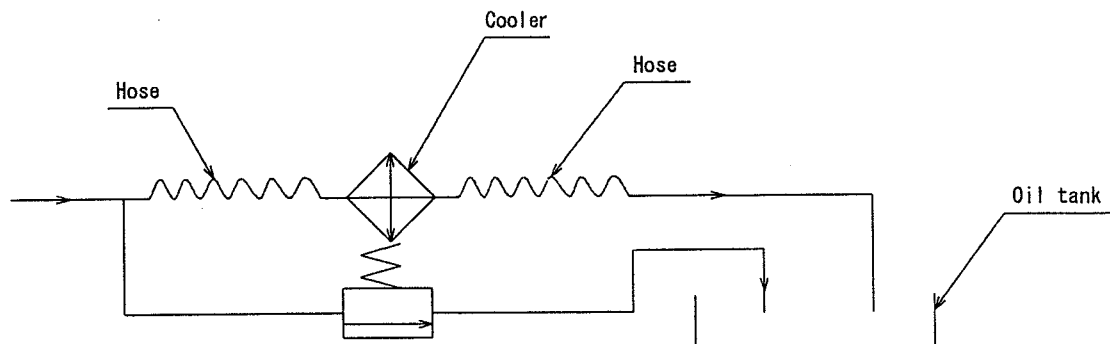
In the oil pressure circuit, never includes a machine after the oil cooler (such as, filter, relief valves, etc).

As the radiator is made of aluminum, it expands greatly.

If abnormal pressure and abnormal vibration occur repeatedly, they cause damages.

A consideration like the figure 1 is thought to be the one way of coping with such condition .

< Figure 1 >



10. Storage

If the oil cooler is not used immediately, keep it in an appropriate place taking care in the following respects.

10-1 Short-time Storage

- (1) Keep the oil cooler in a clean and dry room.
- (2) If the place of storage is outdoor or humid, cover it completely with a vinyl sheet or the like.

10-2 Long-time Storage

- (1) If the oil cooler is not used long, be sure to disengage the circuit breaker on the distribution panel. (If not, insulation could deteriorate and an electric shock could be received or a short circuit failure or a fire could occur as a result.)
- (2) When the oil cooler is used after more than 1 year of storage, it must be tested under the maximum working pressure to make sure that it is in order.

mitsubishi

ECL system

ECL valve test device Instruction manual

mitsubishi ECL system



mitsubishi HEAVY INDUSTRIES, LTD.
KOBE SHIPYARD & MACHINERY WORKS

For Particular Attention

1. This booklet is the Instruction Book for handling of Mitsubishi ECL (Electronically Controlled Lubricating) system.
2. The engineers who operate and maintain this engine are requested to read this booklet before handling the engine, to grasp the engine characteristics sufficiently, and to manage engine handling without mistakes for safety operation and maintenance.



The parts indicated with symbols   in this booklet describe important matters; therefore, pay special attention to the descriptions.



: This symbol indicates that the operator must strictly follow the guidelines preventing danger to the engine operator during engine operation and/or maintenance.



: This symbol indicates that the operator must take certain measures to avoid undesirable conditions and damages to equipment during engine operation and/or maintenance.



Remark

: Related information on the engine operation and/or maintenance and useful information for improving the sufficiency of the engine operator are provided.

3. The intellectual property regarding the content of this manual, particularly the copyright remains with Mitsubishi Heavy Industries, Ltd. Kobe Shipyard & Machinery Works, Kobe, Japan.
4. The extent of any supplies and services is determined exclusively by the relevant supply contract between the purchaser and the manufacturer of the engine. No claims of any manual regarding any additional supplies or service may be inferred from this manual.
5. The particulars, data, presentations, etc. shown in this manual correspond to the situation existing at the time of going to issue and they are based on drawings made by Mitsubishi-Sulzer. It must be recognized that such particulars, data, presentations, etc. may be subject to later modification, due to further developments, experience, etc.
6. This manual is primarily intended for use by the engine operating and maintenance personnel. It is assumed that it will always be at the disposal of such personnel for the operation of the engines and/or for the required maintenance work.
7. This manual has been prepared on the assumption that operation and maintenance of the engines concerned will always be carried out by personnel having the special knowledge and skills needed to handle in a workman-like manner Diesel engines of the corresponding size, the pertaining auxiliary equipment, as well as fuel and other operating media. Therefore, generally applicable rules, which may also concern such items as protection against danger, are specified in this manual in exceptional cases only, i.e. when it must be assumed that the operating personnel qualified as above should not be familiar with the rules concerned.
8. This manual has been prepared to best knowledge and ability of its authors. However, neither MITSUBISHI nor their employees assume any liability for claims for any damages whatsoever or of any other nature with regard to this manual or in connection with the use thereof.

Contents

For Particular Attention	1
1. Outline of ECL valve adjustment	2
2. Preparation	4
3. Adjustment of opening pressure for master ECL valve	6
4. Adjustment of slave ECL valves (Plural valves adjustment at the same time)	8

Attached documents

Outside Drawing Hydraulic unit for ECL valve test machine
 Outside Drawing Hydraulic unit for ECL valve test machine
 Wire Diagram
 Parts List

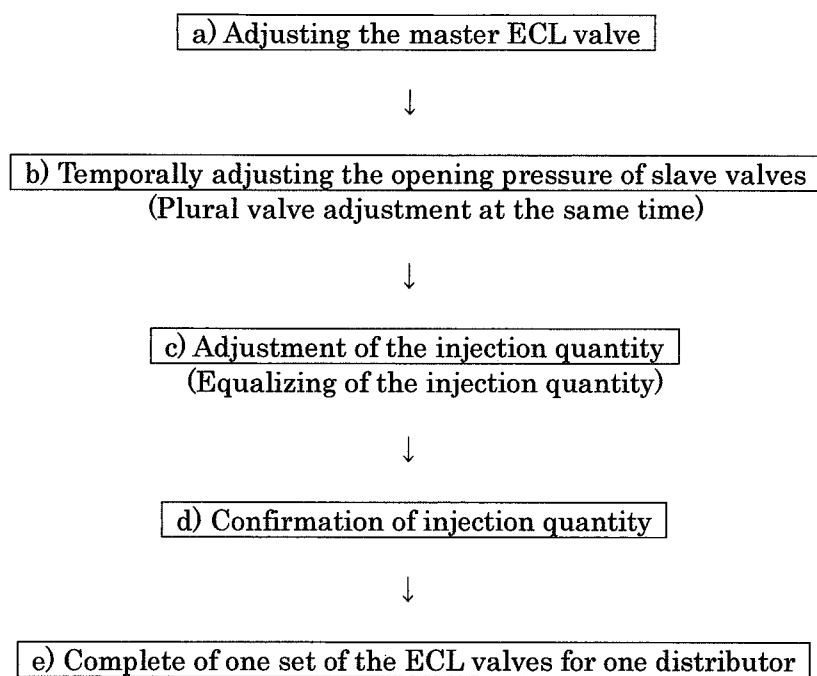
 Operation manual for hydraulic system

1. Outline of ECL valve adjustment

This is a instruction manual for adjusting ECL valves for Mitsubishi ECL system.

ECL system has distributors and ECL valves. One ECL distributor divided into plural ECL valves. Therefore, equalization of the injection quantity for each ECL valve is very important in order to obtain good injection performance.

Flowchart for the adjusting valves are described as follows:



Repeat a) to e)

Confirm the connection of power supply (440V)

Connect air hose for pressurized air to cooler unit

Supply turbine oil (VG46 or VG32) in oil tank

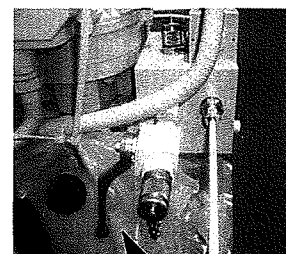
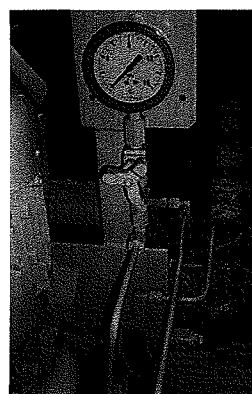
[Execution of air vent]

Confirm the setting pressure of pressure regulating valve (9)
(Setting pressure: 0MPa)

Confirm ball valve (10) "Close"

Switch "ON" the breaker of power supply

Supply pressurized air to cooler



Ball valve (10)

Pressure regulating valve (9)



WARNING

Oil cooler must be used during pump operation in order to avoid too high temperature of the oil. And oil cooler must be cooled by pressurized air.

Otherwise, abnormal temperature increase of the oil might cause fire and explosion in worst case.

Push "Pump start" button (PB1 button turned on green)

Confirm pump start and pressure gauge indicate 0MPa



CAUTION

Pressure must be lower than 0.02Mpa.

Otherwise, oil may be splashed during air vent operation and injure the operator.

Push "Pump stop" button (PB1 button turned off)

Confirm pump stop and pressure gauge indicate 0MPa

Put off a cap on air vent plug (11)

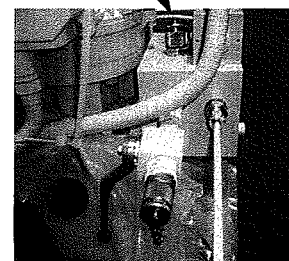
Connect hose (8) to air vent plug

Lead the end of hose (8) to measuring cup

Push "Pump start" button again (PB1 button turned on green)

Confirm pressure gauge indicate 0MPa

Air vent plug (11)



Air in hydraulic unit discharge and poured into measuring cup through hose (8)

After air vent, push "Pump stop" button (PB1 button turned off)

Stop pressurized air supply to cooler

Disconnect hose (8) from air vent plug

Put on a cap on air vent plug (11)

3 Adjustment of opening pressure on master ECL valve

ECL system has distributors and ECL valves. One ECL distributor divided into plural ECL valves. Therefore, equalization of the injection quantity for each ECL valve is very important in order to obtain good injection performance.

Adjustment ECL valves are done as a one set. ECL valves, those are installed to the same one distributor, are adjusted as one set at the same time.

One ECL valve is select from the one set of ECL valves. The one ECL valve is called "Master ECL valve" and the others are called "Slave ECL valves".

At first, master ECL valve is adjusted. Then, slave ECL valves are adjusted based on the injection quantity of the master ECL valve.

Followings are the procedure of adjustment for master ECL valve.

Important

Slave ECL valves are adjusted based on the injection quantity of the master ECL valve. Therefore, adjustment of master ECL valve is very important. Adjustment of the master ECL valve should be done accurately.

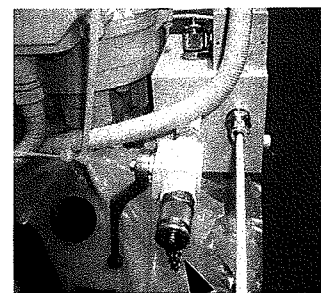
Set a master ECL valve on ECL valve stand

Put off a cap on P1 port (12) and connect hose (8) to it.

Connect other end of the hose to inlet (P) of the ECL valve



Be careful of the connecting position on ECL valve.
Inlet of ECL valve has a stamp mark "P"



P1 port (12)

Loose rock-nut on the master ECL valve

Set measuring cup to outlet of the ECL valve

Confirm ball valve (10) "Close"

Confirm the setting pressure of pressure regulating valve (9)
(Setting pressure: 0MPa)

Supply pressurized air to cooler



Oil cooler must be used during pump operation in order to avoid too high temperature of the oil. And oil cooler must be cooled by pressurized air. Otherwise, abnormal temperature increase of the oil might cause fire and explosion in worst case.

Push "Pump start" button (PB1 button turned on green)
Confirm pump start and pressure gauge indicate 0MPa

Ball valve (10) "Open"

Slowly increase pressure by reducing pressure regulating valve (9) and set the opening pressure of the master ECL valve to the value in Table 1.

Table 1. Opening pressure of the Master ECL valve

Engine type	Opening pressure of the master ECL valve
RT-flex96C/RTA96C	$6.50 \pm 0.01 \text{MPa}$

After adjusting opening pressure of the master ECL valve, tighten the rock-nut on the ECL valve.

Slowly increase the pressure form 0MPa and re-confirm the opening pressure of the master ECL valve is within the tolerance in Table 1.

Set the pressure of hydraulic unit to 0MPa

Ball valve (10) "Close"

Push "Pump stop" button (PB1 button turned off)

Stop pressurized air supply to cooler

Disconnect hose (8) from the master ECL valve

Disconnect hose (8) from P1 port and put a cap on P1 port

4. Adjustment of slave ECL valves (Plural valves adjustment at the same time)

Followings are adjusting procedure for slave ECL valves based on master ECL valves.
For example, in case of RT-flex96C engines, 4 slave ECL valves are set based on 1 master ECL valve. (1 set = 1 master ECL valve and 4 slave ECL valves)

Important One set of ECL valves should be install to the same distributor.

Set 1 set of ECL valves on ECL valve test stand

Connect pipes(4) to inlet(P) of ECL valves



Be careful of the connecting position on ECL valve.
Inlet of ECL valve has a stamp mark "P"

Loose rock-nut on the slave ECL valves



Rock-nut for master ECL valve must not be loosen

Set measuring cups to outlet of the ECL valves

Confirm ball valve (10) "Close"

Confirm the setting pressure of pressure regulating valve (9)
(Setting pressure: 0MPa)

Supply pressurized air to cooler



Oil cooler must be used during pump operation in order to avoid too high temperature of the oil. And oil cooler must be cooled by pressurized air.
Otherwise, abnormal temperature increase of the oil might cause fire and explosion in worst case.

Push "Pump start" button (PB1 button turned on green)
Confirm pump start and pressure gauge indicate 0MPa

Slowly increase pressure by reducing pressure regulating valve (9) and set the pressure to the value in Table 1.

Set the solenoid valve opening time to Table 2.

Table 2. Opening time of Solenoid valve

Engine type	Opening time of Solenoid valve
RT-flex96C/RTA96C	25msec

Push "SOL ON" button (SOL ON button turned on)
(Oil starts to inject from ECL valves periodically)

Adjust opening pressure of slave ECL valves to Table 1.

Important

Air might remain in ECL valve. Therefore, adjust opening pressure of ECL valves after air venting in ECL valve.
And opening pressure of slave ECL valves is fine adjustment based on the actual injection amount afterwards.

Push "SOL OFF" and "Pump stop" button after adjustment of opening pressure
(SOL and PB1 button turned off)

[Equalizing of the injection quantity]

Next step is the adjustment to equalizing the injection quantity of each ECL valves

Set empty measuring cups to ECL valves

Push "Pump start" button (PB1 button turned on green)

Set pressure of hydraulic unit to the pressure in Table 3.

Table 3 Pressure of hydraulic unit

Engine type	Hydraulic unit pressure
RT-flex96C/RTA96C	$8.0 \pm 0.1 \text{ MPa}$

Set the solenoid valve opening time to Table 2.

Push "SOL ON" button (SOL ON button turned on)
(Oil starts to inject from ECL valves periodically)

Fine adjust the injection quantity of each ECL valves. And the deviation of the injection quantity between the master ECL valves and slave ECL valves should be within $\pm 10\%$.

