Nakano technical investigation report, *Ever Elite*

Investigation Report
on Potential Causes of M/V EVER ELITE Accommodation Ladder Fall Accident
and Preventive Measures of Recurrence

November 30, 2009
Nakano Seisakusho Co., Ltd.

Attention: [redacted]
Inspector of Marine Accidents
Marine Accident Investigation Branch

CC: [redacted]
Evergreen Marine (UK) Ltd.
Taiwan Office

Outline

In San Francisco, September 10, 2009, during set-up of the port-side, telescopic slide-out accommodation ladder of the container ship "Ever Elite," the lower ladder fell and caused a fatal accident. At request from the owner, Evergreen Marine, Nakano Seisakusho conducted investigation to find potential causes of the accident and to prevent future recurrence of such accident. The investigation took place in the subject ship when it called to Taipei Port in Taiwan on October 28, 2009. The investigation was witnessed by:

[redacted]	Evergreen Marine(UK) Ltd.
[redacted]	Evergreen Marine Corp.(Taiwan) Ltd.
[redacted]	Evergreen Marine Corp.(Taiwan) Ltd.
[redacted]	Nakano Seisakusho., Ltd.
[redacted]	Nakano Seisakusho., Ltd.
[redacted]	Nakano Seisakusho., Ltd.

Result

Please refer to Appendix A.

Potential Causes of Accident

Roller Bearing of Intermediate Bearing Housing in Gear Box was broken; as a result, Bevel Gear Unit holding the Hoist Drum was set free, Hoist Wire was paid out, Ladder was slid out and extended fully, Base Plate of Sheave Set A with Upper Ladder and Base Plate of Sliding Roller Set with Lower Ladder collided under acceleration, Bolts (M16 SUS304) securing each Base Plate were broken due to the collision and both Base Plates were unfastened, Sliding Wire dia 16 (6X24) hanging from Davit was set free as well because the Base Plates were unfastened.

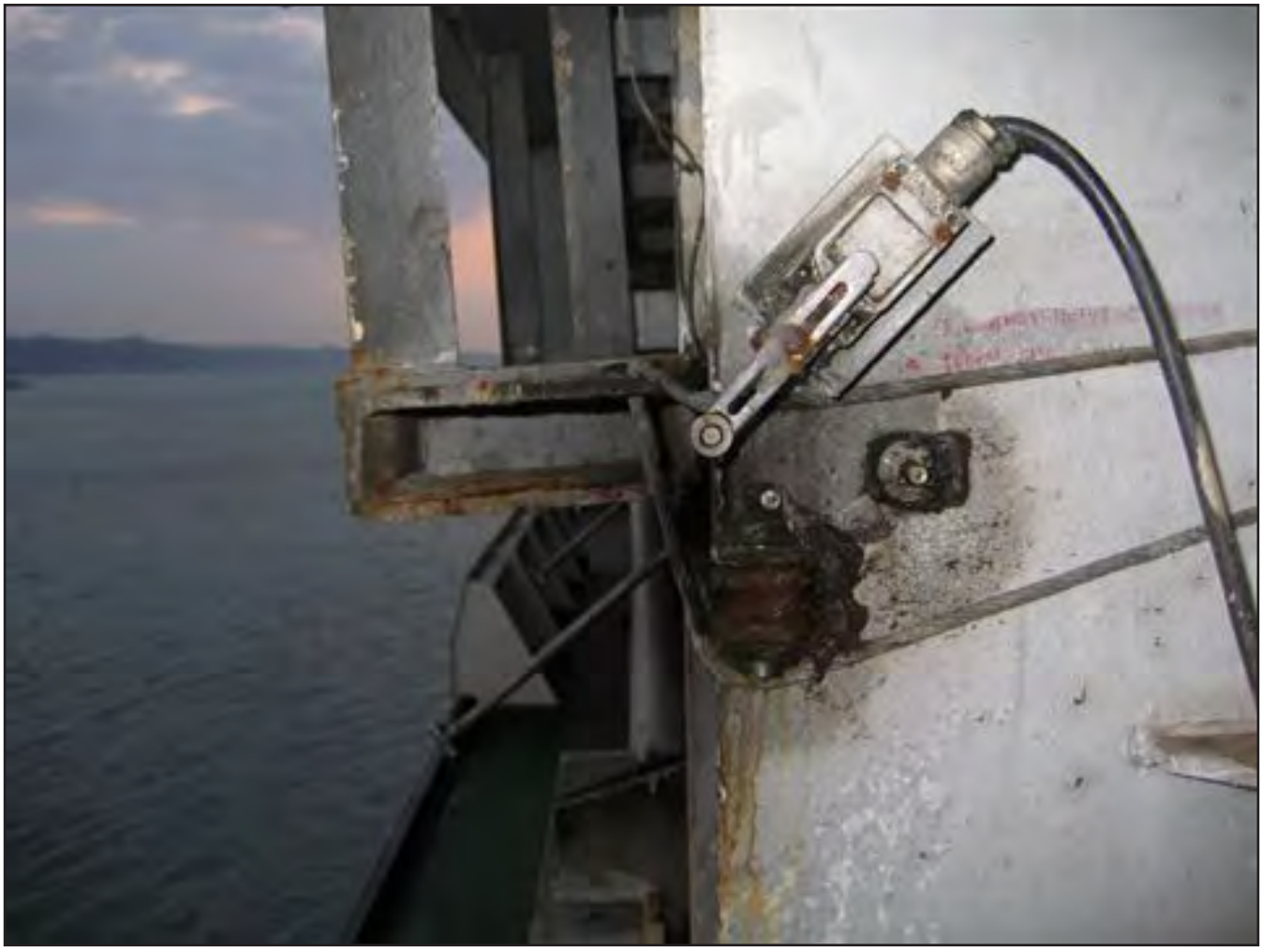
The Sliding Wire is structured to maintain tension consistently from horizontal position to a 55-degree angle; however, disengagement between Bevel Gear Unit and Vertical Bevel Gear set Hoisting Drum free. Then,

Sliding Wire was set free as well and kept going down with Ladder fully extended. As Hoist Wire thoroughly came out of the uncontrolled Hoist Drum, Lower Ladder fell in the sea. (See Appendix 9.)
Considering from the broken Bolts of Sliding Roller Plate, the accident is deemed to take place when Ladder was shrunk to a certain extent at a relatively small angle.
It is impossible that Roller Bearing C is damaged when Top Bearing Housing and Intermediate Bearing Housing have escaped damage.
As is in the Appendix A, Portion D of Bevel Gear Unit shows a trace of contact with Portion E of Vertical Bevel Gear (see Appendix 10: Inside photo of Gear Box of the same type at our factory; approximately 3mm gap between D and E). Hence, it is presumed that a gap of 3mm or more generated between F and G, Vertical Bevel Gear traveled to a lower position, Inside Ring of Roller Bearing contacted Bevel Gear Unit and was broken, then Roller Housing was broken, and disengagement between Bevel Gear Unit and Vertical Bevel Gear ensued. The possible cause of gap generation is foreign body intrusion, or fastening Nylon Nut where Spacer or Collar is not an authorized product. (See Appendix 11)

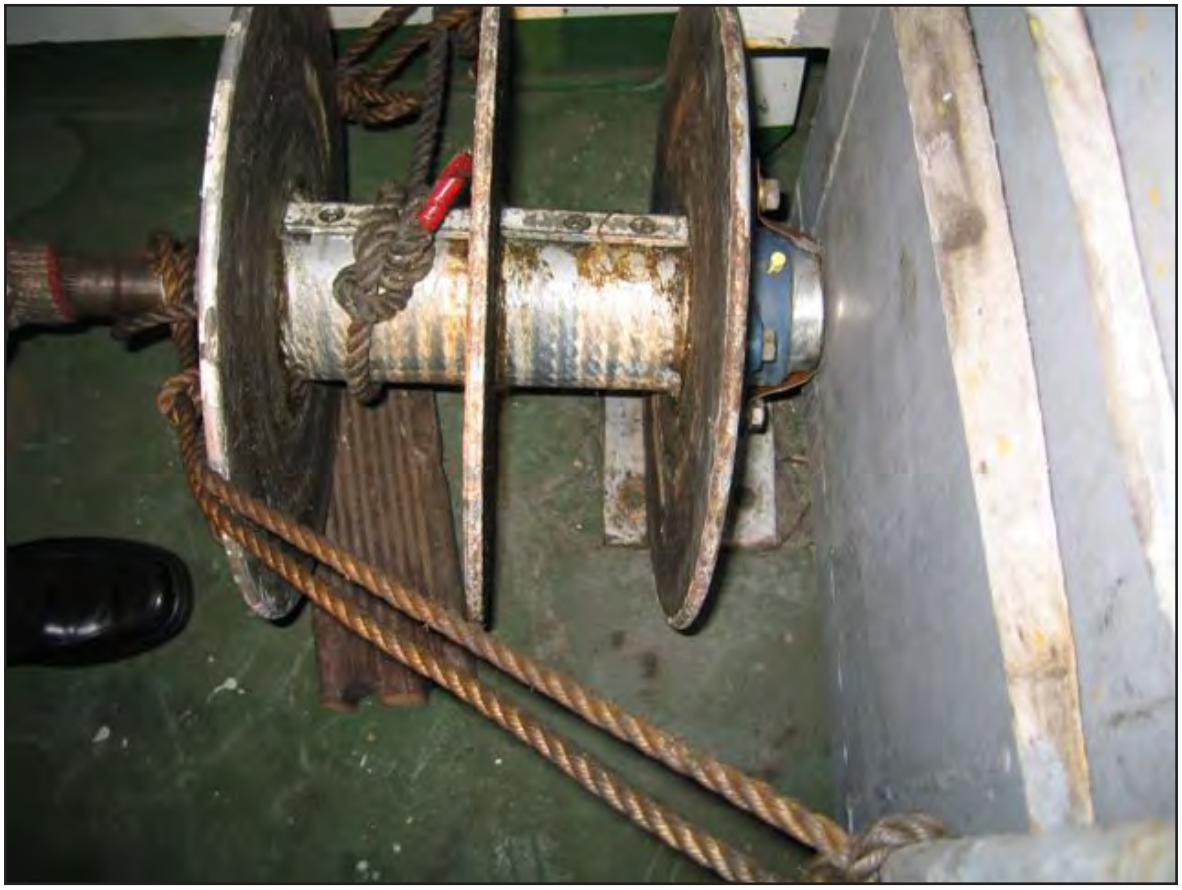
Preventive Measures of Recurrence

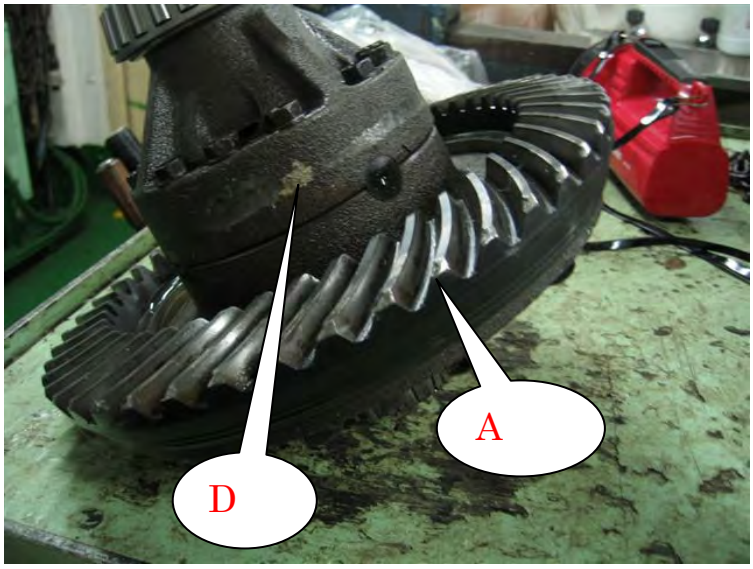
1. Preparing Operation Manual instructing details and cautions for replacing Gear, Oil Seal, Bearing, and the like
2. Measures such as supporting Ladder by Sub Sling Support Wire dispensed from the ship body, in case Hoist Wire and Slide Wire are set free as is in this case, is desired so as to prevent fall accident. Some ports demand such measures for vessels as a requisite to enter.
3. The investigators witnessed gangway ladder installment operation carried out by crew when the subject ship is docked in Taipei Port. To move Ladder with people on it is prohibited; therefore, Ladder is first put down to a certain angle and then crew got off the ship to set Handrail. Here, rope was provided from the deck to protect crew from falling in case of accident. (Appendix 12)
4. In accordance with crew suggestion, Eye Plate was installed each on deck and in the vicinity of Lower Platform of Lower Ladder and painted so as to draw attention. This way, Lower Ladder would be supported by Wire. Nevertheless, the Wire is not used because it can hamper crew's operation hanging always from the deck. (Appendix 12)
5. Until preventive measures is established and crew are assured security, please maintain above 3 and 4 practices.
6. Even skilled operator must follow instruction manual or have a third person double-check when replacing parts, and make sure nothing is omitted or missing.
7. To prevent overloading Winch, adjust Limit Switch accurately so that it stops before Davit and Ladder touches each other. Currently, Limit Switch is not working effectively.
8. Base Plates of Sheave Set A and Sliding Roller Set, as one of the potential causes of the accident, shall be welded to Ladder Frame. (See Appendix 13.) If Hoisting Wire is cut off, Base Plates can work as stopper because they are welded and fixed to Ladder Frame; thus, Ladder stops at a certain point, supported by Sliding Wire dia 16 (6X24) at the maximum slant angle of 55 degree, and fall accident can be prevented.

