09

REVERSING

Part I - General

Diesel engines intended for the propulsion of ship fitted with neither a controllable pitch propeller nor a **reversing gearbox** are made in direct reversing form. **Astern running** involves carrying out the events of the cycle *in the reverse order*, i.e. altering the **timing** of valves and fuel pumps to cause them to start the engine in the opposite direction and then continue its **operating cycle** in this direction.

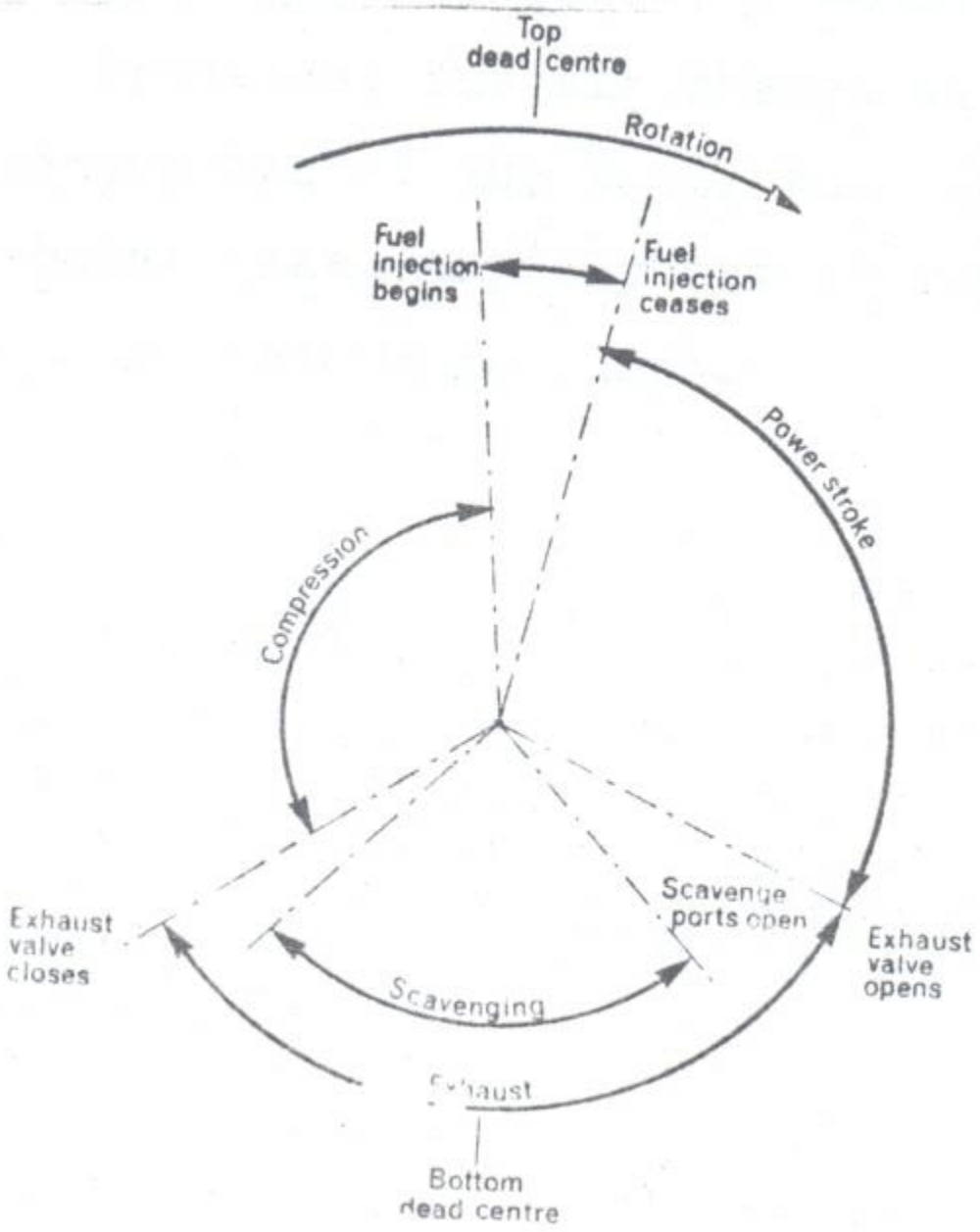
Fill in the missing word

Part I - General

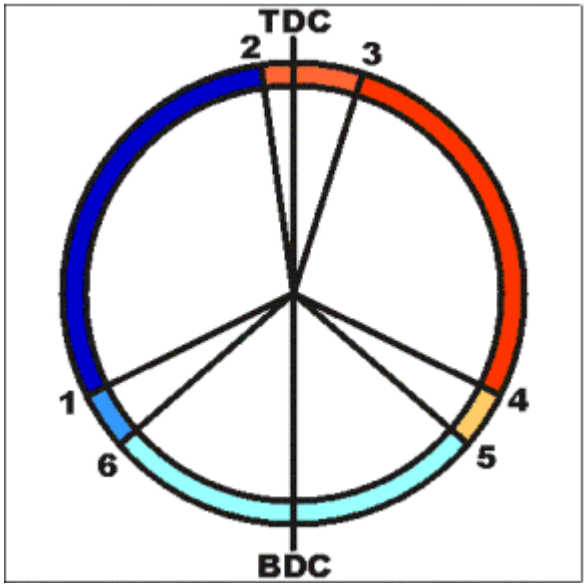
- Diesel engines intended for the propulsion of ship fitted with neither a _____ nor a **reversing gearbox** are made in _____ form.
- _____ involves carrying out the events of the cycle *in the reverse order*, i.e. altering the _____ and fuel pumps to cause them to start the engine in the opposite direction and then continue its _____ in this direction.

Fig. 1

Timing of a 2-stroke diesel engine



Using the diagram below describe the timing of a two-stroke diesel engine



The propeller thrust must be reversible in order to do manoeuvring of a ship. Usually manoeuvring is done while entering a port or leaving a port. In case of a controllable pitch propeller an unidirectional engine is sufficient. In case of limited power systems like medium speed engines of high speed engines, clutches and reverse gears may be used. But in large diesel engines, the main engines must be reversible and should be able to produce thrust efficiently in both the directions (ahead and astern)

To reverse an engine the engine cycle may require re-timing.

Large diesel engines have scavenge ports which controls the scavenge timing. This remains unchanged when reversed.

Engines working with constant pressure turbocharge systems also have symmetrical exhaust valve timing and hence no change in timing is required. Only the fuel timing to be changed since it will be the opposite flank of the cam.

Insert the chunk into the right place in the sentence

- The propeller thrust must be reversible do manoeuvring of a ship. in order to
- Usually manoeuvring is done a port or leaving a port. while entering
- a controllable pitch propeller an unidirectional engine is sufficient. in case of
- In case of limited power systems like medium speed engines of high speed engines, clutches and reverse gears. may be used
- But in large diesel engines, the main engines must be reversible and thrust efficiently in both the directions (ahead and astern) should be able to produce
- an engine the engine cycle may require re-timing. to reverse
- Large diesel engines which controls the scavenge timing. have scavenge ports
- This remains when reversed. unchanged
- Engines working with constant pressure turbocharge systems also have symmetrical exhaust valve timing in timing is required. and hence no change

How the reversing gears works ?

http://www.machineryspaces.com/reversing.html

The diesel engine is a type of internal combustion engine which ignites the fuel by injecting it into hot, high-pressure air in a combustion chamber. In common with all internal combustion engines the diesel engine operates with a fixed sequence of events, which may be achieved either in four strokes or two, a stroke being the travel of the piston between its extreme points. Each stroke is accomplished in half a revolution of the crankshaft.

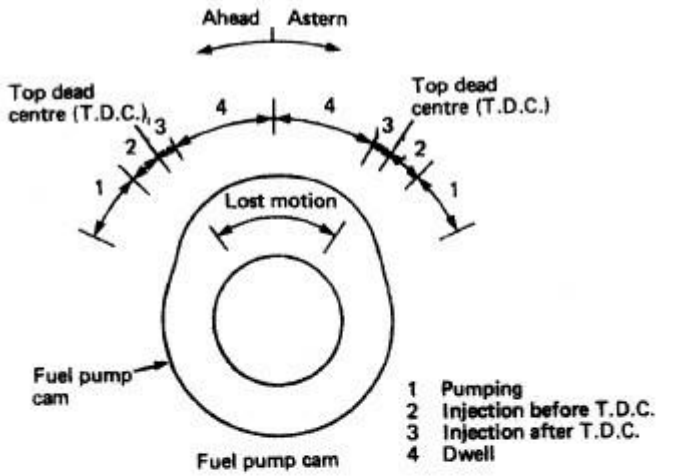
The gearing arrangement used to reduce the medium-speed engine drive down to suitable propeller revolutions . Where a gearbox is used with a diesel engine, reversing gears may be incorporated so that the engine itself is not reversed. Where a controllable pitch propeller is in use there is no requirement to reverse the main engine.