Important

Opening pressure of master ECL valve must not change during fine adjustment

Remark It is better to start to adjust from ECL valve with much injection quantity to ECL valve with little injection quantity

After the fine adjustment, tighten rock nut on ECL valve

Push “SOL OFF” button and “PUMP STOP” button

[Confirmation of injection quantity]

Set empty measuring cups to ECL valves

Push “Pump start” button (PB1 button turned on green)

Set pressure of hydraulic unit to the pressure in Table 3.

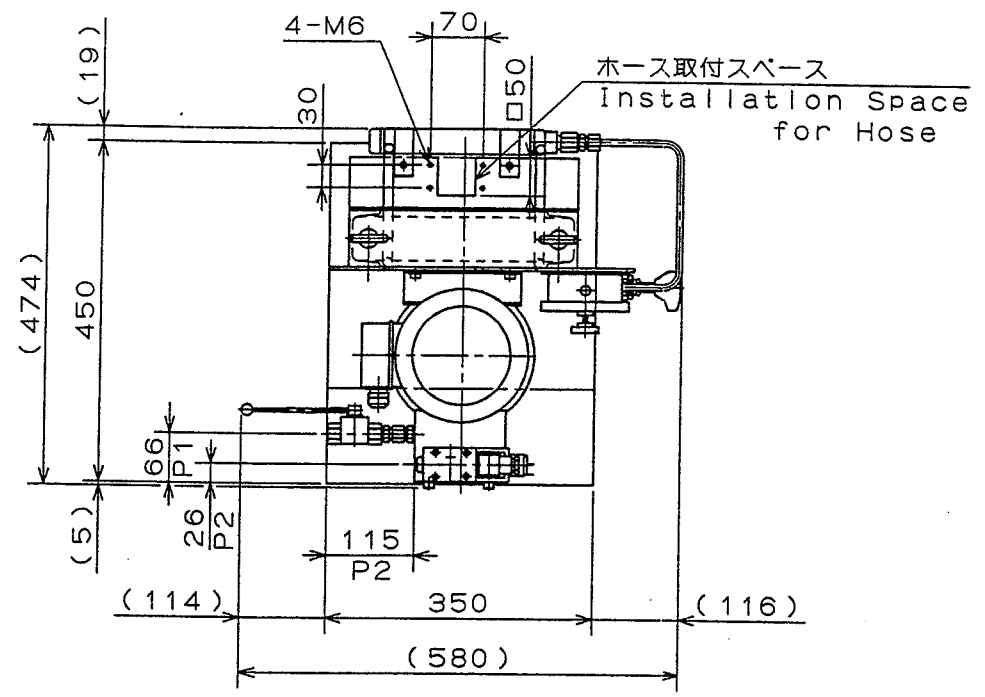
Push “SOL ON” button (SOL ON button turned on)
(Oil starts to inject from ECL valves periodically)

Measure injection quantity of each ECL valve
(Approx. 100ml for each valve)

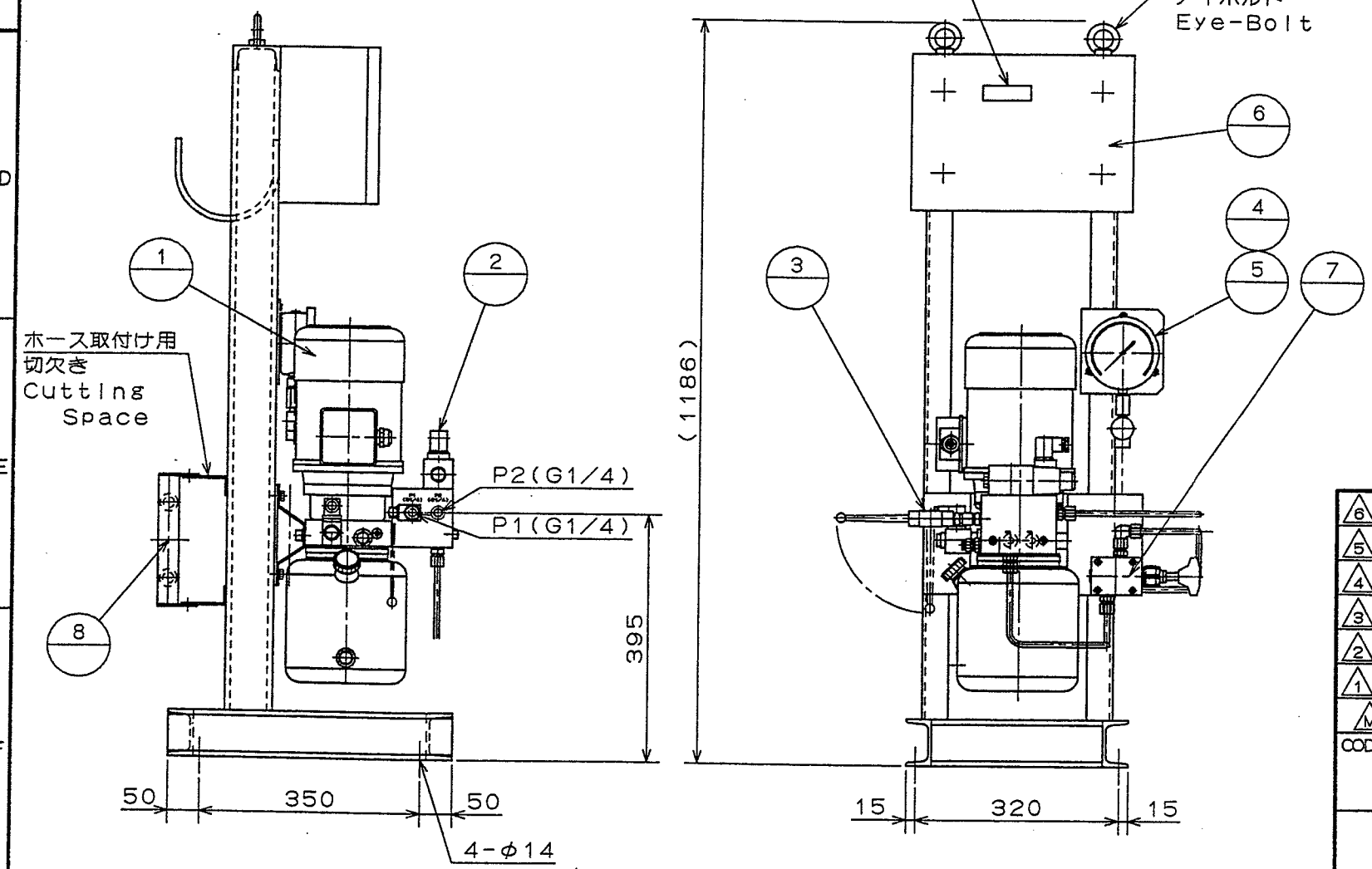
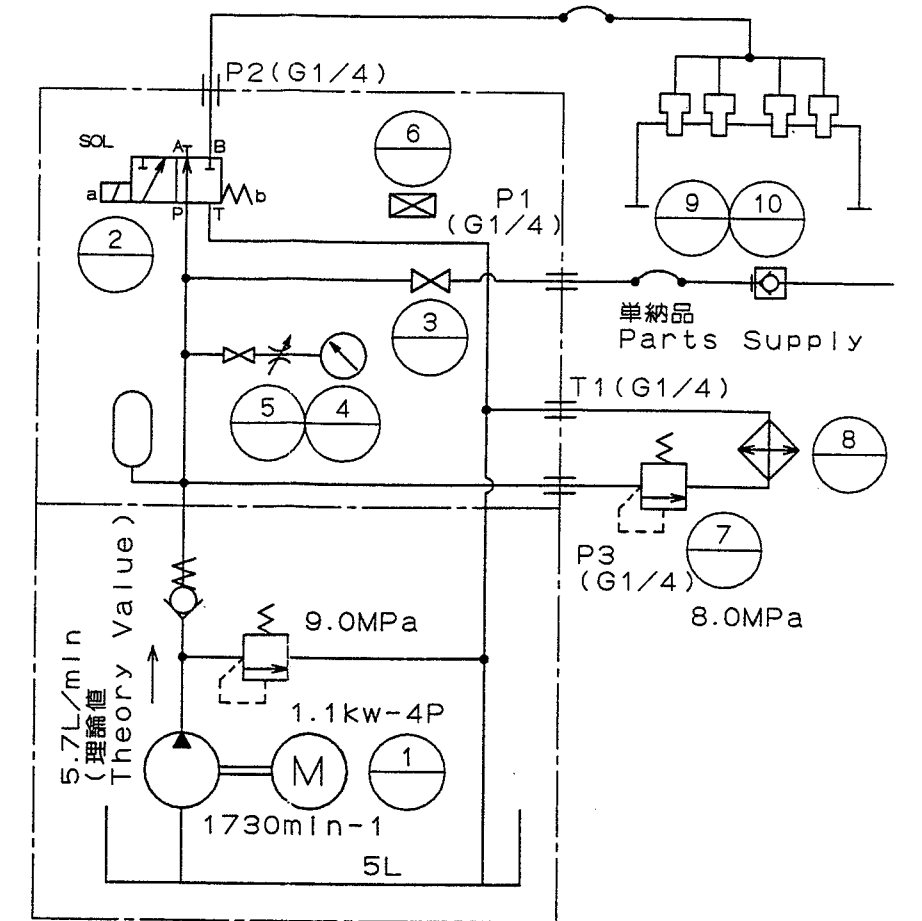
Confirm the injection quantity of each ECL valve
The deviation of the injection quantity between the master ECL valves and slave ECL valves should be within $\pm 10\%$.

After the confirmation, push “SOL OFF” button and “PUMP STOP” button

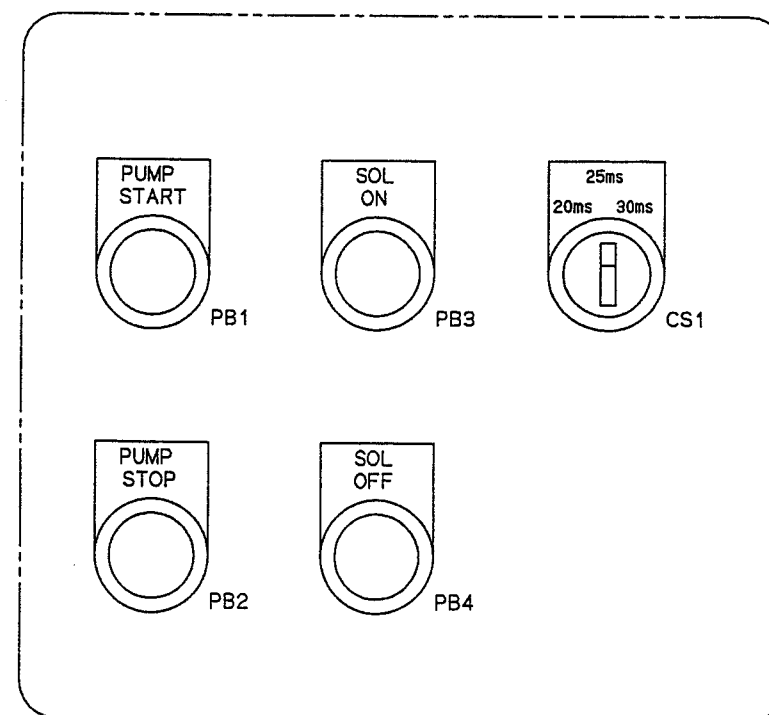
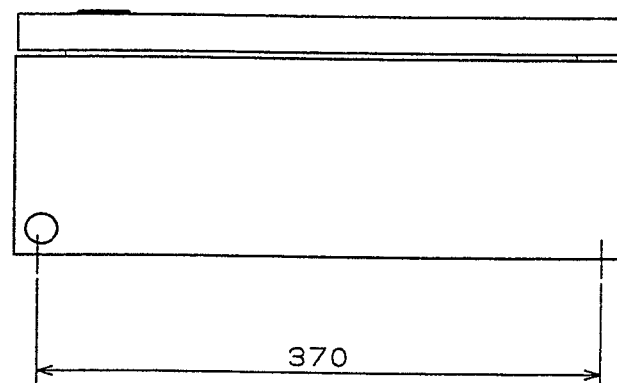
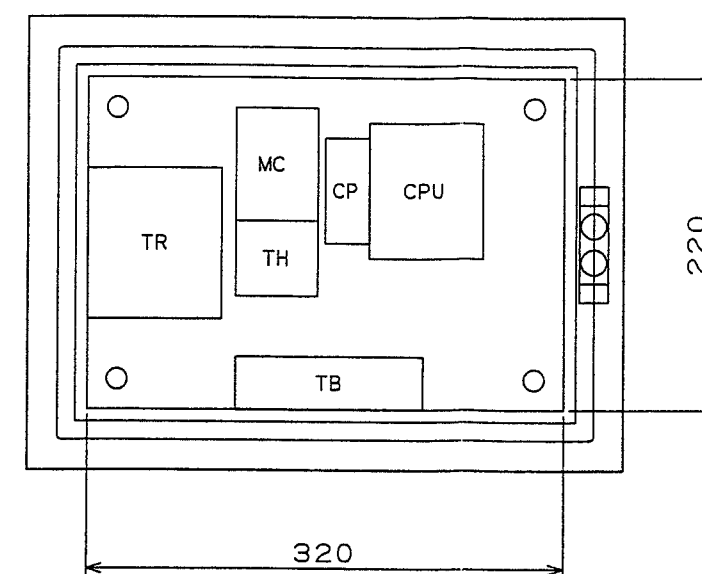
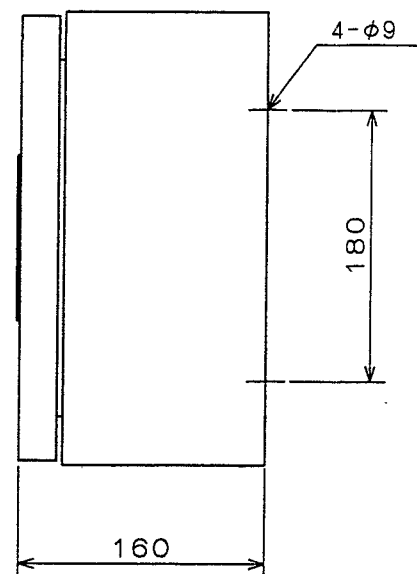
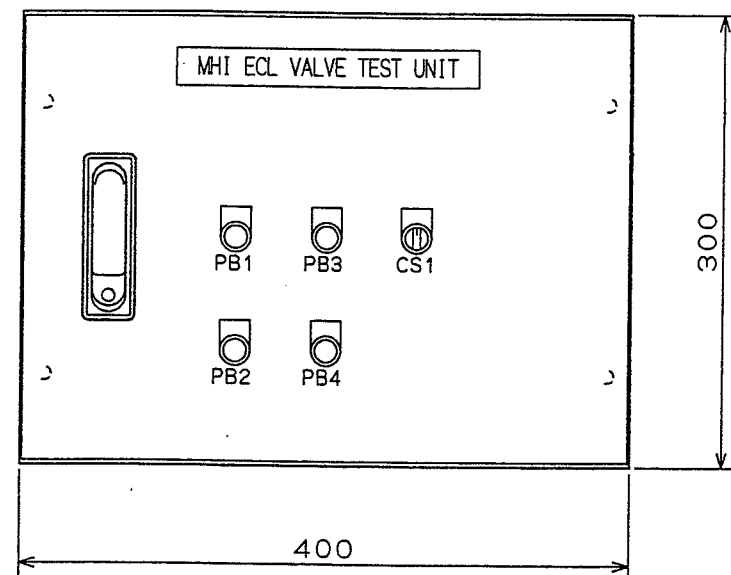
Repeat 3 (Adjustment of opening pressure on master ECL valve) to 4. (Adjustment of slave ECL valves (Plural valves adjustment at the same time))



注意銘板 NAME PLAT
Cooler must be cooled during operation by air.



