Kawasaki GPz750 Turbo Technical Training Manual

The following is Part 1 of the Kawasaki GPz 750 Turbo Technical Training Manual. It deals with turbocharger system theory and operation. Kawasaki used this manual to help train their personnel to understand and troubleshoot the turbo monster. Though some of it has the unmistakable sound of corporate chest-beating (but hey, why not?) there's a lot of good science contained in these pages for owners and tinkerers of any turbo persuasion.

Part II with feature a turbocharger troubleshooting guide. Look for it in our winter edition. Thanks to Jill A. Dunning of Kawasaki's Consumer Services Dept. for supplying the TMIOA with this manual.

INTRODUCTION

What makes Kawasaki's 750 Turbo the world's fastest? Learn just how easy it is to understand, troubleshoot, and tune this high technology system.

This is a comprehensive, technically-oriented program that focuses on systems and components unique to the 750 Turbo.

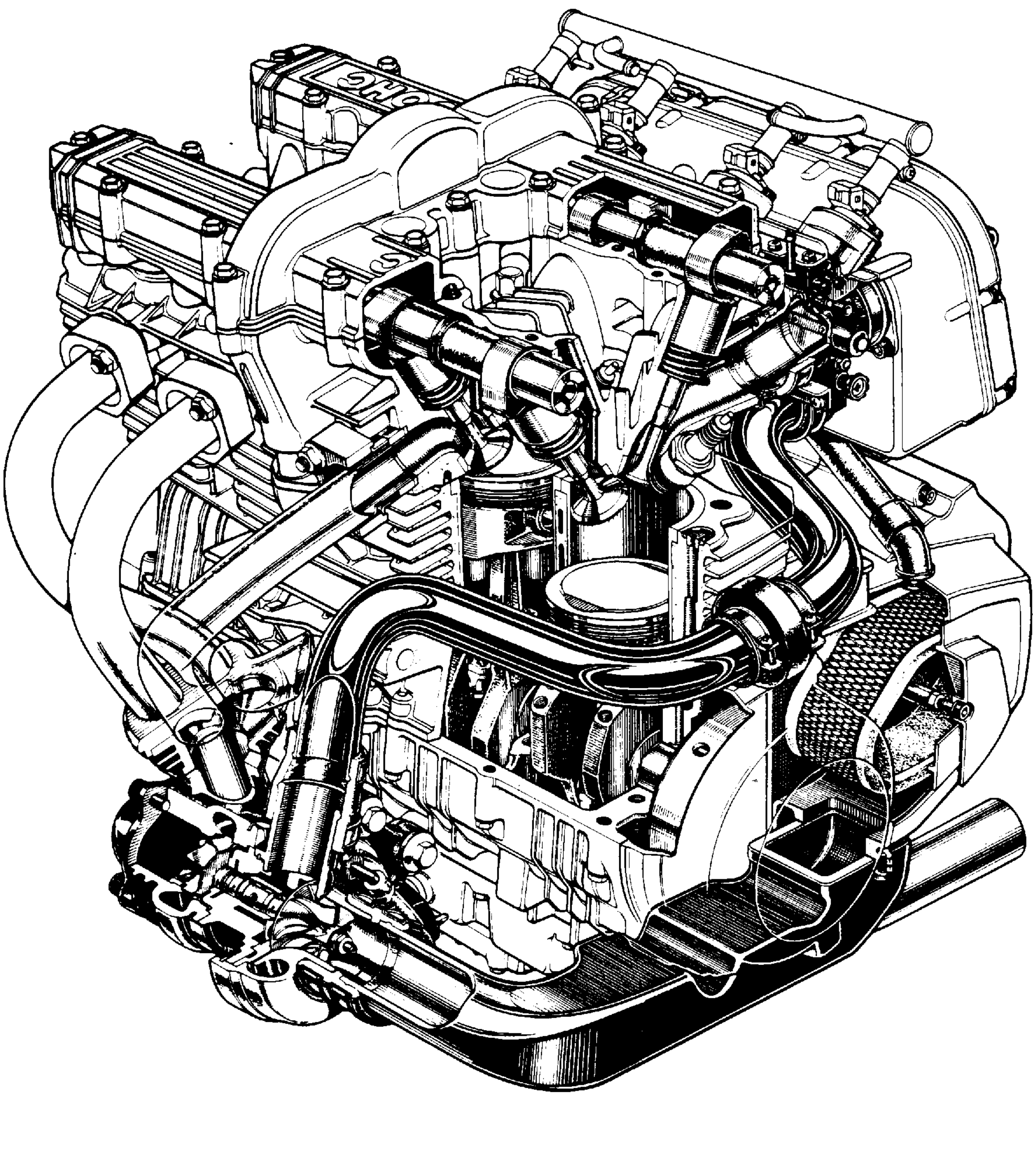
Major emphasis is placed on theory and maintenance of the turbocharger system, while other topics covered include suspension, chassis, internal engine and Digital Fuel Injection components.

Upon review of the 750 Turbo Course, the student will:

- Thoroughly understand the turbocharger and all related systems (such as wastegate valve and actuator, boost pressure sensor and LCD boost indicator).
- Have awareness of the other differences between the GPz750 and the 750 Turbo.

Kawasaki **Technical Training**

Turbocharger System Theory and Operation



NOTE:

This information provides the theory of operation and a structural description of the Turbocharger System. See the accompanying “Troubleshooting Information” *(next Turbo News - ed.)* or the Service Manual for service information.

TURBOCHARGER FEATURES

Unlike the other turbocharged motorcycles on the market, the 750 Turbo has its turbocharger mounted low and in front of the engine. The combination of this unique placement of the turbocharger and Kawasaki’s DFI (Digital Fuel Injection) system makes the 750 Turbo extremely powerful, yet very efficient and responsive.

A turbocharger is a device which uses the high temperature and pressure of the exhaust gases coming out of the engine to push more air into the engine. A turbine is driven by the exhaust gases, and it in turn drives a compressor which pushes air into the cylinders at greater than atmospheric pressure. More air means more horsepower and torque.

The advantages of the turbocharger system are:

- Higher horsepower and torque can be achieved without increasing operating speeds or engine displacement.

