

KELVIN-DIESEL ENGINES

The Running and Repairing of

Model "J"

SPECIAL NOTE

Damage due to rust is not covered by guarantee. The deck above the engine should be perfectly watertight. Any engine room skylight or hatch should be aft of the engine. If bilge water or salt spray is permitted to reach the flywheel, extensive damage to the engine is certain see paragraphs 81 and 96. An engine should be wiped down with oil once a week.

*CAUTION.--Before starting a new engine or an engine which has been standing for some time, make sure that (a) crankcase and reverse gear case contain lubricating oil; (b) governor case is filled with diesel fuel ; (c) fuel pump and pipes are free of air (36); (d) points shown on oiling diagram are attended to; (e) oil is splashed by hand over the crankshaft bearings. After starting, test the oil circulating system by opening the oil test cock (9).

NOTE.--THESE INSTRUCTIONS APPLY TO ENGINES PROPERLY INSTALLED IN VESSELS WHICH OPERATE IN NORMAL WATERS. IN DIRTY WATERS WHERE SAND, SEAWEED, JELLYFISH OR REFUSE MAY FOUL THE COOLING SYSTEM, SPECIAL CARE MUST BE TAKEN TO KEEP THE WATER INLET CLEAR AND THE WATER PASSAGES IN THE ENGINE MUST BE FREQUENTLY AND REGULARLY CLEANED OUT. EVEN A TEMPORARY STOPPAGE OF THE COOLING WATER MAY CAUSE OVERHEATING AND SUBSEQUENT DAMAGE.

1. WHILE it is not necessary to read this instruction book right through, it is essential before starting a new engine to read those paragraphs marked thus, *. In order to avoid repetition, a system of cross-references is used: a symbol "(35) " in the instruction means "here refer to paragraph 35." No subsequent adjustment or repair to the engine should be carried out without reference to this book. Any advice we can give is at your service whether you are the original purchaser of the engine or not. When writing, do not omit to quote the number of the engine stamped on the nameplate, and which should be filled in above.

*2. TOOL BOXES.--A box of tools accompanies each engine. It is closed with a lead seal, and, if delivered with the seal broken, its contents should be checked with the list to be found in the engine catalogue. Provide a convenient dry place for the tool box, and hang the following on nails driven into the bulkhead: (a) 2 finger pins to tighten water pump gland; (b) small brass box spanner for carburettor jet.

3. REPLACEMENTS.--All the parts of current models are usually in stock, also the parts of our older models for which there is a regular demand. Please describe the parts which you require in the terms of the spares list which is contained in the tool box. We can supply boxes containing a selection of spares suitable for customers in remote districts; contents and price as per spares list. To England, Scotland, Northern Ireland, Isle of Man and the Channel Islands, goods not exceeding fifteen pounds (in each package) may be sent by post C.O.D. (cash on delivery). Buyers abroad may have goods sent C.O.D. if they satisfy themselves that the system is available.

4. IMPROVEMENTS.--We make improvements from time to time and, where possible, we make them applicable to engines already despatched. If you wish to know whether any improvements have been added since your engine was made and the cost of supplying them, quote the number of the engine to us.

*5. FUEL.--The engines are tested on Shell Mex Diesolite, but will run on any of the oils marketed in this country as Diesel Oil, Gas Oil, Diesoleum, or Gasoleum, provided that the viscosity does not exceed 40 seconds Redwood No. 1 at 100° Fahrenheit and the oil remains fluid at 20° Fahrenheit. As Diesel fuels are variable, it is desirable to draw a sample in a glass from every consignment. Oil having fine sediment in suspension has a dull appearance, but clean oil is brilliant even although dark in colour. Suitable fuel oils are obtainable from

THE SHELL MEX and B.P. LTD., Shell Mex House, Victoria Embankment. London, W.C.2.

THE ESSO PETROLEUM CO.. LTD., 83 Albert Embankment, London, S.E.11.

THE REGENT OIL COMPANY, LTD., 117 Park Street, London, W.1.

You are recommended to write direct for the name of your nearest dealer.

*6. LUBRICATION is the most important care of an oil engine. Use only a proprietary oil of good quality and see that it is delivered to you with the maker's seal intact. We cannot indicate all the brands which are suitable, but the oils mentioned are used by our customers.

*7. LUBRICATING SYSTEM.--The oil supply is contained within the crankcase and below the reach of the cranks, An oil pump in the sump supplies a drip nozzle situated above each revolving crank, and a pipe leading to each bearing. The surplus is led into the timing wheel case. An oil test cock (9) serves to indicate whether the system is working. The oil level must be maintained between the marks "full" and "low" on the dip rod. The crankcase should be cleaned out once in 300 hours or more often if there is any tendency for soot or sediment to accumulate. When the crankcase has been pumped out (12) the oil pump (11) may become air locked, and it is necessary to make sure that it is working (9) before running the engine for any length of time. The sump holds 1 1/4 gallons.

*8. OIL DRIPS.--The gauze strainer situated in the bottom of the crankcase is sufficiently close to catch anything which would choke the drip nozzles; nevertheless, it is advisable to

inspect the drips occasionally. This may be done by turning the engine with the sparking plugs slackened. The nozzles are removable, they differ in size; each is numbered, the largest should be forward. The nozzles are graded in size to suit a shaft rake of 1 inch in 18 inches, but are suitable for rakes up to 1 in 9. The rake will normally increase when under way, and 1 in 9 is the maximum permissible in this condition.

