| 出図 | | - | | | | |
|---|---|---|---|---|---|---|
| 配布先＼年月日 | | | | | | |
| 船主 | | | | | | |
| 監督 | | | | | | |
| 本船 | | | | | | |
| 協会・本部 | | | | | | |
| 協会・支部 | | | | | | |
| 船営本部 | 営業部 | | | | | |
| | 業務部 | | | | | |
| | アフター | | | | | |
| 資材部 | 管理 | | | | | |
| | 購買 | | | | | |
| 品保部 | 造船 | | | | | |
| | 艦艇 | | | | | |
| | 鉄構・機 | | | | | |
| 艤装部 | 工事 | | | | | |
| | 船装1 | | | | | |
| | 船装2 | | | | | |
| | 機装 | | | | | |
| | 塗装 | | | | | |
| 修繕部 | 工事 | | | | | |
| | 船体 | | | | | |
| | 機関 | | | | | |
| 造兵部 | 電装 | | | | | |
| | 電気 | | | | | |
| | 造兵 | | | | | |
| 造船設計部 | SD | | | | | |
| | SN | | | | | |
| | SC | | | | | |
| | SF1 | | | | | |
| | SF2 | | | | | |
| | SM1 | | | | | |
| | SM2 | | | | | |
| | SE | | | | | |
| | SS | | | | | |
| 生産技術部 | | | | | | |
| 本船 | | 1 | | | | |
| 船主 | | 2 | | | | |
| 控 | | 1 | | | | |
| 合計 | | 4 | | | | |

# OASIS RIVER

S~~761~~/762

## Main Diesel Generator Engine

## (FINISHED PLAN)

| CLASS : ABS (ACCU) | SCALE : — |
|---|---|

SASEBO HEAVY INDUSTRIES CO., LTD.
SASEBO SHIPYARD
SASEBO JAPAN
FEB. 06. 2009
SHIP DESIGN DEPT.

| | |
|---|---|
| DEPT. CHIEF | K. Uyeda |
| D. DEP. CHIEF | T. Satozaki |
| SECT. CHIEF | A. Yoshida |
| IN CHARGE | T. Yamawaki |
| CHECKED BY | |
| DRAWN BY | T. Ohashi |
| DATE DRAWN | September 1, 2008 |
| WORK NO. | 1000761/1000762 |
| DRAWING NO. | --- |

SASEBO HEAVY INDUSTRIES CO., LTD.

DIESEL GENERATOR ENGINE

# DOCUMENT LIST

☐ Approval plans Please confirm documents in this list and return each one of this list & documents with your signature for approval by **11th Jan.2008.**

☐ Working plans Please receive documents in this list and return one of this list with your signature.

☐ Finish plans Please receive documents in this list and return one of this list with your signature.

customer signature

DAIHATSU DIESEL MFG. CO., LTD.
TECHNICAL DEPARTMENT
JAPAN

| | | | |
|---|---|---|---|
| HULL No. | SNO. 761/762 | DRAWN BY | M. Ochi |
| TYPE | 6DK-20 | CHECKED BY | N. Katano |
| LIST No. | AQA10005005C | | |
| DATE | 2007.9.27 | APPROVED BY | |
| REVISION | B : P2,3 2008.2.26 F.S<br>C : P3 2008.4.22 F.S | | |

ADK20-5044-6



KIDS

# DOCUMENTS LIST

LIST No. AQA10005005 C 2/3

| SHIPYARD | SASEBO HEAVY INDUSTRIES CO., LTD. | ENGINE MODEL |
|---|---|---|
| SHIP No. | SNO. 761/762 | 6DK-20 |

| No. | NAME. | DRAWING No. | REMARK | FOR APPROVAL | | | | FOR WORKING | | | | AS BUILT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | COPY | APPLY | REV | DATE | COPY | APPLY | REV | DATE | COPY | APPLY | REV | DATE |
| 1 | DOCUMENTS LIST. | AQA10005005 C | | 7 | O | B | | 5 | O | | | 4 | O | | |
| 2 | SPECIFICATIONS(JAP.). | AQA10005006 C | | | O | | | | O | | | | O | | |
| 3 | SPECIFICATIONS(ENG.) | AQA10005007 C | | 7 | O | C | | 5 | O | | | 4 | O | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | OUTLINE | AQA10005008 B | | 7 | O | B | | 5 | O | | | 4 | O | | |
| 6 | | | | | | | | | | | | | | | |
| 7 | ARRANGE OF FITTINGS | AQA10005009 C | | 7 | O | C | | 5 | O | | | 4 | O | | |
| 8 | DISASSEMBLING | E200050510Z F | | 7 | O | | | 5 | O | | | 4 | O | | |
| 9 | PIPING DIAGRAM (1) | AQA10005010 A | FO&EXH.GAS | 7 | O | | | 5 | O | | | 4 | O | | |
| 10 | PIPING DIAGRAM (2) | AQA10005011 A | SA | 7 | O | | | 5 | O | | | 4 | O | | |
| 11 | PIPING DIAGRAM (3) | AQA10005012 B | LO | 7 | O | B | | 5 | O | | | 4 | O | | |
| 12 | PIPING DIAGRAM (4) | AQA10005013 A | CW | 7 | O | | | 5 | O | | | 4 | O | | |
| 13 | | | | | | | | | | | | | | | |
| 14 | WIRING DIAGRAM | AQA10005014 B | | 7 | O | B | | 5 | O | | | 4 | O | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | SPEED SWITCH UNIT | NN00262001A E | | 7 | O | | | 5 | O | | | 4 | O | | |
| 17 | SPEED SWITCH UNIT SET | NN00262K005 A | | 7 | O | | | 5 | O | | | 4 | O | | |
| 18 | GOVERNOR CONTROL UNIT | NN00031K011 C | AC100V | 7 | O | | | 5 | O | | | 4 | O | | |
| 19 | LO PRIMING PUMP | B106605010Z Z | | 7 | O | | | 5 | O | | | 4 | O | | |
| 20 | EXH. EXPANSION JOINT | NN00271011B B | 250A x 350A | 7 | O | | | 5 | O | | | 4 | O | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | LO PRIMING PUMP STARTER | AQA10005017 A | | 7 | O | | | 5 | O | | | 4 | O | | |
| 23 | AUTO CW VALVE(3PORTS) | S10071-983Z E | | 7 | O | | | 5 | O | | | 4 | O | | |
| 24 | ORIFICE | Q399333950A A | | 7 | O | | | 5 | O | | | 4 | O | | |
| 25 | NOZZLE TEST PUMP | AQA10003156 A | | 7 | O | | | 5 | O | | | 4 | O | | |
| 26 | T/C CLEANING FITTING | AQA10003161 A | | 7 | O | | | 5 | O | | | 4 | O | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | TORSIONAL VIBRATION CAL | | | | | | | | | | | 4 | O | | |
| 29 | | | | | | | | | | | | | | | |
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| 34 | | | | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | | | | |

# DOCUMENTS LIST

LIST No. AQA10005005 C 3/3

| SHIPYARD | SASEBO HEAVY INDUSTRIES CO., LTD. | ENGINE MODEL |
|---|---|---|
| SHIP No. | SNO. 761/762 | 6DK-20 |

| No. | NAME. | DRAWING No. | REMARK | FOR APPROVAL COPY | FOR APPROVAL APPLY | FOR APPROVAL REV | FOR APPROVAL DATE | FOR WORKING COPY | FOR WORKING APPLY | FOR WORKING REV | FOR WORKING DATE | AS BUILT COPY | AS BUILT APPLY | AS BUILT REV | AS BUILT DATE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ***SPARE PARTS LIST*** | | | | | | | | | | | | | | |
| 2 | DIESEL ENGINE | AQA10005015 B | | 7 | ○ | B | | | ○ | | | | | | |
| 3 | TURBO CHARGER | B684300030F A | TPS48D | 7 | ○ | | | | ○ | A | | | | | |
| 4 | GOVERNOR | NN00035001A A | RHD6 | 7 | ○ | | | | ○ | A | | | | | |
| 5 | LO PRIMING PUMP | AQA20002219 A | | 7 | ○ | | | | ○ | | | | | | |
| 6 | LO PRIMING PUMP STARTER | AQA10005018 A | | 7 | ○ | | | | ○ | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |
| 11 | ***TOOL LIST*** | | | | | | | | | | | | | | |
| 12 | DIESEL ENGINE | Q7LT320300F E | | 7 | ○ | | | | ○ | | | | | | |
| 13 | TURBO CHARGER | B684300130F Z | TPS48D | 7 | ○ | | | | ○ | | | | | | |
| 14 | DIESEL ENGINE (2) | QE19302190F Z | | 7 | ○ | | | | ○ | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
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| 19 | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | |
| 21 | TESTING METHOD | Q7LT318450F Z | | 7 | ○ | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | ***INSTRUCTION MANUAL*** | | | | | | | | | | | | | | |
| 24 | SPEED SWITCH UNIT | Q7LT333490F Z | ENG. | | | | | | | | | 4 | ○ | | |
| 25 | TURBO CHARGER | TPS48D | ENG. | | | | | | | | | 4 | ● | | |
| 26 | GOVERNOR | RHD6 | ENG. | | | | | | | | | 4 | ● | | |
| 27 | | | | | | | | | | | | | | | |
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REPRODUCIBLE MYLAR TRACING, EACH ONE (1)

| | | | |
|---|---|---|---|
| Purchaser | | Ship owner | |
| Shipyard | SASEBO HEAVY INDUSTRIES CO.,LTD | Vessel type | 115,000DWT Tanker |
| SNo. | 761/762 | Rule, Flag | ABS-ACCU、SINGAPORE |

# 6 DK－20

## Specifications for Main Generator Engine

AC Generator 875 kVA( 700 )kW
Diesel engine 760 kW X 900 min-1

DAIHATSU

**Daihatsu Diesel Mfg. Co., Ltd.**

Total 17 pages

| | | | |
|---|---|---|---|
| Revise | B : P7,9 2007.10.19 F.S | | |
| | C : P4,7 2007.11.14 M.O. | | |
| Product No. | SNo. 761 ··· ADK20-5044-6 | Technical dept. engineering Gr. 2 | |
| | SNo. 762 ··· ADK20-5047-9 | Draw | M. Ochi |
| | SNo. ··· | Check | N. Iwatani |
| First delivery | Apr-08 | | |
| Q'ty | 3 sets/ship × 2 ships = 6 sets | Approval | A. Takeuchi |
| Dwg. No. | ADK20-5044-6 | Date | 2007/7/18 |

## 1－1. Principal particular



| | | | |
|---|---|---|---|
| 1 | Type | | In-line, single action, 4 cycle, direct injection<br>turbocharged and intercooled, water-cooled diesel engine |
| 2 | Engine type | | 6DK-20 |
| 3 | Rated output | kW | 760 |
| 4 | Revolution | min-1 | 900 |
| 5 | Cylinder numbers | | 6 |
| 6 | Bore x Stroke | mm | 200 X 300 |
| 7 | Break mean effective pressure | MPa | 1.80 |
| 8 | Maximum pressure | MPa | Below 17.0 |
| 9 | Piston speed | m/s | 9.0 |
| 10 | Over load | | 10% over load : 60min (every 12hrs) |
| 11 | Rotation | | Clockwise (right) (view from flywheel side) |
| 12 | Fuel oil consumption | g/kW･h | 197<br>5% margin, fuel oil low caloriec value : 42700kJ/kg |
| 13 | Lub oil consumption | g/kW･h | 0.8<br>Standard value on 100% load |
| 14 | Speed variation | | Momentary : within 10%<br>Permanently : within 5%, 5sec<br>Load variation : 100→0→50→100% |
| 15 | Working condition | | Ambient temperature : 5-45deg.C<br>Relative humidity : ～85%<br>Sea water temperature : upto 32deg.C<br>Cooling fresh water temp. : 70℃ at engine inlet<br>Cooling fresh water press. : 0.25～0.35MPa<br>at engine inlet<br>Max. exhaust gas pressure : 3.0kPa(300mmAq) at full load<br>F.O. viscosity : 14±1.5mm2/s{65±5sec.R.W.NO.1}at engine inlet<br>F.O. injection pump inlet press : 0.5～0.6MPa |
| 16 | Recommendable low load (Gen. Output) | | 140kW |

| Rev | | |
|---|---|---|
| | | |

| | | | | |
|---|---|---|---|---|
| 17 | Combustion air volume (room temp. 25deg.C) | | $m^3$／h | 5000 |
| 18 | Exhaust gas (at 100% load) | Volume | Nm3/h (at 0deg.C) | 4800 |
| | | Temperature at T/C outlet | ℃ | 370 |
| 19 | Necessary volume of cooling sea water | | m3/h/1eng. | 36 |
| 20 | Lubricating oil | | | Engine system oil : API service grade CD class SAE#30<br>TBN 30-40mg KOH/g<br>Turbocharger : supplied from engine system oil<br>Governor : same as engine system oil |
| 21 | Capacity (L) | Cooling water | | Engine : 85, air cooler : 23, LO cooler : 11 |
| | | Lub. Oil | | Engine : 86, LO cooler : 22, governor : 1.3<br>Sumptank : 1100<br>Volume of LO cooler should be added into sumptank volume for initial volume. |

## 1－2. AC Generator

| | | |
|---|---|---|
| 1 | Manufacturer | Nishishiba electric co., ltd. |
| 2 | Type | NTAKL－VE |
| 3 | Output | 875 kVA<br>700 kW<br>AC450V, 3Φ, 60Hz |
| 4 | Necessary engine output | approx. 741kW<br>Power factor : 0.8, generator effeciency : 94.5% |
| 5 | Bearing | Single sleeve bearing |
| 6 | Cooling method | Self vantilation air cooling type |
| 7 | Lubricating method | Forced lubricating |
| 8 | Exciting method | Self-exciting brushless |
| 9 | Insulation | F class |
| 10 | Generator supplier | Shipyard supply |

| Rev | | |
|---|---|---|
| | | |

## 2. Specifications



| | Item | | Specification |
|---|---|---|---|
| 1 | Starting, stopping method | | Remote start/stop, automatic start/stop,<br>manual start/stop, emergency auto stop<br>Start : Compressed air 2.94MPa<br>Automatic stop : control air 0.69MPa and DC24V |
| 2 | Control of NOX emission | | Statement of compliance by ABS |
| 3 | Fuel oil | | 380mm2/s at 50℃ (ISO RMH 380)<br>During initial running (150hrs) MDO to be used<br>※HFO may be used during sea trial |
| 4 | Fuel oil change-over | | Marine diesel oil change-over at start/stop<br>and low load (below 140kW – based on generator output) |
| 5 | Fuel oil supply system | | Pressurization |
| 6 | Lub oil system | | Sumptank incorporated in common bed, batch purification |
| 7 | Cooling method | Jacket | Fresh water |
| | | Cooler | Sea water |
| | | Nozzle | Non cool |
| 8 | Installation method | | Rigid |
| 9 | Coupling method to generator | | Rigid |

C

| Rev | C: 2.3 Rev. Note | |
|---|---|---|
| | | |

## 3 . Accessories



Q'ty : Quantity /1eng. Sco : Scope of Supply Ins : Installation Place

D : to be supplied by Daihatsu S : to be supplied by Shipyard O : to be supplied by Owner

E : with Engine H : to be installed on the Hull

3-1. Cooling Water System

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Cooling fresh water pump (Jacket) | 1 | D | E | Engine driven centrifugal type<br>36m3/h x 25m |
| 2 | CW piping internal treatment | 1 set | D | E | Fresh water : Parkerizing<br>Sea water : Zn plating (STPG370, SCH40) |
| 3 | | | | | |
| 4 | Air vent | 1 | D | E | 5K-15A、with ball valve |
| 5 | LO and air cooler internal treatment | 1 set | D | E | Tar-epoxy coating |
| 6 | Anode (LO and air cooler) | 1 set | D | E | Zn |
| 7 | Chemical cleaning port | 1 | D | E | Air cooler inlet and LO cooler outlet |
| 8 | | | | | |
| 9 | Butterfly valve | 2 | D | E | Air cooler outlet (Sea water cooling) |
| 10 | Orifice | each 1 | D | H | $\phi$ 20,30/80A:for cooling fresh water outlet<br>$\phi$ 5/15A:for cooling fresh water expansion line<br>$\phi$ 10/15A:for warming line<br>$\phi$ 40/80A:for auto cooling water valve by-pass |
| | | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | Fuel filter (eng inlet) | 1 | D | E | Duplex manual back wash notch wire type<br>with ragging, 200mesh |
| 3 | Fuel oil high press pipe | 6 | D | E | Block type (equivalent to double wall) |
| 4 | Nozzle cooling system | 1 | D | E | Non cool |
| 5 | | | | | |
| 6 | | | | | |
| 7 | Level switch box | 1 | D | E | FO leaked oil detect, 15L |
| 8 | FO relief valve<br>(engine outlet) | 1 | D | E | Setting pressure : 0.1～0.2MPa |
| 9 | FO piping heat treatment | 1 | D | E | Ragging and steam trace |
| 10 | | | | | |
| 11 | FO damper | 2 | D | E | Engine inlet and outlet |
| 12 | | | | | |
| | | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification | |
|---|---|---|---|---|---|---|
| 1 | Lub. Oil pump | 1 | D | E | Gear pump, engine driven<br>Capacity : 14.8m3/h<br>Normal press. : 0.4～0.5MPa | |
| 2 | | | | | | |
| 3 | Lub. Oil filter<br>(pump inlet) | 1 | D | E | Punching board type | |
| 4 | Lub. Oil filter<br>(pump outlet) | 1 | D | E | Duplex manual back wash notch wire type, with cover<br>200mesh | C |
| 5 | Lub. Oil filter for<br>turbocharger | 1 | D | E | Duplex manual back wash notch wire type, with cover<br>350mesh | C |
| 6 | Lub. Oil by-pass filter | 2 | D | E | Centrifugal type, GF-2 | |
| 7 | Sump tank | 1 | D | E | without overflow port, incorporated in common bed<br>1100L | |
| 8 | Charge/discharge port | 1 | D | E | 5K-40A | |
| 9 | | | | | | B |
| 10 | | | | | | |
| 11 | Lub. Oil cooler | 1 | D | E | Multi-tubular type, 12.0m2 | |
| 12 | Lub. Oil thermostat valve | 1 | D | E | Wax type, setting temp. 55deg.C, size50 | |
| 13 | Lub. Oil priming pump<br>(continuous priming<br>during engine stop) | 1 | D | E | Electric motor driven<br>Capacity ┌ pump : 2.5m3/h×0.2MPa<br>└ motor : AC440V、3φ、60HZ<br>0.94kW、class F、2.0A | |
| 14 | Lub. Oil purifier | | S | H | Please purify Lub.Oil as long as possible in order to keep Lub.Oil characteristics in proper condition. | |
| | | | | | | |

| Rev | | |
|---|---|---|
| | B : 3-3.9 Del.Note | |
| | C : 3-3.4.5 Add.Note | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| | | | | | |

3－4. Governing device

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Governor | 1 | D | E | Bosch made hydraulic type : RHD6-MC |
| 2 | Governor motor | 1 | D | E | Woodward made, speed changing time 8-12 seconds/Hz<br>DC 24V, 3W |
| 3 | Governor control unit | 1 | D | H | Input AC100V、8W、output DC24V<br>to be installed into MSB |
| | | | | | |

3－5. Intake/Exhaust system

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Air cooler | 1 | D | E | Fin tube type<br>DH39(Box type) |
| 2 | Turbocharger | 1 | D | E | ABB made, radial turbine, anti-coupling side<br>TPS48D |
| 3 | Exh. Gas expansion joint<br>(for T/C outlet) | 1 | D | E | Stainlass steel bellows<br>(inlet)250A x 350A(outlet) |
| 4 | T/C blower cleaning device | 1 | D | E | Water cleaning by syringe, detachable piping<br>syringe to be supplied as tool |
| 5 | Exh. Gas pipe cover | 1 | D | E | |
| 6 | | | | | |
| 7 | T/C turbine cleaning device | 1 | D | E | Water cleaning<br>gauge unit to be supplied as tool |
| 8 | Exhaust pipe treatment | 1 | D | E | Expansion joint inside exhaust pipe cover<br>Lagging covering on the flange |

| Rev | | |
|---|---|---|
| | | |

3－6. Starting air system

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | SA piping internal treatment | 1 | D | E | Parkerizing |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |

3－7. Installed and coupling parts

| | Item | Q'ty | Sco | Ins | Specification | |
|---|---|---|---|---|---|---|
| 1 | Common bed | 1 | D | E | Sounding pipe, maintenance hole, center height 1000mm | |
| 2 | Jack bolt for common bed | 1 | D | E | | |
| 3 | Step | 1 | D | E | FO injection pump side, with handrail and ladder | B |
| 4 | Turning device | 1 | D | E | Ratchet type | |
| 5 | | | | | | |
| 6 | Flywheel cover | 1 | D | E | with generator shaft cover | |
| | | | | | | |

| Rev | B : 3-7.3 Add. Ladder | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Cam shaft | 1 | D | E | Mono-block type |
| 2 | Rack indicator | 1 | D | E | |
| 3 | Engine frame safety valve | 1 | D | E | Quantity by rule requirement, Frame arrest type |
| 4 | Oil pan for strainer | 1 | D | E | Welded steel plate with drain hole |
| 5 | Name plate | 1 | D | E | Engine, panel valves<br>Unit : SI<br>Caution plate : English/Japanese, English |
| | | | | | Caution plate : Drain cock for inlet air duct to be kept 1/4 open |
| 6 | Special parts for rule | 1 | D | E | Thermal switch with pocket<br>Connection plug for press switch test<br>Fire protection of SOLAS 2000<br>PL caution plate |
| 7 | Counter flange | 1 | S | H | JIS |
| 8 | Connection plug for press switch test | 1 | D | E | PF3/8 with plug |
| 9 | Fire prevention | 1 | D | E | |
| 10 | Cylinder head cover | 6 | D | E | With check window |
| 11 | F.O. /L.O. piping spec | 1 | D | E | Steal pipe<br>unable to use union joint |
| 12 | Cylinder indicator & safety valve | 6 | D | E | With cover |
| | | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Gauge board | 1 | D | E | Elastic mounting type, L.O.・T/CL.O.・F.O.is located other position |
| 2 | Pressure gauge (bourdon tube type) | 1 | D | E | $\phi$60, anti-vibration type Glycerin filled type |
| | (1) Lub. Oil | 1 | D | E | 1.0MPa Blue mark:0.4～0.55MPa |
| | (2)T/C lub. Oil | 1 | D | E | 1.0MPa Blue mark:0.2～0.5MPa |
| | (3)Boost | 1 | D | E | 0.3MPa with damper |
| | (4)Jacket cooling water | 1 | D | E | 0.6MPa Blue mark:0.25～0.35MPa |
| | (5)Fuel oil | 1 | D | E | 1.0MPa Blue mark:0.5～0.6MPa with damper and seal pot |
| | (6) | | | | |
| | (7) Cooler cooling water | 1 | D | E | 0.4MPa |
| | (8) | | | | |
| | | | | | |
| 3 | Tachometer | 1 | D | E | 300～1500min-1 Red mark : 750～810min-1 |
| | | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 4 | Thermometer | | | | |
| | (1)Lub. Oil | | | | |
| | 1. Engine inlet | 1 | D | E | Alcohol type、100deg.C、PF1/2 |
| | 2. | | | | |
| | (2)Boost air | | | | |
| | 1. Air cooler outlet | 1 | D | E | Alcohol type、100deg.C、PF1/2 |
| | (3)Jacket cooling water | | | | |
| | 1. Engine inlet | 1 | D | E | Alcohol type、100deg.C、PF1/2 |
| | 2. Engine outlet | 1 | D | E | Alcohol type、100deg.C、PF1/2 |
| | 3. | | | | |
| | (4)Fuel oil | | | | |
| | 1. Engine inlet | 1 | D | E | Mercury type、200deg.C、PF1/2、L=100 |
| | (5) Cooler cooling water | | | | |
| | 1. LO cooler inlet | 1 | D | E | Alcohol type、100degC、PF1/2 |
| | 2. | | | | |
| | 3. | | | | |
| | (6) | | | | |
| | 1. | | | | |
| | 2. | | | | |
| | (7)Exhaust gas | | | | |
| | 1. Each cylinder outlet | 6 | D | E | Mercury type、520deg.C、PF1/2 |
| | 2. Turbo charger inlet | 1 | D | E | Mercury type、620deg.C、PF1/2 |
| | 3. | | | | |
| | | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Pressure transmitter | | | | Power DC24V, output 4～20mA／0～F.S. |
| | (1) LO engine inlet | 1 | D | E | Range : 0-1.0MPa<br>Alarm setting 0.25MPa below<br>Daihatsu supply |
| | (2) Cooling fresh water engine inlet | 1 | D | E | Range : 0-0.6MPa<br>Alarm setting 0.15MPa below<br>Daihatsu supply |
| | (3) FO engine inlet | 1 | D | E | Range : 0-1.0MPa<br>Alarm setting 0.35MPa below<br>Daihatsu supply |
| | (4) Starting Air engine inlet | 1 | D | E | Range : 0-4.0MPa<br>Alarm setting 1.5MPa below<br>Daihatsu supply |
| 2 | Thermometr sensor (thermo-resistance bulb) | | | | Pt100 R100/R0=1.3850 |
| | (1) LO engine inlet | 1 | D | E | install size PF3/4、L=100<br>Alarm setting 65deg.C over<br>Daihatsu supply |
| | (2) Cooling fresh water engine outlet | 1 | D | E | install size PF3/4、L=100<br>Alarm setting 85deg.C over<br>Daihatsu supply |
| | (3) | | | | |
| | (4) | | | | |
| | (5) | | | | |
| | (6) Exhaust gas T/C inlet | 1 | D | E | install size PF3/4、L=100<br>Alarm setting 600deg.C over<br>Daihatsu supply |
| | (7) | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| | (8) | | | | |
| | | | | | |
| | | | | | |

3－11. Protective device

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Switch for alarm | | | | Abnormal contact OFF |
| | (1) | | | | |
| | (2) T/C LO pressure | 1 | D | E | 0.2MPa below<br>63QT |
| | (3) | | | | |
| | (4) | | | | |
| | (5) | | | | |
| | (6) | | | | |
| | (7) | | | | |
| | (8) | | | | |
| | (9) | | | | |
| | (10) FO injection pipe leakage | 1 | D | E | High level alarm in the leakage oil tank<br>33F |
| | (11) | | | | |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| | (12) | | | | |
| 2 | Switch for shut-down | | | | Abnormal contact ON |
| | (1) LO pressure | 1 | D | E | 0.2MPa below<br>63Q2 |
| | (2) Cooling water temp. | 1 | D | E | 90deg.C over<br>26W2 |
| | (3) Overspeed | 1 | D | E | 112-115%<br>12 |
| 3 | Junction box | 1 | D | E | |
| 4 | Wiring of electrical equipment | 1 | D | E | Between each equipment and junction box |

| Rev | | |
|---|---|---|
| | | |

| | Item | Q'ty | Sco | Ins | Specification |
|---|---|---|---|---|---|
| 1 | Speed sensing device | 1 | D | E | Pulse type TS |
| 2 | Speed switch unit | 1 | D | H | to be installed into MSB<br>Alarm setting: Low speed : 300min−1 13,14<br>LL speed : 30min−1 14L<br>Over speed : 112−115% 12<br>Electric source:DC24V±25%、2.5W、with bracket |
| 3 | Starting solenoid valve | 1 | D | E | Electric source:DC24Vx15W 88V<br>Control air:0.69MPa shipyard supply |
| 4 | Shutdown device | 1 | D | E | Air piston type, G type<br>with FO control device |
| 5 | Shutdown solenoid valve | 1 | D | E | Exciting trip, Control system 5V<br>Electric source:DC24VX15W, Safety system<br>Control air:0.69MPa shipyard supply |
| 6 | Each cylinder fuel cut devices | 6 | D | E | Bosch made, air piston type |
| 7 | Shutdown solenoid valve for each cylinder fuel cut devices | 1 | D | E | Exciting trip, Safety system 5S<br>Electric source:DC24VX15W<br>Control air:0.69MPa shipyard supply |
| 8 | FO control solenoid valve | 1 | D | E | for fuel control inprocess of starting 88L<br>Electric source:DC24VX15W<br>Control air:0.69MPa shipyard supply |
| 9 | Handle switch | 1 | D | E | DC30VX6A HS |
| 10 | Turning safety switch | 1 | D | E | DC30VX6A TC |
| 11 | Automatic cooling water valve | 1 | D | E | $\phi$70, 3 ports, with control valve 20W<br>Tar−epoxy corting |
| 12 | | | | | |
| 13 | Starter for LO priming pump | 1/ship | D | H | Continuous priming during engine stop<br>Start/stop controlled by 14/low speed |
| 14 | Engine side control switch box | 1 | D | E | Start push switch START<br>Change over switch COS |
| 15 | | | | | |

| Rev | | |
|---|---|---|
| | | |

3－13. Spare parts and tools

1. Standard spare parts

Spare parts will be supplied in accordance with the requirement of classification society.

Details will be described in "Spare parts list" for delivery plan.

2. Tools

Tools will be supplied in accordance with Daihatsu standard practice.

Details will be described in "Tools list" for delivery plan.

3－14. Shop trials

Details will be described in "Shop trial procedure" for delivery plan.

## 4. Etceteras

4－1. Generator:shipyard supply(including setting bolts, taper pins, adjusting bolts and plates)

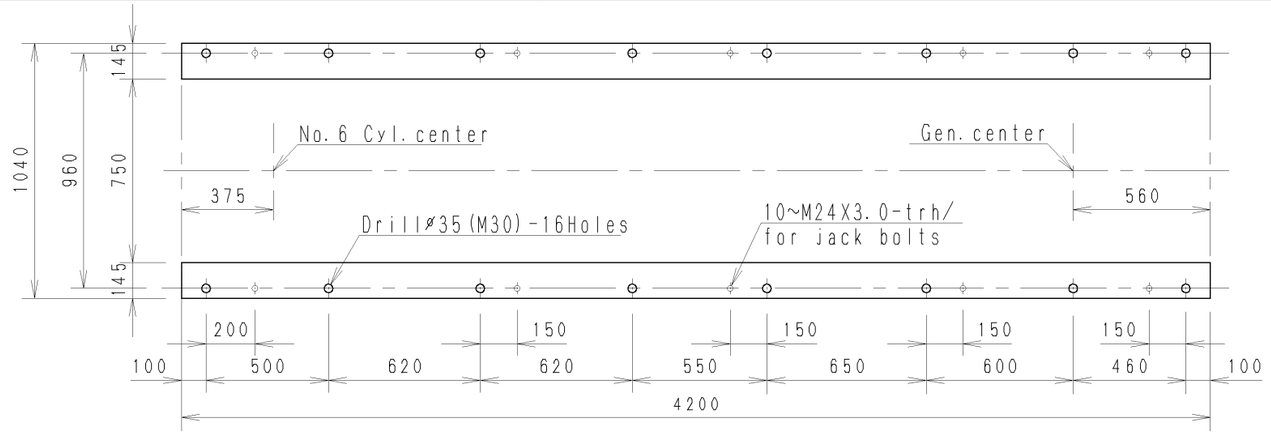
4－2. Painting color:Engine : Mansell7.5BG7/2

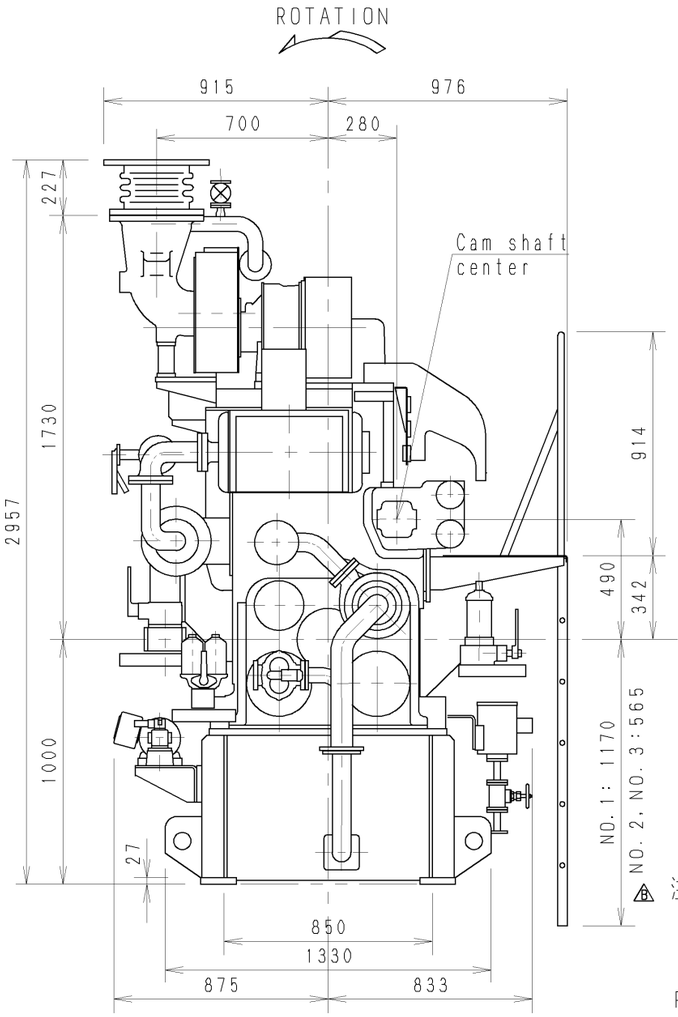
4－3. Drawings for engine

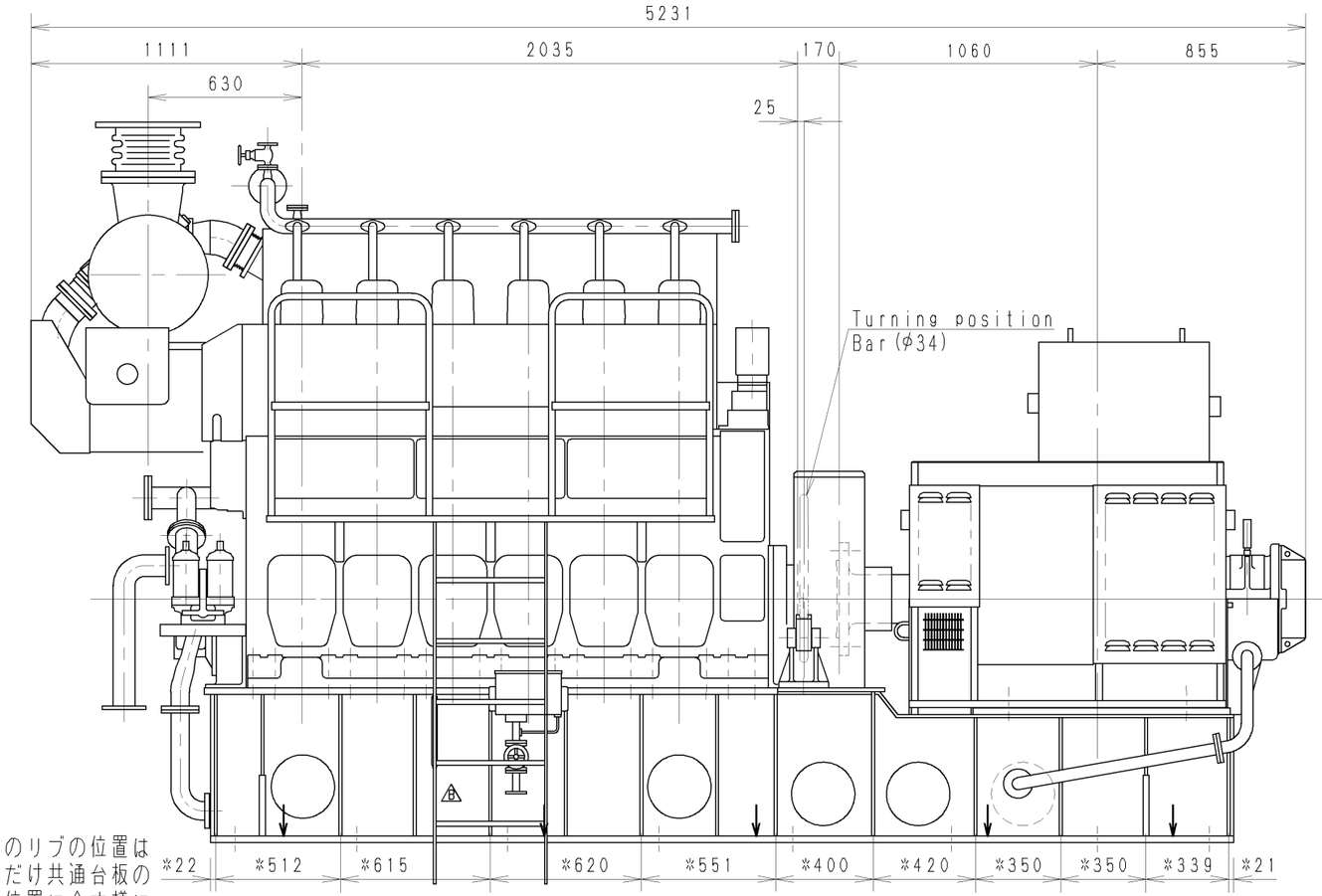
1. Delivery : 7sets
2. Working : 5sets
3. Finished : 4sets

| DIESEL ENGINE | | AC GENERATOR | |
|---|---|---|---|
| TYPE | 6DK-20 | TYPE | NTAKL-VE |
| NO. OF CYL | 6 | OUTPUT | 875 kVA |
| REVOLUTION | 900 min⁻¹ | FREQUENCY | 60 Hz |
| M A S S | 8650 kg | M A S S | 3750 kg |
| DAIHATSU DIESEL MFG.CO.,LTD. | | NISHISHIBA ELECTRIC CO.,LTD. | |

COMMON BED MASS APPROX. 1970 kg
ACCESSORY MASS APPROX. 1620 kg
SET TOTAL MASS APPROX. 15990 kg (DRY)




Ⓑ 注） 船体側のリブの位置は出来るだけ共通台板のリブの位置に合す様に御配慮願います.

Remark: Ribs of hull construction should be arranged to meet each Rib of common bed.

| | | | |
|---|---|---|---|
| Ⓑ | ADD. Ladder | 2007.10.19 | F.S |
| Ⓐ | FIRST DRAWING | 2007.10.1 | M.O |



| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. ADK20-5044-6 | MATERIAL APRV | GROUP 0 | SCALE=1:25 |
| CHECKED | | BEFORE | MASS. | QTY. | A3 |
| | HATANO NAOKAZU | REF. – | TYPE DK-20 | | |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME ガイケイズ：： | | |
| DATE | 2007/10/19 | | OUT LINE：： | | |
| | | | PARTS NO. AQA10005008 | B | ※ |

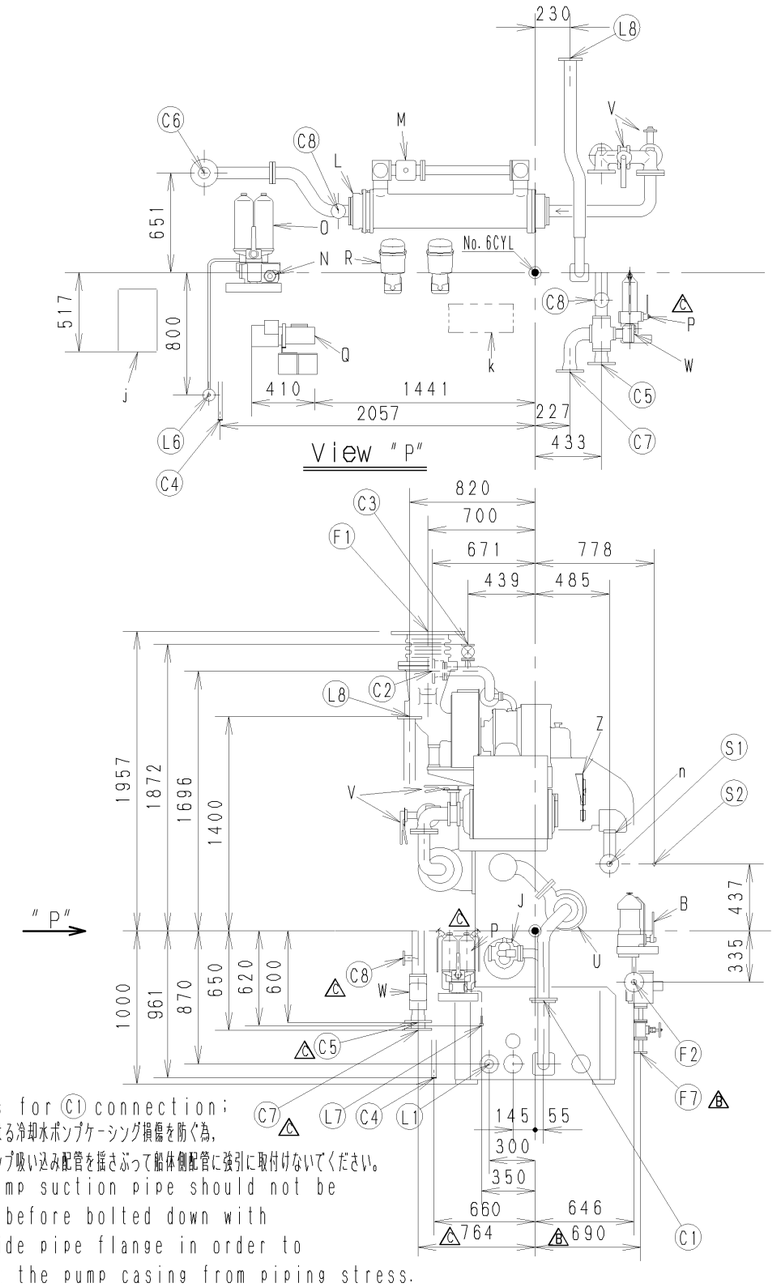
C重油仕様　FO送油ポンプなし
切替スイッチ（COS）

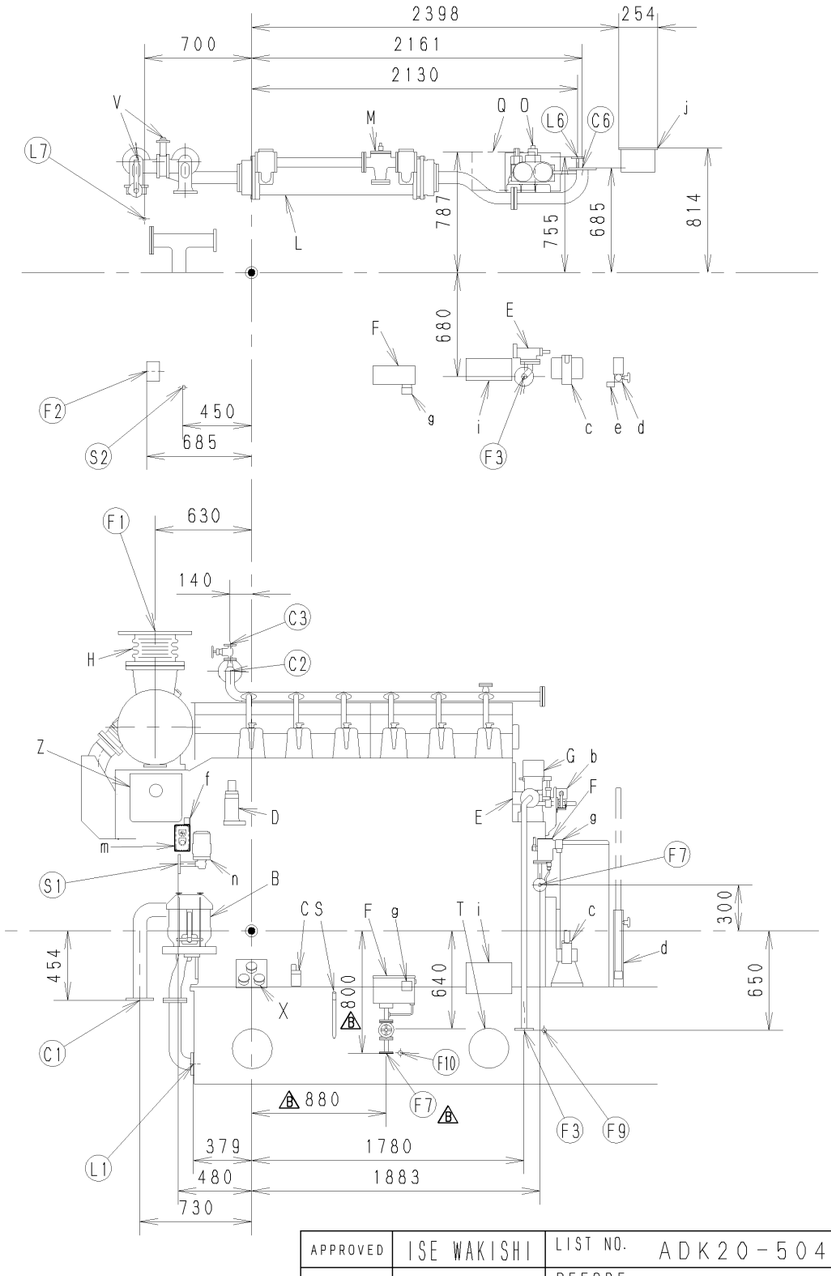
20W付（3方口）　LO補給/取出兼用（40A）

バイパスロ中（GF2）　クーラ系ケミカル座25A盲

I/C DK30型

| No. | NAME | SIZE | F7 | LEAKED OIL DRAIN | 20A | L1 | LO CHARGE & DISCHARGE PORT | 40A | L8 | CRANK CASE VENT | 65A | C5 | COOLER COOLING WATER INLET | 80A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | EXHAUST GAS OUTLET | 350A | | | | ⚠B | | | | | | C6 | COOLER COOLING WATER OUTLET | 80A |
| F2 | FUEL OIL INLET | 25A | F9 | STEAM INLET (PIPE TRACE) | φ10 | | | | | | | C7 | COOLER CW OUTLET TO BY-PASS | 80A |
| F3 | FUEL OIL OUTLET | 25A | F10 | STEAM OUTLET (PIPE TRACE) | φ10 | | | | C1 | JACKET COOLING WATER INLET | 80A | C8 | CHEMICAL CLEANING (SW SIDE) BLANK | 25A |
| | | | | | | | | | C2 | JACKET COOLING WATER OUTLET | 65A | | | |
| | | | S1 | STARTING AIR INLET | 25A | L6 | LO FILTER BLOW OFF DRAIN | 15A | C3 | JACKET CW AIR VENT | 15A | | | |
| | | | S2 | CONTROL AIR INLET | φ10 | L7 | T/C LO FILTER BLOW OFF DRAIN | φ10 | C4 | JACKET CW DRAIN | φ27.2 | | | |




Remarks for (C1) connection;
(1) 芯ずれによる冷却水ポンプケーシング損傷を防ぐ為，
冷却水ポンプ吸い込み配管を揺さぶって船体側配管に強引に取付けないでください。
(1) CW pump suction pipe should not be shaken before bolted down with hull-side pipe flange in order to protect the pump casing from piping stress.

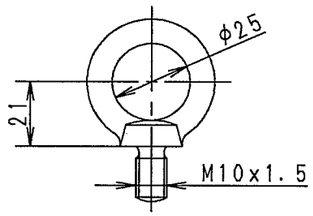
| | | | |
|---|---|---|---|
| ⚠C | Chg. C5, C7, C8 dimension, Rev. T/C LO. FILTER POSITION | 2008.02.20 | M.O |
| ⚠B | Rev. F7 (Leak oil drain pipe fitting), Del. L2 (LO. Return from purifier piping) | 2007.10.19 | F.S |
| ⚠A | FIRST DRAWING | 2007.10.15 | M.O |



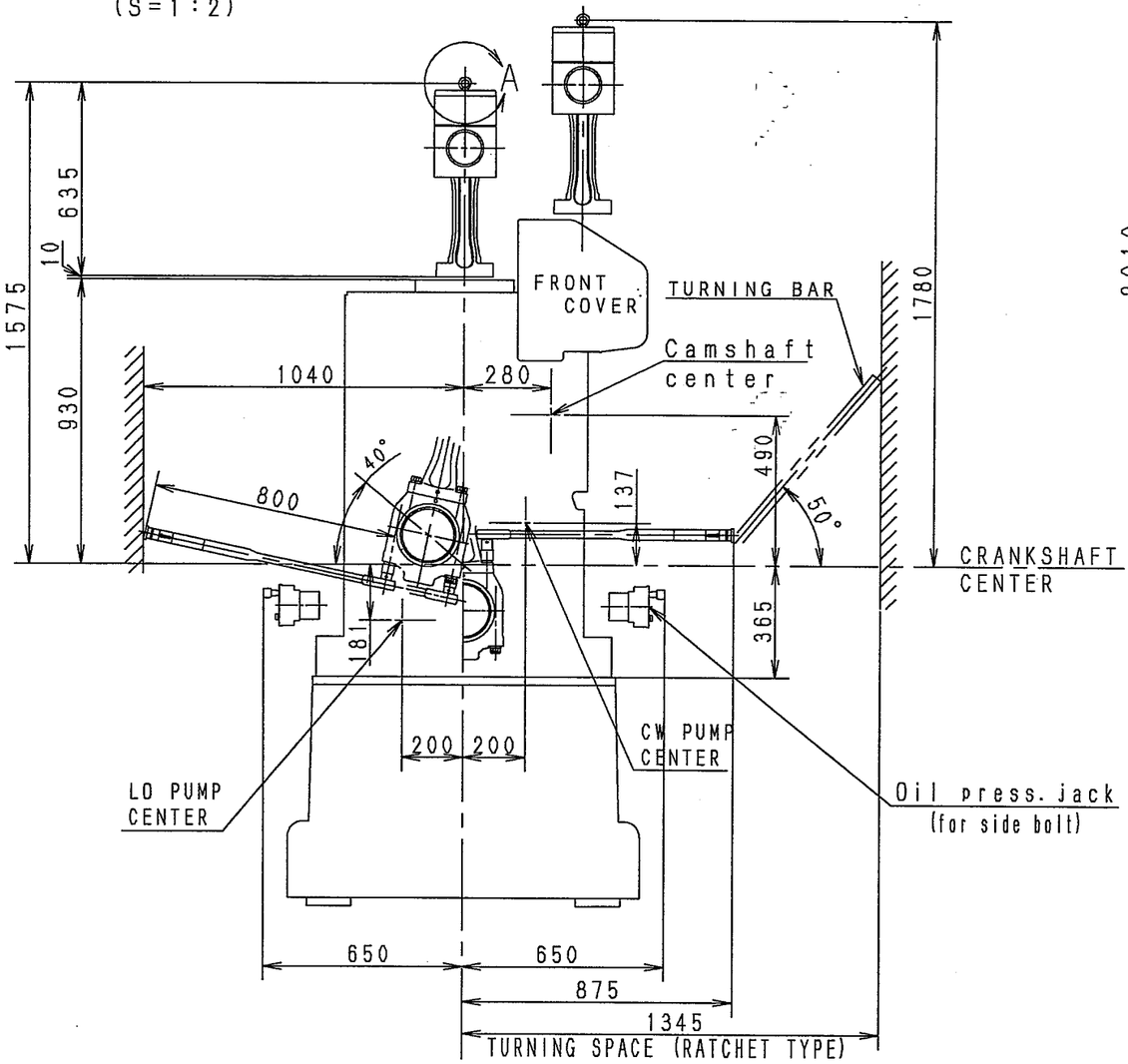
| MARK | NAME |
|---|---|
| z | |
| y | |
| x | |
| w | |
| v | |
| u | |
| t | |
| s | |
| r | |
| q | |
| p | |
| o | |
| n | MAIN AIR STARTING VALVE |
| m | START SWITCH/CONTROL POSITION CHANGE-OVER SWITCH |
| l | |
| k | SWITCH AND/OR TRANSMITTER |
| j | JUNCTION BOX |
| i | CONTROL VALVE BOX |
| h | |
| g | LEVEL SWITCH (FOR FO LEAK ALARM) |
| f | HANDLE SWITCH |
| e | TURNING SAFETY SWITCH |
| d | TURNING BAR HOLDER |
| c | TURNING DEVICE |
| b | FUEL SHUT DOWN DEVICE (G TYPE) |
| a | |
| Z | GAUGE BOARD |
| Y | |
| X | PRESSURE GAUGE (FO, LO, T/C LO) |
| W | SEA WATER VALVE |
| V | I/C BUTTERFLY VALVE |
| U | JACKET COOLING WATER PUMP |
| T | LO TANK CLEANING HOLE |
| S | LO TANK LEVEL GAUGE |
| R | LO BY-PASS FILTER (GF2) |
| Q | LO PRIMING PUMP (MOTOR DRIVEN) |
| P | T/C LUB. OIL FILTER |
| O | LUB. OIL FILTER |
| N | LUB. OIL RELIEF VALVE |
| M | LO THERMOSTAT VALVE |
| L | LUB. OIL COOLER |
| K | |
| J | LUB. OIL PUMP |
| I | |
| H | EXPANSION JOINT |
| G | GOVERNOR |
| F | LEVEL SWITCH BOX |
| E | FUEL OIL RELIEF VALVE |
| D | FUEL OIL INJECTION PUMP |
| C | FUEL OIL LINE SEAL POT |
| B | FUEL OIL FILTER |
| A | |

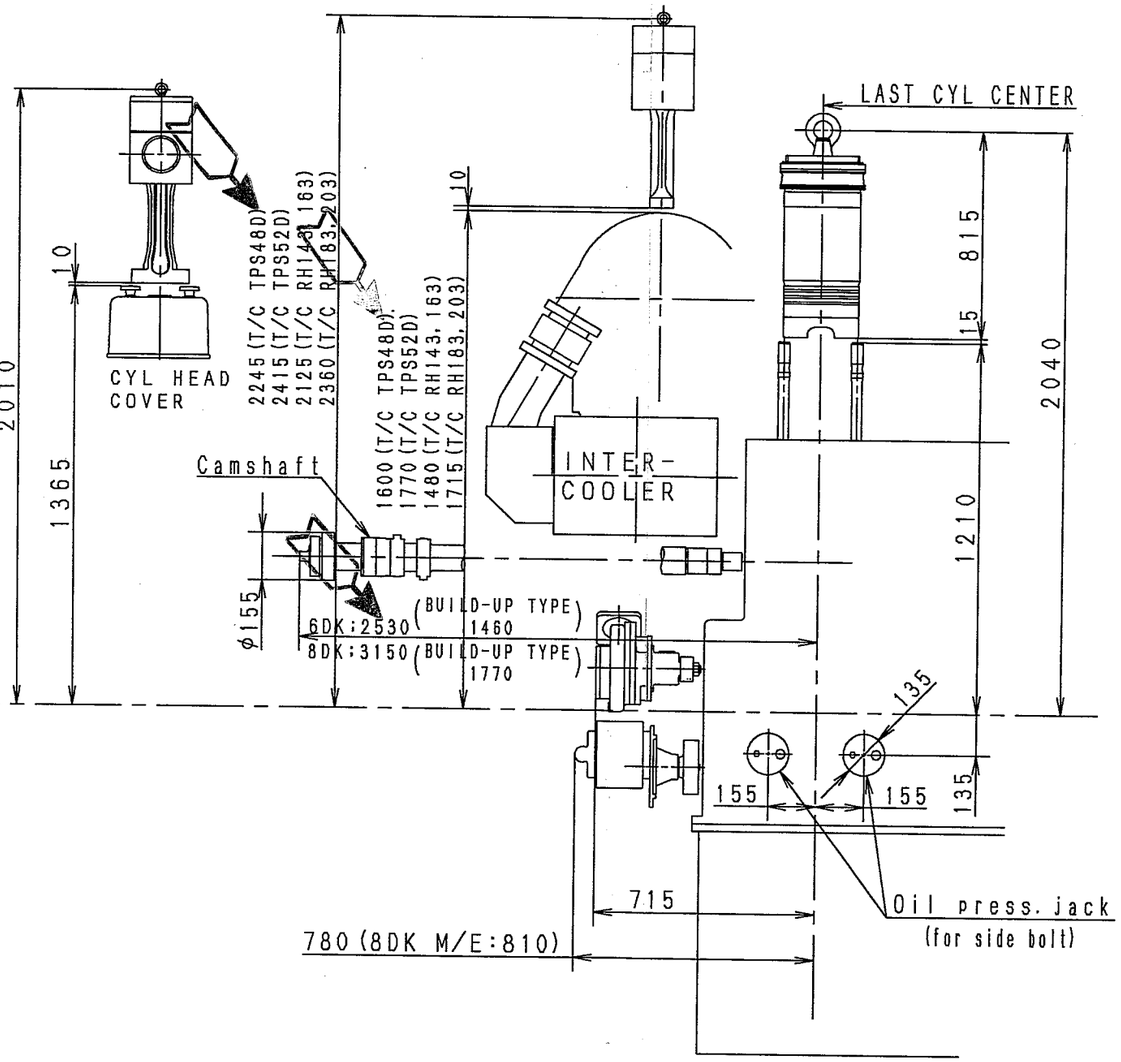
| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. ADK20-5044-6 | MATERIAL APRV | GROUP 0 | SCALE=1:40 |
| CHECKED | | BEFORE | MASS. | QTY. | A3 |
| | HATANO NAOKAZU | REF. – | TYPE DK-20 | | |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | NAME ギソウズ：： | | |
| DATE | 2008/02/20 | | ARRANGMENT OF FITTING：： | | |
| | | | PARTS NO. AQA10005009 | C | * |

| NAME OF PARTS | MASS OF PARTS |
|---|---|
| PISTON&CONNECTING ROD ASSY. | 97 Kg |
| CYLINDER LINER ASSY. | 66 Kg |
| CYLINDER HEAD ASSY. | 126 Kg |
| CAMSHAFT ASSY. (6DK) | 160 Kg |
| CAMSHAFT ASSY. (8DK) | 200 Kg |
| L.O.PUMP ASSY. | 37 Kg |
| C.W.PUMP ASSY. | 35 Kg |




Detail "A"
(S=1:2)




| | | | |
|---|---|---|---|
| F | (2-B) Add:(4~5-C~D) T/C TPS48D&TPS52D (DK-20-1792) | AUG. 24.'01 | N.N. |
| E | Change(1-B):1170(930)→1040(800) (2-A):745→650 (2-B) Add:Rod&Torquewrench=875 (DK-20-1431) | Feb. 15.'99 | T.Aiko |

| | | | |
|---|---|---|---|
| APPROVED | S. Kanno | LIST NO. E20005 | MATERIAL KUMI / GROUP 0 / SCALE=(1:20) |
| CHECKED | R. Maki / T. Aiko | BEFORE / REF. | MASS. / QTY. / A3 |
| DRAWN | K. IWAMI | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | TYPE DK-20 |
| DATE | JAN. 25.'94 | | NAME ENGINE DISASSEMBLING SPACE |
| | | | PARTS NO. E200050510 Z F |
| | | | DWG. NO. 801632 |

## Remarks

| | | | |
|---|---|---|---|
| ⊣⊢ | Flange | ⋈ (with flange) | Valve |
| ⫼ | Union joint | ⋈ | Valve (Union) |
| ⫻ | Bite joint | ⋈ | Check valve |
| ○ | Banjo joint | ⋈ | Cock |
| ∿∿ | Flexible tube | STP | Steel pipe |
| —— | By DAIHATSU | CUP | Copper pipe |
| - - - | By SHIPYARD | Ⓟ | Press. gauge |
| | | Ⓣ | Thermometer |
| ≡≡ | Steam trace with lagging | | |
| | | ⊗ | Thermo bulb conn |
| | | ⊟ | Press. switch test conn PF3/8 |

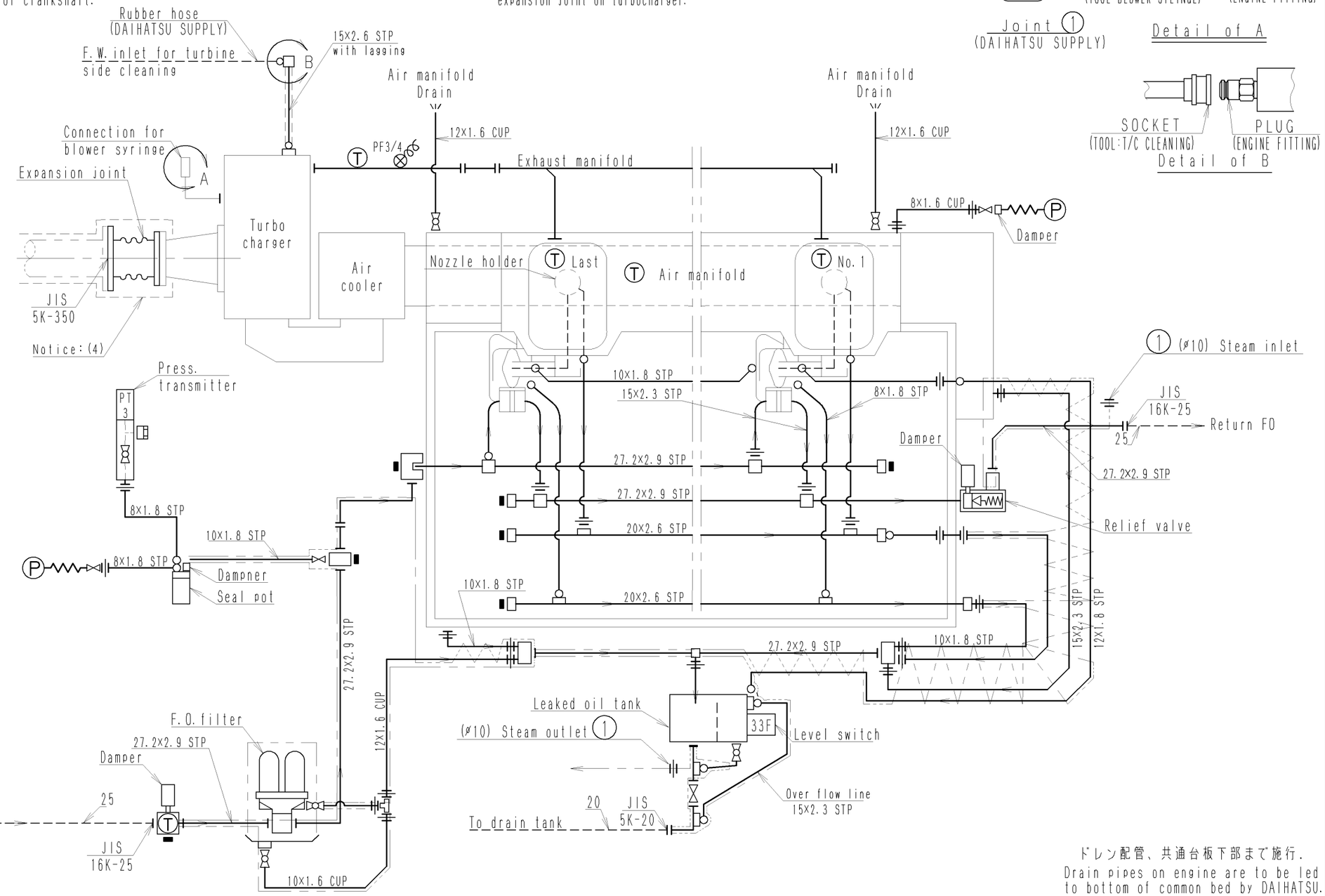
（注） ＪＩＳ標準の相フランジは支給しません.
(NOTICE) JIS Companion flanges are not supplied by DAIHATSU.

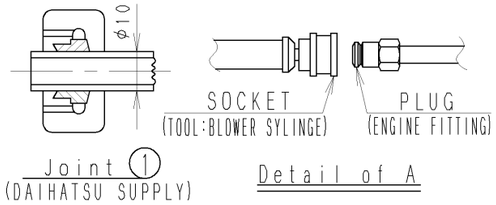
(1) DOタンクの取出口の位置は機関クランク軸中心より１．５ｍ以上の高さに設けて下さい.
Outlet of DO tank to be arranged higher than 1.5m from the center of crankshaft.

(2) 過給機空気取入口附近にはベンチレーターからの通気口を設けて下さい.
Air outlet from the ventilater to be arranged near the turbocharger air inlet.

(3) 排気伸縮接手の出口に出来るだけ近い所で、排気管は移動しないように船体側から固定して下さい。
Exhaust gas piping should be fixed immovably with hull part as close as expansion joint on turbocharger.

(4) 排気伸縮接手を含めた船体側排気管の防熱処理は、造船所にて実施ください。
Heat insulation for exhaust gas piping of hull side including the expansion joint should be carried out by shipyard.




ドレン配管、共通台板下部まで施行.
Drain pipes on engine are to be led to bottom of common bed by DAIHATSU.

| | | | |
|---|---|---|---|
| ⚠ | FIRST DRAWING | 2007.10.1 | M.O |



| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. ADK20-5044-6 | MATERIAL APRV | GROUP 0 | SCALE=- |
| CHECKED | | BEFORE | MASS. | QTY. | A3 |
| | HATANO NAOKAZU | REF. – | TYPE DK-20 | | |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME FO&EXH.ガス ケイトウズ:: | | |
| DATE | 2007/07/18 | | F.O.&EXH.GAS PIPING SYSTEM:: | | |
| | | | PARTS NO. AQA10005010 | A | * |

C 重油仕様
T/C入口温度計
圧力SWテスト用座（PF3/8）
FO圧力発信器（PT3）

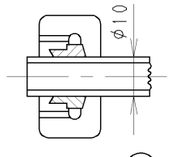
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|

## Remarks

| | | | |
|---|---|---|---|
| ⊣⊢ | Flange | ⋈ | Valve (with flange) |
| ⫼ | Union joint | ⋈ | Valve (Union) |
| ⫼ | Bite joint | ⋈ | Valve (Needle) |
| ○ | Banjo joint | | |
| ∿∿ | Flexible tube | STP | Steel pipe |
| —— | By DAIHATSU | CUP | Copper pipe |
| - - - | By SHIPYARD | Ⓟ | Press. gauge |
| | | | |
| | | ⊟ | Press. switch test conn PF3/8 |

(注) ＪＩＳ標準の相フランジは支給しません.
(NOTICE) JIS Companion flanges are not supplied by DAIHATSU.

(注) デットシップ時の始動用に制御空気を供給ください。
(NOTICE) It is necessary to be supplied control air for Dead Ship Start.




Joint ① (DAIHATSU SUPPLY)




(注) 機側始動は、始動押しボタンスイッチ（電気式）による
ＳＡ入口フランジ゛３０Ｋ－２５Ａ使用

only main pipe
Parkerizing

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| ⚠ | FIRST DRAWING | 2007.7.23 | F.S |



| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. ADK20-5044-6 | MATERIAL APRV | GROUP 0 | SCALE=- |
| CHECKED | | BEFORE | MASS. | QTY. | A3 |
| | HATANO NAOKAZU | REF. – | TYPE DK-20 | | |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME SAケイトウズ：： S.A. PIPING SYSTEM：： | | |
| DATE | 2007/07/18 | | PARTS NO. AQA10005011 | A | * |

圧力SWテスト用座 (PF3/8)

起動空気圧力SW (63AS)

LO圧力発信器 (PT1)

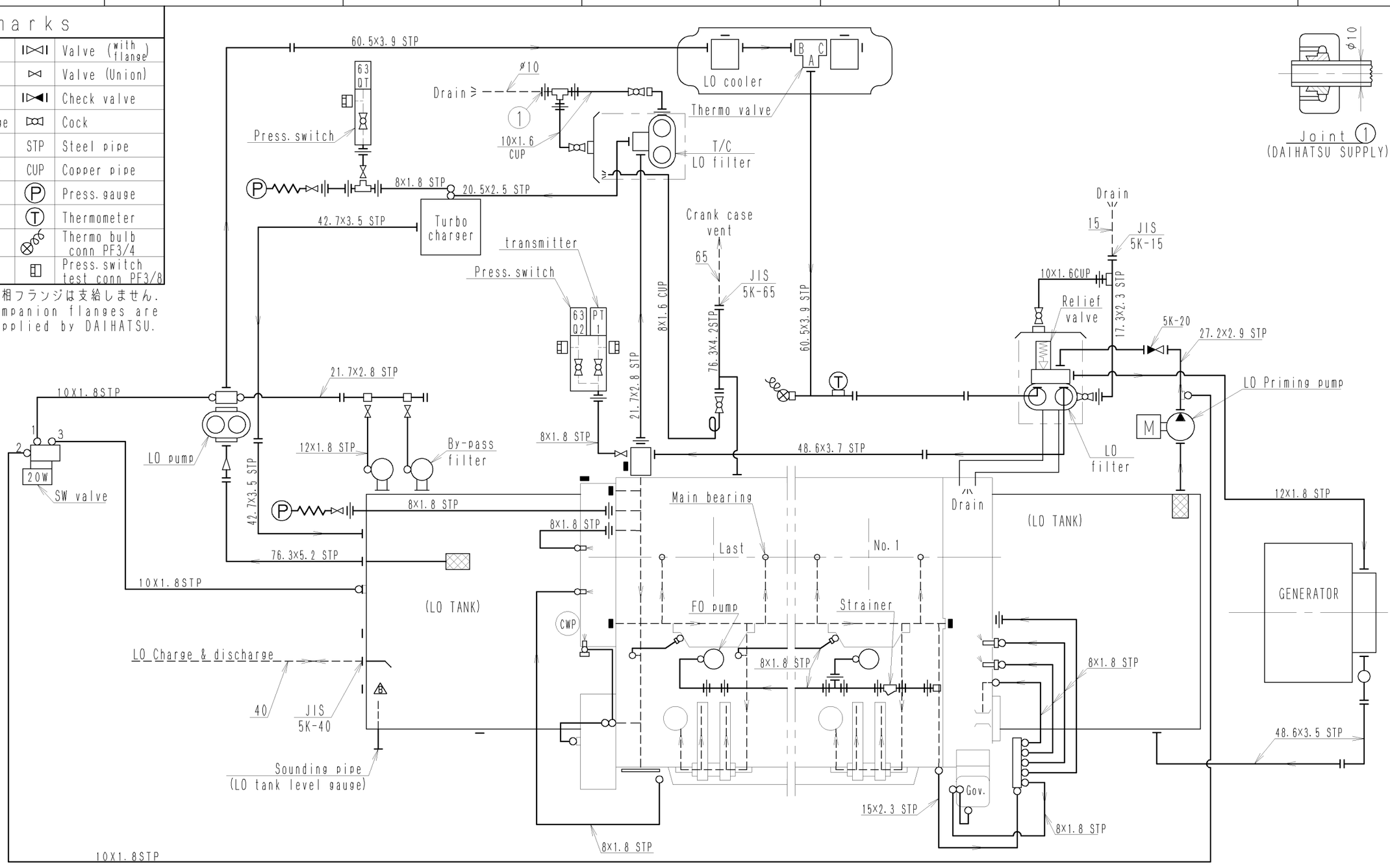
UG10ガバナ　オーバーフロ (65A) 無
GF2

GEN給油配管 (片軸受)

## Remarks

| | | | |
|---|---|---|---|
| ⊣⊢ | Flange | ⋈ | Valve (with flange) |
| ⫼ | Union joint | ⋈ | Valve (Union) |
| ⊣⊢ | Bite joint | ⋈ | Check valve |
| ⫼ | Spectacle flange | ⋈ | Cock |
| ○ | Banjo joint | STP | Steel pipe |
| ∿∿ | Flexible tube | CUP | Copper pipe |
| ◁ | Reducer | Ⓟ | Press. gauge |
| | | Ⓣ | Thermometer |
| —— | By DAIHATSU | | Thermo bulb conn PF3/4 |
| --- | By SHIPYARD | | Press. switch test conn PF3/8 |

(注)　ＪＩＳ標準の相フランジは支給しません.
(NOTICE) JIS Companion flanges are not supplied by DAIHATSU.




ドレン配管、共通台板下部まで施行.
Drain pipes on engine are to be led to bottom of common bed by DAIHATSU.

| | | | |
|---|---|---|---|
| ⚠B | Del. LO. Return from purifier piping | 2007.10.19 | F.S |
| ⚠A | FIRST DRAWING | 2007.10.15 | M.O |

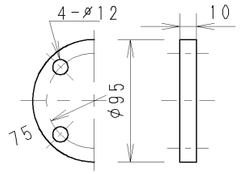


| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. | ADK20-5044-6 | MATERIAL APRV / GROUP 0 | SCALE=- |
| CHECKED | | BEFORE | | MASS. A C / QTY. | A3 |
| | HATANO NAOKAZU | REF. | – | TYPE DK-20 | |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | | NAME LOケイトウズ：： | |
| DATE | 2007/10/19 | | | L.O.PIPING SYSTEM：： | |
| | | | | PARTS NO. AQA10005012 | B ※ |

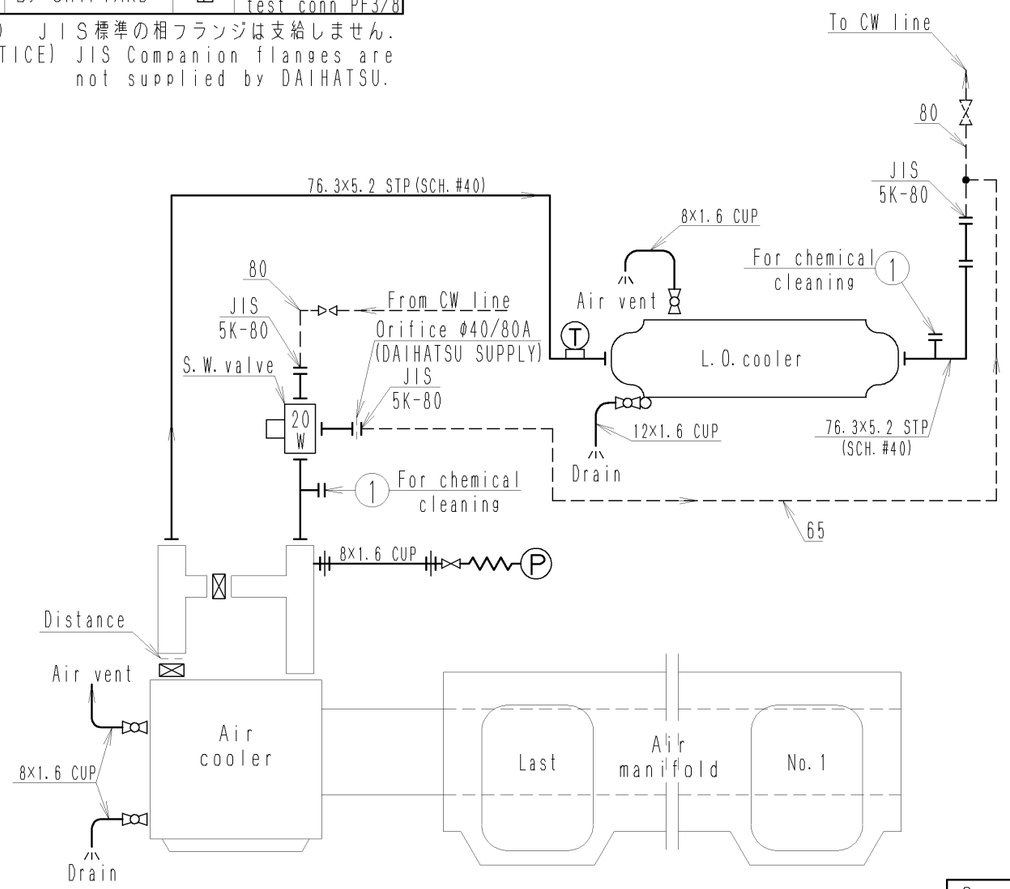
## Remarks

| | | | |
|---|---|---|---|
| ⊣⊢ | Flange | ⋈ | Valve (with flange) |
| ⫴ | Union joint | ⋈ | Valve (Union) |
| ⫴ | Bite joint | ⋈ | Check valve |
| ⫼ | Orifice | ⋈ | Cock |
| ○ | Banjo joint | STP | Steel pipe |
| ∿∿ | Flexible tube | CUP | Copper pipe |
| ≋ | Flex-master | Ⓟ | Press. gauge |
| ⊠ | Butterfly valve | Ⓣ | Thermometer |
| —— | By DAIHATSU | ⊗ | Thermo bulb conn PF3/4 |
| - - - | By SHIPYARD | ⊟ | Press. switch test conn PF3/8 |

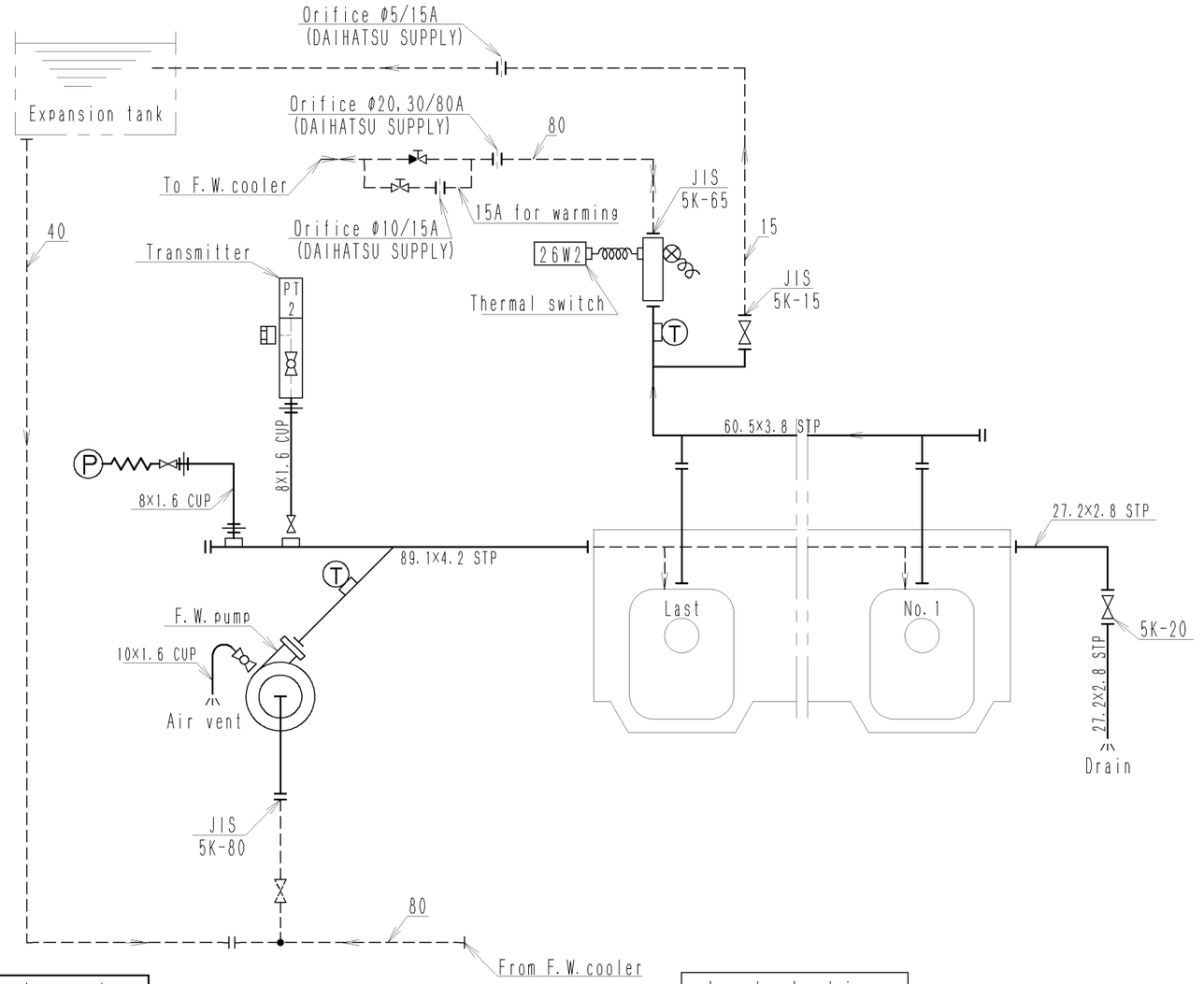
(注) ＪＩＳ標準の相フランジは支給しません.
(NOTICE) JIS Companion flanges are not supplied by DAIHATSU.




Flange ①
(DAIHATSU SUPPLY)




Cooler line




Jacket line

| Sea water pipe |
|---|
| Zn plating |

| Cooler end cover inside |
|---|
| Tar-epoxy coating |

| Fresh water pipe |
|---|
| Parkerizing |

ドレン配管、共通台板下部まで施行.
Drain pipes on engine are to be led to bottom of common bed by DAIHATSU.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| A | FIRST DRAWING | | | 2007.7.23 | F.S | | |

本図はダイハツディーゼル株式会社の所有物ですので、許可無く複写、転載及び第三者への開示を禁止します。
This drawing is the property of Daihatsu Diesel Mfg.Co.,Ltd. Reproduction,use or disclosure to third parties without express authority of Daihatsu is strictly forbidden.

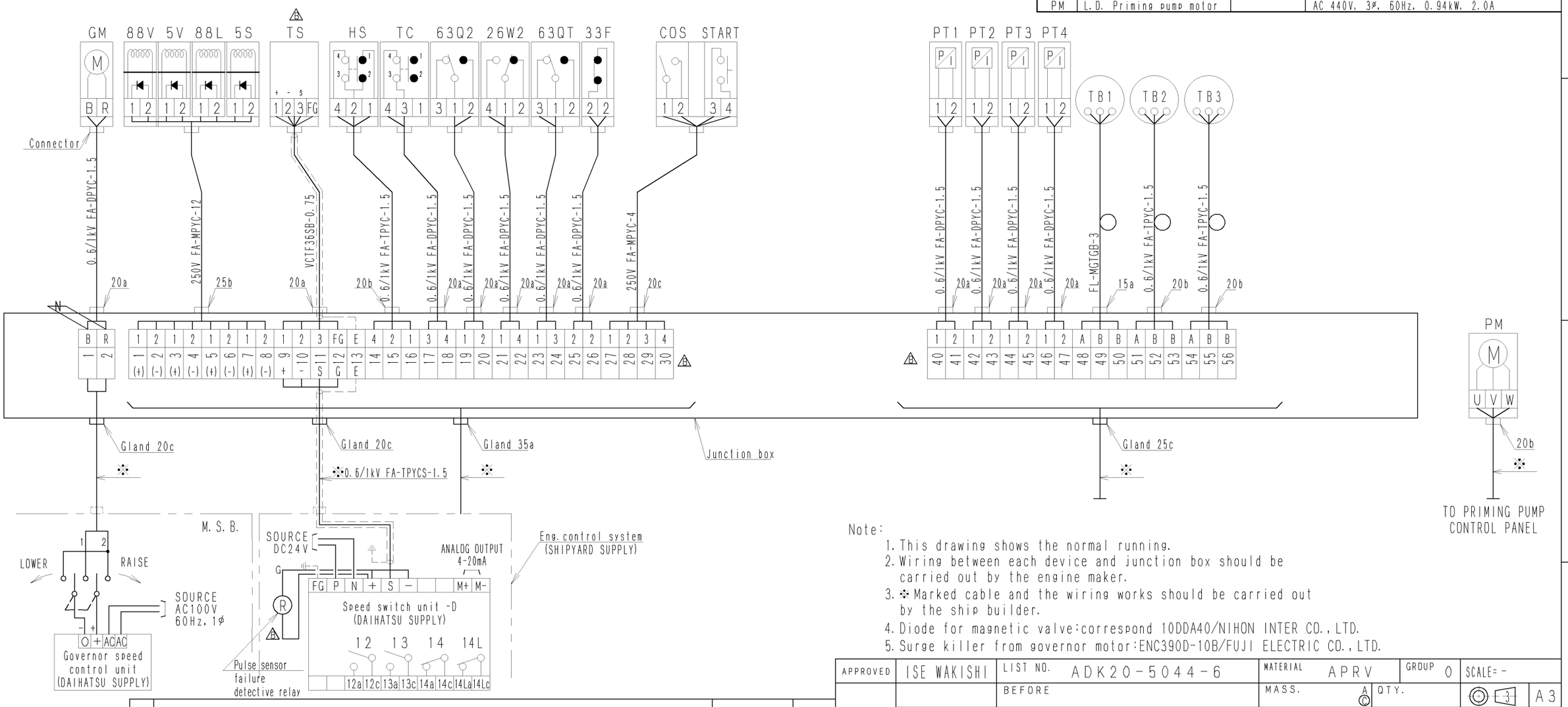
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. | ADK20-5044-6 | MATERIAL | APRV | GROUP 0 | SCALE=- |
| CHECKED | | BEFORE | | MASS. | QTY. | | A3 |
| | | REF. | – | TYPE | DK-20 | | |
| | HATANO NAOKAZU | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | | NAME | CWケイトウズ：： | | |
| DRAWN | OCHI MASARU | | | | C.W. PIPING SYSTEM:: | | |
| DATE | 2007/07/18 | | | PARTS NO. | AQA10005013 | A | ※ |

FW圧力発信器 (PT2)
クーラ系入口圧力計
ケミカル座 (入口側)(出口側) クーラ系冷却管 (SCH40, Zn)
圧力SWテスト座 (PF3/8) 20W (3方)

| MARK | NAME | USE | NOTE |
|---|---|---|---|
| TB1 | Exh. gas T/C inlet temp. | IND. & Alarm | Over 600 °C DAIHATSU SUPPLY |
| TB2 | L.O. engine inlet temp. | IND. & Alarm | Over 65 °C DAIHATSU SUPPLY |
| TB3 | F.W. engine outlet temp. | IND. & Alarm | Over 85 °C DAIHATSU SUPPLY |
| PT1 | L.O. engine inlet press. | IND. & Alarm | Below 0.25 MPa DAIHATSU SUPPLY |
| PT2 | F.W. engine inlet press. | IND. & Alarm | Below 0.15 MPa DAIHATSU SUPPLY |
| PT3 | F.O. engine inlet press. | IND. & Alarm | Below 0.35 MPa DAIHATSU SUPPLY |
| PT4 | S.A. engine inlet press. | IND. & Alarm | Below 1.5 MPa DAIHATSU SUPPLY |

| MARK | NAME | USE | NOTE | REMARKS |
|---|---|---|---|---|
| 63Q2 | L.O. Press. switch | Stop | Below 0.2 MPa (1-2) ON | Normal open |
| 26W2 | F.W. Thermal switch | Stop | Over 90 °C (1-4) ON | |
| COS | Change Over Switch | Local/Remote | Select remote start position contact (1-2)ON | |
| START | Start switch | Start | When pushing the switch, contact (3-4)ON | |
| 33F | Level switch (Leaked oil tank) | Alarm | When F.O. High press. pipe broken contact (2-2) OFF | |
| 63QT | T/C LO Press. switch | Alarm | Below 0.2 MPa (1-3) OFF | Normal close |

| MARK | NAME | USE | NOTE | REMARKS |
|---|---|---|---|---|
| GM | Governor motor | Speed control | Hydraulic constant speed governor control DC 24V | |
| 88V | Start air magnet. valve | Start | DC 24V, about 0.3A | |
| 14, 13 | Low speed contact | Control | Over 300min$^{-1}$, contact(14C-14A)ON, (13C-13A)OFF | |
| 14L | Contact for interlock | Start interlock | Over 30min$^{-1}$, contact..! (14LC-14LA)ON OFF delay 8 seconds | |
| 12 | Over speed contact | Stop | Over 112~115%, contact... (12C-12A)ON | |
| TS | Speed sensor | Speed detect | Pulse sensor type | |
| 5V | Fuel shut down magnetic valve | Control & safety | DC 24V, 0.7A, Fuel shut down when solenoid magnetized | Exciting trip |
| 5S | Fuel shut down magnetic valve | Safety | DC 24V, 0.7A, Fuel shut down when solenoid magnetized | |
| 88L | Fuel control piston magnetic valve | Fuel control | DC24V, 0.7A FO control in starting process when solenoid magnetized | |
| TC | Turning safety switch | Stand-by | When turning bar used contact (3-4).....OFF | Normal close |
| HS | Handle switch | Stand-by | At running position contact (2-4)..ON, (1-2)..OFF | |
| PM | L.O. Priming pump motor | | AC 440V, 3φ, 60Hz, 0.94kW, 2.0A | |




Note:

1. This drawing shows the normal running.
2. Wiring between each device and junction box should be carried out by the engine maker.
3. ※ Marked cable and the wiring works should be carried out by the ship builder.
4. Diode for magnetic valve:correspond 10DDA40/NIHON INTER CO., LTD.
5. Surge killer from governor motor:ENC390D-10B/FUJI ELECTRIC CO., LTD.

