Applicable Trainees: Senior Engine Officers

Objectives of the Training

After completion of the training, the trainees should understand the followings:

1) Maneuvering mechanism of Main Engine from Local and Remote control position

2) Electrical control drawings from the NABTECSO instruction manual

3) Operation of the Control and Safety system Unit and how to change the set points

4) Operation of Electric Governor System and how to change the set points

Duration of Training: 4 Days

Course schedule:

	Contents of the course		Contents of the course	
	AM	AM	PM	PM
1st day	Understanding of control air diagram and	Structure and function of pneumatic system components	Structure and function of pneumatic system components	Structure and function of pneumatic system components
2nd day	Structure and function of pneumatic system components	Remote control system arrangement	Remote control system arrangement	Simulator training and trouble shooting
3rd day	Control system	Control system	Simulator training and trouble shooting	Simulator training and trouble shooting
4th day	Safety system	Governor system	Simulator training and trouble shooting	Simulator training, trouble shooting and Assessment

Contents and Syllabus

1. Maneuvering mechanism of Main engine:

1.1 Symbols used in Maneuvering system diagram:

(Source: NABTESCO Remote control system instruction manual, Vol. 2)

Symbols for Piping Diagram

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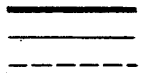
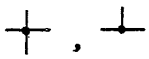
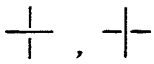
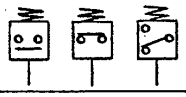
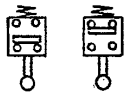
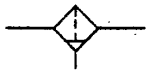
No.	Symbol	Main representation	Note
1		Pipe passage	Broken line especially expresses the oil piping.
2		Connection of pipes	
3		Intersection of pipes	
4		Outlet of which top end is closed	
5		Air reservoir (Air bottles)	
6		Stop valve (BALL valve)	
7		Pressure gauge (Single arrow)	
8		Pressure gauge (Double arrows)	
9		Spring	Springs are scarcely used independently but used in combination with other symbols.
10		Variable tension spring	This symbol is used when tension of the spring can be varied.
11		Pressure switch	Expresses a, b, and c type contact point from the left.
12		Limit switch	Expresses normal position and operated position from the left.
13		Filter	This expresses a filter that accompanies the draining device.

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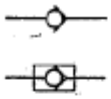
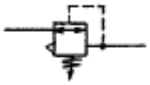
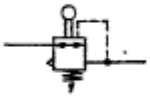
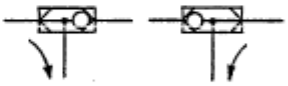
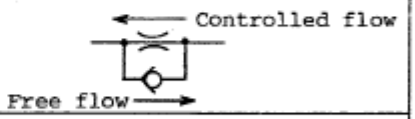
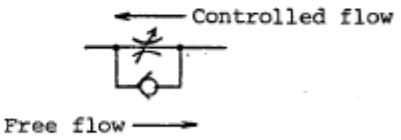
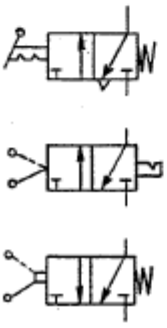
No.	Symbol	Main representation	Note
14		Check valve	If flows from the right to the left but not reverse direction.
15		Relief valve (Safety valve)	
16		Reducing valve, adjustable type with relief valve	
17		Reducing valve, adjustable type with relief valve (Mechanical action through a rod)	
18		Choke valve (orifice valve)	
19		Variable choke valve	This represents a choke that can vary its orifice opening.
20		Double check valve (shuttle valve)	
21		Orifice check valve	
22		Check-choke valve (choke valve with checking function)	
23		3-port/2-position switching valve (Manual action through a lever)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.

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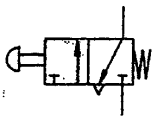
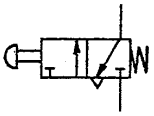
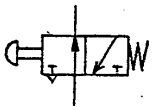
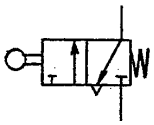
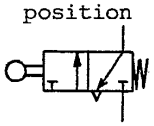
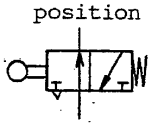
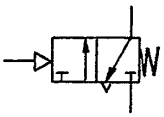
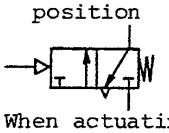
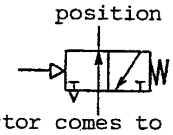
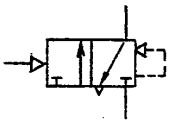
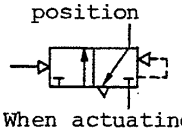
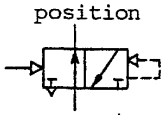
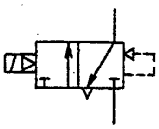
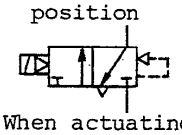
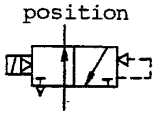
No.	Symbol	Main representation	Note
24		3-port/2-position switching valve (Push button action spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.
25		3-port/2-position switching valve (Mechanical action spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block colsest to the factor symbol is connected with the pipe passage.
26		3-port/2-position switching valve (Pneumatic pilot action spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.
27		3-port/2-position switching valve (Pneumatic pilot action air spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.
28		3-port/2-position switching solenoid valve (Example of sequential action air spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.

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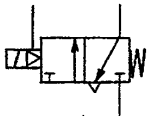
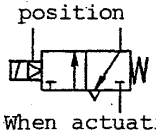
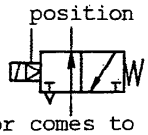
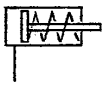
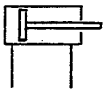
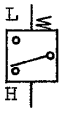
No.	Symbol	Main representation	Note
29	 (External Pilot Type)	3-port/2-position switching solenoid valve (Electromagnetic action spring return system)	Normal position  Operated position  When actuating factor comes to work on the switching valve, the block closest to the factor symbol is connected with the pipe passage.
30		Cylinder	Single motion (With spring)
31		Cylinder	Double motion
32		Exhaust choke valve	
33		Differential pressure switch	

1.2 Maneuvering system diagram:

1.2.1 Understanding of Maneuvering system diagram:

As shown in Figure 1.1, the Maneuvering system diagram is designed for SULZER 12RTA 96C type engine, using NABTESCO M-800III-D6A type Remote control system and MG-800 Governor system.

The maneuvering system comprises of various sub-systems such as:

- Starting air system
- Control air system
- Safety control air system
- Spring air system for Exhaust valve
- Oil system for Fuel cam Reversing mechanism
- Oil system for Exhaust valve
- Fuel system
- Cylinder lubricating oil system

NOTE: DENIS – Diesel ENgine Interface Specification

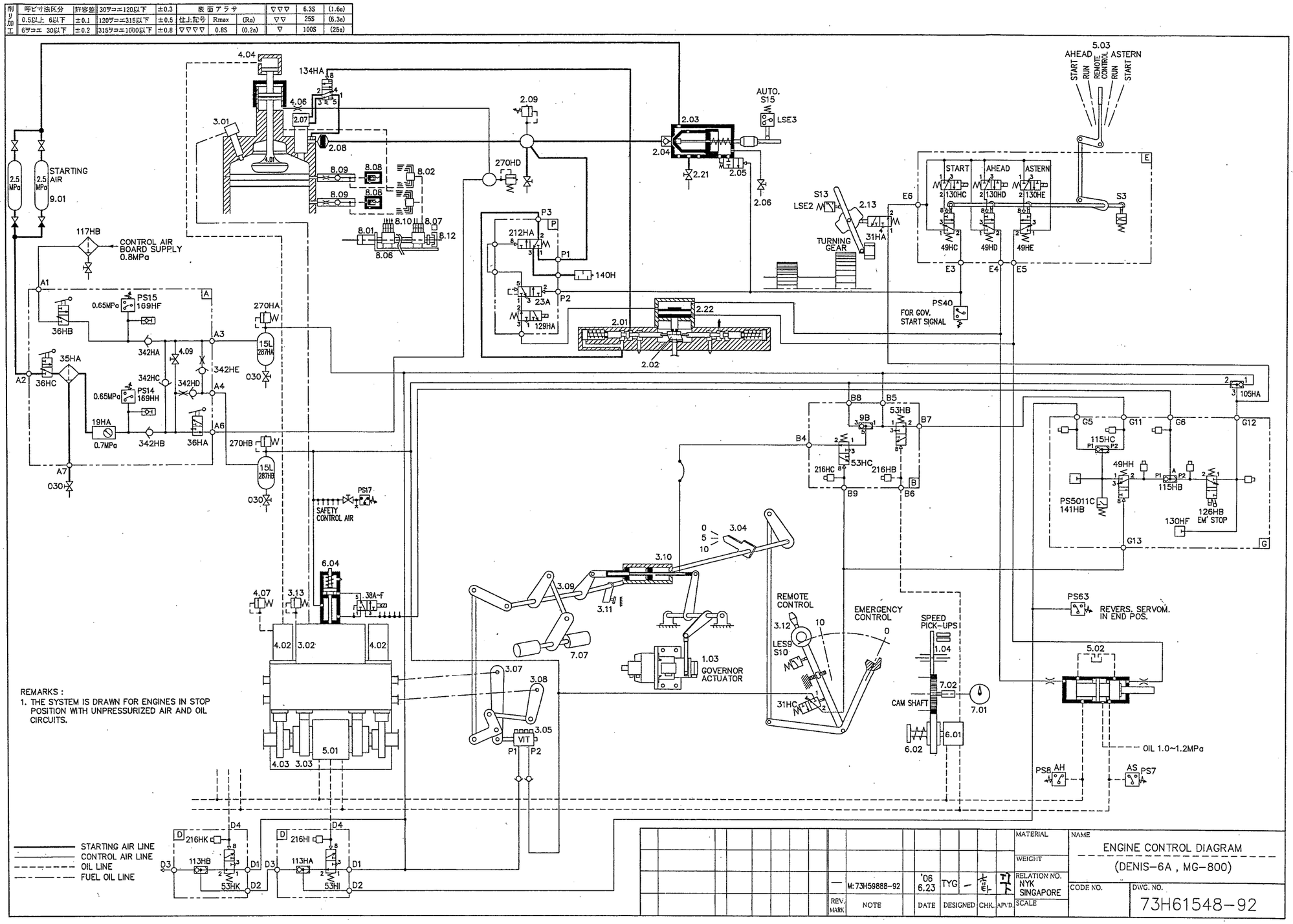


Fig. 1.1 Maneuvering system diagram (Source: NABTESCO Remote control system instruction manual, Vol. 2)

1.2.2 Function of components used in Maneuvering system diagram:

Refer Figure 1.1 for the following description.

117HB: Air filter (GFH- 3S- 2)
Traps impurities in the Main source air control air supply

287HA: Air reservoir (15lts)
Reduces time lag in the control air system

270HA: Safety valve (Set pressure: 0.99MPa)
Relieves excess pressure from the control air reservoir

287HB: Air reservoir (15lts)
Reduces time lag in the safety air system

270HB: Safety valve (Set pressure: 0.99MPa)
Relieves excess pressure from the safety air reservoir

PS17: Pressure switch
Activates alarm in case of low pressure in the safety air system

105HA: Double check valve (GDC-22M)
Allows either control or safety air to valve group E and G

31HC: 3/2 way valve (GA-314M-B)
Allows pilot air signal to valve 53HC and 49HH, when fuel lever 3.12 is shifted to emergency control position

S10 (LSE9): Limit switch
Provides signal to C/R maneuvering unit whether Fuel lever 3.12 is in Remote or Emergency control position

PS40: Pressure switch for local governor control during starting

31HA: 3/2 way valve (GA-314M-B)
Stops control air signal to valve group E, when turning gear is engaged.

S13 (LSE2): Limit switch
Provides signal to C/R maneuvering unit whether turning gear is engaged or disengaged.

S15 (LSE3): Limit switch
Provides signal to C/R maneuvering unit whether auto start air shut-off valve is in Auto or Manual position.

S3: Limit switch (LWD 28)
Provides signal to C/R maneuvering unit whether maneuvering lever 5.03 is in remote or local control position.

A: Control air supply unit
36HB: 3/2 way ball valve (DBVT-1/2)
Used for isolating the main source of control air supply

169HF (PS15): Pressure switch, Set: 0.65MPa
Activates alarm in case of low pressure in the main source of control air

36HC: 3/2 way ball valve (DBVH-1/2)
Used for isolating the back up source of control air supply

35HA: Air Filter (GFH-3S-2)
Traps impurities in the back up source of control air supply

030: Ball valve
Used for draining the Filter 35HA and Air reservoirs (15lts)

19HA: Reducing valve (GRH-22M), Set: 0.7MPa
Reduces pressure of air, supplied directly from starting air reservoirs, from 2.5MPa to 0.7MPa (used as back up source of control air)

169HH (PS14): Pressure switch, Set: 0.65MPa
Activates alarm in case of low pressure in the back up source of control air

342HA, HB…HE: Check valve (GSC-22M-S)
Facilitates continuous supply of control air from back up source, if pressure of main source of control air reduces

36HA: 3/2 way ball valve (DBVT-1/2)
Used for supplying or venting the exhaust valve spring air supply

B: Valve group for auxiliary drives
53HB: 3/2 way valve (GCH-37N)
Supplies pilot air signal to safety device on fuel pump to cut-off fuel, when it is not activated by the pilot oil signal from rotation direction safeguard 6.01.

216HB: Pressure indicator (GPI-14M)
Indicates whether valve 53HB is supplied with pilot oil signal from rotation direction safeguard or not.

53HC: 3/2 way valve (GCH-37N)

Vents the air cylinder 3.10, when the fuel lever 3.12 is in emergency control position, thereby allowing control of fuel quantity being injected from the fuel lever 3.12

216HC: Pressure indicator (GPI-14M)
Indicates whether valve 53HC is supplied with pilot air signal from valve 31HC or not.

9B: Double check valve (MGDC)
Allows either control or safety air to valve 53HC

D: Valve group for reversing interlock
53HI, HK….: 3/2 way valve (GCH-37N)
Supplies pilot air signal to safety device on fuel pump to cut-off fuel, when it is not activated by the pilot oil signal from reversing servomotor 5.01.

216HI, HK….: Pressure indicator (GPI-14M)
Indicates whether valve 53HI, HK….etc. are supplied with pilot oil signal from reversing servomotor 5.01.

113HA, HB….: Double check valve (GDC-14M-A)
Ensure pilot air signal to safety device on fuel pump, even if one servomotor has not reached to end position.

E: Valve group in pneumatic logic unit
130HC: 3/2 way solenoid valve (117 type)
When energized, supplies pilot air signal to valve 49HC.

130HD: 3 way solenoid valve (117 type)
When energized, supplies pilot air signal to valve 49HD.

130HE: 3 way solenoid valve (117 type)
When energized, supplies pilot air signal to valve 49HE.

49HC: 3 way valve (GBCH-K)
Supplies pilot air signal to valve 23A and 2.05.

49HD: 3 way valve (GBCH-K)
Supplies control air to starting air distributor 2.22 and reversing valve 5.02 for shifting their position from ASTERN to AHEAD.

49HE: 3 way valve (GBCH-K)
Supplies control air to starting air distributor 2.22 and reversing valve 5.02 for shifting their position from AHEAD to ASTERN.

G: Valve group in pneumatic logic unit
115HC: Double check valve

Ensures supply of pilot air signal to safety device on fuel pump to cut-off fuel even if one of the following conditions is present in case of Emergency control

a) Rotation direction safeguard not in correct position or
b) Reversing servomotor not in end position

49HH: 3/2 way valve (GBCH-K)
Allows pilot air signal from valve 115HC to pass to valve 115HB

115HB: Double check valve
Ensures an output pilot signal to safety device on fuel pump to cut-off fuel, when receiving input signal from either valve 49Hh or valve 126HB

126HB: 3/2 way solenoid valve (1116 type)
When energized or manually activated, supplies a pilot air signal to safety device on fuel pump to cut-off fuel.
141HB (PS5011C): Pressure switch, Set: 0.2MPa
Provides signal to C/R maneuvering unit when activated to cut-off fuel supply in case of direction rotation safeguard not in correct position or reversing servomotor not in end position.

P: Valve group at starting air distributor
129HA: 3/2 way solenoid valve (1538 type)
When energized (when engine rpm reaches start air cut level), stops control air supply to valve 23A.

23A: 3/2 way valve (MGCC)
When energized, supplies pilot air signal to valve 212HA.

212HA: 3/2 way valve (2456 type)
When energized, supplies pilot air signal to valve 134HA.

140H: Allows controlled draining of starting air pipe line.

Speed setting system
1.03: Actuator
1.04: Speed pick-ups

Starting system
2.01: Starting air distributor
2.02: Cam for starting control valves
2.03: Shut off valve for starting air
2.04: Non-return valve
2.05: Control valve
2.06: Drain and test valve
2.07: Starting valve

2.08: Flame arrestor
2.09: Relief valve
2.13: Blocking valve on turning gear
2.21: Venting valve
2.22: Reversing servomotor for starting system

134HA: 4/2 way valve
Controls opening or closing of starting air valves on the cylinder heads.

Fuel system
3.01: Fuel injection valve
3.02: Fuel injection pump
3.03: Fuel cam
3.04: Load indicator
3.05: Load dependent variable injection timing
3.07: Eccentric shaft for suction valve
3.08: Eccentric shaft for spill valve
3.09: Intermediate regulating shaft
3.10: Air cylinder for Governor / fuel linkage connection
3.11: Fuel linkage maximum limiting screw
3.12: Fuel lever
3.13: Relief valve

38A~F: 3/2 way solenoid valve (MGMCT-2)
When energized due to any abnormality, supply pilot air signal to safety device on fuel pump to cut-off fuel to the engine.

Exhaust valve drive
4.01: Exhaust valve
4.02: Hydraulic actuator pump
4.03: Actuator pump cam
4.04: Exhaust valve actuator
4.05: Air spring
4.06: Throttle
4.07: Relief valve
4.08: Air spring venting
4.09: Air spring valve for emergency
270HD: Relief valve (F-2F)

Reversing system
5.01: Reversing servomotor
5.02: Reversing valve
5.03: Local maneuvering lever

PS63: Pressure switch
Provides signal to C/R maneuvering unit, when activated, to cut-off fuel supply in case of reversing servomotor not in end position.
PS8 (AH): Pressure switch
Provides signal to C/R maneuvering unit, when activated, to cut-off fuel supply in case of reversing valve not in AHEAD position, thereby no oil pressure in AHEAD oil line.
PS7 (AS): Pressure switch
Provides signal to C/R maneuvering unit, when activated, to cut-off fuel supply in case of reversing valve not in ASTERN position, thereby no oil pressure in ASTERN oil line.

Safety devices
6.01: Rotation direction safeguard
6.02: Sliding coupling
6.04: Safety cut out device

Monitoring
7.01: Tachometer
7.02: Revolution counter
7.07: Transmitter for load indicator

Cylinder lubrication system
8.01: Induction motor
8.02: Distributor
8.06: Cylinder lubricating pump
8.07: Sight glass indicator
8.08: Accumulator
8.09: Lubricating quill with non-return valve
8.10: Alarm transmitter
8.12: Transmitter for lubricator revolution
Engine room
9.01: Starting air bottles

1.2.3 Main and Back-up source of control air:

The compressed air required for the pneumatic control system of the engine and for the air spring of the exhaust valve is primarily taken from main air reservoirs. The air piping system is arranged in such a way that, upon failure of the main source, reduced pressure compressed air will be supplied directly from the main air reservoirs with the help of various Check-valves (342 HA, HB, etc.) provided in the control air supply unit..
The shut-offs, pressure reducing valves, filters, etc. necessary for supplying air to the various units are arranged in the control air supply unit “A”.
Air reservoirs for Control and Safety air systems are provided for reducing the time lag in operating various elements by absorbing any pressure fluctuations in the supply air pressure.

Preparation of the control air system:
Refer Figure 1.2 for the following description

1) Open 25 kg/cm2 feed to control air supply unit with shut-off valve 36HC.
2) Open 8 kg/cm2 control air feed at connection A1.
3) Adjust safety control air and stand-by air for air spring 7.0 kg/cm2 with reducing valve 19HA.
For this, valve 36HA must be open. The pressure can be checked on the pressure gauge on the reducing valve 19HA as well as on pressure gauge P2.
4) The pressure gauge P8 must now indicate 8 kg/cm2. Any pressure deviations have to be corrected with the 8 kg/cm2 air supply system.
5) As long as the control air supply is switched on, the pressure indicator G12 in valve group "G" must indicate pressure.
6) Check whether the two orifices of 2mm are fitted at check valves 342HD and 342HE.

Description of components:
Refer figure 1.2.

A1 Main source of Control air
A2 Back up source of Control air
A3 To Control air bottle
A4 To Safety air bottle
A6 Spring air to exhaust v/v
9.01 Main air reservoirs
117HA, HB Filter with drain
36HA Shut off valve for spring air
36 HB Shut-off valve for control air
36 HC Shut-off valve for starting air
242HA, HB, etc. Check valves
287HA, HB Control and Safety air bottle
PS 14, 15 & 17 Pressure transmitter
19 HA Pressure reducing valve
030 Drain valve
270 HA, HB Safety valves

Figure 1.2 shows arrangement of Control air supply unit.

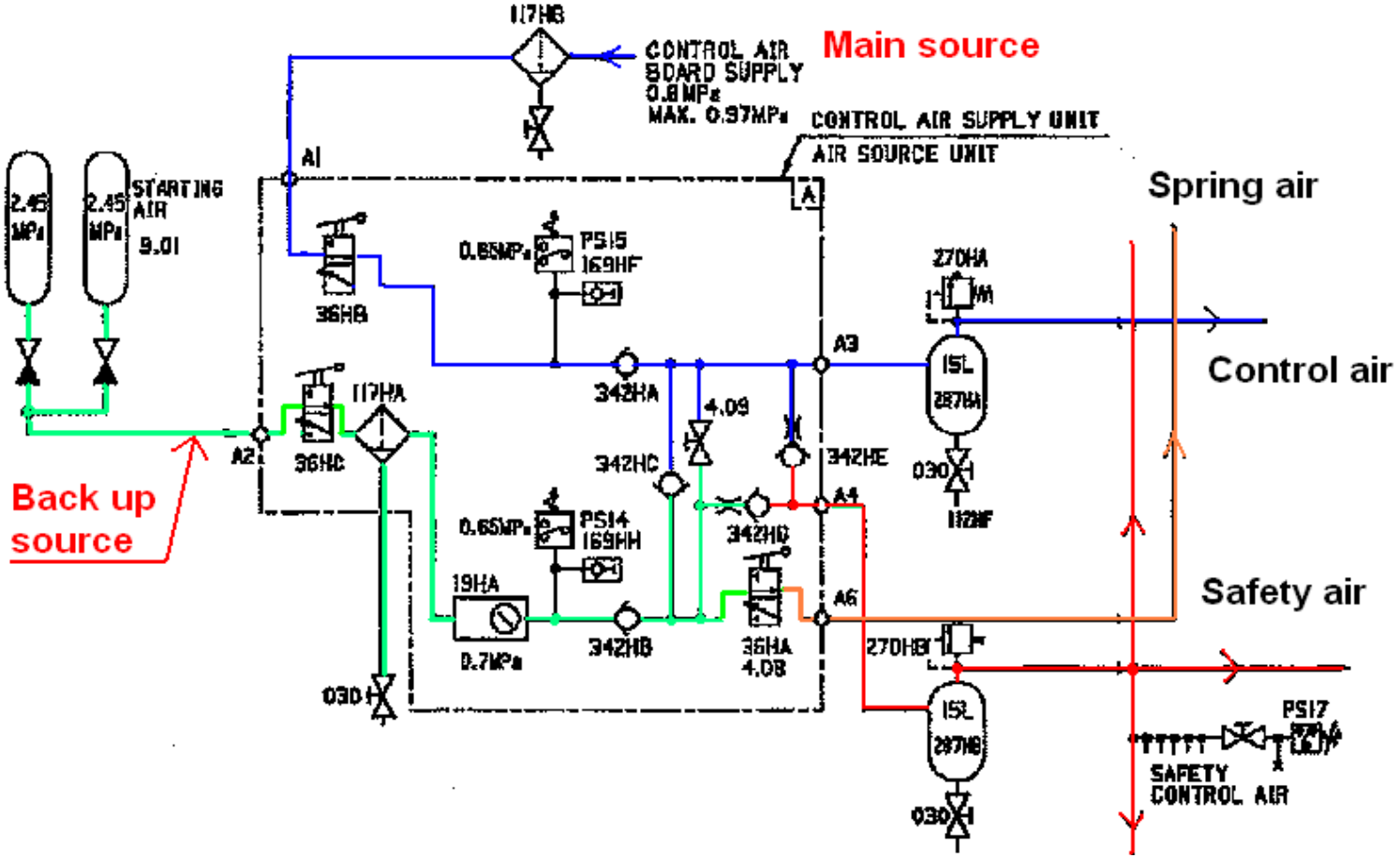


Fig. 1.2 Arrangement of Control air supply unit (Source: SULZER RTA84 T-B instruction manual)

1.2.4 Understanding of Operation from Remote (Bridge and ECR Control) position:

Refer Figure 1.5 for the following description.
Firstly in the group E, following valves are for remote operation:
130 HC (Start), 130 HD (Ahead) and 130 HE (Astern).
For remote operation, lever 5.03 (Local Maneuvering lever) has to be in "REMOTE CONTROL" position in group E. also Fuel Lever 3.12 has to be in "REMOTE CONTROL "position.
Starting AHEAD:
When telegraph transmitter (Bridge Control) and/or telegraph receiver (ECR Control) kept in DS Ahead position.
Electrical signal energizes the valve 130 HD (Ahead) and control air passes and piloted to 49HD.Valve 49 HD is actuated, thereby allowing control air to reach Starting air distributor 2.22 and Reversing valve 5.02. The air pressure causes the piston of starting air distributor and reversing valve to shift to AHEAD position. The control air after passing through the starting air distributor passes through the valve 129 HA and waits before the valve 23A.
After the reversing valve shifts to AHEAD position, the oil pressure (from cross head lubricating oil pump 10 ~ 14 Bar) is applied to the Running direction interlock 6.02 and the Reversing servomotor 5.01.The oil pressure causes the fuel cam to shift to AHEAD position and then oil pressure acts on the valve 53 HI, etc. Once the valve 53HI is actuated, the control air pressure to the valve group "G" is drained (from G5). Thus, reversing of Starting air distributor and Fuel cams is completed.

After a certain timer valve 130HC (Start) is energized by electrical signal and control air passes and piloted valve 49HC. Valve 49HC is actuated to supply pilot air signal to valve 2.05 on the main start air shut-off valve and valve 23A in group "P". As soon as the valve 2.05 is actuated, the space behind the disc of main start air shut-off valve 2.03 gets drained and main start air shut-off valve 2.03 opens. Thus, high pressure air through the non-return valve 2.04 and flame arrestor 2.08 is supplied to all the cylinders and will wait before the starting valves on the cylinders. This high pressure air will also pass through the valve 134HA and assist in keeping the starting valve 2.07 in CLOSED condition. Moreover, high pressure air is also supplied to valve 212HA in group "P" and waits before this valve.
As soon as the valve 23A in group "P" is actuated by the pilot air signal from valve 49HC, it allows the air signal after the starting air cut-off valve 129HA to pass through and acts as pilot signal on the valve 212HA in group "P". As soon as the valve 212HA is actuated, it allows high air pressure from main start air shut-off valve 2.03 to pass and reach the start air distributor 2.22. This high pressure air causes the concerned pilot valves 2.01 in the start air distributor to come in contact with the addendum of the AHEAD cam. Depending on the position of the pilot valves on the addendum of the cam, the valve 134HA on the starting valve 2.07 of respective cylinder will be supplied with the pilot signal. As soon as the valve 134HA is actuated, the high pressure air through valve 134HA will open the starting valve 2.07 on the respective cylinder. As soon as the

starting valve 2.07 opens, the high pressure air will be admitted into the cylinder and the engine will start rotating on air.

Fuel Running:

Once the engine starts rotating in the desired direction on air and all fuel cams have shifted in the desired direction, Rotation direction safeguard 6.01 will supply a pilot oil pressure signal to valve 53HB in valve group "B". As soon as the valve 53HB is actuated, the pilot air signal (through valves 115HC) to pressure switch 141HB for the Fuel cut-off device 6.04 on the fuel pump will get drained (via G11) and the suction valves of fuel pumps will come to injection position. The fuel will be supplied to the engine depending upon the telegraph setting.

1.2.5 Understanding of Local control position (Local Maneuvering stand):

Reefer Maneuvering diagram figure 1.1,

In the group E, Local maneuvering lever (5.03) is used for reversing engine from Ahead to Astern & vice versa.

Valves 49HC, 49HD & 49HE are used for Start, Ahead & Astern operations respectively.

Limit switch S3 will be giving indication to the remote control system (signal to C/R maneuvering unit) whether maneuvering lever 5.03 is in "REMOTE" or "LOCAL" control position.

When you move Lever 5.03 in position "RUN AHEAD".

Check that starting air distributor and reversing valve must move to the Ahead position.

Disengage fuel lever 3.12 from position "REMOTE CONTROL" and engage it into the lever for fuel regulating linkage.

Check that Pressure Indications 216HC in valve group B must indicate pressure (i.e. Pin Out).Air cylinder 3.10 must be vented as long as manual fuel is in operation, i.e. the air cylinder can be rotated by hand without great effort. This is because air from 31HC is passing and piloting valve 53HC and in turn this cylinder 3.10 is vented.

Also air will go to pilot, valve 49HH.

When valve 49HH got actuated and control air from G5 / G11 will pass through valve 49HH and via 115HB, G6 (indication pin out) will activate the Fuel Cut-off device 6.04 in operated position causes engine in shutdown condition.

Engine will remain in fuel cut-off condition unless and until air from both G5 (Reversing Servomotor Interlock) / G11 (Rotation direction Safeguard) will drained out after clearing respected interlock.

Local control position can be operated by two ways WITH Governor & WITHOUT Governor

1.2.5.1 Operation from Local maneuvering stand WITH speed setting by Governor

- Set local control speed setting knob to start position (to about 40%speed)
- Move maneuvering lever 5.03 to "RUN AHEAD or RUN ASTERN.

- Move maneuvering lever to START until the engine runs in the correct rotational direction.
- Once engine runs on fuel put back maneuvering lever 5.03 to "RUN AHEAD or RUN ASTERN" position (whichever direction is desired)
- Adjust desired speed by setting speed setting knob.

1.2.5.2 Operation from Local maneuvering stand WITHOUT Governor (Manual Fuel setting)

- Quickly bring the fuel control lever 3.12 into the same position as the fuel linkage and link them together.
- Move the maneuvering lever to the corresponding position (RUN AHEAD or RUN ASTERN), at which the engine is operated at the time.
- Adjust the engine speed by adjusting fuel control lever 3.12

NOTE: As soon as the fuel lever 3.12 is taken out of the notch "REMOTE CONTROL", the connection between the actuator and the fuel injection pump linkage is interrupted since the air cylinder 3.10 is vented. Unless absolutely necessary, this should, therefore, not be done when the engine is running.
It is essential that the fuel lever 3.12 be engaged into the lever of the fuel regulating linkage (immediately if the engine is running).It must remain engaged throughout the whole period of emergency running.
Since the speed is no longer being maintained by the governor, and engineer must be continuously stationed at the local maneuvering stand so that he can intervene immediately if necessary.

1.2.6 Understanding of Reversing mechanism from Local control position:

Case 1: Maneuvering lever 5.03 in RUN AHEAD position:
Refer Figure 1.3 for the following description.

When the maneuvering lever 5.03 is moved to RUN AHEAD position, Valve 49 HD is actuated, thereby allowing control air to reach Starting air distributor 2.22 and Reversing valve 5.02. The air pressure causes the piston of starting air distributor and reversing valve to shift to AHEAD position. The control air after passing through the starting air distributor passes through the valve 129 HA and waits before the valve 23A.
After the reversing valve shifts to AHEAD position, the oil pressure is applied to the Running direction interlock 6.02 and the Reversing servomotor 5.01.The oil pressure causes the fuel cam to shift to AHEAD position and then oil pressure acts on the valve 53 HI, etc. Once the valve 53HI is actuated, the control air pressure to the valve group "G" is drained. Thus, reversing of Starting air distributor and Fuel cams is completed.

Case 2: Maneuvering lever 5.03 in RUN ASTERN position:
Refer Fig. 1.4 for the following description.

When the maneuvering lever 5.03 is moved to RUN ASTERN position, Valve 49 HE is actuated, thereby allowing control air to reach Starting air distributor 2.22 and Reversing valve 5.02. The air pressure causes the piston of starting air distributor and reversing valve to shift to ASTERN position. The control air after passing through the starting air distributor passes through the valve 129 HA and waits before the valve 23A.
After the reversing valve shifts to ASTERN position, the oil pressure is applied to the Running direction interlock 6.02 and the Reversing servomotor 5.01.The oil pressure causes the fuel cam to shift to ASTERN position and then oil pressure acts on the valve 53 HI, etc. Once the valve 53HI is actuated, the control air pressure to the valve group "G" is drained. Thus, reversing of Starting air distributor and Fuel cams is completed.

Figure1.3 shows the flow of control air and oil, when the Local maneuvering lever 5.03 is in RUN AHEAD position.

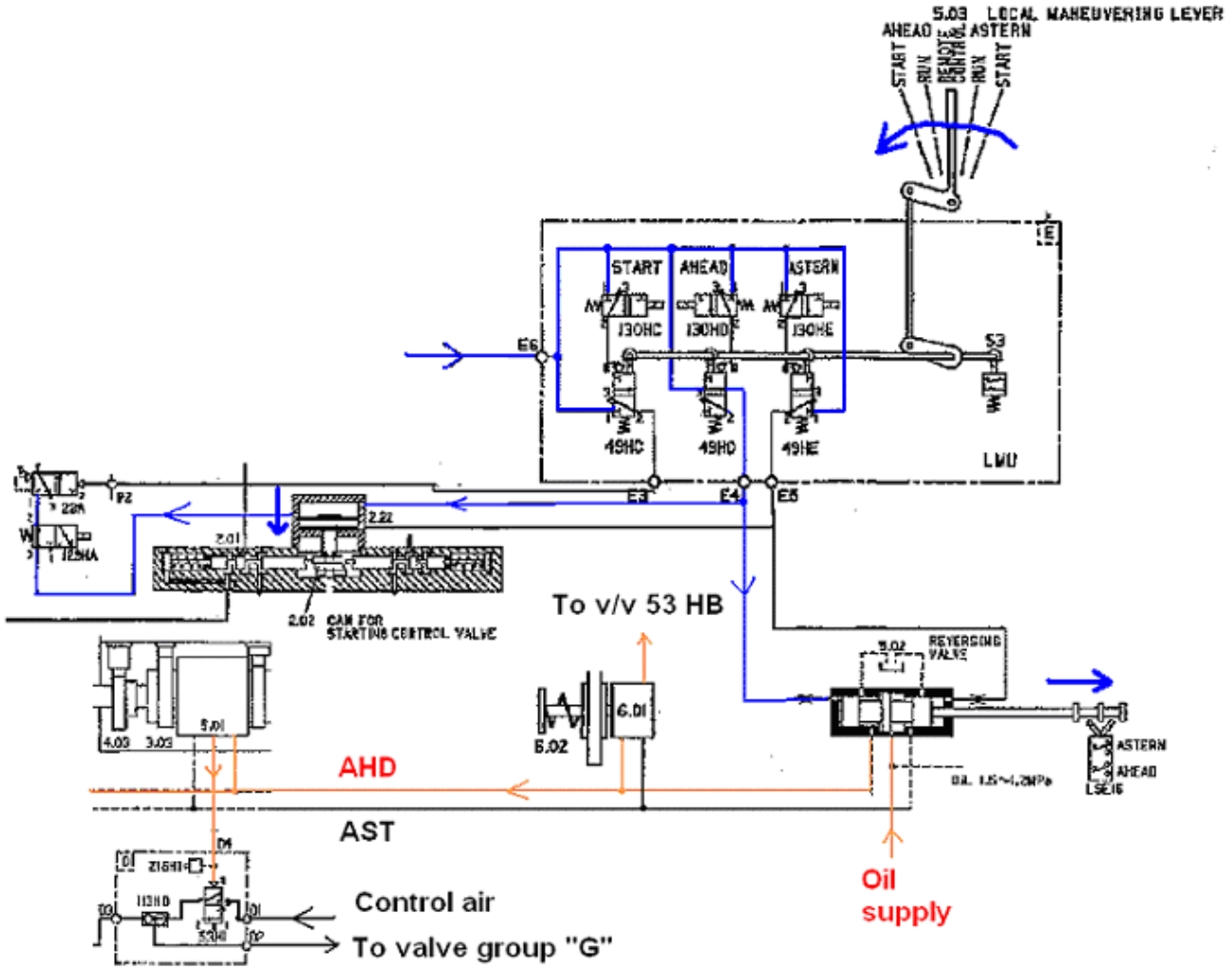


Fig. 1.3 Condition of air and oil flow during reversing in AHEAD direction (Source: SULZER RTA84 T-B instruction manual)

Figure1.4 shows the flow of control air and oil, when the Local maneuvering lever 5.03 is in RUN ASTERN position.

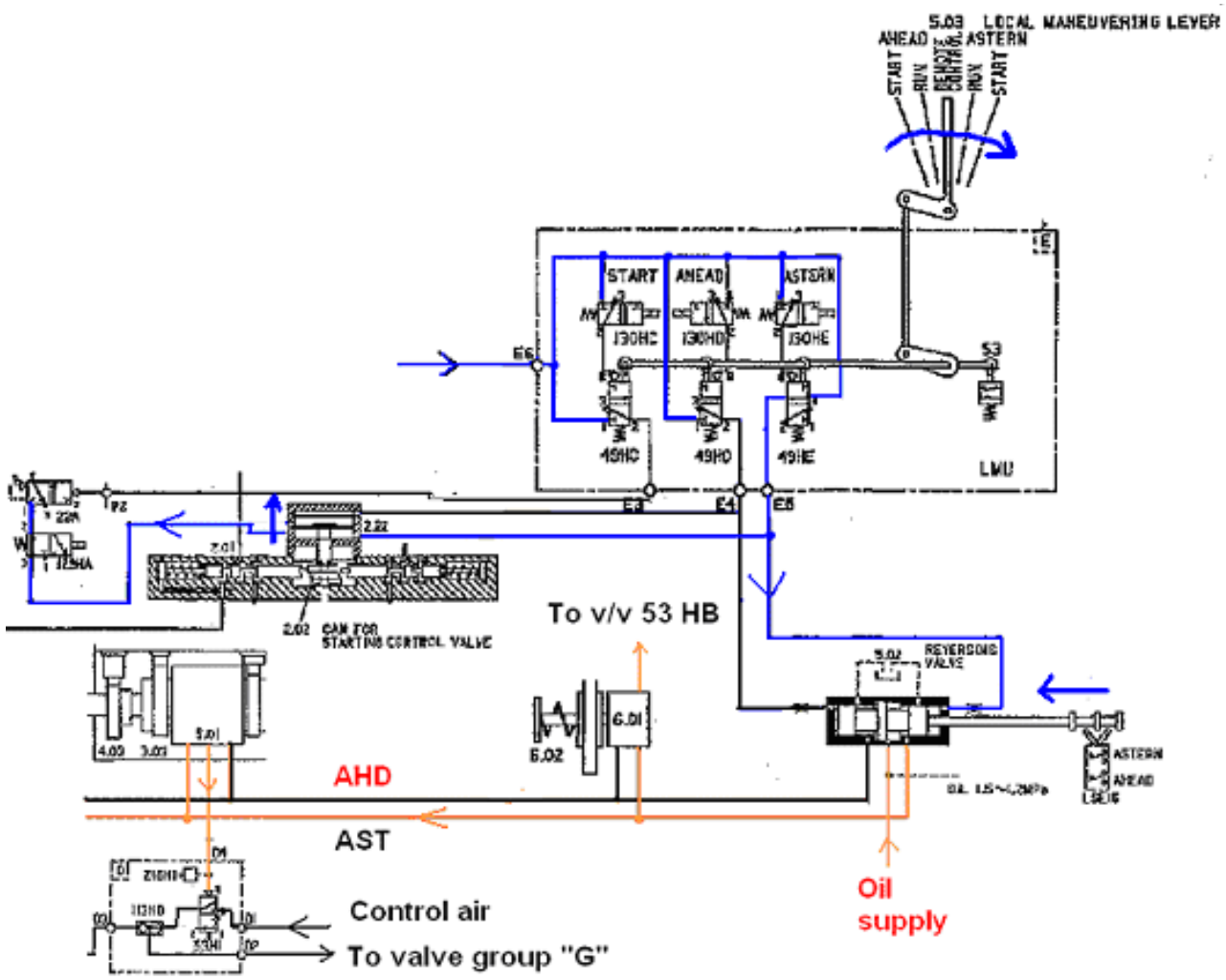


Fig. 1.4 Condition of air and oil flow during reversing in ASTERN direction (Source: SULZER RTA84 T-B instruction manual)

1.2.7 Understanding of Starting mechanism from Local control position:

Refer Figure 1.5 for the following description.

The high pressure starting air from the main air reservoirs is required to turn the engine on air to certain rpm to enable prompt ignition of fuel upon injection.
Figure 1.5 shows Starting air and Control air lines in pressurized condition, when the maneuvering lever 5.03 is moved to START AHEAD position from RUN AHEAD position.