6	5	4	3	2	1	APPD.	CHKD.	ENG.	DWN.	2007-04-26	SURFACE ROUGHNESS
6	5	4	3	2	1	CHKD.	CHKD.	喜多	山本マ		COMMERCIAL TOLERANCE
6	5	4	3	2	1	ENG.	CHKD.	喜多	山本マ		MATERIAL
6	5	4	3	2	1	DWN.	CHKD.	喜多	山本マ		
6	5	4	3	2	1	2007-04-26	CHKD.	喜多	山本マ		
6	5	4	3	2	1	組立外形図	CHKD.	喜多	山本マ		
6	5	4	3	2	1	OUTSIDE DRAWING	CHKD.	喜多	山本マ		
6	5	4	3	2	1	噴射弁試験装置用油圧ユニット	CHKD.	喜多	山本マ		
6	5	4	3	2	1	HYDRAULIC UNIT FOR	CHKD.	喜多	山本マ		
6	5	4	3	2	1	ECL VALVE TEST MACHINE	CHKD.	喜多	山本マ		
6	5	4	3	2	1	CLASSIF. CODE	CHKD.	喜多	山本マ		
6	5	4	3	2	1	DWG. No.	CHKD.	喜多	山本マ		
6	5	4	3	2	1	Bosch Rexroth Corporation	CHKD.	喜多	山本マ		
6	5	4	3	2	1	WW01T	CHKD.	喜多	山本マ		
6	5	4	3	2	1	Y523119944	CHKD.	喜多	山本マ		

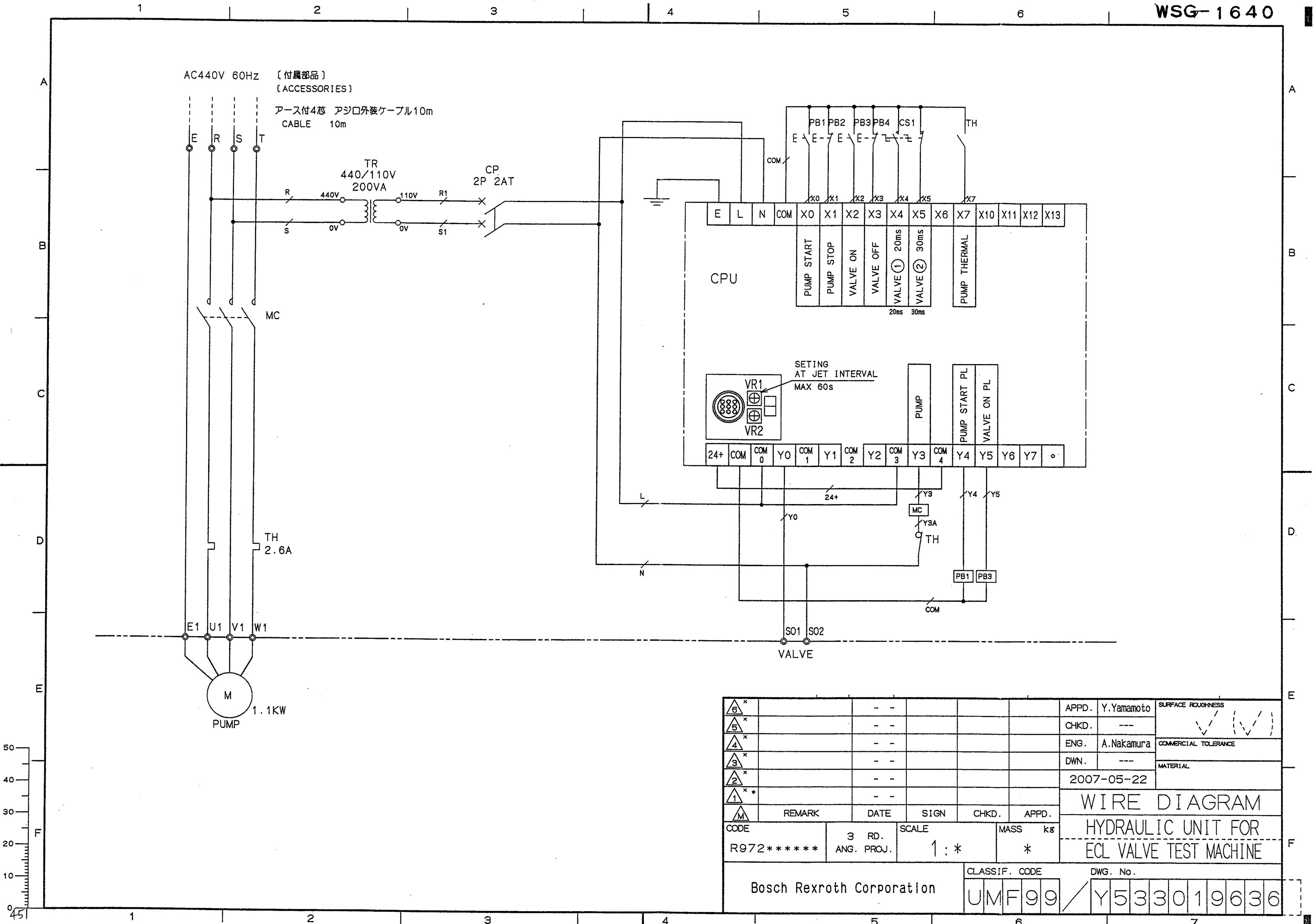


部品表

PARTS LIST

番号 No.	記号 SYMBOL	名称 NAME OF PARTS	型番 MODEL NUMBER	数 Q'TY	メーカー MAKER	記事 REMARK
1	TR	トランス TRANSFORMER	LD41-200E	1	トヨズミ TOYOZUMI	AC440V/110V 200VA
2	CP	サーキットプロテクター CIRCUIT PROTECTOR	CP32FM 2P 2AT	1	富士電機 FUJI	端子部保護カバー(CP-T6) WITH COVER(CP-T6)
3	CPU	シーケンサ PROGRAMMING COUTION	FX1S-20MR	1	三菱電機 MITSUBISHI	
4	MC	電磁接触器 MAGNETIC CONTACTOR	SC-05	1	富士電機 FUJI	AC110V 1a1b
5	TH	サーマルリレー THARMAL RELEY	TR-0N	1	富士電機 FUJI	2.2~3.4A
6	PB1	照光式押ボタン LIGHTING PUSH BUTTON	AR22FOL-10E3G	1	富士電機 FUJI	緑 GREEN
7	PB2	押ボタン PUSH BUTTON	AR22FOR-10R	1	富士電機 FUJI	赤 RED
8	PB3	照光押ボタン LIGHTING PUSH BUTTON	AR22FOL-10E3G	1	富士電機 FUJI	緑 GREEN
9	PB4	押ボタン PUSH BUTTON	AR22FOR-10R	1	富士電機 FUJI	赤 RED
10	CS1	セレクトスイッチ SELECT SWITCH	AM22PR-311B	1	富士電機 FUJI	3ノッチ 1a1b 3 NOTCH 1a1b
11	TB	端子台 TERMINAL	LT2E-020-15P	1	富士電機 FUJI	

6	x	-	-	-	-	APPD.	Y.Yamamoto	SURFACE ROUGHNESS
5	x	-	-	-	-	CHKD.	---	✓
4	x	-	-	-	-	ENG.	A.Nakamura	COMMERCIAL TOLERANCE
3	x	-	-	-	-	DWN.	---	MATERIAL
2	x	-	-	-	-	2007-05-22		
1	x	-	-	-	-	OUTSIDE DRAWING		
M		REMARK	DATE	SIGN	CHKD.	APPD.	HYDRAULIC UNIT FOR ECL VALVE TEST MACHINE	
CODE		3 RD. ANG. PROJ.	SCALE 1:5		MASS kg	CLASSIF. CODE UMF99		
R972*****		Bosch Rexroth Corporation		DWG. No.		Y533019645		



PARTS LIST**Rexroth**
Bosch GroupMITSUBISHI HEAVY INDUSTRIES,LTD.NAME ECL VALVE TEST MACHINENo/SET 1SET

U/S	UNIT NAME				Q'TY	
10	HYDRAULIC UNIT				1	
20	PARTS SUPPLY				1	
30						
40						
50						
60						
70						
80						
90						
100						
110						
120						
130						
140						
150						
160						
170						
180						
190						
200						
210						
220						
230						
240						
250						
260						
270						
280						
		△			APPD	Y.YAMAMOTO
W/No.	Z0705-116	△			CHEKD	
CODE	UMF99	△			ENG.	A.NAKAMURA
No	Y611138864-1	△			DATE	2007/6/6

HEAD1

10 HYDRAULIC UNIT

[illegible]

20 PARTS SUPPLY

1

OPERATION MANUAL FOR HYDRAULIC SYSTEM

(FOR GENERAL MINERAL HYDRAULIC OPERATING FLUID)

C u s t o m e r : MITSUBISHI HEAVY INDUSTRIES,LTD.

Name of System : ECL VALVE TEST MACHINE

Your File No. : 51MT000017

Our Work No. : Z0705-116

Drawing No. : Y618007611



Cautions before Use

- Before using the hydraulic system, be sure to read through the manual to understand the content thoroughly, particularly, always observe the cautions.
- Be sure to keep this operation manual as near as possible to the hydraulic system, so that you can refer to it quickly any time you need.

						Bosch Rexroth Corporation System & Power Unit dept.		
						DATE :		
						APPD.	CHKD.	ENG.
No.	REMARK	DATE	ENG.	CHKD.	APPD.			

This Operation Manual contains only the general description and any special matters, such as the operation method, should be determined according to the content of technical discussions.

*** CONTENTS ***

- [1] Control of Hydraulic Operating Fluid.....Pages 1and2
- [2] Preparation for Test RunPages 3and4
- [3] Procedure for Test RunPages 5to8
- [4] Control of Normal Run.....Pages 9and10
- [5] Procedure for Cessation of Run.....Page 11
- [6] DisassemblingPages 12and13
- [7] Troubleshooting GuidePages 14and15
- [8] Maintenance and Inspection Standard.....Pages 16to18
- [9] Parts List.....Pages
- [10] Oil Hydraulic Circuit DiagramPages
- [11] Overall View of Hydraulic SystemPages
- [12] Operating Instruction for Individual Equipment.....

~Described in subsequent pages~

● Safety Indications

[Possibility of injury to the operator and others or possibility of system failure and trouble] is described with the following marks together with the method to avoid such cases. Since the description below is extremely important, be sure to read with care and understand fully.



DANGER

Failure or trouble may occur, resulting in death or critical accident when the instruction is not observed.



WARNING

Failure or trouble may occur, possibly resulting in death or critical accident when the instruction is not observed.



CAUTION

Failure or trouble may occur, possibly causing injury when the instruction is not observed.

CONTROL OF HYDRAULIC OPERATING FLUID

Cautions for Control of The Hydraulic Operating Fluid

Among maintenance and control duties to ensure efficient operation, prevention of the failure, and maintenance of the rated performance of the hydraulic system, those concerning the hydraulic operating fluid is particularly important. It is essential that the user consults with a manufacturer of the hydraulic operating fluid used thoroughly on how to control the fluid. The minimum requirements for extended use of our hydraulic system are described below.

1 . Kind of the hydraulic operating fluid

Always use the wear-resistant hydraulic operating fluid of the viscosity grade of VG32~VG58 of ISO 3448. Never use other hydraulic operating fluid brands or mix dissimilar fluid.

Caution

Mixed hydraulic operating fluid may cause failure or trouble.

• Never attempt mixing of other fluids

2 . Viscosity Range

Use the fluid within the viscosity range of 700SSU~100SSU (150~20cst). When converted to the fluid temperature, these correspond to 10~50°C for VG32 and 20~60°C for VG58. (Contact the hydraulic operating fluid manufacturer to obtain the viscosity-temperature diagram of the fluid used.)

3 . Contamination

When no control standard value is available, keep the fluid contamination to Class 10 or less of NAS 1638. Observe the control standard value if any.

Caution

If the degree of contamination exceeds the control standard value, failure or trouble may occur.

• Be sure to keep the contamination less than the control standard value.

4 . Periodical Inspection

Initially after test run.....after 500 hours

During normal run..... every 2,000 hours

Sample about 1 liter of hydraulic operating fluid and request the fluid manufacturer to inspect the sample.

Caution

If no periodical inspection is made and the fluid is not changed even after the change time, failure or trouble may occur.

• Be sure to carry out the periodical inspection.

5 . Hydraulic operating fluid change

the fluid change time is determined from the inspection result. Generally, change the fluid every 4,500 hours. The fluid must be changed in total amount and any old fluid must be removed as much as possible.

Caution

If the fluid is not changed even when the change time is reached or if the fluid is changed only partially, with the old fluid mixed with the new one, failure or trouble may occur.

• Be sure to change the fluid in total amount at the predetermined time.

6 . Daily Check Points

DiscolorationEntry of water or air into the fluid or degradation of the fluid may result in discoloration.
Odor.....Oil burn and degradation cause unique odor.
Mixing of foreign materials.....Entry of foreign materials may cause degradation or failure and trouble.
Removal of water content, etc.....At least, once every six months, discharge any water or sediments accumulating in the bottom from a drain port located in the oil reservoir. In a place where the humidity is high, shorten the drain interval.



Caution

If checking is not made or no service is made, failure or trouble may occur as described above.

- Be sure to carry out check and other services.

PREPARATION FOR TEST RUN



Cautions for Preparation for Test Run

Check the installation condition of the hydraulic system and confirm that there is no loose equipment in the system caused during transport. Then, carry out the following items.

1 . External Piping

- Carry out pickling and flushing thoroughly.
Contamination: When no control standard value is available, keep the fluid contamination to Class 10 or less of NAS 1638.
Observe the control standard value if any.
- Provide pipe supports firmly.
Support distance: 15A or less.....about 500 mm
 : 20A ~ 40A..... about 1.000 mm
 : 50A or more... about 2.000 mm
When excessive pipe vibration is expected, reduce the support distance.
- Use the material with sufficient pressure resistance.
Pressure resistance: 1.25~ 1.5 times the operating pressure ;
- The O-ring seal surface finish must be more than equivalent to 6.3S and free from scar.



Caution

If the above works are not made, failure or trouble may occur.
• Be sure to carry out these works.

2 . Electricity

- Checking the motor running direction
Isolate the hydraulic pump at the coupling and run the motor independently to check the running direction.
In the case of a bell housing type or a directly-coupled shaft type, run the motor in the inching mode while preventing the pressure rise to check the running direction. In this case, refer to 'Operation of Hydraulic Pump' on page 5.
Check if the running direction is as indicated with an arrow mark on a nameplate installed in the top portion of the hydraulic pump body or as shown with an arrow in the assembly overall drawing of the hydraulic system.
- Energizing test of solenoid controlled valve
Check if the electric operation circuit is compatible with the solenoid controlled valve. Energize each solenoid controlled valve independently and confirm that the specified magnet is activated.