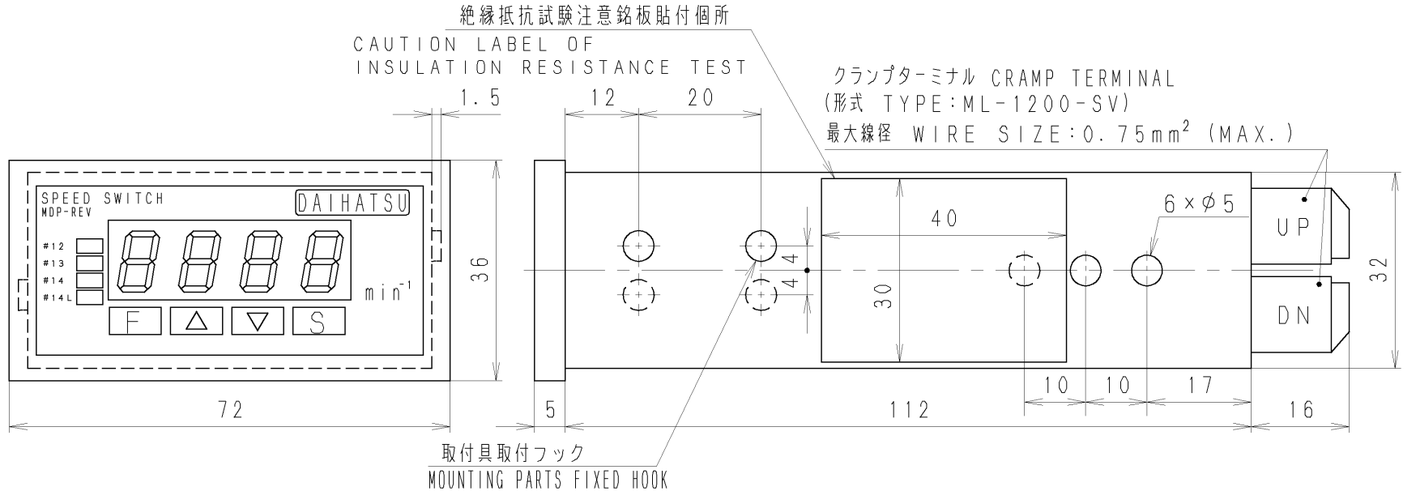
| | | | |
|---|---|---|---|
| B | Add. Relay, Chg. Terminal No. | 2007.11.12 | M.O |
| A | FIRST DRAWING | 2007.10.1 | M.O |



| | | | |
|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. ADK20-5044-6 | MATERIAL APRV / GROUP 0 / SCALE=- |
| CHECKED | | BEFORE | MASS. / QTY. / A3 |
| | HATANO NAOKAZU | REF. – | TYPE DK-20 |
| DRAWN | OCHI MASARU | DAIHATSU DIESEL MFG.CO., LTD. OSAKA JAPAN | NAME ケッセンズ：： |
| DATE | 2007/11/12 | | WIRING DIAGRAM：： |
| | | | PARTS NO. AQA10005014 B ※ |

遠隔温度センサー配線は1回ルーブのこと

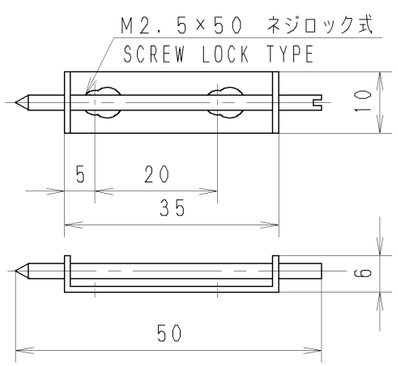
FOA口遠隔圧力 ガバナ RHD(DC24V)




入出力コネクタ
I/O CONNECTOR

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 24Vdc | | SENSOR | | | FREQUENCY OUTPUT | | ANALOG OUTPUT (4~20mA) | |
| FG | P | N | + | S | − | F+ | F− | M+ | M− | 上側コネクタ UPPER CONNECTOR |
| | | 12a | 12c | 13a | 13c | 14a | 14c | 14L a | 14L c | 下側コネクタ LOWER CONNECTOR |
| | | | OVER | | RATED | | LOW | | LOWLOW | |

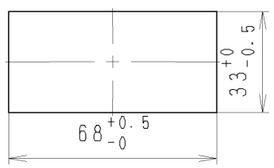
OUTPUT CONTACT




| 端子番号 TERMINAL NUMBER | 用途 OBJECT | | |
|---|---|---|---|
| FG | :フレームグランド | FRAME GRAND | |
| P | :DC24V | | |
| N | :0V | | |
| + | :DC24V | PULSE INPUT | センサ SENSOR |
| S | :パルス入力 | | |
| − | :COM | | |
| F+ | :周波数出力 | FREQUENCY OUTPUT | |
| F− | :COM | | |
| M+ | :電流出力 | CURRENT OUTPUT | オプション OPTION |
| M− | :COM | | |

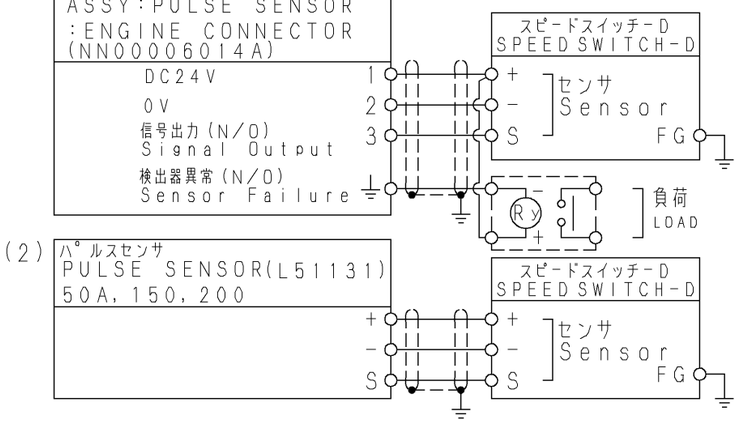
| | | |
|---|---|---|
| 12a | :#12検知接点 | #12 DETECTION CONTACT OUTPUT |
| 12c | : | |
| 13a | :#13検知接点 | #13 DETECTION CONTACT OUTPUT |
| 13c | : | |
| 14a | :#14検知接点 | #14 DETECTION CONTACT OUTPUT |
| 14c | : | |
| 14La | :#14Lタイマー接点 | #14L TIMMER CONTACT OUTPUT |
| 14Lc | :(※使用にあたっては「マニュアル」参照のこと | REFER TO THE MANUAL.) |

パネルカット
PANEL CUT




| | | |
|---|---|---|
| 電源 | POWER VOLTAGE | DC24V(±25%)リップル10%以下 / 24VDC(±25%)RIPPLE 10% OR LESS |
| 消費電力 | POWER CONSUMPTION | 最大3.2W / 3.2W MAX. |
| 計測精度 | MEASURING ACCURACY | 0.05%±1digit atF.S. ±0.5% atF.S.(アナログ出力) / 0.05%1digit atF.S. ±0.5% atF.S.(analog output) |
| 計測範囲 | MEASURING RANGE | 2Hz~7kHz/0~9990min⁻¹ / 2Hzto7kHz/0to9990min⁻¹ |
| 入力 INPUT | | パルスセンサ出力信号 (ロー:8V以下 ハイ:15V以上) / PULSE SENSOR OUTPUT SIGNAL (LOW:under 8V HI.:Over 15V) |
| 出力 OUTPUT | アナログ出力 ANALOG | 4~20mA (負荷抵抗最大500Ω) / 4to20mA (load registance500Ω MAX.) |
| | 接点出力 CONTACT | AC・DC100V 0.1A (無電圧半導体接点) / 100VAC/VDC 0.1A (voltage free contact) |
| | 周波数出力 FREQUENCY | 1Hz/1回転(60Hz以下は除く) 0~15V(負荷抵抗5kΩ以上) / 1Hz/1ROTATION(without under 60Hz) 0to15V(load resistance5kΩover) |
| 表示 DISPLAY | デジタル表示 DIGITAL DISPLAY | 7セグメントLED(赤)×4桁(輝度調整有り) / 7SEGMENTS LED×4DIGITS(WITH DIMMER) |
| | LED表示 LED LAMP | #12(赤),#13(緑) #14(緑),#14L(緑) / #12(RED),#13(GREEN) #14(GREEN),#14L(GREEN) |
| 絶縁抵抗 | INSULATION RESISTANCE | 導体部−箱体間 20MΩ以上 DC50V / CONDUCTOR-BODY OVER20MΩ 50VDC |
| 耐電圧 | DIELECTRIC STRENGTH | 接点出力−箱体間 AC1500V 1分間 / CONTACT OUTPUT-BODY 1500VAC 1min. |
| 使用温度 | OPERATING TEMP. | +5~+55℃ / +5to+55℃ |
| 保存温度 | STORAGE TEMP. | −20~+65℃ / −20to+65℃ |
| 相対湿度 | RELATIVE HUMIDITY | 95%以内(但し、結露がないこと) / WITHIN 95%(NON CONDENSATION) |
| 雰囲気 | ATMOSPHERE | 腐食性ガスがないこと / WITHOUT CORROSIVE GAS |
| 振動 | VIBRATION RESISTANCE | 5~13.2Hz ±1mm,13.2~100Hz 0.7G |
| 衝撃 | SHOCK RESISTANCE | 10G以内 / WITHIN 10G |
| 材質 | MATERIALS | グラスファイバー強化樹脂 / PLASTIC WITH GLASS FIBER |
| 塗装色 | BODY COLOR | 樹脂自然色(黒) / BLACK(PLASTIC NATURAL COLOR) |
| 重量 | WEIGHT | 0.2kg |

パルスセンサ接続図
PULSE SENSOR CONNECTION

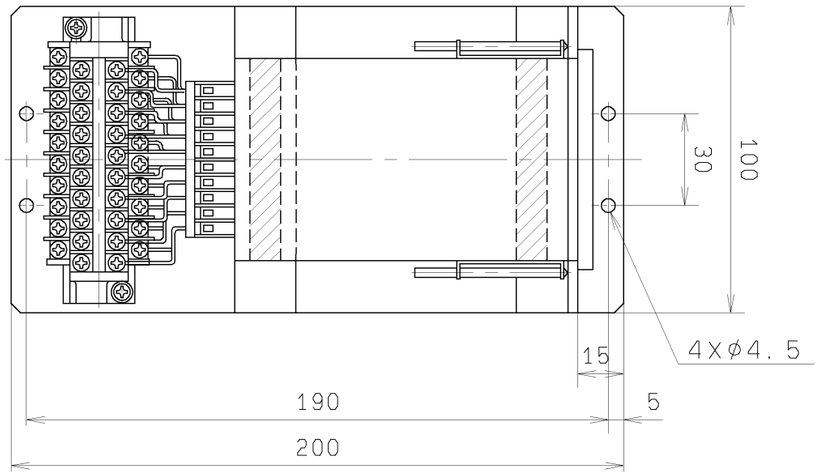


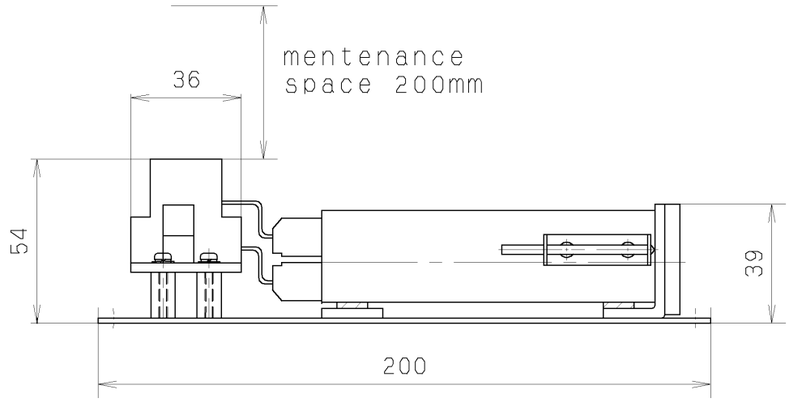

※パルスセンサの検出異常を利用する時は、リレーを使用して下さい。リレーはオムロンMY4−D相当品(コイル定格電流30mA以下)のものを選定下さい。

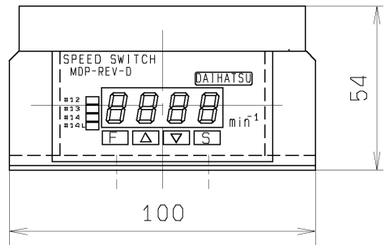
※Please use a relay, when you use the sensor failure output on the pulse sensor. A relay should select the "OMRON MY4-D" or equivalent it(30mA or less of relay coil rated current).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E | (6~7-E) CHANGE | (E005098) | 2007/02/23 | T.N | | | |
| D | (6~7-E) CHANGE | | 2006/03/15 | T.NAKAMITSU | | | |
| C | (4-D) ADD."UP","DN",φ6→φ5,15→17 | | 2005/12/08 | K.YOSHIDA | | | |
| B | (1~4-D) MDP-REV-D→MDP-REV,6×φ6,(4~7-A~D) CHANGE | | 2005/02/14 | K.YOSHIDA | | | |
| ⚠ | FIRST DRAWING | | 2004/06/21 | K.YOSHIDA | | | |

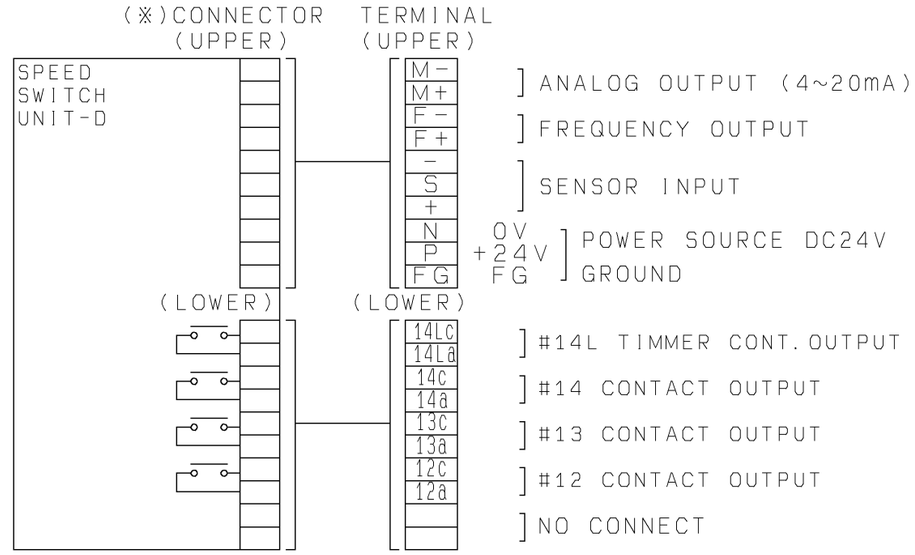
| | | | | | |
|---|---|---|---|---|---|
| APPROVED | MOCHIDUKI MASARU | LIST NO. NN00262 | MATERIAL ASSY. | GROUP 9 | SCALE=1:1 |
| CHECKED | | BEFORE | MASS. − | QTY. − | A3 |
| | | REF. − | TYPE MES | | |
| | CHUJYOU JYUNYA | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME カンビヒン:ソクドスイッチユニット:−D | | |
| DRAWN | (H)NAKAMITSU TOSHIO | | ASSY.:SPEED SWITCH UNIT:-D | | |
| DATE | 2007/02/23 | | PARTS NO. NN00262001A | E | * |




端子接続図 Terminal connection




仕様 Specifications

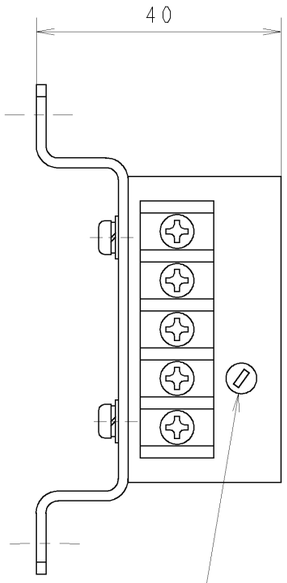
1)重量 WEIGHT about 0.6kg
2)塗装色 COLOR MUNSELL 1.5N

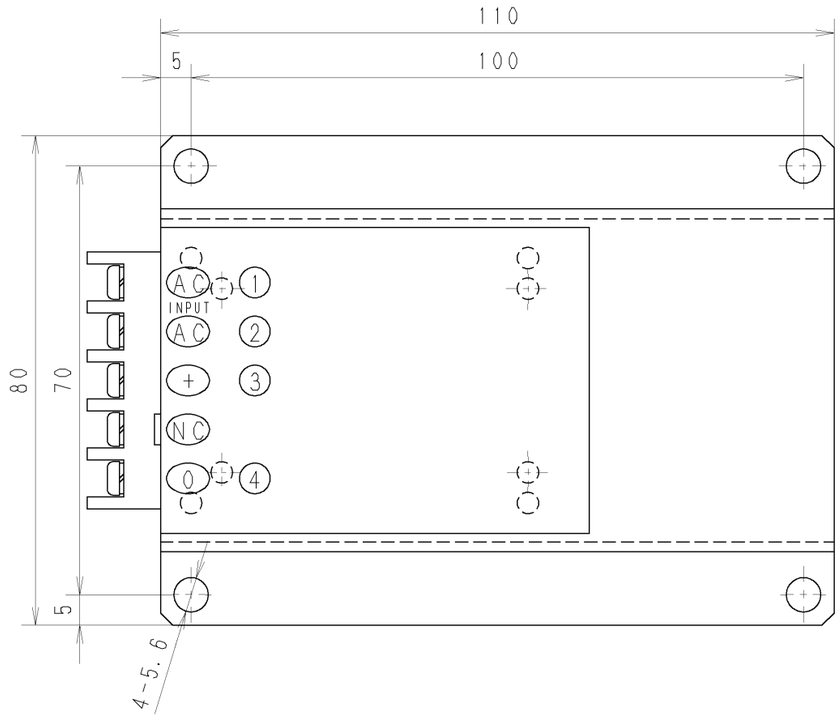
【注記】【NOTE】

1. 当ブラケットは“ソクドスイッチユニット2”を“ソクドスイッチユニットーD”へ換装する為のブラケットである。
   This bracket is for changing the “speed switch unit2” into the “speed switch unit-D”.
2. ソクドスイッチユニットーDの詳細は、“カンビヒン:ソクドスイッチユニット:ーD(NN00262001A)を参照のこと。
   The detail of the“speed switch unit-D” refer to “ASSY :SPEED SWITCH UNIT:-D”(NN00262001A).

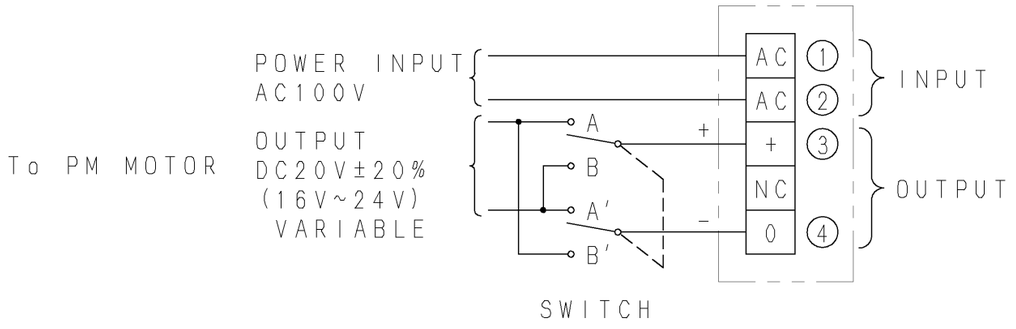
| | | | |
|---|---|---|---|
| ⚠ | FIRST DRAWING | 2004/07/02 | K.YOSHIDA |

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | MOCHIDUKI MASARU | LIST NO. NN00262 | MATERIAL KUMI | GROUP 0 | SCALE=1:2 |
| CHECKED | | BEFORE | MASS. – | QTY. – | A3 |
| | | REF. – | TYPE MES | | |
| | CHUJYOU JYUNYA | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME ショウニンズ:ゴカンソクドスイッチ2:ソクドスイッチーD | | |
| DRAWN | YOSHIDA KENTAROU | | APPROVAL:INTERCHANGEABLE SPEED SWITCH2:SPEED SWITCH-D | | |
| DATE | 2004/07/01 | | PARTS NO. NN00262K005 | A | * |




電圧調整トリマー
V. ADJ：Voltage Adjustable Trimmer




SPECIFICATIONS
INPUT ：AC100Vrms（85~132Vrms：47~440Hz）
OUTPUT：DC20±20%（TO PM MOTOR）
（DC16~24V）

NOTE）
1. The Governer speed rise／lower change over switch should be arranged in between this unit and the motor.
（ガバナスピードの上げ下げ切りかえは、本装置の2次側にスイッチを設けて行ってください。）

CAUTION）
1. Do not stall the motor for a long time, it could burn out the motor or this unit
（長時間ガバナモータをストールさせた状態で放置するとモータや本装置の故障の原因となります。）

| | | | |
|---|---|---|---|
| C | ADD INPUT ALLOWABLE RANGE (E005839) | 2007/08/08 | K. M |
| B | CHANGE OF DRAWING (E005811) | 2007/08/01 | T. N |
| ⚠ | FIRST DRAWING | 2006/08/22 | T. N |



| | | | | | |
|---|---|---|---|---|---|
| APPROVED | CHUJYOU JYUNYA | LIST NO. NN00031 | MATERIAL KUMI | GROUP 0 | SCALE=1:1 |
| CHECKED | | BEFORE | MASS. - | QTY. - | A3 |
| | | REF. - | TYPE MES | | |
| | CHUJYOU JYUNYA | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME ショウニンズ：ガバナコントロールユニット B：AC100V | | |
| DRAWN | (H)MITSUTAKE KYOKO | | APPROVAL：GOVN. CONTROL UNIT B:AC100V | | |
| DATE | 2007/08/08 | | PARTS NO. NN00031K011 | C | * |

DIESEL GENERATOR ENGINE

# L.O.PRIMING PUMP(16)
# L.O.プライミングポンプ(16)

TYPE : ACD 025N61VBP

PUMP : 2.5$m^3$/h × 0.2MPa

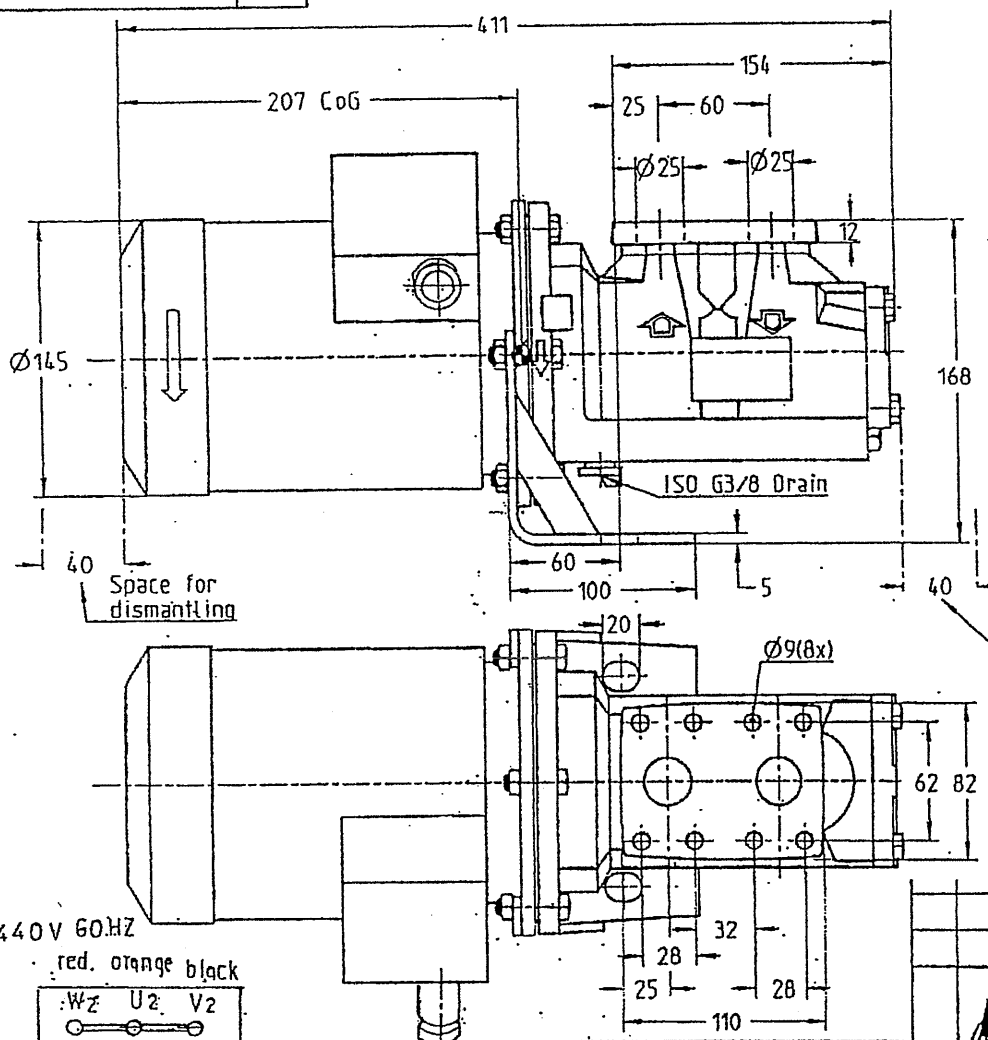
MOTOR : AC440V,3$\phi$,60HZ,0.94kW,2.0A,F

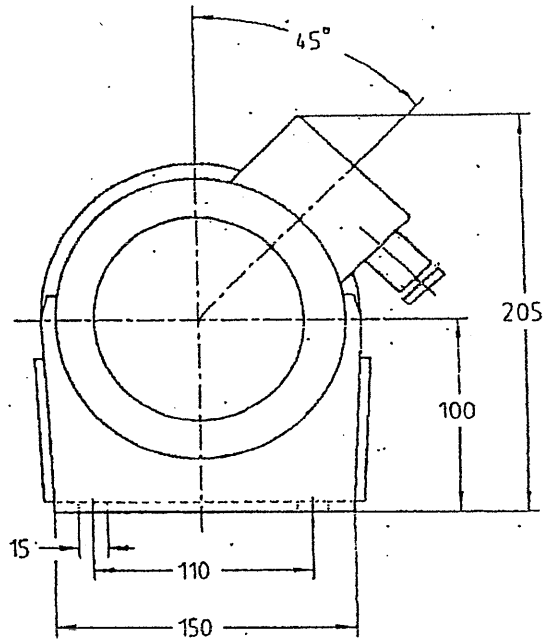
---

DAIHATSU DIESEL MFG. CO., LTD.
TECHNICAL DEPARTMENT
JAPAN

| | | | |
|---|---|---|---|
| SHIP No. | | DRAWN BY | H. Yamane |
| TYPE | | CHECKED BY | K. Fujii |
| LIST No. | B106605010ZZ | | |
| DATE | MAR. 21, 2007 | APPROVED BY | I. Imigamoto |
| REVISION | | | |

Drawing Type - No. MS-24572 Rev.




Dimensions in mm.

Weight approx. 16kg Mounting: M00-9

Subject to change without notice. Not binding unless certified.

| Applicable to the following version codes. | |
|---|---|
| Housing mtrl. | I N |
| Shaft seal | T V |
| Mounting | B |
| Valve arr. | P |

| Article No. | Name/Designation | Material Blank | Pattern No./Note |
|---|---|---|---|
| | | | |

IMO AB
Stockholm
Sweden

Title
IMO-Pump unit
Pump: ACD 025L6, ACD 025N6
Motor: Siemens 1LA09 073

Symbols
- for tolerances: SS-ISO 286-1
- for form and positions: SS-ISO 901
- for surface roughness: ISO 1302

Tolerances if not otherwise stated
- machined surfaces: ISO 2768-mK-E
- castings: ISO 8062 CT10
Burrs removed, edges 0,4x45° or R 0,5

Drawn (Date/Sign) 01.10.19 LN
Checked and approved (D/S) 01.10.19 JS
Production checked (D/S)
Rel. for manufacturing (D/S)

Scale 1:2.5
First angle Projection
Complementary Drawing No.

Drawing Type-No. MS-24572 Rev.

| Rev. | Revision | Revised (Date/Sign) | Appr. |
|---|---|---|---|
| Replaces drawing No. | | | |



B10660501OZZ (2/8)

IMO AB
Stockholm
Sweden

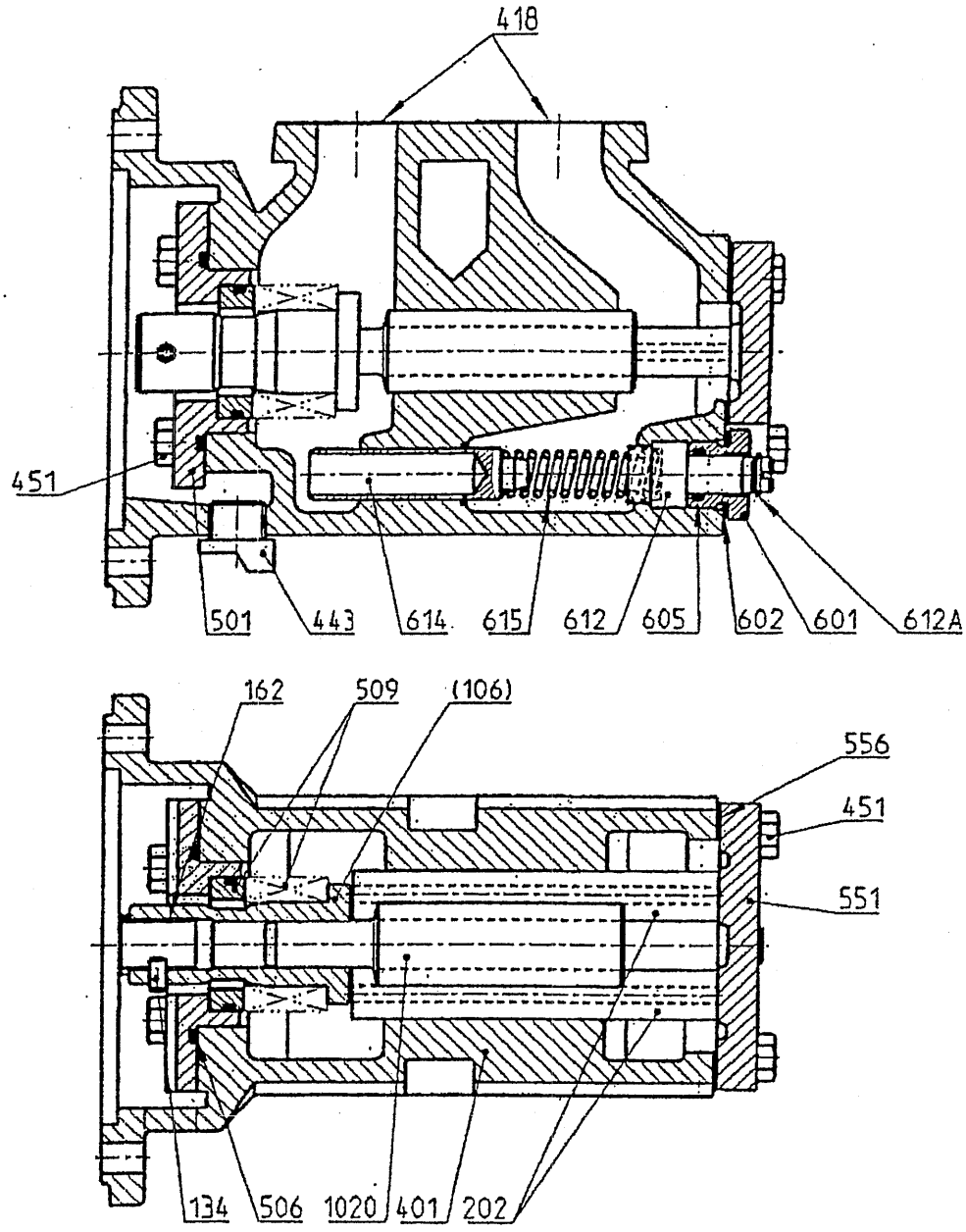
# SECTIONAL DRAWING

## ACD 025N6 IVBP

Drawing Type-No.
A-ACD-003B

Sheet 1 of 1

Scale 1:2




First angle projection

| Rev. | Revision | Revised (Date/Sign) | Appr. |
|---|---|---|---|
| B | Omritad på CAD | 99.12.27 LN | |
| A | RÄ105689 | 96.09.11 LN | AL |
| | Original | 95.06.21 LN | AL |

Drawing Type-No. A-ACD-003 Rev. B

| Pos NO | NAME | PCS. |
|---|---|---|
| 1020 | Power rotor | 1 |
| 134 | Locking screw | 1 |
| 162 | Nylon sleeve socket | 1 |
| 202 | Idler rotor | 2 |
| 401 | Pump body | 1 |
| 418 | Gasket | 1 |
| 443 | Drip nipple | 1 |
| 451 | Screw | 8 |
| 501 | Front cover | 1 |
| 506 | O-ring alt. Gasket | 1 |
| 509 | Shaft seal | 1 |
| 551 | Rear cover | 1 |
| 556 | Gasket | 1 |
| 601 | Valve cover | 1 |
| 602 | Sealing washer | 1 |
| 605 | O-ring | 1 |
| 612 | Regulating screw | 1 |
| 612A | Retaining ring | 1 |
| 614 | Valve piston | 1 |
| 615 | Valve spring | 1 |

| SPECIFICATION | |
|---|---|
| CAPACITY | 2.5m3/h |
| TOTAL HEAD | 0.2Mpa |
| SUCTION HEAD | -0.04Mpa |
| SETTING PRESS. OF SAFETY VALVE | 0.22Mpa |
| SIEMENS MOTOR | 0.94KW, 440V, 60HZ<br>2P, 3300rpm.<br>Rated Current 2.0 A<br>Starting Current 9.6 A |
| START METHOD | DIRECT START |
| PROTECTION | IP55 |
| INSULATION CLASS | F |

Dimensions

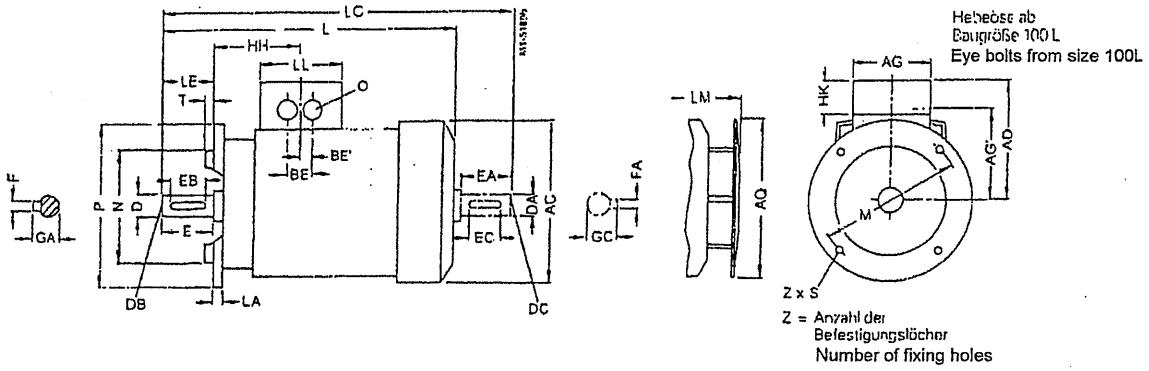
# Maße

Type IMB5 and IMV1

**Bauform IMB5 und IMV1**

Frame sizes 56M to 200L.

1LA9 · Baugrößen 56 M bis 200 L




| For motor Für Motor: Size Baugröße | Type Typ | No. of poles Polzahl | Diemension drawing Maßbezeichnung nach: Flange size IEC DIN Flanschgröße | AC 1) | AD | AG | AO | AO | BE | BE | HH | HK | L | LA | LC | LE | LL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56 M | 1LA9 050 ·<br>1LA9 053 · | 2 und 4 | A 120 | 116 | 101 | 75 | 77,5 | | 32 | 14 | 69,5 | 39 | 169 | 8 | 200 | 20 | 75 |
| 63 M | 1LA9 060<br>1LA9 063 | 2 und 4 | A 140 | 118 | 101 | 75 | 77,5 | 125 | 32 | 14 | 69,5 | 39 | 202,5<br>228,5 | 9 | 232<br>258 | 23 | 75 |
| 71 M | 1LA9 070<br>1LA9 073 | 2 und 4<br>and | A 160 | 145 | 111 | 75 | 87,5 | 125 | 32 | 14 | 63,5 | 39 | 240 | 9 | 278 | 30 | 75 |

MOTOR REAR & FRONT COVER : CAST IRON

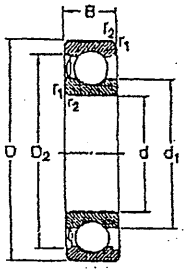
1) Über die Schraubenköpfe gemessen
Measured across the screw

Dimensions
Maße

Type IMB5 and IMV1

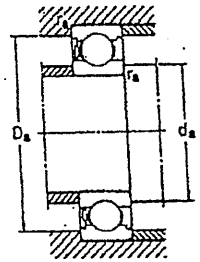
| | | | | | | | | Drive-end shaft extension AS-Wellenende | | | | | | Non-drive-end shaft extension BS-Wellenende | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LM | M | N | O | P | S | T | Z | D | DB | E | EB | F | GA | DA | DC | EA | EC | FA | GC |
| – | 100 | 80 | M16 x 1,5<br>M25 x 1,5 | 120 | 7 | 3 | 4 | 9 | M3 | 20 | 14 | 3 | 10,2 | 9 | M3 | 20 | 14 | 3 | 10,2 |
| 236<br>262 | 115 | 95 | M16 x 1,5<br>M25 x 1,5 | 140 | 10 | 3 | 4 | 11 | M4 | 23 | 16 | 4 | 12,5 | 11 | M4 | 23 | 16 | 4 | 12,5 |
| 269 | 130 | 110 | M16 x 1,5<br>M25 x 1;5 | 160 | 10 | 3,5 | 4 | 14 | M5 | 30 | 22 | 5 | 16 | 14 | M5 | 30 | 22 | 5 | 16 |

With cover plates 3–20mm
ned skyddsplattar
3–20 mm




With one cover plate, type Z
Med en skyddsplåt, utförande Z

With two cover plates, type ZZ
Med två skyddsplåtar, utförande ZZ




SKF

| Main dimensions Huvudmått | | | Carrying capacity Bärighetstal dyn. dynamic C | stat. static $C_0$ | Exhaustion load Utmattningsbelastning $P_u$ | Basic speed (RPM) Basvarvtal Smörjning fett | olja | Mass Massa | Designation, baering Beteckningar Lager med en skyddsplåt with one | två skyddsplåtar with two |
|---|---|---|---|---|---|---|---|---|---|---|
| d | D | B | | | | | | | cover plate | cover plates |
| mm | | | N | | N | r/min | | kg | | |
| 3 | 10 | 4 | 465 | 146 | 6 | 60 000 | 70 000 | 0,0015 | 623-Z | 623-2Z |
| 4 | 13 | 5 | 975 | 305 | 14 | 48 000 | 56 000 | 0,0031 | 624-Z | 624-2Z |
| | 16 | 5 | 1 110 | 380 | 16 | 43 000 | 50 000 | 0,0054 | 634-Z | 634-2Z |
| 5 | 16 | 5 | 1 110 | 380 | 16 | 43 000 | 50 000 | 0,0050 | 625-Z | 625-2Z |
| | 19 | 6 | 1 720 | 620 | 26 | 36 000 | 43 000 | 0,0090 | 635-Z | 635-2Z |
| 6 | 19 | 6 | 1 720 | 620 | 26 | 36 000 | 43 000 | 0,0084 | 626-Z | 626-2Z |
| 7 | 19 | 6 | 1 720 | 620 | 26 | 38 000 | 45 000 | 0,0075 | 607-Z | 607-2Z |
| | 22 | 7 | 3 250 | 1 370 | 57 | 32 000 | 38 000 | 0,013 | 627-Z | 627-2Z |
| 8 | 22 | 7 | 3 250 | 1 370 | 57 | 36 000 | 43 000 | 0,012 | 608-Z | 608-2Z |
| 9 | 24 | 7 | 3 710 | 1 660 | 71 | 32 000 | 38 000 | 0,014 | 609-Z | 609-2Z |
| | 26 | 8 | 4 620 | 1 960 | 83 | 28 000 | 34 000 | 0,020 | 629-Z | 629-2Z |
| 10 | 28 | 8 | 4 620 | 1 960 | 83 | 30 000 | 36 000 | 0,019 | 6000-Z | 6000-2Z |
| | 30 | 9 | 5 070 | 2 360 | 100 | 24 000 | 30 000 | 0,032 | 6200-Z | 6200-2Z |
| | 35 | 11 | 8 060 | 3 400 | 143 | 20 000 | 26 000 | 0,053 | 6300-Z | 6300-2Z |
| 12 | 28 | 8 | 5 070 | 2 360 | 100 | 26 000 | 32 000 | 0,022 | 6001-Z | 6001-2Z |
| | 32 | 10 | 6 890 | 3 100 | 132 | 22 000 | 28 000 | 0,037 | 6201-Z | 6201-2Z |
| | 37 | 12 | 9 750 | 4 150 | 176 | 19 000 | 24 000 | 0,060 | 6301-Z | 6301-2Z |
| 15 | 32 | 8 | 5 590 | 2 850 | 120 | 22 000 | 28 000 | 0,025 | 16002-Z | 16002-2Z |
| | 32 | 9 | 5 590 | 2 850 | 120 | 22 000 | 28 000 | 0,030 | 6002-Z | 6002-2Z |
| | 35 | 11 | 7 800 | 3 750 | 160 | 19 000 | 24 000 | 0,045 | 6202-Z | 6202-2Z |
| | 42 | 13 | 11 400 | 5 400 | 228 | 17 000 | 20 000 | 0,082 | 6302-Z | 6302-2Z |

| d | $d_1$ ≈ | $D_2$ ≈ | $r_{1,2}$ min | $d_a$ min | $D_a$ max | $r_a$ max |
|---|---|---|---|---|---|---|
| mm | | | | mm | | |
| 3 | 5,2 | 8,2 | 0,15 | 4,2 | 8,8 | 0,1 |
| 4 | 6,7 | 11,2 | 0,2 | 5,6 | 11,4 | 0,2 |
| | 8,4 | 13,3 | 0,3 | 6 | 14 | 0,3 |
| 5 | 8,4 | 13,3 | 0,3 | 7 | 14 | 0,3 |
| | 10,7 | 16,5 | 0,3 | 7 | 17 | 0,3 |
| 6 | 10,7 | 16,5 | 0,3 | 8 | 17 | 0,3 |
| 7 | 10,7 | 16,5 | 0,3 | 9 | 17 | 0,3 |
| | 11,8 | 19 | 0,3 | 9 | 20 | 0,3 |
| 8 | 11,8 | 19 | 0,3 | 10 | 20 | 0,3 |
| 9 | 14,2 | 21,2 | 0,3 | 11 | 22 | 0,3 |
| | 14,4 | 22,8 | 0,3 | 11 | 24 | 0,3 |
| 10 | 14,4 | 22,6 | 0,3 | 12 | 24 | 0,3 |
| | 16,7 | 24,8 | 0,6 | 14 | 26 | 0,6 |
| | 17,5 | 28,7 | 0,6 | 14 | 31 | 0,6 |
| 12 | 16,7 | 24,8 | 0,3 | 14 | 26 | 0,3 |
| | 18,2 | 27,4 | 0,6 | 16 | 28 | 0,6 |
| | 19,5 | 31,5 | 1 | 17 | 32 | 1 |
| 15 | 20,2 | 28,2 | 0,3 | 17 | 30 | 0,3 |
| | 20,2 | 28,2 | 0,3 | 17 | 30 | 0,3 |
| | 21,5 | 30,4 | 0,6 | 19 | 31 | 0,6 |
| | 23,7 | 36,3 | 1 | 20 | 37 | 1 |

# Datenblatt für Drehstrom-Käfigläufermotoren

Siemens AG

## *Data sheet for three-phase Squirrel-Cage-Motors*

Kunden-Auftrags-Nr./Client-Order-Nr.:

Siemens-Auftragsnr./Order-No.:

Item-Nr./Item-No.:

Komm.-Nr./Consignment-No.:

### Bestell-Daten/ *Ordering Data*

| | |
|---|---|
| Hersteller<br>*Manufacturer* | Siemens |
| Motortyp<br>*Motortyp* | 1LA9073-2LA91 |
| Kurzangaben<br>*Order codes* | LIY |

### Elektrische Daten/ *Electrical Data*

| | |
|---|---|
| Bemessungsspannung<br>*Rated motor voltage* | 440 V Y |
| Frequenz<br>*Frequency* | 60 Hz |
| Bemessungsleistung<br>*Rated motor power* | 0.94 kW |
| Bemessungsdrehzahl<br>*Rated motor speed* | 3300 min-1 |
| Bemessungsmoment<br>*Rated motor torque* | 3.22 Nm |
| Bemessungsstrom<br>*Rated-motor current* | 2.0 A |
| Anzugs-/ Bemessungsstrom<br>*Starting/ Rated motor current* | 9.6 |
| Kipp-/ Bemessungsmoment<br>*Breakdown/ Rated motor torque* | 2.4 |
| Anzugs-/Bemessungsmoment<br>*Starting/ Rated-motor torque* | 2.5 |
| Wirkungsgrad bei<br>*Efficiency at* | |
| 100 % Pn, 75% Pn, 50 % Pn<br>*100 %, 75% and 50 % rated power* | 73 %, 73 %, 70 % |
| Wirkungsgradklasse<br>*Efficiency class* | nicht definiert/ undefined |
| Leistungsfaktor bei 100% Pn<br>*Power factor at rated power* | 0.82 |
| Leistungsfaktor bei 75% Pn<br>*Power factor at 75% rated power* | 0.77 |
| Leistungsfaktor bei 50% Pn<br>*Power factor at 50% rated power* | 0.67 |

### Mechanische Daten/ *Electrical Data*

| | |
|---|---|
| Geräusch<br>*Noise* | 52 dB(A) |
| Trägheitsmoment<br>*Torque of inertia* | 0.00058 kgm² |
| Lager AS<br>*Bearing AS* COUPLING SIDE | 6202 ZC3 |
| Lager BS<br>*Bearing BS* ANTI COUPLING SIDE | 6202 2ZC3 |
| Festlager/ Kondenswasserlöcher<br>*Locating bearing BS/ Drain holes* | nein/ no / nein/ no |
| Nachschmiereinrichtung<br>*Regreasing device* | nein/ no |
| Schmiermittel<br>*Type of lubrication* | Unirex N3, Fa. Esso |
| Fettgebrauchsdauer: 40°C/25°C<br>*Relubrication interval at 40°C/ 25°C* | 10000 h / 20000 h |
| Äußere Erdungsklemme<br>*External earthing* | nein/ no |
| Anstrich<br>*Paintwork* | Sonderanstrich RAL 7030/<br>Special paintwork RAL 7030 |

### Explosionsschutz/ *Explosion protection*

| | |
|---|---|
| Zündschutzart<br>*Type of explosion protection* | Kein Ex-Schutz/ no Ex-protection |
| tE-Zeit, T1, T2 bzw. T3<br>*tE-time, T1, T2 resp. T3* | — |

### Umgebungsbedingungen/ *Site conditions*

| | |
|---|---|
| Umgebungstemperatur<br>*Ambient temperature* | 50 °C |
| Höhe über Meeresspiegel<br>*Altitude above sea level* | 1000 m |

### Allgemeine Daten/ *General Data*

| | |
|---|---|
| Baugröße<br>*Frame size* | 71 M |
| Bauform<br>*Type of construction* | IM B3 |
| Gewicht in kg<br>*Weight in kg* | 7.2 kg |
| Gehäusematerial<br>*Enclosure material* | Aluminium/ Aluminium-alloy |
| Gehäusefüße<br>*Frame feet* | angegossen/ cast |
| Schutzart<br>*Degree of protection* | IP 55 |
| Kühlart, TEFC<br>*Method of cooling, TEFC* | IC 41 |
| Vibrationsklasse<br>*Vibration class* | N |
| Isolation<br>*Insulation* | F, ausgenutzt B/ F, utilized B |
| Betriebsart<br>*Type of operation* | S1 |
| Anlaufart<br>*Type of starting* | direkt/ direct |
| Drehrichtung<br>*Direction of rotation* | bi-directional/ bi-directional |
| Schaltung<br>*Winding connection* | Y STAR |

### Klemmenkasten/ *Terminal box*

| | |
|---|---|
| Klemmenkastenmaterial<br>*Material of terminal box* | Aluminium/ Aluminium alloy |
| Typ<br>*Typ* | gk 030 |
| Gewinde Kontaktschraube<br>*Terminal screw thread* | M4 |
| Max. Leiterquerschnitt<br>*Max. cable diameter* | 2.5 mm² |
| Max. Kabeldurchmesser<br>*Max. cable diameter* | 4.5 - 10 mm; 9 - 17 mm |
| Kabeleinführung<br>*Cable entry* | 1xM16x1.5; 1xM25x1.5 |
| Zweiteilig Platte, max. Dm<br>*Split plate, max. diameter* | — |
| Anordnung<br>*Position* | Oben/ On the top of motor |

### Sonderausführungen/ *Special configurations*

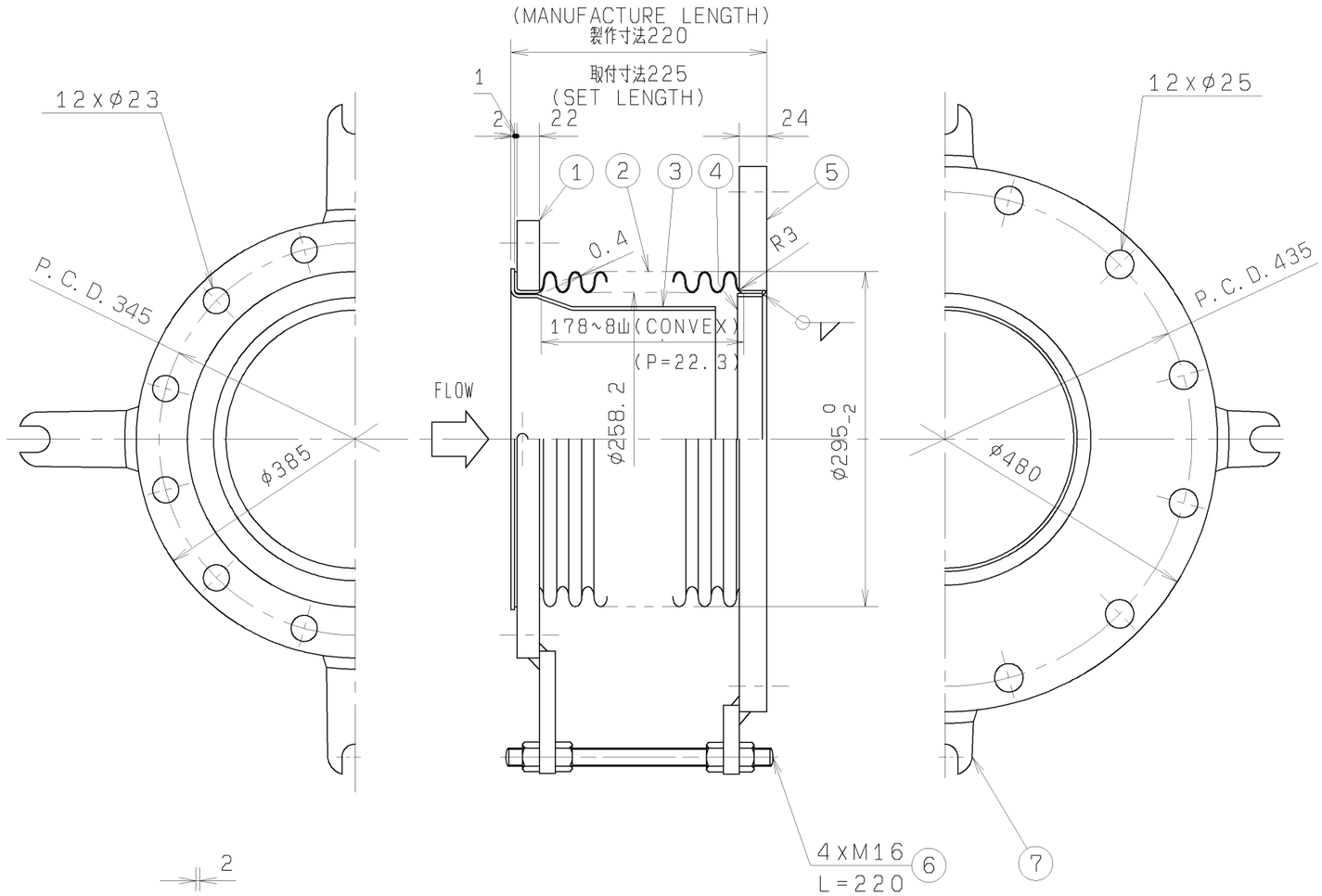
LIY = 3 AC 60 Hz, 440 VD, Pn=1.1 kW
bei KT=40 °C, Höhe=1000 m

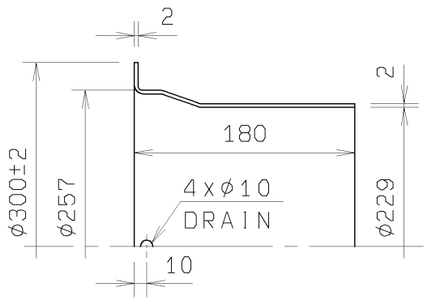
Normen und Vorschriften
*Standards and specifications*: IEC, DIN EN/ VDE, ISO..

Bemerkungen/ *Remarks*

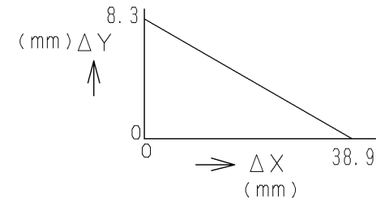
2001/9/20

B106605010ZZ (8/8)




③ DETAIL
(LINER・内筒)




許容変位線図
(ALLOWABLE MOVE CURVE)

| 仕 様 SPECIFICATIONS | | |
|---|---|---|
| AXIAL MOVE ΔX(SET LENGTH BASE)<br>軸方向変位量 ΔX(取付寸法基準) | EXTENSION 伸び | CONTRACTION 縮み |
| | 5 mm | 30 mm |
| LATERAL MOVE ΔY<br>横変位量 ΔY | 偏心 ECCENTRIC | |
| | 5 mm | |
| WORKING P.<br>使用圧力 | 0.003 MPaG | |
| WORKINFG T.<br>使用温度 | MAX.550 ℃ | |
| SPRING RATON<br>バネ定数 | 62.8 N/mm | |

| 用 途 APPLICATIONS | 機関・排気ガス ENGINE EXHAUST GAS |
|---|---|

| ITEM 部品番号 | PAPT NAME 部品名 | MATERIAL 材 質 | REQD 数量 | WEIGHT 単 量 | REMARK 備 考 |
|---|---|---|---|---|---|
| 10 | | | | | |
| 9 | | | | | |
| 8 | | | | | |
| 7 | HOLDER | SS400 | 4x2 | | |
| 6 | SHIPPING BOLTS | SS400 | 4 | | |
| 5 | FLANGE | SS400 | 1 | | JIS5K 相当 |
| 4 | WELD BAND | SUS304 | 1 | | t0.8x20 |
| 3 | LINER | SUS304 | 1 | | |
| 2 | BELLOWS | SUS321 | 1 | | |
| 1 | FLANGE | SS400 | 1 | | JIS5K |

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | MIYAZAKI SYUJI | LIST NO. NN00271 | MATERIAL PCHS | GROUP 7 | SCALE=1:5 |
| CHECKED | | BEFORE | MASS. 36.6kg (A) | QTY. 1/Eng | A3 |
| | | REF. 日本メタルホース M-16687(B2597) | TYPE ALL | | |
| | MIYAZAKI SYUJI | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME ハイキシンシュクセッシュ::250Ax350A<br>EXPANSION JOINT::250Ax350A | | |
| DRAWN | SAIDA SYUICHI | | PARTS NO. NN00271011B | B | * |
| DATE | 2004/10/08 | | | | |

DIESEL GENERATOR ENGINE

# L.O. PRIMING PUMP STARTER

SASEBO HEAVY INDUSTRIES CO., LTD.

**DAIHATSU DIESEL MFG. CO., LTD.**
**TECHNICAL DEPARTMENT**
**OSAKA, JAPAN**

| | | | |
|---|---|---|---|
| SHIP No. | 761/762 | DRAWN BY | M. Ochi |
| TYPE | 6DK-20 | CHECKED BY | N. Watanabe |
| LIST No. | AQA10005017A | | |
| DATE | Jul. 20, 2007 | APPROVED BY | |
| REVISION | | | |

ADK20-5047-9

KYOSAN

SASEBO HEAVY INDUSTRIES CO., LTD

S.No.761
S.No.762

DAIHATSU DIESEL MFG. CO., LTD.

# DIESEL GENERATOR ENGINE
# L.O. PRIMING PUMP STARTER

RULE : ABS—ACCU

6DK—20

**Kyosan Electric Mfg. Co., Ltd.**

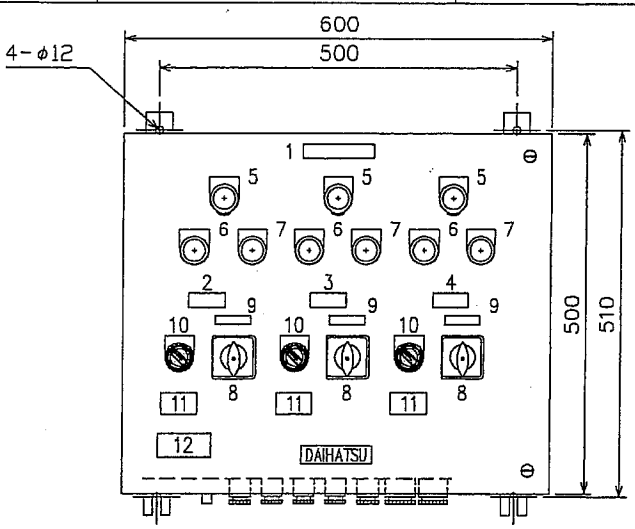
△d 10.SEP.2007
DWG. No. KS2007027

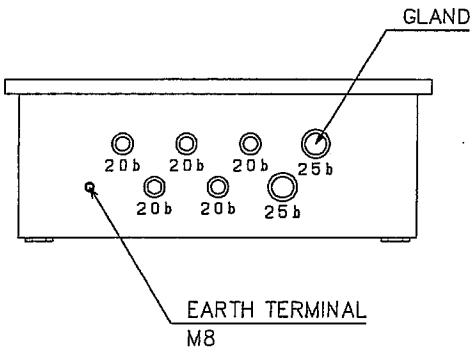
S.No.762 : ADK20—5047—9
S.No.761 : ADK20—5044—6

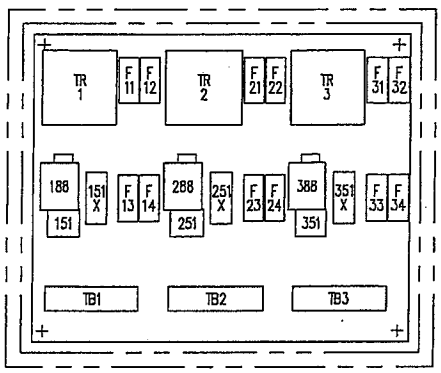
KYOSAN

**Kyosan**
**Electric Mfg.**
**Co., Ltd.**

3-4 MARUNOUCHI, CHIYODA-KU, TOKYO JAPAN
Cable Address: SIGNALKYOSAN TOKYO




| No. | MARK | NAME PLATE | NOTE |
|---|---|---|---|
| 12 | | ⚠ CAUTION ELECTRIC HAZARD | PL LABEL |
| 11 | | THE SELECTOR SWITCH SHOULD BE ALWAYS KEPT AT "ON" POSITION. | CAUTION PLATE |
| 10 | SW1 SW2 SW3 | AUTO. OFF —— ON | SELECTOR SWITCH |
| 9 | | SOURCE AC440V | NAME PLATE |
| 8 | DS1 DS2 DS3 | OFF —— ON | DISCON. SWITCH |
| 7 | RL1 RL2 RL3 | ABNORMAL | LAMP ( RED ) |
| 6 | GL1 GL2 GL3 | RUNNING | 〃 (GREEN) |
| 5 | WL1 WL2 WL3 | SOURCE | 〃 (WHITE) |
| 4 | | No. 3 G/E | NAME PLATE |
| 3 | | No. 2 G/E | 〃 |
| 2 | | No. 1 G/E | 〃 |
| 1 | | L.O. PRIMING PUMP STARTER | 〃 |

PROTECTION GRADE IP44

PAINT COLOR

MUNSELL 7.5BG7/2

WEIGHT ABOUT 50Kg

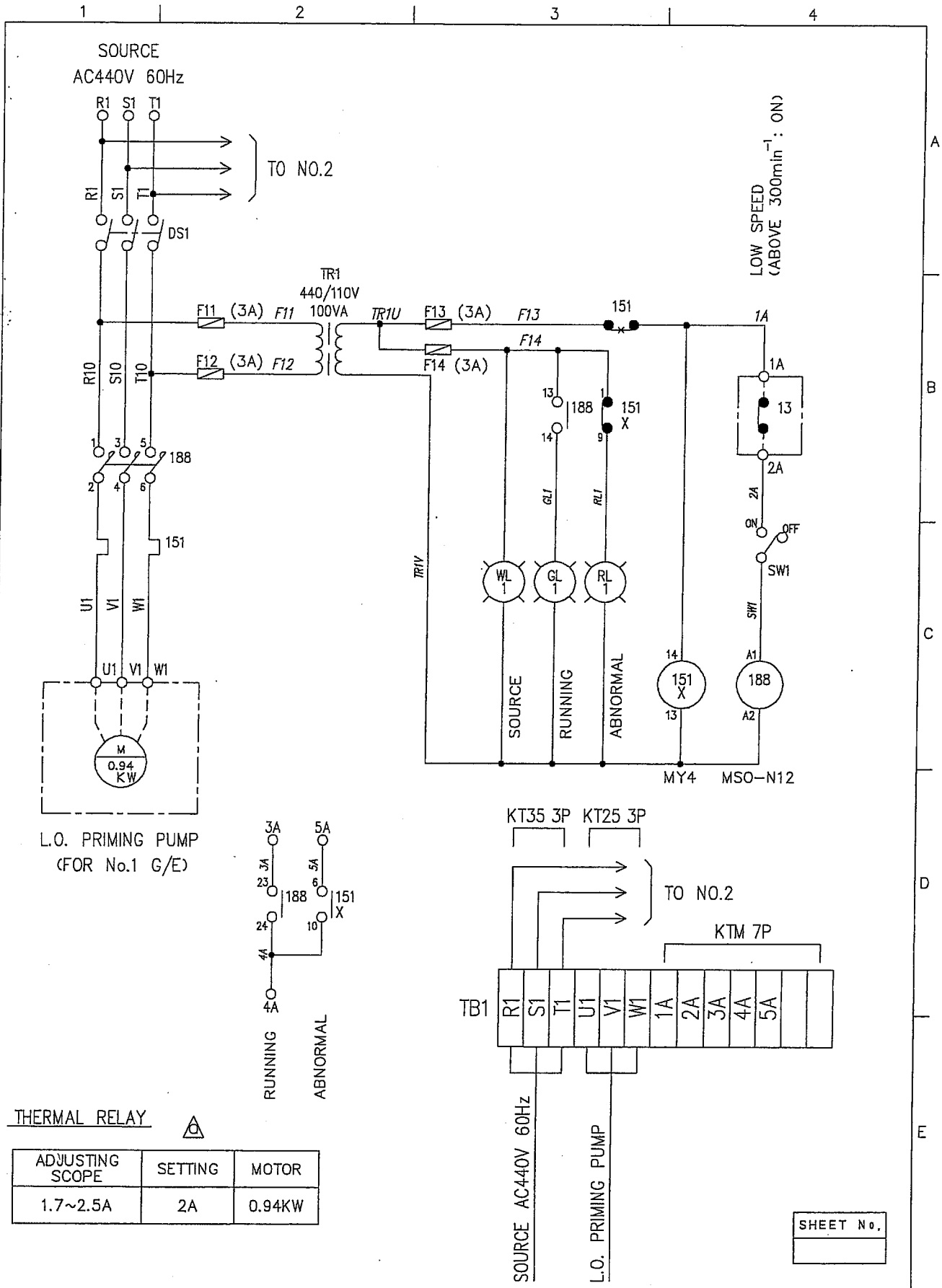
1 SET PER VESSEL

| MARK | REVISION | BY | DATE |
|---|---|---|---|
| △ | | | |
| △ | | | |
| △ | | | |

DIESEL GENERATOR ENGINE
L.O. PRIMING PUMP STARTER
OUT LINE

| DESIGNED | CHECKED | APPROVED | DATE | SCALE | DWG.NO. |
|---|---|---|---|---|---|
| T.K | | | 19.JUL.'07 | 1/10 | KS2007027-1 |

**Kyosan Electric Mfg. Co., Ltd.**




THERMAL RELAY △6

| ADJUSTING SCOPE | SETTING | MOTOR |
|---|---|---|
| 1.7~2.5A | 2A | 0.94KW |

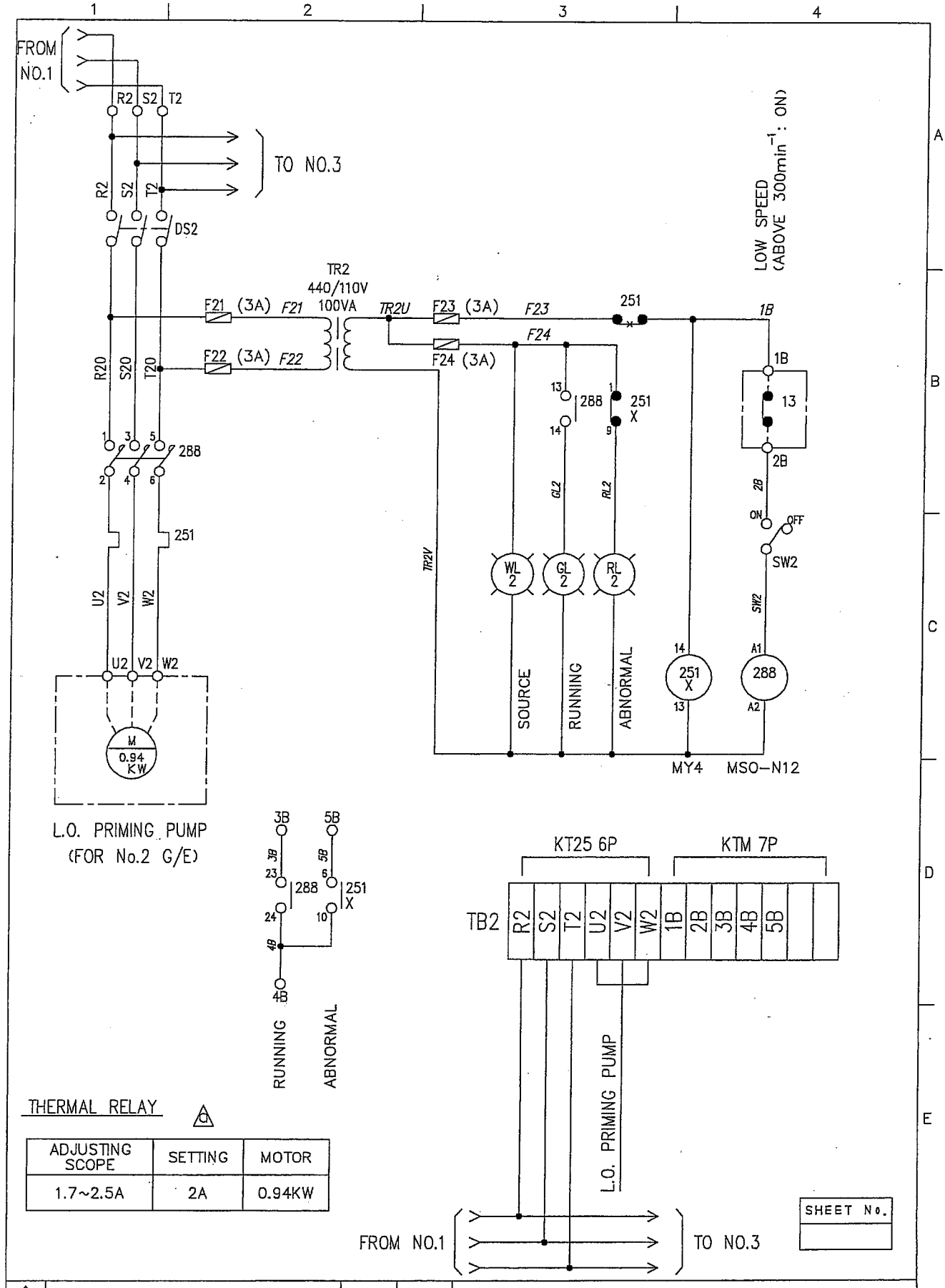
SHEET No.

| MARK | REVISION | BY | DATE |
|---|---|---|---|
| △ | | | |
| △ | | | |
| △6 | | T.Konishi | 10.SEP.2007 |

DIESEL GENERATOR ENGINE
L.O. PRIMING PUMP STARTER
SEQUENCE DIAGRAM (No.1 G/E)

| DESIGNED | CHECKED | APPROVED | DATE | SCALE | DWG.NO. |
|---|---|---|---|---|---|
| T.K | | | 19.JUL.'06 | / | KS2007027-201 |

**Kyosan Electric Mfg. Co., Ltd.**

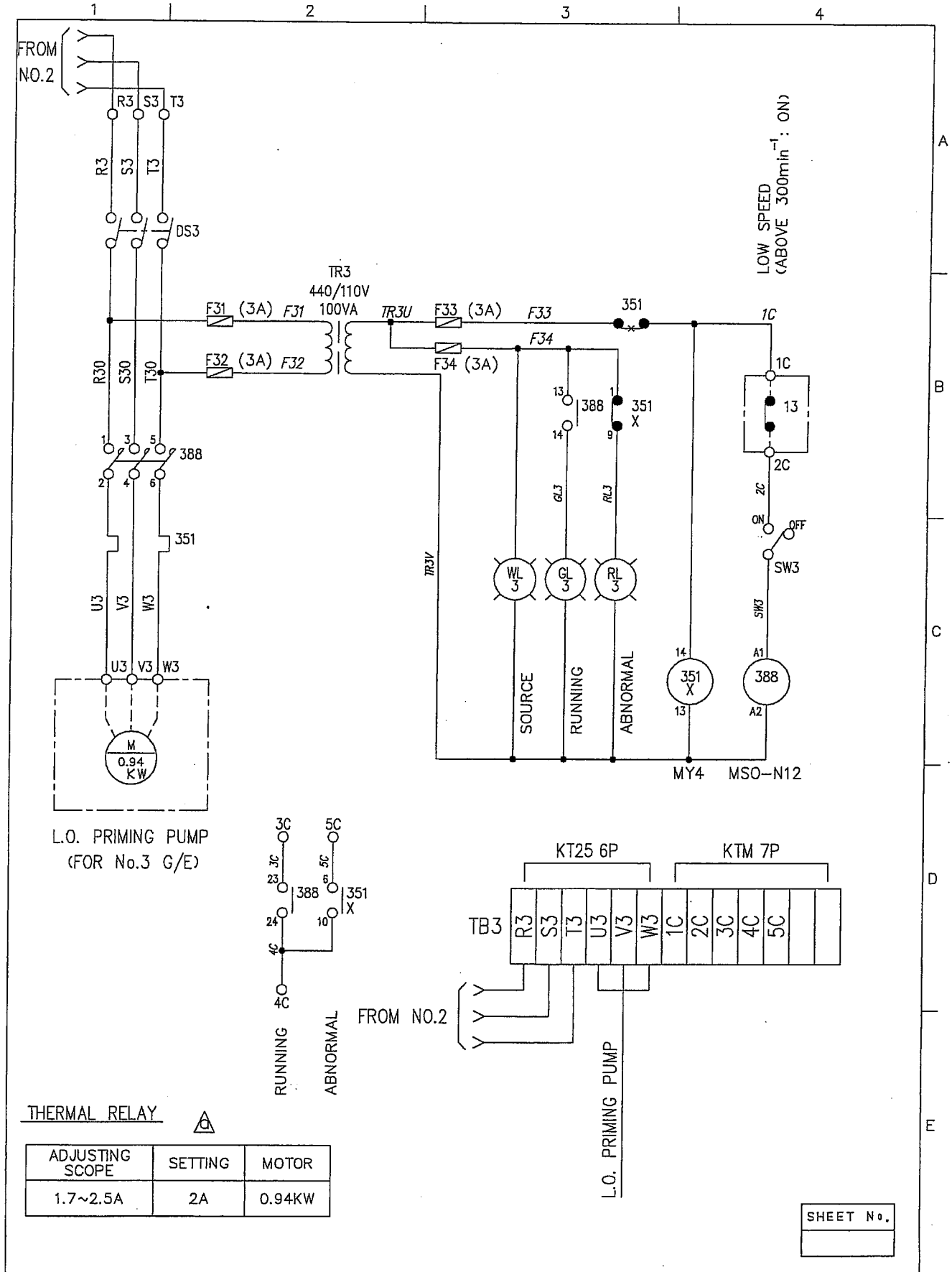



| MARK | REVISION | BY | DATE |
|---|---|---|---|
| △ | | | |
| △ | | | |
| △ | | T.Konishi | 10.SEP.2007 |

DIESEL GENERATOR ENGINE
L.O. PRIMING PUMP STARTER
SEQUENCE DIAGRAM (No.2 G/E)

| DESIGNED | CHECKED | APPROVED | DATE | SCALE | DWG.NO. |
|---|---|---|---|---|---|
| T.K | | | 19.JUL.'06 | / | KS2007027-202 |

**Kyosan Electric Mfg. Co., Ltd.**




THERMAL RELAY

| ADJUSTING SCOPE | SETTING | MOTOR |
|---|---|---|
| 1.7~2.5A | 2A | 0.94KW |

SHEET No.

| MARK | REVISION | BY | DATE |
|---|---|---|---|
| △ | | | |
| △ | | | |
| △ | | T.Konishi | 10.SEP.2007 |

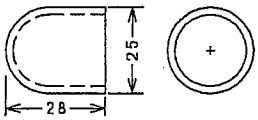
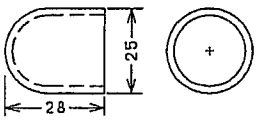
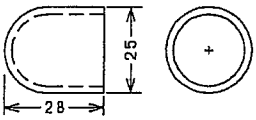
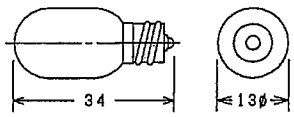
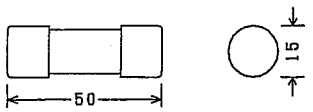
DIESEL GENERATOR ENGINE
L.O. PRIMING PUMP STARTER
SEQUENCE DIAGRAM (No.3 G/E)

| DESIGNED | CHECKED | APPROVED | DATE | SCALE | DWG.NO. |
|---|---|---|---|---|---|
| T.K | | | 19.JUL.'06 | / | KS2007027-203 |

**Kyosan Electric Mfg. Co., Ltd.**

AQA10005017A (7/8)

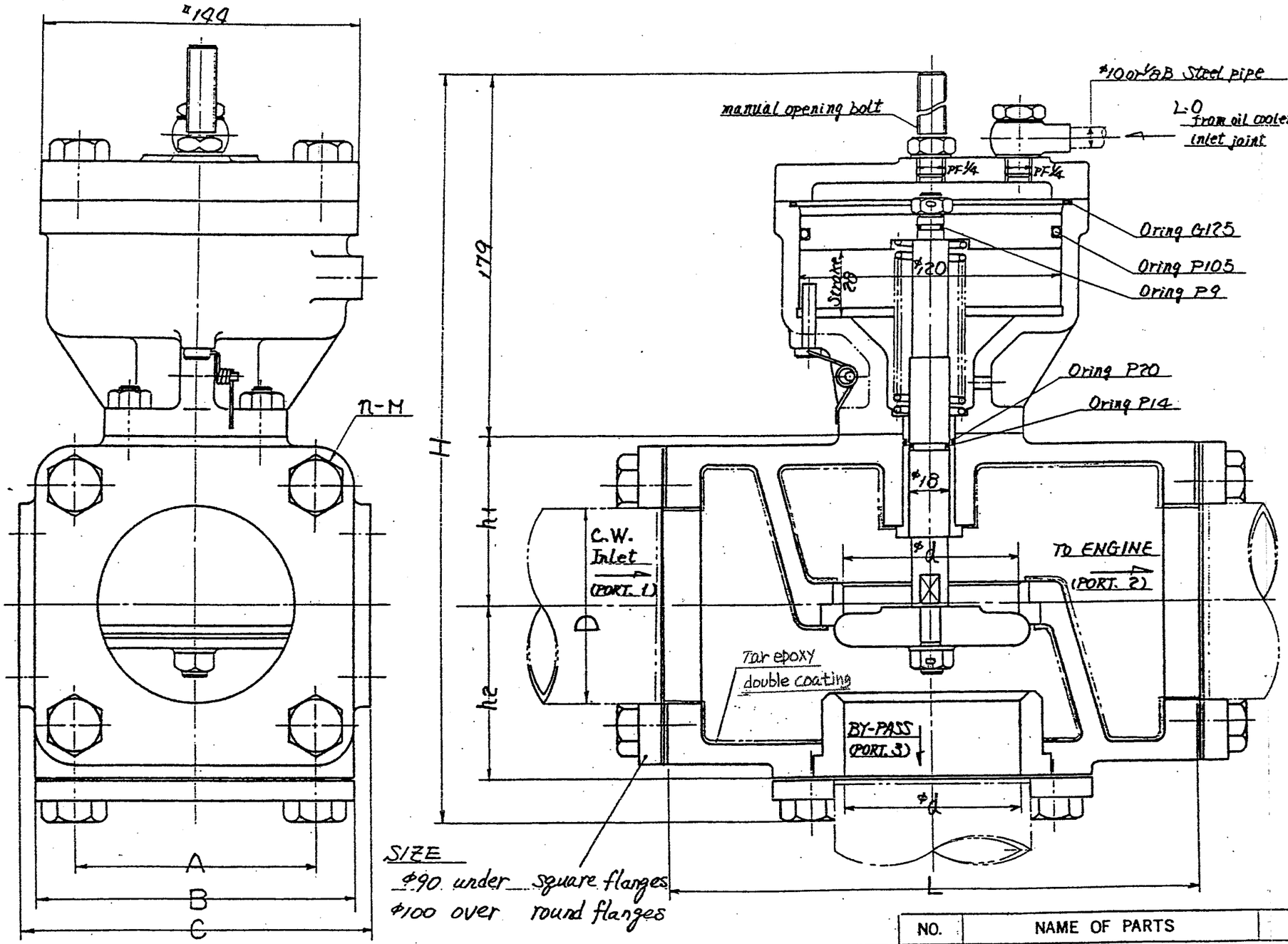
| SHIP No. | SPARE PARTS LIST FOR | U S E | SETS PER VESSEL |
|---|---|---|---|
| 761<br>762 | L.O. PRIMING PUMP STARTER | DIESEL GENERATOR ENGINE | 1 |

| ITEM No. | NAME OF PART | OUTLINE | QUANTITY | | | REMARKS | |
|---|---|---|---|---|---|---|---|
| | | | WORKING PER SET | WORKING PER VESS | SPARE | | |
| 1 | PILOT LAMP GLOBE |  | 3 | 3 | 1 | WHITE | FOR APN118 IDEC |
| 2 | PILOT LAMP GLOBE |  | 3 | 3 | 1 | GREEN | FOR APN118 IDEC |
| 3 | PILOT LAMP GLOBE |  | 3 | 3 | 1 | RED | FOR APN118 IDEC |
| 4 | PILOT LAMP |  | 9 | 9 | 9 | E-12, 18V, 2W | |
| 5 | FUSE ELEMENT |  | 12 | 12 | 12 | UC-1, 3A UTSUNOMIYA ELEC. | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |

| MFR'S NAME | KYOSAN ELECTRIC MANUFACTURING CO., LTD | DRW. No. | KS2007027-3 |
|---|---|---|---|

DRG. NO.

| HISTORY OF DRG. | DATE |
|---|---|
| Ⓓ New Drawing | Oct. 14. '97 |
| Ⓔ Assy No変更 | 1999.1.13 |

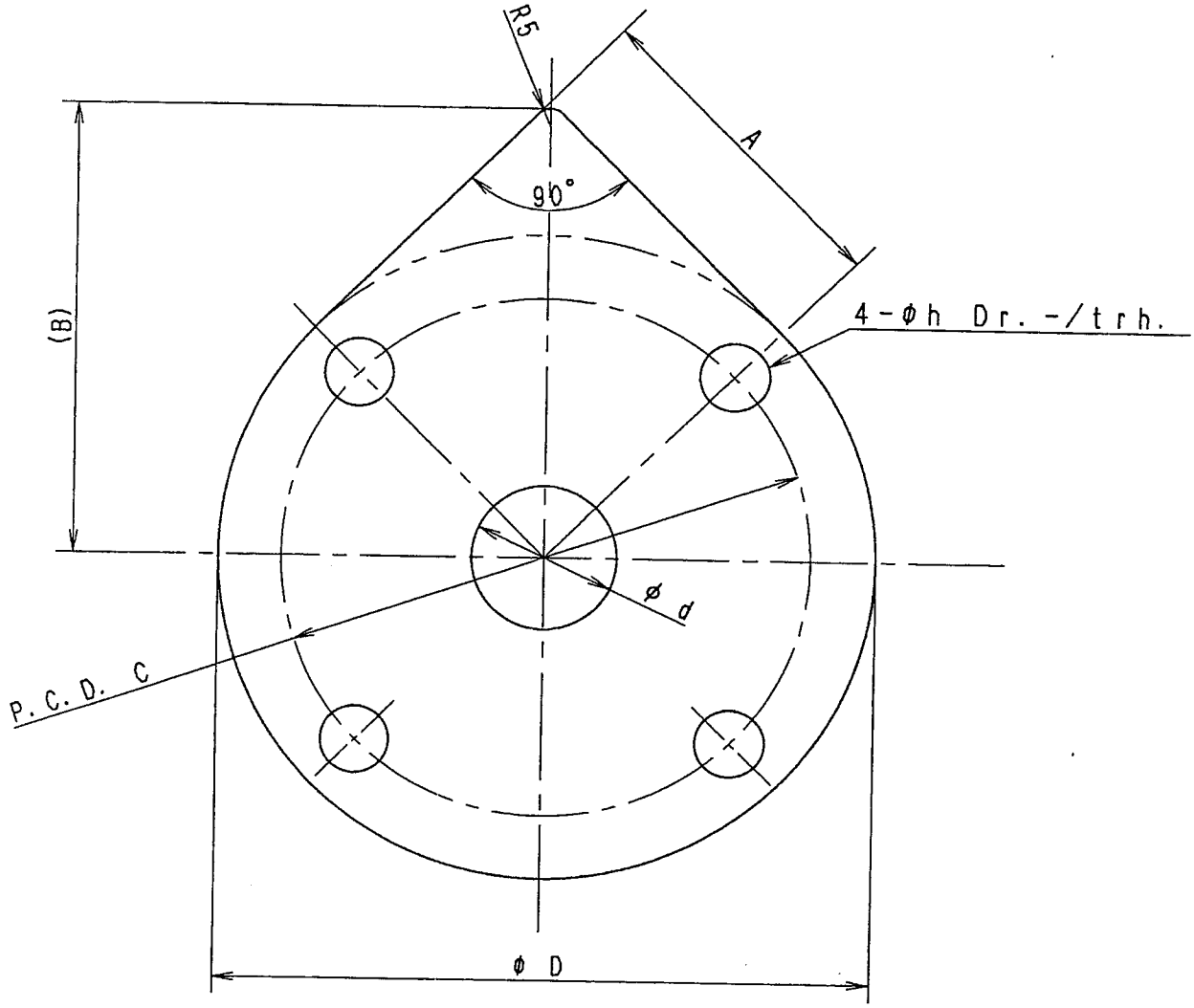



SIZE
φ90 under square flanges
φ100 over round flanges

| MAX. DIFFERENTIAL PRESS. kg/cm² (Lub. Oil Press. 3.5 kg/cm²) | | |
|---|---|---|
| SIZE | PORT 1→2 | PORT 1→3 |
| φ70 | 7.0 | 2.0 |
| φ80 | 4.5 | 1.5 |
| φ90 | 3.5 | 1.2 |
| φ100 | 3.0 | 1.0 |

| NO | ASSY No. | SIZE | D | d | L | h1 | h2 | H | A | B | C | n | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | |
| 2 | S100719162B | φ70 | 2½B | 65 | 200 | 78 | 62 | 347 | φ85 | □114 | 129 | 8 | M12 |
| 3 | S100719163B | φ80 | 3B | 80 | 240 | 78 | 78 | 364 | φ110 | □146 | 156 | 8 | M16 |
| 4 | S100719164B | φ90 | 3½B | 95 | 280 | 115 | 85 | 408 | φ126 | □162 | 172 | 8 | M16 |
| 5 | S100719165B | φ100 | 4B | 103 | 250 | 110 | 110 | 426 | φ165 | □200 | 220 | 8 | M16 |
| 6 | | | | | | | | | | | | | |

| NO. | NAME OF PARTS | PARTS NO. | MATERIAL | WEIGHT A C | QTY. |
|---|---|---|---|---|---|
| APPROVED BY | | LIST NO. S10071 | | GROUP 7 | |
| CHECKED BY | T. Okanda | BEFORE | SCALE 1 : 2 | TYPE ISA | |
| DRAWN BY | M. Kaibara | AFTER | | NAME 3 PORT COOLING WATER VALVE-T (Tar epoxy double coating) | |
| DATE | Junya Choji | REF. | | PARTS NO. S1 1 0 0 7 1 1 - 9 8 3 Z | |
| | OCT. 14. 1997 | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | | DRG. NO. 807753 | E |




t = 3 mm

MATERIAL : SUS304

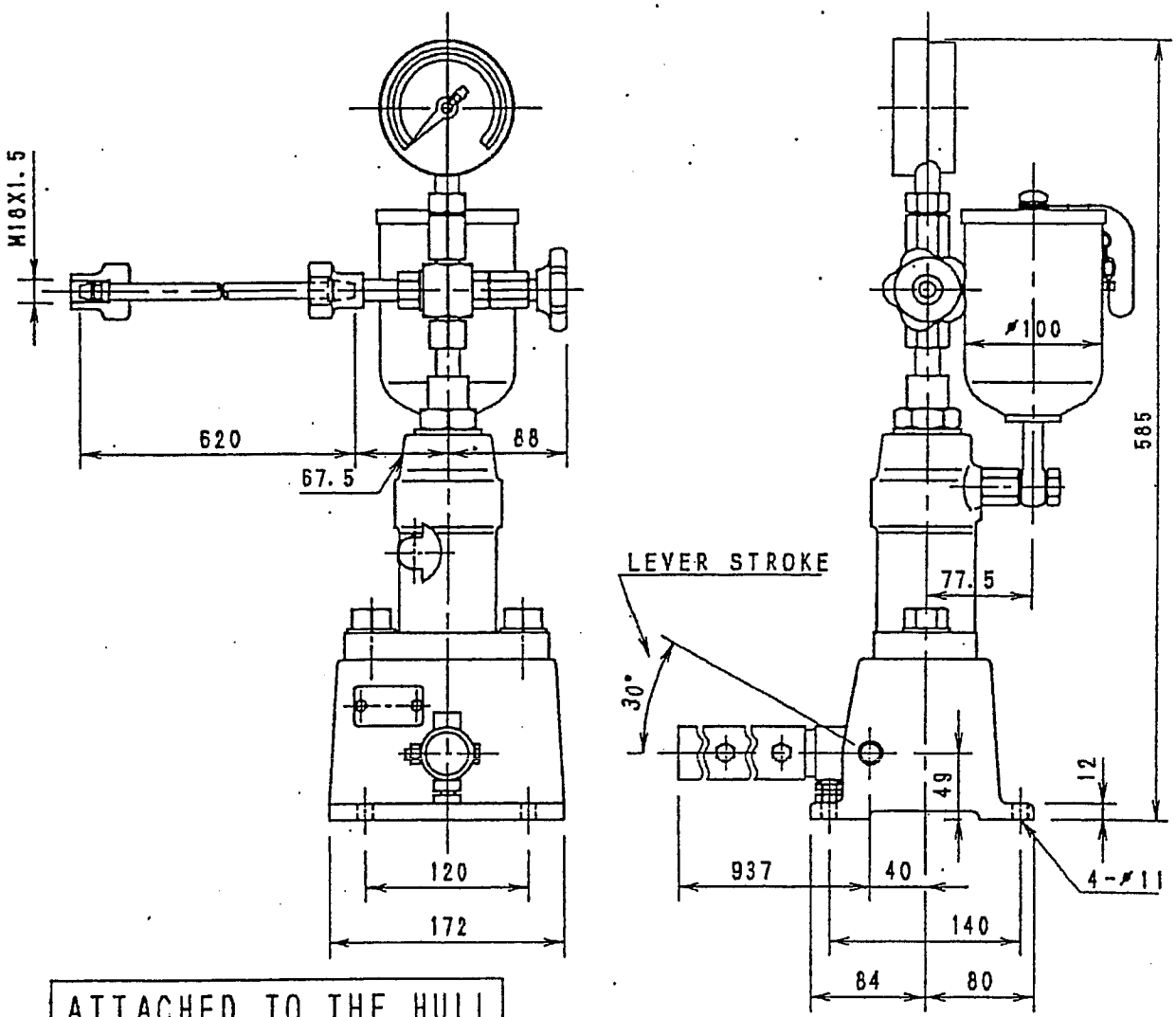
| NO. | ORIFICE TYPE | A | B | C | D | d | h | Purpose |
|---|---|---|---|---|---|---|---|---|
| 1 | ORIFICE 15A-5 | 40 | 54 | 60 | 80 | 5 | 12 | for cooling fresh water expansion line |
| 2 | ORIFICE 15A-10 | 40 | 54 | 60 | 80 | 10 | 12 | for warming line |
| 3 | ORIFICE 80A-20 | 90 | 125 | 145 | 180 | 20 | 19 | for cooling fresh water outlet |
| 4 | ORIFICE 80A-30 | 90 | 125 | 145 | 180 | 30 | 19 | for cooling fresh water outlet |
| 5 | ORIFICE 80A-40 | 90 | 125 | 145 | 180 | 40 | 19 | for auto cooling water valve by-pass |

| | | | |
|---|---|---|---|
| A | ADD DIMENSION FOR 15A-5, 15A-10, 80A-20, 80A-30 | 06. APR. 2005 | K.S |

| | | | | | |
|---|---|---|---|---|---|
| APPROVED | | LIST NO. ADK20-3987-9(10)#003 | MATERIAL APRV | GROUP | SCALE= -:- |
| CHECKED | | BEFORE | MASS. | QTY. | A4 |
| | N. Katano | REF. | TYPE ALL | | |
| DRAWN | H. TOKUNAGA | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | NAME オリフィス | | |
| DATE | 11. DEC. 2004 | | ORIFICE | | |
| | | | PARTS NO. Q399333950 | A | A |
| | | | DWG. NO. Q399333950AA | | |

| HISTORY OF DWG. | DATE |
|---|---|
| | |

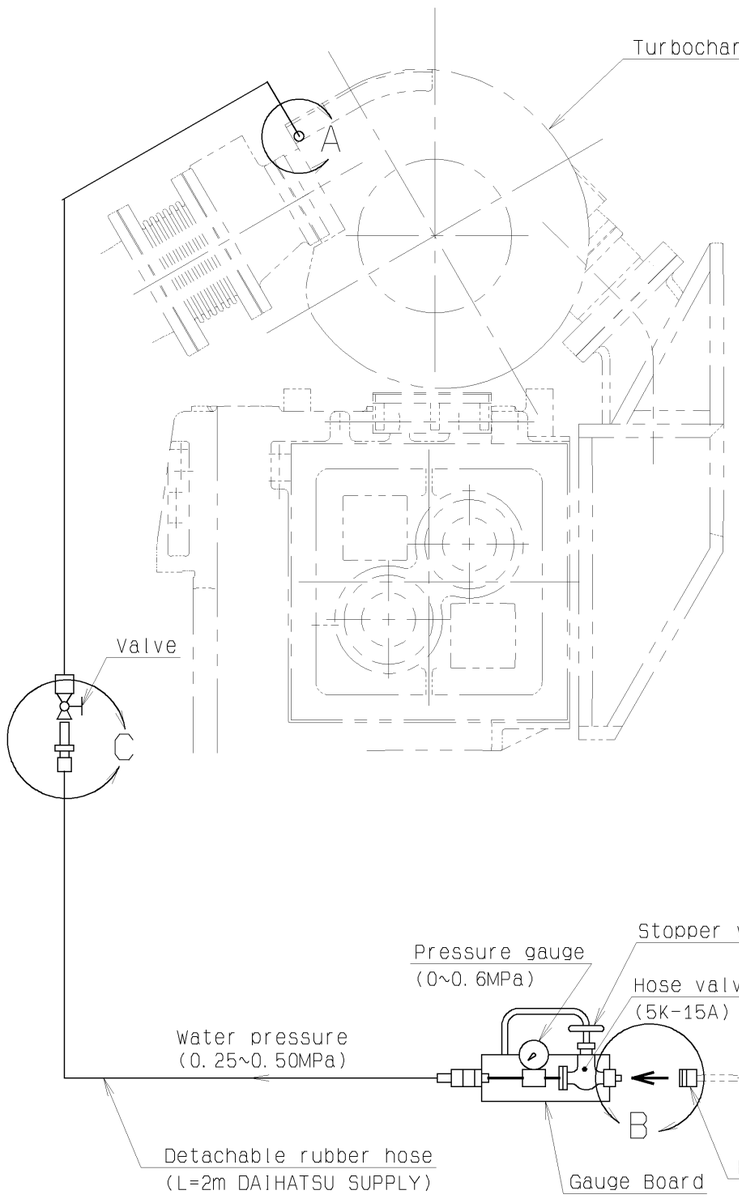
| SPECIFICATION | |
|---|---|
| PLUNGER DIA. | ø16 |
| CAPACITY | 2500mm³/st |
| TANK CAPACITY | 1000 cc |
| PRESS. GAUGE | 1/2X100X50MPa |

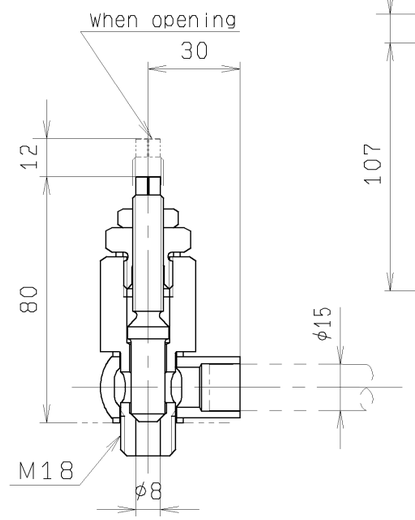



ATTACHED TO THE HULL

| NO. | NAME OF PARTS | PARTS NO. | MATERIAL | MASS. | QTY. |
|---|---|---|---|---|---|
| | | | | | |

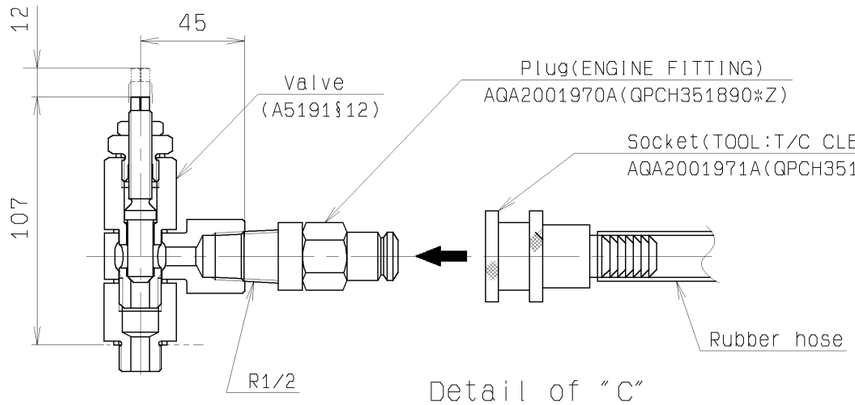
| | | | | | |
|---|---|---|---|---|---|
| APPROVED BY | A. Takeuchi | LIST NO. ADK20-1394-6 (10) #020 | | GROUP | |
| | | BEFORE | SCALE 1/5 | TYPE DK-20 | |
| CHECKED BY | O. Kumabe | AFTER | | NAME NOZZLE TEST PUMP ASSY. G | |
| | | REF. 481546D | 3 | | |
| DRAWN BY | M. OHMURO | DAIHATSU DIESEL MFG. CO., LTD. OSAKA JAPAN | | PARTS NO. | |
| DATE | MAY 29. '98 | | | DWG. NO. AQA10003156 | A |



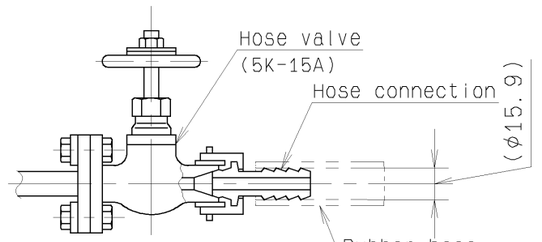

Detail of T/C cleaning nozzle "A"

Note) Keep the needle of T/C cleaning nozzle tightly closed not in use.



