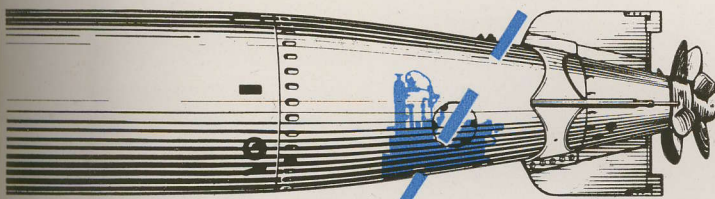


CHAPTER 6

GYRO MECHANISM

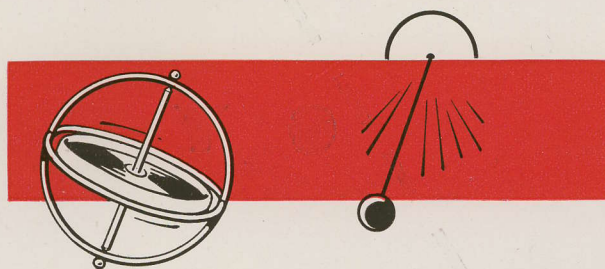


The Gyro Mechanism	106	Progressive Explanation of Gyro Mechanism	120
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THE GYRO MECHANISM

WITH WHICH IS COMBINED THE

IMMERSION MECHANISM



Basically, the gyroscope which steers the Mark 13-1 torpedo on its vertical course resembles the gyroscope tops which were once a

popular toy, and obeys the same natural law. The immersion mechanism which maintains the torpedo on its horizontal course at "set depth" resembles, likewise basically, the pendulum of a clock. The two principles made use of in these mechanisms are (a) the gyroscope's insistence on maintaining the plane in which it is first set in rotation, and (b) the pendulum's insistence on returning to the perpendicular when moved out of that position.

THE GYRO MECHANISM CONTROLS VERTICAL STEERING



Ideally, a torpedo should exactly follow a straight line between its launching point and target. Practically, it is prevented from doing so by such interfering agencies as cross currents, which may deflect it from its exact course either to port or starboard. The gyro's function is the

correction of all such deviations from course; as will be explained later, the manner in which the gyro performs its function results in the torpedo's actual course being a series of surges across its theoretical course, as diagrammed above.

IMMERSION MECHANISM CONTROLS HORIZONTAL STEERING



Again theoretically, a torpedo should exactly follow a straight line horizontally at set depth between its launching point and target. But practically, a torpedo launched from aircraft or from a deck tube first dives well below its set depth, and upon being steered towards

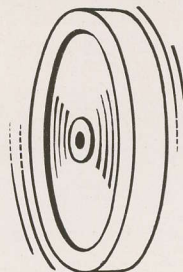
set depth by the immersion mechanism, will over-shoot it somewhat; when steered downwards toward set depth it will under-shoot, and so on. In practise, therefore, the immersion mechanism merely holds the torpedo to a close approximation of its horizontal course.

+ GYRO STEERING OF THE TORPEDO REDUCED TO ITS **SIMPLEST TERMS**

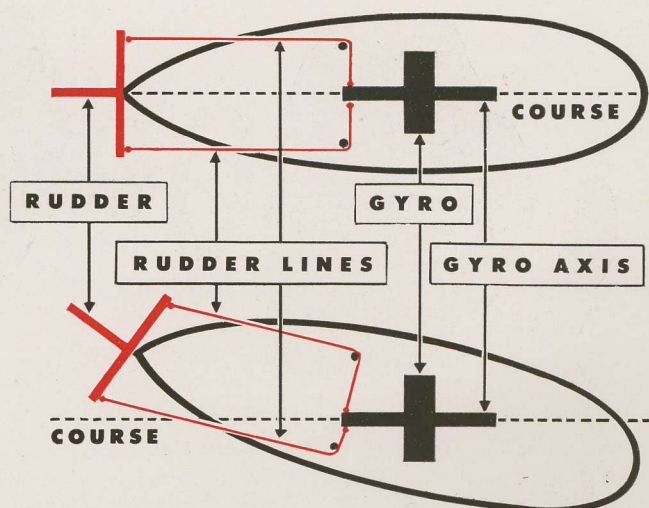
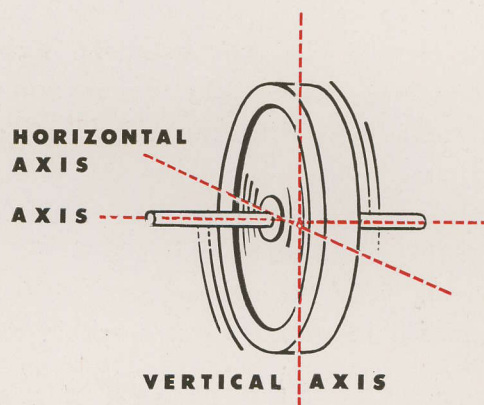
Any form of spinning wheel is a gyroscope in principle. A bicycle is two gyroscopes in tandem, and the tendency of the bicycle to remain upright so long as its wheels are spinning demonstrates the gyroscope's insistence on maintaining rotation in whatever plane it is set in motion. Naturally, if a wheel spins about an axle at right angles to its own plane of rotation, the axle or axis will be maintained at this same angle, so long as the wheel is not moved out of its plane of rotation by some external force.

THE GYRO PRINCIPLE APPLIED

In the diagrammatic demonstration of gyro steering at the right, the spinning wheel and axle representing a simple form of gyroscope are assumed to be located within the hull of a torpedo-shaped boat. The gyroscope is set in rotation with its axle parallel to the course of the boat, and a rudder linked to the axle as shown. Since the gyro will maintain its plane of rotation so long as it continues to spin on its axle, any deviation of the hull in which it spins from the course paralleled by the axle will be corrected by the rudder, as demonstrated in the lower diagram.

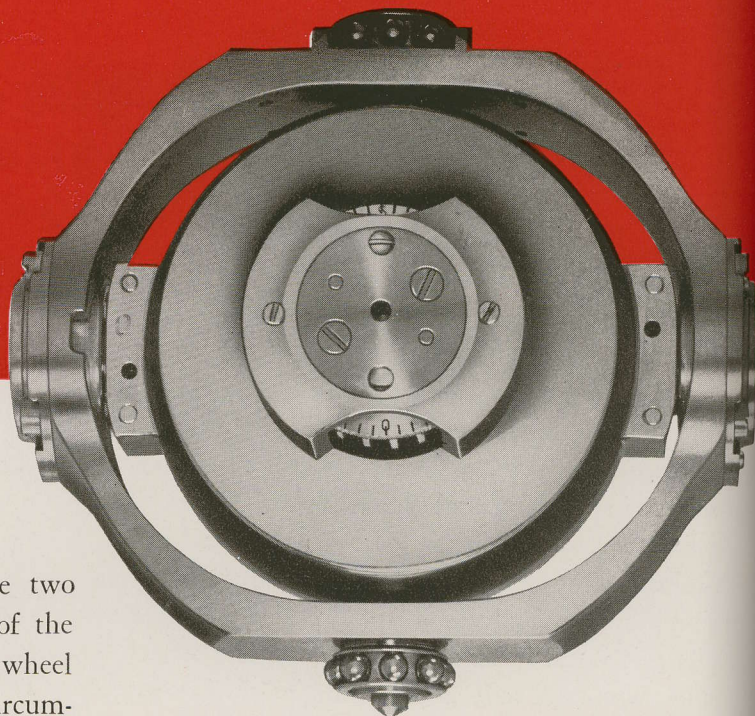


**A SPINNING WHEEL IS A
SIMPLE GYROSCOPE**



THE MARK 12-1 GYROSCOPE

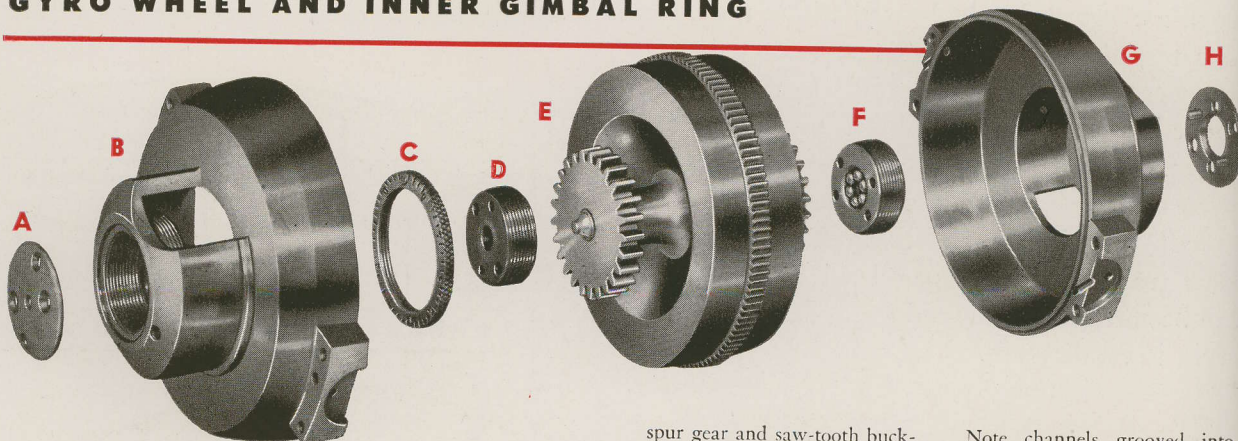
The Mark 12-1 Gyroscope, used in Mark 13 and modification torpedoes, is little more than a practical application of the gyroscopic top discussed on the two previous pages. The spinning flywheel of the top becomes a precisely-machined gyro wheel (see E below) with teeth on its outer circumference which serve as buckets for receiving blasts of air to maintain the wheel at a constant rate of spin. The shaft or spindle of the wheel enlarges at each end, with teeth machined on each enlarged section to form spur gears; one of these meshes with the driving gear of the device which gives the gyro wheel its initial spin (see page 114). The gyro wheel is housed within a split casing called the inner gimbal ring (see below), which in turn is pivoted within the



PARTS OF THE MARK

outer gimbal ring (see top of next page). The gyro wheel thus spins on its own axis and holds to its original plane of rotation, while the mass around it (the torpedo) may swing and even revolve either horizontally or vertically without deflecting the gyro wheel from its rotating plane.

GYRO WHEEL AND INNER GIMBAL RING



A Locking Disc (free end).
B Inner Gimbal (forward half).

C Balance Nut.
D Wheel Bearing B.
E Gyro Wheel, showing pivot,

spur gear and saw-tooth buckets on wheel rim.

F Wheel Bearing A. Side opposite that shown is machined with socket to receive centering pin (see page 162).

G Inner Gimbal, after half.

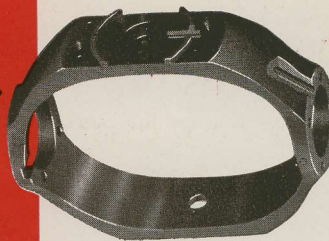
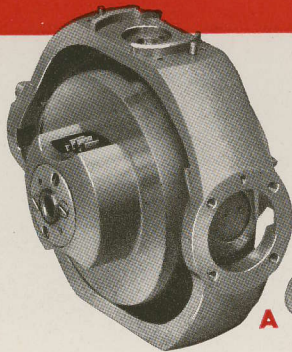
Note channels grooved into brackets at sides of ring; when the two rings meet, these channels form ducts to convey air to buckets on wheel rim.

H Locking Disc. Note locating dowels.

OUTER GIMBAL RING

WITH GYRO AND INNER GIMBAL RING ASSEMBLY IN PLACE

As shown here, wheel bearing A faces observer; note socket for centering pin of spinning and unlocking gear (page 114). Spinning gear (page 114) meshes with spur gear just visible through opening in hub-like portion of inner gimbal ring.



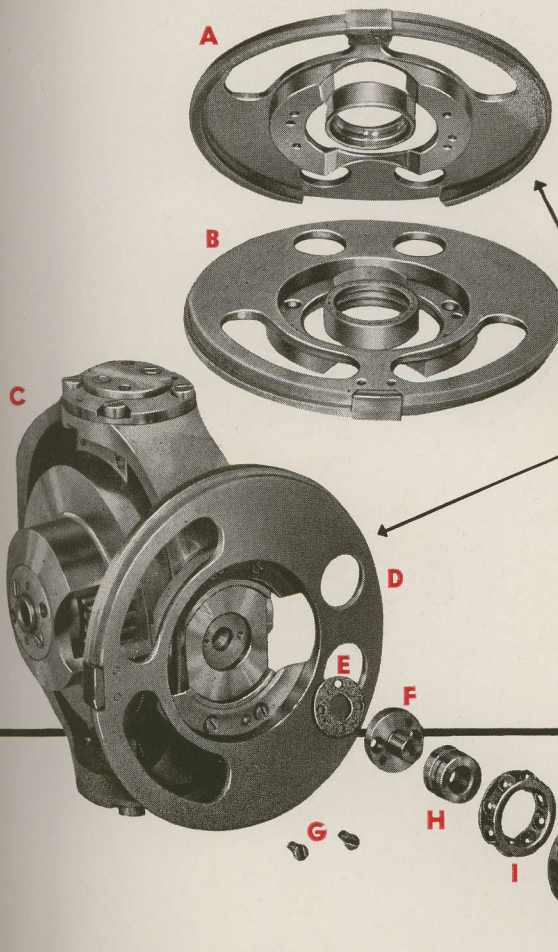
Gyro wheel assembled in inner gimbal ring mounts in outer gimbal ring on bearings contained within a sleeve assembly as shown below. Note air channels in upper half of outer gimbal ring.

INNER GIMBAL RING SLEEVE AND BEARING ASSEMBLY

Inner gimbal ring is suspended within outer gimbal ring on two of these assemblies. Air entering assembly through ducts in outer gimbal ring is trapped by locking disc (M) and passes through central hole in adjusting plate (I) and gimbal center (C) to ducts in inner gimbal bearing bracket (see G, lower illustration on opposite page).

- A Gasket.
- B Screws for Gimbal Center.
- C Gimbal Center.
- D Inner Bearing Race.
- E Ball Bearings and Retainer.

12-1 GYROSCOPE



- F Side Bearing Outer Race.
- G Gasket.
- H Side Bearing Sleeve.
- I Screws for Sleeve.
- J Adjusting Plate. (For taking up end play.)
- K Gasket.
- L Side Bearing Locking Disc.
- M Screws for Locking Disc.

THE CAM PLATE

The Cam Plate, through which the gyro controls the torpedo's mechanism for holding the torpedo to its firing or vertical course (see page 120) is screwed to the top of the outer gimbal ring, with its location determined by dowels projecting from the top of the ring. Cam plate has central opening to permit engagement of top outer gimbal ring bearing with bracket in top of gyro pot.

TOP CENTER BEARING ASSEMBLY

- A Cam Plate (from below) with Cam in place.
- B Cam Plate from above.
- C Gyro with Cam Plate in place.
- D Cam Plate; note that cam is toward end of gyro having centering pin socket.
- E Gasket.
- F Top Gimbal Center.
- G Screws for center.
- H Inner Bearing Race.
- I Ball Bearings and Retainers.
- J Outer Bearing Race.

THE GYRO

COMPLETE WITH CAM PLATE AND BOTTOM PLATE

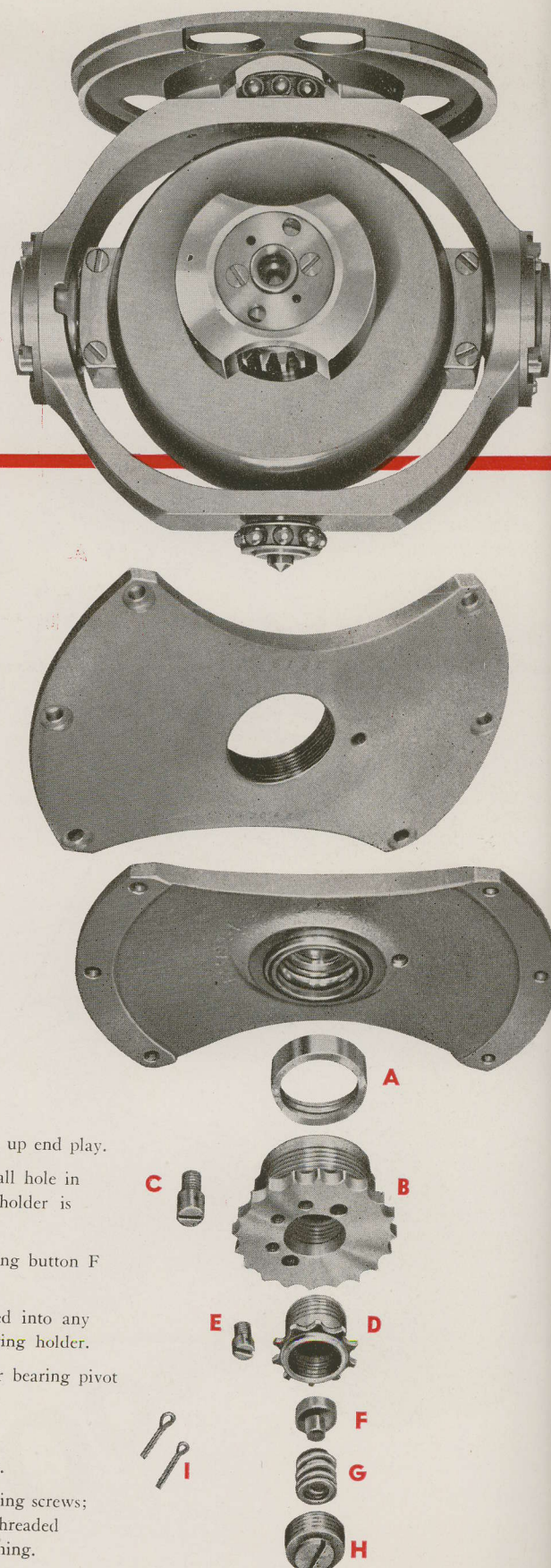
The Mark 12-1 Gyro is shown at right with cam plate in place; this is the forward side of

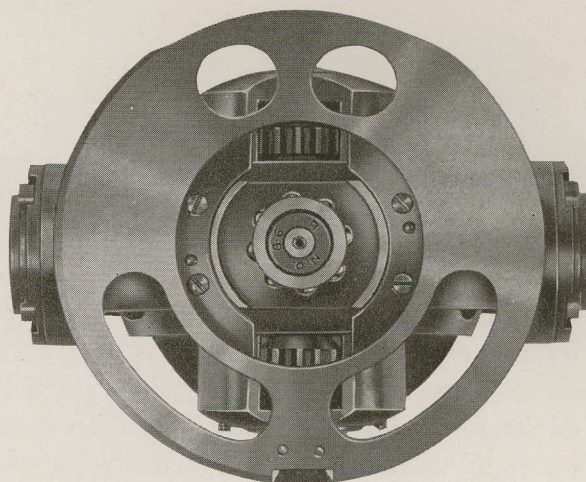
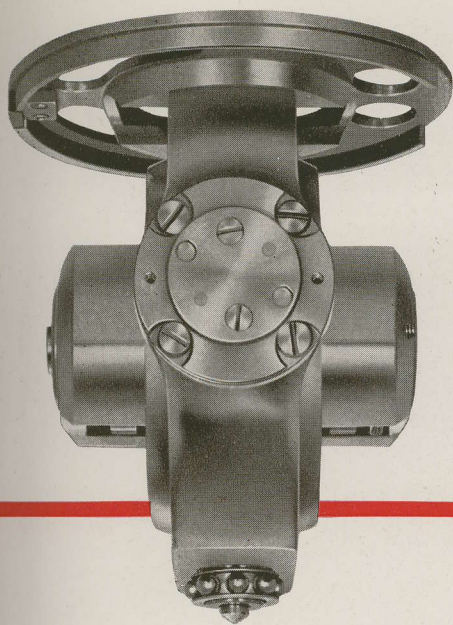
the gyro and cam plate, and clearly shows the socket in gyro wheel bearing "A" into which head of centering pin inserts when spinning and unlocking mechanism is in locked position (see page 114). After gyro as shown is installed in gyro pot, the bottom plate and assembly pictured below install directly beneath it.