Warning

If the condition of sluice valve or relief valve is overlooked during checking of the motor running direction of hydraulic pump, accident, failure or trouble may occur.
• Be sure to carry out the work with utmost care .

3. Centering of the Coupling

The motor and pump have been confirmed to be centered before shipment. Since the center may be deviated in the course of transport or depending on the installation condition, be sure to check the center during test run.

Allowable standard value: Off-center Less than 0.1 mm
: Inclination Less than 0.5° (less than 0.2mm)



Caution

Failure to check the center may result in failure or trouble.
• Be sure to carry out centering.

Though the centering does not present a problem in the case of the bell housing type or directly-coupled shaft type, check if mounting bolts, etc. are tightened without fail.

4. When a Cushion Rubber has been used for the Motor and Pump Base

The base has been fixed with fixing bolts not to move during transport. Loosen top and bottom nuts respectively to obtain a 5 mm clearance.



Caution

If the motor and pump are used without loosening these bolts, the cushion rubber can not function, possibly resulting in failure and trouble.
• Be sure to loosen them before use.

5. When the Magnet Separator is used

Before filling the tank with the hydraulic operating fluid, remove a lid for cleaning or separator and install the magnet separator to a specified position inside the tank. After installation, tighten the cleaning or separator lid fully to the original condition to prevent fluid leakage.

6. When the Accumulator is used

When using the accumulator, never fill it with gases other than the nitrogen gas.



Warning

The accumulator may cause an unexpected accident, failure or trouble.
• Read the Operation Manual for the Accumulator Proper with care to understand the content well before use.

PROCEDURE FOR TEST RUN



Cautions for Test Run

The test run must be made only after completion of thorough preparation. Access of any unauthorized person to the hydraulic system must be prohibited. Never touch the hydraulic system.



Warning

Touching or operation to the hydraulic system of a person who does not know the details may cause an accident or failure.

- Never allow persons other than authorized to enter the site.

1 . Fluid supply

Fill the fluid to a level slightly above the standard fluid level through a specified filling port. In this case, take care not to allow foreign materials and water to enter the fluid. Never mix hydraulic operating fluid of different brands or dissimilar fluids.



Caution

Entry of foreign materials or water or mixing of other hydraulic operating fluids may cause failure or trouble.

- Never allow foreign materials or water to enter. Never mix other hydraulic operating fluid.

2 . Operation of the Hydraulic Pump

Open fully the sluice valve on the suction side and the relief valve on the discharge side of the hydraulic pump. Loosen slightly the air purge plug near the discharge port of the hydraulic pump. Upon completion of preparation, run the motor in the intermittent mode and confirm that the hydraulic pump sucks the hydraulic fluid. Air suction can be confirmed when the foam and hydraulic operating fluid jet out from the air purge plug or the hydraulic pump operation sound changes. Immediately close the air purge plug and continue the unloading pressure operation for about five minutes in this condition.



Warning

Operation without paying attention to the state of the sluice or relief valve may cause an accident, failure, or trouble.

- Always pay attention to these valves during operation.

Operation of the hydraulic pump with a cover of a rotating body (coupling, etc.) removed or touching the rotating body may cause an accident.

- Never operate the hydraulic pump with the cover of the rotating body removed.
- Pay attention to the attire or equipment to prevent from being caught by the rotating body, and never touch the rotating body.

- Check the inside of oil reservoir. If the hydraulic operating fluid containing air comes out continuously from the return pipe, either cavitation or air suction through the suction pipeline is considered.
- More or less vibration occurs during operation. But the excessive vibration may be due to faulty installation.
- Using an ammeter, check for any large load. Large load may be due to faulty installation or seizure.



Warning

With the failures described above left uncorrected, the operation may result in an accident or failure.

- Be sure to find out the cause of failure before resuming the operation.

3 . Fluid Filling (Air purging)

Set the pressure to a level (generally, 10~30 Kgf/cm²) not so high as to activate the actuator. Since air is in the pipeline, operate the relief valve slowly while paying attention to the reading of the pressure gauge, relieving the pressure from an appropriate point in the pipeline after the relief valve. Do not tighten the relief valve rapidly even when the pressure raises only slowly. Otherwise, the high pressure occurs quite suddenly, causing an accident.



Warning

Operation of the relief valve may cause an unexpected accident.

- Be sure to operate the relief valve according to the procedure described above.

Operate the selector changeover valve of the actuator manually after setting of the low pressure, feeding the hydraulic operating fluid into the pipeline. Purge air beforehand from an appropriate point at the pipe end. The fluid level in the reservoir continues decreasing during fluid filling work. Always pay attention to the fluid level and add the new fluid during operation.



Caution

If the operation is continued with the fluid level left below the specified one or the hydraulic operating fluid mixed with a different brand is filled, failure or trouble may occur.

- Pay attention to the fluid level and fill the new fluid of the same brand.

When purging air while operating the actuator, pay attention to the machine operation and stop operation immediately when there is any sign of danger.



Warning

Activating the actuator without paying attention to the machine operation may cause an unexpected accident or failure.

- Be sure to pay attention to the machine operation during fluid filling.

4 . Operating the Actuator

After setting the pressure control valve to the specified value, activate each actuator independently. Initially, operate the actuator manually and at low speed. Operate the actuator many times while watching the machine operation and checking the limit switch. After setting to the specified speed, attempt operation in an interlocked or automatic mode.



Warning

Operation in the interlocked or automatic mode from the very beginning may result in an unexpected accident or failure.

- Be sure to operate the actuator according to the sequence described above.

5 . Cleaning the Filter

During the initial period after test run, the filter tends to be readily clogged. Be sure to clean the filter from time to time.



Caution

Operation with the clogged filter may result in failure and trouble.

- Pay attention to the filter indicator and be sure to carry out cleaning.

6 . Retightening the Bolt

For about 300 hours after start of test run, check bolts and nuts for any looseness and carry out retightening.



Warning

Loose bolts and nuts are dangerous, possibly causing failure, trouble or accident.

- Check bolts and nuts for looseness and be sure to retighten if necessary.

7 . Description of Operation of Valves

In this section, read the item applicable to the valve attached to your hydraulic system.

- Pressure control valve: Turn a relief valve handle clockwise to raise the set pressure and counterclockwise to lower the set pressure.
Set the pressure by turning the handle slowly while checking the pressure gauge. For the relief valve with a solenoid valve, energize the solenoid (normally open) or deenergize the solenoid (normally closed) before pressure setting.



Warning

Never attempt sudden pressure change or normal operation with the pressure left above the specified value. Operation of the relief valve may cause an unexpected accident.

- Before attempting operation of the relief valve, be sure to understand the oil hydraulic circuit diagram and pressure control valve construction and to confirm the design specification.

• Directional control valve

Solenoid valve: Activation of the magnet and the fluid flow direction are determined by the energizing direction. Confirm that this energizing direction is correct by checking the cylinder or motor running direction. For the two-position solenoid valve, energizing of this valve causes change in the fluid flow direction. Deenergizing causes return of the fluid flow direction to the original direction. Note however that deenergizing will not cause the return to the original flow direction in the case of a detent type solenoid valve. To return to the original flow direction, energize the magnet on the opposite side to change the direction.

Manually operated directional control valve:

Operate the handle to change the fluid flow direction. Confirm that this direction is correct by checking the cylinder or motor running direction.



Warning

When the changeover direction is found wrong, the actuator may operate in a direction other than expected, causing an unexpected accident or failure.

- Be sure to understand the oil hydraulic circuit diagram and the changeover valve construction before operating the changeover valve.

• Flow control valve

Flow control valve:

Turn the handle to increase the scale numeral, and the flow increases also. Adjust the speed of cylinder or motor by turning this handle.

Throttle check valve:

Turn an adjusting screw clockwise to reduce the flow and counterclockwise to increase the flow. Adjust the speed of cylinder or motor by means of this valve. Note however that the relationship between the screw turning direction and flow is opposite to the above in the case of TC-02T-330 and TC-04G-330.



Warning

Sudden operation may cause an unexpected accident or failure because this will change the actuator operation speed.

- Avoid sudden operation.

Certain circuit compositions may suffer damage to the actuator if the adjustment method is wrong.

- Be sure to understand the oil hydraulic circuit diagram and the flow control valve construction before operation of the flow control valve.

CONTROL OF NORMAL RUN



Cautions for Control of Normal Run

Daily control is essential to keep the performance of the hydraulic system.
Be sure to understand the following description before carrying out the control and operation.

1 . Hydraulic Operating Fluid

- Quantity of fluid

The fluid level must be at the specified position. Low fluid level may be considered due to fluid leakage and high fluid level due to entry of water.



Caution

Change in the fluid level may cause failure or trouble.

- Always pay sufficient attention to the fluid level.

- Discoloration

Cloudy (white) fluid may be due to entry of water while black fluid due to oil burn.



Caution

Degradation of the hydraulic operating fluid may cause failure or trouble.

- Pay sufficient attention to the condition of hydraulic operating fluid.

- Fluid temperature

The fluid temperature range must be 700SSU to 100SSU (150~20 cst) as converted to the viscosity. When starting the hydraulic pump at high viscosity exceeding 700SSU (150 cst), carry out intermittent unloading pressure.



Caution

Normal loading pressure operation at high viscosity may cause failure or trouble.

- Be sure to carry out intermittent unloading pressure operation at high viscosity and proceed to the normal operation when the fluid temperature becomes around 20°C.

2 . Operating the Hydraulic Pump

- Operating temperature

Allow an alcohol thermometer contact with putty to the hydraulic pump body and measure the operating temperature. The operating temperature must be around the tank fluid temperature (plus 20°C).



Caution

When the operating temperature is abnormally high, failure or trouble may occur.

- Pay attention to the operating temperature daily.

• Operating sound

The operation sound changes when the suction side filter of the hydraulic pump is clogged or the component is worn abnormally or about to break down. Remember what the operation sound is like in the normal operation condition. Then, any abnormality may be detected early.

 Caution

The operating sound different from that during normal operation may due to failure or trouble.
• Pay attention to the operating sound daily.

3 . Fluid Leakage

Check for fluid leakage with utmost care because even oozing of fluid from the weld of piping or the hydraulic pump or hydraulic equipment may lead to a major accident. Be sure to check strictly.

 Warning

fluid leakage. if overlooked and left as it is, may cause an accident or failure.
• Check for any fluid leaking point daily.

4 . Filter

Check the suction filter, line filter, or air breather for clogging and clean early if necessary.

 Caution

Operation with the filter clogged may cause failure or trouble.
• Check the filter daily and clean if necessary.

5 . Pressure Gauge

If a needle is left to displace freely, failure of the pressure gauge may result. When there is no need to check the pressure gauge, always make it a rule to close the gauge cock.

6 . Tank Inside

Once a year, drain the fluid from the tank, and check and clean the tank inside.

 Caution

When the tank itself is abnormal or sediments are left accumulating, failure or trouble may be considered.
• Be sure to check the tank inside.

PROCEDURE FOR CESSATION OF RUN

Caution for Cessation of Run

TO ceased of run the operation for a long period, carry out rust prevention of all systems using a rust-preventive fluid. The rust-preventive fluid to be used must be equivalent to Grade 1 of MIL-L-21260 and determined under instruction of a rust-preventive fluid manufacturer. To restart operation after rust prevention, either carry out cleaning with a flushing fluid or allow the hydraulic operating fluid to circulate and drain the mixed fluid, then fill the new fluid.

• Recommended rust-preventive fluid

Idemitsu kosan	: Daphne No Rust Engine Oil No. 10
Esso Sekiyu	: Ante light P-1010
Sell Sekiyu	: Sell Rust Preventive P-10, Grade 1
Nippon Sekiyu	: Rust preventive Oil P-210
Mobil Sekiyu	: Mobil Coat 501

Caution

When the operation has been ceased of run for a long time without rust prevention, failure or trouble due to rusting may occur.

- Be sure to carry out rust prevention when the operation is to be ceased of run for a long period.

If the rust preventive fluid is not removed through flushing, etc. when the operation is to be restarted after rust prevention, failure or trouble may occur.

- Be sure to carry out flushing before restart of the operation.

DISASSEMBLING

Caution for Disassembling

Before disassembling for the circuit change or repair or inspection of failure, or for overhaul of principal equipment, be sure to understand the following points.

Warning

Disassembling without due understanding may result in an unexpected accident.
The wrong disassembling work content may also cause failure or trouble.
- Be sure to understand the following points before start of disassembling.
- Never allow any unauthorized person to attempt disassembling.

Refer to the reference materials, such as the oil hydraulic circuit diagram or the construction view of equipment used, beforehand in order to understand thoroughly the circuit operation, equipment construction, and equipment handling.

Understand this machine construction well and provide a mechanical stopper or take safety measures to ensure safe disassembling of the hydraulic system.

Warning

Disassembling without taking any safety measures may result in an unexpected accident due to overrun of the actuator, etc.
- Be sure to take the safety measures such as mechanical stopper, etc.

Be sure to isolate the electric circuits (both strong and weak electricity) with a circuit breaker before start of disassembling.

Warning

Disassembling with the electric circuit left active may cause an unexpected accident such as electric shock, etc.
- Be sure to isolate the electric circuit before start of disassembling.

Before loosening bolts and joints, confirm fully by referring to the oil hydraulic circuit diagram and hydraulic system construction that there is no danger of fluid spouting due to residual pressure or head difference. If there is any residual pressure, relieve the pressure by operating manually operated directional control valve.

Warning

Disassembling without due attention on the residual pressure may cause an accident, failure, or trouble due to fluid spouting.
- Be sure to pay attention to the residual pressure and confirm the safety before start of disassembly.

For the system incorporating the accumulator, operate the master valve to release the pressurized fluid into the hydraulic operating fluid tank before operation.

Caution

Never operate the master valve suddenly to prevent damage to the plug.
- Be sure to understand the content of Operation Manual before start of disassembly.

- When the system is to be left as disassembled, apply the rust preventive fluid and set a blind plug to prevent rusting.
- Be sure to replace the seal of O-ring and packing with the new one.
- During reassembling, tightening with uneven torque for equipment or entry or insufficient removal of seal and weld scale for piping may cause failure or trouble.
- Before restart of operation after disassembling, be sure to check if the stop or butterfly valve is closed and if bolts, blind plug, and joints are tightened without fail.