*9 OIL TEST COCK.--To test the oil circulating pump, open the little cock on crankcase inspection door, when oil should drip from it slowly at all engine speeds.

10. OIL HOLES.--In each bearing will be found an oil hole. See that it remains clear.

11. OIL PUMP.--The strainer is visible when the oil has been pumped out. Examine it to time to see that it remains clear.

12. CRANKCASE PUMP.--This pump has no valves and must be operated as follows :- the cut in the handle must be towards the engine on the upstroke and towards the pipe on the downstroke. If the pump will not start put a little oil in by the air hole to seal the piston.

*13. DAILY ATTENTION (see oiling diagram).--(a) Open the cock on the sump of the fuel tank to discharge water and sediment: (b) try the oil test cock (9); (c) fill the oil wells on the cylinders; (d) oil the pump gear at three points, the starting valves, the operating cams, and the coupling of the Bosch pump. Check the level of the oil in the crankcase, reverse gear case and governor (46).

14. WEEKLY ATTENTION.--Draw a sample of oil from the crankcase by means of the pump (12), using a clear glass bottle to detect the presence of water. If the oil has become fouled by water or sediment, renew it. Discoloration is not harmful. Examine the water pump strainer (66). Oil the starting handle by the hole at the end.

15. MONTHLY ATTENTION.--(a) Test the oil drips (8); (b) clean out the crankcase if the sediment is up to the strainer or the oil requires renewal; (c) tighten the packing gland of the water pump with the finger pins provided (69); (d) tighten the gland of the governor if leaking (46); (e) clean the fuel filter (37); (f) renew the oil in the reverse gear once in 300 hours of running; (g) grease the thrust box with the grease gun supplied.

16. ANNUALLY.--A hard working engine should be over-hauled once a year, and the overhaul should be sufficiently extensive to make every part good for another year's service. The practice of running an engine until trouble develops is equivalent to overhauling by instalments, a costly method.

Before starting the work remove all surplus gear out of the engine room. Provide, if possible, a work bench, a paraffin wash tray and cotton waste. Wash down the engine with paraffin to loosen the nuts and soften the rust. Order all necessary replacements by telegraph to avoid delay. Proceed as follows.

(a) Withdraw the pistons (74). Service the ring grooves if necessary (75). If the piston pins are slack, it may be necessary to renew both pistons and pins. Measure the cylinder wear (63). If the liners are renewed it will pay to renew the pistons and the rings unless these are in first-class condition.

(b) Remove the cylinder heads (68) and wash out the water passages. Remove the inlet water connections to the cylinders and see that the pipes and passages are clear. Withdraw the valves and renew, or re-machine, any which are badly worn (72). If the valve seats cannot be restored by grinding borrow a cutter from us. Examine one or more of the valve plungers. Avoid disturbing the compression chambers (70).

(c) Examine and tighten, if necessary, the bearings of the crankshaft. See that the flywheel bolts are secure (78).

(d) Clean out the exhaust manifold and silencer.

(e) Clean the magneto. Adjust the contact breaker (52) and renew the wires if not good for a year's service.

(f) Clean the injectors and nozzles (39), the fuel filter (37); blow through the fuel pipes; drain the water and sediment from the tanks.

(g) Clean the oil filter, and the oil nipples.

(h) Drain the governor case and refill it with Diesel fuel. Add packing to the gland if necessary.

(j) If the valves or valve seats of the water pump are badly worn renew them. Examine the valve springs. Tighten the verrule which is within the pump ram (69). Renew the packing.

(k) Detach the shaft coupling; examine the clutch thrust bearing and renew it if damaged by rust (96). Examine the reverse gear. Renew the chain if it is striking anywhere. See that the ahead clutch is secure on the crankshaft (89). Examine all bolts. Rejoint the case with cement; check the alignment of the shaft and raise the engine, if necessary, on levelling washers obtainable from us.

(l) Examine the propeller (100) and the Cutless rubber bearing. Renew the packing in the stuffing box (99).

(m) Scrape the rust off the engine and the tanks, if necessary, and repaint with Kelvin paint.

17. STARTING BY HAND AND PETROL.--Open injector drains (42). Remove magneto stopping terminal from its pin. Put reverse gear at neutral. Set governor lever in mid position. Turn chang-over valves to petrol. Put petrol in carburettor (49). Prime cylinders with petrol oil mixture (21). 5 to 10 squirts per cylinder ascertain correct quantity by trial. Pull engine over

compression by handle. When engine starts, turn one changeover valve to Diesel and close its injector drain. When the cylinder fires repeat the operation for the remaining cylinders but consume all the petrol in the carburettor. Put the sparking plugs out of action by placing the stopping terminal on its pin. If the engine does not take Diesel fuel, suspect an air lock (36).

18. STARTING BY ELECTRIC STARTER AND PETROL.--Proceed as in (17) but, instead of using starting handle, press starter button. When engine fires, release button.

19. STARTING BY HAND WITHOUT PETROL.-- Close injector drains (42). Decompress all cylinders. Turn engine by starting handle until speed is attained then quickly put one cylinder on full compression. When engine starts repeat the operation for all cylinders.

If starting is difficult, prime all the cylinders heavily with oil. The effect of this is two-fold

(a) The volume of the combustion chamber is reduced and the compression pressure thereby increased.