- A lower specific fuel consumption can be achieved by turning the engine slower and by using “low speed” camshafts (less duration and overlap).

The result is that a turbocharged engine can get better fuel economy than a “normally aspirated” engine with the same power output.

- Intake and exhaust noise is reduced since the turbocharger and related plumbing act as a silencer.

The intake and especially the exhaust paths of the Kawasaki Turbocharger System are made as short as possible by placing the turbocharger low and in front of the engine and the air cleaner near the engine sprocket. As a result, Kawasaki’s Turbocharger System offers these extra advantages:

- Better throttle response due to minimal “turbo lag.” “Turbo lag” is an expression that refers to the response time for the turbo to build pressure after the throttle is opened abruptly. The closer the turbine wheel is to the exhaust port, the less this performance lag will be.

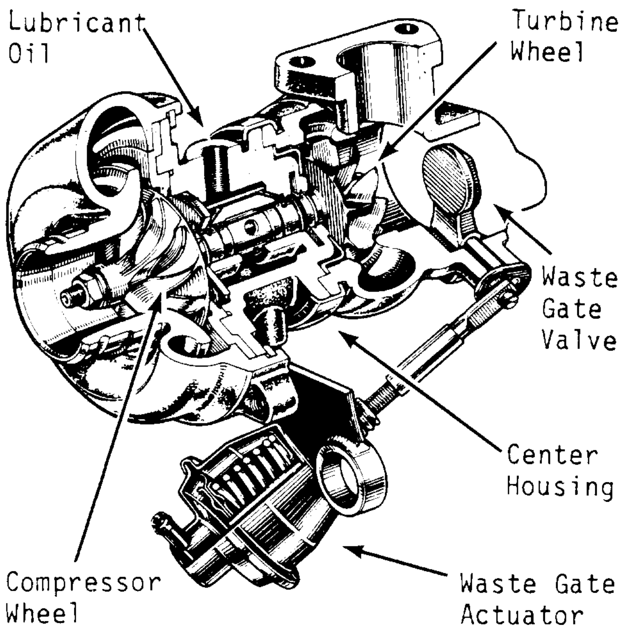
- Minimal loss of exhaust gas heat energy and increased overall efficiency resulting from the very short distance between the exhaust valves and the turbocharger.

- A relatively low center of gravity which improves stability.

- The hottest parts of the system are placed well away from the rider for comfort.

TURBOCHARGER COMPONENTS

The turbocharger basically has four parts: the turbine, which extracts the heat energy of the exhaust gases; the compressor, which compresses the incoming air; the center housing, which carries the shaft between the turbine and compressor; and finally the boost control.



TURBINE

The turbine extracts the heat energy of the exhaust gases, changing it to rotational energy to drive the compressor.

It is made up of the turbine wheel and its surrounding snail-shell-shaped housing. The housing directs the flow of exhaust gas at the turbine wheel, allowing it to expand and cool. The expansion of the exhaust gases turns the turbine wheel through its blades. The shape of the blades forces the gas flow to spin the turbine wheel. The turbine wheel and its housing are made of highly heat resistant alloys.

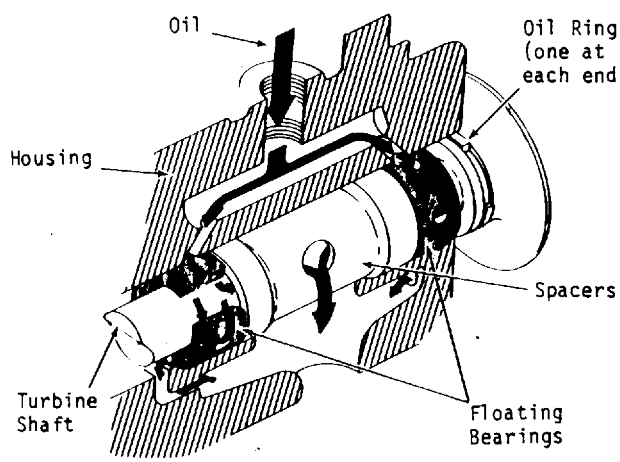
COMPRESSOR

The compressor is a centrifugal-type compressor which pumps air into the engine at pressures greater than atmospheric.

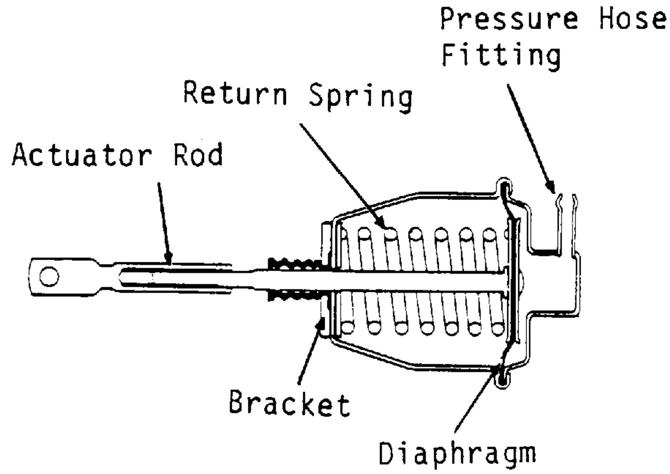
It is made up of a compressor wheel and a surrounding snail-shell-shaped housing. The compressor wheel has twelve specially shaped blades on it, which push the air as the wheel turns. The housing shape allows the speed of the air to drop as it comes off the compressor wheel blades. The drop in speed increases the air pressure as the air flows toward the engine. A special casting method has been used to shape the compressor wheel blades.

CENTER HOUSING

The center housing supports the shaft connecting the turbine and compressor wheels as it turns at speeds as high as 200,000 RPM. A floating bearing, which also turns, is mounted in the center housing, and it carries the shaft on two films of oil, absorbing the minute vibration caused by the tiny imbalance present in even the most precisely manufactured parts. The shaft rides on an oil film inside the bearing shell; and the bearing shell rides on another oil film inside the center housing. The bearing turns at about 30% the speed of the shaft. Thus, the bearing speeds between the shaft and the floating bearing and between the bearing and the center housing are much less than that of a fixed bearing. Lower bearing speeds reduce the likelihood of encountering any cooling or lubrication problems.