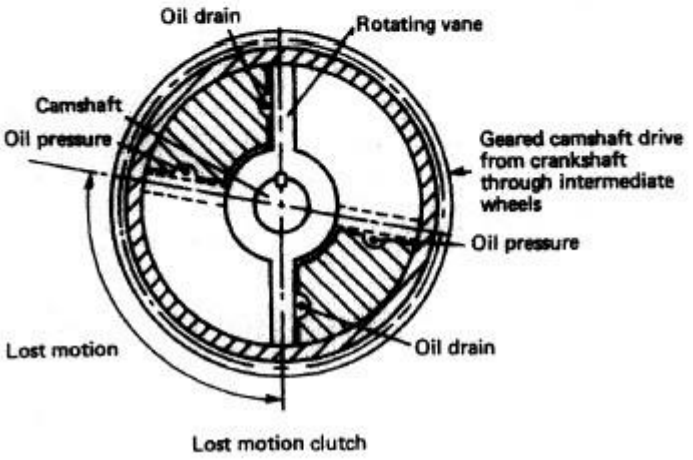
Supply the missing terms

How the reversing gears works ?

The diesel engine is a type of internal combustion engine which _____ the fuel by injecting it into hot, high-pressure air in a _____. In common with all internal combustion engines the diesel engine _____ with a fixed sequence of events, which may be achieved either in four strokes or two, a stroke being the _____ between its extreme points. Each stroke is accomplished in half a _____ of the crankshaft.

The gearing arrangement used to reduce the medium-speed engine drive down to suitable _____ revolutions . Where a _____ is used with a diesel engine, reversing gears may be incorporated so that the engine itself is not _____. Where a controllable pitch propeller is in use there is no requirement to _____ the main engine.


Ahead
Astern
Top dead centre (T.D.C.)
Top dead centre (T.D.C.)
1
2
3
4
4
3
2
1
Lost motion
Fuel pump cam
Fuel pump cam
1 Pumping
2 Injection before T.D.C.
3 Injection after T.D.C.
4 Dwell


Oil drain
Rotating vane
Camshaft
Oil pressure
Geared camshaft drive from crankshaft through intermediate wheels
Oil pressure
Lost motion
Oil drain
Lost motion clutch

However, when it is necessary to run the engine in reverse it must be started in reverse and the fuel injection timing must be changed. Where exhaust timing or poppet valves are used they also must be retimed. With jerk-type fuel pumps the fuel cams on the camshaft must be repositioned. This can be done by having a separate reversing cam and moving the camshaft axially to bring it into position.
Alternatively a lost-motion clutch may be used in conjunction with the ahead pump-timing cam.

MCT

- However, when it is necessary to **stop / run / engage** the engine in reverse it must be started in reverse and the fuel injection timing must be changed.
- Where exhaust timing or poppet valves are used they also must be **retimed / reordered / recognized**.
- With jerk-type fuel pumps the fuel cams on the camshaft must be **repositioned / replaced / reinstalled**.
- This can be done by having a separate reversing cam and moving the **crankshaft / camshaft / tailshaft** axially to bring it into position.
- Alternatively a lost-motion **coupling / clutch / pinion** may be used in conjunction with the ahead pump-timing cam.

The shaping of the cam results in a period of pumping first then about 10° of fuel injection before top dead centre and about 5° after top dead centre. A period of dwell then occurs when the fuel pump plunger does not move.

A fully reversible cam will be symmetrical about this point, as shown. The angular period between the top dead centre points for ahead and astern running will be the 'lost motion' required for astern running. The lost-motion clutch or servo motor uses a rotating vane which is attached to the camshaft but can move in relation to the camshaft drive from the crankshaft. The vane is shown held in the ahead operating position by oil pressure.

When oil is supplied under pressure through the drain, the vane will rotate through the lost-motion angular distance to change the fuel timing for astern operation. The starting air system is retimed, either by this camshaft movement or by a directional air supply being admitted to the starting air distributor, to reposition the cams. Exhaust timing or poppet valves will have their own lost-motion clutch or servo motor for astern timing.

Supply one of the terms below in the right place of the text

plunger / poppet / top dead centre / reversible / running / rotating vane / vane / starting air system / drain

The shaping of the cam results in a period of pumping first then about 10° of fuel injection before and about 5° after top dead centre. A period of dwell then occurs when the fuel pump does not move.

A fully cam will be symmetrical about this point, as shown. The angular period between the top dead centre points for ahead and astern will be the 'lost motion' required for astern running. The lost-motion clutch or servo motor uses a which is attached to the camshaft but can move in relation to the camshaft drive from the crankshaft. The is shown held in the ahead operating position by oil pressure.

When oil is supplied under pressure through the, the vane will rotate through the lost-motion angular distance to change the fuel timing for astern operation. The is retimed, either by this camshaft movement or by a directional air supply being admitted to the starting air distributor, to reposition the cams. Exhaust timing or valves will have their own lost-motion clutch or servo motor for astern timing.

Two-stroke engines

- It is clear that this is easier to do on a **two-stroke engine** where one cycle involves one **rotation** of the crankshaft and one rotation of the camshaft. In a two-stroke exhaust ported engine, both **scavenge and exhaust port timings** are symmetrical about **bottom dead centre** (BDC) and these will be identical when the engine is reversed. (See diagram below). In such engines, only the air start and fuel timings will require **adjustment**.

Supply the missing word

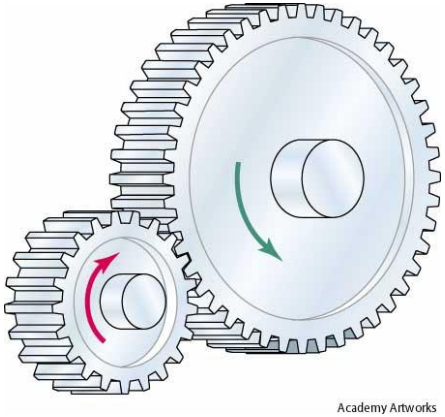
- Two-stroke engines

- It is clear that this is easier to do on a **two-stroke engine** where one _____ involves one **rotation** of the _____ and one rotation of the _____. In a two-stroke exhaust ported engine, both _____ **and exhaust port timings** are symmetrical about _____ (BDC) and these will be identical when the engine is reversed. (See diagram below). In such engines, only the air start and fuel timings will require _____.

- If both are operated from the engine **camshaft**, their cam profiles may be designed to give the same retiming angle for reversing. **Retiming** is then carried out by altering the position of the camshaft to the crankshaft of the engine.
- A **servomotor** may be fitted to the camshaft drive mechanism to do this. (See Fig.9.2.). The **spur wheel** on the camshaft is not connected rigidly with the latter. The **torque** is transmitted by the reversing servomotor which acts as a dog coupling. During normal operation the coupling is effected mechanically. The pressure oil is conducted either in front of or behind the **rotating vane** according to the desired direction of the rotation.

Supply the missing info

- If both are operated from the engine **camshaft**, their cam profiles may be designed .....
- **Retiming** is then carried out by altering ..... to the crankshaft of the engine.
- A **servomotor** ..... to the camshaft drive mechanism to do this.
- The **spur wheel** on the camshaft is not connected rigidly with the latter.
- The **torque** is transmitted by the reversing servomotor which - .....
- During normal operation the coupling is .....
- The pressure oil is conducted either ..... or behind the



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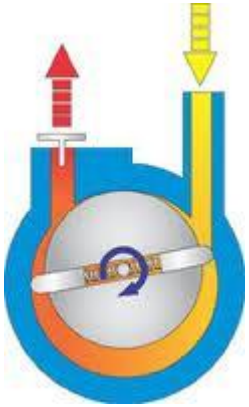

- During reversing the rotating vane is turned , together with the camshaft, until the vane comes to **rest** against the stop segments again. During the process the other side of the vane is **relieved of** the oil pressure through the relief pipe.

Fill in the missing word

- _____ reversing the rotating vane is turned , together with the camshaft, _____ the vane comes to **rest** against the stop segments again. During the process the other side of the vane is **relieved of** the oil pressure _____ the relief pipe.

Four-stroke engines

- With four-stroke engines the altering of the camshaft is a little more complex as the **sequence of operation** of inlet and exhaust cams has to be interchanged. The usual method is to **slide** the camshaft **axially** bringing into use a different set of cams for operation *in the reverse direction*. In some engines a mechanism is incorporated wich lifts the **tappet rollers** clear of the cams whilst they are moved axially.

Match the parts of the sentences below

Four-stroke engines

1. With four-stroke engines the altering of the camshaft is a little more complex	a. which lifts the **tappet rollers** clear of the cams whilst they are moved axially.	
2. The usual method is to **slide** the camshaft **axially**	b. as the **sequence of operation** of inlet and exhaust cams has to be interchanged.	
3. In some engines a mechanism is incorporated	c. bringing into use a different set of cams for operation *in the reverse direction*.	

- In others ahead and astern running cams are interconnected by inclined surfaces, or ramps, on which the **follower rollers** slide during camshaft displacement. Sliding a long camshaft on a multi-cylinder engine requires considerable effort. It is usually carried out by **hydraulic or pneumatic** means or a combination of both. Pneumatic control of **hydraulic rams** is common for moving the camshaft into position.