(b) Leakage past the piston is reduced.

If the engine is easily turned use lubricating oil for this purpose, but if the engine is stiff to turn use fuel oil.

20. STARTING BY ELECTRIC STARTER WITH OUT PETROL.--Proceed as in (19) but, instead of using starting handle, press starter button. When engine fires, release button.

*21. PETROL/OIL MIXTURE.--Should be in the proportion of 16 to 1. This is equivalent to adding one pint of lubricating oil to 2 gallons of petrol.

*22. STOPPING.--Slow the engine to half speed. Put the reverse gear at neutral and slacken the sparking plugs. Open one injector drain and quickly turn its change-over lever to the petrol position. Repeat operation for each cylinder.

*23. IDLING.--The engine may be run without load for any length of time provided that it is run slowly. If permitted to run at speed without load, the cylinder will cool down and the engine will knock (76).

24. ENGINE FIRES PRIMING AND STOPS.-- Petrol spray jet choked (48); carburettor empty.

25. ENGINE NOT FIRING PRIMING.--(a) Sparking plugs damp (61); (b) engine overprimed-turn with sparking plugs slackened; (c) carburettor over-filled (49); (d) stopping wire not detached; (e) impulse starter not in action; (f) lack of spark (59); (g) magneto contact breaker stuck (52); (h) magneto wrongly set (51).

26. ENGINE RUNS IRREGULARLY.--(a) Clean filter: if two filters are used change over to the second filter; (b) air in the fuel system: open the cock at the forward end of the fuel pump;

if this stops the engine the filter is choked; (c) injector valve sticking (43); (d) valve clearance not correct (71); (e) valve stems sticking-fill the oil wells with fuel oil; (f) examine the feed pump if one is fitted.

*27. ENGINE RUNS BACKWARDS.--If the change-over valve is turned to Diesel before the engine has attained sufficient speed on petrol, it is possible for the engine to run backwards. When this occurs, the engine draws its air supply through the silencer and along with it water and soot. This condition can be avoided by allowing the engine to run on petrol for several seconds before turning the change-over valve.

28. ENGINE KNOCKING.--If the knock is within the crankcase, look for something loose, misplaced or hot. A knock within the cylinder is usually due to the jackets being too cold. This occurs if the engine is run at speed without load. If that is not the cause, drain the cylinders by the drain caps and examine the water regulator (65). If the knock is at the water pump (64).

Caution.--If the knock is at a big end, the engine must be stopped at once or the crankshaft will be damaged beyond repair.

29. ENGINE TIGHT TO TURN.--If the tightness developed during the process of starting the engine, it is probably due to the excessive use of petrol, which washes the lubricating oil from the cylinders (21).

*30. ENGINE FLOODED.--The exhaust must discharge slightly above sea level. The silencer must be above the point of discharge. No part of the pipe may be above the silencer. The best arrangement is to give the pipe a gradual fall through out its length from silencer to point of discharge. If these conditions have not been fulfilled report the arrangement and the engine number.

31. SMOKE AT THE EXHAUST.--(a) Cylinders too cold due to the engine being run at speed with the clutch out (23); (b) oil level above the full mark (7); (c) injector valve stuck (39); (d) injection point too late (40); (e) the brass stop on the fuel pump control rod out of position (34); (f) injection pressure adjustment wrong (41).

32. CYLINDERS TOO HOT.--At all speeds the waterpipes leading upward from the cylinder barrel should be as hot as the hand can bear. The cylinder head should be cooler. If these conditions are not met (a) examine the strainer (66), (b) open the water regulator (65), but before doing so drain the cylinders. Permit no water to fall on the pump shaft; (c) salt may have accumulated in the silencer where the water pipe enters from the cylinders. This may be cleared by a wire inserted through a door on the top; (d) the water outlets from the cylinder heads may be choked with salt.

33. COMPRESSION CHAMBER RUNS HOT.--(a) Lack of clearance between end of starting valve stem and rocker (70); (b) starting valve not seating properly.

34. FUEL PUMP.--The internal parts of the fuel pump are accurately finished to the finest limits. They stand up to their work indefinitely if protected from water and grit. The absence of a water trap on the tank or neglect to tap it regularly will quickly ruin the pump. The filter must be cleaned regularly (37). The pipe between the filter and the fuel pump must be scrupulously clean before assembling. Do not attempt to dismantle the fuel pump without reference to the C.A.V. Instruction Book supplied in the tool box. The brass stop on the control rod prevents excessive discharge from the pump. Its position was carefully adjusted on test to suit the power output stated in the catalogue. Do not attempt to move it or disturb the seal.

*35 FUEL PUMP LUBRICATION.--The pump is lubricated by fuel oil and therefore no attention to lubrication is required.

36. AIR LOCK.--Before attempting to start for the first time a new engine, or an engine which has been overhauled or has had its fuel system opened, it is necessary to ensure that all air has been removed from the pump and fuel pipes. Open the cock at the front end of the fuel pump and turn the engine by hand until fuel flows out freely without air bubbles. Then close the cock, open all the injector drains, and again turn the engine until fuel overflows from the governor into the drain bottle. Close the drains and start the engine.

If the engine runs irregularly, inspect the injector nozzles one by one (39).

37. FILTER.--The filter should not be dismantled and cleaned without reference to the C.A.V. Instruction Book supplied in the tool box. If two filters are fitted use one at a time and run until the engine staggers; then change to the second and clean the first so that it is ready. No water will collect in the filter if the drain cock on the fuel tank is regularly tapped.