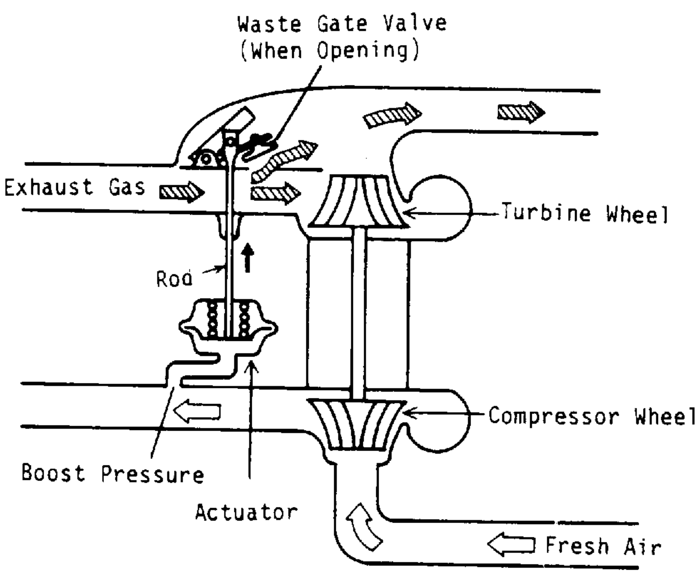


BOOST CONTROL



If the boost pressure were left uncontrolled, it would rise as long as the throttle was held open until the engine exploded. It is very important to keep the boost pressure under control.

Two components working together control the boost pressure. The wastegate allows some of the exhaust gas to bypass the turbine when the pressure approaches the design limit. The actuator is a pressure sensing diaphragm connected to the pressurized part of the intake tract. It opens the wastegate when the maximum boost pressure is reached.



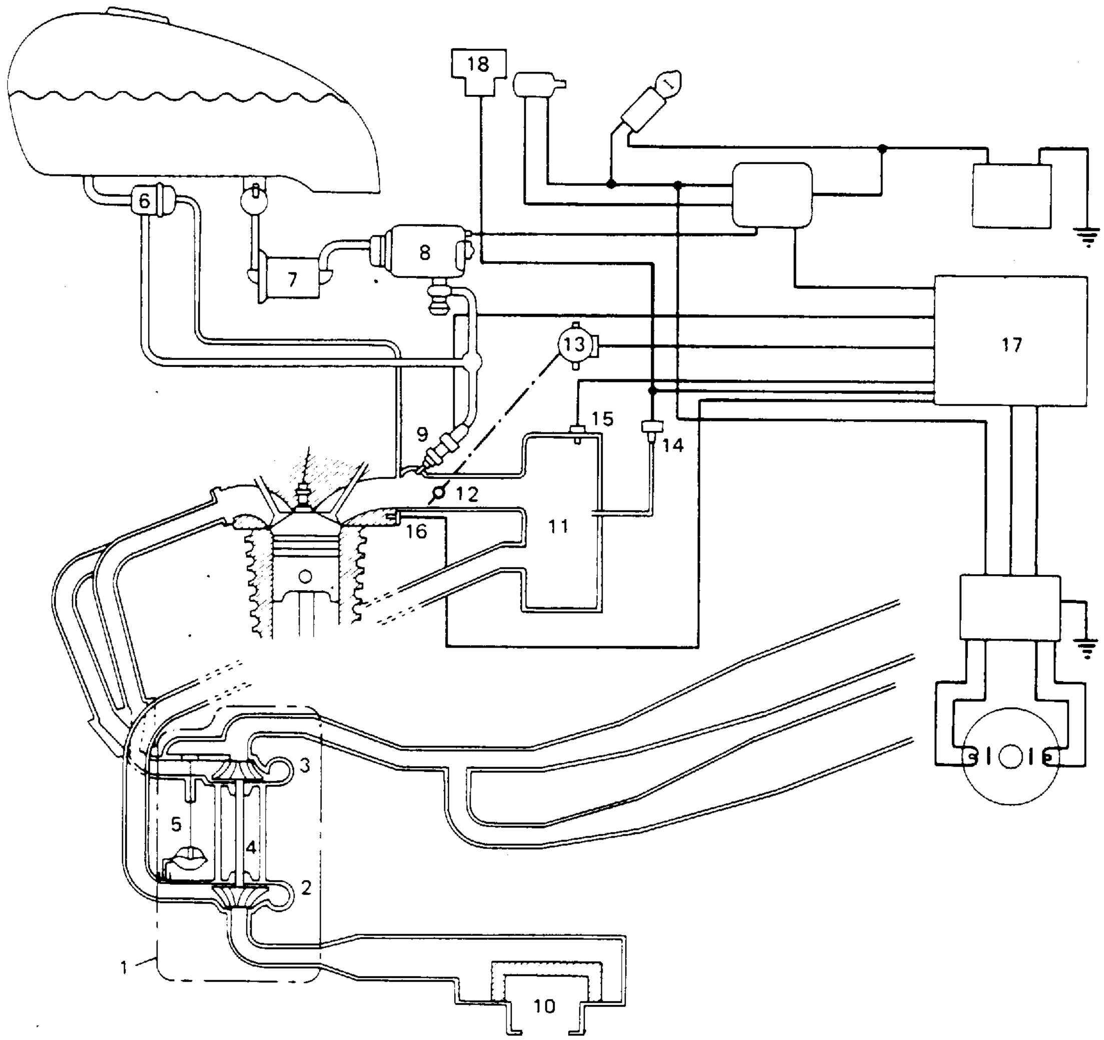
The boost pressure at which the actuator operates is determined by the preload on the actuator's internal return spring. The spring is preloaded when the actuator rod is pulled out slightly in order to attach it to the wastegate valve.

DFI SYSTEM COMPONENTS AND OPERATION

Kawasaki's DFI (Digital Fuel Injection) system used on the 750 Turbo is based upon that of the GPz1100.