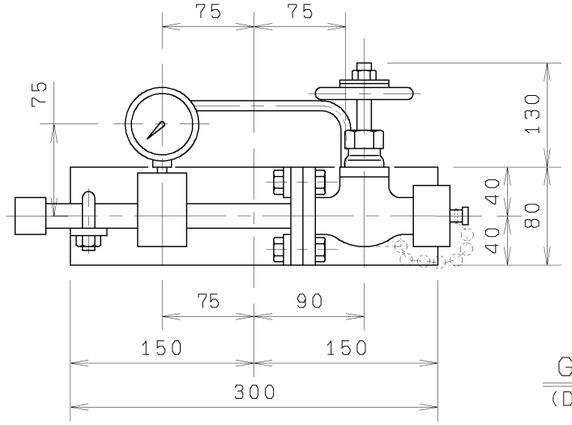

Detail of "C"

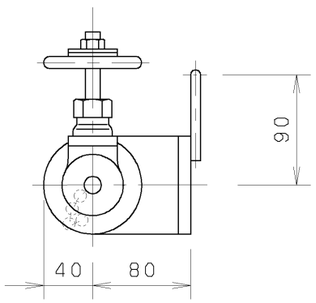
Note) Keep the valve tightly closed not in use.




Detail of "B"

(When rubber hose is connected.)




Gauge Board

(DAIHATSU SUPPLY)

with valve

1 Set/Ship

※ Gauge board hose connections(3PCS) and detachable rubber hose(2m) are supplied for tool by DAIHATSU.

1 Set / Ship

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| ⚠ | FIRST DRAWING | 2006/09/29 | K. S |



| | | | | | |
|---|---|---|---|---|---|
| APPROVED | ISE WAKISHI | LIST NO. | MATERIAL APRV | GROUP 0 | SCALE=※:※ |
| CHECKED | | BEFORE Q990307160BB | MASS. *** A | QTY. *** | 3 A3 |
| | | REF. – | TYPE ALL | | |
| | TERAUCHI YOICHI | DAIHATSU DIESEL MFG.CO.,LTD. OSAKA JAPAN | NAME クミタテズ：タービンセンジョヨウグ：TPS | | |
| DRAWN | SHIMOKAWA KEISUKE | | ASSY.:T/C CLEANING FITTING:TPS | | |
| DATE | 2006/09/29 | | PARTS NO. AQA10003161 | A | ※ |

ABS-RULE

# CALCULATION SHEETS OF TORSIONAL VIBRATION

SASEBO HEAVY INDUSTRIES CO.,LTD.

DAIHATSU DIESEL MFG. CO., LTD.

TECHNICAL DEPARTMENT

MORIYAMA, JAPAN

| | | | |
|---|---|---|---|
| SHIP NO. | 761/762 | DRAWN BY | S. Sonaka |
| TYPE | 6DK-20 | CHECKED BY | R. Suzuki |
| LIST NO. | QE51325880FZ | | |
| DATE | DEC.-14, 2006 | APPROVED BY | R. Kinoshita |
| REVISION | | | |

353

¥1. SPECIFICATIONS

(1) DIESEL ENGINE

TYPE ····· VERTICAL 4-CYCLE, SINGLE-ACTING, SOLID AND DIRECT INJECTION WITH TURBO CHARGER AND INTER COOLER.

NO. OF CYLINDER ····· 6

BORE AND STROKE ····· 200mm X 300mm

RATED SPEED ····· 900 min-1

NORMAL OUTPUT ····· 760kW

OSCILLATING MASS FOR PISTON AND CONNECTING ROD ····· 41.2 kg

FIRING ORDER ····· 1- 5- 3- 6- 2- 4

MANUFACTURE ····· DAIHATSU DIESEL MFG. CO., LTD.

(2) A.C GENERATOR

TYPE ····· NTAKL

NORMAL OUTPUT····· 875.0kVA

MANUFACTURE····· NISHISHIBA ELECTRIC CO.,LTD.

(3) MASS NAME OF HOLZER TABLE

| MASS NO. | MASS NAME |
|---|---|
| 1 | FRONT GEAR |
| 2- 7 | CRANK THROW |
| 8 | FLYWHEEL |
| 9 | GEN. FAN |
| 10 | GEN. ROTOR |

TABLE 1 HOLZER TABLE AND STRESS, TORQUE

THE 1 NODE VIBRATION

N= 78.09 Hz

| MASS NO. | EQ. MASS kgm2 | TORS. STIFF. MNm/rad | SHAFT DIA cm | AMP. radian | TORQUE *1E2 Nm | STRESS N/mm2 |
|---|---|---|---|---|---|---|
| 1 | .741 | 3.515E+01 | 17.0 | 1.000 | 1.785 | .185 |
| 2 | 5.618 | 2.369E+01 | 17.0 | .995 | 15.244 | 1.580 |
| 3 | 5.618 | 2.369E+01 | 17.0 | .931 | 27.832 | 2.885 |
| 4 | 5.618 | 2.369E+01 | 17.0 | .813 | 38.832 | 4.025 |
| 5 | 5.618 | 2.369E+01 | 17.0 | .649 | 47.613 | 4.936 |
| 6 | 5.618 | 2.369E+01 | 17.0 | .448 | 53.675 | 5.564 |
| 7 | 5.618 | 3.027E+01 | 17.0 | .222 | 56.672 | 5.875 |
| 8 | 117.647 | 2.541E+01 | 19.0 | .034 | 66.389 | 4.930 |
| 9 | 12.255 | 3.302E+01 | 17.8 | -.227 | 59.690 | 5.390 |
| 10 | 60.784 | | | -.408 | 0.000 | |

| ORDER NUMBER | ENGINE min-1 | VECTOR SUM |
|---|---|---|
| 5.5 | 851.9 | .528 |
| 6.0 | 780.9 | 4.057 |

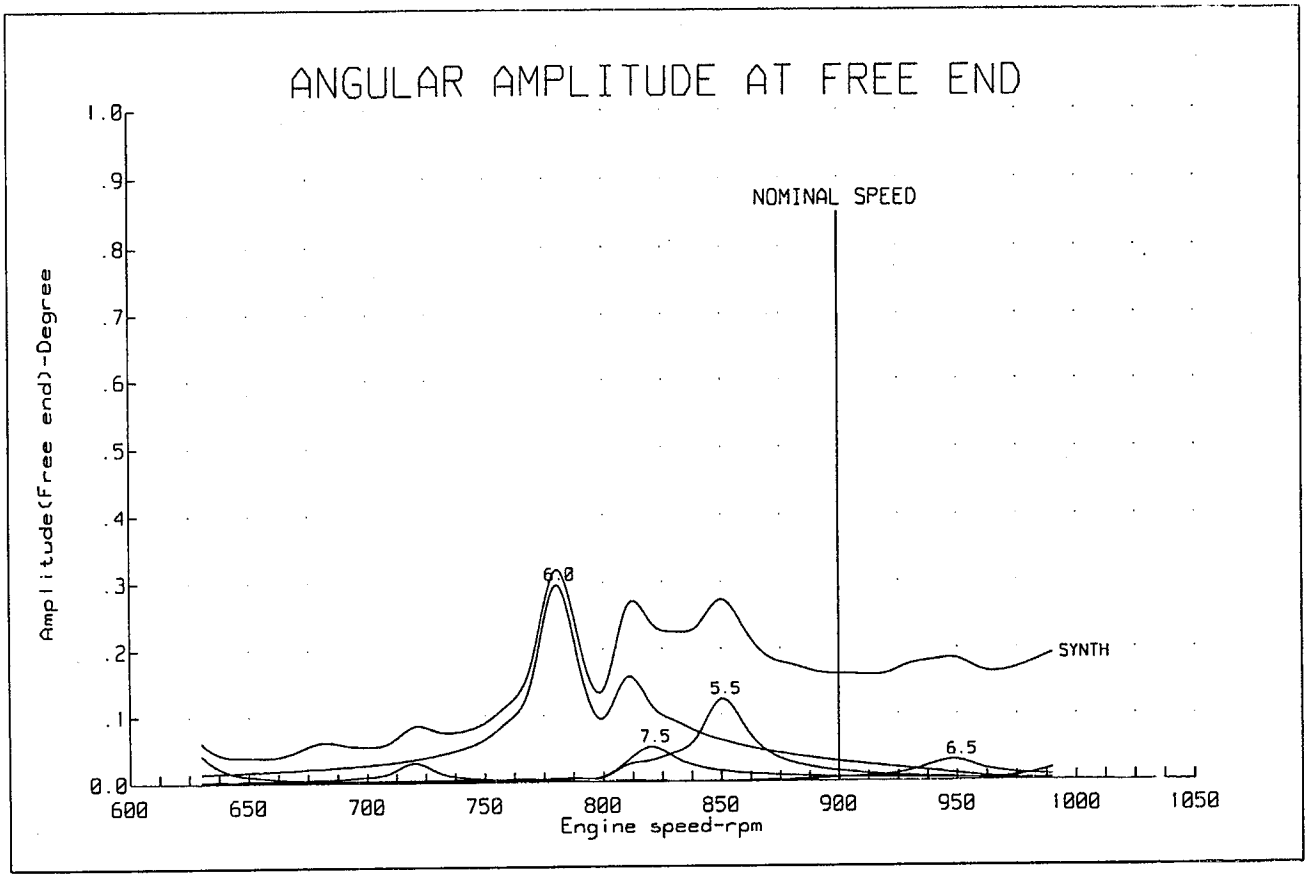
TABLE 2 HOLZER TABLE AND STRESS, TORQUE

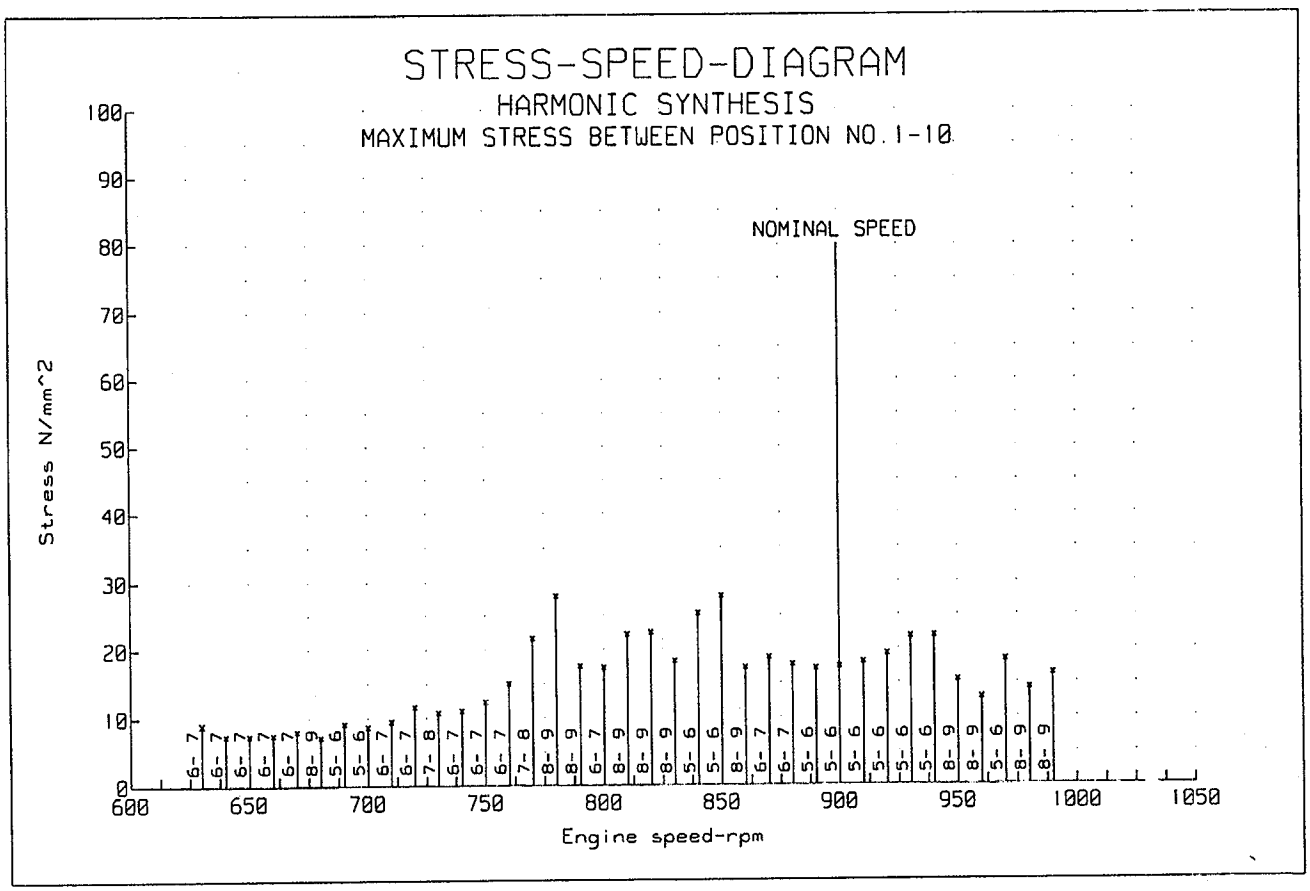
THE 2 NODE VIBRATION

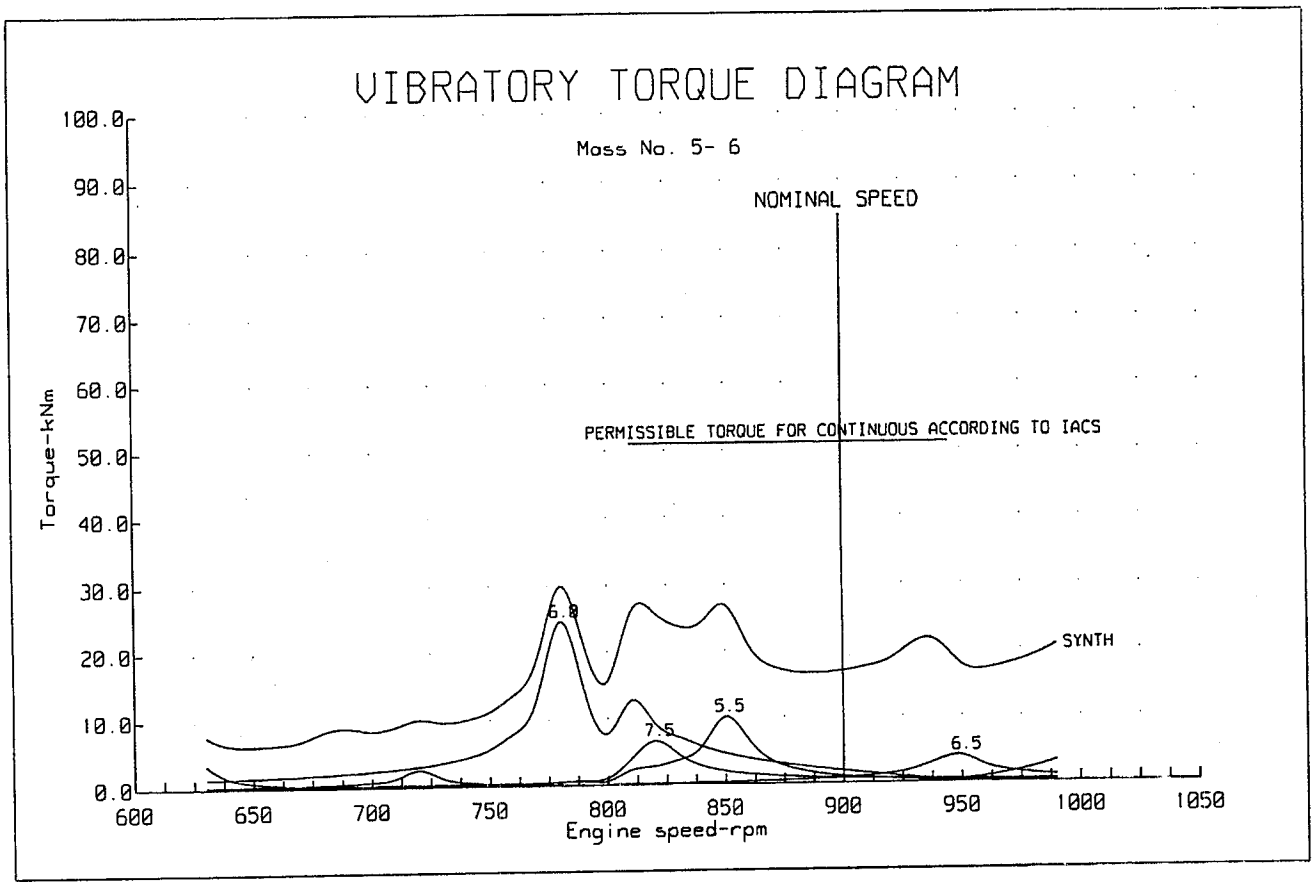
N=102.59 Hz

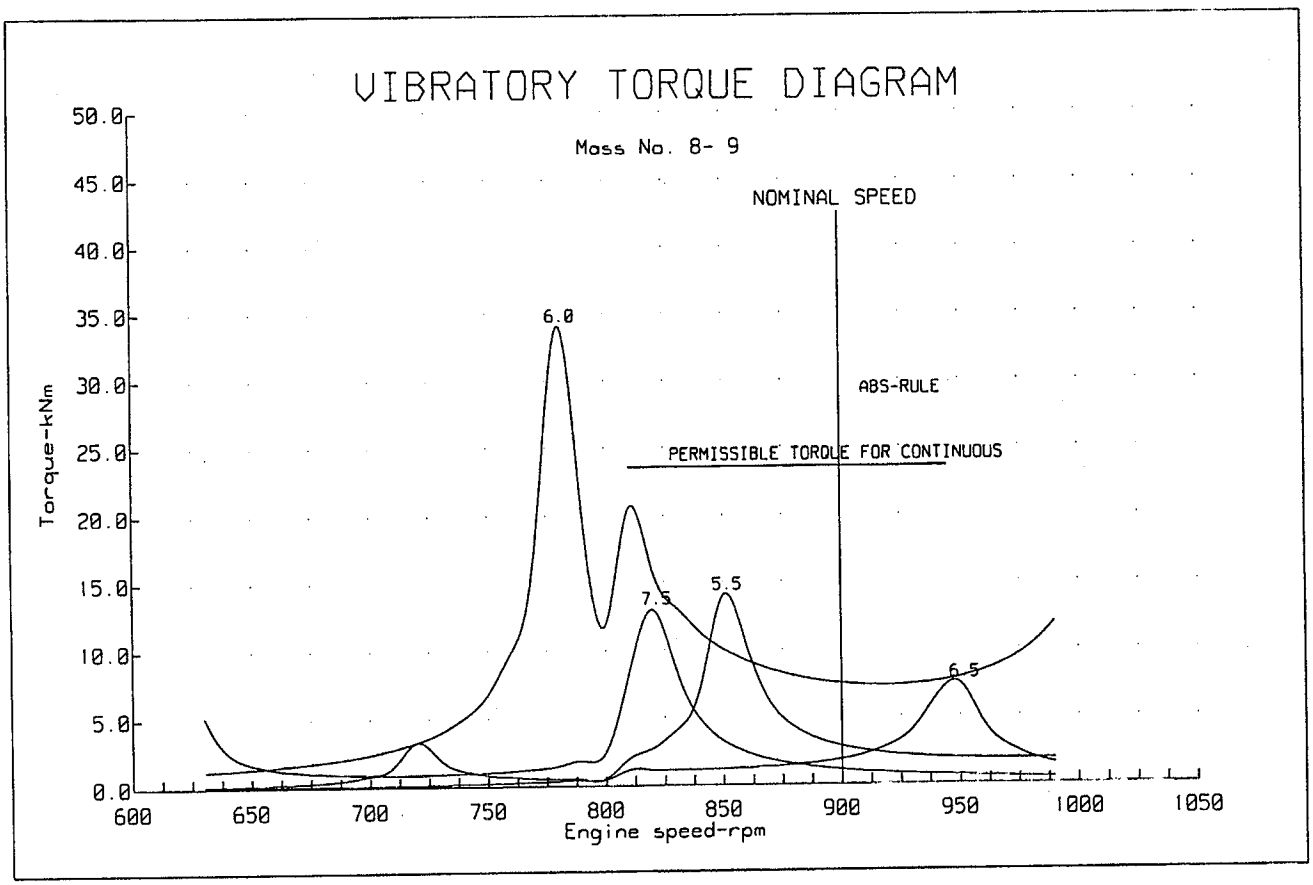
| MASS NO. | EQ. MASS kgm2 | TORS. STIFF. MNm/rad | SHAFT DIA cm | AMP. radian | TORQUE *1E2 Nm | STRESS N/mm2 |
|---|---|---|---|---|---|---|
| 1 | .741 | 3.515E+01 | 17.0 | 1.000 | 3.080 | .319 |
| 2 | 5.618 | 2.369E+01 | 17.0 | .991 | 26.222 | 2.718 |
| 3 | 5.618 | 2.369E+01 | 17.0 | .881 | 46.779 | 4.849 |
| 4 | 5.618 | 2.369E+01 | 17.0 | .683 | 62.726 | 6.502 |
| 5 | 5.618 | 2.369E+01 | 17.0 | .418 | 72.490 | 7.515 |
| 6 | 5.618 | 2.369E+01 | 17.0 | .112 | 75.110 | 7.786 |
| 7 | 5.618 | 3.027E+01 | 17.0 | -.205 | 70.327 | 7.290 |
| 8 | 117.647 | 2.541E+01 | 19.0 | -.437 | -143.441 | -10.651 |
| 9 | 12.255 | 3.302E+01 | 17.8 | .127 | -136.953 | -12.368 |
| 10 | 60.784 | | | .542 | -0.000 | |

| ORDER NUMBER | ENGINE min-1 | VECTOR SUM |
|---|---|---|
| 6.5 | 947.0 | .807 |
| 7.5 | 820.7 | 2.229 |


ANGULAR AMPLITUDE AT FREE END
Amplitude(Free end)-Degree
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.0
NOMINAL SPEED
6.0
SYNTH
5.5
7.5
6.5
600
650
700
750
800
850
900
950
1000
1050
Engine speed-rpm


STRESS-SPEED-DIAGRAM
HARMONIC SYNTHESIS
MAXIMUM STRESS BETWEEN POSITION NO.1-10
Stress N/mm^2
100
90
80
70
60
50
40
30
20
10
0
NOMINAL SPEED
600
650
700
750
800
850
900
950
1000
1050
Engine speed-rpm


VIBRATORY TORQUE DIAGRAM
Mass No. 5- 6
NOMINAL SPEED
PERMISSIBLE TORQUE FOR CONTINUOUS ACCORDING TO IACS
SYNTH
6.0
5.5
7.5
6.5
Torque-kNm
Engine speed-rpm
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
600
650
700
750
800
850
900
950
1000
1050


VIBRATORY TORQUE DIAGRAM
Mass No. 8- 9
NOMINAL SPEED
ABS-RULE
PERMISSIBLE TORQUE FOR CONTINUOUS
6.0
7.5
5.5
6.5
Torque-kNm
Engine speed-rpm
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
600
650
700
750
800
850
900
950
1000
1050

ADK20-5047-9

# TEST RECORDS OF THE DIESEL ENGINE AT SHOP TRIAL
# ディーゼル機関試運転成績書

| | | |
|---|---|---|
| SHIPYARD : | MESSRS. Sasebo Heavy Industries Co., Ltd. | |
| 造 船 所 : | Sasebo Shipyard | SNO. 762 |
| ENGINE TYPE : | | |
| 機 関 型 式 : | 6DK-20 | |
| ENGINE NO. : | | |
| 機 関 番 号 : | DK620Z1818 , DK620Z1819 , DK620Z1820 | |
| DATE OF MFG.: | | |
| 製 造 年 月 : | Sep. - 2008 | |

## RECORDS OF SHOP TRIAL
## 記 事

| | |
|---|---|
| | RUNNING TEST |
| 2 - Sep. - 2008 | 立 会 運 転 検 査 |
| | OVERHAUL INSPECTION |
| 2 - Sep. - 2008 | 立 会 分 解 検 査 |

WITNESSED BY: [signature]

WITNESSED BY: [signature] SSK

DAIHATSU DIESEL MFG. CO., LTD.
MORIYAMA FACTORY, SHIGA
QUALITY CONTROL DEPT.

| | |
|---|---|
| JUDGMENT 判 定 | good. |

APPROVED BY: [signature]

APPROVED BY: [signature]

CHECKED BY: [signature]

# SPECIFICATIONS　主要目

| DIESEL ENGINE | | ディーゼル機関 | | |
|---|---|---|---|---|
| Engine model & type | 機関仕様、型式 | 4-cycle diesel engine 立形単動4サイクルディーゼル機関 | : | 6DK-20 |
| Engine No. | 機関番号 | DK620Z1818 , DK620Z1819 , DK620Z1820 | | |
| Rated output & speed | 定格出力及び回転速度 | 760 kW ( 1034 )PS, | 900 | $min^{-1}$ |
| No of cylinder,Bore & Stroke | シリンダー数、直径、行程 | 6 、 200 mm 、 | 300 | mm |

| A. C. GENERATORS | | 交流発電機 | Supply 御支給品 |
|---|---|---|---|
| Manufacture | 製作所 | NISHISHIBA ELECTRIC Co.,Ltd | made |
| Output, Cycle | 出力、周波数 | 875 KVA ( 700 ) kW 、 | 60 Hz |
| Voltage、Current & P.F. | 電圧、電流、力率 | 450 V 、 1123 A 、 | 80 % |

ACCESSORY　付属機器

| | Mfg. 製作所 | Type 形式 | Spec. 仕様 | No.1 | No.2 | No.3 | |
|---|---|---|---|---|---|---|---|
| Turbo-charger 過給機 | ABB | TPS48D01 | CV10 CT75 CA17 TV01 TT16 TA75 | HT490852 | HT490853 | HT490854 | |
| Air cooler 空気冷却器 | DDK | DH-39-1 | ———— | 39140 | 39141 | 39142 | |
| Governor 調速機 | BOSCH | RHD6-MC | Design No. | 105856-5580 | | | |
| | | | Serial No. | 88742162 | 88742163 | 88742172 | |

SURVEYOR'S MARK　規　格

| | No.1 Eng. | No.2 Eng. | No.3 Eng. | |
|---|---|---|---|---|
| Diesel engine ディーゼル機関 | ABPQA<br>Ⓔ NO.DK620Z1818<br>2-9-08 | ABPQA<br>Ⓔ NO.DK620Z1819<br>2-9-08 | ABPQA<br>Ⓔ NO.DK620Z1820<br>2-9-08 | |
| A.C. Generator 交流発電機 | ABS TYPE APPROVAL<br>KO 1029774<br>NO.252171A1A-1<br>18-JULY-08 | ABS TYPE APPROVAL<br>KO 1029774<br>NO.252171A1A-2<br>18-JULY-08 | ABS TYPE APPROVAL<br>KO 1029774<br>NO.252171A1A-3<br>18-JULY-08 | |

VALVE ADJUSTMENTS　調整要目表

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Intake valve 吸気弁 | Open (before T.D.C) 開 (上死点前) | Degree 度 | 50 | Top clearance ピストン頂隙 | | 10.5 | mm |
| | Close (after B.D.C) 閉 (下死点後) | Degree 度 | 35 | Injection pressure 燃料噴射圧力 | | 29.4 | MPa |
| | Clearance 間隔 | mm | 0.31 | | | 300 | $kg/cm^2$ |
| Exhaust valve 排気弁 | Open (before B.D.C) 開 (下死点前) | Degree 度 | 55 | Fuel pump 燃料ポンプ | Type 形式 | 104257-3032 | |
| | Close (after T.D.C) 閉 (上死点後) | Degree 度 | 50 | Nozzle 噴射弁 | Type 形式 | DLL140TE3010 | |
| | Clearance 間隔 | mm | 0.31 | Firing order 着火順序 | | 1-5-3-6-2-4 | |
| Beginning of Pumping (before T.D.C) 燃料ポンプ突始め (上死点前) | | Degree 度 | 11.5 | | | | |
| Starting valve 起動弁 | Open (before T.D.C) 開 (上死点前) | Degree 度 | 4 | Direction of crank rotation (Viewed from the flywheel) 回転方向(フライホイル側から見て) | | Clock wise 時計方向 | |
| | Close (after T.D.C) 閉 (上死点後) | Degree 度 | 130 | | | | |

## LOAD RUNNING TEST

Date of test : *1-9-2008 2-9-2008 | No.1 ENG. | TYPE : 6DK-20 | ENG.NO. : DK620Z1818

| Kind of load | | | | % | Standard at 100% | * 25 | * 50 | * 75 | | 100 | 100 | | * 110 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of recording | | | | o'clock-min | 9-00~ | 9-20 | 9-40 | 10-00 | 9-00~ | 9-30 | 10-00 | 11-00~ | 11-30 | | |
| Runnning test time | | | | min | | 20 | 20 | 20 | | 30 | 30 | | 30 | | |
| Generator output | | | | kW | | 175 | 350 | 525 | | 700 | 700 | | 770 | | |
| Fuel consumption ** | | | | kg/h | | 48.7 | 79.5 | 111.9 | | 144.1 | 144.1 | | 158.3 | | |
| ( be based on Gen.output ) ** | | | | g/kWh | | 278.0 | 227.2 | 213.1 | | 205.8 | 205.8 | | 205.5 | | |
| ( be based on Eng.output ) ** | | | | g/kWh | ≦ 197 +5% | 255.5 | 215.8 | 204.1 | | 197.6 | 197.6 | | 197.3 | | |
| Gen.efficiency at P.F.=1.0 | | | | | | 91.9 | 95.0 | 95.8 | | 96.0 | 96.0 | | 96.0 | | |
| Fuel pump rack reading | | | | | | 12.0 | 16.5 | 20.0 | | 23.5 | 23.5 | | 25.0 | | |
| Cooling water pressure | | Jacket | | MPa | For reference | 0.22 | 0.22 | 0.22 | | 0.22 | 0.22 | | 0.22 | | |
| | | Cooler | | MPa | For reference | 0.10 | 0.10 | 0.10 | | 0.10 | 0.10 | | 0.10 | | |
| Lub. oil pressure | Bearing | | | MPa | 0.4 ~ 0.55 | 0.54 | 0.52 | 0.51 | | 0.50 | 0.50 | | 0.50 | | |
| | Turbo-charger | | | MPa | 0.2 ~ 0.5 | 0.49 | 0.48 | 0.46 | | 0.46 | 0.46 | | 0.45 | | |
| Boost air pressure | | | | MPa | | 0.030 | 0.080 | 0.140 | | 0.207 | 0.207 | | 0.230 | | |
| Fuel oil pressure | Eng. inlet | | | MPa | For reference | 0.37 | 0.38 | 0.34 | | 0.34 | 0.34 | | 0.34 | | |
| Lub. oil temperature | Oil cooler | Outlet | | ℃ | | 52 | 54 | 54 | | 55 | 55 | | 55 | | |
| Cooling water temperature | Engine | Inlet | | ℃ | | 66 | 66 | 67 | | 67 | 67 | | 68 | | |
| | | Outlet | | ℃ | | 69 | 69 | 70 | | 70 | 70 | | 71 | | |
| | Oil cooler | Inlet | | ℃ | | 30 | 31 | 33 | | 35 | 36 | | 39 | | |
| Exhaust gas temperature | Cylinderhead outlet | | 1 | ℃ | Difference ≦10% | 290 | 310 | 325 | | 340 | 345 | | 360 | | |
| | | | 2 | ℃ | | 295 | 315 | 330 | | 350 | 355 | | 370 | | |
| | | | 3 | ℃ | | 285 | 310 | 330 | | 360 | 365 | | 375 | | |
| | | | 4 | ℃ | | 290 | 315 | 335 | | 350 | 355 | | 370 | | |
| | | | 5 | ℃ | | 280 | 310 | 330 | | 350 | 355 | | 370 | | |
| | | | 6 | ℃ | | 295 | 315 | 335 | | 360 | 365 | | 375 | | |
| | Turbo-charger inlet | | | ℃ | | 325 | 385 | 420 | | 440 | 440 | | 465 | | |
| Fuel oil temperature | | | | ℃ | For reference | 31 | 33 | 34 | | 32 | 34 | | 36 | | |
| Boost air temperature | | | | ℃ | 45 ~ 55 | 35 | 39 | 41 | | 46 | 47 | | 50 | | |
| Maximum combustion pressure | | | 1 | MPa | Difference ≦±0.3 | 5.8 | 8.6 | 11.4 | | 13.8 | 13.8 | | 15.1 | | |
| | | | 2 | MPa | | 5.9 | 8.7 | 11.5 | | 13.8 | 13.8 | | 15.1 | | |
| | | | 3 | MPa | | 5.8 | 8.6 | 11.4 | | 13.8 | 13.8 | | 15.0 | | |
| | | | 4 | MPa | | 5.8 | 8.6 | 11.4 | | 13.8 | 13.8 | | 15.0 | | |
| | | | 5 | MPa | | 5.9 | 8.7 | 11.5 | | 13.8 | 13.8 | | 15.1 | | |
| | | | 6 | MPa | | 5.9 | 8.7 | 11.5 | | 14.0 | 14.0 | | 15.0 | | |
| Generator bearing temperature | | | | ℃ | | 38 | 43 | 46 | | 43 | 47 | | 49 | | |
| Generator Lub. oil pressure | | | | MPa | | 0.43 | 0.42 | 0.41 | | 0.40 | 0.40 | | 0.40 | | |
| **Other Data** | | | | | | | | | | | | | | | |
| Air temp. at Turbo-charger inlet | | | | ℃ | | 28 | 31 | 32 | | 27 | 28 | | 33 | | |
| Room temperature | | | | ℃ | | 29 | 29 | 30 | | 28 | 28 | | 31 | | |
| F.O. temp. of F.O.flowmeter inlet | | | | ℃ | | 25 | 25 | 27 | | 26 | 26 | | 28 | | |
| C.W. temp. of Air cooler inlet | | | | ℃ | | 28 | 28 | 28 | | 27 | 27 | | 32 | | |
| Humidity | | | | % | | 72 | 75 | 72 | | 78 | 78 | | 65 | | |
| Atmospheric pressure | | | | hPa | | 998 | 998 | 998 | | 993 | 993 | | 998 | | |

* Inspected by DAIHATSU
**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO
Fuel consumption ( be based on Eng.output ) = Fuel consumption ( be based on Gen.output ) × Gen.efficiency

TYPE : 6DK-20

No.1 ENG. ENG.NO. : DK620Z1818

## *Crank-shaft Deflection

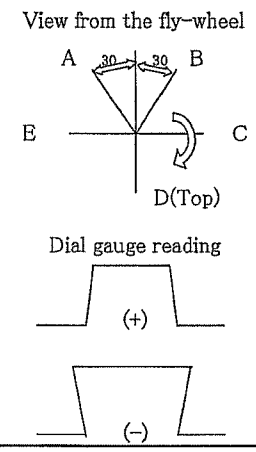
Date of test ; *27-8-2008

Cold condition (Standard +3.0 ～−3.0 ) (Gen.side←→Eng.side) UNIT: 1/100mm

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −1.5 | −0.8 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| D | −2.5 | −1.5 | 0.0 | 0.0 | −0.2 | −0.2 | | |
| E | −1.5 | −0.8 | −0.2 | 0.0 | −0.2 | −0.2 | | |

Hot condition ( crank-arm temperature 66 ℃ )

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | | | | | | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −4.0 | | | | | | | |
| D | −7.0 | | | | | | | |
| E | −3.0 | | | | | | | |




## *Temperature after continuous operation (℃)

Date of test ; *28-8-2008

Diesel Engine

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|
| Main bearing | 64 | 67 | 68 | 68 | 67 | 67 | 63 | | |
| Crank pin bearing | 64 | 65 | 65 | 65 | 65 | 64 | − | | |
| | | | | | | | | | |
| Lub. oil | 64 | | | | | | | | |

## *Engine starting test

Date of test ; *29-8-2008

| Air receiver capasity | Time | Pressure | Time | Pressure | Time | Pressure |
|---|---|---|---|---|---|---|
| 100 L | 1 | 2.45 | 8 | 1.30 | 15 | |
| Initial pressure | 2 | 2.20 | 9 | 1.20 | 16 | |
| 2.45 MPa | 3 | 2.00 | 10 | 1.10 | 17 | |
| Room temperature | 4 | 1.90 | 11 | 1.00 | 18 | |
| 27 ℃ | 5 | 1.70 | 12 | 0.93 | 19 | |
| | 6 | 1.55 | 13 | 0.85 | Standard ≧6 | ≦1.18 |
| | 7 | 1.40 | 14 | × 0.70 | | |

## Protecting Device test

Date of test ; *28-8/2-9-2008

| | | | | | |
|---|---|---|---|---|---|
| Over speed (stop) | ( 1008～1035 ) 1025 min$^{-1}$ | C.W. temp. rise (stop) | ( 90±$^{3}_{2}$ ) 90 ℃ | | |
| L.O. pressure down (stop) | ( 0.20±0.01 ) 0.20 MPa | * Level of Leaked oil rise (alarm) | GOOD | | |
| * L.O. pressure down for T/C (alarm) | ( 0.20±0.01 ) 0.20 MPa | | | | |

- Govenor setting

Needle : 2 rev. open

| | |
|---|---|
| Fuel oil ; | Exxon mobil oil "A" |
| Density ; | *0.8607/0.8628 g/cm$^3$at 15℃ |
| Low heating value ; | *42.61/42.57 MJ/kg |
| Lub. oil ; | Exxon mobil motor oil #30 |
| Power factor; | 100% |
| Drawing ; | T.NAKAGAWA |
| Checked ; | T.FUJIMOTO |

## LOAD RUNNING TEST

Date of test : *1-9-2008 2-9-2008

No.2 ENG.

TYPE : 6DK-20
ENG.NO. : DK620Z1819

| Kind of load | | | | % | Standard at 100% | * 25 | * 50 | * 75 | | 100 | 100 | | * 110 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of recording | | | | o'clock-min | 9-00~ | 9-20 | 9-40 | 10-00 | 9-00~ | 9-30 | 10-00 | 11-00~ | 11-30 | | |
| Runnning test time | | | | min | | 20 | 20 | 20 | | 30 | 30 | | 30 | | |
| Generator output | | | | kW | | 175 | 350 | 525 | | 700 | 700 | | 770 | | |
| Fuel consumption ** | | | | kg/h | | 48.5 | 79.4 | 111.7 | | 144.8 | 144.8 | | 158.5 | | |
| ( be based on Gen.output ) ** | | | | g/kWh | | 277.3 | 226.9 | 212.8 | | 206.9 | 206.9 | | 205.8 | | |
| ( be based on Eng.output ) ** | | | | g/kWh | ≦ 197 +5% | 254.8 | 215.6 | 203.9 | | 198.6 | 198.6 | | 197.6 | | |
| Gen.efficiency at P.F.=1.0 | | | | | | 91.9 | 95.0 | 95.8 | | 96.0 | 96.0 | | 96.0 | | |
| Fuel pump rack reading | | | | | | 11.5 | 16.0 | 20.0 | | 23.0 | 23.0 | | 24.5 | | |
| Cooling water pressure | | Jacket | | MPa | For reference | 0.20 | 0.20 | 0.20 | | 0.20 | 0.20 | | 0.20 | | |
| | | Cooler | | MPa | For reference | 0.10 | 0.10 | 0.10 | | 0.11 | 0.11 | | 0.10 | | |
| Lub. oil pressure | Bearing | | | MPa | 0.4 ~ 0.55 | 0.53 | 0.52 | 0.51 | | 0.50 | 0.50 | | 0.50 | | |
| | Turbo-charger | | | MPa | 0.2 ~ 0.5 | 0.50 | 0.48 | 0.47 | | 0.46 | 0.46 | | 0.46 | | |
| Boost air pressure | | | | MPa | | 0.027 | 0.080 | 0.140 | | 0.208 | 0.208 | | 0.232 | | |
| Fuel oil pressure | Eng. inlet | | | MPa | For reference | 0.38 | 0.40 | 0.38 | | 0.38 | 0.38 | | 0.37 | | |
| Lub. oil temperature | Oil cooler | Outlet | | ℃ | | 52 | 56 | 56 | | 56 | 56 | | 56 | | |
| Cooling water temperature | Engine | Inlet | | ℃ | | 69 | 69 | 69 | | 68 | 68 | | 69 | | |
| | | Outlet | | ℃ | | 71 | 72 | 72 | | 72 | 72 | | 72 | | |
| | Oil cooler | Inlet | | ℃ | | 29 | 30 | 32 | | 34 | 35 | | 38 | | |
| Exhaust gas temperature | Cylinderhead outlet | | 1 | ℃ | Difference ≦10% | 280 | 305 | 315 | | 350 | 350 | | 360 | | |
| | | | 2 | ℃ | | 280 | 315 | 325 | | 355 | 355 | | 370 | | |
| | | | 3 | ℃ | | 290 | 320 | 335 | | 365 | 370 | | 380 | | |
| | | | 4 | ℃ | | 285 | 315 | 330 | | 360 | 360 | | 375 | | |
| | | | 5 | ℃ | | 285 | 320 | 335 | | 360 | 365 | | 380 | | |
| | | | 6 | ℃ | | 275 | 310 | 325 | | 350 | 355 | | 365 | | |
| | Turbo-charger inlet | | | ℃ | | 320 | 390 | 420 | | 445 | 445 | | 465 | | |
| Fuel oil temperature | | | | ℃ | For reference | 29 | 30 | 32 | | 32 | 33 | | 35 | | |
| Boost air temperature | | | | ℃ | 45 ~ 55 | 32 | 37 | 40 | | 46 | 47 | | 50 | | |
| Maximum combustion pressure | | | 1 | MPa | Difference ≦±0.3 | 5.8 | 8.6 | 11.4 | | 13.8 | 13.8 | | 15.0 | | |
| | | | 2 | MPa | | 5.8 | 8.6 | 11.4 | | 14.0 | 14.0 | | 15.0 | | |
| | | | 3 | MPa | | 5.8 | 8.6 | 11.4 | | 14.1 | 14.1 | | 15.1 | | |
| | | | 4 | MPa | | 5.9 | 8.7 | 11.5 | | 14.1 | 14.1 | | 15.2 | | |
| | | | 5 | MPa | | 5.9 | 8.7 | 11.5 | | 13.9 | 13.9 | | 15.0 | | |
| | | | 6 | MPa | | 5.8 | 8.6 | 11.4 | | 13.8 | 13.8 | | 15.0 | | |
| Generator bearing temperature | | | | ℃ | | 38 | 45 | 48 | | 45 | 48 | | 51 | | |
| Generator Lub. oil pressure | | | | MPa | | 0.44 | 0.43 | 0.42 | | 0.42 | 0.42 | | 0.42 | | |
| **Other Data** | | | | | | | | | | | | | | | |
| Air temp. at Turbo-charger inlet | | | | ℃ | | 29 | 30 | 30 | | 29 | 30 | | 33 | | |
| Room temperature | | | | ℃ | | 29 | 29 | 30 | | 28 | 28 | | 31 | | |
| F.O. temp. of F.O.flowmeter inlet | | | | ℃ | | 25 | 25 | 27 | | 26 | 26 | | 28 | | |
| C.W. temp. of Air cooler inlet | | | | ℃ | | 28 | 28 | 28 | | 27 | 27 | | 32 | | |
| Humidity | | | | % | | 72 | 75 | 72 | | 78 | 78 | | 65 | | |
| Atmospheric pressure | | | | hPa | | 998 | 998 | 998 | | 993 | 993 | | 998 | | |

* Inspected by DAIHATSU
**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO
Fuel consumption ( be based on Eng.output ) = Fuel consumption ( be based on Gen.output ) × Gen.efficiency

TYPE : 6DK-20

No.2 ENG. ENG.NO. : DK620Z1819

## *Crank-shaft Deflection

Date of test ; *27-8-2008

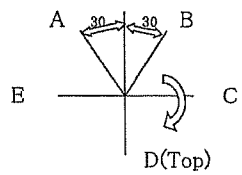
Cold condition (Standard +3.0 ～−3.0 ) (Gen.side←→Eng.side) UNIT: 1/100mm

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −1.5 | −0.5 | +0.5 | +0.5 | +0.2 | 0.0 | | |
| D | −2.5 | −1.0 | 0.0 | 0.0 | +0.2 | 0.0 | | |
| E | −1.5 | −0.2 | 0.0 | 0.0 | +0.2 | 0.0 | | |

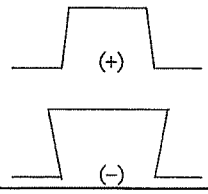
Hot condition ( crank-arm temperature 68 ℃ )

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | −0.5 | | | | | | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −3.0 | | | | | | | |
| D | −7.0 | | | | | | | |
| E | −3.5 | | | | | | | |

View from the fly-wheel




Dial gauge reading




## *Temperature after continuous operation (℃)

Date of test ; *28-8-2008

Diesel Engine

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|
| Main bearing | 64 | 66 | 68 | 68 | 68 | 67 | 64 | | |
| Crank pin bearing | 65 | 66 | 67 | 67 | 66 | 66 | − | | |
| | | | | | | | | | |
| Lub. oil | 64 | | | | | | | | |

## *Engine starting test

Date of test ; *29-8-2008

| Air receiver capasity | Time | Pressure | Time | Pressure | Time | Pressure |
|---|---|---|---|---|---|---|
| 100 L | 1 | 2.45 | 8 | 1.35 | 15 | × 0.70 |
| Initial pressure | 2 | 2.20 | 9 | 1.25 | 16 | |
| 2.45 MPa | 3 | 2.00 | 10 | 1.15 | 17 | |
| Room temperature | 4 | 1.80 | 11 | 1.05 | 18 | |
| 27 ℃ | 5 | 1.65 | 12 | 0.95 | 19 | |
| | 6 | 1.55 | 13 | 0.85 | Standard | |
| | 7 | 1.45 | 14 | 0.80 | ≧6 | ≦1.18 |

## Protecting Device test

Date of test ; *28-8/2-9-2008

| | | | | | |
|---|---|---|---|---|---|
| Over speed (stop) | ( 1008～1035 ) 1030 min$^{-1}$ | C.W. temp. rise (stop) | ( 90±$^{3}_{2}$ ) 90 ℃ | | |
| L.O. pressure down (stop) | ( 0.20±0.01 ) 0.20 MPa | * Level of Leaked oil rise (alarm) | GOOD | | |
| * L.O. pressure down for T/C (alarm) | ( 0.20±0.01 ) 0.20 MPa | | | | |

**・Govenor setting**

Needle : 2 rev. open

| | |
|---|---|
| Fuel oil ; | Exxon mobil oil "A" |
| Density ; | *0.8607/0.8628 g/cm$^3$at 15℃ |
| Low heating value ; | *42.61/42.57 MJ/kg |
| Lub. oil ; | Exxon mobil motor oil #30 |
| Power factor; | 100% |
| Drawing ; | E.IWASA |
| Checked ; | T.FUJIMOTO |

## LOAD RUNNING TEST

Date of test : *1-9-2008 2-9-2008

No.3 ENG.

TYPE : 6DK-20
ENG.NO. : DK620Z1820

| Kind of load | | | | % | Standard at 100% | * 25 | * 50 | * 75 | | 100 | 100 | | * 110 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time of recording | | | | o'clock-min | 9-00～ | 9-20 | 9-40 | 10-00 | 9-00～ | 9-30 | 10-00 | 11-00～ | 11-30 | | |
| Running test time | | | | min | | 20 | 20 | 20 | | 30 | 30 | | 30 | | |
| Generator output | | | | kW | | 175 | 350 | 525 | | 700 | 700 | | 770 | | |
| Fuel consumption ** | | | | kg/h | | 48.6 | 79.5 | 112.0 | | 144.8 | 144.8 | | 158.7 | | |
| ( be based on Gen.output ) ** | | | | g/kWh | | 277.6 | 227.2 | 213.4 | | 206.9 | 206.9 | | 206.1 | | |
| ( be based on Eng.output ) ** | | | | g/kWh | ≦ 197 +5% | 255.1 | 215.8 | 204.4 | | 198.6 | 198.6 | | 197.9 | | |
| Gen.efficiency at P.F.=1.0 | | | | | | 91.9 | 95.0 | 95.8 | | 96.0 | 96.0 | | 96.0 | | |
| Fuel pump rack reading | | | | | | 11.5 | 16.0 | 20.0 | | 23.0 | 23.0 | | 24.5 | | |
| Cooling water pressure | Jacket | | | MPa | For reference | 0.20 | 0.20 | 0.20 | | 0.20 | 0.20 | | 0.20 | | |
| | Cooler | | | MPa | For reference | 0.10 | 0.10 | 0.10 | | 0.10 | 0.10 | | 0.10 | | |
| Lub. oil pressure | Bearing | | | MPa | 0.4 ～ 0.55 | 0.54 | 0.53 | 0.51 | | 0.50 | 0.50 | | 0.49 | | |
| | Turbo-charger | | | MPa | 0.2 ～ 0.5 | 0.48 | 0.46 | 0.45 | | 0.44 | 0.44 | | 0.44 | | |
| Boost air pressure | | | | MPa | | 0.030 | 0.083 | 0.143 | | 0.205 | 0.205 | | 0.230 | | |
| Fuel oil pressure | Eng. inlet | | | MPa | For reference | 0.36 | 0.37 | 0.35 | | 0.33 | 0.33 | | 0.35 | | |
| Lub. oil temperature | Oil cooler | Outlet | | ℃ | | 52 | 55 | 56 | | 57 | 57 | | 57 | | |
| Cooling water temperature | Engine | Inlet | | ℃ | | 65 | 70 | 70 | | 70 | 70 | | 70 | | |
| | | Outlet | | ℃ | | 68 | 72 | 72 | | 72 | 72 | | 72 | | |
| | Oil cooler | Inlet | | ℃ | | 29 | 30 | 33 | | 32 | 33 | | 36 | | |
| Exhaust gas temperature | Cylinderhead outlet | | 1 | ℃ | Difference ≦10% | 295 | 305 | 320 | | 340 | 345 | | 355 | | |
| | | | 2 | ℃ | | 295 | 305 | 320 | | 345 | 345 | | 355 | | |
| | | | 3 | ℃ | | 285 | 315 | 335 | | 360 | 365 | | 375 | | |
| | | | 4 | ℃ | | 295 | 315 | 335 | | 355 | 365 | | 375 | | |
| | | | 5 | ℃ | | 285 | 315 | 335 | | 360 | 365 | | 375 | | |
| | | | 6 | ℃ | | 295 | 315 | 335 | | 360 | 365 | | 375 | | |
| | Turbo-charger inlet | | | ℃ | | 330 | 390 | 420 | | 440 | 450 | | 460 | | |
| Fuel oil temperature | | | | ℃ | For reference | 30 | 32 | 32 | | 31 | 32 | | 34 | | |
| Boost air temperature | | | | ℃ | 45 ～ 55 | 33 | 38 | 41 | | 45 | 46 | | 49 | | |
| Maximum combustion pressure | | | 1 | MPa | Difference ≦±0.3 | 5.9 | 8.9 | 11.6 | | 13.8 | 13.8 | | 15.2 | | |
| | | | 2 | MPa | | 5.9 | 8.7 | 11.6 | | 14.0 | 14.0 | | 15.0 | | |
| | | | 3 | MPa | | 5.9 | 8.7 | 11.6 | | 14.0 | 14.0 | | 15.0 | | |
| | | | 4 | MPa | | 5.9 | 8.7 | 11.6 | | 13.9 | 13.9 | | 15.0 | | |
| | | | 5 | MPa | | 5.8 | 8.6 | 11.5 | | 14.0 | 14.0 | | 15.0 | | |
| | | | 6 | MPa | | 5.9 | 8.9 | 11.6 | | 14.1 | 14.1 | | 15.0 | | |
| Generator bearing temperature | | | | ℃ | | 36 | 45 | 49 | | 47 | 49 | | 50 | | |
| Generator Lub. oil pressure | | | | MPa | | 0.42 | 0.41 | 0.41 | | 0.40 | 0.40 | | 0.40 | | |
| **Other Data** | | | | | | | | | | | | | | | |
| Air temp. at Turbo-charger inlet | | | | ℃ | | 28 | 28 | 30 | | 28 | 31 | | 30 | | |
| Room temperature | | | | ℃ | | 29 | 29 | 30 | | 28 | 28 | | 31 | | |
| F.O. temp. of F.O.flowmeter inlet | | | | ℃ | | 25 | 25 | 27 | | 26 | 26 | | 28 | | |
| C.W. temp. of Air cooler inlet | | | | ℃ | | 28 | 28 | 28 | | 27 | 27 | | 32 | | |
| Humidity | | | | % | | 72 | 75 | 72 | | 78 | 78 | | 65 | | |
| Atmospheric pressure | | | | hPa | | 998 | 998 | 998 | | 993 | 993 | | 998 | | |

* Inspected by DAIHATSU
**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO
Fuel consumption ( be based on Eng.output ) = Fuel consumption ( be based on Gen.output ) ×Gen.efficiency

TYPE : 6DK-20

No.3 ENG. ENG.NO. : DK620Z1820

## *Crank-shaft Deflection

Date of test ; *27-8-2008

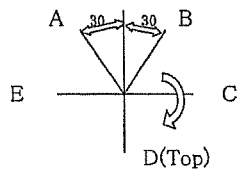
Cold condition (Standard +3.0 ～−3.0 ) (Gen.side←→Eng.side) UNIT: 1/100mm

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −1.0 | −0.5 | 0.0 | −0.2 | 0.0 | 0.0 | | |
| D | −2.5 | −1.0 | −0.2 | −0.2 | 0.0 | 0.0 | | |
| E | −1.0 | −0.5 | +0.2 | 0.0 | 0.0 | 0.0 | | |

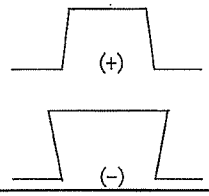
Hot condition ( crank-arm temperature 66 ℃ )

| | 1 | 2 | 3 | 4 | 5 | 6 | | |
|---|---|---|---|---|---|---|---|---|
| A | −0.5 | | | | | | | |
| B | ±0 | ±0 | ±0 | ±0 | ±0 | ±0 | | |
| C | −3.5 | | | | | | | |
| D | −8.0 | | | | | | | |
| E | −4.0 | | | | | | | |

View from the fly-wheel




Dial gauge reading




## *Temperature after continuous operation (℃)

Date of test ; *28-8-2008

Diesel Engine

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|
| Main bearing | 65 | 67 | 68 | 68 | 68 | 67 | 64 | | |
| Crank pin bearing | 66 | 66 | 66 | 67 | 66 | 66 | − | | |
| | | | | | | | | | |
| Lub. oil | 65 | | | | | | | | |

## *Engine starting test

Date of test ; *29-8-2008

| Air receiver capasity | Time | Pressure | Time | Pressure | Time | Pressure |
|---|---|---|---|---|---|---|
| 100 L | 1 | 2.45 | 8 | 1.20 | 15 | |
| Initial pressure | 2 | 2.10 | 9 | 1.10 | 16 | |
| 2.45 MPa | 3 | 1.90 | 10 | 1.00 | 17 | |
| Room temperature | 4 | 1.70 | 11 | 0.90 | 18 | |
| 27 ℃ | 5 | 1.60 | 12 | 0.80 | 19 | |
| | 6 | 1.45 | 13 | 0.75 | Standard | |
| | 7 | 1.30 | 14 | × 0.60 | ≧6 | ≦1.18 |

## Protecting Device test

Date of test ; *28-8/2-9-2008

| | | | | | |
|---|---|---|---|---|---|
| Over speed (stop) | ( 1008～1035 ) 1025 $min^{-1}$ | C.W. temp. rise (stop) | ( 90±$^{3}_{2}$ ) 90 ℃ | | |
| L.O. pressure down (stop) | ( 0.20±0.01 ) 0.20 MPa | * Level of Leaked oil rise (alarm) | GOOD | | |
| * L.O. pressure down for T/C (alarm) | ( 0.20±0.01 ) 0.20 MPa | | | | |

**・Govenor setting**

Needle : 2 rev. open

| | |
|---|---|
| Fuel oil ; | Exxon mobil oil "A" |
| Density ; | *0.8607/0.8628 g/cm$^3$at 15℃ |
| Low heating value ; | *42.61/42.57 MJ/kg |
| Lub. oil ; | Exxon mobil motor oil #30 |
| Power factor; | 100% |
| Drawing ; | K.SUGAWARA |
| Checked ; | T.FUJIMOTO |

*Load character test　負荷特性試験

| | Load 負荷 | % | 100 | 75 | 50 | 25 | 0 | 25 | 50 | 75 | 100 | 110 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | kW | 700 | 525 | 350 | 175 | 0 | 175 | 350 | 525 | 700 | 770 | 700 |
| No.1 Eng. | Volt. 電圧 | V | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | Freq. 周波数 | Hz | 60.0 | 60.55 | 61.1 | 61.7 | 62.6 | 61.7 | 61.1 | 60.55 | 60.0 | 59.75 | 60.0 |
| No.2 Eng. | Volt. 電圧 | V | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | Freq. 周波数 | Hz | 60.0 | 60.55 | 61.1 | 61.7 | 62.6 | 61.7 | 61.1 | 60.55 | 60.0 | 59.75 | 60.0 |
| No.3 Eng. | Volt. 電圧 | V | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | Freq. 周波数 | Hz | 60.0 | 60.55 | 61.1 | 61.7 | 62.6 | 61.7 | 61.1 | 60.55 | 60.0 | 59.75 | 60.0 |

*Parallel running test　並列運転試験（Standard 規格: Deviation of output 並列偏差　≦ 15 %）

| | Load 負荷 | % | 75 | 100 | 80 | 60 | 40 | 20 | 40 | 60 | 80 | 100 | 75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volt. 電圧 | V | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | Freq. 周波数 | Hz | 60.0 | 59.5 | 59.9 | 60.35 | 60.8 | 61.3 | 60.8 | 60.35 | 59.9 | 59.5 | 60.0 |
| No.1 Eng. | Output 出力 | kW | 525 | 700 | 560 | 420 | 280 | 140 | 280 | 420 | 560 | 700 | 525 |
| No.2 Eng. | Output 出力 | kW | 525 | 700 | 560 | 420 | 280 | 145 | 280 | 420 | 560 | 700 | 525 |
| No.3 Eng. | Output 出力 | kW | 525 | 700 | 560 | 420 | 280 | 145 | 285 | 415 | 560 | 700 | 525 |

*Governor test　調速機試験

| | | Load 負荷 | Description 測定値 | | | Regulation 変動率 (%) | | Time 時間 |
|---|---|---|---|---|---|---|---|---|
| | | % | Rated. 変動前 | Inst. 瞬間 | Perma. 整定 | Inst. 瞬間 | Perma. 整定 | (sec) (秒) |
| No.1 Eng. | Freq. 周波数 (Hz) | 100 → 0 | 60.0 | 62.8 | 62.6 | 4.7 | 4.3 | 2.6 |
| | | 0 → 50 | 62.6 | 59.5 | 61.1 | 5.2 | 2.5 | 2.9 |
| | | 50 → 100 | 61.1 | 58.8 | 60.0 | 3.8 | 1.8 | 3.2 |
| | Eng. speed 機関速度 ($min^{-1}$) | 100 → 0 | 900 | 945 | 940 | 5.0 | 4.4 | – |
| | | 0 → 50 | 940 | 905 | 915 | 3.9 | 2.8 | – |
| | | 50 → 100 | 915 | 890 | 900 | 2.8 | 1.7 | – |
| No.2 Eng. | Freq. 周波数 (Hz) | 100 → 0 | 60.0 | 62.8 | 62.6 | 4.7 | 4.3 | 2.5 |
| | | 0 → 50 | 62.6 | 59.7 | 61.1 | 4.8 | 2.5 | 3.1 |
| | | 50 → 100 | 61.1 | 58.7 | 60.0 | 4.0 | 1.8 | 3.2 |
| | Eng. speed 機関速度 ($min^{-1}$) | 100 → 0 | 900 | 945 | 940 | 5.0 | 4.4 | – |
| | | 0 → 50 | 940 | 905 | 915 | 3.9 | 2.8 | – |
| | | 50 → 100 | 915 | 890 | 900 | 2.8 | 1.7 | – |
| No.3 Eng. | Freq. 周波数 (Hz) | 100 → 0 | 60.0 | 62.85 | 62.6 | 4.8 | 4.3 | 2.8 |
| | | 0 → 50 | 62.6 | 59.6 | 61.1 | 5.0 | 2.5 | 3.2 |
| | | 50 → 100 | 61.1 | 58.9 | 60.0 | 3.7 | 1.8 | 3.1 |
| | Eng. speed 機関速度 ($min^{-1}$) | 100 → 0 | 900 | 945 | 940 | 5.0 | 4.4 | – |
| | | 0 → 50 | 940 | 905 | 915 | 3.9 | 2.8 | – |
| | | 50 → 100 | 915 | 885 | 900 | 3.3 | 1.7 | – |
| Standard 規格 | | Freq. 周波数 | – | – | – | ≦ 10 | ≦ 5 | |

| | *Volt. Changing range 電圧変更範囲 | | *1Hz changing time 1Hz変更時間 | | Room temp. *30 ℃ |
|---|---|---|---|---|---|
| | MAX. 最大 | MIN. 最小 | UP 上昇 | DOWN 下降 | |
| No.1 Eng. | 520 V | 395 V | 8.5 sec | 8.5 sec | |
| No.2 Eng. | 520 V | 395 V | 8.5 sec | 8.4 sec | |
| No.3 Eng. | 525 V | 395 V | 8.5 sec | 8.2 sec | |
| | | | | | Date of test ; *28-8-2008 |

# Speed Switch Unit (-D)
# MDP-REV-D
# Instruction Manual

Article

This is prepared for Main Diesel Generator engine from the standard manual Q7LT333430FA.
Output contact of "13" may be used for Low speed detection.

(29 pages including the front page)


**DAIHATSU DIESEL MFG. CO., LTD.**
**TECHNICAL DEPARTMENT**
**MARINE ENGINE DESIGN**


| | | | |
|---|---|---|---|
| **TYPE** | | **Prepared by** | K.Tanabe |
| **LIST No.** | Q7LT333490FZ | | W. Ise |
| **DATE** | October 12, 2004 | **Approved by** | W. Ise |
| **REVISION** | | | |

#

# Speed Switch Unit-D Safety Precautions

This manual describes precautions for safety installation and operation of the speed switch unit-D. Operate equipment following these precautions.

Hazards and damage likely to result from incorrect wrong use or, neglecting of the indicated precautions, is explained below in this Manual using the following symbol marks shown below. The symbols:

 ... **CAUTION** = State likely to cause damage of light or intermediate damage.

## 1. Caution against electric shock

(1) Voltage remains in the internal terminal block even after POWER is turned OFF. See page 24(Fig.17).

(2) When using 100 or 200 VAC for signal output contacts, be aware of possible electrical shock from the terminal block.

## 2. Caution against current leakage

(1) To prevent current leakage, be sure to ground equipment properly. See page 24(Fig.17).

-CONTENTS-

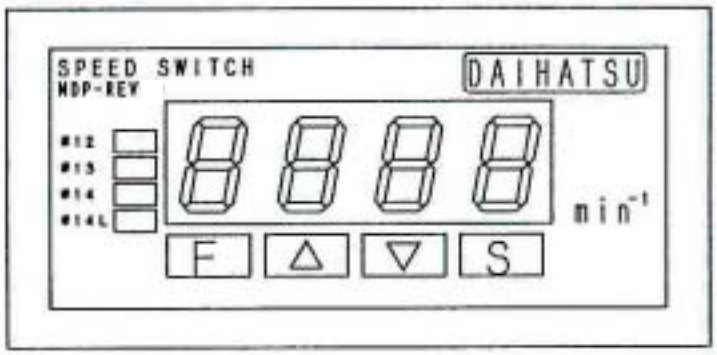



Fig. 1 Speed switch unit–D panel display

## 1 Overview

This product is a revolution detector available with a digital display function. It is a new type of speed switch unit, compact in size and highly functional, that indicates measurements digitally by a micro computer, ensuring high precision, flexible setting that meet a wide range of applications.

## 2 Features and functions

- High measurement precision by digital measurement (0.05% (at F.S.) ± 1 digit)

- Revolution speed displayed digitally to a maximum of 4 digits.

- Three-point revolution detection and one-point contact for start-up interlock.

- High resist pressure semiconductor contact output (resist pressure 1500V, AC 100V, 0.1A)

- 4 ~ 20mA analogue output

- Revolution speed frequency output (1 Hz per revolution)

- Input specification and revolution range can be set at any value.

- Detachable terminal block is used.

# 3 Specifications

| Item | | |
|---|---|---|
| Speed detection | Number of detection points | 3 speeds (#12, #13, #14)<br>(#14L: contact for start-up interlock) |
| | Detection speed range | 100～9990min$^{-1}$ (#14L:1～999min$^{-1}$) |
| | Measurement precision | 0.5min$^{-1}$ when it is 1000min$^{-1}$<br>(0.05% (at FS.) ±1digit) |
| | Setting method | Detection point is set by key operation |
| | Response time | Contact output response 0.3 seconds |
| | Hysterisis | Standard 3.0% (0.0 ～ 1.0% at F.S. setting changeable) |
| Display | Display range | 0～9999 |
| | Display | 4-digit red digital display (brightness adjustable) |
| | Display update | Approx. 0.5 sec. |
| Pulse input | Puls input range | 2～20kHz |
| | Setting method | Set number of pulses and reduction gear ratio per revolution |
| | Input pulse | Dedicated pulse sensor (AC 2Vpp ～ 288Vpp (AC 0.7 ～ 100Vrms)) |
| Frequency output (pulse output) | Output signal | 1Hz, 0/15V (5kΩ) per revolution<br>Allowable load resistance 5 KΩ or more, non-insulated with the power supply |
| | Output potential range | 1～9999 Hz (1～9999min$^{-1}$) |
| | Output error | 0.1% (2000Hz or higher) |
| Analogue | Output signal | Current signal 1 output 4-20mA load resistance 500Ω |
| | Output precision | ±0.5%(FS) |
| | Full scale | 100～9990min$^{-1}$ |
| Contact output | Output contact | 3 contact points<br>(#12: Overspeed, #13 low speed, #14, low speed)<br>1 contact points (#14L: for start-up interlock) |
| | Contact feature | set up with Contact output mode (Reference for P18) |
| | Contact capacity | No-voltage semi-conductor contact point,<br>AC/DC 100V 0.1A, pressure resistance 1500V |
| Power supply | Voltage | DC24V -25～+30% (18.0V～31.2V) |
| | Power consumption | 2.5W |
| Environmental conditions | Working temperature | 5 ～ 55 ° C (Max. 95% RH, with no dew condensation) |
| | Storage temperature | -20～65°C (MAX 95%RH, with no dew condensation) |
| | Ambience | No corrosive gas |
| | Vibration/impact | 5 ～ 13.2Hz:± 1mm, 13.2 ～ 100Hz:0.7G<br>Impact: max. 10G |
| Case | Dimension | 72×36×133 |
| | Weight | 0.2Kg |
| | Color | Black |

# 4 Outline

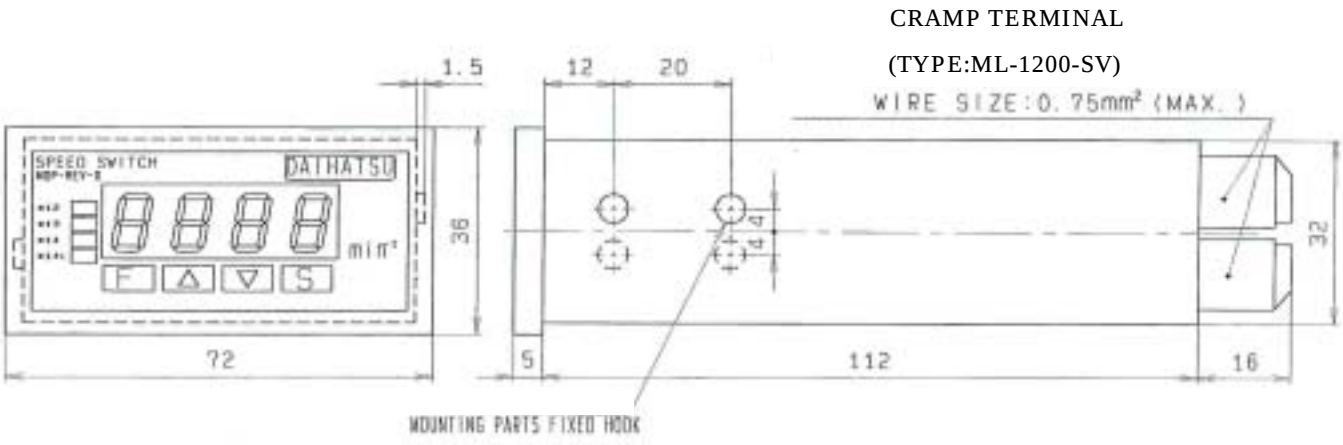



Fig. 2 Outline drawing

# 5 Configuration

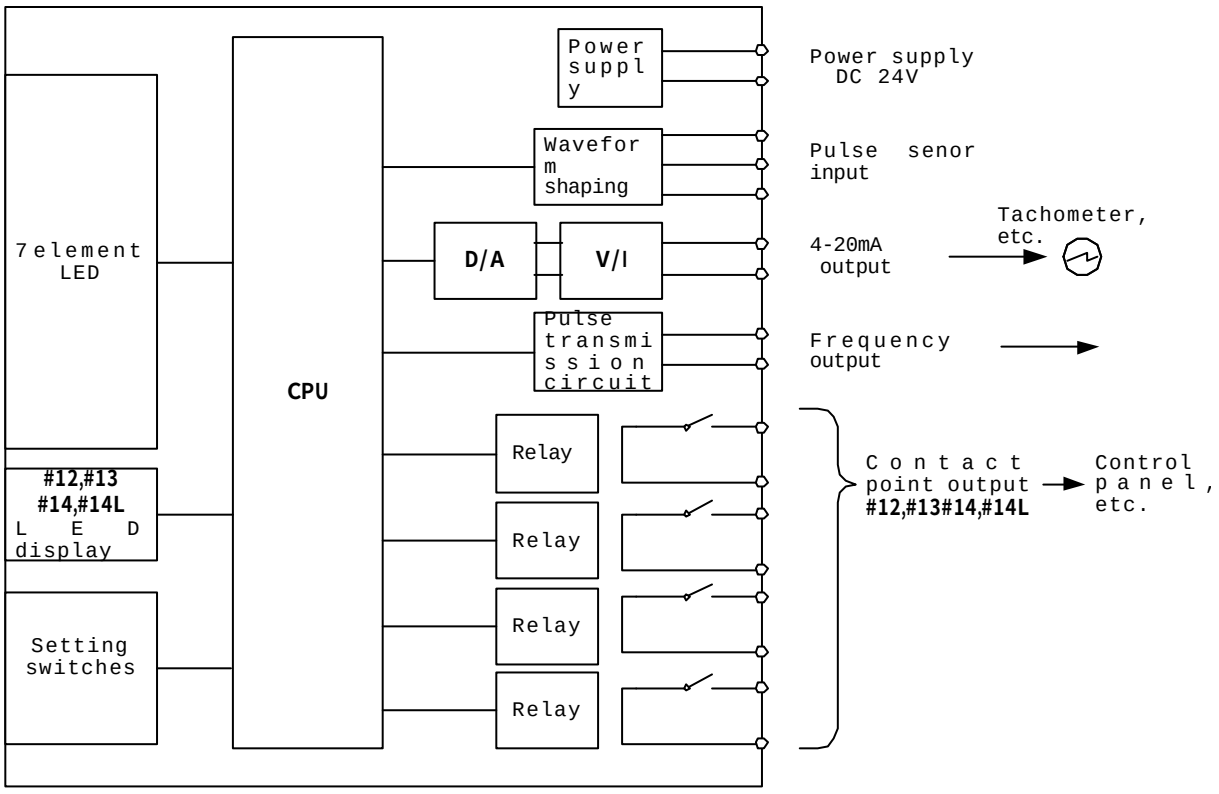



Fig. 3 Internal block diagram

# 6 Operation and modes

## 6.1 Display and operation

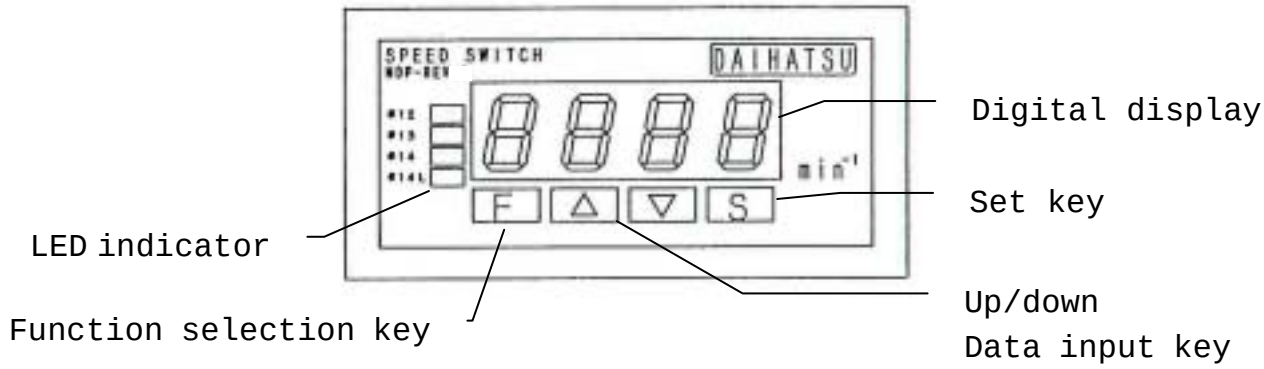



Fig. 4 Panel display

<Display function>

Digital display: Engine revolution speed is indicated digitally on the 4-digit digital LED display.
Set values, etc. are displayed, during various setting operations.

<LED indicator>

＃１２： Means over-speed detection and indicates that the engine is rotating faster that the rated speed.

＃１３： Means Low-speed detection and indicates that the engine speed has passed over the low-speed set value.

＃１４： Means Low-speed detection and indicates that the engine speed has passed over the low-speed set value.

＃１４Ｌ： Indicates that the conditions for start-up interlock have been met. It is applicable in start-up interlock circuits as it can detect complete stop of the engine.