38. INJECTOR FUNCTION.--The valve in the injector nozzle should remain closed until the oil pressure exceeds the compression pressure. The valve should then open and close promptly when injection has ceased.

39. INJECTOR NOZZLE.--To inspect this first remove the injector from the cylinder, then unscrew the steel cap nut by means of the vice at rear end of crankcase. If the valve cannot be withdrawn from the nozzle with the fingers, soak it in paraffin but use no tool which might damage it. The valve is a very close fit in the nozzle, and, while good for its work, cannot stand rough handling. Avoid touching it with gritty hands or with cotton, as the slightest trace of either is sufficient to make it stick. The nozzles and valves are not interchangeable and must be kept together. If one is damaged both must be renewed; a spare nozzle with valve should be carried. Avoid mixing the injector parts. Deal with the injectors one at a time.

40. INJECTION POINT.--The injection should commence a little before the piston reaches the top of its stroke. If the injection is too soon, the engine will knock. If too late, it will lack power or show smoke at the exhaust. The mark on the flywheel indicates the

commencement of injection which was found best on test, but a change of fuel might call for some adjustment which should be made at the pump coupling-half a mark at a time.

Should the fuel pump be removed, re-connect it as follows:-- (a) turn the engine until No. 1 Cylinder blows at the sparking plug; (b) adjust the flywheel to bring "Injection" mark central; (c) turn pump by coupling until marks on coupling and pump coincide; (d) couple the pump to its driving shaft; (e) if this does not give an exact result use the adjustment on the coupling.

41. INJECTOR ADJUSTMENT.--When sent out the injectors were adjusted for a pressure of 90 atmospheres. (100 atmospheres for engines which start without petrol). The pressure is controlled by brass washers below the hexagon brass plug. The figure stamped on the plug represents the combined thickness of the washers. The parts must not be interchanged. An appliance to test injectors is available at C.A.V. Service Stations.

42. INJECTOR DRAIN VALVE.--The hand screw on the injector is the drain valve. When this is open, no fuel passes into the cylinder.

43. INJECTOR VALVE STICKING.--This may be due to fine sediment in the fuel (5) or to wrong adjustment (41).

44. DRAIN BOTTLE FILLING UP MORE RAPIDLY.-- This is due to the injector valves not seating properly or to wear of the valves (39).

45. GOVERNOR ACTION.--The speed of the engine is controlled by the amount of fuel discharged by the pumps. The discharge from the pumps is controlled by the governor. The action of the governor is controlled by the hand lever.

*46 GOVERNOR, CARE OF.--As the governor does not act when the case contains insufficient oil, it is essential to make certain that the oil level is maintained (see instruction plate on governor). If the engine is running, the case can be filled by opening one of the injector drain valves (42). If the engine is stopped, the filling must be done through the hinged cover; use diesel fuel. Should the engine run away, stop it by opening the injector drains.

Tighten the packing gland from time to time to avoid loss of oil by leakage. When the gland is fully tightened up, add a portion of the metallic packing which will be found in the tool box.

Excessive tightening of the packing gland may cause sufficient heat to boil away the oil and thereby put the governor out of action.

47. GOVERNOR ADJUSTMENT.--The movement of the hand lever is limited by two stops. The upper one controls the maximum speed and the lower one the minimum speed. The upper one is adjusted for 1,000 r.p.m. at which speed the engine develops its rated horse power, provided that the propeller is not of excessive size. The lower stop should be adjusted to

give a speed, without load, of 220 r.p.m. with engine cold.

48. CARBURETTOR.--The spherical casting at the rear of the engine is the carburettor. It contains nothing but a spray jet which may be removed for cleaning by means of the brass box spanner provided applied through the plug at the bottom.

*49. PETROL CAN.--This should contain petrol-oil mixture which is poured into the gauze covered well of the carburettor. It gives a measured quantity suitable for one start. Avoid filling above gauze level (21).

50. MAGNETO, CARE OF.--Allow no oil to drip on to the magneto as this causes rapid wear of the platinum contacts. The magneto requires only three drops of oil once a month.

51. MAGNETO SETTING.--If the magneto is removed it must be re-set as follows -(a) turn the engine until No. 1 Cylinder blows at the sparking plug; (b) adjust mark on fly wheel central; (c) remove door from magneto case also cover from end of magneto; (d) lay No.1 sparking plug on top of magneto and oscillate armature by gearwheel until plug sparks; (e) mesh gearwheel so that break occurs when mark on flywheel is central.

52. MAGNETO CONTACT BREAKER.--The moving arm of certain makes is liable to become stuck in damp climates owing to the swelling of its fibre bush. Remove the arm, polish and oil the pin; scrape out the fibre bush with the square tail of a small file or other suitable instrument. The fibre pad on the end of the arm should be oiled, but no oil must reach the platinum contacts. If any spare parts are carried a complete contact breaker should be included.

53. MAGNETO CONTACT BREAKER GAP.--The contact points are platinum tipped and gradually wear further apart with the result that the gap increases. A gauge is attached to the magneto spanner; try it in the gap, and, if necessary, adjust the screw. If the contact points wear rapidly (50).

54. MAGNETO DISTRIBUTOR.--Some distributors have carbon brushes which wear. The dust produced must be removed from time to time. When the brushes are worn down they should be renewed. The stretching of the spring serves temporarily in taking up wear.

