Before beginning to tune any engine, ensure the engine has satisfactory compression. An engine with worn or broken piston rings, burned pistons, or scored cylinder walls, will not perform properly no matter how much time and expense is spent on the tune-up. Poor compression must be corrected or the tune-up will not give the desired results.

A regular maintenance program that is followed throughout the year, is one of the best methods of ensuring the engine will give satisfactory performance. As they say, you can spend a little time now or a lot of time and money later.

The extent of the engine tune-up is usually dependent on the time lapse since the last service. A complete tune-up of the entire engine would entail almost all of the work outlined in this manual. However, this is usually not necessary in most cases.

In this section, a logical sequence of tune-up steps will be presented in general terms. If additional information or detailed service work is required, refer to the section containing the appropriate instructions.

Tune-Up Sequence

During a tune-up, a definite sequence of procedures should be followed to return the engine to its maximum performance level. This type of work should not be confused with troubleshooting (attempting to locate a problem when the engine is not performing satisfactorily). In many cases, these two areas will overlap, because many times a minor or major tune-up will correct a malfunction and return the system to normal operation.

The following list is a suggested sequence of tasks to perform during a tune-up.

- Perform a compression check of each cylinder.
- Perform a valve adjustment
- Start the engine in a body of water and check the water flow through the engine.
- Check the injection pump for adequate performance and delivery.
- Test the starting and charging systems.
- Check the internal wiring.

Cylinder Compression

Cylinder compression test results are extremely valuable indicators of internal engine condition. The best marine mechanics automatically check an engine's compression as the first step in a comprehensive tune-up. A compression test will uncover many mechanical problems that can cause rough running or poor performance.

A compression gauge for diesel engines consists of a dummy injector connected to a gauge capable of reading 600 psi.

CHECKING COMPRESSION

1. Make sure that the proper amount and viscosity of engine oil is in the crankcase, then ensure the battery is fully charged.
2. Warm-up the engine to normal operating temperature, then shut the engine **OFF**.
3. Remove the injector lines and remove the injectors from each cylinder.
4. Install a diesel compression gauge into the No. 1 cylinder injector hole until the fitting is snug. When fitting the compression gauge adapter to the cylinder head, make sure the bleeder of the gauge (if equipped) is closed.
5. According to the tool manufacturer's instructions, connect a remote starting switch to the starting circuit.
6. With the ignition switch in the **OFF**position, use the remote starting switch to crank the engine through at least five compression strokes (approximately 5 seconds of cranking) and record the highest reading on the gauge.
7. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes and/or time as the first.
8. Compare the highest readings from each cylinder to that of the others. The indicated compression pressures are considered within specifications if the lowest reading cylinder is within 75 percent of the pressure recorded for the highest reading cylinder. For example, if your highest reading cylinder pressure was 150 psi (1034 kPa), then 75 percent of that would be 113 psi (779 kPa). So the lowest reading cylinder should be no less than 113 psi (779 kPa).
9. Compression readings that are generally low indicate worn, broken, or sticking piston rings, scored pistons or worn cylinders.
10. If a cylinder exhibits an unusually low compression reading, squirt a tablespoon of clean engine oil into the cylinder through the injector hole and repeat the compression test. If the compression rises after adding oil, it means that the cylinder's piston rings and/or cylinder bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder.
11. If compression in any two adjacent cylinders is low (with normal compression in the other cylinders), and if the addition of oil doesn't help raise compression, there is leakage past the head gasket. Oil and coolant in the combustion chamber, combined with blue or constant white smoke from the tailpipe, are symptoms of this problem. However, don't be alarmed by the normal white smoke emitted from the tailpipe during engine warm-up during cold weather. There may be evidence of water droplets on the engine oil dipstick and/or oil droplets in the cooling system if a head gasket is blown.
12. When reinstalling the injector assemblies, install new washers and/or gaskets as appropriate.