Investigation Result of Accommodation Ladder (Port Side)	
Subject	Investigation Result and Remark
Hoisting Wire	No problem (No trace of cut-off was found) (Appendix 1)
Stowing Wire	No problem (No trace of cut-off was found) (Appendix 1)
Sliding Wire	No problem (No trace of cut-off was found) (Appendix 1)
Limit Switch for Hoisting	Our original instruction was "ladder should be stopped 5-10 mm before davit." However, the installation condition at the port side of the vessel indicated that the ladder stopped after contacting the davit. Please check and readjust. (Appendix 2)
Motor Relay	We confirmed mounting of the motor relay provided in September, 2007 to the starter. Operation condition was not confirmed. (Appendix 3)
Sheave within Davit (dia 137)	One set of sheave and pin within davit was missing. We consider that the set was lost in the accident. Missing of the set is unlikely the cause of the accident. (Appendix 4)
Drum & Drum Shaft	No problem (Appendix 5)
Gear Box	At the time of inspection, the bevel gear unit and vertical bevel gear had been replaced with new ones and the old ones used at the time of the accident were kept in the engine room. We conducted inspection of the old ones, and found the followings: 1) Portion A of the bevel gear unit and Portion B of the vertical bevel gear were damaged. (Appendix 6 and 7) 2) Roller bearing C mounted on the vertical bevel gear was damaged. (Appendix 8) 3) Portion D of the bevel gear unit showed a trace of contact by Portion E of the vertical bevel gear. (Appendix 6) 4) Top bearing housing and intermediate bearing were replaced with new ones. The top bearing housing and intermediate bearing housing that had been used at the time of accident were not damaged. 5) Other parts and gear box had no problem. 6) The ship crew explained that the vessel had been overhauled in April, 2009.
Ladder	Fall and loss of the lower ladder M16 Bolts (SUS304) securing each base plate of sheave set A and sliding roller set to the ladder frame were broken.

