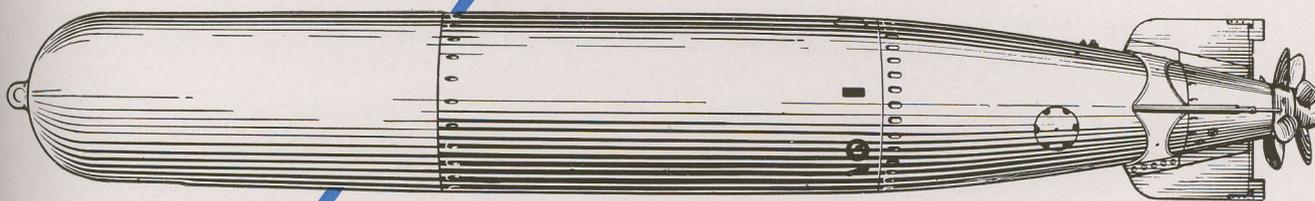


# ADJUSTMENTS AND TESTS



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# ADJUSTMENTS AND TESTS

*Preliminary adjustments include:* thorough check for leaks; check of control units to assure proper functioning; check of coincidence and reference marks, together with index dials and pointers, for alignment and accuracy. On completion of *preliminary adjustments*, torpedo is ready for *final adjustments* (P. 148). Preliminary adjustments are made with torpedo (minus head) on truck or chocks, located under chain hoist. *Equipment tools and supplies for use in making preliminary adjustments:* torpedo truck or chocks; short hoisting

strap; torpedo testing set with wing nut (general use test panels if available; 2 propeller locks; portable pressure gauge. Supply and ready tools also required are indicated by *number* in the text below at the point where each is used. Oils and greases necessary to these adjustments are indicated by *capital letters*; the key to these symbols will be found on page 155. In addition, a small quantity of cleaning solvent is needed for cleaning strainers. All the above material, except cleaning solvent, is listed in the torpedo allowance for vessels.

## PRELIMINARY ADJUSTMENTS

### Charge Air Flask

- 1: Place torpedo topside up on truck or chocks.
- 2: Put on propeller lock 417.
- 3: Remove water compartment filling plug (11).
- 4: Remove fuel filling plug (217, 74).
- 5: Remove charging valve plug (13-14).
- 6: Rotate starting index spindle to seat starting piston (227).
- 7: Open stop valve; close blow valve (49, 227).
- 8: Install charging line and safety strap.
- 9: Charge air flask to 1000 pounds pressure, close stop valve (227), bleed air from charging line and remove safety strap.

### Drain Air Flask

- 10: The air charge in the air flask usually carries some water in with it. This must be drained as follows: Disconnect air lead from blow valve to exercise head (long curved pipe) (24) and turn torpedo topside down so blow valve nipple is at lowest possible point. Open air blow valve (49); any water present in flask will be immediately blown out. The instant water ceases to flow, shut off blow valve and re-connect air pipe (24). Return torpedo to topside-up position.

### Oil and Grease

Following instructions cover Mark 13 Modification torpedoes. For Mark 13 torpedo, see O. P. 629(A) (Pp. 100-101.)

- 11: Fill oil tank with hot running torpedo oil (B), (13-14).

- 12: Remove after propeller and sleeve with bushings (183); wipe bushing and bearing surfaces clean with rags. Remove propeller shaft grease plug (184). With grease gun (462, 481A) fill until bearings will take no more, and replace grease plug (184). Assemble propeller and sleeve in place, lining up assembly marks on end of sleeve and shaft, and replace lock nut, turning it up tight (183).

- 13: Fill tail bearing with tail compound (G), (13-14, 481B).

- 14: Fill forward propeller hub with tail compound (G), (40, 481B).

- 15: Remove drain plugs in afterbody and tail and let drain (13-14).

- 16: Remove hand hole covers (200, 48).

- 17: Remove fuel and water air checks (12, 74, 405), clean, blow off with air, oil (A) and replace.

- 18: Remove fuel and water delivery checks (74, 406, 407), clean, blow off with air, oil (A) and replace.

- 19: Remove fuel and water strainers (372A, 405), wash out with cleaning sol-

vent, blow off with air. Be sure mesh is clean and replace.

### Check Speed Ring

- 20: Remove speed ring (12) and check thickness, making sure it agrees with record book. If correct, set up on speed screw and replace.

- 21: Turn torpedo bottom up; test atmospheric chamber for leaks with test fixture Dr. No. 173758 and tools 92, 11, 461, 48, 410, 409. Routine of test: install test connection with gauge in atmospheric chamber, connect test pump, pump to 15 lb. pressure and test for leaks. If chamber will not hold 15 lb. pressure for 5 minutes, renew diaphragm and repeat tests. When positive leakage is not present, remove test pump and connections and turn torpedo topside up.

- 22: Remove air strainer (12, 372A) and install adapter (191, 223).

- 23: With stop valve closed, install testing set (Dr. No. 79646) in charging valve (227) and connect with adapter (141A).

- 24: Check alignment of top surface of depth rudders with zero lines on tail cone, working rudders by hand.

- 25: With transportation screw in place, turn on 450 pounds air and note position of valve in relation to valve stop. Mid-graduation should line up with reference mark on valve stop; if it does not

line up, unclamp and adjust valve to that position (246A).

26: With transportation screw in place and air on, check neutral position of depth rudders. Should be one and one-half divisions down. If it is not, loosen clamp screw in rudder adjusting rod, remove connecting screw and turn rudder adjusting eye in desired direction. (One-half turn is minimum eye can be turned to line up with forked end of steering rod connection.) Reconnect and clamp adjustment (13-14).

27: Set depth index to 10 feet (135A).

28: Put on hoisting strap and hoist torpedo clear of truck or chocks.

29: With access plug removed from base of air chamber, install screw hook and weight (411B—16 lb. weight for Mark 13 Modification torpedoes except for Mark 13-1 from register number 14543 through register number 14614; on these use 411A—10 lb. weight).

30: Remove transportation pin (49).

31: With spirit level on top center of air flask directly parallel with torpedo axis, level torpedo.

32: Open stop valve (227). Be sure 450 lb. pressure is maintained.

33: With torpedo level, mid-graduation on depth engine valve connecting rod should center on reference mark on valve stop. Raise or lower tension of depth setting spindle to center valve (135A) and obtain neutral throw of rudders. Move pendulum back and forth and make sure valve comes to rest on mid-graduation.

34: If depth index fails to read 10 ft. when valve is centered, disengage side gear spindle from socket (472A), set depth index dial on 10 ft. (135A) and re-engage spindle with socket. Verify adjustments and remove weight and screw hook (411B or 411A).

35: Replace access plug and washer in atmospheric chamber (11).

36: Set depth index on zero (135A). With air on in depth engine give torpedo tilting test; pendulum should start to move with no more than  $\frac{1}{2}$  degree tilt up or down;  $2\frac{1}{2}$  degrees of tilt should cause full travel of pendulum. Use bevel protractor.

37: Make sure full throw of rudders is obtained by moving pendulum against stops. (Full throw is 1 division up, 4 down.)

38: Where locking device is used, check to see that locking fork is clear of and does not interfere with valve lever when device is unlocked. (The height of the locking fork should be adjusted on locking slide so there is no interference between arms of fork and pin on upper end of valve lever when it is moved to extreme forward or aft position. This adjustment is made by loosening clamp screw and moving slide in either direction.

39: Replace transportation pin.

## Check Vertical Rudder Adjustment

40: Adjust vertical rudder throws as follows: Move propellers by hand until pallet is in position farthest from pallet cam; with air on in engine, move valve in either direction by hand, recording vertical rudder throw with vernier scale (44). Vertical rudder throws should not vary over one unit on either side when properly adjusted, and should average 33 for upper and 24 for lower rudder in Mark 13 Modification torpedoes.

41: Lower torpedo back on truck or chocks.

42: Close stop valve (227).

43: Disconnect and remove test set and adapter (141A, 191).

44: Wash air strainer with gasoline or alcohol, blow off with air and replace (372A) with plug and washer (12).

45: Replace charging valve plug and washer (13-14).

## Test Gyro Mechanism

46: Replace water compartment filling plug (11).

47: Turn torpedo bottom up.

48: Remove gyro clamp plate cover and gasket (13-14).

49: Remove gyro bottom head (246A).

50: Make sure gyro top plate is properly centered on reference pointer and wipe inside of gyro pot dry with cloth.

51: Turn propellers by hand to move pallet and cam pawls to extreme after position, away from cam.

52: Inspect and oil (A) gyro top bearing.

53: Lock and unlock spinning mechanism by hand (205A) and make sure it operates freely.

54: Inspect and install gyro.

55: Inspect and oil (A) gyro bottom head bearings; install gyro bottom head with zero marks to coincide (246).

56: Replace drain plugs with washers in afterbody and tail (13-14).

57: Turn torpedo topside up.

58: Lock and unlock gyro by hand (205A), making sure centering pin releases freely and without kick. Check outer gimbal clearances by hand; clearance should be between 0.0025" and 0.005". **IMPORTANT:** Torpedo *must* be turned topside up for step 58, as the gyro must pivot on its bottom bearing (the normal position of gyro for release) during this centering pin check.

59: Lock gyro (205A), turn torpedo bottom up and install gyro clamp plate cover (13-14); turn torpedo topside up.

60: Place gyro engine valve in approximate mid-position by hand; turn propellers by hand. If gyro engine valve moves, top plate is not correctly centered and condition should be reported to Torpedo Officer.

## Test Depth Engine and Vertical Steering Engine with Air

61: Install dummy igniter (391) and connect pipe (438).

62: Put on two propeller locks (417).

63: Replace transportation pin with replacement screw (49).

64: Install starting gear toggle and test lift required to trip it with a spring scale; toggle should release at between 15 and 20 lb. Test action of starting gear and hoist torpedo clear of truck or chocks.

65: Have tool 227 on starting gear spindle ready for use.

66: Trip starting spindle arm.

67: Open stop valve smartly, causing gyro to spin (227).

68: Close stop valve (227).

69: Remove propeller locks (417). Open stop valve slowly (227) and build up speed of main engine to point necessary for proper operation of pallet mechanism.

70: Keep tool 227 on starting gear index spindle for emergency use.

71: Swing torpedo in horizontal and vertical planes, noting movement of horizontal and vertical rudders. Vertical rudder throw to both sides should be snappy.

72: Rotate starting gear index spindle (227) to left to cut off air.

73: Close stop valve (227).

74: Replace propeller locks (417).

75: Remove replacement screw and install transportation screw (49).

76: Disconnect dummy igniter pipe (438).

77: Trip starting spindle arm.

78: Crack stop valve by hand and see if air comes through igniter lead. Close stop valve (227). (This is to make certain igniter lead has not been crushed when afterbody was assembled to air flask.)

79: Rotate starting gear spindle (227) to seat starting piston.

80: Lower torpedo to truck or chocks and turn it bottom up.

81: Permit gyro to run down by itself.

82: Remove gyro clamp plate cover (13-14).

83: Remove gyro bottom head (246A).

84: Remove gyro, clean and return to gyro case.

85: Replace gyro bottom head (246A) and gyro clamp plate cover, with washer (13-14).

86: Turn torpedo topside up.

87: Remove water compartment filling plug (11), replace fuel filling plug (217, 74), and replace water compartment filling plug (11).

88: Loosen speed screw to take compression off reducing valve spring (12).

89: Replace hand hole plates (48), completing preliminary adjustments and tests.

# FINAL ADJUSTMENTS

## MARK 13 AND MODIFICATION TORPEDOES

### Stop Valve

1: Ascertain that stop valve is closed (227A).

### Oil and Grease

2: Remove grease packing screw from end of inner propeller shaft (184). With grease gun (462,481A) fill bearings with tail packing compound (G) until compound begins oozing out around propeller shaft grease ring (approximately 5 oz.). Replace grease packing screw (184).

3: Fill tail bearing with tail packing compound (G) (13-14,481B).

4: Fill forward propeller grease cavity with tail packing compound (G) (40, 481B).

5: Fill oil tank (13, 14) with hot running torpedo oil (B). Turn propellers by hand and note if oil pump draws oil from tank.

6: Put on propeller locks, both wire and standard (417).

### Check Starting Mechanism

7: Rotate starting gear index spindle (227A), lining it up on scribe mark. (A distinct click should be heard).

8: Make sure unlocking cam clears unlocking lever, and that starting valve is closed. Install starting gear toggle with pins and cotter pins (72).

NOTE: Starting spindle must be left in down position (flush with starting gear body) and starting toggle inserted by removing pin from bracket at forward end of starting gear body. When replaced, pin should be secured by cotter pin (72).

9: Install starting gear toggle lock as follows: place leg of lock in space between toggle and spindle arm, inserting locking pin through the holes in toggle lock and lanyard hole in toggle. Secure locking pin with two cotter pins (72).

NOTE: A small block of wood, approximately one inch square and painted red, should be attached to the eye on one of the cotter pins in locking pin with a piece of wire, as a warning that starting toggle lock is attached.

10: Check speed ring to make sure that size is as given in the record book. Replace and set up on speed screw (12).

11: Oil reducing valve with hot running torpedo oil (B) (13-14, 94).

### Charge Air Flask

12: Remove water compartment filling plug (11).

13: Remove fuel filling plug (217, 74).

14: Remove charging valve plug (13,

14) and make sure that leather washer is in place.

15: Install safety strap on wing nut.

16: Install charging lead and safety strap. Open stop valve (227A) and charge to 1500 pounds. Bleed and disconnect charging line (13, 14).

17: Rotate torpedo until nipple from air flask to blow valve is on the bottom. Tip forward end of air flask down, open blow valve (49), drain flask of water, and close blow valve.

### Attach Exercise Head

18: Disconnect and remove air releasing mechanism (48, 141A).

19: Hoist exercise head into line with forward joint of air flask, and connect pipe from air flask blow valve to nipple on exercise head bulkhead (141A).

20: Blank off lead to air release mechanism in head. Crack air flask blow valve and test pipes and connections for leaks. See that no air escapes from relief valve in buoyancy compartment due to leak in piping. Close blow valve and remove blank.

21: Join exercise head to air flask and secure with holding screws (49).

NOTE: Care should be exercised not to distort the pipe from air flask blow valve to head during this step.

22: Work discharge valve by hand. See that valve seats properly and that spring is not broken.

23: Fill forward compartment of exercise head with fresh water.

24: Calibrate air release mechanism to prescribed pressure.

25: Crack air release mechanism blow valve (49) and blow through piping. (See that there is no restriction in pipes).

26: Attach air release mechanism to air line in head (141A).

27: Open air flask blow valve (49) and see that blow valve is seated on its outboard seat.

NOTE: The Mark 26 exercise head uses Mark 2 air releasing mechanism which must be cocked by hand (441). Apply no side force when lifting the cocking tool as this may bind the valve stem. This might result in failure of the exercise head to blow and consequent loss of the torpedo.

28: Test air release mechanism and connection under water for leaks. If no leaks are found around stem, put on air release protection cap. See that washer is in place and vent hole in cap is clear.

29: Check forward bulkhead for tightness by observing if bubbles are present around bulkhead or piping.

30: With air release mechanism cocked, secure with leather gasket and cover plate (48). (See that gasket is evenly in place).

31: Install torch pot in torch case, using leather gasket (48). Secure cover evenly in place.

32: Inspect air relief valve washer and make sure it is in good condition and even on its seat.

NOTE: In preparing the exercise head for firing, *be sure* the leather gaskets under air release mechanism and torch case are tight. If they are not, the head may not blow or the air buoyancy chamber may be flooded and the torpedo will be lost.

### If Using Torpedo Headlight

33: Remove small square of fibre between contact points on switch.

34: Test switch mechanism by striking side of headlight marked "aft" with hand, to see if lamp lights.

35: Reset switch to "off" position by pushing switch lever with finger, through elongated slot in headlight body.

36: Install headlight in forward flange of exercise head, using gasket shellacked evenly in place.

CAUTION: Headlight must be installed with side marked "aft" toward the after side of the head. Otherwise, inertia weight will not close switch and headlight will not light.

### Finish Charging Air Flask

37: Reconnect charging line (227A) and charge torpedo to 2800 lbs.

38: Close stop valve (227A), and bleed charging line of air at pressure. Remove charging line and safety strap and replace charging valve plug (13-14).

39: Open stop valve one-half turn (227).

### Prepare Check Valves

40: Remove (12, 406) and clean (372A) fuel, water and air strainers.

41: Test by hand the action of fuel and water delivery and air check valves, and replace plugs (405, 74).

42: If check valves are sluggish in seating or opening, remove (405), clean, oil lightly (A) and replace.

### Fill Fuel and Water Compartments

43: Fill fuel compartment and replace fuel filling plug (217, 74).

44: Fill water compartment and replace water compartment filling plug (11).

## Drain Combustion Flask

- 45: Remove dummy igniter (391A).
- 46: Turn torpedo 180 degrees (one-half turn) to port, and drain combustion flask.

NOTE: Keep igniter lead clear of combustion pot while turning torpedo, to prevent liquid entering igniter lead.

## Install Gyro

- 47: Remove gyro clamp plate cover (13-14).
- 48: Remove gyro bottom head (246A).
- 49: Oil top bearing, using gyro syringe and gyro oil (A).
- 50: Install gyro. If necessary, remove propeller lock and turn propellers by hand until cam pawl is in extreme after position so gyro can be installed (13-14). Oil (A) and replace bottom head with assembly marks (246A), lock (205A) and trip by hand. Check freeness and movements of gyro, and also clearance. Lock finally, and see that finger trip is flush against pot wall; if not, gyro is not fully locked, so release again, turn spinning gear one and one half turns and again lock. The gyro should now be fully locked as shown by the finger trip being against pot well.

NOTE: It is good practice to revolve gyro assembly on its upper bearing when

installing bottom head, thus making certain that balls and bottom bearing are lined up.

- 51: Replace gyro clamp plate cover (13-14) with gasket.

## Check Afterbody Fittings

- 52: Check joint screws in afterbody and tail (49, 386).
- 53: Check lock nut for after propeller sleeve (183A).
- 54: Check holding screws for tail rails Mark 13 torpedo. Check holding screws for spider straps to tail blades Mk. 13 (new tail) and Mk. 13-1 torpedo.
- 55: Check drain plugs (13-14) in afterbody and tail. See that washers are in place.
- 56: See that gaskets are in good condition and in place, and replace hand hole plates (48).
- 57: Turn torpedo upright.

## Prepare Depth Mechanism

- 58: Set depth index to required depth (135A).
- 59: Remove transportation pin and install replacement screw, making sure washer is in place (49, 227A).

- 60: Open stop valve wide.

NOTE: Step 60 applies only to planes where stop valve is not accessible with torpedo in position on plane. For all other types of plane see step 64.

## Attach Torpedo to Launching Gear on Plane

- 61: Hoist torpedo to rack making sure torpedo is properly positioned in rack and that rack is properly cocked.
- 62: Lock the rack, or provide safety strap so torpedo cannot be accidentally released. (On PBVs a safety strap is used. On TBDs a safety pin is used to lock the rack.)
- 63: Install igniter (391A).
- 64: Open stop valve wide (227A) (if not done as Step 60).
- 65: Connect igniter lead (438).
- 66: Check tripping lanyard and remove starting toggle lock, locking pin and painted block (92).
- 67: Remove standard propeller lock (417).
- 68: Recheck check-off list carefully, to make sure no step has been omitted.
- 69: At the last practical moment, remove safety strap or safety pin.

# P R E P A R A T I O N   F O R   A   W A R   S H O T

(IN ADDITION TO PRELIMINARY AND FINAL ADJUSTMENTS)

- 1: Place torpedo upright on truck or chocks.

## Install Warhead

- 2: Remove air pipe from air flask blow valve (141A).
- 3: Remove steel protecting ring (49).
- 4: Clean joint ring and coat with heavy oil (D).
- 5: Attach warhead to air flask with 26 joint screws (49).
- 6: Turn torpedo bottom up.

- 7: Remove exploder mechanism base plate (49).
- 8: Thoroughly clean and dry exploder mechanism casing.

## Install Mark 2 Tetryl Booster

- 9: Remove booster from container and replace container in stowage space.
- 10: Install booster in casing with recess or pocket for detonator facing out.
- 11: See that booster is a loose fit in

casing, so it will drop down to rest on the safety chamber when torpedo is turned upright.