55. MAGNETO REPLACEMENTS.--Owing to the great variety of magnetos which we have been obliged to supply, we cannot keep stock of all magneto replacements, and buyers are advised to communicate direct with the magneto maker, taking care to quote the number of the magneto if it bears one. A magneto sent to the maker should be labelled with the owner's name and its despatch advised to the maker.

56. IMPULSE STARTER PRINCIPLE.--Revolving with the magneto are two pawls. These project when the engine is turned and recede when it attains about 100 r.p.m. The projecting ends of the pawls engage with a latch which arrests the rotation of the armature and stretches a pair of springs. At a certain point the latch releases the pawl and the springs impart to the

armature a rapid motion which causes the magneto to produce a spark however slowly the engine is turned.

57. IMPULSE STARTER TEST.--When the engine is turned by hand, the impulse starter should produce a click. The action may be observed by removing the cover from the end of the magneto. If the device is not working, remove the inspection door and examine the springs.

58. SPARKING PLUG, CARE OF.--Porcelain plugs must be handled with care. A spanner carelessly applied may produce in the porcelain an invisible crack which in time holds moisture and causes the plug to short. The thread of the sparking plug should be oiled.

59. SPARKING PLUG TEST.--Take out plug, lay it on engine so that its body alone makes contact, turn engine by hand. If no spark results (60).

60. SPARKING PLUG ADJUSTMENT.--The spark gap becomes wider with use, and the points should be bent to maintain the gap between .016" and .020". The size of the spark is in proportion to the width of the gap. A spark too small may fail to start the engine, but a gap too wide may fail to produce a spark.

*61. SPARKING PLUGS DAMP.--The combustion of air and petrol produces water vapour, some of which condenses on the sparking plugs. The sparking plugs supplied by us are so arranged that this water can be blown off before starting by turning the engine by hand with the sparking plug handles slackened one half turn. Note that this cannot be done with ordinary sparking plugs.

62. SPARKING PLUG ON CRANKCASE.--Certain engines are fitted with magnetos which produce more sparks than are required. The superfluous sparks are led by cable to a sparking plug carried in a holder on top of the crankcase. This plug and its connections must be kept in working order or the magneto may be damaged.

63. CYLINDER LINER.--When the internal diameter, about 3/4" from the top, exceeds 4.265" the liner should be renewed. If you have no micrometer, make a length bar of iron wire about 3/16" and a fit for the liner at the top. With this and a set of "feelers" it is possible to measure the diameter where the wear occurs. The liners are pressed into the cylinder and may be withdrawn upwards, without removing the cylinders, by means of a tool loaned on request (114).

*64. AIR COCK.--On the air chamber of the water pump will be found an air cock. This should be opened for a moment occasionally to fill the air chamber and so prevent water hammer. It is necessary to close the sea cock while doing so.

65. WATER REGULATOR.--This is automatic in action. Withdraw the valve occasionally to see that it is free. Control is by a restricting plate fixed between the regulator and the flange of the small pipe. The size stamped on the regulator indicates the original size of the hole in the restricting plate. Restriction bushes within the water- connections distribute the water

equally.

*66. WATER PUMP STRAINER.--This should be cleared regularly. To run until it chokes is dangerous. The strainer requires little attention at sea, but frequent attention if the engine is run with the boat at rest in shallow water, especially if the reverse gear has been in action as that stirs up the water.

It is important to know immediately if the strainer has become choked, one method is to feel frequently the water pipe from cylinder to silencer. A better method is to paint the elbow below the silencer. Immediately the strainer becomes choked, the water fails and the paint on this elbow creates a smell which warns you to stop the engine.

67. CYLINDERS.--The attachment of the cylinder to the crankcase is important. The bolts must be very tight. When the piston is up it should be exactly flush with the cylinder. If not, add or remove a joint between cylinder and crankcase.

68. CYLINDER HEADS.--Joint with the cement to be found in the tool box or obtainable from motor dealers Make the bolts very tight, and verify the valve clearance (71).

69. WATER PUMP.--This is an important accessory, and any abnormal noise or leakage should be immediately investigated. The eccentric should be oiled daily. The gland should be tightened down when the leakage is excessive. The gland is locked by means of two sharp pointed screws which enter the packing. Should the ball joint within the ram develop a knock, it may be tightened by means of the screwed verrule. First slacken the three screws within the ram, then screw down the verrule by the fingers applied to the screws. Tighten the screws and the slackness in the ball is taken up. The packing should be completely renewed each time the engine is overhauled, because in time it loses its grease and will score the rod. The valve seats are renewable and held in position by solder. If the body of the pump is heated they fall out.

70. PETROL COMPRESSION CHAMBER.--This becomes hot when run on petrol at starting, but should cool off when running at full compression, when no leakage should be noticeable at the priming plug. The rocker should be clear of the valve stem about 1/16". This adjustment is made by rotating the upright to which the rocker is attached. As the chamber must be in perfect alignment with the valve, it should not be disturbed unnecessarily. Should the joint leak, screw the stud supplied into the end of the valve stem, remove the nuts, the spring and the chamber; clean the faces with care and remake the joint with the cement supplied. Should the valve leak, grind it by a spanner applied to the upper nut while injecting petrol through the priming plug hole. If this does not suffice, remove the head (68).