When the maneuvering lever 5.03 is moved from Remote control position to RUN AHEAD position, the Starting air distributor and Reversing servomotor are shifted to start the engine in the corresponding direction as explained before.
When the maneuvering lever 5.03 is moved to START AHEAD position, valve 49HC is actuated to supply pilot air signal to valve 2.05 on the main start air shut-off valve and valve 23A in group "P". As soon as the valve 2.05 is actuated, the space behind the disc of main start air shut-off valve 2.03 gets drained and main start air shut-off valve 2.03 opens. Thus, high pressure air through the non-return valve 2.04 and flame arrestor 2.08 is supplied to all the cylinders and will wait before the starting valves on the cylinders. This high pressure air will also pass through the valve 134HA and assist in keeping the starting valve 2.07 in CLOSED condition. Moreover, high pressure air is also supplied to valve 212HA in group "P" and waits before this valve.
As soon as the valve 23A in group "P" is actuated by the pilot air signal from valve 49HC, it allows the air signal after the starting air cut-off valve 129HA to pass through and acts as pilot signal on the valve 212HA in group "P". As soon as the valve 212HA is actuated, it allows high air pressure from main start air shut-off valve 2.03 to pass and reach the start air distributor 2.22. This high pressure air causes the concerned pilot valves 2.01 in the start air distributor to come in contact with the addendum of the AHEAD cam. Depending on the position of the pilot valves on the addendum of the cam, the valve 134HA on the starting valve 2.07 of respective cylinder will be supplied with the pilot signal. As soon as the valve 134HA is actuated, the high pressure air through valve 134HA will open the starting valve 2.07 on the respective cylinder. As soon as the starting valve 2.07 opens, the high pressure air will be admitted into the cylinder and the engine will start rotating on air

Figure1.5 shows the flow of Starting and control air, when the Local maneuvering lever 5.03 is in START AHEAD position.

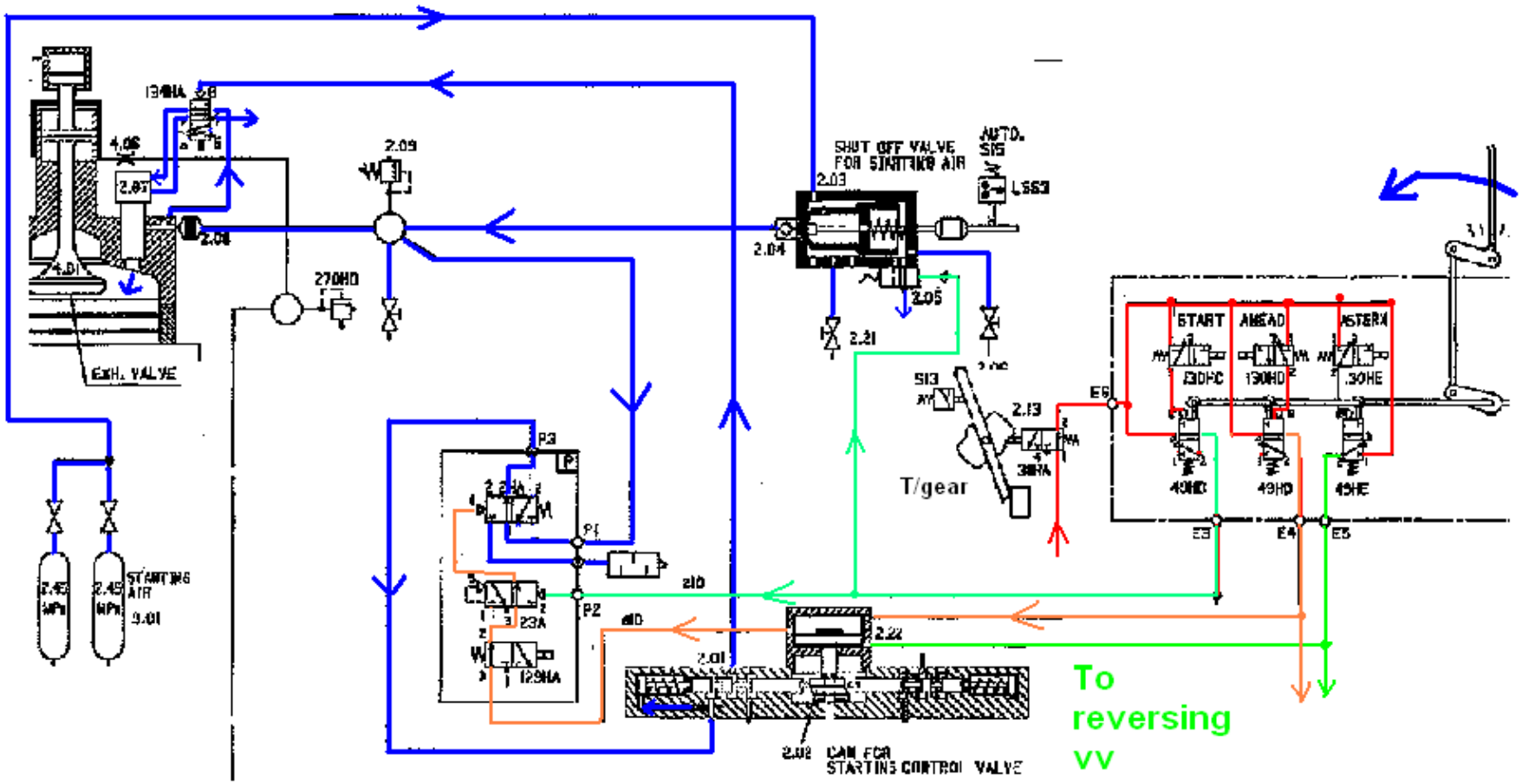


Fig. 1.5 Condition of Starting and Control air flow during starting in AHEAD direction (Source: SULZER RTA84 T-B instruction manual)

1.2.8 Understanding of Fuel running mechanism from Local control position:

Refer Figure 1.1 for the following description.

Once the engine starts rotating in the desired direction on air and all fuel cams have shifted in the desired direction, Rotation direction safeguard 6.01 will supply a pilot oil pressure signal to valve 53HB in valve group "B". As soon as the valve 53HB is actuated, the pilot air signal (through valves 115HC, 49HH, 115HB and 38A-F) to the Fuel cut-off device 6.04 on the fuel pump will get drained and the suction valves of fuel pumps will come to injection position. The fuel will be supplied to the engine depending upon the setting of the Fuel lever 3.12.

Once the engine reaches the air cut level rpm, bring the maneuvering lever 5.03 back to the RUN AHEAD position. In doing so, valve 49HC will get deactivated and pilot air signal to valve 2.05 on the main start air shut-off valve 2.03 and valve 23A in group "P" will get drained at valve 49HC. As soon as, valve 2.05 gets deactivated, the space behind the disc of main start air shut-off valve 2.03 will get pressurized and main start air shut-off valve 2.03 will close.

As soon as the valve 23A in group "P" is deactivated, the pilot air signal to valve 212HA will be drained at valve 23A. As soon as the valve 212HA is deactivated, the high pressure pilot air signal to valve 134HA will be drained at valve 212HA. As soon as the valve 134HA gets deactivated, the pilot signal to open the starting valve 2.07 on the cylinder will get drained at the valve 134HA and starting valve 2.07 will close, thus terminating the supply of high pressure air to the cylinder. The remaining high air pressure in the starting air line to the cylinders will assist in prompt closing of the starting valves 2.07. The engine will continue running on fuel and the rpm can be varied with the help of fuel lever 3.12.

1.2.9 Function of Pressure Indicators:

These are installed to indicate whether a particular valve or line is activated or pressurized. These are very helpful in trouble shooting any problem with the pneumatic system.

Function:
When the pressure signal flows, the Pin 2 is pushed up against the force of the Spring 6 and the top of the pin is in sight.
If the pressure signal is exhausted, the pin is pushed back by the force of the spring and the pin is out of sight,
Figures 1.6a and 1.6b show arrangement of Pressure indicator.

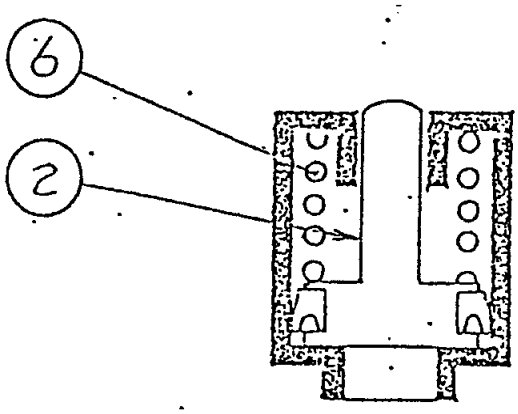


Fig. 1.6a
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

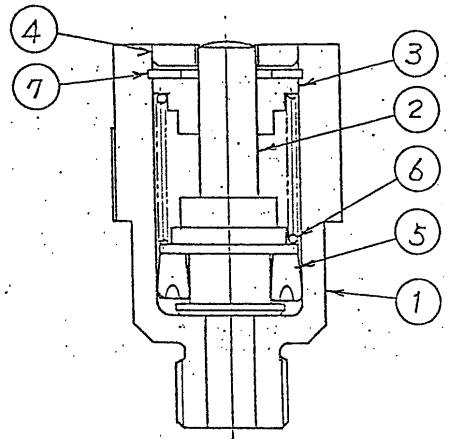


Fig. 1.6b
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Description of parts:
1) Body
2) Pin
3) Spring holder
4) Cap
5) Packing
6) Spring
7) Snap ring

1.3 Structure and Function of components provided in maneuvering system:

1.3.1 Starting air distributor:

Refer Figures 1.1 and 1.7 for the following description.

The starting air distributor 2.01 controls the starting valves in the cylinder covers in such a way that the starting air enters the cylinders in the exact sequence and moment to rotate the crankshaft. A control valve 5 is fitted in the starting air distributor for each starting valve.

Function:

Case 1: Local maneuvering lever 5.03 is in central position RC (Remote control):
All connections on the starting air distributor are without pressure. Rollers 4 with springs are lifted off the cam 2.

Case 2: Maneuvering lever in position ASTERN or AHEAD:
Depending on the lever position, "LA" or "LB" is under pressure and shifts reversing piston 3 with cam 2 to the respective position.

Case 3: Maneuvering lever in position START (ASTERN or AHEAD):
Valve 2.05 actuates shut –off valve 2.03. Starting air reaches the starting valves 2.07 in the cylinder covers. Starting air "AL" gets to ring space "RR" via valve 7 and presses all control valves 5 onto cam 2.
Depending on the position of the control valves 5, the starting valve of that cylinder is actuated, where the working piston is in the right position for starting (i.e. after TDC), so that the flow of starting air presses the piston down and begins to rotate the crankshaft.
Cam 2 begins to turn as well and thus actuates another control valve 5, which in turn, actuates another starting valve. In this way, starting air is supplied to the other cylinders to press the piston down and thus rotating the crankshaft faster and faster.

Case 4: Maneuvering lever in position RUN (ASTERN or AHEAD):
As soon as the maneuvering lever is changed over to RUN position, the engine fires and runs.
Valve 2.05 shuts off valve 2.03. Ring space "RR" has zero pressure and control valves 5 are lifted off the cam 2 by the springs. Starting valves 2.07 are no longer actuated and remain shut. The starting process is finished.

Starting cut-off valve:
The starting cut-off valve 129HA together with valve 212HA is fitted on valve block 10 to the starting air distributor. Valve 129HA is actuated via remote control for following conditions:
- End of start
- Starting time limitation
- Firing speed is reached
- Start interval cut-out (interruption after several starts)
- Slow turning (integrated in the starting system)

When valve 129HA is activated, the pilot air signals to valve 7 (212HA) is drained. The valve 7 is thus deactivated and ring space "RR" in the starting air distributor is vented. Control valves 5 are lifted off cam 2 by their springs. Thus the pilot air signal to valve 134HA is also drained, which causes Starting valves 2.07 to shut. Therefore, the starting process is interrupted.

Description of parts:
Refer figure 1.7.

1) Drive shaft
2) Cam
3) Reversing piston
4) Roller
5) Control valve
6) Silencer
7) Valve 212HA
8) 3/2 way valve 129HA
9) Gear box for auxiliary drives
10) Valve block

LA: Starting air from pneumatic logic unit AHD
LB: Starting air from pneumatic logic unit AST
LC: Starting air to valve 8
LD: Starting air to starting valves 2.07
EL: Vent
AL: Starting air to control valves
RR: Ring space

The figure 1.7 below shows cross sectional view of a starting air distributor for a 6-cylinder engine.

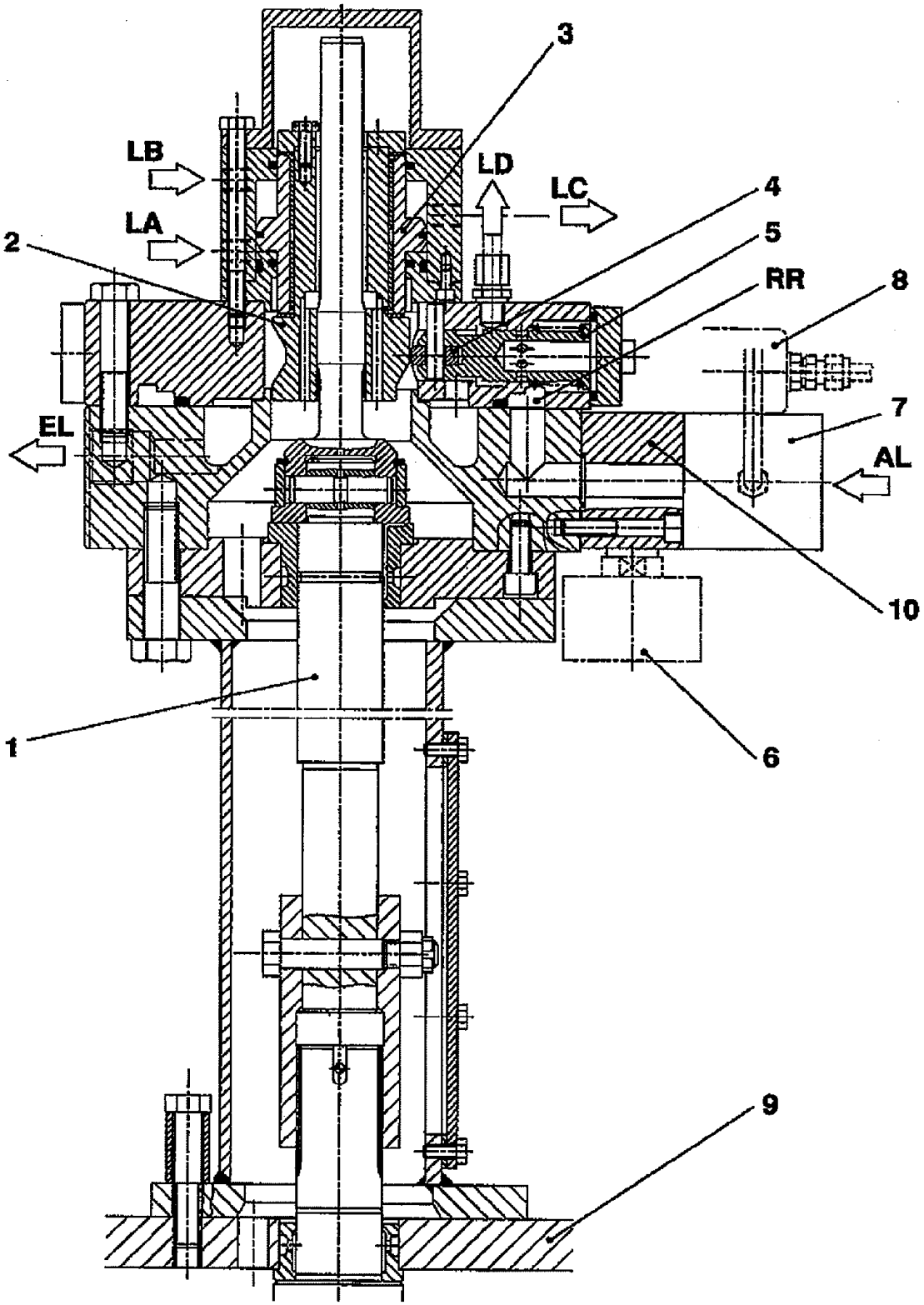


Fig. 1.7 Cross sectional view of Starting air distributor for SULZER RTA84 T-B engine
(Source: SULZER RTA84 T-B instruction manual)

1.3.2 Starting air shut-off valve:

Refer Figures 1.1 and 1.8 for the following description.

The shut-off valve for starting air blocks or releases the starting air to the engine. It can be in put in the following positions:

- Manually closed i.e. closed by hand
- Automatic position
- Manually open i.e. opened by hand

When the engine is on stand-by or in operation, the shut-off valve is positioned at AUTOMATIC position, where it is held by locking lever 6.
When the engine is not in operation, the shut-off valves of the starting air receiver must be closed and the shut-off valve is to be closed (cam in CLOSED position). The shut-off valve and the air feed pipes are vented via vent valve 2.21. When the turning gear is engaged, the distributor piping before the engine is vented.

Function:

Case 1: Ready for starting
Space "ER" is filled with starting air from inlet pipe "LE". Space "VR" is filled through balancing bore "EB". Valve 1 is held shut by spring 3 and by the pressure in space "VR".
Case 2: Starting
Control valve 7 is actuated and vents space "VR". Valve 1 opens and starting air from space "ER" gets to the starting air distribution piping "LV" via non-return valve 2.
Case 3: End of start
Control valve 7 closes space "VR", which again fills with starting air via the balancing bores "EB". Valve 1 shuts.
Case 4: Functional check
When valve 2.06 is actuated on the ready-to-start engine, space "VR" is vented and valve 1 opens audibly. The test valve 2.06 can be actuated to check whether the shut-off valve is working smoothly, while taking precaution to avoid inadvertent turning of engine. When the shut-off valve is ready for operation, then valve 1 opens, which is very audible. However, the engine will not be started.

Description of parts:

Refer Figure 1.8.

1) Valve
2) Non return valve
3) Spring
4) Spindle
6) Locking lever
7) Control valve 2.05
8) Cam

DT: To pressure gauge panel and to pressure transmitter PT4301C
EB: Balancing bore
ER: Air inlet space
EV: To vent valve 2.21
LE: Air inlet piping
LV: To starting air distributor piping and starting valves 2.07
SV: Control valve feed
TV: To test valve 2.06
VR: Valve space

Figure 1.8 shows Cross sectional view of Starting air shut-off valve.

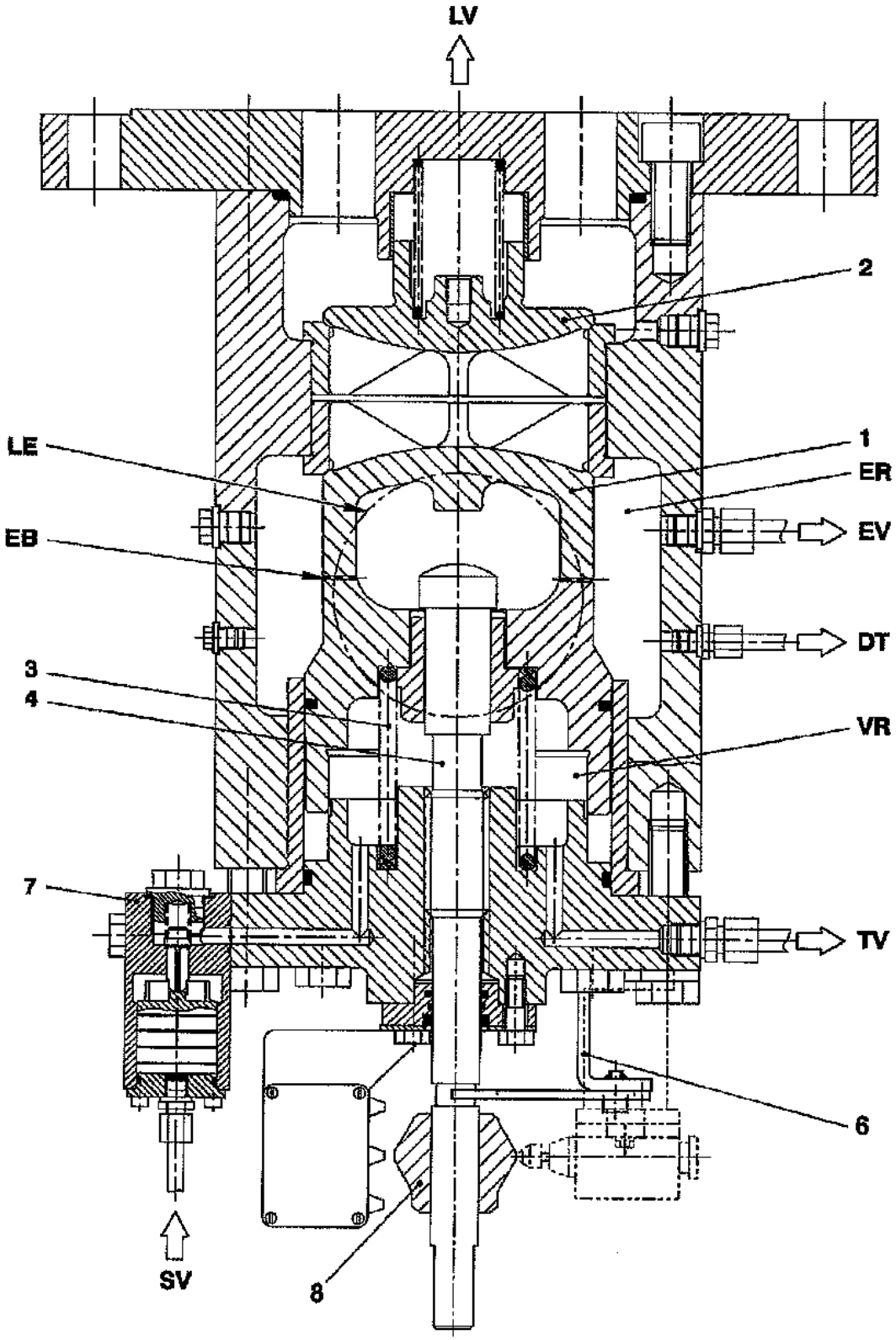
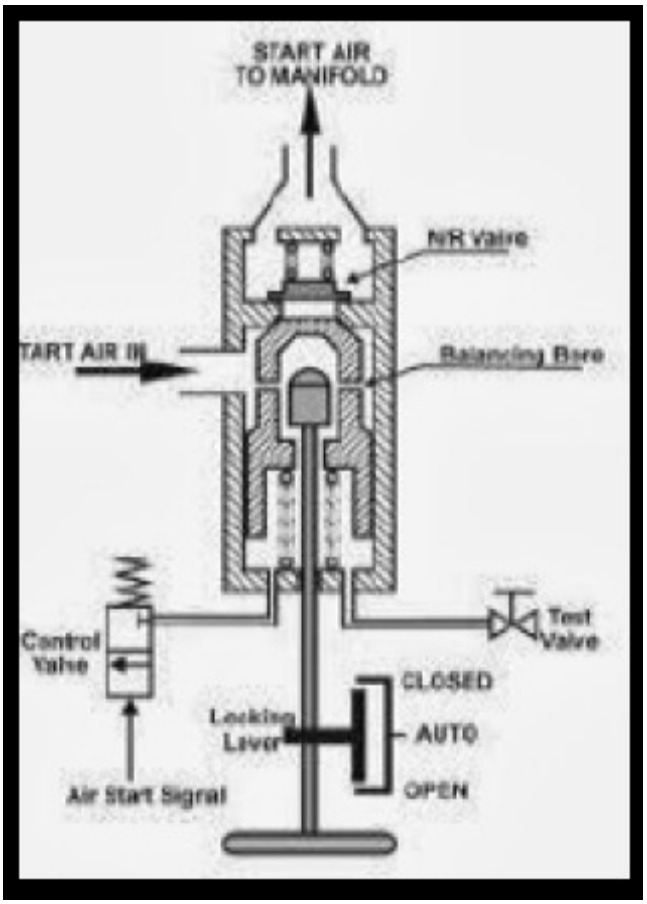


Fig. 1.8 Cross sectional view of Starting air shut-off valve for SULZER RTA84 T-B engine
(Source: SULZER RTA84 T-B instruction manual)



Simple Schematic Diagram of Sulzer Starting Air Shut-off Valve.

1.3.3 Starting Valve (On Cylinder Head):

Key to Illustration:

1 Cover
2 Ring
3 Piston
4 Housing
5 Compression spring
6 Valve spindle
7 Cylinder head
8 Valve 134HA-M

SA Control air connection from starting air distributor
SL Control air connection from starting air piping
AL Starting air
EB Connecting bore
P_1–P_3 Air spaces

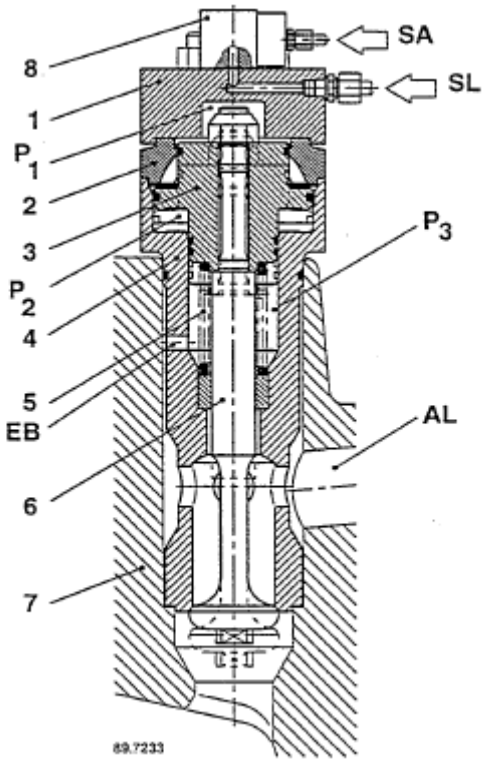


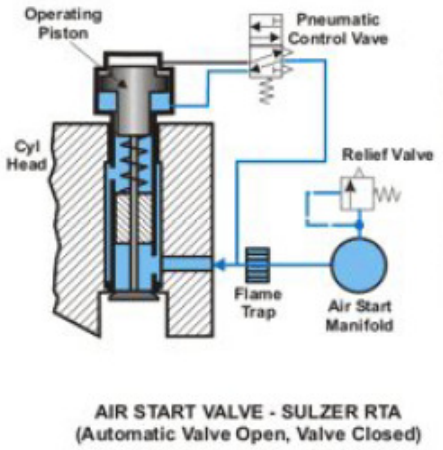
Fig Starting air valve details.

Function:

Closing:
Space "AL" is charged with starting air pressure. Space "P3" is charged through bore"EB" and thereby assists spring 5 in the closing of the valve. Connection "SL" is under pressure from the start air piping. Via valve 134HA space "P2" in housing 4 is connected with supply "SL". This keeps start air valve shut.

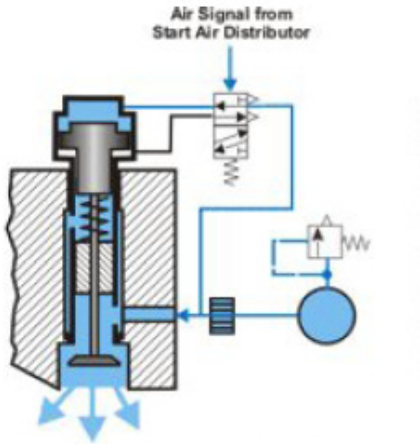
Opening:
For starting engine, start valve has to open. From the starting air distributor 2.01 valve 134HA got piloted. Once valve 134HA actuated, then space "P1" is pressurized and space "P2" is vented. The valve is opened and starting air flows to the cylinder space.

The Sulzer air start valve uses air on both sides of the piston to maintain positive closing. The piston is stepped. The reason for this is so the starting air valve will not open when the gas pressure in the cylinder is higher than the starting air pressure; i.e. when the cylinder is firing. Once the valve starts to open then the opening is accelerated when the larger diameter piston has the opening air acting on it.
The stepped piston also means that closing of the valve is damped as air gets trapped in the annular space formed when the smaller diameter piston enters the upper part of the cylinder.



AIR START VALVE - SULZER RTA
(Automatic Valve Open, Valve Closed)

Fig shows Start air valve in closed position



AIR START VALVE - SULZER RTA
(Valve Opened By Signal From Distributor)

Fig shows Start air valve in open position.

1.3.4 Reversing valve:

Refer Figures 1.1 and 1.9 for the following description.

Depending on the desired direction of rotation, the reversing valve 1 directs control oil to the reversing servomotors on the camshaft and brings them to respective position. Moreover, the direction rotation safeguard is energized. As soon as the engine has attained the desired direction of rotation, the fuel cut-off linkage is released.

Function: (Engine running clockwise):
Depending upon the position of the slide valve 3, supply of Crosshead lub. oil at connection "KO" is either directed through connection "DV" (RUN AHEAD) or through connection "DZ" (RUN ASTERN). Control oil in the side, not under pressure, flows back into the crankcase through drain "OA".
The slide valve 3 is controlled pneumatically by control air signal from either valve 49HD or 49HE. Depending on the desired direction of engine rotation, the slide valve is pressed either to the left or to the right by air pressure through connection "LZ" or "LV". The control pin "KZ" indicates the position of the slide valve 3. Two limit switches are provided to indicate that the reversing valve has reached the end position.
For DENIS-6A control system, pressure switches are provided on AHD and AST oil line, which provide remote indication of end position of the Reversing valve.

Description of parts:
Refer Figure 1.9

1: Reversing valve
2 Pressure oil
3: Slide valve
DV : Pressure oil (at position Run AHEAD)
DZ : Pressure oil (at position RUN ASTERN)
KO: Connection to crosshead bearing oil
KZ: Control pin
LV & LZ: Control air (For position RUN AHEAD & RUN ASTERN)
QA : Oil drain

Figure 1.9 shows Cross sectional view of Reversing valve.

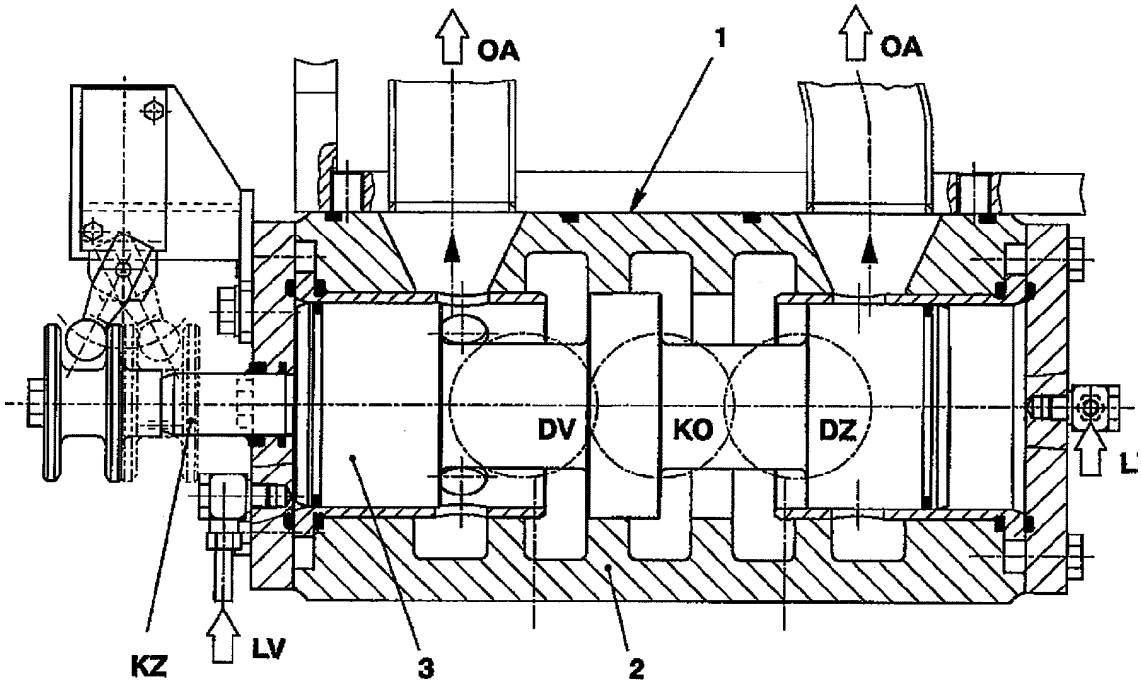


Fig. 1.9 Cross sectional view of Reversing valve for SULZER RTA84 T-B engine
(Source: SULZER RTA84 T-B instruction manual)

1.3.4 Reversing servomotor:

Refer Figures 1.1, 1.10 and 1.11 for the following description.

The duty of the reversing servomotor is to move the fuel cams on the camshaft for forward or reverse engine rotation. Normally, one fuel cam is arranged on either side of the reversing servomotor for each pair of engine cylinders.
In engines with uneven number of cylinders, the Servomotor at the free end is fitted with a single fuel cam 5 (Refer fig. 1.10).
Corresponding to the desired direction of rotation, the cams can be turned relative to the camshaft 1 (Refer fig. 1.10) in the same desired direction so that the fuel is injected at the right movement for running the engine in that direction.
The Fuel cam 5 and the tapered bushes 14 are fitted to the sleeves 13 by pressure bond. The sleeves 13 and the segments 7 are screwed together. Fuel cams5, tapered bushes 14, sleeves 13, segments 7 and bushes 8 thus form individual units which can execute a turning movement limited by the wing 11.

Case 1: Engine in AHEAD direction for right hand engine, rotating clockwise

When the camshaft 1 rotates in direction of the arrow "DR" (AHEAD for right hand engine clockwise rotation) the segments7 are pushed by the wings 11 in the direction of arrow. The connection piece "VA" is subjected to control oil pressure, it fills through the drillings in the bush 8, the spaces "RA" and ensures that the segments 7 lie firmly pressed against the wings 11. The correct end position of the reversing servomotor is transmitted to the valve group "G" in the pneumatic logic unit via the connection piece "VR".

Description of parts: Refer figures 1.10 and 1.11.

1 Camshaft
2 Injection pump casing
3 Actuator cam
4 Camshaft bearing
5 Fuel cam
6 Coupling
7 Segment
8 Bush
9 Sliding ring
10 Waisted screw
11 Wing
12 Locking plate
13 Sleeve
14 Tapered bush

DR Direction of rotation
SO Control oil connection
VA Connecting piece for camshaft rotating Clockwise
VB Connecting piece for camshaft rotating Anti-clockwise
VR Connecting piece for reversing end position signal
RA Space for camshaft rotating Clockwise
RB Space for camshaft rotating Anti-clockwise

Case 2: When Reversing in ASTERN direction:

When reversing, the connection piece "VA" has zero pressure and the spaces "RB" are filled with control oil through the connection piece "VB". The segments 7 and therefore also the fuel cams 5 are turned on the camshaft, until they again rest against the wings 11. As soon as the correct reversal is indicated by the connection piece "VR" and engine rotates in the correct direction, the fuel is injected at the correct timing for running the engine in the new direction.

The figures 1.10 and 1.11 show arrangement of Reversing servomotor.

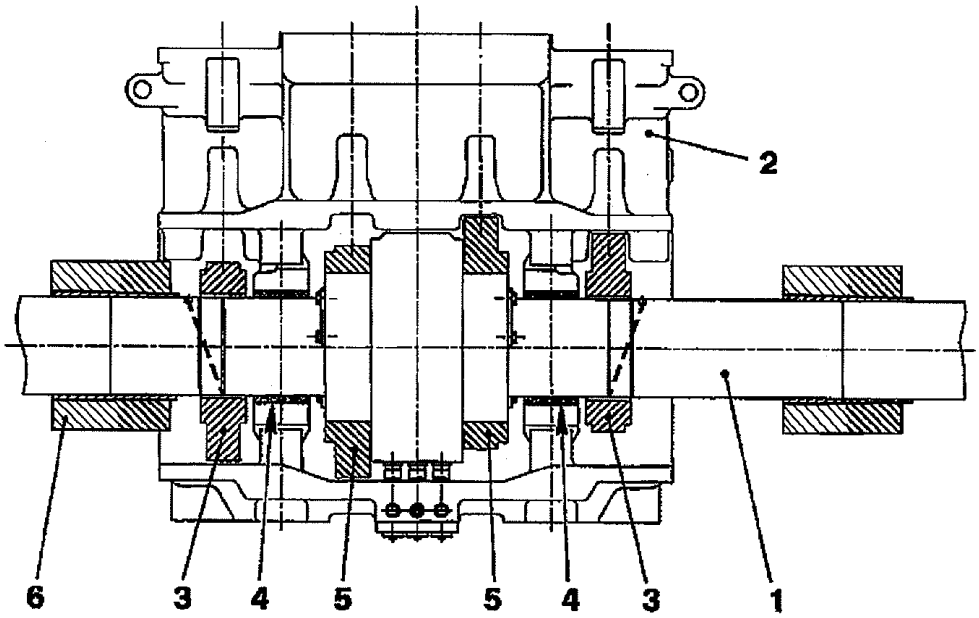


Fig. 1.10 Arrangement of Reversing servomotor for SULZER RTA96 C engine
(Source: SULZER RTA 96 C instruction manual)

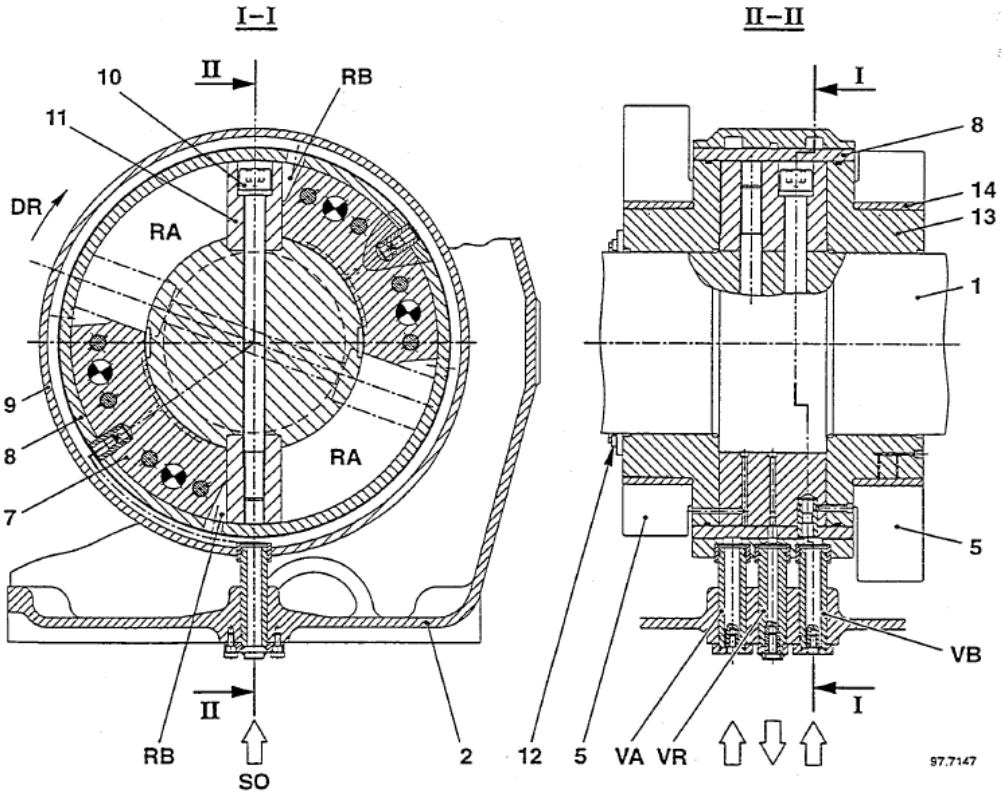


Fig. 1.11 Cross sectional view of Reversing servomotor for SULZER RTA96C engine
(Source: SULZER RTA96C instruction manual)

1.3.6 Arrangement of Reversing interlock:

The valves for the reversing interlock "D" are situated below the injection pump housings. They serve to block the fuel supply until the servomotors are in their correct end positions.
Figure 1.12 shows arrangement of components in valve group "D" below fuel pumps.

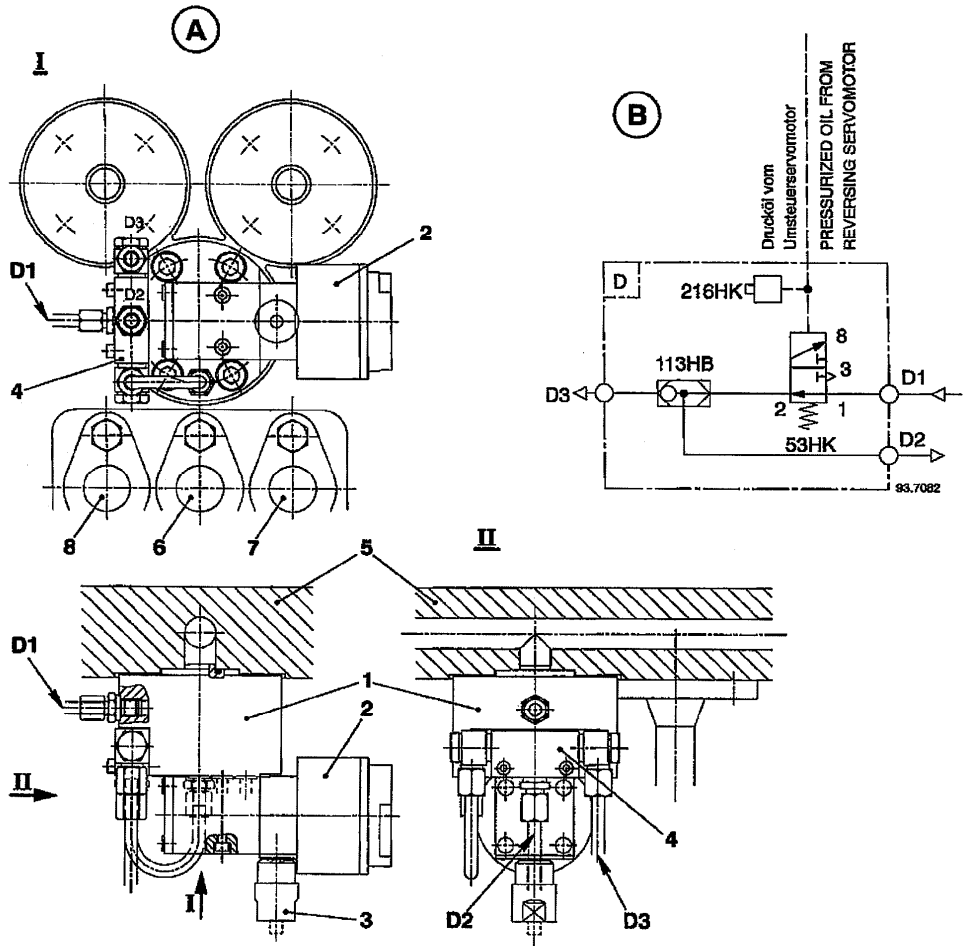


Fig. 1.12 Arrangement of components in valve group "D" below fuel pumps
(Source: SULZER RTA84 T-B instruction manual)

Figure A: Arrangement of valve unit
Figure B: Diagram of valve unit D
1) Valve body
2) 3/2-way valve 53HK
3) Pressure indicator 216HK for valve 53HK
4) Changeover valve 113HB
5) Fuel injection pump housing
6) Connecting piece for reversing servomotor end position signal
7) Connecting piece for camshaft turning clockwise
8) Connecting piece for camshaft turning anti clockwise

D1: From control air supply unit A
D2: To valve group in pneumatic logic unit G
D3: To the next valve unit D

1.3.6 Rotational direction safeguard:

Refer Figures 1.13 and 1.14 for the following description.

