THE HISTORY OF YAMAHA TECHNOLOGY

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NEW ENGINE TECHNOLOGY

DOHC 5 VALVE SYSTEM

DEVELOPMENTAL BACKGROUND

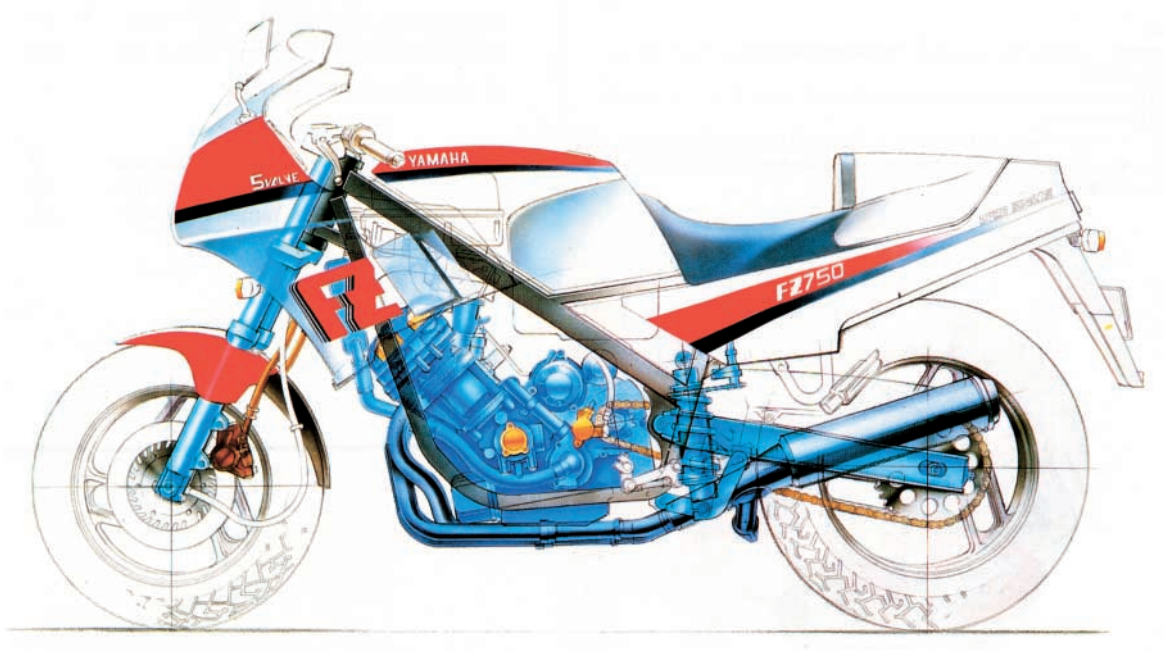
In this new DOHC engine each cylinder has three intake and two exhaust valves. The 1985 forward-leaning parallel four FZ750 is the first production model to feature this system.

This new engine is the latest embodiment of Yamaha's long proven motorcycle design concepts.

The high-speed confusion of today's busy road demands a lightweight, compact high performance engine that helps to improve the steering characteristics of a road vehicle. In addition, as the world's limited fuel reserves diminish and vehicles inevitably move faster, low fuel consumption is also a crucial factor in the develop-ment of today's and tomorrow's engines. In brief, the development of a high performance, good fuel efficiency engine should be considered as a vital social need.

The 4-stroke DOHC 5-valve engine is Yamaha's positive answer to this social need.

This new engine features a high level mechanism that has carried the basic engine technology a step farther.



NEW ENGINE TECHNOLOGY

DOHC 5 VALVE SYSTEM

SUMMARY OF THE 5-VALVE ENGINE

DEVELOPMENTAL CONCEPTS

In designing a high performance, low fuel consumption engine Yamaha has given specific importance to the best ideal development of performance potential that the engine has in itself. While making every possible effort to improve the intake efficiency to a maximum, Yamaha has pursued a new combustion chamber design with higher combustion efficiency in mind.

These efforts have resulted in a technical goal of achieving a multi-valve type engine design that would most likely satisfy the above high performance and low fuel consumption factors by adopting the following improvements:

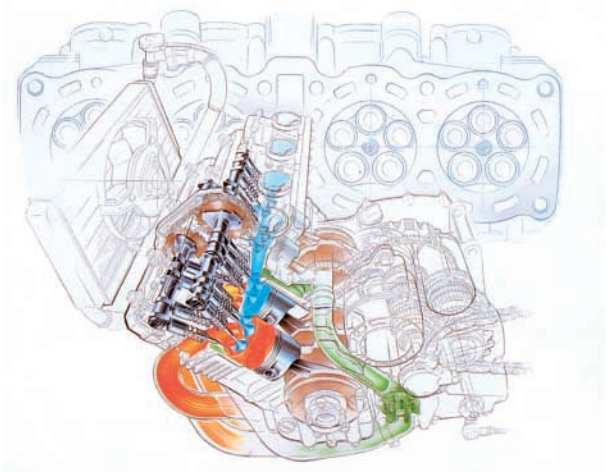
1. Increased effective valve area due to the adoption of three intake valves.
2. A high compression ratio resulting from a compact combustion chamber.
3. Reduction in each valve weight.

The unified effect of these improvements has given the new 5-valve engine extra-high performance and good fuel efficiency.

The '85 FZ750 liquid-cooled 4-stroke DOHC parallel four engine is fitted with a total of 20 valves which are driven directly from the camshafts via valve lifters for sure valve operation even in the high speed range, thus ensuring stable engine performance in the full speed range.

RESULTS

1. High power - About 10% higher power output than a 4-valve engine (Yamaha test engine).
2. Low fuel consumption - About 5% better fuel efficiency than a 4-valve engine (Yamaha test engine).
3. Lightweight, compact design - A lightweight, compact cylinderhead design due to the adoption of a special valve layout.
4. Flexible engine characteristics - Improved power and torque characteristics in a wider range of speeds, increasing the ease of handling.
5. Enhanced reliability and versatility - Increased fuel efficiency and power due to fundamental changes made to the engine design; greater reliability and versatility resulting from simplicity.



NEW ENGINE TECHNOLOGY

DOHC 5 VALVE SYSTEM

AN INNOVATIVE FORWARD-LEANING, LOW-CENTER-OF-GRAVITY DESIGN

DEVELOPMENTAL CONCEPTS

The 5-valve engine on the ’85 FZ750 features an innovative forward-leaning low-center-of-gravity design that helps achieve almost even front and rear weight distribution of the machine. This innovative design does full justice to the improvement of total drivability.

TECHNICAL FEATURES

INCREASED POWER

1. Inclining the cylinders forward allows for near-vertical mounting of the carburetors, to get as straight an induction flow as possible and a downdraft to increase fuel charge velocity.
2. The forward-inclined cylinders help to reduce the bend of exhaust passage for higher exhaust efficiency.
3. In addition, these cylinders also allow for easy crossover layout of exhaust pipes, thus preventing mutual exhaust interference for higher power output.
4. The size of an air cleaner can be enlarged, helping to increase engine power.

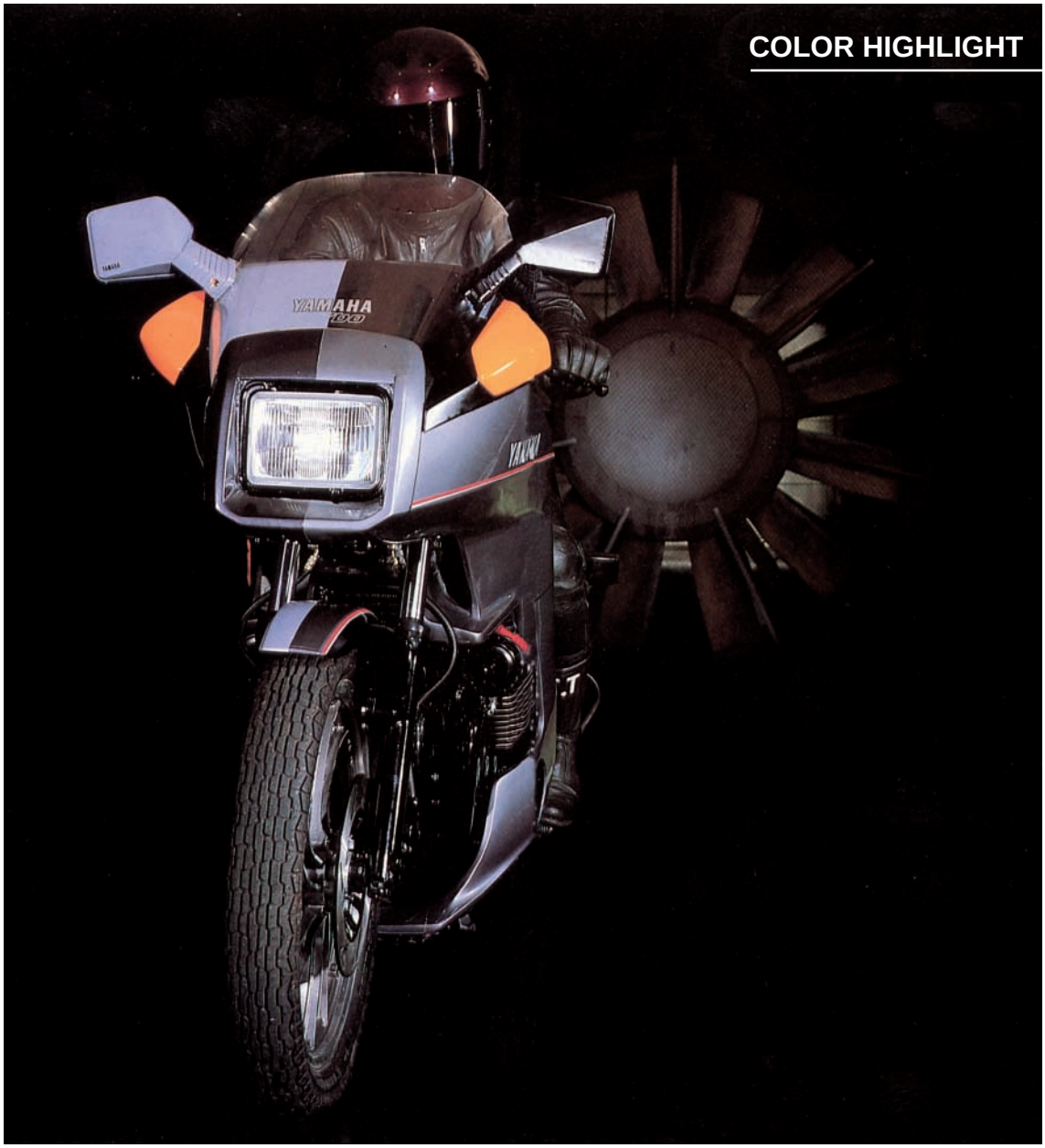
CONTRIBUTIONS TO BETTER STEERING

1. The forward-inclined cylinders allow for a lower center of gravity, increasing steering characteristics.
2. Due to the adoption of the forward-inclined cyiinders the engine’s top-end is moved lower and further forward than on conventional “upright” engines. This achieves almost even front and rear weight distribution for better steering characteristics.
3. The intake system is not positioned under the seat, allowing for easier footing and firmer kneegripping so that the ease and comfort of riding is increased.

CONTENTS

1955 - 1960

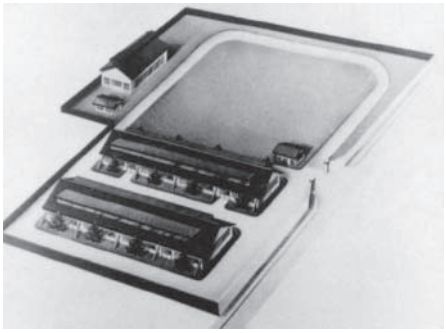
THE ESTABLISHMENT OF “ORIGINALITY”



Wind-tunnel testing for the improvement of aerodynamic characteristics

The shape of a fairing is a crucial factor in the improvement of engine power and rider protection.Yamaha is giving specific emphasis to the improvement of aerodynamic characteristics in the design of a fairing.

1



2

3

4

5

6

7

1. Hamana factory where yamaha's first production model, the YA-1 was produced.

2. The YA-1 got through a 10,000-km test

3~5. Mr.Kawakami, the then President of Yamaha Motor test-rode the YA-1 for himself.

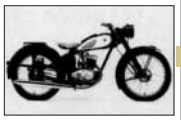
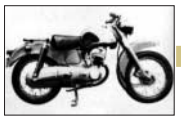
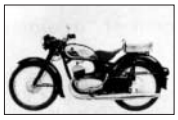
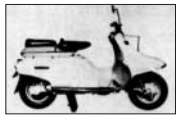
6. Yamama riders taking part in the 1st Asama Volcano Endurance Race (1955)

7. Fumio Ito of the Yamaha Racing Team placed 6th in the 250cc class of the Catalina Island Grand Prix of the United States, the first international race for Yamaha (1958).

1955 to 1960
The establishment of "originality"

- Stepping boldly into the Japanese motorcycle industry in its infancy and experiencing its share and confusion, Yamaha strived to establish a position for itself in the market by introducing new models one after another during the period of 6 years from 1955 to1960.
- Soon after the production or YA-1 125cc bikes got on the right track at the Hamana factory (presently Hamakita factory), the Motorcycle Manufacturing Division was separated from Nippon Gakki and a new company, Yamaha Motor was founded with a starting capital of 30 mil. Yen on July 1, 1955.
- The YA-1 proved itself to be a masterpiece of engineering by dominating the Mt. Fuji Climb Race and the Asama Volcano Endurance Race, the main road race events at that time. This paved the way for the following models, such as the YC-1 175 and the YD-1 250.
- 1960 saw the introduction of the new scooter model, the SC-1 (175cc) and the new moped model, the MF-1 (50cc). These models gained popularity because of their innovated design characteristics and advanced technical features.
- This was also the year that Yamaha ventured into the production of FRP motorboats and outboard motors, thus making clear its attitude toward promoting the spread of leisure-time marine sports as well.

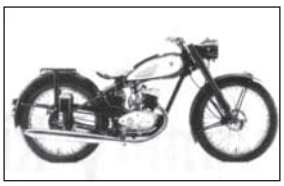
Yamaha motorcycles in the early stage of production

1955	1956	1957	1958	1959	1960
 *YA-1 (125cc)		 *YA-2 (125cc)		 YA-3 (125cc)	 *MF-1 (50cc)
 YB-1 (130cc)					
	 *YC-1 (175cc)				 *SC-1 (175cc)
		 *YD-1 (250cc)	 *YD-2 (250cc)	 *YDS-1 (250cc)	
				 YES-1 (255cc)	
			 YE-1 (256cc)	 YE-2 (256cc)	

Note: See the text pages for the particulars of * marked models.

Yamaha's first production model

—4-speed transmission



YAmahaYA-1(125cc)

SUMMARY

This Was Yamaha's fist production model nicknamed "Red Dragonfly".

BACKGROUND

During the war Nippon Gakki engaged in the production of metal propellers as well as musical instruments. After the war the metal working machinery was pushed off into a corner of the factory, and it was in thinking of a way to make effective use of this unused machinery that the company decided to venture into the manufacture of motorcycles.

CHARACTERISTICS

The 2-stroke engine has a simpler construction than the 4-stroke engine, and it can be produced at a lower cost, while at the same time its performance is satisfactory. Form this point of view Yamaha decided to adopt a 2-stroke single-cylinder engine in the first production model, the YA-1.

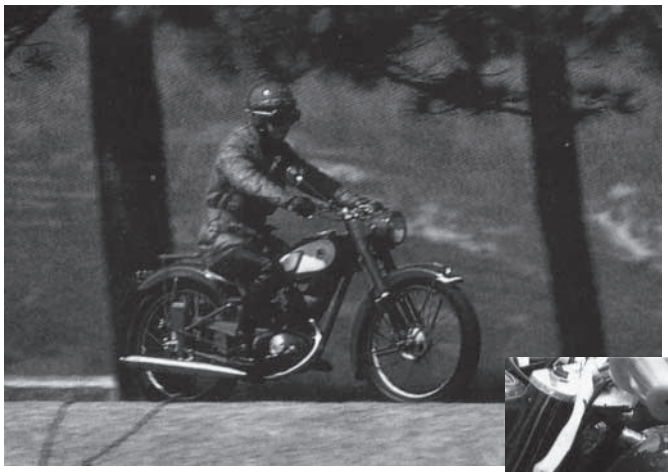
Its main technical data were:

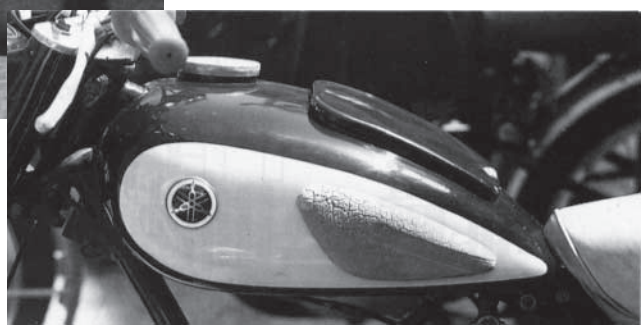
Displacement 123cc, bore × stroke 52 × 58 mm, max. power output 5.6 ps/5,000 rpm and top speed 80 km/h. Although this model was based on the German DKW, it included a number or Yamaha-original features like the 4-speed transmission.

The YA-1 became the first Japanese bike to feature a primary kick starting system, while making it possible to shift directly to neutral by half-stroke operation from any gear.

RESULTS

The memorable first Yamaha bike was received as a very unique model on the market because of its fresh styling and outstanding performance, thus earning Yamaha the reputation of "high quality and high performance".





Primary kick starting system —The first Japanese model of its kind

Yamaha YA-1 (125cc)

SUMMARY

The primary kick starter, which was positioned on the same shaft as the gear shift mechanism, made it possible to kick-start the engine, no matter what gear the transmission was in. This mechanism is in use today on a comparatively large number of motorcycles.

BACKGROUND

The Yamaha YA-1, the very first Yamaha model, popularly known as the “Red Dragonfly”, included many innovative features for the time, so that it could survive an extremely severe competition in the Japanese market. The Yamaha YA-1 was the first Japanese model to feature the primary kick starter.

OPERATION

A kick starting system, earlier than the introduction of the primary kick type, transmitted kick thrust from kick gear, through transmission gear, to the main axle (left illustration on page 26). Kick thrust was therefore not transmitted to the primary driven gear when the clutch was disengaged. In other words, the engine could not be kick-started without putting the gear in neutral, with the clutch being engaged. The primary kick starter (right illustration) employs a kick idle gear and kick pinion, through which kick thrust is transmitted to the primary driven gear. The engine can be kick-started no matter what gear the transmission is in, with the clutch disengaged.

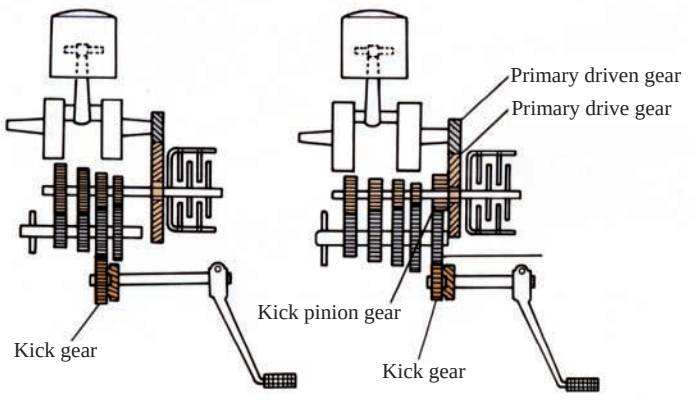
Kick thrust is transmitted as follows:

Kick gear → kick idle gear → kick pinion gear → primary driven gear (high reduction ratio) → primary drive gear (low reduction ratio)

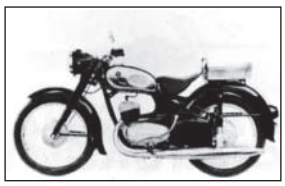
The idle gear which is incorporated in the drive axle rotates freely. The pinion gear rotates with the high reduction ratio gear by means of the dog clutch, and independent of the main axle.

RESULTS

If the engine stalls, it can be easily kick-started once again without putting the gear in neutral.



Monoblock carburetor —Shortened fuel passage



Yamaha YC-1 (175cc)

SUMMARY

The monoblock carburetor combined the mixing chamber and the float chamber in one body as a current type does, which shortened the distance the fuel had to flow, thus improving the engine's response and boosting acceleration performance.

BACKGROUND

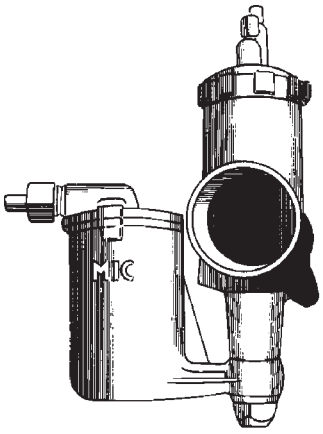
While other bikes at the time were using a standard type carburetor which had separate bodies for the mixing chamber and the float chamber, the Yamaha YC-1 (175cc) which was introduced as the third production model following the YA-1 (125cc) and the YB-l (130cc), was the first Japanese bike to employ the newly designed monoblock type carburetor. In addition to this, the YC-1 was made even more distinctive by the fact that the carburetor and its surrounding area was covered with an attractive streamlined cover.

CONSTRUCTION

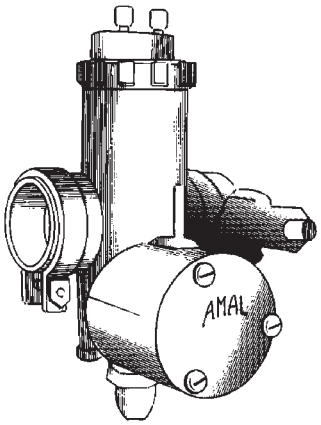
A standard Amal type carburetor had separate bodies for the mixing chamber and float chamber which were joined by means of a holding bolt. On the monoblock carburetor, the mixing chatnber and the float chamber were cast in one block.

RESULTS

The gasoline passage was shortened, resulting in faster response to opening and closing of the throttle than with a standard carburetor. This meant increased performance during acceleration. In addition, the float chamber of the monoblock carburetor was directly above the mixing chamber in terms of the ventilation passage. This meant the lean of the bike had no effect on the fuel surface in the float chamber, resulting in stable carburetion.

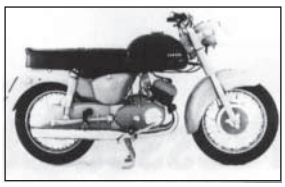


Standard Amal type carburetor



Monoblock carburetor

2-stroke twin engine —Powerful and reliable



Yamaha YD-1 (250cc)

SUMMARY

The newly designed Yamaha YD-1 (250cc) was the first Yamaha bike to adopt a twin-cylinder engine producing a maximum of 14.5 hp at 6,000 rpm.

BACKGROUND

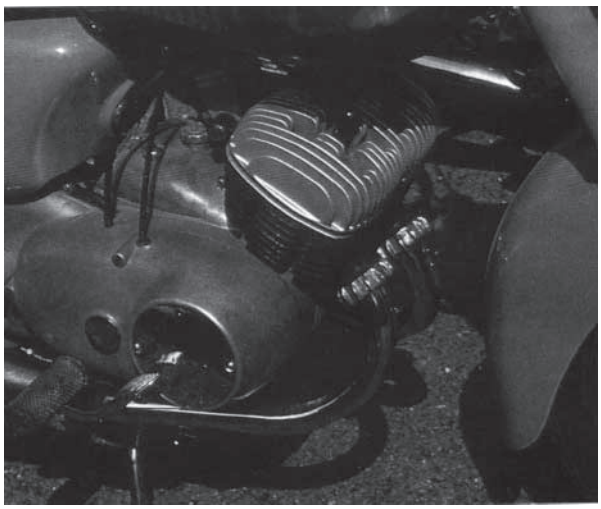
At the time when the YD-1 (250cc) was first conceived, in January of 1956, there were no twin-cylinder 250cc motorcycles in Japan. However, by the time it was released on the market, all the other manufacturers were also beginning to introduce twins one after another because the twin-cylinder design featured shorter firing intervals, thus resulting in smoother running of the engine and less vibration.

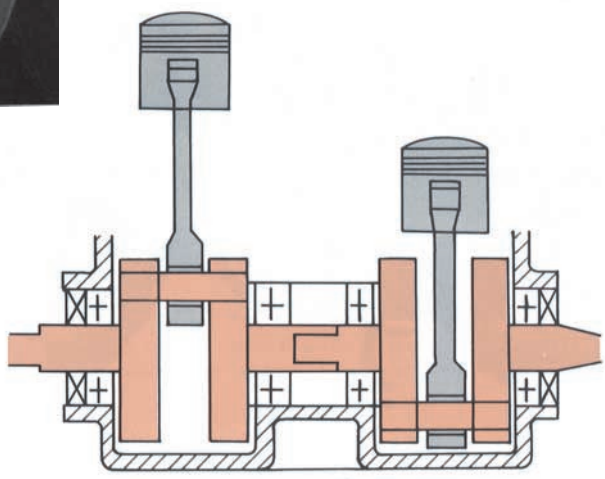
OPERATION

In this 180° crank 2-stroke twin engine the two cylinders fired alternately. A unique feature of this engine was that the right and left crankshafts, which were bolt fastened, could be reached for maintenance without detaching the crankcase.

RESULTS

The new 2-stroke twin engine resulted in minimum change in torque and less vibration.



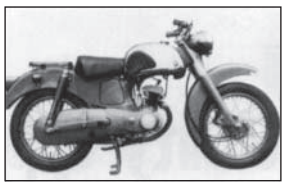


Two cylinders firing alternately

1957

Pressed steel plate frame (Monocoque)

—G-mark awarded design



Yamaha YA-2 (125cc)

SUMMARY

This was an easier-to-produce pressed steel plate monocoque type frame. Today this is in use for a number of Yamaha utility models.

BACKGROUND

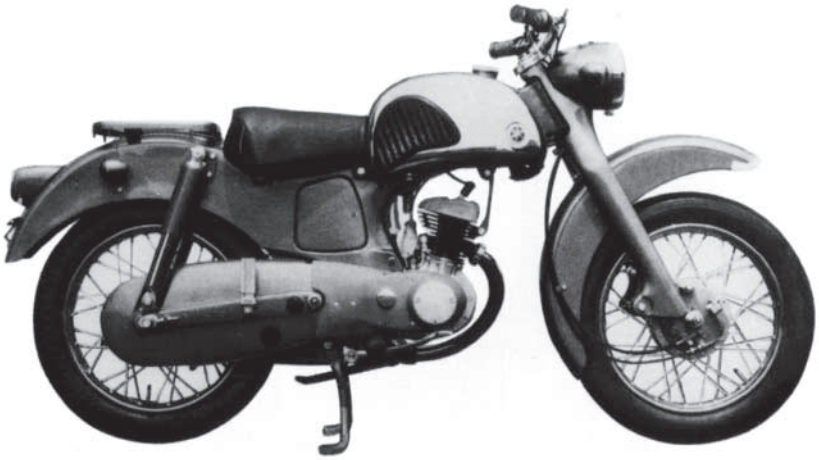
When the YA-2 (125cc) was designed to succeed to the YA-1, the previously used pipe frame was replaced by an easier-to-produce pressed steel plate monocoque frame which was much better suited to mass production.

CONSTRUCTION

Pressed steel parts were made up by combining quality materials of proper thickness and well thought-out shape and structure, resulting in higher frame rigidity as well as greater suitability for mass production.

RESULTS

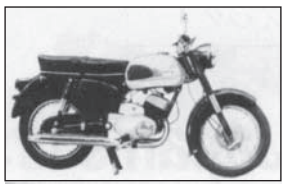
The new monocoque frame allowed for a more attractive frame design. In fact, the YA-2 won Yamaha its first award for design excellence.



G-mark

This is an official award that the Japanese Government grants to the product of excellent design.

Utility type model —Easier maintenance



Yamaha YD-2 (250cc)

SUMMARY

This was Yamaha's first utility type bike that established a new product category separately from a sports bike.

BACKGROUND

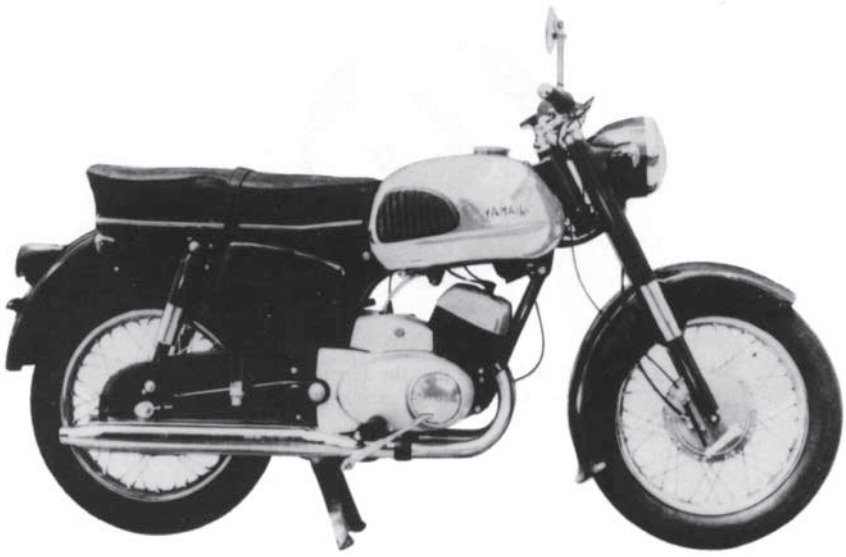
In design, the Yamaha YD-1 (250cc) was 80% sports bike and 20% utility type. When the new YD-2 (250cc) was designed in 1959, it was changed to a completely utility type model in order to avoid a competition with the new sports model YDS-1 (250cc) which was also introduced on the market the same year.

CONSTRUCTION

The YD-2 had a pressed steel semi-diamond type frame which supported the 14.5 hp 2-stroke twin engine with a newly designed electric starter. The engine adopted a 2-cylinder l-carb format for the ease of maintenance; front and rear 16-inch tyres lowered the center of gravity, thus helping to increase the ease of handling and footing. The carburetor and its surrounding area was covered with an attractive streamlined cover.

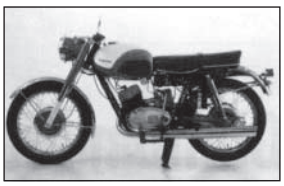
RESULTS

The pressed steel plate frame was better suited to mass production. By giving specific care to the design of chassis components including covers and fenders, the ease of handling and maintenance was greatly increased. The YD-2 and the YDS-1 gave Yamaha two separate and distinctive 250cc models; one for sports use and the other for multi-utility use. In addition, the clutch connected directly to the crankshaft could be interchanged between the two models, resulting in extra ease of maintenance.



Japan's first pure-sports model

—5-speed transmission



Yamaha YDS-1 (250cc)

SUMMARY

The Yamaha YDS-1 (250cc) was designed and built as Japan's first real sports model with a 5-speed transmission.

BACKGROUND

Yamaha developed this model based on its already-proven racer technology in an effort to pave the way for a new motorcycle category—high performance super sports—in the market where multi-utility models were dominant.

CHARACTERISTICS

In addition to the high performance 2-stroke 20 ps/7,500 rpm engine, the YDS-1 employed the following equipment as well:

* 5-speed transmission
* Rigid double cradle frame
* 18-inch wheels
* Cable controlled rear brake
* Highly efficient intake system wherein air cleaner element, carburetor and suction pipe were arranged in a straight line.
* Clutch connected directly to crankshaft
* New breather valve separated from a fuel tank cap
* Friction type steering damper

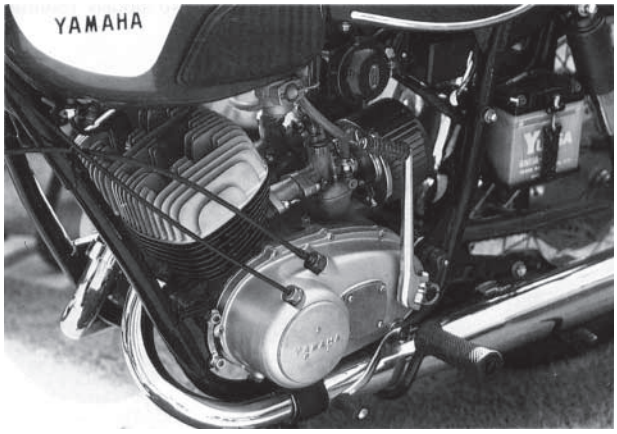
The 5-speed transmission which was suited to this high performance engine, featured the following gear ratios:

lst	2.063
2nd	1.579
3rd	1.273
4th	1.042
5th	0.846

RESULTS

The Yamaha YDS-1 was a true pioneer among Japanese sports bikes, sweeping all of Japan's major races in its day.

Along with the Honda CB72, which appeared on the market about the same time, the YDS-1 played a big part in the true dawning of motorcycle sports in Japan.



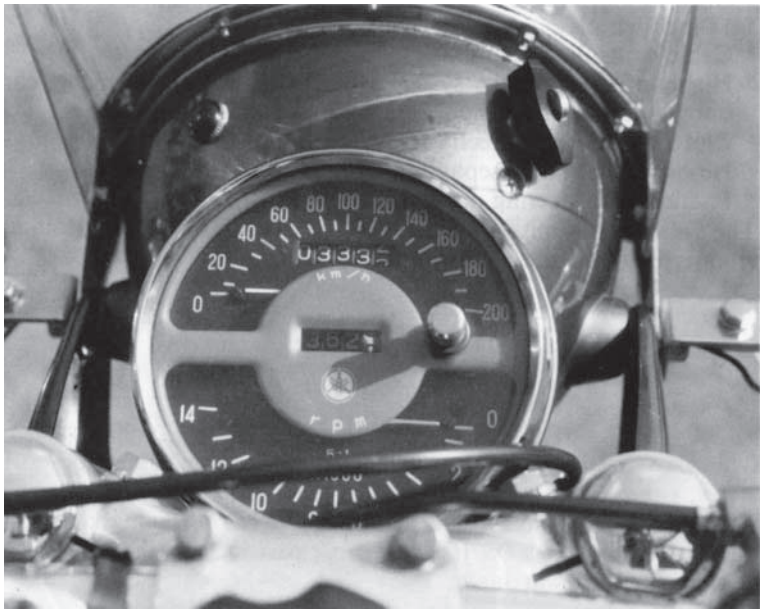
Combination type instrument panel

—A novel instrument panel design

Yamaha YDS-1 (250cc)

SUMMARY

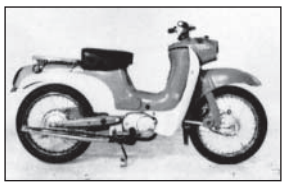
The Yamaha YDS-1 (250cc) had a large-sized circular type instrument panel above the headlamp body. Arranged on the upper part of it was a speedometer with a tachometer on the lower part and resettable tripmeter at the center. This was the first combination type instrument panel ever developed by a Japanese motorcycle manufacturer.



YDS-1's combination type instrument panel

YDS Club meeting

Tank-in-frame design —An innovative styling



Yamaha Moped MF-1 (50cc)

SUMMARY

A fuel tank was built in the end of pressed steel plate monocoque frame.

BACKGROUND

This innovative frame design was developed to give the MF-1 an attractive moped styling quite unlike a conventional motorcycle styling.

RESULTS

The suspension system was also newly designed along with the adoption of this innovative frame. The MF-1 was nice to look at, while it was easy to operate using the electric starter and centrifugal clutch type 3-speed transmission.

New type unit swing rear suspension

—Better shock absorption ettect

Yamaha Moped MF-1 (50cc)

SUMMARY

This suspension system utilized the combination of a coil spring embedded in rubber and a unit swing arm assembly.

BACKGROUND

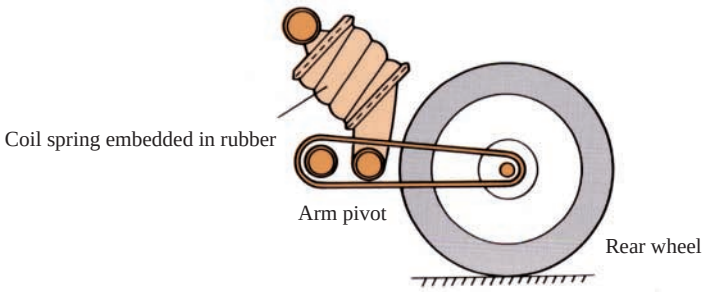
Specific emphasis was given to the utilization of rubber as new shock-absorbing material.

CONSTRUCTION

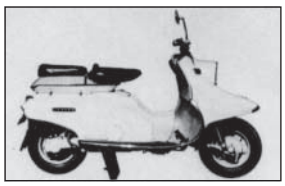
The coil spring was embedded in a cylinder shaped mass of rubber. On impact the rubber absorbed 70 to 75% of the shock, with the remainder being absorbed by the metal spring. This system had the same kind of monoshock construction as the current Monocross suspension system.

RESULTS

The system increased the shock absorption effect, while at the same time giving the MF-1 a refined styling.



Fluid torque converter —Fluid-controlled torque



Yamaha Scooter SC-1 (175cc)

SUMMARY

The automatic 2-speed transmission on the SC-1 (175cc) was a fluid torque converter type.

BACKGROUND

The SC-1 was Yamaha's first scooter model, the engine of which was developed based on that of the YC-1 (175cc), to achieve a new level of drivability as well as the ease of maintenance by employing a fluid torque converter and front and rear cantilever suspension units.

CONSTRUCTION

The fluid torque converter utilized the pressure of fluid to control the torque. This system was combined to the shaft drive and automatic 2-speed (low and high) transmission.

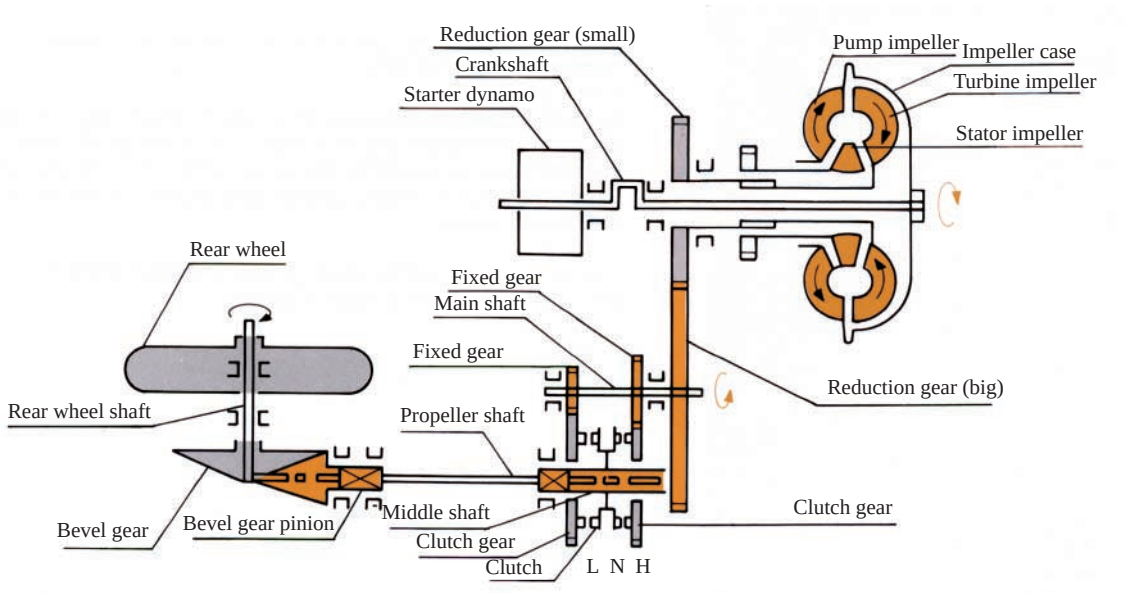
OPERATION

The fluid (oil) which flows from the pump impeller by means of the centrifugal force as the crankshaft rotates, hits and rotates the turbine impeller. The oil which then flows from the turbine impeller, hits the stator impeller and returns to the pump impeller. This action is continuously repeated.