Valve Adjustment

See Figures 102 thru 108

Four-stroke diesel engines use valves to admit the fuel/air mixture into the combustion chamber, to seal the combustion chamber for compression, and to allow the spent exhaust gases to escape. All of these functions occur using the valve train (camshaft, lifters/shims and rocker arms and pushrods.)

In order for the valves to operate properly, they must be adjusted to assure that the full benefit of the camshaft lobe lift is realized, but they also must be able to close fully once the lobe of the camshaft has gone by. Valves are adjusted by increasing or decreasing their lash, which is the amount of free-play in the valve train when the valve is closed (meaning the camshaft lobe is not actuating the pushrod or rocker arm). Valve lash therefore, is basically a gap that exists between components when the valve is fully closed.

Since valves open and close with every turn of the crankshaft, their movement becomes a blur at engine speeds, creating a pounding on the entire valve train. As the engine is operated, internal components slowly wear, affecting distances between the components in the valve train. Valve lash will tend to change (increase or decrease) depending on the model. On some engines, the valve seats and heads will wear slowly, causing the valve to come further

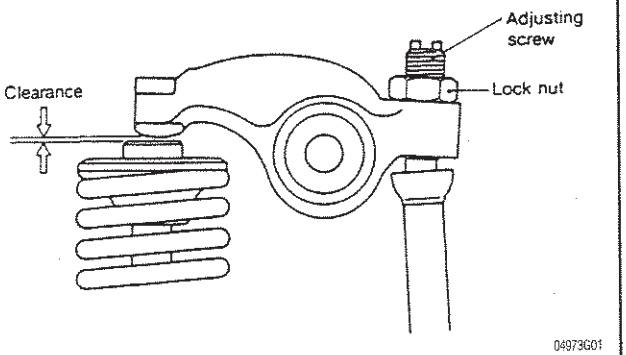

Fig. 102 The clearance between the rocker arm and the valve tip is known as valve lash

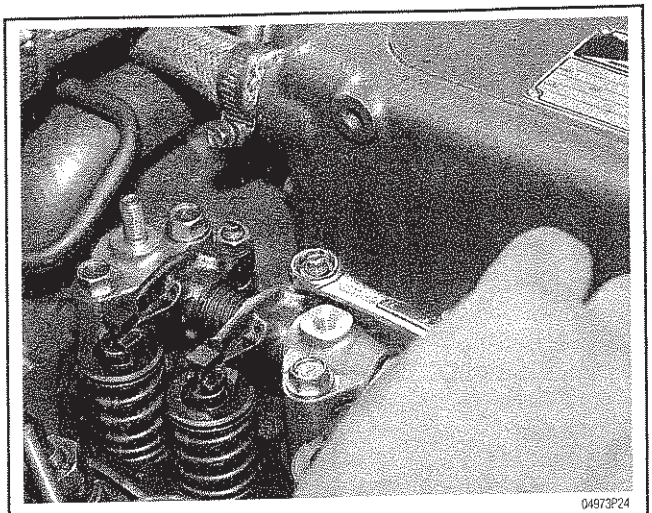

Fig. 105 If the lash is not correct, loosen the locknut on the adjuster. . .

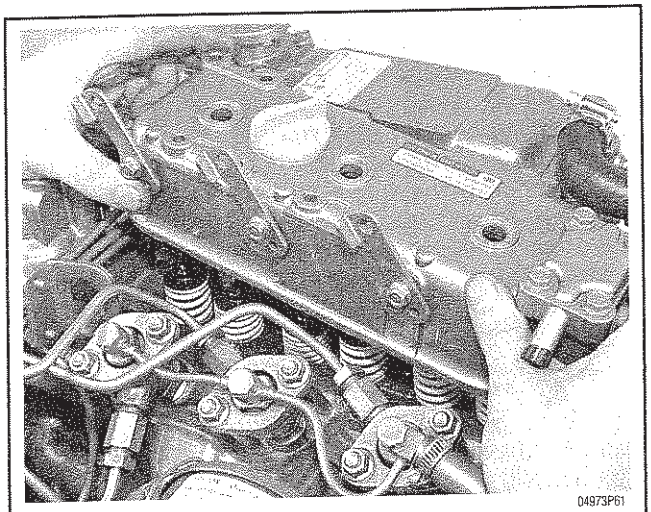

Fig. 103 To access the rocker arms for adjustment, the valve cover must be removed