## Install Exploder Mechanism on Base Plate

- 12: Remove Mark 4-1 exploder mechanism, shaft, and push rod from container, and replace container in stowage space.
- 13: Install spring clip (MF11) on spring and push rod compressing spring.
- 14: Place push rod, *shoulder end down*, in position in diaphragm lever arm.
- 15: Unclip upper worm and gear from drive shaft, place arrow on lower gear inboard (toward worm), place upper worm and gear in mesh with gear on transverse shaft and pinion, and push drive shaft up into its bearing. See that shaft, upper worm and gear snap together.
- 16: Remove three holding screws with lock washers from base plate (49).
- 17: Set exploder mechanism in place on base plate, seeing that arrow on lower

gear on driving shaft is toward worm, and that push rod extends through its guide.

- 18: Secure exploder mechanism to base plate with three holding screws and lock washers (49, 64).
- 19: Remove spring clip (MF11) from spring.

NOTE: With anticountermining device disengaged, there should be from .003" to .005" clearance between push rod and anticountermining device bell crank.

## Test Exploder Mechanism

- 20: Remove set screw and idler gear (40).
- 21: Turn arming gear until exploder mechanism is armed.
- 22: Make sure that clamp (MF9) is in place on guide posts.
- 23: With push balance (98) test pressure against firing ring required to fire the mechanism. (Should be from 3½ to 5½ pounds.)
- 24: Cock and unarm exploder mecha-

nism by turning arming gear until arming screw is flush with it, and scribe marks are lined up.

25: Replace idler gear and set screw (40).

26: Remove six screws (40) and detach impeller guard.

27: With feather gauge (MF7) test pressure required to just start the impeller. (Should be from 12 to 20 ounces.)

28: Replace impeller guard and secure with six screws (40).

29: Remove clamp (MF9) from guide posts.

### Install Mark 7 Detonator

30: Remove detonator and safety cham-

ber from container, and replace container in stowage space.

31: See that detonator moves freely in safety chamber. Screw out one turn and oil with drop of gyro oil (A). Screw back in and line up scribe marks.

32: Install safety chamber and carrier on mechanism with 4 screws (40).

### Install Mechanism and Base Plate in Warhead

33: Install good rubber gasket on seat for base plate.

34: Grease (E) impeller shaft (MF1).

35: Using lifting tools, insert base plate and mechanism in head.

36: Secure base plate with holding screws (49).

### Leakage Test

37: Remove plug in base plate (39) and install adapter, set to open at 5 pounds.

38: Pump 5 pounds of air into exploder casing (MF15) and inspect for leaks around base plate, impeller shaft, and diaphragm plate. (Use soapy water.)

39: Remove test set and replace plug and washer (39).

40: Turn torpedo upright.

41: Load torpedo on plane in accordance with final adjustments.

## ROUTINE FOR UPKEEP OF FULLY READY TORPEDO

### DAILY

#### (A) If Attached to Plane

1: Secure toggle lock to toggle and starting spindle arm (92).

2: Lower torpedo to truck or chocks.

3: Gauge and boost air flasks as necessary.

4: Check oil level in oil tank (13).

5: Attach torpedo to plane.

#### (B) Reload Torpedoes

1: Gauge and boost as necessary.

2: Check oil level in oil tank (13).

### WEEKLY

#### (A) If Attached to Plane

1: Secure toggle lock to toggle and starting spindle arm (92).

2: Lower torpedo to truck or chocks.

3: Turn propellers 50 turns, refill oil tank.

4: Repack propeller shafts and sleeves with grease (G). (462, 481A).

5: Operate depth mechanism from 0 to 50 and reset to required setting (135A).

6: Attach torpedo to plane.

#### (B) Reload Torpedoes

1: Turn propellers 50 turns, refill oil tank.

2: Repack propeller shafts and sleeves with grease (A) (462, 481A).

3: Operate depth mechanism from 0 to 50, and leave tension off depth spring (135A).

### MONTHLY

1: Secure toggle lock to toggle and starting spindle arm (92).

2: Lower torpedo on truck or chocks.

3: Close stop valve (14).

4: Disconnect (141A, 391A) and remove igniter. Note condition of end seal. Replace in container and put in stowage space.

5: Remove afterbody drain plug and one tail cone drain plug (13).

6: Turn torpedo bottom up, draining combustion flask on way over.

7: Remove exploder mechanism, detonator, and booster:

(a) Remove base plate holding screws (49).

(b) Remove safety chamber and detonator from exploder mechanism (40), replace in container, seal tightly and replace in stowage space.

(c) Remove booster from warhead, replace in container and replace in stowage space.

(d) Place base plate and exploder mechanism in safe stowage space.

8: Turn torpedo upright.

9: Remove check valve plugs, operate and oil (C) check valves, and replace plugs (405, 74, 12).

10: Remove strainer plugs, remove and clean air, fuel, and water strainers and

replace. Replace strainer plugs (405, 372A).

11: Check action of starting gear:

(a) Remove toggle lock from toggle and starting spindle arm (92).

(b) Trip starting spindle arm.

(c) Rotate starting gear index spindle through several complete revolutions (227A).

(d) Replace toggle lock to toggle on starting spindle arm (92).

12: Operate depth setting mechanism from 0 to 50 and return to required setting.

13: Remove either hand hole plate (48) and swing pendulum back and forth a few times by hand.

14: Work horizontal rudders up and down a few times by hand, using one hand on each rudder and with the same amount of force on each.

15: Work vertical rudders by hand, using same method as Step 14.

16: Remove propeller lock (417) and turn propellers by hand at least 50 turns. Listen for any unusual sound. Check action of pallet and slide to see that pallet does not engage pallet pawls with gyro locked.

17: While propellers are being turned over, move vertical steering engine control valve by hand. See that pallet blade does not strike pallet pawls.

18: Replace propeller lock (417).

19: Lubricate torpedo:

(a) Fill oil tank.

(b) Fill tail bearing with tail packing compound (G) (462, 481A).

(c) Fill forward propeller grease cavity (G) (462, 481B).

20: Crack stop valve (13-14).

21: Turn torpedo bottom up, draining combustion flask of water.

22: Inspect gyro and gyro mechanism:

(a) Remove gyro cover plate, unlock gyro by hand and remove bottom head (246A, 13-14).

(b) Remove and inspect gyro, noting that balance nut is tight. Apply two (2) drops

of gyro oil (A) in each bearing, using syringe furnished.

(c) Lock and unlock spinning mechanism by hand and by rotating spinning shaft (205A).

(d) Remove propeller lock (417) and turn propellers until cam pawl is in extreme after position. Replace propeller lock.

(e) Install gyro and bottom head; lock gyro. Install gasket and cover plate (246A, 13-14).

23: Replace hand hole plate (13-14) and afterbody and tail drain plugs (48).

24: Install booster, detonator, and exploder mechanism in accordance with instructions in "Preparation for a War Shot."

25: Turn torpedo upright.

26: Gauge and boost air flask.

27: Check level of fuel, oil and water.

28: Load torpedo on plane according to instructions in Final Adjustments.

## T R E A T M E N T   A F T E R   A   R U N

The following treatment should be carried out *immediately after firing* to prevent deterioration of material:

### Immediate Treatment

1: Close stop valve and air flask blow valve (227A, 49).

2: Put on propeller lock (417).

3: Rotate starting gear index spindle until click is heard (227A).

4: Place torpedo on truck, wipe shell dry and slush with (E).

### Drain Afterbody and Tail

5: Remove replacement screw (49).

6: Install transportation screw (49).

7: Remove drain plug in afterbody (13-14).

8: Remove drain plugs in tail (13-14).

9: Remove gyro clamp plate cover (13-14).

10: Remove igniter (438, 391A).

### Fill Oil Tank

11: Fill oil tank with hot running torpedo oil (B) (13-14).

Note quantity of oil required to fill tank, in order to determine the quantity of oil remaining after run.

### Drain Combustion Pot

12: Turn torpedo over sufficiently to drain combustion pot.

13: Drain combustion pot. Turn torpedo bottom up, and install the dummy igniter and connect air lead (438, 391A).

### Remove Gyro

14: Remove gyro bottom head (246A).

15: Remove gyro, wipe pot dry, clean

and oil top and bottom gyro bearings (A), and replace gyro bottom head and clamp plate cover (13-14).

### Drain Fuel and Water Compartment

16: Remove water compartment filling plug (11). Measure quantity of water remaining after run by draining into a can.

17: Remove fuel filling plug (217, 74). Measure quantity of fuel remaining after run by draining into a can.

18: Replace water compartment filling plug (11).

### Overhaul and Clean Tail (Mark 13 Torpedo)

19: Remove holding screws for top, bottom and side rails (39).

20: Remove side rails with rudder arms.

21: Remove depth rudders.

22: Remove bottom rail with rudder arms.

23: Remove lower vertical rudder.

24: Remove upper rail with rudder arms, upper vertical rudders and rudder support body assembly.

25: Remove holding nut, after propeller and sleeve with bushings (183A).

26: Remove two forward propeller lock nut set screws (40).

27: Remove forward propeller lock nut (185C).

28: Remove forward propeller (use lead maul if necessary). Remove keys from sleeve (40).

29: Remove rudder connection screws (13-14).

30: Remove tail joint screws (49, 184A).

31: Remove tail.

32: Remove forward propeller sleeve locking screws (40, 72).

33: Remove forward propeller sleeve.

34: Insert cotter pins in holes on after end of exhaust valve stems (72, 40).

35: Remove cotter pins and nuts on exhaust valve bracket (72, 408).

36: Remove exhaust valves and bracket intact.

37: Examine exhaust valve springs and seats and oil (D).

38: Renew exhaust valve spring and reseat valves, if found necessary (WE202A, 72, 408).

39: Replace exhaust valve bracket and valves (72, 408).

40: Remove cotter pins from holes in exhaust stems (72, 40).

41: Replace forward propeller sleeve. "Zero" marks must coincide.

42: Replace forward propeller sleeve lock screws, and wire all screws (72, 40).

43: Replace tail.

44: Replace tail joint screws (49, 184A).

45: Replace forward propeller sleeve keys.

46: Replace forward hub and propeller. "Zero" marks must coincide.

47: Replace forward propeller lock nut (185C).

48: Replace forward propeller lock nut set screws (40).

49: Wipe clean and apply tail compound (G) thoroughly; replace bushings on after propeller sleeve.

50: Replace after propeller sleeve, hub and propeller ("zero" marks must coincide) and replace after propeller sleeve lock nut (183A).

51: Replace rudder support body assembly, and vertical rudders with rudder arms and rails. Secure rails with holding screws (39).

- 52: Replace depth rudders, side rails and rudder arms, and secure rails with holding screws (39).
- 53: Replace rudder connection screws (13-14).
- 54: Replace tail drain plugs (13-14).
- 55: Grease tail bearing with (G) until it shows (462, 481A).
- 56: Pack shaft with (G) until it shows (184A).
- 57: Grease forward propeller (G) until it shows (40, 481B).

### **Overhaul and Clean Tail (Mark 13 -- Modification Torpedoes)**

- 58: Remove holding nut, after propeller, and sleeve with bushings (183).
- 59: Remove four (4) bronze bushings from sleeve for after propeller.
- 60: Remove two lock screws from nut for forward propeller, and remove nut (185C).
- 61: Remove forward propeller and hub from sleeve for forward propeller.
- 62: Remove keys from sleeve. Use screw driver (41) in milled slot in end of keys.
- 63: Remove two pins for rudder connections (13-14).
- 64: Remove sixteen (16) joint screws and remove tail (459, 184).
- 65: Remove wire from four screws for locking clips, and remove screws (72, 41).
- 66: Turn sleeve for forward propeller until locking clips are in alignment with milled slot in after bulkhead, and remove four locking clips. Pry out with screw driver (41).
- 67: Remove sleeve for forward propeller.
- 68: Remove wire (72) and two screws for grease packing ring, and remove grease packing ring from forward propeller sleeve.
- 69: Insert cotter pins in holes on after end of exhaust valve stems (72, 40).
- 70: Remove cotter pins and nuts on exhaust valve bracket studs (72, 408).
- 71: Remove exhaust valves and bracket intact.
- 72: Examine exhaust valve springs and seats, and oil with (D).
- 73: Renew exhaust valve spring (408, 72), and reseal valves (WE202A) if found necessary.
- 74: Replace exhaust valve bracket and valves (408, 72).
- 75: Remove cotter pins from holes in exhaust stems (72, 40).
- 76: Clean and wipe dry sleeve for forward propeller.
- 77: Clean, grease (G) and replace pack-

ing ring in forward propeller sleeve. Replace holding screws and wire (72, 41).

78: Grease sleeve (G) and replace on forward propeller shaft.

79: Clean, oil with (D), and replace four holding clips for forward propeller sleeve. Replace screws in holding clips and wire heads (72, 41). Try to pull sleeve off, as a check to see that pins are properly seated in holes in shaft.

80: Clean interior of tail cone and wipe dry. Grease (G) and replace on afterbody. Oil and replace joint screws (459, 184).

81: Replace rudder connection screws (13-14).

82: Replace four copper washers and four drain plugs in tail cone (13-14).

83: Clean, oil with (B), and replace two keys for hub on forward propeller sleeve.

84: Clean, grease (G) and replace hub and propeller on forward sleeve.

85: Clean, oil with (B) and replace nut for forward propeller (185D). Replace two keep screws for nut (41, 185C).

86: Clean, wipe dry and grease (G) after propeller sleeve.

87: Clean, grease (G) and replace four bronze bushings for after propeller sleeve.

88: Replace sleeve, hub and after propeller on after propeller shaft.

89: Replace after propeller shaft lock nut (183).

90: Turn torpedo upright.

91: Remove grease plug in tail cone (13-14). With grease gun (462, 481B) force grease (G) into tail bearings to grease bearing surfaces. Remove grease gun and replace grease plug in tail cone.

92: Remove grease plug in after propeller shaft (184). With grease gun (481A) force grease (G) between propeller shafts and grease packing ring. Replace grease plug in after propeller shaft.

### **Make Check Run to Check and Oil the Engine**

- 93: Remove charging valve plug (13-14).
- 94: Put on safety strap and charging lead.
- 95: Open stop valve (227A).
- 96: Charge torpedo to 1000 pounds.
- 97: Close stop valve (227A).
- 98: Bleed and remove charging lead and safety strap.
- 99: Replace charging valve plug and washer (13-14).
- 100: Put tool 227 on starting gear index spindle as a safety measure.
- 101: Remove propeller lock (417) and turn propellers over by hand to see if engine turns freely.

102: Lift starting spindle arm to open starting piston.

103: Open stop valve (227A) sufficiently to give the torpedo a check run at reasonable speed.

104: Close stop valve (227A).

105: Rotate starting gear index spindle to close starting piston (227).

106: Put on propeller lock (417).

107: Remove water compartment plug, replace fuel plug and replace water compartment plug (11, 217, 74).

NOTE: If torpedo is to be made ready for firing, immediately proceed with the final adjustments. If torpedo is not to be fired immediately, proceed as follows:

### **Reducing Valve**

- 1: Oil reducing valve (386, 14, 94).
- 2: Back off speed screw to relieve compression on reducing valve spring (12).

### **Remove Gyro and Immersion Mechanism**

- 3: Set depth index on zero (135A).
  - 4: Turn torpedo bottom up.
  - 5: Disconnect air leads to horizontal and vertical steering engines (141A).
  - 6: Remove pipe from steering engine to reducer valve (141A).
  - 7: Remove valve connection clamp screws for both engines (246A).
  - 8: Remove engine screws (72), detach engines from gyro pot and lay aside in afterbody, leaving engines connected to rudder rods (49, 49A).
  - 9: Disconnect gyro spin lead (229).
  - 10: Remove gyro clamp plate cover and bottom head (13-14, 246A).
  - 11: Remove transportation pin and holding screws for gyro and immersion mechanism base (49).
  - 12: Put lifting screws in gyro housing and remove (200).
  - 13: Wipe gyro pot dry.
  - 14: Blow off gyro top and bottom bearings with low pressure air; with gyro syringe drop 2 drops of gyro oil (A) on each bearing.
  - 15: Blow moisture off gyro spinning and locking mechanism with low pressure air. Wipe dry all parts and oil well (D).
  - 16: Wipe all parts of gyro housing and immersion mechanism dry. Oil (B) well for preservation.
- ### **Oil Engine Gearing and Ball Bearings**
- 17: With (B), use oil gun and lubricate and spray all parts of main engine, starting gear, etc., paying particular attention to ball races, washers and steel parts

which would become rusted from lack of attention. This can be accomplished through the hand holes and gyro and immersion mechanism housing openings (94).

### Replace Gyro and Immersion Mechanism

18: Replace gyro and immersion mechanism housing with gasket, replacing connecting rod for driving pallet bevel pinion (200).

19: Secure housing with clamp screws and replace transportation pin (49).

20: Attach gyro spin lead (229).

21: Attach engines to gyro pot, and wire screws together (72, 49, 49A).

22: Replace valve connection screws (246A).

23: Replace pipe from reducer to vertical engine (141A).

24: Attach air leads to steering engines (141A).

25: Replace gyro bottom head (246A).

26: Replace gyro clamp plate cover and gasket (13-14).

27: Turn torpedo upright.

### Replace Fittings

28: Drain afterbody and tail and replace plugs (13-14).

29: Replace hand hole plates and gaskets (48).

The above will place a torpedo in a state of preservation, pending periodic overhaul.

## GENERAL INFORMATION

1: Data concerning Air Trajectory, Initial Entry and Underwater Trajectory, Air Stabilization and Development of Launching Methods, together with other related information is given in Ordnance Data No. 3816.

2: Ordnance Data concerned with the Mark of Stabilizer for type of planes in use will be issued to activities concerned, as directed by the Bureau of Ordnance.

3: Information about installation of wire impeller stops on Mark 13 Warhead and in Mark 4-1 Exploder Mechanism is given in Naval Torpedo Station Ordnance Data No. 3816.

Note: The above instructions change frequently due to new developments or improvements, making it impractical to incorporate them in this pamphlet. Changes in these instructions, supplementing those now in effect, will be issued when made.

4: Description and instructions for the installation and use of the Igniter Water trip

for Mark 13 Modification torpedoes is in Ordnance Data No. 3819, and will be incorporated in this pamphlet as soon as the design is approved.

### Anti-Freeze Solutions for Below Freezing Temperatures

1: Where planes operate in freezing air due either to altitude or climate, both water compartment and exercise head should be protected against freezing by the addition of alcohol to the water.

2: Possibility of freezing also makes additional precautions necessary to guard against the presence of water in any of the torpedo tubing.

3: The following method should be strictly adhered to for mixing anti-freeze solution:

(a) Alcohol and water should be

thoroughly mixed before pouring into the water compartment.

(b) Whenever practicable, the percentage of alcohol in the water compartment should not exceed that necessary to protect against freezing at a temperature of 30° below the existing atmospheric temperature; otherwise, power plant damage may be caused by excessive combustion flask temperature.

### Instructions for Mixing Pour Point Depressant with Hot Running Torpedo Oil for Torpedoes (Santopour, Monsanto Chemical Co.)

1: Six (6) oz. of Pour Point Depressant should be used for each five (5) gallons of hot running torpedo oil. The hot running torpedo oil must be heated to between 140°-150° F., the Pour Point Depressant added and the mixture agitated until thoroughly blended.

## DISASSEMBLY, OVERHAUL, ASSEMBLY AND TESTS

### General

1: The instructions contained in the Bureau of Ordnance Manual give the prescribed methods for care and handling of torpedoes and torpedo tubes aboard ship, and have the full force of Navy Regulations. In addition to the Manual, the Bureau issues circular letters containing important instructions concerning changes in the handling of torpedoes as made necessary by modifications, etc. Those responsible for the handling of torpedoes and torpedo equipment on board ship should be familiar with the contents of the Manual

and with all Bureau of Ordnance circular letters relating to torpedoes.

2: The periodic overhaul of a torpedo includes:

- A: Cleaning all torpedo parts.
- B: Examining all parts for defects.
- C: Renew or repair of defective parts.
- D: Proper assembly of parts.
- E: Tests of individual mechanisms.
- F: Tests to check proper functioning of torpedo as a whole.
- G: Proper treatment of parts to preserve them from deterioration.