The flowing oil changes its direction when it hits the stator impeller, depending on the rotation ratio of the crankshaft, thus controlling the torque.

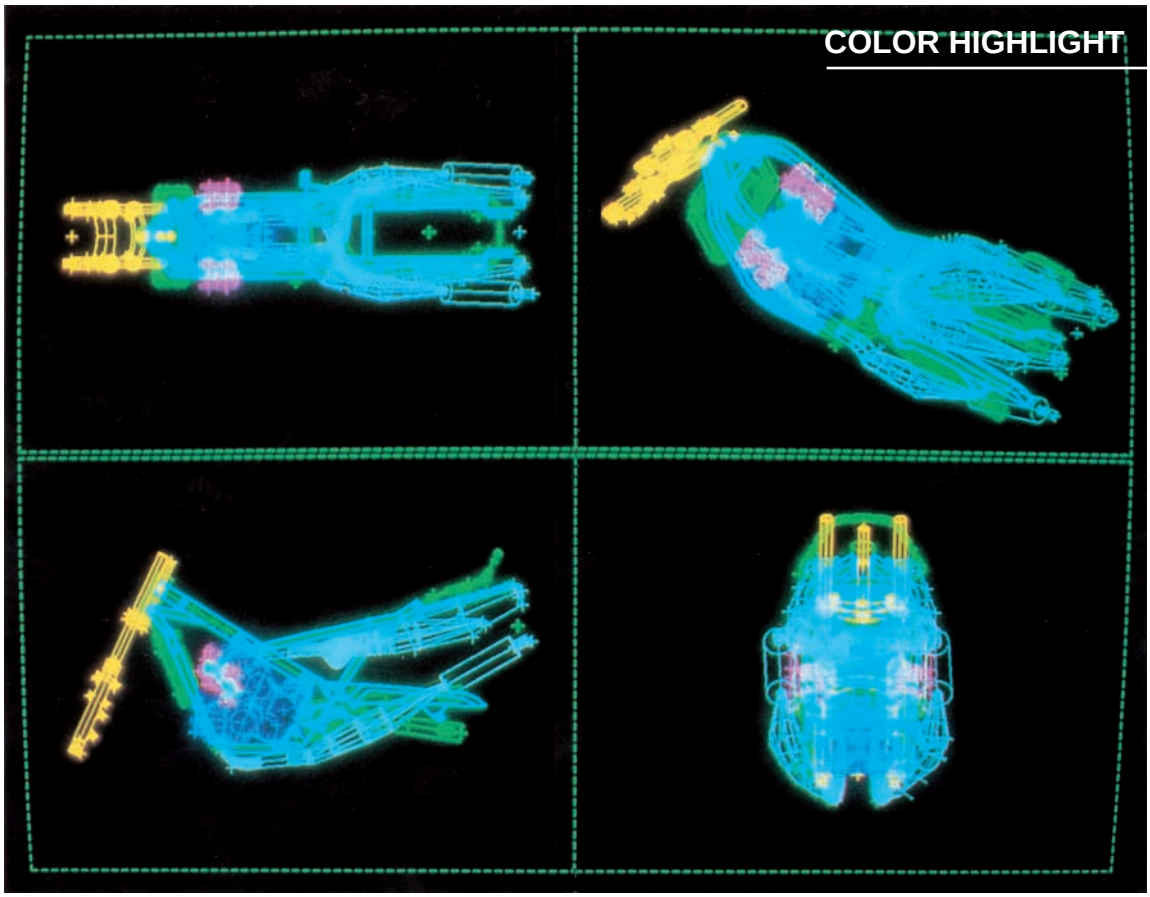
RESULTS

Torque delivery was smoothly controlled so that it became suited to a number of different riding conditions.



1961—1969

REVOLUTIONARY INNOVATIONS IN THE 2-STROKE FIELD



Computer Aided Design (C.A.D.)

Thls is an advanced design method that utilizes the computer system to the fullest extent in order to achieve a new level of perfection in product design.

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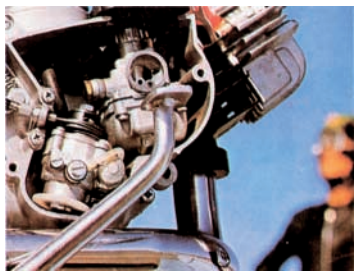

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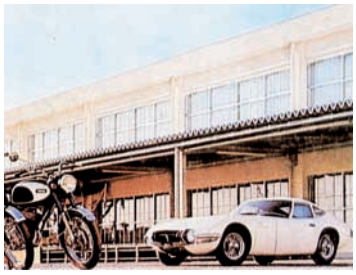


6

7

8

1 The Yamaha TD- 1 production recers swept the ’61 All Japan Championship Road Racing, which caused a big sensation in the road racing world.

2 Yamaha “Autolube” was hailed as a revolutionary 2-stroke breakthrough. 3British star Phil Read earned Yamaha the first championship title in 1964.

4 Chimpanzee taking part in Yamaha Mate commercials.

5 Proven Yamaha technology was adopted even in the Toyota 2000 GT.

6 Jump high in the sky, Yamaha Trail!

7 Popularity-winning Yamaha snowmobile.

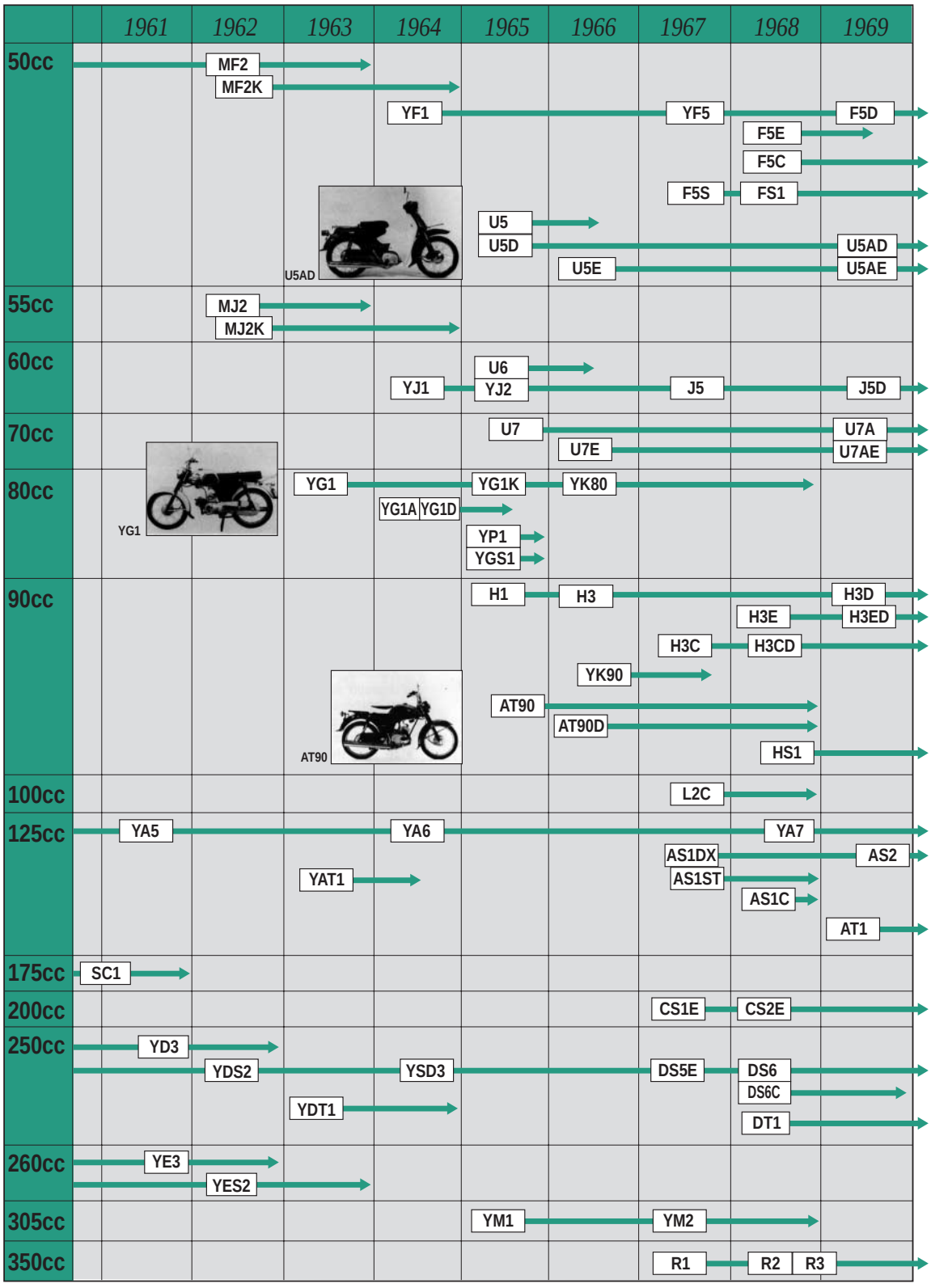
8 Yamaha 50cc licence school started in ’69.

1961 to 1969

Revolutionary innovations in the 2-stroke field

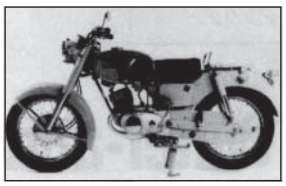
- The tough weeding-out process of weak and small manufacturers was still going on even in the first-sixties with an intensified sales war in the limited market as its setting.
  Yamaha, one of the small number of manufacturers who had got through such a severe competition for survival, began to expand its corporate activities by participating in the world GP racing and developing its unique separate oil injection system “Autolube” during the first-sixties.
- In 1963 the first touring model, the 250cc YTD-1 was marketed and added another dimension to the reputation of Yamaha motorcycle technology. The production of the Yamaha Junior YG-1 (75cc), one of the world’s longest sellers, also started in the same year.
- The separate oil injection system “Autolube” which was adopted in the production model in 1964, was hailed as a revolutionary breakthrough in 2-stroke engine technology.
- In 1964, the third season of participating in the world GP racing, Yamaha won the 250cc world championship title.
- The Mate U50/U50D and the U7 which were introduced in 1965 and 1966 respectively, gave a boost to the moped market.
- To Yamaha engineers the race track was a running experiment laboratory where valuable technical data could be accumulated. In 1968 Yamaha shone in the glory of clinching the 125cc and 250cc world championship titles, while dominating the 125cc race of the Isle of Man TT for the 4th consecutive year.
- In the same year the Yamaha Trail 250 DT-1 was marketed, thus paving the way for off-road motorcycling.
- Also in the same year the Yamaha trail school program started, followed by the Yamaha 50cc licence school program in 1969.
- Snowmobiles and multipurpose engines were newly marketed in 1968 and 1969 respectively.

Yamaha motorcycles in the 60's (Japan)



Rotary disc valve intake system

—A pioneering 2-stroke system



Yamaha YA-5 (125cc)

SUMMARY

Unlike a piston valve system on the 2-stroke engine, where the opening and closing of the intake port depends on the movement of the piston, the rotary disc valve system employs a disc shaped rotary valve to control the intake timing. This system is still used today on high performance racers and a number of small-sized utility models.

BACKGROUND

The Yamaha 125YA-5 became the first production model in the world to feature a rotary disc valve system, which until that time had only been used on factory racers.

OPERATION

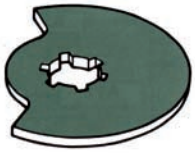
The rotary disc valve system differs from a standard piston valve system in that the intake port is positioned not on the cylinder wall but rather on the crankcase side. A disc plate (rotary valve) which rotates as one part of the crank, opens and closes the passage to the cylinder to control the intake timing. In brief, the rotary valve rotates with the crankshaft, thus opening and closing the intake port; the intake stroke takes place when the cutaway part of the disc passes through the intake port.

In addition, one more transfer port can be provided on the spot that should be occupied by the intake port on a standard piston valve type cylinder. This results in more effective scavenging function.

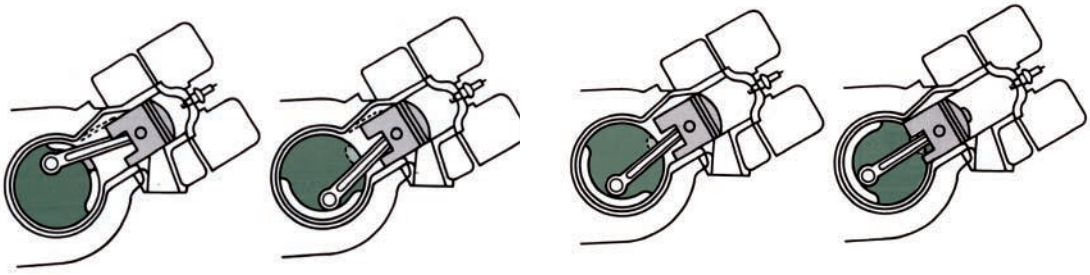
RESULTS

Unlike a piston valve system, where the intake of air-fuel mixture depends directly on the position of the intake port on the cylinder, the rotary disc valve system makes it possible to change the intake timing by changing the cutaway angle of the disc, resulting in a big boost in performance.

In short, the intake port of this system opens sooner than a standard one, thus ensuring a more effective intake action. In addition, the intake port closes more quickly, so that the amount of “blow-back” is decreased and primary compression is improved.



Rotary disc valve



1. Intake (in crankcase) Compression (in cylinder)
2. Explosion (in cylinder) Compression (in crankcase)
3. Exhaust
4. (Exhaust) Scavenging

Water-and-dust resistant drum brake

—Effective labyrinth construction

Yamaha YA-5 (125cc)

SUMMARY

This brake was designed with a labyrinth construction between the hub and the brake plate which caught mud, sand, dust and water from the road. Yamaha obtained a patent for this brake. Even today, this construction is adopted in most drum brakes.

BACKGROUND

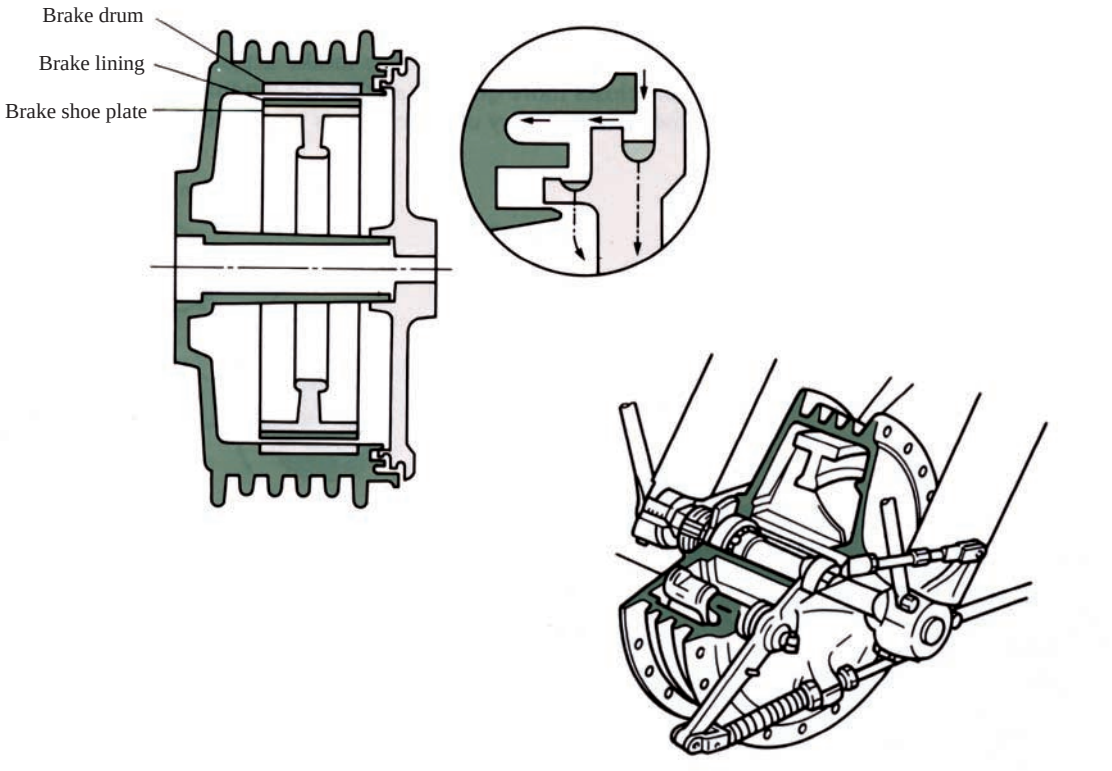
The Yamaha 125YA-5 was the first model to be equipped with this brake of a simple yet highly effective mechanism.

OPERATION

Water on the brake lining or drum surface results in slippage that causes unsure braking. When dust or the like builds up on these surfaces, it causes increased wear of the brake lining and scratching of the drum surface. A labyrinth construction between the hub and the brake plate helps prevent these problems. It catches mud, sand, dust and water from the road before they reach the brake lining and then discharges them out of the brake.

RESULTS

This brake brought added safety, while at the same time contributing greatly to customer trust in the drum brake.



Touring model —Meeting new touring enthusiasm

Yamaha Touring YDT-1 (250cc) & Yamaha Touring YAT-1 (125cc)

SUMMARY

This was a new category of motorcycle developed by Yamaha by combining the tough 2-stroke engine and the rigid double or single cradle type tubular frame.

BACKGROUND

Only motorcycle type models were in rising demand even when a slump in the sales of scooters and mopeds caused the drastic decrease in 2-wheeler manufacturers. This gave an impetus to the introduction of entirely-new categories of motorcycles, especially super sports bikes and production racers due to the growth of motorcycle sports enthusiasm. Yamaha's new touring bikes were developed as a good compromise between the sports model and the utility model.

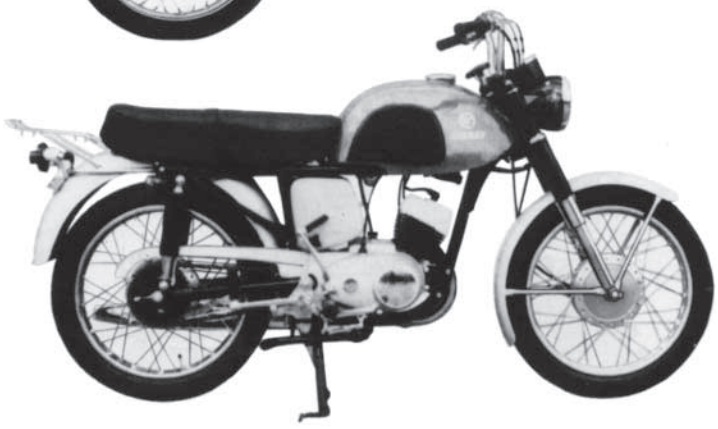
CONSTRUCTION

The Yamaha Touring YDT-1 featured the 2-stroke twin YD-2 engine (250cc), with its reputation for proven toughness and torque characteristics, and the YDS-2 model's double cradle type tubular frame with great rigidity to handle the vibration from the engine as well as other exterior shock.
The Yamaha Touring YAT-1 employed the tuned-up version of the 2-stroke single YA-5 engine (125cc) and the newly developed lightweight single cradle type tubular frame with great longitudinal and lateral rigidity.

RESULTS

Filling a gap between the sports model and the utility model, these touring bikes created a new market by setting spurs to new touring enthusiasm which began to grow among active motorcyclists in Japan.

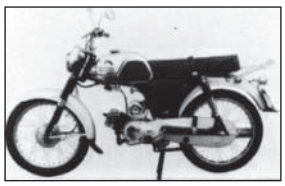
YDT-l



YAT-l

Ball lock type transmission

—Beginner-oriented shift mechanism



Yamaha YG-1 (75cc)

SUMMARY

Unlike a conventional dog clutch type where dog-tooth shaped teeth on the side of the gear are engaged and disengaged to transmit and interrupt the power to the gear, the ball lock type uses steel balls as a gear shift mechanism.

BACKGROUND

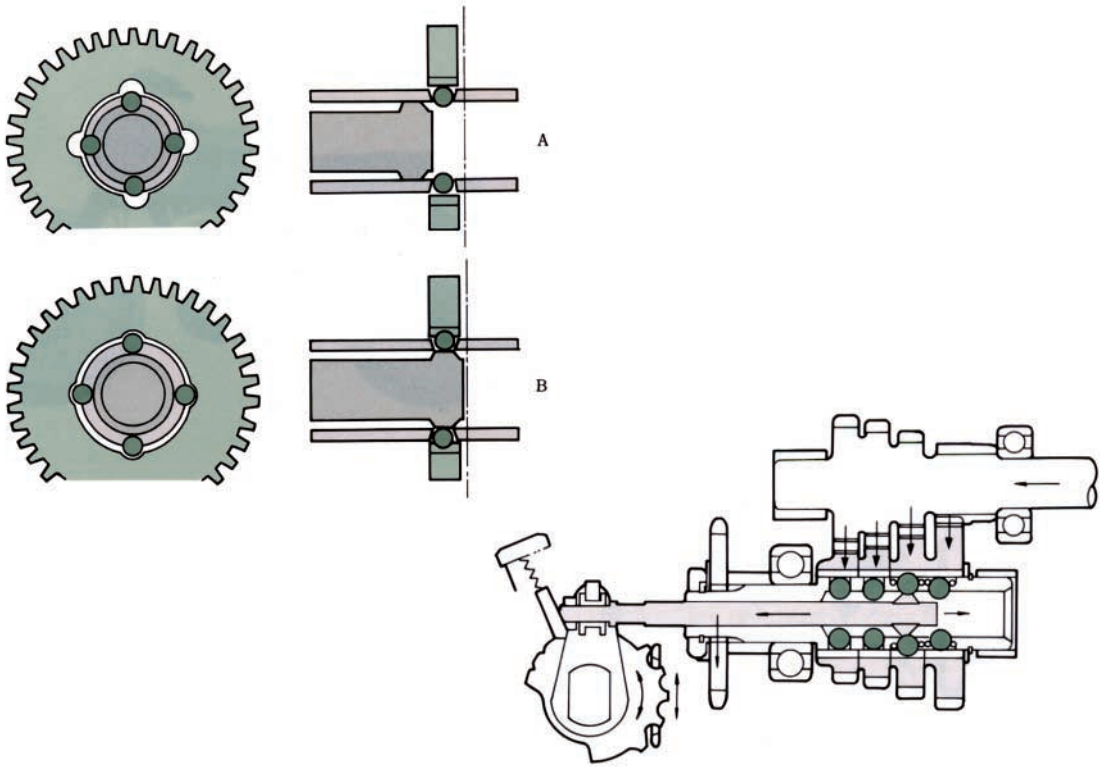
The ball lock type transmission was first adopted on the Yamaha 80YG-1 (75cc), one of Yamaha's long-time best sellers. This was another good example of Yamaha's never-ending creative challenge.

CONSTRUCTION

The drive axle has a through-hole from end to end, in which the shifter rod reciprocates in the axial direction when the change pedal is pushed down. In addition, it has holes in the outer surface and steel balls are kept in these holes by means of ball springs. Each wheel gear has grooves for accepting these balls. The shifter rod forces out these balls into the wheel gear grooves, thus locking the gear and drive axle together.

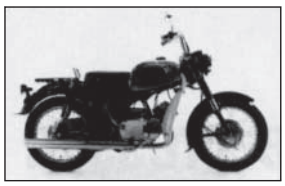
OPERATION

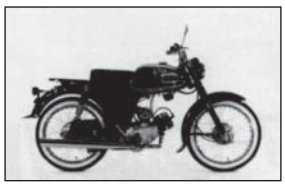
As shown in diagram A, steel balls are kept in the outer holes of the drive axle by ball springs (used mainly for the sake of quiet operation). These springs hold the steel balls in their original positions, thus allowing the wheel gear to run idle, when the shifter rod stays at the position, as shown in the diagram. The shifter rod pushes out these balls into the wheel gear grooves as shown in diagram B when it moves to the position as shown in the diagram. This locks the gear and drive axle together. By moving the shifter rod in the axial direction, any shift up or down operation can be completed easily and smoothly.



Autolube

—Revolutionary 2-stroke engine technology





Yamaha YA-6 (125cc) & Yamaha YG-1D (80cc)

SUMMARY

This was introduced as the world's first separate lubrication system for 2-stroke engines which had formerly depended on a mixture of gasoline and oil premixed in the prescribed ratio. Autolube is a revolutionary system that uses both the engine's speed and throttle opening in the carburetor to control the amount of lubricating oil sent to the engine, so that the engine receives the right amount of lubrication for any condition. Today, this system is adopted in all the 2-stroke bikes of Yamaha, with the exception of competition models.

BACKGROUND

In the pre-Autolube days the 2-stroke engine used a mixture of gasoline and oil premixed in the ratio of 20 to 1. This ratio was given based on the amount of oil required by the engine under its heaviest load. As a result, when the engine's load was descreased, some amount of oil was inevitably wasted, while at the same time the atmosphere was more polluted by exhaust emissions.

Autolube, which was developed from Yamaha's GP racer technology, was first adopted in the Yamaha YA-6 (125cc) and YG-lD (80cc). This proved to be a success and the system was later used in one after another of Yamaha's main 2-stroke models.

OPERATION

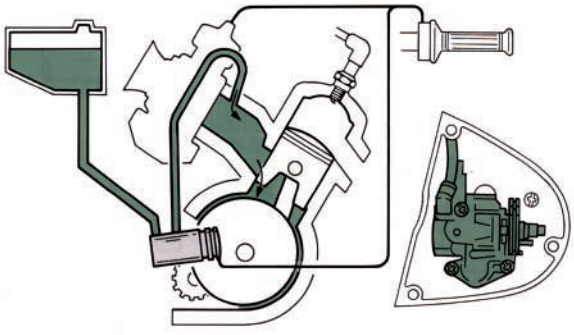
Autolube is a kind of oil pump. As the engine's speed increases, the pump also works faster, sending more oil to the engine. On occasions such as acceleration and going uphill when the throttle is wide open, the amount of oil delivered by each revolution of the pump increases. On the contrary, when the throttle is closed for going downhill, the amount of oil supplied decreases even with the engine running at high speeds. Thus the amount of lubrication is automatically controlled by the above two factors, to meet many different riding conditions.

The oil is injected into the intake manifold on the cylinder side and the cylinder's intake port, where it is atomized to mix with the air/fuel mixture as it enters the crankcase, thus lubricating the necessary parts before proceeding to the combustion and exhaust stages.

In this system, the amount of oil reaching the engine is controlled by both the engine's speed and throttle opening in the carburetor, resulting in actual variations in the mixing ratio. For example, in the case of a 125cc bike, the mixing ratio ranges from 120:1 at idling to 18:1 in the high speed range.

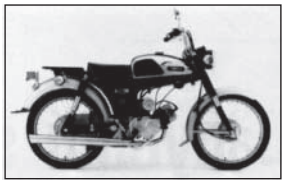
RESULTS

Under normal riding conditions the engine always has the right amount of lubrication, which lowers oil consumption, makes for cleaner exhaust and reduces carbon accumulation.



1966

7-bone type pressed steel plate frame —Increased strength & superior design



Yamaha 90H3

SUMMARY

Because it looked like “7” , this type of frame was referred to as the “7-bone” frame.

BACKGROUND

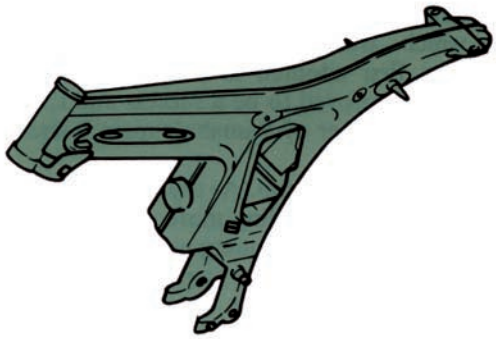
In Japan in 1967, most motorcycle frames were being made by the pressed steel processing method. In spite of this fact, the pressed steel frame on the Yamaha 90H3 was an exceptional one for the time from the points of shape and rigidity.

CONSTRUCTION

This frame comes under the category of backbone type frames, consisting of one thick main beam like a backbone from which the engine is hung.
This type of frame is distinctive in the fact that the rear fender is a detachable unit, and with the exception of the engine mount, everything is welded together.

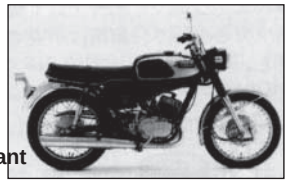
RESULTS

This type of frame resulted in greater overall rigidity, while creating a new motorcycle styling.



1967

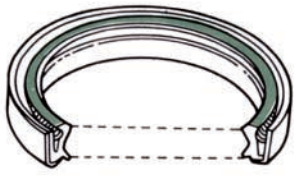
Teflon coated oil seal —Heat-and-friction resistant



Yamaha Sports 350R1

SUMMARY

This is an oil seal that uses a lip of teflon, a substance with an extremely low coefficient of friction. As well as being very strong against both friction and heat, teflon is also not susceptible to damage by chemicals such as gasoline and oil.



Labyrinth seal —More airtight crankcase

Yamaha Sports 350R1

SUMMARY

This is a kind of mechanical seal for a multi-cylinder engine. It can be used semi-permanently because it does not come in contact with the crankshaft, while at the same time the sealing effect is greatly increased due to its advanced design.

BACKGROUND

Previous 2-cylinder engines employed a center seal made of rubber that was in actual contact with the crankshaft in an attempt to make the crankcase airtight. However, wear caused by the revolution of the crankshaft and heat-induced changes in the rubber seal would often lead to leaking of air and this in turn would cause performance problems such as one-cylinder firing. To replace the rubber seal, an aluminum-alloy center seal of labyrinth design was developed. The use of it began with the Yamaha Sports 350R1 (350cc), the largest 2-stroke twin model released in 1967.

CONSTRUCTION

This seal adopts a very practical labyrinth design utilizing hydrodynamics to keep the crankcase airtight. In addition, there is a 0.1mm gap between the seal and the crankshaft. This means there is almost no wear to either one.

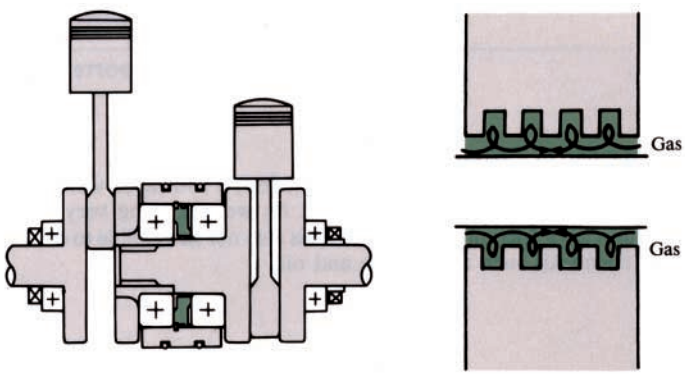
OPERATION

In a 2-stroke engine the primary compression occurs in the crankcase, which means that it must be airtight. In the case of a 2-cylinder engine, the center seal between the right and left parts of the crankcase performs an important function.

Utilizing a hydrodynamic principle that a fluid moving from a small chamber to a large one undergoes a sudden decrease in pressure, a labyrinth making the fluid alternate expansion and contraction is designed into a seal that depressurizes the air passing between the right and left parts of the crankcase, thereby keeping the whole crankcase virtually airtight.

Here is how the seal works:

As gas is pressurized in the right part of the crankcase by the downward motion of the piston, it tries to escape into the left part of the crankcase through the seal. By the time the gas reaches the center portion of the labyrinth, however, it has become depressurized and at this moment gas is already entering the seal from the left part of the crankcase as the piston on the left side begins its downward motion. The gas from the left also becomes depressurized by the time it reaches the center of the seal, so that the result is depressurized gas from both sides meeting in the middle and cancelling each other out.



RESULTS

A better seal with almost no fear of wear.

Shift jump preventive device —Positive shift operation

Yamaha Sports 350R1

SUMMARY

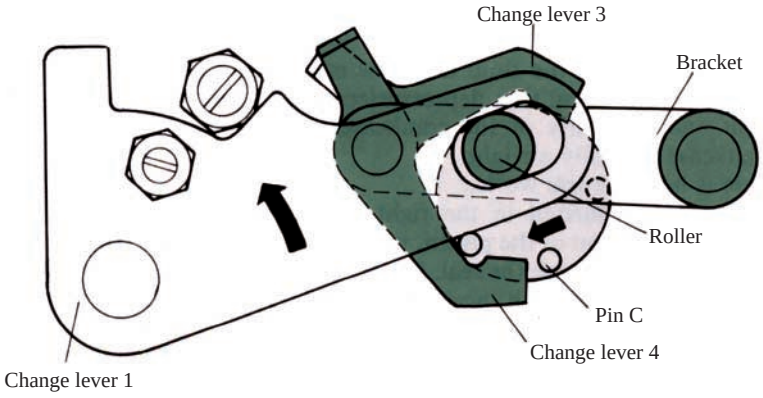
This is a mechanism included in the transmission to prevent the gears from jumping and to make them shift positively in proper sequence.

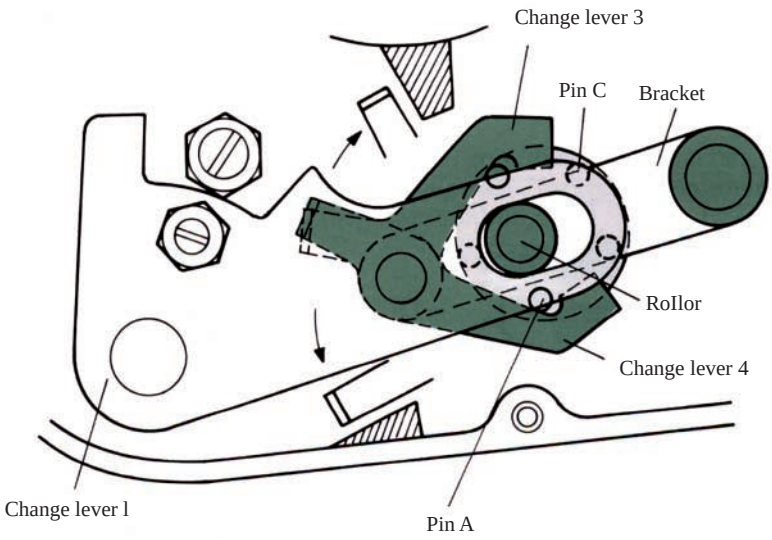
BACKGROUND

When a shift operation is too hard, the gears do not mesh correctly, resulting in slip or jump troubles. This prevents power from being transmitted to the drive train. The above device was developed along with the adoption of a constant-mesh return type five-speed transmission for the Yamaha Sports 350R1 to ensure positive shift operations.

OPERATION

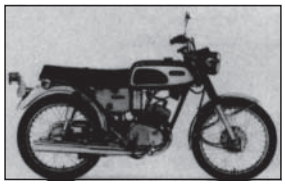
The cause of shift jumping lies in the excessive turning of the shift cam so therefore this trouble can be prevented by controlling the movement of the shift cam. In this device, when the gear is shifted up 1 the change lever 1 moves upward, 2 the roller moves upward by means of the bracket, 3 change lever 4 turns the shift cam through pin A, and 4 so when pin C begins to move excessively for any reason, the change lever 4 acts as a stopper.





5-port piston valve engine

—Better scavenging & cleaner combustion



Yamaha 125AS1-DX

SUMMARY

This engine featured two auxiliary transfer ports in addition to the conventional three ports, so that the scavenging effect could be increased.

BACKGROUND

Better scavenging effect in a 2-stroke engine meant more power output and better fuel economy, as well as preventing overheating. That is why this Yamaha-original system was developed by the technical staff.

CONSTRUCTION

A conventional 3-port system used three different kinds of functioning ports, that is, one intake port, two transfer ports and one exhaust port. In this system some amount of burnt gas was often left near the center of the combustion chamber.

In the new 5-port system the redesigned engine had two auxiliary transfer ports positioned on the right and left behind the main transfer port and at a slight angle to it. Thus the 5-port system features one intake port, one exhaust port, one main transfer port and two auxiliary transfer ports.

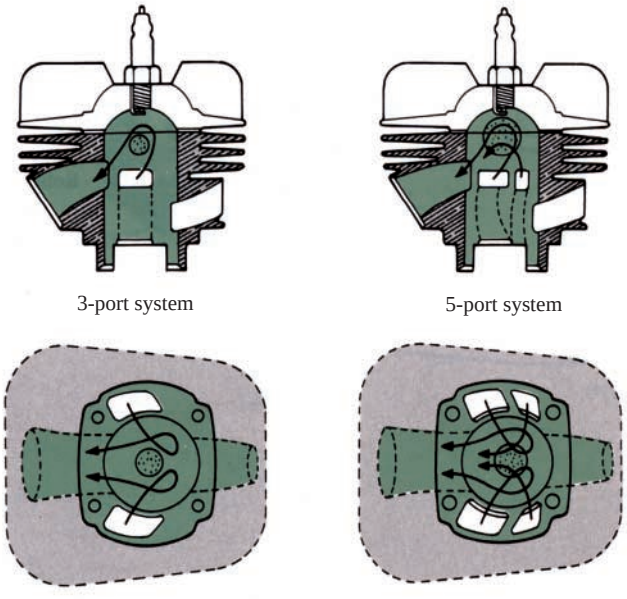
OPERATION

In the 5-port system the fresh gas incoming through the auxiliary transfer ports can almost completely sweep away the leftover gas when it passes through the center of the combustion chamber.

This means virtually no burnt gas mixes with the fresh gas, thus avoiding the problem of the mixture becoming too lean which would result in imperfect combustion.

RESULTS

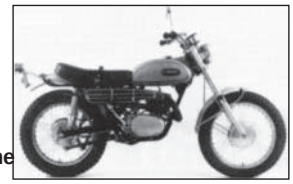
The fact that the increased amount of cool, fresh gas is entering the chamber, means an improved cooling effect for the engine, while at the same time increasing the power output.



3-port system

5-port system

Pure-bred trail model —250cc single-cylinder engine



Yamaha Trail 250DT1

SUMMARY

This model was truly a pure-bred trail bike in both design and performance.