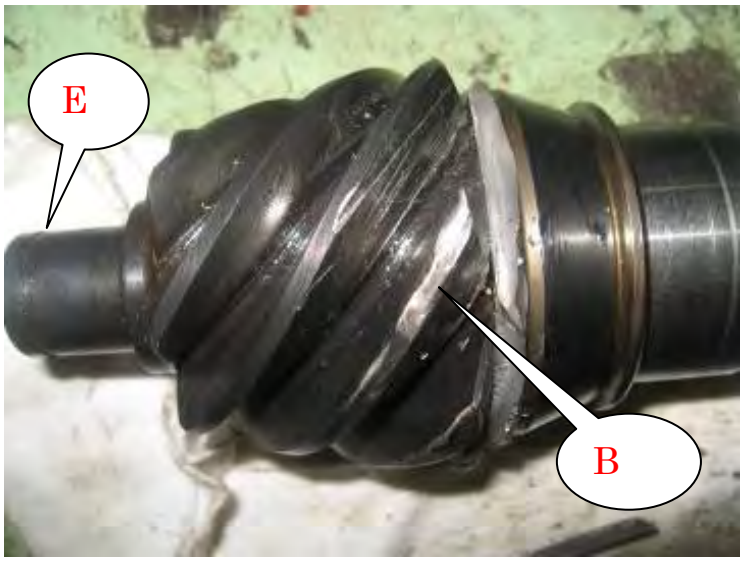



T U1 V1 W1 U2 V2 W2
K2CM



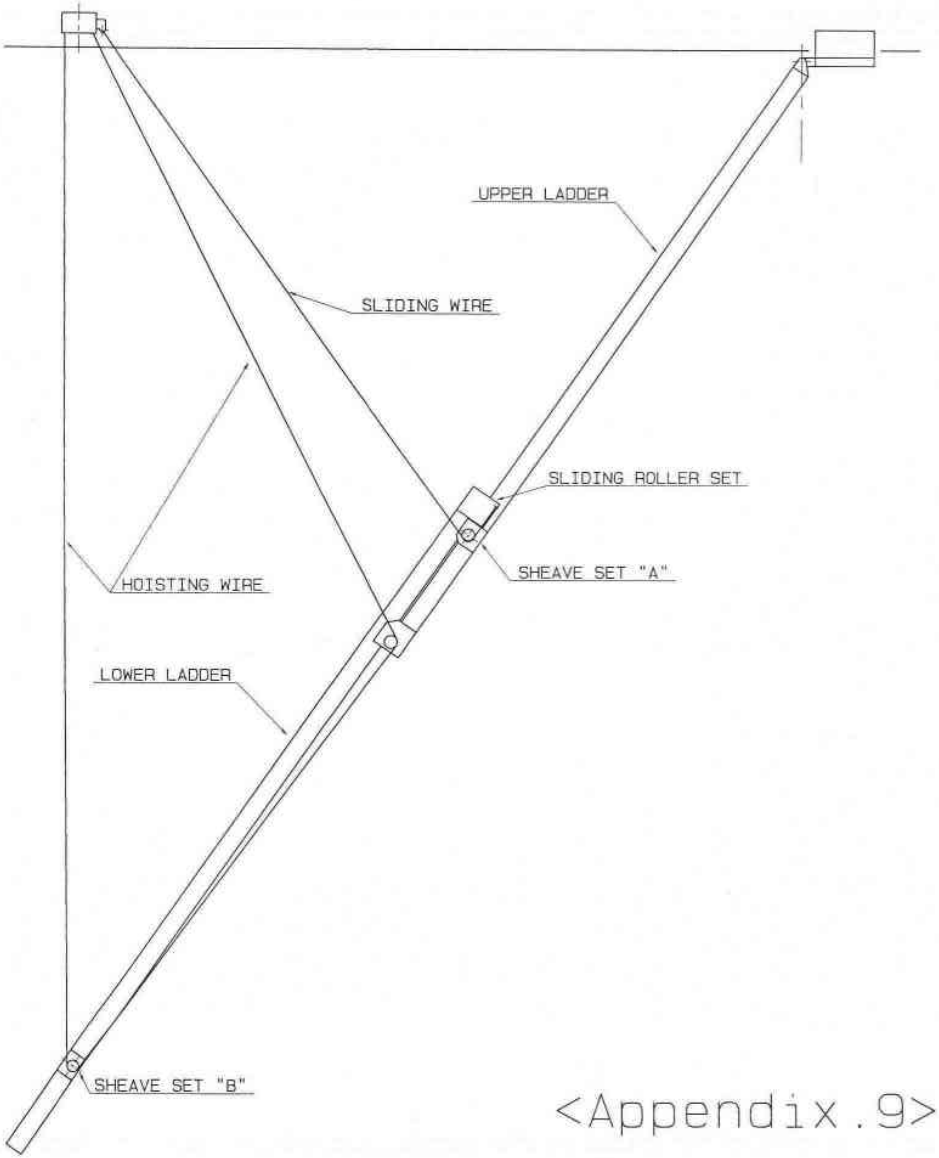


Appendix 6

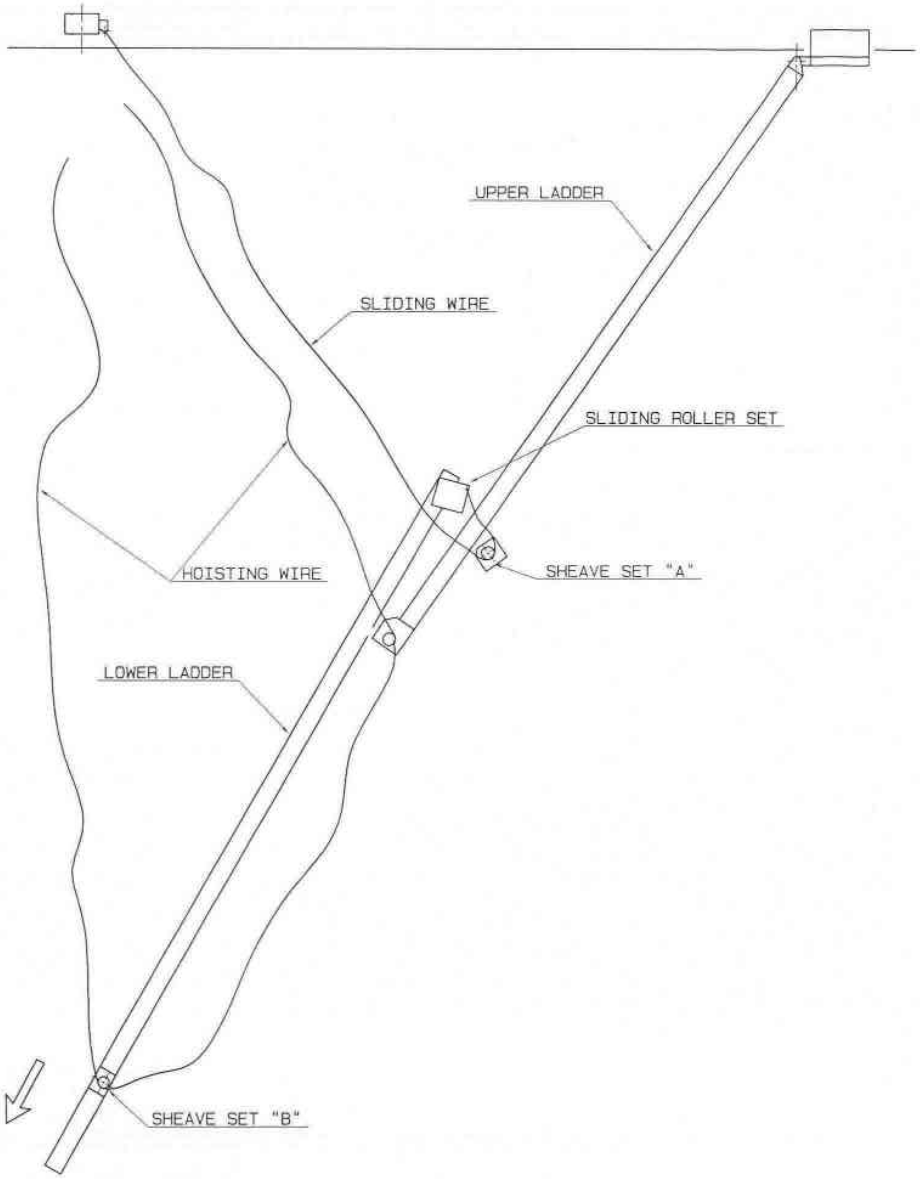


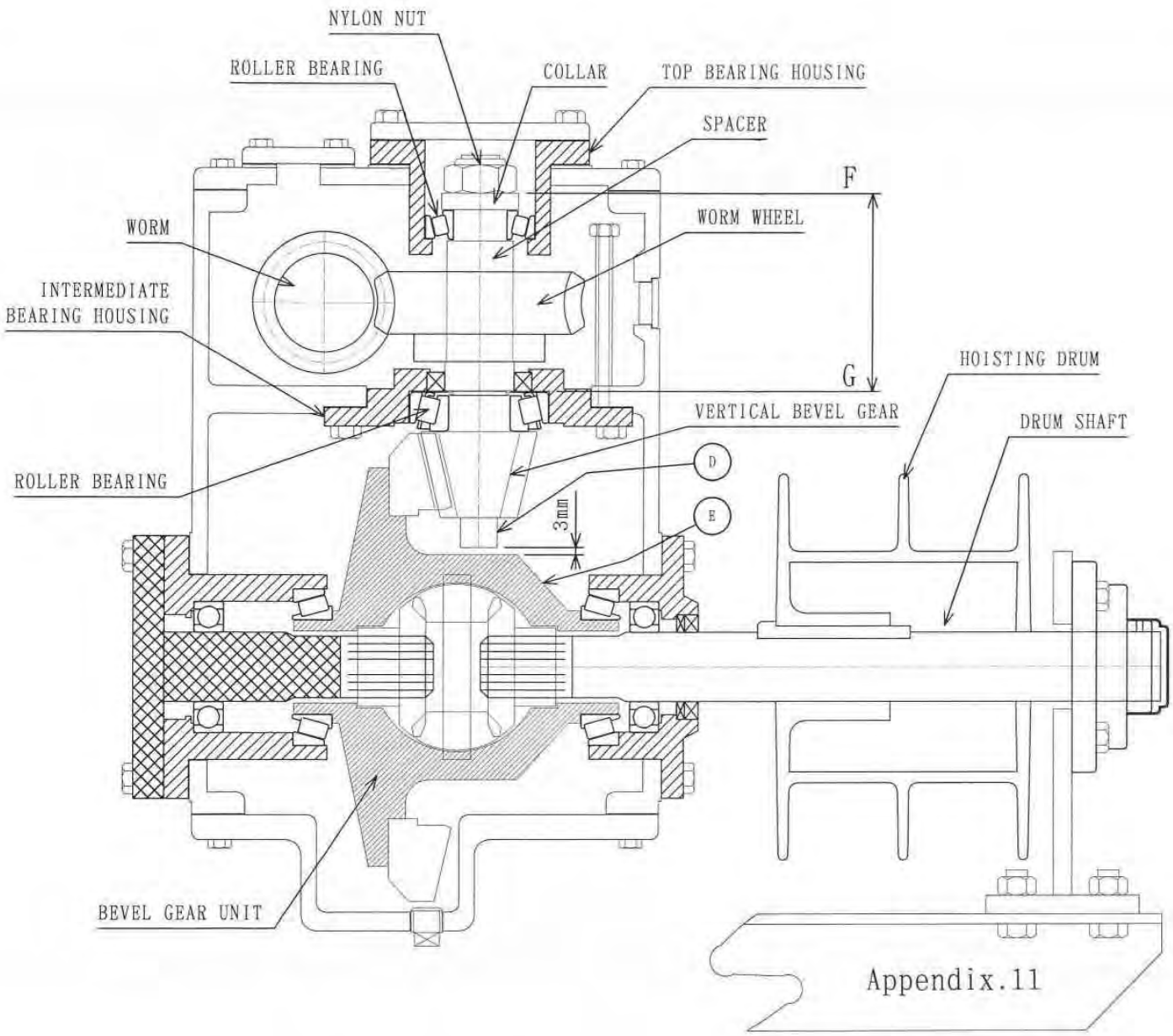
Appendix 7

Appendix 8

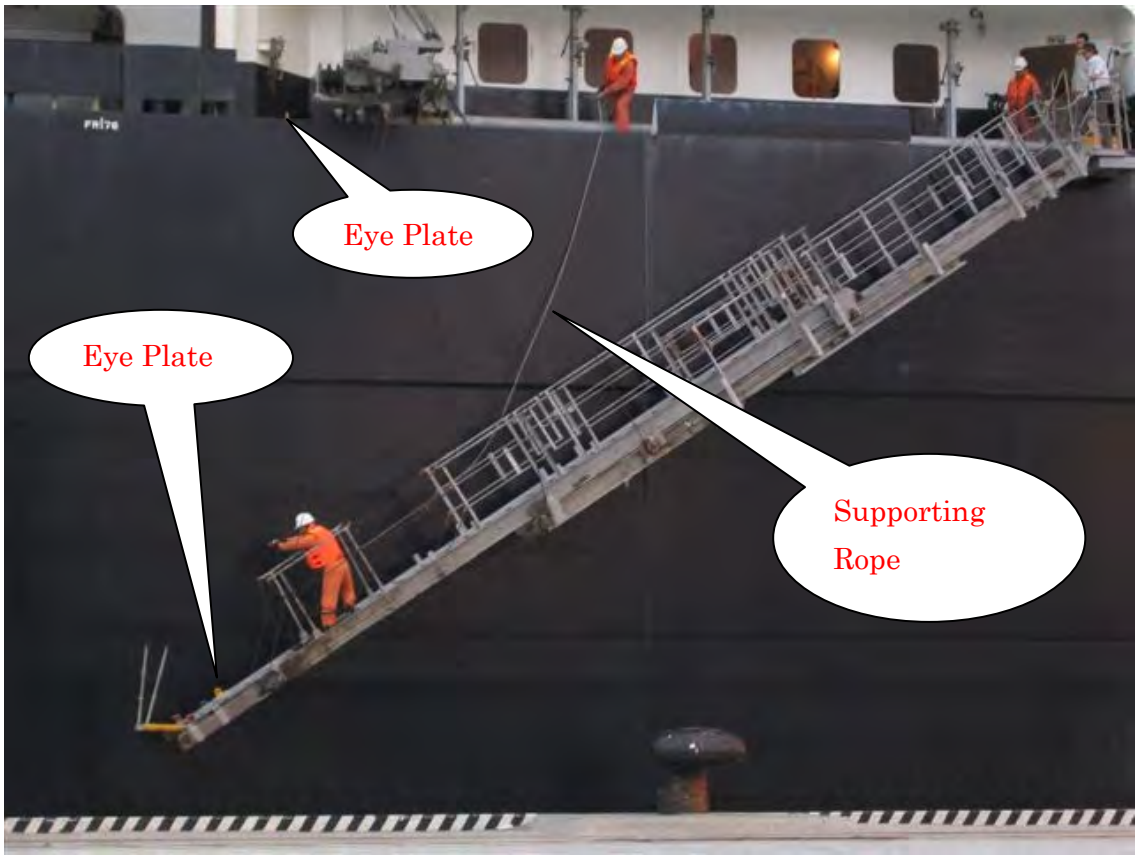

UPPER LADDER
SLIDING WIRE
SLIDING ROLLER SET
SHEAVE SET "A"
HOISTING WIRE
LOWER LADDER
SHEAVE SET "B"

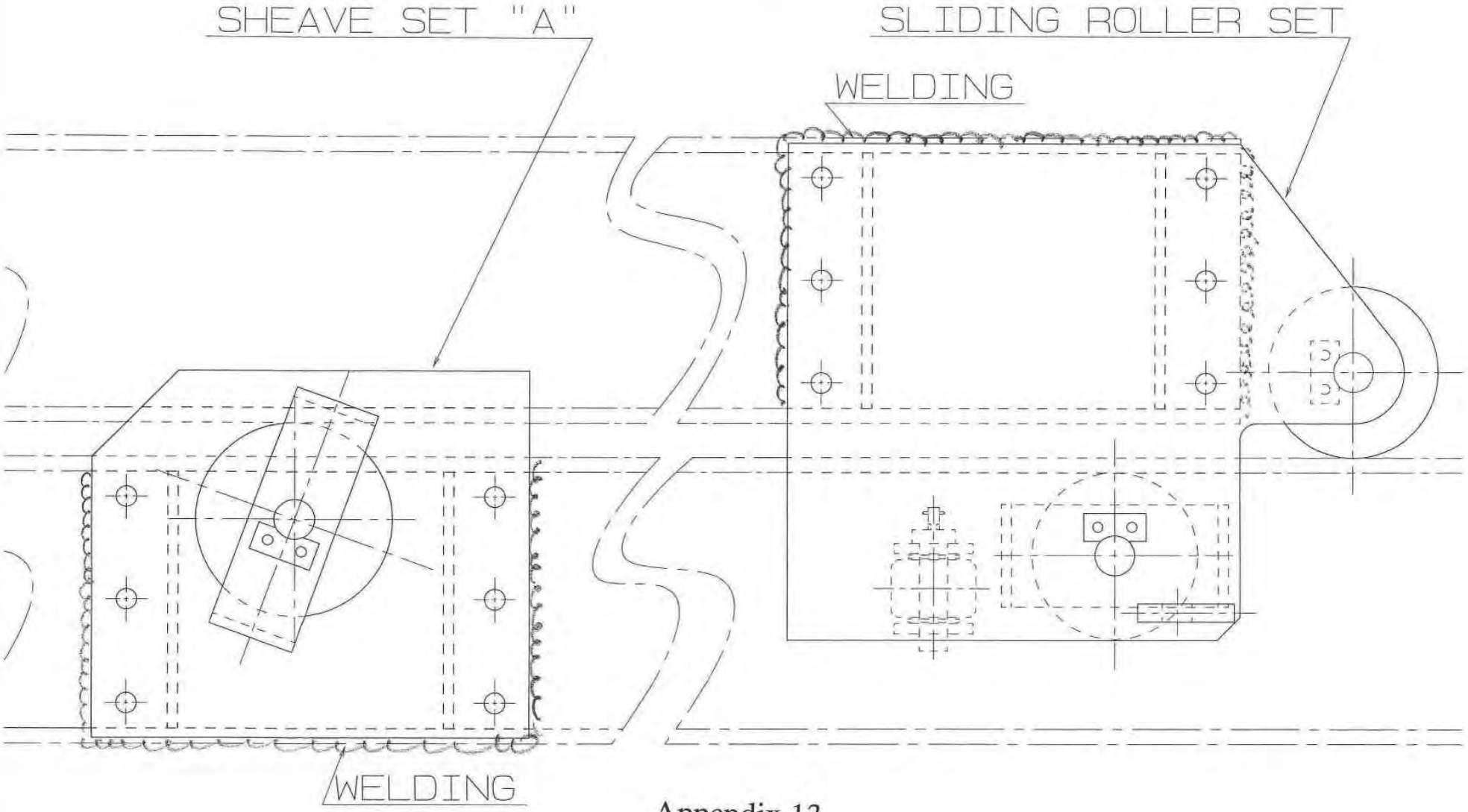
<Appendix.9>


UPPER LADDER
SLIDING WIRE
SLIDING ROLLER SET
SHEAVE SET "A"
HOISTING WIRE
LOWER LADDER
SHEAVE SET "B"


NYLON NUT
ROLLER BEARING
COLLAR
TOP BEARING HOUSING
SPACER
F
WORM
WORM WHEEL
INTERMEDIATE
BEARING HOUSING
G
HOISTING DRUM
VERTICAL BEVEL GEAR
DRUM SHAFT
ROLLER BEARING
D
E
3mm
BEVEL GEAR UNIT

Appendix.11


Eye Plate
Eye Plate
Supporting
Rope



Appendix 13

Annex B

ICS Bridge Procedures Guide manoverboard checklist

C4 MAN OVERBOARD

Actions to be carried out:

- [ ] Release lifebuoy with light and smoke signal on the side the crew member has fallen overboard
- [ ] Take immediate avoiding action so as not to run over the man overboard
- [ ] Note ship's position, wind speed and direction, and time
- [ ] Activate GPS man overboard marker
- [ ] Sound three prolonged blasts of the ship's whistle and repeat as necessary
- [ ] Post a look-out with binoculars and instructions to maintain a continuous watch on the man overboard
- [ ] Engage hand steering, if helmsman available
- [ ] Commence a recovery manoeuvre, such as a Williamson turn
- [ ] Inform master, if not already on the bridge
- [ ] Inform engine room
- [ ] Hoist signal flag "O"
- [ ] Place engines on stand-by
- [ ] Muster rescue boat's crew, master and coxswain, and jointly assess launch/recovery risks
- [ ] Prepare rescue boat for possible launching
- [ ] Consider alternative means of MOB recovery if launch/recovery of rescue boat considered to be of excessive risk
- [ ] Distribute portable VHF radios for communication
- [ ] Rig pilot ladder/nets to assist in the recovery
- [ ] Make ship's position available to radio room/GMDSS station
- [ ] Broadcast URGENCY message to ships in the vicinity
- [ ] Preserve VDR or S-VDR records if not automatically protected
- [ ] Assume role of On Scene Co-ordinator

Other actions:

- [ ]
- [ ]
- [ ]
- [ ]

Accommodation ladder limit switch modification instructions

December 7, 2004

NAKANO SEISAKUSHO CO., LTD.

Request for Confirmation of Installation of Accommodation Ladder System for Commissioned Ships of EMC

To our regret, we have some trouble reports about the gear box ~~as indicated in the attached sheet~~ (No attached) at the commissioned ships (NU Series, NNU Series, E Series, MHI NAGASAKI Ships No.2141/42).
In regard to the reports, please confirm or re-adjust the component parts in reference to the following procedures for keeping their safety characteristics.

A Countermeasures

Judging from the matter occurred in existing vessels, it is necessary to make adjustment/modify the limit switch and the guide plate of davit frame so that the ladder can not touch the davit frame when hoisting. This would prevent any damage of the gear and bearing housing from being caused.

1. Procedure for adjusting the Hoist UP limit switch

   See Appendix 1.

2. Procedure for cutting the davit frame.

   See Appendix 2.

   Note: For S No. 1251 and later series for vessels, the sheave has been already installed in a position that is 25 mm lower than its previous position to ensure that the sheave does not hit the davit frame. So countermeasures has been already completed.

3. Procedure for checking the limit switch for normal operation.

   See Appendix 3.

   Please carry out Appendix.3 once a month without a fail, by applying a tester to the limit switch terminals in the starter panel.
   At the position of finish of Hoist UP or Stowing, the limit switch terminals in the starter panel are NOT applying electricity, and at the position of Hoist DOWN, that they are applying electricity.

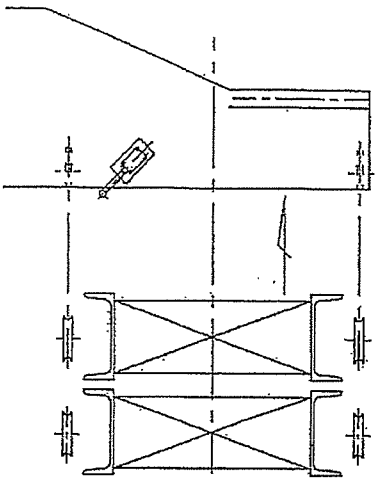
4. Procedure for checking abnormal noise.

   When the accommodation ladder is operated, please pay attention to sound from gear box and motor every time.
   In the case that any irregular sound is confirmed, there is a possibility that a certain damage may occurs at the gear box. We will recommend that this state is counseled with us immediately or the damaged gear box is replaced with a new gear box.

1. Procedure for adjusting the Hoist UP limit switch

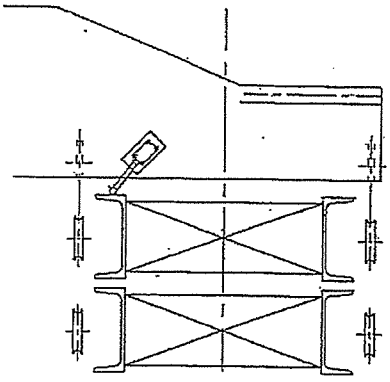
!! NOTE: Make adjustments to ensure that the davit does not hit the ladder.

1-1. When the Hoist UP is started.



1-2. When the limit switch is touching the ladder.

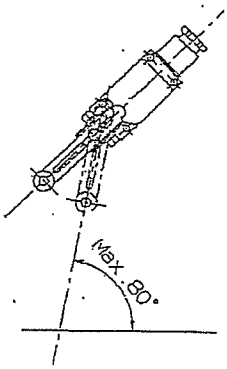
* The limit switch's lever starts moving.