THE BOTTOM PLATE

At right are two views of the bottom plate; the upper of the two views shows the center bearing race in place, and the lower view the underside of the bottom plate, into which is assembled the parts displayed beneath it. All installations pertaining to the gyro must be made with extreme care.

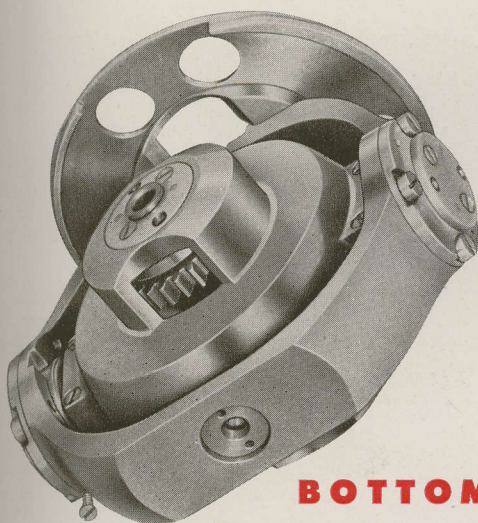
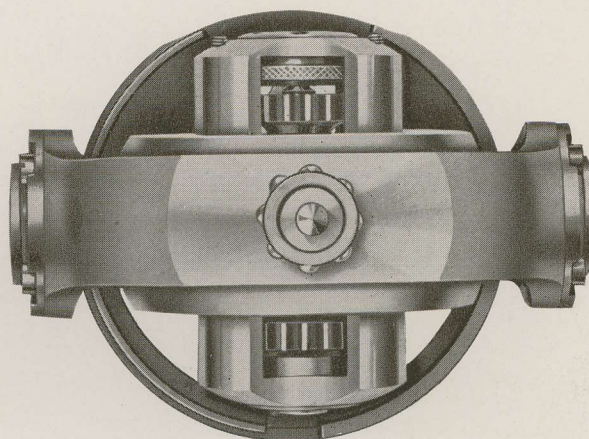
- A** Center bearing race.
- B** Bottom bearing holder; takes up end play.
- C** Keep screw; threads into small hole in bottom plate after bearing holder is adjusted properly.
- D** Adjusting body; receives spring button F and spring G.
- E** Lock screw; may be threaded into any of five holes in bottom bearing holder.
- F** Spring button; bottom center bearing pivot seats on upper side of button.
- G** Spring.
- H** Plug; provides seat for spring.
- I** Cotter pins for keep and locking screws; inserted after screws are threaded down, they prevent their turning.





TOP

BOTTOM



BOTTOM CENTER BEARING ASSEMBLY

B



A Bottom gimbal center or pivot.



B Screws for center.



C Inner bearing race.



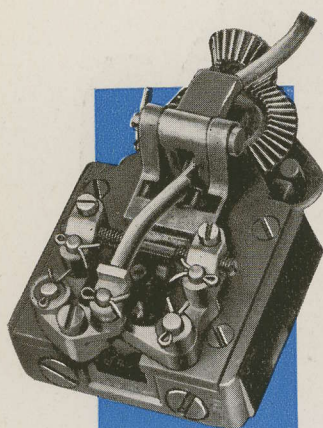
D Ball bearings and retainer.

Various views of the gyro with cam plate in place are shown here to give familiarity with all aspects of the mechanism. Note that bottom gimbal center is pointed: top gimbal center is drilled centrally for passage of air to channels in outer gimbal ring.

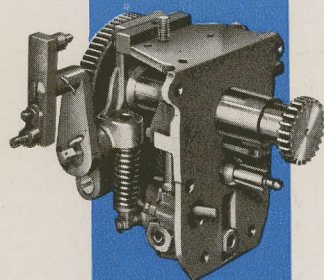
THE GYRO POT

The bronze cylinder within which the gyro is mounted is sweated into place on the gyro mechanism base. It carries the spinning and unlocking mechanism assembly on its forward side, and bosses on its upper port and starboard sides for mounting the depth and vertical steering engines, respectively.

THE GYRO IN GENERAL



**PALLET
MECHANISM**

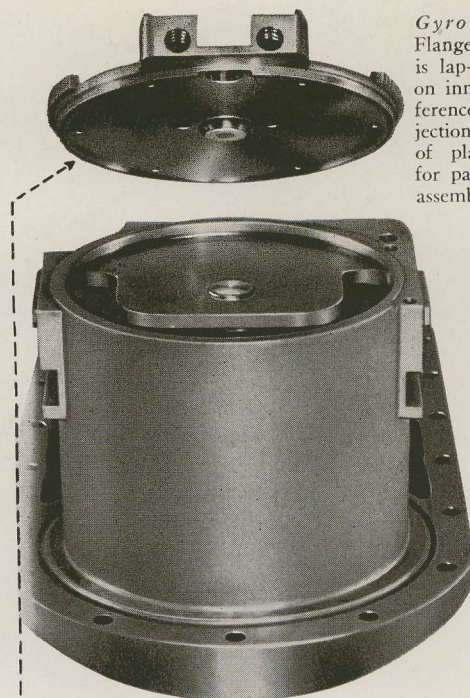


**SPINNING
AND UNLOCKING
MECHANISM**



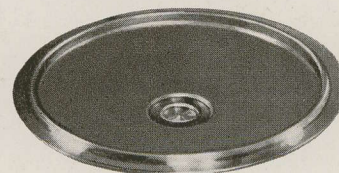
**VERTICAL STEERING
ENGINE**

Mechanisms which are assembled to the gyro pot and operate in conjunction with the gyro are illustrated at left. Top is the Pallet Mechanism, described in pages 122 and 123; center is the Spinning and Unlocking Mechanism, described in pages 114 through 119; bottom is the Vertical Steering Engine, described in pages 122 and 123. The spinning and unlocking mechanism gives the gyro its initial spin, the pallet mechanism takes "steering orders" from the gyro, and the vertical steering engine carries out those orders.

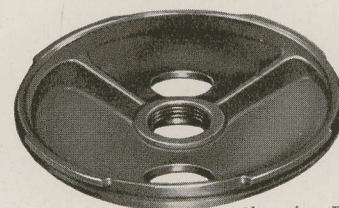


Gyro Top Plate. Flange on lower side is lap-fitted into seat on inner top circumference of pot. Projections at top center of plate are bosses for pallet mechanism assembly.

Gyro Pot. Showing bosses for depth steering engine (left) and vertical steering engine (right), and bracket or shelf to receive top bearing of gyro assembly. Channel is drilled through shelf to transmit air to gyro for maintaining spin.



Gyro Clamp Plate. Seats against lower side of pot, with gasket to form watertight seal.

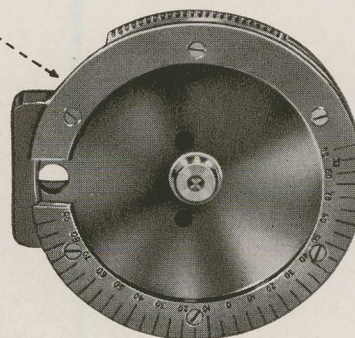


Clamp Plate Cover. Interrupted flange on outer circumference engages similar flange on under side of pot; turned to left or right, and lined up with pot flange, it serves as retainer for clamp plate.

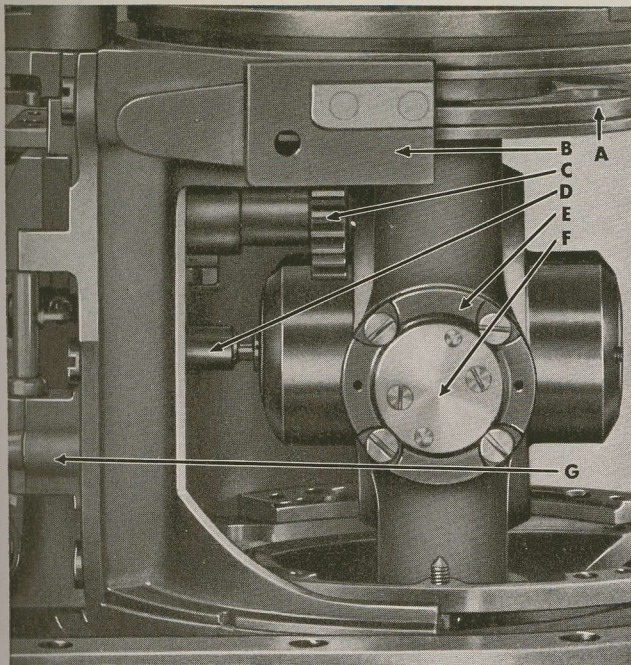


Clamping Plug. Threads into cover and is secured to plate by screw (below), so that plate may be rotated independently of cover and vice versa. With cover in place over plate, turning of plug with tool tightens plate against pot, providing watertight seal.

THE RETAINER PLATES



Two semi-circular plates, with outer flanges, which screw to under side of gyro pot cover to hold it on seat. Graduations are for adjustment of gyro axis to center with axis of torpedo. (See right.)

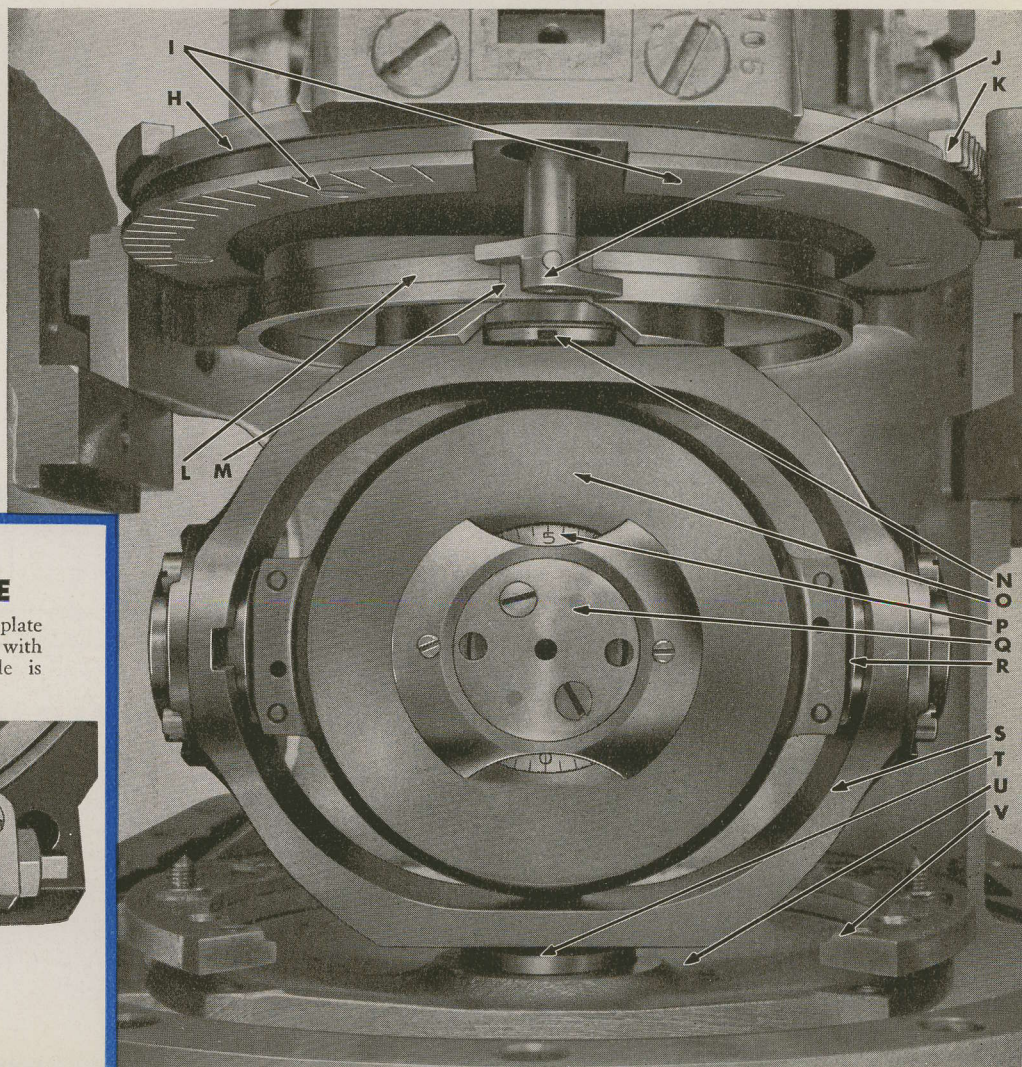


- A** Cam Plate from port side, showing port concentric ridge.
- B** Bracket for depth engine.
- C** Spinning Gear. (See page 114.) Meshed with spur gear at locking end of gyro.
- D** Centering Pin. (See page 114.) Is engaged in socket on outer side of gyro wheel bearing.
- E** Inner Gimbal Ring Sleeve.
- F** Locking Disc.
- G** Spinning Gear Frame.
- H** Gyro Pot Top Plate.
- I** Retainer Plates.
- J** Cam Pawls.
- K** Adjusting Worm Gear Teeth.
- L** Cam Plate from front.
- M** Cam.
- N** Top Outer Gimbal Ring Bearing.
- O** Inner Gimbal Ring.
- P** Balance Nut.
- Q** Locking Disc.
- R** Inner Gimbal Ring Bearing.
- S** Outer Gimbal Ring.
- T** Bottom Outer Gimbal Ring Bearing.
- U** Bottom Head.
- V** Renewal Plate.

THE GYRO AND RELATED MECHANISMS IN PLACE

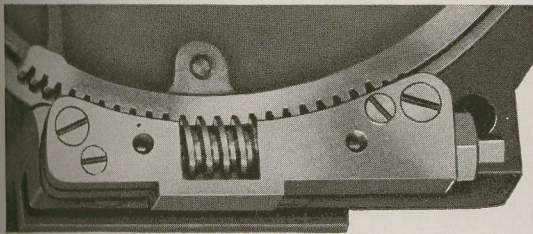
Side view at left and view from aft directly below show gyro in position in gyro pot cut away to reveal how various units involved relate to each other. Letters in each illustration key explanatory matter at left; some of the parts identified are intended purely as reference points to link this complete assembly with disassembled views on preceding pages. Incidentally, gyro is installed in position shown here after gyro base is in place in torpedo, which is turned upside down.