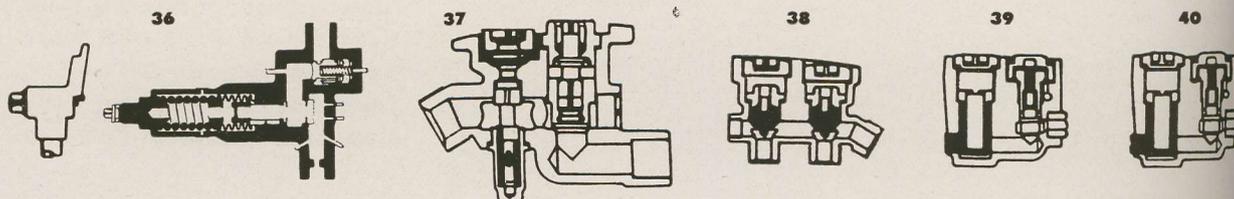
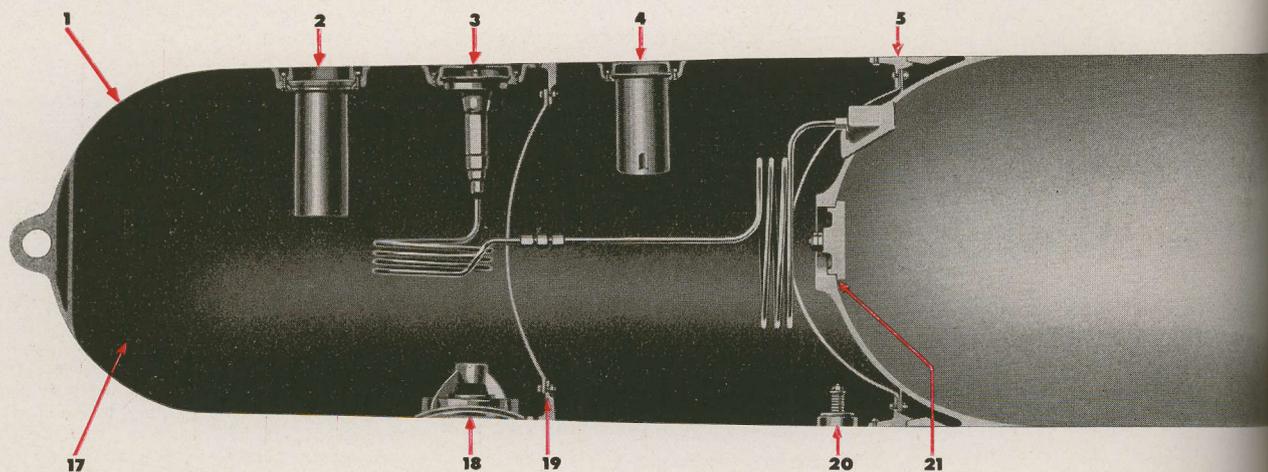
3: Years of torpedo experience have estab-

lished the value of the centralized overhauling station—a ship outfitted and manned for handling the torpedo equipment of all types of vessels having such equipment. On such a ship, competent personnel and testing equipment may be more easily maintained, and uniform methods based on complete knowledge of everything having to do with torpedoes are more certain, than might be the case on board the many individual vessels carrying torpedoes. In all save extraordinary circumstances, torpedoes and torpedo equipment in need of more overhaul or

(Continued on page 156)

# LUBRICATION GUIDE

## MARK 13-1 AND 13-2 TORPEDOES



### KEY TO NUMBERS AND LUBRICATING ROUTINES

The following applies to "ready" torpedoes with the forces afloat:

1. Exterior of Exercise Head. Slush with "E".
2. Searchlight Washer. Apply "D".
3. Air Release Mechanism. Apply "C" on working parts. "D" on washer.
4. Torch Case Washer. Apply "D".
5. Head and Flask Joint. Apply "D".
6. Fuel and Water Filling Plugs. Apply "C".
7. Water Compartment Head Screws. Apply "D".
8. Flask and Afterbody Joint. Apply "D".
9. Main Engine Gears and Bearings. Apply "E" to balls and races, "B" to gears.
10. Depth Index Setting. Apply "B".
11. Starting Gear Starting Valve. Apply "B".
12. Oil Tank. Fill with "B".
13. Afterbody After Bulkhead Bearing. Apply "B".
14. Exhaust Valves. Apply "B".
15. Rudder Bearings. Apply "G".
16. After Shaft Bearing. Apply "G".
17. Exercise Head Interior. Coat lightly with 50-50 mixture of "B" and "D".
18. Water Discharge Valve. Exercise and oil with "B". Apply "D" to washer.
19. Forward Head Joint Screws. Apply "D".
20. Relief Valve. Exercise and oil with "B". Apply "D" to washer.
21. Forward Bulkhead Joint Apply 75% strained white lead and 25% "C".
22. Water Compartment Interior. Coat lightly with 50-50 mixture of "B" and "D".
23. Water Compartment Head Joint. Apply 75% strained white lead and 25% "C".
24. Afterbody Joint Screw. Apply "D".
25. Engine Bulkhead Gasket. Apply "D".
26. Drain Plug. Apply "D".

## Key to Oils and Greases Authorized for Uses Shown

(A) Gyro Oil. Blended by Naval Torpedo Station, Newport, R.I. Obtainable only through requisition to tenders, bases and stations.

(B) Hot Running Torpedo Oil. Purchased by Bureau of Supplies and Accounts under annual contract.

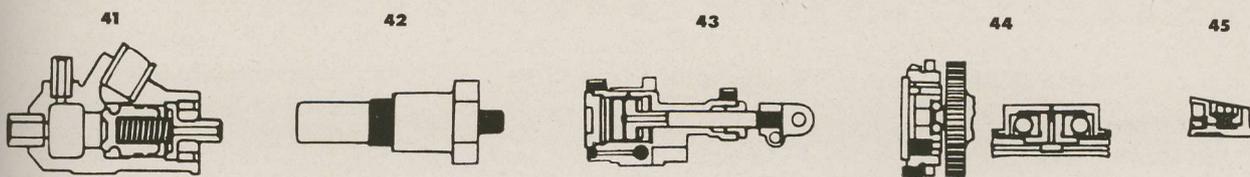
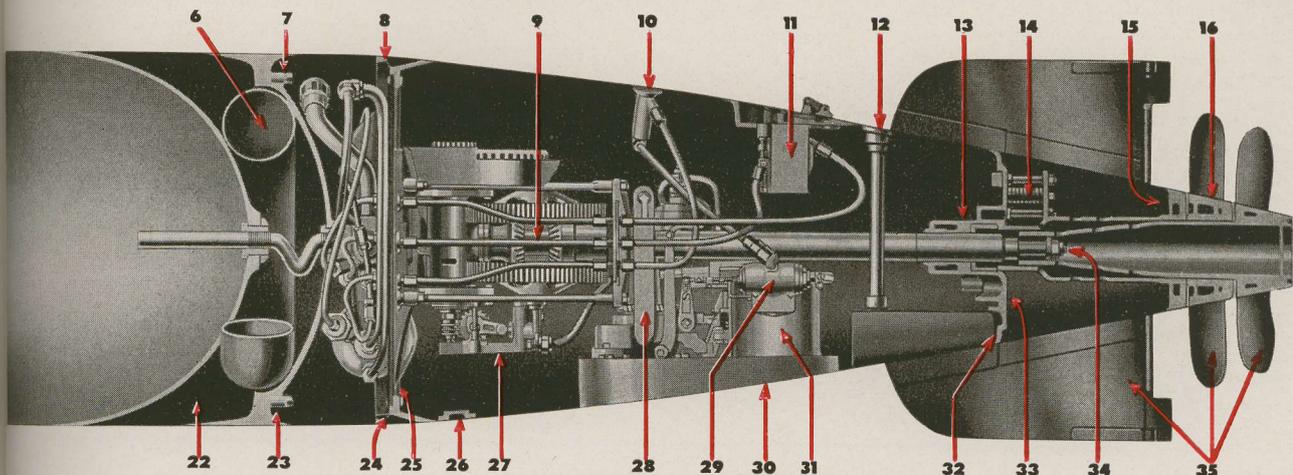
(C) Light Lubricating Oil. Forced-feed and motor cylinder oil, light, (Symbol 2110) purchased by Bureau of Supplies and Accounts under annual contract.

(D) Compound Steam Cylinder Oil, (Symbol 6135). (600-W or its equivalent.) Purchased by Bureau of Supplies

and Accounts under annual contract.

(E) Petrolatum. Purchased under Navy Department Specifications 14P1. Federal stock catalog number for 5-pound cans is 14P100; for 10-pound cans, 14P110.

(G) Naval Torpedo Station Tail Packing Compound. Obtainable only through requisition to tenders, bases and stations.



- 27. Oil Pump. Oil with "B".
- 28. Immersion Mechanism. Oil with "B".
- 29. Depth Engine. Oil with "A".
- 30. Torpedo Exterior. Slush with "B" and "E" mixed.
- 31. Gyro Mechanism. Oil entire mechanism with "C".
- 32. Afterbody and Tail Joint. Apply "D".
- 33. Rudder Rod Connections and Packing. Apply "C".
- 34. After Ends of Propeller Shafts. Apply "G".
- 35. Propeller and Rudder Surfaces. Coat with "E".
- 36. Oil Bracket and Reducer. Apply "B".
- 37. Stop and Charging Valve. Exercise and oil with "A".
- 38. Air Check Valve. Oil with "A".
- 39. Fuel Strainer and Check Valve. Oil with "A".
- 40. Water Strainer and Check Valve. Oil with "A".
- 41. Starting Valve. Oil with "A".
- 42. Igniter. Apply "C".
- 43. Vertical Steering Engine. Oil with "A".
- 44. Gyro Bearings. Oil with "A".
- 45. Tail Cone Oil Hole. Fill with "G".

## GUIDE TO LUBRICATION PROCEDURES AT:

### PRELIMINARY ADJUSTMENT...

#### PERFORM NUMBERS:

12, 16, 29, 34, 36, 37, 38, 39, 40, 42, 43, 44, 45.

### FINAL ADJUSTMENT...

#### PERFORM NUMBERS:

2, 3, 12, 16, 34, 36, 37, 38, 44, 45.

### OVERHAUL...

#### PERFORM NUMBERS:

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45.

repair than is practical on board torpedo-carrying vessels should be handled at such centralized overhauling stations on board designated ships. Too much depends on torpedo performance to excuse makeshift or inadequate overhaul or repair when facilities for the proper servicing of torpedoes and equipment are within reasonable reach.

**4:** All steps necessary to normal disassembly, overhaul, adjustment and repair of torpedoes are covered in this section. Proper completion of all indicated procedures will bring a torpedo to "ready" condition, requiring only the preliminary and final adjustments already detailed to prepare the torpedo for a run.

**5:** The tools required for each step in this section are listed as before (by number at the point each is used). They are classified in three groups under the headings:

- (a) Torpedo Tools
- (b) Workshop Equipment Tools
- (c) Special Testing Fixtures

Tools listed under (a) are sufficient for disassembly, emergency repairs or adjustments, and the application of preliminary and final adjustments before firing.

Tools listed under (b) are for exclusive use in the torpedo workshop for major overhaul and for fitting renewal parts when necessary. Workshop equipment tools are designated by the prefix "WE" before the tool number. Fixtures listed under (c) are used for testing the individual units of a torpedo prior to assembling in a torpedo. Description of and instructions for the use of these fixtures will be found in Ordnance Data Pamphlet No. 750, issued by the Naval Torpedo Station, Newport, R. I.

**6:** Throughout this text the lubricants to be used are indicated by symbols as follows:

<i>Symbol</i>	<i>Description</i>
(A)	GYRO OIL, blended by Naval Torpedo Station, Newport, R. I., and obtainable only by requisition to tenders, bases, or stations.
(B)	HOT RUNNING TORPEDO OIL, purchased under annual contract by the Bureau of Supplies and Accounts.
(C)	LIGHT LUBRICATING OIL—forced feed and motor cylinder oil light, Symbol 2110, purchased under annual contract by the

Bureau of Supplies and Accounts.

- (D) COMPOUNDED STEAM CYLINDER OIL—Symbol 6135, purchased under contract by the Bureau of Supplies and Accounts. (600-W or its equivalent.)
- (E) PETROLATUM, purchased under Navy Department Specifications 14P1. The Federal Stock Catalogue numbers for this material are 14P100 for 5 pound cans, and 14P110 for 10 pound cans.
- (F) GREASE, MINERAL, LUBRICATING (CUP) MEDIUM, purchased under Navy Department Specifications 14G1. The Federal Stock Catalogue number for this material is 14G1680 for 10 pound cans.
- (G) NAVAL TORPEDO STATION TAIL PACKING COMPOUND, obtained only by requisition to tenders, bases, or stations.

**7:** Throughout the text, frequent reference is made to Ordnance Data No. 750. This pamphlet is printed and issued by the Naval Torpedo Station, Newport, R. I. to all torpedo tenders and bases and to torpedo schools.

## EXERCISE HEADS, MARK 26, 26-1, 26-2

### DISASSEMBLE

#### A. Remove Head from Air Flask

- 1: Drain (13, 14), sling head, remove joint screws (49).
- 2: Push head just clear of air flask and disconnect air pipe from air flask blow valve (141A).

#### B. Remove Air Releasing Mechanism

- 1: Remove holding nuts and cover for air releasing mechanism (48) and lift mechanism clear of head.
- 2: Disconnect air pipe (141A), remove mechanism and gasket.
- 3: Disconnect air pipe from nipple in forward bulkhead ring (141A) and let drop in exercise head.
- 4: Unscrew clamp nut holding nipple in forward bulkhead ring (141A).

#### C. Remove Outer Bulkhead

- 1: Remove nuts holding bulkhead (48).
- 2: Remove bulkhead, with after section of air releasing mechanism pipe attached (61).
- 3: Remove air releasing pipe and clamp (41, 141) from after bulkhead.
- 4: Remove gasket.

#### D. Remove Torch Case

- 1: Remove nuts (48), cover, case and gasket.

#### E. Remove Forward Bulkhead

- 1: Remove bulkhead nuts (48).
- 2: Push bulkhead forward to break joint.
- 3: Turn flats on bulkhead into line with slots in bulkhead seat, and withdraw bulkhead. NOTE: When removing bulkhead through slot in seat, take care not to damage holding screws.

#### F. Remove Relief Valve

- 1: Remove relief valve and body assembled (391A).
- 2: Remove nuts for stem, washer for spring, spring and valve with washer (41, 48).

#### G. Remove Water Discharge Valve

- 1: Remove holding nuts (48) and water discharge valve spring plate.
- 2: Remove water discharge valve and spring.
- 3: Unscrew clamping nut for discharge valve washer (clamp discharge valve in tool 448 in vise and remove nut for washer with tool 242A).

#### H. Disassemble Air Releasing Mechanism—Mark 2

- 1: Unscrew restriction nipple with washer (18, 141A).
- 2: Unscrew adjusting nut cap with washer, adjusting nut keep screw and adjusting nut (406, 407, 41).
- 3: Remove air releasing valve spring, spring support and valve. (Removal of valve guide and seat should not be done except when removal is necessary).

#### I. Disassemble Air Releasing Mechanism—Mark 3

- 1: Unscrew adjusting nut cap with washer, adjusting nut keep screw and adjusting nut (41, 407, 406).
- 2: Remove air releasing valve spring and spring support.
- 3: Remove air inlet (restriction) nipple and washer (451, 229).
- 4: Remove air strainer.
- 5: Remove strainer holder and washer (451).
- 6: Remove air releasing valve.

With the above steps completed the exercise head with attachments is disassembled, ready for cleaning and inspection of parts.

## OVERHAUL, TEST AND ASSEMBLY

### J. Replace or Resolder Studs for Bulkhead and Flanges, Where Necessary

1: Apply heat to stud until it will unscrew with screw-driver (41).

2: Tin new stud (442) and screw in place (41) when hot, wipe excess solder off threads with rag and chase threads with  $\frac{1}{4}$ " x 20 finger die (WE19).

### K. Treatment of Interior of Head

1: Clean interior thoroughly.

2: Treat exposed surfaces with protective coating of bitumastic solution (allow to dry at least 12 hours before testing with air).

### L. Lead Ballast

1: Should need arise for removal and re-installation of lead ballast, due to corrosion under ballast or removal of dents in shell, ballast must be replaced in exact location from which removed.

2: Shell having been cleaned and given a heavy coating of tin, replace lead weight and solder in place with soldering iron.

### M. Torch Case

1: Clean, inspect and test torch case in accordance with instructions contained in O.D. No. 750. NOTE: Leakage through torch case may result in the sinking of torpedo. Torch cases which do not satisfactorily pass a hydrostatic test of 85 lbs. to the sq. in. should be scrapped and replaced.

### N. Air Releasing Mechanism Pipes

1: Anneal pipes and bend to shape in accordance with drawings.

2: Reseat seats on pipe collars if necessary (WE 86).

3: Reseat nipples for pipes if necessary (WE85).

### O. Test Exercise Heads for Leaks

1: Oil (D) and replace washer on water discharge valve (242A, 448).

2: Clean, inspect and oil (C) valve guide, seat and studs in discharge valve flange.

3: Insert discharge valve in flange, place gag across the studs and secure with nuts, setting them up until valve is held firmly on seat (48).

4: Replace air release pipe (after section) with nipple in forward bulkhead ring (make sure plated copper washer is in place against shoulder of nipple (141A).

5: Replace clamp nut on nipple and secure (141A), holding after section of pipe in alignment for attaching to after bulkhead.

6: Connect forward section of air release pipe to nipple (141A), holding pipe in position for connecting to air release mechanism.

7: Replace after bulkhead gasket on its seat.

8: Note that plated copper washer is in place against shoulder of nipple on after end of air release pipe, and guide nipple into hole in pocket on after bulkhead.

9: Replace after bulkhead (61) and secure, tightening up evenly on holding nuts (48).

10: Replace and tighten clamp nut (141) on nipple for air release pipe.

11: Blank off air release pipe (forward end) and nipple (after end) (141A).

12: Install air releasing mechanism, blanking off plate and gasket (48).

13: Install torch case, cover and gasket (48).

14: Blank off relief valve flange.

15: Insert test connection in drain plug flange, and connect low pressure gauge and pipe. Crack air valve and build up pressure in head to 15 lbs. per sq. in.; close valve, submerge head in water and examine for leaks.

16: If leaks occur, mark their location and remedy.

17: When satisfactory test has been made (no leaks) unclamp nipple (141A) and remove after bulkhead (48).

18: Remove torch case (48) to provide clearance for the installation of forward bulkhead.

19: Place a new gasket on forward bulkhead and install bulkhead on its seat, being careful not to damage threads on holding screws when passing through the slots in bulkhead ring. Set up evenly on nuts for holding screws (48).

20: Test forward (water) compartment as in step 15; placing head nose down, pour water around forward bulkhead joint and examine for leaks.

21: If leaks occur, mark their location and remedy.

22: When satisfactory test has been made (no leaks) wipe buoyancy compartment inside clean and dry.

23: Reassemble torch case and after bulkhead on head (41, 48), securing pipe to clip and clamp nut on nipple (141A) through bulkhead pocket.

24: Remove test adapter (48), blanking off plates (141A), blank in air release pipe and remove relief valve blank (391A).

25: Replace drain plug (13, 14).

26: Oil (D) and replace water discharge valve spring and cover (48).

27: Replace relief valve:

(a) Oil (D) and replace washer on

valve. (b) Oil (C) valve guide, valve, and spring. (c) Assemble valve in guide, spring, spring washer and nut (48, 41).

(d) Replace valve body (assembled) and washer in exercise head (391A).

### P. Air Releasing Mechanism—Mark 2

1: If necessary to replace air releasing valve guide and seat, unscrew old valve guide (41), applying heat around threads; screw and solder new valve guide and seat into body (141A, 441), reseat valve seat, and lap valve to seat. Use cocking tool (441) for turning valve when lapping into guide, (WE 24).

2: When finished lapping, wash parts thoroughly in gasoline, oil (C) and assemble.

3: Check size of hole in restriction nipple; should be .0625" (use No. 52 drill).

4: Screw nipple into valve guide and seat against a copper washer (18, 141A).

5: Oil (C) and replace spring support around valve stem; replace spring screw adjusting nut into body over spring (406).

6: Connect mechanism to air pipe from test panel or test set (141A).

7: Hold valve on seat by pulling out on cocking tool, turn air on (141) and test for leaks by submerging in water with the valve seated; pressure release tests should be made in accordance with procedure outlined in O.D. No. 750 (mechanism should be set to release at 500 lbs. pressure).

8: With the above tests completed and desired release pressure obtained, insert lock screw for adjusting nut (41).

9: See that .020" hole on top of adjusting nut cap is clear. (If this hole is clogged, a small air leak past the valve may cause failure to function, with possible sinking of torpedo).

10: Screw cap in place with washer under seat (407), thus completing assembling of air releasing mechanism.

### Q. Air Releasing Mechanism—Mark 3

1: Reseat valve seat and lap valve to seat (41, WE 236).