Function: The rotational direction safeguard blocks the fuel injection until the desired direction of rotation corresponds with the actual engine one, by setting the actuator of the electronic speed control to load indicator position "0" (DENIS-6A). This is mounted on the gear transmission for auxiliary drives.

Operating principle (for right hand engine turning clockwise):

During operation, only the driving gear wheel 7 and the pinion 8 are turning. The coupling element 10 and the carrier plate 9 slide only on the pinion and are held in the right position for the actual direction of rotation by the stop pin 6. In section IV-IV, the position of the coupling element is shown for the pinion rotating in direction "RV". (For right hand engine clockwise rotation AHEAD)

The friction surfaces of the pinion 8 are lubricated by lubricating oil "OE", which is spread by lubricating grooves "OS".

The rotary valve 4 is rigidly connected to the coupling element. Depending on the position of the rotary valve 4, a communication is formed via the control slots "SS" either to connections "DV" or "DZ" and "DB".

The position of the rotary valve can be recognized from the exterior on the pointer1.

The table below shows the relationship between the rotary valve position, the direction of rotation of the gear wheels and the control oil connections for direction of travel for the various engine alternatives.

	"DZ" and "RZ"	"DV" and "RV"
Right hand engine clockwise rotation	ASTERN	AHEAD
Right hand engine anticlockwise rotation	AHEAD	ASTERN
Left hand engine clockwise rotation	AHEAD	ASTERN
Left hand engine anticlockwise rotation	ASTERN	AHEAD

Case 1: Reversing lever at RUN AHEAD position: (AHEAD-STOP-AHEAD)

Consider, the starting air distributor, reversing valve and reversing servomotor are in correct (i.e. AHAED) position. Since the position of the rotary valve 4 of the rotation direction safeguard 6.01 is already in correct (i.e. Ports DV and DB are connected) position, the control oil in AHEAD oil line from the reversing valve 5.02 will activate the valve 53HB in the valve group "B" through connection "DB". This can be checked by the pressure indicator 216HB, which will be "OUT". So there will be no control air (though valves115HC, 49HH, 115HB and 38A~F) working on the piston of the safety device 6.04 on the fuel pump and all fuel pumps will be in ready to inject position.

Figure 1.13 shows Cross sectional view of Rotational direction safeguard.

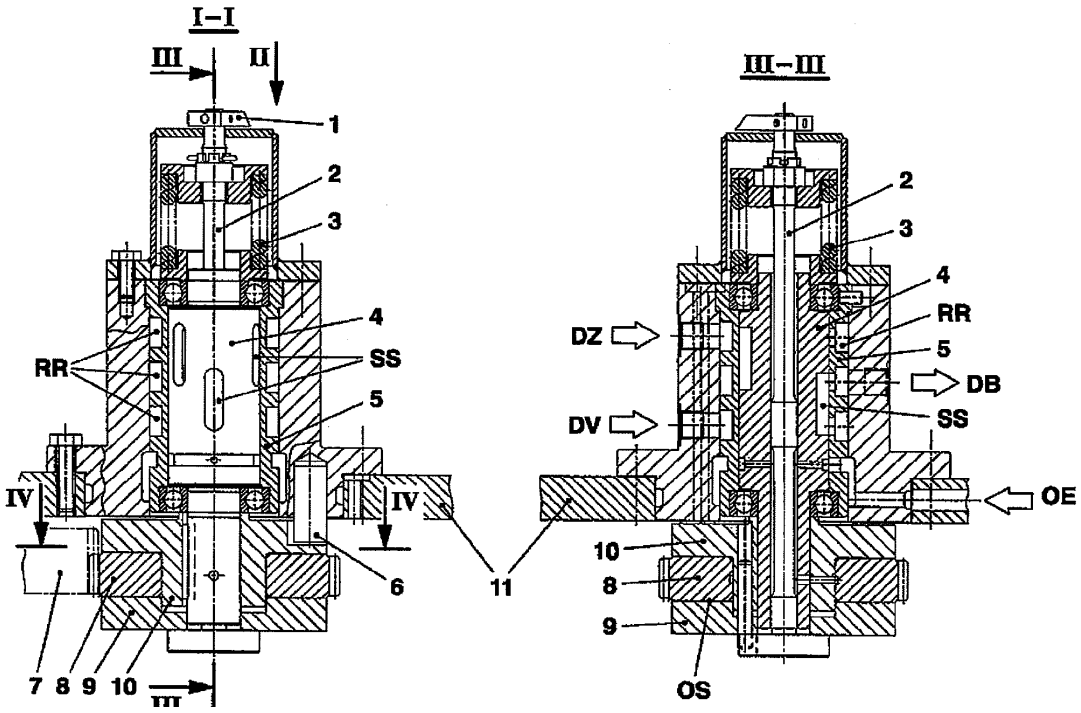


Fig. 1.13 Cross sectional view of Rotational direction safeguard
(Source: SULZER RTA84 T-B instruction manual)

Figure 1.14 shows arrangement of Coupling element and Stop pin.

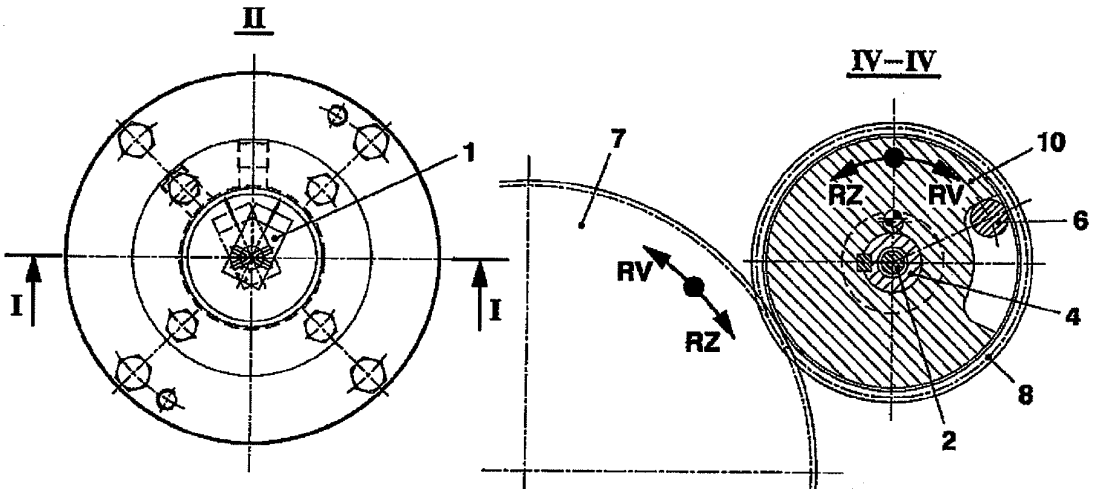


Fig. 1.14 Arrangement of Coupling element and Stop pin
(Source: SULZER RTA84 T-B instruction manual)

Description of parts:
Refer figures 1.13 and 1.14

1: Pointer
2: Screw
3: Spring
4: Rotary valve
5: Bush
6: Stop pin
7: Driving gear wheel in the gear transmission for ancillary drives
8: Pinion
9: Carrier plate
10: Coupling element
11: Gear box auxiliary drives

RR: Ring spaces
SS: Control slots
DV: Pressure oil (at position RUN AHEAD)
DZ: Pressure oil (at position RUN ASTERN)
DB: Pressure oil to valve group "B"
OS: Oil lubricating groves
OE: Oil inlet
RV: Direction of rotation (for RUN AHEAD)
RZ: Direction of rotation (for RUN ASTERN)

Case 2: Reversing lever at RUN ASTERN position: (AHEAD – STOP – ASTERN)

When the reversing lever 5.03 is positioned in RUN ASTERN direction, the starting air distributor, reversing valve and reversing servomotor will shift to ASTERN running position. But, the rotary valve 4 of the rotation direction safeguard 6.01 will still be in AHEAD running position and thus control oil in ASTERN oil line from the reversing valve 5.02 can not activate valve 53HB (since ports DZ and DB of rotation dir. Safeguard are not connected). This can be checked by the pressure indicator 216HB, which will be "IN". So there will be control air (though valves115HC, 49HH, 115HB and 38A~F) working on the piston of the safety device 6.04 on the fuel pump and all fuel pumps will be cut off position. When the reversing lever is changed to START ASTERN position, the engine begins rotating in ASTERN direction and the rotary valve 4 is brought to ASTERN position by the coupling element 10. Now, the Control oil from port "DZ" via the control slots "SS" is led to port "DB" of the rotation direction safeguard and then to valve 53HB. So the control air, (though valves115HC, 49HH, 115HB and 38A~F) working on the piston of the safety device 6.04 on the fuel pump, will be drained and all fuel pumps will be brought to fuel injection position.

False maneuver:
Should the intended reversing maneuver fail for any reason and the engine, influenced by the propeller, begins turning again in the "old" direction, the rotary valve 4 (Fig. 1.13) of the rotation direction safeguard will also return to the previous position and the fuel regulating linkage is then interlocked in Pos."0" by the Governor.

1.3.8 Arrangement of Rotational direction safeguard:

The valve group "B" for the Rotational direction interlock is provided to so as to block the fuel supply, if the rotational direction safeguard is not in the correct position.
Valve 2 is for the actuation of air cylinder 3.10. Valve 3 is controlled by signal from the rotational direction interlock 6.01. Pressure indicators 4 and 5 indicate which valves are pressurized.
Figure 1.15 shows arrangement of Rotational direction safeguard.

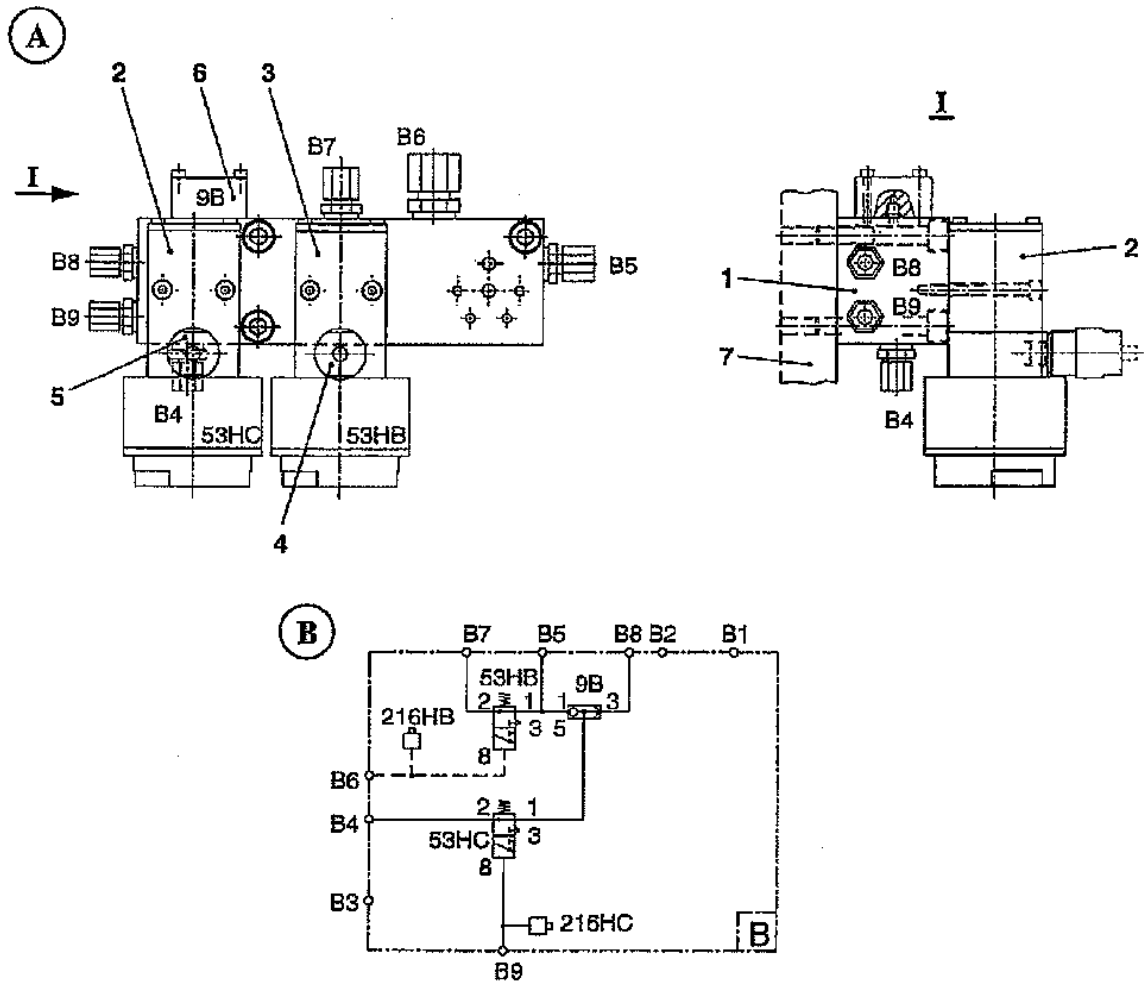


Fig. 1.15 Arrangement of Rotational direction safeguard
(Source: SULZER RTA84 T-B instruction manual)

Description of parts:
A Arrangement of Valve group B Diagram of valve group "B"
1: Valve plate
2: 3/2 way valve 53HC for controlling the air cylinder 3.10 in the regulating linkage
3: 3/2 way valve 53HB for the rotation direction safeguard 6.01
4: Pressure indicator 216HB for valve 53HB
5: Pressure indicator 216HC for valve 53HC
6: Shuttle valve 9B
7: Gear box

1.3.8 Fuel pump automatic emergency shut down mechanism:
(Source: SULZER RTA84 T-B instruction manual)

The safety cut-out device on the fuel pump is provided to stop the engine in case of the followings and independently of the commanded RPM order from the telegraph.
Immediately in case of:
- Engine Over speed
- When emergency stop is activated due to any abnormality

Delayed stop in case of:
- Pressure drop in the air spring of the exhaust valves
- Pressure drop in the main bearing lub. Oil
- Pressure drop in the cylinder cooling water

The above conditions may vary depending on the type of engine.
The mechanical – pneumatic components of the safety cut-out device are mounted on each injection pump block between the suction valves. They interrupt the delivery of fuel from the injection pumps as soon as the corresponding command is triggered.

Function: Refer figures 1.1 and 1.16.
In normal operation, the push rod 10 to the suction valve 9 is free i.e. with clearance between yoke 8.
Control air "DL" fills the storage space "SR" and via the bore "BO" is present at 3/2 way valve 6 (38A, B,…etc.)
As soon as the engine has to be stopped for any of the above mentioned emergencies, the 3/2 way valve 6 is actuated. Control air enters the bore "BO" and "BO1" into the cut-out cylinder "AZ" and pushes the piston 2 upwards. The yoke 8, pulled up by the tie rod 7, lifts the push rod 10 to the suction valve 9, which opens and interrupts the fuel delivery. The activation of the safety cut-out device is indicated by the extension 4 of the tie rod 7. Safety cut-out device can also be activated either directly by energizing valve 6 (38A,B,..) from the remote control or by supplying control air to valve 6 by activating valve 126 HB electrically or manually.

Description of parts:
Refer figure 1.16

1) Intermediate piece
2) Piston
3) Cover
4) Extension
5) Compression spring
6) 3/2 way valve
7) Tie rod
8) Yoke
9) Suction valve
10) Push rod to suction valve
11) Injection pump block

AZ: Cut-out cylinder
BO, BO1: Bores to and from 3/2 way valve
DL: Control air from control air supply unit A
SL: Control air from valve group G in pneumatic logic unit
SR: Storage space for control air

Figure 1.16 shows arrangement of safety cut-out device on Fuel pump.

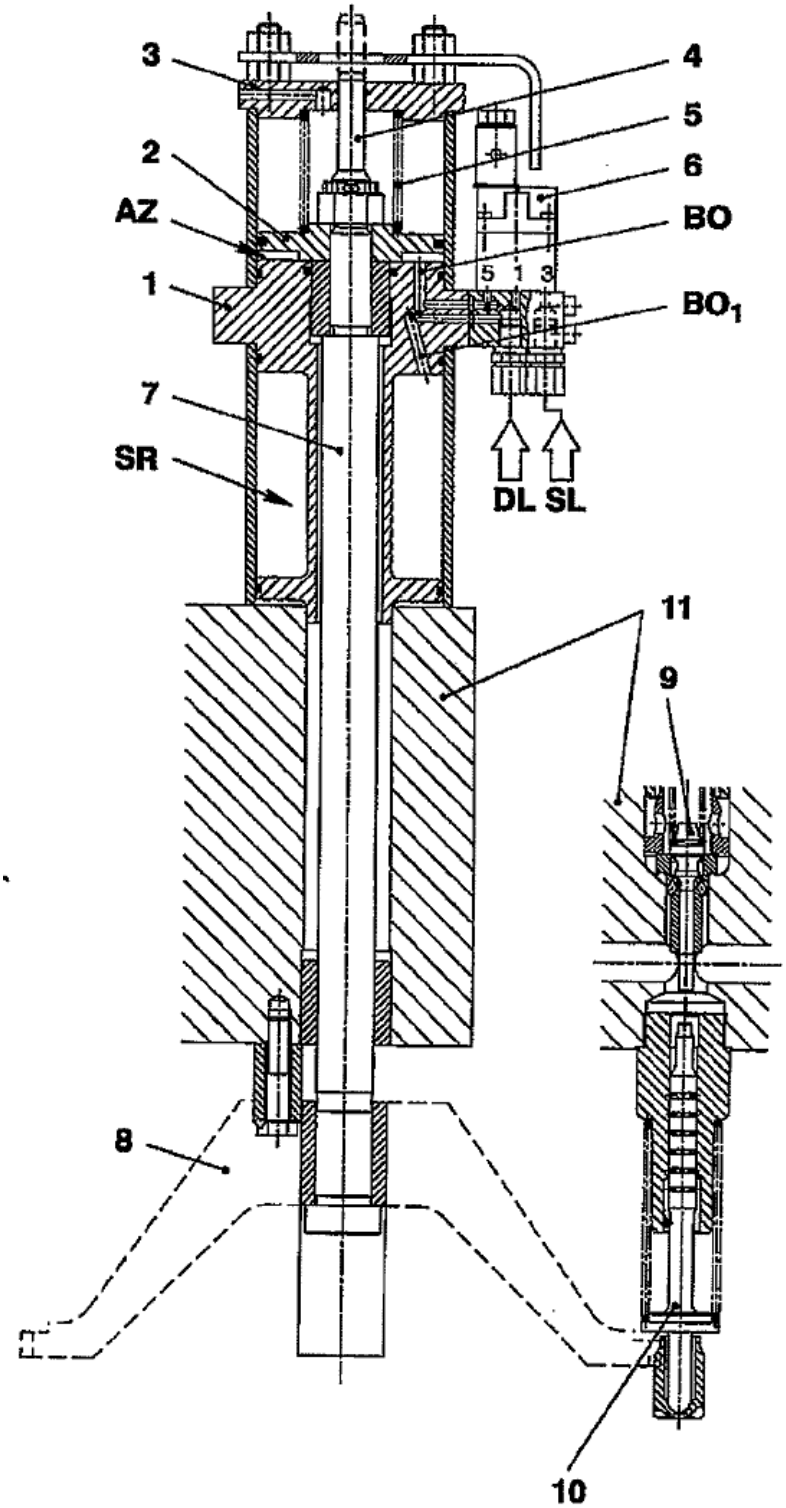


Fig. 1.16 Arrangement of Safety cut-out device on Fuel pump
(Source: SULZER RTA84 T-B instruction manual)

1.3.9 Fuel pump Manual Cut-Off mechanism (SULZER RTA96C):

Fuel Injection pump can be cut-in or cut-out as required during operation. However this should be performed at very low speed (preferably Dead Slow) or in STOP condition. The cut out device is fitted on the injection pumps.

Functioning of device during cutting out:

Every time the roller 2 is on the addendum of the cam 1, the hole 4 in the roller guide 3 comes into line with the cut-out pin 12.

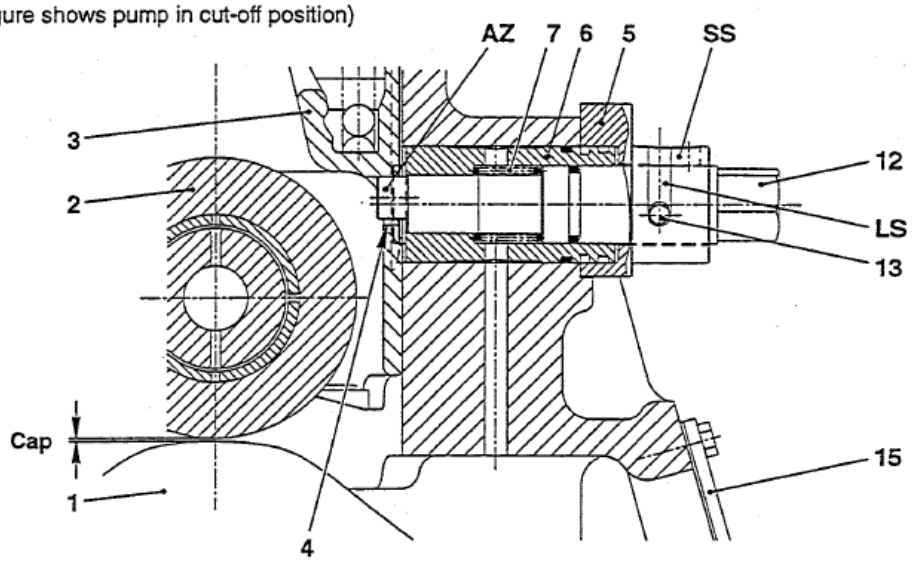
The eccentric pin 12 and therewith the spring dowel 12 are kept in the short slot "SS" of the guide groove by the force of the spring 7. If spring dowel 12 is pressed inwards, cut-out pin "AZ" rests on the roller guide. When hole 4 and cut-out pin "AZ" now come in line with each other, the latter is pushed into the roller guide 3 by pressing inwards.

In this way the piston is held fast in this position.

By turning the eccentric pin 12 through 100 deg in an anti-clockwise direction, the roller guide 3 is raised slightly so that some clearance exists between roller 2 and the addendum 1.

Device for cutting out and cutting in of the fuel injection pump

(A) (Figure shows pump in cut-off position)

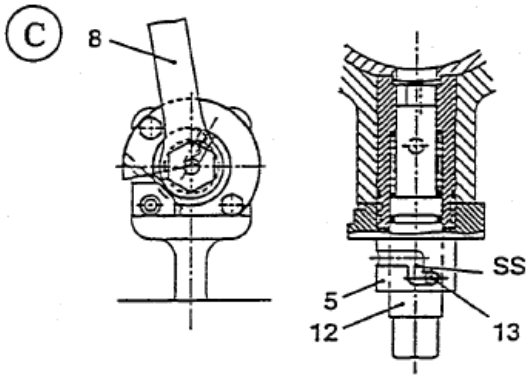


1	Cam		11	Flange	Tool no. 94430
2	Roller		12	Eccentric pin	
3	Roller guide		13	Spring dowel pin	
4	Hole		14	O-ring	
5	Cover		15	Inspection cover	
6	Guide sleeve				
7	Spring		AZ	Cut-out pin	
8	Open end ring spanner		SS	Short slot of guide groove	
9	Blind flange		LS	Long slot of guide groove	
10	Screw		DB	Through bore in flange 11	
			GB	Tap hole in pump housing	

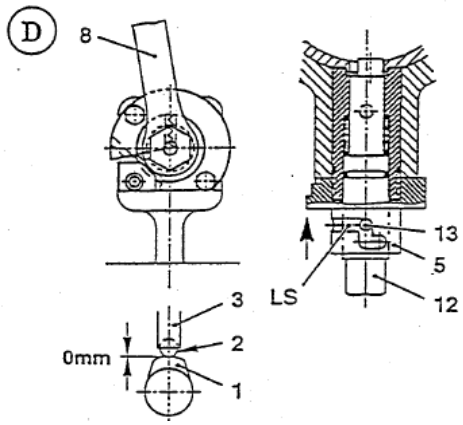
Cut-out procedure:

Starting position: Injection pump in service, engine either running at reduced speed or being turned with turning gear.

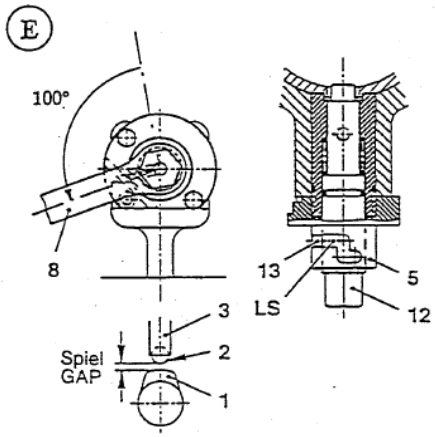
Attach open end ring spanner 8 to the hexagon of the eccentric pin 12 as shown in fig. C



Subsequently turn the eccentric pin 12 through 30 deg in an anti-clockwise direction and press it together with open end ring spanner 8 inwards until spring dowel pin 13 is located at the long slot “LS” of the guide groove see fig D



As soon as this is the case, the open end ring spanner 8 is to be turned through 100 deg in an anti-clockwise direction as quickly as possible. See Fig E

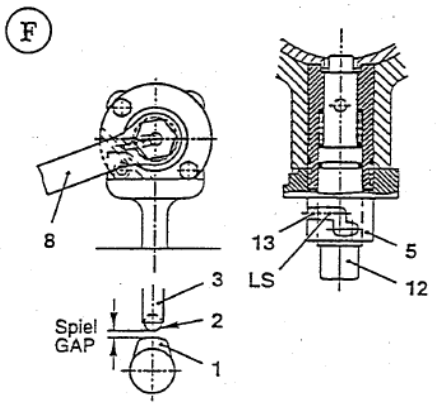


Cutting –in Procedure:

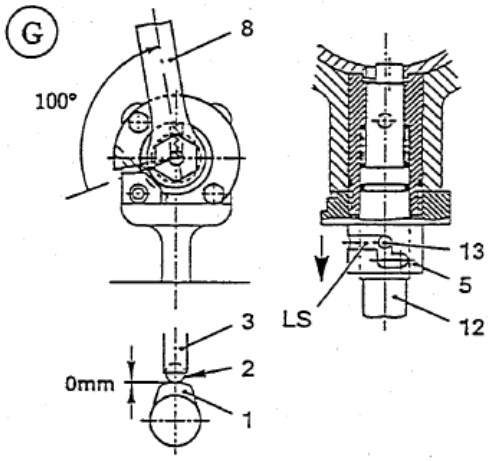
Starting position:

Injection pump is out of service. Engine is either being running or being turned with turning gear.

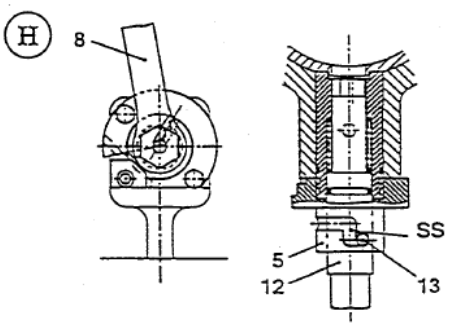
Attach open end ring spanner 8 see fig F



Turn the eccentric pin 12 through 100 deg in a clockwise direction. See fig G



By the force of spring 7 eccentric pin 12 is pressed outwards and, therefore, spring dowel pin 13 enters into the short slot “SS” of the guide groove, and turn the eccentric pin 12 through 30 deg in a clockwise direction. Remove open end ring spanner 8.



1.4 SLOW TURNING Operation with starting air (Optional):

The running gear (Engine) can be turned at about 5 ~10 rpm by releasing the starting air by a measured amount. With the DENIS-6 control the command SLOW TURNING is foreseen for this operation, which is initiated by remote control from the control room.

Once the SLOW TURNING Button is operated from Engine Control Room following takes place:

- This activates the valve 130HC electrically, which allows air to pilot valve 49HC.
- Once valve 49HC got actuated, control air passes to activate valve 23A and 2.05.
- The shut off valve (automatic starting air valve) for starting air 2.03 is opened by the control valve 2.05 and starting air reaches to valve 212HA on the starting air distributor as well as the starting air valves 2.07 in the cylinder heads.
- Starting air cut –off valve 129HA is opened for shorter intervals, and allowed control air to pilot valve, 212HA.Once valve 212HA got actuated, a measured amount of starting air reaches to the starting air distributor 2.01.This valve transmits pneumatic signal to the respective cylinders.
- By this pneumatic signals the valve 134HA before the starting valves are controlled in such a way that the starting valves are opened and shut for shorter intervals only.

In order to carry out SLOW TURNING following conditions must be fulfilled:

- Turning gear disengaged.
- Oil pumps running (Main L.O & cross head L.O pump)
- Fuel interlock not released.
- Reversing lever on REMOTE CONTROL.
- Speed control on zero.
- Indicator valves closed.
- Automatic starting air valve 2.03 in AUTO position.
- Shut-off valves on the starting air receivers open.
- Control air, safety air & Exhaust v/v spring air open.
- During slow turning the cylinder lubrication must be switched –on simultaneously.

NOTE: SLOW TURNING can be manual operated or can be timer based. In the TEN KEY addresses we can change the TIME setting for the SLOW TURNING. It will start after pre-set time when during Standby no movement has been given.
Manually SLOW TURNING can be done to Blow thru engine, with open indicator cocks. This will save the amount of air consumed before manoeuvring and also give sufficient time for operator to observe what is coming out of cylinders (May be leaking water / fuel present in cylinder which may cause HYDRAULIC LOCK and CATASTROPHIC DAMAGE to engine)

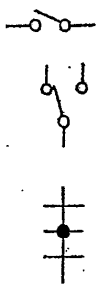
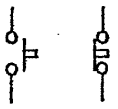
2. Electric Power Source

2.1 Symbols used in Electrical drawings:

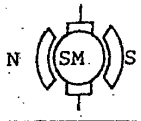
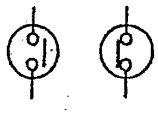
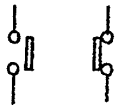
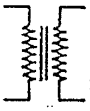
(Source: NABTESCO Remote control system instruction manual, Vol. 2)

Symbols : for Electric Diagram

SS45520-01-1/3

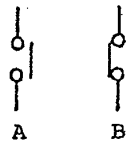
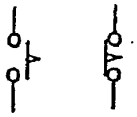
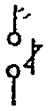
No.	Symbol	Main representation	Note
51		Switch	 Mark : operate position
52		Push button switch	A : "CLOSE" at pushed (a contact) B : "OPEN" at pushed (b contact)
53		Fuse	
54		Auxiliary relay	
55		Power relay	
56		Timer	
57		Flicker relay	
58		Indicator or alarm lamp	
59		LED (Light emitting diode)	

SS45520-01-2/3

No.	Symbol	Main representation	Note
60		DC motor	
61		Pressure switch	A : "CLOSE" at operated (a contact) B : "OPEN" at operated (b contact)
62		Limit switch	A : "CLOSE" at operated (a contact) B : "OPEN" at operated (b contact)
63		Variable resistance	
64		Resistance	
65		Potentiometer	
66		Condencer	
67		Diode	
68		Coil of solenoid valve	
69		Rectifier	
70		Transformer	

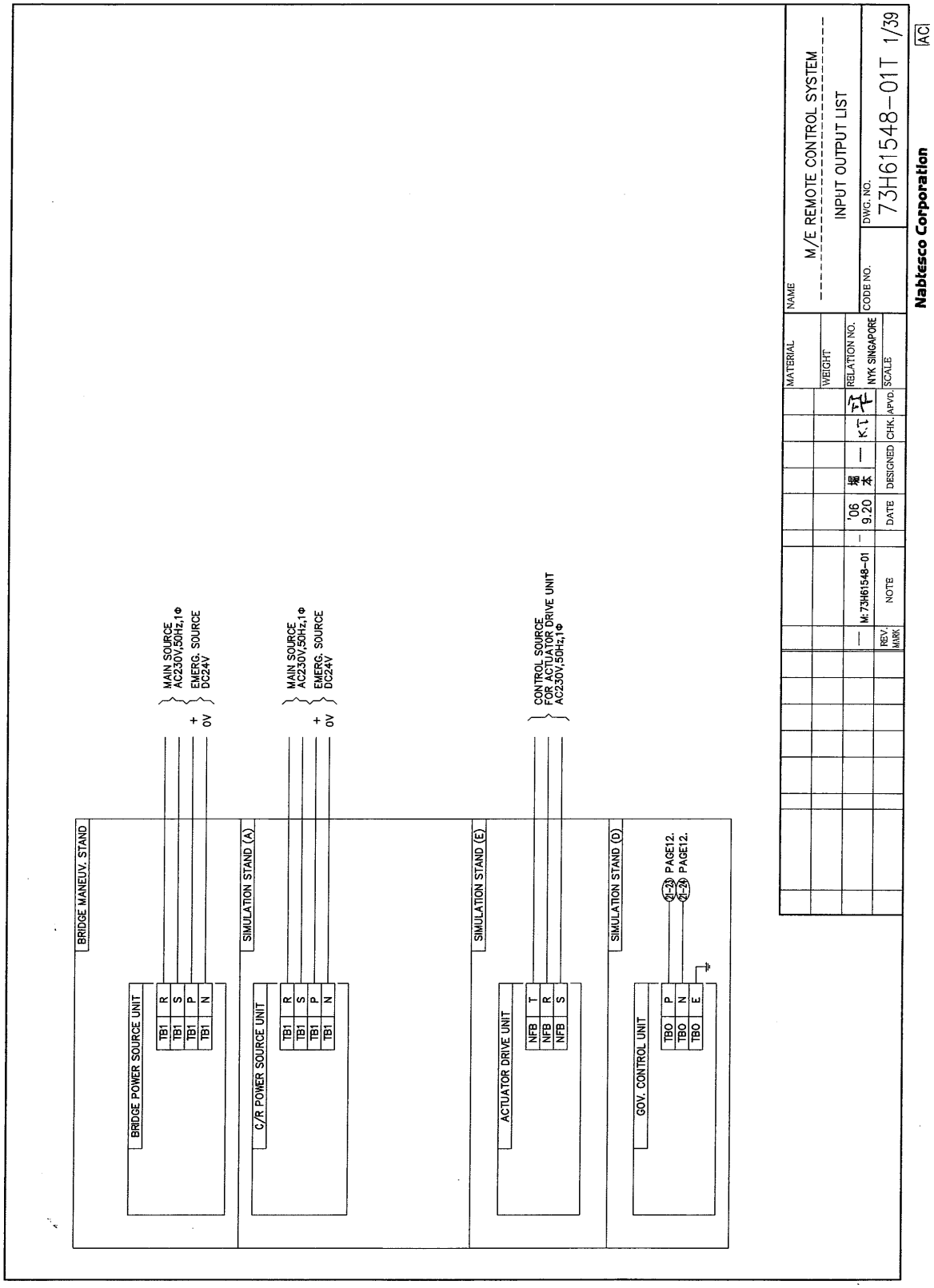
F2

SS45520-01-3/3

No.	Symbol	Main representation	Note
71		Contact of auxiliary relay or power relay	A : "CLOSE" at operated (a contact) B : "OPEN" at operated (b contact)
72		Contact of timer	A : After a prefixed time elapse, the contact is closed B : After a prefixed time elapse, the contact is opened
73		Contact of flicker relay	

2.2 Diagram of electric power source for the system:

(Source: NABTESCO Remote control system instruction manual, Vol. 2)

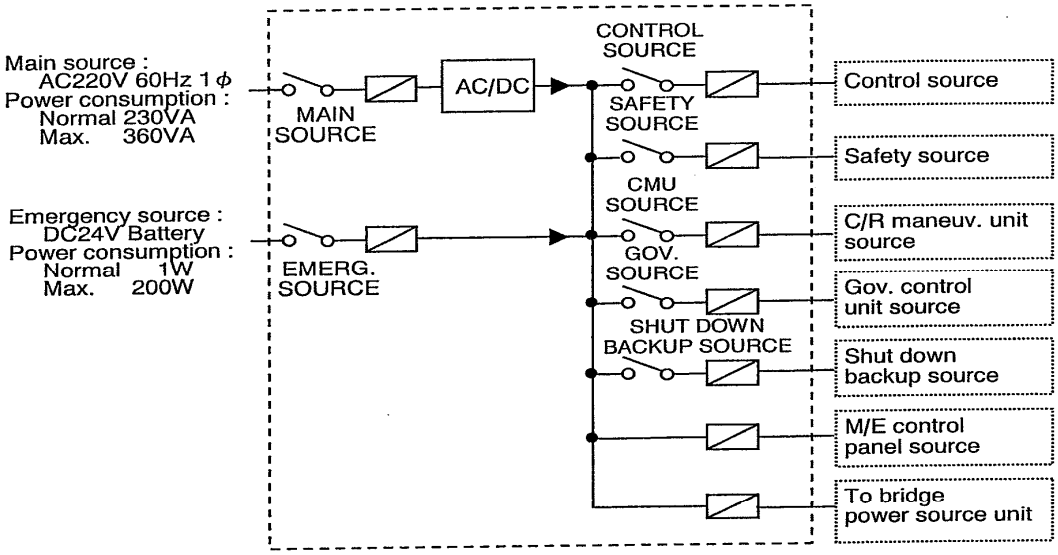


Nabtesco

7SH61548-01 3/42

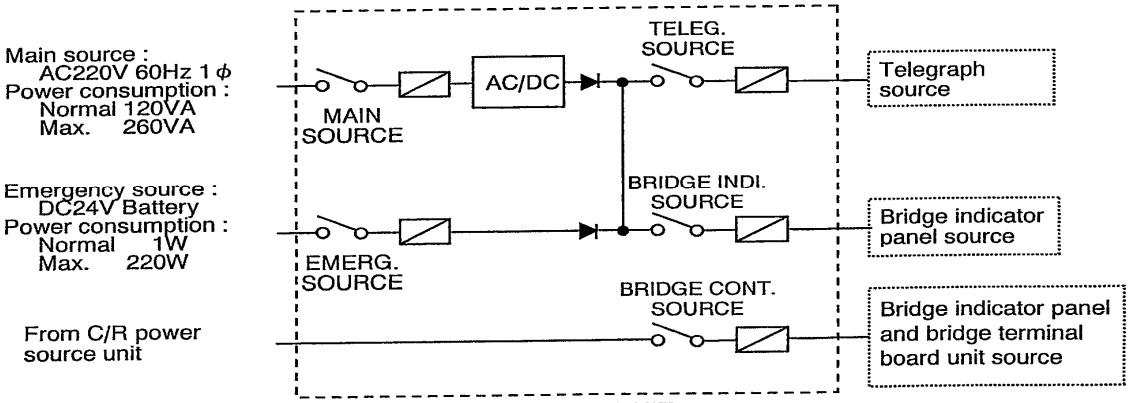
3 Electric Source

・Control room power source unit



C/R POWER SOURCE UNIT

・Bridge power source unit



BRIDGE POWER SOURCE UNIT

A3

3. Remote control System:

3.1 General information:

Type of Remote control system: M-800III – D6A, designed by NABTESCO

This remote control system provides performance of reversing, starting, stopping and speed setting of the main engine, electrically-pneumatically with a micro – computer from the Bridge or Control room by operating a single telegraph handle.

Further more, the backup control system is provided to control of main engine from the control room at failure of the remote control system.

In addition, there is provided with a safety system, which automatically slows down, shut down the main engine under electric-pneumatic control for emergency such as abnormal condition of main engine.

Furthermore, a manual emergency shut down device is provided to shut down the main engine under electric-pneumatic control for emergency such as failure of the remote control system.

Table 1.1 shows various maneuvering methods available with this type of remote control system.

CONTROL POSITION	MANEUVERING METHOD	SPEED CONTROL METHOD	SAFETY SYSTEM
BRIDGE	Automatic control by means of telegraph transmitter (Micro-computer-pneumatic control)	Governor control by electric signal from telegraph transmitter	Manual emergency shut down Automatic emergency shut down Automatic emergency slow down
C/R (Auto. control)	Automatic control by means of telegraph receiver (Micro-computer-pneumatic control)	Governor control by electric signal from telegraph receiver	Manual emergency shut down Automatic emergency shut down Automatic emergency slow down
C/R (Backup control)	Manual control by means of telegraph receiver and start push button switch (Electric-pneumatic control)	Governor control by electric signal from telegraph receiver	Manual emergency shut down Automatic emergency shut down
LOCAL (Gov. cont.)	Manual control by means of manuvering lever (Pneumatic control)	Governor control by electric signal from speed setting dial *1	Manual emergency shut down Automatic emergency shut down
LOCAL (F.O.cont.)	Manual control by means of manuvering lever (Pneumatic control)	Fuel regulating shaft control by fuel lever (Mechanical control)	Manual emergency shut down Automatic emergency shut down

Note
*1 : Speed setting dial : Hold this dial at "0" position by lock dial except when the governor is controlled by speed setting dial.