BACKGROUND

Looking at a small number of riders who were enjoying off-road riding in unsettled areas of the American West, Yamaha saw an entirely new future in motorcycling, and through repeated trial and error, set about to develop the first true “trail” model. The Yamaha Trail 250DT1 threw out the concept that the motorcycle was a vehicle to be ridden on paved roads, and introduced people all over the world to the joys of off-road riding.

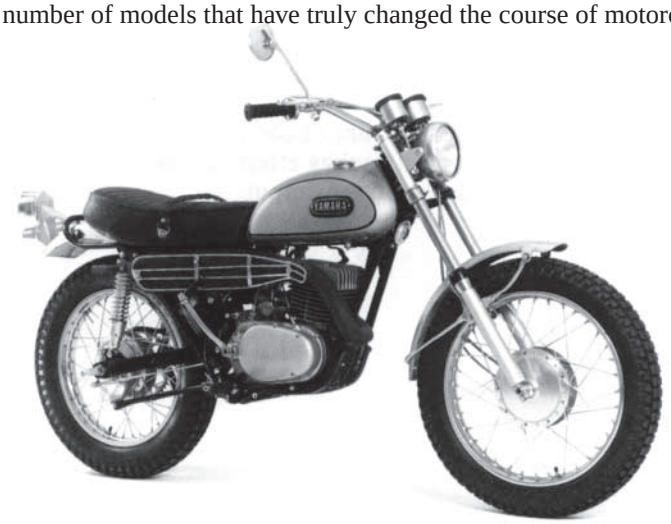
CONSTRUCTION

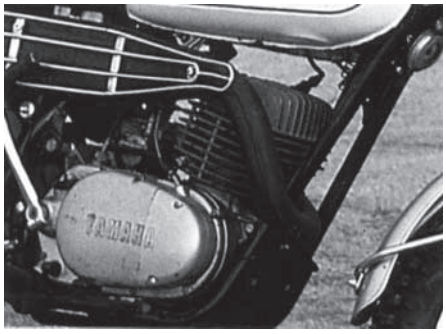
Main features included a 2-stroke 250cc single cylinder engine, a lightweight, high-tensile double cradle type frame that used special steel tubing, an engine guard, a large cushion stroke Ceriani type front fork, wide handlebars and large block pattern tires. The DT1 was unsurpassed in off-road performance with a new and distinctive styling.

A 2-stroke 250cc single cylinder engine was chosen as the most suitable for riding on bumpy surfaces, because of its flat torque characteristics and high power output in the low speed range. In addition, the crankcase was designed to be as slim as possible to ensure easy riding on narrow forest paths, and it was fitted with an engine guard underneath to protect against damage from rocks and other obstacles.

RESULTS

This model became the pioneer for a whole new category of product—dual purpose bike. It is one of a small number of models that have truly changed the course of motorcycle history.





Ceriani type front fork —Increased cushion stroke for off-road riding

Yamaha Trail 250DT1

SUMMARY

Although today it is one of the common telescopic forks, this particular fork was first designed by the Ceriani Company of Italy. Ensuring a large cushion stroke and excellent rigidity, it is in use on most trail bikes and sports bikes.

BACKGROUND

On paved city streets or rough backroads, the right amount of cushioning is important for giving a motorcycle its special charm. Especially in off-road conditions it is not too much to say that the right amount of front and rear cushioning is the most crucial factor in a motorcycle's performance.

CONSTRUCTION

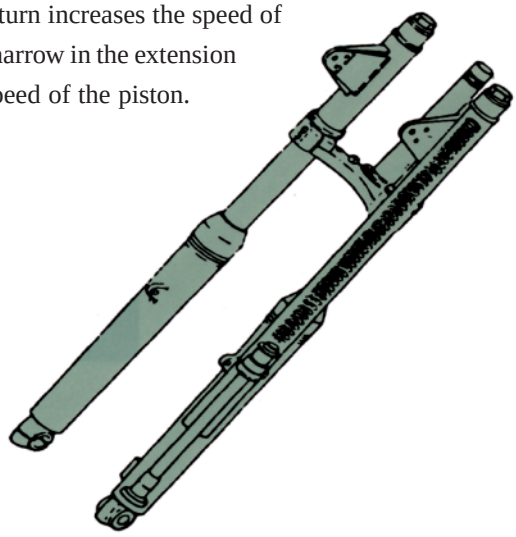
The piston slide type telescopic oleo-fork consists of an inner tube which slides in an outer tube and coil spring, thus alternating extension and compression. An oil damper is also incorporated in the fork. In this type of fork the piston and slide metal move up and down in the outer tube over a relatively small surface area resulting in increased surface pressure. The Ceriani type front fork incorporates a coil spring in its inner tube. In this type the outer tube and inner tube which slide together are in actual contact over a large surface area, thus ensuring excellent rigidity due to decreased surface pressure and giving a long, soft range of stroke assisted by an oil damper positioned as an independent unit in the inner tube.

OPERATION

The fork utilizes the tension of a coil spring and fluid resistance of oil so that shocks and vibrations are effectively softened or absorbed. A coil spring alone cannot absorb or soften the shock easily and quickly when the fork hits a bump.

An oil damper helps to cancel the shock or vibration instantly by making use of the fluid resistance of oil, resulting in increased comfort of riding. It functions as follows:

The piston with an oil passage moves up and down in a completely sealed tube, letting the oil come in and out through the orifice. The fluid resistance of oil then works to change the speed of the moving piston so that damping effect is obtained, that is, the passage becomes wide in the compression stroke, thus reducing the fluid resistance of oil, which in turn increases the speed of the moving piston. On the contrary, the passage becomes narrow in the extension stroke and increased fluid resistance of oil reduces the speed of the piston. This damps out spring oscillations.



RESULTS

1. Extra-long cushion stroke 2. Increased rigidity
3. Better response to changes in load
4. Increased amount of oil; less change in oil quality by heat (change in viscosity, etc.)

Trail pattern tire —Superior roadgripping

Yamaha Trail 250DT1

SUMMARY

Newly designed tires on the Yamaha Trail 250DT1 featured a unique tread pattern with a number of knob-shaped blocks.

BACKGROUND

Even earlier than the introduction of the DT1 Yamaha had developed several off-road models such as the AS1C, DS5C and R1C by taking the AS1 (125cc), DS5 (250cc) and Rl (350cc) as base models and improving their versatility by raising the muffler and putting block pattern tires on both the front and rear. In terms of engine, frame, suspension and tires, however, these models could not be expected to give really satisfying performance while ridden off the road. A new block pattern tire was therefore developed for exclusive use on the DTl. It was called the “trail pattern” tire.

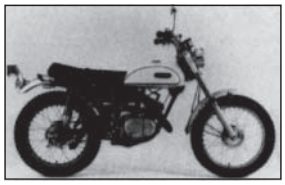
CONSTRUCTION

The new trail pattern tire had a number of independent blocks so that the cord could be given maximum protection and tread versatility could be increased, resulting in stable handling on rough surfaces.

RESULTS

The new tire proved to have excellent roadgrip performance on all kinds of rough surfaces from mud to rock and sand. Especially, the front 19-inch wheel could clear even a large obstacle easily, thus making off-foad riding more comfortable.

5-step adjustable rear shock absorber —Easily adjustable cushion hardness



Yamaha Trail 125AT1

SUMMARY

Cushion hardness was adjusted to suit the rider's body weight or preference by changing the length of the spring setting (pre-load).

BACKGROUND

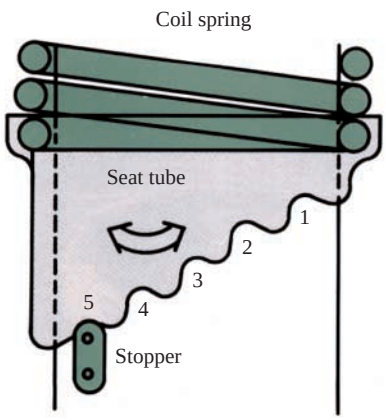
The 125AT1, which was introduced soon after the DT1 , had a 5-step adjustable rear shock absorber on its swing arm for the first time, thus allowing easy adjustment of cushion hardness.

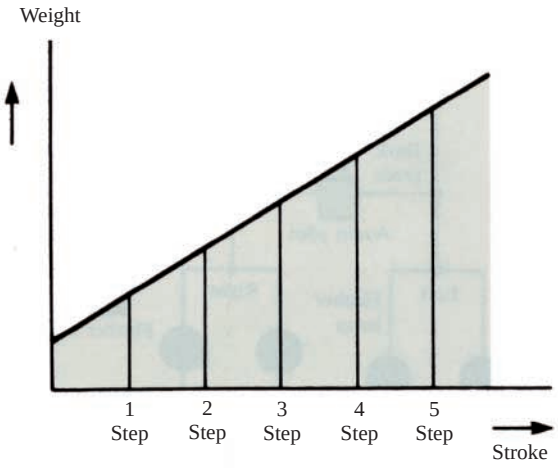
CONSTRUCTION

As illustrated, the length of spring setting could be adjusted by setting the movable seat tube in the stopper in five different steps. For example, cushion hardness reached its maximum in step 5. On the contrary, the softest cushion was obtained in step 1. Depending on the model, one could choose between a 5-step, 3-step or no-step cushion.

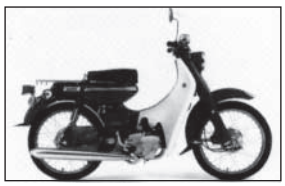
RESULTS

Rear cushion hardness could be changed to fit the rider's body weight or preference, as well as a change in carried load such as an additional passenger or luggage, so that the comfort of riding was increased.





Audio pilot —Sure turning-off of a flasher



Yamaha Mate U5AD (50cc)

SUMMARY

This was a new device which produced a light clicking sound when the flasher was in use, so that the rider would not forget to turn it off after use.

BACKGROUND

In 1969 Yamaha added the U5AD to its underbone type "U" series which already enjoyed wide popularity as utility vehicles for wide commercial use as well as family use. A thoughtful addition to this model was an "audio pilot".

CONSTRUCTION

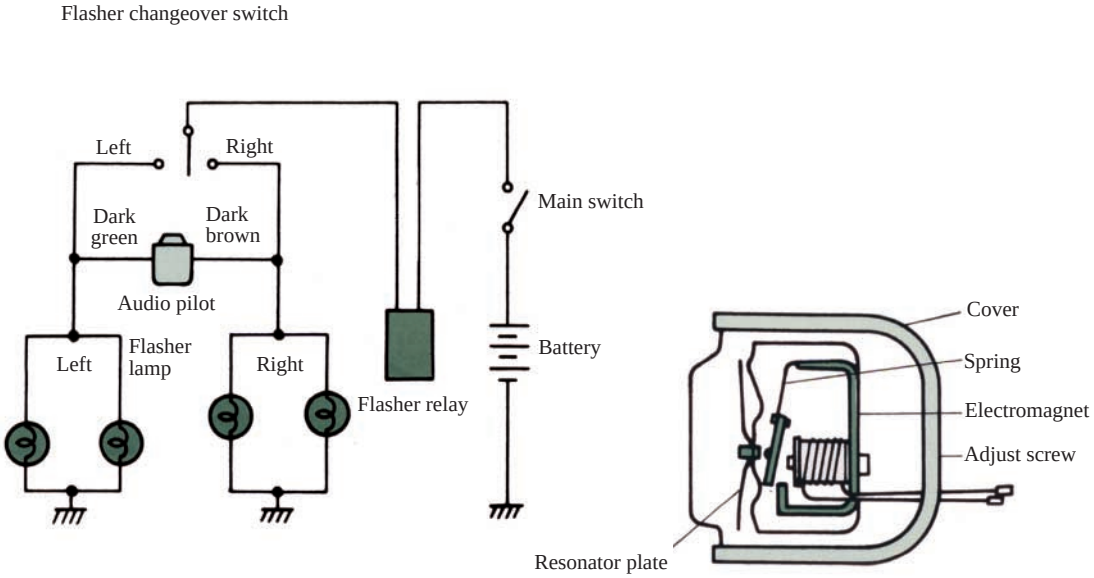
The audio pilot consisted of a resonator plate and electromagnet that worked in conjunction with an armature and spring. The current from the flasher relay operated the electromagnet, which attracted the armature. When the current went off, the spring recoil caused the armature to strike the resonator plate and produce a clicking sound which told the rider that the flasher was still on.

OPERATION

When the main switch was on and the flasher was switched on, an electric current passing through the flasher relay created the repeating on-and-off flasher action. This same on-and-off current from the flasher relay that lighted the flasher lamp also operated the audio pilot at the same time.

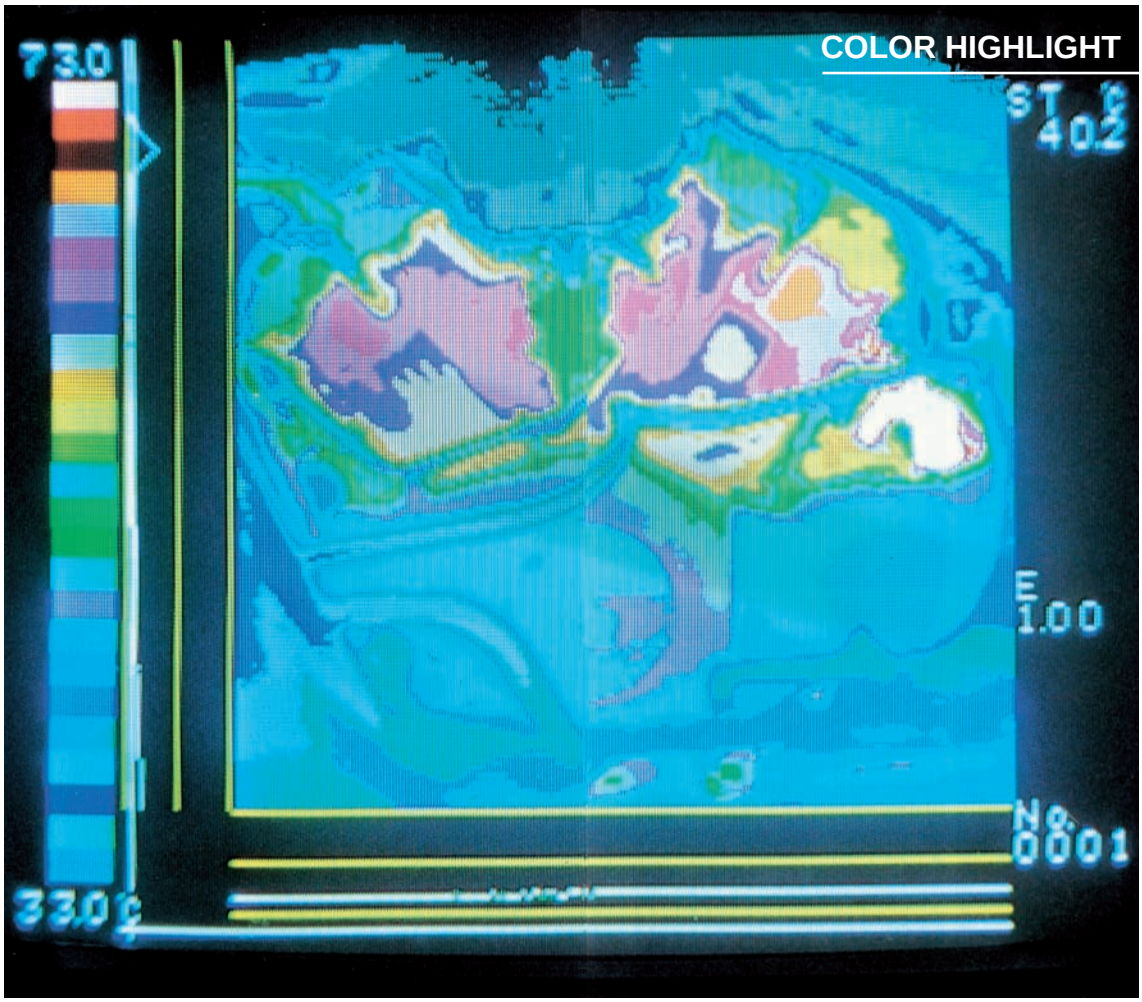
RESULTS

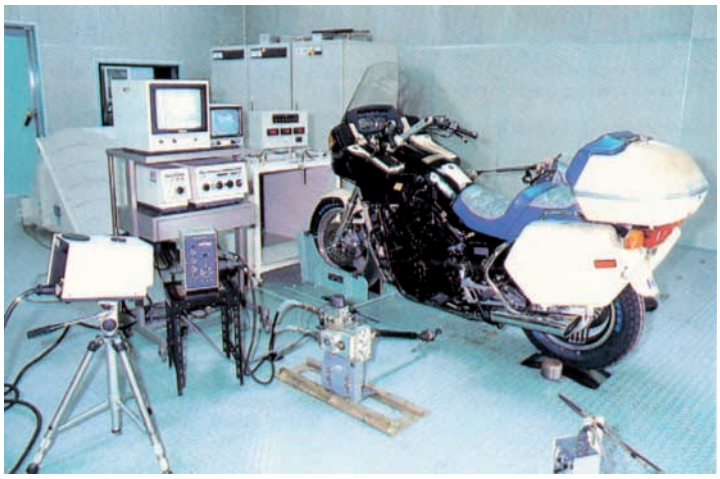
The audio pilot prevented the rider from forgetting to turn the flasher off after use, which could otherwise annoy other vehicles or pedestrians, especially while riding through urban traffic. This also increased the safety of riding.



1970—1974

BUILDING A QUALITY 2 & 4-STROKE LINE-UP





Engine heat distribution test

This test shows which components of the working engine are exposed to intense heat, and also provides general data on cooling efficiency.

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1 Yamaha's first 4-stroke model, the 650XS1.

2 The Yamaha GL750 was displayed as an exhibition model during the '71 Tokyo Motor Show.

3 The 2-stroke 7-port "Torque Induction" engine.

4 YGSF (Yamaha Grand Sports Festival) took place at FISCO in 1972 and 1973.

5 The Yamaha Trial TY250J was marketed in 1973.

6 Sensational Yamaha Monocross suspension system.

7 Many-time world champion Giacomo Agostini at the Yamaha Course (third from the left).

1970 to 1974

Building a quality 2 & 4-stroke line-up

- In the early-seventies Yamaha began to concentrate greater efforts on strengthening the line-up of motorcycles by introducing new models one after another while continuing extensive demand-creating activities both in Japan and overseas. These new models which featured Yamaha's advanced motorcycle technology, included the brand-new 4-stroke models, as well as the newly developed production motocrossers and trials models in the 2-stroke field.

- In 1970 Yamaha's first 4-stroke model, the 650XS1 was launched on the market, thus making a good start in building a quality 2 & 4-stroke line-up with the backing of the increased production capacity of the Iwata factory.

- In 1972 the head office of Yamaha Motor moved from Hamakita to Iwata.

- 1973 saw the introduction of the automatic Mate Series, new production motocrosser and trials machines, etc. to cater to diversified customer needs.

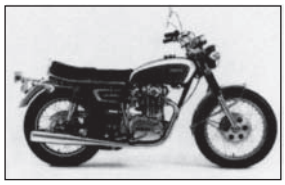
- In the same year Yamaha portable generators and racing karts were also marketed.

- It was also in 1973 that the Yamaha Technical Center was authorized as Japan's first motorcycle school.

- In 1974 Yamaha monopolized the 125cc, 250cc, 350cc and 500cc road racing world championship titles.

Yamaha's first 4-stroke engine

—650cc, SOHC twin



Yamaha Sports 650XS1

BACKGROUND

Yamaha, which had already become the world's largest manufacturer of 2stroke motorcycles, launched its first 4-stroke model, the 650cc SOHC twin 650XS1 on the market.

The same 2-stroke system that offered so many advantages in the field of small capacity engines, ran into some problems, including those of fuel efficiency and exhaust emissions, when applied to a large capacity engine. Along with its 2-stroke engine technology, Yamaha also had many years of experience with 4-stroke engine technology. Through its relationship with Toyota Motor, Yamaha technology had already been included in such trend-setting mass-production models as the 2000GT and the Toyota 7, featuring DOHC engines.

CONSTRUCTION

The Yamaha Sports 650XS1 was the first motorcycle of its class in the world to use an OHC twin engine format. It featured two Solex type carburetors, and a 5-speed transmission with a wet multi-plate clutch. Other features included a trochoid-pump-operated wet sump lubrication system. All these components were built into one body in this extremely compact aluminum engine. This was the first fruit of Yamaha's efforts to build a slim, easy-to-handle big bike.

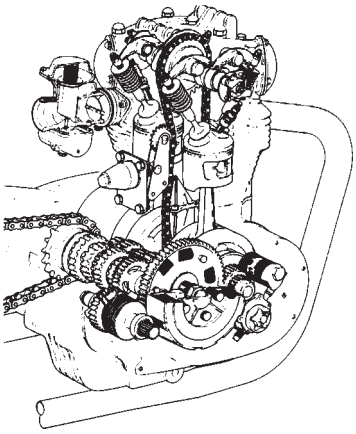
This system is also referred to sometimes as SOHC, meanmg single overhead cam shaft.

OPERATION

The OHC engine has an intake valve and an exhaust valve per cylinderhead. These valves, which are positioned above the piston, move up and down by means of a rocker arm or lifter, thus opening and closing the intake port and the exhaust port. This operation is featured by the OHV engine as well but in the OHC engine the rocker arm or lifter is driven directly from the camshaft in the cylinderhead which is driven via cam chain from the crankshaft. This has decreased the distance between the valves and their drive system, as well as the reciprocating mass, resulting in positive valve operation even in the high speed range. The direct-push type OHC has no rocker arm.

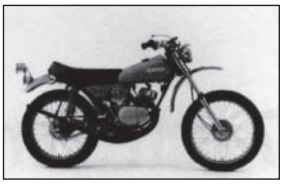
RESULTS

The Yamaha Sports 650XS1 proved to be a very successful approach to the 4-stroke field, and it was followed by a number of quality models.



Reed valve intake mechanism

—Controlling the intake amount and timing



Yamaha Trail HT90

SUMMARY

This was developed as a new kind of intake mechanism for the 2-stroke engine. In this mechanism the reed valve opened and closed automatically with changes in pressure in the crankcase, so that the intake timing and amount of air/fuel mixture was effectively controlled.

BACKGROUND

Effective intake control is a crucial factor in both the performance and fuel economy of the 2-stroke engine. Following the introduction of the rotary valve intake mechanism, Yamaha developed this reed valve intake mechanism.

CONSTRUCTION

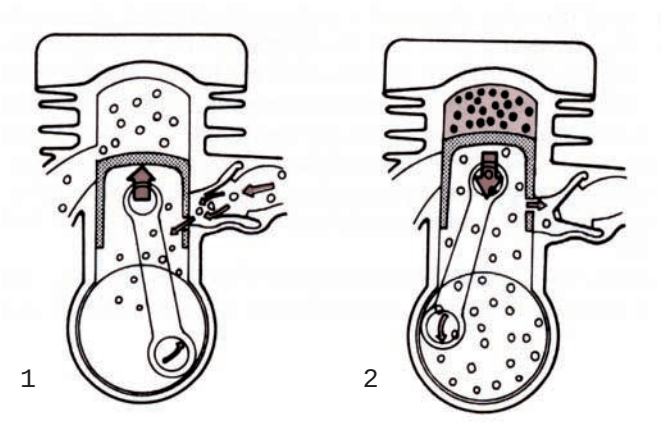
The reed valve intake mechanism is made of synthetic rubber over an aluminum frame which is shaped like a harmonica with thin vibrator valves. This mechanism is incorporated in the intake manifold. The reed valve opens and closes automatically with changes in pressure in the crankcase, and also intake inertia.

OPERATION

As shown in diagram 1, when the upward motion of the piston creates negative pressure in the crankcase, the reed valve opens allowing air/fuel mixture into the crankcase.
As shown in diagram 2, the downward motion of the piston creates a pressurized state in the crankcase and the reed valve then closes automatically.

RESULTS

This mechanism prevented “blow-back” which could take place especially in the low speed range, while at the same time ensuring the smooth intake of air/fuel mixture over the entire speed range by keeping the intake amount just enough for actual engine needs.



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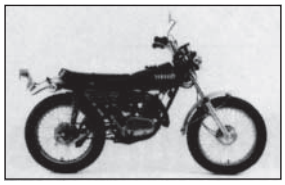
7-port engine "Torque Induction"



—Increased scavenging effect

Yamaha Trail 175CT2

SUMMARY

This was developed as a new type of scavenging system for the 2-stroke engine. The system featured the reed valve intake mechanism and the newly designed intake port with a cutaway on its upper part to provide one more transfer passage . This cutaway passage which was added to a conventional 5-port scavenging system (6 ports including the intake port) was called the "7th" port.

BACKGROUND

The Yamaha Trail 175CT2 and the new DT250 and RT360 that were introduced soon after it, all used this system so that the scavenging effect was increased, resulting in more power output.

CONSTRUCTION

The scavenging function was performed by one intake port, one exhaust port, two main transfer ports, two auxiliary transfer ports and the above "7th" port. During scavenging, when the intake port closed, fresh air/fuel rnixture which had been compressed in the "7th" port, passed directly into the cylinder.

OPERATION

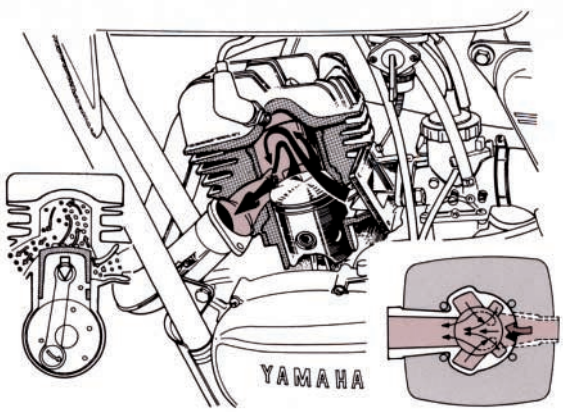
The reed valve is a mechanism which closes when the downward motion of the piston creates a pressurized state of air/fuel mixture in the crankcase, and opens when the upward motion of the piston produces negative pressure in the crankcase.

As illustrated, when the piston moves downward opening the exhaust port and the main and auxiliary transfer ports (5-port system), air/fuel mixture from the pressurized crankcase is sent into the cylinder. The 7th port, as it sucks away the burnt gases, also opens to allow air/fuel mixture from the valve chamber to rush into the cylinder, helping to scavenge the cylinder.

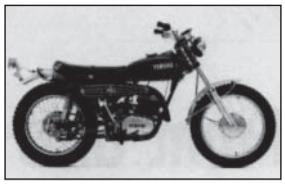
In addition, the inertia of the air/fuel mixture entering the engine and the inertia of part of the exhaust gas open the reed valve, thus allowing the burnt gases to be discharged by the 7th port, so that the scavenging effect is increased overall.

RESULTS

The scavenging effect was improved over the entire speed range, which in turn increased the power output.



Manual decompressor —Easier kick-starting



Yamaha Trail RT360

SUMMARY

The decompressor is a device that decreases the compression pressure in the cylinder for easier kick-starting of the engine.

BACKGROUND

The Yamaha Trail RT360 was equipped with a Yamaha-original decompressor, dissimilar to a conventional one, allowing the big single-cylinder engine to be started easily.

CONSTRUCTIO N

The device was located above the exhaust port and it was operated by pulling in a lever on the left handlegrip. It had a ϕ5mm passage leading from the upper cylinder wall to the exhaust port. This passage was held closed by means of a release valve when it was not in use. It was opened by pulling in the decompression lever, thus reducing the compression pressure in the cylinder.

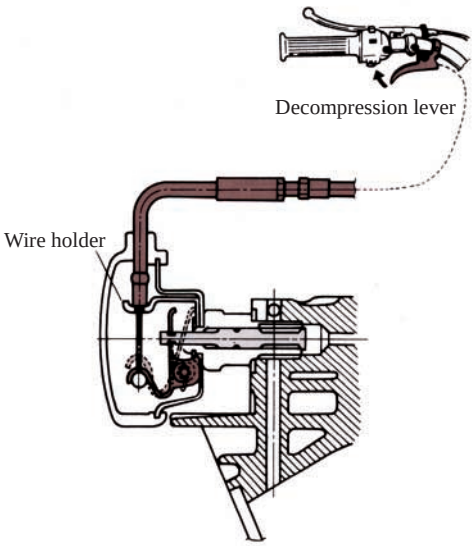
The manual decompressor was followed by an automatic decompressor which decreased the compression pressure automatically by means of a starter interlocked mechanism on the kick crank. Requiring no manual lever operation, this device has increased the ease and convenience of kick-starting.

OPERATION

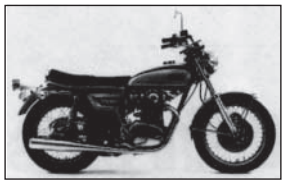
As illustrated, when the decompression lever on the left handlegrip was pulled in, the release valve was opened and released part of the compressed gas in the cylinder to the exhaust port, by reducing the compression pressure in the cylinder. The decompression lever was returned to the original position after the engine was kick-started.

RESULTS

The compression pressure in the cylinder was adequately decreased and the powerful single-cylinder engine was started easily with a light kick of the starter.



Front disc brake —Hydraulic calipers



Yamaha Sports XS650E

SUMMARY

This disc brake consisted of a stainless steel disc plate that was fitted to the front wheel and rotated as a part of the wheel, and a pair of hydraulic caliper cylinder pistons which operated a pair of friction pads sandwiching the disc plate.

BACKGROUND

Yamaha added an electric starter to its 4-stroke model XS650 and this model was designated the XS650E. It also had another significant feature—a hydraulic disc brake on the front wheel.

CONSTRUCTION

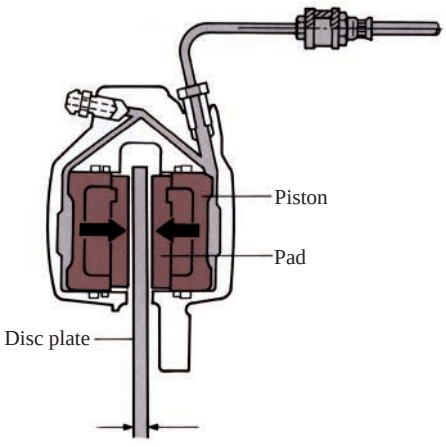
The disc plate, which was directly connected to the front hub, rotated as a part of the wheel but the caliper assembly incorporating a pair of friction pads was secured to the front fork assembly and did not rotate. The disc brake with hydraulic calipers on the XS650E was a girling type, also known as an opposed piston type. The XS650E was the first motorcycle to feature this type of caliper assembly.

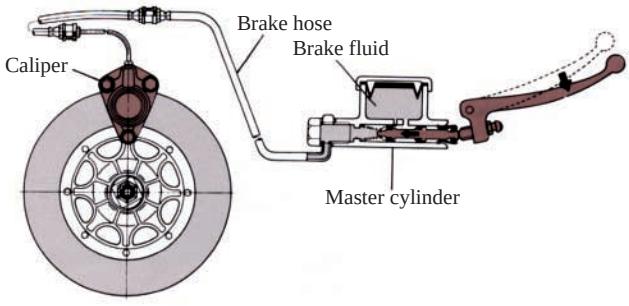
OPERATION

As the front brake lever was squeezed, the master cylinder worked to pressurize the brake fluid and push against the two caliper pistons, which in turn pushed the friction pads against the disc, thus providing a braking action.

RESULTS

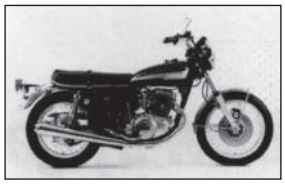
In general, when the brakes are applied, most of the load weight is shifted forward, and so the front brake must be much more powerful than the rear brake.
The newly designed disc brake on the front wheel of the XS650E resulted in increased braking power.





Omni-phase balancer device

—Reduced engine vibration



Yamaha Sports TX750

SUMMARY

In order to reduce the discomfortable vibration created in the running engine, Yamaha developed this balancer device for the Sports TX750. This device, which was positioned behind the crankshaft, had a pair of chain driven balancers (2-shaft design), thus reducing the vibration caused by the primary imbalance in the crankshaft as well as an additional force (couple).
Today, a gear driven type (single-shaft design) has taken the place of the above type.

BACKGROUND

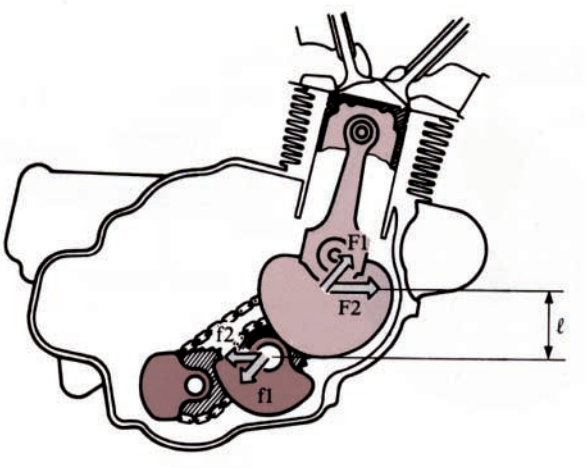
The Sports TX750 was Yamaha's first 750cc model, featuring a 4-stroke OHC air-cooled twin cylinder engine with a dry sump lubrication system. In order to give this 4-stroke engine the smoothness and quietness of operation, Yamaha technical staff succeeded in developing this effective balancer mechanism.

CONSTRUCTION

In general, the balancer device works to offset the imbalance in the reciprocating mass of the piston and connecting rod, that is, the weight equivalent to the reciprocating mass is equally shared by the crank web and the balancer device which rotate at the same speed but in opposite directions.
In order to make the TX750's balancer device as compact as possible, it was designed as a separate unit from the crankshaft, receiving the crankshaft's rotation by means of a chain. The primary balancer worked to offset the vibration caused by the primary imbalance in the crankshaft, while the secondary balancer killed an additional force (couple) created by the rocking action of the crankshaft.

OPERATION

As the engine works and the crankshaft turns, vibration is produced in a number of different directions. There is a balance-cut device in the crankshaft so that this vibration can be reduced as much as possible, but this alone is not sufficient to eliminate vibration. In order to eliminate the remaining vibration in the crankshaft, it is necessary to offset it with opposing vibrations of the same level. The function of the balancer device is to create these equal and opposing vibration waves.
The TX750 employed a pair of balancers. As seen in the diagram, f_1 is on direct line with F_1 and if the vibrations are equal, they will cancel each other out. If F_2 and f_2 are equal, they will also offset each other, but while doing so, because there is a vertical difference of "r", an additional force (couple) $F_2 \times r$ is created. The secondary balancer is designed to offset this force.



Blow-by gas recirculating device

—Effective recirculation of unburnt gas

Yamaha Sports TX750

SUMMARY

This device returned the blow-by gas (unburnt air/fuel mixture) to the combustion chamber for second burning, thus preventing it from escaping into the air through the exhaust system

BACKGROUND

The main air pollutants given off by motor vehicles include blow-by gas, exhaust gas and evaporation from the fuel tank. Among these, blow-by gas is composed of unburnt HC and NO_x that escape when combustion of the air/fuel mixture takes place in the cylinder. When these chemical compounds escape into the air and react with ultra violet rays, they become harmful substances to humans. The Yamaha TX750 was the first motorcycle to feature a blow-by gas recirculating device.

CONSTRUCTION

This device consisted of an air cleaner and reed valve mechanism. The reed valve opened and closed automatically with a change in pressure in the crankcase, thus sending the blow-by gas to the air cleaner, and then returning it to the combustion chamber.

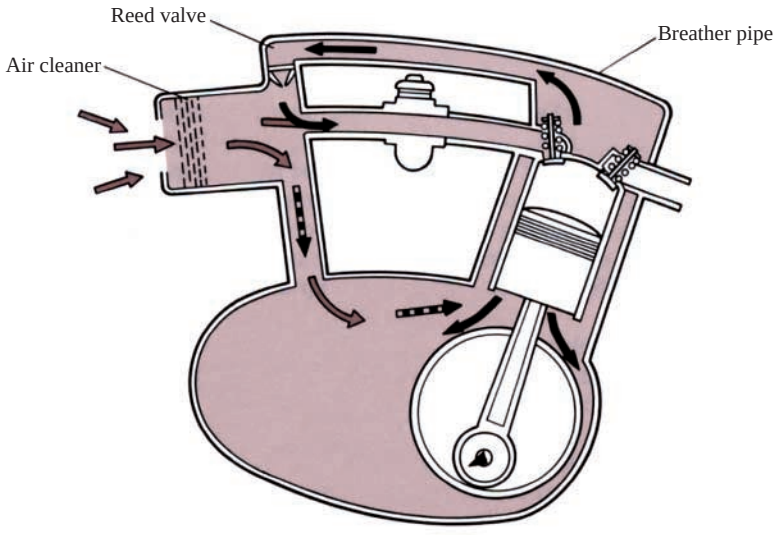
OPERATION

Recirculation of blow-by gas: As the piston goes downward, the pressure in the crankcase and cylinderhead cover increases and opens the reed valve in the air cleaner case. The blow-by gas is then led into the air cleaner through the breather pipe.

Fresh air/fuel mixture intake: As the piston goes upward, the negative pressure is produced in the crankcase, thus closing the reed valve. Fresh air/fuel mixture is then led into the crankcase through the intake duct.

RESULTS

Air pollution was effectively reduced.



Aluminum rim —Decreased unsprung weight

Yamaha Sports TX750

SUMMARY

Lightweight H-beam aluminum rims were used.

BACKGROUND

The TX750 was the first street model to use H-beam aluminum rims on both the front and rear wheels.

RESULTS

These lightweight wheels became more responsive to varied road conditions due to decreased unsprung weight, thus making the bike easier to handle.

Reserve lighting switch —A device against lamp failure

Yamaha Sports TX750

BACKGROUND

This device was developed against the event of a headlamp or stoplamp becoming inoperative.

OPERATION

The headlamp and the stop lamp were constructed so that if by some failure the lamp should go out, the electrical current would automatically switch over to the other beam's circuit as an emergency measure.
In case the tail lamp went out, the current switched over to a pilot lamp, thus turning it going on and off to warn the rider that something was wrong with the lighting mechanism.

Connected righ & left exhaust pipes

—Mutual exhaust interference for more power output

Yamaha Sports TX750

SUMMARY

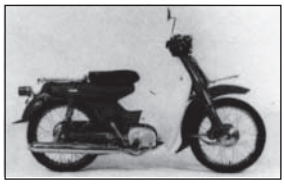
The right and left exhaust pipes were connected at a point close to the exhaust port, so that exhaust pulsations could affect each other for better engine performance.

RESULTS

This exhaust method resulted in a better silencing effect, as well as better engine performance for more power output.

Automatic 2-speed transmission

—Easier operation



Yamaha Mate V50A/V70A

SUMMARY

This transmission had no gearshift pedal and replaced it with an easy throttlegrip operation for gear change from low to high, and vice versa.

BACKGROUND

This automatic transmission was developed specifically for the Yamaha Mate V50 and V70 which were ridden mostly in urban traffic conditions where more gearchange operations were required.