NOTE: If necessary to lap in a new valve, lap hole in body with lap tool WE 237 and new valve with lap tool WE 238.

2: When finished lapping, wash parts thoroughly in gasoline.

3: Blow out restriction hole in valve guide with air, and check size using No. 52 drill; blow out air channels with air.

4: Oil (C) and assemble valve in guide.

5: Clean and replace strainer body with washer in valve guide (451).

6: Oil (C) and replace spring support over valve stem, spring, and spring adjusting nut.

7: Clean and replace strainer in valve guide.

8: Remove burrs from threads if necessary and replace air inlet (restriction) nipple and washer in strainer body (45, 229).

9: Connect mechanism to air pipe from test panel or test set (141A) (Bu. Ord. Dwg. No. 44322, 79646).

10: Turn on air and test for leaks by submerging in water.

11: With valve tight, set valve (406) to

release for pressure required in accordance with procedure outlined in O. D. No. 750.

12: With the above test completed and desired release pressure obtained, insert lock screw for adjusting nut (41).

13: See that .020" hole on top of adjusting nut cap is clear. If this hole is clogged, a small air leak past the valve may cause premature blowing of this head.

14: Screw cap in place, with washers under seat (407), thus completing assembly of Mark 3 air releasing mechanism.

## R. Install Air Releasing Mechanism in Head

1: Put washer in place on beveled flange. Pull out air releasing pipe connection through pocket and connect to mechanism (141A).

2: Drop mechanism down to its seat. Replace cover and secure with holding nuts (48).

Overhaul, assembly and test of exercise head is now complete up to the point of assembly on air flask.

# A I R F L A S K

## DISASSEMBLE

### A. Disconnect and Remove Afterbody from Air Flask

1: Disconnect the following pipes:

(a) Main air connection (135).

(b) Air pipe to air check valves (229).

(c) Pipes to fuel and water strainers (141A).

(d) Pipe from vent fitting to afterbody (141A).

2: Install sling around afterbody and take its weight with chain fall.

3: Unscrew joint screws (386).

4: Lift tail slightly higher, rotate afterbody left to clear main air connection and pull clear of flask.

5: Place afterbody on stand.

### B. Test Prior to Disassembly

NOTE: Prior to disassembly of air flask sections, it is desirable to make tests given below. Steps preceded by an asterisk (\*) in the text should not be taken except to remedy leaks or replace parts found faulty and requiring renewal through the following tests.

1: Charge air flask to 800 lbs. per square inch and test for leaks around the forward bulkhead. Squirt light lubricating oil around the bulkhead joint and note if bubbles appear.

2: Test air flask blow valve for leaks (49).

3: With main air nipple blanked off, operate top valve to open and close and note leaks (227A).

4: Note if charging check valve leaks.

5: Note if charging valve plug leaks.

6: Open air flask blow valve (49) and bleed air from air flask until empty.

## DISASSEMBLE AIR FLASK

(Welded Type)

### C. Remove Air Check Valve Assembly

1: Disconnect pipes from check valve to water compartment bulkhead (229).

2: Disconnect pipe to venting fitting (141A).

3: Remove holding screws (41) and check valve body assembly.

### D. Remove Fuel and Water Check Valve and Strainer Body

1: Disconnect pipe from bulkhead to fuel strainer (141A).

2: Disconnect and remove pipe (141A) from check valve body to vent fitting.

3: Disconnect pipe from bulkhead to water strainer (141A).

4: Remove holding screws (41) and remove check valve and strainer body assembly.

### E. Remove Stop and Charging Valve Complete

1: Disconnect main air pipe at water compartment bulkhead (134).

2: Remove holding screws (41) and stop and charging valve group.

### F. Remove Vent Fitting

1: Remove holding screws (41) and fitting.

### G. Remove Water Compartment Bulkhead Assembly

1: Remove water and fuel filling plug (11, 74, 217).

2: Unscrew clamp nut (242A) for main

air connection through water compartment bulkhead.

3: Loosen clamp nut (144) and unscrew nipple for air to water compartment.

4: Loosen clamp nut (144) and unscrew nipple for water from water compartment.

5: Remove water compartment holding screws (12).

6: Insert lifting handles (S. G. 2868) and remove water compartment bulkhead assembly.

NOTE: It may be necessary to tap around joint with lead hammer to loosen white lead joint.

### I. Remove Forward Bulkhead

1: Loosen clamp nut (404), remove locating clamp, and replace clamp nut on stud in forward bulkhead.

2: Attach piece of wire or heavy string to clamp bolt under clamp nut and holding string (or wire) in one hand, to prevent forward bulkhead from falling inside air flask; push forward bulkhead aft to break seat.

3: Turn flats in bulkhead to line up with slots in air flask toward dome, and remove forward bulkhead.

### \*J. Remove Main Air Connection in After Bulkhead

1: Back off clamp nut (241A) and remove main air pipe assembly through forward end of flask.

### K. Remove Blow Valve Assembly

1: Disconnect pipe to air flask (141A).

2: Remove holding screw (41) and valve assembly.

Disassembling of air flask is now complete.

## OVERHAUL, ASSEMBLY AND TESTS

### L. Replace Forward Bulkhead

\*1: Apply carborundum grinding compound mixed with oil (D) sparingly around seat on bulkhead.

\*2: Insert bulkhead through slots in air flask seat and pull bulkhead up to its seat (see steps 1, 2 & 3).

\*3: Install grinding tool and grind bulkhead to its seat, wiping and inspecting occasionally until a good seat is obtained all around.

\*4: Remove grinding tool.

5: Clean and dry ground seats thoroughly (do not use lye or other alkali nor gasoline or volatile oils—hot water only should be used) and apply a 50-50 mixture of pure strained white lead and light lubricating oil (C) to both seats.

6: Install bulkhead on seat—hold in place by center boss and put on locating clamp—making sure that clamp seats in center slot in bulkhead and in slots in air flask forward dome.

7: Assemble clamp nut with bellows part of nut away from locating clamp and secure (404).

### M. Blow Valve

1: Clean and inspect blow valve body and parts. Remove burrs where necessary on nipples and in blow valve seat. Apply oil (B) to valve.

2: Replace new washer around blow valve stem and assemble blow valve in body (49).

3: Replace retainer over blow valve stem, and secure with set screw (37).

4: Replace blow valve on air flask and secure with screw (41).

5: Clean out joint screw holes with tap.

### N. Test Air Flask Bulkhead for Leaks

1: Connect special fitting (furnished with workshop equipment) to main air nipple in after bulkhead.

2: Close blow valve.

3: Open line gradually and charge flask to 800 lbs.

4: Squirt light lubricating oil (C) around forward bulkhead joint and test for leaks, using a lighted taper as an additional means for detecting leaks.

5: When test is concluded, open blow valve (49) and allow air to bleed until empty. Remove test connection.

### O. Water Compartment Bulkhead with Parts Assembled on It

1: Disconnect air pipe from bulkhead to fuel flask (229).

2: Disconnect fuel pipe from bulkhead to fuel flask (141A).

3: Remove 3 screws for bracket and fuel flask (64), and remove fuel flask (49A).

\*4: Disconnect and remove air pipe to fuel flask, and fuel pipe from fuel flask, at bulkhead (229).

\*5: Unscrew screws (2 each) (40) and remove the three brackets for fuel flask.

\*6: To remove nipples for fuel and fuel air leads, apply only sufficient heat to each nipple to run solder, and unscrew nipples (141A).

\*7: To replace nipples, clean tapped holes in bulkheads and tin threads on nipples and screw into holes in bulkhead, applying only sufficient heat to keep solder soft until screwed all the way up. After soldering in place, reseal seats on end of nipples and chase burrs off thread (WE85, WE83, WE94, WE95).

\*8: Replace the 3 brackets for fuel flask on bulkhead and secure with holding screws (40).

\*9: Clean, inspect, dress burrs off where necessary and connect pipes to bulkhead as follows:

(a) Air pipe from bulkhead to fuel flask at bulkhead (229).

(b) Fuel pipe from bulkhead to fuel flask at bulkhead (141A).

10: Clean, inspect and test fuel flask for leaks as follows:

(a) Blank off air connection (229).

(b) Connect test pipe from fuel outlet connection to valve on outlet pipe for spray (141A), and check valve testing outfit, described in O.D. No. 750. No water should be used in test tank when testing fuel flask.

(c) Open low pressure air valve and allow pressure to enter fuel flask (about 45 lbs.).

(d) Submerge fuel tank in water and note if bubbles rise, indicating a leak.

(e) With test completed, dry fuel flask, cover with light lubricating oil (C), and dress burrs off nipples on fuel flask if necessary (WE82, WE83, WE94, WE95).

11: Replace fuel tank in bracket and secure with 3 screws (49 bent).

12: Connect air and fuel pipes to fuel flask (229, 141A).

13: Clean interior of water compartment; clean out fitting and vent holes.

14: Clean, inspect and install air pipe and nipple for air to water compartment (229).

15: Clean bulkhead seats, including tapped screw holes, and apply a coating of white lead and light lubricating oil (C) on seats.

16: Install water compartment bulkhead assembly, guiding main air connection nipple through hole in bulkhead, and secure with holding screws dipped in compound steam cylinder oil (D) (12).

17: Screw clamp nut over main air connection nipple and secure (241A, 242A).

### P. Stop and Charging Valve Group

1: Remove charging valve plug and washer (13-14).

2: Remove check valve guide, check valve and spring (12).

3: Remove stop valve plug and spindle (183).

4: Remove stop valve and carrier (405).

\*5: Remove keep screw and bushing for charging valve (81, 420 with 377).

\*6: Scribe assembly marks on main air pipe and stop valve body. Apply sufficient heat around threads to soften solder, unscrew main air pipe and wipe solder from valve body.

\*7: Try threads on main air pipe for fit in threaded hole in valve body; tin threads of both. Slip nut over end of pipe, apply sufficient heat around threads to soften solder, and screw pipe in place in body, lining up scribe marks.

NOTE: If a new pipe is fitted screw pipe into valve body without soldering. Install valve group on air flask and secure in place. Fit main air pipe to line up with main air nipple in center of water compartment bulkhead, and scribe marks on pipe and stop valve body. Remove and solder in place as described above.

\*8: Reseat main air connection nipple. Reseat seat for stop valve. Reseat stop valve plug seat in valve body (WE81, WE80, WE41, WE42).

\*9: Screw new charging valve bushing in place. Mark place opposite keep screw hole, remove bushing and with small round file remove sufficient stock on bushing to match half of hole drilled before tapping. Replace bushing in valve body, with hole for keep screw lining up, run a drill into hole and follow up with a tap. Insert keep screw for bushing (420 with 377, 81).

\*10: Reseat charging check valve seat (WE46).

\*11: Lap charging check valve to seat (41).

12: Clean charging check valve and seat; replace valve and spring.

13: Clean, inspect, remove burrs where necessary and see that stop pin is screwed in tight on guide for check valve. Replace over spring and check valve in valve body, screwing up tight against a copper washer (12). Replace charging valve washer and plug (13-14).

14: Grind stop valve to seat. Apply lapping compound sparingly and screw stop valve and carrier down to seat but not hard down (405). Insert a screw driver (41) through carrier to slot in stop valve and grind until seated.

15: Wash grinding compound from valve seat, clean, oil (C) and install stop valve carrier with valve (180).

16: Remove keep screw and stop valve spindle follower and stop valve spindle from stop valve plug. Clean, inspect, re-

move burrs, lap stop valve spindle to seat in plug, oil (C) and assemble spindle follower and keep-screw in plug (181, 81).

17: Replace washer and stop valve plug in valve body.

18: Test stop and charging valve assembly for leaks, using blanks and nipples furnished with Workshop Equipment, and test panel (See O.D. 750).

19: Install stop and charging valve group on air flask as follows:

Catch threads on main air pipe nut to nipple on bulkhead (34), line up and secure valve body to midship shell with 4 screws (41). Turn main air connection nut until it is fully tightened (134).

## Q. Air Check Valves

1: Remove plugs and washers for check valve body (405).

2: Remove check valve plug and guide with centering bushing, check valve and spring (12, 74).

\*3: Reseat seats for valves. Use air check valve plug, with centering bushing removed, for guiding tool when cutting (WE108).

\*4: Reseat seat for air check valve plug washer (WE113).

\*5: Reseat seats on pipe nipples, and remove burrs on threads (WE83).

\*6: Reseat outer seat of valve on plug (WE111).

\*7: Reseat outer seat on valve (WE111).

\*8: Lap hole in air check valve plug, and sleeve on check valve, to fit (a tool is

provided for holding valve for operations (5), (6) and (7) above (WE107, WE110, WE112).

9: Clean, inspect, oil (C) and assemble air check valves, springs and plugs in air check valve body, holding valves in plugs with screw rods until threads are engaged. Then remove screw rod and set up on plugs (74, 12).

10: Replace plugs and washers for check valve body (405).

11: Test air check valves (see O.D. No. 750 for this test).

12: Wipe dry and re-oil (C) air check valve after test. Install on air flask with holding screws and connect pipes (41, 229, 141A, 12, 74).

## R. Fuel and Water Delivery Check Valves and Strainer

1: Remove plugs for strainers, and remove strainers (405, 372A).

2: Remove plugs and washers for fuel and water check valves (406).

3: Remove valve guides, with valves and springs (74, 407).

\*4: Remove burrs out of holes in body for check valves (WE119).

\*5: Reseat counterbored nipples on body, and remove burrs on threads (WE94A, WE95, WE87).

\*6: Remove burrs in tapped hole for check valve guides (WE117).

7: Clean, inspect and oil (C) check valve body.

\*8: Ream burrs out of small diameter hole in check valve guide (WE120).

\*9: Ream burrs out of large diameter hole in check valve guide (WE124).

\*10: Reseat outer seat for valve in check valve guide (WE121).

\*11: Reseat outer seat on valve (tool is provided for holding valve during this operation and when lapping valve stem into hole in guide) (WE122, WE127).

\*12: Lap valve stems into guide.

13: Lap valves to their seats in body (74).

14: Clean, inspect, oil (C) and assemble spring and valve in guide, and replace in check valve body (141A).

15: Clean, inspect and replace check valve plugs and washers (407).

16: Clean, inspect, oil (C) and replace strainers. (Do not set up strainers more than hand tight to prevent sticking on the next removal).

17: Replace washers and strainer plugs (405).

18: Test delivery check valves and strainers (see O.D. No. 750 for this test).

19: Wipe dry and re-oil (C) check valves and strainers after test.

20: Install on air flask and secure with holding screws (41).

21: Connect vent pipe (141A).

## S. Test Water Compartment for Leaks

1: See O.D. No. 750 for instructions relative to this test. Overhaul and test of air flask is now complete.

# AFTER BODY--REMOVAL OF MAJOR UNITS

NOTE: Steps preceded by an asterisk (\*) are necessary only when repairing or replacing damaged parts.

## A. Gyro and Immersion Mechanism

- 1: Remove hand hole plates (with afterbody bottom up) (200, 48).
- 2: Disconnect air leads from horizontal and vertical steering engines (141A).
- 3: Remove pipe from steering engine to gyro reducing valve.
- 4: Remove valve connection clamp screws for both engines (246A).
- 5: Remove engine holding screws, detach engines from gyro pot and lay aside in afterbody, leaving engines connected to rudder rods (72, 49, 49A).
- 6: Disconnect gyro spin lead (229).
- 7: Remove transportation pin (459), and holding screws for gyro and immersion mechanism base (49).
- 8: Remove tension on depth spring (135A).
- 9: Put lifting screws (200) in gyro and immersion mechanism base and remove mechanism from afterbody.
- 10: Remove rudder rod pins (449) and take horizontal and vertical steering engines out of afterbody.

## B. Starting and Reducing Valve Group--Combustion Flask and Nozzle

- 1: Remove air pipe to igniter (141A).
- 2: Remove air pipe to air check valve (229).
- 3: Remove oil pipe to reducing valve (48, 141A).
- 4: Remove gyro spin pipe (229).
- 5: Remove fuel and water pipes to spray (144, 141A).
- 5: Remove air pipe from starting valve to bulkhead (141A).
- 7: Remove air pipe from bulkhead to reducing valve (starting gear return) (141A).
- 8: Remove air pipe from reducing valve to air strainer (141A).
- 9: Disconnect main air connection between valve group and combustion flask. (Loosen coupling nut (134A), then remove valve group holding screws (227A) before disconnecting coupling).
- 10: Remove vent pipe (141A).
- 11: Remove nuts for nozzle stud and remove combustion flask with nozzle and gasket (227A).

## C. Tail

- 1: Remove holding nut (183), after propeller and sleeve with four bushings.
- 2: Remove two lock screws from lock nut for forward propeller and remove lock nut (40, 185C, 185D).
- 3: Remove forward propeller and hub from forward propeller sleeve. (Use lead maul if necessary.)
- 4: Remove keys from sleeve, using screw driver (41) in milled slot in key.
- 5: Remove four drain plugs, disconnect and remove rudder rod connecting pins (13, 14).
- 6: Remove sixteen tail joint screws and remove tail (184).
- 7: Remove wire (72) and four locking clip screws (41).
- 8: Turn forward propeller sleeve until locking clips are in alignment with milled slot in after bulkhead, and remove four locking clips; pry out with screw driver (41).
- 9: Remove forward propeller sleeve.

## D. Gear Train Assembly

- 1: Disconnect gyro spin pipe (229) at nipple in strengthening ring.
- 2: Disconnect oil pipe from pump to oil tank, at oil tank (229).
- 3: Disconnect air pipe (141A) from bulkhead to air strainer at manifold on strengthening ring.
- 4: Disconnect air pipe (141A) from starting valve to starting gear, at manifold on strengthening ring.
- 5: Disconnect air pipe (141A) from starting gear to reducing valve, at manifold on strengthening ring.
- 6: Remove nuts (48) for engine bulkhead studs.
- 7: Install bearing guide on after propeller shaft (WE34).
- 8: Install lifting handles (446A, 446B) on bulkhead and remove gear train assembly from afterbody.

## E. Starting Gear

- 1: Disconnect air pipe (141A) from starting valve to starting gear.
- 2: Disconnect air pipe (141A) from starting gear to reducing valve.
- 3: Remove holding screws (41), starting gear and gasket.

## F. Disconnect Pipes in Afterbody

- 1: Disconnect air pipe (141A) from strengthening ring to air strainer.
- 2: Disconnect air pipes (141A) to depth and steering engine.

3: Disconnect gyro spin (229) from manifold on strengthening ring to gyro pot.

4: Disconnect oil filling pipe (191) from filling bracket to oil tank.

5: Disconnect vent pipe (141A) from oil tank.

## G. Depth and Steering Rudder Rods

1: Remove cotter pins (72), unscrew rudder connection ends (166), loosen packing glands (229) and remove rudder rods, pulling through from the inside.

## H. Exhaust Valves

- 1: Place cotter pins (72) in holes in ends of exhaust valve stems.
- 2: Remove cotter pins (72) and holding nuts (457) for exhaust valve bracket.

## I. Depth Index Assembly

- 1: Remove cotter pin (72) and index spindle socket extension.
- 2: Remove spring.
- 3: Remove cotter pin (72) and spring seat.
- 4: Back out packing gland (18).
- 5: Remove index spindle.
- 6: Remove index dial and pinion.
- \*7: Stationary pinion rack should never be removed except for replacement of a damaged part, in which case apply sufficient heat on set screw to loosen solder. Unscrew set screw and pry the rack out. Extreme care must be exercised not to apply more heat than necessary, as the solder around casing may become loose and cause a leak.

## J. Remove Oil Tank

- 1: Remove wires for holding screws (72) for holding brackets.
- 2: Remove screws and holding brackets (184).
- 3: Remove oil tank.

## K. Exhaust Tubes

- \*1: Remove wires (72) through screw heads, screws (41) and thimbles for exhaust tubes.
- \*2: Pry after end of exhaust tubes clear of grooves and remove exhaust tubes.

## L. After Bulkhead Bearing

- 1: Remove 2 screws (386) for bearing.
- 2: Remove bearing. (Use a stick of hard wood and tap from the after end.)  
Removal of parts assembled with afterbody shell group is now complete.

# OVERHAUL, TEST AND ASSEMBLE PARTS ASSEMBLED WITH AFTERBODY--SHELL GROUP

NOTE: Steps preceded by asterisk (\*) to be taken only if parts need repairs or replacement.

## A. Afterbody Shell Rings and Flanges

1: Clean and inspect afterbody for loose rivets, loose solder around flanges, bulkhead, engine cage, water circulating pipes, after bulkhead, etc.