Table 1.1 Various Maneuvering methods
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

3.2 Arrangement of Remote control system

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

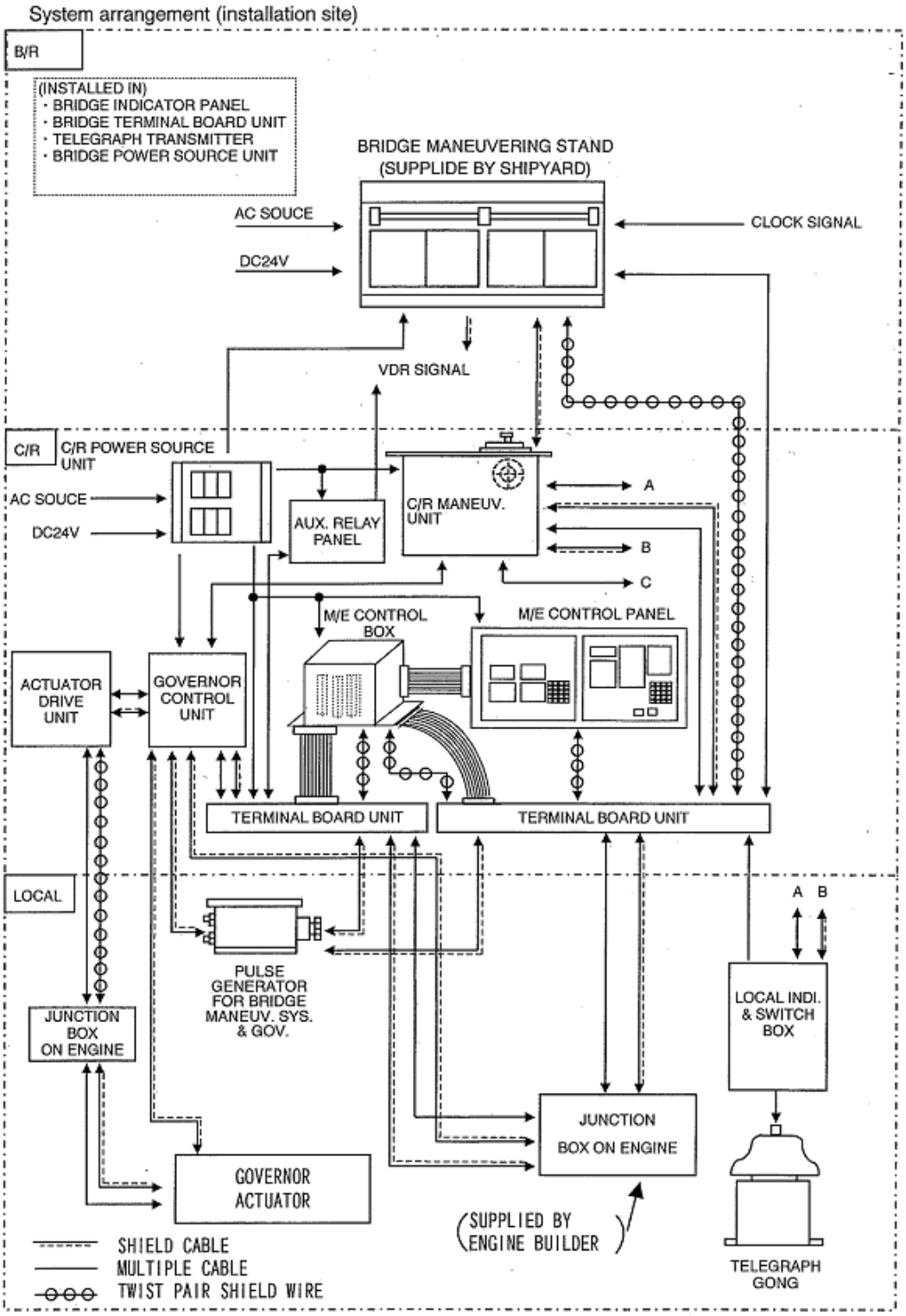


Fig.1.17 Arrangement of Remote control system

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

3.3 Use of various remote control Positions:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

This remote control system consists of the following functions.

1 Bridge

① Ahead/astern changeover
② Starting
③ Speed setting (Governor control, including program control)
④ Stopping
⑤ Normal reversing
⑥ Harbor reversing
⑦ Crash reversing
⑧ Quick passage device of critical speed range
⑨ Scav. limit cancel
⑩ Racing control

2 Control room auto. control

① Ahead/astern changeover
② Starting
③ Speed setting (Governor control, including program control)
④ Stopping
⑤ Normal reversing
⑥ Harbor reversing
⑦ Crash reversing
⑧ Quick passage device of critical speed range
⑨ Upper speed limit (Active only for bridge control)
⑩ Air running
⑪ Scav. limit cancel
⑫ Racing control

3 Control room backup control

① Ahead / astern backup changeover
② Starting
③ Speed setting (Governor control)
④ Stopping
⑤ Scav. limit cancel
⑥ Air running

4 Others

① Variable injection timing and fuel quality setting (VIT+FQS)
② Cylinder liner lubricating system

Note
VIT : Variable Injection Timing
FQS : Fuel Quality Setting

3.4 Bridge control operation:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

(1) Starting

To start the main engine, the following procedure is to be taken.

① By putting the telegraph transmitter in the ahead(astern) position, the reversing mechanism and the F.O. cam change-over into to the ahead (astern) position.

② Next, the starting air is supplied, and when the main engine begins to rotate to ahead (astern) direction, the starting fuel is supplied.

③ When the main engine speed reaches the starting air cut level, the starting air is cut off.

④ After a preset time since the main engine speed has reached the starting finished level, starting fuel setting of the governor is released and the main engine speed is increased or decreased to be equivalent with the telegraph transmitter position.

(2) Starting interlock

Starting can not be made unless the following conditions are satisfied.

In case of the telegraph transmitter in the stop position, starting failure is not available.

① Turning gear is on the position of "DISENGAGE"
② Starting failure is unoperating condition.
(Miss-ignition and starting impossible)
③ Emergency shut down is cancelling or not work condition.
(Manual and automatic emergency shut down)
④ Aux. blower is in normal condition.(No.1, No.2 and/or No.3)
⑤ Sub telegraph is not set to "F/E" (Finished with Engine)

When all of above mentioned condition are satisfied, the indicator lamp "READY TO START" provided on BRIDGE INDICATOR PANEL lights.
When telegraph transmitter is operated in the ahead(astern) unless the above mentioned conditions are not satisfied, an alarm lamp "START INTERLOCK" is given after a preset time.

In case of transferring the control position from bridge to control room only, starting function is not available if telegraph receiver position in control room is different from telegraph transmitter position in bridge.
Starting interlock is reseted by returing the telegraph receiver into "STOP" position.

(3) Miss-ignition and restarting

If a preset time passed with the main engine speed dropped again lower than the starting air cut level after the main engine speed reaches the starting air cut level, it is deemed miss-ignition and restarting is automatically made.

The indicator lamp "REPEATED START." provided on BRIDGE INDICATOR PANEL lights during the restarting.

To ensure the start in third starting, scav. limit due to the scavenging air pressure for th governor is cancelled. This cancel is continued for a preset time even after the main engine revolution reached to the start finish level.

Restarting is limited for twice, and starting operation is interrupted if the third starting fails, and alarm of "STARTING FAILURE" is given.

Reset is made by returning the telegraph transmitter to stop position.

(4) Starting impossible

It is deemed starting impossible that the starting air cut level can not be obtained withi a preset time after starting instruction is given, whereupon the starting operation is interrupted and alarm of "STARTING FAILURE" is given.

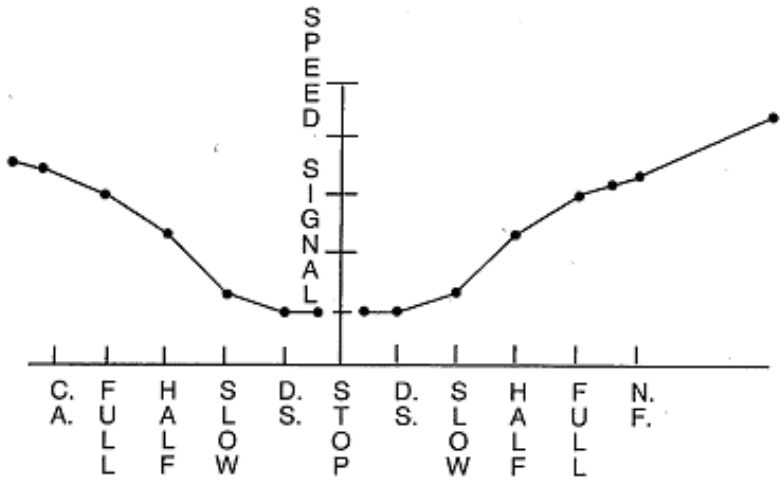
Reset is made by returning the telegraph transmitter to stop position.

(5) Speed control

・Control of harbor speed

By putting the telegraph transmitter into optional position, the main engine speed corresponding with that position is set due to governor control.

Usually operation of the telegraph transmitter is set into the central position of each instruction division, but the engine speed can be continuously changed by putting it in every other position.
The relation between transmitter position and engine speed has been preset.

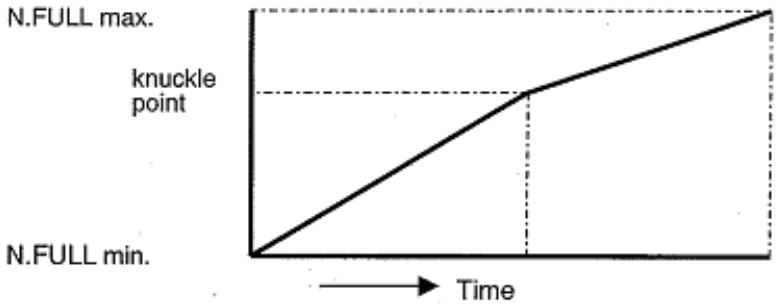


TELEGRAPH TRANSMITTER POSITION

・Acceleration to navigation speed (Acceleration speed can set two speed mode)

By putting the telegraph transmitter into over than load program starting position of N.FULL, the main engine is accelerated instantly as far as the load program starting position, but it is gradually accelerated over than that position as far as equivalent to the telegraph transmitter position due to the program loading up mechanism.

The indicator lamp "LOAD UP PROGRAM" lights during loading up the program.



・Deceleration from navigation speed

By operating the telegraph transmitter from over than load program starting position of N.FULL for reducing, the main engine is gradually decelerated as far as the load program starting position due to the program loading down mechanism, and it is instantly decelerated less than that position as far as equivalent to the telegraph transmitter position.

The indicator lamp "LOAD DOWN PROGRAM" lights during loading down the program. In case that the telegraph transmitter is operated into less than HARBOR FULL (including stop and astern side), the program loading down mechanism does not operate.

・Program cancel

By pushing the load program cancel push button switch provided in the bridge or control room, the indicator lamp "PROGRAM CANCEL" turns on and the program loading up (down) mechanism does not operate even in case that the telegraph transmitter is operated to the load program position, and the main engine is accelerated (decelerated) instantly as far as equivalence with the telegraph transmitter position.

By pushing again the load program cancel push button switch, the indicator lamp fails and the normal condition recovers.

The program cancel switch provided on bridge is available during bridge control condition and the program cancel switch provided on control room is available during control room control condition.

・Limit of setting revolution

The upper limit of setting revolution in the bridge control is limited according as the lower setting value by upper speed limit set "UP" or "DOWN" push button switch in M/E CONTROL PANEL.

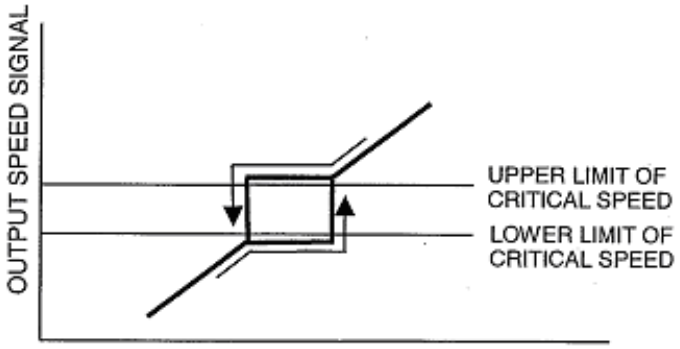
Press and hold both UP and DOWN switches on the M/E CONTROL PANEL simultaneously for more then 1 second so that the setting mode of upper speed limit ca be available.

When the UP or DOWN switch has not been pressed for a preset time, the setting mod will be canceled automatically.

The main engine can be accelerated no farther even by putting the telegraph transmitte over than the position equivalent to limited revolution. At the same time, M/E CONTRO PANEL by light emitting diode "UPPER SPEED LIMIT" lights.

・Quick passage device of critical speed range

When a speed instruction is given inside of the critical speed range, this device keeps the final output speed instruction at the lower limit of the critical range in case of increasing operation, and at the upper limit in case of decreasing operation.



In case of increasing operation, when the main engine speed reaches the lower limit of the critical range, scavenging air pressure limit is cancelled. And after a preset time since the main engine speed reaches the upper limit of the critical range, scavenging ai pressure limit cancel is reset.

If the main engine speed drops down again less than lower limit after the main engine speed exceeds lower limit, the scavenging air pressure limit cancel is kept for a preset time (setting separately with aforementioned and this case).

(6) Stopping

By putting the telegraph transmitter into stop position, the fuel is cut off to stop the main engine.

(7) Reversing mode

・Normal reversing

Reversing in case of operating the telegraph transmitter in reversing side while the main engine is running under than harbor reversing level, takes the following procedure.

① The telegraph transmitter is put directly into astern (ahead) position.

② The fuel is cut off due to difference between the main engine running direction and the telegraph transmitter indication.
The astern(ahead) change-over solenoid valve is energized by returning the F.O. rack to "0" position or upon dropping the main engine speed to the reversing level, and then, the reversing mechanism and F.O. cams changes over into the astern (ahead) position.

③ Upon dropping the main engine speed to the braking air supply level, the braking air (starting air) is supplied.

④ After the main engine stopped and began to rotate to astern (ahead) direction, starting fuel is supplied. Wherein setting of governor is in normal reversing starting position.

⑤ After the main engine speed accelerated to normal starting air cut level, starting air is cut off.

⑥ Upon a preset time(setting normal starting), after the main engine speed reaches starting finished level, starting fuel setting for the governor is released and the engine speed commences to follow the equivalence with the telegraph transmitter position.

・Harbor reversing

If it is necessary to apply the harbor reversing function by the result of sea trial, by changing the setting value of tenkey in M/E CONTROL PANEL, this function will be available.
Reversing in case of operating the telegraph transmitter in reversing side within a preset time while the main engine is running over than harbor reversing level, takes the following procedure.

① The telegraph transmitter is put directly into astern (ahead) position.

② The fuel is cut off due to difference between the main engine running direction and the telegraph transmitter indication.
The astern(ahead) change-over solenoid valve is energized by returning the F.O. rack to "0" position or upon dropping the main engine speed to the reversing level, and then, the reversing mechanism and F.O. cams changes over into the astern (ahead) position.

③ Upon dropping the main engine speed to the braking air supply level, the braking air (starting air) is supplied.

④ After the main engine stopped and began to rotate to astern (ahead) direction, starting fuel is supplied. Wherein setting of governor is in harbor reversing starting position, and scavenging air pressure limit has been cancelled.

⑤ After the main engine speed accelerated to harbor reversing starting air cut level, starting air is cut off.

⑥ Upon a preset time(setting separately with harbor reversing and normal starting) after the main engine speed reaches starting finished level, starting fuel setting for the governor is released and the engine speed commences to follow the equivalence with the telegraph transmitter position. And after another preset time, scavenging air pressure limit cancel is reset.

・Crash reversing

Reversing in case of operating the telegraph transmitter in reversing side within a pr time while the main engine is running over than crash reversing level, takes the following procedure.

① The telegraph transmitter is put directly into astern (ahead) position.

② The fuel is cut off due to difference between the main engine running direction a the telegraph transmitter indication.
The astern(ahead) change-over solenoid valve is energized by returning the F.O rack to "0" position or upon dropping the main engine speed to the reversing lev and then, the reversing mechanism and F.O. cams changes over into the astern (ahead) position.

③ Upon dropping the main engine speed to the braking air supply level, the braking (starting air) is supplied.

④ After the main engine stopped and began to rotate to astern (ahead) direction, starting fuel is supplied. Wherein setting of governor is in crash reversing startin position and scavenging air pressure limit has been cancelled.

⑤ After the main engine speed accelerated to crash reversing starting air cut level starting air is cut off.

⑥ Upon a preset time(setting separately with crash reversing and normal starting) after the main engine speed reaches starting finished level, starting fuel setting the governor is released and the engine speed commences to follow the equivalence with the telegraph transmitter position. And after another preset tim scavenging air pressure limit cancel is reset.

It is deemed crash reversing operation that the telegraph transmitter operates from ahead side or stop position to CRASH ASTERN position, the above mentioned operation is given.

(8) Control system monitoring function

In each case of the following conditions, the alarm of "CONTROL SYSTEM ABNORMAL" is given on BRIDGE INDICATOR PANEL, and the main engine maintains the existing state of things.

The cause of control system abnormal is indicated on M/E CONTROL PANEL by the light emitting diodes.

In case of ④ ~ ⑧, the light emitting diode (LED) of "WIRING ABNORMAL" and LED for each abnormal position flicker on M/E CONTROL PANEL.

① Micro-computer for control system abnormal.
② 15V elect. source voltage abnormal.
③ Communication abnormal.
④ Telegraph transmitter potentiometer disconnection.
⑤ Telegraph receiver potentiometer disconnection.(C/R)
⑥ Ahead changeover solenoid valve circuit disconnection.
⑦ Astern changeover solenoid valve circuit disconnection.
⑧ Start solenoid valve circuit disconnection.
⑨ Revolution signal (for control system) abnormal.

(9) Mimic board

A mimic board is provided on M/E CONTROL PANEL to indicate conditions of the remote control system and the main engine by means of light emitting diodes.

(10) Main engine racing control

When the "ROUGH SEA" push button switch (illuminated push button switch-by pushing switch operates and indicator lamp lights. And by pushing again, switch returns and indicator lamp fails) provided on C/R MANEUVERING UNIT is operated, the main engine is controlled according to the followings.

① The main engine revolution reaches to the racing control active level.

② The stop signal is supplied to governor control unit and the fuel is cut off. At the same time the speed signal of the governor is reduced to the racing control reset level.

③ When the main engine revolution drops down to the racing control reset level, the stop signal is released and the fuel is supplied again. But the main engine revolution is gradually accelerated to the telegraph transmitter position due to the exclusive time schedule.

The program cancel push button switch and program cancel lamp are provided in the bridge.
By pushing this push button switch, the load program cancel indicator lamp is lighted and the exclusive time schedule dose not operate.

By pushing again this switch, the indicator lamp fails and normal condition recovers.
By pushing "CAUSE RESET" push button on the M/E CONTROL PANEL the racing condition has returned normal, the "RACING" lamp fails.

(11) Electric source failure

Abnormal	Reversing, starting and stopping	Speed setting	Manual emerg. shut down	Auto. emerg. shut down	Auto. emerg. slow down	Remarks
Main source failure (AC source)	○	○	○	○	○	Changing to emerg. source and normal operation continue
Emergency source failure (DC24V)	○	○	○	○	○	No influence
Main and emergency source failure	×	×	×	×	×	Maintain the existing state of things

○ : Available, × : Unavailable

NOTE : Electric source failure of remote control system and governor system

In case of both main and emergency power for governor system failure, the governor actuator will be fixed at the previous position before the failure as well as the F.O. rack position.
Since the main engine speeds can fluctuate depending on the engine condition and / or the variation of engine loads, immediately shift the control position to the LOCAL (F.O. control).

(12) Control air failure

When control air pressure comes to be 0MPa completely, it is impossible to change ahead /astern and to start the main engine.
In this case, please change-over the control position to local immediately for safety. It is possible to speed setting by fuel lever, but it is impossible to change ahead/astern and to start the main engine.

(13) Scav. limit cancel (scav. air pressure limit cancel)

By pushing the push button switch "SCAV. LIMIT CANCEL" in C/R MANEUVERING UNIT, the indicator lamp lights and the scavenging air pressure limit is cancelled.
By pushing the push button switch "SCAV. LIMIT CANCEL" again, the indicator lamp fails and the normal condition recovers.
This scavenging air pressure limit cancel can be operated regardless of control position.

3.5 Control room control operation:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

(1) Auto. control

The automatic control of control room can be carried out in the same way as the bridge control by means of the telegraph receiver except the upper speed limiter and racing function.

(2) Air running

The main engine can not be executed air running without the satisfaction of all the following conditions.

① Control position is in control room.
② The turning gear is on the position of "DISENGAGE".
③ Emergency shut down is cancelling or not work condition.
④ The telegraph receiver in control room is set into "STOP" position.

By pushing the ahead (astern) air running push button switch, only starting air supplied to the main engine and main engine begins to rotate to ahead (astern) direction with air running.
By releasing the ahead (astern) air running push button switch, the starting air is cut off and the main engine stops.

3.6 Back up control operation:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

This backup control system provides performance of reversing, starting, stopping and speed setting of the main engine.
If the remote control system is failed, the main engine can be controlled from the control room by operating the backup control accessory.

① Starting

By putting the telegraph receiver in the ahead(astern) position, the reversing mechanism and the F.O. cams change-over into the ahead (astern) position.
Next, the starting push button switch pushes, the start air is supplied to the main engine and the main engine begines to rotare ahead (astern) direction.
Confirm the main engine revolution indicator that the main engine speed reaches the starting air cut level and then release the starting push button switch.

② Speed setting

By operating the telegraph receiver into optional position, the main engine speed corresponding with that position is set due to governor control. This function is independent of the micro computer system.
Since the load program acceleration and deceleration are not provided, the main engine speed is increased or decreased into the navigation speed by operating the telegraph receiver slowly together with its fine adjusting knob.

③ Stopping

By operating the telegraph receiver into stop position, the fuel is cut off to stop the main engine.

④ Reversing

By operating the telegraph receiver into the astern (ahead) position, the fuel is cut off. The astern (ahead) change-over solenoid valve is energized by upon dropping the main engine speed to the reversing level, and then, the starting air distributor, the reversing mechanism and the F.O. cams change-over into the astern (ahead) position.

⑤ Scav. limit cancel (scav. air preeure limit cancel)

By pushing the push button switch "SCAV. LIMIT CANCEL" in C/R MANEUVERING UNIT, the indicator lamp lights and the scavenging air pressure limit is cancelled.
By pushing the push button switch "SCAV. LIMIT CANCEL" again, the indicator lamp fails and the normal condition recovers.

3.7 Variable injection timing and Fuel quality setting:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

The purpose of this function is to keep the 100% firing pressure in the range of CMCR(Contracted maximum continueous rating) above 85%.

This function uses as input signal the scavenging air pressure and main engine speed. The FQS, on the other hand, is manually set according to the fuel quality in use.

By changing the data of tenkey on M/E CONTROL PANEL data to "0", the VIT function is cancelled and the actuator returns to "VIT OFF" position.

If any one of following condition occurs, the alarm "VIT+FQS FAILURE" is given and the actuator returns to the position "retarded injection".
The alarm "VIT+FQS FAIL. / RESET" can be cancelled by pushing "VIT+FQS FAIL. / RESET" push button switch after cause of VIT+FQS failure is removed.

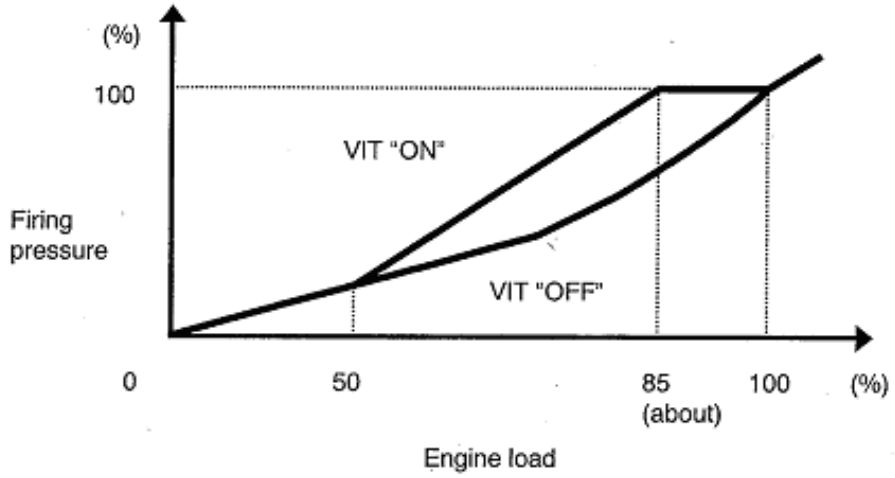
① The deviation between ordered position and feedback position is more than a preset value.
② The feedback signal wire broken.
③ The actuator solenoid valve wire broken.

Furthermore, if the above mentioned item ① or ② occurs during bridge or control room control condition, the main engine revolution reduces automatically to 85% speed. When main engine speed is reduced to the 85% speed, the alarm of "SPEED REDUCE BY VIT" is give and the indicator lamp "SPEED REDUCE BY VIT" will be lit on C/R MANEUVERING UNIT.

The speed reduce can be reset by returning the telegraph handle to a preset position (equivalent to 85% speed) and pushing "VIT+FQS FAIL. / RESET"push button switch after cause of VIT+FQS failure is removed.
The main engine can be run again at the speed equivalent to the telegraph handle position.

If the indicator lamp "VIT+FQS FAIL./RESET" can not be reset even by operating the telegraph handle less than a preset point (equivalent to 85% speed) and pushing "VIT+FQS FAIL./RESET" push button switch on C/R MANEUVERING UNIT, running a speed higher than 85% speed can be obtained by the following procedures ;
First, fix the E/S VIT cylinder advanced angle at 0 degree with the fixing bush (E5) on the actuator.
Next, enter "1" in tenkey of M/E CONTROL PANEL.
Then, the indicator lamp "VIT SPEED REDUCE OVERRIDE" on the C/R MANEUVERING UNIT lights up and running at a speed higher than 85% speed can b available.
The lamp "VIT SPEED REDUCE OVERRIDE" will go off by entering "0" in tenkey.
Before entering "0" in tenkey again, check the restoration of VIT+FQS failure by pressing the "VIT+FQS FAIL. / RESET" push button switch on C/R MANEUVERING UNIT and then remove the fixing bush (E5) of E/S VIT cylinder advanced angle.

The diagram below shows the effect of VIT



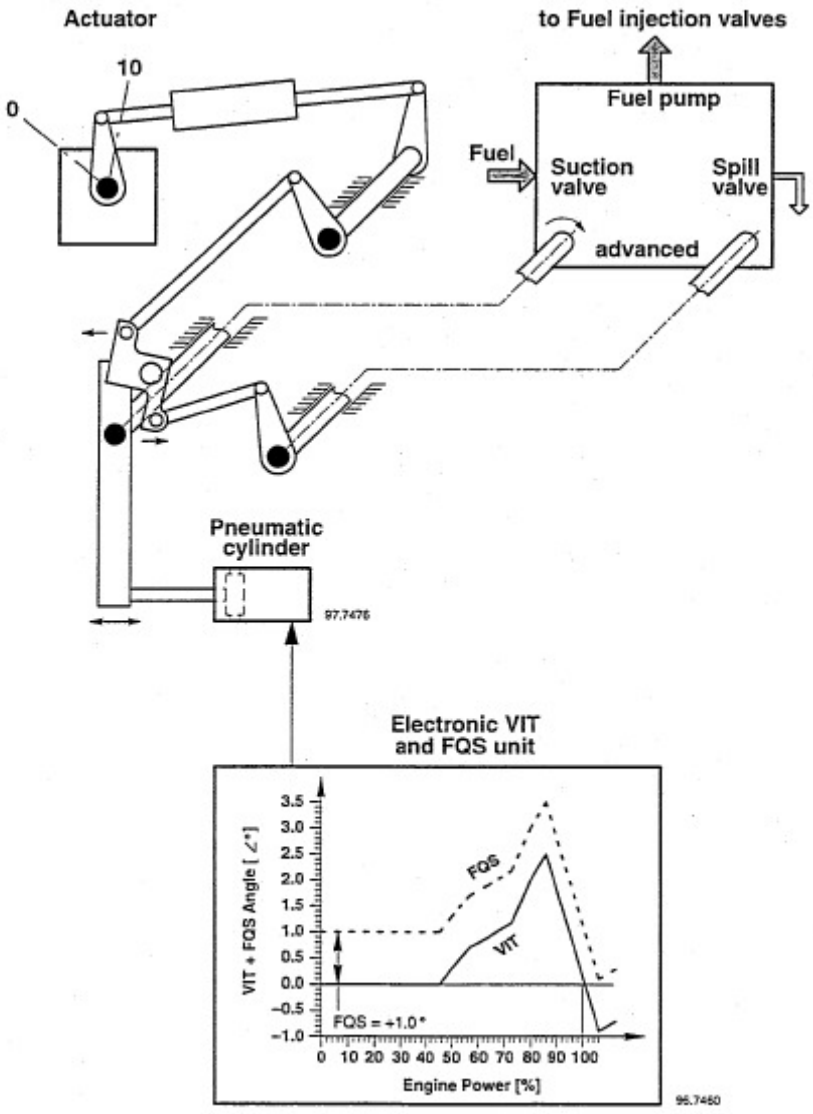


Fig 1 SULZER engine VIT Arrangement with graph**.**

Below figures 2 & 3 shows the general influence of the earlier fuel injection (VIT) to the combustion pressure and specific fuel consumption at part load operation.

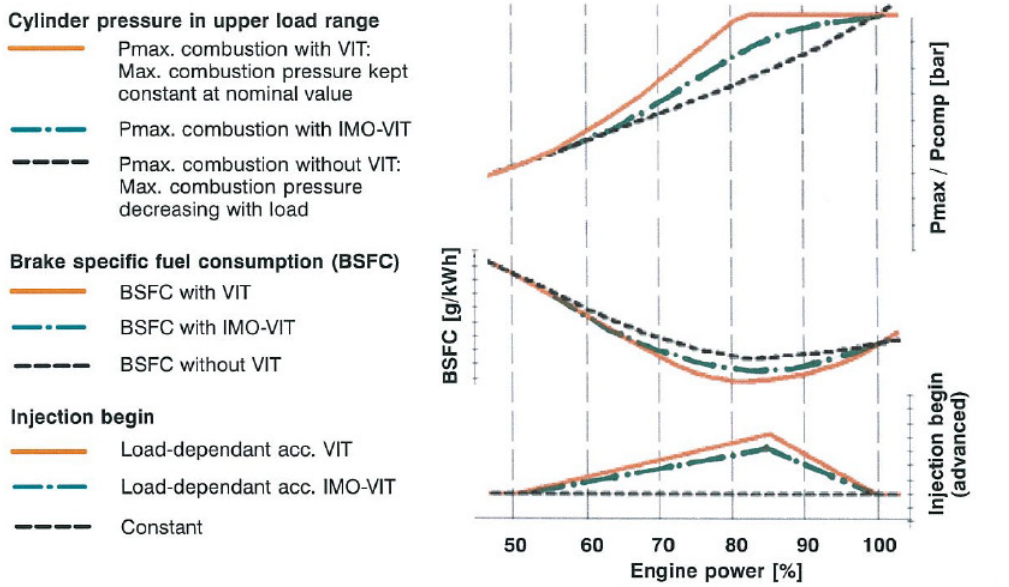

Cylinder pressure in upper load range
Pmax. combustion with VIT: Max. combustion pressure kept constant at nominal value
Pmax. combustion with IMO-VIT
Pmax. combustion without VIT: Max. combustion pressure decreasing with load
Brake specific fuel consumption (BSFC)
BSFC with VIT
BSFC with IMO-VIT
BSFC without VIT
Injection begin
Load-dependant acc. VIT
Load-dependant acc. IMO-VIT
Constant
BSFC [g/kWh]
Pmax / Pcomp [bar]
Injection begin (advanced)
50
60
70
80
90
100
Engine power [%]

Fig 2

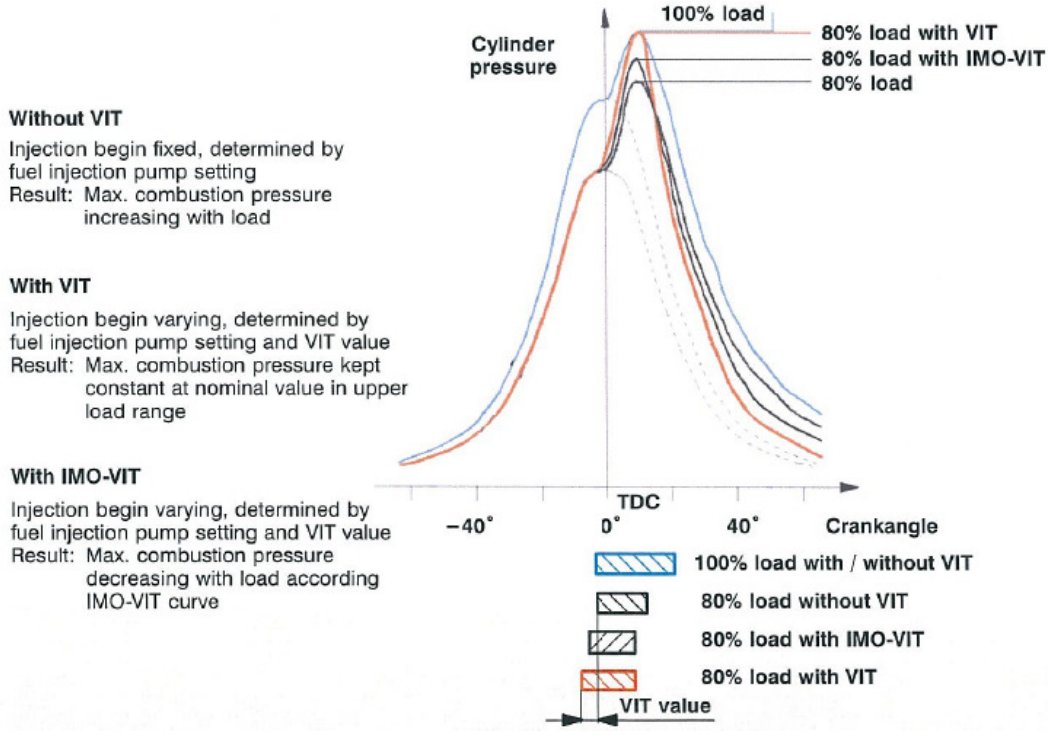

Without VIT
Injection begin fixed, determined by fuel injection pump setting
Result: Max. combustion pressure increasing with load
With VIT
Injection begin varying, determined by fuel injection pump setting and VIT value
Result: Max. combustion pressure kept constant at nominal value in upper load range
With IMO-VIT
Injection begin varying, determined by fuel injection pump setting and VIT value
Result: Max. combustion pressure decreasing with load according IMO-VIT curve
Cylinder pressure
100% load
80% load with VIT
80% load with IMO-VIT
80% load
TDC
−40°
0°
40°
Crankangle
100% load with / without VIT
80% load without VIT
80% load with IMO-VIT
80% load with VIT
VIT value

Fig 3

3.8 Procedure for Change-over of control positions

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Note.1 Change-over of control position from control room to bridge can not be made unless the following conditions are satisfied.

① The turning gear is in the position "DISENGAGE".
② Both electric source AC and DC are in normal condition.
③ The control air pressure is in normal condition.
④ The control system is in normal condition except the telegraph receiver potentiometer disconnection.(the details are described later, refer to item No. 7.1 (8)).
⑤ The auxiliary blower is in the position "AUTO.". (No.1, No.2 and No.3)
⑥ The starting air shut off valve is in the position "AUTO.".

Alarm of "CONTROL SYSTEM ABNORMAL" is given if one of above mentioned condition is imperfect. At the same time, the alarm of "BRIDGE CONT. S/B FAIL." provided on the bridge is given.
And even if one of above mentioned condition is imperfect in the bridge control, the control position is kept in the bridge control.

Note.2 Change-over of control position from local to control room can not be made unless the following conditions are satisfied.

① The turning gear is in the position "DISENGAGE".
② Both electric source AC and DC are in normal condition.
③ The control air pressure is in normal condition.
④ The control system is in normal condition except the telegraph tramsmitter potentiometer disconnection.(the details are described later, refer to item No. 7.1 (8)).
⑤ The starting air shut off valve is in the position "AUTO.".

Alarm of "CONTROL SYSTEM ABNORMAL" is given if one of above mentioned condition is imperfect.
And even if one of above mentioned condition is imperfect in the control room control, the control position is kept in the control room control.

Note.3 Change-over of control position from bridge to control room (AUTO.) can not be made unless the following conditions are satisfied.

① The potentiometer of telegraph receiver is in normal condition.
② The CPU is in normal condition.

In case of CPU abnormal, the control position indications are held previous condition on fail-safe even if the control position transferred to backup control.

Note.4 Change-over of control position from backup control to control room (auto.) can not be made unless the transfer interlock items in Note.2 are satisfied.

Note 5. Control position change over under main engine running condition

When the control position changes over from local to control room, move the telegraph receiver in control room so that the indicator lamp "HANDLE MATCH(LOCAL-C/R)" provided on C/R MANEUVERING UNIT and LOCAL INDI. & SWITCH BOX may light. (for the purpose of restraining speed fluctuation of the main engine as low as possible during transition).

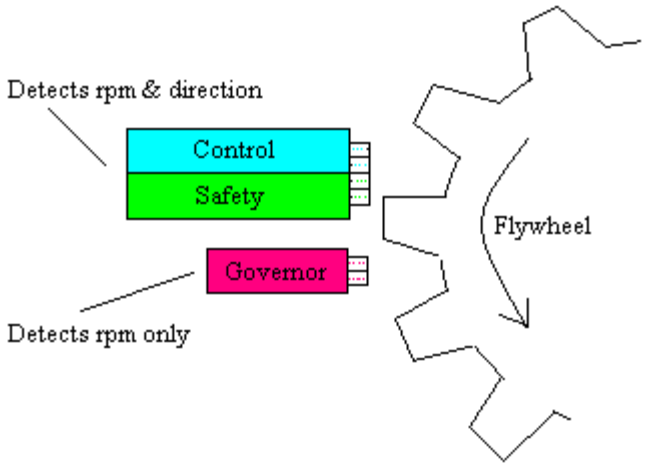
When the control position changes over from control room to local, move the speed setting dial in local so that the indicator lamp "HANDLE MATCH (LOCAL-C/R)" provided on C/R MANEUVERING UNIT and LOCAL INDI. & SWITCH BOX may light. (for the purpose of restraining speed fluctuation of the main engine as low as possible during transition).

When the control position changes over from control room to bridge, move the telegraph transmitter in bridge so that the indicator lamp "HANDLE MATCH" provided on C/R MANEUVERING UNIT and BRIDGE INDICATOR PANEL may light. (for the purpose of restraining speed fluctuation of the main engine as low as possible during transition).

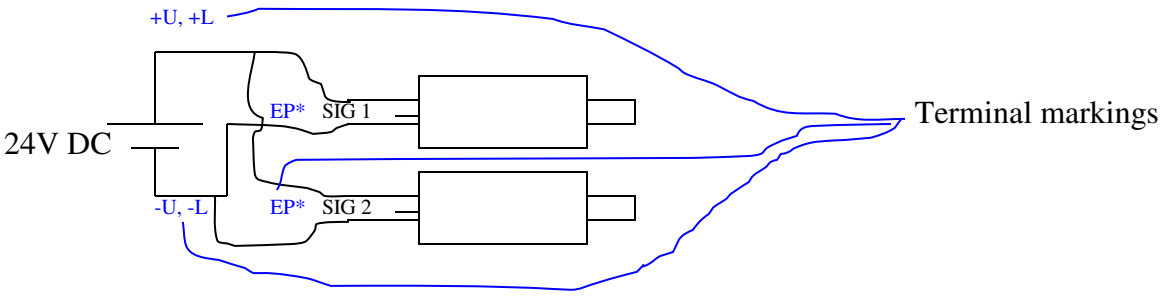
When the control position changes over from bridge to control room, move the telegraph receiver in control room so that the indicator lamp "HANDLE MATCH" provided on C/R MANEUVERING UNIT and BRIDGE INDICATOR PANEL may light. (for the purpose of restraining speed fluctuation of the main engine as low as possible during transition).

3.9 Arrangement of Pick-up sensors (M 800 III-D6A type control system):

There are six pick up sensors provided close to the flywheel to send feedback for actual rpm.
2 for Control system
2 for Safety system
2 for Governor control system



The simplified wiring arrangement for two pick-up sensors is shown below.



When 24V DC is supplied across (+U, -U or +L, -L) output is received at terminal EP*

3.10 Telegraph:

3.10.1 Main Telegraph

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

・Fitting

The equipments of main telegraph are provided on the following area.

① Bridge :
Illuminated lever type transmitter (with buzzer)

② Control room :
Illuminated lever type receiver (with buzzer)

③ Local :
LED indicated and push button switch reply type receiver, ϕ150 Gong

・Division

Ahead side	DEAD SLOW, SLOW, HALF, FULL, NAV. FULL
Astern side	DEAD SLOW, SLOW, HALF, FULL, CRASH ASTRN
And	STOP

・Function

① In case of bridge control, the buzzer and gong sound for 2 seconds at the new order and ordered division lights continuously. Control room or local is not necessary to reply.

② In case of control room or local control, when the transmitter is operated, the ordered division flickers and the buzzer and gong sound.
Next, by replying with the receiver, the ordered division turns continuous lighting and the buzzer and gong stop sounding.

3.10.2 Sub Telegraph

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

・Fitting

The equipments of sub telegraph are provided on the following area.