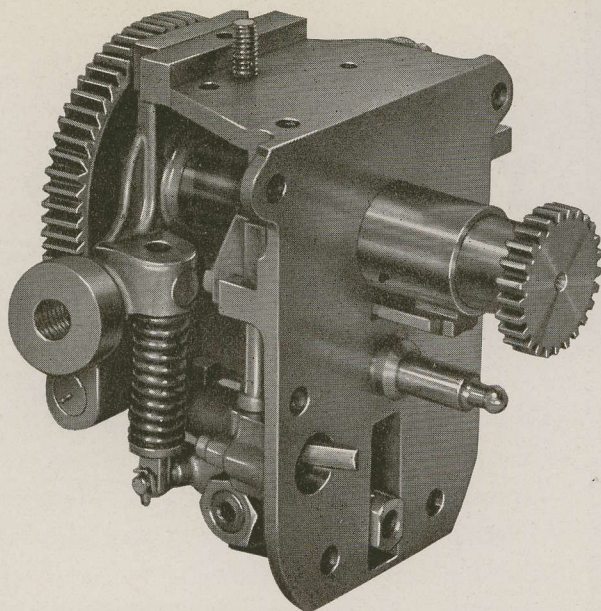
113



TOP PLATE CENTERING DEVICE

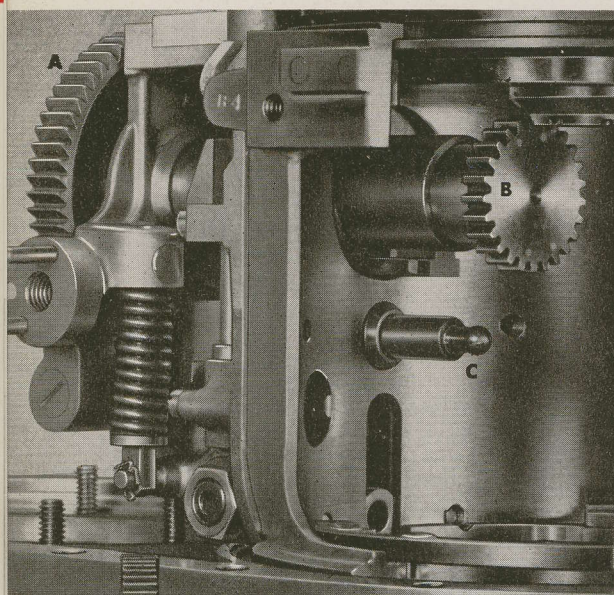
Rotation of worm (see below) rotates top plate in direction necessary to center gyro axis with torpedo axis. Maximum movement possible is 24 degrees.



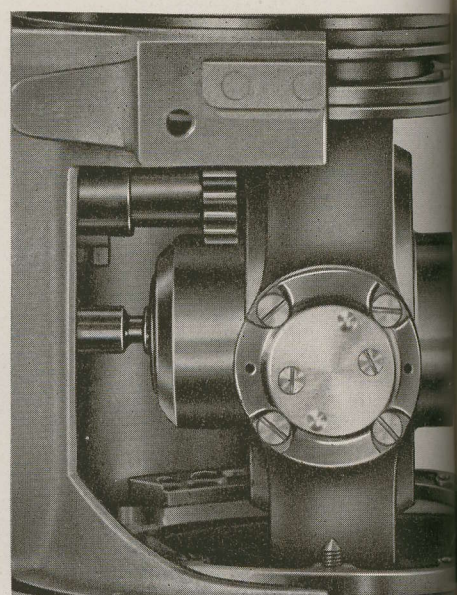


— THE SPINNING AND

A gyroscope behaves as it does only when spinning at a very high rate of speed; the purpose of the spinning and unlocking gear is to give the gyroscope in the Mark 13 and modification torpedoes its initial spin (approximately 20,000 revolutions per minute), while holding it firmly in position so it will take up the spinning

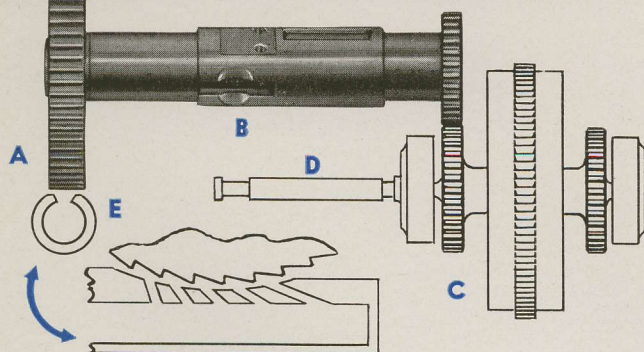


Above, the mechanism is shown apart from the gyro pot, and in locked position. At left, the mechanism is mounted to the gyro pot. A in this illustration is the turbine wheel which spins the spur gear B; C is the centering pin by which the gyro is held as the initial spin is supplied to it.

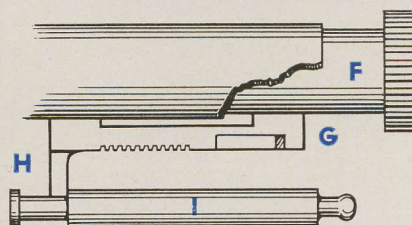


At right the gyro is in position in the gyro pot, which has been cut away to show how the spinning and unlocking mechanism relates to and engages the gyro. The spinning gear meshes with the spur gear on the forward end of the gyro wheel spindle, through opening in the forward half of the inner gimbal; centering pin engages socket in wheel bearing "A."

HOW IT WORKS



- A** Turbine Wheel.
- B** Spinning Shaft Assembly. Extends to mesh spinning gear with gyro spur gear.
- C** Gyro Wheel, Gear and Wheel Bearing "A."
- D** Centering Pin.
- E** Nozzles.

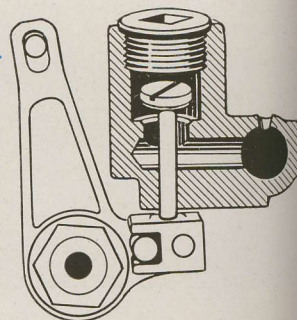


Diagrams across these two pages explain various features of the spinning and unlocking mechanism. They should be studied in conjunction with photographic views above.

- F** Spinning Shaft Controlling Sleeve.
- G** Upper Rack; toe H engages and disengages centering pin with gyro wheel bearing "A."
- H** Toe of upper rack.
- I** Centering Pin.

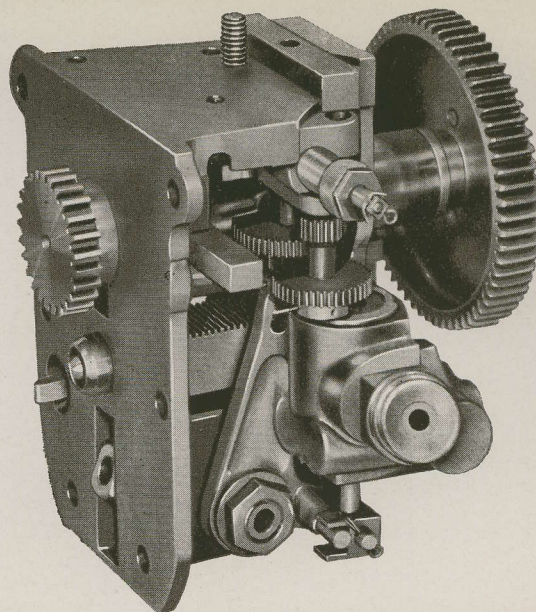
IMPULSE VALVE

The locking of the spinning gear in mesh with the gyro automatically opens the impulse valve (right) through which air is passed to the nozzles for the turbine wheel. Valve closes when mechanism unlocks.

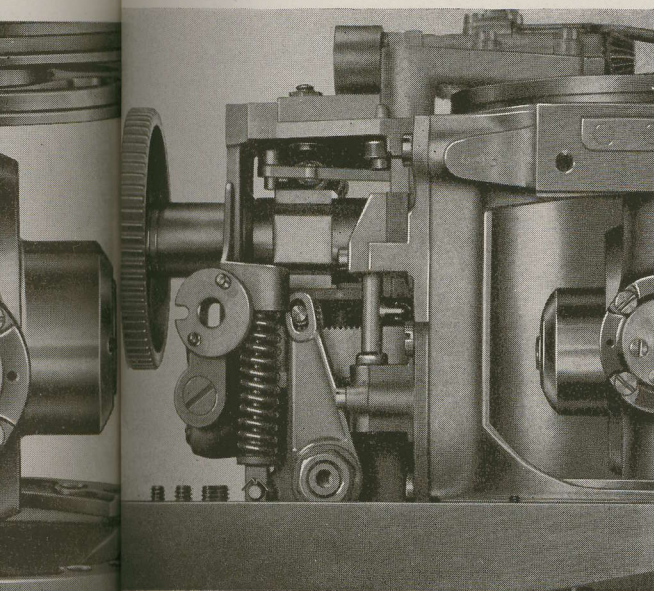


UNLOCKING MECHANISM

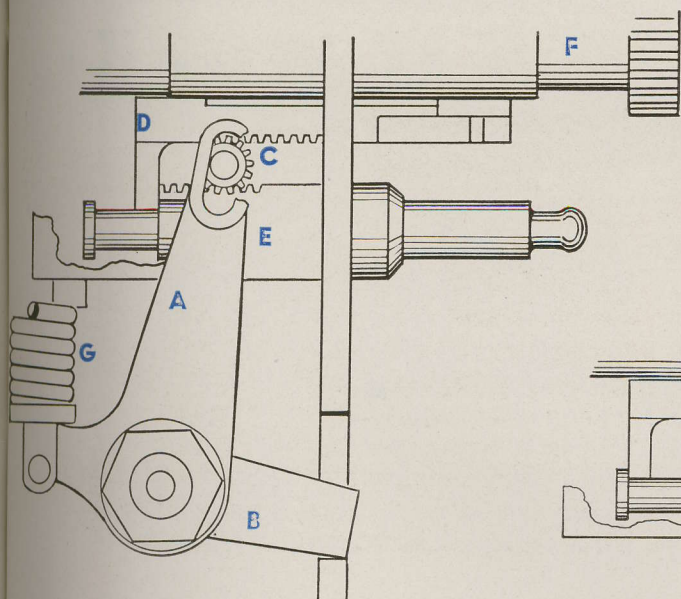
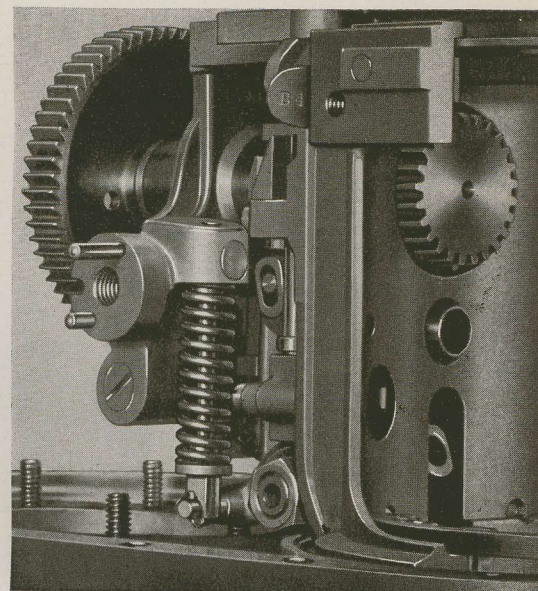
plane by which the firing course of the torpedo is determined and maintained. Having supplied this initial spin, the mechanism must then release the gyro so it may spin freely, and do so without disturbing it. The spinning and unlocking mechanism is seemingly complicated, but actually is relatively simple.



Above, the spinning and unlocking mechanism is shown, away from the gyro pot, as it appears after it has supplied the gyro's initial spin and disengaged from it. At left, the same condition applies to the mechanism in place on the gyro pot; the gyro is now spinning free, its speed maintained by air striking the buckets on the rim of the gyro wheel.

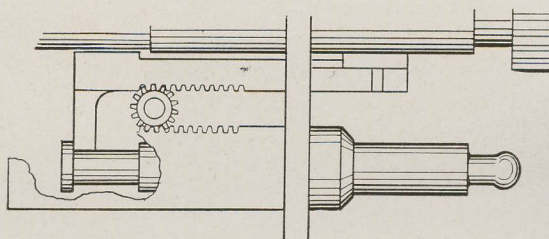


Another view of the spinning and unlocking mechanism in place on the gyro pot, showing the spinning gear drawn back into recess in the wall of the pot, and the centering pin completely out of sight within the lower rack which houses it. As will be explained, the mechanism disengages the spinning gear from the gyro before disengaging the centering pin.

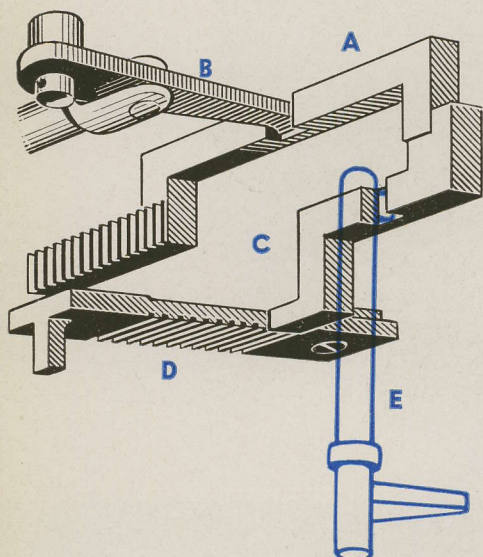


To engage spinning gear and centering pin, bell crank A is advanced by means of locking bar B. Pinion C carries upper rack with it, which in turn extends sleeve E and advances centering pin. When mechanism unlocks, spring G reverses travel of upper rack; spinning gear releases before toe of rack disengages centering pin from gyro wheel bearing "A."

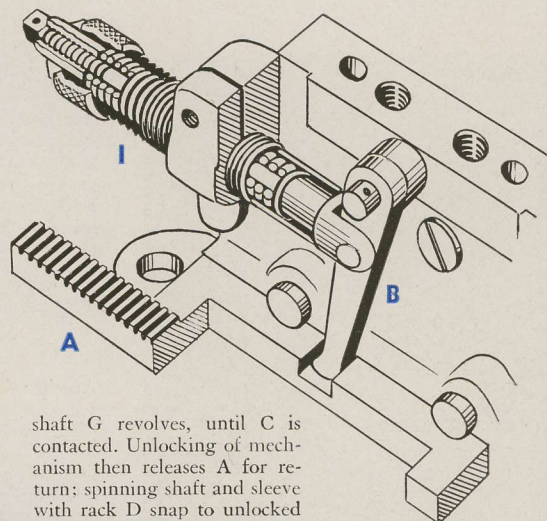
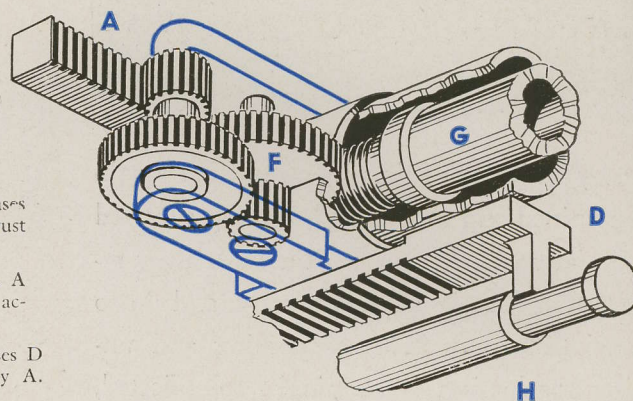
- A Spring Bell Crank.
- B Locking Lever.
- C Pinion.
- D Upper Rack.
- E Lower Rack.
- F Controlling Sleeve.
- G Spring.



SEE
NEXT
PAGE



- A** Unlocking Rack. Releases spinning shaft when thrust against C.
- B** Spring Lever. Returns A to left after unlocking action.
- C** Unlocking Bar. Releases D when moved to right by A.
- D** Upper Rack.
- E** Hand Trip. Cam at top locks C against D, and releases it when lever at bottom is moved by hand.
- F** Reduction Gear Train. Advances A to right as spinning

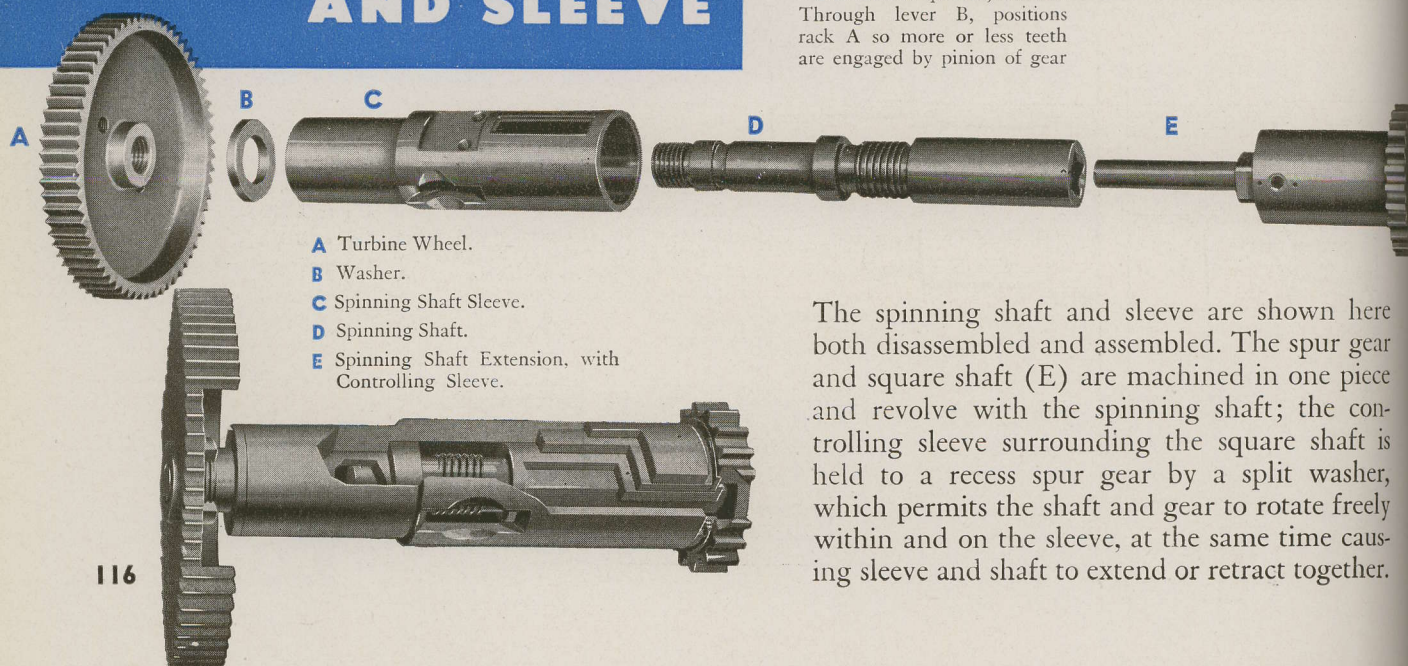


shaft G revolves, until C is contacted. Unlocking of mechanism then releases A for return; spinning shaft and sleeve with rack D snap to unlocked position, D carrying H with it.