TROUBLESHOOTING AND MEASURE

Trouble Ares	Cause	Counter-measures
Noise-Occurs (A) Pump	1. Loading of the pump intake pipe and suction filter.	Check and wash them with good quality wash oil and light oil.
	2. Air leaks from intake side pipe. or pipe joint..	Coat the joint with grease and check how the sound changes. If the sound becomes smaller, tighten up the joint or change the seal.
	3. Air leaks from shaft packing of pump.	Listen carefully to the sound while running the device. Coat the outside of the shaft with grease. If the sound becomes smaller, change the packing.
	4. Fitting bolt of the pump becomes slack.	Tighten up the bolt.
(B) Relief Valve	1. Piston slot catches. or operates defectively.	Disassemble and check. If the flaw is small, lap it again and observe the results.
	2. Abnormal wear of needle valve.	Exchange, and check the hydraulic operating fluid for dirt.
	3. Resonance of spring board, bent board and air.	Extract the air from the the circuit. Check the spots where air enters.
(C) Others	1. Clamping bolt of a component becomes loose.	Tighten up the bolt.
	2. Pipe supporting fitting becomes loose.	Check and tighten up.
	3. Resonance of piping system from surge pressure.	Check the valve performance, the piping diameter, the pipe bend, etc.
Pressure is lost (A) Pump	1. Quantity of oil in the tank is small.	Check the oil level and immediately add the necessary amount (be sure to use the same kind of oil). Also confirm that the edges of the intake and return pipes are below the oil level.
	2. Pump intake port and suction filter are blocked.	The oxides in oil which has been used too long, sink and cause the blockage. Wash suction filter and oil tank.
	3. Air enters from intake pipe.	Check and repair.
	4. Pump is in bad condition.	Check the above-mentioned items, and if no abnormality is detected, check the pump.
(B) Relief Valve	1. Setting pressure is low.	Reset the pressure.
	2. Valve is in bad condition. 2.1 Loading of piston orifice. 2.2 Damage of valve seat. 2.3 Permanent strain of spring. 2.4 Damage or catch in piston.	Wash. Change (change also needle valve). Change. If piston catches, lap again. If damaged, replace. (Replace also piston seat).

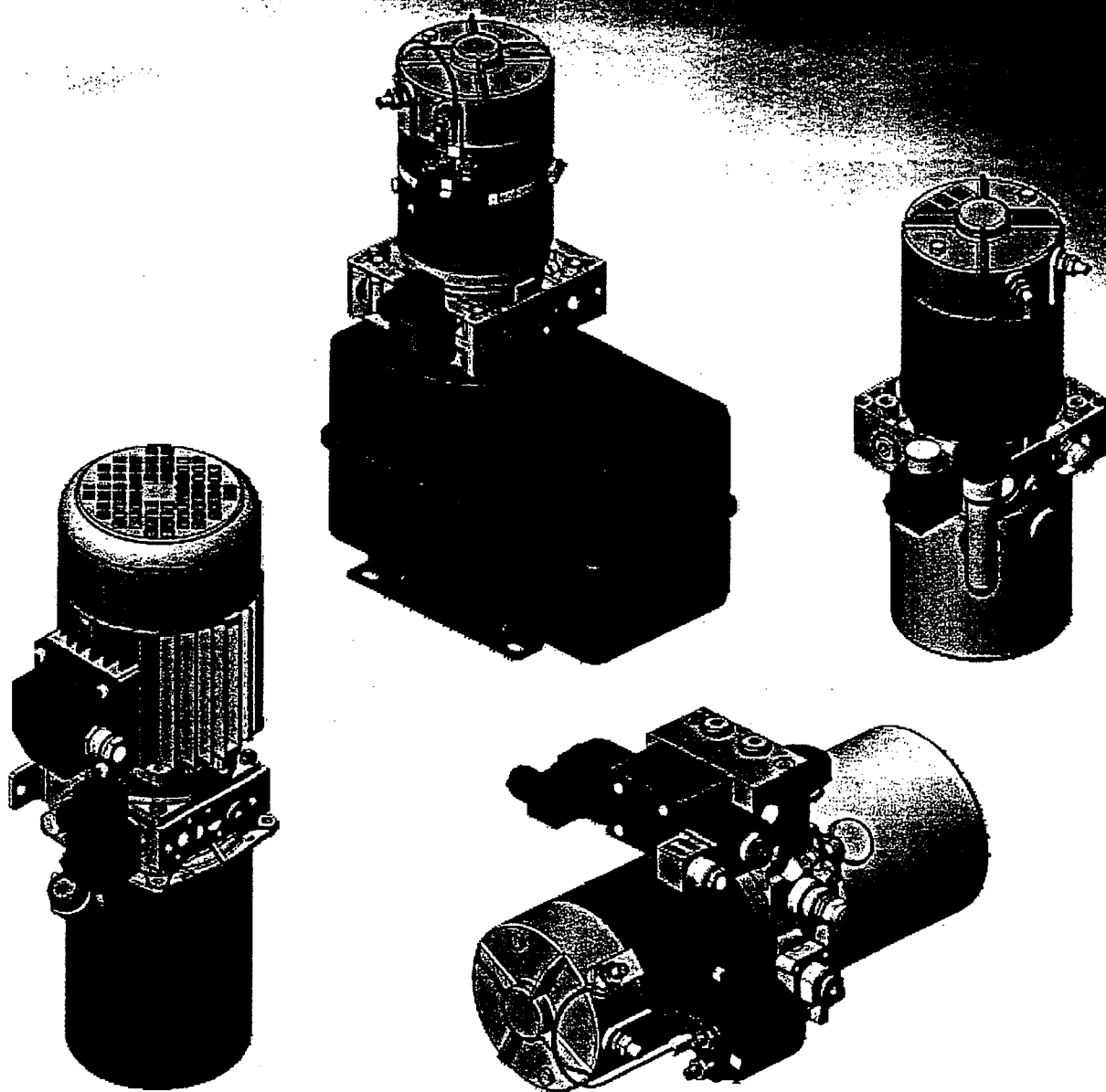
Trouble Ares	Cause	Counter-measures
pressure is lost (C)Others	1.Damage in piping.	Check piping and repair.
	2.According to the damage in the packing of an element.	Check and change.
	3.Damage in pressure gauge. (If pressure rises an estimate can be made from operating sound.)	Change.
	4.Bent solenoid valve operates defectively.	Change the coil or valve.
Cylinder Operation (A)Breakdown	1.Pump discharging pressures is lost.	Change the coil or valve.
	2.Solenoid valve for operation operates defectively. 2.1 Burning of coils . 2.2 Spool sliding part catches.	Change the coil and check the electric circuit. Change or lap spool again depending on the damage.
	3.Cylinder catches.	Check.If it catches again.replace it.
	4.Hitch in electric control system.	Check the electric circuit.
(B)Operation speed is slow	1.Pump discharge quantity is insufficient.	Refer to counter-measures under Pressure is Lost section.
	2.Solenoid valve for operation operates defectively. 2.1 Burning of coils. 2.2 Spool sliding part catches. 2.3 Internal leakage.	Refer to counter-measures under. Breakdown section. Change.
	3.Adjustment of flow control valve or operation defects.	Readjust or check the sliding part.
	4.Leakage from valve cylinder.or piping to outside.	Check and repair. (change depending on damage.)
	5.Solenoid valve doesn't switch completely.	Change. or lap spool again.

MAINTENANCE AND INSPECTION STANDARD

Maintenance Systems	Name of Check Components	Check Items	Check Methods	Period	Maintenance Standards	Repair (replace) Standards	Remarks
Related to Electricity	1. motor	insulation condition	measure at 500V megger.	one year	more than 10MΩ between grounds.		
	2. control circuit	do.	do.	one year	more than 10MΩ between grounds.		
	3. electric wire cord	do.	check the wire cord in general.	one year	more than 10MΩ between grounds.		
	4. electric wire pipe	do.	do.	one year			
hydraulic system	1. hydraulic operating fluid	pipng condition	check the piping in general.	one year	no looseness at screw joints.	tighten up.	
		quantity of oil	measure by level gauge.	one month	quantity of oil should be within regulated range.	change the oil in the tank every 6 month request the oil-maker to inspect sample.	
		purity of oil	ask the sample oil maker.			if heavily worn in a short period, recheck the centering.	
		chain coupling	disassembly and check.	one year	existence of abnormal sounds, wear of chain.	when heavily worn, replace with a new one.	
	2. hydraulic pump	abnormal sound	check by listening, measure by decibel meter.	four months	usually 75-95 decibels.		dirtiness of hydraulic operating fluid loading of filter, valve chattering.
		thermometer	fit thermometer to the pump main body by joint.	one year	maximum 80°C.	when temperature rises rapidly, check the pump and other related components.	
		pressure	measure by pressure gauge.	two months	maintain the regulated pressure without variation.		
		oil leakage air suction	check visually and by touch, put grease, etc., on intake pipe.	two months		change packings.	look out for aging in pump shaft seal.

Maintenance Systems	Name of Check Components	Check Items	Check Methods	Period	Maintenance Standards	Repair(replace) Standards	Remarks
hydraulic system	3. filter	foreign matter attachment	take out and check visually, according to indicator. (yellow)	two months	no foreign matters attached to the surface and no damaged spots.	in case of foreign matter attachment, change the oil.	never use dirty oil.
	4. pressure gauge	pressure measurement	measure by master gauge.	one year	error should be within 1/2 minimum graduation.	replace when error is large, or if gauge is damaged.	
	5. thermometer	temperature measurement	same as above.	one year	same as above.	same as above.	
	6. pressure control valve	pressure control	check by pressure gauge, control from maximum to minimum pressure.	two months	pressure can be kept without change, and control is possible.	if the pressure change is great, check the inside; if abnormal, change.	related to pump and other components.
	7. flow control valve	flow control	measure the speed of cylinder.	one year		when operation is defective, check inside; if abnormal, change.	
	8. stop valve	internal leak	shut the valve and check outside leaks.	one year	according to the purpose for use, no internal leak.	if there is leakage, change.	
	9. solenoid valve	insulation condition	measure at 500V megger.	one year	more than 10M Ω between grounds.		
		voltage measurement	with amperemeter, measure the maximum voltage during operation.	two months	be in permeable range of rated voltage.	when voltage change is big, recheck electric equipment.	coils burn if voltage is out of permeable range.
		operation sound	check by listening.	one year			
		wear of bush rod and looseness of screws	check the shape, looseness of screw of terminal piece and casing.	two months	no burr on edge surface, no looseness at any part.	change the worn parts. Loose screws are a cause of coil burning.	
	10. check valve	operation condition	pressure gauge, coil cover part temperature.	two months	temperature rise at confirmation coil part, under switching condition is less than 85°C.	when operation is defective, change parts; or, depending on the content, change the whole.	depending on the type, more than regulated flow makes operation defective.
		internal leak	increase pressure outside, remove, and check leak.	one year	according to the purpose for use, no internal leak.	in case of leakage, change, depending on the content.	

Maintenance Systems	Name of Check Components	Check Items	Check Methods	Period	Maintenance Standards	Repair (replace) Standards	Remarks
hydraulic system	11. pressure switch	insulation condition	measure st 500V megger.	one year	more than 10MΩ between grounds.		
		operation condition	measure by pressure gauge.	two months	confirm operation within setting pressure range.		
	12. hydraulic cylinder	operation condition	check for smooth operation.	two months	apply corresponding to JIS standards.	in case of operation defects, inside.	related to pump, valves, etc.
		oil leakage (external)	check visually and by touch.	two months	no external leakage.	change packing.	
	13. oil reserver	oil leakage	same as above.	one year	no oil leakage.		especially welded parts
		oil leakage	same as above.	two months	same as above.	change packing.	especially parts which have packing.
	14. piping	vibration	same as above.	two months	pipe shouldn't vibrate greatly during switching.	if it's caused by surge pressure, examine the circuit.	
		pipe support fittings	same as above.	six months	no looseness and nothing missing.	tighten up.	



06/2005

Soil
system

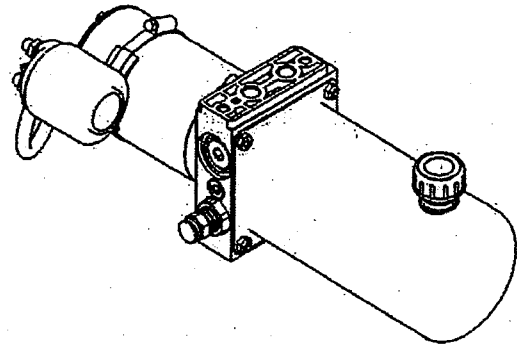
HYDRAULIC POWER PACKS

Rev.1.2

Introduction

Oil Sistem is a leader in power packs production and offers a wide range of solutions suitable for every type of application. Oil Sistem developed in years of experience a high evolved modular system that became powerful, flexible and economically competitive. This catalogue is intended to be an almost complete reference for the available power pack types.

In its easier configuration a *power pack* is an assembly of electric motor, pump, central manifold with valves, oil tank and few other connection elements. You will notice that a large variety of driving circuits would be realizable with only the central manifold and its built-in valves. If more complex circuits are needed, modular blocks will be mounted on the central manifold to extend its capabilities.



Typical applications

- | | | |
|---|---|--|
| <ul style="list-style-type: none"> ♦ Invalid lift ♦ Fork lift ♦ Car and motorcycle lift ♦ Lift tables ♦ Dumper | <ul style="list-style-type: none"> ♦ Tail gate ♦ Scissor lift ♦ Tyre changers ♦ Home lift ♦ Gangway and davits for boats | <ul style="list-style-type: none"> ♦ Material handling ♦ Press machines ♦ Dock leveller ♦ Building crane |
|---|---|--|

General characteristics

Max working pressure	From 150 to 300 bar, according to pump model.
Pump type	External gear pump.
Pump displacement	From 0,18 cm ³ /rev to 9,9 cm ³ /rev.
Electric motors	D.C. from 150 to 3000 W, A.C. from 90 to 4000 W
Oil tank capacity	From 0,5 to 60 litres

Direction for use

Installation

There are no limits in mounting positions, just avoid any installation that could compromise pump's suction. When power pack is to be fitted on structures liable to vibrations, it is better to place vibration-clamping blocks in fixing points.

Oil tank and temperature

Tank size should always be enough to assure proper pump's suction and advised maximum working temperature of 60°C. The gaskets of these power packs allow a correct working between -15°C and 80°C. After the first setting in motion it is necessary to rest the oil level. You must use oil for hydraulic units having viscosity in 15 + 68 cSt (1 cSt = 1 mm²/s), suggested between 25 and 40 cSt (3.5°E + 5.5°E). Different oil grades must be chosen according to ambient temperature and to which temperature would be reached during the unit activity.

Cleaning and maintenance

The set must be cleaned in each part because the group has only one suction filter. In case of defective work, you should check:

- oil level and conditions;
- pump efficiency;
- valves calibrations;
- battery and electric equipment efficiency.

You have to substitute the oil after 100 hours of duty the first time, and then every 3000 hours of duty (in any case at least once a year).

Wiring and starting

The wiring between batteries and electric control panel must be chosen according to the electrical inputs indicated in diagrams. THE STARTING MUST ASSURE PROPER PUMP DIRECTION OF ROTATION. IT IS STRICTLY FORBIDDEN TO INVERT THE DIRECTION OF ROTATION.