① Bridge :
LED and push button type transmitter
(Installed in telegraph transmitter)

② Control room :
LED and push button type receiver
(Installed in telegraph receiver)
Push button switch for sound stop
(Installed in telegraph receiver)

The buzzer and gong for main telegraph are common used.

・Division

Finished with engine	(F/E)
Stand by	(S/B)
Run up	(R/U)

・Function

By pushing the push button switch for transmitter in the bridge, the LED for indicating the ordered division flickers, and the buzzers and gong sound.
Under this condition, by pushing the push button switch for receiver, the LED for indicating the ordered division turns continuous lighting, and the buzzer and gong stop sounding.

In case of S/B or F/E order, by pushing the sound stop push button switch before replying, the buzzer and gong stop sounding but the LED keeps flickering.
Under this condition, by pushing the push button switch for receiver that is ordered division, the LED for indicating the ordered division turns continuous lighting, and the buzzer and gong sound for 2 seconds.

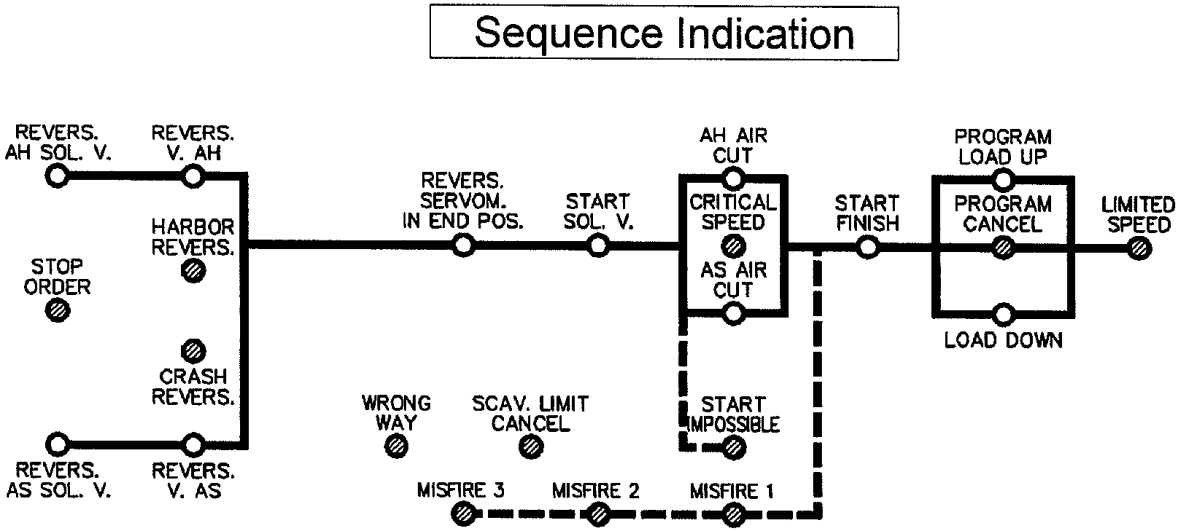
4. Control system

4.1 Familiarization with Control system unit

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

This section contains information about LEDs and various buttons on the M/E Control panel for the M-800-III M/E remote control system. The section explains the basic design philosophy of NABCO systems.
Some names of LEDs might be different from the actual vessel. The specific information for the particular vessel must be located in the instruction manual for that vessel.

Example



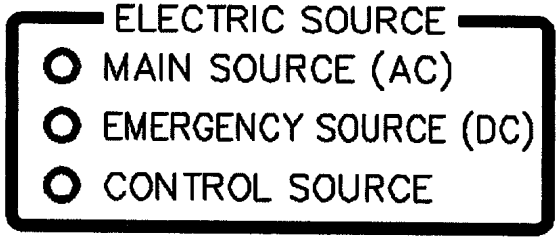
The sequence indication shows the operating condition of the main engine and the remote control system.
When an LED lights up, the main engine or the remote control system will become the condition indicated near the LED.
The LED "XX SOL. V." will be lit when an energizing signal has been given to the XX solenoid valve from the remote control system.

Green LEDs light up under normal running conditions.
Red LEDs light up under unsteady conditions such as starting failure and emergency reversing.
There is no sounding function on this panel.

Some typical LEDs on the sequence indication are explained as follows:

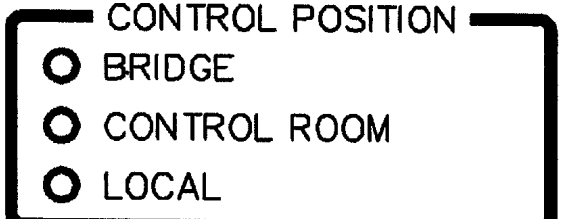
- REVERS. AH SOL. V.: Lights up when a signal has been given to the ahead solenoid valve.
- REVERS. V. AH: Lights up when the revers. valve has been set in the ahead area.
- MISSFIRE 1: Lights up when the first starting attempt has been failed.

Electric Source Indication (for Conrtol)



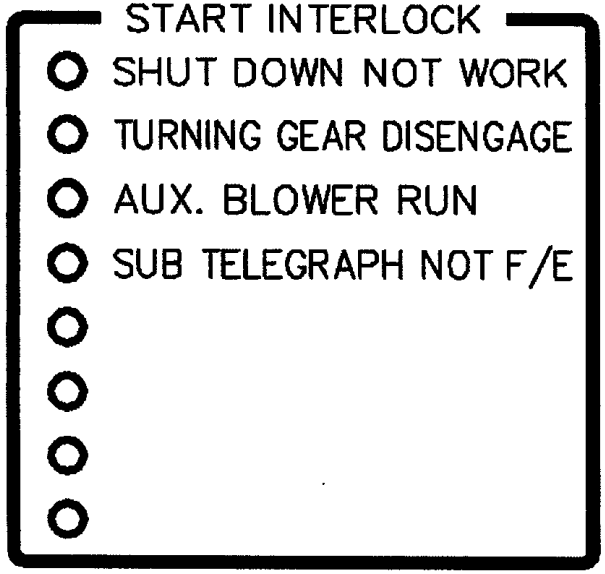
These LEDs show electric source conditions.
Each LED lights up when the electric source is normal.
The system is supplied AC and DC electric sources; the "AC" and "DC" LEDs show their conditions.
The "CONT. SOURCE" LED lights up when the control sources (5 V, 15 V, and 24 V) are normal.

Control position Indication



The control positions are indicated by LEDs.
An LED that is lit now shows the current control position.
The actual names showing control positions can be different from the left names.

Indication of Starting Interlock Conditions



This section includes LEDs for indicating conditions that must be satisfied to start the main engine.

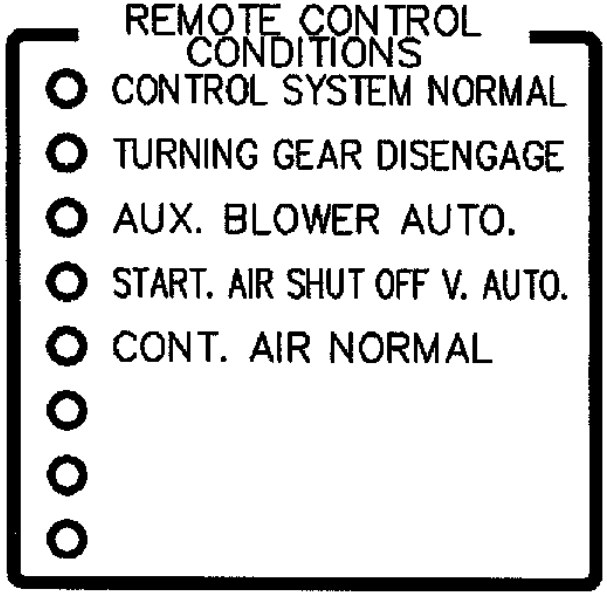
When all conditions are not satisfied, the main engine cannot be started.

Each LED lights up when the condition has been satisfied.

The left conditions might be different vessel by vessel.

For the actual conditions for you vessel, see the specifications.

Indication of Remote Control Conditions



This section includes LEDs showing conditions that must be satisfied to operate the main engine remotely.

When the condition is satisfied, the corresponding LED will light up.

These conditions might be different vessel by vessel.

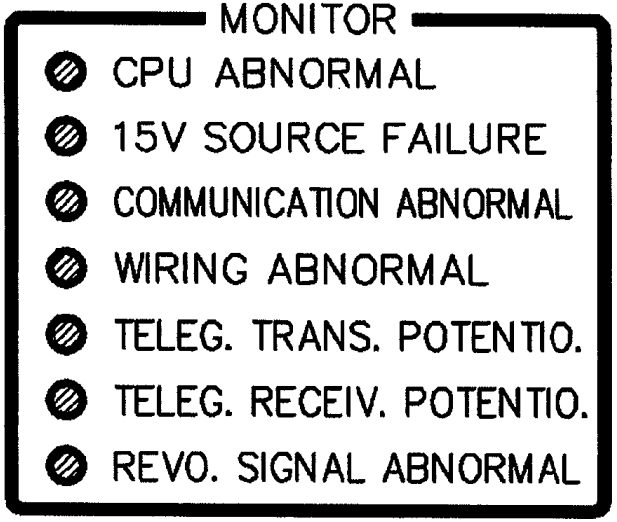
For the actual conditions for you vessel, see the specifications.

Advice:

If the conditions are not satisfied, the control position cannot be shifted from the local to the C/R, the C/R to the bridge.

Under the unsatisfied conditions, the "BRIDGE CONT. S/B FAIL." alarm will be given.

Abnormal Monitoring Indication



This section includes LEDs for indicating abnormal causes that have been detected in the system.
The left abnormal causes show the standard; some vessels can be different from these.

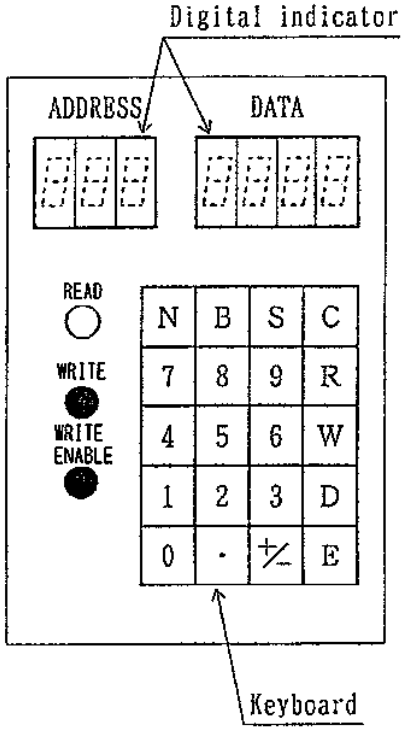
Resetting the indication can be possible by pressing the “CAUSE RESET” button in page 18.

4.1.1 Procedure for Checking and Changing the Set value of TENKEY address

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

1. Construction of keyboard

Read-out and change of each set value memorized in the micro-computer can be carried out by the keyboard operation. And the data can be displayed on the digital indicators.



○ : LED (Green)

● : LED (Red)

Key switch

(This switch is provided on the face of M/E CONTROL PANEL. The key switch for control system and safety system are common used.)

Name of key	Description
N (Next)	: Increases the number of address by one.
B (Before)	: Decreases the number of address by one.
S (Spare)	: Special key for maker's maintenance service. This key is not neccesary for user to handle.
C (Clear)	: Clears the data shown on the display during data input operation.
R (Read)	: Changes the mode from "WRITE" to "READ". If this key is operated, the mode can be changed to "READ" even if at the condition of "WRITE ENABLE"
W (Write)	: Changes the mode from "READ" to "WRITE". This is available at "WRITE ENABLE" condition only.
D (Data)	: Data input command. This operation declares that the input figures are memorized data.
E (Enter)	: Enter key. Input data cannot be memorized until this key operation.
0～9	: Address or data input key.
·	: A decimal point input key during data input operation.
+/-	: A minus sign input key during data input operation. By pushing this key, "+" and "-" is repeated alternately. But in case of "+", indication of sign is suppressed at display.

2. Read out of data

Input the address numbers of the desired data with the keyboard, and the address number is indicated in order of the higher-digit. When three-dig numbers have been set, the memorized data of the address is indicated.
If input the address numbers from 0 to 999, the address numbers should be input in three digit numbers. (for example "000", "001", or "099")
In case of pushing of "N" key ("B" key), the address number increases (decrease) one by one.

When the non-used address number is input, the following mark is indicate on the data area of the digital indicators.

The data are classified into address 000 ~ 999.

3. Change of data

Change of data is available at "WRITE" mode only, and the procedure is as follows.

(1) Changeover to "WRITE" mode.

① Switch for "WRITE ENABLE" to be on.
LED for "WRITE ENABLE" turns on. Mode is changed to "WRITE ENABI and "W" key is available.

② Push the "W" key.
LED for "READ" fails and "WRITE" turns on. Mode is changed from "READ" to "WRITE", and "D" key is available.

(2) Input the address numbers of the desired data with the keyboard.

Input address numbers are indicated on the address area of the digital indicators and the memorized data is indicated on the data area of the digital indicators respectively.

(3) Push "D" key.

Data area of the digital indicators is changed to blank and the compu awaites orders.

(4) Input a new data with the keyboard.

The new data is input and indicated in order.
Data should be input in order of the highest-digit without fail.
When the data is first entered, it will be displayed at the least significant digit of the data area.
When the following digit is entered, the data display so far is raised to the upper digit sequentially, by which the value entered last is entered to the least significant digit for display.
The data input is acceptable in any digits, however, the valid data is that displayed at the data column.
The "." (period) key is acceptable only while "." is not used at the data display unit.
"+" and "-" are repeated alternately every time the "+/-" key is depressed.

(5) Push "E" key.

The data which is indicated on the indicators is memorized in the microcomputer. If the data is not reasonable, the data is not memorized, and the following mark is indicated on the data area.

	E	r	r

When a mistake is found before the "E" key operation, the data is cleared by pushing the "C" key.
Enter the new data in accordance with the previous step-(4), and depress the "E" key.
Since the data will not be modified until the "E" key is depressed, turn off the "R" key or WRITE-ENABLE switch to display the previous data.
In this case, the data has not been changed.

(6) Enter the address desired to change, and then perform the previous step-(3), (4) and (5) repeatedly.

In this case, it is possible to change the addres by using the "N" key and "B" key in the same manner as data-reading.

(7) Reset the "WRITE ENABLE" switch to "OFF".

LEDs for "WRITE" and "WRITE ENABLE" fail and "READ" turns on. Mode is changed to "READ".

When the "WRITE ENABLE" switch is reset to "OFF", the period mark "." is indicated on the second-digit of address indicator for about one minute.
When the period mark is indicated, the electric power source should not be selected to off without fail. When fail, the power should be supplied again. Then, the period mark is indicated again. The power should be selected to off after the period mark disappears.
If the electric power is selected to off before the period mark disappears and more over the power is kept off condition for about one week, the changed data will be reset to former data.

4.2 Flow of speed setting signal from various control positions:

Figure 4.1 shows flow of speed setting signal from various control positions.

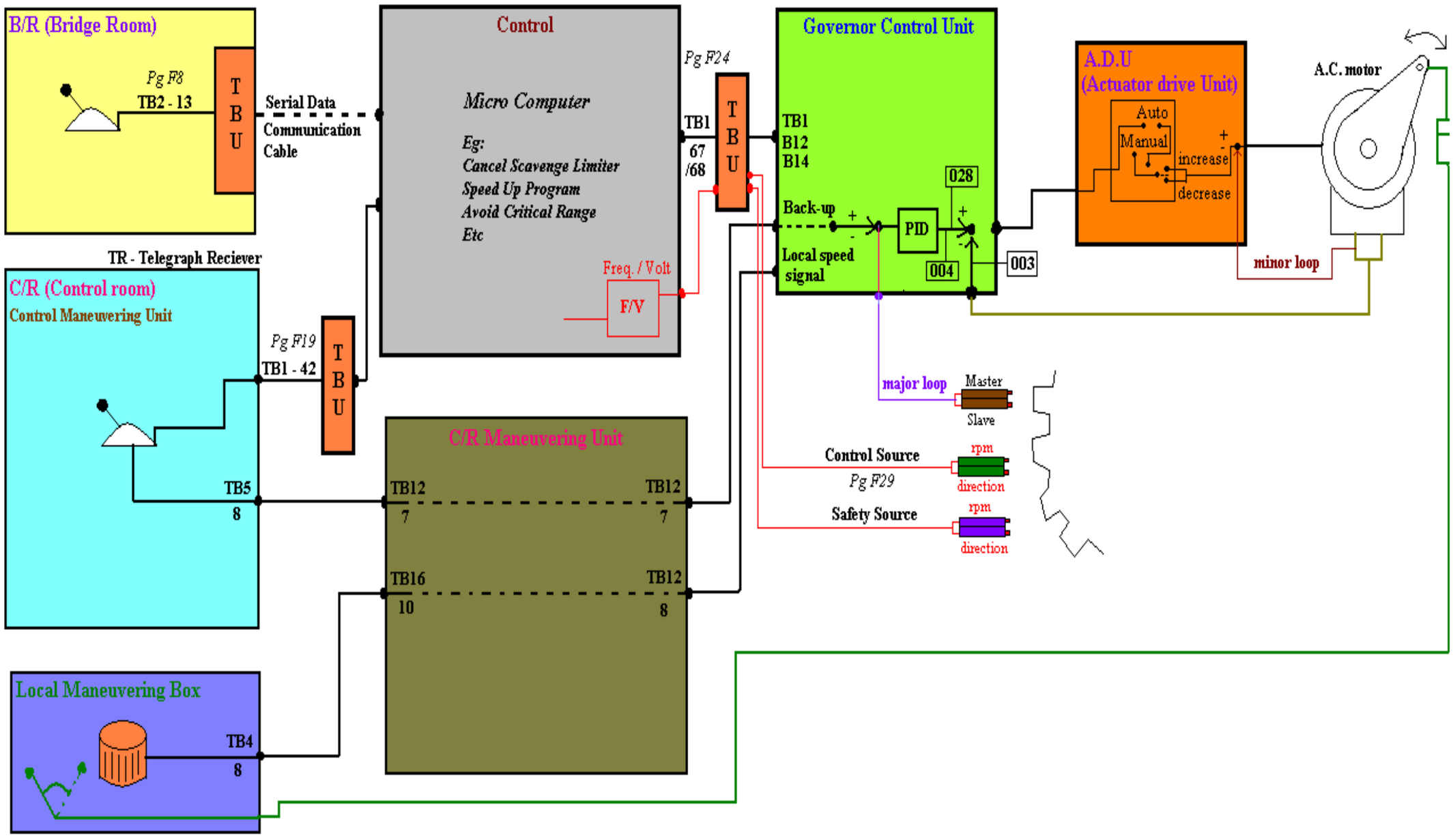
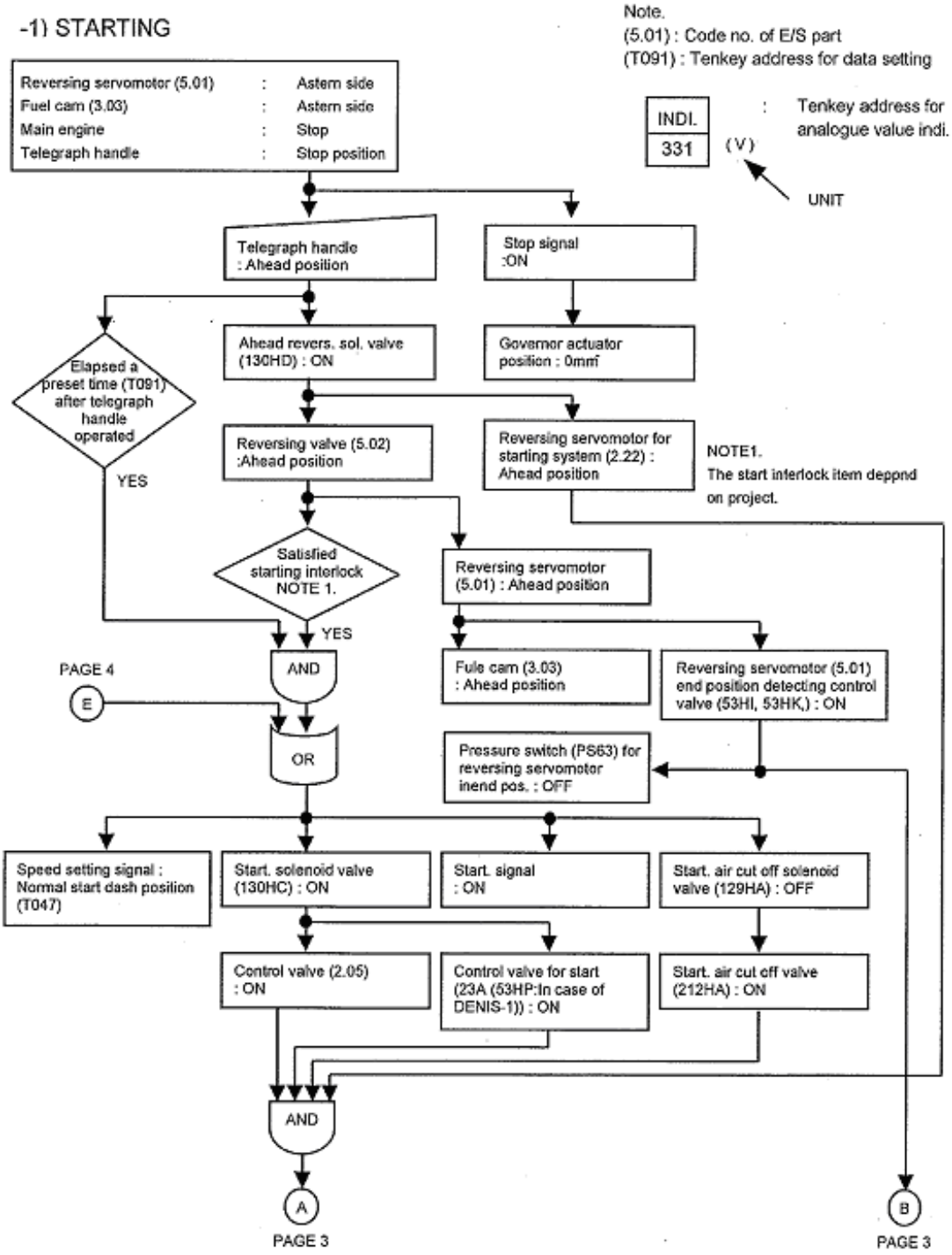


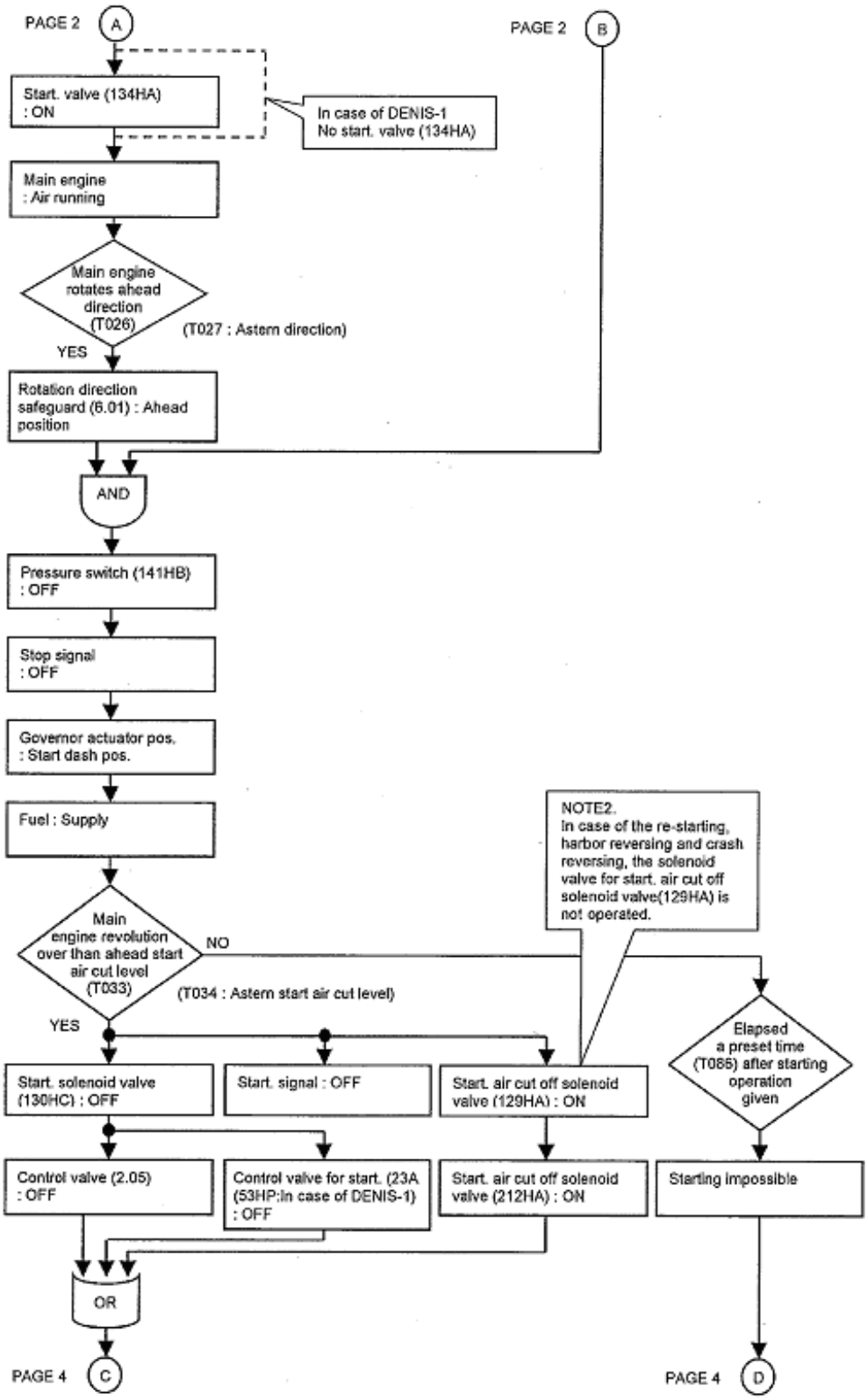
Fig. 4.1 Flow of speed setting signal from various control positions

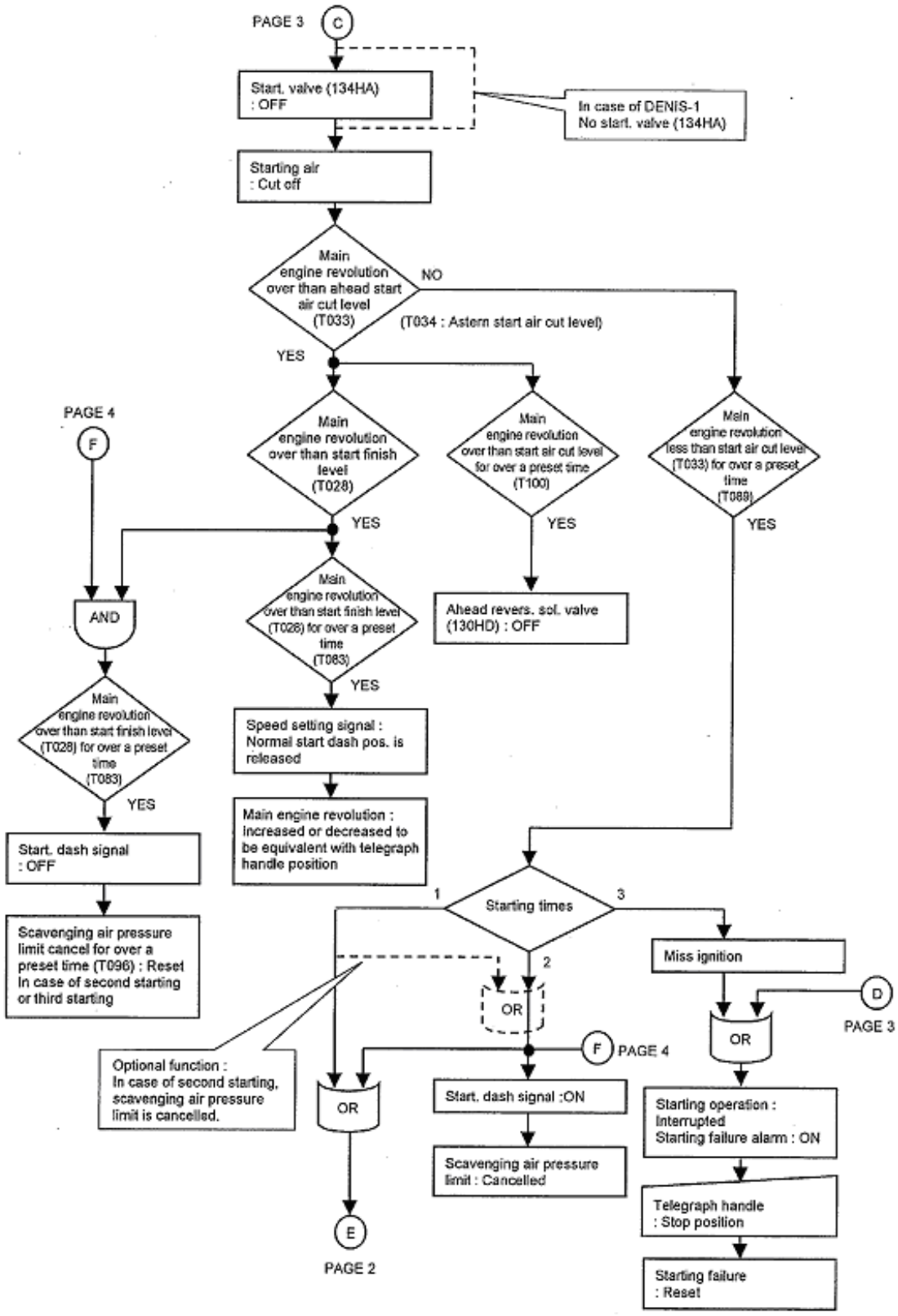
4.3 Operation block diagram:

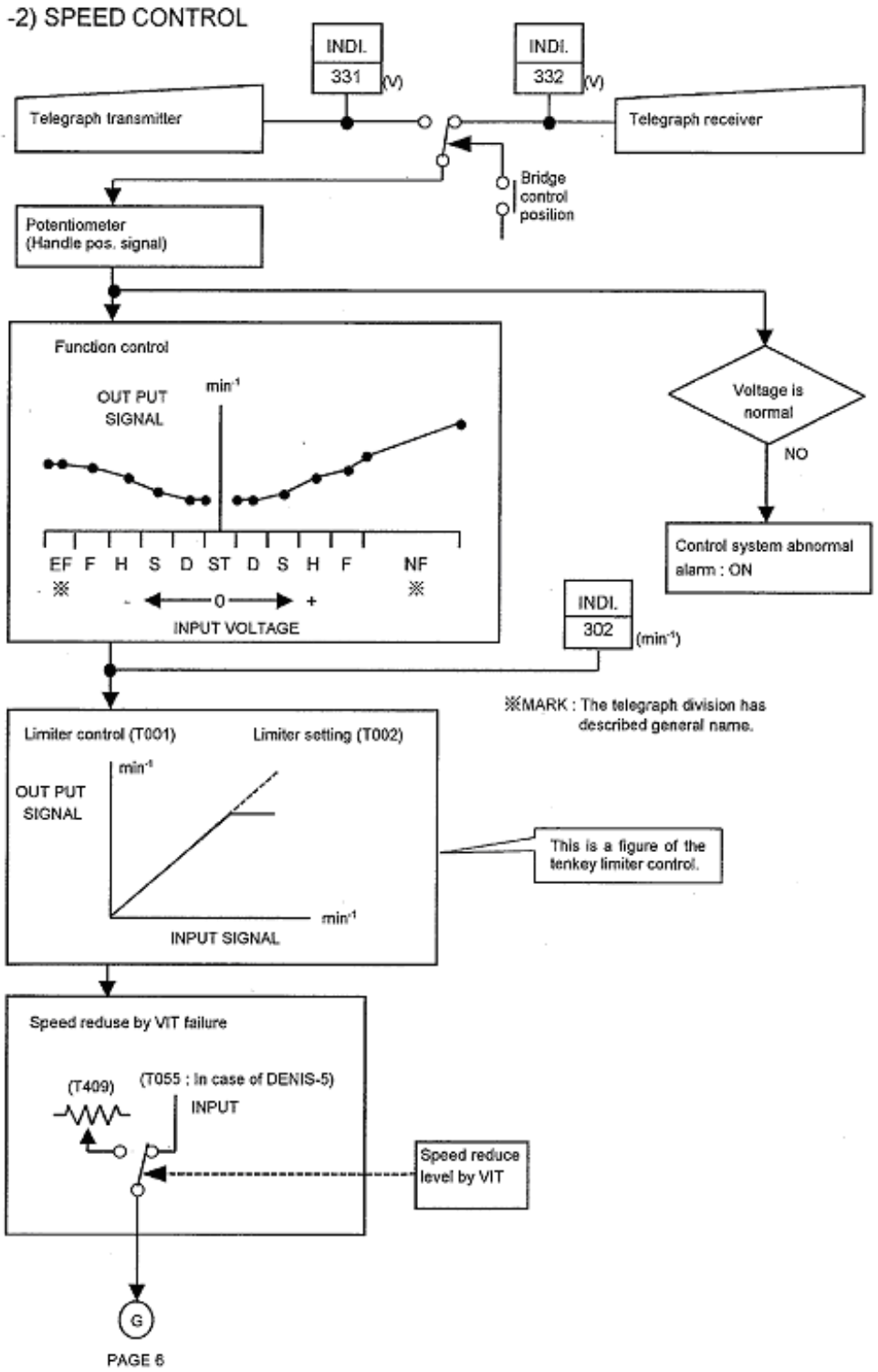
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

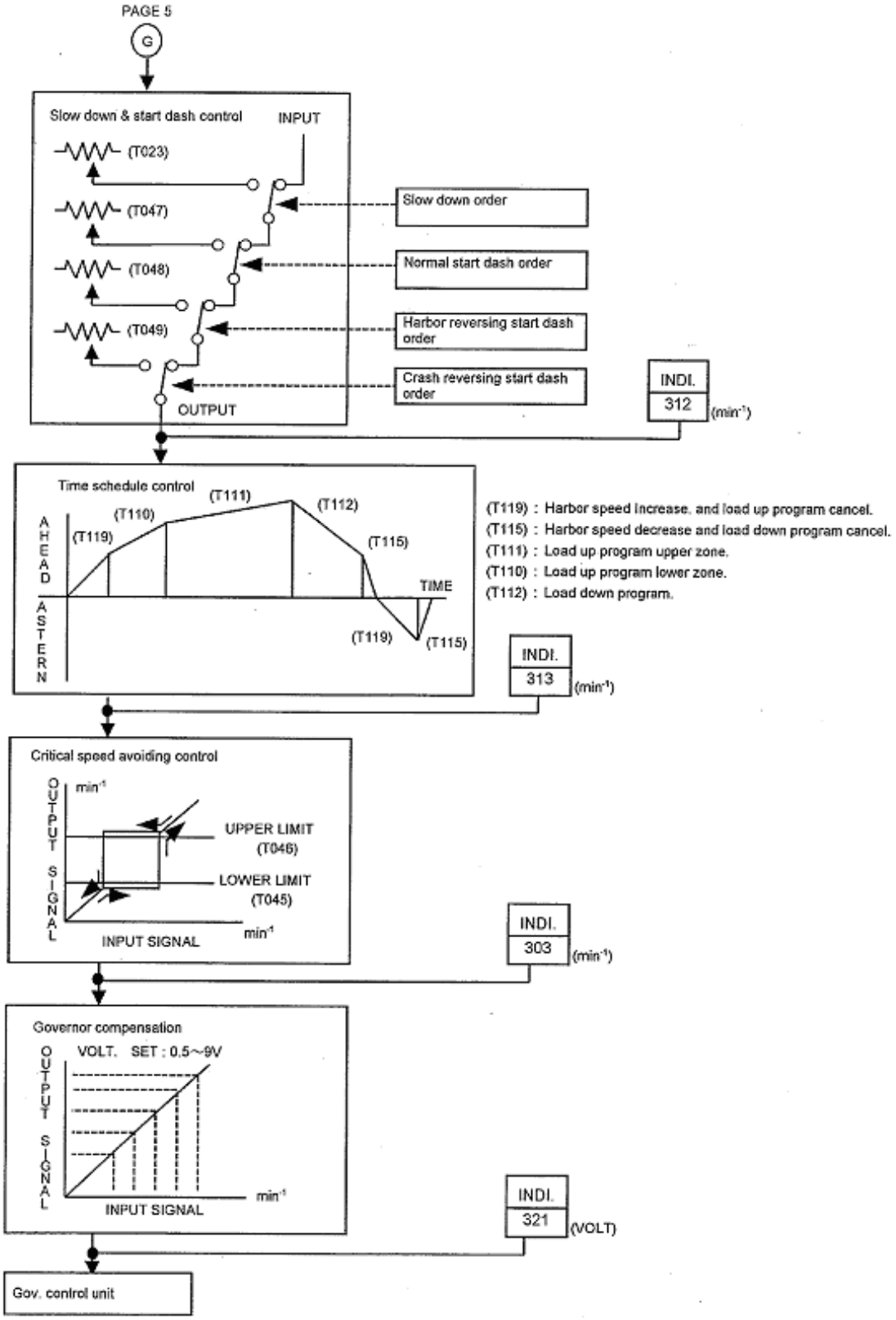
The document has been made to explain the basic design philosophy of NABCO Remote Control System and how to arrange there each items or causes not for any actual vessel. The reader can understand the meaning of them by reference this manual. It may be that the function of optional items is not applied with the installed equipment.