- G** Spinning Shaft.
- H** Centering Pin.
- I** Duration-of-spin Adjustment. Through lever B, positions rack A so more or less teeth are engaged by pinion of gear

train F, controlling time required to advance rack to unlocking point.

SPINNING SHAFT AND SLEEVE

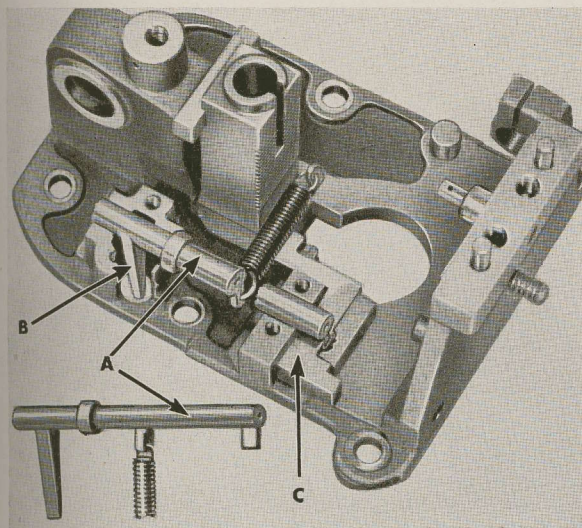


- A** Turbine Wheel.
- B** Washer.
- C** Spinning Shaft Sleeve.
- D** Spinning Shaft.
- E** Spinning Shaft Extension, with Controlling Sleeve.

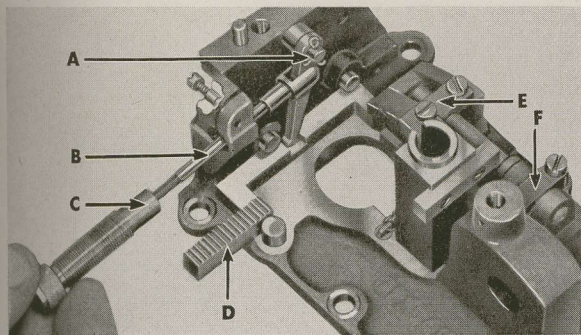
The spinning shaft and sleeve are shown here both disassembled and assembled. The spur gear and square shaft (E) are machined in one piece and revolve with the spinning shaft; the controlling sleeve surrounding the square shaft is held to a recess spur gear by a split washer, which permits the shaft and gear to rotate freely within and on the sleeve, at the same time causing sleeve and shaft to extend or retract together.

SPINNING AND UNLOCKING MECHANISM

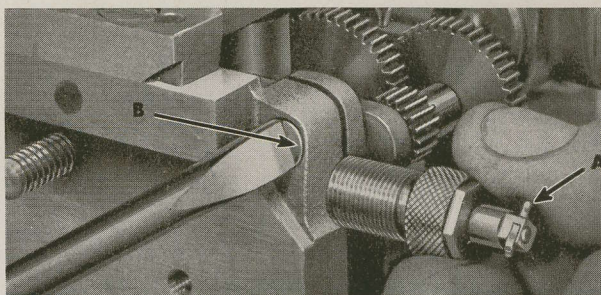
ASSEMBLY The step-by-step routine for assembling the spinning and unlocking mechanism which follows, is likewise the routine for its disassembly when followed in reverse. Special tools for any given step are listed by number, oils or greases by letter. This mechanism must be handled with extreme care to avoid nicks and burrs; *all bearing surfaces must be checked and nicks, burrs or corrosion removed carefully.*



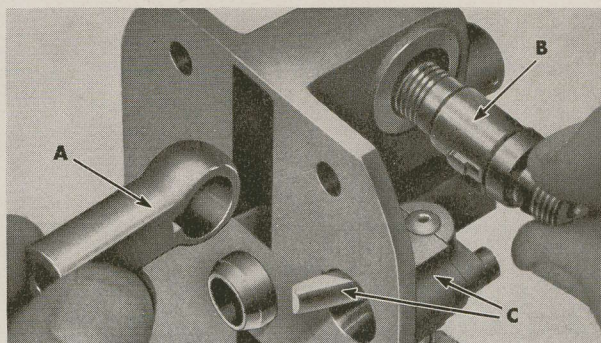
1 Unlocking bar C is fitted as shown; hand trip A mounted in bearings, with spring fitted between poppets on hand trip shaft and gear frame, and hand trip lever enter boss as shown. Hand trip cam engages slot in unlocking bar as shown.



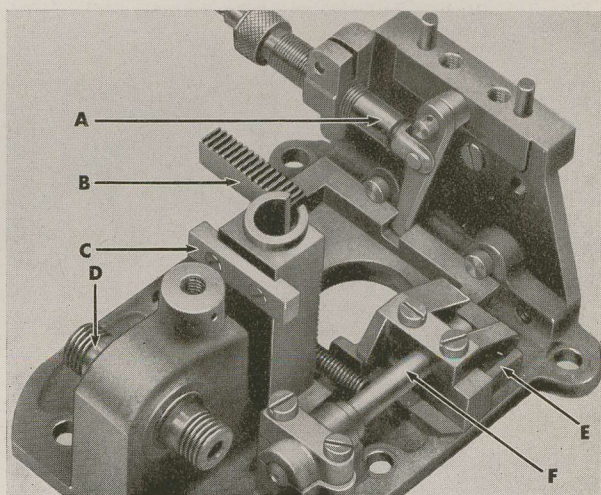
2 Upper and lower bearing caps E and F are screwed in place (37). Unlocking rack D is positioned as shown, care being taken to see that it neither binds nor fits too loosely. Spring rod B inserts in case C, with cotter pin inserted in spring lever pivot at A (72).

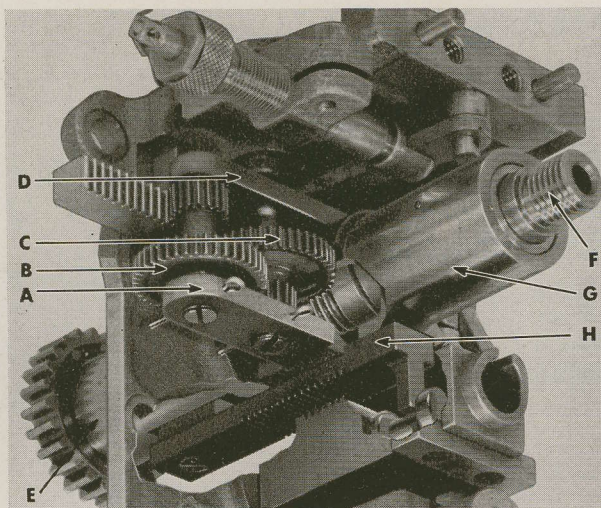


3 Hinge screw B is threaded into place (37). Illustration shows how spring case is worked in or out to adjust duration of spin; when spring lever brings unlocking rack to proper position, B is turned down tight. Note cotter A.

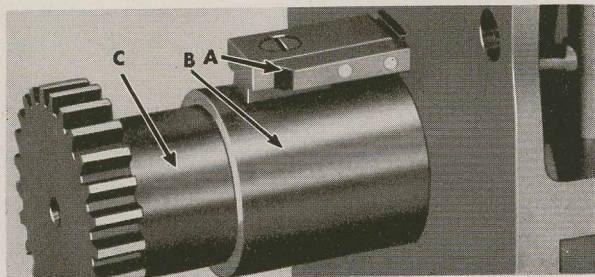


4 Rockshaft B is inserted through housing and locking lever A, with rockshaft key lining up with keyway in locking bar; rockshaft is tapped into place with lead hammer. "X" stamped on locking lever must face hand trip boss C. Assembly is now as shown below; A: duration gear, B: unlocking rack, C: stop for bell cranks, D: rockshaft, E: unlocking bar, F: hand trip.

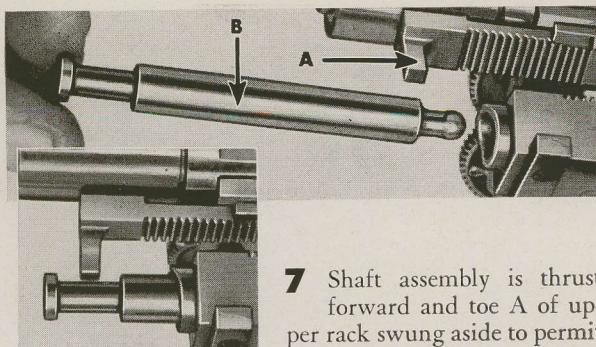




5 Spinning shaft F is oiled (A), inserted in sleeve G; reduction gears B and C are assembled on pivots in lower gear center plate A, with cotter pins through pivots (72), and center plate is then assembled to sleeve (37). Upper gear center plate D is mounted (37), assembly inserted in gear frame and extension shaft with controlling sleeve E is fitted. See below for installation of upper rack H.

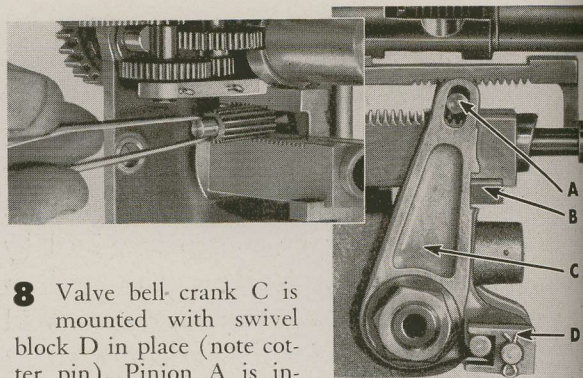


6 Assembly is turned over and upper rack A is fitted to dowel holes in controlling sleeve C through slot in spinning shaft sleeve B and screwed down (37).

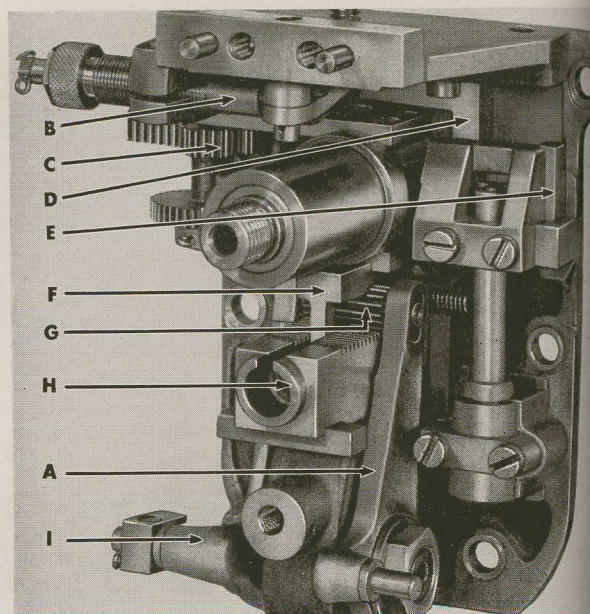


7 Shaft assembly is thrust forward and toe A of upper rack swung aside to permit insertion of centering pin B.

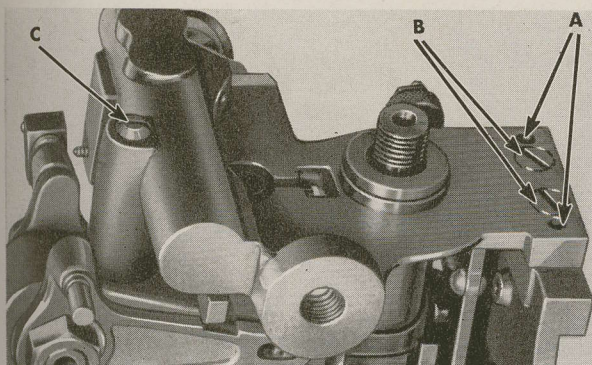
Upper rack is then swung back so toe engages centering pin as shown in small illustration.



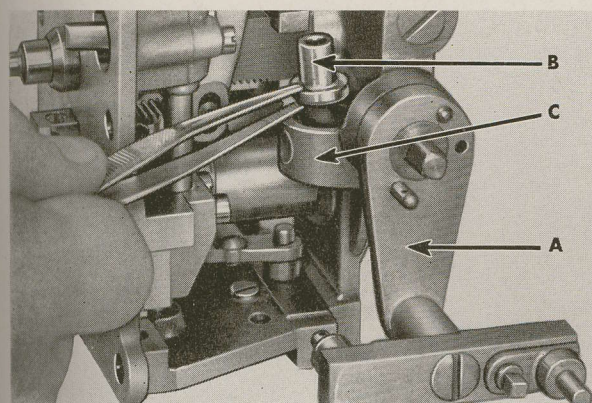
8 Valve bell crank C is mounted with swivel block D in place (note cotter pin). Pinion A is inserted between upper and lower racks (see small illustration; light pliers may be used for this operation, but care must be taken not to burr pinion shaft) and engaged with valve bell crank while the latter is hard against cushion stop B. Spring bell crank is then installed (141A) on end of rockshaft opposite to valve bell crank; position of pinion must be such that distance from face of spur gear to face of spinning gear frame is not more than 13/32".



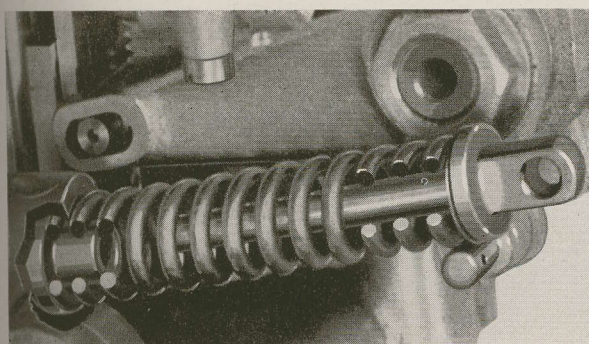
9 Assembly has now reached point shown above. For check on identity of parts so far in place: A—spring bell crank, B—duration gear assembly, C—reduction gearing, D—unlocking rack, E—unlocking bar, F—upper rack, G—pinion, H—lower rack and centering pin housing, I—valve bell crank. As assembly progresses, frequent tests should be made to see that all shafts move freely in bearings, and that no sliding parts bind in any way. All screws must thread down firmly to guard against their being backed out by vibration.



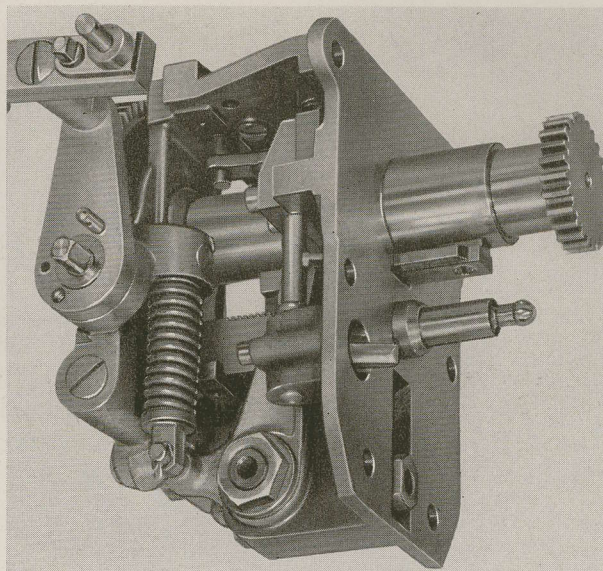
10 Front plate is now installed on dowels A, tapped home with lead hammer, and screws B and C threaded home (37).



11 Valve lever assembly A is now added and spring button B is installed in seat C. Button must seat squarely on bottom of C.



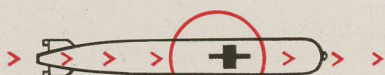
12 Releasing spring is now fitted over spring button, and pin inserted through spring; foot of pin is guided into socket in spring button as head of pin is fitted over spring bell crank stud (WE 178). Cotter is then inserted (72) in stud.



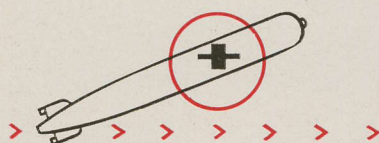
13 Spinning and unlocking mechanism assembly is now complete, ready for tests described in section of Manual concerned with test and overhaul routines, and for mounting on gyro pot. Again all who may perform the assembly or disassembly of this mechanism are cautioned to handle it with great care and be thorough in all tests; if this mechanism fails, both a torpedo and the chance of a destructive hit against an enemy ship are lost.

A PROGRESSIVE EXPLANATION OF THE GYRO MECHANISM

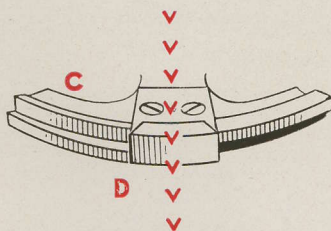
The following diagrams and text are designed to supply sufficient basic understanding of how the gyro mechanism functions for all practical requirements, while supplying at the same time a preliminary grasp of the assembly of the pallet mechanism. Detailed description of the assembly of this mechanism appears on the next two pages.



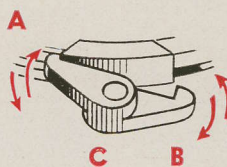
In above diagrammatic representation of a torpedo under way, it is directly on its firing course, with torpedo axis and gyro axis exactly parallel to firing course.



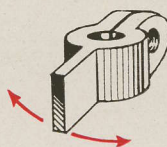
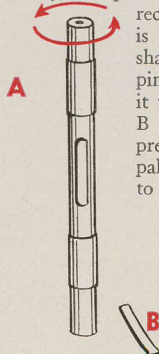
Practically, however, torpedoes do not hold directly to their firing courses, but zig-zag across it. The spinning axis of the gyro, however, always remains parallel to the firing course.