<Input>

[F] Function selection key:

Switch for changing the mode and items. Pressing this key during normal mode changes the mode to setting display/setting mode.
Pressing and holding this key for more than 3 seconds changes the mode to initial setting display/setting mode.

[△][▽] Data input key:

Allows you to increase and decrease the set value.

[S] Set key:

Starts the setting of items and also enters and saves the set value.

## 6.2 Actions when the power supply is turned on

When the power supply is turned on, all LEDs turn on for about 1 second and normal mode starts. During the above action, revolution detection, output and error detection functions are suspended whether or not input signal exists.

**Note)** Before using the speed switch unit for the first time, various settings must be made to enable normal function, as initially set values are only temporary values set for shipment.
Please set each parameter correctly reading this instruction manual to enable correct use of the unit.
The units delivered, as the accessories of diesel engine will be suitably set up.

## 6.3 Normal state/display (normal mode)

During normal mode, the revolution speed presently detected is displayed. When the revolution speed exceeds the detection set values, the relevant contact output operates and at the same time the relevant LED indicator lights. This mode is displayed except when the setting change mode is selected.

During normal mode, the display brightness setting can be changed by the [▲ ][▼ ] data entering keys.(The initial setting value is set at the maximum brightness of 31, and normally it is not particularly necessary to change it.)

The next time the power supply is turned, the brightness is displayed at the value preciously saved.

| | |
|---|---|
| ▲ | Increase the brightness. |
| ▼ | Decrease the brightness |
| S | Pressing this button for more than 3 seconds saves the present brightness. |

## 6.4 Initial set values

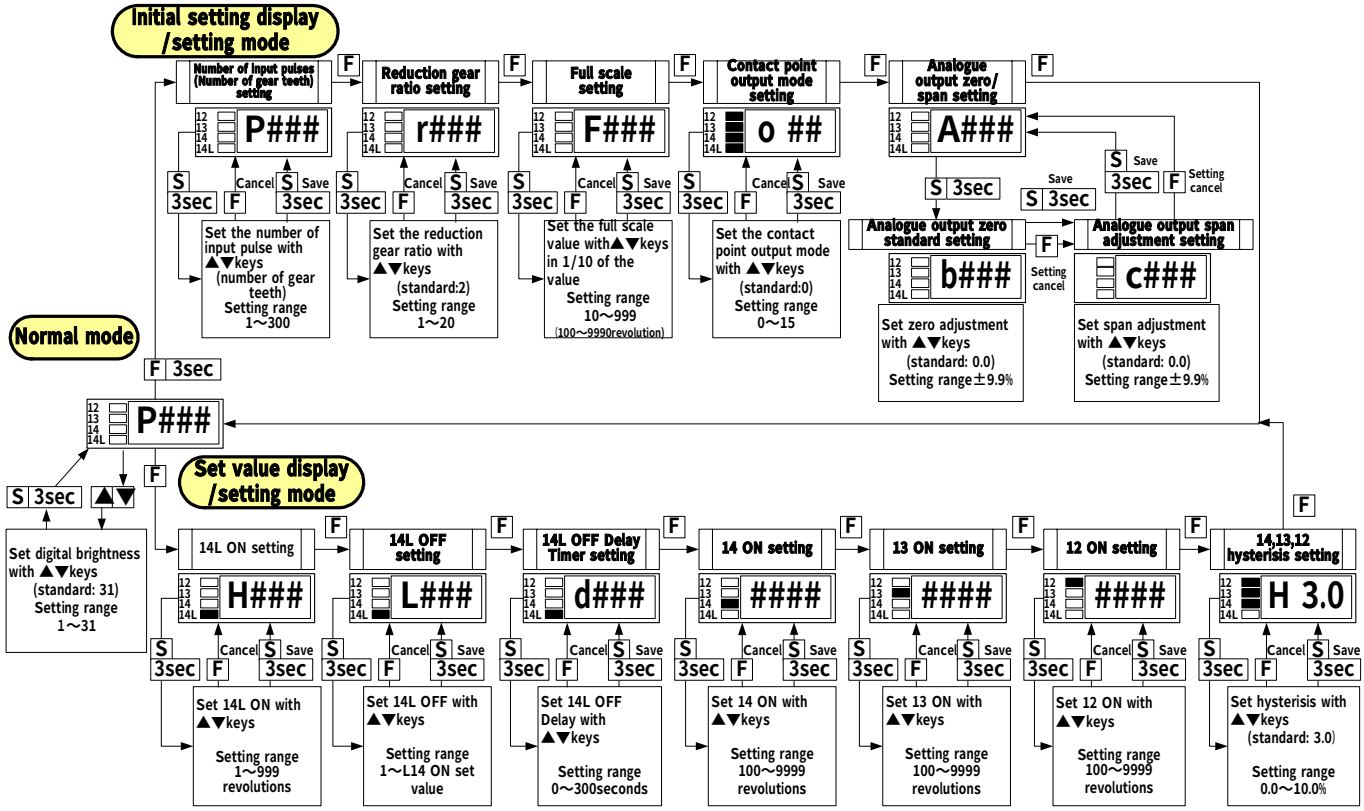
Note) To use this product, it is necessary to pre-set various set values correctly.
Using this unit without setting these values may cause critical problem in engine operation and control.

For the initial set values the following values are entered before shipment.
To encourage setting by the users, the values set in the initial setting are normally impractical values.
Refer to the table below and set items that have no ※ mark attached.
The units delivered, as the accessories of diesel engine will be suitably set up.
※ marked items can be used without changing the initial set value.

| Section | Set Items | | Settable range | Initial Set Value | Set Value |
|---|---|---|---|---|---|
| 8．2 | Number of gear teeth | | 1～300 | 1 | |
| 8．2 | Reduction gear ratio | | 1～20 | 2 | |
| 8．3 | Analogue value full scale | | 10～999 | 10 | |
| 8．4 | Output mode | | 0～15 | 0 | |
| 7．2 | #14L | ON revolution speed | 1～999 | 1 | |
| 7．2 | | OFF revolution speed | 1～999 | 1 | |
| 7．2 | | Off delay timer | 0～300 | 0 | |
| 7．3 | #14 ON (OFF) revolution speed | | 100～9999 | 100 | 300 |
| 7．4 | #13 OFF (ON) revolution speed | | 100～9999 | 100 | 300 |
| 7．5 | #12 ON (OFF) revolution speed | | 100～9999 | 100 | |
| 7．6 | #14, 13, 12 contact hysterisis | | 0～10.0 | 3 | ※ |
| 8．5 | Analogue output zero setting | | -9.9～0～9.9 | 0 | ※ |
| 8．5 | Analogue output span setting | | -9.9～0～9.9 | 0 | ※ |
| 6．3 | Display LED, brightness adjustme | | 1～31 | 31 | ※ |

※ marked items basically require no change

## 6.5 Set value display/setting mode and initial set value display/ setting mode




F：Press the " [F]Function selection key " once. S：Press the " [S]set key " once.

F 3sec：Press and hold (3seconds) the " [F]Function selection key " . S 3sec：Press and hold (3seconds) the " [S]set key".

Fig. 5 Setting procedure list

To change the set values, it is necessary to perform setting change work using the "Set value display/setting mode" and "Initial setting value display/setting mode".

"Set value display/setting mode":

A mode for setting mainly items concerning speed detection.

"Initial setting value display/setting mode":

A mode for setting constants that should be pre-set such as number of gear teeth and full scale value, etc.

To change from the "Normal mode" to "Set value display/setting mode" or "Initial setting value display/setting mode", press the "[F] function selection key" at normal mode.
To change to each mode, press the "[F] function selection key" as follows. Please refer to Fig. 5 Setting procedure list.

① To change to the "Set value display/setting mode", press the "[F] function selection key" once.
② To change to the "Initial setting value display/setting mode" press and hold (3 seconds) the "[F] function selection key".

To increase or decrease the set values by pressing the [▲ ][▼ ] keys, pressing the key once increases/decreases the value by ± 1 step, but pressing and holding the same key changes the mode to repeat mode and the values can be entered continuously. Keep pressing even further, changes the mode to fast forward and values can be changed in 10-fold, 50-fold steps.

# 7 Set value display/setting mode

## 7.1 Mode and setting items

Pressing the “[F] function selection key” from “Normal mode”, changes the mode to “Set value display/setting mode”.

In this mode, each time the “[F] function selection key” is pressed, the table below is displayed sequentially and pressing the “[F] function selection key” once again at the last item, returns the mode to “Normal mode”. (Refer to Fig. 5)

The set value display/setting mode consists of the following setting items.

① Setting #14L ON:
Revolution detection for start-up interlock, ON point revolution speed
② Setting #14L OFF:
Revolution detection for start-up interlock, OFF point revolution speed
③ Setting #14L OFF Delay:
Contact start-up interlock, OFF DELAY TIMER (second)
④ Setting #14 ON:
Low speed detection ON point revolution speed
⑤ Setting #13 OFF:
Low speed detection OFF point revolution speed
⑥ Setting #12 ON:
Overspeed detection ON point revolution speed
⑦ Hysterisis (#14, #13, #12):
ON-OFF width of #14, #13, #12 (% at FS)

Pressing and holding the “[S] set key” during the item display changes the mode to the set value change mode of the applicable item.

When it enters into the set value setting mode, measurement is suspended and external output and external contact point are frozen temporarily.
(When it returns to the normal mode again, it restarts but with a delay of about 1 to 2 seconds)

To add, when no operation is made for 3 minutes when any set value is being displayed or set, it will automatically return to normal mode.

When the brightness degree had been decreased in normal mode, the maximum brightness will be displayed temporarily in set value display mode but will display the original brightness again when returned to normal mode.

### 7.2 Start-up interlock contact point (#14L)

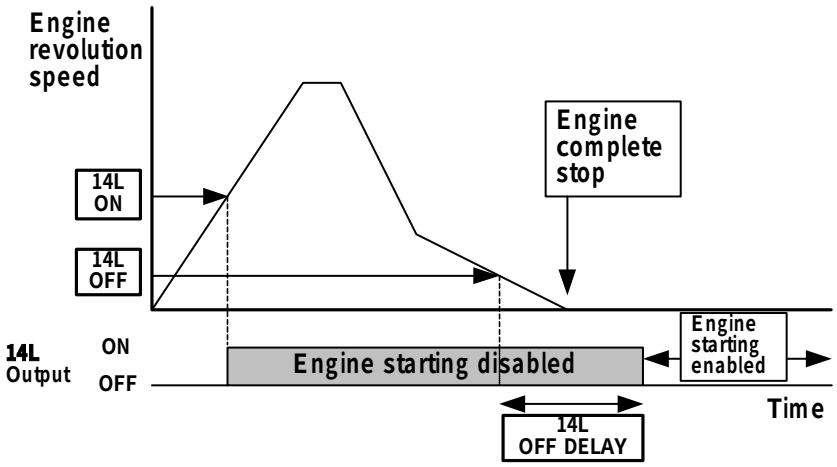



Fig. 6 14L OFF DELAY TIMER contact point operation outline

Internal combustion engine employs fly wheel (inertial mass) at the output axis to reduce output fluctuation. Therefore, when the engine is stopped, revolution remains longer than expected due to inertia of fly wheel, and even when the users stop the machine, the output axis may not be stopped completely. When start-up command is given to the engine under such situation, it may trigger unexpected accidents.
Contact for start-up interlock outputs a condition that can block restarting of engine when the output axis is rotating, with the following 3 conditions combined, so as to enable secure detection of engine stop (refer to Fig. 6 "Engine Activation Disabled" part).

(1) "#14L ON detected revolution speed" as engine operating condition,
(2) "#14L OFF detected revolution speed" as engine condition immediately before stopping,
(3) Time counter timer from (2) to complete stop "#14L DELAY TIMER"

For using the start-up interlock contact (#14L), the following 3 values must be set.

① #14L ON setting
H = 1 ~ 999
② #14L OFF setting
L = 1 ~ "#14 ON set value"
③ #14L OFF Delay setting
d = 0 ~ 300 sec.

Description:

① is an operation point setting for start-up interlock contact and when the engine revolution speed exceeds this set value, #14L contact output operates.

② #14L starts the OFF DELAY timer when the engine revolution speed becomes below this set value.

③ is a set value of #14L OFF DELAY timer and sets the delay time in seconds. #14L contact point output turns off when the time set by this timer is up.

### 7.3 Low speed detection contact (#14)

To use the low speed detection contact (#14), the following value must be set.
When the engine revolution speed increases above this set value, #14 contact output operates.

④ #14 ON setting
#14 = 100 ~ 9999

### 7.4 Low speed detection contact (#13)

To use the low speed detection contact (#13), the following value must be set.
When the engine revolution speed increases above this set value, #13 contact output operates.

⑨ #13 OFF setting
#13 = 100 ~ 9999

### 7.5 Overspeed detection contact point (#12)

To use the overspeed detection contact (#12), the following value must be set.
When the engine revolution speed increases above this set value, #12 contact output operates.

⑩ #12 ON setting
#12 = 100 ~ 9999

### 7.6 Hysterisis (#14, #13, and #12)

Hysterisis is provided to secure stability in detection operation even when the revolution speed sways. At the point of time the revolution speed exceeds the set value (detected revolution speed), the contact turns on and at the point of time the revolution speed become less than set value (return revolution speed) for the amount of hysterisis, the contact turns off.

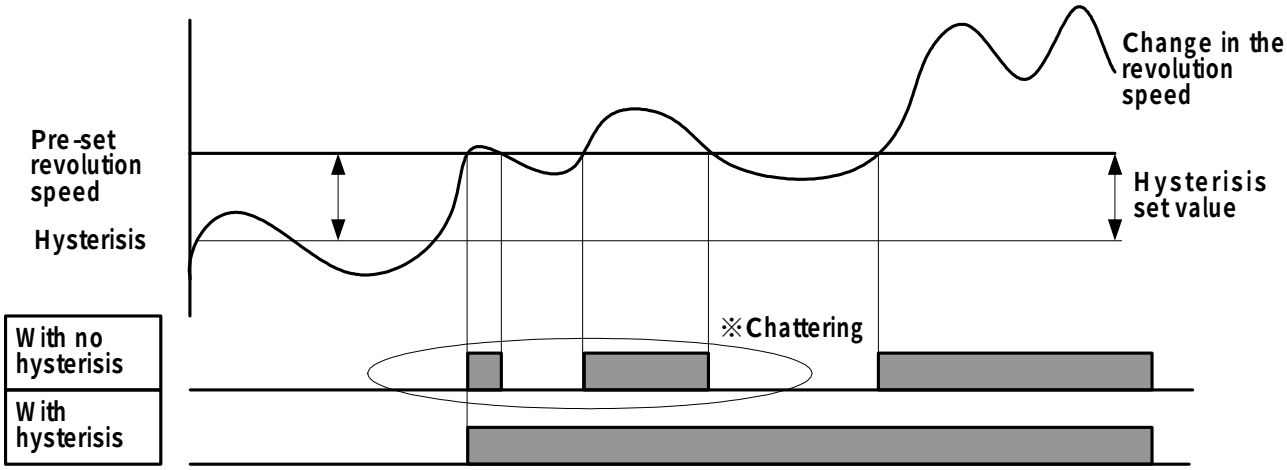



Fig. 7 Hysterisis

※Chattering may generally cause relay contact depositing by contacts repeating ON/OFF in a short time.

Detection revolution speeds for #14, #13 and #12 are set individually, but for return revolution speed, this hysterisis value will be applied to all.

⑪ Hysterisis (#14, #13, and #12)

0.0 ~ 10.0% (at FS)

※ 3.0% is registered as initial set value.

※ It is not particularly necessary to change.

Hysterisis means the range between (detection revolution speed) – (return revolution speed), and this value is set by the percentage value of the full scale set value in § 8.3.

[Ex. 4] When it is F = 150, #12 = 1020, H = 3.0,

(F: analogue full scale set value, #12: overspeed detection set value, H: hysterisis set value)

Hysterisis = 1500 × 3.0/100 = 45min$^{-1}$

#12 ON point (detection speed) ----- 1020min$^{-1}$

#12 OFF point (return speed) ----- 975min$^{-1}$

# 8 Initial setting display/setting mode

## 8.1 Mode and setting items

Pressing and holding (keep pressing for 3 seconds) the “[F] function selection key” from “Normal mode” or “Set value display/setting mode” changes the mode to “Initial setting display/setting mode”.

In this mode, each time the “[F] function selection key” is pressed, the following display will be displayed sequentially and pressing the “[F] function selection key” at the last item returns the mode to normal mode. (Refer to Fig. 5)

Initial set value display/setting mode consists of the following setting items.

① Pulse setting:
Pulse number per revolution (number of teeth)
② Reduction gear ratio setting:
Reduction gear ratio from the crank shaft
③ Full scale setting:
Scale range of analogue output
④ Output mode setting:
N/C, N/O modes of output contacts
⑤ Analogue output zero/span adjustment:
For analogue output range adjustment

Pressing and holding the “[S] set key” during display of each item changes the mode to set value changing mode of the relevant item.

When it changes to the initial setting mode, measurement is suspended and external output and external contact points are frozen temporarily.
(When it returns to the normal mode again, it restarts but with a delay of 1 to 2 seconds).

To add, when either of the set value displayed or set is left for 3 minutes without any operation, automatically returns to normal mode.

When the brightness degree had been decreased in normal mode, the maximum brightness will be displayed temporarily in set value display mode but will display the original brightness again when returned to normal mode.

### 8.2 Pulse setting/reduction gear ratio set values

Engine revolution speed (or revolution speed of rotor) is calculated from the frequency of pulse signal impressed on the sensor input terminal based on the pulse specification set and is displayed.

For the calculation of revolution speed, it is necessary to set the following pulse specifications.

① Number of pulses per revolution (number of gear teeth)
P＝1～300
② Reduction gear ratio
r＝1～20

① is the number of pulses generated per revolution of the rotation axis (gear) installed with a pulse sensor.
② is the reduction gear ratio to set when the engine revolution speed and the rotation axis installed with a pulse sensor are not the same.

For instance, when the revolution of the engine output axis is detected by pulse sensor in the original condition, the reduction gear ratio of ② becomes r = 1.

[Ex. 1] Engine output axis direct measurement: when the number of gear teeth is 142.
P＝142, r＝1

When the pulse sensor is attached to the gear that interlocks with the cam shaft of 4 cycle engine, r becomes 2. (Cam shaft only rotates 1/2 revolutions per engine revolution, so the reduction gear ratio becomes 2).

[Ex. 2] Cam shaft measurement: number of gear teeth 75
P＝75, r＝2

Also when the number of pulses per revolution is not an integral number, set a value 10-times ① and at the same time set a value 10 times large also for ②.

[Ex. 3] Cam shaft measurement: tacho generator 7.5 pulse
P＝75, r＝20

(Reference)
The pulse frequency to be impressed is expressed by the following formula.

**Frequency** = Revolution speed × number of pulses
÷ reduction gear ratio ÷ 60

On the contrary, when calculating the revolution speed from the frequency, it is expressed by the following formula.

**Revolution speed** = Frequency × reduction gear ratio × 60
÷ number of pulses

### 8.3 Full scale set value

The revolution speed can be output by the analogue signal of DC 4 ~ 20mA.
It is necessary to set the full scale value so it meets the specification of the equipment to which this output is connected.
To add, hysteresis (on-off difference) at the time of speed detection is calculated based on this full scale value.

③ Analogue full scale setting range
F＝１００～９９９０$min^{-1}$

The set value is determined by defining the revolution speed necessary at the time of 20mA output to meet the specification of the equipment to be connect to and the value dividing the revolution speed by 10 shall be the set value. 4mA is equivalent to 0 revolution speed.

[Ex. 4] Full scale＝２５００$min^{-1}$
F＝２５０

### 8.4 Contact output mode

Contacts that operate when the contact output and the conditions of (start-up interlock contact (#14), low-speed detection contact (#14), low-speed detection contact (#13) and over-speed detection contact (#12)) are met can be specified whether it should be ON during operation or OFF by the following setting.

④ Output mode setting range
o＝０～１５

Note) As a standard setting, it is set at [0] (all contacts are A contact operation) at the time of shipment from the plant.

This value is expressed by the mode numbers from 0 to 15 and is applied to each contact, #14L, #14, #13 and #12, as follows:

| No. | #14L | #14 | #13 | #12 |
|---|---|---|---|---|
| 0 | A | A | A | A |
| 1 | A | A | A | B |
| 2 | A | A | B | A |
| 3 | A | A | B | B |
| 4 | A | B | A | A |
| 5 | A | B | A | B |
| 6 | A | B | B | A |
| 7 | A | B | B | B |
| 8 | B | A | A | A |
| 9 | B | A | A | B |
| 10 | B | A | B | A |
| 11 | B | A | B | B |
| 12 | B | B | A | A |
| 13 | B | B | A | B |
| 14 | B | B | B | A |
| 15 | B | B | B | B |

A : N/O (On when over the value) mode
B : N/C(Off when over the value) mode

### 8.5 Analogue output zero/span adjustment

When there is a slight deflection in the analogue output range (4 ~ 20mA), this range can be corrected by the adjustment of zero output (4mA) and full output (20mA).

Note 1)

The speed switch unit has been adjusted at the time of shipment to ensure that correct analogue output can be made.
Normally, it is not necessary to change this setting.

Note 2)

Do not attempt to adjust the deflection in the revolution speed caused by the error in the equipment (for instance tachometer) connected to the analogue output by this function of speed switch unit.

⑤ Analogue zero output/full output adjustment setting range
－９．９～０．０～＋９．９％ (no correction when it is 0.0%)

When you enter into this mode, “A” is displayed on the leftmost side of the numerical value display and the present output on the right side.(Continuous lighting)

Under this condition the following keys are accepted.

| | |
|---|---|
| F | changes to normal mode |
| S | Pressing and holding this for 3 seconds changes to “Analogue output adjustment”. |

**[Analogue zero output adjustment]**

When you enter into this mode, “b” is displayed on the leftmost side of the numerical value display in continuous display and the present zero correction value on the right side by flashing. The analogue output will be fixed at “4.00mA”.

The correction value is the % value added to the standard state.

Here, with the following keys, fine adjustment of output value (4mA) will be made.

| | |
|---|---|
| F | Cancels the setting and changes to “full output adjustment”. |
| ▲ | Raises the correction value (output rises at the same time) |
| ▼ | Lowers the correction value (output declines at the same time) |
| S | Pressing and holding for 3 seconds sets and saves the present indicated value. |

To add, the setting range will be ± 9.9% and no correction value when it is 0.0%.

**[Analogue full output adjustment]**

When you enter into this mode, “c” is displayed on the leftmost side of the numerical value display in continuous display and the present zero correction value on the right side by flashing. The analogue output will be fixed at “20.00mA”.

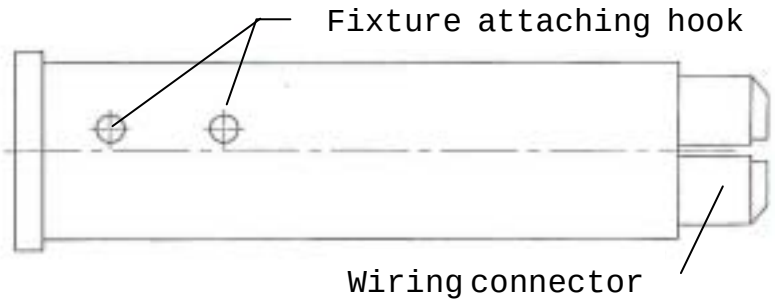
The correction value is the % value added to the standard state.

Here, with the following keys, fine adjustment of output value (20.00mA) will be made.

| | |
|---|---|
| F | Cancels the setting and changes to “full output adjustment”. |
| ▲ | Raises the correction value (output rises at the same time) |
| ▼ | Lowers the correction value (output declines at the same time) |
| S | Pressing and holding for 3 seconds sets and saves the present indicated value. |

To add, the setting range will be ± 9.9% and no correction value when it is 0.0%.

## 9 Installation



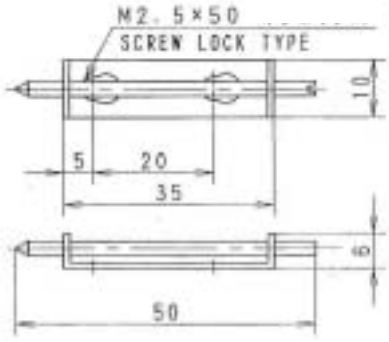




Fig. 8 Speed switch unit–D side face

Fig. 9 Fixture (accessory)

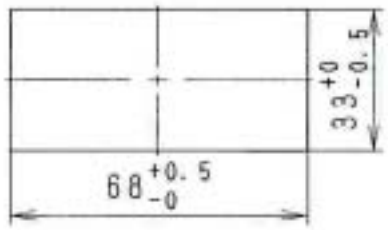



Fig. 10 Panel cut dimension

① Cut the panel of the place to install into in the panel cut size (Fig. 10).
② Insert speed switch unit–D from the front side of the panel cut hole. (Fig. 11)
③ After inserting, hook the attached fixture to the fixture installing hook and screw in metal fitting screw with a slotted screwdriver to securely fasten to the panel side. (Fig. 12)

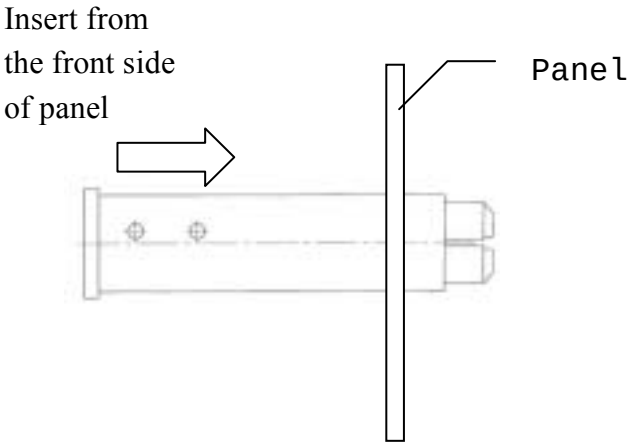



Fig. 11 Installation (insertion)

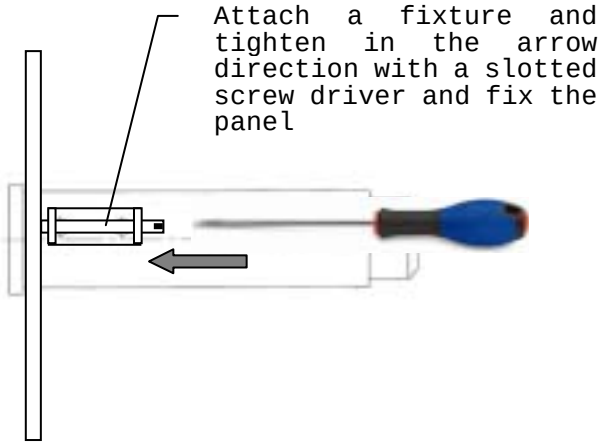



Fig. 12 Installation (fixing)

① When there is vibration on the installation panel face, you can use “bracket: panel installation (NN00262007A)” (option) which can be installed more securely.

② When converting the conventional speed switch unit and speed switch unit 2 to speed switch unit–D during maintenance, etc., you can use the speed switch unit–D available with a compatible case attached with a bracket that fit each unit,

# 10 Wiring

## 10.1 Input/output connector terminal configuration

Speed switch unit–D has double decked input/output connector on the backside of the main body. The terminal configuration is described on the nameplate seal on the upper side of the main body in the same way as below.
Please refer to the drawing for correct wiring.

The connector configuration and terminals are as described below.

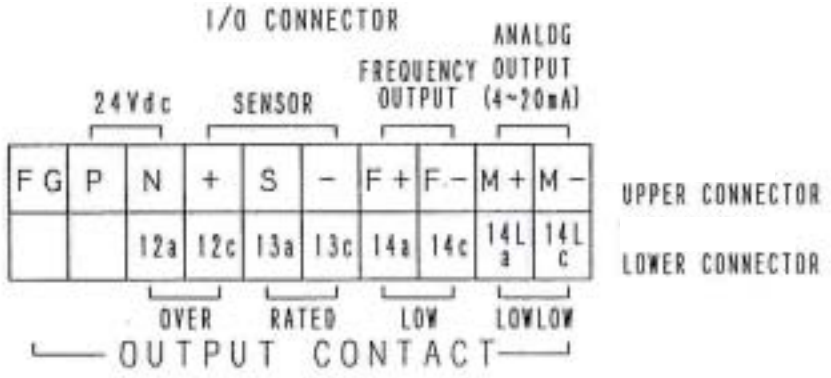



Fig. 13 Terminal configuration

| | | | |
|---|---|---|---|
| **Upper deck terminal** | | | |
| | | FG | Frame ground for the speed switch.<br>Make sure to connect to the ground to prevent noise and the risk of electric |
| | 24Vdc | P | Connect the power supply. Connect + 24V to [P] and 0V to [N]. |
| | | N | Power supply specification, power voltage: DC 24V, allowable voltage range: - 20 ~ + 30%, power consumption: 2.5W |
| | SENSOR | + | Connect the sensor output. |
| | | S | [+] and [-] are DC 24v power supplies. |
| | | − | [S] is for the pulse sensor output which is input in pulse. |
| | FREQUENCY | F+ | Outputs the pulse of detected revolution speed. (1Hz per rotation) |
| | OUTPUT | F- | 0/15V, allowable load resistance is 5KΩ or more and non-insulated from the power supply. |
| | ANALOG | M+ | Outputs current at 4 - 20mA by scaling determined by the full scale setting. |
| | OUTPUT | M- | Load resistance 500Ω or below. |
| **Lower deck connector** | | | |
| OUTPUT CONTACT | OVER | 12a | Turns on (off) the contact point when it reaches the pre-set speed limit. |
| | | 12c | No-voltage semiconductor contact point, contact point rating: AC/DC 100V 0.1A, resist pressure: 1500V |
| | LOW | 13a | Turns off (on) the contact point when it reaches the pre-set low speed. |
| | | 13c | No-voltage semiconductor contact point, contact point rating: AC/DC 100V 0.1A, resist pressure: 1500V |
| | LOW | 14a | Turns on (off) the contact point when it reaches the pre-set low speed. |
| | | 14c | No-voltage semiconductor contact point, contact point rating: AC/DC 100V 0.1A, resist pressure: 1500V |
| | LOWLOW | 14a | Contact attached with a start-up interlock off-delay timer when the engine stops. |
| | | 14c | No-voltage semiconductor contact point, contact point rating: AC/DC 100V 0.1A, resist pressure: 1500V |

### 10.2 Wiring installation to I/O connector

Fig. 14 Connector

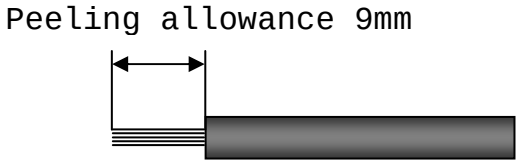



Fig. 15 Peeling allowance of wiring

1) Electric wires to connect to the connector must satisfy the following specification.

Recommended: Single wire: φ 1.0mm (AWG 18)

Twisted wire: 0.75mm$^2$ (AWG 20)

Strand diameter: Min. φ 0.18mm

Usable electric wire range

Single wire: φ 0.4 ~ 1.0mm (AWGF 26 ~ 18)

Twisted wire: 0.3 ~ 0.75mm$^2$ (AWG 22 ~ 20)

Strand diameter: Min. φ 0.18mm

2) Secure 9mm for peeling allowance of wiring. Twist it lightly so it will not spread out. Solderless terminal is not necessary.

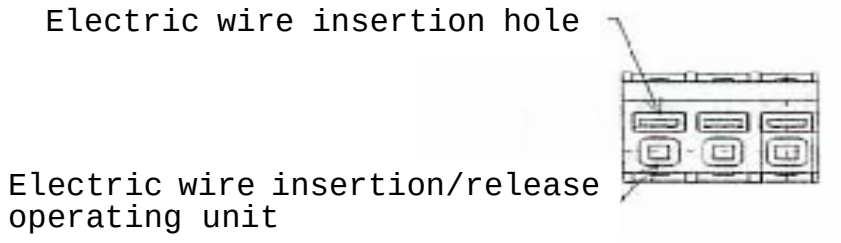



Fig. 16 Connector ele

3) Insert and release wiring to the connector by pressing the wire insertion/release operation unit located at the side of the wiring insertion hole, with a slotted driver or the like. Insert it fully and release the driver from the electric wire insertion/release operation unit. Wiring is grasped inside the connector and fixed securely.

4) Connector can be inserted, only one line to one pin. Should it become necessary to insert multiple wirings into one pin, a separate terminal block will be necessary to bundle the wiring into one before connecting to the wiring.

5) Connector itself can be removed easily by pulling it out. If it is difficult to install wiring, remove the connector to make installation easier. Also at the time of speed switch unit–D replacement, wirings can be removed in a lump at the connector, and there is no need to remove wirings one by one.

6) After completing installation, be sure to check that the wiring is correct and that no short circuiting has occurred due to spreading of wiring. Also pull the wirings to see that they do not come off.

### 10.3 External wiring

External wiring example of speed switch unit-D is given below.

1) Standard connection

A combination of one unit of pulse sensor and one unit of speed switch.

There are one analogue output system, three contact output systems, frequency (pulse) output and start-up interlock contact output. The contact signal is connected to the engine control panel for control.

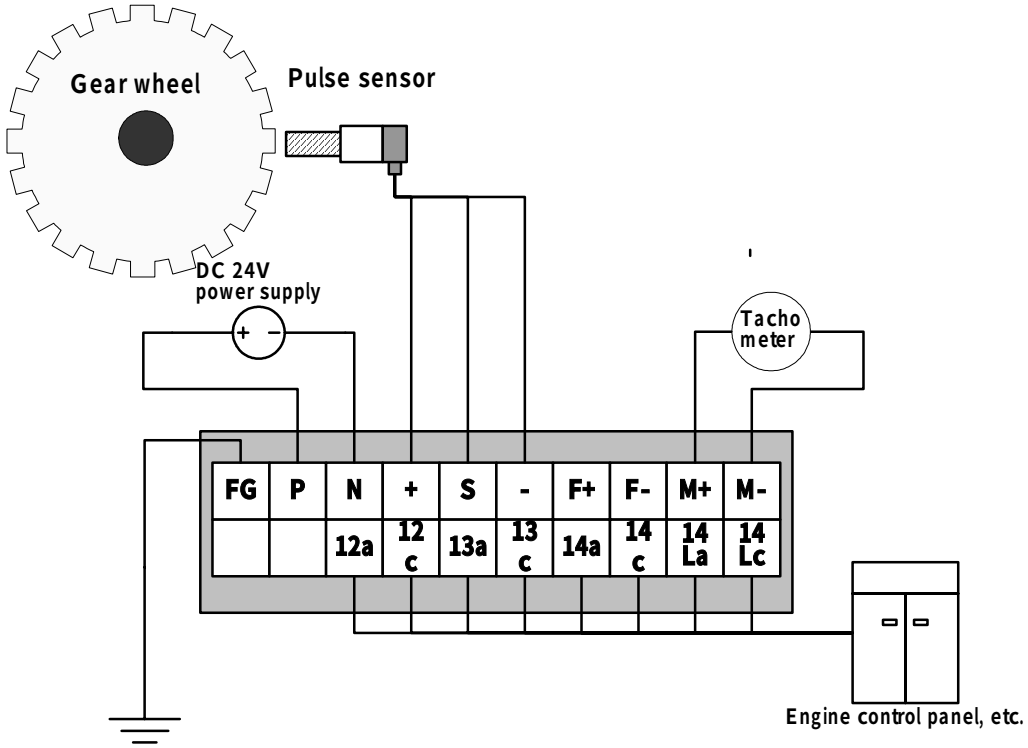



Fig. 17 Standard connection with one unit of pulse sensor and one unit of speed switch

2) Driving two units of speed switch

One unit of pulse sensor can drive up to two units of speed switches.

By parallel driving, the number of outputs can be expanded to 2-fold. (2 systems of analogue output, 6 systems of contact output).

To connect from the first speed switch to the other, do so via separate relay terminal block.

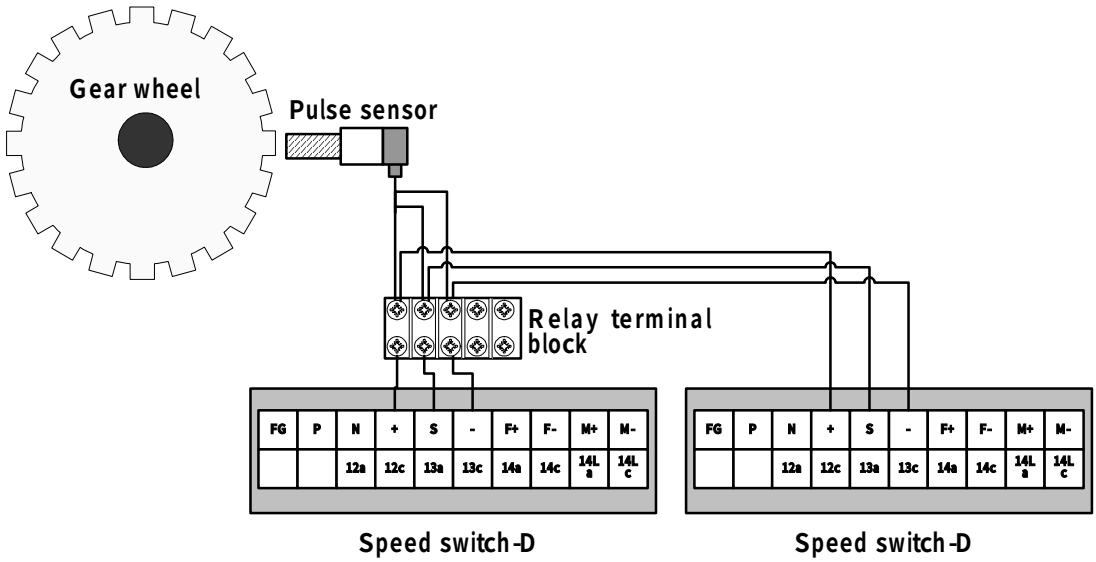



Fig. 18 Parallel driving connection by one unit of pulse sensor and two units of speed switches.

### 10.4 Connection with the pulse sensor

1）When connecting the pulse sensor NN00006014A (new type) (DC series engine since 2005)

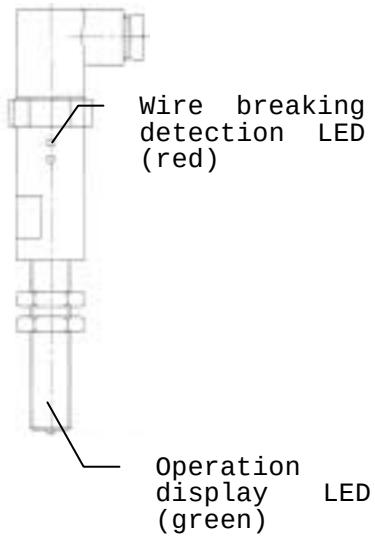



Fig. 19 Pulse sensor NN00006014A

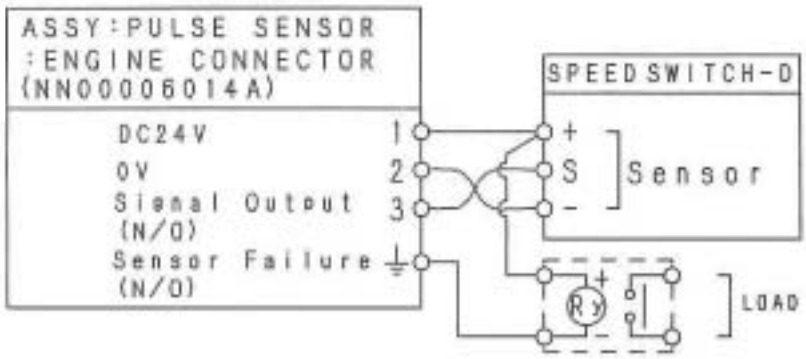



Fig. 20 Pulse sensor speed switch connection diagram

When connecting this pulse sensor to the speed switch unit –D, refer to the connection diagram in Figure 20.

This pulse sensor is provided with a wire breaking detection function for coil and the red LED at the upper part of pulse sensor turns on when the coil wire breaks, to display the state of wire breakage and at the same time to output it outside. When using the coil breakage detection, prepare a separate relay as in the drawing above and connect it.

For the relay to be used in wire breaking detection, select the one with a coil rated current 30mA or below during operation.(Omron: MY 4-D equivalent)

This pulse sensor is compatible with the (2) pulse sensor (conventional type) in terms of the dimension at the installation section and electrically, it is possible to use it as an alternative model.

2) When connecting pulse sensor 50A, 100, 200 (L51131) (conventional type) (Except for the above)

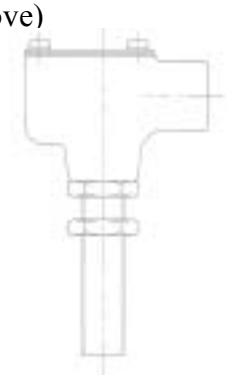


Fig. 21 Pulse sensor（L51131）

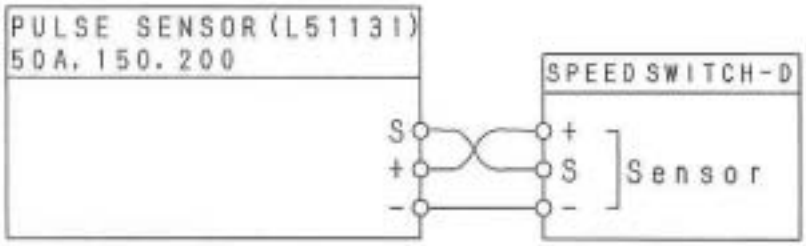



Fig. 22 Pulse sensor (conventional) – speed switch connection diagram

When connecting this pulse sensor to the speed switch unit–D, refer to the connection diagram in Figure 22.

This pulse sensor has no display/output function for coil breaking detection.

### 10.5 Connection and branching of analogue output

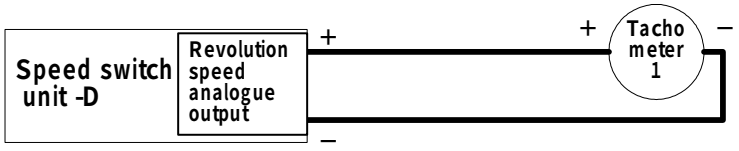



Fig. 23 Analogue output connection (one system)

The speed switch unit –D has one output of analogue output signal (4-20mA signal) that outputs the rotational speed. For the connection diagram, refer to Figure 23. The allowable load resistance of connecting instrument is 500Ω maximum.

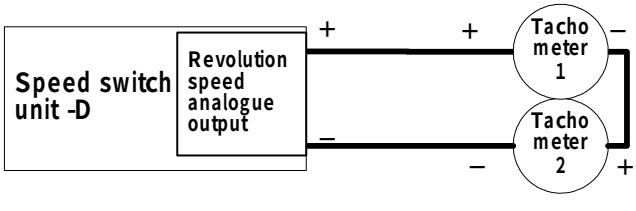



Fig. 24 Analogue output connection (two systems) part 1

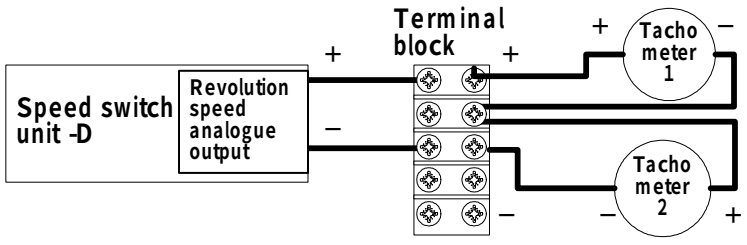



Fig. 25 Analogue output connection (two systems) part 2

When outputs of two systems are necessary for sending signals to the meter and data logger, connect the instrument in serial referring to Figure 24 and 25.

However, in the following cases, use an isolator and divide the analogue signal into two.

① When load resistance is set to over 500Ω in total.

② When floating of the input signal is not carried out in either instrument.

Note)

① When connecting to an instrument with a load resistance exceeding 500Ω, nonconformity may occur such as discrepancy between the actual revolution speed and the revolution speed indicated on the instrument.

② When negative terminal sides of two units of connecting instruments are grounded, current wraparound occurs through grounding and as a result, the input of equipment on the downstream side bypasses, causing disability in signal input to this instrument.
These incidents can be avoided by inserting an isolator and insulating the signal by direct current. For the isolator, select the insulator type with two-outputs (M system: W2YV-AAA-R2 equivalent).

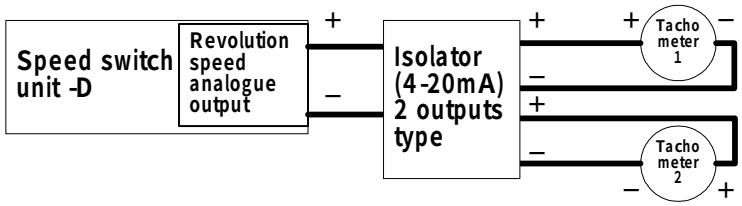



Fig. 26 Analogue output connection
(isolator used for dividing into 2)

### 10.6 Precautions in wiring handling

1） Wiring and shield handling

Wiring to the speed switch unit must be installed taking note of the following points.

① For power supply wirings, pair negative and positive wirings and twist them together.
② For the pulse sensor wiring, use three-wire shield wire.
③ For analogue output, use two–wire shield wire.
④ For frequency output, use two-wire shield wire.
⑤ Use the shield wire on the basis of single-point grounding. Make sure to connect grounding.
⑥ Keep wirings connected to the speed switch unit away from the power line and large size relays.

2）Twisted pair wiring

Twisted pair wiring means twisting 2 wirings. This is generally done on electric wires to improve the resistance to noise easily and reduce the effect of electromagnetic induction to the outside.

Fig. 27 Twisted pair wiring

Fig. 28 Normal parallel wiring

3）Grounding of shield wire (single-point grounding)

Grounding of three-core shield wire between pulse sensor speed switch units.

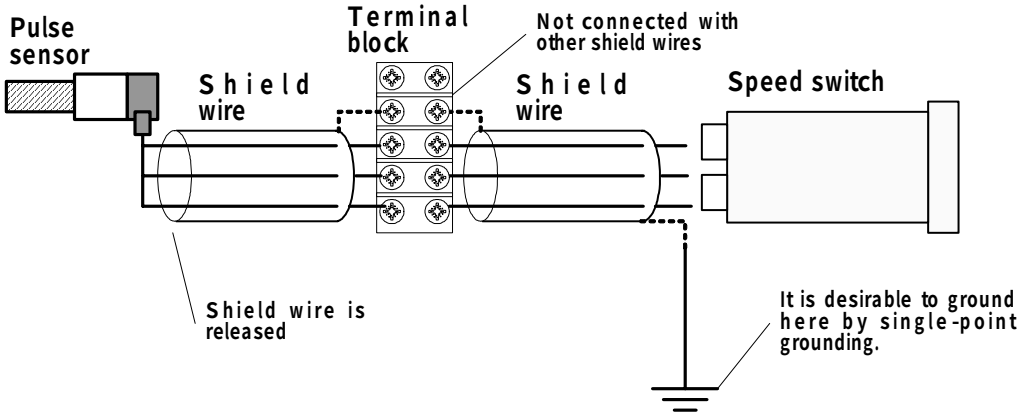



Fig. 29 Shield wire grounding (single-point grounding)

Single-point grounding is an effective connecting method for strengthening the noise resistance of wiring, using the weak signal and pulse, by grounding the shield wire at only single point as shown in the above diagram.

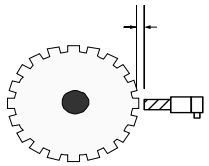
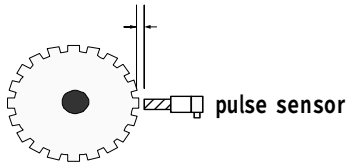
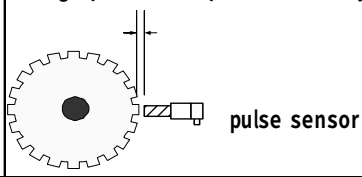
If the sensor side is also connected to the ground, two sides, the sensor side and speed switch side would be grounded. This would cause potential difference between the two points that would provide a good condition for the noise to adhere, it is normally not done.

But if neither grounding is available, there would be no place for noise ingredient to escape to when external noise ingredient adheres to the shield wire, making it possible for the noise to adhere to the signal line, which otherwise should be protected, impeding the effective use of shield wire.

The shield wire must be connected based on single-point grounding.

# 11 Troubleshooting

## 11.1 Troubleshooting table

| | Phenomenon | Cause | Countermeasure |
|---|---|---|---|
| 1 | Display/LED does not light | The power is not supplied | Turn on the power supply |
| | | Power supply mis-wired. | Redo wiring work. |
| | | Mis-wired to pulse sensor | Redo wiring work. |
| 2 | Contact signal does not output<br><br>The meter does not work | Wrong set value | Redo the setting work. |
| | | Wrong wiring | Redo wiring work. |
| | | Pulse sensor attaching gap inappropriate | Fix within the range of 1 to 2 turn return from the rotor.<br>It can be checked if it is detected during operation of pulse sensor by the green LED.<br>  |
| | | This unit or pulse sensor failure | Check if either the unit or sensor is defective and replace with anew one if any defect is found. |
| 3 | Meter indication swings during constant rotation.<br>Contact output turns off sometimes. | Pulse sensor attaching gap inappropriate | Fix within the range of 1 to 2 turn return from the rotor.<br>It can be checked if it is detected during operation of pulse sensor by the green LED.<br>  |
| | | Looseness in pulse sensor lock nut | Retighten |
| | | Pulse sensor failure | Replace the pulse sensor with a new one. |
| | | Noise influence | Contact the person in charge of engineering |
| | | Looseness, omission of wiring | Redo wiring work. |
| 4 | Meter reading differs from the actual measurement | Incorrect speed switch set value | Redo the setting work |
| | Contact output differs from the revolution speed detected by the contact output. | Analogue adjustment defect (Only for the phenomenon of meter reading being different from the actual measurement) | Make adjustment by analogue setting (Correctable up to ± 9.9%) |
| | | Pulse sensor attaching gap inappropriate | Fix within the range of 1 to 2 turn return from the rotor.<br>It can be checked if it is detected during operation of pulse sensor by<br>  |
| | | Analogue output load resistance exceeds 500Ω | Lower the load resistance |

Turbocharging

# Operation Manual

# TPS 48D01

| ABB Turbo Systems Ltd<br>CH 5401 Baden | | | | |
|---|---|---|---|---|
| Type TPS 48D01 | | HT486842 | | |
| $n_{Mmax}$ 1022 1/s<br>$n_{Bmax}$ 971 | | $t_{Mmax}$ 650 °C<br>$t_{Bmax}$ 620 | | |
| | | | | |
| | 175 kg | 8 | 50 | 50 |
| Year 2007 | | Application according to the Operation Manual CE | | |
| made in Switzerland | | | | |

HZTL2410 Japanese

ABB Turbo Systems Ltd

Operating condition and replacement intervals

The operational limits for the turbocharger nBmax, tBmax, nMmax, tMmax, inspection- and replacement intervals for the components concerned on the rating plate are valid for the operational mode and compressor inlet condition, which has been agreed upon between the engine builder and ABB.

**Note:** Replacement intervals of components depends on the load profile, turbine inlet temperature, suction air temperature and turbocharger speed. In case the operation conditions differs significantly from what is considered to be normal for the current application, it is recommended to contact ABB for a re-calculation of replacement intervals. Frequent load alterations, high temperatures and high speed lower the life of components.
Unless otherwise agreed, the application limits nMmax, tMmax are valid for the test operation for a limited time.

We herewith confirm that this Operation Manual has been drawn up orientated towards the Product Liability Law 1/1/90 as well as to the „European Machinery Directives“.



Design and specifications are subject to change without notice.

Printed on naturally white paper, bleached free from chlorine and environmentally acceptable.
The CD is made of polycarbonate and contains in addition aluminium, lacquer, dye stuffs and materials of the adhesive label. The CD-cover is made of recycled cardboard.
These materials may be disposed with the domestic wastes or at a specialised collecting centre.

ABB Turbo Systems AG
Bruggerstrasse 71a
CH-5401 Baden
Switzerland

September 2005

HZTL2410_EN (TPS48-61)

Version 2

# Table of Contents

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# 1 Preliminary remarks

## 1.1 Foreword

This operation manual will help you to become familiar with your ABB Turbo Systems Ltd turbocharger and to use it to full effect in its intended application. You will find important instructions as to the safe, correct, and economical operation of the turbocharger.

This operation manual includes helpful information on the following topics:

- Information on the operation of a turbocharger and ways to prolong the turbocharger's service life.
- Early awareness and avoidance of hazards.
- Minimising repair costs and failure times.

This operation manual is a complement to, and an extension of, existing national regulations on accident protection and prevention.

NOTE

At least one operation manual must be available at all times at the site where the turbocharger is used. It is essential that this operation manual is read before beginning work by all persons working with or on the turbocharger. Personnel only working occasionally on the turbocharger (e.g. during installation and maintenance) must also have read and fully understood the operating manual before working on the turbocharger.

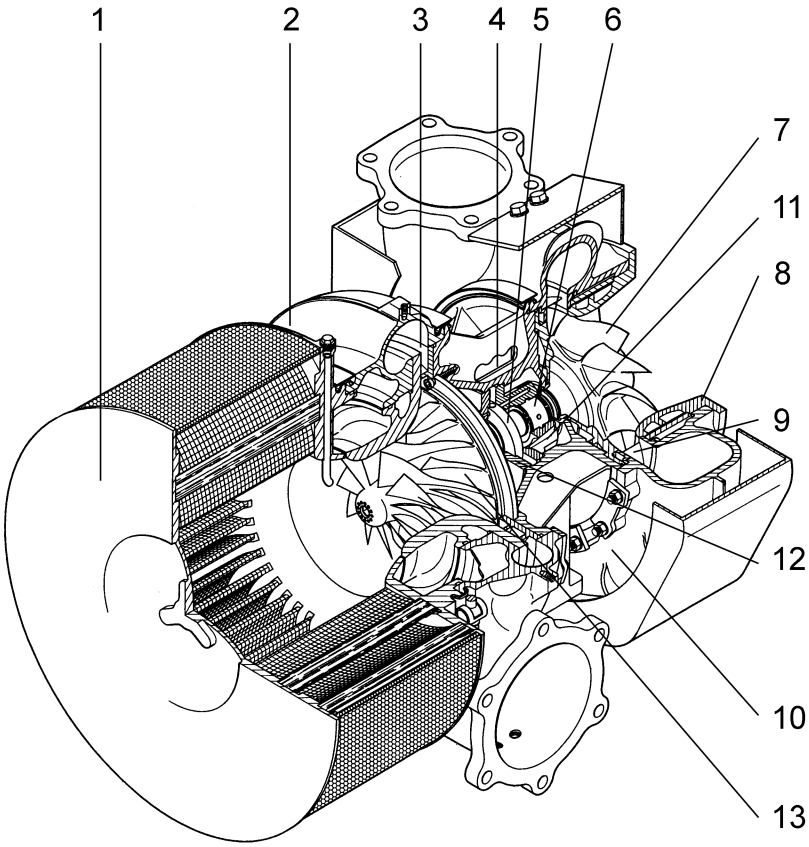
The instructions included in this operation manual must be followed under all circumstances.

NOTE

This applies especially to the general and special safety instructions preceding and in the respective chapters. Ignoring hazards and the safety instructions can lead to serious personal injury and damage to equipment.

In the event of doubt, consult the officer for safety and accident protection responsible for your area.

# 1.2 Layout and function

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| | | | |
|---|---|---|---|
| **1** | Suction branch / Filter silencer | **8** | Gas outlet flange |
| **2** | Compressor casing | **9** | Nozzle ring |
| **3** | Diffuser | **10** | Turbine casing |
| **4** | Bearing casing | **11** | Turbine-end bearing flange |
| **5** | Axial thrust bearing | **12** | Compressor-end bearing flange |
| **6** | Radial plain bearing (only visible turbine-end) | **13** | Compressor wheel |
| **7** | Turbine | | |

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## Mode of operation

The turbocharger is a turbo-machine and consists of the following main components:

- Turbine
- Compressor

These are both connected with a common shaft.

The exhaust gases from the diesel or gas engine flow through the turbine casing (10) and nozzle ring (9) to the turbine (7).

The turbine (7) uses the energy contained in the exhaust gas to drive the compressor wheel (13), whereby the compressor draws in fresh air, and the compressed air is forced into the cylinders.

The exhaust gases escape through the exhaust pipe which is connected to the gas outlet flange (8).

The air which is necessary for the operation of the diesel or petrol engine and which is compressed in the turbocharger, is drawn through the suction branch or the filter silencer (1) into the compressor wheel (13). It then passes through the diffuser (3) and leaves the turbocharger through the outlet on the compressor casing (2).

The rotor runs in two radial plain bearings (6), which are located in the bearing flanges (11/12) between the compressor and the turbine. The axial thrust bearing (5) is located between the two radial plain bearings.

The bearings are connected to a central lubricating oil feed which is supplied by the oil lubrication circuit of the engine. The oil outlet is always at the lowest point of the bearing casing (4).

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# 1.3 Correct application


NOTE

This turbocharger supplied by ABB Turbo Systems has been developed exclusively for use on diesel and gas engines to generate the volume of air and the charging pressure necessary for the operation of such engines. Any other usage shall be regarded as a special application which must be discussed with ABB Turbo Systems. The manufacturer accepts no liability for other applications.

The turbocharger has been designed for the diesel or petrol engine described, including speed and output. If it is used otherwise ABB Turbo Systems reserves the right to reject all claims under the warranty.

This turbocharger was built in accordance with state of the art technology and is operationally safe according to prevailing safety regulations.


NOTE

The turbocharger may be hazardous to life and limb of the user or third parties. In addition, improper use may cause damage to the machine.

The machine may only be operated by trained personnel.

Correct use of the turbocharger also includes observation of the assembly, disassembly, operating, maintenance and repair conditions specified by the manufacturer. Regulations set out by local authorities must be observed when disposing of the turbine.

The turbocharger should only be operated and used in a technically perfect condition, for its intended purpose and in compliance with the operation manual.

▶ Defects which could affect safety must be eliminated immediately.

The manufacturer shall not accept liability for damages resulting from unauthorised alterations to the turbocharger.

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# 1.4 Essential information



### Organizational measures

In addition to this manual, the general, statutory regulations applicable in the respective country for the prevention of accidents and the protection of the environment must be observed.

This also applies to the provision and wearing of personnel protection equipment.

NOTE

The safety and risk consciousness of the personnel working on and with the turbocharger must be checked regularly with reference to this manual.

▶ The turbocharger must be shut down immediately in the event of alterations affecting safety or of corresponding operating behaviour. The fault should be reported to the person or department responsible.

NOTE

Additions to, and alterations and conversions of the turbocharger that could compromise safety require the prior approval of ABB Turbo Systems.

## Original parts and safety

Original parts and accessories are especially designed for the turbocharger supplied by ABB Turbo Systems Ltd .

NOTE

We herewith expressly state that parts and accessories not supplied by us have also not been tested and approved by us.

WARNING

If components and assemblies not manufactured and tested by ABB Turbo Systems are used, this may have a negative effect on the technical design specifications of the turbocharger.

Moreover, the active and/or passive safety of the turbocharger may be compromised by the use of non-original parts. Note that such improper use may endanger personnel and the machine.

ABB Turbo Systems shall not be liable for any damage caused by using non-original parts and accessories.

## Qualification of personnel

The turbocharger must only be operated and maintained by trained and authorised personnel.

CAUTION

Work on mechanical components, such as bearings or rotors, must only be performed by qualified fitters from an official service station of ABB Turbo Systems Ltd !

It must be ensured that only authorised personnel work on the turbocharger.

## After-sales service

The Contact Information brochure contains an overview of official ABB Turbo Systems Ltd service stations worldwide.

## Design variants

This instruction manual is valid for various turbocharger design variants.

This means that some sections and component descriptions in this operating manual do not apply to your turbocharger.

Our service stations and agencies will gladly answer your questions relating specifically to your model.

## Storage of new turbochargers

New turbochargers supplied by ABB Turbo Systems Ltd can be stored without additional safeguarding measures for a period of 6 months after the delivery date.

Ensure that the area where the turbocharger is to be stored is dry with humidity of 40-70% and free of condensation.

- ▶ After 6 months, rust-proofing oil should be sprayed on exposed surfaces and all accessible areas of the turbocharger.
- ▶ To do this, the insulating materials must be removed.

NOTE

Repeat the steps described for rust-proofing your turbocharger every 6 months.

# 1.5 Abbreviations and symbols

The following abbreviations are used in this document:

▷ Prerequisite
▶ Work step

⇨ Result

✓ Positive checkpoint (activity which must be performed without fail)
✕ Negative Checkpoint (activity which may not be performed under any circumstances)

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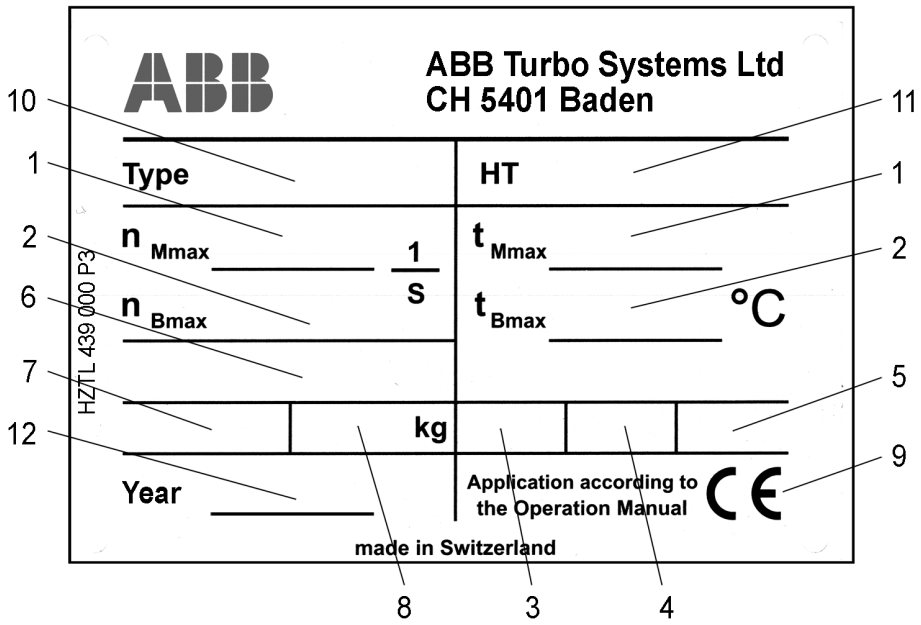
# 1.6 Turbocharger rating plate

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**Operational limits**

1 Turbocharger operational limits at engine overload (110%). In test rig operation only, unless otherwise agreed with the engine manufacturer.

2 Turbocharger operational limits in service.

**Inspection and exchange intervals for turbocharger components**

3 Inspection interval for plain bearings in 1000 h

4 Exhange interval for the compressor in 1000 h (no values 100,000 h)

5 Exchange interval for the turbine in 1000 h (no values 100,000 h)

Additional specifications:

6 Customer part number
7 Field for special design designation
8 Weight of the turbocharger in kg
9 CE = Conformité Européenne
10 Turbocharger type
11 Series number
12 Year of construction of the turbucharger

## Explanations of the rating plate

The conditions agreed with the engine manufacturer apply to the values indicated on the rating plate with regard to operational limits, inspection intervals and replacement intervals.

CAUTION

Continuous running above the indicated values $n_{Bmax}$ , $t_{Bmax}$ can considerably reduce the recommended exchange intervals. In such cases, you should contact the nearest official service station of ABB Turbo Systems Ltd.

$n_{Mmax}$ , $t_{Mmax}$ normally apply only when running at overload (110%) during trials on the engine test bed. These limits may also be permitted in service for special applications. The operation over $n_{Mmax}$ , $t_{Mmax}$ is not permitted.

Non-compliance with the recommended exchange intervals may increase the risk of unpredictable component failure.

The inspection intervals and replacement intervals for the turbocharger components specified must be observed without fail!

Turbocharger components whose permissible operating times have expired may not be used again under any circumstances!

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# 2 Safety

## 2.1 Basic safety instructions

The following symbols and terms are used for the safety instructions in this operation manual:

**WARNING**

Serious injury or fatal accident may result if the working and operation instructions marked with this symbol are not, or only partly observed.

**Warning signs must be strictly observed at all times.**

**CAUTION**

Serious damage to the machine or to other property may result if the working and operation instructions marked with this symbol are not, or only partly, observed.

**Caution signs must be strictly observed at all times.**

# 2.2 General safety instructions

The instructions listed here are designed to ensure your safety and to promote safe handling of the turbocharger and its associated operating materials.

WARNING

The following safety instructions must be followed when operating and when working on the turbocharger.

- Do not work on the turbocharger if you are under physical or mental stress.
- Wear protective clothing at all times.
  - Helmet
  - Ear protection
  - Protective glasses
  - Protective suit
  - Oil and petrol resistant gloves
  - Protective shoes
- Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.
- Do not stand under suspended loads.
- If welding work is to be carried out above the turbocharger, the air filter must be covered to prevent damage to the filter mat.
- When working on the turbocharger, be aware of the risk of it falling.
- For overhead assembly work, use the steps and platforms provided for this purpose.

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# 2.3 Special safety instructions



### Safety when connecting

- Work only on those connections for which you are qualified.

### Safety when commissioning and during operation

- Before starting work, make a visual inspection of the working area.
- Remove obstacles and any objects lying around from the work area.
- Before commissioning check the turbocharger for damage and leaks.
- Refrain from any activity which could compromise safety while working with the turbocharger.
- Inspect the turbocharger after about 12 hours of operation or at least once a day for visible damage and defects.
- Report any damage or changes in operational performance to the person/department responsible immediately.
- In the event of damage, shut down the turbocharger immediately and secure it against inadvertent or unauthorized use.

## Safety when cleaning

When handling detergents, solvents, acids and alkalis be sure to observe the respective safety directions on the manufacturers' labels.

Follow directions regarding the environmentally compatible collection, storage and disposal of these liquids.

WARNING

**Explosion hazard**

Cleaning work should be carried out outdoors due to explosion hazard. If this is not possible, ensure that there is adequate ventilation and air circulation. Before beginning cleaning work in confined spaces, extinguish naked flames (including cigarettes!) due to the risk of explosion.

- Before cleaning, protect the floor against unintended leaks of oil and operation materials.
- You must wear protective clothing (see section **General safety instructions**).
- Handle operation materials and detergents with utmost caution.
- When handling solvents, wear protective clothing **and** observe the following rules:
  - Avoid skin contact with solvents.
  - Avoid inhaling vapours under all circumstances.
  - Do not allow solvents to soak protective clothing.
- After cleaning, check electric cables for signs of wear or damage.

### Safety during disassembly, assembly, maintenance and troubleshooting

- Perform the prescribed adjustment, maintenance and inspection work at the specified intervals.
- Inform operating personnel about special work and repairs before starting.
- Ensure that absorbent materials are available to clean up any operation materials that escape accidentally.
- Ensure safe and environmentally-friendly drainage, collection and disposal of operating and auxiliary materials.
- Before opening a cover or removing a protective component on the turbocharger, the engine must have been switched off and must not be started up again until all parts have been properly re-assembled.

CAUTION

Assembly and disassembly work must only be performed by trained personnel. Work on mechanical components, such as bearings or rotors, must only be performed by qualified fitters from an official service station of ABB Turbo Systems.

### Safety when taking out of operation or putting into storage

- Secure the rotor against turning.
- Clean the turbocharger before mothballing.
- Wear protective clothing when mothballing the turbocharger.
- Keep the work area clean and free of oil and operating materials.
- Remove any obstacles lying around on the floor.

# 2.4 Safety instructions and hazard protection



Associated hazards may arise during operation of and work on the turbocharger:

- from the turbocharger and its accessories.
- from the operating materials used.
- due to failure to comply with the safety instructions.
- from inadequate performance of maintenance and inspection work.

### Mechanical influences

Mechanical influences can cause serious or even fatal injury:

**Personal injury**

Unconsciousness and injury due to:

- crushing
- shearing
- cutting
- winding
- smashing
- drawing in
- knocking
- stabbing
- rubbing
- escape of liquids under high pressure **and** at high temperature
- slipping
- tripping
- falling

**Causes**

- sharp edges, pointed parts
- crush, shear and winding areas
- fragmentation / ejection of parts
- fracture or rupture of parts due to overload
- Elastic elements (springs), liquids **and** gases under pressure/in a vacuum
- slippery, oily work area, obstacles on the floor

**Protective measures**

- ✓ Wear leather protective gloves
- ✓ Wear close-fitting protective clothing
- ✓ Tie up long hair and beards (wear hair protection)
- ✓ Wear face and eye protection
- ✓ Wear protective shoes
- ✓ Keep floor, equipment and the turbocharger clean
- ✓ Ensure the availability of oil absorbing materials and have oil collector basins ready or in position
- ✓ Eliminate leaks

## Operation and process materials

Operation and process materials refer to **chemical and hazardous substances**:

- Oil
- Grease
- Coolants
- Detergents and solvents
- Acids

CAUTION

Note that operation and process materials are harmful to the environment if they penetrate soil or water.

**Personal injury**

The following injuries can be caused by operation and process materials:

- Allergies
- Skin disease
- Loss of consciousness
- Poisoning or nausea after inhalation

**Causes**

- Inhalation of toxic gases, smoke and vapours
- Skin contact with aggressive fluids
- Clothing wet or soaked with hazardous substances
- Spilling and tipping over of vessels containing substances used during operation
- Escape due to leakage
- Tanks and collectors which are not gas-tight and which do not comply with the regulations on hazardous substances
- Burning cigarettes or open flame in the proximity of operation materials

**Protective measures**

- ✓ Utmost caution when handling process and operation materials
- ✓ Protective clothing must be worn
- ✓ Avoid skin contact and inhalation under all circumstances
- ✓ Ensure that the workroom is properly ventilated
- ✓ Observe the hazard indications on the containers for operation and process materials
- ✓ Immediately after use, seal the hazardous substance container tight
- ✓ Used operation materials must be collected safely in accordance with the legal provisions, stored separately in suitable containers as prescribed, and disposed of as special waste in a technically and environmentally compatible manner
- ✓ Ensure that containers for new / used operation materials are sealed tight
- ✓ In the event of leaks or spills immediately apply a suitable absorbent material and dispose of this in a technically and environmentally compatible manner as special waste

### Handling insulating materials

- ✓ Ensure that the work area is well ventilated
- ✓ Keep the work area clean
- ✓ Avoid disturbing dust
- ✓ Dust-suppressing tools and processing steps
- ✓ Remove from packaging only in the work area
- ✓ Exercise particular care when removing old insulating materials
- ✓ Dispose of insulating materials in a technically and environmentally compatible manner
- ✓ If large quantities of dust are created, wear protective glasses
- ✓ Use half or quarter masks
- ✓ Wear suitable work clothing and gloves
- ✓ For sensitive skin, apply moisturising, protective barrier cream

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## Noise

The effects of noise above a legally permitted level can cause personal injury.

**Personal injury**

- Loss of hearing
- Deafness
- Impaired hearing
- Health disorders such as loss of balance or of consciousness
- Cardiac and circulatory disturbances

**Causes**

- Machine noise level above 85 dB (A)

**Protective measures**

✓ Wear ear protection

## Heat hazard

When the turbocharger is operated, surfaces become very hot.

**Personal injury**

- Burns

**Causes**

- Missing or incorrectly fitted insulation.

**Protective measures**

✓ Wear leather protective gloves.

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# 3 Commissioning

## 3.1 Oil supply

A carefully designed oil supply, which functions under all operating conditions, is an important precondition for trouble-free operation of the turbocharger.

Lubrication of the turbocharger is normally carried out with oil from the engine oil circuit.

If a separate lubrication system is used, then standby lubrication is also to be proved.

NOTE

The engine manaufacturer's recommendations regarding oil selection and oil change intervals are to be observed.

### Oil filtration

CAUTION

To prevent dangerous wear to the bearing parts, depending on the turbine specification and bearing used, different-sized impurities must be filtered out of the lubrication oil.

As standard, for the turbocharger an oil filtration of **34 µm** is prescribed. That means, impurities which are larger than **0.034 mm**, must be filtered out of the oil with a filtration efficiency of **> 99%**.

- ▶ If the oil is not sufficiently filtered through the engine filter, an additional filter is to be installed.
- ▶ During a cold start and, if due to deposits of dirt in the additional filter, the flow resistance rises above **0.5 bar**, a bypass must respond, which guarantees the oil supply of the turbocharger by bypassing the filter.
- ▶ Before putting into operation for the first time, check that the oil filters are clean.

NOTE

Also observe the specifications of the engine manufacturer concerning filter fineness and filtration efficiency.

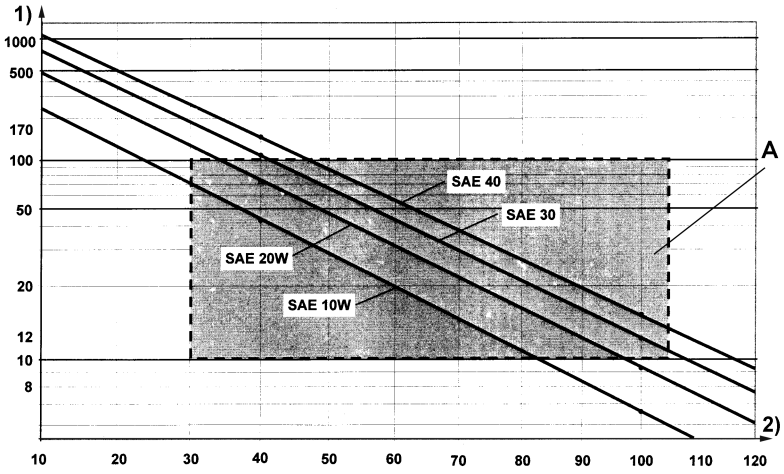
## Lubricants

NOTE

All lubricating oils used for engines are permissible.

## Oil inlet viscosity and temperature

The oil inlet temperature must not exceed 105°C. The permissible oil inlet viscosities and temperatures are shown in the following diagram.

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| | |
|---|---|
| **1)** | Kinetic viscosity ($mm^2/s$ = cSt) |
| **2)** | Oil inlet temperature (°C) |
| **A** | Permissible range |

NOTE

During engine start, the lower temperature limit may be temporarily undershot.

The oil inlet temperature however should thereby not fall below **10 °C**.



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## Oil pressure

The oil pressure before the bearings must be exactly maintained to ensure fault-free operation.

The oil pressure (overpressure) before the turbocharger with the engine under load should be **2.0 ... 4.5 bar** and at idling speed at least **0.2 bar** .

With cold oil, during the starting phase, temporarily a higher oil pressure of up to **8 bar** is permissible. During pre- and post-lubrication, the oil pressure must not exceed **1.0 bar** .

## Pre-lubrication

CAUTION

Before every engine start, actuate pre-lubrication device. The turbocharger must be supplied with oil from the very first moment the engine is started.

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# 3.2 Inspection work

This inspection work includes preventive visual controls, as well as monitoring and measurement to ensure the correct functioning of the turbocharger. These serve as an aid to detecting anomalies before and during commissioning, thus preventing possible damage to the machine.

- The safety instructions must be followed before and during all inspection work.

## 3.2.1 Inspection before commissioning

**Monitoring equipment**

▶ To be checked for correct functioning.

**Oil filters**

▶ Check cleanliness before commissioning.

**Manometers on oil lines**

▶ Check oil pressure in oil supply lines.

**Air filter mat**

▶ Inspect for damage.

CAUTION

It is urgently recommended that the entire lubrication system is bridged using a bypass pipe, in order to be flushed thoroughly with warm, clean oil before commissioning and after every servicing operation on the lubrication system.

We strongly recommend the use of a starting filter when running the engine in and after every servicing operation on the lubrication system.

**Pre-lubrication**

CAUTION

Before every engine start, actuate pre-lubrication device. The turbocharger must be supplied with oil from the very first moment the engine is started.

### 3.2.2 Inspection after commissioning

**Charger speed**

- Measuring (optional, charger speed counter not included as standard with all turbocharger types)

**Charger pressure**

- Measuring

**Temperatures**

- Measure upstream/downstream from turbine, compressor and oil feed for various engine speeds

**Gas, air, and oil lines**

- After the engine has been started up, check all gas, air and oil lines for leaks.



NOTE

Lubricants and pastes used during assembly of the turbocharger are liquefied or vaporised and may escape as an oily liquid or smoke in the first few hours after commissioning. If oily liquid continues to escape after this period, the cause must be treated as an oil leak and located. The first step in this process is to check the oil supply to the turbocharger for leaks. If this is not in order, contact an official ABB Turbo Systems service station.

- Measure the speed, oil pressure, charging pressure and temperatures before and after the turbine and the compressor at various engine speeds.
- Compare the measured values with those of the inspection report, taking into account the different operating conditions.

### 3.2.3 Inspection after 100 service hours

Clean or replace lubricating oil filters after the first 100 service hours.

# 3.3 Putting into operation after out of service period

- ▶ Inspect the exhaust pipe before and after the turbine for possible combustion residues, foreign bodies or residual water and clean if necessary.
- ▶ Start up the engine end oil circulation system.
- ▶ Inspect air supply lines or filter segments for possible foreign bodies and clean if necessary.

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# 4 Operation

## 4.1 Servicing work

Servicing work during operation includes visual checks, monitoring and measuring as well as inspection and function checks in order to ensure correct functioning of the turbocharger. It serves as an aid to detecting anomalies during operation, thus preventing damage to the machine. The inspection, measurement and servicing operations listed must be carried out at the intervals indicated.

**WARNING**

The pertinent safety instructions must be observed during all servicing work.

**CAUTION**

Servicing work must be carried out at the prescribed intervals in order to avoid damage to and malfunctioning of the turbocharger.



### 4.1.1 Servicing work every 25 to 50 hours

**Operation data**

- ▶ must be recorded
- ▶ Enter in the machine logbook
- ▶ In the event of significant anomalies, establish the cause

**CAUTION**

If you are unable to establish the cause of the anomalies, contact an official ABB Turbo Systems service station.

- ▶ Visual check for air, exhaust gas, water and oil leaks.

## 4.1.2 Servicing work according to the engine manufacturer's instructions

**Oil filters**

- With the engine at standstill clean or replace oil filters

## 4.1.3 Servicing work every 8,000 -12,000 hours

- Dismantle the turbocharger
- Clearance measurement
- Clean turbine- and compressor casings and check for any cracks and erosion / corrosion.
- Clean bearing casing, blow through oil ports
- Clean nozzle ring and check for cracks and erosion
- Inspection and assessment of the rotor and bearing parts

NOTE

**Inspection and assessment of the rotor**

The first inspection and assessment of the bearing parts has to be carried out in acc. with the rating plate or between 8,000 and 12,000 service hours.
The inspection and assessment of the rotor and the bearing parts must be carried out by an official service station of ABB Turbo Systems.



## 4.1.4 Entries in the machine logbook

Monitoring of the machine plant provides information about the performance of the turbocharger.

The following operation data and measurement values must be entered regularly in the engine manufacturer's machine log book:

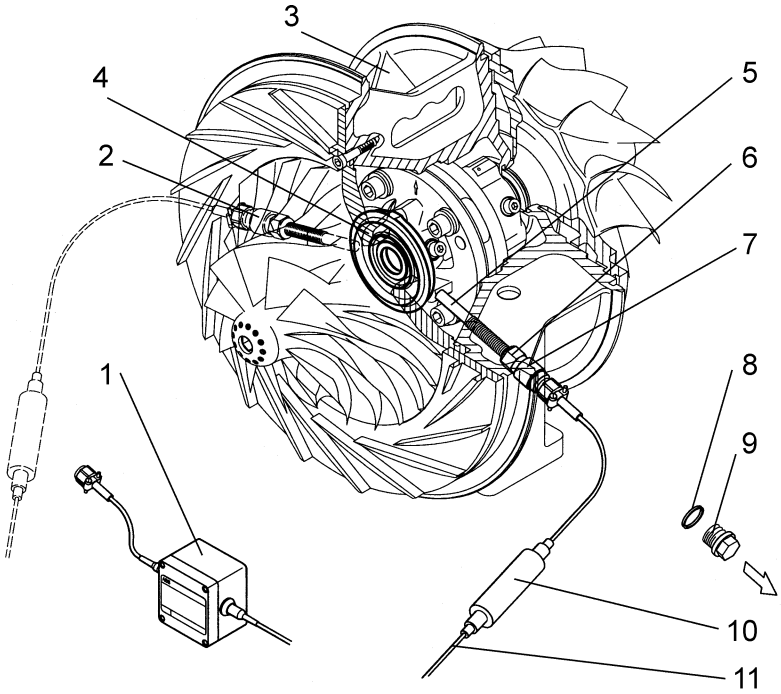
- Output and speed of the engine
- Air intake temperature
- Exhaust gas temperature before and after the turbine
- Pressure of the charge-air
- Pressure drop in the charge-air cooler
- Lube oil pressure, lube oil temperature

**If provided**

- Air temperature after compressor and after the charge-air cooler
- Speed of the turbocharger
- Pressure loss in the air filter

# 4.2 Monitoring

## 4.2.1 Speed measurement

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| | | | |
|---|---|---|---|
| **1** | Line amplifier | **7** | Cable plug |
| **2** | Installation variants (right or left) | **8** | Gasket |
| **3** | Bearing casing | **9** | Screw plug |
| **4** | Sealing disc with cam or groove | **10** | Voltage limiting module |
| **5** | Speed transmitter | **11** | Connecting cable |
| **6** | Flange plug | | |

TPS turbochargers can be optionally fitted with a speed transmitter system for measuring the turbocharger speed. This speed transmitter, in connection with the corresponding measuring units or monitoring systems (not part of the delivery), permits continuous remote monitoring of the turbocharger speed. With continuous monitoring of the engine installation, the turbocharger speed can be used as a suitable control parameter.

If required, the line amplifier can be purchased as an optional addition to the described speed measuring system.

**A reduction in speed of a charger can signify:**

- Damaged rotor components or bearing.
- Defects in the connected pulse charging cylinders.
- Defects or leaks on the exhaust gas pipes or on the charge-air lines.

NOTE

With 4-stroke applications, heavy fouling of the turbine can also be a cause of an increase in the turbocharger speed.

**Possible reasons for failure of the speed indicator:**

- Defects on the speed transmitting system, on the connecting cable, on the measuring unit or in the power supply. (if applicable on the line amplifier or the line amplifier power supply).
- Turbocharger damage.

CAUTION

If the speed indication fails, it is recommended that the engine output be reduced to idling speed and the engine stopped. The cause of the failure should then be determined.

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**Installation:**

If the speed transmitter system is not assembled on the turbocharger at the time of delivery, it will be in a separate package together with its cable.

To assemble, the transmitter system must be screwed into the left or right threaded hole on the bearing casing, depending on the desired position. The screw plug which is in this threaded hole and its seal must first be removed. It should be noted that the sensor is screwed in completely and to the correct tightening torque without a gasket (see chapter Tightening torques table).

**Exchange or subsequent assembly of the speed sensor:**

**NOTE**

We recommend that subsequent assembly or replacement of the speed transmitter system should be carried out only by an official ABB Turbo Systems service station.

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# 4.3 Surging of turbocharger

Surging of the turbocharger can occur with certain engine operating states, such as rapid load removal or while manoeuvring. The direction of flow in the compressor is then briefly reversed. However, sporadic surging of this kind does not generally affect the safe operation of the turbocharger.

CAUTION

**Prolonged or periodic surging**

If surging is prolonged or occurs periodically, the following components may be damaged:
- Compressor wheel (vibration fractures, ...)
- Turbine blades (cracks)
- Bearing (overheating)
- Filter silencer

**Action to be taken:**

The operating safety of the turbocharger is no longer ensured with continuous or periodically recurring surging. The operator must take immediate steps to correct the surging together with the closest official ABB Turbo Systems service station.
The above mentioned components are to be examined for damage by an official service station of ABB Turbo Systems and replaced in cases of doubt.

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# 4.4 Contact with rotating parts

Mild, uniform wear around the circumference of rotor components, caused by slight local grazing against adjacent components, is non-hazardous and permissible. This slightly reduces the length of the blades in the compressor and/or the turbine. Certain tolerances must be observed to avoid significant loss of efficiency.

▶ A check on dimensions must be carried out by an official ABB Turbo Systems service station.

# 4.5 Shutting the engine down

CAUTION

Before shutting the engine down, it must be allowed to idle for a further **5** to **10 Minutes**, so that the circulating oil can dissipate the heat in the turbocharger bearings.

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# 5 Maintenance

## 5.1 Outline of cleaning work

Cleaning work includes regular visual checks and washing to ensure the correct functioning of the turbocharger and its auxiliary appliances.

- The external condition and the degree of contamination of the cleaning points listed below must be established by visual checks at the intervals indicated.
- The safety instructions must be observed during all cleaning work.

**Filter silencer**

▷ Filter ring must be cleaned wet
▶ Dismantle the filter silencer
▶ Felt segments in the cover panels are to be cleaned dry

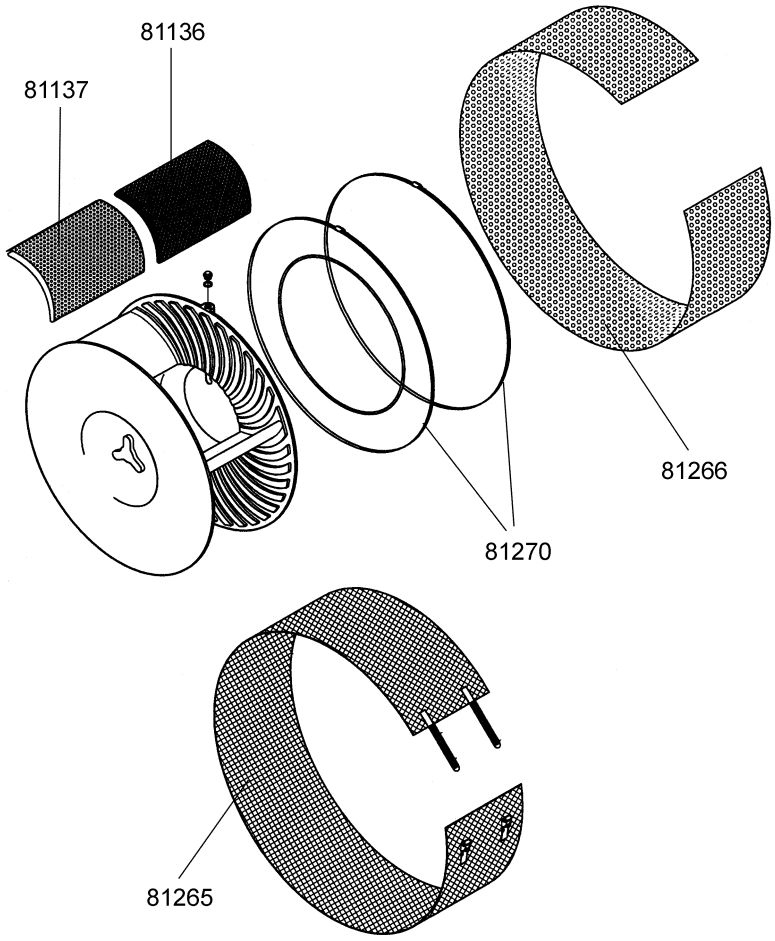
**Compressor**

▷ Wet clean with fresh water in accordance with the engine manufacturer's instructions
▶ Engine warm from running
▶ High compressor speed

**Turbine**

▷ Wet clean with fresh water in accordance with the engine manufacturer's instructions
▶ High engine load
▶ Gas inlet temperature before turbine may not exceed 450°C

# 5.2 Cleaning the filter silencer

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**If provided**

The filter ring (81265) can be replaced or cleaned by washing.