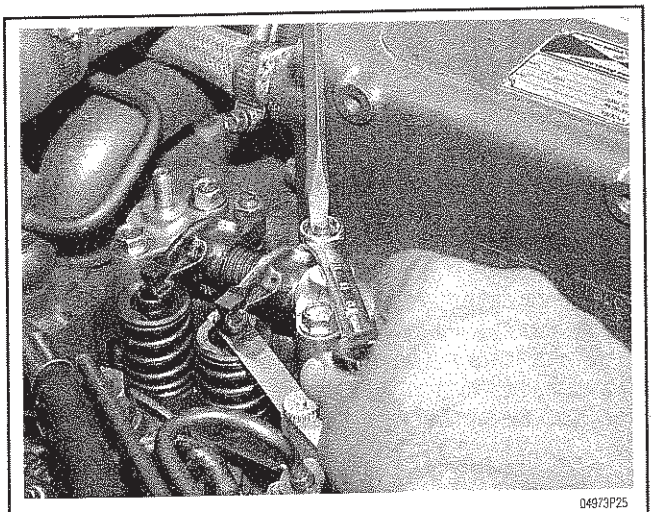

Fig. 106 . . .and hold it stationary while turning the adjuster with a screwdriver

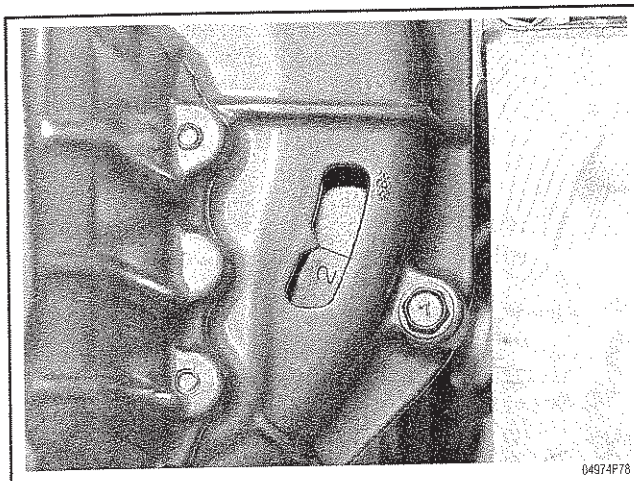

Fig. 104 To properly adjust the valves for each cylinder, the marks on the flywheel must be aligned to the view port on the transmission

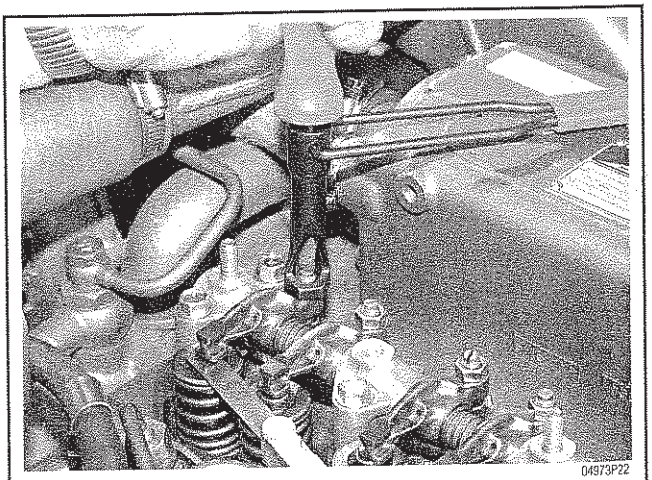

Fig. 107 Here is an example of a special valve lash adjuster tool. A screwdriver and wrench are combined, making the job easier