## B. Exhaust Tubes

\*1: Reform after ends of exhaust tubes (WE 210) (if using tubes previously removed).

\*2: Insert exhaust tubes through forward end, guide ends into holes in after bulkhead and push in place. Roll into groove with expander tool (WE209) and line up forward ends with holes in strengthening ring (vertical bulkhead).

\*3: Insert thimbles for exhaust tubes and secure with (6 each) screws (41), wiring screws together (72).

## C. After Bulkhead Bearing

1: Clean, inspect and dress burrs off where necessary on after bearing.

2: Install new gasket and after bearing, securing with 2 holding screws (386).

## D. Oil Tank

1: Clean and wash interior of tank with solution of tri-sodium phosphate.

\*2: Small dents in tank may be removed by the application of hydraulic pressure to the interior; about 5 lbs. should be sufficient.

\*3: Dress burrs found on seats or threads of nipples.

4: Replace oil tank in afterbody, pointing after holding stud into slotted clip on after bulkhead.

5: Replace securing brackets and secure brackets to strengthening rings with screws (184). Wire screws (72).

## E. Rudder Rods and Connections

1: Clean, inspect and remove burrs where necessary.

2: Remove old packing. Clean and inspect stuffing boxes for rudder connections.

3: Replace rudder rods and connections through stuffing boxes, with guides on connections in alignment with guide slots.

4: Repack rudder rod stuffing boxes, using 2 pieces, 7" long, of 3/16" diameter asbestos packing. Set up on packing gland for stuffing box (229), gradually working rudder rods back and forth; use oil (D) on packing when working into place. It may be necessary to add more packing, in which case split 3/16" packing to the amount required. When properly packed, rods should move with a push balance test (98) of not more than 9 lbs. with the gland nut set up flush.

NOTE: It is important that gland nut be set up flush, as otherwise the rudder rod movement may be restricted.

5: Replace rudder connection ends and pin in place with cotter pins (72).

## F. Exhaust Valves

1: Clean and inspect exhaust valves and their seats.

2: Assemble valves in exhaust valve bracket, without springs. Make certain that numbers on valves correspond with numbers on seats.

3: Replace bracket with exhaust valves over studs and secure with nuts (457).

4: Check valve alignment to seat by inserting strips of cigarette paper dipped in oil (C) about 90° across seat of valves. Hold valves against seats and try to remove paper strips. If this can be done without binding, valve is out of alignment with seat.

\*5: Insert valve in collet on bench lathe, and determine if seat on valve runs true by placing indicator (WE 10) in tool post and against valve. If seat runs out more than .002", it will be necessary to turn the seat true in bench lathe.

\*6: If valve seat is found out of alignment, install re-seating tool (WE 214) in valve bracket, in line with valve seat to be refaced, and secure bracket on studs. Place forked end of expander clamp over stem between cutter and bearing boss on bracket, set up on screw in center of expander clamp and turn reseating tool until new seat is obtained (457, 40, 227).

7: Having obtained true seats, grind valves to seat (40) using grinding compound sparingly.

8: Remove valves and bracket; clean and oil (B) valves and seats.

9: Replace valves with springs on bracket,

numbers corresponding with numbers on seat, inserting cotter pins (72) in ends of valve stems to hold valves in bracket during assembly on after bulkhead.

10: Replace exhaust valve bracket with valves and springs on studs on after bulkhead; secure with nuts (457) and cotter pins (72).

11: Remove assembly cotter pins (72) on exhaust valve stems.

## G. After Bulkhead

1: Clean tapped holes for joint screw for tail.

## H. Propeller Shaft Packing

1: Unscrew follower for packing (452) remove old packing, clean and inspect.

2: Replace follower, setting up by hand.

## I. Circulating Water Holes

1: Clean (41) and blow air through to see if holes are clogged up.

## J. Depth Index

1: Clean, inspect teeth in fixed wheel, and remove burrs where necessary.

\*2: To remove fixed wheel from casing see Part III—Step J-7. (41, 72)

\*3: To replace fixed wheel, remove burrs, if necessary, push in place, secure with lock screw (41, 72).

4: Oil (B) and replace pinion, index wheel and depth index spindle (135A).

5: Replace felt packing ring and gland around depth index spindle, and tighten up on gland (18).

6: Replace spring seat and secure with cotter pin (72).

7: Replace spring.

8: Replace depth index socket extension and spindle and secure with cotter pin.

## K. Pipes Assembled with Afterbody

1: Clean, inspect, reseat seats on collars, chase burrs from threads and connect pipes, removed in PART III, Step G, disassembly of afterbody (141A, 229, 191, WE85, WE83, WE94, WE95).

Assembly of afterbody ready for installation of major units and tail is now complete.

# VALVE GROUP AND SUPERHEATER

## DISASSEMBLY, OVERHAUL ASSEMBLY AND TEST

### A. Disassemble Reducing Valve

- 1: Place valve group in swivel vise.
- 2: Remove reducing valve plug with pipes (191).
- 3: Remove speed screw and speed ring (12).
- 4: Remove clamp for spring case (49).
- 5: Remove spring case seal.
- 6: Remove spring case (377).
- 7: Remove outer spring button and spring.
- 8: Remove inner spring collar and stem.
- 9: Unscrew lock nut (180) and nut (252) for valve stem.
- 10: Lift out sylphon, remove valve and stem and remove washer.

### B. Remove Starting Valve

- 1: Remove starting valve follower nut and cap (151, 151A).
- 2: Remove spring and starting valve.

### C. Starting and Reducing Valve Body

- 1: Clean, inspect, chase burrs off threads and seats of nipples where necessary (WE94, WE95).

### D. Starting Valve

- 1: Clean and inspect starting valve.
- \*2: Reseat seat in body for starting valve (24, WE50).
- \*3: Lap hole in body for starting valve piston (WE53).

\*4: Grind starting valve to its seat (212, WE54).

\*5: Lap starting valve piston rings (WE51, WE52).

\*6: Grind starting cap to seat in body (WE55).

7: Clean, oil (B) and assemble starting valve in body, replace starting valve cap and follower (151, 151A).

### E. Overhaul, Assemble and Test Reducing Valve

1: Clean, with particular attention to hole for oil, inspect, remove burrs if necessary, and oil (B) hole in reducing valve body for reducing valve stem.

\*2: Lap hole in body for reducing valve sleeve (WE59).

\*3: Lap reducing valve sleeve to body (WE60).

\*4: Lap reducing valve sleeve to stem (WE61).

\*5: Lap reducing valve stem to sleeve (WE62).

\*6: Lap flange on sylphon cup to valve body.

7: Clean, oil (C) and replace sylphon diaphragm assembly with valve washer.

8: Clean, oil (C) and replace reducing valve (180) with stem entering sylphon sleeve from valve end.

9: Clean, inspect, remove burrs where necessary, and replace reducing valve stem nut (180) and lock nut (252).

10: Test sylphon diaphragm for leaks; see O. D. No. 750.

11: Clean, inspect, oil (C) and replace inner spring stem with collar.

12: Clean, inspect, oil (C) and replace outer spring button in spring casing.

13: Oil (D) and replace reducing valve spring.

14: Replace reducing valve spring case (377), setting up hard.

15: Replace speed ring and screw (12).

16: Install new spring case seal.

17: Clean, inspect and replace clamp, with clamp screw, for spring case (49).

18: Clean, inspect, oil (C) and replace plug with pipes and washer over the reducing valve (191).

19: Test assembled reducing valve; see O. D. No. 750.

### F. Combustion Pot and Nozzle, Disassemble

- 1: Remove fuel spray and washer (388).
- 2: Remove water spray and washer (388).
- 3: Remove dummy igniter and washer (391A).

### G. Combustion Pot and Nozzle, Assemble

- 1: Inspect and clean interior of combustion pot.
- \*2: Reseat seat and clean threads on nipples on combustion flask (WE92, WE95, WE89, WE85).
- \*3: Run nozzle clearance tool through nozzle (WE37B).
- 4: Test fuel and water sprays; see O. D. No. 750, and replace in holders (12, 141A).
- 5: Replace spray holders in combustion pot (388).
- 6: Test combustion flask and nozzle, assembled, for leaks; see O. D. No. 750.  
Assembly of valve group and superheater is now complete.

## MAIN ENGINE

### DISASSEMBLE

#### A. Remove Turbine Bulkhead

- 1: Hold assembly in special jaws in vise (300).
- 2: Disconnect gyro spin pipe (229) on bulkhead.
- 3: Disconnect air pipe (141A) to air strainer on bulkhead.
- 4: Disconnect air pipe (141A) to start-

ing gear on bulkhead.

5: Disconnect air pipe (141A) from starting gear on bulkhead.

NOTE: It is good practice to tag pipes in steps 3, 4 and 5 above prior to removal. These pipes are very similar, and can easily be placed on the wrong nipple if not tagged.

6: Take out cotter pins (72), and remove nuts for turbine A frame studs (141A).

7: Remove bulkhead.

#### B. Remove Oil Pump

- 1: Remove wire (72) and two holding screws (49) for oil pump.
- 2: Remove oil connection for crosshead (12).
- 3: Remove oil pump, being careful not to burr oil connection or sleeve.

#### C. Disassemble Main Engine

Proceed according to description, pages 72 to 75.

### D. Remove Gears from Forward and After Propeller Shafts

1: Due to infrequent necessity for removal of bevel gears and strut bearing races, tools for this operation are not furnished. Appropriate sleeves may be made from brass piping of a size to slip over end of shafting, and by the use of arbor press on tender no difficulty should be experienced in the removal or replacement of bevel gears on their shafts.

## OVERHAUL ASSEMBLY AND TEST

### E. See Procedure, Pages 72 to 75

### F. Oil Pump

NOTE: For overhaul and test of oil pump see Paragraphs H and AA.

- 1: Insert oil connection sleeve in turbine shaft.
- 2: Replace oil pump, guiding oil connection to turbine shaft into sleeve and joint on pump for crosshead into recessed seat in lower A frame.
- 3: Clean, inspect, oil (B) and replace (12) oil connection for crosshead.
- 4: Replace holding screws (49) for oil pump and thread wire (72) through holes in heads of screws to secure.

### G. Turbine Bulkhead

- 1: Clean, inspect, chase burrs of threads and reseal seats on nipples where necessary, check up alignment of bulkhead.
- 2: Install bulkhead and secure with 4 nuts (141A) for turbine frame studs, and cotter pins (172).
- 3: Connect gyro spin pipe, starting gear pipes and air strainer pipe to nipples on bulkhead (141A, 229).
- 4: Perform tests as outlined in O. D. No. 750.  
Assembly and test of main engine, ready for assembly in afterbody, is now complete.

## OIL PUMP

### H. Disassembly

- 1: Remove oil connection sleeve, oil connection for turbine shaft, 4 screws (41) and oil connection collar.
- 2: Remove discharge valve stops (tap on wrench (12) with a hammer to loosen threads for removal) and remove discharge valves.
- 3: Remove suction plugs and valves (12).
- 4: Remove (2 each) holding screws (41) and 2 worm wheel bearings.
- 5: Remove worm wheel, shaft, and connecting rods with pin and plungers.
- \*6: Remove cotter pin (72), washer and connecting rod pin, with 3 distance collars; (note position of collars before disassembly so that they may be replaced in their proper places).  
Disassembly of oil pump is now complete.

### AA. Overhaul, Assemble and Test

- 1: Clean, inspect, blow air through and clear out all oil holes. Note if suction nipple is soldered in place with silver solder, or if it is loose. If not soldered in place, use silver solder in replacing it, being careful to use only sufficient heat to melt the solder.
- \*2: Apply sufficient heat to loosen solder around screws and bushings for plunger. Unscrew (41) and remove screws, washer and bushing.
- \*3: Lap in new plungers to new bushings. Replace and solder bushing in place with washer and screws (WE205, WE204).
- 4: Clean, inspect, oil (B) and assemble worm wheel and shaft in bearings; connecting rod, distance collars, plungers, connecting rod pin washers and split pin for pin, assembling the whole on pump body, and securing bearings with 4 holding screws (41). Make sure that bench marks coincide when assembling.
- 5: Clean, inspect to obtain condition outlined in O. D. No. 750, and assemble valves and plugs (WE40, WE40A, WE40B, WE40C, 12).
- 6: Clean, inspect and assemble oil connection for turbine shaft on oil pump, securing collar with 4 screws (41), and slip oil connection sleeve over connection.
- 7: Conduct test with assembled pump as outlined in O. D. No. 750. If test is passed, pump is ready for assembly on main engine.

## STARTING GEAR

## DISASSEMBLE

### A. Remove Starting Piston Body

- 1: Remove plug for starting piston and washer (12).
- 2: Remove starting piston and spring.
- 3: Remove holding nut, starting piston body, and washer (432).

### B. Remove Index Spindle

- 1: Remove taper pin for unlocking cam.
- 2: Withdraw index spindle through unlocking cam and starting gear frame.
- 3: Remove holding screws for packing ring (41).
- 4: Remove cup leather packing and packing ring.

### C. Remove Unlocking Lever

- 1: Remove unlocking lever spring (72).
- 2: Remove cotter pin (72) and nut (48, 40) for unlocking lever pivot.
- 3: Remove pivot pin and unlocking lever.

### D. Remove Connecting Lever and Valve Lift

- 1: Remove cotter pin (72) for connecting lever on valve lift shaft.
- 2: Push valve lift and shaft clear of connecting lever.
- 3: Remove connecting lever.

### E. Remove Starting Spindle and Arm

- 1: Disconnect spring (72) on starting spindle head.

- 2: Remove pin holding starting spindle head on starting spindle.
- 3: Unscrew starting spindle head from starting spindle.
- 4: Remove pivot screw for starting spindle arm.
- 5: Remove starting spindle, spindle arm and pin (41).

## OVERHAUL, ASSEMBLY

### F. Replace Starting Spindle and Arm

- 1: Insert starting spindle in its bearing.
- 2: Replace starting spindle arm and pin for spindle arm.
- 3: Replace pivot screw for starting spindle arm (41).

- 4: Replace starting spindle head on spindle, line up holes for pin, and insert.
- 5: Replace spring for starting spindle head (72, 41).

### G. Replace Connecting Lever and Valve Lift

- 1: Insert connecting lever in its slot.
- 2: Insert valve lift, lining up holes in connecting lever and square end of spindle.
- 3: Insert cotter pin through lever and spindle (72).

### H. Replace the Unlocking Lever

- 1: Replace unlocking lever.

- 2: Replace pivot pin through unlocking lever and frame.

- 3: Secure pivot pin with nut (40, 48) and cotter pin (72).

- 4: Replace spring for unlocking lever (72).

### I. Replace Index Spindle and Unlocking Cam

- 1: Renew packing washer.
- 2: Replace packing ring and three screws (41).
- 3: Insert index spindle through starting gear frame and unlocking cam.
- 4: Replace taper pin in unlocking cam and spindle.

### J. Replace Starting Piston Body

- 1: Reseat valve seat in body and lap valve to seat (41, WE75).

NOTE: If necessary to lap in a new valve, lap hole in body with lap tool WE56 and new valve with lap tool WE57.

- 2: When finished lapping, wash parts thoroughly in gasoline.

- 3: Replace starting piston body and washer in starting gear frame. Replace lock nut (432).

- 4: Oil (A) and replace starting piston and spring.

- 5: Replace valve plug and washer (12). Assembly of Starting Gear is now complete. For adjustments and tests see O. D. No. 750.

## IMMERSION MECHANISM, GYRO MECHANISM, GYRO GEARS

### A. Gyro and Immersion Mechanism—Disassemble

- 1: Remove gyro reducing valve and pipes:
  - (a) Disconnect air pipe to reducing valve (24).
  - (b) Disconnect air pipe from reducing valve at nipple on mechanism (24).
  - (c) Remove 2 holding screws, and remove reducing valve with "T" nipple and pipes assembled (246A).
- 2: Remove air chamber:
  - (a) Remove transportation screw (49).
  - (b) Remove access plug for weight and washer (11).
  - (c) Remove holding nuts for air chamber (48).
  - (d) Install lifting tool and remove air chamber (409).
- 3: Remove diaphragm:
  - (a) Remove cotter pin (72) through lower depth spring socket nut.
  - (b) Remove nut on lower depth spring socket (407, 461).
  - (c) Remove diaphragm plate (pry off with screw drivers).
  - (d) Remove diaphragm.
  - (e) Remove 3 holding screws and the diaphragm ring (40).
- 4: Remove pendulum lever and diaphragm lever shaft:
  - (a) Remove cotter pin and pin for pendulum link to pendulum lever (72).
  - (b) Remove keep screw for diaphragm lever shaft (41).
  - (c) Remove pendulum lever and diaphragm lever shaft assembled.

NOTE: Insert a soft brass rod in back of pendulum lever, close to its hub, and

tap out the shaft. Great care must be exercised, in removal of this shaft, not to bend the pendulum lever.

- 5: Remove depth spring and sockets assembled and diaphragm lever:
  - (a) Turn depth spring adjusting spindle until thread or adjusting screw disengages threads on upper depth spring socket (180).
  - (b) Remove depth spring with sockets and diaphragm lever assembled.
  - (c) Remove cotter pin, washer, pin and diaphragm lever from depth spring socket (72).

- 6: Remove linkage from pendulum to valve:
  - (a) Remove cotter pin (72) for tension rod bearing pin.
  - (b) Slip pendulum tension rod assembly clear of its pivot on pendulum.
  - (c) Remove wire (72) and holding screw (49) for valve lever bracket.
  - (d) Remove valve lever bracket with valve lever and pendulum tension rod assembly.

- 7: Remove steering engine valve rockshaft linkage:
  - (a) Remove 2 screws (41) for bearing cap.
  - (b) Remove rockshaft assembly from bearing.
  - (c) Remove spring buttons and springs under rockshaft bearings.

- 8: Remove pallet mechanism driving gear shaft, bearing cap and bracket:
  - (a) Remove 6 holding screws (41).
  - (b) Remove driving gear bearing cap.
  - (c) Remove pallet driving gear and shaft.

- (d) Remove driving gear bracket (41, 48).

- 9: Remove clamp for gyro pipe nipple:
  - (a) Remove 2 holding screws (40).
  - (b) Remove clamp.

- 10: Remove after section of pendulum:
  - (a) Lock gyro spinning mechanism (205A).
  - (b) Remove 2 screws (39) holding after section of pendulum.
  - (c) Remove after section of pendulum.

- 11: Remove gyro spinning rotor:
  - (a) Hold spinning shaft gear with a spanner, (201) pins of spanner meshing across teeth of spinning gear (File spanner pins to fit).
  - (b) Insert pins of tool No. 25 in holes in rotor and unscrew rotor from spinning shaft.
  - (c) Remove bronze spacing washer.
  - (d) Unlock gyro spinning mechanism.

- 12: Remove gyro spinning and unlocking mechanism assembled:
  - (a) Remove 6 holding screws (41, 233) for spinning mechanism.
  - (b) Remove gyro spinning mechanism.

- 13: Remove depth setting spindle and socket:
  - (a) Remove cotter pin (72) and nut (180, 155).
  - (b) Lift out depth setting spindle and remove pinion gear.

- 14: Remove forward section of pendulum:
  - (a) Remove cotter pins (72) and taper pins for knife edges (166).
  - (b) Remove knife edges, pushing through from the outside.

(c) Remove forward section of pendulum.

(d) Remove depth spring, adjusting screw and idler gear.

**15:** Remove pendulum adjusting linkage:

(a) Remove cotter pin (72) and washer in pivot for linkage adjusting arm.

(b) Remove linkage adjusting arm with pendulum link.

(c) Remove pin in nut for plate adjusting screw (166).

(d) Remove nut for plate adjusting screw.

(e) Back out clamp screw (40) for plate adjusting screw.

(f) Remove plate adjusting screw.

**16:** Remove immersion gear casing:

(a) Remove 10 holding nuts (48).

(b) Remove immersion gear casing.

(c) Remove gasket for immersion gear casing.

**17:** Remove top plate:

(a) Remove 2 holding screws (41) for adjusting worm bracket.

(b) Remove bracket with worm.

(c) Remove holding screws (41) and retainer plates for top plate.

(d) Remove top plate.

## **B. Gyro and Immersion Mechanism—Assemble**

**1:** Replace top plate:

(a) Clean, inspect for burrs, oil (A) and see that top plate fits snugly and turns smoothly on its seat on gyro pot.

(b) Replace retainer ring, marked with a zero, in line with reference pointer in pot and secure with holding screws (41).

(c) Replace retainer ring not marked and secure with holding screws. See that top plate turns smoothly in its bearing after securing with retainer rings.