**NOTE**

To ensure perfect operation during washing it is advisable to replace the filter ring with another (filter rings available in packs of two).

**CAUTION**

Wash or replace the filter ring every 500 service hours. The filter ring is not to be washed more than five times.

**Washing the filter ring**

- ▶ Rinse filter ring with water (up to 40°C) using fine washing powder or, if very dirty, soak it and squeeze out carefully. Rinse in cold water. Avoid high mechanical stress (wringing, strong water jet).
- ▶ Allow the filter ring to dry completely before assembly.

**Cleaning the silencer**

- ▶ Loosen the tension bands (81270) and withdraw cover grid (81266).
- ▶ Withdraw the cover panels (81137), bend them upwards and remove the felt segments (81136).

CAUTION

During cleaning take care that the felt segments do not get wet!

- ▶ Remove dirt with a cloth, a soft brush or compressed air.
- ▶ Have heavily soiled felt segments replaced by an ABB Turbo Systems service station.

CAUTION

Damaged tension bands must be replaced with new ones.

# 5.3 Cleaning the compressor during operation

The dirt in the compressor stage (compressor wheel and diffuser) depends on the cleanness of the air drawn in and the operating point.

A deposit of dirt in the flow ducts will be formed if the following substances are present in the intake air:

- Oil or saline mist
- Solid combustion residues
- Dust of various kinds

Soiling of the compressor stage has a negative effect on compressor efficiency and charging pressure, particularly for smaller turbochargers.

This results in higher exhaust temperatures and increased fuel consumption by the engine. Contamination of the compressor also increases the rotor unbalance.

Periodic cleaning of the compressor in operation prevents or retards an increase in soiling, but in no way replaces the regular servicing work, during which the turbocharger is completely dismantled.

NOTE

If the coating of dirt is very thick and hard, the compressor can only be cleaned manually when dismantled. This cleaning should be carried out by an official ABB Turbo Systems service station.

**Principle of wet cleaning**

Water is injected before the compressor wheel via an injection pipe fitted in the filter silencer or the suction branch in order to clean the compressor stage in operation.

The water does not act as a solvent in the process, but the deposit is removed by the mechanical impact of the drops. The process is ideal, provided the soiling is not too advanced.

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### 5.3.1 Wet cleaning of the compressor

NOTE

These guidelines for wet cleaning the compressor apply exclusively for cleaning with water and are subject to the approval of the **engine manufacturer**.

CAUTION

Due to the danger of corrosion, only **fresh water** may be used, and on no account salt water. The water should also not contain any cooling additives or solvents, which could form deposits in the flow ducts.

The injection pipe must on no account be connected directly via a cock to a water pipe or a dosing vessel larger than the one supplied. This prevents uncontrolled volumes of water entering the turbocharger and engine, which can lead to serious damage.

**Cleaning interval**

The interval between periodic cleanings depends in large measure on the operating conditions. In general, cleaning should be carried out every **24** to **72 operating hours**.

**Engine load during wet cleaning**

Cleaning of the compressor stage must be performed with the engine warm from running and **as fully loaded** as possible (i.e. at high turbocharger speed).

The success of the cleaning can be seen from the charging or scavenging pressure or also from the exhaust gas temperatures. If cleaning is unsuccessful, it can be repeated up to 2 times.

An unsuccessful cleaning should be repeated after a stabilisation period of 10 minutes at the earliest.

NOTE

If cleaning is still unsuccessful after three attempts, and if the engine operating values are unsatisfactory, we recommend that the turbocharger be checked and cleaned by an official ABB Turbo Systems service station.

After cleaning the compressor stage, the engine must be run under load for at least another **5 minutes**.

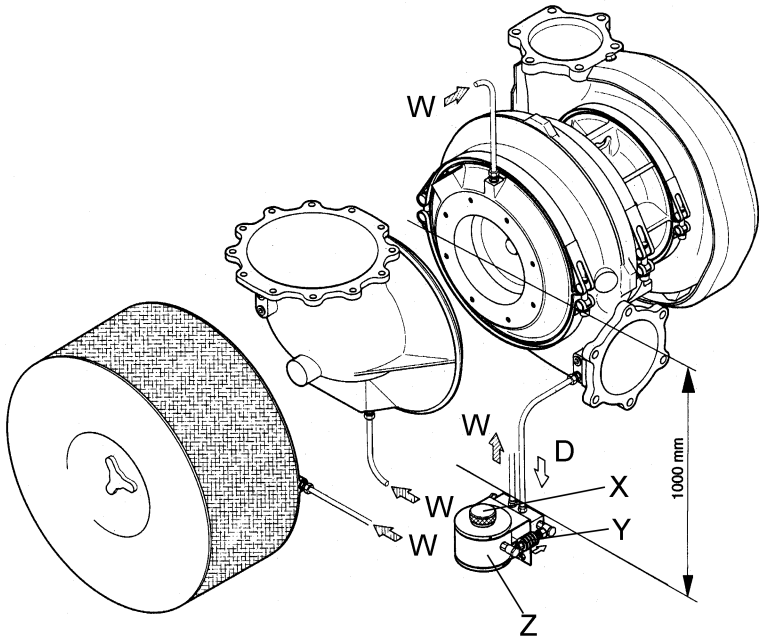
**Cleaning more than one turbocharger compressor**

If several turbochargers are installed on one engine, we recommend cleaning the turbocharger compressors one after the other.

### 5.3.2 Wet cleaning with external pressurised water container

NOTE

The supply of water from the externally mounted dosing vessel is not suitable for applications where underpressure is not present before the compressor wheel (e.g.: Blower connected upstream of the compressor or high-pressure compressor stage in the case of two-stage charging).

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| | | | |
|---|---|---|---|
| **X** | Screw plugs | **D** | Compressed air |
| **Y** | Valve lever | **W** | Water |
| **Z** | Container | | |

**Cleaning parameters for each turbocharger compressor**

| Turbocharger type | Turbocharger speed | Contents of the dosing vessel [dm³] | Water injection time $t_1$ [s] |
|---|---|---|---|
| TPS 48 | roughly $n_{Bmax}$ | 0.4 | 10 |
| TPS 52 | | | |
| TPS 57 | | | |
| TPS 61 | | | |

**Operating the pressure water vessel**

- ▶ Remove the screw plug (**X**).
- ▶ Fill the vessel with pure water.
- ▶ Screw the screw plug back in place.
- ▶ Actuate valve lever(**Y**) against the spring and hold it for **10** to **15 seconds** until all the water has been injected.

# 5.4 Cleaning turbine blades and nozzle ring in operation

Combustion of heavy fuel oil in diesel engines causes soiling of the turbine blades and nozzle rings of the turbochargers. Heavy fuel oil of particularly poor quality in combination with a high exhaust gas temperature, as occurs with a 4-stroke engine, can lead to particularly hard deposits, above all on the nozzle ring.

Poor turbine efficiency, increased exhaust gas temperatures, higher charging and ignition pressures and a lower engine output are the result.

Experience in operation shows, that with periodical cleaning during operation, the interval between overhauls can be extended. The wet cleaning of the turbine blades and the nozzle ring described in the following can be applied with 4-stroke applications with heavy fuel oil and gas engines with heavy deposits (e.g. waste dump gas).

For the other applications, in general no turbine cleaning is necessary.

NOTE

Regular cleaning of the turbine during operation prevents or retards a severe increase in soiling.

This cleaning does not replace the normal maintenance work, during which the turbocharger is to be completely dismantled.

NOTE

Very heavily soiled turbochargers are not to be cleaned with this method. In this case, the rotor must be cleaned by an official ABB Turbo Systems service station.

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## Wet cleaning

Wet cleaning is used for TPS turbochargers.

To clean the turbine components during operation, the thermal shock principle is applied in combination with a subsequent flushing phase. During the cleaning process, the layer of dirt on the material surface of the turbine components loosens.

CAUTION

Only clean fresh water without cleaning agents or solvents may be used for the wet cleaning.

NOTE

The instructions of the engine manufacturer for wet cleaning are to be observed.

To achieve the required thermal shock effect for wet cleaning, the temperature before the turbine $T_{TI}$ must lie between 400°C (673 K) and 450°C (723 K).

CAUTION

For reasons of material strength, during the cleaning process the temperature before the turbine $T_{TI}$ must not exceed 450°C (723 K).

If the exhaust gas temperature can be reduced for wet cleaning, we recommend this should be done as far as possible, to reduce stress on the material, but the exhaust gas temperature must not be reduced below 400°C (673 K).

The prescribed water injection pressure and the duration of water injection must be observed without fail.

Smaller volumes of water can lead to an inadequate cleaning effect. Larger volumes of water lead to impermissible thermal stresses.

Clean fresh water free from cleaning agents and solvents must be used.

**Cleaning more than one turbocharger turbine**

If on a single engine, more than one turbocharger is mounted feeding into the same air receiver, the turbochargers are to be cleaned one after the other.

The cleaning of all turbochargers at the same time causes a greater drop in performance.

To avoid corrosion on the inner surfaces of the casing, the engine must be run for a further 10 minutes after the wet cleaning operation is completed.

**Cleaning interval**

The frequency of the cleaning depends on the extent of soiling. As a guidance value, the turbine components are to be cleaned approx. every 200 service hours.

If required, this cleaning interval can be shortened after consultation with ABB Turbo Systems.

### Requirement for water supply

During the injection, the absolute static water pressure $p_{WT}$ before the water connection on the turbine casing must be at least 1.5 bar above the absolute turbine inlet pressure ($p_{WT} - p_{Ti} \geq 1.5$ bar).

If necessary, the engine load must be lowered during cleaning.

- $p_{WT}$ = absolute static pressure before water connection on turbine casing
- $p_{Ti}$ = absolute static pressure before the turbine

**CAUTION**

The water supply line to the turbine casing must on no account be connected to a water pipe directly via a cock.

### Wet cleaning procedure

Check that the temperature before the turbine $T_{Ti}$ is between 400°C (673 K) and 450°C (723 K). If necessary the engine output is to be adapted.

The engine output must also be lowered if $p_{WT} - p_{Ti} \geq 1.5$ bar.

NOTE

If $T_{Ti}$ = 400°C can not be achieved ($T_{Ti}$ < 400°C), then the temperature should be set as high as possible.

- ▷ Check that the water supply is ensured.
- ▶ Open shut-off valve
- ▶ Inject water with pressure $p_{WT}$ for 15 to 30 seconds (As standard 15 seconds are recommended. Extend the injection period if cleaning effect with 15 seconds is unsatisfactory and if engine operation permits this.)
- ▶ Reheating phase of the turbocharger components over a time $t_h$ according to the following table „Cleaning parameters“.
- ▶ Repeat the last 2 previous points until water has been injected three times.
- ▶ This completes the turbine cleaning process. The shut-off valve must be closed.

NOTE

If an engine is charged by more than one turbocharger, to save time the turbines should be cleaned sequentially. That means, that during the reheating phase of one turbocharger, the water injection can take place at the next one.

## Cleaning parameters

| Type | Temperature before turbine [°C] | Water Absolute pressure 1) [ bar ] | Injection period per injection [s] |
|---|---|---|---|
| **TPS 48** | 400 … 450 | 3,5 … 6,0 | 15 … 30 |
| **TPS 52** | 400 … 450 | 3,5 … 6,0 | 15 … 30 |
| **TPS 57** | 400 … 450 | 3,5 … 6,0 | 15 … 30 |
| **TPS 61** | 400 … 450 | 3,5 … 6,0 | 15 … 30 |

| Type | Water volume per injection 2) [l] | Pause between the injections [min] | Number of water injections |
|---|---|---|---|
| **TPS 48** | 1,5 … 3,5 | 3 | 3 |
| **TPS 52** | 2,0 … 5,0 | 3 | 3 |
| **TPS 57** | 3,5 … 8,0 | 3 | 3 |
| **TPS 61** | 5,0 … 12,0 | 5 | 3 |

1) Before the water connection on the turbine casing during cleaning

2) Water volume depending on pressure before turbine, water injection pressure and injection period

**CAUTION**

The specified water volume is per turbocharger.

# 5.5 Maintenance work

Maintenance work includes inspection and function checks of wearing parts with or without changing process materials, parts or modules. It must be carried out in accordance with the intervals as set out in the Outline of Maintenance work.

CAUTION

**Failure to conduct scheduled maintenance work**

Failure to carry out the maintenance work at the prescribed intervals can lead to damage and malfunction of the turbocharger.
The safety instructions in the respective chapters must be observed for all maintenance work.
Keep lubrication and auxiliary materials ready

**Overview of maintenance work**

- ▶ Completely replace bearings in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.
- ▶ Replace compressor wheel in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.
- ▶ Replace turbine in accordance with the instructions on the rating plate and/or as indicated by the service station or in case of damage.

NOTE

These operations must be carried out by an authorised ABB Turbo Systems service station.

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# 6 Troubleshooting

## 6.1 Possible remedies for failures

### 6.1.1 Exhaust temperature too high

Engine output and speed unchanged

**Engine**

▷ Malfunction in the injection system
▶ Repair, or contact the manufacturer.

**Turbocharger**

▷ Air starvation, e.g. air filter clogged with dirt
▶ Clean

▷ Compressor / turbine soiled
▶ Clean

▷ Exhaust counterpressure too high
▶ Clean or repair boiler or exhaust silencer

▷ Turbine damaged or worn
▶ Contact an official ABB Turbo Systems service station.

**Charge-air cooler**

▷ Cooler soiled
▶ Clean

▷ Insufficient coolant water quantity
▶ Replenish

▷ Coolant water inlet temperature too hot
▶ Clean/inspect cooling system

▷ Ventilation inadequate
▶ Improve ventilation

## 6.1.2 Charge-air pressure too low

Engine output and speed unchanged

Intake condition normal

**Engine**

▷ Air receiver leaking
▶ Repair

▷ Gas line between engine and turbine leaking
▶ Repair

▷ Injection misadjusted
▶ Correct adjustment

▷ Valve control misadjusted
▶ Correct adjustment

**Turbocharger**

▷ Manometer display faulty
▶ Replace manometer

▷ Leak in line to the manometer
▶ Repair leak

▷ Air filter dirty, causing excessive loss of pressure
▶ Clean

▷ Compressor / turbine soiled
▶ Clean

▷ Compressor / turbine damaged
▶ Contact an official ABB Turbo Systems service station.

▷ Excessive exhaust counterpressure
▶ Clean boiler or exhaust silencer

### 6.1.3 Charge-air pressure too high

Engine output and speed unchanged

Intake condition normal

**Engine**

▷ Malfunction in the injection system
▶ Correct adjustment

▷ Engine output higher than expected
▶ Check engine output

▷ Injection misadjusted
▶ Correct adjustment

**Turbocharger**

▷ Manometer display faulty
▶ Replace manometer



### 6.1.4 Vibrations

**Turbocharger**

▷ Rotor imbalance due to heavy fouling of compressor/turbine
▷ Turbine or compressor damaged
▷ Bearing defective
▶ Contact an official ABB Turbo Systems service station.

### 6.1.5 Noises during run-out

**Turbocharger**

▷ Turbocharger dirty
▶ Clean

▷ Bearing damaged
▷ Rotor grazing
▷ Foreign bodies in the turbocharger
▶ Contact an official ABB Turbo Systems service station.

### 6.1.6 Run-out time too short

**Turbocharger**

▷ Turbocharger dirty
▶ Clean

▷ Bearing damaged
▷ Rotor grazing
▷ Foreign bodies in the turbocharger
▶ Contact an official ABB Turbo Systems service station.

### 6.1.7 Sluggish start-up

**Turbocharger**

▷ Turbocharger dirty
▶ Clean

▷ Bearing damaged
▷ Rotor grazing
▷ Foreign bodies in the turbocharger
▶ Contact an official ABB Turbo Systems service station.

### 6.1.8 Lubricating oil pressure too low

**Engine**

▷ Oil filter heavily soiled
▶ Clean

▷ Oil pump in the lubricating system defective
▶ Inspect

▷ Manometer provides false reading
▶ Replace manometer

**Turbocharger**

▷ Axial clearance of the rotor too big
▶ Contact an official ABB Turbo Systems service station.

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### 6.1.9 Constant surging of the turbocharger

**Engine**

- ▷ Exhaust pressure to the turbine elevated because boiler or exhaust silencer is dirty
- ▷ Trap dirty
- ▶ Clean

**Turbocharger**

- ▷ Charge-air cooler or silencer dirty
- ▷ Heavy deposits of contamination in the turbine
- ▶ Clean

NOTE

If it is not possible to determine the reason for the surging, contact an official ABB Turbo Systems service station.

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# 7 Removal and installation

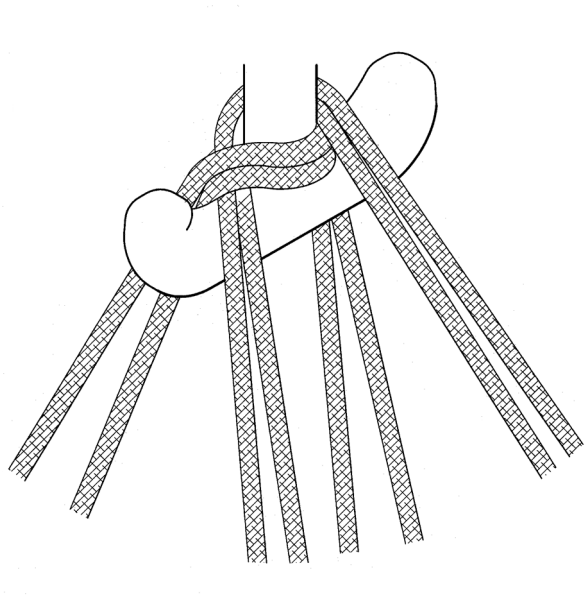
## 7.1 Turbocharger weights

**WARNING**

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.

Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.



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**NOTE**

To ensure the safety of loads on the crane hook, the ropes must be crossed for suspending. See also the illustration above.

### Turbocharger complete without silencer / air suction branch and without gas outlet manifold

Weight [kg]

| TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|
| 110 | 160 | 260 | 450 |

### Turbocharger complete without gas outlet manifold and with silencer

Weight [kg]

| TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|
| 129 | 187 | 300 | 512 |

### Turbocharger complete without gas outlet manifold and with air suction branch (radial)

Weight [kg]

| TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|
| 116 | 168 | 271 | 471 |

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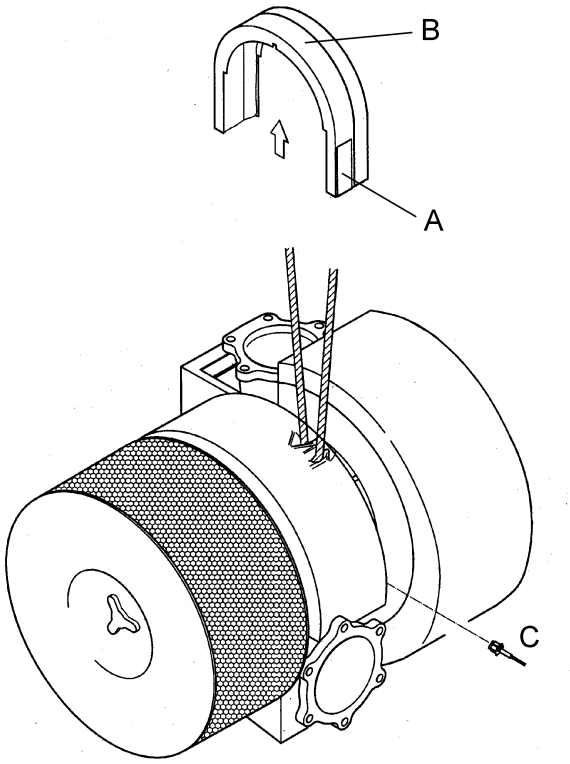
# 7.2 Remove the turbocharger

▶ Disconnect all gas and air lines in accordance with the engine manufacturer's instructions.

**If provided** Remove insulation as follows:

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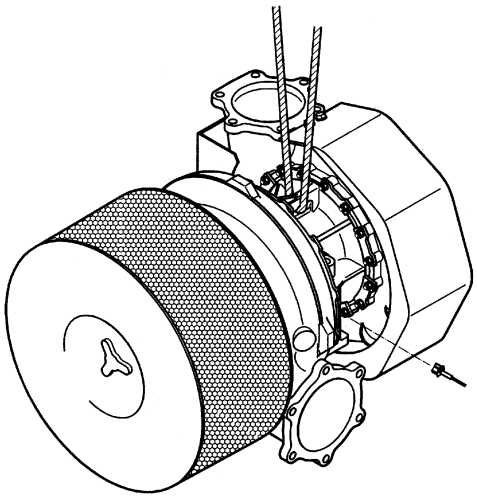
▶ Remove screws and plate (**A**) of the bearing casing insulation.
▶ Remove remaining screws of the bearing casing insulation (**B**).
▶ Withdraw bearing casing insulation upwards. For more simple removal, the bearing casing insulation can be compressed.
▶ Unplug cable on the speed measurement (C).
▶ Check the lifting equipment.

**Turbocharger without gas outlet manifold**



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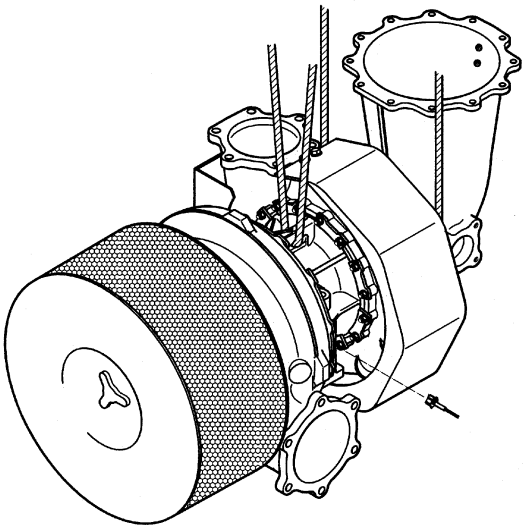
▶ Secure lifting equipment to bearing casing.

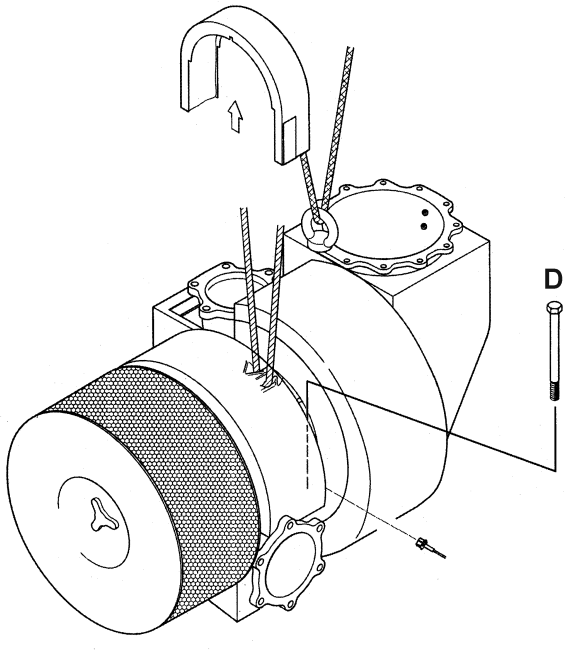
**Turbocharger with gas outlet manifold without insulation:**



*S_00100*

▶ Sling lifting equipment around the gas outlet manifold and secure to the bearing casing.

**Turbocharger with gas outlet manifold and with insulation:**




*S_00101*

▶ Secure lifting equipment with a ring bolt and nut to the flange of the gas outlet mainfold and to the bearing casing.

**WARNING**

During removal, a turbocharger that is not lifted in compliance with regulations may fall, and can cause serious or even fatal injury.

▶ Select a suitable rope taking into account the weight of the turbocharger.

▶ Loosen securing screws (**D**) on the bearing casing.
▶ Lift the turbocharger from the engine and place it aside.
▶ Cover oil connections.

# 7.3 Installing the turbocharger



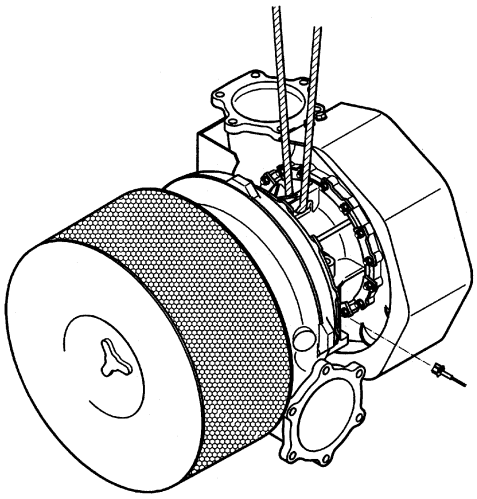
**WARNING**

During installation, a turbocharger that is not lifted in compliance with regulations may fall, and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger.

- ▶ Remove covers from the oil connections.
- ▶ Visual inspection of the O-ring gaskets of oil supply- and drain pipe (the engine-end O-ring gaskets are not part of the scope of delivery of ABB Turbo Systems).
- ▶ Check the lifting equipment.

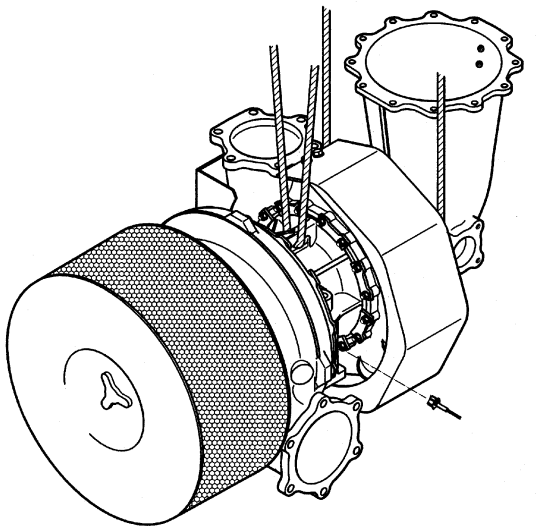
**Turbocharger without gas outlet manifold**



*S_00099*

- ▶ Secure lifting equipment to bearing casing

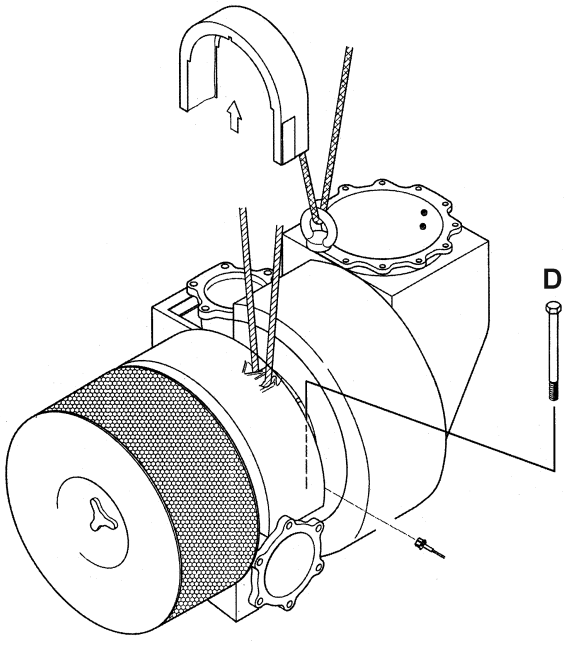
**Turbocharger with gas outlet manifold without insulation:**



*S_00100*

▶ Sling lifting equipment around the gas outlet manifold and secure to the bearing casing.

**Turbocharger with gas outlet manifold and with insulation:**



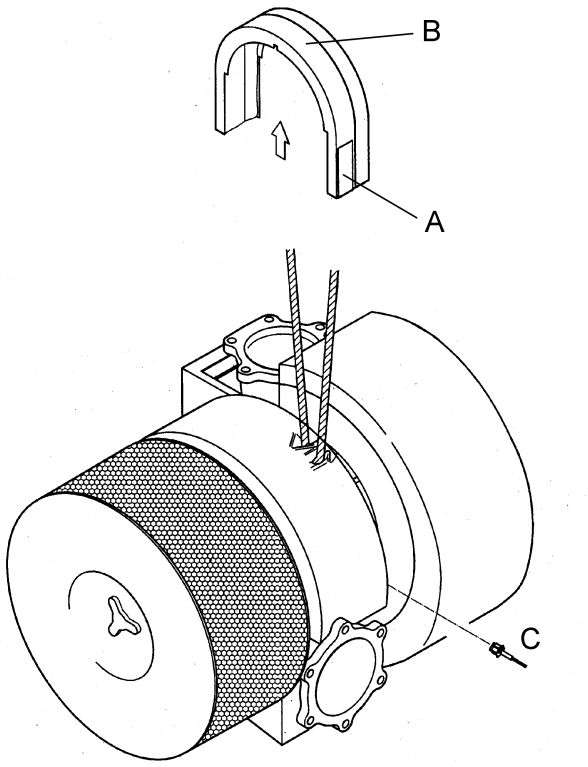

*S_00101*

- ▶ Secure lifting equipment with a ring bolt and nut to the flange of the gas outlet mainfold and to the bearing casing.
- ▶ Mate turbocharger with the engine.
- ▶ Tighten securing screws (**D**) on the bearing casing.
- ▶ Plug in cable for the speed measurrement (**C**).

**If provided:**

Secure insulation as follows:

- ▶ Mate bearing casing insulation.




*S_00098*

- ▶ Tighten screws of the bearing casing insulation (**B**).
- ▶ Mate screws and plate (**A**) of the bearing casing insulation.

- ▶ Secure all gas and air lines in accordance with the engine manufacturer's instructions.

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# 8 Disassembly and assembly

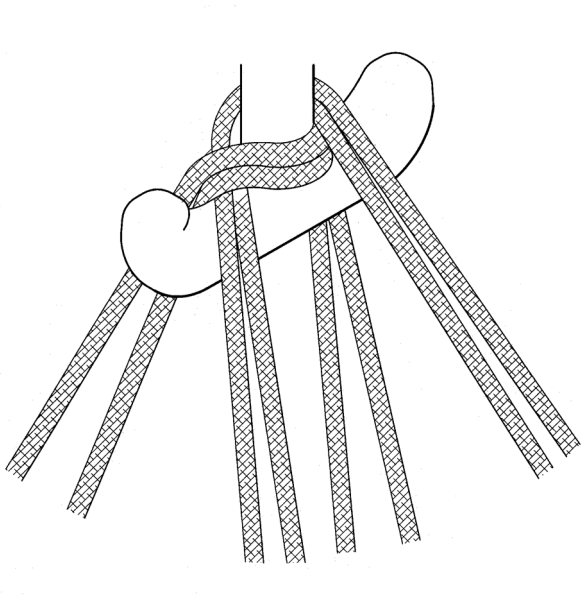
## 8.1 Module weights

WARNING

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.

Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.

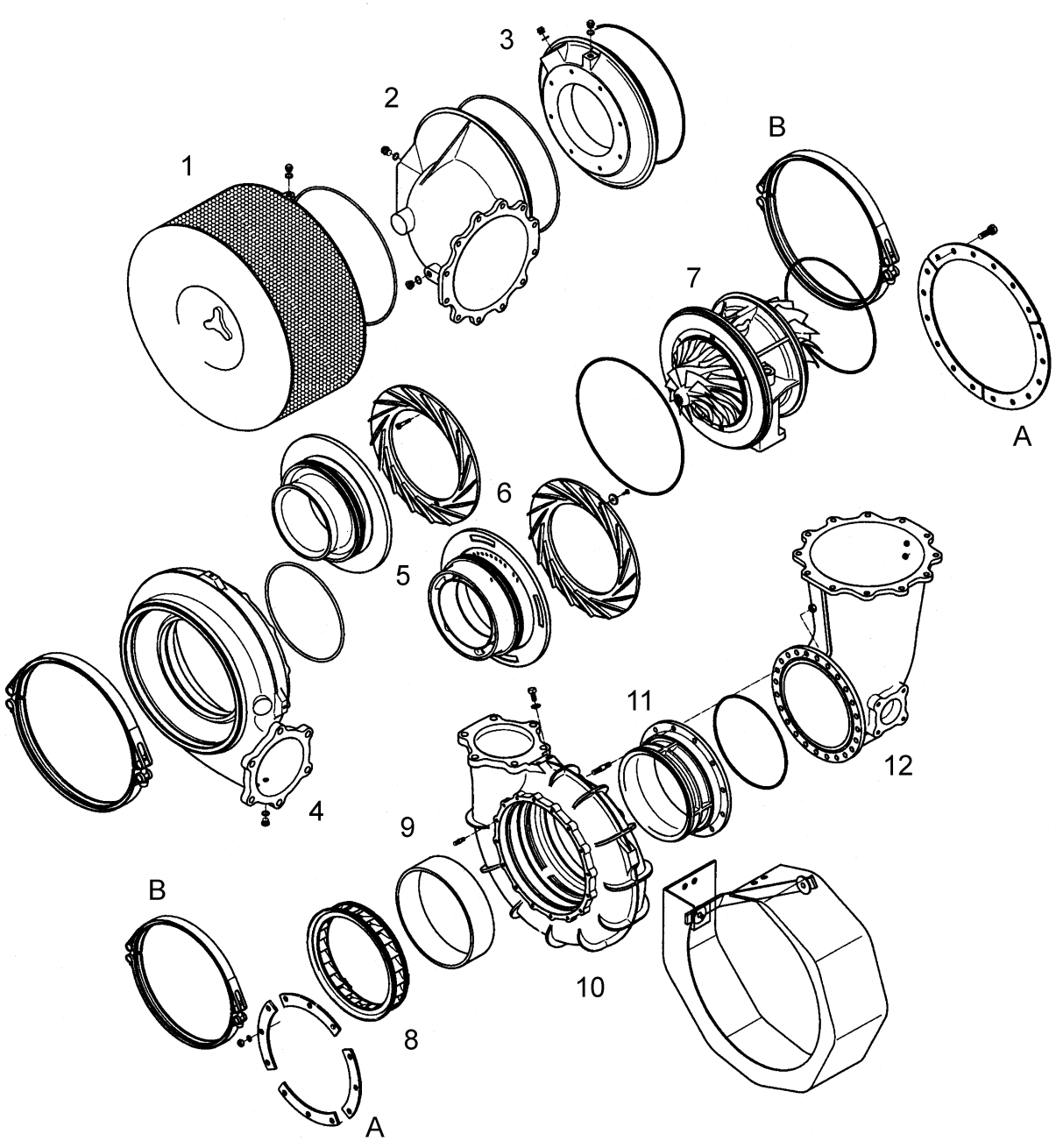


*L_00082*

NOTE

To ensure the safety of loads on the crane hook, the ropes must be crossed for suspending. See also the illustration above.

## Modules




*S_00102*

| | | | |
|---|---|---|---|
| **A** | Strap connection | **B** | V-band connection |

**Weights [kg]**

| | Description | | TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|---|---|---|
| **1** | Silencer | | 19 | 27 | 40 | 62 |
| **2** | Air suction branch, radial | | 6 | 8 | 11 | 21 |
| **3** | Air suction branch, axial | | 4 | 4 | 6 | 9 |
| **4** | Compressor casing | | 24 | 35 | 51 | 89 |
| **5** | Wall insert | | 7 | 10 | 13 | 30 |
| **6** | Diffuser | | 2 | 3 | 6 | 10 |
| **7** | Cartridge group | | 32 | 48 | 83 | 136 |
| **8** | Nozzle ring | | 1 | 2 | 3 | 6 |
| **9** | Rupture ring | | 2 | 3 | 5 | 12 |
| **10** | Turbine casing with external rupture protection | 1 inlet | 32 | 47 | 77 | 130 |
| | | 2 inlets | 35 | 50 | 86 | 145 |
| | | 3 inlets | - | 53 | 96 | 162 |
| | | 4 inlets | - | - | 93 | 162 |
| **11** | Gas outlet flange | | 4 | 8 | 16 | 30 |
| **12** | Gas outlet manifold | | 18 | 25 | 40 | 56 |

# 8.2 Disassembling and assembling turbocharger (with V-band connection)

NOTE

Not all tools are identified with a part number. The identification of the tools is ensured with the tools list (included in the toolbox).

WARNING

During removal and assembly, turbocharger components that have not been suspended in compliance with regulations may fall, and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.

### Removing compressor casing

- ▶ Disconnect all air ducts in accordance with the engine manufacturer's instructions.

**If provided:**

- ▶ Remove screws of the compressor casing insulation and dismantle insulation.
- ▶ Loosen V-band (72020) and remove filter silencer or air suction branch.

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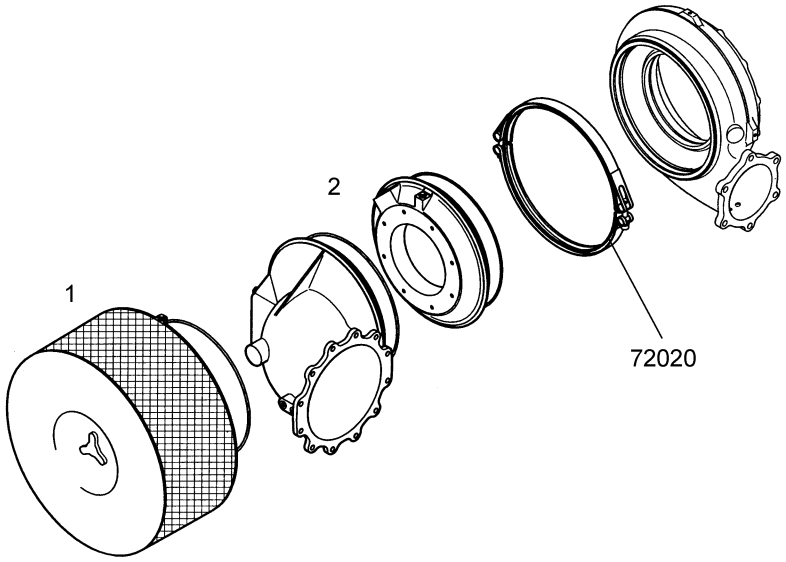
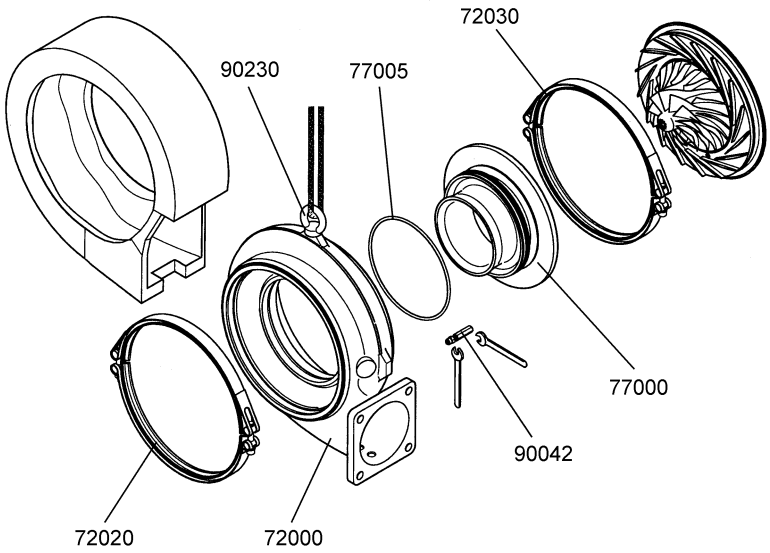



*S_00103*

| | | | |
|---|---|---|---|
| **1** | Filter silencer | **2** | Air suction branch |

- ▶ Slightly loosen V-band (72030) and turn compressor casing (72000), until the ring bolt (90230) on the lifting equipment can be secured.
- ▶ Completely loosen V-band (72030) and travel compressor casing (72000) away horizontally with wall insert (77000).
- ▶ Knock wall insert (77000) out of the compressor casing with nylon hammer and remove O-ring gasket (77005).

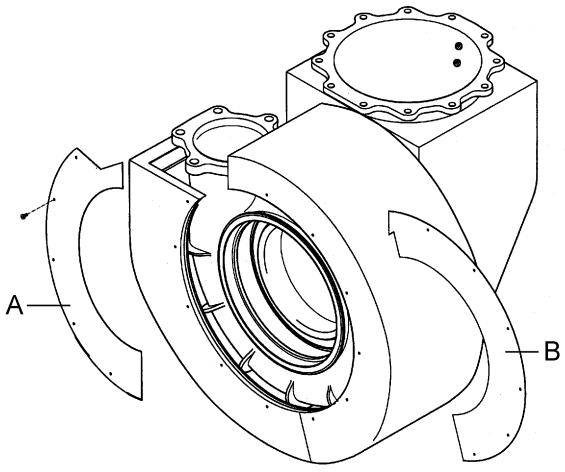



*S_00104*

NOTE

If the compressor casing can not be easily released, it can be pushed off against the turbine casing with the press-off tool (90042). For this, the two cover plates (**A+B**) of the turbine casing insulation must be removed.

**If provided**




*S_00105*

CAUTION

**Axial force**

A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

▶ Therefore always engage at both sides alternately and do not press off too much at each side.

## Installing compressor casing

▶ Install the compressor casing following these instructions in the reverse order.

NOTE

Always replace O-ring gaskets (see section **Spare parts**)

▶ Clean V-bands (72020/72030) thoroughly before assembly.
▶ Grease V-band thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).
▶ Check lifting equipment and secure to bearing casing (42001).

CAUTION

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

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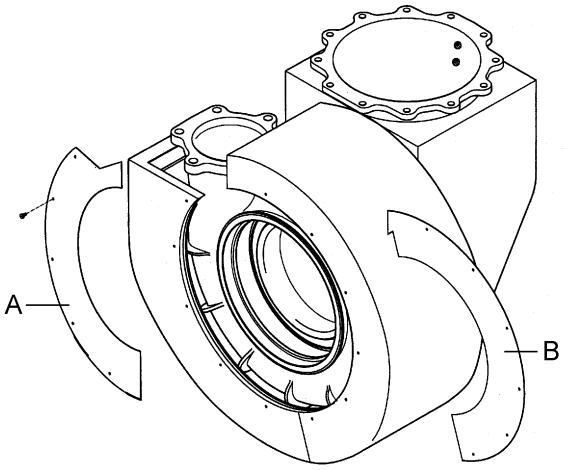
## Removing cartridge group

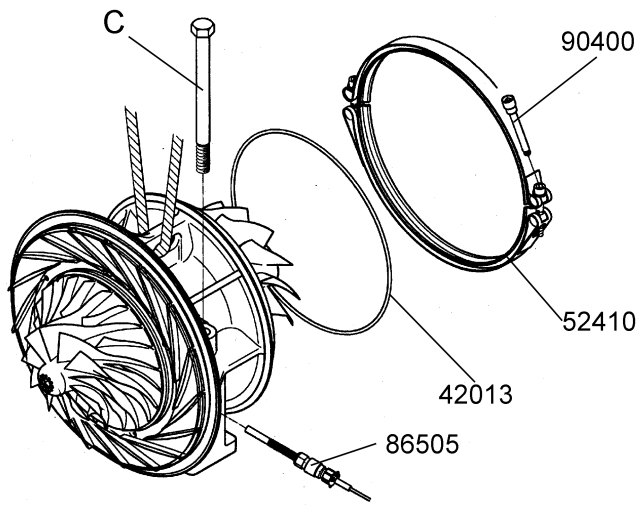
**If provided**

▶ Disconnect all lines according to engine manufacturer's specifications, remove insulation, dismantle turbocharger and remove compressor casing as well as filter silencer (see also previous chapter).




*S_00105*

▶ Remove screws on both plates (**A**+**B**) of the turbine casing insulation and dismantle the plates.




*S_00106*

**If provided**

▶ Disconnect plug to speed measuring transmitter (86505).

- ▶ Treat screw thread of the V-band (52410) with rust dissolver and allow to act.
- ▶ Loosen V-band (52410) with hexagon insert (90400) and remove.
- ▶ Loosen fastening screws (**C**) of the bearing casing (42001) and remove.
- ▶ Carefully withdraw cartridge group and remove gasket (42013).

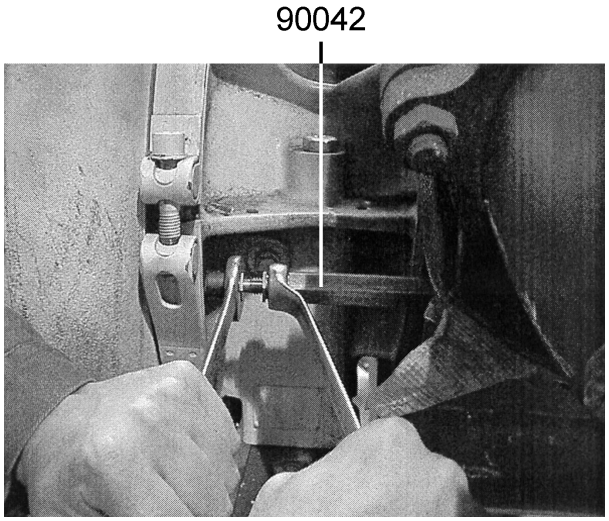
- ▷ Bearing casing is not easy to remove.
- ▶ Press off bearing casing with press-off tool (90042) against the turbine casing (see following diagram).

CAUTION

**Axial force**

A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

- ▶ Therefore always engage at both sides alternately and do not press off too much at each side.

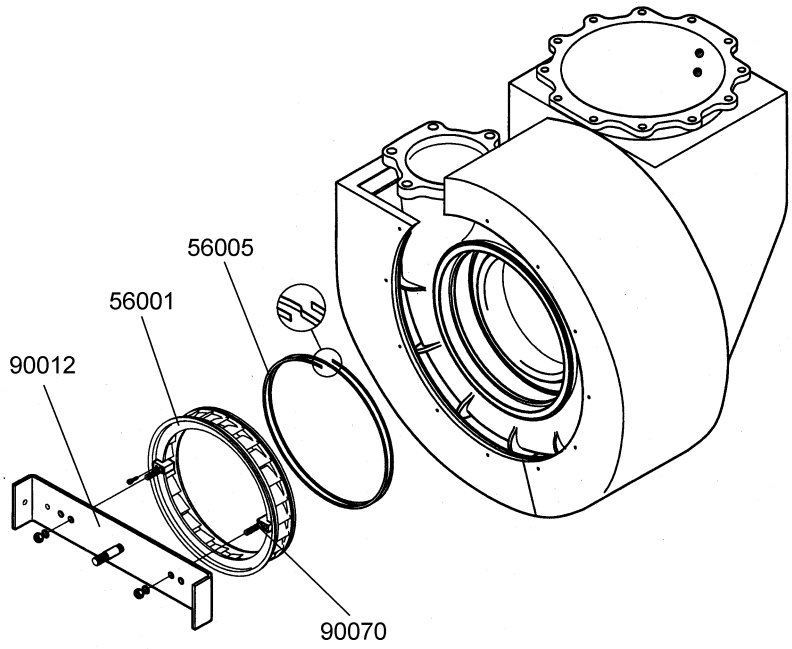



*S_00128*

- ▶ Cover oil connections.

NOTE

The V-band (52410) is always to be replaced by a new one. (see section **Spare parts**)




*S_00107*

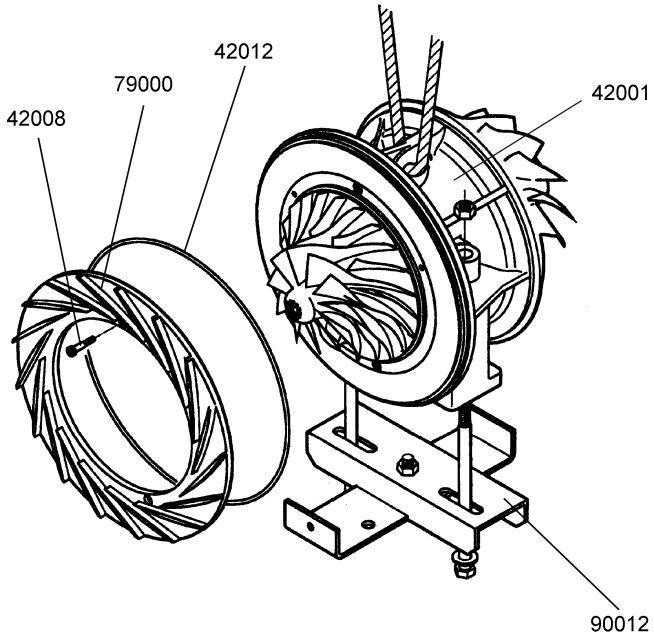
▶ Press off nozzle ring (56001) with the two withdrawal devices (90070) and the service support bracket (90012) and remove.

**If provided:**

▶ Remove lamellar sealing ring (56005).

▶ Place cartridge group on the service support (90012) and screw tight.

**Diffusor disassembly TPS…D/E/F33**




*S_00110*

- ▶ Loosen screws (42008), remove diffuser (79000) and O-ring gasket (42012).
- ▶ Measure axial and radial clearances (see section **Axial and Radial Clearances**).

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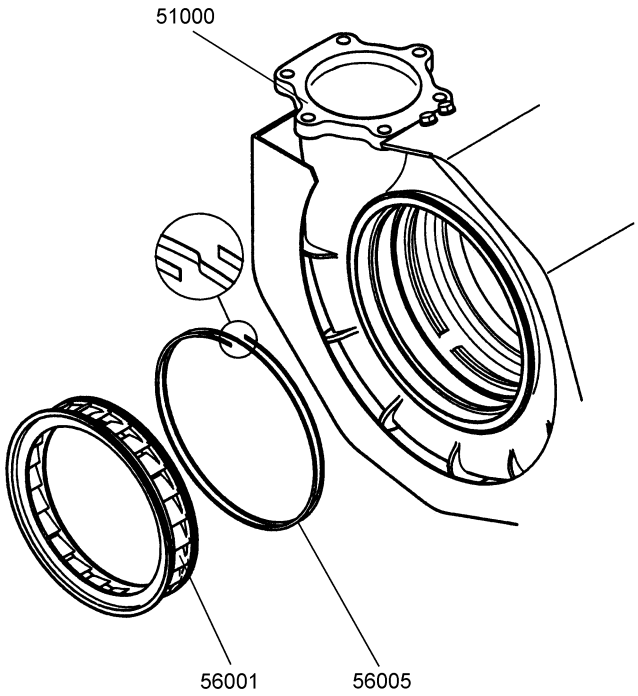
## Installing the cartridge group

NOTE

Always replace O-ring gaskets (see section **Spare parts**)




*S_00109*

**If provided:**

▶ Fit lamellar sealing ring (56005).

NOTE

Ensure the correct coiling of the lamellar sealing ring (56005).

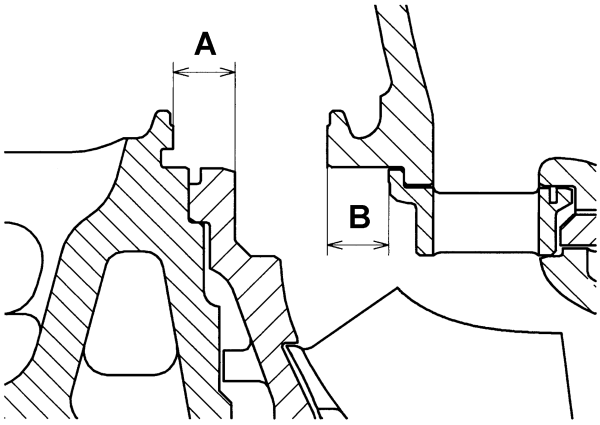
▶ Push in nozzle ring (56001) up to the stop in the turbine casing (51000).

▶ Pay attention to the position of the cam.

NOTE

So that the nozzle ring is fixed during operation, it must be clamped between the partition wall and the turbine casing.

▶ The pressing (PD) must be calculated.

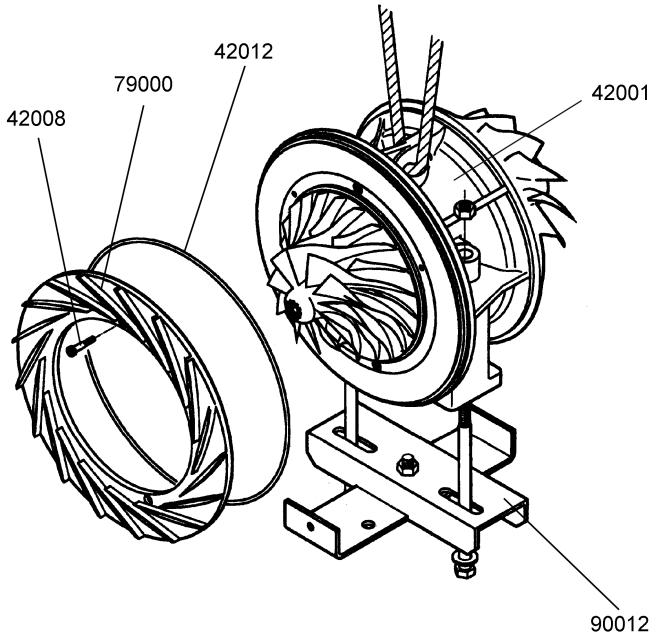



**PD=A-B**

*S_00129*

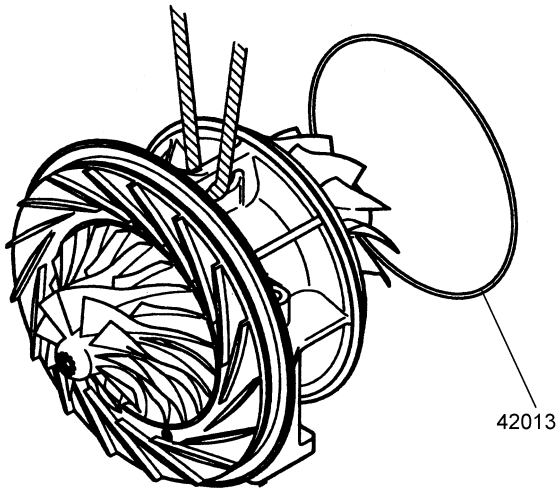
NOTE

If the calculated value is less than **0.1 mm**, an official service station of ABB Turbo Systems must be contacted.




*S_00110*

- ▶ Measuring axial and radial clearances (see section Axial and Radial Clearances).
- ▶ Secure diffuser (79000) and O-ring gasket (42012) with screws (42008).
- ▶ Check lifting equipment and secure to bearing casing (42001).
- ▶ Unscrew cartridge group and lift from the service support (90012).




*S_00111*

- ▶ Grease centering seats, inside of the V-band profile and screw threads with Antiscuff (or similar high-temperature lubricating paste).
- ▶ Remove provisional covers at the oil connections.
- ▶ Assemble cartridge group and gasket (42013) as far as possible by hand.

CAUTION

During assembly of the cartridge group, do not damage or move gasket rings (**A**) in the securing support. The gasket rings (**A**) are engine side and are not included in the scope of supply of ABB Turbo Systems.

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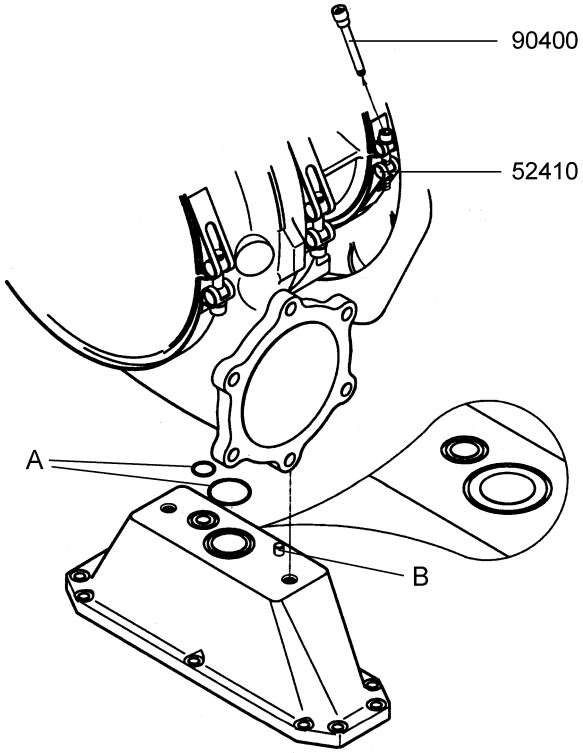



*S_00112*

**NOTE**

If two turbochargers, each with a left and right oil inlet, are mounted on one engine, as a precaution against mistaken, incorrect assembly, a pin can be fitted in the bracket as assembly security device. This pin (**B**) fits in the respective groove on the foot of the bearing casing.

- ▶ Fit V-band (52410) and tighten using hexagon insert (90400) to the specified torque. (use torque spanner!).
- ▶ Loosen V-band and remove.
- ▶ Measure the distance between the V-band flanges at several points with a feeler gauge. This distance must not be greater than the calculated value (**PD**).

**CAUTION**

**Correct positioning of the turbine casing**

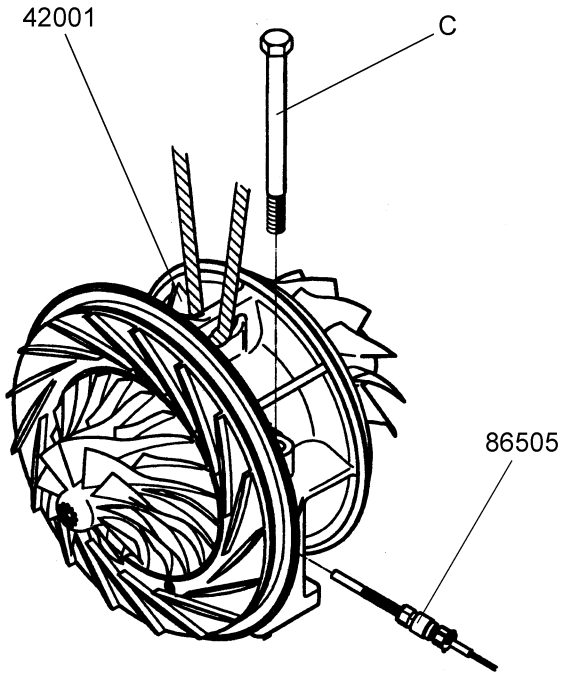
Operation of the TPS turbocharger with axially incorrect positioned turbine casing leads to damage to the nozzle ring and turbine casing.

- ▶ If the calculated value is not nicht achieved, repeat tightening procedure with V-band (do not tighten V-band with more than the specified torque) or separate casing with press-off tool and start from the beginning.
- ▶ Fit V-band and tighten with the specified torque.

NOTE

An optimal seating of the V-band is achieved through gentle taps on the cover band with a nylon hammer.

- ▶ Retighten V-band with torque spanner (see chapter Tightening torques table).



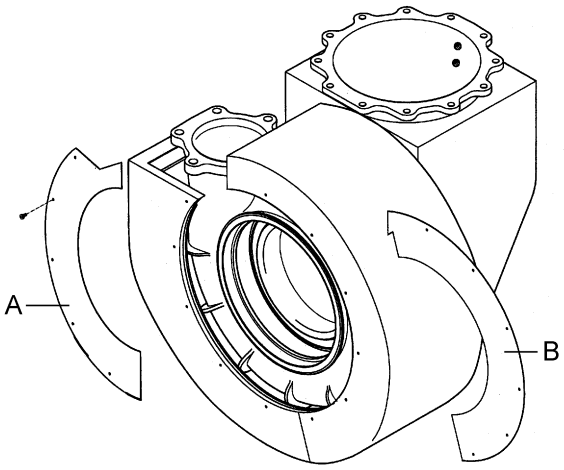

*S_00113*

- ▶ Assemble bearing casing (42001) with fixing screws (**C**).
- ▶ Tighten fixing screws with the torques specified in the following table.

| TPS | Fixing screws C [mm] | Tightening torques [Nm] |
|---|---|---|
| 48 | M16 | 230 |
| 52 | M20 | 455 |
| 57 | M20 | 455 |
| 61 | M24 | 780 |

▶ Fit speed sensor (86505).

**If provided:**




*S_00105*

▶ Fit insulation plates (**A+B**).

**CAUTION**

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

# 8.3 Disassembling and assembling turbocharger (with strap connection)



NOTE

Not all tools are identified with a part number. The identification of the tools is ensured with the tools list (included in the toolbox).

WARNING

Attach individual parts and larger component modules carefully to suitable hoists/lifting devices which are in technically perfect condition and which have adequate load-bearing capacity.
Turbocharger parts that are not suspended in accordance with the regulations during disassembly and assembly may fall and can cause serious or even fatal injury.

- ▶ Select a suitable rope taking into account the weight of the turbocharger parts.
- ▶ Do not stand under suspended loads.

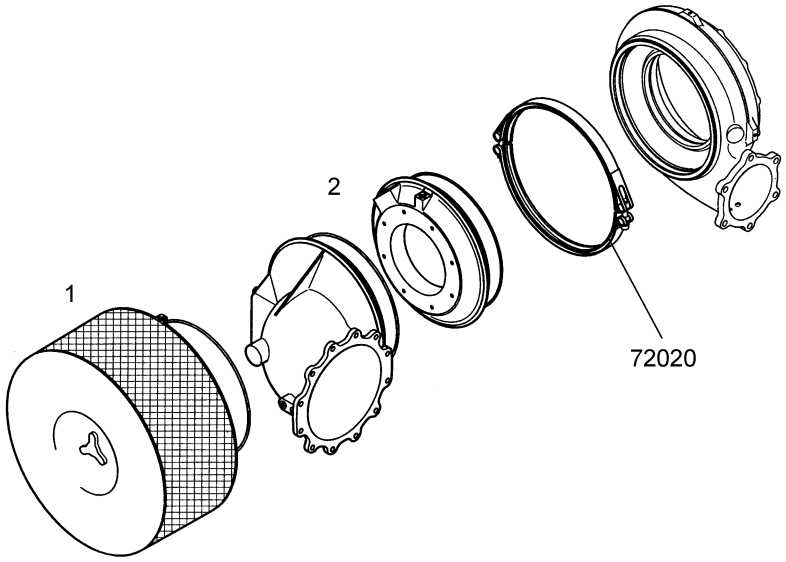
## Removing compressor casing

- ▶ Disconnect all air ducts in accordance with the engine manufacturer's instructions.

**If provided**

- ▶ Remove screws of the compressor casing insulation and dismantle insulation.

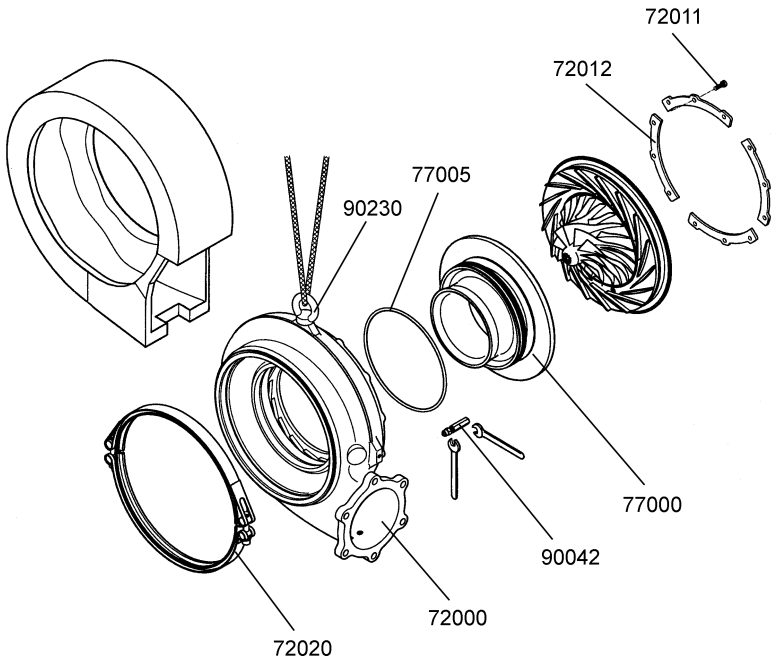
- ▶ Loosen V-band (72020) and remove silencer or air suction branch.




*S_00103*

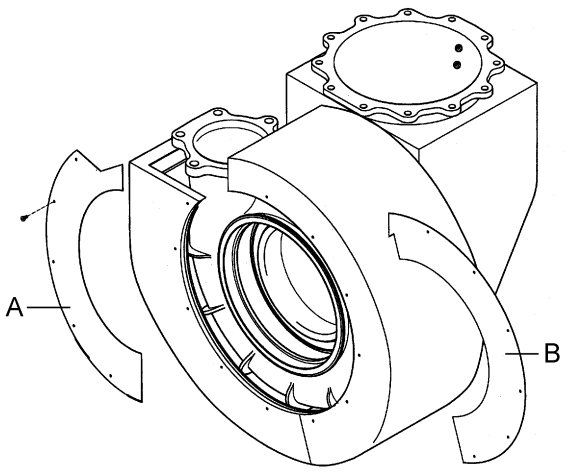
| | | | |
|---|---|---|---|
| **1** | Silencer | **2** | Air suction branch |

▶ Slightly loosen screws (72011) and turn compressor casing (72000), until the ring bolt (90230) on the lifting equipment can be secured.




*S_00114*

**If provided**




*S_00105*

**NOTE**

If the compressor casing can not be easily released, it can be pushed off against the turbine casing with the press-off tool (90042). For this, the two cover plates (A+B) of the turbine casing insulation must be removed.

CAUTION

**Axial force**

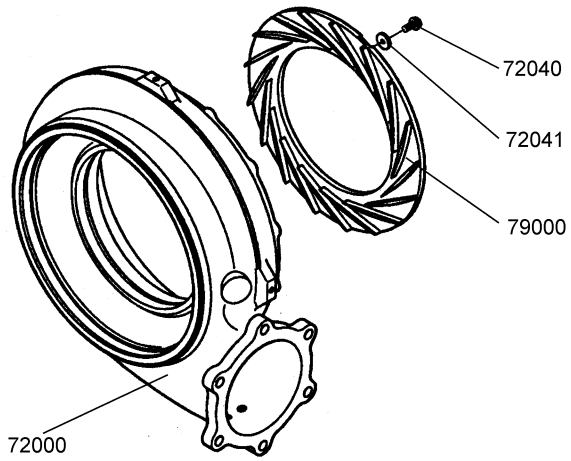
A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

▶ Therefore always engage at both sides alternately and do not press off too much at each side.

▶ Loosen screws (72011) and remove with securing straps (72012).

▶ Carefully travel compressor casing (72000) away horizontally with wall insert (77000).

**Diffusor disassembly TPS.. –F31/F32**




*S_00115*

▶ Release screws (72040) and remove from compressor casing (72000) with fixing washers (72041) and diffuser (79000).

▶ Knock wall insert (77000) out of the compressor casing with nylon hammer and remove O-ring gasket (77005).

**TPS 61**

To lift the wall insert (77000) use the ring bolts (90255).

## Installing compressor casing

**Diffusor assembly TPS.. – F31/F32**

- ▶ Install wall insert (77000) and O-ring gasket (77005) analogously in the reverse order.
- ▶ Install diffuser analogously in the reverse order.
- ▶ Fit the compressor casing analogously in the reverse order.

NOTE

Always replace O-ring gaskets. (see section **Spare parts**)

- ▶ Thoroughly clean securing straps (72012) and V-band (72020) before assembly. Grease V-band thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).

CAUTION

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

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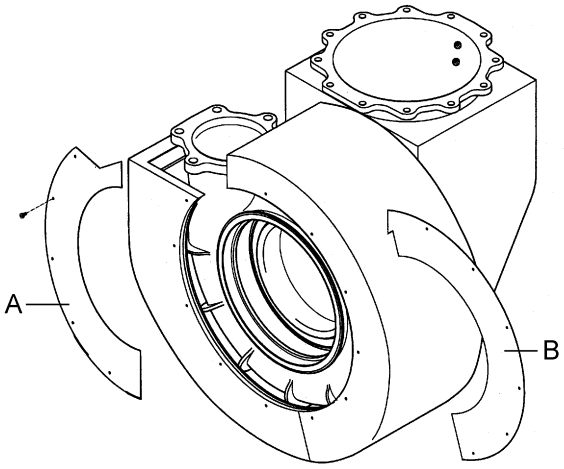
## Removing cartridge group

▶ Check lifting equipment and secure to bearing casing (42001).

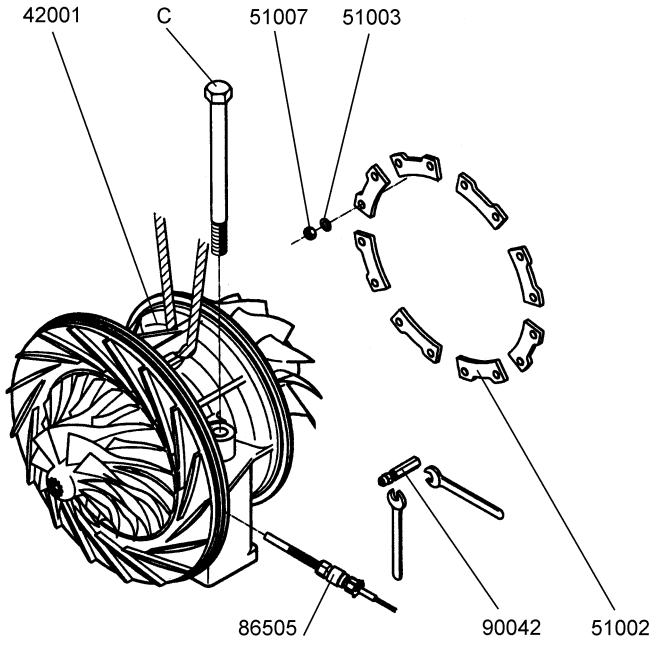
## If provided

▶ Disconnect all lines according to engine manufacturer's specifications, remove insulation, dismantle turbocharger and remove compressor casing as well as filter silencer (see also previous chapter).




*S_00105*

▶ Remove screws on both plates (A+B) of the turbine casing insulation and remove the plates.




*S_00117*

**If provided**

▶ Disconnect plug to speed measuring transmitter (86505)

▶ Treat screw thread of the studs (51006) with creep oil and allow to react.

▶ Release nuts (51007) and remove Verbus washers (51003) with securing straps (51002).

▶ Loosen fastening screws (**C**) of the bearing casing (42001) and remove.

▶ Remove cartridge group.

▷ Bearing casing is not easy to remove.

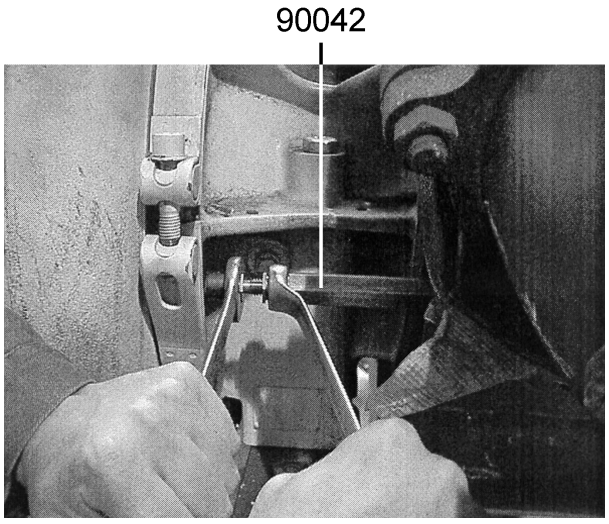
▶ Press off bearing casing with press-off tool (90042) against the turbine casing (see following diagram)

CAUTION

**Axial force**

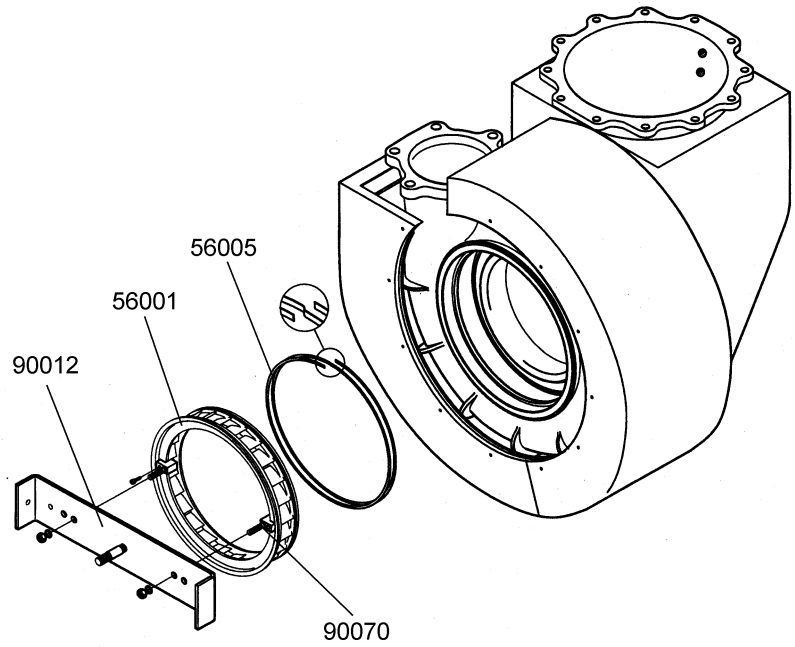
A high axial force can be generated with the press-off tool and with improper handling (pressing off too strongly at one side) the rotor can be damaged.

▶ Therefore always engage at both sides alternately and do not press off too much at each side.




*S_00128*

▶ Cover oil connections.



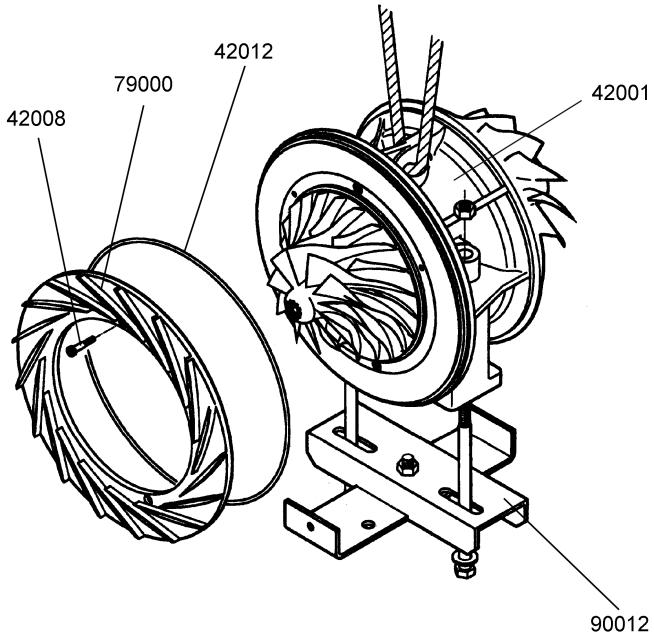

*S_00107*

▶ Withdraw nozzle ring (56001) with the two withdrawal devices (90070) and the service support bracket (90012).

**If provided**

▶ Remove lamellar sealing ring (56005).

**Diffusor disassembly TPS.. D/E/F33**



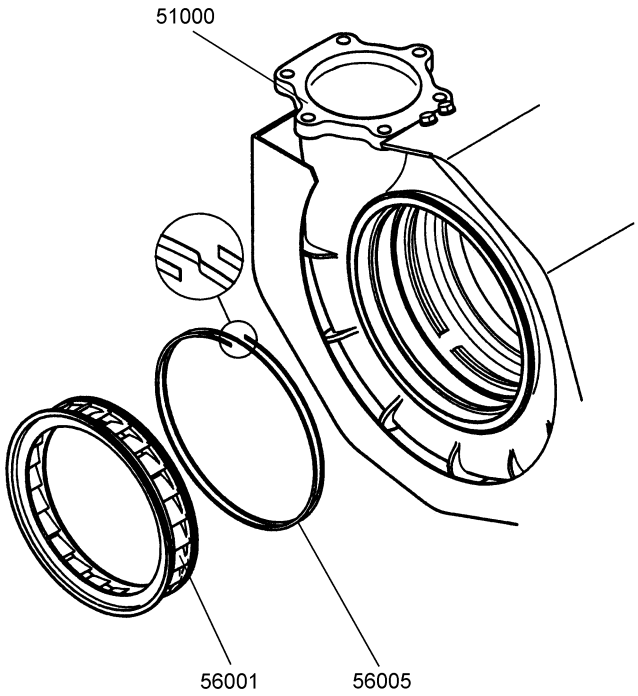

*S_00110*

- ▶ Place cartridge group on the service support (90012) and screw tight.
- ▶ Loosen screw (42008) and remove diffuser (79000) and O-ring gasket (42012).
- ▶ Measure axial and radial clearances (see section **Axial and Radial Clearances**).

## Installing the cartridge group

NOTE

Always replace O-ring gaskets (see section **Spare parts**)




*S_00109*

**If provided**

▶ Fit lamellar sealing ring (56005).

NOTE

Ensure the correct coiling of the lamellar sealing ring (56005).

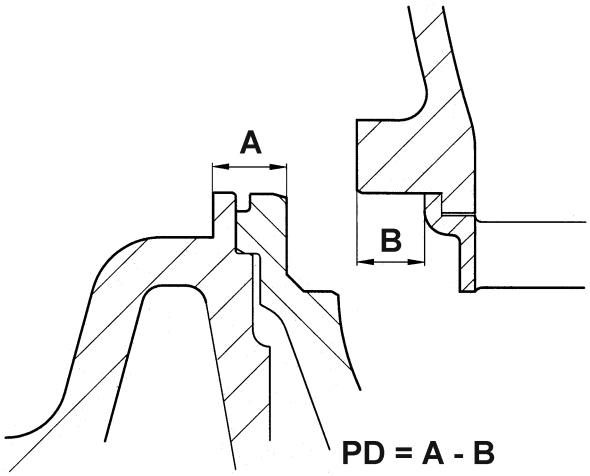
▶ Push in nozzle ring (56001) up to the stop in the turbine casing (51000).

▶ Pay attention to the position of the cam.

NOTE

So that the nozzle ring is fixed during operation, it must be clamped between the partition wall and the turbine casing.

▶ The pressing (PD) must be calculated.



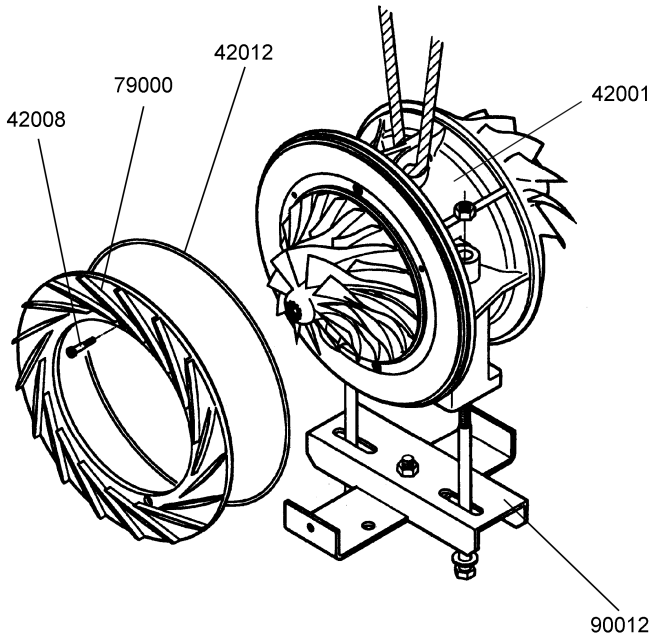

*S_00133*

NOTE

If the calculated value (PD) is less than **0.1 mm**, an official service station of ABB Turbo Systems must be contacted.

▶ Measure axial and radial clearances (see section **Axial and Radial Clearances**).

**Diffusor assembly TPS…D/E/F33**



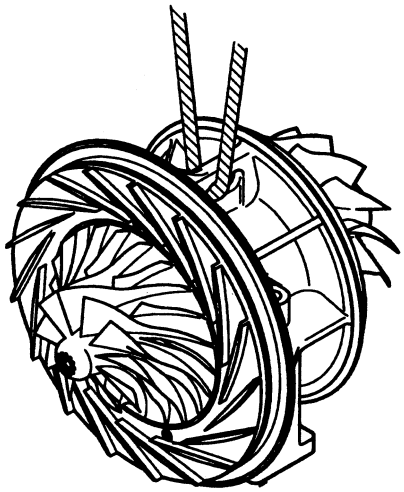

*S_00110*

▶ Secure diffuser (79000) and O-ring gasket (42012) with screw (42008).

**NOTE**

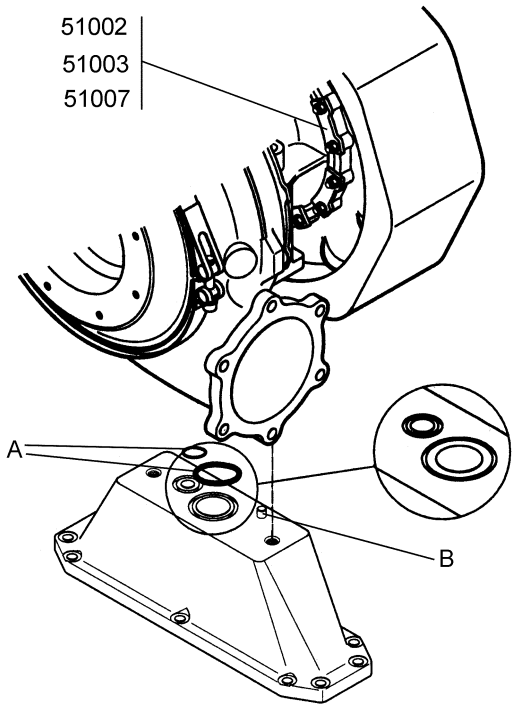
See section Removing Rotor.

▶ Check lifting equipment and secure to bearing casing (42001).
▶ Unscrew cartridge group and lift from the service support (90012).
▶ Grease centering seats and screw threads with Antiscuff (or similar high-temperature lubricating paste).
▶ Remove provisional covers at the oil connections.



*S_00134*

▶ Fit cartridge group as far as possible by hand



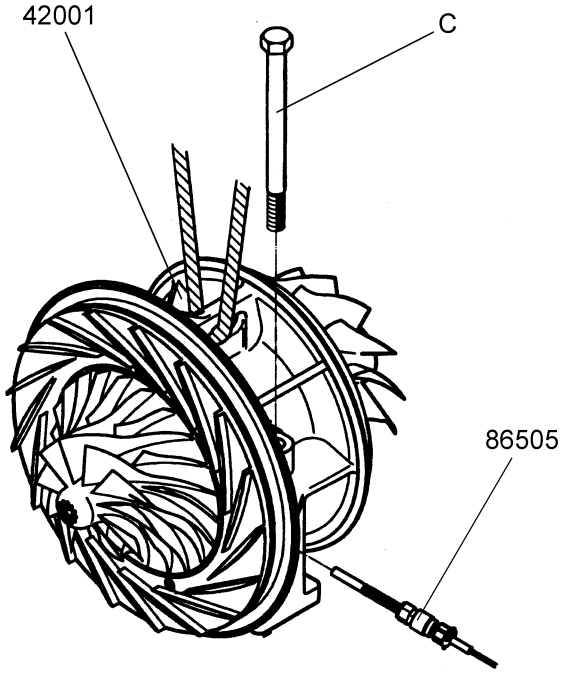

*S_00118*

CAUTION

During assembly of the cartridge group, do not damage or move gasket rings (**A**) in the securing support. The gasket rings (**A**) are engine side and are not included in the scope of supply of ABB Turbo Systems.

NOTE

If two turbochargers, each with a left and right oil inlet, are mounted on one engine, as a precaution against mistaken, incorrect assembly, a pin can be fitted in the bracket as assembly security device. This pin (**B**) fits in the respective groove on the foot of the bearing casing.

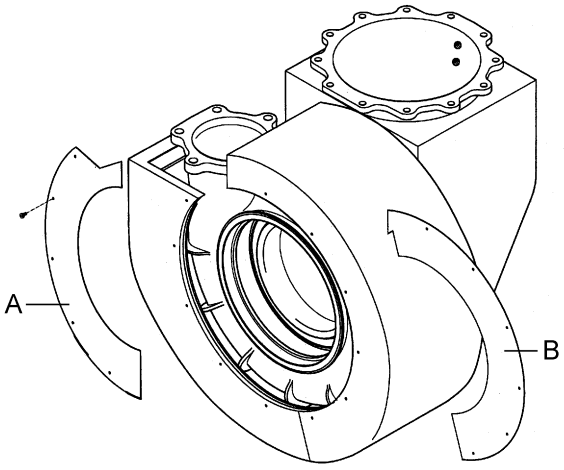



*S_00113*

- ▶ Secure cartridge group with the securing straps (51002), the Verbus washers (51003) and nuts (51007) (see also chapter Tightening torques table).
- ▶ Secure bearing casing (42001) with fixing screws (**C**).
- ▶ Tighten fixing screws (**C**) with the tightening torques according to the following table.

| TPS | Fixing screws C [mm] | Tightening torques [Nm] |
|---|---|---|
| 48 | M16 | 230 |
| 52 | M20 | 455 |
| 57 | M20 | 455 |
| 61 | M24 | 780 |

**If provided**



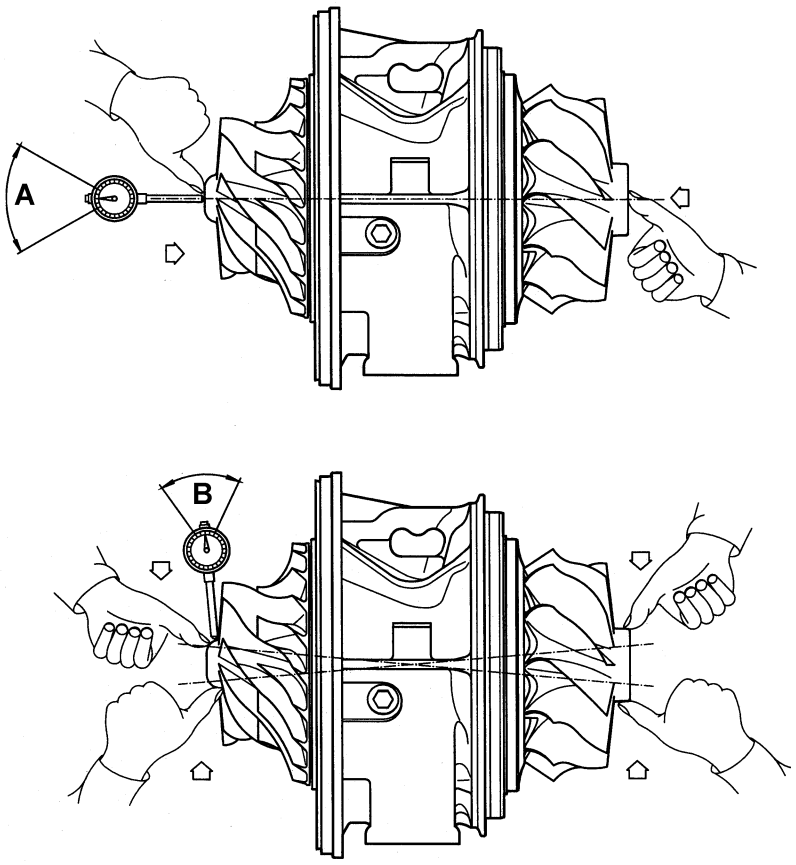

*S_00105*

▶ Plug in connector for speed measuring transmitter (86505) and fit the insulation plates (**A/B**).