71. VALVE CLEARANCE.--The clearance between the rockers and the; ends of the push rods should be .006" with the engine cold; a gauge is provided. This must be verified each time the cylinder heads are tightened down. If the valves are adjusted, with the, engine hot, the clearance must be .010" or three times, the gauge; and should be checked when the engine

is cold.

72. VALVE GRINDING.--The inlet valves (rear) remain tight indefinitely, but the exhaust valves should be ground every twelve months of running. If this is neglected, the valves and the seats may become pitted beyond repair. A cutter to recondition can be lent on request.

73. VALVES INCLINED TO STICK.--Should a valve stick, the piston will strike it. The oil well on top of each cylinder lubricates the rockers. The surplus lubricates the valve stems. Should a joint between the top of the cylinder and the rocker block become broken or charred, the oil intended for the valve stems might escape.

74. PISTON.--The piston and connecting rod are removable through the inspection door on the starboard side. It is desirable to have some assistance to turn the flywheel, in order to bring the crank into the various positions necessary for this operation. If any of the piston rings are stuck fast, they must be broken out and renewed.

75. PISTON RINGS.--If the slackness sideways exceeds .020", the grooves should be enlarged for oversize (.030"). rings. If the pistons cannot be sent to us for this service, it must be done locally. A small piece of a new ring will be found useful as a gauge. The groove should be of sufficient width to allow it to enter flush, along with a feeler .004" to provide, the necessary clearance.

76. EXCESSIVE OIL CONSUMPTION.--This may be due to the use of oil which loses its viscosity when hot (6); if the consumption has, gradually increased it is probably due to the piston rings having become slack in their grooves; ring groove wear is, in turn, due to cylinder wear, and cylinder wear, according to the latest opinions, is due partly to high gas pressure and partly to corrosion resulting from combustion. It is thought that most of the wear occurs before the cylinder liner has heated up, during which time the products of combustion condense on the liner and corrode it. It is therefore important to heat up the cylinder quickly and maintain the temperature of it as near boiling point as possible. The practice of starting a cold engine long before it can be put on load causes cylinder wear.

77. EXHAUST MANIFOLD.--If the manifold, appears to become hotter remove the end covers and scrape out any salt accumulated. As the joints are perishable, it is necessary to have spares at hand.

*78 FLYWHEEL.--The attachment of the flywheel is important. If it is necessary to remove it, draw the bolts by means of the puller and stud in the tool box. These bolts must be oiled and replaced with care as a loose flywheel may involve a new crankshaft.

79. TIMING GEARS.--These are within the case behind the flywheel. They are all marked to indicate how they must be assembled. It is possible to see the gears without removing the flywheel. First remove the flywheel pan, then slacken the cover.

80. FIRING ORDER.

Firing order	J2	J3	J4
Rotation clock-wise	1002	132	1243
Rotation anti-clock-wise	1002	123	1243

81. OIL ESCAPES BEHIND FLYWHEEL.--If water is permitted to reach the crankshaft at the back of the flywheel, rust will occur, and the white metal oil retaining ring will be destroyed. As this cannot easily be rectified, it is important to allow no water to reach the flywheel (96).

82. FRONT OIL RETAINING RING.--Fitted around the crankshaft and immediately behind the flywheel there is a white metal ring to prevent escape of oil. To remove it first prise off the spring and then remove the upper half of the iron plate. The plate must be rejoined with cement (109).

83. REAR OIL RETAINING RING.--Between the rearmost crank and the reverse gear and visible from within the crankcase there is an iron plate with a white metal bush fitting close around the crankshaft. This serves two purposes-to prevent the escape of oil into the reverse gear and the passage of damp vapour from the crankcase to the ball thrust bearing situated immediately behind it. The bush carries no load and requires no attention.

*84. STARTING HANDLE.--The spring around the starting shaft brings the handle out of engagement when the engine starts. This is necessary for safety because a Diesel engine stopped on full compression recoils and causes the handle to spin round.

85. CRANKSHAFT BUSH.--The clearance between the bush and the shaft should be .003". The shaft should measure between 2.749" and 2.751". Should a lower half become damaged, order a half crankend bush. When this is placed in the cap, the edges may stand above the flush and it is necessary first to file them flush. The bedding of the bush should be carried out by the use of red lead and a scraper in the ordinary manner. All bolts must be left as tight as is possible with the spanner provided. As the upper halves control the alignment of the shaft, it is desirable to avoid renewing them. Should it be necessary to do so, the work must be very carefully done.

86. CRANKPIN BUSH.--The clearance between the bush and the crankpin should be .003". The clearance may be checked by inserting between the bush and the crankpin a feeler .003" in thickness. It is preferable to bed the bush to a mandrel which is oversize by the amount of the clearance. Such mandrels are supplied at small cost. They are designed to be held in the vice. When the bush has been made a working fit on the mandrel, its clearance on the engine will be correct provided that the crankpin is still between 2.624" and 2.626".

Do not attempt to reline any of the crankshaft bushes as it cannot be done without elaborate appliances. For engines shipped abroad it is advisable to have spare bushes and a mandrel.

87. TO DISMANTLE REVERSING GEAR.--Remove the control wheel bracket; withdraw the starting shaft; remove the upper half of the case; find the joint in the large chain and remove it; lift out the gears and the lower half of the case can be removed.