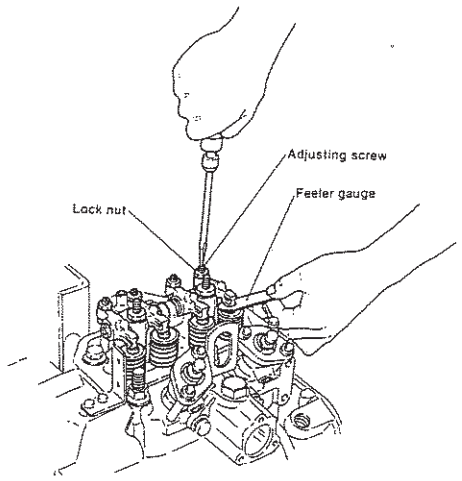

Fig. 108 Turn the adjusting screw on the rocker arm until the feeler gauge slides with a slight resistance

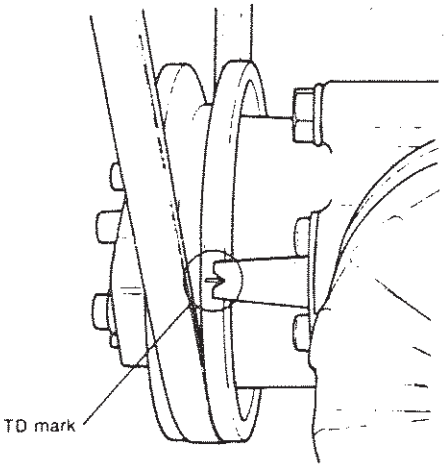

Fig. 109 QM series engines have a mark on the front crankshaft pulley for locating Top Dead Center (TDC) for valve adjustment

into the cylinder head (moving the stem closer to the shim or rocker arm and decreasing valve lash). On other models, the stem, shim or other valve train components will wear, causing the gap to increase.

Increased valve lash will not allow a valve to fully open since some of the camshaft lobe lift will be wasted on taking up the excess lash. If an intake valve does not open sufficiently, the full air charge will not make it into the cylinder and power will be lost during combustion. If an exhaust valve does not fully open, some exhaust gases will be left in the cylinder. Again, the result will be a reduction in engine power.

Decreased valve lash will have a less noticeable effect on engine power, but could have a more devastating effect on your engine. As valve lash is decreased beyond specification, the valve train components may be "too tight" and not allow the valve to fully come into contact with the seat. This will prevent the valve from cooling through heat transfer with the valve seat. The term "burnt valve" which you have likely heard someone mention before means that a valve was ruined by heat. A burnt valve will not properly seal the combustion chamber, and can also break, destroying your piston and cylinder wall. As valve lash decreases, the engine could lose power if valves are held partially open by the valve train (not allowing for proper compression).

Intake and exhaust valves usually have different specifications, because of the differences in their sizes and jobs. The exhaust valve is usually set a little looser than the intake, because of the harsh environment it lives in (superheated gases pass over it into the exhaust system when it is open). Intake valves have it easy (for a valve) as they are in contact with the cylinder head when they are exposed to combustion gases and temperatures (when they are open, relatively cool air/fuel mixture passes over their surface).

To identify an exhaust or intake valve, look at its position in relation to the rest of the cylinder head. In most cases, the intake valve will be closest to and in alignment with the intake manifold, while the exhaust valve is closest to and adjacent to the exhaust pipe.

QM SERIES ENGINES

See Figures 102 thru 109

The valve lash should be adjusted when the engine is cold.