**CAUTION**

Work that exceeds the scope of the description in this chapter must only be performed by a trained fitter from an official ABB Turbo Systems service station.

# 8.4 Axial and radial clearances




*S_00119*

▶ After removal and before the installation of the cartridge group, the axial clearance **A** and the radial clearance **B** are to be measured and noted.

NOTE

To correctly measure the axial clearance **A**, raise the turbine slightly.

**Axial and radial clearance [mm]**

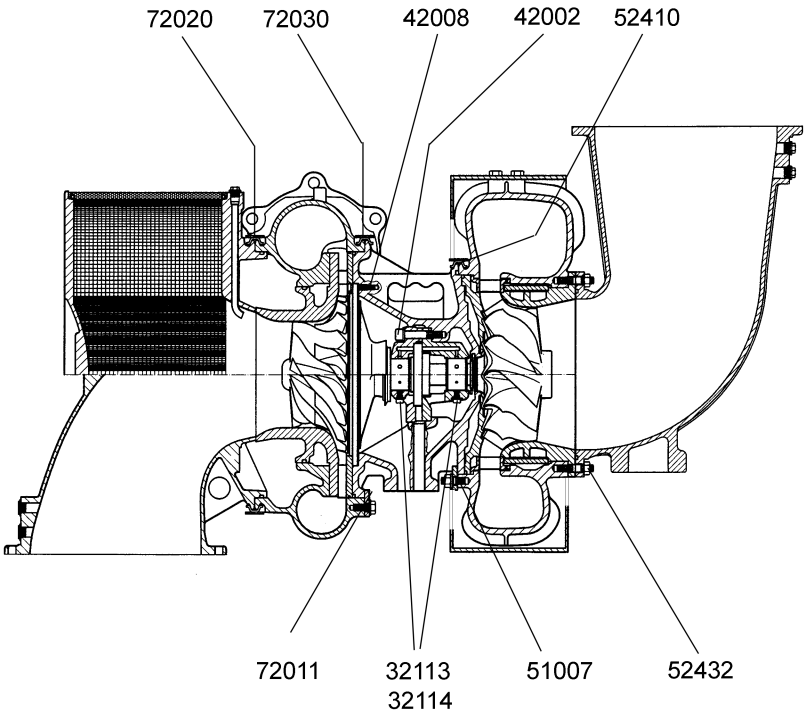
| | TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|---|
| **A at least** | 0.08 | 0.10 | 0.12 | 0.15 |
| **A maximum** | 0.16 | 0.18 | 0.21 | 0.25 |
| **B at least** | 0.50 | 0.61 | 0.72 | 0.81 |
| **B maximum** | 0.99 | 1.15 | 1.31 | 1.55 |

**CAUTION**

If the clearances are outside the tolerance, an official ABB Turbo Systems service station must be contacted.

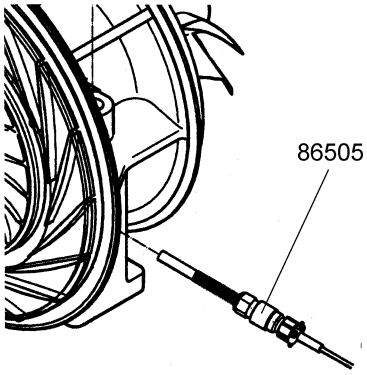
# 8.5 Table of tightening torques






*S_00120*

**If provided**




*S_00121*

The tightening torques listed must be observed for the screwed connections listed in the following table.

**Tightening torques [Nm]**

| Part no. | TPS 48 | TPS 52 | TPS 57 | TPS 61 |
|---|---|---|---|---|
| 32113 | 10 | 10 | 20 | 40 |
| 32114 | 10 | 10 | 20 | 40 |
| 42002 | 20 | 40 | 65 | 65 |
| 42008 | 10 | 10 | 20 | 40 |
| 51007 | 25 | 45 | 75 | 75 |
| 52410 | 60 [1)] | 60 [1)] | 60 [1)] | - |
| 52432 | 20 | 40 | 65 | 65 |
| 72011 | 35 | 70 | 105 | 105 |
| 72020 | 60 | 60 | 60 | 60 |
| 72030 | 60 [1)] | 60 [1)] | - | - |
| 86505 | 15 | 15 | 15 | 15 |

[1)] V-band connection only

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# 9 Taking out of operation

## 9.1 Turbocharger shut down (with V-band connection)

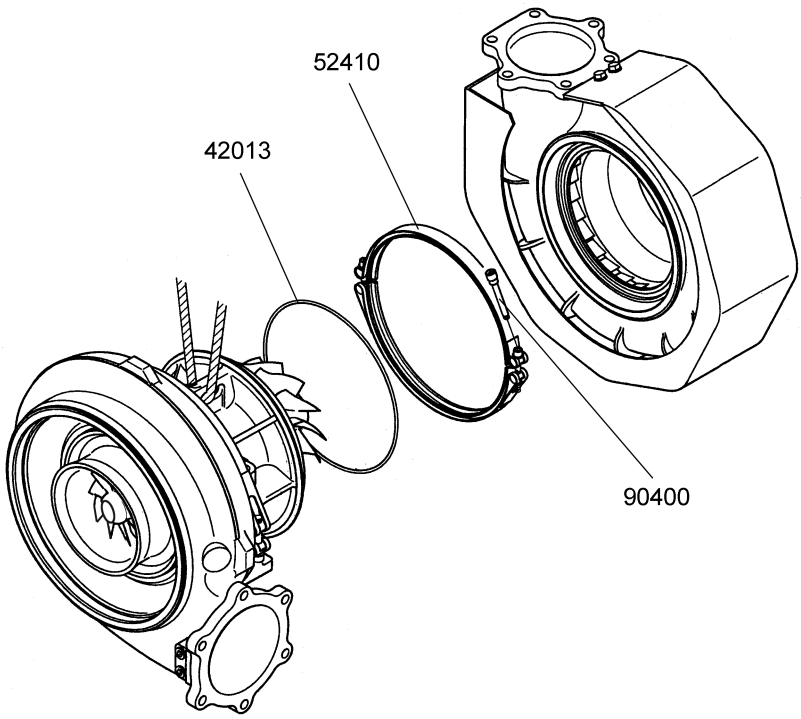
If with a damaged turbocharger, the Diesel engine can only be shut down temporarily for an emergency repair, then the following procedure should be adopted:

▶ Fit cover plate.

CAUTION

The instructions of the engine manufacturer for operation of the engine with locked / isolated turbocharger must be followed precisely in all cases!

**Fitting the cover plate**

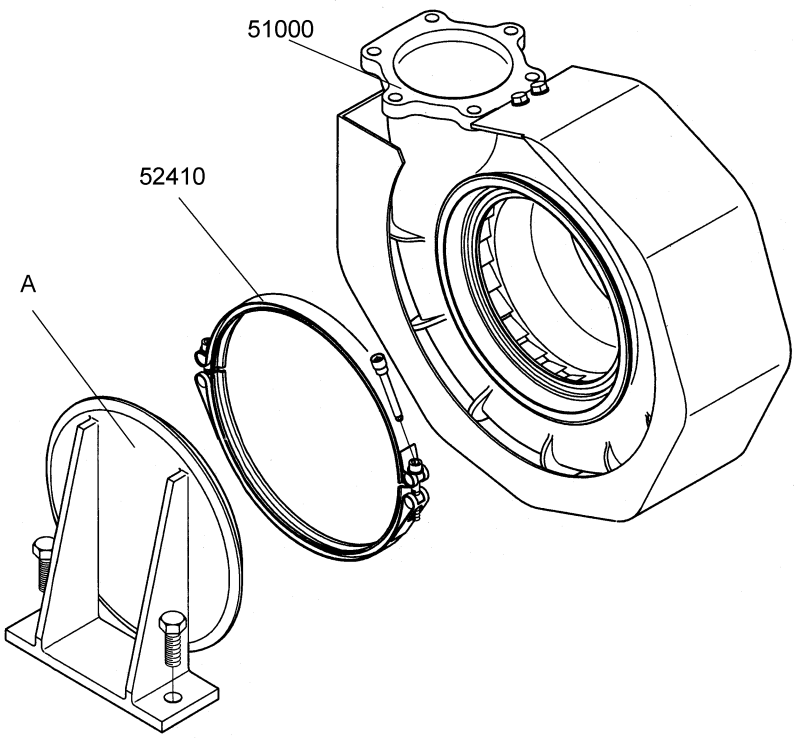



*S_00122*

▶ Dismantle turbocharger. (See section **Disassembling and assembling turbocharger with V-band connection**)

NOTE

Do not disassemble nozzle ring.




*S_00123*

▶ Block the opening in the turbine casing with the cover plate (**A**).
▶ Secure cover plate to turbine casing (51000) with V-band (52410) and screw tight on support.

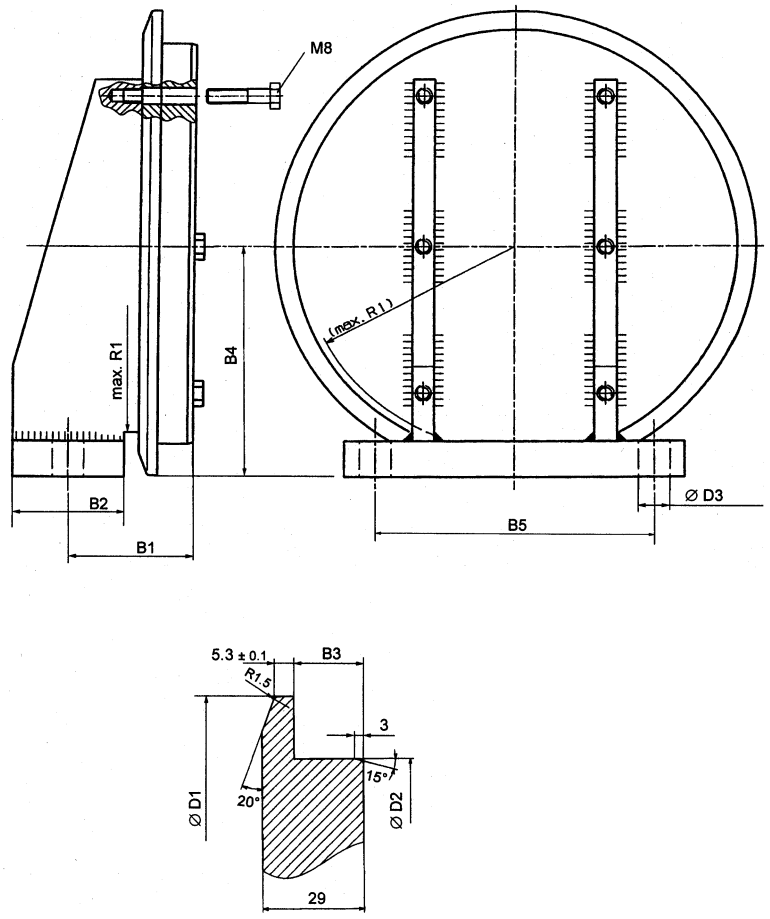
NOTE

Clean V-band (52410) thoroughly with a steel brush before assembly. Grease thread and inside of the profile with Antiscuff (or similar high-temperature lubricating paste).

## Cover plate drawing

NOTE

The cover plate (material: general structural steel, in accordance with DIN EN 10025-2) must be produced in-house according to the drawing.




*S_00124*

**Cover plate with V-band connection**

| TPS | B1 [mm] | B2 [mm] | B3 [mm] | B4 [mm] |
|---|---|---|---|---|
| 48 | 65.7 ± 0.4 | 60 | 19.1 ± 0.1 | 130 |
| 52 | 79.6 ± 0.4 | 78 | 20.1 ± 0.1 | 155 |

| TPS | B5 [mm] | ØD1 [mm] | ØD2 [mm] | ØD3 [mm] | R1 [mm] |
|---|---|---|---|---|---|
| 48 | 150 | 258 ± 0.2 | 222.7 ± 0.2 | 17 | 115 |
| 52 | 180 | 307 ± 0.2 | 265.7 ± 0.2 | 21 | 135 |

# 9.2 Turbocharger shut down (with strap connection)

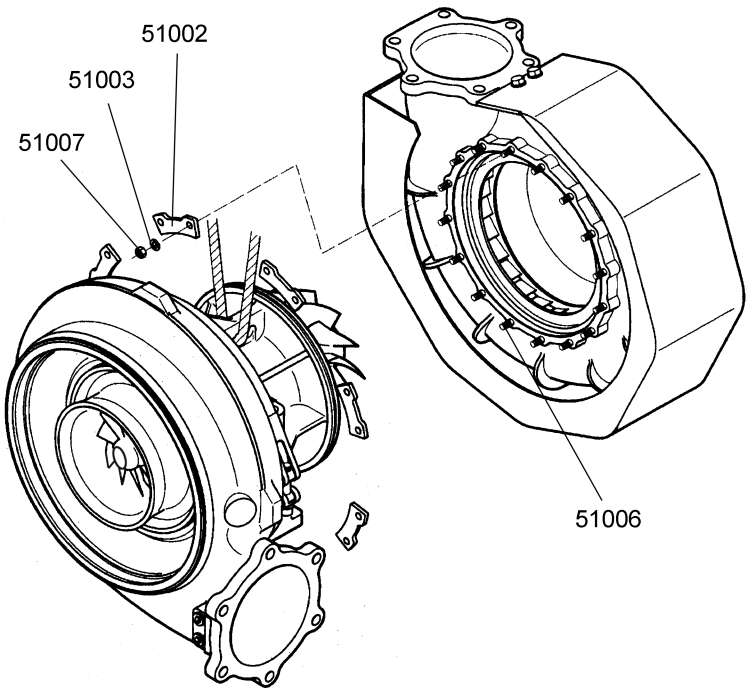
If with a damaged turbocharger, the Diesel engine can only be shut down temporarily for an emergency repair, then the following procedure should be adopted:

▶ Fit cover plate.

CAUTION

The instructions of the engine manufacturer for operation of the engine with locked / isolated turbocharger must be followed precisely in all cases!

**Fitting the cover plate**

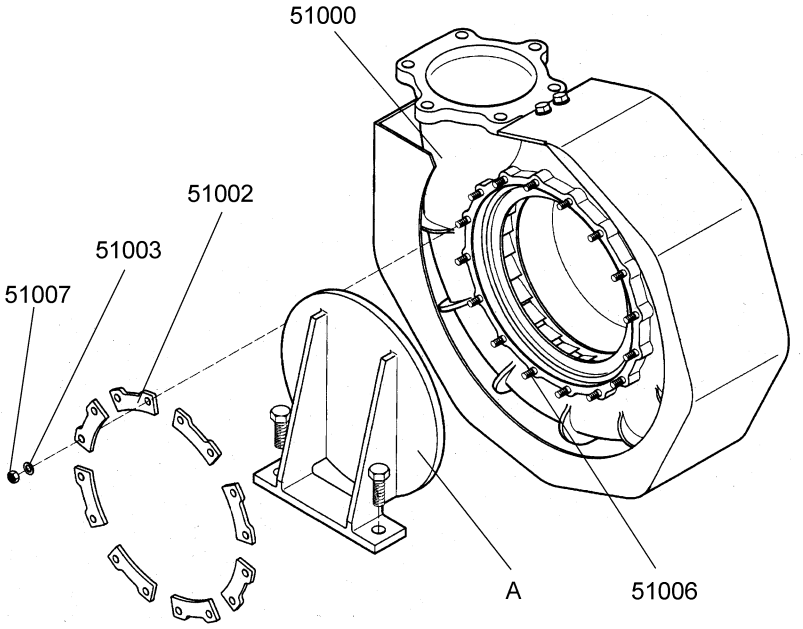



*S_00125*

▶ Turbocharger disassembly (see section **Disassembling and assembling turbocharger with strap connection**).

NOTE

Do not disassemble nozzle ring.




*S_00126*

- ▶ Block the opening in the turbine casing with the cover plate (**A**).
- ▶ Secure cover plate to the turbine casing (51000) with securing straps (51002), Verbus washers (51003) and nuts (51007) and screw tight on support.

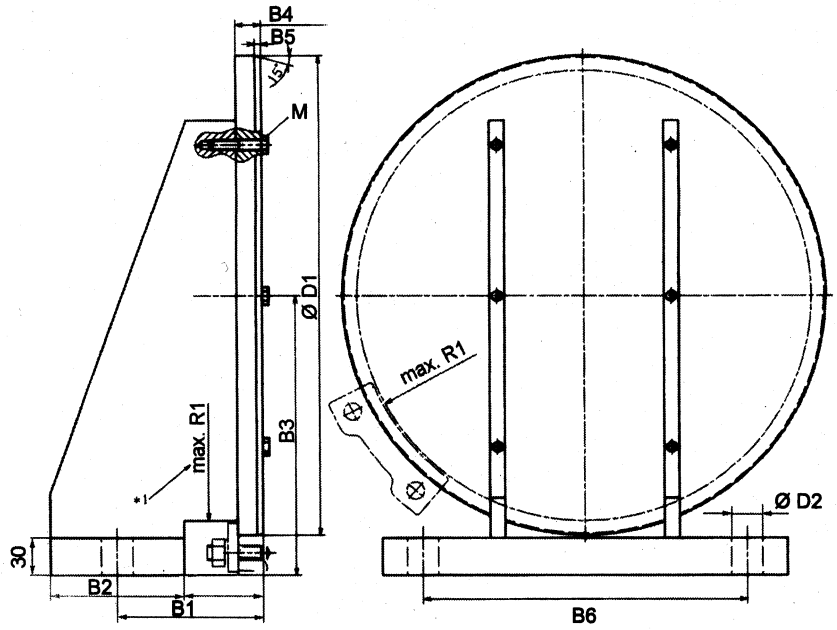
NOTE

Clean securing straps (51002) thoroughly before assembly. Grease thread of studs (51006) with Antiscuff (or similar high-temperature lubricating paste).

## Cover plate drawing

NOTE

The cover plate (material: general structural steel, in accordance with DIN EN 10025-2) must be produced in-house according to the drawing.




*S_00127*

**Cover plate with strap connection**

| TPS | B1 [mm] | B2 [mm] | B3 [mm] | B4 [mm] | B5 [mm] |
|---|---|---|---|---|---|
| 48 | 65.7 ± 0.5 | 60 | 130 | 11.7 ± 0.2 | 1.5 |
| 52 | 79.6 ± 0.5 | 78 | 155 | 14.2 ± 0.2 | 1.5 |
| 57 | 98.2 ± 0.5 | 100 | 190 | 17.2 ± 0.2 | 2 |
| 61 | 116.8 ± 0.5 | 120 | 226 | 20.5 ± 0.2 | 2.4 |

| TPS | B6 [mm] | ØD1 [mm] | ØD2 [mm] | R1 [mm] | M |
|---|---|---|---|---|---|
| 48 | 150 | 222.7 ± 0.2 | 17 | maximum 150 | M8 |
| 52 | 180 | 265.7 ± 0.2 | 21 | maximum 125 | M8 |
| 57 | 220 | 325.7 ± 0.2 | 21 | maximum 153 | M10 |
| 61 | 260 | 387.7 ± 0.2 | 25 | maximum 182 | M10 |

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# 10 Mothballing the turbocharger

## 10.1 Taking out of operation for up to 12 months

If a turbocharger has to be laid up for up to 12 months, the decision whether the turbocharger needs special protection or not depends mainly on the condition of the lubricating oil before laying up.

If the Total Acid Number (TAN) is lower than 2 mg KOH/g no special measures need to be taken. However, if the neutralisation factor is higher the turbocharger must be dismantled after laying up, cleaned and protective oil must be applied to the naked parts.

If the turbocharger is left mounted on the engine, and the engine oil is replaced by a protective oil which is circulated with a pre-lubrication pump prior to laying up, no measures need to be taken in respect of the turbocharger. The remains of the old engine oil will be washed away and the sensitive bearing parts will be largely protected against corrosion.

If the rotor turns due to a draught from the flue, fit a blind flange between the compressor casing and the charge-air duct.

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# 10.2 Taking out of operation for more than 12 months

If the turbocharger has to be removed from the engine and stored for a prolonged period of time, disassembly and mothballing of the turbocharger must be done by an official ABB Turbo Systems service station.

Ensure that the area where the turbocharger is to be stored is dry with humidity of 40-70% and free of condensation.

NOTE

Check mothballed turbochargers yearly for corrosion.

In the event of rust, clean and renew the corrosion protection.

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# 11 Reserve and spare parts

## 11.1 Ordering spare parts

When making inquiries or ordering spare parts, the following data should be specified:

- Turbocharger type
- HT number
- Description and part number

Our service stations and agents accept orders for spare parts.

▶ If special variants/cases are not addressed in these general instructions, contact an official ABB Turbo Systems Ltd. service station or an ABB agent.

### Spare-parts set

NOTE

Spare-parts set (97070) is required for the work described in this manual. The parts included in the spare-parts set are only available as part of the complete set.

**Spare parts set (97070)**

| Quantity | Description | Part number |
|---|---|---|
| 1 | Socket head screw | 42008 |
| 2 | O-ring gasket | 42012/ 81010/ 82010 |
| 1 | O-ring gasket | 77005 |
| 1[1)] | Gasket | 42013 |
| 1 | Gasket | 52406 |
| 1[1)] | V-Band | 52410 |

[1)] Only TPS with bearing casings with V-band connection

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CAUTION

All spare parts that have been ordered with the turbocharger should be kept complete and serviceable.

▶ Rusty parts should be carefully cleaned and greased.

▶ Dispose of parts that have been exchanged and are no longer usable in a technically and environmentally compatible manner.

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# 11.2 Directory of part numbers



The following part numbers and descriptions must be used in ALL correspondence or orders:

**Turbocharger**

| Part no. | Description |
|---|---|
| 51000 | Turbine casing |
| 51002 | Securing straps |
| 51100 | Gas outlet manifold |
| 52400 | Gas outlet flange |
| 56001 | Nozzle ring |
| 57200 | Rupture protection |
| 57210 | Rupture ring |
| 72000 | Compressor casing |
| 72011 | Socket head screw |
| 72012 | Securing straps |
| 72020 | V-Band |
| 77000 | Wall insert |
| 79000 | Diffuser |
| 81000 | Filter silencer |
| 82000 | Air suction branch, axial |

Cartridge group

| Part no. | Description |
|---|---|
| 21000 | Shaft |
| 21002 | Piston ring |
| 25000 | Compressor wheel |
| 32101 | Plain bearing bush |
| 32103 | Seeger circlip |
| 32105 | Thrust ring |
| 32106 | Thrust bearing |
| 32108 | Piston ring |
| 32109 | Sealing disc |
| 32110 | Compressor-end bearing flange |
| 32111 | Auxiliary bearing |
| 32112 | Turbine-end bearing flange |
| 32113 | Socket head screw |
| 32114 | Socket head screw |
| 32221 | Bearing cap |
| 32222 | O-ring gasket |
| 42001 | Bearing casing |
| 42002 | Socket head screw |
| 42008 | Socket head screws |
| 43001 | Interior wall |

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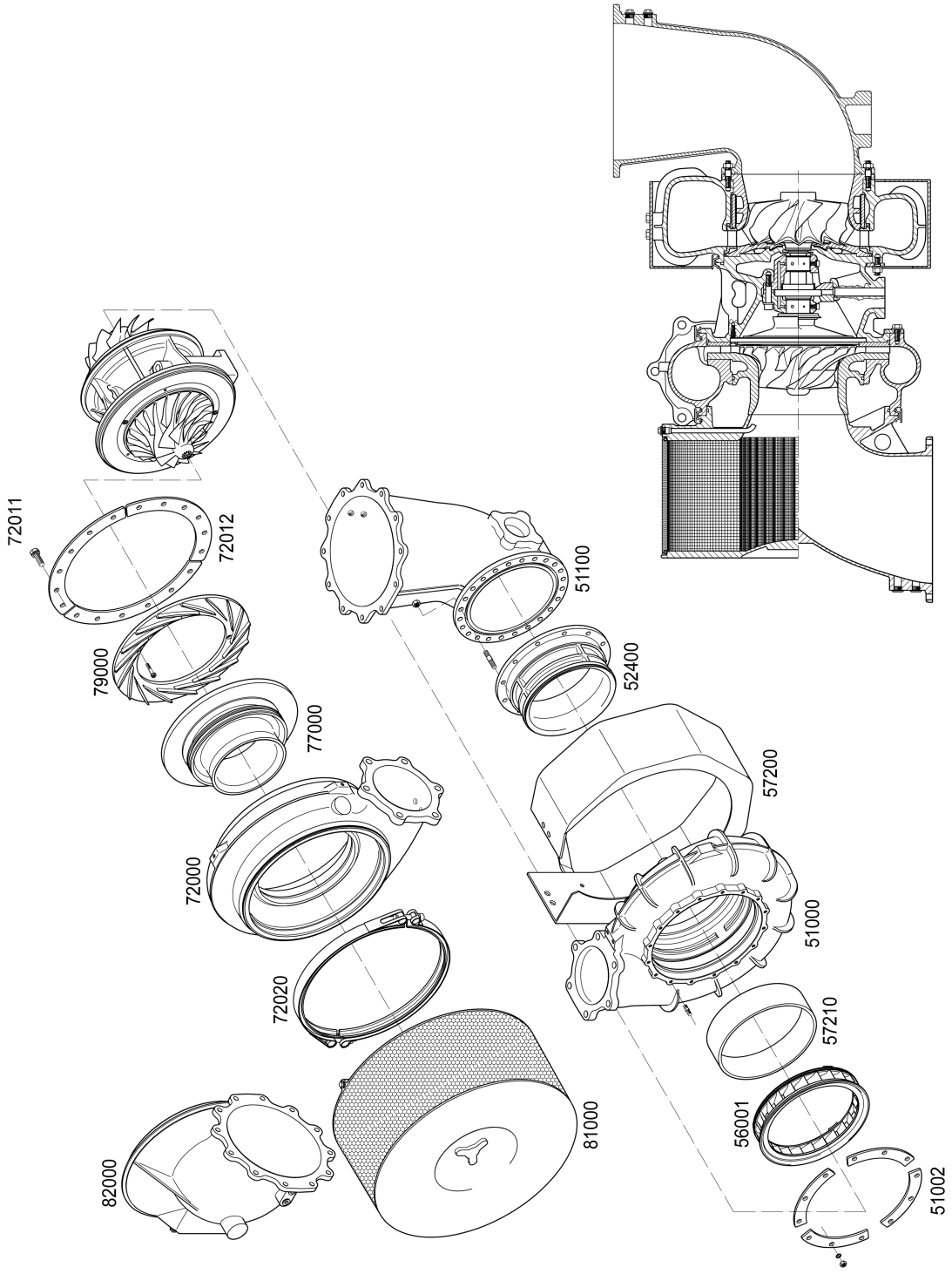
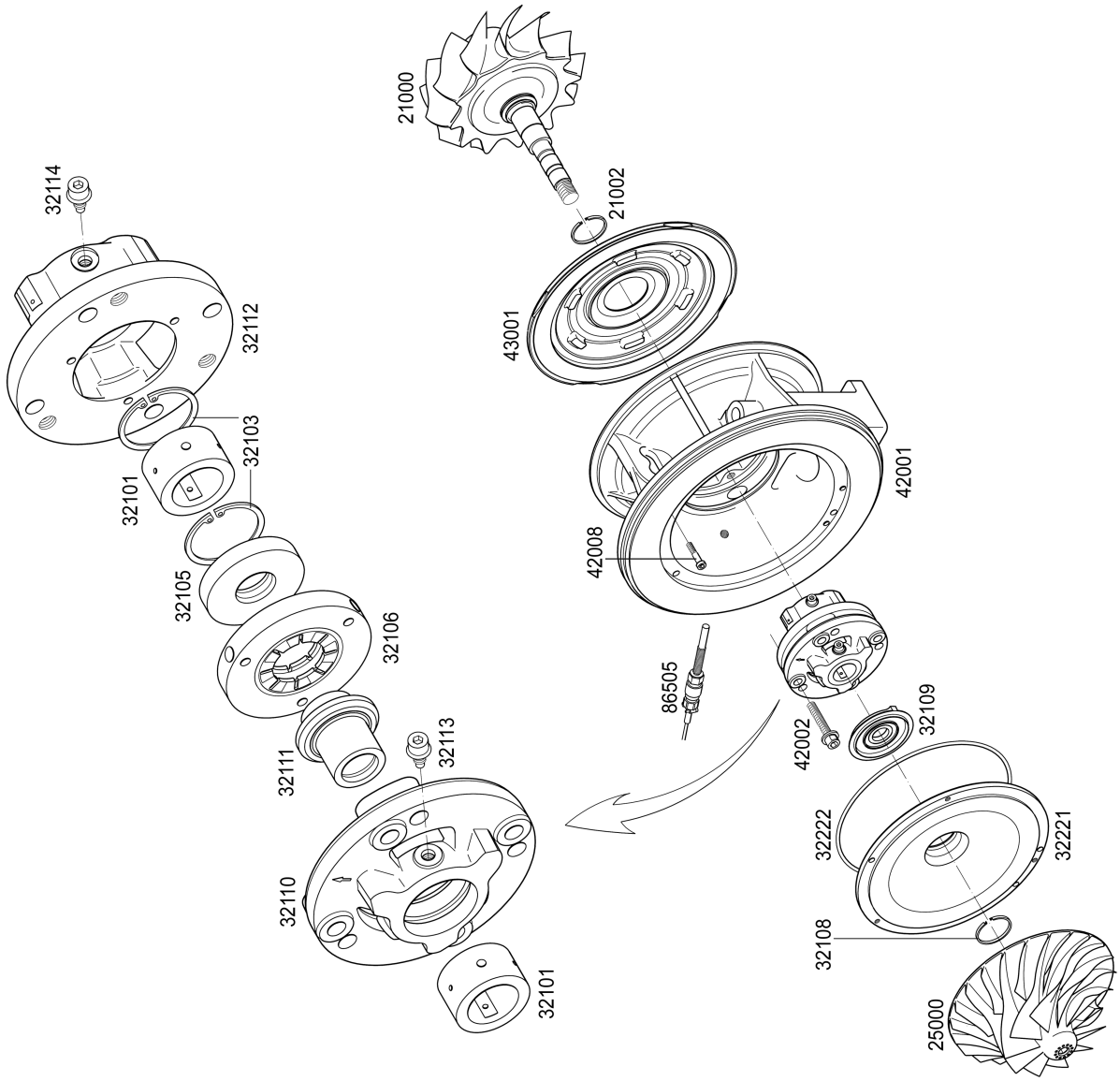
# 11.3 General view of turbocharger






*S_00130*

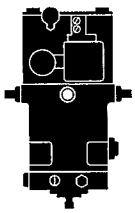
# 11.4 General view of cartridge group




*S_00131*

ABB Turbo Systems AG
Bruggerstrasse 71a
CH-5400 Baden
Switzerland

·ZEXEL·



**Service Manual** - Operation & Maintenance

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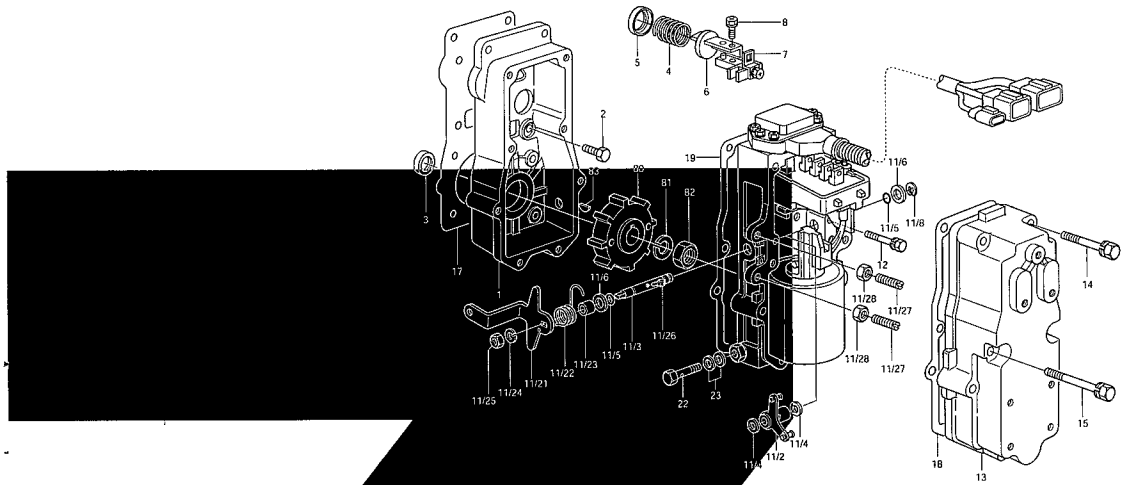
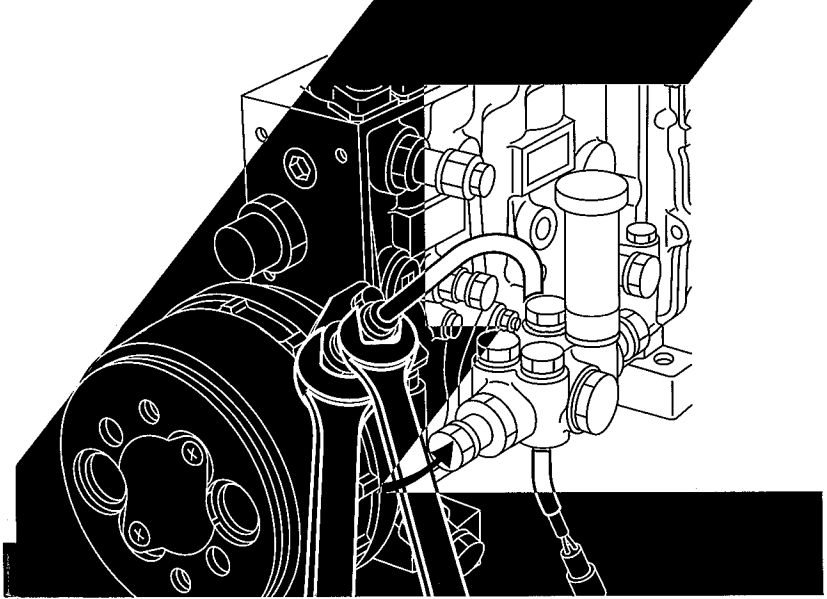
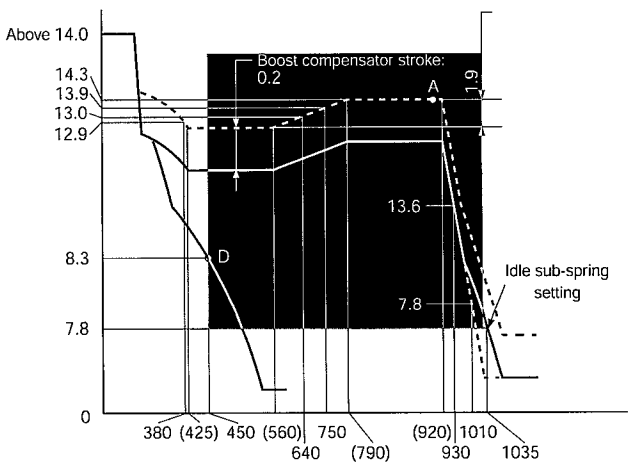
# RHD MODEL GOVERNOR (RHD6 & RHD10)







## WARNINGS

The following definitions and warning signs are used in this service manual.
These are extremely important to safe operation.
Important points are described to prevent bodily injury and property damage.
They must be fully understood before beginning governor maintenance.

**⚠CAUTION** Improper maintenance can result in injury and property damage.

## MEANINGS OF MARKS

The following marks are used in this service manual to facilitate correct governor maintenance.

**Advice** Procedures that must be performed to enable the best possible governor maintenance.

Note Information assisting in the best possible governor maintenance.

# FOREWORD

The RHD hydraulic governor is a high performance variable speed governor for use with main and auxiliary marine engines, engines for electric generators and general power engines.
This service manual describes the construction and operation, repair and maintenance, and adjustment of the RHD6 and RHD10 hydraulic governors.

The contents of the manual, including illustrations, drawings and specifications were the latest available at the time of printing.
The right is reserved to make changes in specifications and procedures at any time without notice.

**Bosch Corporation**
Automotive Aftermarket Division

# CONTENTS

1. The RHD governor has a large controlling force, despite its compact size.
2. As the hydraulic fluid is contained in the governor, piping and sub-tank installation are unnecessary when installing the governor on the engine.
3. As the power piston utilizes a differential system, the operating force is uniform. Moreover, it is not necessary to install a return spring in the fuel control linkage. When play in the linkage system is excessive, however, it is necessary to install a spring at the end of the system to absorb this play.
4. The governor is able to rotate in either direction, and therefore it can be used without modification on engines which rotate in the reverse direction.
5. Because the normal operating speed is low, governor endurance is high, and gearing is simple when installing the governor on low and intermediate speed engines.
6. The governor has a speed droop mechanism and a compensator mechanism, enabling it to be easily and freely adjusted.
   The adjustment range is very wide, enabling governor use on a wide range of engines. The governor can also be used as an isochronous governor with 0% speed droop.
7. The governor body's high tensile aluminum alloy casting makes it extremely lightweight.
8. The governor can be equipped with a governor motor, a pneumatic controller and a hydraulic controller.
9. RHD6 and RHD10 governors are interchangeable. For example, if a higher pressure injection system is required or if the governor's control force is insufficient to cope with the demand for increased engine output, decreased fuel consumption or the use of lower quality fuel oil, then the RHD10 can replace the RHD6.
10. The governor is equipped with a standardized piping connection to enable the installation of an auxiliary starting booster.
11. Of the RHD10 governor's main components, 80% are identical to those of the RHD6. Almost 100% of the remote control device's components are identical to those of the RHD6.

## 2 SPECIFCATIONS

| | RHD6 | RHD10 |
|---|---|---|
| **Control force** | 5.9 J {0.6 kgf·m} | 9.8 J {1.0 kgf·m} |
| **Output shaft torque** | 9.8 N·m {1.0 kgf·m} | 15 N·m {1.5 kgf·m} |
| **Output shaft operation angle** | 35° | 40° |
| **Power piston diameter** | Small: ϕ17.7; Large: ϕ25 | Small: ϕ18.6; Large: ϕ27 |
| **Controlled speed range** | Standard rating: 600 ~ 2,000 r/min<br>(Normal: 1,700 ~ 2,000 r/min)<br>High speed rating: 800 ~ 2,400 r/min<br>(Normal: 1,900 ~ 2,400 r/min) | |
| **Maximum allowable speed** | 2,500 r/min | |
| **Compensator** | Needle valve type | |
| **Speed droop adjustment range** | 0 ~ approx 10% (rated) | |
| **Direction of rotation** | Clockwise & counterclockwise | |
| **Hydraulic fluid** | SAE20W~40 (Mobiloil) | |
| **Dry weight (lever type)** | 5.5 kg | 5.7 kg |
| **Governor drive power** | Max approx 0.2 kW {0.3ps} | |
| **Applicable engines** | Low speed: up to approx 1,500 kW {2,000 ps}<br>Intermediate speed: up to approx 1,850 kW {2,500 ps}<br>High speed: up to approx 2,200 kW {3,000 ps} | Low speed: up to approx 2,200 kW {3,000 ps}<br>-<br><br>High speed: up to approx 2,950 kW {4,000 ps} |
| **Applicable injection pumps** | PE (all types)<br>PF1Z x 18 cyl<br>PF1C, -1CD x 16 (18) cyl<br>PF1W x 12 (16) cyl<br>PF1GD x 8 cyl<br>PF1DD x 6 cyl | PE (all types)<br>PF1CX x 18 cyl<br>PF1WX x 16 cyl<br>PF1GX x 12 cyl<br>PF1DX x 8 cyl<br>PF1EX x 6 cyl |

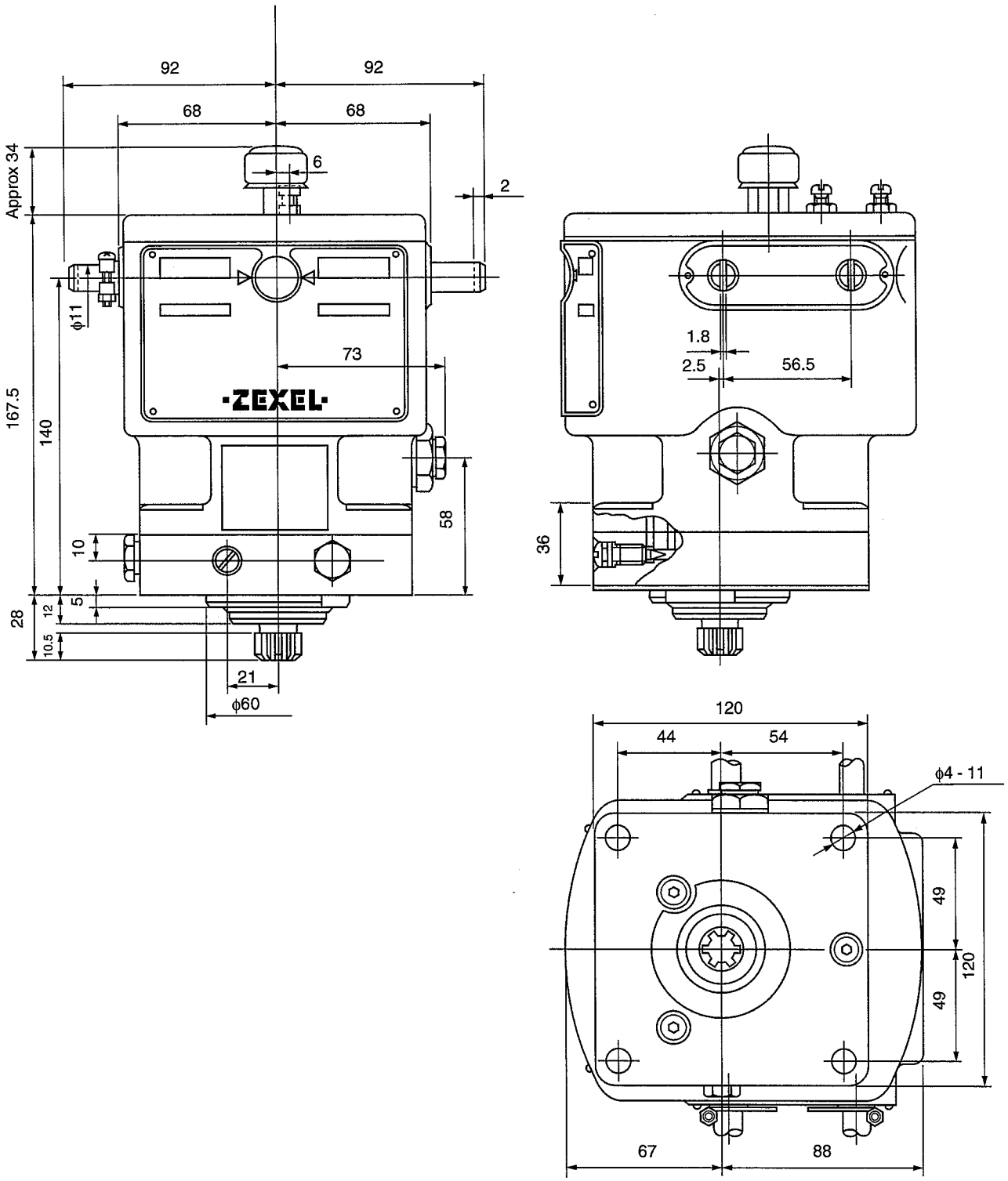
The main difference between the RHD6 and the RHD10 is the power piston. The parts adjacent to the power piston also differ.

Note:

1. The method of connecting fuel linkages and the amount of corresponding resistance differ depending on the size of the applicable engine and the size and number of the injection pumps.
   Consequently, engines with little friction loss can be used in high output engine applications and, conversely, engines with large friction loss can only be used in applications equal to or less than those specified above.
2. Simply because the governor has surplus control force does not necessarily mean that stable operation can be ensured.
   In order to ensure stable operation and to prevent the speed from exceeding the necessary speed, the inertia of the engine and the drive system should be as large as possible.

The figure below shows the RHD6 hydraulic governor (lever type). The RHD10 has a special plug (piping connection) for auxiliary starting booster installation located below the center of the name plate.

Lever type

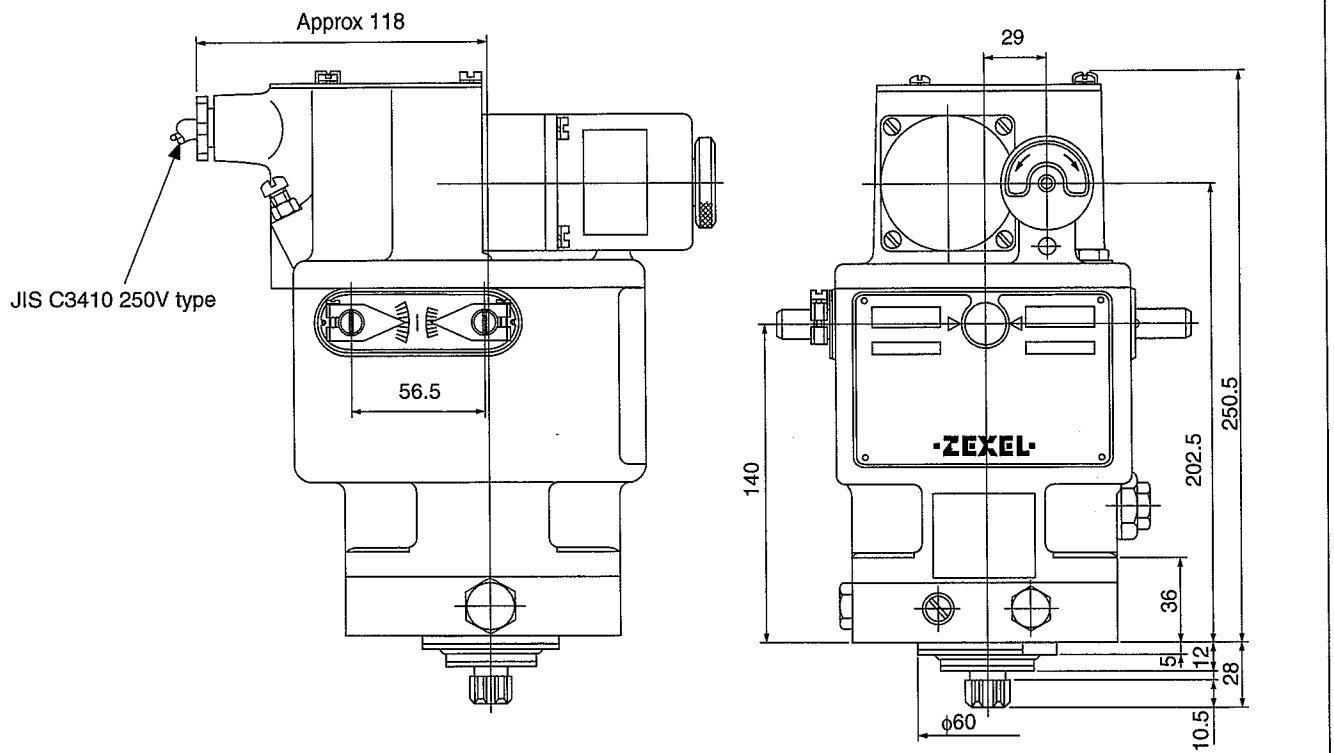



P-RHDR- 001

# 2 SPECIFCATIONS

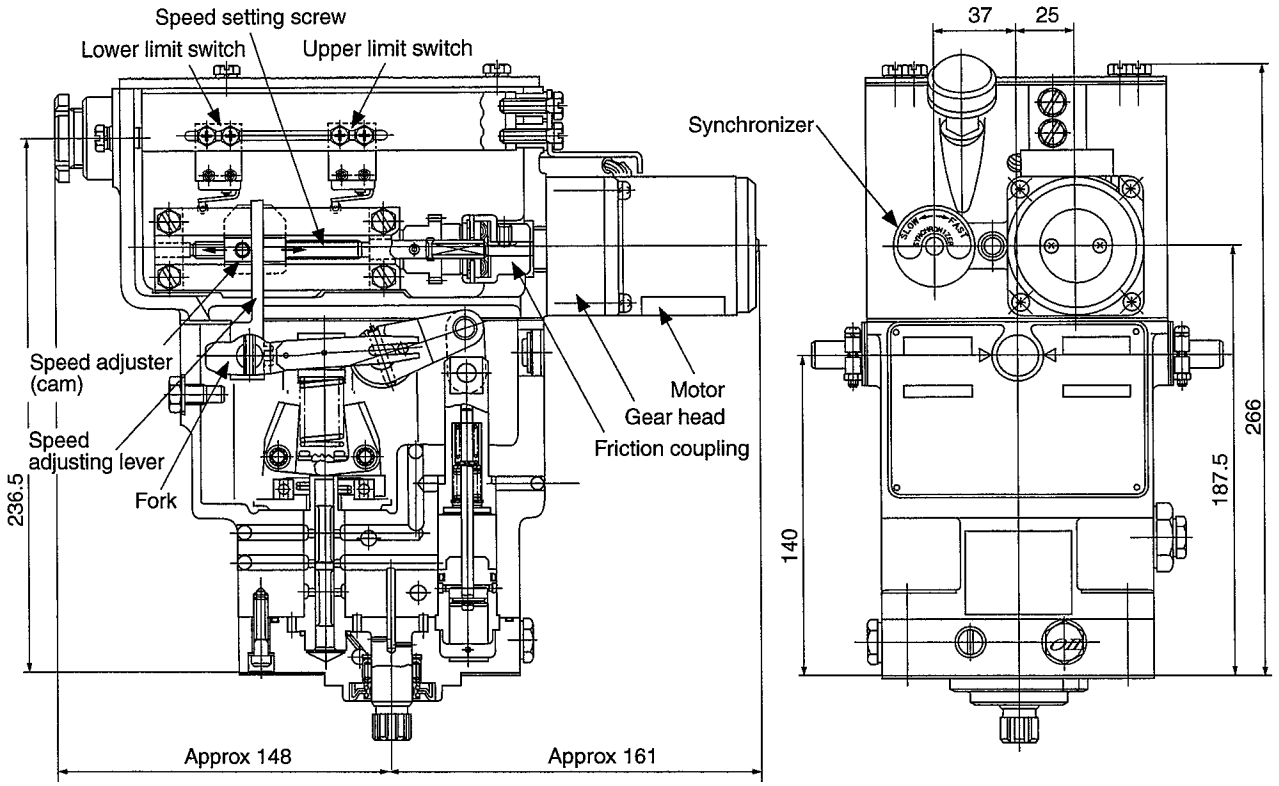
## RHD6 and RHD10-MC, -MCL type governor motors

MC type with governor motor



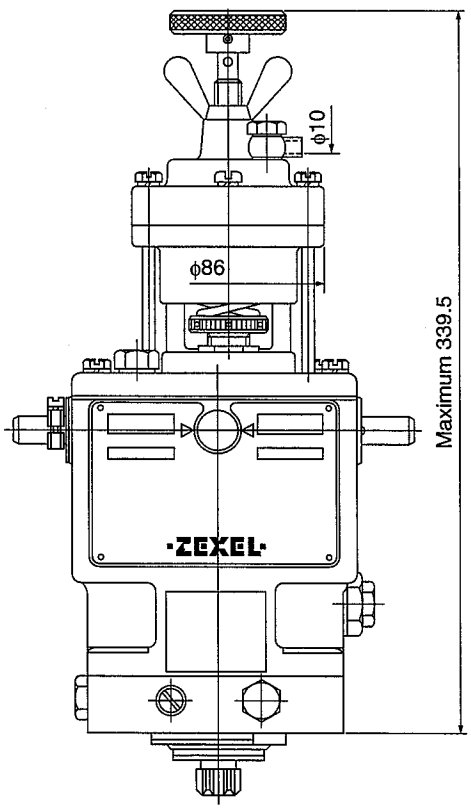

| | Voltage | Cycle | Speed | Current consumption | Output |
|---|---|---|---|---|---|
| **Motor** | AC100V | 50/60 Hz | 1,200/1,450 r/min | 20 W | 4 W |
| | AC220V | 50/60 Hz | 1,200/1,450 r/min | 20 W | 4 W |
| | DC24V | - | 2,200 r/min | 20 W | 3 W |
| | DC100V | - | 2,200 r/min | 20 W | 3 W |
| **Gear head (speed reduction ratio)** | 1/18, 1/30, 1/50, 1/75, 1/100, 1/150, 1/300, 1/375, 1/450, 1/600, 1/900, 1/1500 | | | | |
| **Speed setting time** | The speed setting time can be determined freely by choosing from any of the above gear heads.<br>The standard specified time, however, is approximately that shown below.<br>Main engines: 20 ~ 25 sec dead slow to rated speed<br>Engines for generators: 7 ~ 9 sec/1 Hz | | | | |
| **Limit switch adjustment range (RHD6, 10 -MCL)** | Standard specification<br>Lower limit: 600 r/min<br>Upper limit: 2,000 r/min<br>Prior to shipment, the lower limit is set at 600 r/min, and the upper at 1,600 r/min.<br>High speed specification<br>Lower limit: 800 r/min<br>Upper limit: 2,400 r/min<br>Prior to shipment, the lower limit is set at 800 r/min, and the upper at 2,000 r/min. | | | | |

MCL type with governor motor

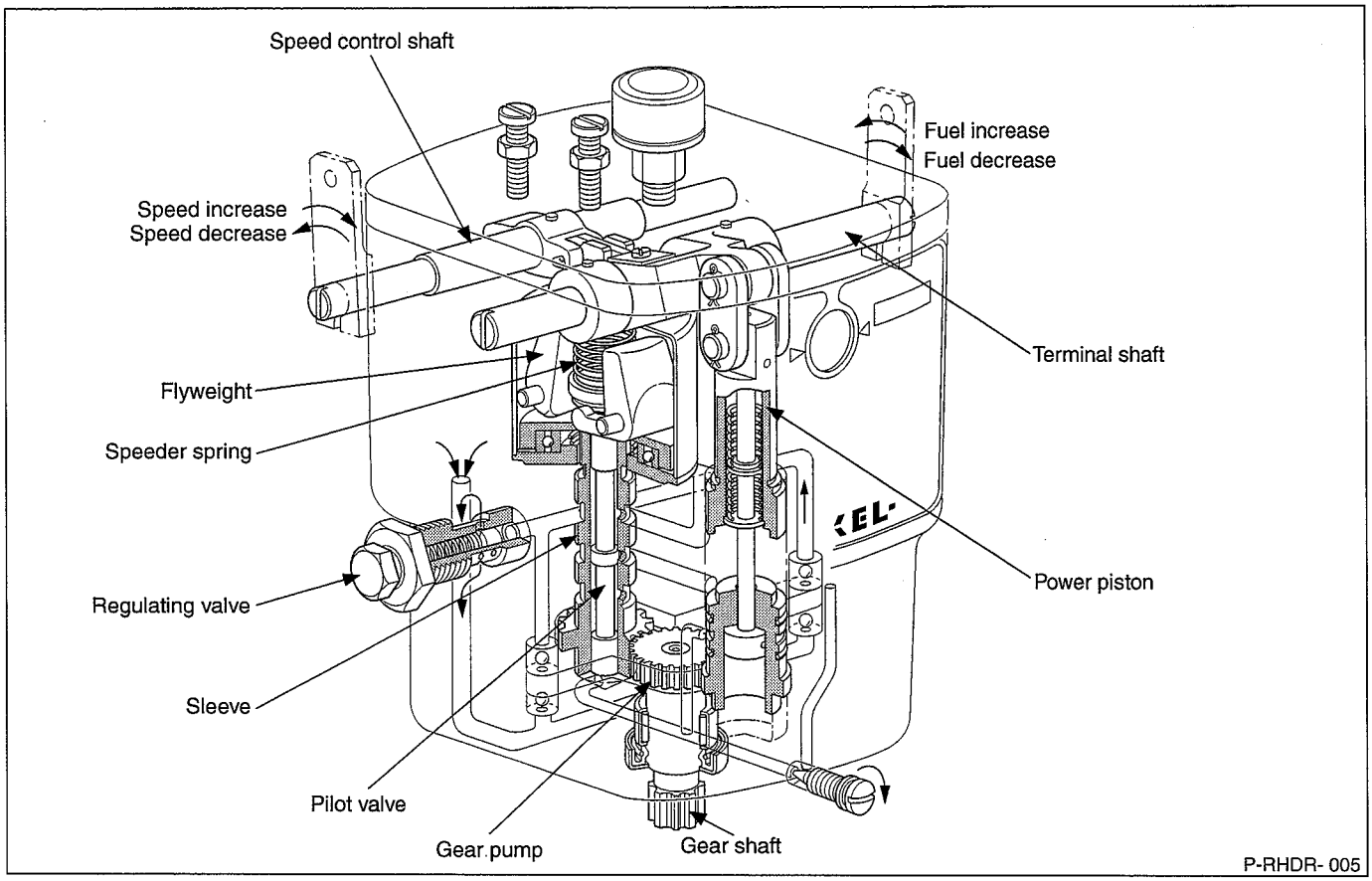



P-RHDR- 003

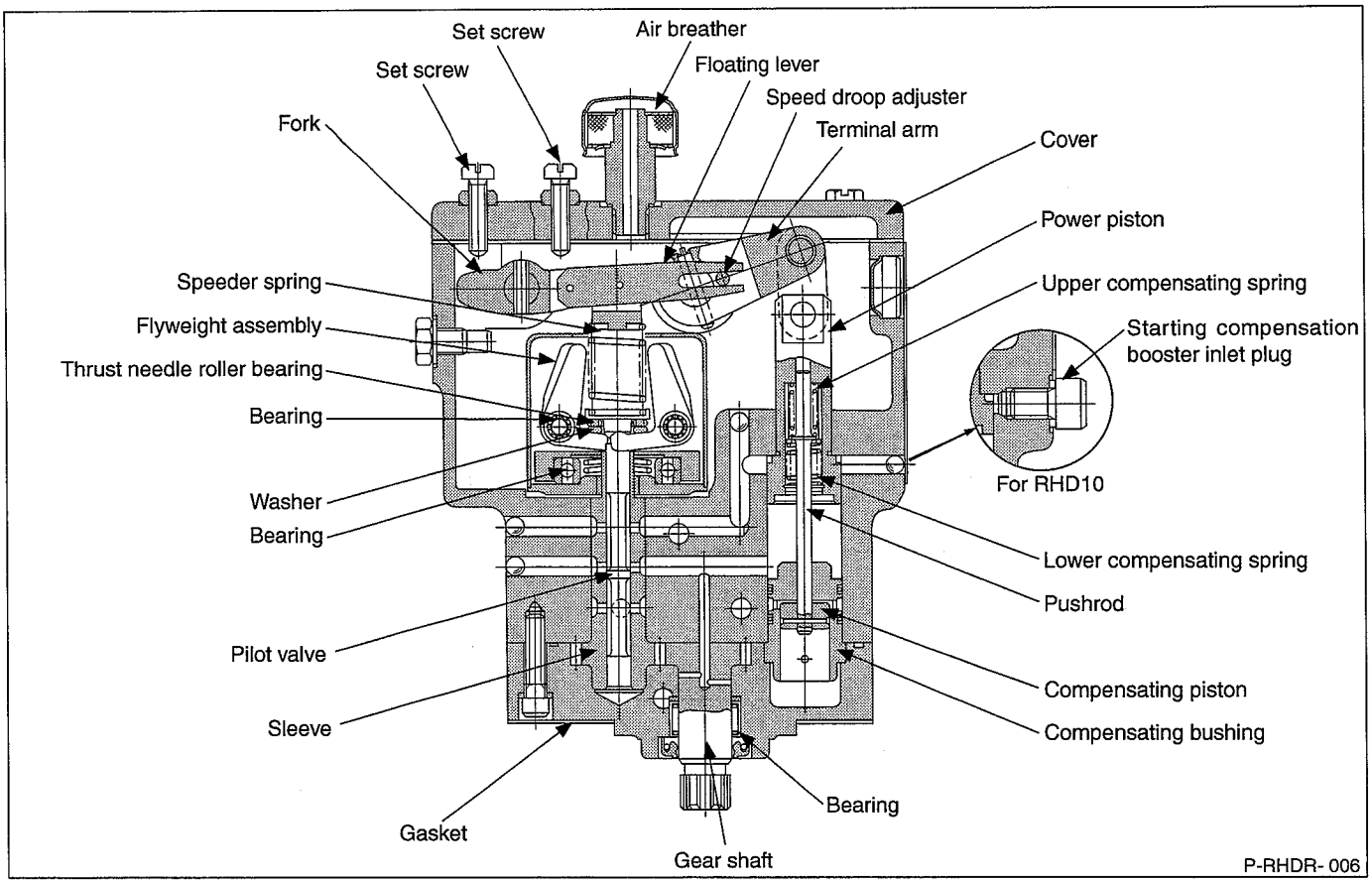
## Pneumatic controller dimensions




P-RHDR- 004




The above figure shows a cutaway view of the RHD6 hydraulic governor.
The governor is installed directly on the engine.
Engine crankshaft speed is increased using a suitable gear ratio, and is then transmitted to the governor gear shaft. This rotation is transmitted to the hydraulic governor's gear pump, which pressurizes the hydraulic fluid.
The gear pump pumps hydraulic fluid from the governor's hydraulic fluid tank in through the low pressure side of the regulating valve, and delivers the high pressure hydraulic fluid to the pilot valve. The regulating valve also regulates the pressure of the fluid pressurized by the gear pump (RHD6: 1.18 MPa {12 kfg/cm$^2$}, RHD10: 1.47 MPa {15 kgf/cm$^2$}) and returns excess fluid to the gear pump's intake side.
The gear pump has four check valves so that governor performance does not vary, even when the governor rotates in the reverse direction. The gear pump's driven gear and the sleeve are unified. One end of the sleeve is connected to the governor flyweight. The pilot valve inside the sleeve is moved up and down in response to the flyweight's centrifugal force to control the flow of hydraulic fluid to the power piston, reacting promptly to variations in engine load to rotate the terminal shaft.




The flyweight's centrifugal force is transmitted to the pilot valve by the thrust needle roller bearing. The speeder spring's force is always acting against the flyweight's centrifugal force. The set force of the speeder spring can be changed by moving the control lever.

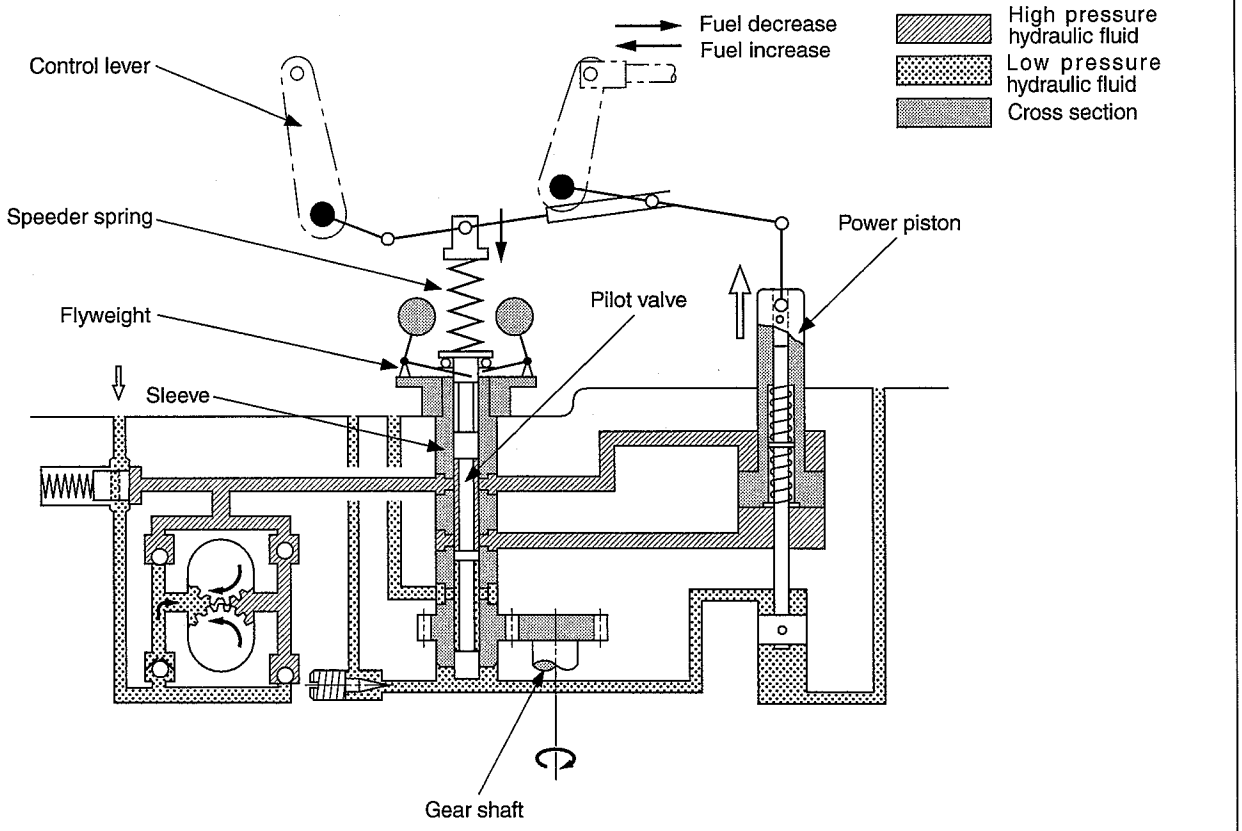
The flyweight assembly is an oil damper type assembly. When sleeve rotation is transmitted to the flyweight, the oil acts to absorb unnecessary high frequency rotation fluctuations and enable stable output.

The power piston, which controls the fuel injection quantity to the engine, is a simple mechanism which enables high stabilized output.

The power piston is operated by the hydraulic fluid to move in both the fuel increase and fuel decrease directions. The power piston rotates the terminal shaft via the guide lever and the terminal arm to directly control fuel injection quantity.

In addition to having a larger diameter power piston, the RHD10 is equipped with a piping connection to enable the connection of an auxiliary starting booster to the top of the power piston.

## ENGINE STARTING



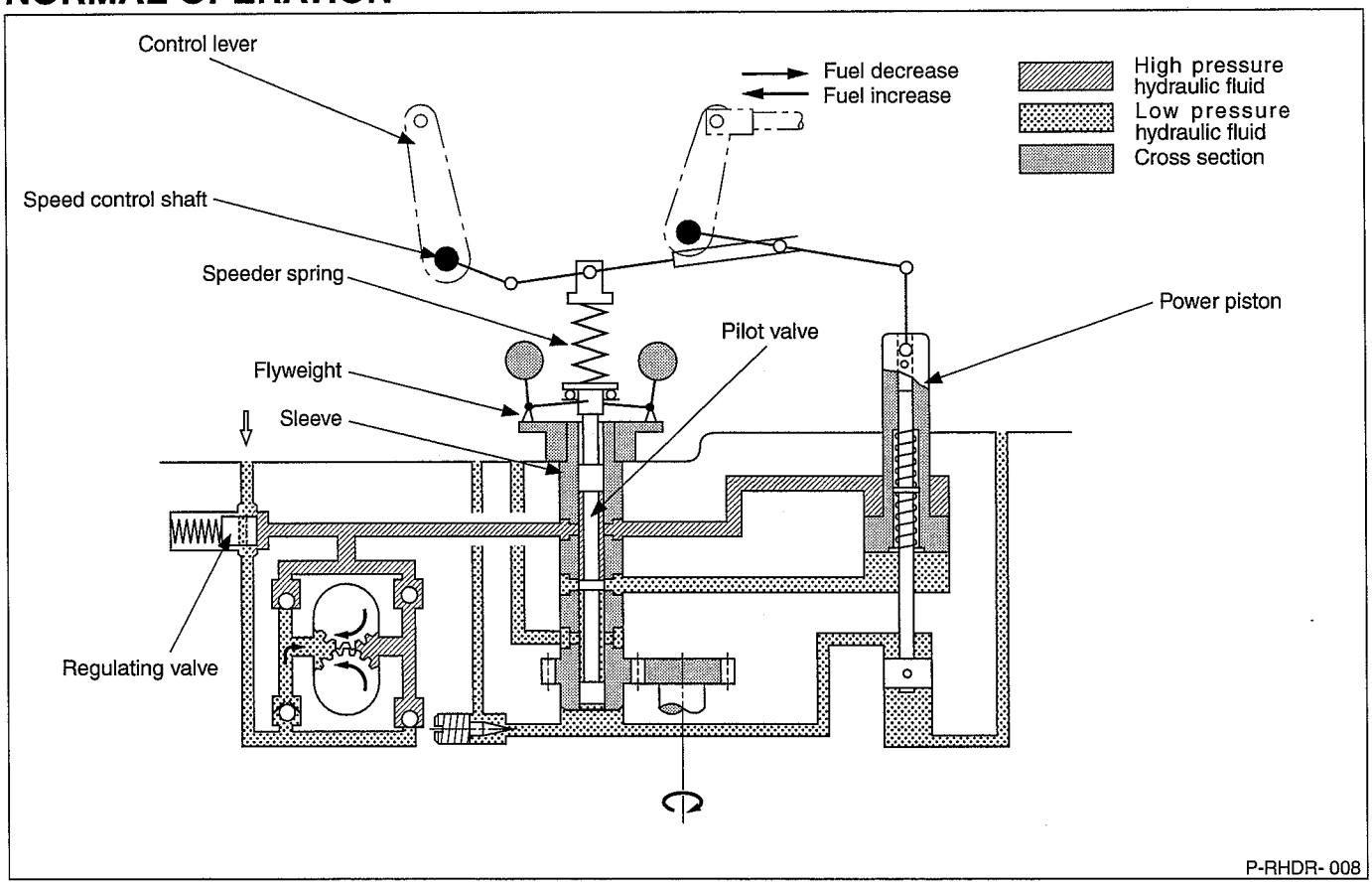

When the engine is stopped, the flyweight is pushed down and closed by the force of the speeder spring. Consequently, the pilot valve is in its lowermost position.

When the control lever is then moved in the fuel increase direction, the engine is rotated by compressed air, etc, the gear pump is operated through the gear shaft and the hydraulic fluid is pressurized.

Because the flyweight is pushed down by the speeder spring and the pilot valve does not move, the pressurized hydraulic fluid passage and the passage to the power piston are open, and the hydraulic fluid pressurized by the gear pump is delivered through the pilot valve to the top and bottom of the power piston.

Because the ratio of the areas of the power piston subject to hydraulic pressure is 1:2, the power piston is immediately moved up (in the fuel increase direction) to move the output shaft side lever in the fuel increase direction through the system of links and facilitate engine starting.

## NORMAL OPERATION

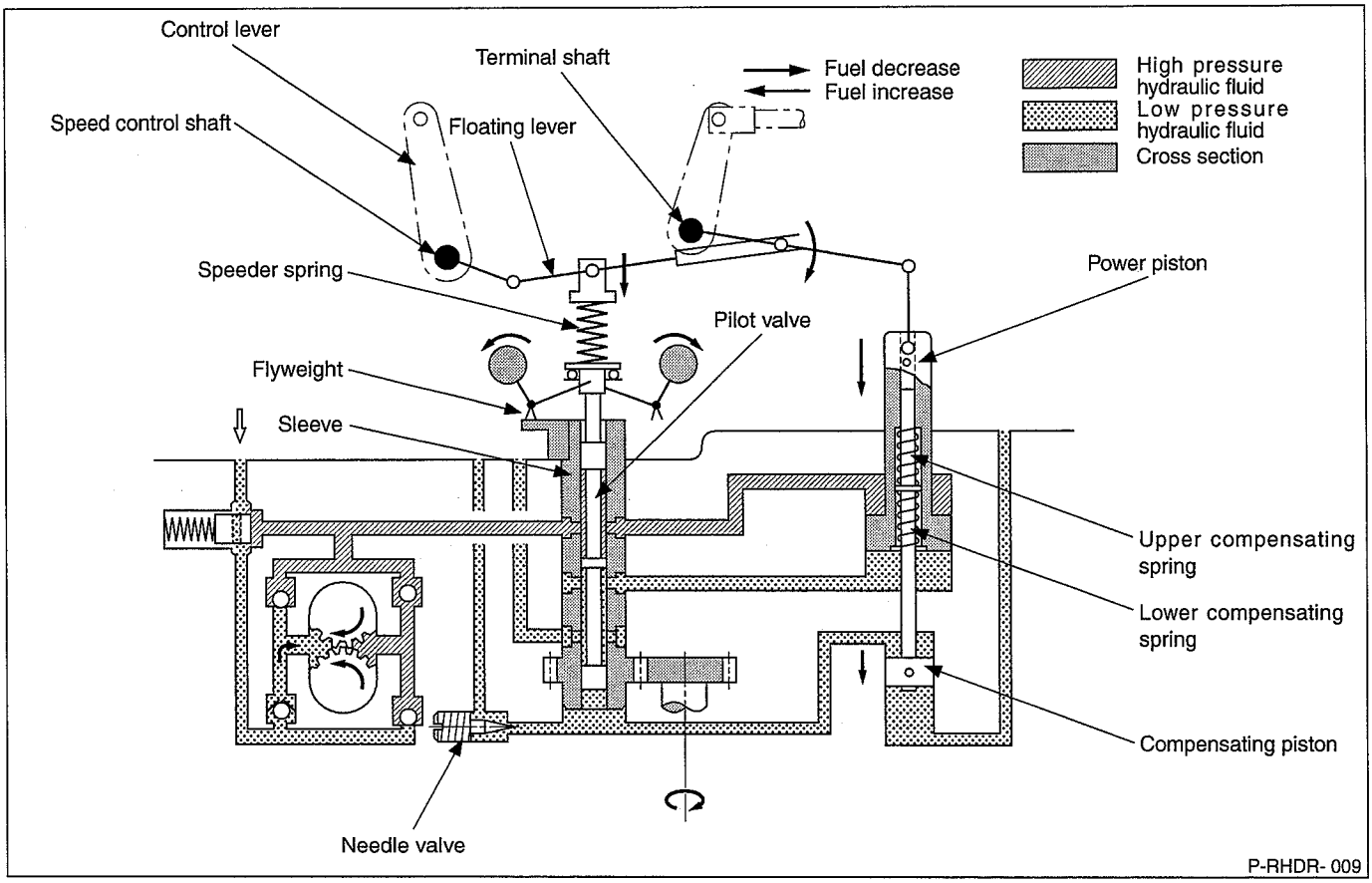



When the control lever is moved in the speed increase direction, the speeder spring is compressed by the speed control shaft. When the speeder spring force exceeds the flyweight' s centrifugal force, the pilot valve is moved down. Because of this, the high pressure hydraulic fluid passage and the top and bottom power piston passages open, and the high pressure hydraulic fluid pressure moves the power piston in the fuel increase direction to increase engine speed. As the engine speed increases, the flyweight's centrifugal force increases and the pilot valve is pulled up.

At the position where the speeder spring force and the flyweight's centrifugal force balance, the high pressure hydraulic fluid passage and the bottom power piston passage are closed by the pilot valve land. Because of this, the power piston maintains this position and a constant stable speed is maintained.

At this time, excess hydraulic fluid overflows through the regulating valve and is returned to the gear pump's intake side to maintain a stable hydraulic fluid pressure to the pilot valve.

## LOAD DECREASE




When engine load decreases, and governor rotation has increased, the flyweight's centrifugal force increases and moves the pilot valve up. This opens the center pilot port so that the hydraulic fluid in the bottom of the power piston returns to the governor's hydraulic fluid tank. Consequently, the power piston is moved down (in the fuel decrease direction) by the high pressure hydraulic fluid in the top of the cylinder and the speed is decreased to the previous balanced condition.

When the power piston moves down, it compresses the speeder spring through the speed droop mechanism's floating lever, the pilot valve moves down, and the land moves to a position where it closes the pilot port.

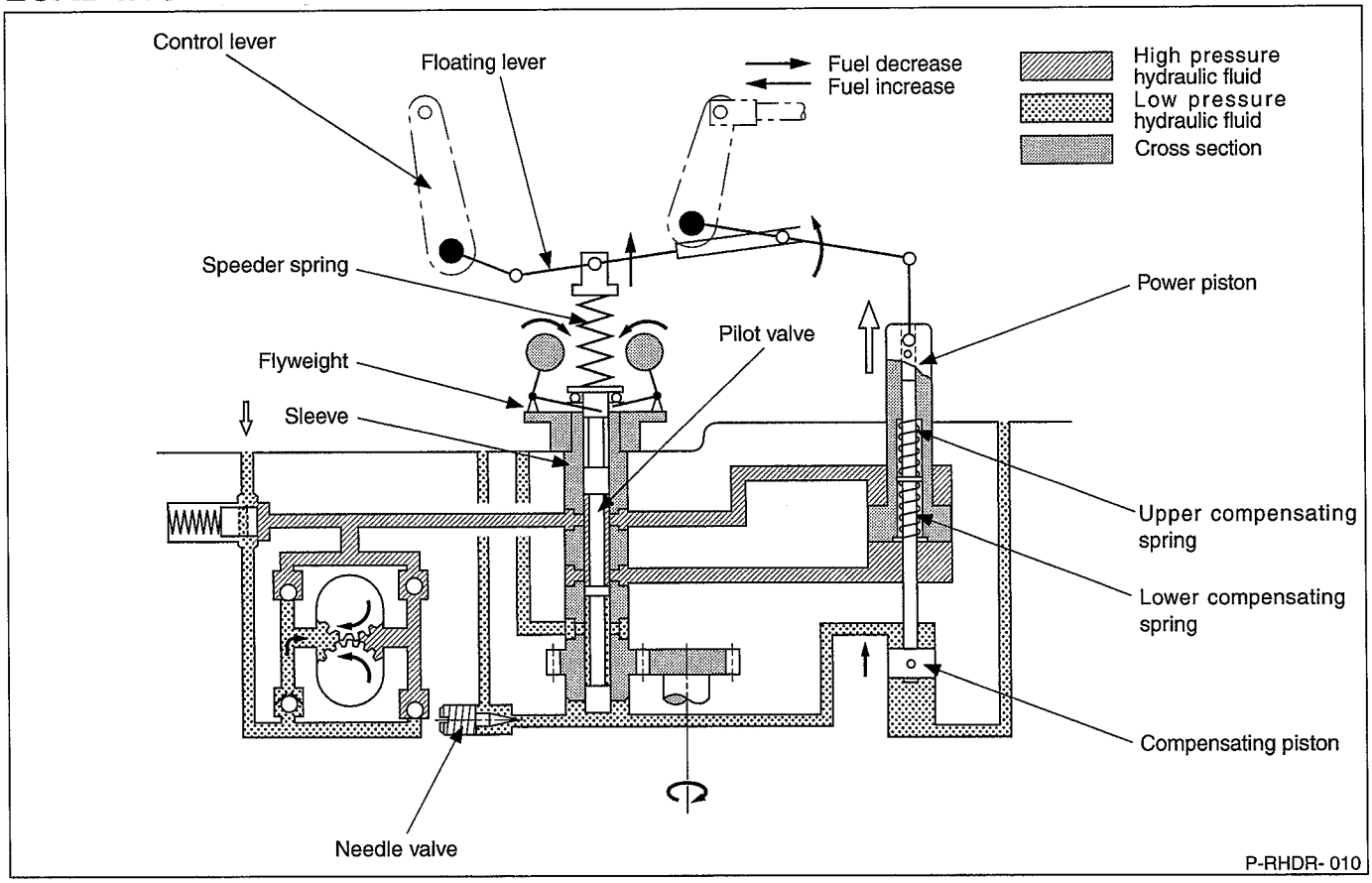
When the power piston moves down, its downward movement is also transmitted to the compensating pushrod and piston through the compensating spring in the power piston.

Because of this, the negative pressure generated in the compensator chamber relieves the upward movement of the pilot valve, momentarily applying a force in the downward direction.

The compensating effect ends when hydraulic fluid from the governor chamber flows in through the needle valve for a fixed period to restore the negative pressure in the compensator chamber to atmospheric pressure.

Consequently, when the pilot port is closed by the speed droop mechanism and the compensator mechanism, the power piston and the terminal shaft stop at a new position where the fuel necessary to operate the engine at normal no-load speed is supplied when the engine load is cut.

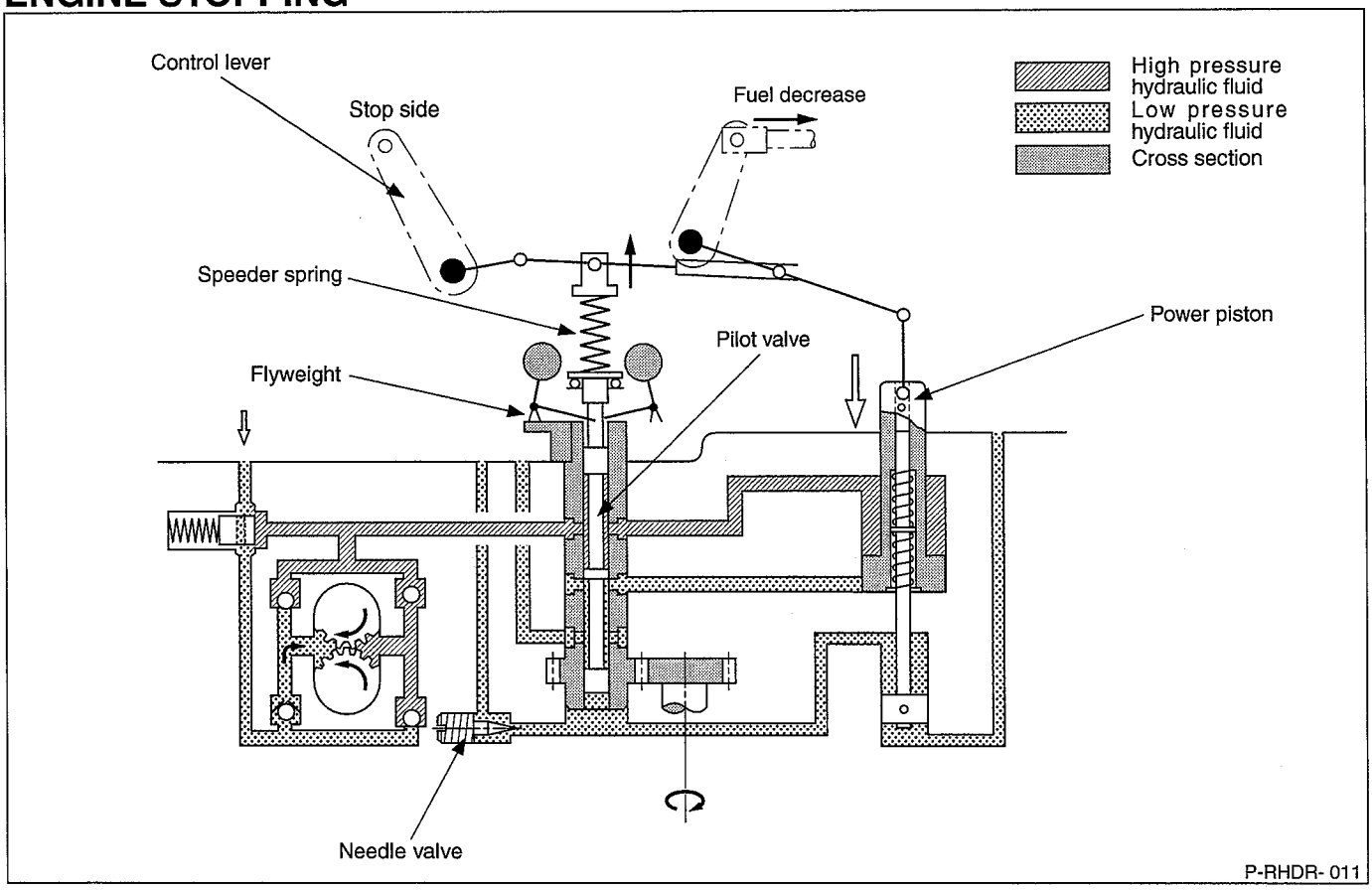
## LOAD INCREASE



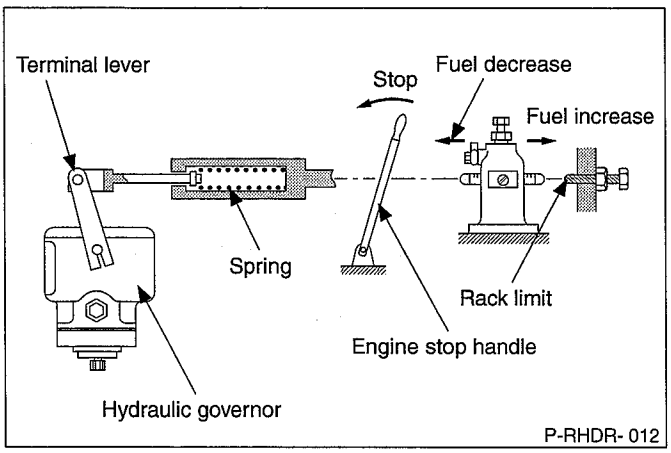

When the engine load increases, engine speed decreases and the governor's operation is exactly opposite to that at load decrease.
Thus, the pilot valve moves down, high pressure hydraulic fluid flows into the chamber below the power piston, and the power piston moves upward in the fuel increase direction to increase the engine speed and return it to the previous balanced condition.
When the power piston moves up, the speeder spring is moved upward by the speed droop mechanism through the floating lever. Consequently, the pilot valve also moves upward until the pilot valve land closes the pilot port.

As the power piston moves up, the compensating piston is drawn up by the lower compensating spring, and the compensator chamber pressure becomes positive.
Because of this, the speed at which the pilot valve moves down is relieved as this pressure is applied in an upward direction.
The compensating effect ends when the hydraulic fluid flows from the governor chamber in through the needle valve for a fixed period to restore the pressure in the compensator chamber to atmospheric pressure.
In this way, the pilot valve returns to its regular position and the engine is maintained at the new power piston position.