Put the text in the right column in the right place in the left column

In others ahead and astern running cams are interconnected by inclined surfaces, or ramps, during camshaft displacement. Sliding a long camshaft requires considerable effort. It is usually carried out or a combination of both. Pneumatic control of **hydraulic rams** is common into position.	**on which the follower rollers slide** **on a multi-cylinder engine** **by hydraulic or pneumatic means** **for moving the camshaft**

QUESTIONS AND DISCUSSION

1. State why ships equipped with controlable pitch propellers do not need reversible engines.
2. How does astern running affect the cycle ?
3. Why is reversing performed more easily on two-stroke than on four-stroke engines ?
4. Explain the meaning of the term “retiming” and say by what mean it is done.
5. Describe in Fig.9.2. how the relative positions of the crankshaft and the camshaft are altered.
6. Why is the preparation for reverse running in four-stroke engines more comlex than that in two-stroke engines ?
7. Describe the methods of reversing four-stroke engines.
8. How is the shifting of camshafts on large muli-vylinder engines carried out ?

I. Say which of the following statements are TRUE and which are FALSE. If FALSE state why.

1. Engines that are directly reversible can rotate in either a clockwise or an anticlockwise directions.
2. Controlable pitch propellers cause the engine to turn in the opposite direction.
3. In a reversible direction the angle of the propleller blades is changed to produce an astern thrust as the engine rotates in the same direction.
4. "Non-reversible" means the same as "unidirctional" and the terms, applied to an engine indicates that it cannot run in the opposite direction.
5. A reverse gearbox provides astern thrust without reversing the propeller rotation.
6. The reversal of the engine is accomplihed by axial translation of the camshaft, on which a double series of cams arranged.
7. A simple method of reversing two-cycle engines is to rotate the camshaft $30^0 - 40^0$ thus putting the oposite profile of the cam under the fuel valve or pump.
8. The reversing servomotor serves to turn the crankshaft in the opposite direction.
9. The four-cycle Diesel engine is easier to reverse than the two-cycle Diesel engines as there are fever moving parts to be changed in direction of rotation.

II. Give terms opposite in meaning to the following:

1.	air inlet valve	a. _____
2.	ahead running	b. _____
3.	fixed-blade propeller	c. _____
4.	unidirectional engine	d. _____
5.	tdc	e. _____
6.	exhaust port	f. _____
7.	pressure pipe	g. _____

III. Fill the gaps in the following sentences with the suitable expressions from the previous exercises

- Cooling of _____ valves will prolong the useful life of valves and seats.
- With _____ _____ propeller it si possible to provide astern running without reversing the direction of motion
- In a reversible engine the timing of the valves and the fuel pumps must be altered for _____ running.
- At reversing the roller must be _____ of the cams, then the camshaft is moved axially.
- The point of highest travel of a piston in its cylinder is indicated by the abbreviation _____ .
- Air enteres the cylinder through _____ when these are uncovered by the piston crown near the bottom of its travel.
- While the oil is forced at one side of the rotating vane, at the other the _____ is opened to let oil pressure out.
- Engines inteded for electric power generation are _____ , i.e. not arranged for direct reversing.

IV. Change the following VERB + NOUN + ADVERB collocations into ADJECTIVE + NOUN + of + NOUN ones:

- Eg. **To move the camshaft axially – axial movement of the camshaft**

- To reverse the engine directly - _____
- To connect the spur wheel rigidly - _____
- To perform astern running readily - _____
- To control the engines remotely - _____
- To transmit signals electrially - _____
- To proplel ship mecanically - _____
- To adjust only the air start and fuel timing - _____

GRAMMAR

- **V. Replace the VERB + NOUN + ADVERB collocations in the following sentences with the ADJECTIVE + NOUN + of + NOUN ones making the necessary changes. Use the verbs in brackets when provided.**

- Eg.
- *Before reversing it is necessary to move the camshaft axially.*
- *An axial movement of the camshaft is necessary before reversing.*

Paraphrase the sentences below:

1. The spur wheel is not connected rigidly with the camshaft. (there is no …)
2. Ships not supplied with controlable pitch propellers reverse the engine directly. (… is indispensable for …)
3. As a rule – today engines are remotely controlled from an enclosed control room or from the bridge. (… is possible …)
4. In older vessels we find that engine orders are still transmitted mechanically by telegraph. (… is used …)
5. Astern running is performed more simply with a controlable pitch propeller operated in astern pitch. (… is achieved …)
6. The first mechanically propelled ships used a steam reciprocating engine. (the first ships on …)

UZROK, RAZLOG (Cause, Reason) II.

Pored primjera iz VII lekcije uzrok ili razlog odnosno uzrok i posljedica mogu se izraziti i na slijedeće načine:

(1a) With four-stroke engines …. …., due to the fact (owing to the fact) that the sequence of operation of inlet and exhaust cams has to be interchanged.

- *(1b) Sliding followers are avoided in medium speed engines because the running speedsare high.*

(2a.) Sliding followers are avoided in medium speed engines because of high running speeds.

- *(2b.) … due to high running speed.*
- *(2c.) … owing to high running speeds.*
- *(2d.) … on a account of high running speeds.*
- *(2e.) The reason why sliding followers are avoided in medium speed engines is that there are high runnig speeds.*

Continued

Since the pressure increased, the relief valve opened.

- *(3a.) Because of an increase in pressure, the relief valve opened.*
- *(3b.) As a result of the increase in pressure, the relief valve opened.*
- *(3c.) The increase in pressure caused the relief valve to open.*
- *(3d.) The reason why the relief valve opened was that the pressure increased.*
- *(3e.) The pressure increased and the relief valve opened.*

I. Find the instances of Relative Clauses in Lessons 8 and 9 translate them into Croatian.

II. Find the instances of Purpose in the same Lessons and translate then into Croatian.

III. Connect the following sentences applying the Cause-Result relation.

Eg.

- *The castings are not so big and heavy. The column and cylinder block may be made in one piece.*

- Due to (Owing to) the fact that the castings are not so big and heavy, the column and Cylinder block may be made in one piece.
- *The reason why the column and cylinder block may be made in one piece is that the castings are not so big and heavy.*
- *The valves did not open. The valve rocker gear was blocked.*
- *The camshaft can be slided axially. In this type of engine a different set of cams is used.*

Connect the following sentences applying the Cause-Result relation

1. Astern running is performed more easily in two-stroke engines than in four-stroke ones. The cycle includes only one rotation of the crankshaft and the camshaft.
2. The rising and falling characteristics of the cam rotation in two stroke engines are the same. In such cases the cams are made to be symmetrical.
3. The upper of the liner suffers the graetest wear. At this point the piston ring comes at rest and runs down.
4. This valve needs reconditioning. The valve seat conatins carbonaceous particles.
5. The exhaust valves were not cooled sufficiently. This is why thermal problems accurred.
6. The frame structure of the cylinder does not come into contact with water. The danger of corrosion is minimized.

IV. Make a change to the sentences as in the following example:

- *Eg. The flow of burnt gases expelled from the cylinder causes the exhaust valves to rotate intermittently.*

1. Intermittent rotation of exhaust valves is due to / caused by the flow of burnt gases expelled from the cylinder.
2. The instant combustion of injected fuel causes the pressure to rise rapidly. (… in pressure …)
3. Missagignment of the main bearings may cause the crankshaft to bend heavily.
4. The timed rotation of the crankshaft causes the inlet and exhaust valves to open and close alternatively.

1. Slow or late combustion of fuel during the expansion stroke commonly referred to as afterburning may cause the engine to lose power considerably.
2. Acord attached to some form of engine stroke sinhronizing mechanism causes the indicator drum to rotate suitably.
3. Faulty piston rings caused the compression in cylinder No.3 and No.5 to be reduced greatly. (… in compression …)
4. Construction and design differences such as ratio of connecting rod length / crankleght, stroke / bore ratio, engine speed, etc. cause the actual timing to vary slightly between engines.
5. The tilting of the piston rings causes them to wear excessively.
6. Contamination of the crankcase lube oil with residue from combustion caused the bearing surface to corrode irreparably.

V. Translate into English

- Čestice gareži, koje se nakupljaju u sjedište ventila izazivaju (uzrokuju) ljuštenje.
- Ispušni ventili moraju imati bolje hlađenje jer rade na višim temperaturama.
- Najčešći uzroci požara na brodu su zavarivanje i loše održavanje.
- Budući da su radne brzine kod srednjehodnih motora velike, može doći do pretjeranog zagrijavanja i trošenja elemenata motora.
- Hlađenjem ispušnih ventila je lakše jer su manji od usisnih.
- Okretanje bregaste osovine omogućeno je jer se između nje i koljenaste osovine nalazi niz zupčanika ili su spojene lančastim prijenosom.
- Budući da se redoslijed rada usisnih i ispušnih ventila mora izmijeniti, kod četverotaktnih motora teže je izvršiti prekret.
- Bregovi bregaste osovine pokreću ventile i pumpu goriva. Zbog toga što su specijalno oblikovani otvaranje i zatvaranje ventila obavlja se lako.