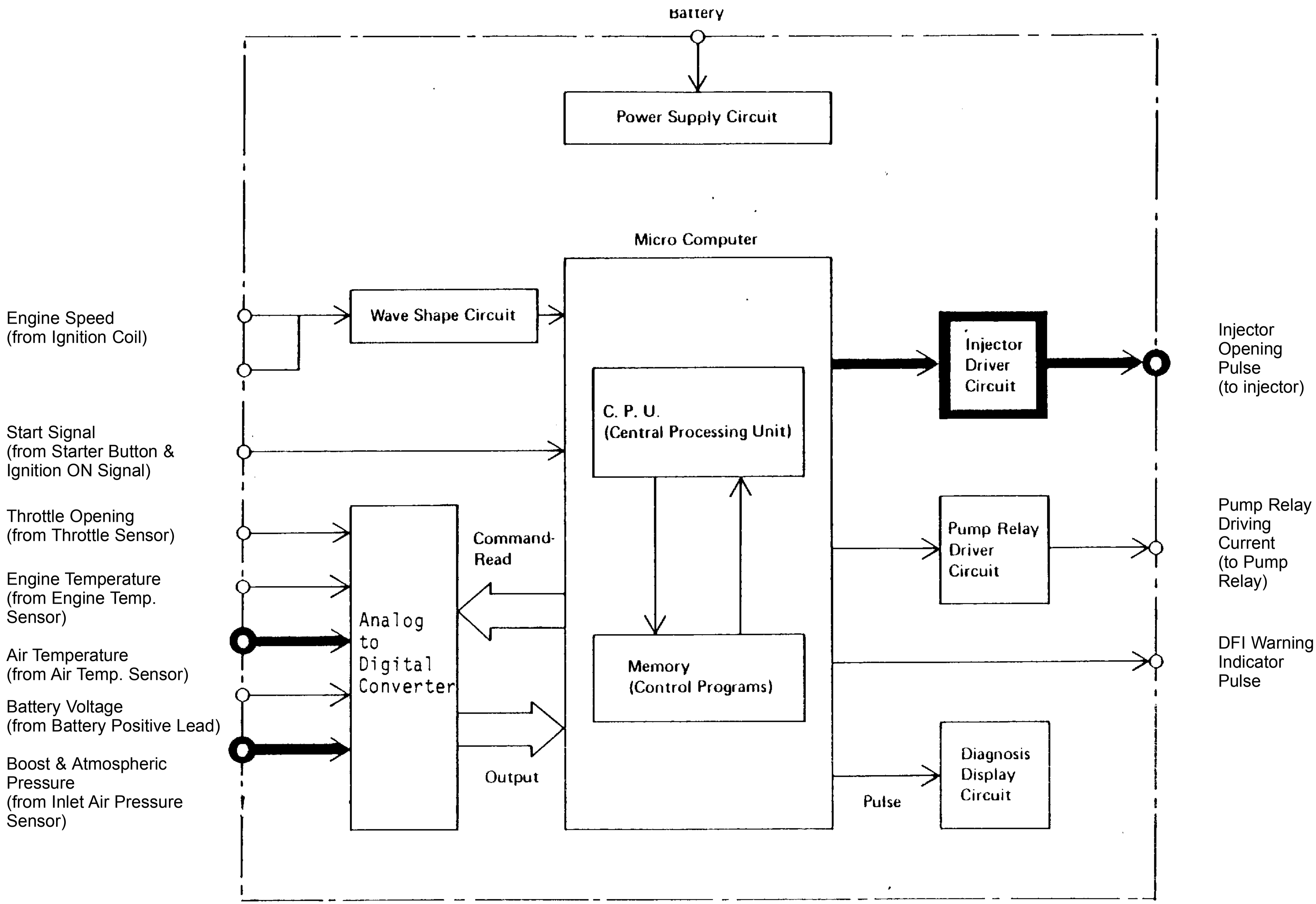
The DFI system computes the optimum fuel injection quantity according to the program stored in the memory of the control unit and information collected by various sensors which detect engine operating conditions. The sensors constantly monitor boost pressure, throttle position, engine RPM, engine temperature, and intake air temperature.

The following are the differences from the GPz1100 DFI system.



1. Turbocharger
2. Compressor
3. Turbine
4. Centerhousing
5. Boost Control
6. Fuel Pressure Regulator
7. Fuel Filter
8. Fuel Pump
9. Injector
10. Air Cleaner
11. Surge Tank
12. Throttle Valve
13. Throttle Sensor
14. Boost Pressure Sensor
15. Air Temperature Sensor
16. Engine Temperature Sensor
17. D.F.I. Control Unit
18. Boost Meter

NOTE: The broad-pointed lines show the difference between 750 Turbo and GPz1100 DFI Control Units.

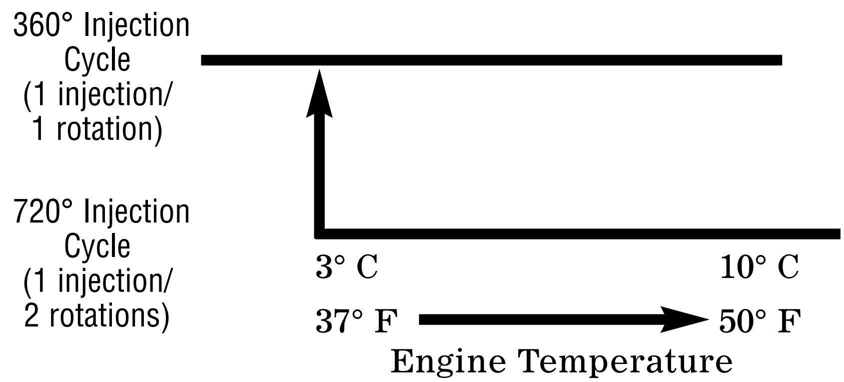


INJECTOR TIMING

Injection timing is changed from a 360 degree injection cycle (1 injection/1 crankshaft rotation) to a 720 degree injection cycle (1 injection/2 crankshaft rotations). Because the range of injection fuel quantity a turbocharged engine needs is wider than that of the conventional engine, it was necessary to increase the injection time for high engine RPM and reduce injection frequency to improve the accuracy of the injection fuel quantity at idle.