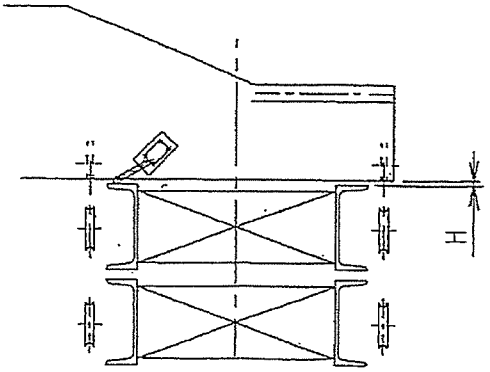


1-3. When the limit switch stops functioning (Finish of Hoist UP)

* The limit switch's lever is moving. The limit switch's circuit is turned off. The ladder stops moving.
* At this time, make sure that a clearance of 5 to 10 mm is created in the H dimension. Adjust the length and angle of the limit switch's lever to ensure that the ladder can stop properly.
* Make sure that the motor does not start rotating even when the Hoist UP pushbutton is pressed.

Max. angle of setting

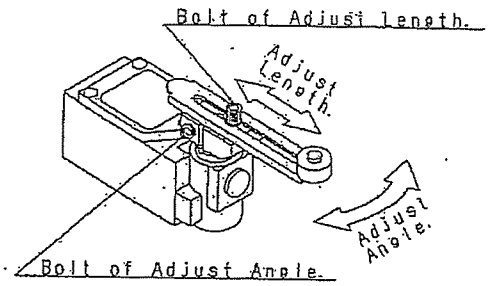


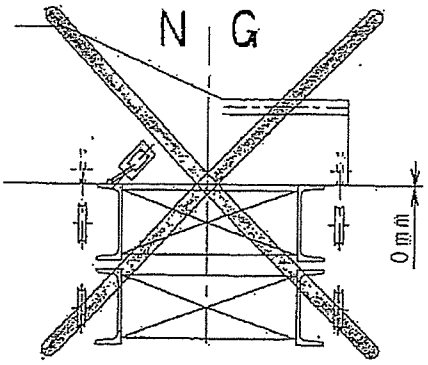


〈Appendix 1〉

1-4. NG

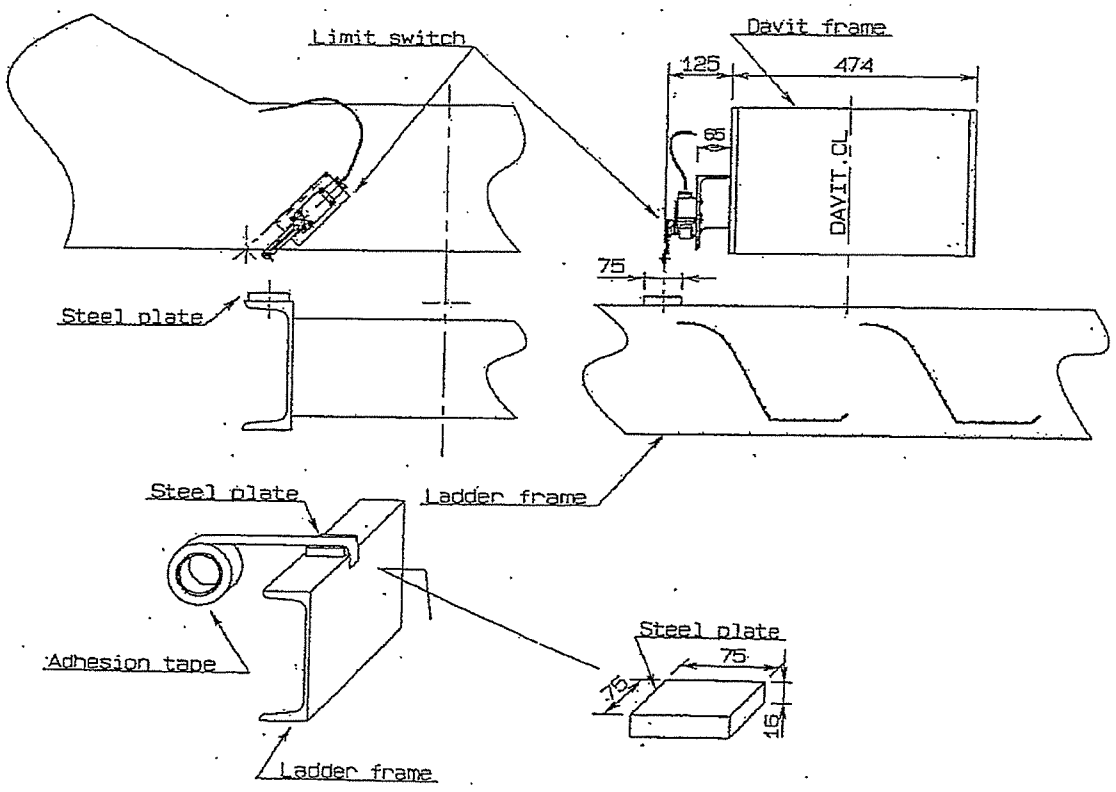
* If the davit hits the ladder when the limit switch has stopped functioning (Finish of Hoist UP), this means a fault. So make adjustments to ensure that the davit does not touch the ladder.





Note: If lever of limit switch have not enough for adjust length at the above procedure, do it followings.

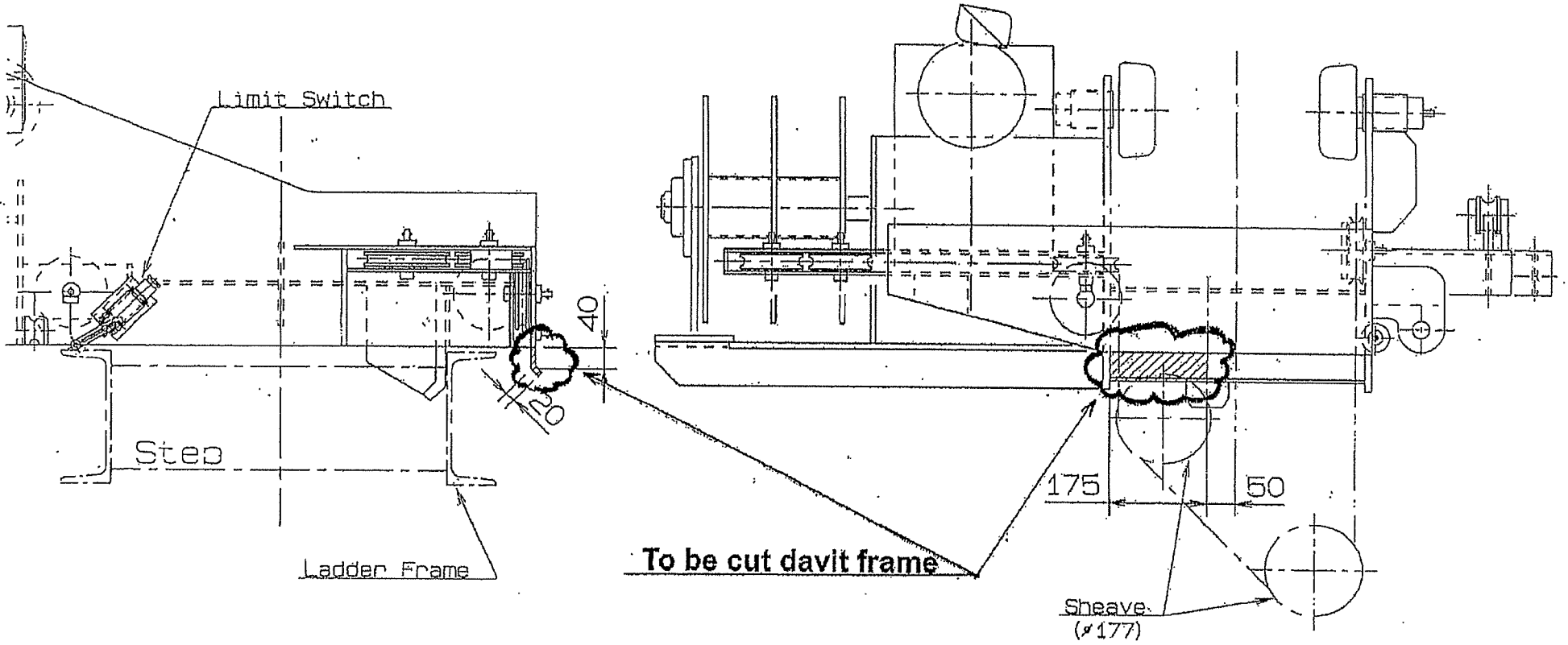
1-A1. Please attach temporarily the steel plate(abt.75x75x16mm) by adhesion tape like below figure. Please be careful not to drop that.



1-A2. Check the 1-1 ~ 1-3.

1-A3. At last, weld attached temporarily the steel plate to the top of ladder frame

2. Procedure for cutting the davit frame



〈Appendix 2〉

3 . Checking the "Hoist Up" Limit Switch for Normal Operation

Please confirm or check each of the following terminals.

When finish of Hoist UP or Stowing

As to Hoisting UP limit switch for starboard side

Both (2S) terminal and its adjoining (6) terminal ····· Not applying electricity

As to Hoisting UP limit switch for port side

Both (2P) terminal and its adjoining (6) terminal ····· Not applying electricity

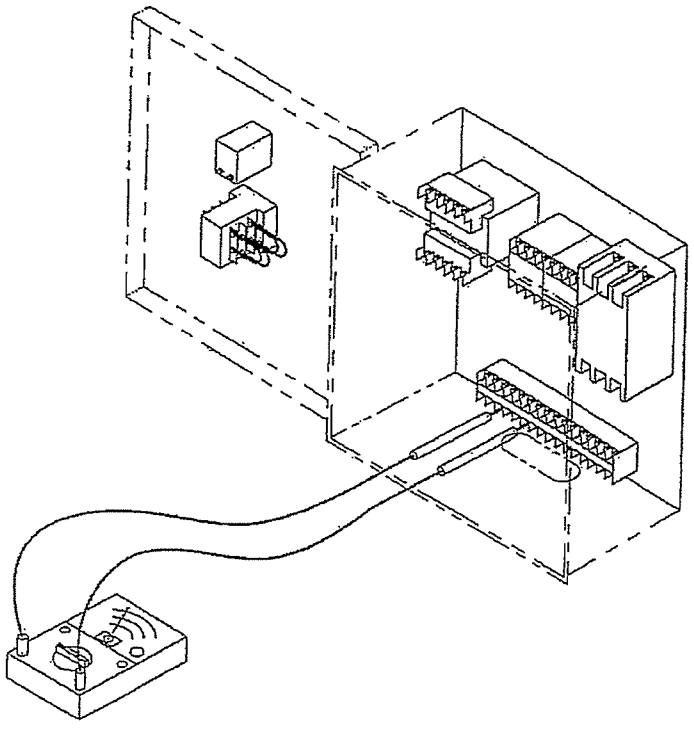
When Hoist DOWN

As to Hoisting UP limit switch for starboard side

Both (2S) terminal and its adjoining (6) terminal ····· Applying electricity

As to Hoisting UP limit switch for port side

Both (2P) terminal and its adjoining (6) terminal ····· Applying electricity



〈Appendix 3〉

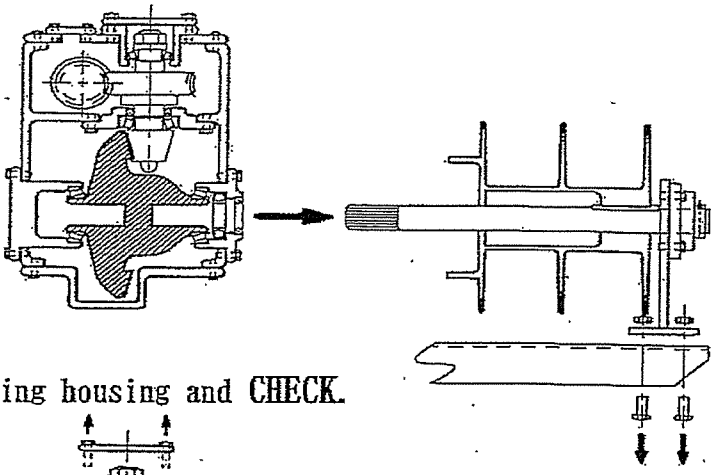
4. Procedure for checkong abnormal noise

(Check of the gear & the bearing housing)

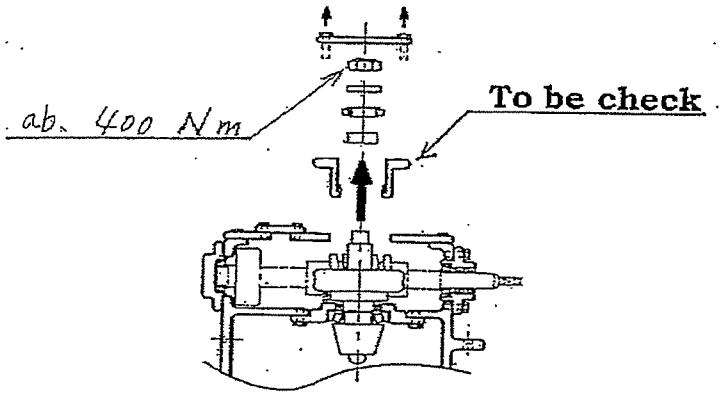
1. Remove the Hoisting gear box from the Davit.