Test 1. Supply the missing terms:

- ***follower, scavenge, reversing gearbox, rotating vane, astern running, spur wheel, timing, tappet rollers, operating cycle, two-stroke engine, rotation, bottom dead centre, adjustment, camshaft, rams, retiming, servomotor, torque, rest, relieved, sequence of operation, slide, axially, pneumatic,***

REVERSING

- Diesel engines intended for the propulsion of ship fitted with neither a controllable pitch propeller nor a _____ are made in direct reversing form. _____ involves carrying out the events of the cycle *in the reverse order*, i.e. altering the _____ of valves and fuel pumps to cause them to start the engine in the opposite direction and then continue its _____ in this direction.

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Two-stroke engines

- It is clear that this is easier to do on a _____ where one cycle involves one _____ of the crankshaft and one rotation of the camshaft. In a two-stroke exhaust ported engine, both _____ and exhaust port timings are symmetrical about _____ (BDC) and these will be identical when the engine is reversed. (See diagram below). In such engines, only the air start and fuel timings will require _____ .
- If both are operated from the engine _____, their cam profiles may be designed to give the same retiming angle for reversing. _____ is then carried out by altering the position of the camshaft to the crankshaft of the engine.

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- A _____ may be fitted to the camshaft drive mechanism to do this. (See Fig.9.2.). The _____ on the camshaft is not connected rigidly with the latter. The _____ is transmitted by the reversing servomotor which acts as a dog coupling. During normal operation the coupling is effected mechanically. The pressure oil is conducted either in front of or behind the _____ according to the desired direction of the rotation.
- During reversing the rotating vane is turned , together with the camshaft, until the vane comes to _____ against the stop segments again. During the process the other side of the vane is _____ of the oil pressure through the relief pipe.

rotation, bottom dead centre, adjustment, camshaft, rams, retiming, servomotor, torque, rest, relieved, sequence of operation, slide, axially, pneumatic,

Four-stroke engines

- With four-stroke engines the altering of the camshaft is a little more complex as the _____ of inlet and exhaust cams has to be interchanged. The usual method is to_____ the camshaft _____ bringing into use a different set of cams for operation *in the reverse direction*. In some engines a mechanism is incorporated wich lifts the _____ clear of the cams whilst they are moved axially.
- In others ahead and astern running cams are interconnected by inclined surfaces, or ramps, on which the _____ rollers slide during camshaft displacement. Sliding a long camshaft on a multi-cylinder engine requires considerable effort. It is usually carried out by hydraulic or _____ means or a combination of both. Pneumatic control of hydraulic _____ is common for moving the camshaft into position.

Part II.

Reversing Gear
Couplings, clutches and gearboxes

Where the shaft speed of a medium-speed diesel engine is not suitable for its application, e.g. where a low speed drive for a propeller is required, a ***gearbox*** must be provided. Between the engine and gearbox it is usual to fit some form of flexible ***coupling*** to dampen out vibrations. There is also often a need for a ***clutch*** to disconnect the engine from the gearbox.

Couplings

Supply the missing info

- Where the shaft speed of a medium-speed diesel engine is not suitable for its application, e.g. where ……, a ***gearbox*** must be provided.
- Between the engine and gearbox it is usual to fit some form of flexible ***coupling*** to …… .
- There is also often a need for a ***clutch*** to …… the gearbox.

- *R & D Marine has developed a wide range of Flexible Couplings to fit all major installations.*
- *The R & D Flexible Couplings reduce engine noise, vibration transmission and are designed to accept propeller thrust, a separate thrust bearing and bulk head are not required.*
- *The couplings are made from a polyester elastomer which is not affected by salt water, diesel and lubrication fluids.*
- *If electrical continuity is required an earthing connector can be fitted in the centre of most Flexible Couplings.*
- *Installation is quick and easy as the R & D Coupling requires no machining and comes supplied with bolts to connect between the two existing shaft flanges.*
- *Checking alignment on installation and during service checks is quick and easy using the red cone headed bolt.*

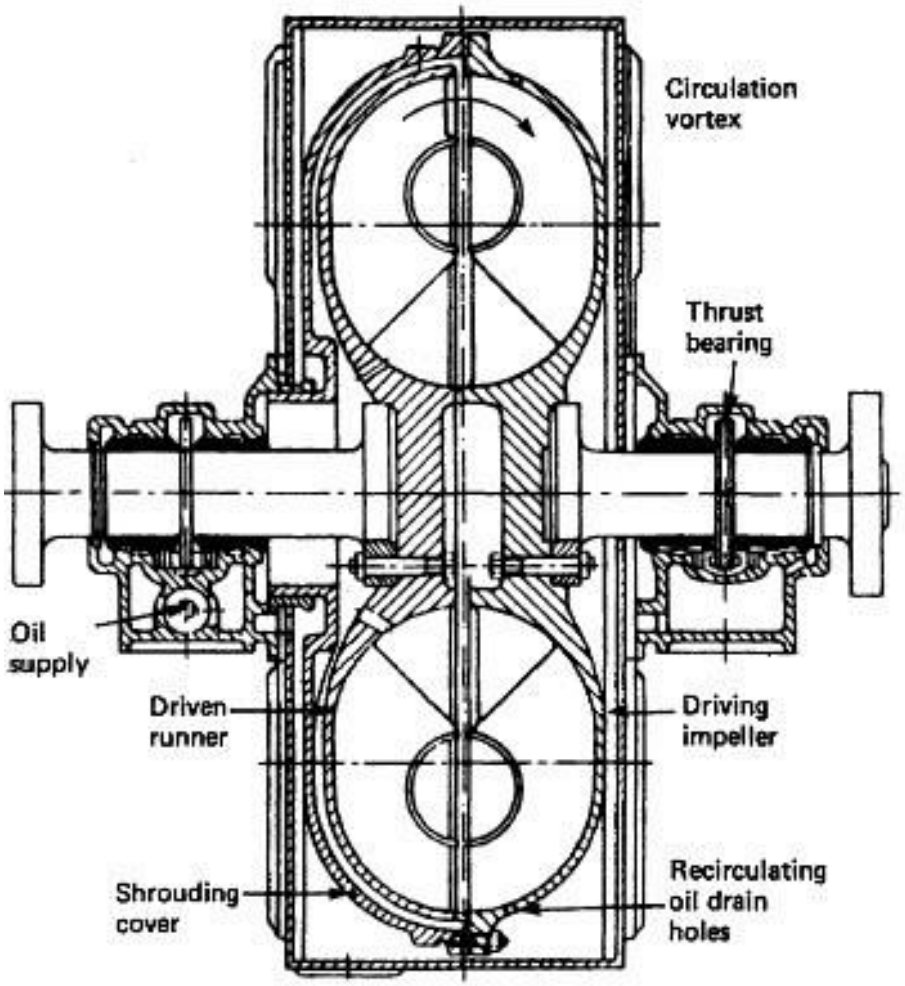
Fill in the missing term

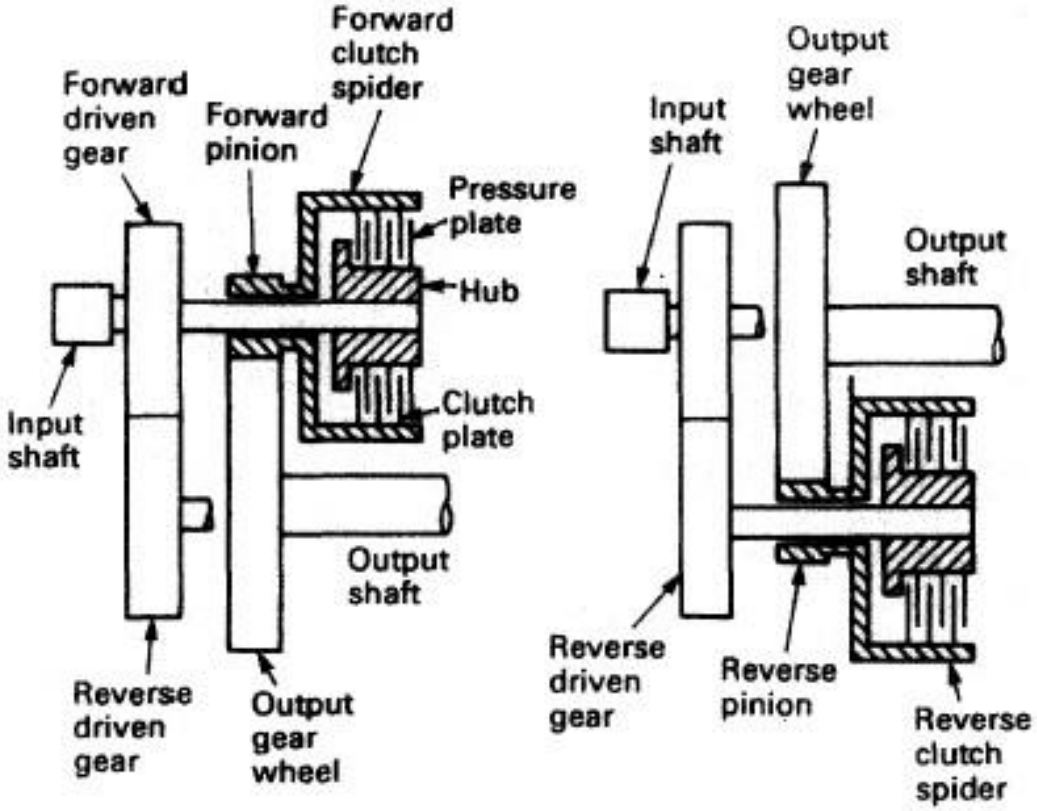
- *R & D Marine has developed a wide range of _____ Couplings to fit all major installations.*
- *The R & D Flexible Couplings reduce engine noise, _____ transmission and are designed to accept propeller _____, a separate thrust bearing and bulk head are not required.*
- *The couplings are made from a polyester elastomer which is not affected by salt water, diesel and _____ fluids.*
- *If electrical continuity is required an _____ connector can be fitted in the centre of most Flexible Couplings.*
- *Installation is quick and easy as the R & D _____ requires no machining and comes supplied with _____ to connect between the two existing shaft flanges.*
- *Checking _____ on installation and during service checks is quick and easy using the red cone headed bolt.*