## ENGINE STOPPING




Because the governor's power piston is moved in the fuel decrease direction by the high pressure hydraulic fluid above the power piston, when the control lever is moved to the stop side the pilot valve is moved up by the speeder spring.



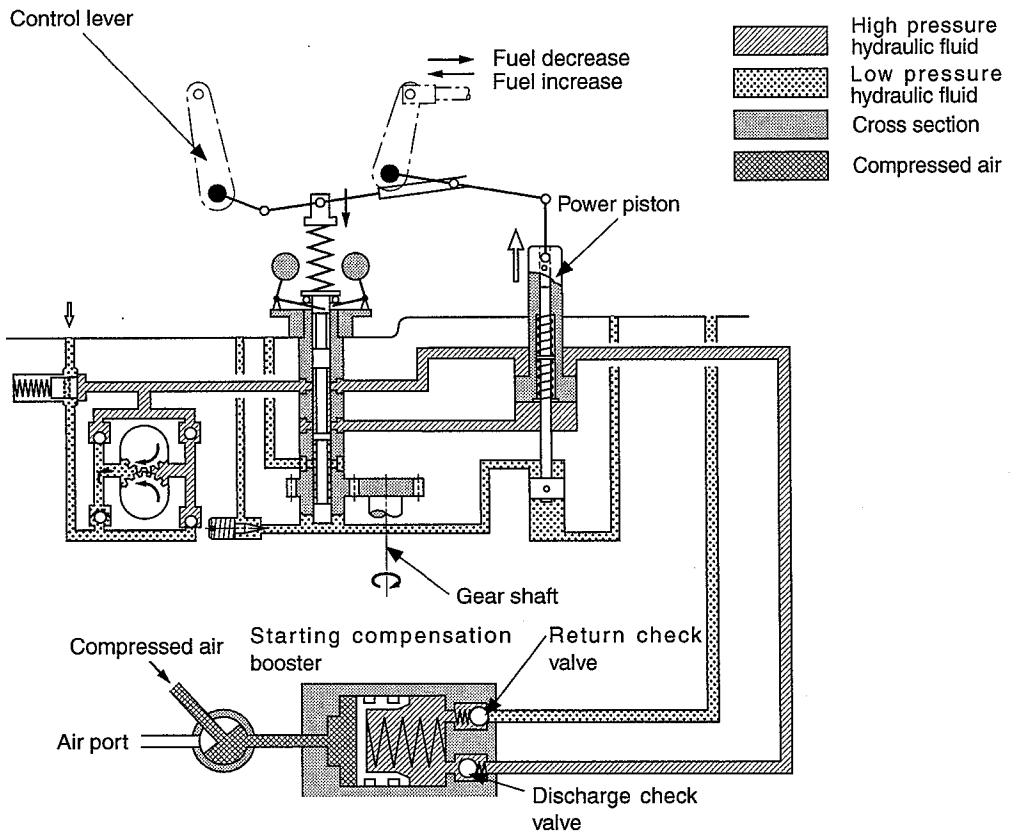

The high pressure hydraulic fluid in the bottom of the power piston is then returned to the governor's hydraulic fluid tank, the power piston moves down (in the fuel decrease direction) and the engine can be forcibly stopped.

The engine can also be stopped by remote control by a governor motor or pneumatic controller. These remote control devices are also installed with a synchronizer to enable manual engine stopping.

When the engine is not stopped on the governor side as described above, but is instead stopped by a handle which mechanically sets the control rack to the non-injection position, it is necessary to install a spring in the link system to prevent excessive force being applied to the governor.

As this governor does not have a load limit device, it is also necessary to install a spring as above when it is necessary to mechanically limit the load.

## AUXILIARY STARTING BOOSTER




An auxiliary starting booster can be connected to the RHD10 governor when necessary. The following explains engine operation at starting when a booster has been connected to the governor.

When compressed air is supplied to the booster piston to facilitate starting, the piston compresses the spring and the hydraulic fluid in the chamber opposite the compressed air is guided through the discharge side check valve to the chamber above the power piston.

As the governor at this time is in the engine starting status, as explained previously, the hydraulic fluid also flows through the pilot valve to the chamber below the power piston.

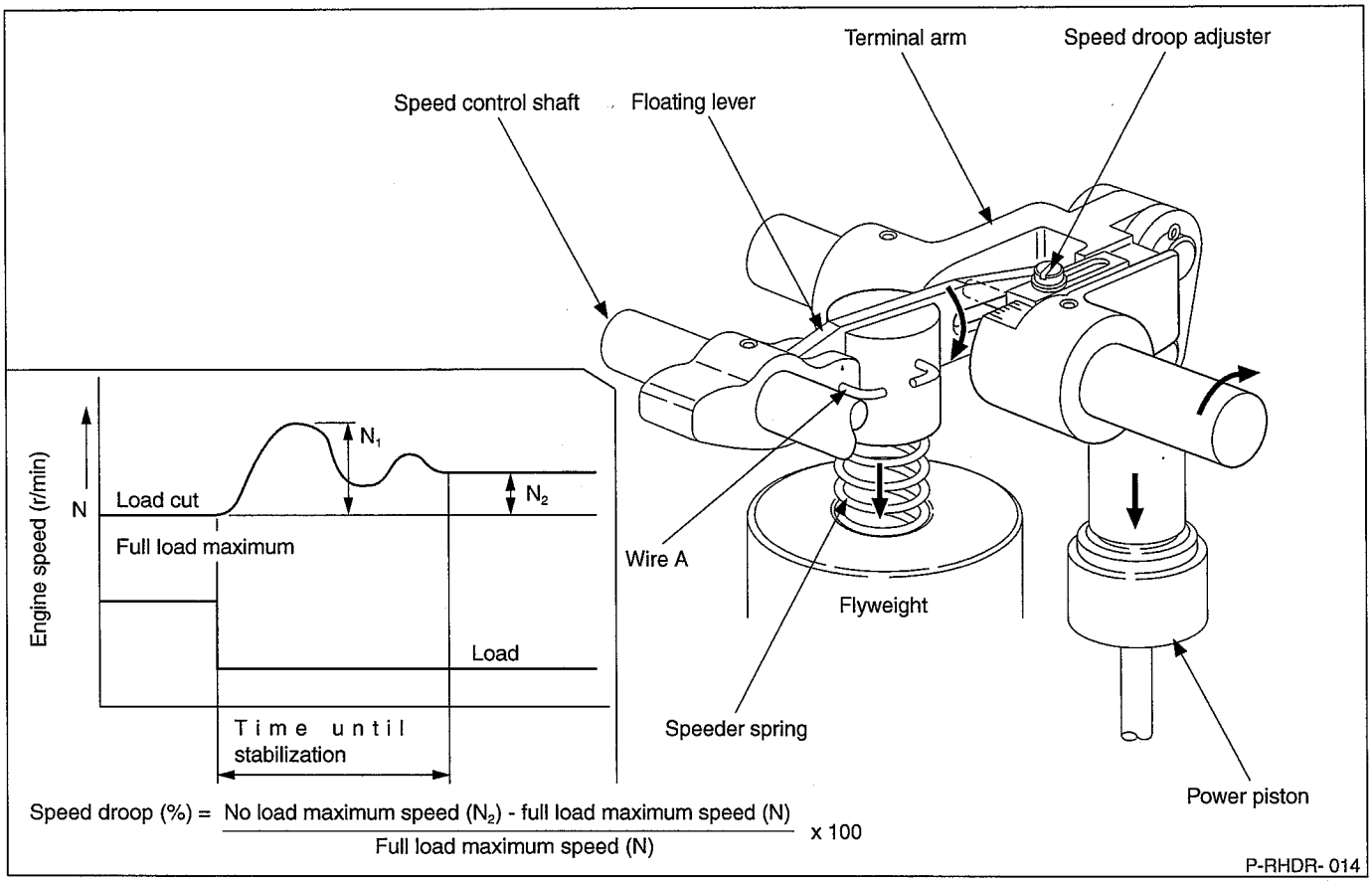
As the governor is simultaneously being turned, high pressure hydraulic fluid from the gear pump is also acting on the top and bottom chambers of the power piston.

Consequently, hydraulic fluid pressurized by the booster moves the power piston in the fuel increase direction faster than normal, and it arrives at the fuel position necessary for starting faster than normal.

The booster is an effective means of assisting starting for engines such as those for emergency power generators, where mis-starting must be avoided, and high output engines where the governor's surplus output is small.

Boosters are manufactured especially for the RHD6 and RHD10 governors.

## SPEED DROOP MECHANISM




With the speed droop mechanism, speed droop can be varied freely from 0% ~ 10% by adjusting the speed droop adjuster.
When the speed control shaft position is fixed using the control lever, and the engine speed is maintained at a speed suitable for a fixed load, should the load decrease, the power piston is moved in the fuel decrease direction (ie, down) to prevent an excessive speed increase.
With this power piston movement, the speed droop adjuster attached to the terminal arm turns and pivots the floating lever in a clockwise direction around the wire A to compress the speeder spring and apply a new set load.
Because the speeder spring's set load is increased, the pilot valve is again moved down to a position where it closes the pilot port, the flyweight's centrifugal force and the speeder spring are balanced at an engine speed a little higher than the initial balanced condition, and this engine speed is maintained.

Conversely, when the load increases, power piston movement in the fuel increase direction extends the speeder spring so that the engine speed is maintained at a speed a little lower than that when the engine speed was originally balanced.
Consequently, by adjusting the speed droop adjuster scale, the link lever ratio is changed and, as the speeder spring's set force can be changed, speed droop can be set freely.

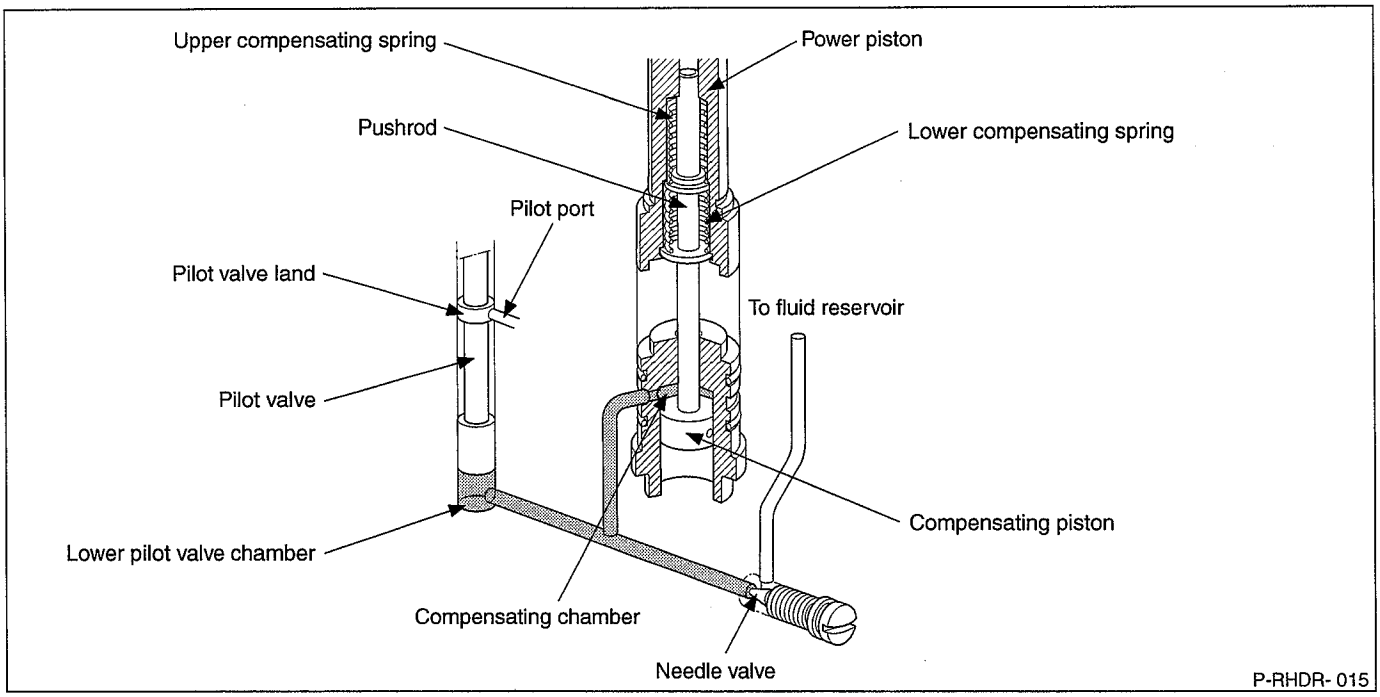
- Speed droop (stabilizing droop)

When load is cut at full-load maximum speed (N), the speed will increase and then stabilize at no-load maximum speed ($N_2$).
Speed droop is the no-load maximum speed ($N_2$) expressed as a percentage of the full-load maximum speed (N).

- Momentary droop

When the load is cut at full-load maximum speed (N), the maximum speed ($N_1$) attained while the speed is stabilizing expressed as a percentage of the full-load maximum speed (N) is referred to as the momentary droop.

## COMPENSATOR MECHANISM




The compensator mechanism is used to prevent hunting, which generally more easily occurs when speed droop is decreased.

The compensator mechanism's upper compensating spring and lower compensating spring are both assembled with a set load.

When engine speed increases and the power piston has moved in the fuel decrease direction (ie, down), the power piston and pushrod and the compensating piston first move down together. Because of this, the pressure in the compensating chamber becomes negative. When this negative pressure falls below a certain value, as it overcomes the upper spring's set load and compresses the spring, the amount of compensating spring movement becomes relatively less than the amount of power piston movement (the rate that negative pressure is generated becomes less than power piston movement). As the compensating chamber is connected to the lower pilot valve chamber, the lower pilot valve chamber pressure also becomes negative, and the pilot valve works to move down against the flyweight's centrifugal force and close the previously open pilot port. Because of this, power piston movement in response to engine fluctuations can be slowed to a certain extent and hunting prevented.

In other words, providing the compensating spring with a set load and varying the rate at which negative pressure is generated by power piston movement can improve stability by preventing hunting, and improve response (ie, the speed at which the power piston moves in the fuel increase direction) by minimizing momentary droop.

Conversely, when engine speed decreases, the power piston moves up. As the lower compensating spring has a set force, however, the compensating piston also initially moves up, and the compensating chamber pressure becomes positive. When this positive pressure exceeds a certain level, the spring is compressed and the rate at which the positive pressure is generated is slowed. When the compensating chamber pressure becomes positive, the lower pilot valve chamber pressure also becomes positive, and the pilot valve is pushed up to close the pilot port.

Because of this, excessive power piston movement and therefore hunting can be prevented.

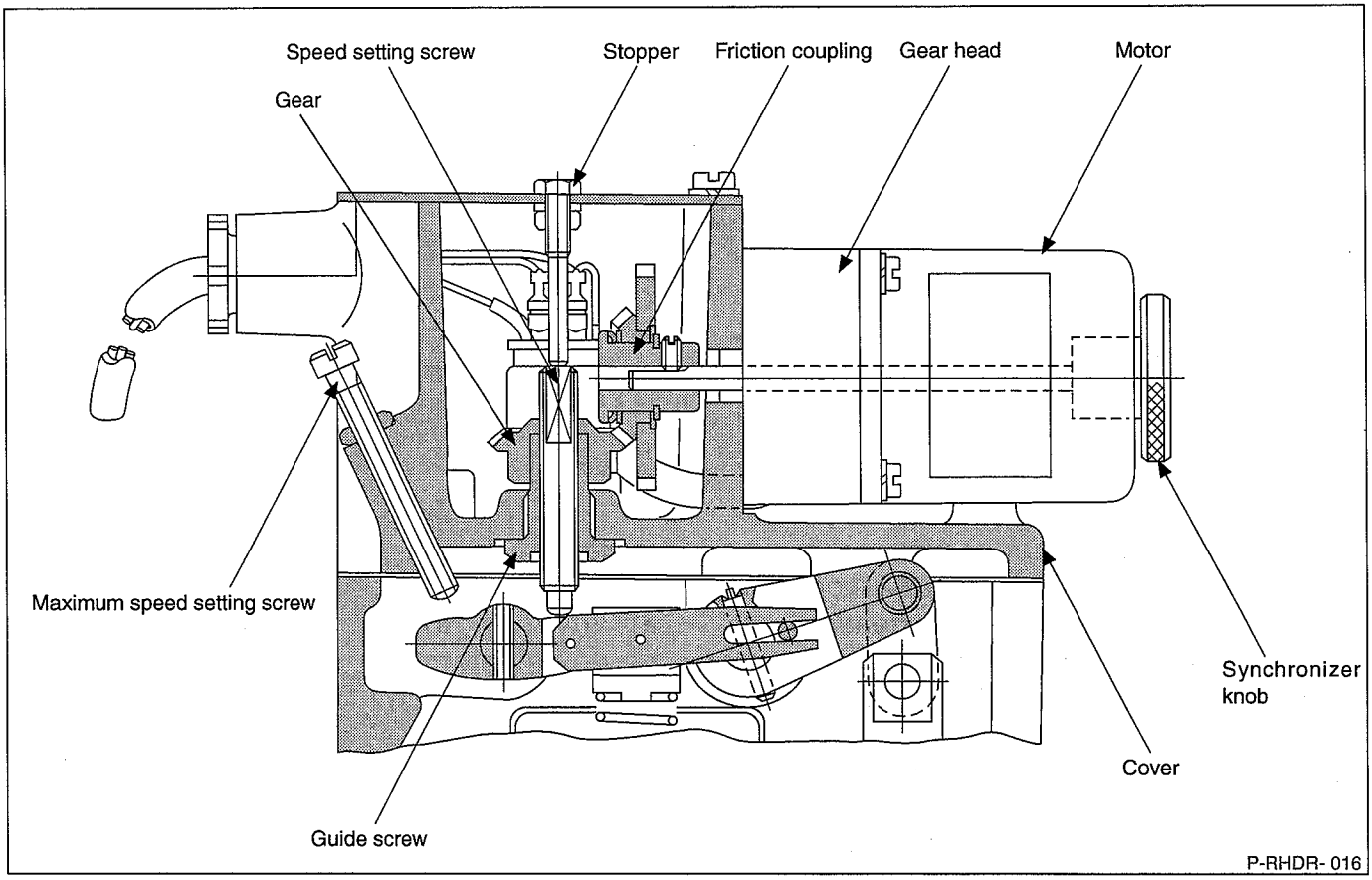
Closing the needle valve increases the pressure generated in the compensating chamber, and thus increases the compensator effect, so that response can be further slowed.

The governor can be equipped with a governor motor and a pneumatic controller. These facilitate remote engine control from a central control room.

Their construction and operation are explained below.

## GOVERNOR MOTOR

### RHD6 and RHD10 - MC type governor motor




The governor motor operates when the engine speed set switch in the control room is turned ON.

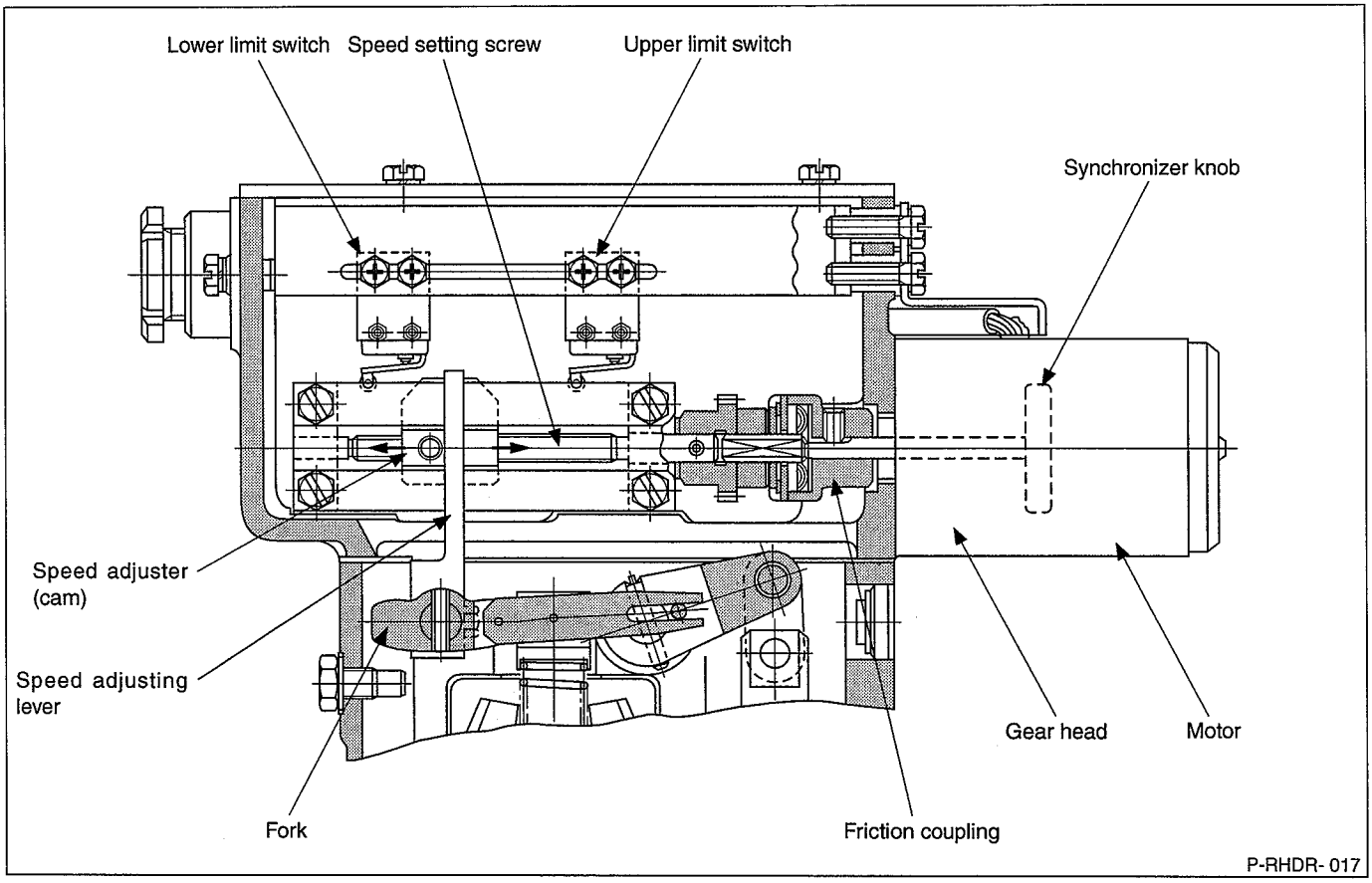
When the motor operates, the speed setting screw is rotated by the friction coupling and gear.

As the speed setting screw is screwed into the guide screw, this rotation results in vertical movement.

Because the speed setting screw acts on the speed adjusting mechanism within the governor, speed setting screw movement changes the set load of the speeder spring to vary engine speed.

The speed can also be changed manually in the same way by turning the synchronizer knob.

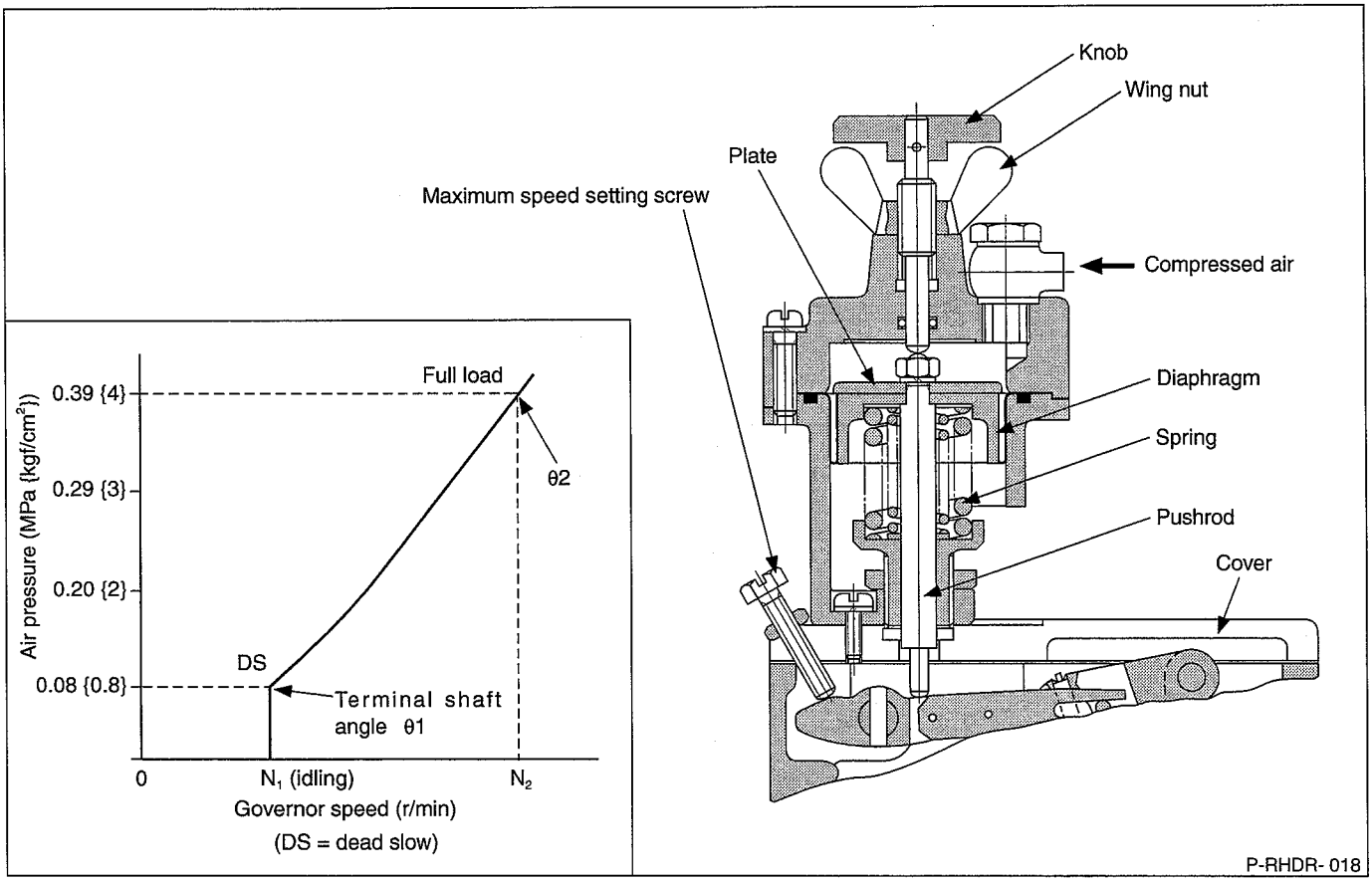
## RHD6 and RHD10 - MCL type governor motor (with limit switches)




This governor motor enables electrical control of the set governor speed's upper and lower limits through limit switches.
Three types are available for use with ships' main engines, pumps, and generators. The control ranges and speed setting times differ depending on the type used.
The motor is decelerated by the gear head which, through the friction coupling, turns the speed setting screw to slide the speed adjuster in an axial direction. A pin protruding from the speed adjuster turns the speed adjusting lever fixed to the speed control shaft to vary the set speed.

The upper part of the speed adjuster also serves as a cam to operate the limit switches and move them within the range determined by the slot to enable adjustment of the upper and lower set speeds.
When setting the speed manually, the motor side synchronizer can be used to freely vary the speed from the minimum to the maximum irrespective of limit switch control.
Also, when an attempt is made to simultaneously change the set speed by remote control, the friction coupling ensures that the speed is first changed on the engine side to prevent any adverse effect on the motor.

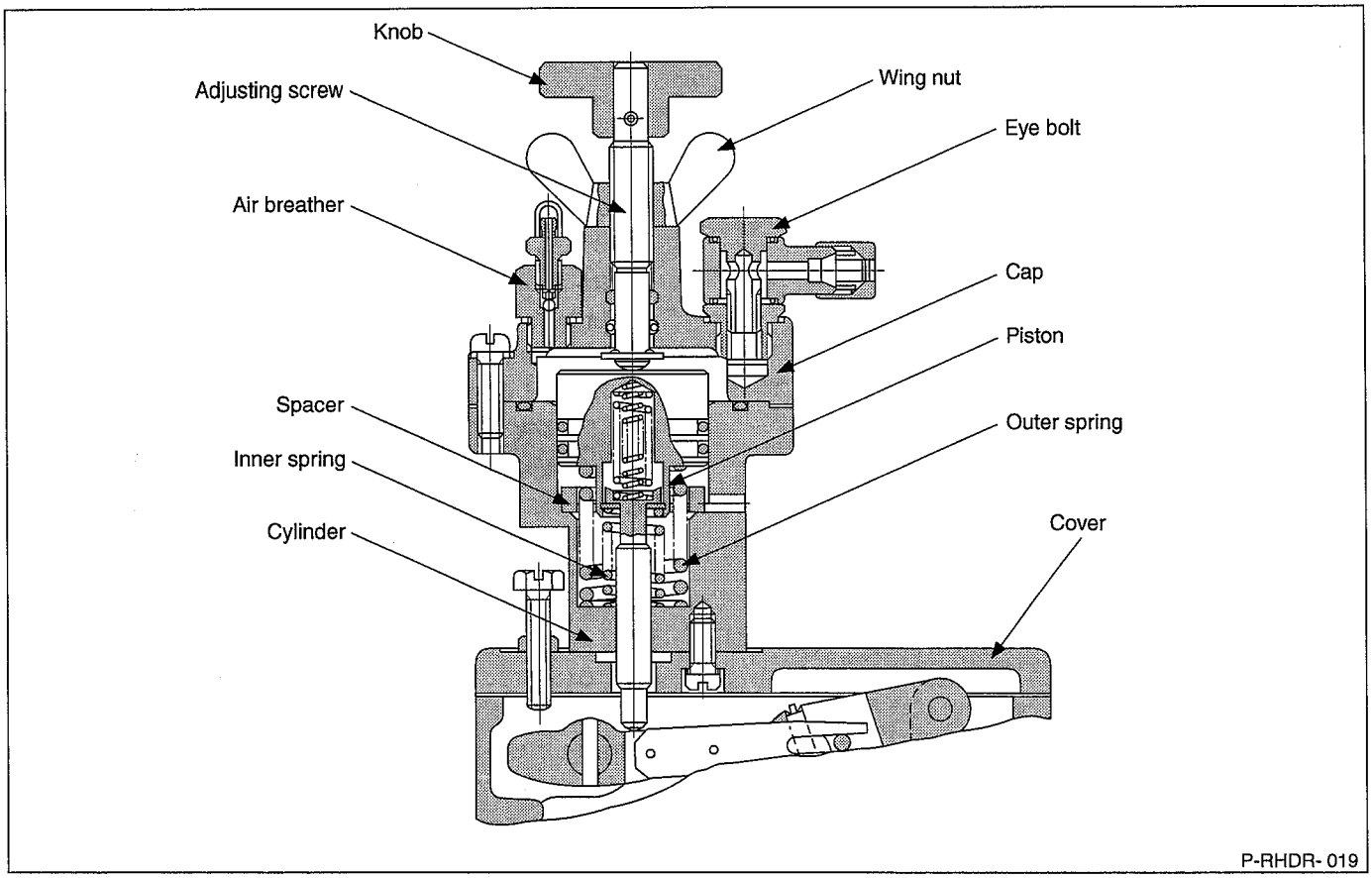
## PNEUMATIC CONTROLLER




The pneumatic controller is used to control engine speed.
When air at a specified pressure is supplied to the pneumatic controller, the air pressure acts on the diaphragm and plate, compressing the spring and pushing the pushrod down.

The pushrod acts on the speed adjusting link mechanism in the governor to change the set load of the speeder spring.
The engine speed can also be freely changed manually in the same way by turning the knob on the top of the controller.

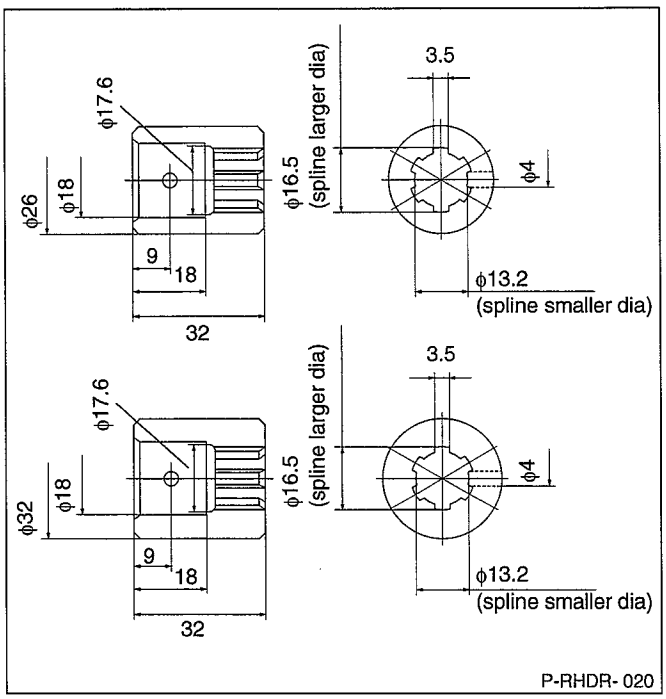
## HYDRAULIC CONTROLLER




The hydraulic controller is used to control engine speed, but utilizes hydraulic pressure instead of air pressure, and a piston instead of a diaphragm.

The hydraulic controller's piston displacement is 12 $cm^3$.

## GOVERNOR INSTALLATION




1. Install the governor vertically to the governor drive case. Use the accompanying gasket at the installation surface.
2. Ensure the governor gear shaft is not subjected to a direct radial load, and that eccentricity and acceleration-gear play are as small as possible.
   Gear shaft spline coupling dimensions are shown at left. These are the same for RHD6 and RHD10 governors.

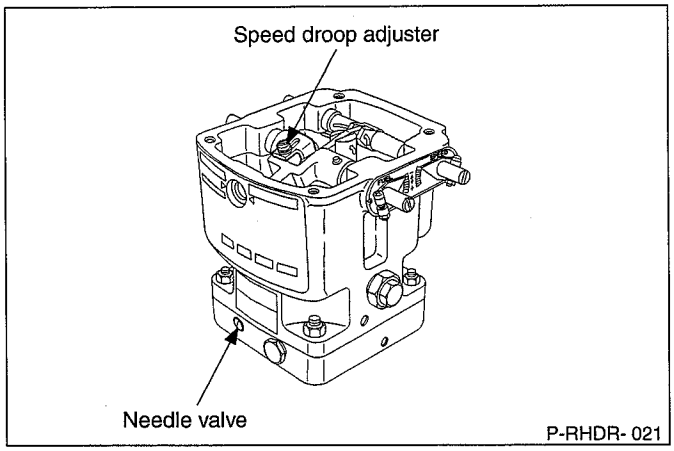
**⚠ CAUTION**

**When handling the governor, ensure the end of the governor's gear shaft is not subject to force or impact.**

Note:
Although the spline is a standard JIS square-shaped spline (6 x 13 x 16), the dimensions shown at left are recommended to avoid even minute eccentricity when installing the coupling. The spline couplings shown at left are standard Bosch Corporation spline couplings.

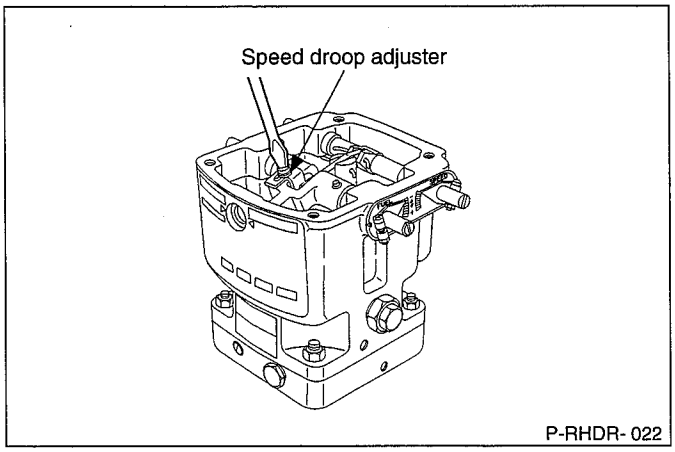
## HYDRAULIC FLUID

| Hydraulic fluid type | Fluid charge | Inspection | Replacement |
|---|---|---|---|
| The type of hydraulic fluid used varies depending on the governor oil temperature during normal operation.<br>Less than 50°C:<br>SAE20<br>50°C ~ 70°C:<br>SAE30<br>Over 70°C:<br>SAE40 | Approx 1,300 $cm^3$.<br>With the governor horizontal, fill the governor with fluid until the level is slightly above the middle of the governor case window.<br>If the fluid charge is insufficient, bubbles will form, performance will decrease, and fluid deterioration will be accelerated. | Check the hydraulic fluid daily. If the charge is less than that specified, check for leaks. If repair is not possible, contact an authorized Bosch Corporation service station. | The fluid must initially be replaced after 1,000 hours or 3 months. Thereafter, the fluid must then be replaced every 3,000 hours or 6 months. |

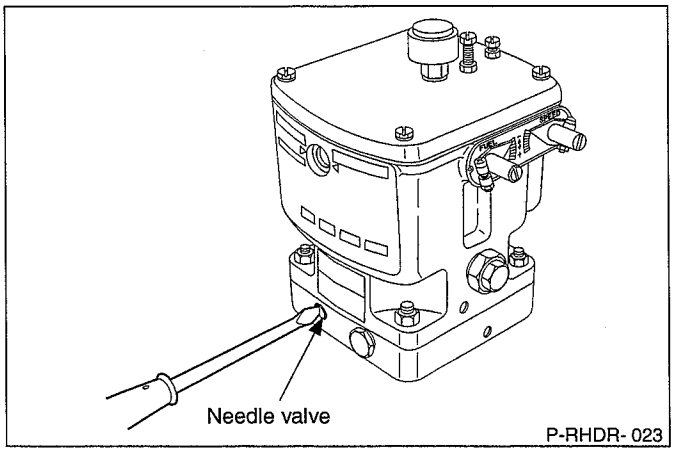



## AIR BLEEDING AND COMPENSATION ADJUSTMENT

1. Set the speed droop at the smallest value possible using the speed droop adjuster (0 ~ 2 on the adjuster scale) and fully open the compensating needle valve (3 turns from the fully closed position).
2. Operate the engine at low speed and cause the engine to 'hunt' or 'surge' for approximately 30 seconds to bleed the air.



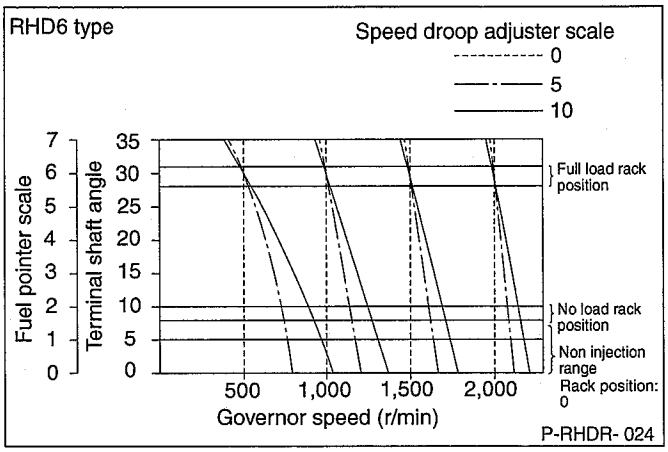

3. Stop the engine, set the speed droop to the setting estimated for the particular application (determined from the performance diagram) and then restart the engine.




4. Close the needle valve until 'hunting' stops.

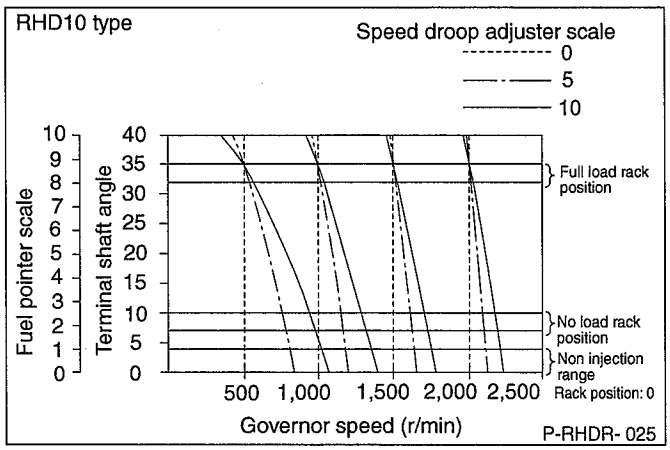
**Advice**

**The above completes air bleeding and compensation adjustment. If, however, the speed droop adjustment setting is changed during engine adjustment, readjust the needle valve to as open a position as possible at which stabilized engine operation is obtained.**




## LINKAGE CONNECTIONS

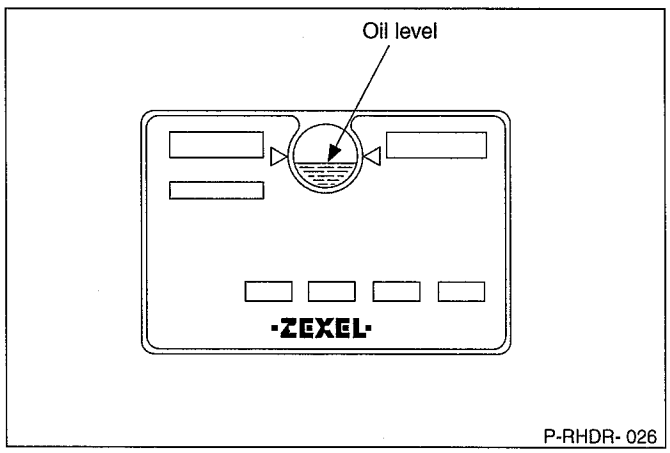
1. Use a split tightening type lever. After determining the correct position, secure it using a knock pin, etc.
2. The linkage must be as simple and direct as possible. Minimize resistance and the actual mass of the linkage.




3. The figures at left show the recommended relationships for connections between the terminal shaft angle and the injection pump for a static governor.

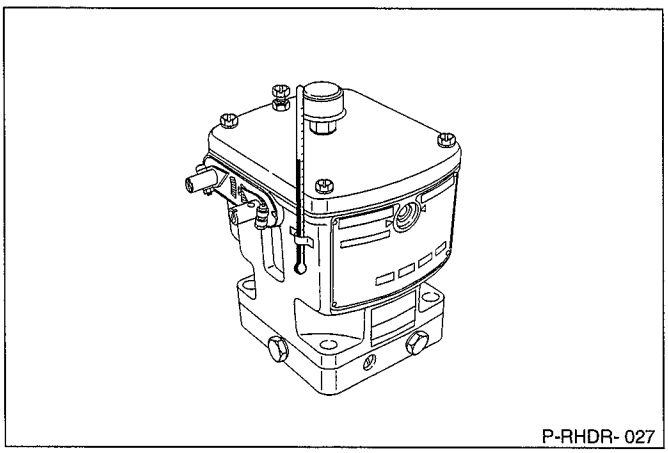
**Advice**

**As play in the link system adversely affects performance, ensure play is as small as possible.**




## DAILY INSPECTION

1. Check the fluid level daily before beginning operation.
   If the level is below the middle of the gauge, add fluid to the governor.
2. Check that the governor mounting bolts are not loose and that there are no faults in the linkage connections from the governor terminal shaft to the injection pumps' control rack.



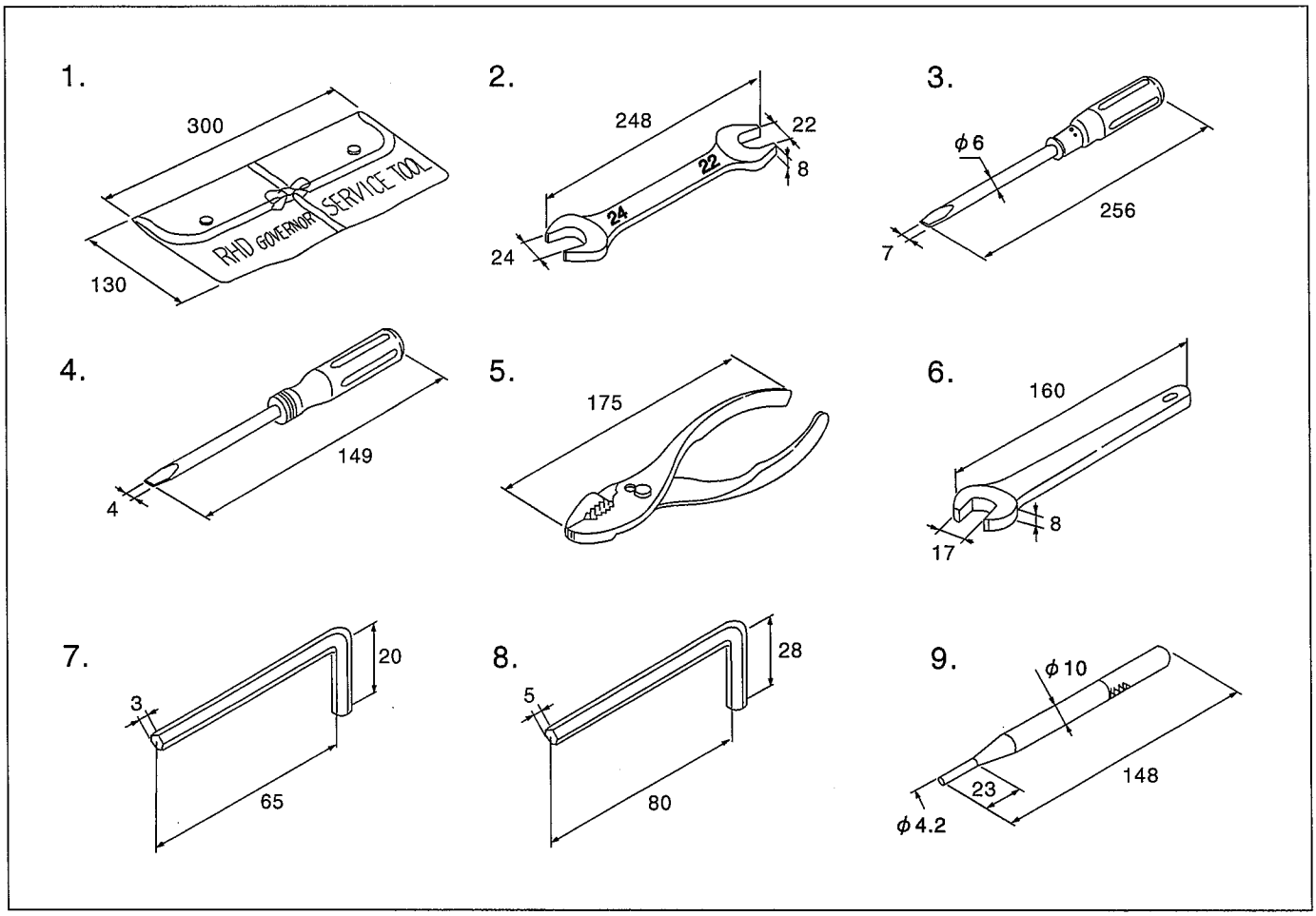

## IN-SERVICE INSPECTION

1. Check the governor temperature. The temperature should generally increase to approx 60°C after 30 ~ 40 min of high speed engine operation. If the ambient temperature is high, the temperature may increase to 80°C after continued high speed operation (over 1,800 r/min).
   Temperatures over 100°C are abnormal.
2. Check for abnormal noises.
3. Wipe any fluid from the outside of the governor and check that no fluid leaks during operation.

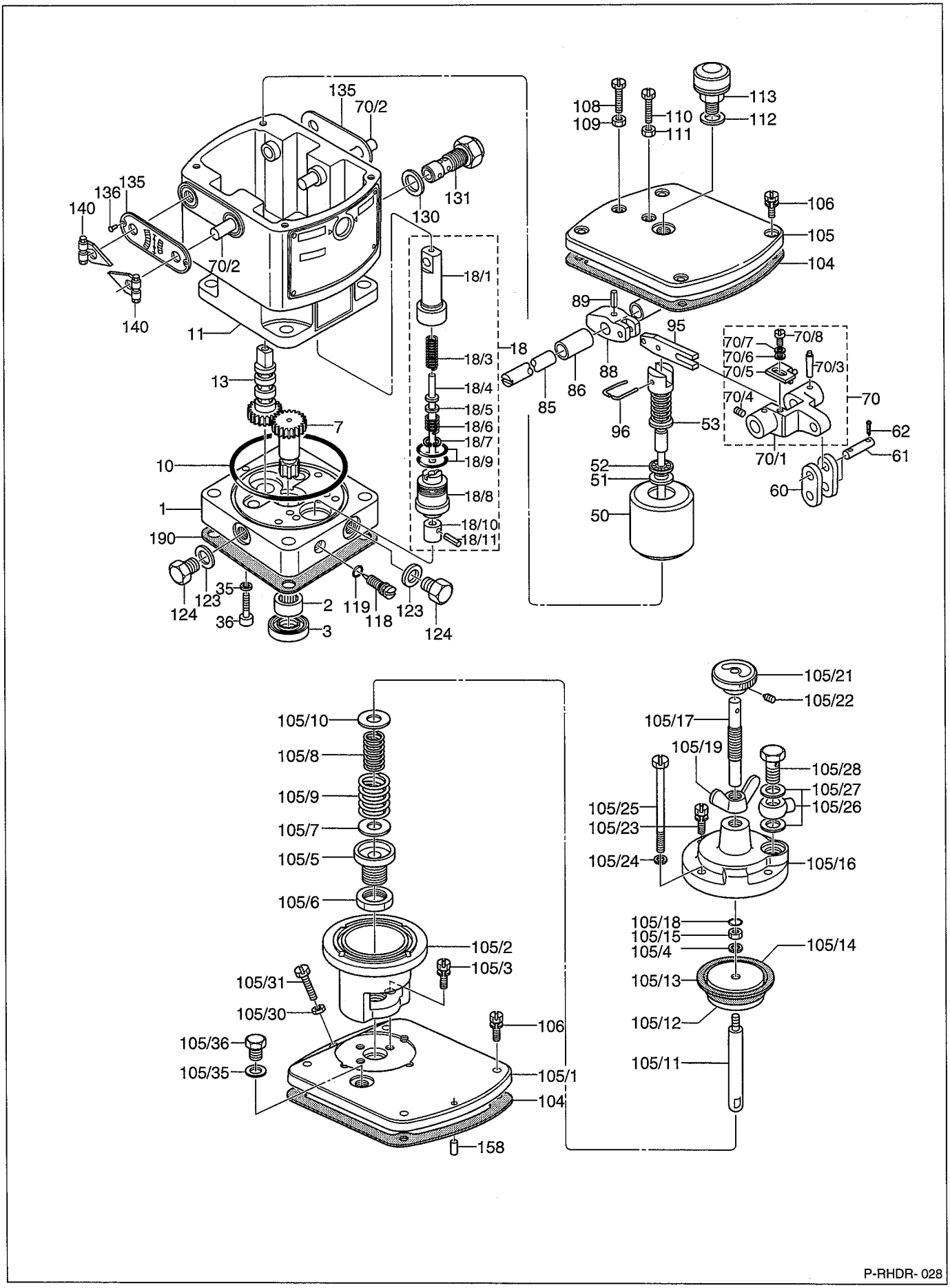
## SPECIAL TOOLS

The following special tools (in addition to general tools) are required for disassembly and reassembly of the RHD hydraulic governor.

| Key no. | Part name | Zexel part no. | Bosch part no. | Qty | Application |
|---|---|---|---|---|---|
| 1 | Case | 376100-2000 | 9 421 622 974 | 1 | For tools |
| 2 | Spanner | 376100-2100 | 9 421 622 811 | 1 | For removing/installing regulating valve (SW22mm, 24mm) |
| 3 | Screwdriver | 376100-2200 | 9 421 622 812 | 1 | For removing/installing cover bolts |
| 4 | Screwdriver | 376100-2300 | 9 421 622 813 | 1 | For speed droop adjuster adjustment |
| 5 | Pliers | 376100-2400 | 9 421 622 814 | 1 | For removing split pins |
| 6 | Spanner | 376100-2500 | 9 421 622 815 | 1 | For removing/installing plug (SW17mm) |
| 7 | Allan wrench | 376100-2600 | 9 421 622 816 | 1 | SW3mm |
| 8 | Allan wrench | 376100-2700 | 9 421 622 817 | 1 | SW5mm |
| 9 | Extractor | 376100-2800 | 9 421 622 818 | 1 | For removing pin |



## EXPLODED VIEW



## PART LIST

### RHD-LC type hydraulic governor

| Key no. | Part name | Key no. | Part name | Key no. | Part name |
|---|---|---|---|---|---|
| 1 | Base | 36 | Bolt | 89 | Roll pin |
| 2 | Needle roller bearing | 50 | Flyweight | 95 | Floating lever |
| | | 51 | Washer | 96 | Wire |
| 3 | Oil seal | 52 | Thrust needle roller bearing | 104 | Gasket |
| 7 | Gear shaft | | | 105 | Cover |
| 10 | O-ring | 53 | Pilot valve assembly | 106 | Bolt |
| 11 | Housing | | | 108 | Maximum speed setting screw |
| 13 | Sleeve | 60 | Guide lever | | |
| 18 | Compensator assembly | 61 | Pin | 109 | Nut |
| | | 62 | Split pin | 110 | Minimum speed setting screw |
| 18/1 | Power piston | 70 | Terminal arm assembly | | |
| 18/3 | Upper compensating spring | | | 111 | Nut |
| | | 70/1 | Terminal arm | 112 | Gasket |
| 18/4 | Pushrod | 70/2 | Terminal shaft | 113 | Air breather |
| 18/5 | Washer | 70/3 | Taper pin | 118 | Needle valve |
| 18/6 | Lower compensating spring | 70/4 | Set screw | 119 | O-ring |
| | | 70/5 | Speed droop adjuster | 123 | Gasket |
| 18/7 | Snapring | | | 124 | Screw plug |
| 18/8 | Compensator bushing | 70/6 | Washer | 130 | Gasket |
| | | 70/7 | Lock washer | 131 | Regulating valve |
| 18/9 | O-ring | 70/8 | Screw | 135 | Indication plate |
| 18/10 | Compensating piston | 85 | Speed control shaft | 136 | Nail |
| 18/11 | Roll pin | 86 | Collar | 137 | Indication plate |
| 35 | Gasket washer | 88 | Fork | 140 | Pointer |

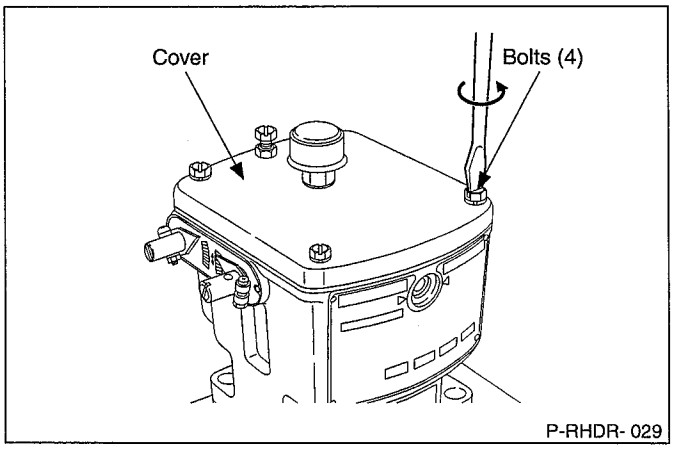
### Pneumatic controller

| Key no. | Part name | Key no. | Part name | Key no. | Part name |
|---|---|---|---|---|---|
| 105 | Pneumatic controller | 105/12 | Piston | 105/25 | Bolt |
| 105/1 | Cover | 105/13 | Diaphragm | 105/26 | Eye |
| 105/2 | Cylinder | 105/14 | Plate | 105/27 | Gasket |
| 105/3 | Screw | 105/15 | Nut | 105/28 | Eye bolt |
| 105/4 | Spring washer | 105/16 | Cover | 105/30 | Nut |
| 105/5 | Spring seat | 105/17 | Screw | 105/31 | Bolt (set screw) |
| 105/6 | Nut | 105/18 | O-ring | 105/35 | Gasket |
| 105/7 | Washer | 105/19 | Wing nut | 105/36 | Bolt |
| 105/8 | Spring | 105/21 | Knob | (158) | Pin |
| 105/9 | Spring | 105/22 | Set screw | | |
| 105/10 | Washer | 105/23 | Screw | | |
| 105/11 | Pushrod | 105/24 | Spring washer | | |

## PREPARATION

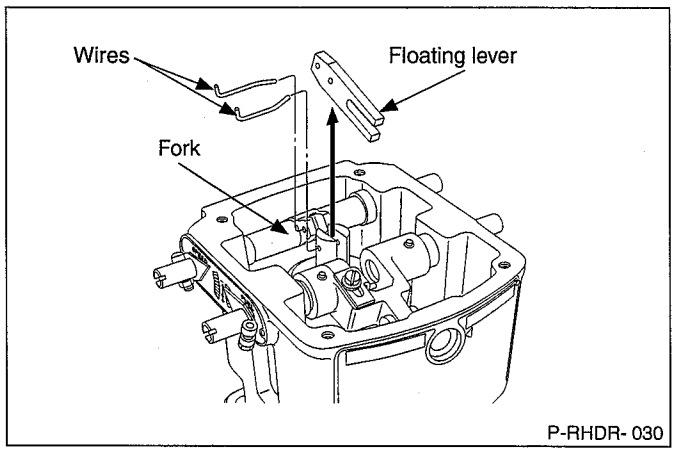
Keep the work bench clean and tidy.
Before starting disassembly, record performance data and the positions of adjustable parts for later reference. This data will facilitate the detection and diagnosis of any governor malfunctions and defects.

During disassembly, put the disassembled parts neatly and sequentially on the work bench, labelling them if necessary to facilitate later reassembly.
Clean the outside of the governor before disassembly.

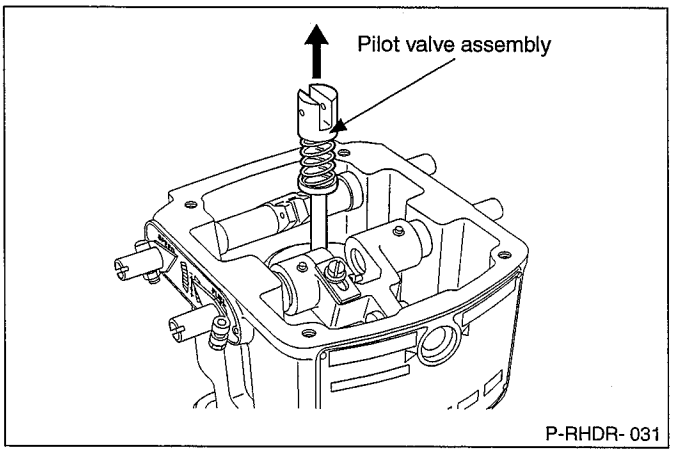



## DISASSEMBLY

1. Remove the four bolts using a screwdriver and then remove the cover together with the gasket.
2. Turn the governor upside down and drain the fluid.

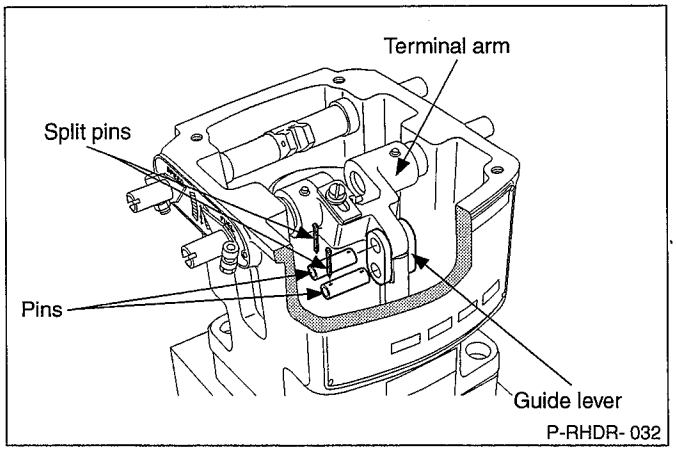



3. Remove the two wires connecting the fork to the floating lever and then remove the floating lever.

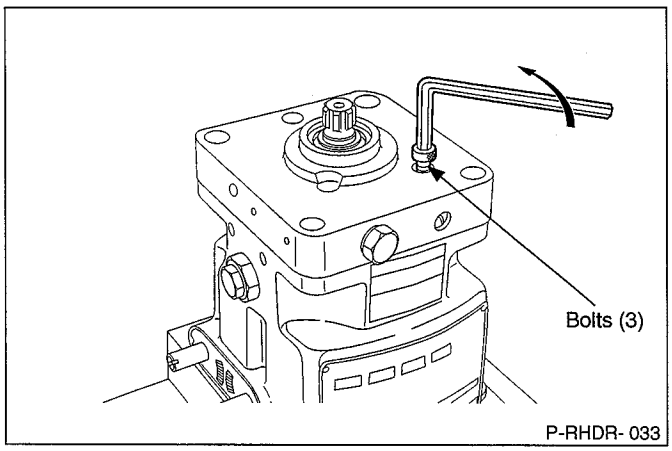



4. Remove the pilot valve assembly.

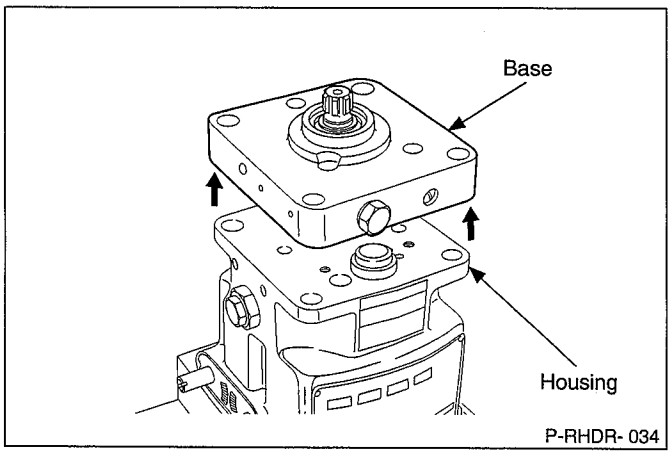
**Advice**
**Put the pilot valve in clean light oil.**



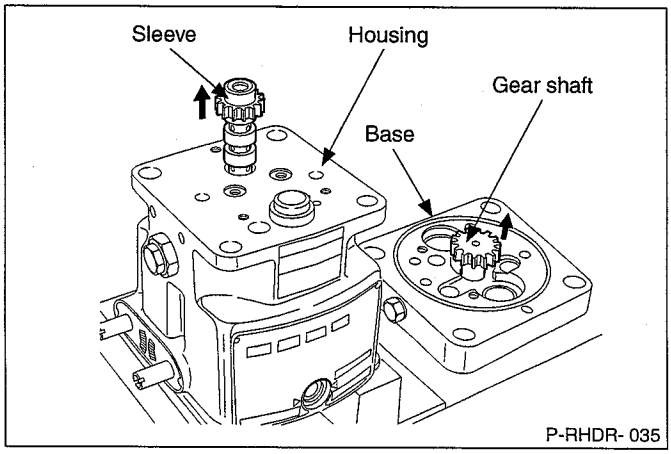

5. Remove the two split pins and then remove the two pins connecting the terminal arm and the guide lever to the power piston.




6. Remove the bolts using an allan wrench (SW 5 mm).



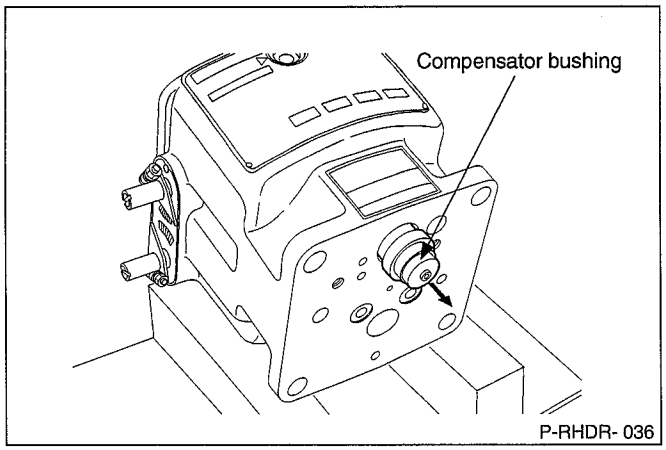

7. Tap the base lightly with a plastic hammer to separate it from the housing.



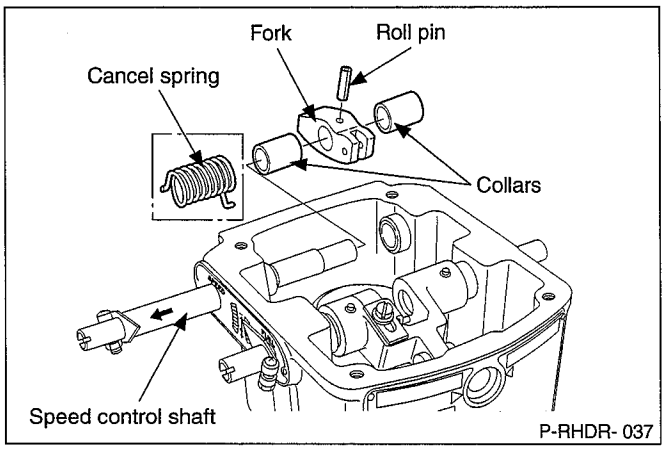

8. Remove the sleeve from the housing and the gear shaft from the base.

**Advice**

**Put the sleeve in clean light oil.**

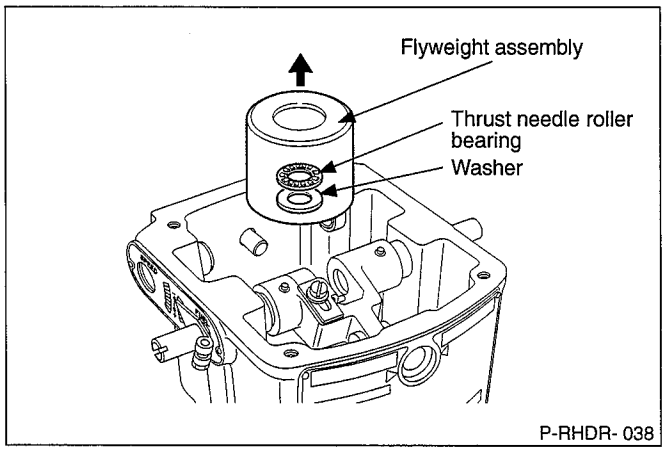



9. Push the power piston down from the top of the governor and then remove the compensator bushing and the compensator assembly.

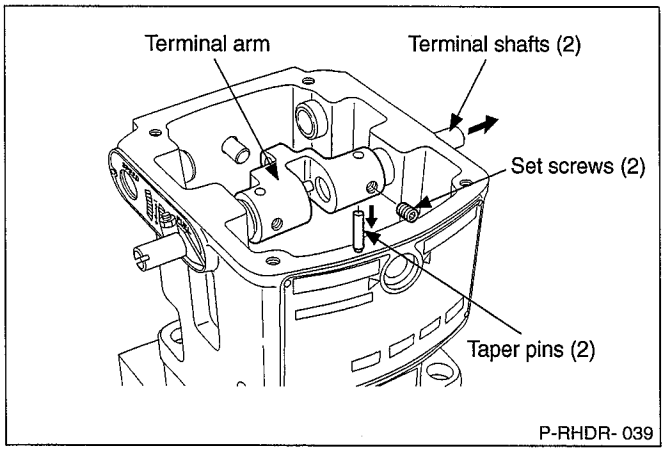



10. Remove the roll pin securing the fork to the speed control shaft, and then remove the speed control shaft, the collars and the fork.

Note:
PC, MC, and MCL type governors are equipped with a cancel spring on the speed control shaft. Remove the cancel spring when removing the speed control shaft.



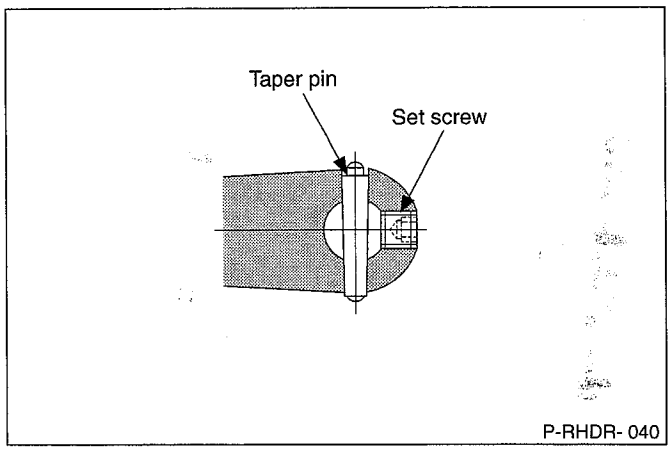

11. Remove the flyweight assembly together with the thrust needle roller bearing and the washer from the housing.

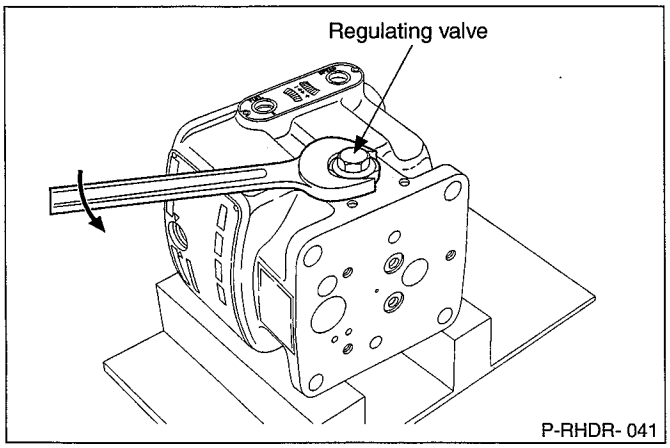



12. Turn one terminal shaft one half turn and remove the terminal shafts' taper pins. Remove the set screws using an allan wrench (SW 3 mm), then remove the terminal shafts and arm.

**Advice**

1. **Do not remove the terminal arm assembly unless it is not operating smoothly or it is necessary to replace parts.**
2. **When replacing the terminal shafts and arm, they must be replaced as an assembly.**



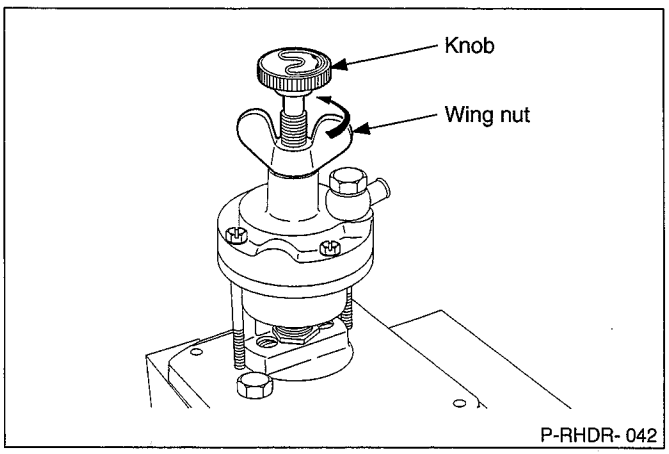

13. Remove the needle valve and regulating valve (hexagon head, SW 24 mm) and any other external parts.

The above completes disassembly of main RHD governor components.

Disassemble other components when necessary.

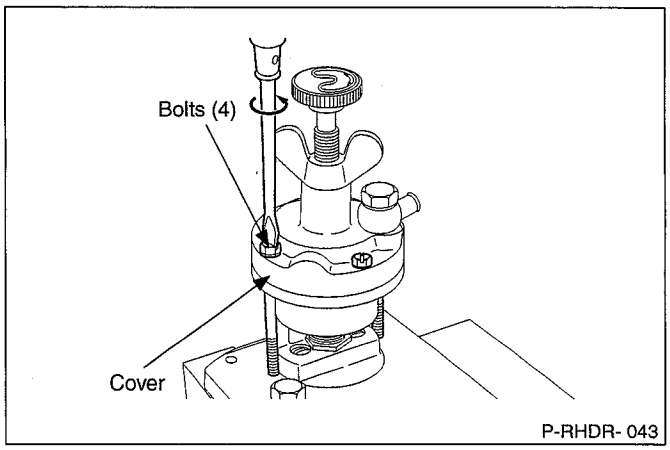
The pneumatic controller is the most commonly equipped additional device.

Disassembly is described below.

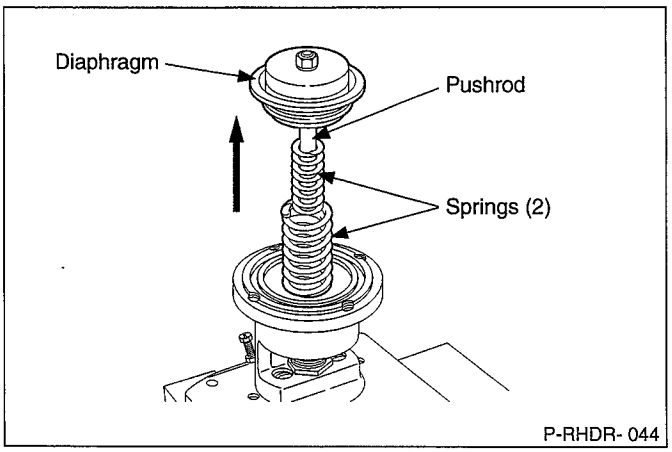



## PNEUMATIC CONTROLLER DISASSEMBLY

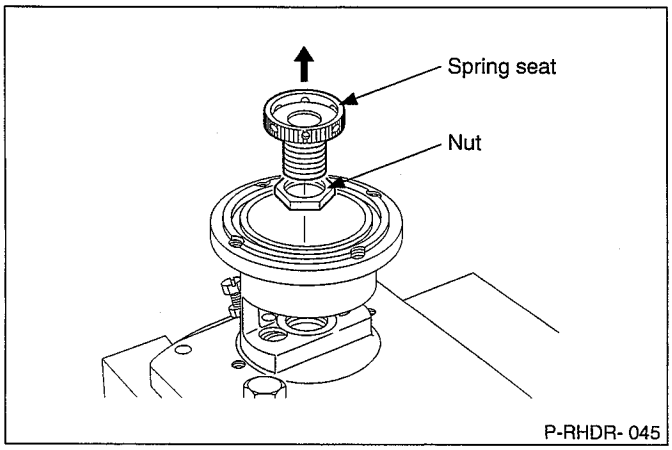
1. Loosen the wing nut. Then, loosen the knob until it can be easily turned.




2. Remove the four bolts using a screwdriver and then remove the cover.




3. Remove the diaphragm together with the pushrod, and then remove the two springs.




4. Loosen the nut and then remove the spring seat.

The above completes disassembly of main pneumatic controller parts.
Disassemble other parts when necessary.

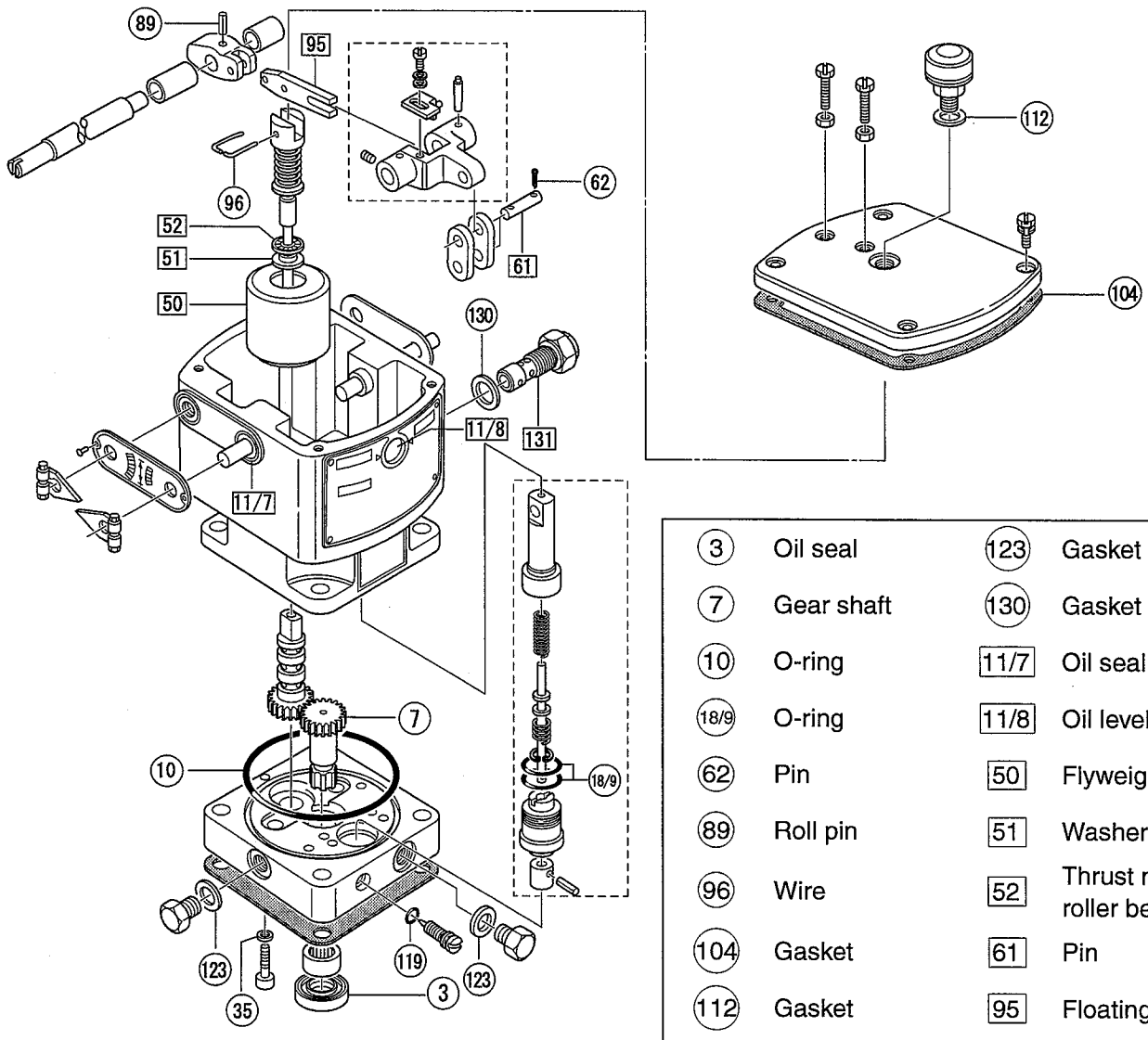
Record the details of all inspections and repairs.
With parts such as those listed below, first check their external appearance to determine whether further disassembly is necessary.

- Terminal arm assembly
- Pilot valve assembly
- Housing assembly
- Flyweight assembly
- Governor motor assembly

Wash all parts thoroughly in clean light oil, and check for wear, damage and scratches. Replace any parts that cannot be reused with new parts.

## REPLACEMENT STANDARDS

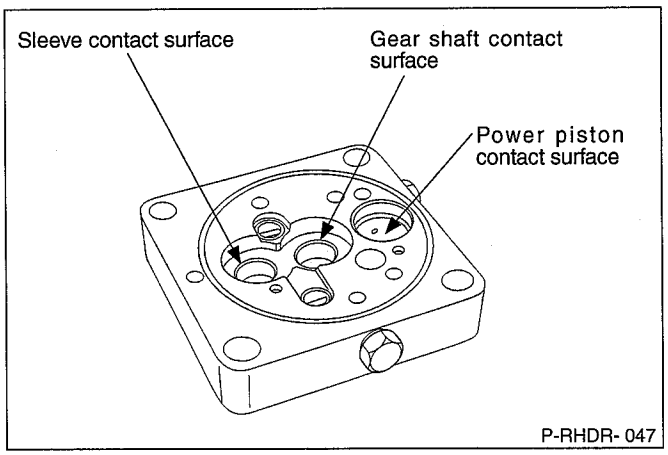
Parts with key numbers marked ○ :
Replace at disassembly or every 2 years
Parts with key numbers marked □ :
Replace every 4 years or 20,000 hours
In principle, assemblies must be replaced when any of their component parts have been used for 8 years or 40,000 hours.




P-RHDR- 046

| | | | |
|---|---|---|---|
| 3 | Oil seal | 123 | Gasket |
| 7 | Gear shaft | 130 | Gasket |
| 10 | O-ring | 11/7 | Oil seal |
| 18/9 | O-ring | 11/8 | Oil level gauge |
| 62 | Pin | 50 | Flyweight |
| 89 | Roll pin | 51 | Washer |
| 96 | Wire | 52 | Thrust needle roller bearing |
| 104 | Gasket | 61 | Pin |
| 112 | Gasket | 95 | Floating lever |
| 119 | O-ring | 131 | Regulating valve |

If parts other than the above are worn or damaged, replace them with new ones.

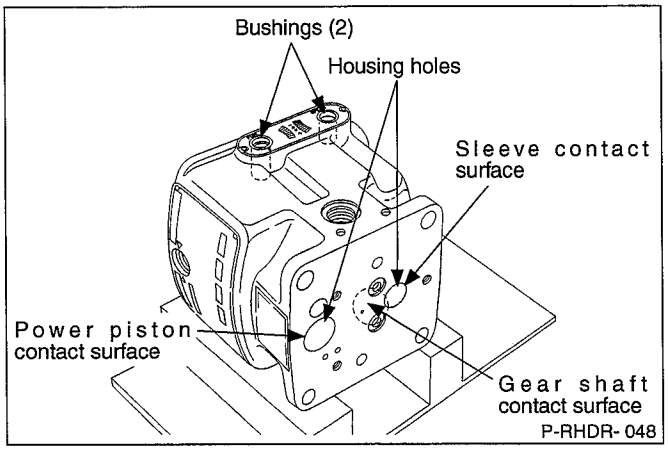


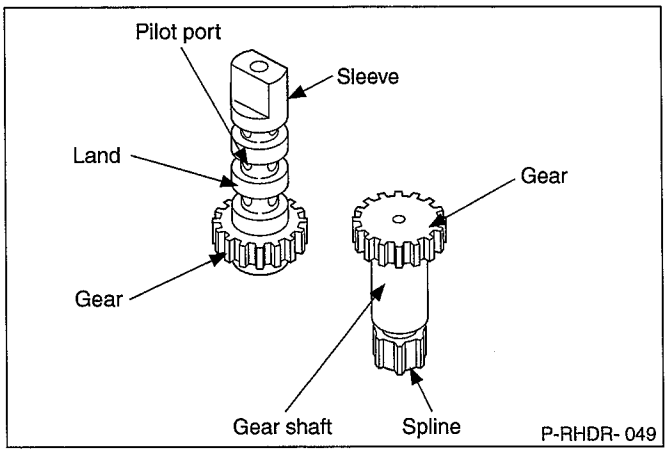

**Base assembly and housing**

Replace the base if the power piston, gear shaft or sleeve contact surfaces are worn or damaged.

Replace the housing if the power piston, gear shaft or sleeve contact surfaces, or the housing holes, are worn or damaged.

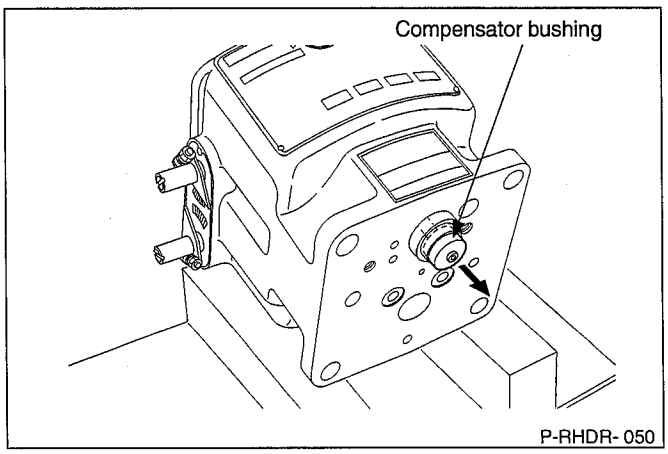
Replace the housing if the pressfitted terminal arm bushings are worn or loose.




**Gear shaft and sleeve**

Replace the gear shaft if the outside, spline, oil seal contact surface or gear is worn or damaged. Replace the sleeve if the gear, pilot ports or lands are worn or damaged.



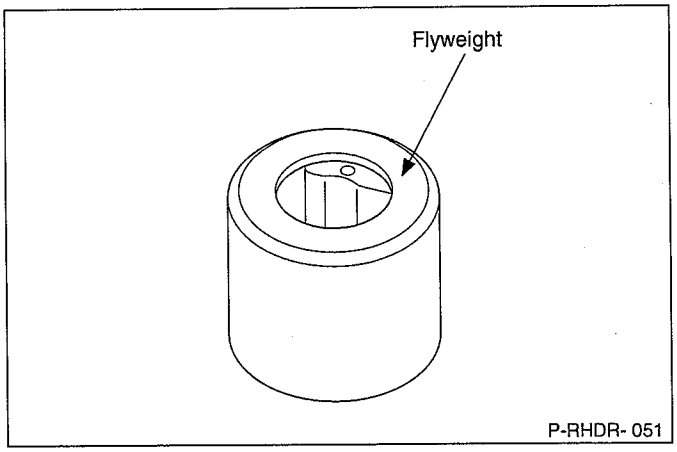

**Compensator assembly**

Assemble the compensator assembly's power piston, pushrod and compensator bushing in the housing and check that they move smoothly up and down under their own weight when the housing is moved.

Repair or replace them if they do not move smoothly.

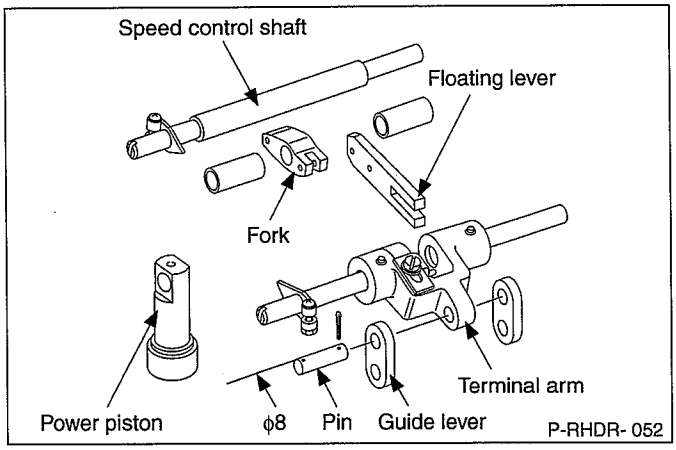
Note:

If the power piston does not move smoothly, hunting or excessive speed droop will prevent engine adjustment.