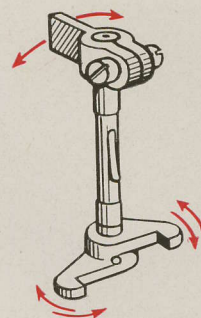
Fastened to the gyro, cam plate C holds cam D with its center on the firing course. For later reference, A is port concentric ridge, B is starboard concentric ridge.



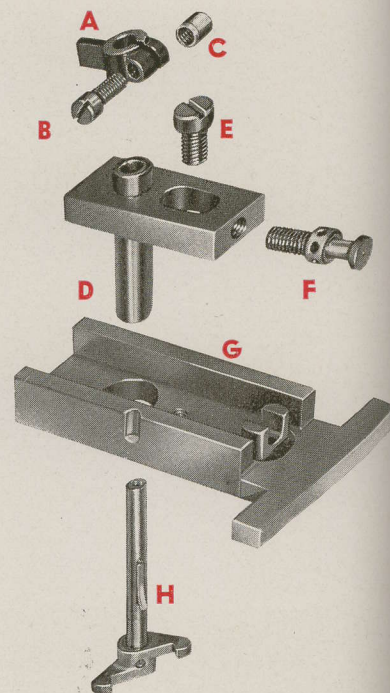
Cam pawls A and B have a span just under the width of cam; if put in contact with cam with torpedo off course either way, one pawl or the other will drop into recess above ridge to which it is opposite. C receives pallet shaft A (at left); pawls are pinned to shaft and oscillate it to right or left. Leaf spring B lies in recess in shaft to prevent it from chattering in pallet holder (D in assembly to right).



Pallet above mounts at top of pallet shaft and clamps to it, with blade facing aft and at right angles to the oscillating plane of the cam pawls.

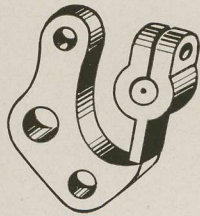


Above, cam pawls, pallet shaft and pallet are assembled; movement of cam pawls fore or aft results in port or starboard movement of pallet blade.

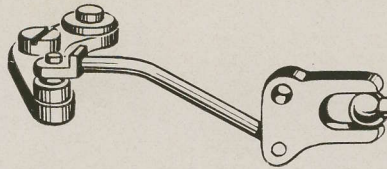


Contact of cam pawls with the cam must be brief to avoid disturbance to the gyro; hence holder for pallet shaft assembly rides in a pallet slide.

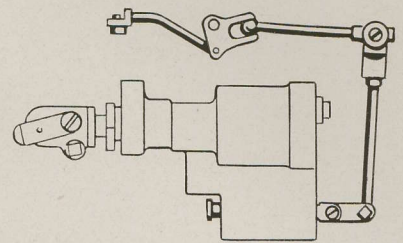
- A Pallet.
- B Clamp Screw.
- C Clamp Nut.
- D Pallet Holder.
- E Lock Screw.
- F Adjusting Screw.
- G Pallet Slide.
- H Pallet Shaft, with cam pawls and leaf spring in place.



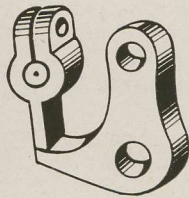
The pallet blade having taken a right or left hand throw from the cam pawls, it is advanced by movement of the pallet slide and moves one or the other of two pallet pawls about its pivot; above is left hand or port pallet pawl.



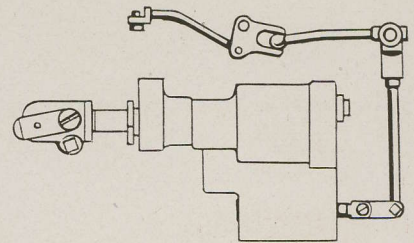
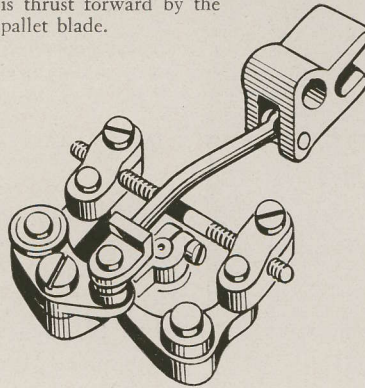
To further pass on the directional motion set up by the cam and cam pawls, an "extender" is mounted on the left hand pallet pawl; an arm pinned to the extender pivots a bell crank in an up-and-down movement, as the arm is given a back-and-forth movement by the extender. A linkage arrangement (see below) results in the left hand pallet pawl moving backward when the right hand pallet pawl is thrust forward by the pallet blade.



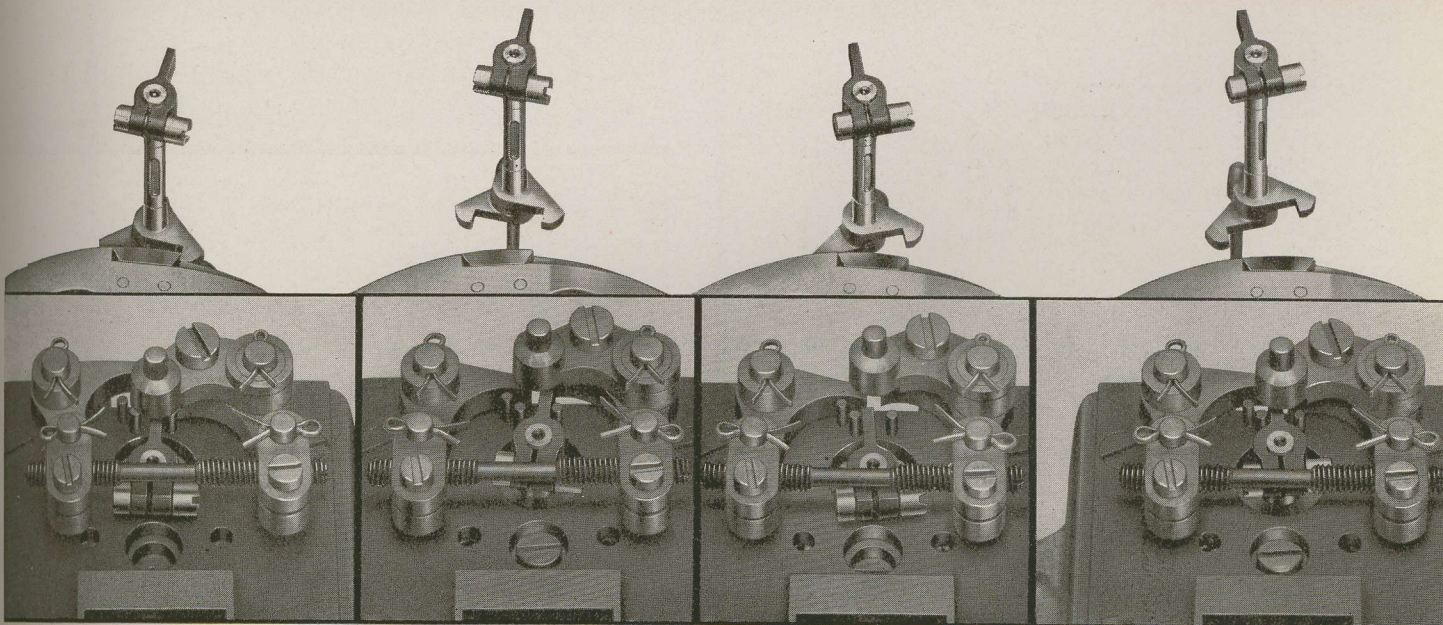
To complete the steering process begun when the cam pawls are moved about their mutual axis, the bell crank raises or lowers a bell crank arm, which in turn moves an arm connected to the vertical steering engine valve.



Above is right hand or starboard pallet pawl with pallet blade thrusting against it. The pallet pawls are positioned so that if cam pawls straddle cam, pallet blade passes between pallet pawls.



As the vertical steering engine valve moves forward or aft, its piston moves in the opposite direction; being linked to the vertical rudders, it steers the torpedo to port or starboard.

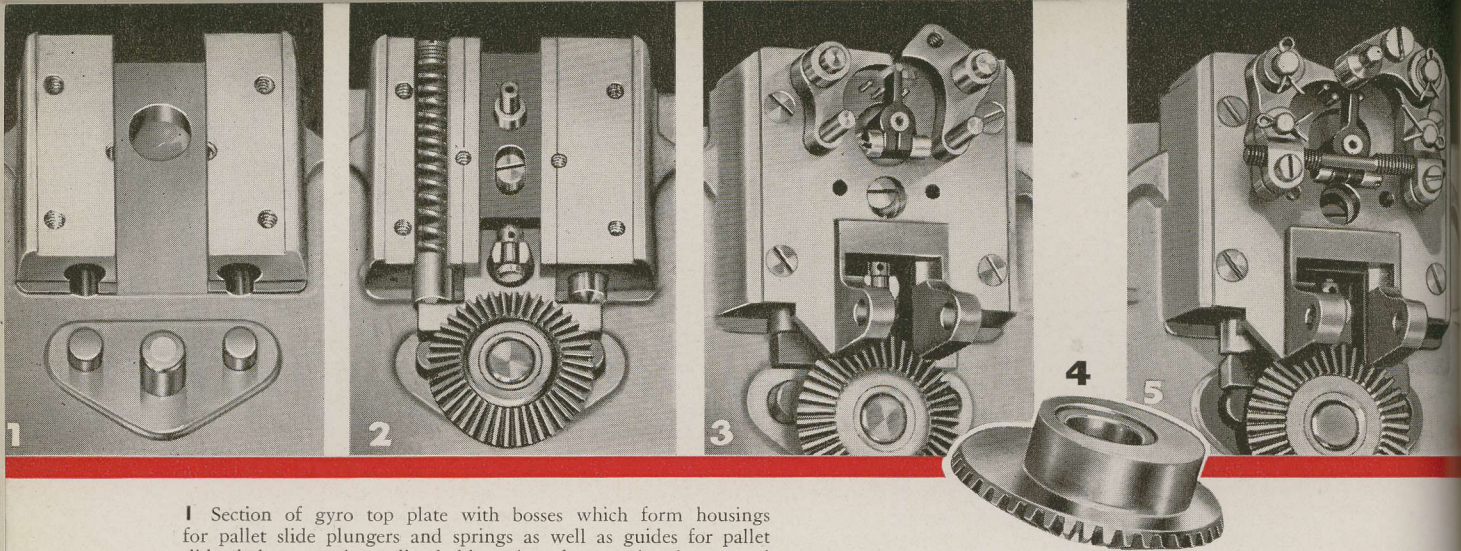


Top view above shows cam pawls aft with port pawl engaging port groove, causing pallet blade to swing to position opposite port pallet pawl. Lower view shows pallet blade in position for thrust against pawl.

Pallet assembly has been thrust ahead by motion of pallet slide; pallet blade pivots port pallet pawl aft. To avoid disturbance of gyro, pallet slide is kept in constant motion fore and aft, so contacts with cam are momentary.

Pallet assembly has been brought back by motion of pallet slide; torpedo is now assumed to have swung off course to starboard. Starboard cam pawl engages starboard groove in cam plate, and pallet blade swings to starboard.

The pallet blade having received its "steering orders" through momentary contact of the cam pawls with the cam and plate, the pallet slide moves aft, carrying the toe of the starboard pallet pawl with it.



1 Section of gyro top plate with bosses which form housings for pallet slide plungers and springs as well as guides for pallet slide, hole to receive pallet holder, pivot for cam bevel gear and pallet slide stop studs.

2 Pallet slide, pallet holder, cam bevel gear, plungers, springs and screw plugs in place. Note adjusting screw in pallet holder.

3 Pallet slide cover, and left and right hand pallet pawls in place.

4 Cam bevel gear in inverted position to show eccentric which works against spring plungers in pallet slide guides, giving oscillating motion to pallet slide.

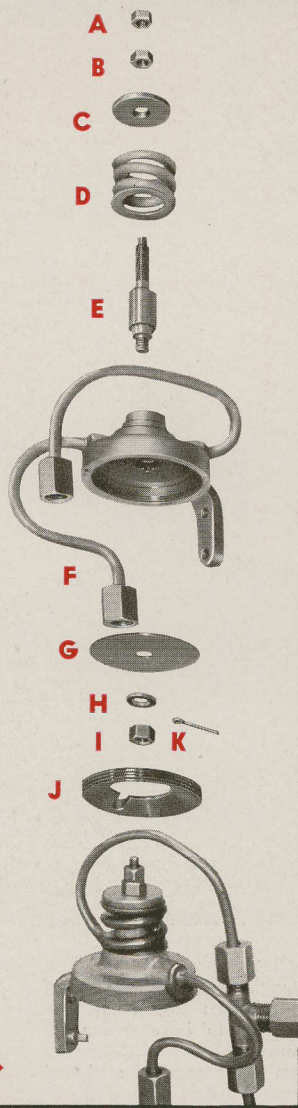
5 Adjusting links in place on both pallet pawls, extender on left hand pawl and adjusting screw threaded into adjusting links.

THE GYRO REDUCING VALVE

Air for maintaining the gyro wheel at the velocity given it by the initial spin is supplied at approximately 450 pounds per square inch to the gyro reducing valve, from which it is conveyed to the gyro wheel at 125 pounds per square inch. High pressure air enters valve through pipe nearest bracket, bears down on diaphragm G against tension of spring D; when air pressure equals spring tension, valve allows desired reduced volume of air to pass on to gyro wheel.

- A Lock Nut.
- B Nut.
- C Spring Washer.
- D Spring.
- E Valve Stem.
- F Valve Body.
- G Diaphragm.
- H Washer.
- I Nut.
- J Plug Nut.
- K Cotter Pin.

ASSEMBLED →



THE ASSEMBLY OF THE PALLET

The routine for the assembly of the pallet mechanism as displayed and described above, is likewise the routine for its disassembly if the procedure is reversed. In handling the parts for this and similar small and highly-machined mechanisms of the torpedo, the greatest possible care must be exercised; a burr or scratch on a steering engine's valve so small as to be practically invisible to the unaided eye,

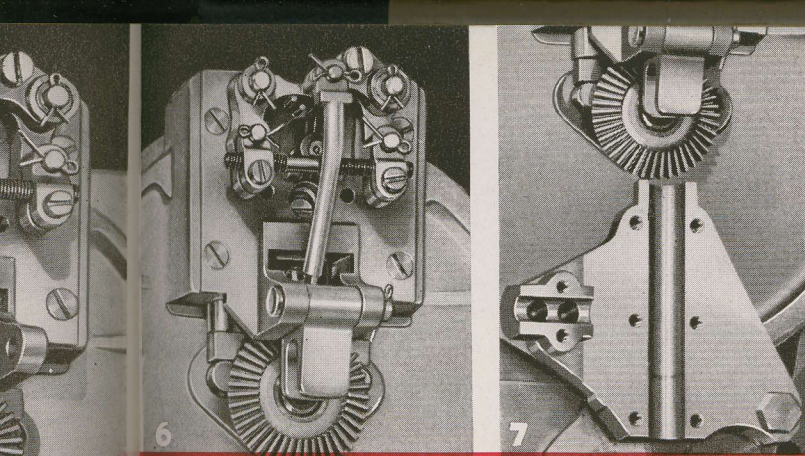
THE VERTICAL

- 1 Clamp Screw.
- 2 Screw.
- 3 Locking Spring.
- 4 Pin.
- 5 Connecting Fork.
- 6 Asbestos Wick Packing.
- 7 Keep Screw.
- 8 Gland.
- 9 Holding Screw (2 are fitted.)
- 10 Screw; threads into after end of valve.
- 11 Washer; checks forward stroke of valve.
- 12 Valve Body, includ-



ing strainer holder and valve chamber liner.

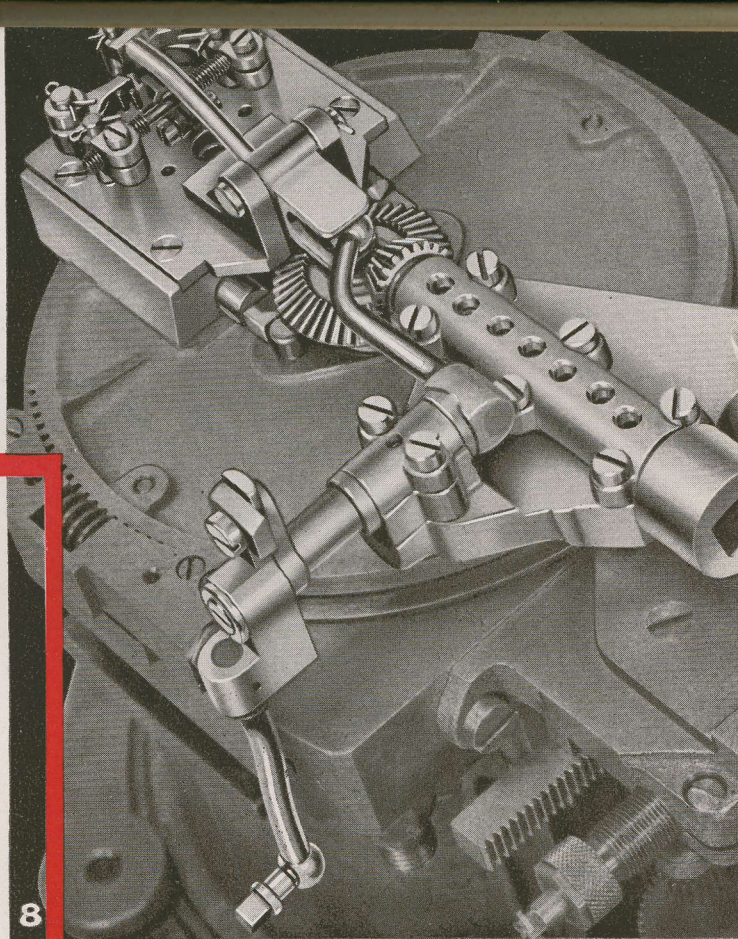
13 Strainer Washer.