88. TO REPLACE REVERSING GEAR.--Fix the lower half of the case; place the gears in position.

Draw in the chain by means of a copper wire passed around the lower wheel. When the chain engages the lower wheel, help it around by turning the engine gently. Join the upper half of the case with cement to be found in the tool box or obtainable in tubes from motor dealers (109).

89. AHEAD CLUTCH.--This must be very secure on the crankshaft and should not be removed unnecessarily. It is secured by a nut and two pairs of tapered keys. To slacken the keys, proceed exactly as follows :-with the key punch provided drive in the lower keys slightly. This slackens them and makes it possible to pull off the clutch. When replacing the clutch it is necessary to insert the lead key stops at the back of the lower keys (spares in tool box). If this is not done, removal of the clutch becomes a very troublesome operation.

90. CLUTCH SLIPPING.--Causes (a) propeller blade bent; (b) shaft out of line (98, 106); (c) propeller of excessive pitch-report engine number, dimensions and speed of boat, r.p.m. of engine at full speed.

91. CLUTCH, WORN OUT.--Causes: (a) Manipulating the clutch without first slowing the engine; (b) running with the clutch slipping (90).

92. REVERSING GEAR RUNNING HOT.--Causes: (a) excessive oil, drain case and put in correct quantity; (b) slipping clutch, due to an obstruction on the propeller or a bent blade; (c) heat generated at the rear bush, verify alignment of shafts.

93. BUSH AT REAR OF REVERSE GEAR RUNS HOT.--Causes: (a) lack of oil due to oil leakage, renew oil according to instruction plate; (b) shafts out of line, remove shaft coupling and check alignment of shafts with steel rule or the blade of a carpenter's square (106). Levelling washers were supplied to be used below the engine as the foundation shrinks.

94. ABNORMAL NOISE IN REVERSE GEAR.--Should be investigated at once as it might be caused by a slackness in some of the keys which, if permitted to continue, may ruin the crankshaft (89).

95. REVERSE GEAR LEAKING OIL.--(a) Drain flange not tight or joint defective; (b) white metal run out of rear oil retaining ring (83); (c) engine installed at rake in excess of 1 in 9.

*96. BILGE WATER IN REVERSE GEAR.--The practice of cementing the bilges restricts the space available for bilge water, with the result that a trifling amount may rise to the level of the shaft, enter the reverse gear and ruin it entirely. This is particularly to be guarded against if the engine is installed far aft. The clutch thrust bearing is within the gunmetal thrust box and it cannot withstand salt water.

97. ENGINE LOSING SPEED.--If the loss has been gradual it may be due to an accumulation of soot and salt in the silencer, clean it out, or to the fouling of the vessel below water. A growth not visible to the eye is sufficient to affect the speed. If the bottom is slippery to the hand the boat requires cleaning. It pays to use anti-fouling paint as the best qualities (all brown in colour) resist growth in a temperate climate for four months, growth begins on ordinary paint in four weeks. There are various makes, but a good brand is obtainable from The International Paint & Composition Co., Ltd., 31 Grosvenor Gardens House, London, S.W. 1.

*98. SHAFT COUPLINGS.--Must be very tight. If once they slip both coupling and shaft become torn and ruined. All parts of the shaft coupling should be painted before being assembled. If shaft runs out of truth it is probably due to unequal tightening of shaft coupling bolts. Hold a pencil to the running shaft and tighten the bolts at the side marked by the pencil.

*99 STERN TUBE.--A Cutless rubber bearing is fitted on the outside. It requires a through circulation of water which enters by two little pipes. The sternpost must be trimmed down to bring these pipes into the stream line. As rubber does not stand grease, the shaft must be inserted dry and the packing must be impregnated with graphite and the minimum of grease. As the graphite is dissolved out of the packing in time, it is desirable to renew the packing once a year.

100. PROPELLERS.--Should be removed with a heavy hammer, a light one harms the propeller without removing it. Secure the nuts with a turn of monel wire through the end of the shaft. If you consider the propeller unsuitable for your boat, report to us the length, beam and draught of the boat, the full speed of the engine and the markings on your propeller.

101. PROPELLER INEFFICIENCY.--Causes: (a) Lack of clearance between propeller and woodwork, increase the aperture wherever possible; (b) sternpost too clumsy, reduce it as much as possible; (c) rudder post too thick, reduce it or abolish it; (d) diameter or pitch of propeller not suitable. Report the engine number, length, beam and, if possible, the speed of the boat, also the full speed of the engine.

102. PROPELLER SHAFT VIBRATION.--Causes: (a) Lack of clearance between propeller and woodwork (101); (b) propeller blade bent; (c) shaft out of truth (98); (d) shaft bearings slack, file the lower half.

103. SPEED IN RELATION TO POWER.--The resistance of a vessel to propulsion is due to two distinct causes, surface friction and wave making. Surface friction is present at all speeds. Wave making is absent at low speed, commences suddenly and increases rapidly. It follows, therefore, that any boat is easily driven up to its wave making speed, and beyond that only by an extravagant expenditure of power. If economy in first cost or in running expense is of importance, it is advisable to instal only sufficient power to produce the wave making speed. It is a common fallacy that a vessel with good lines must be easily driven. At low speeds the lines count for nothing; surface friction is the whole source of resistance. At higher speeds what counts is the relation between the displacement (weight) and the water line length. It follows that an increase of speed should be sought by decreasing the displacement or increasing the length rather than by increasing the power. These remarks will explain why heavy short high power craft are disappointing in speed.