!! Be careful of dropping the Ladder,when works on level condition.

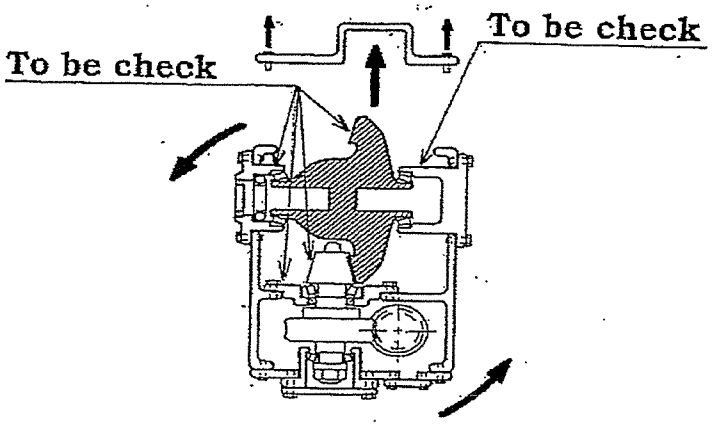
2. Remove the Drum from the Gear box.



3. Remove the Upper bearing housing and CHECK.



4. Turn up the bottom of Gear box.
5. Remove the Lower cover of the Gear box.
6. CHECK the Gears & the Bearing housings.



Annex D

Hoist winch overload relay installation and gearbox bearing housing exchange instructions and guidance

2007.09.10

NAKANO SEISAKUSHO CO., LTD.

NU,NNU & E Class Container Vessels for EVERGREEN and LT

Improvement Working Plan of The Accommodation Ladder

1. Working procedure for addition of the motor relay

!! Note: Working of additional the motor relay is sure to do by the expert knowledge with of electrical circuit.

See Appendix 1.

2. Working procedure for change of the bearing housing.

See Appendix 2.

Instruction Manual of Motor Relay

The starting lock time is factory-configured to a period of 2 seconds so that the motor relay can be instantaneously tripped at a rated current of 7.1A (100%) running in the 3.7 kW motor for a purpose of protecting the winch gear if you do not keep pushing the HOIST UP or HOIST DOWN pushbutton for more than 2 seconds. During normal operation, the limit switch operates and never be tripped. If the accommodation ladder is hoisted up when the limit switch is damaged and disabled, the motor relay will be instantaneously tripped. So press the RESET pushbutton to return the motor relay to a normal operating state.

See the Figure, "RESET Button," attached hereto.

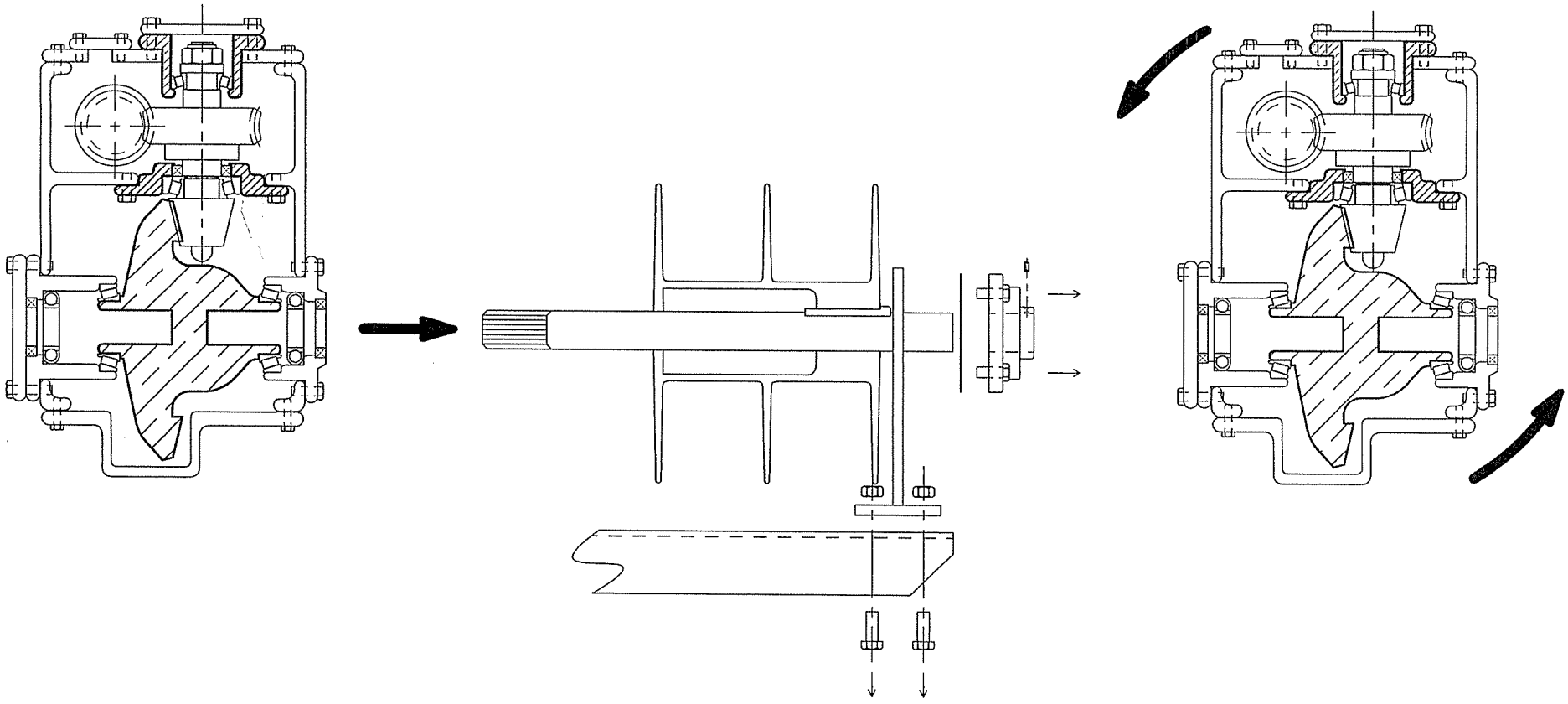
NOTES:

1. The starting lock time is factory-configured to a period of 2 seconds so that the motor relay cannot be tripped at a starting current during inching operation.
2. The motor relay is factory-configured to a rated current of 7.1A (100%) at which it can be tripped to prevent any extra load from being imposed on the winch gear and the like. Although the current adjusting knob has the adjusting range between 4A and 13A, do not make adjustments to the electric current settings.
3. If the motor relay is tripped during hoisting operation, check the operation indicator LED for input elements. Then check and eliminate any possible cause(s) after immediately switching off the power source of the man circuit. After the causes are eliminated, switch on the power source of the main circuit and then reset the tripped motor relay.
   Any possible causes rather than a failure in the limit switch are a failure in the motor, abnormality in the gear, engagement of wires, breakage of pillow bearings, and so on. Be sure to reset a failed device after troubleshooting is completed.

Be careful of dropping the ladder,when works on level condition.

Take to pieces

1. Extract the oil from the gear box.
2. Remove the motor from the gear box.
3. Remove the drum from the gear box.
4. Turn up the bottom of the gear box.



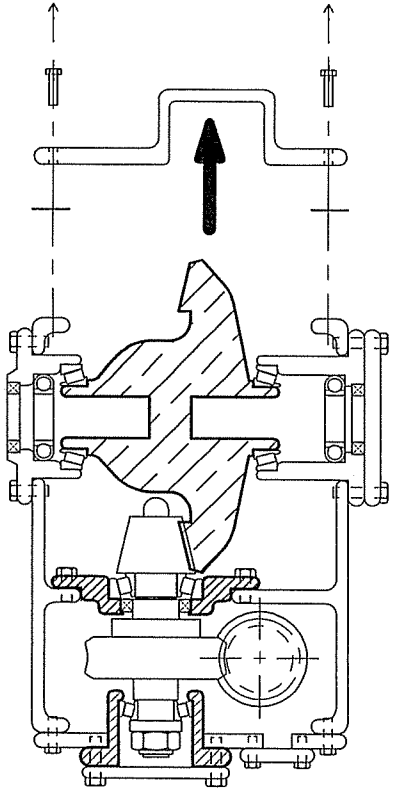
Appendix 2.

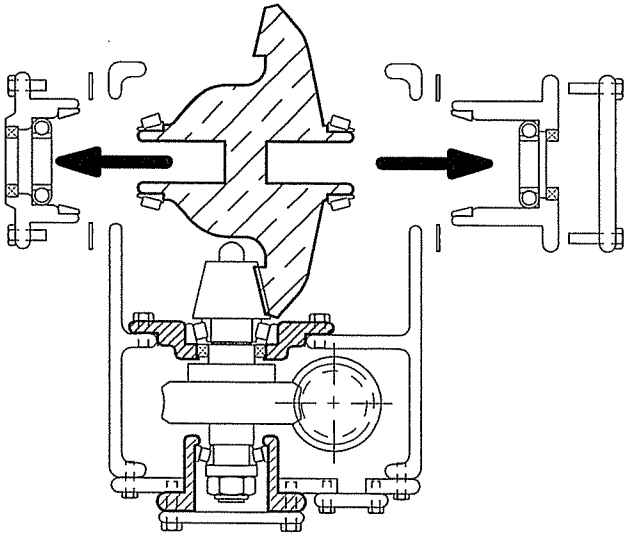
5. Remove the lower cover of the gear box.

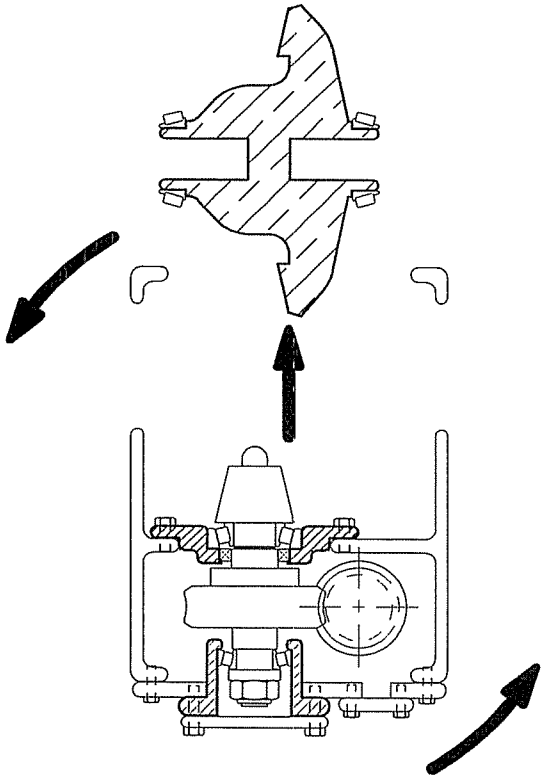
6. Remove the both side bearing housing for the drum.

7. Remove the Horizontal bevel gear unit.

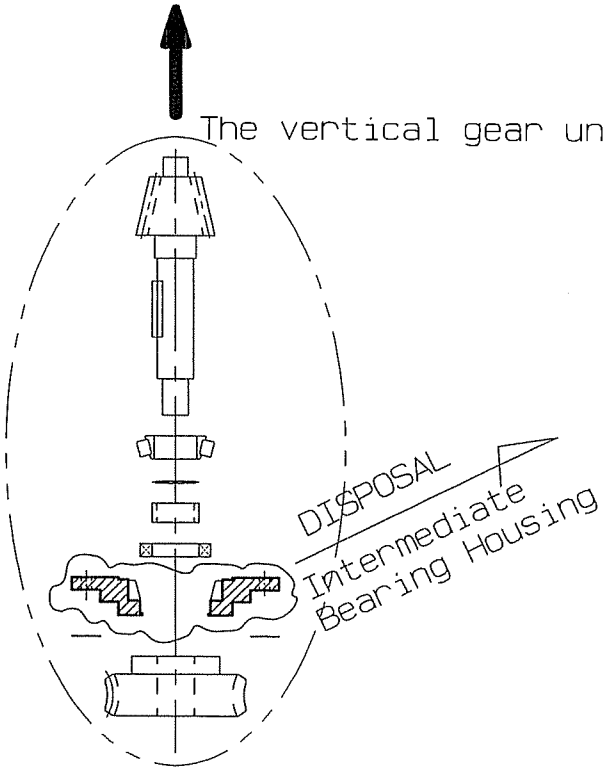
8. Turn up the top of The gear box.