6 Bell crank and link to extender in place.

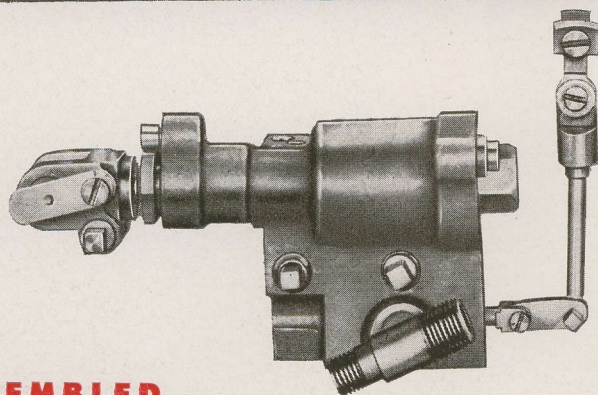
7 Bearing bracket in place.

8 Completed assembly. Driving spindle for driving cam bevel gear is in place. Valve rock shaft is fitted and linked to bell crank by bell crank arm. At outboard end of rock shaft the valve connection arm is fitted by means of adjusting head, ready to be connected to vertical steering engine valve link, as pictured directly below.



T MECHANISM

may entirely prevent it from operating and so cause the failure or even the loss of a torpedo. Valves and similar parts which require a lap fit may rarely be successfully interchanged. It is better to change an entire engine assembly, than to attempt an interchange of parts which may result in faulty operation and possible failure at a critical time.



L STEERING ENGINE

14 Strainer.

15 Strainer Holder Cap.

16 Valve.

17 Screw.

18 Valve Link.

19 Adjusting Washer.

20 Piston and Piston Rod, with one set of piston rings in place.

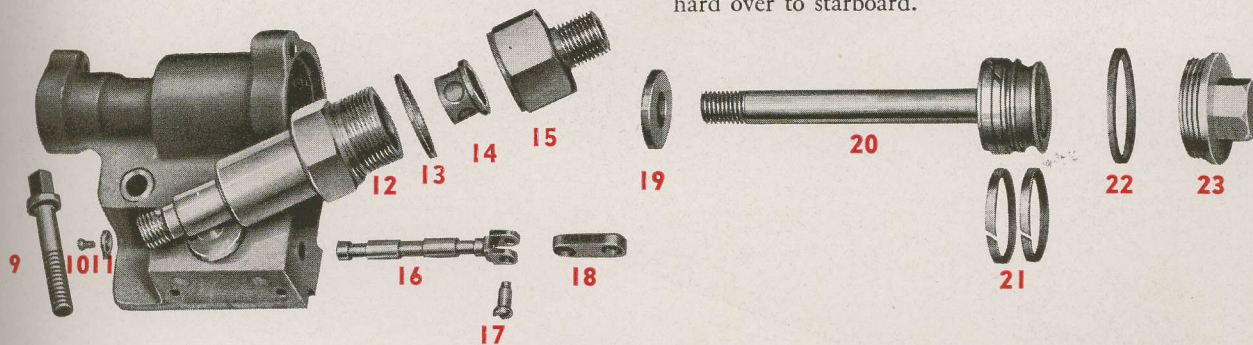
21 Piston Rings.

22 Head Gasket.

23 Cylinder Head.

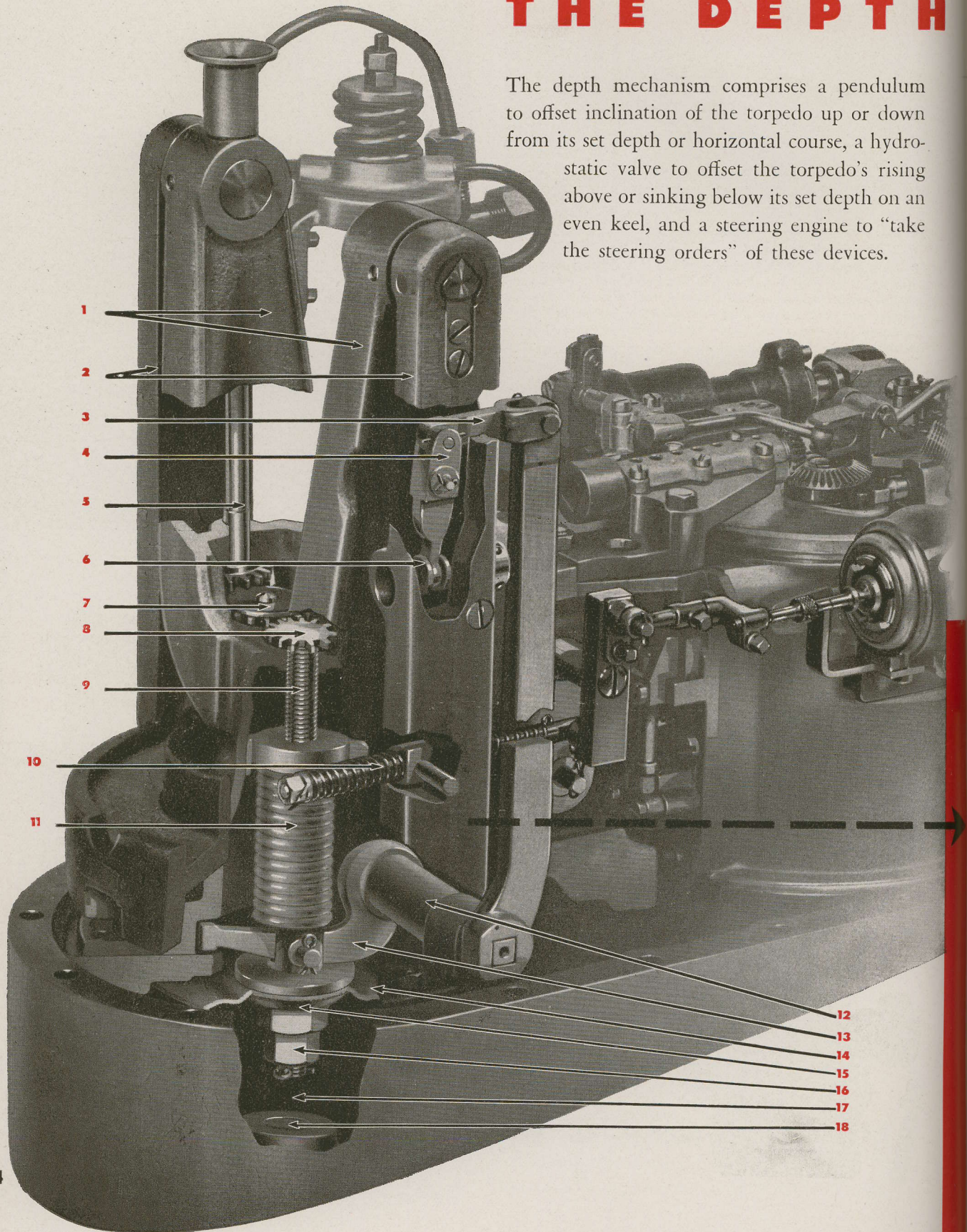
ASSEMBLED

The assembled vertical steering engine above is shown with valve connection arm, adjusting head and outboard end of rock shaft. Note that the valve is shown at the end of its forward stroke; with the valve in this position the piston is likewise at the end of its forward stroke. With piston forward, the vertical rudders are thrown hard over to starboard.




THE DEPTH

The depth mechanism comprises a pendulum to offset inclination of the torpedo up or down from its set depth or horizontal course, a hydrostatic valve to offset the torpedo's rising above or sinking below its set depth on an even keel, and a steering engine to "take the steering orders" of these devices.

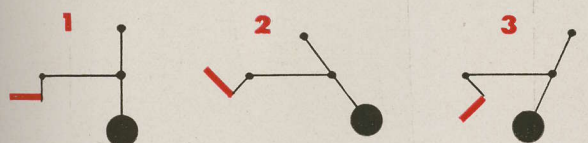


MECHANISM

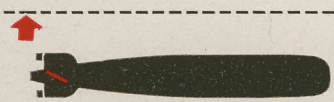
SIMPLY EXPLAINED



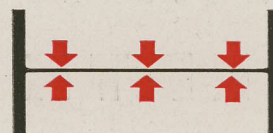
When a torpedo inclines up or down from its set depth, the pendulum of the depth mechanism functions in principle according to the simple diagrams below.



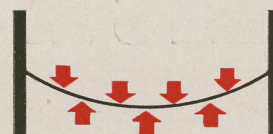
(1) shows the pendulum linked to the rudder; the torpedo is on an even keel. (2) assumes the torpedo inclined downwards and (3) shows pendulum swinging aft to give a down rudder.

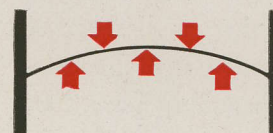
When a torpedo sinks below or rises above its set depth on an even keel, the pendulum would hang straight down and no steering effect would result, were it not for a combination of a hydrostatic valve and lever arrangement which causes the pendulum to swing as though the torpedo were inclined.



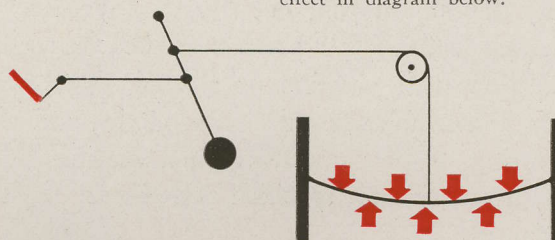
The basis of the hydrostatic valve is a diaphragm, with air on one side opposing water on the other. At set depth these forces are equal.



In the hydrostatic valve, the top face of the diaphragm is open to the sea; the bottom face is over an air chamber. As torpedo sinks below set depth, water pressure becomes greater than air pressure.



As torpedo rises above set depth, air pressure exceeds water pressure, and the diaphragm moves accordingly. Linkage of the diaphragm with the pendulum and thence to the horizontal rudder has effect in diagram below.



DEPTH MECHANISM IN GENERAL DETAIL

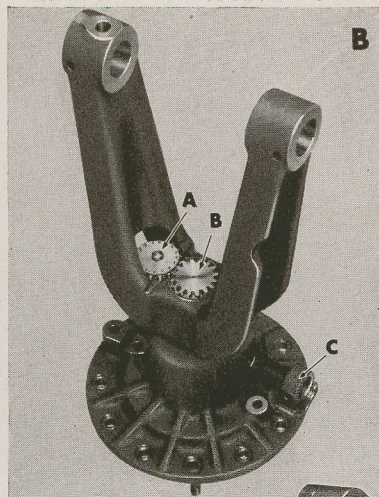
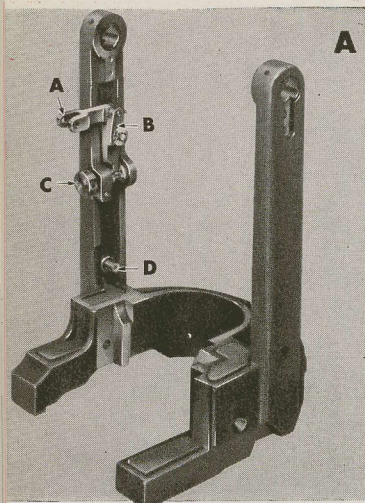
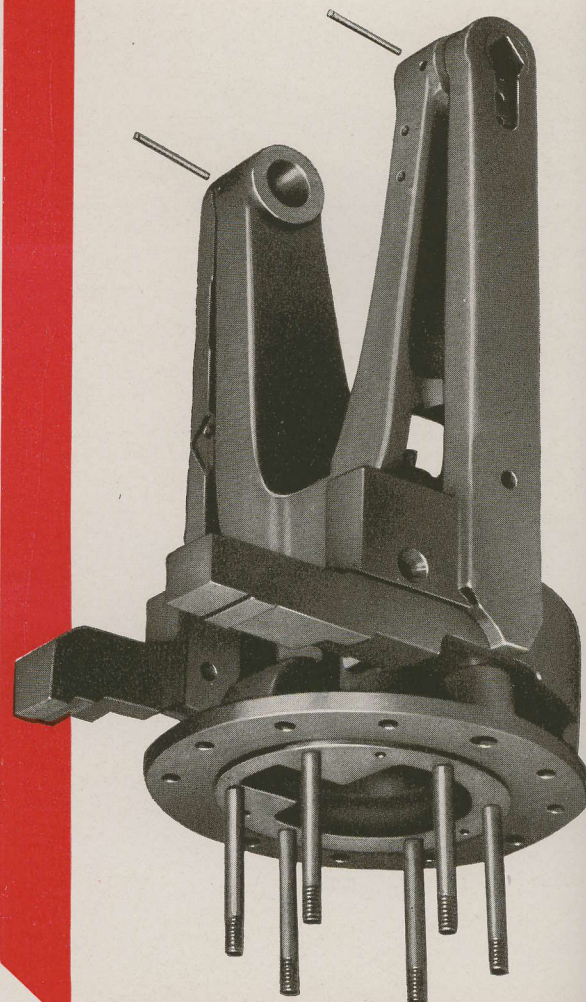
Study of the cut-away view of the depth mechanism at left will reveal the application of the principles discussed above, with the steering engine introduced as the device by which the very slight movements and forces involved are converted into sufficient power to actuate the horizontal rudders.

- 1 Pendulum bracket, or Uhlan gear case; the combination of pendulum and hydrostatic valve actions is called the Uhlan principle.
- 2 Pendulum; note lead ballast.
- 3 Pendulum Link—part of device by which movement of diaphragm cause inclination of the pendulum.
- 4 Linkage Adjusting Arm.
- 5 Depth Spring Adjusting Spindle.
- 6 Linkage Adjusting Screw.
- 7 Idler Gear—communicates movement of depth setting spindle to depth spring adjusting screw.
- 8 Depth Spring Adjusting Screw Gear.
- 9 Depth Spring Adjusting Screw.
- 10 Tension Rod and Buffer Spring Assembly.
- 11 Depth Spring; amount of tension applied to spring determines point at which sea water and air pressures are equalized in hydrostatic valve.
- 12 Diaphragm Lever Shaft.
- 13 Diaphragm Lever; as this raises or lowers, it moves the pendulum lever at opposite end of shaft backward or forward, giving inclination to the pendulum.
- 14 Diaphragm.
- 15 Diaphragm Plate.
- 16 Clamp Nut.
- 17 Air Chamber.
- 18 Plug.

CONSTRUCTION AND ASSEMBLY DETAILS OF THE **DEPTH MECHANISM**

There are sufficient views here of the depth mechanism, in all stages of assembly, to enable anyone to put it together or disassemble it with ease. As in other step-by-step presentations in this Manual, the assembly procedure shown here is followed in reverse for disassembly. Before carrying out this or any other assembly routine, all parts must be thoroughly cleaned with gasoline or alcohol, dried with air if available, or with clean cloths, and if a bearing or part operating in a bearing, oiled with lubricants specified elsewhere in the Manual.

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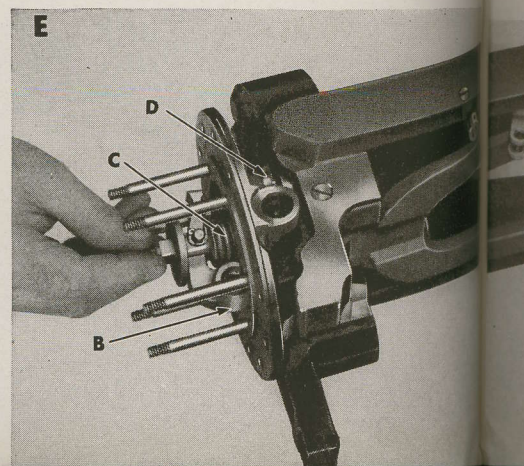
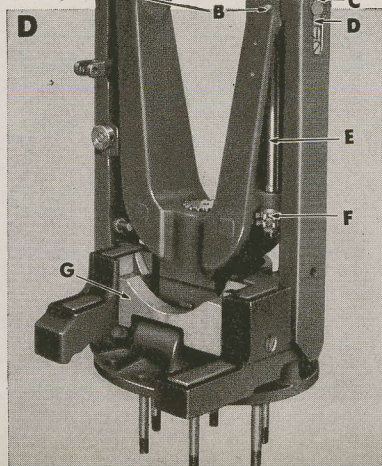
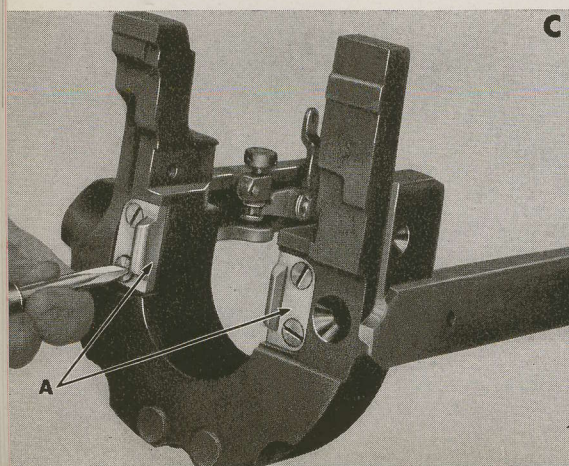
A Pendulum with pendulum link A, adjusting arm B and linkage adjusting screw C in place. D is pivot for tension rod bearing (see illustration F).

outboard bearing for pendulum lever shaft.