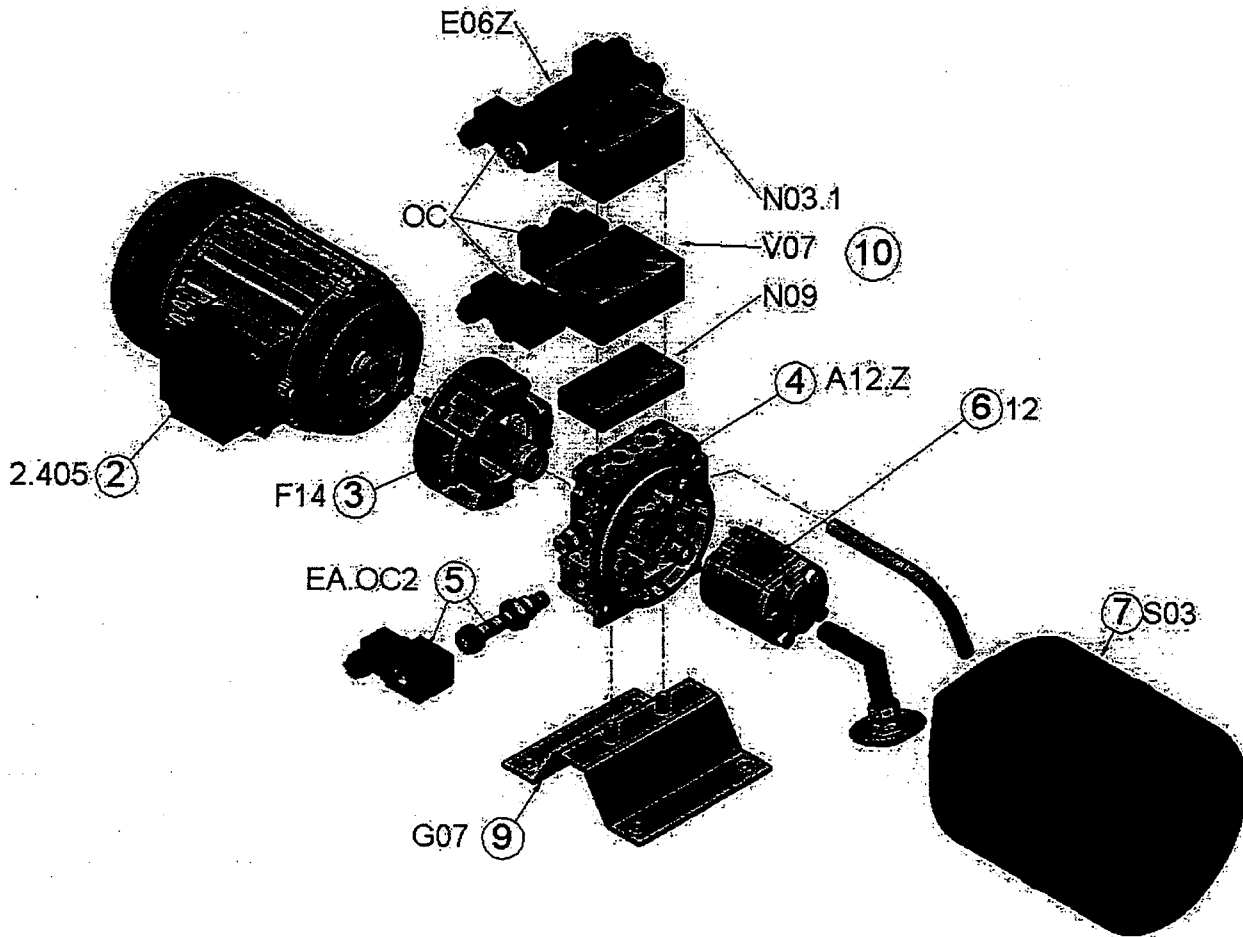
Specifications, descriptions and figures contained in this catalogue were as accurate as known at the time this publication was approved for printing. Oil Sistem S.p.A. reserves the right to discontinue models at any time, or change specifications or designs without notice or incurring obligation.

How to order

Example code:

KE	1 . C91 . B . 0	TR51	M04 . Z	MC.17 - TC2 - TC4	13	S248	O1 . R4	G80	N22
1	2	3	4	5	6	7	8	9	10

1. Power Pack type
2. Motor + starting relay and plastic protection for D.C. motors
3. Junction elements
4. Central manifold and relief valve setting
5. Built-in valves
6. Pump
7. Oil tank
8. Mounting position
9. Mounting brackets
10. Modular elements

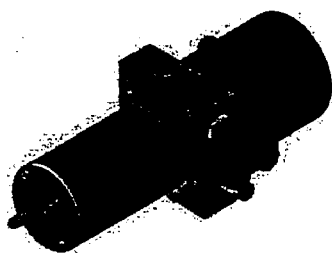


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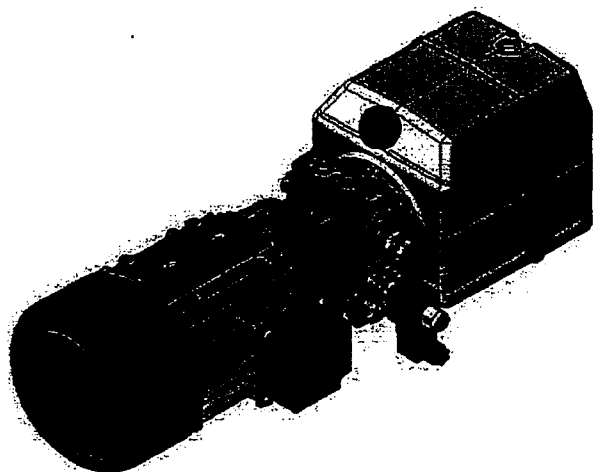
K	2.405	F14	A12.Z	EA.OC2	12	S03	O1	G07	N09-V07-N03.1.E06Z-OC
1	2	3	4	5	6	7	8	9	10

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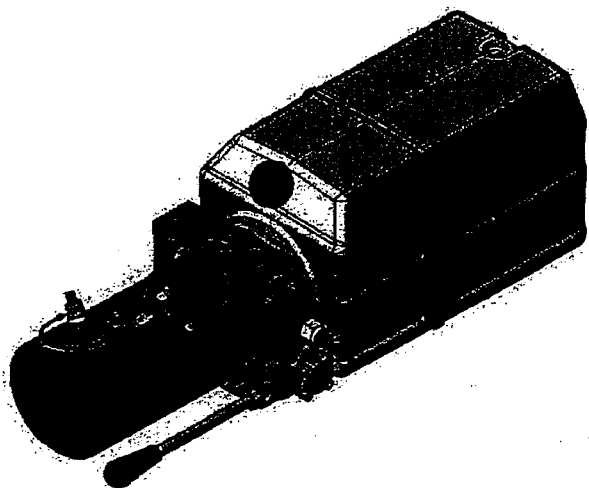
N°	Description	Code explanation and example	Reference
1	Power pack type	M E or K or K E or K S	p. 6
2	Motor + starting relay and plastic protection for D.C. motors	A . . X X X X . B . C A : 0 for power pack without motor. 1 for D.C. motor. 2 for A.C. 3-phase motor. 3 for A.C. single-phase motor. XXXX : motor's code. B : relay specification for D.C. motors. C : plastic protection for D.C. motors. Examples: 1 . C 9 1 . B . 0 2 . 2 0 5	p. 7
3	Junction elements	Example: T R 5 1	p. 9
4	Central manifold and relief valve setting	X X X . A XXX : central manifold's code. A : relief valve setting. Example: M 0 4 . Z	p. 12
5	Built-in valves	Example: E E . O C - P M C 1 2 - T C 4	p. 48
6	Pump	Example: 1 1	p. 53
7	Oil tank	Example: S 1 8 2	p. 54
8	Mounting position	Leave blank for standard position. Example: O 6	p. 64
9	Mounting brackets	Leave blank for no mounting brackets. Example: G 0 7	p. 65
10	Modular elements	Example: N 2 2	p. 66
Accessories and data			
	Suction and return pipes, filters		p. 62
	Manometer		p. 70
	D.C. motors cables kit		p. 71
	D.C. motors performance curves		p. 72

**ME**

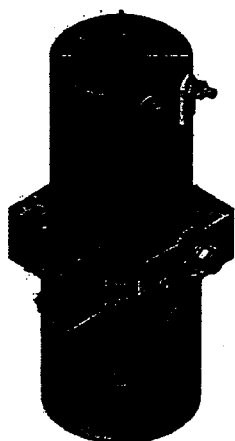
- Small overall dimensions.
- Pump group 05 from 0,18 to 1,50 cm³.

**K**

- Standardized central manifold for simple hydraulic circuits.
- Electric motor of unified dimensions.
- Pump group 1 from 0,82 to 9,9 cm³.

**KE**

- Realization of complex circuits with die casted central manifold.
- *Optional:* electric motor with direct coupling for smaller dimensions.

**KS**

- Ready solution for simple acting circuits with the possibility of unloading valve.

Please note that every power pack type can be mounted in horizontal or vertical position.

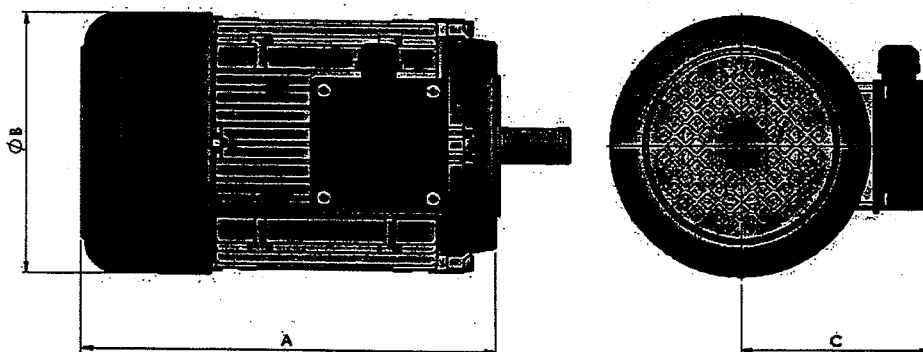
Alternate current motors 2 poles (2900 rpm at 50Hz)

Three phase motors (230-400V 50Hz IP54)									Single phase motors (220V 50Hz IP54)								
Code	Power (kW)	Power (CV)	Duty cycle	Size MEC	A (mm)	ØB (mm)	C (mm)	D (mm)	Code	Power (kW)	Power (CV)	Duty cycle	Size MEC	A (mm)	ØB (mm)	C (mm)	D (mm)
200	0,13	0,175	S1	56	169	110	95	56	200M	0,13	0,175	S1	56	169	110	95	56
201	0,25	0,34	S1	63	189	124	104	63	201M	0,25	0,34	S1	63	189	124	104	63
202	0,37	0,5	S1	71	218	140	109	71	202M	0,37	0,5	S1	71	218	140	109	71
203	0,55	0,75	S1	71	218	140	109	71	203M	0,55	0,75	S1	71	218	140	109	71
204	0,75	1	S1	80	237	156	123	80	204M	0,75	1	S1	80	237	156	123	80
205	1,1	1,5	S1	80	237	156	123	80	205M	1,1	1,5	S1	80	237	156	123	80
206	1,5	2	S1	90	255	178	128	90	206M	1,5	2	S1	90	255	178	128	90
207	2,2	3	S1	90	279	178	128	90	207M	2,2	3	S1	90	279	178	128	90
208	3	4	S1	90	279	178	128	90									
210	4	5,5	S1	112	331	219	150	112									

Alternate current motors 4 poles (1450 rpm at 50Hz)

Three phase motors (230-400V 50Hz IP54)									Single phase motors (220V 50Hz IP54)								
Code	Power (kW)	Power (CV)	Duty cycle	Size MEC	A (mm)	ØB (mm)	C (mm)	D (mm)	Code	Power (kW)	Power (CV)	Duty cycle	Size MEC	A (mm)	ØB (mm)	C (mm)	D (mm)
400	0,09	0,12	S1	56	169	110	95	56	400M	0,09	0,12	S1	56	169	110	95	56
401	0,18	0,25	S1	63	189	124	104	63	401M	0,18	0,25	S1	63	189	124	104	63
402	0,25	0,35	S1	71	218	140	109	71	402M	0,25	0,35	S1	71	218	140	109	71
403	0,37	0,5	S1	71	218	140	109	71	403M	0,37	0,5	S1	71	218	140	109	71
404	0,55	0,75	S1	80	237	156	123	80	404M	0,55	0,75	S1	80	237	156	123	80
405	0,75	1	S1	80	237	156	123	80	405M	0,75	1	S1	80	237	156	123	80
406	1,1	1,5	S1	90	255	178	128	90	406M	1,1	1,5	S1	90	255	178	128	90
407	1,5	2	S1	90	279	178	128	90	407M	1,5	2	S1	90	279	178	128	90
408	2,2	3	S1	90	279	178	128	90	408M	2,2	3	S1	100	309	194	137	100
409	3	4	S1	100	309	194	137	100									
410	4	5,5	S1	112	331	219	150	112									

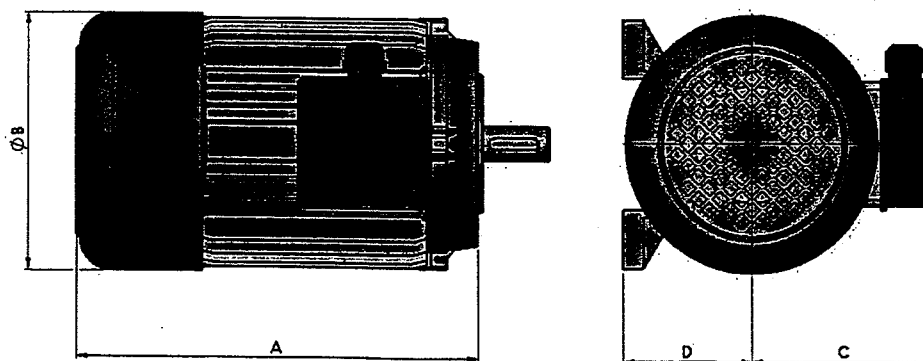
Standard A.C. motors B14 form.



Our standard A.C. motors are in B14 form.

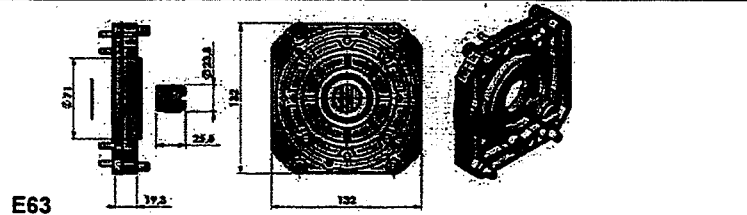
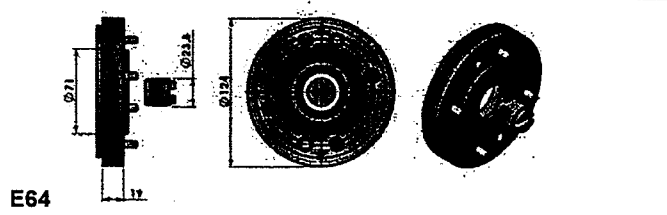
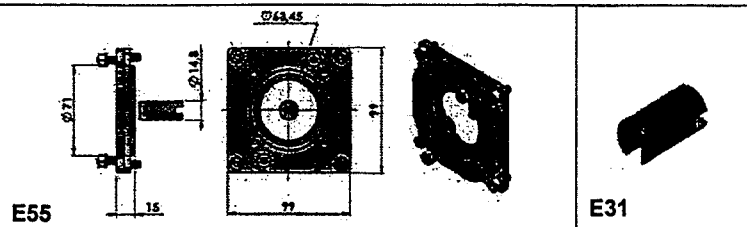
On request the same motors in B34 form are available.