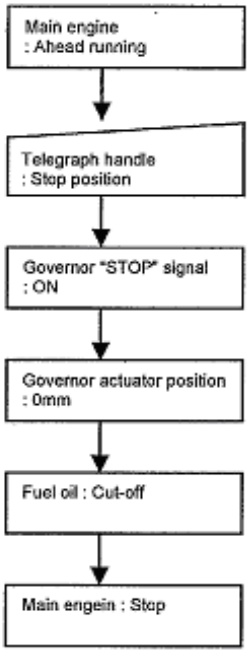

PAGE 2
A
PAGE 2
B
Start. valve (134HA) : ON
In case of DENIS-1 No start. valve (134HA)
Main engine : Air running
Main engine rotates ahead direction (T026)
(T027 : Astern direction)
YES
Rotation direction safeguard (6.01) : Ahead position
AND
Pressure switch (141HB) : OFF
Stop signal : OFF
Governor actuator pos. : Start dash pos.
Fuel : Supply
NOTE2.
In case of the re-starting, harbor reversing and crash reversing, the solenoid valve for start. air cut off solenoid valve(129HA) is not operated.
Main engine revolution over than ahead start air cut level (T033)
NO
(T034 : Astern start air cut level)
YES
Elapsed a preset time (T085) after starting operation given
Start. solenoid valve (130HC) : OFF
Start. signal : OFF
Start. air cut off solenoid valve (129HA) : ON
Control valve (2.05) : OFF
Control valve for start. (23A (53HP:In case of DENIS-1) : OFF
Start. air cut off solenoid valve (212HA) : ON
Starting impossible
OR
PAGE 4
C
PAGE 4
D


PAGE 3
C
Start. valve (134HA) : OFF
In case of DENIS-1 No start. valve (134HA)
Starting air : Cut off
Main engine revolution over than ahead start air cut level (T033)
NO
(T034 : Astern start air cut level)
YES
PAGE 4
F
Main engine revolution over than start finish level (T028)
Main engine revolution over than start air cut level for over a preset time (T100)
Main engine revolution less than start air cut level (T033) for over a preset time (T088)
YES
AND
Main engine revolution over than start finish level (T028) for over a preset time (T083)
Ahead revers. sol. valve (130HD) : OFF
Speed setting signal : Normal start dash pos. is released
Main engine revolution : Increased or decreased to be equivalent with telegraph handle position
Start. dash signal : OFF
Scavenging air pressure limit cancel for over a preset time (T096) : Reset In case of second starting or third starting
Starting times
1
2
3
Miss ignition
D
PAGE 3
OR
F
PAGE 4
Optional function : In case of second starting, scavenging air pressure limit is cancelled.
Start. dash signal :ON
Scavenging air pressure limit : Cancelled
Starting operation : Interrupted Starting failure alarm : ON
Telegraph handle : Stop position
Starting failure : Reset
E
PAGE 2

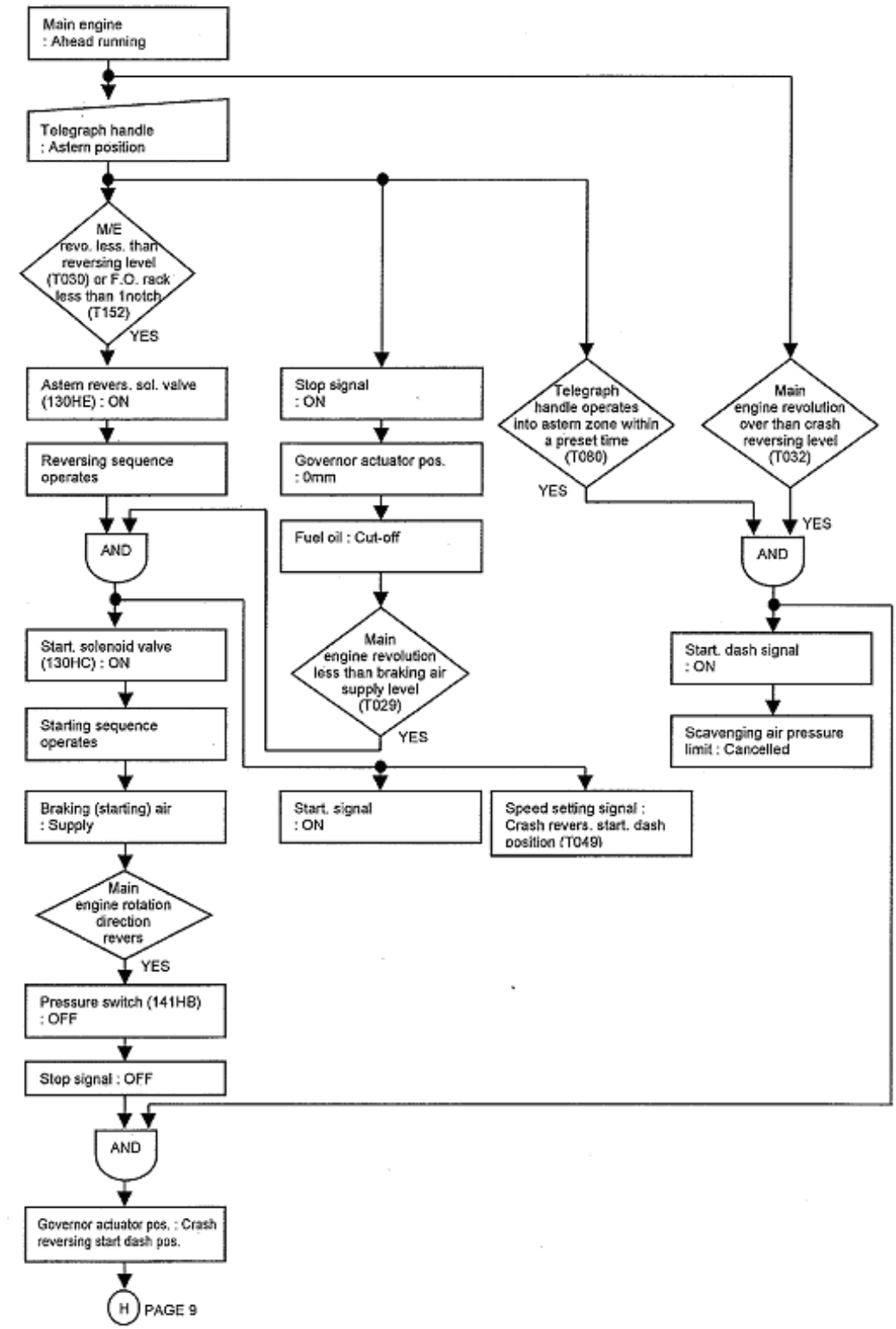

-2) SPEED CONTROL
INDI. 331 (V)
INDI. 332 (V)
Telegraph transmitter
Telegraph receiver
Bridge control position
Potentiometer (Handle pos. signal)
Function control
OUT PUT SIGNAL
min-1
EF F H S D ST D S H F NF
※ ※
- 0 +
INPUT VOLTAGE
Voltage is normal
NO
Control system abnormal alarm : ON
INDI. 302 (min-1)
※MARK : The telegraph division has described general name.
Limiter control (T001)
Limiter setting (T002)
OUT PUT SIGNAL
min-1
min-1
INPUT SIGNAL
This is a figure of the tenkey limiter control.
Speed reduse by VIT failure
(T409)
(T055 ; In case of DENIS-5) INPUT
Speed reduce level by VIT
G
PAGE 6

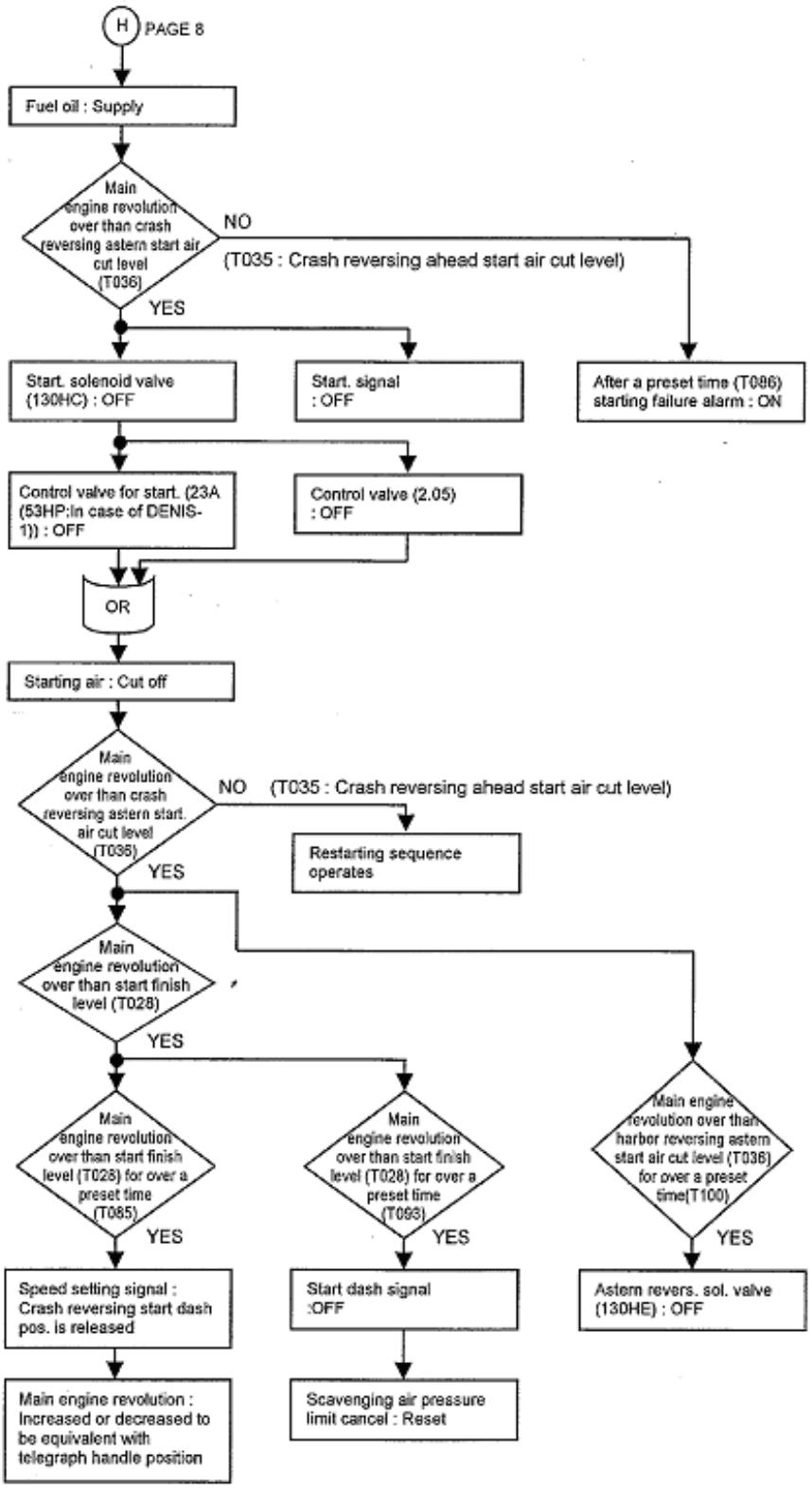

PAGE 5
G
Slow down & start dash control
INPUT
(T023)
(T047)
(T048)
(T049)
Slow down order
Normal start dash order
Harbor reversing start dash order
Crash reversing start dash order
OUTPUT
INDI.
312
(min-1)
Time schedule control
(T111)
(T110)
(T112)
(T119)
(T115)
AHEAD
ASTERN
TIME
(T119)
(T115)
(T119) : Harbor speed increase, and load up program cancel.
(T115) : Harbor speed decrease and load down program cancel.
(T111) : Load up program upper zone.
(T110) : Load up program lower zone.
(T112) : Load down program.
INDI.
313
(min-1)
Critical speed avoiding control
min-1
OUTPUT SIGNAL
UPPER LIMIT
(T046)
LOWER LIMIT
(T045)
INPUT SIGNAL
min-1
INDI.
303
(min-1)
Governor compensation
VOLT. SET : 0.5~9V
OUTPUT SIGNAL
INPUT SIGNAL
min-1
INDI.
321
(VOLT)
Gov. control unit

-3) STOPPING


Main engine
: Ahead running
Telegraph handle
: Stop position
Governor "STOP" signal
: ON
Governor actuator position
: 0mm
Fuel oil : Cut-off
Main engein : Stop

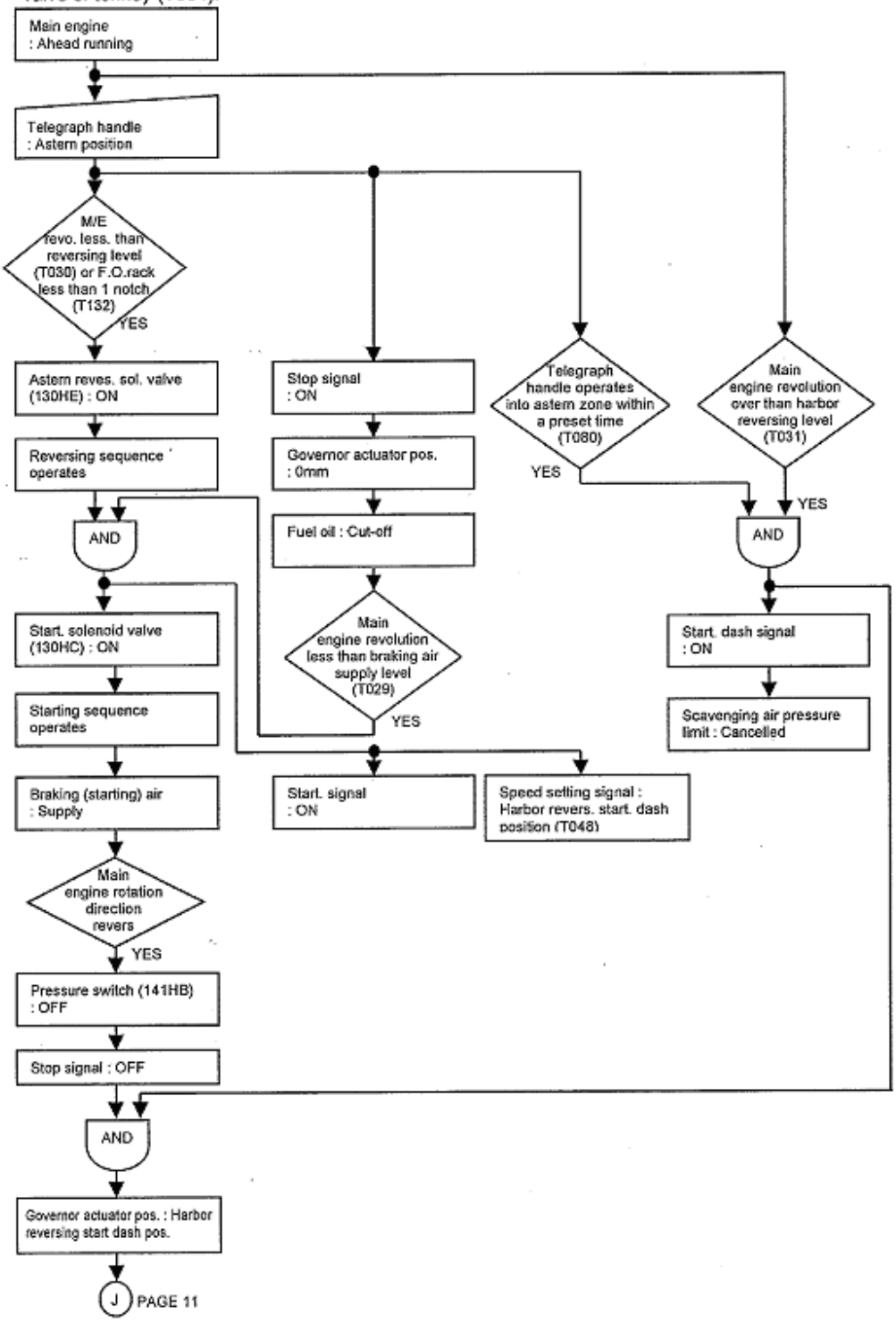
-4) CRASH REVERSING

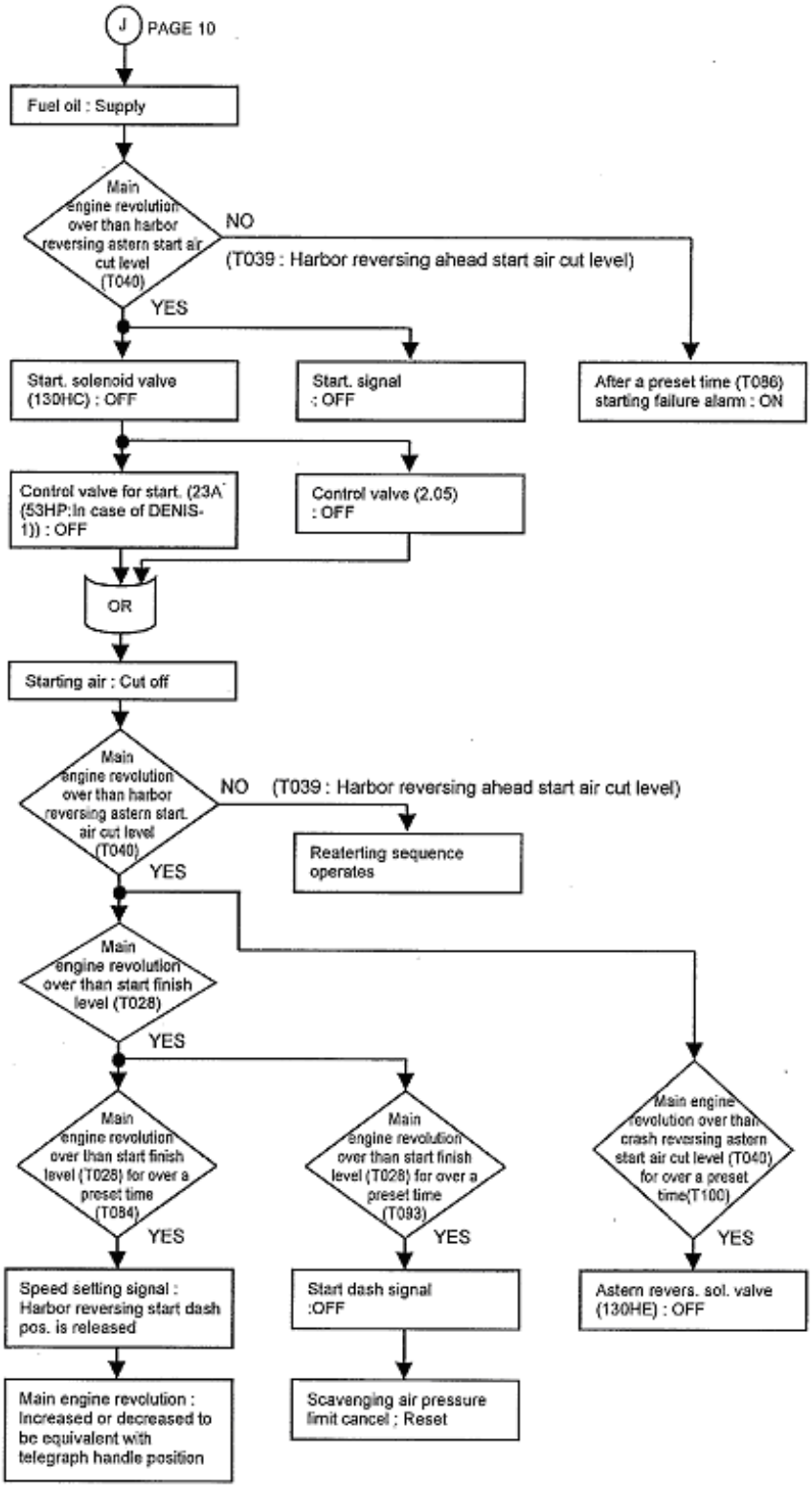



H
PAGE 8
Fuel oil : Supply
Main engine revolution over than crash reversing astern start air cut level (T036)
NO
(T035 : Crash reversing ahead start air cut level)
YES
Start. solenoid valve (130HC) : OFF
Start. signal : OFF
After a preset time (T086) starting failure alarm : ON
Control valve for start. (23A (53HP:In case of DENIS-1)) : OFF
Control valve (2.05) : OFF
OR
Starting air : Cut off
Main engine revolution over than crash reversing astern start air cut level (T036)
NO
(T035 : Crash reversing ahead start air cut level)
Restarting sequence operates
YES
Main engine revolution over than start finish level (T028)
YES
Main engine revolution over than start finish level (T028) for over a preset time (T085)
YES
Main engine revolution over than start finish level (T028) for over a preset time (T093)
YES
Main engine revolution over than harbor reversing astern start air cut level (T036) for over a preset time(T100)
YES
Speed setting signal : Crash reversing start dash pos. is released
Start dash signal :OFF
Astern revers. sol. valve (130HE) : OFF
Main engine revolution : Increased or decreased to be equivalent with telegraph handle position
Scavenging air pressure limit cancel : Reset

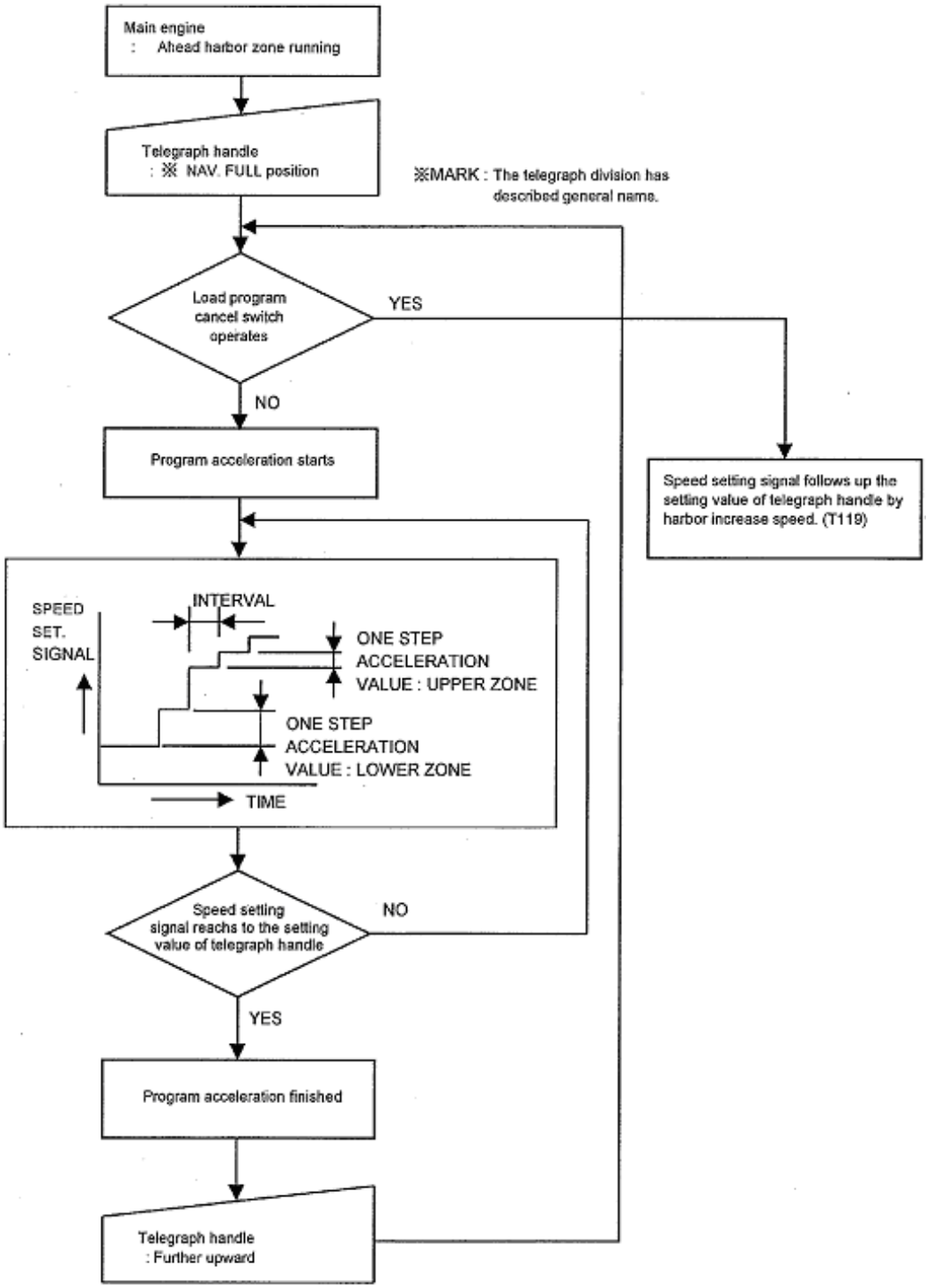
-5) HARBOR REVERSING

If it is necessary to apply the harbor reversing function by result of sea trial, by changing the setting valve of tenkey (T031).

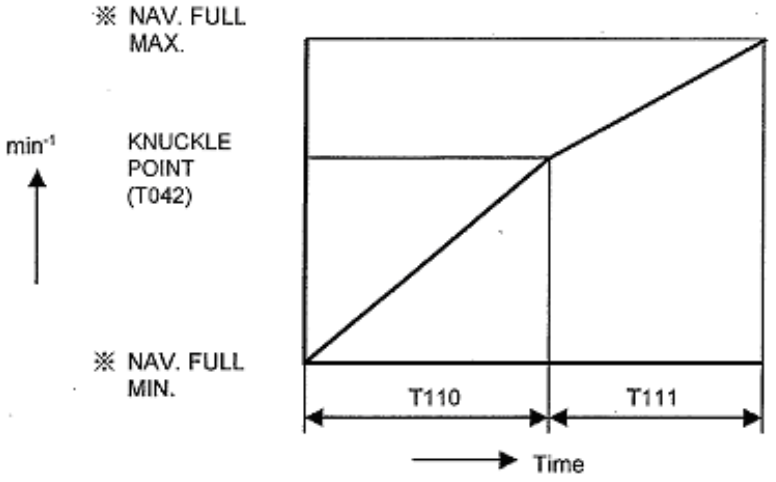



J
PAGE 10
Fuel oil : Supply
Main engine revolution over than harbor reversing astern start air cut level (T040)
NO
(T039 : Harbor reversing ahead start air cut level)
YES
Start. solenoid valve (13DHC) : OFF
Start. signal : OFF
After a preset time (T086) starting failure alarm : ON
Control valve for start. (23A (53HP:In case of DENIS-1)) : OFF
Control valve (2.05) : OFF
OR
Starting air : Cut off
Main engine revolution over than harbor reversing astern start. air cut level (T040)
NO
(T039 : Harbor reversing ahead start air cut level)
Reatarting sequence operates
YES
Main engine revolution over than start finish level (T028)
YES
Main engine revolution over than start finish level (T028) for over a preset time (T084)
YES
Main engine revolution over than start finish level (T028) for over a preset time (T093)
YES
Main engine revolution over than crash reversing astern start air cut level (T040) for over a preset time(T100)
YES
Speed setting signal : Harbor reversing start dash pos. is released
Start dash signal :OFF
Astern revers. sol. valve (130HE) : OFF
Main engine revolution : Increased or decreased to be equivalent with telegraph handle position
Scavenging air pressure limit cancel ; Reset

-6) LOAD UP PROGRAM

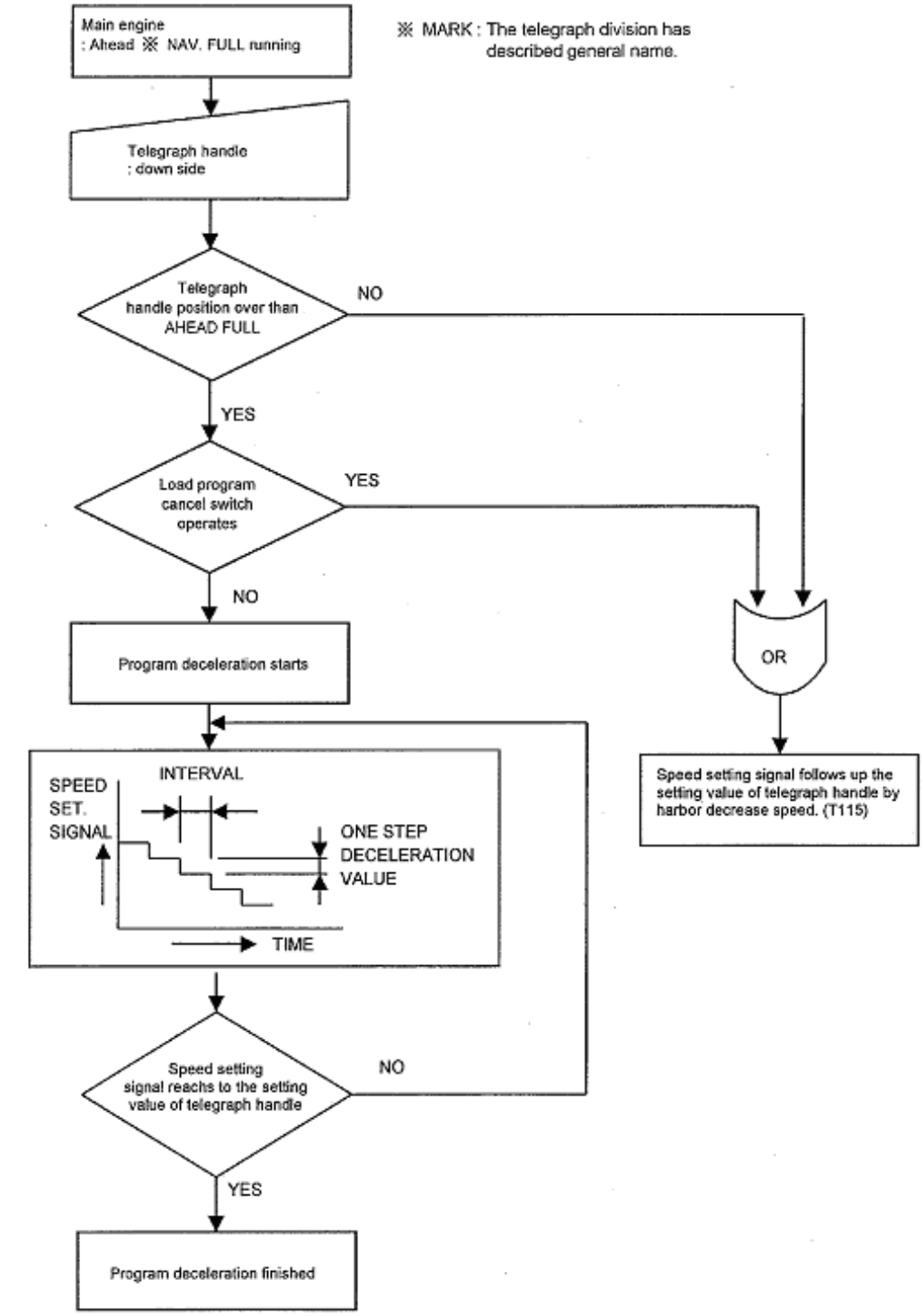


※ MARK : The telegraph division has described general name.



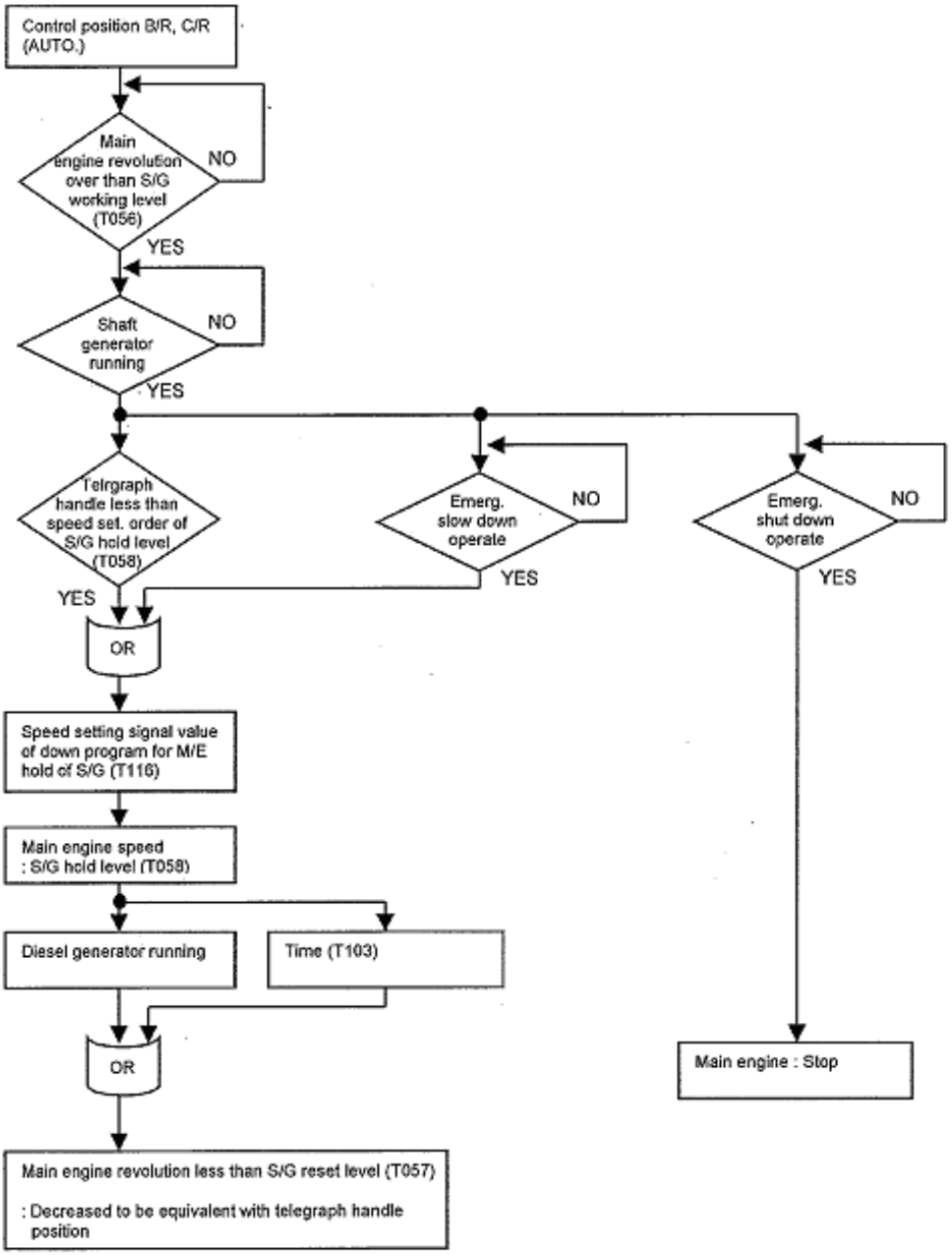
If the setting data of tenkey address T372 changes to "1", the increasing time for low load zone and high load zone in navigation full zone can be set separetely.

-7) LOAD DOWN PROGRAM



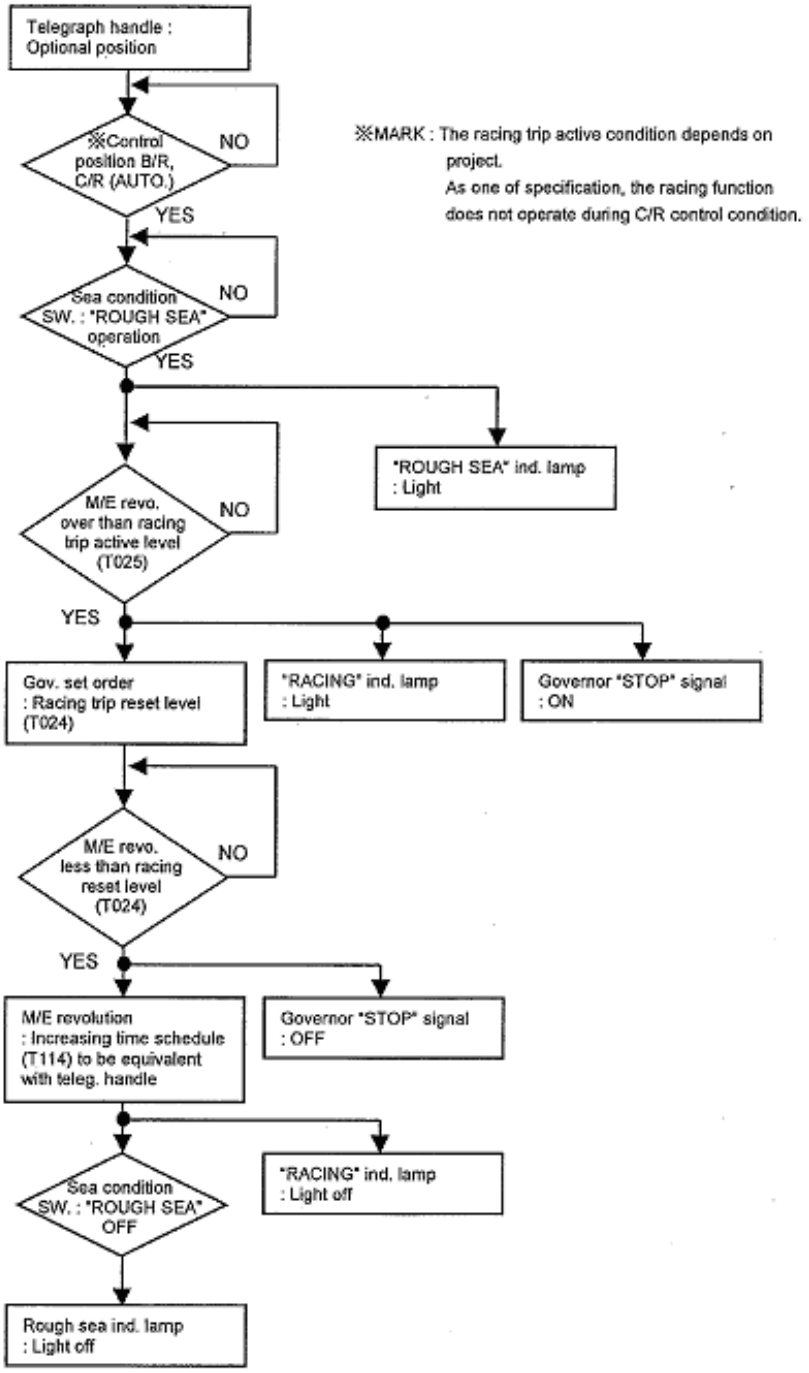
-8) M/E SPEED MAINTAINING FUNCTION

OPTIONAL ITEM : SHAFT GENERATOR



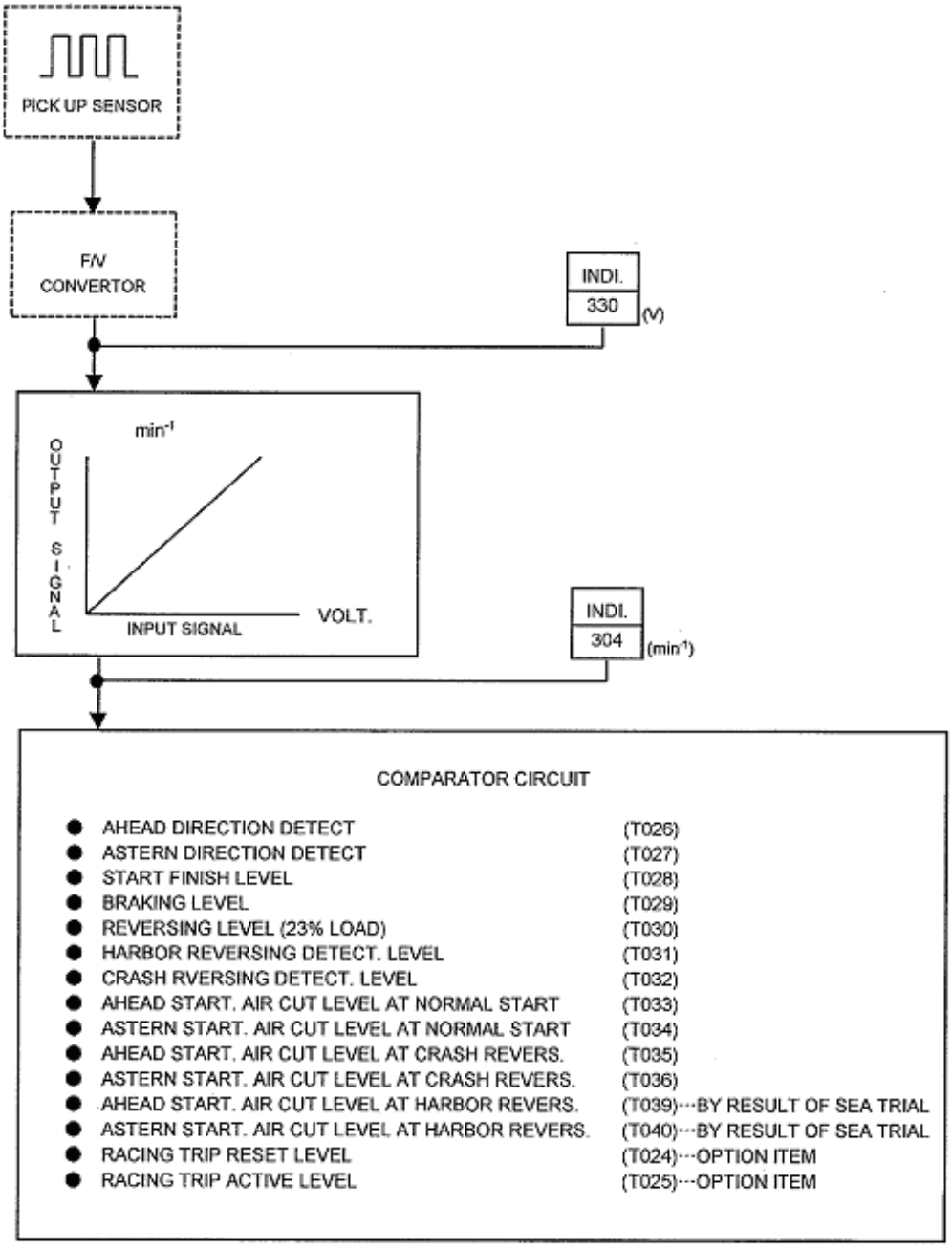
-9) RACING TRIP

OPTIONAL ITEM



※MARK : The racing trip active condition depends on project.
As one of specification, the racing function does not operate during C/R control condition.

-10) MAIN ENGINE REVOLUTION DETECT CIRCUIT



5. Safety system unit:

5.1 Safety features of the system:

5.1.1 Manual emergency shut down:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

・Function of manual emergency shut down

Manual emergency shut down switches are provided on the following control position.

① BRIDGE INDICATOR PANEL : Change-over switch (with cover)

② C/R MANEUVERING UNIT : Change-over switch (with cover)

③ LOCAL INDI. & SWITCH BOX : Change-over switch (with cover)

With operation of above mentioned switch operated, the fuel is cut off to stop the main engine. At the same time, alarm of "MANUAL EMERGENCY SHUT DOWN" is given and the shut down cause is indicated on BRIDGE INDICATOR PANEL, C/R MANEUVERING UNIT, LOCAL INDI. & SWITCH BOX and M/E CONTROL PANEL.

The manual emergency shut down switches are available regardless of the control position.

・Reset of manual emergency shut down

Resetting is operated according to the following procedure, after recovering the switch.

① In case of bridge control :
Put the telegraph transmitter in the bridge into stop position.

② In case of control room auto. control :
Put the telegraph receiver in the control room into stop position.

③ In case of backup control :
Put the telegraph receiver in the control room into stop position.

④ In case of local control (Gov. control) :
Put the speed setting dial in the local into "0" position.

⑤ In case of local control (F.O. lever control):
Put the F.O. lever in the local into "0" position.

5.1.2 Automatic emergency shut down:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

・Function of automatic emergency shut down

Indicator lamps of automatic emergency shut down are provided on the following control position.

・Bridge : BRIDGE INDICATOR PANEL
・Control room : M/E CONTROL PANEL
The lamps are provided on the panel individually (4 lamps in total, refer to ①~④ mentioned below.)
and C/R MANEUVERING UNIT
・Local : LOCAL INDI. & SWITCH BOX

The main engine is shut down in any of the following conditions.
Refer to the time chart in item No.8.9.

① Over speed
② (SH-1) : Main bearing lub. oil very low pressure
③ (SH-2) : Exh. valve spring air very low pressure
④ (SH-3) : Turbo charger lub. oil low pressure

In case of over speed (item①), emergency shut down instantly operates. In case the others, first, the alarm of "SHUT DOWN PREWARING" is given. Then, emergency shut down operates after abnormal condition continued for a preset time (each causes individual setting, "0" sec. setting is possible).

If the automatic emergency shut down of over speed (item①) operates, the alarm of "AUTO. EMERG. SHUT DOWN" is given on BRIDGE INDICATOR PANEL and indication of "EMERG. SHUT DOWN" is given on C/R MANEUVERING UNITand LOCAL INDI. & SWITCH BOX.

If the automatic emergency shut down operates, the alarm of "EMERG. SHUT DOWN" is given on BRIDGE INDICATOR PANEL and indication of "EMERG. SHUT DOWN" is given on C/R MANEUVERING UNITand LOCAL INDI. & SWITCH BOX.

At the same time, the shut down cause are indicated on M/E CONTROL PANEL by light emitting diodes.

The automatic emergency shut down is available regardless of the control position.

・Cancel of automatic emergency shut down

In case of the above mentioned cause ③, ④ of automatic emergency shut down, this cause can be cancelled operating the shut down override swiches (illuminated push button switch-by pushing, switch operates and indicator lamp lights. And by pushing again, switch returns and indicator lamp turns off fails.) provided on BRIDGE INDICATOR PANEL, C/R MANEUVERING UNIT and LOCAL INDI. & SWITCH BOX.

The shut down override switchs are available regardless of the control position.

The shut down override switch provided on bridge is available during bridge control and the shut down override switch provided on the control room and the local are available regardless of the control position.

When the main engine has been tripped by above item ③, ④ the emergency shut down can be cancelled by pushing the emergency shut down override push button switch after the emergency shut down reset operation is carried out.
However, by pushing the emergency shut down override push button switch before the main engine shall be tripped, any emergency shut down of above items ③, ④ does not operate.

Due to this cancelling operation, the main engine can be run again by the telegraph handle (Bridge or C/R) still in abnormal condition.