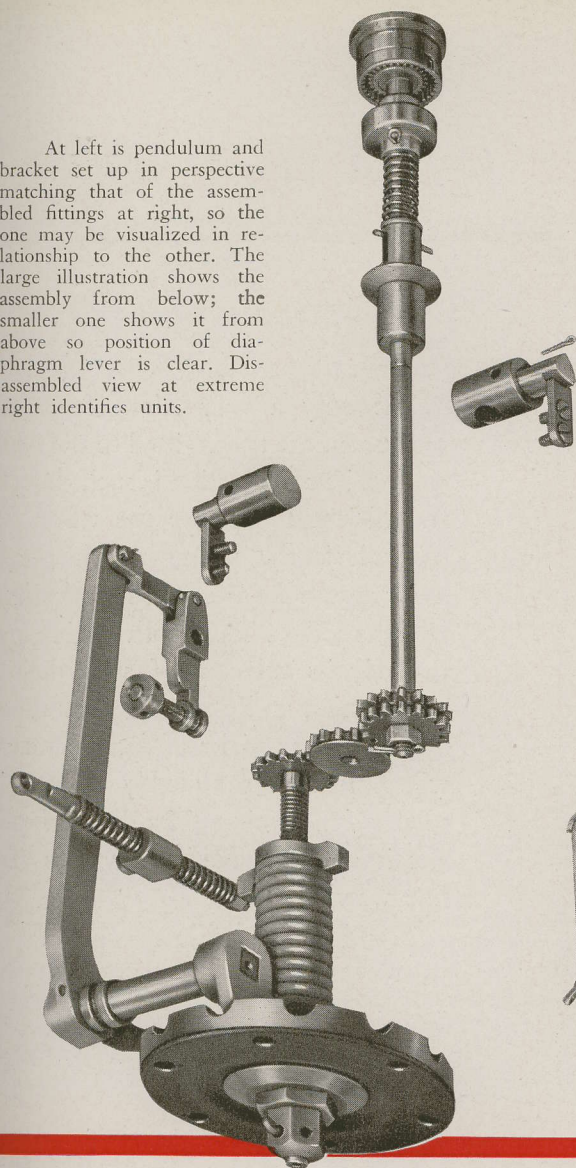
B Pendulum bracket with idler gear A and spring adjusting screw B in place. C is

C Underside of pendulum, with roller guides A screwed in place.

D Pendulum suspended in bracket on knife edge bearings C. A: adjusting spindle socket. B: pins securing knife edge bearings in bracket. D:

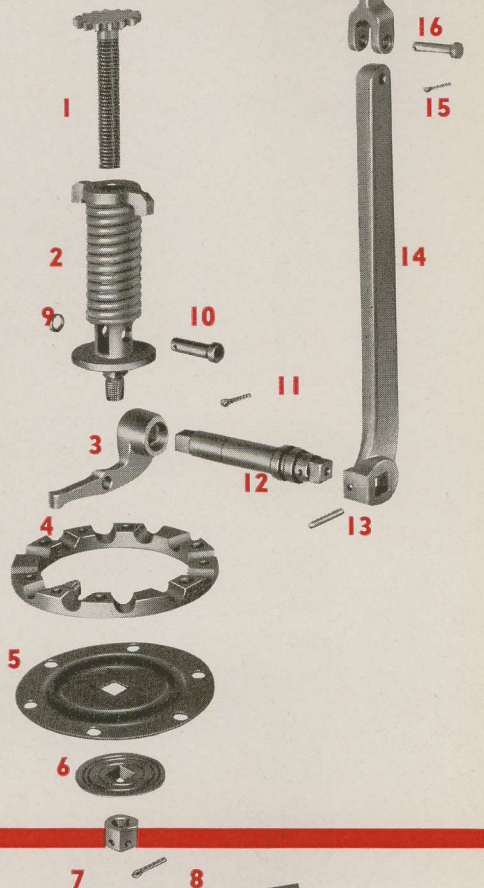


At left is pendulum and bracket set up in perspective matching that of the assembled fittings at right, so the one may be visualized in relationship to the other. The large illustration shows the assembly from below; the smaller one shows it from above so position of diaphragm lever is clear. Disassembled view at extreme right identifies units.



- 1 Spring Adjusting Screw.
- 2 Depth Spring.
- 3 Diaphragm Lever.
- 4 Diaphragm Ring.
- 5 Diaphragm.
- 6 Diaphragm Cap.
- 7 Clamp Nut.
- 8 Cotter Pin.
- 9 Washer.
- 10 Diaphragm Lever Pin.
- 11 Cotter.
- 12 Pendulum Lever Shaft.
- 13 Pin.
- 14 Pendulum Lever.

- 15 Cotter Pin.
- 16 Pin.
- 17 Link.
- 18 Adjusting Arm.
- 19 Pin.
- 20 Cotter Pin.



retainer plate. E: spring adjusting spindle. F: spindle gear. G: after section.

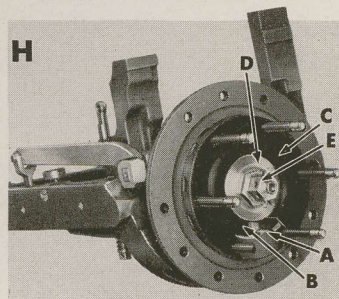
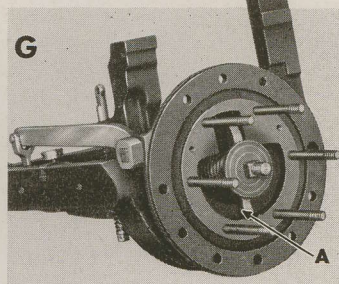
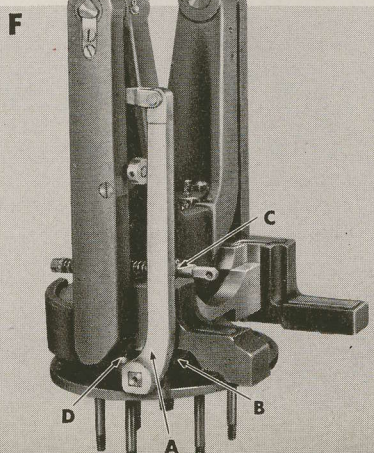
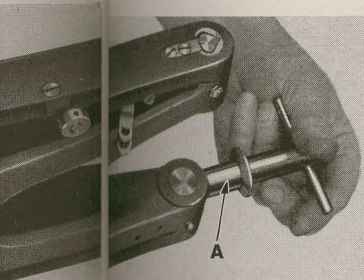
E Depth spring C and diaphragm lever B installed. Spring adjusting screw is run into depth spring cap by means of adjusting spindle A and gearing assembly. D is roller which contacts roller guide (see illustration C) in

event of side sway, preventing damage to knife edge bearings.

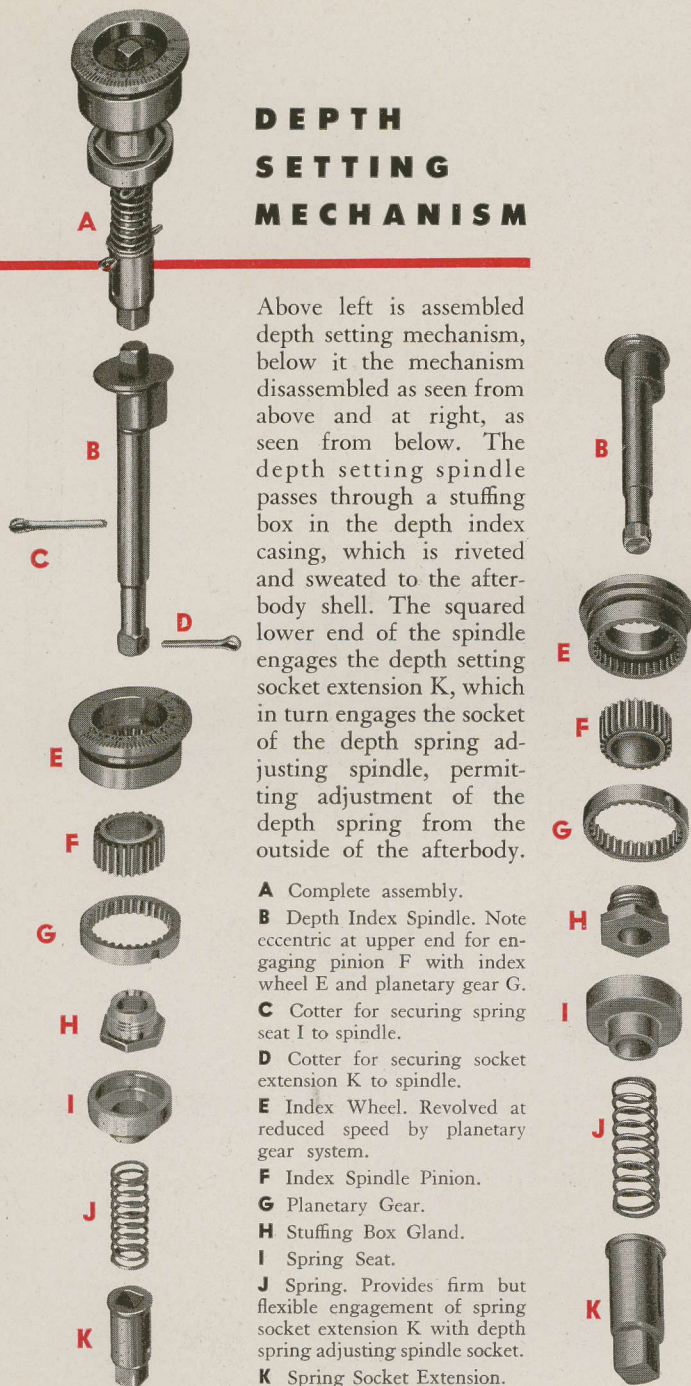
F Assembly ready for mounting of diaphragm ring and diaphragm. A is pendulum lever, B is pendulum lever shaft, C is tension rod and buffer spring assembly, D is roller.

G Underside of pendulum assembly before addition of diaphragm assembly. Note recess in casting opposite diaphragm lever A. Diaphragm lever pivots within this recess on the pendulum lever shaft; in assembly, diaphragm lever is fitted into recess, and shaft then inserted through it and casting.

H Assembly complete. Note that diaphragm ring A is mounted so projection on inner circumference provides lower bearing surface for diaphragm lever B. C is diaphragm, D is diaphragm plate, E is clamp nut. Note that lower end of nut is tapped to receive hook rod for testing weight.



DEPTH SETTING MECHANISM



Above left is assembled depth setting mechanism, below it the mechanism disassembled as seen from above and at right, as seen from below. The depth setting spindle passes through a stuffing box in the depth index casing, which is riveted and sweated to the afterbody shell. The squared lower end of the spindle engages the depth setting socket extension K, which in turn engages the socket of the depth spring adjusting spindle, permitting adjustment of the depth spring from the outside of the afterbody.

A Complete assembly.

B Depth Index Spindle. Note eccentric at upper end for engaging pinion F with index wheel E and planetary gear G.

C Cotter for securing spring seat I to spindle.

D Cotter for securing socket extension K to spindle.

E Index Wheel. Revolved at reduced speed by planetary gear system.

F Index Spindle Pinion.

G Planetary Gear.

H Stuffing Box Gland.

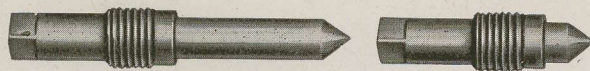
I Spring Seat.

J Spring. Provides firm but flexible engagement of spring socket extension K with depth spring adjusting spindle socket.

K Spring Socket Extension.

TRANSPORTATION SCREW

Also known as the centering screw. Inserted through starboard underside of the immersion gear casing, transportation screw A locks the pendulum in mid position, providing reference point for



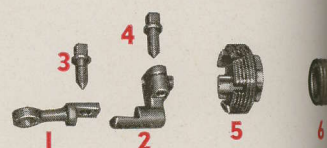
adjusting depth engine valve and diaphragm lever to similar positions. Transportation screw also locks pendulum against violent movement during handling or in shipment. Replacement screw B takes place of transportation when torpedo is made ready for a run.

THE DEPTH

While only a very slight force and movement are transmitted to the depth engine, its construction is such that this is sufficient to operate the valve, and through it the piston which greatly steps up the force applied to the horizontal rudders. The depth engine, particularly its valve, is of such delicate construction and operation that almost microscopic particles of foreign matter will hinder or completely prevent its proper functioning. Handle and protect it as you would the works of a fine watch.

HORIZONTAL ENGINE DISASSEMBLED

- 1 Eye Connection to Valve Operating Lever.
- 2 Adjusting Nut.
- 3 Clamp Screw.
- 4 Lock Screw.
- 5 Stuffing Box Gland.
- 6 Packing.
- 7 Valve Connecting Rod, assembled by wrist pin to Valve.
- 8 Strainer Holder Cap.

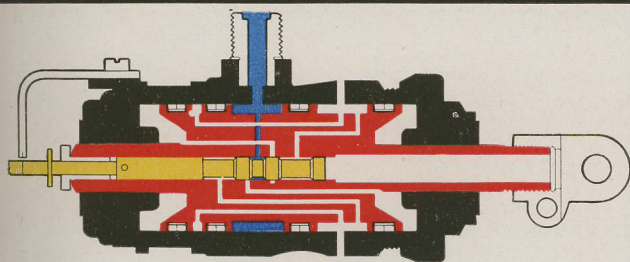


- 9 Strainer (100-mesh).
- 10 Washer.
- 11 Valve Stop.
- 12 Screws for mounting Valve Stop.

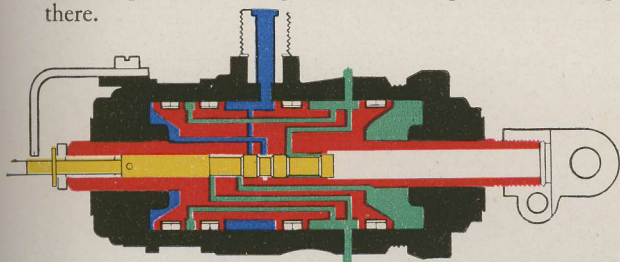
THE BUFFER SPRING

The buffer spring and tension rod assembly provides a cushioned linkage between the pendulum and the valve lever, transmitting the fore-and-aft motion of the pendulum to the valve lever smoothly and preventing abrupt, shearing strain on the depth engine valve wrist pin.

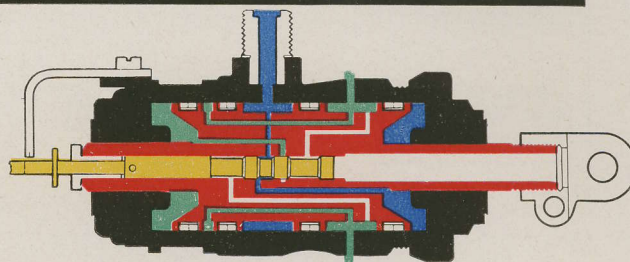
ENGINE



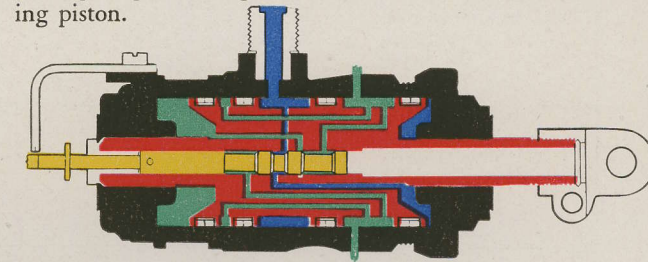
1 Depth engine in neutral position. Valve (yellow) rides within piston (red). Air (blue) enters cylinder through strainer and passes to valve chamber as shown. Stuffing boxes in cylinder heads prevent air leakage around piston rod; lap fit of valve prevents leakage there.



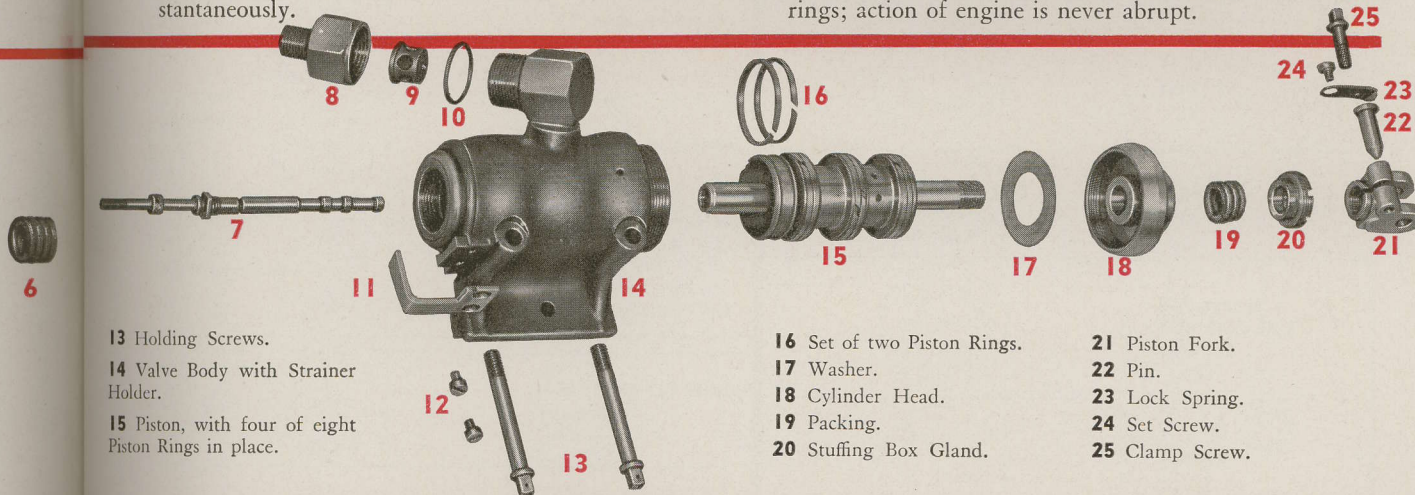
3 Valve (yellow) has made full stroke forward and started aft, admitting air (blue) to forward end of cylinder. Piston (red) has finished forward stroke and will follow valve aft; rudders are now hard down. Piston movement follows valve movement almost instantaneously.