In this cases, please put "B34" after the code of the motor when filling in the description.
Example "408MB34"



D.C. Motors

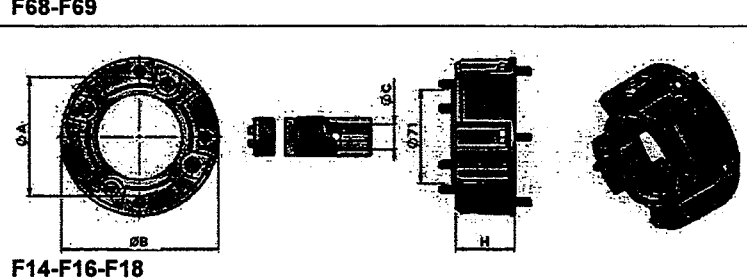
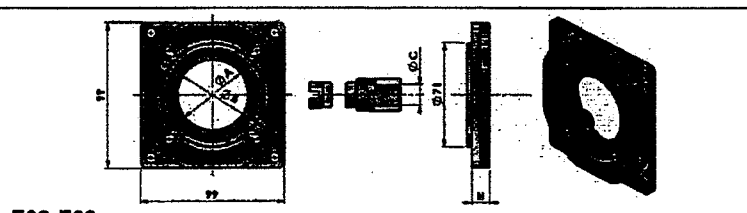
Code	Motor codes
E55	C40-C41-C67-C94-C105-C122-C123
E31	C78-C79-C91-C92-C97-C98-C102-C103-C144-C145
E64	C96-C151-C140
E63	C111



A.C. Motors

Standard couplings

Code	Motor codes	Size MEC	A (mm)	B (mm)	C (mm)	H (mm)
F69	201-201M-401-401M	63	60	-	11	12,5
F68	202-202M-402-402M	71	70	-	14	12,5
F14	203-203M-403-403M	80	80	120	19	45
F16	204-204M-404-404M	90	95	140	24	57
F18	205-205M-405-405M	110	110	160	28	67
	206-206M-406-406M	112				
	207-207M-407-407M					
	208-208M-408-408M					
	409					
	210-410					

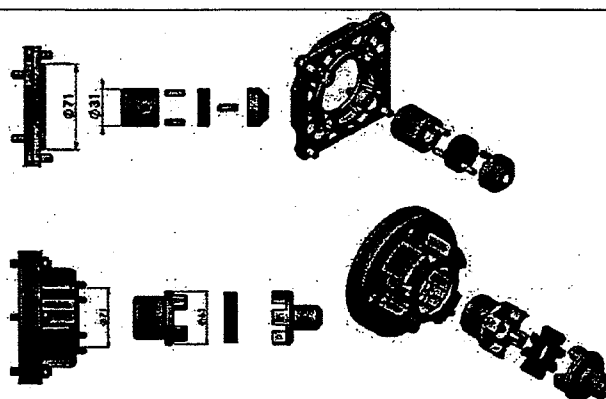


Elastic couplings

Code	Motor codes	Size MEC
F82	202-202M-402-402M	71
F24	203-203M-403-403M	80
F25	204-204M-404-404M	90
F26	205-205M-405-405M	100
	206-206M-406-406M	112
	207-207M-407-407M	
	208-208M-408-408M	
	409	
	210-410	

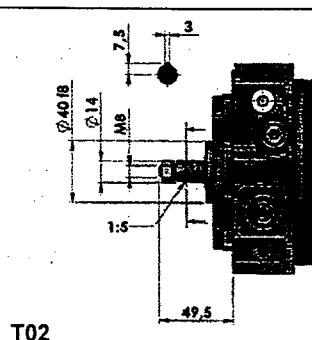
F82

F24-F25-F26

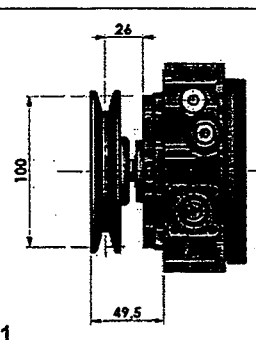


Alternative drives

Code	Description
T02	Direct drive
TC1	Direct drive with "A" belt pulley Ø100



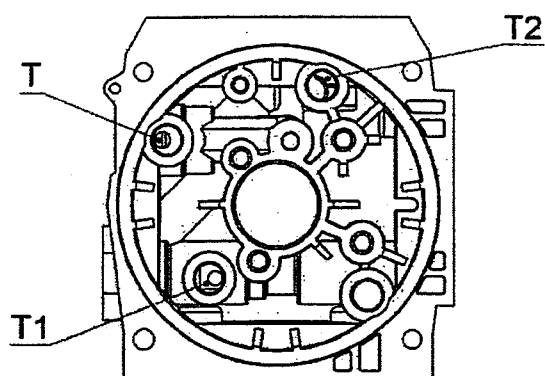
T02



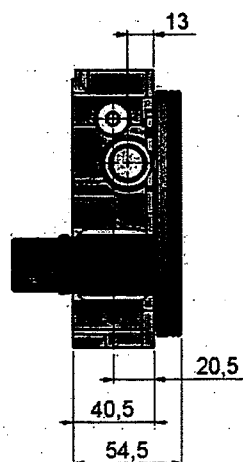
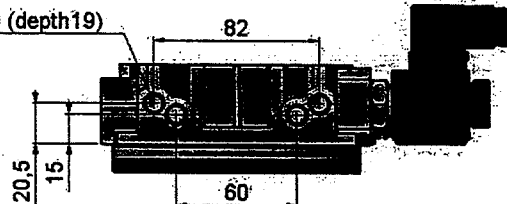
TC1

A12

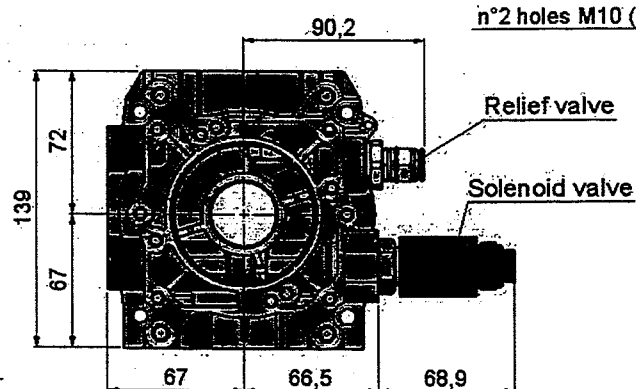
Relief valve		Pressure range (bar)	Manifold hydraulic diagram
VM15 standard	W	5 ÷ 50	
	Y	30 ÷ 120	
	Z	80 ÷ 250	
VM25 optional	W	5 ÷ 50	
	Y	10 ÷ 100	
	Z	40 ÷ 200	
	X	70 ÷ 350	



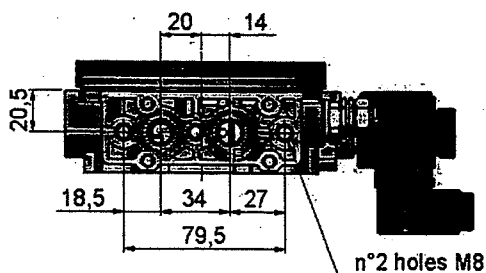
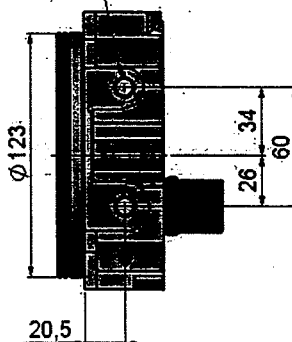
n°4 holes M10 (depth19)

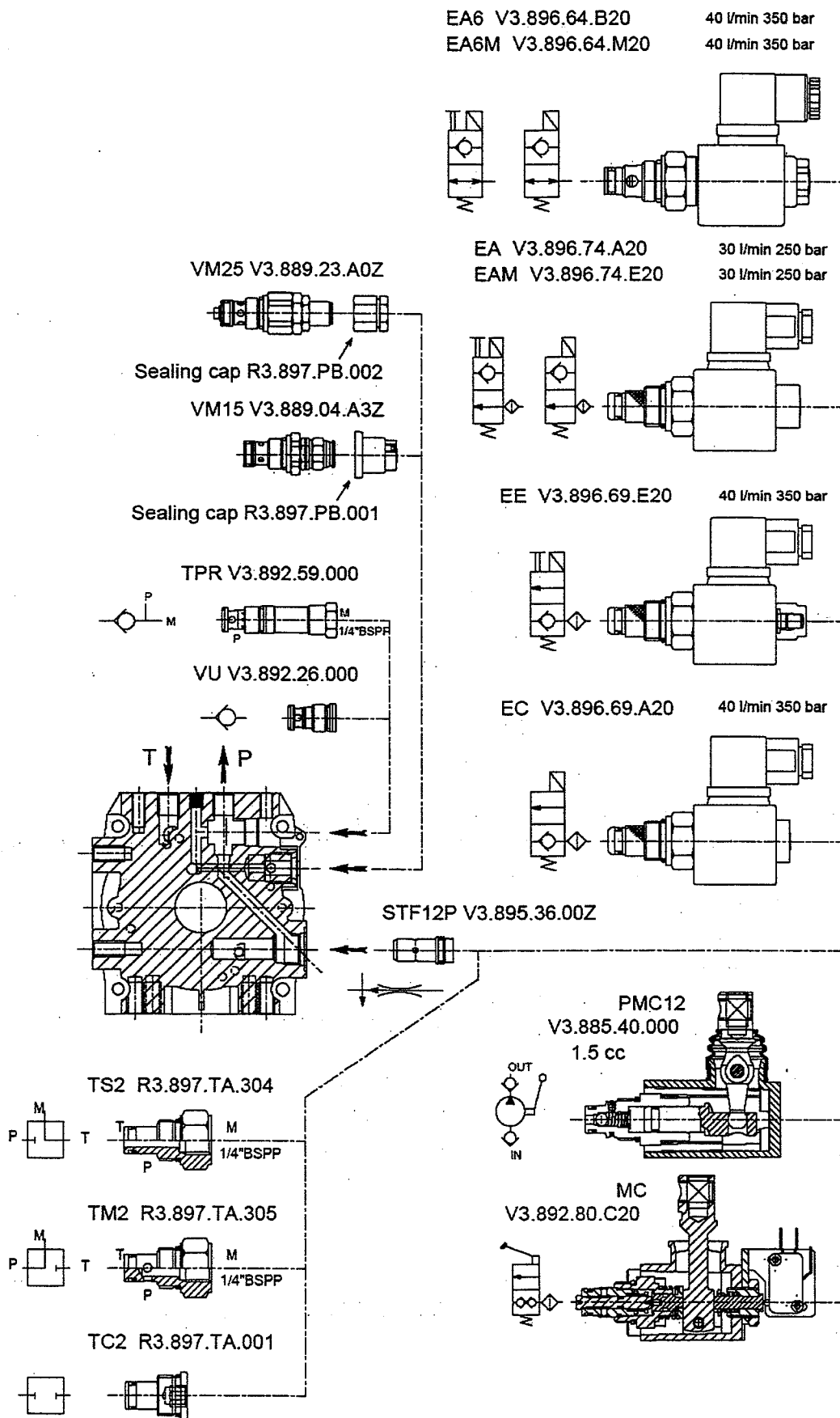


P-T = 1/4"BSPP



n°2 holes M10 (depth19)



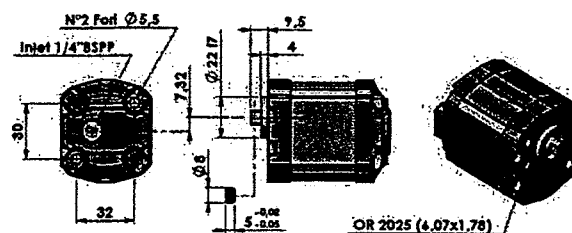


CODE	Description	Diagram	Drawing	Compatibility
TC2	Plug for cavity			ME K - KE
TS2	1/4" auxiliary return port			ME K - KE
TS3	3/8" auxiliary return port			ME K - KE
TM2	1/4" auxiliary pressure port			ME K - KE
TM3	1/4" auxiliary pressure port			KE
TM4	3/8" auxiliary pressure port			KE
ST6CP-PR	Pressure compensated flow regulator			K - KE

Please note: all pumps have anti-clockwise rotation.

Gear pumps group 05 for ME – standard version

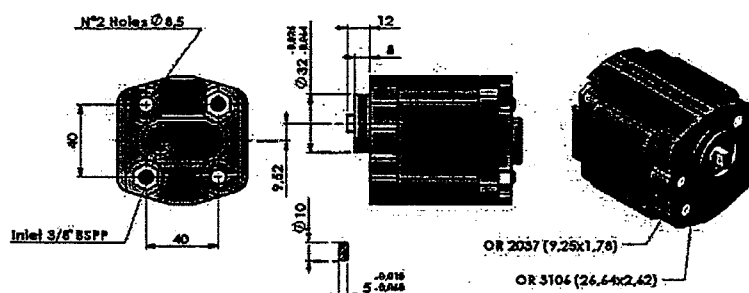
Code	Displacement (cc/rev)	Flow (l/min) @1500 rpm	P2 (bar)	P3 (bar)
L1	0,18	0,27	190	230
L2	0,25	0,37	190	230
L3	0,50	0,75	190	230
L4	0,62	0,93	190	230
L5	0,75	1,12	190	230
L6	1,00	1,50	190	230
L7	1,25	1,87	190	230
L8	1,50	2,25	190	230



P2= Intermittent max. pressure P3= Peak max. pressure (max. 2 seconds)

Gear pumps group 1 for K-KE-KS – standard version

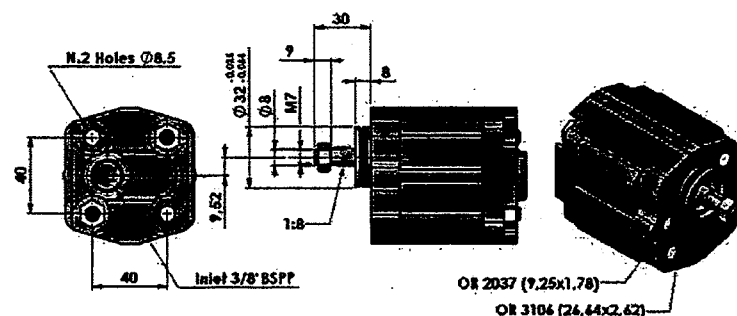
Code	Displacement (cc/rev)	Flow (l/min) @1500 rpm	P2 (bar)	P3 (bar)
10	0,82	1,3	230	270
11	1,1	1,6	230	270
12	1,6	2,4	230	270
13	2,1	3,1	230	270
14	2,7	3,9	230	270
15	3,2	4,8	210	250
16	3,7	5,5	210	250
17	4,2	6,3	210	250
18	4,8	7,2	190	230
19	5,8	8,7	190	230
20	8,0	11,8	160	200
21	9,9	14,8	150	190



P2= Intermittent max. pressure P3= Peak max. pressure (max. 2 seconds)