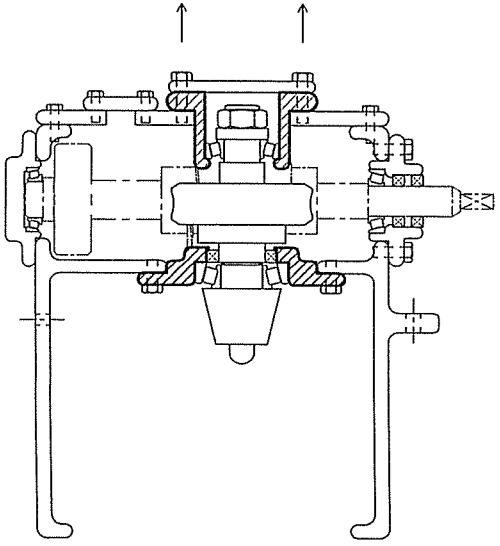


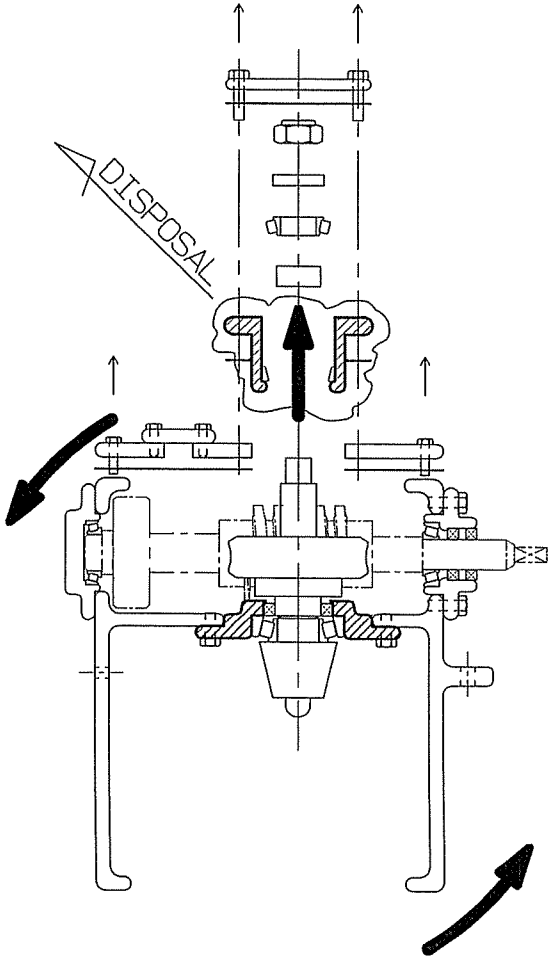


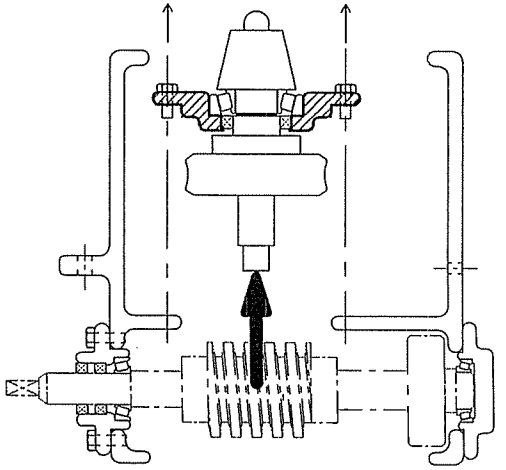


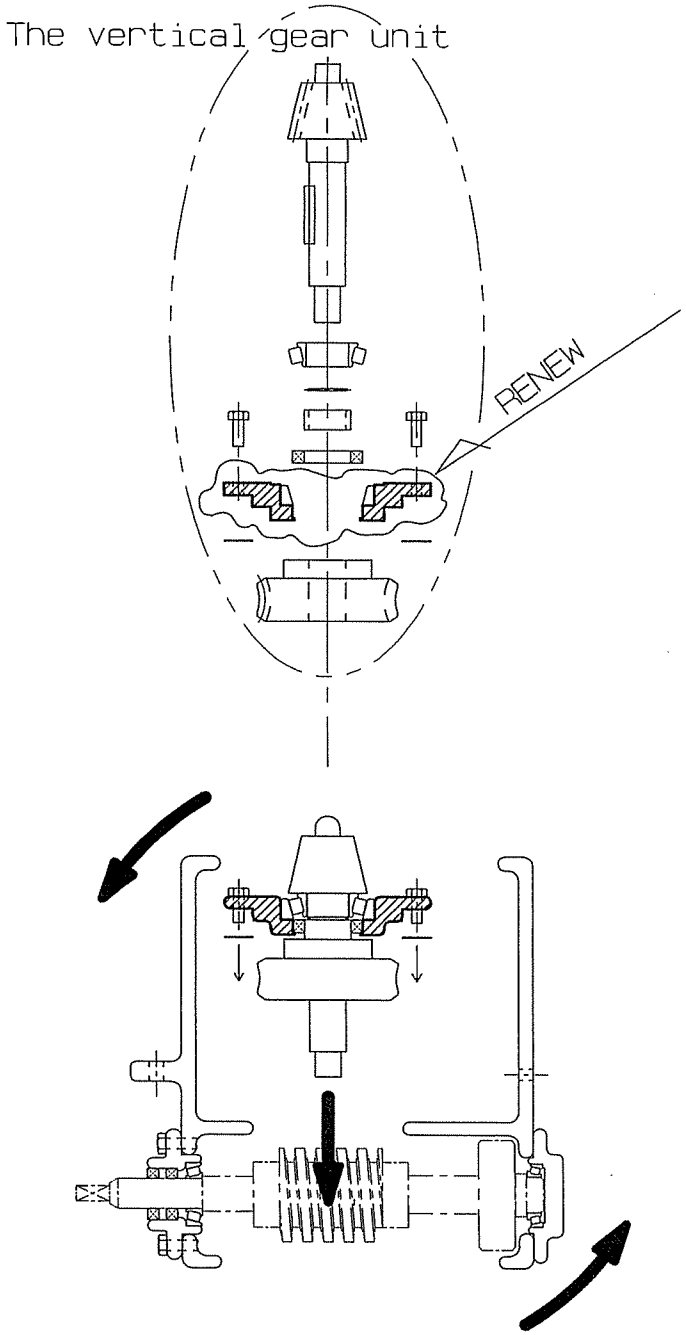
9. Remove the housing cover for the vertical bevel gear unit.
10. Remove the top bearing housing & disposal it.
11. Remove the upper cover.
12. Turn up the bottom of the gear box.
13. Remove the vertical bevel gear unit.
14. Remeve the intermediate bearing housing from gear unit.
15. Dispose the intermediate bearing housing.











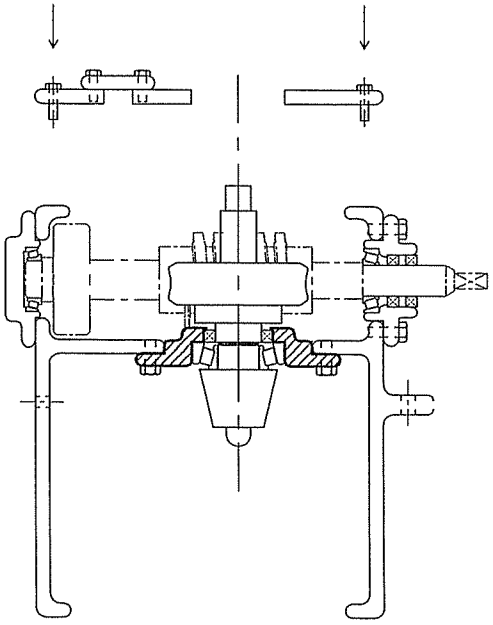
Reset

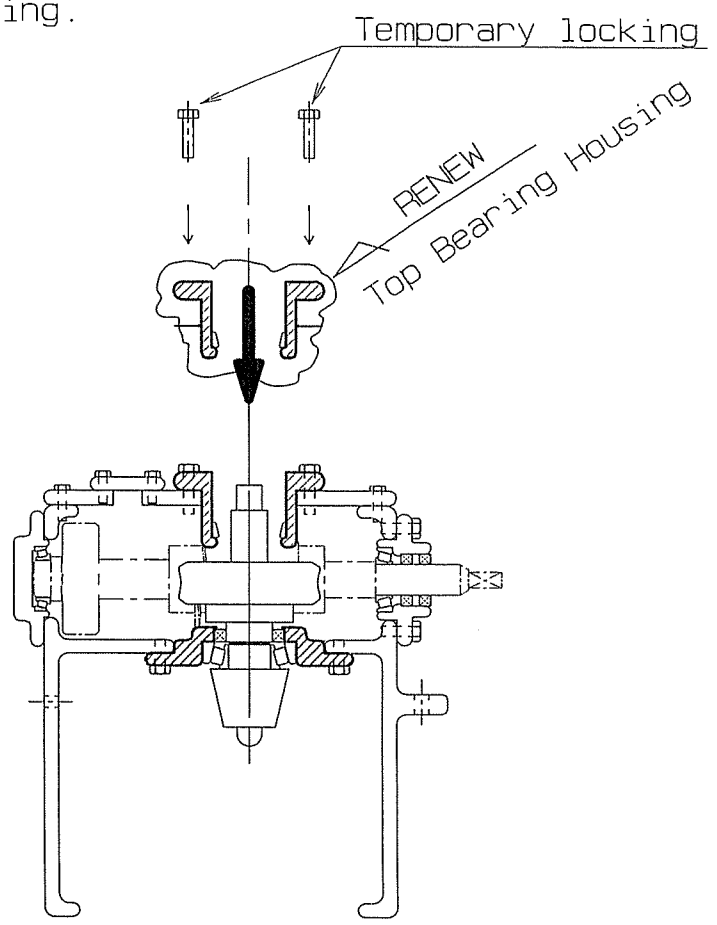
16. Set The vertical bevel gear unit
    with The new intermediate bearing housing.

17. Turn up the top of the gear box.

18. Set the upper cover.

19. Set up temporary locking
    the new top bearing housing.





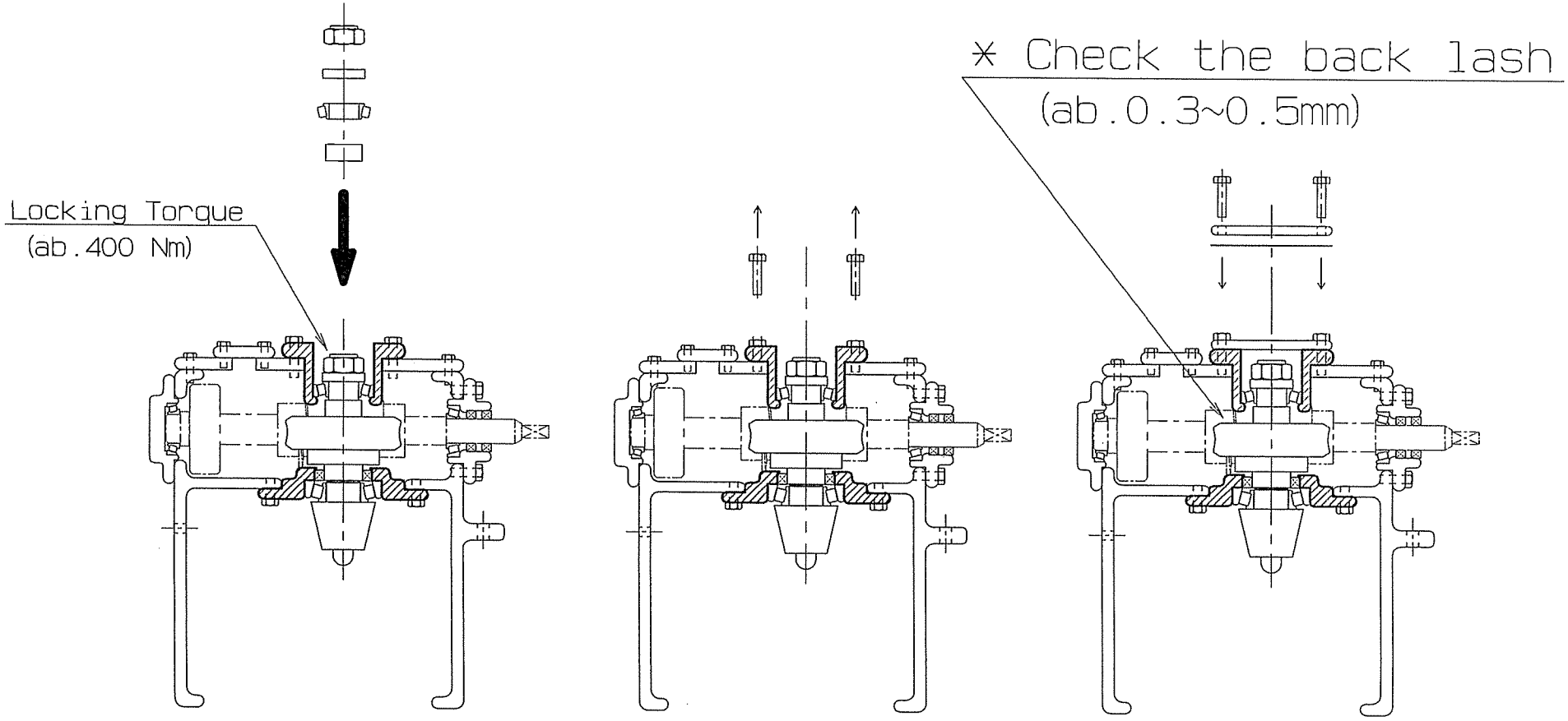
20. Set in oder the spacer, the roller bearing, the washer & the lock nut.

21. Locking torque of the nut (opposite side size of socket: 41mm) is about 400Nm.

22. Remove the bolt of temporary locking.

23. Set the top cover.

Note; In the case of large back lash,
adjust of slice the spacer.