During cold starting only, the 360 degree injection cycle is used. Injection timing is changed in accordance with cylinder head temperature as shown below.

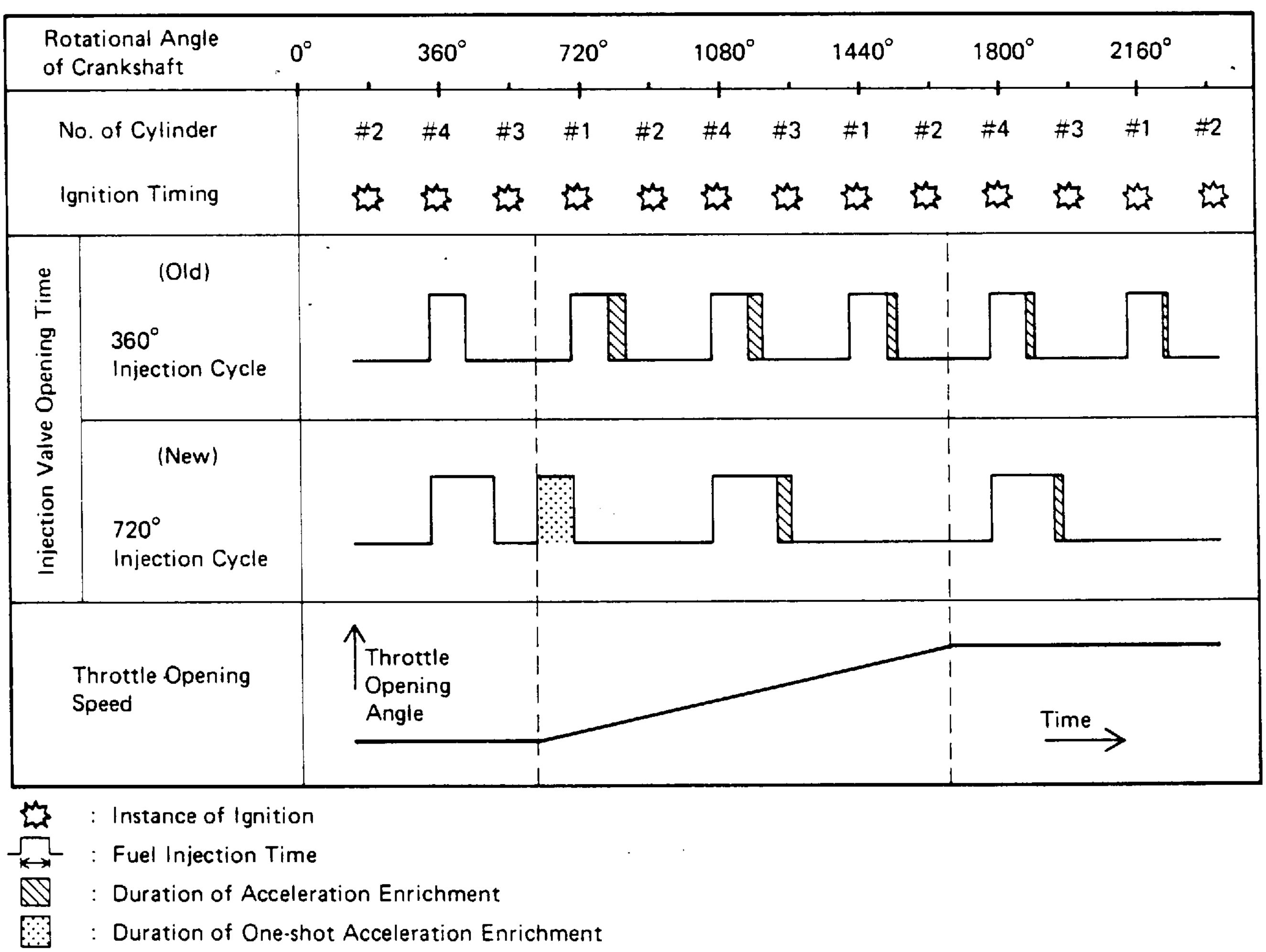
INJECTION TIMING



ONE-SHOT ACCELERATION ENRICHMENT

One-shot acceleration enrichment is an added feature. It injects a specified fuel quantity at the instant the throttle is snapped open.

This eliminates any “time lag” if the throttle is snapped open in the interval between injections. In the GPz1100 DFI sys-



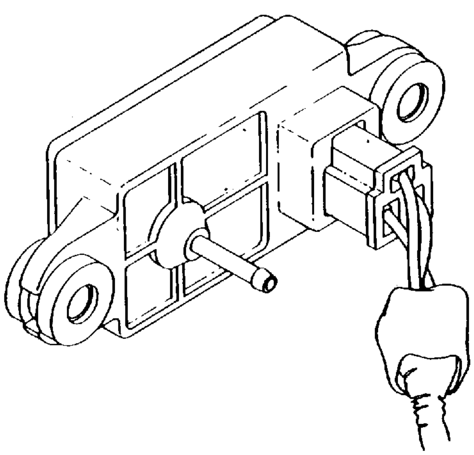
tem, the fuel quantity is not enriched until the next closest normal injection point.

NOTE :

"Acceleration enrichment" which is used on both the 750 Turbo DFI and the GPz1100 DFI, enriches the mixture only when the engine is cold. However, one-shot acceleration enrichment, used only on the 750 Turbo DFI, works not only before, but also after the engine is warmed up whenever the throttle opening speed becomes greater than a predetermined level.

BOOST AND ATMOSPHERE PRESSURE SENSOR

The boost sensor is mounted on the back of the surge tank, and senses boost pressure through a small rubber hose connected to a fitting on the surge tank. Since it monitors whatever pressure exists inside the surge tank, the boost sensor also measures atmospheric pressure at low RPM's and light loads. The atmospheric pressure sensor mounted in the GPz1100 control unit is therefore not needed.



The boost sensor sends signals not only to the DFI control unit, but also to the boost meter which gives the rider an opportunity to visually monitor the boost pressure. (See wiring diagram in "Troubleshooting" handout.)