1. Remove the rocker cover from the engine.
2. Turn the engine over by hand, and set the number one cylinder to Top Dead Center (TDC). By aligning the mark on the crankshaft pulley with the mark on the engine. Both the intake and exhaust valves for the number one cylinder should be in a resting position (not depressed). The rocker arms should not move when the engine is slightly turned back and forth from the TDC mark on the flywheel. If the rocker arms move back and forth, and the flywheel is on the correct mark, rotate the engine one full revolution of the timing mark. This should be the compression stroke.

CAUTION

It is advisable to loosen the injector fuel lines before attempting to turn the engine over by hand. It IS possible for the engine to start when turning it by hand! When turning the engine, do so very slowly to prevent accidental starting of the engine.

3. Insert a flat feeler gauge of the proper dimension between the tappet and the rocker lever for the number 1 cylinder. The lash should be 0.0059 in. (0.15mm) The gauge should slide between these two parts with a slight pull.
4. If the gauge will not slide readily, or there is no resistance when pulling it through, loosen the locknut on the rocker arm, and use a screwdriver to rotate the adjusting screw. When a slight pull is obtained, hold the adjusting screw in place with a screwdriver and use a box or open end wrench to tighten the locknut. If the adjustment has tightened up, change the setting of the adjusting screw. If a great deal of effort is required to pull the gauge (adjustment too tight), burned valves may result.
5. On two cylinder engines, adjust the valves on the number 2 cylinder by rotating the crankshaft by 180 degrees. On three cylinder engines, rotate the crankshaft pulley by 120 degrees. The number three cylinder can be adjusted by turning the number three cylinder an additional 120 degrees.
6. Once all of the valves are adjusted to the proper specification, install the rocker arm cover.

GM/HM SERIES ENGINES

See Figures 102 thru 108, 110 and 111

The valve lash should be adjusted when the engine is cold.

1. Remove the rocker cover from the engine.

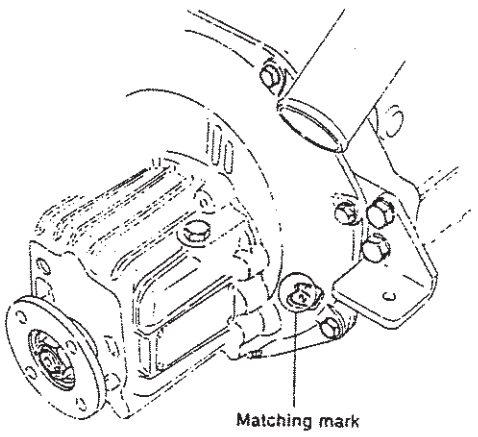

Fig. 110 Some GM/HM series engines are equipped with an opening in the flywheel housing on the for viewing of the timing marks

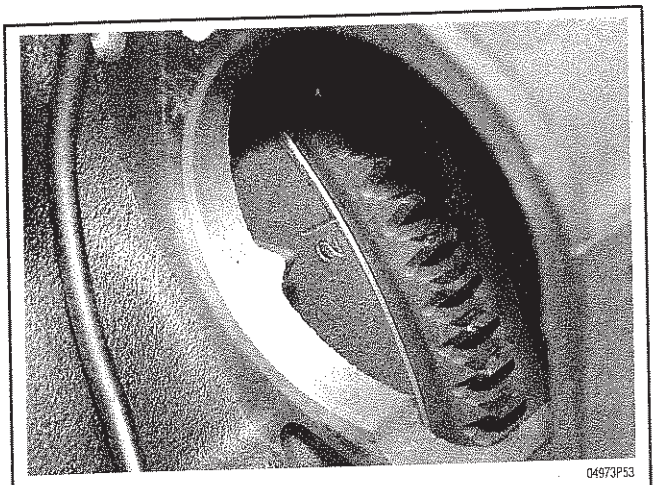

Fig. 111 On GM series engines, the starter can be removed to view the timing marks if the marks on the transmission cannot be seen

2. If necessary, remove the starter motor from the engine. This will allow for viewing of the timing mark(s) on the flywheel. (Some transmissions do not have a viewing port for the timing marks on the flywheel)

CAUTION

It is advisable to loosen the injector fuel lines before attempting to turn the engine over by hand. It IS possible for the engine to start when turning it by hand! When turning the engine, do so very slowly to prevent accidental starting of the engine.