CONSTRUCTION

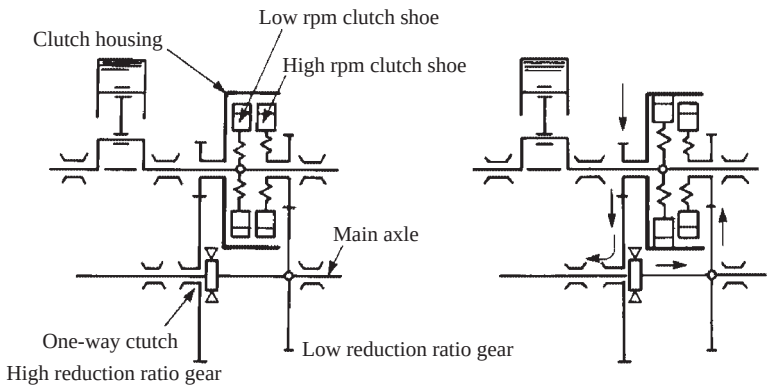
This transmission featured a centrifugal-force type clutch mechanism in which the clutch shoe was fitted with a centrifugal weight (this unit being called the clutch shoe complete, which rotated as a part of the crankshaft). As the engine's speed increased, centrifugal force sent the weight out against the inside of the clutch housing for power transmission. This was called the automatic centrifugal-force type shoe clutch. The automatic 2-speed transmission had two such clutches, one for low rpm (power transmission to the gear with a high reduction ratio) and the other for high rpm (power transmission to the gear with a low reduction ratio).

OPERATION

At low rpm (idle speed) the clutch shoe complete did not come in contact wrth the clutch housing and no power transmission, therefore, could take place. As the speed increased, centrifugal force sent the weight out against the inside of the housing because the clutch shoe complete (centrifugal weight plus clutch shoe) was designed to rotate as a part of the crankshaft. Power was then transmitted to the clutch housing and the low rpm clutch engaged the gear with a high reduction ratio, thus putting the bike in motion. As the speed increased further to exceed the level of stall rpm, the high rpm clutch began to operate so that power could be transmitted automatically to the low reduction ratio gear. At this point the low rpm clutch was intercepted by a one-way clutch positioned between the high reduction ratio gear and the main axle. To make this operation as smooth as possible, an oil-bath wet-type clutch was used.

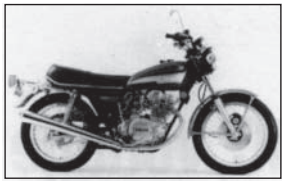
RESULTS

The automatic 2-speed transmission increased the utility of a bike, as well as the ease of riding. It was especially appreciated by novice motorcyclists and people riding in crowded urban traffic conditions.



DOHC 8-valve engine

—Increased intake/exhaust efficiency



Yamaha Sports TX500

SUMMARY

In this 4-stroke DOHC twin-cylinder engine, each cylinder was fitted with two intake and two exhaust valves, which meant increased valve area and thus greater intake/exhaust efficiency.

BACKGROUND

The Yamaha Sports TX500, which was released soon after the 650cc and 750cc models, featured a DOHC twin-cylinder engine with a 8-valve system that was unprecedented for a production model in the motorcycle world. This model became known for its reliable high power output.

CONSTRUCTION

The DOHC (double overhead camshafts) system was developed from a single overhead camshaft (SOHC or OHC) system. In the DOHC system intake valves and exhaust valves were driven directly from their respective camshafts. Each of the two cylinders had two intake and two exhaust valves, making a total of eight valves driven from two (double) camshafts.

OPERATION

In the DOHC system each valve operation can be performed over a shorter distance, while at the same time reciprocating mass is decreased, thus allowing each valve to follow the camshaft very smoothly.

In addition, intake valves and exhaust valves are driven from their respective camshafts, resulting in more reliable high-speed power output. The 8-valve system means increased valve area which results in the smoother flowing of air/fuel mixture, thus improving intake/exhaust efficiency.

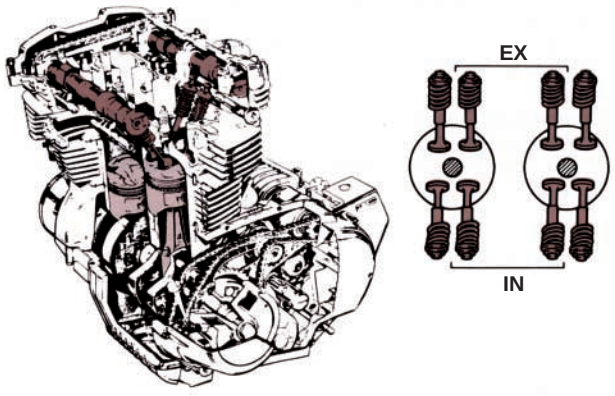
In addition, each valve can be made lighter and smaller, which prevents “valve float” (a phenomenon where the valve does not follow the camshaft exactly, becoming separated from the cam), or “valve bounce” (a phenomenon where the valve bounces up again after being correctly seated once),

This means that the engine could function over a wider high speed range, thereby delivering greater power output. (In general, the greater the mass, the greater the inertia of the body, which means that the bigger valve becomes poorer in following the cam.)

The positioning of the spark plug in the center of the combustion chamber helps greatly to improve combustion efficiency by ensuring better flame propagation.

RESULTS

The 8-valve DOHC twin-cylinder engine earned the Sports TX500 a position on the market because of its reliable high performance.



IC voltage regulator —No points of contact & virtually maintenance free

Yamaha Sports TX500

SUMMARY

This electrical system utilized transistors and integrated circuits to regulate the voltage produced in the generator.

BACKGROUND

This was the world's first IC voltage regulator ever adopted in a motorcycle for the sake of reliable, virtually maintenance-free operation.

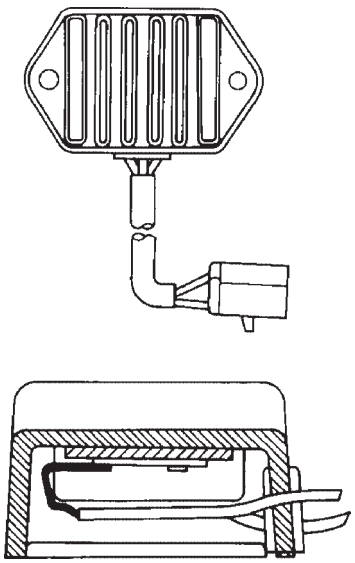
CONSTRUCTION

Of course this system had no points that needed adjustment. Plus it was lightweight and compact. Other advantages included the fact that there were very few moving parts and the entire body was resin fixed so that it was water-resistant and vibration-proof.

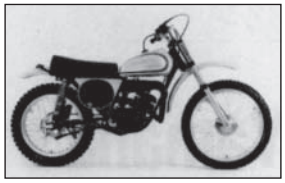
The regulator is a device that regulates the voltage of electricity coming from the generator. Regulators up until that time were a contact breaker type, which meant that they were easily influenced by engine vibration, the points were worn by the intermittent field current of up to several hundred cycles, they suffered from heat damage, the setting would require frequent adjustment, and they could not be said to be water resistant. The IC voltage regulator corrected these weak points. Utilizing a semiconductor, it needed no points or gap adjustment, resulting in virtually maintenance-free operation.

RESULTS

The voltage was regulated with a higher degree of accuracy regardless of variations in the engine's speed.



Thermal flow shock absorber unit



—Stable damping effect—

Yamaha Motocrosser MX125

SUMMARY

A Yamaha-original rear shock absorber unit incorporating an oil tank with a cooling fin.

BACKGROUND

In off-road bikes and motocrossers the suspension systems have to endure severe punishment, so the problem of deteriorating damping effect arises due to the rise in the temperature of the oil. Therefore, the development of this system was undertaken with the aim of stabilizing the damping effect.

CONSTRUCTION

This unit has three times the oil capacity of a conventional shock absorber unit, and in addition, it is a rear shock unit which comes with an oil tank fitted with a cooling fin.

OPERATION UNDER COMPRESSION (FIGURE 1)

When the piston and rod enter the cylinder under the compression force, the oil is placed at the bottom of the piston and becomes compressed. Then the oil passes through an orifice in the cylinder base and flows into the tank as indicated by the arrows in the figure.

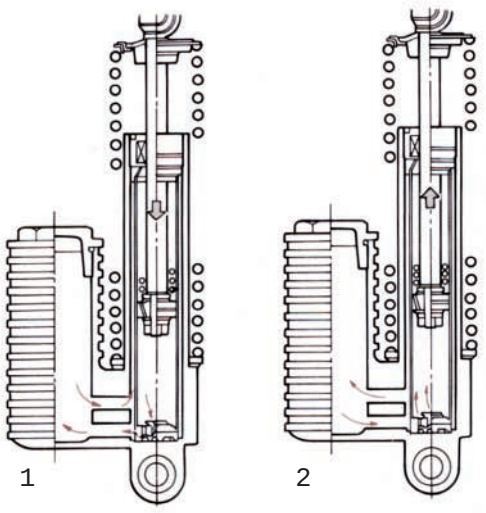
Because pressure is lowered on the top side of the piston, part of the cool oil from the bottom side passes through the valve into the top side, thus creating a damping force.

OPERATION DURING EXTENSION (FIGURE 2)

The shock absorber, once compressed, extends out again by the tension of the spring. At this time pressure is raised on the top side of the cylinder and the oil pushes the valve open to flow to the bottom side of the piston. This gives rise to the damping effect. Pressure is lowered on the bottom end of the piston and cool oil flows in from the oil tank through the base valve and orifice. In this action also, a damping effect is attained.

RESULTS

A rise in the temperature of oil lowers the viscosity of oil, thus resulting in poorer damping effect. This system has helped correct this weak point by increasing the amount of oil to ensure better cooling effect, so that a more stable damping effect can be obtained even in severe conditions.



Compression Extension

Yamaha's first trials machine

—Street legal competition model

Yamaha Trial TY250J

SUMMARY

This was Yamaha's first production trials machine. Featuring a headlight, rearview mirror and other street legal equipment, the TY250J could be ridden on normal roads as well.

BACKGROUND

Yamaha developed this model with the aim of promoting the spread of trials competition and establishing a whole new category of commodity.

CHARACTERISTICS

The TY250J looked like a normal road model but it was truly a competition machine in its performance. The newly designed 2-stroke "Torque Induction" engine gave a superbly stable performance in the low speed range with plenty of controllable torque. The 5-speed transmission featured specially set gear ratios for third and lower gears with the smoothest possible negotiation of trials sections in mind. The minimum idle angle of the dog clutch was 5°, thus giving another dimension to the trials characteristics of this model. 4th and 5th gears had wide ratios suitable for moving easily from one section to another and also for riding comfortably on normal roads. The light aluminum alloy sprocket wheel (53 T) was available as optional competition equipment.

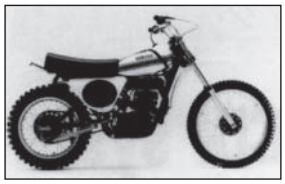
The diamond type frame was made of lightweight, rigid and hightensile double steel tubing, providing an adequate road clearance. Dry weight was only 97kg.

RESULTS

The TY250J helped greatly to establish "trials" as a new competitlon category in Japan.

Monocross suspension

—Improved off-road drivability



Yamaha Motocrosser YZ250

SUMMARY

Using just one shock absorber, the front end of which was located at the joint between the head pipe of the frame and the tank rail, with the rear end positioned on the upper portion of the triangular shaped rear swing arm, this mechanism succeeded in changing the up/down motion of the rear wheel into a forward/rearward motion, so that better shock absorption effect could be obtained.

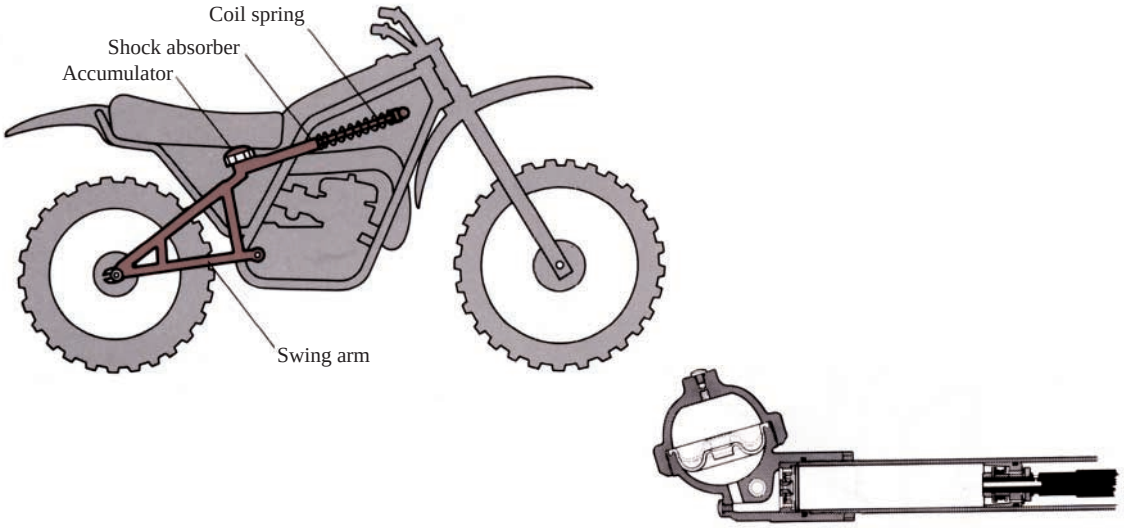
OPERATION

The term “Monocross suspension” referred to the combined construction of frame, swing arm and shock absorber. The shock absorber utilized inert gas (nitrogen gas), oil, coil spring and rubber as shock absorbing materials, so that an extremely soft cushioning could be created. This shock absorber, unlike conventional upright double-cylinder type shock absorbers, used a base valve and rubber membrane to pressurize the damper oil separately from nitrogen gas. As a result, even under hard use causing the unit to incline, the oil in it did not become aerated,which contributed to a more stable damping effect.

Since the introduction of the Monocross suspension, every year has seen new improvements, such as the lighter and easier-to-produce de Carbon type and adoption of a specially designed coil spring that gives a progressive damping effect. Indeed, the amount of new technology that has come out of the development of this system is truly amazing.

RESULTS

Earlier than the introduction of the Monocross suspension conventional rear suspension systems had always relied on two separate shock absorbers on the right and left working on the swing arm. This meant that when the rear end received a severe shock from the road, the two shock absorbers would function independently, thus twisting the swing arm and causing a shake in the rear of the bike body. However, the newly developed Monocross suspension was able to solve these problems by adopting a single shock absorber attached to a rigid triangular swing arm that was highly resistant to twisting forces. In addition, the fitting positions of the wheel axle and the shock absorber to the rear arm were altered so that the ratio between wheel travel and cushion stroke increased from 1.2-1.5 on conventional systems to 5 on the Monocross system, which meant much greater wheel travel, resulting in increased comfort, improved drivability and better roadgripping.



CDI system —Hot, strong spark for ignition

Yamaha Motocrosser YZ250

SUMMARY

The CDI system, unlike a conventional mechanical switch like a contact breaker, utilized an electrical switch (thyristor). This system functions differently from a mechanical switch ignition system as follows:

* The mechanical switch ignition system uses a contact breaker to interrupt the flow of current in the primary winding of the ignition coil. When the current is cut, a surge of high voltage (250V to 300V) is produced by self-induction in the secondary winding, thus causing a spark to jump across the spark gap.
* The CDI (capacitor discharge ignition) employs a condensor in place of the contact breaker, and the magneto charges the ignition condensor up to 300V to 500V. The electric charge flows from the condensor to the ignition coil by means of the semi-conductor element.

BACKGROUND

This system was developed so that a more relaible ignition function could be provided for motorcycles.

OPERATION

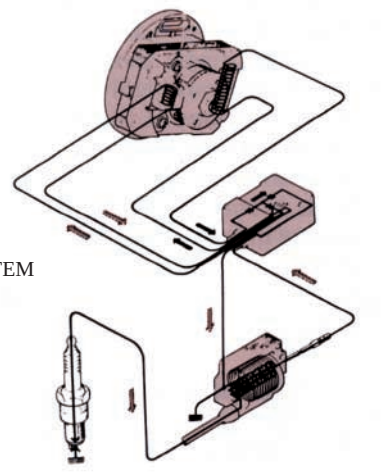
The CDI system is a device where electricity produced by the rotating magneto charges the condensor up to a few hundred volts. The pulser coil gives a signal to switch on a thyristor, thus allowing the electric charge to flow from the condensor to the primary winding of the ignition coil, so that a surge of high voltage is instantly induced in the secondary winding.

The charge accumulated in the condensor is sent instantly from the primary winding to the secondary winding where once again a surge of high voltage is induced, so an extra-strong spark is produced at the spark plug.

RESULTS

The CDI system helps to give a stronger spark. This results in better starting characteristics. It is a positive ignition system where misfiring is less frequent, even by a fouled plug. In addition, it does not have many of the problems associated with an ignition system using a contact breaker, such as changes in the point gap, carbon build-up and point corrosion, which in turn makes it a virtually maintenance-free system.

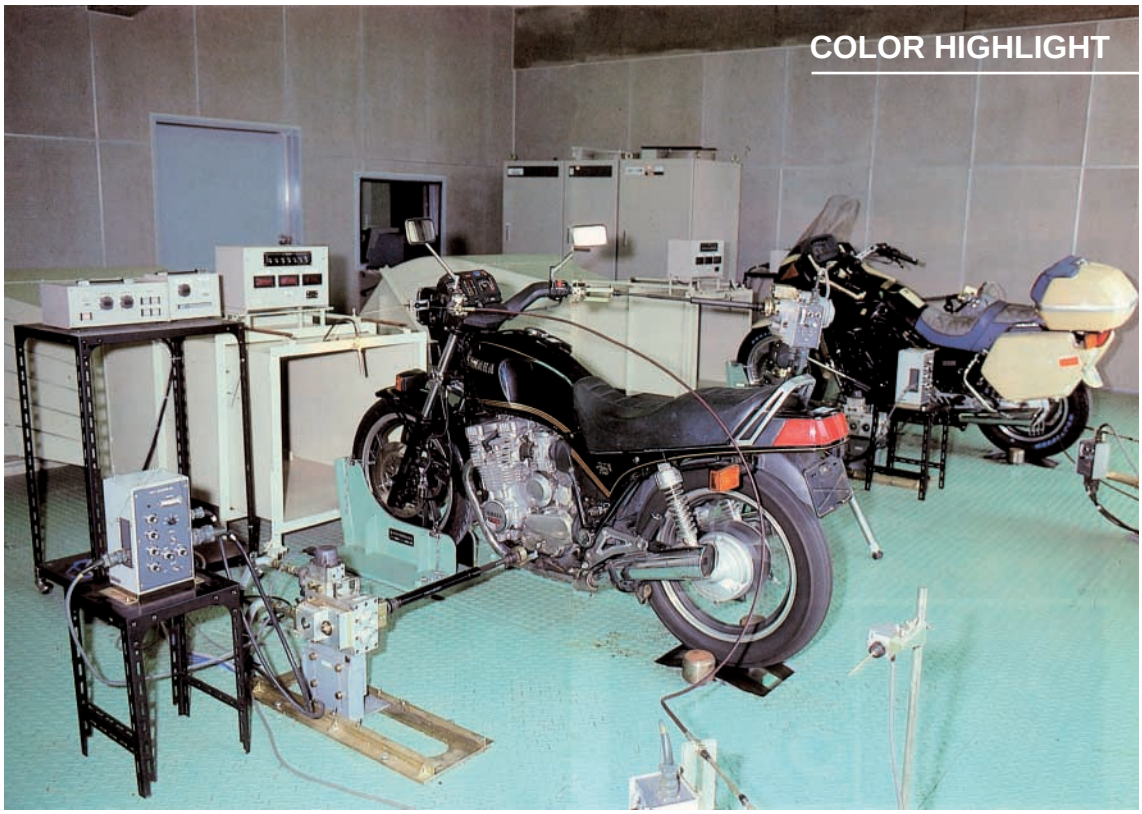
Because of these qualities, the CDI system has come to be adopted in a large number of models including most of the 2-stroke road sports bikes and even family bikes.



CDI SYSTEM

1975—1979

CONTINUED EFFORTS TO MEET DIVERSIFIED CUSTOMER NEEDS



Durability test on a simulation chassis

The simulation chassis is used to test the machine to the very limit of its durability at different speeds and in different gears as directed by a computer.

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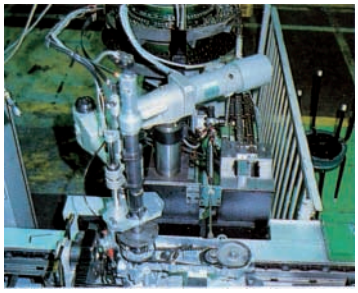


1 In 1975 Sportsland Sugo opened.

2 In 1975 Don Vesco set a new motorcycle speed record of 302.928 mph (487.411 kph) at Salt Lake, Uta.

3 In l977 the Yamaha Passol opened a new era of scooters in Japan.

4 50cc licence school and motorcycle riding school were also getting popular everywhere.

5 In 1979 the Yamaha Riding School program started.

6 The alcohol bike gained popularity in Brazil.

7 A number of industrial robots were adopted in the assembly line.

1975 to 1979
Continued efforts to meet diversified customer needs

• The introduction of new family bikes and scooters gave a strong boost to the Japanese motorcycle market which had remained inactive under the adverse effect of the worldwide oil crisis.
These vehicles became more and more considered to be a normal means of daily transport, thus helping make people change their biased view of the 2-wheeler. Efforts were continued to meet more diversified customer needs.

• “Sportsland Sugo” a modern leisure-time sports complex, opened in 1975.

• The Marine Division also continued to grow, manufacturing and supplying a wide variety of FRP sailboats, motorboats, fishing boats and marine engines. In 1975 the Wing of Yamaga won the frst Trans-Pacific single-handed race held in commemoration of the Okinawa Marine Expo.

• In 1977 the Yamaha Passol S50 was marketed. This opened a new era of scooters by creating a huge market especially among women.

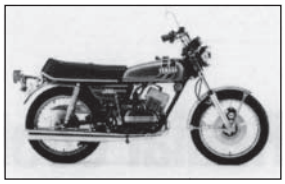
• In 1977 Yamaha Motor Corporation, USA was founded. The number of overseas production bases was greatly increased in the form of joint venture or technical cooperation during the period from 1975 to 1979.

• In 1978 the Yamaha Sports Special Series was introduced.

• In 1979 the Yamaha Tri-Moto was marketed.

Flasher self-canceeing system

— Sure flasher cancelling



(RD250/350)

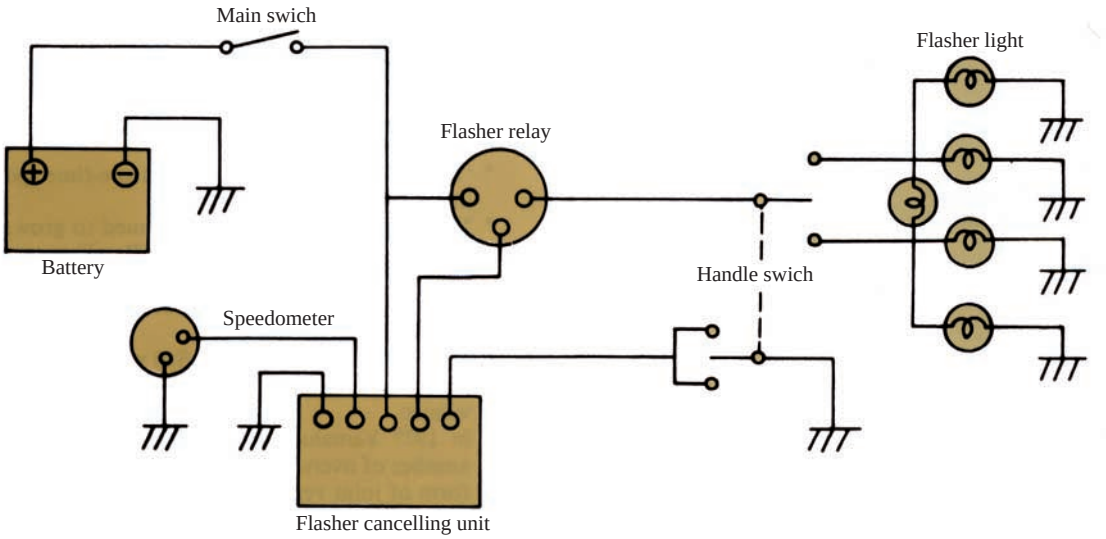
SUMMARY

This is a system that automatically switches off the flasher when it has been left “ON”. An electronic system is used to switch off the turn signal automatically after a predetermined amount of time or distance has elapsed from the moment it was turned on.

OPERATION

The speedometer reads the elapsed time and distance, and sends the information to the cancelling unit, which keeps the circuit disconnected to the flasher relay for a given period of time.

When the flasher switch is pressed to either the right or left, the cancelling unit begins to work as soon as the hand is taken off the switch. Therefore, if you wish to keep the flasher on for more than the set 100 meters or 10 seconds, it can be done by either keeping your hand in the switch or by pressing the switch from time to time to reset the cancelling unit.



Radial cooling fin —Innovative design

DT400

Yamaha Trail DT400/250

SUMMARY

This fin configuration was designed in a radial pattern, which meant that a more even cooling effect could be obtained.

BACKGROUND

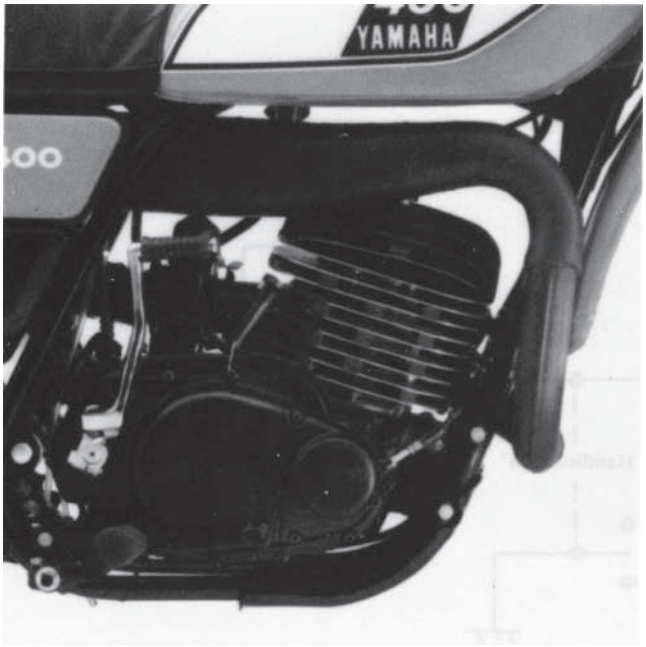
First adopted on the '75 production motocrosser YZ250, this design, with its excellent cooling characteristics for the air-cooled 2-stroke engine, was soon featured in the Yamaha Trail DT400/250. This type of fin also helped to make up an innovative engine design.

The natural air cooled 2-stroke engine has a cooling fin on the outside of the cylinder, and cooling effect varies depending on the fin configuration.

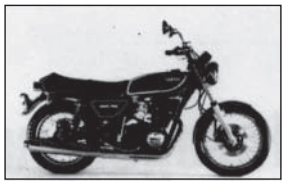
By designing the cylinderhead fin in a radial pattern a more even cooling effect was achieved in line with the true heat distribution around the cylinderhead.

RESULTS

Cooling effect for the cylinderhead was greatly increased.



DOHC 3-cylinder engine —Unique power feeling



Yamaha Sports GX750 (XS750)

SUMMARY

For the GX750 (released overseas as the XS750), Yamaha developed a new forward-leaning in-line 3-cylinder engine. The muffler brought the three exhaust pipes into one unit, thus lowering the level of exhaust noise and allowing for an increase in power output.

BACKGROUND

This was part of the design aim of creating a slim profile 750cc sports bike.

CONSTRUCTION

This 4-stroke DOHC in-line 3-cylinder engine, with a crank angle of 120° and a slim configuration, was unique in the world. A stronger multi sensation than a twin, and more exciting torque sensation than a four, resulted in a unique power feeling. For extra ease of maintenance, it was designed so that the cylinders could be removed without demounting the whole engine assembly.

RESULTS

The GX750 was not a bike with just a few high performance features, rather everything about it resulted in stable, comfortable, high speed riding.

Shaft drive —A 90° turn of drive power

Yamaha Sports GX750 (XS750)

SUMMARY

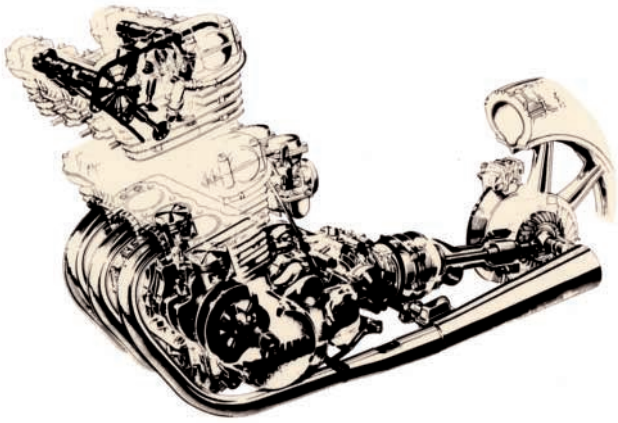
This shaft drive system was designed so that drive power from the in-line engine could be given a 90° turn when it was taken by the rear wheel.

OPERATION

In the GX750's in-line 3-cylinder engine the crankshaft rotated in the same direction as the vehicle advanced. This rotation was given a 90° turn at the transmission before it reached the drive shaft. It was given a 90° turn once again by the spiral bevel gear at the rear wheel.

RESULTS

Minimizing the anti-torque phenomenon, the in-line shaft drive prevented the machine from leaning to either side even during hard throttle operation.



Halogen headlamp —Long lasting brightness

Yamaha Sports GX750 (XS750)

SUMMARY

This headlamp featured sealed-in halogen gas so that luminous intensity could be increased.

BACKGROUND

For a large-sized bike, which was often ridden at high speeds, a powerful headlight became an indispensable safety feature to ensure good visibility for night driving. That is why Yamaha equipped the GX750 (XS750) with a strong halogen headlamp.

CONSTRUCTION

This bulb type lamp used quartz glass for the bulb and featured sealed-in halogen gas to prevent evaporation of the filament, As a result, the bulb was made smaller, and it did not darken with age, remaining as bright as a new one.

Flexible flasher mounting —An unbreakable stay

Yamaha Trail DT250

SUMMARY

This was a flexible mount for the rear flasher on the DT250. It was not broken even when the bike fell down.

BACKGROUND

The redesigned model of the DT250, which was ridden mostly off the road, used this mount as one of its new features.

CONSTRUCTION

This mount consisted of a coil spring and rubber mold, so that it could be easily bent without breaking. This system was later adopted for the front flasher as well, and has now come to be standard equipment on all of the Yamaha off-road models .

Front and rear disc brakes —New sports fashion

Yamaha Sports RD400/250

RESULTS

The high performance 2-stroke sports RD400/250 were equipped with disc brakes on both the front and rear. Not only did this improve braking performance, but also established a new look for sports type motorcycles.

4-stroke big single —Man and machine in one

Yamaha Enduro XT500

SUMMARY

This was an all-new 4-stroke big single-cylinder engine. It became popular because of the way it combined the reliability of a 4-stroke engine in the low speed range and the sharp pick-up of a 2-stroke engine.

BACKGROUND

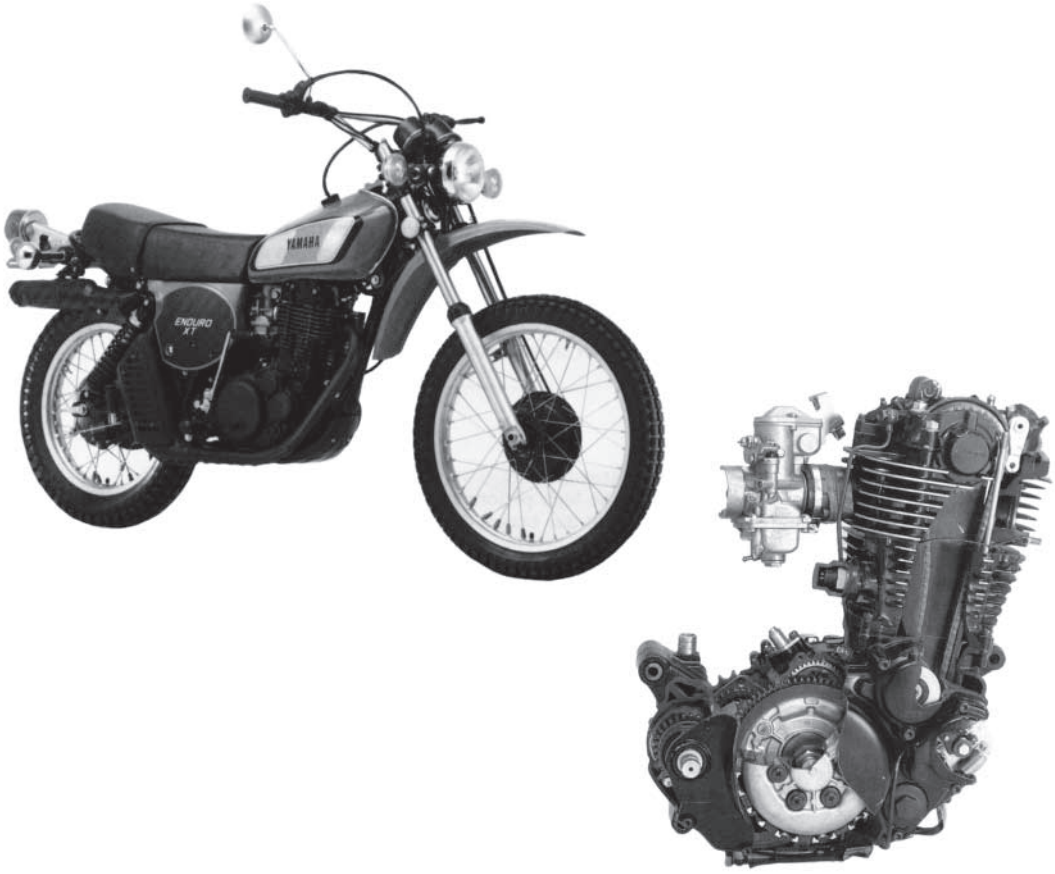
As a result of constant efforts on the part of Yamaha to develop unique new models in the 4-stroke range, the big 4-stroke enduro model XT500 was released in 1976, being the largest single-cylinder bike available on the market at the time in Japan. The engine featured a number of unique technical refinements.

CONSTRUCTION

Mounted on a semi-double cradle frame of high-tensile steel tubing, the engine was all black with an over-square type OHC cylmder with an 8.3:1 compression ratio. Maximum power output was 30ps/5,800rpm, while maximum torque reached 3.9kg·m/5,400rpm. The oil tank for a dry sump lubrication system was designed as a part of the frame. The crankcase cover was made of magnesium alloy.

RESULTS

As much at home off the road as on, the XT500 with the newly designed engine was truly a dual-purpose machine that brought a whole new level of riding enjoyment, unifying man and machine in one. Its outstanding durability was really deserving of the name “enduro”.



In-frame oil tank design —Slim chassis design

Yamaha Enduro XT500

SUMMARY

The oil tank on the XT500 was designed as a part of the frame, thus resulting in very effective dry sump lubrication.

BACKGROUND

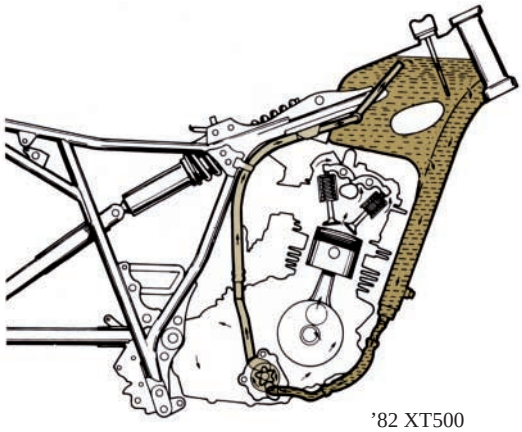
The in-frame oil tank design allowed the engine to be positioned higher in the frame for greater ground clearance which was a must for off-road riding, while chassis construction was made slim and compact.

CONSTRUCTION

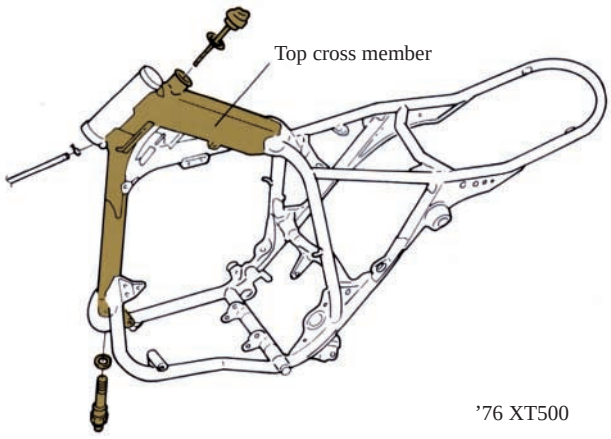
In this unique in-frame oil tank design, the upper cross member joining the steering head held the oil, which passed through the forward down tube to the engine and then was sent back to the upper cross member. This was called a forced-pressure dry sump lubrication system, thus eliminating the need for a separate oil reservoir that was indispensable to the wet sump lubrication system on most 4-stroke engines. This also helped to reduce the overall height of the engine, resulting in greater ground clearance for smoother off-road riding. In addition, a dry sump lubrication model, as is also seen on a number of 2-stroke models, must usually have an oil tank fitted to the side cover, but on the XT500 this need was eliminated. This allowed for a slimmer body at the riding position, which meant that the rider could take a freer, more natural position for off-road riding.

RESULTS

This lightweight, compact chassis design enabled the rider to take a better riding position, while at the same time allowing the adoption of a large-capacity air cleaner.



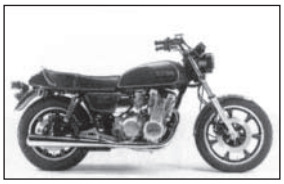
’82 XT500



’76 XT500

Yamaha's first parallel four

—Truly exciting power



Yamaha XS Eleven

SUMMARY

This was the first DOHC 4-stroke parallel-four engine ever developed by Yamaha. Its max. power output reached95 ps at 8,000rpm and peak torque 9.2kg·m at 6,500rpm.

BACKGROUND

This high performance engine was developed for the XS Eleven to cater to the growing demand for a powerful one-liter bike in the American and European markets.

BACKGROUND

The large-sized engine that displaced a full 1,100cc adopted an air-cooled parallel four cylinder layout (bore × stroke, 71.5 × 68.6mm) for better cooling effect.

In this cylindcr layout firing took place at short, equal 180˚ intervals, so that engine speed rose quickly and smoothly while vibration was kept to a minimum. The SU type four carburetors and reliable shaft drive system helped improve the characteristics of this high performance engine.