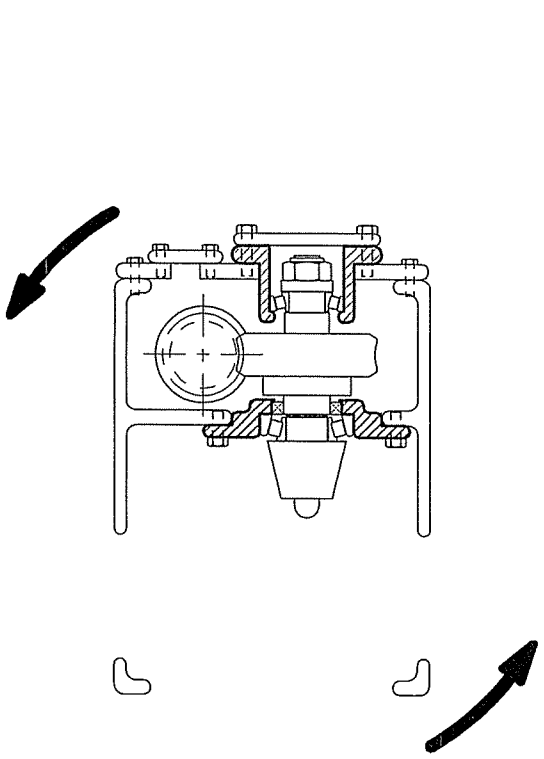
Appendix 2.

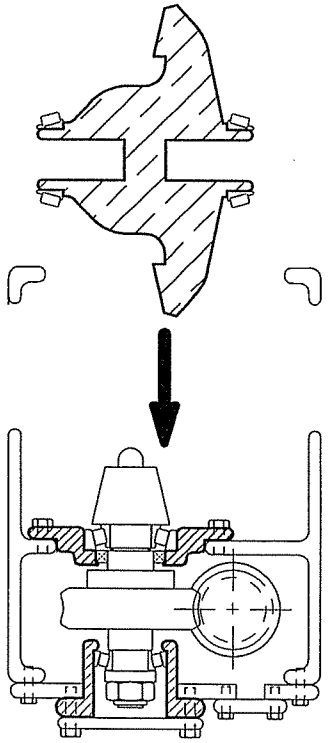
24. Turn up the bottom of the gear box.

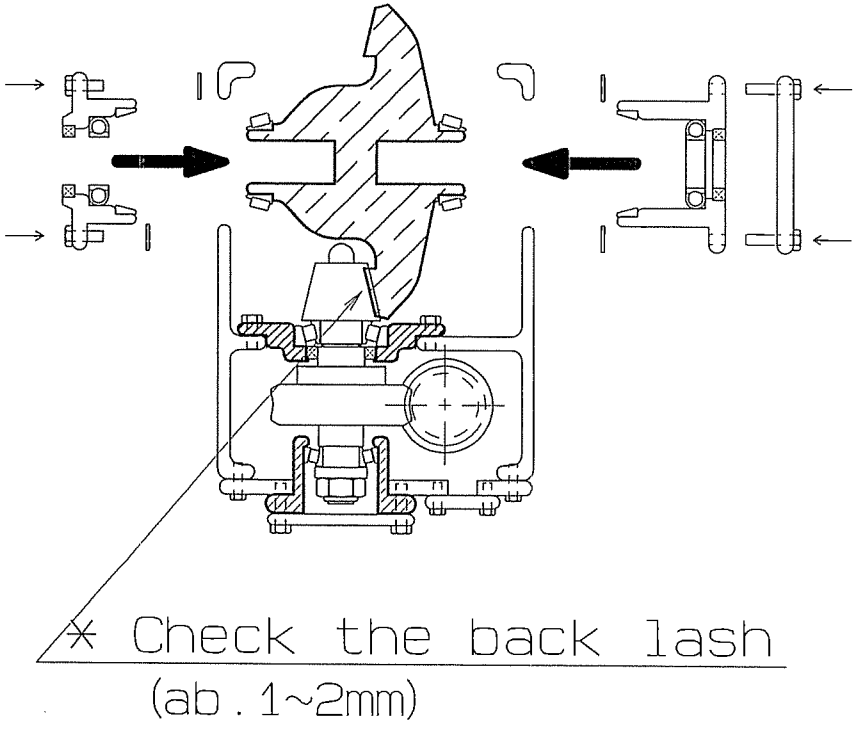
25. Set the horizontal bevel gear unit.

26. Set the both side bearing housing for the drum.

Note; As occasion demands, adjust of use the seat gasket.







27. Set the lower cover.

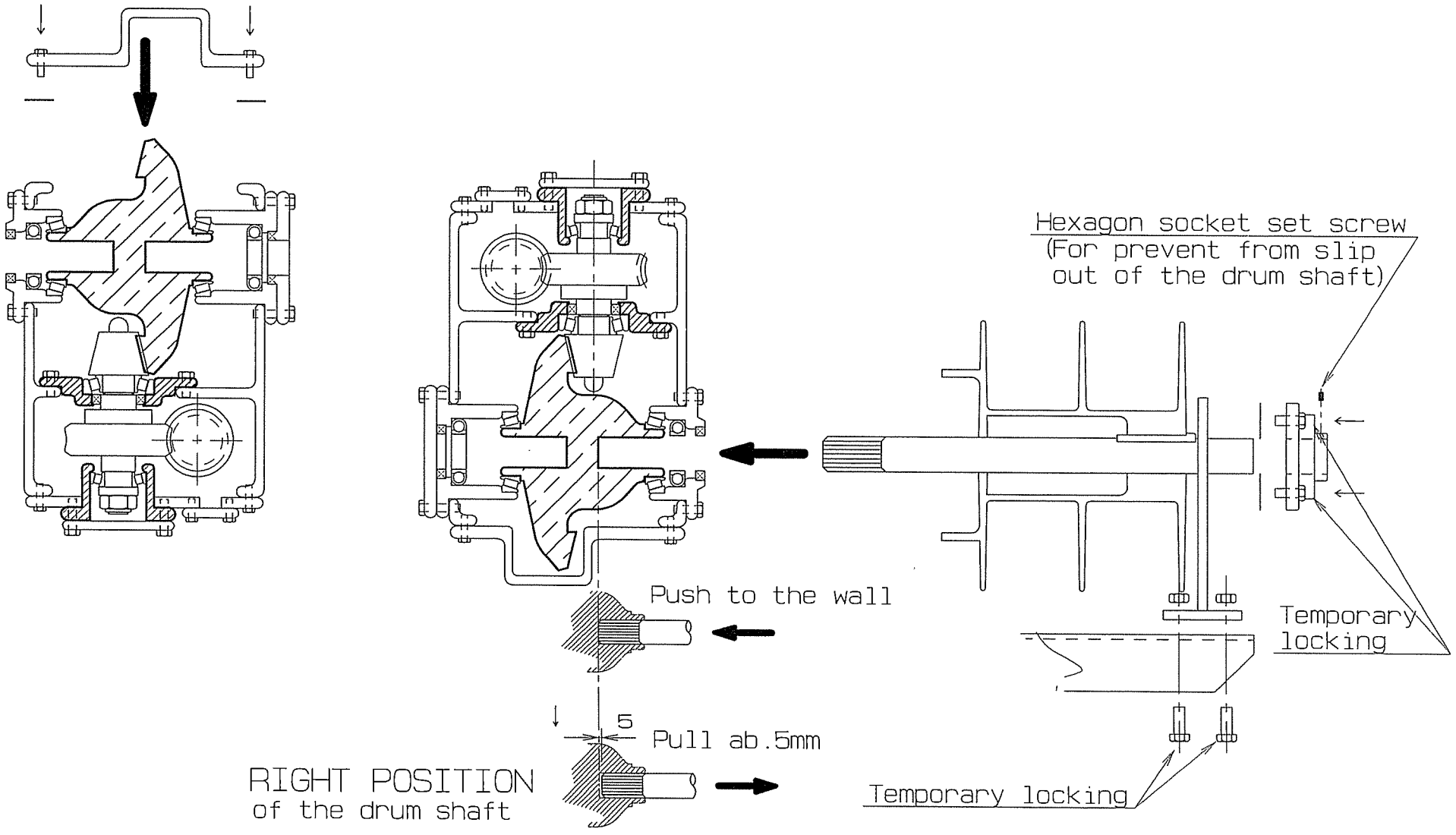
28. Set the gear box on the davit.

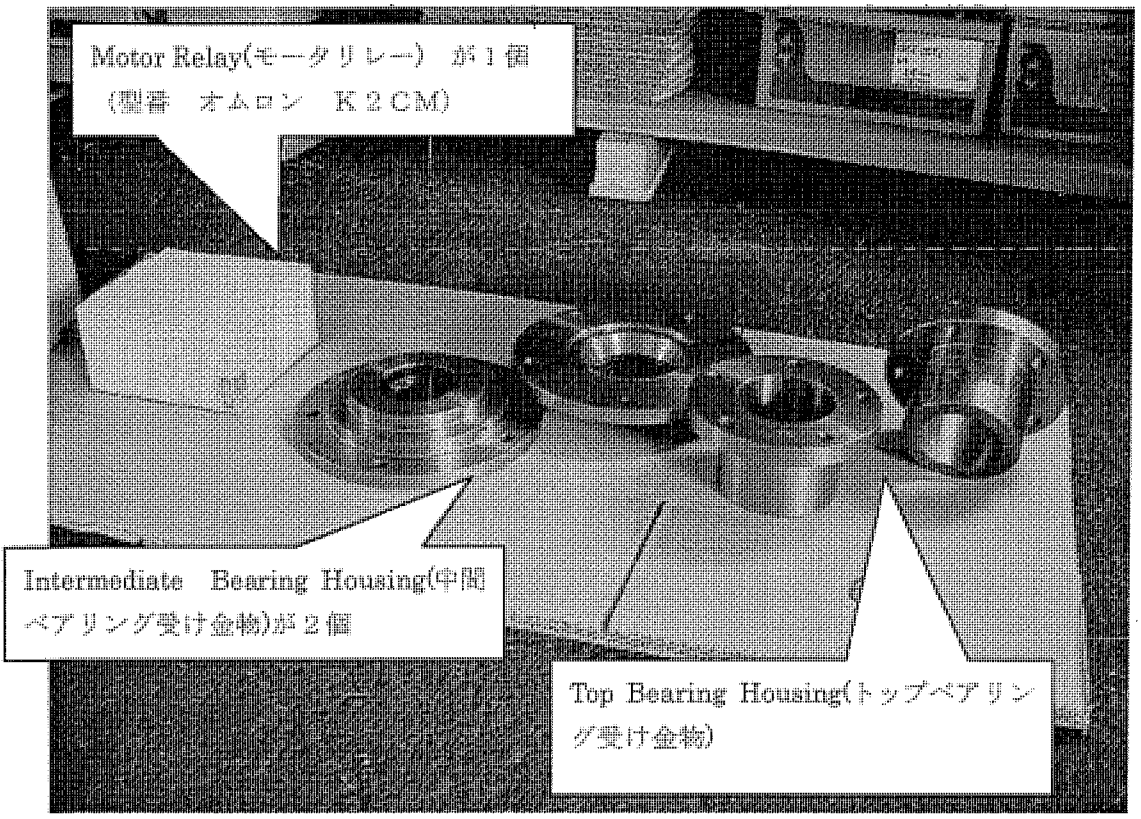
29. Set the drum & the pillow bearing.

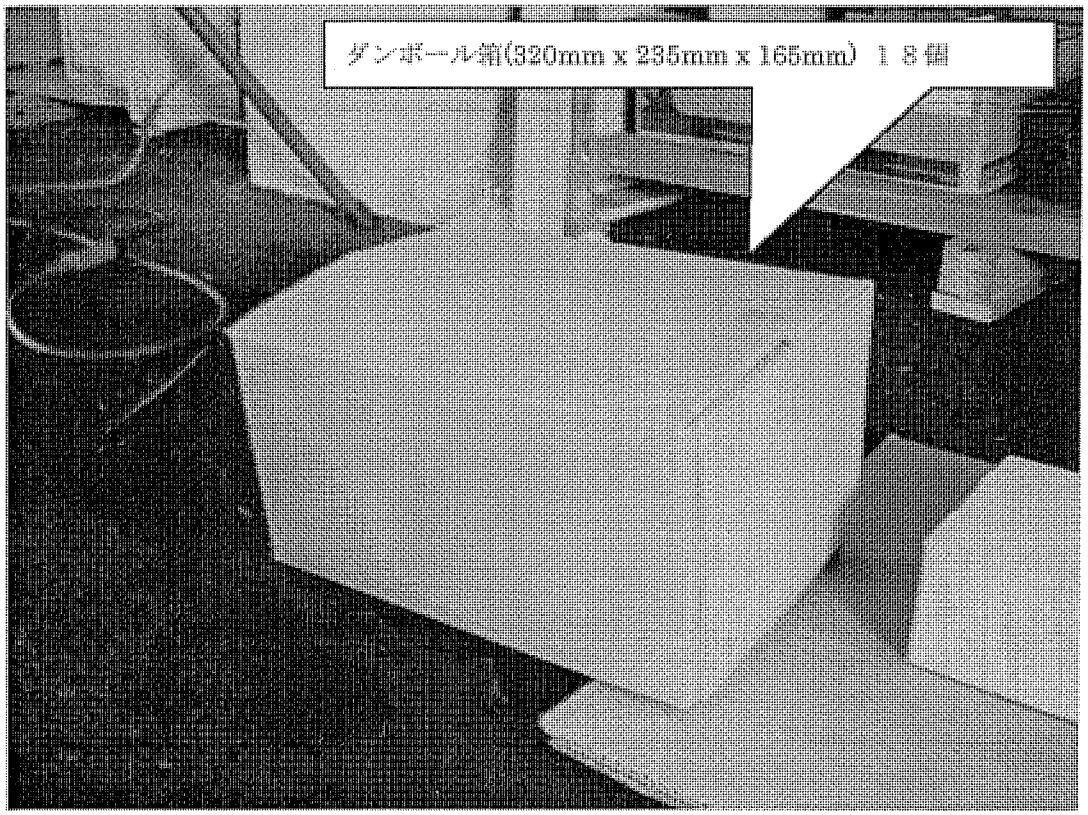
    Note; At first, adjust in and out the drum smoothly, for the next, adjust turn the drum smoothly by the bolts of the pillow block & the drum support fitting.