・Reset of automatic emergency shut down

In case that the automatic emergency shut down has operated, reset operation is to follow the procedure given below.
Resetting is unable unless the abnormal condition has returned normal.

① In case of bridge control :
Put the telegraph transmitter in the bridge into stop position.

② In case of control room auto. control :
Put the telegraph receiver in the control room into stop position.

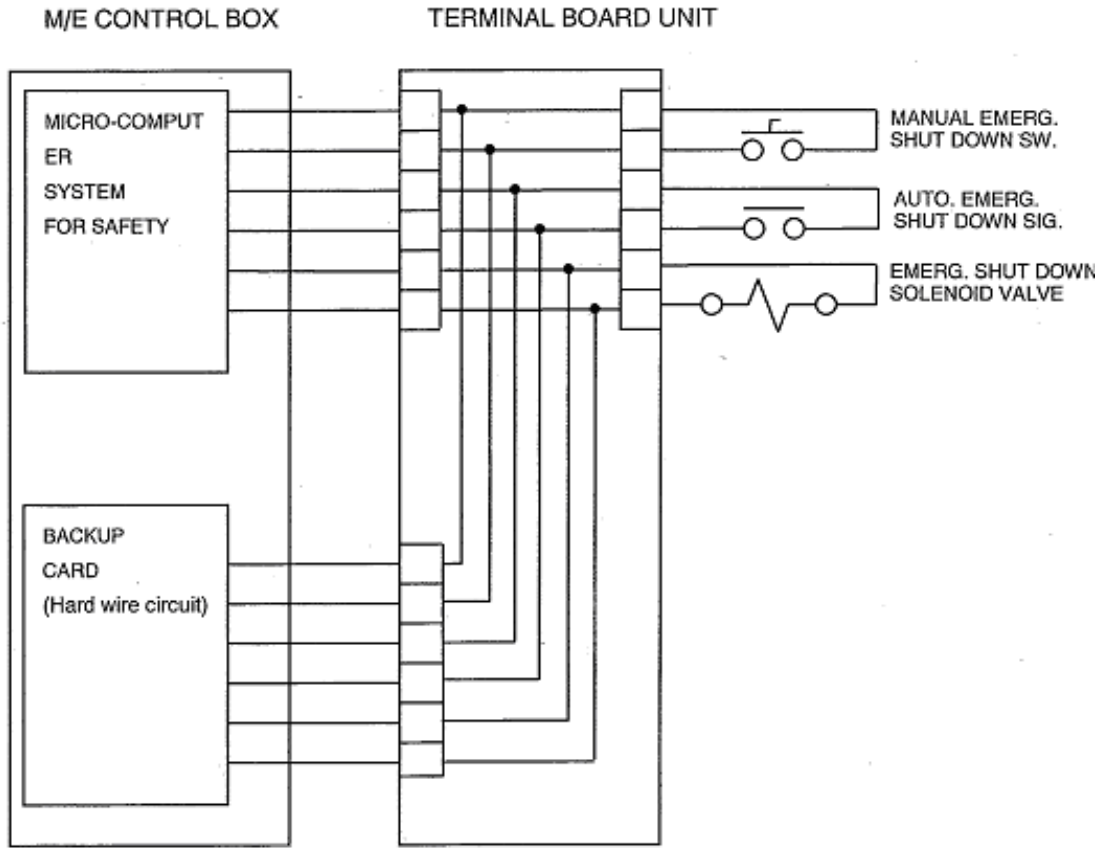
③ In case of backup control :
Put the telegraph receiver in the control room into stop position.

④ In case of local control (Gov. control) :
Put the speed setting dial in the local into "0" position.

⑤ In case of local control (F.O. lever control):
Put the F.O. lever in the local into "0" position.

Backup System (Hard wire) for Safety System (see Figure 1)

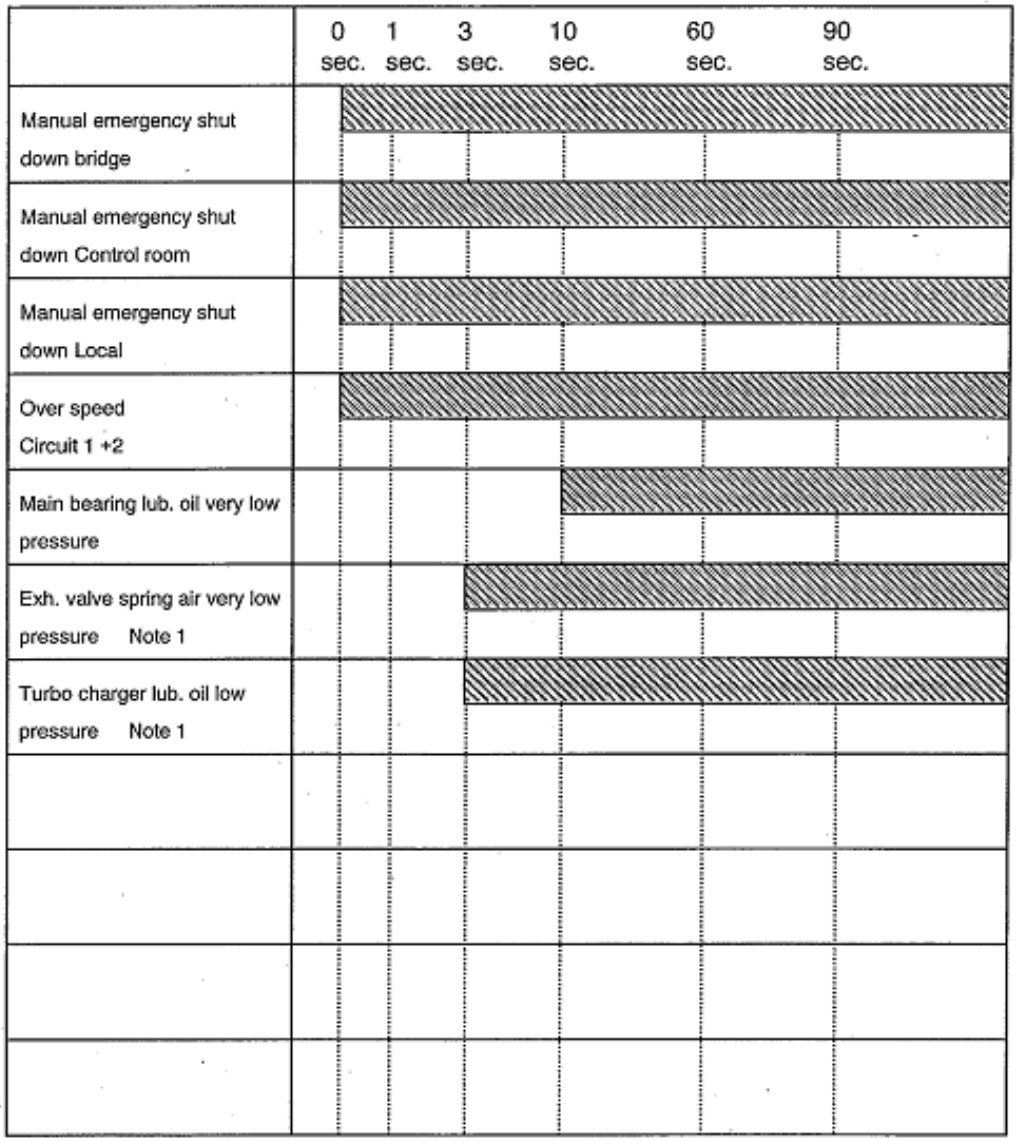
***** EXCEPT GL ****
If the microcomputer becomes abnormal, the backup system will take over the operation of shutting down the main engine due to the manual and automatic emergency shut down causes ;



Reset of emergency shut down

During the microcomputer in the safety system works normally, an emergency shut down can be reset by the ordinary reset procedures described on item 8.1 and 8.2. If the microcomputer has been failed and then an emergency shut down operated by the backup system, the reset can be available by the above mentioned ordinaly reset procedure or by pushing the emergency shut down reset button on the backup card (J-CARD) in the M/E CONTROL BOX.

Time chart for safety system
(Emergency shut down)



: Shut down with reset

Note1. This item can be cancelled

5.1.3 Automatic emergency slow down:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

・Function of automatic emergency slow down

Indicator lamp of automatic emergency slow down are provided on the following control position.

・Bridge : BRIDGE INDICATOR PANEL
・Control room : M/E CONTORL PANEL
The lamps are provided on the panel individually (6 lamps in total refer to ①～⑥ mentioned below.)
and C/R MANEUVERING UNIT
・Local : LOCAL INDI. & SWITCH BOX

In case under any of the following conditions and such abnormal condition continued for a preset time, the main engine is slowed down automatically to a preset speed (DEAD SLOW).
Refer to the time chart in item No.8.9.

① (SL-1) : Scavenging box high temperature
② (SL-2) : Cylinder lub. oil non flow
(This is available where the main engine revolution more than 5 min^{-1}.
This is to be set after offical sea trial.)
③ (SL-3) : Crankcase oil mist high density
④ (SL-4) : Thrust pad lub. oil high temerature
⑤ (SL-5) : Main bearing lub. oil high temerature
⑥ (SL-6) : Stern tube bearing lub. oil high temperature

In case of abovementioned causes, first, the alarm of "SLOW DOWN PREWARING" is given. Then, emergency slow down operates after abnormal condition continued for a preset time (each causes individual setting, "0" sec. setting is possible).

If the automatic emergency slow down operates, the alarm of "AUTO. EMERGENCY SLOW DOWN" is given on BRIDGE INDICATOR PANEL and the indication of "AUTO. EMERG. SLOW DOWN" is given on C/R MANEUVERING UNIT and LOCAL INDI. & SWITCH BOX.
At the same time, the slow down cause is indicated on M/E CONTROL PANEL by light emitting diode.

Alarm of "SLOW DOWN REQUEST" is given if the above mentioned occur under any of following conditions. But the main engine is not slowed down automatically.

① Main engine running under than above mentioned automatic emergency slow down speed (include astern side).
② Slow down cancel condition.
③ Backup or Local control.

・Cancel of automatic emergency slow down

The automatic emergency slow down can be cancelled by operating the slow down override switch(illuminated push button switch-by pushing, switch operates and indicator lamp lights. And by pushing again, switch returns and indicator lamp turns off.) provided on the BRIDGE INDICATOR PANEL and C/R MANEUVERING UNIT.

The slow down override switchs are available regardless of the control position.

The slow down override switch provided on bridge is available during bridge control condition and the slow down override switch provided on the control room is available regardless of the control position.

The slow down override switchs are available regardless of the control position.

When the main engine has been slowed down, the emergency slow down can be cancelled by pushing the emergency slow down override push button switch after the telegraph handle in charge of control position is returned less than a preset position (DEAD SLOW).
However, by pushing the emergency slow down override push button switch before the main engine shall be slowed down, any emergency slow down of above items does not operate.

Due to this cancelling operation, the main engine can be run again by the telegraph handle (Bridge or C/R) still in abnormal condition.

・Reset of automatic emergency slow down

In case that the automatic emergency slow down has operated, reset operation is to follow the procedure given below.
Resetting is unable unless the abnormal condition has returned normal.

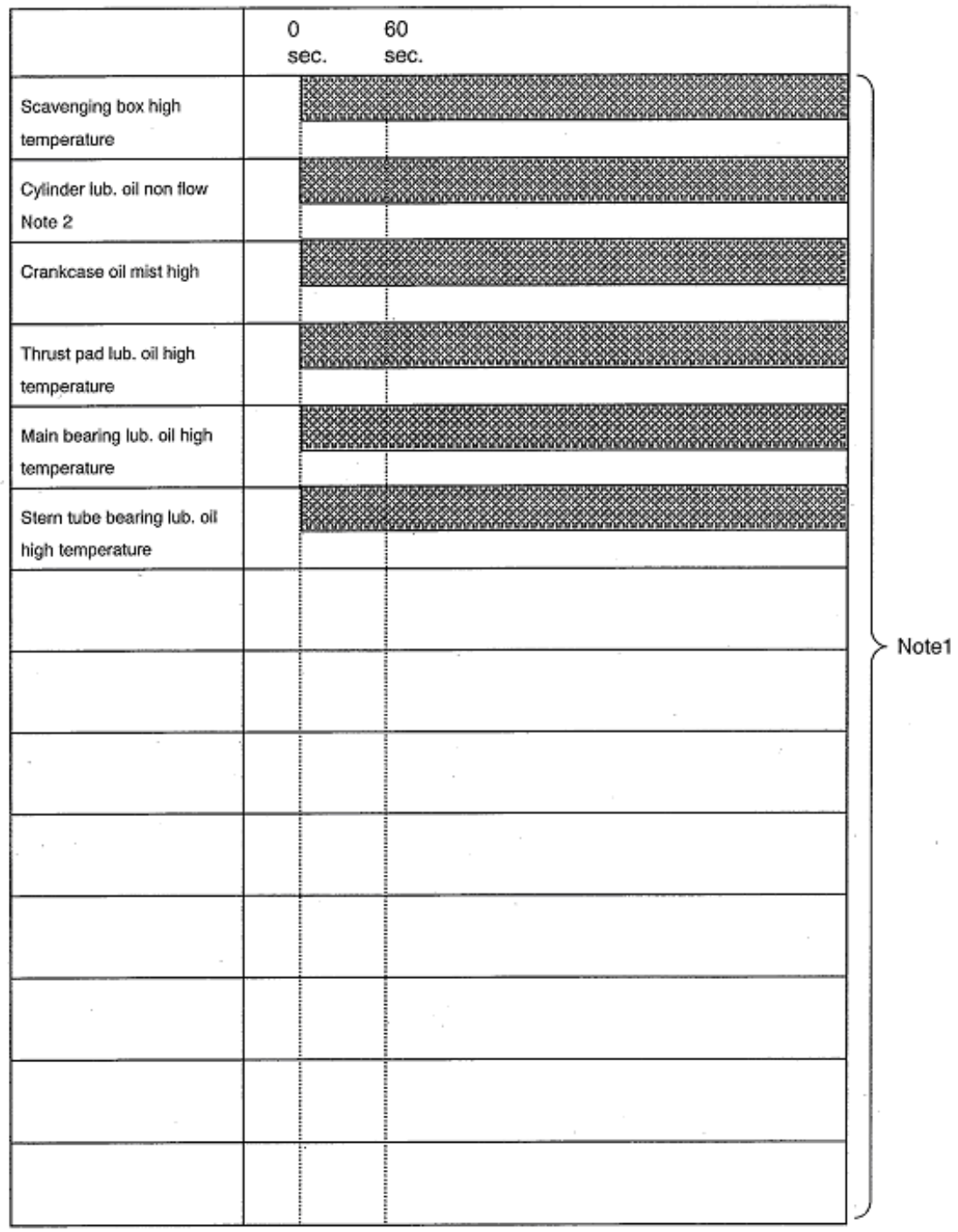
① In case of bridge control :

Put the telegraph transmitter in the bridge into less than preset position. (DEAD SLOW)

② In case of control room control :

Put the telegraph receiver in the control room into less than preset position. (DEAD SLOW)

Time chart for safety system (Emergency slow down)



: Slow down with reset

Note 1 : Slow down is available under bridge and control room control.

Note 2 : This is available where the main engine revolution more than 10 min^{-1}, this is to be set after offical sea trial.

5.1.4 Slow down request alarm:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

If any one of following conditions occurs, the alarm of "SLOW DOWN REQUEST" is given at the bridge, control room, backup and local, so that the speed of main engine shall be reduced to DEAD SLOW by manually.

(a) : Main bearing lub. oil high temperature
(b) : Crosshead bearing lub. oil low pressure
(This is available where both the load index more than 5.0 notch and the main engine revolution more than N min^{-1}, which is to be set after official sea trial.)
(c) : Piston cooling oil high temperature
(d) : Exh. gas high temperature
(e) : Exh. valve spring air low pressure
(f) : Jacket cool. fresh water low pressure
(g) : Jacket cool. fresh water high temperature
(h) : T/C lub. oil high temperature
(i) : Piston cooling oil high deviation
(j) : Exh. gas high temperature deviation

There signals are supplied by one contact from shipyard monitoring system.

5.1.5 Wrong way alarm:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

If the ordering direction of the telegraph transmitter is different from the position of reversing valve under the local or backup control, it is deemed a wrong way condition and the indicator lamp "WRONG WAY" on LOCAL INDI. & SWITCH BOX and M/E CONTROL PANEL lights, and the telegraph buzzer and gong sound.

And the aforementioned condition continues over than a preset time, the alarm of "WRONG WAY" is given.

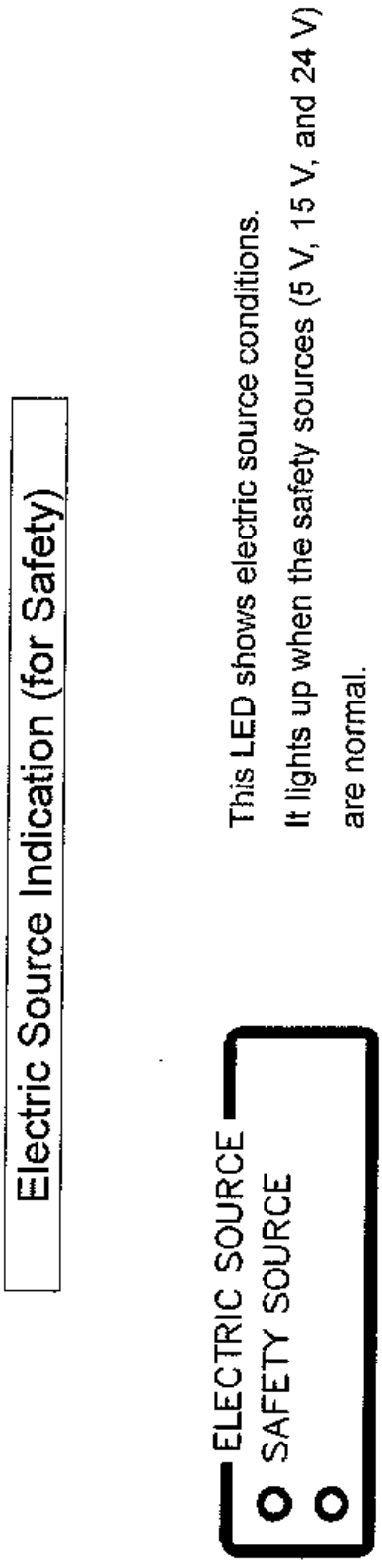
5.1.6 Critical speed alarm:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

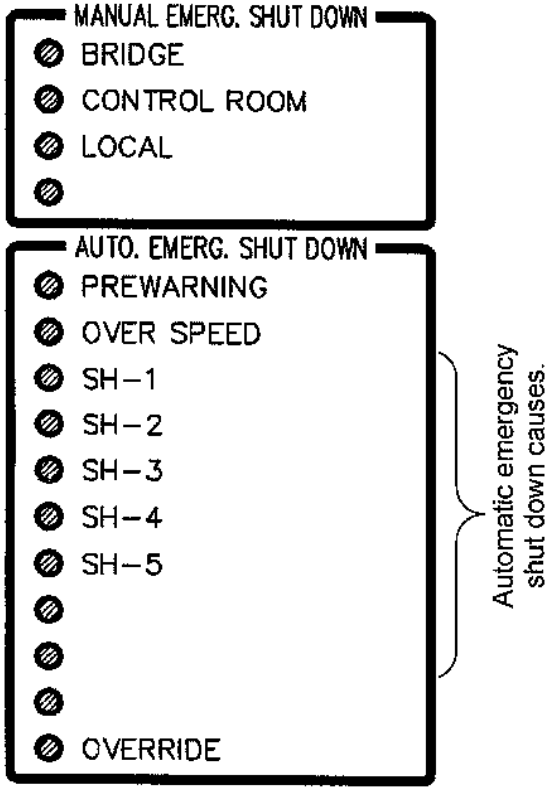
Upon a preset time after the engine speed going between the lower limit and the upper limit of the critical speed range, the alarm of "CRITICAL SPEED" is given on BRIDGE INDICATOR PANEL.

5.2 Familiarization with Safety system unit:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)



SHUT DOWN Indication



These LEDs show the conditions of emergency shut down causes. If an emergency shut down operates, an LED corresponding to the shut down cause will light up continuously. Then, immediately solve the abnormal condition. Even after the cause is solved, the LED will continue lighting. To turn off the LED, press the CAUSE RESET button shown on page 18 after resetting the shut down. When the emergency shut down has been reset, the LED will go off.

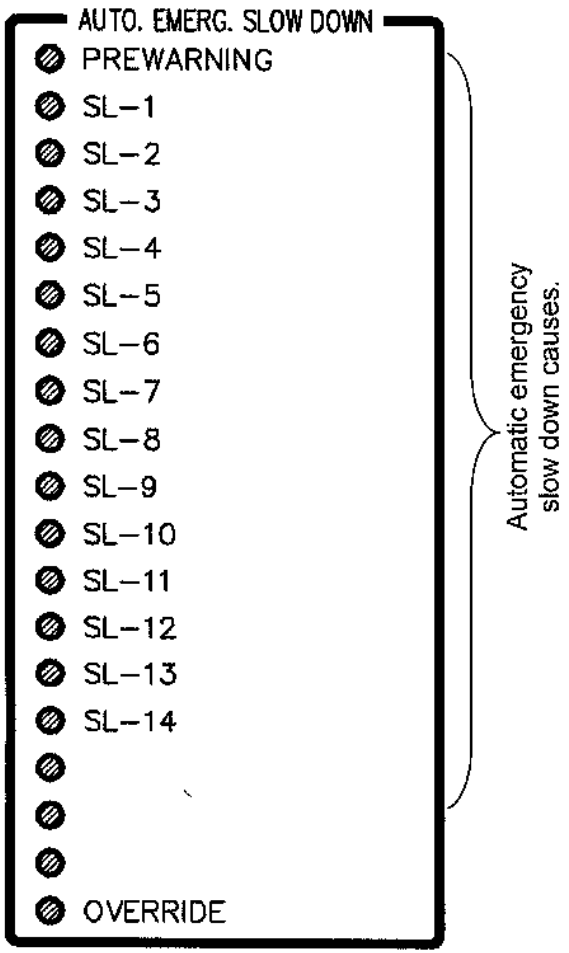
In a case where emergency shut down will operate a specified time after an abnormal condition is detected, the "PREWARNING" and abnormal cause LEDs will flicker at intervals of 0.3 seconds during counting.

If any manual/automatic shut down cause LED flickers at intervals of 0.5 seconds, the signal line for the cause will be disconnected. Then, the SYSTEM ABNORMAL alarm will be given and the "WIRING ABNROMAL" LED on the panel will flicker (page 7).
Immediately repair the disconnected signal line.

The "OVERRIDE" LED will light up when any emergency shut down is cancelled by the emergency shut down cancel operation.

The left indication shows an example; for the actual names of causes and LEDs, see the outline drawing.

SLOW DOWN Indication



These LEDs show the conditions of emergency slow down causes. If an emergency slow down operates, an LED corresponding to the slow down cause will light up continuously. Then, immediately solve the abnormal condition.
Even after the cause is solved, the LED will continue lighting. To turn off the LED, press the CAUSE RESET button shown on page 18 after resetting the slow down.
When the emergency slow down has been reset, the LED will go off.

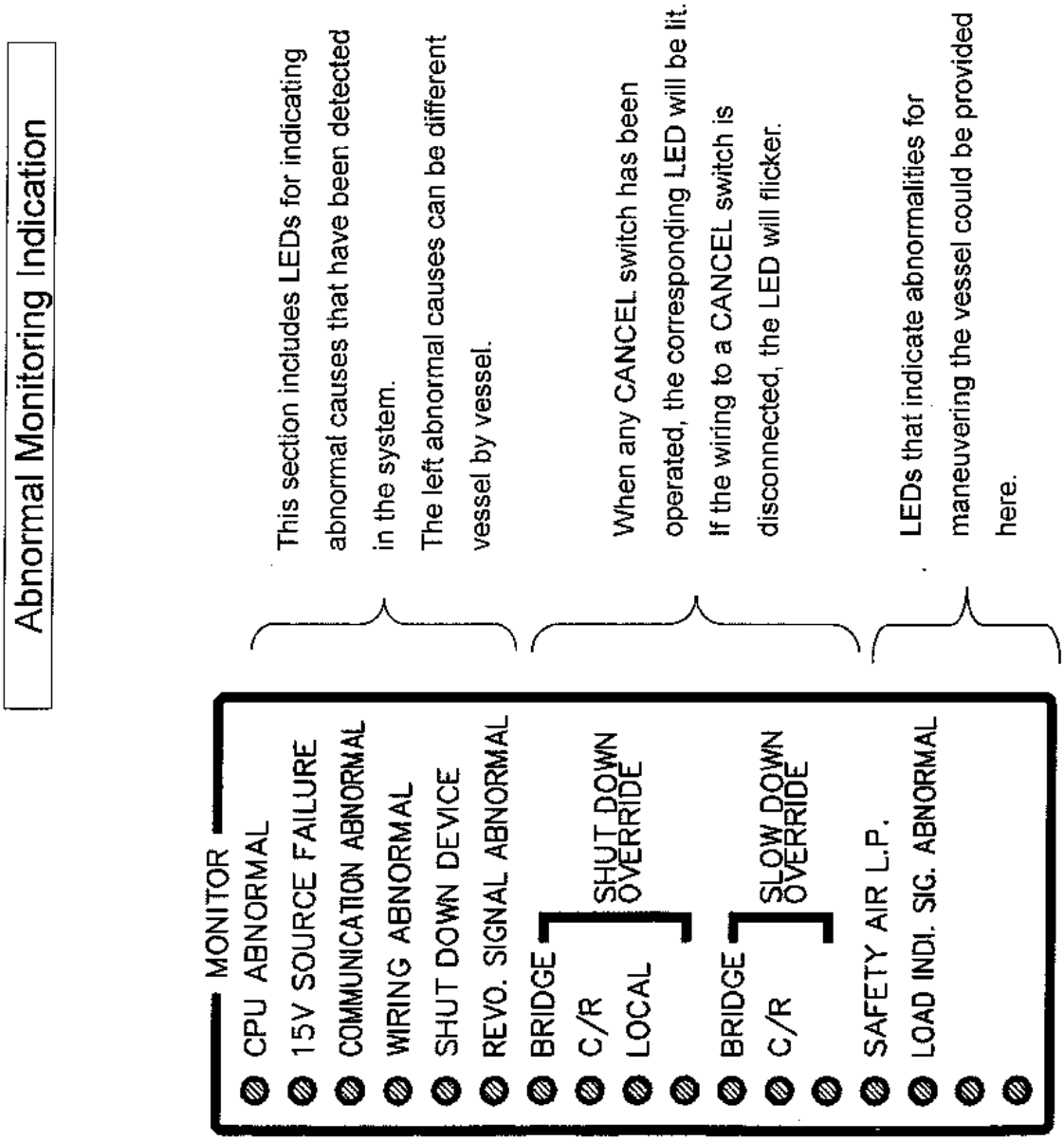
In a case where emergency slow down will operate a specified time after an abnormal condition is detected, the "PREWARNING" and abnormal cause LEDs will flicker at intervals of 0.3 seconds during counting.

If any manual/automatic shut down cause LED flickers at intervals of 0.5 seconds, the signal line for the cause will be disconnected. Then, the SYSTEM ABNORMAL alarm will be given and the "WIRING ABNROMAL" LED on the panel will flicker (page 7).
Immediately repair the disconnected signal line.

The "OVERRIDE" LED will light up when any emergency slow down is cancelled by the emergency slow down cancel operation.

The left indication shows an example; for the actual names of causes and LEDs, see the outline drawing.

Abnormal Monitoring Indication



6. Electric Governor system: (Type: MG-800)

6.1 Arrangement of Electric Governor system:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Figure 6.1 shows the Schematic drawing of electric governor system.

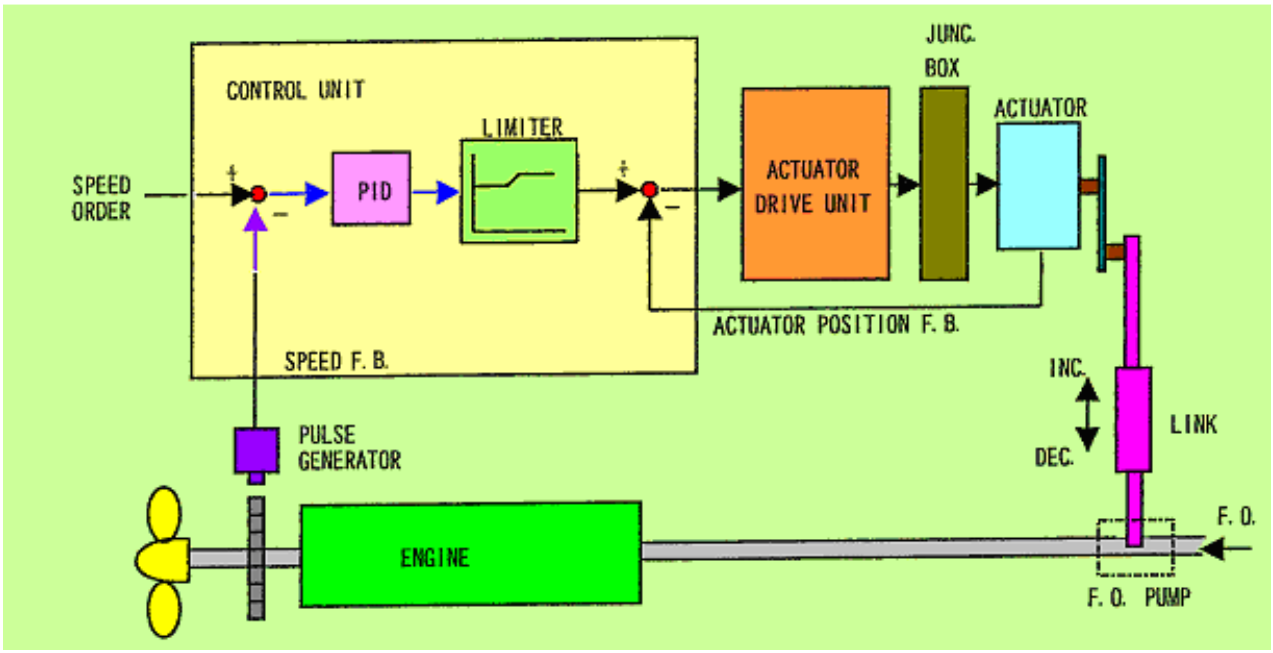


Fig. 6.1 Schematic drawing of governor system
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Note: PID: Proportional, Integral and Differential F/V: Frequency / Voltage F.B: Feed Back

6.1.1 System outline:

This Governor system uses a micro-computer method for automatically executing the optimum control. Thus, it is possible to assure the following improved performance over the mechanical-hydraulic governor.

1) Stability at low speed
2) Start-up performance
3) Stabilized state performance of F.O. rack at cruising speed range, and stabilized rotation.

In addition, the inspection and maintenance can be readily performed, as the system is a all electro-mechanical type without using any hydraulic-pneumatic component.

The Control unit:

- compares the commanded rotating speed signal with the actual speed, detected by the pulse generator,

executes the PID calculation for the deviation to control the position of the actuator, connected to the fuel pump

- thus adjusts the amount of fuel, supplied to the engine so that the deviation in the rotating speed can be eliminated.

6.1.2 Features of the system:

1) Since the equipment is fully electric, it does not require any governor drive shaft.
2) RPM detection is backed up by the dual system i.e. main and sub.
3) The actuator position sensor adopts the non contact type sensor, so as to provide increased reliability.
4) When any faults occurs, the self-monitoring system serves to activate alarm and changes over the Main/Sun system automatically or maintains the current position of the actuator.
5) It is possible to identify the cause and location of the error by reading the LED indication lamp and error code.
6) The starting index (fuel rack position) is available at two levels.
7) Sure and stabilized starting can be assured by keeping the fuel rack position at the jump-out position until the engine rpm exceeds the setting value.
8) Since the control with PID constant (exclusive use for starting) is used, it is possible to restrict any unnecessary rpm increase.
9) Since the constant of P (proportional gain), I (integration time) and D (differential time) are set independently as function of five points and selected, depending on the rpm or actuator position, it is possible to secure the excellent speed control performance in wide rpm/load range.
10) The fluctuation in fuel rack is restricted by decreasing the control sensitivity automatically through assumption of the sea condition from the rotating speed fluctuation (Gain –low control). When the rpm is increased excessively due to racing, etc., the control sensitivity is increased automatically to prevent over-speed tripping (OSP control).
11) It is possible to remove the noise (irregular rotation) from the actual engine speed, to prevent the fuel rack from jiggling by taking the section average of engine combustion periods.
12) The equipment is provided with four types of fuel limiters for prevention of engine overload and stalling.
13) Since the data setting is executed by using key board, the setting and adjustment can be performed easily and desired repeatability can be assorted.
14) It is possible to confirm the data by numerical value indicated by the digital indicator.
15) Since the optimum constant has been predetermined through the simulation using the computer and the control performance been confirmed by using the dedicated testing equipment prior to shipment, it is possible to complete the adjustment with the actual equipment in a short time.
16) Important data is protected with a password.
17) The control status can be confirmed by the status of the following LED indication lamps.
a) Operation status LED indication lamp
b) Fuel limiting LED indication lamp
c) Control mode LED indication lamp

6.1.3 System configuration:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Figure 6.2 shows layout of governor control system.

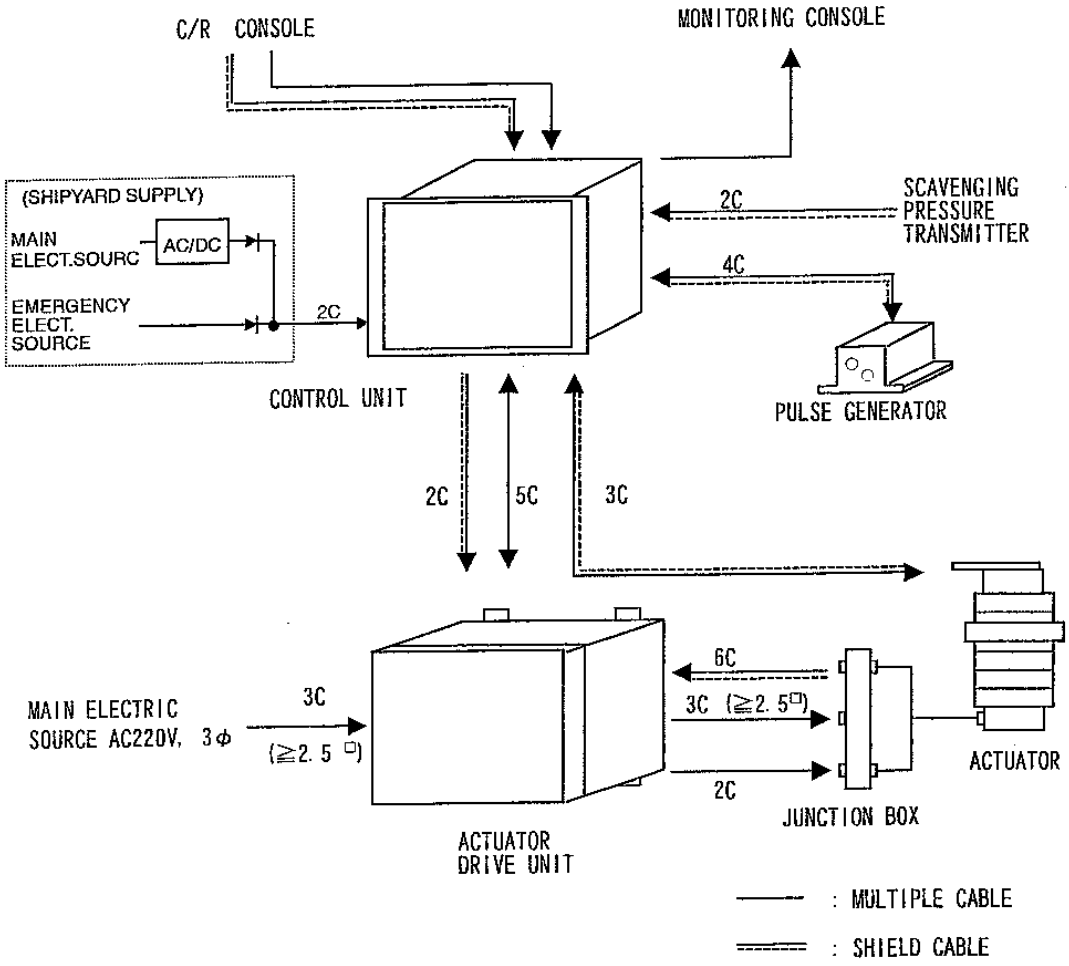


Fig. 6.2 Layout of governor control system
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

1) Control unit: Printed card board and PID control
2) Actuator drive unit: Servo motor driver + Power supply
3) Actuator: AC servo motor + Cyclo reduction gear
4) Pulse generator: Proximity switch (2 nos.)

Power supply for control unit: DC 24V ± 20%
Power supply for actuator drive unit: AC 220V (±10%), 60Hz-3Φ

6.1.4 Control Function:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

1) Control position

The control position corresponds to the maneuvering position (three-system) of POSITION1, POSITION2 and POSITION3.

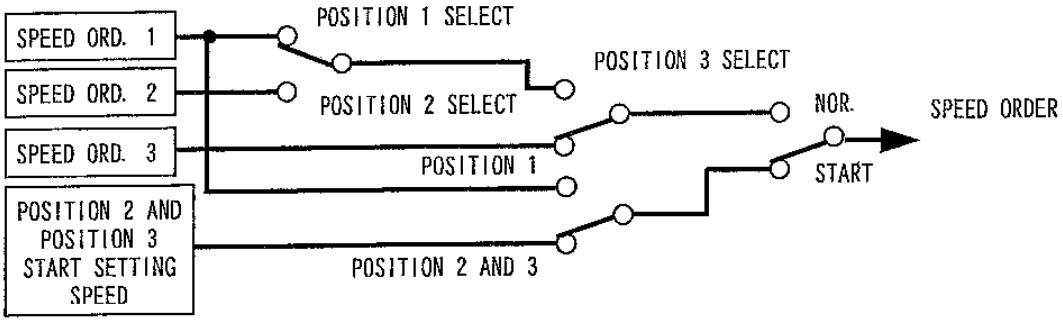
- CONTROL POSITION1 : BRIDGE or C/R
- CONTROL POSITION2 : LOCAL
- CONTROL POSITION3 : BACKUP

2) Start-up

When the start signal is entered, the F.O. rack is fixed to the start-up set point until actual engine rotating speed exceeds the setting rotating speed.
Since it is not influenced by the actual rotating speed rise rate, etc., it is possible to secure the sure and stabilized start-up.
The set point comes in 2 levels (LOW, HIGH1, HIGH2), each of which is selective, depending on ON/OFF of START DASH HIGH LEVEL signal, and on whether setting rotating speed is greater or smaller than the change-over level Low / High.
When the START DASH HIGH LEVEL signal is turned on, the scavenging pressure limiter is invalidated.

CONTROL POSITION	START DASH HIGH LEVEL	SPEED ORDER	SET POINT LEVEL	SCAVEN. LIMIT
1	OFF	—	LOW	ON
	ON	SPEED ORDER < "HIGH"	HIGH 1	OFF
		SPEED ORDER ≧ "HIGH"	HIGH 2	OFF
2 AND 3	OFF	—	LOW	ON
	ON	SPEED ORDER < "LOW"	LOW	OFF
		"LOW" ≦ SPEED ORDER < "HIGH"	HIGH 1	OFF
		SPEED ORDER ≧ "HIGH"	HIGH 2	OFF

When the control position is selected to POSITION2 or 3, the rotaing speed set to the governor control unit is applied as setting rotating speed at time of start-up for fixed time when the start-up signal is entered and after the air / fuel changeover is made, so that the same start-up as POSITION1 can be performed.