*104. TANKS.--The fuel pump of a Diesel engine is readily damaged by water, rust, and zinc sediment, and damage from these causes is not covered by guarantee if the tanks are not of our make. Flat bottomed tanks always contain some water; ungalvanised tanks produce rust; tanks galvanised after being put together usually produce zinc sediment. We always endeavour to persuade buyers, builders, and designers to use our tanks of which we keep a large variety in stock.

105. FEED PUMP.--This is necessary if the tanks are less than 14 inches above the centre of the flywheel.

*106. ENGINE FOUNDATION.--All Kelvin models are designed to rest on two transverse bearers (longitudinal bearers are not suitable). The bearers must be of hardwood and should rest direct on the planking clear of ribs. In boats having only steam-bent ribs the bearers must run up the bilge to the height of the flywheel centre, but in boats with grown frames the bearers may be straight on the upper surface. The bearers should be fastened from outside with Kelvin bolts and drawn hard down to the keel with a Kelvin Wood Stud. This should be tightened once a year as the wood shrinks. 12 levelling washers were supplied with the engine. One at least should be below each foot to prevent it sinking into the wood. 4 chocks were also supplied. These should be fixed one against each engine foot to locate it sideways.

*107. DECK CONTROL.--For leading the control of the clutch and governor on deck or into the cockpit, a variety of fittings are kept in stock; particulars on application.

108. BALL BEARINGS.--The failure of ball bearings is seldom due to fair wear or to original defect, but almost always to lack of protection from damp or to defective mounting. As soon as the burnished surface of the balls shows rust the failure of the bearing is imminent.

109. JOINTS.--Each boat should carry a stock of joints obtainable from us. In cases of urgency, joints may be cut from certain materials obtainable from mill furnishers or motor dealers. For exhaust use "asbestos millboard" coated with graphite or black lead to prevent adhesion; for water use "rubber insertion"; for oil use white of egg or Shellac or any of the cements sold by motor dealers. Red fibre withstands oil and water but not heat. India-rubber withstands water but not heat or oil.

*110. CARE OF ENGINE.--" Kelvin" engines are designed to be easily kept clean, all parts are rounded, no sharp edges., Use cotton waste obtainable from chandlers; old cloth is not suitable, keep your waste dry. Wipe your tools each time you use them.

111. FROST.--In severe weather the water should be drained from the jackets by the drain caps. The seacocks must be closed and the floorboards should be left open to remind you to open the seacocks before starting. If the drain caps will not hold tight don't abuse them with the pliers. Renew the corks inside them.

112. WINTERING.--Before laying up an engine for the winter it is important to remove any salt dried on to it, as this draws damp and causes an excessive rusting action. To do so, wash down the engine with hot water. Drain all the water from the cylinders, pumps, and from any pipe bend where water can lie. Pour some lubricating oil into each cylinder, and turn the engine by hand. Grease everything not protected by paint. As a wooden vessel exudes moisture inside for about 6 months after being hauled up, It is necessary to provide continuous ventilation if excessive rust is to be avoided.

*113. BILGES.--Although Kelvin engines are oil tight, it is impossible to avoid some spillage when pipes are detached for the cleaning of filters. Instead of attempting to catch this by means of drip trays, it is more practical to provide for the easy cleaning of the bilges. All floor boards should be portable and the engine room bilge should be isolated. Cleaning is a simple matter if done as follows

Pump out the salt water, and substitute fresh; add 7 pounds of washing soda, dissolved in hot water; swab the bilges with a mop. If enough fresh water is available the rolling of the boat may be utilised to do the work of swabbing.

114. LINER EXTRACTING TOOL.--(a) Oil the stud so that the nut is perfectly free; (b) bring the piston to its lowest position; (c) assemble the tool as shewn, spacing the (6 or more) teeth equally around; (d) tighten the nut; (e) rotate the flywheel from side to side while maintaining a tightening pressure on the nut.

115. KELVIN STEERING AND CONTROL COLUMN.

This should be installed according to the catalogue. The stopper chain should be adjusted to allow the helm over 45 degrees each side. After installation test as follows:-

Put the helm over until the stopper chain is taut and apply your full strength to the wheel. Repeat the test to the other side. When the speed control lever is moved from side to side, the governor lever should come against its upper and lower stops.

The weight of the vertical rod should be borne by the balance spring. This may be checked by detaching it from the governor lever. The deck shaft should be perfectly free in its bearings.

The chain pulleys are fitted with "Oilite" bushes. No lubrication is required.

The deck bearing of the helm stock has space for a little cotton to retain the oil. This may be inserted through the oil plug.

Test the water-tightness of the steering column at the deck by pouring water around it.

MONTHLY ATTENTION.--Remove the steering column cover and oil the chain and bearings. Remove the oil plug from the deck bearing of the helm stock and fill with oil. Oil the chain where it works through a pulley or a lead.

Please Note:

There is no sump plug on the J series, I used to remove one of the crankcase doors, the 3rd I think, on the port side and remove the old oil using a can or old garden syringe, mopping out the last remains with a cloth. It's a mucky job! With the sump empty, the brass gauze strainer is exposed and can be removed for cleaning. Refilling is via the same removed door, keeping an eye on level using the dipstick on the other side of the engine. Once full, I rarely needed to top up as oil from the dashpots on the heads maintained the level, or raised it slightly.