RESULTS

Plenty of torque and sharply responsive acceleration established the XS Eleven as a quality superbike in the market.

SU type 4-carb system

—Quick response to hard throttle operation

Yamaha XS Eleven

SUMMARY

This carb system featured a butterfly type throttle valve that was operated by a throttle grip, which in turn controlled the piston valve of a carburetor by means of negative intake pressure. This was called an SU type carb system.

BACKGROUND

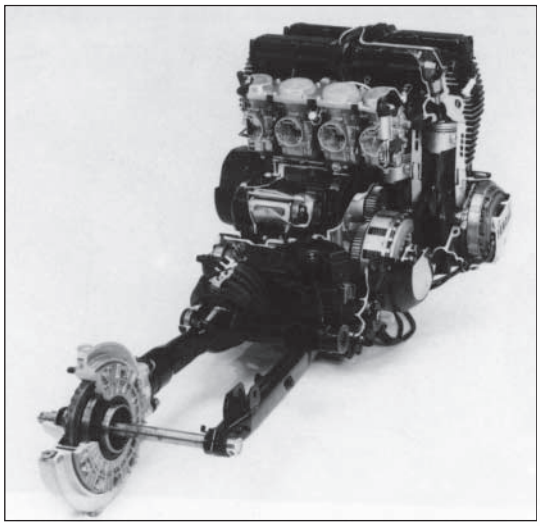
The SU type 4-carb system was developed specifically for the large-capacity 4-cylinder engine of the XS Eleven (1,100cc).

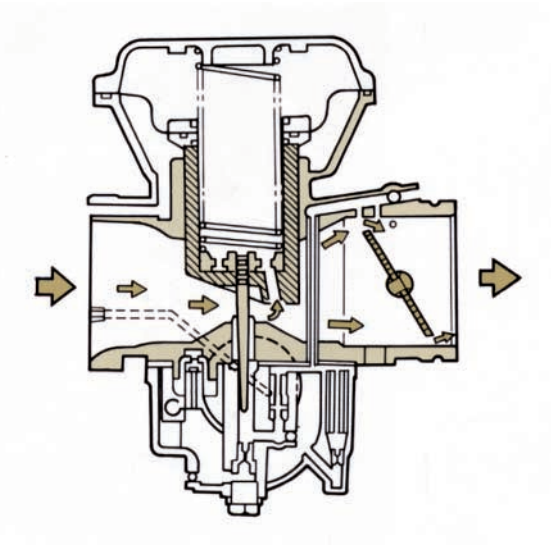
OPERATION

The throttle valve positioned close to the engine was operated by a throttle grip, thus controlling the intake of air/fuel mixture. The carb's piston valve opened and closed automatically by making use of the negative intake pressure, thus automatically changing the sectional area of the venturi. This in turn kept the velocity of air/fuel mixture stream more constant to supply the engine with the necessary amount of air/fuel mixture at all times.

RESULTS

This carb system almost eliminated undesired "breathing" when the throttle valve was opened suddenly in the low or middle speed range. This made the build-up of rpm especially smooth. In addition, the piston valve made use of a diaphragm, which absorbed shock and reduced wear of moving parts. With a special slow air jet system, the amount of air/fuel mixture was more precisely adjusted so that stabler idling and low speed performance could be obtained.





Oilbath type drive chain

—Virtually maintenance-free characteristics

Yamaha Scooter Passol S50

SUMMARY

The chain was encased in a sealed aluminum alloy case where the chain was constantly submerged in oil for very effective lubrication.

BACKGROUND

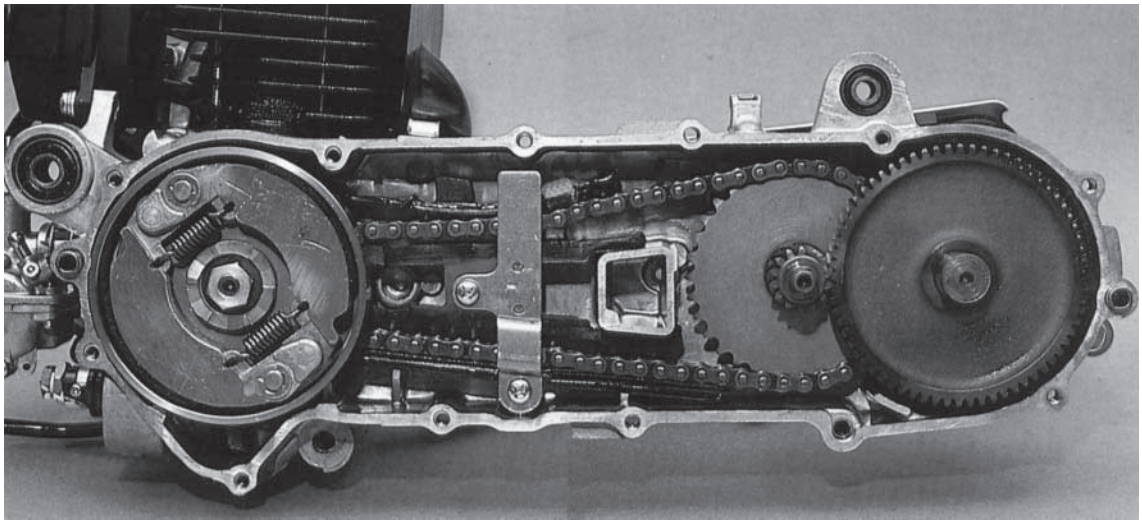
The Yamaha Passol was developed as a vehicle for women, and in that way succeeded in creating an entirely new market. One of the important design points of this model was to make it look as non-mechanical as possible. To also make this model as maintenance free as possible, the drive chain was designed in a completely sealed oilbath system.

CONSTRUCTION

The drive chain was kept in oil in the completely sealed aluminum alloy case, so that very effective lubrication could be obtained, while resulting in less stretching of the chain. The system also included an automatic tensioner that kept the chain adjusted to the proper tension.

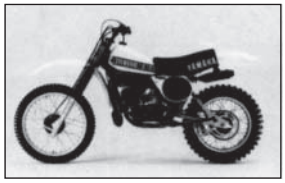
RESULTS

This system not only gave the bike a nicer look, but also made it cleaner, and virtually maintenance-free.



High speed ignition-timing retarding system

—Properly controlled ignition timing



Yamaha Motocrosser YZ250

SUMMARY

This system was originally developed for the high-speed type engine on a racing machine. In general, the racing engine needs a somewhat retarded ignition timing when the speed exceeds a certain level. The high speed ignition timing retarding system is designed to change the ignition timing in response to the actual requirement of the engine.

BACKGROUND

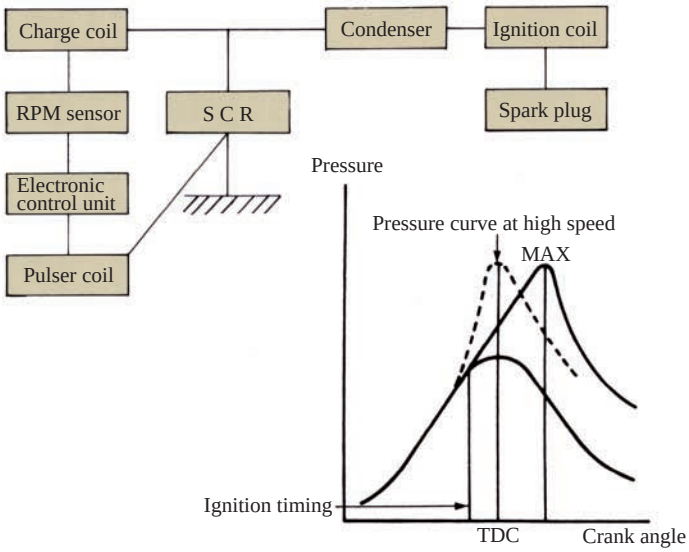
In a gasoline engine, each rpm range has its own optimum ignition timing and this is called "ignition timing characteristics". In general, the timing must be slow in the low speed range, and as the speed increases, the timing must also be advanced. However, it is not always enough to simply advance the timing in proportion to the rpm increase. In the case of a high-speed, high-power type racing engine, the combustion of air/fuel mixture speeds up (faster flame propagation) when the engine's speed exceeds a certain level. The high speed ignition timing retarding system adjusts the timing to the actual needs of the engine by increasing the filling efficiency of air/fuel mixture.

OPERATION

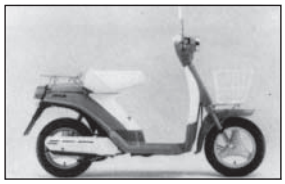
The Yamaha Motocrosser YZ250 was the first production model to feature this system. The system used a CDI magneto to add high speed retarding characteristics to a conventional timing advance curve, to meet the ignition timing as required by the engine so that reliable high-speed performance could be obtained. The initial version of this system was designed to electrically advance the timing in the low speed range and retard it in the high speed range by making use of CDI pulser coil's output curve which was changing in accor dance with the rpm change. The rpm sensor circuit was later incorporated in the system so that ignition timing could be adjusted electronically by means of a thyristor.

RESULTS

When ignition timing is retarded in the high speed range, the temperature of combustion rises, thus increasing the temperature of exhaust gas which in turn raises the temperature in the exhaust chamber. This accelerates the reaction of exhaust gas. The blow back of fresh air/fuel mixture coming from the combustion chamber is then caught and sent back into the combustion chamber, so that power development characteristics are improved in the high speed range.



Automatic choke —Extra-easy engine starting



Yamaha Scooter Passola SA50

SUMMARY

This device automatically adjusted the amount of air according to the engine temperature at the time of starting, so that the engine could be started more easily.

BACKGROUND

The Yamaha Passola SA50, a women's bike which was introduced after the Passol, featured another technical improvement to make operation even easler—an automatic choke.

OPERATION

1.When the engine is cold (diagram 1)

*BVS valve (cable operated slide valve)

When the engine is cold, the BVS valve closes and the negative pressure from the negative pressure cock does not work on the negative pressure chamber of the automatic choke.

*Automatic choke

When negative pressure is not at work, the choke valve is always open to give the engine the proper amount of air/fuel mixture necessary for starting.

2.When the engine is warm (diagram 2)

*BVS valve

When the engine becomes warm, the BVS valve opens and allows negative pressure from the negative pressure cock to work on the negative pressure chamber of the automatic choke.

*Automatic choke

When negative pressure works on the negative pressure chamber of the automatic choke, a diaphragm pushes the choke valve down, automatically closing it.

RESULTS

This system eliminated the need for choke lever operation, resulting in fewer mechanical parts. Thus durability was greatly increased.

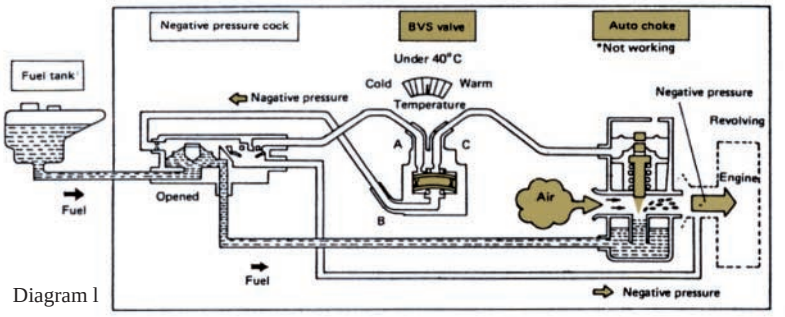


Diagram l

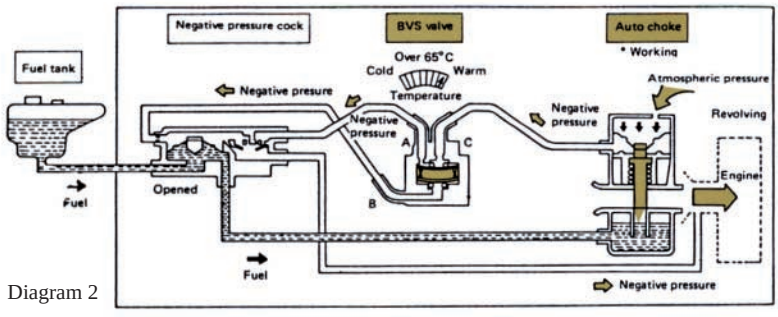
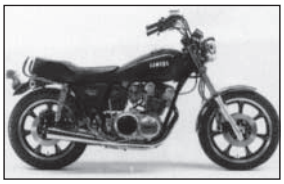


Diagram 2

"Special" styling

—An increased feel of unifying man and machine



XS750 Special

Yamaha Sports XS650/750 Special

SUMMARY

Keeping in mind that a motorcycle should always have a special character of its own, Yamaha designed its "Special" Series with a slim, lightweight body and a low seat position, bringing a new meaning to the concept of unifying man and machine in one.

BACKGROUND

As a result of thorough marketing research in the North American market, Yamaha came up with an entirely-new type of motorcycle styling. The aim was an easy riding big bike with the power, the comfort and the safety features for high speed, long distance touring.

CHARACTERISTICS

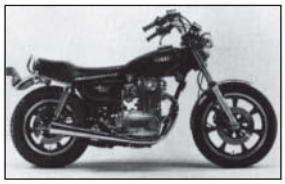
The XS650 and the XS750 differed in that the former adopted a vertical twin-cylinder engine with chain drive while the latter featured a forward-leaning 3-cylinder engine with shaft drive, but they both shared the comfortable king-and-queen type seat, leading axle type long front forks, slim body construction for easy footing, pull-back type extended handlebars and megaphone type short mufflers for excellent noise control.

RESULTS

The "Special" styling created a new motorcycle category in the United States, which the other manufacturers soon followed.

XS650 Special

Electronic ignition-timing advancing system —Smoother starting performance



Yamaha Sports XS650 Special

SUMMARY

This is an advanced electronic mechanism that advances the ignition timing electronically so that it continues to meet the engine's needs even in the highest speed range, giving reliable high-speed performance.

BACKGROUND

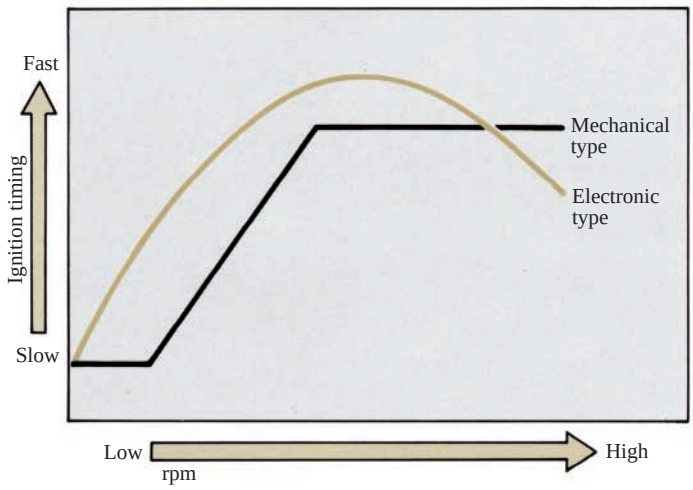
In a gasoline engine, each rpm range has its own optimum ignition timing. With a conventional mechanical system, the timing is kept slow in the low speed range, and as the speed increases, the timing continues to advance at a given rate until the speed reaches the prescribed level, where the timing is fixed. The electronic system is designed to adjust the timing to actual engine needs even after the speed exceeds the prescribed level.

OPERATION

The electronic system uses an rpm sensor circuit and the function of a thyristor to advance the ignition timing accurately in accordance with the engine's actual needs. The result is more precise ignition timing for better engine performance.

RESULTS

Optimum ignition timing is ensured in the entire speed range, from the lowest to the highest, resulting in better engine performance especially in the high speed range.



Transistor controlled ignition system

—Smoother engine start and better combustion

Yamaha Sports XS650 Special

SUMMARY

In this system, electricity from the battery is sent to the ignition circuit where the action of a signal-producing pick-up coil and transistors converts it into an intermittent current, which is then passed on to the ignition coil where a surge of high voltage is induced.

BACKGROUND

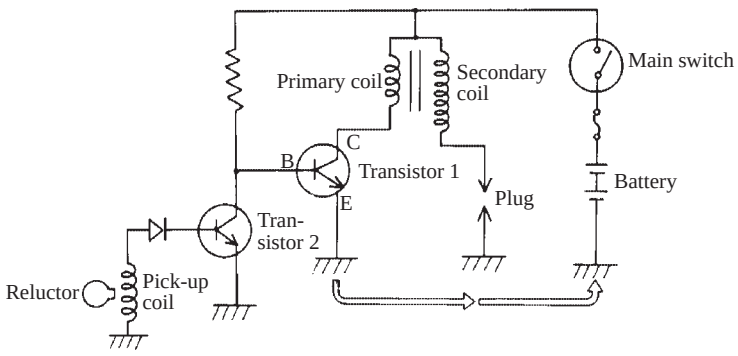
This innovative ignition mechanism was developed so that a more positive and virtually maintenance-free ignition system could be obtained.

OPERATION

When the main switch is turned on, the current from the battery flows to the fuse—main switch—transistor 1 , where C-E of transistor 1 begins to send the current to the primary coil. The turning crank turns the reluctor, and when it is time for ignition, an electrical signal is generated in the pick-up coil and sent to transistor 2's B-E which turns on transistor 2's C-E. When this happens, the currcnt flowing from the battery to transistor 1's B-E then flows to transistor 2's C-E, turning off transistor 1 and also stopping the current to the primary coil. This then induces a surge of high voltage in the secondary coil, which then flies to the spark plug.

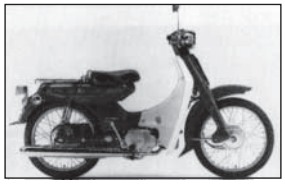
RESULTS

Because switching is performed by an electric signal, its performance does not deteriorate easily with age, and so the system becomes virtually maintenance free once the timing is set. In addition, the combination of this system and an ignition coil produces a surge of secondary voltage that is 30 to 50% higher than a conventional contact breakcr type system, so, starting is easier aud smoother aud combustion is more efficient, even with a fouled spark plug.



Brake lining wear indicator

—Extra-easy check



Yamaha V50/V80 Series

SUMMARY

An indicator needle enabled the rider to see at a glance how worn the drum brake lining was.

BACKGROUND

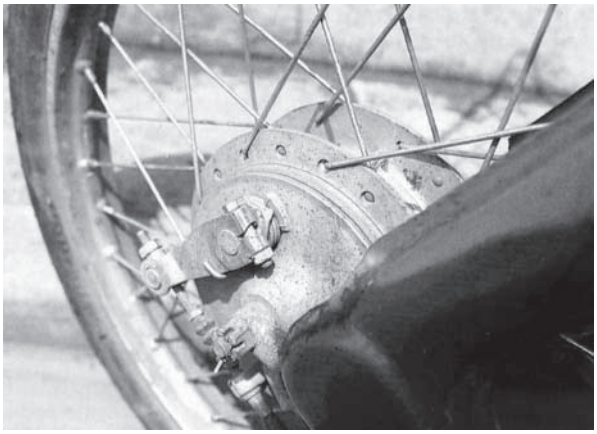
This was developed as part of a well-thought out chassis design for the Yamaha V series models.

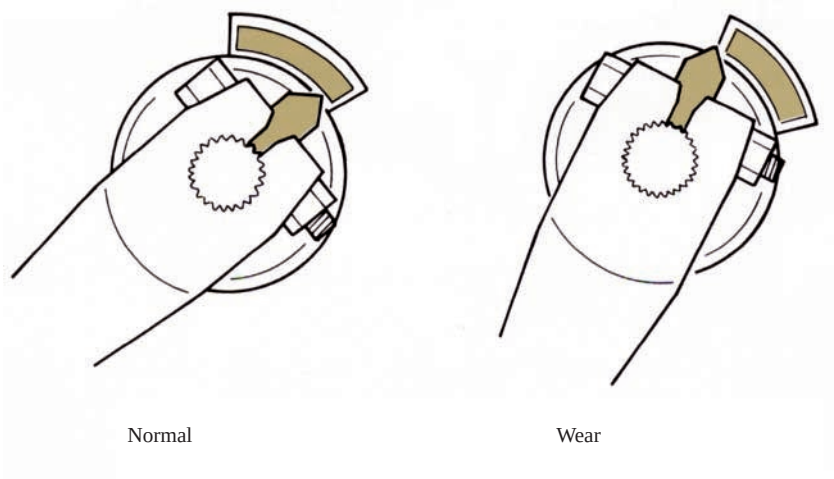
OPERATION

An indicator needle attached to the brake camshaft moved when the brake was applied, according to how worn the brake lining was, so that the rider could see at a glance how much wear there was.
When the needle reached a mark shown on the brake shoe plate, it meant that it was time to change the shoe.

RESULTS

The rider could see the brake lining wear at a glance, confirming the need of maintenance.





Normal Wear

1978

New automatic 2-speed transmission

—Combination of two shoe-type clutches

Yamaha Scooter Passola SA50

SUMMARY

This simple transmission was developed specifically for a 50cc scooter. It had a low and high gears operated by respective automatic centrifugal clutches.

BACKGROUND

This transmission was developed for the Passola that would be larger and more powerful than its sister model, the automatic transmission-equipped Passol marketed in 1977.

CONSTRUCTION

This transmission, like that on the Yamaha Mate, had two shoe-type clutches, that is, one for low rpm (power transmission to the high reduction ratio gear) and the other for high rpm (power transmission to the low reduction ratio gear).

1979

50cc shaft drive

—One unit with the engine

Yamaha Soft Bike Carrot MA50

SUMMARY

This was a simple, lightweight shaft drive designed especially for a 50cc soft bike.

OPERATION

The engine and the shaft drive were built as one unit that was hanged from the frame as a swing unit, which eliminated the need for a universal joint, thus making the unit lightweight but strong. Concerning meshing of the spiral gears, which could effect the performance, the square cross section gearshafts at the drive end and the driven end were designed to mesh with a central propeller shaft. Spacers and shims were screw locked for maintaining the proper meshing position.

Power jet carburetor

—Fuel supply route for high rpm range

Yamaha Road Racer TZ350

SUMMARY

This system was developed based on carburetor technology featured in the YZR factory racer. In this system the carburetor was set to meet the engine's actual needs especially in the middle speed range, so that power output could be increased in this range. The resultant problem of too lean a mixture in the high speed range was solved by providing another fuel supply route.

BACKGROUND

In a high-speed, high-power type racing engine, the carburetor is usually set to meet the peak rpm range, but when a VM type carb is set in this way, it invariably results in too rich a mixture in the middle speed range, thus reducing power output.

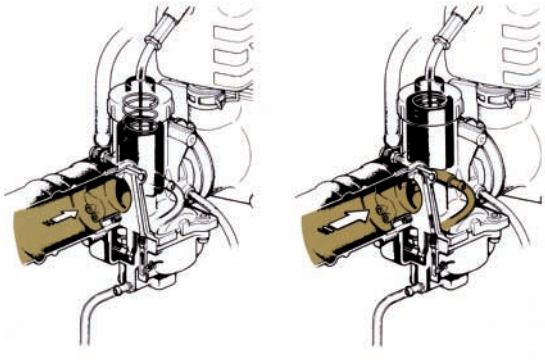
Yamaha therefore developed this system with a good solution to the mid-range mixture problem in mind.

OPERATION

The power jet worked on the principle of engine's negative intake pressure, pulling fuel directly from the carburetor's float chamber, through a separate passage, to the intake side of the carburetor' Namely, fuel coming from the carburetor's float chamber was induced to the intake side of the carburetor through a power jet nozzle that was fitted on the upper flow section of the venturi (large bore side) and made use of engine's negative intake pressure. This meant that when the engine was running in the middle speed range, fuel was sent to the engine from the main jet, but when it reached the high speed range, fuel was sent from both the main jet and the power jet.

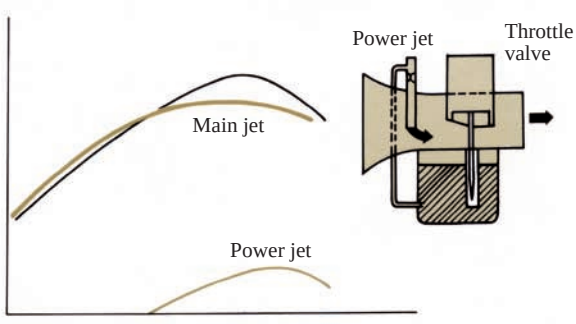
RESUETS

Power output of the high-speed, high-power type engme was increased in the middle speed range as well.



Low speed

High speed



1980—1984

LEADING THE AGE OF INTEGRATED TECHNOLOGY

Stringent exhaust emission test

Exhaust emissions are discharged into a special collector for careful analysis of their constituents such as CO, CO_2, HC & NO_x in an endeavour to make each engine as clean as possible.

1

2

3

4

5

6

7

1. The Research and Development Center
2. All-new superbike FJ1100 set an SS 1/4-mile world record
3. The turbo-charged XJ650T
4. A new scooter age opened!
5. The Yamaha Technical Center moved from Iwata to Kakegawa.
6. The Off-road Riding School program started
7. Advancing into the field of aircraft engines. . . . . .

1980 to 1984
Leading the age of integrated technology

- In the early-eighties the sales war became more and more intense. Each manufacturer concentrated its efforts on developing new technology and improving its production system, using a number of industrial robots.
- In 1980 Yamaha celebrated the 25th anniversary of its founding. This was also the year that Yamaha took great strides in new technology development. New energy-saving systems, the YICS and the YEIS, were announced, thus bringing both more power and better fuel efficiency together.
- Computer technology and electronics were also fully utilized for the development of the new turbo system and CYCOM.
- In February of 1981 Yamaha's total scooter production reached the one million mark.
- In 1982 Yamaha's total motorcycle production exceeded the 20 million mark.
- The Research and Development Center was completed as the new nucleus of technical research and development activities.
- Yamaha boldly advanced into the fields of aircraft engines and wind-force generators, while continuing to strengthen the line-up of motorcycles in many different types and sizes.
- In 1982 Yamaha's capital increased to ¥8,061,735,800.
- In 1984 Yamaha won the Daytona 200, Florida, USA for the 13th consecutive year.
- Yamaha led the way into a supersports era with its RZV 500R (RD500LC).

YPVS (Yamaha Power Valve System)

—Effective exhaust timing control

YAMAHA Road Racer TZ500

SUMMARY

This system controls the exhaust timing by means of a variable valve so that more effective timing can be ensured in accordance with each rpm level, so that more power output is obtained.

BACKGROUND

Port timing (intake, exhaust and scavenging) is a very important factor that determines the characteristics of a 2-stroke engine. In general, fast exhaust timing means that the engine will perform well in the high-speed, high-power range, while slow timing means the engine will have good low-end torque. However, a road racer or motocrosser which must perform well especially in the high power range will also encounter many other situations, such as commg out of a corner, when it will need high torque and good mid-range performance. The YPVS answers both of these needs.

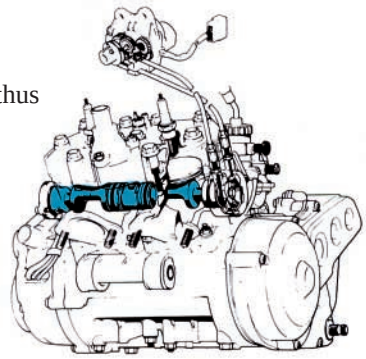
OPERATION

The YPVS employs a spiral shaped valve located on the top of the cylinder's exhaust port. This valve is operated by means of a cable from a computerized mechanical control unit which detects the ignition frequency and determines the required turning angle of the valve. In this way the valve moves upward and downward out of the exhaust port. This means the exhaust timing is constantly adjusted in accordance with the rpm level, thus giving more effectrve timing over the entire speed range.

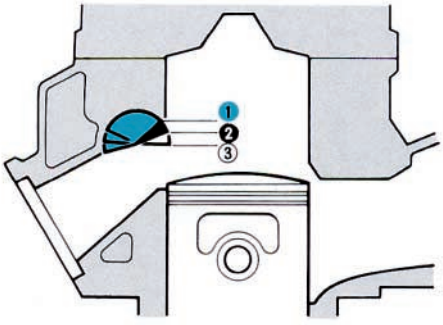
The TZ production racer employs a mechanical control system, but the factory racer YZR500, the first Yamaha machine to adopt the YPVS, features an electrical control system to adjust the exhaust timing by means of an ignition pulse, as do most current sports bikes.

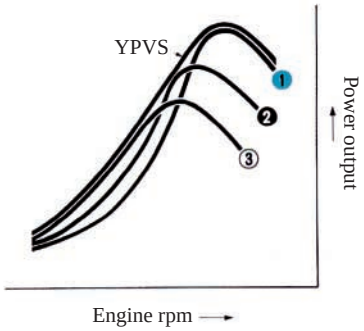
RESULTS

More effective exhaust timing is given in the entire speed range' thus bringing both high performance and good fuel economy together.



'84 YPVS RZ 250RR





Zero cutawa carburetor —Keeping the engine more responsive

Yamaha Road Racer TZ500

SUMMARY

This carburetor employs a non-cutaway throttle valve. Even when the throttle valve is completely closed, the fuel level remains at the height of the injection nozzle.

BACKGROUND

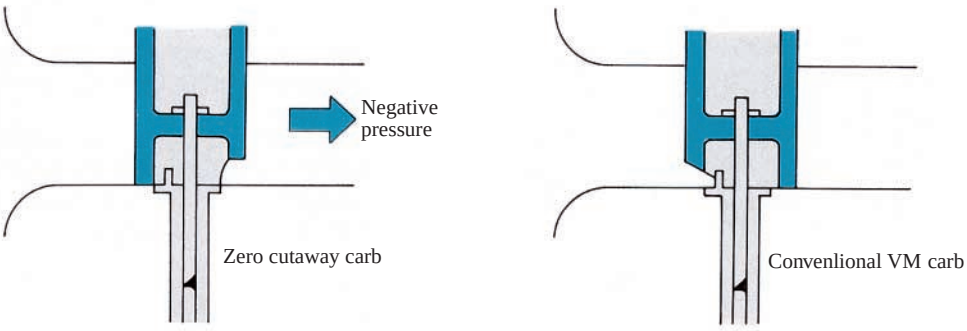
The high-performance production racers employed this Yamaha-original system to make them even more competitive.

OPERATION

The unique quality of this system is that when the throttle valve is completely closed, the fuel level is brought up to the upper surface of the nozzle. As the name suggests, when this throttle valve is completely closed, the entire main bore of the carburetor is also closed, and in order to ensure that the vacuum created on the engine side is always working on the nozzle jet, a special cutaway is provided on the engine side of the throttle valve.

RESULTS

This system makes the engine ready to respond quickly to any situation, so that race performance is substantially increased.



’80 TZ500

Liquid-cooled 2-storke engine

—Preventing heat-induced power loss

Yamaha Motocrosser YZ125

SUMMARY

The revolution of the crank is used to operate a water pump which forcefully circulates the coolant around the cylinderhead.

BACKGROUND

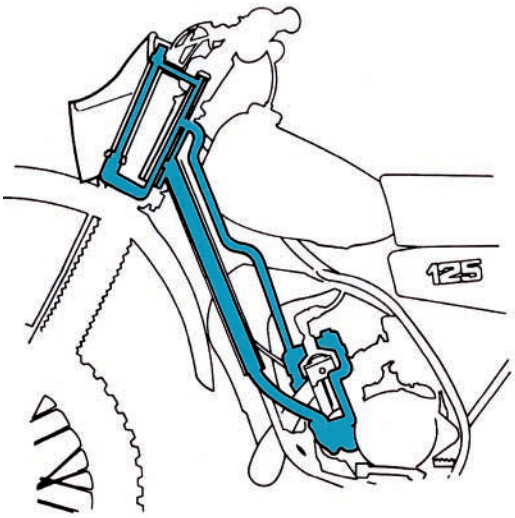
Back in 1975, Yamaha's first liquid-cooled works motocrosser YZM125 made its debut on the motocross racing scene, and it created quite a sensation. The YZ125 was the first production model to feature this race-proven cooling system.

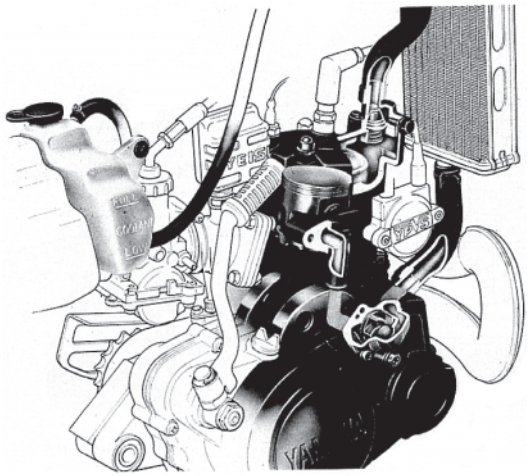
OPERATION

The aluminum alloy radiator, which was located on the front of the steering head, was compact and light-weight. The coolant passage consisted of the handle crown, the steering head pipe and the down pipe of the frame. This unique layout resulted in a simpler hose arrangement and smoother steering operation. The radiator and number plate were designed as one unit, and its high position protected it from flying stones and the like.

RESULTS

The liquid-cooled engine showed the advantage of more even cooling, which prevented heat-induced power loss. This meant that the engine could perform well even in the latter stages of a race, and there was also less worry about the area surrounding the cylinder and piston.





'84 DT200R

Calibmatic carburetor system

—Effective control of atmospheric pressure

Yamaha Enduro 175

(Built to Central and South American specifications)

SUMMARY

This is a special carburetion system that was developed for motorcycles used at both high and low elevations. The system automatically controls the atmospheric pressure that comes to work on the float chamber, so that the optimum mixing ratio of air and fuel is insured.

BACKGROUND

This system was developed to meet the needs of motorcycle users in Central and South America, who may often drive from sea-level to as high as some 4,000 meters elevation all in the course of a day's work.

OPERATION

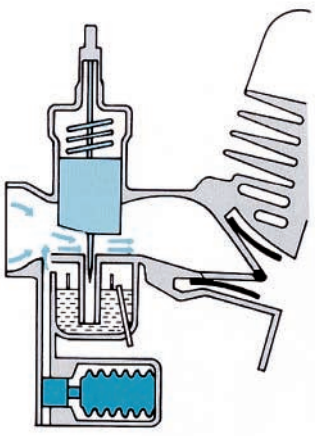
Carburetor setting is extremely sensitive to changes in air pressure. When it rains or when riding at high elevations, the mixing ratio of air and fuel becomes too rich, thus affecting the engine's performance.

The Calibmatic carburetor system functions to control the atmospheric pressure that comes to bear on the float chamber. At high elevations the size of the air vent pipe is reduced, which lowers the relative pressure on the fuel surface, thus decreasing the amount of gasoline passing through the jets. Therefore, as the amount of air passing through the venturi decreases, the amount of gasoline also decreases, so the mixing ratio remains constant and the engine's performance remains more stable and reliable.

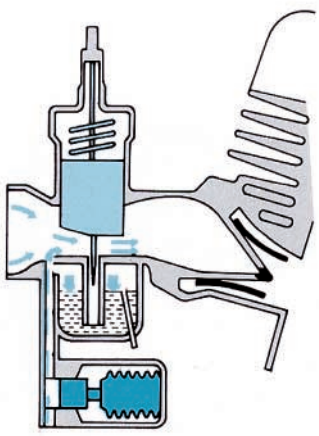
The system uses a vacuum bellows similar to that used in a pressure gauge to adjust the size of the air vent pipe. The tube expands and contracts with changes in air pressure, the amount of which is transmitted to the valve, which in turn controls the amount of air.

RESULTS

The carburetor functions well when used at many different elevations.



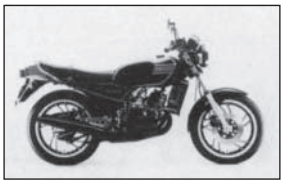
High altitude



Low altitude

Orthogonal engine mount

—Decreased engine vibration



Yamaha Sports RZ250/350 (RD250/350)

SUMMARY

Engine mounts were positioned at either end of the axis passing through the center of gravity of the engine. In this way the vibrations created in a number of different directions were all converted into rolling vibrations around this axis so that they could be absorbed by the rubber mounts.

BACKGROUND

Most of the vibration is produced by the up and down motion of the pistons. However, because of a number of complicated factors, such as revolution and weight distribution balance, some vibration is also created in other directions.

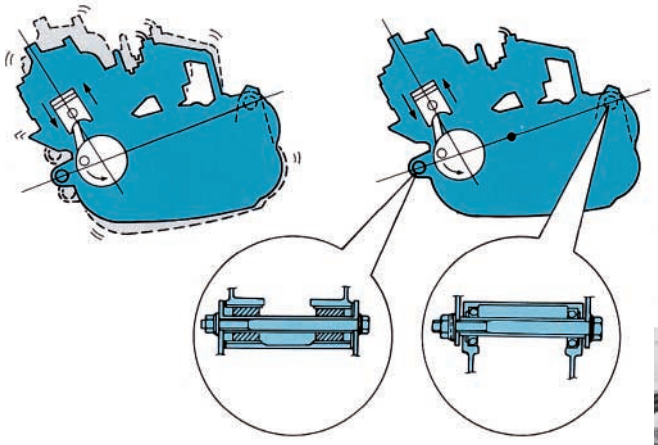
The RZ250 (exported as the RD250) employed engine mounts that were designed based on data from a computer analysis of the engine's vibration patterns. The data determined the right number and positioning of mounts, so that engine vibration could be decreased for more riding comfort.

OPERATION

An axis was established that passed through the center of gravity of the engine at a prescribed angle to the cylinder, and engine mounts were positioned at either end of this axis. When all the vibrations produced in a number of different directions were converted into a rolling vibration, a vibration system with only one resonance was created. The resonant rpm could be determined by the stiffeness and width of the mounts. Therefore, the resonant rpm was kept at the usable engine operating speed range by employing rubber mounts with properly preset stiffeness, so that vibrations outside this resonance level would be absorbed.

RESULTS

By decreasing the amount of load on the frame, the bike body could then be made lighter, at the same time creating a whole new feeling in 2-stroke super sports motorcycling.



YEIS (Yamaha Energy Induction System)

—More power and better fuel efficiency

Yamaha Motocrosser YZ250/Yamaha Enduro IT200

SUMMARY

This system utilizes the negative pressure produced in the intake passage when the piston moves up and down to induce a part of the air/fuel mixture into and out of a special chamber. In this way the fluctuations in the velocity of air/fuel mixture stream can be evened out, thus creating a more stable and effective intake function for higher power and better fuel economy mainly in a 2-stroke engine.

BACKGROUND

When the intake port is closed in conventional 2-stroke engines, the negative pressure level in the venturi rises and thus decreases the effectiveness of the venturi action in a certain rpm range during the next intake stroke. The YEIS is a good technical solution to this problem. At first this system was adopted in motocrossers so that their race performance could be increased, but its range of application has gradually spread to include even the Yamaha Mate V50.

CONSTRUCTION

Its basic construction is very simple using a connecting pipe between the intake passage (carb joint) and the special chamber. Power is increased especially in the low to medium speed range, without changing the basic design of the engine.