(d) Turn top plate so that zero mark on retainer ring lines up with reference pointer.

(e) Clean, inspect for burrs on seat of bracket and on worm, and replace top plate adjusting worm bracket, with worm meshing in toothed segment of top plate.

NOTE: Make sure that worm is in proper mesh, and that holes for holding screws are in alignment, before setting up on screws. It may be necessary to loosen up clamp nut for adjusting worm to obtain proper alignment.

(f) Replace holding screws and secure (41).

**2:** Replace immersion gear casing:

(a) Clean old gasket material and rough spots from seat for gasket.

(b) Install new gasket over studs on seat.

(c) Install immersion gear casing, and secure with holding nuts, tightening up evenly (48).

**3:** Replace pendulum adjusting linkage:

(a) Clean, inspect, oil (A) and replace plate adjusting screw (41).

(b) Clean, inspect, oil (A) and replace clamp screw for plate adjusting screw (40).

(c) Replace nut and pin for plate adjusting screw (166).

(d) Clean, inspect, oil (A) and replace linkage adjusting arm with pendulum link.

(e) Replace washer and cotter pin (72) in pivot for linkage adjusting arm.

**4:** Replace forward section of pendulum and knife edges:

(a) Clean and inspect pendulum arms for alignment, seeing that lead weight is secure, and that roller path is clean.

(b) Place pendulum around immersion gear casing.

(c) Clean, inspect and oil (A) knife edges.

(d) Lift pendulum rods into alignment with holes, and install knife edges with holes for taper pins in line.

(e) Replace taper pins and cotter pins (72).

**5:** Install gyro spinning and unlocking mechanism:

NOTE: If necessary to overhaul gyro spinning and unlocking mechanism, see step D.

(a) Lock gyro spinning mechanism (205A).

(b) Remove spinning rotor and spacer (25).

(c) Unlock gyro spinning mechanism.

(d) Install gyro spinning mechanism and secure with 6 holding screws (41, 233).

(e) Replace holding clamp for air impulse nipple and secure with two holding screws (40).

**6:** Replace after section of pendulum:

(a) Lock gyro spinning mechanism (205A).

(b) Clean, inspect, oil (A) and replace after section of pendulum.

(c) Secure after section of pendulum with 2 holding screws (40).

**7:** Replace spinning rotor:

(a) Replace spacing washer, seeing that washer fits properly over end of spinning shaft.

(b) Replace spinning rotor, turning spinning shaft by hand until rotor is seated, then tighten with spanner wrenches.

**8:** Replace pallet driving gear bracket and driving gear:

(a) Clean, inspect, oil (A) and replace driving gear bracket (48, 41).

(b) Clean, inspect, oil (A) and replace driving gear and bearing cap.

(c) Secure bearing cap with six holding screws (41).

**9:** Replace steering engine valve rockshaft linkage:

(a) Clean, inspect, oil (A) and replace springs and buttons in rockshaft bearing.

(b) Clean, inspect, oil (A) and replace valve rockshaft with arms assembled.

(c) Clean, inspect, and replace bearing cap and screws (41).

**10:** Replace depth spring adjusting spindle with gears:

(a) Clean, inspect, oil (C) and replace idler gear in mesh with gear on adjusting screw; see that thin flanged side of idler gear is facing against the casing.

(b) Clean, inspect, oil (C) and replace adjusting spindle and gear and secure gear to bottom of spindle with nut (155) and cotter pin (72).

**11:** Replace depth spring, diaphragm lever and sockets assembled:

(a) Inspect diaphragm lever for trueness, using inspection plate (WE175).

(b) Replace diaphragm lever in slot on lower spring guide, secure with pin, washer, and cotter pin (72).

(c) Clean, inspect, oil (C) and replace depth spring and socket assembly. See that spring guides line up with slots in casing. Turn adjusting spindle when inserting until square hole in diaphragm lever lines up with bearing holes for shaft (180).

**12:** Replace pendulum lever (long) and diaphragm shaft:

(a) Remove pendulum lever from diaphragm lever shaft and check for trueness on inspection plate (WE175); replace on shaft, and secure with taper pin (166).

(b) Replace pendulum lever and diaphragm lever shaft in bearing guiding shaft through diaphragm lever, and secure with keep screw (41).

(c) Re-connect linkage of pendulum to upper end of pendulum lever with pin and cotter pin (72).

**13:** Replace linkage from pendulum to valve:

(a) Replace valve lever bracket with valve lever and pendulum tension rod assembly.

(b) Replace holding screw for valve lever bracket (49) and secure with wire (72).

(c) Replace cotter pin (72) for tension rod bearing on pin in pendulum arm.

**14:** Replace diaphragm ring:

(a) Replace diaphragm ring on its seat with projecting lip in line with diaphragm lever.

(b) Secure diaphragm ring with 3 holding screws (41).

(c) See that there is a clearance of not less than .015" between diaphragm lever and its stops, when pendulum is moved full over either way, and that clearance is equal at both stops.

**15:** Replace diaphragm:

(a) Replace diaphragm with bulged side facing out.

(b) Clean and replace diaphragm plate.

(c) Replace diaphragm nut (461, 407) and cotter pin (72).

**16:** Replace air chamber:

(a) Replace air chamber over diaphragm.

(b) Secure with 6 nuts (48).

(c) Replace washer and access plug in air chamber (11).

**17:** Replace transportation screw:

(a) Center pendulum, hold it there and screw transportation screw into place (49).

**18:** Replace bottom head and gyro clamp cover:

(a) Clean, inspect, oil (A) and replace bottom head with screw holes lining up.

(b) Secure with 6 holding screws (246A).

(c) Replace gyro clamp plate cover and washer (13-14).

#### 19: Replace gyro reducing valve:

NOTE: For overhaul of gyro reducing valve see steps D and E.

(a) Replace reducing valve, with T nipple and pipes assembled (246A).

(b) Connect air pipe (24) from reducing valve to nipple on mechanism.

(c) Connect air pipe (24) to reducing valve.

### \*C. Spinning and Unlocking Mechanism—Disassemble

See pages 114 to 119 for procedure. Follow only if overhaul is necessary.

### \*D. Gyro Reducing Valve—Disassemble

NOTE: Leak and function test (See O. D. No. 750) should be performed prior to disassembly, to determine if it is necessary to proceed with steps F and G.

1: Remove lock (48) and adjusting nuts (155).

2: Remove spring and washer.

3: Remove the diaphragm follower plug.

4: Remove split pins (72), nut and washer (155) for diaphragm.

5: Remove diaphragm and reducing valve stem.

6: Clean and inspect reducing valve body, checking closely for scored cylinder walls. Lap hole if necessary (WE177).

7: Clean and inspect reducing valve stem. See that lapped surface is free of scratches or burrs. If stem is too close in body, replace by lapping in a new stem (WE139).

8: Clean, inspect and renew diaphragm if it shows indication of having been strained.

9: Place a small amount of lapping compound around seat for diaphragm. Screw diaphragm follower plug down against this seat and rock tool back and forth, thus removing any high spots which may be found in this seat. Remove nut and wash seats clean.

### \*E. Gyro Reducing Valve—Assemble and Test

1: Replace diaphragm:

NOTE: Before proceeding, turn a hardwood stick to the diameter of the valve stem, with one end tapered down to fit hole in center of diaphragm.

(a) Slip hardwood stick through hole in reducing valve body.

(b) Replace diaphragm on seat in valve body, centered on small end of hardwood stick.

(c) Replace follower nut for diaphragm, and set up tight.

(d) Remove wooden stick.

2: Replace valve stem:

(a) Wipe small amount of oil (D) on the lapped portion of reducing valve stem.

(b) Insert valve stem into valve body.

(c) Secure to diaphragm with washer, nut (246A, 155) and cotter pin (72).

3: Replace spring:

(a) Replace spring, washer, adjusting and lock nuts (48, 155).

4: Test gyro reducing valve:

(a) For test of gyro reducing valve, see O. D. No. 750.

### F. Pallet Mechanism—Disassemble

1: Hold thumb on bell crank and loosen screw (40) for extender on left hand pallet pawl.

2: Remove cotter pin and pin (72) for bell crank.

3: Remove cotter pin (72), conical washer and lift out bell crank and link.

4: Remove holding screw (37) and extender from left pallet pawl.

5: Remove cotter pins (72) from pins in pallet slide cover and remove pallet pawls with adjusting links and adjusting spring.

\*6: Remove cotter pins (72) and adjusting links from pallet pawls.

7: Remove clamp screw and nut (37) for pallet blade.

8: Remove pallet shaft with spring and cam pawls. (Care should be taken when removing pallet shaft that the small bridge or leaf spring in slot on pallet shaft does not get lost).

9: Remove 4 screws (37), pallet slide cover and bell crank bracket.

10: Remove screw plugs (40), springs and actuating plungers for pallet slide.

11: Remove bearing cap (40) and driving gear.

12: Remove cam bevel gear.

13: Remove pallet slide, with pallet holder and adjusting screws assembled.

\*14: Remove gimbal bearing holder and washer in top plate (WE165, WE165B).

NOTE: Should it be necessary to remove gimbal bearing holder in top plate, care must be taken that spacing washer under holder is not misplaced before reassembly, as this washer is made the correct thickness for proper adjustment of outer gimbal bearing. It is good practice to measure thickness of washer as soon as removed, so that should it become lost, a new washer may be ground to exact size. Spare washers are furnished 0.045" thick and in most cases are ground down to between 0.025" and 0.030" when fitted.

Disassembly of parts on top plate is now complete.

### G. Pallet Mechanism—Assemble and Adjust

1: Clean and inspect pallet slide and holder:

(a) See that hardened insert fits tightly on pallet slide.

(b) See that pallet shaft is a snug, lapped fit in pallet holder.

(c) Stone out any burrs found on pallet slide.

(d) See that pallet holder adjusting screws works freely.

(e) Install pallet slide, with holder assembled on top plate.

2: Replace cam bevel gear:

(a) Clean and see that bushing is tight in cam bevel gear.

(b) Inspect for burrs on gear teeth and bearing surface.

(c) Install cam bevel gear.

(d) Replace driving gear, bearing cap and holding screws (40).

(e) See that, with pallet slide against stops on top plate, only a maximum play of 3.5 teeth exists when moving cam bevel gear to and fro; if more, it will be necessary to dress the pallet slide down with a stone, in wake of stops, in order to obtain the proper clearance.

3: Replace pallet slide cover:

(a) Clean and inspect, with particular attention to pins and stop pins for pallet pawls being tightly riveted on.

(b) Replace pallet slide cover and bell crank bracket, securing with four holding screws (40).

(c) After tightening screws, see that pallet slide moves in and out in top plate without restriction.

4: Clean, inspect and replace pallet slide spring plugs, springs and screw plugs (40); screw plugs should be flush with holes in top plate when tight. Turn cam bevel gear and see that spring plugs are moving freely.

5: Replace pallet shaft with cam pawl and spring: See that:

(a) Cam pawl is a snug fit on end of pallet shaft without any lost motion.

(b) Pallet shaft is a lap fit with unrestricted rotary movement in bearing in pallet holder (WE162, WE163).

(c) Ends of spring are free to slide in slot on shaft.

(d) Upper end of pallet shaft extends to just below upper end of bearing in pallet holder, permitting pallet blade to be installed on shaft without vertical motion (WE162A).

6: Replace pallet blade on pallet shaft: See that:

(a) Pallet blade is free of burrs and edges are sharp and square.

(b) Pallet blade fits snugly on pallet shaft.

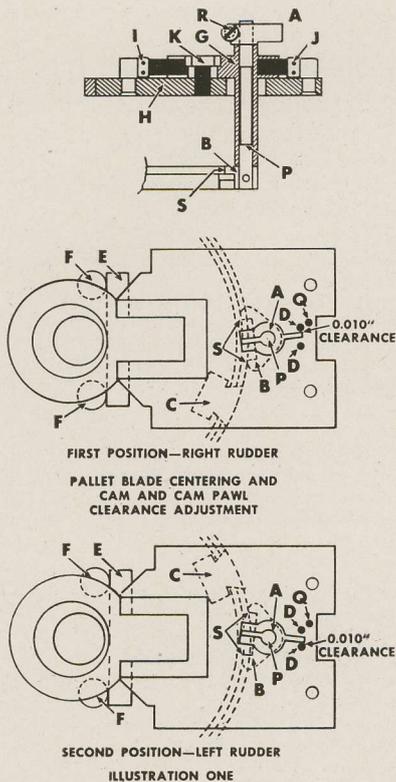
(c) Pallet blade is centered on pallet shaft.

(d) Pallet blade is installed and clamped on pallet shaft with only a very slight vertical play.

\*7: Replace spacing washer and top bearing holder. (WE165B, WE165) Make sure that spacing washer is the correct size.

8: Adjust clearance between cam and cam pawl:

(a) Turn cam bevel gear until pallet has moved to its extreme outer position,



and temporarily install gyro with cam on cam plate facing opposite the cam pawl. (13-14, 246A).

(b) Move pallet shaft (P) in toward cam plate by turning cam bevel gear, at the same time turning gyro vertically, so that the pallet cam (C) is brought into line with cam pawl (B); at the slightest indication of cam pawl binding on cam, loosen clamp screw (41) (K) and turn pallet holder adjusting screws (J and I) in a direction giving more clearance between cam pawl and cam.

(c) With cam pawl (B) moved all the way in against the gyro cam (C), so that a slight drag may be felt, due to cam pawl sliding against one or the other of concentric ridges on cam plate; when moving gyro right or left in pot, note clearance of pallet blade (A) with pins (D) in either direction. This clearance should be equal for both sides, and so adjusted by pallet holder adjusting screw that a measurement of  $0.010'' \pm 0$  may be attained on either side. (See first and second positions of Illustration One.)

9: Check pallet blade with gyro locked:

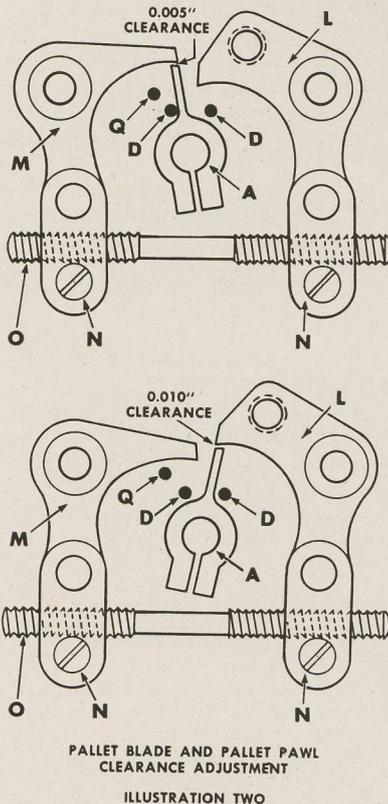
(a) Lock gyro (205A).  
 (b) Center pallet blade by turning cam gear until pallet pawl contacts cam on gyro cam plate.

(c) Check by eye to see that pallet blade is centered between pins. If off center, turn top plate adjusting worm until blade is centered between pins (246A, 161).

(d) Re-check clearances on both sides of blade and pins as in step 8 (c).

\*10: If previously taken off, replace right

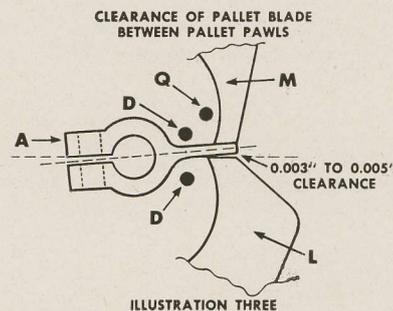
and left adjusting links (N) with adjusting screw (O) and split pins on pallet pawls (L and M); see that adjusting screw works freely in links; and that edges of pallet pawls are sharp. (Illustration Two).



11: Replace pallet pawl and linkage assembly on pallet pawl pins and secure with cotter pins (72).

See that:

(a) Fit of pins and holes is snug without binding.



(b) A clearance of not less than .003" nor more than .005" is present between either side of pallet blade and pallet pawl being measured. (Illustration Three).

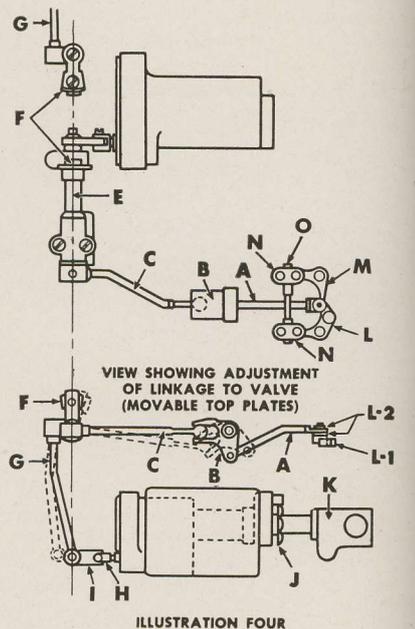
12: Check centering of pallet blade and zero graduation on retainer plates, with line on marker in pot.

(a) Lock gyro (205A).  
 (b) Place and hold pallet pawls in neutral position.

(c) Turn cam gear and see if pallet blade passes between pallet pawls. If pallet blade touches either pawl instead of passing between, the pallet blade is off center on pallet shaft, or marker for graduation on retainer plate is out of line.

(d) Turn top plate adjusting worm spindle slightly in direction necessary to cause pallet blade to run between pallet pawls. Now see if pallet blade clearances are equal on both sides (see step 8 (c)); if not, the pallet blade will have to be re-centered on shaft and it will be necessary to repeat the steps outlined above, after re-centering blade (246A, 161).

(e) Unlock and remove gyro (246A, 13-14).



13: Replace bell crank and link.

(a) Clean, inspect and replace extender and screw on left pallet pawl (40).

(b) Install bell crank (B) and link (A); insert pin for bell crank and secure with cotter pin (Illustration Four) (72).

(c) Clean, inspect, and replace small conical washer (L2) on pin in extender.

(d) Replace end of bell crank over pin on extender and secure with cotter pin (72).

Final adjustments of the pallet mechanism, including pallet and pallet pawl clearances, are made in combination with the gyro in adjusting stand.

## Steering Engine

1: Test prior to disassembly:

(a) Place engine in block of leakage testing stand.

(b) Connect low pressure air line to inlet nipple (141A) and turn on the air.

(c) Operate valve to move piston to full "in" position.

(d) Fork should just clear gland, with clearance of from .001" to .002".

(e) Move valve to full "out" and measure length of piston stroke. Full stroke

should be  $.375" \pm .010"$ . If the stroke is too short, decrease the thickness of the adjusting washer the amount required to obtain full throw after engine is disassembled.

(f) Test for leaks around valve and through piston exhaust. (Ability to judge excessive leakage is dependent upon knowledge of properly fitting steering engines.) In general, leaks through the piston exhaust should not be audible, and the valve should fit snugly enough to prevent air from blowing into the atmosphere. There is always a certain amount of leakage past the rings and out of the piston exhaust, as well as around the valve; the limit of such leakage must remain a matter of judgment. As an aid in determining this limit, operate the valve and note drop in pressure on supply line during stroke. This drop in pressure should be in the neighborhood of 10 lbs. per sq. in., using a supply line  $\frac{3}{8}"$  diam. and 2 ft. long. Excessive leakage from the exhaust is corrected by renewal of piston rings, although in extreme cases pistons or cylinders may have to be replaced.

#### 2: Disassemble engine:

- (a) Loosen fork clamp screw (49).
- (b) Unscrew fork. Scribe position before removal and count turns.
- (c) Remove gland lock screw (41).
- (d) Remove gland (18).
- (e) Remove valve, hold connection end with pliers (72), and unscrew valve stop screw (37).
- (f) Remove locking screw and washer from cylinder head (41).
- (g) Remove cylinder head (407 or 25).
- (h) Remove piston and adjusting washer, using screw driver to push piston out of cylinder.
- (i) Remove cap for strainer body and remove air strainer (402).

#### 3: Clean and repair:

- (a) Immerse parts in clean gasoline and blow dry with air.
- (b) If engine stroke is not correct as noted from step 1 (c) above, remedy by facing off or renewing adjusting washer.
- (c) Fit new piston rings if necessary (see O. D. No. 750 for method) (WE154, WE155, WE156).
- (d) Fit new valve if necessary (see O. D. No. 750) (WE126).
- (e) Lap valve hole if necessary (see O. D. No. 750) (WE135).
- (f) Lap cylinder if necessary (see O. D. No. 750) (WE153).