3. Turn the engine over by hand, and set the number one cylinder to Top Dead Center (TDC). Both the intake and exhaust valves should be in a resting position (not depressed). The rocker arms should not move when the engine is slightly turned back and forth from the TDC mark on the flywheel. If the rocker arms move back and forth, and the flywheel is on the correct mark, rotate the engine one full revolution of the timing mark. This will be the compression stroke.

4. Insert a flat feeler gauge of the proper dimension between the tappet and the rocker lever for the No. 1 cylinder. The lash should be 0.0079 in. (0.2 mm). The gauge should slide between these two parts with a slight pull.

5. If the gauge will not slide readily, or there is no resistance when pulling it through, loosen the locknut on the rocker arm, and use a screwdriver to rotate the adjusting screw. When a slight pull is obtained, hold the adjusting screw in place with a screwdriver and use a box or open end wrench to tighten the locknut. If the adjustment has tightened up, change the setting of the adjusting screw. If a great deal of effort is required to pull the gauge (adjustment too tight), burned valves may result.

6. Adjust the remaining valves on the engine by aligning the timing mark for each of the remaining cylinders.

7. Once all of the valves are adjusted to the proper specification, install the starter, and the rocker arm cover.

JH SERIES ENGINES

See Figures 102 thru 108, 112 and 113

The valve lash should be adjusted with the engine cold.

1. Remove the rocker (valve) cover from the engine.

CAUTION

It is advisable to loosen the injector fuel lines before attempting to turn the engine over by hand. It IS possible for the engine to start when turning it by hand! When turning the engine, do so very slowly to prevent accidental starting of the engine.

2. Turn the engine over by hand, and set the number 1 cylinder to Top Dead Center (TDC) by aligning the mark on the flywheel with the mark on the flywheel housing. Both the intake and exhaust valves for the number one cylinder should be in a resting position (not depressed). The rocker arms should not move when the engine is slightly turned back and forth from the TDC mark on the flywheel. If the rocker arms move back and forth, and the flywheel is on the correct mark, rotate the engine one full revolution of the timing mark. This will be the compression stroke.

3. Insert a flat feeler gauge of the proper dimension between the tappet and the rocker lever for the number 1 cylinder. The lash should be 0.0079 in. (0.2mm). The gauge should slide between these two parts with a slight pull.

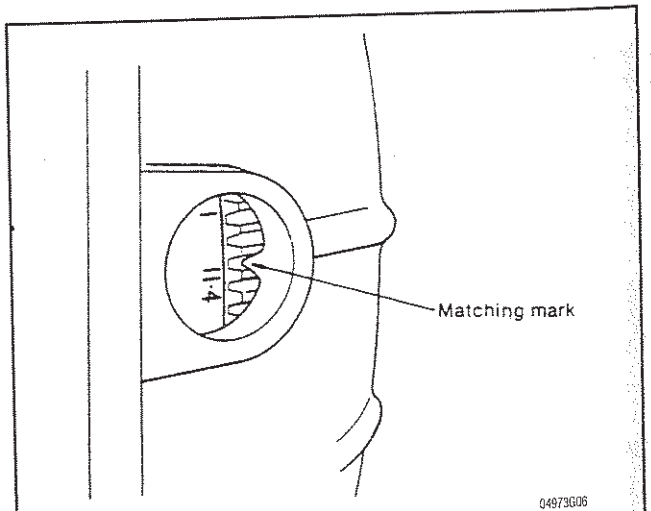

Fig. 112 The timing marks on JH series engines are viewed through an opening in the flywheel housing