OPERATION

Fig.1

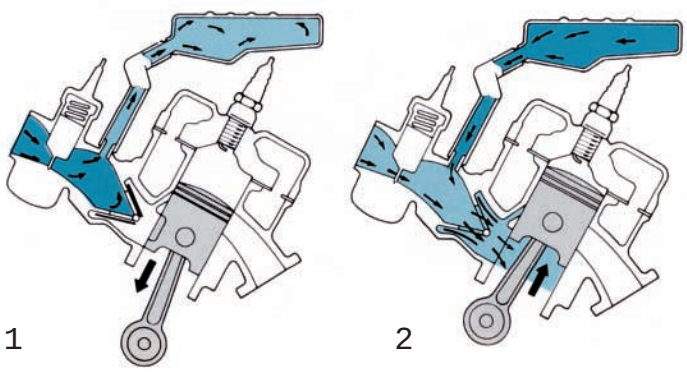
When the piston moves down, the air/fuel mixture in the crankcase is compressed to close the reed valve. A part of the air/fuel mixture is then induced from the intake passage into the special chamber while at the same time giving a boost to the air/fuel mixture stream past the throttle valve.

Fig.2

When the piston moves up and the reed valve opens, a negative pressure is produced in the intake passage. The chamber then releases the air/fuel mixture into the intake passage. This intake stream joins the stream coming through the throttle valve and enters the cylinder, thus increasing the supply of air/fuel mixture each time.

RESULTS

The air/fuel mixture flows through the intake passage smoothly and continuously so that the intake efficiency is increased and fuel supply from the carburetor is evened out, thus allowing easier carburetor setting for higher power and better fuel economy especially in the low to medium speed range.



1 2

XJ400

YICS (Yamaha Induction Control System)

—Increased combustion efficiency

Yamaha Sports XJ400/550/650

SUMMARY

This 4-stroke engine system induces a swift swirl of the air/fuel mixture into the cylinder during an intake stroke so that the combustion speed and effect is increased, thus resulting in an increase in fuel efficiency.

BACKGROUND

This outstanding engine system was developed as a part of Yamaha's positive answer to the worldwide problems of protection of resources and energy conservation. Its construction is so simple that it can be adopted in any kind of 4-stroke gasoline engine, regardless of the number of cylinders and cylinder shape, with only minor modifications in its design.

OPERATION

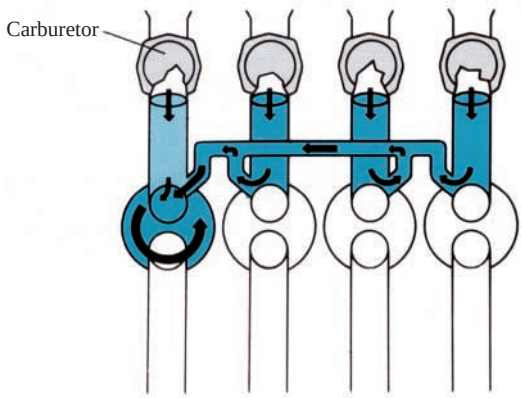
• Use on a multi-cylinder motorcycle engine:

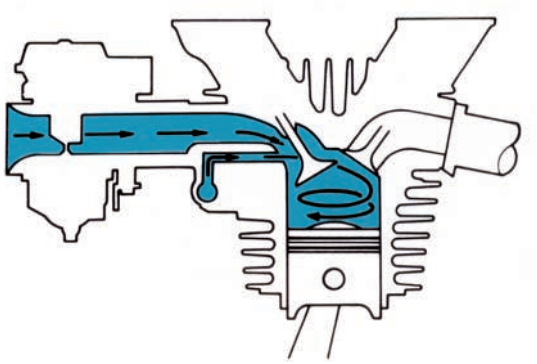
The YICS includes a sub-intake port along with each main intake port. The sub-intake port is about one fourth the size of the main intake port. The nozzle of each sub-intake passage is set parallel with a tangent line on the cylinder. All these sub-intake ports are designed to work in linkage with one another.

When the intake valve on a cylinder opens, all the others are kept closed. Then all the air/fuel mixture in the interrupted narrow sub-intake passages rushes into the opened sub-intake port, thus producing a swift swirl when it goes into the cylinder. Compression, ignition and burning take place while the air/fuel mixture is still swirling along the inner wall of the cylinder. This results in the same level of combustion effect as a good conventional engine, despite much less fuel consumption.

RESULTS

Fuel efficiency is greatly improved.





CV50E

V-belt type stepless transmission

—Smooth acceleratIon and deceleration

Yamaha Beluga CV50E/80E

SUMMARY

This is a newly designed V-belt drive stepless transmission that needs no gearchange operation. The reduction ratio changes automatically in accordance with the rpm range, thus, resulting in smooth, shockless speed change.

BACKGROUND

This transmission was designed specifically for the Scooter Beluga. It was adopted in the ’82 Salient as well.

CONSTRUCTION

The V-belt links the primary sheave assembly on the crankshaft side to the secondary sheave assembly on the rear wheel side. The reduction ratio changes in accordance with the change of the V-belt diameter.

OPERATION

1. Idling

   When the engine is idling, its drive power is transmitted as follows:

   Primary sheave—V-belt—secondary sheave—clutch carrier.

   In this case, however, the centrifugal force of the clutch carrier is weaker than the force of the clutch spring, thus, preventing the clutch carrier from coming into contact with the inside of the clutch housing. No drive power is then transmitted to the clutch housing .
2. Starting-off

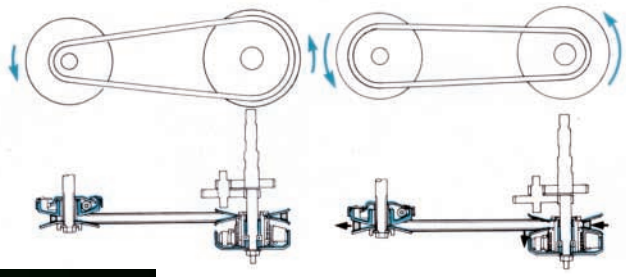
   When the engine’s speed reaches about 3,000rpm, the centrifugal force of the clutch carrier becomes stronger than the force of the clutch spring thus the clutch carrier comes into contact with the inside of the clutch housing. Friction force (transmission torque) is then produced
3. Medium speed range

   As the engine’s speed increases, the centrifugal force begins to move the roller weight outward which in turn pushes the primary movable sheave toward the primary fixed sheave. The V-belt is then pushed up outward (diameter of the V-belt is increased).
4. High speed range

   In the high speed range, the roller weight shifts farthest outward and the primary movable sheave is pushed farther toward the fixed primary sheave. The V-belt is then pushed up farthest outward. On the contrary, the V-belt on the secondary sheave side is pushed down farthest inward, thus providing the lowest reduction ratio.

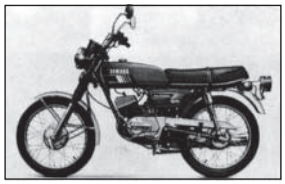
RESULTS

Throttle operation alone ensures smooth acceleration, deceleratron and uphill riding.



100% alcohol engine

—Use of corrosion-resistant materials



Yamaha RX125 (Built to Brazilian specifications)

SUMMARY

This is a 100% alcohol powered 2-stroke engine. Gasohol which contains 20% alcohol is used to start a cold engine but it is switched over to 100% alcohol once the engine is started.

BACKGROUND

At the same time that Yamaha has been working to improve the fuel efficiency of the gasoline engine, it has also been putting a lot of energy into the development of alternative fuel engines. Much earlier, in cooperation with Yamaha Motor do Brasil, Yamaha developed a gasoline/alcohol engined bike called “gasohol model” for sale in Brazil. Then, at the request of the Brazilian Government, a 100% alcohol powered 2-stroke model was completed.

OPERATION

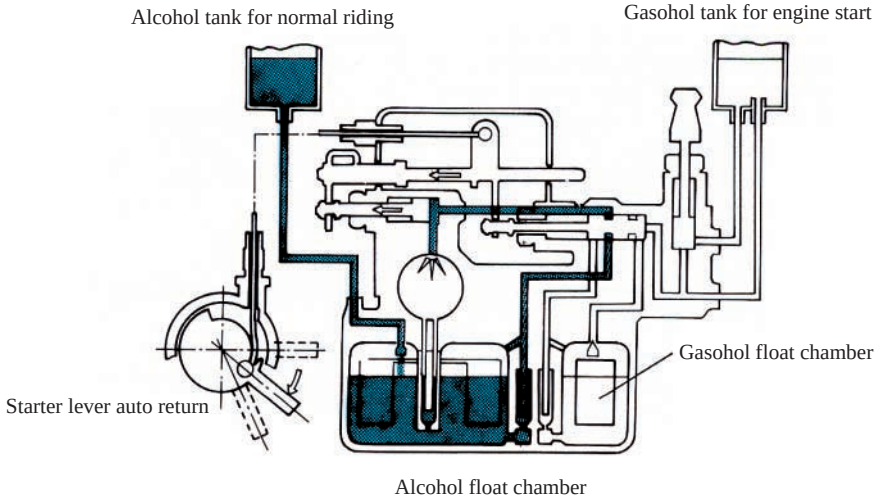
During the development of this model, a number of problems had to be overcome. In order to prevent corrosion, research was done on the effect of alcohol on various engine materials. In terms of performance, changes in the carburetor, compression ratio and spark plug succeeded in producing an engine that gave the power demanded of it, while at the same time being very fuel efficient.

The 100% alcohol powered model is operated in the same manner as a conventional gasoline powered bike, but it is equipped with a gasohol tank for starting the engine as well as an alcohol tank. Gasohol is induced into the carburetor by means of a starter lever positioned close to the handlegrip to start a cold engine. The engine runs on 100% alcohol fuel after it is started.

The gasohol passage is automatically interrupted by releasing the starter lever once the engine is started.

RESULTS

Alcohol proves to be a very effective alternative fuel because of its outstanding properties including a high octane value. The 100% alcohol engine with a high compression ratio and good combustion characteristics is comparable to a good gasoline engine.



In-line 75° V-twin engine

—Unique design format

Yamaha Sports XV750 Special

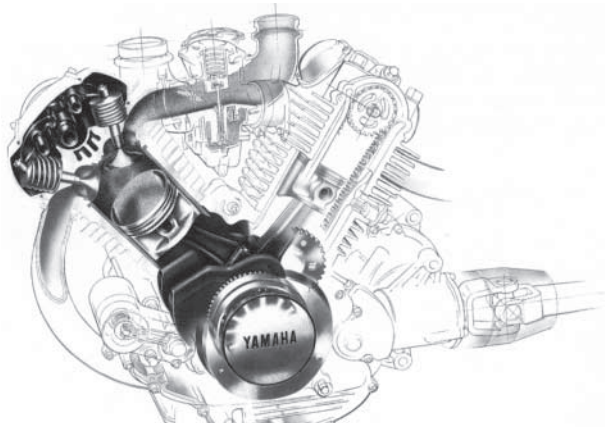
CHARACTERISTICS

This new engine was developed to set a new direction in superbike design. The two cylinders were lined up front and rear with an angle of 75° and only one crankshaft was used, thus making the whole power unit much slimmer than a conventional parallel-twin engine. Taking into consideration such factors as firing interval and vibration, an angle of 75°, midway between 90° and 45°, was chosen because it would retain the good vibration qualities of a V-twin engine. In addition, the two carburctors could be positioned within this V-space.

The weak point of an in-line V-twin engine is the cooling of the rear cylinder, but Yamaha engineers handled this problem by designing the sidecover with good wind-inducing characteristics in mind and also by fitting a heat-conductive steel gasket to the cylinderhead.

RESULTS

The new V-twin model appealed especially to adult motorcyclists because of its truly innovated styling and distinctively comfortable riding feel. It was recognized as one of the masterpieces of Yamaha's popular Special Series.



'81 XV750 Special

'84 XV750 Virago

Frame integrated engine design

—Simple, lightweight chassis design

Yamaha Sports XV750 Special

SUMMARY

This was an advanced frame design using the engine as a part of the frame construction, so that a simple, lightweight chassis design could be obtained. The Yamaha Sports XV750 Special came with this advanced feature.

CONSTRUCTION

Yamaha created a new frame design method using the pressed steel plate backbone type main members with box-type cross section. The front cylinder and crankcase were designed as a part of these main members. A through-head stud bolt was used to flx the front cylinder securely.

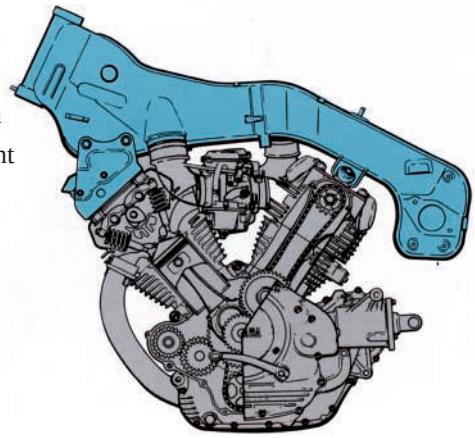
The adoption of steel gaskets increased the sealing effect.

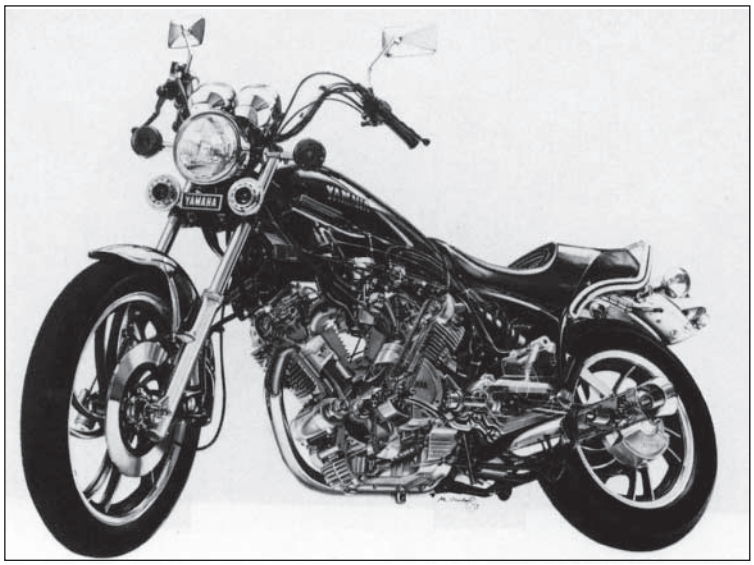
The inside of these main members was also used as the intake passage, which in turn increased the effect of intake silencing.

The frame was constructed of these main members and tubular rear members.

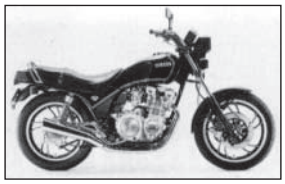
RESULTS

This design method thus succeeded in carrying the easy-to-handle design concept of the Special Series one step further. In addition, this design had sufficient strength and suitable amount of rigidity for good cornering characteristics.





Anti-nosedive front fork —Decreased front dive



Yamaha Sports XJ750A (XJ750 Seca)

SUMMARY

This is a Yamaha-original anti-nosedive mechanism, which controls the front fork stroke by regulating the flow of fork oil. It is fitted on the lower end of the front fork and helps prevent front dive during hard braking so that the bike retains its balance with sufficient ground clearance.

BACKGROUND

Compared to a 4-wheel vehicle, the center of gravity of a motorcycle is much higher. This is an unavoidable fact resulting from certain structural necessities as well as from the fact that the bike must lean to a certain degree when it takes a corner. It is also a fact that the changes in the center of gravity caused by certain conditions that are encountered during driving are also much greater. Sudden braking causes a forward shift in the center of gravity, due to the force of inertia, for example. This can affect the stability of riding posture Yamaha's newly designed anti-nosedive mechanism is a good solution to this problem.

CONSTRUCTION

The anti-nosedive mechanism incorporates a compression damping system that restricts the flow of fork oil. There is a valve located in this system that is activated when the brake is applied, thereby controlling the flow of fork oil.

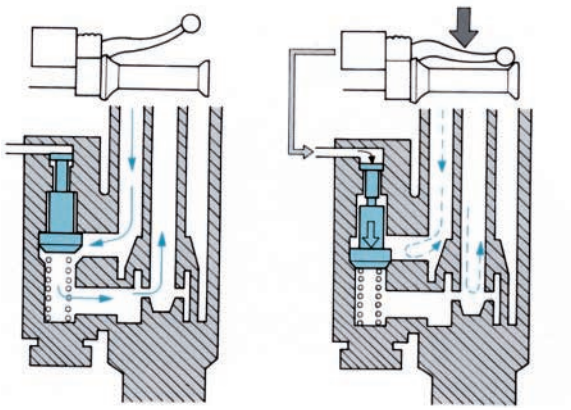
OPERATION

When the brake lever is squeezed a certain amount, the pressure of the brake fluid pushes a valve piston into the valve seat, thus, restricting the flow of fork oil.

When the road conditions are bad and the suspension must respond to bumps in the road, the increase in the fork oil pressure caused by a shock from the road opens the spring loaded valve seat. The valve piston is then released from the valve seat. When this happens, the fork oil once again flows unrestricted, and the suspension can absorb the shock from the road surface. When the road surface becomes smooth again, the pressure in the compression damping system decreases, and the valve seat returns to its normal position.

RESULTS

This mechanism helped reduce front dive during hard braking while at the same time keeping the forward shift of the rider's weight to a minimum, thus helping to improve both riding comfort and steering characteristics.



Computerized monitor system —Easier machine check

Yamaha Sports XJ750A (XJ750 Seca)

SUMMARY

This system utilizes a micro-computer to monitor the position of the sidestand, the amount of brake fluid, lubrication oil, battery fluid, fuel level, and the headlight and tail/brake lamp functions, and clearly display all these information on the instrument panel, thus enabling the rider to see them at a glance. The above model became the world's first motorcycle to feature this system.

BACKGROUND

The system represents Yarnaha's positive and strong policy of developing new technology and new quality products, clearly saying— "This is Yamaha's idea of how a motorcycle should be built in the '80s".

CONSTRUCTION

The system consists of sensors that monitor the motorcycle's vital functions, and by means of a micro-computer and an integrated cir-cuit board, analyzes and displays the information on a liquid crystal display (LCD) panel.

OPERATION

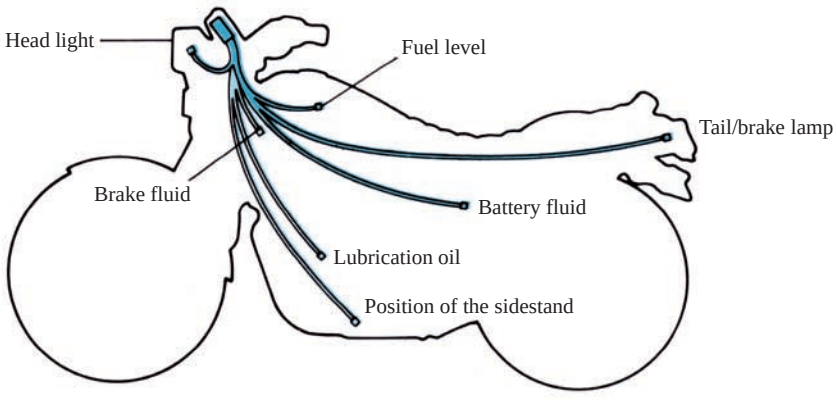
When the main switch is turned "ON", raw information from the sensors is fed to the micro-computer which analyzes it and displays the results on the panel. If there is some irregularity that requires the rider's attention, a warning lamp goes on.

Also, while driving, the rider can press the check button at any time to put the system into function. The display time for one function on the check list is 0.7 sec.

RESULTS

The machine can be checked out automatically before or during riding.

Points for monitoring



YZ250

Rising-rate Monocross suspension

—Newly designed link mechanism

Yamaha Motocrosser YZ490/250/125/100 & Enduro IT175

SUMMARY

In this system two arms link the shock absorber and the swing arm so that the shock absorption effect may be changed in accordance with the degree of wheel stroke induced by shocks from the road in what is called a rising-rate (progressive) function.

BACKGROUND

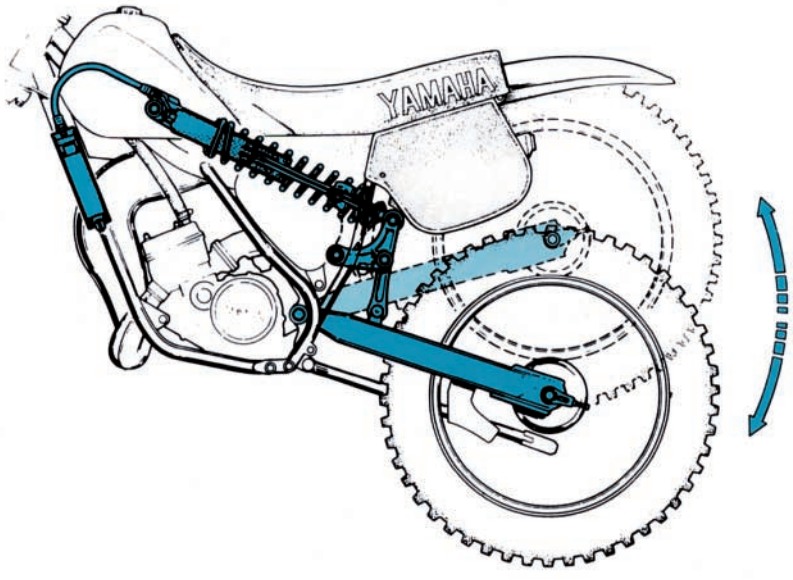
Yamaha, which leads the industry in the development of rear suspension technology, has added a new link mechanism to its already-proven Monocross suspension.

OPERATION

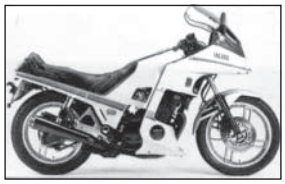
The new rising-rate Monocross suspension system features an I-shaped rod and an L-shaped arm that function as a lever between the swing arm and the shock absorber. In this mechanism, changes in the lever ratio cause the shock absorption effect to differ from near-full extension stroke to near-full compression stroke even over the same degree of wheel travel. The shock absorber works softly against small bumps or minor shocks, but when bumps are large or when shocks from the road surface are strong, such as when landing from a jump, the shock absorber works hard to prevent bottoming. In addition, the damping force of the damper unit is fully adjustable on both the extension and compression sides.

RESULTS

The rising-rate effect of the new Monocross suspension helps greatly to improve the handling characteristics of a machine on bumpy road surfaces.



Turbo system —Yamaha's new total system



Yamaha Sports XJ650T

SUMMARY

The turbo system makes use of the exhaust energy to turn a turbine which in turn drives a compressor to supply more air into the engine to produce more power.
The unique quality of Yamaha's turbo system is that it employs a conventional carburetor system instead of a special fuel injection system while it makes the high performance turbo charger even more effective by combining it with several other technological achievements, thus creating a new "total system".

BACKGROUND

Yamaha's history in turbo technology goes all the way back to the Toyota 7 which had its first test run in July of 1970. The Toyota 7 was the first turbocharged car built in Japan, having a 5-liter V-8 engine equipped with a Yamaha designed twin turbo system. The XJ650T was introduced as Yamaha's first production turbo model, using a conventional carburetor system based on Yamaha's long proven turbo technology.

CONSTRUCTION

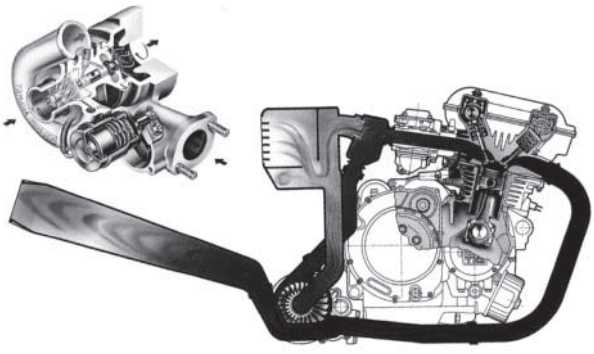
Completed into one integrated system are: the proven reed valve induction system and energy-saving YICS along with the unique turbo charger, pressurized carburetor system and vacuum type electronic governor with knocking sensor.

OPERATION

* At low speeds: Normal aspiration. Of course, this includes the proven YICS function that ensures good fuel economy without sacrificing drivability
* At high speeds: As the exhaust energy increases, the turbo charger begins to work, supplying more air into the engine to produce more power, which in turn gets more performance out of the fuel that is consumed.
* Acceleration: When the throttle is snapped open, the reed valve opens without delay to ensure that the engine gets all the air it needs. This means quick engine response and a smooth lead into the turbo charger function.

RESULTS

Better fuel economy, quicker engine response and outstanding power development characteristics are ensured over the entire speed range. In addition, the conventional carburetor system increases the maintenance-free characteristics of this turbo system.



Aerodynamics —Greatly reduced wind resistance

Yamaha Sports XJ650T

SUMMARY

The XJ650T features full fairing which was developed to give a high degree of aerodynamic effect. The design retains a slim overall profile while actively supplying the engine with the necessary cooling air flow, and it also creates an effective down force that improves the stability of riding at high speeds.

BACKGROUND

Wind resistance and front wheel lift at high speeds are the two problems of motorcycle fairing design. As a result of repeated wind tunnel testing, Yamaha has succeeded in reducing the negative effect of these two factors to a minimum.

CONSTRUCTION

The fairing consists of four parts: l) the screen 2) front cowl 3) center cowl and 4) seat side cowl.

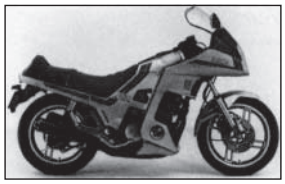
* The screen is designed so that normally the road ahead is seen over the top of it while a flair at the top of it throws the wind up and over the top of the rider's helmet.
* The inside of the fairing eliminates protrusions as much as posslble, and the seat is long with plenty of room for forward and backward movement while the kneegrip and other sections are slim for a comfortable riding position.
* The forward part of the fuel tank and the inside of the front cowl are free of protrusions, giving the rider a comfortable knee position. The inside of the cowl is also used as a compartment for small articles.
* The instrument panel is built into the steering head and integrated with the front cowl. The front flashers are built into the fairlng, and even the rearview mirror is designed for minimum air resistance.

RESULTS

Wind tunnel test results show that with the fairing, wind resistance is reduced by 7%, and the front lift is reduced by 25% at 200kph.

YFIS (Yamaha Fuel Injection System)

—Microcomputer-cotrolled fuel supply



Yamaha Sports XJ750D

SUMMARY

This system uses a digital microcomputer to sense the amount of air intake, engine speed and engine temperature so that the proper amount of air/fuel mixture is always supplied in the form of a strong swirl from the injector into the intake manifold.

BACKGROUND

The electronic fuel injection system that is known as a high performance, fuel saving system has been adopted in a motorcycle for the first time.

CONSTRUCTION

More than 10 years ago Yamaha succeeded in developing an electronic fuel injection system as well as a turbo system for the Toyota 7. The Y,F,I,S, that has been adopted in the XJ750D is an advanced version of the above system.

This system that is called an air intake type has been developed exclusively for a motorcycle by giving specific emphasis to the improvement of both performance and durability. It employs a hot wire type air flow sensor built in the air cleaner.

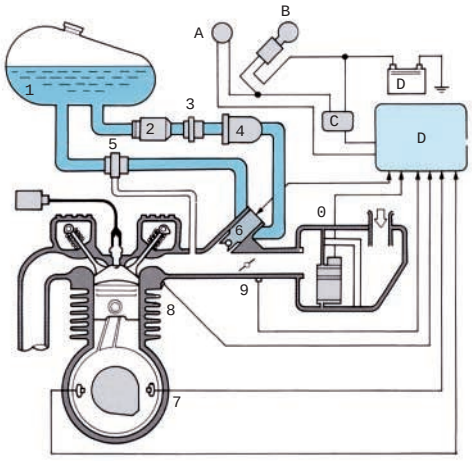
The system, unlike a conventional air flow gauge type, puts up no resistance to the intake stream.

This helps to prevent “time lag” in the supply of air-fuel mixture, making the system more responsive to the engine need for more power output. The system employs a pure electronic measurement method with no moving parts. This achieves the accuracy of every measurement, while ensuring almost trouble-free operation.

RESULTS

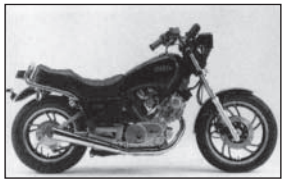
The system is not easily affected by a change in atmospheric pressure and maintains the proper mixing ratio of air and fuel with no adjustments even when operated in different temperatures or at different altitudes. This helps to make up a low-pollution engine with high performance and good fuel efficiency.

YFIS component parts



1 Fuel tank	4 Fuel filter	7 pulser	0 Air flow sensor	C Relay
2 Fuel pump	5 Pressure regulator	8 Temperature sensor	A Starter switch	D Battery
3 Fuel damper	6 Injector	9 Throttle switch	B Ignition switch	E Control unit

XV920



Adjustable riding position —Improved drivability

Yamaha XV920 Virago/XJ750 Maxim

SUMMARY

Handlebars, footrests and pedals have all been made adjustable, to fit the build or riding form of each individual rider.

BACKGROUND

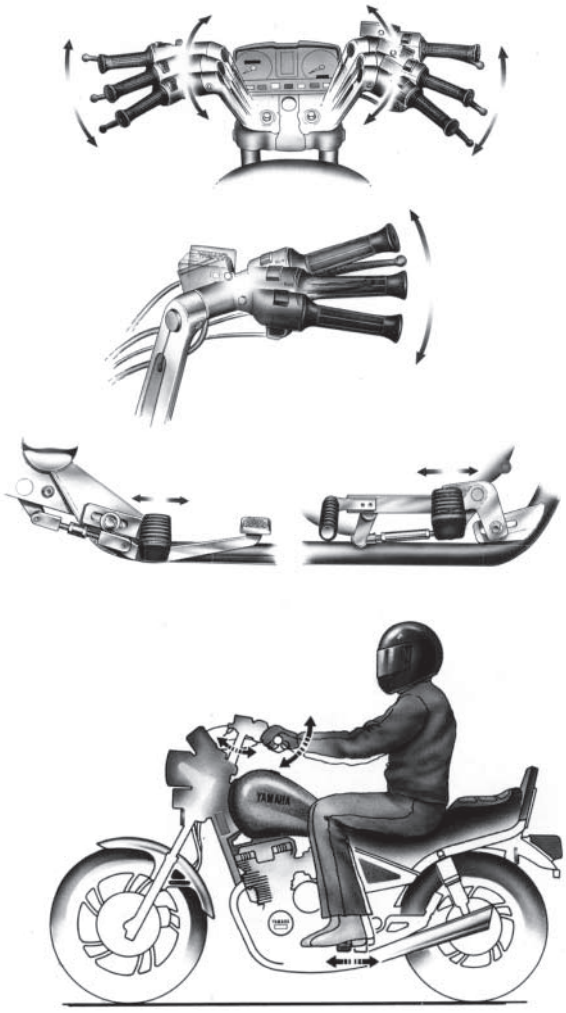
Motorcycles come in all shapes and sizes, and the same can be said for motorcycle riders. The aim of this revolutionary new system is to create a better match between man and machine for greater riding comfort.

CONSTRUCTION

The grip height and bend of the handlebars are both 3-step adjustable while the handlebar width can be adjusted over a 6-step range. The footrests, brake pedal and shift pedal can all be adjusted 30mm forward and 20mm backward from their standard positions. All these are simple bolt adjustments.

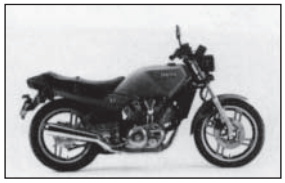
RESULTS

The riding position can be adjusted to the build or preference of the rider.



Liquid-cooled V-twin YICS engine

—Renewed V-twin sensation



Yamaha Sports XZ400/550

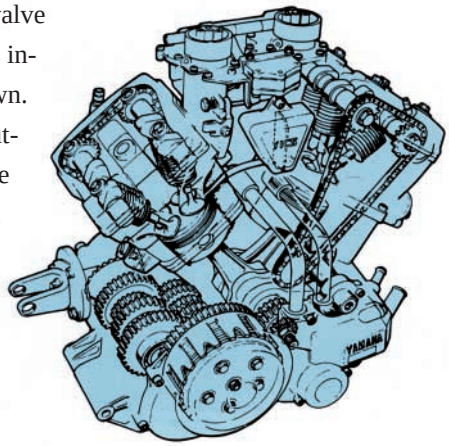
SUMMARY

Featuring a liquid-cooled, DOHC, 8-valve V-twin format with YICS, the new engine has answered the dreams of a new generation of superbike enthusiasts.

BACKGROUND

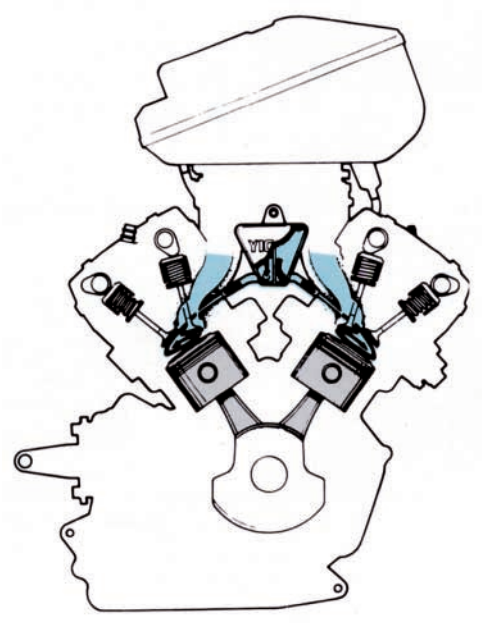
The XZ400 (the export model is the XZ550) has been introduced as Yamaha's positive answer to the diversified needs of motorcycle users.

CONSTRUCTION



The newly designed engine features a liquid-cooled, DOHC, 8-valve 70° V-twin format with YICS. Plus, a 3-weight 1-shaft balancer is included in the design to give this V-twin engine a feeling of its own. The DOHC, 8-valve system guarantees smooth, strong power output from the engine with overhead cam shafts directly driving the valves. Each cylinder has two intake and two exhaust valves. In addition, the adoption of the YICS means high power output and low fuel consumption at the same time. The newly designed, corrugate-type aluminum radiator features good heat dissipation and gives an effective solution to the biggest problem in V-twin engines—cooling of the rear cylinder.

This model has won widespread popularity because of its unique styling and distinctive performance in the true super sports spirit.



XT400

YDIS (Yamaha Duo Intake System)

—Two carburetors functioning in high rpm range

Yamaha Trail XT400/550

SUMMARY

In this system, connected to each of the ports are two carburetors (primary and secondary) functioning differentially according to the throttle opening. This is the first system of its type in the world.

BACKGROUND

This system has been developed as a epoch-making mechanism for increasing the performance of the "big single"—XT400 (export model: XT550).

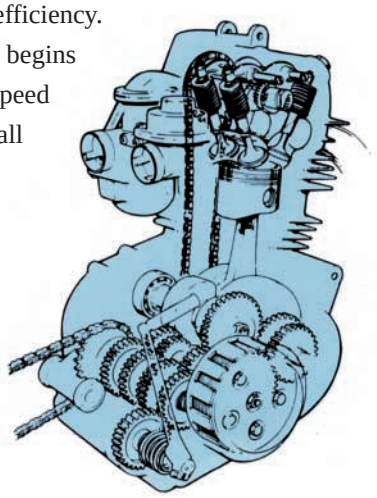
CONSTRUCTION

The primary carburetor is a cable-operated slide type (VM type) and the secondary carburetor is a vacuum-controlled slide type (BS type). These carburetors function as one integrated system.

OPERATION

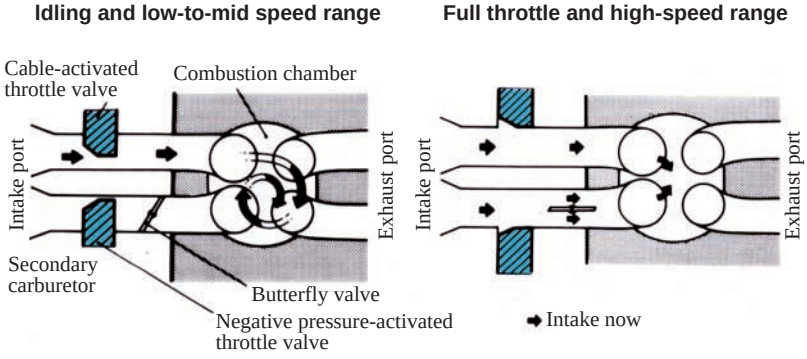
From idle to about half throttle, the primary carb supplies the air/fuel mixture. The velocity of the air passing through the narrow venturi is increased, thus allowing the precise adjustment of air/fuel mixing ratio, which in turn provides excellent throttle response. In addition, because the 4-valve layout offsets the intake ports relative to the cylinder-bore axis, the air/fuel mixture coming from the primary carb produces a strong YICS type swirl in the combustion chamber, resulting in better combustion efficiency.

As the throttle is turned from half to wide open, the secondary carb also begins to work, ensuring that the engine receives more mixture in the high speed range. When the throttle is fully opened, both of the venturis also open all the way for full power capacity.

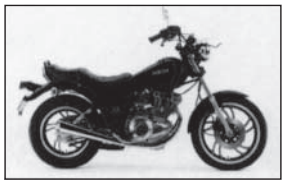


RESULTS

The problem of poor carburetion in the low-speed range is almost eliminated. The new system means smoother power development over the entire speed range than a conventional single-carb system.



XS400 Special



DOHC twin with YICS —Chamber-type new YICS

Yamaha Sports XS400 Special (XS400)

SUMMARY

This is a new DOHC twin that features a 180° crankshaft, gear-driven balancer system and chamber-type YICS (Yamaha Induction Control System).

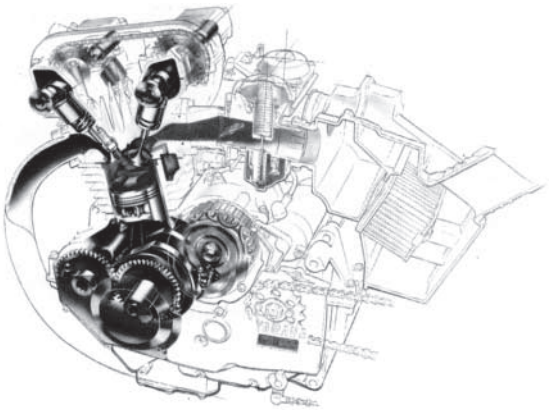
BACKGROUND

The main developmental aim of this model was to make the power unit as slim, compact, lightweight and easy to maintain as possible.