Matching exercise

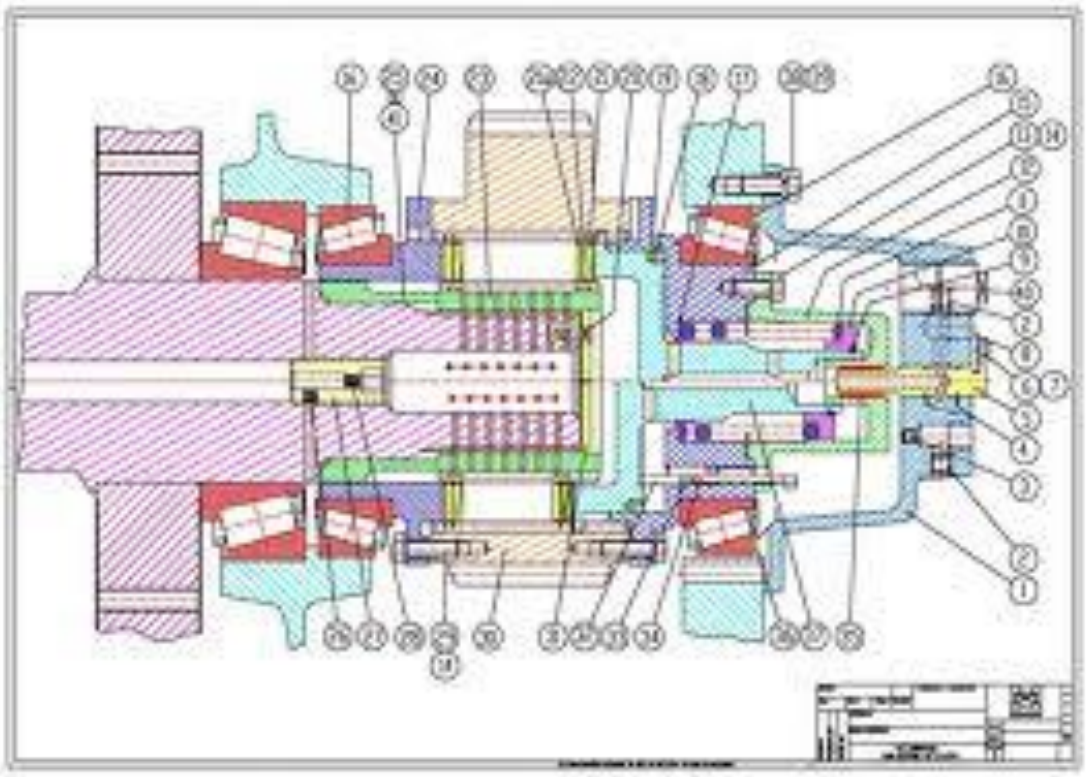
1	**Elastic or flexible couplings *allow* slight misalignment and damp out**	**a**	**hydraulic or pneumatic in operation.**
2	The coupling may in addition *function as*	b	coupling and this is not readily possible with the mechanical coupling.
3	Couplings may be mechanical, electrical,	c	or *remove* torque variations from the engine.
4	It is usual to combine the function of clutch with a	d	a clutch or disconnecting device.

Fig: Hydraulic couplings




Forward clutch spider
Forward driven gear
Forward pinion
Pressure plate
Hub
Clutch plate
Input shaft
Output shaft
Reverse driven gear
Output gear wheel
Output gear wheel
Input shaft
Output shaft
Reverse driven gear
Reverse pinion
Reverse clutch spider

Clutches



- A **clutch** is a device to *connect or separate* a driving unit from the unit it drives. With two engines connected to a gearbox a clutch enables one or both engines *to be run*, and *facilitates* reversing of the engine.
- The **hydraulic or fluid coupling** uses oil to connect the driving section or **impeller** with the driven section or **runner**. No wear will thus take place between these two, and the clutch operates smoothly. The runner and impeller have pockets that face each other which are *filled with oil* as they rotate. The engine driven impeller provides kinetic energy to the oil which transmits the drive to the runner. **Thrust bearings** must be provided on either side of the coupling because of the **axial thrust** developed by this coupling.

Pair work: Define and discuss the function of the terms below

- clutch
  hydraulic or fluid coupling
- impeller
- thrust bearings
- axial thrust

- A **plate-type clutch** consists of pressure plates and clutch plates arranged in a **clutch spider**. A forward and an aft **clutch assembly** are provided, and an externally mounted selector valve assembly is the control device which hydraulically *engages* the desired clutch. The forward clutch assembly is made up of the input shaft and the forward clutch spider.

- The input shaft includes the **forward driven gear** and, at its extreme end, a hub with the steel pressure plates of the forward clutch assembly spline-connected, i.e. free to slide. Thus when the input shaft turns, the forward driven gear and the forward clutch pressure plates will *rotate*. The forward clutch plates are positioned between the pressure plates and are spline-connected to the forward clutch spider or housing. This forward clutch spider forms part of the forward **pinion** assembly which surrounds but does not touch the input shaft.

Fill in the missing terms

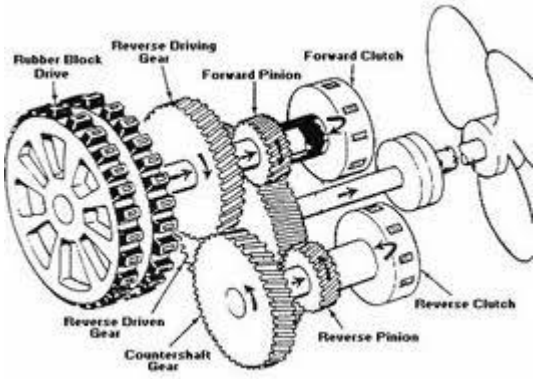
- A _____ **clutch** consists of pressure plates and clutch plates arranged in a **clutch spider**.
- A forward and an aft **clutch** _____ are provided, and an externally mounted selector valve assembly is the control device which hydraulically *engages* the desired clutch.
- The forward clutch assembly is made up of the _____ and the forward clutch spider.
- The input shaft includes the **forward driven** _____ and, at its extreme end, a hub with the steel pressure plates of the forward clutch assembly spline-connected, i.e. free to slide.
- Thus when the input shaft turns, the forward driven gear and the forward clutch _____ will *rotate*.
- The forward clutch plates are positioned between the pressure plates and are _____ -connected to the forward clutch spider or housing.
- This forward clutch spider forms part of the forward _____ assembly which surrounds but does not touch the input shaft.

Gearboxes

Supply the missing info

- The gearing arrangement is used to ……
- It is always ……
- Reduction ratios range ……

Reversing gearboxes



Part III - How the reversing gears works ?

- The diesel engine operates with a *fixed sequence of events*, which may be achieved either in four strokes or two, a **stroke** being the travel of the piston between its extreme points. Each stroke is accomplished in half a revolution of the crankshaft.

How the reversing gears works ? – ctd.

- The **gearing arrangement** is used to reduce the medium-speed engine drive down to suitable **propeller revolutions**. Where a gearbox is used with a diesel engine, **reversing gears** may be incorporated so that the engine itself is not reversed. Where a **controllable pitch propeller** is in use there is no requirement to reverse the main engine.
- However, when it is necessary *to run the engine in reverse* it must be started in reverse and the **fuel injection timing** must be changed. Where exhaust timing or poppet valves are used they also must be retimed. With **jerk-type fuel pumps** the fuel cams on the camshaft must be repositioned. This can be done by having a separate **reversing cam** and moving the camshaft axially to bring it into position. Alternatively a **lost-motion clutch** may be used in conjunction with the ahead pump-timing cam.

Read the slide above and find the missing verbs

- The **gearing arrangement** is used to _____ the medium-speed engine drive down to suitable **propeller revolutions**.
- Where a gearbox is used with a diesel engine, **reversing gears** may be incorporated so that the engine itself is not _____.
- Where a **controllable pitch propeller** is in use there is no requirement to _____ the main engine.
- However, when it is necessary *to* _____ *the engine in reverse* it must be _____ in reverse and the **fuel injection timing** must be changed.
- Where exhaust timing or poppet valves are used they also must be _____.
- With **jerk-type fuel pumps** the fuel cams on the camshaft must be _____.
- This can be done by having a separate **reversing cam** and moving the camshaft axially to _____ it into position.
- Alternatively a **lost-motion clutch** may be _____ in conjunction with the ahead pump-timing cam.