Boost pressure is controlled at the turbocharger with the wastegate and its actuator. As a further safety measure, the DFI system cuts off fuel supply to the engine by interrupting the injector signal if the boost pressure exceeds the preset maximum.

AIR TEMPERATURE SENSOR

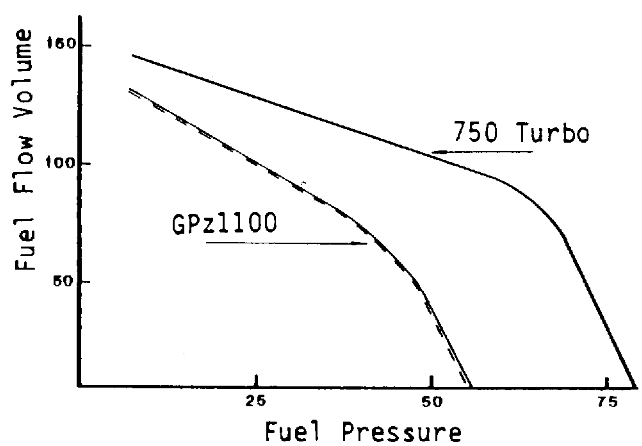
The air temperature sensor in the air cleaner case has been replaced with a new air temperature sensor mounted on top of the surge tank. In the surge tank, it can react to changes in air temperature caused by boost pressure so that the optimum fuel injection quantity can always be determined accurately.

FUEL INJECTORS, FUEL PUMP, PRESSURE REGULATOR VALVE

The GPz1100 system injects fuel into an intake tract which is always less than atmospheric pressure. The ZX750 Turbo system, however, must inject fuel into an intake tract which ranges from less than atmospheric pressure (similar to the GPz1100) to well above atmospheric pressure on boost. In order to deliver fuel properly under these more varied conditions, the pump, regulator valve, and injectors have been changed.

The fuel flow rate of the injectors has been increased by almost 30%.

Fuel delivery capabilities of the pump have been increased as shown below.



This graph shows that for any given fuel flow rate (combined injector flow), a far greater pressure is possible. This is necessary because of the greater injectors flow rate and the need to maintain a constant pressure differential between the fuel system and intake manifold even at high boost pressures.

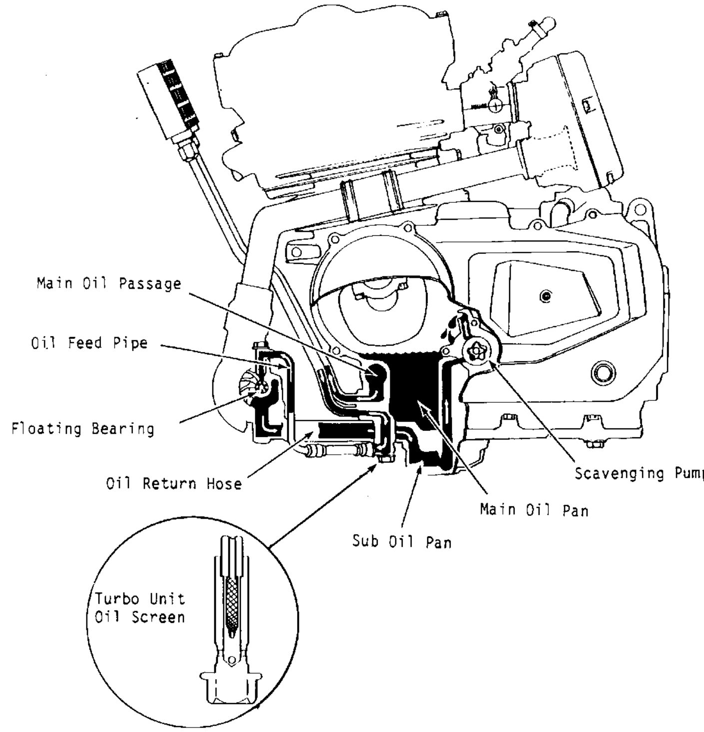
A different pressure regulator valve is also needed in order to maintain a constant pressure differential at high boost as well as during "off boost" operations.

LUBRICATION

The lubrication system of the 750 Turbo is based on that of the GPz750. The difference between the two is that new oil flow passages are added, which route some oil from the oil cooler through the turbocharger, the sub-oil pan, the scavenging oil pump, and back to the oil pan.

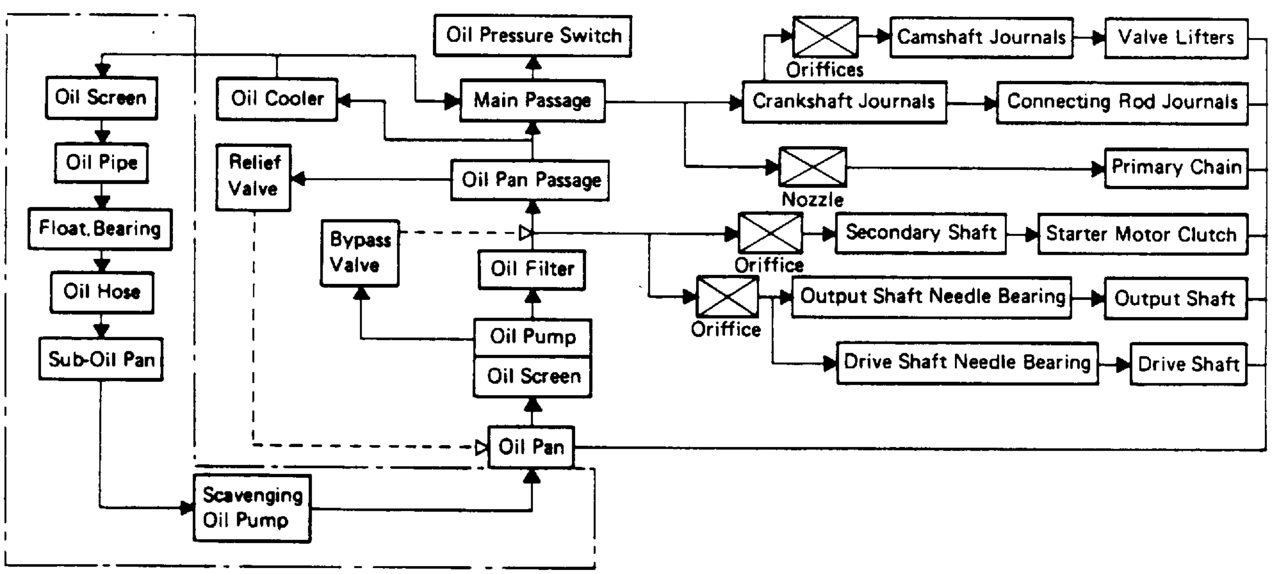
The oil automatically flows down into the sub-oil pan after lubricating the turbocharger floating bearings. From there, the oil is pumped up to the oil pan by the scavenging pump, which is mounted on the left end of the secondary shaft in front of the engine sprocket.