2 Pendulum through linkage with valve connecting rod moves valve (yellow) forward. Air (blue) feeds to after end of cylinder, forcing piston (red) forward. Exhaust air (green) in forward end of cylinder first leaks past piston rings into exhaust channel, cushioning piston.



4 Piston is now aft and horizontal rudders consequently are hard up. Valve has started forward to admit air through central valve chamber into port leading to after end of cylinder. Exhaust air (green) always finds its first release by leakage past piston rings; action of engine is never abrupt.



13 Holding Screws.

14 Valve Body with Strainer Holder.

15 Piston, with four of eight Piston Rings in place.

16 Set of two Piston Rings.

17 Washer.

18 Cylinder Head.

19 Packing.

20 Stuffing Box Gland.

21 Piston Fork.

22 Pin.

23 Lock Spring.

24 Set Screw.

25 Clamp Screw.



A Buffer Connection.

BBB Spring Buttons.

CC Buffer Springs.

D Tension Rod.

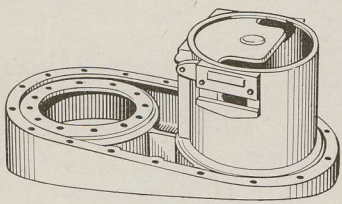

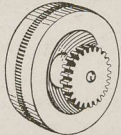
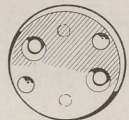

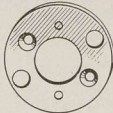

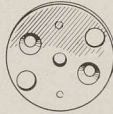
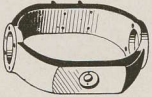

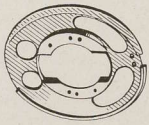

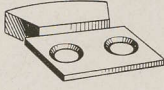

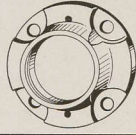

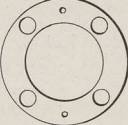

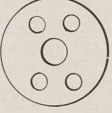
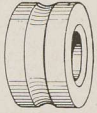




E Bearing.

F Nut.

G Cotter.

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
	<p>GYRO MECHANISM BASE with GYRO POT Base SP 14812 Pot SP 14778</p> 		<p>BALANCE NUT SP 9383</p> 
	<p>GYRO WHEEL SP 8794</p> <p>PIVOT SP 9899</p> 		<p>LOCKING DISC FOR SIDE BEARINGS SP 5541</p> 
	<p>INNER GIMBAL AFTER HALF SP 10178</p> 		<p>LOCKING DISC SP 3293</p> 
	<p>INNER GIMBAL FORWARD HALF SP 10177</p> 		<p>LOCKING DISC FREE END SP 8933</p> 
	<p>OUTER GIMBAL RING SP 5534</p> 		<p>ADJUSTING PLATE SIDE BEARINGS SP 8850</p> 
	<p>CAM PLATE SP 8853</p> 		<p>OUTER BEARING RACE SIDE BEARINGS SP 8911</p> 
	<p>CAM SP 3297</p> 		<p>WHEEL BEARING "A" SP 8847</p> 
	<p>SLEEVE FOR SIDE BEARINGS SP 8851</p> 		<p>WHEEL BEARING "B" SP 8846</p> 
	<p>GASKET SP 10123</p> 		<p>BALL BEARINGS AND RETAINER Retainer SP 8912 Ball Bearings SP 4676</p> 
	<p>GASKET SP 10124</p> 		<p>INNER BEARING RACE SP 8910</p> 
	<p>GASKET SP 10122</p> 		<p>GIMBAL CENTER, BOTTOM SP 9905</p> 
			<p>GIMBAL CENTER, SIDE BEARING SP 8848</p> 
			<p>GIMBAL CENTER, TOP SP 8916</p> 

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
INNER GIMBAL SCREW SP 9382	4	SPRING SP 9906	1
SLEEVE SCREW SP 12	8	PLUG SP 10834	1
SCREW, LOCKING DISC SP 8840	8	COTTER PIN SP 3074	2
BALL BEARING, WHEEL SP 1191	12	GYRO REDUCER VALVE BODY SP 9190	1
CAM PLATE SCREW SP 2	4	PIPE AND NUT SG 3378	1
CAM SCREW SP 102	2	PIPE AND NUT SG 3379	1
GIMBAL CENTER SCREWS SP 103	8	SPRING SP 7715	1
BALANCE NUT KEY SCREW SP 9381	2	NUT SP 6839	1
BOTTOM PLATE FOR GYRO POT SP 11874	1	DIAPHRAGM SP 6572	1
BOTTOM BEARING HOLDER SP 10553	1	SPRING WASHER SP 6855	1
CENTER BEARING RACE SP 8911	4	WASHER SP 281	1
ADJUSTING BODY SP 10554	1	NUT SP 430	3
KEEP SCREW SP 8917	1	TEE SP 6765	1
LOCK SCREW SP 10556	1	DISC SP 1080	1
SPRING BUTTON SP 9908	1	BLANK NUT SP 409	1

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
DOUBLE END NIPPLE SP 10786	1	UNLOCKING RACK SP 3244	1
VALVE STEM SP 6838	1	SPRING LEVER SP 11927	1
HOLDING SCREW SP 7967	2	SPRING ROD SP 3256 RIVET SP 566	1
COTTER PIN SP 477	1	SPRING CASE SP 3255	1
PIPE AND NUT SP 3580	1	NUT SP 1615	1
PIPE AND NUT (VERTICAL ENGINE) SG 3861	1	LOCKING LEVER SP 3270	1
SPINNING AND UN- LOCKING GEAR FRAME SP 14808	1	ROCK SHAFT SG 156	1
FRONT PLATE SG 3547	1	VALVE BELL CRANK SG 2775	1
UNLOCKING BAR SP 8757	1	SWIVEL BLOCK SP 3269	1
HAND TRIP LEVER SG 557 SPRING SP 4716	1	SPRING BELL CRANK SG 2776	1
UPPER CAP SP 8772	1	WASHER SP 301	2
GIB SP 3251	1	NUT SP 442	2
		PINION SP 8755	1
		CONTROLLING SLEEVE GROUP SP 8753 SP 8763 SP 8766 SP 8424	6
		SPINNING SHAFT SP 8762	2
		SPINNING SHAFT SLEEVE AND BUSHING SG 2142	1

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
TURBINE WHEEL SP 10851	1	IMPULSE VALVE WASHER No. SP 312	1
SPACING WASHER SP 8767	1	IMPULSE VALVE PLUG LARGE—No. SP 3259 MED.—No. SP 3262 SMALL—No. SP 3263	1
SCREW SP 44	2	VALVE LEVER BRACKET SP 14814	1
SCREW SP 11826	1	PIVOT PIN SP 8421	1
COTTER PIN SP 4630	2	PLUG SP 10873	1
LOWER GEAR CENTERING PLATE SP 8773	1	PIN SP 16082	1
UPPER GEAR CENTERING PLATE SG 2922	1	PIN SP 16083	1
SCREW SP 8768	6	LEVER SP 11886	1
UNLOCKING PINION SP 3242	1	VALVE CONNECTION SP 8419	1
WORM WHEEL AND GEAR SP 3243	1	PIN SP 8422	1
GEAR CENTER SP 8799	2	SCREW SP 387	1
RIVET SP 8760 RACK SP 8754 LOCKING BAR SP 8756	1	COTTER PIN SP 4630	4
SCREW SP 8758	1	COTTER PIN SP 3174	4
CENTERING PIN SP 8752	1	CLAMP PLATE SP 10837	1
PIN SP 1239	1	CLAMP PLATE COVER SP 10838	1
SPRING SP 860	1	PLUG FOR CLAMP PLATE COVER SP 10835	1
BUTTON SP 1579	1		
IMPULSE VALVE No. SP 3258	1		

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
CLAMP PLATE COVER SCREW SP 11875	1	ADJUSTING SCREW SP 11729	1
TOP PLATE SG 3517	1	LOCKING SCREW SP 2911	1
GYRO POT RETAINER HALF SP 10790	1	PALLET SP 2175	2
GYRO POT RETAINER HALF SP 10791	1	SCREW SP 4355	2
SCREW SP 120	6	NUT SP 3213	1
GYRO POT RETAINER MARKER SP 10792	1	BELL CRANK SP 11721	1
SCREWS FOR MARKER TO GYRO POT	2	WASHER SP 3222	2
PLUG SP 199	2	PIN SP 3217	1
SPRING SP 826	2	LINK SP 3882	1
SCREW PLUG SP 612	1	PALLET SLIDE COVER SG 3518	1
PALLET SLIDE SG 3519	1	PIN SP 3218	1
PALLET SHAFT WITH CAM PAWLS SG 140	1	SCREW SP 3107	4
LEAF SPRING SP 2185	1	RIGHT HAND LINK SP 2174	2
PALLET HOLDER SP 3212	1	LEFT HAND LINK SP 2173	2
		ADJUSTING SCREW SP 1377	1
		SCREW SP 8	3
		RIGHT HAND PAWL SG 144	1
		LEFT HAND PAWL SG 143	1
		EXTENDER FOR LEFT HAND PAWL SG 3626	1




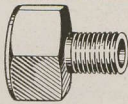





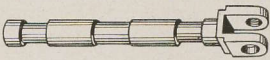

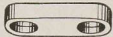




PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES	
8	SCREW SP 3167	1	DRIVING SPINDLE SP 14922
1	WORM BRACKET SP 12106	1	CAP SP 3548
1	WORM BRACKET SP 12105	1	NUT SP 430
1	WORM AND SHAFT SP 12107	1	SCREW SP 387
2	HOLDING SCREW SP 12116	1	SCREW SP 4355
1	SCREW SP 9	6	SCREW SP 120
1	LOCK NUT SP 12108	6	COTTER PIN SP 3278
1	CAP SP 3550	1	HOLDER SP 11928
1	WASHER SP 3225	2	SCREW SP 3609
4	SCREW SP 3107	1	VERTICAL ENGINE CYLINDER SG 3525
1	ADJUSTING HEAD FOR SHAFT SG 3539	1	STRAINER HOLDER SP 13241
1	VALVE ROCK SHAFT SG 3480	1	CYLINDER HEAD SP 1299
1	CAM BEVEL GEAR SP 3551	1	HEAD GASKET SP 9139
1	BRACKET SP 14809	1	PISTON SP 3895
2	SPRING SP 3680	1	WASHER SP 4702
2	PLUG SP 3679	4	PISTON RING SP 1363
1	HEX SCREW SP 11822		

PARTS FOR GYRO MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

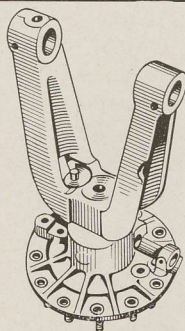
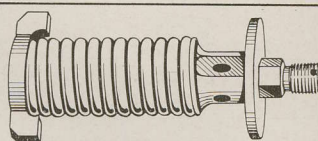
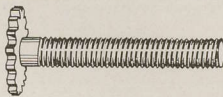


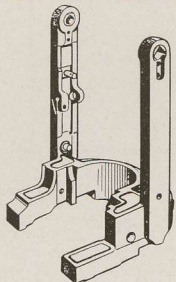
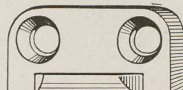

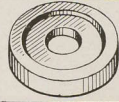

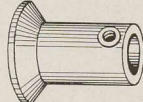

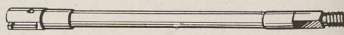

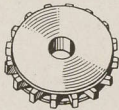
NUMBER OF PIECES			NUMBER OF PIECES		
PACKING SP 4122	4		STRAINER SG 3062	1	
GLAND SP 1546	1		CAP FOR STRAINER HOLDER SP 9144	1	
FORK SP 3229	1		SCREW SP 102	1	
PIN SP 1234	1		WASHER SP 251	1	
LOCKING SPRING SP 3200	1		VALVE SP 13252	1	
SCREW SP 142	1		LINK SP 3227	1	
SCREW SP 145	1		SCREW SP 360	1	
WASHER SP 9139	1		SCREW SP 3231	1	

TOOLS FOR GYRO MECHANISM

NUMBER OF PIECES		NUMBER OF PIECES	
FACE SPANNER No. 201A	1	TESTING CLIP No. 414A	1
OPEN END WRENCH No. 24	1	SYRINGE FOR OILING GYRO BEARINGS (No SG No.)	1
SOCKET WRENCH No. 246	1		
LOCKING TOOL No. 205A	1		
DOUBLE OPEN END WRENCH No. 144	1		

PARTS FOR IMMERSION MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES		NUMBER OF PIECES						
UHLAN GEAR BRACKET SG 3912	1		DEPTH SPRING SG 3522	1				
			DEPTH SPRING ADJUSTING SCREW SP 11804	1				
			DIAPHRAGM PLATE SP 7106	1				
			CLAMP NUT SP 7110	1				
			SCREW SP 38	3				
PENDULUM ASSEMBLY PIN SP 8418 PIN SP 7139 PENDULUM SP 13329 SET SCREW SP 7961 KNIFE EDGE BEARING SP 7960 BALLAST SP 13330	1		ROLLER GUIDE SP 7181	2				
	1		SCREW SP 7195	4				
	1		ROLLER SP 7197	1				
	1		WASHER SP 8411	1				
	2		PIN SP 8412	1				
1	DEPTH SPRING ADJUSTING SPINDLE HEAD SP 3168	1						
	SET SCREW SP 108	1						
	ADJUSTING SPINDLE SG 3523	1						
	ADJUSTING SPINDLE GEAR SP 13849	1						
	IDLER GEAR SP 3510	1						
		</						


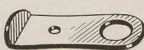


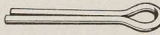

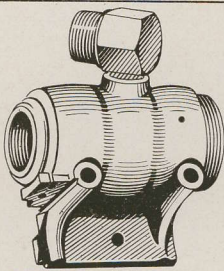


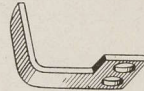






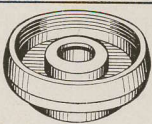
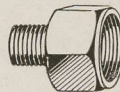



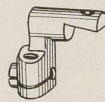



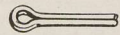
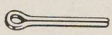

PARTS FOR IMMERSION MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

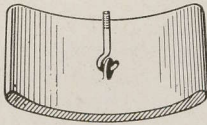
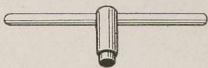

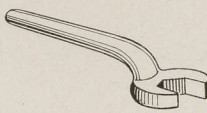
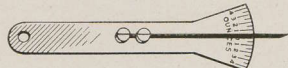
NUMBER OF PIECES		NUMBER OF PIECES	
PIN SP 7146	2	COTTER SP 3074	1
ADJUSTING ARM SP 7188	1	WASHER SP 7112	1
PENDULUM LINK SP 7187	1	PIN SP 7111	1
PENDULUM LEVER SP 7184	1	KEEP SCREW SP 7193	1
KNIFE EDGE BEARING (STARBOARD) SP 7144	1	DIAPHRAGM LEVER SP 7185	1
KNIFE EDGE BEARING (PORT) SP 7145	1	PENDULUM LEVER SHAFT SP 7186	1
RETAINER PLATE SP 7142	2	TAPER PIN SP 517	1
SCREW SP 7143	4	NUT SP 7190	1
SCREW SP 7196	2	WASHER SP 4639	1
AFTER SECTION SP 13331	1	PIN SP 7125	1
ADJUSTING SCREW SP 7189	1	TRANSPORTATION SCREW SP 7149	1
CLAMP SCREW SP 7192	1	REPLACEMENT SCREW SP 7160	1
PIN SP 8075	1	TENSION ROD BEARING SP 8127	1
TAPER PIN SP 7191	2	TENSION ROD SP 8126	1
BUFFER CONNECTION SP 11885	1	BUFFER SPRING SP 8128	2

PARTS FOR IMMERSION MECHANISM

KEY: SG—STOCK GROUP • SP—STOCK PART

NUMBER OF PIECES			NUMBER OF PIECES		
SPRING BUTTON SP 8130	4		LOCK SPRING SP 3200	1	
NUT SP 8132	1		SCREW SP 360	1	
COTTER SP 4630	3		SET SCREW SP 145	1	
DEPTH ENGINE CYLINDER SP 11801	1		HOLDING SCREW SP 11819	2	
DEPTH ENGINE VALVE ASSEMBLY VALVE SP 3201 PIN SP 529 VALVE CONNECTING ROD SP 11887	1		STOP SP 3223	1	
PISTON SP 3543	1		SCREW SP 4813	2	
PISTON RING SP 3280	8		WASHER SP 9139	1	
WASHER SP 3272	1		STRAINER SG 3062	1	
CYLINDER HEAD SP 3271	1		STRAINER HOLDER CAP SP 9144	1	
PACKING SP 4122	1		EYE CONNECTION SP 11883	1	
GLAND SP 3273	2		ADJUSTING NUT SP 11884	1	
YOKE SP 3199	1		SCREW SP 387	1	
PIN SP 1234	1		COTTER PIN SP 475	3	
			COTTER PIN SP 3074	2	
			COTTER PIN SP 3278	2	

TOOLS FOR IMMERSION MECHANISM

NUMBER OF PIECES		NUMBER OF PIECES	
TESTING WEIGHT FOR DEPTH SPRING No. 411B		LIFTING SCREW No. 409	
		OPEN END WRENCH No. 155	
OPEN END WRENCH No. 191		SENSITIVE GAUGE No. 222	

NOTES FOR GYRO MECHANISM