Gear pumps group 1 for K – elastic couplings version with tapered shaft

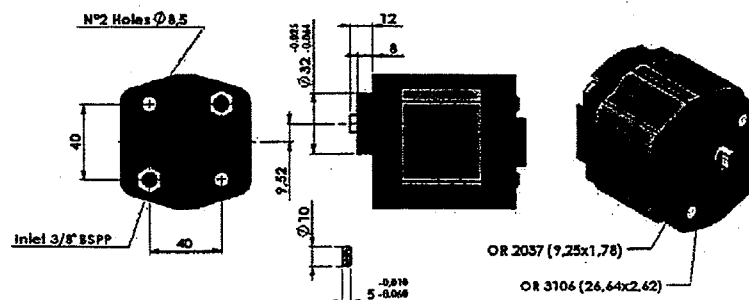
Code	Displacement (cc/rev)	Flow (l/min) @1500 rpm	P2 (bar)	P3 (bar)
10CON	0,82	1,3	230	270
11CON	1,1	1,6	230	270
12CON	1,6	2,4	230	270
13CON	2,1	3,1	230	270
14CON	2,7	3,9	230	270
15CON	3,2	4,8	210	250
16CON	3,7	5,5	210	250
17CON	4,2	6,3	210	250
18CON	4,8	7,2	190	230
19CON	5,8	8,7	190	230
20CON	8,0	11,8	160	200
21CON	9,9	14,8	150	190



P2= Intermittent max. pressure P3= Peak max. pressure (max. 2 seconds)

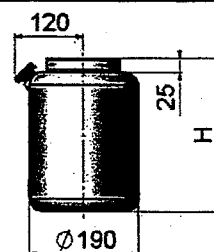
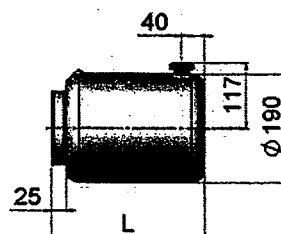
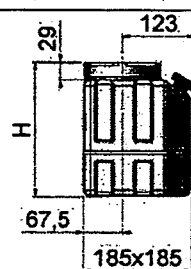
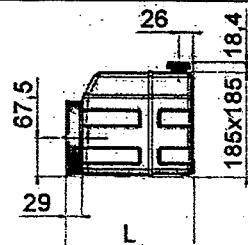
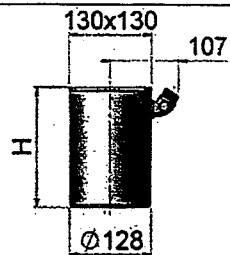
High pressure gear pumps group 1 for K-KE-KS – cast iron covers version for high pressure applications

Code	Displacement (cc/rev)	Flow (l/min) @1500 rpm	P2 (bar)	P3 (bar)
11GH	1,1	1,6	300	350
12GH	1,6	2,4	300	350
13GH	2	3	300	350
14GH	2,5	3,7	300	350
15GH	3,15	4,7	280	330
16GH	3,65	5,5	250	300
17GH	4,2	6,3	230	280
18GH	5	7,5	210	250
19GH	6,1	9,1	210	250
20GH	7,4	11,1	180	230

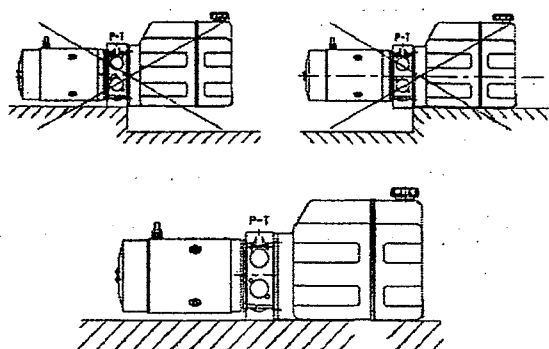


P2= Intermittent max. pressure P3= Peak max. pressure (max. 2 seconds)

CODE	Tank capacity (l)	Useable capacity (l)	H (mm)	Material
S339	1	0,6	140	PP
S340	1,8	1,1	180	PP
S341	2,5	1,7	240	PP
S342	3	2,3	285	PP
CODE	Tank capacity (l)	Useable capacity (l)	L (mm)	Material
S202	5	3,8	227	PP
S205	8	6	334	PP
S208	12	9	492	PP
CODE	Tank capacity (l)	Useable capacity (l)	H (mm)	Material
S198	5	3,5	227	PP
S191	8	6,3	334	PP
S192	12	10,8	492	PP
CODE	Tank capacity (l)	Useable capacity (l)	L (mm)	Material
S374	5	4	219	PP
S376	7	5,4	271	PP
S378	8	6,6	323	PP
S380	11	9,6	453	PP
CODE	Tank capacity (l)	Useable capacity (l)	H (mm)	Material
S375	5	4	219	PP
S377	7	5,4	271	PP
S379	8	6,6	323	PP
S381	11	9,6	453	PP



Please make sure that the tank and motor are mounted correctly

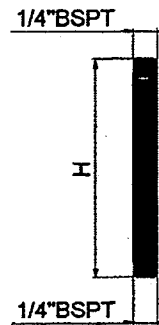


Assembly kit for plastic tank

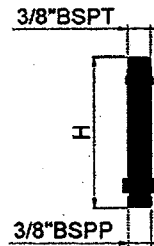
Oil tank	K	KE
S246 - S247 - S248 S249 - S250 - S251	K2.501.VT.002	K2.501.VT.007
S335 - S336 - S337 - S338 S339 - S340 - S341 - S342 S202 - S205 - S208 S198 - S191 - S192	K2.501.VT.001	K2.501.VT.006
S332 - S344 - S313 - S315 S343 - S331 - S316 - S314 S374 - S375 - S376 - S377 S378 - S379 - S380 - S381	K2.501.VT.013	K2.501.VT.014

Suction pipe
Vertical suction steel pipe

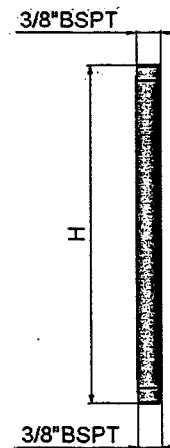
Central manifold	CODE	H (mm)
ME	M2.340.49.000	42
	K2.340.S2.009	52
	K2.340.57.000	58
	M2.340.51.000	70
	M2.340.52.000	86
	M2.340.46.000	96
	M2.340.50.000	108
	M2.340.55.000	123
	M2.340.54.000	145
	M2.340.53.000	170
	M2.340.95.000	250
	M2.340.22.000	330


Vertical suction plastic pipe

Central manifold	CODE	H (mm)
K - KE	K2.340.69.000	32
	K2.340.73.000	47
	K2.340.74.000	76
	K2.340.76.000	98
	K2.340.79.000	109
	K2.340.72.000	129
	K2.340.63.000	144
	K2.340.66.000	194
	K2.340.64.000	211
	K2.340.S2.012	240
	K2.340.S2.013	287
	K2.340.S2.014	320
	K2.340.S2.015	337
	K2.340.S2.016	358
	K2.340.S2.017	385



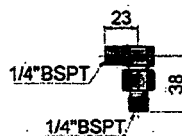
Code: K2.340.XX.000



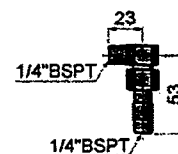
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Horizontal suction steel pipe

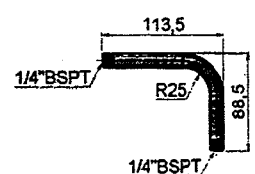
Central manifold	Oil tank diameter (mm)	CODE
ME	Ø96	K2.501.S1.319
	Ø123	K2.501.S1.320
	Ø190	M2.340.48.000



Code: K2.501.S1.319

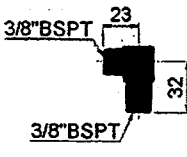
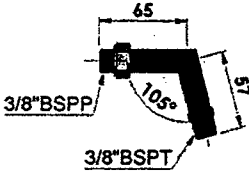
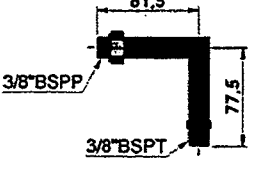
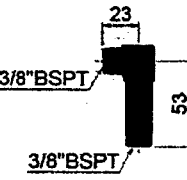
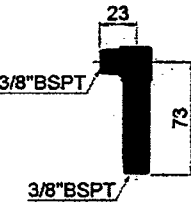
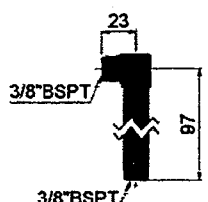


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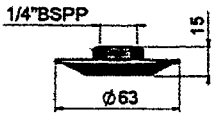
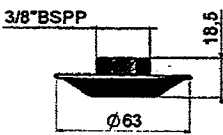
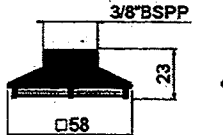


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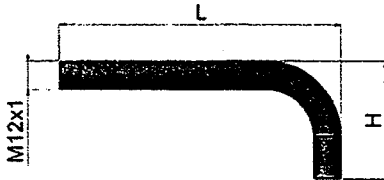
Suction pipe

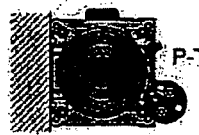
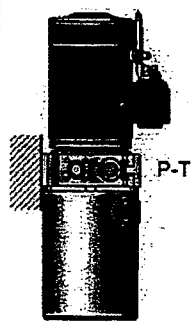
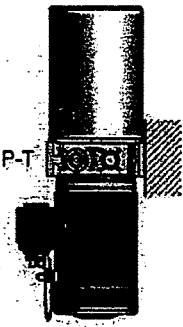
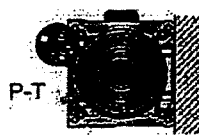
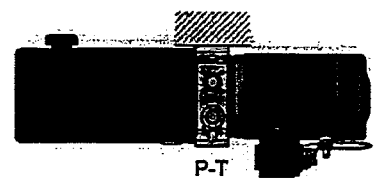
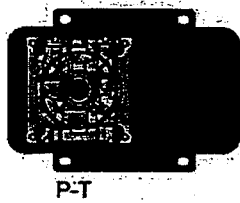
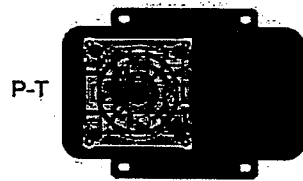
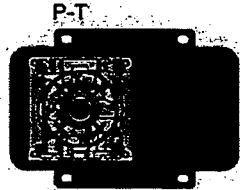
Horizontal suction, plastic pipe					
Central manifold	Oil tank diameter (mm)	CODE			
K	Ø123	K2.340.S2.004	  		
	Ø190	K2.501.S1.060			
	Ø250	K2.501.S1.061			
			Code: K2.340.S2.004	Code: K2.501.S1.060	Code: K2.501.S1.061
Central manifold	Oil tank diameter (mm)	CODE			
KE	Ø123	K2.340.S2.005	  		
	Ø190	K2.340.S2.006			
	Ø250	K2.340.S2.007			
			Code: K2.340.S2.005	Code: K2.340.S2.006	Code: K2.340.S2.007

Suction filter

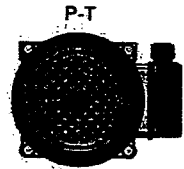
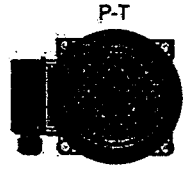
					
ME	K2.255.15.000 90 µm, 5 l/min	K - KE	K2.255.37.000 90 µm, 8 l/min	K - KE	K2.255.66.000 90 µm, 15 l/min

Return pipe

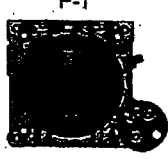
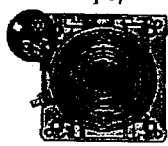
Vertical return, plastic pipe			Vertical return, steel pipe		
CODE	H (mm)		CODE	H (mm)	
K2.347.15.000	100		K2.347.18.000	250	
K2.347.14.000	150		K2.347.19.000	300	
K2.347.13.000	200		K2.347.22.000	400	
Horizontal return, steel pipe					
CODE	L (mm)	H (mm)			
K2.347.16.000	120	45			
K2.347.17.000	134	90			
K2.347.27.000	170	90			

		Mounting position			
CODE	Image	1	3	5	6
O1	1				
O2	2				
O3	3				
O4	4				
V1	5				
V2	6				
-	7				
O6	8	7 - STANDARD 	8 		
O7	9				
O8	10				
		9 	10 		

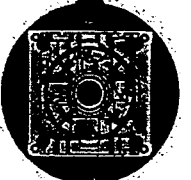
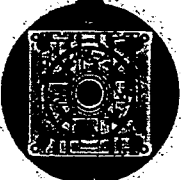
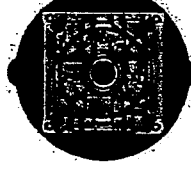
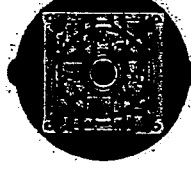
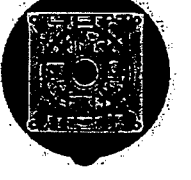
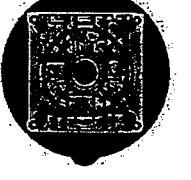
Terminal box position for A.C. motors

CODE	Image	11 - STANDARD	12
-	11		
M2	12		
M3	13		
M4	14	13 	14 

Relay position for D.C. motors

CODE	Image	15 - STANDARD	16
-	15		
R2	16		
R3	17		
R4	18		
		17 	18 

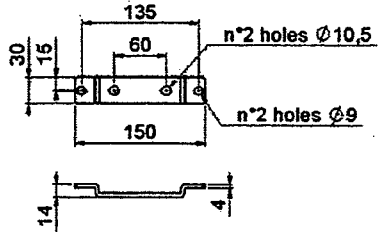
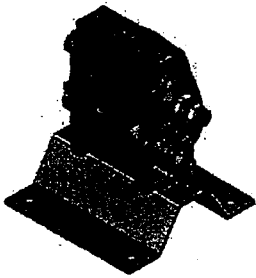
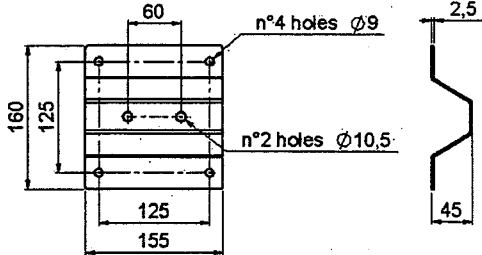
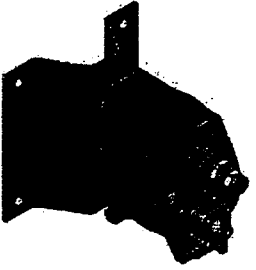
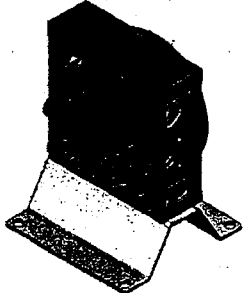
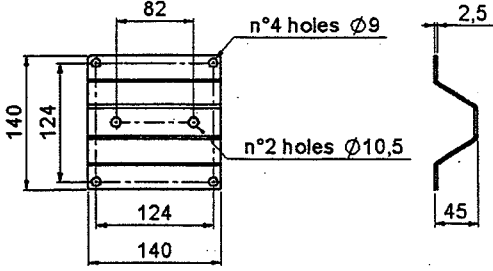
Oil cap position for V1 only

CODE	Image	19 - STANDARD	P-T	20	P-T
-	19				
LU	20				
LO	21				
LP	22				
		21	P-T	22	P-T
					

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Mounting brackets

Support

Central manifold	CODE	Drawing	
ME	G06		
K	G07		
	G07L		
KE	G80		



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