OPERATION

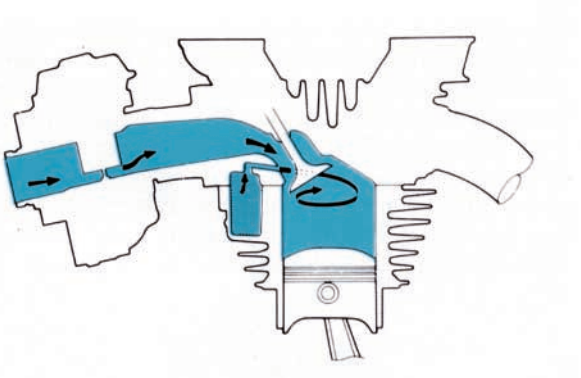
This new DOHC twin-cylinder engine is only 40mm wider than the OHC single-cylinder engine on the SR500. The generator is positioned on the back of the cylinder assembly above the crankcase. A large diameter clutch is adopted, but the clutch housing is thinner than before. The adoption of an electric starter has eliminated the need for a kick crank. All of these factors have contributed in making a slimmer power unit.

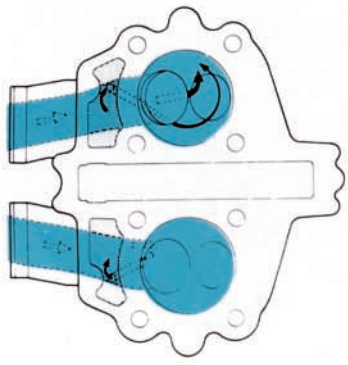
The YICS adopted on the XS series is different from that on the 4-cylinder XJ series in that it features a separate chamber on each side so that air/fuel mixture is compressed into the chamber by utilizing the induction momentum during compression stroke. The passage leading to the chamber is smaller in diameter, and the compressed air/fuel mixture is made into a jet stream by utilizing the negative pressure during induction stroke. The jet stream is led into along the inner wall of the cylinder, thus producing a strong swirl. This system is based on that of the XZ400 but differs in that each chamber is positioned on the inside of the cylinder block.



RESULTS

The air/fuel mixture fills the cylinder quickly, which in turn shortens the period of combustion time, thus, increasing power output and reducing fuel consumption.





XTI25

4-storke single with balancer

—Surprisingly quiet operation

Yamaha Trail XT125/200

SUMMARY

The newly designed 4-stroke single-cylinder engine features a gear driven single-shaft type balancer.

BACKGROUND

This new 4-stroke engine was developed specifically for the dual purpose XT125/200 with a fresh new styling and controllable torque characteristics in mind.

OPERATION

The SOHC system is gear driven, and Yamaha's exclusive dual-dome type combustion chamber makes use of the largest possible squash area to improve combustion efficiency.

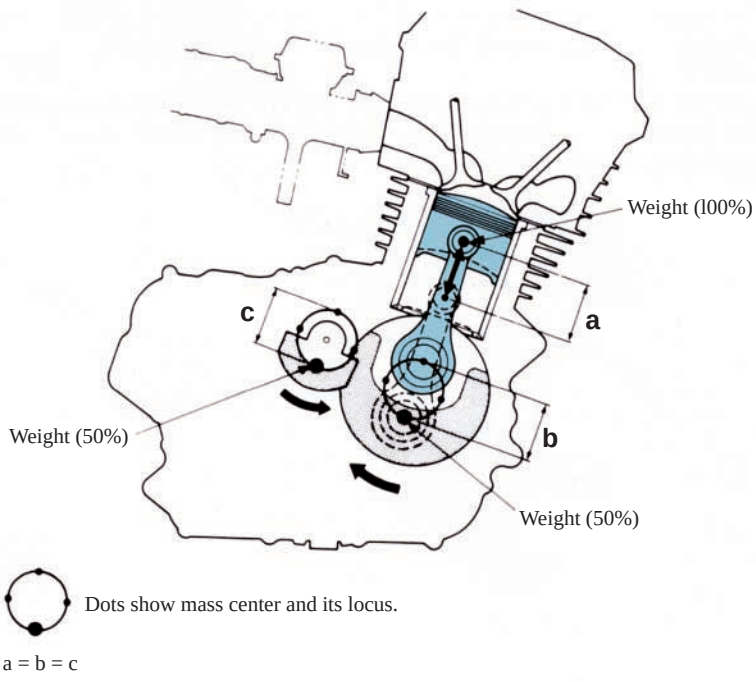
The heat-dissipating aluminum alloy cylinderhead is built as one unit with the head cover, making the whole power unit more compact. The source of engine vibration is the force of inertia created by the reciprocating motion of the piston and connecting rod. Ordinarily, the force of inertia of the piston's up and down motion can be directed to some degree into a horizontal direction by attaching a balance weight of about 60% of the weight of the up and down force to the side opposite the crank pin.

Although this method dissipates some of the vibration, it can not eliminate the vibration completely, but the new balancer mechanism on Yamaha's 4-stroke single cylinder engine works to offset the inertia force of the engine's reciprocating mass very effectively as follows:

One 50% balance weight of the up/down inertia force is positioned opposite the crank pin, and in addition, the other 50% weight is fitted on the balance shaft which rotates at the same speed as but in the opposite direction from the crankshaft. In this way the inertia force of the engine's reciprocating mass, including that of the horizontal direction, cancels out.

RESULTS

The new balancer mechanism decreases the load on the frame by reducing the engine vibration, thus making it possible t



CYCOM (Cycle Communication) —New LCD speedometer & tachometer

Yamaha XV920 Virago/XJ750D/XJ650T

SUMMARY

Now Yamaha has expanded its proven motorcycle computer technology, which began with the computerized monitor system, to include this new CYCOM (Cycle Communication) system. In addition to the monitor system, the speedometer and tachometer have also been newly designed in a liquid crystal display.

BACKGROUND

This system has been developed as part of Yamaha's positive policy of applying advanced computer technology to motorcycles. This technology is another world's first by Yamaha.

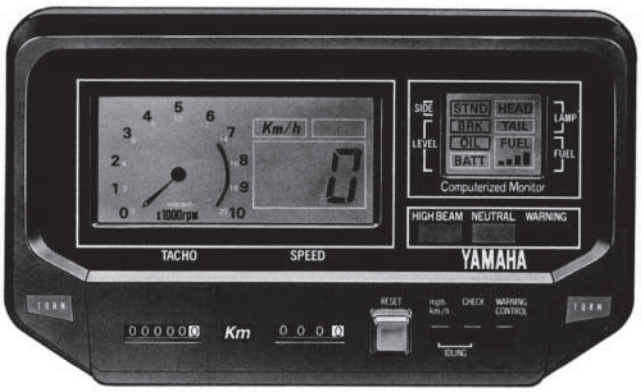
OPERATION

The speedometer uses an electronic circuit to carry information to a digital display that tells the rider the road speed in miles/hour or kilometers/hour at the touch of a button.

The tachometer is a dial type, like most tachometers, but when the engine is started and the speed increases, LCD graphics appear. One graphic is 250rpm. At idle, one press of a button will change one graphic to 50rpm.

RESULTS

The system makes man-machine communication better than ever before. In addition, the LCD speedometer allows the rider to make every read-out instantly.



Hydraulic valve lifter

—Reduced engine noise and vibration

Yamaha scooter XC180

SUMMARY

This hydraulic mechanism was a new technical feature adopted in the 4-stroke scooter XC180 that was introduced in 1982 as the top-of-the-line model. The engine using this valve lifter in the valve system runs quieter because there is no valve clearance during operation.

BACKGROUND

This hydraulic mechanism was developed as one of the essential technical features for the XC180 which was designed as a stylish, high performance scooter to change the ideas of non-motorcyclists on two-wheel transportation.

OPERATION

The hydraulic valve lifter functions as follows:

1 Oil in the high pressure chamber is blocked by the check ball. Thus, the valve lifter pushes the push rod to operate valve.

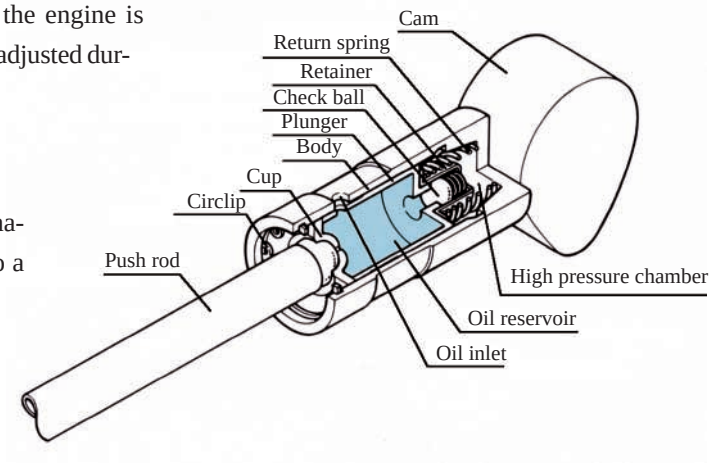
2 Small amount of oil leaks out through the clearance between the lifter body and the plunger.

3 Plunger moves further down in the lifter body for the loss of oil.

4 Plunger is pushed up by the return spring in the body until the valve clearance becomes zero.

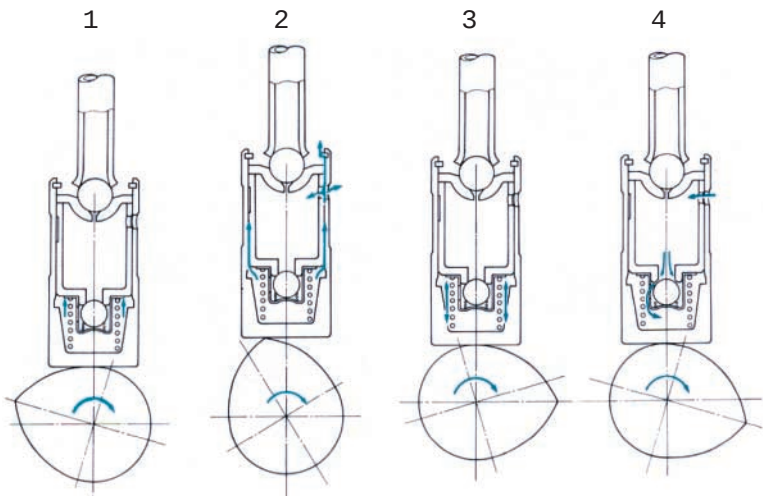
Thus, the check ball is pushed down and oil enters into high pressure chamber in order to fillit with oil again.

The valve lifter assembly is rotating while the engine is running. The valve clearance is automatically adjusted during operation.



RFSULTS

This virtually maintenance-free valve mechanism keeps the engine noise and vibration to a minimum.



New V-4 engine —Long comfortable touring

Yamaha Venture XVZ12T/XVZ12TD (1,200cc)

SUMMARY

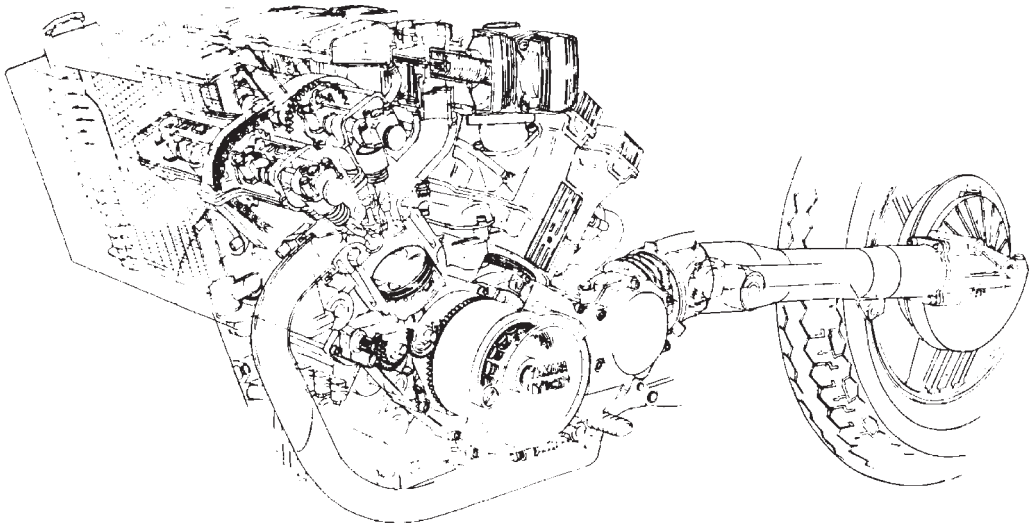
This new V-4 engine is Yamaha's largest engine yet, with 1,198cc total displacement, and combines such examples of Yamaha's advanced 4-stroke technology as liquid cooling, DOHC, 16-valve system and a balancer mechanism. This engine has been developed for the Yamaha Venture, an ultimate touring bike for the North American market. It has a slim, compact design for its large capacity, giving the bike excellent handling characteristics.

BACKGROUND

In North America there is a large group of big bike fans who enjoy touring 500 or 600 kilometers a day at a leisurely pace. In order to create the kind of bike that could tour for long hours on the highway at the 55miles/hour speed limit, Yamaha engineers have fitted this model with a new engine that has the characteristics right for this kind of riding condition, and they have also added the above features to ensure a comfortable carefree ride. In other words, the developmental aim was to build an engine that would provide good low to mid-range torque, while having the capacity to run at high speeds with fairly low rpm to ensure quietness and comfort of operation as well as greater freedom from maintenance worries and lower fuel consumption.

RESULTS

This new engine successfully combines various technical features into a highly integrated, effective engine. For example, the combination of DOHC 16-valve timing and YICS dramatically improves the low to mid-range torque characteristics, while the combination of the liquid-cooling system, single-shaft balancer and rubber mounts succeeds in making the engine exceedingly smooth and quiet.



Computer Leveling Air Suspension System (C.L.A.S.S.)

—Easily adiustable air pressure

Yamaha Venture Royale XVZ12TD (1,200cc)

SUMMARY

This system uses a computer to adiust the front and rear suspension to meet actual load conditions.

BACKGROUND

In touring, the amount of load on the suspension varies greatly depending on the weight of the rider, passenger, and amount of cargo carried onboard. Therefore, to enjoy comfortable touring there is a need to adjust the preload spring force of the front and rear suspension systems according to the load at any given time. Yamaha's new big touring model for the North American market, the Venture Royale (XVZ12TD), has the industry's first computer-controlled suspension system.

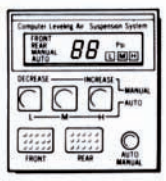
CONSTRUCTION

The shock absorbers on the front and rear of the Venture Royale use both springs and air, in what is called an air-assisted suspension, to create a soft new feel to its ride. This air pressure adjustment system includes the following parts:

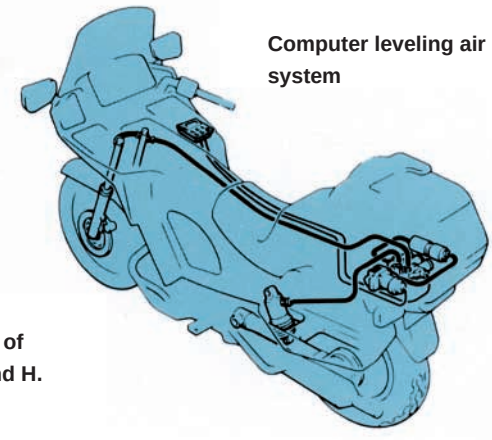
1 Electromagnetic valves for front & rear shock absorbers.
2 Air compressor
3 Air intake valve
4 Arr pressure sensor
5 Air pressure gauge
6 Air pressure control computer
7 Drier for steam produced when the air pressure is changed.

OPERATION

First, the computer is given three adjustment settings, L, M and H, The air pressure level is chosen so that "L" is right for a particularly light load, "M" is for a normal load and "H" is for a heavy load. When the L, M or H switch on the gauge is pressed, the sensor and compressor go to work to create the prescribed air pressure. By setting the gauge on manual, it is also possible to choose a desired air pressure level other than L, M or H.



The system automatically controls front and rear suspension setting at any of three preset levels L, M and H.



Computer leveling air suspension system

Wide Lateral frame —GP race-bred technology

Yamaha Sports FJ1100

SUMMARY

The main frame unit has an innovative “lateral” design proved on the GP racers.
It is constructed of high-tensile, box-section steel tubing. Its widely-spaced triangulated loops have a unique steering head configuration. This design provides excellent strength, rigidity and overall balance.

BACKGROUND

The lateral frame has been designed as an essential component to the new superbike at the top of the Yamaha range, in order to improve high-speed stability and maneuverability.

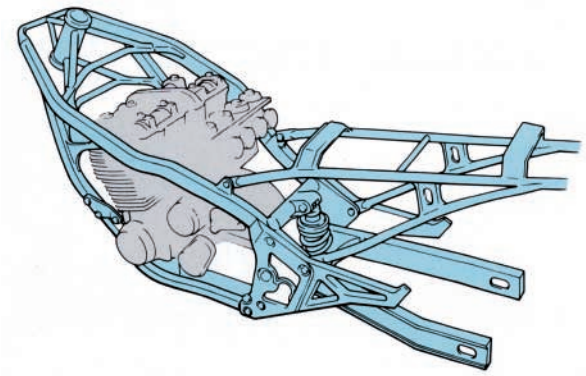
CONSTRUCTION

Unlike a conventional frame design, on the FJ1100 there is no frame top tube running over the engine and up to the steering head pivot. Instead, the frame loops are spread wide around the engine and continue on around the outside of the front fork legs to join ahead of the fork assembly.
The actual steering head pivot that carries the front fork spindle is set in the main frame assembly so that it is positioned as close to the swing arm pivot as possible.
This design gives the chassis much more rigidity, and the greater resistance to torsional stresses.
The results of computer analysis show that this is an advanced frame design in terms of strength, rigidity and vibration-reducing characteristics.

RESULTS

High-speed stability is enhanced, with one or two persons up, or when carrying a tank bag and side bags. Exceptionally good handling is ensured even when the machine is ridden at speeds up to 180km/h. Straight-line stability is actually increased when ridden in the higher speed range.
Engine accessibility is also improved by the removal of the frame’s lower rails on each side.

“Wide lateral” frame and monocross suspension



Cruise control system —More comfortable touring

Yamaha Venture Royale (XVZ12TD)

SUMMARY

This is the first cruise control feature ever adopted in a motorcycle. Once set, it works to hold the machine on a constant cruising speed.

BACKGROUND

This feature is standard on the ’84 Venture Royale for the US market. With this system, the rider can enjoy more comfortable long distance touring.

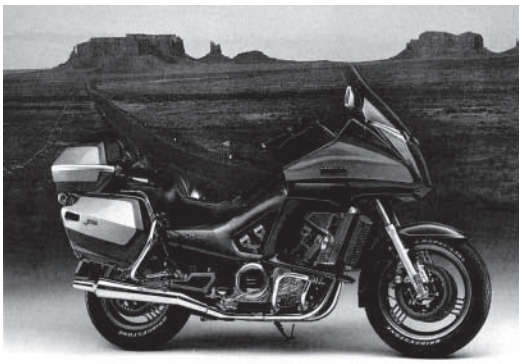
OPERATION

In this system all devices, as illustrated by the diagram, work in linkage with each other by means of an 8-bit micro-computer system, so that a constant cruising speed is maintained.

The rider can select any speed preferred by operating the control switch positioned close to the right handlegrip. The machine can be accelerated or decelerated by the normal throttle operation even when the cruise control system is in use.

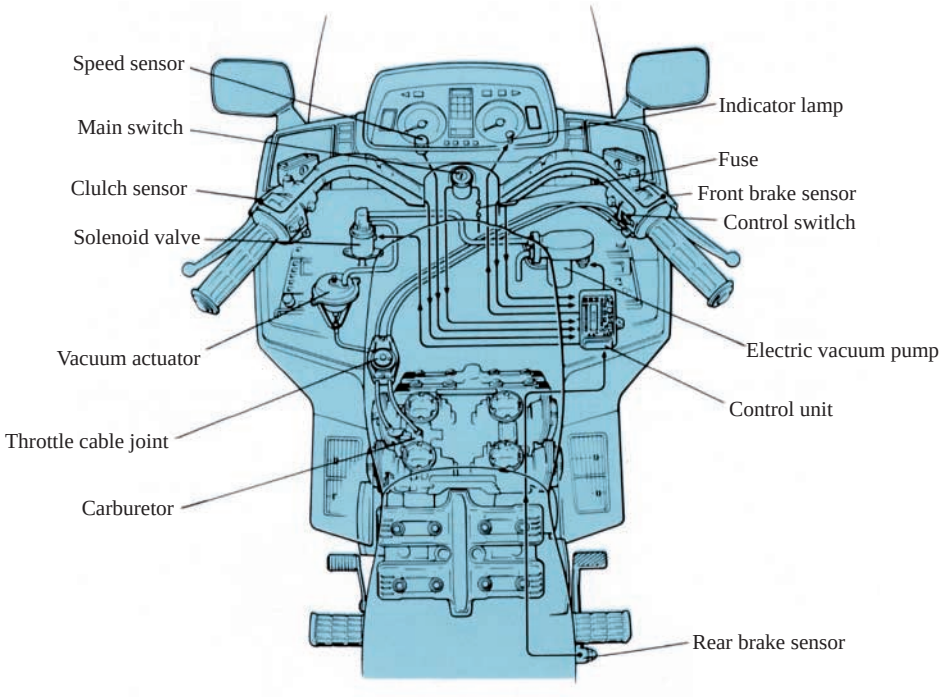
The cruising speed is automatically returned to its pre-set level when the rider ceases to accelerate the machine.

The system is automatically released when the speed is reduced by more than 5mph by throttle operation. Otherwise, it can be released by operating the front brake, rear brake or clutch. The power control switch or ignition cut-out switch also serves to release the system.

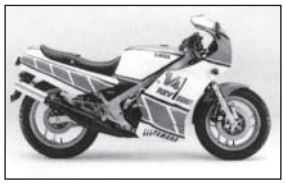


RESULTS

The rider can enjoy comfortable, tireless long distance touring.



2-stroke V-4 engine —Another race-bred technology



Yamaha Sports RZV500R (RD500LC)

SUMMARY

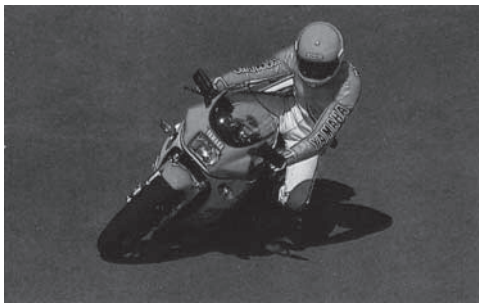
This engine has been developed for the new Yamaha Sports RZV500R (RD500LC), following the layout of the GP-winning YZR500. It adopts a liquid-cooled 2-stroke V-4 design with the YPVS linked Autolube system.

BACKGROUD

At a time when racer technology is getting more attention as an important base for the development of high performance supersports bikes, the '84 RZV500R (RD500LC) has made its debut as the ultimate 2-stroke road machine that features all of Yamaha's long accumulated 2-stroke technology.
The RZV500R (RD500LC) is part of a powerful RZ trio including the RZ250RR and RZ350RR.

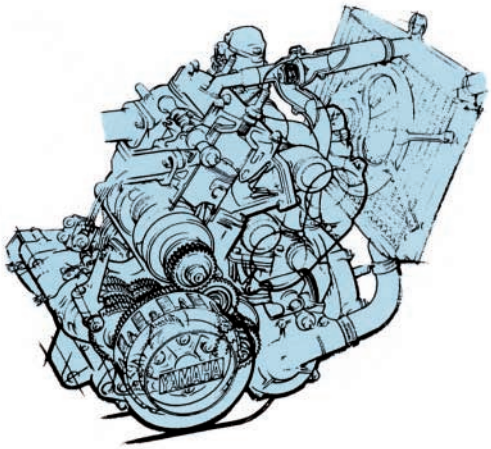
CONSTRUCTION

It is designed as a true replica of the YZR500 with which Kenny Roberts won six Grand Prix rounds in the 1983 World Championship series.
On this model, however, a piston reed valve intake system has been adopted for the front cylinders and a crankcase reed valve intake system for the rear cylinders, while the YZR500 features a rotary disc valve intake system. This provides the best possible match to the power development characteristics of this high performance supersports model.
The two banks of cylinders are set at the narrowest feasible angle (50 degrees) and in this V bank four cable-controlled carburetors are neatly arranged to make the unit as compact as possible.



Another important part of this engine's performance potential comes from the Yamaha Power Valve System (YPVS) used in the exhaust system.
This system, along with the proven function of the electronic governor type CDI system, helps to ensure smooth power development characteristics over the entire speed range.
The newly designed 6-speed transmission is pressure-lubricated.

RZV500R 2-stroke V-4 engine



COMPUTERIZED STRUCTURE ANALYSIS

The strength and rigidity of chassis and individual component parts are analyzed by means of a computer. This computerized method applies also to vibration analysis and stress analysis against external force, helping to improve product quality.

Engine noise level test

In this test room mechanical noise and exhaust noise are thoroughly examined under various simulated riding conditions in order to build a quiet engine.

YAMAHA MOTORCYCLE TECHNICAL GUIDE

OHV Engine —First Yamaha sports OHV engine

Reduced engine height enables low-angle chassis design. Adopted on '99 model "XV1600 Road Star."

Summary of the Mechanism

OHV is an abbreviation for "Overhead Valve" and is a type of intake/exhaust valve drive system. The side valve format that has been used on conventional motorcycles has the disadvantage of making it difficult to achieve an ideal combustion chamber shape. This system was designed to solve that problem by positioning the valves on top of the combustion camber (head) and driving them by means of a push rod and locker arm driven via a camshaft positioned beside the crank shaft, thus enabling a more efficient combustion chamber shape.

Development Aim

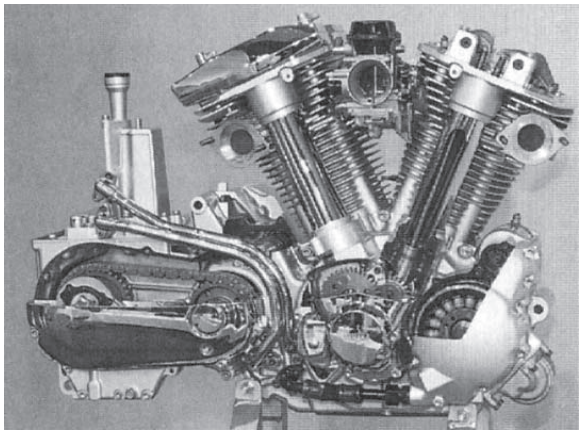
The adoption of an OHV engine on the "XV1600 Road Star" enables a lower engine height and thus a design with a lower profile chassis. Also, the OHV engine has an advantage in cooling characteristics. At the same time, because this was a large displacement engine and a high rpm was not necessary to get good power out-put, it was not necessary to use OHC to get the desired engine performance.

Structure and Function

A push rod and locker arm are used to drive the intake/exhaust valves. The mechanism involves a cam shaft located next to the crank shaft that drives the push rod up and down, which in turn works a locker arm that opens and closes the valves.

Effect

There is no need for camshafts to be located on top of the cylinder head and also no need for a cam chain, thus enabling a more compact design for the head area. Also, even if the engine is given a long stroke ratio, it can still be designed with a lower profile than an SOHC engine. What's more, the push rod cover becomes an extra accent point for the engine exterior.



One-piece Plated Cylinder and Crankcase

A plated cylinder in a single-unit with crankcase made possible by rapid plating technology. Adopted on YZF-R1 and other models.

Summary of the Mechanism

A plated cylinder is one that eliminates the conventional steel cylinder sleeve and replaces it with a coating of a ceramic base cornposite plating material in order to improve cooling characteristics and reliability. Although there are existing techniques for plating the cylinder surface separately, the Yamaha "Rapid Plating Technology" used on the TZR engines makes it possible to plate only the necessary portion (cylinder sleeve surface area) on a singleunit crankcase and cylinder block. This is a technology that has been fed back fromYamaha's manufacturing technology used on automobile engines built for Ford.

Development Aim

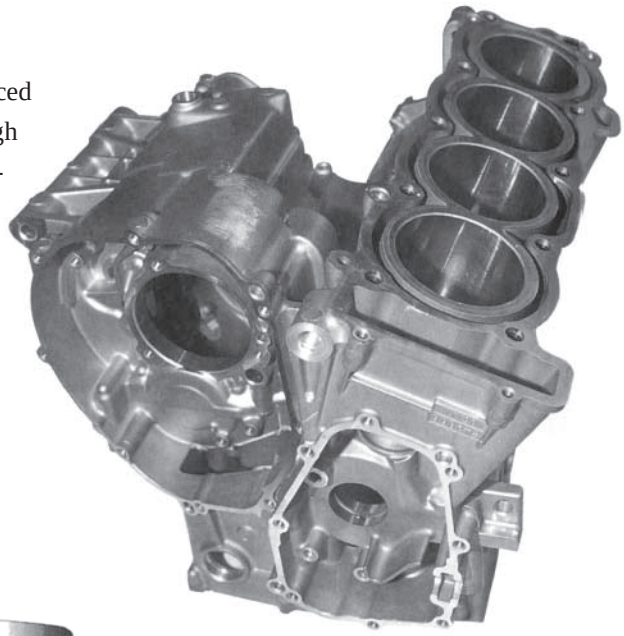
The engine developed for the first YZF-R1 model achieved a 10kg weight reduction and 81mm longitudinal length reduction compared to the existing engine, and one of the features that made this high-performance engine design possible was this single-unit crankcase-cylinder block.

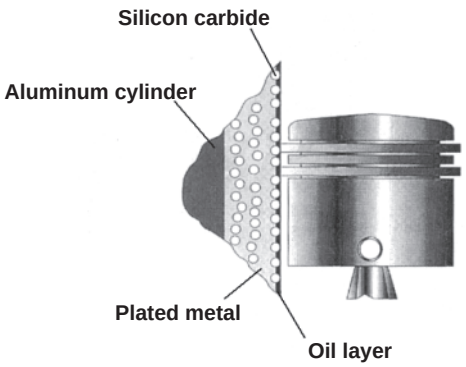
Structure and Function

The formation of a thin film of oil between the piston rings and the Ni (P) metal imbedded with hard silicon carbide particles produces outstanding sliding efficiency. And, since aluminum with the same heat expansion rate can be used for the opposing faces of the piston and cylinder, there is minimum heat-induced change in the gap between the piston and cylinder as well as better cooling characteristics, thus resulting in more stable performance. As a result it also produces excellent oil economy.

Effect

The effects of this construction include: (1) reduced weight, (2) excellent strength to support a high compression ratio. (3) excellent cooling performance, (4) improved abrasion resistance and (5) excellent oil economy.





Carbrized connecting rods —Carbrization Processing Technology

A carbrization processing technology (high-strength heat treatment technology) that enables construction of super lightweight, high performance engines. Adopted on YZF-R1 and other models.

Summary of the Mechanism

Carbrization processing is a manufacturing technology for metal surface hardening in which the surface of steel is permeated with carbon. This is a unique technology that makes it possible to harden the desired surface areas to the desired permeation depth.

Development Aim

Metal surfaces that touch or rub against each other demand a high level of hardness to prevent abrasion. However, there is the problem that hard means brittle as well and, thus, easy to break. This presents the need for metal material that is hard on the surface but retains its tensile strength on the inside. The steel used in engine parts like connecting rods has good inherent tensile strength and can also be hardened with the addition of carbon.

This Carbrization Processing Technology is a metal-material production technology that makes use of the fact that adding carbon only to the surface and then rapidly cooling it can produce metal material that is hardened only on the surface.

Structure and Function

The basic work process for this production technology involves placing the entire metal material in an oven and heating it to a temperature of about 900 degrees centigrade. After that, carbon is made to permeate the surface. Then, using a special oil and water, the material is rapidly cooled to make the iron crystals harder. In this Yamaha technology factors like the temperature to which the material is heated, the length of the heating time and the concentration of carbon introduced are all minutely controlled according to the type of material being processed in order to produce the high level of hardness demanded.

Effect

The numerous merits of processing materials with this technique include the ability to achieve high rpm and high power output while maintaining excellent reliability and enabling lightweight, compact design.

Exhaust Ultimate Power Valve —EXUP

A variable valve system that eliminates "valleys" in the torque development curve in 4-stroke engines. With continual improvement since the first adoption on the '87 model FZR400R, the latest version is used on the YZF-R1.

Summary of the Mechanism

This is a system that employs a variable EXUP valve in the muffler that can change the configuration of the exhaust duct in a way that controls fluctuations in exhaust pressure at the moments of overlap between the intake and exhaust valves in order to improve intake efficiency, boost power output and improve fuel economy. It can also be called a technology that applies the 2-stroke YPVS function to a 4-stroke engine. It was first adopted on the '87 model FZR400R, since which constant improvements have been added. The EXUP adopted on the YZF-R1 has evolved to the point where input on five different parameters are used to regulate the controller.

Development Aim

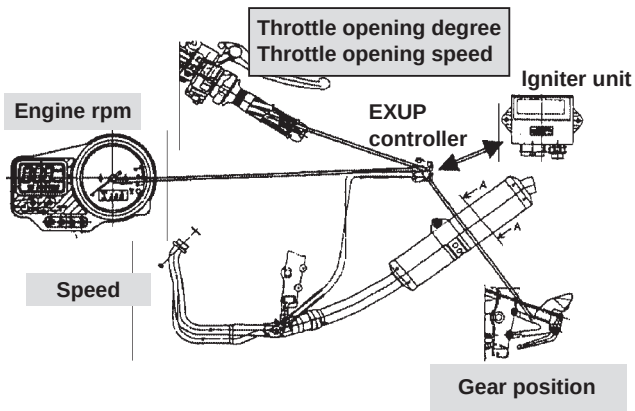
In this system a variable EXUP valve is placed in the muffler that functions in accordance with engine rpm to control the reflection wave cycle in the muffler. It was developed to help optimize the exhaust flow in the exhaust valve area in a way that makes the exhaust as well as the intake function more efficient and reduces power loss due to the "blow-back" phenomenon. It is a device that in effect creates an adjustable valve that changes the cross-section shape of the interior of the muffler depending on engine rpm to improve performance.

Structure and Function

In order to achieve greater accuracy, the system on the YZF-R1 functions on readings of five parameters: (1) engine rpm, (2) speed, (3) degree of throttle opening, (4) speed of throttle motion and (5) gear position. This information is processed by the control unit and, while also being relayed to the ignitor unit so it optimizes the ignition timing, the information is used to operate the EXUP valve to regulate the exhaust pressure wave and in that way improve intake efficiency. This helps achieve optimum response over a wide rpm range from low to high speeds.

Elffect

1) Realizes elimination of low torque in certain rpm ranges and smooth acceleration all the way up to high speed.
2) Improved actual fuel economy.
3) Improved low-speed range combustion for (1) more stable idling, (2) less idling noise and reduced HC levels in the exhaust.



Forged Aluminum Piston —Controlled Forging Technology

A technology for forged aluminum pistons and their mass production that enables lightweight design. First adopted on the '96 model YZF1000 ThunderAce. Used since on large-displacement sports models from the YZF-R series to the Road Star.

Summary

This is an aluminum piston forging technology and its mass production method that involves heating aluminum alloy to a set temperature and putting it in a temperature-controlled metal mold and forging it under pressure into the piston shape. This forged aluminum piston technology is characterized by the fact that it can make use of strong aluminum alloy material which does not have to be heated until it melts so that it maintains its original even solidification matrix. This makes possible a thinner-walled piston design, thus reducing the piston's reciprocating inertial weight. The primary merit is that a stronger aluminum alloys can be used in the forging process.

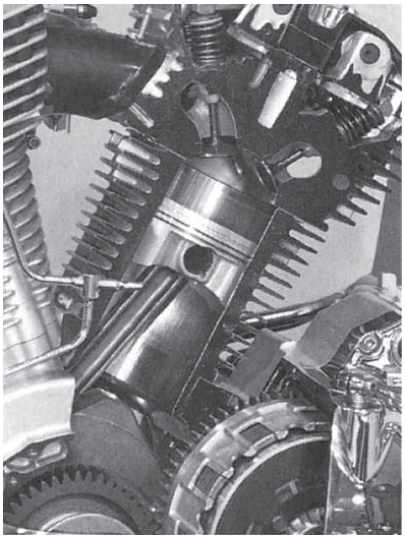
What's more, the "Controlled Forging Technology" used for mass production involves comprehensive control of (1) optimum heating of the aluminum alloy, (2) the temperature of the metal mold, (3) optimum use of the mold freeing agent and (4) control of the pressure applied. In this way it is possible to achieve mass production of aluminum forged pistons that until now had proved difficult.

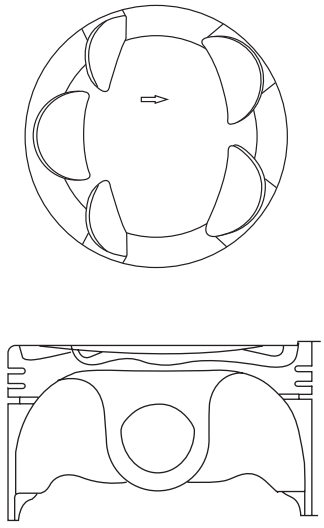
Summary of the mass production technology

A program was developed by which the aluminum alloy is heated to a specified temperature, inserted into the mold with the best timing and forged with just the right amount of pressure. This is called our "Controlled Forging Technology".

Effect

1) Design of thinner-walled pistons due to the use of stronger aluminum alloys, 2) reduction of reci-procating inertial weight due to the piston's lighter weight, and 3) improved piston durability and reliability.





Traction Control System

A system that creates more positive rear tire traction by controlling ignition timing based on changes in engine rpm. First adopted on the Lanza.

Summary of the Mechanism

This system anticipates rear wheel revolution conditions based on changes in engine rpm and makes calculations based on this data and converts it to control signals that cause compensations in the ignition timing to reduce drive power loss from the rear wheel. At times of rear wheel spin due to such factors as sudden changes in the road surface, this system can take that information and effect changes in the ignition timing, and thus engine rpm, in order to help produce optimum traction.

Development Aim

The aim was to achieve a high-level integration of the goals of (1) achieving performance that makes for more enjoyable off-road ridiing, (2) pursuit of the special feeling of rear wheel slippage that can only be enjoyed in off-road riding, (3) a function that enables delicate throttle operation on poor road surfaces, (4) attaining optimum traction to match changing road conditions, and (5) a “traction control” function operation that the rider isn’t even aware of.