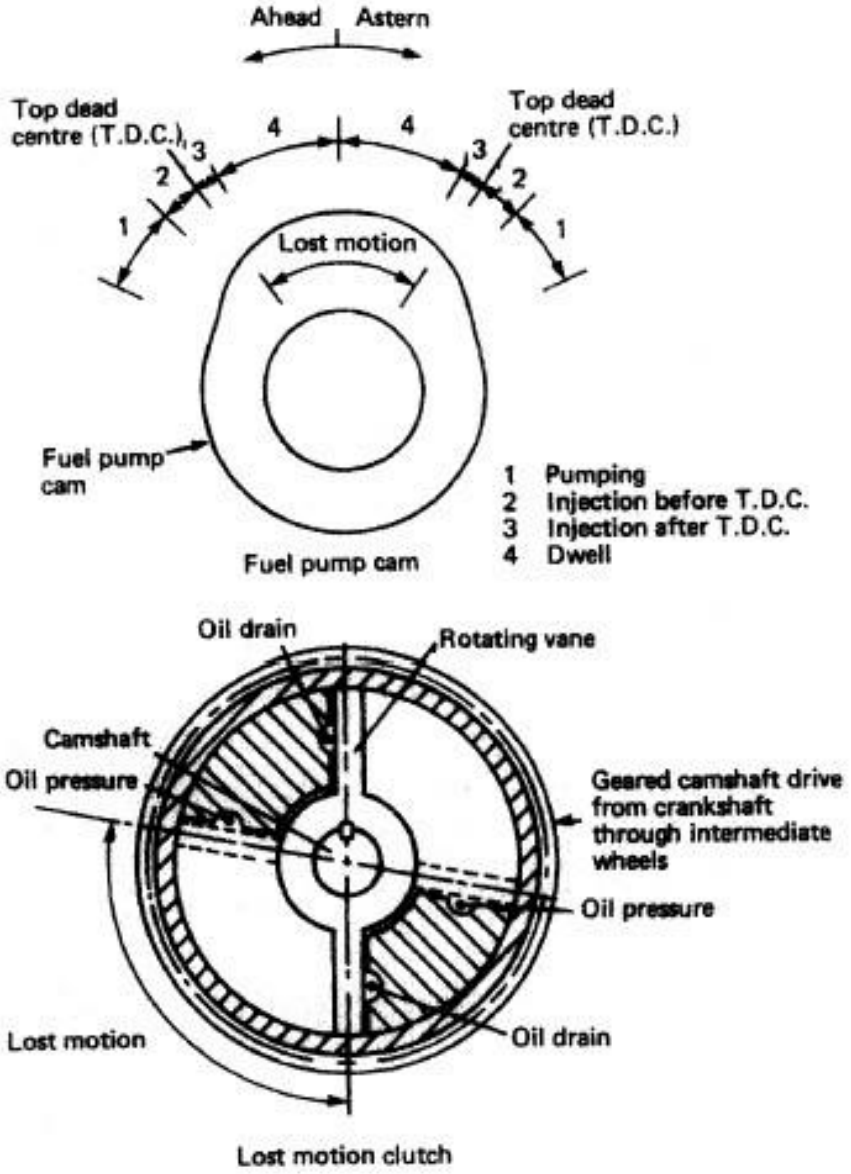


Fig: Reversing arrangements

Underline the words in the text below that you find important when talking about clutches

- The fuel pump cam and lost-motion **clutch arrangement** is shown in the Figure above. The shaping of the cam results in a period of pumping first then about 10° of fuel injection before top dead centre and about 5° after top dead centre. A period of dwell then occurs when the fuel pump plunger does not move.
- A fully reversible cam will be symmetrical about this point, as shown. The angular period between the top dead centre points *for ahead and astern running* will be the 'lost motion' required for astern running. The lost-motion clutch or servo motor uses a rotating vane which is attached to the camshaft but can move in relation to the camshaft drive from the crankshaft. The vane is shown held in the ahead operating position by oil pressure.

Insert the expression the the right place

admitted to / when / for astern timing / for astern operation / either

- oil is supplied under pressure through the drain, the vane will rotate through the lost-motion angular distance to change the fuel timing.
- The starting air system is retimed, by this camshaft movement or by a directional air supply being the starting air distributor, to reposition the cams.
- Exhaust timing or poppet valves will have their own lost-motion clutch or servo motor.

Engine reversing

When running at manoeuvring speeds:

1. Where manually operated auxiliary blowers are fitted they should be started.

2. The fuel supply is shut off and the engine will quickly slow down,

3. The direction handle is positioned astern.

4. Compressed air is admitted to the engine to turn it in the astern direction.

5. When turning astern under the action of compressed air, fuel will be admitted. The combustion process will take over and air admission cease.

***Test*: Put the actions below in the right sequence of operations:** Engine reversing, when running at manoeuvring speeds	
	The fuel supply is shut off and the engine will quickly slow down
	When turning astern under the action of compressed air, fuel will be admitted. The combustion process will take over and air admission cease.
	Where manually operated auxiliary blowers are fitted they should be started.
	Compressed air is admitted to the engine to turn it in the astern direction.
	The direction handle is positioned astern.
	The fuel supply is shut off and the engine will quickly slow down,

Part IV - Turning gear

- The turning gear or turning engine is a **reversible electric motor** which drives a **worm gear** which can be connected with the toothed **flywheel** to turn a large diesel. A slow-speed drive is thus provided to enable positioning of the engine parts *for overhaul purposes*. The turning gear is also used *to turn the engine one or two revolutions prior to starting*. This is a safety check to ensure that the engine is free to turn and that no water has collected in the cylinders. The **indicator cocks** must always be open when the turning gear is operated.

Supply the missing info

- The turning gear or turning engine is a **.....** which drives a **worm gear** which can be connected with the toothed **flywheel** to .....
- A slow-speed drive is thus provided to enable ..... *for overhaul purposes*.
- The turning gear is also used *to turn the engine one or two revolutions* ..... .
- This is a safety check to ensure that the engine is free to turn and that no water .....
- The **indicator cocks** ..... when the turning gear is operated.

Worm gear

Bevel gear

Part V.
Reversing

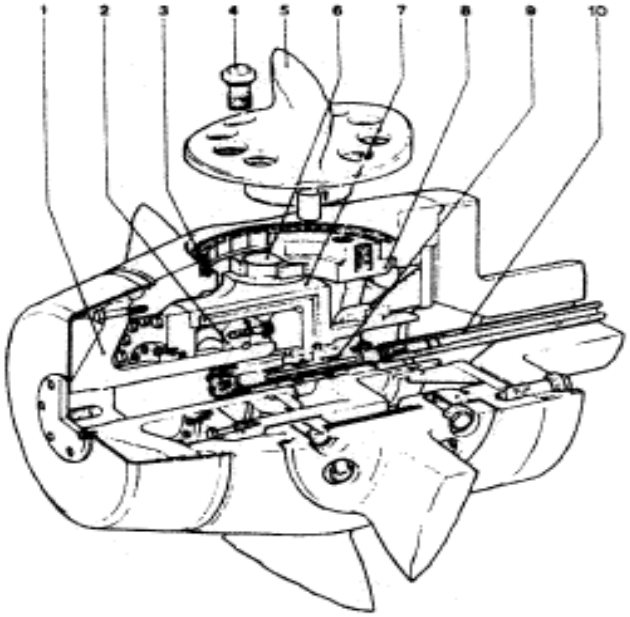
Ships may move:

- Ahead
- _____
- Sideways (Athwarthships)

Ships may change the direction of movement (ahead to astern and viceversa) by means of:

- _____ (CPP)
- Reversing (gear) gearbox
- Direct reversing

CONTROLLABLE PITCH PROPELLER



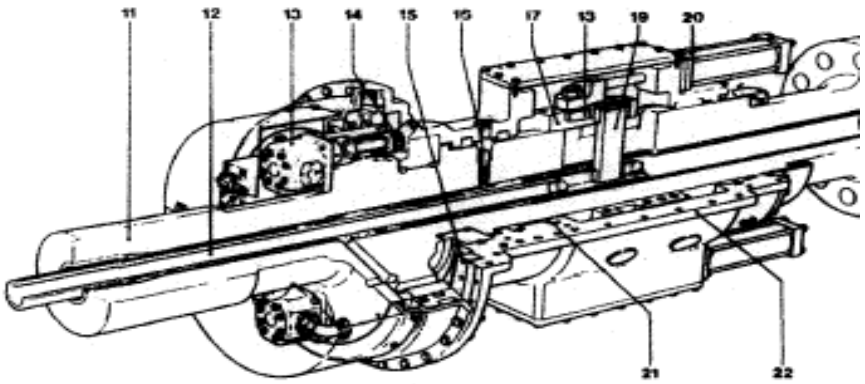


Figure 11.7 Controllable-pitch propeller

1 Piston rod
2 Piston
3 Blade seal
4 Blade bolt
5 Blade
6 Crank pin
7 Servo motor cylinder
8 Crank ring
9 Control valve
10 Valve rod
11 Mainshaft
12 Valve rod
13 Main pump
14 Pinion
15 Internally toothed gear ring
16 Non-return valve
17 Sliding ring
18 Sliding thrust block
19 Corner pin
20 Auxiliary servo motor
21 Pressure seal
22 Casing