#### 4: Assemble engine:

- (a) Oil (C) parts.
- (b) Insert piston with adjusting washer (213).
- (c) Screw in cylinder head, with gasket in place (25).
- (d) Install locking screw for cylinder head (41).
- (e) Insert valve, secure with stop screw (72, 37).
- (f) Pack and install gland (18).
- (g) Screw in fork to scribe mark, using same number of turns as on disassembly.
- (h) Set up fork clamp screw (49).

(i) Replace air strainer in strainer holder.

(j) Replace cap for strainer body with washer (402).

(k) Test for leaks and clearance as outlined in test before disassembly. When engine passes these tests, it is ready for assembly on gyro mechanism.

### H. Depth Engine

1: For overhaul and test of depth engine see O. D. No. 750.

### I. Gyroscope—Disassemble

1: Test constant spin gyro for leaks prior to disassembly:

(a) Place gyro in fixture; see O. D. No. 750.

(b) Adjust air so that there is 125 lbs. per square inch pressure on air supply line.

(c) Turn on air to fixture. (Take air from heater issued with gyro spinning stand outfit.)

2: Test side bearings for leaks:

(a) Around edges of locking discs.

(b) Around edges of side bearing sleeves.

Note position of leaks for remedy after disassembly. Leaks around edges of locking discs are remedied by the insertion of paper washers between locking discs and sleeves, and also by lapping heads of screws for locking discs to their seats in discs. Leaks around edges of side bearing sleeves are remedied by lapping sleeves with a face lap, and outer gimble bearing surface lap (use light lubricating oil), and also by use of paper gaskets.

3: Remove locking discs for side bearings:

(a) Remove locking disc screws and locking discs (81).

(b) Take care not to injure paper washers beneath locking discs.

(c) Inspect recess between disc and sleeve for rust.

(d) Clean recess, but do not move position of bearing.

(e) Remedy any leak between locking disc and sleeve.

(f) Replace locking discs and washers (81).

4: Remove side bearing sleeve assemblies:

(a) Remove holding screws for sleeves to outer gimble ring (81).

(b) Note bench marks on sleeves and outer gimbal. Remove sleeves, using two No. 91 tools simultaneously.

(c) Place each sleeve assembly, with holding screws, in separate compartment of cleaning stand.

(d) See that holding screws are so placed that they can be reassembled in the same holes they occupied before assembly.

(e) When removing sleeve, take care not to damage paper washer.

5: Remove balls and retainer for side bearings:

(a) Use two hard wood sticks, preferably orange wood, for prying commercial balls and retainers off the inner races on center.

(b) Place in correct compartment of cleaning stand.

6: Remove inner races:

(a) Remove inner races, being sure that flanged ends of tool body fit into groove of supporting ring (416).

(b) Place inner races in proper compartment of the cleaning stand.

(c) See that commercial name of race is outside.

7: Remove inner gimbal and wheel assembly:

(a) Rotate inner gimbal and wheel, so that wheel axis is parallel to plane of outer gimbal ring.

(b) Remove inner gimbal and wheel assembly by rotating inner gimbal about wheel axis. Inner gimbal ring pivots pass through recesses of outer gimbal ring.

8: Test top pivot for leaks:

(a) Replace inner gimbal sleeves in outer gimbal ring, turned  $90^\circ$  from regular position, to blank off alignment of holes for air to side bearings (81, 483).

(b) Install test nozzle in top pivot, hold against seat and admit air until pressure in gimbal ring is 90 lbs. per square inch.

(c) Test with oil around edges, and over lifting holes of top pivot.

(d) Remedy leaks by lapping pivot seat, male lap (WE166). Paper washer will stop small leaks.

(e) Remove inner gimbal sleeves from outer gimbal ring (81, 91).

9: Disassemble inner gimbal ring:

(a) Slack off holding screws for inner gimbal halves (81).

(b) Remove holding screws for inner gimbal ring halves (81).

(c) Remove one holding screw for each inner gimbal side bearing center on same gimbal half (81).

(d) Loosen other holding screw for each inner gimbal side bearing center on opposite gimbal half (81).

(e) Start inner gimbal ring halves apart with lifting screws (91).

(f) As ring parts, grasp geared wheel hub and force it up into the wheel bearing that is uppermost, to prevent balls of wheel bearing from falling out.

(g) When halves are parted, reverse position of upper half.

(h) Remove gyro wheel.

(i) Remove balls from wheel bearings, placing them in proper compartment of stand (90).

10: Remove balls and retainers from bottom and top races:

(a) Use two hardwood sticks, preferably orange wood, for prying commercial balls and retainers of the inner races on center.

(b) Place in correct compartment of cleaning stand.

11: Remove wheel bearing:

(a) If necessary to remove or adjust wheel bearings, use tool (204).

12: Remove inner gimbal bearings:

(a) If necessary to remove or adjust side bearings, use tools (80, 204).

13: Remove bottom bearing assembly:

(a) With bottom bearing holder of gyro pot secured by set screw, and ad-

justing body secured with set screw, back out retainer plate or spring seat (41).

(b) Remove spring and button.

(c) Clean spring and button, oil (A) and replace in bearing holder.

(d) Remove bottom bearing holder from bottom head. Inspect and clean race (463, 41, WE192).

(e) Remove adjusting body assembly (204, 41).

## J. Inspect and Renew Gyro Parts Where Necessary

1: Inspect balls, ball bearings, inner and outer races of top, bottom and side bearings. Parts of these races are not interchangeable. If one part is unfit for use, the entire bearing must be renewed. Use tools as follows:

(a) Lapping flats under gimbal pivots (WE166).

(b) Lapping gimbal centers (WE167).

(c) Lapping side of ball bearings (WE168).

(d) Lapping bottom of ball cups (WE171).

(e) Scriber for turning balls in bearing when checking for freedom of movement in races (WE172).

(f) For squaring top bearing holders in lathe (WE182).

(g) Wrench, ball cup retainer assembly in top plate (WE188).

(h) For removing ball cup in top plate (WE189).

(i) Remove upper outer gimbal race (WE192).

(j) Lap side bearing sleeve to gimbal ring (WE193).

(k) Lap inner race for center (WE194).

(l) Lap top and bottom pivots (WE195).

(m) Lap side bearing pivots (WE196).

(n) Lap threads of wheel bearing (WE176).

2: Inspect gyro wheel:

(a) Inspect pivots for dents or fractures, using magnifying glass.

(b) Dented wheel pivots cannot be replaced in service.

(c) New wheel should be installed and old wheel sent to Naval Torpedo Station, Newport, R. I., for overhaul.

3: Inspect wheel bearings:

(a) Balls must be measured for correct diameter (WE5), and be free from pits.

(b) Outer races must be free from dents or pits. When renewing a wheel bearing, the new bearing should be balanced on the most accurate scales available, to insure its being the same weight as the old bearing. Where necessary, take weight off the new bearing by grinding. The gyro bearing polishing machine is furnished for this purpose.

4: Remove outer race in bearing holder for gyro top plate. Clean and replace (WE192).

5: Test bearing holder and top bearing in gyro top plate for leaks:

(a) Use test pipe and nozzle, furnished with balancing fixture, to carry away from extender.

(b) Test edges of bearing holder and

outer race, while air is being admitted through constant spin connection.

6: Remove cam plate from outer gimbal ring.

NOTE: It should never be necessary to remove the cam plate from the outer gimbal ring after manufacturing assembly, except if bent out of alignment due to the accidental dropping of the gyro, in which case proceed as follows:

(a) Remove 4 holding screws for cam plate (37), and remove cam plate.

(b) Place cam plate on surface plate and check position of band.

(c) Tap plate back into alignment with soft lead hammer.

(d) Replace on gimbal ring and secure.

(e) Place one side bearing end of gimbal ring on surface plate.

(f) With Universal indicator (WE10) measure height from surface plate to upper side of the cam.

(g) Reverse gimbal on surface plate so as to rest on the opposite side bearing end.

(h) Take measurements as in step (f) above (WE10).

(i) Measurements taken in steps (f) and (h) should be the same, within 0.001" of an inch.

(j) Should the measurements taken in steps (f) and (h) differ beyond allowable tolerances, it will be necessary to realign the cam plate as in steps (k), (l), (m) and (n).

(k) Remove the dowels, drill, tap and plug holes, using 1/8" x 40 plugs.

(l) Proceed to measure as in steps (e), (f), (g), (h), moving cam plate until within tolerance as given in step (i).

(m) Drill new holes for dowels, with cam plate secured in place on outer gimbal.

(n) Push dowels into plate in their new location.

## K. Gyroscope—Assemble

1: Assemble gyro wheel and inner gimbal halves:

(a) Place balls in wheel bearings, making sure that they are returned to their own races (90).

(b) Place wheel in position in one bearing of gimbal ring, and reverse position of wheel and gimbal half, holding wheel against bearing to prevent balls from falling out. See that bench mark on wheel coincides with bench mark on gimbal.

(c) Fit inner gimbal halves together.

(d) Replace holding screws for inner gimbal halves (37).

(e) Replace inner gimbal ring pivots and washers. See that pivot scratches coincide.

(f) Replace holding screws for pivots (37).

(g) See that balance nut sets at position of static balance. (1 1/2 turns from hard-up position) (37).

2: Place wheel in centering fixture (block) and center; see O.D. No. 750.

3: Check clearance of gyro wheel:

(a) Install and check number of swings of tool No. 414A.

(b) The tool should swing past the lower center position from 5 to 7 times.

(c) If wheel bearing position is changed due to this step, the wheel should be centered again as in step K (2).

4: Place inner gimbal on knife edges and test for static balance; see O.D. No. 750.

5: Replace inner gimbal and wheel assembly in outer gimbal:

(a) Replace top and bottom pivots and oil (A) each pivot with two drops of oil, using needle syringe.

(b) Replace inner gimbal and wheel assembly in outer gimbal; see step I (7).

(c) Replace inner races on inner gimbal ring pivots. Be sure race is all the way home, with commercial marking out. Inner races should go back on own pivots, in same relative position.

(d) Replace balls and retainers on inner races.

(e) Replace sleeve, paper washer and ball race assembly (see step I [4]). Do not remove locking discs (81, 91).

6: Replace balls and retainers on top and bottom pivots. Oil pivot with two (2) drops of oil (A) each, using needle syringe.

7: Place gyroscope assembly in balancing fixture and center in outer gimbal; see O.D. No. 750.

8: Check end play of side bearing; see O.D. No. 750. The end play of the side bearings should be 0.005" in all gyros.

9: Retain gyro in fixture and test side bearings for leaks. (See steps I [1] and [2] of disassembly.)

Gyro is now ready for installation and final adjustment with mechanism.

## L. Adjustments and Tests

1: Place gyro mechanism in spinning stand; see O.D. No. 750 for instructions.

2: Install gyro in mechanism:

(a) Turn pallet driving gear until cam pawls are in extreme out position, away from center.

(b) Install gyro in pot, with cam on cam plate opposite from cam pawls, to prevent fouling.

(c) Make sure that top pivot is centered in ball race and does not hang up; in gyros with commercial bearings, make sure that balls for top race do not hang up on edge of outer race.

NOTE: It is good practice to cause gyroscope assembly to revolve on its upper bearing when installing bottom head, thus making certain that balls and bottom bearing are lined up.

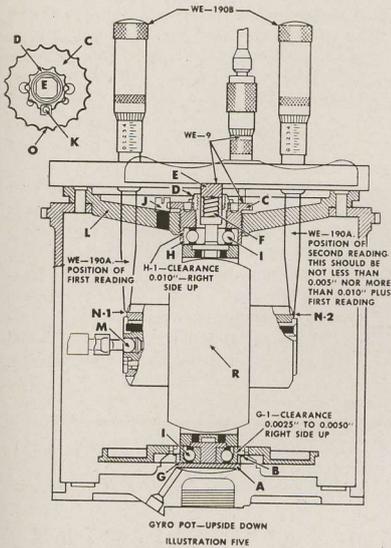
3: Install bottom head (L) (246A) with lower adjustable bearing holder (C) removed (See Illustration Five).

4: Install bottom bearing holder:

(a) Remove the adjusting body assembly D, E, F and P from the bottom bearing holder.

(b) Install the bottom bearing holder (C) and outer race (H).

(c) Set up on the bottom bearing holder (C) until the balls (I) of both bottom



GYRO POT—UPSIDE DOWN  
ILLUSTRATION FIVE

and top races (G & H) are in contact with the curved path of these races.

**CAUTION:** See that balls are properly centered in their races when executing step 2 above. The balls for the lower bearing may be seen through the tapped hole in the bearing holder.

**5:** Check spacing washer under top bearing for proper thickness:

**NOTE:** It is important that this washer be of the correct thickness to insure alignment of the gyroscope axis with the centering pin in the spinning gear, so that when the centering pin is withdrawn after spinning, no reaction will be set up which will tend to deflect the gyroscope. As the relative heights of the gyroscope and centering pin (M) in pot cannot be measured directly on their axes, two measurements are taken, one on each end of the inner gimbal ring. (See N1, N2, Illustration Five). Half the difference between these measurements (see R) will be the amount which the center of the gyroscope is out of alignment with the centering pin.

(a) Lock gyro (205A).

(b) Place Depth Micrometer base (WE190B) across seat for gyro clamp plate in pot, located so that depth gauge spindle will line up with outer edge (see location at N1) of gimbal ring locking end. Note measurement carefully.

(c) Reverse location of Depth Micrometer (WE190B) so that depth gauge spindle will line up with outer edge of gimbal ring free end (see location at N2), and note reading carefully.

(d) Subtract the sum of the first reading from the sum of the second reading; with allowable tolerance, the remainder should be not less than 0.005" nor more than 0.010".

(e) Example where remainder less than 0.005":

Remainder is minus 0.025"

Unlock gyro (205A).

Remove bottom head (L) (246A).

Remove gyro from mechanism.

Remove top bearing holder (A).

Remove washer (B) under top bearing.

With micrometer calipers (WE5), measure thickness of this washer.

Since the remainder is minus 0.025", it must be minus 0.030" of allowable tolerance on reading at N2; in this case it will be necessary to reduce the thickness of the washer by grinding to 0.015", or one-half of the remainder. Should it be necessary to fit a new top bearing washer (B) in the service, care must be exercised to grind to an even thickness all over, in order that the top bearing holder (A) will seat evenly on this washer.

(f) Should the remainder be more than plus 0.010", washer (B) is too thin, in which case a new washer of the proper thickness will have to be fitted.

**6:** Adjust bottom bearing holder to give clearance between upper and lower ball bearings:

**NOTE:** The external diameter of bottom bearing holder (C) is threaded 20 threads to the inch, to fit similar threads tapped in the bottom head (L). 20 scallops (O) are machined around a flange on its outer end for alignment with the adjustment lock screw (J). Thus rotating the holder one scallop in the bottom head will cause a traversing movement of 0.0025".

For this adjustment a clearance of 0.0125" is the most desirable between the balls (I) in the lower bearing, and the curved path on their outer race (H), provided the balls (I) of the top race contact the curved path of their outer race (G). This clearance will permit a 0.010" clearance at (H1) and a 0.0025" clearance at (G1), after adjustments are made and gyro is right side up. However, this adjustment may vary slightly, as a scallop may not line up with the lock screw hole, in which case the scallop nearest the screw hole should be moved in line with same.

(a) See that a scallop (O) on the bearing holder (C) lines up with the hole for lock screw (J); if not, back the nearest scallop into line. If this movement is less than half a scallop, back off 5 additional scallops and install set screw (J); this will give a clearance of from 0.0125" to 0.0137".

(b) If the lining up of the first scallop takes a rotation of more than 1/2 a scallop, the bearing holder (C) should be backed off only 4 scallops and the lock screw (J) installed; this adjustment will give a clearance of from 0.0100" to 0.0125".

(c) If a scallop is lined up with lock screw hole when top and bottom balls (I) contact curved path of their races (G and H), back off 5 full scallops and install lock screw (J). The clearance between top and bottom ball races will then be exactly 0.0125", which is the most desirable clearance.

**7:** Adjust clearance of top outer gimbal bearing:

**NOTE:** In order to obtain correct vertical alignment of the gyroscope axis with the centering pin, when the lower center of outer gimbal ring is contacting the spring button in the lower bearing (with torpedo right side up) the clearance in the top outer gimbal bearing must be adjusted

to half of the sum of the difference obtained between first reading at N1, and the second reading at N2, of micrometer tool WE190A, as taken in step L (5) above.

(a) Ascertain that gyroscope assembly is properly seated on its upper bearing, with balls (I) contacting curved path of the outer race (G).

(b) Install adjusting body assembly (D), (E), (F), (P) in bottom bearing holder (C).

(c) Set up on adjusting body until no vertical play can be felt between upper bearing at (G1) and lower bearing at (P1).

(d) Place micrometer depth gauge (WE9) with the base resting on the flat face of plug (E).

(e) Measure depth to flat face on bottom bearing holder (C) (note position of [WE9] as shown in figure 5) and check this reading carefully.

(f) Reset micrometer depth gauge, adding one half of the difference between the reading of (WE190A) at N1 and N2, as taken in step L5. For example:

$$\text{Reading at N1} - \text{Reading at N2} = 0.005" \\ \frac{0.005"}{2} = 0.0025" \text{ to be added.}$$

$$\text{Reading at N1} - \text{Reading at N2} = 0.0075" \\ \frac{0.0075"}{2} = 0.037" \text{ to be added.}$$

$$\text{Reading at N1} - \text{Reading at N2} = 0.010" \\ \frac{0.010"}{2} = 0.005" \text{ to be added.}$$

(g) Back out the adjusting body (D), sufficiently to permit measuring-spindle on micrometer depth gauge (WE9) to clear flat face on bottom bearing holder (C), when base of gauge is resting flush on plug (E), as in step L (7) (d) above. Replace depth gauge on plug (E).

(h) Screw in on adjusting body (D) until measuring-spindle on depth gauge just contacts the flat on bearing holder (C) with the base flush on plug (E). This will give a clearance at (P1) equal to the difference in depth gauge adjustment, as reset in step L (7) (f) above, and consequently a similar clearance at (G1) with the torpedo right side up.

(i) Secure adjustment made in step (h) above with lock screw (K).

**NOTE:** It is not always possible to secure adjustment obtained in step (h) above, without a slight change, as the scallop in adjusting body (D) may not line up with the hole for lock screw (K), making it necessary to turn the nearest scallop into alignment for set screw. A change so made is considered negligible and is within the tolerance of allowable bearing clearances.

**8:** Adjust pallet mechanism linkage to steering engine:

**NOTE:** Adjustment for cam and cam pawl clearance, and centering of pallet blade, is done during assembly of pallet mechanism on top plate. For these adjustments see step H, Pallet Mechanism Assembly.

(a) Install steering engine, connect

valve, and connect air to engine (141A, 246A, 184).

(b) Turn driving gear shaft until cam bevel gear moves pallet slide with pallet to its extreme outer position away from gyro cam plate.

(c) Move pallet (A) in line with the left pallet pawl (L); note clearance between end of pallet and the pawl. (See Illustration Two) (WE2).

(d) Move pallet (A) in line with the right pallet pawl (M); note clearance between end of pallet and the pawl (WE2).

(e) Assuming that step H (12) of assembly procedure, has been complied with, and that valve arm (G) is bent to correct alignment with valve, loosen clamp

screw (41) for adjusting head (F) on rockshaft (E) and clamp screws on right and left pallet pawl adjusting links (N) for pallet pawl adjusting screw (O). (See Illustration Four).

(f) Rotate adjusting head (F) on rockshaft (E) in a direction to obtain the desired difference in clearances, and at the same time turn pallet pawl adjusting screw (O) (WE2) to obtain the proper amount of this clearance.

(g) As will be noted for "Pallet blade and pallet pawl clearance adjustment" shown in Illustration Three, the clearance of pallet (A) and right pawl (M) should be 0.005", whereas the clearance of pallet (A) and left pawl (L) should be 0.010".

This difference in clearance is necessary in order to obtain a uniform valve movement, with a snappy steering engine throw from both pawls. The motion from the pallet (A) to the right pawl (M) is transmitted through the right and left adjusting links (N) and adjusting screw (O) to the left pawl (L), with lost motion due to tolerances in linkage; whereas the motion from the pallet (A) to the left pawl (L) is transmitted by direct contact and therefore without this lost motion.

(h) Having obtained the desired clearance adjustments, secure clamp screws.

The above steps will complete the pallet mechanism linkage adjustment, and the adjustment of gyro to its mechanism.