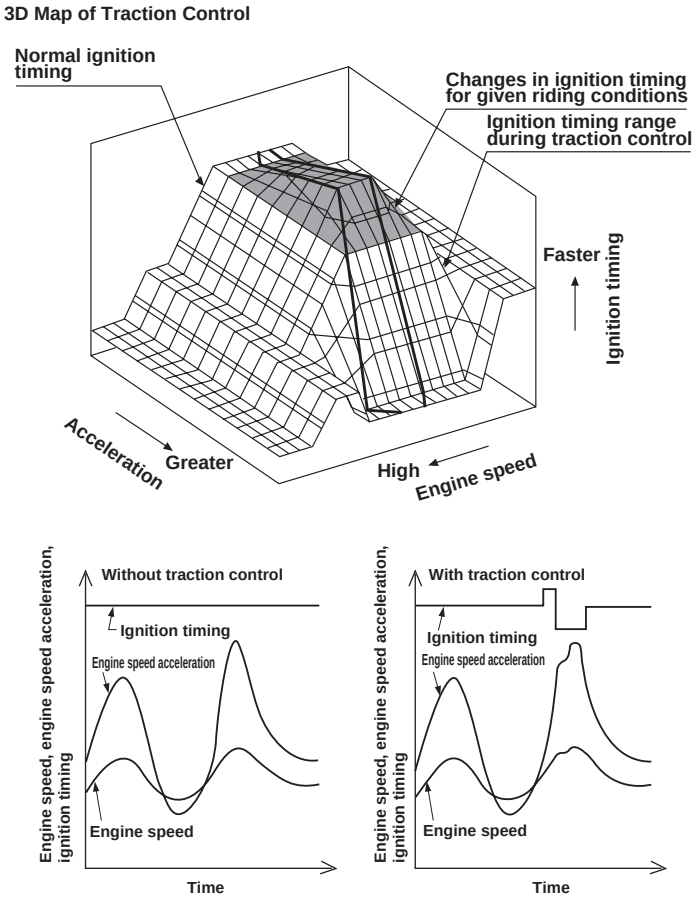
Structure and Function

An 8-bit microcomputer is used to calculate acceleration from changes in the engine rpm and use this calculation to detect rear wheel spinning. Furthermore, using a 3-D map of engine rpm and acceleration to regulate ignition timing, the system helps opti-mize rear wheel traction.

Effect

Effects include: (1) effective use of tire performance potential, (2) excellent rear tire controllability, (3) running stability when acceler-ating on poor road surfaces, (4) greater freedom of line choice during cornering, and (5) less fatigue in continuous riding.

Because this system achieves its function without adding any additional mechanisms but working through the existing systems, it can be adopted with little cost and no significant weight increase.



270-degree Crank Parallel Twin

A small parallel twin engine that lets you enjoy both power and pulse with irregular-interval combustion. Adopted on the "TRX850" and "TDM850".

Summary of the Mechanism

V-twin engines are known to have such disadvantages as long front-aft length and greater weight. The Yamaha-conceived 270-degree Crank Parallel Twin can be thought of as a revolutionary power unit that inherits the "Genesis concept" of a "forward inclined low-center-of-gravity engine" while at the same time satisfying the demand for a motorcycle power unit to be "lightweight, slim and compact."
This also represents feedback technology from Paris-Dakar factory machine research and development.

Development Aim

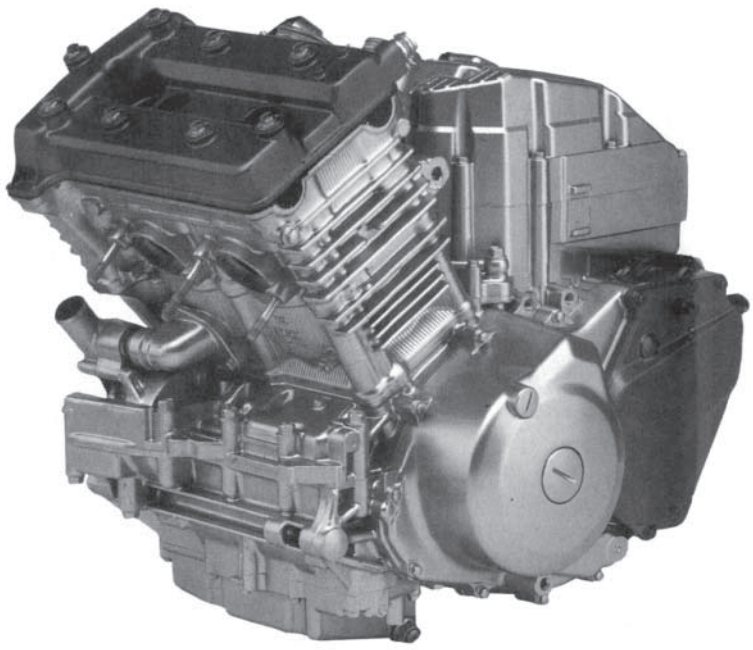
This engine was developed for the "TRX850", a model conceived as a new European big-twin sports bike. Research and development was carried out under the concept of an "Exciting Big Twin". Later it was also adopted on the "TDM850".

Structure and Function

Usually, a parallel twin 4-stroke engine uses either a 180 or a 360 degree crank moment, but the parallel twin developed for the TRX850 adopted a 90-degree phase for the crank shaft to create a unique 270-degree crank parallel twin (world's first). As a result, the combustions of 270-degree and 450-degree are repeated. The resulting compact design realized both outstanding handling and running performance plus the pulse of a V-twin.

Effect

This engine produced a number of advantages, including outstanding running performance and the feeling of solid pulse, plus the agility and handling worthy of the development concept of an "Exciting Big Twin".



Triple YPVS —Triple Yamaha Power Valve System

An exhaust valve system to improve low to middle speed power development in a high power 2-stroke engine. First adopted on the '95 "TZR250SPR". A new 2-way control "YPVS" system for even more precise valve control is adopted on the '99 "YZ250".

Summary of the Mechanism

A technology born of experimental research in the race arena, it was first adopted on a production model with the release of the 1980 model TZ500 production road racer. The mechanism consists of a variable valve that controls exhaust timing to achieve efficient timing across the rpm range from low to high speeds to achieve improved power output. The "Triple YPVS" introduced in 1994 is a further development of the basic YPVS mechanism that adopts auxiliary ports to the right and left of the cylinder and auxiliary valves in a total of three locations (the original YPVS has one) .

Development Aim

The timing of the intake, scavenging and exhaust ports is an important element in determining the character of a 2-stroke engine. Among these, the general rule with the exhaust timing is that the faster the timing the more the engine will be characterized by high speed and high power, while a slower exhaust timing will produce a tendency toward lower speed and greater torque. But, even for a racer or high-performance sports bike for which high speed is important, there is also a need for torque at times like when accelerating out of a turn. This system was developed with the aim of satisfying both of these demands.

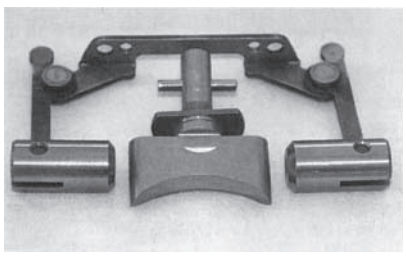
Structure and Function

On the outside of the upper portion of the cylinder's exhaust port is positioned a valve that when rotated will open and close the upper portion of the exhaust port. This serves to control the exhaust timing. It functions by means of a motor that rotates the valve to the desired angle in response to a signal calculated by a microcomputer from readings of the engine rpm.

In the case of the "Triple YPVS", in addition to the original valve there are auxiliary valves on each of the two auxiliary ports on either side of the cylinder to give even more precise exhaust control. Also, the valve control function is now a two-way type based on the two parameters of engine rpm and the degree of throttle opening. This mechanism reduces blow-by in the low to middle speed range, resulting in increased power and torque across this range. In this way the advanced two-way-control "Triple YPVS" achieves more precise valve control.

Effect

A 15% boost in performance in the low to middle speed range and a 10% improvement in running fuel economy (Yamaha comparison) is realized. (On the '94 "TZR250R SP")



YCLS —Yamaha Computerized Lubrication System

A system to reduce engine oil consumption in 2-strokes. Adopted on models like the "GEAR", "LANZA" and "TZR250SPR".

Summary of the Mechanism

This is a system that injects oil into the engine in amounts regulated by means of a microcomputer, and also returns excess oil to the oil tank. This makes possible a reduction in oil consumption and exhaust smoke. In short, it can be considered an oil pump version of fuel injection.

Development Aim

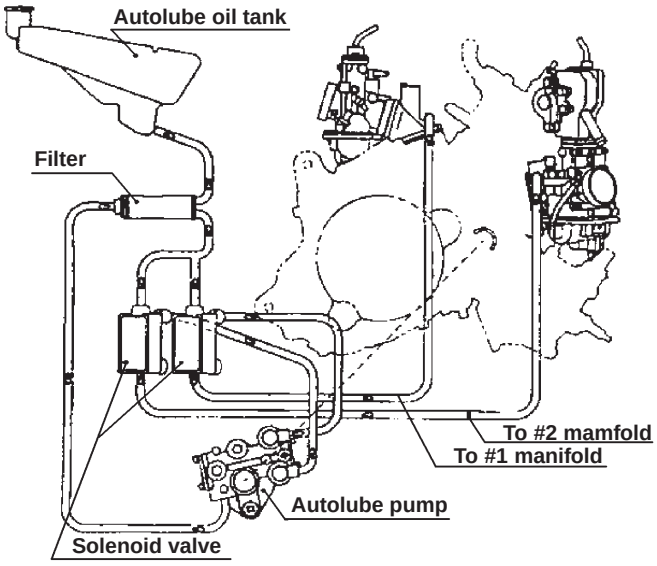
Generally, the maximum stroke on a 2-stroke engine oil pump is set to correspond with the full-open position of the throttle. For this reason it is difficult to accurately control oil supply in the low rpm range on a high-speed type 2-stroke engine. This technology was developed to solve this problem.

Structure and Function

Making use of mapped microcomputer control, readings of engine rpm and degree of throttle opening are used to calculate the right amount of oil to be injected into the engine, with injection being regulated by means of a solenoid valve based on these calculations. What is regulated is the amount of oil injected (injection time length) for each combustion cycle. Also, the system includes a mechanism for returning excess oil to the oil tank.

Effect

This system makes it possible to prevent incomplete burning of the oil when staring up or when running at low speeds and reduce overall oil consumption and exhaust smoke.



5-Valve DOHC Engine

An innovative Yamaha valve system that breaks through the conventions of high-power 4-stroke engines. From the "YZF-R1" to the "YZ400F", adopted not only on 4-cylinder models, but 2-cylinder and single-cylinder models as it matured.

Summary of the Mechanism

Going beyond the common concept of two intake and two exhaust valves per cylinder, this engine design adds a third intake valve to the combustion chamber. By boosting the engine's own intake efficiency, while at the same time creating a compact lens-shaped combustion chamber, this design achieves both high power and low fuel consumption.

Development Aim

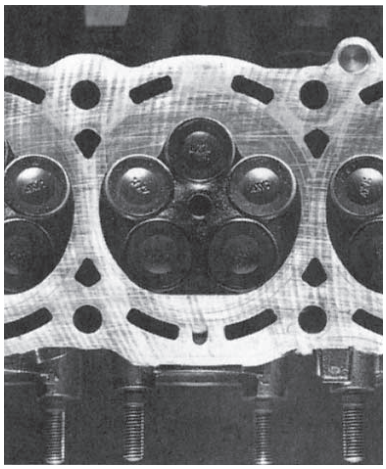
A lightweight, compact high-power engine is an important element in determining the handling characteristics and steering stability of a motorcycle. At the same time, the concerns of society call for outstanding fuel economy. This engine was developed to meet both the demand for a lightweight, compact, high-performance engine and for an engine with low fuel consumption. The aim was to see just how far the inherent potential of the engine itself could be developed. The addition of the fifth valve increased intake/exhaust efficiency, while at the same time optimum positioning of the valves enabled a compact combustion chamber design and thus produced high combustion efficiency.

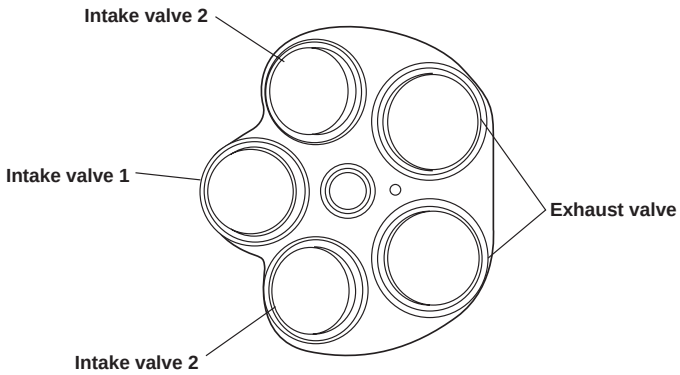
Structure and Function

The combined effect of (1) the increased intake valve surface area with the addition of the 3rd intake valve, (2) the high compression ratio made possible by the compact combustion chamber design achieved with the 5-valve layout, and (3) reduction of the weight of each valve, produces a high-power output plus good fuel economy. The 5-valve DOHC engine adopted on the FZ750 had a total of 20 valves on its four cylin-ders driven directly from camshafts by means of direct lifters to achieve outstanding reliability in the high-speed range.

Effect

(1) Improved power output, (2) improved fuel economy, (3) a compact cylinder head design made possible by a unique layout, and (4) improved power and torque over a wide rpm range make this an extremely easy-to-use engine.





Hair-pin Catalyzer

Yamaha's exclusive hair-pin shaped catalyzer. Adopted on the new Majesty that debuted in Oct., '99.

Summary of the Mechanism

This is an exhaust cleaning system adopted on 4-stroke scooters (Majesty) to meet emissions standards and it works to further clean the exhaust that has already had its emissions levels reduced by the Yamaha air injection system (secondary air induction system).

Development Aim

With 4-stroke engines, the concern today is to reduce levels of toxic emissions including CO, HC and NOx. This system was developed to be an ernissions cleaning system with a simple construction that doesn't sacrifice the desired motorcycle engine qualities of lightweight, compactness and good response.

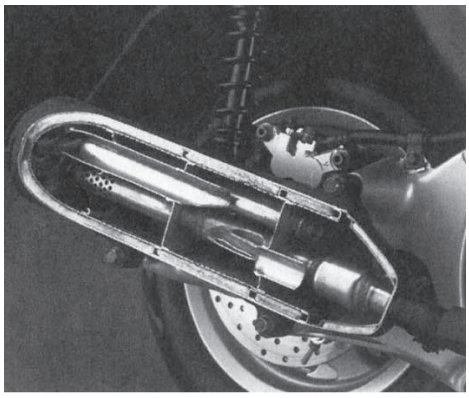
Structure and Function

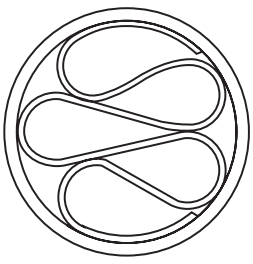
First of all, the exhaust is cleaned by means of a secondary air induction system. This system includes a pipe that introduces fresh air from the air cleaner to a point next to the exhaust valve where it mixes with the exhaust and enables a re-burn in the exhaust duct to clean it of CO and HC. Then, to further clean the exhaust, a catalyzer is positioned in the muffler.

This hair-pin catalyzer is one that is literally given a sharp bend, like a hair-pin. This sharp curve increases the contact between the exhaust gas and the catalytic surface for more effective exhaust cleaning. Its design also makes it lighter in weight. The catalytic surface is coated with platinum and rhodium that clean CO and HC from the exhaust that passes along it.

Effect

On the new Majesty this system produces an outstanding cleaning effect that brings emissions below the present regulatory standards by over 50% for CO, over 80% for HC and over 30% for NOx.





Exhaust cleaning system for 2-stroke engines

Combining a Yamaha-original Catalyst Tube (tapered catalyzer) and compensator. Adopted on '99 scooter models.

Summary of the Mechanism

This exhaust cleaning system for 2-stroke scooters consists of: (1) a carburetor with compensator function and (2) a catalyzer with tapered catalyst tube.

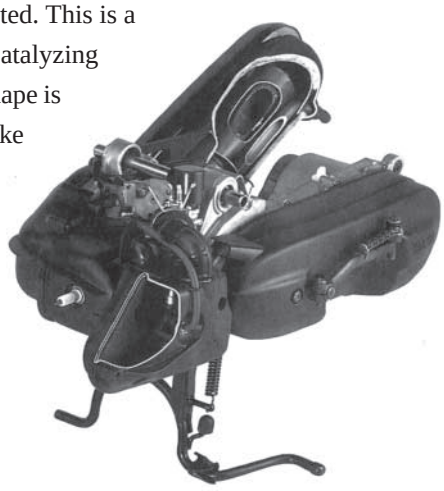
Development Aim

Two-stroke engines are characterized by high power output, high rpm and sharp response as well as their lightweight, slimness and compactness. These qualities are the key to a motorcycle's sprightly and enjoyable running performance. This environment-friendly technology was developed to preserve and advance these qualities while cleaning the engine exhaust.

Structure and Function

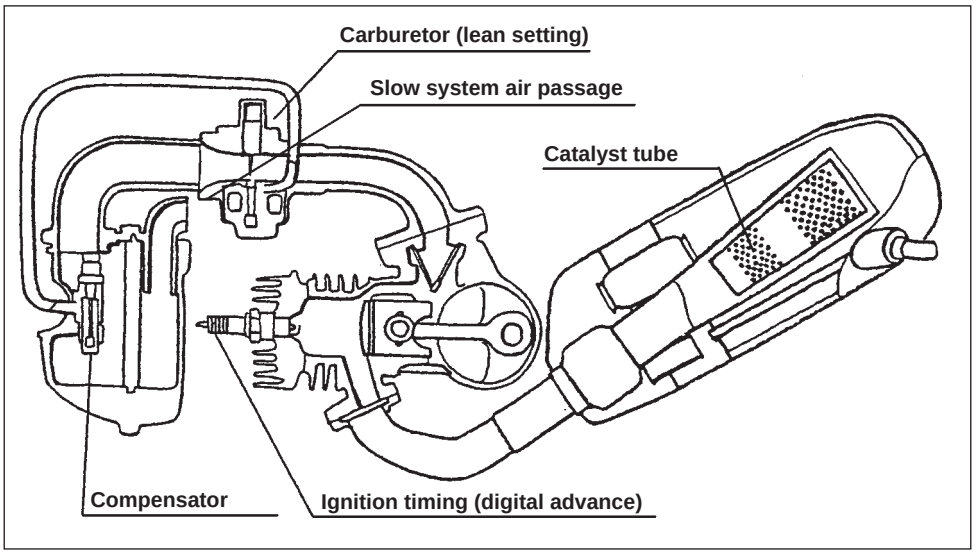
First of all, a compensator that senses intake air temperature and adjusts the intake volume accordingly is adopted. This achieves a lean-setting character for the air-gas mixture once the engine is running. Furthermore, this combines with the digital ignition advance function to produce cleaner exhaust and better combustion performance.

Next, a catalyzer with a new type of "catalyst tube" was adopted. This is a design specially created for 2-stroke engines that features a catalyzing element in a tapered tube inside the defuser. (A tapered tube shape is adopted to prevent detrimental effect on the characteristic 2-stroke function of utilizing the reflection wave in the muffler to heighten power output.)

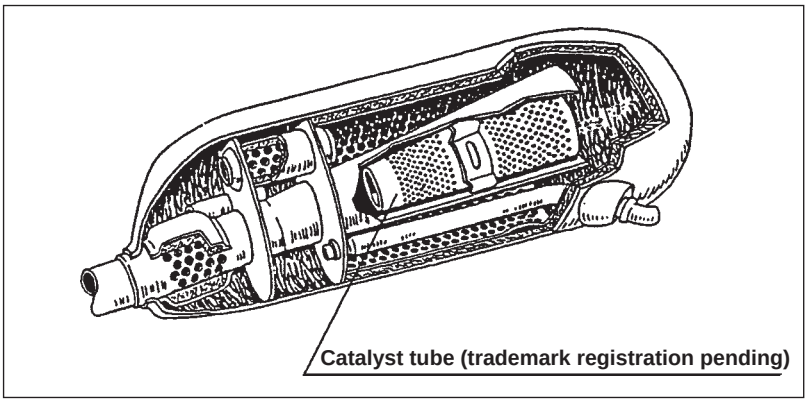


Effect

A rated fuel economy (@30km/h) improvement of 25% (48km/L (60km/L) is achieved. At the same time CO in the exhaust is reduced by more than half and HC by more than one third.



Construction of the Muffler



3-Way Catalyser + Electronic-controlled Direct Fuel Injection System

An exhaust cleaning system for 4-strokes. First adopted on the '93 European model "GTS1000/A".

Summary of the Mechanism

This 3-Way Catalyser is part of a system that functions with electronic-control fuel injection to reduce levels of toxic elements in the exhaust. It can reduce levels of HC, CO and NOx.

Development Aim

This catalyzer was developed as a means to achieve maximum exhaust cleaning function while maintaining a balance with product character.

Structure and Function

The surface of a monolith type 3-way catalyzer in a stainless steel tube 60mm in length and 90mm in diameter in the muffler is coated with the precious metals platinum, palladium and rhodium. As the exhaust flows through a fine honeycombed passage the platinum and palladium oxidize the hydrocarbons and carbon monoxide, while the rhodium reduces NOx to its elements to clean the exhaust.

In order for this catalyzer to function sufficiently, it is necessary for air and fuel to be supplied to the engine in a mixture with the proper ratios.

This optimum ratio for catalyzer functioning is 1 unit of fuel to 14.5 units of air, and is signified by the Greek letter λ. A λ sensor (oxygen sensor) is placed in the silencer (muffler) to monitor remaining oxygen concentration in the exhaust as a basis for controlling the air-fuel mixture ratio in a system that utilizes electronically controlled fuel injection.

Belt Drive System

Yamaha's first belt drive system achieves both outstanding running performance and "change-ability". Adopted on the '99 model XV1600 Road Star.

Summary of the Mechanism

This is a drive system that uses a "cogged belt" to transmit power from the drive axle to the rear wheel. In a function usually performed by a chain or shaft drive, Yamaha introduced a belt drive system on the Road Star that both answers the call from users for greater "change-ability" to allow them to customize their bikes, and also provides outstanding running performance.

Development Aim

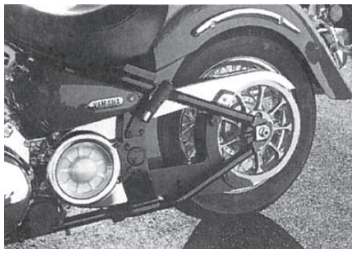
Up until now, Yamaha has fitted its large-displacement cruiser models with reliable, maintenance-free shaft drive systems in order to achieve the both "change-ability" and low-maintenance, the decision was made to adopt Yamaha's first belt drive system.

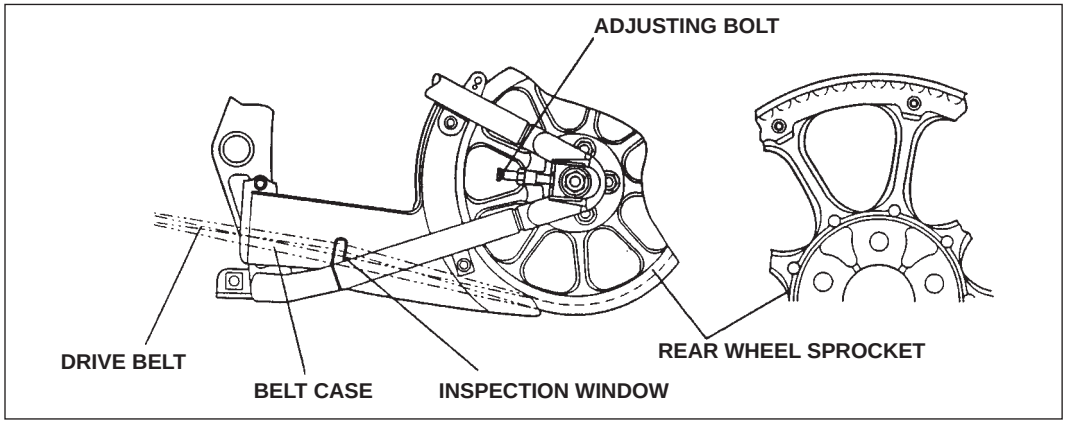
Structure and Function

The basic structure is the same as for chain drive, but with a pulley replacing the sprocket and the chain replaced by a belt. The operating principle is also the same as chain drive, but there is no need for the kind of slack adjustment necessary with a chain. And, since there is always tension applied, a feeling of more direct drive force application is achieved. Also, the pulley and the belt cover assembly offer the owner additional opportunities to enjoy customizing their bike.

Effect

Since there is always tension applied by the belt from when the bike is at rest until it gets in motion, there is a feeling of more direct power application.
When accelerating there is no time lag between throttle action and wheel drive, meaning sharper response.
It is a low-maintenance, low noise system.





Deltabox II Frame

A new frame that takes the Aluminum Deltabox Frame concept to a new level. Adopted on the "YZF-R" series models.

Summary of the Mechanism

This new frame represents a further development of the aluminum Deltabox frame concept of a light-weight, high rigidity frame that achieves outstanding chassis characteristics with sufficient rigidity secured at crucial points like the steering head pipe and the pivot axis. By means of a more concentrated layout of the various frame parts and active use of the engine as a stressed member of the structure, lighter weight and even more suitable rigidity have been achieved.

Development Aim

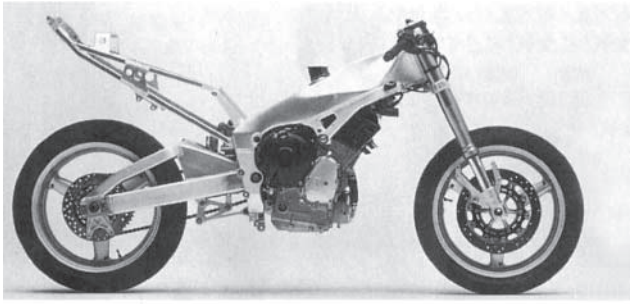
This frame was developed as the foundation for a new generation of supersport models. In the development, chassis technologies were fed back from the World GP competitor YZR500. The long rear arm that is the pride of the Deltabox II Frame and Yamaha's GP machines is an important feature contributing to these machines' outstanding handling performance.

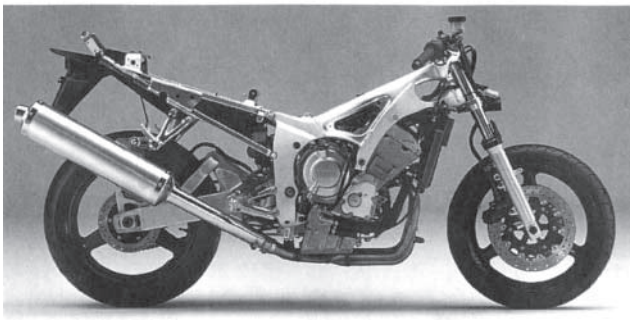
Structure and Function

Although the frames adopted on the 600cc YZF-R6, the 750cc YZF-R7 and the 1,000cc YZF-R1 all carry the Deltabox II name, there are detail differences in all three.

For the R1 frame, the point was to develop a frame that lets the rider experience "the fun of handling a big 1,000cc engine", with emphasis not only on rigidity but overall balance.

The R6 frame is developed primarily with concern for race potential and is characterized primarily by the high rigidity that enables sharp, nimble handling. For this purpose, the device of variable thickness in the cast aluminum alloy material used in the frame parts is adopted. Thus, greater thickness is given to the points where particular rigidity is necessary while other sections are thinned down as far as possible in the same type of principle seen in the evolution of animal bone structures. Also, since this model adopts an intake system that makes optimum use of wind pressure when running to provide intake pressure for the 120ps engine, the frame is designed around the optimurn positioning of the air intake portal and ducts. In this sense it is also an induction-specialized frame. Meanwhile, the R7 frame is also developed with top priority on potential in racing competition like Superbike and thus features vari-ous technologies fed back from Yamaha GP machines and the World Superbike machines.





Effect

It realizes excellent handling and nimble steering performance.

ABS

A system that automatically controls against slipping in the direction of travel during braking. Designed as a compact version of the proven ABS system used on the FJ1200A and GTS1000A, this system was adopted on the 1998 "Majesty ABS".

Summary of the Mechanism

This is a mechanism that uses instantaneous ECU calculations of rotation information sent frorn sensors on the front and rear wheels to precisely control against wheel lock by regulating the brakes' hydraulic systems.

Development Aim

This is a brake system that has been developed to control against wheel lock under a variety of road surface conditions in order to bring out the full performance potential of the tires. Adopting two separate electronic control systems for the front and rear brakes, this ABS system has been used by Yamaha in the past on export models like the "FJ1200A" and "GTS1000A", but in 1998 a new ABS unit with a more compact design and lighter weight was developed to mount on the 250cc scooter "Majesty ABS".
To achieve outstand-ing reliability, a twin CPU format was adopted in the ECU to add a self-diagnosis function.

Structure and Function

With separate hydraulic control units for the front and rear brakes, this system employs information gathered by front and rear wheel sensors to make instantaneous calculations about the speed and acceleration and possible slippage for each of the wheels and when predetermined values regarding slip and deceleration that indicate a locking tendency in the brakes, the ECU sends a signal to the hydraulic pressure control unit. Based on the signal from the ECU, the hydraulic pressure control unit functions to reduce pressure when there is a locking tendency and then apply pressure again at a suitable rate when the lock tendency is relieved. Repeated functioning of this mechanism makes it possible to achieve control that can prevent wheel lock.
In order to ensure that the system does not negatively effect the rider's driving feeling when the ABS system is not engaged, separate front and rear pressure control units are adopted.
The system is designed so that when the lock tendency is approaching the limit of vehicle control the rider feels a repulse action in the brake lever or pedal to let him/her know that the ABS function is at work.

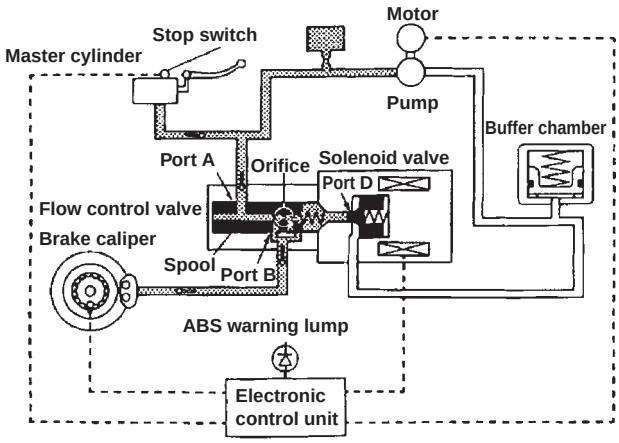
Features

1) When sudden braking is necessary in straight forward motion on a variety of road and weather conditions, the system functions precisely to control against wheel lock and bring out the inherent performance potential of the tires. Also, to achieve greater reliability, a twin CPU format was adopted in the ECU to add a self-diagnosis function.

2) Because the system features separate front and rear control units, a natural braking operation occurs during normal braking. And, when the ABS function is activated still produces a smooth braking action. There is minimum unevenness in front-rear motion and the driving feeling of the rider is not compromised. What's more, the system is designed so that the rider feels a repulse action in the brake lever or pedal to let him/her know that the ABS function has goes to work.

3) Because of the lightweight, compact design of the hydraulic unit that is the core of the system, weighs only 2.2kg (*Majesty ABS) .

* ABS refers to a system that controls the pressure applied to the brake pad based on readings of the locking tendency during wheel lock. It is not a system that prevents wheel lock due to engine brake effect. Also, as with a vehicle with conventional brakes, side force is reduced during braking. Therefore, sudden braking during turns endangers the stability of the vehicle regardless of whether it has ABS or not and must be avoided at all times.



Truss Frame

A frame that utilizes the inherent material qualities of steel to achieve outstanding rigidity that produces high-level running performance. Adopted on the "TRX850".

Summary of the Mechanism

This is a frame that uses steel tubing for the main structural members of the frame such as the tank rail, the down-tube and the seat rail in an overall truss design that provides outstanding rigidity. The result is a highly rigid chassis.

Development Aim

This frame was developed to provide outstanding handling stability on the "TRX850", a model with a design concept of an "Exciting Big Twin". The development utilized Yamaha's unique rigidity analysis system.

Effect

1) Realized an optimum balance of torsional rigidity, longitudinal rigidity and lateral rigidity.
2) Achieved an overall nimbleness in the machine's running performance.
3) Realized easy handling characteristics in a variety of riding conditions.
4) Produced uniquely distinct exterior styling.

YRACS

The introduction of the shock-absorbent material "YRACS" within the urethane interior of the seat achieves both greater sitting comfort and easier leg reach to the ground. Adopted on models including the "XJRI 300".

Summary of the Mechanism

This is a technology that inserted a shock-absorbent material called "YRACS" (pronounced Y-racks) inside the urethane foam interior of the seat to produce the combined benefits of greater sitting comfort and easier leg reach to the ground. Because this material eliminated the rebound force from shocks, the rider maintains a more stable riding posture. And, it provides the additional benefits like excellent absorption of road vibration and a better feeling if fit. The shock-absorbent YRACS material was developed exclusively by Yamaha and its feeling is similar to that of a piece of raw steak.

Development Aim

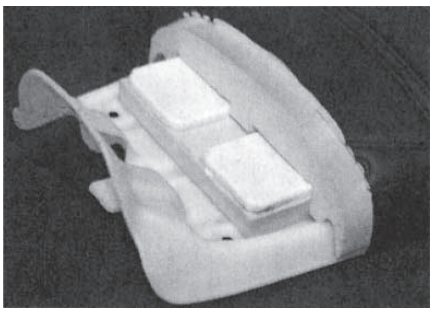
Increasing the thickness of the urethane foam padding in a seat increases the sitting comfort, but at the same time it makes for a longer reach to the ground for the rider's legs. This technology was developed with the aim of overcoming these conflicting qualities by introducing a material that improved sitting comfort without compromising leg reach. The result is an ideal balance of otherwise conflicting qualities.

Structure and Function

A 3-1ayer construction is adopted in which the shock-absorbent "YRACS" material is placed between the seat bottom and the urethane padding. (In the conventional 2-1ayer design the urethane is primarily responsible for absorbing shocks and providing sitting comfort.) In general, a seat has three cushioning functions: the urethane padding provides (1) the feeling of softness and (2) shock absorption while the outer skin functions to (3) support the body. In the YRACS seat, the urethane padding and the outer skin perform their usual functions while the YRACS material layer serves to further heighten the functions of (2) shock absorption and (3) supporting the body.

Effect

1) Because there is less rebound force in response to shocks, the rider maintains a more stable riding posture.
2) The high capacity to absorb vibration and shocks from the road reduces fatigue and increases riding comfort.
3) Because the YRACS material supports the pelvic bone and distributes pressure to the pelvic area better, there is a greater feeling of fit. This also means a better fit during sports riding as well.



Backrest Fitted Seat

Ergonomic design seat with backrest for a more comfortable ride and reduced fatigue in long-distance riding.

Summary of the Mechanism

This seat is the product of research and development efforts aimed at realizing one of the main points of the Majesty's developmental concept: a seat that provided comfortable riding. It is a seat with a backrest designed not only to give good pelvic support but also to be adjustable to the preferences or body size of the rider. While achieving a position of optimum balance between the pelvis and lower backbone, this seat is also designed to distribute pressure over a larger area of the seat and backrest to reduce fatigue in the rider's back muscles. Supporting in this way a relaxed and comfortable seating posture provides a riding experience that is less tiring.

Development Aim

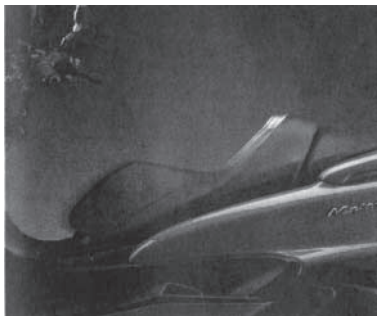
This seat was developed with the aim of reducing both the physical and mental stress of riding. Based on ergonomic principles, the a thorough pursuit was made of design elements that would help maintain a relaxed, comfortable riding posture. The result was a seat that reduced fatigue especially on longer rides.

Structure and Function

A backrest was built into the back end of the main seat where it joined the rear seat with a structure designed to support the rider's pelvic region. This helps prevent the gradual sliding forward on the seat that results from a slouched seating position and maintains an ideal balance between the pelvis and lower backbone during riding. This design enabled a more spacious, relaxed sitting posture while also spreading out over a larger area the sitting pressure that normally tends to be concentrated at the tailbone and hipbone regions, thus reducing stress on the lower back muscles. The backrest also features a slide mechanism that enables adjustment to fit the body size of the rider.

Effect

1) By preventing roll-back of the pelvis due to forward sliding of the buttocks during riding, an ideal balance is maintained between the pelvis and lower backbone that results in a more relaxed, comfortable riding position.
2) The addition of a backrest means that the sitting pressure during riding that normally tends to be concentrated at the is distributed between the seat and backrest. This relieves the concentration of pressure on the tailbone and hipbone regions for greater sitting comfort.
3) The distribution of sitting pressure reduces stress on the lower back muscles.
4) The combined effects of 1) ~ 3) particularly reduces riding fatigue durig longer rides in excess of two hours. (Lower average rider heartbeat.)



“Miracreate Finish” Fuel Tank

First mirror-like reflective gloss finish on a motorcycle fuel tank. Adopted on various models since the ’89 “XV400 Virago”.

Summary of the Mechanism

The name Miracreate is a combination of the words miracle and create. This is the name given to Yamaha’s fuel tank finish technology that achieves a level of reflective gloss close to that of a mirror.

Development Aim

This technology was developed to heighten exterior quality of motorcycles by giving the fuel tank a finish with a mirror-like reflective gloss. This finish was first adopted with the 1989 model change of Yamaha popular American-style model “Virago”.

Structure and Function

This finish is characterized by the fact that its clear outer layer is thicker than on conventional finishes. This high-quality finished is applied to mass production models by means of a unique, highly efficient method.

Effect

The clear coating that forms the outer layer of the finish is more than twice as thick as a conventional finish at 100 microns, adding greater depth and shine to the finish. The reflective gloss value is thus increased 0.6 points (cornpared to previous Yamaha value) to approach that of a mirror and add an impressive touch to the machine’s exterior.

Aluminum Deltabox Frame

High-rigidity aluminum frame helps achieve outstanding handling stability. Adopted first on the '85 model "TZR250". Since then it has been adopted on important supersport models. The further evolved Deltabox II frame now appears on the "R" series models.

Summary of the Mechanism

This frame was developed as a further evolution of the conventional steel pipe double cradle frame to achieve the high rigidity necessary to mount a high-performance engine on a supersport model. Its design was based on technologies garnered from the YZR500 GP competition machines. It is characterized particularly by its light weight and high rigidity made possible by the use of aluminum, enabling a 40% weight reduction compared to a conventional steel pipe frame.

Development Aim

The "TZR250" was developed with the aim of bringing the feeling and riding characteristics of the fabled YZR factory machines to a production model. The Aluminum Deltabox frame was an important design point in realizing this goal.

Structure and Function

The frame adopts a box-shaped cross-section that enables a larger cross-section surface area, lighter weight and high rigidity. Of particular note in the design is the structure by which the steering head and the pivot point are connected in as straight a line as possible and the fact that a special construction technique is used to give a triangular shape (delta) to the side surface to achieve outstanding rigidity. Another exterior characteristic is the added width that is given to the steering head area where particular stress comes to bear during riding.

What's more, practical measures are taken in terms of the materials used in the critical steering head and pivot areas to ensure sufficient performance potential.

Effect

1) Thanks to the weight reduction (a dry weight of 126kg was made possible on the TZR250) outstanding handling was achieved.
2) The lightweight, high-rigidity chassis helped achieve high-level performance in the basis functions of "running, turning and stopping".
3) Outstanding steering stability and nimble handling were also achieved.