30. Set the motor.

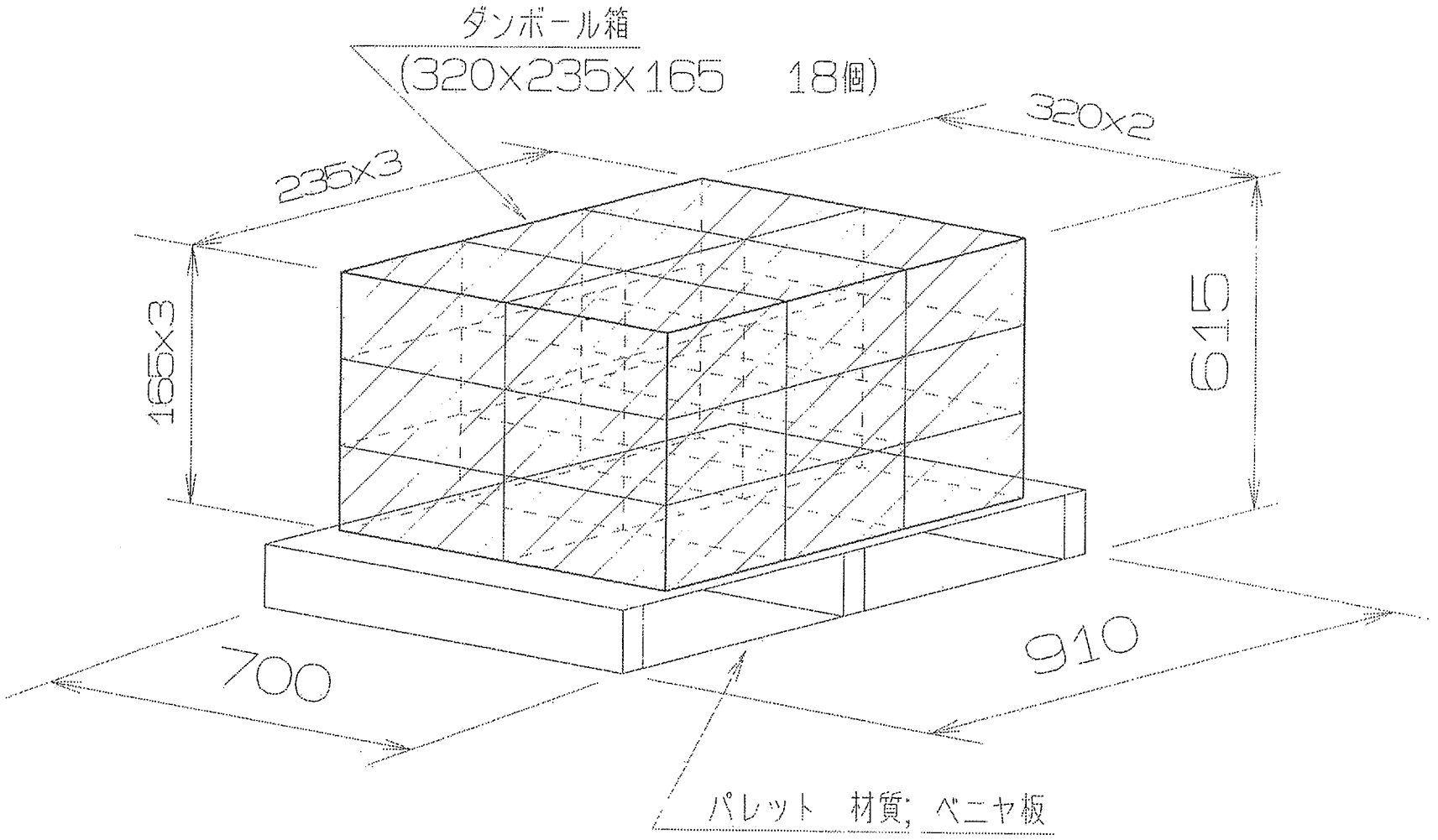
31. Last of all, fill up the gear oil of right quantity.



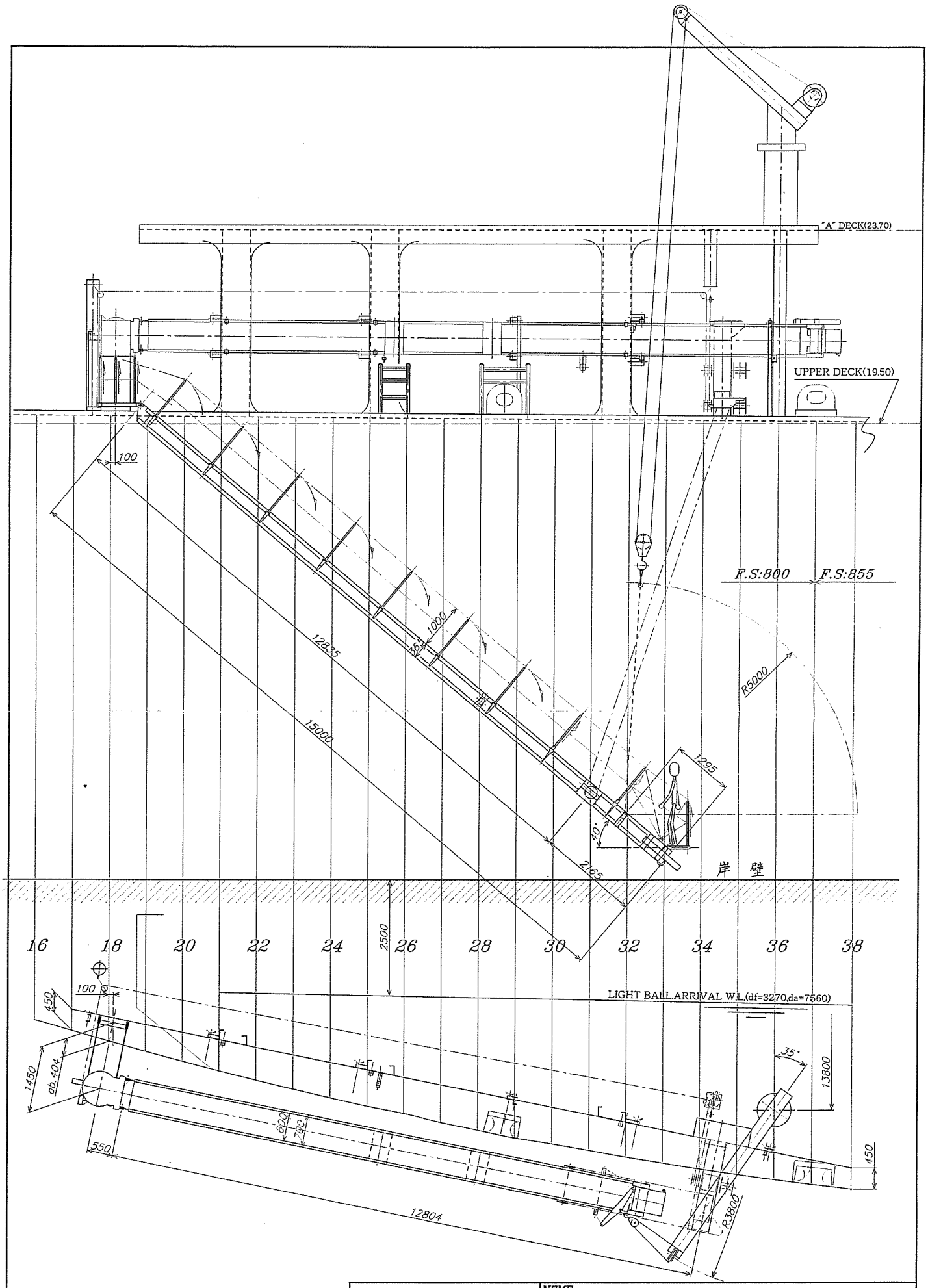

Motor Relay(モータリレー) が１個
（型番　オムロン　Ｋ２ＣＭ）
Intermediate Bearing Housing(中間ベアリング受け金物)が２個
Top Bearing Housing(トップベアリング受け金物)


ダンボール箱(320mm x 235mm x 165mm) １８個

荷　姿

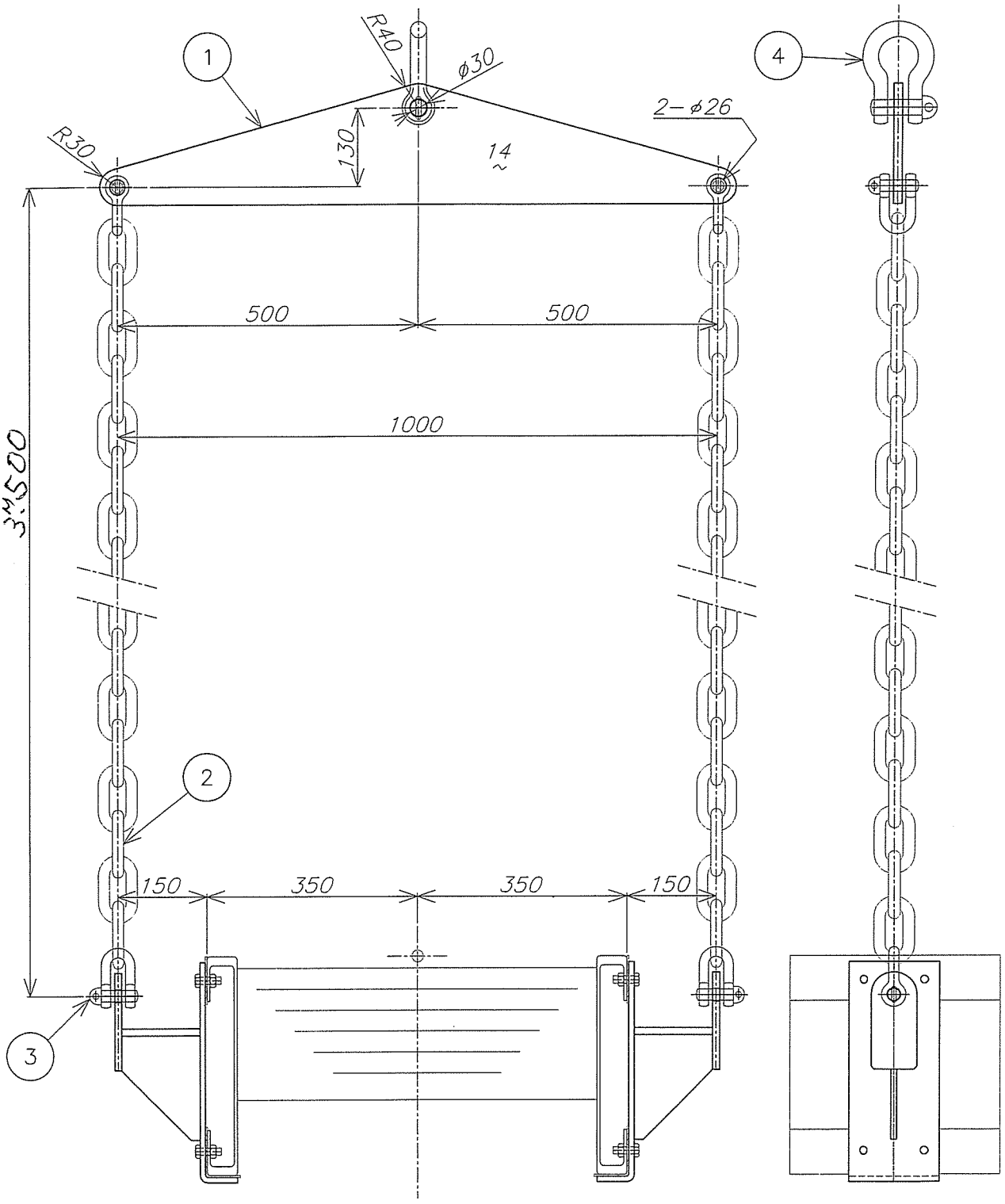


Nakano sub-wire arrangement



APPROVED		NEME.	ARRANGEMENT OF ACC'LADDER
CHECKED			
DRAWN	T. Kikugawa		
SCALE	1 / 75	DWG.No.	N A – 1 5 – 7 6 B C 0 0 – 1477
DATE	1st, May, 2008.		

Nitano Seisakusho CO.,LTD.



TOTAL WEIGHT 94.72Kg

ITEM No.	NAME OF PART	MATERIAL		Q'TY	WEIGHT	REMARKS
4	SHACKLE(B)	STEEL	SS400	1	2.98	BC−22 GALV.
3	SHACKLE(A)	STEEL	SS400	4	1.0/4.0	SC−16 GALV.
2	CHAIN	STEEL	SS400	2	36.5/73.0	φ19 GALV.
1	YOKE	STEEL	SS400	1	14.74	t14 GALV.

APPROVED

CHECKED

DRAWN T. Kikugawa

SCALE 1 / 10

DATE 2nd, May, 2008,

NEME.

YOKE (FOR SLING)

DWG.No.

NA − 365 − 085021

Nakano Seisakusho CO.,LTD.