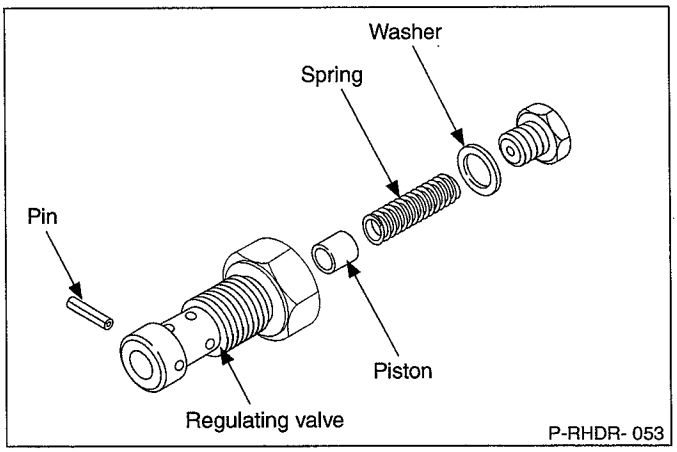

**Flyweight assembly**

Foreign matter in the flyweight will prevent smooth flyweight movement.
Check that the flyweight moves smoothly.
Wash the flyweight thoroughly.




**Power piston, guide lever and terminal arm**

- Replace the guide lever if the pin holes are worn.
  Replace the pins if they are worn.
  Replace the power piston if the inside is worn.
- Replace the speed control shaft if it is bent or the shaft journals are worn.

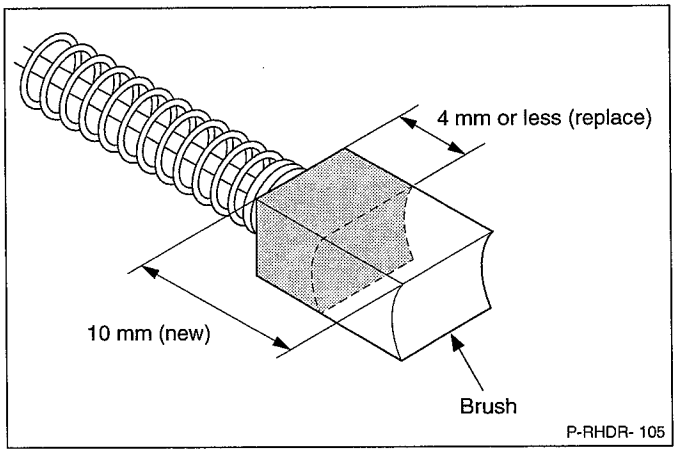



**Regulating valve**

Check that the piston moves smoothly.
Repair or replace the piston if it is worn or does not move smoothly.

**Other parts**

- Check all other parts for cracks, damage, damaged threads and rust.
  Repair or replace them if necessary.
- Replace all O-rings and gaskets.
- Replace springs that are damaged, bent or rusted.




## GOVERNOR MOTOR BRUSH INSPECTION (MC, MCL TYPES)

**Advice**

**Inspection applies only to direct current (DC) type motors. The following is not necessary for alternating current (AC) motors.**

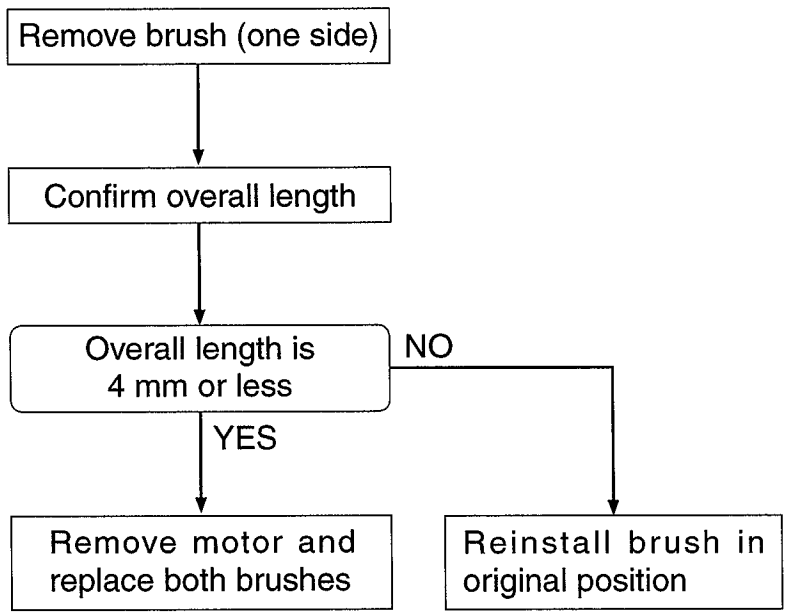
### Brush inspection intervals

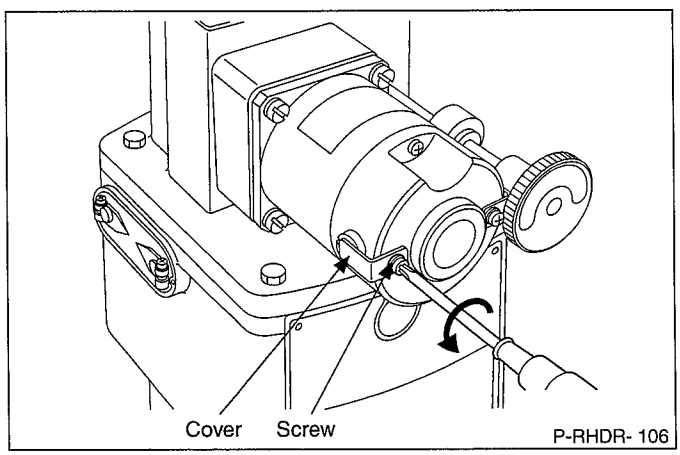
Brush inspection intervals are shown below.

| Part name | Inspection interval | Remarks |
|---|---|---|
| Brush | Monthly | When overall length is 4 mm or less |

Note:
Overall length of new brushes: 10 mm

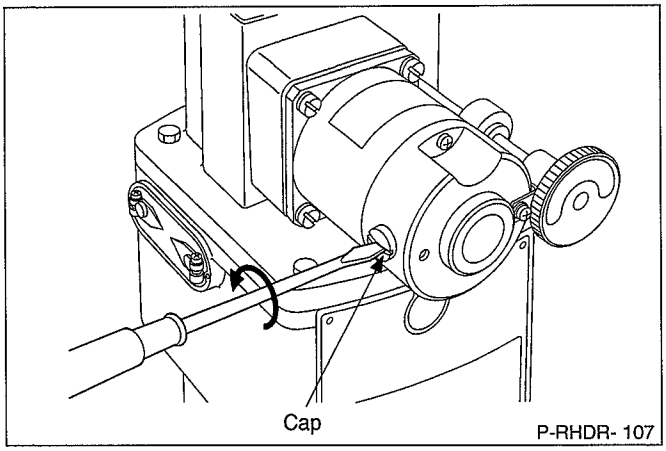
### Brush inspection



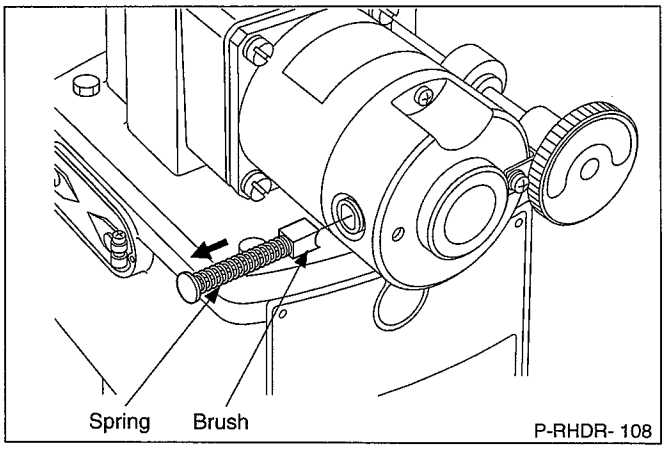




### Brush removal

1. Remove the screw and then remove the cover.



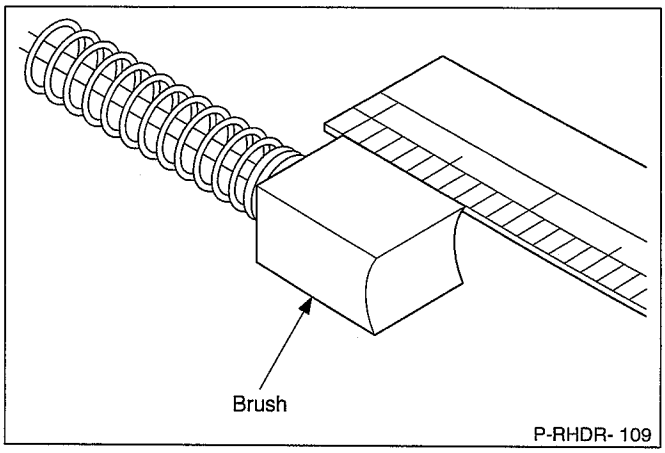

2. Loosen and then remove the cap.




3. Remove the brush from the motor.

**Advice**

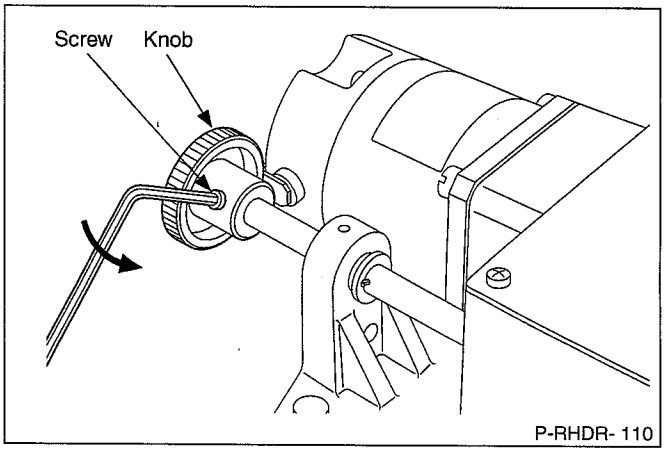
**Do not stretch the brush spring during removal.**




4. Measure the overall length of the brush.

**Advice**

- **When overall brush length still exceeds the wear limit of 4 mm, reverse the removal procedure to reinstall the brush. (Inspection is complete.)**
- **When overall brush length is 4 mm or less, continue with the following steps. (Replace both brushes at the same time.)**

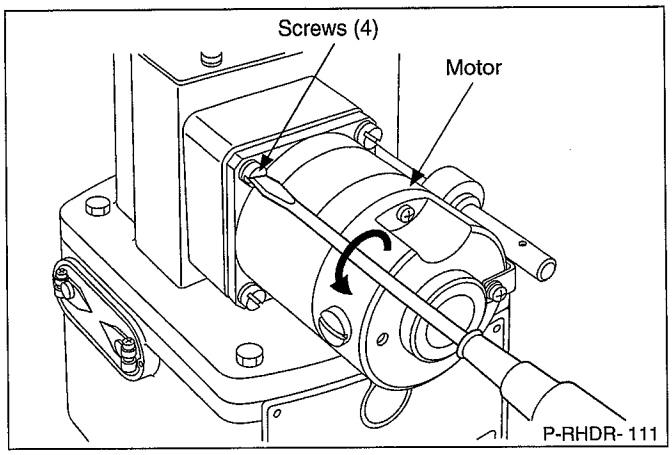



**Motor removal**

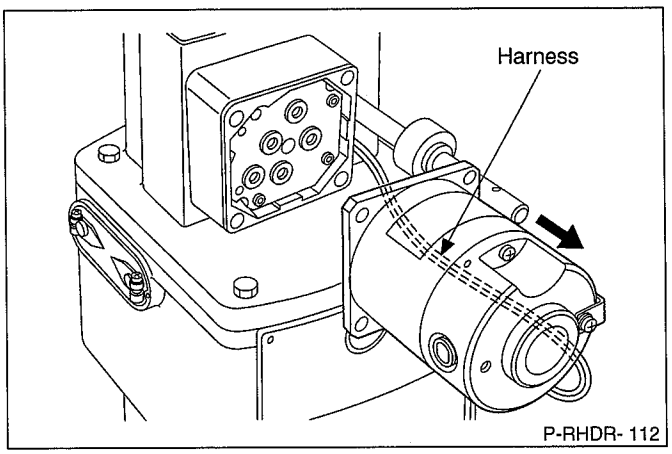
1. Loosen the screw and then remove the knob.

Note:

Screw: SW3

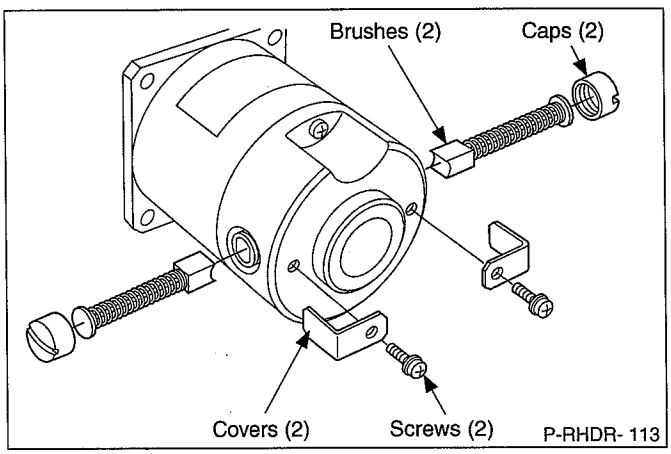



2. Remove the screws and then remove the motor horizontally.




**Advice**

**The motor is connected to a harness. Do not pull the harness excessively.**




**Brush replacement**

1. Remove the knob-side brush using the same procedure as above.
2. Replace both brushes with new ones and then reinstall the motor and knob by reversing the removal procedure.

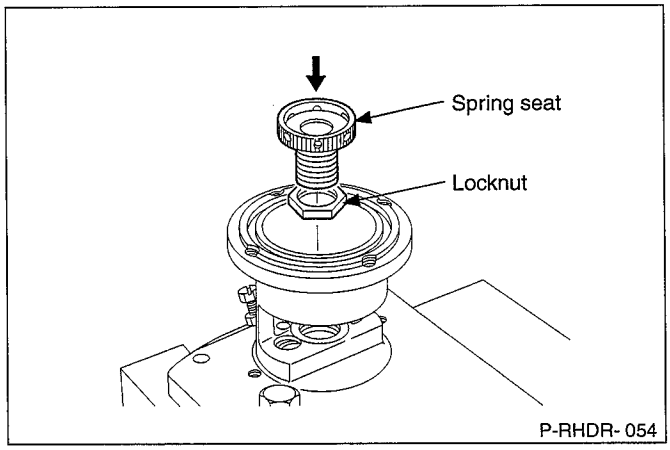
**Advice**

- **When reinstalling the motor, install the motor so that the side with the nameplate is facing up.**
- **Tighten diagonally opposed motor fixing screws (4) gradually and evenly.**

**Tightening torque: 2 ~ 2.2 N·m**
**{0.2 ~ 0.22 kgf·m}**

**Brush part numbers**

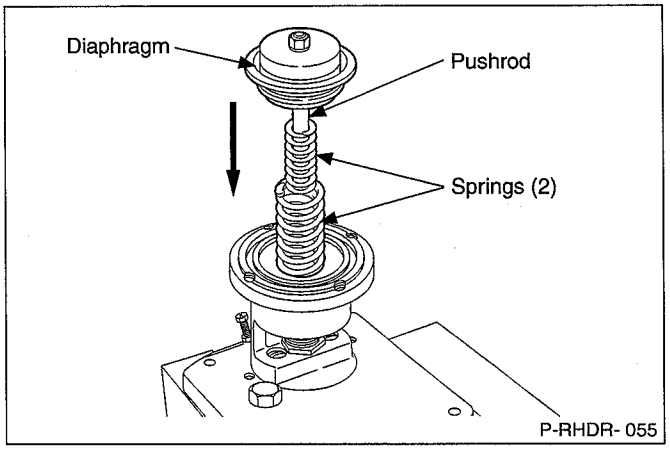
| Part name | Zexel part no. (Bosch part no.) | Remarks |
|---|---|---|
| Brush | 158901-4500 (9 421 622 899) | For DC24V |
| | 158901-4600 (9 421 622 900) | For DC100V |



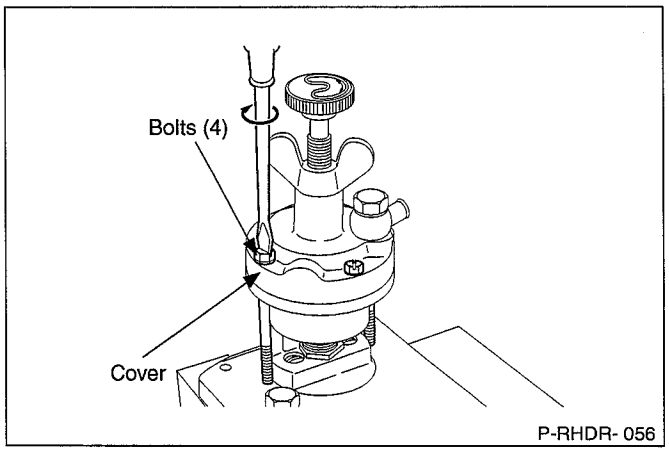

Governor reassembly is described below.

## PNEUMATIC CONTROLLER
**(if installed)**

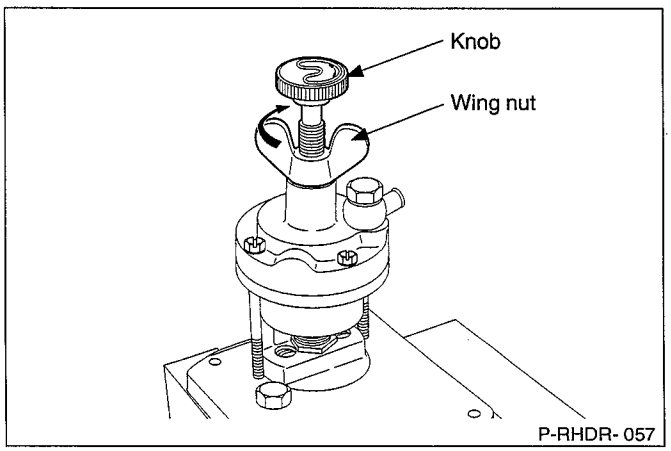
1. Screw the locknut onto the spring seat, then screw the spring seat into the cylinder.



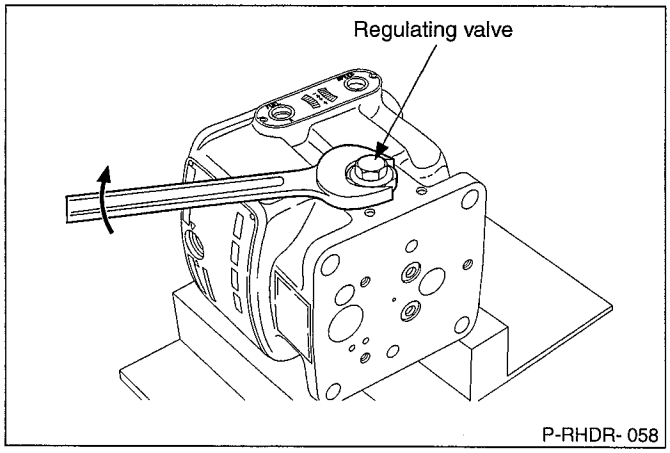

2. Install the diaphragm and pushrod together with the two springs.




3. Install the cover and secure it using the four bolts.



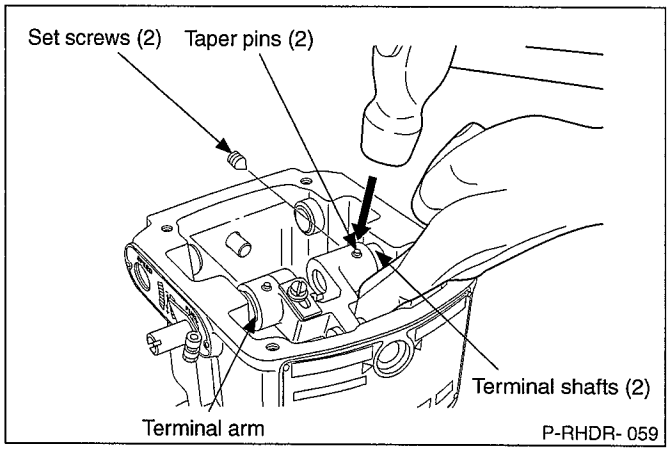

4. Install the knob and wing nut.




## GOVERNOR ASSEMBLY

1. Install the regulating valve.

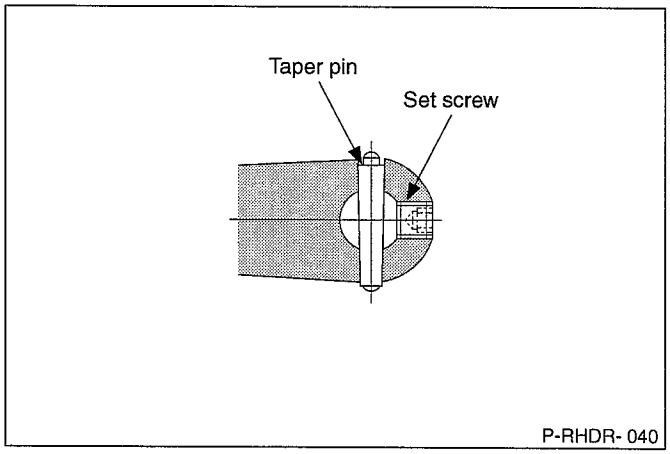
**Tightening torque: 25 ~ 29 N·m {2.5 ~ 3.0 kgf·m}**




2. Install the terminal shafts and arm. Align each terminal shaft's and terminal arm's taper hole.
   Coat the taper pins with an adhesive and install the taper pins.

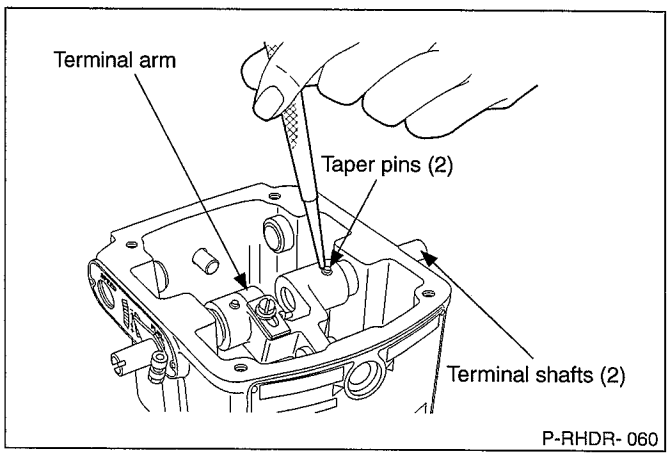
**⚠ CAUTION**

**When installing the two taper pins in the terminal shafts, support the terminal arm and terminal shafts to avoid damaging the bushings pressfitted to the housing.**

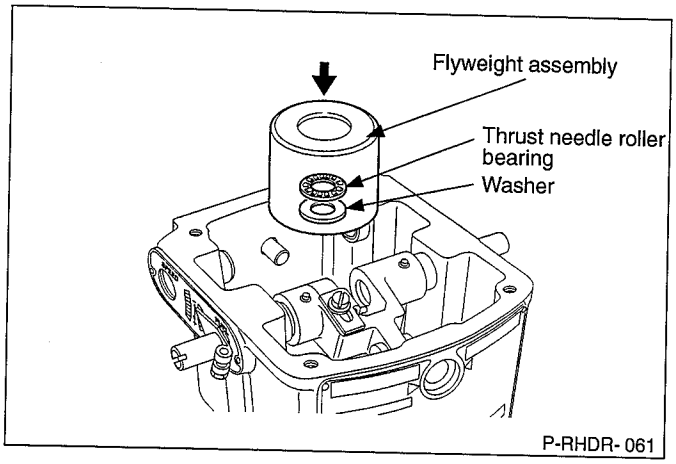



3. Coat the set screws with an adhesive and install the two set screws.

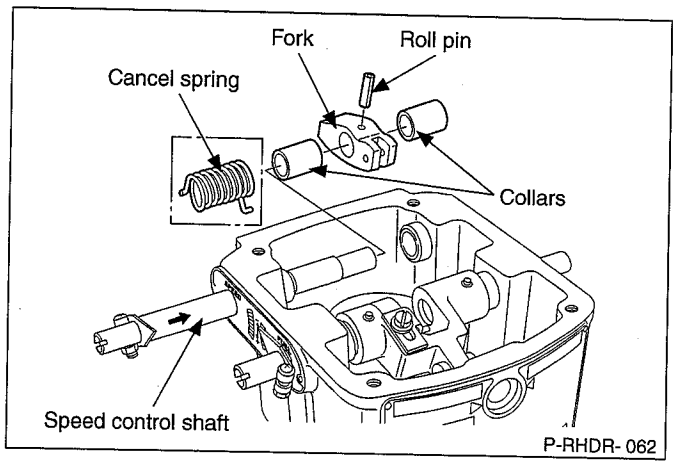
**Tightening torque: 3.9 ~ 4.9 N·m {0.4 ~ 0.5 kgf·m}**




4. Caulk the two taper pins after final tightening.



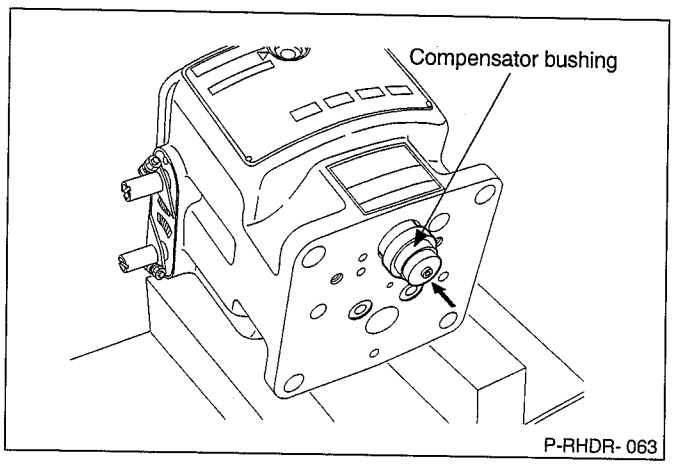

5. Install the flyweight assembly, thrust needle roller bearing and washer in the housing.



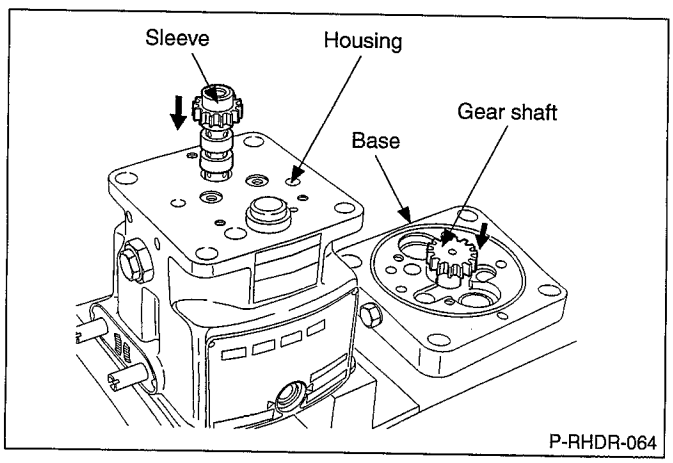

6. Install the speed control shaft, collars and fork, and then install the roll pin.

**Advice**

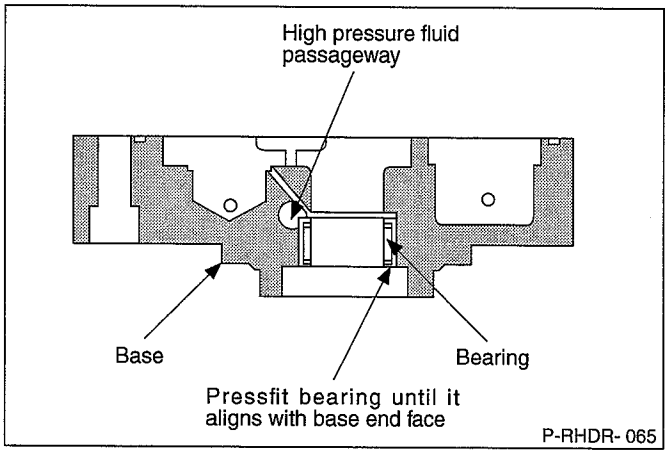
**PC, MC, and MCL governors are equipped with a cancel spring. Install the cancel spring when installing the speed control shaft.**




7. Install the power piston, the compensator assembly and the compensator bushing.

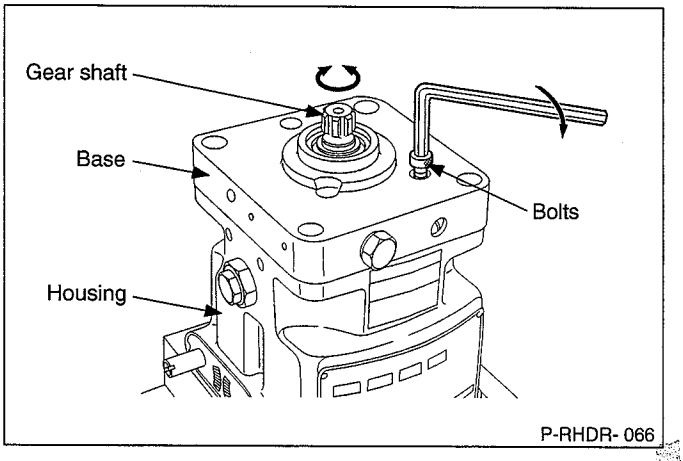



8. Install the gear shaft in the base, and the sleeve in the housing.




**Advice**

**When pressfitting the gear shaft bearing into the base, pressfit the bearing to align with the base face, as shown. If the bearing is pressfitted too deep, the bearing will block the high pressure fluid passageway.**

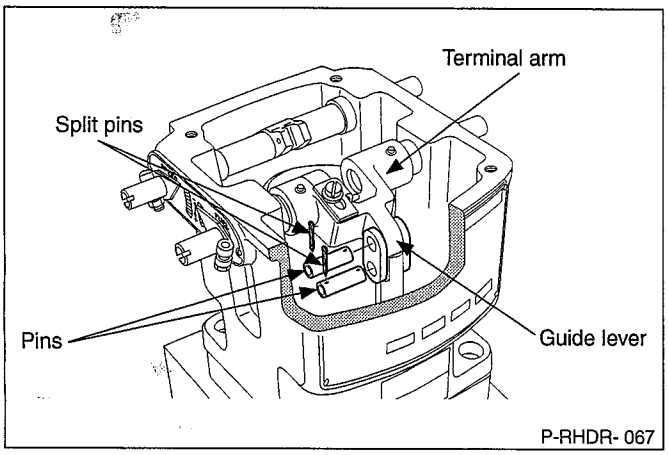



9. Install the base to the housing using the bolts and gasket washers.

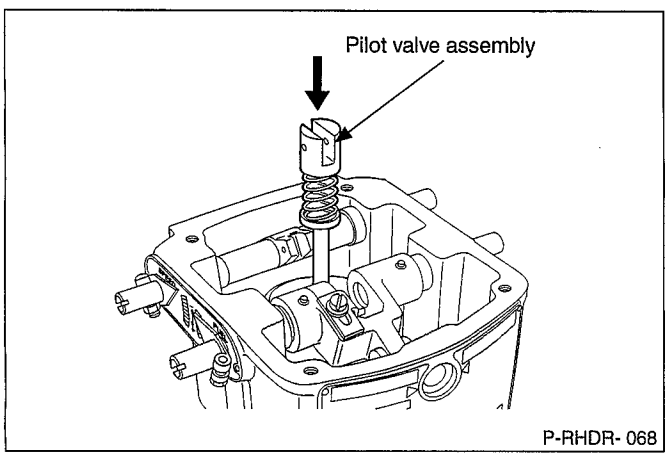
**Tightening torque: 10 ~ 15 N·m {1.0 ~ 1.5 kgf·m}**

**⚠ CAUTION**

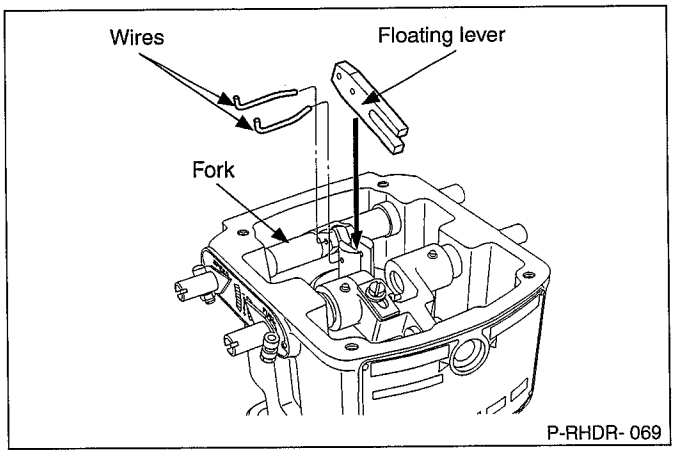
**While securing the base to the housing, check that the gear shaft turns smoothly. If the gear shaft does not turn smoothly, the oil delivery gear may be damaged.**



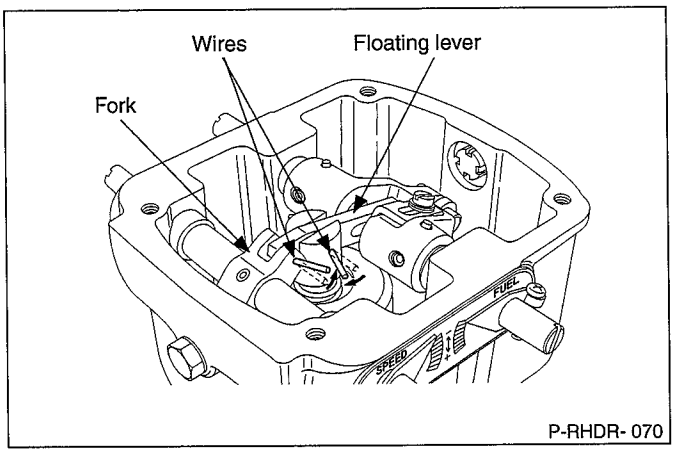

10. Attach the guide lever to the terminal arm and the power piston using the two pins and two split pins.
Then, bend the split pins over.



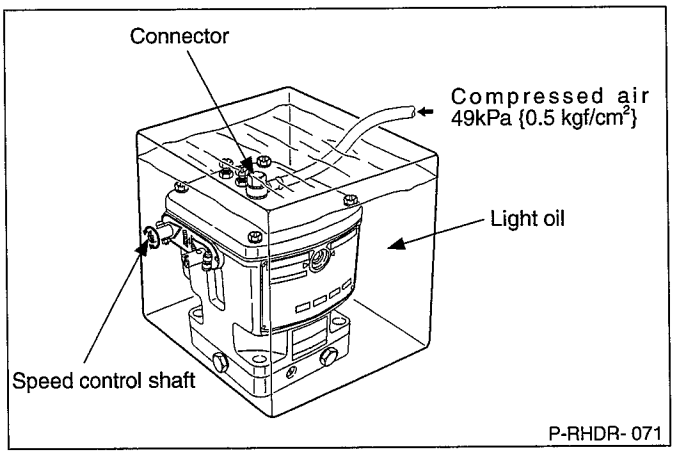

11. Install the pilot valve assembly.




12. Install the floating lever and secure it to the fork and pilot valve using the two wires.




**Advice**
**Bend the ends of the wires to prevent them from loosening.**



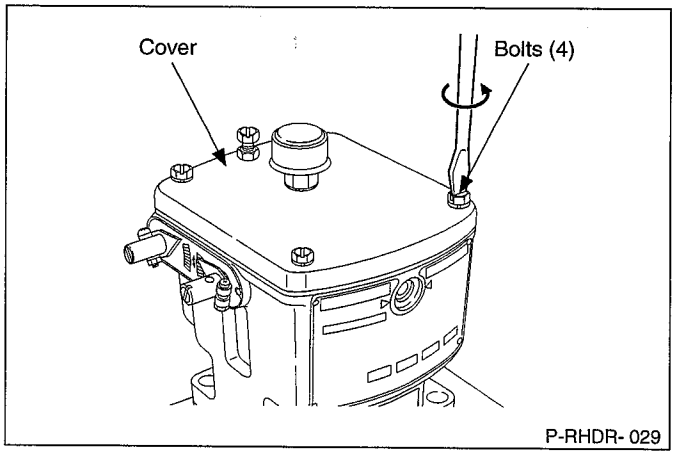

13. After assembling the governor's inner components, thoroughly wash the inside and then install the cover using the bolts.

**Air tightness test**

-1 Before filling the governor with hydraulic fluid, remove the air breather and install the connector, gaskets and eye bolt. Then, supply compressed air at 49 kPa {0.5 kgf/cm$^2$} to the governor through the connector, and immerse the governor in light oil.

-2 Operate the speed control shaft and check that no air leaks from the governor. If air leaks, repair the governor.

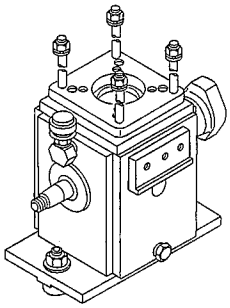
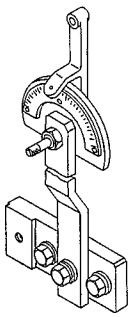
**Advice**
**If the governor is equipped with an overflow valve, seal it using a blind plug.**
**If the governor is equipped with booster connections, remove them and seal the openings with blind plugs.**
**Remove the blind plugs and reinstall all components after adjustment.**

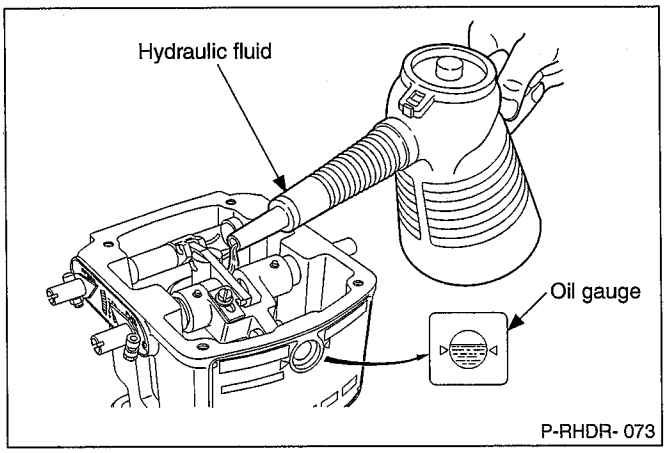



14. Remove the connector, gaskets and eye bolt.
Reinstall the air breather, then remove the cover.

In addition to general tools, the following special tools are necessary for governor adjustment.

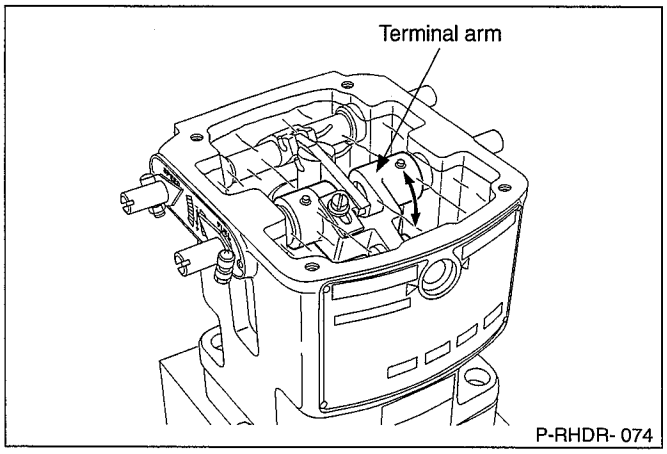
## SPECIAL TOOLS

| Key no. | Part name | Part no. | Shape | Remarks |
|---|---|---|---|---|
| 1 | Driving stand | 307610-0050 |  | For driving RHD governor |
| 2 | Adjusting device | 307610-1010 |  | For measuring lever angle |

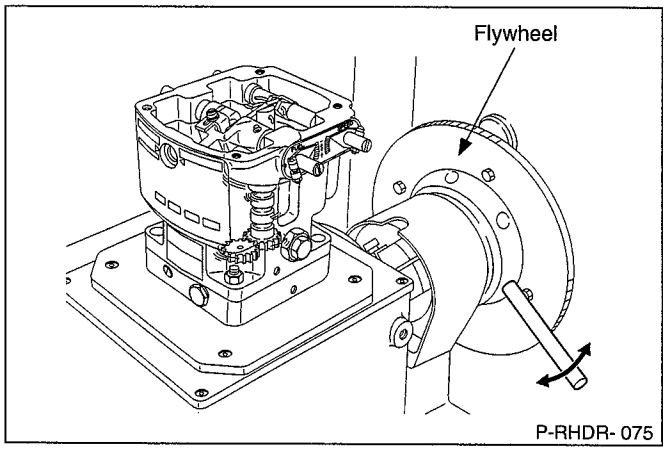



## PREPARATION

1. Attach the driving stand to the pump tester and install the governor on the driving stand.
   Fill the governor with the specified amount of hydraulic fluid (approx 1,300 $cm^3$; the fluid should be a little over the middle of the gauge).




2. Move the terminal arm by hand until it becomes difficult to move to bleed the air from the governor.

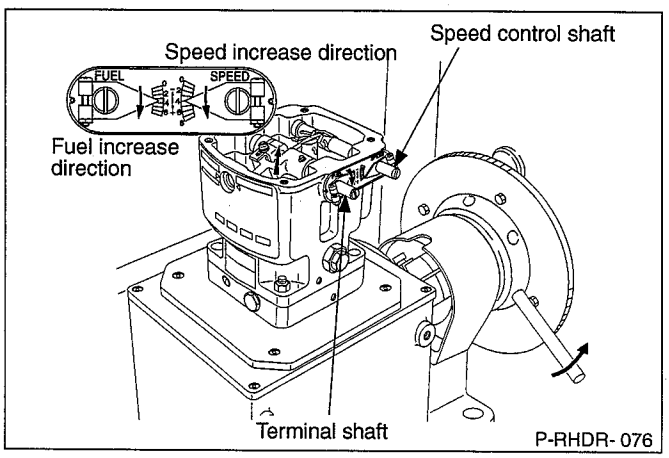



3. Turn the flywheel by hand and check that the gear shaft can be turned easily, and that the flyweight turns together.

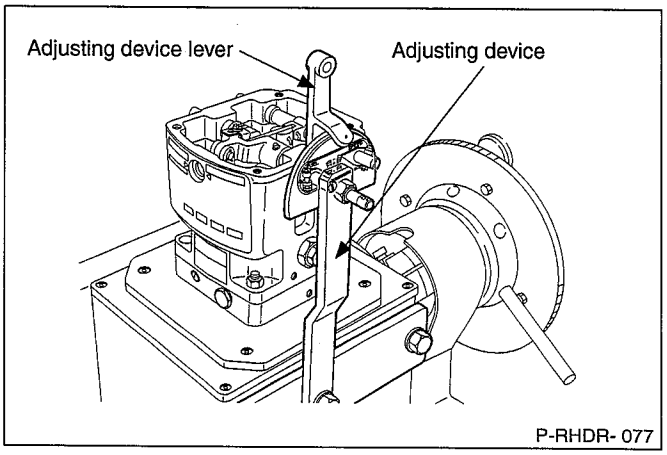
**Note:**
**If the gear shaft does not turn easily, it will heat up during operation and adversely affect endurance.**

**⚠ CAUTION**

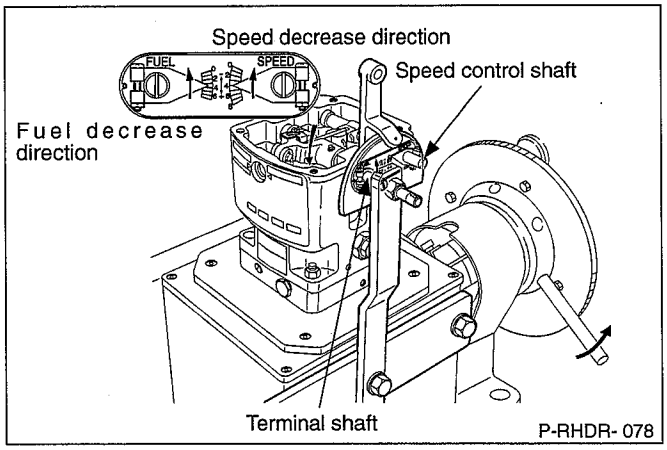
**Remove the lever after operating the flywheel.**
**Operating the test bench without removing the lever can cause serious injury and damage the test bench.**




4. Set the speed control shaft in the speed increase position, rotate the gear shaft and check that the terminal shaft moves in the fuel increase direction.



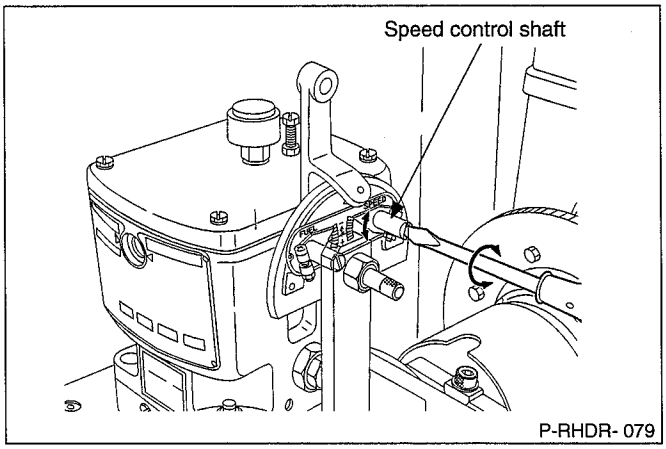

5. Attach the adjusting device to the driving stand and then attach the adjusting device lever to the terminal shaft.




6. Set the speed control shaft in the speed decrease position, rotate the gear shaft and check that the terminal shaft moves in the fuel decrease direction.

**Note:**
**If the cover is installed, the terminal shaft may not return in the fuel decrease direction, depending on the set position of the speed control shaft.**

7. Install the governor cover.



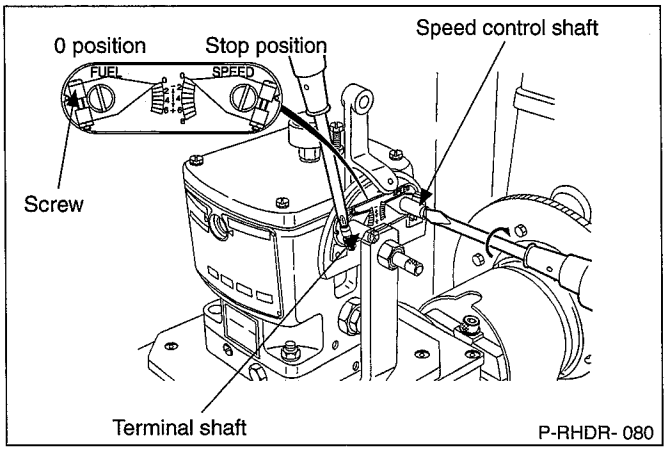

**Warming-up operation**

Run the governor at 1,000 r/min for 20 mins and check that no fluid leaks.

**Air bleeding**

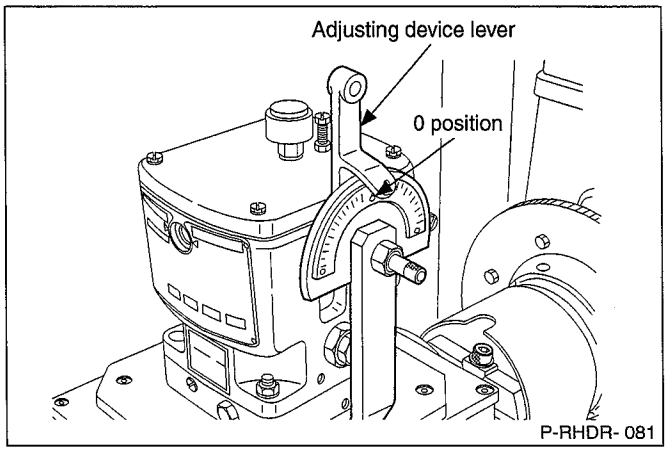
Fully open the needle valve (approx 3 turns from the fully closed position) and run the governor at 1,000 r/min. Operate the speed control shaft so that the power piston moves through its full stroke.

Do this at least 10 times to bleed all air from the governor's hydraulic system.

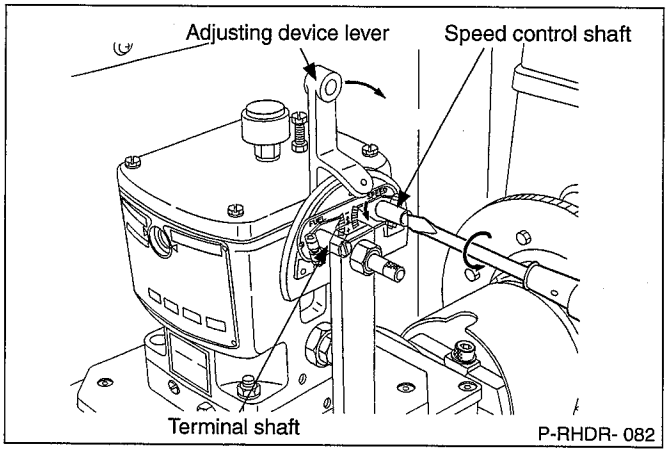



**Terminal shaft pointer adjustment**

1. Run the governor at approx 1,000 r/min and move the speed control shaft to the stop position.
2. In the above condition, align the terminal shaft side pointer with the indication plate's (fuel side) 0 position and fix it using the screw.




3. This position is the terminal shaft angle's 0 position. Align the adjusting device's 0 position with this position.



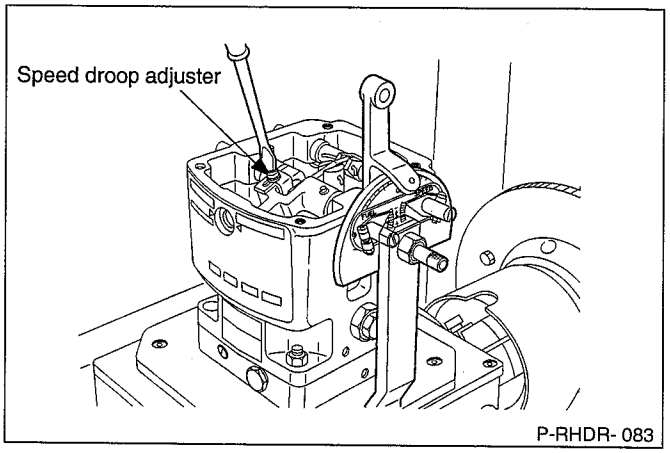

4. Run the governor at approx 600 r/min (with the needle valve fully open, ie, returned 3 turns from the fully closed position) and turn the speed control shaft. Check that the terminal shaft moves easily from 0° ~ 35° (RHD10: 0° ~ 40°) when the power piston moves through its full stroke.
   At this time, check that the terminal shaft operating torque is 9.8 N·m {1 kgf·m} for the RHD6 or 14.7 N·m {1.5 kgf·m} for the RHD10 using a spring balance attached to the adjusting device.

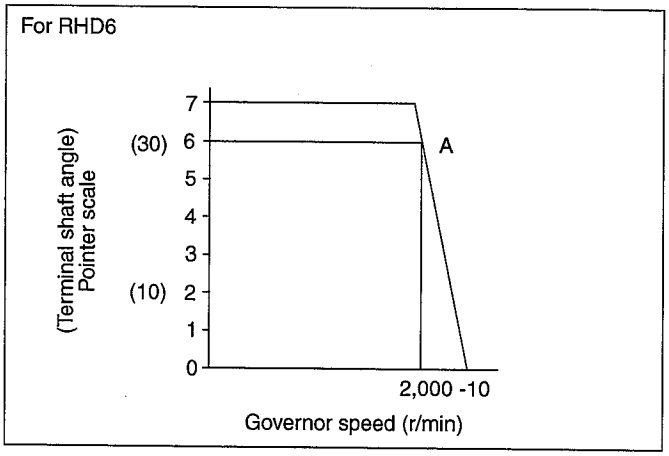
## OPERATION TEST

The operation test is the same for LC, PC, MC, and MCL type governors.
Perform the operation test with the needle valve fully open.

### Speed control shaft pointer angle adjustment

1. Remove the governor cover and set the droop adjuster pointer at the specified value.

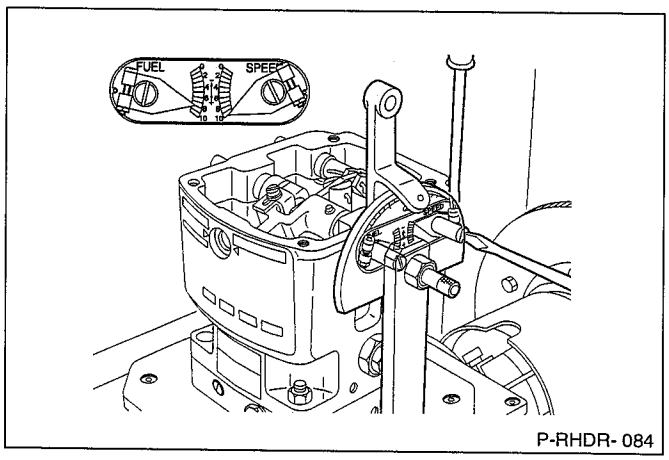


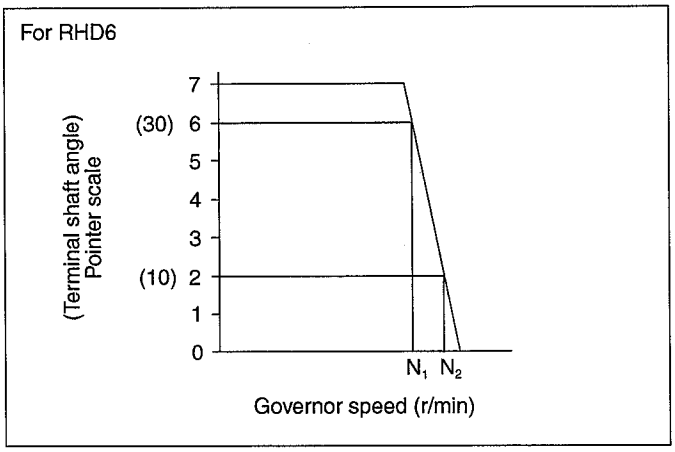

2. Run the governor at 2,000-10 r/min and secure the speed control shaft at the position (A) where the terminal shaft angle is 30° (ie, 6 on the scale). Then, align the speed control shaft pointer at 8 (on scales graduated from 0 ~ 8) and tighten the screw.

Note:

-1 On PC, MC and MCL governors, the terminal shaft is fixed (at A) by a knob.

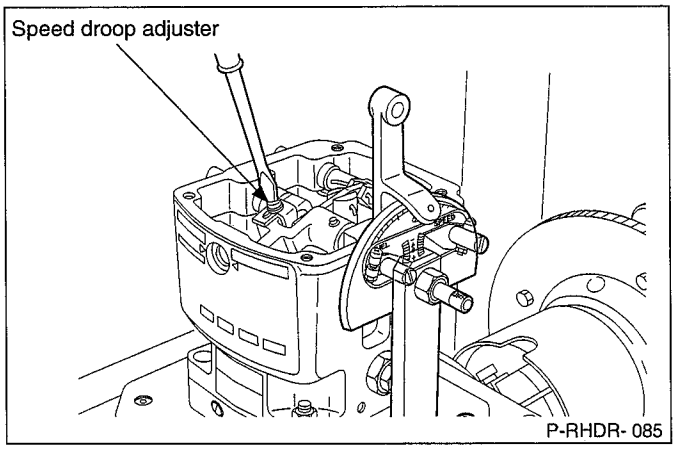



-2 On RHD10 governors, when the terminal shaft angle is 32° (ie, 8 on the scale), align the speed control shaft pointer at 10 using the screw.




**Speed droop adjustment**

1. Temporarily fix the droop adjuster pointer at the specified position.
2. Operate the governor at $N_1$ r/min and then fix the speed control shaft when the terminal shaft angle is 30° for the RHD6 or 32° for the RHD10.



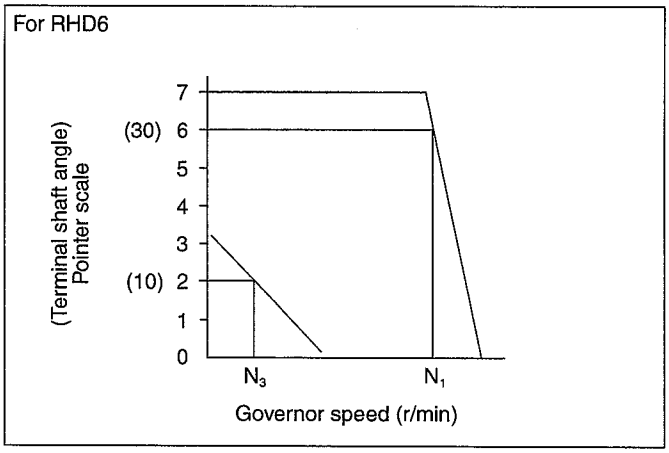

3. Gradually increase governor speed and further adjust the speed droop adjuster so that governor speed is $N_2$ r/min when the terminal shaft angle is returned to 10° for the RHD6 or 8° for the RHD10.

Note:
When the speed droop adjuster pointer is moved toward 0, speed droop decreases.
When the speed droop adjuster is moved toward 10, speed droop increases.

**Advice**

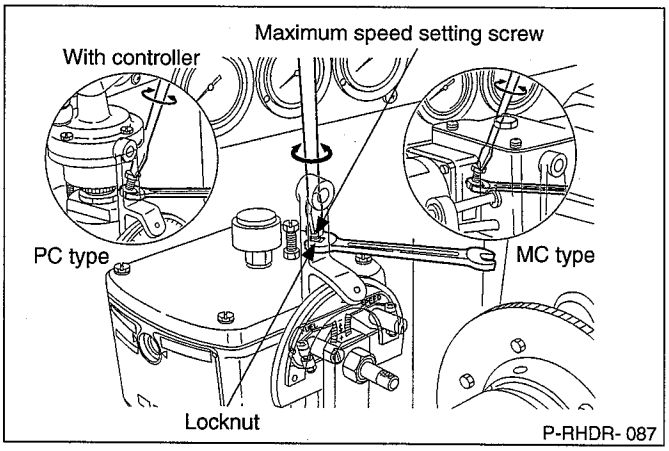
**Confirm that $N_2$ is within the allowable speed when the speed droop adjuster is exactly as specified.**

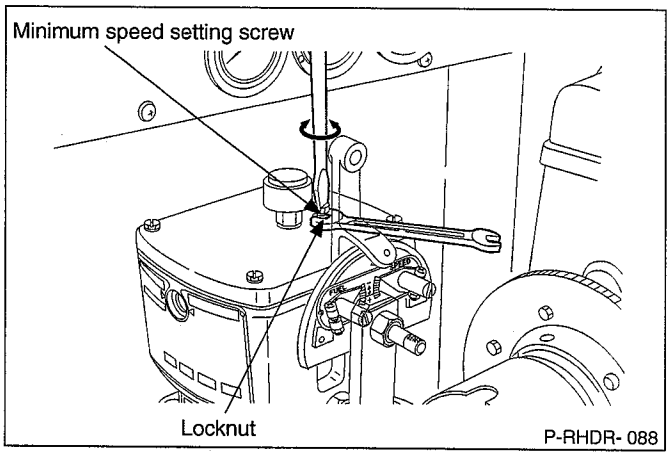
Note:
If the lever attached to the terminal shaft deviates more than ±1° during high speed operation (ie, at approx 1,800 r/min), check as follows.
Regular deviation: Check compensator related parts (housing, base, assembly, regulating valve). Replace them if necessary.
Irregular deviation: Check the flyweight assembly. Replace it if necessary.
Perform the following adjustments with the governor adjusted as described above.




**Maximum speed setting screw adjustment**
(not necessary on MCL type governors)

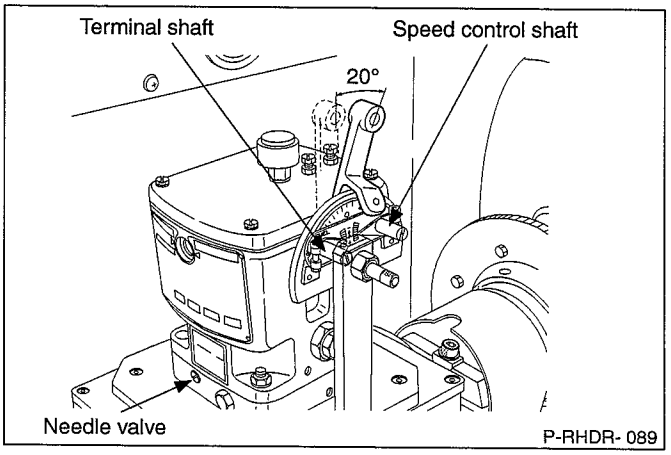
1. Install the governor cover.
   Operate the governor at $N_1$ r/min, adjust the maximum speed setting screw until the terminal shaft angle is 30° for the RHD6 or 32° for the RHD10, and then fix the screw using the locknut.




**Minimum speed setting screw adjustment**
(not necessary on PC, MC or MCL type governors)

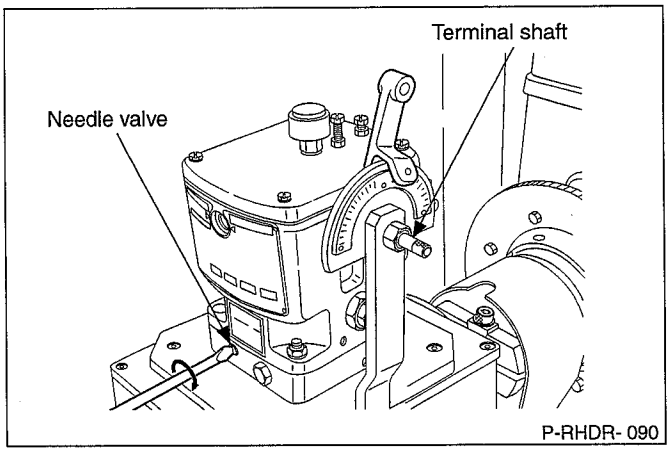
1. With the governor stopped, move the speed control shaft as far as possible to the low speed side (0 or less on the scale), and then temporarily set the minimum speed setting screw.
2. Operate the governor at $N_3$ r/min and adjust the minimum speed setting screw so that the terminal shaft angle does not exceed 10° (RHD6) or 8° (RHD10). Then, fix the screw using the locknut.

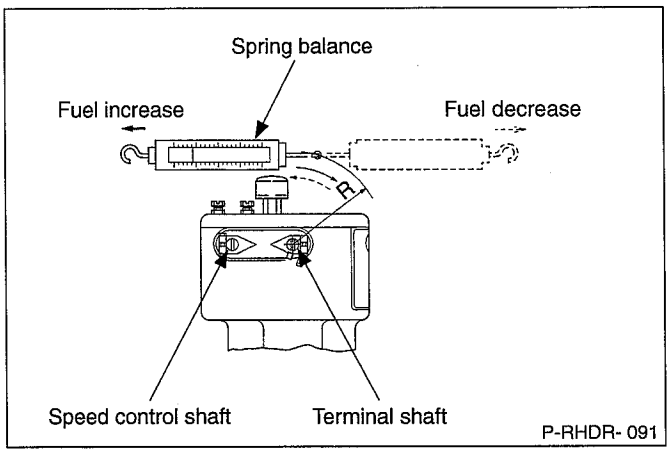



**Compensator chamber high pressure hydraulic fluid flow**

The flow of a large quantity of hydraulic fluid to the compensator is not desirable.
To check for this, perform the following test.

1. Fully open the needle valve (approx 3 turns from the fully closed position) and maintain governor speed at approx 1,000 r/min.
2. Fix the speed control shaft so that the terminal shaft angle is approx 20° (4 on the scale).




3. Fully close the needle valve and check that the terminal shaft does not move more than 1° in the 0 direction.

**Advice**

**If the terminal shaft moves more than 1° in the 0 direction, check for the following.**

- **Clearance between the sleeve and base.**
- **The base-housing contact surfaces may not be even, or may be scratched.**
- **The needle valve escape ports (ϕ 0.4 and ϕ 0.8) and the base escape ports (ϕ 1.5) may be blocked.**
- **The compensator bushing O-ring may be damaged.**

### Governor control confirmation

Under the following conditions, operate the speed control shaft to move the terminal shaft in the fuel increase direction (RHD6: 0° → 35°; RHD10: 0° → 40°) and in the fuel decrease direction (RHD6: 35° → 0°; RHD10: 40° → 0°) and check that the lever resistance is as specified.

Measurement conditions

| | |
|---|---|
| Governor speed: | 600 r/min |
| Needle valve position: | fully open |
| R (see fig at left): | 100 mm |

Note :

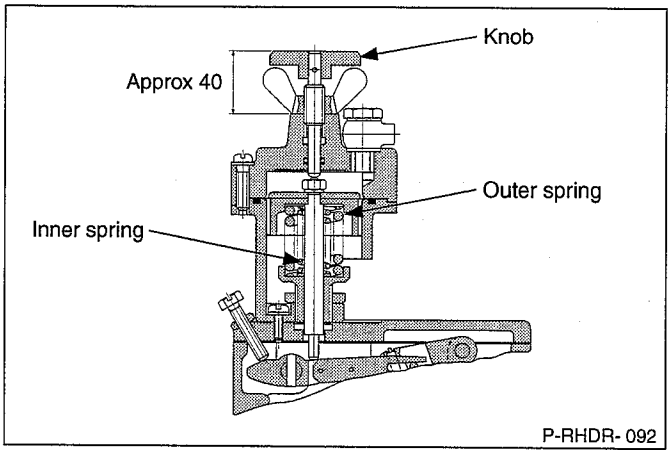
If the lever resistance is not as specified, replace the following parts.

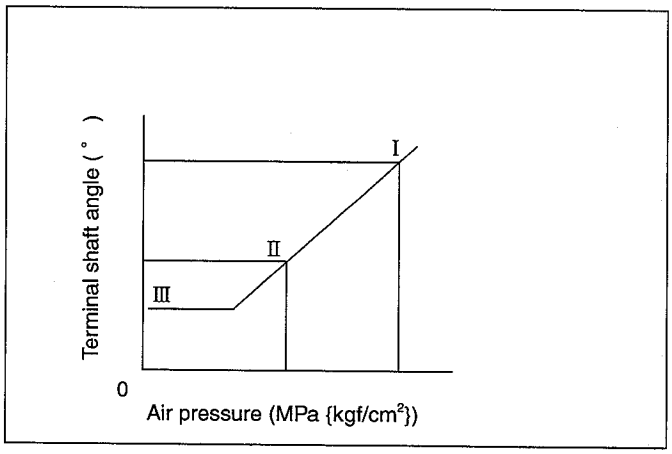
- Regulating valve assembly
- Check for openings or leaks in the gear pump or hydraulic fluid system and replace faulty or damaged parts.

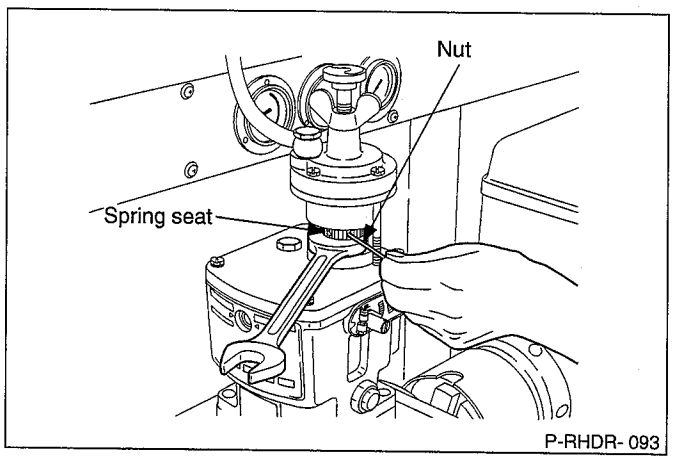
### Reverse operation

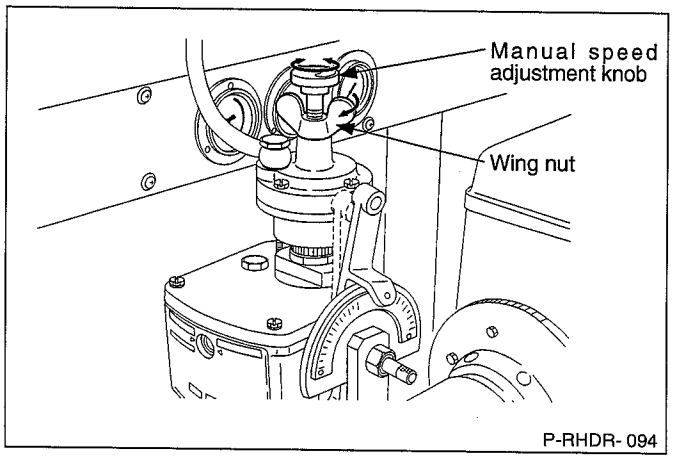
The RHD governor is constructed so that identical performance is obtained whether it is operating clockwise or counterclockwise.

To confirm this, operate the governor in the reverse direction and check governor control as described above under the exact same conditions and procedures, and check that performance is as specified.




## ADDITIONAL DEVICES

### Pneumatic controller adjustment

1. Before adjustment, check that the outer and inner springs' distinguishing colors are as specified.
2. Temporarily position the manual knob as shown at left and connect a compressed air source capable of supplying 0 ~ 0.49 MPa {0 ~ 5 kgf/cm$^2$ } to the eye bolt.

Note :

Perform the following adjustments and confirmations based on the individual test standards.

3. Point I adjustment

**Example:**

| | | |
|---|---|---|
| **1,680 ~** | **0.37 MPa ~ {3.8 kgf/cm$^2$}** | **30±0.5** |
| **(speed)** | **(air pressure)** | **(terminal shaft angle)** |

Operate the governor at 1,680 r/min and adjust the spring seat so that the terminal shaft angle is 30±0.5° when when 0.37 MPa {3.8 kgf/cm$^2$} air pressure is supplied. Then, secure the spring seat using the nut.

**Advice**

**When adjusting point I, return the air pressure to 0 and the manual speed adjusting knob to its original position to prevent diaphragm damage.**

4. Point II adjustment

**Example:**

| | | |
|---|---|---|
| **1,055 ~** | **0.16 MPa ~ {1.6 kgf/cm$^2$}** | **(Approx 16.5)** |
| **(speed)** | **(air pressure)** | **(terminal shaft angle)** |

Operate the governor at 1,055 r/min and confirm that the terminal shaft angle is 16.5° when 0.16 MPa {1.6 kgf/cm$^2$} air pressure is supplied.

5. Point III adjustment

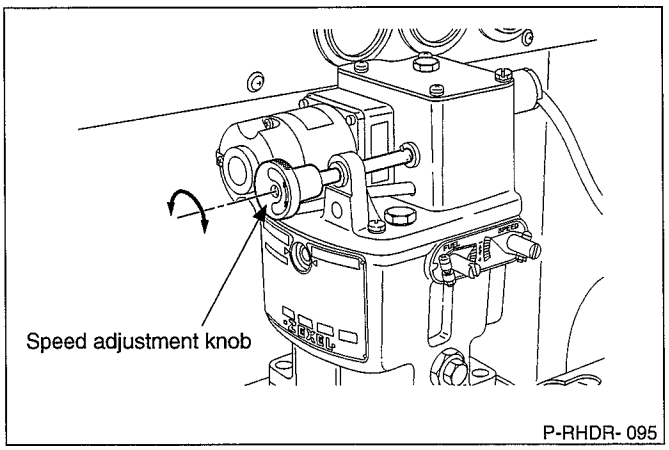
**Example:**

| | | |
|---|---|---|
| **700 ~** | **0 ~** | **8.5+1.5** |
| **(speed)** | **(air pressure)** | **(terminal shaft angle)** |

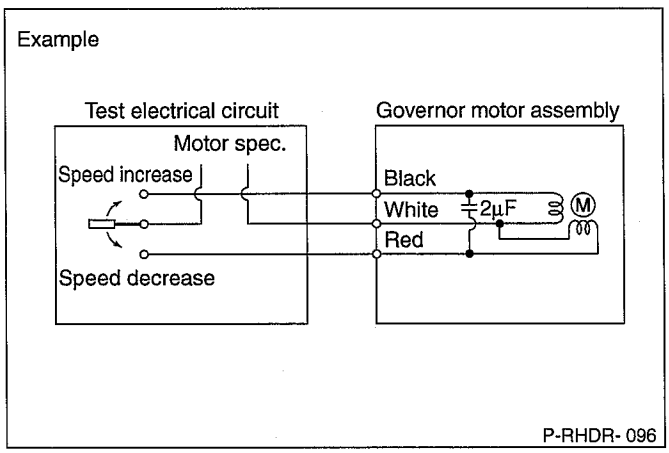
Operate the governor at 700 r/min and adjust the manual speed adjustment knob so that the terminal shaft angle is 8+1.5° at an air pressure of 0. Then, secure the knob using the wing nut.

**Governor motor operation confirmation (MC type)**

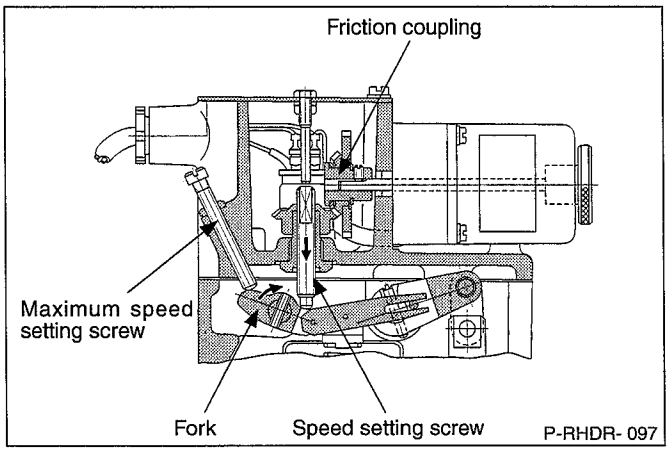
1. Specification confirmation
   Confirm from the individual standards that the specifications of individual parts are correct.
- Motor specification (voltage)
- Condenser capacity
- Speed reduction ratio



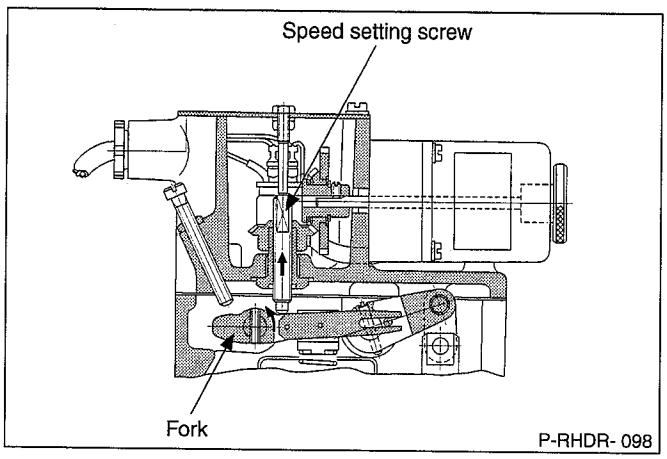

2. Operation confirmation (using speed adjustment knob)
   Turn the knob manually, and confirm that the speed setting screw turns smoothly over the whole range by observing speed control shaft pointer movement.
   If it does not move smoothly over the whole range, loosen the friction coupling set screw, adjust the positions of the bevel gear teeth and recheck screw movement.



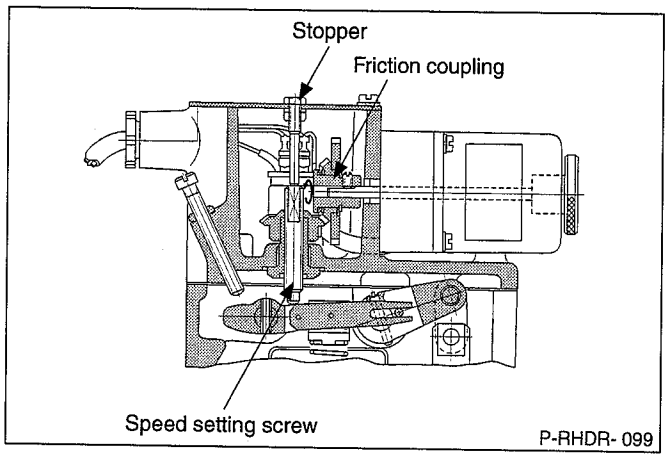

3. Operation confirmation (using the motor)
   Connect the governor motor assembly to the electrical test circuit in accordance with the particular motor's specifications, as shown at left.



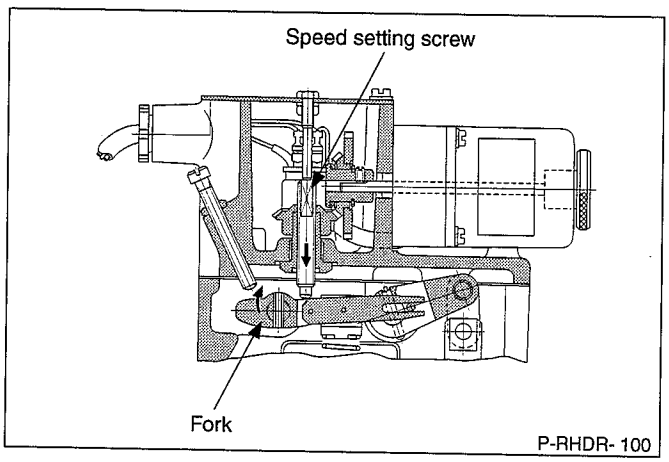

4. Operation test
- Turn the governor motor's speed switch ON in the speed increase direction to operate the motor.
  Then, operate the motor until the fork contacts the maximum speed setting screw adjusted above and the friction coupling is rotating freely.




- Then, turn the switch OFF and then ON in the speed decrease direction, and confirm that the speed setting screw begins moving smoothly.




- Operate the governor motor until the speed setting screw contacts the stopper and the friction coupling is rotating freely.




- Then, turn the switch OFF and then ON in the speed increase direction and confirm that the speed setting screw moves smoothly.

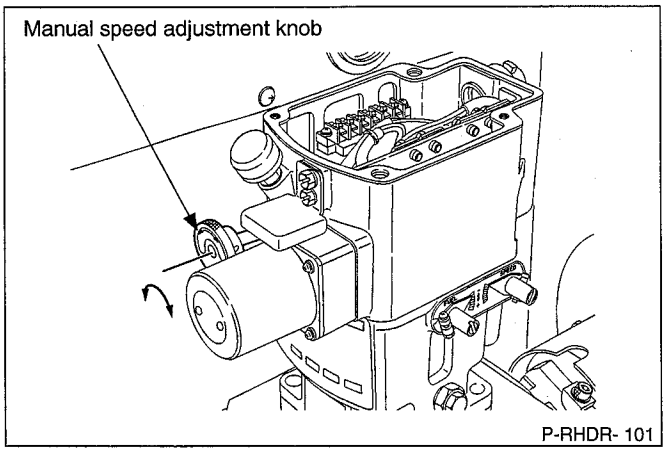
**Advice**

**During the above operation test, if the friction coupling rotates freely in other than the following two cases, check the alignment of the bevel gear teeth.**

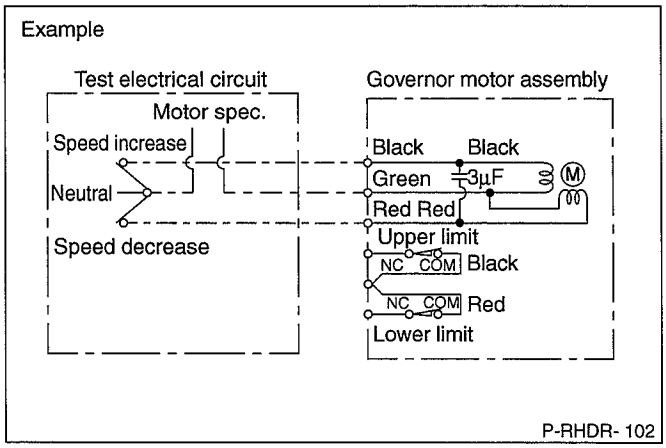
- **When the maximum speed setting screw is contacting the fork**
- **When the speed setting screw is contacting the stopper**

**Governor motor operation test and limit switch adjustment (MCL type)**

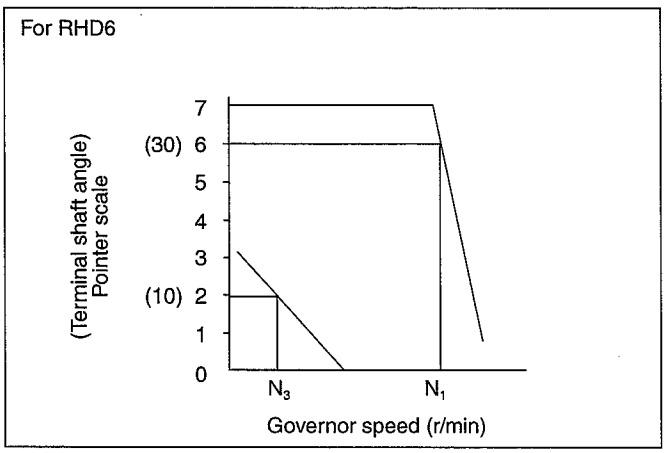
1. Specification confirmation
   Confirm from the data sheet that the specifications of individual parts are correct.
- Motor specification (voltage)
- Condenser capacity
- Speed reduction ratio



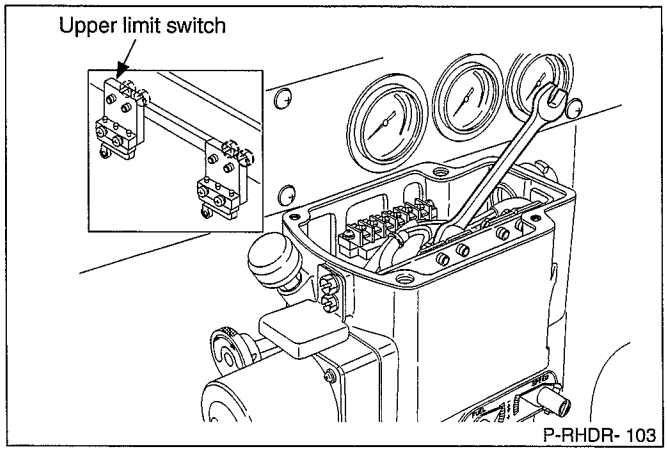

2. Operation confirmation
(using the manual speed adjustment knob)
Confirm operation as described below before adjusting the terminal shaft side pointer.
Operate the knob manually and confirm that the speed setting screw rotates smoothly over the full range.
If it does not move smoothly in some places, check the installation of the holder or the speed setting screw.

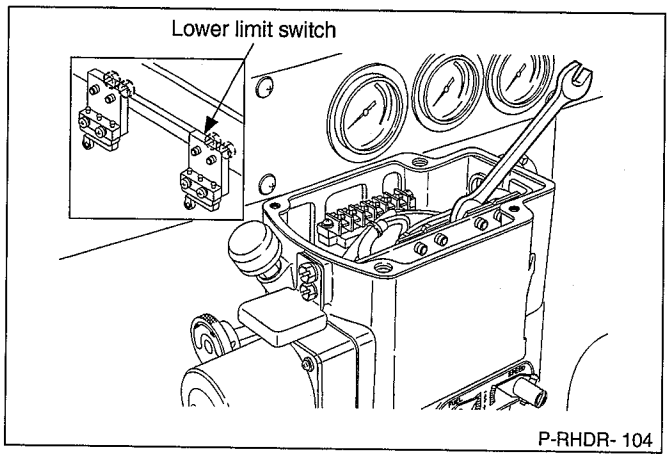



3. Governor motor operation test
(limit switch adjustment)
Connect the governor motor assembly to the electrical test circuit in accordance with the particular motor's specifications, as shown at left.
Then, adjust each limit switch.




- Maximum speed limit switch adjustment
Operate the governor at the specified speed ($N_1$ r/min), and the governor motor in the speed increase direction.
Adjust the limit switch's upper limit position so that the governor motor stops at the terminal shaft angle of 30±3° for the RHD6 or 32±3° for the RHD10.






- Minimum speed limit switch adjustment
  Operate the governor at the specified speed ($N_3$ r/min), and the governor motor in the speed decrease direction.
  Adjust the limit switch's lower limit position so that the governor motor stops at the terminal shaft angle of 10±3° for the RHD6 or 8±3° for the RHD10.
  Set the governor speed at 1,500 r/min and confirm that the governor motor operates correctly between the upper and lower operation limits and that the friction coupling does not rotate freely.

## TROUBLESHOOTING

Of the phenomena listed below, some originate solely in the governor, and some solely in the engine.

- Faulty starting
- Hunting
- Insufficient engine output
- Engine will not operate at maximum speed
- Excessive momentary speed droop, or inability to control speed

First, check the engine for the following faults. If engine faults are found, perform repairs in accordance with the engine maker's instructions.

- Compression pressure of each cylinder is extremely uneven
- Excessive play in fuel control and speed adjustment linkage
- Excessive resistance in injection pump control rack and fuel control linkage
- Excessive play because of worn governor drive system gear or rubber damper
- Relative positions of linkages incorrect
- Dashpot spring in fuel control linkage bent or damaged

If no engine faults are found, check the governor.

As the governor uses many precision parts, there is a danger of the engine overrunning if these parts are incorrectly assembled.

**⚠ CAUTION**

**Never attempt to repair the governor on-site.**

**Always consult your nearest Bosch Corporation representative.**

# 12 PART NUMBER EXPLANATION

## MODEL NUMBER

**Example:** RHD 6 L C
(1) (2) (3) (4)

(1) Independent type hydraulic governor, manufactured by Bosch Corporation
(2) Control force (work load)
Indicates 10 times the controlling force (work load) in kgf·m.
(3) L: lever type
M: with governor motor
P: with pneumatic controller
(4) C: with compensator

Note:
No symbol 'C' indicates that a compensator is not used.

## CODE NUMBER

**Example:** 10 58 5 6 - 0 000
(1) (2) (3) (4) (5) (6)

(1) 10: Assembly part number
(2) 58: Hydraulic governor manufactured by Bosch Corporation
(3) Type
5: RHD6 type
6: RHD10 type
(4) Direction of pump rotation and governor installation position

| | Direction of pump rotation | Governor installation position | Remarks |
|---|---|---|---|
| 0 | Clockwise | Right side | For in-line pumps |
| 1 | Clockwise | Left side | |
| 2 | Counterclockwise | Right side | |
| 3 | Counterclockwise | Left side | |
| 4 | Clockwise | - | |
| 5 | Counterclockwise | - | |
| 6 | Reversible | - | |

Note:
With in-line pumps, the direction of pump rotation is viewed from the pump's drive side.
Governor installation position is viewed from the pump's cover plate side.

(5) Remote control device installation
3: LC type without remote control device
4: PC type
5: MC type
6: MC type
7: MCL type
8: MCL type
9: HC type, others
} with remote control device

(6) Characteristic number

Pub. No: EE74E-11016

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