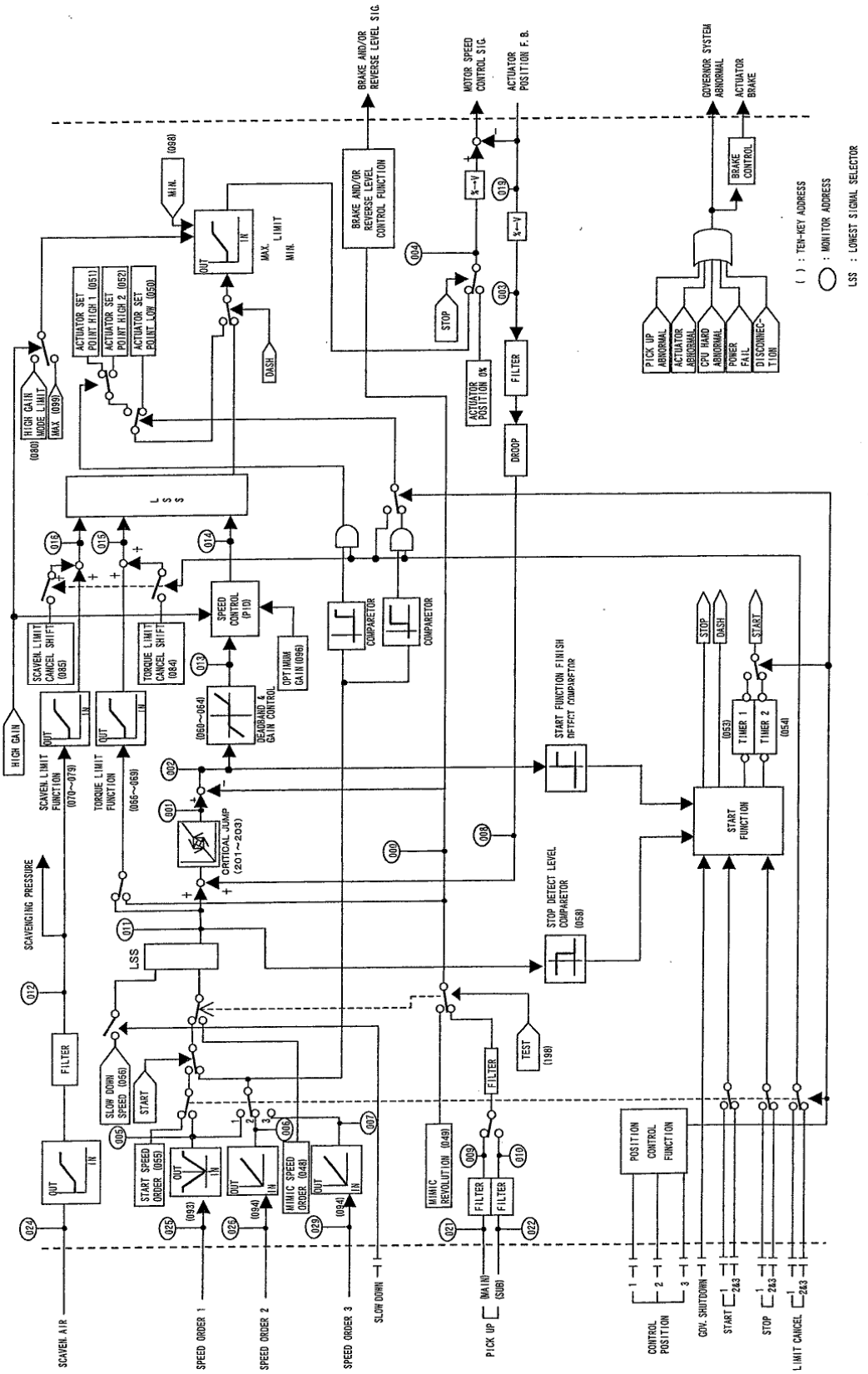

BRAKE AND/OR REVERSE LEVEL SIG.
MOTOR SPEED CONTROL SIG.
ACTUATOR POSITION F.B.
GOVERNOR SYSTEM ABNORMAL
ACTUATOR BRAKE
BRAKE AND/OR REVERSE LEVEL CONTROL FUNCTION
BRAKE CONTROL
MIN.
MAX. LIMIT MIN.
ACTUATOR SET POINT HIGH 1 (051)
ACTUATOR SET POINT HIGH 2 (052)
ACTUATOR SET POINT LOW (050)
DASH
STOP
FILTER
ACTUATOR POSITION 0%
DROOP
PICK UP ABNORMAL
ACTUATOR ABNORMAL
CPU HARD ABNORMAL
POWER FAIL
DISCONNECTION
( ) : TEN-KEY ADDRESS
○ : MONITOR ADDRESS
LSS : LOWEST SIGNAL SELECTOR
HIGH GAIN MODE LIMIT (099)
LSS
SPEED CONTROL (PID)
COMPARETOR
COMPARETOR
SCAVEN. LIMIT CANCEL SHIFT (085)
TORQUE LIMIT CANCEL SHIFT (084)
OPTIMUM GAIN (096)
DEADBAND & GAIN CONTROL (060~064)
HIGH GAIN
SCAVEN. LIMIT FUNCTION (070~079)
TORQUE LIMIT FUNCTION (065~069)
START FUNCTION FINISH DETECT COMPARETOR
CRITICAL JUMP (201~203)
STOP
DASH
START
TIMER 1 (053)
TIMER 2 (054)
START FUNCTION
STOP DETECT LEVEL COMPARETOR (058)
SCAVENGING PRESSURE
LSS
FILTER
SLOW DOWN SPEED (056)
START
TEST (198)
FILTER
START SPEED ORDER (055)
MIMIC SPEED ORDER (048)
MIMIC REVOLUTION (049)
FILTER
FILTER
POSITION CONTROL FUNCTION
SCAVEN AIR
SPEED ORDER 1
SPEED ORDER 2
SPEED ORDER 3
SLOW DOWN
PICK UP (MAIN) (SUB)
CONTROL POSITION
GOV. SHUTDOWN
START
STOP
LIMIT CANCEL

Fig. 6.3 Block diagram of control unit function
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

3) Stopping

The actuator is set to the fuel shut-off position.
The operating conditions are as follows;

(1) When setting speed is less than 10rpm (changeable). [Start-up signal:off]
(2) When normal stop signal (STOP) is turned on. [Start-up signal:off]
(3) When emergency stop signal (GOVERNOR SHUT DOWN) is turned on.

4) Emergency slow down

In this case, the upper limit of setting rotating speed is restricted to slow down level, to slow down the engine rotating speed.

6.1.5 Control mode:
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

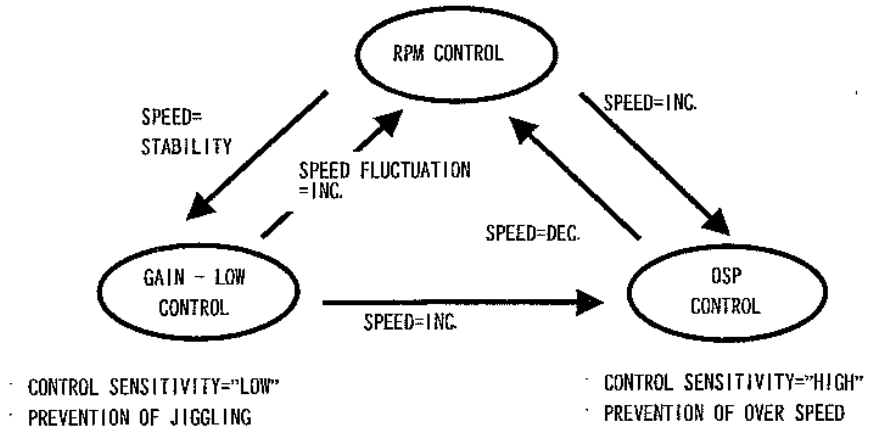
① NORMAL mode

This is a normal control mode in which the control is executed in accordance with the following sub-control mode, depending on operation condition.

a)RPM control : Executes control so that the engine rotating speed is within specified rotating speed all time.

b)GAIN-LOW control : Decreases control sensitivity automatically, when control rotating speed deviation remains within setting value for fixed time continuously, to minimize F.O. rack fluctuation, and execute quantitative F.O. control.

c)OSP control : Prevents over-speed tripping by automatically control increasing control sensitivity and by decreasing F.O. rack position when rotating speed exceeds specified value due to sudden load fluctuation during stormy weather. This OSP control function is operated automatically under all mode.



② HIGH GAIN mode

The actuator operating upper limit is reduced to a constant value and the control sensitivity is also increased.
This mode is effective to control the fluctuation in rotation during racing.
This mode is selected by pressing the HIGH GAIN push button on the front panel.

③ TEST mode

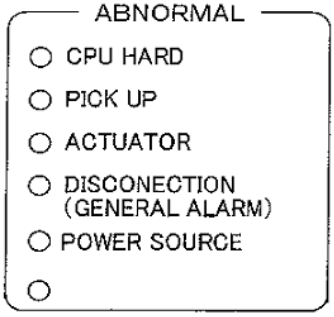
It is possible to confirm the control function / performance by simulating the engine operation condition with the simulation setting speed (MIMIC SPEED ORDER) and the simulation engine speed (MIMIC REVOLUTION) without practically.
This test mode is selected by setting value of parameter in the control unit.(The setting value of the simulation setting speed and simulation engine speed are changed by tenkey in the control unit)
Bear in mind that the operation mode is unable to be changed over to this mode unless the engine is stopping.

6.2 Familiarization with MCG unit:

6.2.1 Identification of LED indication lamps:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

ABNORMAL Indication Lamps



1) CPU HARD : Any microcomputer fails

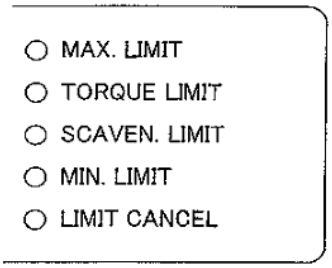
2) PICK UP : Any pickup fails

3) ACTUATOR : Actuator fails by
- Position F.B. sensor failure
- Motor & driver failure

4) DISCONECTION (GENERAL ALARM) : Wire disconnection in
- Speed command signal line
- Scaven. pressure signal line ※1
- Control position signal line

5) POWER SOURCE : Power source fails in
- Contrl unit
- Actuator drive unit

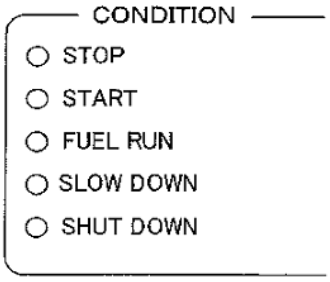
FUEL LIMIT Indication Lamps



※1

※1
1) MAX. LIMIT : Max. limiter operates
2) TORQUE LIMIT : Torque limiter operates
3) SCAVEN. LIMIT : Scaven. limiter operates
4) MIN. LIMIT : Min. limiter operates
5) LIMIT CANCEL : Limit cancel operates

CONDITION Indication Lamps



※1

1) STOP : At a stop
2) START : During starting control
3) FUEL RUN : Fuel running
※1 4) SLOW DOWN : Emergency slowdown operated
5) SHUT DOWN : Emergency shutdown operated

※1 Case of spec, some indication lamp are not exist.

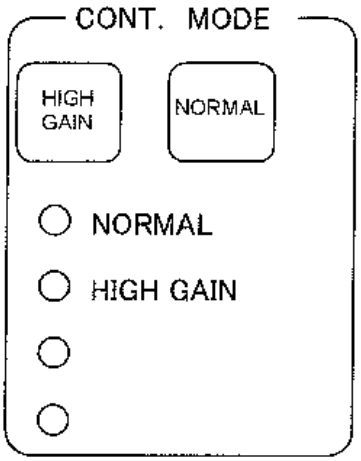
CONTROL MODE Indication Lamp／ Selector Switch

(Indication Lamps) (Switch Location)

1) NORMAL :Constant-speed control mode

2) HIGH GAIN :High-sensitivity control mode

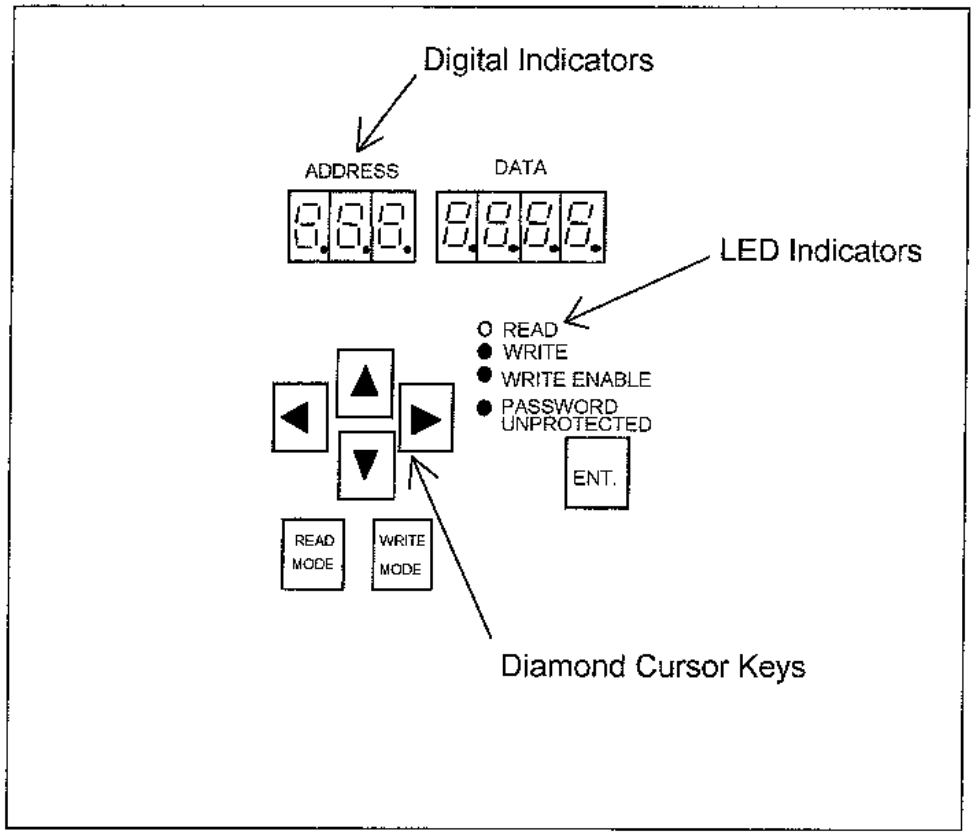
Front Panel



6.2.2 Procedure for Checking and Changing the Set value of TANKEY address:
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

Keyboard Arrangement

Various setting values can be checked and changed by operating the keyboard (ten-key pad), and displayed on the digital indicators (ADDRESS and DATA sections).



Keys	Contents
READ MODE	Prepared for switching to READ mode. When the switch is depressed, the mode is changed to READ mode. With the READ mode selected, pressing this key switches between digital indicator flickering and continuous lighting.
WRITE MODE	Prepared for switching to WRITE mode. When the switch is depressed, the mode is changed to WRITE mode.
ENT.	Prepared for writting DATA. Pressing this key causes the data indicated on the DATA section to be entered in the internal memory.
Diamond Cursor Keys	Prepared for changing address and data. With the READ or WRITE mode selected, pressing ◄ ► causes the flashing part to move and pressing ▲ ▼ causes the flashing numeral value to change. When changing an address, the data in the address will be displayed immediately.

Indicators	Contents
Address Indicator	3-digit, 7-segment LED is used to display ten-key addresses between [TK-000] and [TK-351].
Data Indicator	4-digit, 7-segment LED is used to display data between "-999" and "9999". The indication is fixed point type.
READ Indicator (Green LED)	Lights up during the READ mode.
WRITE Indicator (Red LED)	Lights up during the WRITE mode.
WRITE ENABLE Indicator (Red LED)	When data in address [TK-351] is not "0", entering data becomes possible, resulting in lighting up of this indicator LED.
PASSWORD UNPROTECTED Indicator (Red LED)	When data in address [TK-350] is the specified value (password), data in ten-key addresses [TK-100] and after will become possible to be written, resulting in lighting up of this indicator LED.

Operating Procedures

1) Reading Data

When entering the ten-key address number of data to be read out, the data will be displayed on the DATA section immediately.
Different address numbers can be set in both READ and WRITE modes.
For instance, during the PID adjustment, set ten-key address [TK-110] (proportional gain) in the WRITE mode and ten-key address [TK-000] in the READ mode, which enables the proportional gain to be changed in the WRITE mode and the M/E speed to be able to check promptly by pressing the READ MODE key.

2) Changing Data (Addresses [TK-047] Through [TK-099])

These data can be changed only during the WRITE mode as follows.
Changing the data in ten-key addresses [TK-100] and after requires the entry of password as shown in item 3).

① Switch to the WRITE mode.
Press the "WRITE MODE" key.
(The WRITE mode becomes effective and the "WRITE" LED lights up.

② Switch to the WRITE ENABLE mode.
Enter ten-key address [TK-351] and data "1".
(The WRITE ENABLE mode becomes effective and the "WRITE ENABLE" LED lights up.

③ Enter a ten-key address number of which data is to be changed in the ADDRESS section.
The DATA section displays the current data.

④ Enter new data.
Each data has the upper and lower limit values, which means that no data can be set greater than the upper limit value or smaller than the lower limit value. If a data cannot be changed even pressing the and ▲ keys, check the upper and lower limit values.

⑤ Press the "ENT." Key.
The data displayed on the DATA section will become effective.

⑥ When the other data are to be changed, repeat the steps ③, ④, and ⑤.

⑦ Turn off the WRITE ENABLE key.

After completing the change of data, enter the ten-key address [TK-351] and the data "0" and then turn off the WRITE ENABLE key, which causes the "WRITE ENABLE" LED to go off.

3) Changing Data (Ten-Key Addresses [TK-100] and After, With Password Protection)

The password can be inputted only in the WRITE mode and the password protection will be cancelled by entering the specified value (password) in ten-key address [TK-350]. Turning off the WRITE ENABLE key causes the password protection to become effective again.

① Switch to the WRITE mode.

Press the "WRITE MODE" key.

(The WRITE mode becomes effective and the "WRITE" LED lights up.)

② Switch to the WRITE ENABLE mode.

Enter the ten-key address [TK-351] and the data "1."

(The WRITE ENABLE mode becomes effective and the "WRITE ENABLE" LED lights up.)

③ Cancel the password protection.

Enter the specified value (password) in ten-key address [TK-350].

(The password protection will be cancelled with the "PASSWORD UNPROTECTED" LED lighting up.)

④ Enter a ten-key address number of which data is to be changed in the ADDRESS section.

The DATA section displays the current data.

⑤ Enter new data.

Each data has the upper and lower limit values, which means that no data can be set greater than the upper limit value or smaller than the lower limit value. If a data cannot be changed even pressing the ▲ and ▼ keys, check the upper and lower limit values.

⑥ Press the "ENT." Key.

The data displayed on the DATA section will become effective.

⑦ When the other data are to be changed, repeat the steps ③, ④, and ⑤.

⑧ Turn off the WRITE ENABLE key.

After completing the change of data, enter the ten-key address [TK-351] and the data "0" and then turn off the WRITE ENABLE key, which causes the "WRITE ENABLE" LED to go off.

Note: Even if the mode is switched to the READ mode once, it is not necessary to cancel the password protection again until the WRITE ENABLE switch is turned off.

Test Mode

Enter the ten-key address [TK-198] and the data "1", the test operation mode will be effective. When the test mode becomes effective, the mode indicator LED "NORMAL" will flicker.
A mimic speed setting signal can be applied by entering a data in ten-key address [TK-048] and a mimic rpm F.B. signal in [TK-049] so that a mimic running condition of engine can be made to check the governing function.

Power switch:

The power switch is provided on the back of the Control unit. This switch is used to turn on and off the power supply for the Control unit and speed pickup sensors.

6.3 Flow of revolution signal for governor control unit:

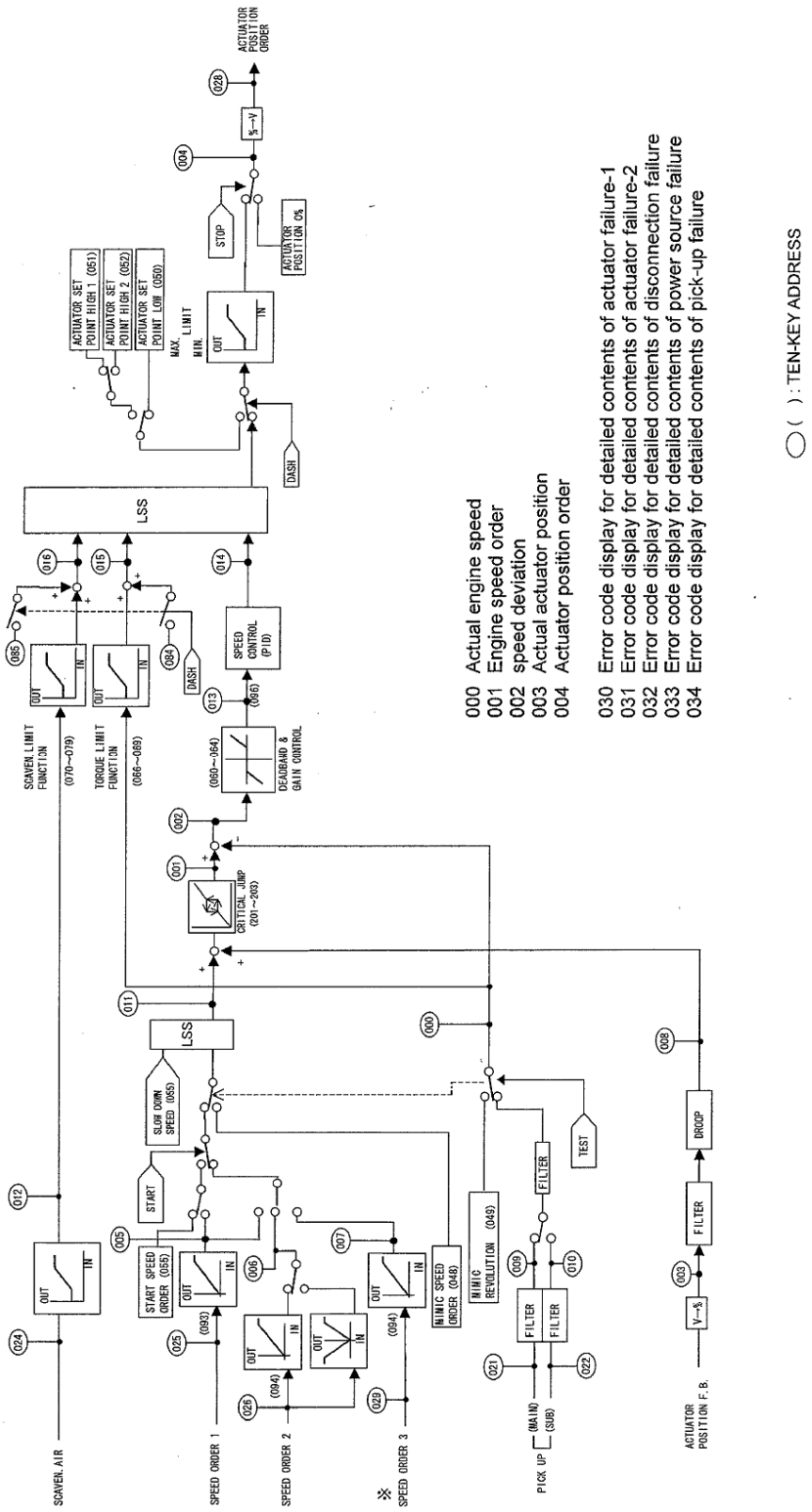


Fig. 6.4 List of internal monitors for the control unit
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

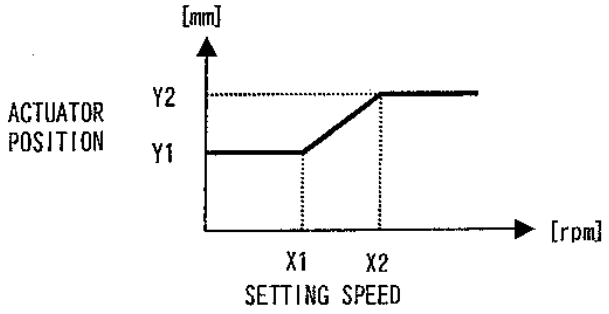
Three type of upper fuel limiters are used to prevent the engine overload.
It is possible to output the contact signal when one or more of the following upper limiter are functioned during fuel operation (excluding preset time after start-up).
MIN. LIMIT function will serve to prevent the engine stalling for such case when the engine speed is greatly changed (decreased).
When the LIMIT CANCEL signal is entered, the scavenging air pressure limiter will shift to increase fuel.

①MAX. LIMIT

- Defines the upper operation limit position for the actuator.

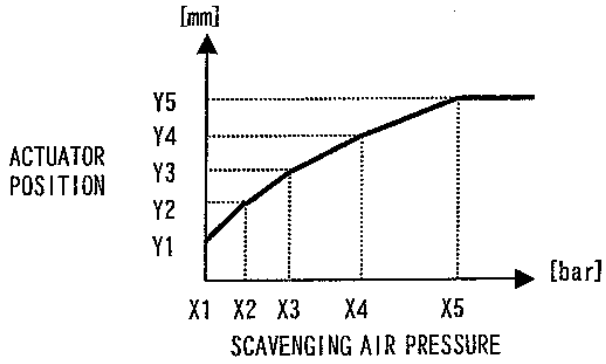
②TORQUE LIMIT

- The setting speed subjects the actuator position to the limiter. (two point function curve)



③SCAVEN. AIR LIMIT

- The actuator position is subjected to the limiter by the scavenging pressure. (five point function curve)



④MIN. LIMIT

- Restricts actuator so as not be decreased to lower than fixed position.
(Reset automatically when engine is stopped or under OSP control)

6.4.1 Maximum fuel limiter:

The value slightly greater than the full-load rack position is set.
This value should be also 1-2 mm smaller than the position where the rack touches the mechanical stopper.

Ten-Key	Description	Guidance/Adjustment Procedure
TK-099	Rack maximum limiter	The maximum limiter of the rack position during engine running is set. Too great setting could cause a collision of the mechanical limiter on the engine with the rack and a subsequent trouble with the rack or destruction of the mechanical limiter. On the contrary, too small setting could cause an impossibility of 110% running. ◎ Recommended setting: 1-2 mm smaller than the mechanical limiter setting.

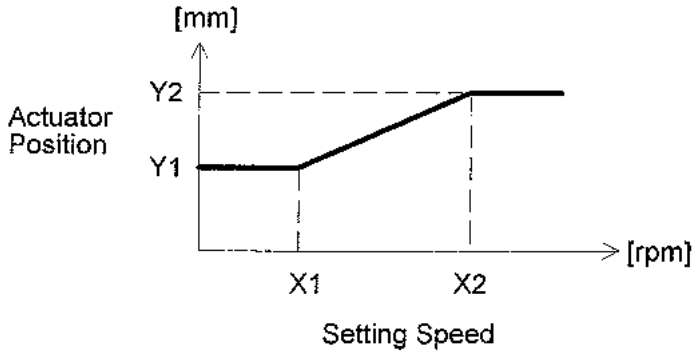
Maximum Limiter at the HIGH GAIN Mode

The maximum limiter position of the rack in the HIGH GAIN mode is set.

Ten-Key	Description	Guidance/Adjustment Procedure
TK-080	Actuator maximum limiter (for HIGH GAIN mode)	The maximum limiter of the rack at the HIGH GAIN mode is set. ◎ Recommended setting: the actuator stroke equivalent to 80-85% load running.

6.4.2 Torque limiter:

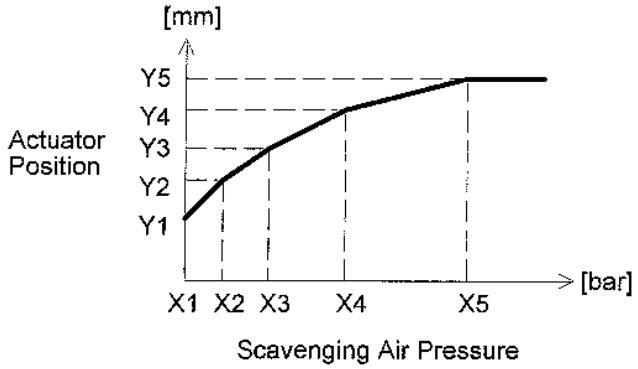
The upper limit of the actuator is determined by speed setting orders.
Two setting points are provided.



Ten-Key	Description	Guidance/Adjustment Procedure
TK-086	Slector swtch for Torque limiter	Slector swtch for Torque limiter. 0:Setting engine speeds 1:actual engine speeds
TK-066	Torque limiter (X1)	Setting actual speed point "X1" for torque limit is set.
TK-067	Torque limiter (X2)	Setting actual speed point "X2" for torque limit is set.
TK-068	Torque limiter (Y1)	Setting speed point "Y1" is set. If setting speed is below X1, the limit value is Y1.
TK-069	Torque limiter (Y2)	Setting speed point "Y2" is set. If setting speed is below X1, the limit value is Y2.
TK-081	Actual speed filter for torque limiters	Filter time constant for first-order time lag of actual speed used for torque limiter.
TK-084	Shift amount when torque limit is cancelled	Torque limiter value will be shifted upward by specified amount when touque limit is cancelled.

6.4.3 Scavenge pressure limiter:

The actuator position is limited by scavenging air pressure.
Five setting points are provided.



Ten-Key	Description	Guidance/Adjustment Procedure
TK-070	Scav. air press. limiter (X1)	Scav. air press. limiter point "X1" is set.
TK-071	Scav. air press. limiter (X2)	Scav. air press. limiter point "X2" is set.
TK-072	Scav. air press. limiter (X3)	Scav. air press. limiter point "X3" is set.
TK-073	Scav. air press. limiter (X4)	Scav. air press. limiter point "X4" is set.
TK-074	Scav. air press. limiter (X5)	Scav. air press. limiter point "X5" is set.
TK-075	Scav. air press. limiter (Y1)	Rack pos. of scav. air press. limiter point "Y1" is set. If the press. is below X1, the limit value should be Y1.
TK-076	Scav. air press. limiter (Y2)	Rack pos. of scav. a/p limiter point "Y2" is set.
TK-077	Scav. air press. limiter (Y3)	Rack pos. of scav. a/p limiter point "Y3" is set.
TK-078	Scav. a/p limiter(Y4)	Rack pos. of scav. a/p limiter point "Y4" is set.
TK-079	Scav. air press. limiter (Y5)	Rack pos. of scav. a/p limiter point "Y5" is set. If the press. is above X5, the limit value should be Y5.
TK-085	Scav. air press. limiter cancel amount	Scavenging air press. limiter value will be shifted upward by specified amount when limit is cancelled.

6.4.4 Minimum fuel limiter:

This limiter is used to prevent a stall of the engine.
The function works only during fuel running and automatically canceled at stop.

Ten-Key	Description	Guidance/Adjustment Procedure
TK-098	Rack minimum limiter	The minimum limit of the rack during engine running is set. A greater value could reduce a great hunting of the actuator during minimum speed running. However, a too great setting could cause a engine speed holding or an overspeed at running with high speed and low load. Adjust the value noting the characteristics that the higher the speed increases, the lower the rack position is. ◎ Recommended setting: 2-5 mm smaller than the actuator position of no load and high speed, or 5-10 mm smaller than that of no load and low speed.

6.5 Precautions for changing Fuel limiter:
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

When changing the setting of fuel limiter on the engine, observe the following precautions for the protection of the actuator.
1) When setting fuel limiter on the engine, do not change the position of the mechanical limiter but the setting of the electrical limiter.
2) The MG-800 Governor System provides an electrical limiter (electrical maximum position limiter for actuator) for protection of the actuator. When changing the mechanical limiter position due to unavoidable reason, this electrical limiter must be set 1 mm or more lower than the mechanical limiter (the maximum limiter of the fuel rack).
3) Prevent interface between the actuator and any limiting device such as the stop cylinder or the rack stopper on the stop side. Set the rack minimum position to -1 mm or less in the actuator position.
However, if both setting positions are reversed after changing the mechanical stopper position, the actuator may be damaged due to contact of the mechanical limiter with the fuel rack before the electrical limiter.
The electrical limiter is set by the ten-key address [099] on the governor control unit. Be advised that the setting value determines the position of the governor actuator, which is not same as the fuel rack position.

6.6 Procedure for adjusting Electrical Fuel limiter:
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

1) Turn off the power supply of main engine remote control system.
2) Set the mechanical stopper to the upper limit and record the value in ten-key [099].
3) Multiply the value in ten-key [099] by 0.09 and then enter the result in ten-key [195]. The actuator will move to the position, 10% lower than the setting in ten-key [099].
This operation will activate alarm “Actuator Abnormal” by the error code [030], but it can be ignored.
4) Adjust the fuel rack position 1mm lower than the mechanical limiter by changing the setting value of ten-key [195] by 0.1.
The value 0.1 equals 1% in the actuator position.
Record the value in ten-key [195], when the rack position is 1mm lower than the mechanical stopper position.
5) Multiply the value in ten-key [195] by 10 and then enter the result in ten-key [099].
The value in ten-key [099] will be the electrical limiter for the actuator.
6) Enter “0” into ten-key [195] so that the actuator will move to the stop position.
Push the “Cause Reset” button and then confirm that the indication LED for “Actuator Abnormal” goes OFF.
7) The adjustment is completed. Turn on the power supply of main engine remote control system.

6.7 Operating procedure for ADU unit:

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

1) The Power Switch (Breaker) is used to turn on and off the AC (main power supply).
2) Auto/Manual Selector Switch is used to switch the actuator operation mode. Normally, it is set to Auto position. When it is set to Auto position, the actuator operates according to the order signal from the Governor control unit.
When it is set to Manual position, the actuator can be moved manually.
3) UP/DOWN Switch is used to move the actuator in the corresponding direction, when the Auto/Manual switch is in the Manual position.
4) Normally, both indicator lamps CL1 and CL2 light up. If any abnormality occurs, the CL1 or CL2 will go off according to the abnormal cause.
Figure 6.5 shows Arrangement of Actuator drive unit.

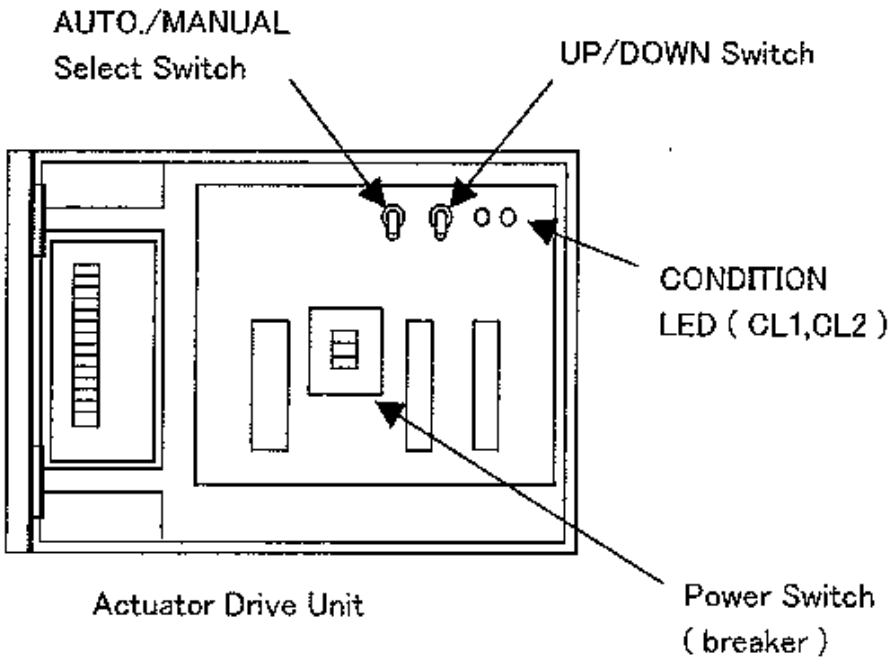


Fig.6.5 Arrangement of Actuator drive unit

(Source: NABTESCO Remote control system instruction manual, Vol. 1)

5) When turning the system ON, turn on the Power switch on the ADU unit and then the Power switch on the MCG unit.
As the system is turned on, some numerals are displayed on the Address and Data sections of the MCG unit. Check that all LEDs on the "Abnormal" section of MCG unit are OFF. If any Abnormal LED lights up, it means that there is some trouble. The same should be rectified according to the maintenance and inspection procedure, provided in the instruction manual.

6.8 Governor Actuator (Type: EAR-120):
(Source: NABTESCO Remote control system instruction manual, Vol. 1)

The EAR-120 type actuator is rotary type and adopted with AC servomotors.
Specifications of EAR-120 type actuator:
Maximum output in normal use condition: 330Nm
Working speed (no load, 100% stroke): 0.4 sec.
Working temperature/humidity for continuous duty: 55ºC/95°C or less (No condensation)
Working temperature/humidity for Short time duty (within 2hrs): 55ºC/95°C or less (No condensation)
Weight: 43 Kg

Precautions for Adjusting Mechanical Stopper:

The actuator has no mechanical stopper at both upper and lower sides.
If a stopper is required at the stop side due to the specification of fuel linkage, fuel pumps, or the like, it is recommended to provide it by the engine manufacturer.
If mechanical stoppers are provided, the lower stopper for the stop side should be set at a position 2% lower than the stop position, and the upper stopper for the fuel increase side at a position 2% higher that the electrical stopper set by the governor.
Since the actuator is continuously carrying out the position control, an actuator abnormal alarm will be given to prevent motor burnout if the actuator has been interfered with the mechanical stopper for two minutes.

Figure 6.6 shows cross-sectional view of the EAR type Actuator.

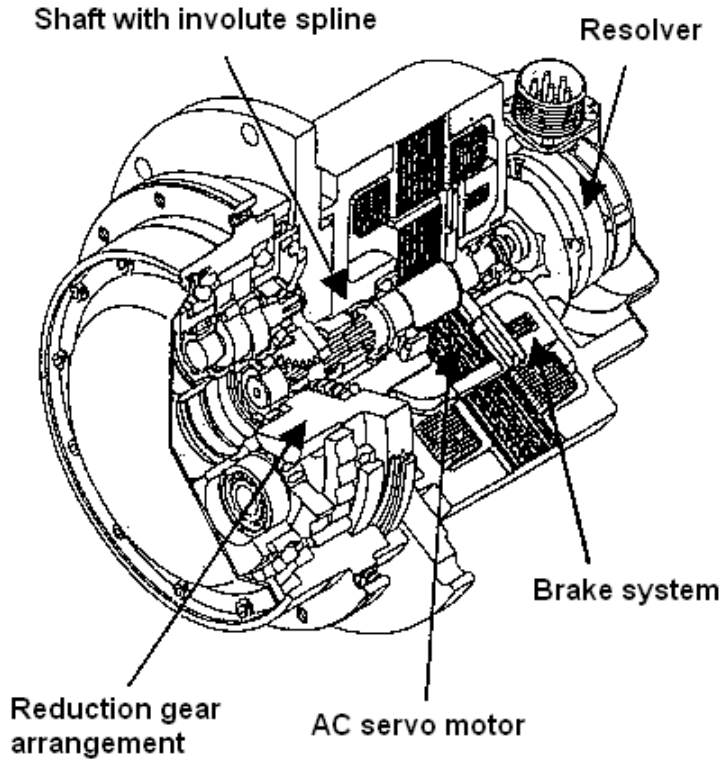


Fig.6.6 Cross-sectional view of Actuator

(Source: NABTESCO)

7. TROUBLE SHOOTING REMOTE CONTROL SYSTEM

Whenever the troubles for the remote control system have occurred the cause of trouble to be checked by suitable process not to be checked at random.

Trouble condition pattern:

7.1 Starting Failure

Pattern 1) Normal firing, engine speed goes down to stop

Pattern 2) Crankshaft moves, but no firing

Pattern 3) No crankshaft move

Pattern 4) Starting air goes on each cylinder, can't cut starting air

7.2 Unable to reverse

7.3 Takes long time to raise up engine speed.

The easiest way of troubleshooting is to see the symptom/indication of engine and try to ask yourself questions which are tabulated below.

Mode of operation	Remote (Bridge/ECR)		Local (with Governor)		Local (Without Governor)	
Is air distributor reversing?	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
Is main engine turning on air??	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
Is main engine turning on fuel??	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
If not turning on air – is main air v/v opening??						

For example

EXERCISE :

- Engine is reversing Ahead & Astern from remote control station.
- Engine not turning on air from remote mode.
- Engine operation normal from local stand in both ahead & astern directions (Air & Fuel).

Ref : Use Fig 1.1 Sulzer manoeuvring diagram.

Mode of operation	Remote (Bridge/ECR)		Local (with Governor)		Local (Without Governor)	
Is air distributor reversing?	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
	YES	YES	YES	YES	YES	YES
Is main engine turning on air??	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
	NO	NO	YES	YES	YES	YES
Is main engine turning on fuel??	AHEAD	ASTERN	AHEAD	ASTERN	AHEAD	ASTERN
	NO	NO	YES	YES	YES	YES
If not turning on air – is main air v/v opening??	YES		YES		YES	

By asking yourself above tabulated question, you can draw conclusion that there is some problem with remote, it seems that in this case start solenoid valve may not get energized / stuck.

8. TROUBLE REPORTS

CASE 1:

Container Vessel Main Engine: DU SULZER 12RTA96C

Remote Control System: NABCO DENIS-6

While the vessel was on the south bound route at the Suez Canal, the vessel dropped her anchors and waited for the north bound vessel group at Great Bitter Lake. The start failure occurred while the engine trial was conducted in the following manner.

1. Engine Control Room: Engine Trial (astern/ahead) started (No abnormality found)
2. Wheel House: Engine Trial (astern) failed
   Engine Trial (ahead) started
   Engine Trial (astern) failed
3. Engine Control Stand: Engine Trial (astern/ahead) failed

Although several attempts (ahead/astern) were made to start the main engine, neither ahead nor astern rotation was possible. It was found that the main engine started some minutes after the previous starting operation, however, start failure happened when starting and stopping of the engine were repeated in a short time.
Upon examination it was found that malfunction of the starting cut off valve, which was located between the starting air shut off valve and the starting air distributor, was responsible for the start failure.

After the starting cut off valve (129HA) was overhauled, a gasket was found to be deformed. As the vessel did not have a spare gasket, only temporary repair was taken, and the vessel resumed sailing. After the temporary repair, however, the vessel was required by the Suez Port Authority to have a survey of the Classification Society.
Consequently, the ship's schedule was delayed 33 hours to conduct the survey. The damaged gasket was replaced when the vessel received a new spare at the next port.

CASE 2:

Container Vessel Main Engine: DU SULZER 12RTA96C

Remote Control System: NABCO DENIS-6

While approaching Oakland, vessel carried out M/E astern test and found satisfactory. After some time vessel experienced problem with maneuvering system and unable to manuevre.Vessel anchored.
After troubleshooting, vessel staff suspected valve 49HC and they overhauled it. Engine was successfully tried out Ahead/ Astern.USCG requested for class survey and same has been carried out to the satisfaction of surveyor. At anchorage, bunkered arrange.
After bunkering, pilot boarded again & while underway C/E again reported for malfunctioning same as before. Took the advice of NABTESCO engineer and vessel overhauled valve 129HA & 212HA. After these also M/E was not able to start.

Again contacted NABTESCO and then they suggest to overhaul valve 49HC, same has been overhauled & O-ring renewed. After this M/E was able to start & maneuver.

CASE 3:

Container Vessel Main Engine: DU SULZER 12RTA96C

Remote Control System: NABCO DENIS-6

While approaching berth Savannah, M/E did not respond to astern movement. (Pre arrival ASTERN test was successful as per CFR 164).

The Astern movement failed from ECR as well as Local Control Stand.
Berthing is done with the help of 3 tugs and after berthing in port ship staff overhauled valve 49HD & 49HC. Engine tried out and found successful.
Same has been confirmed in presence of class surveyor & vessel allowed to sail after cargo work.