- A controllable-pitch propeller is made up of a boss with separate blades mounted into it. An internal mechanism enables the blades to be moved

- Where CPP is in use there is no requirement to reverse the main engine

- A controllable-pitch propeller is made up of a _____ with separate _____ mounted into it. An internal mechanism enables the _____ to be moved

- Where CPP is in use there is no requirement to _____ the main engine

REVERSING GEAR

- The engine itself is not reversed if the reversing gears are incorporated

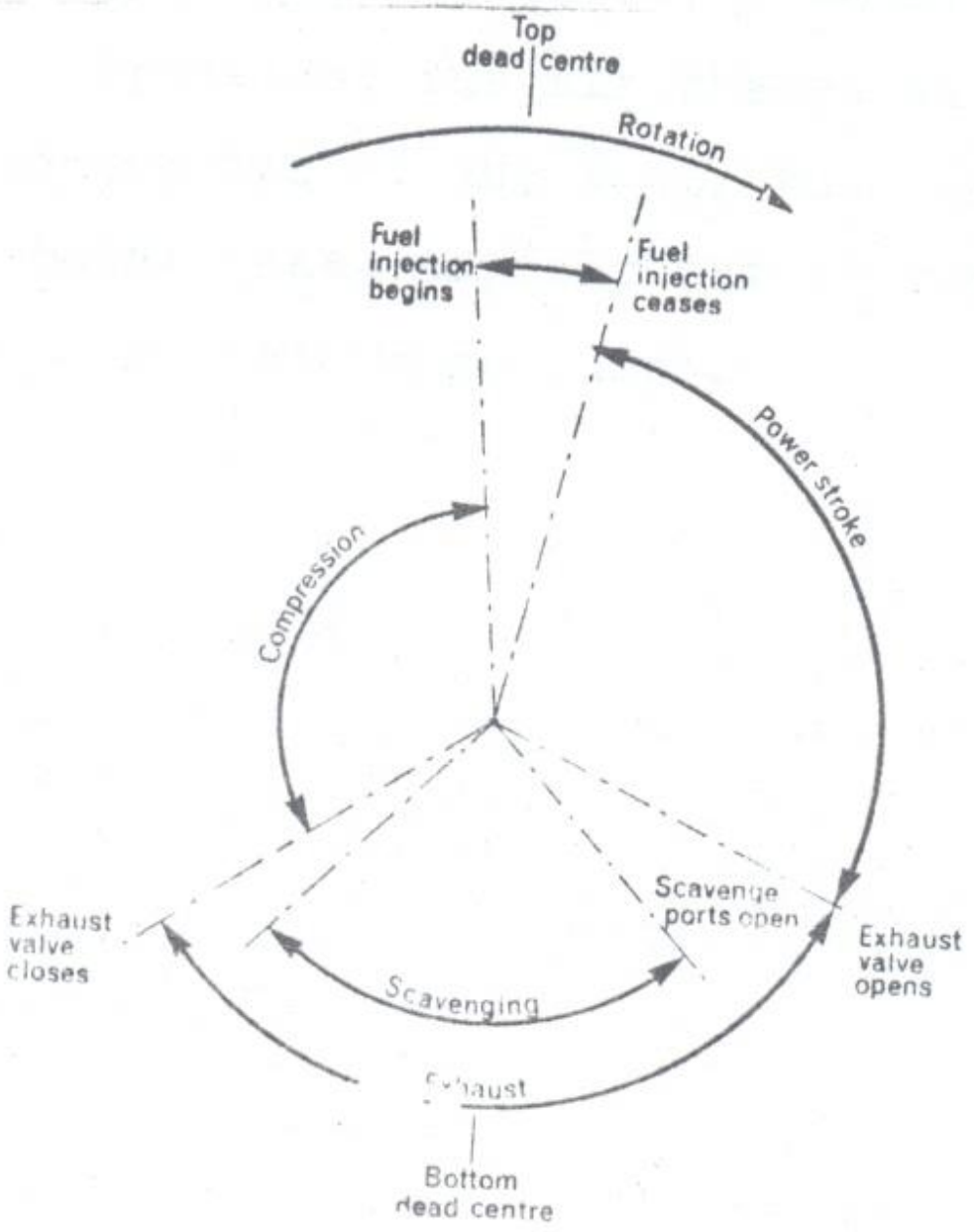
DIRECT REVERSING

- The engine must be started in reverse and the fuel injection timing must be changed.

- Reversing is easier in 2-stroke engines.

Fig. 1

Timing of a 2-stroke diesel engine



4-STROKE ENGINE

- The position of the _____ to the crankshaft is changed by a _____ The camshaft is slided _____, bringing into use a different set of _____