This system eliminates oil consumption problems within the turbo unit which have plagued other turbocharger systems. The turbo shaft bearings are lubricated by oil directly from the oil cooler. That oil is then "pulled" away from the turbo by the scavenging oil pump and returned to the pan preventing any oil pressure build-up in the turbocharger center housing.

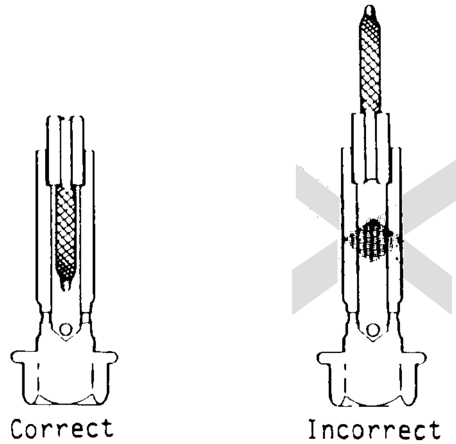


NOTE :

The small oil screen located In the turbocharger oil feed line banjo bolt must be



installed as shown in the illustration below. Incorrect installation can result in severely reduced oil flow to the turbocharger.



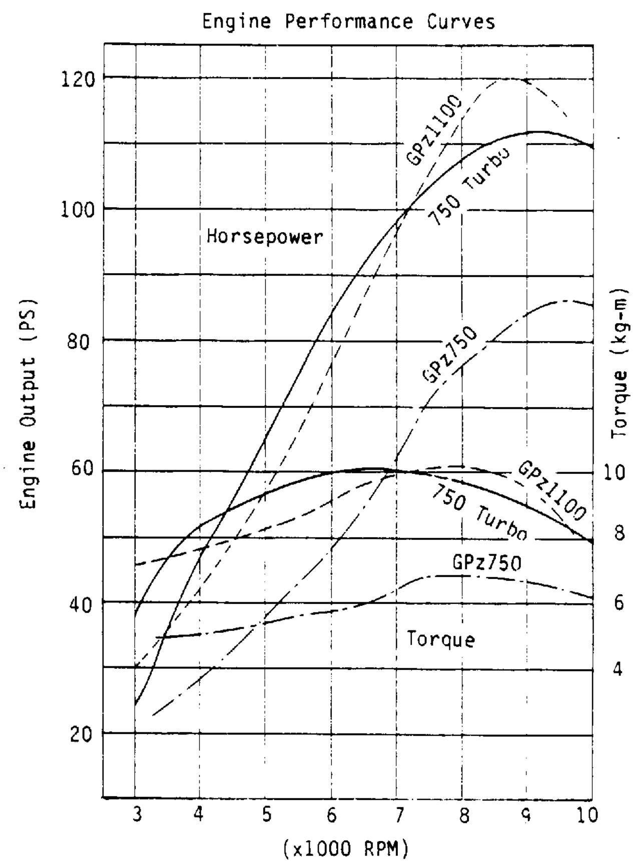
CHANGES IN THE 750 TURBO FROM THE GPz750

In order to make use of the power potential of a turbocharged 750cc engine and still maintain a high degree of reliability, acceptable off-boost performance and good high-speed handling, Kawasaki made several changes to the base model GPz750 engine, drive train and chassis. The following to a list of the most significant changes.

ENGINE

Flat-top pistons are used to lower the compression ratio enough to allow significant boost pressures without requiring the use of exotic fuels to prevent detonation. In conjunction with the flat-top pistons, a different cylinder head with a smaller combustion chamber is used. This smaller combustion chamber helps control combustion and prevent detonation. The compression ratio of the 750 Turbo is 7.8:1 compared to 9.5:1 in the Gpz750.

Very mild (short duration, low lift) cams have been used in the 750 Turbo to help compensate for the low compression and improve low RPM, off-boost performance. Since the intake tract is under high pressure at high RPM, there is no need for high RPM cams. As a result the 750 Turbo has a very flat horsepower and torque curve with an impressive 73.1 ft.-lb. of torque (10.1 kg-m) at a very low 6,500 RPM.

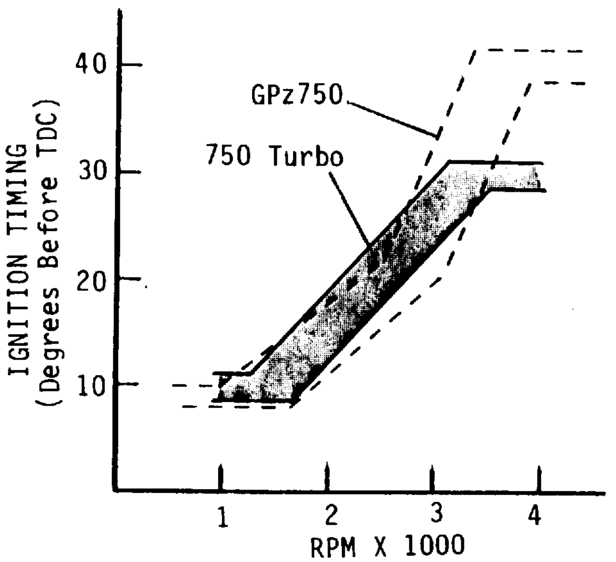


To handle the more than 30% increase in horsepower and almost 50% increase in maximum torque, stronger connecting rods and bolts are used.