## ASSEMBLY AND TEST OF AFTERBODY AND TAIL COMPLETE

### A. Afterbody Pipes

1: Clean, inspect, anneal, reseal seats on collars, and chase burrs off threads on nuts where necessary, of the following pipes on bulkhead and in afterbody, using tools indicated:

(a) Stop and charging valve to valve group (WE81).

(b) Valve group to turbine bulkhead (gyro spin) (WE84).

(c) Strengthening ring to gyro mechanism (gyro spin) (WE84).

(d) Combustion pot to bulkhead (air strainer) (WE86).

(e) Strengthening ring to air strainer (WE86).

(f) Air strainer to depth engine (WE86).

(g) Air strainer to steering engine (WE86).

(h) Valve group starting valve to bulkhead (WE86).

(i) Strengthening ring to starting gear (WE86).

(j) Valve group to air checks (WE84).

(k) Valve group to igniter (WE86).

(l) Bulkhead to sprays (WE86, WE88).

(m) Vent fitting to bulkhead (WE85).

NOTE: Other pipes assembled with afterbody are listed with units to which they assemble.

### B. Replace Starting Gear

1: Place a new gasket on starting valve flange and soak with oil (D).

2: Install starting gear.

3: Secure with eight holding screws (40).

4: Connect pipes, strengthening ring to starting gear (141A).

5: Connect pipe-strengthening ring to air strainer (141A).

### C. Install Main Engine Assembly in Afterbody

1: Attach propeller guiding tool (WE34).

2: Connect pipe (oil tank to oil pump) to nipple on oil pump (229).

3: Swing rudder rods clear.

4: Install lifting handles (446A, 446B).

5: Place a new gasket on bulkhead seat and soak with oil (D).

6: Insert main engine assembly in afterbody, guiding propeller shaft through after bearing, and push all the way in on bulkhead seat.

NOTE: It requires two men to install main engine assembly in afterbody; one to guide shaft and one to carry forward end. It is important that forward end be carried high all the way in, as otherwise the propeller shafts may bind in after bearing.

7: Remove lifting handles.

8: Replace nuts for turbine bulkhead screws (48).

9: Connect the following pipes to manifold bracket on strengthening ring:

(a) Bulkhead to strengthening ring, gyro spin (229).

(b) Bulkhead to strengthening ring, starting gear (141A).

(c) Bulkhead to strengthening ring, strainer (141A).

(d) Bulkhead to strengthening ring, starting gear return (141A).

10: Connect pipe (oil pump to oil tank) to oil tank (229).

11: Replace gasket and turbine nozzles with combustion flask; secure with nuts (227A).

12: Install valve group:

(a) Hold valve group in place, and attach to combustion flask with coupling nut (134A).

NOTE: Care must be exercised when securing coupling nut, to see that threaded parts of the valve group and combustion flask enter each the same distance into the coupling nut to insure proper seating of the joint.

(b) Secure valve group to bulkhead with two (2) holding screws (227A).

(c) Secure heads of holding screws with wire (72).

13: Connect the following pipes on bulkhead:

(a) Valve group to turbine bulkhead (gyro spin) (229).

(b) Combustion flask to bulkhead (air strainer) (141A).

(c) Starting valve to bulkhead (141A).

(d) Valve group to air checks (229).

(e) Valve group to igniter (141A).

(f) Bulkhead to fuel sprays (141A).

(g) Vent fitting to bulkhead (141A).

(h) Bulkhead to water spray (144).

### D. Pack After Propeller Shaft Bearing

1: Remove follower for packing (452).

2: Oil (D) and replace felt packing in after propeller shaft bearing.

NOTE: If packing appears to be too small to go over the shaft, do not attempt to force and so tear the end; by heating the packing it will go over the shaft without being forced.

3: Remove propeller guide tool (WE34).

4: Replace follower for packing, and set up tight (452, 54).

### E. Install Gyro and Immersion Mechanism

1: Place gasket on gyro door frame.

2: Remove gyro clamp plate cover (13-14).

- 3: Remove transportation pin (49).
- 4: Relieve all tension on depth spring (180).
- 5: Set depth index on zero (135A).
- 6: Remove pipe from gyro reducing valve to steering engine (141A).
- 7: Attach depth and steering engines to their respective rudder rods in afterbody, secure with rudder rod pins and lay aside in afterbody (449).
- 8: Replace gyro and immersion mechanism, replacing connecting rod for pallet driving gear.
- 9: Remove lifting screws (200).
- 10: Secure housing with clamp screws (456).
- 11: Replace transportation pin (49).
- 12: Attach gyro spin lead (229).
- 13: Attach steering engine to gyro pot, secure with two holding screws (49, 49A) and wire screw heads (72).
- 14: Connect valve connection (246A).
- 15: Replace pipe, reducer valve to steering engine (141A).
- 16: Attach air lead to steering engine (141A).
- 17: Attach depth engine to gyro pot, secure with two holding screws (49, 49A) and wire screw heads (72).
- 18: Connect valve connection (246A).
- 19: Attach air lead to depth engine (141A).

## F. Replace Hand Hole Plates

- 1: Oil gaskets (D) and replace.
- 2: Replace hand hole plates (200).
- 3: Secure hand hole plates with holding nuts (48).
- 4: Replace washer and afterbody drain hole plug (13-14).

## G. Test Afterbody Assembly for Leaks

- 1: Blank off the following pipes:
  - (a) Main air pipe from stop and charging valve (134A).
  - (b) Fuel from check to spray (141A).
  - (c) Water from check to spray (144).
  - (d) Reduced pressure air to air check valve (229).
- 2: With grease gun force grease (G) through after propeller shaft until it appears around bushing between shafts (462, 481B).
- 3: Install exhaust valve gag spring (WE228).
- 4: Remove drain plug (13-14) and install special test fitting for low pressure air with gauge (141A).
- 5: Connect low pressure gauge and air line to this fitting.
- 6: Turn air on and allow 10 lbs. pressure to accumulate in afterbody.

7: Pour oil (C) around flange and joints, and see if any air bubbles appear, indicating leaks. Inspect for leaks around steering rod stuffing boxes, propeller shaft packing, and exhaust valves. All leaks so found must be remedied before proceeding further with assembly.

8: With the test completed, and leaks stopped where necessary, remove special tools and fittings used for this test.

## H. Overhaul and Assemble Tail on Afterbody

- 1: Clean and inspect tail cone:
  - (a) Clean and inspect all bearing surfaces of both rudder yokes. If necessary to remove burrs, use bearing scraper and fine oil stone. With aligning gauge (WE219) check alignment of vertical rudders, and with (WE212) check alignment of horizontal rudders.
  - (b) Clean, inspect, oil (B) and replace rudder connections (41), washer and cotter pin (72) on rudder yokes (72).
  - (c) Clean and inspect vertical and horizontal rudders, and outboard bearings for rudders.
  - (d) Oil (B) and replace rudder yokes and rudders in tail cone. Oil (B) and replace outboard bearings for rudders. Replace screws previously removed in outboard bearing in the same holes from which removed, and set up tight (41).
  - (e) With thickness gauge (WE2) check clearance of rudder yokes between yokes and outer bearing surface. This clearance should be .015".

**IMPORTANT NOTE:** When assembling rudders and outboard bearings, particular attention should be paid to the assembly numbers. The tail blades are numbered 1, 2, 3, and 4 on their after edges, the rudders the same on their forward edges and the outboard bearings the same on their after ends. It is important that these numbers are assembled to match. When assembled, the clearances between the bearing shoulders of the rudder spindles and the outboard bearings should be .015" (WE2).

(f) Clean, inspect, oil (B) and replace tail bearing in tail cone. Secure with screws, setting up tight (40).

- 2: Assemble forward propeller sleeve:
  - (a) Clean and inspect forward propeller sleeve, keys and keyways.
  - (b) Replace grease packing ring in forward propeller sleeve secure with keep screws (41) and wire (72).

**NOTE:** Tapered side of grease packing ring is assembled in the forward position.

(c) Grease (G) and replace forward propeller sleeve on propeller shaft.

**NOTE:** Assemble with bench marks (O) in line.

(d) Clean, oil (D) and replace four holding clips for forward propeller sleeve.

**NOTE:** Before inserting clips, turn propeller shaft in line with recess in bulkhead.

(e) Replace screws (41) in holding clips and wire (72); try to pull sleeve off as a check to see that pins are properly seated in the holes in the shaft.

3: Replace tail on afterbody:

(a) If previously removed, replace spider supporting straps, with their reinforced pieces, on forward ends of tail blades with numbers corresponding, and secure with holding screws (39).

(b) See that tapped holes for joint screws in after bulkhead are clean and free of burrs. If necessary, tap out hole, use 1/4 x 20 tap.

(c) Replace tail on afterbody and secure with sixteen joint screws (184).

(d) Connect rudder connections to rudder rod eyes, and replace washers and drain plugs in tail cone (13-14).

4: Assemble forward propeller:

(a) Clean, inspect, oil (B) and replace two keys for forward propeller hub in forward propeller sleeve.

(b) Replace hub for forward propeller on propeller sleeve. It may be necessary to tap hub on tight with lead hammer.

(c) Replace forward propeller on propeller hub.

(d) Replace nut for forward propeller. Set up on nut until screw holes for lock screws are in line (185C, 185D).

(e) Replace two lock screws in nut for forward propeller (40).

5: Assemble after propeller:

(a) Clean and inspect keys and keyways for after propeller sleeve.

(b) Clean and inspect, for burrs and scored surfaces, four bushings for after propeller sleeve. If necessary, remove burrs with bearing scraper and stone smooth with oil stone. See that all oil holes and oil grooves are clean. Grease (G) and replace four bushings on after propeller sleeve.

(c) Grease (G) and replace after propeller sleeve on shaft.

(d) Oil (B) and replace after propeller sleeve holding nut (183).

(e) Oil (B) and replace after propeller sleeve hub.

(f) Replace after propeller on hub.

(g) Clean, inspect, oil (B) and replace nut for after propeller. Set up on nut until screw holes for keep screws are in alignment (185C, 185D).

(h) Replace two keep screws in nut for after propeller. Set up tight (40).

## I. Test Assembled Afterbody in Adjusting Stand

1: Sling afterbody assembly (bail sling is furnished with WE equipment) and place on afterbody adjusting stand.

2: Check afterbody for leaks:

(a) Blank off the following pipes, using in line too's: Reducer to air check valve (229). Check valve to fuel spray (141A). Check valve to water spray (144). Vent pipe on bulkhead (141A).

(b) Connect nipple and H.P. air line to main air pipe from stop valve to valve group (134A).

(c) With starting gear index off zero, throw starting lever to rear and crack valve on main air line to test for leaks around joints of flanges and bulkhead joint (227A).

**NOTE:** The above test is a check on

afterbody leak test, previously described in step G.

**3:** Test starting gear for leaks:

(a) Turn starting index to seat valve in starting gear (227A).

(b) Remove blank on either fuel or water spray pipe, loosen pipe and turn end down, place a cup of water over end of pipe and see if any air bubbles appear; if so, there must be a leak around starting gear pipe connections, or the valve in starting gear. Locate and repair (12, 141A).

**4:** Test gyro impulse valve:

(a) Disconnect and remove pipe from valve group to bulkhead (gyro spin) and connect with test pipe to H.P. air line (229).

(b) Turn on H.P. air and test for leaks in gyro spin and impulse valve; if air escapes through end of pipe to fuel or water spray, there is a leak in the line, which must be corrected.

(c) Reconnect pipe from valve group to bulkhead (gyro spin) and test pipe from stop valve to valve group (229, 134).

**5:** Check depth (horizontal) rudder throws:

(a) Remove hand hole plates (48, 200).

(b) Move horizontal rudder up and down by hand, and read throw each way. It should be 1 up and 4 down for Mk. 13 Modification torpedoes. Both rudders should line up; if the combined throws do not give a total of five, check the following places for trouble:

Fork for steering rod not screwed all the way up on depth engine piston rod. Gland for steering rod through after bulkhead not screwed all the way in on packing. Rudder connection on yoke too long, and readjustment must be made.

(c) If rudder throw is out, remove drain plugs (13-14) in tail cone, loosen clamp screws and adjust rudder connections to give the desired throws; with correct throws obtained, clamp adjustment and replace drain plugs and washers.

**6:** Check depth (horizontal) rudder throws with air:

(a) Remove air strainer plug and replace with adapter tool; connect low pressure (450 lbs.) air line to nipple on adapter tool with transportation screw in place (372A, 223).

(b) Turn on air.

(c) See that centerline on depth engine valve stem lines up with mark on valve stop.

(d) See that rudders in tail read "neu-

tral throw," which should be  $1\frac{1}{2}$  down for Mk. 13 Modification torpedoes.

(e) Any deviation from the above will require readjustment. See step J(5)(c).

(f) Remove transportation pin (49).

(g) Swing pendulum its full travel forward and back; rudders should show 1 up and 4 down for Mark 13 modification torpedoes.

**7:** Check depth index setting:

(a) Level afterbody (WE4).

(b) Remove access hole plug (11).

(c) Install 16 lb. weight in diaphragm nut (411C, 411B).

NOTE: For Mk. 13-1 torpedoes, reg. no. 14543-14614, a 10 lb. test weight is used.

(d) With air on, turn depth index spindle until centerline on depth engine valve is in line with mark on depth engine valve stop (135A).

(e) With spindle-socket lifting tool, hold spindle disengaged and turn depth index to read 10 feet; remove lifting tool and turn depth index slightly to engage square end on spindle socket with square hole in adjusting socket (135A, 472A).

(f) Turn index to zero and back again to 10 ft. The valve center-line should again line up with line on valve stop; if not, readjust until it does.

**8:** Check pendulum and valve movement:

(a) Level afterbody (WE4).

(b) Adjust pointer, attached to cradle, to the zero graduation on indicator scale on carriage of adjusting stand.

(c) With air on, tilt stand  $2\frac{1}{2}$  degrees up and down.

(d) See that pendulum and valve move smoothly.

(e) See that full rudder throw is obtained at maximum inclination of  $2\frac{1}{2}$  degrees each way.

(f) See that rudders move up and down without a jerk.

(g) See that pendulum starts to move during first  $\frac{1}{2}$  degree movement of stand in either direction.

**9:** Check vertical rudder throws:

(a) Remove gyro clamp plate cover and washer (13-14).

(b) Turn propeller until pallet is in extreme after position.

(c) With air on, move steering engine valve and read rudders each way; this should be 33 each way for upper rudder and 24 each way for lower for Mk. 13 Modification torpedoes; equalize throw by rudder rod adjustment in tail (13-14, 44).

**10:** Inspect gyro for cleanliness and oil (A).

**11:** Try gyro locking gear for functioning (205A).

**12:** Check vertical rudder throws with air:

(a) Install gyro and bottom head (246A).

(b) With air on line through strainer, turn propellers by hand, also turning gyro back and forth by hand, and see if any binding occurs when pallet is nearest to cam and concentric ridges of cam plate.

(c) Check rudder throws again, which should be the same as taken in step (9) (c) above (44).

(d) Lock gyro. Un'lock again by hand trip to try functioning of locking gear with gyro installed (205A).

(e) Check "O" mark in pot.

(f) Lock gyro (205A).

(g) Replace gasket and clamp plate cover (13-14).

(h) Remove test connection from air strainer, replace air strainer and plug with washer (223, 372A).

**13:** Check gyro and gyro mechanism:

(a) Clamp afterbody adjusting stand with azimuth pointer on "C".

NOTE: Warn personnel not to approach close to tail during test.

(b) Remove propeller lock (417).

(c) Turn dial on starting gear off zero, to seat valve (227A).

(d) Open air line valve (wide open).

(e) Throw back starting lever, spinning gyro; regulate air line valve to about 700 lbs. pressure.

(f) Loosen clamp on adjusting stand and tilt stand each way; gyro rudders should operate inside of  $1.5$  of  $1^\circ$  of tilt on each side of center, if gyro and mechanism are properly adjusted.

(g) Close air line valve and replace propeller lock (417).

(h) Remove gyro clamp plate, bottom head and gyro (246A, 13-14).

(i) Replace gyro clamp plate and gasket

**14:** Give final inspection to inside of afterbody, seeing that piston fork pin links are properly secured, etc., and that no tools are left inside.

**15:** Replace hand hole plates with good gaskets, and secure with nuts (200, 48).

**16:** Insert transportation pin (49).

**17:** Remove blanks and air fittings from pipes (141A, 144).

Afterbody is now ready for assembly on air flask.

# ASSEMBLY OF AFTERBODY AND EXERCISE HEAD ON AIR FLASK

## A. Join Afterbody to Air Flask

1: Install bail sling and hoist afterbody up about 2" above air flask joint.

2: Join afterbody to flask holding tail up and slightly to the right. With pipe connections lined up, lower chain fall and push afterbody in place on air flask joint.

3: Secure with afterbody joint screws, inserting top screws first, and tightening screws evenly around joint (386).

NOTE: After a major overhaul, or where it has been necessary to straighten out dents in afterbody or midships section, it is desirable to check alignment of afterbody with air flask. In this case, proceed as outlined in step (A) (4).

4: Locate blocks with rolls (furnished tenders and bases as workshop equipment) on deck in wake of hoisting gear:

(a) Pace torpedo, with afterbody assembled, on block with rolls.

(b) Place 12"x12" surface plate (furnished tenders and bases as workshop equipment) directly under tail to furnish a plane and rigid foundation for dial indicator base. Level surface plate (WE4).

(c) With dial indicator placed on surface plate, obtain successive readings on each outer surface of outer bearings of vertical and horizontal rudders, turning torpedo and leveling each blade in succession before tolerance of .015" is allowed on the four readings (WE10).

5: Connect pipes in midship section in the following order and with indicated tools:

(a) Air pipe to air check valves (229).

(b) Main air pipe to stop and charging valve (134A).

(c) Fuel pipe to fuel check valve (141A).

(d) Water pipe to water check valve (144).

(e) Vent pipe to vent fitting (141A).

6: Remove and observe condition of blow valve and its washers; renew or an-

neal washer if necessary (49, 90).

7: Charge air flask to 1000 lbs.

(a) Remove fuel and water filling plugs when charging (217, 74).

(b) Place cigarette paper soaked in oil over water filling plug hole and note if any air leaks into water compartment while charging.

(c) Try holding screws for stop and charging valve body, air check valve body and delivery check valve body, for tightness during charging (40).

8: Test air connections in midship section for leaks:

(a) Secure propeller lock in place (417).

(b) Turn dial on index spindle off zero, and lift starting latch (227A).

(c) Crack stop valve, squirt oil (C) around air connection in midship section, and with a lighted taper, note if oil bubbles appear around joints or if the lighted taper flickers, indicating leaks (72, 227A).

(d) Turn index spindle to seat starting valve, open stop valve wide, and proceed to test H.P. connections in midship section as in step 8 (c) above (71, 227A).

(e) Blank off end of air pipe from blow valve to exercise head. Open air blow valve and proceed to test as in step 8 (c) above (49, 141A).

(f) It will be necessary to remedy any leaks which may be discovered by tests given in steps 8(c), 8(d), 8(e) above before proceeding further.

9: Charge flask to 2800 lbs. and again go over high pressure air connections in midship section. Testing valves and connection for leaks as in step 8(c) above (13-14, 227A, 71).

The above completes assembly of afterbody to air flask.

## B. Join Exercise Head to Air Flask

1: Sling and hoist exercise head to level of air flask.

2: Connect air pipe from blow valve to nipple in exercise head (141A).

3: Connect air pipe in head to nipple on air releasing mechanism clear of pocket (141A).

4: Open air flask blow valve and note that valve is seated on its outboard seat (49).

NOTE: The Mark 26 exercise head uses the Mark 2 air releasing mechanism, which has to be cocked by hand with tool number 441. Care should be taken, when lifting the cocking tool, not to apply side force, which has a tendency to bind the valve stem.

5: Note if air connection in head is leaking, in which case it will be necessary to repair before proceeding with assembly.

6: Wipe air flask and head joint with oil (D), and join head to flask securing with joint screws (49).

7: Install air releasing mechanism (48).

8: The above completes the assembly of torpedo ready for preliminary and final adjustment.

9: If torpedo is to be placed in stowage the following is necessary:

(a) Close air flask blow valve (49).

(b) Remove exercise head (See steps B(1) to 7) (141A, 49).

(c) Open air flask blow valve and bleed flask to 500 lbs. pressure (49).

## C. Shipment of Torpedoes

1: When issued from a torpedo station the replacement screw will be found in a bag or a tin box, attached to the tail of each torpedo.

2: If boxed, the air flask and afterbody will not be disassembled and step (1) applies.

3: The joint screws for exercise or war head will be found in a bag attached to the head.