_____

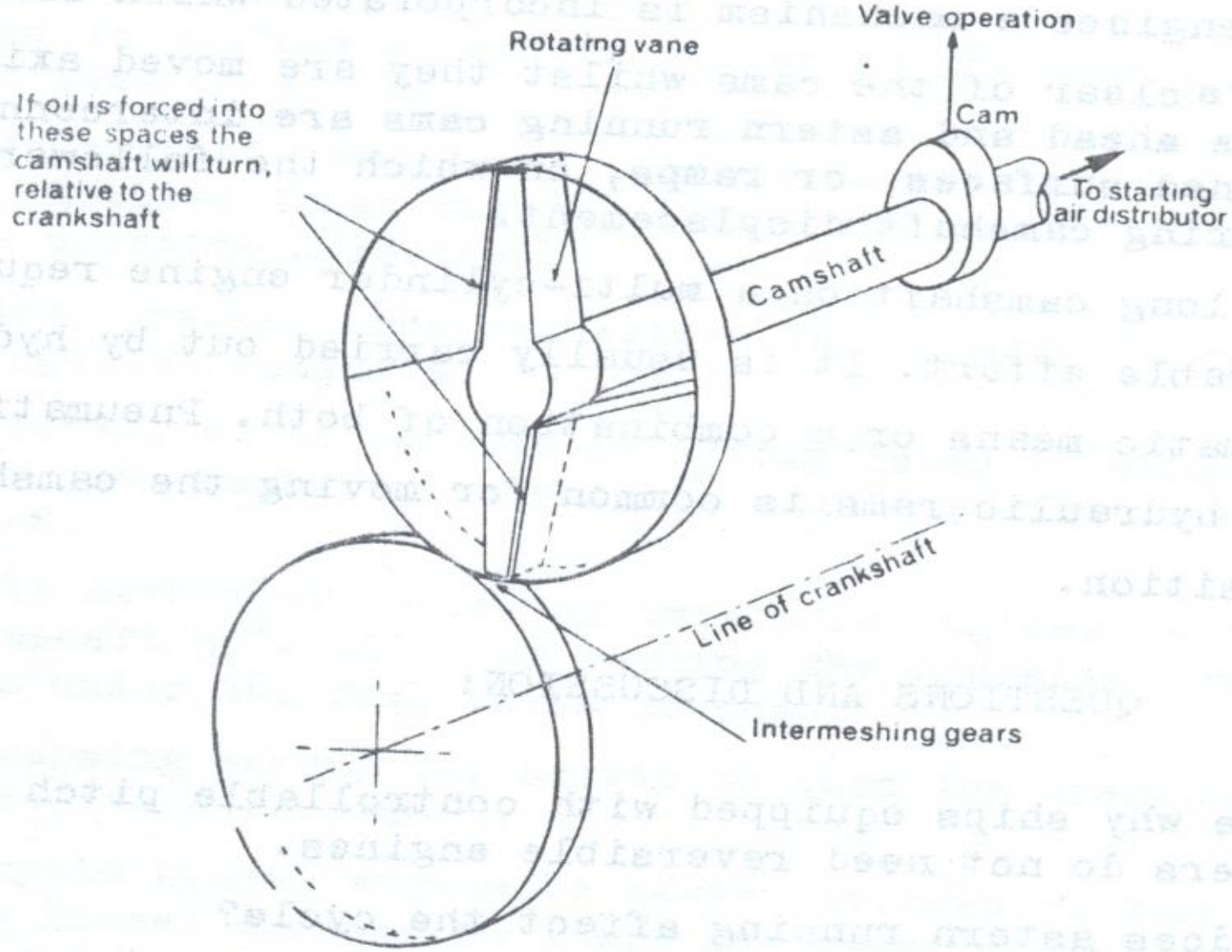
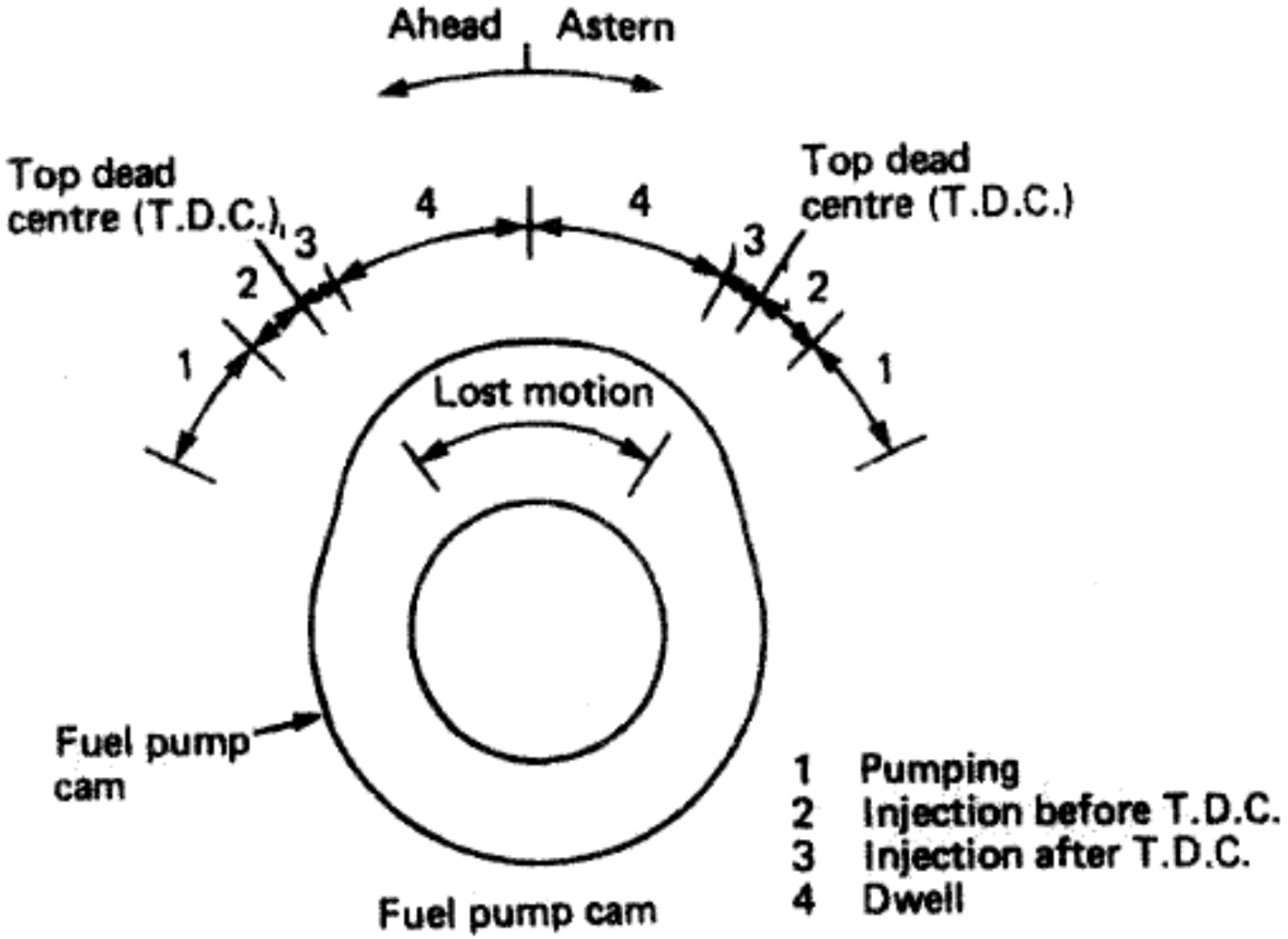
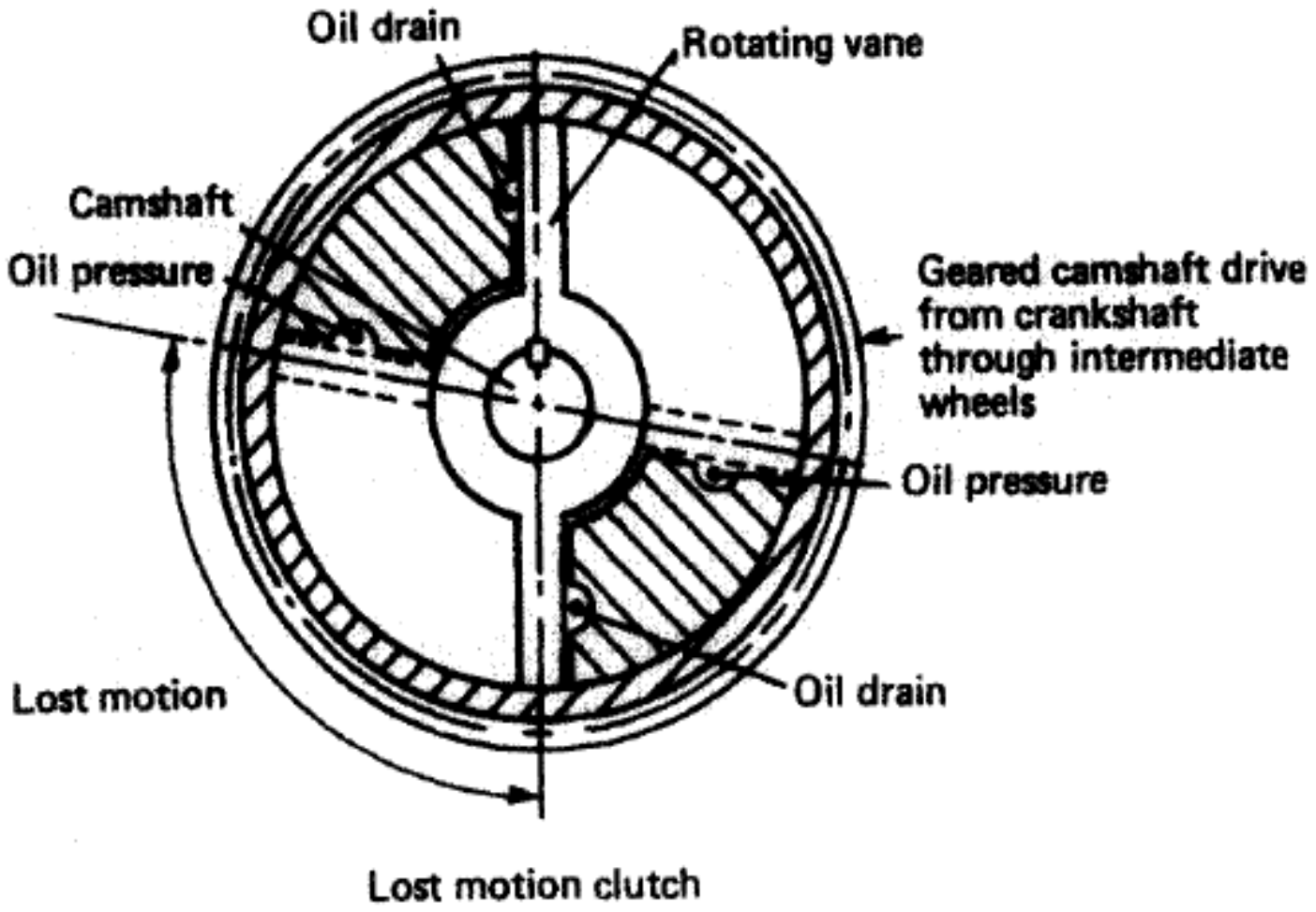


Figure 2. Method of altering the relative positions of the crankshaft and camshaft before reversing a diesel engine.

LOST MOTION


Ahead
Astern
Top dead centre (T.D.C.)
Top dead centre (T.D.C.)
4
4
3
3
2
2
1
1
Lost motion
Fuel pump cam
Fuel pump cam
1 Pumping
2 Injection before T.D.C.
3 Injection after T.D.C.
4 Dwell

LOST MOTION CLUTCH



Lost motion clutch

ENGINE REVERSING PROCEDURE

- The auxiliary _____, where manually operated, should be started
- _____ is shut off from the engine.
- Blasts of _____ air may be used to slow the _____ down.

- When the engine is stopped the direction handle is positioned astern.

- Compressed air is admitted to turn the engine astern and fuel is admitted to accelerate the engine. The compressed air supply will then cease.

- When the engine is stopped the direction handle is positioned _____.

- Compressed air is _____ to turn the engine astern and fuel is admitted to _____ the engine. The compressed air supply will then _____.

COUPLING

- Elastic or flexible couplings allow slight misalignment and damp out or remove torque variations from the engine. The coupling may in addition function as a clutch or disconnecting device. Couplings may be mechanical, electrical, hydraulic or pneumatic in operation.

COUPLING

- Elastic or _____ couplings allow slight _____ and damp out or remove _____ variations from the engine. The _____ may in addition function as a clutch or disconnecting device. Couplings may be mechanical, _____, hydraulic or pneumatic in operation.

CLUTCH

- A clutch is a device to connect or separate a driving unit from the unit it drives. With two engines connected to a gearbox a clutch enables one or both engines to be run, and facilitates reversing of the engine.

CLUTCH

- A clutch is a device to _____ or separate a driving unit from the unit it _____. With two engines connected to a _____ a clutch enables one or both engines to be run, and facilitates _____ of the engine.