The power is transmitted to the jack shaft through a stronger hy-vo primary chain.

IGNITION

Even with the latest in combustion chamber design, detonation can be a problem with the tremendous pressures created under full boost. For this reason, the 750 Turbo ignition advance curve has been changed as shown to provide less maximum spark advance and thus further reduce the possibility of detonation.



TRANSMISSION

Different primary gear ratios (larger pinion gear, smaller clutch gear) are used to reduce the load on the clutch and transmission. The clutch housing is strengthened and an additional clutch friction plate is used.

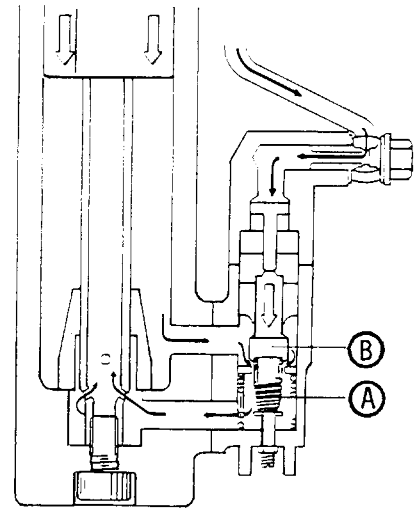
The output shaft and bearings are made larger for increased strength. Also the internal gear ratios and final drive sprockets were changed in order to attain the overall drive ratios most favorable for all-around performance.

SUSPENSION

All of the changes found in the 750 Turbo suspension have been done to improve high-speed stability.

Front Suspension

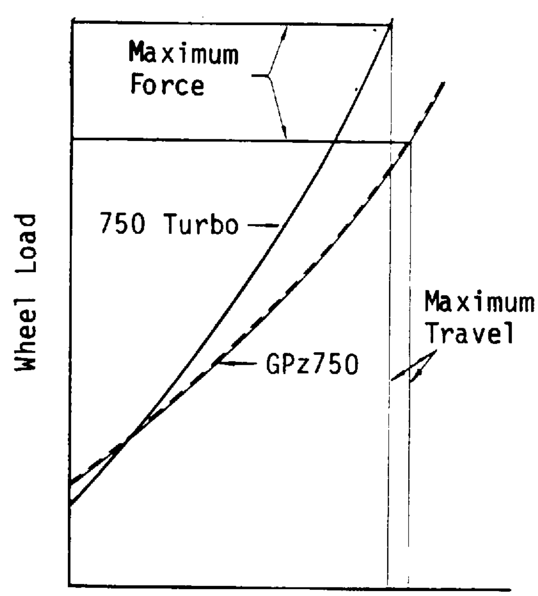
The front damping is slightly heavier than the GPz750 and the anti-dive is made more effective by making the valve spring (A) weaker, thereby allowing more movement of the valve (B) during braking. Fork travel has been reduced from 6.2 to 5.1 inches.



Rear Suspension

The shock absorber has heavier damping, a stronger constant rate spring, and shock travel is reduced.

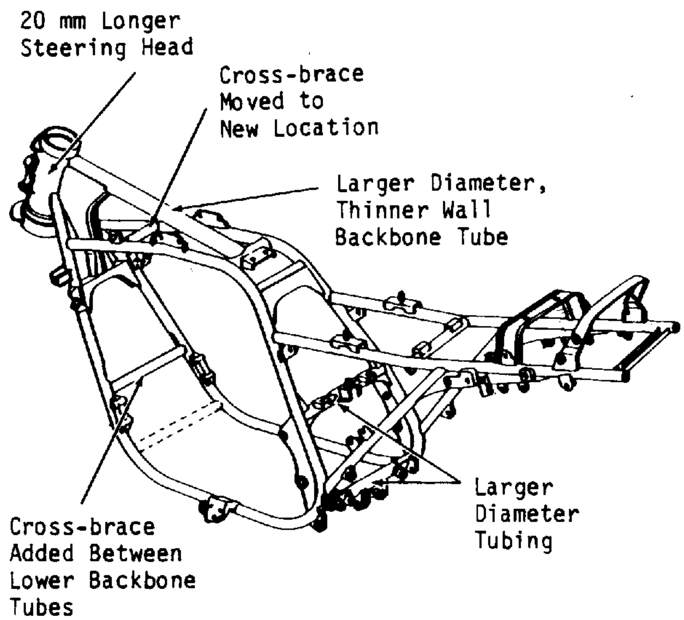
The rocker arm and connecting links are aluminum for reduced weight, and the geometry is changed to produce a slightly more progressive suspension curve. The combined effect of the stronger spring and the more progressive ratio is shown in this graph. Rear wheel travel has been reduced from 5.1 inches on the GPz750 to 4.1 inches.



The aluminum swing arm wall thickness has been increased by 0.5 mm to add rigidity.

FRAME

The steering head pipe has been lengthened by 20 mm over the GPz750. Also, frame tube sizes and locations have been changed as shown in this illustration.



For better high speed stability, the frame geometry has been changed as shown below.

	750 Turbo	GPz750
Rake Angle	28 deg	26.5 deg
Trail	117 mm	103 mm

BRAKES AND WHEELS

The front wheel is cast using an advanced high pressure process which allows it to be made about two pounds lighter than the GPz front wheel.

The front and rear brake discs are 10 mm larger than the GPz 750 discs (increasing the brake swept area) and the front hydraulic hoses are made of an extremely strong braided synthetic fiber and teflon. These new brake lines are nearly as strong as braided steel lines and resist expansion when high pressure to applied.

Corrections...

The photo at right that appeared in *Turbo News* #23 (page 26) was only half right in its caption. Yes, that is Ron Graf on the left, but on the right is none other than **Terry Cree** of Boulder Creek, CA, NOT Ted Engle of Boring, OR. Thanks to Ron Graf who took great joy in pointed this out to *Turbo News*.

e-mail corrections...

Turbo News #23 also goofed on the e-mail addresses (page 29) of the following:

Anton Sop's correct e-mail address is: ***antonsop@hookup.net***
Tim Driscoll's correct e-mail address is: ***fatherhd@harborside.com***

We apologize for the mix-ups